Function MachineDoubleEpsi()
' MachineDoubleEpsi: obtain DP machine characteristics in VBA6/7
Copyright (C) 2011, Georg Stroehlein, Iserlohn, Germany; drgst (at) web (dot) de
version: 2.5.6, first public release

usage: 1.) copy the text found on the first six pages of this document
      into a standard text file and then import that as a VBA module.
      2.) mark 13 cells in a row, then type "=MachineDoubleEpsi()"
      (without quotation marks) and finally [CTRL][SHIFT][ENTER]

Sample output (between >>...<<) created with XL2002/WinXP32 on a German i5 machine:
  ibeta  it  irnd  ngrd  machep  negep  iexp  minexp  maxexp  eps  ...
>>  2  53  5  0  -52  -53  11  -1022  1024  2,22045E-16  ...
  epsneg  xmin  xmax
  1,11022E-16  2,251E-308  1,7977E+308<<

You might want to copy the items given above this sample output into a block of
13 cells in a single row in your worksheet.

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R8_MACHAR determines double precision real machine constants.

Discussion:

This routine determines the parameters of the double precision
real arithmetic system. The determination of the first
three uses an extension of an algorithm due to Malcolm,
incorporating some of the improvements suggested by Gentleman and
Marovich.

This routine appeared as ACM algorithm 665.

An earlier version of this program was published in Cody and Waite.

Modified:
  11 November 2006

Author:
  William Cody
  MATLAB version by John Burkardt

Reference:
  William Cody,
  ACM Algorithm 665, MACHAR, a routine to dynamically determine
  machine parameters,
  ACM Transactions on Mathematical Software,
Parameters:

Output, integer IBETA, the radix for the floating-point representation.

Output, integer IT, the number of base IBETA digits in the floating-point significand.

Output, integer IRND:
   0, if floating-point addition chops.
   1, if floating-point addition rounds, but not in the IEEE style.
   2, if floating-point addition rounds in the IEEE style.
   3, if floating-point addition chops, and there is partial underflow.
   4, if floating-point addition rounds, but not in the IEEE style, and there is partial underflow.
   5, if floating-point addition rounds in the IEEE style, and there is partial underflow.

Output, integer NGRD, the number of guard digits for multiplication with truncating arithmetic. It is
   0, if floating-point arithmetic rounds, or if it truncates and only IT base IBETA digits participate in the post-normalization shift of the floating-point significand in multiplication;
   1, if floating-point arithmetic truncates and more than IT base IBETA digits participate in the post-normalization shift of the floating-point significand in multiplication.

Output, integer MACHEP, the largest negative integer such that
   1.0 < 1.0 + real ( IBETA )^MACHEP,
except that MACHEP is bounded below by - ( IT + 3 ).

Output, integer NEGEPS, the largest negative integer such that
   1.0 - real ( IBETA )^NEGEPS < 1.0,
except that NEGEPS is bounded below by - ( IT + 3 ).

Output, integer IEXP, the number of bits (decimal places if IBETA = 10) reserved for the representation of the exponent (including the bias or sign) of a floating-point number.

Output, integer MINEXP, the largest in magnitude negative integer such that
   real ( IBETA )^MINEXP
is positive and normalized.

Output, integer MAXEXP, the smallest positive power of BETA that overflows.

Output, real EPS, the smallest positive floating-point number such that
   1.0 + EPS ~= 1.0.
in particular, if either IBETA = 2 or IRND = 0,
   EPS = real ( IBETA )^MACHEP.
Otherwise,
\[ \text{EPS} = \left( \text{real} \left( \text{IBETA} \right) \right)^{\text{MACHEP}} / 2. \]

Output, real EPSNEG, a small positive floating-point number such that
\[ 1.0 - \text{EPSNEG} < 1.0. \]
In particular, if IBETA = 2 or IRND = 0,
\[ \text{EPSNEG} = \text{real} \left( \text{IBETA} \right)^{\text{NEGEPS}}. \]
Otherwise,
\[ \text{EPSNEG} = \left( \text{real} \left( \text{IBETA} \right) \right)^{\text{NEGEPS}} / 2. \]
Because NEGEPS is bounded below by \(- (\text{IT} + 3)\), EPSNEG might not be the smallest number that can alter 1.0 by subtraction.

Output, real XMIN, the smallest non-vanishing normalized floating-point power of the radix:
\[ \text{XMIN} = \text{real} \left( \text{IBETA} \right)^{\text{MINEXP}} \]

Output, real XMAX, the largest finite floating-point number. In particular,
\[ \text{XMAX} = (1.0 - \text{EPSNEG}) \times \text{real} \left( \text{IBETA} \right)^{\text{MAXEXP}} \]
On some machines, the computed value of XMAX will be only the second, or perhaps third, largest number, being too small by 1 or 2 units in the last digit of the significand.

