kiSHA2 Demo   Kenneth Ives kenaso@tx.rr.com

I am open to ways to improve this application, please email me.

Visual Basic 6.0 with Service Pack 6 runtime files required.
To obtain required files (VBRun60sp6.exe):
http://www.microsoft.com/downloads/details.aspx?FamilyId=7B9BA261-7A9C-43E7-9117-F673077FFB3C

VBRun60sp6.exe installs Visual Basic 6.0 SP6 run-time files.
http://support.microsoft.com/kb/290887

This software has been tested on Windows XP through Windows 7.
Windows 9x, 2000 and NT4 are no longer supported.

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```
*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*=*
```

REFERENCE:

NIST (National Institute of Standards and Technology)
FIPS (Federal Information Processing Standards Publication)
SP (Special Publications)
http://csrc.nist.gov/publications/PubsFIPS.html

FIPS 180-2 (Federal Information Processing Standards Publication)
dated 1-Aug-2002, with Change Notice 1, dated 25-Feb-2004
http://csrc.nist.gov/publications/fips/fips180-2/FIPS180-2_changenotice.pdf

FIPS 180-3 (Federal Information Processing Standards Publication)
dated Oct-2008 (supercedes FIPS 180-2)
http://csrc.nist.gov/publications/fips/fips180-3/fips180-3_final.pdf

FIPS 180-4 (Federal Information Processing Standards Publication)
dated Mar-2012 (Supercedes FIPS-180-3)
http://csrc.nist.gov/publications/fips/fips180-4/fips-180-4.pdf

Examples of the implementation of the secure hash algorithms
SHA-1, SHA-224, SHA-256, SHA-384, SHA-512, SHA-512/224 and
SHA-512/256, can be found at:
http://csrc.nist.gov/groups/ST/toolkit/examples.html
http://csrc.nist.gov/groups/ST/toolkit/documents/Examples/SHA2_Additional.pdf

Aaron Gifford's additional test vectors
http://www.adg.us/computers/sha.html

Guidelines for Media Sanitization (SP800-88)
http://csrc.nist.gov/publications/nistpubs/800-88/NISTSP800-88_rev1.pdf

Feb-2005: SHA-1 has been compromised. Recommended that you do not use for password or document authentication.
http://www.schneier.com/blog/archives/2005/02/sha1_broken.html
http://csrc.nist.gov/groups/ST/toolkit/documents/shs/NISTHashComments-final.pdf

March 15, 2006: The SHA-2 family of hash functions (i.e., SHA-224, SHA-256, SHA-384 and SHA-512) may be used by Federal agencies for all applications using secure hash algorithms. Federal agencies should stop using SHA-1 for digital signatures, digital time stamping and other applications that require collision resistance as soon as practical, and must use the SHA-2 family of hash functions for these applications after 2010. After 2010, Federal agencies may use SHA-1 only for the following applications:

- hash-based message authentication codes (HMACs)
- key derivation functions (KDFs)
- random number generators (RNGs)

Regardless of use, NIST encourages application and protocol designers to use the SHA-2 family of hash functions for all new applications and protocols.
http://csrc.nist.gov/groups/ST/hash/policy.html

Export Control: Certain cryptographic devices and technical data regarding them are subject to Federal export controls. Exports of cryptographic modules implementing this standard and technical data regarding them must comply with these Federal regulations and be licensed by the Bureau of Export Administration of the U.S. Department of Commerce. Information about export regulations is available at:
http://www.bis.doc.gov/index.htm

SHA-2 support on MS Windows
Paraphrasing: Regarding SHA-224 support, SHA-224 offers less security than SHA-256 but takes the same amount of resources. Also SHA-224 is not generally used by protocols and applications. The NSA's (National Security Agency) Suite B standards also do not include it. Microsoft has no plans to add it to future versions of their CSPs (Cryptographic Service Providers).
http://blogs.msdn.com/b/alejacma/archive/2009/01/23/sha-2-support-on-windows-xp.aspx

****

How to use:

For a simple example, execute the SHA_Demo application. The demo converts the data to a byte array prior to passing it to the DLL to be hashed.

[STRING DATA]
Convert string data to byte array prior to passing to the HashString function.

```
Example:   abytData() = StrConv("abc", vbFromUnicode)
```

[FILE DATA]
Just the path and filename are passed in the byte array. Convert the path\filename data to byte array prior to passing to the HashFile function. The HashFile routine will open and read the file into an internal byte array.

```
Example:
  abytData() = StrConv("C:\Files\Test Folder\Testfile.doc", vbFromUnicode)


Both will create a hashed output string based on file data input.

