Intel® Integrated Performance Primitives for Intel® Architecture

Reference Manual, Volume 4: Cryptography

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-01	Documents Intel® Integrated Performance Primitives (Intel® IPP) 4.0 beta release.	05/ 2003
-02	Documents the Intel® IPP 4.0 gold release.	10/2003
-03	Documents the Intel® IPP 5.0 release with ECC and DL-based functionalities.	03/2005
-04	Documents the Intel® IPP 5.0 gold release.	08/2005
-05	Documents the Intel® IPP 5.1 gold release.	02/2006
-06	Documents the Intel® IPP 5.2 beta release.	09/2006
-07	Documents the Intel® IPP 5.2 gold release.	01/2007
-08	Documents the Intel® IPP 5.3 release. Appendix describing Fortran-90 interface to Intel IPP for cryptography has been added.	09/2007
-09	Documents the Intel® IPP 6.0 beta release. The usage of a safe implementation of the AES algorithm with the Cryptographic primitives has been documented.	02/2008
-10	Documents the Intel® IPP 6.0 gold release. Description of the AES-CCM and AES-GCM functions has been added to chapter 2. Description of the AES-XCBC functions has been added to chapter 4. Description of functions computing the authentication tag for a message without stopping the authentication process has been added for Hash and Keyed Hash Functions.	08/2008
-11	Documents the Intel® IPP 6.1 beta release. Functions implementing RSA schemes defined in version 1.5 of the PKCS#1 standard have been documented in chapter 5.	01/2009
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Contents

Version Information..... 3
Legal Information..... 5

Chapter 1: Overview

Basic Features.....27
About This Software.....28
Hardware and Software Requirements.....28
Platforms Supported.....28
Cross-Architecture Alignment.....28
API Changes in Version 5.0.....29
Technical Support.....29
About This Manual.....30
Manual Organization.....30
Function Descriptions.....31
Audience for This Manual 31
Notational Conventions.....31

Chapter 2: Symmetric Cryptography Primitive Functions

Block Cipher Modes of Operation.....33
DES/TDES Functions.....34
DESGetSize.....36
DESInit.....37
DESEncryptECB.....38
DESDecryptECB.....39
DESEncryptCBC.....40

DESDecryptCBC....41
DESEncryptCFB....42
DESDecryptCFB....43
DESEncryptOFB....44
DESDecryptOFB....45
DESEncryptCTR....46
DESDecryptCTR....47
TDESEncryptECB....48
TDESDecryptECB....49
TDESEncryptCBC....50
TDESDecryptCBC....51
TDESEncryptCFB....52
TDESDecryptCFB....53
TDESEncryptOFB....55
TDESDecryptOFB....56
TDESEncryptCTR....57
TDESDecryptCTR....58
Example of Using DES/TDES Functions....60
Rijndael Functions....61
Rijndael128GetSize....66
Rijndael128Init, SafeRijndael128Init....66
Rijndael128EncryptECB....67
Rijndael128DecryptECB....68
Rijndael128EncryptCBC....69
Rijndael128DecryptCBC....70
Rijndael128EncryptCFB....71
Rijndael128DecryptCFB....72
Rijndael128EncryptOFB....73
Rijndael128DecryptOFB....74
Rijndael128EncryptCTR....75
Rijndael128DecryptCTR....76
Rijndael128EncryptCCM....77

Rijndael128EncryptCCM_u8.....79
Rijndael128DecryptCCM.....80
Rijndael128DecryptCCM_u8.....81
Rijndael192GetSize.....82
Rijndael192Init.....83
Rijndael192EncryptECB.....84
Rijndael192DecryptECB.....85
Rijndael192EncryptCBC.....86
Rijndael192DecryptCBC.....87
Rijndael192EncryptCFB.....88
Rijndael192DecryptCFB.....89
Rijndael192EncryptOFB.....90
Rijndael192DecryptOFB.....91
Rijndael192EncryptCTR.....92
Rijndael192DecryptCTR.....93
Rijndael256GetSize.....94
Rijndael256Init.....94
Rijndael256EncryptECB.....95
Rijndael256DecryptECB.....96
Rijndael256EncryptCBC.....97
Rijndael256DecryptCBC.....98
Rijndael256EncryptCFB.....99
Rijndael256DecryptCFB.....100
Rijndael256EncryptOFB.....101
Rijndael256DecryptOFB.....102
Rijndael256EncryptCTR.....103
Rijndael256DecryptCTR.....104
Example of Using Rijndael Functions.....106
AES-CCM Functions.....108
Rijndael128CCMEncryptMessage.....109
Rijndael128CCMDecryptMessage.....111
Rijndael128CCMGetSize.....112

Rijndael128CCMInit....113
Rijndael128CCMStart....114
Rijndael128CCMEncrypt....115
Rijndael128CCMDecrypt....115
Rijndael128CCMGetTag....116
Rijndael128CCMMessageLen....117
Rijndael128CCMTagLen....118
AES-GCM Functions....119
Rijndael128GCMEncryptMessage....120
Rijndael128GCMDecryptMessage....121
Rijndael128GCMGetSize....122
Rijndael128GCMInit....123
Rijndael128GCMStart....124
Rijndael128GCMEncrypt....125
Rijndael128GCMDecrypt....125
Rijndael128GCMGetTag....126
Blowfish Functions....127
BlowfishGetSize....128
BlowfishInit....129
BlowfishEncryptECB....130
BlowfishDecryptECB....131
BlowfishEncryptCBC....132
BlowfishDecryptCBC....133
BlowfishEncryptCFB....134
BlowfishDecryptCFB....135
BlowfishEncryptOFB....136
BlowfishDecryptOFB....137
BlowfishEncryptCTR....138
BlowfishDecryptCTR....139
Example of Using Blowfish Functions....141
Twofish Functions....143
TwofishGetSize....144

TwofishInit....144
TwofishEncryptECB....145
TwofishDecryptECB....146
TwofishEncryptCBC....147
TwofishDecryptCBC....148
TwofishEncryptCFB....149
TwofishDecryptCFB....150
TwofishEncryptOFB....151
TwofishDecryptOFB....152
TwofishEncryptCTR....153
TwofishDecryptCTR....154
Example of Using Twofish Functions....156
RC5* Functions....158
RC5* Algorithm Functions for 64-bit Block Size....160
ARCFive64GetSize....160
ARCFive64Init....161
ARCFive64EncryptECB....162
ARCFive64DecryptECB....163
ARCFive64EncryptCBC....164
ARCFive64DecryptCBC....165
ARCFive64EncryptCFB....166
ARCFive64DecryptCFB....167
ARCFive64EncryptOFB....168
ARCFive64DecryptOFB....169
ARCFive64EncryptCTR....170
ARCFive64DecryptCTR....171
RC5* Algorithm Functions for 128-bit Block Size....172
ARCFive128GetSize....172
ARCFive128Init....172
ARCFive128EncryptECB....173
ARCFive128DecryptECB....174
ARCFive128EncryptCBC....175

ARCFive128DecryptCBC....176
ARCFive128EncryptCFB....177
ARCFive128DecryptCFB....178
ARCFive128EncryptOFB....179
ARCFive128DecryptOFB....180
ARCFive128EncryptCTR....181
ARCFive128DecryptCTR....182
ARCFour Functions....183
ARCFourGetSize....184
ARCFourCheckKey....185
ARCFourInit....185
ARCFourEncrypt....186
ARCFourDecrypt....187
ARCFourReset....188

Chapter 3: One-Way Hash Primitives

Hash Functions....191
MD5GetSize....192
MD5Init....193
MD5Duplicate....193
MD5Update....194
MD5Final....195
MD5GetTag....195
SHA1GetSize....196
SHA1Init....197
SHA1Duplicate....197
SHA1Update....198
SHA1Final....199
SHA1GetTag....200
SHA224GetSize....200
SHA224Init....201
SHA224Duplicate....202

SHA224Update....202
SHA224Final....203
SHA224GetTag....204
SHA256GetSize....205
SHA256Init....205
SHA256Duplicate....206
SHA256Update....207
SHA256Final....208
SHA256GetTag....208
SHA384GetSize....209
SHA384Init....210
SHA384Duplicate....210
SHA384Update....211
SHA384Final....212
SHA384GetTag....213
SHA512GetSize....213
SHA512Init....214
SHA512Duplicate....215
SHA512Update....215
SHA512Final....216
SHA512GetTag....217
Generalized Hash Functions for Non-Streaming Messages....218
General Definition of a Hash Function....218
MD5MessageDigest....219
SHA1MessageDigest....220
SHA224MessageDigest....223
SHA256MessageDigest....224
SHA384MessageDigest....224
SHA512MessageDigest....225
Mask Generation Functions....226
User’s Implementation of a Mask Generation Function....226
MGF_MD5....227

MGF_SHA1.....228
MGF_SHA224.....229
MGF_SHA256.....229
MGF_SHA384.....230
MGF_SHA512.....231

Chapter 4: Data Authentication Primitive Functions

Message Authentication Functions.....233
Keyed Hash Functions.....233
HMACSHA1GetSize.....237
HMACSHA1Init.....237
HMACSHA1Duplicate.....238
HMACSHA1Update.....239
HMACSHA1Final.....240
HMACSHA1GetTag.....241
HMACSHA1MessageDigest.....241
HMACSHA224GetSize.....242
HMACSHA224Init.....243
HMACSHA224Duplicate.....244
HMACSHA224Update.....244
HMACSHA224Final.....245
HMACSHA224GetTag.....246
HMACSHA224MessageDigest.....247
HMACSHA256GetSize.....248
HMACSHA256Init.....248
HMACSHA256Duplicate.....249
HMACSHA256Update.....250
HMACSHA256Final.....251
HMACSHA256GetTag.....252
HMACSHA256MessageDigest.....252
HMACSHA384GetSize.....254
HMACSHA384Init.....255

HMACSHA384Duplicate....256
HMACSHA384Update....256
HMACSHA384Final....257
HMACSHA384GetTag....258
HMACSHA384MessageDigest....259
HMACSHA512GetSize....260
HMACSHA512Init....260
HMACSHA512Duplicate....261
HMACSHA512Update....262
HMACSHA512Final....263
HMACSHA512GetTag....264
HMACSHA512MessageDigest....264
HMACMD5GetSize....265
HMACMD5Init....266
HMACMD5Duplicate....267
HMACMD5Update....267
HMACMD5Final....268
HMACMD5GetTag....269
HMACMD5MessageDigest....270
CMAC Functions....271
CMACRijndael128GetSize....272
CMACRijndael128Init, CMACSafeRijndael128Init....273
CMACRijndael128Update....274
CMACRijndael128Final....275
CMACRijndael128MessageDigest....275
AES-XCBC Functions....276
XCBCRijndael128GetSize....277
XCBCRijndael128Init....278
XCBCRijndael128Update....278
XCBCRijndael128GetTag....279
XCBCRijndael128Final....280
XCBCRijndael128MessageTag....281

Data Authentication Functions....282
DAADESGetSize....285
DAADESInit....285
DAADESUpdate....286
DAADESFinal....287
DAADESMessageDigest....288
DAATDESGetSize....289
DAATDESInit....289
DAATDESUpdate....290
DAATDESFinal....291
DAATDESMessageDigest....292
DAARijndael128GetSize....293
DAARijndael128Init, DAASafeRijndael128Init....293
DAARijndael128Update....294
DAARijndael128Final....295
DAARijndael128MessageDigest....296
DAARijndael192GetSize....297
DAARijndael192Init....297
DAARijndael192Update....298
DAARijndael192Final....299
DAARijndael192MessageDigest....300
DAARijndael256GetSize....301
DAARijndael256Init....301
DAARijndael256Update....302
DAARijndael256Final....303
DAARijndael256MessageDigest....304
DAABlowfishGetSize....305
DAABlowfishInit....305
DAABlowfishUpdate....306
DAABlowfishFinal....307
DAABlowfishMessageDigest....308
DAATwofishGetSize....309

DAATwofishInit....309
DAATwofishUpdate....310
DAATwofishFinal....311
DAATwofishMessageDigest....312

Chapter 5: Public Key Cryptography Functions

Big Number Arithmetic....315
Add_BNU....317
Sub_BNU....318
MulOne_BNU....319
MACOne_BNU_I....320
Mul_BNU4....321
Mul_BNU8....321
Div_64u32u....322
Sqr_32u64u....323
Sqr_BNU4....324
Sqr_BNU8....324
SetOctString_BNU....325
GetOctString_BNU....326
BigNumGetSize....327
BigNumInit....327
Set_BN....328
SetOctString_BN....329
GetSize_BN....331
Get_BN....332
ExtGet_BN....332
Ref_BN....334
GetOctString_BN....334
Cmp_BN....336
CmpZero_BN....337
Add_BN....338
Sub_BN....339

Mul_BN....340
MAC_BN_I....341
Div_BN....342
Mod_BN....344
Gcd_BN....345
ModInv_BN....346
Montgomery Reduction Scheme Ffunctions....347
MontGetSize....349
MontInit....350
MontSet....350
MontGet....351
MontForm....352
MontMul....353
Example of Using Montgomery Reduction Scheme Functions...355
MontExp....356
Pseudorandom Number Generation Functions....357
User's Implementation of a Pseudorandom Number Generator....358
PRNGGetSize....359
PRNGInit....359
PRNGSetSeed....360
PRNGSetAugment....361
PRNGSetModulus....362
PRNGSetH0....362
PRNGen....363
PRNGen_BN....364
Example of Using Pseudorandom Number Generation Functions....365
Prime Number Generation Functions....366
PrimeGetSize....368
PrimeInit....369
PrimeGen....369

PrimeTest....370
PrimeSet....371
PrimeSet_BN....372
PrimeGet....373
PrimeGet_BN....373
Example of Using Prime Number Generation Functions....375
RSA Algorithm Functions....377
Functions for Building RSA System....377
RSAGetSize....378
RSAInit....379
RSASetKey....380
RSAGetKey....382
RSAGenerate....383
RSAValidate....384
RSA Primitives....385
RSAEncrypt....386
RSADecrypt....387
Example of Using RSA Algorithm Functions....389
RSA Encryption Schemes....392
RSA-OAEP Scheme Functions....392
PKCS v1.5 Encryption Scheme Functions....406
RSA Signature Schemes....408
RSA-SSA Scheme Functions....408
PKCS V1.5 Signature Scheme Functions....422
Discrete-logarithm Based Cryptography Functions....435
DLPGetSize....436
DLPInit....437
DLPSet....438
DLPGet....439
DLPSetDP....440
DLPGetDP....441
DLPGenKeyPair....442

DLPPublicKey....443
DLPValidateKeyPair....444
DLPSetKeyPair....445
DLPGenerateDSA....446
DLPValidateDSA....447
DLPSignDSA....448
DLPVerifyDSA....449
Example of Using Discrete-logarithm Based Cryptography Functions....451
DLPGenerateDH....454
DLPValidateDH....455
DLPSharedSecretDH....456
Elliptic Curve Cryptography Functions....457
Functions Based on GF(p)....461
ECCPGetSize....461
ECCPInit....462
ECCPSet....463
ECCPSetStd....464
ECCPGet....466
ECCPGetOrderBitSize....467
ECCPValidate....468
ECCPPointGetSize....469
ECCPPointInit....470
ECCPSetPoint....471
ECCPSetPointAtInfinity....472
ECCPGetPoint....472
ECCPCheckPoint....473
ECCPComparePoint....474
ECCPNegativePoint....475
ECCPAddPoint....476
ECCPMulPointScalar....477
ECCPGenKeyPair....478

ECCPPublicKey....479
ECCPValidateKeyPair....480
ECCPSetKeyPair....481
ECCPSharedSecretDH....482
ECCPSharedSecretDHC....484
ECCPSignDSA....485
ECCPVerifyDSA....487
ECCPSignNR....488
ECCPVerifyNR....490
Functions Based on GF(2^m)....491
ECCBGetSize....492
ECCBInit....492
ECCBSet....493
ECCBSetStd....495
ECCBGet....496
ECCBGetOrderBitSize....497
ECCBValidate....498
ECCBPointGetSize....500
ECCBPointInit....501
ECCBSetPoint....501
ECCBSetPointAtInfinity....502
ECCBGetPoint....503
ECCBCheckPoint....504
ECCBComparePoint....505
ECCBNegativePoint....506
ECCBAddPoint....507
ECCBMulPointScalar....508
ECCBGenKeyPair....509
ECCBPublicKey....510
ECCBValidateKeyPair....511
ECCBSetKeyPair....512
ECCBSharedSecretDH....513

ECCBSharedSecretDHC....515
ECCBSignDSA....516
ECCBVerifyDSA....518
ECCBSignNR....519
ECCBVerifyNR....521
Finite Field Arithmetic....522
Functions for the GF(p) Field....526
GFPGetSize....526
GFPInit....527
GFPGet....528
GFPElementGetSize....528
GFPElementInit....529
GFPSetElement....530
GFPSetElementZero....531
GFPSetElementPower2....532
GFPSetElementRandom....533
GFPCmpElement....534
GFPCpyElement....534
GFPGetElement....535
GFPNeg....536
GFPInv....537
GFPSqrt....538
GFPAdd....538
GFPSub....539
GFPMul....540
GFPExp....541
GFPMontEncode....542
GFPMontDecode....543
Functions for the GF(p^d) Field....544
GFPXGetSize....544
GFPXInit....545
GFPXGet....546

GFPXElementGetSize.....547
GFPXElementInit.....547
GFPXSetElement.....548
GFPXSetElementZero.....549
GFPXSetElementPowerX.....550
GFPXSetElementRandom.....551
GFPXCmpElement.....552
GFPXCpyElement.....553
GFPXGetElement.....553
GFPXNeg.....554
GFPXInv.....555
GFPXAdd.....556
GFPXAdd_GFP.....557
GFPXSub.....558
GFPXSub_GFP.....559
GFPXMul.....560
GFPXMul_GFP.....561
GFPXExp.....562
GFPXDiv.....563
Functions for the GF(p^d^2) Field.....564
GFPXQGetSize.....564
GFPXQInit.....565
GFPXQGet.....566
GFPXQElementGetSize.....567
GFPXQElementInit.....567
GFPXQSetElement.....568
GFPXQSetElementZero.....569
GFPXQSetElementPowerX.....570
GFPXQSetElementRandom.....571
GFPXQCmpElement.....572
GFPXQCpyElement.....573
GFPXQGetElement.....573

GFPXQNeg....574
GFPXQInv....575
GFPXQAdd....576
GFPXQSub....577
GFPXQMul....578
GFPXQMul_GFP....579
GFPXQExp....580
Arithmetic of the Group of Elliptic Curve Points....581
Functions for the Elliptic Curve over GF(p)....583
GFPECGetSize....583
GFPECInit....584
GFPECSet....585
GFPECGet....586
GFPECVerify....587
GFPECPointGetSize....588
GFPECPointInit....589
GFPECSetPoint....590
GFPECSetPointAtInfinity....590
GFPECSetPointRandom....591
GFPECCpyPoint....592
GFPECGetPoint....593
GFPECVerifyPoint....593
GFPECCmpPoint....594
GFPECNegPoint....595
GFPECAddPoint....596
GFPECMulPointScalar....597
Functions for the Elliptic Curve over GF(p^d)....598
GFPXECGetSize....598
GFPXECInit....599
GFPXECSet....600
GFPXECGet....601
GFPXECVerify....602

GFPXECPointGetSize....603
GFPXECPointInit....604
GFPXECSetPoint....605
GFPXECSetPointAtInfinity....605
GFPXECSetPointRandom....606
GFPXECCpyPoint....607
GFPXECGetPoint....608
GFPXECVerifyPoint....608
GFPXECCmpPoint....609
GFPXECNegPoint....610
GFPXECAddPoint....611
GFPXECMulPointScalar....612
Tate Pairing....613
TatePairingDE3GetSize....613
TatePairingDE3Init....614
TatePairingDE3Get....615
TatePairingDE3Apply....616

Appendix A: Functions Removed from Intel® Integrated Performance Primitives 5.0

Appendix B: Support Functions and Classes

Version Information Function....621
GetLibVersion....621
Classes and Functions Used in Examples....622
BigNumber Class....622
Functions for Creation of Cryptographic Contexts....633

Appendix C: Calling the Cryptography Functions from Fortran-90

Bibliography

Index

1 Overview

This manual describes the structure, operation, and functions of Intel® Integrated Performance Primitives (Intel® IPP) for cryptography. This is the fourth volume of the Intel IPP Reference Manual, which also provides descriptions of Intel IPP for signal processing (volume 1), Intel IPP for image and video processing (volume 2), and Intel IPP for small matrices and realistic rendering (volume 3).

The Intel IPP software supports many functions whose performance can be significantly enhanced on Intel architecture, particularly using the MMX™ technology, Streaming SIMD Extensions (SSE), Streaming SIMD Extensions 2 (SSE2), Streaming SIMD Extensions 3 (SSE3), as well as on Intel® Itanium® processors.

Intel IPP for cryptography is a cross-platform software layer optimized for IA-32, Intel® 64, and IA-64 architectures and running on the Microsoft* Windows*, Linux*, or Mac OS* X operating systems.

This manual provides detailed descriptions of the Intel IPP functions developed for cryptographic operations.

This chapter introduces the Intel IPP cryptography software and explains the organization of this manual.

Basic Features

Like other members of Intel® Performance Libraries, Intel Integrated Performance Primitives is a collection of high-performance code that performs domain-specific operations. It is distinguished by providing a low-level, stateless interface.

Based on experience in developing and using Intel Performance Libraries, Intel IPP has the following major distinctive features:

- Intel IPP provides basic low-level functions for creating applications in several different domains, such as signal processing, image and video processing, operations on small matrices, and cryptography applications.
- Intel IPP functions follow the same interface conventions, including uniform naming conventions and similar composition of prototypes for primitives that refer to different application domains.
- Intel IPP functions use an abstraction level which is best suited to achieve superior performance figures by the application programs.

To speed up the performance, Intel IPP functions are optimized to use all benefits of Intel® architecture processors. Besides this, most of Intel IPP functions do not use complicated data structures, which helps reduce overall execution overhead.

Intel IPP is well-suited for cross-platform applications. For example, the functions developed for IA-32 architecture-based platform can be readily ported to Intel® 64, IA-64 architecture-based platforms and systems with Intel® XScale™ technology. For more information on platform compatibility,

see Cross-Architecture Alignment. In addition, each Intel IPP function has its reference code written in ANSI C, which clearly presents the algorithm used and provides for compatibility with different operating systems.

About This Software

Intel IPP software enables taking advantage of the parallelism of the single-instruction, multiple data (SIMD) instructions that make up the core of the MMX technology and Streaming SIMD Extensions.

The Intel Integrated Performance Primitives for cryptography provide a broad set of cryptographic primitive functions optimized for maximum performance on Intel® platforms, including IA-32, Intel® 64, and IA-64 architectures.The set of cryptography primitive functions can be thought of as a set of "building blocks" that enable independent software vendors to build their own FIPS-conformant security solutions.

The package of Intel IPP cryptography functions offers developers cross-platform and cross operating system API for routines commonly used for cryptographic operations. Use of Intel IPP primitive functions can help to drastically reduce development costs and accelerate time-to market by eliminating the need of writing processor-specific code for computation intensive routines.

Hardware and Software Requirements

Intel IPP for Intel architecture software runs on personal computers that are based on processors using IA-32, Intel® 64 or IA-64 architecture and running the Microsoft Windows*, Linux*, or Mac OS* X operating system. Intel IPP integrates into the customer's application or library written in C or C++.

Platforms Supported

Intel IPP for Intel architecture software runs on the Windows*, Linux*, and Mac OS* X operating systems. The code and syntax used in this manual for function and variable declarations are written in the ANSI C style. However, versions of Intel IPP for different processors or operating systems may, of necessity, vary slightly.

Cross-Architecture Alignment

Intel IPP has been designed to support application development on various Intel® architectures.

By providing a single cross-architecture application programming interface (API), Intel IPP allows software application repurposing and enables developers to port to unique features across Intel® processor-based desktop, server, and mobile platforms. Developers can write their code once in order to realize the application performance over many processor generations.

API Changes in Version 5.0

As Intel IPP evolved and the functions got aligned for the Intel® Pentium®, Xeon® and Itanium® processors and the Intel PCA processors, the libraries accumulated numerous changes, which, in particular, caused quite a few functions grow obsolete. So, in Intel IPP 5.0, compatibility in API with previous versions had to be compromised to achieve the following library improvements:

- A number of functions were replaced by newer functions with extended functionality.
- Some other functions were changed to make the API more consistent.
- Odd and unusable functions were removed.

Several modifications of Intel IPP, and especially those that improve directory structure, also break *binary* backward compatibility of version 5.0. So, to migrate to Intel IPP 5.0, you have at least to rebuild your applications. If an application calls a function missing from Intel IPP 5.0, you have also to modify the source code. To help you migrate to Intel IPP 5.0, Appendix A lists functions removed from Intel IPP 5.0 for cryptography and specifies Intel IPP 5.0 function(s) to substitute for the missing ones. Higher versions of Intel IPP, starting from 5.1, will be fully backward compatible with version 5.0.

Technical Support

Intel IPP provides a product web site that offers timely and comprehensive product information, including product features, white papers, and technical articles. For the latest information, see http://www.intel.com/software/products/.

Intel also provides a support web site that contains a rich repository of self-help information, including getting started tips, known product issues, product errata, license information, and more (visit http://www.intel.com/software/products/support).

Registering your product entitles you to one-year technical support and product updates through Intel® Premier Support. Intel Premier Support is an interactive issue management and communication web site providing the following services:

- Submit issues and review their status.
- Download product updates anytime of the day.

To register your product, or contact Intel, or seek product support, please visit http://www.intel.com/software/products/support.

About This Manual

This manual provides a background for cryptography concepts used in the Intel IPP software as well as detailed description of the respective Intel IPP functions. The Intel IPP functions are combined in groups by their functionality. Each group of functions is described in a separate chapter.

Manual Organization

This manual contains the following chapters and appendices:

Chapter 1	Overview. Introduces Intel IPP for cryptography operations, provides information on manual organization, and explains notational conventions.
Chapter 2	Symmetric Cryptography Primitive Functions. Explains basic concepts underlying the Intel IPP functions used for symmetric cryptography algorithm operations and describes the supported data layout and operation modes.
Chapter 3	One-Way Hash Primitives. Describes functions used for hash cryptography operations and data authentication.
Chapter 4	Data Authentication Primitive Functions. Describes functions for generating message authentication code using the Keyed Hash Functions (HMAC) and the Data authentication Functions (DAA) schemes.
Chapter 5	Public Key Cryptography Functions. Explains basic concepts underlying the Intel IPP functions used for asymmetric cryptography algorithm operations and describes the supported data layout and operation modes. In addition, the chapter covers the Diffie-Hellman functionality functions and the elliptic cryptography primitives operated on finite fields.
Appendix A	Functions Removed from Intel® Integrated Performance Primitives 5.0. Lists cryptography functions removed from Intel IPP 5.0 along with their version 5.0 substitutes.
Appendix B	Support Functions and Classes. Presents miscellaneous information on support functions and classes that are used in Intel IPP cryptography software or in examples given in the manual chapters.

Appendix C	Calling the Cryptography Functions from Fortran-90. Presents Fortran-90 interface to Intel IPP cryptography functions.

The manual also includes a Bibliography and Index of major terms and definitions used in this volume.

Function Descriptions

In this manual, each function is introduced by its short name (without the `ipps` prefix and descriptors) and a brief description of its purpose. This is followed by an example of the function call sequence, definition of its parameters, and a more detailed explanation of the function purpose. The following sections are included in the function description:

Syntax	Lists function prototypes.
Parameters	Describes all function parameters.
Description	Defines the function and details the operation performed by the function. Code examples and equations that the function implements may be included in the description.
Return Value	Describes values indicating status codes set as the result of the function execution.

Audience for This Manual

This manual is intended for cryptography system developers who may benefit from avoiding hand optimization of cryptography operations. In the Intel IPP primitive functions for cryptography, developers may find a convenient and easy-to-use building block resource that covers cryptography algorithms widely used for creating products that require data security and integrity.

The audience must have experience using C and a working knowledge of the vocabulary and principles of basic crypto algorithms.

Notational Conventions

In this manual, notational conventions include:

- Fonts used for distinction between the text and the code
- Naming conventions for different items.

Font Conventions

The following font conventions are used throughout this manual:

`This type style`	Mixed with the uppercase in function names, code examples, and call statements, for example, *ippsAdd_BNU*.
`This type style`	Parameters in function prototype parameters and parameters description, for example, *pCtx*, *pSrcMesg*.

Naming Conventions

The naming conventions for different items are the same as used by the Intel IPP software.

- All names of the functions used for cryptographic operations have the `ipps` prefix. In code examples, you can distinguish the Intel IPP interface functions from the application functions by this prefix.

NOTE. In this manual, the *ipps* prefix in function names is always used in code examples and function prototypes. In the text, this prefix is omitted when referring to the function group.

- Each new part of a function name starts with an uppercase character, without underscore, for example, `ippsDESInit`.

Symmetric Cryptography Primitive Functions

2

In the context of secure data communication, symmetric cryptography primitive functions protect messages transferred over open communication media by offering adequate security strength to meet application security requirement, as well as algorithmic efficiency to enable secure communication in real time.

Intel® Integrated Performance Primitives (Intel® IPP) for cryptography offer operations using the following symmetric cryptography algorithms:

- Block ciphers: DES, Triple DES (TDES) [FIPS PUB 46-3], Rijndael [AES], including AES-CCM [NIST SP 800-38C] and AES-GCM [NIST SP 800-38D], Twofish [TF], Blowfish [BF], and RC5* [RC5]
- Stream ciphers: ARCFour [AC], producing the same encryption/decryption as the RC4* proprietary cipher of RSA Security Inc.

Block Cipher Modes of Operation

Most of Symmetric Cryptography Algorithms implemented in Intel IPP are Block Ciphers, which operate on data blocks of the fixed size. Block Ciphers encrypt a plaintext block into a ciphertext block or decrypts a ciphertext block into a plaintext block. The size of the data blocks depends on the specific algorithm. Table 2-1 shows the correspondence between Block Ciphers applied and their data block size.

Table 2-1 Block Sizes in Symmetric Algorithms

Block Cipher Name	Data Block Size (bits)
DES	64
TDES	64
Rijndael128	128
Rijndael192	192
Rijndael256	256
Twofish	128
Blowfish	64
RC5	64 or 128

Block Cipher modes of executing the operation of encryption/decryption are applied in practice more frequently than "pure" Block Ciphers. On one hand, the modes enable you to process arbitrary length data stream. On the other hand, they provide additional security strength.

Intel IPP for cryptography supports five widely used modes, as specified in [NIST SP 800-38A]:

- Electronic Code Book (ECB) mode
- Cipher Block Chain (CBC) mode
- Cipher Feedback (CFB) mode

- Output Feedback (OFB) mode
- Counter (CTR) mode.

NOTE. For simplicity and consistency, the mathematical expression and pseudocode in this chapter describes the behaviour of each function.

The cryptographic functions described in this chapter require the application to specify both the plaintext message and the ciphertext message lengths as multiples of block size of the respective algorithm (see Table 2-1). To meet this requirement in ciphering the message, the application may use any padding scheme, for example, the scheme defined in [PKCS7]. In case padding is used, the application is responsible for correct interpretation and processing of the last deciphered message block. So of the three padding schemes available for earlier releases,

```
typedef enum {
    NONE  = 0, IppsCPPaddingNONE = 0,
    PKCS7 = 1, IppsCPPaddingPKCS7 = 1,
    ZEROS = 2, IppsCPPaddingZEROS = 2
} IppsCPPadding;
```

only `IppsCPPaddingNONE` remains acceptable.

DES/TDES Functions

Data Encryption Standard (DES) is a well-known symmetric cipher and also the first modern commercial-grade algorithm with open and fully specified implementation details. DES consists of a Feistel network iterated 16 times with the block size of 64 bits and the effective key size of 56 bits.

Triple Data Encryption Standard (TDES) is a revised symmetric algorithm scheme built on the DES system. TDES encryption process includes three consecutive DES operations in the encryption, decryption, and encryption (E-D-E) sequence again in accordance with the American standard FIPS 46-3.

Although the functions that support TDES operations require three sets of round keys, the functions can operate under TDES cipher system with a two-set round keys by simply setting the third set of round keys to be the same as the first set.

You can use the functions described in this section for performing various operational modes under the DES/TDES cipher systems.

Table 2-2 lists Intel IPP DES/TDES functions:

Table 2-2 Intel IPP DES/TDES Functions

Function Base Name	Operation
DES Functions	
DESGetSize	Gets the size of the IppsDESSpec context.
DESInit	Initializes user-supplied memory as IppsDESSpec context for future use.
DESEncryptECB	Encrypts a variable length data stream in the ECB mode.
DESDecryptECB	Decrypts a variable length data stream in the ECB mode.
DESEncryptCBC	Encrypts a variable length data stream in the CBC mode.
DESDecryptCBC	Decrypts a variable length data stream in the CBC mode.
DESEncryptCFB	Encrypts a variable length data stream in the CFB mode.
DESDecryptCFB	Decrypts a variable length data stream in the CFB mode.
DESEncryptOFB	Encrypts a variable length data stream in the OFB mode.
DESDecryptOFB	Decrypts a variable length data stream in the OFB mode.
DESEncryptCTR	Encrypts a variable length data stream in the CTR mode.
DESDecryptCTR	Decrypts a variable length data stream in the CTR mode.
TDES Functions	
TDESEncryptECB	Encrypts variable length data stream in the ECB mode.
TDESDecryptECB	Decrypts variable length data stream in the ECB mode.
TDESEncryptCBC	Encrypts variable length data stream in the CBC mode.
TDESDecryptCBC	Decrypts variable length data stream in the CBC mode.
TDESEncryptCFB	Encrypts variable length data stream in the CFB mode.
TDESDecryptCFB	Decrypts variable length data stream in the CFB mode.
TDESEncryptOFB	Encrypts variable length data stream in the OFB mode.
TDESDecryptOFB	Decrypts variable length data stream in the OFB mode.
TDESEncryptCTR	Encrypts a variable length data stream in the CTR mode.
TDESDecryptCTR	Decrypts a variable length data stream in the CTR mode.

NOTE. Intel IPP functions for cryptography operations do not allocate memory internally. The function GetSize does not require allocated memory. You need to call the function GetSize to find out how much available memory you need to have to work with the selected algorithm and after that you call the initialization function to create a memory buffer and initialize it.

Intel IPP for cryptography supports ECB, CBC, CFB, and CTR modes. You can tell which algorithm a given function supports from the function base name, for example, the function DESEncryptECB operates under the ECB mode for DES encryption and the function TDESEncryptECB operates under the ECB mode under the TDES scheme.

The encryption functions DESEncryptCBC and TDESEncryptCBC operate under the CBC mode using their respective cipher scheme and require to have an initialization vector *iv*. Since there exists a number of ways to initialize the initialization vector *iv*, you should remember which of these ways you used to be able to decrypt the message when needed.

Functions DESEncryptCFB and TDESEncryptCFB operate under CFB mode for encryption using their respective cipher scheme, both require having the initialization vector *pIV*, and CFB block size *cfbBlkSize*.

All functions described in this section use the context IppsDESSpec to serve as an operational vehicle that carries a set of round keys.

The application code for conducting a typical encryption under CBC mode using the TDES scheme must perform the following sequence of operations:

1. Get the size required to configure the context IppsDESSpec by calling the function DESGetSize.
2. Call operating system memory allocation service function to allocate three buffers whose sizes are not less than the one specified by the function DESGetSize. Initialize pointers to contexts *pCtx1*, *pCtx2*, and *pCtx3* by calling the function DESInit three times, each with the allocated buffer and the respective DES key.
3. Specify the initialization vector and then call the function TDESEncryptCBC to encrypt the input data stream under CBC mode using TDES scheme.
4. Free the memory allocated to the buffer once TDES encryption under the CBC mode has been completed and the data structures allocated for set of round keys are no longer required.

NOTE. Similar procedure can be applied for ECB, CFB, and CTR mode operation.

DESGetSize

Gets the size of the IppsDESSpec *context.*

Syntax

```
IppStatus ippsDESGetSize(int* pSize);
```

Parameters

pSize	Pointer to the IppsDESSpec context size value.

Description

This function is declared in the `ippcp.h` file. The function gets the `IppsDESSpec` context size in bytes and stores it in *`*pSize`*.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.

DESInit

Initializes user-supplied memory as the `IppsDESSpec` *context for future use.*

Syntax

```
IppStatus ippsDESInit(const Ipp8u* pKey, IppsDESSpec* pCtx);
```

Parameters

`pKey`	Pointer to the DES key.
`pCtx`	Pointer to the `IppsDESSpec` context being initialized.

Description

This function is declared in the `ippcp.h` file. The function initializes the memory pointed by *`pCtx`* as `IppsDESSpec` context. In addition, the function uses the key to provide all necessary key material for both encryption and decryption operations.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.

DESEncryptECB

Encrypts a variable length data stream in the ECB mode.

Syntax

```
IppStatus ippsDESEncryptECB(const Ipp8u* pSrc, Ipp8u* pDst, int srclen, const IppsDESSpec* pCtx, IppsCPPadding padding);
```

Parameters

pSrc	Pointer to the input plaintext data stream of variable length.
pDst	Pointer to the resulting ciphertext data stream.
srcLen	Length of the plaintext data stream in bytes.
pCtx	Pointer to the `DECSpec` context.
padding	`IppsCPPaddingNONE` padding scheme.

Description

This function is declared in the `ippcp.h` file. The function encrypts the input data stream of a variable length according to the cipher scheme specified in [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than or equal to zero.
`ippStsUnderRunErr`	Indicates an error condition if *srclen* is not divisible by cipher block size.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

DESDecryptECB

Decrypts a variable length data stream in the ECB mode.

Syntax

```
IppStatus ippsDESDecryptECB(const Ipp8u* pSrc, Ipp8u* pDst, int srclen, const IppsDESSpec* pCtx, IppsCPPadding padding);
```

Parameters

pSrc	Pointer to the input ciphertext data stream of variable length.
pDst	Pointer to the resulting plaintext data stream of variable length.
srclen	Length of the ciphertext data stream in bytes.
pCtx	Pointer to the `IppsDESSpec` context.
padding	`IppsCPPaddingNONE` padding scheme.

Description

This function is declared in the `ippcp.h` file. The function decrypts the input data stream of a variable length according to the ECB mode as specified in [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than or equal to zero.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.
`ippStsUnderRunErr`	Indicates an error condition if *srclen* is not divisible by cipher block size.

DESEncryptCBC

Encrypts a variable length data stream in the CBC mode.

Syntax

```
IppStatus ippsDESEncryptCBC(const Ipp8u* pSrc, Ipp8u* pDst, int srclen, const IppsDESSpec* pCtx, const Ipp8u* pIV, IppsCPPadding padding);
```

Parameters

pSrc	Pointer to the input plaintext data stream of variable length.
pDst	Pointer to the resulting ciphertext data stream.
srclen	Length of the plaintext data stream length in bytes.
pCtx	Pointer to the `IppsDESSpec` context.
pIV	Pointer to the initialization vector for the CBC mode operation.
padding	`IppsCPPaddingNONE` padding scheme.

Description

This function is declared in the `ippcp.h` file. The function encrypts the input data stream of a variable length according to the CBC mode as specified in [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than or equal to zero.
`ippStsUnderRunErr`	Indicates an error condition if `srclen` is not divisible by data block size.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

DESDecryptCBC

Decrypts a variable length data stream in the CBC mode.

Syntax

```
IppStatus ippsDESDecryptCBC(const Ipp8u* pSrc, Ipp8u* pDst, int srclen, const IppsDESSpec* pCtx, const Ipp8u* pIV, IppsCPPadding padding);
```

Parameters

pSrc	Pointer to the input ciphertext data stream.
pDst	Pointer to the resulting plaintext data stream of the variable length.
srclen	Length of the ciphertext data stream length in bytes.
pCtx	Pointer to the `IppsDESSpec` context.
pIV	Pointer to the initialization vector for CBC mode operation.
padding	`IppsCPPaddingNONE` padding scheme.

Description

This function is declared in the `ippcp.h` file. The function decrypts the input data stream of a variable length according to the CBC mode as specified in [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than or equal to zero.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.
`ippStsUnderRunErr`	Indicates an error condition if *srclen* is not divisible by cipher block size.

DESEncryptCFB

Encrypts a variable length data stream in the CFB mode.

Syntax

```
IppStatus ippsDESEncryptCFB(const Ipp8u* pSrc, Ipp8u* pDst, int srcLen, int cfbBlkSize, const IppsDESSpec* pCtx, const Ipp8u* pIV, IppsCPPadding padding);
```

Parameters

pSrc	Pointer to the input plaintext data stream of variable length.
pDst	Pointer to the resulting ciphertext data stream.
srcLen	Length of the plaintext data stream in bytes.
cfbBlkSize	Size of the CFB block in bytes.
pCtx	Pointer to the `IppsDESSpec` context.
pIV	Pointer to the initialization vector for the CFB mode operation.
padding	`IppsCPPaddingNONE` padding scheme.

Description

This function is declared in the `ippcp.h` file. The function encrypts the input data stream of variable length according to the CFB mode as specified in [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than or equal to zero.
`ippStsUnderRunErr`	Indicates an error condition if *srcLen* is not divisible by *cfbBlkSize* parameter value.
`ippStsCFBSizeErr`	Indicates an error condition if the value for *cfbBlkSize* is illegal.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

DESDecryptCFB

Decrypts a variable length data stream in the CFB mode.

Syntax

```
IppStatus ippsDESDecryptCFB(const Ipp8u* pSrc, Ipp8u* pDst, int srclen, int cfbBlkSize, const IppsDESSpec* pCtx, const Ipp8u* pIV, IppsCPPadding padding);
```

Parameters

pSrc	Pointer to the input ciphertext data stream.
pDst	Pointer to the resulting plaintext data stream of variable length.
srclen	Length of the ciphertext data stream in bytes.
cfbBlkSize	Size of the CFB block in bytes.
pCtx	Pointer to the `IppsDESSpec` context.
pIV	Pointer to the initialization vector for the CFB mode operation.
padding	`IppsCPPaddingNONE` padding scheme.

Description

This function is declared in the `ippcp.h` file. The function decrypts the input data stream of variable length according to the CFB mode as specified in [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than or equal to zero.
`ippStsCFBSizeErr`	Indicates an error condition if the value for *cfbBlkSize* is illegal.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.
`ippStsUnderRunErr`	Indicates an error condition if *srcLen* is not divisible by cipher block size.

DESEncryptOFB

Encrypts a variable length data stream according to the DES algorithm in the OFB mode.

Syntax

```
IppStatus ippsDESEncryptOFB (const Ipp8u* pSrc, Ipp8u* pDst, int srclen, int ofbBlkSize, const IppsDESSpec* pCtx, Ipp8u* pIV);
```

Parameters

pSrc	Pointer to the input plaintext data stream of variable length.
pDst	Pointer to the resulting ciphertext data stream.
len	Length of the plaintext data stream in bytes.
ofbBlkSize	Size of the OFB block in bytes.
pCtx	Pointer to the *IppsDESSpec* context.
pIV	Pointer to the initialization vector for the OFB mode operation.

Description

This function is declared in the `ippcp.h` file. The function encrypts the input data stream of a variable length in the OFB mode as specified in [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than or equal to zero.
`ippStsUnderRunErr`	Indicates an error condition if *srclen* is not divisible by the *ofbBlkSize* parameter value.
`ippStsOFBSizeErr`	Indicates an error condition if the value of *ofbBlkSize* is illegal.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

DESDecryptOFB

Decrypts a variable length data stream according to the DES algorithm in the OFB mode.

Syntax

```
IppStatus ippsDESDecryptOFB (const Ipp8u* pSrc, Ipp8u* pDst, int srclen, int ofbBlkSize, const IppsDESSpec* pCtx, Ipp8u* pIV);
```

Parameters

pSrc	Pointer to the input ciphertext data stream of variable length.
pDst	Pointer to the resulting plaintext data stream.
srclen	Length of the ciphertext data stream in bytes.
ofbBlkSize	Size of the OFB block in bytes.
pCtx	Pointer to the *IppsDESSpec* context.
pIV	Pointer to the initialization vector for the OFB mode operation.

Description

This function is declared in the `ippcp.h` file. The function decrypts the input data stream of a variable length in the OFB mode as specified in [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than or equal to zero.
`ippStsUnderRunErr`	Indicates an error condition if *srclen* is not divisible by the *ofbBlkSize* parameter value.
`ippStsOFBSizeErr`	Indicates an error condition if the value of *ofbBlkSize* is illegal.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

DESEncryptCTR

Encrypts a variable length data stream in the CTR mode.

Syntax

```
IppStatus ippsDESEncryptCTR(const Ipp8u* pSrc, Ipp8u* pDst, int srcLen, const
IppsDESSpec* pCtx, Ipp8u*pCtrValue, int ctrNumBitSize);
```

Parameters

pSrc	Pointer to the input plaintext data stream of a variable length.
pDst	Pointer to the resulting ciphertext data stream.
srcLen	Length of the plaintext data stream in bytes.
pCtx	Pointer to the `IppsDESSpec` context.
pCtrValue	Pointer to the counter data block.
ctrNumBitSize	Number of bits in the specific part of the counter to be incremented.

Description

This function is declared in the `ippcp.h` file. The function encrypts the input data stream of a variable length according to the CTR mode as specified in [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than or equal to zero.
`ippStsCTRSizeErr`	Indicates an error condition if the value of the *ctrNumBitSize* is illegal.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

DESDecryptCTR

Decrypts a variable length data stream in the CTR mode.

Syntax

```
IppStatus ippsDESDecryptCTR(const Ipp8u* pSrc, Ipp8u* pDst, int srcLen, const IppsDESSpec* pCtx, Ipp8u* pCtrValue, int ctrNumBitSize);
```

Parameters

pSrc	Pointer to the input ciphertext data stream.
pDst	Pointer to the resulting plaintext data stream of a variable length.
srclen	Length of the plaintext data stream in bytes.
pCtx	Pointer to the `IppsDESSpec` context.
pCtrValue	Pointer to the counter data block.
ctrNumBitSize	Number of bits in the specific part of the counter to be incremented.

Description

This function is declared in the `ippcp.h file`. The function decrypts the input data stream of a variable length according to the CTR mode as specified in the [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the output data stream length is less than or equal to zero.
`ippStsCTRSizeErr`	Indicates an error condition if the value of the *ctrNumBitSize* is illegal.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

TDESEncryptECB

Encrypts variable length data stream in ECB mode.

Syntax

```
IppStatus ippsTDESEncryptECB(const Ipp8u *pSrc, Ipp8u *pDst, int srclen,
const IppsDESSpec *pCtx1, const IppsDESSpec *pCtx2, const IppsDESSpec *
pCtx3, IppsCPPadding padding);
```

Parameters

pSrc	Input plaintext data stream of a variable length.
pDst	Resulting ciphertext data stream.
srclen	Input data stream length in bytes.
pCtx1	First set of round keys scheduled for TDES internal operations.
pCtx2	Second set of round keys scheduled for TDES internal operations.
pCtx3	Third set of round keys scheduled for TDES internal operations.
padding	`IppsCPPaddingNONE` padding scheme.

Description

This function is declared in the `ippcp.h` file. The function encrypts the input data stream of a variable length according to the cipher scheme specified in [NIST SP 800-38A]. The function uses three sets of supplied round keys in the ECB mode. The function returns the ciphertext result.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than or equal to zero.
`ippStsUnderRunErr`	Indicates an error condition if the input data stream length *is* not divisible by cipher block size .

ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

TDESDecryptECB

Decrypts variable length data stream in the ECB mode.

Syntax

```
IppStatus ippsTDESDecryptECB(const Ipp8u *pSrc, Ipp8u *pDst, int srclen,
const IppsDESSpec *pCtx1, const IppsDESSpec *pCtx2, const IppsDESSpec *
pCtx3, IppsCPPadding padding);
```

Parameters

pSrc	Input ciphertext data stream of variable length.
pDst	Resulting plaintext data stream.
srclen	Input data stream length in bytes.
pCtx1	First set of round keys scheduled for TDES internal operations.
pCtx2	Second set of round keys scheduled for TDES internal operations.
pCtx3	Third set of round keys scheduled for TDES internal operations.
padding	IppsCPPaddingNONE padding scheme.

Description

This function is declared in the ippcp.h file. The function decrypts the input data stream of a variable length according to the cipher scheme specified in [NIST SP 800-38A]. The function uses three sets of supplied round keys in the ECB mode. The function returns the ciphertext result and validates the final plaintext block.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

ippStsLengthErr	Indicates an error condition if the decrypted plaintext data stream length is less than or equal to zero.
ippStsUnderRunErr	Indicates an error condition if *srclen* is not divisible by cipher block size.

TDESEncryptCBC

Encrypts variable length data stream in the CBC mode.

Syntax

```
IppStatus ippsTDESEncryptCBC(const Ipp8u *pSrc, Ipp8u *pDst, int srclen,
const IppsDESSpec *pCtx1, const IppsDESSpec *pCtx2, const IppsDESSpec *
pCtx3, const Ipp8u *pIV, IppsCPPadding padding);
```

Parameters

pSrc	Input plaintext data stream of a variable length.
pDst	Resulting ciphertext data stream.
pIV	Initialization vector for TDES CBC mode operation.
srclen	Input data stream length in bytes.
pCtx1	First set of round keys scheduled for TDES internal operations.
pCtx2	Second set of round keys scheduled for TDES internal operations.
pCtx3	Third set of round keys scheduled for TDES internal operations.
padding	IppsCPPaddingNONE padding scheme.

Description

This function is declared in the ippcp.h file. The function encrypts the input data stream of a variable length according to the cipher scheme specified in [NIST SP 800-38A]. The function uses three sets of the supplied round keys in the Cipher Block Chaining (CBC) mode with the initialization vector. The function returns the ciphertext result.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the input data stream length is less than or equal to zero.
ippStsUnderRunErr	Indicates an error condition if the input data stream length is not divisible by cipher block size.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

TDESDecryptCBC

Decrypts variable length data stream in the CBC mode.

Syntax

```
IppStatus ippsTDESDecryptCBC(const Ipp8u *pSrc, Ipp8u *pDst, int srclen,
const IppsDESSpec *pCtx1, const IppsDESSpec *pCtx2, const IppsDESSpec *
pCtx3, const Ipp8u *pIV, IppsCPPadding padding);
```

Parameters

pSrc	Input ciphertext data stream of a variable length.
pDst	Resulting plaintext data stream.
pIV	Initialization vector for TDES CBC mode operation.
srclen	Input data stream length in bytes.
pCtx1	First set of round keys scheduled for TDES internal operations.
pCtx2	Second set of round keys scheduled for TDES internal operations.
pCtx3	Third set of round keys scheduled for TDES internal operations.
padding	IppsCPPaddingNONE padding scheme.

Description

This function is declared in the `ippcp.h` file. The function decrypts the input data stream of a variable length according to the cipher scheme specified in [NIST SP 800-38A]. The function uses three sets of the supplied round keys in the Cipher Block Chaining (CBC) mode with the initialization vector. The function returns the ciphertext result and validates the final plaintext block.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the decrypted plaintext data stream length is less than or equal to zero.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.
`ippStsUnderRunErr`	Indicates an error condition if *`srclen`* is not divisible by cipher block size.

TDESEncryptCFB

Encrypts variable length data stream in the CFB mode.

Syntax

```
IppStatus ippsTDESEncryptCFB(const Ipp8u *pSrc, Ipp8u *pDst, int srclen, int cfbBlkSize, const IppsDESSpec *pCtx1, const IppsDESSpec * pCtx2, const IppsDESSpec *pCtx3, const Ipp8u *pIV, IppsCPPadding padding);
```

Parameters

`pSrc`	Input plaintext data stream of variable length.
`pDst`	Resulting ciphertext data stream.
`pIV`	Initialization vector for TDES CFB mode operation.
`srclen`	Input data stream length in bytes.
`pCtx1`	First set of round keys scheduled for TDES internal operations.

pCtx2	Second set of round keys scheduled for TDES internal operations.
pCtx3	Third set of round keys scheduled for TDES internal operations.
cfbBlkSize	CFB block size in bytes.
padding	IppsCPPaddingNONE padding scheme.

Description

This function is declared in the ippcp.h file. The function encrypts the input data stream of a variable length according to the cipher scheme specified in [NIST SP 800-38A]. The function uses three sets of the supplied round keys in the Cipher Feedback (CFB) mode with the initialization vector. The function returns the ciphertext result.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the input data stream length is less than or equal to zero.
ippStsUnderRunErr	Indicates an error condition if *srcLen i*s not divisible by *cfbBlkSize* parameter value.
ippStsCFBSizeErr	Indicates an error condition if the value for *cfbBlkSize* is illegal.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

TDESDecryptCFB

Decrypts variable length data stream in the CFB mode.

Syntax

```
IppStatus ippsTDESDecryptCFB(const Ipp8u *pSrc, Ipp8u *pDst, int srclen, int
cfbBlkSize, const IppsDESSpec *pCtx1, const IppsDESSpec * pCtx2, const
IppsDESSpec *pCtx3, const Ipp8u *pIV, IppsCPPadding padding);
```

Parameters

pSrc	Input ciphertext data stream of variable length.
pDst	Resulting plaintext data stream.
pIV	Initialization vector for TDES CFB mode operation.
srclen	Ciphertext data stream length in bytes.
pCtx1	First set of round keys scheduled for TDES internal operations.
pCtx2	Second set of round keys scheduled for TDES internal operations.
pCtx3	Third set of round keys scheduled for TDES internal operations.
cfbBlkSize	CFB block size in bytes.
padding	`IppsCPPaddingNONE` padding scheme.

Description

This function is declared in the `ippcp.h` file. The function decrypts the input data stream of a variable length according to the cipher scheme specified in [NIST SP 800-38A]. The function uses three sets of the supplied round keys in the Cipher Feedback (CFB) mode with the initialization vector. The function returns the ciphertext result and validates the final plaintext block.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the decrypted plaintext data stream length is less than or equal to zero.
`ippStsCFBSizeErr`	Indicates an error condition if the value for *cfbBlkSize* is illegal.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.
`ippStsUnderRunErr`	Indicates an error condition if *srcLen* is not divisible by cipher block size.

TDESEncryptOFB

Encrypts a variable length data stream according to the TDES algorithm in the OFB mode.

Syntax

```
IppStatus ippsTDESEncryptOFB (const Ipp8u* pSrc, Ipp8u* pDst, int srclen,
int ofbBlkSize, const IppsDESSpec *pCtx1, const IppsDESSpec * pCtx2, const
IppsDESSpec *pCtx3, Ipp8u* pIV);
```

Parameters

pSrc	Pointer to the input plaintext data stream of variable length.
pDst	Pointer to the resulting ciphertext data stream.
srclen	Length of the plaintext data stream in bytes.
ofbBlkSize	Size of the OFB block in bytes.
pCtx1	First set of round keys scheduled for TDES internal operations.
pCtx2	Second set of round keys scheduled for TDES internal operations.
pCtx3	Third set of round keys scheduled for TDES internal operations.
pIV	Pointer to the initialization vector for the OFB mode operation.

Description

This function is declared in the `ippcp.h` file. The function encrypts the input data stream of a variable length in the OFB mode as specified in [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than or equal to zero.

ippStsUnderRunErr	Indicates an error condition if *srclen* is not divisible by the *ofbBlkSize* parameter value.
ippStsOFBSizeErr	Indicates an error condition if the value of *ofbBlkSize* is illegal.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

TDESDecryptOFB

Decrypts a variable length data stream according to the TDES algorithm in the OFB mode.

Syntax

```
IppStatus ippsTDESDecryptOFB (const Ipp8u* pSrc, Ipp8u* pDst, int srclen,
int ofbBlkSize, const IppsDESSpec *pCtx1, const IppsDESSpec * pCtx2, const
IppsDESSpec *pCtx3, Ipp8u* pIV);
```

Parameters

pSrc	Pointer to the input ciphertext data stream of variable length.
pDst	Pointer to the resulting plaintext data stream.
srclen	Length of the ciphertext data stream in bytes.
ofbBlkSize	Size of the OFB block in bytes.
pCtx1	First set of round keys scheduled for TDES internal operations.
pCtx2	Second set of round keys scheduled for TDES internal operations.
pCtx3	Third set of round keys scheduled for TDES internal operations.
pIV	Pointer to the initialization vector for the OFB mode operation.

Description

This function is declared in the `ippcp.h` file. The function decrypts the input data stream of a variable length in the OFB mode as specified in [NIST SP 800-38A].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the input data stream length is less than or equal to zero.
ippStsUnderRunErr	Indicates an error condition if *srclen i*s not divisible by the *ofbBlkSize* parameter value.
ippStsOFBSizeErr	Indicates an error condition if the value of *ofbBlkSize* is illegal.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

TDESEncryptCTR

Encrypts a variable length data stream in the CTR mode.

Syntax

```
IppStatus ippsTDESEncryptCTR(const Ipp8u *pSrc, Ipp8u *pDst, int srclen,
const IppsDESSpec *pCtx1, const IppsDESSpec *pCtx2, const IppsDESSpec
*pCtx3,Ipp8u  *pCtrValue, int ctrNumBitSize);
```

Parameters

pSrc	Input plaintext data stream of a variable length.
pDst	Resulting ciphertext data stream.
srclen	Input data stream length in bytes.
pCtx1	First set of round keys scheduled for TDES internal operations.
pCtx2	Second set of round keys scheduled for TDES internal operations.
pCtx3	Third set of round keys scheduled for TDES internal operations.
pCtrValue	Counter.

ctrNumBitSize	Number of bits in the specific part of the counter to be incremented.

Description

This function is declared in the `ippcp.h` file. The function encrypts the input data stream of a variable length according to the cipher scheme specified in the [NIST SP 800-38A] recommendation. The function uses three sets of the supplied round keys. The standard incrementing function is applied to increment counter value. The function returns the ciphertext result.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less that or equal to zero.
`ippStsCTRSizeErr`	Indicates an error condition if the value of the *ctrNumBitSize* is illegal.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

TDESDecryptCTR

Decrypts a variable length data stream in the CTR mode.

Syntax

```
IppStatus ippsTDESDecryptCTR(const Ipp8u *pSrc, Ipp8u *pDst, int srcLen,
const IppsDESSpec *pCtx1, const IppsDESSpec *pCtx2, const IppsDESSpec *pCtx3,
Ipp8u *pCtrValue, int ctrNumBitSize);
```

Parameters

pSrc	Input ciphertext data stream of a variable length.
pDst	Resulting plaintext data stream.
srcLen	Length of the plaintext data stream in bytes.

pCtx1	First set of round keys scheduled for TDES internal operations.
pCtx2	Second set of round keys scheduled for TDES internal operations.
pCtx3	Third set of round keys scheduled for TDES internal operations.
pCtrValue	Counter.
ctrNumBitSize	Number of bits in the specific part of the counter to be incremented.

Description

This function is declared in the `ippcp.h` file. The function decrypts the input data stream of a variable length according to the cipher scheme specified in the [NIST SP 800-38A] recommendation. The function uses three sets of the supplied round keys. The standard incrementing function is applied to increment value of counter. The function returns the ciphertext result.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the descrypted plaintext data stream length is less that or equal to zero.
`ippStsCTRSizeErr`	Indicates an error condition if the value of the *ctrNumBitSize* is illegal.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

Example of Using DES/TDES Functions

Example 2-1 DES/TDES Encryption and Decryption

```
   // use of the ECB mode
void DES_sample(void){
   // size of the DES algorithm block is equal to 8
   const int desBlkSize = 8;

   // get size of the context needed for the encryption/decryption operation
   int ctxSize;
   ippsDESGetSize(&ctxSize);
   // and allocate one
   IppsDESSpec* pCtx = (IppsDESSpec*)( new Ipp8u [ctxSize] );


    // define the key
   Ipp8u key[] = {0x01,0x2,0x3,0x4,0x5,0x6,0x7,0x8};
   // and prepare the context for the DES usage
   ippsDESInit(key, pCtx);
   // define the message to be encrypted
   Ipp8u ptext[] = {"quick brown fox jupm over lazy dog"};

   // allocate enough memory for the ciphertext
   // note that
   // the size of ciphertext is always multiple of cipher block size
   Ipp8u ctext[(sizeof(ptext)+desBlkSize-1) &~(desBlkSize-1)];
   // encrypt (ECB mode) ptext message
   // pay attention to the 'length' parameter
```

```
   // it defines the number of bytes to be encrypted
   ippsDESEncryptECB(ptext, ctext, sizeof(ctext),
                     pCtx,
                     IppsCPPaddingNONE);
      // allocate memory for the decrypted message
   Ipp8u rtext[sizeof(ctext)];
   // decrypt (ECB mode) ctext message
   // pay attention to the 'length' parameter
   // it defines the number of bytes to be decrypted
   ippsDESDecryptECB(ctext, rtext, sizeof(ctext),
                     pCtx,
                     IppsCPPaddingNONE);
   delete (Ipp8u*)pCtx;
}
```

Rijndael Functions

Rijndael cipher scheme is an iterated block cipher with a variable block size and a variable key length. You can independently specify the lengths of the data block and the key as 128, 192, or 256 bits.

This section describes the functions operating in various operational modes under the various Rijndael cipher systems. The functions in this section are categorized by their data block sizes of the baseline Rijndael cipher functions:

- `Rijndael128` refers to the Rijndael cipher scheme with 128-bit data block size
- `Rijndael192` refers to the Rijndael cipher scheme with 192-bit data block size
- `Rijndael256` refers to the Rijndael cipher scheme with 256-bit data block size.

To specify the key length for these baseline Rijndael cipher schemes, all the functions in this section use the following enumeration

```
typedef enum {
IppsRijndaelKey128 = 128, // 128-bit key
IppsRijndaelKey192 = 192, // 192-bit key
```

```
IppsRijndaelKey256 = 256, // 256-bit key
} IppsRijndaelKeyLength;
```

The functions for Rijndael128 with the 128-bit key length described in this section are, in fact, American Encryption Standard (AES) cipher functions implemented in the way to comply with the American Standard FIPS 197. All other functions for various other Rijndael block cipher schemes fully comply to the respective cipher schemes documented by Joan Daeman and Vincent Rijmen.

Table 2-3 lists Intel IPP Rijndael functions:

Table 2-3 Intel IPP Rijndael Algorithm Functions

Function Base Name	Operation
Rijndael128GetSize	Gets the size of the IppsRijndael128Spec context.
Rijndael128Init, SafeRijndael128Init	Initialize user-supplied memory as IppsRijndael128Spec context for future use.
Rijndael128EncryptECB	Encrypts plaintext message using Rijndael128 algorithm in the ECB encryption mode.
Rijndael128DecryptECB	Decrypts byte data stream using Rijndael128 algorithm in the ECB mode.
Rijndael128EncryptCBC	Encrypts byte data stream according to Rijndael128 in the CBC mode.
Rijndael128DecryptCBC	Decrypts byte data stream according to Rijndael128 in the CBC mode.
Rijndael128EncryptCFB	Encrypts byte data stream according to Rijndael128 in the CFB mode.
Rijndael128DecryptCFB	Decrypts byte data stream according to Rijndael128 in the CFB mode.
Rijndael128EncryptOFB	Encrypts byte data stream according to Rijndael128 in the OFB mode.
Rijndael128DecryptOFB	Decrypts byte data stream according to Rijndael128 in the OFB mode.
Rijndael128EncryptCTR	Encrypts a variable length data stream according to Rijndael128 in the CTR mode.

Function Base Name	Operation
Rijndael128DecryptCTR	Decrypts a variable length data stream according to Rijndael128 in the CTR mode.
Rijndael128EncryptCCM	DEPRECATED. Use Rijndael128CCMEncryptMessage istead of this function. Encrypts a variable length data stream and generates its authentication tag in the CCM mode.
Rijndael128DecryptCCM	DEPRECATED. Use Rijndael128CCMDecryptMessage istead of this function. Decrypts and verifies a variable length data stream in the CCM mode.
Rijndael128EncryptCCM_u8	DEPRECATED. Use Rijndael128CCMEncryptMessage istead of this function. Encrypts a variable length data stream and generates its authentication tag in the CCM mode using enhanced interface.
Rijndael128DecryptCCM_u8	DEPRECATED. Use Rijndael128CCMDecryptMessage istead of this function. Decrypts and verifies a variable length data stream in the CCM mode using enhanced interface.
Rijndael192GetSize	Gets the size of the `IppsRijndael192Spec` context.
Rijndael192Init	Initializes user-supplied memory as `IppsRijndael192Spec` context for future use.
Rijndael192EncryptECB	Encrypts plaintext message using Rijndael192 algorithm in the ECB encryption mode.
Rijndael192DecryptECB	Decrypts byte data stream using Rijndael192 algorithm in the ECB mode.
Rijndael192EncryptCBC	Encrypts byte data stream according to Rijndael192 in the CBC mode.
Rijndael192DecryptCBC	Decrypts byte data stream according to Rijndael192 in the CBC mode.

Function Base Name	Operation
Rijndael192EncryptCFB	Encrypts byte data stream according to Rijndael192 in the CFB mode.
Rijndael192DecryptCFB	Decrypts byte data stream according to Rijndael192 in the CFB mode.
Rijndael192EncryptOFB	Encrypts byte data stream according to Rijndael192 in the OFB mode.
Rijndael192DecryptOFB	Decrypts byte data stream according to Rijndael192 in the OFB mode.
Rijndael192EncryptCTR	Encrypts a variable length data stream according to Rijndael192 in the CTR mode.
Rijndael192DecryptCTR	Decrypts a variable length data stream according to Rijndael192 in the CTR mode.
Rijndael256GetSize	Gets the size of the `IppsRijndael256Spec` context.
Rijndael256Init	Initializes user-supplied memory as `IppsRijndael256Spec` context for future use.
Rijndael256EncryptECB	Encrypts plaintext message using Rijndael256 algorithm in the ECB encryption mode.
Rijndael256DecryptECB	Decrypts byte data stream using Rijndael256 algorithm in the ECB mode.
Rijndael256EncryptCBC	Encrypts byte data stream according to Rijndael256 in the CBC mode.
Rijndael256DecryptCBC	Decrypts byte data stream according to Rijndael256 in the CBC mode.
Rijndael256EncryptCFB	Encrypts byte data stream according to Rijndael256 in the CFB mode.
Rijndael256DecryptCFB	Decrypts byte data stream according to Rijndael256 in the CFB mode.
Rijndael256EncryptOFB	Encrypts byte data stream according to Rijndael256 in the OFB mode.

Function Base Name	Operation
Rijndael256DecryptOFB	Decrypts byte data stream according to Rijndael256 in the OFB mode.
Rijndael256EncryptCTR	Encrypts a variable length data stream according to Rijndael256 in the CTR mode.
Rijndael256DecryptCTR	Decrypts a variable length data stream according to Rijndael256 in the CTR mode.

[1] Obsolete. Use AES-CCM Functions.

Throughout this section, the functions for Rijndael128 baseline cipher schemes employ the context IppsRijndael128Spec, the functions for Rijndael192 baseline cipher schemes employ the context IppsRijndael192Spec, and the functions for Rijndael256 baseline cipher schemes employ the context IppsRijndael256Spec. They serve as operational vehicles to carry not only a set of round keys and a set of round inverse keys at the same time, but also the key management information.

Once the respective initialization function generates the round keys, the functions for ECB, CBC, CFB, and other modes are ready for the execution of either encrypting or decrypting the streaming data with the specified padding scheme.

The Intel IPP versions 5.3 or lower employed the implementation of AES (that is, Rijndael128) based on the use of large pre-calculated tables (S-boxes). This implementation provides the best performance. However, the research done in recent years proved vulnerability of this solution to various attacks, for example, timing and cache-behavior attacks. To provide a proper level of protection, IPP 6.0 introduces a safe implementation of the AES algorithm. Though 1.3 times slower than the existing one, the safe implementation is invulnerable to the known implementations of timing and cache-behavior attacks. To use Rijndael128 functions with the safe implementation of the algorithm, call initialization function SafeRijndael128Init. If performance is the priority, call Rijndael128Init.

The application code for conducting a typical encryption under CBC mode using the AES scheme, that is, the Rijndael128 with a 128-bit key, should follow the sequence of operations as outlined below:

1. Get the size required to configure the context IppsRijndael128Spec by calling the function Rijndael128GetSize .
2. Call the operating system memory-allocation service function to allocate a buffer whose size is no less than the one specified by the function Rijndael128GetSize.
3. Initialize the context IppsRijndael128Spec *pCtx by calling the function Rijndael128Init with the allocated buffer and the respective 128-bit AES key.

4. Specify the initialization vector and the padding scheme, then call the function `Rijndael128EncryptCBC` to encrypt the input data stream using the AES encryption function with CBC mode.
5. Call the operating system memory free service function to release the buffer allocated for the context `IppsRijndael128Spec`, if needed.

See also AES-CCM Functions and AES-GCM Functions.

Rijndael128GetSize

Gets the size of the `IppsRijndael128Spec` *context.*

Syntax

```
IppStatus ippsRijndael128GetSize(int* pSize);
```

Parameters

pSize	Pointer to the `IppsRijndael128Spec` context size value.

Description

This function is declared in the `ippcp.h` file. The function gets the `IppsRijndael128Spec` context size in bytes and stores it in **pSize*.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.

Rijndael128Init, SafeRijndael128Init

Initialize user-supplied memory as `IppsRijndael128Spec` *context for future use.*

Syntax

```
IppStatus ippsRijndael128Init(const Ipp8u *pKey, IppsRijndaelKeyLength keylen,
IppsRijndael128Spec* pCtx);
```

```
IppStatus ippsSafeRijndael128Init(const Ipp8u *pKey, IppsRijndaelKeyLength
keylen, IppsRijndael128Spec* pCtx);
```

Parameters

pKey	Pointer to the Rijndael128 key.
keylen	Key byte stream length in bytes defined by the `IppsRijndaelKeyLength` enumerator.
pCtx	Pointer to the `IppsRijndael128Spec` context being initialized.

Description

These functions are declared in the `ippcp.h` file. Each function initializes the memory pointed by *pCtx* as `IppsRijndael128Spec`. In addition, each function uses the key to provide all necessary key material for both encryption and decryption operations. Depending upon whether you wish to employ fast or safe implementation of the AES algorithm, call `Rijndael128Init` or `SafeRijndael128Init`, respectively.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Returns an error condition if *keyLen* is not set to `IppsRijndaelKey128, IppsRijndaelKey192` or `IppsRijndaelKey256`.

Rijndael128EncryptECB

Encrypts plaintext message by using ECB encryption mode.

Syntax

```
IppStatus ippsRijndael128EncryptECB(const Ipp8u *pSrc, Ipp8u *pDst, int
srclen, const IppsRijndael128Spec* pCtx, IppsCPPadding padding);
```

Parameters

pSrc	Pointer to the input plaintext data stream of variable length.
pDst	Pointer to the resulting ciphertext data stream.
srclen	Length of the input plaintext data in bytes.
pCtx	Pointer to the `IppsRijndael128Spec` context.
padding	`IppsCPPaddingNONE` padding scheme.

Description

This function is declared in the `ippcp.h` file. The function encrypts the input data stream of a variable length according to the cipher scheme specified in [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than or equal to zero.
`ippStsUnderRunErr`	Indicates an error condition if *srclen* is not divisible by cipher block size.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

Rijndael128DecryptECB

Decrypts byte data stream by using Rijndael algorithm in the ECB mode.

Syntax

```
IppStatus ippsRijndael128DecryptECB(const Ipp8u* pSrc, Ipp8u* pDst, int srclen, const IppsRijndael128Spec* pCtx, IppsCPPadding padding);
```

Parameters

pSrc	Pointer to the input ciphertext data stream of variable length.

pDst	Pointer to the resulting plaintext data stream of variable length.
srclen	Length of the ciphertext data stream in bytes.
pCtx	Pointer to the `IppsRijndael128Spec` context.
padding	`IppsCPPaddingNONE` padding scheme.

Description

This function is declared in the `ippcp.h` file. The function decrypts the input data stream of a variable length according to the ECB mode as specified in [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the output data stream length is less than or equal to zero.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.
`ippStsUnderRunErr`	Indicates an error condition if *srclen* is not divisible by cipher block size.

Rijndael128EncryptCBC

Encrypts byte data stream according to Rijndael in the CBC mode.

Syntax

```
IppStatus ippsRijndael128EncryptCBC(const Ipp8u* pSrc, Ipp8u* pDst, int srclen, const IppsRijndael128Spec* pCtx, const Ipp8u* pIV, IppsCPPadding padding);
```

Parameters

pSrc	Pointer to the input plaintext data stream of variable length.
pDst	Pointer to the resulting ciphertext data stream.

srclen	Length of the plaintext data stream length in bytes.
pCtx	Pointer to the `IppsRijndael128Spec` context.
pIV	Pointer to the initialization vector for the CBC mode operation.
padding	`IppsCPPaddingNONE` padding scheme.

Description

This function is declared in the `ippcp.h` file. The function encrypts the input data stream of a variable length according to the CBC mode as specified in [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than or equal to zero.
`ippStsUnderRunErr`	Indicates an error condition if `srclen` is not divisible by data block size.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

Rijndael128DecryptCBC

Decrypts byte data stream according to Rijndael in the CBC mode.

Syntax

```
IppStatus ippsRijndael128DecryptCBC(const Ipp8u* pSrc, Ipp8u* pDst, int srclen, const IppsRijndael128Spec* pCtx, const Ipp8u* pIV, IppsCPPadding padding);
```

Parameters

pSrc	Pointer to the input ciphertext data stream.
pDst	Pointer to the resulting plaintext data stream of the variable length.

srclen	Length of the ciphertext data stream length in bytes.
pCtx	Pointer to the `IppsRijndael128Spec` context.
pIV	Pointer to the initialization vector for CBC mode operation.
padding	`IppsCPPaddingNONE` padding scheme.

Description

This function is declared in the `ippcp.h` file. The function decrypts the input data stream of a variable length according to the CBC mode as specified in [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the output data stream length is less than or equal to zero.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.
`ippStsUnderRunErr`	Indicates an error condition if *srclen* is not divisible by cipher block size.

Rijndael128EncryptCFB

Encrypts byte data stream according to Rijndael in the CFB mode.

Syntax

```
IppStatus ippsRijndael128EncryptCFB(const Ipp8u* pSrc, Ipp8u* pDst, int srcLen, int cfbBlkSize, const IppsRijndael128Spec* pCtx, const Ipp8u *pIV, IppsCPPadding padding);
```

Parameters

pSrc	Pointer to the input plaintext data stream of variable length.
pDst	Pointer to the resulting ciphertext data stream.

srcLen	Length of the plaintext data stream in bytes.
cfbBlkSize	Size of the CFB block in bytes.
pCtx	Pointer to the IppsRijndael128Spec context.
pIV	Pointer to the initialization vector for the CFB mode operation.
padding	IppsCPPaddingNONE padding scheme.

Description

This function is declared in the ippcp.h file. The function encrypts the input data stream of variable length according to the CFB mode as specified in [NIST SP 800-38A].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the input data stream length is less than or equal to zero.
ippStsUnderRunErr	Indicates an error condition if *srcLen* is not divisible by *cfbBlkSize* parameter value.
ippStsCFBSizeErr	Indicates an error condition if the value for *cfbBlkSize* is illegal.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

Rijndael128DecryptCFB

Decrypts byte data stream according to Rijndael in CFB mode.

Syntax

```
IppStatus ippsRijndael128DecryptCFB(const Ipp8u* pSrc, Ipp8u* pDst, int srclen, int cfbBlkSize, const IppsRijndael128Spec* pCtx, const Ipp8u* pIV, IppsCPPadding padding);
```

Parameters

pSrc	Pointer to the input ciphertext data stream.

pDst	Pointer to the resulting plaintext data stream of variable length.
srclen	Length of the ciphertext data stream in bytes.
cfbBlkSize	Size of the CFB block in bytes.
pCtx	Pointer to the IppsRijndael128Spec context.
pIV	Pointer to the initialization vector for the CFB mode operation.
padding	IppsCPPaddingNONE padding scheme.

Description

This function is declared in the ippcp.h file. The function decrypts the input data stream of variable length according to the CFB mode as specified in [NIST SP 800-38A].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the output data stream length is less than or equal to zero.
ippStsCFBSizeErr	Indicates an error condition if the value for *cfbBlkSize* is illegal.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsUnderRunErr	Indicates an error condition if *srcLen* is not divisible by cipher block size.

Rijndael128EncryptOFB

Encrypts a variable length data stream according to Rijndael128 in the OFB mode.

Syntax

```
IppStatus ippsRijndael128EncryptOFB (const Ipp8u* pSrc, Ipp8u* pDst, int
srclen, int ofbBlkSize, const IppsRijndael128Spec* pCtx, Ipp8u* pIV);
```

Parameters

pSrc	Pointer to the input plaintext data stream of variable length.
pDst	Pointer to the resulting ciphertext data stream.
srclen	Length of the plaintext data stream in bytes.
ofbBlkSize	Size of the OFB block in bytes.
pCtx	Pointer to the *IppsRijndael128Spec* context.
pIV	Pointer to the initialization vector for the OFB mode operation.

Description

This function is declared in the `ippcp.h` file. The function encrypts the input data stream of a variable length in the OFB mode as specified in [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than or equal to zero.
`ippStsUnderRunErr`	Indicates an error condition if *srclen* is not divisible by the *ofbBlkSize* parameter value.
`ippStsOFBSizeErr`	Indicates an error condition if the value of *ofbBlkSize* is illegal.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

Rijndael128DecryptOFB

Decrypts a variable length data stream according to Rijndael128 in the OFB mode.

Syntax

```
IppStatus ippsRijndael128DecryptOFB (const Ipp8u* pSrc, Ipp8u* pDst, int srclen, int ofbBlkSize, const IppsRijndael128Spec* pCtx, Ipp8u* pIV);
```

Parameters

pSrc	Pointer to the input ciphertext data stream of variable length.
pDst	Pointer to the resulting plaintext data stream.
srclen	Length of the ciphertext data stream in bytes.
ofbBlkSize	Size of the OFB block in bytes.
pCtx	Pointer to the `IppsRijndael128Spec` context.
pIV	Pointer to the initialization vector for the OFB mode operation.

Description

This function is declared in the `ippcp.h` file. The function decrypts the input data stream of a variable length in the OFB mode as specified in [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than or equal to zero.
`ippStsUnderRunErr`	Indicates an error condition if *srclen* is not divisible by the *ofbBlkSize* parameter value.
`ippStsOFBSizeErr`	Indicates an error condition if the value of *ofbBlkSize* is illegal.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

Rijndael128EncryptCTR

Encrypts a variable length data stream in the CTR mode.

Syntax

```
IppStatus ippsRijndael128EncryptCTR(const Ipp8u* pSrc, Ipp8u* pDst, int srcLen, const IppsRijndael128Spec* pCtx, Ipp8u* pCtrValue , int ctrNumBitSize);
```

Parameters

pSrc	Pointer to the input plaintext data stream of a variable length.
pDst	Pointer to the resulting ciphertext data stream.
srcLen	Length of the plaintext data stream in bytes.
pCtx	Pointer to the IppsRijndael128Spec context.
pCtrValue	Pointer to the counter data block.
ctrNumBitSize	Number of bits in the specific part of the counter to be incremented.

Description

This function is declared in the ippcp.h file. The function encrypts the input data stream of a variable length according to the CTR mode as specified in [NIST SP 800-38A].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the input data stream length is less than or equal to zero.
ippStsCTRSizeErr	Indicates an error condition if the value of the *ctrNumBitSize* is illegal.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

Rijndael128DecryptCTR

Decrypts a variable length data stream in the CTR mode.

Syntax

```
IppStatus ippsRijndael128DecryptCTR(const Ipp8u* pSrc, Ipp8u* pDst, int srcLen, const  IppsRijndael128Spec* pCtx, Ipp8u* pCtrValue, int ctrNumBitSize);
```

Parameters

pSrc	Pointer to the input ciphertext data stream.
pDst	Pointer to the resulting plaintext data stream of a variable length.
srcLen	Length of the plaintext data stream in bytes.
pCtx	Pointer to the `IppsRijndael128Spec` context.
pCtrValue	Pointer to the counter data block.
ctrNumBitSize	Number of bits in the specific part of the counter to be incremented.

Description

This function is declared in the `ippcp.h` file. The function decrypts the input data stream of a variable length according to the CTR mode as specified in the [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the output data stream length is less than or equal to zero.
`ippStsCTRSizeErr`	Indicates an error condition if the value of the *ctrNumBitSize* is illegal.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

Rijndael128EncryptCCM

DEPRECATED. Encrypts a variable length data stream and generates its authentication tag in the CCM mode.

Syntax

```
IppStatus ippsRijndael128EncryptCCM(const Ipp8u* pNonce, Ipp32u nonceLen,
const Ipp8u* pAssc, Ipp64u asscLen, const Ipp8u* pSrc, Ipp64u srcLen, int
macLen, Ipp8u* pDst, const IppsRijndael128Spec* pCtx);
```

Parameters

pNonce	Pointer to the nonce.
nonceLen	Length of the nonce **pNonce* (in octets).
pAssc	Pointer to the assosiated data.
asscLen	Length of the assosiated data **pAssc* (in octets).
pSrc	Pointer to the input plaintext data.
srcLen	Length of the input plaintext **pSrc* (in octets).
macLen	Length of the authentication tag in octets.
pDst	Pointer to the resulting ciphertext data stream.
pCtx	Pointer to the `IppsRijndael128Spec` context.

Description

This function is deprecated. Use Rijndael128CCMEncryptMessage istead of this function.

This function is declared in the `ippcp.h` file. The function encrypts the input data stream of a variable length and computes the authentication tag according to the Counter with Cipher Block Chaining-Message Authentication Code (CCM) mode, as specified in [NIST SP 800-38C]. Unless you have successfully implemented the encryption with this function, you are encouraged to use the newer function `Rijndael128EncryptCCM_u8` having the same functionality.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the length input data does not meet any of the following conditions: $7 \le nonceLen \le 13$ $asscLen \ge 0$ $srcLen \ge 1$ $macLen = 2n$, $1 \le n \le 8$.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

Rijndael128EncryptCCM_u8

DEPRECATED. Encrypts a variable length data stream and generates its authentication tag in the CCM mode.

Syntax

```
IppStatus ippsRijndael128EncryptCCM_u8(const Ipp8u* pNonce, int nonceLen,
const Ipp8u* pAssc, int asscLen, const Ipp8u* pSrc, int srcLen, int macLen,
Ipp8u* pDst, const IppsRijndael128Spec* pCtx);
```

Parameters

pNonce	Pointer to the nonce.
nonceLen	Length of the nonce **pNonce* (in octets).
pAssc	Pointer to the assosiated data.
asscLen	Length of the assosiated data **pAssc* (in octets).
pSrc	Pointer to the input plaintext data.
srcLen	Length of the input plaintext **pSrc* (in octets).
macLen	Length of the authentication tag in octets.
pDst	Pointer to the resulting ciphertext data stream.
pCtx	Pointer to the `IppsRijndael128Spec` context.

Description

This function is deprecated. Use Rijndael128CCMEncryptMessage istead of this function.

This function is declared in the `ippcp.h` file. The function encrypts the input data stream of a variable length and computes the authentication tag according to the CCM mode, as specified in [NIST SP 800-38C]. Unlike `Rijndael128EncryptCCM`, `Rijndael128EncryptCCM_u8` employs the `int` data type for *all* length parameters. Use this function rather than `Rijndael128EncryptCCM`.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.

ippStsLengthErr	Indicates an error condition if the length input data does not meet any of the following conditions: $7 \le nonceLen \le 13$ $asscLen \ge 0$ $srcLen \ge 1$ $macLen = 2n, 1 \le n \le 8$.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

Rijndael128DecryptCCM

DEPRECATED. Decrypts and verifies a variable length data stream in the CCM mode.

Syntax

```
IppStatus ippsRijndael128DecryptCCM(const Ipp8u* pNonce, Ipp32u nonceLen,
const Ipp8u* pAssc, Ipp64u asscLen, const Ipp8u* pSrc, Ipp64u srcLen, int
macLen, Ipp8u* pDst, IppBool* pResult, const IppsRijndael128Spec* pCtx);
```

Parameters

pNonce	Pointer to the nonce of length.
nonceLen	Length of the nonce **pNonce* (in octets).
pAssc	Pointer to the assosiated data.
asscLen	Length of the assosiated data **pAssc* (in octets).
pSrc	Pointer to the input ciphertext data.
srcLen	Length of the input ciphertext * *pSrc* (in octets).
macLen	Length of the authentication tag in octets.
pDst	Pointer to the resulting plaintext data stream.
pResult	Pointer to the result of verification.
pCtx	Pointer to the IppsRijndael128Spec context.

Description

This function is deprecated. Use Rijndael128CCMDecryptMessage istead of this function.

This function is declared in the ippcp.h file. The function decrypts the input data stream of a variable length and verifies the authentication tag according to the CCM mode, as specified in [NIST SP 800-38C] . Unless you have successfully implemented the decryption with this function, you are encouraged to use the newer function Rijndael128DecryptCCM_u8 having the same functionality.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	ndicates an error condition if the length input data does not meet any of the following conditions: $7 \le nonceLen \le 13$ $srcLen > macLen$ $macLen = 2n, 1 \le n \le 8$.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

Rijndael128DecryptCCM_u8

DEPRECATED. Decrypts and verifies a variable length data stream in the CCM mode.

Syntax

```
IppStatus ippsRijndael128DecryptCCM_u8(const Ipp8u* pNonce, int nonceLen,
const Ipp8u* pAssc, int asscLen, const Ipp8u* pSrc, int srcLen, int macLen,
Ipp8u* pDst, IppBool* pResult, const IppsRijndael128Spec* pCtx);
```

Parameters

pNonce	Pointer to the nonce of length.
nonceLen	Length of the nonce **pNonce* (in octets).
pAssc	Pointer to the assosiated data.
asscLen	Length of the assosiated data **pAssc* (in octets).
pSrc	Pointer to the input ciphertext data.
srcLen	Length of the input ciphertext * *pSrc* (in octets).
macLen	Length of the authentication tag in octets.

pDst	Pointer to the resulting plaintext data stream.
pResult	Pointer to the result of verification.
pCtx	Pointer to the IppsRijndael128Spec context.

Description

This function is deprecated. Use Rijndael128CCMDecryptMessage istead of this function.

This function is declared in the ippcp.h file. The function decrypts the input data stream of a variable length and verifies the authentication tag according to the CCM mode, as specified in [NIST SP 800-38C]. Unlike Rijndael128DecryptCCM, Rijndael128DecryptCCM_u8 employs the int data type for *all* length parameters. Use this function rather than Rijndael128DecryptCCM.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	ndicates an error condition if the length input data does not meet any of the following conditions: $7 \le nonceLen \le 13$ $asscLen \ge 0$ $srcLen > macLen$ $macLen = 2n, 1 \le n \le 8$.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

Rijndael192GetSize

Gets the size of the IppsRijndael192Spec *context.*

Syntax

```
IppStatus ippsRijndael192GetSize(int* pSize);
```

Parameters

pSize	Pointer to the IppsRijndael192Spec context size value.

Description

This function is declared in the `ippcp.h` file. The function gets the `IppsRijndael192Spec` context size in bytes and stores it in *`*pSize`*.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.

Rijndael192Init

Initializes user-supplied memory as the `IppsRijndael192Spec` *context for future use.*

Syntax

```
IppStatus ippsRijndael192Init(const Ipp8u *pKey, IppsRijndaelKeyLength keylen,
IppsRijndael192Spec* pCtx);
```

Parameters

`pKey`	Pointer to the Rijndael192 key.
`keylen`	Key byte stream length in bytes as defined by the `IppsRijndaelKeyLength` enumerator.
`pCtx`	Pointer to the `IppsRijndael192Spec` context.

Description

This function is declared in the `ippcp.h` file. The function initializes the memory pointed by *`pCtx`* as the `IppsRijndael192Spec` context. In addition, the function uses the key to provide all the necessary key material for both encryption and decryption operations.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.

ippStsLengthErr	Indicates an error condition if *keylen* is not set to IppsRijndaelKey128, IppsRijndaelKey192 or IppsRijndaelKey256.

Rijndael192EncryptECB

Encrypts a byte data stream according to Rijndael in the ECB mode.

Syntax

```
IppStatus ippsRijndael192EncryptECB(const Ipp8u *pSrc, Ipp8u *pDst, int srclen, const IppsRijndael192Spec* pCtx, IppsCPPadding padding);
```

Parameters

pSrc	Pointer to the input plaintext data stream of variable length.
pDst	Pointer to the resulting ciphertext data stream.
srclen	Length of the input data stream in bytes.
pCtx	Pointer to the IppsRijndael192Spec context.
padding	IppsCPPaddingNONE padding scheme.

Description

This function is declared in the ippcp.h file. The function encrypts the input data stream of a variable length according to the cipher scheme specified in [NIST SP 800-38A].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the input data stream length is less than or equal to 0.
ippStsUnderRunErr	Indicates an error condition if *srclen* is not divisible by data block size.

ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

Rijndael192DecryptECB

Decrypts byte data stream according to Rijndael in the EBC mode.

Syntax

```
IppStatus ippsRijndael192DecryptECB(const Ipp8u* pSrc, Ipp8u* pDst, int srclen, const IppsRijndael192Spec *pCtx, IppsCPPadding padding);
```

Parameters

pSrc	Pointer to the input ciphertext data stream of variable length.
pDst	Pointer to the resulting plaintext data stream of variable length.
srclen	Length of the ciphertext data stream in bytes.
pCtx	Pointer to the IppsRijndael192Spec context.
padding	IppsCPPaddingNONE padding scheme.

Description

This function is declared in the ippcp.h file. The function decrypts the input data stream of a variable length according to the ECB mode as specified in [NIST SP 800-38A].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the output data stream length is less than or equal to zero.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsUnderRunErr	Indicates an error condition if *srclen* is not divisible by cipher block size.

Rijndael192EncryptCBC

Encrypts a byte data stream according to Rijndael in the CBC mode.

Syntax

```
IppStatus ippsRijndael192EncryptCBC(const Ipp8u* pSrc, Ipp8u* pDst, int srclen, const IppsRijndael192Spec* pCtx, const Ipp8u* pIV, IppsCPPadding padding);
```

Parameters

pSrc	Pointer to the input plaintext data stream of variable length.
pDst	Pointer to the resulting ciphertext data stream.
srclen	Length of the plaintext data stream length in bytes.
pCtx	Pointer to the `IppsRijndael192Spec` context.
pIV	Pointer to the initialization vector for the CBC mode operation.
padding	`IppsCPPaddingNONE` padding scheme.

