```
*  TSC FLOATING POINT PACKAGE
*  VER 2.3
*
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*    TECHNICAL SYSTEMS CONSULTANTS
*    BOX 2574  W. LAFAYETTE IN.  47906
*
*     THE TSC FLOATING POINT PACKAGE PROVIDES
* THE BASIC ARITHMETIC FUNCTIONS ADD, SUBTRACT,
* MULTIPLY, AND DIVIDE.  THE NORMALIZED
* FORM OF THE X AND Y OPERANDS IS A MIXED
* FORMAT.  THE MANTISSA IS SIGN PLUS MAGNI-
* TUDE PACKED BCD NOTATION.  THIS IMPLIES
* THAT THE SIGN BYTE (XSIGN OR YSIGN) IS
* EITHER ALL ZEROS FOR POSITIVE OR ALL ONES
* FOR NEGATIVE.  THE MANTISSA ITSELF (XOP OR
* YOP) IS VIEWED AS BEING A 9 DIGIT FRAC-
* TIONAL NUMBER WITH A ZERO TO THE LEFT OF
* THE DECIMAL POINT (IN THE UPPER HALF OF THE
* MOST SIGNIFICANT BYTE OF XOP OR YOP).  THIS
* IS DONE TO SIMPLIFY THE ARITHMETIC AND NOR-
* MALIZATION OPERATIONS.  PACKED BCD IMPLIES
* THAT THERE ARE 2 BCD DIGITS PER BYTE.
*     THE EXPONENT IS AN 8 BIT 2'S COMPLEMENT
* NUMBER WITH A RANGE OF +128 TO -127.  HOW-
* EVER, BECAUSE OF THE WAY IN WHICH THE
* MULTIPLY, DIVIDE, AND NORMALIZE OPERATIONS
* ARE DONE THE PRACTICAL RANGE IS SLIGHTLY
* SMALLER.  ONE CAN TOTALLY AVOID DEALING
* WITH THIS PROBLEM BY RESTRICTING THE EX-
* PONENT RANGE TO +99 AND -99.  THIS SHOULD
* NOT PROVE TO BE AN UNREASONABLE CONSTRAINT.
*     THE RESULT OF ALL ARITHMETIC OPERATIONS
* IS RETURNED IN NORMALIZED FORM WITH THE SIGN
* IN RSIGN, THE MANTISSA IN FPAC, AND THE
* EXPONENT IN ACEXP.
*     EXAMPLES OF THE NORMALIZED FORM ARE GIVEN
* BELOW:
*       NUMBER      SIGN    MANTISSA  EXPONENT
*    +100            00    0100000000   03
*    -1163.12        FF    0116312000   04
*    +0.125          00    0125000000   00
*    +0.000213       00    0213000000   FD
*    -0.000213       FF    0213000000   FD
*
*     THIS PACKAGE CONTAINS SUBOUTINES ONLY.
* AN EXTERNAL DRIVER PROGRAM MUST BE USED TO
* EXERCISE THEM.  THE ROUTINE ADDRESSES
* ARE GIVEN BELOW:
*   OPERATION    NAME      ADDRESS
*    ADD         FPADD       0103
*    SUBTRACT    FPSUB       0100
*    MULTIPLY    FPMUL       0180
```

```
                    *    DIVIDE      FPDIV       0194
                    *
                    *
                    *
                    *
                    * STORAGE SPACE
0020                      ORG    $20
0020                RSIGN RMB    1          RESULT SIGN BYTE
0021                FPAC  RMB    5          FLOATING POINT ACCUMULATOR
0026                ACEXP RMB    1          ACCUMULATOR EXPONENT
0027                FPMQ  RMB    5          FLOATING POINT MQ REGISTER
002C                XSIGN RMB    1          X SIGN BYTE
002D                XOP   RMB    5          X OPERAND MANTISSA
0032                XEX   RMB    1          X OPERAND EXPONENT
0033                YSIGN RMB    1          Y SIGN BYTE
0034                YOP   RMB    5          Y OPERAND MANTISSA
0039                YEX   RMB    1          Y OPERAND EXPONENT
003A                OVFL  RMB    1
003B                ATEMP RMB    1
003C                ATEMP2 RMB   1
003D                BTEMP RMB    1
003E                BTEMP2 RMB   1
003F                XTEMP RMB    2          TEMPORARY X STORAGE
0041                XTEMP2 RMB   2
                    *
0005                BC    EQU    05         OPERAND BYTE COUNT
                    *
0100                      ORG    $100
                    *
                    *
                    *FPSUB
                    * FLOATING POINT SUBTRACT
                    * SUBTRACTS YOP*YEX FROM XOP*XEX
0100 73 00 33       FPSUB   COM    YSIGN      CHANGE SIGN
                    *  GO INTO FPADD
                    *
                    *FPADD
                    * FLOATING POINT ADD ROUTINE
                    * ADDS YOP*YEX TO XOP*XEX
0103 8D 71          FPADD   BSR    SETSIN     SET SIGN HOLDER
0105 BD 02 CB             JSR    EXPADJ     ADJUST EXPONENTS
0108 CE 00 21             LDX    #FPAC
010B BD 02 5B             JSR    XOPTOX     MOVE XOP TO FPAC
010E CE 00 21             LDX    #FPAC
0111 BD 02 75             JSR    ZCHK       CHECK XOP FOR =0
0114 27 1D                BEQ    FPAD01
0116 CE 00 34             LDX    #YOP
0119 BD 02 75             JSR    ZCHK       CHECK YOP FOR =0
011C 27 19                BEQ    FPADD1
011E 96 20                LDA A  RSIGN
0120 2A 15                BPL    FPADD1     USE EITHER SIGN
0122 BD 01 C7             JSR    BCDSUB     SUBTRACT
0125 25 10                BCS    FPADD1     USE X SIGN
0127 CE 00 34             LDX    #YOP       POINT TO YOP
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012A BD 02 AB           JSR     LTC         RECOMPLEMENT YOP
012D CE 00 2D           LDX     #XOP
0130 BD 02 AB           JSR     LTC         COMPLEMENT XOP
0133 96 33      FPAD01  LDA A   YSIGN       USE Y SIGN
0135 20 02              BRA     FPADD2
0137 96 2C      FPADD1  LDA A   XSIGN
0139 97 20      FPADD2  STA A   RSIGN
013B CE 00 21   FPAD21  LDX     #FPAC
013E BD 02 5B           JSR     XOPTOX      MOVE XOP TO FPAC
0141 BD 01 CD           JSR     BCDADD      ADD
0144 CE 00 27           LDX     #FPMQ
0147 BD 02 80           JSR     CLROP       CLEAR THE MQ
                * GO INTO NORM
                *
                *NORM
                * NORMALIZE FLOATING POINT RESULTS
                * MQ MUST CONTAIN VALID DATA
014A CE 00 21   NORM    LDX     #FPAC
014D BD 02 75           JSR     ZCHK        CHECK FOR ZERO
0150 26 07              BNE     NORM2
0152 7F 00 26           CLR     ACEXP
0155 7F 00 20           CLR     RSIGN
0158 39                 RTS
0159 CE 00 21   NORM2   LDX     #FPAC
015C A6 00              LDA A   0,X
015E 27 0C              BEQ     NORM3
0160 84 F0              AND A   #$F0
0162 27 1B              BEQ     SETSI1
0164 7C 00 26           INC     ACEXP
0167 29 5A              BVS     FPDIV3      CHECK FOR OVERFLOW
0169 7E 02 2F           JMP     EL4RR
016C BD 02 45   NORM3   JSR     EL4RL
016F 7A 00 26           DEC     ACEXP
0172 29 4F              BVS     FPDIV3      CHECK FOR OVERFLOW
0174 20 E3              BRA     NORM2
                *
                *SETSIN
                * CALCULATE XSIGN.XOR.YSIGN
                * STORE IN RSIGN
0176 96 2C      SETSIN  LDA A   XSIGN
0178 98 33              EOR A   YSIGN
017A 97 20              STA A   RSIGN
017C 7F 00 3A           CLR     OVFL
017F 39         SETSI1  RTS
                *
                *
                *FPMUL
                * FLOATING POINT MULTIPLY ROUTINE
                * MULTIPLIES XOP*XEX BY YOP*YEX
                * TRUNCATES PRODUCT TO BC*2-1 BCD DIGITS
0180 8D F4      FPMUL   BSR     SETSIN      STORE OPERAND SIGNS
0182 96 32              LDA A   XEX
0184 9B 39              ADD A   YEX         CALCULATE EXPONENT
0186 29 3B              BVS     FPDIV3      CHECK FOR OVERFLOW
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0188 97 26              STA A  ACEXP     SAVE EXPONENT
018A CE 00 27           LDX    #FPMQ
018D BD 02 5B           JSR    XOPTOX    MOVE XOP TO MQ
0190 8D 50              BSR    BCDMUL    MULTIPLY
0192 20 B6              BRA    NORM
                *
                *FPDIV
                *FLOATING POINT DIVIDE ROUTINE
                *DIVIDES XOP*XEX BY YOP*YEX
                *TRUNCATES THE REMAINDER
0194 8D E0      FPDIV   BSR    SETSIN    STORE SIGNS
0196 96 32              LDA A  XEX
0198 90 39              SUB A  YEX       CALCULATE EXPONENT
019A 29 27              BVS    FPDIV3    CHECK FOR OVERFLOW
019C CE 00 21           LDX    #FPAC
019F BD 02 5B           JSR    XOPTOX    MOVE XOP TO THE AC
01A2 CE 00 27           LDX    #FPMQ
01A5 BD 02 80           JSR    CLROP     CLEAR THE MQ
01A8 BD 02 2F           JSR    EL4RR     SHIFT ACMQ TO AVOID OVFL
01AB 4C                 INC A            COMPENSATE EXPONENT
01AC 29 15              BVS    FPDIV3    CHECK FOR OVERFLOW
01AE 97 26              STA A  ACEXP     STORE EXPONENT
01B0 8D 4B              BSR    BCDDIV    DIVIDE
01B2 25 0F              BCS    FPDIV3    CHECK FOR OVERFLOW
01B4 C6 05              LDA B  #BC
01B6 CE 00 21           LDX    #FPAC
01B9 A6 06      FPDIV1  LDA A  BC+1,X
01BB A7 00              STA A  0,X       MOVE QUOTIENT TO THE AC
01BD 08                 INX
01BE 5A                 DEC B
01BF 26 F8              BNE    FPDIV1
01C1 20 87              BRA    NORM
01C3 73 00 3A   FPDIV3  COM    OVFL
01C6 39                 RTS
                *
                *BCDSUB
                * SUBTRACTS YOP FROM FPAC
01C7 CE 00 34   BCDSUB  LDX    #YOP
01CA BD 02 AB           JSR    LTC       TAKE TENS COMP
                *    GO INTO BCDADD
                *
                *BCDADD
                * ADDS YOP TO FPAC
                * USES ZERO INITIAL CARRY
01CD 8D 59      BCDADD  BSR    SAVREG    SAVE REGISTER CONTENTS
01CF CE 00 21           LDX    #FPAC
01D2 0C                 CLC
01D3 C6 05              LDA B  #BC       SET COUNTER
01D5 A6 04      BCDAD1  LDA A  BC-1,X
01D7 A9 17              ADC A  BC*4+3,X
01D9 19                 DAA              ADJUST FOR BCD
01DA A7 04              STA A  BC-1,X
01DC 09                 DEX
01DD 5A                 DEC B            ONCE DONE
```

```
01DE 26 F5              BNE     BCDAD1
01E0 20 40              BRA     RSTREG      RESTORE REGISTERS
                *
                *BCDMUL
                * MULTIPLIES FPMQ BY YOP
                * ANSWER IN FPAC AND FPMQ
01E2 CE 00 21   BCDMUL  LDX     #FPAC
01E5 BD 02 80           JSR     CLROP       CLEAR FPAC
01E8 C6 09              LDA B   #BC*2-1     SET CTR
01EA 96 2B      BCDMU1  LDA A   FPMQ+BC-1 GET LS BYTE
01EC 84 0F              AND A   #$0F        MASK OFF LS BCD
01EE 27 07              BEQ     BCDMU3
01F0 8D DB      BCDMU2  BSR     BCDADD      ADD IN OPERAND
01F2 7A 00 2B           DEC     FPMQ+BC-1
01F5 20 F3              BRA     BCDMU1
01F7 8D 36      BCDMU3  BSR     EL4RR       SHIFT ACMQ 1 BCD RIGHT
01F9 5A                 DEC B
01FA 26 EE              BNE     BCDMU1
01FC 39                 RTS
                *
                *BCDDIV
                * DIVIDES FPAC AND FPMQ BY YOP
                * QUOTIENT RETURNED IN FPMQ, REMAINDER IN FPAC
                * CARRY RETURNED SET ON OVERFLOW
01FD CE 00 34   BCDDIV  LDX     #YOP
0200 8D 73              BSR     ZCHK.
0202 26 02              BNE     BCDD15      CHECK FOR DIV BY 0
0204 0D                 SEC
0205 39         BCDDI1  RTS
0206 C6 0A      BCDD15  LDA B   #BC*2
0208 8D BD              BSR     BCDSUB      SUBTRACT OPERAND
020A 24 0C              BCC     BCDDI3      CHECK FOR OVFL
020C 39                 RTS
020D 8D 36      BCDD16  BSR     EL4RL       SHIFT ACMQ 1 BCD LEFT
020F 8D BC      BCDDI2  BSR     BCDADD      SUBTRACT OPERAND
0211 24 05              BCC     BCDDI3      IF NO CARRY, TOO SMALL
0213 7C 00 2B           INC     FPMQ+BC-1 TALLY ONE
0216 20 F7              BRA     BCDDI2
0218 8D AD      BCDDI3  BSR     BCDSUB      COMPENSATE REMAINDER
021A BD 02 AB           JSR     LTC         RECOMPLEMENT
021D 5A                 DEC B               DEC LOOP CTR
021E 26 ED              BNE     BCDD16
0220 0C                 CLC
0221 39                 RTS
                *
                *RSTREG
                * RESTORE REGISTERS X, A, B
0222 96 3B      RSTREG  LDA A   ATEMP
0224 D6 3D              LDA B   BTEMP
0226 DE 3F              LDX     XTEMP
                *     GO INTO SAVREG
                *
                *SAVREG
                * SAVE REGISTERS X, A, B
```

```
0228 97 3B      SAVREG  STA A   ATEMP
022A D7 3D              STA B   BTEMP
022C DF 3F              STX     XTEMP
022E 39                 RTS
                *
                *EL4RR
                * EXTRA LONG 4 ROTATE RIGHT
                * ROTATES ACMQ RIGHT ONE BCD
022F 8D F7      EL4RR   BSR     SAVREG      SAVE PTRS
0231 86 04              LDA A   #04
0233 CE 00 21   EL4RR1  LDX     #FPAC       POINT TO AC
0236 C6 01              LDA B   #01
0238 0C                 CLC
0239 8D 4E              BSR     LRR         SHIFT AC
023B CE 00 27           LDX     #FPMQ       POINT TO MQ
023E 8D 49              BSR     LRR         SHIFT MQ
0240 4A                 DEC A
0241 26 F0              BNE     EL4RR1
0243 20 DD              BRA     RSTREG
                *
                *EL4RL
                * EXTRA LONG 4 ROTATE LEFT
                * ROTATES ACMQ LEFT ONE BCD DIGIT
0245 8D E1      EL4RL   BSR     SAVREG
0247 86 04              LDA A   #04         SET SHIFT COUNT
0249 CE 00 27   EL4RL1  LDX     #FPMQ
024C 0C                 CLC
024D C6 01              LDA B   #01
024F 8D 49              BSR     LRL         SHIFT
0251 CE 00 21           LDX     #FPAC
0254 8D 44              BSR     LRL         SHIFT AC
0256 4A                 DEC A
0257 26 F0              BNE     EL4RL1
0259 20 C7      EL4RL2  BRA     RSTREG      RESTORE POINTERS
                *
                *XOPTOX
                * MOVE XOP TO LOCN POINTED TO BY X
                * MODIFIES X
025B 8D CB      XOPTOX  BSR     SAVREG
025D CE 00 2D           LDX     #XOP        POINT TO XOP
0260 C6 05              LDA B   #BC         SET CTR
0262 A6 00      XOPT01  LDA A   0,X
0264 08                 INX
0265 DF 41              STX     XTEMP2      STORE PTR
0267 DE 3F              LDX     XTEMP       LOAD DEST PTR
0269 A7 00              STA A   0,X
026B 08                 INX
026C DF 3F              STX     XTEMP
026E DE 41              LDX     XTEMP2
0270 5A                 DEC B
0271 26 EF              BNE     XOPT01
0273 20 AD              BRA     RSTREG
                *
                *ZCHK
```

```
                        * CHECK A 5 BYTE BCD FOR =0
                        * OPERAND POINTED TO BY X
                        *  MODIFIES B,X
0275 C6 05      ZCHK    LDA B   #BC
0277 6D 00      ZCHK1   TST     0,X
0279 26 04              BNE     ZCHK2
027B 08                 INX
027C 5A                 DEC B
027D 26 F8              BNE     ZCHK1
027F 39         ZCHK2   RTS
                        *
                        *CLROP
                        * CLEAR 5 BYTE OPERAND POINTED TO BY X
                        * MODIFIES B,X
0280 C6 05      CLROP   LDA B   #BC
0282 6F 00      CLROP1  CLR     0,X
0284 08                 INX
0285 5A                 DEC B
0286 26 FA              BNE     CLROP1
0288 39                 RTS
                        *
                        *LRR
                        * LONG ROTATE RIGHT WITH CARRY
                        * X POINTS TO THE MS BYTE
                        * B CONTAINS AMOUNT OF SHIFT
0289 8D 65      LRR     BSR     SVRG2
028B DE 41      LRR1    LDX     XTEMP2
028D 86 05              LDA A   #BC
028F 66 00      LRR2    ROR     0,X
0291 08                 INX
0292 4A                 DEC A
0293 26 FA              BNE     LRR2
0295 5A                 DEC B
0296 26 F3              BNE     LRR1
0298 20 5C      LRR3    BRA     RSRG2
                        *
                        *LRL
                        * LONG ROTATE LEFT WITH CARRY
                        * X POINTS TO THE MS BYTE
                        * B CONTAINS THE AMOUNT OF SHIFT
029A 8D 54      LRL     BSR     SVRG2
029C DE 41      LRL1    LDX     XTEMP2
029E 86 05              LDA A   #BC
02A0 69 04      LRL2    ROL     BC-1,X
02A2 09                 DEX
02A3 4A                 DEC A
02A4 26 FA              BNE     LRL2
02A6 5A                 DEC B
02A7 26 F3              BNE     LRL1
02A9 20 4B              BRA     RSRG2
                        *
                        *LTC
                        * LONG TENS COMPLEMENT OF OPERAND
                        * POINTED TO BY X
```

```
02AB 8D 43      LTC     BSR     SVRG2
02AD C6 05              LDA B   #BC
02AF 86 99      LTC1    LDA A   #$99
02B1 A0 04              SUB A   BC-1,X
02B3 A7 04              STA A   BC-1,X
02B5 09                 DEX
02B6 5A                 DEC B
02B7 26 F6              BNE     LTC1
02B9 0D                 SEC
02BA C6 05              LDA B   #BC
02BC DE 41              LDX     XTEMP2
02BE 86 00      LTC2    LDA A   #00
02C0 A9 04              ADC A   BC-1,X
02C2 19                 DAA
02C3 A7 04              STA A   BC-1,X
02C5 09                 DEX
02C6 5A                 DEC B
02C7 26 F5              BNE     LTC2
02C9 20 2B      LTC4    BRA     RSRG2
                *
                *EXPADJ
                * ADJUSTS EXPONENTS FOR ADD AND SUBTRACT
                * OPERATES ON XOP AND YOP
                * MODIFIES A,B,X
02CB 96 32      EXPADJ  LDA A   XEX     LOAD X EXPONENT
02CD 91 39              CMP A   YEX     COMPARE WITH Y EXP
02CF 27 1C              BEQ     EXP3    EXPONENTS SAME?
02D1 2E 07              BGT     EXP1    XEX>YEX?
02D3 CE 00 2D           LDX     #XOP    POINT TO XOP
02D6 96 39              LDA A   YEX     GET YEX
02D8 20 03              BRA     EXP2
02DA CE 00 34   EXP1    LDX     #YOP    POINT TO YOP
02DD C6 04      EXP2    LDA B   #04
02DF 8D A8              BSR     LRR
02E1 E6 00              LDA B   0,X
02E3 C4 0F              AND B   #$0F    MASK OFF GOOD BCD
02E5 E7 00              STA B   0,X     SHIFTED 1 BCD RIGHT
02E7 6C 05              INC     BC,X    INCREMENT EXPONENT
02E9 A1 05              CMP A   BC,X    SAME YET?
02EB 26 F0              BNE     EXP2    IF NOT, DO AGAIN
02ED 97 26      EXP3    STA A   ACEXP   STORE NEW EXPONENT
02EF 39                 RTS             DONE
                *
                *SVRG2
                * LEVEL2 REGISTER SAVE
02F0 DF 41      SVRG2   STX     XTEMP2
02F2 97 3C              STA A   ATEMP2
02F4 D7 3E              STA B   BTEMP2
                *  GO INTO RSRG2
                *
                *RSRG2
                * LEVEL2 REGISTER RESTORE
02F6 DE 41      RSRG2   LDX     XTEMP2
02F8 96 3C              LDA A   ATEMP2
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```
02FA D6 3E              LDA B  BTEMP2
02FC 39                 RTS
                *
                *
                        END
```

