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Solutions for a Quadratic Equation

Executable Division

The operation q = z/n has to be executed.

Here we assume for the moment $z \geq 0$ and $n \geq 0$.

Let m be the largest absolute value of any real value in floating point format,

e.g. $m = max_2 = 1E4932$ for Intel FPUs, using the internal 10 byte format.

The actually used value (program below) may be smaller.

For IEEE single precision we have $max_2 = 1E38$ (e.g. for PostScript).

For $n \geq 1$ the division is always executable.

For $n < 1$ the division is executable if $z/n < m$.

This can be checked without division by $z < m \cdot n$.

If this inequality is false, then the division is not executable.

This doc:

http://docs-hoffmann.de/quadequ04062002.pdf

```
Procedure QuadEqu (p2,p1,p0: Single; Var r1,r2,i1,i2: Single; Var flag:Integer);
{ QuadEqu p2*x^2+p1*x+p0=0, Solution x1=r1+j*i1; x2=r2+j*i2              }
{ Flag 2: 2 Sol.; -2: 2 complex Sol.; 1: 1 real Sol.; 0: No Sol.        }
{ x=-0.5*p1/p2+-Sqrt[(0.5*p1/p2)^2-(p0/p2)]                             }
{ Starting by x1:=0+0*j; x2:=0+0*j                                      }
Const   max1=1E38; { for Single }
        max2=1E19;
Var     ap0,ap1,ap2,rak,sig: Single;
Begin
flag:=0; r1:=0; r2:=0; i1:=0; i2:=0;
ap0:=Abs(p0); ap1:=Abs(p1); ap2:=Abs(p2);
If (ap2>=1) Then flag:=2
    Else If (ap1<2*ap2*max1) And (ap0<ap2*max2) Then flag:=2
    Else If (ap1>=1)                            Then flag:=1
    Else If (ap0<ap1*max2)                      Then flag:=1;
Case flag Of
2:  Begin
    sig:=-0.5*p1/p2; rak:=Sqr(sig)-p0/p2;
    If rak>0 Then Begin r1:=sig+Sqrt(rak); r2:=sig-Sqrt(rak);          End Else
    If rak<0 Then Begin r1:=sig;r2:=r1; i1:=Sqrt(-rak);i2:=-i1; flag:=-2;  End Else
    { If rak=0 Then}Begin r1:=sig; r2:=r1; End;
    End;
1:  r1:=-p0/p1;
End;
End;
```

Quadratic Equation / Algebraic Solution

$$p_2 \cdot x^2 + p_1 \cdot x + p_0 = 0$$

$$x_{1/2} = -0.5 \cdot p_1/p_2 \pm \mathrm{Sqrt}\left((0.5 \cdot p_1/p_2)^2 - p_0/p_2 \right)$$

$$x_1 = r_1 + j \cdot i_1$$
$$x_2 = r_2 + j \cdot i_2$$

Quadratic Equation / Structogram

$r_1 = 0 \quad r_2 = 0 \quad i_1 = 0 \quad i_2 = 0$

$m_2 = m$ (for actual format) $\quad m_1 = \mathrm{Sqrt}(m_2)$

$a_2 = \mathrm{Abs}(p_2) \quad a_1 = \mathrm{Abs}(p_1) \quad a_0 = \mathrm{Abs}(p_0)$

$a_2 \geq 1$?

Yes	No			
	$a_1 < 2 \cdot a_2 \cdot m_1$?			
	Yes			No
	$a_0 < a_2 \cdot m_2$?			
	Yes	No		
		$a_1 \geq 1$?		
		Yes	No	
			$a_0 < a_1 \cdot m_2$?	
			Yes	No

$s = -0.5 \cdot p_1/p_2$

$r = s^2 - p_0/p_2$

$t = \mathrm{Sqrt}(\,\mathrm{Abs}(r)\,)$

$r \geq 0$?

Yes	No	$r_1 = -p_0/p_1$	
$r_1 = s + t$ $r_2 = s - t$	$r_1 = s$ $r_2 = s$ $i_1 = +t$ $i_2 = -t$		
flag = +2	flag = -2	flag = +1	flag = 0
2 real solutions	2 complex	1 real	None