```
FLOATING IN-OUT ROUTINES 2/24/67 (FINOUT,14)

/APM 8-64, MOD SRW 12-65

/FLIP IOT
FLIP,       LAC I (FSA)
FLIP+1,     DAC A           /KEEP TEXT PTR IN A
            DZM G           /HIGH ORDER MANTISSA IN G
            DZM H           /LOW ORDER MANTISSA IN H
            DZM C           /CHARACTERISTIC IN C
            DZM I (ATEM)    /CORRECTIVE SCALE FACTOR IN ATEM
            DZM B           /EXPONENT OF "E" IN B
CHLPLS,
FLIP1,      LCH I A         /MAIN LOOP, CLASSIFY CHARACTER
            SAD (CHARAC L,)
            JMP FLIP4
            SAS CHLPLS      /(CHARAC L+)
            SAD (CHARAC L-)
            JMP FLIP5
            SZA I
            JMP FLIP5
            SAD CHARLE      /(CHARAC LE)
            JMP FLIP6
            RAL 6S          /TEST FOR A DIGIT
            XOR B13         /(23)
            SUB C1M,
            SPA             /WAS CHARACTER A DIGIT?
            JMP FLIP7       /YES,  GO PROCESS IT,
FLIP2,      SZF 4           /ANY DIGITS IN THIS FIELD?
            JMP FLIP13      /YES,  GO EVALUATE FOREGOING STRING,
FLIP3,      JSP FLIPX       /EXIT SUBROUTINE, FAILURE
            JMP R1          /GIVE R1 TO INDICATE FAILURE

FLIP4,      SZF I 1         /DECIMAL POINT, CHECK FOR REDUNDANCE
            SZF 2           /HAVE WE SEEN AN "E" ALREADY?
            JMP FLIP2       /YES,  THIS CHARACTER FAILS,
            STF 1           /FLAG 1 INDICATES "SEEN A DECIMAL POINT"
            JMP FLIP1       /GO GET NEXT CHARACTER

FLIP5,      SZF I 3         /SIGN, CHECK FOR REDUNDANCE
            SZF 1           /HAVE WE SEEN A DECIMAL POINT ALREADY?
            JMP FLIP2       /YES,  THIS CHARACTER FAILS,
            SZF 4           /HAVE WE ALREADY SEEN A DIGIT?
            JMP FLIP13      /YES, THIS CHARACTER FAILS
            STF 3           /INDICATES "SEEN A SIGN" IN THIS FIELD
            SAS (CHARAC L-)
            JMP FLIP1       /NO,  GET NEXT CHARACTER,
            SZF 2           /SET FLAG 6 IF WE HAVE SEEN AN E
            STF 6           /FLAG 6 INDICATES A NEGATIVE EXPONENT OF "E"
            SZF I 2         /IF FLAG 2 IS NOT SET, SET FLAG 5
            STF 5           /FLAG 5 INDICATES A NEGATIVE MANTISSA
            JMP FLIP1       /GET NEXT CHARACTER
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FLIP4,    SZF I 2          /FOUND AN E, CHECK FOR REDUNDANCY
          SZF I 4          /HAS THE E PRECEDED ALL DIGITS?
          JMP FLIP2        /YES,  THIS CHARACTER FAILS.
          CLF 1            /INITIALIZE FOR A NEW FIELD
          STF 2            /FLAG 2 INDICATES "SEEN AN "E""
          CLF 3            /DONE SO A SIGN WON'T FAIL
          CLF 4
          JMP FLIP1        /GET NEXT CHARACTER

FLIP7,    STF 4            /FOUND A DIGIT
          ADD C10,         /GETS VALUE OF DIGIT IN AC
          DAC E            /SAVE DIGIT IN E TEMPORARILY
          SZF 2            /HAVE WE SEEN AN "E"
          JMP FLIP12       /YES,  GO BUILD UP EXPONENT OF "E",
          JSP FPM10        /NO, BUILD UP MANTISSA
          JSP FPNORM       /PREPARE TO ADD IN THIS DIGIT
          DIO H
          LAW 4            /NEEDED TO FINISH MUL BY 10
          ADD C
          SUB F            /SUBTRACT DECREMENT LEFT BY NORMALIZE ROUTINE
          DAC C            /SAVE NEW CHARACTERISTIC
          LAC E            /MAKE THIS DIGIT INTO A MANTISSA
          RAP 5S
          SCI↑USZL I       /TEST FOR Ø & CLEAR IO
          JMP FLIP8        /PREVIOUS MANTISSA WAS NOT ZERO,  GO AROUND,
          DAC G            /STORE CURRENT DIGIT AS MANTISSA
          LAW 4            /WITH 4 AS CHARACTERISTIC
          DAC C
          JMP FLIP11       /GO CHECK FOR DIGIT TO RIGHT OF DEC. PT.

