```
  3494                          59300           MVI     C,0             ;SET COMMA COUNT TO ZERO, THE COMMA SPEC IS
  3495                          59320           PUSH    D               ; IGNORED.  SAVE TRAILING SIGN INFO
  3496                          59340           CALL    FOUTCV          ;CONVERT THE NUMBER TO DECIMAL DIGITS
  3497                          59360           POP     D               ;GET THE TRAILING SIGN INFO BACK
  3498                          59380           POP     B               ;GET # OF SIG DIGITS AND "B" FIELD SPEC BACK
  3499                          59400           MOV     A,C             ;PRINT TRAILING ZEROS IF THE FIELD LENGTH IS
  3500                          59420           SUB     E               ; LONGER THAN ~~THE~~ NUMBER OF DIGITS WE CAN PRINT
  3501
  3502                          59440           CP      FOTZRC          ;THE DECIMAL POINT COULD COME OUT IN HERE
  3503                          59460           POP     PSW             ;GET THE "C" FIELD SPEC BACK
  3504                          59480           CZ      FOFXIS          ;IF C=0, THE LAST THING WAS A DECIMAL POINT,
  3505                          59500                                   ; SO IGNORE IT.  ALL WE CARE ABOUT IS THE
  3506                          59520                                   ; "DCX  H" AND NOT THE "MOV     M,B" AT FOFXIS
  3507                          59540           POP     PSW             ;GET THE EXPONENT BACK
  3508                          59560           ADD     E               ;SCALE IT CORRECTLY
  3509                          59580           SUB     B
  3510                          59600           SUB     D
  3511                          59620           PUSH    B               ;SAVE THE "B" FIELD SPEC
  3512                          59640           CALL    FOFLON          ;PUT THE EXPONENT IN THE BUFFER
  3513                          59660           XCHG                    ;GET THE POINTER TO THE END IN (HL)
  3514                          59680                                   ; IN CASE WE HAVE A TRAILING SIGN
  3515                          59700           POP     D               ;GET THE "B" FIELD SPEC IN D, PUT ON ~~A POSSIBLE~~
  3516
  3517                          59720           JMP     FOUTTS          ; TRAILING SIGN AND WE ARE DONE
                                                                          POSSIBLE
  3518                          59740
  3519                          59760           ;NORMALIZE THE NUMBER IN THE FAC SO ALL THE DIGITS ARE IN THE INTEGER
  3520                          59760           ;PART.  RETURN THE BASE 10 EXPONENT IN A
  3521                          59800           ;D,E ARE LEFT UNALTERED
  3522                          59820   FOUTNV: PUSH    D               ;SAVE (DE)
  3523                          59840           LDA     VALTYP          ;GET WHAT KIND OF VALUE WE HAVE
  3524                          59860           CPI     4
  3525                          59880           JNZ     FOUTND          ;WE HAVE A DBL
  3526                          59900           ;NORMALIZE A SNG
  3527                          59920           XRA     A               ;ZERO THE EXPONENT
  3528                          59940           PUSH    PSW             ;SAVE IT
  3529                          59960           CALL    FOUNSC          ;IS THE FAC TOO BIG OR TOO SMALL?
  3530                          59980   FOUNS1: MOVRI   221,103,117,370 ;GET 99999.9499 TO SEE IF THE FAC IS BIG
  3531                          60000           CALL    FCOMP           ; ENOUGH YET
  3532                          60020           JPO     FOUNS3          ;IT IS, WE ARE DONE
  3533                          60040           POP     PSW             ;IT ISN'T, MULTIPLY BY TEN
  3534                          60060           CALL    FINMLT
  3535                          60080           PUSH    PSW             ;SAVE THE EXPONENT AGAIN
  3536                          60100           JMP     FOUNS1          ;NOW SEE IF IT IS BIG ENOUGH
  3537                          60120   FOUNS2: POP     PSW             ;THE FAC IS TOO BIG, GET THE EXPONENT
  3538                          60140           CALL    FINDIV          ;DIVIDE IT BY TEN
  3539                          60160           PUSH    PSW             ;SAVE THE EXPONENT AGAIN
  3540                          60180           CALL    FOUNSC          ;SEE IF THE FAC IS SMALL ENOUGH
  3541                          60200   FOUNS3: POP     PSW             ;WE ARE DONE, GET THE EXPONENT BACK
  3542                          60220           POP     D               ;GET (DE) BACK
  3543                          60240           RET                     ;ALL DONE
  3544                          60260           ;HERE TO SEE IF THE FAC IS SMALL ENOUGH YET
  3545                          60280   FOUNSC: MOVRI   224,164,043,367 ;GET 999999.499 TO SEE IF THE FAC IS TOO BIG
  3546                          60300           CALL    FCOMP
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  3547                          60320           POP     H               ;GET THE RETURN ADRESS OFF THE STACK
  3548                          60340           JPO     FOUNS2          ;IT IS TOO BIG, MAKE IT SMALLER
  3549                          60360           PCHL                    ;IT IS SMALL ENOUGH, RETURN
  3550                          60380           ;HERE TO NORMALIZE A DBL NUMBER
  3551                          60400   >
  3552                          60420   PAGE
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3553                                    60440   SUBTTL  EXPONENTIATION AND THE SQUARE ROOT FUNCTION
3554                                    60460   IFE     EXTFNC,<
3555                                    60480           ;SQUARE ROOT FUNCTION  ---  X=SQR(A)
3556                                    60500           ;WE FIRST SCALE THE ARGUMENT TO BETWEEN .5 AND 2 BY LOOKING AT THE
3557                                    60520           ;EXPONENT AND USING SQR(M*2^(2*N))=2^N*SQR(M).  THEN NEWTON'S METHOD
3558                                    60540           ;IS USED TO COMPUTE SQR(M).  THE EXPONENT IS SAVED TO SCALE THE
3559                                    60560           ;RESULT AT THE END.
