

DIGITAL RESEARCH

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CP/M ASSEMBLER (ASM)

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SER. # _____

ASM 1.0

```

; COMMON DATA FOR CP/M ASSEMBLER MODULE
0100  ORG 100H
20F0 = ENDA EQU 20F0H ;END OF ASSEMBLER PROGRAM
0005 = BDOS EQU 5H ;ENTRY TO DOS, USED TO COMPUTE END MEMORY
0103 310002 LXI SP,ENDMOD
0103 2A2600 LHLD BDOS+1
0105 22CD01 SHLD SYMAX ;COMPUTE END OF MEMORY
0109 C30002 JMP ENDMOD

; PRINT BUFFER AND PRINT BUFFER POINTER
0078 = PBMAX EQU 120 ;MAX PRINT BUFFER
010C PBUF: DS PBMAX
0134 PBP: DS 1 ;PRINT BUFFER POINTER

; SCANNER PARAMETERS
0105 TOKEN: DS 1 ;CURRENT TOKEN
0106 VALUE: DS 2 ;BINARY VALUE FOR NUMBERS
0108 ACCLEN: DS 1 ;ACCUMULATOR LENGTH
0040 = ACMAX EQU 64 ;LENGTH OF ACCUMULATOR
0109 ACCUM: DS ACMAX ;ACCUMULATOR (MUST FOLLOW ACCLEN)

; OPERAND EXPRESSION EVALUATOR PARAMETERS
0103 EVALU: DS 2 ;VALUE OF EXPRESSION AFTER EVALUATION

; SYMBOL TABLE MODULE PARAMETERS
010B F020 SYTOP: DW ENDA ;FIRST LOCATION AVAILABLE FOR SYMBOL TABLE
010D SYMAX: DS 2 ;LAST AVAILABLE LOCATION FOR SYMBOL TABLE

; MISCELLANEOUS DATA AREAS
010F PASS: DS 1 ;PASS # 0,1
0108 PPC: DS 2 ;FILL ADDRESS FOR NEXT HEX RECORD
0102 ASPC: DS 2 ;ASSEMBLER'S PSEUDO PC
0104 F020 SYBAS: DW ENDA ;SYMBOL TABLE BASE
0106 SYACR: DS 2 ;CURRENT SYMBOL BASE
0203 = ENDMOD EQU ($ AND 0FF00H)+100H
0108 END

```

```

; I/O MODULE FOR CP/M ASSEMBLER
;
0200  ORG 200H
0000 = BOOT EQU 000H ;REBOOT LOCATION
; I/O MODULE ENTRY POINTS
0200 C3E00C JMP INIT ;INITIALIZE, START ASSEMBLER
0203 C3A10D JMP SETUP ;FILE SETUP
0206 C3CA0D JMP GNC ;GET NEXT CHARACTER
0209 C3340E JMP PNC ;PUT NEXT OUTPUT CHARACTER
020C C3AA0E JMP PNB ;PUT NEXT HEX BYTE
020F C3DE0E JMP PCHAR ;PRINT CONSOLE CHARACTER
0212 C3BC0C JMP PCON ;PRINT CONSOLE BUFFER TO CRLF
0215 C3E00F JMP WOBUFF ;WRITE OUTBUFFER
0218 C32F0F JMP PERR ;PLACE ERROR CHARACTER INTO PBUF
021B C34C10 JMP DHEX ;PLACE HEX BYTE INTO OUTPUT BUFFER
021E C3390F JMP EOR ;END OF ASSEMBLY

; DATA FOR I/O MODULE
0221 BPC: DS 2 ;BASE PC FOR CURRENT HEX RECORD
0223 DBL: DS 1 ;HEX BUFFER LENGTH
0224 DBUFF: DS 16 ;HEX BUFFER

; DISK NAMES
0234 CDISK: DS 1 ;CURRENTLY SELECTED DISK
0235 ADISK: DS 1 ;.ASM DISK
0236 PDISK: DS 1 ;.PRN DISK
0237 HDISK: DS 1 ;.HEX DISK

; COMMON EQUATES
0078 = ORMAX EQU 120 ;MAX PRINT SIZE
010C = OBUFF EQU 100H ;PRINT BUFFER
0104 = QUP EQU OBUFF+ORMAX ;PRINT BUFFER POINTER

0105 = TOKEN EQU QBP+1 ;CURRENT TOKEN UNDER SCAN
0106 = VALUE EQU TOKEN+1 ;VALUE OF NUMBER IN BINARY
0108 = ACCLEN EQU VALUE+2 ;ACCUMULATOR LENGTH
0040 = ACMAX EQU 64 ;MAX ACCUMULATOR LENGTH
0109 = ACCUM EQU ACCLEN+1

0109 = EVALU EQU ACCUM+ACMAX ;VALUE FROM EXPRESSION ANALYSIS

010B = SYTOP EQU EVALU+2 ;CURRENT SYMBOL TOP
010D = SYMAX EQU SYTOP+2 ;MAX ADDRESS+1

010F = PASS EQU SYMAX+2 ;CURRENT PASS NUMBER
0108 = PPC EQU PASS+1 ;FILL ADDRESS FOR DHEX ROUTINE
0102 = ASPC EQU PPC+2 ;ASSEMBLER'S PSEUDO PC

```

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```

220D = CR EQU 0DH ;CARRIAGE RETURN
002A = LF EQU 0AH ;LINE FEED
001A = EOP EQU 1AH ;END OF FILE MARK

```

```

;
; DOS ENTRY POINTS
0205 = BDOS EQU 5H ;DOS ENTRY POINT
0301 = READC EQU 1 ;READ CONSOLE DEVICE
0002 = WRITC EQU 2 ;WRITE CONSOLE DEVICE
0003 = REDYC EQU 11 ;CONSOLE CHARACTER READY
000E = SELECT EQU 14 ;SELECT DISK SPECIFIED BY REGISTER E
000F = OPENF EQU 15 ;OPEN FILE
0010 = CLOSF EQU 16 ;CLOSE FILE
0013 = DELEF EQU 19 ;DELETE FILE
0014 = READP EQU 20 ;READ FILE
0015 = WRITP EQU 21 ;WRITE FILE
0016 = MAKEP EQU 22 ;MAKE A FILE
0019 = CSEL EQU 25 ;RETURN CURRENTLY SELECTED DISK
001A = SETDM EQU 26 ;SET DMA ADDRESS

```

```

; FILE AND BUFFERING PARAMETERS
0208 = NSB EQU 8 ;NUMBER OF SOURCE BUFFERS
0206 = NPB EQU 6 ;NUMBER OF PRINT BUFFERS
0205 = NHB EQU 6 ;NUMBER OF HEX BUFFERS

```

```

0400 = SSIZE EQU NSB*128
0300 = FSIZE EQU NPB*128
0300 = ESIZE EQU NHB*128

```

```

; FILE CONTROL BLOCKS
0238 = SCB: DS 9 ;FILE NAME
0241 41534D DB 'ASM' ;FILE TYPE
0244 = SCBR: DS 1 ;REEL NUMBER (ZEROED IN SETUP)
0245 = DS 19 ;MISC AND DISK MAP
0258 = SCBCR: DS 1 ;CURRENT RECORD (ZEROED IN SETUP)

```

```

;
0259 = PCB: DS 9
0262 50524E00 DB 'PRN',0
0266 = DS 19
0279 00 DB 0 ;RECORD TO WRITE NEXT

```

```

;
027A = HCB: DS 9
0283 48455800 DB 'HEX',0
0287 = DS 19
029A 00 DB 0

```

```

; POINTERS AND BUFFERS
029B 0004 = SBP: DW SSIZE ;NEXT CHARACTER POSITION TO READ
029D = SBUFP: DS SSIZE

```

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```

069D 0000
069F

```

```

099F 0000
09A1
005C =
0031 =
0009 =
0080 =

```

```

0CA1 213402
0CA4 BE
0CA5 C8
0CA6 77
0CA7 5F
0CA8 0E0E
0CAA CD0500
0CAD C9

```

```

0CAE 23
0CAF 7E
0CB0 FE20
0CB2 CAB80C
0CB5 DE41
0CB7 C9
0CB8 3A3402
0CB8 C9

```

```

0CBC 7E
0CB0 CDDE0E
0CC0 7E
0CC1 23
0CC2 FE0D
0CC4 C2BC0C
0CC7 3E0A
0CC9 CDDE0E
0CCC C9

```

```

0CCD 115C00
0CD0 0609
0CD2 1A
0CD3 FE3F
0CD5 CAB80D
0CD8 77
0CD9 23

```

```

;
BPP: DW 0
PBUFP: DS PSIZE

```

```

;
HBP: DW 0
HBUFP: DS HSIZE
PCB EQU 5CH ;FILE CONTROL BLOCK ADDRESS
FNM EQU 1 ;POSITION OF FILE NAME
FLN EQU 9 ;FILE NAME LENGTH
BUFP EQU 80H ;INPUT DISK BUFFER ADDRESS

```

```

;
SEL: ;SELECT DISK IN REG-A
LXI H,CDISK
CMP M ;SAME?
RZ
MOV M,A ;CHANGE CURRENT DISK
MOV E,A
MVI C,SELECT
CALL BDOS
RET

```

```

;
SCNP: ;SCAN THE NEXT PARAMETER
INX H
MOV A,M
CPI 'A'
JZ SCNP0
SBI 'A' ;NORMALIZE
RET
SCNP0: LDA CDISK
RET

```

```

;
PCON: ;PRINT MESSAGE AT H,L TO CONSOLE DEVICE
MOV A,M
CALL PCHAR
MOV A,M
INX H
CPI CR
JNZ PCON
MVI A,LF
CALL PCHAR
RET

```

```

;
FNAME: ;FILL NAME FROM DEFAULT FILE CONTROL BLOCK
LXI D,FCB
MVI B,FLN
FNAME0: LDAX D ;GET NEXT FILE CHARACTER
CPI '?'
JZ FNERR ;FILE NAME ERROR
MOV M,A ;STORE TO FILE CNTRL BLOCK
INX H

```

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```

00DA 13      INX      D
00DB 05      DCR      B
00DC C2D200  JNZ      FNAME ;FOR NEXT CHARACTER
00DF C9      RET

```

```

; INIT: ;SET UP STACK AND FILES, START ASSEMBLER

```

```

00E0 21A00F  LXI      H,TITL
00E3 CDB00C  CALL     PCON
00E6 C33F0D  JMP      SET0

```

```

; OPEN: ;OPEN FILE ADDRESSED BY D,E

```

```

00E9 0E0F    MVI      C,OPENF
00EB CD0500  CALL     BDOS
00EE FEFF    CPI      255
00F0 C0      RNZ

```

```

; OPEN ERROR

```

```

00F1 21B90F  LXI      H,ERR0P
00F4 CDB00C  CALL     PCON
00F7 C30000  JMP      BOOT

```

```

; CLOSE: ;CLOSE FILE ADDRESSED BY D,E

```

```

00FA 0E10    MVI      C,CLOSF
00FC CD0500  CALL     BDOS
00FF FEFF    CPI      255
0001 C0      RNZ
0002 212910  LXI      H,ERRCL
0005 CDB00C  CALL     PCON
0008 C30000  JMP      BOOT

```

```

; DELETE: ;DELETE FILE ADDRESSED BY D,E

```

```

000B 0E13    MVI      C,DELEF
000D C30500  JMP      BDOS

```

```

; MAKE: ;MAKE FILE ADDRESSED BY D,E

```

```

0010 0E16    MVI      C,MAKEF
0012 CD0500  CALL     BDOS
0015 FEFF    CPI      255
0017 C0      RNZ

```

```

; MAKE ERROR

```

```

0018 21D00F  LXI      H,ERRMA
001B CDB00C  CALL     PCON
001E C30000  JMP      BOOT

```

```

; SELA: LDA      ADISK

```

```

0021 3A3502  LDA      ADISK
0024 CDA10C  CALL     SEL
0027 C9      RET

```

```

; NPR: ;RETURN ZERO FLAG IF NO PRINT FILE

```

```

0028 3A3602  LDA      PDISK
002B FE19    CPI      'Z'-A'

```

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```

002D C8      RZ
002E FE17    CPI      'X'-A' ;CONSOLE:
0030 C9      RET

```

```

; SELP: LDA      PDISK

```

```

0031 3A3602  LDA      PDISK
0034 CDA10C  CALL     SEL
0037 C9      RET

```

```

; SELH: LDA      HDISK

```

```

0038 3A3702  LDA      HDISK
003B CDA10C  CALL     SEL
003E C9      RET

```

```

; SET0: ;SET UP FILES FOR INPUT AND OUTPUT

```

```

003F 3A5C00  LDA      FCB ;GET FIRST CHARACTER
0042 FE20    CPI      'Z'-A' ;MAY HAVE FORGOTTEN NAME
0044 CABB0D  JZ       FNERR ;FILE NAME ERROR
0047 0E19    MVI      C,CSEL ;CURRENT DISK?
0049 CD0500  CALL     BDOS ;GET IT TO REG
004C 323402  STA      CDISK

```

SCAN PARAMETERS

```

004F 216400  LXI      H,FCB+FLN-1
0052 CDAE0C  CALL     SCNP
0055 323502  STA      ADISK
0058 CDAE0C  CALL     SCNP
005B 323702  STA      HDISK
005E CDAE0C  CALL     SCNP
0061 323602  STA      PDISK

```

```

; LXI      H,SCB ;ADDRESS SOURCE FILE CONTROL BLOCK

```

```

0064 213802  LXI      H,SCB
0067 CDCD0C  CALL     FNAME ;FILE NAME OBTAINED FROM DEFAULT FCB

```

```

; CALL     NPR ;Z OR X?

```

```

006A CD280D  CALL     NPR
006D CA830D  JZ       NOPR
0070 215902  LXI      H,PCB ;ADDRESS PRINT FILE CONTROL BLOCK
0073 E5      PUSH     H ;SAVE A COPY FOR OPEN
0074 E5      PUSH     H ;SAVE A COPY FOR DELETE
0075 CDCD0C  CALL     FNAME ;FILL PCB
0078 CD310D  CALL     SELP
007B D1      POP      D ;FCB ADDRESS
007C CD0B0D  CALL     DELETE
007F D1      POP      D ;FCB ADDRESS
0080 CD100D  CALL     MAKE

```

```

; NOPR: ;TEST FOR HEX FILE

```

```

0083 3A3702  LDA      HDISK
0086 FE19    CPI      'Z'-A'
0088 CA9E0D  JZ       NOHEX
008B 217A02  LXI      H,HCB
008E E5      PUSH     H

```

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```

0D8F E5      PUSH    H
0D93 CDCD0C  CALL    FNAME
0D93 CD380D  CALL    SELH
0D96 D1      POP     D
0D97 CD0B0D  CALL    DELETE
0D9A D1      POP     D
0D9B CD100D  CALL    MAKE
  
```

```

;
; FILES SET UP, CALL ASSEMBLER
0D9E C30011  NOHEX: JMP    ENDMOD
;
; SETUP: ;SETUP INPUT FILE FOR SOURCE PROGRAM
  
```

```

0DA1 210004  LXI     H,SSIZE
0DA4 229B02  SHLD   SBP      ;CAUSE IMMEDIATE READ
0DA7 AF      XRA     A      ;ZERO VALUE
0DA8 324402  STA     SCBR     ;CLEAR REEL NUMBER
0DAB 325802  STA     SCBCR    ;CLEAR CURRENT RECORD
0DAE 322302  STA     DBL      ;CLEAR HEX BUFFER LENGTH
0DB1 CD210D  CALL    SELA
0DB4 113802  LXI     D,SCB
0DB7 CDE90C  CALL    OPEN
  
```

```

0DEA C9      RET
  
```

```

;
; FNERR: ;FILE NAME ERROR
0DBB 21E30F  LXI     H,ERRFN
0DBE CD0C0C  CALL    PCON
0DC1 C30000  JMP     BOOT
  
```

```

;
; GCOMP: ;COMPARE D,E AGAINST H,L
0DC4 7A      MOV     A,D
0DC5 BC      CMP     H
0DC6 C0      RNZ
0DC7 7B      MOV     A,E
0DC8 BD      CMP     L
0DC9 C9      RET
  
```

```

;
; GNC: ;GET NEXT CHARACTER FROM SOURCE BUFFER
0DCA C5      PUSH    B
0DCB D5      PUSH    D
0DCC E5      PUSH    H      ;ENVIRONMENT SAVED
0DCE 2A9B02  LHLD   SBP
0DD3 110304  LXI     D,SSIZE
0DD3 CDC40D  CALL    GCOMP
0DD6 C2190E  JNZ    GNC2
  
```

```

;
; READ ANOTHER BUFFER
0DD9 CD210D  CALL    SELA
0DDC 210000  LXI     H,0
  
```

```

0DDF 229B02  SHLD   SBP
0DE2 0608    MVI     B,NSB      ;NUMBER OF SOURCE BUFFERS
0DE4 219D02  LXI     H,SBUFF
  
```

```

GNC0: ;READ 128 BYTES
      PUSH    B      ;SAVE COUNT
      PUSH    H      ;SAVE BUFFER ADDRESS
      MVI     C,READF
      LXI     D,SCB
      CALL    BDOS    ;PERFORM THE READ
      POP     H      ;RESTORE BUFFER ADDRESS
      POP     B      ;RESTORE BUFFER COUNT
      ORA     A      ;SET FLAGS
      MVI     C,128
      JNZ    GNC1
  
```

```

; NORMAL READ OCCURRED
      LXI     D,BUFF  ;SOURCE BUFFER ADDRESS
      MVI     C,128
  
```

```

MOV0: LDAX   D      ;GET CHARACTER
      MOV     M,A    ;STORE CHARACTER
  
```

```

0E00 13      INX     D
0E01 23      INX     H
0E02 0D      DCR     C
0E03 C2FE0D  JNZ    MOV0
  
```

```

; BUFFER LOADED, TRY NEXT BUFFER
  
```

```

0E06 05      DCR     B
0E07 C2E70D  JNZ    GNC0
0E0A C3190E  JMP    GNC2
  
```

```

0E0D FE03      CPI     3      ;ALLOW 0,1,2
0E0F D22B0E  JNC     FRERR    ;FILE READ ERROR
0E12 361A     MVI     M,EOF  ;STORE AND END OF FILE CHARACTER
0E14 23      INX     H
0E15 0D      DCR     C
0E16 C2120E  JNZ    GNC1
  
```

```

GNC1: ;EOF OR ERROR
      CPI     3      ;ALLOW 0,1,2
      JNC     FRERR  ;FILE READ ERROR
      MVI     M,EOF  ;STORE AND END OF FILE CHARACTER
      INX     H
      DCR     C
      JNZ    GNC1   ;FILL CURRENT BUFFER WITH EOF'S
  
```

```

; GNC2: ;GET CHARACTER TO ACCUMULATOR AND RETURN
  
```

```

0E19 119D02  LXI     D,SBUFF
0E1C 2A9B02  LHLD   SBP
0E1F E5      PUSH    H
0E20 23      INX     H
0E21 229B02  SHLD   SBP
0E24 E1      POP     H
0E25 19      DAD     D
0E26 7E      MOV     A,M
0E27 E1      POP     H
0E28 D1      POP     D
0E29 C1      POP     B
0E2A C9      RET
  
```

```

      LHLD   SBP      ;SAVE CURRENT SBP
      INX     H      ;READY FOR NEXT READ
      SHLD   SBP
      POP     H      ;RESTORE PREVIOUS SBP
      DAD     D      ;ABSOLUTE ADDRESS OF CHARACTER
      MOV     A,M    ;GET IT
      POP     H
      POP     D
      POP     B
      RET
  
```

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```

0E28 21FA0F  ;FRERR: LXI  H,ERRFR
0E2E CDB0C  CALL  PCON  ;PRINT READ ERROR MESSAGE
0E31 C30000  JMP  BOOT

```

```

0E34 C5      ;PNC:  ;SAME AT PNCF, BUT ENVIRONMENT IS SAVED FIRST
;          PUSH  B
;          CHECK FOR CONSOLE OUTPUT / NO OUTPUT
0E35 47      MOV  B,A  ;SAVE CHARACTER
0E36 3A3602  LDA  PDISK  ;Z OR X?
0E39 FE19    CPI  'Z'-A  ;Z NO OUTPUT
0E3B CA510E  JZ   PNRET

```

```

0E3E FE17    CPI  'X'-A
0E40 78      MOV  A,B  ;RECOVER CHAR FOR CON OUT
0E41 C24A0E  JNZ  PNGO
0E44 CDDE0E  CALL  PCHAR
0E47 C3510E  JMP  PNRET

```

```

;          NOT X OR Z, SO PRINT IT
0E4A D5      PNGO:  PUSH  D
0E4B E5      PUSH  H
0E4C CD530E  CALL  PNCF
0E4F E1      POP   H
0E50 D1      POP   D
0E51 C1      PNRET:  POP   B
0E52 C9      RET

```

```

;          PNCF:  ;PRINT NEXT CHARACTER
0E53 2A9D06  LHLD  PBP
0E56 E8      XCHG
0E57 219F06  LXI  H,PBUFF
0E5A 19      DAD   D
0E5B 77      MOV  M,A  ;CHARACTER STORED AT PBP IN PBUFF
0E5C EB      XCHG
0E5D 23      INX  H  ;PBP TO H,L
0E5E 229D06  SHLD  PBP  ;POINT TO NEXT CHARACTER
0E61 E8      XCHG
0E62 210023  LXI  H,PSIZE
0E65 CDC40D  CALL  GCOMP  ;AT END OF BUFFER?
0E68 C8      RNZ   ;RETURN IF NOT

```

```

;          OVERFLOW, WRITE BUFFER
0E69 CD310D  CALL  SELP
0E6C 210200  LXI  H,0
0E6F 229D06  SHLD  PBP
0E72 219F26  LXI  H,PBUFF
0E75 115902  LXI  D,PCB  ;D,E ADDRESS FILE CONTROL BLOCK
0E78 0606    MVI  B,NPB  ;NUMBER OF BUFFERS TO B
;          (DROP THROUGH TO WBUF0)

```

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```

0E7A 7E      ;WBUF0: ;WRITE BUFFERS STARTING AT H,L FOR B BUFFERS
0E7B FE1A    ;          CHECK FOR EOF'S
0E7D C8      MOV  A,M
;          CPI  EOF
;          RZ   ;DON'T DO THE WRITE

```

```

0E7E C5      ;          PUSH  B  ;SAVE NUMBER OF BUFFERS
0E7F D5      PUSH  D  ;SAVE FCB ADDRESS
0E80 0E80    MVI  C,128 ;READY FOR MOVE
0E82 118000  LXI  D,BUFF

```

```

0E85 7E      WBUF0: ;MOVE TO BUFFER
0E86 12      MOV  A,M  ;GET CHARACTER
0E87 23      STAX  D  ;PUT CHARACTER
0E88 13      INX  H
0E89 0D      INX  D
0E8A C2850E  DCR  C
;          JNZ  WBUF0

```

```

0E8D D1      ;          WRITE BUFFER
0E8E D5      POP   D  ;RECOVER FCB ADDRESS
0E8F E5      PUSH  D  ;SAVE IT AGAIN FOR LATER
0E90 0E15    PUSH  H  ;SAVE BUFFER ADDRESS
0E92 CD0500  MVI  C,WRITE ;DOS WRITE FUNCTION
0E95 E1      CALL  BDOS
0E96 D1      POP   H  ;RECOVER BUFFER ADDRESS
0E97 C1      POP   D  ;RECOVER FCB ADDRESS
0E98 B7      POP   B  ;RECOVER BUFFER COUNT
0E99 C2A10E  ORA  A  ;SET ERROR RETURN FLAGS
;          JNZ  FWERR

```

```

0E9C 05      ;          WRITE OK
0E9D C8      DCR  B
0E9E C37A0E  RZ   ;RETURN IF NO MORE BUFFERS TO WRITE

```

```

0EA1 211110  ;FWERR: ;ERROR IN WRITE
0EA4 CDB0C   LXI  H,ERRFW
0EA7 C3770F  CALL  PCON  ;ERROR MESSAGE OUT
;          JMP  EORC  ;TO CLOSE AND REBOOT

```