Description

This function is declared in the `ippcp.h` file. The function encrypts the input data stream of a variable length according to the CBC mode as specified in [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than or equal to zero.
`ippStsUnderRunErr`	Indicates an error condition if `srclen` is not divisible by data block size.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

Rijndael192DecryptCBC

Decrypts a byte data stream according to Rijndael in the CBC mode.

Syntax

```
IppStatus ippsRijndael192DecryptCBC(const Ipp8u* pSrc, Ipp8u* pDst, int srclen, const IppsRijndael192Spec* pCtx, const Ipp8u* pIV, IppsCPPadding padding);
```

Parameters

pSrc	Pointer to the input ciphertext data stream.
pDst	Pointer to the resulting plaintext data stream of the variable length.
srclen	Length of the ciphertext data stream length in bytes.
pCtx	Pointer to the `IppsRijndael192Spec` context.
pIV	Pointer to the initialization vector for CBC mode operation.
padding	`IppsCPPaddingNONE` padding scheme.

Description

This function is declared in the `ippcp.h` file. The function decrypts the input data stream of a variable length according to the CBC mode as specified in [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the output data stream length is less than or equal to zero.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.
`ippStsUnderRunErr`	Indicates an error condition if *srclen* is not divisible by cipher block size.

Rijndael192EncryptCFB

Encrypts a byte data stream according to Rijndael in the CFB mode.

Syntax

```
IppStatus ippsRijndael192EncryptCFB(const Ipp8u* pSrc, Ipp8u* pDst, int srcLen, int cfbBlkSize, const IppsRijndael192Spec* pCtx, const Ipp8u* pIV, IppsCPPadding padding);
```

Parameters

pSrc	Pointer to the input plaintext data stream of variable length.
pDst	Pointer to the resulting ciphertext data stream.
srcLen	Length of the plaintext data stream in bytes.
cfbBlkSize	Size of the CFB block in bytes.
pCtx	Pointer to the `IppsRijndael192Spec` context.
pIV	Pointer to the initialization vector for the CFB mode operation.
padding	`IppsCPPaddingNONE` padding scheme.

Description

This function is declared in the `ippcp.h` file. The function encrypts the input data stream of variable length according to the CFB mode as specified in [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than or equal to zero.
`ippStsUnderRunErr`	Indicates an error condition if *srcLen* is not divisible by *cfbBlkSize* parameter value.
`ippStsCFBSizeErr`	Indicates an error condition if the value for *cfbBlkSize* is illegal.

ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

Rijndael192DecryptCFB

Decrypts a byte data stream according to Rijndael in the CFB mode.

Syntax

```
IppStatus ippsRijndael192DecryptCFB(const Ipp8u* pSrc, Ipp8u* pDst, int srclen, int cfbBlkSize, const IppsRijndael192Spec* pCtx, const Ipp8u* pIV, IppsCPPadding padding);
```

Parameters

pSrc	Pointer to the input ciphertext data stream.
pDst	Pointer to the resulting plaintext data stream of variable length.
srclen	Length of the ciphertext data stream in bytes.
cfbBlkSize	Size of the CFB block in bytes.
pCtx	Pointer to the `IppsRijndael192Spec` context.
pIV	Pointer to the initialization vector for the CFB mode operation.
padding	`IppsCPPaddingNONE` padding scheme.

Description

This function is declared in the `ippcp.h` file. The function decrypts the input data stream of variable length according to the CFB mode as specified in [NIST SP 800-38A].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is `NULL`.
ippStsLengthErr	Indicates an error condition if the output data stream length is less than or equal to zero.
ippStsCFBSizeErr	Indicates an error condition if the value for *cfbBlkSize* is illegal.

ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsUnderRunErr	Indicates an error condition if *srcLen* is not divisible by cipher block size.

Rijndael192EncryptOFB

Encrypts a variable length data stream according to Rijndael192 in the OFB mode.

Syntax

```
IppStatus ippsRijndael192EncryptOFB (const Ipp8u* pSrc, Ipp8u* pDst, int srclen, int ofbBlkSize, const IppsRijndael192Spec* pCtx, Ipp8u* pIV);
```

Parameters

pSrc	Pointer to the input plaintext data stream of variable length.
pDst	Pointer to the resulting ciphertext data stream.
srclen	Length of the plaintext data stream in bytes.
ofbBlkSize	Size of the OFB block in bytes.
pCtx	Pointer to the IppsRijndael192Spec context.
pIV	Pointer to the initialization vector for the OFB mode operation.

Description

This function is declared in the ippcp.h file. The function encrypts the input data stream of a variable length in the OFB mode as specified in [NIST SP 800-38A].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the input data stream length is less than or equal to zero.

ippStsUnderRunErr	Indicates an error condition if *srclen* is not divisible by the *ofbBlkSize* parameter value.
ippStsOFBSizeErr	Indicates an error condition if the value of *ofbBlkSize* is illegal.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

Rijndael192DecryptOFB

Decrypts a variable length data stream according to Rijndael192 in the OFB mode.

Syntax

```
IppStatus ippsRijndael192DecryptOFB (const Ipp8u* pSrc, Ipp8u* pDst, int srclen, int ofbBlkSize, const IppsRijndael192Spec* pCtx, Ipp8u* pIV);
```

Parameters

pSrc	Pointer to the input ciphertext data stream of variable length.
pDst	Pointer to the resulting plaintext data stream.
srclen	Length of the ciphertext data stream in bytes.
ofbBlkSize	Size of the OFB block in bytes.
pCtx	Pointer to the IppsRijndael192Spec context.
pIV	Pointer to the initialization vector for the OFB mode operation.

Description

This function is declared in the ippcp.h file. The function decrypts the input data stream of a variable length in the OFB mode as specified in [NIST SP 800-38A].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the input data stream length is less than or equal to zero.

ippStsUnderRunErr	Indicates an error condition if *srclen* is not divisible by the *ofbBlkSize* parameter value.
ippStsOFBSizeErr	Indicates an error condition if the value of *ofbBlkSize* is illegal.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

Rijndael192EncryptCTR

Encrypts a variable length data stream in the CTR mode.

Syntax

```
IppStatus ippsRijndael192EncryptCTR(const Ipp8u* pSrc, Ipp8u* pDst, int srcLen, const IppsRijndael192Spec* pCtx, Ipp8u* pCtrValue , int ctrNumBitSize);
```

Parameters

pSrc	Pointer to the input plaintext data stream of a variable length.
pDst	Pointer to the resulting ciphertext data stream.
srcLen	Length of the plaintext data stream in bytes.
pCtx	Pointer to the IppsRijndael192Spec context.
pCtrValue	Pointer to the counter data block.
ctrNumBitSize	Number of bits in the specific part of the counter to be incremented.

Description

This function is declared in the ippcp.h file. The function encrypts the input data stream of a variable length according to the CTR mode as specified in [NIST SP 800-38A].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

ippStsLengthErr	Indicates an error condition if the input data stream length is less than or equal to zero.
ippStsCTRSizeErr	Indicates an error condition if the value of the *ctrNumBitSize* is illegal.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

Rijndael192DecryptCTR

Decrypts a variable length data stream in the CTR mode.

Syntax

```
IppStatus ippsRijndael192DecryptCTR(const Ipp8u* pSrc, Ipp8u* pDst, int srcLen, const  IppsRijndael192Spec* pCtx, Ipp8u* pCtrValue, int ctrNumBitSize);
```

Parameters

pSrc	Pointer to the input ciphertext data stream.
pDst	Pointer to the resulting plaintext data stream of a variable length.
srcLen	Length of the plaintext data stream in bytes.
pCtx	Pointer to the IppsRijndael192Spec context.
pCtrValue	Pointer to the counter data block.
ctrNumBitSize	Number of bits in the specific part of the counter to be incremented.

Description

This function is declared in the *ippcp.h* file. The function decrypts the input data stream of a variable length according to the CTR mode as specified in the [NIST SP 800-38A].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

ippStsLengthErr	Indicates an error condition if the output data stream length is less than or equal to zero.
ippStsCTRSizeErr	Indicates an error condition if the value of the *ctrNumBitSize* is illegal.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

Rijndael256GetSize

Gets the size of the IppsRijndael256Spec *context.*

Syntax

```
IppStatus ippsRijndael256GetSize(int* pSize);
```

Parameters

pSize	Pointer to the IppsRijndael256Spec context size value.

Description

This function is declared in the ippcp.h file. The function gets the IppsRijndael256Spec context size in bytes and stores it in **pSize*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

Rijndael256Init

Initializes user-supplied memory as IppsRijndael256Spec *context for future use.*

Syntax

```
IppStatus ippsRijndael256Init(const Ipp8u *pKey, IppsRijndaelKeyLength keylen,
IppsRijndael256Spec* pCtx);
```

Parameters

pKey	Pointer to the Rijndael256 key.
keylen	Key byte stream length in bytes defined by the `IppsRijndaelKeyLength` enumerator.
pCtx	Pointer to the `IppsRijndael256Spec` context being initialized.

Description

This function is declared in the `ippcp.h` file. The function initializes the memory pointed by *pCtx* as the `IppsRijndael256Spec` context. In addition, the function uses the key to provide all necessary key material for both encryption and decryption operations.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if *keylen* is not set to `IppsRijndaelKey128`, `IppsRijndaelKey192` or `IppsRijndaelKey256`.

Rijndael256EncryptECB

Encrypts a byte data stream according to Rijndael in the ECB mode.

Syntax

```
IppStatus ippsRijndael256EncryptECB(const Ipp8u *pSrc, Ipp8u *pDst, int srclen, const IppsRijndael256Spec* pCtx, IppsCPPadding padding);
```

Parameters

pSrc	Pointer to the input plaintext data stream of variable length.
pDst	Pointer to the resulting ciphertext data stream.
srclen	Length of the input data stream in bytes.

pCtx	Pointer to the IppsRijndael256Spec context.
padding	IppsCPPaddingNONE padding scheme.

Description

This function is declared in the ippcp.h file. The function encrypts the input data stream of a variable length according to the cipher scheme specified in [NIST SP 800-38A].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the input data stream length is less than or equal to 0.
ippStsUnderRunErr	Indicates an error condition if *srclen* is not divisible by data block size.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

Rijndael256DecryptECB

Decrypts a byte data stream according to Rijndael in the ECB mode.

Syntax

```
IppStatus ippsRijndael256DecryptECB(const Ipp8u* pSrc, Ipp8u* pDst, int
srclen, const IppsRijndael256Spec* pCtx, IppsCPPadding padding);
```

Parameters

pSrc	Pointer to the input ciphertext data stream of variable length.
pDst	Pointer to the resulting plaintext data stream of variable length.
srclen	Length of the ciphertext data stream in bytes.
pCtx	Pointer to the IppsRijndael256Spec context.

padding	IppsCPPaddingNONE padding scheme.

Description

This function is declared in the ippcp.h file. The function decrypts the input data stream of a variable length according to the ECB mode as specified in [NIST SP 800-38A].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the output data stream length is less than or equal to zero.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsUnderRunErr	Indicates an error condition if *srclen* is not divisible by cipher block size.

Rijndael256EncryptCBC

Encrypts byte data stream according to Rijndael in the CBC mode.

Syntax

```
IppStatus ippsRijndael256EncryptCBC(const Ipp8u* pSrc, Ipp8u* pDst, int srclen, const IppsRijndael256Spec* pCtx, const Ipp8u* pIV, IppsCPPadding padding);
```

Parameters

pSrc	Pointer to the input plaintext data stream of variable length.
pDst	Pointer to the resulting ciphertext data stream.
srclen	Length of the plaintext data stream length in bytes.
pCtx	Pointer to the IppsRijndael256Spec context.
pIV	Pointer to the initialization vector for the CBC mode operation.

padding	IppsCPPaddingNONE padding scheme.

Description

This function is declared in the ippcp.h file. The function encrypts the input data stream of a variable length according to the CBC mode as specified in [NIST SP 800-38A].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the input data stream length is less than or equal to zero.
ippStsUnderRunErr	Indicates an error condition if srclen is not divisible by data block size.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

Rijndael256DecryptCBC

Decrypts byte data stream according to Rijndael in the CBC mode.

Syntax

```
IppStatus ippsRijndael256DecryptCBC(const Ipp8u* pSrc, Ipp8u* pDst, int srclen, const IppsRijndael256Spec* pCtx, const Ipp8u* pIV, IppsCPPadding padding);
```

Parameters

pSrc	Pointer to the input ciphertext data stream.
pDst	Pointer to the resulting plaintext data stream of the variable length.
srclen	Length of the ciphertext data stream length in bytes.
pCtx	Pointer to the IppsRijndael256Spec context.
pIV	Pointer to the initialization vector for CBC mode operation.

padding	IppsCPPaddingNONE padding scheme.

Description

This function is declared in the ippcp.h file. The function decrypts the input data stream of a variable length according to the CBC mode as specified in [NIST SP 800-38A].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the output data stream length is less than or equal to zero.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsUnderRunErr	Indicates an error condition if *srclen* is not divisible by cipher block size.

Rijndael256EncryptCFB

Encrypts byte data stream according to Rijndael in the CFB mode.

Syntax

```
IppStatus ippsRijndael256EncryptCFB(const Ipp8u* pSrc, Ipp8u* pDst, int srcLen, int cfbBlkSize, const IppsRijndael256Spec* pCtx, const Ipp8u* pIV, IppsCPPadding padding);
```

Parameters

pSrc	Pointer to the input plaintext data stream of variable length.
pDst	Pointer to the resulting ciphertext data stream.
srcLen	Length of the plaintext data stream in bytes.
cfbBlkSize	Size of the CFB block in bytes.
pCtx	Pointer to the IppsRijndael256Spec context.

pIV	Pointer to the initialization vector for the CFB mode operation.
padding	IppsCPPaddingNONE padding scheme.

Description

This function is declared in the ippcp.h file. The function encrypts the input data stream of variable length according to the CFB mode as specified in [NIST SP 800-38A].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the input data stream length is less than or equal to zero.
ippStsUnderRunErr	Indicates an error condition if *srcLen* is not divisible by *cfbBlkSize* parameter value.
ippStsCFBSizeErr	Indicates an error condition if the value for *cfbBlkSize* is illegal.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

Rijndael256DecryptCFB

Decrypts byte data stream according to Rijndael in the CFB mode.

Syntax

```
IppStatus ippsRijndael256DecryptCFB(const Ipp8u* pSrc, Ipp8u* pDst, int srclen, int cfbBlkSize, const IppsRijndael256Spec* pCtx, const Ipp8u* pIV, IppsCPPadding padding);
```

Parameters

pSrc	Pointer to the input ciphertext data stream.
pDst	Pointer to the resulting plaintext data stream of variable length.
srclen	Length of the ciphertext data stream in bytes.

cfbBlkSize	Size of the CFB block in bytes.
pCtx	Pointer to the `IppsRijndael256Spec` context.
pIV	Pointer to the initialization vector for the CFB mode operation.
padding	`IppsCPPaddingNONE` padding scheme.

Description

This function is declared in the `ippcp.h` file. The function decrypts the input data stream of variable length according to the CFB mode as specified in [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the output data stream length is less than or equal to zero.
`ippStsCFBSizeErr`	Indicates an error condition if the value for *cfbBlkSize* is illegal.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.
`ippStsUnderRunErr`	Indicates an error condition if *srcLen* is not divisible by cipher block size.

Rijndael256EncryptOFB

Encrypts a variable length data stream according to Rijndael256 in the OFB mode.

Syntax

```
IppStatus ippsRijndael256EncryptOFB (const Ipp8u* pSrc, Ipp8u* pDst, int srclen, int ofbBlkSize, const IppsRijndael256Spec* pCtx, Ipp8u* pIV);
```

Parameters

pSrc	Pointer to the input plaintext data stream of variable length.
pDst	Pointer to the resulting ciphertext data stream.

srclen	Length of the plaintext data stream in bytes.
ofbBlkSize	Size of the OFB block in bytes.
pCtx	Pointer to the IppsRijndael256Spec context.
pIV	Pointer to the initialization vector for the OFB mode operation.

Description

This function is declared in the ippcp.h file. The function encrypts the input data stream of a variable length in the OFB mode as specified in [NIST SP 800-38A].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the input data stream length is less than or equal to zero.
ippStsUnderRunErr	Indicates an error condition if *srclen* is not divisible by the *ofbBlkSize* parameter value.
ippStsOFBSizeErr	Indicates an error condition if the value of *ofbBlkSize* is illegal.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

Rijndael256DecryptOFB

Decrypts a variable length data stream according to Rijndael256 in the OFB mode.

Syntax

```
IppStatus ippsRijndael256DecryptOFB (const Ipp8u* pSrc, Ipp8u* pDst, int srclen, int ofbBlkSize, const IppsRijndael256Spec* pCtx, Ipp8u* pIV);
```

Parameters

pSrc	Pointer to the input ciphertext data stream of variable length.
pDst	Pointer to the resulting plaintext data stream.

srclen	Length of the ciphertext data stream in bytes.
ofbBlkSize	Size of the OFB block in bytes.
pCtx	Pointer to the IppsRijndael256Spec context.
pIV	Pointer to the initialization vector for the OFB mode operation.

Description

This function is declared in the ippcp.h file. The function decrypts the input data stream of a variable length in the OFB mode as specified in [NIST SP 800-38A].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the input data stream length is less than or equal to zero.
ippStsUnderRunErr	Indicates an error condition if *srclen* is not divisible by the *ofbBlkSize* parameter value.
ippStsOFBSizeErr	Indicates an error condition if the value of *ofbBlkSize* is illegal.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

Rijndael256EncryptCTR

Encrypts a variable length data stream in the CTR mode.

Syntax

```
IppStatus ippsRijndael256EncryptCTR(const Ipp8u* pSrc, Ipp8u* pDst, int srcLen, const IppsRijndael256Spec* pCtx, Ipp8u* pCtrValue , int ctrNumBitSize);
```

Parameters

pSrc	Pointer to the input plaintext data stream of a variable length.

pDst	Pointer to the resulting ciphertext data stream.
srcLen	Length of the plaintext data stream in bytes.
pCtx	Pointer to the IppsRijndael256Spec context.
pCtrValue	Pointer to the counter data block.
ctrNumBitSize	Number of bits in the specific part of the counter to be incremented.

Description

This function is declared in the ippcp.h file. The function encrypts the input data stream of a variable length according to the CTR mode as specified in [NIST SP 800-38A].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the input data stream length is less than or equal to zero.
ippStsCTRSizeErr	Indicates an error condition if the value of the *ctrNumBitSize* is illegal.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

Rijndael256DecryptCTR

Decrypts a variable length data stream in the CTR mode.

Syntax

```
IppStatus ippsRijndael256DecryptCTR(const Ipp8u* pSrc, Ipp8u* pDst, int
srcLen, const  IppsRijndael256Spec* pCtx, Ipp8u* pCtrValue, int
ctrNumBitSize);
```

Parameters

pSrc	Pointer to the input ciphertext data stream.

pDst	Pointer to the resulting plaintext data stream of a variable length.
srcLen	Length of the plaintext data stream in bytes.
pCtx	Pointer to the `IppsRijndael256Spec` context.
pCtrValue	Pointer to the counter data block.
ctrNumBitSize	Number of bits in the specific part of the counter to be incremented.

Description

This function is declared in the `ippcp.h` file. The function decrypts the input data stream of a variable length according to the CTR mode as specified in the [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the output data stream length is less than or equal to zero.
`ippStsCTRSizeErr`	Indicates an error condition if the value of the *ctrNumBitSize* is illegal.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

Example of Using Rijndael Functions

Example 2-2 AES Encryption and Decryption

```
    // use of the CTR mode
void AES_sample(void){
   // size of Rijndael-128 algorithm block is equal to 16
   const int aesBlkSize = 16;

   // get the size of the context needed for the encryption/decryption operation
   int ctxSize;
   ippsRijndael128GetSize(&ctxSize);

   // and allocate one
   IppsRijndael128Spec* pCtx = (IppsRijndael128Spec*)( new Ipp8u [ctxSize] );
   // define the key
   Ipp8u key[16] = {0x00,0x01,0x02,0x03,0x04,0x05,0x06,0x07,
                    0x08,0x09,0x10,0x11,0x12,0x13,0x14,0x15};

   // and prepare the context for Rijndael128 usage
   ippsRijndael128Init(key,IppsRijndaelKey128, pCtx);

   // define the message to be encrypted
   Ipp8u ptext[] = {"quick brown fox jupm over lazy dog"};

  // define an initial vector
   Ipp8u crt0[aesBlkSize] = {0xff,0xee,0xdd,0xcc,0xbb,0xaa,0x99,0x88,
   0x77,0x66,0x55,0x44,0x33,0x22,0x11,0x00};
   Ipp8u  crt[aesBlkSize];
```

```
// counter the variable number of bits
int ctrNumBitSize = 64;


 // allocate enough memory for the ciphertext
// note that
// the size of the ciphertext is always equal to that of the planetext
Ipp8u ctext[sizeof(ptext)];

// init the counter
memcpy(crt, crt0, sizeof(crt0));
// encrypt (CTR mode) ptext message
// pay attention to the 'length' parameter
// it defines the number of bytes to be encrypted
memcpy(crt, crt0, sizeof(crt0));
ippsRijndael128EncryptCTR(ptext, ctext, sizeof(ptext),
                          pCtx,
                          crt, ctrNumBitSize);

// allocate memory for the decrypted message
Ipp8u rtext[sizeof(ptext)];

// init the counter
memcpy(crt, crt0, sizeof(crt0));


// decrypt (ECTR mode) ctext message
```

```
    // pay attention to the 'length' parameter
    // it defines the number of bytes to be decrypted
    ippsRijndael128DecryptCTR(ctext, rtext, sizeof(ptext),
                              pCtx,
                              crt, ctrNumBitSize);
    delete (Ipp8u*)pCtx;
}
```

AES-CCM Functions

This section describes functions for authenticated encryption/decryption using the Counter with Cipher Block Chaining-Message Authentication Code (CCM) mode [NIST SP 800-38C] of the AES (Rijndael128) block cipher.

Table 2-4 lists Intel IPP AES-CCM functions:

Table 2-4 Intel IPP AES-CCM Functions

Function Base Name	Operation
Rijndael128CCMEncryptMessage	Encrypts an entire message and generates its authentication tag in the CCM mode.
Rijndael128CCMDecryptMessage	Decrypts an entire message and generates its authentication tag in the CCM mode.
Rijndael128CCMGetSize	Gets the size of the IppsRijndael128CCMState context.
Rijndael128CCMInit	Initializes user-supplied memory as the IppsRijndael128CCMState context for future use.
Rijndael128CCMStart	Starts the process of authenticated encryption/decryption for a new message.
Rijndael128CCMEncrypt	Encrypts a data buffer in the CCM mode.
Rijndael128CCMDecrypt	Decrypts a data buffer in the CCM mode.
Rijndael128CCMGetTag	Generates the message authentication tag in the CCM mode.
Rijndael128CCMMessageLen	Sets up the length of the message to be processed.
Rijndael128CCMTagLen	Sets up the length of the required authentication tag.

The Intel IPP AES-CCM function set includes:

- Functions for complete message operations, to be used for authenticated encryption/decryption of an entire message, if available: Rijndael128CCMEncryptMessage and Rijndael128CCMDecryptMessage

- Incremental functions, to be used if the message is too long to be processed in one step.

The AES-CCM incremental functions enable authenticated encryption/decryption of several messages using one key that the Rijndael128CCMInit function specifies. The processing of each new message starts with a call to the Rijndael128CCMStart function. The application code for conducting a typical AES-CCM authenticated encryption should follow the sequence of operations as outlined below:

1. Get the size required to configure the context IppsRijndael128CCMState by calling the function Rijndael128CCMGetSize.
2. Call the system memory-allocation service function to allocate a buffer whose size is not less than the function Rijndael128CCMGetSize specifies.
3. Initialize the context IppsRijndael128CCMState *pCtx by calling the function Rijndael128CCMInit with the allocated buffer and the respective AES key.
4. Optionally call Rijndael128CCMMessageLen and/or Rijndael128CCMTagLen to set up message and tag parameters.
5. Call Rijndael128CCMStart to start authenticated encryption of the first/next message.
6. Keep calling Rijndael128CCMEncrypt until the entire message is processed.
7. Request the authentication tag by calling Rijndael128CCMGetTag.
8. Proceed to the next message, if any, that is, go to step 5.
9. Call the system memory free service function to release the buffer allocated for the context IppsRijndael128Spec, if needed.

Rijndael128CCMEncryptMessage

Encrypts an entire message and generates its authentication tag in the CCM mode.

Syntax

```
IppStatus ippsRijndael128CCMEncryptMessage(const Ipp8u* pKey,
IppsRijndaelKeyLength keyLen, const Ipp8u* pIV, Ipp32u ivLen, const Ipp8u*
pAAD, Ipp32u addLen,const Ipp8u* pSrc, Ipp8u* pDst, Ipp32u len, Ipp8u* pTag,
Ipp32u tagLen);
```

Parameters

pKey	Pointer to the secret key.
keyLength	Length of the secret key.
pIV	Pointer to the initialization vector.
ivLen	Length of the initialization vector **pIV* (in bytes).

pAAD	Pointer to the additional authenticated data (not to be encrypted).
aadLen	Length of the additional authenticated data **pAAD* (in bytes).
pSrc	Pointer to the input plaintext data stream of a variable length.
pDst	Pointer to the resulting ciphertext data stream.
len	Length of the plaintext and ciphertext data stream (in bytes).
pTag	Pointer to the authentication tag.
tagLen	Length of the authentication tag **pTag* (in bytes).

Description

This function is declared in the `ippcp.h` file. The function encrypts the input data stream of a variable length and computes the authentication tag in the CCM mode as specified in [NIST SP 800-38C]. Use this function if the entire message is available. Otherwise, follow the typical sequence of invoking the incremental functions (see AES-CCM Functions).

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the length parameters do not meet any of the following conditions: *keyLen* = `IppsRijndaelKey128` or *keyLen* = `IppsRijndaelKey192` or *keyLen* = `IppsRijndaelKey256` $7 \le ivLen \le 13$ $4 \le tagLen \le 16$ and *tagLen* is even.

Rijndael128CCMDecryptMessage

Decrypts an entire message and generates its authentication tag in the CCM mode.

Syntax

```
IppStatus ippsRijndael128CCMDecryptMessage(const Ipp8u* pKey,
IppsRijndaelKeyLength keyLen, const Ipp8u* pIV, Ipp32u ivLen, const Ipp8u*
pAAD, Ipp32u aadLen, const Ipp8u* pSrc, Ipp8u* pDst, Ipp32u len, Ipp8u* pTag,
Ipp32u tagLen);
```

Parameters

pKey	Pointer to the secret key.
keyLength	Length of the secret key.
pIV	Pointer to the initialization vector.
ivLen	Length of the initialization vector **pIV* (in bytes).
pAAD	Pointer to the additional authenticated data (not encrypted).
aadLen	Length of additional authenticated data **pAAD* (in bytes).
pSrc	Pointer to the input ciphertext data stream of a variable length.
pDst	Pointer to the resulting plaintext data stream.
len	Length of the plaintext and ciphertext data stream (in bytes).
pTag	Pointer to the authentication tag.
tagLen	Length of the authentication tag **pTag* (in bytes).

Description

This function is declared in the `ippcp.h` file. The function decrypts the input data stream of a variable length and verifies the authentication tag in the CCM mode as specified in [NIST SP 800-38C]. Use this function if the entire message is available. Otherwise, follow the typical sequence of invoking the incremental functions (see AES-CCM Functions).

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the length parameters do not meet any of the following conditions: *keyLen* = IppsRijndaelKey128 or *keyLen* = IppsRijndaelKey192 or *keyLen* = IppsRijndaelKey256 $7 \le ivLen \le 13$ $4 \le tagLen \le 16$ and *tagLen* is even.

Rijndael128CCMGetSize

Gets the size of the IppsRijndael128CCMState *context.*

Syntax

```
IppStatus ippsRijndael128CCMGetSize(Ipp32u* pSize);
```

Parameters

pSize	Pointer to the size of the IppsRijndael128CCMState context.

Description

This function is declared in the ippcp.h file. The function gets the size of the IppsRijndael128CCMState context in bytes and stores it in **pSize*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if the specified pointer is NULL.

Rijndael128CCMInit

Initializes user-supplied memory as the `IppsRijndael128CCMState` *context for future use.*

Syntax

```
IppStatus ippsRijndael128CCMInit(const Ipp8u* pKey, IppsRijndaelKeyLength keyLen, IppsRijndael128GCMState* pState);
```

Parameters

pKey Pointer to the secret key.

keyLength Length of the secret key.

pState Pointer to the `IppsRijndael128CCMState` context.

Description

This function is declared in the `ippcp.h` file. The function initializes the memory pointed by *pState* as the `IppsRijndael128CCMState` context. In addition, the function uses the initialization variable and additional authenticated data to provide all necessary key material for both encryption and decryption.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.
`ippStsLengthErr`	Indicates an error condition an error condition if *keyLen* is not set to `IppsRijndaelKey128`, `IppsRijndaelKey192` or `IppsRijndaelKey256`.

Rijndael128CCMStart

Starts the process of authenticated encryption/decryption for a new message.

Syntax

```
IppStatus ippsRijndael128CCMStart(const Ipp8u* pIV, Ipp32u ivLen, const Ipp8u* pAAD, Ipp32u aadLen, IppsRijndael128CCMState* pState);
```

Parameters

pIV	Pointer to the initialization vector.
ivLen	Length of the initialization vector **pIV* (in bytes).
pAAD	Pointer to the additional authenticated data.
aadLen	Length of additional authenticated data **pAAD* (in bytes).
pState	Pointer to the IppsRijndael128CCMState context.

Description

This function is declared in the ippcp.h file. The function resets internal counters and buffers of the **pState* context.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
pState	Indicates an error condition if any of the specified pointers is NULL.
pState	Indicates an error condition if the context parameter does not match the operation.
pState	Indicates an error condition if *ivLen* < 7 or *ivLen* > 13 .

Rijndael128CCMEncrypt

Encrypts a data buffer in the CCM mode.

Syntax

```
IppStatus ippsRijndael128CCMEncrypt(const Ipp8u* pSrc, Ipp8u* pDst, Ipp32u len, IppsRijndael128CCMState* pState);
```

Parameters

pSrc	Pointer to the input plaintext data stream of a variable length.
pDst	Pointer to the resulting ciphertext data stream.
len	Length of the plaintext and ciphertext data stream in bytes.
pState	Pointer to the `IppsRijndael128CCMState` context.

Description

This function is declared in the `ippcp.h` file. The function encrypts the input data stream of a variable length in the CCM mode as specified in [NIST SP 800-38C].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

Rijndael128CCMDecrypt

Decrypts a data buffer in the CCM mode.

Syntax

```
IppStatus ippsRijndael128CCMDecrypt(const Ipp8u* pSrc, Ipp8u* pDst, Ipp32u len, IppsRijndael128CCMState* pState);
```

Parameters

pSrc	Pointer to the input ciphertext data stream of variable length.
pDst	Pointer to the resulting plaintext data stream.
len	Length of the plaintext and ciphertext data stream in bytes.
pState	Pointer to the IppsRijndael128CCMState context.

Description

This function is declared in the ippcp.h file. The function decrypts the input ciphered data stream of a variable length in the CCM mode as specified in [NIST SP 800-38C].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

Rijndael128CCMGetTag

Generates the message authentication tag in the CCM mode.

Syntax

```
IppStatus ippsRijndael128CCMGetTag (Ipp8u* pTag, Ipp32u tagLen, const IppsRijndael128CCMState* pState);
```

Parameters

pTag	Pointer to the authentication tag.
tagLen	Length of the authentication tag **pTag* (in bytes).
pState	Pointer to the IppsRijndael128CCMState context.

Description

This function is declared in the `ippcp.h` file. The function generates and computes the authentication tag of length *tagLen* bytes in the CCM mode as specified in [NIST SP 800-38C]. The `ippsRijndael128GCMGetTag` function does not stop the encryption/decryption and authentication process.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.
`ippStsLengthErr`	Indicates an error condition if *tagLen* < 1 or *tagLen* does not exceed the tag length specified in the previous call to Rijndael128CCMStart .

Rijndael128CCMMessageLen

Sets up the length of the message to be processed.

Syntax

```
IppStatus ippsRijndael128CCMMessageLen(Ipp32u msgLen, IppsRijndael128CCMState* pState);
```

Parameters

msgLen	Length of the message to be processed (in bytes).
pState	Pointer to the `IppsRijndael128CCMState` context.

Description

This function is declared in the `ippcp.h` file. The function assigns the value of *msgLen* to the length of the message to be processed in the **pState* context.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.

ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsLengthErr	Indicates an error condition if *msgLen*=0.

Rijndael128CCMTagLen

Sets up the length of the required authentication tag.

Syntax

```
IppStatus ippsRijndael128CCMTagLen(Ipp32u tagLen, IppsRijndael128CCMState* pState);
```

Parameters

tagLen	Length of the required authentication tag (in bytes).
pState	Pointer to the IppsRijndael128CCMState context.

Description

This function is declared in the ippcp.h file. The function assigns the value of *tagLen* to the length of the required authentication tag in the **pState* context.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsLengthErr	Indicates an error condition if *tagLen* < 4 or *tagLen* > 16 or *taglen* is odd.

AES-GCM Functions

The Galois/Counter Mode (GCM) is a mode of operation of the AES algorithm. GCM [NIST SP 800-38D] uses a variation of the Counter mode of operation for encryption. GCM assures authenticity of the confidential data (of up to about 64 GB per invocation) using a universal hash function defined over a binary finite field (the Galois field).

GCM can also provide authentication assurance for additional data (of practically unlimited length per invocation) that is not encrypted. If the GCM input contains only data that is not to be encrypted, the resulting specialization of GCM, called GMAC, is simply an authentication mode for the input data.

GCM provides stronger authentication assurance than a (non-cryptographic) checksum or error detecting code. In particular, GCM can detect both accidental modifications of the data and intentional, unauthorized modifications.

Table 2-5 lists Intel IPP AES-GCM functions:

Table 2-5 Intel IPP AES-GCM Functions

Function Base Name	Operation
`Rijndael128GCMEncryptMessage`	Encrypts an entire message and generates its authentication tag in the GCM mode.
`Rijndael128GCMDecryptMessage`	Decrypts an entire message and generates its authentication tag in the GCM mode.
`Rijndael128GCMGetSize`	Gets the size of the `IppsRijndael128GCMState` context.
`Rijndael128GCMInit`	Initializes user-supplied memory as the `IppsRijndael128GCMState` context for future use.
`Rijndael128GCMStart`	Starts the process of authenticated encryption/decryption for a new message.
`Rijndael128GCMEncrypt`	Encrypts a data buffer in the GCM mode.
`Rijndael128GCMDecrypt`	Decrypts a data buffer in the GCM mode.
`Rijndael128GCMGetTag`	Generates the message authentication tag in the GCM mode.

Like AES-CCM Functions, the AES-GCM function set includes:

- Functions for complete message operations, to be used for authenticated encryption/decryption of an entire message, if available: `Rijndael128GCMEncryptMessage` and `Rijndael128GCMDecryptMessage`.
- Incremental functions, to be used if the message is too long to be processed in one step. A typical usage of the incremental functions is similar to the one described in AES-CCM Functions.

Rijndael128GCMEncryptMessage

Encrypts an entire message and generates its authentication tag in the GCM mode.

Syntax

```
IppStatus ippsRijndael128GCMEncryptMessage(const Ipp8u* pKey,
IppsRijndaelKeyLength keyLen, const Ipp8u* pIV, Ipp32u ivLen, const Ipp8u*
pAAD, Ipp32u addLen, const Ipp8u* pSrc, Ipp8u* pDst, Ipp32u len, Ipp8u* pTag,
Ipp32u tagLen);
```

Parameters

pKey	Pointer to the secret key.
keyLen	Length of the secret key.
pIV	Pointer to the initialization vector.
ivLen	Length of the initialization vector **pIV* (in bytes).
pAAD	Pointer to the additional authenticated data (not to be encrypted).
aadLen	Length of the additional authenticated data **pAAD* (in bytes).
pSrc	Pointer to the input plaintext data stream of a variable length.
pDst	Pointer to the resulting ciphertext data stream.
len	Length of the plaintext and ciphertext data stream (in bytes).
pTag	Pointer to the authentication tag.
tagLen	Length of the authentication tag **pTag* (in bytes).

Description

This function is declared in the `ippcp.h` file. The function encrypts the input data stream of a variable length and computes the authentication tag according to GCM as specified in [NIST SP 800-38D]. Use this function if the entire message is available. Otherwise, use the incremental functions.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the length parameters do not meet any of the following conditions: *keyLen* = IppsRijndaelKey128 or *keyLen* = IppsRijndaelKey192 or *keyLen* = IppsRijndaelKey256 *ivLen* > 0 1 ≤ *tagLen* ≤ 16.

Rijndael128GCMDecryptMessage

Decrypts an entire message and generates its authentication tag in the GCM mode.

Syntax

```
IppStatus ippsRijndael128GCMDecryptMessage(const Ipp8u* pKey,
IppsRijndaelKeyLength keyLen, const Ipp8u* pIV, Ipp32u ivLen, const Ipp8u*
pAAD, Ipp32u aadLen, const Ipp8u* pSrc, Ipp8u* pDst, Ipp32u len, Ipp8u* pTag,
Ipp32u tagLen);
```

Parameters

pKey	Pointer to the secret key
keyLen	Length of the secret key.
pIV	Pointer to the initialization vector.
ivLen	Length of the initialization vector **pIV* (in bytes).
pAAD	Pointer to the additional authenticated data (not encrypted).
aadLen	Length of additional authenticated data **pAAD* (in bytes).
pSrc	Pointer to the input ciphertext data stream of a variable length.
pDst	Pointer to the resulting plaintext data stream.
len	Length of the plaintext and ciphertext data stream (in bytes).

pTag	Pointer to the authentication tag.
tagLen	Length of the authentication tag **pTag* (in bytes).

Description

This function is declared in the ippcp.h file. The function decrypts the input data stream of a variable length and verifies the authentication tag according to GCM, as specified in [NIST SP 800-38D]. Use this function if the entire message is available. Otherwise, use the incremental functions.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the length parameters do not meet any of the following conditions: *keyLen* = IppsRijndaelKey128 or *keyLen* = IppsRijndaelKey192 or *keyLen* = IppsRijndaelKey256 *ivLen* > 0 1 ≤ *tagLen* ≤ 16.

Rijndael128GCMGetSize

Gets the size of the IppsRijndael128GCMState *context.*

Syntax

```
IppStatus ippsRijndael128GCMGetSize(Ipp32u* pSize);
```

Parameters

pSize	Pointer to the size of the IppsRijndael128GCMState context.

Description

This function is declared in the ippcp.h file. The function gets the size of the IppsRijndael128GCMState context in bytes and stores it in **pSize*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if the specified pointer is NULL.

Rijndael128GCMInit

Initializes user-supplied memory as the IppsRijndael128GCMState *context for future use.*

Syntax

```
IppStatus ippsRijndael128GCMInit(const Ipp8u* pKey, IppsRijndaelKeyLength keyLen, IppsRijndael128GCMState* pState);
```

Parameters

pKey	Pointer to the secret key.
keyLen	Length of the secret key.
pState	Pointer to the IppsRijndael128GCMState context.

Description

This function is declared in the ippcp.h file. The function initializes the memory pointed by *pState* as IppsRijndael128GCMState context. In addition, the function uses the initialization variable and additional authenticated data to provide all necessary key material for both encryption and decryption.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsLengthErr	Indicates an error condition if *keyLen* is not set to IppsRijndaelKey128, IppsRijndaelKey192 or IppsRijndaelKey256.

Rijndael128GCMStart

Starts the process of authenticated encryption/decryption for new message.

Syntax

```
IppStatus ippsRijndael128GCMStart(const Ipp8u* pIV, Ipp32u ivLen, const Ipp8u* pAAD, Ipp32u aadLen, IppsRijndael128GCMState* pState);
```

Parameters

pIV	Pointer to the initialization vector.
ivLen	Length of the initialization vector **pIV* (in bytes).
pAAD	Pointer to the additional authenticated data.
aadLen	Length of additional authenticated data **pAAD* (in bytes).
pState	Pointer to the `IppsRijndael128GCMState` context.

Description

This function is declared in the `ippcp.h` file. The function resets internal counters and buffers of the **pState* context.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is NULL.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.
`ippStsLengthErr`	Indicates an error condition if the length of the initialization vector is zero.

Rijndael128GCMEncrypt

Encrypts a data buffer in the GCM mode.

Syntax

```
IppStatus ippsRijndael128GCMEncrypt(const Ipp8u* pSrc, Ipp8u* pDst, Ipp32u len, IppsRijndael128GCMState* pState);
```

Parameters

pSrc	Pointer to the input plaintext data stream of a variable length.
pDst	Pointer to the resulting ciphertext data stream.
len	Length of the plaintext and ciphertext data stream in bytes.
pState	Pointer to the `IppsRijndael128GCMState` context.

Description

This function is declared in the `ippcp.h` file. The function encrypts the input data stream of a variable length according to GCM as specified in [NIST SP 800-38D].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

Rijndael128GCMDecrypt

Decrypts a data buffer in the GCM mode.

Syntax

```
IppStatus ippsRijndael128GCMDecrypt(const Ipp8u* pSrc, Ipp8u* pDst, Ipp32u len, IppsRijndael128GCMState* pState);
```

Parameters

pSrc	Pointer to the input ciphertext data stream of a variable length.
pDst	Pointer to the resulting plaintext data stream.
len	Length of the plaintext and ciphertext data stream in bytes.
pState	Pointer to the `IppsRijndael128GCMState` context.

Description

This function is declared in the `ippcp.h` file. The function decrypts the input cipher data stream of a variable length according to GCM as specified in [NIST SP 800-38D].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

Rijndael128GCMGetTag

Generates the authentication tag in the GCM mode.

Syntax

```
IppStatus ippsRijndael128GCMGetTag (Ipp8u* pTag, Ipp32u tagLen, const IppsRijndael128GCMState* pState);
```

Parameters

pTag	Pointer to the authentication tag.
tagLen	Length of the authentication tag *pTag (in bytes).
pState	Pointer to the `IppsRijndael128GCMState` context.

Description

This function is declared in the `ippcp.h` file. The function generates and computes the authentication tag of length *tagLen* according to GCM as specified in [NIST SP 800-38D]. A call to `ippsRijndael128GCMGetTag` does not stop the process of authenticated encryption/decryption.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.
`ippStsLengthErr`	Indicates an error condition if *tagLen* <1 or *taglen* >16.

Blowfish Functions

Blowfish is a 16-round Feistel block cipher. Under this algorithm, the block size is 64 bits and the key can be of any size up to 448 bits. Although the algorithm requires a computationally intensive key expansion process that creates a set of eighteen 32-bit subkeys plus four 8x32-bit S-boxes derived from the input key, for a total of 4168 bytes, the actual encryption of streaming data is very efficient for software implementation.

This section describes the functions performing various operational modes under the Blowfish cipher systems. The implementation of the functions described in this section complies with the Blowfish cipher schemes.

Table 2-6 lists Intel IPP Blowfish algorithm functions.

Table 2-6 Intel IPP Blowfish Algorithm Functions

Function Base Name	Operation
`BlowfishGetSize`	Gets the size of the `IppsBlowfishSpec` context.
`BlowfishInit`	Initializes user-supplied memory as `IppsBlowfishSpec` context for future use.
`BlowfishEncryptECB`	Encrypts input plaintext according to Blowfish scheme in the ECB mode.
`BlowfishDecryptECB`	Decrypts byte data stream according to Blowfish scheme in the EBC mode.
`BlowfishEncryptCBC`	Encrypts byte data stream according to Blowfish scheme in the CBC mode.

Function Base Name	Operation
BlowfishDecryptCBC	Decrypts byte data stream according to Blowfish scheme in the CBC mode.
BlowfishEncryptCFB	Encrypts byte data stream according to Blowfish scheme in the CFB mode.
BlowfishDecryptCFB	Decrypts byte data stream according to Blowfish scheme in the CFB mode.
BlowfishEncryptOFB	Encrypts byte data stream according to Blowfish scheme in the OFB mode.
BlowfishDecryptOFB	Decrypts byte data stream according to Blowfish scheme in the OFB mode.
BlowfishEncryptCTR	Encrypts a variable length data stream in the CTR mode.
BlowfishDecryptCTR	Decrypts a variable length data stream in the CTR mode.

Throughout this section, the functions for Blowfish baseline cipher scheme employ the context IppsBlowfishSpec. It serves as an operational vehicles to carry not only both a set of subkeys and a set of S-Boxes, but also the key management information.

Once the respective initialization function has generated a set of subkeys and S-Boxes, the functions for ECB, CBC, CFB, and CTR modes are ready for the execution of either encrypting or decrypting the streaming data with the selected padding scheme.

The application code for conducting a typical encryption under CBC mode using Blowfish scheme should follow the sequence of operations as outlined below:

1. Get the buffer size required to configure the context IppsBlowfishSpec by calling the function BlowfishGetSize.
2. Call the operating system memory allocation service function to allocate a buffer whose size is no less than the one specified by the function BlowfishGetSize.
3. Initialize the context IppsBlowfishSpec * *pCtx* by calling the function BlowfishInit with the allocated buffer and the respective Blowfish cipher key of the specified size.
4. Specify the initialization vector and the padding scheme, then call the function BlowfishEncryptCBC to encrypt the input data stream using the Blowfish encryption function with CBC mode.
5. Call the operating system memory free service function to release the buffer allocated for the context IppsBlowfishSpec, if needed.

BlowfishGetSize

Gets the size of the IppsBlowfishSpec *context.*

Syntax

```
IppStatus ippsBlowfishGetSize(int* pSize);
```

Parameters

pSize	Pointer to the IppsBlowfishSpec context size value.

Description

This function is declared in the ippcp.h file. The function gets the IppsBlowfishSpec context size in bytes and stores it in **pSize*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

BlowfishInit

Initializes user-supplied memory as the IppsBlowfishSpec context for future use.

Syntax

```
IppStatus ippsBlowfishInit(const Ipp8u *pKey, int keylen, IppsBlowfishSpec* pCtx);
```

Parameters

pKey	Pointer to the Blowfish key.
keylen	Key byte stream length in bytes.
pCtx	Pointer to the IppsBlowfishSpec context being initialized.

Description

This function is declared in the ippcp.h file. The function initializes the memory pointed by *pCtx* as the IppsBlowfishSpec context. In addition, the function uses the key to provide all necessary key material for both encryption and decryption operations.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.

ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *keylen* is less than 1 or greater than 56.

BlowfishEncryptECB

Encrypts input plaintext in the ECB mode.

Syntax

```
IppStatus ippsBlowfishEncryptECB(const Ipp8u *pSrc, Ipp8u *pDst, int srclen,
const IppsBlowfishSpec* pCtx, IppsCPPadding padding);
```

Parameters

pSrc	Pointer to the input plaintext data stream of variable length.
pDst	Pointer to the resulting ciphertext data stream.
srclen	Length of the input data stream in bytes.
pCtx	Pointer to the IppsBlowfishSpec context.
padding	IppsCPPaddingNONE padding scheme.

Description

This function is declared in the ippcp.h file. The function encrypts the input data stream of a variable length according to the cipher scheme specified in [NIST SP 800-38A].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the input data stream length is less than or equal to 0.
ippStsUnderRunErr	Indicates an error condition if *srclen* is not divisible by data block size.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

BlowfishDecryptECB

Decrypts byte data stream according to Blowfish scheme in the EBC mode.

Syntax

```
IppStatus ippsBlowfishDecryptECB(const Ipp8u* pSrc, Ipp8u* pDst, int srclen,
const IppsBlowfishSpec* pCtx, IppsCPPadding padding);
```

Parameters

pSrc	Pointer to the input ciphertext data stream of variable length.
pDst	Pointer to the resulting plaintext data stream of variable length.
srclen	Length of the ciphertext data stream in bytes.
pCtx	Pointer to the `IppsBlowfishSpec` context.
padding	`IppsCPPaddingNONE` padding scheme.

Description

This function is declared in the `ippcp.h` file. The function decrypts the input data stream of a variable length according to the ECB mode as specified in [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the output data stream length is less than or equal to zero.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.
`ippStsUnderRunErr`	Indicates an error condition if *srclen* is not divisible by cipher block size.

BlowfishEncryptCBC

Encrypts byte data stream according to Blowfish scheme in the CBC mode.

Syntax

```
IppStatus ippsBlowfishEncryptCBC(const Ipp8u* pSrc, Ipp8u* pDst, int srclen,
const IppsBlowfishSpec* pCtx, const Ipp8u* pIV, IppsCPPadding padding);
```

Parameters

pSrc	Pointer to the input plaintext data stream of variable length.
pDst	Pointer to the resulting ciphertext data stream.
srclen	Length of the plaintext data stream in bytes.
pCtx	Pointer to the `IppsBlowfishSpec` context.
pIV	Pointer to the initialization vector for the CBC mode operation.
padding	`IppsCPPaddingNONE` padding scheme.

Description

This function is declared in the `ippcp.h` file. The function encrypts the input data stream of a variable length according to the CBC mode as specified in [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than or equal to zero.
`ippStsUnderRunErr`	Indicates an error condition if `srclen` is not divisible by data block size.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

BlowfishDecryptCBC

Decrypts byte data stream according to Blowfish scheme in the CBC mode.

Syntax

```
IppStatus ippsBlowfishDecryptCBC(const Ipp8u* pSrc, Ipp8u* pDst, int srclen,
const IppsBlowfishSpec* pCtx, const Ipp8u* pIV, IppsCPPadding padding);
```

Parameters

pSrc	Pointer to the input ciphertext data stream.
pDst	Pointer to the resulting plaintext data stream of the variable length.
srclen	Length of the ciphertext data stream length in bytes.
pCtx	Pointer to the `IppsBlowfishSpec` context.
pIV	Pointer to the initialization vector for CBC mode operation.
padding	`IppsCPPaddingNONE` padding scheme.

Description

This function is declared in the `ippcp.h` file. The function decrypts the input data stream of a variable length according to the CBC mode as specified in [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the output data stream length is less than or equal to zero.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.
`ippStsUnderRunErr`	Indicates an error condition if *srclen* is not divisible by cipher block size.

BlowfishEncryptCFB

Encrypts byte data stream according to Blowfish scheme in the CFB mode.

Syntax

```
IppStatus ippsBlowfishEncryptCFB(const Ipp8u* pSrc, Ipp8u* pDst, int srcLen,
int cfbBlkSize, const IppsBlowfishSpec* pCtx, const Ipp8u* pIV, IppsCPPadding
padding);
```

Parameters

pSrc	Pointer to the input plaintext data stream of variable length.
pDst	Pointer to the resulting ciphertext data stream.
srcLen	Length of the plaintext data stream in bytes.
cfbBlkSize	Size of the CFB block in bytes.
pCtx	Pointer to the `IppsBlowfishSpec` context.
pIV	Pointer to the initialization vector for the CFB mode operation.
padding	`IppsCPPaddingNONE` padding scheme.

Description

This function is declared in the `ippcp.h` file. The function encrypts the input data stream of variable length according to the CFB mode as specified in [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than or equal to zero.
`ippStsUnderRunErr`	Indicates an error condition if *srcLen* is not divisible by *cfbBlkSize* parameter value.
`ippStsCFBSizeErr`	Indicates an error condition if the value for *cfbBlkSize* is illegal.

ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

BlowfishDecryptCFB

Decrypts byte data stream according to Blowfish scheme in the CFB mode.

Syntax

```
IppStatus ippsBlowfishDecryptCFB(const Ipp8u* pSrc, Ipp8u* pDst, int srclen,
int cfbBlkSize, const IppsBlowfishSpec* pCtx, const Ipp8u* pIV, IppsCPPadding
padding);
```

Parameters

pSrc	Pointer to the input ciphertext data stream.
pDst	Pointer to the resulting plaintext data stream of variable length.
srclen	Length of the ciphertext data stream in bytes.
cfbBlkSize	Size of the CFB block in bytes.
pCtx	Pointer to the IppsBlowfishSpec context.
pIV	Pointer to the initialization vector for the CFB mode operation.
padding	IppsCPPaddingNONE padding scheme.

Description

This function is declared in the ippcp.h file. The function decrypts the input data stream of variable length according to the CFB mode as specified in [NIST SP 800-38A].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the output data stream length is less than or equal to zero.
ippStsCFBSizeErr	Indicates an error condition if the value for *cfbBlkSize* is illegal.

ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsUnderRunErr	Indicates an error condition if *srcLen* is not divisible by cipher block size.

BlowfishEncryptOFB

Encrypts a variable length data stream according to Blowfish scheme in the OFB mode.

Syntax

```
IppStatus ippsBlowfishEncryptOFB (const Ipp8u* pSrc, Ipp8u* pDst, int srclen,
int ofbBlkSize, const IppsBlowfishSpec* pCtx, Ipp8u* pIV);
```

Parameters

pSrc	Pointer to the input plaintext data stream of variable length.
pDst	Pointer to the resulting ciphertext data stream.
srclen	Length of the plaintext data stream in bytes.
ofbBlkSize	Size of the OFB block in bytes.
pCtx	Pointer to the *IppsBlowfishSpec* context.
pIV	Pointer to the initialization vector for the OFB mode operation.

Description

This function is declared in the `ippcp.h` file. The function encrypts the input data stream of a variable length in the OFB mode as specified in [NIST SP 800-38A].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is `NULL`.
ippStsLengthErr	Indicates an error condition if the input data stream length is less than or equal to zero.

ippStsUnderRunErr	Indicates an error condition if *srclen* is not divisible by the *ofbBlkSize* parameter value.
ippStsOFBSizeErr	Indicates an error condition if the value of *ofbBlkSize* is illegal.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

BlowfishDecryptOFB

Decrypts a variable length data stream according to Blowfish scheme in the OFB mode.

Syntax

```
IppStatus ippsBlowfishDecryptOFB (const Ipp8u* pSrc, Ipp8u* pDst, int srclen,
int ofbBlkSize, const IppsBlowfishSpec* pCtx, Ipp8u* pIV);
```

Parameters

pSrc	Pointer to the input ciphertext data stream of variable length.
pDst	Pointer to the resulting plaintext data stream.
srclen	Length of the ciphertext data stream in bytes.
ofbBlkSize	Size of the OFB block in bytes.
pCtx	Pointer to the *IppsBlowfishSpec* context.
pIV	Pointer to the initialization vector for the OFB mode operation.

Description

This function is declared in the ippcp.h file. The function decrypts the input data stream of a variable length in the OFB mode as specified in [NIST SP 800-38A].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the input data stream length is less than or equal to zero.

ippStsUnderRunErr	Indicates an error condition if *srclen* is not divisible by the *ofbBlkSize* parameter value.
ippStsOFBSizeErr	Indicates an error condition if the value of *ofbBlkSize* is illegal.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

BlowfishEncryptCTR

Encrypts a variable length data stream in the CTR mode.

Syntax

```
IppStatus ippsBlowfishEncryptCTR(const Ipp8u* pSrc, Ipp8u* pDst, int srcLen,
const IppsBlowfishSpec* pCtx, Ipp8u* pCtrValue , int ctrNumBitSize);
```

Parameters

pSrc	Pointer to the input plaintext data stream of a variable length.
pDst	Pointer to the resulting ciphertext data stream.
srcLen	Length of the plaintext data stream in bytes.
pCtx	Pointer to the IppsBlowfishSpec context.
pCtrValue	Pointer to the counter data block.
ctrNumBitSize	Number of bits in the specific part of the counter to be incremented.

Description

This function is declared in the *ippcp.h* file. The function encrypts the input data stream of a variable length according to the CTR mode as specified in [NIST SP 800-38A].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the input data stream length is less than or equal to zero.

ippStsCTRSizeErr	Indicates an error condition if the value of the *ctrNumBitSize* is illegal.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

BlowfishDecryptCTR

Decrypts a variable length data stream in the CTR mode.

Syntax

```
IppStatus ippsBlowfishDecryptCTR(const Ipp8u* pSrc, Ipp8u* pDst, int srcLen,
const  IppsBlowfishSpec* pCtx, Ipp8u* pCtrValue, int ctrNumBitSize);
```

Parameters

pSrc	Pointer to the input ciphertext data stream.
pDst	Pointer to the resulting plaintext data stream of a variable length.
srcLen	Length of the plaintext data stream in bytes.
pCtx	Pointer to the IppsBlowfishSpec context.
pCtrValue	Pointer to the counter data block.
ctrNumBitSize	Number of bits in the specific part of the counter to be incremented.

Description

This function is declared in the *ippcp.h* file. The function decrypts the input data stream of a variable length according to the CTR mode as specified in the [NIST SP 800-38A].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the output data stream length is less than or equal to zero.

ippStsCTRSizeErr	Indicates an error condition if the value of the *ctrNumBitSize* is illegal.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

Example of Using Blowfish Functions

Example 2-3 Blowfish Encryption and Decryption

```
   // use of the CBC mode
void BF_sample(void){
   // size of Blowfish algorithm block is equal to 8
   const int bfBlkSize = 8;

   // get the size of the context needed for the encryption/decryption operation
   int ctxSize;
   ippsBlowfishGetSize(&ctxSize);

   // and allocate one
   IppsBlowfishSpec* pCtx = (IppsBlowfishSpec*)( new Ipp8u [ctxSize] );
  // define the key
   // note that the key length may vary from 1 to 56 bytes
   Ipp8u key[] = {0x00,0x01,0x02,0x03,0x04,0x05,0x06,0x07,
                  0x08,0x09,0x10,0x11,0x12,0x13,0x14,0x15,
                  0x16,0x17};

   // and prepare the context for Blowfish usage
   ippsBlowfishInit(key,sizeof(key), pCtx);

   // define the message to be encrypted
   Ipp8u ptext[] = {"quick brown fox jupm over lazy dog"};

   // define an initial vector
   Ipp8u iv[bfBlkSize] = {0x77,0x66,0x55,0x44,0x33,0x22,0x11,0x00};
```

```
    // allocate enough memory for the ciphertext
    // note that
    // the size of the ciphertext is always multiple of the cipher block size
    Ipp8u ctext[(sizeof(ptext)+bfBlkSize-1) &~(bfBlkSize-1)];

    // encrypt (CBC mode) ptext message
    // pay attention to the 'length' parameter
    // it defines  the number of bytes to be encrypted
    ippsBlowfishEncryptCBC(ptext, ctext, sizeof(ptext),
                           pCtx,
                           iv,
                           IppsCPPaddingPKCS7);
// allocate memory for the decrypted message
    Ipp8u rtext[sizeof(ptext)];
    // decrypt (CBC mode) ctext message
    // pay attention to the 'length' parameter
    // it defines the number of bytes to be decrypted
    ippsBlowfishDecryptCBC(ctext, rtext, sizeof(ptext),
                           pCtx,
                           iv,
                           IppsCPPaddingPKCS7);
    delete (Ipp8u*)pCtx;
}
```

Twofish Functions

Twofish is a 16-round Feistel block cipher. The block size is 128 bits and the key can be any size up to 256 bits. The algorithm is one of the five Advanced Encryption Standard (AES) finalists. The cipher design for both the round function and key schedule enables an efficient implementation in software. Even though Twofish is free and not patented, it is nevertheless efficient and highly secure block cipher.

This section describes the functions for various operational modes under the Twofish cipher systems. The functions in this section are implemented to comply to the Twofish cipher schemes documented and submitted to NIST for candidacy of AES by B. Schneier.

Table 2-7 lists Intel IPP Twofish algorithm functions:

Table 2-7 Intel IPP Twofish Algorithm Functions

Function Base Name	Operation
TwofishGetSize	Gets the size of the IppsTwofishSpec context.
TwofishInit	Initializes user-supplied memory as IppsTwofishSpec context for future use.
TwofishEncryptECB	Encrypts input plaintext according to Twofish scheme in the ECB mode.
TwofishDecryptECB	Decrypts byte data stream according to Twofish scheme in the EBC mode.
TwofishEncryptCBC	Encrypts byte data stream according to Twofish scheme in the CBC mode.
TwofishDecryptCBC	Decrypts byte data stream according to Twofish scheme in the CBC mode.
TwofishEncryptCFB	Encrypts byte data stream according to Twofish scheme in the CFB mode.
TwofishDecryptCFB	Decrypts byte data stream according to Twofish scheme in the CFB mode.
TwofishEncryptOFB	Encrypts byte data stream according to Twofish scheme in the OFB mode.
TwofishDecryptOFB	Decrypts byte data stream according to Twofish scheme in the OFB mode.
TwofishEncryptCTR	Encrypts a variable length data stream in the CTR mode.
TwofishDecryptCTR	Decrypts a variable length data stream in the CTR mode.

Throughout this section, the functions for Twofish baseline cipher scheme employ the context IppsTwofishSpec. This structure serves as an operational vehicle to carry not only both a set of subkeys and a set of S-Boxes, but also the key management information.

Once the respective initialization function has generated a set of subkeys and S-Boxes, the functions for ECB, CBC, CFB, and CTR modes are ready to the execution of either encrypting or decrypting the streaming data with the selected padding scheme.

The application code for conducting typical encryption under the CBC mode using the Twofish scheme should follow the sequence of operations as outlined below:

1. Get the buffer size required to configure the context IppsTwofishSpec by calling the function TwofishGetSize.

2. Call operating system memory allocation service function to allocate a buffer whose size is not less than the one specified by the function TwofishGetSize.
3. Initialize the context IppsTwofishSpec * *pCtx* by calling the function TwofishInit with the allocated buffer and the respective Twofish cipher key of the specified size.
4. Specify the initialization vector and the padding scheme, then call the function TwofishEncryptCBC to encrypt the input data stream using the Twofish encryption function with CBC mode.
5. Call the operating system memory free service function to release the buffer allocated for the context IppsTwofishSpec, if needed.

TwofishGetSize

Gets the size of the IppsTwofishSpec *context.*

Syntax

```
IppStatus ippsTwofishGetSize(int* pSize);
```

Parameters

pSize	Pointer to the IppsTwofishSpec context size value.

Description

This function is declared in the ippcp.h file. The function gets the IppsTwofishSpec context size in bytes and stores it in **pSize*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

TwofishInit

Initializes user-supplied memory as the IppsTwofishSpec *context for future use.*

Syntax

```
IppStatus ippsTwofishInit(const Ipp8u *pKey, int keylen, IppsTwofishSpec*
pCtx);
```

Parameters

pKey	Pointer to the Twofish key.
keylen	Key byte stream length in bytes.
pCtx	Pointer to the IppsTwofishSpec context being initialized.

Description

This function is declared in the ippcp.h file. The function initializes the memory pointed by *pCtx* as the IppsTwofishSpec context. In addition, the function uses the key to provide all necessary key material for both encryption and decryption operations.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *keylen* is less than 1 or greater than 32.

TwofishEncryptECB

Encrypts input plaintext in the ECB mode.

Syntax

```
IppStatus ippsTwofishEncryptECB(const Ipp8u *pSrc, Ipp8u *pDst, int scrlen,
const IppsTwofishSpec* pCtx, IppsCPPadding padding);
```

Parameters

pSrc	Pointer to the input plaintext data stream of variable length.
pDst	Pointer to the resulting ciphertext data stream.
srclen	Length of the input data stream in bytes.
pCtx	Pointer to the IppsTwofishSpec context.
padding	IppsCPPaddingNONE padding scheme.

Description

This function is declared in the `ippcp.h` file. The function encrypts the input data stream of a variable length according to the cipher scheme specified in [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than or equal to 0.
`ippStsUnderRunErr`	Indicates an error condition if *`srclen`* is not divisible by data block size.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

TwofishDecryptECB

Decrypts byte data stream according to Twofish scheme in the EBC mode.

Syntax

```
IppStatus ippsTwofishDecryptECB(const Ipp8u* pSrc, Ipp8u* pDst, int srclen,
const IppsTwofishSpec* pCtx, IppsCPPadding padding);
```

Parameters

`pSrc`	Pointer to the input ciphertext data stream of variable length.
`pDst`	Pointer to the resulting plaintext data stream of variable length.
`srclen`	Length of the ciphertext data stream in bytes.
`pCtx`	Pointer to the `IppsTwofishSpec` context.
`padding`	`IppsCPPaddingNONE` padding scheme.

Description

This function is declared in the `ippcp.h` file. The function decrypts the input data stream of a variable length according to the ECB mode as specified in [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the output data stream length is less than or equal to zero.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.
`ippStsUnderRunErr`	Indicates an error condition if *`srclen`* is not divisible by cipher block size.

TwofishEncryptCBC

Encrypts byte data stream according to Twofish scheme in the CBC mode.

Syntax

```
IppStatus ippsTwofishEncryptCBC(const Ipp8u* pSrc, Ipp8u* pDst, int srclen,
const IppsTwofishSpec* pCtx, const Ipp8u* pIV, IppsCPPadding padding);
```

Parameters

`pSrc`	Pointer to the input plaintext data stream of variable length.
`pDst`	Pointer to the resulting ciphertext data stream.
`srclen`	Length of the plaintext data stream length in bytes.
`pCtx`	Pointer to the `IppsTwofishSpec` context.
`pIV`	Pointer to the initialization vector for the CBC mode operation.
`padding`	`IppsCPPaddingNONE` padding scheme.

Description

This function is declared in the ippcp.h file. The function encrypts the input data stream of a variable length according to the CBC mode as specified in [NIST SP 800-38A].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the input data stream length is less than or equal to zero.
ippStsUnderRunErr	Indicates an error condition if srclen is not divisible by data block size.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

TwofishDecryptCBC

Decrypts byte data stream according to Twofish scheme in the CBC mode.

Syntax

```
IppStatus ippsTwofishDecryptCBC(const Ipp8u* pSrc, Ipp8u *pDst, int srclen,
const IppsTwofishSpec* pCtx, const Ipp8u* pIV, IppsCPPadding padding);
```

Parameters

pSrc	Pointer to the input ciphertext data stream.
pDst	Pointer to the resulting plaintext data stream of the variable length.
srclen	Length of the ciphertext data stream length in bytes.
pCtx	Pointer to the IppsDESSpec context.
pIV	Pointer to the initialization vector for CBC mode operation.
padding	IppsCPPaddingNONE padding scheme.

Description

This function is declared in the `ippcp.h` file. The function decrypts the input data stream of a variable length according to the CBC mode as specified in [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the output data stream length is less than or equal to zero.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.
`ippStsUnderRunErr`	Indicates an error condition if *`srclen`* is not divisible by cipher block size.

TwofishEncryptCFB

Encrypts byte data stream according to Twofish scheme in the CFB mode.

Syntax

`IppStatus ippsTwofishEncryptCFB(const Ipp8u* pSrc, Ipp8u* pDst, int srcLen, int cfbBlkSize, const IppsTwofishSpec* pCtx, const Ipp8u* pIV, IppsCPPadding padding);`

Parameters

`pSrc`	Pointer to the input plaintext data stream of variable length.
`pDst`	Pointer to the resulting ciphertext data stream.
`srcLen`	Length of the plaintext data stream in bytes.
`cfbBlkSize`	Size of the CFB block in bytes.
`pCtx`	Pointer to the `IppsTwofishSpec` context.
`pIV`	Pointer to the initialization vector for the CFB mode operation.
`padding`	`IppsCPPaddingNONE` padding scheme.

Description

This function is declared in the `ippcp.h` file. The function encrypts the input data stream of variable length according to the CFB mode as specified in [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than or equal to zero.
`ippStsUnderRunErr`	Indicates an error condition if *`srcLen`* is not divisible by *`cfbBlkSize`* parameter value.
`ippStsCFBSizeErr`	Indicates an error condition if the value for *`cfbBlkSize`* is illegal.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

TwofishDecryptCFB

Decrypts byte data stream according to Twofish scheme in the CFB mode.

Syntax

```
IppStatus ippsTwofishDecryptCFB(const Ipp8u* pSrc, Ipp8u* pDst, int srclen,
int cfbBlkSize, const IppsTwofishSpec* pCtx, const Ipp8u* pIV, IppsCPPadding
padding);
```

Parameters

`pSrc`	Pointer to the input ciphertext data stream.
`pDst`	Pointer to the resulting plaintext data stream of variable length.
`srclen`	Length of the ciphertext data stream in bytes.
`cfbBlkSize`	Size of the CFB block in bytes.
`pCtx`	Pointer to the `IppsTwofishSpec` context.
`pIV`	Pointer to the initialization vector for the CFB mode operation.

padding	IppsCPPaddingNONE padding scheme.

Description

This function is declared in the ippcp.h file. The function decrypts the input data stream of variable length according to the CFB mode as specified in [NIST SP 800-38A].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the output data stream length is less than or equal to zero.
ippStsCFBSizeErr	Indicates an error condition if the value for *cfbBlkSize* is illegal.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsUnderRunErr	Indicates an error condition if *srcLen* is not divisible by cipher block size.

TwofishEncryptOFB

Encrypts a variable length data stream according to Twofish scheme in the OFB mode.

Syntax

```
IppStatus ippsTwofishEncryptOFB (const Ipp8u* pSrc, Ipp8u* pDst, int srclen,
int ofbBlkSize, const IppsTwofishSpec* pCtx, Ipp8u* pIV);
```

Parameters

pSrc	Pointer to the input plaintext data stream of variable length.
pDst	Pointer to the resulting ciphertext data stream.
srclen	Length of the plaintext data stream in bytes.
ofbBlkSize	Size of the OFB block in bytes.
pCtx	Pointer to the *IppsTwofishSpec* context.

pIV	Pointer to the initialization vector for the OFB mode operation.

Description

This function is declared in the ippcp.h file. The function encrypts the input data stream of a variable length in the OFB mode as specified in [NIST SP 800-38A].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the input data stream length is less than or equal to zero.
ippStsUnderRunErr	Indicates an error condition if *srclen* is not divisible by the *ofbBlkSize* parameter value.
ippStsOFBSizeErr	Indicates an error condition if the value of *ofbBlkSize* is illegal.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

TwofishDecryptOFB

Decrypts a variable length data stream according to Twofish scheme in the OFB mode.

Syntax

```
IppStatus ippsTwofishDecryptOFB (const Ipp8u* pSrc, Ipp8u* pDst, int srclen,
int ofbBlkSize, const IppsTwofishSpec* pCtx, Ipp8u* pIV);
```

Parameters

pSrc	Pointer to the input ciphertext data stream of variable length.
pDst	Pointer to the resulting plaintext data stream.
srclen	Length of the ciphertext data stream in bytes.
ofbBlkSize	Size of the OFB block in bytes.
pCtx	Pointer to the *IppsTwofishSpec* context.

pIV	Pointer to the initialization vector for the OFB mode operation.

Description

This function is declared in the `ippcp.h` file. The function decrypts the input data stream of a variable length in the OFB mode as specified in [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than or equal to zero.
`ippStsUnderRunErr`	Indicates an error condition if *srclen* is not divisible by the *ofbBlkSize* parameter value.
`ippStsOFBSizeErr`	Indicates an error condition if the value of *ofbBlkSize* is illegal.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

TwofishEncryptCTR

Encrypts a variable length data stream in the CTR mode.

Syntax

```
IppStatus ippsTwofishEncryptCTR(const Ipp8u* pSrc, Ipp8u* pDst, int srcLen,
const IppsTwofishSpec* pCtx, Ipp8u* pCtrValue , int ctrNumBitSize);
```

Parameters

pSrc	Pointer to the input plaintext data stream of a variable length.
pDst	Pointer to the resulting ciphertext data stream.
srcLen	Length of the plaintext data stream in bytes.
pCtx	Pointer to the `IppsTwofishSpec` context.
pCtrValue	Pointer to the counter data block.

ctrNumBitSize	Number of bits in the specific part of the counter to be incremented.

Description

This function is declared in the `ippcp.h` file. The function encrypts the input data stream of a variable length according to the CTR mode as specified in [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than or equal to zero.
`ippStsCTRSizeErr`	Indicates an error condition if the value of the *ctrNumBitSize* is illegal.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

TwofishDecryptCTR

Decrypts a variable length data stream in the CTR mode.

Syntax

```
IppStatus ippsTwofishDecryptCTR(const Ipp8u* pSrc, Ipp8u* pDst, int srcLen,
const  IppsTwofishSpec* pCtx, Ipp8u* pCtrValue, int ctrNumBitSize);
```

Parameters

pSrc	Pointer to the input ciphertext data stream.
pDst	Pointer to the resulting plaintext data stream of a variable length.
srcLen	Length of the plaintext data stream in bytes.
pCtx	Pointer to the `IppsTwofishSpec` context.
pCtrValue	Pointer to the counter data block.

ctrNumBitSize	Number of bits in the specific part of the counter to be incremented.

Description

This function is declared in the *ippcp.h* file. The function decrypts the input data stream of a variable length according to the CTR mode as specified in the [NIST SP 800-38A].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the output data stream length is less than or equal to zero.
ippStsCTRSizeErr	Indicates an error condition if the value of the *ctrNumBitSize* is illegal.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

Example of Using Twofish Functions

Example 2-4 Twofish Encryption and Decryption

```
// use of the FCB mode
void TF_sample(void){
   // size of the Twofish algorithm block is equal to 16
   const int tfBlkSize = 16;

   // get the size of the context needed for the encryption/decryption operation
   int ctxSize;
   ippsTwofishGetSize(&ctxSize);

   // and allocate one
   IppsTwofishSpec* pCtx = (IppsTwofishSpec*)( new Ipp8u [ctxSize] );

   // define the key
   // note that the key length may vary from 16 to 32 bytes
   Ipp8u key[] = {0x00,0x01,0x02,0x03,0x04,0x05,0x06,0x07,
                  0x08,0x09,0x10,0x11,0x12,0x13,0x14,0x15,
                  0x16,0x17};

   // and prepare the context for Twofish usage
   ippsTwofishInit(key,sizeof(key), pCtx);

   // define the message to be encrypted
   Ipp8u ptext[] = {"quick brown fox jupm over lazy dog"};

   // fcb value (bytes)
```

```
const int cfbBlkSize = 2;


// define an initial vector
Ipp8u iv[tfBlkSize] = {0xff,0xee,0xdd,0xcc,0xbb,0xaa,0x99,0x88,
                       0x77,0x66,0x55,0x44,0x33,0x22,0x11,0x00};


// allocate enough memory for the ciphertext
// note that
// the size of the ciphertext is always multiple of the cfbBlkSize size
Ipp8u ctext[(sizeof(ptext)+cfbBlkSize-1) &~(cfbBlkSize-1)];

// encrypt (CFB mode) ptext message
// pay attention to the 'length' parameter
// it defines the number of bytes to be encrypted
ippsTwofishEncryptCFB(ptext, ctext, sizeof(ptext), cfbBlkSize,
                      pCtx,
                      iv,
                      IppsCPPaddingPKCS7);
// allocate memory for the decrypted message
Ipp8u rtext[sizeof(ptext)];
// decrypt (CFB mode) ctext message
```

```
// pay attention to the 'length' parameter
   // it defines the number of bytes to be decrypted
ippsTwofishDecryptCFB(ctext, rtext, sizeof(ptext), cfbBlkSize,
                          pCtx,
                          iv,
                          IppsCPPaddingPKCS7);
   delete (Ipp8u*)pCtx;
}
```

RC5* Functions

RC5, introduced by R.Rivest, is a fast symmetric block cipher that has a variable block size, variable key length, variable number of rounds and heavily uses data-independent rotations. Intel IPP for Cryptography implements functions for RC5 algorithm with 64- and 128-bit block sizes.

This section describes functions for various operational modes of RC5 cipher systems. The functions are implemented to comply with the RC5 cipher schemes documented in [RC5].

Table 2-8 lists Intel IPP RC5 functions.

Table 2-8 Intel IPP RC5 Functions

Function Base Name	Operation
Functions for 64-bit Block Size	
ARCFive64GetSize	Gets the size of the IppsARCFive64Spec context.
ARCFive64Init	Initializes user-supplied memory as the IppsARCFive64Spec context for future use.
ARCFive64EncryptECB	Encrypts a variable length data stream using the RC5 cipher with 64-bit block size in the ECB mode.
ARCFive64DecryptECB	Decrypts a variable length data stream using the RC5 cipher with 64-bit block size in the ECB mode.
ARCFive64EncryptCBC	Encrypts a variable length data stream using the RC5 cipher with 64-bit block size in the CBC mode.
ARCFive64DecryptCBC	Decrypts a variable length data stream using the RC5 cipher with 64-bit block size in the CBC mode.

Function Base Name	Operation
ARCFive64EncryptCFB	Encrypts a variable length data stream using the RC5 cipher with 64-bit block size in the CFB mode.
ARCFive64DecryptCFB	Decrypts a variable length data stream using the RC5 cipher with 64-bit block size in the CFB mode.
ARCFive64EncryptOFB	Encrypts a variable length data stream using the RC5 cipher with 64-bit block size in the OFB mode.
ARCFive64DecryptOFB	Decrypts a variable length data stream using the RC5 cipher with 64-bit block size in the OFB mode.
ARCFive64EncryptCTR	Encrypts a variable length data stream using the RC5 cipher with 64-bit block size in the CTR mode.
ARCFive64DecryptCTR	Decrypts a variable length data stream using the RC5 cipher with 64-bit block size in the CTR mode.
Functions for 128-bit Block Size	
ARCFive128GetSize	Gets the size of the IppsARCFive128Spec context.
ARCFive128Init	Initializes user-supplied memory as the IppsARCFive128Spec context for future use.
ARCFive128EncryptECB	Encrypts a variable length data stream using the RC5 cipher with 128-bit block size in the ECB mode.
ARCFive128DecryptECB	Decrypts a variable length data stream using the RC5 cipher with 128-bit block size in the ECB mode.
ARCFive128EncryptCBC	Encrypts a variable length data stream using the RC5 cipher with 128-bit block size in the CBC mode.
ARCFive128DecryptCBC	Decrypts a variable length data stream using the RC5 cipher with 128-bit block size in the CBC mode.
ARCFive128EncryptCFB	Encrypts a variable length data stream using the RC5 cipher with 128-bit block size in the CFB mode.
ARCFive128DecryptCFB	Decrypts a variable length data stream using the RC5 cipher with 128-bit block size in the CFB mode.
ARCFive128EncryptOFB	Encrypts a variable length data stream using the RC5 cipher with 128-bit block size in the OFB mode.
ARCFive128DecryptOFB	Decrypts a variable length data stream using the RC5 cipher with 128-bit block size in the OFB mode.
ARCFive128EncryptCTR	Encrypts a variable length data stream using the RC5 cipher with 128-bit block size in the CTR mode.
ARCFive128DecryptCTR	Decrypts a variable length data stream using the RC5 cipher with 128-bit block size in the CTR mode.

Throughout this section, the functions for the RC5 cipher with 64-bit block size employ the context IppsARCFive64Spec and the functions for the RC5 cipher with 128-bit block size employ the context IppsARCFive128Spec. These contexts serve as operational vehicles to carry variables needed to accomplish RC5 encryption/decryption, namely the number of rounds and expanded key table S.

Once the respective initialization function generates these variables, the functions for ECB, CBC, CFB, and other modes are ready for either encrypting or decrypting the streaming data with the specified padding scheme.

The application code for conducting a typical encryption in the CBC mode using the RC5 cipher with 64-bit block size should follow the sequence of operations outlined below:

1. Get the size required to configure the context `IppsARCFive64Spec` by calling the function `ARCFive64GetSize`.
2. Allocate a buffer whose size is not less than the function `ARCFive64GetSize` returns by calling the memory allocation service function of the operating system.
3. Initialize the context `IppsARCFive64Spec *pCtx` by calling the function `ARCFive64Init` with the allocated buffer and the respective RC5 cipher key of the specified size.
4. Specify the initialization vector and the padding scheme and then call the function `ARCFive64EncryptCBC` to encrypt the input data stream using the RC5 cipher in the CBC mode.
5. Release the memory allocated to the buffer by calling the respective operating system function.

NOTE. Similar procedure can be applied for ECB, CFB, OFB, and CTR modes of operation as well as the RC5 cipher with 128-bit block size.

RC5* Algorithm Functions for 64-bit Block Size

ARCFive64GetSize

Gets the size of the `IppsARCFive64Spec` *context.*

Syntax

```
IppStatus ippsARCFive64GetSize (int rounds, int* pSize);
```

Parameters

rounds	The number of rounds for the cipher.
pSize	Pointer to the size value of the `IppsARCFive64Spec` context.

Description

This function is declared in the `ippcp.h` file. The function gets the `IppsARCFive64Spec` context size in bytes and stores it in *`*pSize`*.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.

ARCFive64Init

Initializes user-supplied memory as the `IppsARCFive64Spec` *context for future use.*

Syntax

```
IppStatus ippsARCFive64Init (const Ipp8u *pKey, int keylen, int rounds,
IppsARCFive64Spec* pCtx);
```

Parameters

`pKey`	Pointer to the RC5 key.
`keylen`	Key byte stream length in bytes.
`rounds`	The number of rounds for the cipher.
`pCtx`	Pointer to the *`IppsARCFive64Spec`* context.

Description

This function is declared in the `ippcp.h` file. The function initializes the memory pointed by *`pCtx`* as the `IppsARCFive64Spec` context. In addition, the function uses the key to provide all necessary key material for both encryption and decryption operations.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.

ippStsLengthErr	Indicates an error condition if *keylen* is less than 1 or greater than 256.

ARCFive64EncryptECB

Encrypts a variable length data stream using the RC5 cipher with 64-bit block size in the ECB mode.

Syntax

```
IppStatus ippsARCFive64EncryptECB (const Ipp8u* pSrc, Ipp8u* pDst, int length,
const IppsARCFive64Spec* pCtx, IppsCPPadding padding);
```

Parameters

pSrc	Pointer to the input plaintext data stream of variable length.
pDst	Pointer to the resulting ciphertext data stream.
length	Length of the input data stream in bytes.
pCtx	Pointer to the IppsARCFive64Spec context.
padding	IppsCPPaddingNONE padding scheme.

Description

This function is declared in the ippcp.h file. The function encrypts the input data stream of a variable length in the ECB mode as specified in [NIST SP 800-38A].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the input data stream length is less than or equal to 0.
ippStsUnderRunErr	Indicates an error condition if *length* is not divisible by data block size.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

ARCFive64DecryptECB

Decrypts a variable length data stream using the RC5 cipher with 64-bit block size in the ECB mode.

Syntax

```
IppStatus ippsARCFive64DecryptECB (const Ipp8u* pSrc, Ipp8u* pDst, int length,
const IppsARCFive64Spec* pCtx, IppsCPPadding padding);
```

Parameters

pSrc	Pointer to the input ciphertext data stream of variable length.
pDst	Pointer to the resulting plaintext data stream.
length	Length of the ciphertext data stream in bytes.
pCtx	Pointer to the `IppsARCFive64Spec` context.
padding	`IppsCPPaddingNONE` padding scheme.

Description

This function is declared in the `ippcp.h file`. The function decrypts the input data stream of a variable length in the ECB mode as specified in the [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than or equal to 0.
`ippStsUnderRunErr`	Indicates an error condition if *length* is not divisible by data block size.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

ARCFive64EncryptCBC

Encrypts a variable length data stream using the RC5 cipher with 64-bit block size in the CBC mode.

Syntax

```
IppStatus ippsARCFive64EncryptCBC (const Ipp8u* pSrc, Ipp8u* pDst, int length,
const IppsARCFive64Spec* pCtx, const Ipp8u* pIV, IppsCPPadding padding);
```

Parameters

pSrc	Pointer to the input plaintext data stream of variable length.
pDst	Pointer to the resulting ciphertext data stream.
length	Length of the plaintext data stream in bytes.
pCtx	Pointer to the `IppsARCFive64Spec` context.
pIV	Pointer to the initialization vector for the CBC mode operation.
padding	`IppsCPPaddingNONE` padding scheme.

Description

This function is declared in the `ippcp.h file`. The function encrypts the input data stream of a variable length in the CBC mode as specified in the [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than or equal to 0.
`ippStsUnderRunErr`	Indicates an error condition if *length* is not divisible by data block size.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

ARCFive64DecryptCBC

Decrypts a variable length data stream using the RC5 cipher with 64-bit block size in the CBC mode.

Syntax

```
IppStatus ippsARCFive64DecryptCBC (const Ipp8u* pSrc, Ipp8u* pDst, int length,
const IppsARCFive64Spec* pCtx, const Ipp8u* pIV, IppsCPPadding padding);
```

Parameters

pSrc	Pointer to the input ciphertext data stream of variable length.
pDst	Pointer to the resulting plaintext data stream.
length	Length of the ciphertext data stream in bytes.
pCtx	Pointer to the `IppsARCFive64Spec` context.
pIV	Pointer to the initialization vector for the CBC mode operation.
padding	`IppsCPPaddingNONE` padding scheme.

Description

This function is declared in the `ippcp.h file`. The function decrypts the input data stream of a variable length in the CBC mode as specified in the [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than or equal to 0.
`ippStsUnderRunErr`	Indicates an error condition if *length* is not divisible by data block size.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

ARCFive64EncryptCFB

Encrypts a variable length data stream using the RC5 cipher with 64-bit block size in the CFB mode.

Syntax

```
IppStatus ippsARCFive64EncryptCFB (const Ipp8u* pSrc, Ipp8u* pDst, int length,
int cfbBlkSize, const IppsARCFive64Spec* pCtx, const Ipp8u* pIV, IppsCPPadding
padding);
```

Parameters

pSrc	Pointer to the input plaintext data stream of variable length.
pDst	Pointer to the resulting ciphertext data stream.
length	Length of the plaintext data stream in bytes.
cfbBlkSize	Size of the CFB block in bytes.
pCtx	Pointer to the `IppsARCFive64Spec` context.
pIV	Pointer to the initialization vector for the CFB mode operation.
padding	`IppsCPPaddingNONE` padding scheme.

Description

This function is declared in the `ippcp.h` file. The function encrypts the input data stream of a variable length in the CFB mode as specified in [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than or equal to zero.
`ippStsUnderRunErr`	Indicates an error condition if *length* is not divisible by the *cfbBlkSize* parameter value.
`ippStsCFBSizeErr`	Indicates an error condition if the value of *cfbBlkSize* is illegal.

ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

ARCFive64DecryptCFB

Decrypts a variable length data stream using the RC5 cipher with 64-bit block size in the CFB mode.

Syntax

```
IppStatus ippsARCFive64DecryptCFB (const Ipp8u* pSrc, Ipp8u* pDst, int length, int cfbBlkSize, const IppsARCFive64Spec* pCtx, const Ipp8u* pIV, IppsCPPadding padding);
```

Parameters

pSrc	Pointer to the input ciphertext data stream of variable length.
pDst	Pointer to the resulting plaintext data stream.
length	Length of the ciphertext data stream in bytes.
cfbBlkSize	Size of the CFB block in bytes.
pCtx	Pointer to the IppsARCFive64Spec context.
pIV	Pointer to the initialization vector for the CFB mode operation.
padding	IppsCPPaddingNONE padding scheme.

Description

This function is declared in the ippcp.h file. The function decrypts the input data stream of a variable length in the CFB mode as specified in [NIST SP 800-38A].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the input data stream length is less than or equal to zero.

ippStsUnderRunErr	Indicates an error condition if *length* is not divisible by the *cfbBlkSize* parameter value.
ippStsCFBSizeErr	Indicates an error condition if the value of *cfbBlkSize* is illegal.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

ARCFive64EncryptOFB

Encrypts a variable length data stream using the RC5 cipher with 64-bit block size in the OFB mode.

Syntax

```
IppStatus ippsARCFive64EncryptOFB (const Ipp8u* pSrc, Ipp8u* pDst, int length,
int ofbBlkSize, const IppsARCFive64Spec* pCtx, Ipp8u* pIV);
```

Parameters

pSrc	Pointer to the input plaintext data stream of variable length.
pDst	Pointer to the resulting ciphertext data stream.
length	Length of the plaintext data stream in bytes.
ofbBlkSize	Size of the OFB block in bytes.
pCtx	Pointer to the IppsARCFive64Spec context.
pIV	Pointer to the initialization vector for the OFB mode operation.

Description

This function is declared in the ippcp.h file. The function encrypts the input data stream of a variable length in the OFB mode as specified in [NIST SP 800-38A].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the input data stream length is less than or equal to zero.

ippStsUnderRunErr	Indicates an error condition if *length* is not divisible by the *ofbBlkSize* parameter value.
ippStsOFBSizeErr	Indicates an error condition if the value of *ofbBlkSize* is illegal.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

ARCFive64DecryptOFB

Decrypts a variable length data stream using the RC5 cipher with 64-bit block size in the OFB mode.

Syntax

```
IppStatus ippsARCFive64DecryptOFB (const Ipp8u* pSrc, Ipp8u* pDst, int length,
int ofbBlkSize, const IppsARCFive64Spec* pCtx, Ipp8u* pIV);
```

Parameters

pSrc	Pointer to the input ciphertext data stream of variable length.
pDst	Pointer to the resulting plaintext data stream.
length	Length of the ciphertext data stream in bytes.
ofbBlkSize	Size of the OFB block in bytes.
pCtx	Pointer to the IppsARCFive64Spec context.
pIV	Pointer to the initialization vector for the OFB mode operation.

Description

This function is declared in the ippcp.h file. The function encrypts the input data stream of a variable length in the OFB mode as specified in [NIST SP 800-38A].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the input data stream length is less than or equal to zero.

ippStsUnderRunErr	Indicates an error condition if *length* is not divisible by the *ofbBlkSize* parameter value.
ippStsOFBSizeErr	Indicates an error condition if the value of *ofbBlkSize* is illegal.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

ARCFive64EncryptCTR

Encrypts a variable length data stream using the RC5 cipher with 64-bit block size in the CTR mode.

Syntax

```
IppStatus ippsARCFive64EncryptCTR (const Ipp8u* pSrc, Ipp8u* pDst, int length,
const IppsARCFive64Spec* pCtx, Ipp8u* pCtrValue, int ctrNumBitSize);
```

Parameters

pSrc	Pointer to the input plaintext data stream of a variable length.
pDst	Pointer to the resulting ciphertext data stream.
length	Length of the plaintext data stream in bytes.
pCtx	Pointer to the IppsARCFive64Spec context.
pCtrValue	Pointer to the counter data block.
ctrNumBitSize	Number of bits in the specific part of the counter to be incremented.

Description

This function is declared in the ippcp.h file. The function encrypts the input data stream of a variable length in the CTR mode as specified in [NIST SP 800-38A].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the input data stream length is less than or equal to zero.

ippStsCTRSizeErr	Indicates an error condition if the value of the *ctrNumBitSize* is illegal.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

ARCFive64DecryptCTR

Decrypts a variable length data stream using the RC5 cipher with 64-bit block size in the CTR mode.