\textbf{function r8_machar( ibeta, it, irnd, ngrd, machep, negep, iexp, minexp, maxexp, eps, epsneg, xmin, xmax )}

\textbf{Dim ibeta As Long, it As Long, irnd As Long, ngrd As Long}
\textbf{Dim machep As Long, negep As Long, iexp As Long, minexp As Long, maxexp As Long}
\textbf{Dim itemp As Long, i As Long, iz As Long, j As Long, k As Long, mx As Long, nxres As Long}
\textbf{Dim eps As Double, epsneg As Double, xmin As Double, xmax As Double}
\textbf{Dim a As Double, b As Double, one As Double, two As Double, zero As Double}
\textbf{Dim temp As Double, temp1 As Double, beta As Double, betah As Double, betain As Double}
\textbf{Dim t As Double, tempa As Double, y As Double, z As Double}
\textbf{Dim result(13)}
\textbf{one = 1#}
\textbf{two = one + one}
\textbf{zero = one - one}

' Determine IBETA and BETA ala Malcolm.
\textbf{a = one}
\textbf{Do}
\textbf{a = a + a}
\textbf{temp = a + one}
\textbf{temp1 = temp - a}
\textbf{If (temp1 - one <> zero) Then}
\textbf{End If}
\textbf{Loop While True}

\textbf{b = one}
\textbf{Do}
\textbf{b = b + b}
\textbf{temp = a + b}
\textbf{itemp = Fix(temp - a)}
\textbf{If (itemp <> 0) Then}
\textbf{End If}
\textbf{Loop While True}

\textbf{ibeta = itemp}
\textbf{beta = ibeta}
' Determine IT and IRND.
it = 0
b = one
Do
    it = it + 1
    b = b * beta
    temp = b + one
    temp1 = temp - b
    If (temp1 - one <> zero) Then
        Exit Do
    End If
Loop While True
irnd = 0
betah = beta / two
temp = a + betah
If (temp - a <> zero) Then
    irnd = 1
End If
tempa = a + beta
temp = tempa + betah
If (irnd = 0 And temp - tempa <> zero) Then
    irnd = 2
End If

' Determine NEGEP and EPSNEG.
negep = it + 3
betain = one / beta
a = one
For i = 1 To negep
    a = a * betain
Next i
b = a
Do
    temp = one - a
    If (temp - one <> zero) Then
        Exit Do
    End If
    a = a * beta
    negep = negep - 1
Loop While True
negep = -negep
epsneg = a
If (i * beta <> 2 And irnd <> 0) Then
    a = (a * (one + a)) / two
    temp = one - a
    If (temp - one <> zero) Then
        epsneg = a
    End If
End If

' Determine MACHEP and EPS.
machep = -it - 3
a = b
Do
    temp = one + a
    If (temp - one <> zero) Then
        Exit Do
    End If
    a = a * beta
    machep = machep + 1
Loop While True
eps = a
temp = tempa + beta * (one + eps)
If (i * beta <> 2 And irnd <> 0) Then
    a = (a * (one + a)) / two
    temp = one + a
    If (temp - one <> zero) Then
        eps = a
    End If
End If
Determine NGRD.

ngrd = 0
temp = one + eps
If (irnd = 0 And temp * one - one <> zero) Then
    ngrd = 1
End If

Determine IEXP, MINEXP and XMIN.

Loop to determine largest I and K = 2^I such that (1/BETA)^(2^(I))
does not underflow. Exit from loop is signaled by an underflow.
i = 0
k = 1
z = betain
t = one + eps
nxres = 0
Do
    y = z
    z = y * y
    a = z * one
    temp = z * t
    If (a + a = zero Or y <= Abs(z)) Then
        Exit Do
    End If
    temp1 = temp * betain
    If (temp1 * beta = z) Then
        Exit Do
    End If
    i = i + 1
    k = k + k
Loop While True

If (ibeta <> 10) Then
    ' This segment is for nondecimal machines.
    iexp = i + 1
    mx = k + k
Else
    ' This segment is for decimal machines only.
    iexp = 2
    iz = ibeta
    Do
        If (k < iz) Then
            Exit Do
        End If
        iz = iz * ibeta
        iexp = iexp + 1
    Loop While True
    mx = iz + iz - 1
End If

Loop to determine MINEXP, XMIN.

' Exit from loop is signaled by an underflow.
xmin = y
y = y * betain
a = y * one
temp = y * t
If (a + a = zero Or xmin <= Abs(y)) Then
    Exit Do
End If
k = k + 1
temp1 = temp * betain
If (temp1 * beta = y) Then
    nxres = 3
    xmin = y
    Exit Do
End If
Loop While True

minexp = -k
' Determine MAXEXP and XMAX.
If (mx <= k + k - 3 And ibeta <> 10) Then
    mx = mx + mx
    iexp = iexp + 1
End If
maxexp = mx + minexp

' Adjust IRND to reflect partial underflow.
irnd = irnd + nxres

' Adjust for IEEE-style machines.
If (irnd = 2 Or irnd = 5) Then
    maxexp = maxexp - 2
End If

' Adjust for non-IEEE machines with partial underflow.
If (irnd = 3 Or irnd = 4) Then
    maxexp = maxexp - it
End If

' Adjust for machines with implicit leading bit in binary significand,
' and machines with radix point at extreme right of significand.
i = maxexp + minexp
If (ibeta = 2 And i = 0) Then
    maxexp = maxexp - 1
End If
If (20 < i) Then
    maxexp = maxexp - 1
End If
If (a <> y) Then
    maxexp = maxexp - 2
End If
xmax = one - epsneg
If (xmax * one <> xmax) Then
    xmax = one - beta * epsneg
End If
xmax = xmax / (beta * beta * beta * xmin)
i = maxexp + minexp + 3
For j = 1 To i
    If (ibeta = 2) Then
        xmax = xmax + xmax
    Else
        xmax = xmax * beta
    End If
Next j

' putting it all together into an array
result(0) = ibeta
result(1) = it
result(2) = irnd
result(3) = ngrd
result(4) = machep
result(5) = negep
result(6) = iexp
result(7) = minexp
result(8) = maxexp
result(9) = eps
result(10) = epsneg
result(11) = xmin
result(12) = xmax

MachineDoubleEpsi = result()

End Function
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