```

0EAA C5      ;          PNB:  ;PUT NEXT HEX BYTE
0EAB D5      PUSH  B
0EAC E5      PUSH  D
0EAD CDB40E  PUSH  H
0EB0 E1      CALL  PNB
0EB1 D1      POP   H
0EB2 C1      POP   D
;          POP   B

```

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```

02B3 C9      RET
;
;PNBF: ;PUT NEXT BYTE
;          (SIMILAR TO THE PNCF SUBROUTINE)
02B4 2A9F09  LHLD  HBP
02B7 EB      XCHG
02B8 21A109  LXI   H,HBUFF
02BB 19      DAD   D
02BC 77      MOV   M,A      ;CHARACTER STORED AT HBP IN HBUFF
02BD EB      XCHG
02BE 23      INX   H      ;HBP INCREMENTED
02BF 229F09  SHLD  HBP
02C2 EB      XCHG      ;BACK TO D,E
02C3 210203  LXI   H,HSIZE
02C6 CDC4D0  CALL  GCOMP ;EQUAL?
02C9 C0      RNZ

```

```

;
; OVERFLOW, WRITE BUFFERS
02CA C038D0  CALL  SELH
02CD 210200  LXI   H,0
02D0 229F09  SHLD  HBP
02D3 21A109  LXI   H,HBUFF
02D6 117A02  LXI   D,HCN ;FILE CONTROL BLOCK FOR HEX FILE
02D9 0606    MVI   B,NHB
02DB C37A0E  JMP   WBUFF ;WRITE BUFFERS

```

```

;
;PCHAR: ;PRINT CHARACTER IN REGISTER A
02DE C5      PUSH  B
02DF D5      PUSH  D
02E0 E5      PUSH  H
02E1 0E02    MVI   C,WRITC
02E3 5F      MOV   E,A
02E4 CD0500  CALL  BDOS
02E7 E1      POP   H
02E8 D1      POP   D
02E9 C1      POP   B
02EA C9      RET

```

```

;
;WOCHAR: ;WRITE CHARACTER IN REG-A WITH REFLECT AT CONSOLE IF ERROR
02EB 4F      MOV   C,A      ;SAVE THE CHAR
02EC CD340E  CALL  PNC      ;PRINT CHAR
02EF 3A0C01  LDA   QBUFF
02F2 FE20    CPI
02F4 C8      RZ
;
; ERROR IN LINE
02F5 3A3602  LDA   PDISK
02F8 FE17    CPI   'X'-A
02FA C8      RZ      ;ALREADY PRINTED IF 'X'
;
;
02FB 79      MOV   A,C      ;RECOVER CHARACTER

```

```

02FC CDDE0E  CALL  PCHAR ;PRINT IT
02FF C9      RET

```

```

;
;WOBUFF: ;WRITE THE OUTPUT BUFFER TO THE PRINT FILE
02F0 3A8401  LDA   QBP      ;GET CHARACTER COUNT
02F3 210C01  LXI   H,QBUFF ;BASE OF BUFFER
02F6 B7      ORA   A      ;ZERO COUNT?
02F7 CA150F  JZ    WORE
;
; NOT END, SAVE COUNT AND GET CHARACTER
02F8 47      MOV   B,A      ;SAVE COUNT
02FB 7E      MOV   A,M
02FC CDEB0E  CALL  WOCHAR ;WRITE CHARACTER
02FD 23      INX   H      ;ADDRESS NEXT CHARACTER OF BUFFER
02FE 78      MOV   A,B      ;GET COUNT
02FF 3D      DCR   A
0300 70      JMP   WOB0

```

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;
;WORE: ;END OF PRINT - ZERO QBP
0301 328401  STA   QBP
;
; FOLLOW BY CR LF
0302 3E0D    MVI   A,CR
0303 CDEB0E  CALL  WOCHAR
0304 3E0A    MVI   A,LF
0305 CDEB0E  CALL  WOCHAR
0306 210C01  LXI   H,QBUFF
0307 3E78    MVI   A,QBMX ;READY TO BLANK OUT
0308 3620    MVI   M,
0309 23      INX   H
030A 3D      DCR   A
030B C2270F  JNZ   WOB2
030C C9      RET

```

```

;
;PERR: ;FILL QBUFF ERROR MESSAGE POSITION
030D 47      MOV   B,A      ;SAVE CHARACTER
030E 210C01  LXI   H,QBUFF
030F 7E      MOV   A,M
0310 CDEB0E  CALL  CPI
0311 3E0A    MVI   A,LF
0312 3E0A    MVI   A,LF
0313 3E0A    MVI   A,LF
0314 3E0A    MVI   A,LF
0315 3E0A    MVI   A,LF
0316 3E0A    MVI   A,LF
0317 3E0A    MVI   A,LF
0318 3E0A    MVI   A,LF
0319 3E0A    MVI   A,LF
031A 3E0A    MVI   A,LF
031B 3E0A    MVI   A,LF
031C 3E0A    MVI   A,LF
031D 3E0A    MVI   A,LF
031E 3E0A    MVI   A,LF
031F 3E0A    MVI   A,LF
0320 3E0A    MVI   A,LF
0321 3E0A    MVI   A,LF
0322 3E0A    MVI   A,LF
0323 3E0A    MVI   A,LF
0324 3E0A    MVI   A,LF
0325 3E0A    MVI   A,LF
0326 3E0A    MVI   A,LF
0327 3E0A    MVI   A,LF
0328 3E0A    MVI   A,LF
0329 3E0A    MVI   A,LF
032A 3E0A    MVI   A,LF
032B 3E0A    MVI   A,LF
032C 3E0A    MVI   A,LF
032D 3E0A    MVI   A,LF
032E 3E0A    MVI   A,LF
032F 3E0A    MVI   A,LF
0330 3E0A    MVI   A,LF
0331 3E0A    MVI   A,LF
0332 3E0A    MVI   A,LF
0333 3E0A    MVI   A,LF
0334 3E0A    MVI   A,LF
0335 3E0A    MVI   A,LF
0336 3E0A    MVI   A,LF
0337 3E0A    MVI   A,LF
0338 3E0A    MVI   A,LF
0339 3E0A    MVI   A,LF
033A 3E0A    MVI   A,LF
033B 3E0A    MVI   A,LF
033C 3E0A    MVI   A,LF
033D 3E0A    MVI   A,LF
033E 3E0A    MVI   A,LF
033F 3E0A    MVI   A,LF
0340 3E0A    MVI   A,LF
0341 3E0A    MVI   A,LF
0342 3E0A    MVI   A,LF
0343 3E0A    MVI   A,LF
0344 3E0A    MVI   A,LF
0345 3E0A    MVI   A,LF
0346 3E0A    MVI   A,LF
0347 3E0A    MVI   A,LF
0348 3E0A    MVI   A,LF
0349 3E0A    MVI   A,LF
034A 3E0A    MVI   A,LF
034B 3E0A    MVI   A,LF
034C 3E0A    MVI   A,LF
034D 3E0A    MVI   A,LF
034E 3E0A    MVI   A,LF
034F 3E0A    MVI   A,LF
0350 3E0A    MVI   A,LF
0351 3E0A    MVI   A,LF
0352 3E0A    MVI   A,LF
0353 3E0A    MVI   A,LF
0354 3E0A    MVI   A,LF
0355 3E0A    MVI   A,LF
0356 3E0A    MVI   A,LF
0357 3E0A    MVI   A,LF
0358 3E0A    MVI   A,LF
0359 3E0A    MVI   A,LF
035A 3E0A    MVI   A,LF
035B 3E0A    MVI   A,LF
035C 3E0A    MVI   A,LF
035D 3E0A    MVI   A,LF
035E 3E0A    MVI   A,LF
035F 3E0A    MVI   A,LF
0360 3E0A    MVI   A,LF
0361 3E0A    MVI   A,LF
0362 3E0A    MVI   A,LF
0363 3E0A    MVI   A,LF
0364 3E0A    MVI   A,LF
0365 3E0A    MVI   A,LF
0366 3E0A    MVI   A,LF
0367 3E0A    MVI   A,LF
0368 3E0A    MVI   A,LF
0369 3E0A    MVI   A,LF
036A 3E0A    MVI   A,LF
036B 3E0A    MVI   A,LF
036C 3E0A    MVI   A,LF
036D 3E0A    MVI   A,LF
036E 3E0A    MVI   A,LF
036F 3E0A    MVI   A,LF
0370 3E0A    MVI   A,LF
0371 3E0A    MVI   A,LF
0372 3E0A    MVI   A,LF
0373 3E0A    MVI   A,LF
0374 3E0A    MVI   A,LF
0375 3E0A    MVI   A,LF
0376 3E0A    MVI   A,LF
0377 3E0A    MVI   A,LF
0378 3E0A    MVI   A,LF
0379 3E0A    MVI   A,LF
037A 3E0A    MVI   A,LF
037B 3E0A    MVI   A,LF
037C 3E0A    MVI   A,LF
037D 3E0A    MVI   A,LF
037E 3E0A    MVI   A,LF
037F 3E0A    MVI   A,LF
0380 3E0A    MVI   A,LF
0381 3E0A    MVI   A,LF
0382 3E0A    MVI   A,LF
0383 3E0A    MVI   A,LF
0384 3E0A    MVI   A,LF
0385 3E0A    MVI   A,LF
0386 3E0A    MVI   A,LF
0387 3E0A    MVI   A,LF
0388 3E0A    MVI   A,LF
0389 3E0A    MVI   A,LF
038A 3E0A    MVI   A,LF
038B 3E0A    MVI   A,LF
038C 3E0A    MVI   A,LF
038D 3E0A    MVI   A,LF
038E 3E0A    MVI   A,LF
038F 3E0A    MVI   A,LF
0390 3E0A    MVI   A,LF
0391 3E0A    MVI   A,LF
0392 3E0A    MVI   A,LF
0393 3E0A    MVI   A,LF
0394 3E0A    MVI   A,LF
0395 3E0A    MVI   A,LF
0396 3E0A    MVI   A,LF
0397 3E0A    MVI   A,LF
0398 3E0A    MVI   A,LF
0399 3E0A    MVI   A,LF
039A 3E0A    MVI   A,LF
039B 3E0A    MVI   A,LF
039C 3E0A    MVI   A,LF
039D 3E0A    MVI   A,LF
039E 3E0A    MVI   A,LF
039F 3E0A    MVI   A,LF
03A0 3E0A    MVI   A,LF
03A1 3E0A    MVI   A,LF
03A2 3E0A    MVI   A,LF
03A3 3E0A    MVI   A,LF
03A4 3E0A    MVI   A,LF
03A5 3E0A    MVI   A,LF
03A6 3E0A    MVI   A,LF
03A7 3E0A    MVI   A,LF
03A8 3E0A    MVI   A,LF
03A9 3E0A    MVI   A,LF
03AA 3E0A    MVI   A,LF
03AB 3E0A    MVI   A,LF
03AC 3E0A    MVI   A,LF
03AD 3E0A    MVI   A,LF
03AE 3E0A    MVI   A,LF
03AF 3E0A    MVI   A,LF
03B0 3E0A    MVI   A,LF
03B1 3E0A    MVI   A,LF
03B2 3E0A    MVI   A,LF
03B3 3E0A    MVI   A,LF
03B4 3E0A    MVI   A,LF
03B5 3E0A    MVI   A,LF
03B6 3E0A    MVI   A,LF
03B7 3E0A    MVI   A,LF
03B8 3E0A    MVI   A,LF
03B9 3E0A    MVI   A,LF
03BA 3E0A    MVI   A,LF
03BB 3E0A    MVI   A,LF
03BC 3E0A    MVI   A,LF
03BD 3E0A    MVI   A,LF
03BE 3E0A    MVI   A,LF
03BF 3E0A    MVI   A,LF
03C0 3E0A    MVI   A,LF
03C1 3E0A    MVI   A,LF
03C2 3E0A    MVI   A,LF
03C3 3E0A    MVI   A,LF
03C4 3E0A    MVI   A,LF
03C5 3E0A    MVI   A,LF
03C6 3E0A    MVI   A,LF
03C7 3E0A    MVI   A,LF
03C8 3E0A    MVI   A,LF
03C9 3E0A    MVI   A,LF
03CA 3E0A    MVI   A,LF
03CB 3E0A    MVI   A,LF
03CC 3E0A    MVI   A,LF
03CD 3E0A    MVI   A,LF
03CE 3E0A    MVI   A,LF
03CF 3E0A    MVI   A,LF
03D0 3E0A    MVI   A,LF
03D1 3E0A    MVI   A,LF
03D2 3E0A    MVI   A,LF
03D3 3E0A    MVI   A,LF
03D4 3E0A    MVI   A,LF
03D5 3E0A    MVI   A,LF
03D6 3E0A    MVI   A,LF
03D7 3E0A    MVI   A,LF
03D8 3E0A    MVI   A,LF
03D9 3E0A    MVI   A,LF
03DA 3E0A    MVI   A,LF
03DB 3E0A    MVI   A,LF
03DC 3E0A    MVI   A,LF
03DD 3E0A    MVI   A,LF
03DE 3E0A    MVI   A,LF
03DF 3E0A    MVI   A,LF
03E0 3E0A    MVI   A,LF
03E1 3E0A    MVI   A,LF
03E2 3E0A    MVI   A,LF
03E3 3E0A    MVI   A,LF
03E4 3E0A    MVI   A,LF
03E5 3E0A    MVI   A,LF
03E6 3E0A    MVI   A,LF
03E7 3E0A    MVI   A,LF
03E8 3E0A    MVI   A,LF
03E9 3E0A    MVI   A,LF
03EA 3E0A    MVI   A,LF
03EB 3E0A    MVI   A,LF
03EC 3E0A    MVI   A,LF
03ED 3E0A    MVI   A,LF
03EE 3E0A    MVI   A,LF
03EF 3E0A    MVI   A,LF
03F0 3E0A    MVI   A,LF
03F1 3E0A    MVI   A,LF
03F2 3E0A    MVI   A,LF
03F3 3E0A    MVI   A,LF
03F4 3E0A    MVI   A,LF
03F5 3E0A    MVI   A,LF
03F6 3E0A    MVI   A,LF
03F7 3E0A    MVI   A,LF
03F8 3E0A    MVI   A,LF
03F9 3E0A    MVI   A,LF
03FA 3E0A    MVI   A,LF
03FB 3E0A    MVI   A,LF
03FC 3E0A    MVI   A,LF
03FD 3E0A    MVI   A,LF
03FE 3E0A    MVI   A,LF
03FF 3E0A    MVI   A,LF

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```

02F2 47      MOV   B,A      ;SAVE CHARACTER
02F3 210C01  LXI   H,QBUFF
02F4 7E      MOV   A,M
02F5 CDEB0E  CALL  CPI
02F6 3E0A    MVI   A,LF
02F7 3E0A    MVI   A,LF
02F8 3E0A    MVI   A,LF
02F9 3E0A    MVI   A,LF
02FA 3E0A    MVI   A,LF
02FB 3E0A    MVI   A,LF
02FC 3E0A    MVI   A,LF
02FD 3E0A    MVI   A,LF
02FE 3E0A    MVI   A,LF
02FF 3E0A    MVI   A,LF

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;
;EOR: ;END OF ASSEMBLER
0300 3E0A    MVI   A,LF
0301 3E0A    MVI   A,LF
0302 3E0A    MVI   A,LF
0303 3E0A    MVI   A,LF
0304 3E0A    MVI   A,LF
0305 3E0A    MVI   A,LF
0306 3E0A    MVI   A,LF
0307 3E0A    MVI   A,LF
0308 3E0A    MVI   A,LF
0309 3E0A    MVI   A,LF
030A 3E0A    MVI   A,LF
030B 3E0A    MVI   A,LF
030C 3E0A    MVI   A,LF
030D 3E0A    MVI   A,LF
030E 3E0A    MVI   A,LF
030F 3E0A    MVI   A,LF
0310 3E0A    MVI   A,LF
0311 3E0A    MVI   A,LF
0312 3E0A    MVI   A,LF
0313 3E0A    MVI   A,LF
0314 3E0A    MVI   A,LF
0315 3E0A    MVI   A,LF
0316 3E0A    MVI   A,LF
0317 3E0A    MVI   A,LF
0318 3E0A    MVI   A,LF
0319 3E0A    MVI   A,LF
031A 3E0A    MVI   A,LF
031B 3E0A    MVI   A,LF
031C 3E0A    MVI   A,LF
031D 3E0A    MVI   A,LF
031E 3E0A    MVI   A,LF
031F 3E0A    MVI   A,LF
0320 3E0A    MVI   A,LF
0321 3E0A    MVI   A,LF
0322 3E0A    MVI   A,LF
0323 3E0A    MVI   A,LF
0324 3E0A    MVI   A,LF
0325 3E0A    MVI   A,LF
0326 3E0A    MVI   A,LF
0327 3E0A    MVI   A,LF
0328 3E0A    MVI   A,LF
0329 3E0A    MVI   A,LF
032A 3E0A    MVI   A,LF
032B 3E0A    MVI   A,LF
032C 3E0A    MVI   A,LF
032D 3E0A    MVI   A,LF
032E 3E0A    MVI   A,LF
032F 3E0A    MVI   A,LF
0330 3E0A    MVI   A,LF
0331 3E0A    MVI   A,LF
0332 3E0A    MVI   A,LF
0333 3E0A    MVI   A,LF
0334 3E0A    MVI   A,LF
0335 3E0A    MVI   A,LF
0336 3E0A    MVI   A,LF
0337 3E0A    MVI   A,LF
0338 3E0A    MVI   A,LF
0339 3E0A    MVI   A,LF
033A 3E0A    MVI   A,LF
033B 3E0A    MVI   A,LF
033C 3E0A    MVI   A,LF
033D 3E0A    MVI   A,LF
033E 3E0A    MVI   A,LF
033F 3E0A    MVI   A,LF
0340 3E0A    MVI   A,LF
0341 3E0A    MVI   A,LF
0342 3E0A    MVI   A,LF
0343 3E0A    MVI   A,LF
0344 3E0A    MVI   A,LF
0345 3E0A    MVI   A,LF
0346 3E0A    MVI   A,LF
0347 3E0A    MVI   A,LF
0348 3E0A    MVI   A,LF
0349 3E0A    MVI   A,LF
034A 3E0A    MVI   A,LF
034B 3E0A    MVI   A,LF
034C 3E0A    MVI   A,LF
034D 3E0A    MVI   A,LF
034E 3E0A    MVI   A,LF
034F 3E0A    MVI   A,LF
0350 3E0A    MVI   A,LF
0351 3E0A    MVI   A,LF
0352 3E0A    MVI   A,LF
0353 3E0A    MVI   A,LF
0354 3E0A    MVI   A,LF
0355 3E0A    MVI   A,LF
0356 3E0A    MVI   A,LF
0357 3E0A    MVI   A,LF
0358 3E0A    MVI   A,LF
0359 3E0A    MVI   A,LF
035A 3E0A    MVI   A,LF
035B 3E0A    MVI   A,LF
035C 3E0A    MVI   A,LF
035D 3E0A    MVI   A,LF
035E 3E0A    MVI   A,LF
035F 3E0A    MVI   A,LF
0360 3E0A    MVI   A,LF
0361 3E0A    MVI   A,LF
0362 3E0A    MVI   A,LF
0363 3E0A    MVI   A,LF
0364 3E0A    MVI   A,LF
0365 3E0A    MVI   A,LF
0366 3E0A    MVI   A,LF
0367 3E0A    MVI   A,LF
0368 3E0A    MVI   A,LF
0369 3E0A    MVI   A,LF
036A 3E0A    MVI   A,LF
036B 3E0A    MVI   A,LF
036C 3E0A    MVI   A,LF
036D 3E0A    MVI   A,LF
036E 3E0A    MVI   A,LF
036F 3E0A    MVI   A,LF
0370 3E0A    MVI   A,LF
0371 3E0A    MVI   A,LF
0372 3E0A    MVI   A,LF
0373 3E0A    MVI   A,LF
0374 3E0A    MVI   A,LF
0375 3E0A    MVI   A,LF
0376 3E0A    MVI   A,LF
0377 3E0A    MVI   A,LF
0378 3E0A    MVI   A,LF
0379 3E0A    MVI   A,LF
037A 3E0A    MVI   A,LF
037B 3E0A    MVI   A,LF
037C 3E0A    MVI   A,LF
037D 3E0A    MVI   A,LF
037E 3E0A    MVI   A,LF
037F 3E0A    MVI   A,LF
0380 3E0A    MVI   A,LF
0381 3E0A    MVI   A,LF
0382 3E0A    MVI   A,LF
0383 3E0A    MVI   A,LF
0384 3E0A    MVI   A,LF
0385 3E0A    MVI   A,LF
0386 3E0A    MVI   A,LF
0387 3E0A    MVI   A,LF
0388 3E0A    MVI   A,LF
0389 3E0A    MVI   A,LF
038A 3E0A    MVI   A,LF
038B 3E0A    MVI   A,LF
038C 3E0A    MVI   A,LF
038D 3E0A    MVI   A,LF
038E 3E0A    MVI   A,LF
038F 3E0A    MVI   A,LF
0390 3E0A    MVI   A,LF
0391 3E0A    MVI   A,LF
0392 3E0A    MVI   A,LF
0393 3E0A    MVI   A,LF
0394 3E0A    MVI   A,LF
0395 3E0A    MVI   A,LF
0396 3E0A    MVI   A,LF
0397 3E0A    MVI   A,LF
0398 3E0A    MVI   A,LF
0399 3E0A    MVI   A,LF
039A 3E0A    MVI   A,LF
039B 3E0A    MVI   A,LF
039C 3E0A    MVI   A,LF
039D 3E0A    MVI   A,LF
039E 3E0A    MVI   A,LF
039F 3E0A    MVI   A,LF
03A0 3E0A    MVI   A,LF
03A1 3E0A    MVI   A,LF
03A2 3E0A    MVI   A,LF
03A3 3E0A    MVI   A,LF
03A4 3E0A    MVI   A,LF
03A5 3E0A    MVI   A,LF
03A6 3E0A    MVI   A,LF
03A7 3E0A    MVI   A,LF
03A8 3E0A    MVI   A,LF
03A9 3E0A    MVI   A,LF
03AA 3E0A    MVI   A,LF
03AB 3E0A    MVI   A,LF
03AC 3E0A    MVI   A,LF
03AD 3E0A    MVI   A,LF
03AE 3E0A    MVI   A,LF
03AF 3E0A    MVI   A,LF
03B0 3E0A    MVI   A,LF
03B1 3E0A    MVI   A,LF
03B2 3E0A    MVI   A,LF
03B3 3E0A    MVI   A,LF
03B4 3E0A    MVI   A,LF
03B5 3E0A    MVI   A,LF
03B6 3E0A    MVI   A,LF
03B7 3E0A    MVI   A,LF
03B8 3E0A    MVI   A,LF
03B9 3E0A    MVI   A,LF
03BA 3E0A    MVI   A,LF
03BB 3E0A    MVI   A,LF
03BC 3E0A    MVI   A,LF
03BD 3E0A    MVI   A,LF
03BE 3E0A    MVI   A,LF
03BF 3E0A    MVI   A,LF
03C0 3E0A    MVI   A,LF
03C1 3E0A    MVI   A,LF
03C2 3E0A    MVI   A,LF
03C3 3E0A    MVI   A,LF
03C4 3E0A    MVI   A,LF
03C5 3E0A    MVI   A,LF
03C6 3E0A    MVI   A,LF
03C7 3E0A    MVI   A,LF
03C8 3E0A    MVI   A,LF
03C9 3E0A    MVI   A,LF
03CA 3E0A    MVI   A,LF
03CB 3E0A    MVI   A,LF
03CC 3E0A    MVI   A,LF
03CD 3E0A    MVI   A,LF
03CE 3E0A    MVI   A,LF
03CF 3E0A    MVI   A,LF
03D0 3E0A    MVI   A,LF
03D1 3E0A    MVI   A,LF
03D2 3E0A    MVI   A,LF
03D3 3E0A    MVI   A,LF
03D4 3E0A    MVI   A,LF
03D5 3E0A    MVI   A,LF
03D6 3E0A    MVI   A,LF
03D7 3E0A    MVI   A,LF
03D8 3E0A    MVI   A,LF
03D9 3E0A    MVI   A,LF
03DA 3E0A    MVI   A,LF
03DB 3E0A    MVI   A,LF
03DC 3E0A    MVI   A,LF
03DD 3E0A    MVI   A,LF
03DE 3E0A    MVI   A,LF
03DF 3E0A    MVI   A,LF
03E0 3E0A    MVI   A,LF
03E1 3E0A    MVI   A,LF
03E2 3E0A    MVI   A,LF
03E3 3E0A    MVI   A,LF
03E4 3E0A    MVI   A,LF
03E5 3E0A    MVI   A,LF
03E6 3E0A    MVI   A,LF
03E7 3E0A    MVI   A,LF
03E8 3E0A    MVI   A,LF
03E9 3E0A    MVI   A,LF
03EA 3E0A    MVI   A,LF
03EB 3E0A    MVI   A,LF
03EC 3E0A    MVI   A,LF
03ED 3E0A    MVI   A,LF
03EE 3E0A    MVI   A,LF
03EF 3E0A    MVI   A,LF
03F0 3E0A    MVI   A,LF
03F1 3E0A    MVI   A,LF
03F2 3E0A    MVI   A,LF
03F3 3E0A    MVI   A,LF
03F4 3E0A    MVI   A,LF
03F5 3E0A    MVI   A,LF
03F6 3E0A    MVI   A,LF
03F7 3E0A    MVI   A,LF
03F8 3E0A    MVI   A,LF
03F9 3E0A    MVI   A,LF
03FA 3E0A    MVI   A,LF
03FB 3E0A    MVI   A,LF
03FC 3E0A    MVI   A,LF
03FD 3E0A    MVI   A,LF
03FE 3E0A    MVI   A,LF
03FF 3E0A    MVI   A,LF

```

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```

0F47 3E1A      MVI    A,EOP    ;CTL-Z IS END OF FILE
0F49 CD340E    CALL   PNC      ;PUT ENDFILES IN PRINT BUFFER
0F4C C33F0F    JMP     EOR2     ;EVENTUALLY BUFFER IS WRITTEN

;
EOPR: ;END OF PRINT FILE, CHECK HEX
      LDA    HDISK
      CPI    'Z'-'A'
      JZ     EORC
EOR0: ;WRITE TERMINATING RECORD INTO HEX FILE
      LDA    DBL      ;MAY BE ZERO ALREADY
      ORA    A
      CNZ    WHEX      ;WRITE HEX BUFFER IF NOT ZERO
      LHL    FPC      ;GET CURRENT FPC AS LAST ADDRESS
      SHLD   BPC      ;RECORD LENGTH ZERO, BASE ADDRESS 0000
      CALL   WHEX      ;WRITE HEX BUFFER

;
; NOW CLEAR OUTPUT BUFFER FOR HEX FILE
EOR1: LHL    HBP
      MOV    A,L
      ORA    H
      JZ     EORC
      MVI    A,EOP
      CALL   PNC
      JMP    EOR1

;
; CLOSE FILES AND TERMINATE
EORC: CALL   NPR
      JZ     EORPC
      CALL   SELP
      LXI    D,PCB
      CALL   CLOSE

EORPC: LDA    HDISK
      CPI    'Z'-'A'
      JZ     EORHC
      CALL   SELH
      LXI    D,HCB
      CALL   CLOSE

;
EORHC: LXI    H,ENDA
      CALL   PCON
      JMP    EOC1

;
0FA0 43502F4D20TITL: DB    'CP/M ASSEMBLER - VER 1.0',CR
0FB9 4E4F20534FERR0P: DB    'NO SOURCE FILE PRESENT',CR
0FD0 4E4F204449ERRMA: DB    'NO DIRECTORY SPACE',CR
0FE3 534F555243ERRFN: DB    'SOURCE FILE NAME ERROR',CR
0FFA 534F555243ERRFR: DB    'SOURCE FILE READ ERROR',CR

