Identifiers and Test Vectors for HMAC-SHA-224, HMAC-SHA-256, HMAC-SHA-384, and HMAC-SHA-512

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Abstract

This document provides test vectors for the HMAC-SHA-224, HMAC-SHA-256, HMAC-SHA-384, and HMAC-SHA-512 message authentication schemes. It also provides ASN.1 object identifiers and Uniform Resource Identifiers (URIs) to identify use of these schemes in protocols. The test vectors provided in this document may be used for conformance testing.
RFC 4231  HMAC-SHA Identifiers and Test Vectors     December 2005

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1. Introduction

This document provides test vectors for the HMAC-SHA-224,
HMAC-SHA-256, HMAC-SHA-384, and HMAC-SHA-512 message authentication
schemes. It also provides ASN.1 object identifiers and URIs to
identify use of these schemes in protocols using ASN.1 constructs
(such as those built on Secure/Multipurpose Internet Mail Extensions
(S/MIME) [4]) or protocols based on XML constructs (such as those
leveraging XML Digital Signatures [5]).

HMAC-SHA-224 is the realization of the HMAC message authentication
code [1] using the SHA-224 hash function, HMAC-SHA-256 is the
realization of the HMAC message authentication code using the SHA-256
hash function, HMAC-SHA-384 is the realization of the HMAC message
authentication code using the SHA-384 hash function, and HMAC-SHA-512
is the realization of the HMAC message authentication code using the
SHA-512 hash function. SHA-224, SHA-256, SHA-384, and SHA-512 are
all described in [2].

2. Conventions Used in This Document

The key word "SHOULD" in this document is to be interpreted as
described in RFC 2119 [3].
3. Scheme Identifiers

3.1. ASN.1 Object Identifiers

The following ASN.1 object identifiers have been allocated for these schemes:

```
rsadsi OBJECT IDENTIFIER ::= {iso(1) member-body(2) us(840) rsadsi(113549)}
```

```
digestAlgorithm OBJECT IDENTIFIER ::= {rsadsi 2}
```

```
id-hmacWithSHA224 OBJECT IDENTIFIER ::= {digestAlgorithm 8}
id-hmacWithSHA256 OBJECT IDENTIFIER ::= {digestAlgorithm 9}
id-hmacWithSHA384 OBJECT IDENTIFIER ::= {digestAlgorithm 10}
id-hmacWithSHA512 OBJECT IDENTIFIER ::= {digestAlgorithm 11}
```

When the "algorithm" component in a value of ASN.1 type AlgorithmIdentifier (see, e.g., [4], Section 10) identifies one of these schemes, the "parameter" component SHOULD be present but have type NULL.

3.2. Algorithm URIs

The following URIs have been allocated for these schemes:

```
http://www.rsasecurity.com/rsalabs/pkcs/schemas/pkcs-5#hmac-sha-224
http://www.rsasecurity.com/rsalabs/pkcs/schemas/pkcs-5#hmac-sha-256
http://www.rsasecurity.com/rsalabs/pkcs/schemas/pkcs-5#hmac-sha-384
http://www.rsasecurity.com/rsalabs/pkcs/schemas/pkcs-5#hmac-sha-512
```

As usual, when used in the context of [5], the <ds:HMACOutputLength> element may specify the truncated length of the scheme output.

4. Test Vectors

4.1. Introduction

The test vectors in this document have been cross-verified by three independent implementations. An implementation that concurs with the results provided in this document should be interoperable with other similar implementations.