*****************************************************************************

Project:       Secure Hash Algorithm
               SHA-1 SHA-224, SHA-256, SHA-384, SHA-512, SHA-512/224, SHA-512/256
Module:        clsSHA1.cls & clsSHA2.cls

Description:   The Secure Hash Algorithm (SHA) is required for use with
               the Digital Signature Algorithm (DSA) as specified in the
               Digital Signature Standard (DSS) and whenever a secure
               hash algorithm is required for federal applications.  For
               a message of length < 2^64 bits, this algorithm produces a
               condensed representation of the message called a
               message digest. The message digest is used during
               generation of a signature for the message.  This
               also used to compute a message digest for the received
               version of the message during the process of verifying the
               signature.  Any change to the message in transit will,
               with very high probability, result in a different message
               digest, and the signature will fail to verify.

               These algorithms have been tested to be accurate in accordance
               with FIPS 180-2, FIPS 180-3, FIPS 180-4 publications.  Also,
               test vectors by Aaron Gifford at:
               http://www.adg.us/computers/sha.html

               According to FIPS-180-2 there are only two differences
               between SHA-224 and SHA-256.

                    1.  The initalizing values are different
                    2.  Just the left most 224 bits (28 bytes) are saved

               According to FIPS-180-2 there are only two differences
               between SHA-384 and SHA-512.

                    1.  The initalizing values are different
                    2.  SHA-384 only uses the first six elements for the output.
                        SHA-512 uses all eight elements for the output.

IMPORTANT NOTE
   I have kept SHA-1 in this DLL because I have other uses for a fast hash
   that will not compromise security.  (i.e., Seeding or enhancing random
   number generation)

=============================================================================
                              Overview
=============================================================================

Message padding

All data is stored in Big_Endian format with the Most Significant Bit (MSB)
first.

The message 'M' shall be padded before hash computation begins. The purpose
of this padding is to ensure that the padded message is a multiple of 512 or
1024 bits, depending on the algorithm.
```

32-Bit Format (160, 224, 256)

Suppose the length of the message 'M', in bits, is 'l' bits. Append the bit '1' to the end of the message, followed by 'k' zero bits, where 'k' is the smallest non-negative solution to the equation l+1+k=448 mod 512. Then append the 64-bit block that is equal to the number 'l' expressed using a binary representation. The length of the padded message should now be a multiple of 512 bits.

64-Bit Format (384, 512)

Suppose the length of the message 'M', in bits, is 'l' bits. Append the bit '1' to the end of the message, followed by 'k' zero bits, where 'k' is the smallest non-negative solution to the equation l+1+k=896 mod 1024. Then append the 128-bit block that is equal to the number 'l' expressed using a binary representation. The length of the padded message should now be a multiple of 1024 bits.

Constant and work arrays

The definition of the initial hash value H(0) allows its implementation to be shared between the algorithms. That is, the left halves of the SHA-512 words of H(0) are the words of H(0) for SHA-256. Similarly for SHA-384, the right halves of the words of H(0) are the words for H(0) for SHA-224. For example for H(0):

```
    SHA-224 H(0) =         c1059ed8       Right half of SHA-384
    SHA-384 H(0) = cbbb9d5dc1059ed8

    SHA-256 H(0) = 6a09e667               Left half of SHA-512
    SHA-512 H(0) = 6a09e667f3bbc908
```

A similar implementation holds true for the constants arrays. This uses the left half of SHA-512.

```
    SHA-224, SHA-256 = 428a2f98           Left half of SHA-512
             SHA-512 = 428a2f98d728ae22
```

Calculating the Square and Cube Roots

Got this explanation from Ask Dr. Math web site.
http://mathforum.org/dr.math/

There is a simple process for converting a base 10 decimal fraction to a "decimal" fraction in another base. We repeatedly multiply (in base 10) our decimal fraction by the new base, picking off the whole number part each time as the next digit of the final output.