```

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```

1011 4F55545055ERRFW: DB    'OUTPUT FILE WRITE ERROR',CR
1029 43414E4E4FERRCL: DB    'CANNOT CLOSE FILES',CR
103C 454E44204FENDA:  DB    'END OF ASSEMBLY',CR

```

```

;
DHEX: ;DATA TO HEX BUFFER (BYTE IN REG-A)
      PUSH   B
      MOV    B,A      ;HOLD CHARACTER FOR 'Z' TEST
      LDA    HDISK
      CPI    'Z'-'A'
      MOV    A,B      ;RECOVER CHARACTER
      JZ     DHRET
      PUSH   D
      PUSH   PSW      ;ENVIRONMENT SAVED
      LXI    H,DBL    ;SAVE DATA BYTE
      MOV    A,M      ;CURRENT LENGTH
      ORA    A        ;TO ACCUM
      JZ     DHEX3    ;ZERO?

```

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```

;
; LENGTH NOT ZERO, MAY BE FULL BUFFER
CPI    16
JC     DHEX1 ;BR IF LESS THAN 16 BYTES
;
; BUFFER FULL, DUMP IT
CALL   WHEX ;DBL = 0 UPON RETURN
JMP    DHEX3 ;SET BPC AND DATA BYTE

```

```

;
DHEX1: ;PARTIAL BUFFER IN PROGRESS, CHECK FOR SEQUENTIAL BYTE LOAD
      LHL    FPC
      XCHG
      LHL    BPC      ;BASE PC IN H,L
      MOV    C,A      ;CURRENT LENGTH OF BUFFER
      MVI    B,0      ;IS IN B,C
      DAD    B        ;BPC+DBL TO H,L
      MOV    A,E      ;READY FOR COMPARE
      CMP    L        ;EQUAL?
      JNZ    DHEX2    ;BR IF NOT
      MOV    A,D      ;CHECK HO BYTE
      CMP    H
      JZ     DHEX4    ;BR IF SAME ADDRESS

```

```

;
DHEX2: ;NON SEQUENTIAL ADDRESS, DUMP AND CHANGE BASE ADDRESS
      CALL   WHEX
DHEX3: ;SET NEW BASE
      LHL    FPC
      SHLD   BPC

```

```

;
DHEX4: ;STORE DATA BYTE AND INC DBL
      LXI    H,DBL
      MOV    E,M      ;LENGTH TO REG-E
      INR    M        ;DBL=DBL+1
      MVI    D,0      ;HIGH ORDER ZERO FOR DOUBLE ADD

```

```

1091 212402 LXI H,DBUFF
1094 19 DAD D ;DBUFF+DBL TO H,L
1095 F1 POP PSW ;RESTORE DATA BYTE
1096 77 MOV M,A ;INTO DATA BUFFER
1097 D1 POP D
1098 C1 DHRET: POP B ;ENVIRONMENT RESTORED
1099 C9 RET

```

```

; WRC: ;WRITE CHARACTER WITH CHECK SUM IN D
109A F5 PUSH PSW
109B 0F RRC
109C 0F RRC
109D 0F RRC
109E 0F RRC
109F E60F ANI 0FH
10A1 CDAF10 CALL HEXC ;OUTPUT HEX CHARACTER
10A4 F1 POP PSW ;RESTORE BYTE
10A5 F5 PUSH PSW ;SAVE A VERSION
10A6 E60F ANI 0FH
10A8 CDAF10 CALL HEXC ;WRITE LOW NIBBLE
10AB F1 POP PSW ;RESTORE BYTE
10AC 82 ADD D ;COMPUTE CHECKSUM
10AD 57 MOV D,A ;SAVE CS
10AE C9 RET

```

```

; HEXC: ;WRITE CHARACTER
10AF C693 ADI 90H
10B1 27 DAA
10B2 CE40 ACI 40H
10B4 27 DAA
10B5 C3AA0E JMP PNB ;PUT BYTE

```

```

; WHEX: ;WRITE CURRENT HEX BUFFER
10B8 3E3A MVI A, ;RECORD HEADER
10BA CDAA0E CALL PNB ;PUT BYTE
10BD 212302 LXI H,DBL ;RECORD LENGTH ADDRESS
10C0 5E MOV E,M ;LENGTH TO REG-E
10C1 AF XRA A ;ZERO TO REG-A
10C2 57 MOV D,A ;CLEAR CHECKSUM
10C3 77 MOV M,A ;LENGTH IS ZEROED FOR NEXT WRITE
10C4 2A2102 LHLD BPC ;BASE ADDRESS FOR RECORD
10C7 7B MOV A,E ;LENGTH TO A
10C8 CD9A10 CALL WRC ;WRITE HEX VALUE
10CB 7C MOV A,H ;HIGH ORDER BASE ADDR
10CC CD9A10 CALL WRC ;WRITE HO BYTE
10CF 7D MOV A,L ;LOW ORDER BASE ADDR
10D0 CD9A10 CALL WRC ;WRITE LO BYTE
10D3 AF XRA A ;ZERO TO A
10D4 CD9A10 CALL WRC ;WRITE RECORD TYPE 00
10D7 7B MOV A,E ;CHECK FOR LENGTH 0

```

```

10D8 B7 ORA A
10D9 CAE810 JZ WHEX1

```

```

; NON - ZERO, WRITE DATA BYTES
10DC 212402 LXI H,DBUFF
10DF 7E WHEX0: MOV A,M ;GET BYTE
10E0 23 INX H
10E1 CD9A10 CALL WRC ;WRITE DATA BYTE
10E4 1D DCR E ;END OF BUFFER?
10E5 C2DF10 JNZ WHEX0

```

```

; END OF DATA BYTES, WRITE CHECK SUM
10E8 AF WHEX1: XRA A
10E9 92 SUB D ;COMPUTE CHECKSUM
10EA CD9A10 CALL WRC

```

```

; SEND CRLF AT END OF RECORD
10ED 3E0D MVI A,CR
10EF CDAA0E CALL PNB
10F2 3E0A MVI A,LF
10F4 CDAA0E CALL PNB
10F7 C9 RET

```

```

1100 =
10F8

```

```

ENDMOD EQU ($ AND 0FFE0H)+20H
END

```

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1100
1100 C30014
1103 C33211
1106 C3C011

ORG 1100H
JMP ENDMOD ;END OF THIS MODULE
JMP INITS ;INITIALIZE THE SCANNER
JMP SCAN ;CALL THE SCANNER

0200 =
0206 =
0215 =
0218 =
; ENTRY POINTS IN I/O MODULE
IOMOD EQU 200H
GNCF EQU IOMOD+6H
WOBUF EQU IOMOD+15H
PERR EQU IOMOD+18H

1129 LASTC: DS 1 ;LAST CHAR SCANNED
110A NEXTC: DS 1 ;LOOK AHEAD CHAR
110B STYPE: DS 1 ;RADIX INDICATOR

0078 =
010C =
0184 =
; COMMON EQUATES
PBMAX EQU 120 ;MAX PRINT SIZE
PBUFF EQU 10CH ;PRINT BUFFER
PBP EQU PBUFF+PBMAX ;PRINT BUFFER POINTER

0185 =
0186 =
0188 =
0340 =
0189 =
TOKEN EQU PBP+1 ;CURRENT TOKEN UDER SCAN
VALUE EQU TOKEN+1 ;VALUE OF NUMBER IN BINARY
ACCLEN EQU VALUE+2 ;ACCUMULATOR LENGTH
ACMAX EQU 64 ;MAX ACCUMULATOR LENGTH
ACCUM EQU ACCLEN+1

01C9 =
; EVALUE EQU ACCUM+ACMAX ;VALUE FROM EXPRESSION ANALYSIS

01CB =
01CD =
SYTOP EQU EVALUE+2 ;CURRENT SYMBOL TOP
SYMAX EQU SYTOP+2 ;MAX ADDRESS+1

01CF =
01D0 =
01D2 =
PASS EQU SYMAX+2 ;CURRENT PASS NUMBER
FPC EQU PASS+1 ;FILL ADDRESS FOR NEXT HEX BYTE
ASPC EQU FPC+2 ;ASSEMBLER'S PSEUDO PC

0301 =
0302 =
0303 =
0304 =
; GLOBAL EQUATES
IDEN EQU 1 ;IDENTIFIER
NUMB EQU 2 ;NUMBER
STRNG EQU 3 ;STRING
SPECL EQU 4 ;SPECIAL CHARACTER

0301 =
0302 =
0304 =
0305 =
0306 =
PLABT EQU 0001B ;PROGRAM LABEL
DLABT EQU 0010B ;DATA LABEL
EQUAT EQU 0100B ;EQUATE
SETT EQU 0101B ;SET
MACT EQU 0110B ;MACRO

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0008 =
000B =
000C =

0002 =
0008 =
000A =
0010 =
000D =
000A =
001A =
0009 =

EXTT EQU 1000B ;EXTERNAL
REFT EQU 1011B ;REFER
GLBT EQU 1100B ;GLOBAL

; BINV EQU 2
; OCTV EQU 8
; DECV EQU 10
; HEXV EQU 16
; CR EQU 0DH
; LF EQU 0AH
; EOF EQU 1AH
; TAB EQU 09H ;TAB CHARACTER

UTILITY SUBROUTINES
GNC: ;GET NEXT CHARACTER AND ECHO TO PRINT FILE

CALL GNCF
PUSH PSW
CPI CR
JZ GNC0
CPI LF ;IF LF THEN DUMP CURRENT BUFFER
JZ GNC0

;NOT A CR OR LF, PLACE INTO BUFFER IF THERE IS ENOUGH ROOM

LDA PBP
CPI PBMAX
JNC GNC0
; ENOUGH ROOM, PLACE INTO BUFFER
MOV E,A
MVI D,0 ;DOUBLE PRECISION PBP IN D,E
INR A
STA PBP ;INCREMENTED PBP IN MEMORY
LXI H,PBUFF
DAD D ;PBUFF(PBP)
POP PSW
MOV M,A ;PBUFF(PBP) = CHAR
RET

GNC0: ;CHAR NOT PLACED INTO BUFFER
POP PSW
RET

INITS: ;INITIALIZE THE SCANNER

CALL ZERO
STA NEXTC ;CLEAR NEXT CHARACTER
STA PBP
MVI A,LF ;SET LAST CHAR TO LF
STA LASTC
CALL WOBUFF ;CLEAR BUFFER
MVI A,16 ;START OF PRINT LINE
STA PBP

110C CD0602
110F F5
1110 FE0D
1112 CA3011
1115 FE0A
1117 CA3011

111A 3A8401
111D FE78
111F D23011

1122 5F
1123 1600
1125 3C
1126 328401
1129 210C01
112C 19
112D F1
112E 77
112F C9

1130 F1
1131 C9

1132 CD4911
1135 320A11
1138 328401
113B 3E0A
113D 323911
1140 CD1502
1143 3E10
1145 328401

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```

1148 C9      RET
;
1149 AF      ZERO: XRA      A
114A 328601  STA      ACCLN
114D 320311 STA      STYPE
1152 C9      RET
;
1151 218801  SAVER: ;STORE THE NEXT CHARACTER INTO THE ACCUMULATOR AND UPDATE ACCLN
1154 7E      LXI      H,ACCLN
1155 FE40    MOV      A,M
1157 0A5F11  CPI      ACMAK
115A 3600    JC      SAVI ;JUMP IF NOT UP TO LAST POSITION
115C CD1E13  MVI      M,0
115F 5E      CALL     ERRO
1160 1600    SAVI: MOV      E,M ;D,E WILL HOLD INDEX
1162 34      MVI      D,0
1163 23      INR      M ;ACCLN INCREMENTED
1164 19      INX      H ;ADDRESS ACCUMULATOR
1165 3A0A11  DAD      D ;ADD INDEX TO ACCUMULATOR
1166 77      LDA      NEXTC ;GET CHARACTER
1168 C9      MOV      M,A ;INTO ACCUMULATOR
1169 C9      RET
;
116A 7E      TDOLL: ;TEST FOR DOLLAR SIGN, ASSUMING H,L ADDRESS NEXTC
116B FE24    MOV      A,M
116D C8      CPI      '$'
116E AF      RNZ
116F 77      XRA      A ;TO GET A ZERO
1170 C9      MOV      M,A ;CLEARS NEXTC
1171 C9      RET ;WITH ZERO FLAG SET
;
1171 3A0A11  NUMERIC: ;CHECK NEXTC FOR NUMERIC, RETURN ZERO FLAG IF NOT NUMERIC
1174 D630    LDA      NEXTC
1176 FE3A    SUI      0
1177 C9      CPI      10
1178 17      CARRY RESET IF NUMERIC
1179 E601    RAL
117B C9      ANI      1B ;ZERO IF NOT NUMERIC
117C C9      RET
;
117C CD7111  HEX: ;RETURN ZERO FLAG IF NEXTC IS NOT HEXADECIMAL
117F C8      CALL     NUMERIC
1180 3A2A11  RNZ ;RETURNS IF 0-9
1183 D641    LDA      NEXTC
1185 FE06    SUI      'A'
1186 C9      CPI      6
1187 17      CARRY SET IF OUT OF RANGE
1188 E601    RAL
118A C9      ANI      1B
118B C9      RET

```

```

118B 3A0A11
118E D641
1190 FE1A
1192 17
1193 E601
1195 C9

```

```

1196 CD8B11
1199 C8
119A CD7111
119D C9

```

```

119E 3A0A11
11A1 FE61
11A3 D8
11A4 FE7B
11A6 D8
11A7 E65F
11A9 320A11
11AC C9

```

```

11AD CD0C11
11B0 320A11
11B3 CD9E11
11B6 C9

```

```

11B7 FE0D
11B9 C8
11BA FE1A
11BC C8
11BD FE21
11BF C9

```

```

11C0 AF
11C1 328501
11C4 CD4911

```

```

11C7 3A0A11
11CA FE09
11CC CAF411
11CF FE3B
11D1 CAE111

```

; LETTER: ;RETURN ZERO FLAG IF NEXTC IS NOT A LETTER

```

LDA      NEXTC
SUI      'A'
CPI      26
RAL
ANI      1B
RET

```

; ALNUM: ;RETURN ZERO FLAG IF NOT ALPHANUMERIC

```

CALL     LETTER
RNZ
CALL     NUMERIC
RET

```

; TRANS: ;TRANSLATE TO UPPER CASE

```

LDA      NEXTC
CPI      'A' OR 1100000B ;LOWER CASE A
RC       ;CARRY IF LESS THAN LOWER A
CPI      ('Z' OR 1100000B)+1 ;LOWER CASE Z
RNC      ;NO CARRY IF GREATER THAN LOWER A
ANI      1011111B
STA      NEXTC
RET

```

; GNCN: ;GET CHARACTER AND STORE TO NEXTC

```

CALL     GNC
STA      NEXTC
CALL     TRANS ;TRANSLATE TO UPPER CASE
RET

```

; EOLT: ;END OF LINE TEST FOR COMMENT SCAN

```

CPI      CR
RZ
CPI      EOF
RZ
CPI      '!'
RET

```

; SCAN: ;FIND NEXT TOKEN IN INPUT STREAM

```

XRA      A
STA      TOKEN
CALL     ZERO

```

; DEBL: DEBLANK

```

LDA      NEXTC
CPI      TAB ;TAB CHARACTER TREATED AS BLANK OUTSIDE STRING
JZ      DEB0
CPI      ';' ;MAY BE A COMMENT
JZ      DEB1 ;DEBLANK THROUGH COMMENT

```

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```

11D4 FE2A      CPI      *      ;PROCESSOR TECH COMMENT
11D6 C2ED11    JNZ      DEB2    ;NOT *
11D9 3A8911    LDA      LASTC   ;LAST LINE FEED?
11DC FE2A      CPI      LF      ;NOT LF*
11DE C2ED11    JNZ      DEB2    ;NOT LF*
; COMMENT FOUND, REMOVE IT
11E1 CDAD11    DEB1: CALL   GNCN   ;CR, EOF, OR !
11E4 CDB711    CALL   EOLT    ;HANDLE END OF LINE
11E7 CAF411    JZ      FINDL   ;OTHERWISE CONTINUE SCAN
11EA C3E111    JMP      DEB1    ;MAY BE ZERO
11ED F628      DEB2: ORI      *
11EF FE28      CPI
11F1 C2FA11    JNZ      FINDL
11F4 CDAD11    DEB0: CALL   GNCN   ;GET NEXT AND STORE TO NEXTC
11F7 C3C711    JMP      DEBL

; LINE DEBLANKED, FIND TOKEN TYPE
; FINDL: ;LOOK FOR LETTER, DECIMAL DIGIT, OR STRING QUOTE
11FA CD8B11    CALL   LETTER
11FD CA8512    JZ      FIND0
1203 3E01      MVI      A,IDEN
1202 C33912    JMP      STOKEN

1205 CD7111    FIND0: CALL  NUMERIC
1208 CA1812    JZ      FIND1
120B 3E02      MVI      A,NUMB
120D C33912    JMP      STOKEN

1210 3A0A11    FIND1: LDA     NEXTC
1213 FE27      CPI      *
1215 C22112    JNZ      FIND2
1218 AF        XRA      A
1219 320A11    STA      NEXTC ;DON'T STORE THE QUOTE
121C 3E03      MVI      A,STRNG
121E C33912    JMP      STOKEN

1221 FE0A      FIND2: ;ASSUME IT IS A SPECIAL CHARACTER
1223 C23712    CPI      LF      ;IF LF THEN DUMP THE BUFFER
; LF FOUND
1226 3ACF01    LDA      PASS
1229 B7        ORA      A
122A C41502    CNZ      WOBUFF
122D 210C01    LXI      H,PBUFF ;CLEAR ERROR CHAR ON BOTH PASSES
1230 3628      MVI      M,
1232 3E18      MVI      A,16
1234 328401    STA      PBP     ;START NEW LINE
1237 3E04      FIND3: MVI     A,SPECL
1239 328501    ;STOKEN: STA     TOKEN

```

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```

123C 3A0A11
123F 320911
1242 B7
1243 C45111
1246 CDAD11
1249 3A8501
124C FE04
124E C8
124F FE03
1251 C49E11
1254 210A11
1257 3A8501

```

```

125A FE01
125C C26C12

```

```

125F CD6A11
1262 CA3C12
1265 CD9611
1268 C8

```

```

1269 C33C12

```

```

126C FE02
126E C20213

```

```

1271 CD6A11
1274 CA3C12
1277 CD7C11
127A C23C12

```

```

127D 3A0A11
1280 FE4F
1282 CA8A12
1285 FE51
1287 C28F12

```

```

128A 3E08
128C C39612

```

```

128F FE48
1291 C2A012

```

```

;
;
; LOOP WHILE CURRENT ITEM IS ACCUMULATING
SCTOK: LDA     NEXTC
      STA     LASTC ;SAVE LAST CHARACTER
      ORA     A
      CNZ     SAVER ;STORE CHARACTER INTO ACCUM IF NOT ZERO
      CALL    GNCN ;GET NEXT TO NEXTC
      LDA     TOKEN
      CPI     SPECL
      RZ      ;RETURN IF SPECIAL CHARACTER
      CPI     STRNG
      CNZ     TRANS ;TRANSLATE TO UPPER CASE IF NOT IN STRING
      LXI     H,NEXTC
      LDA     TOKEN

;
; CPI     IDEN
; JNZ     SCT2

; ACCUMULATING AN IDENTIFIER
; CALL    TDOLL ;$?
; JZ      SCTOK ;IF $O, SKIP IT
; CALL    ALNUM ;ALPHA NUMERIC?
; RZ      ;RETURN IF END
; NOT END OF THE IDENTIFIER
; JMP     SCTOK

SCT2: ;NOT SPECIAL OR IDENT, CHECK NUMBER
      CPI     NUMB
      JNZ     SCT3

; ACCUMULATING A NUMBER, CHECK FOR $
; CALL    TDOLL
; JZ      SCTOK ;SKIP IF FOUND
; CALL    HEX   ;HEX CHARACTER?
; JNZ     SCTOK ;STORE IT IF FOUND
; END OF NUMBER, LOOK FOR RADIX INDICATOR
;
; LDA     NEXTC
; CPI     'O'   ;OCTAL INDICATOR
; JZ      NOCT
; CPI     'Q'   ;OCTAL INDICATOR
; JNZ     NUM2

