

## Test Cases for HMAC-RIPEMD160 and HMAC-RIPEMD128

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### Abstract

This document provides two sets of test cases for HMAC-RIPEMD160 and HMAC-RIPEMD128, respectively. HMAC-RIPEMD160 and HMAC-RIPEMD128 are two constructs of the HMAC [HMAC] message authentication function using the RIPEMD-160 and RIPEMD-128 [RIPE] hash functions. The test cases and results provided in this document are meant to be used as a conformance test for HMAC-RIPEMD160 and HMAC-RIPEMD128 implementations.

### 1. Introduction

The general method for constructing a HMAC message authentication function using a particular hash function is described in section 2 of [HMAC].

In sections 2 and 3 test cases for HMAC-RIPEMD160 and HMAC-RIPEMD128, respectively are provided. Each case includes the key, the data, and the result. The values of keys and data are either hexadecimal numbers (prefixed by "0x") or ASCII character strings in double quotes. If a value is an ASCII character string, then the HMAC computation for the corresponding test case DOES NOT include the trailing null character ('\0') in the string.

The C source code of the functions used to generate HMAC-RIPEMD160 and HMAC-RIPEMD128 results is listed in the Appendix. Please Note that the functions provided are implemented in such a way as to be simple and easy to understand as a result they are not optimized in any way. The C source code for computing HMAC-MD5 can be found in [MD5].



```
key_len =      80
data =        "Test Using Larger Than Block-Size Key and Larger
              Than One Block-Size Data"
data_len =    73
digest =     0x69ea60798d71616cce5fd0871e23754cd75d5a0a
```

### 3. Test Cases for HMAC-RIPEMD128

```
test_case =    1
key =         0x0b0b0b0b0b0b0b0b0b0b0b0b0b0b0b0b
key_len =     16
data =       "Hi There"
data_len =    8
digest =     0xfbf61f9492aa4bbf81c172e84e0734db
```

```
test_case =    2
key =         "Jefe"
key_len =     4
data =       "what do ya want for nothing?"
data_len =   28
digest =     0x875f828862b6b334b427c55f9f7ff09b
```

```
test_case =    3
key =         0xaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa
key_len =     16
data =       0xdd repeated 50 times
data_len =   50
digest =     0x09f0b2846d2f543da363cbec8d62a38d
```

```
test_case =    4
key =         0x0102030405060708090a0b0c0d0e0f10111213141516171819
key_len =     25
data =       0xcd repeated 50 times
data_len =   50
digest =     0xbd77c7cf03e44b5aa60af815be4d2294
```

```
test_case =    5
key =         0x0c0c0c0c0c0c0c0c0c0c0c0c0c0c0c0c
key_len =     16
data =       "Test With Truncation"
data_len =   20
digest =     0xe79808f24b25fd031c155f0d551d9a3a
digest-96 =   0xe79808f24b25fd031c155f0d
```

```
test_case =    6
key =         0xaa repeated 80 times
key_len =     80
data =       "Test Using Larger Than Block-Size Key - Hash Key
```

```

                                First"
data_len =                       54
digest =                          0xdc732928de98104a1f59d373c150acbb

test_case =                       7
key =                             0xaa repeated 80 times
key_len =                          80
data =                             "Test Using Larger Than Block-Size Key and Larger
                                Than One Block-Size Data"
data_len =                          73
digest =                          0x5c6bec96793e16d40690c237635f30c5
```

#### 4. Security Considerations

This document raises no security issues. Discussion on the strength of the HMAC construction can be found in [HMAC].

#### References

- [HMAC] Krawczyk, H., Bellare, M., and R. Canetti,  
"HMAC: Keyed-Hashing for Message Authentication", RFC 2104,  
February 1997.
- [MD5] Rivest, R., "The MD5 Message-Digest Algorithm",  
RFC 1321, April 1992.
- [OG] Oehler, M., and R. Glenn,  
"HMAC-MD5 IP Authentication with Replay Prevention", RFC  
2085, February 1997
- [CG] Chang, S., and R. Glenn,  
"Test Cases for HMAC-MD5 and HMAC-SHA-1", RFC 2202,  
September 1997.
- [RIPE] Dobbertin, H., Bosselaers A., and Preneel, B.  
"RIPEMD-160: A Strengthened Version of RIPEMD" April 1996

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## Appendix

This code which implements HMAC-RIPEMD160 using an existing RIPEMD-160 library. It assumes that the RIPEMD-160 library has similar API's as those of the MD5 code described in RFC 1321. The code for HMAC-MD5, is similar, this HMAC-MD5 code is also listed in RFC 2104. To adapt this example to produce the HMAC-RIPEMD128 then replace each occurrence of 'RMD160' with 'RMD128'.

```
#ifndef RMD160_DIGESTSIZE
#define RMD160_DIGESTSIZE 20
#endif

#ifndef RMD128_DIGESTSIZE
#define RMD128_DIGESTSIZE 16
#endif

/* HMAC_RMD160 implements HMAC-RIPEMD160 */

void HMAC_RMD160(input, len, key, keylen, digest)
unsigned char *input;          /* pointer to data stream */
int len;                      /* length of data stream */
unsigned char *key;           /* pointer to authentication key */
int keylen;                   /* length of authentication key */
unsigned char *digest;        /* resulting MAC digest */
{
    RMD160_CTX context;
    unsigned char k_ipad[65]; /* inner padding - key XORd with ipad */
    unsigned char k_opad[65]; /* outer padding - key XORd with opad */
    unsigned char tk[RMD160_DIGESTSIZE];
    int i;

    /* if key is longer than 64 bytes reset it to key=SHA1(key) */
    if (keylen > 64) {
        RMD160_CTX tctx;

        RMD160Init(&tctx);
        RMD160Update(&tctx, key, keylen);
        RMD160Final(tk, &tctx);

        key = tk;
        keylen = RMD160_DIGESTSIZE;
    }

    /* The HMAC_SHA1 transform looks like:

        RMD160(K XOR opad, RMD160(K XOR ipad, text))
```

```
    where K is an n byte key
    ipad is the byte 0x36 repeated 64 times
    opad is the byte 0x5c repeated 64 times
    and text is the data being protected */

    /* start out by storing key in pads */
    memset(k_ipad, 0x36, sizeof(k_ipad));
    memset(k_opad, 0x5c, sizeof(k_opad));

    /* XOR key with ipad and opad values */
    for (i=0; i<keylen; i++) {
        k_ipad[i] ^= key[i];
        k_opad[i] ^= key[i];
    }

    /* perform inner RIPEMD-160 */

    RMD160Init(&context);          /* init context for 1st pass */
    RMD160Update(&context, k_ipad, 64); /* start with inner pad */
    RMD160Update(&context, input, len); /* then text of datagram */
    RMD160Final(digest, &context); /* finish up 1st pass */

    /* perform outer RIPEMD-160 */
    RMD160Init(&context);          /* init context for 2nd pass */
    RMD160Update(&context, k_opad, 64); /* start with outer pad */
    /* then results of 1st hash */
    RMD160Update(&context, digest, RMD160_DIGESTSIZE);
    RMD160Final(digest, &context); /* finish up 2nd pass */

    memset(k_ipad, 0x00, sizeof(k_ipad));
    memset(k_opad, 0x00, sizeof(k_opad));
}
```

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