

DIGITAL RESEARCH

Post Office Box 579, Pacific Grove, California 93950, (408) 373-3403

MDS BASIC I/O SYSTEM (BIOS)

CP/M VERSION _____

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SER. # _____

BIOS

MDS I/O DRIVERS FOR CP/M
 VERSION 1.3 OCTOBER, 1976
 EQU 000H ;FOR RELOCATION

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1500 C34415
 1503 C35415
 1506 C3F815
 1509 C3F815
 150C C30116
 150F C31716
 1512 C31A16
 1515 C31D16
 1518 C32016
 151B C32516
 151E C33B16
 1521 C34016
 1524 C34516
 1527 C34816
 152A C35416

JUMP VECTOR FOR INDIVIDUAL ROUTINES
 WBOOTE.
 JMP BOOT
 JMP WBOOT
 JMP CONST
 JMP CONIN
 JMP CONOUT
 JMP LIST
 JMP PUNCH
 JMP PEADER
 JMP HOME
 JMP SELDSK
 JMP SETTRK
 JMP SETSEC
 JMP SETDMA
 JMP READ
 JMP WRITE

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0000 =

BIAS

0000 =
 1500 =

VEPS EQU 13 ;CPM VERSION NUMBER
 PATCH EQU 1500H+BIAS

1500
 0000 =
 0000 =
 1500 =
 0024 =
 0000 =
 0002 =
 0004 =
 0000 =
 0004 =

ORG PATCH
 CPMB EQU 000H+BIAS ;BASE OF CPM CONSOLE PROCESSOR
 BDOS EQU 900H+BIAS ;BASIC DOS (RESIDENT PORTION)
 CPML EQU 1-CPMB ;LENGTH (IN BYTES) OF CPM SYSTEM
 NSECTS EQU CPML/120 ;NUMBER OF SECTORS TO LOAD
 LBIAS EQU 900H-CPMB ;LOADER BIAS VALUE USED IN SYSGEN
 OFFSET EQU 2 ;NUMBER OF DISK TRACKS USED BY CP/M
 DISKA EQU 04H ;ADDRESS OF LAST LOGGED DISK ON WARM START
 BUFF EQU 00H ;DEFAULT BUFFER ADDRESS
 RETRY EQU 10 ;MAX RETRIES ON DISK I/O BEFORE ERROR

PERFORM FOLLOWING FUNCTIONS

BOOT COLD START
 WBOOT WARM START (SAVE I/O BYTE)
 (BOOT AND WBOOT ARE THE SAME FOR MDS)
 CONST CONSOLE STATUS
 REG-A = 00 IF NO CHARACTER READY
 REG-A = FF IF CHARACTER READY
 CONIN CONSOLE CHARACTER IN (RESULT IN REG-A)
 CONOUT CONSOLE CHARACTER OUT (CHAR IN REG-C)
 LIST LIST OUT (CHAR IN REG-C)
 PUNCH PUNCH OUT (CHAR IN REG-C)
 READER PAPER TAPE READER IN (RESULT TO REG-A)
 HOME MOVE TO TRACK 00

(THE FOLLOWING CALLS SET-UP THE IO PARAMETER BLOCK FOR THE
 MDS, WHICH IS USED TO PERFORM SUBSEQUENT READS AND WRITES)
 SELDSK SELECT DISK GIVEN BY REG-C (0,1,2...)
 SETTRK SET TRACK ADDRESS (0...76) FOR SUBSEQUENT READ/WRITE
 SETSEC SET SECTOR ADDRESS (1...26) FOR SUBSEQUENT READ/WRITE
 SETDMA SET SUBSEQUENT DMA ADDRESS (INITIALLY 00H)

(READ AND WRITE ASSUME PREVIOUS CALLS TO SET UP THE IO PARAMETER
 READ READ TRACK/SECTOR TO PRESET DMA ADDRESS
 WRITE WRITE TRACK/SECTOR FROM PRESET DMA ADDRESS

08>
 09>
 10>

END OF CONTROLLER - INDEPENDENT CODE, THE REMAINING SUBROUTINES
 ARE TAILORED TO THE PARTICULAR OPERATING ENVIRONMENT, AND MUST
 BE ALTERED FOR ANY SYSTEM WHICH DIFFERS FROM THE INTEL MDS.