SYMBOL TABLE:

ACEXP	0026	ATEMP	003B	ATEMP2	003C	BC	0005	BCDAD1	01D5
BCDADD	01CD	BCDD15	0206	BCDD16	020D	BCDDI1	0205	BCDDI2	020F
BCDDI3	0218	BCDDIV	01FD	BCDMU1	01EA	BCDMU2	01F0	BCDMU3	01F7
BCDMUL	01E2	BCDSUB	01C7	BTEMP	003D	BTEMP2	003E	CLROP	0280
CLROP1	0282	EL4RL	0245	EL4RL1	0249	EL4RL2	0259	EL4RR	022F
EL4RR1	0233	EXP1	02DA	EXP2	02DD	EXP3	02ED	EXPADJ	02CB
FPAC	0021	FPAD01	0133	FPAD21	013B	FPADD	0103	FPADD1	0137
FPADD2	0139	FPDIV	0194	FPDIV1	01B9	FPDIV3	01C3	FPMQ	0027
FPMUL	0180	FPSUB	0100	LRL	029A	LRL1	029C	LRL2	02A0
LRR	0289	LRR1	028B	LRR2	028F	LRR3	0298	LTC	02AB
LTC1	02AF	LTC2	02BE	LTC4	02C9	NORM	014A	NORM2	0159
NORM3	016C	OVFL	003A	RSIGN	0020	RSRG2	02F6	RSTREG	0222
SAVREG	0228	SETSI1	017F	SETSIN	0176	SVRG2	02F0	XEX	0032
XOP	002D	XOPTO1	0262	XOPTOX	025B	XSIGN	002C	XTEMP	003F
XTEMP2	0041	YEX	0039	YOP	0034	YSIGN	0033	ZCHK	0275
ZCHK1	0277	ZCHK2	027F						

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S113010073003380D71BD02CBCEC021BD025BCE00E6
S113011021BD0275271DCE0034BD02752719962016
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S1130130BD02AB96332002962C9720CE0021BD023F
S11301405BBD01CDCE0027BD0280CE0021BD02756E
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S11302C0A90419A704095A26F5202B963291392737
S11302D01C2E07CE002D96392003CE0034C6048D83
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S9030000FC
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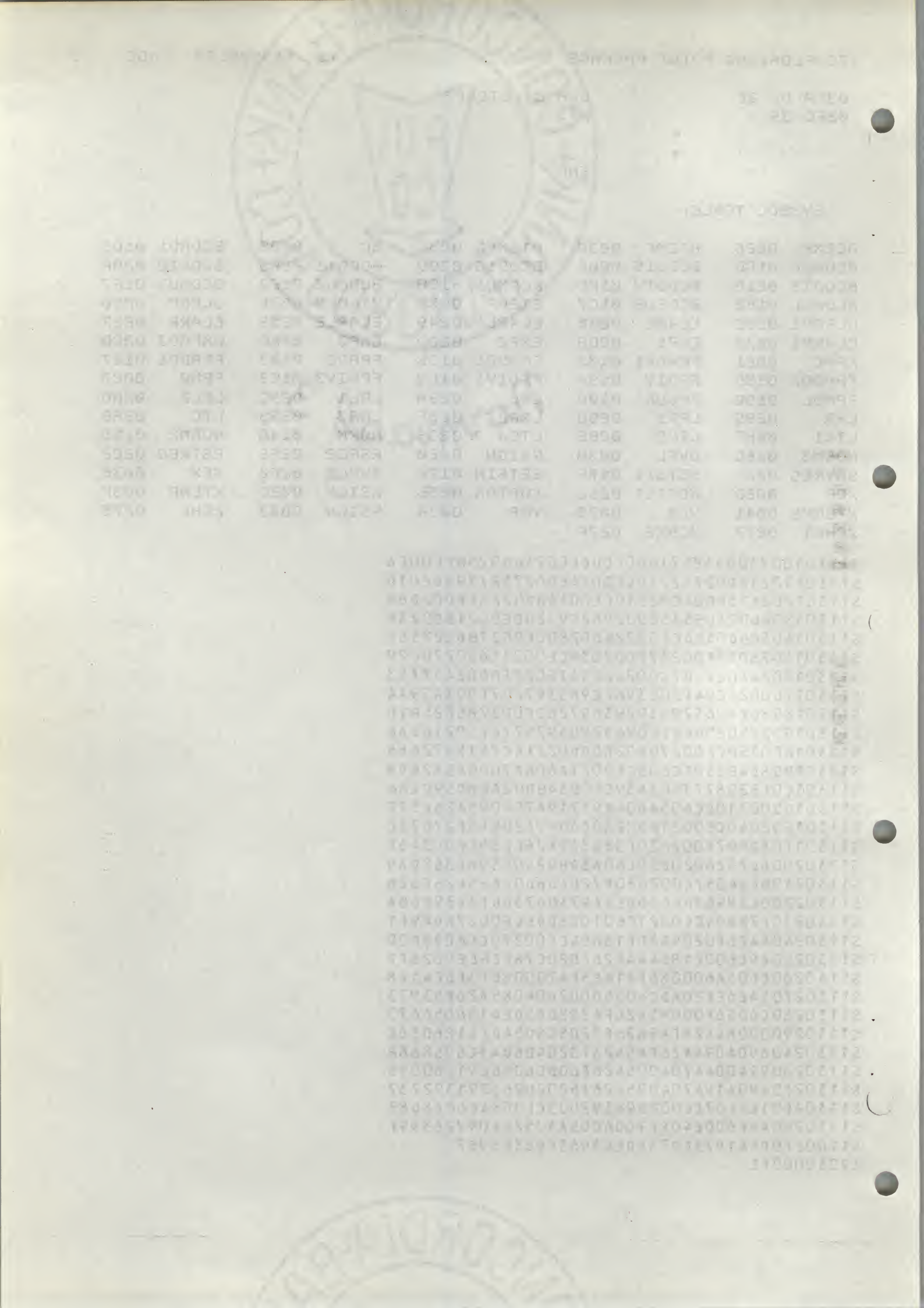

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* TSC FLOATING POINT PACKAGE DRIVER
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*
*  COPYRIGHT (C) 1976 BY
*     TECHNICAL SYSTEMS CONSULTANTS
*     BOX 2574  W. LAFAYETTE  IN.  47906
*
*     THE TSC FLOATING POINT PACKAGE DRIVER, WHEN
* USED IN CONJUNCTION WITH THE TSC FLOATING POINT
* PACKAGE, IMPLEMENTS A BASIC FOUR-FUNCTION
* SCIENTIFIC NOTATION CALCULATOR.  THIS PROGRAM
* ACCEPTS INPUT FROM THE KEYBOARD, IN A FORM
* TO BE DESCRIBED LATER, INITIATES THE CALCULATION
* AND THEN OUTPUTS THE RESULT.
*     THE USER IS PROMPTED WITH THE SYMBOL  >
* AT WHICH POINT THE FIRST OPERAND IS TYPED.  THE
* OPERANDS ARE SUBJECT TO FORMAT RESTRICTIONS
* AS NOTED BELOW.  DIRECTLY FOLLOWING THE FIRST
* OPERAND THE USER TYPES THE OPERATOR, EITHER A
*   +, -, *, OR /   FOR ADD, SUBTRACT, MULTIPLY, OR
* DIVIDE, RESPECTIVELY.  DIRECTLY FOLLOWING THE
* OPERATOR, THE USER TYPES THE SECOND OPERAND,
* SUBJECT TO THE SAME RESTRICTIONS AS THE FIRST.
* NEXT A CARRIAGE RETURN IS TYPED TO INITIATE
* THE CALCULATION AND THEN THE ANSWER IS TYPED
* OUT AND THE USER IS PROMPTED FOR THE NEXT
* CALCULATION.
*     THE RESTRICTIONS ON THE FORMAT OF THE
* OPERANDS ARE AS FOLLOWS:
*  1)  THE OPERAND MUST BEGIN WITH A PLUS,
*     A MINUS, A DECIMAL POINT (PERIOD), OR ANY
*     DECIMAL DIGIT.
*  2)  THE DECIMAL POINT, IF IT APPEARS, MAY
*     BE ANY WHERE IN THE NUMBER AFTER THE SIGN
*     (IF ANY) AND BEFORE THE EXPONENT (IF ANY).
*  3)  THE EXPONENT, INDICATED BY THE LETTER
*     E, MAY BE PRECEEDED BY A PLUS OR MINUS SIGN
*     AND IS LIMITED TO TWO DIGITS.
*
*  THE CALCULATOR TRUNCATES ALL DIGITS IN EXCESS
* OF 9 SIGNIFICANT DIGITS.
*     SOME POSSIBLE FORMS ARE SHOWN BELOW:
*    >12*1.3
*    >.001-6
*    >-12+3E2
*    >+5.6E-21/-21E+00
*    >123456.789+.987654321
*    >+1.2--3.1E-1
*    >4*-5
*
* DEPARTURE FROM THE FORMAT RESTRICTIONS WILL
* CAUSE A SYNTAX ERROR MESSAGE TO BE PRINTED.
*     OPERATIONS RESULTING IN ARITHMETIC OVER-
```