Syntax

```
IppStatus ippsARCFive64DecryptCTR (const Ipp8u* pSrc, Ipp8u* pDst, int length,
const IppsARCFive64Spec* pCtx, Ipp8u* pCtrValue, int ctrNumBitSize);
```

Parameters

pSrc	Pointer to the input ciphertext data stream of variable length.
pDst	Pointer to the resulting plaintext data stream.
length	Length of the ciphertext data stream in bytes.
pCtx	Pointer to the IppsARCFive64Spec context.
pCtrValue	Pointer to the counter data block.
ctrNumBitSize	Number of bits in the specific part of the counter to be incremented.

Description

This function is declared in the ippcp.h file. The function decrypts the input data stream of a variable length in the CTR mode as specified in [NIST SP 800-38A].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the input data stream length is less than or equal to zero.

ippStsCTRSizeErr	Indicates an error condition if the value of the *ctrNumBitSize* is illegal.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

RC5* Algorithm Functions for 128-bit Block Size

ARCFive128GetSize

Gets the size of the IppsARCFive128Spec context.

Syntax

```
IppStatus ippsARCFive128GetSize (int rounds, int* pSize);
```

Parameters

rounds	The number of rounds for the cipher.
pSize	Poiner to the size of the IppsARCFive128Spec context.

Description

This function is declared in the ippcp.h file. The function gets the IppsARCFive128Spec context size in bytes and stores it in **pSize*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

ARCFive128Init

Initializes user-supplied memory as the IppsARCFive128Spec context for future use.

Syntax

```
IppStatus ippsARCFive128Init (const Ipp8u *pKey, int keylen, int rounds,
IppsARCFive128Spec* pCtx);
```

Parameters

pKey	Pointer to the RC5 key.
keylen	Key byte stream length in bytes.
rounds	The number of rounds for the cipher.
pCtx	Pointer to the `IppsARCFive128Spec` context.

Description

This function is declared in the `ippcp.h` file. The function initializes the memory pointed by *pCtx* as the `IppsARCFive128Spec` context. In addition, the function uses the key to provide all necessary key material for both encryption and decryption operations.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if *keylen* is less than 1 or greater than 256.

ARCFive128EncryptECB

Encrypts a variable length data stream using the RC5 cipher with 128-bit block size in the ECB mode.

Syntax

```
IppStatus ippsARCFive128EncryptECB (const Ipp8u* pSrc, Ipp8u* pDst, int length, const IppsARCFive128Spec* pCtx, IppsCPPadding padding);
```

Parameters

pSrc	Pointer to the input plaintext data stream of variable length.
pDst	Pointer to the resulting ciphertext data stream.
length	Length of the input data stream in bytes.
pCtx	Pointer to the `IppsARCFive128Spec` context.

padding	IppsCPPaddingNONE padding scheme.

Description

This function is declared in the ippcp.h file. The function encrypts the input data stream of a variable length in the ECB mode as specified in [NIST SP 800-38A].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the input data stream length is less than or equal to 0.
ippStsUnderRunErr	Indicates an error condition if *length* is not divisible by data block size.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

ARCFive128DecryptECB

Decrypts a variable length data stream using the RC5 cipher with 128-bit block size in the EBC mode.

Syntax

```
IppStatus ippsARCFive128DecryptECB (const Ipp8u* pSrc, Ipp8u* pDst, int length, const IppsARCFive128Spec* pCtx, IppsCPPadding padding);
```

Parameters

pSrc	Pointer to the input ciphertext data stream of variable length.
pDst	Pointer to the resulting plaintext data stream.
length	Length of the ciphertext data stream in bytes.
pCtx	Pointer to the IppsARCFive128Spec context.
padding	IppsCPPaddingNONE padding scheme.

Description

This function is declared in the `ippcp.h file`. The function decrypts the input data stream of a variable length in the ECB mode as specified in the [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than or equal to 0.
`ippStsUnderRunErr`	Indicates an error condition if *`length`* is not divisible by data block size.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

ARCFive128EncryptCBC

Encrypts a variable length data stream using the RC5 cipher with 128-bit block size in the CBC mode.

Syntax

```
IppStatus ippsARCFive128EncryptCBC (const Ipp8u* pSrc, Ipp8u* pDst, int length, const IppsARCFive128Spec* pCtx, const Ipp8u* pIV, IppsCPPadding padding);
```

Parameters

`pSrc`	Pointer to the input plaintext data stream of variable length.
`pDst`	Pointer to the resulting ciphertext data stream.
`length`	Length of the plaintext data stream in bytes.
`pCtx`	Pointer to the `IppsARCFive128Spec` context.
`pIV`	Pointer to the initialization vector for the CBC mode operation.
`padding`	`IppsCPPaddingNONE` padding scheme.

Description

This function is declared in the `ippcp.h file`. The function encrypts the input data stream of a variable length in the CBC mode as specified in the [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than or equal to 0.
`ippStsUnderRunErr`	Indicates an error condition if *`length`* is not divisible by data block size.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

ARCFive128DecryptCBC

Decrypts a variable length data stream using the RC5 cipher with 128-bit block size in the CBC mode.

Syntax

```
IppStatus ippsARCFive128DecryptCBC (const Ipp8u* pSrc, Ipp8u* pDst, int length, const IppsARCFive128Spec* pCtx, const Ipp8u* pIV, IppsCPPadding padding);
```

Parameters

`pSrc`	Pointer to the input ciphertext data stream of variable length.
`pDst`	Pointer to the resulting plaintext data stream.
`length`	Length of the ciphertext data stream in bytes.
`pCtx`	Pointer to the `IppsARCFive128Spec` context.
`pIV`	Pointer to the initialization vector for the CBC mode operation.
`padding`	`IppsCPPaddingNONE` padding scheme.

Description

This function is declared in the `ippcp.h file`. The function decrypts the input data stream of a variable length in the CBC mode as specified in the [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than or equal to 0.
`ippStsUnderRunErr`	Indicates an error condition if *`length`* is not divisible by data block size.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

ARCFive128EncryptCFB

Encrypts a variable length data stream using the RC5 cipher with 128-bit block size in the CFB mode.

Syntax

```
IppStatus ippsARCFive128EncryptCFB (const Ipp8u* pSrc, Ipp8u* pDst, int length, int cfbBlkSize, const IppsARCFive128Spec* pCtx, const Ipp8u* pIV, IppsCPPadding padding);
```

Parameters

`pSrc`	Pointer to the input plaintext data stream of variable length.
`pDst`	Pointer to the resulting ciphertext data stream.
`length`	Length of the plaintext data stream in bytes.
`cfbBlkSize`	Size of the CFB block in bytes.
`pCtx`	Pointer to the `IppsARCFive128Spec` context.
`pIV`	Pointer to the initialization vector for the CFB mode operation.
`padding`	`IppsCPPaddingNONE` padding scheme.

Description

This function is declared in the `ippcp.h` file. The function encrypts the input data stream of a variable length in the CFB mode as specified in [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than or equal to zero.
`ippStsUnderRunErr`	Indicates an error condition if *`length`* is not divisible by the *`cfbBlkSize`* parameter value.
`ippStsCFBSizeErr`	Indicates an error condition if the value of *`cfbBlkSize`* is illegal.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

ARCFive128DecryptCFB

Decrypts a variable length data stream using the RC5 cipher with 128-bit block size in the CFB mode.

Syntax

```
IppStatus ippsARCFive128DecryptCFB (const Ipp8u* pSrc, Ipp8u* pDst, int length, int cfbBlkSize, const IppsARCFive128Spec* pCtx, const Ipp8u* pIV, IppsCPPadding padding);
```

Parameters

`pSrc`	Pointer to the input ciphertext data stream of variable length.
`pDst`	Pointer to the resulting plaintext data stream.
`length`	Length of the ciphertext data stream in bytes.
`cfbBlkSize`	Size of the CFB block in bytes.
`pCtx`	Pointer to the `IppsARCFive128Spec` context.
`pIV`	Pointer to the initialization vector for the CFB mode operation.

padding	IppsCPPaddingNONE padding scheme.

Description

This function is declared in the ippcp.h file. The function decrypts the input data stream of a variable length in the CFB mode as specified in [NIST SP 800-38A].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the input data stream length is less than or equal to zero.
ippStsUnderRunErr	Indicates an error condition if *length* is not divisible by the *cfbBlkSize* parameter value.
ippStsCFBSizeErr	Indicates an error condition if the value of *cfbBlkSize* is illegal.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

ARCFive128EncryptOFB

Encrypts a variable length data stream using the RC5 cipher with 128-bit block size in the OFB mode.

Syntax

```
IppStatus ippsARCFive128EncryptOFB (const Ipp8u* pSrc, Ipp8u* pDst, int length, int ofbBlkSize, const IppsARCFive128Spec* pCtx, Ipp8u* pIV);
```

Parameters

pSrc	Pointer to the input plaintext data stream of variable length.
pDst	Pointer to the resulting ciphertext data stream.
length	Length of the plaintext data stream in bytes.
ofbBlkSize	Size of the OFB block in bytes.
pCtx	Pointer to the IppsARCFive128Spec context.

pIV	Pointer to the initialization vector for the OFB mode operation.

Description

This function is declared in the `ippcp.h` file. The function encrypts the input data stream of a variable length in the OFB mode as specified in [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than or equal to zero.
`ippStsUnderRunErr`	Indicates an error condition if *length* is not divisible by the *ofbBlkSize* parameter value.
`ippStsOFBSizeErr`	Indicates an error condition if the value of *ofbBlkSize* is illegal.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

ARCFive128DecryptOFB

Decrypts a variable length data stream using the RC5 cipher with 128-bit block size in the OFB mode.

Syntax

```
IppStatus ippsARCFive128DecryptOFB (const Ipp8u* pSrc, Ipp8u* pDst, int length, int ofbBlkSize, const IppsARCFive128Spec* pCtx, Ipp8u* pIV);
```

Parameters

pSrc	Pointer to the input ciphertext data stream of variable length.
pDst	Pointer to the resulting plaintext data stream.
length	Length of the ciphertext data stream in bytes.
ofbBlkSize	Size of the OFB block in bytes.

pCtx	Pointer to the IppsARCFive128Spec context.
pIV	Pointer to the initialization vector for the OFB mode operation.

Description

This function is declared in the ippcp.h file. The function encrypts the input data stream of a variable length in the OFB mode as specified in [NIST SP 800-38A].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the input data stream length is less than or equal to zero.
ippStsUnderRunErr	Indicates an error condition if *length* is not divisible by the *ofbBlkSize* parameter value.
ippStsOFBSizeErr	Indicates an error condition if the value of *ofbBlkSize* is illegal.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

ARCFive128EncryptCTR

Encrypts a variable length data stream using the RC5 cipher with 128-bit block size in the CTR mode.

Syntax

```
IppStatus ippsARCFive128EncryptCTR (const Ipp8u* pSrc, Ipp8u* pDst, int
length, const IppsARCFive128Spec* pCtx, Ipp8u* pCtrValue, int ctrNumBitSize);
```

Parameters

pSrc	Pointer to the input plaintext data stream of a variable length.
pDst	Pointer to the resulting ciphertext data stream.
length	Length of the plaintext data stream in bytes.
pCtx	Pointer to the IppsARCFive128Spec context.

pCtrValue	Pointer to the counter data block.
ctrNumBitSize	Number of bits in the specific part of the counter to be incremented.

Description

This function is declared in the `ippcp.h` file. The function encrypts the input data stream of a variable length in the CTR mode as specified in [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than or equal to zero.
`ippStsCTRSizeErr`	Indicates an error condition if the value of the *ctrNumBitSize* is illegal.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

ARCFive128DecryptCTR

Decrypts a variable length data stream using the RC5 cipher with 128-bit block size in the CTR mode.

Syntax

```
IppStatus ippsARCFive128DecryptCTR (const Ipp8u* pSrc, Ipp8u* pDst, int length, const IppsARCFive128Spec* pCtx, Ipp8u* pCtrValue, int ctrNumBitSize);
```

Parameters

pSrc	Pointer to the input ciphertext data stream of variable length.
pDst	Pointer to the resulting plaintext data stream.
length	Length of the ciphertext data stream in bytes.
pCtx	Pointer to the `IppsARCFive128Spec` context.
pCtrValue	Pointer to the counter data block.

ctrNumBitSize	Number of bits in the specific part of the counter to be incremented.

Description

This function is declared in the `ippcp.h` file. The function decrypts the input data stream of a variable length in the CTR mode as specified in [NIST SP 800-38A].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than or equal to zero.
`ippStsCTRSizeErr`	Indicates an error condition if the value of the *ctrNumBitSize* is illegal.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

ARCFour Functions

As the RC4* stream cipher, widely used for file encryption and secure communications, is the property of RSA Security Inc., a cipher discussed in this section and resulting in the same encryption/decryption as RC4* is called ARCFour.

The ARCFour stream cipher ([AC]) uses a variable length key of up to 256 octets (bytes). ARCFour operates in the Output Feedback mode (OFB), defined in [NIST SP 800-38A], which creates the keystream independently of both the plaintext and the ciphertext.

Table 2-9 lists Intel IPP ARCFour algorithm functions:

Table 2-9 Intel IPP ARCFour Algorithm Functions

Function Base Name	Operation
`ARCFourGetSize`	Gets the size of the `IppsARCFourState` context.
`ARCFourCheckKey`	Checks weakness of a user defined key.
`ARCFourInit`	Initializes user-supplied memory as the `IppsARCFourState` context for future use.
`ARCFourEncrypt`	Encrypts a variable length data stream according to ARCFour.
`ARCFourDecrypt`	Decrypts a variable length data stream according to ARCFour.
`ARCFourReset`	Resets the `IppsARCFourState` context to the initial state.

The ARCFour algorithm functions, described in this section, use the context IppsARCFourState as an operational vehicle to carry variables needed to execute the algorithm: S-Boxes and a current pair of indices.

The typical application code for conducting an encryption or decryption using ARCFour should follow the sequence of operations listed below:

1. Get the buffer size required to configure the context IppsARCFourState by calling the function ARCFourGetSize.
2. Call the operating system memory allocation service function to allocate a buffer whose size is not less than the one specified by the function ARCFourGetSize.
3. Initialize the pointer *pCtx* to the IppsARCFourState context by calling the function ARCFourInit with the allocated buffer and the respective ARCFour cipher key of the specified size.
4. Call the ARCFourEncrypt or ARCFourDecrypt function to encrypt or decrypt the input data stream, respectively.
5. Call the operating system memory free service function to release the buffer allocated for the IppsARCFourState context, if needed.

ARCFourGetSize

Gets the size of the IppsARCFourState *context.*

Syntax

```
IppStatus ippsARCFourGetSize(int* pSize);
```

Parameters

pSize	Pointer to the size value of the IppsARCFourState context.

Description

This function is declared in the ippcp.h file. The function gets the size of the IppsARCFourState context in bytes and stores it in **pSize*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if the specified pointer is NULL.

ARCFourCheckKey

Checks weakness of a user-defined key.

Syntax

```
IppStatus ippsARCFourCheckKey(const Ipp8u* pKey, int keyLen, IppsBool*
pIsWeak);
```

Parameters

pKey	Pointer to the user-defined key.
keyLen	Length of the user-defined key in octets.
pIsWeak	Pointer to the result of checking.

Description

This function is declared in the `ippcp.h` file. The function checks weakness of user-defined key. The function allows to make sure that the supplied key provides sufficient security.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if *keyLen* <1 or *keyLen* >256.

ARCFourInit

Initializes user-supplied memory as the `IppsARCFourState` *context for future use.*

Syntax

```
IppStatus ippsARCFourInit(const Ipp8u* pKey, int keyLen, IppsARCFourState*
pCtx);
```

Parameters

pKey	Pointer to the user-defined key.
keyLen	Length of the user-defined key in octets.

pCtx	Pointer to the IppsARCFourState context being initialized.

Description

This function is declared in the ippcp.h file. The function initializes the memory pointed by *pCtx* as IppsARCFourState context. In addition, the function uses the key to provide all necessary key material for both encryption and decryption operations.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *keyLen* <1 or *keyLen* >256.

ARCFourEncrypt

Encrypts a variable length data stream according to ARCFour.

Syntax

```
IppStatus ippsARCFourEncrypt(const Ipp8u* pSrc, Ipp8u* pDst, int srclen,
IppsARCFourState* pCtx);
```

Parameters

pSrc	Pointer to the input plaintext data stream of variable length.
pDst	Pointer to the resulting ciphertext data stream.
srclen	Length of the plaintext data stream in octets.
pCtx	Pointer to the ARCFourState context.

Description

This function is declared in the ippcp.h file. The function encrypts the input data stream of a variable length using the ARCFour algorithm.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if length of the input data stream is less than one octet.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

ARCFourDecrypt

Decrypts a variable length data stream according to ARCFour.

Syntax

```
IppStatus ippsARCFourDecrypt(const Ipp8u* pSrc, Ipp8u* pDst, int srclen,
IppsARCFourState* pCtx);
```

Parameters

pSrc	Pointer to the input ciphertext data stream of variable length.
pDst	Pointer to the resulting plaintext data stream.
srclen	Length of the ciphertext data stream in octets.
pCtx	Pointer to the ARCFourState context.

Description

This function is declared in the ippcp.h file. The function decrypts the input data stream of a variable length according to the ARCFour algorithm.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if length of the input data stream is less than one octet.

ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

ARCFourReset

Resets the IppsARCFourState *context to the initial state.*

Syntax

```
IppStatus ippsARCFourReset(IppsARCFourState* pCtx);
```

Parameters

pCtx	Pointer to the IppsARCFourState context being reset.

Description

This function is declared in the ippcp.h file. The function resets the IppsARCFourState context to the state it had immediately after the ARCFourInit function call. Contrary to ARCFourInit, ARCFourReset requires no secret key to initialize the S-Box.

Return Values

ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

3 One-Way Hash Primitives

Hash functions are used in cryptography with digital signatures and for ensuring data integrity.

When used with digital signatures, a publicly available hash function hashes the message and signs the resulting hash value. The party who receives the message can then hash the message and check if the block size is authentic for the given hash value.

Hash functions are also referred to as "message digests" and "one-way encryption functions". Both terms are appropriate since hash algorithms do not have a key like symmetric and asymmetric algorithms and you can recover neither the length nor the contents of the plaintext message from the ciphertext.

To ensure data integrity, hash functions are used to compute the hash value that corresponds to a particular input. Then, if necessary, you can check if the input data has remained unmodified; you can re-compute the hash value again using the available input and compare it to the original hash value.

The Hash Functions section of this chapter describes functions that implement the following hash algorithms for streaming messages: MD5 [RFC 1321] , SHA-1, SHA-224, SHA-256, SHA-384, and SHA-512 [FIPS PUB 180-2]. These algorithms are widely used in enterprise applications nowadays.

Subsequent sections of this chapter describe Generalized Hash Functions for Non-Streaming Messages, which apply hash algorithms to entire (non-streaming) messages, and Mask Generation Functions, whose algorithms are often based on hash computations.

Each of the above algorithms is implemented as a set of primitive functions.

The full list of Intel® Integrated Performance Primitives (Intel® IPP) Hash Primitive Functions is given in Table 3-1.

Table 3-1 One-way Hash Primitive Functions

Function Base Name	Operation
Hash Functions	
MD5GetSize	Gets the size of the IppsMD5State context.
MD5Init	Initializes user-supplied memory as IppsMD5State context for future use.
MD5Duplicate	Copies one IppsMD5State context to another.
MD5Update	Digests the current input message stream of the specified length.
MD5Final	Completes computation of the MD5 digest value.
MD5GetTag	Computes the current MD5 digest value of the processed part of the message.
SHA1GetSize	Gets the size of the IppsSHA1State context.
SHA1Init	Initializes user-supplied memory as IppsSHA1State context for future use.
SHA1Duplicate	Copies one IppsSHA1State context to another.

Function Base Name	Operation
SHA1Update	Digests the current input message stream of the specified length.
SHA1Final	Completes computation of the SHA-1 digest value.
SHA1GetTag	Computes the current SHA-1 digest value of the processed part of the message.
SHA224GetSize	Gets the size of the IppsSHA224State context.
SHA224Init	Initializes user-supplied memory as IppsSHA224State context for future use.
SHA224Duplicate	Copies one IppsSHA224State context to another.
SHA224Update	Digests the current input message stream of the specified length.
SHA224Final	Completes computation of the SHA-224 digest value.
SHA224GetTag	Computes the current SHA-224 digest value of the processed part of the message.
SHA256GetSize	Gets the size of the IppsSHA256State context.
SHA256Init	Initializes user-supplied memory as IppsSHA256State context for future use.
SHA256Duplicate	Copies one IppsSHA256State context to another.
SHA256Update	Digests the current input message stream of the specified length.
SHA256Final	Completes computation of the SHA-256 digest value.
SHA256GetTag	Computes the current SHA-256 digest value of the processed part of the message.
SHA384GetSize	Gets the size of the IppsSHA384State context.
SHA384Init	Initializes user-supplied memory as IppsSHA384State context for future use.
SHA384Duplicate	Copies one IppsSHA384State context to another.
SHA384Update	Digests the current input message stream of the specified length.
SHA384Final	Completes computation of the SHA-384 digest value.
SHA384GetTag	Computes the current SHA-384 digest value of the processed part of the message.
SHA512GetSize	Gets the size of the IppsSHA512State context.
SHA512Init	Initializes user-supplied memory as IppsSHA512State context for future use.
SHA512Duplicate	Copies one IppsSHA512State context to another.
SHA512Update	Digests the current input message stream of the specified length.
SHA512Final	Completes computation of the SHA-512 digest value.
SHA512GetTag	Computes the current SHA-512 digest value of the processed part of the message.
Generalized Hash Functions for Non-Streaming Messages	
MD5MessageDigest	Computes MD5 digest value of the input message.

Function Base Name	Operation
SHA1MessageDigest	Computes SHA-1 digest value of the input message.
SHA224MessageDigest	Computes SHA-224 digest value of the input message.
SHA256MessageDigest	Computes SHA-256 digest value of the input message.
SHA384MessageDigest	Computes SHA-384 digest value of the input message.
SHA512MessageDigest	Computes SHA-512 digest value of the input message.
Mask Generation Functions	
MGF_MD5	Generates a pseudorandom mask of the specified length using MD5 hash function.
MGF_SHA1	Generates a pseudorandom mask of the specified length using SHA-1 hash function.
MGF_SHA224	Generates a pseudorandom mask of the specified length using SHA-224 hash function.
MGF_SHA256	Generates a pseudorandom mask of the specified length using SHA-256 hash function.
MGF_SHA384	Generates a pseudorandom mask of the specified length using SHA-384 hash function.
MGF_SHA512	Generates a pseudorandom mask of the specified length using SHA-512 hash function.

Hash Functions

Functions featured in this section apply hash algorithms to digesting streaming messages. A primitive implementing a hash algorithm uses the `State` context as an operational vehicle to carry all necessary variables to manage the computation of the chaining digest value. For example, the primitive implementing the SHA-1 hash algorithm must use the `ippsSHA1State` context.

The function `Init` initializes (`MD5Init`, `SHA1Init`, `SHA224Init`, `SHA256Init`, `SHA384Init`, and `SHA512Init`) the context and sets up specified initialization vectors. Once initialized, the function `Update` (`MD5Update`, `SHA1Update`, `SHA224Update`, `SHA256Update`, `SHA384Update`, and `SHA512Update`) digests the input message stream with the selected hash algorithm till it exhausts all message blocks. The function `Final` (`MD5Final`, `SHA1Final`, `SHA224Final`, `SHA256Final`, `SHA384Final`, and `SHA512Final`) is designed to pad the partial message block into a final message block with the specified padding scheme, and then uses the hash algorithm to transform the final block into a message digest value.

The following example illustrates how the application code can apply the implemented SHA-1 hash standard to digest the input message stream.

- Call the function `SHA1GetSize` to get the size required to configure the `ippsSHA1State` context.

- Ensure that the required memory space is properly allocated. With the allocated memory, call the SHA1Init function to set up the initial context state with the SHA-1 specified initialization vectors.
- Keep calling the function SHA1Update to digest incoming message stream in the queue till its completion. To determine the current value of the digest, call SHA1GetTag between the two calls to SHA1Update.
- Call the function SHA1Final for padding the partial block into a final SHA-1 message block and transforming it into a 160-bit message digest value.
- Call the operating system memory free service function to release the ippsSHA1State context.

MD5GetSize

Gets the size of the IppsMD5State *context in bytes.*

Syntax

```
IppStatus ippsMD5GetSize(int *pSize);
```

Parameters

pSize	Pointer to the IppsMD5State context size value.

Description

This function is declared in the ippcp.h file. The function gets the IppsMD5State context size in bytes and stores it in **pSize*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

MD5Init

Initializes user-supplied memory as `IppsMD5State` *context for future use.*

Syntax

```
IppStatus ippsMD5Init(IppsMD5State* pCtx);
```

Parameters

pCtx	Pointer to the `IppsMD5State` context being intialized.

Description

This function is declared in the `ippcp.h` file. The function initializes the memory pointed by *pCtx* as `IppsMD5State` context.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.

MD5Duplicate

Copies one `IppsMD5State` *context to another.*

Syntax

```
IppStatus ippsMD5Duplicate(const IppsMD5State* pSrcCtx, IppsMD5State* pDstCtx);
```

Parameters

pSrcCtx	Pointer to the source `IppsMD5State` context.
pDstCtx	Pointer to the `IppsMD5State` context to be cloned.

Description

The function is declared in the `ippcp.h` file. The function copies one `IppsMD5State` context to another.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

MD5Update

Digests the current input message stream of the specified length.

Syntax

```
IppStatus ippsMD5Update(const Ipp8u *pSrcMesg, int mesglen, IppsMD5State *pCtx);
```

Parameters

pSrcMesg	Pointer to the buffer containing a part of or the whole message.
mesglen	Length of the actual part of the message in bytes.
pCtx	Pointer to the IppsMD5State context.

Description

This function is declared in the ippcp.h file. The function digests the current input message stream of the specified length.

The function first integrates the previous partial block with the input message stream and then partitions them into multiple message blocks (as specified by the applied hash algorithm) with a possible additional partial block. For each message block, the function uses the selected hash algorithm to transform the block into a new chaining digest value.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsLengthErr	Indicates an error condition if the input data stream length is less than zero.

MD5Final

Completes computation of the MD5 digest value.

Syntax

```
IppStatus ippsMD5Final(Ipp8u *pMD, IppsMD5State *pCtx);
```

Parameters

pMD	Pointer to the resultant digest value.
pCtx	Pointer to the IppsMD5State context.

Description

This function is declared in the ippcp.h file. The function completes calculation of the digest value and stores the result into the specified memory.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

MD5GetTag

Computes the current MD5 digest value of the processed part of the message.

Syntax

```
IppStatus ippsMD5GetTag(Ipp8u* pDstTag, Ipp32u tagLen, const IppsMD5State*
pState);
```

Parameters

pDstTag	Pointer to the authentication tag.
tagLen	Length of the tag (in bytes).
pState	Pointer to the IppsMD5State context.

Description

This function is declared in the ippcp.h file. The function computes the message digest based on the current context as specified in [FIPS PUB 180-2] and [RFC 1321]. A call to this function retains the possibility to update the digest.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *tagLen* < 1 or *tagLen* exceeds the maximal length of a particular digest.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

SHA1GetSize

Gets the size of the IppsSHA1State *context in bytes.*

Syntax

```
IppStatus ippsSHA1GetSize(int *pSize);
```

Parameters

pSize	Pointer to the IppsSHA1State context size value.

Description

This function is declared in the ippcp.h file. The function gets the IppsSHA1State context size in bytes and stores it in **pSize*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

SHA1Init

Initializes user-supplied memory as IppsSHA1State *context for future use.*

Syntax

```
IppStatus ippsSHA1Init(IppsSHA1State* pCtx);
```

Parameters

pCtx	Pointer to the IppsSHA1State context being intialized.

Description

This function is declared in the ippcp.h file. The function initializes the memory pointed by *pCtx* as IppsSHA1State context.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

SHA1Duplicate

Copies one IppsSHA1State *context to another.*

Syntax

```
IppStatus ippsSHA1Duplicate(const IppsSHA1State* pSrcCtx, IppsSHA1State*
pDstCtx);
```

Parameters

pSrcCtx	Pointer to the source IppsSHA1State context.

pDstCtx	Pointer to the IppsSHA1State context to be cloned.

Description

The function is declared in the ippcp.h file. The function copies one IppsSHA1State context to another.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

SHA1Update

Digests the current input message stream of the specified length.

Syntax

```
IppStatus ippsSHA1Update(const Ipp8u *pSrcMesg, int mesglen, IppsSHA1State *pCtx);
```

Parameters

pSrcMesg	Pointer to the buffer containing a part of or the whole message.
mesglen	Length of the actual part of the message in bytes.
pCtx	Pointer to the IppsSHA1State context.

Description

This function is declared in the ippcp.h file. The function digests the current input message stream of the specified length.

The function first integrates the previous partial block with the input message stream and then partitions them into multiple message blocks (as specified by the applied hash algorithm) with a possible additional partial block. For each message block, the function uses the selected hash algorithm to transform the block into a new chaining digest value.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsLengthErr	Indicates an error condition if the input data stream length is less than zero.

SHA1Final

Completes computation of the SHA-1 digest value.

Syntax

```
IppStatus ippsSHA1Final(Ipp8u *pMD, IppsSHA1State *pCtx);
```

Parameters

pMD	Pointer to the resultant digest value.
pCtx	Pointer to the IppsSHA1State context.

Description

This function is declared in the ippcp.h file. The function completes calculation of the digest value and stores the result into the specified memory.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

SHA1GetTag

Computes the current SHA-1 digest value of the processed part of the message.

Syntax

```
IppStatus ippsSHA1GetTag(Ipp8u* pDstTag, Ipp32u tagLen, const IppsSHA1State* pState);
```

Parameters

pDstTag	Pointer to the authentication tag.
tagLen	Length of the tag (in bytes).
pState	Pointer to the `IppsSHA1State` context.

Description

This function is declared in the `ippcp.h` file. The function computes the message digest based on the current context as specified in [FIPS PUB 180-2] and [RFC 1321]. A call to this function retains the possibility to update the digest.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if *tagLen* < 1 or *tagLen* exceeds the maximal length of a particular digest.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

SHA224GetSize

Gets the size of the `IppsSHA224State` *context in bytes.*

Syntax

```
IppStatus ippsSHA224GetSize(int *pSize);
```

Parameters

pSize	Pointer to the IppsSHA224State context size value.

Description

This function is declared in the ippcp.h file. The function gets the IppsSHA224State context size in bytes and stores it in **pSize*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

SHA224Init

Initializes user-supplied memory as IppsSHA224State *context for future use.*

Syntax

```
IppStatus ippsSHA224Init(IppsSHA224State* pCtx);
```

Parameters

pCtx	Pointer to the IppsSHA224State context being intialized.

Description

This function is declared in the ippcp.h file. The function initializes the memory pointed by *pCtx* as IppsSHA224State context.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

SHA224Duplicate

Copies one `IppsSHA224State` *context to another.*

Syntax

```
IppStatus ippsSHA224Duplicate(const IppsSHA224State* pSrcCtx, IppsSHA224State* pDstCtx);
```

Parameters

pSrcCtx	Pointer to the source `SHA224State` context.
pDstCtx	Pointer to the `IppsSHA224State` context to be cloned.

Description

The function is declared in the `ippcp.h` file. The function copies one `IppsSHA224State` context to another.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

SHA224Update

Digests the current input message stream of the specified length.

Syntax

```
IppStatus ippsSHA224Update(const Ipp8u *pSrcMesg, int mesglen, IppsSHA224State *pCtx);
```

Parameters

pSrcMesg	Pointer to the buffer containing a part of or the whole message.

mesglen	Length of the actual part of the message in bytes.
pCtx	Pointer to the IppsSHA224State context.

Description

This function is declared in the ippcp.h file. The function digests the current input message stream of the specified length.

The function first integrates the previous partial block with the input message stream and then partitions them into multiple message blocks (as specified by the applied hash algorithm) with a possible additional partial block. For each message block, the function uses the selected hash algorithm to transform the block into a new chaining digest value.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsLengthErr	Indicates an error condition if the input data stream length is less than zero.

SHA224Final

Completes computation of the SHA-224 digest value.

Syntax

```
IppStatus ippsSHA224Final(Ipp8u *pMD, IppsSHA224State *pCtx);
```

Parameters

pMD	Pointer to the resultant digest value.
pCtx	Pointer to the IppsSHA224State context.

Description

This function is declared in the ippcp.h file. The function completes calculation of the digest value and stores the result into the specified memory.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

SHA224GetTag

Computes the current SHA-224 digest value of the processed part of the message.

Syntax

```
IppStatus ippsSHA224GetTag(Ipp8u* pDstTag, Ipp32u tagLen, const IppsSHA224State* pState);
```

Parameters

pDstTag	Pointer to the authentication tag.
tagLen	Length of the tag (in bytes).
pState	Pointer to the IppsSHA224State context.

Description

This function is declared in the ippcp.h file. The function computes the message digest based on the current context as specified in [FIPS PUB 180-2] and [RFC 1321]. A call to this function retains the possibility to update the digest.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *tagLen* < 1 or *tagLen* exceeds the maximal length of a particular digest.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

SHA256GetSize

Gets the size of the `IppsSHA256State` *context in bytes.*

Syntax

```
IppStatus ippsSHA256GetSize(int *pSize);
```

Parameters

pSize	Pointer to the `IppsSHA256State` context size value.

Description

This function is declared in the `ippcp.h` file. The function gets the `IppsSHA256State` context size in bytes and stores it in *pSize*.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.

SHA256Init

Initializes user-supplied memory as `IppsSHA256State` *context for future use.*

Syntax

```
IppStatus ippsSHA256Init(IppsSHA256State *pCtx);
```

Parameters

pCtx	Pointer to the `IppsSHA256State` context being intialized.

Description

This function is declared in the `ippcp.h` file. The function initializes the memory pointed by *pCtx* as `IppsSHA256State` context.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

SHA256Duplicate

Copies one IppsSHA256State *context to another.*

Syntax

```
IppStatus ippsSHA256Duplicate(const IppsSHA256State* pSrcCtx, IppsSHA256* pDstCtx);
```

Parameters

pSrcCtx	Pointer to the source IppsSHA256State context.
pDstCtx	Pointer to the IppsSHA256State context to be cloned.

Description

The function is declared in the ippcp.h file. The function copies one IppsSHA256State context to another.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

SHA256Update

Digests the current input message stream of the specified length.

Syntax

```
IppStatus ippsSHA256Update(const Ipp8u *pSrcMesg, int mesglen, IppsSHA256State *pCtx);
```

Parameters

pSrcMesg	Pointer to the buffer containing a part of or the whole message.
mesglen	Length of the actual part of the message in bytes.
pCtx	Pointer to the `IppsSHA256State` context.

Description

This function is declared in the `ippcp.h` file. The function digests the current input message stream of the specified length.

The function first integrates the previous partial block with the input message stream and then partitions them into multiple message blocks (as specified by the applied hash algorithm) with a possible additional partial block. For each message block, the function uses the selected hash algorithm to transform the block into a new chaining digest value.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than zero.

SHA256Final

Completes computation of the SHA-256 digest value.

Syntax

```
IppStatus ippsSHA256Final(Ipp8u *pMD, IppsSHA256State *pCtx);
```

Parameters

pMD	Pointer to the resultant digest value.
pCtx	Pointer to the `IppsSHA256State` context.

Description

This function is declared in the `ippcp.h` file. The function completes calculation of the digest value and stores the result into the specified memory.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

SHA256GetTag

Computes the current SHA-256 digest value of the processed part of the message.

Syntax

```
IppStatus ippsSHA256GetTag(Ipp8u* pDstTag, Ipp32u tagLen, const
IppsSHA256State* pState);
```

Parameters

pDstTag	Pointer to the authentication tag.
tagLen	Length of the tag (in bytes).

pState	Pointer to the IppsSHA265State context.

Description

This function is declared in the ippcp.h file. The function computes the message digest based on the current context as specified in [FIPS PUB 180-2] and [RFC 1321]. A call to this function retains the possibility to update the digest.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *tagLen* < 1 or *tagLen* exceeds the maximal length of a particular digest.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

SHA384GetSize

Gets the size of the IppsSHA384State *context in bytes.*

Syntax

```
IppStatus ippsSHA384GetSize(int *pSize);
```

Parameters

pSize	Pointer to the IppsSHA384State context size value.

Description

This function is declared in the ippcp.h file. The function gets the IppsSHA384State context size in bytes and stores it in **pSize*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

SHA384Init

Initializes user-supplied memory as `IppsSHA384State` *context for future use.*

Syntax

```
IppStatus ippsSHA384Init(IppsSHA384State* pCtx);
```

Parameters

pCtx	Pointer to the `IppsSHA384State` context being intialized.

Description

This function is declared in the `ippcp.h` file. The function initializes the memory pointed by *pCtx* as `IppsSHA384State` context.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.

SHA384Duplicate

Copies one `IppsSHA384State` *context to another.*

Syntax

```
IppStatus ippsSHA384Duplicate(const IppsSHA384State* pSrcCtx, IppsSHA384State* pDstCtx);
```

Parameters

pSrcCtx	Pointer to the source `IppsSHA384State` context.
pDstCtx	Pointer to the `IppsSHA384State` context to be cloned.

Description

The function is declared in the `ippcp.h` file. The function copies one `IppsSHA384State` context to another.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

SHA384Update

Digests the current input message stream of the specified length.

Syntax

```
IppStatus ippsSHA384Update(const Ipp8u *pSrcMesg, int mesglen, IppsSHA384State *pCtx);
```

Parameters

pSrcMesg	Pointer to the buffer containing a part of or the whole message.
mesglen	Length of the actual part of the message in bytes.
pCtx	Pointer to the `IppsSHA384State` context.

Description

This function is declared in the `ippcp.h` file. The function digests the current input message stream of the specified length.

The function first integrates the previous partial block with the input message stream and then partitions them into multiple message blocks (as specified by the applied hash algorithm) with a possible additional partial block. For each message block, the function uses the selected hash algorithm to transform the block into a new chaining digest value.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsLengthErr	Indicates an error condition if the input data stream length is less than zero.

SHA384Final

Completes computing of the SHA-384 digest value.

Syntax

```
IppStatus ippsSHA384Final( Ipp8u *pMD, IppsSHA384State *pCtx );
```

Parameters

pMD	Pointer to the resultant digest value.
pCtx	Pointer to the IppsSHA384State context.

Description

This function is declared in the ippcp.h file. The function completes calculation of the digest value and stores the result into the specified memory.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

SHA384GetTag

Computes the current SHA-384 digest value of the processed part of the message.

Syntax

```
IppStatus ippsSHA384GetTag(Ipp8u* pDstTag, Ipp32u tagLen, const
IppsSHA384State* pState);
```

Parameters

pDstTag	Pointer to the authentication tag.
tagLen	Length of the tag (in bytes).
pState	Pointer to the `IppsSHA384State` context.

Description

This function is declared in the `ippcp.h` file. The function computes the message digest based on the current context as specified in [FIPS PUB 180-2] and [RFC 1321]. A call to this function retains the possibility to update the digest.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if *tagLen* < 1 or *tagLen* exceeds the maximal length of a particular digest.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

SHA512GetSize

Gets the size of the `IppsSHA512State` *context in bytes.*

Syntax

```
IppStatus ippsSHA512GetSize(int *pSize);
```

Parameters

pSize	Pointer to the IppsSHA512State context size value.

Description

This function is declared in the ippcp.h file. The function gets the IppsSHA512State context size in bytes and stores it in **pSize*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

SHA512Init

Initializes user-supplied memory as IppsSHA512State *context for future use.*

Syntax

```
IppStatus ippsSHA512Init(IppsSHA512State* pState);
```

Parameters

pCtx	Pointer to the IppsSHA512State context being intialized.

Description

This function is declared in the ippcp.h file. The function initializes the memory pointed by *pCtx* as IppsSHA512State context.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

SHA512Duplicate

Copies one `IppsSHA512State` *context to another.*

Syntax

```
IppStatus ippsSHA512Duplicate(const IppsSHA512State* pSrcCtx, IppsSHA512* pDstCtx);
```

Parameters

pSrcCtx	Pointer to the source `IppsSHA512State` context.
pDstCtx	Pointer to the `IppsSHA512State` context to be cloned.

Description

The function is declared in the `ippcp.h` file. The function copies one `IppsSHA512State` context to another.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

SHA512Update

Digests the current input message stream of the specified length.

Syntax

```
IppStatus ippsSHA512Update(const Ipp8u *pSrcMesg, int mesglen, IppsSHA512State *pCtx);
```

Parameters

pSrcMesg	Pointer to the buffer containing a part of or the whole message.

mesglen	Length of the actual part of the message in bytes.
pCtx	Pointer to the IppsSHA512State context.

Description

This function is declared in the ippcp.h file. The function digests the current input message stream of the specified length.

The function first integrates the previous partial block with the input message stream and then partitions them into multiple message blocks (as specified by the applied hash algorithm) with a possible additional partial block. For each message block, the function uses the selected hash algorithm to transform the block into a new chaining digest value.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsLengthErr	Indicates an error condition if the input data stream length is less than zero.

SHA512Final

Completes computation of the SHA-512 digest value.

Syntax

```
IppStatus ippsSHA512Final(Ipp8u *pMD, IppsSHA512State *pCtx);
```

Parameters

pMD	Pointer to the resultant digest value.
pCtx	Pointer to the IppsSHA512State context.

Description

This function is declared in the ippcp.h file. The function completes calculation of the digest value and stores the result into the specified memory.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

SHA512GetTag

Computes the current SHA-512 digest value of the processed part of the message.

Syntax

```
IppStatus ippsSHA512GetTag(Ipp8u* pDstTag, Ipp32u tagLen, const IppsSHA512State* pState);
```

Parameters

pDstTag	Pointer to the authentication tag.
tagLen	Length of the tag (in bytes).
pState	Pointer to the IppsSHA512State context.

Description

This function is declared in the ippcp.h file. The function computes the message digest based on the current context as specified in [FIPS PUB 180-2] and [RFC 1321]. A call to this function retains the possibility to update the digest.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *tagLen* < 1 or *tagLen* exceeds the maximal length of a particular digest.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

Generalized Hash Functions for Non-Streaming Messages

Intel IPP hash functions MD5MessageDigest, SHA1MessageDigest, SHA224MessageDigest, SHA256MessageDigest, SHA384MessageDigest, and SHA512MessageDigest are used to calculate a digest of an entire (non-streaming) input message by applying a selected hash algorithm.

Having the six hash algorithms currently available in the Intel IPP, you may still prefer to use a different implementation of a hash algorithm, based on some other function. In this case you can also use the IPPCP library. To do this, use the definition of a hash function introduced in IPPCP and given in the subsection below. This definition is also applied to a hash function when it is passed as a parameter that some Public Key Cryptography operations optionally use.

General Definition of a Hash Function

Syntax

```
typedef IppStatus(_STDCALL *IppHASH)(const Ipp8u* pMsg, int msgLen, Ipp8u* pMD);
```

Parameters

pMsg	Pointer to the input octet string.
msgLen	ength of the input string in octers.
pMDparmname>	Pointer to the output message digest.

Description

This declaration is included in the ippcp.h file. The function calculates the digest of a non-streaming message using the implemented hash algorithm.

NOTE. Definition of a hash function used in Intel IPP limits length (in octets) of an input message for any specific hash function by the range of the int data type, with the upper bound of 2^{32}-1.

MD5MessageDigest

Computes MD5 digest value of the input message.

Syntax

```
IppStatus ippsMD5MessageDigest(const Ipp8u *pSrcMesg, int mesgLen, Ipp8u *pMD);
```

Parameters

pSrcMesg	Pointer to the input message.
mesglen	Message length in octets.
pMD	Pointer to the resultant digest.

Description

This function is declared in the `ippcp.h` file. The function uses the selected hash algorithm to compute digest value of the entire (non-streaming) input message.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than zero.

Example 3-1 MD5 Digest of a Message

```
void MD5_sample(void){
   // define message
   Ipp8u msg[] = "abcdefghijklmnopqrstuvwxyz";

   // once the whole message is placed into memory,
   // one can use the integrated primitive
   Ipp8u digest[16];
   ippsMD5MessageDigest(msg, strlen((char*)msg), digest);
}
```

SHA1MessageDigest

Computes SHA-1 digest value of the input message.

Syntax

`IppStatus ippsSHA1MessageDigest(const Ipp8u *pSrcMesg, int mesglen, Ipp8u *pMD);`

Parameters

pSrcMesg	Pointer to the input message.
mesglen	Message length in octets.
pMD	Pointer to the resultant digest.

Description

This function is declared in the `ippcp.h` file. The function uses the selected hash algorithm to compute the digest value of the entire (non-streaming) input message.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.

`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than zero.

Example 3-2 SHA1 Digest of a Message

```
    //    Compute two SHA1 digests of a message:
    //    1-st will correspond of 1/2 message
    //    2-nd will correspond of whole message
void SHA1_sample(void){
   // get size of the SHA1 context
   int ctxSize;
   ippsSHA1GetSize(&ctxSize);

   // allocate the SHA1 context
   IppsSHA1State* pCtx = (IppsSHA1State*)( new Ipp8u [ctxSize] );
   // and initialize the context
   ippsSHA1Init(pCtx);
   // define a message
   Ipp8u msg[] = "abcdbcdecdefdefgefghfghighijhijkijkljklmklmnlmnomnopnopq";
   int n;
   // update digest using a piece of message
   for(n=0; n<(sizeof(msg)-1)/2; n++)
      ippsSHA1Update(msg+n, 1, pCtx);
// clone the SHA1 context
   IppsSHA1State* pCtx2 = (IppsSHA1State*)( new Ipp8u [ctxSize] );
   ippsSHA1Init(pCtx2);
   ippsSHA1Duplicate(pCtx, pCtx2);
 // finalize and extract digest of a half message
   Ipp8u digest[20];
   ippsSHA1Final(digest, pCtx);
   // update digest using the SHA1 clone context
   ippsSHA1Update(msg+n, sizeof(msg)-1-n, pCtx2);
```

```
    // finalize and extract digest of a whole message
    Ipp8u digest2[20];
    ippsSHA1Final(digest2, pCtx2);

    delete [] (Ipp8u*)pCtx;
    delete [] (Ipp8u*)pCtx2;
}
```

SHA224MessageDigest

Computes SHA-224 digest value of the input message.

Syntax

`IppStatus ippsSHA224MessageDigest(const Ipp8u *pSrcMsg, int mesglen, Ipp8u *pMD);`

Parameters

pSrcMesg	Pointer to the input message.
mesglen	Message length in octets.
pMD	Pointer to the resultant digest.

Description

This function is declared in the `ippcp.h` file. The function uses the selected hash algorithm to compute the digest value of the entire (non-streaming) input message.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than zero.

SHA256MessageDigest

Computes SHA-256 digest value of the input message.

Syntax

```
IppStatus ippsSHA256MessageDigest(const Ipp8u *pSrcMsg, int mesglen, Ipp8u *pMD);
```

Parameters

pSrcMesg	Pointer to the input message.
mesglen	Message length in octets.
pMD	Pointer to the resultant digest.

Description

This function is declared in the `ippcp.h` file. The function uses the selected hash algorithm to compute the digest value of the entire (non-streaming) input message.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than zero.

SHA384MessageDigest

Computes SHA-384 digest value of the input message.

Syntax

```
IppStatus ippsSHA384MessageDigest(const Ipp8u *pSrcMsg, int mesglen, Ipp8u *pMD);
```

Parameters

pSrcMesg	Pointer to the input message.
mesglen	Message length in octets.
pMD	Pointer to the resultant digest.

Description

This function is declared in the `ippcp.h` file. The function uses the selected hash algorithm to compute the digest value of the entire (non-streaming) input message.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than zero.

SHA512MessageDigest

Computes SHA-512 digest value of the input message.

Syntax

```
IppStatus ippsSHA512MessageDigest(const Ipp8u *pSrcMsg, int mesglen, Ipp8u *pMD);
```

Parameters

pSrcMesg	Pointer to the input message.
mesglen	Message length in octets.
pMD	Pointer to the resultant digest.

Description

This function is declared in the `ippcp.h` file. The function uses the selected hash algorithm to compute the digest value of the entire (non-streaming) input message.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than zero.

Mask Generation Functions

Public Key Cryptography frequently uses mask generation functions (MGFs) to achieve a particular security goal. For example, MGFs are used both in RSA-OAEP encryption and RSA-SSA signature schemes.

MGF function takes an octet string of a variable length and generates an octet string of a desired length. MGFs are deterministic, which means that the input octet string completely determines the output one. The output of an MGF should be pseudorandom, that is, infeasible to predict. The provable security of such cryptography schemes as RSA-OAEP or RSA-SSA, relies on the random nature of the MGF output. That is why one-way hash functions is one of the well-known ways to implement an MGF. The exact definition of an MGF based on a one-way hash function may be found in [PKCS 1.2.1].

This section describes MGFs based on widely-used MD5, SHA-1, SHA-224, SHA-256, SHA-384 and SHA-512 hash algorithms as well as the possibility to use a different implementation of MGF.

NOTE. Intel IPP implementation of MGFs limits length (in octets) of an input message for any specific MGF by the range of the `int` data type, with the upper bound of 2^{32}-1.

User's Implementation of a Mask Generation Function

In case you prefer or have to use a different implementation of an MGF you can still use IPPCP. To do this, use the definition of MGF introduced in the IPPCP library and described in this section. The declaration provided below also defines an MGF when it is used as a parameter in some Public Key Cryptography operations.

Syntax

```
typedef IppStatus(_STDCALL *IppMGF)(const Ipp8u* pSeed, int seedLen, Ipp8u*
pMask, int maskLen);
```

Parameters

pSeed	Pointer to the input octet string.
seedLen	Length of the input string.
pMask	Pointer to the output pseodorandom mask.
maskLen	Desired length of the output.

Description

This declaration is included in the `ippcp.h` file. The function generates an octet string of length *maskLen* according to the implemented algorithm, providing pseudorandom output.

MGF_MD5

Generates a pseudorandom mask of the specified length using MD5 hash function.

Syntax

```
IppStatus ippsMGF_MD5(const Ipp8u *pSeed, int seedLen, Ipp8u* pMask, int
maskLen);
```

Parameters

pSeed	Pointer to the input octet string.
seedLen	Length of the input string.
pMask	Pointer to the output pseodorandom mask.
maskLen	Desired length of the output.

Description

This function is declared in the `ippcp.h` file. The function generates a pseudorandom mask of the specified length using MD5 hash algorithm.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if *pMask* pointer is NULL.
ippStsLengthErr	Indicates an error condition if any of the specified lengths is negative or zero.

MGF_SHA1

Generates a pseudorandom mask of the specified length using SHA-1 hash function.

Syntax

```
IppStatus ippsMGF_SHA1(const Ipp8u *pSeed, int seedLen, Ipp8u* pMask, int maskLen);
```

Parameters

pSeed	Pointer to the input octet string.
seedLen	Length of the input string.
pMask	Pointer to the output pseodorandom mask.
maskLen	Desired length of the output.

Description

This function is declared in the ippcp.h file. The function generates a pseudorandom mask of the specified length using SHA-1 hash algorithm.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if *pMask* pointer is NULL.
ippStsLengthErr	Indicates an error condition if any of the specified lengths is negative or zero.

MGF_SHA224

Generates a pseudorandom mask of the specified length using SHA-224 hash function.

Syntax

```
IppStatus ippsMGF_SHA224(const Ipp8u *pSeed, int seedLen, Ipp8u* pMask, int maskLen);
```

Parameters

pSeed	Pointer to the input octet string.
seedLen	Length of the input string.
pMask	Pointer to the output pseodorandom mask.
maskLen	Desired length of the output.

Description

This function is declared in the `ippcp.h` file. The function generates a pseudorandom mask of the specified length using SHA-224 hash algorithm.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if *pMask* pointer is `NULL`.
`ippStsLengthErr`	Indicates an error condition if any of the specified lengths is negative or zero.

MGF_SHA256

Generates a pseudorandom mask of the specified length using SHA-256 hash function.

Syntax

```
IppStatus ippsMGF_SHA256(const Ipp8u *pSeed, int seedLen, Ipp8u* pMask, int maskLen);
```

Parameters

pSeed	Pointer to the input octet string.
seedLen	Length of the input string.
pMask	Pointer to the output pseodorandom mask.
maskLen	Desired length of the output.

Description

This function is declared in the ippcp.h file. The function generates a pseudorandom mask of the specified length using SHA-256 hash algorithm.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if *pMask* pointer is NULL.
ippStsLengthErr	Indicates an error condition if any of the specified lengths is negative or zero.

MGF_SHA384

Generates a pseudorandom mask of the specified length using SHA-384 hash function.

Syntax

```
IppStatus ippsMGF_SHA384(const Ipp8u *pSeed, int seedLen, Ipp8u* pMask, int maskLen);
```

Parameters

pSeed	Pointer to the input octet string.
seedLen	Length of the input string.
pMask	Pointer to the output pseodorandom mask.
maskLen	Desired length of the output.

Description

This function is declared in the ippcp.h file. The function generates a pseudorandom mask of the specified length using SHA-384 hash algorithm.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if *pMask* pointers is NULL.
ippStsLengthErr	Indicates an error condition if any of the specified lengths is negative or zero.

MGF_SHA512

Generates a pseudorandom mask of the specified length using SHA-512 hash function.

Syntax

```
IppStatus ippsMGF_SHA512(const Ipp8u *pSeed, int seedLen, Ipp8u* pMask, int maskLen);
```

Parameters

pSeed	Pointer to the input octet string.
seedLen	Length of the input string.
pMask	Pointer to the output pseodorandom mask.
maskLen	Desired length of the output.

Description

This function is declared in the ippcp.h file. The function generates a pseudorandom mask of the specified length using SHA-512 hash algorithm.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if *pMask* pointer is NULL.
ippStsLengthErr	Indicates an error condition if any of the specified lengths is negative or zero.

Data Authentication Primitive Functions

4

This chapter describes the Intel® IPP functions for generating message authentication code (MAC), that is, Message Authentication Functions, and the Data Authentication Functions (DAA) schemes.

Message Authentication Functions

Hash function-based MAC (HMAC) is widely used in the applications requiring message authentication and data integrity check. HMAC was initially put forward in [RFC 2401] and adopted by ANSI X9.71 and [FIPS PUB 198]. See Keyed Hash Functions for a description of the Intel® Integrated Performance Primitives (Intel® IPP) HMAC primitives.

A MAC algorithm based on a symmetric key block cipher, in other words, a cipher-based MAC (CMAC), is standardized in [NIST SP 800-38B]. CMAC may be appropriate for information systems where an approved block cipher is available rather than an approved hash function. See CMAC Functions for a description of the Intel IPP CMAC primitives.

AES-XCBC-MAC-96A, a specialization of MAC based on the AES block cipher in conjunction with the Cipher-Block-Chaining (CBC) mode of operation, is standardized in [RFC 3566] and has proved its security not only for messages of pre-selected fixed lengths but also for messages of varying lengths, such as used in typical IP datagrams. See AES-XCBC Functions for a description of the Intel IPP AES-XCBC-MAC-96A primitives.

Keyed Hash Functions

The Intel IPP HMAC primitive functions, described in this section, use various HMAC schemes based on one-way hash functions described in the One-Way Hash Primitives chapter.

Table 4-1 lists the Intel IPP HMAC functions.

Table 4-1 Intel IPP HMAC Functions

Function Base Name	Operation
`HMACSHA1GetSize`	Gets the size of the `IppsHMACSHA1State` context.
`HMACSHA1Init`	Initializes user-supplied memory as `IppsHMACSHA1State` context for future use.
`HMACSHA1Duplicate`	Copies one `IppsHMACSHA1State` context to another.

Function Base Name	Operation
HMACSHA1Update	Digests the current input message stream of the specified length using SHA1-based MAC.
HMACSHA1Final	Completes computation of the SHA1-based MAC value.
HMACSHA1GetTag	Computes the current HMAC value of the processed part of the message.
HMACSHA1MessageDigest	Computes the SHA1-based MAC value of an entire message.
HMACSHA224GetSize	Gets the size of the IppsHMACSHA224State context.
HMACSHA224Init	Initializes user-supplied memory as IppsHMACSHA224State context for future use.
HMACSHA224Duplicate	Copies one IppsHMACSHA224State context to another.
HMACSHA224Update	Digests the current input message stream of the specified length using SHA224-based MAC.
HMACSHA224Final	Completes computation of the SHA224-based MAC value.
HMACSHA224GetTag	Computes the current SHA224-based MAC value of the processed part of the message.
HMACSHA224MessageDigest	Computes the SHA224-based MAC value of an entire message.
HMACSHA256GetSize	Gets the size of the IppsHMACSHA256State context.
HMACSHA256Init	Initializes user-supplied memory as IppsHMACSHA256State context for future use.
HMACSHA256Duplicate	Copies one IppsHMACSHA256State context to another.
HMACSHA256Update	Digests the current input message stream of the specified length using SHA256-based MAC.
HMACSHA256Final	Completes computation of the SHA254-based MAC value.

Function Base Name	Operation
HMACSHA256GetTag	Computes the current SHA256-based MAC value of the processed part of the message.
HMACSHA256MessageDigest	Computes the SHA256-based MAC value of an entire message.
HMACSHA384GetSize	Gets the size of the IppsHMACSHA384State context.
HMACSHA384Init	Initializes user-supplied memory as IppsHMACSHA384State context for future use.
HMACSHA384Duplicate	Copies one IppsHMACSHA384State context to another.
HMACSHA384Update	Digests the current input message stream of the specified length using SHA384-based MAC.
HMACSHA384Final	Completes computation of the SHA384-based MAC value.
HMACSHA384GetTag	Computes the current SHA384-based MAC value of the processed part of the message.
HMACSHA384MessageDigest	Computes the SHA384-based MAC value of an entire message.
HMACSHA512GetSize	Gets the size of the IppsHMACSHA512State context.
HMACSHA512Init	Initializes user-supplied memory as IppsHMACSHA512State context for future use.
HMACSHA512Duplicate	Copies one IppsHMACSHA512State context to another.
HMACSHA512Update	Digests the current input message stream of the specified length using SHA512-based MAC.
HMACSHA512Final	Completes computation of the SHA512-based MAC value.
HMACSHA512GetTag	Computes the current SHA512-based MAC value of the processed part of the message.

Function Base Name	Operation
HMACSHA512MessageDigest	Computes the SHA512-based MAC value of an entire message.
HMACMD5GetSize	Gets the size of the IppsHMACMD5State context.
HMACMD5Init	Initializes user-supplied memory as IppsHMACMD5State context for future use.
HMACMD5Duplicate	Copies one IppsHMACMD5State context to another.
HMACMD5Update	Digests the current input message stream of the specified length using MD5-based MAC.
HMACMD5Final	Completes computation of the MD5-based MAC value.
HMACMD5GetTag	Computes the current MD5-based MAC value of the processed part of the message.
HMACMD5MessageDigest	Computes the MD5-based MAC value of an entire message.

Each HMAC scheme is implemented as a set of the primitive functions tabled above.

For example, the primitive implementing HMAC that is based on SHA-1 hash algorithm uses the ippsHMACSHA1State context as an operational vehicle to carry all necessary variables to manage computation of chaining digest value.

The function HMACSHA1Init initializes the context and sets up the specified initialization vectors. After the initialization, the function HMACSHA1Update digests the input message stream with the selected hash algorithm till it exhausts all message blocks.

The function HMACSHA1Final is designed to pad the partial message block into a final message block with the specified padding scheme, and then use the hash algorithm to transform the final block into a message digest value.

The following example illustrates how the application code can apply the implemented HMAC-SHA1 hash standard to digest the input message stream:

- Call the function HMACSHA1GetSize to get the size required to configure the IppsHMACSHA1State context.
- Ensure that the required memory space is properly allocated. With the allocated memory, call the function HMACSHA1Init to set up key material and the initial context state with the SHA-1 specified initialization vectors.

- Keep calling the function HMACSHA1Update to digest incoming message stream in the queue till its completion. To determine the current value of the message digest, call HMACSHA1Get-Tag between the two calls to HMACSHA1Update.
- Call the function HMACSHA1Final for padding the partial block into a final SHA-1 message block and transforming it into a resulting HMAC value.
- Call the operating system memory free service function to release the IppsHMACSHA1State context.

HMACSHA1GetSize

Gets the size of the IppsHMACSHA1State *context.*

Syntax

```
IppStatus ippsHMACSHA1GetSize(int *pSize);
```

Parameters

pSize	Pointer to the IppsHMACSHA1State context size value.

Description

The function is declared in the ippcp file. The function gets the IppsHMACSHA1State context size in bytes and stores it in *pSize*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

HMACSHA1Init

Initializes user-supplied memory as IppsHMACSHA1State *context for future use.*

Syntax

```
IppStatus ippsHMACSHA1Init(const Ipp8u *pKey, int keyLen, IppsHMACSHA1State
* pCtx);
```

Parameters

pKey	Pointer to the user-supplied key.
keyLen	Key length in bytes.
pCtx	Pointer to the IppsHMACSHA1State context being initialized.

Description

This function is declared in the ippcp file. The function initializes the memory pointed by *pCtx* as the IppsHMACSHA1State context. The function also sets up the initial chaining digest value according to the Hash algorithm specified by the function base name and computes necessary key material from the supplied key *pKey*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *keyLen* is less than one.

HMACSHA1Duplicate

Copies one IppsHMACSHA1State *context to another.*

Syntax

```
IppStatus ippsHMACSHA1Duplicate(const IppsHMACSHA1State* pSrcCtx,
IppsHMACSHA1State* pDstCtx);
```

Parameters

pSrcCtx	Pointer to the source IppsHMACSHA1State context.
pDstCtx	Pointer to the source IppsHMACSHA1State context to be cloned.

Description

The function is declared in the ippcp file. The function copies one IppsHMACSHA1State context to another.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

HMACSHA1Update

Digests the current input message stream of the specified length.

Syntax

```
IppStatus ippsHMACSHA1Update(const Ipp8u *pSrcMesg, int mesglen,
IppsHMACSHA1State *pCtx);
```

Parameters

pSrcMesg	Pointer to the buffer containing a part of the whole message.
mesglen	Length of the actual part of the message in bytes.
pCtx	Pointer to the IppsHMACSHA1State context.

Description

This function is declared in the ippcp file. The function digests the current input message stream of the specified length.

The function first integrates the previous partial block with the input message stream and then partitions them into multiple message blocks (as specified by the applied hash algorithm) with a possible additional partial block. For each message block, the function uses the selected hash algorithm to transform the block into a new chaining digest value.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.

ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsLengthErr	Indicates an error condition if the input data stream length is less than zero.

HMACSHA1Final

Completes computation of the HMAC value.

Syntax

```
IppStatus ippsHMACSHA1Final(Ipp8u *pMAC, int macLen, IppsHMACSHA1State *pCtx);
```

Parameters

pMAC	Pointer to the resultant HMAC value.
macLen	Specified HMAC length.
pCtx	Pointer to the IppsHMACSHA1State context.

Description

This function is declared in the ippcp file. The function completes calculation of the digest value and stores the result into the specified *pMD* memory.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsLengthErr	Indicates an error condition if *macLen* is less than one or greater than the length of the hash value.

HMACSHA1GetTag

Computes the current HMAC value of the processed part of the message.

Syntax

```
IppStatus ippsHMACSHA1GetTag(Ipp8u* pDstTag, Ipp32u tagLen, const
IppsHMACSHA1State* pState);
```

Parameters

pDstTag	Pointer to the authentication tag.
tagLen	Length of the tag (in bytes).
pState	Pointer to the `IppsHMACSHA1State` context.

Description

This function is declared in the `ippcp` file. The function computes the message digest based on the current context as specified in [FIPS PUB 198]. A call to this function retains the possibility to update the digest.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if *tagLen* <1 or *tagLen* exceeds the maximal length of a particular digest.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

HMACSHA1MessageDigest

Computes the HMAC value of an entire message.

Syntax

```
IppStatus ippsHMACSHA1MessageDigest(const Ipp8u *pSrcMesg, int mesgLen, const
Ipp8u *pKey, int keyLen, Ipp8u *pMAC, int macLen);
```

Parameters

pSrcMesg	Pointer to the input message.
mesgLen	Message length in bytes.
pKey	Pointer to the user-supplied key.
keyLen	Key length in bytes.
pMAC	Pointer to the resultant HMAC value.
macLen	Specified HMAC length.

Description

This function is declared in the `ippcp` file. The function takes the input key *pKey* of the specified key length *keyLen* and applies the keyed hash-based message authentication code scheme to transform the input message into the respective message authentication code *pMAC* of the specified length *macLen*.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if *msgLen* is less than zero and *macLen* is less than one or greater than the length of the hash value.

HMACSHA224GetSize

Gets the size of the `IppsHMACSHA224State` *context.*

Syntax

```
IppStatus ippsHMACSHA224GetSize(int *pSize);
```

Parameters

pSize	Pointer to the `IppsHMACSHA224State` context size value.

Description

The function is declared in the `ippcp` file. The function gets the `IppsHMACSHA224State` context size in bytes and stores it in *`pSize`*.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.

HMACSHA224Init

Initializes user-supplied memory as `IppsHMACSHA224State` *context for future use.*

Syntax

```
IppStatus ippsHMACSHA224Init(const Ipp8u *pKey, int keyLen,
IppsHMACSHA224State * pCtx);
```

Parameters

`pKey`	Pointer to the user-supplied key.
`keyLen`	Key length in bytes.
`pCtx`	Pointer to the `IppsHMACSHA224State` context being initialized.

Description

This function is declared in the `ippcp` file. The function initializes the memory pointed by *`pCtx`* as the `IppsHMACSHA224State` context. The function also sets up the initial chaining digest value according to the Hash algorithm specified by the function base name and computes necessary key material from the supplied key *`pKey`*.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if *`keyLen`* is less than one.

HMACSHA224Duplicate

Copies one `IppsHMACSHA224State` *context to another.*

Syntax

```
IppStatus ippsHMACSHA224Duplicate(const IppsHMACSHA224State* pSrcCtx,
IppsHMACSHA224State* pDstCtx);
```

Parameters

pSrcCtx	Pointer to the source `IppsHMACSHA224State` context.
pDstCtx	Pointer to the source `IppsHMACSHA224State` context to be cloned.

Description

The function is declared in the `ippcp` file. The function copies one `IppsHMACSHA224State` context to another.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	*I*ndicates an error condition if the context parameter does not match the operation.

HMACSHA224Update

Digests the current input message stream of the specified length.

Syntax

```
IppStatus ippsHMACSHA224Update(const Ipp8u *pSrcMesg, int mesglen,
IppsHMACSHA224State *pCtx);
```

Parameters

pSrcMesg	Pointer to the buffer containing a part of the whole message.
mesglen	Length of the actual part of the message in bytes.
pCtx	Pointer to the `IppsHMACSHA224State` context.

Description

This function is declared in the `ippcp` file. The function digests the current input message stream of the specified length.

The function first integrates the previous partial block with the input message stream and then partitions them into multiple message blocks (as specified by the applied hash algorithm) with a possible additional partial block. For each message block, the function uses the selected hash algorithm to transform the block into a new chaining digest value.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than zero.

HMACSHA224Final

Completes computation of the HMAC value.

Syntax

```
IppStatus ippsHMACSHA224Final(Ipp8u *pMAC, int macLen, IppsHMACSHA224State *pCtx);
```

Parameters

pMAC	Pointer to the resultant HMAC value.
macLen	Specified HMAC length.

pCtx	Pointer to the IppsHMACSHA224State context.

Description

This function is declared in the ippcp file. The function completes calculation of the digest value and stores the result into the specified *pMD* memory.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsLengthErr	Indicates an error condition if *macLen* is less than one or greater than the length of the hash value.

HMACSHA224GetTag

Computes the current HMAC value of the processed part of the message.

Syntax

```
IppStatus ippsHMACSHA224GetTag(Ipp8u* pDstTag, Ipp32u tagLen, const IppsHMACSHA224State* pState);
```

Parameters

pDstTag	Pointer to the authentication tag.
tagLen	Length of the tag (in bytes).
pState	Pointer to the IppsHMACSHA224State context.

Description

This function is declared in the ippcp file. The function computes the message digest based on the current context as specified in [FIPS PUB 198]. A call to this function retains the possibility to update the digest.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *tagLen* <1 or *tagLen* exceeds the maximal length of a particular digest.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

HMACSHA224MessageDigest

Computes the HMAC value of an entire message.

Syntax

```
IppStatus ippsHMACSHA224MessageDigest(const Ipp8u *pSrcMesg, int mesgLen,
const Ipp8u *pKey, int keyLen, Ipp8u *pMAC, int macLen);
```

Parameters

pSrcMesg	Pointer to the input message.
mesgLen	Message length in bytes.
pKey	Pointer to the user-supplied key.
keyLen	Key length in bytes.
pMAC	Pointer to the resultant HMAC value.
macLen	Specified HMAC length.

Description

This function is declared in the ippcp file. The function takes the input key *pKey* of the specified key length *keyLen* and applies the keyed hash-based message authentication code scheme to transform the input message into the respective message authentication code *pMAC* of the specified length *macLen*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.

ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *msgLen* is less than zero and *macLen* is less than one or greater than the length of the hash value.

HMACSHA256GetSize

Gets the size of the IppsHMACSHA256State *context.*

Syntax

```
IppStatus ippsHMACSHA256GetSize(int *pSize);
```

Parameters

pSize	Pointer to the IppsHMACSHA256State context size value.

Description

The function is declared in the ippcp file. The function gets the IppsHMACSHA256State context size in bytes and stores it in *pSize*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

HMACSHA256Init

Initializes user-supplied memory as IppsHMACSHA256State *context for future use.*

Syntax

```
IppStatus ippsHMACSHA256Init(const Ipp8u *pKey, int keyLen,
IppsHMACSHA256State * pCtx);
```

Parameters

pKey	Pointer to the user-supplied key.

keyLen	Key length in bytes.
pCtx	Pointer to the IppsHMACSHA256State context being initialized.

Description

This function is declared in the ippcp file. The function initializes the memory pointed by *pCtx* as the IppsHMACSHA256State context. The function also sets up the initial chaining digest value according to the Hash algorithm specified by the function base name and computes necessary key material from the supplied key *pKey*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *keyLen* is less than one.

HMACSHA256Duplicate

Copies one IppsHMACSHA256State *context to another.*

Syntax

```
IppStatus ippsHMACSHA256Duplicate(const IppsHMACSHA256State* pSrcCtx,
IppsHMACSHA256State* pDstCtx);
```

Parameters

pSrcCtx	Pointer to the source IppsHMACSHA256State context.
pDstCtx	Pointer to the source IppsHMACSHA256State context to be cloned.

Description

The function is declared in the ippcp file. The function copies one IppsHMACSHA256State context to another.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

HMACSHA256Update

Digests the current input message stream of the specified length.

Syntax

```
IppStatus ippsHMACSHA256Update(const Ipp8u *pSrcMesg, int mesglen,
IppsHMACSHA256State *pCtx);
```

Parameters

pSrcMesg	Pointer to the buffer containing a part of the whole message.
mesglen	Length of the actual part of the message in bytes.
pCtx	Pointer to the IppsHMACSHA256State context.

Description

This function is declared in the ippcp file. The function digests the current input message stream of the specified length.

The function first integrates the previous partial block with the input message stream and then partitions them into multiple message blocks (as specified by the applied hash algorithm) with a possible additional partial block. For each message block, the function uses the selected hash algorithm to transform the block into a new chaining digest value.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.

ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsLengthErr	Indicates an error condition if the input data stream length is less than zero.

HMACSHA256Final

Completes computation of the HMAC value.

Syntax

```
IppStatus ippsHMACSHA256Final(Ipp8u *pMAC, int macLen, IppsHMACSHA256State *pCtx);
```

Parameters

pMAC	Pointer to the resultant HMAC value.
macLen	Specified HMAC length.
pCtx	Pointer to the IppsHMACSHA256State context.

Description

This function is declared in the ippcp file. The function completes calculation of the digest value and stores the result into the specified *pMD* memory.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsLengthErr	Indicates an error condition if *macLen* is less than one or greater than the length of the hash value.

HMACSHA256GetTag

Computes the current HMAC value of the processed part of the message.

Syntax

```
IppStatus ippsHMACSHA256GetTag(Ipp8u* pDstTag, Ipp32u tagLen, const IppsHMACSHA256State* pState);
```

Parameters

pDstTag	Pointer to the authentication tag.
tagLen	Length of the tag (in bytes).
pState	Pointer to the `IppsHMACSHA256State` context.

Description

This function is declared in the `ippcp` file. The function computes the message digest based on the current context as specified in [FIPS PUB 198]. A call to this function retains the possibility to update the digest.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if *tagLen* <1 or *tagLen* exceeds the maximal length of a particular digest.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

HMACSHA256MessageDigest

Computes the HMAC value of an entire message.

Syntax

```
IppStatus ippsHMACSHA256MessageDigest(const Ipp8u *pSrcMesg, int mesgLen, const Ipp8u *pKey, int keyLen, Ipp8u *pMAC, int macLen);
```

Parameters

pSrcMesg	Pointer to the input message.
mesgLen	Message length in bytes.
pKey	Pointer to the user-supplied key.
keyLen	Key length in bytes.
pMAC	Pointer to the resultant HMAC value.
macLen	Specified HMAC length.

Description

This function is declared in the `ippcp` file. The function takes the input key *pKey* of the specified key length *keyLen* and applies the keyed hash-based message authentication code scheme to transform the input message into the respective message authentication code *pMAC* of the specified length *macLen*.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if *msgLen* is less than zero and *macLen* is less than one or greater than the length of the hash value.

Example 4-1 SHA256 HMACs of a Message

```
   // Compute two keyed-hash based message
   // authentication codes using the HMAC scheme
   //    1-st will correspond of 1/2 message
   //    2-nd will correspond of whole message

void HMACSHA256_sample(void){
   // define key
   Ipp8u key[] = "the key for HMAC scheme";

   // get size of HMACSHA256 context
   int ctxSize;
   ippsHMACSHA256GetSize(&ctxSize);

   // allocate HMACSHA256 context
   IppsHMACSHA256State* pCtx = (IppsHMACSHA256State*)( new Ipp8u [ctxSize] );
   // and ini context
   ippsHMACSHA256Init(key, strlen((char*)key), pCtx);
```

```
 // define message
   Ipp8u msg[] = "abcdbcdecdefdefgefghfghighijhijkijkljklmklmnlmnomnopnopq";

   int n;
  // update MAC using piece of message
   for(n=0; n<(sizeof(msg)-1)/2; n++)
      ippsHMACSHA256Update(msg+n, 1, pCtx);

// clone HMACSHA256 context
   IppsHMACSHA256State* pCtx2 = (IppsHMACSHA256State*)( new Ipp8u [ctxSize] );
   ippsHMACSHA256Init(key, strlen((char*)key), pCtx2);
   ippsHMACSHA256Duplicate(pCtx, pCtx2);

   // finalize and extract digest of a half message
   const int macLen = 16;
   Ipp8u mac[macLen];
   ippsHMACSHA256Final(mac, macLen, pCtx);

   // update MAC using HMACSHA256 clone context
   ippsHMACSHA256Update(msg+n, sizeof(msg)-1-n, pCtx2);

   // finalize and extract digest of a whole message
   Ipp8u mac2[macLen];
   ippsHMACSHA256Final(mac2, macLen, pCtx2);

   delete [] (Ipp8u*)pCtx;
   delete [] (Ipp8u*)pCtx2;
}
```

HMACSHA384GetSize

Gets the size of the `IppsHMACSHA384State` *context.*

Syntax

```
IppStatus ippsHMACSHA384GetSize(int *pSize);
```

Parameters

pSize	Pointer to the `IppsHMACSHA384State` context size value.

Description

The function is declared in the `ippcp` file. The function gets the `IppsHMACSHA384State` context size in bytes and stores it in *pSize*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

HMACSHA384Init

Initializes user-supplied memory as IppsHMACSHA384State *context for future use.*

Syntax

```
IppStatus ippsHMACSHA384Init(const Ipp8u *pKey, int keyLen,
IppsHMACSHA384State * pCtx);
```

Parameters

pKey	Pointer to the user-supplied key.
keyLen	Key length in bytes.
pCtx	Pointer to the IppsHMACSHA384State context being initialized.

Description

This function is declared in the ippcp file. The function initializes the memory pointed by *pCtx* as the IppsHMACSHA384State context. The function also sets up the initial chaining digest value according to the Hash algorithm specified by the function base name and computes necessary key material from the supplied key *pKey*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *keyLen* is less than one.

HMACSHA384Duplicate

Copies one `IppsHMACSHA384State` *context to another.*

Syntax

```
IppStatus ippsHMACSHA384Duplicate(const IppsHMACSHA384State* pSrcCtx,
IppsHMACSHA384State* pDstCtx);
```

Parameters

pSrcCtx	Pointer to the source `IppsHMACSHA384State` context.
pDstCtx	Pointer to the source `IppsHMACSHA384State` context to be cloned.

Description

The function is declared in the `ippcp` file. The function copies one `IppsHMACSHA384State` context to another.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

HMACSHA384Update

Digests the current input message stream of the specified length.

Syntax

```
IppStatus ippsHMACSHA384Update(const Ipp8u *pSrcMesg, int mesglen,
IppsHMACSHA384State *pCtx);
```

Parameters

pSrcMesg	Pointer to the buffer containing a part of the whole message.
mesglen	Length of the actual part of the message in bytes.
pCtx	Pointer to the `IppsHMACSHA384State` context.

Description

This function is declared in the `ippcp` file. The function digests the current input message stream of the specified length.

The function first integrates the previous partial block with the input message stream and then partitions them into multiple message blocks (as specified by the applied hash algorithm) with a possible additional partial block. For each message block, the function uses the selected hash algorithm to transform the block into a new chaining digest value.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than zero.

HMACSHA384Final

Completes computation of the HMAC value.

Syntax

```
IppStatus ippsHMACSHA384Final(Ipp8u *pMAC, int macLen, IppsHMACSHA384State *pCtx);
```

Parameters

pMAC	Pointer to the resultant HMAC value.
macLen	Specified HMAC length.

pCtx	Pointer to the IppsHMACSHA384State context.

Description

This function is declared in the ippcp file. The function completes calculation of the digest value and stores the result into the specified *pMD* memory.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsLengthErr	Indicates an error condition if *macLen* is less than one or greater than the length of the hash value.

HMACSHA384GetTag

Computes the current HMAC value of the processed part of the message.

Syntax

```
IppStatus ippsHMACSHA384GetTag(Ipp8u* pDstTag, Ipp32u tagLen, const IppsHMACSHA384State* pState);
```

Parameters

pDstTag	Pointer to the authentication tag.
tagLen	Length of the tag (in bytes).
pState	Pointer to the IppsHMACSHA384State context.

Description

This function is declared in the ippcp file. The function computes the message digest based on the current context as specified in [FIPS PUB 198]. A call to this function retains the possibility to update the digest.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *tagLen* <1 or *tagLen* exceeds the maximal length of a particular digest.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

HMACSHA384MessageDigest

Computes the HMAC value of an entire message.

Syntax

```
IppStatus ippsHMACSHA384MessageDigest(const Ipp8u *pSrcMesg, int mesgLen,
const Ipp8u *pKey, int keyLen, Ipp8u *pMAC, int macLen);
```

Parameters

pSrcMesg	Pointer to the input message.
mesgLen	Message length in bytes.
pKey	Pointer to the user-supplied key.
keyLen	Key length in bytes.
pMAC	Pointer to the resultant HMAC value.
macLen	Specified HMAC length.

Description

This function is declared in the ippcp file. The function takes the input key *pKey* of the specified key length *keyLen* and applies the keyed hash-based message authentication code scheme to transform the input message into the respective message authentication code *pMAC* of the specified length *macLen*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.

ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *msgLen* is less than zero and *macLen* is less than one or greater than the length of the hash value.

HMACSHA512GetSize

Gets the size of the IppsHMACSHA512State *context.*

Syntax

```
IppStatus ippsHMACSHA512GetSize(int *pSize);
```

Parameters

pSize	Pointer to the IppsHMACSHA512State context size value.

Description

The function is declared in the ippcp file. The function gets the IppsHMACSHA512State context size in bytes and stores it in *pSize*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

HMACSHA512Init

Initializes user-supplied memory as IppsHMACSHA512State *context for future use.*

Syntax

```
IppStatus ippsHMACSHA512Init(const Ipp8u *pKey, int keyLen,
IppsHMACSHA512State * pCtx);
```

Parameters

pKey	Pointer to the user-supplied key.

keyLen	Key length in bytes.
pCtx	Pointer to the IppsHMACSHA512State context being initialized.

Description

This function is declared in the ippcp file. The function initializes the memory pointed by *pCtx* as the IppsHMACSHA512State context. The function also sets up the initial chaining digest value according to the Hash algorithm specified by the function base name and computes necessary key material from the supplied key *pKey*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *keyLen* is less than one.

HMACSHA512Duplicate

Copies one IppsHMACSHA512State *context to another.*

Syntax

```
IppStatus ippsHMACSHA512Duplicate(const IppsHMACSHA512State* pSrcCtx,
IppsHMACSHA512State* pDstCtx);
```

Parameters

pSrcCtx	Pointer to the source IppsHMACSHA512State context.
pDstCtx	Pointer to the source IppsHMACSHA512State context to be cloned.

Description

The function is declared in the ippcp file. The function copies one IppsHMACSHA512State context to another.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

HMACSHA512Update

Digests the current input message stream of the specified length.

Syntax

```
IppStatus ippsHMACSHA512Update(const Ipp8u *pSrcMesg, int mesglen,
IppsHMACSHA512State *pCtx);
```

Parameters

pSrcMesg	Pointer to the buffer containing a part of the whole message.
mesglen	Length of the actual part of the message in bytes.
pCtx	Pointer to the IppsHMACSHA512State context.

Description

This function is declared in the ippcp file. The function digests the current input message stream of the specified length.

The function first integrates the previous partial block with the input message stream and then partitions them into multiple message blocks (as specified by the applied hash algorithm) with a possible additional partial block. For each message block, the function uses the selected hash algorithm to transform the block into a new chaining digest value.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.

ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsLengthErr	Indicates an error condition if the input data stream length is less than zero.

HMACSHA512Final

Completes computation of the HMAC value.

Syntax

```
IppStatus ippsHMACSHA512Final(Ipp8u *pMAC, int macLen, IppsHMACSHA512State
* pCtx);
```

Parameters

pMAC	Pointer to the resultant HMAC value.
macLen	Specified HMAC length.
pCtx	Pointer to the IppsHMACSHA512State context.

Description

This function is declared in the ippcp file. The function completes calculation of the digest value and stores the result into the specified *pMD* memory.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsLengthErr	Indicates an error condition if *macLen* is less than one or greater than the length of the hash value.

HMACSHA512GetTag

Computes the current HMAC value of the processed part of the message.

Syntax

```
IppStatus ippsHMACSHA512GetTag(Ipp8u* pDstTag, Ipp32u tagLen, const IppsHMACSHA512State* pState);
```

Parameters

pDstTag	Pointer to the authentication tag.
tagLen	Length of the tag (in bytes).
pState	Pointer to the `IppsHMACSHA512State` context.

Description

This function is declared in the `ippcp` file. The function computes the message digest based on the current context as specified in [FIPS PUB 198]. A call to this function retains the possibility to update the digest.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if *tagLen* <1 or *tagLen* exceeds the maximal length of a particular digest.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

HMACSHA512MessageDigest

Computes the HMAC value of an entire message.

Syntax

```
IppStatus ippsHMACSHA512MessageDigest(const Ipp8u *pSrcMesg, int mesgLen, const Ipp8u *pKey, int keyLen, Ipp8u *pMAC, int macLen);
```

Parameters

pSrcMesg	Pointer to the input message.
mesgLen	Message length in bytes.
pKey	Pointer to the user-supplied key.
keyLen	Key length in bytes.
pMAC	Pointer to the resultant HMAC value.
macLen	Specified HMAC length.

Description

This function is declared in the `ippcp` file. The function takes the input key *pKey* of the specified key length *keyLen* and applies the keyed hash-based message authentication code scheme to transform the input message into the respective message authentication code *pMAC* of the specified length *macLen*.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if *msgLen* is less than zero and *macLen* is less than one or greater than the length of the hash value.

HMACMD5GetSize

Gets the size of the `IppsHMACMD5State` *context.*

Syntax

```
IppStatus ippsHMACMD5GetSize(int *pSize);
```

Parameters

pSize	Pointer to the `IppsHMACMD5State` context size value.

Description

The function is declared in the `ippcp` file. The function gets the `IppsHMACMD5State` context size in bytes and stores it in *pSize*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

HMACMD5Init

Initializes user-supplied memory as IppsHMACMD5State *context for future use.*

Syntax

```
IppStatus ippsHMACMD5Init(const Ipp8u *pKey, int keyLen, IppsHMACMD5State *pCtx);
```

Parameters

pKey	Pointer to the user-supplied key.
keyLen	Key length in bytes.
pCtx	Pointer to the IppsHMACMD5State context being initialized.

Description

This function is declared in the ippcp file. The function initializes the memory pointed by *pCtx* as the IppsHMACMD5State context. The function also sets up the initial chaining digest value according to the Hash algorithm specified by the function base name and computes necessary key material from the supplied key *pKey*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *keyLen* is less than one.

HMACMD5Duplicate

Copies one `IppsHMACMD5State` *context to another.*

Syntax

```
IppStatus ippsHMACMD5Duplicate(const IppsHMACMD5State* pSrcCtx,
IppsHMACMD5State* pDstCtx);
```

Parameters

pSrcCtx	Pointer to the source `IppsHMACMD5State` context.
pDstCtx	Pointer to the source `IppsHMACMD5State` context to be cloned.

Description

The function is declared in the `ippcp` file. The function copies one `IppsHMACMD5State` context to another.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

HMACMD5Update

Digests the current input message stream of the specified length.

Syntax

```
IppStatus ippsHMACMD5Update(const Ipp8u *pSrcMesg, int mesglen,
IppsHMACMD5State *pCtx);
```

Parameters

pSrcMesg	Pointer to the buffer containing a part of the whole message.
mesglen	Length of the actual part of the message in bytes.
pCtx	Pointer to the `IppsHMACMD5State` context.

Description

This function is declared in the `ippcp` file. The function digests the current input message stream of the specified length.

The function first integrates the previous partial block with the input message stream and then partitions them into multiple message blocks (as specified by the applied hash algorithm) with a possible additional partial block. For each message block, the function uses the selected hash algorithm to transform the block into a new chaining digest value.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than zero.

HMACMD5Final

Completes computation of the HMAC value.

Syntax

```
IppStatus ippsHMACMD5Final(Ipp8u *pMAC, int macLen, IppsHMACMD5State *pCtx);
```

Parameters

pMAC	Pointer to the resultant HMAC value.
macLen	Specified HMAC length.

pCtx	Pointer to the IppsHMACMD5State context.

Description

This function is declared in the ippcp file. The function completes calculation of the digest value and stores the result into the specified *pMD* memory.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsLengthErr	Indicates an error condition if *macLen* is less than one or greater than the length of the hash value.

HMACMD5GetTag

Computes the current HMAC value of the processed part of the message.

Syntax

```
IppStatus ippsHMACMD5GetTag(Ipp8u* pDstTag, Ipp32u tagLen, const
IppsHMACMD5State* pState);
```

Parameters

pDstTag	Pointer to the authentication tag.
tagLen	Length of the tag (in bytes).
pState	Pointer to the IppsHMACMD5State context.

Description

This function is declared in the ippcp file. The function computes the message digest based on the current context as specified in [FIPS PUB 198]. A call to this function retains the possibility to update the digest.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *tagLen* <1 or *tagLen* exceeds the maximal length of a particular digest.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

HMACMD5MessageDigest

Computes the HMAC value of the message in a single call.

Syntax

```
IppStatus ippsHMACMD5MessageDigest(const Ipp8u *pSrcMesg, int mesgLen, const Ipp8u *pKey, int keyLen, Ipp8u *pMAC, int macLen);
```

Parameters

pSrcMesg	Pointer to the input message.
mesgLen	Message length in bytes.
pKey	Pointer to the user-supplied key.
keyLen	Key length in bytes.
pMAC	Pointer to the resultant HMAC value.
macLen	Specified HMAC length.

Description

This function is declared in the ippcp file. The function takes the input key *pKey* of the specified key length *keyLen* and applies the keyed hash-based message authentication code scheme to transform the input message into the respective message authentication code *pMAC* of the specified length *macLen*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *msgLen* is less than zero and *macLen* is less than one or greater than the length of the hash value.

Example 4-2 MD5 HMAC of a Message

```
void HMACMD5_sample(void){
   // define key
   Ipp8u key[] = "the key for HMAC scheme";

   // define message
   Ipp8u msg[] = "abcdefghijklmnopqrstuvwxyz";

   // as soon as whole message placed into memory
   // one can use integrated primitive
   int macLen = 12;
   Ipp8u mac[16];
   ippsHMACMD5MessageDigest(msg, strlen((char*)msg),
                            key, strlen((char*)key),
                            mac, macLen);
}
```

CMAC Functions

The Intel IPP CMAC primitive functions use CMAC schemes based on block ciphers described in the Symmetric Cryptography Primitive Functions chapter.

Table 4-2 lists the Intel IPP CMAC functions. A typical usage of the CMAC primitives is similar to the one of the Keyed Hash Functions.

Table 4-2 Intel IPP CMAC Functions

Function Base Name	Operation
CMACRijndael128GetSize	Gets the size of the IppsCMACRijndael128State context.
CMACRijndael128Init, CMACSafeRijndael128Init	Initialize user-supplied memory as IppsCMACRijndael128State context for future use.

Function Base Name	Operation
CMACRijndael128Update	Updates the MAC value depending on the current input message stream of the specified length.
CMACRijndael128Final	Completes computation of the MAC value.
CMACRijndael128MessageDigest	Computes the MAC value of the entire message.

CMACRijndael128GetSize

Gets the size of the `IppsCMACRijndael128State` *context.*

Syntax

```
IppStatus ippsCMACRijndael128GetSize(int *pSize);
```

Parameters

pSize	Pointer to the `IppsCMACRijndael128State` context.

Description

This function is declared in the `ippcp` file. It gets the size of the `IppsCMACRijndael128State` context.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.