; NOCT: ;OCTAL
; MVI     A,OCTV
; JMP     SSTYP

; NUM2: CPI     'H'
; JNZ     NUM3

```

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```

1294 3E18      MVI    A,HEXV
1296 328B11    SSTYP: STA    STYPE
1299 AP        XRA     A
129A 328A11    STA     NEXTC ;CLEARS THE LOOKAHEAD CHARACTER
129D C38B12    JMP     NCON

;
;   RADIX MUST COME FROM ACCUM
NUM3: LDA     LASTC
      CPI     'B'
      JNZ     NUM4
12A8 3A8911    MVI     A,BINV
12A5 C2AD12    JMP     SSTY1
12A6 3E82
12AA C38412

;
NUM4: CPI     'D'
      MVI     A,DECV
12AD FE44      JNZ     SSTY2
12AF 3E8A      SSTY1: LXI     H,ACCLN
12B1 C28612    DCR     M ;ACCLN DECREMENTED TO REMOVE RADIX INDICATOR
12B4 218801    SSTY2: STA    STYPE
12B7 35
12B8 328B11    NCON: ;NUMERIC CONVERSION OCCURS HERE
      LXI     H,0
12B9 218800    SHLD    VALUE ;VALUE ACCUMULATES BINARY EQUIVALENT
12BE 228601    LXI     H,ACCLN
12C1 218801    MOV     C,M ;C=ACCLN
12C4 4E        INX     H ;ADDRESSES ACCUM
12C5 23        CLOP: ;NEXT DIGIT IS PROCESSED HERE
      MOV     A,M
12C6 7E        INX     H ;READY FOR NEXT LOOP
12C7 23        CPI     'A'
12C8 FE41      JNC     CLOP1 ;NOT HEX A-F
12CA D2D212    SUI     '0' ;NORMALIZE
12CD D638      JMP     CLOP2
12CF C3D412

;
CLOP1: ;HEX A-F
      SUI     'A'-10
12D2 D637      CLOP2: ;CHECK SIZE AGAINST RADIX
      PUSH    H ;SAVE ACCUM ADDR
12D4 E5        PUSH    B ;SAVE CURRENT POSITION
12D5 C5        MOV     C,A
12D6 4F        LXI     H,STYPE
12D7 218B11    CMP     M
12DA BE        CNC     ERRV ;VALUE ERROR IF DIGIT>=RADIX
12DB D41813    MVI     B,0 ;DOUBLE PRECISION DIGIT
12DE 8602      MOV     A,M ;RADIX TO ACCUMULATOR
12E0 7E        LHLD    VALUE
12E1 2A8601    XCHG    ;VALUE TO D,E - ACCUMULATE RESULT IN H,L
12E4 EB        LXI     H,0 ;ZERO ACCUMULATOR
12E5 218800    CLOP3: ;LOOP UNTIL RADIX GOES TO ZERO
12E8 B7        ORA     A

```

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```

12E9 CAF712    JZ      CLOP4
12EC 1F        RAR     ;TEST LSB
12ED D2F112    JNC     TTWO ;SKIP SUMMING OPERATION IF LSB=0
12F0 19        DAD     D ;ADD IN VALUE
      TTWO: ;MULTIPLY VALUE * 2 FOR SHL OPERATION
      XCHG
      DAD     H
      XCHG
      JMP     CLOP3

;
; CLOP4: ;END OF NUMBER CONVERSION
      DAD     B ;DIGIT ADDED IN
      SHLD    VALUE
      POP     B
      POP     H
      DCR     C ;MORE DIGITS?
      JNZ     CLOP ;DONE WITH THE NUMBER
      RET

;
SCT3: ;MUST BE A STRING
      LDA     NEXTC
      CPI     CR ;END OF LINE?
      JZ      ERRO ;AND RETURN
      CPI     ' '
      JNZ     SCTOK
      CALL    GNCN
      CPI     ' '
      JMP     SCTOK ;RETURN IF SINGLE QUOTE ENCOUNTERED
                  ;OTHERWISE TREAT AS ONE QUOTE

;
;   END OF SCANNER

;
;   ERROR MESSAGE ROUTINES
ERRV: ;'V' VALUE ERROR
      PUSH    PSW
      MVI     A,'V'
      JMP     ERR

;
ERRO: ;'O' OVERFLOW ERROR
      PUSH    PSW
      MVI     A,'O'
      JMP     ERR

;
ERR: ;PRINT ERROR MESSAGE
      PUSH    B
      PUSH    H
      CALL    PERR
      POP     H
      POP     B

```

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```

1302 3A8A11    1305 FE0D
1307 CA1E13    130A FE27
130C C23C12    130F CDAD11
1312 FE27      1315 C33C12

1318 F5        1319 3E56
131B C32413    131E F5
131F 3E4F      1321 C32413

1324 C5        1325 E5
1326 CD1802    1329 E1
132A C1

```

1328 F1
132C C9

1400 -
132D

POP PSW
RET

ENDMOD EQU (\$ AND 0FF00H) + 100H
END

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SER. # _____

1340
0200 =
0212 =
021E =

1340 C3A015
1343 C35C14
1346 C39E14
1349 C39814
134C C3E814
134F C36815
1352 C37215
1355 C38D15
1358 C39615

0078 =
010C =
0184 =

0185 =
0186 =
0188 =
0040 =
0189 =

01C9 =
01CB =
01CD =

01CF =
01D0 =
01D2 =
01D4 =
01D6 =

0001 =
0002 =
0003 =
0004 =

0001 =

SYMBOL TABLE MANIPULATION MODULE

ORG 1340H
EQU 200H ;IO MODULE ENTRY POINT
PCON EQU IOMOD+12H
EOR EQU IOMOD+1EH

ENTRY POINTS TO SYMBOL TABLE
JMP ENDMOD
JMP INISY
JMP LOOKUP
JMP FOUND
JMP ENTER
JMP SETTY
JMP GETTY
JMP SETVAL
JMP GETVAL

COMMON EQUATES
PBMAX EQU 120 ;MAX PRINT SIZE
PBUFF EQU 10CH ;PRINT BUFFER
PBP EQU PBUFF+PBMAX ;PRINT BUFFER POINTER

TOKEN EQU PBP+1 ;CURRENT TOKEN UNDER SCAN
VALUE EQU TOKEN+1 ;VALUE OF NUMBER IN BINARY
ACCLN EQU VALUE+2 ;ACCUMULATOR LENGTH
ACMAX EQU 64 ;MAX ACCUMULATOR LENGTH
ACCUM EQU ACCLN+1

EVALUE EQU ACCUM+ACMAX ;VALUE FROM EXPRESSION ANALYSIS

SYTOP EQU EVALUE+2 ;CURRENT SYMBOL TOP
SYMAY EQU SYTOP+2 ;MAX ADDRESS+1

PASS EQU SYMAX+2 ;CURRENT PASS NUMBER
FPC EQU PASS+1 ;FILL ADDRESS FOR NEXT HEX BYTE
ASPC EQU FPC+2 ;ASSEMBLER'S PSEUDO PC
SYBAS EQU ASPC+2 ;BASE OF SYMBOL TABLE
SYADR EQU SYBAS+2 ;CURRENT SYMBOL BEING ACCESSED

GLOBAL EQUATES
IDEN EQU 1 ;IDENTIFIER
NUMB EQU 2 ;NUMBER
STRNG EQU 3 ;STRING
SPECL EQU 4 ;SPECIAL CHARACTER

PLABT EQU 0001B ;PROGRAM LABEL

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```

0022 = DLABT EQU 0010B ;DATA LABEL
0024 = EQUT EQU 0100B ;EQUATE
0025 = SETT EQU 0101B ;SET
0026 = MACT EQU 0110B ;MACRO

```

```

;
0028 = EXTT EQU 1000B ;EXTERNAL
002B = REPT EQU 1011B ;REFER
002C = GLBT EQU 1100B ;GLOBAL
;

```

```

002D = CR EQU 00H
;

```

```

; DATA AREAS
; SYMBOL TABLE BEGINS AT THE END OF THIS MODULE
0025 = FIXD EQU 5 ;5 BYTES OVERHEAD WITH EACH SYMBOL ENTRY
; 2BY COLLISION, 1BY TYPE/LEN, 2BY VALUE
0028 = HSIZE EQU 128 ;HASH TABLE SIZE
002F = HMASK EQU HSIZE-1 ;HASH MASK FOR CODING
135B = HASHT: DS HSIZE*2 ;HASH TABLE
145B = HASHC: DS 1 ;HASH CODE AFTER CALL ON LOOKUP
;

```

SYMBOL TABLE ENTRY FORMAT IS

```

;-----
; HIGH VAL BYTE :
;-----
; LOW VAL BYTE :
;-----
; CHARACTER N :
;-----
; ... :
;-----
; CHARACTER 1 :
;-----
; TYPE : LENG :
;-----
; HIGH COLLISION:
;-----
SYADR= : LOW COLLISION :
;-----

```

WHERE THE LOW/HIGH COLLISION FIELD ADDRESSES ANOTHER ENTRY WITH THE SAME HASH CODE (OR ZERO IF THE END OF CHAIN), TYPE DESCRIBES THE ENTRY TYPE (GIVEN BELOW), LENG IS THE NUMBER OF CHARACTERS IN THE SYMBOL PRINTNAME -1 (I.E., LENG=0 IS A SINGLE CHARACTER PRINTNAME, WHILE LENG=15 INDICATES A 16 CHARACTER NAME). CHARACTER 1 THROUGH N GIVE THE PRINTNAME CHARACTERS IN ASCII UPPER CASE (ALL LOWER CASE NAMES ARE TRANSLATED ON INPUT), AND THE LOW/HIGH VALUE GIVE THE PARTICULAR ADDRESS OR CONSTANT VALUE ASSOCIATED WITH THE NAME. THE REPRESENTATION OF MACROS DIFFERS IN THE FIELDS WHICH FOLLOW THE VALUE FIELD (MACROS ARE NOT CURRENTLY IMPLEMENTED).

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```

0001 = PLABT EQU 0001B ;PROGRAM LABEL
0002 = DLABT EQU 0010B ;DATA LABEL
0004 = EQUT EQU 0100B ;EQUATE
0005 = SETT EQU 0101B ;SET
0006 = MACT EQU 0110B ;MACRO
;
0008 = EXTT EQU 1000B ;EXTERNAL ATTRIBUTE
000B = REPT EQU 1011B ;REFER
000C = GLBT EQU 1100B ;GLOBAL ATTRIBUTE
;

```

```

145C 215B13
145F 0680
1461 AF

```

```

1462 77
1463 23
1464 77
1465 23
1466 05
1467 C26214

```

```

146A 210000
146D 22D601

```

THE TYPE FIELD CONSISTS OF FOUR BITS WHICH ARE ASSIGNED AS FOLLOWS:

```

0000 UNDEFINED SYMBOL
0001 LOCAL LABELLED PROGRAM
0010 LOCAL LABELLED DATA
0011 (UNUSED)
0100 EQUATE
0101 SET
0110 MACRO
0111 (UNUSED)
;
1000 (UNUSED)
1001 EXTERN LABELLED PROGRAM
1010 EXTERN LABELLED DATA
1011 REFERENCE TO MODULE
1100 (UNUSED)
1101 GLOBAL UNDEFINED SYMBOL
1110 GLOBAL LABELLED PROGRAM
1111 (UNUSED)

```

TYPE DEFINITIONS

```

;
PLABT EQU 0001B ;PROGRAM LABEL
DLABT EQU 0010B ;DATA LABEL
EQUT EQU 0100B ;EQUATE
SETT EQU 0101B ;SET
MACT EQU 0110B ;MACRO
;
EXTT EQU 1000B ;EXTERNAL ATTRIBUTE
REPT EQU 1011B ;REFER
GLBT EQU 1100B ;GLOBAL ATTRIBUTE
;

```

```

;
INISY: ;INITIALIZE THE SYMBOL TABLE
LXI H,HASHT ;ZERO THE HASH TABLE
MVI B,HSIZE
XRA A ;CLEAR ACCUM

```

```

;
INI0:
MOV M,A
INX H
MOV M,A ;CLEAR DOUBLE WORD
INX H
DCR B
JNZ INI0
;

```

```

; SET SYMBOL TABLE POINTERS
LXI H,0
SHLD SYADR

```

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```

1470 C9      RET
;
; CHASH: ;COMPUTE HASH CODE FOR CURRENT ACCUMULATOR
1471 218801  LXI    H,ACCLN
1474 46      MOV    B,M      ;GET ACCUM LENGTH
1475 A7      XRA    A        ;CLEAR ACCUMULATOR
1476 23      CH0: INX    H      ;MOVE TO FIRST/NEXT CHARACTER POSITION
1477 86      ADD    M        ;ADD WITH OVERFLOW
1478 85      DCR    B
1479 C27614  JNZ    CH0
147C E67F    ANI    HMASK    ;MASK BITS FOR MODULO HZISE
147E 325B14  STA    HASHC    ;FILL HASHC WITH RESULT
1481 C9      RET

;
; SETLN: ;SET THE LENGTH FIELD OF THE CURRENT SYMBOL
1482 47      MOV    B,A      ;SAVE LENGTH IN B
1483 2AD601  LHLD   SYADR
1485 23      INX    H
1487 23      INX    H
1488 7E      MOV    A,M      ;GET TYPE/LENGTH FIELD
1489 E6F0    ANI    0F0H    ;MASK OUT TYPE FIELD
148B B0      ORA    B        ;MASK IN LENGTH
148C 77      MOV    M,A
148D C9      RET

;
; GETLN: ;GET THE LENGTH FIELD TO REG-A
148E 2AD601  LHLD   SYADR
1491 23      INX    H
1492 23      INX    H
1493 7E      MOV    A,M
1494 E60F    ANI    0FH
1496 3C      INR    A        ;LENGTH IS STORED AS VALUE - 1
1497 C9      RET

;
; FOUND: ;FOUND RETURNS TRUE IF SYADR IS NOT ZERO (TRUE IS NZ FLAG HERE)
1498 2AD601  LHLD   SYADR
1499 7D      MOV    A,L
149C B4      ORA    H
149D C9      RET

;
; LOOKUP: ;LOOK FOR SYMBOL IN ACCUMULATOR
149E CD7114  CALL   CHASH    ;COMPUTE HASH CODE
;
; NORMALIZE IDENTIFIER TO 16 CHARACTERS
14A1 218801  LXI    H,ACCLN
14A4 7E      MOV    A,M
14A5 FE11    CPI    17
14A7 DAAC14  JC     LENOK
14AA 3610    MVI    M,16

LENOK:

```

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```

14AC 215B14 ;
14AF 5E      ; LOOK FOR SYMBOL THROUGH HASH TABLE
14B0 1600    LXI    H,HASHC
14B2 215B13  MOV    E,M
14B5 19      MVI    D,0      ;DOUBLE HASH CODE IN D,ESER.#
14B6 19      LXI    H,HASHT ;BASE OF HASH TABLE
14B7 5E      DAD    D
14B8 23      DAD    D      ;HASHT(HASHC)
14B9 66      MOV    E,M      ;LOW ORDER ADDRESS
14BA 6B      INX    H
14BB 22D601  MOV    H,M
14BE CD9814  MOV    L,E      ;HEADER TO LIST OF SYMBOLS IS IN H,L
14C1 C8      SHLD   SYADR
;           CALL   FOUND
;           RZ           ;RETURN IF SYADR BECOMES ZERO

;
; OTHERWISE EXAMINE CHARACTER STRING FOR MATCH
14C2 CD8E14  CALL   GETLN    ;GET LENGTH TO REG-A
14C5 218801  LXI    H,ACCLN
14C8 BE      CMP    M
14C9 C2E114  JNZ    LCOMP

;
; LENGTH MATCH, TRY TO MATCH CHARACTERS
14CC 47      MOV    B,A      ;STRING LENGTH IN B
14CD 23      INX    H        ;HL ADDRESSES ACCUM
14CE EB      XCHG          ;TO D,E
14CF 2AD601  LHLD   SYADR
14D2 23      INX    H
14D3 23      INX    H
14D4 23      INX    H      ;ADDRESSES CHARACTERS
14D5 1A      LDAX   D        ;NEXT CHARACTER FROM ACCUM
14D6 BE      CMP    M        ;NEXT CHARACTER IN SYMBOL TABLE
14D7 C2E114  JNZ    LCOMP

;
; CHARACTER MATCHED, INCREMENT TO NEXT
14DA 13      INX    D
14DB 23      INX    H
14DC 05      DCR    B
14DD C2D514  JNZ    LOOK1

;
; COMPLETE MATCH AT CURRENT SYMBOL, SYADR IS SET
14E0 C9      RET

;
; LCOMP: ;NOT FOUND, MOVE SYADR DOWN ONE COLLISION ADDRESS
14E1 2AD601  LHLD   SYADR
14E4 5E      MOV    E,M
14E5 23      INX    H
14E6 56      MOV    D,M      ;COLLISION ADDRESS IN D,E
14E7 EB      XCHG
14E8 C3BB14  JMP    LOOK0
;
;

```

```

ENTER: ;ENTER SYMBOL IN ACCUMULATOR
; ENSURE THERE IS ENOUGH SPACE IN THE TABLE
14EB 218801 LXI H,ACCLN
14EE 5E MOV E,M
14EF 1600 MVI D,0 ;DOUBLE PRECISION ACCLN IN D,E
14F1 2ACB01 LHLD SYTOP
14F4 22D601 SHLD SYADR ;NEXT SYMBOL LOCATION
14F7 19 DAD D ;SYTOP+ACCLN
14F8 110500 LXI D,FXD ;FIXED DATA/SYMBOL
14FB 19 DAD D ;HL HAS NEXT TABLE LOCATION FOR SYMBOL
14FC EB XCHG ;NEW SYTOP IN D,E
14FD 2ACD01 LHLD SYMAX ;MAXIMUM SYTOP VALUE
1500 73 MOV A,E
1501 95 SUB L ;COMPUTE 16-BIT DIFFERENCE
1502 7A MOV A,D
1503 9C SBB H
1504 EB XCHG ;NEW SYTOP IN H,L
1505 D24115 JNC OVERER ;OVERFLOW IN TABLE

; OTHERWISE NO ERROR
1528 22CB01 SHLD SYTOP ;SET NEW TABLE TOP
153B 2AD601 LHLD SYADR ;SET COLLISION FIELD
152E EB XCHG ;CURRENT SYMBOL ADDRESS TO D,E
153F 215314 LXI H,HASHC ;HASH CODE FOR CURRENT SYMBOL TO H,L
1512 4E MOV C,M ;LOW BYTE
1513 0600 MVI B,0 ;DOUBLE PRECISION VALUE IN B,C
1515 215313 LXI H,HASHT ;BASE OF HASH TABLE
1518 09 DAD B
1519 09 DAD B ;HASHT(HASHC) IN H,L
; D,E ADDRESSES CURRENT SYMBOL - CHANGE LINKS
151A 4E MOV C,M ;LOW ORDER OLD HEADER
151B 23 INX H
151C 46 MOV B,M ;HIGH ORDER OLD HEADER
151D 72 MOV M,D ;HIGH ORDER NEW HEADER TO HASH TABLE
151E 2B DCX H
151F 73 MOV M,E ;LOW ORDER NEW HEADER TO HASH TABLE
1520 EB XCHG ;H,L HOLDS SYMBOL TABLE ADDRESS
1521 71 MOV M,C ;LOW ORDER OLD HEADER TO COLLISION FIELD
1522 23 INX H
1523 70 MOV M,B ;HIGH ORDER OLD HEADER TO COLLISION FIELD

; HASH CHAIN NOW REPAIRED FOR THIS ENTRY, COPY THE PRINTNAME
1524 118801 LXI D,ACCLN
1527 1A LDAX D ;GET SYMBOL LENGTH
1528 FE11 CPI 17 ;LARGER THAN 16 SYMBOLS?
152A CA2F15 JC ENT1
152D 3E10 MVI A,16 ;TRUNCATE TO 16 CHARACTERS
; COPY LENGTH FIELD, FOLLOWED BY PRINTNAME CHARACTERS
152F 47 ENT1: MOV B,A ;COPY LENGTH TO B
1530 3D DCR A ;1-16 CHANGED TO 0-15

```

```

1531 23 INX H ;FOLLOWING COLLISION FIELD
1532 77 MOV M,A ;STORE LENGTH WITH UNDEFINED TYPE (0000)
1533 23 ENT2: INX H
1534 13 INX D
1535 1A LDAX D
1536 77 MOV M,A ;STORE NEXT CHARACTER OF PRINTNAME
1537 05 DCR B ;LENGTH=LENGTH-1
1538 C23315 JNZ ENT2 ;FOR ANOTHER CHARACTER

; PRINTNAME COPIED, ZERO THE VALUE FIELD
153B AF XRA A ;ZERO A
153C 23 INX H ;LOW ORDER VALUE
153D 77 MOV M,A
153E 23 INX H
153F 77 MOV M,A ;HIGH ORDER VALUE
1540 C9 RET

; OVERER: ;OVERFLOW IN SYMBOL TABLE
1541 214A15 LXI H,ERRO
1544 C01202 CALL PCON
1547 C31E02 JMP EOR ;END OF EXECUTION
154A 53594D424FERRO: DB 'SYMBOL TABLE OVERFLOW',CR

; SETTY: ;SET CURRENT SYMBOL TYPE TO VALUE IN REG-A
1560 17 RAL
1561 17 RAL
1562 17 RAL
1563 17 RAL
1564 E6F0 ANI 0F0H ;TYPE MOVED TO HIGH ORDER 4-BITS
1566 47 MOV B,A ;SAVE IT IN B
1567 2AD601 LHLD SYADR ;BASE OF SYMBOL TO ACCESS
156A 23 INX H
156B 23 INX H ;ADDRESS OF TYPE/LENGTH FIELD
156C 7E MOV A,M ;GET IT AND MASK
156D E60F ANI 0FH ;LEAVE LENGTH
156F B0 ORA B ;MASK IN TYPE
1570 77 MOV M,A ;STORE IT
1571 C9 RET

; GETTY: ;RETURN THE TYPE OF THE VALUE IN CURRENT SYMBOL
1572 2AD601 LHLD SYADR
1575 23 INX H
1576 23 INX H
1577 7E MOV A,M
1578 1F RAR
1579 1F RAR
157A 1F RAR
157B 1F RAR
157C E60F ANI 0FH ;TYPE MOVED TO LOW 4-BITS OF REG-A
157E C9 RET

```

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```

157F CD8E14      ; VALADR:      ;GET VALUE FIELD ADDRESS FOR CURRENT SYMBOL
1582 2AD601      CALL      GETLN  ;PRINTNAME LENGTH TO ACCUM
1585 5P          LHL      SYADR   ;BASE ADDRESS
1586 1600        MOV      E,A
1588 19          MVI      D,0
1589 23          DAD      D        ;BASE(LEN)
158A 23          INX      H
158B 23          INX      H        ;FOR COLLISION FIELD
158C C9          INX      H        ;FOR TYPE/LEN FIELD
                                ;WITH H,L ADDRESSING VALUE FIELD

; SETVAL:      ;SET THE VALUE FIELD OF THE CURRENT SYMBOL
; VALUE IS SENT IN H,L
158D E5          PUSH     H        ;SAVE VALUE TO SET
158E CD7F15      CALL     VALADR
1591 D1          POP      D        ;POP VALUE TO SET, HL HAS ADDRESS TO FILL
1592 73          MOV      M,E
1593 23          INX      H
1594 72          MOV      M,D      ;FIELD SET
1595 C9          RET

; GETVAL:      ;GET THE VALUE FIELD OF THE CURRENT SYMBOL TO H,L
; VALADR      ;ADDRESS OF VALUE FIELD TO H,L
1596 CD7F15      CALL     VALADR
1599 5E          MOV      E,M
159A 23          INX      H
159B 56          MOV      D,M
159C EB          XCHG
159D C9          RET

15A0 -          ; ENDMOD EQU      ($ AND 0FF00H) + 20H
159E          END

```

33

```

15A0          ORG      15A0H
15A0 C36018     JMP      ENDMOD  ;TO NEXT MODULE
15A3 C38317     JMP      BSEAR
15A6 C31018     JMP      BGEB

; COMMON EQUATES
; PBMAX EQU     120      ;MAX PRINT SIZE
; PBUFF EQU     10CH    ;PRINT BUFFER
; PBP EQU       PBUFF+PBMAX ;PRINT BUFFER POINTER

; TOKEN EQU     PBP+1    ;CURRENT TOKEN UDER SCAN
; VALUE EQU     TOKEN+1  ;VALUE OF NUMBER IN BINARY
; ACCLEN EQU    VALUE+2  ;ACCUMULATOR LENGTH
; ACMAX EQU     64       ;MAX ACCUMULATOR LENGTH
; ACCUM EQU     ACCLEN+1

; EVALUE EQU    ACCUM+ACMAX ;VALUE FROM EXPRESSION ANALYSIS

; SYTOP EQU     EVALUE+2 ;CURRENT SYMBOL TOP
; SYMAX EQU     SYTOP+2  ;MAX ADDRESS+1

; PASS EQU     SYMAX+2  ;CURRENT PASS NUMBER
; FPC EQU      PASS+1   ;FILL ADDRESS FOR NEXT HEX BYTE
; ASPC EQU     FPC+2    ;ASSEMBLER'S PSEUDO PC

