
Algorithm 1 A Basic Multiplication Algorithm Based on Classic Decimal Multiplication

```
for  $i = 0; i < 32; i++$  do  
  if  $multiplier_0 == 1$  then  
     $product \leftarrow product + multiplicand$   
  end if  
   $multiplicand \leftarrow multiplicand \ll 1$   
   $multiplier \leftarrow multiplier \gg 1$   
end for
```

Algorithm 2 An Improved Algorithm that Adds to the Left Half of the 64-bit Product Register and Shifts into Place on the Right Half so that a 32-bit ALU Can be Used

```
for  $i = 0; i < 32; i++$  do
    if  $multiplier_0 == 1$  then
         $product_{63:32} \leftarrow product_{63:32} + multiplicand$ 
    end if
     $product \leftarrow product \gg 1$ 
     $multiplier \leftarrow multiplier \gg 1$ 
end for
```

Algorithm 3 A Further Improved Algorithm that Utilizes the Unused Right Half of the 64-bit Product Register (which will be shifted out of the register) as the Multiplier (eliminating a register)

```
product31:0  $\leftarrow$  multiplier
for  $i = 0; i < 32; i++$  do
  if product0 == 1 then
    product63:32  $\leftarrow$  product63:32 + multiplicand
  end if
  product  $\leftarrow$  product >> 1
end for
```

Algorithm 4 A Binary Integer Division Algorithm

```
remainder  $\leftarrow$  dividend
divisor  $\leftarrow$  divisor  $\ll$  32
for  $i = 0; i < 33; i++$  do
    remainder  $\leftarrow$  remainder  $-$  divisor
    if remainder  $\geq 0$  then
        quotient  $\leftarrow$  quotient  $\ll$  1
        quotient0  $\leftarrow$  1
    else
        remainder  $\leftarrow$  remainder  $+$  divisor
        quotient  $\leftarrow$  quotient  $\ll$  1
        quotient0  $\leftarrow$  0
    end if
    divisor  $\leftarrow$  divisor  $\gg$  1
end for
```

Algorithm 5 An Improved Binary Integer Division Algorithm Using a 32-bit ALU and that Uses the Unused Left Half of the Remainder as the Dividend, Placing the Remainder in the Left Half of the Remainder Register, and the Quotient in the Right Half of the Remainder Register

```

remainder63:32  $\leftarrow$  dividend
remainder  $\leftarrow$  remainder  $\ll$  1
for  $i = 0; i < 32; i++$  do
    remainder63:32  $\leftarrow$  remainder63:32 - divisor
    if remainder  $\geq 0$  then
        remainder  $\leftarrow$  remainder  $\ll$  1
        remainder0  $\leftarrow$  1
    else
        remainder63:32  $\leftarrow$  remainder63:32 + divisor
        remainder  $\leftarrow$  remainder  $\ll$  1
        remainder0  $\leftarrow$  0
    end if
end for
remainder63:32  $\leftarrow$  remainder63:32  $\gg$  1

```