CMACRijndael128Init, CMACSafeRijndael128Init

Initialize user-supplied memory as `IppsCMACRijndael128State` *context for future use.*

Syntax

```
IppStatus ippsCMACRijndael128Init(const Ipp8u* pKey, IppsRijndaelKeyLength keyLen, IppsCMACRijndael128State* pState);

IppStatus ippsCMACSafeRijndael128Init(const Ipp8u* pKey, IppsRijndaelKeyLength keyLen, IppsCMACRijndael128State* pState);
```

Parameters

pKey	Pointer to the Rijndael128 key.
keyLen	Key bytestream length (in bytes) defined by the `IppsRijndaelKeyLength` enumerator.
pState	Pointer to the *IppsCMACRijndael128State* being initialized.

Description

These functions are declared in the `ippcp` file. Each function initializes the memory at the address of *pState* as the `IppsCMACRijndael128State` context. In addition, each function uses the key to provide all necessary key material for both encryption and decryption operations. CMAC based on the `Rijndael128` cipher scheme uses the AES algorithm. Depending upon whether you wish to employ fast or safe implementation of the AES algorithm, call `CMACRijndael128Init` or `CMACSafeRijndael128Init`, respectively. For more information, see Rijndael Functions in chapter 2.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if *keyLen* is not equal to `IppsRijndaelKey128`, `IppsRijndaelKey192`, or `IppsRijndaelKey256`.

CMACRijndael128Update

Updates the MAC value depending on the current input message stream of the specified length.

Syntax

```
IppStatus ippsCMACRijndael128Update(const Ipp8u *pSrc, int len,
IppsCMACRijndael128State* pState);
```

Parameters

pSrc	Pointer to the buffer containing a part or the entire message.
len	Length of the actual part of the message in bytes.
pState	Pointer to the `IppsCMACRijndael128State` context.

Description

This function is declared in the `ippcp` file. The function updates the MAC value depending on the current input message stream of the specified length. The function first integrates the previous partial message block with the input message stream and then partitions the obtained message into multiple message blocks with a possible additional partial block. For each message block, the function uses the Rijndael128 cipher to transform the input block into a new chaining MAC value.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than zero.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

CMACRijndael128Final

Completes computation of the MAC value.

Syntax

```
IppStatus ippsCMACRijndael128Final(Ipp8u *pMD, int mdLen,
IppsCMACRijndael128State *pState);
```

Parameters

pMD	Pointer to the MAC value.
mdLen	Specified length of the MAC.
pState	Pointer to the `IppsCMACRijndael128State` context.

Description

This function is declared in the `ippcp` file. The function completes calculation of the digest value and stores the result into memory at the address of *pMD*.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if *mdLen* is less than 1 or greater than cipher's data block length.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

CMACRijndael128MessageDigest

Computes the MAC value of the entire message.

Syntax

```
IppStatus ippsCMACRijndael128MessageDigest(const Ipp8u *pMsg, int msgLen,
const Ipp8u *pKey, IppsRijndaelKeyLength keyLen, Ipp8u *pMD, int mdLen);
```

Parameters

pMsg	Pointer to the input message.
msgLen	Message length in bytes.
pKey	Pointer to the user-supplied key.
keyLen	Key length.
pMD	Pointer to the resulting MAC value.
mdLen	Specified MAC length.

Description

This function is declared in the `ippcp` file. The function takes the input key *pKey* of the specified key length *keyLen* and applies keyed cipher-based message authentication code scheme to transform the *entire* input message into the respective message authentication code *pMAC* of the specified length *mdLen*.

The function is actually a wrapper around the `CMACRijndael128Init, CMACSafeRijndael128Init`, `CMACRijndael128Update`, and `CMACRijndael128Final` functions. If your application has no access to *all* the necessary data, you can compute the MAC using a typical sequence of invoking the primitives, like the one described at the beginning of the Keyed Hash Functions section. `CMACMessageDigest` is convenient when the application can access the entire message. In this case, you can use this function to compute the result in a single call.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if *msgLen* is less than zero, *mdLen* is less than 1 or greater than cipher's data block length, or *keyLen* value is illegal.

AES-XCBC Functions

The AES-XCBC-MAC-96 [RFC 3566] extends the classic CBC-MAC algorithm to messages of varying lengths.

Table 4-3 lists the Intel IPP AES-XCBC functions. A typical usage of the AES-XCBC primitives is similar to the one of Keyed Hash Functions.

Table 4-3 Intel IPP AES-XCBC Functions

Function Base Name	Operation
XCBCRijndael128GetSize	Gets the size of the IppsXCBCRijndael128State context.
XCBCRijndael128Init	Initializes user-supplied memory as IppsCMACRijndael128State context for future use.
XCBCRijndael128Update	Updates the internal authentication tag depending on the current input message.
XCBCRijndael128GetTag	Computes the authentication tag.
XCBCRijndael128Final	Computes the authentication tag and terminates the authentication process.
XCBCRijndael128MessageTag	Computes the authentication tag of an entire message.

XCBCRijndael128GetSize

Gets the size of the `IppsXCBCRijndael128State` *context.*

Syntax

```
IppStatus ippsXCBCRijndael128GetSize(Ipp32u* pSize);
```

Parameters

pSize	Pointer to the size size of the I `ppsXCBCRijndael128State` context.

Description

This function is declared in the `ippcp` file. The function gets the size of the `IppsXCBCRijndael128State` context in bytes and stores it in `*pSize`.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if the specified pointer is `NULL`.

XCBCRijndael128Init

Initializes user-supplied memory as the `IppsXCBCRijndael128State` *context for future use.*

Syntax

```
IppStatus ippsXCBCRijndael128Init(const Ipp8u* pKey, IppsRijndaelKeyLength keyLen, IppsXCBCRijndael128State* pState);
```

Parameters

pKey	Pointer to the authentication key.
keyLen	Length of the key.
pState	Pointer to the `IppsXCBCRijndael128State` context.

Description

This function is declared in the `ippcp` file. The function initializes the memory pointed by *pState* as the `IppsXCBCRijndael128State` context.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if *keyLen* is not set to `IppsRijndaelKey128`, `IppsRijndaelKey192` or `IppsRijndaelKey256`.

XCBCRijndael128Update

Updates the internal authentication tag depending on the current input message.

Syntax

```
IppStatus ippsXCBCRijndael128Update(const Ipp8u* pSrc, Ipp32u len, IppsXCBCRijndael128State* pState);
```

Parameters

pSrc	Pointer to the input data.
len	Length of the input data in bytes.
pState	Pointer to the `IppsXCBCRijndael128State` context.

Description

This function is declared in the `ippcp` file. The function updates the internal value of the authentication tag according to [RFC 3566].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

XCBCRijndael128GetTag

Computes the authentication tag.

Syntax

```
IppStatus ippsXCBCRijndael128GetTag(Ipp8u* pDstTag, Ipp32u tagLen, const IppsXCBCRijndael128State* pState);
```

Parameters

pDstTag	Pointer to the authentication tag.
tagLen	Length of the tag (in bytes).
pState	Pointer to the `IppsXCBCRijndael128State` context.

Description

This function is declared in the `ippcp` file. The function computes the authentication tag based on the current context as specified in [RFC 3566]. A call to `ippsXCBCRijndael128GetTag` does not stop the process of updating the authentication tag.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *tagLen* < 1 or *tagLen* > 16.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

XCBCRijndael128Final

Computes the authentication tag and terminates the authentication process.

Syntax

```
IppStatus ippsXCBCRijndael128Final(Ipp8u* pDstTag, Ipp32u tagLen,
IppsXCBCRijndael128State* pState);
```

Parameters

pDstTag	Pointer to the authentication tag.
tagLen	Length of the tag (in bytes).
pState	Pointer to the IppsXCBCRijndael128State context.

Description

This function is declared in the ippcp file. The function computes the authentication tag based on the current context as specified in [RFC 3566]. Additionally ippsXCBCRijndael128Final reinitializes the internal state to enable computation of the authentication tag for another message.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *tagLen* < 1 or *tagLen* > 16.

ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

XCBCRijndael128MessageTag

Computes the authentication tag of an entire message.

Syntax

```
IppStatus ippsXCBCRijndael128MessageTag(const Ipp8u* pMsg, Ipp32u msgLen,
const Ipp8u* pKey, IppsRijndaelKeyLength keyLen, Ipp8u* pDstTag, Ipp32u
tagLen);
```

Parameters

pMsg	Pointer to the input message.
msgLen	Length of the message (in bytes).
pKey	Pointer to the authentication key.
keyLen	Length of the key.
pDstTag	Pointer to the authentication tag.
tagLen	Length of the tag (in bytes).

Description

This function is declared in the ippcp file. The function performs all steps of the authentication tag calculation, that is, the initialize, update, and final steps, in a single call. You can use this function when your application can access the entire message.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the length parameters do not meet any of the following conditions: *keyLen* = IppsRijndaelKey128 or *keyLen* = IppsRijndaelKey192 or *keyLen* = IppsRijndaelKey256 $1 \le tagLen \le 16$.

Data Authentication Functions

DAA is widely used in applications to detect both intentional and accidental unauthorized data modifications. DAA specification can be found in [FIPS PUB 113].

The Intel IPP Data Authentication (DAA) primitive functions are designed for applications to use various DAA schemes based on the set of symmetric cryptography functions described in the Symmetric Cryptography Primitive Functions chapter.

The implementation of each DAA scheme is presented as a set of primitive functions.

The full list of Intel IPP DAA Functions is given is Table 4-4.

Table 4-4 Intel IPP Data Authentication Functions

Function Base Name	Operation
DAADESGetSize	Gets the size of the IppsDAADESState context.
DAADESInit	Initializes user-supplied memory as IppsDAADESState context for future use.
DAADESUpdate	Digests the current input message stream of the specified length.
DAADESFinal	Completes computation of the DAC value.
DAADESMessageDigest	Computes the DAC value of the message.
DAATDESGetSize	Gets the size of IppsDAATDESState context.
DAATDESInit	Initializes user-supplied memory as IppsDAATDESState context for future use.
DAATDESUpdate	Digests the current input message stream of the specified length.
DAATDESFinal	Completes computation of the DAC value.
DAATDESMessageDigest	Computes the DAC value of the message.
DAARijndael128GetSize	Gets the size of the IppsDAARijndael128State context.

Function Base Name	Operation
DAARijndael128Init, DAASafeRijndael128Init	Initialize user-supplied memory as IppsDAARijndael128State context for future use.
DAARijndael128Update	Digests the current input message stream of the specified length.
DAARijndael128Final	Completes computation of the DAC value.
DAARijndael128MessageDigest	Computes the DAC value of the message.
DAARijndael192GetSize	Gets the size of the IppsDAARijndael192State context.
DAARijndael192Init	Initializes user-supplied memory as IppsDAARijndael192State context for future use.
DAARijndael192Update	Digests the current input message stream of the specified length.
DAARijndael192Final	Completes computation of the DAC value.
DAARijndael192MessageDigest	Computes the DAC value of the message.
DAARijndae256GetSize	Gets the size of the IppsDAARijndael256State context.
DAARijndael256Init	Initializes user-supplied memory as IppsDAARijndael256State context for future use.
DAARijndael256Update	Digests the current input message stream of the specified length.
DAARijndael256Final	Completes computation of the DAC value.
DAARijndael256MessageDigest	Computes the DAC value of the message.
DAABlowfishGetSize	Gets the size of the IppsDAABlowfishState context.

Function Base Name	Operation
DAABlowfishInit	Initializes user-supplied memory as IppsDAABlowfishState context for future use.
DAABlowfishUpdate	Digests the current input message stream of the specified length.
DAABlowfishFinal	Completes computation of the DAC value.
DAABlowfishMessageDigest	Computes the DAC value of the message.
DAATwofishGetSize	Gets the size of the IppsDAATwofishState context.
DAATwofishInit	Initializes user-supplied memory as IppsDAATwofishState context for future use.
DAATwofishUpdate	Digests the current input message stream of the specified length.
DAATwofishFinal	Completes computation of the DAC value.
DAATwofishMessageDigest	Computes the DAC value of the message.

The primitive implementing a DAA scheme uses the context as the operational vehicle to carry all necessary variables to manage computation of the chaining digest value. For example, the primitive implementing the DAA scheme based on the Rijndael128 block cipher uses ippsDAARijndael128 context.

The function Init (DAARijndael128Init, DAADESInit, and others) initializes the context and sets up the specified initialization vectors. Once initialized, the function Update (DAARijndael128Update, DAADESUpdate, and others) digests the input message stream with the selected hash algorithm till it exhausts all message blocks. The function Final (DAARijndael128Final, DAADESFinal, and others) is designed to pad the partial message block into a final message block with the specified padding scheme, and further uses the hash algorithm to transform the final block into a message digest value.

The following example illustrates how the application code can apply an implemented DAA based on the Rijndael128 block cipher to digest the input message stream:

- Call the function DAARijndael128GetSize to get the size required to configure the ippsDAARijndael128State context.

- Ensure that the required memory space is properly allocated. With the allocated memory, call the function DAARijndael128Init to set up the initial context state.
- Keep calling the function DAARijndael128Update to digest incoming message stream in the queue till its completion.
- Call the function DAARijndael128Final for padding the final partial block applying Rijndael128 block cipher and transforming ciphertext block into resultant DAA value.
- Call the operating system memory free service function to release the IppsDAARijndaelState context.

DAADESGetSize

Gets the size of the IppsDAADESState *context.*

Syntax

```
IppStatus ippsDAADESGetSize(int *pSize);
```

Parameters

pSize	Pointer to the IppsDAADESState context.

Description

The function is declared in the ippcp file. The function gets the IppsDAADESState context size in bytes and stores it in *pSize*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

DAADESInit

Initializes user-supplied memory as the IppsDAADESState *context for future use.*

Syntax

```
IppStatus ippsDAADESInit(const Ipp8u *pKey, IppsDAADESState *pCtx);
```

Parameters

pKey	Pointer to the DES key.
pCtx	Pointer to the IppsDAADESState context being initialized.

Description

This function is declared in the ippcp file. The function initializes the memory pointed by *pCtx* as the IppsDAADESState context. In addition, the function uses the key to provide all necessary key material for both encryption and decryption operation.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

DAADESUpdate

Digests the current input message stream of the specified length.

Syntax

```
IppStatus ippsDAADESUpdate(const Ipp8u *pSrcMesg, int mesglen,
IppsDAADESState* pCtx);
```

Parameters

pSrcMesg	Pointer to the buffer containing a part or the whole message.
mesglen	Length of the actual part of the message in bytes.
pCtx	Pointer to the IppsDAADESState context.

Description

This function is declared in the ippcp file. The function digests the current input message stream of the specified length. The function first integrates the previous partial message block with the input message stream, and then partitions them into multiple message blocks (as

specified by applied hash algorithm) with a possible additional partial block. For each message block, the function uses the selected block cipher to transform the block of plaintext into a new chaining digest value.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than zero.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

DAADESFinal

Completes computation of the DAC value.

Syntax

```
IppStatus ippsDAADESFinal(Ipp8u *pDAC, int dacLen, IppsDAADESState*  pCtx);
```

Parameters

pDAC	Pointer to the DAC value.
dacLen	Specified length of the DAC.
pCtx	Pointer to the `IppsDAADESState` context.

Description

This function is declared in the `ippcp` file. The function completes calculation of the digest value and stored result into the specified *pDAC* memory.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.

ippStsLengthErr	Indicates an error condition if *dacLen* is less than 1 or greater than cipher's data block length.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

DAADESMessageDigest

Computes the DAC value of the message.

Syntax

```
IppStatus ippsDAADESMessageDigest(const Ipp8u *pSrcMsg, int msgLen, const Ipp8u *pKey, Ipp8u *pMAC, int macLen);
```

Parameters

pSrcMsg	Pointer to the input message.
msgLen	Message length in bytes.
pKey	Pointer to the user-supplied key.
pMAC	Pointer to the resultant HMAC value.
macLen	Specified HMAC length.

Description

This function is declared in the ippcp file. The function takes the input key *pKey* of the specified key length *keyLen* and applied keyed hash-based message authentication code scheme to transform the input message into the respective message authentication code *pMAC* of the specified length *macLen*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *msgLen* is less than zero, *macLen* is less than 1 or greater than cipher's data block length, *keyLen* value is illegal.

DAATDESGetSize

Gets the size of the `IppsDAATDESState` *context.*

Syntax

```
IppStatus ippsDAATDESGetSize(int *pSize);
```

Parameters

pSize	Pointer to the `IppsDAATDESState` context.

Description

The function is declared in the `ippcp` file. The function gets the `IppsDAATDESState` context size in bytes and stores it in *pSize*.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.

DAATDESInit

Initializes user-supplied memory as the `IppsDAATDESState` *context for future use.*

Syntax

```
IppStatus ippsDAATDESInit(const Ipp8u* pKey, const Ipp8u* pKey2, const Ipp8u*
pKey3, IppsDAATDESState* pCtx);
```

Parameters

pKey	Pointer to the TDES key.
pKey2	Pointer to the TDES key.
pKey3	Pointer to the TDES key.
pCtx	Pointer to the `IppsDAATDESState` context being initialized.

Description

This function is declared in the ippcp file. The function initializes the memory pointed by *pCtx* as the IppsDAATDESState context. In addition, DAATDESInit uses the key to provide all necessary key material for both encryption and decryption operations.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

DAATDESUpdate

Digests the current input message stream of the specified length.

Syntax

```
IppStatus ippsDAATDESUpdate(const Ipp8u *pSrcMesg, int mesglen,
IppsDAATDESState *pCtx);
```

Parameters

pSrcMesg	Pointer to the buffer containing a part or the whole message.
mesglen	Length of the actual part of the message in bytes.
pCtx	Pointer to the IppsDAATDESState context.

Description

This function is declared in the ippcp file. The function digests the current input message stream of the specified length. The function first integrates the previous partial message block with the input message stream, and then partitions them into multiple message blocks (as specified by applied hash algorithm) with a possible additional partial block. For each message block, the function uses the selected block cipher to transform the block of plaintext into a new chaining digest value.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.

ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if the input data stream length is less than zero.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

DAATDESFinal

Completes computation of the DAC value.

Syntax

```
IppStatus ippsDAATDESFinal(Ipp8u *pDAC, int dacLen, IppsDAATDESState* pCtx);
```

Parameters

pDAC	Pointer to the DAC value.
dacLen	Specified length of the DAC.
pCtx	Pointer to the IppsDAATDESState context.

Description

This function is declared in the ippcp file. The function completes calculation of the digest value and stored result into the specified *pDAC* memory.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *dacLen* is less than 1 or greater than cipher's data block length.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

DAATDESMessageDigest

Computes the DAC value of the message.

Syntax

```
IppStatus ippsDAATDESMessageDigest(const Ipp8u *pSrcMsg, int msgLen, const Ipp8u *pKey1, const Ipp8u *pKey2, const Ipp8u *pKey3, Ipp8u *pMAC, int macLen);
```

Parameters

pSrcMsg	Pointer to the input message.
msgLen	Message length in bytes.
pKey1	Pointer to the user-supplied key.
pKey2	Pointer to the user-supplied key.
pKey3	Pointer to the user-supplied key.
pMAC	Pointer to the resultant HMAC value.
macLen	Specified HMAC length.

Description

This function is declared in the `ippcp` file. The function takes the input key *pKey1*, *pKey2*, and *pKey3* of the specified key length *keyLen* and applied keyed hash-based message authentication code scheme to transform the input message into the respective message authentication code *pMAC* of the specified length *macLen*.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if *msgLen* is less than zero, *macLen* is less than 1 or greater than cipher's data block length, *keyLen* value is illegal.

DAARijndael128GetSize

Gets the size of the `IppsDAARijndael128State` *context.*

Syntax

```
IppStatus ippsDAARijndael128GetSize(int *pSize);
```

Parameters

pSize	Pointer to the `IppsDAARijndael128State` context.

Description

The function is declared in the `ippcp` file. The function gets the `IppsDAARijndael128State` context size in bytes and stores it in *pSize*.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.

DAARijndael128Init, DAASafeRijndael128Init

Initialize user-supplied memory as `IppsDAARijndael128State` *context for future use.*

Syntax

```
IppStatus ippsDAARijndael128Init(const Ipp8u* pKey, IppsRijndaelKeyLength keyLen, IppsDAARijndael128State* pCtx);
```

```
IppStatus ippsDAASafeRijndael128Init(const Ipp8u* pKey, IppsRijndaelKeyLength keyLen, IppsDAARijndael128State* pCtx);
```

Parameters

pKey	Pointer to the `Rijndael128` key.

keyLen	Key byte stream length in bytes defined by the IppsRijndaelKeyLength enumerator.
pCtx	Pointer to the IppsDAARijndael128State context being initialized.

Description

These functions are declared in the ippcp file. Each function initializes the memory pointed by *pCtx* as the IppsDAARijndael128State context. In addition, each function uses the key to provide all necessary key material for both encryption and decryption operations. DAA based on the Rijndael128 cipher scheme uses the AES algorithm. Depending upon whether you wish to employ fast or safe implementation of the AES algorithm, call DAARijndael128Init or DAASafeRijndael128Init, respectively. For more information, see Rijndael Functions in chapter 2.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *keyLen* is not equal to IppsRijndaelKey128, IppsRijndaelKey192, or IppsRijndaelKey256.

DAARijndael128Update

Digest the current input message stream of the specified length.

Syntax

```
IppStatus ippsDAARijndael128Update(const Ipp8u *pSrcMesg, int mesglen,
IppsDAARijndael128State* pCtx);
```

Parameters

pSrcMesg	Pointer to the buffer containing a part or the whole message.
mesglen	Length of the actual part of the message in bytes.
pCtx	Pointer to the IppsDAARijndael128State context.

Description

This function is declared in the `ippcp` file. The function digests the current input message stream of the specified length. The function first integrates the previous partial message block with the input message stream, and then partitions them into multiple message blocks (as specified by applied hash algorithm) with a possible additional partial block. For each message block, the function uses the selected block cipher to transform the block of plaintext into a new chaining digest value.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than zero.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

DAARijndael128Final

Completes computation of the DAC value.

Syntax

```
IppStatus ippsDAARijndael128Final(Ipp8u *pDAC, int dacLen,
IppsDAARijndael128State *pCtx);
```

Parameters

pDAC	Pointer to the DAC value.
dacLen	Specified length of the DAC.
pCtx	Pointer to the `IppsDAARijndael128State` context.

Description

This function is declared in the `ippcp` file. The function completes calculation of the digest value and stored result into the specified *pDAC* memory.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *dacLen* is less than 1 or greater than cipher's data block length.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

DAARijndael128MessageDigest

Computes the DAC value of the message.

Syntax

```
IppStatus ippsDAARijndael128MessageDigest(const Ipp8u *pSrcMsg, int msgLen,
const Ipp8u *pKey, IppsRijndaelKeyLength keyLen, Ipp8u *pMAC, int macLen);
```

Parameters

pSrcMsg	Pointer to the input message.
msgLen	Message length in bytes.
pKey	Pointer to the user-supplied key.
keyLen	Key length.
pMAC	Pointer to the resultant HMAC value.
macLen	Specified HMAC length.

Description

This function is declared in the ippcp file. The function takes the input key *pKey* of the specified key length *keyLen* and applied keyed hash-based message authentication code scheme to transform the input message into the respective message authentication code *pMAC* of the specified length *macLen*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.

ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *msgLen* is less than zero, *macLen* is less than 1 or greater than cipher's data block length, *keyLen* value is illegal.

DAARijndael192GetSize

Gets the size of the IppsDAARijndael192State *context.*

Syntax

```
IppStatus ippsDAARijndael192GetSize(int *pSize);
```

Parameters

pSize	Pointer to the IppsDAARijndael192State context.

Description

The function is declared in the ippcp file. The function gets the IppsDAARijndael192State context size in bytes and stores it in *pSize*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

DAARijndael192Init

Initializes user-supplied memory as IppsDAARijndael192State *context for future use.*

Syntax

```
IppStatus ippsRijndael192Init(const Ipp8u* pKey, IppsDAARijndaelKeyLength
keyLen, IppsRijndael192State* pCtx);
```

Parameters

pKey	Pointer to the Rijndael192 key.
keyLen	Key byte stream length in bytes defined by the IppsRijndaelKeyLength enumerator.
pCtx	Pointer to the IppsDAARijndael192State context being initialized.

Description

This function is declared in the ippcp file. The function initializes the memory pointed by *pCtx* as the IppsDAARijndael192State context. In addition, the function uses the key to provide all necessary key material for both encryption and decryption operations.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *keyLen* is not equal to IppsRijndaelKey128, IppsRijndaelKey192, or IppsRijndaelKey256.

DAARijndael192Update

Digest the current input message stream of the specified length.

Syntax

```
IppStatus ippsDAARijndael192Update(const Ipp8u *pSrcMesg, int mesglen,
IppsDAARijndael192State* pCtx);
```

Parameters

pSrcMesg	Pointer to the buffer containing a part or the whole message.
mesglen	Length of the actual part of the message in bytes.
pCtx	Pointer to the IppsDAARijndael192State context.

Description

This function is declared in the `ippcp` file. The function digests the current input message stream of the specified length. The function first integrates the previous partial message block with the input message stream, and then partitions them into multiple message blocks (as specified by applied hash algorithm) with a possible additional partial block. For each message block, the function uses the selected block cipher to transform the block of plaintext into a new chaining digest value.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than zero.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

DAARijndael192Final

Completes computation of the DAC value.

Syntax

```
IppStatus ippsDAARijndael192Final(Ipp8u *pDAC, int dacLen,
IppsDAARijndael192State *pCtx);
```

Parameters

pDAC	Pointer to the DAC value.
dacLen	Specified length of the DAC.
pCtx	Pointer to the `IppsDAARijndael192State` context.

Description

This function is declared in the `ippcp` file. The function completes calculation of the digest value and stored result into the specified *pDAC* memory.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *dacLen* is less than 1 or greater than cipher's data block length.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

DAARijndael192MessageDigest

Computes the DAC value of the message.

Syntax

```
IppStatus ippsDAARijndael192MessageDigest(const Ipp8u *pSrcMsg, int msgLen,
const Ipp8u *pKey, IppsRijndaelKeyLength keyLen, Ipp8u *pDAC, int macLen);
```

Parameters

pSrcMsg	Pointer to the input message.
msgLen	Message length in bytes.
pKey	Pointer to the user-supplied key.
keyLen	Key length.
pMAC	Pointer to the resultant HMAC value.
macLen	Specified HMAC length.

Description

This function is declared in the ippcp file. The function takes the input key *pKey* of the specified key length *keyLen* and applied keyed hash-based message authentication code scheme to transform the input message into the respective message authentication code *pMAC* of the specified length *macLen*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.

ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *msgLen* is less than zero, *macLen* is less than 1 or greater than cipher's data block length, *keyLen* value is illegal.

DAARijndael256GetSize

Gets the size of the IppsDAARijndael256State *context.*

Syntax

```
IppStatus ippsDAARijndael256GetSize(int *pSize);
```

Parameters

pSize	Pointer to the IppsDAARijndael256State context.

Description

The function is declared in the ippcp file. The function gets the IppsDAARijndael256State context size in bytes and stores it in *pSize*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

DAARijndael256Init

Initializes user-supplied memory as IppsDAARijndael256State *context for future use.*

Syntax

```
IppStatus ippsDAARijndael256Init(const Ipp8u* pKey, IppsDAARijndaelKeyLength
keyLen, IppsRijndael256State* pCtx);
```

Parameters

pKey	Pointer to the Rijndael256 key.
keyLen	Key byte stream length in bytes defined by the IppsRijndaelKeyLength enumerator.
pCtx	Pointer to the IppsDAARijndael256State being initialized.

Description

This function is declared in the ippcp file. The function initializes the memory pointed by *pCtx* as the IppsDAARijndael256State context. In addition, the function uses the key to provide all necessary key material for both encryption and decryption operations.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *keyLen* is not equal to IppsRijndaelKey128, IppsRijndaelKey192, or IppsRijndaelKey256.

DAARijndael256Update

Digest the current input message stream of the specified length.

Syntax

```
IppStatus ippsDAARijndael256Update(const Ipp8u *pSrcMesg, int mesglen,
IppsDAARijndael256State* pCtx);
```

Parameters

pSrcMesg	Pointer to the buffer containing a part or the whole message.
mesglen	Length of the actual part of the message in bytes.
pCtx	Pointer to the IppsDAARijndael256State context.

Description

This function is declared in the `ippcp` file. The function digests the current input message stream of the specified length. The function first integrates the previous partial message block with the input message stream, and then partitions them into multiple message blocks (as specified by applied hash algorithm) with a possible additional partial block. For each message block, the function uses the selected block cipher to transform the block of plaintext into a new chaining digest value.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than zero.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

DAARijndael256Final

Completes computation of the DAC value.

Syntax

```
IppStatus ippsDAARijndael256Final(Ipp8u *pDAC, int dacLen,
IppsDAARijndael256State* pCtx);
```

Parameters

pDAC	Pointer to the DAC value.
dacLen	Specified length of the DAC.
pCtx	Pointer to the `IppsDAARijndael256State` context.

Description

This function is declared in the `ippcp` file. The function completes calculation of the digest value and stored result into the specified *pDAC* memory.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *dacLen* is less than 1 or greater than cipher's data block length.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

DAARijndael256MessageDigest

Computes the DAC value of the message.

Syntax

```
IppStatus ippsDAARijndael256MessageDigest(const Ipp8u *pSrcMsg, int msgLen,
const Ipp8u *pKey, IppsRijndaelKeyLength keyLen, Ipp8u *pMAC, int maclen);
```

Parameters

pSrcMsg	Pointer to the input message.
msgLen	Message length in bytes.
pKey	Pointer to the user-supplied key.
keyLen	Key length.
pMAC	Pointer to the resultant HMAC value.
macLen	Specified HMAC length.

Description

This function is declared in the ippcp file. The function takes the input key *pKey* of the specified key length *keyLen* and applied keyed hash-based message authentication code scheme to transform the input message into the respective message authentication code *pMAC* of the specified length *macLen*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.

ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *msgLen* is less than zero, *macLen* is less than 1 or greater than cipher's data block length, *keyLen* value is illegal.

DAABlowfishGetSize

Gets the size of the IppsDAABlowfishState *context.*

Syntax

```
IppStatus ippsDAABlowfishGetSize(int *pSize);
```

Parameters

pSize	Pointer to the IppsDAABlowFishState context.

Description

The function is declared in the ippcp file. The function gets the IppsDAABlowFishState context size in bytes and stores it in *pSize*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

DAABlowfishInit

Initializes user-supplied memory as IppsDAABlowfishState *context for future use.*

Syntax

```
IppStatus ippsDAABlowfishInit(const Ipp8u* pKey, int keylen,
IppsDAABlowfishState* pCtx);
```

Parameters

pKey	Pointer to the DAABlowfish key.
keylen	Key byte stream length in bytes.
pCtx	Pointer to the IppsDAABlowfishState context being initialized.

Description

This function is declared in the ippcp file. The function initializes the memory pointed by *pCtx* as the IppsDAABlowfishState context. In addition, the function uses the key to provide all necessary key material for both encryption and decryption operations.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *keylen* is less than 1 or greater than 56.

DAABlowfishUpdate

Digests the current input message stream of the specified length.

Syntax

```
IppStatus ippsDAABlowfishUpdate(const Ipp8u *pSrcMesg, int mesglen,
IppsDAABlowfishState* pCtx);
```

Parameters

pSrcMesg	Pointer to the buffer containing a part or the whole message.
mesglen	Length of the actual part of the message in bytes.
pCtx	Pointer to the IppsDAABlowfishState context.

Description

This function is declared in the `ippcp` file. The function digests the current input message stream of the specified length. The function first integrates the previous partial message block with the input message stream, and then partitions them into multiple message blocks (as specified by applied hash algorithm) with a possible additional partial block. For each message block, the function uses the selected block cipher to transform the block of plaintext into a new chaining digest value.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than zero.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

DAABlowfishFinal

Completes computation of the DAC value.

Syntax

```
IppStatus ippsDAABlowfishFinal(Ipp8u *pDAC, int dacLen, IppsDAABlowfishState* pCtx);
```

Parameters

pDAC	Pointer to the DAC value.
dacLen	Specified length of the DAC.
pCtx	Pointer to the `IppsDAABlowfishState` context.

Description

This function is declared in the `ippcp` file. The function completes calculation of the digest value and stored result into the specified *pDAC* memory.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *dacLen* is less than 1 or greater than cipher's data block length.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

DAABlowfishMessageDigest

Computes the DAC value of the message.

Syntax

```
IppStatus ippsDAABlowfishMessageDigest(const Ipp8u *pSrcMsg, int msgLen,
const Ipp8u *pKey, int keyLen, Ipp8u *pMAC, int macLen);
```

Parameters

pSrcMsg	Pointer to the input message.
msgLen	Message length in bytes.
pKey	Pointer to the user-supplied key.
keyLen	Key length.
pMAC	Pointer to the resultant HMAC value.
macLen	Specified HMAC length.

Description

This function is declared in the ippcp file. The function takes the input key *pKey* of the specified key length *keyLen* and applied keyed hash-based message authentication code scheme to transform the input message into the respective message authentication code *pMAC* of the specified length *macLen*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.

ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *msgLen* is less than zero, *macLen* is less than 1 or greater than cipher's data block length, *keyLen* value is illegal.

DAATwofishGetSize

Gets the size of the IppsDAATwofishState *context.*

Syntax

```
IppStatus ippsDAATwofishGetSize(int *pSize);
```

Parameters

pSize	Pointer to the IppsDAATwoFishState context.

Description

The function is declared in the ippcp file. The function gets the IppsDAATwoFishState context size in bytes and stores it in *pSize*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

DAATwofishInit

Initializes user-supplied memory as IppsDAATwofishState *context for future use.*

Syntax

```
IppStatus ippsDAATwofishInit(const Ipp8u* pKey, int keylen,
IppsDAATwofishState* pCtx);
```

Parameters

pKey	Pointer to the DAATwofish key.
keylen	Key byte stream length in bytes.
pCtx	Pointer to the IppsDAATwofishState context being initialized.

Description

This function is declared in the ippcp file. The function initializes the memory pointed by *pCtx* as the IppsDAATwofishState context. In addition, the function uses the key to provide all necessary key material for both encryption and decryption operations.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *keylen* is less than 1 or greater than 32.

DAATwofishUpdate

Digests the current input message stream of the specified length.

Syntax

```
IppStatus ippsDAATwofishUpdate(const Ipp8u *pSrcMesg, int mesglen,
IppsDAATwofishState* pCtx);
```

Parameters

pSrcMesg	Pointer to the buffer containing a part or the whole message.
mesglen	Length of the actual part of the message in bytes.
pCtx	Pointer to the IppsDAATwofishState context.

Description

This function is declared in the `ippcp` file. The function digests the current input message stream of the specified length. The function first integrates the previous partial message block with the input message stream, and then partitions them into multiple message blocks (as specified by applied hash algorithm) with a possible additional partial block. For each message block, the function uses the selected block cipher to transform the block of plaintext into a new chaining digest value.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the input data stream length is less than zero.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

DAATwofishFinal

Completes computation of the DAC value.

Syntax

```
IppStatus ippsDAATwofishFinal(Ipp8u *pDAC, int dacLen, IppsDAATwofishState* pCtx);
```

Parameters

pDAC	Pointer to the DAC value.
dacLen	Specified length of the DAC.
pCtx	Pointer to the `IppsDAATwofishState` context.

Description

This function is declared in the `ippcp` file. The function completes calculation of the digest value and stored result into the specified *pDAC* memory.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *dacLen* is less than 1 or greater than cipher's data block length.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

DAATwofishMessageDigest

Computes the DAC value of the message.

Syntax

```
IppStatus ippsDAATwofishMessageDigest(const Ipp8u *pSrcMsg, int msgLen, const Ipp8u *pKey, int keyLen, Ipp8u *pMAC, int maclen);
```

Parameters

pSrcMsg	Pointer to the input message.
msgLen	Message length in bytes.
pKey	Pointer to the user-supplied key.
keyLen	Key length.
pMAC	Pointer to the resultant HMAC value.
macLen	Specified HMAC length.

Description

This function is declared in the ippcp file. The function takes the input key *pKey* of the specified key length *keyLen* and applied keyed hash-based message authentication code scheme to transform the input message into the respective message authentication code *pMAC* of the specified length *macLen*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.

ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *msgLen* is less than zero, *macLen* is less than 1 or greater than cipher's data block length, *keyLen* value is illegal.

Public Key Cryptography Functions

5

This chapter introduces Intel® Integrated Performance Primitives (Intel® IPP) for public cryptography.

Big Number Arithmetic

This section describes primitives for performing arithmetic operations with integer big numbers of variable length.

The full list of functions for big number arithmetic is given in Table 5-1.

Table 5-1 Intel IPP Big Number Arithmetic Functions

Function Base Name	Operation
Unsigned Big Number Arithmetic Functions	
Add_BNU	Adds two unsigned integer big numbers of the same length.
Sub_BNU	Subtracts one integer big number from another integer big number of the same length.
MulOne_BNU	Multiplies unsigned integer big number by 32-bit unsigned integer.
MACOne_BNU_I	Computes multiplication of unsigned integer big number by 32-bit integer and accumulates the result with another integer big number.
Mul_BNU4	Multiplies two unsigned integers of 4*32 bits.
Mul_BNU8	Multiplies two unsigned integers of 8*32 bits.
Div_64u32u	Divides unsigned 64-bit integer by unsigned 32-bit integer.
Sqr_32u64u	Computes the square of 32-bit words in the input array.
Sqr_BNU4	Computes the square of an unsigned integer big number of 4*32 bits.
Sqr_BNU8	Computes the square of an unsigned integer big number of 8*32 bits.
SetOctString_BNU	Converts octet string into unsigned integer big number.
GetOctString_BNU	Converts unsigned integer big number into octet string.
Signed Big Number Arithmetic Functions	
BigNumGetSize	Gets the size of the IppsBigNumState context.
BigNumInit	Initializes context and partitions allocated buffer.
Set_BN	Defines the sign and value of the context.
SetOctString_BN	Converts octet string into a positive Big Number.

Function Base Name	Operation
GetSize_BN	Returns the maximum length of the integer big number the structure can store.
Get_BN	Extracts the sign and value of the integer big number from the input structure.
ExtGet_BN	Extracts the specified combination of the sign, data length, and value characteristics of the integer big number from the input structure.
GetOctString_BN	Converts a positive Big Number into octet String.
Cmp_BN	Compares two Big Numbers.
CmpZero_BN	Checks the value of the input data field.
Add_BN	Adds two integer big numbers.
Sub_BN	Subtracts one integer big number from another.
Mul_BN	Multiplies two integer big numbers.
MAC_BN_I	Multiplies two integer big numbers and accumulates the result with the third integer big number.
Div_BN	Divides one integer big number by another.
Mod_BN	Computes modular reduction for input integer big number with respect to specified modulus.
Gcd_BN	Computes the greatest common divisor.
ModInv_BN	Computes multiplicative inverse of a positive integer big number with respect to specified modulus.

The magnitude of an integer big number is specified by an array of unsigned integer data type `Ipp32u rp [length]` and corresponds to the mathematical value

$$r = \sum_{0 \le i < length} rp[i] \times 2^{32i}.$$

This section uses the following definition for the sign of an integer big number:

```
typedef enum {
IppsBigNumNEG=0,
IppsBigNumPOS=1
} IppsBigNumSGN;
```

The functions described in this section use the context `IppsBigNumState` to serve as an operational vehicle that carries not only the sign and value of the data, but also a sufficient working buffer reserved for various arithmetic operations. The length of the context

IppsBigNumState is defined as the length of the data carried by the structure and the size of the context IppsBigNumState is therefore defined as the maximal length of the data that this operational vehicle can carry.

NOTE. In all unsigned big number arithmetic functions described below, integers pointed to by *a*, *b*, and *r* are all of (*n**32) bits.

Add_BNU

Adds two unsigned integer big numbers of the same length.

Syntax

```
IppStatus ippsAdd_BNU(const Ipp32u *a, const Ipp32u *b, Ipp32u *r, int n,
Ipp32u * carry);
```

Parameters

a	First unsigned integer big number of *n**32 bits.
b	Second unsigned integer big number of *n**32 bits.
n	Size specified for the input parameters *a* and *b* and the result parameter *r*. The size is expressed in the number of 32-bit words.
r	On output, addition result.
carry	On output, addition carry. The possible value is 0 or 1.

Description

This function is declared in the ippcp.h file. The function adds two unsigned integer big numbers of the same length and returns the result of the operation with a possible carry.

The following pseudocode represents this function:

(*carry*|(**r*)) ← (**a*) + (**b*).

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.

ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *n* is less than or equal to 0.

Sub_BNU

Subtracts one integer big number from another integer big number of the same length.

Syntax

```
IppStatus ippsSub_BNU(const Ipp32u *a, const Ipp32u *b, Ipp32u *r, int n,
Ipp32u * carry);
```

Parameters

a	First unsigned integer big number of *n**32 bits.
b	Second unsigned integer big number of *n**32 bits.
n	Size specified for the input parameters *a* and *b* and the result parameter *r*. The size is expressed in the number of 32-bit words.
r	Subtraction result.
carry	Subtraction borrow. Possible value is 0 or 1.

Description

This function is declared in the ippcp.h file. The function subtracts one integer big number from another big-number integer of the same length and returns the result of the operation with a possible borrow returned as the *carry* argument.

The following pseudocode represents this function:

(**r*) ← (**a*) - (**b*);

carry = ((**a*) < (**b*)).

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

ippStsLengthErr	Indicates an error condition if *n* is less than or equal to 0.

MulOne_BNU

Multiplies unsigned integer big number by 32-bit unsigned integer.

Syntax

```
IppStatus ippsMulOne_BNU(const Ipp32u *a, Ipp32u *r, int n, Ipp32u w, Ipp32u *carry);
```

Parameters

a	Unsigned integer big number of *n* *32 bits.
w	Unsigned long integer of 32 bits serving as multiplier for the operation.
n	Size specified for the input parameter *a* and the result parameter *r*. The size is expressed in the number of 32-bit words.
r	Multiplication result.
carry	Multiplication carry.

Description

This function is declared in the ippcp.h file. The function computes the multiplication of an unsigned integer big number *a* by a 32-bit unsigned integer *w*. The function returns the result to the length array *r*, and the carry of the result to *carry*.

The following pseudocode represents this function:

(*carry*|(*r)) ← (*a)*w*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *n* is less than or equal to 0.

MACOne_BNU_I

Computes multiplication of unsigned integer big number by 32-bit integer and accumulates the result with another integer big number.

Syntax

```
IppStatus ippsMACOne_BNU_I(const Ipp32u *a, Ipp32u *r, int n, Ipp32u w,
Ipp32u *carry);
```

Parameters

a	Multiplicand, an unsigned integer big number.
w	32-bit unsigned long integer multiplier.
n	Size specified for the input parameters *a* and the result parameter *r*. The size is expressed in the number of 32-bit words.
r	Unsigned integer big number accumulator.
carry	Operation carry.

Description

This function is declared in the `ippcp.h` file. The function computes the multiplication of an unsigned integer big number *a* by a 32-bit integer *w* and accumulates the result with another integer big number *r* of same length. The result of the operation is returned to *r*, and the carry of the result is returned as *carry*.

The following pseudocode represents this function:

(*carry*|(*r*)) ← (*r*) + (*a*)*w*.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if *n* is less than or equal to 0.

Mul_BNU4

*Multiplies two unsigned integers of 4*32 bits.*

Syntax

```
IppStatus ippsMul_BNU4(const Ipp32u *a, const Ipp32u *b, Ipp32u *r);
```

Parameters

a	Multiplicand, an integer big number of 4*32 bits.
w	Multiplier, an integer big number of 4*32 bits.
r	Multiplication result of 8*32 bits.

Description

This function is declared in the ippcp.h file. The function multiplies two unsigned integers of 4*32 bit and returns the result of 8*32 bits.

The following pseudocode represents this function:

(*r) ← (*a) (*b).

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

Mul_BNU8

*Multiplies two unsigned integers of 8*32 bits.*

Syntax

```
IppStatus ippsMul_BNU8(const Ipp32u *a, const Ipp32u *b, Ipp32u *r);
```

Parameters

a	Multiplicand, an integer big number of 8*32 bits.
b	Multiplier, an integer big number of 8*32 bits.
r	Multiplication result of 16*32 bits.

Description

This function is declared in the ippcp.h file. The function multiplies two unsigned integers of 8*32 bit and returns the result of 16*32 bits.

The following pseudocode represents this function:

(*r) ← (*a) (*b).

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

Div_64u32u

Divides unsigned 64-bit integer by unsigned 32-bit integer.

Syntax

```
IppStatus ippsDiv_64u32u(Ipp64u a, Ipp32u b, Ipp32u *q, Ipp32u *r);
```

Parameters

a	Dividend of 64 bits.
b	Divisor of 32 bits.
q	Quotient of 32 bits.
r	Remainder of 32 bits.

Description

This function is declared in the ippcp.h file. The function divides a 64-bit unsigned integer dividend by a 32-bit unsigned divisor and returns the quotient and remainder.

The following pseudocode represents this function:

a = *b***q* + *r*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.

ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsOutOfRangeErr	Indicates an error condition if the quotient is not 32 bits. In this case the result is undefined.
ippStsDivByZeroErr	Indicates an error condition if zero divisor is used.

Sqr_32u64u

Computes the square of 32-bit words in the input array.

Syntax

```
IppStatus ippsSqr_32u64u(const Ipp32u *src, int n, Ipp64u *dst);
```

Parameters

src	Array of 32-bit words.
n	Input array size.
dst	Pointer to the result.

Description

This function is declared in the ippcp.h file. The function computes the square of each unsigned 32-bit long word in the input array. The result of the operation is stored in the array of 64-bit unsigned integers.

The following pseudocode represents this function:

dst[i] ← *src[i] * src[i]*, where *i* = 0, 1, 2, ..., *n* –1.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *n* is less than or equal to 0.

Sqr_BNU4

*Computes the square of an unsigned integer big number of 4*32 bits.*

Syntax

```
IppStatus ippsSqr_BNU4(const Ipp32u *a, Ipp32u *r);
```

Parameters

a	Multiplicand of 4*32 bits.
r	Square operation result of 8*32 bits.

Description

This function is declared in the ippcp.h file. The function computes the square of an unsigned integer big number of 4*32 bits and stores the result in the memory.

The following pseudocode represents this function:

(*r) ← (*a) (*a).

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

Sqr_BNU8

*Computes the square of an unsigned integer big number of 8*32 bits.*

Syntax

```
IppStatus ippsSqr_BNU8(const Ipp32u *a, Ipp32u *r);
```

Parameters

a	Multiplicand of 8*32 bits.
r	Square operation result of 16*32 bits.

Description

This function is declared in the `ippcp.h` file. The function computes the square of an unsigned integer big number of `8*32` bits and stores the result in the memory.

The following pseudocode represents this function:

(*r) ← (*a) (*a).

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.

SetOctString_BNU

Converts octet string into unsigned integer big number.

Syntax

```
IppStatus ippsSetOctString_BNU(const Ipp8u* pOctStr, int strLen, Ipp32u*
pBNU, int* pBNUsize);
```

Parameters

pOctStr	Pointer to the input octet string `OctStr`.
strLen	Length of the octet string.
pBNU	Pointer to the unsigned integer big number BNU.
pBNUsize	Pointer to the size (in 32-bit items) of the unsigned integer big number.

Description

The function is declared in the `ippcp.h` file. This function converts octet string into unsigned integer big number.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.

ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if specified *strLen* is less than 1.
ippStsSizeErr	Indicates an error condition if specified **pBNUsize* is not sufficient for keeping actual *strLen*.

GetOctString_BNU

Converts unsigned integer big number into octet string.

Syntax

```
IppStatus ippsGetOctString_BNU(const Ipp32u* pBNU, int bnuSize, Ipp8u*
pOctStr, int strLen);
```

Parameters

pBNU	Pointer to the source unsigned integer big number BNU.
bnuSize	Unsigned integer big number size (in 32-bit items)
pOctStr	Pointer to the source octet string OctStr.
strLen	Length of the octet string.

Description

The function is declared in the ippcp.h file. This function converts unsigned integer big number BNU into octet string OctStr.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if specified *bnuSize* is less than 1.
ippStsRangeErr	Indicates an error condition if 256^*strLen* is less than the unsigned integer big number.

BigNumGetSize

Gets the size of the `IppsBigNumState` *context in bytes.*

Syntax

```
IppStatus ippsBigNumGetSize(int length, int *size);
```

Parameters

length	Integer big number length in `Ipp32u`.
size	Size of the buffer in bytes required for initialization.

Description

This function is declared in the `ippcp.h` file. The function specifies the buffer size required to define a structuralized working buffer of the context `IppsBigNumState` for the storage and operations on an integer big number in bytes.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if *length* is less than or equal to 0.

BigNumInit

Initializes context and partitions allocated buffer.

Syntax

```
IppStatus ippsBigNumInit(int length, IppsBigNumState *b);
```

Parameters

length	Size of the big number for the context initialization.
b	Pointer to the supplied buffer used to store the initialized context `IppsBigNumState`.

Description

This function is declared in the `ippcp.h` file. The function initializes the context `IppsBigNumState` using the specified buffer space and partitions the given buffer to store and execute arithmetic operations on an integer big number of the *`length`* size.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if *`length`* is less than or equal to 0.

Set_BN

Defines the sign and value of the context.

Syntax

```
IppStatus ippsSet_BN(IppsBigNumSGN sgn, int length, const Ipp32u *data,
IppsBigNumState *x);
```

Parameters

`sgn`	Sign of `IppsBigNumState *` *`x`*.
`length`	Array length of the input data.
`data`	Data array.
`x`	On output, the context `IppsBigNumState` updated with the input data.

Description

This function is declared in the `ippcp.h` file. The function defines the sign and value for `IppsBigNumState *`*`x`* with the specified inputs `IppsBigNumSGN` *`sgn`* and `const Ipp32u *`*`data`*.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.

ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *length* is less than or equal to 0.
ippStsOutOfRangeErr	Indicates an error condition if *length* is more than the size of IppsBigNumState *x.
ippStsBadArgErr	Indicates an error condition if the big number is set to zero with the negative sign.

Example 5-1 Create a Big Number

```
IppsBigNumState* New_BN(int size, const Ipp32u* pData=0){
   // get the size of the Big Number context
   int ctxSize;
   ippsBigNumGetSize(size, &ctxSize);
   // allocate the Big Number context
   IppsBigNumState* pBN = (IppsBigNumState*) (new Ipp8u [ctxSize] );
   // and initialize one
   ippsBigNumInit(size, pBN);
   // if any data was supplied, then set up the Big Number value
   if(pData)
      ippsSet_BN(IppsBigNumPOS, size, pData, pBN);
   // return pointer to the Big Number context for future use
   return pBN;
}
```

SetOctString_BN

Converts octet string into a positive Big Number.

Syntax

```
IppStatus ippsSetOctString_BN(const Ipp8u* pOctStr, int strLen,
IppsBigNumState* pBN);
```

Parameters

pOctStr	Pointer to the input octet string.
strLen	Octet string length in bytes.
pBN	Pointer to the context of the output Big Number.

Description

The function is declared in the `ippcp.h` file. This function converts octet string into a positive Big Number.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.
`ippStsLengthErr`	Indicates an error condition if specified *strLen* is less than 1.
`ippStsSizeErr`	Indicates an error condition if insufficient space has been reserved for Big Number.

Example 5-2 Create a Big Number from a String

```
void Set_BN_sample(void){

   // desired value of Big Number is 0x123456789abcdef0fedcba9876543210

   Ipp8u desiredBNvalue[] = "\x12\x34\x56\x78\x9a\xbc\xde\xf0"

                            "\xfe\xdc\xba\x98\x76\x54\x32\x10";

   // estimate required size of Big Number
```

```
    //int size = (sizeof(desiredBNvalue)+3)/4;
    int size = (sizeof(desiredBNvalue)-1+3)/4;
    // and create new (and empty) one
    IppsBigNumState* pBN = New_BN(size);
    // set up the value from the srting
    ippsSetOctString_BN(desiredBNvalue, sizeof(desiredBNvalue)-1, pBN);
    Type_BN("Big Number value is:\n", pBN);
}
```

GetSize_BN

Returns the maximum length of the integer big number the structure can store.

Syntax

```
IppStatus ippsGetSize_BN(const IppsBigNumState *b, int *size);
```

Parameters

b	Integer big number of the data type `IppsBigNumState`.
size	Maximum length of the integer big number.

Description

This function is declared in the `ippcp.h` file. The function evaluates the working buffer assigned to the context `IppsBigNumState` and returns the size of the structure to indicate the maximum length of the integer big number that the structure can store.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.

Get_BN

Extracts the sign and value of the integer big number from the input structure.

Syntax

```
IppStatus ippsGet_BN(IppsBigNumSGN *sgn, int *length, Ipp32u *data, const IppsBigNumState *x);
```

Parameters

sgn	Sign of `IppsBigNumState *x`.
length	Array length of the input data.
data	Data array.
x	Integer big number of the context `IppsBigNumState`.

Description

This function is declared in the `ippcp.h` file. The function extracts the sign and value of the integer big number from the input structure.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

ExtGet_BN

Extracts the specified combination of the sign, data length, and value characteristics of the integer big number from the input structure.

Syntax

```
IppStatus ippsExtGet_BN(IppsBigNumSGN *pSgn, int *pLengthInBits, Ipp32u *pData, const IppsBigNumState *pBN);
```

Parameters

pSgn	Pointer to the sign of IppsBigNumState *pBN.
pLengthInBits	Pointer to the length of *pData in bits.
pData	Pointer to the data array.
pBN	Pointer to the integer big number context IppsBigNumState.

Description

This function is declared in the ippcp.h file. For the integer big number from the input structure, the function extracts the specified combination of the following characteristics: sign, data length, and value. The function is similar to the Get_BN function but more flexible, because any target pointer (*pSgn*, *pLengthInBits*, and/or *pData*) may be NULL, in which case the appropriate big number characteristic will not be extracted. For example,

`ippsExtGet_BN(&sgn, 0,0, pBN);` extracts only the sign

`ippsExtGet_BN(0, &dataLen, 0, pBN);` extracts only the data length

`ippsExtGet_BN(&sgn, &dataLen, 0, pBN);` extracts the sign and data length

`ippsExtGet_BN(0,0,0, pBN);` does nothing

`ippsExtGet_BN(&sgn, &dataLen, pData, pBN);` does exactly what Get_BN does.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if the pointer to the integer big number of the context is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

Ref_BN

Extracts the main characteristics of the integer big number from the input structure.

Syntax

```
IppStatus ippsRef_BN(IppsBigNumSGN *sgn, int *bitSize, const Ipp32u **pData,
const IppsBigNumState *x);
```

Parameters

sgn	Sign of `IppsBigNumState *x`.
bitSize	Length of the integer big number in bits.
pData	Pointer to the data array.
x	Integer big number of the context `IppsBigNumState`.

Description

This function is declared in the `ippcp.h` file. The function extracts from the input structure the main characteristics of the integer big number: sign, length, and pointer to the data array. You can extract either the entire set or any subset of these characteristics. To turn off extraction of a particular characteristic, set the appropriate function parameter to NULL.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

GetOctString_BN

Converts a positive Big Number into octet String.

Syntax

```
IppStatus ippsGetOctString_BN(const Ipp8u* pOctStr, int strLen, const
IppsBigNumState* pBN);
```

Parameters

pOctStr	Pointer to the input octet string.
strLen	Octet string length in bytes.
pBN	Pointer to the context of the input Big Number.

Description

The function is declared in the `ippcp.h` file. This function converts a positive Big Number into the octet string.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.
`ippStsLengthErr`	Indicates an error condition if specified *pOctStr* is insufficient in length.
`ippStsRangeErr`	Indicates an error condition if Big Number is negative.

Example 5-3 Type a Big Number

```
void Type_BN(const char* pMsg, const IppsBigNumState* pBN){
   // size of Big Number
   int size;
   ippsGetSize_BN(pBN, &size);
   // extract Big Number value and convert it to the string presentation
   Ipp8u* bnValue = new Ipp8u [size*4];
   ippsGetOctString_BN(bnValue, size*4, pBN);
   // type header
   if(pMsg)
      cout <<pMsg;
   // type value
   for(int n=0; n<size*4; n++)
      cout<<hex <<(int)bnValue[n];
   cout <<endl;
   delete [] bnValue;
}
```

Cmp_BN

Compares two Big Numbers.

Syntax

```
IppStatus ippsCmp_BN(const IppsBigNumState *pA, const IppsBigNumState *pB,
Ipp32u *pRsult);
```

Parameters

pA	Pointer to the context of the Big Number A.
pB	Pointer to the context of the Big Number B.
pRsult	Pointer to the result of the comparison.

Description

The function is declared in ippcp.h file. This function compares Big Numbers A and B and sets up the result according to the following conditions:

- if A==B, then *pResult = IS_ZERO
- if A > B, then *pResult = GREATER_THAN_ZERO
- if A < B, then *pResult = LESS_THAN_ZERO

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

CmpZero_BN

Checks the value of the input data field.

Syntax

```
IppStatus ippsCmpZero_BN(const IppsBigNumState *b, Ipp32u *result);
```

Parameters

b	Integer big number of the data type IppsBigNumState.
result	Indicates whether the input integer big number is positive, negative, or zero.

Description

This function is declared in the ippcp.h file. The function scans the data field of the input const IppsBigNumState *b and returns

- IS_ZERO if the value held by IppsBigNumState *b is zero
- GREATER_THAN_ZERO if the input is more than zero
- LESS_THAN_ZERO if the input is less than zero.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

Add_BN

Adds two integer big numbers.

Syntax

```
IppStatus ippsAdd_BN(IppsBigNumState *a, IppsBigNumState *b, IppsBigNumState
* r);
```

Parameters

a	First integer big number of the data type IppsBigNumState.
b	Second integer big number of the data type IppsBigNumState.
r	Addition result.

Description

This function is declared in the ippcp.h file. The function adds two integer big numbers regardless of their signs and sizes and returns the result of the operation.

The following pseudocode represents this function:

$(*r) \leftarrow (*a) + (*b)$.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsOutOfRangeErr	Indicates an error condition if the size of *r* is smaller than the resulting data length.

NOTE. The function executes only under the condition that size of `IppsBigNumState * r` is not less than either the length of `IppsBigNumState *a` or that of `IppsBigNumState *b`.

Example 5-4 Add Big Numbers

```
void Add_BN_sample(void){
   // define and set up Big Number A
   const Ipp32u bnuA[] = {0x01234567,0x9abcdeff,0x11223344};
   IppsBigNumState* bnA = New_BN(sizeof(bnuA)/sizeof(Ipp32u));
   // define and set up Big Number B
   const Ipp32u bnuB[] = {0x76543210,0xfedcabee,0x44332211};
   IppsBigNumState* bnB = New_BN(sizeof(bnuB)/sizeof(Ipp32u), bnuB);
   // define Big Number R
   int sizeR = max(sizeof(bnuA), sizeof(bnuB));
   IppsBigNumState* bnR = New_BN(1+sizeR/sizeof(Ipp32u));
   // R = A+B
   ippsAdd_BN(bnA, bnB, bnR);
   // type R
   Type_BN("R=A+B:\n", bnR);
   delete [] (Ipp8u*)bnA;
   delete [] (Ipp8u*)bnB;
   delete [] (Ipp8u*)bnR;
}
```

Sub_BN

Subtracts one integer big number from another.

Syntax

`IppStatus ippsSub_BN(IppsBigNumState *a, IppsBigNumState *b, IppsBigNumState * r);`

Parameters

a	First integer big number of the data type IppsBigNumState.
b	Second integer big number of the data type IppsBigNumState.
r	Subtraction result.

Description

This function is declared in the ippcp.h file. The function subtracts one integer big number from another regardless of their signs and sizes and returns the result of the operation.

The following pseudocode represents this function:

(*r) ← (*a) - (*b).

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsOutOfRangeErr	Indicates an error condition if IppsBigNumState *r is smaller than the result data length.

NOTE. The function executes only under the condition that size of IppsBigNumState * r is not less than either the length of IppsBigNumState *a or that of IppsBigNumState *b.

Mul_BN

Multiplies two integer big numbers.

Syntax

```
IppStatus ippsMul_BN(IppsBigNumState *a, IppsBigNumState *b, IppsBigNumState
* r);
```

Parameters

a	Multiplicand of IppsBigNumState.
b	Multiplier of IppsBigNumState.
r	Multiplication result.

Description

This function is declared in the ippcp.h file. The function multiplies an integer big number by another integer big number regardless of their signs and sizes and returns the result of the operation.

The following pseudocode represents this function:

$r \leftarrow a * b$.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsOutOfRangeErr	Indicates an error condition if IppsBigNumState *r is smaller than the result data length.

NOTE. The function executes only under the condition that the size IppsBigNumState *r is not less than the sum of the lengths of IppsBigNumState *a or that of IppsBigNumState *b minus one.

MAC_BN_I

Multiplies two integer big numbers and accumulates the result with the third integer big number.

Syntax

```
IppStatus ippsMAC_BN_I(IppsBigNumState *a, IppsBigNumState *b, IppsBigNumState
* r);
```

Parameters

a	Multiplicand of IppsBigNumState.
b	Multiplier of IppsBigNumState.
r	Multiplication result.

Description

This function is declared in the ippcp.h file. The function multiplies one integer big number by another and accumulates the result with the third input integer big number regardless of their signs and sizes. The function subsequently returns the result of the operation.

The following pseudocode represents this function:

$r \leftarrow r + a * b$.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsOutOfRangeErr	Indicates an error condition if IppsBigNumState *r is smaller than the result data length.

NOTE. The function executes only under the condition that the size IppsBigNumState *r is not less than the sum of the lengths of IppsBigNumState *a or that of IppsBigNumState *b minus one.

Div_BN

Divides one integer big number by another.

Syntax

```
IppStatus ippsDiv_BN(IppsBigNumState *a, IppsBigNumState *b, IppsBigNumState
* q, IppsBigNumState *r);
```

Parameters

a	Dividend of IppsBigNumState.

b	Divisor of IppsBigNumState.
q	Quotient of IppsBigNumState.
r	Remainder of IppsBigNumState.

Description

This function is declared in the ippcp.h file. The function divides an integer big number dividend by another integer big number regardless of their signs and sizes and returns the quotient of the division and the respective remainder.

The following pseudocode represents this function:

$q \leftarrow a/b$

$r \leftarrow a - b*q$.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsOutOfRangeErr	Indicates an error condition if IppsBigNumState *r is smaller than the length of IppsBigNumState *b or when the size of IppsBigNumState *q is smaller than the quotient result data length.
ippStsDivByZeroErr	Indicates an error condition if the zero divisor is attempted.

NOTE. The size of IppsBigNumState *q should not be less than (*length of* *a) – (*length of* * b) + 1, and the size of IppsBigNumState *r should be no less than the length of IppsBigNumState *b.

Mod_BN

Computes modular reduction for input integer big number with respect to specified modulus.

Syntax

```
IppStatus ippsMod_BN(IppsBigNumState *a, IppsBigNumState *m, IppsBigNumState * r);
```

Parameters

a	Integer big number of `IppsBigNumState`.
m	Modulus integer of `IppsBigNumState`.
r	Modular reduction result.

Description

This function is declared in the `ippcp.h` file. The function computes the modular reduction for an input integer big number with respect to the modulus specified by a positive integer big number and returns the modular reduction result in the range of `[0, (m-1)]`.

The following pseudocode represents this function:

$r \leftarrow a \bmod m$.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsOutOfRangeErr`	Indicates an error condition if `IppsBigNumState *r` is smaller than the length of `IppsBigNumState *m`.
`ippStsBadModulusErr`	Indicates an error condition if the modulus `IppsBigNumState *m` is not a positive integer.

NOTE. The size of `IppsBigNumState *r` should not be less than the length of `IppsBigNumState *m`.

Gcd_BN

Computes greatest common divisor.

Syntax

```
IppStatus ippsGcd_BN(IppsBigNumState *a, IppsBigNumState *b, IppsBigNumState * g);
```

Parameters

a	First integer big number of IppsBigNumState.
b	Second integer big number of IppsBigNumState.
g	Greatest common divisor to *a* and *b*.

Description

This function is declared in the ippcp.h file. The function computes the greatest common divisor (GCD) for two positive integer big numbers.

The following pseudocode represents this function:

g ← *gcd* (*a* , *b*).

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsOutOfRangeErr	Indicates an error condition if IppsBigNumState *g is smaller than the length of IppsBigNumState *a or IppsBigNumState *b.

NOTE. The size of IppsBigNumState *g should not be less than either the length of IppsBigNumState *a and IppsBigNumState *b.

ModInv_BN

Computes multiplicative inverse of a positive integer big number with respect to specified modulus.

Syntax

```
IppStatus ippsModInv_BN(IppsBigNumState *e, IppsBigNumState *m,
IppsBigNumState * d);
```

Parameters

e	Integer big number of IppsBigNumState.
m	Modulus integer of IppsBigNumState.
d	Multiplicative inverse.

Description

This function is declared in the ippcp.h file. The function uses the extended Euclidean algorithm to compute the multiplicative inverse of a given positive integer big number *e* with respect to the modulus specified by another positive integer big number *m*, where *gcd (e, m) = 1*.

The following pseudocode represents this function:

compute *d* such that *d * e = 1 mod m*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsBadArgErr	Indicates an error condition if *e* is less than or equal to 0.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsBadModulusErr	Indicates an error condition if the modulus *e* is more than *m*, or *gcd (e,m)* is more than 1, or *m* is less than or equal to 0.
ippStsOutOfRangeErr	Indicates an error condition if IppsBigNumState *d is smaller than the length of IppsBigNumState *m.

NOTE. The size of IppsBigNumState *d should not be less than the length of IppsBigNumState *m.

Montgomery Reduction Scheme Functions

This section describes Montgomery reduction scheme functions. The full list of these functions is given in Table 5-2.

Table 5-2 Intel IPP Montgomery Reduction Scheme Functions

Function Base Name	Operation
MontGetSize	Gets the size of the IppsMontState context.
MontInit	Initializes the context and partitions the specified buffer space.
MontSet	Sets the input integer big number to a value and computes the Montgomery reduction index.
MontGet	Extracts the big number modulus.
MontForm	Converts input positive integer big number into Montgomery form.
MontMul	Computes Montgomery modular multiplication for positive integer big numbers of Montgomery form.
MontExp	Computes Montgomery exponentiation.

Montgomery reduction is a technique for efficient implementation of modular multiplication without explicitly carrying out the classical modular reduction step.

This section describes functions for Montgomery modular reduction, Montgomery modular multiplication, and Montgomery modular exponentiation.

Let n be a positive integer, and let R and T be integers such that $R > n$, $\gcd(n, R) = 1$, and $0 < T < nR$. The Montgomery reduction of T modulo n with respect to R is defined as $TR^{-1} \bmod n$.

For better results, functions included in the cryptography package use $R = b^k$ where $b = 2^{32}$ and k is the Montgomery index integer computed by the ceiling function of the bit length of the integer n over 32.

All functions use employ the context IppsMontState to serve as an operational vehicle to carry the Montgomery reduction index k, the integer big number modulus n, the least significant word n_0 of the multiplicative inverse of the modulus n with respect to the Montgomery reduction factor R, and a sufficient working buffer reserved for various Montgomery modular operations.

Furthermore, two new terms are introduced in this section:

- length of the context IppsMontState is defined as the data length of the modulus n carried by the structure
- size of the context IppsMontState is therefore defined as the maximum data length of such an integer modulus n that could be carried by this operational vehicle.

The following example can briefly illustrate the procedure of using the primitives described in this section to compute a classical modular exponentiation `T = x^e mod n`. Consider computing `T = x^4 mod n`, for some integer *x* with `0 < x < n`.

First get the buffer size required to configure the context `IppsMontState` by calling `MontGetSize` and then allocate the working buffer using OS service function, with allocated buffer to call `MontInit` to initialize the context `IppsMontState`.

Set the modulus *n* by calling `MontSet` and then convert *x* into its respective Montgomery form by calling `MontForm`, that is, computing

$$\underline{x} = xR \bmod n .$$

Then compute the Montgomery reduction of

$$\underline{x}\underline{x}$$

using the function `MontMul` to generate

$$T = \underline{x}\underline{x}R^{-1} \bmod n .$$

The Montgomery reduction of `T* T` *mod n* with respect to *R* is

$$T^2R^{-1} \bmod n = (\underline{x}^2R^{-1})^2R^{-1} \bmod n = x^4R \bmod n .$$

Further applying `MontMul` with this value and the value of 1 yields the desired result `T = x^4 mod n`.

The classical modular exponentiation should be computed by performing the following sequence of operations:

1. Get the buffer size required to configure the context `IppsMontState` by calling the function `MontGetSize`. For limited memory system, choose binary method, and otherwise, choose sliding window method. Using the binary method reduces the buffer size significantly while using sliding window method enhances the performance.

2. Allocate working buffer through an operating system memory allocation function and configure the structure IppsMontState by calling the function MontInit with the allocated buffer and the choice made on the modular exponential method at time invoking MontGetSize.
3. Call the function MontSet to set the integer big number module for IppsMontState.
4. Call the function MontForm to convert the integer *x* to be its Montgomery form.
5. Call the function MontExp to compute the Montgomery modular exponentiation.
6. Call the function MontMul to compute the Montgomery modular multiplication of the above result with the integer 1 as to convert the above result back to the desired classical modular exponential result.
7. Free the memory using an operating system memory free function, if needed.

MontGetSize

Gets the size of the IppsMontState *context.*

Syntax

```
IppStatus ippsMontGetSize(IppsExpMethod method, int length, int * size);
```

Parameters

method	Selected exponential method.
length	Data field length for the modulus.
size	Size of the buffer required for initialization.

Description

This function is declared in the ippcp.h file. The function specifies the buffer size required to define the structuralized working buffer of the context IppsMontState to store the modulus and perform operations using various Montgomery modulus schemes.

The function returns the required buffer size based on the selected exponential method. The binary method helps to significantly reduce the buffer size, while the sliding windows method results in enhanced performance.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *length* is less than or equal to 0.

MontInit

Initializes the context and partitions the specified buffer space.

Syntax

```
IppStatus ippsMontInit(IppsExpMethod method, int length, IppsMontState *m);
```

Parameters

method	Selected exponential method.
buffer	Buffer for initializing *m*.
length	Data field length for the modulus.
m	Pointer to the context IppsMontState.

Description

This function is declared in the ippcp.h file. The function initializes the context using the specified buffer space. The function then partitions the buffer using the selected modular exponential method in such a way as to carry up to *length* **sizeof*(Ipp32u)-bit big number modulus and execute various Montgomery modulus operations.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *length* is less than or equal to 0.

MontSet

Sets the input integer big number to a value and computes the Montgomery reduction index.

Syntax

```
IppStatus ippsMontSet(const Ipp32u *n, int length, IppsMontState *m);
```

Parameters

n	Input big number modulus.
m	Pointer to the context IppsMontState capturing the modulus and the least significant word of the multiplicative inverse *Ni*.

Description

This function is declared in the ippcp.h file. The function sets the input positive integer big number *n* to be the modulus for the context IppsMontState * *m*, computes the Montgomery reduction index *k* with respect to the input big number modulus *n* and the least significant 32-bit word of the multiplicative inverse *Ni* with respect to the modulus *R*, that satisfies $R*R^{-1}-n*Ni = 1$.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsBadModulusErr	Indicates an error condition if the modulus is not a positive odd integer.
ippStsLengthErr	Indicates an error condition if *length* is less than or equal to 0.
ippStsOutOfRangeErr	Indicates an error condition if *length* is larger than IppsMontState*m*.

MontGet

Extracts the big number modulus.

Syntax

```
IppStatus ippsMontGet(Ipp32u *n, int *length, const IppsMontState *m);
```

Parameters

m	context IppsMontState.
n	Modulus data field.
length	Modulus data length.

Description

This function is declared in the `ippcp.h` file. The function extracts the big number modulus from the input `IppsMontState *m`.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.

MontForm

Converts input positive integer big number into Montgomery form.

Syntax

```
IppStatus ippsMontForm(IppsBigNumState *a, IppsMontState *m, IppsBigNumState * r);
```

Parameters

a	Input integer big number within the range `[0, m - 1]`.
m	Input big number modulus of `IppsBigNumState`.
r	Resulting Montgomery form *r = a*R mod m*.

Description

This function is declared in the `ippcp.h` file. The function converts an input positive integer big number into the Montgomery form with respect to the big number modulus and stores the conversion result.

The following pseudocode represents this function:

*r ← a *R mod m*.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.

ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsBadArgErr	Indicates an error condition if *a* is a negative integer.
ippStsScaleRangeErr	Indicates an error condition if *a* is more than *m*.
ippStsOutOfRangeErr	Indicates an error condition if IppsBigNumState *r is larger than IppsMontState *m.

NOTE. The size of IppsBigNumState *r should not be less than the data length of the modulus *m*.

MontMul

Computes Montgomery modular multiplication for positive integer big numbers of Montgomery form.

Syntax

```
IppStatus ippsMontMul(IppsBigNumState *a, IppsBigNumState *b, IppsMontState *m, IppsBigNumState *r);
```

Parameters

a	Multiplicand within the range [0, *m* – 1].
b	Multiplier within the range [0, *m* – 1].
m	Modulus.
r	Montgomery multiplication result.

Description

This function is declared in the ippcp.h file. The function computes the Montgomery modular multiplication for positive integer big numbers of Montgomery form with respect to the modulus IppsMontState *m. As a result, IppsBigNumState *r holds the product.

The following pseudocode represents this function:

$r \leftarrow a*b*R^{-1} \bmod m$.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsBadArgErr`	Indicates an error condition if *a* or *b* is a negative integer.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsScaleRangeErr`	Indicates an error condition if *a* or *b* is more than *m*.
`ippStsOutOfRangeErr`	Indicates an error condition if `IppsBigNumState` *r is larger than `IppsMontState` *m.

NOTE. The size of `IppsBigNumState *r` should not be less than the data length of the modulus *m*.

Example of Using Montgomery Reduction Scheme Functions

Example 5-5 Montgomery Multiplication

```
void MontMul_sample(void){
   int size;

   // define and initialize Montgomery Engine over Modulus N
   Ipp32u bnuN = 19;
   ippsMontGetSize(IppsBinaryMethod, 1, &size);
   IppsMontState* pMont = (IppsMontState*)( new Ipp8u [size] );
   ippsMontInit(IppsBinaryMethod, 1, pMont);
   ippsMontSet(&bnuN, 1, pMont);

   // define and init Big Number multiplicant A
   Ipp32u bnuA = 12;
   IppsBigNumState* bnA = New_BN(1, &bnuA);
   // encode A into Montfomery form
   ippsMontForm(bnA, pMont, bnA);

   // define and init Big Number multiplicant A
   Ipp32u bnuB = 15;
   IppsBigNumState* bnB = New_BN(1, &bnuB);


   // compute R = A*B mod N
   IppsBigNumState* bnR = New_BN(1);
   ippsMontMul(bnA, bnB, pMont, bnR);
```

```
    Type_BN("R = A*B mod N:\n", bnR);
    delete [] (Ipp8u*)pMont;
    delete [] (Ipp8u*)bnA;
    delete [] (Ipp8u*)bnB;
    delete [] (Ipp8u*)bnR;
}
```

MontExp

Computes Montgomery exponentiation.

Syntax

```
IppStatus ippsMontExp(IppsBigNumState *a, IppsBigNumState *e, IppsMontState *m, IppsBigNumState *r);
```

Parameters

a	Big number Montgomery integer within the range of [0, *m* - 1].
e	Big number exponent.
m	Modulus.
r	Montgomery exponentiation result.

Description

This function is declared in the ippcp.h file. The function computes Montgomery exponentiation with the exponent specified by the input positive integer big number to the given positive integer big number of the Montgomery form with respect to the modulus *m*.

The following pseudocode represents this function:

$r \leftarrow a^e R^{-(e-1)} \bmod m$.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsBadArgErr	Indicates an error condition if *a* or *e* is a negative integer.

ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsScaleRangeErr	Indicates an error condition if *a* or *e* is more than *m*.
ippStsOutOfRangeErr	Indicates an error condition if IppsBigNumState**r* is larger than IppsMontState**m*.

NOTE. The size of IppsBigNumState **r* should not be less than the data length of the modulus *m*.

Pseudorandom Number Generation Functions

Many cryptographic systems rely on pseudorandom number generation functions in their design that make the unpredictable nature inherited from a pseudorandom number generator the security foundation to ensure safe communication over open channels and protection against potential adversaries.

The full list of Intel IPP Pseudorandom Number Generation Functions is given in Table 5-3.

Table 5-3 Intel IPP Pseudorandom Number Generation Functions

Function Base Name	Operation
PRNGGetSize	Gets the size of the IppsPRNGState context.
PRNGInit	Initializes user-supplied memory as IppsPRNGState context for future use.
PRNGSetSeed	Sets the initial state with the given input seed for pseudorandom number generation.
PRNGSetAugment	Sets the initial state with the given input entropy for the pseudorandom number generation.
PRNGSetModulus	Sets the initial state with the given input modulus for the pseudorandom number generation.
PRNGSetH0	Sets the initial state with the given input IV for the SHA-1 algorithm.
PRNGGen	Generates a pseudorandom unsigned Big Number of the specified bitlength.
PRNGGen_BN	Generates a pseudorandom positive Big Number of the specified bitlength.

This section describes functions that comprise the pseudorandom bit sequence generator implemented by a US FIPS-approved method and based on a SHA-1 one-way hash function specified by [FIPS PUB 186-2], *appendix 3*.

The application code for generating a sequence of pseudorandom bits should perform the following sequence of operations:

1. Call the function PRNGGetSize to get the size required to configure the IppsPRNGState context.
2. Ensure that the required memory space is properly allocated. With the allocated memory, call the PRNGInit function to set up the default value of the parameters for pseudorandom generation process.
3. If the default values of the parameters are not satisfied, call the function PRNGSetSeed and/or PRNGSetAugment and/or PRNGSetModulus and/or PRNGSetH0 to reset any of the control pseudorandom generator parameters.
4. Keep calling the function PRNGen or PRNGen_BN to generate pseudo random value of the desired format.
5. Free the memory allocated for the IppsPRNGState context by calling the operating system memory free service function.

User's Implementation of a Pseudorandom Number Generator

Both functions ippsPRNGGen and ippsPRNGGen_BN, as well as their supplementary functions represent the implementation of the pseudorandom number generator in the IPPCP library. This given implementation is based on recommendations made in [FIPS PUB 186-2]. If you prefer to use the implementation of the pseudorandom number generator which is different from the given, you can still use IPPCP library. To do this, use the following definition of the generator introduced by the IPPCP library:

Syntax

```
typedef IppStatus(_STDCALL *IppBitSupplier)(Ipp32u* pData, int nBits, void* pEbsParams);
```

Parameters

pData	Pointer to the output data.
nBits	Number of generated data bits.
pEbsParams	Pointer to the user defined context.

Description

This declaration is included in the ippcp.h file. The function generates ny data (probably pseudorandom numbers) of the specified *nBits* length.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsErr	Indicates an error condition.

PRNGGetSize

Gets the size of the IppsPRNGState *context in bytes.*

Syntax

```
IppStatus ippsPRNGGetSize(int *pSize);
```

Parameters

pSize	Pointer to the IppsPRNGState context size in bytes.

Description

This function is declared in the ippcp.h file. The function gets the IppsPRNGState context size in bytes and stores it in **pSize*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

PRNGInit

Initializes user-supplied memory as IppsPRNGState *context for future use.*

Syntax

```
IppStatus ippsPRNGInit(int seedBits, IppsPRNGState* pCtx);
```

Parameters

seedBits	Size in bits for the seed value.
pCtx	Pointer to the IppsPRNGState context being intialized.

Description

This function is declared in the `ippcp.h` file. The function initializes the memory pointed by *pCtx* as the `IppsPRNGState` context. In addition, the function sets up the default internal random generator parameters (seed, entropy augment, modulus, and initial hash value H0 of the SHA-1 algorithm). PRNG default parameters are as follows:

- seed =0x0
- entropy augment =0x0
- modulus =0xFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF
- H0 =*0x*C3D2E1F01032547698BADCFEEFCDAB8967452301

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if *seedBits* is less than 1 or greater than 512.

PRNGSetSeed

Sets up the seed value for the pseudorandom number generator.

Syntax

```
IppStatus ippsPRNGSetSeed(const IppsBigNumState* pSeed, IppsPRNGState* pCtx);
```

Parameters

pSeed	Pointer to the seed value being set up.
pCtx	Pointer to the `IppsPRNGState` context.

Description

This function is declared in the `ippcp.h` file. The function resets the seed value with the supplied value of *seedBits* bit length. The supplied big number should be created prior to the function call using the appropriate Big Number Arithmetic functions (see Example 5-1).

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

NOTE. This function restarts the pseudorandom number generation process, which results in losing already generated pseudorandom numbers.

PRNGSetAugment

Sets the initial state with the given input entropy for the pseudorandom number generation.

Syntax

```
IppsStatus ippsPRNGSetAugment(const IppsBigNumState* pAugment, IppsPRNGState* pCtx);
```

Parameters

pAugment	Pointer to the entropy augment value being set up.
pCtx	Pointer to the IppsPRNGState context.

Description

This function is declared in the ippcp.h file. The function resets entropy augment value with the supplied value of the *seedBits* bit length. The supplied big number should be created prior to the function call using the appropriate Big Number Arithmetic functions (see Example 5-1).

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

PRNGSetModulus

Sets the initial state with the given input modulus for the pseudorandom number generation.

Syntax

```
IppStatus ippsPRNGSetModulus(const IppsBigNumState* pModulus, IppsPRNGState* pCtx);
```

Parameters

pModulus	Pointer to the modulus value being set up.
pCtx	Pointer to the `IppsPRNGState` context.

Description

This function is declared in the `ippcp.h` file. The function resets the modulus value with the supplied value up to 160 bit length. The supplied big number should be created prior to the function call using the appropriate Big Number Arithmetic functions (see Example 5-1).

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

PRNGSetH0

Sets the initial state with the given input IV for the SHA-1 algorithm.

Syntax

```
IppStatus ippsPRNGSetH0(const IppsBigNumState* pH0, IppsPRNGState* pCtx);
```

Parameters

pH0	Pointer to the initial hash value being set up.

pCtx	Pointer to the IppsPRNGState context.

Description

This function is declared in the ippcp.h file. The function resets the initial hash value with the supplied value up to 160 bit length. The supplied big number should be created prior to the function call using the appropriate Big Number Arithmetic functions (see Example 5-1).

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

PRNGen

Generates a pseudorandom unsigned Big Number of the specified bitlength.

Syntax

```
IppStatus ippsPRNGen(Ipp32u* pRandBNU, int nBits, void* pCtx);
```

Parameters

pRandBNU	Pointer to the output pseudorandom unsigned integer big number.
nBits	Number of the generated pseudorandom bit.
pCtx	Pointer to the IppsPRNGState context.

Description

This function is declared in the ippcp.h file. The function generates pseudorandom unsigned integer big number of the specified *nBits* length.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.

ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsLengthErr	Indicates an error condition if *nBits* is less than 1.

PRNGen_BN

Generates a pseudorandom positive Big Number of the specified bitlength.

Syntax

```
IppStatus ippsPRNGen_BN(IppsBigNumState* pRandBN, int nBits, void* pCtx);
```

Parameters

pRandBN	Pointer to the output pseudorandom Big Number.
nBits	Number of the generated pseudorandom bit.
pCtx	Pointer to the IppsPRNGState context.

Description

This function is declared in the ippcp.h file. The function generates pseudorandom positive Big Number of the specified *nBits* length.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsLengthErr	Indicates an error condition if *nBits* is less than 1.

Example of Using Pseudorandom Number Generation Functions

Example 5-6 Find Pseudorandom Co-primes

```
void FindCoPrimes(void){
   int size;

   // define Pseudo Random Generator (default settings)
   ippsPRNGGetSize(&size);
   IppsPRNGState* pPrng = (IppsPRNGState*)(new Ipp8u [size] );
   ippsPRNGInit(160, pPrng);

   // define 256-bits Big Numbers X and Y
   const int bnBitSize = 256;
   IppsBigNumState* bnX = New_BN(bnBitSize/32);
   IppsBigNumState* bnY = New_BN(bnBitSize/32);

   // define temporary Big Numbers GCD and 1
   IppsBigNumState* bnGCD = New_BN(bnBitSize/32);
   Ipp32u one = 1;
   IppsBigNumState* bnOne = New_BN(1, &one);


   // generate pseudo random X and Y
   // while GCD(X,Y) != 1
   Ipp32u result;
   int counter;
   for(counter=0,result=1; result; counter++) {
      ippsPRNGen_BN(bnX, bnBitSize, pPrng);
```

```
        ippsPRNGen_BN(bnY, bnBitSize, pPrng);
        ippsGcd_BN(bnX, bnY, bnGCD);
        ippsCmp_BN(bnGCD, bnOne, &result);
    }

    cout <<"Coprimes:" <<endl;
    Type_BN("X: ", bnX); cout <<endl;
    Type_BN("Y: ", bnY); cout <<endl;
    cout <<"were fond on " <<counter <<" attempt" <<endl;

    delete [] (Ipp8u*)pPrng;
    delete [] (Ipp8u*)bnX;
    delete [] (Ipp8u*)bnY;
    delete [] (Ipp8u*)bnGCD;
    delete [] (Ipp8u*)bnOne;
}
```

Prime Number Generation Functions

This section introduces Intel® Integrated Performance Primitives (Intel® IPP) functions for prime number generation.

The full list of prime number generation functions is given in Table 5-4.

Table 5-4 Intel IPP Prime Number Generation Functions

Function Base Name	Operation
PrimeGetSize	Gets the size of the IppsPrimeState context.
PrimeInit	Initializes user-supplied memory as the IppsPrimeState context for future use.
PrimeGen	Generates a random probable prime number of the specified bitlength.
PrimeTest	Tests the given integer for being a probable prime.
PrimeSet	Sets the Big Number for primality testing.

Function Base Name	Operation
PrimeSet_BN	Sets the Big Number for primality testing.
PrimeGet	Extracts the probable prime unsigned integer big number.
PrimeGet_BN	Extracts the probable prime positive Big Number.

This section describes Intel IPP functions for generating probable prime numbers of variable lengths and validating probable prime numbers through a probabilistic primality test scheme for cryptographic use. A probable prime number is thus defined as an integer that passes the Miller-Rabin probabilistic primality-based test.

The scheme adopted for the probable prime number generation is based on a well-known prime number theorem. Study shows that the number of primitives that are no greater than the given large integer x is closely approximated by the expression. Let denote the number of primes that are not greater than x. In this case the statement is true

$$\lim_{x \to \infty} \frac{\pi(x)}{x / (\ln x)} = 1 .$$

Further study indicates that if X represents the event where the tested k-bit integer n is composite and if Y_t denotes the event where the Miller-Rabin test with the security parameter t declares n to be a prime, the test error probability is upper bounded by

$$p_{k,\,t} \le k^{2/3} 2^{t-1/2} t 4^{2-\sqrt{tk}} \text{ for } t = 2,\ k \ge 88, \text{ or } 3 \le t \le k/9,\ k \ge 21 .$$

Subsequently, a practical strategy for generating a random k-bit probable prime is to repeatedly pick k-bit random odd integers until finding one integer that can pass a recognized probabilistic primality test scheme as a probable prime. The available set of probable prime number generation functions enables you to specify an appropriate value of the security parameter t used in the Miller-Rabin primality test to meet the cryptographic requirements for your application.

All Intel IPP for prime number generation use the context IppsPrimeState as an operational vehicle that carries the bitlength of the target probable prime number, the structure capturing the state of the pseudorandom number generation, the structuralized working buffer used for Montgomery modular computation in the Miller-Rabin primality test, and the buffer to store the generated probable prime number.

The following sequence of operations is required to generate a probable prime number of the specified bitlength:

1. Call the function PrimeGetSize to get the size required to configure the IppsPrimeState context.
2. Allocate memory through the operating system memory allocation function and configure the IppsPrimeState *context* by calling the function PrimeInit.
3. Generate probable prime number of the specified bitlength by calling the function PrimeGen. If the returned IppStatus is ippStsInsufficientEntropy, then change the parameters of the pseudorandom generator and call the function PrimeGen again.
4. Extract the generated probable prime number by calling the functions PrimeGet and PrimeGet_BN.
5. Free the memory allocated to the IppsPrimeState context by calling the operating system memory-free service function.

PrimeGetSize

Gets the size of the IppsPrimeState *context in bytes.*

Syntax

```
IppStatus ippsPrimeGetSize(int nMaxBits, int* pSize);
```

Parameters

nMaxBits	Maximum length of the probable prime number in bits.
pSize	Pointer to the IppsPrimeState context size in bytes.

Description

This function is declared in the ippcp.h file. The function gets the IppsPrimeState context size in bytes and stores it in *pSize*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *nMaxBits* is less than 1.

PrimeInit

Initializes user-supplied memory as `IppsPrimeState` *context for future use.*

Syntax

```
IppStatus ippsPrimeInit(int nMaxBits, IppsPrimeState* pCtx);
```

Parameters

nMaxBits	Maximum length of the probable prime number in bits.
pCtx	Pointer to the `IppsPrimeState` context being initialized.

Description

This function is declared in the `ippcp.h` file. The function initializes the memory pointed by *pCtx* as the `IppsPrimeState` context.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if *nMaxBits* is less than 1.

PrimeGen

Generates a random probable prime number of the specified bitlength.

Syntax

```
IppStatus ippsPrimeGen(int nBits, int nTrials, IppsPrimeState* pCtx,
IppBitSupplier rndFunc, void* pRndParam);
```

Parameters

nbits	Target bitlength for the desired probable prime number.

nTrials	Security parameter specified for the Miller-Rabin probable primality.
pCtx	Pointer to the IppsPrimeState context.
rndFunc	Specified Random Generator.
pRndParam	Pointer to the Random Generator context.

Description

This function is declared in the ippcp.h file. The function employs the rndFuncRandom Generator specified by the user to generate a random probable prime number of the specified *nBits* length. The generated probable prime number is further validated by the Miller-Rabin primality test scheme with the specified security parameter *nTrials*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsLengthErr	Indicates an error condition if *nBits* is less than 1.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsBadArgErr	Indicates an error condition if *nTrials* is less than 1.
ippStsOutOfRangeErr	Indicates an error condition if *nBits* > *nMaxBits* (see PrimeGetSize and PrimeInit)
ippStsInsufficientEntropy	Indicates a warning condition if prime generation fails due to poor choice of entropy.

PrimeTest

Tests the given integer for being a probable prime.