; GLOBAL EQUATES
; IDEN EQU     1        ;IDENTIFIER
; NUMB EQU     2        ;NUMBER
; STRNG EQU    3        ;STRING
; SPECL EQU    4        ;SPECIAL CHARACTER

; PLABT EQU    0001B    ;PROGRAM LABEL
; DLABT EQU    0010B    ;DATA LABEL
; EQUATE EQU    0100B   ;EQUATE
; SETT EQU     0101B    ;SET
; MACT EQU     0110B    ;MACRO

; EXTT EQU     1000B    ;EXTERNAL
; REFT EQU     1011B    ;REFER
; GLBT EQU     1100B    ;GLOBAL

; CR EQU       0DH      ;CARRIAGE RETURN

; TABLE DEFINITIONS
; TYPES

```

```

0000 = XBASE EQU 0 ;START OF OPERATORS
;
0010 = RT EQU 16
0011 = PT EQU RT+1 ;RT IS REGISTER TYPE, PT IS PSEUDO OPERATION
0012 = OBASE EQU PT+1
0013 = O1 EQU OBASE+1 ;SIMPLE
0014 = O2 EQU OBASE+2 ;LXI
0015 = O3 EQU OBASE+3 ;DAD
0016 = O4 EQU OBASE+4 ;PUSH/POP
0017 = O5 EQU OBASE+5 ;JMP/CALL
0018 = O6 EQU OBASE+6 ;MOV
0019 = O7 EQU OBASE+7 ;MVI
001A = O8 EQU OBASE+8 ;ACC IMMEDIATE
001B = O9 EQU OBASE+9 ;LDAX/STAX
001C = O10 EQU OBASE+10 ;LHLD/SHLD/LDA/STA
001D = O11 EQU OBASE+11 ;ACCUM REGISTER
001E = O12 EQU OBASE+12 ;INC/DEC
001F = O13 EQU OBASE+13 ;INX/DCX
0020 = O14 EQU OBASE+14 ;RST
0021 = O15 EQU OBASE+15 ;IN/OUT

```

```

;
; X1 THROUGH X15 DENOTE OPERATORS

```

```

0020 = X1 EQU XBASE ;*
0001 = X2 EQU XBASE+1 ;/
0002 = X3 EQU XBASE+2 ;MOD
0023 = X4 EQU XBASE+3 ;SHL
0024 = X5 EQU XBASE+4 ;SHR
0025 = X6 EQU XBASE+5 ;+
0026 = X7 EQU XBASE+6 ;-
0027 = X8 EQU XBASE+7 ;UNARY -
0028 = X9 EQU XBASE+8 ;NOT
0029 = X10 EQU XBASE+9 ;AND
000A = X11 EQU XBASE+10 ;OR
000B = X12 EQU XBASE+11 ;XOR
003C = X13 EQU XBASE+12 ;(
002D = X14 EQU XBASE+13 ;)
002E = X15 EQU XBASE+14 ;,
002F = X16 EQU XBASE+15 ;CR

```

RESERVED WORD TABLES

BASE ADDRESS VECTOR FOR CHARACTERS

```

15A9 C415 C1NX: DW CHAR1 ;LENGTH 1 BASE
15AB D415 DW CHAR2 ;LENGTH 2 BASE
15AD E615 DW CHAR3 ;LENGTH 3 BASE
15AF 8216 DW CHAR4 ;LENGTH 4 BASE
15B1 AE16 DW CHAR5 ;LENGTH 5 BASE

```

```

15B3 BD16 DW CHAR6 ;LENGTH 6 BASE
0005 = CMAX EQU ($-C1NX)/2-1 ;LARGEST STRING TO MATCH
;
CLEN: ;LENGTH VECTOR GIVES THE NUMBER OF ITEMS IN EACH TABLE
DB CHAR2-CHAR1
DB (CHAR3-CHAR2)/2
DB (CHAR4-CHAR3)/3
DB (CHAR5-CHAR4)/4
DB (CHAR6-CHAR5)/5

```

TVINX: ;TABLE OF TYPE,VALUE PAIRS FOR EACH RESERVED SYMBOL

```

15BA BD16 DW TV1
15BC DD16 DW TV2
15BE EF16 DW TV3
15C0 5717 DW TV4
15C2 6D17 DW TV5

```

CHARACTER VECTORS FOR 1,2,3,4, AND 5 CHARACTER NAMES

```

15C4 0D28292A CHAR1: DB CR, '()*'
15C8 2B DB '+', '-', '/'
15C9 2C2D2F41 DB 'BCDE'
15CD 42434445 DB 'HLM'
15D1 484C4D DB

```

```

15D4 4442444944 CHAR2: DB 'DBDIDSDW'
15DC 4549494649 DB 'EIIIFINOR'
15E4 5350 DB 'SP'

```

```

15E6 4143494144 CHAR3: DB 'ACIADCADDADI'
15F2 414E41414E DB 'ANAANDANICMA'
15FE 434D43434D DB 'CMCCMPCPIDAA'
160A 4441444443 DB 'DADDCRDCXEND'
1616 455155484C DB 'EQUHLTINRINX'
1622 4A4D504C44 DB 'JMFLOALXIMOD'
162E 4D4F564D56 DB 'MOVXVINOPNOT'
163A 4F52414F52 DB 'ORACRGORIOUT'
1646 504F505053 DB 'POPPSWALNAR'
1652 524554524C DB 'RETRLCRRCRST'
165E 5342425342 DB 'SBBSEISETSHL'
166A 5348525354 DB 'SHRSTASTCSUB'
1676 535549584F DB 'SUIXORXRAXRI'

```

```

1682 43414C4C45 CHAR4: DB 'CALLENDMLDAXLHLDPCHL'
1696 5055534853 DB 'PUSHSHLDSPLSTAX'
16A6 5843484758 DB 'XCHGXTHL'

```

```

16AE 454E444946 CHAR5: DB 'ENDIFMACROTITLE'
CHAR6: ;END OF CHARACTER VECTOR

```

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TV1: ;TYPE,VALUE PAIRS FOR CHAR1 VECTOR

```

16BD 0F0A0C14 DB X16,10, X13,20
16C1 0D1E0050 DB X14,30, X1,80
16C5 0546 DB X6,70
16C7 0E0A0646 DB X15,10, X7,70
16CB 01501007 DB X2,80, RT,7
16CF 10001001 DB RT,0, RT,1
16D3 10021003 DB RT,2, RT,3
16D7 10041005 DB RT,4, RT,5
16DB 1006 DB RT,6

```

TV2: ;TYPE,VALUE PAIRS FOR CHAR2 VECTOR

```

16DD 110113F3 DB PT,1, O1,0F3H
16E1 11021103 DB PT,2, PT,3
16E5 130A1108 DB O1,0FBH, PT,8
16E9 21CB0A28 DB O15,0DBH, X11,40
16ED 1006 DB RT,6

```

TV3: ;TYPE,VALUE PAIRS FOR CHAR3 VECTOR

```

16EF 1ACE1D88 DB O8,0CEH, O11,88H ;ACI ADC
16F3 1D901AC6 DB O11,80H, O8,0C6H ;ADD ADI
16F7 1DA00932 DB O11,0A0H, X10,50 ;ANA AND
16FB 1AE6132F DB O8,0E6H, O1,2FH ;ANI CMA
16FF 133F1D88 DB O1,3FH, O11,0B8H ;CMC CMP
1703 1AFE1327 DB O8,0FEH, O1,27H ;CPI DAA
1707 15091E05 DB O3,09H, O12,05H ;DAD DCR
170B 1F0B1104 DB O13,0BH, PT,4 ;DCX END
170F 11071376 DB PT,7, O1,76H ;EQU HLT
1713 1E041F03 DB O12,04H, O13,03H ;INR INX
1717 17C31C3A DB O5,0C3H, O10,3AH ;JMP LDA
171B 14010250 DB O2,01H, X3,80 ;LXI MOD
171F 18401906 DB O6,40H, O7,06H ;MOV MVI
1723 1300003C DB O1,00H, X9,60 ;NOP NOT
1727 1DB0110A DB O11,0B0H, PT,10 ;ORA ORG
172B 1AF621D3 DB O8,0F6H, O15,0D3H ;ORI OUT
172F 16C11006 DB O4,0C1H, RT,6 ;POP PSW
1733 1317131F DB O1,17H, O1,1FH ;RAL RAR
1737 13C91307 DB O1,0C9H, O1,07H ;RET RLC
173B 130F20C7 DB O1,0FH, O14,0C7H ;RRC RST
173F 1D981ADE DB O11,098H, O3,0DEH ;SBB SBI
1743 11030350 DB PT,11, X4,80 ;SET SHL
1747 04501C32 DB X5,80, O10,32H ;STA STC
174B 13371D90 DB O1,37H, O11,90H ;STC SUB
174F 1AD60B28 DB O8,0D6H, X12,40 ;SUI XOR
1753 1DA81AE8 DB O11,0A8H, O8,0EEH ;XRA XRI

```

TV4: ;TYPE,VALUE PAIRS FOR CHAR4 VECTOR

```

1757 17CD DB O5,0CDH ;CALL
1759 11061B0A DB PT,6, O9,0AH ;ENDM LDAX
175D 1C2A13E9 DB O10,02AH, O1,0E9H ;LHLD PCHL
1761 16C51C22 DB O4,0C5H, O10,22H ;PUSH SHLD
1765 13F91B02 DB O1,0F9H, O9,02H ;SPHL STAX
1769 13EB13E3 DB O1,0EBH, O1,0E3H ;XCHG XTHL

```

TV5: ;TYPE,VALUE PAIRS FOR CHAR5 VECTOR

```

176D 11051109 DB PT,5, PT,9 ;ENDIF MACRO
1771 110C DB PT,12 ;TITLE

```

SUFTAB: ;TABLE OF SUFFIXES FOR J C AND R OPERATIONS

```

1773 4E5A5A204E DB 'NZZ NCC POPE M'
;
;BSEAR: ;BINARY SEARCH MNEMONIC TABLE
; INPUT: UR = UPPER BOUND OF TABLE (I.E., TABLE LENGTH-1)
; SR = SIZE OF EACH TABLE ELEMENT
; H,L ADDRESS BASE OF TABLE TO SEARCH
; OUTPUT: ZERO FLAG INDICATES MATCH WAS FOUND, IN WHICH CASE
; THE ACCUMULATOR CONTAINS AN INDEX TO THE ELEMENT
; NOT ZERO FLAG INDICATES NO MATCH FOUND IN TABLE

```

```

0000 = UR EQU B ;UPPER BOUND REGISTER
0001 = LR EQU C ;LOWER BOUND REGISTER
0002 = SR EQU D ;SIZE REGISTER
0003 = MR EQU E ;MIDDLE POINTER REGISTER
0004 = SPL EQU B ;SIZE PRIME, USED IN COMPUTING MIDDLE POSITON
0001 = SPLP EQU C ;ANOTHER COPY OF SIZE PRIME
0004 = KR EQU H ;K

```

```

1783 1EFF MVI MR,255 ;MARK M <> OLD M
1785 04 INR UR ;U=U+1
1786 0E00 MVI LR,0 ;L = 0

```

```

;
; COMPUTE M' = (U+L)/2
NEXT: XRA A
MOV A,UR ;CY=0, A=U
ADD LR ;(U+L)
RAR ;(U+L)/2
CMP MR ;SAME AS LAST TIME THROUGH?
JZ NMATCH ;JUMP IF = TO NO MATCH

```

```

;
; MORE ELEMENTS TO SCAN
MOV MR,A ;NEW MIDDLE VALUE
PUSH H ;SAVE A COPY OF THE BASE ADDRESS
PUSH D ;SAVE S,M
PUSH B ;SAVE U,L
PUSH H ;SAVE ANOTHER COPY OF THE BASE ADDRESS
MOV SPL,SR ;S' = S
MOV SPLP,SPL ;S'' = S'

```

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```

1797 1600      MVI      SR,0      ;FOR DOUBLE ADD OPERATION BELOW (DOUBLE M)
;
1799 210000    LXI      KR,0      ;K=0
SUMK: DAD      D      ;K = K + M
179C 19        DCR      SP1      ;S' = S' - 1
179D 05        JNZ      SUMK      ;DECREMENT IF SP1 <> 0
179E C29C17

```

```

;
; K IS NOW RELATIVE BYTE POSITION
17A1 D1        POP      D      ;TABLE BASE ADDRESS
17A2 19        DAD      D      ;H,L CONTAINS ABSOLUTE ADDRESS OF BYTE TO COMPARE
17A3 118901    LXI      D,ACCUM ;D,E ADDRESS CHARACTERS TO COMPARE
;

```

```

;
; COMK: ;COMPARE NEXT CHARACTER
17A6 1A        LDAX     D      ;ACCUM CHARACTER TO REG A
17A7 BE        CMP      M      ;SAME AS TABLE ENTRY?
17A8 13        INX      D
17A9 23        INX      H      ;TO NEXT POSITIONS
17AA C28617    JNZ      NCOM     ;JUMP IF NOT THE SAME
17AD 0D        DCR      SP1P    ;MORE CHARACTERS?
17AE C2A617    JNZ      COMK

```

```

;
; COMPLETE MATCH AT M
17B1 C1        POP      B
17B2 D1        POP      D      ;M RESTORED
17B3 E1        POP      H
17B4 7B        MOV      A,MR    ;VALUE OF M COPIED IN A
17B5 C9        RET          ;WITH ZERO FLAG SET

```

```

;
; NCOM: ;NO MATCH, DETERMINE IF LESS OR GREATER
17B6 C1        POP      B      ;U,L
17B7 D1        POP      D      ;S,M
17B8 E1        POP      H      ;TABLE ADDRESS
17B9 DAC017    JC        NCOML
;
; ACCUM IS HIGHER
17BC 4B        MOV      LR,MR   ;L = M
17BD C38817    JMP      NEXT

```

```

;
; NCOML: ;ACCUMULATOR IS LOW
17C0 43        MOV      UR,MR   ;U = M
17C1 C38817    JMP      NEXT

```

```

;
; NMATCH: ;NO MATCH
17C4 AF        XRA      A
17C5 3C        INR      A      ;SETS NOT ZERO FLAG
17C6 C9        RET

```

```

;
; PREFIX: ;J C OR R PREFIX?
17C7 3A8931    LDA      ACCUM
17CA 0117C2    LXI      B,(0C2H SHL 8) OR 05 ;JNZ OPCODE TO B, TYPE TO C
17CD FE4A      CPI      'J'

```

```

17CF C8        RZ
17D0 06C4      MVI      B,0C4H ;RETURN WITH ZERO FLAG SET IF J
17D2 FE43      CPI      'C'    ;CNZ OPCODE TO B, TYPE IS IN C
17D4 C8        RZ
17D5 0113C0    LXI      B,(0C0H SHL 8) OR 01 ;RNZ OPCODE
17D8 FE52      CPI      'R'
17DA C9        RET

```

```

17DB 3A8801    LDA
17DE FE04      CPI      4      ;CHECK LENGTH
17E0 D20D18    JNC      NSUFF   ;CARRY IF 0,1,2,3 IN LENGTH
17E3 FE03      CPI      3
17E5 CAF217    JZ        SUF0    ;ASSUME 1 OR 2 IF NO BRANCH
17E8 FE02      CPI      2
17EA C20D18    JNZ      NSUFF   ;RETURNS IF 0 OR 1
17ED 218B01    LXI      H,ACCUM+2
17F0 3620      MVI      M,' ' ;BLANK-OUT FOR MATCH ATTEMPT

```

```

17F2 010800    SUF0: ;SEARCH 'TIL END OF TABLE
17F5 117317    LXI      B,8      ;B=0, C=8 COUNTS TABLE DOWN TO ZERO OR MATCH
;

```

```

17F8 218A01    NEXTS: ;LOOK AT NEXT SUFFIX
17FB 1A        LXI      H,ACCUM+1 ;SUFFIX POSITION
17FC BE        LDAX     D      ;CHARACTER TO ACCUM
17FD 13        CMP      M
17FE C20518    INX      D      ;READY FOR NEXT CHARACTER
1801 1A        JNZ      NEXT0   ;JMP IF NO MATCH
1802 23        LDAX     D      ;GET NEXT CHARACTER
1803 BE        INX      H      ;READY FOR COMPARE WITH ACCUM
1804 C8        CMP      M      ;SAME?
1805 13        RZ          ;RETURN WITH ZERO FLAG SET, B IS SUFFI
1806 04        NEXT0: INX      D      ;MOVE TO NEXT CHARACTER
1807 0D        INR      B      ;COUNT SUFFIX UP
1808 C2F817    DCR      C      ;COUNT TABLE LENGTH DOWN
;

```

```

180B 0C        ;
180C C9        END OF TABLE, MARK WITH NON ZERO FLAG
;

```

```

180D AF        ;
180E 3C        INR      C
180F C9        RET

```

```

;
; BGET: ;PERFORM BINARY SEARCH, AND EXTRACT TYPE AND VAL FIELDS FOR
; THE ITEM. ZERO FLAG INDICATES MATCH WAS FOUND, WITH TYPE
; IN THE ACCUMULATOR, AND VAL IN REGISTER B. THE SEARCH IS BAS
; UPON THE LENGTH OF THE ACCUMULATOR
1810 3A8801    LDA      ACCLEN ;ITEM LENGTH
1813 4F        MOV      C,A     ;SAVE A COPY

```

```

;
; SUFFIX: ;J R OR C RECOGNIZED, LOOK FOR SUFFIX
1814 04        LDA      ACCLEN
1815 04        CPI      4      ;CHECK LENGTH
1816 04        JNC      NSUFF   ;CARRY IF 0,1,2,3 IN LENGTH
1817 03        CPI      3
1818 02        JZ        SUF0    ;ASSUME 1 OR 2 IF NO BRANCH
1819 02        CPI      2
181A 02        JNZ      NSUFF   ;RETURNS IF 0 OR 1
181B 02        LXI      H,ACCUM+2
181C 02        MVI      M,' ' ;BLANK-OUT FOR MATCH ATTEMPT

```

```

181D 02        SUF0: ;SEARCH 'TIL END OF TABLE
181E 02        LXI      B,8      ;B=0, C=8 COUNTS TABLE DOWN TO ZERO OR MATCH
181F 02        LXI      D,SUFTAB
;

```

```

1820 02        NEXTS: ;LOOK AT NEXT SUFFIX
1821 02        LXI      H,ACCUM+1 ;SUFFIX POSITION
1822 02        LDAX     D      ;CHARACTER TO ACCUM
1823 02        CMP      M
1824 02        INX      D      ;READY FOR NEXT CHARACTER
1825 02        JNZ      NEXT0   ;JMP IF NO MATCH
1826 02        LDAX     D      ;GET NEXT CHARACTER
1827 02        INX      H      ;READY FOR COMPARE WITH ACCUM
1828 02        CMP      M      ;SAME?
1829 02        RZ          ;RETURN WITH ZERO FLAG SET, B IS SUFFI
182A 02        NEXT0: INX      D      ;MOVE TO NEXT CHARACTER
182B 02        INR      B      ;COUNT SUFFIX UP
182C 02        DCR      C      ;COUNT TABLE LENGTH DOWN
;

```

```

182D 02        ;
182E 02        END OF TABLE, MARK WITH NON ZERO FLAG
182F 02        INR      C
1830 02        RET
;

```

```

;
; BGET: ;PERFORM BINARY SEARCH, AND EXTRACT TYPE AND VAL FIELDS FOR
; THE ITEM. ZERO FLAG INDICATES MATCH WAS FOUND, WITH TYPE
; IN THE ACCUMULATOR, AND VAL IN REGISTER B. THE SEARCH IS BAS
; UPON THE LENGTH OF THE ACCUMULATOR
1831 02        LDA      ACCLEN ;ITEM LENGTH
1832 02        MOV      C,A     ;SAVE A COPY

```

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```

1814 3D      DCR      A      ;ACCLN-1
1815 5F      MOV      E,A
1816 1600    MVI      D,0      ;DOUBLE ACCLN-1 TO D,E SER. #
1818 D5      PUSH     D      ;SAVE A COPY FOR LATER
1819 FE05    CPI      CMAX     ;TOO LONG?
181B D25A18  JNC      NGET     ;NOT IN RANGE IF CARRY
181E 21B515  LXI      H,CLEN   ;LENGTH VECTOR
1821 19      DAD      D
1822 46      MOV      UR,M      ;FILL UPPER BOUND FROM MEMORY
1823 21A915  LXI      H,CINX
1826 19      DAD      D
1827 19      DAD      D      ;BASE ADDRESS TO H,L
1828 56      MOV      D,M
1829 23      INX      H
182A 66      MOV      H,M
182B 6A      MOV      L,D      ;NOW IN H,L
182C 51      MOV      SR,C      ;FILL THE SIZE REGISTER
182D CD8317  CALL     BSEAR     ;PERFORM THE BINARY SEARCH
1830 C24518  JNZ      SCASE     ;ZERO IF FOUND
1833 D1      POP      D      ;RESTORE INDEX
1834 21BA15  LXI      H,TVINX
1837 19      DAD      D
1838 19      DAD      D      ;ADDRESSING PROPER TV ELEMENT
1839 5E      MOV      E,M
183A 23      INX      H
183B 56      MOV      D,M
; D,E IS BASE ADDRESS OF TYPE/VALUE VECTOR, ADD DISPLACEMENT
183C 6F      MOV      L,A
183D 2600    MVI      H,0
183F 29      DAD      H      ;DOUBLED
1840 19      DAD      D      ;INDEXED
1841 7E      MOV      A,M      ;TYPE TO ACC
1842 23      INX      H
1843 46      MOV      B,M      ;VALUE TO B
1844 C9      RET           ;TYPE IN ACC, VALUE IN B
;
SCASE: ;NAME NOT TOO LONG, BUT NOT FOUND IN TABLES, MAY BE J C OR R
1845 D1      POP      D      ;RESTORE INDEX
1846 CDC717  CALL     PREFIX
1849 C0      RNZ
184A C5      PUSH     B      ;NOT FOUND AS PREFIX J C OR R IF NOT ZERO FLAG
184B C0B17  CALL     SUFFIX   ;SAVE VALUE AND TYPE
184E 78      MOV      A,B      ;ZERO IF SUFFIX MATCHED
184F C1      POP      B      ;READY FOR MASK IF ZERO FLAG
1850 C0      RNZ           ;RECALL VALUE AND TYPE
; RETURN IF NOT ZERO FLAG SET
; MASK IN THE PROPER BITS AND RETURN
1851 B7      ORA      A      ;CLEAR CARRY
1852 17      RAL
1853 17      RAL
1854 17      RAL

```

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```

1855 B0
1856 47
1857 79
1858 BF
1859 C9

```

```

185A D1
185B AF
185C 3C
185D C9

```

```

1860 -
185E

```

```

ORA      B      ;VALUE SET TO JNZ ...
MOV      B,A     ;REPLACE
MOV      A,C     ;RETURN WITH TYPE IN REGISTER A
CMP      A      ;CLEAR THE ZERO FLAG
RET

```

```

; NGET: ;CAN'T FIND THE ENTRY, RETURN WITH ZERO FLAG RESET
POP      D      ;GET THE ELEMENT BACK
XRA      A      ;CLEAR
INR      A      ;ZERO FLAG RESET
RET

```

```

;
; ENDMOD EQU      ($ AND 0FFFEH) + 20H ;NEXT MODULE ADDRESS
END

```

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```

1860      ;      OPERAND SCAN MODULE
          ORG      1860H

          ;      EXTERNALS
0200 =    IOMOD EQU      220H      ;I/O MODULE
1100 =    SCMOD EQU      1100H     ;SCANNER MODULE
1340 =    SYMOD EQU      1340H     ;SYMBOL TABLE MODULE
15A0 =    BMOD EQU       15A0H     ;BINARY SEARCH MODULE

          ;
0218 =    PERR EQU       IOMOD+18H
1106 =    SCAN EQU       SCMOD+6H      ;SCANNER ENTRY POINT
002D =    CR EQU         0DH         ;CARRIAGE RETURN

          ;
1346 =    LOOKUP EQU     SYMOD+6H      ;LOOKUP
1349 =    FOUND EQU      LOOKUP+3     ;FOUND SYMBOL IF ZERO FLAG NOT SET
134C =    ENTER EQU       FOUND+3     ;ENTER SYMBOL
134F =    SETTY EQU       ENTER+3     ;SET TYPE FIELD
1352 =    GETTY EQU       SETTY+3     ;SET TYPE FIELD
1355 =    SETVAL EQU      GETTY+3     ;SET VALUE FIELD
1358 =    GETVAL EQU      SETVAL+3    ;GET VALUE FIELD