3560                                    60580           ;NEWTON'S METHOD FOR SQUARE ROOT:
3561                                    60600           ;  X(0)=A
3562                                    60620           ;  X(N+1)=(X(N)+A/X(N))/2
3563                                    60640   SQR:    FSIGN                   ;CHECK FOR ERROR CONDITION
3564                                    60660           JM      FCERR           ;CAN'T TAKE SQR OF NEGATIVE NUMBER
3565                                    60680           RZ                      ;  0=SQR(0)
3566                                    60700           LXI     H,FAC           ;SCALE ARGUMENT TO BETWEEN .5 AND 2
3567                                    60720           MOV     A,M             ;GET EXPONENT
3568                                    60740           RAR                     ;GET EXPONENT OF SCALE FACTOR
3569                                    60760                                   ;USE  SQR(M*2^(2*N))=2^N*SQR(M)
3570                                    60780           PUSH    PSW             ;SAVE IT
3571                                    60800           PUSH    H               ;SAVE POINTER TO EXPONENT
3572                                    60820           MVI     A,100           ;SET EXPONENT OF SCALED DOWN NUMBER
3573                                    60840           RAL
3574                                    60860           MOV     M,A             ;REPLACE IT
3575                                    60880           LXI     H,FBUFFR        ;SAVE A
3576                                    60900           CALL    MOVMF
3577                                    60920           MVI     A,4             ;SET ITERATION COUNT
3578                                    60940   SQR1:   PUSH    PSW             ;SAVE COUNT
3579                                    60960           CALL    PUSHF           ;SAVE X(N)
3580                                    60980           LXI     H,FBUFFR        ;COMPUTE A/X(N)
3581                                    61000           CALL    MOVRM           ;GET A IN THE REGISTERS
3582                                    61020           CALL    FDIV
3583                                    61040           POPR
3584                                    61060           CALL    FADD            ;ADD IN X(N)
3585                                    61080           LXI     H,FHALF         ;DIVIDE BY 2
3586                                    61100           CALL    FMULTS
3587                                    61120           POP     PSW             ;GET COUNT
3588                                    61140           DCR     A               ;ARE WE DONE?