```
                    * FLOW OR UNDERFLOW WILL CAUSE AN OVERFLOW
                    * MESSAGE TO BE PRINTED.
                    *     THE STARTING ADDRESS OF THIS PROGRAM
                    * IS 0300.
                    *
                    * MIKBUG  ROUTINES
                    *   (MIKBUG IS A REGISTERED
                    *     TRADEMARK OF MOTOROLA INC. )
E07E                PDATA1  EQU     $E07E
E1AC                INEEE   EQU     $E1AC
E1D1                OUTEEE  EQU     $E1D1
E067                OUTHL   EQU     $E067
E06B                OUTHR   EQU     $E06B
                    *
                    * STORAGE
0050                        ORG     $0050
0050                INBUF   RMB     6
0056                INEXP   RMB     1
0057                SIGDIG  RMB     1
0058                DECFLG  RMB     1
0059                EXPNEG  RMB     1
005A                EXP     RMB     1
005B                SYNTAX  RMB     1
005C                OPER    RMB     1
003F                XTEMP   EQU     $003F
0041                XTEMP2  EQU     $0041
003D                CTR     EQU     $003D
003E                TOGGLE  EQU     $003E
002C                XSIGN   EQU     $002C
0033                YSIGN   EQU     $0033
0026                ACEXP   EQU     $0026
0020                RSIGN   EQU     $0020
003A                OVFL    EQU     $003A
                    *
                    *
                    *FLOATING POINT PACKAGE ROUTINES
0103                FPADD   EQU     $0103
0100                FPSUB   EQU     $0100
0180                FPMUL   EQU     $0180
0194                FPDIV   EQU     $0194
                    *
                    *
                    *
A048                        ORG     $A048
A048 03 00                  FDB     BEG
0300                        ORG     $0300
0300 8E A0 42       BEG     LDS     #$A042      INITIALIZE SP
0303 CE 04 DB       START   LDX     #PROM
0306 BD E0 7E               JSR     PDATA1
0309 4F                     CLR A
030A 97 5B                  STA A   SYNTAX      CLEAR SYNTAX ERROR
030C 97 5C                  STA A   OPER        CLEAR OPERATOR FLAG
030E BD 03 EE               JSR     INPUT       FILL THE INPUT BUFFER
0311 96 5B                  LDA A   SYNTAX
```

```
0313 26 3C          BNE    SYNERR    CHECK FOR SYNTAX ERROR
0315 CE 00 2C       LDX    #XSIGN
0318 BD 03 D3       JSR    BUFTOX    TRANSFER INPUT TO XOP
031B BD 03 EE NXTOP JSR    INPUT     FILL BUFFER AGAIN
031E 96 5B          LDA A  SYNTAX
0320 26 2F          BNE    SYNERR    CHECK FOR SYNTAX ERROR
0322 CE 00 33       LDX    #YSIGN
0325 BD 03 D3       JSR    BUFTOX    TRANSFER TO YOP
0328 96 5C          LDA A  OPER      GET OPERATOR
032A 4A             DEC A
032B 27 15          BEQ    ADDOP     IS IT AN ADD REQUEST
032D 4A             DEC A
032E 27 0D          BEQ    SUBOP     IS IT A SUBTRACT REQ.
0330 4A             DEC A
0331 27 05          BEQ    MULOP     IS IT A MULT. REQUEST
0333 BD 01 94       JSR    FPDIV     ASSUME IT IS A DIVIDE
0336 20 0D          BRA    PRINT
0338 BD 01 80 MULOP JSR    FPMUL     GO MULTIPLY
033B 20 08          BRA    PRINT
033D BD 01 00 SUBOP JSR    FPSUB     GO SUBTRACT
0340 20 03          BRA    PRINT
0342 BD 01 03 ADDOP JSR    FPADD     GO ADD
0345 96 3A    PRINT LDA A  OVFL
0347 27 0D          BEQ    NOVFL     TEST FOR OVERFLOW
0349 CE 04 E2 OV    LDX    #OVER
034C BD E0 7E PRTMES JSR   PDATA1    GIVE HIM MESSAGE
034F 20 B2          BRA    START     DO AGAIN
0351 CE 04 EF SYNERR LDX   #SYNT
0354 20 F6          BRA    PRTMES    PRINT MESSAGE
0356 96 21    NOVFL LDA A  RSIGN+1   GET FIRST DIGIT
0358 27 03          BEQ    OVCHK     CHECK FOR =0
035A 7A 00 26       DEC    ACEXP     ADJUST FOR OUTPUT
035D 96 26    OVCHK LDA A  ACEXP
035F 81 63          CMP A  #99
0361 2E E6          BGT    OV        TEST FOR EXP OVERFLOW
0363 81 9D          CMP A  #$9D
0365 2D E2          BLT    OV        TEST FOR EXP UNDERFLOW
0367 CE 04 FA       LDX    #EQUAL
036A BD E0 7E       JSR    PDATA1    PRINT CRLF =
036D 96 20          LDA A  RSIGN     GET SIGN
036F 27 05          BEQ    POS       IS IT POSITIVE
0371 86 2D          LDA A  #'-
0373 BD E1 D1       JSR    OUTEEE    PRINT A MINUS
0376 96 21    POS   LDA A  RSIGN+1   GET BYTE
0378 BD E0 6B       JSR    OUTHR     PRINT LS BCD
037B C6 08          LDA B  #8        SET FOR COUNTING OFF
037D CE 00 25       LDX    #ACEXP-1  POINT TO LAST BYTE
0380 A6 00    CNTOFF LDA A 0,X       GET THE BYTE
0382 85 0F          BIT A  #$0F
0384 26 09          BNE    GOTCNT    CHECK FOR LS ZERO
0386 5A             DEC B            COUNT OFF DIGIT
0387 85 F0          BIT A  #$F0
0389 26 04          BNE    GOTCNT    CHECK FOR MS ZERO
038B 09             DEX              POINT TO NEXT
```

```
038C 5A          DEC B          COUNT OFF ONE DIGIT
038D 26 F1       BNE   CNTOFF   IF NOT 8 DO AGAIN
038F CE 00 22 GOTCNT LDX   #RSIGN+2 POINT TO SEC. BYTE
0392 5D          TST B          CHECK FOR ZERO
0393 27 16       BEQ   PRTEXP   IF SO, GO PRINT EXP.
0395 86 2E       LDA A  #'.
0397 BD E1 D1    JSR   OUTEEE   PRINT DECIMAL POINT
039A A6 00    PRTLOP LDA A  0,X GET NEXT CHAR
039C BD E0 67    JSR   OUTHL   PRINT MS BCD
039F 5A          DEC B          CHECK IF DONE
03A0 27 09       BEQ   PRTEXP   IF SO GO PRINT EXP.
03A2 A6 00       LDA A  0,X     GET BYTE AGAIN
03A4 BD E0 6B    JSR   OUTHR   PRINT LS BCD
03A7 08          INX
03A8 5A          DEC B          ONE BYTE DONE
03A9 26 EF       BNE   PRTLOP
03AB D6 26    PRTEXP LDA B  ACEXP+1
03AD 27 21       BEQ   NOPRT    CHECK FOR EXP =0
03AF 86 45       LDA A  #'E
03B1 BD E1 D1    JSR   OUTEEE   PRINT AN E
03B4 86 2B       LDA A  #'+     GET ASCII FOR +
03B6 5D          TST B          CHECK THE SIGN
03B7 2A 03       BPL   PRTEXS   TEST SIGN
03B9 50          NEG B          COMPLEMENT THE EXP.
03BA 86 2D       LDA A  #'-
03BC BD E1 D1 PRTEXS JSR   OUTEEE   PRINT EXPONENT SIGN
03BF 4F          CLR A          CONVERT TO BCD AND PRINT
03C0 C0 0A    SUBT   SUB B  #10    SUBTRACT 10
03C2 25 03       BCS   TOOMAN   SHOULDN'T SUBTRACT?
03C4 4C          INC A          COUNT ONCE
03C5 20 F9       BRA   SUBT
03C7 BD E0 6B TOOMAN JSR   OUTHR   PRINT MS DIGIT
03CA 86 0A       LDA A  #10
03CC 1B          ABA            COMPENSATE REMAINDER
03CD BD E0 6B    JSR   OUTHR   PRINT LS DIGIT
03D0 7E 03 03 NOPRT  JMP   START
                 *
                 *BUFTOX
                 * MOVE INPUT BUFFER CONTENTS TO X
03D3 DF 3F    BUFTOX STX   XTEMP  SAVE X
03D5 CE 00 50    LDX   #INBUF
03D8 A6 00    BUF1   LDA A  0,X   GET CHAR OF BUFFER
03DA 08          INX
03DB 8C 00 58    CPX   #INEXP+2 DONE YET?
03DE 27 0D       BEQ   DONE
03E0 DF 41       STX   XTEMP2
03E2 DE 3F       LDX   XTEMP
03E4 A7 00       STA A  0,X
03E6 08          INX
03E7 DF 3F       STX   XTEMP
03E9 DE 41       LDX   XTEMP2
03EB 20 EB       BRA   BUF1
03ED 39       DONE   RTS
                 *
```

```
                        *INPUT
                        * FILL THE INPUT BUFFER AND SET FLAGS
03EE CE 00 5A  INPUT    LDX     #EXP
03F1 6F 00     STUF     CLR     0,X         CLEAR THE BUFFER
03F3 09                 DEX
03F4 8C 00 4F           CPX     #INBUF-1
03F7 26 F8              BNE     STUF
03F9 08                 INX
03FA 7F 00 3D           CLR     CTR         CLEAR FULL FLAG
03FD C6 FF              LDA B   #$FF
03FF D7 3E              STA B   TOGGLE      SET BYTE TOGGLE
0401 BD 04 D3  INCH     JSR     INCHAR      GET A CHAR
0404 81 2B              CMP A   #'+
0406 27 11              BEQ     INNEXT      IGNORE PLUS SIGN
0408 81 2D              CMP A   #'-
040A 26 04              BNE     NOTNEG      IF NOT MINUS PROCEED
040C 63 00              COM     0,X         SET SIGN INDICATOR
040E 20 09              BRA     INNEXT      GET NEXT CHAR
0410 81 2E     NOTNEG   CMP A   #'.
0412 27 03              BEQ     ISPT        CHECK FOR DEC. POINT
0414 08        NOTPT    INX                 POINT NEXT BYTE
0415 20 06              BRA     CRCHK       GO CHECK FOR CR
0417 97 58     ISPT     STA A   DECFLG      SET DECIMAL FLAG
0419 08        INNEXT   INX
041A BD 04 D3  GETIN    JSR     INCHAR      GET CHAR
041D 81 0D     CRCHK    CMP A   #$D
041F 27 71              BEQ     REL         CHECK FOR CR
0421 80 30              SUB A   #'0         REMOVE ASCII BIAS
0423 27 08              BEQ     GOTZER      CHECK FOR ZERO INPUT
0425 2B 3A              BMI     NOTYET      CHECK FOR <0
0427 81 09              CMP A   #'9-'0
0429 22 36              BHI     NOTYET      CHECK FOR >9
042B 97 57              STA A   SIGDIG      SET SIGNIFICANT FLAG
042D D6 3D     GOTZER   LDA B   CTR
042F 26 E9              BNE     GETIN       CHECK FOR BUFF. FULL
0431 D6 57              LDA B   SIGDIG      HAD SIG. DIGITS?
0433 26 09              BNE     TSTNXT
0435 D6 58              LDA B   DECFLG      HAD DECIMAL PT?
0437 27 E1              BEQ     GETIN       IF NOT 0 NOT SIG.
0439 7A 00 56           DEC     INEXP       IF SO BACK UP EXP.
043C 20 DC              BRA     GETIN
043E D6 58     TSTNXT   LDA B   DECFLG      HAD DECIMAL PT?
0440 26 03              BNE     STORIT      IF SO EXP. OK
0442 7C 00 56           INC     INEXP       KICK EXPONENT
0445 D6 3E     STORIT   LDA B   TOGGLE      CHECK FOR WHICH DIGIT
0447 26 04              BNE     LOHALF
0449 48                 ASL A
044A 48                 ASL A
044B 48                 ASL A
044C 48                 ASL A               GET TO TOP HALF
044D AA 00     LOHALF   ORA A   0,X         MERGE
044F A7 00              STA A   0,X         RE-STORE IT
0451 73 00 3E           COM     TOGGLE      SET FOR NEXT DIGIT
0454 26 01              BNE     NOTNXT      CHECK FOR NEXT BYTE
```