Syntax

```
IppStatus ippsPrimeTest(int nTrials, Ipp32u *pResult, IppsPrimeState* pCtx,
IppBitSupplier rndFunc, void* pRndParam);
```

Parameters

nTrials	Security parameter specified for the Miller-Rabin probable primality.
pResult	Pointer to the result of the primality test.
pCtx	Pointer to the IppsPrimeState context.
rndFunc	Specified Random Generator.
pRndParam	Pointer to the Random Generator context.

Description

This function is declared in the ippcp.h file. The function uses the Miller-Rabin probabilistic primality test scheme with the given security parameter to test if the given integer is a probable prime. The pseudorandom number used in the Miller-Rabin test is generated by the specified rndFunc Random Generator. The function sets up the **pResult* as IS_PRIME or IS_COMPOSITE to show if the input probable prime passes the Miller-Rabin test.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsBadArgErr	Indicates an error condition if *nTrials* is less than 1.

PrimeSet

Sets the Big Number for primality testing.

Syntax

```
IppStatus ippsPrimeSet(const Ipp32u* pBNU, int nBits, IppsPrimeState* pCtx);
```

Parameters

pBNU	Pointer to the unsigned integer big number.
nBits	Unsigned integer big number length in bits.
pCtx	Pointer to the IppsPrimeState context.

Description

This function is declared in the `ippcp.h` file. The function sets a probable prime number and its length for the probabilistic primality test.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if *`nBits`* is less than 1.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.
`ippStsOutOfRangeErr`	Indicates an error condition if *`nBits`* is too large to fit *`pCtx`*.

PrimeSet_BN

Sets the Big Number for primality testing.

Syntax

```
IppStatus ippsPrimeSet_BN(const IppsBigNumState* pBN, IppsPrimeState* pCtx);
```

Parameters

`pBN`	Pointer to the Big Number context.
`pCtx`	Pointer to the `IppsPrimeState` context.

Description

This function is declared in the `ippcp.h` file. The function sets the Big Number for probabilistic primality test.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

ippStsOutOfRangeErr	Indicates an error condition if the Big Number is too large to fit *pCtx*.

PrimeGet

Extracts the probable prime unsigned integer big number.

Syntax

```
IppStatus ippsPrimeGet(Ipp32u* pBNU, int *pSize, const IppsPrimeState *pCtx);
```

Parameters

pBNU	Pointer to the unsigned integer big number.
pSize	Pointer to the length of the unsinged integer big number.
p	Pointer to the IppsPrimeState context.

Description

This function is declared in the ippcp.h file. The function extracts the probable prime number from **pCtx* context and stores it into the specified unsigned integer big number.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

PrimeGet_BN

Extracts the probable prime positive Big Number.

Syntax

```
IppStatus IppsPrimeGet_BN(IppsBigNumState* pBN, const IppsPrimeState *pCtx);
```

Parameters

pBN	Pointer to the Big NUmber context.
pCtx	Pointer to the IppsPrimeState context.

Description

This function is declared in the ippcp.h file. The function extracts the probable prime positive big number from the **pCtx* context and stores it into the specified Big Number context.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsOutOfRangeErr	Indicates an error condition if the Big Number is too small to store probable prime number.

Example of Using Prime Number Generation Functions

Example 5-7 Check Primality

```
void CheckPrime(void){
   Ipp32u result;
   int size;

   // define 256-bit Prime Generator
   int maxBitSize = 256;
   ippsPrimeGetSize(maxBitSize, &size);
   IppsPrimeState* pPrimeGen = (IppsPrimeState*)( new Ipp8u [size] );
   ippsPrimeInit(maxBitSize, pPrimeGen);

   // define Pseudo Random Generator (default settings)
   ippsPRNGGetSize(&size);
   IppsPRNGState* pPrng = (IppsPRNGState*)(new Ipp8u [size] );
   ippsPRNGInit(160, pPrng);

   // define known prime value (2^128 -3)/76439
   Ipp32u bnuPrime1[] = {
      0xBEAD208B, 0x5E668076, 0x2ABF62E3, 0xDB7C};
   IppsBigNumState* bnP1 = New_BN(4, bnuPrime1);
   // make sure P1 is really prime
   ippsPrimeSet_BN(bnP1, pPrimeGen);
   ippsPrimeTest(50, &result, pPrimeGen,
                 ippsPRNGen, pPrng);
   IS_PRIME==result?
      cout <<"Primality of P1 is confirmed\n" :
```

```
   cout <<"Primality of P1 isn't confirmed\n";


   // define another known prime value 2^128 -2^97 -1
Ipp32u bnuPrime2[] = {
   0xFFFFFFFF, 0xFFFFFFFF, 0xFFFFFFFF, 0xFFFFFFFD};
IppsBigNumState* bnP2 = New_BN(4, bnuPrime2);
// make sure P2 is really prime
ippsPrimeSet_BN(bnP2, pPrimeGen);
ippsPrimeTest(50, &result, pPrimeGen,
              ippsPRNGen, pPrng);
IS_PRIME==result?
   cout <<"Primality of P2 is confirmed\n" :
   cout <<"Primality of P2 isn't confirmed\n";

// define composite Big Number C = P1*P2
IppsBigNumState* bnC = New_BN(8);
ippsMul_BN(bnP1, bnP2, bnC);
// make sure C is really composite
ippsPrimeSet_BN(bnC, pPrimeGen);
ippsPrimeTest(50, &result, pPrimeGen,
              ippsPRNGen, pPrng);
IS_PRIME==result?
   cout <<"Strange, but C=P1*P2 is prime\n" :
   cout <<"OK, C=P1*P2 is composite\n";

delete [] (Ipp8u*)pPrimeGen;
delete [] (Ipp8u*)pPrng;
```

```
    delete [] (Ipp8u*)bnP1;
    delete [] (Ipp8u*)bnP2;
    delete [] (Ipp8u*)bnC;
}
```

RSA Algorithm Functions

This section introduces Intel® Integrated Performance Primitives (Intel® IPP) functions for RSA algorithm. The section describes a set of primitives to perform operations required for RSA cryptographic systems [PKCS 1.2.1]. This set of primitives offers a flexible user interface that enables the RSA crypto key size scalability with the limit of up to 4096 bits.

RSA algorithm functions include:

- Functions for Building RSA System, the system being then used by functions listed below.
- RSA Primitives, which perform RSA encryption and decryption.
- RSA Encryption Schemes and RSA Signature Schemes, which combine RSA cryptographic primitives with other techniques, such as computing hash message digests or applying mask generation functions (MGFs), to achieve a particular security goal.

Functions for Building RSA System

The list of functions for building RSA cryptographic system is given in Table 5-5.

Table 5-5 Intel IPP RSA Algorithm Functions

Function Base Name	Operation
RSAGGetSize	Gets the size of the IppRSAState context.
RSAInit	Initializes user-supplied memory as the IppRSAState context for future use.
RSASetKey	Sets the tag-designated key component into the established RSA context.
RSAGetKey	Extracts the tag-designated key component from the RSA context.
RSAGenerate	Generates key components for the desired RSA cryptographic system.
RSAValidate	Validates key components of the RSA cryptographic system.

You can use the primitives to build an RSA cryptographic system with the supplied randomized seed and stimulus. The function RSAGenerate generates the RSA system probable primes p and q, the system composite integer n, as well as the key pair, the RSA public key e and its respective private key d.

RSA Primitives and RSA-based schemes (RSA-OAEP Scheme Functions and RSA-SSA Scheme Functions) use IppsRSAState context, which is initialized using the RSAInit function, as an operational vehicle carrying the RSA system composite integer, a pair of RSA probable primes, RSA key pair, and working buffers.

RSAGetSize

Gets the size of the IppsRSAState *context.*

Syntax

```
IppStatus ippsRSAGetSize(int nBitsN, int nBitsP, IppRSAKeyType flag, int* pSize);
```

Parameters

nBitsN	Length of the RSA system in bits (that is, the length of the composite RSA modulus n in bits).
nBitsP	Length in bits of the largest of two prime factors of the RSA modulus.
flag	The flag indicating RSA system for encryption or decryption operation.
pSize	Pointer to the IppsRSAState context size in bytes.

Description

This function is declared in the ippcp.h file. The function gets the IppsRSAState context size in bytes and stores it in **pSize*. Use the *flag* == IppRSApublic to establish RSA for encryption or *flag* == IppRSAprivate to establish RSA for the decryption operation. Refer to RSA-OAEP Scheme Functions and RSA-SSA Scheme Functions on which *flag* value to select for the schemes.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsNotSupportedModeErr	Indicates an error condition if *nBitsN* < 32 or *nBitsN* > 4096.
ippStsBadArgErr	Indicates an error condition if (*nBitsP* ≥ *nBitsN*) or (*2*nBitsP* < *nBitsN*) or *flag* value is illegal.

RSAInit

Initializes user-supplied memory as the `IppsRSAState` *context for future use.*

Syntax

```
IppStatus ippsRSAInit(int nBitsN, int nBitsP, IppRSAKeyType flag,
IppsRSAState* pCtx);
```

Parameters

nBitsN	Length of the RSA system in bits (that is, the length of the composite RSA modulus n in bits)
nBitsP	Length in bits of the largest of two prime factors of the RSA modulus.
flag	The flag indicating RSA system for encryption or decryption operation.
pCtx	Pointer to the `IppsRSAState` context being initialized.

Description

This function is declared in the `ippcp.h` file. The function initializes the memory pointed by *pCtx* as the `IppsRSAState` context. Use the *flag* == `IppRSApublic` to initialize RSA context for encryption or *flag* == `IppRSAprivate` to initialize RSA context for the decryption operation. Refer to RSA-OAEP Scheme Functions and RSA-SSA Scheme Functions on which *flag* value to select for the schemes.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsNotSupportedModeErr`	Indicates an error condition if *nBitsN* < 32 or *nBitsN* > 4096.
`ippStsBadArgErr`	Indicates an error condition if *nBitsN* > *nBitsP* or illegal *flag* value.

RSASetKey

Sets the tag-designated key component into the established RSA context.

Syntax

```
IppStatus ippsRSASetKey(const IppsBigNumState* pBN, IppsRSAKeyTag tag,
IppsRSAState* pCtx);
```

Parameters

pBN	Pointer to the Big Number context presented by key component.
tag	The tag of the key component being set up.
pCtx	Pointer to the `IppsRSAState` context.

Description

This function is declared in the `ippcp.h` file. The function sets the key specified by *pBN* to the tag-designated component of the `IppRSAState` context:

- *tag* == `IppRSAkeyN`, the function sets up the RSA composite integer *n*
- *tag* == `IppRSAkeyP`, the function sets up the RSA prime factor *p*
- *tag* == `IppRSAkeyQ`, the function sets up the RSA prime factor *q*
- *tag* == `IppRSAkeyE`, the function sets up the RSA public exponent *e*
- *tag* == `IppRSAkeyD`, the function sets up the RSA public exponent *d*
- *tag* == `IppRSAkeyDp`, the function sets up the RSA CRT exponent *dP* of the p-th factor
- *tag* == `IppRSAkeyDq`, the function sets up the RSA CRT exponent *dQ* of the q-th factor
- *tag* == `IppRSAkeyQinv`, the function sets up the RSA CRT coefficient *qInv*.

The values of *p*, *q*, *dP*, *dQ*, *qInv*, and *e* must meet the following equations:

$e*dP = 1 \bmod (p - 1)$

$e*dQ = 1 \bmod (q - 1)$

$q*qInv = 1 \bmod p$.

The sequence of function calls

```
ippsRSASetKey(pBN_E, IppRSAkeyE, pRSActx);
ippsRSASetKey(pBN_N, IppRSAkeyN, pRSActx);
```

defines the public key of the RSA cryptosystem.

The sequence of function calls

```
ippsRSASetKey(pBN_D, IppRSAkeyD, pRSActx);
ippsRSASetKey(pBN_N, IppRSAkeyN, pRSActx);
```

defines the RSA private key with its type 1 representation.

The sequence of function calls

```
ippsRSASetKey(pBN_P, IppRSAkeyP, pRSActx);
ippsRSASetKey(pBN_Q, IppRSAkeyQ, pRSActx);
ippsRSASetKey(pBN_dP, IppRSAkeyDp, pRSActx);
ippsRSASetKey(pBN_dQ, IppRSAkeyDq, pRSActx);
ippsRSASetKey(pBN_qInv, IppRSAkeyQinv, pRSActx);
```

defines the RSA private key with its type 2 representation.

Representation types for a private key of an RSA cryptosystem are defined in [PKCS 1.2.1].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsLengthErr`	Indicates an error condition if the length of the Big Number specified by *pBN* is less than 1.
`ippStsBadArgErr`	Indicates an error condition if some of the arguments are invalid: Big Number specified by *pBN* is negative, key component specified by *tag* does not match the RSA context.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.
`ippStsOutOfRangeErr`	Indicates an error condition if the length of the Big Number specified by *pBN* is too big to be stored in the `IppsRSAState` context.

RSAGetKey

Extracts the tag-designated key component from the RSA context.

Syntax

```
IppStatus ippsRSAGetKey(IppsBigNumState* pBN, IppsRSAKeyTag tag, IppsRSAState* pCtx);
```

Parameters

pBN	Pointer to the output Big Number context.
tag	The tag of the key component being extracted from.
pCtx	Pointer to the `IppsRSAState` context.

Description

This function is declared in the `ippcp.h` file. The function extracts the tag-designated key component from the **pCtx* RSA context and stores it in the specified **pBN* Big Number context:

- *tag* == `IppRSAkeyN`, the function extracts the RSA composite integer *n*
- *tag* == `IppRSAkeyP`, the function extracts the RSA prime factor *p*
- *tag* == `IppRSAkeyQ`, the function extracts the RSA prime factor *q*
- *tag* == `IppRSAkeyE`, the function extracts the RSA public exponent *e*
- *tag* == `IppRSAkeyD`, the function extracts the RSA public exponent *d*
- *tag* == `IppRSAkeyDp`, the function extracts the RSA CRT exponent *dP* of the p-th factor
- *tag* == `IppRSAkeyDq`, the function extracts the RSA CRT exponent *dQ* of the q-th factor
- *tag* == `IppRSAkeyQinv`, the function extracts the RSA CRT coefficient *qInv*.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsBadArgErr`	Indicates an error condition if the key component speicified by tag does not match the RSA context.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

ippStsOutOfRangeErr	Indicates an error condition if the length of the Big Number specified by *pBN* is too small to be stored as a key component.

RSAGenerate

Generates key components for the desired RSA cryptographic system.

Syntax

```
IppStatus ippsRSAGenerate(IppsBigNumState* pE, int nBitsN, int nBitsP, int nTrials, IppsRSAState* pCtx, IppBitSupplier rndFunc, void* pRndParam);
```

Parameters

pE	Pointer to the IppsBigNumState context of the newly generated RSA public exponent key.
nBitsN	Length of the RSA system in bits (that is, the length of the composite RSA modulus *n* in bits)
nBitsP	Length in bits of one of the two prime factors of the RSA modulus.
nTrials	Security parameter specified for the Miller-Rabin probable primality
pCtx	Pointer to the IppsRSAState context.
rndFunc	Specified Random Generator
pRndParam	Pointer to the random Generator context.

Description

The function is declared in the ippcp.h file. This function generates the desired RSA cryptographic system based on:

- the input **pE* specifying the initial value for searching the RSA public exponent
- input parameters *nBitsN* and *nBitsP* specifying the bit lengths of the composite RSA modulus *n* and the largest RSA prime factor *p* respectively.

This function employs the specified *rndFunc* Random Generator to generate a random probable prime numbers *p* and *q*.

The function then computes the RSA composite modulus *n = (p*q)*, and the RSA private exponent *d*, and it further computes all other CRT-related RSA components.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsNotSupportedModeErr	Indicates an error condition if RSA context was initialized with the IppRSApublic flag.
ippStsBadArgErr	Indicates an error condition in cases not explicitly mentioned above.
ippStsInsufficientEntropy	Indicates a warning condition if prime generation fails due to poor choice of entropy.

RSAValidate

Validates key components of the RSA cryptographic system.

Syntax

```
IppStatus ippsRSAValidate(const IppsBigNumState* pE, int nTrials, Ipp32u*
pResult, IppsRSAState* pCtx, IppBitSuppler rndFunc, void* pRndParam);
```

Parameters

pE	Pointer to the IppsBigNumState context of the RSA public exponent.
nTrails	Security parameter specified for the Miller-Rabin probable primality.
pResult	Pointer to the result of validation.
pCtx	Pointer to the IppsRSAState context.
rndFunc	Specified Random Generator.
pRndParam	Pointer to the Random Generator context.

Description

This function is declared in the ippcp.h file. The function validates key components of the RSA cryptographic system and stores the result (IS_VALID_KEY or IS_INVALID_KEY) of the validation procedure in *pResult.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsBadArgErr	Indicates an error condition if *nBitsN* > *nBitsP* or *nTrials* < 1.
ippStsLengthErr	Indicates an error condition if the length of the Big Number specified by *pE* is less than 1.
ippStsOutOfRangeErr	Indicates an error condition if the length of the Big Number specified by *pE* is too big to be stored in the IppsRSAState context.

RSA Primitives

The list of RSA cryptographic primitives is given in Table 5-6.

Table 5-6 Intel IPP RSA Primitives

Function Base Name	Operation
RSAEncrypt	Performs the RSA encryption operation.
RSADecrypt	Performs the RSA decryption operation.

The application code for conducting a typical RSA encryption must perform the following sequence of operations, starting with building of a crypto system:

1. Call the function RSAGGetSize to get the size required to configure IppsRSAState context.
2. Ensure that the required memory space is properly allocated. With the allocated memory, call the RSAInit function to initialize the context for the RSA encryption.
3. Keep calling the RSASetKey to set up RSA public key (*n*, *e*).
4. Invoke the RSAEncrypt function with the established RSA public key to encode the plaintext into the respective ciphertext.
5. Free the memory allocated for the IppsRSAState context by calling the operating system memory free service function.

The typical application code for the RSA decryption must perform the following sequence of operations:

1. Call the function RSAGGetSize to get the size required to configure IppsRSAState context.
2. Ensure that the required memory space is properly allocated. With the allocated memory, call the RSAInit function to initialize the context for the RSA decryption.
3. Establish the RSA private key by means of either RSAGenerate function or by key setup function RSASetKey. The RSAGenerate function computes the private key *d* with respect to the generated public key e, as well as several other components for applying the CRT. When using RSASetKey, you have an option of presenting the private key either as a pair (*n*,*d*) or quantiple (*p*, *q*, *dP*, *dQ*, *qInv*).
4. Invoke the RSADecrypt function with the established RSA public key to decode the ciphertext into the respective plaintext.
5. Free the memory allocated for the IppsRSAState context by calling the operating system memory free service function.

RSAEncrypt

Performs the RSA encryption operation.

Syntax

```
IppStatus ippsRSAEncrypt(const IppsBigNumState* pX, IppsBigNumState* pY,
IppsRSAState* pCtx);
```

Parameters

pX	Ppointer to the IppsBigNumState context of the plaintext.
pY	Pointer to the IppsBigNumState context of the ciphertext.
pCtx	Pointer to the IppsRSAState context.

Description

This function is declared in the ippcp.h file. The function performs the RSA encryption operation.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsInvalidCryptoKeyErr	Indicates an error condition if the RSA context has not been properly set up for the operation.
ippStsOutOfRangeErr	Indicates an error condition if: length of the Big Number specified by *pX* is too big length of the Big Number specified by *pY* is too small.

RSADecrypt

Performs the RSA decryption operation.

Syntax

```
IppStatus ippsRSADecrypt(IppsBigNumState* pX, IppsBigNumState* pY,
IppsRSAState* pCtx);
```

Parameters

pX	Ppointer to the IppsBigNumState context of the ciphertext.
pY	Pointer to the IppsBigNumState context of the plaintext.
pCtx	Pointer to the IppsRSAState context.

Description

This function is declared in the ippcp.h file. The function performs the RSA encryption operation.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsInvalidCryptoKeyErr	Indicates an error condition if the RSA context has not been properly set up for the operation.

`ippStsOutOfRangeErr`	Indicates an error condition if: length of the Big Number specified by *pX* is too big or length of the Big Number specified by *pY* is too small.

The example below illustrates the use of RSA primitives. The example uses the `BigNumber` class and functions creating some cryptographic contexts, whose source code can be found in Appendix Support Functions and Classes.

Example of Using RSA Primitive Functions

Example 5-8 Use of RSA Primitives

```
static Ipp32u dataN[] = {
   0x091DBDCB,0x46F8E5FD,
   0xCA2A8F59,0xE2537298,0xF6C1687F,0x527A9A41,0x7B61A51F,0xE0AAB12D,
   0x4598394E,0x8834B245,0x06095374,0xEE6A649D,0xD93A2584,0x3EE6B4B7,
   0xDFC73772,0xAFB8E0A3,0x5B8B807F,0x19719D8A,0x60E1EC46,0x76ED520D,
   0xEB6FCD48,0x61EA48CE,0x035C02AB,0xB8DFBAAF,0x7454F51F,0x40D6B6F0,
   0xD41043A4,0x368D07EE,0x9DA871F7,0x2338AC2B,0x0682CE9C,0xBBF82F09
};
static Ipp32u dataP[] = {
   0x58FB6599,0x7541BA2A,0x459D1F39,0x5B252176,
   0xAA040A2D,0x7E28FAE7,0x6E5D1E3B,0x124EF023,0x3D84F632,0x93B81A9E,
   0xAEF4FDA4,0x99EB9F44,0xA1B56001,0x08810B10,0xB1B9B3C9,0xEECFAE81
};
static Ipp32u dataQ[] = {
   0xAF461503,0xA441E700,0x4D0416A5,0xCE335252,
   0x3204B5CF,0xEA0DA3B4,0x66B42E92,0x9840B416,0x028B9D86,0x5A0F2035,
   0x8866B1D0,0x3F6C42D0,0xAAD1D935,0x341233EA,0x27F453F6,0xC97FB1F0
};
static Ipp32u dataE[] = {0x11};



   int RSA_sample(void)
{
   BigNumber P(dataP, sizeof(dataP)/sizeof(dataP[0]));
   BigNumber Q(dataQ, sizeof(dataQ)/sizeof(dataQ[0]));
```

```
   BigNumber N = P*Q;
   BigNumber E(dataE, sizeof(dataE)/sizeof(dataE[0]));
   IppsRSAState* pRSApub  = newRSA(N.BitSize(), P.BitSize(), IppRSApublic);
   IppsRSAState* pRSAprv1 = newRSA(N.BitSize(), P.BitSize(), IppRSAprivate);
   IppsRSAState* pRSAprv2 = newRSA(N.BitSize(), P.BitSize(), IppRSAprivate);

   // compute private key
   BigNumber phi = (P-BigNumber(1))*(Q-BigNumber(1));
   BigNumber D = phi.InverseMul(E);

   // set up public RSA (N,E)
   ippsRSASetKey(N, IppRSAkeyN, pRSApub);
   ippsRSASetKey(E, IppRSAkeyE, pRSApub);

   // set up private (no CRT) RSA (N, D)
   ippsRSASetKey(N, IppRSAkeyN, pRSAprv1);
   ippsRSASetKey(D, IppRSAkeyD, pRSAprv1);

   // set up private (CRT) RSA (P,Q,D)
   ippsRSASetKey(P, IppRSAkeyP, pRSAprv2);
   ippsRSASetKey(Q, IppRSAkeyQ, pRSAprv2);
   ippsRSASetKey(D, IppRSAkeyD, pRSAprv2);

   // validate RSA
   IppsPRNGState* pRand = newPRNG();
   Ipp32u result;
   ippsRSAValidate(E, 50, &result, pRSAprv2, ippsPRNGen, pRand);
   if(IS_VALID_KEY!=result)
{
```

```
   cout <<"validation fail" <<endl;
   return 0;
}
// validation pass

// planetext
Ipp32u dataM[] = {
   0x4D353E2D,0xD2F1B76D,
   0x5281CE32,0x7BC27519,0x2F3AC14F,0x0448DB97,0xD095AEB4,0x82FB3E87,
   0x1BE392F9,0x43581159,0xD5024121,0xB48D2869,0x2BAAD29A,0xA1B7C136,
   0xF47728B4,0x4CDCFE4F,0x839A2DDB,0xFF8AE10E,0x25C9C2B3,0xF93EDCFB,
   0x4626F5AF,0xD7E0B2C0,0xB4251F84,0xC31B2E8B,0xA8F55267,0x5C68F1EE,
   0x26DCD87D,0xCA82310B,0x504B45E2,0x6350E329,0xACE9E300,0x00EB7A19
};
BigNumber M(dataM,sizeof(dataM)/sizeof(dataM[0]));

// encrypt planetext
BigNumber C(0,N.DwordSize());
ippsRSAEncrypt(M, C, pRSApub);

// decrypt ciphertext using pRSAprv1
BigNumber Z1(0,N.DwordSize());
ippsRSADecrypt(C, Z1, pRSAprv1);


// decrypt ciphertext using pRSAprv2
BigNumber Z2(0,N.DwordSize());
ippsRSADecrypt(C, Z2, pRSAprv2);
```

```
    deleteRSA(pRSApub);
    deleteRSA(pRSAprv1);
    deleteRSA(pRSAprv2);

    return (M==Z1) && (M==Z2);
}
```

RSA Encryption Schemes

This subsection describes functions implementing RSA-based encryption schemes.

RSA-OAEP Scheme Functions

This subsection describes functions implementing RSA-OAEP encryption scheme, featured in [PKCS 1.2.1].

The full list of these functions is given in Table 5-7.

Table 5-7 Intel IPP RSA-based Encryption Scheme Functions

Function Base Name	Operation
RSAOAEPEncrypt	Carries out the RSA-OAEP encryption scheme.
RSAOAEPEncrypt_MD5	MD5-based helper of the RSA-OAEP encryption scheme.
RSAOAEPEncrypt_SHA1	SHA-1-based helper of the RSA-OAEP encryption scheme.
RSAOAEPEncrypt_SHA224	SHA-224-based helper of the RSA-OAEP encryption scheme.
RSAOAEPEncrypt_SHA256	SHA-256-based helper of the RSA-OAEP encryption scheme.
RSAOAEPEncrypt_SHA384	SHA-384-based helper of the RSA-OAEP encryption scheme.
RSAOAEPEncrypt_SHA512	SHA-512-based helper of the RSA-OAEP encryption scheme.
RSAOAEPDecrypt	Carries out the RSA-OAEP decryption scheme.
RSAOAEPDecrypt_MD5	MD5-based helper of the RSA-OAEP decryption scheme.
RSAOAEPDecrypt_SHA1	SHA-1-based helper of the RSA-OAEP decryption scheme.
RSAOAEPDecrypt_SHA224	SHA-224-based helper of the RSA-OAEP decryption scheme.
RSAOAEPDecrypt_SHA256	SHA-256-based helper of the RSA-OAEP decryption scheme.
RSAOAEPDecrypt_SHA384	SHA-384-based helper of the RSA-OAEP decryption scheme.
RSAOAEPDecrypt_SHA512	SHA-512-based helper of the RSA-OAEP decryption scheme.

To invoke a function that carries out RSA-OAEP scheme, the IppsRSAState context must be initialized (by the RSAInit function) with a proper value of the *flag* parameter:

- For the RSA-OAEP encryption scheme, *flag* == IppRSApublic
- For the RSA-OAEP decryption scheme, *flag* == IppRSAprivate.

RSAOAEPEncrypt

Carries out the RSA-OAEP encryption scheme.

Syntax

```
IppStatus ippsRSAOAEPEncrypt(const Ipp8u* pSrc, int srcLen, const Ipp8u*
pLabel, int labLen, const Ipp8u* pSeed, Ipp8u* pDst, IppsRSAState* pCtx,
IppHash hushFunc, int hashLen, IppMGF mgfFunc);
```

Parameters

pSrc	Pointer to the octet message to be encrypted.
srcLen	Length of the message to be encrypted.
pLabel	Pointer to the optional label to be associated with the message.
labLen	Length of the optional label.
pSeed	Pointer to the random octet string of length *hashLen*.
pDst	Pointer to the output octet ciphertext string.
pCtx	Pointer to the properly initialized IppsRSAState context.
hashFunc	Hash function, which meets the General Definition of a Hash Function provided in chapter 3.
hashLen	Length of the hash function output, in octets.
mgfFunc	Mask generation function (MGF), which meets the definition provided in section User's Implementation of a Mask Generation Function in chapter 3.

Description

This function is declared in the ippcp.h file. The function carries out the RSA-OAEP encryption scheme, defined in [PKCS 1.2.1].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsInvalidCryptoKeyErr	Indicates an error condition if the RSA context has not been properly set up for the operation.
ippStsLengthErr	Indicates an error condition if the input length parameters do not meet any of the following conditions: *srcLen* > 0 *srcLen* > *N* - 2**hashLen* - 2, where *N* is the length of the RSA modulus in octets, *labLen* > 0, *hashLen* > 0.

RSAOAEPEncrypt_MD5

Carries out the RSA-OAEP encryption scheme using MD5 hash algorithm.

Syntax

```
IppStatus ippsRSAOAEPEncrypt_MD5(const Ipp8u* pSrc, int srcLen, const Ipp8u*
pLabel, int labLen, const Ipp8u* pSeed, Ipp8u* pDst, IppsRSAState* pCtx);
```

Parameters

pSrc	Pointer to the octet message to be encrypted.
srcLen	Length of the message to be encrypted.
pLabel	Pointer to the optional label to be associated with the message.
labLen	Length of the optional label.

pSeed	Pointer to the random octet string of length *hashLen*, where *hashLen* is the length (in octets) of the hash message digest.
pDst	Pointer to the output octet ciphertext string.
pCtx	Pointer to the properly initialized IppsRSAState context.

Description

This function is declared in the ippcp.h file. The function uses MD5 hash function and MD5-based MGF implemented in Intel IPP to carry out the RSA-OAEP encryption scheme and thus is a specific form of the general RSAOAEPEncrypt function.

Return Values

The function may return any of the values that the general RSAOAEPEncrypt function returns.

RSAOAEPEncrypt_SHA1

Carries out the RSA-OAEP encryption scheme using SHA-1 hash algorithm.

Syntax

```
IppStatus ippsRSAOAEPEncrypt_SHA1(const Ipp8u* pSrc, int srcLen, const Ipp8u*
pLabel, int labLen, const Ipp8u* pSeed, Ipp8u* pDst, IppsRSAState* pCtx);
```

Parameters

pSrc	Pointer to the octet message to be encrypted.
srcLen	Length of the message to be encrypted.
pLabel	Pointer to the optional label to be associated with the message.
labLen	Length of the optional label.
pSeed	Pointer to the random octet string of length *hashLen*, where *hashLen* is the length (in octets) of the hash message digest.
pDst	Pointer to the output octet ciphertext string.

pCtx	Pointer to the properly initialized IppsRSAState context.

Description

This function is declared in the ippcp.h file. The function uses SHA-1 hash function and SHA-1-based MGF implemented in Intel IPP to carry out the RSA-OAEP encryption scheme and thus is a specific form of the general RSAOAEPEncrypt function.

Return Values

The function may return any of the values that the general RSAOAEPEncrypt function returns.

RSAOAEPEncrypt_SHA224

Carries out the RSA-OAEP encryption scheme using SHA-224 hash algorithm.

Syntax

```
IppStatus ippsRSAOAEPEncrypt_SHA224(const Ipp8u* pSrc, int srcLen, const Ipp8u* pLabel, int labLen, const Ipp8u* pSeed, Ipp8u* pDst, IppsRSAState* pCtx);
```

Parameters

pSrc	Pointer to the octet message to be encrypted.
srcLen	Length of the message to be encrypted.
pLabel	Pointer to the optional label to be associated with the message.
labLen	Length of the optional label.
pSeed	Pointer to the random octet string of length *hashLen*, where *hashLen* is the length (in octets) of the hash message digest.
pDst	Pointer to the output octet ciphertext string.
pCtx	Pointer to the properly initialized IppsRSAState context.

Description

This function is declared in the ippcp.h file. The function uses SHA-224 hash function and SHA-224-based MGF implemented in Intel IPP to carry out the RSA-OAEP encryption scheme and thus is a specific form of the general RSAOAEPEncrypt function.

Return Values

The function may return any of the values that the general RSAOAEPEncrypt function returns.

RSAOAEPEncrypt_SHA256

Carries out the RSA-OAEP encryption scheme using SHA-256 hash algorithm.

Syntax

```
IppStatus ippsRSAOAEPEncrypt_SHA256(const Ipp8u* pSrc, int srcLen, const Ipp8u* pLabel, int labLen, const Ipp8u* pSeed, Ipp8u* pDst, IppsRSAState* pCtx);
```

Parameters

pSrc	Pointer to the octet message to be encrypted.
srcLen	Length of the message to be encrypted.
pLabel	Pointer to the optional label to be associated with the message.
labLen	Length of the optional label.
pSeed	Pointer to the random octet string of length *hashLen*, where *hashLen* is the length (in octets) of the hash message digest.
pDst	Pointer to the output octet ciphertext string.
pCtx	Pointer to the properly initialized IppsRSAState context.

Description

This function is declared in the ippcp.h file. The function uses SHA-256 hash function and SHA-256-based MGF implemented in Intel IPP to carry out the RSA-OAEP encryption scheme and thus is a specific form of the general RSAOAEPEncrypt function.

Return Values

The function may return any of the values that the general `RSAOAEPEncrypt` function returns.

RSAOAEPEncrypt_SHA384

Carries out the RSA-OAEP encryption scheme using SHA-384 hash algorithm.

Syntax

```
IppStatus ippsRSAOAEPEncrypt_SHA384(const Ipp8u* pSrc, int srcLen, const Ipp8u* pLabel, int labLen, const Ipp8u* pSeed, Ipp8u* pDst, IppsRSAState* pCtx);
```

Parameters

pSrc	Pointer to the octet message to be encrypted.
srcLen	Length of the message to be encrypted.
pLabel	Pointer to the optional label to be associated with the message.
labLen	Length of the optional label.
pSeed	Pointer to the random octet string of length *hashLen*, where *hashLen* is the length (in octets) of the hash message digest.
pDst	Pointer to the output octet ciphertext string.
pCtx	Pointer to the properly initialized `IppsRSAState` context.

Description

This function is declared in the `ippcp.h` file. The function uses SHA-384 hash function and SHA-384-based MGF implemented in Intel IPP to carry out the RSA-OAEP encryption scheme and thus is a specific form of the general `RSAOAEPEncrypt` function.

Return Values

The function may return any of the values that the general `RSAOAEPEncrypt` function returns.

RSAOAEPEncrypt_SHA512

Carries out the RSA-OAEP encryption scheme using SHA-512 hash algorithm.

Syntax

```
IppStatus ippsRSAOAEPEncrypt_SHA512(const Ipp8u* pSrc, int srcLen, const Ipp8u* pLabel, int labLen, const Ipp8u* pSeed, Ipp8u* pDst, IppsRSAState* pCtx);
```

Parameters

pSrc	Pointer to the octet message to be encrypted.
srcLen	Length of the message to be encrypted.
pLabel	Pointer to the optional label to be associated with the message.
labLen	Length of the optional label.
pSeed	Pointer to the random octet string of length *hashLen*, where *hashLen* is the length (in octets) of the hash message digest.
pDst	Pointer to the output octet ciphertext string.
pCtx	Pointer to the properly initialized IppsRSAState context.

Description

This function is declared in the ippcp.h file. The function uses SHA-512 hash function and SHA-512-based MGF implemented in Intel IPP to carry out the RSA-OAEP encryption scheme and thus is a specific form of the general RSAOAEPEncrypt function.

Return Values

The function may return any of the values that the general RSAOAEPEncrypt function returns.

RSAOAEPDecrypt

Carries out the RSA-OAEP decryption scheme.

Syntax

```
IppStatus ippsRSAOAEPDecrypt(const Ipp8u* pSrc, const Ipp8u* pLabel, int labLen, Ipp8u* pDst, int* pDstLen, IppsRSAState* pCtx, IppHash hushFunc, int hashLen, IppMGF mgfFunc);
```

Parameters

pSrc	Pointer to the octet ciphertext to be decrypted.
pLabel	Pointer to the optional label to be associated with the message.
labLen	Length of the optional label.
pDst	Pointer to the output octet plaintext message.
pDstLen	Pointer to the length of the decrypted message.
pCtx	Pointer to the properly initialized `IppsRSAState` context.
hashFunc	Hash function, which meets the General Definition of a Hash Function provided in chapter 3.
hashLen	Length of the hash function output, in octets.
mgfFunc	Mask generation function (MGF), which meets the definition provided in section User's Implementation of a Mask Generation Function in chapter 3.

Description

This function is declared in the `ippcp.h file`. The function carries out the RSA-OAEP decryption scheme defined in [PKCS 1.2.1].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

ippStsInvalidCryptoKeyErr	Indicates an error condition if the RSA context has not been properly set up for the operation.
ippStsLengthErr	Indicates an error condition if the input length parameters do not meet any of the following conditions: *labLen* > 0, *hashLen* > 0, 2**hashLen* + 2 ≥ *N*, where *N* is the length of the RSA modulus in octets.

RSAOAEPDecrypt_MD5

Carries out the RSA-OAEP decryption scheme using MD5 hash algorithm.

Syntax

```
IppStatus ippsRSAOAEPDecrypt_MD5(const Ipp8u* pSrc, const Ipp8u* pLabel, int labLen, Ipp8u* pDst, int* pDstLen, IppsRSAState* pCtx);
```

Parameters

pSrc	Pointer to the octet ciphertext to be decrypted.
pLabel	Pointer to the optional label to be associated with the message.
labLen	Length of the optional label.
pDst	Pointer to the output octet plaintext message.
pDstLen	Pointer to the length of the decrypted message.
pCtx	Pointer to the properly initialized IppsRSAState context.

Description

This function is declared in the ippcp.h file. The function uses MD5 hash function and MD5-based MGF implemented in Intel IPP to carry out the RSA-OAEP decryption scheme and thus is a specific form of the general RSAOAEPDecrypt function.

Return Values

The function may return any of the values that the general `RSAOAEPDecrypt` function returns.

RSAOAEPDecrypt_SHA1

Carries out the RSA-OAEP decryption scheme using SHA-1 hash algorithm.

Syntax

```
IppStatus ippsRSAOAEPDecrypt_SHA1(const Ipp8u* pSrc, const Ipp8u* pLabel,
int labLen, Ipp8u* pDst, int* pDstLen, IppsRSAState* pCtx);
```

Parameters

pSrc	Pointer to the octet ciphertext to be decrypted.
pLabel	Pointer to the optional label to be associated with the message.
labLen	Length of the optional label.
pDst	Pointer to the output octet plaintext message.
pDstLen	Pointer to the length of the decrypted message.
pCtx	Pointer to the properly initialized `IppsRSAState` context.

Description

This function is declared in the `ippcp.h` file. The function uses SHA-1 hash function and SHA-1sbased MGF implemented in Intel IPP to carry out the RSA-OAEP decryption scheme and thus is a specific form of the general `RSAOAEPDecrypt` function.

Return Values

The function may return any of the values that the general `RSAOAEPDecrypt` function returns.

RSAOAEPDecrypt_SHA224

Carries out the RSA-OAEP decryption scheme using SHA-224 hash algorithm.

Syntax

```
IppStatus ippsRSAOAEPDecrypt_SHA224(const Ipp8u* pSrc, const Ipp8u* pLabel,
int labLen, Ipp8u* pDst, int* pDstLen, IppsRSAState* pCtx);
```

Parameters

pSrc	Pointer to the octet ciphertext to be decrypted.
pLabel	Pointer to the optional label to be associated with the message.
labLen	Length of the optional label.
pDst	Pointer to the output octet plaintext message.
pDstLen	Pointer to the length of the decrypted message.
pCtx	Pointer to the properly initialized `IppsRSAState` context.

Description

This function is declared in the `ippcp.h` file. The function uses SHA-224 hash function and SHA-224-based MGF implemented in Intel IPP to carry out the RSA-OAEP decryption scheme and thus is a specific form of the general `RSAOAEPDecrypt` function.

Return Values

The function may return any of the values that the general `RSAOAEPDecrypt` function returns.

RSAOAEPDecrypt_SHA256

Carries out the RSA-OAEP decryption scheme using SHA-256 hash algorithm.

Syntax

```
IppStatus ippsRSAOAEPDecrypt_SHA256(const Ipp8u* pSrc, const Ipp8u* pLabel,
int labLen, Ipp8u* pDst, int* pDstLen, IppsRSAState* pCtx);
```

Parameters

pSrc	Pointer to the octet ciphertext to be decrypted.
pLabel	Pointer to the optional label to be associated with the message.
labLen	Length of the optional label.
pDst	Pointer to the output octet plaintext message.
pDstLen	Pointer to the length of the decrypted message.
pCtx	Pointer to the properly initialized `IppsRSAState` context.

Description

This function is declared in the `ippcp.h` file. The function uses SHA-256 hash function and SHA-256-based MGF implemented in Intel IPP to carry out the RSA-OAEP decryption scheme and thus is a specific form of the general `RSAOAEPDecrypt` function.

Return Values

The function may return any of the values that the general `RSAOAEPDecrypt` function returns.

RSAOAEPDecrypt_SHA384

Carries out the RSA-OAEP decryption scheme using SHA-384 hash algorithm.

Syntax

```
IppStatus ippsRSAOAEPDecrypt_SHA384(const Ipp8u* pSrc, const Ipp8u* pLabel,
int labLen, Ipp8u* pDst, int* pDstLen, IppsRSAState* pCtx);
```

Parameters

pSrc	Pointer to the octet ciphertext to be decrypted.
pLabel	Pointer to the optional label to be associated with the message.
labLen	Length of the optional label.
pDst	Pointer to the output octet plaintext message.
pDstLen	Pointer to the length of the decrypted message.

pCtx	Pointer to the properly initialized IppsRSAState context.

Description

This function is declared in the ippcp.h file. The function uses SHA-384 hash function and SHA-384-based MGF implemented in Intel IPP to carry out the RSA-OAEP decryption scheme and thus is a specific form of the general RSAOAEPDecrypt function.

Return Values

The function may return any of the values that the general RSAOAEPDecrypt function returns.

RSAOAEPDecrypt_SHA512

Carries out the RSA-OAEP decryption scheme using SHA-512 hash algorithm.

Syntax

```
IppStatus ippsRSAOAEPDecrypt_SHA512(const Ipp8u* pSrc, const Ipp8u* pLabel,
int labLen, Ipp8u* pDst, int* pDstLen, IppsRSAState* pCtx);
```

Parameters

pSrc	Pointer to the octet ciphertext to be decrypted.
pLabel	Pointer to the optional label to be associated with the message.
labLen	Length of the optional label.
pDst	Pointer to the output octet plaintext message.
pDstLen	Pointer to the length of the decrypted message.
pCtx	Pointer to the properly initialized IppsRSAState context.

Description

This function is declared in the ippcp.h file. The function uses SHA-512 hash function and SHA-512-based MGF implemented in Intel IPP to carry out the RSA-OAEP decryption scheme and thus is a specific form of the general RSAOAEPDecrypt function.

Return Values

The function may return any of the values that the general `RSAOAEPDecrypt` function returns.

PKCS V1.5 Encryption Scheme Functions

This subsection describes functions implementing the RSA encryption scheme defined in version 1.5 of the PKCS#1 standard ([PKCS 1.2.1]).

The full list of these functions is given in Table 5-7a.

Table 5-7a Intel IPP PKCS V1.5 Encryption Scheme Functions

Function Base Name	Operation
`RSAEncrypt_PKCSv15`	Carries out the encryption using the v1.5 version of the PKCS#1 standard.
`RSADecrypt_PKCSv15`	Carries out the decryption using the v1.5 version of the PKCS#1 standard.

To invoke a function that carries out a PKCS V1.5 encryption scheme, the `IppsRSAState` context must be initialized (by the `RSAInit` function) with a proper value of the *`flag`* parameter:

- For PKCS V1.5 encryption, *`flag`* == `IppRSApublic`
- For PKCS V1.5 decryption, *`flag`* == `IppRSAprivate`.

RSAEncrypt_PKCSv15

Carries out the encryption using the v1.5 version of the PKCS#1 standard.

Syntax

```
IppStatus ippsRSAEncrypt_PKCSv15(const Ipp8u* pSrc, Ipp32u srcLen, const Ipp8u* pRandPS, Ipp8u* pDst, IppsRSAState* pRSA);
```

Parameters

`pSrc`	Pointer to the message to be encrypted.
`srcLen`	Length (in bytes) of the message.
`pRandPS`	Pointer to the padding string of an appropriate length.
`pDst`	Pointer to the output ciphertext string.
`pRSA`	Pointer to the properly initialized `IppsRSAState` context.

Description

This function is declared in the `ippcp.h` file. The function carries out the RSA encryption using the public key according to the v1.5 version of the PKCS#1 standard, defined in [PKCS 1.2.1].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the RSA context parameter does not match the operation.
`ippStsInvalidCryptoKeyErr`	Indicates an error condition if the RSA context has not been properly set up for the operation.
`ippStsSizeErr`	Indicates an error condition if the length *n* of the RSA modulus is too small in comparison with the length of plaintext, that is, *srcLen* > *n* - 11.

RSADecrypt_PKCSv15

Carries out the decryption using the v1.5 version of the PKCS#1 standard.

Syntax

```
IppStatus ippsRSADecrypt_PKCSv15(const Ipp8u* pSrc, Ipp8u* pDst, Ipp32u* pDstLen, IppsRSAState* pRSA);
```

Parameters

pSrc	Pointer to the cyphertext to be decrypted.
pDst	Pointer to the output text message.
pDstLen	Pointer to the length (in bytes) of the decrypted message.
pRSA	Pointer to the properly initialized `IppsRSAState` context.

Description

This function is declared in the ippcp.h file. The function carries out the RSA decryption using the private key according to the v1.5 version of the PKCS#1 standard, defined in [PKCS 1.2.1].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the RSA context parameter does not match the operation.
ippStsInvalidCryptoKeyErr	Indicates an error condition if the RSA context has not been properly set up for the operation.
ippStsSizeErr	Indicates an error condition if the length n of the RSA modulus is too small, that is, $n < 11$.
ippStsPaddingErr	Indicates an error condition if the value to be decrypted exceeds the RSA modulus.

RSA Signature Schemes

This subsection describes functions implementing RSA-based signature schemes.

RSA-SSA Scheme Functions

This subsection describes functions implementing RSA-SSA signature scheme with appendix, featured in [PKCS 1.2.1].

The full list of these functions is given in Table 5-8.

Table 5-8 Intel IPP RSA-based Signature Scheme Functions

Function Base Name	Operation
RSASSASign	Carries out the RSA-SSA signature generation scheme.
RSASSASign_MD5	MD5-based helper of the RSA-SSA signature generation scheme.
RSASSASign_SHA1	SHA-1-based helper of the RSA-SSA signature generation scheme.
RSASSASign_SHA224	SHA-224-based helper of the RSA-SSA signature generation scheme.
RSASSASign_SHA256	SHA-256-based helper of the RSA-SSA signature generation scheme.
RSASSASign_SHA384	SHA-384-based helper of the RSA-SSA signature generation scheme.
RSASSASign_SHA512	SHA-512-based helper of the RSA-SSA signature generation scheme.
RSASSAVerify	Carries out the RSA-SSA signature verification scheme.

Function Base Name	Operation
RSASSAVerify_MD5	MD5 based helper of the RSA-SSA signature verification scheme.
RSASSAVerify_SHA1	SHA-1-based helper of the RSA-SSA signature verification scheme.
RSASSAVerify_SHA224	SHA-224-based helper of the RSA-SSA signature verification scheme.
RSASSAVerify_SHA256	SHA-256-based helper of the RSA-SSA signature verification scheme.
RSASSAVerify_SHA384	SHA-384-based helper of the RSA-SSA signature verification scheme.
RSASSAVerify_SHA512	SHA-512-based helper of the RSA-SSA signature verification scheme.

To invoke a function that carries out RSA-SSA scheme, the IppsRSAState context must be initialized (by the RSAInit function) with a proper value of the *flag* parameter:

- For the RSA-SSA signing scheme, *flag* == IppRSAprivate
- For the RSA-SSA verification scheme, *flag* == IppRSApublic.

RSASSASign

Carries out the RSA-SSA signature generation scheme.

Syntax

```
IppStatus ippsRSASSASign(const Ipp8u* pHMsg, int hashLen, const Ipp8u* pSalt,
int saltLen, Ipp8u* pSign, IppsRSAState* pCtx, IppHash hushFunc, IppMGF
mgfFunc);
```

Parameters

pHMsg	Pointer to the octet message hash to be signed.
hashLen	Length of the message hash **pHMsg* in octets.
pSalt	Pointer to the random octet salt string
saltLen	Length of the salt string in octets.
pSign	Pointer to the output octet signature.
pCtx	Pointer to the properly initialized IppsRSAState context.
hashFunc	Hash function, which meets the General Definition of a Hash Function provided in chapter 3.
mgfFunc	MGF, which meets the definition provided in section User's Implementation of a Mask Generation Function in chapter 3.

Description

This function is declared in the `ippcp.h` file. The function generates a message signature according to the RSASSA-PSS scheme defined in [PKCS 1.2.1]. Intel IPP implementation of the scheme assumes that its first step, i.e. computing the hash digest of the original message, is executed prior to the function call and the resulting message hash **pHMsg* is passed to the function. The use of a message hash instead of the original message reduces the length of the function input message, limited by the upper bound of the integer data type ((2^{32} - 1) * 8 bit), and thus allows applying the entire RSA-SSA scheme to input messages of greater lengths. To compute the original message hash to be passed to the function, you should use the same hash function as the one specified by the *hashFunc* parameter and applied at the subsequent steps of the scheme.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.
`ippStsInvalidCryptoKeyErr`	Indicates an error condition if the RSA context has not been properly set up for the operation.
`ippStsLengthErr`	Indicates an error condition if the input length parameters do not meet any of the following conditions: *hashLen* > 0, *saltLen* ≥ 0, *N* > *hashLen* + *saltLen* + 2, where *N* is the length of the RSA modulus in octets.

RSASSASign_MD5

Carries out the RSA-SSA signature generation scheme using MD5 hash algorithm.

Syntax

```
IppStatus ippsRSASSASign_MD5(const Ipp8u* pHMsg, const Ipp8u* pSalt, int saltLen, Ipp8u* pSign , IppsRSAState* pCtx);
```

Parameters

pHMsg	Pointer to the octet message hash to be signed.
pSalt	Pointer to the random octet salt string.
saltLen	Length of the salt string in octets.
pSign	Pointer to the output octet signature.
pCtx	Pointer to the properly initialized `IppsRSAState` context.

Description

This function is declared in the `ippcp.h` file. The function uses MD5 hash function and MD5-based MGF implemented in Intel IPP to generate a message signature according to the RSASSA-PSS scheme and thus is a specific form of the general `RSASSASign` function. Provided the `IppsRSAState` context is properly initialized, the entire RSA-SSA signing scheme is carried out in two steps:

1. Call the `MD5MessageDigest` function to generate the hash message to be signed.
2. Call `RSASSASign_MD5` with *pHMsg* pointing to the resulting message hash.

Return Values

The function may return any of the values that the general `RSASSASign` function returns.

RSASSASign_SHA1

Carries out the RSA-SSA signature generation scheme using SHA-1 hash algorithm.

Syntax

```
IppStatus ippsRSASSASign_SHA1(const Ipp8u* pHMsg, const Ipp8u* pSalt, int saltLen, Ipp8u* pSign, IppsRSAState* pCtx);
```

Parameters

pHMsg	Pointer to the octet message hash to be signed.
pSalt	Pointer to the random octet salt string.
saltLen	Length of the salt string in octets.
pSign	Pointer to the output octet signature.
pCtx	Pointer to the properly initialized `IppsRSAState` context.

Description

This function is declared in the `ippcp.h` file. The function uses SHA-1 hash function and SHA-1-based MGF implemented in Intel IPP to generate a message signature according to the RSASSA-PSS scheme and thus is a specific form of the general `RSASSASign` function. Provided the `IppsRSAState` context is properly initialized, the entire RSA-SSA signing scheme is carried out in two steps:

1. Call the `SHA1MessageDigest` function to generate the hash message to be signed.
2. Call `RSASSASign_SHA1` with *pHMsg* pointing to the resulting message hash.

Return Values

The function may return any of the values that the general `RSASSASign` function returns.

RSASSASign_SHA224

Carries out the RSA-SSA signature generation scheme using SHA-224 hash algorithm.

Syntax

```
IppStatus ippsRSASSASign_SHA224(const Ipp8u* pHMsg, const Ipp8u* pSalt, int saltLen, Ipp8u* pSign, IppsRSAState* pCtx);
```

Parameters

pHMsg	Pointer to the octet message hash to be signed.
pSalt	Pointer to the random octet salt string.
saltLen	Length of the salt string in octets.
pSign	Pointer to the output octet signature.
pCtx	Pointer to the properly initialized `IppsRSAState` context.

Description

This function is declared in the `ippcp.h` file. The function uses SHA-224 hash function and SHA-224-based MGF implemented in Intel IPP to generate a message signature according to the RSASSA-PSS scheme and thus is a specific form of the general `RSASSASign` function. Provided the `IppsRSAState` context is properly initialized, the entire RSA-SSA signing scheme is carried out in two steps:

1. Call the `SHA224MessageDigest` function to generate the hash message to be signed.
2. Call `RSASSASign_SHA224` with *pHMsg* pointing to the resulting message hash.

Return Values

The function may return any of the values that the general `RSASSASign` function returns.

RSASSASign_SHA256

Carries out the RSA-SSA signature generation scheme using SHA-256 hash algorithm.

Syntax

```
IppStatus ippsRSASSASign_SHA256(const Ipp8u* pHMsg, const Ipp8u* pSalt, int saltLen, Ipp8u* pSign, IppsRSAState* pCtx);
```

Parameters

pHMsg	Pointer to the octet message hash to be signed.
pSalt	Pointer to the random octet salt string.
saltLen	Length of the salt string in octets.
pSign	Pointer to the output octet signature.
pCtx	Pointer to the properly initialized `IppsRSAState` context.

Description

This function is declared in the `ippcp.h` file. The function uses SHA-256 hash function and SHA-256-based MGF implemented in Intel IPP to generate a message signature according to the RSASSA-PSS scheme and thus is a specific form of the general `RSASSASign` function. Provided the `IppsRSAState` context is properly initialized, the entire RSA-SSA signing scheme is carried out in two steps:

1. Call the `SHA256MessageDigest` function to generate the hash message to be signed.
2. Call `RSASSASign_SHA256` with *pHMsg* pointing to the resulting message hash.

Return Values

The function may return any of the values that the general `RSASSASign` function returns.

RSASSASign_SHA384

Carries out the RSA-SSA signature generation scheme using SHA-384 hash algorithm.

Syntax

```
IppStatus ippsRSASSASign_SHA384(const Ipp8u* pHMsg, const Ipp8u* pSalt, int saltLen, Ipp8u* pSign, IppsRSAState* pCtx);
```

Parameters

pHMsg	Pointer to the octet message hash to be signed.
pSalt	Pointer to the random octet salt string.
saltLen	Length of the salt string in octets.
pSign	Pointer to the output octet signature.
pCtx	Pointer to the properly initialized `IppsRSAState` context.

Description

This function is declared in the `ippcp.h` file. The function uses SHA-384 hash function and SHA-384-based MGF implemented in Intel IPP to generate a message signature according to the RSASSA-PSS scheme and thus is a specific form of the general `RSASSASign` function. Provided the `IppsRSAState` context is properly initialized, the entire RSA-SSA signing scheme is carried out in two steps:

1. Call the `SHA384MessageDigest` function to generate the hash message to be signed.
2. Call `RSASSASign_SHA384` with *pHMsg* pointing to the resulting message hash.

Return Values

The function may return any of the values that the general `RSASSASign` function returns.

RSASSASign_SHA512

Carries out the RSA-SSA signature generation scheme using SHA-512 hash algorithm.

Syntax

```
IppStatus ippsRSASSASign_SHA512(const Ipp8u* pHMsg, const Ipp8u* pSalt, int saltLen, Ipp8u* pSign, IppsRSAState* pCtx);
```

Parameters

pHMsg	Pointer to the octet message hash to be signed.
pSalt	Pointer to the random octet salt string.
saltLen	Length of the salt string in octets.
pSign	Pointer to the output octet signature.
pCtx	Pointer to the properly initialized `IppsRSAState` context.

Description

This function is declared in the `ippcp.h` file. The function uses SHA-512 hash function and SHA-512-based MGF implemented in Intel IPP to generate a message signature according to the RSASSA-PSS scheme and thus is a specific form of the general `RSASSASign` function. Provided the `IppsRSAState` context is properly initialized, the entire RSA-SSA signing scheme is carried out in two steps:

1. Call the `SHA512MessageDigest` function to generate the hash message to be signed.
2. Call `RSASSASign_SHA512` with *pHMsg* pointing to the resulting message hash.

Return Values

The function may return any of the values that the general `RSASSASign` function returns.

RSASSAVerify

Carries out the RSA-SSA signature verification scheme.

Syntax

```
IppStatus ippsRSASSAVerify(const Ipp8u* pHMsg, int hashLen, const Ipp8u*
pSign, IppBool* pIsValid, IppsRSAState* pCtx, IppHash hushFunc, IppMGF
mgfFunc);
```

Parameters

pHMsg	Pointer to the octet message hash that has been signed.
hashLen	Length in octets of the message hash **pHMsg*.
pSign	Pointer to the octet signature string to be verified.
pIsValid	Pointer to the verification result.
pCtx	Pointer to the properly initialized `IppsRSAState` context.
hashFunc	Hash function, which meets the General Definition of a Hash Function provided in chapter 3.
mgfFunc	MGF, which meets the definition provided in section User's Implementation of a Mask Generation Function in chapter 3.

Description

This function is declared in the `ippcp.h` file. The function carries out the RSASSA-PSS signature verification scheme defined in [PKCS 1.2.1].

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

ippStsInvalidCryptoKeyErr	Indicates an error condition if the RSA context has not been properly set up for the operation.
ippStsLengthErr	Indicates an error condition if the input length parameter does not meet any of the following conditions: *hashLen* > 0, *hashLen* + 2 > *N*, where *N* is the length of the RSA modulus in octets.

RSASSAVerify_MD5

Carries out the RSA-SSA signature verification scheme using MD5 hash algorithm.

Syntax

```
IppStatus ippsRSASSAVerify_MD5(const Ipp8u* pHMsg, const Ipp8u* pSign,
IppBool* pIsValid, IppsRSAState* pCtx);
```

Parameters

pHMsg	Pointer to the octet message hash that has been signed.
pSign	Pointer to the octet signature string to be verified.
pIsValid	Pointer to the verification result.
pCtx	Pointer to the properly initialized IppsRSAState context.

Description

This function is declared in the ippcp.h file. The function uses MD5 hash function and MD5-based MGF implemented in Intel IPP to verify a signature according to the RSASSA-PSS scheme and thus is a specific form of the general RSASSAVerify function.

Return Values

The function may return any of the values that the general RSASSAVerify function returns.

RSASSAVerify_SHA1

Carries out the RSA-SSA signature verification scheme using SHA-1 hash algorithm.

Syntax

```
IppStatus ippsRSASSAVerify_SHA1(const Ipp8u* pHMsg, const Ipp8u* pSign,
IppBool* pIsValid, IppsRSAState* pCtx);
```

Parameters

pHMsg	Pointer to the octet message hash that has been signed.
pSign	Pointer to the octet signature string to be verified.
pIsValid	Pointer to the verification result.
pCtx	Pointer to the properly initialized `IppsRSAState` context.

Description

This function is declared in the `ippcp.h` file. The function uses SHA-1 hash function and SHA-1-based MGF implemented in Intel IPP to verify a signature according to the RSASSA-PSS scheme and thus is a specific form of the general `RSASSAVerify` function.

Return Values

The function may return any of the values that the general `RSASSAVerify` function returns.

RSASSAVerify_SHA224

Carries out the RSA-SSA signature verification scheme using SHA-224 hash algorithm.

Syntax

```
IppStatus ippsRSASSAVerify_SHA224(const Ipp8u* pHMsg, const Ipp8u* pSign,
IppBool* pIsValid, IppsRSAState* pCtx);
```

Parameters

pHMsg	Pointer to the octet message hash that has been signed.
pSign	Pointer to the octet signature string to be verified.
pIsValid	Pointer to the verification result.
pCtx	Pointer to the properly initialized `IppsRSAState` context.

Description

This function is declared in the `ippcp.h` file. The function uses SHA-224 hash function and SHA-224-based MGF implemented in Intel IPP to verify a signature according to the RSASSA-PSS scheme and thus is a specific form of the general `RSASSAVerify` function.

Return Values

The function may return any of the values that the general `RSASSAVerify` function returns.

RSASSAVerify_SHA256

Carries out the RSA-SSA signature verification scheme using SHA-256 hash algorithm.

Syntax

```
IppStatus ippsRSASSAVerify_SHA256(const Ipp8u* pHMsg, const Ipp8u* pSign,
IppBool* pIsValid, IppsRSAState* pCtx);
```

Parameters

pHMsg	Pointer to the octet message hash that has been signed.
pSign	Pointer to the octet signature string to be verified.
pIsValid	Pointer to the verification result.
pCtx	Pointer to the properly initialized `IppsRSAState` context.

Description

This function is declared in the `ippcp.h` file. The function uses SHA-256 hash function and SHA-256-based MGF implemented in Intel IPP to verify a signature according to the RSASSA-PSS scheme and thus is a specific form of the general `RSASSAVerify` function.

Return Values

The function may return any of the values that the general `RSASSAVerify` function returns.

RSASSAVerify_SHA384

Carries out the RSA-SSA signature verification scheme using SHA-384 hash algorithm.

Syntax

```
IppStatus ippsRSASSAVerify_SHA384(const Ipp8u* pHMsg, const Ipp8u* pSign,
IppBool* pIsValid, IppsRSAState* pCtx);
```

Parameters

pHMsg	Pointer to the octet message hash that has been signed.
pSign	Pointer to the octet signature string to be verified.
pIsValid	Pointer to the verification result.
pCtx	Pointer to the properly initialized `IppsRSAState` context.

Description

This function is declared in the `ippcp.h` file. The function uses SHA-384 hash function and SHA-384-based MGF implemented in Intel IPP to verify a signature according to the RSASSA-PSS scheme and thus is a specific form of the general `RSASSAVerify` function.

Return Values

The function may return any of the values that the general `RSASSAVerify` function returns.

RSASSAVerify_SHA512

Carries out the RSA-SSA signature verification scheme using SHA-512 hash algorithm.

Syntax

```
IppStatus ippsRSASSAVerify_SHA512(const Ipp8u* pHMsg, const Ipp8u* pSign,
IppBool* pIsValid, IppsRSAState* pCtx);
```

Parameters

pHMsg	Pointer to the octet message hash that has been signed.
pSign	Pointer to the octet signature string to be verified.
pIsValid	Pointer to the verification result.
pCtx	Pointer to the properly initialized `IppsRSAState` context.

Description

This function is declared in the `ippcp.h` file. The function uses SHA-512 hash function and SHA-512-based MGF implemented in Intel IPP to verify a signature according to the RSASSA-PSS scheme and thus is a specific form of the general `RSASSAVerify` function.

Return Values

The function may return any of the values that the general `RSASSAVerify` function returns.

PKCS V1.5 Signature Scheme Functions

This subsection describes functions implementing the RSA signature scheme defined in version 1.5 of the PKCS#1 standard ([PKCS 1.2.1]).

The full list of these functions is given in Table 5-8a.

Table 5-8a Intel IPP PKCS V1.5 Signature Scheme Functions

Function Base Name	Operation
`RSASSASign_MD5_PKCSv15`	Generates a signature using the v1.5 version of the RSA scheme with the MD5 message digest.
`RSASSASign_SHA1_PKCSv15`	Generates a signature using the v1.5 version of the RSA scheme with the SHA-1 message digest.

Function Base Name	Operation
RSASSAS-ign_SHA224_PKCSv15	Generates a signature using the v1.5 version of the RSA scheme with the SHA-224 message digest.
RSASSAS-ign_SHA256_PKCSv15	Generates a signature using the v1.5 version of the RSA scheme with the SHA-256 message digest.
RSASSAS-ign_SHA384_PKCSv15	Generates a signature using the v1.5 version of the RSA scheme with the SHA-384 message digest.
RSASSAS-ign_SHA512_PKCSv15	Generates a signature using the v1.5 version of the RSA scheme with the SHA-512 message digest.
RSASSAVeri-fy_MD5_PKCSv15	Verifies a signature using the v1.5 version of the RSA scheme with the MD5 message digest.
RSASSAVeri-fy_SHA1_PKCSv15	Verifies a signature using the v1.5 version of the RSA scheme with the SHA-1 message digest.
RSASSAVeri-fy_SHA224_PKCSv15	Verifies a signature using the v1.5 version of the RSA scheme with the SHA-224 message digest.
RSASSAVeri-fy_SHA256_PKCSv15	Verifies a signature using the v1.5 version of the RSA scheme with the SHA-256 message digest.
RSASSAVeri-fy_SHA384_PKCSv15	Verifies a signature using the v1.5 version of the RSA scheme with the SHA-384 message digest.
RSASSAVeri-fy_SHA512_PKCSv15	Verifies a signature using the v1.5 version of the RSA scheme with the SHA-512 message digest.

To invoke a function that carries out a PKCS V1.5 signature scheme, the `IppsRSAState` context must be initialized (by the `RSAInit` function) with a proper value of the *`flag`* parameter:

- For the PKCS V1.5 signing scheme, *`flag`* == `IppRSAprivate`
- For the PKCS V1.5 verification scheme, *`flag`* == `IppRSApublic`.

RSASSASign_MD5_PKCSv15

Generates a signature using the v1.5 version of the RSA scheme with the MD5 message digest.

Syntax

```
IppStatus ippsRSASSASign_MD5_PKCSv15 (const Ipp8u* pMsg, Ipp32u msgLen,
Ipp8u* pSign, IppsRSAState* pRSA);
```

Parameters

`pMsg`	Pointer to the message to be signed.

msgLen	Length of the message.
pSign	Pointer to the output signature.
pRSA	Pointer to the properly initialized IppsRSAState context.

Description

This function is declared in the ippcp.h file. The function generates a signature using the v1.5 version of the RSA scheme, defined in [PKCS 1.2.1], with the MD5 message digest.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the RSA context parameter does not match the operation.
ippStsInvalidCryptoKeyErr	Indicates an error condition if the RSA context has not been properly set up for the operation.
ippStsSizeErr	Indicates an error condition if the length of the RSA modulus is too small (see details in [PKCS 1.2.1]).

RSASSASign_SHA1_PKCSv15

Generates a signature using the v1.5 version of the RSA scheme with the SHA-1 message digest.

Syntax

```
IppStatus ippsRSASSASign_SHA1_PKCSv15 (const Ipp8u* pMsg, Ipp32u msgLen,
Ipp8u* pSign, IppsRSAState* pRSA);
```

Parameters

pMsg	Pointer to the message to be signed.
msgLen	Length of the message.
pSign	Pointer to the output signature.
pRSA	Pointer to the properly initialized IppsRSAState context.

Description

This function is declared in the `ippcp.h` file. The function generates a signature using the v1.5 version of the RSA scheme, defined in [PKCS 1.2.1], with the SHA-1 message digest.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the RSA context parameter does not match the operation.
`ippStsInvalidCryptoKeyErr`	Indicates an error condition if the RSA context has not been properly set up for the operation.
`ippStsSizeErr`	Indicates an error condition if the length of the RSA modulus is too small (see details in [PKCS 1.2.1]).

RSASSASign_SHA224_PKCSv15

Generates a signature using the v1.5 version of the RSA scheme with the SHA-224 message digest.

Syntax

```
IppStatus ippsRSASSASign_SHA224_PKCSv15 (const Ipp8u* pMsg, Ipp32u msgLen,
Ipp8u* pSign, IppsRSAState* pRSA);
```

Parameters

pMsg	Pointer to the message to be signed.
msgLen	Length of the message.
pSign	Pointer to the output signature.
pRSA	Pointer to the properly initialized `IppsRSAState` context.

Description

This function is declared in the `ippcp.h` file. The function generates a signature using the v1.5 version of the RSA scheme, defined in [PKCS 1.2.1], with the SHA-224 message digest.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the RSA context parameter does not match the operation.
ippStsInvalidCryptoKeyErr	Indicates an error condition if the RSA context has not been properly set up for the operation.
ippStsSizeErr	Indicates an error condition if the length of the RSA modulus is too small (see details in [PKCS 1.2.1]).

RSASSASign_SHA256_PKCSv15

Generates a signature using the v1.5 version of the RSA scheme with the SHA-256 message digest.

Syntax

```
IppStatus ippsRSASSASign_SHA256_PKCSv15 (const Ipp8u* pMsg, Ipp32u msgLen,
Ipp8u* pSign, IppsRSAState* pRSA);
```

Parameters

pMsg	Pointer to the message to be signed.
msgLen	Length of the message.
pSign	Pointer to the output signature.
pRSA	Pointer to the properly initialized IppsRSAState context.

Description

This function is declared in the ippcp.h file. The function generates a signature using the v1.5 version of the RSA scheme, defined in [PKCS 1.2.1], with the SHA-256 message digest.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

ippStsContextMatchErr	Indicates an error condition if the RSA context parameter does not match the operation.
ippStsInvalidCryptoKeyErr	Indicates an error condition if the RSA context has not been properly set up for the operation.
ippStsSizeErr	Indicates an error condition if the length of the RSA modulus is too small (see details in [PKCS 1.2.1]).

RSASSASign_SHA384_PKCSv15

Generates a signature using the v1.5 version of the RSA scheme with the SHA-384 message digest.

Syntax

```
IppStatus ippsRSASSASign_SHA384_PKCSv15 (const Ipp8u* pMsg, Ipp32u msgLen,
Ipp8u* pSign, IppsRSAState* pRSA);
```

Parameters

pMsg	Pointer to the message to be signed.
msgLen	Length of the message.
pSign	Pointer to the output signature.
pRSA	Pointer to the properly initialized IppsRSAState context.

Description

This function is declared in the ippcp.h file. The function generates a signature using the v1.5 version of the RSA scheme, defined in [PKCS 1.2.1], with the SHA-384 message digest.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the RSA context parameter does not match the operation.
ippStsInvalidCryptoKeyErr	Indicates an error condition if the RSA context has not been properly set up for the operation.

ippStsSizeErr	Indicates an error condition if the length of the RSA modulus is too small (see details in [PKCS 1.2.1]).

RSASSASign_SHA512_PKCSv15

Generates a signature using the v1.5 version of the RSA scheme with the SHA-512 message digest.

Syntax

```
IppStatus ippsRSASSASign_SHA512_PKCSv15 (const Ipp8u* pMsg, Ipp32u msgLen,
Ipp8u* pSign, IppsRSAState* pRSA);
```

Parameters

pMsg	Pointer to the message to be signed.
msgLen	Length of the message.
pSign	Pointer to the output signature.
pRSA	Pointer to the properly initialized IppsRSAState context.

Description

This function is declared in the ippcp.h file. The function generates a signature using the v1.5 version of the RSA scheme, defined in [PKCS 1.2.1], with the SHA-512 message digest.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the RSA context parameter does not match the operation.
ippStsInvalidCryptoKeyErr	Indicates an error condition if the RSA context has not been properly set up for the operation.
ippStsSizeErr	Indicates an error condition if the length of the RSA modulus is too small (see details in [PKCS 1.2.1]).

RSASSAVerify_MD5_PKCSv15

Verifies a signature using the v1.5 version of the RSA scheme with the MD5 message digest.

Syntax

```
IppStatus ippsRSASSAVerify_MD5_PKCSv15 (const Ipp8u* pMsg, Ipp32u msgLen,
const Ipp8u* pSign, IppBool* pIsValid, IppsRSAState* pRSA);
```

Parameters

pMsg	Pointer to the message that has been signed.
msgLen	Length of the message.
pSign	Pointer to the signature string to be verified.
pIsValid	Pointer to the verification result.
pRSA	Pointer to the properly initialized `IppsRSAState` context.

Description

This function is declared in the `ippcp.h` file. The function verifies a signature using the v1.5 version of the RSA scheme, defined in [PKCS 1.2.1], with the MD5 message digest.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the RSA context parameter does not match the operation.
`ippStsInvalidCryptoKeyErr`	Indicates an error condition if the RSA context has not been properly set up for the operation.
`ippStsSizeErr`	Indicates an error condition if the length of the RSA modulus is too small (see details in [PKCS 1.2.1]).

RSASSAVerify_SHA1_PKCSv15

Verifies a signature using the v1.5 version of the RSA scheme with the SHA-1 message digest.

Syntax

```
IppStatus ippsRSASSAVerify_SHA1_PKCSv15 (const Ipp8u* pMsg, Ipp32u msgLen,
const Ipp8u* pSign, IppBool* pIsValid, IppsRSAState* pRSA);
```

Parameters

pMsg	Pointer to the message that has been signed.
msgLen	Length of the message.
pSign	Pointer to the signature string to be verified.
pIsValid	Pointer to the verification result.
pRSA	Pointer to the properly initialized `IppsRSAState` context.

Description

This function is declared in the `ippcp.h` file. The function verifies a signature using the v1.5 version of the RSA scheme, defined in [PKCS 1.2.1], with the SHA-1 message digest.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the RSA context parameter does not match the operation.
`ippStsInvalidCryptoKeyErr`	Indicates an error condition if the RSA context has not been properly set up for the operation.
`ippStsSizeErr`	Indicates an error condition if the length of the RSA modulus is too small (see details in [PKCS 1.2.1]).

RSASSAVerify_SHA224_PKCSv15

Verifies a signature using the v1.5 version of the RSA scheme with the SHA-224 message digest.

Syntax

```
IppStatus ippsRSASSAVerify_SHA224_PKCSv15 (const Ipp8u* pMsg, Ipp32u msgLen,
const Ipp8u* pSign, IppBool* pIsValid, IppsRSAState* pRSA);
```

Parameters

pMsg	Pointer to the message that has been signed.
msgLen	Length of the message.
pSign	Pointer to the signature string to be verified.
pIsValid	Pointer to the verification result.
pRSA	Pointer to the properly initialized `IppsRSAState` context.

Description

This function is declared in the `ippcp.h` file. The function verifies a signature using the v1.5 version of the RSA scheme, defined in [PKCS 1.2.1], with the SHA-224 message digest.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the RSA context parameter does not match the operation.
`ippStsInvalidCryptoKeyErr`	Indicates an error condition if the RSA context has not been properly set up for the operation.
`ippStsSizeErr`	Indicates an error condition if the length of the RSA modulus is too small (see details in [PKCS 1.2.1]).

RSASSAVerify_SHA256_PKCSv15

Verifies a signature using the v1.5 version of the RSA scheme with the SHA-256 message digest.

Syntax

```
IppStatus ippsRSASSAVerify_SHA256_PKCSv15 (const Ipp8u* pMsg, Ipp32u msgLen,
const Ipp8u* pSign, IppBool* pIsValid, IppsRSAState* pRSA);
```

Parameters

pMsg	Pointer to the message that has been signed.
msgLen	Length of the message.
pSign	Pointer to the signature string to be verified.
pIsValid	Pointer to the verification result.
pRSA	Pointer to the properly initialized `IppsRSAState` context.

Description

This function is declared in the `ippcp.h` file. The function verifies a signature using the v1.5 version of the RSA scheme, defined in [PKCS 1.2.1], with the SHA-256 message digest.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the RSA context parameter does not match the operation.
`ippStsInvalidCryptoKeyErr`	Indicates an error condition if the RSA context has not been properly set up for the operation.
`ippStsSizeErr`	Indicates an error condition if the length of the RSA modulus is too small (see details in [PKCS 1.2.1]).

RSASSAVerify_SHA384_PKCSv15

Verifies a signature using the v1.5 version of the RSA scheme with the SHA-384 message digest.

Syntax

```
IppStatus ippsRSASSAVerify_SHA384_PKCSv15 (const Ipp8u* pMsg, Ipp32u msgLen,
const Ipp8u* pSign, IppBool* pIsValid, IppsRSAState* pRSA);
```

Parameters

pMsg	Pointer to the message that has been signed.
msgLen	Length of the message.
pSign	Pointer to the signature string to be verified.
pIsValid	Pointer to the verification result.
pRSA	Pointer to the properly initialized `IppsRSAState` context.

Description

This function is declared in the `ippcp.h` file. The function verifies a signature using the v1.5 version of the RSA scheme, defined in [PKCS 1.2.1], with the SHA-384 message digest.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the RSA context parameter does not match the operation.
`ippStsInvalidCryptoKeyErr`	Indicates an error condition if the RSA context has not been properly set up for the operation.
`ippStsSizeErr`	Indicates an error condition if the length of the RSA modulus is too small (see details in [PKCS 1.2.1]).

RSASSAVerify_SHA512_PKCSv15

Verifies a signature using the v1.5 version of the RSA scheme with the SHA-512 message digest.

Syntax

```
IppStatus ippsRSASSAVerify_SHA512_PKCSv15 (const Ipp8u* pMsg, Ipp32u msgLen,
const Ipp8u* pSign, IppBool* pIsValid, IppsRSAState* pRSA);
```

Parameters

pMsg	Pointer to the message that has been signed.
msgLen	Length of the message.
pSign	Pointer to the signature string to be verified.
pIsValid	Pointer to the verification result.
pRSA	Pointer to the properly initialized `IppsRSAState` context.

Description

This function is declared in the `ippcp.h` file. The function verifies a signature using the v1.5 version of the RSA scheme, defined in [PKCS 1.2.1], with the SHA-512 message digest.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the RSA context parameter does not match the operation.
`ippStsInvalidCryptoKeyErr`	Indicates an error condition if the RSA context has not been properly set up for the operation.
`ippStsSizeErr`	Indicates an error condition if the length of the RSA modulus is too small (see details in [PKCS 1.2.1]).

Discrete-Logarithm-Based Cryptography Functions

This section introduces Intel® Integrated Performance Primitives (Intel® IPP) functions allowing for different operations with Discrete Logarithm (DL) based cryptosystem over a prime finite field GF(*p*). The functions are mainly based on the [IEEE P1363A] standard. Implementation of the Digital Signature operations is based on [FIPS PUB 186-2]. The Diffie-Hellman (DH) Agreement scheme is based on [X9.42].

The full list of Intel IPP DL-based cryptography functions is given in Table 5-9.

Table 5-9 Intel IPP Discrete-Logarithm-Based Cryptography Functions

Function Base Name	Operation
DLPGetSize	Gets the size of the IppsDLPState context.
DLPInit	Initializes user-supplied memory as the IppsDLPState context for future use.
DLPSet	Sets up domain parameters of the DL-based cryptosystem over GF(*p*).
DLPGet	Retrieves domain parameters of the DL-based cryptosystem over GF(*p*).
DLPSetDP	Sets up a particular domain parameter of the DL-based cryptosystem over GF(*p*).
DLPGetDP	Retrieves a particular domain parameter of the DL-based cryptosystem over GF(*p*).
DLPGenKeyPair	Generates a private key and computes public keys of the DL-based cryptosystem over GF(*p*).
DLPPublicKey	Computes a public key from the given private key of the DL-based cryptosystem over GF(*p*).
DLPValidateKey-Pair	Validates private and public keys of the DL-based cryptosystem over GF(*p*).
DLPSetKeyPair	Sets private and/or public keys of the DL-based cryptosystem over GF(*p*).
DLPGenerateDSA	Generates domain parameters of the DL-based cryptosystem over GF(*p*) to use DSA.
DLPValidateDSA	Validates domain parameters of the DL-based cryptosystem over GF(*p*) to use DSA.
DLPSignDSA	Performs the DSA digital signature signing operation.
DLPVerifyDSA	Verifies the input DSA digital signature.
DLPGenerateDH	Generates domain parameters of the DL-based cryptosystem over GF(*p*) to use the DH Agreement scheme.
DLPValidateDH	Validates domain parameters of the DL-based cryptosystem over GF(*p*) to use the DH Agreement scheme.
DLPSharedSecretDH	Computes a shares secret field element by using the Diffie-Hellman scheme.

All functions described in this section employ the IppsDLPState context as operational vehicle that carries domain parameters of the DL cryptosystem, a pair of keys, and working buffers.

The application code intended for executing typical operations should perform the following sequence of operations:

1. Call the function DLPGetSize to get the size required to configure the IppsDLPState context.
2. Ensure that the required memory space is properly allocated. With the allocated memory, call the DLPInit function to initialize the context of the DL-based cryptosystem.
3. Set domain parameters of the DL-based cryptosystem by calling the DLPSet function, or generate domain parameters by calling the DLPGenerateDSA or DLPGenerateDH.
4. Call one of the functions DLPSignDSA, DLPVerifyDSA, and DLPSharedSecretDH to compute digital signature, to verify authenticity of the digital signature, and to compute the shared element accordingly.
5. Free the memory allocated for the IppsDLPState context by calling the operating system memory free service function unless the context is no longer needed.

Free the memory allocated for the IppsPRNGState context by calling the operating system memory free service function.

DLPGetSize

Gets the size of the IppsDLPState *context.*

Syntax

```
IppStatus ippsDLPGetSize(int peBits, int reBits, int *pSize);
```

Parameters

peBits	Bitsize of the GF(p) element (that is, the length of the DL-based cryptosystem in bits)
reBits	Bitsize of the multiplicative subgroup GF(r).
pSize	Pointer to the IppsDLPState context size in bytes.

Description

This function is declared in the ippcp.h file. The function gets the IppsDLPState context size in bytes and stores in **pSize*. DL-based cryptosystem over GF(p) assumes that $r/p-1$ where both p and r are primes.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.

ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsSizeErr	Indicates an error condition if *peBits* ≤ *reBits*.

DLPInit

Initializes user-supplied memory as the IppsDLPState *context for future use.*

Syntax

```
IppsStatus IppsDLPInit(int peBits, int reBits, IppsDLPState* pCtx);
```

Parameters

peBits	Bitsize of the GF(p) element (that is, the length of the DL-based cryptosystem in bits)
reBits	Bitsize of the multiplicative subgroup GF(r).
pCtx	Pointer to the IppsDLPState context being initialized.

Description

This function is declared in the ippcp.h file. The function initializes the memory pointed by *pCtx* as the IppsDLPState context.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsSizeErr	Indicates an error condition if *peBits* ≤ *reBits*.

DLPSet

Sets up domain parameters of the DL-based cryptosystem over GF(p).

Syntax

```
IppStatus ippsDLPSet(const IppsBigNumState* pP, const IppBigNumState* pQ,
const IppsBigNumState* pG, IppsDLPState* pCtx);
```

Parameters

pP	Pointer to the characteristic *p* of the prime finite field GF(*p*).
pQ	Pointer to the characteristic *q* of the multiplicative subgroup GF(*q*).
pG	Pointer to the generator *G* of the multiplicative subgroup GF(*r*).
pCtx	Pointer to the cryptosystem context.

Description

This function is declared in the `ippcp.h` file. The function sets up DL-based cryptosystem domain parameters into the cryptosystem context.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.
`ippStsRangeErr`	Indicates an error condition if any of the Big Numbers specified by *pP*, *pR*, and *pG* is too big to be stored in the `IppsDLPState` context.

DLPGet

Retrieves domain parameters of the DL-based cryptosystem over GF(p).

Syntax

```
IppStatus ippsDLPGet(IppsBigNumState* pP, IppsBigNumState* pQ,
IppsBigNumState* pG, IppsDLPState* pCtx);
```

Parameters

pP	Pointer to the characteristic *p* of the prime finite field GF(*p*).
pQ	Pointer to the characteristic *q* of the multiplicative subgroup GF(*q*).
pG	Pointer to the generator *G* of the multiplicative subgroup GF(*r*).
pCtx	Pointer to the cryptosystem context.

Description

This function is declared in the `ippcp.h` file. The function retrieves DL-based cryptosystem domain parameters into the cryptosystem context.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.
`ippStsIncompleteContextErr`	Indicates an error condition if the cryptosystem context has not been properly set up.
`ippStsRangeErr`	Indicates an error condition if any of the Big Numbers specified by *pP*, *pR*, and *pG* is too small for the DL parameter.

DLPSetDP

Sets up a particular domain parameter of the DL-based cryptosystem over GF(p).

Syntax

```
IppStatus ippsDLPSetDP(const IppsBigNumState* pDP, IppsDLPKeyTag tag,
IppsDLPState* pCtx);
```

Parameters

pDP	Pointer to the domain parameter value to be set.
tag	Tag specifying the desired domain parameter.
pCtx	Pointer to the cryptosystem context.

Description

This function is declared in the `ippcp.h` file. The function assigns the value specified by *pDP* to a particular domain parameter of the DL-based cryptosystem. The domain parameter to be set up is determined by *tag* as follows:

- If *tag* == `IppDLPkeyP`, the function assigns value to the characteristic *p*, the size of the prime finite field GF(*p*).
- If *tag* == `IppDLPkeyR`, the function assigns value to the characteristic *r*, the prime divisor of (*p*-1) and the order of *g.*
- If *tag* == `IppDLPkeyG`, the function assigns value to the characteristic *g,* the element of GF(*p*) generating a multiplicative subgroup of order *r.*

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.
`ippStsRangeErr`	Indicates an error condition if the Big Number specified by *pDP* is too big to be stored in the `IppsDLPState` context.

ippStsBadArgErr	Indicates an error condition if some of the function parameters are invalid: Big Number specified by *pDP* is negative Domain parameter specified by *tag* does not match the IppsDLPState context.

DLPGetDP

Retrieves a particular domain parameter of the DL-based cryptosystem over GF(p).

Syntax

```
IppStatus ippsDLPGetDP(const IppsBigNumState* pDP, IppsDLPKeyTag tag,
IppsDLPState* pCtx);
```

Parameters

pDP	Pointer to the output Big Number context.
tag	Tag specifying the domain parameter to be retrieved.
pCtx	Pointer to the cryptosystem context.

Description

This function is declared in the ippcp.h file. The function retrieves value of a particular domain parameter of the DL-based cryptosystem from the *IppsDLPState* context and stores the value in the Big Number context **pDP*. The domain parameter to be retrieved is determined by *tag* as follows:

- If *tag* == IppDLPkeyP, the function retrieves value of the characteristic *p*, the size of the prime finite field GF(*p*).
- If *tag* == IppDLPkeyR, the function retrieves value of the characteristic *r*, the prime divisor of (*p*-1) and the order of *g*.
- If *tag* == IppDLPkeyG, the function retrieves value of the characteristic *g*, the element of GF(*p*) generating a multiplicative subgroup of order *r*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.

ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsIncompleteContextErr	Indicates an error condition if the cryptosystem context has not been properly set up.
ippStsOutOfRangeErr	Indicates an error condition if the Big Number specified by *pDP* is too small for the DL parameter.
ippStsBadArgErr	Indicates an error condition if the domain parameter specified by the tag does not match the IppsDLPState context.

DLPGenKeyPair

Generates a private key and computes public keys of the DL-based cryptosystem over GF(p).

Syntax

```
IppStatus ippsDLPGenKeyPair(IppsBigNumState* pPrivate, IppsBigNumState*
pPublic, IppsDLPState* pCtx, IppBitSupplier rndFunc, void* pRndParam);
```

Parameters

pPrivate	Pointer to the private key *privKey*.
pPublic	Pointer to the public key *pubKey*.
pCtx	Pointer to the cryptosystem context.
rndFunc	Specifed Random Generator.
pRndParam	Pointer to the Random Generator context.

Description

This function is declared in the ippcp.h file. The function generates a private key *privKey* and computes a public key *pubKey* of the DL-based cryptosystem. The function employs specified *rndFunc* Random Generator to generate a pseudorandom private key. The value of the private key *privKey* is a random number that lies in the range of [2,*R*-2].

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.

ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsIncompleteContextErr	Indicates an error condition if the cryptosystem context has not been properly set up.
ippStsRangeErr	Indicates an error condition if any of the Big Numbers specified by *pPrivate* and *pPublic* is too small for the DL key.

DLPPublicKey

Computes a public key from the given private key of the DL-based cryptosystem over GF(p).

Syntax

```
IppStatus ippsDLPPublicKey(const IppsBigNumState* pPrivate, IppsBigNumState* pPublic, IppsDLPState* pCtx);
```

Parameters

pPrivate	Pointer to the input private key *privKey*.
pPublic	Pointer to the output public key *pubKey*.
pCtx	Pointer to the cryptosystem context.

Description

This function is declared in the ippcp.h file. The function computes a public key *pubKey* of the DL-based cryptosystem.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsIncompleteContextErr	Indicates an error condition if the cryptosystem context has not been properly set up.

ippStsInvalidPrivateKey	Indicates an error condition if the *privKey* has an illegal value.
ippStsRangeErr	Indicates an error condition if Big Number specified by *pPublic* is too small for the DL public key.

DLPValidateKeyPair

Validates private and public keys of the DL-based cryptosystem over GF(p).

Syntax

```
IppStatus ippsDLPValidateKeyPair(const IppsBigNumState* pPrivate, const
IppsBigNumState* pPublic, IppDLPResult* pResult, IppsDLPState* pCtx);
```

Parameters

pPrivate	Pointer to the input private key *privKey*.
pPublic	Pointer to the output public key *pubKey*.
pResult	Pointer to the validation result.
pCtx	Pointer to the cryptosystem context.

Description

This function is declared in the ippcp.h file. The function validates the private key *privKey* and the public key *pubKey* of the DL-based cryptosystem. The result of the validation is stored in the **pResult* and may be assigned to one of the enumerators listed below:

ippDLValid	Validation has passed successfully.
ippDLInvalidPrivateKey	(1 < *private* < (*R* - 1)) is false.
ippDLInvalidPublicKey	(1 < *public* ≤ (*P* - 1)) is false.
ippDLInvalidKeyPair	*public* != *G*^*private* (mod *P*).

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.

ippStsIncompleteContextErr	Indicates an error condition if the cryptosystem context has not been properly set up.

DLPSetKeyPair

Sets private and/or public keys of the DL-based cryptosystem over GF(p).

Syntax

```
IppStatus ippsDLPSetKeyPair(const IppsBigNumState* pPrivate, const
IppsBigNumState* pPublic, IppsDLPState* pCtx);
```

Parameters

pPrivate	Pointer to the input private key *privKey*.
pPublic	Pointer to the output public key *pubKey*.
pCtx	Pointer to the cryptosystem context.

Description

This function is declared in the `ippcp.h` file. The function stores the private key *priveKey* and public key *pubKey* in the cryptosystem context.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsIncompleteContextErr	Indicates an error condition if the cryptosystem context has not been properly set up.

DLPGenerateDSA

Generates domain parameters of the DL-based cryptosystem over GF(p) to use DSA.