3589                                    61160           JNZ     SQR1            ;NO, DO MORE ITERATIONS
3590                                    61180           POP     H               ;YES, SET EXPONENT OF ANSWER
3591                                    61200           POP     PSW             ;GET SCALE FACTOR
3592                                    61220           ADI     300             ;CONVERT TO AN EXPONENT
3593                                    61240           ADD     M               ;ADD EXPONENT IN
3594                                    61260           MOV     M,A             ;REPLACE EXPONENT
3595                                    61280           RET>                    ;ALL DONE
3596
3597
3598                                    61340   IFN     EXTFNC,<
3599                                    61360           ;SUBROUTINE FOR FPWR, ATN
3600  002340' 001000  000041            61380   PSHNEG: LXI     H,NEG           ;GET THE ADDRESS OF NEG
3601  002341' 000000  001175'
3602  002342' 000000  002307'
3603  002343' 001000  000343            61400           XTHL                    ;SWITCH RET ADDR AND ADDR OF NEG
3604  002344' 001000  000351            61420           PCHL                    ;RETURN, THE ADDRESS OF NEG IS ON THE STACK
3605
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3606
3607                                    61480           ;SQUARE ROOT FUNCTION
3608                                    61500           ;WE USE SQR(X)=X^.5
3609  002345' 001000  000315            61520   SQR:    CALL    PUSHF           ;SAVE ARG
3610  002346' 000000  001205'
3611  002347' 000000  002341'
3612  002350' 001000  000041            61540           LXI     H,FHALF         ;GET 1/2
3613  002351' 000000  002312'
3614  002352' 000000  002346'
3615  002353' 001000  000315            61560           CALL    MOVFM           ;  SQR(X)=X^.5
3616  002354' 000000  001222'
3617  002355' 000000  002351'
3618  002356' 001000  000301            61580   FPWRT:  POPR                    ;GET ARG IN REGISTERS, ENTRY TO FPWR IF
3619  002357' 001000  000321
3620                                    61600                                   ; ARGUMENT IS ON STACK.  FALL INTO FPWR
3621
3622
3623                                    61660           ;EXPONENTIATION    ---    X^Y
3624                                    61680           ;N.B.  0^0=1
3625                                    61700           ;FIRST WE CHECK IF Y=0, IF SO, THE RESULT IS 1.
3626                                    61720           ;NEXT, WE CHECK IF X=0, IF SO, THE RESULT IS 0.
3627                                    61740           ;THEN WE CHECK IF X IS POSITIVE, IF NOT, WE CHECK THAT Y IS A
3628                                    61760           ;NEGATIVE INTEGER, AND WHETHER IT IS EVEN OR ODD.  IF Y IS A NEGATIVE
3629                                    61780           ;INTEGER, WE NEGATE X.  IF NOT, LOG WILL GIVE AN FC ERROR WHEN WE CALL
3630                                    61800           ;IT.  IF X IS NEGATIVE AND Y IS ODD, WE PUSH THE ADDRESS OF NEG ON THE
3631                                    61820           ;STACK SO WE WILL RETURN TO IT AND GET A NEGATIVE RESULT.  TO COMPUTE
3632                                    61840           ;THE RESULT WE USE X^Y=EXP(Y*LOG(X))
3633  002360' 001000  000357            61860   FPWR:   FSIGN                   ;SEE IF Y IS ZERO
3634  002361' 001000  000312            61880           JZ      EXP             ;IT IS, RESULT IS ONE
3635  002362' 000000  002452'
3636  002363' 000000  002354'
3637  002364' 001000  000170            61900           MOV     A,B             ;SEE IF X IS ZERO
3638  002365' 001000  000267            61920           ORA     A
3639  002366' 001000  000312            61940           JZ      ZERO0           ;IT IS, RESULT IS ZERO
3640  002367' 000000  000174'
3641  002370' 000000  002362'
3642  002371' 001000  000325            61960           PUSHR                   ;SAVE X ON STACK
3643  002372' 001000  000305
3644  002373' 001000  000171            61980           MOV     A,C             ;CHECK THE SIGN OF X
3645  002374' 001000  000366            62000           ORI     177             ;TURN THE ZERO FLAG OFF
3646  002375' 000000  000177
3647  002376' 001000  000315            62020           CALL    MOVRF           ;GET Y IN THE REGISTERS
3648  002377' 000000  001240'
3649  002400' 000000  002367'
3650  002401' 001000  000362            62040           JP      FPWR1           ;NO PROBLEMS IF X IS POSITIVE
3651  002402' 000000  002422'
3652  002403' 000000  002377'
3653  002404' 001000  000325            62060           PUSHR                   ;SAVE Y
3654  002405' 001000  000305
3655  002406' 001000  000315            62080           CALL    INT             ;SEE IF Y IS AN INTEGER