          ;
15A3 =    BSEAR EQU       BMOD+3      ;BINARY SEARCH ROUTINE
15A6 =    BGET EQU        BSEAR+3     ;GET VALUES WITH SEARCH

          ;      COMMON EQUATES
0078 =    PBMAX EQU       120        ;MAX PRINT SIZE
010C =    PBUFF EQU       10CH       ;PRINT BUFFER
0184 =    PBP EQU         PBUFF+PBMAX ;PRINT BUFFER POINTER

          ;
0185 =    TOKEN EQU       PBP+1      ;CURRENT TOKEN UDER SCAN
0186 =    VALUE EQU       TOKEN+1    ;VALUE OF NUMBER IN BINARY
0188 =    ACCLEN EQU      VALUE+2    ;ACCUMULATOR LENGTH
0240 =    ACMAX EQU       64         ;MAX ACCUMULATOR LENGTH
0189 =    ACCUM EQU       ACCLEN+1

          ;
01C9 =    EVALUE EQU      ACCUM+ACMAX ;VALUE FROM EXPRESSION ANALYSIS

          ;
01C8 =    SYTOP EQU       EVALUE+2    ;CURRENT SYMBOL TOP
01CD =    SYMAX EQU       SYTOP+2    ;MAX ADDRESS+1

          ;
01CF =    PASS EQU        SYMAX+2    ;CURRENT PASS NUMBER
01D0 =    PPC EQU         PASS+1     ;FILL ADDRESS FOR NEXT HEX BYTE
01D2 =    ASPC EQU        PPC+2      ;ASSEMBLER'S PSEUDO PC

          ;      GLOBAL EQUATES
0031 =    IDEN EQU        1          ;IDENTIFIER
0032 =    NUMB EQU        2          ;NUMBER
  
```

```

0003 =    STRNG EQU       3          ;STRING
0004 =    SPECL EQU       4          ;SPECIAL CHARACTER

          ;
0001 =    PLABT EQU       0001B     ;PROGRAM LABEL
0002 =    DLABT EQU       0010B     ;DATA LABEL
0004 =    EQUT EQU        0100B     ;EQUATE
0005 =    SETT EQU        0101B     ;SET
0006 =    MACT EQU        0110B     ;MACRO

          ;
0008 =    EXTT EQU        1000B     ;EXTERNAL
000B =    REFT EQU        1011B     ;REFER
000C =    GLBT EQU        1100B     ;GLOBAL

          ;
          ;      TABLE DEFINITIONS
0000 =    XBASE EQU       0          ;START OF OPERATORS
000F =    OPER EQU        15         ;LAST OPERATOR
0010 =    RT EQU          16
0011 =    PT EQU          RT+1       ;RT IS REGISTER TYPE, PT IS PSEUDO OPERATION
0012 =    OBASE EQU       PT+1

          ;
0005 =    PLUS EQU        5
0006 =    MINUS EQU       6
0008 =    NOTF EQU        8          ;NOT
000C =    LPAR EQU        12
000D =    RPAR EQU        13
000A =    OSMAX EQU       10
0010 =    VSMAX EQU       8*2

          ;
          ;      BEGINNING OF MODULE
1860 C3A01B JMP      ENDMOD      ;PAST THIS MODULE
1863 C3191A JMP      OPAND      ;SCAN OPERAND FIELD
1866 C36E19 JMP      MULF       ;MULTIPLY FUNCTION
1869 C33819 JMP      DIVE       ;DIVIDE FUNCTION
186C          UNARY: DS          1      ;TRUE IF NEXT OPERATOR IS UNARY
186D          OPERV: DS          OSMAX ;OPERATOR STACK
1877          HIERV: DS          OSMAX ;OPERATOR PRIORITY
1881          VSTACK: DS          1     ;VALUE STACK
1891          OSP: DS            1      ;OPERATOR STACK POINTER
1892          VSP: DS            1      ;VALUE STACK POINTER

          ;
          ;
          ;      STKV: ;PLACE CURRENT H,L VALUE AT TOP OF VSTACK
1893 EB      XCHG      ;HOLD VALUE IN D,E
1894 219218 LXI        H,VSP
1897 7E      MOV        A,M
1898 FE10    CPI        VSMAX
189A DAA218 JC          STKV0
  
```

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```

189D CD851B      CALL    ERREX    ;OVERFLOW IN EXPRESSION
18A0 3600        MVI      M,0      ;VSP=0
18A2 7E          STKV8: MOV     A,M    ;GET VSP
18A3 34          INR      M        ;VSP=VSP+1
18A4 34          INR      M        ;VSP=VSP+2
18A5 4F          MOV     C,A      ;SAVE VSP
18A6 0600        MVI      B,0      ;DOUBLE VSP
18A8 218118      LXI      H,VSTACK
18AB 09          DAD      B
18AC 73          MOV     M,E      ;LOW BYTE
18AD 23          INX      H
18AE 72          MOV     M,D      ;HIGH BYTE
18AF C9          RET

;
STKO: ;STACK OPERATOR (REG-A) AND PRIORITY (REG-B)
      PUSH      PSW    ;SAVE IT
      LXI      H,OSP
      MOV     A,M
      CPI      OSMAX
      JC      STK01
      MVI      M,0
      CALL    ERREX    ;OPERATOR STACK OVERFLOW
STK01: MOV     E,M      ;GET OSP
      MVI      D,0
      INR      M        ;OSP=OSP+1
      POP      PSW    ;RECALL OPERATOR
      DAD      D        ;OPERV(OSP)
      MOV     M,A      ;OPERV(OSP)=OPERATOR
      LXI      H,HIERV
      DAD      D
      MOV     M,B      ;HIERV(OSP)=PRIORITY
      RET

;
LODV1: ;LOAD TOP ELEMENT FROM VSTACK TO H,L
      LXI      H,VSP
      MOV     A,M
      ORA      A
      JNZ     LODOK
      CALL    ERREX    ;UNDERFLOW
      LXI      H,0
      RET

;
LODOK: DCR      M
      DCR      M        ;VSP=VSP-2
      MOV     C,M      ;LOW BYTE
      MVI      B,0
      LXI      H,VSTACK
      DAD      B        ;VSTACK(VSP)
      MOV     C,M      ;GET LOW BYTE

```

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```

18E8 23          INX      H
18E9 66          MOV     H,M
18EA 69          MOV     L,C
18EB C9          RET

```

```

18EC CDCF18      CALL    LODV1
18EF EB          XCHG
18F0 CDCF18      CALL    LODV1
18F3 C9          RET

```

```

18F4 6F          MOV     L,A
18F5 2600        MVI      H,0
18F7 29          DAD      H        ;OPERATOR NUMBER*2
18F8 110119      LXI      D,OPTAB
18FB 19          DAD      D        ;INDEXED OPTAB
18FC 5E          MOV     E,M      ;LOW ADDRESS
18FD 23          INX      H
18FE 66          MOV     H,M      ;HIGH ADDRESS
18FF 6B          MOV     L,E
1900 E9          PCHL        ;SET PC AND GO TO SUBROUTINE

```

```

1901 8919        DW      MULOP
1903 9219        DW      DIVOP
1905 9919        DW      MODOP
1907 9F19        DW      SHLOP
1909 AB19        DW      SHROP
190B BF19        DW      ADDOP
190D C619        DW      SUBOP
190F D019        DW      NEGOP
1911 D919        DW      NOTOP
1913 E019        DW      ANDOP
1915 EC19        DW      OROP
1917 F819        DW      XOROP
1919 851B        DW      ERREX    ; (

```

```

191B CDEC18      ;
191E 7A          ;SET UP OPERANDS FOR SHIFT L AND R
191F B7          CALL    LODV2
1920 C22719      MOV     A,D      ;ENSURE 0-15
1923 7B          ORA      A
1924 FE11        JNZ     SHERR
1926 D8          MOV     A,E
1927 CD851B      CPI      17
192A 3E10        RC          ;RETURN IF 0-16 SHIFT
192C C9          SHERR: CALL    ERREX
                  MVI      A,16
                  RET

```

```

;
LODV2: ;LOAD TOP TWO ELEMENTS DE HOLDS TOP, HL HOLDS TOP-1
      CALL    LODV1
      XCHG
      CALL    LODV1
      RET

```

```

;
APPLY: ;APPLY OPERATOR IN REG-A TO TOP OF STACK
      MOV     L,A
      MVI      H,0
      DAD      H        ;OPERATOR NUMBER*2
      LXI      D,OPTAB
      DAD      D        ;INDEXED OPTAB
      MOV     E,M      ;LOW ADDRESS
      INX      H
      MOV     H,M      ;HIGH ADDRESS
      MOV     L,E
      PCHL        ;SET PC AND GO TO SUBROUTINE

```

```

;
OPTAB: DW      MULOP
      DW      DIVOP
      DW      MODOP
      DW      SHLOP
      DW      SHROP
      DW      ADDOP
      DW      SUBOP
      DW      NEGOP
      DW      NOTOP
      DW      ANDOP
      DW      OROP
      DW      XOROP
      DW      ERREX    ; (

```

```

;
;
SHFT: ;SET UP OPERANDS FOR SHIFT L AND R
      CALL    LODV2
      MOV     A,D      ;ENSURE 0-15
      ORA      A
      JNZ     SHERR
      MOV     A,E
      CPI      17
      RC          ;RETURN IF 0-16 SHIFT
      SHERR: CALL    ERREX
              MVI      A,16
              RET

```

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```

192D AF      NEGFP: ; COMPUTE 0-H,L TO H,L
192E 95      XRA    A
192F 6F      SUB    L
1930 3E00    MOV    L,A
1932 9C      MVI    A,0
1933 67      SBB    H
1934 C9      MOV    H,A
              RET

1935 CDEC18  ;
DIVE: CALL   LODV2
; (EXTERNAL ENTRY FROM MAIN PROGRAM)
1938 EB      XCHG    ; SWAP D,E WITH H,L FOR DIVIDE FUNCTION
;
; COMPUTE X/Y WHERE X IS IN D,E AND Y IS IN H,L
; THE VALUE OF X/Y APPEARS IN D,E AND X MOD Y IS IN H,L
;
1939 226B19  SHLD    DTEMP ; SAVE X IN TEMPORARY
193C 216D19  LXI     H,BNUM ; STORE BIT COUNT
193F 3611    MVI     M,11H
1941 010300  LXI     B,0 ; INITIALIZE RESULT
1944 C5      PUSH    B
1945 AF      XRA     A ; CLEAR FLAGS

DLOOP:
1946 78      MOV     A,E ; GET LOW Y BYTE
1947 17      RAL
1948 5F      MOV     E,A
1949 7A      MOV     A,D
194A 17      RAL
194B 57      MOV     D,A
194C 35      DCR     M ; DECREMENT BIT COUNT
194D E1      POP     H ; RESTORE TEMP RESULT
194E C8      RZ       ; ZERO BIT COUNT MEANS ALL DONE
194F 3E00    MVI     A,0 ; ADD IN CARRY
1951 CE00    ACI     0 ; CARRY
1953 29      DAD     H ; SHIFT TEMP RESULT LEFT ONE BIT
1954 44      MOV     B,H ; COPY HA AND L TO A AND C
1955 85      ADD     L
1956 2A6B19  LHLD    DTEMP ; GET ADDRESS OF X
1959 95      SUB     L ; SUBTRACT FROM TEMPORARY RESULT
195A 4F      MOV     C,A
195B 78      MOV     A,B
195C 9C      SBB     H
195D 47      MOV     B,A
195E C5      PUSH    B ; SAVE TEMP RESULT IN STACK
195F D26419  JNC     DSKIP ; NO BORROW FROM SUBTRACT
1962 09      DAD     B ; ADD X BACK IN
1963 E3      XTHL    ; REPLACE TEMP RESULT ON STACK
1964 216D19  LXI     H,BNUM ; RESTORE H,L
1967 3F      CMC
1968 C34619  JMP     DLOOP ; REPEAT LOOP STEPS
  
```

```

196B      DTEMP: DS    2
196D      BNUM: DS    1

;
MULP: ; MULTIPLY D,E BY H,L AND REPLACE H,L WITH RESULT
      MOV     B,H
      MOV     C,L ; COPY OF 1ST VALUE TO B,C FOR SHIFT AND ADD
      LXI     H,0 ; H,L IS THE ACCUMULATOR
MUL0:  XRA     A ; CARRY IS CLEARED
      MOV     A,B
      RAR
      MOV     B,A
      MOV     A,C
      RAR
      MOV     C,A
      JC      MUL1 ; SKIP THIS ADD IF LSB IS ZERO
      ORA     B
      RZ       ; RETURN WITH H,L
      JMP     MUL2 ; SKIP ADD
MUL1:  DAD     D ; ADD CURRENT VALUE OF D
MUL2:  XCHG    ; READY FOR *2
      DAD     H
      XCHG
      JMP     MUL0

;
MULOP: ; MULTIPLY D,E BY H,L
      CALL    LODV2
      CALL    MULF
      JMP     ENDOP

;
DIVOP: ; DIVIDE H,L BY D,E
      CALL    DIVF
      XCHG    ; RESULT TO H,L
      JMP     ENDOP

;
MODOP: CALL    DIVF
      JMP     ENDOP

;
SHLOP: CALL    SHFT ; CHECK VALUES
SHL0:  ORA     A ; DONE?
      JZ      ENDOP
      DAD     H ; HL=HL*2
      DCR     A
      JMP     SHL0

;
SHROP: CALL    SHFT
SHR0:  ORA     A ; DONE?
      JZ      ENDOP
      PUSH    PSW ; SAVE CURRENT COUNT
      XRA     A
      MOV     A,H
  
```

```

1985 1F      RAR
1986 67      MOV      H,A
1987 7D      MOV      A,L
1988 1F      RAR
1989 6F      MOV      L,A
198A F1      POP      PSW
198B 3D      DCR      A
198C C3AE19  JMP      SHRB

```

```

198F CDEC18  ; ADDOP: CALL LODV2
19C2 19      ADD0: DAD      D
19C3 C3011A  JMP      ENDOP

```

```

19C6 CDEC18  ; SUBOP: CALL LODV2
19C9 EB      XCHG
19CA C02D19  CALL      NEG0
19CD C3C219  JMP      ADD0

```

```

19D0 C0CF18  ; NEGOP: CALL LODV1
19D3 C02D19  NEG0: CALL      NEG0
19D6 C3011A  JMP      ENDOP

```

```

19D9 C0CF18  ; NOTOP: CALL LODV1
19DC 23      INX      H
19DD C3D319  JMP      NEG0

```

```

19E0 CDEC18  ; ANDOP: CALL LODV2
19E3 7A      MOV      A,D
19E4 A4      ANA      H
19E5 67      MOV      H,A
19E6 7B      MOV      A,E
19E7 A5      ANA      L
19E8 6F      MOV      L,A
19E9 C3011A  JMP      ENDOP

```

```

19EC CDEC18  ; OROP: CALL LODV2
19EF 7A      MOV      A,D
19F0 B4      ORA      H
19F1 67      MOV      H,A
19F2 7B      MOV      A,E
19F3 B5      ORA      L
19F4 6F      MOV      L,A
19F5 C3011A  JMP      ENDOP

```

```

19F8 CDEC18  ; XOROP: CALL LODV2
19FB 7A      MOV      A,D
19FC AC      XRA      H
19FD 67      MOV      H,A
19FE 7B      MOV      A,E
19FF AD      XRA      L

```

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;TREAT AS HL+(-DE)
 ;0-HL

;COMPUTE 0-HL

;65536-HL = 65535-(HL+1)

```

1A00 6F      MOV      L,A
1A01 C39318  ; ENDOP: JMP      STKV

```

```

1A04 3A8501  LDA
1A07 FE04    CPI
1A09 C0      RNZ

```

```

1A0A 3A8901  LDA
1A0D FE0D    CPI
1A0F C8      RZ
1A10 FE3B    CPI
1A12 C8      RZ
1A13 FE2C    CPI
1A15 C8      RZ
1A16 FE21    CPI
1A18 C9      RET

```

```

1A19 AF
1A1A 329118  STA
1A1D 329218  STA
1A20 3D      DCR
1A21 326C18  STA
1A24 210000  LXI
1A27 22C901  SHLD

```

```

1A2A C0041A  CALL
1A2D C25D1A  JNZ

```

```

1A30 219118  LXI
1A33 7E      MOV
1A34 B7      ORA
1A35 CA481A  JZ
1A38 35      DCR
1A39 5F      MOV
1A3A 1D      DCR
1A3B 1600    MVI
1A3D 216D18  LXI
1A40 19      DAD
1A41 7E      MOV
1A42 CDF418  CALL
1A45 C3301A  JMP

```

```

; ENDOP: JMP      STKV
;
;
; ENDEXP:

```

```

;RETURNS ZERO FLAG IF SYMBOL IS CR, ;, OR .
LDA      TOKEN
CPI      SPECL
RNZ
;NOT END IF NOT SPECIAL

```

```

; LDA      ACCUM
; CPI      CR
; RZ
; CPI
; RZ
; CPI
; RZ
; CPI
; RET

```

```

; OPAND: ;SCAN THE OPERAND FIELD OF AN INSTRUCTION
; (NOT A DB WITH FIRST TOKEN STRING > 2 OR 0)
XRA      A
STA      OSP ;ZERO OPERATOR STACK POINTER
STA      VSP
DCR      A ;255
STA      UNARY
LXI      H,0
SHLD     EVALUE

```

```

; OP0: ;ARRIVE HERE WITH NEXT ITEM ALREADY SCANNED
CALL     ENDEXP ;DONE?
JNZ      OP1
; EMPTY THE OPERATOR STACK
EMPOP: LXI      H,OSP
MOV      A,M ;GET THE OSP AND CHECK FOR EMPTY
ORA      A
JZ        CHKVAL ;JUMP IF EMPTY
DCR      M ;POP ELEMENT
MOV      E,A ;COPY FOR DOUBLE ADD
DCR      E
MVI      D,0
LXI      H,OPERV
DAD      D ;INDEXED - OPRV(OSP)
MOV      A,M ;GET OPERATOR
CALL     APPLY ;APPLY OPERATOR
JMP      EMPOP

```

;CHKVAL:

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```

1A48 3A9218      LDA    VSP      ;MUST HAVE ONE ELEMENT IT THE STACK
1A48 FE02        CPI      2
1A4D C4851B      CNZ      ERREX
1A50 3A0C01      LDA      PBUFF
1A53 FE20        CPI
1A55 C0          RNZ
1A56 2A8118      LHL      VSTACK ;EVALUE REMAINS AT ZERO
1A59 22C901      SHLD     EVALUE ;GET DOUBLE BYTE IN
1A5C C9          RET

```

```

;
OP1: ;MORE TO SCAN
      LDA      PBUFF
      CPI
      JNZ      GETOP
      LDA      TOKEN
      CPI      STRNG ;IS THIS A STRING?
      JNZ      OP3

```

```

;
; STRING - CONVERT TO DOUBLE PRECISION
      LDA      ACCLEN
      ORA      A
      CZ       ERREX ;ERROR IF LENGTH=0
      CPI      3
      CNC      ERREX ;ERROR IF LENGTH>2
      MVI      D,0
      LXI      H,ACCUM
      MOV      E,M ;LSBYTE
      INX      H
      DCR      A ;A HAS THE LENGTH
      JZ       OP2 ;ONE OR TWO BYTES
      MOV      D,M ;FILL HIGH ORDER
      XCHG
      JMP      STNUM ;STORE TO STACK

```

```

;
OP3: ;NOT A STRING, CHECK FOR NUMBER
      CPI      NUMB
      JNZ      OP4
      LHL      VALUE ;NUMERIC VALUE
      JMP      STNUM

```

```

;
OP4: ;NOT STRING OR NUMBER, MUST BE ID OR SPEC
      CALL     BGST ;BINARY SEARCH, GET ATTRIBUTES
      JNZ      OP6 ;MATCH?
      YES, MAY BE OPERATOR
      CPI      OPER+1
      JNC      OP5
      OPERATOR ENCOUNTERED MS NIBBLE OF B IS PRIORITY NUMBER LS NIBBLE
      IS THE OPERATOR
      ACC HAS THE OPERATOR NUMBER, B HAS PRIORITY
      CPI      LPAR ;(?)

```

```

1A9F FE0C

```

```

1AA1 4F
1AA2 3A6C18
1AA5 C2B51A

```

```

1AA8 B7
1AA9 CC851B
1AAC 3EFF
1AAE 326C18
1AB1 79
1AB2 C3031B

```

```

1AB5 B7
1AB6 C20E1B

```

```

1AB9 C5
1ABA 3A9118
1ABD B7
1ABE CADE1A
1AC1 5F
1AC2 1D
1AC3 1600
1AC5 217718
1AC8 19
1AC9 7E
1ACA B8
1ACB DADE1A

```

```

1ACE 219118
1AD1 73
1AD2 216D18
1AD5 19
1AD6 7E
1AD7 CDF418
1ADA C1
1ADB C3B91A

```

```

1ADE C1
1ADF 79
1AE0 FE0D
1AE2 C2031B

```

```

1AE5 219118
1AE8 7E

```

```

MOV      C,A ;SAVE COPY OF OPERATOR NUMBER
LDA      UNARY
JNZ      OPER1 ;JUMP IF NOT A (
; ( ENCOUNTERED, UNARY MUST BE TRUE
ORA      A
CZ       ERREX
MVI      A,0FFH
STA      UNARY ;UNARY IS SET TRUE
MOV      A,C ;RECOVER OPERATOR
JMP      OPER4 ;CALLS STKO AND SETS UNARY TO TRUE

```

```

;
OPER1: ;NOT A LEFT PAREN
      ORA      A
      JNZ      OPER6 ;MUST BE + OR - SINCE UNARY IS SET

```

```

;
; UNARY NOT SET, MUST BE BINARY OPERATOR
OPER2: ;COMPARE HIERARCHY OF TOS
      PUSH     B ;SAVE PRIORITY AND OPERATOR NUMBER
      LDA      OSP
      ORA      A
      JZ       OPER3 ;NO MORE OPERATORS IN STACK
      MOV      E,A ;OSP TO E
      DCR      E ;OSP-1
      MVI      D,0
      LXI      H,HIERV
      DAD      D ;HL ADDRESSES TOP OF OPERATOR STACK
      MOV      A,M ;PRIORITY OF TOP OPERATOR
      CMP      B ;CURRENT GREATER?
      JC       OPER3 ;JUMP IF SO
      APPLY TOP OPERATOR TO VALUE STACK
      LXI      H,OSP
      MOV      M,E ;OSP=OSP-1
      LXI      H,OPERV
      DAD      D
      MOV      A,M ;OPERATOR NUMBER TO ACC
      CALL     APPLY
      POP      B ;RESTORE OPERATOR NUMBER AND PRIORITY
      JMP      OPER2 ;FOR ANOTHER TEST

```

```

;
OPER3: ;ARRIVE HERE WHEN OPERATOR IS STACKED
; CHECK FOR RIGHT PAREN BALANCE
      POP      B ;OPERATOR NUMBER IN C, PRIORITY IN B
      MOV      A,C
      CPI      RPAR
      JNZ      OPER4 ;JUMP IF NOT A RIGHT PAREN
;
; RIGHT PAREN FOUND, STACK MUST CONTAIN LEFT PAREN TO DELETE
      LXI      H,OSP
      MOV      A,M

```

```

1AE9 B7
1AEA CAPCIA
1AED 3D
1AEE 77
1AEF 5F
1AF0 1600
1AF2 216D18
1AF5 19
1AF6 7E
1AF7 FE0C
1AF9 CAFF1A
1AFC CD851B

1AFF AF
1B00 C3081B

1B03 CD3018
1B06 3EFF
1B08 326C18
1B0B C37F1B

1B0E 79
1B0F FE05
1B11 CA7F1B
1B14 FE06
1B16 C21E1B
1B19 3C
1B1A 4F
1B1B C3891A

1B1E FE08
1B20 C4851B
1B23 C3891A

1B26 FE11
1B28 CC851B
1B2B 68
1B2C 2600
1B2E C3711B

1B31 3A8501
1B34 FE04
1B36 C2501B
1B39 3A8901
1B3C FE24

ORA A ;ZERO?
JZ LPERR ;PAREN ERROR IF SO
DCR A ;OSP-1
MOV M,A ;STORED TO MEMORY
MOV E,A
MVI D,0
LXI H,OPERV
DAD D
MOV A,M ;TOP OPERATOR IN REG-A
CPI LPAR
JZ NLERR ;JMP IF NO ERROR - PARENS BALANCE
LPERR: CALL ERREX
NLERR: ;ERROR REPORTING COMPLETE
XRA A
JMP OPERS ;TO CLEAR UNARY FLAG