Syntax

```
ippStatus ippsDLPGenerateDSA(const IppsBigNumState* pSeedIn, int nTrials,
IppsDLPState* pCtx, IppsBigNumState* pSeedOut, int* pCounter, IppBitSupplier
rndFunc, void* pRndParam);
```

Parameters

pSeedIn	Pointer to the input *Seed*.
nTrials	Security parameter specified for the Miller-Rabin probable primality.
pCtx	Pointer to the cryptosystem context.
pSeedOut	Pointer to the output *Seed* value (if requested).
pCounter	Pointer to the *counter* value (if requested).
rndFunc	Specified Random Generator.
pRndParam	Pointer to the Random Generator context.

Description

This function is declared in the `ippcp.h` file. The function generates domain parameters of the DL-based cryptosystem over GF(*p*) to use DSA. The function uses a procedure specified in [FIPS PUB 186-2] for generating both a 160-bit randomized prime r and a *LpeBits* prime *p* based on the input **pSeedIn*.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.
`ippStsSizeErr`	Indicates an error condition if: *peBits* < 512, *peBits* is not divided by 64, *reBits* != 160.

ippStsRangeErr	Indicates an error condition if: bitsize of the input *Seed* value is less than 160, bitsize of the input *Seed* value is greater than *peBits*, not enough space to store the output *Seed* value (if requested).
ippStsBadArgErr	Indicates an error condition if *nTrials* < 1.
ippStsInsuffucientEntropy	Indicates a warning condition if prime generation fails due to a poor choice of the entropy.

DLPValidateDSA

Validates domain parameters of the DL-based cryptosystem over GF(p) to use DSA.

Syntax

```
IppStatus ippsDLPValidateDSA(int nTrials, IppDLResult* pResult, IppsDLPState*
pCtx, IppBitSupplier rndFunc, void* pRndParam);
```

Parameters

nTrials	Security parameter specified for the Miller-Rabin probable primality.
pResult	Pointer to the validation result.
pCtx	Pointer to the cryptosystem context.
rndFunc	Specified Random Generator.
pRndParam	Pointer to the Random Generator context.

Description

This function is declared in the `ippcp.h` file. The function validates domain parameters of the DL-based cryptosystem over GF(*p*) to use DSA. The result of validation is stored in the **pResult* and may be assigned to one of the enumerators listed below:

ippDLValid	Validation has passed successfully.
ippDLBaseIsEven	P is even.
ippDLOrderIsEven	R is even.
ippDLInvalidBaseRange	$P \le 2^{peBits-1}$ or $P \ge 2^{peBits}$.
ippDLInvalidOrderRange	$R \le 2^{reBits-1}$ or $R \ge 2^{reBits}$.

ippDLCompositeBase	*P* is not a prime.
ippDLCompositeOrder	*R* is not a prime.
ippDLInvalidCofactor	*R* is not divisible by (*P* -1).
ippDLInvalidGenerator	(1 < *G* < (*P* -1)) is false or *G*^*R* != 1 (mod *P*).

To ensure that both *p* and *r* are primes, the function applies *nTrial*-round Miller-Rabin primality test. Test data for primality test is provided by the specified *rndFunc* Random Generator.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsIncompleteContextErr	Indicates an error condition if the cryptosystem context has not been properly set up.
ippStsBadArgErr	Indicates an error condition if *nTrials* < 1.

DLPSignDSA

Performs the DSA digital signature signing operation.

Syntax

```
IppStatus ippsDLPSignDSA(const IppsBigNumState* pMsg, const IppsBigNumState*
pPrivate, IppsBigNumState* pSignR, IppsBigNumState* pSignS, IppsDLPState*
pCtx);
```

Parameters

pMsg	Pointer to the message representation *msgRep* to be signed.
pPrivate	Pointer to the signer's private key *privKey*.
pSignR	Pointer to the *r*-component of the signature.
pSignS	Pointer to the *s*-component of the signature.
pCtx	Pointer to the cryptosystem context.

Description

This function is declared in the `ippcp.h` file. The function performs the DSA digital signature signing operation provided that the ephemeral signer's key pair (both private and public) was previously computed (generated by `DLPGenKeyPair` or computed by `DLPPublicKey`) and then set up into the DLP context by the `DLPSetKeyPair` function.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.
`ippStsIncompleteContextErr`	Indicates an error condition if the cryptosystem context has not been properly set up.
`ippStsMessageErr`	Indicates an error condition if the value of *msgRep* is greater than the multiplicative subgroup characteristic (*q*).
`ippStsInvalidPrivateKey`	Indicates an error condition if an illegal value has been assigned to *privKey*.
`ippStsRangeErr`	Indicates an error condition if any of the signature components has not enough space.

DLPVerifyDSA

Verifies the input DSA digital signature.

Syntax

```
IppStatus ippsDLPVerifyDSA(const IppsBigNumState* pMsg, const IppsBigNumState*
pSignR, const IppsBigNumState* pSignS, IppDLResult* pResult, IppsDLPState*
pCtx);
```

Parameters

pMsg	Pointer to the message representation *msgRep*.
pSignR	Pointer to the signature *r*-component to be verified.
pSignS	Pointer to the signature *s*-component to be verified.
pResult	Pointer to the result of the verification.

pCtx	Pointer to the cryptosystem context.

Description

This function is declared in the ippcp.h file. The function verifies the input DSA digital signature's components **pSignR* and **pSignS* with the supplied message representation *msgRep*. Signer's public key must be stored by the DLPSetKeyPair function before the DLPVerifyDSA operation.

The function sets the **pResult* to ippDLValid if it validates the input DSA digital signature, or to ippDLInvalidSignature if the DSA digital signature verification fails.

Example 5-9 illustrates the use of functions DLPSignDSA and DLPVerifyDSA. The example uses the BigNumber class and functions creating some cryptographic contexts, whose source code can be found in Appendix B.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsIncompleteContextErr	Indicates an error condition if the cryptosystem context has not been properly set up.
ippStsMessageErr	Indicates an error condition if the value of *msgRep* is greater than the multiplicative subgroup characteristic (*q*).

Example of Using RSA Primitive Functions

Example 5-9 Use of DLPSignDSA and DLPVerifyDSA

```
//
// known domain parameters
//
static const int M = 512; // DSA system bitsize
static const int L = 160; // DSA order  bitsize
static
BigNumber P("0x8DF2A494492276AA3D25759BB06869CBEAC0D83AFB8D0CF7" \
            "CBB8324F0D7882E5D0762FC5B7210EAFC2E9ADAC32AB7AAC" \
            "49693DFBF83724C2EC0736EE31C80291");

static
BigNumber Q("0xC773218C737EC8EE993B4F2DED30F48EDACE915F");

static
BigNumber G("0x626D027839EA0A13413163A55B4CB500299D5522956CEFCB" \
            "3BFF10F399CE2C2E71CB9DE5FA24BABF58E5B79521925C9C" \
            "C42E9F6F464B088CC572AF53E6D78802");

//
// known DSA regular key pair
//
static
BigNumber X("0x2070B3223DBA372FDE1C0FFC7B2E3B498B260614");
```

```
static
BigNumber Y("0x19131871D75B1612A819F29D78D1B0D7346F7AA77BB62A85" \
            "9BFD6C5675DA9D212D3A36EF1672EF660B8C7C255CC0EC74" \
            "858FBA33F44C06699630A76B030EE333");


int DSAsign_verify_sample(void)
{
   // DLP context
   IppsDLPState *DLPState = newDLP(M, L);

   // set up DLP crypto system
   ippsDLPSet(P, Q, G, DLPState);

  // message
   Ipp8u message[] = "abc";

   // compute message digest to be signed
   Ipp8u md[SHA1_DIGEST_LENGTH/8];
   ippsSHA1MessageDigest(message, sizeof(message)-1, md);
   BigNumber digest(0, BITS_2_WORDS(SHA1_DIGEST_LENGTH));
   ippsSetOctString_BN(md, SHA1_DIGEST_LENGTH/8, digest);

   // generate ephemeral key pair (ephX,ephY)
   BigNumber ephX(0, BITS_2_WORDS(L));
   BigNumber ephY(0, BITS_2_WORDS(M));
```

```
   IppsPRNGState* pRand = newPRNG();
   ippsDLPGenKeyPair(ephX, ephY, DLPState, ippsPRNGen, pRand);
   deletePRNG(pRand);
   //
   // generate signature
   //
   BigNumber signR(0, BITS_2_WORDS(L));      // R and S signature's component
   BigNumber signS(0, BITS_2_WORDS(L));
   ippsDLPSetKeyPair(ephX, ephY, DLPState);  // set up ephemeral keys
   ippsDLPSignDSA(digest, X,                 // sign digest
                  signR, signS,
                  DLPState);



   //
   // verify signature
   //
   ippsDLPSetKeyPair(0, Y, DLPState);        // set up regular public key
 IppDLResult result;
 ippsDLPVerifyDSA(digest, signR,signS,     // verify
                    &result, DLPState);

   deleteDLP(DLPState);
   return result==ippDLValid;
}
```

DLPGenerateDH

Generates domain parameters of the DL-based cryptosystem over GF(p) to use the DH Agreement scheme.

Syntax

```
IppStatus IppsDLPGenerateDH(const IppsBigNumState* pSeedIn, int nTrials,
IppsDLPState* pCtx, IppsBigNumState* pSeedOut, int* pCounter, IppBitSupplier
rndFunc, void* pRndParam);
```

Parameters

pSeedIn	Pointer to the input *Seed*.
nTrials	Security parameter specified for the Miller-Rabin probable primality.
pCtx	Pointer to the cryptosystem context.
pSeedOut	Pointer to the output *Seed* value (if requested).
pCounter	Pointer to the *counter* value (if requested).
rndFunc	Specified Random Generator.
pRndParam	Pointer to the Random Generator context.

Description

This function is declared in the `ippcp.h` file. The function generates domain parameters of the DL-based cryptosystem over GF(*p*) to use Diffie-Hellman Agreement scheme. The function uses a procedure specified in [X9.42] for generating both randomized prime *p* and *r* based on the input **pSeedIn*.

Generated primes *r* and *p* are further validated through a *nTrial*-round Miller-Rabin primality test. Both generation and primality test procedures employ specified *rndFunc* Random Generator.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.

ippStsSizeErr	Indicates an error condition if: *peBits* < 512 or *reBits* < 160, *peBits* is not divided by 256.
ippStsRangeErr	Indicates an error condition if: bitsize of the input *Seed* value is less than *reBits*, not enough space to store the output *Seed* value (if requested).
ippStsBadArgErr	Indicates an error condition if *nTrials* < 1.
ippStsInsuffucientEntropy	Indicates a warning condition if prime generation fails due to a poor choice of the entropy.

DLPValidateDH

Validates domain parameters of the DL-based cryptosystem over GF(p) to use the DH Agreement scheme.

Syntax

```
IppStatus ippsDLPValidateDH(int nTrials, IppDLResult* pResult, IppsDLPState* pCtx, IppBitSupplier rndFunc, void* pRndParam);
```

Parameters

nTrials	Security parameter specified for the Miller-Rabin probable primality.
pResult	Pointer to the validation result.
pCtx	Pointer to the cryptosystem context.
rndFunc	Specified Random Generator.
pRndParam	Pointer to the Random Generator context.

Description

This function is declared in the `ippcp.h` file. The function validates domain parameters of the DL-based cryptosystem over GF(*p*) to use Diffie-Hellman Agreement scheme. The result of validation is stored in the **pResult* and may be assigned to one of the enumerators listed below:

ippDLValid	Validation has passed successfully.
ippDLBaseIsEven	*P* is even.
ippDLOrderIsEven	*R* is even.

ippDLInvalidBaseRange	$P \le 2^{peBits-1}$ or $P \ge 2^{peBits}$.
ippDLInvalidOrderRange	$R \le 2^{reBits-1}$ or $R \ge 2^{reBits}$.
ippDLCompositeBase	*P* is not a prime.
ippDLCompositeOrder	*R* is not a prime.
ippDLInvalidCofactor	*R* is not divisible by (*P* -1).
ippDLInvalidGenerator	(1 < *G* < (*P* -1)) is false or *G*^*R* != 1 (mod *P*).

To ensure that both *p* and *r* are primes, the function applies *nTrial*-round Miller-Rabin primality test. Test data for primality test is provided by the specified *rndFunc* Random Generator.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the context parameter does not match the operation.
ippStsIncompleteContextErr	Indicates an error condition if the cryptosystem context has not been properly set up.
ippStsBadArgErr	Indicates an error condition if *nTrials* < 1.

DLPSharedSecretDH

Computes a shared field element by using the Diffie-Hellman scheme.

Syntax

```
IssStatus ippsDLPSharedSecretDH(const IppsBigNumState* pPrivateA, const
IppsBigNumState* pPublicB, IppsBigNumState* pShare, IppsDLPState* pCtx);
```

Parameters

pPrivateA	Pointer to your own private key *privateKeyA*.
pPublicB	Pointer to the public key *pubKeyB* belonging to the other party.
pShare	Pointer to the shared secret element *Share*.

pCtx	Pointer to the cryptosystem context.

Description

This function is declared in the `ippcp.h` file. The function computes a shared secret element FG(p) $pubKeyB^{privateKeyA}(mod\ p)$.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the context parameter does not match the operation.
`ippStsIncompleteContextErr`	Indicates an error condition if the cryptosystem context has not been properly set up.
`ippStsRangeErr`	Indicates an error condition if *Share* does not have enough space.

Elliptic Curve Cryptography Functions

Intel® Integrated Performance Primitives (Intel® IPP) for cryptography offer functions allowing for different operations with an elliptic curve defined over a prime finite field GF(p) and binary finite field GF(2^m). The functions are based on standards [IEEE P1363A], [SEC1], and [ANSI]. For more information on parameters recommended for the functions, see [SEC2].

The full list of Elliptic Curve Cryptography functions is given in Table 5-9.

Table 5-10 Intel IPP Elliptic Curve Cryptography Functions

Function Base Name	Operation
Functions Operating over GF(*p*)	
`ECCPGetSize`	Gets the size of the `IppsECCPState` context.
`ECCPInit`	Initializes context for the elliptic curve cryptosystem over GF(p).
`ECCPSet`	Sets up elliptic curve domain parameters over GF(p).
`ECCPSetStd`	Sets up a recommended set of elliptic curve domain parameters over GF(p).
`ECCPGet`	Retrieves elliptic curve domain parameters over GF(p).

Function Base Name	Operation
ECCPGetOrderBitSize	Retrieves order size of the elliptic curve base point over GF(*p*) in bits
ECCPValidate	Checks validity of the elliptic curve domain parameters over GF(*p*).
ECCPPointGetSize	Gets the size of the IppsECCPPoint context in bytes for a point on the elliptic curve point defined over GF(*p*).
ECCPPointInit	Initializes context for a point on the elliptic curve defined over GF(*p*).
ECCPSetPoint	Sets coordinates of a point on the elliptic curve defined over GF(*p*).
ECCPSetPointAtInfinity	Sets the point at infinity.
ECCPGetPoint	Retrieves coordinates of the point on the elliptic curve defined over GF(*p*).
ECCPCheckPoint	Checks correctness of the point on the elliptic curve defined over GF(*p*).
ECCPComparePoint	Compares two points on the elliptic curve defined over GF(*p*).
ECCPNegativePoint	Finds an elliptic curve point which is an additive inverse for the given point over GF(*p*).
ECCPAddPoint	Computes the addition of two elliptic curve points over GF(*p*).
ECCPMulPointScalar	Performs scalar multiplication of a point on the elliptic curve defined over GF(*p*).
ECCPGenKeyPair	Generates a private key and computes public keys of the elliptic cryptosystem over GF(*p*).
ECCPPublicKey	Computes a public key from the given private key of the elliptic cryptosystem over GF(*p*).
ECCPValidateKeyPair	Validates private and public keys of the elliptic cryptosystem over GF(*p*).
ECCPSetKeyPair	Sets private and/or public keys of the elliptic cryptosystem over GF(*p*).
ECCPSharedSecretDH	Computes a shared secret field element by using the Diffie-Hellman scheme.
ECCPSharedSecretDHC	Computes a shared secret field element by using the Diffie-Hellman scheme and the elliptic curve cofactor.
ECCPSignDSA	Computes a digital signature over a message digest.
ECCPVerifyDSA	Verifies authenticity of the digital signature over a message digest (ECDSA).

Function Base Name	Operation
ECCPSignNR	Computes the digital signature over a message digest (the Nyberg-Rueppel scheme).
ECCPVerifyNR	Verifies authenticity of the digital signature over a message digest (the Nyberg-Rueppel scheme).
Functions Operating over GF(2^m)	
ECCBGetSize	Gets the size of the IppsECCBState context.
ECCBInit	Initializes context for the elliptic curve cryptosystem over GF(2^m).
ECCBSet	Sets up elliptic curve domain parameters over GF(2^m).
ECCBSetStd	Sets up a recommended set of elliptic curve domain parameters over GF(2^m).
ECCBGet	Retrieves elliptic curve domain parameters over GF(2^m).
ECCBGetOrderBitSize	Retrieves order size of the elliptic curve base point over GF(2^m) in bits.
ECCBValidate	Checks validity of the elliptic curve domain parameters over GF(2^m).
ECCBPointGetSize	Gets the size of the IppsECCBPoint context in bytes for a point on the elliptic curve point defined over GF(2^m).
ECCBPointInit	Initializes context for a point on the elliptic curve defined over GF(2^m).
ECCBSetPoint	Sets coordinates of a point on the elliptic curve defined over GF(2^m).
ECCBSetPointAtInfinity	Sets the point at infinity.
ECCBGetPoint	Retrieves coordinates of the point on the elliptic curve defined over GF(2^m).
ECCBCheckPoint	Checks correctness of the point on the elliptic curve defined over GF(2^m).
ECCBComparePoint	Compares two points on the elliptic curve defined over GF(2^m).
ECCBNegativePoint	Finds an elliptic curve point which is an additive inverse for the given point over GF(2^m).
ECCBAddPoint	Computes the addition of two elliptic curve points over GF(2^m).
ECCBMulPointScalar	Performs scalar multiplication of a point on the elliptic curve defined over GF(2^m).

Function Base Name	Operation
ECCBGenKeyPair	Generates a private key and computes public keys of the elliptic cryptosystem over GF(2^m).
ECCBPublicKey	Computes a public key from the given private key of the elliptic cryptosystem over GF(2^m).
ECCBValidateKeyPair	Validates private and secret keys of the elliptic cryptosystem over GF(2^m).
ECCBSetKeyPair	Sets private and/or public keys in the elliptic cryptosystem over GF(2^m).
ECCBSharedSecretDH	Computes a shared secret field element by using the Diffie-Hellman scheme.
ECCBSharedSecretDHC	Computes a shared secret field element by using the Diffie-Hellman scheme and the elliptic curve cofactor.
ECCBSignDSA	Computes a digital signature over a message digest.
ECCBVerifyDSA	Verifies authenticity of the digital signature over a message digest (ECDSA).
ECCBSignNR	Computes the digital signature over a message digest (the Nyberg-Rueppel scheme).
ECCBVerifyNR	Computes authenticity of the digital signature over a message digest (the Nyberg-Rueppel scheme).

Public key cryptography successfully allows to solve problems of information security by enabling secure communication over insecure channels. Although elliptic curves are well studied as a branch of mathematics, an interest to the cryptographic schemes based on elliptic curves is constantly rising due to the advantages that the elliptic curve algorithms provide in the wireless communications: shorter processing time and key length.

Elliptic curve cryptosystems (ECCs) implement a different way of creating public keys. Because elliptic curve calculation is based on the addition of the rational points in the (x,y) plane and it is difficult to solve a discrete logarithm from these points, a higher level of security is achieved through the cryptographic schemes that use the elliptic curves. The cryptographic systems that encrypt messages by using the properties of elliptic curves are hard to attack due to the extreme complexity of deciphering the private key.

Use of elliptic curves allows for shorter public key length and encourage cryptographers to create cryptosystems with the same or higher encryption strength as the RSA or DSA cryptosystems. Because of the relatively short key length, ECCs do encryption and decryption faster on the hardware that requires less computation processing volumes. For example, with a key length of 150-350 bits, ECCs provide the same encryption strength as the cryptosystems who have to use 600 -1400 bits. Alternatively, it requires considerably less time to create a digital signature with the ECDSA (Elliptic Curve Digital Signature Algorithm) algorithm rather than with the RSA algorithm even though you are using the same processor machine.

Functions Based on GF(*p*)

This section describes functions designed to specify the elliptic curve cryptosystem and perform various operations on the elliptic curve defined over a prime finite field. The examples of the operations are shown below:

1. Setting up operations `ECCPSet` sets up elliptic curve domain parameters. `ECCPSetKeyPair` sets a pair of public and private keys for the given cryptosystem.
2. Computation operations `ECCPAddPoint` adds two points on the elliptic curve. `ECCPMul-PointScalar` performs the scalar multiplication of a point on the elliptic curve. `ECCPSignDSA` computes the digital signature of a message.
3. Validation operations `ECCPValidate` checks validity of the elliptic curve domain parameters. `ECCPValidateKeyPair` validates correctness of the public and private keys.
4. Generation operations `ECCPGenKeyPair` generates a private key and computes a public key for the given elliptic cryptosystem.
5. Retrieval operations `ECCPGet` retrieves elliptic curve domain parameters. `ECCPGetOrder-BitSize` retrieves the size of a base point in bytes.

All functions described in this section employ a context `IppsECCPState` that catches several auxiliary components specifying operations performed on the elliptic curve or entire elliptic cryptosystem. ECCP stands for Elliptic Curve Cryptography Prime and means that all functions whose name include this abbreviation perform operations over a prime finite field GF(*p*).

ECCPGetSize

Gets the size of the `IppsECCPState` *context.*

Syntax

```
IppStatus ippsECCPGetSize(int feBitSize, int *pSize);
```

Parameters

feBitSize	Size (in bits) of the field element.
pSize	Pointer to the size (in bytes) of the context.

Description

The function computes the size of the context in bytes for the elliptic cryptosystem over a prime finite field GF (*p*).

Context is a structure `IppsECCPState` designed to store information about the cryptosystem status.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsSizeErr`	Indicates an error condition if the value of the parameter *`feBitSize`* is less than 2.

ECCPInit

Initializes context for the elliptic curve cryptosystem over GF(p).

Syntax

```
IppStatus ippsECCPInit(int feBitSize, IppsECCPState* pECC);
```

Parameters

`feBitSize`	Size (in bits) of a field element.
`pECC`	Pointer to the cryptosystem context.

Description

The function initializes the context of the elliptic curve cryptosystem over the prime finite field GF(*p*).

Context is a structure `IppsECCPState` designed to store information about the cryptosystem status.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is NULL.
`ippStsSizeErr`	Indicates an error condition if the value of the parameter *`feBitSize`* is less than 2.

ECCPSet

Sets up elliptic curve domain parameters over GF(p).

Syntax

```
IppStatus ippsECCPSet(const IppsBigNumState* pPrime, const IppsBigNumState*
pA, const IppsBigNumState* pB, const IppsBigNumState* pGX, const
IppsBigNumState* pGY, const IppsBigNumState* pOrder, int cofactor,
IppsECCPState* pECC);
```

Parameters

pPrime	Pointer to the characteristic *p* of the prime finite field GF(*p*).
pA	Pointer to the coefficient *A* of the equation defining the elliptic curve.
pB	Pointer to the coefficient *B* of the equation defining the elliptic curve.
pGX	Pointer to the *x*-coordinate of the elliptic curve base point.
pGY	Pointer to the *y*-coordinate of the elliptic curve base point.
pOrder	Pointer to the order of the elliptic curve base point.
cofactor	Cofactor.
pECC	Pointer to the context of the cryptosystem.

Description

The function sets up the elliptic curve domain parameters over a prime finite field GF(*p*). These are as follows:

- *pPrime* sets up the characteristic *p* of a finite field GF(*p*) where *p* is a prime number.
- *pA*, *pB* set up the coefficients *A* and *B* of the equation defining the elliptic curve: $y^2 = x^3 + A \cdot x + B \pmod{p}$.
- *pGX*, *pGY* are pointers to the affine coordinates of the elliptic curve base point *G*.

- *pOrder* is a pointer to the order *n* of the elliptic curve base point *G* such that $n \cdot G = O$, where *O* is the point at infinity and *n* is a prime number.
- *cofactor* sets up the ratio *h* of a general number of points #E on the elliptic curve (including the point at infinity) to the order *n* of the base point:

  $h = \#E/n$.

The domain parameters are set in the cryptosystem context which must be already created by the ECCPGetSize and ECCPInit functions.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if one of the contexts pointed by *pPrime*, *pA*, *pB*, *pGX*, *pGY*, *pOrder*, and *pECC* is not valid.
ippStsRangeErr	Indicates an error condition if of one of the parameters pointed by *pPrime*, *pA*, *pB*, *pGX*, *pGY*, and *pOrder* cannot embed the *feBitSize* bits length or the value of *cofactor* is less than 1.

ECCPSetStd

Sets up a recommended set of elliptic curve domain parameters over GF(p).

Syntax

```
IppStatus ippsECCPSetStd(IppECCType flag, IppsECCPState* pECC);
```

Parameters

flag	Set specifier.
pECC	Pointer to the cryptosystem context.

Description

The function sets a recommended set of elliptic curve domain parameters over a prime finite field GF(*p*).

The set is defined by the value of the parameter *flag*. Possible values of the parameter are as follows:

IppECCPStd112r1	For the cryptosystem context where *feBitSize*==112
IppECCPStd112r2	For the cryptosystem context where *feBitSize*==112
IppECCPStd128r1	For the cryptosystem context where *feBitSize*==128
IppECCPStd128r2	For the cryptosystem context where *feBitSize*==128
IppECCPStd160r1	For the cryptosystem context where *feBitSize*==160
IppECCPStd160r2	For the cryptosystem context where *feBitSize*==160
IppECCPStd192r1	For the cryptosystem context where *feBitSize*==192
IppECCPStd224r1	For the cryptosystem context where *feBitSize*==224
IppECCPStd256r1	For the cryptosystem context where *feBitSize*==256
IppECCPStd384r1	For the cryptosystem context where *feBitSize*==384
IppECCPStd521r1	For the cryptosystem context where *feBitSize*==521.

For more information on parameter values for the recommended elliptic curves, see [SEC2].

The cryptosystem context must be already created by the ECCPGetSize and ECCPInit functions. The value of *feBitSize* is applied when these functions are called and predetermines the possible choice of the *flag* value.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the cryptosystem context is not valid.
ippStsECCInvalidFlagErr	Indicates an error condition if the value of the parameter *flag* is not valid.

ECCPGet

Retrieves elliptic curve domain parameters over GF(p).

Syntax

```
IppStatus ippsECCPGet(IppsBigNumState* pPrime, IppsBigNumState* pA,
IppsBigNumState* pB, IppsBigNumState* pGX,IppsBigNumState* pGY,
IppsBigNumState* pOrder, int* cofactor, IppsECCPState* pECC);
```

Parameters

pPrime	Pointer to the characteristic p of the prime finite field GF(p).
pA	Pointer to the coefficient A of the equation defining the elliptic curve.
pB	Pointer to the coefficient B of the equation defining the elliptic curve.
pGX	Pointer to the x-coordinate of the elliptic curve base point.
pGY	Pointer to the y-coordinate of the elliptic curve base point.
pOrder	Pointer to the order n of the elliptic curve base point.
cofactor	Pointer to the cofactor h.
pECC	Pointer to the context of the cryptosystem.

Description

The function retrieves elliptic curve domain parameters from the context of the elliptic cryptosystem over a finite field GF(p) and allocates them in accordance with the pointers *pPrime*, *pA*, *pB*, *pGX*, *pGY*, *pOrder*, and *cofactor*. The elliptic curve domain parameters must be hitherto defined by one of the functions: ECCPSet or ECCPSetStd.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

ippStsContextMatchErr	Indicates an error condition if one of the contexts pointed by *pPrime*, *pA*, *pB*, *pGX*, *pGY*, *pOrder*, or *pECC* is not valid.
ippStsRangeErr	Indicates an error condition if the memory size of one of the parameters pointed by *pPrime*, *pA*, *pB*, *pGX*, *pGY*, *pOrder*, and *pECC* is less than the value of *feBitSize* in the ECCPInit function.

ECCPGetOrderBitSize

Retrieves order size of the elliptic curve base point over GF(p) in bits.

Syntax

```
IppStatus ippsECCPGetOrderBitSize(int* pBitSize, IppsECCPState* pECC);
```

Parameters

pBitSize	Pointer to the size of the base point (in bits).
pECC	Pointer to the cryptosystem context.

Description

The function retrieves the order size (in bits) of the elliptic curve base point *G* from the context of elliptic cryptosystem over a prime finite field GF(*p*) and allocates it in accordance with the pointer *pBitsSize*. The elliptic curve domain parameters must be hitherto defined by one of the functions: ECCPSet or ECCPSetStd.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the cryptosystem context is not valid.

ECCPValidate

Checks validity of the elliptic curve domain parameters over GF(p).

Syntax

```
IppStatus ippsECCPValidate(int nTrials, IppECResult* pResult, IppsECCPState*
pECC, IppBitSupplier rndFunc, void* pRndParam);
```

Parameters

nTrials	A number of attempts made to check the number for primality.
pResult	Pointer to the result received upon the check of the elliptic curve domain parameters.
pECC	Pointer to the cryptosystem context.
rndFunc	Specified Random Generator.
pRndParam	Pointer to Random Generator context.

Description

The function checks validity of the elliptic curve domain parameters over a prime finite field GF(*p*) and stores the result of the check in accordance with the pointer *pResult*.

Elliptic curve domain parameters must be hitherto defined by one of the functions: ECCPSet or ECCPSetStd. The purpose of the parameters *rndFunc*, *pRndParam*, and *nTrials* is analogous to that of the parameters *rndFunc*, *pRndParam*, and *nTrials* in the PrimeTest function.

The result of the elliptic curve domain parameters check can take one of the following values:

ippECValid	The parameters are valid.
ippECCompositeBase	The prime finite field characterisitc p is a composite number.
ippECIsNotAG	The solutions of the elliptic curve equation do not form the abelian group because the only requirement that $4 \cdot a^3 + 27 \cdot b^3 \neq 0$ is not met.
ippECPointIsNotValid	The base point *G* is not on the elliptic curve.
ippECCompositeOrder	The order *n* of the base point *G* is a composite number.

ippECInvalidOrder	The order *n* of the base point *G* is not valid because the requirement that $n \cdot G = O$ where *O* is the point at infinity is not met.
ippECIsWeakSSSA	The order *n* of the base point *G* is equal to the finite field characteristic *p*.
ippECIsWeakMOV	The curve is excluded because it is subject to the MOV reduction attack.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if one of the contexts pointed by *c* or *pECC* is not valid.
ippStsBadArgErr	Indicates an error condition if the memory size of the parameter *seed* is less than five words (32 bytes in each) or the value of the parameter *nTrails* is less than 1.

ECCPPointGetSize

Gets the size of the IppsECCPPoint *context in bytes for a point on the elliptic curve point defined over GF(p).*

Syntax

```
IppStatus ippsECCPPointGetSize(int feBitSize, int* pSize);
```

Parameters

feBitSize	Size (in bits) of the field element.
pSize	Pointer to the context size.

Description

The function computes the context size in bytes for a point on the elliptic curve defined over a prime finite field GF(*p*).

Context is a structure `IppsECCPPoint` intended for storing the information about a point on the elliptic curve defined over GF(*p*).

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsSizeErr`	Indicates an error condition if the value of the parameter *`feBitSize`* is less than 2.

ECCPPointInit

Initializes the context for a point on the elliptic curve defined over GF(p).

Syntax

```
IppStatus ippsECCPPointInit(int feBitSize, IppsECCPPoint* pPoint);
```

Parameters

`feBitSize`	Size (in bits) of the field element.
`pECC`	Pointer to the context of the elliptic curve point.

Description

The function initializes the context for a point on the elliptic curve defined over a finite field GF(*p*).

Context is a structure `IppsECCPPoint` intended for storing the information about a point on the elliptic curve defined over GF(*p*).

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsSizeErr`	Indicates an error condition if the value of the parameter *`feBitSize`* is less than 2.

ECCPSetPoint

Sets coordinates of a point on the elliptic curve defined over GF(p).

Syntax

```
IppStatus ippsECCPSetPoint(const IppsBigNumState* pX, const IppsBigNumState* pY, IppsECCPPoint* pPoint, IppsECCPState* pECC);
```

Parameters

pX	Pointer to the *x*-coordinate of the point on the elliptic curve.
pY	Pointer to the *y*-coordinate of the point on the elliptic curve.
pPoint	Pointer to the context of the elliptic curve point.
pECC	Pointer to the context of the elliptic cryptosystem.

Description

The function sets the coordinates of a point on the elliptic curve defined over a prime finite field GF(*p*).

The context of the point on the elliptic curve must be already created by functions: ECCPPoint-GetSize and ECCPPointInit. The elliptic curve domain parameters must be hitherto defined by one of the functions: ECCPSet or ECCPSetStd.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if one of the contexts pointed by *pX*, *pY*, *pPoint*, or *pECC* is not valid.

ECCPSetPointAtInfinity

Sets the point at infinity.

Syntax

```
IppStatus ippsECCPSetPointAtInfinity(IppsECCPPoint* pPoint, IppsECCPState* pECC);
```

Parameters

pPoint	Pointer to the context of the elliptic curve point.
pECC	Pointer to the context of the elliptic cryptosystem.

Description

The function sets the point at infinity. The context of the elliptic curve point must be already created by functions: ECCPPointGetSize and ECCPPointInit. The elliptic curve domain parameters must be hitherto defined by one of the functions: ECCPSet or ECCPSetStd.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if one of the contexts pointed by *pPoint* or *pECC* is not valid.

ECCPGetPoint

Retrieves coordinates of the point on the elliptic curve defined over GF(p).

Syntax

```
IppStatus ippsECCPGetPoint(IppsBigNumState* pX, IppsBigNumState* pY, const IppsECCPPoint* pPoint, IppsECCPState* pECC);
```

Parameters

pX	Pointer to the *x*-coordinate of the point on the elliptic curve.
pY	Pointer to the *y*-coordinate of the point on the elliptic curve.
pPoint	Pointer to the context of the elliptic curve point.
pECC	Pointer to the context of the elliptic cryptosystem.

Description

The function retrieves the coordinates of the point on the elliptic curve defined over a prime finite field GF(*p*) from the point context and allocates them in accordance with the set pointers *pX* and *pY*.

The elliptic curve domain parameters must be hitherto defined by one of the functions: ECCPSet or ECCPSetStd.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if one of the contexts pointed by *pX*, *pY*, *pPoint*, or *pECC* is not valid.

ECCPCheckPoint

Checks correctness of the point on the elliptic curve defined over GF(p).

Syntax

```
IppStatus ippsECCPCheckPoint(const IppsECCPPoint* pP, IppECResult* pResult,
IppsECCPState* pECC);
```

Parameters

pP	Pointer to the elliptic curve point.
pResult	Pointer to the result of the check.

pECC	Pointer to the context of the elliptic cryptosystem.

Description

The function checks the correctness of the point on the elliptic curve defined over a prime finite field GF(*p*) and allocates the result of the check in accordance with the pointer *pResult*.

The elliptic curve domain parameters must be hitherto defined by one of the functions: ECCPSet or ECCPSetStd.

The result of the check for the correctness of the point can take one of the following values:

ippECValid	Point is on the elliptic curve.
ippECPointIsNotValid	Point is not on the elliptic curve and is not the point at infinity.
ippECPointIsAtInfinite	Point is the point at infinity.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if one of the contexts pointed by *pP* or *pECC* is not valid.

ECCPComparePoint

Compares two points on the elliptic curve defined over GF(p).

Syntax

```
IppStatus ippsECCPComparePoint(const IppsECCPPoint* pP, const IppsECCPPoint* pQ, IppECResult* pResult, IppsECCPState* pECC);
```

Parameters

pP	Pointer to the elliptic curve point *P*.
pQ	Pointer to the elliptic curve point *Q*.
pResult	Pointer to the comparison result of two points: *P* and *Q*.
pECC	Pointer to the context of the elliptic cryptosystem.

Description

The function compares two points *P* and *Q* on the elliptic curve defined over a prime finite field GF(*p*) and allocates the comparison result in accordance with the pointer *pResult*.

The elliptic curve domain parameters must be hitherto defined by one of the functions: ECCPSet or ECCPSetStd.

The comparison result of two points *P* and *Q* can take one of the following values:

ippECPointIsEqual	Points *P* and *Q* are equal.
ippECPointIsNotEqual	Points *P* and *Q* are different.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if one of the contexts pointed by *pP* or *pECC* is not valid.

ECCPNegativePoint

Finds an elliptic curve point which is an additive inverse for the given point over GF(p).

Syntax

```
IppStatus ippsECCPNegativePoint(const IppsECCPPoint* pP, IppsECCPPoint* pR,
IppsECCPState* pECC);
```

Parameters

pP	Pointer to the elliptic curve point *P*.
pR	Pointer to the elliptic curve point *R*.
pECC	Pointer to the context of the elliptic cryptosystem.

Description

The function finds an elliptic curve point *R* over a prime finite field GF(*p*), which is an additive inverse of the given point *P*, that is, *R* = – *P* .

The elliptic curve domain parameters must be hitherto defined by one of the functions: ECCPSet or ECCPSetStd.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if one of the contexts pointed by *pP*, *pR*, or *pECC* is not valid.

ECCPAddPoint

Computes the addition of two elliptic curve points over GF(p).

Syntax

```
IppStatus ippsECCPAddPoint(const IppsECCPPoint* pP, const IppsECCPPoint* pQ,
IppsECCPPoint* pR, IppsECCPState* pECC);
```

Parameters

pP	Pointer to the elliptic curve point *P*.
pQ	Pointer to the elliptic curve point *Q*.
pR	Pointer to the elliptic curve point *R*.
pECC	Pointer to the context of the elliptic cryptosystem.

Description

The function calculates the addition of two elliptic curve points *P* and *Q* over a finite field GF(*p*) with the result in a point *R* such that *R = P + Q*.

The elliptic curve domain parameters must be hitherto defined by one of the functions: ECCPSet or ECCPSetStd.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

ippStsContextMatchErr	Indicates an error condition if one of the contexts pointed by *pP*, *pQ*, *pR*, or *pECC* is not valid.

ECCPMulPointScalar

Performs scalar multiplication of a point on the elliptic curve defined over GF(p).

Syntax

```
IppStatus ippsECCPMulPointScalar(const IppsECCPPoint* pP, const
IppsBigNumState* pK, IppsECCPPoint* pR, IppsECCPState* pECC);
```

Parameters

pP	Pointer to the elliptic curve point *P*.
pK	Pointer to the scalar *K*.
pR	Pointer to the elliptic curve point *R*.
pECC	Pointer to the context of the elliptic cryptosystem.

Description

The function performs the *K* scalar multiplication of an elliptic curve point *P* over GF(*p*) with the result in a point *R* such that $R = K \cdot P$.

The elliptic curve domain parameters must be hitherto defined by one of the functions: ECCPSet or ECCPSetStd.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if one of the contexts pointed by *pP*, *pK*, *pR*, or *pECC* is not valid.

ECCPGenKeyPair

Generates a private key and computes public keys of the elliptic cryptosystem over GF(p).

Syntax

```
IppStatus ippsECCPGenKeyPair(IppsBigNumState* pPrivate, IppsECCPPointState*
pPublic, IppsECCPState* pECC, IppBitSupplier rndFunc, void* pRndParam);
```

Parameters

pPrivate	Pointer to the private key *privKey*.
pPublic	Pointer to the public key *pubKey*.
pECC	Pointer to the context of the elliptic cryptosystem.
rndFunc	Specified Random Generator.
pRndParam	Pointer to the Random Generator context.

Description

The function generates a private key *privKey* and computes a public key *pubKey* of the elliptic cryptosystem over a finite field GF(*p*). The generation process employs the user specified *rndFunc* Random Generator.

The private key *privKey* is a number that lies in the range of [1, *n*-1] where *n* is the order of the elliptic curve base point.

The public key *pubKey* is an elliptic curve point such that $pubKey = privKey \cdot G$, where *G* is the base point of the elliptic curve.

The memory size of the parameter *privKey* pointed by *pPrivate* must be less than that of the base point which can also be defined by the function ECCPGetOrderBitSize.

The context of the point *pubKey* as an elliptic curve point must be created by using the functions ECCPPointGetSize and ECCPPointInit.

The elliptic curve domain parameters must be hitherto defined by one of the functions: ECCPSet or ECCPSetStd.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.

ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if one of the contexts pointed by *pPrivate*, *pPublic*, or *pECC* is not valid.
ippStsSizeErr	Indicates an error condition if the memory size of the parameter *privKey* pointed by *pPrivate* is less than that of the order of the elliptic curve base point.

ECCPPublicKey

Computes a public key from the given private key of the elliptic cryptosystem over GF(p).

Syntax

```
IppStatus ippsECCPPublicKey(const IppsBigNumState* pPrivate, IppsECCPPoint* pPublic, IppsECCPState* pECC);
```

Parameters

pPrivate	Pointer to the private key *privKey*.
pPublic	Pointer to the public key *pubKey*.
pECC	Pointer to the context of the elliptic cryptosystem.

Description

The function computes the public key *pubKey* from the given private key *privKey* of the elliptic cryptosystem over a finite field GF(*p*).

The private key *privKey* is a number that lies in the range of [1, *n*-1] where *n* is the order of the elliptic curve base point. The public key *pubKey* is an elliptic curve point such that *pubKey* = *privKey* · *G*, where *G* is the base point of the elliptic curve.

The context of the point *pubKey* as an elliptic curve point must be created by using the functions ECCPPointGetSize and ECCPPointInit.

The elliptic curve domain parameters must be defined by one of the functions: ECCPSet or ECCPSetStd.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.

ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if one of the contexts pointed by *pPrivate*, *pPublic*, or *pECC* is not valid.
ippStsIvalidPrivateKey	Indicates an error condition if the value of the private key falls outside the range of [1, *n*-1].

ECCPValidateKeyPair

Validates private and public keys of the elliptic cryptosystem over GF(p).

Syntax

```
IppStatus ippsECCPValidateKeyPair(const IppsBigNumState* pPrivate, const IppsECCPPoint* pPublic, IppECResult* pResult, IppsECCPState* pECC);
```

Parameters

pPrivate	Pointer to the private key *privKey*.
pPublic	Pointer to the public key *pubKey*.
pResult	Pointer to the validation result.
pECC	Pointer to the context of the elliptic cryptosystem.

Description

The function validates the private key *privKey* and public key *pubKey* of the elliptic cryptosystem over a finite field GF(*p*) and allocates the result of the validation in accordance with the pointer *pResult*.

The private key *privKey* is a number that lies in the range of [1, *n*-1] where *n* is the order of the elliptic curve base point. The public key *pubKey* is an elliptic curve point such that *pubKey* = *privKey* · *G*, where *G* is the base point of the elliptic curve.

The elliptic curve domain parameters must be hitherto defined by one of the functions: ECCPSet or ECCPSetStd.

The result of the cryptosystem keys validation for correctness can take one of the following values:

ippECValid	Keys are valid.

ippECInvalidKeyPair	Keys are not valid because $privKey \cdot G \neq pubKey$
ippECInvalidPrivateKey	Key *privKey* falls outside the range of [1, *n*-1].
ippECPointIsAtInfinite	Key *pubKey* is the point at infinity.
ippECInvalidPublicKey	Key *pubKey* is not valid because $n \cdot pubKey \neq O$, where *O* is the point at infinity.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if one of the contexts pointed by *pPrivate*, *pPublic*, or *pECC* is not valid.

ECCPSetKeyPair

Sets private and/or public keys of the elliptic cryptosystem over GF(p).

Syntax

```
IppStatus ippsECCPSetKeyPair(const IppsBigNumState* pPrivate, const
IppsECCPPoint* pPublic, IppBool regular, IppsECCPState* pECC);
```

Parameters

pPrivate	Pointer to the private key *privKey*.
pPublic	Pointer to the public key *pubKey*.
regular	Key status flag.
pECC	Pointer to the context of the elliptic cryptosystem.

Description

The function sets a private key *privKey* and/or public key *pubKey* in the elliptic cryptosystem defined over a prime finite field GF(*p*).

The private key *privKey* is a number that lies in the range of [1, *n*-1] where *n* is the order of the elliptic curve base point. The public key *pubKey* is an elliptic curve point such that $pubKey = privKey \cdot G$, where *G* is the base point of the elliptic curve.

The two possible values of the parameter *regular* define the key timeliness status:

ippTrue	Keys are regular.
ippFalse	Keys are ephemeral.

The elliptic curve domain parameters must be hitherto defined by one of the functions: ECCPSet or ECCPSetStd.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if one of the contexts pointed by *pPrivate*, *pPublic*, or *pECC* is not valid.

ECCPSharedSecretDH

Computes a shared secret field element by using the Diffie-Hellman scheme.

Syntax

```
IppStatus ippsECCPSharedSecretDH(const IppsBigNumState* pPrivate, const IppsECCPPointState* pPublic, IppsBigNumState* pShare, IppsECCPState* pECC);
```

Parameters

pPrivate	Pointer to your own public key *pubKey*.
pPublic	Pointer to the public key *pubKey*.
pShare	Pointer to the secret number*bnShare*.
pECC	Pointer to the context of the elliptic cryptosystem.

Description

The function computes a secret number *bnShare*, which is a secret key shared between two participants of the cryptosystem.

In cryptography, metasyntactic names such as Alice as Bob are normally used as examples and in discussions and stand for participant A and participant B.

Both participants (Alice and Bob) use the cryptosystem for receiving a common secret point on the elliptic curve called a secret key. To receive a secret key, participants apply the Diffie-Hellman key-agreement scheme involving public key exchange. The value of the secret key entirely depends on participants.

According to the scheme, Alice and Bob perform the following operations:

1. Alice calculates her own public key *pubKeyA* by using her private key *privKeyA*: *pubKeyA = privKeyA · G*, where *G* is the base point of the elliptic curve. Alice passes the public key to Bob.
2. Bob calculates his own public key *pubKeyB* by using his private key *privKeyB*: *pubKeyB = privKeyB · G*, where *G* is a base point of the elliptic curve. Bob passes the public key to Alice.
3. Alice gets Bob's public key and calculates the secret point *shareA*. When calculating, she uses her own private key and Bob's public key and applies the following formula: *shareA = privKeyA · pubKeyB = privKeyA · privKeyB · G*.
4. Bob gets Alice's public key and calculates the secret point *shareB*. When calculating, he uses his own private key and Alice's public key and applies the following formula: *shareB = privKeyB · pubKeyA = privKeyB · privKeyA · G*.

Because the following equation is true *privKeyA · privKeyB · G = privKeyB · privKeyA · G*, the result of both calculations is the same, that is, the equation *shareA = shareB* is true. The secret point serves as a secret key.

Shared secret *bnShare* is an x-coordinate of the secret point on the elliptic curve.

The elliptic curve domain parameters must be hitherto defined by one of the functions: ECCPSet or ECCPSetStd.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if one of the contexts pointed by *pPublic*, *pPShare*, or *pECC* is not valid.
ippStsRangeErr	Indicates an error condition if the memory size of *bnShare* pointed by *pShare* is less than the value of *feBitSize* in the function ECCPInit.

ippStsShareKeyErr	Indicates an error condition if the shared secret key is not valid. (For example, the shared secret key is invalid if the result of the secret point calculation is the point at infinity.

ECCPSharedSecretDHC

Computes a shared secret field element by using the Diffie-Hellman scheme and the elliptic curve cofactor.

Syntax

```
IppStatus ippsECCPSharedSecretDHC(const IppsBigNumState* pPrivate, const
IppsECCPPointState* pPublic, IppsBigNumState* pShare, IppsECCPState* pECC);
```

Parameters

pPrivate	Pointer to your own public key *pubKey*.
pPublic	Pointer to the public key *pubKey*.
pShare	Pointer to the secret number *bnShare*.
pECC	Pointer to the context of the elliptic cryptosystem.

Description

The function computes a secret number *bnShare* which is a secret key shared between two participants of the cryptosystem. Both participants (Alice and Bob) use the cryptosystem for getting a common secret point on the elliptic curve by using the Diffie-Hellman scheme and elliptic curve cofactor *h*.

Alice and Bob perform the following operations:

1. Alice calculates her own public key *pubKeyA* by using her private key *privKeyA*: *pubKeyA = privKeyA* · *G*, where *G* is the base point of the elliptic curve. Alice passes the public key to Bob.
2. Bob calculates his own public key *pubKeyB* by using his private key *privKeyB*: *pubKeyB = privKeyB* · *G*, where *G* is a base point of the elliptic curve. Bob passes the public key to Alice.
3. Alice gets Bob's public key and calculates the secret point *shareA*. When calculating, she uses her own private key and Bob's public key and applies the following formula: *shareA = h* · *privKeyA* · *pubKeyB = h* · *privKeyA* · *privKeyB* · *G*, where *h* is the elliptic curve cofactor.

4. Bob gets Alice's public key and calculates the secret point *shareB*. When calculating, he uses his own private key and Alice's public key and applies the following formula: *shareB = h · privKeyB · pubKeyA = h · privKeyB · privKeyA · G*, where *h* is the elliptic curve cofactor.

Shared secret *bnShare* is an x-coordinate of the secret point on the elliptic curve.

The elliptic curve domain parameters must be hitherto defined by one of the functions: ECCPSet or ECCPSetStd.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if one of the contexts pointed by *pPublic*, *pPShare*, or *pECC* is not valid.
ippStsRangeErr	Indicates an error condition if the memory size of *bnShare* pointed by *pShare* is less than the value of *feBitSize* in the function ECCPInit.
ippStsShareKeyErr	Indicates an error condition if the shared secret key is not valid. (For example, the shared secret key is invalid if the result of the secret point calculation is the point at infinity.

ECCPSignDSA

Computes a digital signature over a message digest.

Syntax

```
IppStatus ippsECCPSignDSA(const IppsBigNumState* pMsgDigest, const
IppsBigNumState* pPrivate, IppsBigNumState* pSignX, IppsBigNumState* pSignY,
IppsECCPState* pECC);
```

Parameters

pMsgDigest	Pointer to the message digest *msg* to be digitally signed, that is, to be ecrypted with a private key.
pPrivate	Pointer to the signer's regular private key.

pSignX	Pointer to the integer *r* of the digital signature.
pSignY	Pointer to the integer *s* of the digital signature.
pECC	Pointer to the context of the elliptic cryptosystem.

Description

A message digest is a fixed size number derived from the original message with an applied hash function over the binary code of the message. The signer's private key and the message digest are used to create a signature.

A digital signature over a message consists of a pair of large numbers *r* and *s* which the given function computes.

The scheme used for computing a digital signature is analogue of the ECDSA scheme, an elliptic curve analogue of the DSA scheme. ECDSA assumes that the following keys are hitherto set by a message signer:

ephPrivKey	Ephemeral private key.
ephPubKey	Ephemeral public key.

The keys can be generated and set up by the unctions ECCPGenKeyPair and ECCPSetKeyPair with only requirement that the key *regPrivKey* be different from the key *ephPrivKey*.

The elliptic curve domain parameters must be hitherto defined by one of the functions: ECCPSet or ECCPSetStd.

For more information on digital signatures, please refer to the [ANSI] standard.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if one of the contexts pointed by *pMsgDigest*, *pSignX*, *pSignY*, or *ECC* is not valid.
ippStsMessageErr	Indicates an error condition if the value of *msg* pointed by *pMsgDigest* falls outside the range of [1, 1-*n*] where *n* is the order of the elliptic curve base point *G*.
ippStsRangeErr	Indicates an error condition if one of the parameters pointed by *pSignX* or *pSignY* has a less memory size than the order *n* of the elliptic curve base point *G*.

ippStsEphemeralKeyErr	Indicates an error condition if the values of the ephemeral keys *ephPrivKey* and *ephPubKey* are not valid. (Either $r = 0$ or $s = 0$ is received as a result of the digital signature calculation).

ECCPVerifyDSA

Verifies authenticity of the digital signature over a message digest (ECDSA).

Syntax

```
IppStatus ippsECCPVerifyDSA(const IppsBigNumState* pMsgDigest, const
IppsBigNumState* pSignX, const IppsBigNumState* pSignY, IppECResult* pResult,
IppsECCPState* pECC);
```

Parameters

pMsgDigest	Pointer to the message digest *msg*.
pSignX	Pointer to the integer *r* of the digital signature.
pSignY	Pointer to the integer *s* of the digital signature.
pResult	Pointer to the digital signature verification result.
pECC	Pointer to the context of the elliptic cryptosystem.

Description

The function verifies authenticity of the digital signature over a message digest *msg*. The signature consists of two large integers: *r* and *s*.

The scheme used to verify the signature is an elliptic curve analogue of the DSA scheme and assumes that the following cryptosystem key be hitherto set:

regPubKey	Message sender's regular public key.

The *regPubKey* is set by the function ECCPSetKeyPair.

The result of the digital signature verification can take one of two possible values:

ippECValid	Digital signature is valid.
ippECInvalidSignature	Digital signature is not valid.

The call to the ECCPVerifyDSA function must be preceded by the call to the ECCPSignDSA function which computes the digital signature over the message digest *msg* and represents the signature with two numbers: *r* and *s*.

The elliptic curve domain parameters must be hitherto defined by one of the functions: ECCPSet or ECCPSetStd.

For more information on digital signatures, please refer to the [ANSI] standard.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if one of the contexts pointed by *pMsgDigest*, *pSignX*, *pSignY*, or *ECC* is not valid.
ippStsMessageErr	Indicates an error condition if the value of *msg* pointed by *pMsgDigest* falls outside the range of [1, 1-*n*] where *n* is the order of the elliptic curve base base point *G*.

ECCPSignNR

Computes the digital signature over a message digest (the Nyberg-Rueppel scheme).

Syntax

```
IppStatus ippsECCPSignNR(const IppsBigNumState* pMsgDigest, IppsBigNumState*
pSignX, IppsBigNumState* pSignY, IppsECCPState* pECC);
```

Parameters

pMsgDigest	Pointer to the message digest *msg*.
pSignX	Pointer to the integer *r* of the digital signature.
pSignY	Pointer to the integer *s* of the digital signature.
pECC	Pointer to the context of the elliptic cryptosystem.

Description

The function computes two large numbers *r* and *s* which form the digital signature over a message digest *msg*.

The scheme used to compute the digital signature is an elliptic curve analogue of the El-Gamal Digital Signature scheme with the message recovery (the Nyberg-Rueppel signature scheme). The scheme that the given function uses assumes that the following cryptosystem keys are hitherto set up by the message sender:

regPrivKey	Regular private key.
ephPrivKey	Ephemeral private key.
ephPubKey	Ephemeral public key.

The keys can be generated and set up by the functions `ECCPGenKeyPair` and `ECCPSetKeyPair` with only requirement that the key *regPrivKey* be different from the key *ephPrivKey*.

The elliptic curve domain parameters must be hitherto defined by one of the functions: `ECCPSet` or `ECCPSetStd`.

For more information on digital signatures, please refer to the [ANSI] standard.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if one of the contexts pointed by *`pMsgDigest`*, *`pSignX`*, *`pSignY`*, or *`ECC`* is not valid.
`ippStsMessageErr`	Indicates an error condition if the value of *msg* pointed by *`pMsgDigest`* falls outside the range of [1, 1-*n*] where *n* is the order of the elliptic curve base point *G*.
`ippStsRangeErr`	Indicates an error condition if one of the parameters pointed by *`pSignX`* or *`pSignY`* has a less memory size than the order *n* of the elliptic curve base point *G*.
`ippStsEphemeralKeyErr`	Indicates an error condition if the values of the ephemeral keys *ephPrivKey* and *ephPubKey* are not valid. (Either $r = 0$ or $s = 0$ is received as a result of the digital signature calculation).

ECCPVerifyNR

Verifies authenticity of the digital signature over a message digest (the Nyberg-Rueppel scheme).

Syntax

```
IppStatus ippsECCPVerifyNR(const IppsBigNumState* pMsgDigest, const
IppsBigNumState* pSignX, const IppsBigNumState* pSignY, IppECResult* pResult,
IppsECCPState* pECC);
```

Parameters

pMsgDigest	Pointer to the message digest *msg*.
pSignX	Pointer to the integer *r* of the digital signature.
pSignY	Pointer to the integer *s* of the digital signature.
pResult	Pointer to the digital signature verification result.
pECC	Pointer to the context of the elliptic cryptosystem.

Description

The function verifies authenticity of the digital signature over a message digest *msg*. The signature is presented with two large integers *r* and *s*.

The scheme used to compute the digital signature is an elliptic curve analogue of the El-Gamal Digital Signature scheme with the message recovery (the Nyberg-Rueppel signature scheme). The scheme that the given function uses assumes that the following cryptosystem keys be hitherto set up by the message sender:

regPubKey	Message sender's regular private key.

The key can be generated and set up by the function ECCPGenKeyPair.

The result of the digital signature verification can take one of two possible values:

ippECValid	The digital signature is valid.
ippECInvalidSignature	The digital signature is not valid.

The call to the ECCPVerifyNR function must be preceded by the call to the ECCPSignNR function which computes the digital signature over the message digest *msg* and represents the signature with two numbers: *r* and *s*.

The elliptic curve domain parameters must be hitherto defined by one of the functions: ECCPSet or ECCPSetStd.

For more information on digital signatures, please refer to the [ANSI] standard.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if one of the contexts pointed by *pMsgDigest*, *pSignX*, *pSignY*, or *ECC* is not valid.
ippStsMessageErr	Indicates an error condition if the value of *msg* pointed by *pMsgDigest* falls outside the range of [1, 1-*n*] where *n* is the order of the elliptic curve base point *G*.

Functions Based on GF(*2^m*)

This section describes functions designed to specify the elliptic curve cryptosystem and perform various operations on the elliptic curve defined over a binary finite field. The examples of the operations are illustrated below:

1. Setting up operations ECCBSet sets up elliptic curve domain parameters. ECCBSetKeyPair sets a pair of public and private keys for the given cryptosystem.
2. Computation operations ECCBAddPoint adds two points on the elliptic curve. ECCBMul-PointScalar performs the scalar multiplication of a point on the elliptic curve. ECCBSignDSA computes the digital signature of a message.
3. Validation operations ECCBValidate checks validity of the elliptic curve domain parameters. ECCBValidateKeyPair validates correctness of the public and private keys.
4. Generation operations ECCBGenKeyPair generates a private key and computes a public key for the given elliptic cryptosystem.
5. Retrieval operations ECCBGet retrieves elliptic curve domain parameters. ECCBGetOrder-BitSize retrieves the size of a base point in bytes.

All functions described in this section employ a context IppsECCBState that catches several auxiliary components specifying operations performed on the elliptic curve or entire elliptic cryptosystem. ECCB stands for Elliptic Curve Cryptography Binary and means that all functions whose name include this abbreviation perform operations over a binary finite field GF(2^m).

ECCBGetSize

Gets the size of the `IppsECCBState` *context.*

Syntax

```
IppStatus ippsECCBGetSize(int feBitSize, int *pSize);
```

Parameters

feBitSize	Size (in bits) of the field element.
pSize	Pointer to the size of the context (in bytes).

Description

The function computes the size of the context in bytes for the elliptic cryptosystem over a binary finite field GF (2^m).

Context is a structure `IppsECCBState` designed to store information about the cryptosystem status.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsSizeErr`	Indicates an error condition if the value of the parameter *feBitSize* is less than 1.

ECCBInit

Initializes context for the elliptic curve cryptosystem over GF(2^m).

Syntax

```
IppStatus ippsECCBInit(int feBitSize, IppsECCBState* pECC);
```

Parameters

feBitSize	Size (in bits) of a field element.
pECC	Pointer to the cryptosystem context.

Description

The function initializes the context of the elliptic curve cryptosystem over a binary finite field GF (2^m).

Context is a structure `IppsECCBState` designed to store information about the cryptosystem status.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsSizeErr`	Indicates an error condition if the value of the parameter *`feBitSize`* is less than 1.

ECCBSet

Sets up elliptic curve domain parameters over GF(2^m).

Syntax

```
IppStatus ippsECCBSet(const IppsBigNumState* pPrime, const IppsBigNumState*
pA, const IppsBigNumState* pB, const IppsBigNumState* pGX, const
IppsBigNumState* pGY, const IppsBigNumState* pOrder, int cofactor,
IppsECCBState* pECC);
```

Parameters

`pPrime`	Pointer to the irreducible binary polynomial *`f(x)`* of degree *m* which specifies the presentation of the field GF(2^m).
`pA`	Pointer to the coefficient *A* of the equation defining the elliptic curve.
`pB`	Pointer to the coefficient *B* of the equation defining the elliptic curve.
`pGX`	Pointer to the *x*-coordinate of the elliptic curve base point.

pGY	Pointer to the *y*-coordinate of the elliptic curve base point.
pOrder	Pointer to the order of the elliptic curve base point.
cofactor	Cofactor.
pECC	Pointer to the context of the cryptosystem.

Description

The function sets up the elliptic curve domain parameters over a binary finite field GF(2^m). These are as follows:

- *pPrime* sets up the characteristic *f(x)* of degree *m*, which specifies the presentation of the field GF(2^m).
- *pA*, *pB* set up the coefficients *A* and *B* of the equation defining the elliptic curve:
  $y^2 + x \cdot y = x^3 + A \cdot x^2 + B$ in GF(2^m)
- *pGX*, *pGY* are pointers to the affine coordinates of the elliptic curve base point *G*.
- *pOrder* is a pointer to the order *n* of the elliptic curve base point *G* such that
  $n \cdot G = O$, where *O* is the point at infinity and *n* is a prime number.
- *cofactor* sets up the ratio *h* of a general number of points #E on the elliptic curve (including the point at infinity) to the order *n* of the base point:
  $h = \#E/n$.

The domain parameters are set in the cryptosystem context which must be already created by the ECCBGetSize and ECCBInit functions.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if one of the contexts pointed by *pPrime*, *pA*, *pB*, *pGX*, *pGY*, *pOrder*, and *pECC* is not valid.
ippStsRangeErr	Indicates an error condition if the memory size of one of the parameters pointed by *pPrime*, *pA*, *pB*, *pGX*, *pGY*, *pOrder*, and *pECC* is more than the value of *feBitSize* in the ECCBInit function or the value of *cofactor* is less than or equal to zero.

ECCBSetStd

Sets up a recommended set of elliptic curve domain parameters over GF(2^m).

Syntax

```
IppStatus ippsECCBSetStd(IppECCType flag, IppsECCBState* pECC);
```

Parameters

flag	Set specifier.
pECC	Pointer to the cryptosystem context.

Description

The function sets a recommended set of elliptic curve domain parameters over a binary finite field GF(2^m).

The set is defined by the value of the parameter *flag*. Possible values of the parameter are as follows:

IppECCBStd113r1	For the cryptosystem context where *feBitSize*==113
IppECCBStd113r2	For the cryptosystem context where *feBitSize*==113
IppECCBStd131r1	For the cryptosystem context where *feBitSize*==131
IppECCBStd131r2	For the cryptosystem context where *feBitSize*==131
IppECCBStd163k1	For the cryptosystem context where *feBitSize*==163
IppECCBStd163r1	For the cryptosystem context where *feBitSize*==163
IppECCBStd163r2	For the cryptosystem context where *feBitSize*==163
IppECCBStd193r1	For the cryptosystem context where *feBitSize*==193
IppECCBStd193r2	For the cryptosystem context where *feBitSize*==193
IppECCBStd233k1	For the cryptosystem context where *feBitSize*==233
IppECCBStd233r1	For the cryptosystem context where *feBitSize*==233
IppECCBStd239k1	For the cryptosystem context where *feBitSize*==239
IppECCBStd283k1	For the cryptosystem context where *feBitSize*==283
IppECCBStd283r1	For the cryptosystem context where *feBitSize*==283
IppECCBStd409k1	For the cryptosystem context where *feBitSize*==409

IppECCBStd409r1	For the cryptosystem context where *feBitSize*==409
IppECCBStd571k1	For the cryptosystem context where *feBitSize*==571
IppECCBStd571r1	For the cryptosystem context where *feBitSize*==571.

For more information on parameter values for the recommended elliptic curves, see [SEC2] .

The cryptosystem context must be already created by the ECCBGetSize and ECCBInit functions. The value of *feBitSize* is applied when these function are called and predetermines the possible choice of the *flag* value.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the cryptosystem context is not valid.
ippStsECCInvalidFlagErr	Indicates an error condition if the value of the parameter *flag* is not valid.

ECCBGet

Retrieves elliptic curve domain parameters over GF(2^m).

Syntax

```
IppStatus ippsECCBGet(IppsBigNumState* pPrime, IppsBigNumState* pA,
IppsBigNumState* pB, IppsBigNumState* pGX,IppsBigNumState* pGY,
IppsBigNumState* pOrder, int* cofactor, IppsECCBState* pECC);
```

Parameters

pPrime	Pointer to the irreducible binary polynomial *f(x)* of degree *m* which specifies the presentation of the field GF(2^m).
pA	Pointer to the coefficient *A* of the equation defining the elliptic curve.
pB	Pointer to the coefficient *B* of the equation defining the elliptic curve.

pGX	Pointer to the *x*-coordinate of the elliptic curve base point.
pGY	Pointer to the *y*-coordinate of the elliptic curve base point.
pOrder	Pointer to the order *n* of the elliptic curve base point.
cofactor	Pointer to the cofactor *h*.
pECC	Pointer to the context of the cryptosystem.

Description

The function retrieves elliptic curve domain parameters from the context of the elliptic cryptosystem over a binary finite field GF(2^m) and allocates them in accordance with the pointers *pPrime*, *pA*, *pB*, *pGX*, *pGY*, *pOrder*, and *cofactor*.

The elliptic curve domain parameters must be hitherto defined by one of the functions: ECCBSet or ECCBSetStd.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if one of the contexts pointed by *pPrime*, *pA*, *pB*, *pGX*, *pGY*, *pOrder*, or *pECC* is not valid.
ippStsRangeErr	Indicates an error condition if the memory size of one of the parameters pointed by *pPrime*, *pA*, *pB*, *pGX*, *pGY*, *pOrder*, and *pECC* is less than the value of *feBitSize* in the ECCBInit function.

ECCBGetOrderBitSize

Retrieves order size of the elliptic curve base point over GF(2^m) in bits.

Syntax

```
IppStatus ippsECCBGetOrderBitSize(int* pBitSize, IppsECCBState* pECC);
```

Parameters

pBitSize	Pointer to the size of the base point (in bits).

pECC	Pointer to the cryptosystem context.

Description

The function retrieves the order size (in bits) of the elliptic curve base point *G* from the context of elliptic cryptosystem over a binary finite field GF(2^m) and allocates it in accordance with the pointer *pBitsSize*.

The elliptic curve domain parameters must be hitherto defined by one of the functions: ECCBSet or ECCBSetStd.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if the cryptosystem context is not valid.

ECCBValidate

Checks validity of the elliptic curve domain parameters over GF(2^m).

Syntax

```
IppStatus ippsECCBValidate(int nTrials, IppECResult* pResult, IppsECCBState*
pECC, IppBitSupplier rndFunc, void* pRndParam);
```

Parameters

nTrials	A number of attempts made to check the number for primality.
pResult	Pointer to the result received upon the check of the elliptic curve domain parameters.
pECC	Pointer to the cryptosystem context.
rndFunc	Specified Random Generator.
pRndParam	Pointer to the Random Generator context.

Description

The function checks validity of the elliptic curve domain parameters over a binary finite field GF(2^m) and stores the result of the check in accordance with the pointer *pResult*.

Elliptic curve domain parameters must be hitherto defined by one of the functions: ECCBSet or ECCBSetStd. The purpose of the parameters *rndFunc*, *pRndParam*, and *nTrials* is analogous to that of the parameters *rndFunc*, *pRndParam*, and *nTrials* in the PrimeTest function.

The result of the elliptic curve domain parameters check can take one of the following values:

ippECValid	The parameters are valid.
ippECComplicatedBase	The irreducible binary polynomial *f(x)* of degree *m* which specifies the presentation of the field GF(2^m) is not valid because the set of polynomials consists of more than five elements.
ippECCompositeBase	The binary polynomial *f(x)* is not irreducible.
ippECIsSupersingular	The coefficient in the elliptic curve equation is NULL.
ippECPointAtInfinite	The elliptic curve base point *G* is the point at infinity.
ippECPointIsNotValid	Base point *G* is not on the elliptic curve.
ippECCompositeOrder	The order *n* of the base point *G* is a composite number.
ippECInvalidOrder	The order *n* of the base point *G* is not valid because the requirement that $n \cdot G = O$, where *O* is the point at infinity is not met.
ippECIsWeakSSSA	$h \cdot n = 2^m$ where *h* is a cofactor and *n* is the order *n* of the base point.
ippECIsWeakMOV	The curve is excluded because it is subject to the MOV reduction attack.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if one of the contexts pointed by *c* or *pECC* is not valid.

ippStsBadArgErr	Indicates an error condition if the memory size of the parameter *seed* is less than five words (32 bytes in each) or the value of the parameter *nTrails* is less than 1.

ECCBPointGetSize

Gets the size of the IppsECCBPoint *context in bytes for a point on the elliptic curve point defined over GF(2^m).*

Syntax

```
IppStatus ippsECCBPointGetSize(int feBitSize, int* pSize);
```

Parameters

feBitSize	Size (in bits) of the field element.
pSize	Pointer to the context size.

Description

The function computes the context size in bytes for a point on the elliptic curve defined over a binary finite field GF(2^m).

Context is a structure IppsECCBPoint intended for storing the information about a point on the elliptic curve defined over GF(2^m).

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsSizeErr	Indicates an error condition if the value of the parameter *feBitSize* is less than 1.

ECCBPointInit

Initializes the context for a point on the elliptic curve defined over GF(2^m).

Syntax

```
IppStatus ippsECCBPointInit(int feBitSize, IppsECCBPoint* pPoint);
```

Parameters

feBitSize	Size (in bits) of the field element.
pECC	Pointer to the context of the elliptic curve point.

Description

The function initializes the context for a point on the elliptic curve defined over a binary finite field GF(2^m).

Context is a structure `IppsECCBPoint` intended for storing the information about a point on the elliptic curve defined over GF(2^m).

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsSizeErr`	Indicates an error condition if the value of the parameter *feBitSize* is less than 1.

ECCBSetPoint

Sets coordinates of a point on the elliptic curve defined over GF(2^m).

Syntax

```
IppStatus ippsECCBSetPoint(const IppsBigNumState* pX, const IppsBigNumState*
pY, IppsECCBPoint* pPoint, IppsECCBState* pECC);
```

Parameters

pX	Pointer to the *x*-coordinate of the point on the elliptic curve.
pY	Pointer to the *y*-coordinate of the point on the elliptic curve.
pPoint	Pointer to the context of the elliptic curve point.
pECC	Pointer to the context of the elliptic cryptosystem.

Description

The function sets the coordinates of a point on the elliptic curve defined over a binary finite field GF(2^m).

The context of the point on the elliptic curve must be already created by functions: ECCBPoint-GetSize and ECCBPointInit. The elliptic curve domain parameters must be hitherto defined by one of the functions: ECCBSet or ECCBSetStd.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if one of the contexts pointed by *pX*, *pY*, *pPoint*, or *pECC* is not valid.

ECCBSetPointAtInfinity

Sets the point at infinity.

Syntax

```
IppStatus ippsECCBSetPointAtInfinity(IppsECCBPoint* pPoint, IppsECCBState* pECC);
```

Parameters

pPoint	Pointer to the context of the elliptic curve point.
pECC	Pointer to the context of the elliptic cryptosystem.

Description

The function sets the point at infinity. The context of the elliptic curve point must be already created by functions: ECCBPointGetSize and ECCBPointInit. The elliptic curve domain parameters must be hitherto defined by one of the functions: ECCBSet or ECCBSetStd.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if one of the contexts pointed by *pPoint* or *pECC* is not valid.

ECCBGetPoint

Retrieves coordinates of the point on the elliptic curve defined over GF(2^m).

Syntax

```
IppStatus ippsECCBGetPoint(IppsBigNumState* pX, IppsBigNumState* pY, const IppsECCBPoint* pPoint, IppsECCBState* pECC);
```

Parameters

pX	Pointer to the *x*-coordinate of the point on the elliptic curve.
pY	Pointer to the *y*-coordinate of the point on the elliptic curve.
pPoint	Pointer to the context of the elliptic curve point.
pECC	Pointer to the context of the elliptic cryptosystem.

Description

The function retrieves the coordinates of the point on the elliptic curve defined over a binary finite field GF(2^m) from the point context and allocates them in accordance with the set pointers *pX* and *pY*.

The elliptic curve domain parameters must be hitherto defined by one of the functions: ECCBSet or ECCBSetStd.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if one of the contexts pointed by *pX*, *pY*, *pPoint*, or *pECC* is not valid.

ECCBCheckPoint

Checks correctness of the point on the elliptic curve defined over GF(2^m).

Syntax

```
IppStatus ippsECCBCheckPoint(const IppsECCBPoint* pP, IppECResult* pResult,
IppsECCBState* pECC);
```

Parameters

pP	Pointer to the elliptic curve point.
pResult	Pointer to the result of the check.
pECC	Pointer to the context of the elliptic cryptosystem.

Description

The function checks the correctness of the point on the elliptic curve defined over a binary finite field GF(2^m) and allocates the result of the check in accordance with the pointer *pResult*.

The elliptic curve domain parameters must be hitherto defined by one of the functions: ECCBSet or ECCBSetStd.

The result of the check for the correctness of the point can take one of the following values:

ippECValid	Point is on the elliptic curve.
ippECPointIsNotValid	Point is not on the elliptic curve and is not the point at infinity.
ippECPointIsAtInfinite	Point is the point at infinity.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.

ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if one of the contexts pointed by *pP* or *pECC* is not valid.

ECCBComparePoint

Compares two points on the elliptic curve defined over GF(2^m).

Syntax

```
IppStatus ippsECCBComparePoint(const IppsECCBPoint* pP, const IppsECCBPoint* pQ, IppECResult* pResult, IppsECCBState* pECC);
```

Parameters

pP	Pointer to the elliptic curve point *P*.
pQ	Pointer to the elliptic curve point *Q*.
pResult	Pointer to the comparison result of two points: *P* and *Q*.
pECC	Pointer to the context of the elliptic cryptosystem.

Description

The function compares two points *P* and *Q* on the elliptic curve defined over a binary finite field GF(2^m) and allocates the comparison result in accordance with the pointer *pResult*.

The elliptic curve domain parameters must be hitherto defined by one of the functions: ECCBSet or ECCBSetStd.

The comparison result of two points *P* and *Q* can take one of the following values:

ippECPointIsEqual	Points *P* and *Q* are equal.
ippECPointIsNotEqual	Points *P* and *Q* are different.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

ippStsContextMatchErr	Indicates an error condition if one of the contexts pointed by *pP* or *pECC* is not valid.

ECCBNegativePoint

Finds the elliptic curve point which is an additive inverse for the given point over GF(2^m).

Syntax

```
IppStatus ippsECCBNegativePoint(const IppsECCBPoint* pP, IppsECCBPoint* pR,
IppsECCBState* pECC);
```

Parameters

pP	Pointer to the elliptic curve point *P*.
pR	Pointer to the elliptic curve point *R*.
pECC	Pointer to the context of the elliptic cryptosystem.

Description

The function finds an elliptic curve point *R* over a binary finite field GF(2^m) which is an additive inverse of the given point *P*, i.e., *R = – P*.

The elliptic curve domain parameters must be hitherto defined by one of the functions: ECCBSet or ECCBSetStd.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if one of the contexts pointed by *pP*, *pR*, or *pECC* is not valid.

ECCBAddPoint

Computes the addition of two elliptic curve points over GF(2^m).

Syntax

```
IppStatus ippsECCBAddPoint(const IppsECCBPoint* pP, const IppsECCBPoint* pQ,
IppsECCBPoint* pR, IppsECCBState* pECC);
```

Parameters

pP	Pointer to the elliptic curve point *P*.
pQ	Pointer to the elliptic curve point *Q*.
pR	Pointer to the elliptic curve point *R*.
pECC	Pointer to the context of the elliptic cryptosystem.

Description

The function calculates the addition of two elliptic curve points *P* and *Q* over a binary finite field GF(2^m) with the result in a point *R* such that *R=P+Q*.

The elliptic curve domain parameters must be hitherto defined by one of the functions: ECCBSet or ECCBSetStd.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if one of the contexts pointed by *pP*, *pQ*, *pR*, or *pECC* is not valid.

ECCBMulPointScalar

Performs scalar multiplication of a point on the elliptic curve defined over GF(2^m).

Syntax

```
IppStatus ippsECCBMulPointScalar(const IppsECCBPoint* pP, const
IppsBigNumState* pK, IppsECCBPoint* pR, IppsECCBState* pECC);
```

Parameters

pP	Pointer to the elliptic curve point *P*.
pK	Pointer to the scalar *K*.
pR	Pointer to the elliptic curve point *R*.
pECC	Pointer to the context of the elliptic cryptosystem.

Description

The function performs the *K* scalar multiplication of an elliptic curve point *P* over GF(2^m) with the result in a point *R* such that $R = K \cdot P$.

The elliptic curve domain parameters must be hitherto defined by one of the functions: ECCPSet or ECCPSetStd.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if one of the contexts pointed by *pP*, *pK*, *pR*, or *pECC* is not valid.

ECCBGenKeyPair

Generates a private key and computes public keys of the elliptic cryptosystem over GF(2^m).

Syntax

```
IppStatus ippsECCBGenKeyPair(IppsBigNumState* pPrivate, IppsECCBPointState*
pPublic, IppsECCBState* pECC, IppBitSupplier rndFunc, void* pRndParam);
```

Parameters

pPrivate	Pointer to the private key *privKey*.
pPublic	Pointer to the public key *pubKey*.
pECC	Pointer to the context of the elliptic cryptosystem.
rndFunc	Specified Random Generator.
pRndParam	Pointer to the Random Generator context.

Description

The function generates a private key *privKey* and computes a public key *pubKey* of the elliptic cryptosystem over a binary finite field GF(2^m). The generation process employs user specified *rndFunc* Random Generator.

The private key *privKey* is a number that lies in the range of [1, *n*-1] where *n* is the order of the elliptic curve base point.

The public key *pubKey* is an elliptic curve point such that $pubKey = privKey \cdot G$, where *G* is the base point of the elliptic curve.

The memory size of the parameter *privKey* pointed by *pPrivate* must be less than that of the base point, which can also be defined by the function ECCBGetOrderBitSize.

The context of the point *privKey* as an elliptic curve point must be created by using the functions ECCBPointGetSize and ECCBPointInit.

The elliptic curve domain parameters must be hitherto defined by one of the functions: ECCBSet or ECCBSetStd.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.

ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if one of the contexts pointed by *pPrivate*, *pPublic*, or *pECC* is not valid.
ippStsSizeErr	Indicates an error condition if the memory size of the parameter *privKey* pointed by *pPrivate* is less than that of the order of the elliptic curve base point.

ECCBPublicKey

Computes a public key from the given private key of the elliptic cryptosystem over GF(2^m).

Syntax

```
IppStatus ippsECCBPublicKey(const IppsBigNumState* pPrivate, IppsECCBPoint* pPublic, IppsECCBState* pECC);
```

Parameters

pPrivate	Pointer to the private key *privKey*.
pPublic	Pointer to the public key *pubKey*.
pECC	Pointer to the context of the elliptic cryptosystem.

Description

The function computes the public key *pubKey* from the given private key *privKey* of the elliptic cryptosystem over a binary finite field GF(2^m).

The private key *privKey* is a number that lies in the range of [1, *n*-1] where *n* is the order of the elliptic curve base point. The public key *pubKey* is an elliptic curve point such that *pubKey* = *privKey* · *G*, where *G* is the base point of the elliptic curve.

The context of the point *pubKey* as an elliptic curve point must be created by using the functions ECCBPointGetSize and ECCBPointInit.

The elliptic curve domain parameters must be hitherto defined by one of the functions: ECCBSet or ECCBSetStd.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if one of the contexts pointed by *pPrivate*, *pPublic*, or *pECC* is not valid.
ippStsIvalidPrivateKey	Indicates an error condition if the value of the private key falls outside the range of [1, *n*-1].

ECCBValidateKeyPair

Validates private and secret keys of the elliptic cryptosystem over GF(2^m).

Syntax

```
IppStatus ippsECCBValidateKeyPair(const IppsBigNumState* pPrivate, const
IppsECCBPoint* pPublic, IppECResult* pResult, IppsECCBState* pECC);
```

Parameters

pPrivate	Pointer to the private key *privKey*.
pPublic	Pointer to the public key *pubKey*.
pResult	Pointer to the validation result.
pECC	Pointer to the context of the elliptic cryptosystem.

Description

The function validates the private key *privKey* and public key *pubKey* of the elliptic cryptosystem over a binary finite field GF(2^m) and allocates the result of the validation in accordance with the pointer *pResult*.

The private key *privKey* is a number that lies in the range of [1, *n*-1] where *n* is the order of the elliptic curve base point. The public key *pubKey* is an elliptic curve point such that *pubKey* = *privKey* · *G*, where *G* is the base point of the elliptic curve.

The elliptic curve domain parameters must be hitherto defined by one of the functions: ECCBSet or ECCBSetStd.

The result of the cryptosystem keys validation for correctness can take one of the following values:

ippECValid	Keys are valid.
ippECInvalidKeyPair	Keys are not valid because $privKey \cdot G \neq pubKey$
ippECInvalidPrivateKey	Key *privKey* falls outside the range of [1, *n*-1].
ippECPointIsAtInfinite	Key *pubKey* is the point at infinity.
ippECInvalidPublicKey	Key *pubKey* is not valid because $n \cdot pubKey \neq O$, where *O* is the point at infinity.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if one of the contexts pointed by *pPrivate*, *pPublic*, or *pECC* is not valid.

ECCBSetKeyPair

Sets private and/or public keys in the elliptic cryptosystem over GF(2^m).

Syntax

```
IppStatus ippsECCBSetKeyPair(const IppsBigNumState* pPrivate, const
IppsECCBPoint* pPublic, IppBool regular, IppsECCBState* pECC);
```

Parameters

pPrivate	Pointer to the private key *privKey*.
pPublic	Pointer to the public key *pubKey*.
regular	Key status flag.
pECC	Pointer to the context of the elliptic cryptosystem.

Description

The function sets the private key *privKey* and/or public key *pubKey* in the elliptic cryptosystem defined over a binary finite field GF(2^m).

The private key *privKey* is a number that lies in the range of [1, *n*-1] where *n* is the order of the elliptic curve base point. The public key *pubKey* is an elliptic curve point such that *pubKey* = *privKey* · *G*, where *G* is the base point of the elliptic curve.

The two possible values of the parameter *regular* define the key timeliness status:

ippTrue	Keys are regular.
ippFalse	Keys are ephemeral.

The elliptic curve domain parameters must be hitherto defined by one of the functions: ECCBSet or ECCBSetStd.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if one of the contexts pointed by *pPrivate*, *pPublic*, or *pECC* is not valid.

ECCBSharedSecretDH

Computes a shared secret field element by using the Diffie-Hellman scheme.

Syntax

```
IppStatus ippsECCBSharedSecretDH(const IppsBigNumState* pPrivate, const IppsECCBPointState* pPublic, IppsBigNumState* pShare, IppsECCBState* pECC);
```

Parameters

pPrivate	Pointer to your own public key *pubKey*.
pPublic	Pointer to the public key *pubKey*.
pShare	Pointer to the secret number *bnShare*.
pECC	Pointer to the context of the elliptic cryptosystem.

Description

The function computes a secret number *bnShare*, which is a secret key shared between two participants of the cryptosystem.

In cryptography, metasyntactic names such as Alice as Bob are normally used as examples and in discussions and stand for participant A and participant B.

Both participants (Alice and Bob) use the cryptosystem for receiving a common secret point on the elliptic curve called a secret key. To receive a secret key, participants apply the Diffie-Hellman key-agreement scheme involving public key exchange. The value of the secret key entirely depends on participants.

According to the scheme, Alice and Bob perform the following operations:

1. Alice calculates her own public key *pubKeyA* by using her private key *privKeyA*: *pubKeyA = privKeyA · G*, where *G* is the base point of the elliptic curve. Alice passes the public key to Bob.
2. Bob calculates his own public key *pubKeyB* by using his private key *privKeyB*: *pubKeyB = privKeyB · G*, where *G* is a base point of the elliptic curve. Bob passes the public key to Alice.
3. Alice gets Bob's public key and calculates the secret point *shareA*. When calculating, she uses her own private key and Bob's public key and applies the following formula: *shareA = privKeyA · pubKeyB = privKeyA · privKeyB · G*.
4. Bob gets Alice's public key and calculates the secret point *shareB*. When calculating, he uses his own private key and Alice's public key and applies the following formula: *shareB = privKeyB · pubKeyA = privKeyB · privKeyA · G*.

Because the following equation is true *privKeyA · privKeyB · G = privKeyB · privKeyA · G*, the result of both calculations is the same, that is, the equation *shareA = shareB* is true. The secret point serves as a secret key.

Shared secret *bnShare* is an x-coordinate of the secret point on the elliptic curve.

The elliptic curve domain parameters must be hitherto defined by one of the functions: ECCBSet or ECCBSetStd.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if one of the contexts pointed by *pPublic*, *pPShare*, or *pECC* is not valid.
ippStsRangeErr	Indicates an error condition if the memory size of *bnShare* pointed by *pShare* is less than the value of *feBitSize* in the function ECCBInit.

`ippStsShareKeyErr`	Indicates an error condition if the shared secret key is not valid. (For example, the shared secret key is invalid if the result of the secret point calculation is the point at infinity.

ECCBSharedSecretDHC

Computes a shared secret field element by using the Diffie-Hellman scheme and the elliptic curve cofactor.

Syntax

```
IppStatus ippsECCBSharedSecretDHC(const IppsBigNumState* pPrivate, const
IppsECCBPointState* pPublic, IppsBigNumState* pShare, IppsECCBState* pECC);
```

Parameters

pPrivate	Pointer to your own public key *pubKey*.
pPublic	Pointer to the public key *pubKey*.
pShare	Pointer to the secret number *bnShare*.
pECC	Pointer to the context of the elliptic cryptosystem.

Description

The function computes a secret number *bnShare* which is a secret key shared between two participants of the cryptosystem. Both participants (Alice and Bob) use the cryptosystem for getting a common secret point on the elliptic curve by using the Diffie-Hellman scheme and elliptic curve cofactor *h*.

Alice and Bob perform the following operations:

1. Alice calculates her own public key *pubKeyA* by using her private key *privKeyA*: $pubKeyA = privKeyA \cdot G$, where *G* is the base point of the elliptic curve. Alice passes the public key to Bob.
2. Bob calculates his own public key *pubKeyB* by using his private key *privKeyB*: $pubKeyB = privKeyB \cdot G$, where *G* is a base point of the elliptic curve. Bob passes the public key to Alice.
3. Alice gets Bob's public key and calculates the secret point *shareA*. When calculating, she uses her own private key and Bob's public key and applies the following formula: $shareA = h \cdot privKeyA \cdot pubKeyB = h \cdot privKeyA \cdot privKeyB \cdot G$, where *h* is the elliptic curve cofactor.

4. Bob gets Alice's public key and calculates the secret point *shareB*. When calculating, he uses his own private key and Alice's public key and applies the following formula: *shareB = h · privKeyB · pubKeyA = h · privKeyB · privKeyA · G*, where *h* is the elliptic curve cofactor.

Shared secret *bnShare* is an x-coordinate of the secret point on the elliptic curve.

To define a secret key, the call to the ECCBSharedSecretDH function must be preceded by the call to the ECCBSetKeyPair function.

The elliptic curve domain parameters must be hitherto defined by one of the functions: ECCBSet or ECCBSetStd.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if one of the contexts pointed by *pPublic*, *pPShare*, or *pECC* is not valid.
ippStsRangeErr	Indicates an error condition if the memory size of *bnShare* pointed by *pShare* is less than the value of *feBitSize* in the function ECCBInit.
ippStsShareKeyErr	Indicates an error condition if the shared secret key is not valid. (For example, the shared secret key is invalid if the result of the secret point calculation is the point at infinity.

ECCBSignDSA

Computes a digital signature over a message digest.

Syntax

```
IppStatus ippsECCBSignDSA(const IppsBigNumState* pMsgDigest, const
IppsBigNumState* pPrivate, IppsBigNumState* pSignX, IppsBigNumState* pSignY,
IppsECCBState* pECC);
```

Parameters

pMsgDigest	Pointer to the message digest *msg* to be digitally signed, that is, to be ecrypted with a private key.
pPrivate	Pointer to the signer's regular private key.
pSignX	Pointer to the integer *r* of the digital signature.
pSignY	Pointer to the integer *s* of the digital signature.
pECC	Pointer to the context of the elliptic cryptosystem.

Description

A message digest is a fixed size number derived from the original message with an applied hash function over the binary code of the message. The signer's private key and the message digest are used to create a signature.

A digital signature over a message consists of a pair of large numbers *r* and *s* which the given function computes.

The scheme used for computing a digital signature is analogue of the ECDSA scheme, an elliptic curve analogue of the DSA scheme. ECDSA assumes that the following keys are hitherto set by a message signer:

ephPrivKey	Ephemeral private key.
ephPubKey	Ephemeral public key.

The keys can be generated and set up by the functions ECCBGenKeyPair and ECCBSetKeyPair with only requirement that the key *regPrivKey* be different from the key *ephPrivKey*.

The elliptic curve domain parameters must be hitherto defined by one of the functions: ECCBSet or ECCBSetStd.

For more information on digital signatures, please refer to the [ANSI] standard.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if one of the contexts pointed by *pMsgDigest*, *pSignX*, *pSignY*, or *ECC* is not valid.

ippStsMessageErr	Indicates an error condition if the value of *msg* pointed by *pMsgDigest* falls outside the range of [1, 1-*n*] where *n* is the order of the elliptic curve base point *G*.
ippStsRangeErr	Indicates an error condition if one of the parameters pointed by *pSignX* or *pSignY* has a less memory size than the order *n* of the elliptic curve base point *G*.
ippStsEphemeralKeyErr	Indicates an error condition if the values of the ephemeral keys *ephPrivKey* and *ephPubKey* are not valid. (Either *r* = 0 or *s* = 0 is received as a result of the digital signature calculation).

ECCBVerifyDSA

Verifies authenticity of the digital signature over a message digest (ECDSA).