3656  002407' 000000  001445'
3657  002410' 000000  002402'
3658  002411' 001000  000301            62100           POPR                    ;GET Y BACK
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  3659  002412' 001000  000321
  3660  002413' 001000  000365          62120           PUSH    PSW             ;SAVE LO OF INT FOR EVEN AND ODD INFORMATION
  3661  002414' 001000  000315          62140           CALL    FCOMP           ;SEE IF WE HAVE AN INTEGER
  3662  002415' 000000  001317'
  3663  002416' 000000  002407'
  3664  002417' 001000  000341          62160           POP     H               ;GET EVEN-ODD INFORMATION
  3665  002420' 001000  000174          62180           MOV     A,H             ;PUT EVEN-ODD FLAG IN CARRY
  3666  002421' 001000  000037          62200           RAR
  3667  002422' 001000  000341          62220   FPWR1:  POP     H               ;GET X BACK IN FAC
  3668  002423' 001000  000042          62240           SHLD    FAC-1           ;STORE HO'S
  3669  002424' 777777  777777*
  3670  002425' 000000  002415'
  3671  002426' 001000  000341          62260           POP     H               ;GET LO'S OFF STACK
  3672  002427' 001000  000042          62280           SHLD    FACLO           ;STORE THEM IN FAC
  3673  002430' 000000  001454*
  3674  002431' 000000  002424'
  3675  002432' 001000  000334          62300           CC      PSHNEG          ;NEGATE NUMBER AT END IF Y WAS ODD
  3676  002433' 000000  002340'
  3677  002434' 000000  002430'
  3678  002435' 001000  000314          62320           CZ      NEG             ;NEGATE THE NEGATIVE NUMBER
  3679  002436' 000000  001175'
  3680  002437' 000000  002433'
  3681  002440' 001000  000325          62340   FPWR2:  PUSHR                   ;SAVE Y AGAIN
  3682  002441' 001000  000305
  3683  002442' 001000  000315          62360           CALL    LOG             ;COMPUTE  EXP(Y*LOG(X))
  3684  002443' 000000  000421'
  3685  002444' 000000  002436'
  3686  002445' 001000  000301          62380           POPR                    ;IF X WAS NEGATIVE AND Y NOT AN INTEGER THEN
  3687  002446' 001000  000321
  3688  002447' 001000  000315          62400           CALL    FMULT>          ; LOG WILL BLOW HIM OUT OF THE WATER
  3689  002450' 000000  000517'
  3690  002451' 000000  002443'
  3691                                  62420   ;       JMP     EXP
  3692                                  62440   PAGE
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  3693                                  62460   SUBTTL  EXPONENTIAL FUNCTON
  3694                                  62480   IFN     EXTFNC,<
  3695                                  62500           ;WE FIRST SAVE THE ORIGINAL ARGUMENT AND MULTIPLY THE FAC BY LOG2(E)
  3696                                  62520           ;THE RESULT IS USED TO DETERMINE IF WE WILL GET OVERFLOW SINCE
  3697                                  62540           ;EXP(X)=2^(X*LOG2(E)) WHERE LOG2(E)=LOG(E) BASE 2, THEN WE SAVE THE
  3698                                  62560           ;INTEGER PART OF THIS TO SCALE THE ANSWER AT THE END, SINCE
  3699                                  62580           ;2^Y=2^INT(Y)*2^(Y-INT(Y)) AND 2^INT(Y) IS EASY TO COMPUTE,  SO WE
  3700                                  62600           ;NOW COMPUTE 2^(X*LOG2(E)-INT(X*LOG2(E))) BY
  3701                                  62620           ;P(LN(2)*(INT(X*LOG2(E))+1)-X) WHERE P IS AN APPROXIMATION
  3702                                  62640           ;POLYNOMIAL,  THE RESULT IS THEN SCALED BY THE POWER OF 2 WE
  3703                                  62660           ;PREVIOUSLY SAVED.
  3704  002452' 001000  000315          62680   EXP:    CALL    PUSHF           ;SAVE ARGUMENT
  3705  002453' 000000  001205'
  3706  002454' 000000  002450'
  3707  002455' 001000  000001          62700           MOVRI   201,070,252,073 ;GET LOG(E) BASE 2,   CACULATE:
  3708  002456' 000000  000070
  3709  002457' 000000  000201
  3710  002460' 001000  000021
  3711  002461' 000000  000073
  3712  002462' 000000  000252
  3713  002463' 001000  000315          62720           CALL    FMULT           ;   INT(ARG/LN(2)) = INT(ARG*LOG2(E))
  3714  002464' 000000  000517'
  3715  002465' 000000  002453'
  3716  002466' 001000  000072          62740           LDA     FAC             ;CARRY=0 IF FAC IS TOO BIG
  3717  002467' 000000  001446*
  3718  002470' 000000  002464'
  3719  002471' 001000  000376          62760           CPI     210             ; I.E. IF ABS(FAC) .GE. 128
  3720  002472' 000000  000210
  3721  002473' 001000  000322          62780           JNC     MLDVEX          ;IT IS TOO BIG
  3722  002474' 000000  001073'
  3723  002475' 000000  002467'
  3724  002476' 001000  000315          62800           CALL    INT             ;IS ARGUMENT TOO BIG?