FLIP8,    DAC E            /SAVE HI-ORD PART OF MANTISSA, LO-ORD=Ø
          LAW 4            /CHAR.=4, SET UP TO UN-NORMALIZE FOR ADDING
          DAC F
FLIP9,    SAD C            /UN-NORMALIZING LOOP,  FINISHED WHEN C=F,
          JMP FLIP10
          LAC E            /SHIFT MANTISSA RIGHT 1 BIT
          SCR 1S
          DAC E
          IDX F            /ADD 1 TO CHARACTERISTIC TO PRESERVE VALUE
          JMP FLIP9        /GO AROUND AGAIN
FLIP10,   LAC E            /ADD THE TWO 36-BIT MANTISSAS TOGETHER
          SWP
          TAD H
          SWP
          TAD G
          SCR 1S           /NUMBERS ARE +, CORRECT POSSIBLE OVERFLOW
          AND (377777)
          DAC G            /SET UP NORMALIZE ROUTINE
          JSP FPNORM       /GO NORMALIZE
          DIO H            /SAVE LO-ORD MANTISSA, (MUST BE NON-Ø)
          IDX C            /OFFSET UN-NORMALIZING SHIFT
          SUB F            /SUBTRACT NORMALIZING DECREMENT
          DAC C            /STORE NEW CHARACTERISTIC
FLIP11,   SZF 1            /ARE WE TO THE RIGHT OF THE DECIMAL POINT?
          IDX I (ATEM)     /YES, IDX THE CORRECTIVE SCALE FACTOR
          JMP FLIP1        /GET NEXT CHARACTER
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FLIP12, LAC B           /GET CURRENT EXPONENT OF E
        MUL C1M,
        SWP             /GET LOW-ORDER PART OF PRODUCT
        SNI↑USMA I      /OVERFLOWS IF LARGER THAN 17 BITS
        JMP FLIP18      /OVERFLOW
        SAR 1S          /MULTIPLY LEAVES THINGS SHIFTED LEFT A BIT
        ADD E           /ADD IN CURRENT DIGIT
        DAC B           /SAVE NEW EXPONENT OF "E"
        JMP FLIP1       /GET NEXT CHARACTER

FLIP13, IDX I (USERPC)  /SUCCESS, SET UP P2
        LAC B           /GET EXPONENT OF "E"
        SZA↑USZF 6      /RESTORE SIGN UNLESS Ø
        CMA
        SUB I (ATEM)    /COMBINE IT WITH CORRECTIVE SCALE FACTOR
        DAC I (ATEM)    /POWER OF TEN TO TAKE NUMBER TO
FLIP14, LAC I (ATEM)    /GET CORRECTIVE SCALING FACTOR
        SZA I           /END TEST, QUIT WHEN CORRECTION = Ø
        JMP FLIP17      /EXIT LOOP, NUMBER IS NOW OK
        SPA             /MUST WE MUL OR DIV TO GET CORRECTION TO Ø?