```
Example:   1st Prime number = 2
           Cube root of 2 = 1.2599210498948731647672106073

           0.2599210498948731647672106073 * 16 =  4.1587367983179706362753697168
           0.1587367983179706362753697168 * 16 =  2.5397887730875301804059154688
           0.5397887730875301804059154688 * 16 =  8.636620369400482886494647501
           0.636620369400482886494647501  * 16 = 10.185925910407726183914360016
           0.185925910407726183914360016  * 16 =  2.974814566523618942629760256
           0.974814566523618942629760256  * 16 = 15.597033064377903082076164096
           0.597033064377903082076164096  * 16 =  9.552529030046449313218625536
           0.552529030046449313218625536  * 16 =  8.840464480743189011498008576
           0.840464480743189011498008576  * 16 = 13.447431691891024183968137216
           0.447431691891024183968137216  * 16 =  7.158907070256386943490195456
           0.158907070256386943490195456  * 16 =  2.542513124102191095843127296
           0.542513124102191095843127296  * 16 =  8.680209985635057533490036736
           0.680209985635057533490036736  * 16 = 10.883359770160920535840587776
           0.883359770160920535840587776  * 16 = 14.133756322574728573449404416
           0.133756322574728573449404416  * 16 =  2.140101161195657175190470656
           0.140101161195657175190470656  * 16 =  2.241618579130514803047530496

           The hex representation of the fractional part of the
           CUBE ROOTS of 2 is:   428a2f98d728ae22


Example:   1st Prime number = 2
           Square root of 2 = 1.4142135623730950488016887242

           0.4142135623730950488016887242 * 16 =  6.6274169979695207808270195872
           0.6274169979695207808270195872 * 16 = 10.0386719675123324932323133395
           0.038671967512332493232313395  * 16 =  0.618751480197319891717014320
           0.61875148019731989171701432   * 16 =  9.90002368315711826747222912
           0.90002368315711826747222912   * 16 = 14.40037893051389227955566592
           0.40037893051389227955566592   * 16 =  6.40606288822227647289065472
           0.40606288822227647289065472   * 16 =  6.49700621155642356625047552
           0.49700621155642356625047552   * 16 =  7.95209938490277706000760832
           0.95209938490277706000760832   * 16 = 15.23359015844443296012173312
           0.23359015844443296012173312   * 16 =  3.73744253511092736194772992
           0.73744253511092736194772992   * 16 = 11.79908056177483779116367872
           0.79908056177483779116367872   * 16 = 12.78528898839740465861885952
           0.78528898839740465861885952   * 16 = 12.56462381435847453790175232
           0.56462381435847453790175232   * 16 =  9.03398102973559260642803712
           0.03398102973559260642803712   * 16 =  0.54369647576948170284859392
           0.54369647576948170284859392   * 16 =  8.69914361231170724557750272

           The hex representation of the fractional part of the
           SQUARE ROOTS of 2 is:   6a09e667f3bcc908


SHA-512 Work array:

These words were obtained by taking the first sixty-four bits of the fractional
parts of the SQUARE ROOTS of the first 8 prime numbers.


SHA-384 Work array:

These words were obtained by taking the first sixty-four bits of the fractional
parts of the SQUARE ROOTS of the 9th through 16th prime numbers.


Data for constants array:

SHA-384 and SHA-512 use the first sixty-four bits of the fractional part of the
CUBE ROOTS of the first 80 prime numbers.


Test data was obtained from the following:

    FIPS 180-2 (Federal Information Processing Standards Publication)
    http://www.aarongifford.com/computers/sha.html
    All other test data is of my choosing.

==============================================================================

' ***************************************************************************
' Enumerations
' ***************************************************************************
  Public Enum enumHASH_ALGORITHM
```

```
      eHASH_SHA1        ' 0
      eHASH_SHA224      ' 1
      eHASH_SHA256      ' 2
      eHASH_SHA384      ' 3
      eHASH_SHA512      ' 4
      eHASH_SHA512_224  ' 5  As per FIPS 180-4 (dtd March-2012)
      eHASH_SHA512_256  ' 6  As per FIPS 180-4 (dtd March-2012)
  End Enum

' ****************************************************************************
' ****                       Properties                                   ****
' ****************************************************************************
  Version - Output - String - Name of DLL and version information

  StopProcessing - Input/Output - Boolean data to designate if the user has
            opted to stop the processing.
            Syntax:  X.StopPressed = TRUE         (Input)
                     Debug.Print X.StopPressed    (Output)

  HashMethod - Input only - [OPTIONAL] Long integer (0-12) designating what
            hash algorithm to use. See enumHASH_ALGORITHM

  HashRounds - Input only - [OPTIONAL] Long integer (0-10) designating number
            of hashing iterations to be performed.


' ****************************************************************************
' ****                       Methods                                      ****
' ****************************************************************************
' Creates a hash output string based on string data input.
Function HashString(ByRef abytInput() As Byte) As Variant

' Just the path and filename are passed in the byte array.
' The HashFile routine will open and read the file into
' another byte array prior to performing the hash.
Function HashFile(ByRef abytInput() As Byte) As Variant
```

```
=================================================================
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                                                 kenaso@tx.rr.com
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```

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