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PROGRAM

Unsigned Multiply

TAPES

ASCII Source: 090-000020

ABSTRACT

This routine multiplies two unsigned, 16-bit numbers to form an unsigned 32-bit product.

1. REQUIREMENTS

1.1 Memory

1K or larger alterable memory

1.2 Equipment

NOVA central processor

1.3 External Subroutines

None

1.4 Other

None

2. OPERATING PROCEDURES

2.1 Calling Sequence

To multiply AC1 by AC2,

```
JSR  .MPYU
return
```

To multiply AC1 by AC2 and add the result to ACØ

```
JSR  .MPYA
return
```

2.2 Input Format

The unsigned multiplicand is passed in AC2, the multiplier in AC1. If entry is made to .MPYA, the product is added to the contents of ACØ to form the final result.

2.3 Output Format

The 32-bit result will be returned in ACØ, AC1 (high order, low order).

2.4 Error Returns

None

2.5 State of Active Registers upon Exit

AC2 and Carry remain unchanged. ACØ, AC1, and AC3 are destroyed.

2.6 Cautions to User

None

3. DISCUSSION

3.1 Algorithms

The unsigned multiply routine performs 16 iterations to form the 32-bit product. At each step, a bit of the multiplier is examined. If the bit is a 1, the multiplicand is added to a running partial sum and the sum is shifted right one position. If the bit is a Ø, the partial sum is merely shifted right.

3.2 Limitations and Accuracy

The routine is exact.

3.3 Size and Timing

Unsigned multiply is 14 (octal) words in length.

Average execution time is 340 μ seconds.

3.4 References

Section 2.2 of "How to Use the NOVA" contains a further discussion of unsigned multiply.

3.5 Flow Diagrams

Not applicable.

4. EXAMPLES AND APPLICATIONS

The source tape of .MPYU is provided with the NOVA software. This tape can be directly edited into user programs that require unsigned multiply.

This routine is called by a number of other programs in the Math Library.

5. PROGRAM LISTING

A listing of .MPYU follows. No origin is given in the source, enabling the user to edit this subroutine anywhere within his programs.

```
                        ; UNSIGNED MULTIPLY
                        ; MULTIPLIES TWO UNSIGNED, FIXED POINT, SINGLE
                        ;       PRECISION NUMBERS

                        ; INPUT:          N1 IN AC1, N2 IN AC2

                        ; OUTPUT:         N1*N2, HIGH ORDER IN ACØ, LOW ORDER IN
                        ;                 AC1

                        ; CALLING SEQUENCE:
                        ;       JSR     .MPYU
                        ;       RETURN

                        ; INPUT:          NØ IN ACØ, N1 IN AC1, N2 IN AC2

                        ; OUTPUT:         NØ + N1*N2, HIGH ORDER IN ACØ, LOW
                        ;                 ORDER IN AC1

                        ; CALLING SEQUENCE
                        ;       JSR     .MPYA
                        ;       RETURN

                        ; DESTROYED:      ACØ, AC1, AC3
                        ; UNCHANGED:      AC2, CARRY
                        ;

ØØØØØ 1Ø246Ø .MPYU:  SUBC Ø,Ø          ; CLEAR ACO, DON'T DISTURB
                                       ; CARRY
ØØØØ1 Ø54Ø12 .MPYA:  STA 3,.CBØ3       ; SAVE AC3
ØØØØ2 Ø34Ø13         LDA 3,.CB2Ø       ; 16 TIMES THRU LOOP
ØØØØ3 1252Ø3 .CB99:  MOVR 1,1,SNC      ; CHECK NEXT MULTIPLIER BIT
ØØØØ4 1Ø12Ø1         MOVR Ø,Ø,SKP      ; Ø, JUST SHIFT
ØØØØ5 14322Ø         ADDZR 2,Ø         ; 1, ADD MULTIPLICAND AND SHIFT
ØØØØ6 1754Ø4         INC 3,3,SZR       ; CHECK FOR 16TH TIME THRU
ØØØØ7 ØØØØØ3         JMP .CB99         ; NO, CONTINUE
ØØØ1Ø 12526Ø         MOVCR 1,1         ; YES, SHIFT LAST LOW BIT
                                       ; (NOTE IT WAS COMPLEMENTED BY
                                       ; FINAL INC)
ØØØ11 ØØ2Ø12         JMP @.CBØ3        ; RETURN

ØØØ12 ØØØØØØ .CBØ3:  Ø                 ; RETURN ADDRESS

ØØØ13 17776Ø .CB2Ø:  -2Ø               ; -16 DECIMAL
```