
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

```
remainder63:32  $\leftarrow$  dividend  
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

```
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  
  remainder63:32  $\leftarrow$  remainder63:32  $\gg$  1  
end for
```