        JMP FLIP16      /GO ADD 1 TO SCALE FACTOR AND DIVIDE BY TEN
        SUB B17         /SUB (1) AND DIV BY 1Ø
        DAC I (ATEM)
        JSP FPM1Ø       /FPM1Ø MULTIPLIES MANTISSA IN G AND H BY TEN
        JSP FPNORM      /GO NORMALIZE
        DIO H           /SAVE LOW-ORDER MANTISSA IN H
        LAW 4           /ADD (4) TO CHARACTERISTIC IS PART OF MULTIPLY
FLIP15, ADD C           /ADD IN PREVIOUS CHARACTERISTIC
        SUB F           /SUBTRACT DECREMENT LEFT BY NORMALIZE ROUTINE
        DAC C           /SAVE NEW CHARACTERISTIC
        SZL I           /TEST FOR A ZERO MANTISSA
        JMP FLIP14      /MANTISSA WAS NON-ZERO,  GO AROUND AGAIN,
        JSP FLIPX       /MANTISSA WAS ZERO,  PREPARE TO EXIT
        JMP FADD6       /GO PUT ZERO IN FLOATING AC AND RETURN TO USER

FLIP16, IDX I (ATEM)    /ADD 1 TO SCALE FACTOR & DIV BY 1Ø
        JSP FPD1Ø       /DIVIDE MANTISSA IN G AND H BY TEN
        JSP FPNORM      /GO NORMALIZE
        DIO H           /SAVE LOW-ORDER MANTISSA
        LAW I 3         /DECREMENT CHARACTERISTIC FINISHES DIV BY 1Ø
        JMP FLIP15      /COMPUTE NEW CHARACTERISTIC & LOOP AROUND
FLIP17, LAC G           /NUMBER IS NOW OF PROPER MAGNITUDE
        LIO H           /GET MANTISSA
        SZF 5           /IF FLAG 5 IS SET, MANTISSA IS NEGATIVE
        CMA↑UCMI
        DAC G           /SAVE MANTISSA WITH CORRECT SIGN
        DIO H
        JSP FLIPX       /PREPARE TO EXIT
        LIO H           /GET LOW-ORDER MANTISSA IN I.O,
        JMP FADD4       /GO PACK # INTO FAC & RETURN
FLIP18, IDX I (USERPC)  /OVERFLOW
        JSP FLIPX       /PREPARE TO EXIT
        JMP FPOVFL      /GO TO THE FLOATING OVERFLOW ROUTINE
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FLIPX,      DAP D           /FLIP EXIT SUBROUTINE
            LAC CJ
            DIP D           /SAVE RETURN IN D
            LAW I 1         /GET PTR TO CHAR AND UNSTEP IT
            ADD A
            IOC
            IOC
            DAC I (FSA)     /STORE PTR IN FSA
            JMP D           /RETURN

/FLOPE & FLOPF IOTS

FLOP,       LIO I (JMODE)   /CHECK FOR JBH
            SPI↑USE 6
            JMP R2
            LAC I (FAC+1)   /GET FL PNT #
            LIO I (FAC)
            SPI             /MAKE SURE MANTISSA IS POSITIVE
            CMA↑UCMI↑USTF 1             /NEGATIVE FLAG
            AND (777400)    /GET RID OF CHARACTERISTIC
            DIO G           /SAVE 36-BIT POSITIVE MANTISSA IN G AND H
            DAC H
            LAW I 1         /C CONTAINS EXPONENT OF 10 LESS 1
            DAC C
            LAC I (FAC+1)   /GET CHARACTERISTIC
            RAR 8S
            SAR 9S
            SAR 1S
FLOP1,      DAC E           /SAVE IT IN E
            SZM             /IS CHARACTERISTIC >0?
            JMP FLOP6       /YES, DIVIDE FL. PNT. # BY 10 & IDX C
            ADD (3)
            SMA             /TEST WHETHER NUMBER IS <=3
            JMP FLOP7       /EXIT, CHARACTERISTIC IS -3, -2, -1, OR 0.
FLOP2,      JSP FPM10       /MUL FL. PNT. # BY 10 & DECREMENT C
            JSP FPNORM      /NORMALIZE
            DIO H           /LO-ORD MANTISSA
            SZL I           /ZERO?
            JMP FLOP4       /NO, NON-ZERO MANTISSA, GO AROUND.
FLOP3,      DZM C           /GO PRINT A 0
            JMP FLOP10      /EXIT WITH C, G, AND H ALL PLUS ZERO
FLOP4,      LAW I 1         /SUBTRACT 1 FROM EXPONENT OF TEN
            ADD C
            DAC C
            LAW 4           /PART OF MUL BY 10
FLOP5,      ADD E           /ADD IN CHARACTERISTIC
            SUB F           /SUBTRACT DECREMENT LEFT BY NORMALIZE ROUTINE
            JMP FLOP1       /GO AROUND AGAIN
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FLOP6,    JSP FP010       /DIVIDE NUMBER BY TEN
          JSP FPNORM      /NORMALIZE
          DIO H           /SAVE LOW ORDER HALF OF MANTISSA
          SZL             /WERE WE NORMALIZING PLUS ZERO?
          JMP FLOP3       /YES,  EXIT,  PRINT OUT A ZERO,
          IDX C           /ADD 1 TO EXPONENT OF TEN
          LAW I 3         /PART OF DIV BY 10
          JMP FLOP5       /COMPUTE NEW CHARACTERISTIC & GO AROUND AGAIN

FLOP7,    SZF 3           /HAVE WE BEEN HERE BEFORE?
          JMP FLOP8       /YES,  GO ON TO NEXT PART OF ROUTINE,
          STF 3           /REMEMBER THAT WE'VE BEEN HERE
          JMP FLOP2       /SOME =3 CHARACTERISTICS CAN GO TO 0, TRY

FLOP8,    LIO H           /FP # IN E,C,H; UN=NORMALIZE C,H TO GET E=0
          LAC E
FLOP9,    SZA I           /FINISHED?