```
0456 08                  INX              POINT TO NEXT BYTE
0457 8C 00 56  NOTNXT    CPX    #INEXP    CHECK FOR END OF BUFF
045A 26 BE               BNE    GETIN     IF NOT GET MORE
045C 73 00 3D            COM    CTR       SET BUFFER END FLG
045F 20 B9               BRA    GETIN     GET NEXT CHAR
0461 8B 30     NOTYET    ADD A  #'0       RESTORE ASCII
0463 81 45     FULL      CMP A  #'E
0465 27 2D               BEQ    EXPIN     CHECK FOR EXP IND.
0467 C6 01               LDA B  #1        SET OPER FLAG
0469 81 2B               CMP A  #'+
046B 27 1F               BEQ    GOTOP     CHECK FOR ADD OPER.
046D 5C                  INC B
046E 81 2D               CMP A  #'-
0470 27 1A               BEQ    GOTOP     CHECK FOR SUB.  OPER.
0472 5C                  INC B
0473 81 2A               CMP A  #'*
0475 27 15               BEQ    GOTOP     CHECK FOR MUL.  OPER.
0477 5C                  INC B
0478 81 2F               CMP A  #'/
047A 27 10               BEQ    GOTOP     CHECK FOR DIV.  OPER.
047C 81 2E               CMP A  #'.       CHECK FOR DEC. PT
047E 26 08               BNE    SYNERF
0480 D6 58               LDA B  DECFLG    CHECK FOR ALREADY DEC.  PT.
0482 26 04               BNE    SYNERF
0484 97 58               STA A  DECFLG    FLAG A DEC.  PT.
0486 20 92               BRA    GETIN
0488 97 5B     SYNERF    STA A  SYNTAX    FLAG A SYNTAX ERROR
048A 20 8E               BRA    GETIN     GET MORE CHARS.
048C 96 5C     GOTOP     LDA A  OPER      CHECK FOR ALREADY OPER.
048E 26 F8               BNE    SYNERF    IF SO, FLAG AN ERROR
0490 D7 5C               STA B  OPER      SET OPER FLG
0492 20 27     REL       BRA    GOTDIG
0494 8D 3D     EXPIN     BSR    INCHAR
0496 81 2B               CMP A  #'+
0498 27 FA               BEQ    EXPIN     IGNORE PLUS
049A 81 2D               CMP A  #'-
049C 26 05               BNE    CHKNXT
049E 73 00 59            COM    EXPNEG    SET EXPONENT SIGN
04A1 8D 30     EXINP     BSR    INCHAR    GET A CHAR
04A3 80 30     CHKNXT    SUB A  #'0
04A5 2B 04               BMI    SYNEXP    CHECK FOR <0
04A7 81 09               CMP A  #9
04A9 23 05               BLS    EXPOK     CHECK FOR >9
04AB 8B 30     SYNEXP    ADD A  #'0       RESTORE ASCII
04AD 7E 04 1D            JMP    CRCHK     GO CHECK FOR CR
04B0 D6 5A     EXPOK     LDA B  EXP
04B2 58                  ASL B
04B3 58                  ASL B
04B4 58                  ASL B
04B5 58                  ASL B
04B6 1B                  ABA              MERGE
04B7 97 5A               STA A  EXP       STUFF EXP
04B9 20 E6               BRA    EXINP
04BB 96 5A     GOTDIG    LDA A  EXP
```

```
04BD 84 F0            AND A  #$F0      MASK MS 4 BITS
04BF 44               LSR A
04C0 16               TAB
04C1 44               LSR A
04C2 44               LSR A
04C3 1B               ABA              MULTIPLY BY 10
04C4 D6 5A            LDA B  EXP       GET OLD EXP BACK
04C6 C4 0F            AND B  #$0F      GET LS DIGIT
04C8 1B               ABA              ADD IN
04C9 D6 59            LDA B  EXPNEG    CHECK FOR EXP SIGN
04CB 27 01            BEQ    POSEXP
04CD 40               NEG A
04CE 9B 56      POSEXP ADD A  INEXP     GET RESULTING EXP.
04D0 97 56            STA A  INEXP     STORE IT
04D2 39               RTS
04D3 BD E1 AC   INCHAR JSR    INEEE     GET A CHAR
04D6 81 20            CMP A  #$20
04D8 27 F9            BEQ    INCHAR    IGNORE BLANKS
04DA 39               RTS
04DB 0D         PROM  FCB    $D,$A,0,0
04DF 3E               FCC    ;> ;
04E1 04               FCB    4
04E2 0D         OVER  FCB    $D,$A,0,0
04E6 4F               FCC    ;OVERFLOW;
04EE 04               FCB    4
04EF 0D         SYNT  FCB    $D,$A,0,0
04F3 53               FCC    ;SYNTAX;
04F9 04               FCB    4
04FA 0A         EQUAL FCB    $A,0,0
04FD 20               FCC    ;  =;
04FF 04               FCB    4
                      END
```

SYMBOL TABLE:

```
ACEXP  0026   ADDOP  0342   BEG    0300   BUF1   03D8   BUFTOX 03D3
CHKNXT 04A3   CNTOFF 0380   CRCHK  041D   CTR    003D   DECFLG 0058
DONE   03ED   EQUAL  04FA   EXINP  04A1   EXP    005A   EXPIN  0494
EXPNEG 0059   EXPOK  04B0   FPADD  0103   FPDIV  0194   FPMUL  0180
FPSUB  0100   FULL   0463   GETIN  041A   GOTCNT 038F   GOTDIG 04BB
GOTOP  048C   GOTZER 042D   INBUF  0050   INCH   0401   INCHAR 04D3
INEEE  E1AC   INEXP  0056   INNEXT 0419   INPUT  03EE   ISPT   0417
LOHALF 044D   MULOP  0338   NOPRT  03D0   NOTNEG 0410   NOTNXT 0457
NOTPT  0414   NOTYET 0461   NOVFL  0356   NXTOP  031B   OPER   005C
OUTEEE E1D1   OUTHL  E067   OUTHR  E06B   OV     0349   OVCHK  035D
OVER   04E2   OVFL   003A   PDATA1 E07E   POS    0376   POSEXP 04CE
PRINT  0345   PROM   04DB   PRTEXP 03AB   PRTEXS 03BC   PRTLOP 039A
PRTMES 034C   REL    0492   RSIGN  0020   SIGDIG 0057   START  0303
STORIT 0445   STUF   03F1   SUBOP  033D   SUBT   03C0   SYNERF 0488
SYNERR 0351   SYNEXP 04AB   SYNT   04EF   SYNTAX 005B   TOGGLE 003E
TOOMAN 03C7   TSTNXT 043E   XSIGN  002C   XTEMP  003F   XTEMP2 0041
YSIGN  0033
```

```
S105A0480000F
S11303008EA042CE04DBBDE07E4F975[illegible]CBD03B[illegible]
S1130310EE965B263CCF002CBD03D3B[illegible]965B6[illegible]
S1130320262FCE0033BD03D3965C4A2[illegible]270DE[illegible]
S11303304A2705BD0194200DBD01802[illegible]0100A[illegible]
S11303402003BD0103963A270DCE04E[illegible]07F20D[illegible]
S1130350B2CE04EF20F69621270 37A0[illegible]526815[illegible]
S1130360632EE6819D2DE2CE04FABDE[illegible]2C272[illegible]
S11303700058620BDE1D19621BDE06BC[illegible]0025D[illegible]
S11303800A600850F26095A85F02634 0[illegible]F1CEB[illegible]
S1130390000225D2716862EBDE1D1A60[illegible]0675A7[illegible]
S11303A02709A600BDE06BD85A26EFD[illegible]721862[illegible]
S11303B0045BDE1D18628 5D2A0350862[illegible]1D14F8[illegible]
S11303C0C00A25034C20F9BDE06B86[illegible]E06B1[illegible]
S11303D07[illegible]303DF3FCE0050A600088[illegible]270D9[illegible]
S11303E00F41DE3FA70008DF3FDE412[illegible]CE00C[illegible]
S11303F05A6F00098C004F26F8087F0[illegible]D7C[illegible]
S11304003FBD0403812B2711812D260[illegible]2009C[illegible]
S11304108 12E27030820069758 08BD0[illegible]C0279[illegible]
S113042071803027082B3A81092236 9[illegible]3026C[illegible]
S1130430E906572609D65827E17A005[illegible]D6584[illegible]
S113044026037C0056D63E2604484 84[illegible]00A7F[illegible]
S1130450007300 3E26010 88C0056 26B[illegible]03D202[illegible]
S1130460B98B308145272DC601812B2[illegible]C812D3[illegible]
S1130470271A[illegible]C812A27155C812F271[illegible]2608D[illegible]
S1130480[illegible]2604975820 92975B208[illegible]C26F8B[illegible]
S1130490[illegible]C20278 03D812027FA812[illegible]7300F[illegible]
S11304A0[illegible]3080302B0481092305[illegible]041D4[illegible]
S11304B0[illegible]58585818975A20E69[illegible]F44E[illegible]
S11304C01[illegible]418D65AC40F1BD0592[illegible]9B56C[illegible]
S11304D097[illegible]39BDE1AC812027F9390[illegible]003E5[illegible]
S11304E0200400 0A00004F5645524 4[illegible]040D4[illegible]
S11304F00[illegible]0053594E544158040A000[illegible]3D049[illegible]
S9030000FC
```


```
*R E1 2A E1 AF08 0300,A043
*G
> 12*12
 =1.44E+02
> 355/113
 =3.14159292
> [illegible]E2/1.33E2
 =[illegible]7093
> 100/3
 =3.3333333E+01
> 40-45
 =-5.7E+01
> -12.123456789*1
 =-1.2123457E+01
> 8888*4
SYNTAX
> 1/0
OVERFLOW
> 1E60*1E60
OVERFLOW
> 5.28E3/3
 =1.76E+03
>
```

SCIENTIFIC FUNCTIONS


```
*
*
*    COPYRIGHT (C) 1976 BY
*  TECHNICAL SYSTEMS CONSULTANTS
* BOX 2574  W. LAFAYETTE  IN  47906
*
*  THE TSC SCIENTIFIC FUNCTIONS PACKAGE IS DESIGNED
* TO UTILIZE THE TSC FLOATING POINT PACKAGE FOR
* ARITHMETIC PROCESSING.  THE ROUTINES IMPLEMENT
* SOME OF THE MOST USED SCIENTIFIC FUNCTIONS USING
* THE CORDIC (COORDINATE ROTATION DIGITAL COMPUTER)
* ALGORITHM, AN OBSCURE BUT USEFUL ALGORITHM BECAUSE
* IT INVOLVES FEWER MULTIPLICATIONS (BUT MORE ADDITIONS)
* THAN OTHER APPROXIMATION TECHNIQUES, AND THEREFORE
* RUNS FASTER.  THE TECHNIQUE INVOLVES ROTATING A
* COORDINATE SYSTEM TO OBTAIN A MAPPING FROM THE FIRST
* SYSTEM INTO A SECOND COORDINATE SYSTEM WHICH IS
* ROTATIONALLY DISPLACED FROM THE FIRST.  THE ROTATION
* IS ACCOMPLISHED IN A SEQUENCE OF CAREFULLY CALCULATED
* DISPLACEMENTS SUCH THAT THE INTERMEDIATE MAPPINGS
* CAN BE PERFORMED BY MERELY ADDING AND SHIFTING, OR
* IN THIS CASE, ADDING AND DECREMENTING EXPONENTS.
* BE REMINDED THAT THIS PACKAGE CONTAINS SUBROUTINES ONLY.
*  THIS PACKAGE ALSO CONTAINS SEVERAL USEFUL CONSTANTS
* FOR THE USER.  AMONG THESE ARE PI, E, AND LN10.  SEE
* THE DATA BLOCKS BELOW.
*  THIS PROGRAM IS DESIGN SUCH THAT THE USER DESIRING
* ONLY TRIG FUNCTIONS CAN DELETE THE SECTION OF CODE
* BEYOND 0700 AS THAT CODE IS ONLY USED FOR THE
* HYPERBOLIC FAMILY OF FUNCTIONS (LOGS, ETC. ).
*  THE PRECISION OF THE APPROXIMATIONS IS LIMITED TO
* SIX DIGITS (MORE DIGITS WOULD TAKE PROPORTIONATELY
* LONGER).  THE ENTRY ADDRESSES, ARGUMENT AND RESULT
* LOCATIONS, AND RANGE OF ARGUMENTS ARE SHOWN IN THE
* TABLES BELOW:
*
*    OPERATION     ARGUMENT     RESULT          ARGUMENT LIMITS
*      SIN(X)     XSIGN-XEX  RSIGN-ACEXP    .1<X<INF   (ABS VAL)
*      COS(X)     XSIGN-XEX  RSIGN-ACEXP   .1< X <INF (ABS VAL)
*      TAN(X)     XSIGN-XEX  RSIGN-ACEXP   .1< X <INF (ABS VAL)
*    ARCSIN(X)    XSIGN-XEX  RSIGN-ACEXP  .01< X <1.0 (ABS VAL)
*    ARCCOS(X)    XSIGN-XEX  RSIGN-ACEXP  .01< X <1.0 (ABS VAL)
*    ARCTAN(X)    XSIGN-XEX  RSIGN-ACEXP  .01< X <INF (ABS VAL)
*     SINH(X)     XSIGN-XEX  RSIGN-ACEXP   .1< X <LN(10) (ABS VAL)
*     COSH(X)     XSIGN-XEX  RSIGN-ACEXP   .1< X <LN(10) (ABS VAL)
*     TANH(X)     XSIGN-XEX  RSIGN-ACEXP   .1< X <LN(10) (ABS VAL)
*       E↑X       XSIGN-XEX  RSIGN-ACEXP   0 < X < 227 (ABS VAL)
*      10↑X       XSIGN-XEX  RSIGN-ACEXP   0 < X < 98  (ABS VAL)
*      LN(X)      XSIGN-XEX  RSIGN-ACEXP     ANY POSITIVE VALUE
*     LOG(X)      XSIGN-XEX  RSIGN-ACEXP     ANY POSITIVE VALUE
*    SQRT(X)      XSIGN-XEX  RSIGN-ACEXP   ANY POSITIVE VALUE AND 0
*       X↑Y       XSIGN-XEX                  ANY POSITIVE VALUE
*                 YSIGN-YEX  RSIGN-ACEXP     ANY VALUE
```

```
*     1/X         XSIGN-XEX  RSIGN-ACEXP     X NOT ZERO
*
*
*  NOTES:
*
*  1)  TRIG FUNCTIONS CAN BE COMPUTED IN DEGREE OR RADIAN MODE
*      THE INDICATOR BYTE "MODE" (0076 HEX) SPECIFIES THE MODE
*      00 = DEGREE MODE,  FF = RADIAN MODE
*
*  2)  E↑X  IS THE NUMBER E RAISED TO THE X POWER.
*
*  3)  LN(X) IS THE NATURAL LOG (BASE E) OF X
*
*  4)  LOG(X) IS THE COMMON LOG (BASE 10) OF X
*
*  5)  SQRT(X) IS THE SQUARE ROOT OF X
*
*  6)  X↑Y IS X RAISED TO THE Y POWER.  X IS IN XSIGN-XEX
*      Y IS IN YSIGN-YEX.
*
*  7)  1/X  IS THE INVERSE OF X
*
*  8)  OVERFLOW IS INDICATED BY "OVFL" (003A HEX) NOT ZERO
*
*  9)  ILLEGAL OPERATION IS INDICATED BY "NLEGAL" (0072)
*      NOT ZERO.  THE USER MUST CLEAR NLEGAL BEFORE
*      CALLING A PARTICULAR ROUTINE.
*
* 10)  INF ABOVE MEANS .999999999 X 10↑99
*      -INF ABOVE MEANS .100000000 X 10↑-99
*
*
*
*    OPERATION      ENTRY ADDRESS
*       SIN             0460
*       COS             0459
*       TAN             0496
*     ARCSIN            05B7
*     ARCCOS            059C
*     ARCTAN            0647
*      SINH             07BE
*      COSH             07C8
*      TANH             07CF
*       E↑X             075F
*      10↑X             0751
*      LN(X)            0836
*     LOG(X)            0820
*       1/X             0744
*      SQRT             0739
*      X↑Y              0701
*
*
*
*  EXTERNAL ROUTINES FROM FP PACKAGE
```