Syntax

```
IppStatus ippsECCBVerifyDSA(const IppsBigNumState* pMsgDigest, const
IppsBigNumState* pSignX, const IppsBigNumState* pSignY, IppECResult* pResult,
IppsECCBState* pECC);
```

Parameters

pMsgDigest	Pointer to the message digest *msg*.
pSignX	Pointer to the integer *r* of the digital signature.
pSignY	Pointer to the integer *s* of the digital signature.
pResult	Pointer to the digital signature verification result.
pECC	Pointer to the context of the elliptic cryptosystem.

Description

The function verifies authenticity of the digital signature over a message digest *msg*. The signature consists of two large integers: *r* and *s*.

The scheme used to verify the signature is an elliptic curve analogue of the DSA scheme and assumes that the following cryptosystem key be hitherto set:

regPubKey	Message sender's regular public key.

The *regPubKey* is set by the function ECCBSetKeyPair.

The result of the digital signature verification can take one of two possible values:

ippECValid	Digital signature is valid.
ippECInvalidSignature	Digital signature is not valid.

The call to the ECCBVerifyDSA function must be preceded by the call to the ECCBSignDSA function which computes the digital signature over the message digest *msg* and represents the signature with two numbers: *r* and *s*.

The elliptic curve domain parameters must be hitherto defined by one of the functions: ECCBSet or ECCBSetStd.

For more information on digital signatures, please refer to the [ANSI] standard.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if one of the contexts pointed by *pMsgDigest*, *pSignX*, *pSignY*, or *ECC* is not valid.
ippStsMessageErr	Indicates an error condition if the value of *msg* pointed by *pMsgDigest* falls outside the range of [1, 1-*n*] where *n* is the order of the elliptic curve base base point *G*.

ECCBSignNR

Computes the digital signature over a message digest (the Nyberg-Rueppel scheme).

Syntax

```
IppStatus ippsECCBSignNR(const IppsBigNumState* pMsgDigest, IppsBigNumState*
pSignX, IppsBigNumState* pSignY, IppsECCBState* pECC);
```

Parameters

pMsgDigest	Pointer to the message digest *msg*.
pSignX	Pointer to the integer *r* of the digital signature.
pSignY	Pointer to the integer *s* of the digital signature.
pECC	Pointer to the context of the elliptic cryptosystem.

Description

The function computes two large numbers *r* and *s* which form the digital signature over a message digest *msg*.

The scheme used to compute the digital signature is an elliptic curve analogue of the El-Gamal Digital Signature scheme with the message recovery (the Nyberg-Rueppel signature scheme). The scheme that the given function uses assumes that the following cryptosystem keys are hitherto set up by the message sender:

regPrivKey	Regular private key.
ephPrivKey	Ephemeral private key.
ephPubKey	Ephemeral public key.

The keys can be generated and set up by the functions `ECCBGenKeyPair` and `ECCBSetKeyPair` with only requirement that the key *regPrivKey* be different from the key *ephPrivKey*.

The elliptic curve domain parameters must be hitherto defined by one of the functions: `ECCBSet` or `ECCBSetStd`.

For more information on digital signatures, please refer to the [ANSI] standard.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if one of the contexts pointed by *`pMsgDigest`*, *`pSignX`*, *`pSignY`*, or *`ECC`* is not valid.
`ippStsMessageErr`	Indicates an error condition if the value of *msg* pointed by *`pMsgDigest`* falls outside the range of [1, 1-*n*] where *n* is the order of the elliptic curve base point *G*.
`ippStsRangeErr`	Indicates an error condition if one of the parameters pointed by *`pSignX`* or *`pSignY`* has a less memory size than the order *n* of the elliptic curve base point *G*.
`ippStsEphemeralKeyErr`	Indicates an error condition if the values of the ephemeral keys *ephPrivKey* and *ephPubKey* are not valid. (Either *r* = 0 or *s* = 0 is received as a result of the digital signature calculation).

ECCBVerifyNR

Computes authenticity of the digital signature over a message digest (the Nyberg-Rueppel scheme).

Syntax

```
IppStatus ippsECCBVerifyNR(const IppsBigNumState* pMsgDigest, const
IppsBigNumState* pSignX, const IppsBigNumState* pSignY, IppECResult* pResult,
IppsECCBState* pECC);
```

Parameters

pMsgDigest	Pointer to the message digest *msg*.
pSignX	Pointer to the integer *r* of the digital signature.
pSignY	Pointer to the integer *s* of the digital signature.
pResult	Pointer to the digital signature verification result.
pECC	Pointer to the context of the elliptic cryptosystem.

Description

The function verifies authenticity of the digital signature over a message digest *msg*. The signature is presented with two large integers *r* and *s*.

The scheme used to compute the digital signature is an elliptic curve analogue of the El-Gamal Digital Signature scheme with the message recovery (the Nyberg-Rueppel signature scheme). The scheme that the given function uses assumes that the following cryptosystem keys be hitherto set up by the message sender:

regPubKey	Message sender's regular private key.

The key can be generated and set up by the function ECCBGenKeyPair.

The result of the digital signature verification can take one of two possible values:

ippECValid	The digital signature is valid.
ippECInvalidSignature	The digital signature is not valid.

The call to the ECCBVerifyNR function must be preceded by the call to the ECCBSignNR function which computes the digital signature over the message digest *msg* and represents the signature with two numbers: *r* and *s*.

The elliptic curve domain parameters must be hitherto defined by one of the functions: ECCBSet or ECCBSetStd.

For more information on digital signatures, please refer to the [ANSI] standard.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if one of the contexts pointed by *pMsgDigest*, *pSignX*, *pSignY*, or *ECC* is not valid.
ippStsMessageErr	Indicates an error condition if the value of *msg* pointed by *pMsgDigest* falls outside the range of [1, 1-*n*] where *n* is the order of the elliptic curve base point *G*.

Finite Field Arithmetic

This section describes the Intel IPP primitives that implement arithmetic operations with elements of finite fields [ANT]. Arithmetic of the following finite fields is implemented:

G(p)	A finite field of p elements represented by integers modulo p, where p is an odd prime number. This field is also known as a *prime finite field*.
GF(p^d)	A finite field of p^d elements represented by equivalence classes modulo $g(x)$ of polynomials whose coefficients belong to GF(p), where $g(x)$ is an irreducible polynomial of degree d. Coefficients of $g(x)$ are elements of the GF(p) field. This field is also known as an *extension field of degree d of GF(p)* or the *Galois field*.
GF(p^d^2)	A quadratic extension of GF(p^d).

Table 5-11 lists all the finite field arithmetic functions.

Table 5-11 Intel IPP Finite Field Arithmetic Functions

Function Base Name	Operation
Arithmetic of Finite Fields GF(p)	
GFPGetSize	Gets the size of the context of a GF(p) field.
GFPInit	Initializes the context of a GF(p) field.
GFPGet	Extracts parameters of the GF(p) field from the context.
GFPElementGetSize	Gets the size of the context for an element of the GF(p) field.

Function Base Name	Operation
GFPElementInit	Initializes the context of an element of the GF(p) field.
GFPSetElement	Assigns a value to an element of the GF(p) field.
GFPSetElementZero	Assigns the zero value to an element of the GF(p) field.
GFPSetElementPower2	Assigns the value of a given power of two to an element of the GF(p) field.
GFPSetElementRandom	Assigns a random value to an element of the GF(p) field.
GFPCpyElement	Copies one element of the GF(p) field to another.
GFPGetElement	Extracts the element of the GF(p) field from the context.
GFPCmpElement	Compares elements of the GF(p) field.
GFPNeg	Computes the additive inverse for an element of the GF(p) field.
GFPInv	Computes the multiplicative inverse for an element of the GF(p) field.
GFPSqrt	Takes the square root of an element of the GF(p) field.
GFPAdd	Adds elements of the GF(p) field.
GFPSub	Subtracts elements of the GF(p) field.
GFPMul	Multiplies elements of the GF(p) field.
GFPExp	Exponentiates an element of the GF(p) field.
GFPMontEncode	Converts an element of the GF(p) field to the Montgomery residue number system.
GFPMontDecode	Converts an element of the GF(p) field represented in the Montgomery residue number system to the regular GF(p) element.
Arithmetic of Finite Fields GF(p^d)	
GFPXGetSize	Gets the size of the context of a GF(p^d) field.
GFPXInit	Initializes the context of a GF(p^d) field.
GFPXGet	Extracts parameters of the GF(p^d) field from the context.
GFPXElementGetSize	Gets the size of the context for an element of the GF(p^d) field.
GFPXElementInit	Initializes the context of an element of the GF(p^d) field.
GFPXSetElement	Assigns a value to an element of the GF(p^d) field.
GFPXSetElementZero	Assigns the zero value to an element of the GF(p^d) field.

Function Base Name	Operation
GFPXSetElementPowerX	Assigns the value of a given power of x to an element of the GF(p^d) field.
GFPXSetElementRandom	Assigns a random value to an element of the GF(p^d) field.
GFPXCpyElement	Copies one element of the GF(p^d) field to another.
GFPXGetElement	Extracts the element of the GF(p^d) field from the context.
GFPXCmpElement	Compares elements of the GF(p^d) field.
GFPXNeg	Computes the additive inverse for an element of the GF(p^d) field.
GFPXInv	Computes the multiplicative inverse for an element of the GF(p^d) field.
GFPXAdd	Adds elements of the GF(p^d) field.
GFPXAdd_GFP	Adds elements of the GF(p^d) and GF(p) fields.
GFPXSub	Subtracts elements of the GF(p^d) field.
GFPXSub_GFP	Subtracts elements of the GF(p^d) and GF(p) fields.
GFPXMul	Multiplies elements of the GF(p^d) field.
GFPXMul_GFP	Multiplies elements of the GF(p^d) and GF(p) fields.
GFPXExp	Exponentiates an element of the GF(p^d) field.
GFPXDiv	Divides elements of the GF(p^d) field.
Arithmetic of Finite Fields GF(p^d^2)	
GFPXQGetSize	Gets the size of the context of a GF(p^{d^2}) field.
GFPXQInit	Initializes the context of a GF(p^{d^2}) field.
GFPXQGet	Extracts parameters of the GF(p^{d^2}) field from the context.
GFPXQElementGetSize	Gets the size of the context for an element of the GF(p^{d^2}) field.
GFPXQElementInit	Initializes the context of an element of the GF(p^{d^2}) field.
GFPXQSetElement	Assigns a value to an element of the GF(p^{d^2}) field.
GFPXQSetElementZero	Assigns the zero value to an element of the GF(p^{d^2}) field.
GFPXQSetElementPowerX	Assigns the value of a given power of x to an element of the GF(p^{d^2}) field.
GFPXQSetElementRandom	Assigns a random value to an element of the GF(p^{d^2}) field.
GFPXQCpyElement	Copies one element of the GF(p^{d^2}) field to another.

Function Base Name	Operation
GFPXQGetElement	Extracts the element of the GF(*p^d^2*) field from the context.
GFPXQCmpElement	Compares elements of the GF(*p^d^2*) field.
GFPXQNeg	Computes the additive inverse for an element of the GF(*p^d^2*) field.
GFPXQInv	Computes the multiplicative inverse for an element of the GF(*p^d^2*) field.
GFPXQAdd	Adds elements of the GF(*p^d^2*) field.
GFPXQSub	Subtracts elements of the GF(*p^d^2*) field.
GFPXQMul	Multiplies elements of the GF(*p^d^2*) field.
GFPXQMul_GFP	Multiplies elements of the GF(*p^d^2*) and GF(*p*) fields.
GFPXQExp	Exponentiates an element of the GF(*p^d^2*) field.

Each element *E* of GF(*p*) is represented by an unsigned big number, which, in turn, is represented by a data array `Ipp32u pe[length]`, so that

$$E = \sum_{0 \le i < length} pe[i] * 2^{(32*i)}$$

Each element *E* of GF(*p^d*) is represented by a polynomial of degree less than *d*, which, in turn, is represented by an array of coefficients `pe[d]` that belong to GF(*p*).

Each element *E* of GF(*p^d^2*) is represented by a polynomial of degree less than 2, which, in turn, is represented by an array of coefficients `pe[2]` that belong to GF(*p^d*).

For polynomials that represent elements of both fields, a coefficient of a lower degree is stored in an element of the respective array with a smaller index.

The Intel IPP finite field arithmetic functions use context structures of the following types to carry data of the field and field element:

GF(*p*)	`IppsGFPState` and `IppsGFPElement`, respectively.
GF(*p^d*)	`IppsGFPXState` and `IppsGFPXElement`, respectively.
GF(*p^d^2*)	`IppsGFPXQState` and `IppsGFPXQElement`, respectively.

Comparison functions `GFPCmpElement`, `GFPXCmpElement`, and `GFPXQCmpElement` return the result of comparison:

```
typedef enum {
    IppsElementEQ = 0, // elements are equal
    IppsElementNE = 1, // elements are not equal
    IppsElementGT = 2, // the first element is greater than the second one
```

```
    IppsElementLT = 3, // the first element is less than the second one
    IppsElementNA = 4 // elements are not comparable
} IppsElementCmpResult;
```

Functions for the GF(p) Field

GFPGetSize

Gets the size of the `IppsGFPState` *context of the finite field GF(p).*

Syntax

```
IppStatus ippsGFPGetSize(Ipp32u bitSize, Ipp32u *stateSizeInBytes);
```

Parameters

bitSize	Size in bytes of the odd prime number *p* (modulus of GF(*p*)).
stateSizeInBytes	Buffer size in bytes needed for the `IppsGFPState` context.

Description

This function is declared in the `ippcp.h` file. The function returns the size of the buffer associated with the `IppsGFPState` context, suitable for storing data for the finite field GF(*p*) determined by the odd prime number *p* of size not greater than *bitSize* bit.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsSizeErr`	Indicates an error condition if *bitSize* is less than 2.

GFPInit

Initializes the `IppsGFPState` *context of the finite field GF(p).*

Syntax

```
IppStatus ippsGFPInit(IppsGFPState *pGFp, Ipp32u *pPrime, Ipp32u bitSize);
```

Parameters

pGFp	Pointer to the context of the GF(p) field being initialized.
pPrime	Pointer to the data storing the GF(p) modulus.
bitSize	Size of the GF(p) modulus.

Description

This function is declared in the `ippcp.h` file. The function initializes the memory buffer **pGFp* associated with the `IppsGFPState` context and sets up the specific value of the GF(p) modulus. The initialized context is used in the functions that create contexts of elements of the GF(p) field and perform operations with the field elements.

NOTE. The function does not check primality of the modulus.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsSizeErr`	Indicates an error condition if *bitSize* is less than 2.

GFPGet

Extracts parameters of the finite field GF(p) from the input structure.

Syntax

```
IppStatus ippsGFPGet(const IppsGFPState *pGFp, const Ipp32u **ppPrime, Ipp32u *elementLen);
```

Parameters

pGFp	Pointer to the context of the GF(p) field.
ppPrime	Address of the pointer to the data array storing the GF(p) modulus.
elementLen	Length of a GF(p) element.

Description

This function is declared in the `ippcp.h` file. The function extracts parameters of the GF(p) field from the input `IppsGFPState` context. You can get the following parameters of the finite field or any of them: a reference to the modulus and the element length. To turn off extraction of a particular field parameter, set the appropriate function parameter to `NULL`.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if the *pGFp* pointer is `NULL`.

GFPElementGetSize

Gets the size of the `IppsGFPElement` *context of a GF(p) element.*

Syntax

```
IppStatus ippsGFPElementGetSize(const IppsGFPState *pGFp, Ipp32u *stateSizeInBytes);
```

Parameters

pGFp	Pointer to the IppsGFPState context of the GF(p) field.
stateSizeInBytes	Buffer size in bytes needed for the of the IppsGFPElement context.

Description

This function is declared in the ippcp.h file. The function returns the size of the buffer associated with the IppsGFPElement context, suitable for storing an element of the finite field GF(p).

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

GFPElementInit

Initializes the IppsGFPELement *context of a GF(p) element.*

Syntax

```
IppStatus ippsGFPElementInit(IppsGFPElement *pGFpElement, const Ipp32u *pData,
Ipp32u dataLen, IppsGFPState *pGFp);
```

Parameters

pGFpElement	Pointer to the context of the GF(p) element being initialized.
pData	Pointer to the data array storing the GF(p) element.
dataLen	Length of the element.
pGFp	Pointer to the context of the GF(p) field.

Description

This function is declared in the ippcp.h file. The function initializes the memory buffer **pGFpElement* associated with the IppsGFPElement context and sets up the specific element of the GF(p) field. The initialized IppsGFPElement context is used in all the operations with this element of the GF(p) field.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippContextMatchErr	Indicates an error condition if any of the IppsGFPState or IppsGFPElement context parameters does not match the operation.
ippStsSizeErr	Indicates an error condition if *dataLen* is ten times greater than the GF(p) modulus.

GFPSetElement

Assigns a value to an element of the GF(p) field.

Syntax

```
IppStatus ippsGFPSetElement(const Ipp32u *pData, Ipp32u dataLen,
IppsGFPElement *pGFpElement, IppsGFPState *pGFp);
```

Parameters

pData	Pointer to the data array storing the element of the GF(p) field.
dataLen	Length of the GF(p) element.
pGFpElement	Pointer to the context of the GF(p) element.
pGFp	Pointer to the context of the GF(p) field.

Description

This function is declared in the ippcp.h file. The function copies (and converts if needed) the value from the user-defined *pData buffer to the IppsGFPElement context of the GF(p) element.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

ippContextMatchErr	Indicates an error condition if any of the IppsGFPState or IppsGFPElement context parameters does not match the operation.
ippStsSizeErr	Indicates an error condition if *dataLen* is ten times greater than the GF(p) modulus.

GFPSetElementZero

Assigns the zero value to an element of the GF(p) field.

Syntax

```
IppStatus ippsGFPSetElementZero(IppsGFPElement *pGFpElement, IppsGFPState *pGFp);
```

Parameters

pGFpElement	Pointer to the context of the GF(p) element.
pGFp	Pointer to the context of the GF(p) field.

Description

This function is declared in the ippcp.h file. The function assigns the zero value to the given element of the GF(p) field.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippContextMatchErr	Indicates an error condition if any of the IppsGFPState or IppsGFPElement context parameters does not match the operation.

GFPSetElementPower2

Assigns the value of a given power of two to an element of the GF(p) field.

Syntax

```
IppStatus ippsGFPSetElementPower2(Ipp32u power, IppsGFPElement *pGFpElement,
IppsGFPState *pGFp);
```

Parameters

power	The exponent.
pGFpElement	Pointer to the context of the GF(p) element.
pGFp	Pointer to the context of the GF(p) field.

Description

This function is declared in the `ippcp.h` file. The function sets (and converts if needed) the value of the given element of the GF(p) field to 2^{power}.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippContextMatchErr`	Indicates an error condition if any of the `IppsGFPState` or `IppsGFPElement` context parameters does not match the operation.
`ippStsSizeErr`	Indicates an error condition if (*power* + 1) is ten times greater than the GF(p) modulus in bits.

GFPSetElementRandom

Assigns a random value to an element of the GF(p) field.

Syntax

```
IppStatus ippsGFPSetElementRandom(IppsGFPElement *pGFpElement, IppsGFPState *pGFp, IppBitSupplier rndFunc, void* pRndParam);
```

Parameters

pGFpElement	Pointer to the context of the GF(p) element.
pGFp	Pointer to the context of the GF(p) field.
rndFunc	Function that generates random sequences.
pRndParam	Pointer to the context of a random sequence generator.

Description

This function is declared in the `ippcp.h` file. The function assigns a random value to the given element of the GF(p) field.

See also:

Pseudorandom Number Generation Functions.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippContextMatchErr`	Indicates an error condition if any of the `IppsGFPState` or `IppsGFPElement` context parameters does not match the operation.

GFPCmpElement

Compares two elements of the GF(p) field.

Syntax

```
IppStatus ippsGFPCmpElement(const IppsGFPElement *pGFpElementA, const
IppsGFPElement *pGFpElementB, IppsElementCmpResult *cmpResult, const
IppsGFPState *pGFp);
```

Parameters

pGFpElementA	Pointer to the context of the first GF(p) element.
pGFpElementB	Pointer to the context of the second GF(p) element.
cmpResult	Result of the comparison. For details, see comparison functions.
pGFp	Pointer to the context of the GF(p) field.

Description

This function is declared in the `ippcp.h` file. The function compares two elements of the GF(p) field and returns the result in **cmpResult*.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippContextMatchErr`	Indicates an error condition if any of the `IppsGFPState` or `IppsGFPElement` context parameters does not match the operation.

GFPCpyElement

Copies one element of the GF(p) field to another.

Syntax

```
IppStatus ippsGFPCpyElement(const IppsGFPElement *pGFpElementA, IppsGFPElement
*pGFpElementB, const IppsGFPState *pGFp);
```

Parameters

pGFpElementA	Pointer to the context of the GF(p) element being copied.
pGFpElementB	Pointer to the context of the GF(p) element being changed.
pGFp	Pointer to the context of the GF(p) field.

Description

This function is declared in the `ippcp.h` file. The function copies one element of the GF(p) field to another.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippContextMatchErr`	Indicates an error condition if any of the `IppsGFPState` or `IppsGFPElement` context parameters does not match the operation.

GFPGetElement

Extracts the element of the GF(p) field from an input `IppsGFPELement` *context.*

Syntax

```
IppStatus ippsGFPGetElement(const IppsGFPElement *pGFpElement, Ipp32u *pData,
Ipp32u dataLen, const IppsGFPState *pGFp);
```

Parameters

pGFpElement	Pointer to the context of the GF(p) element.
pData	Pointer to the data array to copy the GF(p) element from.
dataLen	Length of the data array.
pGFp	Pointer to the context of the GF(p) field.

Description

This function is declared in the ippcp.h file. The function copies the element of the GF(p) field from the IppsGFPElement context to the user-defined *pData buffer.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippContextMatchErr	Indicates an error condition if any of the IppsGFPState or IppsGFPElement context parameters does not match the operation.

GFPNeg

Computes the additive inverse for an element of the GF(p) field.

Syntax

```
IppStatus ippsGFPNeg(const IppsGFPElement *pGFpElementA, IppsGFPElement *pGFpElementR, IppsGFPState *pGFp);
```

Parameters

pGFpElementA	Pointer to the context of the given GF(p) element.
pGFpElementR	Pointer to the context of the resulting GF(p) element.
pGFp	Pointer to the context of the GF(p) field.

Description

This function is declared in the ippcp.h file. The function computes the additive inverse for a given element of the GF(p) field. The following pseudocode represents this operation: *R = 0 – A*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

ippContextMatchErr	Indicates an error condition if any of the IppsGFPState or IppsGFPElement context parameters does not match the operation.

GFPInv

Computes the multiplicative inverse for an element of the GF(p) field.

Syntax

```
IppStatus ippsGFPInv(const IppsGFPElement *pGFpElementA, IppsGFPElement *pGFpElementR, IppsGFPState *pGFp);
```

Parameters

pGFpElementA	Pointer to the context of the given GF(p) element.
pGFpElementR	Pointer to the context of the resulting GF(p) element.
pGFp	Pointer to the context of the GF(p) field.

Description

This function is declared in the ippcp.h file. The function computes the multiplicative inverse for a given element of the GF(p) field. The following pseudocode represents this operation: $R = A^{(-1)}$.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippContextMatchErr	Indicates an error condition if any of the IppsGFPState or IppsGFPElement context parameters does not match the operation.
ippStsDivByZeroErr	Indicates an error condition if the zero element is attempted.

GFPSqrt

Takes the square root of an element of the GF(p) field.

Syntax

```
IppStatus ippsGFPSqrt(const IppsGFPElement *pGFpElementA, IppsGFPElement *pGFpElementR, IppsGFPState *pGFp);
```

Parameters

pGFpElementA	Pointer to the context of the given GF(p) element.
pGFpElementR	Pointer to the context of the resulting GF(p) element.
pGFp	Pointer to the context of the GF(p) field.

Description

This function is declared in the `ippcp.h` file. The function computes the square root of a given element of the GF(p) field. The following pseudocode represents this operation: $R = A^{(1/2)}$.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippContextMatchErr`	Indicates an error condition if any of the `IppsGFPState` or `IppsGFPElement` context parameters does not match the operation.
`ippStsSqrtNegErr`	Indicates an error condition if a square non-residue element is attempted.

GFPAdd

Adds two elements of the GF(p) field.

Syntax

```
IppStatus ippsGFPAdd(const IppsGFPElement *pGFpElementA, const IppsGFPElement *pGFpElementB, IppsGFPElement *pGFpElementR, IppsGFPState *pGFp);
```

Parameters

pGFpElementA	Pointer to the context of the first summand element of the GF(p) field.
pGFpElementB	Pointer to the context of the second summand element of the GF(p) field.
pGFpElementR	Pointer to the context of the resulting element of the GF(p) field.
pGFp	Pointer to the context of the GF(p) field.

Description

This function is declared in the `ippcp.h` file. The function computes the sum of the two elements of the GF(p) field. The following pseudocode represents this operation: *R = A + B*.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippContextMatchErr`	Indicates an error condition if any of the `IppsGFPState` or `IppsGFPElement` context parameters does not match the operation.

GFPSub

Subtracts one element of the GF(p) field from another.

Syntax

```
IppStatus ippsGFPSub(const IppsGFPElement *pGFpElementA, const IppsGFPElement *pGFpElementB, IppsGFPElement *pGFpElementR, IppsGFPState *pGFp);
```

Parameters

pGFpElementA	Pointer to the context of the minuend element of the GF(p) field.
pGFpElementB	Pointer to the context of the subtrahend element of the GF(p) field.

pGFpElementR	Pointer to the context of the resulting element of the GF(p) field.
pGFp	Pointer to the context of the GF(p) field.

Description

This function is declared in the `ippcp.h` file. The function computes the difference of the two elements of the GF(p) field. The following pseudocode represents this operation: *R = A – B*.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippContextMatchErr`	Indicates an error condition if any of the `IppsGFPState` or `IppsGFPElement` context parameters does not match the operation.

GFPMul

Multiplies two elements of the GF(p) field.

Syntax

```
IppStatus ippsGFPMul(const IppsGFPElement *pGFpElementA, const IppsGFPElement *pGFpElementB, IppsGFPElement *pGFpElementR, IppsGFPState *pGFp);
```

Parameters

pGFpElementA	Pointer to the context of the first multiplicand element of the GF(p) field.
pGFpElementB	Pointer to the context of the second multiplicand element of the GF(p) field.
pGFpElementR	Pointer to the context of the resulting element of the GF(p) field.
pGFp	Pointer to the context of the GF(p) field.

Description

This function is declared in the `ippcp.h` file. The function computes the product of the two elements of the GF(p) field. The following pseudocode represents this operation: $R = A * B$.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippContextMatchErr`	Indicates an error condition if any of the `IppsGFPState` or `IppsGFPElement` context parameters does not match the operation.

GFPExp

Raises an element of the GF(p) field to a non-negative power.

Syntax

```
IppStatus ippsGFPExp(const IppsGFPElement *pGFpElementA, const IppsGFPElement *pGFpElementE, IppsGFPElement *pGFpElementR, IppsGFPState *pGFp);
```

Parameters

pGFpElementA	Pointer to the context of the GF(p) element that represents the base of the exponentiation.
pGFpElementE	Pointer to the context of the GF(p) element that represents the exponent.
pGFpElementR	Pointer to the context of the resulting element of the GF(p) field.
pGFp	Pointer to the context of the GF(p) field.

Description

This function is declared in the `ippcp.h` file. The function raises the element of the GF(p) field to the given non-negative power. The following pseudocode represents this operation: $R = A^E$.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippContextMatchErr	Indicates an error condition if any of the IppsGFPState or IppsGFPElement context parameters does not match the operation.

GFPMontEncode

Converts an element of the GF(p) field to a Montgomery residue number system.

Syntax

```
IppStatus ippsGFPMontEncode(const IppsGFPElement *pGFpElementA, IppsGFPElement *pGFpElementR, IppsGFPState *pGFp);
```

Parameters

pGFpElementA	Pointer to the context of the given element of the GF(p) field.
pGFpElementR	Pointer to the context of the resulting element of the GF(p) field.
pGFp	Pointer to the context of the GF(p) field.

Description

This function is declared in the ippcp.h file. The function converts the given element of the GF(p) field to the Montgomery residue number system. The following pseudocode represents this operation: $R = MontMul(A, M^2)$, where $M > p$ and $gcd(M,p) = 1$ (here $MontMul$ denotes the Montgomery multiplication and gcd denotes the greatest common divisor).

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

ippContextMatchErr	Indicates an error condition if any of the IppsGFPState or IppsGFPElement context parameters does not match the operation.

GFPMontDecode

Converts an element of the GF(p) field represented in the Montgomery residue number system to the regular GF(p) element.

Syntax

```
IppStatus ippsGFPMontDecode(const IppsGFPElement *pGFpElementA, IppsGFPElement *pGFpElementR, IppsGFPState *pGFp);
```

Parameters

pGFpElementA	Pointer to the context of the given element of the GF(p) field.
pGFpElementR	Pointer to the context of the resulting element of the GF(p) field.
pGFp	Pointer to the context of the GF(p) field.

Description

This function is declared in the ippcp.h file. The function converts the element of the GF(p) field represented in the Montgomery residue number system to the regular GF(p) element. The following pseudocode represents this operation: *R = MontMul(A, 1)* (here *MontMul* denotes the Montgomery multiplication).

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippContextMatchErr	Indicates an error condition if any of the IppsGFPState or IppsGFPElement context parameters does not match the operation.

Functions for the GF(p^d) Field

GFPXGetSize

Gets the size of the `IppsGFPXState` *context of the finite field GF(p^d).*

Syntax

```
IppStatus ippsGFPXGetSize(const IppsGFPState *pGroundGFp, Ipp32u degree,
Ipp32u *stateSizeInBytes);
```

Parameters

pGroundGFP	Pointer to the extended finite field GF(p).
degree	The degree of the extension.
stateSizeInBytes	Buffer size in bytes needed for the `IppsGFPXState` context.

Description

This function is declared in the `ippcp.h` file. The function returns the size of the buffer associated with the `IppsGFPXState` context, suitable for storing data for the finite field GF(p^d) determined by the extension degree of the finite field GF(p) supplied in the *degree* parameter.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the `IppsGFPState` context parameter does not match the operation.

GFPXInit

Initializes the `IppsGFPXState` *context of the finite field GF(p^d).*

Syntax

```
IppStatus ippsGFPXInit(IppsGFPXState *pGFpx, IppsGFPState *pGroundGFp, Ipp32u degree, const Ipp32u *pIrrPoly);
```

Parameters

pGFpx	Pointer to the context of the GF(*p^d*) field being initialized.
pGroundGFp	Pointer to the context of the extended field GF(*p*).
degree	The degree of the extension.
pIrrPoly	Pointer to the array with coefficients of the irreducible polynomial.

Description

This function is declared in the `ippcp.h` file. The function initializes the memory buffer **pGFpx* associated with the `IppsGFPXState` context and sets up the specific irreducible polynomial. The initialized context is used in the functions that create contexts of elements of the GF(*p^d*) field and perform operations with the field elements.

NOTE. The function does not check primality of the polynomial.

Important. While you are calling the functions over the GF(*p^d*) field, a properly initialized **pGroundGFp* context of the extended field GF(*p*) is required.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.

ippStsContextMatchErr	Indicates an error condition if the IppsGFPState context parameter does not match the operation.

GFPXGet

Extracts parameters of the finite field GF(p^d) from the input structure.

Syntax

```
IppStatus ippsGFPXGet(const IppsGFPXState *pGFpx, const Ipp32u **ppGroundGFp,
Ipp32u *pIrrPoly, Ipp32u *polyDegree, Ipp32u *polyLen, Ipp32u *elementLen);
```

Parameters

pGFpx	Pointer to the context of the GF(p^d) field.
pGroundGFp	Pointer to the extended GF(p) field.
pIrrPoly	Pointer to the array with coefficients of the irreducible polynomial.
polyDegree	The degree of the polynomial.
polyLen	Length of the array with the coefficients of the polynomial.
elementLen	Length of a GF(p^d) element.

Description

This function is declared in the ippcp.h file. The function extracts parameters of the GF(p^d) field from the IppsGFPXState context. You can get any combination of the following field parameters: a reference to the extended field GF(p), a copy of the irreducible polynomial, its degree and length, as well as the length of an element of the GF(p^d) field. To turn off extraction of a particular function parameter, set the appropriate function parameter to NULL.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if the *pGFpx* pointer is NULL.

GFPXElementGetSize

Gets the size of the `IppsGFPXElement` *context of a GF(p^d) element.*

Syntax

```
IppStatus ippsGFPXElementGetSize(const IppsGFPXState *pGFpx, Ipp32u *stateSizeInBytes);
```

Parameters

pGFpx	Pointer to the `IppsGFPXState` context of the GF(*p^d*) field.
stateSizeInBytes	Buffer size in bytes needed for the `IppsGFPXElement` context.

Description

This function is declared in the `ippcp.h` file. The function returns the size of the buffer associated with the `IppsGFPXElement` context, suitable for storing an element of the finite field GF(*p^d*).

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.

GFPXElementInit

Initializes the `IppsGFPXELement` *context of a GF(p^d) element.*

Syntax

```
IppStatus ippsGFPXElementInit(IppsGFPXElement *pGFpxElement, const Ipp32u *pData, Ipp32u dataLen, IppsGFPXState *pGFpx);
```

Parameters

pGFpxElement	Pointer to the context of the GF(*p^d*) element being initialized.

pData	Pointer to the data array storing the GF(*p^d*) element.
dataLen	Length of the element.
pGFpx	Pointer to the context of the GF(*p^d*) field.

Description

This function is declared in the `ippcp.h` file. The function initializes the memory buffer **pGFpxElement* associated with the `IppsGFPXElement` context and sets up the specific element of the GF(*p^d*) field. The initialized `IppsGFPXElement` context is used in all the operations with this element of the GF(*p^d*) field.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the *pGFpxElement* or *pGFpx* pointers is `NULL`.
`ippContextMatchErr`	Indicates an error condition if the `IppsGFPXState` context parameters does not match the operation.

GFPXSetElement

Assigns a value to an element of the GF(p^d) field.

Syntax

```
IppStatus ippsGFPXSetElement(const Ipp32u *pData, Ipp32u dataLen,
IppsGFPXElement *pGFpxElement, IppsGFPXState *pGFpx);
```

Parameters

pData	Pointer to the data array storing the element of the GF(*p^d*) field.
dataLen	Length of the GF(*p^d*) element.
pGFpxElement	Pointer to the context of the GF(*p^d*) element.
pGFpx	Pointer to the context of the GF(*p^d*) field.

Description

This function is declared in the `ippcp.h` file. The function copies (and converts if needed) the value from the user-defined *`*pData`* buffer to the `IppsGFPXElement` context of the GF(*`p^d`*) element.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippContextMatchErr`	Indicates an error condition if any of the `IppsGFPXState` or `IppsGFPXElement` context parameters does not match the operation.

GFPXSetElementZero

Assigns the zero value to an element of the GF(p^d) field.

Syntax

```
IppStatus ippsGFPXSetElementZero(IppsGFPXElement *pGFpxElement, IppsGFPXState *pGFpx);
```

Parameters

`pGFpxElement`	Pointer to the context of the GF(*`p^d`*) element.
`pGFpx`	Pointer to the context of the GF(*`p^d`*) field.

Description

This function is declared in the `ippcp.h` file. The function assigns the zero value to the given element of the GF(*`p^d`*) field.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.

ippContextMatchErr	Indicates an error condition if any of the IppsGFPXState or IppsGFPXElement context parameters does not match the operation.

GFPXSetElementPowerX

Assigns the value of a given power of x to an element of the GF(p^d) field.

Syntax

```
IppStatus ippsGFPXSetElementPowerX(Ipp32u power, IppsGFPXElement
*pGFpxElement, IppsGFPXState *pGFpx);
```

Parameters

power	The exponent.
pGFpxElement	Pointer to the context of the GF(*p^d*) element.
pGFpx	Pointer to the context of the GF(*p^d*) field.

Description

This function is declared in the ippcp.h file. The function sets (and converts if needed) the value of the given element of the GF(*p^d*) field to x^{power}.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippContextMatchErr	Indicates an error condition if any of the IppsGFPXState or IppsGFPXElement context parameters does not match the operation.

GFPXSetElementRandom

Assigns a random value to an element of the GF(p^d) field.

Syntax

```
IppStatus ippsGFPXSetElementRandom(IppsGFPXElement *pGFpxElement,
IppsGFPXState *pGFpx, IppBitSupplier rndFunc, void* pRndParam);
```

Parameters

pGFpxElement	Pointer to the context of the GF(*p^d*) element.
pGFpx	Pointer to the context of the GF(*p^d*) field.
rndFunc	Function that generates random sequences.
pRndParam	Pointer to the context of a random sequence generator.

Description

This function is declared in the `ippcp.h` file. The function assigns a random value to the given element of the GF(*p^d*) field.

See also:

Pseudorandom Number Generation Functions.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippContextMatchErr`	Indicates an error condition if any of the `IppsGFPXState` or `IppsGFPXElement` context parameters does not match the operation.

GFPXCmpElement

Compares two elements of the GF(p^d) field.

Syntax

```
IppStatus ippsGFPXCmpElement(const IppsGFPXElement *pGFpxElementA, const
IppsGFPXElement *pGFpxElementB, IppsElementCmpResult *cmpResult, const
IppsGFPXState *pGFpx);
```

Parameters

pGFpxElementA	Pointer to the context of the first element of the GF(*p^d*) field.
pGFpxElementB	Pointer to the context of the second element of the GF(*p^d*) field.
cmpResult	Result of the comparison. For details, see comparison functions.
pGFpx	Pointer to the context of the GF(*p^d*) field.

Description

This function is declared in the `ippcp.h` file. The function compares two elements of the GF(*p^d*) field and returns the result in **cmpResult*.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippContextMatchErr`	Indicates an error condition if any of the `IppsGFPXState` or `IppsGFPXElement` context parameters does not match the operation.

GFPXCpyElement

Copies one element of the GF(p^d) field to another.

Syntax

```
IppStatus ippsGFPXCpyElement(const IppsGFPXElement *pGFpxElementA,
IppsGFPXElement *pGFpxElementB, const IppsGFPXState *pGFpx);
```

Parameters

pGFpxElementA	Pointer to the context of the GF(*p^d*) element being copied.
pGFpxElementB	Pointer to the context of the GF(*p^d*) element being changed.
pGFpx	Pointer to the context of the GF(*p^d*) field.

Description

This function is declared in the `ippcp.h` file. The function copies one element of the GF(*p^d*) field to another.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippContextMatchErr`	Indicates an error condition if any of the `IppsGFPXState` or `IppsGFPXElement` context parameters does not match the operation.

GFPXGetElement

Extracts the element of the GF(p^d) field from an input `IppsGFPXELement` *context.*

Syntax

```
IppStatus ippsGFPXGetElement(const IppsGFPXElement *pGFpxElement, Ipp32u
*pData, Ipp32u dataLen, const IppsGFPXState *pGFpx);
```

Parameters

pGFpxElement	Pointer to the context of the GF(*p^d*) element.
pData	Pointer to the data array to copy the GF(*p^d*) element from.
dataLen	Length of the data array.
pGFpx	Pointer to the context of the GF(*p^d*) field.

Description

This function is declared in the `ippcp.h` file. The function copies the element of the GF(*p^d*) field from the `IppsGFPXElement` context to the user-defined *`*pData`* buffer.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippContextMatchErr`	Indicates an error condition if any of the `IppsGFPXState` or `IppsGFPXElement` context parameters does not match the operation.

GFPXNeg

Computes the additive inverse for an element of the GF(p^d) field.

Syntax

```
IppStatus ippsGFPXNeg(const IppsGFPXElement *pGFpxElementA, IppsGFPXElement *pGFpxElementR, IppsGFPXState *pGFpx);
```

Parameters

pGFpxElementA	Pointer to the context of the given GF(*p^d*) element.
pGFpxElementR	Pointer to the context of the resulting GF(*p^d*) element.
pGFpx	Pointer to the context of the GF(*p^d*) field.

Description

This function is declared in the `ippcp.h` file. The function computes the additive inverse for a given element of the GF(*p^d*) field. The following pseudocode represents this operation: *R = 0 - A*.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippContextMatchErr`	Indicates an error condition if any of the `IppsGFPXState` or `IppsGFPXElement` context parameters does not match the operation.

GFPXInv

Computes the multiplicative inverse for an element of the GF(p^d) field.

Syntax

```
IppStatus ippsGFPXInv(const IppsGFPXElement *pGFpxElementA, IppsGFPXElement *pGFpxElementR, IppsGFPXState *pGFpx);
```

Parameters

pGFpxElementA	Pointer to the context of the given GF(*p^d*) element.
pGFpxElementR	Pointer to the context of the resulting GF(*p^d*) element.
pGFpx	Pointer to the context of the GF(*p^d*) field.

Description

This function is declared in the `ippcp.h` file. The function computes the multiplicative inverse for a given element of the GF(*p^d*) field. The following pseudocode represents this operation: $R = A^{(-1)}$.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.

ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippContextMatchErr	Indicates an error condition if any of the IppsGFPXState or IppsGFPXElement context parameters does not match the operation.
ippStsDivByZeroErr	Indicates an error condition if the zero element is attempted.

GFPXAdd

Adds two elements of the GF(p^d) field.

Syntax

```
IppStatus ippsGFPXAdd(const IppsGFPXElement *pGFpxElementA, const
IppsGFPXElement *pGFpxElementB, IppsGFPXElement *pGFpxElementR, IppsGFPXState
*pGFpx);
```

Parameters

pGFpxElementA	Pointer to the context of the first summand element of the GF(p^d) field.
pGFpxElementB	Pointer to the context of the second summand element of the GF(p^d) field.
pGFpxElementR	Pointer to the context of the resulting element of the GF(p^d) field.
pGFpx	Pointer to the context of the GF(p^d) field.

Description

This function is declared in the ippcp.h file. The function computes the sum of the two elements of the GF(p^d) field. The following pseudocode represents this operation: $R = A + B$.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

ippContextMatchErr	Indicates an error condition if any of the IppsGFPXState or IppsGFPXElement context parameters does not match the operation.

GFPXAdd_GFP

Adds elements of the GF(p^d) and GF(p) fields.

Syntax

```
IppStatus ippsGFPXAdd_GFP(const IppsGFPXElement *pGFpxElementA, const IppsGFPElement *pGFpElementB, IppsGFPXElement *pGFpxElementR, IppsGFPXState *pGFpx);
```

Parameters

pGFpxElementA	Pointer to the context of the summand element of the GF(p^d) field.
pGFpElementB	Pointer to the context of the summand element of the GF(p) field.
pGFpxElementR	Pointer to the context of the resulting element of the GF(p^d) field.
pGFpx	Pointer to the context of the GF(p^d) field.

Description

This function is declared in the ippcp.h file. The function computes the sum of the elements of the GF(p^d) and GF(p) fields. The following pseudocode represents this operation: *R = A + B*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippContextMatchErr	Indicates an error condition if any of the IppsGFPXState, IppsGFPXElement, or IppsGFPElement context parameters does not match the operation.

GFPXSub

Subtracts one element of the GF(p^d) field from another.

Syntax

```
IppStatus ippsGFPXSub(const IppsGFPXElement *pGFpxElementA, const IppsGFPXElement *pGFpxElementB, IppsGFPXElement *pGFpxElementR, IppsGFPXState *pGFpx);
```

Parameters

pGFpxElementA	Pointer to the context of the minuend element of the GF(*p^d*) field.
pGFpxElementB	Pointer to the context of the subtrahend element of the GF(*p^d*) field.
pGFpxElementR	Pointer to the context of the resulting element of the GF(*p^d*) field.
pGFpx	Pointer to the context of the GF(*p^d*) field.

Description

This function is declared in the `ippcp.h` file. The function computes the difference of the two elements of the GF(*p^d*) field. The following pseudocode represents this operation: *R = A – B*.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippContextMatchErr`	Indicates an error condition if any of the `IppsGFPXState` or `IppsGFPXElement` context parameters does not match the operation.

GFPXSub_GFP

Subtracts an element of the GF(p) field from an element of the GF(p^d) field.

Syntax

```
IppStatus ippsGFPXSub_GFP(const IppsGFPXElement *pGFpxElementA, const IppsGFPElement *pGFpElementB, IppsGFPXElement *pGFpxElementR, IppsGFPXState *pGFpx);
```

Parameters

pGFpxElementA	Pointer to the context of the minuend element of the GF(p^d) field.
pGFpElementB	Pointer to the context of the subtrahend element of the GF(p) field.
pGFpxElementR	Pointer to the context of the resulting element of the GF(p^d) field.
pGFpx	Pointer to the context of the GF(p^d) field.

Description

This function is declared in the `ippcp.h` file. The function computes the difference of the elements of the GF(p^d) and GF(p) fields. The following pseudocode represents this operation: *R = A – B*.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippContextMatchErr`	Indicates an error condition if any of the `IppsGFPXState`, `IppsGFPXElement`, or `IppsGFPElement` context parameters does not match the operation.

GFPXMul

Multiplies two elements of the GF(p^d) field.

Syntax

```
IppStatus ippsGFPXMul(const IppsGFPXElement *pGFpxElementA, const
IppsGFPXElement *pGFpxElementB, IppsGFPXElement *pGFpxElementR, IppsGFPXState
*pGFpx);
```

Parameters

pGFpxElementA	Pointer to the context of the first multiplicand element of the GF(p^d) field.
pGFpxElementB	Pointer to the context of the second multiplicand element of the GF(p^d) field.
pGFpxElementR	Pointer to the context of the resulting element of the GF(p^d) field.
pGFpx	Pointer to the context of the GF(p^d) field.

Description

This function is declared in the `ippcp.h` file. The function computes the product of the two elements of the GF(p^d) field. The following pseudocode represents this operation: *R = A * B*.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippContextMatchErr`	Indicates an error condition if any of the `IppsGFPXState` or `IppsGFPXElement` context parameters does not match the operation.

GFPXMul_GFP

Multiplies an element of the GF(p^d) field by an element of the GF(p) field.

Syntax

```
IppStatus ippsGFPXMul_GFP(const IppsGFPXElement *pGFpxElementA, const IppsGFPElement *pGFpElementB, IppsGFPXElement *pGFpxElementR, IppsGFPXState *pGFpx);
```

Parameters

pGFpxElementA	Pointer to the context of the first multiplicand element of the GF(p^d) field.
pGFpElementB	Pointer to the context of the second multiplicand element of the GF(p) field.
pGFpxElementR	Pointer to the context of the resulting element of the GF(p^d) field.
pGFpx	Pointer to the context of the GF(p^d) field.

Description

This function is declared in the `ippcp.h` file. The function computes the product of the elements of the GF(p^d) and GF(p) fields. The following pseudocode represents this operation: *R = A * B*.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippContextMatchErr`	Indicates an error condition if any of the `IppsGFPXState`, `IppsGFPXElement`, or `IppsGFPElement` context parameters does not match the operation.

GFPXExp

Raises an element of the GF(p^d) field to a non-negative power.

Syntax

```
IppStatus ippsGFPXExp(const IppsGFPXElement *pGFpxElementA, const Ipp32u *pExp, Ipp32u expLen, IppsGFPXElement *pGFpxElementR, IppsGFPXState *pGFpx);
```

Parameters

pGFpxElementA	Pointer to the context of the GF(*p^d*) element that represents the base of the exponentiation.
pExp	Pointer to the data array that stores the exponent.
expLen	Length of the exponent.
pGFpxElementR	Pointer to the context of the resulting element of the GF(*p^d*) field.
pGFpx	Pointer to the context of the GF(*p^d*) field.

Description

This function is declared in the `ippcp.h` file. The function raises the element of the GF(*p^d*) field to the given non-negative power. The following pseudocode represents this operation: $R = A^E$.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippContextMatchErr`	Indicates an error condition if any of the `IppsGFPXState` or `IppsGFPXElement` context parameters does not match the operation.

GFPXDiv

Performs the Euclidean division of two elements of the GF(p^d) field.

Syntax

```
IppStatus ippsGFPXDiv(const IppsGFPXElement *pGFpxElementA, const
IppsGFPXElement *pGFpxElementB, IppsGFPXElement *pGFpxElementQ,
IppsGFPXElement *pGFpxElementR, IppsGFPXState *pGFpx);
```

Parameters

pGFpxElementA	Pointer to the context of the dividend element of the GF(p^d) field.
pGFpxElementB	Pointer to the context of the divisor element of the GF(p^d) field.
pGFpxElementQ	Pointer to the context of the resulting quotient element of the GF(p^d) field.
pGFpxElementR	Pointer to the context of the resulting remainder element of the GF(p^d) field.
pGFpx	Pointer to the context of the GF(p^d) field.

Description

This function is declared in the `ippcp.h` file. For the two given elements of the GF(p^d) field, the function computes the unique pair of the quotient and remainder. The following pseudocode represents this operation: *A = B * Q + R*.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippContextMatchErr`	Indicates an error condition if any of the `IppsGFPXState` or `IppsGFPXElement` context parameters does not match the operation.
`ippDivByZeroErr`	Indicates an error condition if the zero divisor is attempted.

Functions for the GF(p^d^2) Field

GFPXQGetSize

Gets the size of the `IppsGFPXQState` *context of the finite field GF(p^d^2).*

Syntax

```
IppStatus ippsGFPXQGetSize(const IppsGFPXState *pGroundGFpx, Ipp32u *stateSizeInBytes);
```

Parameters

pGroundGFPx	Pointer to the extended finite field GF(*p^d*).
stateSizeInBytes	Buffer size in bytes needed for the `IppsGFPXQState` context.

Description

This function is declared in the `ippcp.h` file. The function returns the size of the buffer associated with the `IppsGFPXQState` context, suitable for storing data for the GF(*p^d^2*) field, that is, the quadratic extension of the finite field GF(*p^d*).

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if the `IppsGFPXState` context parameter does not match the operation.

GFPXQInit

Initializes the `IppsGFPXQState` *context of the finite field GF(p^d^2).*

Syntax

```
IppStatus ippsGFPXQInit(IppsGFPXQState *pGFpxq, IppsGFPXState *pGroundGFpx,
const Ipp32u *pIrrPoly);
```

Parameters

pGFpxq	Pointer to the context of the GF(*p^d^2*) field being initialized.
pGroundGFpx	Pointer to the context of the extended field GF(*p^d*).
pIrrPoly	Pointer to the array with coefficients of the irreducible polynomial.

Description

This function is declared in the `ippcp.h` file. The function initializes the memory buffer **pGFpxq* associated with the `IppsGFPXQState` context and sets up the specific irreducible polynomial. The initialized context is used in the functions that create contexts of elements of the GF(*p^d^2*) field and perform operations with the field elements.

NOTE. The function does not check primality of the polynomial.

Important. While you are calling the functions over the GF(*p^d^2*) field, properly initialized `IppsGFPState` and `IppsGFPXState` contexts of the respective extended fields GF(*p*) and GF(*p^d*) are required.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.

ippStsContextMatchErr	Indicates an error condition if the IppsGFPXState context parameter does not match the operation.

GFPXQGet

Extracts parameters of the finite field GF(p^d^2) from the input structure.

Syntax

```
IppStatus ippsGFPXQGet(const IppsGFPXQState *pGFpxq, const Ipp32u **ppGroundGFpx, Ipp32u *pIrrPoly, Ipp32u *polyDegree, Ipp32u *polyLen, Ipp32u *elementLen);
```

Parameters

pGFpxq	Pointer to the context of the GF(*p^d^2*) field.
pGroundGFpx	Pointer to the extended field GF(*p^d*).
pIrrPoly	Pointer to the array with coefficients of the irreducible polynomial.
polyDegree	The degree of the polynomial.
polyLen	Length of the array with the coefficients of the polynomial.
elementLen	Length of a GF(*p^d^2*) element.

Description

This function is declared in the ippcp.h file. The function extracts parameters of the GF(*p^d^2*) field from the IppsGFPXQState context. You can get any combination of the following field parameters: a reference to the extended field GF(*p^d*), a copy of the irreducible polynomial, its degree and length, as well as the length of an element of the GF(*p^d^2*) field. To turn off extraction of a particular field parameter, set the appropriate function parameter to NULL.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if the *pGFpxq* pointer is NULL.

GFPXQElementGetSize

Gets the size of the `IppsGFPXQElement` *context of a GF(p^d^2) element.*

Syntax

```
IppStatus ippsGFPXQElementGetSize(const IppsGFPXQState *pGFpxq, Ipp32u *stateSizeInBytes);
```

Parameters

pGFpxq	Pointer to the `IppsGFPXQState` context of the GF(*p^d^2*) field.
stateSizeInBytes	Buffer size in bytes needed for the `IppsGFPXQElement` context.

Description

This function is declared in the `ippcp.h` file. The function returns the size of the buffer associated with the `IppsGFPXQElement` context, suitable for storing an element of the finite field GF(*p^d^2*).

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.

GFPXQElementInit

Initializes the `IppsGFPXQELement` *context of a GF(p^d^2) element.*

Syntax

```
IppStatus ippsGFPXQElementInit(IppsGFPXQElement *pGFpxqElement, const Ipp32u *pData, Ipp32u dataLen, IppsGFPXQState *pGFpxq);
```

Parameters

pGFpxqElement	Pointer to the context of the GF(*p^d^2*) element being initialized.

pData	Pointer to the data array storing the GF(*p^d^2*) element.
dataLen	Length of the element.
pGFpxq	Pointer to the context of the GF(*p^d^2*) field.

Description

This function is declared in the ippcp.h file. The function initializes the memory buffer **pGFpxqElement* associated with the IppsGFPXQElement context and sets up the specific element of the GF(*p^d^2*) field. The initialized IppsGFPXQElement context is used in all the operations with this element of the GF(*p^d^2*) field.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the *pGFpxqElement* or *pGFpxq* pointers is NULL.
ippContextMatchErr	Indicates an error condition if the IppsGFPXQState context parameters does not match the operation.

GFPXQSetElement

Assigns a value to an element of the GF(p^d^2) field.

Syntax

```
IppStatus ippsGFPXQSetElement(const Ipp32u *pData, Ipp32u dataLen,
IppsGFPXQElement *pGFpxqElement, IppsGFPXQState *pGFpxq);
```

Parameters

pData	Pointer to the data array storing the element of the GF(*p^d^2*) field.
dataLen	Length of the GF(*p^d^2*) element.
pGFpxqElement	Pointer to the context of the GF(*p^d^2*) element.
pGFpxq	Pointer to the context of the GF(*p^d^2*) field.

Description

This function is declared in the `ippcp.h` file. The function copies (and converts if needed) the value from the user-defined *`*pData`* buffer to the `IppsGFPXQElement` context of the GF(*`p^d^2`*) element.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippContextMatchErr`	Indicates an error condition if any of the `IppsGFPXQState` or `IppsGFPXQElement` context parameters does not match the operation.

GFPXQSetElementZero

Assigns the zero value to an element of the GF(p^d^2) field.

Syntax

```
IppStatus ippsGFPXQSetElementZero(IppsGFPXQElement *pGFpxqElement,
IppsGFPXQState *pGFpxq);
```

Parameters

`pGFpxqElement`	Pointer to the context of the GF(*`p^d^2`*) element.
`pGFpxq`	Pointer to the context of the GF(*`p^d^2`*) field.

Description

This function is declared in the `ippcp.h` file. The function assigns the zero value to the given element of the GF(*`p^d^2`*) field.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.

ippContextMatchErr	Indicates an error condition if any of the IppsGFPXQState or IppsGFPXQElement context parameters does not match the operation.

GFPXQSetElementPowerX

Assigns the value of a given power of x to an element of the GF(p^d^2) field.

Syntax

```
IppStatus ippsGFPXQSetElementPowerX(Ipp32u power, IppsGFPXQElement
*pGFpxqElement, IppsGFPXQState *pGFpxq);
```

Parameters

power	The exponent.
pGFpxqElement	Pointer to the context of the GF(*p^d^2*) element.
pGFpxq	Pointer to the context of the GF(*p^d^2*) field.

Description

This function is declared in the ippcp.h file. The function sets (and converts if needed) the value of the given element of the GF(*p^d^2*) field to x^{power}.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippContextMatchErr	Indicates an error condition if any of the IppsGFPXQState or IppsGFPXQElement context parameters does not match the operation.

GFPXQSetElementRandom

Assigns a random value to an element of the GF(p^d^2) field.

Syntax

```
IppStatus ippsGFPXQSetElementRandom(IppsGFPXQElement *pGFpxqElement,
IppsGFPXQState *pGFpxq, IppBitSupplier rndFunc, void* pRndParam);
```

Parameters

pGFpxqElement	Pointer to the context of the GF(*p^d^2*) element.
pGFpxq	Pointer to the context of the GF(*p^d^2*) field.
rndFunc	Function that generates random sequences.
pRndParam	Pointer to the context of a random sequence generator.

Description

This function is declared in the `ippcp.h` file. The function assigns a random value to the given element of the GF(*p^d^2*) field.

See also:

Pseudorandom Number Generation Functions.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippContextMatchErr`	Indicates an error condition if any of the `IppsGFPXQState` or `IppsGFPXQElement` context parameters does not match the operation.

GFPXQCmpElement

Compares two elements of the GF(p^d^2) field.

Syntax

```
IppStatus ippsGFPXQCmpElement(const IppsGFPXQElement *pGFpxqElementA, const IppsGFPXQElement *pGFpxqElementB, IppsElementCmpResult *cmpResult, const IppsGFPXQState *pGFpxq);
```

Parameters

pGFpxqElementA	Pointer to the context of the first element of the GF(*p^d^2*) field.
pGFpxqElementB	Pointer to the context of the second element of the GF(*p^d^2*) field.
cmpResult	Result of the comparison. For details, see comparison functions.
pGFpx	Pointer to the context of the GF(*p^d^2*) field.

Description

This function is declared in the `ippcp.h` file. The function compares two elements of the GF(*p^d^2*) field and returns the result in **cmpResult*.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippContextMatchErr`	Indicates an error condition if any of the `IppsGFPXQState` or `IppsGFPXQElement` context parameters does not match the operation.

GFPXQCpyElement

Copies one element of the GF(p^d^2) field to another.

Syntax

```
IppStatus ippsGFPXQCpyElement(const IppsGFPXQElement *pGFpxqElementA,
IppsGFPXQElement *pGFpxqElementB, const IppsGFPXQState *pGFpxq);
```

Parameters

pGFpxqElementA	Pointer to the context of the GF(*p^d^2*) element being copied.
pGFpxqElementB	Pointer to the context of the GF(*p^d^2*) element being changed.
pGFpxq	Pointer to the context of the GF(*p^d^2*) field.

Description

This function is declared in the `ippcp.h` file. The function copies one element of the GF(*p^d^2*) field to another.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippContextMatchErr`	Indicates an error condition if any of the `IppsGFPXQState` or `IppsGFPXQElement` context parameters does not match the operation.

GFPXQGetElement

Extracts the element of the GF(p^d^2) field from an input `IppsGFPXQELement` *context.*

Syntax

```
IppStatus ippsGFPXQGetElement(const IppsGFPXQElement *pGFpxqElement, Ipp32u
*pData, Ipp32u dataLen, const IppsGFPXQState *pGFpxq);
```

Parameters

pGFpxqElement	Pointer to the context of the GF(*p^d^2*) element.
pData	Pointer to the data array to copy the GF(*p^d^2*) element from.
dataLen	Length of the data array.
pGFpxq	Pointer to the context of the GF(*p^d^2*) field.

Description

This function is declared in the `ippcp.h` file. The function copies the element of the GF(*p^d^2*) field from the `IppsGFPXQElement` context to the user-defined **pData* buffer.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippContextMatchErr`	Indicates an error condition if any of the `IppsGFPXQState` or `IppsGFPXQElement` context parameters does not match the operation.

GFPXQNeg

Computes the additive inverse for an element of the GF(p^d^2) field.

Syntax

```
IppStatus ippsGFPXQNeg(const IppsGFPXQElement *pGFpxqElementA,
IppsGFPXQElement *pGFpxqElementR, IppsGFPXQState *pGFpxq);
```

Parameters

pGFpxqElementA	Pointer to the context of the given GF(*p^d^2*) element.
pGFpxqElementR	Pointer to the context of the resulting GF(*p^d^2*) element.
pGFpxq	Pointer to the context of the GF(*p^d^2*) field.

Description

This function is declared in the `ippcp.h` file. The function computes the additive inverse for a given element of the GF(*p^d^2*) field. The following pseudocode represents this operation: *R = 0 - A*.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippContextMatchErr`	Indicates an error condition if any of the `IppsGFPXQState` or `IppsGFPXQElement` context parameters does not match the operation.

GFPXQInv

Computes the multiplicative inverse for an element of the GF(p^d^2) field.

Syntax

```
IppStatus ippsGFPXQInv(const IppsGFPXQElement *pGFpxqElementA,
IppsGFPXQElement *pGFpxqElementR, IppsGFPXQState *pGFpxq);
```

Parameters

pGFpxqElementA	Pointer to the context of the given GF(*p^d^2*) element.
pGFpxqElementR	Pointer to the context of the resulting GF(*p^d^2*) element.
pGFpxq	Pointer to the context of the GF(*p^d^2*) field.

Description

This function is declared in the `ippcp.h` file. The function computes the multiplicative inverse for a given element of the GF(*p^d^2*) field. The following pseudocode represents this operation: $R = A^{(-1)}$.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.

ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippContextMatchErr	Indicates an error condition if any of the IppsGFPXQState or IppsGFPXQElement context parameters does not match the operation.
ippStsDivByZeroErr	Indicates an error condition if the zero element is attempted.

GFPXQAdd

Adds two elements of the GF(p^d^2) field.

Syntax

```
IppStatus ippsGFPXQAdd(const IppsGFPXQElement *pGFpxqElementA, const
IppsGFPXQElement *pGFpxqElementB, IppsGFPXQElement *pGFpxqElementR,
IppsGFPXQState *pGFpxq);
```

Parameters

pGFpxqElementA	Pointer to the context of the first summand element of the GF(*p^d^2*) field.
pGFpxqElementB	Pointer to the context of the second summand element of the GF(*p^d^2*) field.
pGFpxqElementR	Pointer to the context of the resulting element of the GF(*p^d^2*) field.
pGFpxq	Pointer to the context of the GF(*p^d^2*) field.

Description

This function is declared in the ippcp.h file. The function computes the sum of the two elements of the GF(*p^d^2*) field. The following pseudocode represents this operation: *R = A + B*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

ippContextMatchErr	Indicates an error condition if any of the IppsGFPXQState or IppsGFPXQElement context parameters does not match the operation.

GFPXQSub

Subtracts one element of the GF(p^d^2) field from another.

Syntax

```
IppStatus ippsGFPXQSub(const IppsGFPXQElement *pGFpxqElementA, const
IppsGFPXQElement *pGFpxqElementB, IppsGFPXQElement *pGFpxqElementR,
IppsGFPXQState *pGFpxq);
```

Parameters

pGFpxqElementA	Pointer to the context of the minuend element of the GF(*p^d^2*) field.
pGFpxqElementB	Pointer to the context of the subtrahend element of the GF(*p^d^2*) field.
pGFpxqElementR	Pointer to the context of the resulting element of the GF(*p^d^2*) field.
pGFpxq	Pointer to the context of the GF(*p^d^2*) field.

Description

This function is declared in the ippcp.h file. The function computes the difference of the two elements of the GF(*p^d^2*) field. The following pseudocode represents this operation: *R = A – B*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippContextMatchErr	Indicates an error condition if any of the IppsGFPXQState or IppsGFPXQElement context parameters does not match the operation.

GFPXQMul

Multiplies two elements of the GF(p^d^2) field.

Syntax

```
IppStatus ippsGFPXQMul(const IppsGFPXQElement *pGFpxqElementA, const
IppsGFPXQElement *pGFpxqElementB, IppsGFPXQElement *pGFpxqElementR,
IppsGFPXQState *pGFpxq);
```

Parameters

pGFpxqElementA	Pointer to the context of the first multiplicand element of the GF(*p^d^2*) field.
pGFpxqElementB	Pointer to the context of the second multiplicand element of the GF(*p^d^2*) field.
pGFpxqElementR	Pointer to the context of the resulting element of the GF(*p^d^2*) field.
pGFpxq	Pointer to the context of the GF(*p^d^2*) field.

Description

This function is declared in the `ippcp.h` file. The function computes the product of the two elements of the GF(*p^d^2*) field. The following pseudocode represents this operation: *R = A * B*.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippContextMatchErr`	Indicates an error condition if any of the `IppsGFPXQState` or `IppsGFPXQElement` context parameters does not match the operation.

GFPXQMul_GFP

Multiplies an element of the GF(p^d^2) field by an element of the GF(p) field.

Syntax

```
IppStatus ippsGFPXQMul_GFP(const IppsGFPXQElement *pGFpxqElementA, const IppsGFPElement *pGFpElementB, IppsGFPXQElement *pGFpxqElementR, IppsGFPXQState *pGFpxq);
```

Parameters

pGFpxqElementA	Pointer to the context of the first multiplicand element of the GF(p^d^2) field.
pGFpElementB	Pointer to the context of the second multiplicand element of the GF(p) field.
pGFpxqElementR	Pointer to the context of the resulting element of the GF(p^d^2) field.
pGFpxq	Pointer to the context of the GF(p^d^2) field.

Description

This function is declared in the `ippcp.h` file. The function computes the product of the elements of the GF(p^d^2) and GF(p) fields. The following pseudocode represents this operation: *R = A * B*.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippContextMatchErr`	Indicates an error condition if any of the `IppsGFPXQState`, `IppsGFPXQElement`, or `IppsGFPElement` context parameters does not match the operation.

GFPXQExp

Raises an element of the GF(p^d^2) field to a non-negative power.

Syntax

```
IppStatus ippsGFPXQExp(const IppsGFPXQElement *pGFpxqElementA, const Ipp32u *pExp, Ipp32u expLen, IppsGFPXQElement *pGFpxqElementR, IppsGFPXQState *pGFpxq);
```

Parameters

pGFpxqElementA	Pointer to the context of the GF(*p^d^2*) element that represents the base of the exponentiation.
pExp	Pointer to the data array that stores the exponent.
expLen	Length of the exponent.
pGFpxqElementR	Pointer to the context of the resulting element of the GF(*p^d^2*) field.
pGFpxq	Pointer to the context of the GF(*p^d^2*) field.

Description

This function is declared in the `ippcp.h` file. The function raises the element of the GF(*p^d^2*) field to the given non-negative power. The following pseudocode represents this operation: $R = A^E$.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippContextMatchErr`	Indicates an error condition if any of the `IppsGFPXQState` or `IppsGFPXQElement` context parameters does not match the operation.

Arithmetic of the Group of Elliptic Curve Points

This section describes the Intel IPP primitives that implement arithmetic operations with points of elliptic curves [EC]. Arithmetic of elliptic curves over the following finite fields is implemented:

GF(p)	The elliptic curve is defined by the equation: $y^2=x^3+A*x+B \bmod p$, where the odd prime number p is the modulus of the GF(p) field.
GF($p\hat{}d$)	The elliptic curve is defined by the equation: $y^2=x^3+A*x+B \bmod g(t)$, where $g(t)$ is the irreducible polynomial of degree d.

Here A, B, x, and y belong to the respective field GF(p) or GF($p\hat{}d$),

A and B are the coefficients (parameters) of the curve,

x and y are coordinates of a point on the curve.

Table 5-12 lists all the functions for the elliptic curve point arithmetic.

Table 5-12 Intel IPP Arithmetic Functions for the Group of Elliptic Curve Points

Function Base Name	Operation
Arithmetic of Elliptic Curves over GF(p)	
GFPECGetSize	Gets the size of the context of an elliptic curve over the GF(p) field.
GFPECInit	Initializes the context of an elliptic curve over the GF(p) field.
GFPECSet	Sets up parameters of an elliptic curve over the GF(p) field.
GFPECGet	Extracts parameters of the elliptic curve over the GF(p) field from the context.
GFPECVerify	Verifies parameters of an elliptic curve over the GF(p) field.
GFPECPointGetSize	Gets the size of the context of a point on the elliptic curve over the GF(p) field.
GFPECPointInit	Initializes the context of a point on the elliptic curve over the GF(p) field.
GFPECSetPoint	Sets up the coordinates of a point on the elliptic curve over the GF(p) field.
GFPECSetPointAtInfinity	Sets the coordinates of a point on the elliptic curve over the GF(p) field to those of the point at infinity.
GFPECSetPointRandom	Sets random coordinates of a point on the elliptic curve over the GF(p) field.
GFPECCpyPoint	Copies one point of the elliptic curve over the GF(p) field to another.

Function Base Name	Operation
GFPECGetPoint	Extracts coordinates of the point on the elliptic curve over the GF(p) field from the context.
GFPECVerifyPoint	Verifies a point of the elliptic curve over the GF(p) field.
GFPECCmpPoint	Compares points of the elliptic curve over the GF(p) field.
GFPECNegPoint	Computes the inverse for a point of the elliptic curve over the GF(p) field.
GFPECAddPoint	Adds points on the elliptic curve over the GF(p) field.
GFPECMulPointScalar	Multiplies a point on the elliptic curve over the GF(p) field by a scalar.
Arithmetic of Elliptic Curves over GF(p^d)	
GFPXECGetSize	Gets the size of the context of an elliptic curve over the GF(p^d) field.
GFPXECInit	Initializes the context of an elliptic curve over the GF(p^d) field.
GFPXECSet	Sets up parameters of an elliptic curve over the GF(p^d) field.
GFPXECGet	Extracts parameters of the elliptic curve over the GF(p^d) field from the context.
GFPXECVerify	Verifies parameters of an elliptic curve over the GF(p^d) field.
GFPXECPointGetSize	Gets the size of the context of a point on the elliptic curve over the GF(p^d) field.
GFPXECPointInit	Initializes the context of a point on the elliptic curve over the GF(p^d) field.
GFPXECSetPoint	Sets up the coordinates of a point on the elliptic curve over the GF(p^d) field.
GFPXECSetPointAtInfinity	Sets the coordinates of a point on the elliptic curve over the GF(p^d) field to those of the point at infinity.
GFPXECSetPointRandom	Sets random coordinates of a point on the elliptic curve over the GF(p^d) field.
GFPXECCpyPoint	Copies one point of the elliptic curve over the GF(p^d) field to another.
GFPXECGetPoint	Extracts coordinates of the point on the elliptic curve over the GF(p^d) field from the context.
GFPXECVerifyPoint	Verifies a point of the elliptic curve over the GF(p^d) field.
GFPXECCmpPoint	Compares points of the elliptic curve over the GF(p^d) field.

Function Base Name	Operation
GFPXECNegPoint	Computes the inverse for a point of the elliptic curve over the GF(*p^d*) field.
GFPXECAddPoint	Adds points on the elliptic curve over the GF(*p^d*) field.
GFPXECMulPointScalar	Multiplies a point on the elliptic curve over the GF(*p^d*) field by a scalar.

The functions described in this section use context structures of the following types to carry data of the elliptic curve and elliptic curve point:

Elliptic curve over GF(*p*)	IppsGFPECState and IppsGFPECPoint, respectively.
Elliptic curve over GF(*p^d*)	IppsGFPXECState and IppsGFPXECPoint, respectively.

See also:

Finite Field Arithmetic

Functions for the Elliptic Curve over GF(p)

GFPECGetSize

Gets the size of the IppsGFPECState *context of the elliptic curve over the GF(p) field.*

Syntax

```
IppStatus ippsGFPECGetSize(const IppsGFPState *pGFp, Ipp32u
*stateSizeInBytes);
```

Parameters

pGFp	Pointer to the IppsGFPState context of the finite field GF(*p*).
stateSizeInBytes	Buffer size in bytes needed for the IppsGFPECState context.

Description

This function is declared in the ippcp.h file. The function returns the size of the buffer associated with the IppsGFPECState context, suitable for storing data for the elliptic curve over the GF(*p*) field.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if any of the context parameters does not match the operation.

GFPECInit

Initializes the IppsGFPECState *context of the elliptic curve over the GF(p) field.*

Syntax

```
IppStatus ippsGFPECInit(IppsGFPECState *pEC, const IppsGFPElement *pA, const
IppsGFPElement *pB, const IppsGFPElement *pX, const IppsGFPElement *pY, const
Ipp32u *pOrder, Ipp32u orderLen, Ipp32u cofactor, IppsGFPState *pGFp);
```

Parameters

pEC	Pointer to the context of the elliptic curve being initialized.
pA	Pointer to the *A* parameter of the elliptic curve.
pB	Pointer to the *B* parameter of the elliptic curve.
pX, pY	Pointers to the *x* and *y* coordinates of the base point of the elliptic curve.
pOrder	Pointer to the array storing the order of the base point.
orderLen	Length of the array storing the order of the base point.
cofactor	The value of the cofactor.
pGFp	Pointer to the context of the elliptic curve definition field GF(*p*).

Description

This function is declared in the ippcp.h file. The function initializes the memory buffer **pEC* associated with the IppsGFPECState context and sets up the specific parameters of the elliptic curve, if they are supplied. The initialized context is used in the functions that create contexts of points on the curve (elements of the group of points) and perform operations with the points.

NOTE. Only the *pEC* and *pGFp* parameters are required. You can omit the other parameters by setting their values to NULL or zero and set up the missing parameters of the elliptic curve later on by calling GFPECSet.

Important. While you are calling the arithmetic functions for the elliptic curve **pEC*, a properly initialized **pGFp* context of the definition field GF(*p*) is required.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the *pEC* or *pGFp* pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if any of the context parameters does not match the operation.

GFPECSet

Sets up parameters of the elliptic curve in the IppsGFPECState *context.*

Syntax

```
IppStatus ippsGFPECSet(const IppsGFPElement *pA, const IppsGFPElement *pB,
const IppsGFPElement *pX, const IppsGFPElement *pY, const Ipp32u *pOrder,
Ipp32u orderLen, Ipp32u cofactor, IppsGFPECState *pEC);
```

Parameters

pA	Pointer to the *A* parameter of the elliptic curve.
pB	Pointer to the *B* parameter of the elliptic curve.
pX, pY	Pointers to the *x* and *y* coordinates of the base point of the elliptic curve.
pOrder	Pointer to the array storing the order of the base point.
orderLen	Length of the array storing the order of the base point.
cofactor	The value of the cofactor.
pEC	Pointer to the context of the elliptic curve.

Description

This function is declared in the `ippcp.h` file. The function assigns values to the parameters of the elliptic curve in the `IppsGFPECState` context.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if the *pEC* pointer is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if any of the context parameters does not match the operation.

GFPECGet

Extracts elliptic curve parameters from the input `IppsGFPECState` *context.*

Syntax

```
IppStatus ippsGFPECGet(const IppsGFPECState *pEC, const IppsGFPState **pGFp,
Ipp32u *pElementLen, IppsGFPElement *pA, IppsGFPElement *pB, IppsGFPElement
*pX, IppsGFPElement *pY, const Ipp32u **pOrder, Ipp32u *orderLen, Ipp32u
*cofactor);
```

Parameters

pEC	Pointer to the context of the elliptic curve.
pGFp	Pointer to the context of the elliptic curve definition field GF(*p*).
pA	Pointer to a copy of the *A* parameter of the elliptic curve.
pB	Pointer to a copy of the *B* parameter of the elliptic curve.
pX, pY	Pointers to copies of the *x* and *y* coordinates of the base point of the elliptic curve.
pOrder	Address of the pointer to the array storing the order of the base point.
orderLen	Length of the array storing the order of the base point.
cofactor	The value of the cofactor.

Description

This function is declared in the ippcp.h file. The function extracts parameters of the elliptic curve from the input IppsGFPECState context. You can get any combination of the following parameters: a reference to the definition field, copies of the *A* and *B* coefficients and *x* and *y* coordinates, a reference to the order of the base point, the length of the order, and the value of the cofactor. To turn off extraction of a particular parameter of the elliptic curve, set the appropriate function parameter to NULL.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if the *pEC* pointer is NULL.
ippStsContextMatchErr	Indicates an error condition if any of the context parameters does not match the operation.

GFPECVerify

Verifies parameters of the elliptic curve over the GF(p) field.

Syntax

```
IppStatus ippsGFPECVerify(IppsGFPECState *pEC, IppsECResult *result);
```

Parameters

pEC	Pointer to the context of the elliptic curve.
result	The result of the parameter verification.

Description

This function is declared in the ippcp.h file. The function verifies parameters of the elliptic curve from the input IppsGFPECState context and returns the result in **result*. The result of the verification may have the following values:

ippECValid	Parameters are valid.
ippECIsZeroDiscriminant	$4*A^3+3*B^2=0 \ mod \ p$.
ippECPointIsAtInfinity	Base point *G=(x,y)* is the point at infinity.
ippECPointIsNotValid	Base point *G=(x,y)* is not on the curve.

ippECInvalidOrder	The order of the base point *G=(x,y)* is invalid.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if any of the context parameters does not match the operation.

GFPECPointGetSize

Gets the size of the IppsGFPECPoint *context of a point on the elliptic curve.*

Syntax

```
IppStatus ippsGFPECPointGetSize(const IppsGFPECState *pEC, Ipp32u *stateSizeInBytes);
```

Parameters

pEC	Pointer to the context of the elliptic curve.
stateSizeInBytes	Buffer size in bytes needed for the IppsGFPECPoint context.

Description

This function is declared in the ippcp.h file. The function returns the size of the buffer associated with the IppsGFPECPoint context, suitable for storing data for a point on the elliptic curve over the GF(p) field.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if any of the context parameters does not match the operation.

GFPECPointInit

Initializes the `IppsGFPECPoint` *context of a point on the elliptic curve.*

Syntax

```
IppStatus ippsGFPECPointInit(IppsGFPECPoint *pPoint, const IppsGFPElement *pX, const IppsGFPElement *pY, IppsGFPECState *pEC);
```

Parameters

pPoint	Pointer to the `IppsGFPECPoint` context being initialized.
pX, pY	Pointers to the *X* and *Y* coordinates of the point on the elliptic curve.
pEC	Pointer to the context of the elliptic curve.

Description

This function is declared in the `ippcp.h` file. The function initializes the `IppsGFPECPoint` context and sets up the specific coordinates of the elliptic curve point.

NOTE. Setting the *pX* and *pY* pointers to `NULL` initializes the context for the point at infinity.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if the *pEC* pointer is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if any of the context parameters does not match the operation.

GFPECSetPoint

Sets up the coordinates of a point on the elliptic curve over the GF(p) field.

Syntax

```
IppStatus ippsGFPECSetPoint(const IppsGFPElement *pX, const IppsGFPElement
*pY, IppsGFPECPoint *pPoint, IppsGFPECState *pEC);
```

Parameters

pX, pY	Pointers to the *X* and *Y* coordinates of the point on the elliptic curve.
pPoint	Pointer to the context of the elliptic curve point.
pEC	Pointer to the context of the elliptic curve.

Description

This function is declared in the `ippcp.h` file. The function assigns the given values to the coordinates of the elliptic curve point in the `IppsGFPECPoint` context.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if the *pEC* pointer is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if any of the context parameters does not match the operation.

GFPECSetPointAtInfinity

Sets the coordinates of the elliptic curve point in the `IppsGFPECPoint` *context to those of the point at infinity.*

Syntax

```
IppStatus ippsGFPECSetPointAtInfinity(IppsGFPECPoint *pPoint, IppsGFPECState
*pEC);
```

Parameters

pPoint	Pointer to the context of the elliptic curve point.
pEC	Pointer to the context of the elliptic curve.

Description

This function is declared in the ippcp.h file. The function sets the coordinates of the elliptic curve point in the IppsGFPECPoint context to the coordinates of the point at infinity.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if the *pEC* pointer is NULL.
ippStsContextMatchErr	Indicates an error condition if any of the context parameters does not match the operation.

GFPECSetPointRandom

Sets random coordinates of a point on the elliptic curve over the GF(p) field.

Syntax

```
IppStatus ippsGFPECSetPointRandom(IppsGFPECPoint *pPoint, IppsGFPECState
*pEC, IppBitSupplier rndFunc, void* pRndParam);
```

Parameters

pPoint	Pointer to the context of the elliptic curve point.
pEC	Pointer to the context of the elliptic curve.
rndFunc	Function that generates random sequences.
pRndParam	Pointer to the context of a random sequence generator.

Description

This function is declared in the ippcp.h file. The function assigns random values to the coordinates of the elliptic curve point in the IppsGFPECPoint context.

See also:

Pseudorandom Number Generation Functions.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if the *pEC* pointer is NULL.
ippStsContextMatchErr	Indicates an error condition if any of the context parameters does not match the operation.

GFPECCpyPoint

Copies one point of the elliptic curve over the GF(p) field to another.

Syntax

```
IppStatus ippsGFPECCpyPoint(const IppsGFPECPoint *pA, IppsGFPECPoint *pR,
IppsGFPECState *pEC);
```

Parameters

pA	Pointer to the context of the elliptic curve point being copied.
pR	Pointer to the context of the elliptic curve point being changed.
pEC	Pointer to the context of the elliptic curve.

Description

This function is declared in the ippcp.h file. The function copies one point of the elliptic curve over the GF(*p*) field to another.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if the *pEC* pointer is NULL.
ippContextMatchErr	Indicates an error condition if any of the context parameters does not match the operation.

GFPECGetPoint

Extracts coordinates of the point on the elliptic curve from the `IppsGFPECPoint` *context.*

Syntax

```
IppStatus ippsGFPECGetPoint(const IppsGFPECPoint *pPoint, IppsGFPElement
*pX, IppsGFPElement *pY, IppsGFPECState *pEC);
```

Parameters

pPoint	Pointer to the context of the elliptic curve point.
pX, pY	Pointers to the *X* and *Y* coordinates of the point on the elliptic curve.
pEC	Pointer to the context of the elliptic curve.

Description

This function is declared in the `ippcp.h` file. The function exports the coordinates of the elliptic curve point from the `IppsGFPECPoint` context to the user-defined elements of the definition field. To turn off extraction of a particular coordinate, set the appropriate function parameter to `NULL`.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the *pEC* or *pPoint* pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if any of the context parameters does not match the operation.

GFPECVerifyPoint

Verifies whether the point belongs to the elliptic curve over the GF(p) field.

Syntax

```
IppStatus ippsGFPECVerifyPoint(const IppsGFPECPoint *pPoint, IppsECResult
*result, IppsGFPECState *pEC);
```

Parameters

pPoint	Pointer to the context of the elliptic curve point.
result	The result of the verification.
pEC	Pointer to the context of the elliptic curve.

Description

This function is declared in the ippcp.h file. The function verifies whether the given point belongs to the elliptic curve over the GF(*p*) field. The result of the verification is returned in **result* and may have the following values:

ippECValid	The point belongs to the curve.
ippECPointIsNotValid	The point does not belong to the curve.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if any of the context parameters does not match the operation.

GFPECCmpPoint

Compares two points on the elliptic curve over the GF(p) field.

Syntax

```
IppStatus ippsGFPECCmpPoint(const IppsGFPECPoint *pA, const IppsGFPECPoint *pB, IppsElementCmpResult *result, IppsGFPECState *pEC);
```

Parameters

pA	Pointer to the context of the first point on the elliptic curve.
pB	Pointer to the context of the second point on the elliptic curve.
result	The result of the parameter verification.

pEC	Pointer to the context of the elliptic curve.

Description

This function is declared in the `ippcp.h` file. The function compares coordinates of two points on the elliptic curve over the GF(*p*) field and returns the result in `*result`. The result of the comparison may have the following values:

`ippElementEQ`	The points are equal.
`ippElementNE`	The points are not equal.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if any of the context parameters does not match the operation.

GFPECNegPoint

Computes the inverse point for a given point on the elliptic curve over the GF(p) field.

Syntax

```
IppStatus ippsGFPECNegPoint(const IppsGFPECPoint *pA, IppsGFPECPoint *pR,
IppsGFPECState *pEC);
```

Parameters

pA	Pointer to the context of the given point on the elliptic curve.
pR	Pointer to the context of the resulting point on the elliptic curve.
pEC	Pointer to the context of the elliptic curve.

Description

This function is declared in the ippcp.h file. For a given point of the elliptic curve over the GF(*p*) field, the function computes the coordinates of the inverse point. The following pseudocode represents this operation: *R = 0 – A*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if any of the context parameters does not match the operation.

GFPECAddPoint

Adds two points on the elliptic curve over the GF(p) field.

Syntax

```
IppStatus ippsGFPECAddPoint(const IppsGFPECPoint *pA, const IppsGFPECPoint
*pB, IppsGFPECPoint *pR, IppsGFPECState *pEC);
```

Parameters

pA	Pointer to the context of the first summand point on the elliptic curve.
pB	Pointer to the context of the second summand point on the elliptic curve.
pR	Pointer to the context of the resulting point on the elliptic curve.
pEC	Pointer to the context of the elliptic curve.

Description

This function is declared in the ippcp.h file. The function computes the coordinates of the elliptic curve point that equals the sum of the two given points. The following pseudocode represents this operation: *R = A + B*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if any of the context parameters does not match the operation.

GFPECMulPointScalar

Adds a point on the elliptic curve over the GF(p) field to itself multiple times.

Syntax

```
IppStatus ippsGFPECMulPointScalar(const IppsGFPECPoint *pA, const Ipp32u
*pScalar, Ipp32u scalarLen, IppsGFPECPoint *pR, IppsGFPECState *pEC);
```

Parameters

pA	Pointer to the context of the given point on the elliptic curve.
pScalar	Pointer to the data array that stores the scalar.
scalarLen	Length of the scalar.
pR	Pointer to the context of the resulting point on the elliptic curve.
pEC	Pointer to the context of the elliptic curve.

Description

This function is declared in the ippcp.h file. The function computes the coordinates of the elliptic curve point that equals the product of the given point and the scalar. The following pseudocode represents this operation: *R = scalar * A*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

ippStsContextMatchErr	Indicates an error condition if any of the context parameters does not match the operation.

Functions for the Elliptic Curve over GF(p^d)

GFPXECGetSize

Gets the size of the IppsGFPXECState *context of the elliptic curve over the GF(p) field.*

Syntax

```
IppStatus ippsGFPXECGetSize(const IppsGFPXState *pGFpx, Ipp32u
*stateSizeInBytes);
```

Parameters

pGFpx	Pointer to the IppsGFPXState context of the finite field GF(*p^d*).
stateSizeInBytes	Buffer size in bytes needed for the IppsGFPXECState context.

Description

This function is declared in the ippcp.h file. The function returns the size of the buffer associated with the IppsGFPXECState context, suitable for storing data for the elliptic curve over the GF(*p^d*) field.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if any of the context parameters does not match the operation.

GFPXECInit

Initializes the `IppsGFPXECState` *context of the elliptic curve over the GF(p^d) field.*

Syntax

```
IppStatus ippsGFPXECInit(IppsGFPXECState *pEC, const IppsGFPXElement *pA,
const IppsGFPXElement *pB, const IppsGFPXElement *pX, const IppsGFPXElement
*pY, const Ipp32u *pOrder, Ipp32u orderLen, Ipp32u cofactor, IppsGFPXState
*pGFpx);
```

Parameters

pEC	Pointer to the context of the elliptic curve being initialized.
pA	Pointer to the *A* parameter of the elliptic curve.
pB	Pointer to the *B* parameter of the elliptic curve.
pX, pY	Pointers to the *x* and *y* coordinates of the base point of the elliptic curve.
pOrder	Pointer to the array storing the order of the base point.
orderLen	Length of the array storing the order of the base point.
cofactor	The value of the cofactor.
pGFpx	Pointer to the context of the elliptic curve definition field GF(*p^d*).

Description

This function is declared in the `ippcp.h` file. The function initializes the memory buffer **pEC* associated with the `IppsGFPXECState` context and sets up the specific parameters of the elliptic curve, if they are supplied. The initialized context is used in the functions that create contexts of points on the curve (elements of the group of points) and perform operations with the points.

NOTE. Only the *pEC* and *pGFpx* parameters are required. You can omit the other parameters by setting their values to `NULL` or zero and set up the missing parameters of the elliptic curve later on by calling `GFPXECSet`.

Important. While you are calling the arithmetic functions for the elliptic curve *pEC, properly initialized IppsGFPXState and IppsGFPState contexts of the definition field GF(p^d) and extended field GF(p) are required.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the *pEC or *pGFpx pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if any of the context parameters does not match the operation.

GFPXECSet

Sets up parameters of the elliptic curve in the IppsGFPXECState *context.*

Syntax

```
IppStatus ippsGFPXECSet(const IppsGFPXElement *pA, const IppsGFPXElement
*pB, const IppsGFPXElement *pX, const IppsGFPXElement *pY, const Ipp32u
*pOrder, Ipp32u orderLen, Ipp32u cofactor, IppsGFPXECState *pEC);
```

Parameters

*pA	Pointer to the A parameter of the elliptic curve.
*pB	Pointer to the B parameter of the elliptic curve.
*pX, *pY	Pointers to the x and y coordinates of the base point of the elliptic curve.
*pOrder	Pointer to the array storing the order of the base point.
orderLen	Length of the array storing the order of the base point.
cofactor	The value of the cofactor.
*pEC	Pointer to the context of the elliptic curve.

Description

This function is declared in the ippcp.h file. The function assigns values to the parameters of the elliptic curve in the IppsGFPXECState context.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if the *pEC* pointer is NULL.
ippStsContextMatchErr	Indicates an error condition if any of the context parameters does not match the operation.

GFPXECGet

extracts elliptic curve parameters from the input IppsGFPXECState *context.*

Syntax

```
IppStatus ippsGFPXECGet(const IppsGFPXECState *pEC, const IppsGFPXState
**pGFpx, Ipp32u *pElementLen, IppsGFPXElement *pA, IppsGFPXElement *pB,
IppsGFPXElement *pX, IppsGFPXElement *pY, const Ipp32u **pOrder, Ipp32u
*orderLen, Ipp32u *cofactor);
```

Parameters

pEC	Pointer to the context of the elliptic curve.
pGFpx	Pointer to the context of the elliptic curve definition field GF(*p^d*).
pA	Pointer to a copy of the *A* parameter of the elliptic curve.
pB	Pointer to a copy of the *B* parameter of the elliptic curve.
pX, pY	Pointers to copies of the *x* and *y* coordinates of the base point of the elliptic curve.
pOrder	Address of the pointer to the array storing the order of the base point.
orderLen	Length of the array storing the order of the base point.
cofactor	The value of the cofactor.