;
OP4: ;ORDINARY OPERATOR
CALL STKO
MVI A,0FFH ;TO SET UNARY FLAG
OPERS: STA UNARY
JMP GETOP ;FOR ANOTHER ELEMENT

;
OP6: ;UNARY SET, MUST BE + OR -
MOV A,C ;RECALL OPERATOR
CPI PLUS
JZ GETOP ;IGNORE UNARY PLUS
CPI MINUS
JNZ CHKNOT
INR A ;CHANGE TO UNARY MINUS
MOV C,A
JMP OPER2
CHKNOT: ;UNARY NOT SYMBOL?
CPI NOTP
CNZ ERREX
JMP OPER2

;
;
OP5: ;ELEMENT FOUND IN TABLE, NOT AN OPERATOR
CPI PT ;PSEUDO OPERATOR?
CZ ERREX ;ERROR IF SO
MOV L,B ;GET LOW VALUE TO L
MVI H,0 ;ZERO HIGH ORDER BYTE
JMP STNUM ;STORE IT

;
OP6: ;NOT FOUND IN TABLE SCAN, $?
LDA TOKEN
CPI SPECI
JNZ OP7
LDA ACCUM
CPI '$'

```

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```

1B3E CA4A1B
1B41 CD851B
1B44 210000
1B47 C3711B
1B4A 2AD201
1B4D C3711B

```

```

1B50 CD4613
1B53 CD4913
1B56 C2641B

```

```

1B59 3E50
1B5B CD1802
1B5E CD4C13
1B61 C36E1B
1B64 CD5213
1B67 E607
1B69 3E55
1B6B CC1802

```

```
1B6E CD5813
```

```

1B71 3A6C18
1B74 B7
1B78 CC851B
1B79 326C18
1B7C CD9318

```

```
1B7E C32611
```

```

1B85 E5
1B86 3E45
1B88 CD1802
1B8B E1
1B8C C9

```

```

1BA0 =
1B8D

```

```

JZ CURPC ;USE CURRENT PC
CALL ERREX
LXI H,0
JMP STNUM
CURPC: LHLD ASPC ;GET CURRENT PC
JMP STNUM

```

```
; OP7: ;NOT $, LOOK IT UP
```

```

CALL LOOKUP
CALL FOUND
JNZ FIDENT

```

```
; NOT FOUND IN SYMBOL TABLE, ENTER IF PASS 1
```

```

MVI A,'P'
CALL PERR
CALL ENTER ;ENTER SYMBOL WITH ZERO TYPE FIELD
JMP FIDE0
FIDENT: CALL GETTY ;TYPE TO H,L
ANI 111B
MVI A,'U'
CZ PERR

```

```
FIDE0: CALL GETVAL ;VALUE TO H,L
```

```

;
STNUM: ;STORE H,L TO VALUE STACK
LDA UNARY
ORA A
STA UNARY ;UNARY OPERATION SET
CALL STKV ;STACK THE VALUE
;
GETOP: CALL SP0N
;
ERREX: ;PUT 'E' ERROR IN OUTPUT BUFFER
PUSH H
MVI A,'E'
CALL PERR
POP H
RET
;
ENDMOD EQU ($ AND 0FF0H) + 20H ;NEXT HALF PAGE
END

```

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```

; CP/M RESIDENT ASSEMBLER MAIN PROGRAM
;
;
;
;

```

```

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```

```

1BA0H      ORG      1BA0H
;
; MODULE ENTRY POINTS
;
0200H = IOMOD EQU 200H ;IO MODULE
1100H = SCMOD EQU 1100H ;SCANNER MODULE
1340H = SYMOD EQU 1340H ;SYMBOL TABLE MODULE
15A0H = BMOD EQU 15A0H ;BINARY SEARCH MODULE
1860H = OPMOD EQU 1860H ;OPERAND SCAN MODULE
;
0203H = SETUP EQU IOMOD+3H ;FILE SETUP FOR EACH PASS
0212H = PCON EQU IOMOD+12H ;WRITE CONSOLE BUFFER TO CR
0215H = WOBUFF EQU IOMOD+15H ;WRITE PRINT BUFFER AND REINITIALIZE
0218H = PERR EQU IOMOD+18H ;WRITE ERROR CHARACTER TO PRINT BUFFER
021BH = DHEX EQU IOMOD+1BH ;SEND HEX CHARACTER TO MACHINE CODE FILE
021EH = EGR EQU IOMOD+1EH ;END OF PROCESSING, CLOSE FILES AND TERMINATE
;
1103H = INITS EQU SCMOD+3H ;INITIALIZE SCANNER MODULE
1106H = SCAN EQU SCMOD+6H ;SCAN NEXT TOKEN
;
1343H = INISY EQU SYMOD+3H ;INITIALIZE SYMBOL TABLE
1346H = LOOKUP EQU SYMOD+6H ;LOOKUP SYMBOL IN ACCUMULATOR
1349H = FOUND EQU SYMOD+9H ;FOUND IF NZ FLAG
134CH = ENTER EQU SYMOD+0CH ;ENTER SYMBOL IN ACCUMULATOR
134FH = SETTY EQU SYMOD+0FH ;SET TYPE FIELD
1352H = GETTY EQU SYMOD+12H ;GET TYPE FIELD
1355H = SETVAL EQU SYMOD+15H ;SET VALUE FIELD
1358H = GETVAL EQU SYMOD+18H ;GET VALUE FIELD
;
15A6H = BGET EQU BMOD+6H ;BINARY SEARCH AND GET TYPE/VALUE PAIR
;
1863H = OPAND EQU OPMOD+3H ;GET OPERAND VALUE TO 'EVALUE'
1866H = MULP EQU OPMOD+6H ;MULT D,E BY H,L TO H,L
1869H = DIVP EQU OPMOD+9H ;DIVIDE HL BY DE, RESULT TO DE
;
; COMMON EQUATES
0078H = PBMAX EQU 120 ;MAX PRINT SIZE
010CH = PBUFF EQU 10CH ;PRINT BUFFER
0184H = PBP EQU PBUFF+PBMAX ;PRINT BUFFER POINTER
;
0185H = TOKEN EQU PBP+1 ;CURRENT TOKEN UNDER SCAN
0186H = VALUE EQU TOKEN+1 ;VALUE OF NUMBER IN BINARY
0188H = ACCLEN EQU VALUE+2 ;ACCUMULATOR LENGTH
0040H = ACMAX EQU 64 ;MAX ACCUMULATOR LENGTH

```

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```

0189H = ACCUM EQU ACCLEN+1
;
01C9H = EVALUE EQU ACCUM+ACMAX ;VALUE FROM EXPRESSION ANALYSIS
;
01CBH = SYTOP EQU EVALUE+2 ;CURRENT SYMBOL TOP
01CDH = SYMAX EQU SYTOP+2 ;MAX ADDRESS+1
;
01CFH = PASS EQU SYMAX+2 ;CURRENT PASS NUMBER
01D0H = FPC EQU PASS+1 ;FILL ADDRESS FOR NEXT HEX BYTE
01D2H = ASPC EQU FPC+2 ;ASSEMBLER'S PSEUDO PC
01D4H = SYBAS EQU ASPC+2 ;BASE OF SYMBOL TABLE
01D6H = SYADR EQU SYBAS+2 ;CURRENT SYMBOL ADDRESS
;
; GLOBAL EQUATES
0001H = IDEN EQU 1 ;IDENTIFIER
0002H = NUMB EQU 2 ;NUMBER
0003H = STRNG EQU 3 ;STRING
0004H = SPEC EQU 4 ;SPECIAL CHARACTER
;
0001H = PLABT EQU 0001B ;PROGRAM LABEL
0002H = DLABT EQU 0010B ;DATA LABEL
0004H = ECUT EQU 0100B ;EQUATE
0005H = SETT EQU 0101B ;SET
0006H = MACT EQU 0110B ;MACRO
;
0008H = EXTT EQU 1000B ;EXTERNAL
000BH = REFT EQU 1011B ;REFER
000CH = GLBT EQU 1100B ;GLOBAL
;
000DH = CR EQU 0DH ;CARRIAGE RETURN
000AH = LF EQU 0AH ;LINE FEED
001AH = EOF EQU 1AH ;END OF FILE
0310H = NBMAX EQU 16 ;STARTING POSITION OF PRINT LINE
;
;
0010H = RT EQU 16 ;REGISTER TYPE
0011H = PT EQU RT+1 ;PSEUDO OPERATION
0005H = PENDIF EQU 5 ;PSEUDO OPERATOR 'ENDIF'
0012H = OBASE EQU PT+1
0013H = O1 EQU OBASE+1 ;FIRST OPERATOR
0021H = O15 EQU OBASE+15 ;LAST OPERATOR
;
; MAIN STATEMENT PROCESSING LOOP
1BA0 AF XRA A
1BA1 32CF01 STA PASS ;SET TO PASS 0 INITIALLY
1BA4 CD4313 CALL INISY ;INITIALIZE THE SYMBOL TABLE
;
RESTART: CALL ;PASS LOOP GOES FROM 0 TO 1
INITI: CALL ;INITIALIZE THE SCANNER
SETUP: CALL SETUP ;SET UP THE INPUT FILE
LXI R,0

```

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```

1B33 22E820      SHLD  SYLAB  ;ASSUME NO STARTING LABEL
1B33 22D001      SHLD  FPC
1B26 22D201      SHLD  ASPC
1B39 22ED20      SHLD  EPC      ;END PC

;
SCNEXT:          ;SCAN THE NEXT INPUT ITEM
1B3C CD0611      CALL  SCAN
SCN0:            LDA  TOKEN
1B3F FE02        CPI   NUMB      ;SKIP LEADING NUMBERS FROM LINE EDITORS
1B42 CABC1B      JZ    SCNEXT
1B45 FE04        CPI   SPECL      ;MAY BE PROCESSOR TECH'S COMMENT
1B48 C2DD1B      JNZ   SCN1
;               SPECIAL CHARACTER, CHECK FOR *
1B4C 3A8901      LDA  ACCUM
1B4F FE2A        CPI   "*"
1B52 C2311F      JNZ   CHEND      ;END OF LINE IF NOT *
;               * FOUND, NO PRECEDING LABEL ALLOWED
1B54 CD0020      CALL  SETLA
1B57 C27C1F      JNZ   STERR      ;ERROR IF LABEL
1B5A C3521F      JMP   CHEN1      ;SCAN THE COMMENT OTHERWISE

;
SCN1:            ;NOT NUMBER OR SPECIAL CHARACTER, CHECK FOR IDENTIFIER
1B5D FE01        CPI   IDEN
1B60 C27C1F      JNZ   STERR      ;ERROR IF NOT
;
;               IDENTIFIER FOUND, MAY BE LABEL, OPCODE, OR MACRO
1B62 CDA615      CALL  BGET      ;BINARY SEARCH FIXED DATA
1B65 CA301C      JZ    CHKPT      ;CHECK FOR PSEUDO OR REAL OPERATOR
;
;               BINARY SEARCH WAS UNSUCCESSFUL, CHECK FOR MACRO
1B68 CD4613      CALL  LOOKUP
1B6B CD4913      CALL  FOUND
1B6E C2FE1B      JNZ   LFOUN      ;NZ FLAG SET IF FOUND
;
;               NOT FOUND, ENTER IT
1B71 CD4C13      CALL  ENTER      ;THIS MUST BE PASS
1B74 3ACF01      LDA  PASS
1B77 B7          ORA  A
1B7A C4D720      CNZ   ERRL      ;PHASE ERROR IF NOT
1B7D C30C1C      JMP   SETSY      ;SET SYLAB

;
;               ITEM WAS FOUND, CHECK FOR MACRO
1B7F CD5213      LFOUN: CALL  GETTY
1B82 FE06        CPI   MACT
1B85 C20C1C      JNZ   SETSY

;
;               MACRO DEFINITION FOUND, EXPAND MACRO
1B88 CDE320      CALL  ERRL      ;NOT CURRENTLY IMPLEMENTED
1B8B C3521F      JMP   CHEN1      ;SCANS TO END OF CURRENT LINE

```

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```

1C0C 2AEB20      LHL  SYLAB
1C0F 7D          MOV  A,L
1C10 B4          ORA  H
1C11 C40D20      CNZ   ERRL      ;LABEL ERROR IF NOT
1C14 2AD601      LHL  SYADR      ;ADDRESS OF SYMBOL
1C17 22EB20      SHLD SYLAB      ;MARK AS LABEL FOUND

```

```

1C1A CD0611      CALL  SCAN
1C1D 3A8501      LDA  TOKEN
1C20 FE04        CPI   SPECL
1C22 C20F1B      JNZ   SCN0      ;SKIP NEXT SCAN IF NOT SPECIAL
1C25 3A8901      LDA  ACCUM
1C28 FE3A        CPI   "*"
1C2A C20F1B      JNZ   SCN0
1C2D C30C1B      JMP   SCNEXT      ;TO IGNORE "*"

```

```

1C30 FE11        CPI   PT
1C32 C2D71D      JNZ   CHKOT

```

```

1C35 58          MOV  E,B      ;B HAS PARTICULAR OPERATOR NUMBER
1C36 1600        MVI  D,0      ;DOUBLE PRECISION VALUE TO D,E
1C38 1B          DCX  D      ;BIASED BY +1
1C39 21431C      LXI  H,PTTAB ;BASE OF JUMP TABLE
1C3C 19          DAD  D
1C3D 19          DAD  D
1C3E 5E          MOV  E,M
1C3F 23          INX  H
1C40 66          MOV  H,M
1C41 6B          MOV  L,E
1C42 E9          PCHL      ;JUMP INTO TABLE

```

```

1C43 5B1C        DW   SDB      ;DB
1C45 A91C        DW   SDS      ;DS
1C47 C01C        DW   SDW      ;DW
1C49 DE1C        DW   SEND     ;END
1C4B 151D        DW   SENDIF   ;ENDIF
1C4D 181D        DW   SENDM     ;ENDM
1C4F 1E1D        DW   SECU      ;EQU
1C51 401D        DW   SIF       ;IF
1C53 871D        DW   SMACRO    ;MACRO
1C55 8D1D        DW   SORG      ;ORG
1C57 A71D        DW   SSET      ;SET
1C59 CE1D        DW   STITLE     ;TITLE

```

```

SETSY: ;LABEL FOUND - IS IT THE ONLY ONE?
      LHL  SYLAB
      MOV  A,L
      ORA  H
      CNZ   ERRL      ;LABEL ERROR IF NOT
      LHL  SYADR      ;ADDRESS OF SYMBOL
      SHLD SYLAB      ;MARK AS LABEL FOUND

```

```

;               LABEL FOUND, SCAN OPTIONAL ":"
;               CALL  SCAN
;               LDA  TOKEN
;               CPI   SPECL
;               JNZ   SCN0      ;SKIP NEXT SCAN IF NOT SPECIAL
;               LDA  ACCUM
;               CPI   "*"
;               JNZ   SCN0
;               JMP   SCNEXT      ;TO IGNORE ":"

;               BINARY SEARCH FOUND SYMBOL, CHECK FOR PSEUDO OR REAL OP
CHKPT: CPI   PT
      JNZ   CHKOT

```

```

;               PSEUDO OPCODE FOUND, BRANCH TO CASES
      MOV  E,B      ;B HAS PARTICULAR OPERATOR NUMBER
      MVI  D,0      ;DOUBLE PRECISION VALUE TO D,E
      DCX  D      ;BIASED BY +1
      LXI  H,PTTAB ;BASE OF JUMP TABLE
      DAD  D
      DAD  D
      MOV  E,M
      INX  H
      MOV  H,M
      MOV  L,E
      PCHL      ;JUMP INTO TABLE

```

```

PTTAB: ;PSEUDO OPCODE JUMP TABLE
      DW   SDB      ;DB
      DW   SDS      ;DS
      DW   SDW      ;DW
      DW   SEND     ;END
      DW   SENDIF   ;ENDIF
      DW   SENDM     ;ENDM
      DW   SECU      ;EQU
      DW   SIF       ;IF
      DW   SMACRO    ;MACRO
      DW   SORG      ;ORG
      DW   SSET      ;SET
      DW   STITLE     ;TITLE

```

SDB:

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```

1C5B CD0A20      CALL    FILAB    ;SET LABEL FOR THIS LINE TO ASPC
SDB0:           CALL    SCAN     ;PAST DB TO NEXT ITEM
                LDA      TOKEN    ;LOOK FOR LONG STRING
1C61 3A8501      CPI      STRNG
1C64 FE93        JNZ      SDBC    ;SKIP IF NOT STRING
1C66 C29C1C      LDA      ACCLEN
1C69 3A8801      DCR      A       ;LENGTH 1 STRING?
1C6C 3D          JZ        SDBC
1C6D CA8C1C      ;
                ; LENGTH 0,2,... STRING
1C70 47          MOV      B,A
1C71 04          INR      B
1C72 04          INR      B
1C73 218901      LXI      H,ACCUM ;BECOMES 1,3,... FOR 0,2,... LENGTHS
1C76 05          DCR      B       ;ADDRESS CHARACTERS IN STRING
SDB1:           JZ        SDB2     ;COUNT DOWN TO ZERO
                PUSH     B        ;SCAN DELIMITER AT END OF STRING
1C7A C5          MOV      B,M     ;SAVE COUNT
1C7B 46          INX      H       ;GET CHARACTER
1C7C 23          PUSH     H
1C7D E5          CALL     FILHB   ;SAVE ACCUM POINTER
1C7E CD4820      POP      H       ;SEND TO HEX FILE
1C81 E1          POP      B
1C82 C1          POP      B
1C83 C3761C      JMP      SDB1
1C86 CD2611      CALL     SCAN    ;TO THE DELIMITER
1C89 C39B1C      JMP      SDB3
                ;
                ; NOT A LONG STRING
SDBC:           CALL     OPAND    ;COMPUTE OPERAND
                LHL      EVALUE  ;VALUE TO H,L
1C92 7C          MOV      A,H
1C93 87          ORA      A       ;HIGH ORDER MUST BE ZERO
1C94 45          MOV      B,L    ;GET LOW BYTE
1C98 CD4820      CALL     FILHB
SDB3:           ;END OF ITEM - UPDATE ASPC
                CALL     SETAS   ;SET ASPC TO FPC
1C9B CDF91F      CALL     DELIM
1C9E CDBA1E      CPI      ' '
1CA1 FE2C        JZ        SDB0   ;FOR ANOTHER ITEM
1CA3 CA5E1C      JMP      CHEND   ;CHECK END OF LINE SYNTAX
                ;
SDS:            CALL     FILAB   ;HANDLE LABEL IF IT OCCURRED
1CA9 CD3A20      CALL     PADD    ;PRINT ADDRESS
1CAC CDA620      CALL     EXP16   ;SCAN AND GET 16BIT OPERAND
1CAF CDD11E      XCHG          ;TO D,E
1CB2 EB          LHL      ASPC   ;CURRENT PSEUDO PC
1CB3 2AD201      DAD      D      ;+EXPRESSION
1CB6 19          SHLD     ASPC
1CB7 22D201

```

```

1CBA 22D001
1CBD C3311F

```

```
1CC0 CD0A20
```

```

1CC3 CDD11E
1CC6 E5
1CC7 45
1CC8 CD4820
1CCB E1
1CCC 44
1CCD CD4820
1CD0 CDF91F
1CD3 CDBA1E
1CD6 FE2C
1CD8 CAC31C
1CDB C3311F

```

```

1CDE CD0A20
1CE1 CDA620
1CE4 3A0C01
1CE7 FE20
1CE9 C2311F
1CEC CDD11E
1CEF 3A0C01
1CF2 FE20
1CF4 C2FA1C
1CF7 22ED20
1CFA 3E20
1CFC 320C01
1CFF CD0611
1D02 3A8501
1D05 FE04
1D07 C27C1F
1D0A 3A8901
1D0D FE0A
1D0F C27C1F
1D12 C36B1F

```

```
1D15 C3D11D
```

```

1D18 CDE320
1D1B C3D11D

```

```
1D1E CD0020
```

```

SHLD    FPC    ;NEXT TO FILL
JMP     CHEND

```

```

; SDW:
SDW0:   CALL    FILAB    ;HANDLE OPTIONAL LABEL

```

```

CALL     EXP16   ;GET 16BIT OPERAND
PUSH     H       ;SAVE A COPY
MOV      B,L     ;LOW BYTE FIRST
CALL     FILHB   ;SEND LOW BYTE
POP      H       ;RECLAIM A COPY
MOV      B,H     ;HIGH BYTE NEXT
CALL     FILHB   ;SEND HIGH BYTE
CALL     SETAS   ;SET ASPC=FPC
CALL     DELIM   ;CHECK DELIMITER SYNTAX
CPI      ' '
JZ        SDW0   ;GET MORE DATA
JMP      CHEND

```

```

; SEND:
CALL     FILAB
CALL     PADD    ;WRITE LAST LOC
LDA      PBUFF
CPI      CHEND
JNZ      CHEND
CALL     EXP16   ;GET EXPRESSION IF IT'S THERE
LDA      PBUFF
CPI      ' '
JNZ      SEND0
SHLD     EPC

```

```

SEND0:   MVI      A,' '
STA      PBUFF   ;EXPRESSION FOUND, STORE IT FOR LATER
CALL     SCAN    ;CLEAR ERROR, IF IT OCCURRED
LDA      TOKEN
CPI      SPECL
JNZ      STERR
LDA      ACCUM
CPI      LF
JNZ      STERR
JMP      ENDAS   ;END OF ASSEMBLER

```

```

; SENDIF:
JMP      POEND

```

```

; SENDM:
CALL     ERRN
JMP      POEND

```

```

; SEQU:
CALL     SETLA

```

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```

1D21 CA7C1F      JZ      STERR      ;MUST BE A LABEL
1D24 2AD201      LHLD     ASPC      ;HOLD TEMP ASPC
1D27 E5          PUSH     H          ;IN STACK
1D28 CDD11E      CALL     EXP16     ;GET 16BIT OPERAND
1C2B 22D201      SHLD     ASPC      ;VALUE OF EXPRESSION
1D2E C09A20      CALL     FILAB     ;
1D31 CDA920      CALL     PADDR     ;COMPUTED VALUE
1D34 211201      LXI      H,PBUFF+6 ;SPACE AFTER VALUE
1D37 363D        MVI      M," "
1D39 E1          POP      H          ;REAL ASPC
1D3A 22D201      SHLD     ASPC      ;CHANGE BACK
1D3D C3311F      JMP      CHEND

```

```

;
;SIF:
CALL     FILAB     ;IN CASE OF LABEL
CALL     EXP16     ;GET IF EXPRESSION
LDA      PBUFF
CPI
JNZ      CHEND     ;SKIP IF ERROR
MOV      A,L       ;GET LSB
RAR
JC        CHEND     ;TRUE IF CARRY BIT SET

```

```

;
;SIF0:
CALL     SCAN
LDA      TOKEN
CPI      SPECL
JNZ      SIF1
LDA      ACCUM
CPI      EOF
MVI      A,"B"     ;BALANCE ERROR
CZ      PERR
JZ      ENDAS
JMP      SIF0      ;FOR ANOTHER
;NOT A SPECIAL CHARACTER
SIF1:
CPI      IDEN
JNZ      SIF0      ;NOT AN IDENTIFIER
CALL     BGET      ;LOOK FOR ENDIF
JNZ      SIF0      ;NOT FOUND
CPI      PT        ;PSEUDO OP?
JNZ      SIF0
MOV      A,B       ;GET OPERATOR NUMBER
CPI      PENDIF    ;ENDIF?
JNZ      SIF0      ;GET ANOTHER TOKEN
JMP      POEND     ;OK, CHECK END OF LINE

```