          JMP FLOP10      /EXIT
          LAC G
          SCR 1S
          DAC G
          IDX E
          JMP FLOP9
FLOP10,   DIO H           /PUT LOW ORDER MANTISSA BACK IN H
          LAW ATEM
          DAC A           /A IS TEM STORAGE PTR
FLOP11,   JSP FPM10       /LOOP TO GENERATE 8 DIGITS
          LAC C           /HI=ORD RESULT OF MUL
          DAC B
          AND (17777)     /REMOVE BITS TO LEFT OF BIN PT
          SCL 4S          /PUT BIN PT BETWEEN BITS 0&1
          DAC C           /STORE NEW MANTISSA
          DIO H
          LAC B           /GET NEW DIGIT ALONE IN LO END OF AC
          RAL 5S
          AND (17)
          DAC I A         /STORE IN TEM AREA
          IDX A           /MAKE A POINT TO NEXT REGISTER
          SAS (ATEM+10)   /QUIT AFTER 8 DIGITS
          JMP FLOP11      /GO AROUND AGAIN
          LAC I (STS)
          DAC G           /SET UP BYTE PTR FOR TEXT
          IDX I (USERPC)  /GET PTR TO FORMAT WORD
          DZM E
          DAP E           /SAVE PTR
          LDH I E         /1ST BYTE OF FORMAT WD IS # OF COLUMNS
          RAL 6S
          IDA
          CMA
          DAC I (ATEM+10)             /COLUMN COUNT WD
          LDH I E         /NEXT BYTE IS # OF SIGNIFICANT FIGURES
          RAL 6S
          DAC B
          LDH I E         /3RD BYTE IS # OF PLACES PAST DEC, PT,
          RAL 6S
          IDA
          DAC F           /1 + # OF SIG, FIGURES
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        LAC C           /THIS SECTION CALCULATES WHICH DIGIT TO ROUND
        SZF 2           /SKIP ON F FORMAT
        CLA
        ADD F
        LIA
        SUB B
        SZM             /ROUND ON ACCURACY OR DIGITS?
        LID B           /ACCURACY
        LAI             /# OF CHARACTERS TO BE TYPED
        SPA             /TEST FOR ROUND BEING TOO FAR LEFT
        STF 4           /TOO FAR LEFT, PF4 PREVENTS ROUNDING
        SUB B11         /(8.)
        SMA             /TEST FOR ROUND BEING TOO FAR RIGHT
        STF 4           /PREVENT ROUNDING IF SO
        ADD (ATEM+10)   /GETS PTR AT REG TO ROUND
        DAC A           /SAVE PTR FOR LOOP AT FLOP12
        DAC E           /SAVE PTR MORE PERMANENTLY FOR USE LATER
        LAW I 5         /SUB (5) & TEST WHETHER +@-
        ADD I A
        SZF I 4         /SKIP TO SUPPRESS ROUNDING
        SPA             /SKIP TO ADD CARRY TO NEXT CHARACTER
        JMP FLOP14      /QUIT ROUNDING
CHRLEQ,
FLOP12, DZM I A         /CARRY LOOP ON ROUND-UP
        LAW I 1         /UNSTEP TEM PTR
        ADD A
CHARL4, DAC A
        SAS (ATEM-1)    /TEST WHETHER ROUND CARRIED OFF THE LEFT END
        JMP FLOP13      /OTHERWISE, GO AROUND
        IDX I (ATEM)    /ATEM WAS Ø, MAKE IT 1
        IDX C           /ADD 1 TO EXPONENT OF TEN
        IDX E
        JMP FLOP14      /EXIT FROM LOOP
CHARLE,
FLOP13, IDX I A         /ADD CARRY FROM PREVIOUS DIGIT
        SAD C10.        /DOES THIS CHARACTER CARRY LEFT NOW?
        JMP FLOP12      /GO AROUND CARRY LOOP AGAIN
FLOP14, CLI             /ROUNDOFF NOW COMPLETE, READY TO PRINT
        SZF 1           /FLAG 1 SET FOR NEGATIVE NUMBER
        LIO (CHARAC L-)
        IDX I (ATEM+10)
        SZF I 5
        JSP TYOIF
        LAW I 2         /INITIALIZE D FOR STORING DIGITS
        SZF I 2
        SUB C
        SMA
        LAW I 1
        DAC D           /D GETS IDX'ED FOR EACH DIGIT, STORE "," AT Ø
        LAC C           /INITIALIZE B
        SZF I 2
        SMA
        LAW I 1
        ADD (ATEM)
        DAC B           /B ALWAYS POINTS TO NEXT DIGIT, AFTER IDX
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FLOP15,  IDX D           /LOOP FOR PRINTING
         SZA             /SKIP IF TIME TO PRINT DECIMAL POINT
         JMP FLOP16      /OTHERWISE, GO AROUND
         LIO (CHARAC L.)             /PRINT DEC PT
         JMP FLOP20
FLOP16,  SAD F           /ALL DONE PRINTING DIGITS?