Description

This function is declared in the ippcp.h file. The function extracts parameters of the elliptic curve from the input IppsGFPXECState context. You can get any combination of the following parameters: a reference to the definition field, copies of the *A* and *B* coefficients and the *x* and *y* coordinates, a reference to the order of the base point, the length of the order, and the value of the cofactor. To turn off extraction of a particular parameter of the elliptic curve, set the appropriate function parameter to NULL.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if the *pEC* pointer is NULL.
ippStsContextMatchErr	Indicates an error condition if any of the context parameters does not match the operation.

GFPXECVerify

Verifies parameters of the elliptic curve over the GF(p^d) field.

Syntax

```
IppStatus ippsGFPXECVerify(IppsGFPXECState *pEC, IppsECResult *result);
```

Parameters

pEC	Pointer to the context of the elliptic curve.
result	The result of the parameter verification.

Description

This function is declared in the ippcp.h file. The function verifies parameters of the elliptic curve from the input IppsGFPXECState context and returns the result in **result*. The result of the verification may have the following values:

ippECValid	Parameters are valid.
ippECIsZeroDiscriminant	$4*A^3+3*B^2=0 \bmod g(t)$.
ippECPointIsAtInfinity	Base point *G=(x,y)* is the point at infinity.
ippECPointIsNotValid	Base point *G=(x,y)* is not on the curve.

ippECInvalidOrder	The order of the base point *G=(x,y)* is invalid.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if any of the context parameters does not match the operation.

GFPXECPointGetSize

Gets the size of the IppsGFPXECPoint *context of a point on the elliptic curve.*

Syntax

```
IppStatus ippsGFPXECPointGetSize(const IppsGFPXECState *pEC, Ipp32u
*stateSizeInBytes);
```

Parameters

pEC	Pointer to the context of the elliptic curve.
stateSizeInBytes	Buffer size in bytes needed for the IppsGFPXECPoint context.

Description

This function is declared in the ippcp.h file. The function returns the size of the buffer associated with the IppsGFPXECPoint context, suitable for storing data for a point on the elliptic curve over the GF(*p^d*) field.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if any of the context parameters does not match the operation.

GFPXECPointInit

Initializes the `IppsGFPXECPoint` *context of a point on the elliptic curve.*

Syntax

```
IppStatus ippsGFPXECPointInit(IppsGFPXECPoint *pPoint, const IppsGFPXElement *pX, const IppsGFPXElement *pY, IppsGFPXECState *pEC);
```

Parameters

pPoint	Pointer to the `IppsGFPXECPoint` context being initialized.
pX, pY	Pointers to the *X* and *Y* coordinates of the point on the elliptic curve.
pEC	Pointer to the context of the elliptic curve.

Description

This function is declared in the `ippcp.h` file. The function initializes the `IppsGFPXECPoint` context and sets up the specific coordinates of the elliptic curve point.

NOTE. Setting the *pX* and *pY* pointers to `NULL` initializes the context for the point at infinity.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if the *pEC* pointer is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if any of the context parameters does not match the operation.

GFPXECSetPoint

Sets up the coordinates of a point on the elliptic curve over the GF(p^d) field.

Syntax

```
IppStatus ippsGFPXECSetPoint(const IppsGFPXElement *pX, const IppsGFPXElement
*pY, IppsGFPXECPoint *pPoint, IppsGFPXECState *pEC);
```

Parameters

pX, pY	Pointers to the *X* and *Y* coordinates of the point on the elliptic curve.
pPoint	Pointer to the context of the elliptic curve point.
pEC	Pointer to the context of the elliptic curve.

Description

This function is declared in the `ippcp.h` file. The function assigns the given values to the coordinates of the elliptic curve point in the `IppsGFPXECPoint` context.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if the *pEC* pointer is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if any of the context parameters does not match the operation.

GFPXECSetPointAtInfinity

Sets the coordinates of the elliptic curve point in the `IppsGFPXECPoint` *context to those of the point at infinity.*

Syntax

```
IppStatus ippsGFPXECSetPointAtInfinity(IppsGFPXECPoint *pPoint,
IppsGFPXECState *pEC);
```

Parameters

pPoint	Pointer to the context of the elliptic curve point.
pEC	Pointer to the context of the elliptic curve.

Description

This function is declared in the ippcp.h file. The function sets the coordinates of the elliptic curve point in the IppsGFPXECPoint context to the coordinates of the point at infinity.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if the *pEC* pointer is NULL.
ippStsContextMatchErr	Indicates an error condition if any of the context parameters does not match the operation.

GFPXECSetPointRandom

Sets random coordinates of a point on the elliptic curve over the GF(p^d) field.

Syntax

```
IppStatus ippsGFPXECSetPointRandom(IppsGFPXECPoint *pPoint, IppsGFPXECState
*pEC, IppBitSupplier rndFunc, void* pRndParam);
```

Parameters

pPoint	Pointer to the context of the elliptic curve point.
pEC	Pointer to the context of the elliptic curve.
rndFunc	Function that generates random sequences.
pRndParam	Pointer to the context of a random sequence generator.

Description

This function is declared in the ippcp.h file. The function assigns random values to the coordinates of the elliptic curve point in the IppsGFPXECPoint context.

See also:

Pseudorandom Number Generation Functions.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if the *pEC* pointer is NULL.
ippStsContextMatchErr	Indicates an error condition if any of the context parameters does not match the operation.

GFPXECCpyPoint

Copies one point of the elliptic curve over the GF(p^d) field to another.

Syntax

```
IppStatus ippsGFPXECCpyPoint(const IppsGFPXECPoint *pA, IppsGFPXECPoint *pR,
IppsGFPXECState *pEC);
```

Parameters

pA	Pointer to the context of the elliptic curve point being copied.
pR	Pointer to the context of the elliptic curve point being changed.
pEC	Pointer to the context of the elliptic curve.

Description

This function is declared in the ippcp.h file. The function copies one point of the elliptic curve over the GF(*p^d*) field to another.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if the *pEC* pointer is NULL.
ippContextMatchErr	Indicates an error condition if any of the context parameters does not match the operation.

GFPXECGetPoint

Extracts coordinates of the point on the elliptic curve from the `IppsGFPXECPoint` *context.*

Syntax

```
IppStatus ippsGFPXECGetPoint(const IppsGFPXECPoint *pPoint, IppsGFPXElement
*pX, IppsGFPXElement *pY, IppsGFPXECState *pEC);
```

Parameters

pPoint	Pointer to the context of the elliptic curve point.
pX, pY	Pointers to the *X* and *Y* coordinates of the point on the elliptic curve.
pEC	Pointer to the context of the elliptic curve.

Description

This function is declared in the `ippcp.h` file. The function exports the coordinates of the elliptic curve point from the `IppsGFPXECPoint` context to the user-defined elements of the definition field. To turn off extraction of a particular coordinate, set the appropriate function parameter to `NULL`.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the *pEC* or *pPoint* pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if any of the context parameters does not match the operation.

GFPXECVerifyPoint

Verifies whether the point belongs to the elliptic curve over the GF(p^d) field.

Syntax

```
IppStatus ippsGFPXECVerifyPoint(const IppsGFPXECPoint *pPoint, IppsECResult
*result, IppsGFPXECState *pEC);
```

Parameters

pPoint	Pointer to the context of the elliptic curve point.
result	The result of the verification.
pEC	Pointer to the context of the elliptic curve.

Description

This function is declared in the ippcp.h file. The function verifies whether the given point belongs to the elliptic curve over the GF(*p^d*) field. The result of the verification is returned in **result* and can have the following values:

ippECValid	The point belongs to the curve.
ippECPointIsNotValid	The point does not belong to the curve.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if any of the context parameters does not match the operation.

GFPXECCmpPoint

Compares two points on the elliptic curve over the GF(p^d) field.

Syntax

```
IppStatus ippsGFPXECCmpPoint(const IppsGFPXECPoint *pA, const IppsGFPXECPoint
*pB, IppsElementCmpResult *result, IppsGFPXECState *pEC);
```

Parameters

pA	Pointer to the context of the first point on the elliptic curve.
pB	Pointer to the context of the second point on the elliptic curve.
result	The result of the parameter verification.

pEC	Pointer to the context of the elliptic curve.

Description

This function is declared in the `ippcp.h` file. The function compares coordinates of two points on the elliptic curve over the GF(*p^d*) field and returns the result in **result*. The result of the comparison may have the following values:

`ippElementEQ`	The points are equal.
`ippElementNE`	The points are not equal.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if any of the context parameters does not match the operation.

GFPXECNegPoint

Computes the inverse point for a given point on the elliptic curve over the GF(p^d) field.

Syntax

```
IppStatus ippsGFPXECNegPoint(const IppsGFPXECPoint *pA, IppsGFPXECPoint *pR,
IppsGFPXECState *pEC);
```

Parameters

pA	Pointer to the context of the given point on the elliptic curve.
pR	Pointer to the context of the resulting point on the elliptic curve.
pEC	Pointer to the context of the elliptic curve.

Description

This function is declared in the `ippcp.h` file. For a given point of the elliptic curve over the GF(*p^d*) field, the function computes the coordinates of the inverse point. The following pseudocode represents this operation: *R = 0 – A*.

Return Values

`ippStsNoErr`	Indicates no error. Any other value indicates an error or warning.
`ippStsNullPtrErr`	Indicates an error condition if any of the specified pointers is `NULL`.
`ippStsContextMatchErr`	Indicates an error condition if any of the context parameters does not match the operation.

GFPXECAddPoint

Adds two points on the elliptic curve over the GF(p^d) field.

Syntax

```
IppStatus ippsGFPXECAddPoint(const IppsGFPXECPoint *pA, const IppsGFPXECPoint *pB, IppsGFPXECPoint *pR, IppsGFPXECState *pEC);
```

Parameters

pA	Pointer to the context of the first summand point on the elliptic curve.
pB	Pointer to the context of the second summand point on the elliptic curve.
pR	Pointer to the context of the resulting point on the elliptic curve.
pEC	Pointer to the context of the elliptic curve.

Description

This function is declared in the `ippcp.h` file. The function computes the coordinates of the elliptic curve point that equals the sum of the two given points. The following pseudocode represents this operation: *R = A + B*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if any of the context parameters does not match the operation.

GFPXECMulPointScalar

Adds a point on the elliptic curve over the GF(p^d) field to itself multiple times.

Syntax

```
IppStatus ippsGFPXECMulPointScalar(const IppsGFPXECPoint *pA, const Ipp32u *pScalar, Ipp32u scalarLen, IppsGFPXECPoint *pR, IppsGFPXECState *pEC);
```

Parameters

pA	Pointer to the context of the given point on the elliptic curve.
pScalar	Pointer to the data array that stores the scalar.
scalarLen	Length of the scalar.
pR	Pointer to the context of the resulting point on the elliptic curve.
pEC	Pointer to the context of the elliptic curve.

Description

This function is declared in the ippcp.h file. The function computes the coordinates of the elliptic curve point that equals the product of the given point and the scalar. The following pseudocode represents this operation: *R = scalar * A*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.

ippStsContextMatchErr	Indicates an error condition if any of the context parameters does not match the operation.

Tate Pairing

This section describes the Intel IPP primitives for Tate pairing [EHCC].

Table 5-13 lists all the functions for Tate pairing.

Table 5-13 Intel IPP Tate Pairing Functions

Function Base Name	Operation
TatePairingDE3GetSize	Gets the size of the context of the pairing operation.
TatePairingDE3Init	Initializes the context of the pairing operation.
TatePairingDE3Get	Extracts parameters of the pairing operation from the context.
TatePairingDE3Apply	Performs Tate pairing.

TatePairingDE3GetSize

Gets the size of the `IppsTatePairingDE3State` *context of the pairing operation.*

Syntax

```
IppStatus ippsTatePairingDE3GetSize(const IppsGFPECState *pECp, const IppsGFPXECState *pECpx, Ipp32u *stateSizeInBytes);
```

Parameters

pECp	Pointer to the context of the elliptic curve over the GF(p) field.
pECpx	Pointer to the context of the elliptic curve over the GF(p^d) field.
stateSizeInBytes	Buffer size in bytes needed for the `IppsTatePairingDE3State` context.

Description

This function is declared in the ippcp.h file. The function returns the size of the buffer associated with the IppsGFPXECPoint context, suitable for storing data and buffers for the pairing operation.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if any of the context parameters does not match the operation.

TatePairingDE3Init

Initializes the IppsTatePairingDE3State *context of the pairing operation.*

Syntax

```
IppStatus ippsTatePairingDE3Init(IppsTatePairingDE3State *pPairing, const IppsGFPECState *pECp, const IppsGFPXECState *pECpx, const IppsGFPXQState *pGFpxq);
```

Parameters

pPairing	Pointer to the context being initialized.
pECp	Pointer to the context of the elliptic curve over the GF(*p*) field.
pECpx	Pointer to the context of the elliptic curve over the GF(*p^d*) field.
pGFpxq	Pointer to the context of the finite field GF(*p^d^2*).

Description

This function is declared in the ippcp.h file. The function initializes the **pPairing* buffer associated with the IppsTatePairingDE3State context, sets up and precomputes the parameters needed for the pairing operation.

Important. While the *pPairing context exists, properly initialized contexts of the elliptic curves and the GF(p^d^2) field are required.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if any of the context parameters does not match the operation.

TatePairingDE3Get

Extracts parameters of the pairing operation from the IppsTatePairingDE3State *context.*

Syntax

```
IppStatus ippsTatePairingDE3Get(const IppsTatePairingDE3State *pPairing,
const IppsGFPECState **pECp, const IppsGFPXECState **pECpx, const
IppsGFPXQState **pGFpxq);
```

Parameters

pPairing	Pointer to the context of the pairing operation.
pECp	Address of the pointer to the context of the elliptic curve over the GF(p) field.
pECpx	Address of the pointer to the context of the elliptic curve over the GF(p^d) field.
pGFpxq	Address of the pointer to the context of the finite field GF(p^d^2).

Description

This function is declared in the ippcp.h file. The function extracts parameters of the pairing operation from the input IppsTatePairingDE3State context. You can get any combination of the following parameters: references to the IppsGFPECState and IppsGFPXECState contexts

of the elliptic curves and a reference to the IppsGFPXQState context of the GF(*p^d^2*) field. To turn off extraction of a particular parameter of the pairing operation, set the appropriate function parameter to NULL.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.
ippStsNullPtrErr	Indicates an error condition if the *pPairing* pointer is NULL.
ippStsContextMatchErr	Indicates an error condition if any of the IppsTatePairingDE3State context parameters does not match the operation.

TatePairingDE3Apply

Performs the pairing operation.

Syntax

```
IppStatus ippsTatePairingDE3Apply(const IppsGFPECPoint *pPointA, const
IppsGFPXECPoint *pPointB, IppsGFPXQElement *pGFpxqElementR,
IppsTatePairingDE3State *pPairing);
```

Parameters

pPointA	Pointer to the context of the elliptic curve over the GF(*p*) field.
pPointB	Pointer to the context of the elliptic curve over the GF(*p^d*) field.
pGFpxqElementR	Pointer to the context of the resulting element of the finite field GF(*p^d^2*).
pPairing	Pointer to the context of the pairing operation.

Description

This function is declared in the ippcp.h file. The function computes the GF(*p^d^2*) field element that equals the pairing of elliptic curve points **pPointA* and **pPointB*.

Return Values

ippStsNoErr	Indicates no error. Any other value indicates an error or warning.

ippStsNullPtrErr	Indicates an error condition if any of the specified pointers is NULL.
ippStsContextMatchErr	Indicates an error condition if any of the context parameters does not match the operation.

Functions Removed from Intel® Integrated Performance Primitives 5.0

A

The table below lists functions removed from Intel® Integrated Performance Primitives (Intel® IPP) 5.0 for cryptography and suggests Intel IPP functions to be called instead.

Table 30: Table A-1 Functions Removed from Intel IPP 5.0

Removed Function	Function for Substitution or Workaround
ippsBigNumBufferSize	ippsBigNumGetSize
ippsBlowfishBufferSize	ippsBlowfishGetSize
ippsDAABlowfishBufferSize	ippsDAABlowfishGetSize
ippsDAADESBufferSize	ippsDAADESGetSize
ippsDAARijndael128BufferSize	ippsDAARijndael128GetSize
ippsDAARijndael192BufferSize	ippsDAARijndael192GetSize
ippsDAARijndael256BufferSize	ippsDAARijndael256GetSize
ippsDAATDESBufferSize	ippsDAATDESGetSize
ippsDAATwofishBufferSize	ippsDAATwofishGetSize
ippsDESBufferSize	ippsDESGetSize
ippsDESDecrypt	ippsDESDecryptECB (...*length*==8...)
ippsDESDecrypt_I	ippsDESDecryptECB (...*length*==8...)
ippsDESEncrypt	ippsDESEncryptECB (...*length*==8...)
ippsDESEncrypt_I	ippsDESEncryptECB (...*length*==8...)
ippsDSABufferSizes	ippsDLPGetSize
ippsDSAInit	ippsDLPInit
ippsDSAKeyCheck	ippsDLPValidateDSA
ippsDSAKeyGen	ippsDLPGenerateDSA
ippsDSAKeyGet	ippsDLPGet
ippsDSAKeySet	ippsDLPSet
ippsDSASign	ippsDLPSignGSA
ippsDSAVerify	ippsDLPVerifyGSA
ippsHMACMD5BufferSize	ippsHMACMD5GetSize
ippsHMACSHA1BufferSize	ippsHMASHA1GetSize
ippsHMACSHA256BufferSize	ippsHMASHA256GetSize
ippsHMACSHA384BufferSize	ippsHMASHA384GetSize

Removed Function	Function for Substitution or Workaround
ippsHMACSHA512BufferSize	ippsHMASHA512GetSize
ippsMD5BufferSize	ippsMD5GetSize
ippsMontBufferSize	ippsMontGetSize
ippsPrimeBufferSize	ippsPrimeGetSize
ippsPRNGAdd	Functionality is not obvious, not needed, removed.
ippsPRNGBufferSize	ippsPRNGGetSize
ippsPRNGen	ippsPRNGen , ippsPRNGen_BN
ippsPRNGGetRand	ippsPRNGen, ippsPRNGen_BN
ippsPRNGSetPrimeQ	ippsPRNGSetModulus
ippsRijndael128BufferSize	ippsRijndael128GetSize
ippsRijndael192BufferSize	ippsRijndael192GetSize
ippsRijndael256BufferSize	ippsRijndael256GetSize
ippsRSABufferSizes	ippsRSAGetSize
ippsRSAKeyCheck	ippsRSAValidate
ippsRSAKeyGen	ippsRSAGenerate
ippsRSAKeyGet	ippsRSAGetKey
ippsRSAKeySet	ippsRSASetKey
ippsSHA1BufferSize	ippsSHA1GetSize
ippsSHA256BufferSize	ippsSHA256GetSize
ippsSHA384BufferSize	ippsSHA384GetSize
ippsSHA512BufferSize	ippsSHA512GetSize
ippsTDESDecrypt	ippsTDESDecryptECB (…*length*==8...)
ippsTDESDecrypt_I	ippsTDESDecryptECB (…*length*==8...)
ippsTDESEncrypt	ippsTDESEncryptECB (…*length*==8...)
ippsTDESEncrypt_I	ippsTDESEncryptECB (…*length*==8...)
ippsTwofishBufferSize	ippsTwofishGetSize

Support Functions and Classes

B

This appendix contains miscellaneous information on support functions and classes that may be helpful to users of the Intel® Integrated Performance Primitives (Intel® IPP) for cryptography.

The Version Information Function section describes an Intel IPP function that provides version information for cryptography software.

The Classes and Functions Used in Examples section presents source code of classes and functions needed for examples given in the manual chapters.

Version Information Function

GetLibVersion

Returns information about the active version of the Intel IPP software for cryptography.

Syntax

```
const IppLibraryVersion* ippcpGetLibVersion(void);
```

Description

The function `ippcpGetLibVersion` is declared in the `ippcp.h` file. This function returns a pointer to a static data structure `IppLibraryVersion` that contains information about the current version of the Intel IPP software for cryptography. There is no need for you to release memory referenced by the returned pointer because it points to a static variable. The following fields of the `IppLibraryVersion` structure are available:

major	is the major number of the current library version.
minor	is the minor number of the current library version.
majorBuild	is the number of builds for the (*major.miror*) version.
build	is the total number of Intel IPP builds.
Name	is the name of the current library version.
Version	is the version string.
BuildDate	is the actual build date

For example, if the library version is "5.2 gold", library name is "ippcppxl.lib", and build date is "Nov 14 06", then the fields in this structure are set as follows:

major = 5, *minor* = 2, *Name* = "ippcppxl.lib", *Version* = "5.2 gold", *BuildDate* = "Nov 14 2006".

Example B-1 shows how to use the function ippcpGetLibVersion.

Example B-1 Using the ippcpGetLibVersion Function

```
void libinfo(void) { const IppLibraryVersion* lib = ippcpGetLibVersion();

printf("%s %s %d.%d.%d.%d\n", lib->Name, lib->Version, lib->major, lib->minor,
lib->majorBuild, lib->build);

}
```

Output:

```
ippcppxl.lib 5.2 gold 5.2.35.285
```

Classes and Functions Used in Examples

This section presents source code of functions and classes used in Example 5-8 and Example 5-9, provided in the "Public Key Cryptography Functions" chapter.

BigNumber Class

The section presents source code of the BigNumber class.

Declarations

Contents of the header file (bignum.h) declaring the BigNumber class are presented below:

```
#if !defined _BIGNUMBER_H_
#define _BIGNUMBER_H_

#include "ippcp.h"

#include <iostream>
#include <vector>
#include <iterator>
using namespace std;


class BigNumber
```

```
{
public:
   BigNumber(Ipp32u value=0);
   BigNumber(Ipp32s value);
   BigNumber(const IppsBigNumState* pBN);
   BigNumber(const Ipp32u* pData, int length=1, IppsBigNumSGN sgn=IppsBigNumPOS);
   BigNumber(const BigNumber& bn);
   BigNumber(const char *s);
   virtual ~BigNumber();

   // set value
   void Set(const Ipp32u* pData, int length=1, IppsBigNumSGN sgn=IppsBigNumPOS);

   // conversion to IppsBigNumState
   friend IppsBigNumState* BN(const BigNumber& bn) {return bn.m_pBN;}
   operator IppsBigNumState* () const { return m_pBN; }

   // some useful constatns
   static const BigNumber& Zero();
   static const BigNumber& One();
   static const BigNumber& Two();

   // arithmetic operators probably need
   BigNumber& operator  = (const BigNumber& bn);
   BigNumber& operator += (const BigNumber& bn);
   BigNumber& operator -= (const BigNumber& bn);
   BigNumber& operator *= (Ipp32u n);
   BigNumber& operator *= (const BigNumber& bn);
   BigNumber& operator /= (const BigNumber& bn);
   BigNumber& operator %= (const BigNumber& bn);
   friend BigNumber operator + (const BigNumber& a, const BigNumber& b);
   friend BigNumber operator - (const BigNumber& a, const BigNumber& b);
   friend BigNumber operator * (const BigNumber& a, const BigNumber& b);
   friend BigNumber operator * (const BigNumber& a, Ipp32u);
   friend BigNumber operator % (const BigNumber& a, const BigNumber& b);
   friend BigNumber operator / (const BigNumber& a, const BigNumber& b);

   // modulo arithmetic
   BigNumber Modulo(const BigNumber& a) const;
   BigNumber ModAdd(const BigNumber& a, const BigNumber& b) const;
   BigNumber ModSub(const BigNumber& a, const BigNumber& b) const;
   BigNumber ModMul(const BigNumber& a, const BigNumber& b) const;
   BigNumber InverseAdd(const BigNumber& a) const;
   BigNumber InverseMul(const BigNumber& a) const;

   // comparisons
   friend bool operator <  (const BigNumber& a, const BigNumber& b);
   friend bool operator >  (const BigNumber& a, const BigNumber& b);
   friend bool operator == (const BigNumber& a, const BigNumber& b);
   friend bool operator != (const BigNumber& a, const BigNumber& b);
   friend bool operator <= (const BigNumber& a, const BigNumber& b) {return !(a>b);}
```

```
   friend bool operator >= (const BigNumber& a, const BigNumber& b) {return !(a<b);}

   // easy tests
   bool IsOdd() const;
   bool IsEven() const { return !IsOdd(); }

   // size of BigNumber
   int MSB() const;
   int LSB() const;
   int BitSize() const { return MSB()+1; }
   int DwordSize() const { return (BitSize()+31)>>5;}
   friend int Bit(const vector<Ipp32u>& v, int n);

   // conversion and output
   void num2hex( string& s )   const; // convert to hex string
   void num2vec( vector<Ipp32u>& v ) const; // convert to 32-bit word vector

   friend ostream&   operator << (ostream& os,   const BigNumber& a);

protected:
   bool create(const Ipp32u* pData, int length, IppsBigNumSGN sgn=IppsBigNumPOS);
   int compare(const BigNumber& ) const;

   IppsBigNumState* m_pBN;
};

// convert bit size into 32-bit words
#define BITSIZE_WORD(n) ((((n)+31)>>5))

#endif // _BIGNUMBER_H_
```

Definitions

C++ definitions for the `BigNumber` class methods are given below. For the declarations to be included, see the preceding Declarations section.

```
#include "bignum.h"

//////////////////////////////////////////////////////////////////////
//
// BigNumber
//
//////////////////////////////////////////////////////////////////////

BigNumber::~BigNumber()
{
   delete [] (Ipp8u*)m_pBN;
}
```

```
bool BigNumber::create(const Ipp32u* pData, int length, IppsBigNumSGN
sgn)
{
   int size;
   ippsBigNumGetSize(length, &size);
   m_pBN = (IppsBigNumState*)( new Ipp8u[size] );
   if(!m_pBN)
      return false;
   ippsBigNumInit(length, m_pBN);
   if(pData)
      ippsSet_BN(sgn, length, pData, m_pBN);
   return true;
}

// constructors
//
BigNumber::BigNumber(Ipp32u value)
{
   create(&value, 1, IppsBigNumPOS);
}

BigNumber::BigNumber(Ipp32s value)
{
   Ipp32s avalue = abs(value);
   create((Ipp32u*)&avalue, 1, (value<0)? IppsBigNumNEG :
IppsBigNumPOS);
}

BigNumber::BigNumber(const IppsBigNumState* pBN)
{
   int bnLen;
   ippsGetSize_BN(pBN, &bnLen);
   Ipp32u* bnData = new Ipp32u[bnLen];
   IppsBigNumSGN sgn;
   ippsGet_BN(&sgn, &bnLen, bnData, pBN);
   //
   create(bnData, bnLen, sgn);
   //
   delete bnData;
}

BigNumber::BigNumber(const Ipp32u* pData, int length, IppsBigNumSGN
sgn)
{
   create(pData, length, sgn);
}

static
char HexDigitList[] = "0123456789ABCDEF";

BigNumber::BigNumber(const char* s)
```

```
{
   bool neg = '-' == s[0];
   if(neg) s++;
   bool hex = ('0'==s[0]) && (('x'==s[1]) || ('X'==s[1]));

   int dataLen;
   Ipp32u base;
   if(hex) {
      s += 2;
      base = 0x10;
      dataLen = (strlen(s) + 7)/8;
   }
   else {
      base = 10;
      dataLen = (strlen(s) + 9)/10;
   }

   create(0, dataLen);
   *(this) = Zero();
   while(*s) {
      char tmp[2] = {s[0],0};
      Ipp32u digit = strcspn(HexDigitList, tmp);
      *this = (*this) * base + BigNumber( digit );
      s++;
   }

   if(neg)
      (*this) = Zero()- (*this);
}

BigNumber::BigNumber(const BigNumber& bn)
{
   IppsBigNumSGN sgn;
   int length;
   ippsGetSize_BN(bn.m_pBN, &length);
   Ipp32u* pData = new Ipp32u[length];
   ippsGet_BN(&sgn, &length, pData, bn.m_pBN);
   //
   create(pData, length, sgn);
   //
   delete pData;
}


// set value
//
void BigNumber::Set(const Ipp32u* pData, int length, IppsBigNumSGN
sgn)
{
   ippsSet_BN(sgn, length, pData, BN(*this));
}
```

```
// constants
//
const BigNumber& BigNumber::Zero()
{
    static const BigNumber zero(0);
    return zero;
}

const BigNumber& BigNumber::One()
{
    static const BigNumber one(1);
    return one;
}

const BigNumber& BigNumber::Two()
{
    static const BigNumber two(2);
    return two;
}


// arithmetic operators
//
BigNumber& BigNumber::operator =(const BigNumber& bn)
{
   if(this != &bn) {    // prevent self copy
      int length;
      ippsGetSize_BN(bn.m_pBN, &length);
      Ipp32u* pData = new Ipp32u[length];
      IppsBigNumSGN sgn;
      ippsGet_BN(&sgn, &length, pData, bn.m_pBN);
      //
      delete (Ipp8u*)m_pBN;
      create(pData, length, sgn);
      //
      delete pData;
   }
   return *this;
}

BigNumber& BigNumber::operator += (const BigNumber& bn)
{
   int aLength;
   ippsGetSize_BN(BN(*this), &aLength);
   int bLength;
   ippsGetSize_BN(BN(bn), &bLength);
   int rLength = IPP_MAX(aLength,bLength) + 1;

   BigNumber result(0, rLength);
```

```
   ippsAdd_BN(BN(*this), BN(bn), BN(result));
   *this = result;
   return *this;
}

BigNumber& BigNumber::operator -= (const BigNumber& bn)
{
   int aLength;
   ippsGetSize_BN(BN(*this), &aLength);
   int bLength;
   ippsGetSize_BN(BN(bn), &bLength);
   int rLength = IPP_MAX(aLength,bLength);

   BigNumber result(0, rLength);
   ippsSub_BN(BN(*this), BN(bn), BN(result));
   *this = result;
   return *this;
}

BigNumber& BigNumber::operator *= (const BigNumber& bn)
{
   int aLength;
   ippsGetSize_BN(BN(*this), &aLength);
   int bLength;
   ippsGetSize_BN(BN(bn), &bLength);
   int rLength = aLength+bLength;

   BigNumber result(0, rLength);
   ippsMul_BN(BN(*this), BN(bn), BN(result));
   *this = result;
   return *this;
}

BigNumber& BigNumber::operator *= (Ipp32u n)
{
   int aLength;
   ippsGetSize_BN(BN(*this), &aLength);
   BigNumber bn(n);

   BigNumber result(0, aLength+1);
   ippsMul_BN(BN(*this), BN(bn), BN(result));
   *this = result;
   return *this;
}

BigNumber& BigNumber::operator %= (const BigNumber& bn)
{
   BigNumber remainder(bn);
   ippsMod_BN(BN(*this), BN(bn), BN(remainder));
   *this = remainder;
   return *this;
```

```
}

BigNumber& BigNumber::operator /= (const BigNumber& bn)
{
   BigNumber quotient(*this);
   BigNumber remainder(bn);
   ippsDiv_BN(BN(*this), BN(bn), BN(quotient), BN(remainder));
   *this = quotient;
   return *this;
}

BigNumber operator + (const BigNumber& a, const BigNumber&
b )
{
   BigNumber r(a);
   return r += b;
}

BigNumber operator - (const BigNumber& a, const BigNumber&
b )
{
   BigNumber r(a);
   return r -= b;
}

BigNumber operator * (const BigNumber& a, const BigNumber&
b )
{
   BigNumber r(a);
   return r *= b;
}

BigNumber operator * (const BigNumber& a, Ipp32u n)
{
   BigNumber r(a);
   return r *= n;
}

BigNumber operator / (const BigNumber& a, const BigNumber&
b )
{
   BigNumber q(a);
   return q /= b;
}

BigNumber operator % (const BigNumber& a, const BigNumber&
b )
{
   BigNumber r(b);
   ippsMod_BN(BN(a), BN(b), BN(r));
   return r;
```

```
}


// modulo arithmetic
//
BigNumber BigNumber::Modulo(const BigNumber& a)  const
{
   return a % *this;
}

BigNumber BigNumber::InverseAdd(const BigNumber& a) const
{
   BigNumber t = Modulo(a);
   if(t==BigNumber::Zero())
      return t;
   else
      return *this - t;
}

BigNumber BigNumber::InverseMul(const BigNumber& a) const
{
   BigNumber r(*this);
   ippsModInv_BN(BN(a), BN(*this), BN(r));
   return r;
}

BigNumber BigNumber::ModAdd(const BigNumber& a, const BigNumber&
b) const
{
   BigNumber r = this->Modulo(a+b);
   return r;
}

BigNumber BigNumber::ModSub(const BigNumber& a, const BigNumber&
b) const
{
   BigNumber r = this->Modulo(a + this->InverseAdd(b));
   return r;
}

BigNumber BigNumber::ModMul(const BigNumber& a, const BigNumber&
b) const
{
   BigNumber r = this->Modulo(a*b);
   return r;
}


// comparison
//
int BigNumber::compare(const BigNumber &bn) const
```

```
{
   Ipp32u result;
   BigNumber tmp = *this - bn;
   ippsCmpZero_BN(BN(tmp), &result);
   return (result==IS_ZERO)? 0 : (result==GREATER_THAN_ZERO)? 1
: -1;
}

bool operator <  (const BigNumber &a, const BigNumber &b)
{ return a.compare(b) < 0; }
bool operator >  (const BigNumber &a, const BigNumber &b)
{ return a.compare(b) > 0; }
bool operator == (const BigNumber &a, const BigNumber &b)
{ return 0 == a.compare(b);}
bool operator != (const BigNumber &a, const BigNumber &b)
{ return 0 != a.compare(b);}


// easy tests
//
bool BigNumber::IsOdd() const
{
   vector<Ipp32u> v;
   num2vec(v);
   return v[0]&1;
}

// size of BigNumber
//
int BigNumber::LSB() const
{
   if( *this == BigNumber::Zero() )
      return 0;

   vector<Ipp32u> v;
   num2vec(v);

   int lsb = 0;
   vector<Ipp32u>::iterator i;
   for(i=v.begin(); i!=v.end(); i++) {
      Ipp32u x = *i;
      if(0==x)
         lsb += 32;
      else {
         while(0==(x&1)) {
            lsb++;
            x >>= 1;
         }
         break;
      }
   }
```

```
   return lsb;
}

int BigNumber::MSB() const
{
   if( *this == BigNumber::Zero() )
      return 0;

   vector<Ipp32u> v;
   num2vec(v);

   int msb  = v.size()*32 -1;
   vector<Ipp32u>::reverse_iterator i;
   for(i=v.rbegin(); i!=v.rend(); i++) {
      Ipp32u x = *i;
      if(0==x)
         msb -=32;
      else {
         while(!(x&0x80000000)) {
            msb--;
            x <<= 1;
         }
         break;
      }
   }
   return msb;
}

int Bit(const vector<Ipp32u>& v, int n)
{
   return 0 != ( v[n>>5] & (1<<(n&0x1F)) );
}


// conversions and output
//
void BigNumber::num2vec( vector<Ipp32u>& v ) const
{
   int length;
   ippsGetSize_BN(BN(*this), &length);
   Ipp32u* pData = new Ipp32u[length];
   IppsBigNumSGN sgn;
   ippsGet_BN(&sgn, &length, pData, BN(*this));
   //
   for(int n=0; n<length; n++)
      v.push_back( pData[n] );
   //
   delete pData;
}
```

```
void BigNumber::num2hex( string& s ) const
{
   int length;
   ippsGetSize_BN(BN(*this), &length);
   Ipp32u* pData = new Ipp32u[length];
   IppsBigNumSGN sgn;
   ippsGet_BN(&sgn, &length, pData, BN(*this));

   s.append(1, (sgn==IppsBigNumNEG)? '-' : ' ');
   s.append(1, '0');
   s.append(1, 'x');
   for(int n=length; n>0; n--) {
      Ipp32u x = pData[n-1];
      for(int nd=8; nd>0; nd--) {
         char c = HexDigitList[(x>>(nd-1)*4)&0xF];
         s.append(1, c);
      }
   }
   delete pData;
}

ostream& operator << ( ostream &os, const BigNumber& a) {
   string s;
   a.num2hex(s);
   os << s.c_str();
   return os;
}
```

Functions for Creation of Cryptographic Contexts

The section presents source code for creation of some cryptographic contexts.

Declarations

Contents of the header file (`cpobjs.h`) declaring functions for creation of some cryptographic contexts are presented below:

```
#if !defined _CPOBJS_H_
#define _CPOBJS_H_
//
// create new of some ippCP 'objects'
//
#include "ippcp.h"
#include <stdlib.h>

#define BITS_2_WORDS(n) (((n)+31)>>5)
int Bitsize2Wordsize(int nBits);
```

```
Ipp32u* rand32(Ipp32u* pX, int size);

IppsBigNumState* newBN(int len, const Ipp32u* pData=0);
IppsBigNumState* newRandBN(int len);
void deleteBN(IppsBigNumState* pBN);

IppsPRNGState* newPRNG(int seedBitsize=160);
void deletePRNG(IppsPRNGState* pPRNG);

IppsRSAState* newRSA(int lenN, int lenP, IppRSAKeyType type);
void deleteRSA(IppsRSAState* pRSA);

IppsDLPState* newDLP(int lenM, int lenL);
void deleteDLP(IppsDLPState* pDLP);

#endif // _CPOBJS_H_
```

Definitions

C++ definitions of functions creating cryptographic contexts are given below. For the declarations to be included, see the preceding Declarations section.

```
#include "cpobjs.h"


// convert bitsize into 32-bit wordsize
int Bitsize2Wordsize(int nBits)
{ return (nBits+31)>>5; }


// new BN number
IppsBigNumState* newBN(int len, const Ipp32u* pData)
{
   int size;
   ippsBigNumGetSize(len, &size);
   IppsBigNumState* pBN = (IppsBigNumState*)( new Ipp8u [size] );
   ippsBigNumInit(len, pBN);
   if(pData)
      ippsSet_BN(IppsBigNumPOS, len, pData, pBN);
   return pBN;
}

// desrtoy BN
void deleteBN(IppsBigNumState* pBN)
{ delete [] (Ipp8u*)pBN; }


// set up array of 32-bit items random
```

```
Ipp32u* rand32(Ipp32u* pX, int size)
{
   for(int n=0; n<size; n++)
      pX[n] = (rand()<<16) + rand();
   return pX;
}

IppsBigNumState* newRandBN(int len)
{
   Ipp32u* pBuffer = new Ipp32u [len];
   IppsBigNumState* pBN = newBN(len, rand32(pBuffer,len));
   delete [] pBuffer;
   return pBN;
}


//
// 'external' PRNG
//
IppsPRNGState* newPRNG(int seedBitsize)
{
   int seedSize = Bitsize2Wordsize(seedBitsize);
   Ipp32u* seed = new Ipp32u [seedSize];
   Ipp32u* augm = new Ipp32u [seedSize];

   int size;
   IppsBigNumState* pTmp;
   ippsPRNGGetSize(&size);
   IppsPRNGState* pCtx = (IppsPRNGState*)( new Ipp8u [size] );
   ippsPRNGInit(seedBitsize, pCtx);

   ippsPRNGSetSeed(pTmp=newBN(seedSize,rand32(seed,seedSize)), pCtx);
   delete [] (Ipp8u*)pTmp;
   ippsPRNGSetAugment(pTmp=newBN(seedSize,rand32(augm,seedSize)),
pCtx);
   delete [] (Ipp8u*)pTmp;

   delete [] seed;
   delete [] augm;
   return pCtx;
}
void deletePRNG(IppsPRNGState* pPRNG)
{ delete [] (Ipp8u*)pPRNG; }


//
// RSA context
//
IppsRSAState* newRSA(int lenN, int lenP, IppRSAKeyType type)
{
   int size;
```

```
   ippsRSAGetSize(lenN,lenP, type, &size);
   IppsRSAState* pCtx = (IppsRSAState*)( new Ipp8u [size] );
   ippsRSAInit(lenN,lenP, type, pCtx);

   return pCtx;
}
void deleteRSA(IppsRSAState* pRSA)
{ delete [] (Ipp8u*)pRSA; }


//
// DLP context
//
IppsDLPState* newDLP(int lenM, int lenL)
{
   int size;
   ippsDLPGetSize(lenM, lenL, &size);
   IppsDLPState *pCtx= (IppsDLPState *)new Ipp8u[ size ];
   ippsDLPInit(lenM, lenL, pCtx);

   return pCtx;
}
void deleteDLP(IppsDLPState* pDLP)
{ delete [] (Ipp8u*)pDLP; }
```

Calling the Cryptography Functions from Fortran-90

C

The Intel® Integrated Performance Primitives (Intel® IPP) for cryptography basically provide C interface. However, you can invoke Intel IPP cryptography functions directly from other languages if you are familiar with the inter-language calling conventions of your platforms. To promote portability, relieve you of having to deal with the calling convention specifics, and provide an interface to the functions that looks natural in Fortran-90, the Fortran-specific header file has been implemented.

The header file is available with the Intel IPP Samples, an extensive library of code samples and codecs implemented using the Intel IPP functions to help demonstrate the use of Intel IPP and accelerate the development of your application, components, and codecs. The samples can be downloaded from http://www.intel.com/cd/software/products/asmo-na/eng/220046.htm. The header file is a part of the Fortran-90 Interface to Intel IPP for Cryptography sample, which can be found in the `\ipp_samples\language-interface\f90-crypto` directory after downloading the code samples.

The interface header file `.\include\ippcp.f90` contains interfaces for direct calling Intel IPP cryptography functions from Fortran-90 applications.

Along with the header file, the sample, in particular, provides Fortran-90 examples for all Intel IPP cryptography functions.

The Fortran-90 Interface to Intel IPP for Cryptography sample demonstrates how to call Intel IPP cryptography functions using Fortran-90 API. The structure of the sample is designed so that each specific cryptographic algorithm, for example, an encryption in the OFB mode according to DES algorithm, is represented by a module. Each module contains the sequence of operations that an application code must perform to complete the algorithm. So, from the module you can get to know how to carry out the algorithmic chain, define parameters, set data, and call the cryptography functions in a Fortran-90 application. Modules related to a certain cryptographic algorithm, for example, TDES block cipher, make up a file with the corresponding name, `crypto_tdes_samples.f90`, in this case. Names of modules inside the files are also self-explanatory. For example, in the above file, the module `TDES_CBC_SAMPLE` implements a typical TDES encryption in the CBC mode.

The file `\ipp_samples\language-interface\f90-crypto\doc\crypto-f90.pdf` contains the detailed description of the Fortran-90 cryptography API and the sample usage.

In Example C-1, modules are fragments of the definition module `IPPCP_DEFS` and interface module `IPPCP_F90` from the header file `ippcp.f90` and the `DES_ECB_SAMPLE` program demonstrates a Fortran-90 implementation of Example 2-1.

Example C-1 Fortran-90 Implementation of DES Encryption and Decryption

```
MODULE IPPCP_DEFS

    ! Codes for parameter PADDING
    INTEGER(4), PARAMETER ::  IppsCPPaddingNONE  = 0
```

```
    ! DES/TDES DEFINITIONS
    INTEGER(4), PARAMETER ::  DES_BLOCKSIZE = 8 ! cipher blocksize (bytes)
    INTEGER(4), PARAMETER ::  DES_KEYSIZE   = 8 ! cipher keysize (bytes)

END MODULE IPPCP_DEFS

MODULE IPPCP_F90

  USE IPPCP_DEFS
  INTERFACE
    !IppStatus ippsDESGetSize(int* pSize)
    INTEGER(4) FUNCTION ippsDESGetSize(size)

        INTEGER(4), INTENT(OUT) :: size
        !DEC$ATTRIBUTES STDCALL, DECORATE, ALIAS : 'ippsDESGetSize':: ippsDESGetSize
        !MS$ATTRIBUTES REFERENCE :: size
    END FUNCTION ippsDESGetSize
  END INTERFACE

  INTERFACE
    !IppStatus ippsDESInit(const Ipp8u* pKey, IppsDESSpec* pCtx);
     INTEGER(4) FUNCTION ippsDESInit(Key, SPEC_CONTEXT)
       USE IPPCP_DEFS
       CHARACTER(LEN=DES_KEYSIZE), INTENT(IN) :: Key
       CHARACTER(LEN=1), INTENT(INOUT) :: SPEC_CONTEXT(*)

       !DEC$ATTRIBUTES STDCALL, DECORATE, ALIAS : 'ippsDESInit'::ippsDESInit
       !MS$ATTRIBUTES REFERENCE  :: Key
       !MS$ATTRIBUTES REFERENCE  :: SPEC_CONTEXT
    END FUNCTION ippsDESInit
  END INTERFACE

  INTERFACE
    !IppStatus ippsDESEncryptECB(const Ipp8u* pSrc, Ipp8u* pDst, int len,
    !                    const IppsDESSpec* pCtx, IppsCPPadding padding);
    INTEGER(4) FUNCTION ippsDESEncryptECB(Src, Dst, len, SPEC_CONTEXT, PADDING)

       CHARACTER(LEN=*), INTENT(IN)  :: Src
       CHARACTER(LEN=*), INTENT(OUT) :: Dst
       INTEGER(4), INTENT(IN) :: len
       CHARACTER(LEN=1), INTENT(IN) :: SPEC_CONTEXT(*)
       INTEGER(4), INTENT(IN) :: PADDING

       !DEC$ATTRIBUTES STDCALL, DECORATE, ALIAS : 'ippsDESEncryptECB'::ippsDESEncryptECB
       !MS$ATTRIBUTES REFERENCE  :: Src
       !MS$ATTRIBUTES REFERENCE  :: Dst
       !MS$ATTRIBUTES REFERENCE  :: SPEC_CONTEXT
    END FUNCTION ippsDESEncryptECB
  END INTERFACE

  INTERFACE
```

```
    !IppStatus ippsDESDecryptECB(const Ipp8u* pSrc, Ipp8u* pDst, int len,
    !                   const IppsDESSpec* pCtx, IppsCPPadding padding);
    INTEGER(4) FUNCTION ippsDESDecryptECB(Src, Dst, len, SPEC_CONTEXT, PADDING)

       CHARACTER(LEN=*), INTENT(IN)  :: Src
       CHARACTER(LEN=*), INTENT(OUT) :: Dst
       INTEGER(4), INTENT(IN) :: len
       CHARACTER(LEN=1), INTENT(IN) :: SPEC_CONTEXT(*)
       INTEGER(4), INTENT(IN) :: PADDING

       !DEC$ATTRIBUTES STDCALL, DECORATE, ALIAS : 'ippsDESDecryptECB'::ippsDESDecryptECB
       !MS$ATTRIBUTES REFERENCE  :: Src
       !MS$ATTRIBUTES REFERENCE  :: Dst
       !MS$ATTRIBUTES REFERENCE  :: SPEC_CONTEXT
    END FUNCTION ippsDESDecryptECB
  END INTERFACE

END MODULE IPPCP_F90

PROGRAM DES_ECB_SAMPLE
  USE IPPCP_F90

  INTEGER(4) :: size
  INTEGER(4) status

  CHARACTER(LEN=DES_KEYSIZE) Key
  INTEGER(1), DIMENSION(DES_KEYSIZE) :: Key_int
  INTEGER(4) textSize

! context description
  CHARACTER(LEN=1), ALLOCATABLE :: SPEC_CONTEXT(:)

  CHARACTER(LEN=40) ptext
  CHARACTER(LEN=40) rtext
  CHARACTER(LEN=40) ctext

! the size of text is always multiple of cipher block size
! (DES_DES_BLOCKSIZE =8 bytes)
  textSize = 40

! define the message to be encrypted
  ptext = 'quick brown fox jupm over lazy dog     '

! define the Key
  Key_int = (/Z'01',Z'02',Z'03',Z'04',Z'05',Z'06',Z'07',Z'08'/)
  Key = TRANSFER(Key_int, Key)

! get size of the context needed for the encryption/decryption operation
  status = ippsDESGetSize(size)

! allocate context
```

```
  ALLOCATE (SPEC_CONTEXT(size))

! prepare the context for the DES usage
  status = ippsDESInit(Key, SPEC_CONTEXT)

! encrypt (ECB mode) ptext message
  status = ippsDESEncryptECB(ptext, ctext, textSize, SPEC_CONTEXT, IppsCPPaddingNONE)


! decrypt (ECB mode) ctext message
  status = ippsDESDecryptECB(ctext, rtext, textSize, SPEC_CONTEXT, IppsCPPaddingNONE)

! deallocate context
  DEALLOCATE (SPEC_CONTEXT)

END PROGRAM
```

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Index

A

about this manual 30
AES-CCM Functions 108, 109, 111, 112, 113, 114, 115, 116, 117, 118
  Rijndael128CCMDecrypt 115
  Rijndael128CCMDecryptMessage 111
  Rijndael128CCMEncrypt 115
  Rijndael128CCMEncryptMessage 109
  Rijndael128CCMGetSize 112
  Rijndael128CCMGetTag 116
  Rijndael128CCMInit 113
  Rijndael128CCMMessageLen 117
  Rijndael128CCMStart 114
  Rijndael128CCMTagLen 118
AES-GCM Functions 119, 120, 121, 122, 123, 124, 125, 126
  Rijndael128GCMDecrypt 125
  Rijndael128GCMDecryptMessage 121
  Rijndael128GCMEncrypt 125
  Rijndael128GCMEncryptMessage 120
  Rijndael128GCMGetSize 122
  Rijndael128GCMGetTag 126
  Rijndael128GCMInit 123
  Rijndael128GCMStart 124
AES-XCBC Functions 276, 277, 278, 279, 280, 281
  XCBCRijndael128Final 280
  XCBCRijndael128GetSize 277
  XCBCRijndael128GetTag 279
  XCBCRijndael128Init 278
  XCBCRijndael128MessageTag 281
  XCBCRijndael128Update 278
AES-XCBC-MAC-96A 233
ARCFour Functions 183, 184, 185, 186, 187, 188
  ARCFourCheckKey 185
  ARCFourDecrypt 187
  ARCFourEncrypt 186
  ARCFourGetSize 184
  ARCFourInit 185
  ARCFourReset 188
ARCFour stream cipher 183
audience for this manual 31

B

Big Number Arithmetic 315
Big Number Arithmetic Functions
  Add_BN 338
  Add_BNU 317
  BigNumGetSize 327
  BigNumInit 327
  Cmp_BN 336
  CmpZero_BN 337
  Div_64u32u 322
  Div_BN 342
  ExtGet_BN 332
  Gcd_BN 345
  Get_BN 332
  GetOctString_BN 334
  GetOctString_BNU 326
  GetSize_BN 331
  MAC_BN_I 341
  MACOne_BNU_I 320
  Mod_BN 344
  ModInv_BN 346
  Mul_BN 340
  Mul_BNU4 321

Big Number Arithmetic Functions *(continued)*
Mul_BNU8 321
MulOne_BNU 319
Ref_BN 334
Set_BN 328
SetOctString_BN 329
SetOctString_BNU 325
Sqr_32u64u 323
Sqr_BNU4 324
Sqr_BNU8 324
Sub_BN 339
Sub_BNU 318
Blowfish Functions 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139
BlowfishDecryptCBC 133
BlowfishDecryptCFB 135
BlowfishDecryptCTR 139
BlowfishDecryptECB 131
BlowfishDecryptOFB 137
BlowfishEncryptCBC 132
BlowfishEncryptCFB 134
BlowfishEncryptCTR 138
BlowfishEncryptECB 130
BlowfishEncryptOFB 136
BlowfishGetSize 128
BlowfishInit 129

C

CMAC 233
CMAC Functions 271, 272, 273, 274, 275
CMACRijndael128Final 275
CMACRijndael128GetSize 272
CMACRijndael128Init 273
CMACRijndael128MessageDigest 275
CMACRijndael128Update 274
CMACSafeRijndael128Init 273
concepts of IPP 27
cross-architecture alignment 28
cross-platform applications 27

D

Data Authentication Functions 282, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312
DAA Rijndael Functions 293
DAABlowfishFinal 307
DAABlowfishGetSize 305
DAABlowfishInit 305
DAABlowfishMessageDigest 308
DAABlowfishUpdate 306
DAADESFinal 287
DAADESGetSize 285
DAADESInit 285
DAADESMessageDigest 288
DAADESUpdate 286
DAARijndael128Final 295
DAARijndael128GetSize 293
DAARijndael128Init 293
DAARijndael128MessageDigest 296
DAARijndael128Update 294
DAARijndael192Final 299
DAARijndael192GetSize 297
DAARijndael192Init 297
DAARijndael192MessageDigest 300
DAARijndael192Update 298
DAARijndael256Final 303
DAARijndael256GetSize 301
DAARijndael256Init 301
DAARijndael256MessageDigest 304
DAARijndael256Update 302
DAASafeRijndael128Init 293
DAATDESFinal 291
DAATDESGetSize 289
DAATDESInit 289
DAATDESMessageDigest 292
DAATDESUpdate 290
DAATwofishFinal 311
DAATwofishGetSize 309
DAATwofishInit 309
DAATwofishMessageDigest 312
DAATwofishUpdate 310
Data Encryption Standard (DES) 34
DES/TDES Functions 34, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 55, 56, 57, 58
DESDecryptCBC 41
DESDecryptCFB 43
DESDecryptCTR 47
DESDecryptECB 39
DESDecryptOFB 45

DES/TDES Functions *(continued)*
DESEncryptCBC 40
DESEncryptCFB 42
DESEncryptCTR 46
DESEncryptECB 38
DESEncryptOFB 44
DESGetSize 36
DESInit 37
TDESDecryptCBC 51
TDESDecryptCFB 53
TDESDecryptCTR 58
TDESDecryptECB 49
TDESDecryptOFB 56
TDESEncryptCBC 50
TDESEncryptCFB 52
TDESEncryptCTR 57
TDESEncryptECB 48
TDESEncryptOFB 55
Discrete Logarithm Based Functions
DLPGenerateDH 454
DLPGenerateDSA 446
DLPGenKeyPair 442
DLPGet 439
DLPGetDP 441
DLPGetSize 436
DLPInit 437
DLPPublicKey 443
DLPSet 438
DLPSetDP 440
DLPSetKeyPair 445
DLPSharedSecretDH 456
DLPSignDSA 448
DLPValidateDH 455
DLPValidateDSA 447
DLPValidateKeyPair 444
DLPVerifyDSA 449

E

Elliptic Curve Cryptographic Functions
ECCBAddPoint 507
ECCBCheckPoint 504
ECCBComparePoint 505
ECCBGenKeyPair 509
ECCBGet 496
ECCBGetOrderBitSize 497
ECCBGetPoint 503
ECCBGetSize 492
Elliptic Curve Cryptographic Functions *(continued)*
ECCBInit 492
ECCBMulPointScalar 508
ECCBNegativePoint 506
ECCBPointGetSize 500
ECCBPointInit 501
ECCBPublicKey 510
ECCBSet 493
ECCBSetKeyPair 512
ECCBSetPoint 501
ECCBSetPointAtInfinity 502
ECCBSetStd 495
ECCBSharedSecretDH 513
ECCBSharedSecretDHC 515
ECCBSignDSA 516
ECCBSignNR 519
ECCBValidate 498
ECCBValidateKeyPair 511
ECCBVerifyDSA 518
ECCBVerifyNR 521
ECCPAddPoint 476
ECCPCheckPoint 473
ECCPComparePoint 474
ECCPGenKeyPair 478
ECCPGet 466
ECCPGetOrderBitSize 467
ECCPGetPoint 472
ECCPGetSize 461
ECCPInit 462
ECCPMulPointScalar 477
ECCPNegativePoint 475
ECCPPointGetSize 469
ECCPPointInit 470
ECCPPublicKey 479
ECCPSet 463
ECCPSetKeyPair 481
ECCPSetPoint 471
ECCPSetPointAtInfinity 472
ECCPSetStd 464
ECCPSharedSecretDH 482
ECCPSharedSecretDHC 484
ECCPSignDSA 485
ECCPSignNR 488
ECCPValidate 468
ECCPValidateKeyPair 480
ECCPVerifyDSA 487
ECCPVerifyNR 490
Elliptic Curve Point Arithmetic Functions 581, 583, 584, 585, 586, 587, 588, 589, 590, 591,

Elliptic Curve Point Arithmetic Functions *(continued)*
592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612
GFPECAddPoint 596
GFPECCmpPoint 594
GFPECCpyPoint 592
GFPECGet 586
GFPECGetPoint 593
GFPECGetSize 583
GFPECInit 584
GFPECMulPointScalar 597
GFPECNegPoint 595
GFPECPointGetSize 588
GFPECPointInit 589
GFPECSet 585
GFPECSetPoint 590
GFPECSetPointAtInfinity 590
GFPECSetPointRandom 591
GFPECVerify 587
GFPECVerifyPoint 593
GFPXECAddPoint 611
GFPXECCmpPoint 609
GFPXECCpyPoint 607
GFPXECGet 601
GFPXECGetPoint 608
GFPXECGetSize 598
GFPXECInit 599
GFPXECMulPointScalar 612
GFPXECNegPoint 610
GFPXECPointGetSize 603
GFPXECPointInit 604
GFPXECSet 600
GFPXECSetPoint 605
GFPXECSetPointAtInfinity 605
GFPXECSetPointRandom 606
GFPXECVerify 602
GFPXECVerifyPoint 608
encryption, decryption, and encryption (E-D-E) sequence 34

F

Finite Field Arithmetic Functions 522, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580
GFPAdd 538
GFPCmpElement 534
GFPCpyElement 534
GFPElementGetSize 528
GFPElementInit 529
GFPExp 541
GFPGet 528
GFPGetElement 535
GFPGetSize 526
GFPGFPMontDecode 543
GFPGFPMontEncode 542
GFPInit 527
GFPInv 537
GFPMul 540
GFPNeg 536
GFPSetElement 530
GFPSetElementPower2 532
GFPSetElementRandom 533
GFPSetElementZero 531
GFPSqrt 538
GFPSub 539
GFPXAdd 556
GFPXAdd_GFP 557
GFPXCmpElement 552
GFPXCpyElement 553
GFPXDiv 563
GFPXElementGetSize 547
GFPXElementInit 547
GFPXExp 562
GFPXGet 546
GFPXGetElement 553
GFPXGetSize 544
GFPXInit 545
GFPXInv 555
GFPXMul 560
GFPXMul_GFP 561
GFPXNeg 554
GFPXQAdd 576
GFPXQCmpElement 572
GFPXQCpyElement 573
GFPXQElementGetSize 567
GFPXQElementInit 567
GFPXQExp 580
GFPXQGet 566
GFPXQGetElement 573

Finite Field Arithmetic Functions *(continued)*
GFPXQGetSize 564
GFPXQInit 565
GFPXQInv 575
GFPXQMul 578
GFPXQMul_GFP 579
GFPXQNeg 574
GFPXQSetElement 568
GFPXQSetElementPowerX 570
GFPXQSetElementRandom 571
GFPXQSetElementZero 569
GFPXQSub 577
GFPXSetElement 548
GFPXSetElementPowerX 550
GFPXSetElementRandom 551
GFPXSetElementZero 549
GFPXSub 558
GFPXSub_GFP 559
font conventions 31
Fortran-90 interface to cryptography functions 637
function descriptions, in manual sections 31

G

GetLibVersion 621

H

hardware and software requirements 28
hash function 189
Hash Functions for Non-Streaming Messages 218, 219, 220, 223, 224, 225
general definition 218
MD5MessageDigest 219
SHA1MessageDigest 220
SHA224MessageDigest 223
SHA256MessageDigest 224
SHA384MessageDigest 224
SHA512MessageDigest 225
user-implemented 218
HMAC 233
HMAC Functions 233

I

initialization vector iv 34
Intel Performance Library Suite 27
IPP software 28
ippcpGetLibVersion 621
ippsAdd_BN 338
ippsAdd_BNU 317
ippsARCFive128DecryptCBC 176
ippsARCFive128DecryptCFB 178
ippsARCFive128DecryptCTR 182
ippsARCFive128DecryptECB 174
ippsARCFive128DecryptOFB 180
ippsARCFive128EncryptCBC 175
ippsARCFive128EncryptCFB 177
ippsARCFive128EncryptCTR 181
ippsARCFive128EncryptECB 173
ippsARCFive128EncryptOFB 179
ippsARCFive128GetSize 172
ippsARCFive128Init 172
ippsARCFive64DecryptCBC 165
ippsARCFive64DecryptCFB 167
ippsARCFive64DecryptCTR 171
ippsARCFive64DecryptECB 163
ippsARCFive64DecryptOFB 169
ippsARCFive64EncryptCBC 164
ippsARCFive64EncryptCFB 166
ippsARCFive64EncryptCTR 170
ippsARCFive64EncryptECB 162
ippsARCFive64EncryptOFB 168
ippsARCFive64GetSize 160
ippsARCFive64Init 161
ippsARCFourCheckKey 185
ippsARCFourDecrypt 187
ippsARCFourEncrypt 186
ippsARCFourGetSize 184
ippsARCFourInit 185
ippsARCFourReset 188
ippsBigNumGetSize 327
ippsBigNumInit 327
ippsBlowfishDecryptCBC 133
ippsBlowfishDecryptCFB 135
ippsBlowfishDecryptCTR 139
ippsBlowfishDecryptECB 131
ippsBlowfishDecryptOFB 137
ippsBlowfishEncryptCBC 132
ippsBlowfishEncryptCFB 134
ippsBlowfishEncryptCTR 138
ippsBlowfishEncryptECB 130
ippsBlowfishEncryptOFB 136
ippsBlowfishGetSize 128
ippsBlowfishInit 129
ippsCMACRijndael128Final 275

ippsCMACRijndael128GetSize 272
ippsCMACRijndael128Init 273
ippsCMACRijndael128MessageDigest 275
ippsCMACRijndael128Update 274
ippsCMACSafeRijndael128Init 273
ippsCmp_BN 336
ippsCmpZero_BN 337
ippsDAABlowfishFinal 307
ippsDAABlowfishGetSize 305
ippsDAABlowfishInit 305
ippsDAABlowfishMessageDigest 308
ippsDAABlowfishUpdate 306
ippsDAADESFinal 287
ippsDAADESGetSize 285
ippsDAADESInit 285
ippsDAADESMessageDigest 288
ippsDAADESUpdate 286
ippsDAARijndael128Final 295
ippsDAARijndael128GetSize 293
ippsDAARijndael128Init 293
ippsDAARijndael128MessageDigest 296
ippsDAARijndael128Update 294
ippsDAARijndael192Final 299
ippsDAARijndael192GetSize 297
ippsDAARijndael192MessageDigest 300
ippsDAARijndael192Update 298
ippsDAARijndael256Final 303
ippsDAARijndael256GetSize 301
ippsDAARijndael256Init 301
ippsDAARijndael256MessageDigest 304
ippsDAARijndael256Update 302
ippsDAASafeRijndael128Init 293
ippsDAATDESFinal 291
ippsDAATDESGetSize 289
ippsDAATDESInit 289
ippsDAATDESMessageDigest 292
ippsDAATDESUpdate 290
ippsDAATwofishFinal 311
ippsDAATwofishGetSize 309
ippsDAATwofishInit 309
ippsDAATwofishMessageDigest 312
ippsDAATwofishUpdate 310
ippsDESDecryptCBC 41
ippsDESDecryptCFB 43
ippsDESDecryptCTR 47
ippsDESDecryptECB 39
ippsDESDecryptOFB 45
ippsDESEncryptCBC 40
ippsDESEncryptCFB 42
ippsDESEncryptCTR 46
ippsDESEncryptECB 38
ippsDESEncryptOFB 44
ippsDESGetSize 36
ippsDESInit 37
ippsDiv_64u32u 322
ippsDiv_BN 342
IppsDLPGenerateDH 454
ippsDLPGenerateDSA 446
ippsDLPGenKeyPair 442
ippsDLPGet 439
ippsDLPGetDP 441
ippsDLPGetSize 436
IppsDLPInit 437
ippsDLPPublicKey 443
ippsDLPSet 438
ippsDLPSetDP 440
ippsDLPSetKeyPair 445
ippsDLPSharedSecretDH 456
ippsDLPSignDSA 448
ippsDLPValidateDH 455
ippsDLPValidateDSA 447
ippsDLPValidateKeyPair 444
ippsDLPVerifyDSA 449
ippsECCBAddPoint 507
ippsECCBCheckPoint 504
ippsECCBComparePoint 505
ippsECCBGenKeyPair 509
ippsECCBGet 496
ippsECCBGetOrderBitSize 497
ippsECCBGetPoint 503
ippsECCBGetSize 492
ippsECCBInit 492
ippsECCBMulPointScalar 508
ippsECCBNegativePoint 506
ippsECCBPointGetSize 500
ippsECCBPointInit 501
ippsECCBPublicKey 510
ippsECCBSet 493
ippsECCBSetKeyPair 512
ippsECCBSetPoint 501
ippsECCBSetPointAtInfinity 502
ippsECCBSetStd 495
ippsECCBSharedSecretDH 513
ippsECCBSharedSecretDHC 515
ippsECCBSignDSA 516
ippsECCBSignNR 519
ippsECCBValidate 498
ippsECCBValidateKeyPair 511

ippsECCBVerifyDSA 518
ippsECCBVerifyNR 521
ippsECCPAddPoint 476
ippsECCPCheckPoint 473
ippsECCPComparePoint 474
ippsECCPGenKeyPair 478
ippsECCPGet 466
ippsECCPGetOrderBitSize 467
ippsECCPGetPoint 472
ippsECCPGetSize 461
ippsECCPInit 462
ippsECCPMulPointScalar 477
ippsECCPNegativePoint 475
ippsECCPPointGetSize 469
ippsECCPPointInit 470
ippsECCPPublicKey 479
ippsECCPSet 463
ippsECCPSetKeyPair 481
ippsECCPSetPoint 471
ippsECCPSetPointAtInfinity 472
ippsECCPSetStd 464
ippsECCPSharedSecretDH 482
ippsECCPSharedSecretDHC 484
ippsECCPSignDSA 485
ippsECCPSignNR 488
ippsECCPValidate 468
ippsECCPValidateKeyPair 480
ippsECCPVerifyDSA 487
ippsECCPVerifyNR 490
ippsExtGet_BN 332
ippsGcd_BN 345
ippsGet_BN 332
ippsGetOctString_BN 334
ippsGetOctString_BNU 326
ippsGetSize_BN 331
ippsGFPAdd 538
ippsGFPCmpElement 534
ippsGFPCpyElement 534
ippsGFPECAddPoint 596
ippsGFPECCmpPoint 594
ippsGFPECCpyPoint 592
ippsGFPECGet 586
ippsGFPECGetPoint 593
ippsGFPECGetSize 583
ippsGFPECInit 584
ippsGFPECMulPointScalar 597
ippsGFPECNegPoint 595
ippsGFPECPointGetSize 588
ippsGFPECPointInit 589
ippsGFPECSet 585
ippsGFPECSetPoint 590
ippsGFPECSetPointAtInfinity 590
ippsGFPECSetPointRandom 591
ippsGFPECVerify 587
ippsGFPECVerifyPoint 593
ippsGFPElementGetSize 528
ippsGFPElementInit 529
ippsGFPExp 541
ippsGFPGet 528
ippsGFPGetElement 535
ippsGFPGetSize 526
ippsGFPGFPMontDecode 543
ippsGFPGFPMontEncode 542
ippsGFPInit 527
ippsGFPInv 537
ippsGFPMul 540
ippsGFPNeg 536
ippsGFPSetElement 530
ippsGFPSetElementPower2 532
ippsGFPSetElementRandom 533
ippsGFPSetElementZero 531
ippsGFPSqrt 538
ippsGFPSub 539
ippsGFPXAdd 556
ippsGFPXAdd_GFP 557
ippsGFPXCmpElement 552
ippsGFPXCpyElement 553
ippsGFPXDiv 563
ippsGFPXECAddPoint 611
ippsGFPXECCmpPoint 609
ippsGFPXECCpyPoint 607
ippsGFPXECGet 601
ippsGFPXECGetPoint 608
ippsGFPXECGetSize 598
ippsGFPXECInit 599
ippsGFPXECMulPointScalar 612
ippsGFPXECNegPoint 610
ippsGFPXECPointGetSize 603
ippsGFPXECPointInit 604
ippsGFPXECSet 600
ippsGFPXECSetPoint 605
ippsGFPXECSetPointAtInfinity 605
ippsGFPXECSetPointRandom 606
ippsGFPXECVerify 602
ippsGFPXECVerifyPoint 608
ippsGFPXElementGetSize 547
ippsGFPXElementInit 547
ippsGFPXExp 562

ippsGFPXGet 546
ippsGFPXGetElement 553
ippsGFPXGetSize 544
ippsGFPXInit 545
ippsGFPXInv 555
ippsGFPXMul 560
ippsGFPXMul_GFP 561
ippsGFPXNeg 554
ippsGFPXQAdd 576
ippsGFPXQCmpElement 572
ippsGFPXQCpyElement 573
ippsGFPXQElementGetSize 567
ippsGFPXQElementInit 567
ippsGFPXQExp 580
ippsGFPXQGet 566
ippsGFPXQGetElement 573
ippsGFPXQGetSize 564
ippsGFPXQInit 565
ippsGFPXQInv 575
ippsGFPXQMul 578
ippsGFPXQMul_GFP 579
ippsGFPXQNeg 574
ippsGFPXQSetElement 568
ippsGFPXQSetElementPowerX 570
ippsGFPXQSetElementRandom 571
ippsGFPXQSetElementZero 569
ippsGFPXQSub 577
ippsGFPXSetElement 548
ippsGFPXSetElementPowerX 550
ippsGFPXSetElementRandom 551
ippsGFPXSetElementZero 549
ippsGFPXSub 558
ippsGFPXSub_GFP 559
ippsHMACMD5Duplicate 267
ippsHMACMD5Final 268
ippsHMACMD5GetSize 265
ippsHMACMD5GetTag 269
ippsHMACMD5Init 266
ippsHMACMD5MessageDigest 270
ippsHMACMD5Update 267
ippsHMACSHA1Duplicate 238
ippsHMACSHA1Final 240
ippsHMACSHA1GetSize 237
ippsHMACSHA1GetTag 241
ippsHMACSHA1Init 237
ippsHMACSHA1MessageDigest 241
ippsHMACSHA1Update 239
ippsHMACSHA224Final 245
ippsHMACSHA224GetSize 242
ippsHMACSHA224GetTag 246
ippsHMACSHA224Init 243
ippsHMACSHA224MessageDigest 247
ippsHMACSHA224Update 244
ippsHMACSHA256Duplicate 249
ippsHMACSHA256Final 251
ippsHMACSHA256GetTag 252
ippsHMACSHA256Init 248
ippsHMACSHA256MessageDigest 252
ippsHMACSHA256Update 250
ippsHMACSHA384Duplicate 256
ippsHMACSHA384Final 257
ippsHMACSHA384GetSize 254
ippsHMACSHA384GetTag 258
ippsHMACSHA384Init 255
ippsHMACSHA384MessageDigest 259
ippsHMACSHA384Update 256
ippsHMACSHA512Duplicate 261
ippsHMACSHA512Final 263
ippsHMACSHA512GetSize 260
ippsHMACSHA512GetTag 264
ippsHMACSHA512Init 260
ippsHMACSHA512MessageDigest 264
ippsHMACSHA512Update 262
ippsMAC_BN_I 341
ippsMACOne_BNU_I 320
ippsMD5Duplicate 193
ippsMD5Final 195
ippsMD5GetSize 192
ippsMD5GetTag 195
ippsMD5Init 193
ippsMD5MessageDigest 219
ippsMD5Update 194
ippsMGF_MD5 227
ippsMGF_SHA1 228
ippsMGF_SHA224 229
ippsMGF_SHA256 229
ippsMGF_SHA384 230
ippsMGF_SHA512 231
ippsMod_BN 344
ippsModInv_BN 346
ippsMontExp 356
ippsMontForm 352
ippsMontGet 351
ippsMontGetSize 349
ippsMontInit 350
ippsMontMul 353
ippsMontSet 350
ippsMul_BN 340

ippsMul_BNU4 321
ippsMul_BNU8 321
ippsMulOne_BNU 319
ippsPrimeGen 369
ippsPrimeGet 373
IppsPrimeGet_BN 373
ippsPrimeGetSize 368
ippsPrimeInit 369
ippsPrimeSet 371
ippsPrimeSet_BN 372
ippsPrimeTest 370
ippsPRNGen 363
ippsPRNGen_BN 364
ippsPRNGGetSize 359
ippsPRNGInit 359
ippsPRNGSetAugment 361
ippsPRNGSetH0 362
ippsPRNGSetModulus 362
ippsPRNGSetSeed 360
ippsRef_BN 334
ippsRijndael128CCMDecrypt 115
ippsRijndael128CCMDecryptMessage 111
ippsRijndael128CCMEncrypt 115
ippsRijndael128CCMEncryptMessage 109
ippsRijndael128CCMGetSize 112
ippsRijndael128CCMGetTag 116
ippsRijndael128CCMInit 113
ippsRijndael128CCMMessageLen 117
ippsRijndael128CCMStart 114
ippsRijndael128CCMTagLen 118
ippsRijndael128DecryptCBC 70
ippsRijndael128DecryptCCM 80
ippsRijndael128DecryptCCM_u8 81
ippsRijndael128DecryptCFB 72
ippsRijndael128DecryptCTR 76
ippsRijndael128DecryptECB 68
ippsRijndael128DecryptOFB 74
ippsRijndael128EncryptCBC 69
ippsRijndael128EncryptCCM 77
ippsRijndael128EncryptCCM_u8 79
ippsRijndael128EncryptCFB 71
ippsRijndael128EncryptCTR 75
ippsRijndael128EncryptECB 67
ippsRijndael128EncryptOFB 73
ippsRijndael128GCMDecrypt 125
ippsRijndael128GCMDecryptMessage 121
ippsRijndael128GCMEncrypt 125
ippsRijndael128GCMEncryptMessage 120
ippsRijndael128GCMGetSize 122
ippsRijndael128GCMGetTag 126
ippsRijndael128GCMInit 123
ippsRijndael128GCMStart 124
ippsRijndael128GetSize 66
ippsRijndael128Init 66
ippsRijndael192DecryptCBC 87
ippsRijndael192DecryptCFB 89
ippsRijndael192DecryptCTR 93
ippsRijndael192DecryptECB 85
ippsRijndael192DecryptOFB 91
ippsRijndael192EncryptCBC 86
ippsRijndael192EncryptCFB 88
ippsRijndael192EncryptCTR 92
ippsRijndael192EncryptECB 84
ippsRijndael192EncryptOFB 90
ippsRijndael192GetSize 82
ippsRijndael192Init 83, 297
ippsRijndael256DecryptCBC 98
ippsRijndael256DecryptCFB 100
ippsRijndael256DecryptCTR 104
ippsRijndael256DecryptECB 96
ippsRijndael256DecryptOFB 102
ippsRijndael256EncryptCBC 97
ippsRijndael256EncryptCFB 99
ippsRijndael256EncryptCTR 103
ippsRijndael256EncryptECB 95
ippsRijndael256EncryptOFB 101
ippsRijndael256GetSize 94
ippsRijndael256Init 94
ippsRSADecrypt 387
ippsRSADecrypt_PKCSv15 407
ippsRSAEncrypt 386
ippsRSAEncrypt_PKCSv15 406
ippsRSAGenerate 383
ippsRSAGetKey 382
ippsRSAGetSize 378
ippsRSAInit 379
ippsRSAOAEPDecrypt 400
ippsRSAOAEPDecrypt_MD5 401
ippsRSAOAEPDecrypt_SHA1 402
ippsRSAOAEPDecrypt_SHA224 403
ippsRSAOAEPDecrypt_SHA256 403
ippsRSAOAEPDecrypt_SHA384 404
ippsRSAOAEPDecrypt_SHA512 405
ippsRSAOAEPEncrypt 393
ippsRSAOAEPEncrypt_MD5 394
ippsRSAOAEPEncrypt_SHA1 395
ippsRSAOAEPEncrypt_SHA224 396
ippsRSAOAEPEncrypt_SHA256 397

ippsRSAOAEPEncrypt_SHA384 398
ippsRSAOAEPEncrypt_SHA512 399
ippsRSASetKey 380
ippsRSASSASign 409
ippsRSASSASign_MD5 411
ippsRSASSASign_MD5_PKCSv15 423
ippsRSASSASign_SHA1 412
ippsRSASSASign_SHA1_PKCSv15 424
ippsRSASSASign_SHA224 413
ippsRSASSASign_SHA224_PKCSv15 425
ippsRSASSASign_SHA256 414
ippsRSASSASign_SHA256_PKCSv15 426
ippsRSASSASign_SHA384 415
ippsRSASSASign_SHA384_PKCSv15 427
ippsRSASSASign_SHA512 416
ippsRSASSASign_SHA512_PKCSv15 428
ippsRSASSAVerify 417
ippsRSASSAVerify_MD5 418
ippsRSASSAVerify_MD5_PKCSv15 429
ippsRSASSAVerify_SHA1 419
ippsRSASSAVerify_SHA1_PKCSv15 430
ippsRSASSAVerify_SHA224 419
ippsRSASSAVerify_SHA224_PKCSv15 431
ippsRSASSAVerify_SHA256 420
ippsRSASSAVerify_SHA256_PKCSv15 432
ippsRSASSAVerify_SHA384 421
ippsRSASSAVerify_SHA384_PKCSv15 433
ippsRSASSAVerify_SHA512 422
ippsRSASSAVerify_SHA512_PKCSv15 434
ippsRSAValidate 384
ippsSafeRijndael128Init 66
ippsSet_BN 328
ippsSetOctString_BN 329
ippsSetOctString_BNU 325
ippsSHA1Duplicate 197
ippsSHA1Final 199
ippsSHA1GetSize 196
ippsSHA1GetTag 200
ippsSHA1Init 197
ippsSHA1MessageDigest 220
ippsSHA1Update 198
ippsSHA224Duplicate 202
ippsSHA224Final 203
ippsSHA224GetSize 200
ippsSHA224GetTag 204
ippsSHA224Init 201
ippsSHA224MessageDigest 223
ippsSHA224Update 202
ippsSHA256Duplicate 206
ippsSHA256Final 208
ippsSHA256GetSize 205
ippsSHA256GetTag 208
ippsSHA256Init 205
ippsSHA256MessageDigest 224
ippsSHA256Update 207
ippsSHA384Duplicate 210
ippsSHA384Final 212
ippsSHA384GetSize 209
ippsSHA384GetTag 213
ippsSHA384Init 210
ippsSHA384MessageDigest 224
ippsSHA384Update 211
ippsSHA512Duplicate 215
ippsSHA512Final 216
ippsSHA512GetSize 213
ippsSHA512GetTag 217
ippsSHA512Init 214
ippsSHA512MessageDigest 225
ippsSHA512Updat 215
ippsSqr_32u64u 323
ippsSqr_BNU4 324
ippsSqr_BNU8 324
ippsSub_BN 339
ippsSub_BNU 318
ippsTatePairingDE3Apply 616
ippsTatePairingDE3Get 615
ippsTatePairingDE3GetSize 613
ippsTatePairingDE3Init 614
ippsTDESDecryptCBC 51
ippsTDESDecryptCFB 53
ippsTDESDecryptCTR 58
ippsTDESDecryptECB 49
ippsTDESDecryptOFB 56
ippsTDESEncryptCBC 50
ippsTDESEncryptCFB 52
ippsTDESEncryptCTR 57
ippsTDESEncryptECB 48
ippsTDESEncryptOFB 55
ippsTwofishDecryptCBC 148
ippsTwofishDecryptCFB 150
ippsTwofishDecryptCTR 154
ippsTwofishDecryptECB 146
ippsTwofishDecryptOFB 152
ippsTwofishEncryptCBC 147
ippsTwofishEncryptCFB 149
ippsTwofishEncryptCTR 153
ippsTwofishEncryptECB 145
ippsTwofishEncryptOFB 151

ippsTwofishGetSize 144
ippsTwofishInit 144
ippsXCBCRijndael128Final 280
ippsXCBCRijndael128GetSize 277
ippsXCBCRijndael128GetTag 279
ippsXCBCRijndael128Init 278
ippsXCBCRijndael128MessageTag 281
ippsXCBCRijndael128Update 278

K

Keyed Hash Functions 233, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270
HMACMD5Duplicate 267
HMACMD5Final 268
HMACMD5GetSize 265
HMACMD5GetTag 269
HMACMD5Init 266
HMACMD5MessageDigest 270
HMACMD5Update 267
HMACSHA1Duplicate 238
HMACSHA1Final 240
HMACSHA1GetSize 237
HMACSHA1GetTag 241
HMACSHA1Init 237
HMACSHA1MessageDigest 241
HMACSHA1Update 239
HMACSHA224Duplicate 244
HMACSHA224Final 245
HMACSHA224GetSize 242
HMACSHA224GetTag 246
HMACSHA224Init 243
HMACSHA224MessageDigest 247
HMACSHA224Update 244
HMACSHA256BufferSize 248
HMACSHA256Duplicate 249
HMACSHA256Final 251
HMACSHA256GetTag 252
HMACSHA256Init 248
HMACSHA256MessageDigest 252
HMACSHA256Update 250
HMACSHA384Duplicate 256
HMACSHA384Final 257
HMACSHA384GetSize 254
HMACSHA384GetTag 258
Keyed Hash Functions *(continued)*
HMACSHA384Init 255
HMACSHA384MessageDigest 259
HMACSHA384Update 256
HMACSHA512Duplicate 261
HMACSHA512Final 263
HMACSHA512GetSize 260
HMACSHA512GetTag 264
HMACSHA512Init 260
HMACSHA512MessageDigest 264
HMACSHA512Update 262

M

manual organization 30
mask generation function 226
Mask Generation Functions 226, 227, 228, 229, 230, 231
MGF_MD5 227
MGF_SHA1 228
MGF_SHA224 229
MGF_SHA256 229
MGF_SHA384 230
MGF_SHA512 231
user-implemented 226
MD5 and SHA Algorithms 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217
MD5Duplicate 193
MD5Final 195
MD5GetSize 192
MD5GetTag 195
MD5Init 193
MD5MessageDigest 196
MD5Update 194
SHA1Duplicate 197
SHA1Final 199
SHA1GetSize 196
SHA1GetTag 200
SHA1Init 197
SHA1Update 198
SHA224Duplicate 202
SHA224Final 203
SHA224GetSize 200
SHA224GetTag 204
SHA224Init 201
SHA224Update 202

MD5 and SHA Algorithms *(continued)*
SHA256Duplicate 206
SHA256Final 208
SHA256GetSize 205
SHA256GetTag 208
SHA256Init 205
SHA256MessageDigest 209
SHA256Update 207
SHA384Duplicate 210
SHA384Final 212
SHA384GetSize 209
SHA384GetTag 213
SHA384Init 210
SHA384MessageDigest 213
SHA384Update 211
SHA512Duplicate 215
SHA512Final 216
SHA512GetSize 213
SHA512GetTag 217
SHA512Init 214
SHA512Update 215
Message Authentication Functions 233, 271, 276
AES-XCBC Functions 276
CMAC Functions 271
Keyed Hash Functions 233
MGF 226
modes of operation for block ciphers
CBC 33
CCM 108
CFB 33
CTR 33
ECB 33
OFB 33
Montgomery Reduction Scheme Functions 347, 349, 350, 351, 352, 353, 356
MontInit 350
MontSet 350
MontExp 356
MontForm 352
MontGet 351
MontGetSize 349
MontMul 353

N

naming conventions 31
notational conventions 31

P

PKCS V1.5 Encryption Scheme Functions 406
PKCS V1.5 Signature Scheme Functions 422
platforms supported 28
Prime Number Generation Functions 366, 368, 369, 370, 371, 372, 373
PrimeGen 369
PrimeGetSize 368
PrimeInit 369
PrimeGet 373
PrimeGet_BN 373
PrimeSet 371
PrimeSet_BN 372
PrimeTest 370
Pseudorandom Number Generation Functions 357, 358, 359, 360, 361, 362, 363, 364
PRNGen 363
PRNGen_BN 364
PRNGGetSize 359
PRNGInit 359
PRNGSetAugment 361
PRNGSetH0 362
PRNGSetModulus 362
PRNGSetSeed 360
user-implemented 358

R

RC4 stream cipher 183
RC5 Functions 158, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182
ARCFive128DecryptCBC 176
ARCFive128DecryptCFB 178
ARCFive128DecryptCTR 182
ARCFive128DecryptECB 174
ARCFive128DecryptOFB 180
ARCFive128EncryptCBC 175
ARCFive128EncryptCFB 177
ARCFive128EncryptCTR 181
ARCFive128EncryptECB 173
ARCFive128EncryptOFB 179
ARCFive128GetSize 172
ARCFive128Init 172
ARCFive64DecryptCBC 165
ARCFive64DecryptCFB 167
ARCFive64DecryptCTR 171

RC5 Functions *(continued)*
ARCFive64DecryptECB 163
ARCFive64DecryptOFB 169
ARCFive64EncryptCBC 164
ARCFive64EncryptCFB 166
ARCFive64EncryptCTR 170
ARCFive64EncryptECB 162
ARCFive64EncryptOFB 168
ARCFive64GetSize 160
ARCFive64Init 161
reference code 27
Rijndael Functions 61, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 108, 109, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126
AES-CCM Functions 108
AES-GCM Functions 119
Rijndael128CCMDecrypt 115
Rijndael128CCMDecryptMessage 111
Rijndael128CCMEncrypt 115
Rijndael128CCMEncryptMessage 109
Rijndael128CCMGetSize 112
Rijndael128CCMGetTag 116
Rijndael128CCMInit 113
Rijndael128CCMMessageLen 117
Rijndael128CCMStart 114
Rijndael128CCMTagLen 118
Rijndael128DecryptCBC 70
Rijndael128DecryptCCM 80
Rijndael128DecryptCCM_u8 81
Rijndael128DecryptCFB 72
Rijndael128DecryptCTR 76
Rijndael128DecryptECB 68
Rijndael128DecryptOFB 74
Rijndael128EncryptCBC 69
Rijndael128EncryptCCM 77
Rijndael128EncryptCCM_u8 79
Rijndael128EncryptCFB 71
Rijndael128EncryptCTR 75
Rijndael128EncryptECB 67
Rijndael128EncryptOFB 73
Rijndael128GCMDecrypt 125
Rijndael128GCMDecryptMessage 121
Rijndael128GCMEncrypt 125
Rijndael128GCMEncryptMessage 120
Rijndael128GCMGetSize 122
Rijndael128GCMGetTag 126
Rijndael Functions *(continued)*
Rijndael128GCMInit 123
Rijndael128GCMStart 124
Rijndael128GetSize 66
Rijndael128Init 66
Rijndael192DecryptCBC 87
Rijndael192DecryptCFB 89
Rijndael192DecryptCTR 93
Rijndael192DecryptECB 85
Rijndael192DecryptOFB 91
Rijndael192EncryptCBC 86
Rijndael192EncryptCFB 88
Rijndael192EncryptCTR 92
Rijndael192EncryptECB 84
Rijndael192EncryptOFB 90
Rijndael192GetSize 82
Rijndael192Init 83
Rijndael256DecryptCBC 98
Rijndael256DecryptCFB 100
Rijndael256DecryptCTR 104
Rijndael256DecryptECB 96
Rijndael256DecryptOFB 102
Rijndael256EncryptCBC 97
Rijndael256EncryptCFB 99
Rijndael256EncryptCTR 103
Rijndael256EncryptECB 95
Rijndael256EncryptOFB 101
Rijndael256GetSize 94
Rijndael256Init 94
SafeRijndael128Init 66
RSA Algorithm Functions 377
RSA Primitives 385, 386, 387
RSADecrypt 387
RSAEncrypt 386
RSA System Building Functions 377, 378, 379, 380, 382, 383, 384
RSAGenerate 383
RSAGetKey 382
RSAGetSize 378
RSAInit 379
RSASetKey 380
RSAValidate 384
RSA-based Encryption Scheme Functions 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407
RSADecrypt_PKCSv15 407
RSAEncrypt_PKCSv15 406
RSAOAEPDecrypt 400
RSAOAEPDecrypt_MD5 401

RSA-based Encryption Scheme Functions *(continued)*
RSAOAEPDecrypt_SHA1 402
RSAOAEPDecrypt_SHA224 403
RSAOAEPDecrypt_SHA256 403
RSAOAEPDecrypt_SHA384 404
RSAOAEPDecrypt_SHA512 405
RSAOAEPEncrypt 393
RSAOAEPEncrypt_MD5 394
RSAOAEPEncrypt_SHA1 395
RSAOAEPEncrypt_SHA224 396
RSAOAEPEncrypt_SHA256 397
RSAOAEPEncrypt_SHA384 398
RSAOAEPEncrypt_SHA512 399
RSA-based scheme 377
RSA-based Signature Scheme Functions 408, 409, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434
RSASSASign 409
RSASSASign_MD5 411
RSASSASign_MD5_PKCSv15 423
RSASSASign_SHA1 412
RSASSASign_SHA1_PKCSv15 424
RSASSASign_SHA224 413
RSASSASign_SHA224_PKCSv15 425
RSASSASign_SHA256 414
RSASSASign_SHA256_PKCSv15 426
RSASSASign_SHA384 415
RSASSASign_SHA384_PKCSv15 427
RSASSASign_SHA512 416
RSASSASign_SHA512_PKCSv15 428
RSASSAVerify 417
RSASSAVerify_MD5 418
RSASSAVerify_MD5_PKCSv15 429
RSASSAVerify_SHA1 419
RSASSAVerify_SHA1_PKCSv15 430
RSASSAVerify_SHA224 419
RSASSAVerify_SHA224_PKCSv15 431
RSASSAVerify_SHA256 420
RSASSAVerify_SHA256_PKCSv15 432
RSASSAVerify_SHA384 421
RSASSAVerify_SHA384_PKCSv15 433
RSASSAVerify_SHA512 422
RSASSAVerify_SHA512_PKCSv15 434
RSA-OAEP Scheme Functions 392
RSA-SSA Scheme Functions 408

S

support functions and classes 621
symmetric algorithm modes
Cipher Block Chain (CBC) 33
Cipher Feedback (CFB) 33
Counter (CTR) 33
Counter with Cipher Block Chaining-Message Authentication Code (CCM) 108
Electronic Code Book (ECB) 33
Output Feedback (OFB) 33

T

Tate Pairing Functions 613, 614, 615, 616
TatePairingDE3Apply 616
TatePairingDE3Get 615
TatePairingDE3GetSize 613
TatePairingDE3Init 614
Triple Data Encryption Standard (TDES) 34
Twofish Functions 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154
TwofishDecryptCBC 148
TwofishDecryptCFB 150
TwofishDecryptCTR 154
TwofishDecryptECB 146
TwofishDecryptOFB 152
TwofishEncryptCBC 147
TwofishEncryptCFB 149
TwofishEncryptCTR 153
TwofishEncryptECB 145
TwofishEncryptOFB 151
TwofishGetSize 144
TwofishInit 144

V

version information function 621