```
0103                FPADD   EQU     $0103
0100                FPSUB   EQU     $0100
0180                FPMULT  EQU     $0180
0194                FPDIV   EQU     $0194
0262                XOPTO1  EQU     $0262
0275                ZCHK    EQU     $0275
014A                NORM    EQU     $014A
01CD                BCDADD  EQU     $01CD
                    *
                    *
                    *   STORAGE ALSO USED BY FP PACKAGE
0020                RSIGN   EQU     $0020
002C                XSIGN   EQU     $002C
0032                XEX     EQU     $0032
002D                XOP     EQU     $002D
0033                YSIGN   EQU     $0033
0034                YOP     EQU     $0034
0039                YEX     EQU     $0039
003A                OVFL    EQU     $003A
003F                XTEMP   EQU     $003F
0041                XTEMP2  EQU     $0041
                    *
                    *
                    *  TEMPORARY STORAGE FOR SCIENTIFIC PACKAGE
0045                        ORG     $0045
                    *
0045                XPRIME  RMB     7
004C                YPRIME  RMB     7
0053                ZPRIME  RMB     7
005A                TPRIME  RMB     7
0061                ANGLE   RMB     7
0068                AFACTX  RMB     2
006A                XOPN    RMB     1
006B                YOPN    RMB     1
006C                AOPN    RMB     1
006D                LSTSGN  RMB     1
006E                SIGN    RMB     1
006F                OPX     RMB     2
0071                ITER    RMB     1
0072                NLEGAL  RMB     1
0073                C4      RMB     2
0075                QUADRT  RMB     1
                    *
0076 00             MODE    FCB     0       SET DEGREE MODE
                    *
                    *
0300                        ORG     $0300
                    *
                    *
                    * FUNDAMENTAL CONSTANTS
                    *
0300 00             PI      FCB     $00,$03,$14,$15,$92,$65,$01
0307 00             LN10    FCB     $00,$02,$30,$25,$85,$09,$01
030E 00             E       FCB     $00,$02,$71,$82,$81,$83,$01
```

```
                        *
                        * MISCELLANEOUS NUMERICAL CONSTANTS
0315 00                 NINETY  FCB     $00,$09,$00,$00,$00,$00,$02
031C 00                 C360    FCB     $00,$03,$60,$00,$00,$00,$03
0323 00                 TWO     FCB     $00,$02,$00,$00,$00,$00,$01
032A 00                 ONE     FCB     $00,$01,$00,$00,$00,$00,$01
0331 00                 ZERO    FCB     $00,$00,$00,$00,$00,$00,$00
0338 00                 INF     FCB     $00,$09,$99,$99,$99,$99,$63
033F 00                 RCON    FCB     $00,$00,$00,$00,$05,$00
0345 00                 RTODEG  FCB     $00,$05,$72,$95,$77,$95,$02
                        *  CONSTANTS FOR THE ALGORITHM
034C 00                 TRIGX   FCB     $00,$06,$75,$83,$61,$59,$00
0353 04                 ANGFAC  FCB     $04,$50,$00,$00,$00,$02
0359 05                         FCB     $05,$71,$05,$93,$14,$01
035F 05                         FCB     $05,$72,$93,$86,$98,$00
0365 05                         FCB     $05,$72,$95,$76,$04,$FF
036B 05                         FCB     $05,$72,$95,$77,$89,$FE
0371 05                         FCB     $05,$72,$95,$77,$95,$FD
0377 05                         FCB     $05,$72,$95,$77,$95,$FC
037D 05                         FCB     $05,$72,$95,$77,$95,$FB
0383 05                         FCB     $05,$72,$95,$77,$95,$FA
0389 00                 HYPCON  FCB     $00,$01,$11,$81,$37,$93,$01
0390 01                 HYPANG  FCB     $01,$00,$33,$53,$48,$00
0396 01                         FCB     $01,$00,$00,$33,$33,$FF
039C 01                         FCB     $01,$00,$00,$00,$33,$FE
03A2 01                         FCB     $01,$00,$00,$00,$00,$FD
03A8 01                         FCB     $01,$00,$00,$00,$00,$FC
03AE 01                         FCB     $01,$00,$00,$00,$00,$FB
03B4 01                         FCB     $01,$00,$00,$00,$00,$FA
03BA 01                         FCB     $01,$00,$00,$00,$00,$F9
03C0 01                         FCB     $01,$00,$00,$00,$00,$F8
                        *
                        *
                        * SIGN DETERMINANTS FOR SINE AND TANGENT
0030                    SSBYTE  EQU     00110000B
0050                    TSBYTE  EQU     01010000B
                        *
                        ** INTEGER
                        * THIS ROUTINE INTEGERIZES THE OPERAND POINTED TO BY X
03C6 A6 06              INTEGER LDA A   6,X             GET THE EXPONENT
03C8 C6 05                      LDA B   #5
03CA 08                         INX
03CB 81 00              TESTIT  CMP A   #0              CHECK FOR 0
03CD 2F 06                      BLE     GOTIT
03CF 08                         INX                     ADVANCE POINTER
03D0 5A                         DEC B
03D1 80 02                      SUB A   #2
03D3 20 F6                      BRA     TESTIT          DO AGAIN
03D5 26 0A              GOTIT   BNE     ALLZER          CHECK WHICH DIGIT
03D7 A6 00                      LDA A   0,X             GET BYTE
03D9 84 F0                      AND A   #$F0            MASK OUT LOW
03DB A7 00                      STA A   0,X             PUT BACK
03DD 08                 NEXDIG  INX                     ADVANCE POINTER
03DE 5A                         DEC B                   KICK COUNTER
```

```
03DF 27 04          BEQ    INTDON
03E1 6F 00    ALLZER CLR   0,X        SET 0
03E3 20 F8          BRA    NEXDIG
03E5 A6 00    INTDON LDA A 0,X        GET EXPONENT
03E7 2A 02          BPL    ALLOK
03E9 6F 00          CLR    0,X        SET 0
03EB 39       ALLOK  RTS              DONE
                    *
                    *
                    ** EXTRCT
                    * THIS ROUTINE EXTRACTS FACTORS FROM ARGUMENTS.  THE
                    * ARGUMENT IS ASSUMED IN XSIGN-XOP-XEX WHILE THE
                    * INDEX REGISTER POINTS TO THE FACTOR TO BE EXTRACTED.
                    * THE INTEGER NUMBER OF FACTORS IS RETURNED IN ZPRIME.
03EC DF 73    EXTRCT STX   C4         SAVE FACTOR POINTER
03EE BD 06 E5       JSR    MOVE3
03F1 BD 01 94       JSR    FPDIV      GO REMOVE FACTOR
03F4 CE 00 20       LDX    #RSIGN
03F7 8D CD          BSR    INTEGER    GO INTEGERIZE
03F9 CE 00 53       LDX    #ZPRIME
03FC BD 06 D5       JSR    MOVE1      SAVE THE FACTOR
03FF CE 00 2C       LDX    #XSIGN
0402 BD 06 EC       JSR    MOVE4      SAVE OPERAND
0405 CE 00 2C       LDX    #XSIGN
0408 BD 06 D5       JSR    MOVE1
040B DE 73          LDX    C4         GET FACTOR POINTER
040D BD 06 E5       JSR    MOVE3      SET YOP
0410 BD 01 80       JSR    FPMULT     GO MULTIPLY BACK
0413 CE 00 33       LDX    #YSIGN
0416 BD 06 D5       JSR    MOVE1      GET RESULT
0419 CE 00 45       LDX    #XPRIME    GET OPERAND
041C BD 06 DE       JSR    MOVE2
041F 7E 01 00       JMP    FPSUB      GO SUBTRACT
                    *
                    *
                    ** TRGFAC
                    * THIS ROUTINE IS THE FRONT END ROUTINE FOR
                    * TRIGONOMETRIC FUNCTIONS.  CONVERSION FROM RADIAN
                    * TO DEGREE MODE IS DONE HERE.  THE ANGLES ARE
                    * THEN REDUCED TO LESS THAN 90 DEGREES IN MAG-
                    * NITUDE AND MADE POSITIVE.  THIS ROUTINE THEN
                    * CALLS THE BASIC ROUTINE FOR TRIGONOMETRIC CORDIC.
0422 96 2C    TRGFAC LDA A XSIGN      GET THE SIGN
0424 97 6E          STA A  SIGN       SAVE THE SIGN
0426 7F 00 2C       CLR    XSIGN      SET =00
0429 96 76          LDA A  MODE       GO GET MODE INDICATOR
042B 27 0F          BEQ    DEGREE     IF 0, THEN DEGREE
042D CE 03 45       LDX    #RTODEG    PT TO CONSTANT
0430 BD 06 E5       JSR    MOVE3      MOVE TO YOP
0433 BD 01 80       JSR    FPMULT     GO CONVERT TO DEGREES
0436 CE 00 2C       LDX    #XSIGN     POINT TO XOP
0439 BD 06 D5       JSR    MOVE1      MOVE RESULT THERE
043C CE 03 1C DEGREE LDX   #C360      POINT TO CONSTANT
043F 8D AB          BSR    EXTRCT     GO REMOVE FACTORS OF 360
```

```
0441 CE 00 2C          LDX    #XSIGN
0444 BD 06 D5          JSR    MOVE1      MOVE THE RESULT
0447 CE 03 15          LDX    #NINETY
044A 8D A0             BSR    EXTRCT     REMOVE FACTORS OF 90
044C 96 54             LDA A  ZPRIME+1   GET QUADRANT
044E 97 75             STA A  QUADRT
0450 96 21             LDA A  RSIGN+1
0452 27 04             BEQ    EXCEPT     IF 0, EXCEPTION
0454 BD 04 DB          JSR    TRIGN      GO COMPUTE
0457 43                COM A             SET FLAG
0458 39       EXCEPT   RTS               DONE
               *
               *
               *
               ** COS
               * ENTRY POINT FOR COSINE
0459 86 01    COS      LDA A  #01        SET PHASE DIFFERENCE
045B 7F 00 2C          CLR    XSIGN
045E 20 01             BRA    SIN0       GO DO SINE
               *
               *
               ** SIN
               * ENTRY POINT FOR SINE
0460 4F       SIN      CLR A             SET BYTE
0461 36       SIN0     PSH A             SAVE
0462 8D BE             BSR    TRGFAC     GO COMPUTE
0464 07                TPA               SAVE STATUS
0465 33                PUL B             GET PHASE
0466 DB 75             ADD B  QUADRT     ADD TO QUADRANT
0468 C4 03             AND B  #3         MASK TO 0-3
046A D7 75             STA B  QUADRT
046C 06                TAP               RESTORE STATUS
046D 27 1C             BEQ    SPECL      IF Z, SPECIAL CASE
046F CE 00 4C          LDX    #YPRIME    POINT TO ANSWER
0472 56                ROR B             CHECK QUADRANT
0473 24 03             BCC    SIN1       IF 1 OR 3, THEN OK
0475 CE 00 45          LDX    #XPRIME    ELSE SWITCH TO COS
0478 C6 30    SIN1     LDA B  #SSBYTE    GET SINE SIGN BYTE
               *
               *
               ** TRGSGN
               * THIS ROUTINE SELECTS THE SIGN OF THE RESULT
               * OF TRIG FUNCTIONS AND THEN GOES TO THE
               * ROUNDING PROCESSOR.
047A 96 75    TRGSGN   LDA A  QUADRT     GET QUADRANT INFO
047C 27 04    TESTSG   BEQ    GOTBIT     CHECK Q1
047E 58                ASL B             SHIFT SIGN BYTE
047F 4A                DEC A             COUNT DOWN QUADRANT
0480 20 FA             BRA    TESTSG     DO AGAIN
0482 96 6E    GOTBIT   LDA A  SIGN       RETRIEVE SIGN
0484 5D                TST B             CHECK NEW SIGN
0485 2A 01             BPL    TRGDON     IF POS USE SAME SIGN
0487 43                COM A             ELSE  USE OTHER
0488 7E 06 97 TRGDON   JMP    ROUND0     GO ROUND OFF
```

```
                        *
                        *
                        ** SPECL
                        * THIS ROUTINE HANDLES THE SPECIAL CASES OF
                        * TRIG FUNCTIONS.  IE.  0,90,180,270, AND 360
048B CE 03 31   SPECL   LDX     #ZERO       SPECIAL  CASE 0
048E 56                 ROR B               CHECK QUADRANT
048F 24 E7              BCC     SIN1        IF 1 OR 3 THEN 0
0491 CE 03 2A           LDX     #ONE        SET FOR 1
0494 20 E2              BRA     SIN1
                        *
                        *
                        ** TAN
                        * ENTRY POINT FOR TANGENT
0496 BD 04 22   TAN     JSR     TRGFAC      GO COMPUTE
0499 07                 TPA                 SAVE STATUS
049A D6 75              LDA B   QUADRT      GET QYADRANT INFO
049C 06                 TAP                 RESTORE STATUS
049D 27 25              BEQ     SPECLT      IF Z, SPECIAL CASE
049F 56                 ROR B               CHECK QUADRANT
04A0 24 0D              BCC     TAN1        IF 1 OR 3 DO TAN
04A2 CE 00 45           LDX     #XPRIME     ELSE DO COTAN
04A5 BD 06 DE           JSR     MOVE2       MOVE TO XOP
04A8 CE 00 4C           LDX     #YPRIME
04AB 8D 28              BSR     TAN3        GO DIVIDE
04AD 20 02              BRA     TAN4
04AF 8D 1B      TAN1    BSR     TAN2        GO DIVIDE
04B1 CE 00 20   TAN4    LDX     #RSIGN      POINT TO RESULT
04B4 C6 50              LDA B   #TSBYTE     GET TAN SIGN BYTE
04B6 96 3A              LDA A   OVFL        CHECK OVERFLOW
04B8 27 C0              BEQ     TRGSGN      IF NO GO FIX SIGNS
04BA CE 03 38   INFIN   LDX     #INF        POINT TO  INFINITY
04BD 86 FF              LDA A   #$FF
04BF 97 3A              STA A   OVFL        SET OVERFLOW
04C1 7E 06 C7   TAN5    JMP     MOVE0       SET
04C4 56         SPECLT  ROR B               CHECK QUADRANT
04C5 25 F3              BCS     INFIN       IF 90 OR 270, THEN INFINITY
04C7 CE 03 31           LDX     #ZERO       ELSE 0
04CA 20 F5              BRA     TAN5
04CC CE 00 4C   TAN2    LDX     #YPRIME     POINT TO SORE
04CF BD 06 DE           JSR     MOVE2       MOVE TO XOP
04D2 CE 00 45           LDX     #XPRIME     POINT TO X STORE
04D5 BD 06 E5   TAN3    JSR     MOVE3       MOVE TO YOP
04D8 7E 01 94           JMP     FPDIV       GO DIVIDE
                        *
                        *
                        ** TRIGN
                        * THIS IS THE IMPLEMENTATION OF THE ALGORITHM
                        * OF TRIGONOMETRIC CORDIC.
04DB CE 00 61   TRIGN   LDX     #ANGLE      POINT TO ANGLE STORE
04DE DF 6F              STX     OPX         SAVE PTR
04E0 BD 06 D5           JSR     MOVE1       MOVE ARGUMENT THERE
04E3 CE 03 4C           LDX     #TRIGX      POINT TO INIT CONST.
04E6 BD 06 EC           JSR     MOVE4       SET UP
```