         JMP FLOP21      /QUIT PRINTING DIGITS, EXIT FROM LOOP
         IDX B           /GET PTR TO NEXT DIGIT TO BE PRINTED
         SUB (ATEM)      /FIGURE OUT IF TOO FAR LEFT
         SMA             /TOO FAR LEFT?
         JMP FLOP18      /NO,  GO AROUND,
FLOP17,  LAW 20          /YES, PRINT A 0
         JMP FLOP19
FLOP18,  LAC B           /FIGURE OUT IF TOO FAR RIGHT
         SUB E           /E IS PTR TO DIGIT ROUNDED AT
         SMA             /TOO FAR RIGHT?
         JMP FLOP17      /YES, PAST SIGNIFICANT FIGURES, PRINT A 0
         LAW 20          /NO,  GET INTERNAL CODE FOR THIS DIGIT,
         ADD I B
FLOP19,  RCR 6S          /POSITION INTERNAL CODE FOR PRINTING
FLOP20,  IDX I (ATEM+10)
         SZF I 5
         JSP TYOIF
         JMP FLOP15      /GO AROUND LOOP AGAIN
FLOP21,  SZF I 2         /FINISHED WITH DIGITS, TEST FOR E FORMAT
         JMP FLOP22      /"F" FORMAT,  GO AROUND,
         LAW 4
         ADD I (ATEM+10)
         DAC I (ATEM+10)
         SZF 5
         JMP FLOP22
         LIO CHARLE      /(CHARAC LE) E FORMAT, PRINT THE E
         JSP TYOIF
         LAC C           /GET EXPONENT OF E, TEST SIGN, AND TYPE IT
         LIO (CHARAC L-)
         SMA
         CLI!UCMA
         DAC A
         JSP TYOIF
         LAC A
         CLI!UCMA!USWP
         RCL 1S
         DIV C1M,
C5,      5               /CONSTANT STORED AFTER DIVIDE
         RIR 6S
         RCL 6S
         IOR C2020
         RCR 6S
         RCR 6S          /POSITION FIRST DIGIT
         JSP TYOIF
         JSP TYOIF
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FLOP22,   LAC G           /UPDATE PTR
          SZF I 6
          DAC I (STS)
          SZF 5
          JMP FLOP23      /RIGHT ADJUST
          LAC ML4
          SZF I 6
          DCH I C
          JMP R1

FLOP24,   CLI
          JSP TYOIF
FLOP23,   ISP I (ATEM+10)
          JMP FLOP24
          CLF 5
          JMP FLOP14

/SUBR TO MUL A 36BIT +MANTISSA IN G,H BY 10 & SHIFT BIN PT 4 TO RIGHT
FPM10,    DAP D
          LAC CJ          /RETURN
          DIP D
CLACH,    LAC H           /GET MANTISSA, WITH HALVES REVERSED
          LIO G
          AND (777760)    /REMOVE LAST 4 BITS TO KEEP SIGN +
          RCR 3S          /UN-NORM,INC SHIFT TO PROTECT SIGN
          DIO G
          RAR 1S
          MUL C5          /(5), MUL (5) & SHIFT 1
          DAC F
          DIO H
          LAW 5
          MUL G
          RCR 1S
          LAI
          ADD F           /COMBINE THE TWO HALVES OF THE NEW MANTISSA
          DAC G
          LIO H           /LEAVES LO-ORD IN H & IO, HI-ORD IN G
          JMP D           /RETURN

/SUBR TO DIV A 36BIT +MANTISSA IN G,H BY 10 & SHIFT BIN PT 3 TO LEFT
FPD10,    DAP D
          LAC CJ
          DIP D
          LAC G           /SET UP FOR DIVIDE
          LIO H
          SCR 1S          /SIC,
          DIV CHARL4      /(240000)
C1849,,   1849,
          DAC G
          CLA!USWP
          DIV CHARL4      /(240000)
C720,,    720,
          RAL 1S
          DAC H
          LIA             /SAME EXIT FORMAT AS FPM10
          JMP D           /RETURN
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START