THE FOLLOWING CODE ASSUMES THE MDS MONITOR EXISTS AT 0F000H
 AND USES THE I/O SUBROUTINES WITHIN THE MONITOR

WE ALSO ASSUME THE MDS SYSTEM HAS TWO DISK DRIVES AVAILABLE
 NDISKS EQU 2 ;NUMBER OF DRIVES AVAILABLE
 REVRT EQU 0FDH ;INTERRUPT REVEPT PORT
 INTC EQU 0FC0H ;INTERRUPT MASK PORT
 ICON EQU 0F3H ;INTERRUPT CONTROL PORT
 INTE EQU 0111#11100 ;ENABLE RST 0(WARM BOOT), RST 7 (MDS)

MDS MONITOR EQUATES

MON00 EQU 0F000H ;MDS MONITOR
 RMON00 EQU 0FF0FH ;RESTART MON00 (DISK SELECT ERROR)
 CI EQU 0F003H ;CONSOLE CHARACTER TO REG-A
 RI EQU 0F006H ;READER IN TO REG-A
 CO EQU 0F007H ;CONSOLE CHAR FROM C TO CONSOLE OUT
 PO EQU 0F00CH ;PUNCH CHAR FROM C TO PUNCH DEVICE
 LO EQU 0F00FH ;LIST FROM C TO LIST DEVICE
 CSTS EQU 0F012H ;CONSOLE STATUS 00/FF TO REGISTER A

DISK PORTS AND COMMANDS

BASE EQU 70H ;BASE OF DISK COMMAND IO PORTS
 DSTAT EQU BASE ;DISK STATUS (INPUT)
 RTYPE EQU BASE+1 ;RESULT TYPE (INPUT)
 RBYTE EQU BASE+3 ;RESULT BYTE (INPUT)
 LOW EQU BASE+1 ;IOPB LOW ADDRESS (OUTPUT)
 HIGH EQU BASE+2 ;IOPB HIGH ADDRESS (OUTPUT)
 READF EQU 4H ;READ FUNCTION
 WRITF EQU 6H ;WRITE FUNCTION
 RECAL EQU 3H ;RECALIBRATE DRIVE
 IORDY EQU 4H ;I/O FINISHED MASK
 CR EQU 0DH ;CARRIAGE RETURN
 LF EQU 0AH ;LINE FEED