```
04E9 CE 03 4C          LDX    #TRIGX
04EC BD 06 F3          JSR    MOVE5
04EF 4F        TRIG    CLR A
04F0 97 6B             STA A  YOPN      SET FOR Y ADDITION
04F2 97 6D             STA A  LSTSGN
04F4 43                COM A
04F5 97 6A             STA A  XOPN      SET FOR X SUBTRACTION
04F7 97 6C             STA A  AOPN      SET FOR ANGLE SUBTRACTION
04F9 86 01             LDA A  #01
04FB 97 71             STA A  ITER      SET ITERATION COUNTER
04FD CE 03 52          LDX    #ANGFAC-1 POINT TO ANGLE FACTOR
0500 DF 68             STX    AFACTX    STORE POINTER
0502 8D 1D             BSR    NEWAN1    COMPUTE NEW ANGLE
0504 BD 05 8F  TRIG1   JSR    NEXANG    GET TO NEXT FACTOR
0507 86 09             LDA A  #9        SET FOR 9 ITERATIONS
0509 36        TRIG2   PSH A            SAVE
050A 8D 2B             BSR    NEWOPN    SET NEW OPERATIONS
050C 8D 3D             BSR    NEWXY     CALCULATE NEW X AND Y
050E BD 05 1F          JSR    NEWANG    COMPUTE NEW ANGLE
0511 32                PUL A            GET ITERATION
0512 4A                DEC A            ONCE DONE
0513 26 F4             BNE    TRIG2     CHECK IF DONE
0515 96 71     TRIG4   LDA A  ITER      GET COUNT
0517 4C                INC A
0518 97 71             STA A  ITER      BUMP ITERATION COUNT
051A 81 09             CMP A  #9        CHECK DONE ?
051C 26 E6             BNE    TRIG1     CHECK IF DONE
051E 39        TRIG5   RTS              DONE
               *
               *
               ** NEWANG
               * THIS ROUTINE CALCULATES THE NEW ANGLE BASED
               * ON THE SIGN DETERMINANT FOR CORDIC.
051F DE 68     NEWANG  LDX    AFACTX    GET ANGLE POINTER
0521 BD 06 E5  NEWAN1  JSR    MOVE3     MOVE IT
0524 CE 00 61          LDX    #ANGLE    POINT TO ANGLE ACC.
0527 BD 06 DE          JSR    MOVE2     SET UP
052A 96 6C             LDA A  AOPN      GET ANGLE OPERATION (+ OR -)
052C 97 33             STA A  YSIGN     FIX UP THE SIGN ACCORDINGLY
052E BD 01 03          JSR    FPADD     GO ADD TOGETHER
0531 CE 00 61  NEW1    LDX    #ANGLE    POINT TO ANGLE STORE
0534 7E 06 D5          JMP    MOVE1     RESTORE NEW VALUE
               *
               *
               ** NEWOPN
               * THIS ROUTINE SELECTS NEW OPERATIONS FOR X,Y
               * AND ANGLE BASED ON THE SIGN DETERMINANT.
               * OPX HOLDS THE POINTER TO THE DETERMINANT.
0537 DE 6F     NEWOPN  LDX    OPX       GET OPERATION POINTER
0539 A6 00     NEWOP1  LDA A  0,X       GET NEW SIGN
053B 91 6D     NEWOP3  CMP A  LSTSGN    COMPARE WITH LAST SIGN
053D 27 0B             BEQ    NEWOP2    IF SAME, DON'T CHANGE OPER.
053F 97 6D             STA A  LSTSGN    SAVE FOR NEXT TIME
0541 73 00 6A  NEWOP4  COM    XOPN
```

```
0544 73 00 6B          COM     YOPN
0547 73 00 6C          COM     AOPN        CHANGE OPERATIONS
054A 39        NEWOP2  RTS
               *
               *
               ** NEWXY
               * THIS ROUTINE CALCULATES THE NEW X AND Y VALUES
               * FOR THE CORDIC ALGORITHM BASED ON THE SIGN
               * DETERMINANTS FOR THE INDIVIDUAL QUANTITIES.
054B CE 00 45  NEWXY   LDX     #XPRIME     POINT TO X
054E BD 06 DE          JSR     MOVE2       MOVE TO XOP
0551 CE 00 4C          LDX     #YPRIME     POINT TO Y
0554 BD 06 E5          JSR     MOVE3       MOVE TO YOP
0557 96 39             LDA A   YEX         GET EXPONENT
0559 90 71             SUB A   ITER        SCALE FOR ITERATION
055B 97 39             STA A   YEX         PUT BACK
055D 96 6A             LDA A   XOPN        CHECK X OPERATION
055F 2A 03             BPL     NEWXY1
0561 73 00 33          COM     YSIGN       CHANGE SIGNS
0564 BD 01 03  NEWXY1  JSR     FPADD       GO ADD IN
0567 CE 00 45          LDX     #XPRIME
056A BD 06 E5          JSR     MOVE3       MOVE TO YOP
056D CE 00 4C          LDX     #YPRIME
0570 BD 06 DE          JSR     MOVE2       MOVE TO XOP
0573 CE 00 45          LDX     #XPRIME
0576 BD 06 D5          JSR     MOVE1       MOVE NEW VALUE
0579 96 39             LDA A   YEX         GET EXPONENT
057B 90 71             SUB A   ITER        SCALE FOR ITERATION
057D 97 39             STA A   YEX         PUT BACK
057F 96 6B             LDA A   YOPN        GET OPERATION
0581 2A 03             BPL     NEWXY2
0583 73 00 33          COM     YSIGN
0586 BD 01 03  NEWXY2  JSR     FPADD       GO COMPUTE NEW VALUE
0589 CE 00 4C          LDX     #YPRIME
058C 7E 06 D5          JMP     MOVE1       RESTORE NEW VALUE
               *
               *
               ** NEXANG
               * THIS SECTION MOVES THE POINTER TO THE NEXT
               * ANGLE FACTOR.
058F 86 06     NEXANG  LDA A   #6          LOAD OFFSET
0591 9B 69             ADD A   AFACTX+1    ADD IN
0593 97 69             STA A   AFACTX+1    SAVE BACK
0595 96 68             LDA A   AFACTX      GET MS BYTE
0597 89 00             ADC A   #0          ADD IN  CARRY
0599 97 68             STA A   AFACTX      STORE BACK
059B 39                RTS
               *
               *
               ** ARCCOS
               * ENTRY POINT FOR ARCCOSINE
059C 8D 21     ARCCOS  BSR     ARC         GO DO ARC FUNCTION
059E BD 06 E5          JSR     MOVE3       MOVE TO YOP
05A1 96 6E             LDA A   SIGN        GET SIGN
```

```
05A3 97 33              STA A  YSIGN     SET SIGN
05A5 CE 03 15           LDX    #NINETY
05A8 BD 06 DE           JSR    MOVE2     SET X=90
05AB BD 01 00           JSR    FPSUB     SUBTRACT Y FROM 90
05AE CE 00 20           LDX    #RSIGN
05B1 A6 00              LDA A  0,X       GET THE SIGN
05B3 36                 PSH A            SAVE SIGN
05B4 7E 06 82           JMP    ATAN3     GO FIX
                        *
                        *
                        ** ARCSIN
                        * ENTRY POINT FOR ARCSINE
05B7 8D 06              ARCSIN BSR    ARC       GO DO ARC FUNCTION
05B9 96 6E             LDA A  SIGN      GET SIGN
05BB 36                 PSH A            SAVE
05BC 7E 06 82           JMP    ATAN3     GO FIX
                        *
                        *
                        ** ARC
                        * INVERSE TRIGONOMETRIC CORDIC
05BF 96 2C              ARC    LDA A  XSIGN     GET SIGN
05C1 97 6E              STA A  SIGN      SAVE SIGN
05C3 7F 00 2C           CLR    XSIGN     SET +
05C6 CE 03 2A           LDX    #ONE
05C9 BD 03 EC           JSR    EXTRCT    CHECK >1.0
05CC CE 00 20           LDX    #RSIGN    POINT TO REMAINDER
05CF 96 59              LDA A  ZPRIME+6
05D1 81 01              CMP A  #1        IF SO, ERROR
05D3 22 0C              BHI    ARC5
05D5 96 54              LDA A  ZPRIME+1  CHECK FACTOR
05D7 27 0F              BEQ    ARC3      ZERO?
05D9 81 01              CMP A  #1        CHECK FACTOR
05DB 22 04              BHI    ARC5      TOO MANY?
05DD 96 21              LDA A  RSIGN+1   CHECK REMAINDER
05DF 27 03              BEQ    ARC4      IF 1.0, SPECIAL CASE
05E1 7E 08 F5  ARC5     JMP    ILLEGL
05E4 CE 03 15  ARC4     LDX    #NINETY
05E7 39                 RTS              DONE
05E8 96 21     ARC3     LDA A  RSIGN+1   CHECK FOR 0.0
05EA 26 01              BNE    ARC6
05EC 39                 RTS
05ED CE 00 53  ARC6     LDX    #ZPRIME
05F0 BD 06 D5           JSR    MOVE1     SAVE THE SCALED ARG.
05F3 CE 03 52           LDX    #ANGFAC-1
05F6 DF 68              STX    AFACTX    SAVE NEW PTR
05F8 BD 06 FA           JSR    MOVE6     SET ANGLE = 45 DEG.
05FB CE 03 4C           LDX    #TRIGX
05FE BD 06 EC           JSR    MOVE4     SET X
0601 CE 03 4C           LDX    #TRIGX
0604 BD 06 F3           JSR    MOVE5     SET Y
0607 86 01              LDA A  #01
0609 97 71              STA A  ITER      SET UP ITERATION COUNTER
060B 8D 82     ARC1     BSR    NEXANG    GO GET NEXT ANGLE
060D 86 09              LDA A  #9
```

```
060F 36          ARC2    PSH A           SET FOR 9 LOOPS
0610 CE 00 53    ARCCHK  LDX   #ZPRIME   POINT TO SCALED ARG.
0613 BD 06 DE            JSR   MOVE2
0616 CE 00 4C            LDX   #YPRIME
0619 BD 06 E5            JSR   MOVE3     SET UP FOR COMPARISON
061C BD 01 00            JSR   FPSUB     GO SUBTRACT
061F 5F                  CLR B
0620 96 45               LDA A XPRIME    CHECK SIGN OF X
0622 26 04               BNE   ARCC3     IF MINUS, REVERSE
0624 96 20               LDA A RSIGN     GET COMPARISON INDICATOR
0626 2A 01               BPL   ARCC2
0628 53          ARCC3   COM B           CHANGE
0629 D7 6B       ARCC2   STA B YOPN
062B D7 6C               STA B AOPN
062D 53                  COM B
062E D7 6A               STA B XOPN      FIX OPERATORS
0630 BD 05 4B    ARCC5   JSR   NEWXY     COMPUTE X & Y CHANGES
0633 BD 05 1F            JSR   NEWANG    COMPUTE NEW ANGLE
0636 32                  PUL A
0637 4A                  DEC A           DECREMENT COUNTER
0638 26 D5               BNE   ARC2      IF NOT DONE, DO AGAIN
063A 96 71               LDA A ITER
063C 4C                  INC A           KICK ITERATION COUNT
063D 97 71               STA A ITER
063F 81 09               CMP A #9        CHECK IF DONE
0641 26 C8               BNE   ARC1
0643 CE 00 61            LDX   #ANGLE    POINT TO ANSWER
0646 39                  RTS             DONE
                 *
                 *
                 ** ARCTAN
                 * ENTRY POINT FOR ARCTANGENT
0647 96 2C       ARCTAN  LDA A XSIGN
0649 36                  PSH A           SAVE SIGN
064A 7F 00 2C            CLR   XSIGN     SET SIGN = +
064D CE 00 2C            LDX   #XSIGN
0650 A6 01               LDA A 1,X       GET FIRST BYTE
0652 27 44               BEQ   ROUND     IF 0, SPECIAL CASE
0654 BD 06 F3            JSR   MOVE5     MOVE ARG. TO Y
0657 CE 03 2A            LDX   #ONE
065A BD 06 EC            JSR   MOVE4     SET X=1
065D CE 03 52            LDX   #ANGFAC-1
0660 DF 68               STX   AFACTX    STORE PTR
0662 BD 06 FA            JSR   MOVE6     SET ANGLE=45
0665 CE 00 4C            LDX   #YPRIME
0668 DF 6F               STX   OPX
066A 4F                  CLR A
066B 97 6C               STA A AOPN
066D 97 6A               STA A XOPN
066F 97 71               STA A ITER
0671 97 6D               STA A LSTSGN    SET UP CONSTANTS
0673 43                  COM A
0674 97 6B               STA A YOPN      SET Y SUBTRACT
0676 BD 05 4B            JSR   NEWXY     GET INITIAL X AND Y
```