  3725  002477' 000000  001445'
  3726  002500' 000000  002474'
  3727  002501' 001000  000306          62820           ADI     200             ;CHECK FOR OVERFLOW
  3728  002502' 000000  000200
  3729  002503' 001000  000306          62840           ADI     2
  3730  002504' 000000  000002
  3731  002505' 001000  000332          62860           JC      MLDVEX          ;WE HAVE OVERFLOW!!
  3732  002506' 000000  001073'
  3733  002507' 000000  002477'
  3734  002510' 001000  000365          62880           PUSH    PSW             ;SAVE SCALE FACTOR
  3735  002511' 001000  000041          62900           LXI     H,FONE          ;ADD ONE TO THE NUMBER
  3736  002512' 000000  000400'
  3737  002513' 000000  002506'
  3738  002514' 001000  000315          62920           CALL    FADDS
  3739  002515' 000000  000003'
  3740  002516' 000000  002512'
  3741  002517' 001000  000315          62940           CALL    MULLN2          ;MULTIPLY BY LN(2)
  3742  002520' 000000  000506'
  3743  002521' 000000  002515'
  3744  002522' 001000  000361          62960           POP     PSW             ;GET SCALE FACTOR OFF STACK
  3745  002523' 001000  000301          62980           POPR                    ;GET ARGUMENT
  3746  002524' 001000  000321
  3747  002525' 001000  000365          63000           PUSH    PSW             ;PUT SCALE FACTOR BACK ON STACK
  3748  002526' 001000  000315          63020           CALL    FSUB            ;SUBTRACT ORIGINAL ARG
  3749  002527' 000000  000017'
  3750  002530' 000000  002520'
  3751  002531' 001000  000315          63040           CALL    NEG
  3752  002532' 000000  001175'
  3753  002533' 000000  002527'
  3754  002534' 001000  000041          63060           LXI     H,EXPCON        ;EVALUATE THE APPROXIMATION POLYNOMIAL
  3755  002535' 000000  002552'
  3756  002536' 000000  002532'
  3757  002537' 001000  000315          63080           CALL    POLY
  3758  002540' 000000  002632'
  3759  002541' 000000  002535'
  3760  002542' 001000  000021          63100           LXI     D,$CODE         ;MULTIPLY BY 2 ^ (B-1) INSTEAD OF JUST
  3761  002543' 000000  001477*
  3762  002544' 000000  002540'
  3763  002545' 001000  000301          63120           POP     B               ; ADDING IT TO THE EXPONENT SO FMULT
  3764  002546' 001000  000112          63140           MOV     C,D             ; WILL CHECK FOR EXPONENT OVERFLOW
  3765  002547' 001000  000303          63160           JMP     FMULT
  3766  002550' 000000  000517'
  3767  002551' 000000  002543'
  3768
  3769                                  63200           ;CONSTANTS FOR EXP
  3770  002552' 000000  000010          63220   EXPCON: 10      ;DEGREE
  3771  002553' 000000  000100          63240           100     ; -.0001413161
  3772  002554' 000000  000056          63260           056
  3773  002555' 000000  000224          63280           224
  3774  002556' 000000  000164          63300           164
  3775  002557' 000000  000160          63320           160     ; .001329882
  3776  002560' 000000  000117          63340           117
  3777  002561' 000000  000056          63360           056
  3778  002562' 000000  000167          63380           167
  3779  002563' 000000  000156          63400           156     ; -.00830136
  3780  002564' 000000  000002          63420           002
  3781  002565' 000000  000210          63440           210
  3782  002566' 000000  000172          63460           172
  3783  002567' 000000  000346          63480           346     ; .04165735
  3784  002570' 000000  000240          63500           240
  3785  002571' 000000  000052          63520           052
  3786  002572' 000000  000174          63540           174
  3787  002573' 000000  000120          63560           120     ; -.1666653
  3788  002574' 000000  000252          63580           252
  3789  002575' 000000  000252          63600           252
  3790  002576' 000000  000176          63620           176
  3791  002577' 000000  000377          63640           377     ; .4999999
  3792  002600' 000000  000377          63660           377
  3793  002601' 000000  000177          63680           177
  3794  002602' 000000  000177          63700           177
  3795  002603' 000000  000000          63720           000     ; -1.0
  3796  002604' 000000  000000          63740           000
  3797  002605' 000000  000200          63760           200
  3798  002606' 000000  000201          63780           201
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  3799  002607' 000000  000000          63800           000     ; 1.0
  3800  002610' 000000  000000          63820           000
  3801  002611' 000000  000000          63840           000
  3802  002612' 000000  000201          63860           201>
  3803                                  63880   PAGE
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