```

;
;SMACRO:
CALL     ERRN
JMP      CHEND
;

```

```

1D8D CDD11E
1D90 3A0C01
1D93 FE20
1D95 C2311F
1D98 22D201
1D9B 22D001
1D9E CDDA20
1DA1 CDA620
1DA4 C3311F

```

```

SORG:
CALL     EXP16
LDA      PBUFF
CPI
JNZ      CHEND     ;SKIP ORG IF ERROR
SHLD     ASPC      ;CHANGE PC
SHLD     FPC        ;CHANGE NEXT TO FICP/M VERSION
CALL     FILAB     ;IN CASE OF LABEL
CALL     PADR
JMP      CHEND

```

```

;
;SSET:
CALL     SETLA
JZ      STERR      ;MUST BE LABELLED

```

```

;
CALL     GETTY
CPI      SETT
CNZ      ERRL      ;LABEL ERROR
MVI      A,SETT
CALL     SETTY     ;REPLACE TYPE WITH 'SET'
CALL     EXP16     ;GET THE EXPRESSION
PUSH     H          ;SAVE IT
CALL     SETLA     ;RE-ADDRESS LABEL
POP      H          ;RECLAIM IT
CALL     SETVAL
LXI      H,0
SHLD     SYLAB     ;PREVENT LABEL PROCESSING
JMP      CHEND

```

```

;
;STITLE:
CALL     ERRN      ;NOT IMPLEMENTED

```

```

;
;POEND: ;PSEUDO OPERATOR END - SCAN TO NEXT TOKEN
CALL     SCAN
JMP      CHEND

```

```

;
;NOT A PSEUDO OPCODE, CHECK FOR REAL OPCODE
CHKOT: SUI      01      ;BASE OF OPCODES
CPI      015         ;PAST LAST OPCODE?
JNC      STERR      ;STATEMENT ERROR IF SO

```

```

;
;FOUND OPCODE, COMPUTE INDEX INTO TABLE AND JUMP TO CASE
MOV      E,A
MVI      D,0
LXI      H,OPTAB
DAD      D
DAD      D
MOV      E,M
INX      H

```

```

1DA7 CD0020
1DAA CA7C1F

```

```

1DAD CD5213
1DB0 FE05
1DB2 C4DD20
1DB5 3E05
1DB7 CD4F13
1DBA CDD11E
1DBD E5
1DBE CD0020
1DC1 E1
1DC2 CD5513
1DC5 210000
1DC8 22EB20
1DCB C3311F

```

```

1DCE CDE320

```

```

1DD1 CD0611
1DD4 C3311F

```

```

1DD7 D613
1DD9 FE21
1DDB D27C1F

```

```

1DDE 5F
1DDF 1600
1DE1 21EB1D
1DE4 19
1DE5 19
1DE6 5E
1DE7 23

```

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```

1DE8 66      MOV      H,M
1DE9 6B      MOV      L,E
1DEA E9      PCHL      ;JUMP TO CASE

```

```

;OPTAB: ;OPCODE CATEGORIES
1DEB 091E    DW      SSIMP ;SIMPLE
1DED 121E    DW      SLXI  ;LXI
1DEF 1E1E    DW      SDAD   ;DAD
1DF1 241E    DW      SPUSH  ;PUSH/POP
1DF3 381E    DW      SJMP   ;JMP/CALL
1DF5 411E    DW      SMOV   ;MOV
1DF7 501E    DW      SMVI   ;MVI
1DF9 601E    DW      SACCI  ;ACCUM IMMEDIATE
1DFB 691E    DW      SLDAX  ;LDAX/STAX
1DFD 781E    DW      SLHLD  ;LHLD/SHLD/LDA/STA
1DF7 811E    DW      SACCR  ;ACCUM-REGISTER
1E01 881E    DW      SINC   ;INC/DCR
1E03 8F1E    DW      SINX   ;INX/DCX
1E05 9E1E    DW      SKST   ;RESTART
1E07 A51E    DW      SIN     ;IN/OUT

```

```

;SSIMP: ;SIMPLE OPERATION CODES
1E09 CD4820  CALL    FILHB ;SEND HEX VALUE TO MACHINE CODE FILE
1E0C CD0611  CALL    SCAN  ;TO NEXT TOKEN
1E0F C3B11E  JMP      INCPC

```

```

;SLXI: ;LXI H,16B
1E12 CDFC1E  CALL    SHDREG ;SCAN DOUBLE PRECISION REGISTER
1E15 CD171F  CALL    CHCOM  ;CHECK FOR COMMA FOLLOWING REGISTER
1E18 CD111F  CALL    SETADR ;SCAN AND EMIT DOUBLE PRECISION OPERAND
1E1B C3B11E  JMP      INCPC

```

```

;SDAD: ;DAD B
1E1E CDFC1E  CALL    SHDREG ;SCAN AND EMIT DOUBLE PRECISION REGISTER
1E21 C3B11E  JMP      INCPC

```

```

;SPUSH: ;PUSH B POP D
1E24 CDF21E  CALL    SHREG  ;SCAN SINGLE PRECISION REGISTER TO A
1E27 FE38    CPI      111000B ;MAY BE PSW
1E29 CA311E  JZ       SPU8

```

```

;NOT PSW, MUST BE B,D, OR H
1E2C E608    ANI      001000B ;LOW BIT MUST BE 0
1E2E C43D20  CNZ      ERRR   ;REGISTER ERROR IF NOT
1E31 79      MOV      A,C    ;RECALL REGISTER AND MASK IN CASE OF ERROR
1E32 E630    ANI      110000B ;MASK IN OPCODE FOR PUSH OR POP
1E34 B930    ORA      110000B ;MASK IN OPCODE
1E35 C3AE1E  JMP      FILINC ;FILL HEX VALUE AND INCREMENT PC

```

```

;SJMP: ;JMP 16B/ CALL 16B
1E38 CD4820  CALL    FILHB ;EMIT JMP OR CALL OPCODE

```

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```

1E3B CD111F  CALL    SETADR ;EMIT 16BIT OPERAND
1E3E C3B11E  JMP      INCPC

```

```

;SMOV: ;MOV A,B
1E41 CDF21E  CALL    SHREG
1E44 B0      ORA      B      ;MASK IN OPCODE
1E45 47      MOV      B,A    ;SAVE IN B TEMPORARILY
1E46 CD171F  CALL    CHCOM  ;MUST BE COMMA SEPARATOR
1E49 CDE71E  CALL    EXP3   ;VALUE MUST BE 0-7
1E4C B0      ORA      B      ;MASK IN OPCODE
1E4D C3AE1E  JMP      FILINC

```

```

;SMVI: ;MVI A,8B
1E50 CDF21E  CALL    SHREG
1E53 B0      ORA      B      ;MASK IN OPCODE
1E54 CD4720  CALL    FILHEX ;EMIT OPCODE
1E57 CD171F  CALL    CHCOM  ;SCAN COMMA
1E5A CD081F  CALL    SETBYTE ;EMIT 8BIT VALUE
1E5D C3B11E  JMP      INCPC

```

```

;SACCI: ;ADI 8B
1E60 CD4820  CALL    FILHB ;EMIT IMMEDIATE OPCODE
1E63 CD081F  CALL    SETBYTE ;EMIT 8BIT OPERAND
1E66 C3B11E  JMP      INCPC

```

```

;SLDAX: ;LDAX B/STAX D
1E69 CDF21E  CALL    SHREG
1E6C E628    ANI      101000B ;MUST BE B OR D
1E6E C4BD20  CNZ      ERRR   ;REGISTER ERROR IF NOT
1E71 79      MOV      A,C    ;RECOVER REGISTER NUMBER
1E72 E610    ANI      010000B ;CHANGE TO B OR D IF ERROR
1E74 B0      ORA      B      ;MASK IN OPCODE
1E75 C3AE1E  JMP      FILINC ;EMIT OPCODE

```

```

;SLHLD: ;LHLD 16B/ SHLD 16B/ LDA 16B/ STA 16B
1E78 CD4820  CALL    FILHB ;EMIT OPCODE
1E7B CD111F  CALL    SETADR ;EMIT OPERAND
1E7E C3B11E  JMP      INCPC

```

```

;SACCR: ;ADD B
1E81 CDE71E  CALL    EXP3   ;RIGHT ADJUSTED 3BIT VALUE FOR REGISTER
1E84 B0      ORA      B      ;MASK IN OPCODE
1E85 C3AE1E  JMP      FILINC

```

```

;SINC: ;INR B/DCR D
1E88 CDF21E  CALL    SHREG  ;GET REGISTER
1E8B B0      ORA      B
1E8C C3AE1E  JMP      FILINC

```

```

;SINX: ;INX H/DCX B

```

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```

1E8F CDF21E      CALL  SHREG
1E92 E608        ANI    001000B ;MUST BE B D M OR SP
1E94 C4BD20      CNZ    ERRR    ;REGISTER ERROR IF NOT
1E97 79          MOV     A,C    ;RECOVER REGISTER
1E98 E630        ANI    110000B ;IN CASE OF ERROR
1E9A B0          ORA     B      ;MASK IN OPCODE
1E9B C3AE1E      JMP     FILINC

```

```

;SRST: ;RESTART 4
1E9E CDF21E      CALL  SHREG ;VALUE IS 0-7
1EA1 B0          ORA     B      ;OPCODE MASKED
1EA2 C3AE1E      JMP     FILINC

```

```

;SIN: ;IN 8B/OUT 8B
1EA5 CD4820      CALL  FILHB ;EMIT OPCODE
1EA8 CD831F      CALL  SETBYTE ;EMIT 8BIT OPERAND
1EAB C3B11E      JMP     INCP

```

```

;FILINC: ;FILL HEX VALUE FROM A BEFORE INCREMENTING PC
1EAE CD4720      CALL  FILHEX

```

```

;INCP: ;CHANGE ASSEMBLER'S PSEUDO PROGRAM COUNTER
1EB1 CD0A20      CALL  FILAB ;SET ANY LABELS WHICH OCCUR ON THE LINE
1EB4 CDF91F      CALL  SETAS ;ASPC=FPC
1EB7 C3311F      JMP     CHEND ;END OF LINE SCAN

```

UTILITY SUBROUTINES FOR OPERATION CODES

DELIM: ;CHECK DELIMITER SYNTAX FOR DATA STATEMENTS

```

1EBA 3A8501      LDA     TOKEN
1EBD FE34        CPI     SPECL
1EBF C4D120      CNZ    ERRD
1EC2 3A8901      LDA     ACCUM
1EC5 FE2C        CPI     ' '
1EC7 C8          RZ
1EC8 FE3B        CPI     ' '
1ECA C8          RZ
1ECB FE8D        CPI     CR
1ECD C4D120      CNZ    ERRD
1ED8 C9          RET

```

```

;EXP16: ;GET 16BIT VALUE TO H,L
1ED1 C5          PUSH    B
1ED2 CD8611      CALL  SCAN ;START SCANNING OPERAND FIELD
1ED5 CD6318      CALL  OPAND
1ED8 2AC901      LHL    EVALUE ;VALUE TO H,L
1EDB C1          POP     B
1EDC C9          RET

```

```

1EDD CDD11E      ;GET 8BIT VALUE TO REG A
1EE0 7C          CALL  EXP16
1EE1 B7          MOV     A,H
1EE2 C4C720      ORA     A
1EE5 7D          CNZ    ERRV ;VALUE ERROR IF HIGH BYTE NOT ZERO
1EE6 C9          MOV     A,L
1EE6 C9          RET

```

```

;EXP3: ;GET 3BIT VALUE TO REG A
1EE7 CDDD1E      CALL  EXP8
1EEA FE08        CPI     8
1EEC D4C720      CNC    ERRV ;VALUE ERROR IF >=8
1EEF E607        ANI    111B ;REDUCE IF ERROR OCCURS
1EF1 C9          RET

```

```

;SHREG: ;GET 3BIT VALUE AND SHIFT LEFT BY 3
1EF2 CDE71E      CALL  EXP3
1EF5 17          RAL
1EF6 17          RAL
1EF7 17          RAL
1EF8 E638        ANI    111000B
1EFA 4F          MOV     C,A ;COPY TO C
1EF8 C9          RET

```

```

;SHDREG: ;GET DOUBLE REGISTER TO A
1EFC CDF21E      CALL  SHREG
1EFF E608        ANI    001000B ;CHECK FOR A,C,E, OR L
1F01 C4BD20      CNZ    ERRR ;REGISTER ERROR
1F04 79          MOV     A,C ;RECOVER REGISTER
1F05 E630        ANI    110000B ;FIX IT IF ERROR OCCURRED
1F07 B0          ORA     B ;MASK OPCODE
1F08 C34720      JMP     FILHEX ;EMIT IT

```

```

;SETBYTE: ;EMIT 16BIT OPERAND
1F0B CDDD1E      CALL  EXP8
1F0E C34720      JMP     FILHEX

```

```

;SETADR: ;EMIT 16BIT OPERAND
1F11 CDD11E      CALL  EXP16
1F14 C37420      JMP     FILADR

```

```

;CHCOM: ;CHECK FOR COMMA FOLLOWING EXPRESSION
1F17 F5          PUSH    PSW
1F18 C5          PUSH    B
1F19 3A8501      LDA     TOKEN
1F1C FE04        CPI     SPECL
1F1E C2291F      JNZ    COMER
1F21 3A8901      LDA     SPECIAL CHARACTER, CHECK FOR COMMA
1F24 FE2C        CPI     ' '

```

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1F26 CA2E1F JZ COMRET ;RETURN IF COMMA FOUND

COMER: ;COMMA ERROR
MVI A, 'C'
CALL PERR

COMRET:
POP B
POP PSW
RET

1F2E C1
1F2F F1
1F30 C9

;CHEND: ;END OF LINE CHECK
CALL FILAB ;IN CASE OF A LABEL
LDA TOKEN
CPI SPECL
JNZ STERR ;MUST BE A SPECIAL CHARACTER
LDA ACCUM
CPI CR ;CARRIAGE RETURN
JNZ CHEN0
;CARRIAGE RETURN FOUND, SCAN PICKS UP LF AND PUSHES LINE
CALL SCAN
JMP SCNEXT

;CHEN0: ;NOT CR, CHECK FOR COMMENT
CPI ;
JNZ CHEN2
CALL FILAB ;IN CASE LABELLED EMPTY LINE
;CLEAR COMMENT TO END OF LINE

;CHEN1: CALL SCAN
LDA TOKEN
CPI SPECL
JNZ CHEN1
LDA ACCUM
CPI LF
JZ SCNEXT
CPI EOF
JZ ENDAS ;END OF ASSEMBLY IF EOF
CPI ;
JZ SCNEXT ;LOGICAL END OF LINE
JMP CHEN1 ;NONE OF THE ABOVE

;NOT CR OR LF, MAY BE LOGICAL END OF LINE
;CHEN2: CPI ;
JZ SCNEXT
CPI EOF
JZ ENDAS

;STATEMENT ERROR IN OPERAND FIELD
STERR: MVI A, 'S'
CALL PERR
JMP CHEN1 ;TO DUMP LINE

1F4A FE3B
1F4C C2721F
1F4F CDA20

1F52 CD0611
1F55 3A8501
1F58 FE74
1F5A C2521F
1F5D 3A8901
1F60 FE0A
1F62 CA9C1B
1F65 FE1A
1F67 CA8B1F
1F6A FE21
1F6C CA9C1B
1F6F C3521F

1F72 FE21
1F74 CA9C1B
1F77 FE1A
1F79 CA9B1F

1F7C 3E53
1F7E CD1802
1F81 C3521F

1F84 7B
1F85 95
1F86 6F
1F87 7A
1F88 9C
1F89 67
1F8A C9

1F8B 21CF01
1F8E 7E
1F8F 34
1F90 B7
1F91 CAA71B
1F94 CD0611
1F97 CDA620
1F9A 211101
1F9D 3600
1F9F 210D01
1FA2 CD1202

1FA5 2ACB01
1FA8 E0
1FA9 2AD401
1FAC CD841F
1FAF E5
1FB0 2ACD01
1FB3 E0
1FB4 2AD401
1FB7 CD841F
1FBA 5C
1FBB 1600
1FBD E1
1FBE CD6918
1FC1 E0
1FC2 CDA920
1FC5 211101
1FC8 11D61F
1FCB 1A
1FCC B7
1FCD CAE41F
1FD0 77
1FD1 23
1FD2 13
1FD3 C3CB1F

1FD6 482055345MSG: DB 'H USE FACTOR',CR,0

DIFF: ;COMPUTE DE-HL TO HL

MOV A,E
SUB L
MOV L,A
MOV A,D
SBB H
MOV H,A
RET

;ENDAS: ;END OF ASSEMBLY FOR THIS PASS

LXI H,PASS
MOV A,M
INR M ;PASS NUMBER INCREMENTED
ORA A
JZ RESTART
CALL SCAN ;TO CLEAR LAST LINE FEED
CALL PADD ;WRITE LAST ADDRESS
LXI H,PBUFF+5
MVI M,CR ;SET TO CR FOR END OF MESSAGE
LXI H,PBUFF+1
CALL PCON ;PRINT LAST ADDRESS

;COMPUTE REMAINING SPACE

LHLD SYTOP
XCHG
LHLD SYBAS
CALL DIFF ;DIFFERENCE TO H,L
PUSH H ;SYTOP-SYBAS TO STACK
LHLD SYMAX
XCHG
LHLD SYBAS
CALL DIFF ;SYMAX-SYBAS TO H,L
MOV E,H
MVI D,0 ;DIVIDED BY 256
POP H ;SYTOP-SYBAS TO H,L
CALL DIVF ;RESULT TO DE
XCHG
CALL PADDR ;PRINT H,L TO PBUFF
LXI H,PBUFF+5 ;MESSAGE
LXI D,MSG ;END MESSAGE

ENDAS: LDAX D
ORA A ;ZERO?
JZ ENDA1
MOV M,A
INX H
INX D
JMP ENDA0

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```

1FE4 21E001  ENDAL: LXI    H, PBUFF+2      ;BEGINNING OF RATIO
1FE7 CD1202  CALL    PCON
1FEA 2AED20  LHL    EPC
1FED 22D001  SHLD   FPC      ;END PROGRAM COUNTER
1FF0 C31E02  JMP     EOR

```

```

1FF3 7A      ;
1FF4 BC      ;
1FF5 C0      ;
1FF6 7B      ;
1FF7 BD      ;
1FF8 C9      ;

```

```

1FF9 2AD001  SETAS: ;ASPC=FPC
1FFC 22D201  LHL    FPC
1FFF C9      SHLD   ASPC

```

```

2000 2AEB20  SETLA: ;SYADR=SYLAB, FOLLOWED BY CHECK FOR ZERO
2003 22D601  LHL    SYLAB
2006 CD4913  SHLD   SYADR
2009 C9      CALL    FOUND

```

```

200A CD0200  FILAB: ;FILL LABEL VALUE WITH CURRENT ASPC, IF LABEL FOUND
200D C8      CALL    SETLA

```

```

200E 21E000  RZ      ;RETURN IF NO LABEL DETECTED
2011 22E320  ;
2014 3ACF01  LABEL FOUND, MUST BE DEFINED ON PASS-1
2017 B7      SHLD   SYLAB ;TO MARK NEXT STATEMENT WITH NO LABEL
2018 C23120  LDA     PASS

```

```

201B CD5213  JNZ     FIL1
201E F5      ;
201F E607    ;
2021 C4DD20  ;
2024 F1      ;
2025 F601    ;
2027 CD4F13  ;
202A 2AD201  ;
202D CD5513  ;
2030 C9      ;

```

```

FIL1: ;CHECK FOR DEFINED VALUE

```

```

2031 CD5213
2034 E607
2036 CCD720

```

```

2039 CD5813
203C E8
203D 2AD201
2040 CDF31F
2043 C4D720
2046 C9

```

```

2047 47
2048 3ACF01
204B B7
204C 78
204D CA6C20

```

```

2050 C5
2051 CD1B02

```

```

2054 3A0D01
2057 FE20
2059 2AD201
205C CCA920

```

```

205F 3AEF20
2062 FE10
2064 C1
2065 D26C20

```

```

2068 78
2069 CD9620
206C 2AD001
206F 23
2070 22D001
2073 C9

```

```

2074 E5
2075 45
2076 CD4820
2079 E1
207A 44
207B C34820

```

```

207E C630

```

```

CALL    GETTY
ANI     111B
CZ      ERRP      ;PHASE ERROR
GET VAL AND COMPARE WITH ASPC
CALL    GETVAL    ;TO H,L
XCHG
LHL     ASPC
CALL    COMDH
CNZ     ERRP      ;PHASE ERROR IF NOT THE SAME
RET

```

```

;
FILHEX: ;WRITE HEX BYTE IN REGISTER A TO MACHINE CODE FILE IF PASS
;
FILHB:  LDA     PASS
        ORA     A
        MOV     A,B
        JZ      FILHI

```

```

;
PASS - 1, WRITE HEX AND PRINT DATA
PUSH    B      ;SAVE A COPY
CALL    DHEX    ;INTO MACHINE CODE FILE
MAY BE COMPLETELY EMPTY LINE, SO CHECK ADDRESS
LDA     PBUFF+1
CPI
LHL     ASPC
CZ      PADDR    ;PRINT ADDRESS FIELD

```

```

;
LDA     NBP
CPI     NBMAX    ;TRUNCATE CODE IF TOO MUCH ON THIS LINE
POP     B        ;RECALL HEX DIGIT
JNC     FILHI
ROOM FOR DIGIT ON THIS LINE
MOV     A,B
CALL    WHHEXB   ;WRITE HEX BYTE TO PRINT LINE
FILHI:  LHL     FPC
        INX     H
        SHLD    FPC ;READY FOR NEXT BYTE
        RET

```

```

;
FILADR: ;EMIT DOUBLE PRECISION VALUE FROM H,L
        PUSH    H      ;SAVE A COPY
        MOV     B,L
        CALL    FILHB  ;LOW BYTE EMITTED
        POP     H      ;RECOVER A COPY OF H,L
        MOV     B,H
        JMP     FILHB  ;EMIT HIGH BYTE AND RETURN

```

```

;
CHEX:   ;UTILITY FUNCTIONS FOR PRINTING HEX ADDRESSES AND DATA
        ;CONVERT TO HEX
        ADI     '0'

```

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```

2080 FE3A      CPI      '0'+10
2082 D8        RC
2083 C607      ADI      'A'-'0'-10
2085 C9        RET

;
WHEXN: ;WRITE HEX NIBBLE
CALL CHEX      ;CONVERT TO ASCII FROM HEX
LXI H,NBP
MOV E,M        ;NEXT POSITION TO PRINT
MVI D,0        ;DOUBLE PRECISION
INR M          ;NBP=NBP+1
LXI H,PBUFF
DAD D
MOV M,A        ;STORE IN PRINT BUFFER
RET

;
WHEXB: ;WRITE HEX BYTE TO PRINT BUFFER
PUSH PSW
RAR
RAR
RAR
RAR
ANI 0FH        ;HIGH ORDER NIBBLE NORMALIZE IN A
CALL WHEXN     ;WRITE IT
POP PSW
ANI 0FH
JMP WHEXN      ;WRITE AND RETURN

;
PADD: LHL      ASPC
PADDR: ;PRINT ADDRESS FIELD OF PRINT LINE FROM H,L
XCHG
LXI H,NBP      ;INITIALIZE NEXT TO FILL
MVI M,D        ;PRINT HIGH BYTE NBP'S ADDRESS
PUSH D          ;SAVE A COPY
CALL WHEXB
POP D
MOV A,E
CALL WHEXB
POP H           ;ADDRESSING NBP
INR M          ;SKIP A SPACE AFTER ADDRESS FIELD
RET

;
ERRR: ;EMIT REGISTER ERROR
PUSH PSW
PUSH B
MVI A,'R'
CALL PERR
POP B

```

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```

20C5 F1      POP      PSW
20C6 C9      RET

;
ERRV: ;EMIT VALUE ERROR
PUSH PSW
PUSH H
MVI A,'V'
CALL PERR
POP H
POP PSW
RET

;
ERRD: PUSH PSW
MVI A,'D' ;DATA ERROR
JMP ERR

;
ERRP: PUSH PSW
MVI A,'P'
JMP ERR

;
ERRL: PUSH PSW
MVI A,'L' ;LABEL ERROR
JMP ERR

;
ERRN: PUSH PSW
MVI A,'N' ;NOT IMPLEMENTED

;
ERR: CALL PERR
POP PSW
RET

;
SYLAB: DS 2 ;ADDRESS OF LINE LABEL
EPC: DS 2 ;END PC VALUE
NBP: DS 1 ;NEXT BYTE POSITION TO WRITE FOR MACHINE CODE
END

```

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