```
0679 7C 00 71          INC     ITER      SET COUNTER
067C BD 05 04          JSR     TRIG1     GO COMPUTE
067F CE 00 61          LDX     #ANGLE    POINT TO RESULT
0682 96 76     ATAN3   LDA A   MODE      CHECK MODE
0684 27 0F             BEQ     ATAN5     IF DEGREE, DONE
0686 BD 06 DE          JSR     MOVE2     PUT ANSWER IN XOP
0689 CE 03 45          LDX     #RTODEG
068C BD 06 E5          JSR     MOVE3     SET Y= CONV. CONST.
068F BD 01 94          JSR     FPDIV     GO SCALE
0692 CE 00 20          LDX     #RSIGN    POINT TO ANSWER
0695 20 01     ATAN5   BRA     ROUND
               *
               *
               ** ROUND
               * THIS IS THE ROUNDING PROCESSOR.  THE ROUNDING
               * CONSTANT IS RCON.
0697 36        ROUND0  PSH A             SAVE THE SIGN
0698 A6 06     ROUND   LDA A   6,X       GET EXPONENT
069A 36                PSH A             SAVE
069B BD 06 C7          JSR     MOVE0     MOVE TARGET TO AC
069E CE 03 3F  ROUND1  LDX     #RCON
06A1 8D 42             BSR     MOVE3     MOVE ROUNDING CONSTANT TO YOP
06A3 BD 01 CD          JSR     BCDADD    GO ADD IN ROUNDING
06A6 32                PUL A             GET EXPONENT
06A7 97 26             STA A   RSIGN+6   INSTALL
06A9 32                PUL A             GET SIGN
06AA 97 20             STA A   RSIGN     SET SIGN
06AC 96 24             LDA A   RSIGN+4
06AE 84 F0             AND A   #$F0      MASK OFF
06B0 97 24             STA A   RSIGN+4   STORE BACK
06B2 4F                CLR A
06B3 97 25             STA A   RSIGN+5   ZERO OUT LAST BYTE
06B5 BD 01 4A          JSR     NORM      GO NORMALIZE
06B8 5F                CLR B
06B9 96 26             LDA A   RSIGN+6   GET EXPONENT
06BB 81 63             CMP A   #$63      CHECK EXPONENT FOR >63
06BD 2E 04             BGT     ERROR
06BF 81 9C             CMP A   #$9C      CHECK <-63
06C1 2E 01             BGT     ANSOK
06C3 53        ERROR   COM B
06C4 D7 3A     ANSOK   STA B   OVFL      SET OVERFLOW
06C6 39                RTS               DONE
               *
               *
               ** THIS SECTION OF CODE PERFORMS ALL OF THE
               * OPERAND TRANSPORTATION.
               *
               * MOVE X TO  RESULT
06C7 DF 41     MOVE0   STX     XTEMP2    SAVE SOURCE PTR.
06C9 CE 00 20          LDX     #RSIGN    POINT TO RESULT
06CC DF 3F     MOVE01  STX     XTEMP     SAVE DESTINATION PTR
06CE DE 41             LDX     XTEMP2
06D0 C6 07     MOVE02  LDA B   #7         SET FOR 7 BYTES
06D2 7E 02 62          JMP     XOPTO1    MOVE IT
```

```
                        *
                        *   MOVE RESULT TO X
06D5 DF 3F      MOVE1   STX     XTEMP       SAVE DESTINATION PTR
06D7 CE 00 20           LDX     #RSIGN      POINT TO RESULT
06DA DF 41              STX     XTEMP2      SET SOURCE PTR
06DC 20 F2              BRA     MOVE02
                        *
                        *   MOVE X TO XOP
06DE DF 41      MOVE2   STX     XTEMP2      SAVE SOURCE PTR
06E0 CE 00 2C           LDX     #XSIGN      POINT TO DESTINATION
06E3 20 E7              BRA     MOVE01
                        *
                        *   MOVE X TO YOP
06E5 DF 41      MOVE3   STX     XTEMP2      SAVE SOURCE PTR
06E7 CE 00 33           LDX     #YSIGN      POINT TO DESTINATION
06EA 20 E0              BRA     MOVE01
                        *
                        *   MOVE X TO XPRIME
06EC DF 41      MOVE4   STX     XTEMP2      SAVE SOURCE PTR
06EE CE 00 45           LDX     #XPRIME     POINT TO DESTINATION
06F1 20 D9              BRA     MOVE01      GO MOVE
                        *
                        *   MOVE X TO YPRIME
06F3 DF 41      MOVE5   STX     XTEMP2      SAVE SOURCE POINTER
06F5 CE 00 4C           LDX     #YPRIME     POINT TO DESTINATION
06F8 20 D2              BRA     MOVE01      MOVE IT
                        *
                        *   MOVE X TO ANGLE
06FA DF 41      MOVE6   STX     XTEMP2      SAVE SOURCE
06FC CE 00 61           LDX     #ANGLE      POINT
06FF 20 CB              BRA     MOVE01
                        *
                        *
                        ** XTOY
                        * THIS SECTION PERFORMS THE FUNCTION X**Y
                        * OR X TO Y POWER
0701 CE 00 33   XTOY    LDX     #YSIGN      POINT TO POWER
0704 8D C1              BSR     MOVE0
0706 CE 00 5A   XTOY0   LDX     #TPRIME
0709 8D CA              BSR     MOVE1       SAVE IN TPRIME
070B CE 00 2C           LDX     #XSIGN      POINT TO ARG
070E A6 01              LDA A   1,X         GET MS BYTE
0710 26 03              BNE     XTOY3
0712 7E 07 C3           JMP     SINH1
0715 BD 08 36   XTOY3   JSR     NATLOG      TAKE LN(X)
0718 96 72              LDA A   NLEGAL      CHECK ILLEGAL OPER.
071A 27 01              BEQ     XTOY2
071C 39         XTOY1   RTS
071D 96 3A      XTOY2   LDA A   OVFL        CHECK OVERFLOW
071F 26 FB              BNE     XTOY1
0721 CE 00 2C           LDX     #XSIGN
0724 8D AF              BSR     MOVE1       MOVE RESULT TO X
0726 CE 00 5A           LDX     #TPRIME
0729 8D BA              BSR     MOVE3       MOVE POWER TO Y
```

```
072B BD 01 80           JSR    FPMULT    GO MULTIPLY
072E 96 3A              LDA A  OVFL      CHECK OVERFLOW
0730 26 EA              BNE    XTOY1
0732 CE 00 2C           LDX    #XSIGN
0735 8D 9E              BSR    MOVE1     MOVE RESULT BACK TO X
0737 20 26              BRA    EXP       GO EXPONENTIATE
                *
                *
                ** SQRT
                * THIS ROUTINE IMPLEMENTS  SQRT(X)
                * AS SPECIAL CASE OF X**Y
0739 CE 03 31   SQRT    LDX    #ZERO
073C 8D 89              BSR    MOVE0
073E 86 05              LDA A  #$05
0740 97 21              STA A  RSIGN+1   SET RESULT TO 0.5
0742 20 C2              BRA    XTOY0
                *
                *
                ** INVERS
                * THIS ROUTINE IMPLEMENTS 1/X
0744 CE 00 2C   INVERS  LDX    #XSIGN    POINT TO ARG
0747 8D 9C              BSR    MOVE3     MOVE TO YOP
0749 CE 03 2A           LDX    #ONE      POINT TO ONE
074C 8D 90              BSR    MOVE2     SET XOP=1
074E 7E 01 94           JMP    FPDIV     GO DIVIDE
                *
                *
                ** ALOG10
                * ENTRY POINT FOR COMMON ANTILOG   (OR 10**X)
0751 CE 03 07   ALOG10  LDX    #LN10     POINT TO CONST
0754 8D 8F              BSR    MOVE3     SET Y=LN10
0756 BD 01 80           JSR    FPMULT    GO SCALE
0759 CE 00 2C           LDX    #XSIGN
075C BD 06 D5           JSR    MOVE1     MOVE SCALED ARGUMENT
                *
                *
                ** EXP
                * IMPLEMENTATION OF E**X  (EXPONENTIATION)
075F 96 32      EXP     LDA A  XSIGN+6   GET EXPONENT OF ARG
0761 81 03              CMP A  #3        CHECK FOR OVFL
0763 2F 03              BLE    EXP1      IF SO, OK
0765 7E 04 BA   EXP11   JMP    INFIN
0768 81 F9      EXP1    CMP A  #$F9      CHECK <-6
076A 2E 06              BGT    EXP2
076C CE 03 2A   EXP10   LDX    #ONE
076F 7E 06 C7   EXP12   JMP    MOVE0     SET ANSWER
0772 CE 03 07   EXP2    LDX    #LN10
0775 BD 03 EC           JSR    EXTRCT    REMOVE FACTORS OF LN10
0778 CE 00 2C           LDX    #XSIGN
077B BD 06 D5           JSR    MOVE1     MOVE REMAINDER TO XOP
077E BD 07 D9           JSR    HYP       GO DO HYPERBOLIC CORDIC
0781 CE 00 45           LDX    #XPRIME
0784 BD 06 DE           JSR    MOVE2     SET UP XOP
0787 CE 00 4C           LDX    #YPRIME
```

```
078A BD 06 E5           JSR    MOVE3      SET UP YOP
078D BD 01 03           JSR    FPADD      EXP=SINH+COSH
0790 D6 59              LDA B  ZPRIME+6   GET FACTOR
0792 C1 02              CMP B  #2         CHECK EXPONENT
0794 23 09              BLS    EXP21
0796 CE 03 31           LDX    #ZERO
0799 96 53              LDA A  ZPRIME     GET SIGN
079B 2B D2              BMI    EXP12      IF MINUS THEN 0
079D 20 C6              BRA    EXP11      ELSE INFINITY
079F 96 54      EXP21   LDA A  ZPRIME+1
07A1 56                 ROR B
07A2 25 0C              BCS    EXPOK1
07A4 48                 ASL A
07A5 16                 TAB
07A6 48                 ASL A
07A7 48                 ASL A
07A8 1B                 ABA               MULTIPLY BY 10
07A9 D6 55              LDA B  ZPRIME+2   GET ONES
07AB 54                 LSR B
07AC 54                 LSR B
07AD 54                 LSR B
07AE 54                 LSR B             MOVE TO LS HALF
07AF 1B                 ABA               MERGE
07B0 D6 53      EXPOK1  LDA B  ZPRIME     GET SIGN
07B2 27 01              BEQ    ADDON      IF + JUST ADD
07B4 40                 NEG A             CHANGE SIGN
07B5 9B 26      ADDON   ADD A  RSIGN+6    ADD IN
07B7 97 26              STA A  RSIGN+6    PUT BACK
07B9 CE 00 20           LDX    #RSIGN     POINT TO RESULT
07BC 20 05              BRA    SINH1      GO ROUND
                *
                *
                *
                ** SINH
                * ENTRY POINT FOR HYPERBOLIC SINE
07BE 8D 19      SINH    BSR    HYP        CALCULATE
07C0 CE 00 4C           LDX    #YPRIME    POINT TO ANSWER
07C3 A6 00      SINH1   LDA A  0,X        GET SIGN
07C5 7E 06 97           JMP    ROUND0     GO ROUND
                *
                *
                ** COSH
                * ENTRY POINT FOR HYPERBOLIC COSINE
07C8 8D 0F      COSH    BSR    HYP        CALCULATE HYPERBOLIC
07CA CE 00 45           LDX    #XPRIME    POINT TO ANSWER
07CD 20 F4              BRA    SINH1      MOVE IT
                *
                *
                ** TANH
                * ENTRY POINT FOR HYPERBOLIC TANGENT
07CF 8D 08      TANH    BSR    HYP        GO CALCULATE
07D1 BD 04 CC           JSR    TAN2       TANH=SINH/COSH
07D4 CE 00 20           LDX    #RSIGN     POINT TO RESULT
07D7 20 EA              BRA    SINH1      GO ROUND
```

```
                        *
                        *
                        ** HYP
                        * THIS ROUTINE IMPLEMENTS HYPERBOLIC CORDIC.
07D9 CE 03 89  HYP      LDX     #HYPCON     POINT TO CONSTANT
07DC BD 06 EC           JSR     MOVE4       SET UP XPRIME
07DF CE 03 31           LDX     #ZERO
07E2 BD 06 F3           JSR     MOVE5       SET YPRIME=0
07E5 CE 00 2C           LDX     #XSIGN      POINT TO ARGUMENT
07E8 BD 06 FA           JSR     MOVE6       MOVE TO ANGLE
07EB CE 00 61           LDX     #ANGLE
07EE DF 6F              STX     OPX         SET OPERATION DETERMINANT
07F0 CE 03 8F           LDX     #HYPANG-1
07F3 DF 68              STX     AFACTX      SET ANGLE FACTOR POINTER
07F5 4F                 CLR A
07F6 97 6D              STA A   LSTSGN      SET LAST SIGN
07F8 97 6A              STA A   XOPN        SET FOR ADD ON X
07FA 97 6B              STA A   YOPN        SET FOR ADD ON Y
07FC 43                 COM A
07FD 97 6C              STA A   AOPN        SET FOR SUB. ON ANGLE
07FF 86 01      HYP0    LDA A   #1
0801 97 71              STA A   ITER        SET ITERATION COUNTER
0803 86 16      HYP1    LDA A   #22
0805 36         HYP2    PSH A
0806 BD 05 37           JSR     NEWOPN      SET NEW OPERATIONS
0809 BD 05 4B           JSR     NEWXY       CALCULATE NEW X AND Y
080C BD 05 1F           JSR     NEWANG      CALCULATE NEW ANGLE
080F 32                 PUL A
0810 4A                 DEC A               DECREMENT COUNTER
0811 26 F2              BNE     HYP2
0813 BD 05 8F           JSR     NEXANG      POINT TO NEXT FACTOR
0816 96 71              LDA A   ITER
0818 4C                 INC A               KICK ITERATION COUNT
0819 97 71              STA A   ITER
081B 81 0A              CMP A   #10         CHECK IF DONE
081D 26 E4              BNE     HYP1        LOOP
081F 39                 RTS                 DONE
                        *
                        *
                        ** LOG10
                        * IMPLEMENTATION OF COMMON LOGARITHM (BASE 10)
0820 8D 14      LOG10   BSR     NATLOG      GO DO NATLOG
0822 CE 00 2C           LDX     #XSIGN
0825 BD 06 D5           JSR     MOVE1       MOVE RESULT TO X
0828 CE 03 07           LDX     #LN10
082B BD 06 E5           JSR     MOVE3       SET Y= LN10
082E BD 01 94           JSR     FPDIV       SCALE
0831 CE 00 20  LOG10A   LDX     #RSIGN      POINT TO RESULT
0834 20 8D              BRA     SINH1       GO ROUND
                        *
                        *
                        ** NATLOG
                        * IMPLEMENTATION OF NATURAL LOGARITHM (BASE E)
0836 CE 00 2C  NATLOG   LDX     #XSIGN
```