Keys, data, and digests are provided in hex.
4.2. Test Case 1

Key = 0b0b0b0b0b0b0b0b0b0b0b0b0b0b0b0b0b0b0b0b0b0b0b0b0b0b0b0b0b0b0b0b (20 bytes)

Data = 4869205468657265 ("Hi There")

HMAC-SHA-224 = 896fb1128abbdf196832107cd49df33f47b4b1169912ba4f53684b22
HMAC-SHA-256 = b0344c61d8db38535ca8afceaf0bf12b881dc200c9833da726e9376c2e32cfc7
HMAC-SHA-384 = afd03944d84895626b0825f4ab46907f15f9dadbe4101ec682aa034c7cebc59cfaea9ea9076ede7f4af152e8b2fa9cb6
HMAC-SHA-512 = 87aa7cdea5ef619d4ff0b4241a1d6cb02379f4e2ce4ec2787ad0b30545e17cde6aa833b7d6b8a702038b274eaa3f4e4be9d914eeb61f1702e696c203a126854

4.3. Test Case 2

Test with a key shorter than the length of the HMAC output.

Key = 4a656665 ("Jefe")

Data = 7768617420646f2079612077616e7420666f72206e6f746869673f ("what do ya want ")

66ef72206e6f7468696673f ("for nothing")

HMAC-SHA-224 = a30e01098bc6dbbf45690f3a7e9e6d0f88bea2a39e6d4800f805e44
HMAC-SHA-256 = 5bdcc146bf6075466a042426089575c75a003f089d2739839dec58b964ec3843
HMAC-SHA-384 = af45d2e376484031617f78d2b58a6b1b9c7ef466f5a01b47e42ecc373632245e8e2240ca5e69e2c78b3239ecfab21649
HMAC-SHA-512 = 164b7a7b6cf819e2e395fbe73b56e0a387bd64222e831fd610270cd7ea2505549758bf75c05a994a6d034f65f8f0e6fdcaeab1a34d4a6b4b636e070a38bce737
4.4. Test Case 3

Test with a combined length of key and data that is larger than 64 bytes (= block-size of SHA-224 and SHA-256).

Key            aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa
               aaaaaaaaa                          (20 bytes)
Data =         dddddddddddddddddddddddddddddddd
               dddddddddddddddddddddddddddddddddd
               dddddddddddddddddddddddddddddddddd
               dddddddddddddddddddddddddddddddddd
               dddd                              (50 bytes)

HMAC-SHA-224 = 7fb3cb3588c6c1f6ffa9694d7d6ad264
               9365b0c1f65d69d1ec8333ea
HMAC-SHA-256 = 773ea91e36800e46854db8ebd09181a7
               2959098b3ef8c122d9635514ced565fe
HMAC-SHA-384 = 88062608d3e6ad8a0a2ace014c8a86f
               0a635d947ac9febe83ef4e55966144b
               2a5ab39dc13814b94e3ab6e101a34f27
HMAC-SHA-512 = fa73b0089d56a284efb0f0756c890be9
               b1b5dddb8ee81a3655f83e33b2279d39
               bf3e848279a722c806b485a47e67c807
               b946a337bee8942674278859e13292fb

4.5. Test Case 4

Test with a combined length of key and data that is larger than 64 bytes (= block-size of SHA-224 and SHA-256).

Key =          0102030405060708090a0b0c0d0e0f10
               111213141516171819                (25 bytes)
Data =         cdcdcdcdcdcdcdcdcdcdcdcdcdcdcdcd
cdcdcdcdcdcdcdcdcdcdcdcdcdcdcdcd
cdcdcdcdcdcdcdcdcdcdcdcdcdcdcdcd
cdcdcdcdcdcdcdcdcdcdcdcdcdcdcdcd
cdcd                              (50 bytes)

HMAC-SHA-224 = 6c11506874013cac6a2abc1bb382627c
               ec6a90d86efc012de7afec5a
HMAC-SHA-256 = 82558a389a443c0ea4cc819899f2083a
               85f0faa3e578f8077a2e3ff46729665b
HMAC-SHA-384 = 3e8a69b7783c25851933ab6290af6ca7
               7a9981480850009cc5577c6e1f573b4e
               6801dd23c4a7d679ccf8a386c674cffe
HMAC-SHA-512 = b0ba465637458c6990e5a8c5f61d4af7
               e576d97ff94b872de76f8050361ee3db
               a91ca5c11aa25eb4d679275cc5788063
               a5f19741120c4f2de2adebeb10a298dd
4.6. Test Case 5

Test with a truncation of output to 128 bits.

