Division with Large Numbers

The program BIGDIV is for dividing very large numbers that your calculator could not handle otherwise; for example, numbers with divisors, dividends or quotients containing as many as 200 digits. It does so by using matrices and processing with groups of four digits in each cell (thus allowing plenty of room for carrying). One exception the first group in the dividend (or numerator) is a double group; that is, a group with 5 to 8 digits, thus insuring that the first group division will produce a partial quotient.

Here is the form of the division

\[
\begin{array}{c}
\text{Q} \\
\text{D) N} \\
\text{P} \\
\text{R}
\end{array}
\]

The numbers appear as follows in the matrix

row 1 N
row 2 D
row 3 R
row 4 P
row 5 Q

PROGRAMBIGDIV

'Part I Getting Information into the Calculator'

"N"? → N
"D"? → D
"T"? → T

N is the number of dividend groups,
'D divisor groups, and T output groups

For 1 → I To N
"X"? → Mat A[1,I] 'Fill in the dividend groups
Next

Separately you must create a Matrix A with 5 rows and an adequate number of columns. This program is written to handle 20 column (up to 80 digit) input and output values.
For 1⇒I To D
  "Y"⇒Mat A[2,I]  'Fill in the divisor groups
Next

For 1⇒I To 20
  0⇒Mat A[3,I]  'These eleven lines zero the
  0⇒Mat A[4,I]  'remaining matrix entries in case
  0⇒Mat A[5,I]  'data remains from previous
Next
For N+1⇒I To 20
  0⇒Mat A[1,I]
Next
For D+1⇒I To 20
  0⇒Mat A[2,I]
Next

'Part 2 Processing

' It is important to understand that this process
'mirrors standard long division except as noted below,
'each group replacing a single digit in the usual
'algorithm.

1⇒J

For 1⇒I To D
Next  'the dividend to the remainder
  'differs from the usual algorithm but
  'only to make the first step in the
  'process like succeeding ones

Lbl 1

  'corresponds to the first step in the
  'usual long division algorithm
  'obtaining the first group in the
  'quotient

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Lbl 2

For I→1 To D
  Next
  'the divisor groups by the dividend group

  'These products will usually contain more than
  'four digits so it is necessary to carry extra
  'digits to the next group to the left. That is
  'the role of the next five lines.

For D→I To 2 Step -1
  Intg(Mat A[4,I]×10^-4)→C
  Next

  'Now recall how, in long division, your quotient
  'might have been too large and you had to reduce
  'it, returning to do the division again. The
  'following nine lines checks for this, sending
  'you on if there is no problem but reducing your
  'quotient and sending you back if there is.

For 1→I To D
    Then Goto 3
  IfEnd

    Then Mat A[5,J]-1→Mat A[5,J]
    Goto 2
  IfEnd

Next

Lbl 3

  'Here we check to see if we are done.
  J+1→J
  If J>T
    Then Goto 4  'where answers are printed out.
  IfEnd
At this point you have determined a correct quotient group and you are ready to move on to repeat the algorithm to determine subsequent groups. To do so you must determine the remainder left from your prior step and divide that by your divisor. The following six lines 'borrow if necessary to prepare for subtraction

For D→I To 2 Step -1
Then Mat A[3,I-1]-1→Mat A[3,I-1]
IfEnd
Next

Now we carry out the subtraction, but again in a minor difference from the usual algorithm, we shift the resulting groups to the left so that they fill the digits from the left (with the first group again with more than four digits)

→A[3,1]  'Obtaining the first 5-8 digit group
For 2→I To D-1)
Goto 1  'To repeat the algorithm steps.

Part 3 Print out the quotient.

Lbl 4

For 1→I To T
Mat A[5,I]  
Next
Stop
An Example

Suppose we wish to calculate to 24 digits accuracy the quotient of 1,413,121,110,987,654,321/123,456,789,100

First, we separate the dividend into four digit groups working from right to left and seeing to it that the leftmost group has more than four digits

1413121 1109 8765 4321

We do the same to the divisor

1234 5678 9100

We're now ready to run the program BIGDIV.

N= 4 'Number of groups in the dividend
D= 3 'Number of groups in the divisor
T= 6 'Number of groups in the quotient (24 digits)
X= 1413121
X= 1109
X= 8765
X= 4321
Y= 1234
Y= 5678
Y= 9100

'After calculating, the calculator will print:

1144
6281
938
8967
268
4453
Done

You must complete the four-digit groups with zeros (for example, 938 becomes 0938) and place the decimal point in the answer to give:

11,446,281.0938896702684453