```
0839 BD 06 F3          JSR    MOVE5      SAVE IN YPRIME
083C CE 03 2A          LDX    #ONE
083F BD 06 E5          JSR    MOVE3      SET Y=1
0842 BD 01 00          JSR    FPSUB      SUBTRACT 1
0845 96 21             LDA A  RSIGN+1    GET MS BYTE
0847 26 06             BNE    NATL2
0849 CE 03 31          LDX    #ZERO      SET ZERO
084C 7E 07 C3          JMP    SINH1      GO FIX
084F CE 03 2A  NATL2   LDX    #ONE
0852 BD 06 DE          JSR    MOVE2      USE CLEAR TRICK
0855 96 52             LDA A  YPRIME+6   GET ARGS EXP.
0857 2A 04             BPL    SIGNOK     IF + NO TRICKS
0859 40                NEG A             IF MINUS MAKE PLUS
085A 73 00 2C          COM    XSIGN      CHANGE SIGNS TO COMP.
085D C6 FF     SIGNOK  LDA B  #$FF       SET -1
085F 5C        SUBT    INC B             KICK COUNTER
0860 80 0A             SUB A  #10        TAKE OUT TEN
0862 24 FB             BCC    SUBT       IF NO BORROW OK
0864 8B 0A             ADD A  #10        ELSE ADD BACK
0866 97 2D             STA A  XSIGN+1    STORE ONES
0868 5D                TST B             CHECK IF HAVE TENS
0869 27 0C             BEQ    FACTOK     IF NOT, ALL DONE FOOLING
086B D7 2D             STA B  XSIGN+1    SAVE ONES
086D 48                ASL A
086E 48                ASL A
086F 48                ASL A
0870 48                ASL A             GET TO MS HALF
0871 97 2E             STA A  XSIGN+2    SAVE ONES
0873 86 02             LDA A  #02        SET EXP=2
0875 97 32             STA A  XEX        STORE IT
0877 CE 03 07  FACTOK  LDX    #LN10
087A BD 06 E5          JSR    MOVE3      SET Y=LN10
087D BD 01 80          JSR    FPMULT     GO SCALE
0880 CE 00 53          LDX    #ZPRIME
0883 BD 06 D5          JSR    MOVE1      SAVE SCALING FACTOR
0886 96 4D             LDA A  YPRIME+1   CHECK FOR ZERO
0888 27 6B             BEQ    ILLEGL     IF 0 ERROR
088A CE 00 4C          LDX    #YPRIME
088D A6 00     INVHYP  LDA A  0,X        GET SIGN
088F 2B 64             BMI    ILLEGL     IF NEGATIVE, ILLEGAL
0891 6F 06             CLR    6,X        SET EXP = 0
0893 BD 06 DE          JSR    MOVE2      RETRIEVE ARGUMENT
0896 CE 03 2A          LDX    #ONE
0899 BD 06 E5          JSR    MOVE3      SET Y=1
089C BD 01 03          JSR    FPADD
089F CE 00 45          LDX    #XPRIME
08A2 BD 06 D5          JSR    MOVE1      SET X=ARG+1
08A5 CE 00 4C          LDX    #YPRIME
08A8 BD 06 DE          JSR    MOVE2      SET XOP=ARG
08AB CE 03 2A          LDX    #ONE
08AE BD 06 E5          JSR    MOVE3      SET YOP=1
08B1 BD 01 00          JSR    FPSUB
08B4 CE 00 4C          LDX    #YPRIME
08B7 DF 6F             STX    OPX        SET DECISION PTR
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08B9 BD 06 D5          JSR    MOVE1     SET Y=ARG-1
08BC CE 03 31          LDX    #ZERO
08BF BD 06 FA          JSR    MOVE6     SET ANG=0
08C2 4F                CLR A
08C3 97 6C             STA A  AOPN
08C5 97 6D             STA A  LSTSGN
08C7 43                COM A
08C8 97 6B             STA A  YOPN      SET UP OPERATIONS
08CA 97 6A             STA A  XOPN
08CC CE 03 8F          LDX    #HYPANG-1
08CF DF 68             STX    AFACTX    SET CONSTANT PTR.
08D1 BD 07 FF          JSR    HYP0      GO COMPUTE
08D4 CE 00 61          LDX    #ANGLE
08D7 BD 06 D5          JSR    MOVE1     SET X=RESULT
08DA CE 03 23          LDX    #TWO
08DD BD 06 E5          JSR    MOVE3     SET Y= 2
08E0 BD 01 80          JSR    FPMULT    GO SCALE
08E3 CE 00 2C          LDX    #XSIGN
08E6 BD 06 D5          JSR    MOVE1     GET RESULT
08E9 CE 00 53          LDX    #ZPRIME
08EC BD 06 E5          JSR    MOVE3     SET Y= ADDON
08EF BD 01 03          JSR    FPADD     GO ADD IT ON
08F2 7E 08 31          JMP    LOG10A    GO ROUND
                *
                *
                ** THIS ROUTINE SETS ILLEGAL OPERATION INDICATOR
08F5 86 FF      ILLEGL LDA A  #$FF
08F7 97 72             STA A  NLEGAL    SET NOT LEGAL
08F9 39                RTS              DONE
```

SYMBOL TABLE:

ADDON	07B5	AFACTX	0068	ALLOK	03EB	ALLZER	03E1	ALOG10	0751
ANGFAC	0353	ANGLE	0061	ANSOK	06C4	AOPN	006C	ARC	05BF
ARC1	060B	ARC2	060F	ARC3	05E8	ARC4	05E4	ARC5	05E1
ARC6	05ED	ARCC2	0629	ARCC3	0628	ARCC5	0630	ARCCHK	0610
ARCCOS	059C	ARCSIN	05B7	ARCTAN	0647	ARGSTR	0960	ATAN3	0682
ATAN5	0695	BCDADD	01CD	BYTE	E055	C360	031C	C4	0073
COS	0459	COSH	07C8	DEGREE	043C	E	030E	ERROR	06C3
EXCEPT	0458	EXP	075F	EXP1	0768	EXP10	076C	EXP11	0765
EXP12	076F	EXP2	0772	EXP21	079F	EXPOK1	07B0	EXTRCT	03EC
FACTOK	0877	FPADD	0103	FPDIV	0194	FPMULT	0180	FPSUB	0100
GOTBIT	0482	GOTIT	03D5	HYP	07D9	HYP0	07FF	HYP1	0803
HYP2	0805	HYPANG	0390	HYPCON	0389	ILLEGL	08F5	INEEE	E1AC
INF	0338	INFIN	04BA	INTDON	03E5	INTEGE	03C6	INVERS	0744
INVHYP	088D	ITER	0071	LN10	0307	LOAD	090E	LOG10	0820
LOG10A	0831	LSTSGN	006D	MODE	0076	MOVE0	06C7	MOVE01	06CC
MOVE02	06D0	MOVE1	06D5	MOVE2	06DE	MOVE3	06E5	MOVE4	06EC
MOVE5	06F3	MOVE6	06FA	NATL2	084F	NATLOG	0836	NEW1	0531
NEWAN1	0521	NEWANG	051F	NEWOP1	0539	NEWOP2	054A	NEWOP3	053B
NEWOP4	0541	NEWOPN	0537	NEWXY	054B	NEWXY1	0564	NEWXY2	0586
NEXANG	058F	NEXDIG	03DD	NINETY	0315	NLEGAL	0072	NORM	014A
ONE	032A	OPS	096F	OPX	006F	OUTHL	E067	OUTHR	E06B
OUTS	E0CC	OVFL	003A	PBYTE	0958	PDATA1	E07E	PI	0300
PRT	0935	QUADRT	0075	RCON	033F	ROUND	0698	ROUND0	0697
ROUND1	069E	RSIGN	0020	RTODEG	0345	SIGN	006E	SIGNOK	085D
SIN	0460	SIN0	0461	SIN1	0478	SINE	097D	SINH	07BE
SINH1	07C3	SPECL	048B	SPECLT	04C4	SQRT	0739	SSBYTE	0030
START	0900	SUBT	085F	TABOFF	092E	TAN	0496	TAN1	04AF
TAN2	04CC	TAN3	04D5	TAN4	04B1	TAN5	04C1	TANH	07CF
TESTIT	03CB	TESTSG	047C	TPRIME	005A	TRGDON	0488	TRGFAC	0422
TRGSGN	047A	TRIG	04EF	TRIG1	0504	TRIG2	0509	TRIG4	0515
TRIG5	051E	TRIGN	04DB	TRIGX	034C	TSBYTE	0050	TWO	0323
XEX	0032	XOP	002D	XOPN	006A	XOPTO1	0262	XPRIME	0045
XSIGN	002C	XTEMP	003F	XTEMP2	0041	XTOY	0701	XTOY0	0706
XTOY1	071C	XTOY2	071D	XTOY3	0715	YEX	0039	YOP	0034
YOPN	006B	YPRIME	004C	YSIGN	0033	ZCHK	0275	ZERO	0331
ZPRIME	0053								

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S10400760085
S1130300000314159265010002302585090100020D
S1130310718281830100090000000002000360073
S1130320000003000200000000010001000000C2
S1130330010000000000000000999999996300E8
S1130340000000050000057295779502000675838C
S1130350615900045000000002057105931401056 1
S1130360729386980005729576O4FF057295778905
S1130370FE0572957795FD0572957795FC05729546
S11303807795FB0572957795FA00011181379301F2
S1130390010033534800010000333FF0100000023
S11303A033FE0100000000FD0100000000FC01001C
S11303B0000000FB0100000000FA0100000000F949
S11303C001000000000F8A606C6050881002F0608F3
S11303D05A800220F6260AA60084F0A700085A27AD
S11303E0046F0020F8A6002A026F0039DF73BD06EF
S11303F0E5BD0194CE00208DCDCE0053BD06D5CEF3
S1130400002CBD06ECCE002CBD06D5DE73BD06E582
S1130410BD0180CE0033BD06D5CE0045BD06DE7ECF
S1130420010096 2C976E7F002C9676270FCE0345FD
S1130430BD06E5BD0180CE002CBD06D5CE031C8DC6
S1130440ABCE002CBD06D5CE03158DA09654977562
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S11308C006FA4F976C976D43976B976ACE038FDF49
S11308D068BD07FFCE0061BD06D5CE0323BD06E586
S11308E0BD0180CE002CBD06D5CE0053BD06E5BDAE
S10D08F001037E083186FF97723978
```

```
                *
                *
                * EXTERNAL ROUTINES (MIKBUG)
E067            OUTHL   EQU     $E067
E06B            OUTHR   EQU     $E06B
E0CC            OUTS    EQU     $E0CC
E07E            PDATA1  EQU     $E07E
E1AC            INEEE   EQU     $E1AC
E055            BYTE    EQU     $E055
                *
                *
                *
                *
                *
                *  THE FOLLOWING IS A VERY CRUDE DRIVER USED FOR TESTING
                * THE SCIENTIFIC PACKAGE.  NOTE THAT THIS CODE IS NOT
                * A PART OF THE PACKAGE.  THE PROGRAM IS ENTERED AT 0900
                * AND THE PROMPT "ARGUMENT" IS PRINTED.  AT THIS TIME YOU
                * ARE TO ENTER THE ARGUMENT IN FULL INTERNAL FLOATING POINT
                * FORMAT (SIGN,MANTISSA,EXPONENT).  AFTER THE EXPONENT IS
                * ENTERED THE PROMPT "OPERATION" IS PRINTED AND YOU TYPE
                * ONE OF THE OPERATION CODES FOUND IN THE TABLE BELOW (0-7)
                * NOTE THAT NO CHECKING FOR INPUT NOT IN RANGE IS DONE
                * (WE SAID IT WAS CRUDE).  AFTER TIME FOR THE CALCULATION
                * HAS ELAPSED THE ANSWER WILL BE PRINTED IN FULL INTERNAL
                * FLOATING POINT FORMAT NORMALIZED FORM.  THE OVFL AND NLEGAL
                * BYTES ARE ALSO PRINTED OUT FOR YOUR INFORMATION.  THE
                * FUNCTION X↑Y MUST BE TREATED SPECIALLY BECAUSE NO PROVISIONS
                * ARE MADE FOR ENTERING THE SECOND OPERAND (THE VALUE
                * FOR Y MUST BE INSTALLED IN YSIGN-YEX BY THE USER BEFORE
                * CALLING THE FUNCTION.
                *   THIS DRIVER USES MANY ROUTINES FROM MIKBUG (MOT. TRADEMARK)
                * IT IS NOT INTENDED FOR SALE BUT IS INCLUDED HERE FOR THE
                * CONVENIENCE OF THOSE WHO MAY FIND USE FOR IT.
                *
                *
0900                            ORG     $900
0900 8E A0 7F   START           LDS     #$A07F
0903 CE 09 60                   LDX     #ARGSTR
0906 BD E0 7E                   JSR     PDATA1
0909 CE 00 2C                   LDX     #XSIGN
090C C6 07                      LDA B   #7
090E BD E0 55   LOAD            JSR     BYTE
0911 A7 00                      STA A   0,X
0913 08                         INX
0914 8C 00 33                   CPX     #XSIGN+7
0917 26 F5                      BNE     LOAD
0919 CE 09 6F                   LDX     #OPS
091C BD E0 7E                   JSR     PDATA1
091F CE 09 7D                   LDX     #SINE
0922 BD E1 AC                   JSR     INEEE
0925 80 30                      SUB A   #$30
0927 48                         ASL A
```

```
0928 B7 09 2F           STA A  TABOFF+1
092B BD E0 CC           JSR    OUTS
092E EE 00      TABOFF  LDX    0,X
0930 AD 00              JSR    0,X
0932 CE 00 20           LDX    #RSIGN
0935 A6 00      PRT     LDA A  0,X
0937 BD 09 58           JSR    PBYTE
093A 08                 INX
093B 8C 00 27           CPX    #RSIGN+7
093E 26 F5              BNE    PRT
0940 BD E0 CC           JSR    OUTS
0943 96 3A              LDA A  OVFL
0945 BD 09 58           JSR    PBYTE
0948 BD E0 CC           JSR    OUTS
094B 96 72              LDA A  NLEGAL
094D BD 09 58           JSR    PBYTE
0950 7F 00 72           CLR    NLEGAL
0953 7F 00 3A           CLR    OVFL
0956 20 A8              BRA    START
0958 36         PBYTE   PSH A
0959 BD E0 67           JSR    OUTHL
095C 32                 PUL A
095D 7E E0 6B           JMP    OUTHR
0960 0D 0A      ARGSTR  FDB    $0D0A,$0000
0964 41                 FCC    ;ARGUMENT? ;
096E 04                 FCB    4
096F 20         OPS     FCC    ;   OPERATION? ;
097C 04                 FCB    4
                *
                *
                ** OPERATION CODE TABLE
097D 04 60      SINE    FDB    SIN        (0)
097F 04 59              FDB    COS        (1)
0981 04 96              FDB    TAN        (2)
0983 05 B7              FDB    ARCSIN     (3)
0985 05 9C              FDB    ARCCOS     (4)
0987 06 47              FDB    ARCTAN     (5)
0989 07 5F              FDB    EXP        (6)
098B 07 BE              FDB    SINH       (7)
098D 07 C8              FDB    COSH       (8)
098F 07 CF              FDB    TANH       (9)
0991 08 36              FDB    NATLOG     (:)
0993 08 20              FDB    LOG10      (;)
0995 07 51              FDB    ALOG10     (<)
0997 07 44              FDB    INVERS     (=)
0999 07 39              FDB    SQRT       (>)
099B 07 01              FDB    XTOY       (?)
                *
                        END
```

NO ERROR(S) DETECTED