Key = 0c0c0c0c0c0c0c0c0c0c0c0c0c0c0c0c0c0c0c0c0c0c0c0c0c0c0c0c0c0c0c0c (20 bytes)
Data = 546573742057697468205472756e6361 ("Test With Trunca")
4696f6e ("tion")
HMAC-SHA-224 = 0e2aea68a90c8d37c988bcd9fca6fa8
HMAC-SHA-256 = a3b6167473100ee06e0c796c2955552b
HMAC-SHA-384 = 3abf34c3503b2a3a46efc619bafef897
HMAC-SHA-512 = 415fad6271580a531d4179bc891d87a6

4.7. Test Case 6

Test with a key larger than 128 bytes (= block-size of SHA-384 and SHA-512).

Key = aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa
       aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa
       aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa
       aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa
       aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa
       aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa
       aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa
       aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa
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       aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa
64 bytes

Data = 546573742055736967204c61726765 ("Test Using Large")
       7220568616e20426c6f636b2d53697a ("r Than Block-Siz")
       65204b6579202d2048617368204b6579 ("e Key - Hash Key")
       204669727374 (" First")
HMAC-SHA-224 = 95e9a0db962095adaebe9b2d6f0dbce2
d499f112f2d2b7273fa6870e
HMAC-SHA-256 = 60e431591ee0b67f0d8a26aaccf5b77f
e80b6c6213728c5140546040f0e37f54
HMAC-SHA-384 = 4ece084485813e9088d2c63a041bc5b4
        4f9ef1012a2b588f3cd11f05033ac4c6
        80b24263c7c1a3eb71493c1d7be8b4
9b46d1f41b4aeec1121b013783f8f352
6b56d037e5f259b0d0fd2215d6a1e52
95e64f73f63f0aec8b915a985d786598
4.8. Test Case 7

Test with a key and data that is larger than 128 bytes (= block-size of SHA-384 and SHA-512).

Key =

```
aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa
aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa
aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa
aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa
aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa
aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa
aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa
aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa

```

(131 bytes)

Data =

```
5468697320697320612074657374207573696e672061206c61726765722074616e20626c6f636b2d73697a65206b657920616e642061206c6172676572207468616e20626c6f636b2d73697a6520646174612e20546865206b6579206e65657320746f20626520686173686564206265666f7265206265696e6720757365642062792074686520484d414320616c676f726974686d2e
```

("This is a test u"
"sing a larger th"
"an block-size ke"
"y and a larger t"
"han block-size d"
"ata. The key nee"
"ds to be hashed"
"before being use"
"by the HMAC al"
"gorithm."

HMAC-SHA-224 = 3a854166ac5d9f023f54d517d0b39dbd
HMAC-SHA-256 = 9b09ffaf71b942fcb27635fbcdf55be944
HMAC-SHA-384 = 6617178e941f020d351e2f254e8fd32c
HMAC-SHA-512 = e37b6a775dc87dbaa4df49f9e53fffd
debe71f886728865d5fa32d20c0c944
b6022cac3c4982b10d5e6e5533e4de15
134676fb6de0446065c97440fa8c6a58

5. Security Considerations

This document is intended to provide the identifications and test vectors for the four identified message authentication code schemes to the Internet community. No assertion of the security of these message authentication code schemes for any particular use is intended. The reader is referred to [1] for a discussion of the general security of the HMAC construction.
6. Acknowledgements

The test cases in this document are derived from the test cases in [6], although the keys and data are slightly different.

Thanks to Jim Schaad and Brad Hards for assistance in verifying the results.

7. References

7.1. Normative References


7.2. Informative References


Author’s Address

Magnus Nystrom
RSA Security

EMail: magnus@rsasecurity.com
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Acknowledgement

Funding for the RFC Editor function is currently provided by the Internet Society.