SIGNON ;SIGNON MESSAGE, XXX CP/M VERS Y.Y

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1> 1520 0D0A0A DB CR,LF,LF
2> 1530 3030402043 DB '80K CP/M VERS '
3> 153E 312E33 DB VERS/10+'0',',',VERS MOD 10+'0'
4> 1541 0D0A00 DB CR,LF,0
5>
6>
7> 1544 310001 BCOT. ;PRINT SIGNON MESSAGE AND GO TO DOS
8> 1547 212D15 LXI SP,BUFF+80H
9> 154A CD5D16 LXI H,SIGNON
10> 154D AF CALL PRMSG ;PRINT MESSAGE
11> 154E 320400 XPA A ;CLEAR ACCUMULATOR
12> 1551 C3A015 STA DISKA ;SET INITIALLY TO DISK A
13> JMP GOCPM ;GO TO CP/M
14>
15>
16>
17>
18>
19> 1554 310000 WBOOT. ;LOADER ON TRACK 0, SECTOR 1, WHICH WILL BE SKIPPED FOR WARM
20> READ CP/M FROM DISK - ASSUMING THERE IS A 120 BYTE COLD START
21> START.
22>
23>
24>
25> 1554 310000 LXI SP,BUFF ;USING DMA - THUS 00 THRU FF AVAILABLE FOR STACK
26>
27>
28> 1557 0E0A MVI C,RETRY ;MAX RETRIES
29> 1559 C5 PUSH B
30>
31> 155A 010000 WBOOT0. ;ENTER HERE ON ERROR RETRIES
32> 155D CD4516 LXI B,CPMB ;SET DMA ADDRESS TO START OF DISK SYSTEM
33> 155E 0E02 CALL SETDMA
34> 1562 CD4016 MVI C,2 ;START READING SECTOR 2
35> 1565 0E00 CALL SETSEC
36> 1567 CD3816 MVI C,0 ;START READING TRACK 0
37> 156A FE08 CALL SETTRK
38> 156C CD2516 MVI C,0 ;START WITH DISK 0
39> CALL SELDSK ;CHANGES DISKN TO 0
40>
41>
42>
43>
44>
45> 156F C1 READ SECTORS, COUNT NSECTS TO ZERO
46> 1570 062A POP B ;10-ERROR COUNT
47> MVI B,NSECTS
48>
49> 1572 C5 RDSEC. ;READ NEXT SECTOR
50> 1573 CD4816 PUSH B ;SAVE SECTOR COUNT
51> 1576 C2DA15 CALL READ
52> 1579 24C216 JNZ BOOTERR ;RETRY IF ERRORS OCCUR
53> 157C 110600 LHLD IOD ;INCREMENT DMA ADDRESS
54> 157F 19 LXI D,120 ;SECTOR SIZE
55> 1580 44 DAD D ;INCREMENTED DMA ADDRESS IN HL
56> 1581 40 MOV B,H
57> 1582 CD4516 MOV C,L ;READY FOR CALL TO SET DMA
58> 1585 3AC116 CALL SETDMA
59> 1588 FE1A LDA IOS ;SECTOR NUMBER JUST READ
60> 158A DA9615 CPI 26 ;READ LAST SECTOR?
61> JC RD1
62>
63> MUST BE SECTOR 26, ZERO AND GO TO NEXT TRACK
64> 158B 3AC016 LDA IOT ;GET TRACK TO REGISTER A
65> 1589 3C INR A
66> 1591 4F MOV C,A ;READY FOR CALL
67> 1592 CD3816 CALL SETTRK
68> 1595 AF XRA A ;CLEAR SECTOR NUMBER
69> 1596 3C INP A ;TO NEXT SECTOR
70> 1597 4F MOV C,A ;READY FOR CALL
71> 1598 CD4016 CALL SETSEC
72> 159B C1 POP B ;RECALL SECTOR COUNT
73> 159C 05 DCR B ;DONE?
74> 159D C27215 JNZ RDSEC

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15A0 F3
15A1 3E12
15A3 D3FD
15A5 AF
15A6 D3FC
15A8 3E7E
15AA D3FC
15AC AF
15AD D3F3
15AF 010000
15B2 CD4516
15B5 3EC3
15B7 320000
15BA 210315
15BD 220100
15C0 320500
15C3 210609
15C6 220600
15C9 323000
15CC 2100F8
15CF 223900
15D2 210400
15D5 4E
15D6 FB
15D7 C30000
15DA C1
15DB 0D
15DC CAE315
15DF C5
15E0 C35A15
15E3 21EC15
15E6 CD6A16
15E9 C35415
15EC 43414E4E4F
15F8 C312F0

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;
; DONE WITH THE LOAD, RESET DEFAULT BUFFER ADDRESS
; (ENTER HERE FROM COLD START BOOT)
; ENABLE RST0 AND RST7
DI
MVI A,12H ;INITIALIZE COMMAND
OUT REVDT
XRA A
OUT INTC ;CLEARED
MVI A,INTE ;RST0 AND RST7 BITS ON
OUT INTC
XRA A
OUT ICON ;INTERRUPT CONTROL
;
; SET DEFAULT BUFFER ADDRESS TO 00H
LXI B,BUFF
CALL SETDMA
;
; RESET MONITOR ENTRY POINTS
MVI A,JMP
STA 0
LXI H,WBOOT0
SHLD 1 ;JMP WBOOT AT LOCATION 00
STA 5
LXI H,BDOS
SHLD 6 ;JMP BDOS AT LOCATION 5
STA 7+0 ;JMP TO MON80 (MAY HAVE BEEN CHANGED BY DST)
LXI H,MON80
SHLD 7+0+1
LEAVE IOBYTE SET
PREVIOUSLY SELECTED DISK WAS B, SEND PARAMETER TO CPM
LXI H,DISKA
MOV C,M ;LOOKS LIKE A SINGLE PARAMETER TO CPM
EI
JMP CPMB
;
; ERROR CONDITION OCCURRED, PRINT MESSAGE AND RETRY
BOOTERR.
POP B ;RECALL COUNTS
DCR C
JZ BOOTERR0
TRY AGAIN
PUSH B
JMP WBOOT0
;
BOOTERR0.
; OTHERWISE TOO MANY RETRIES
LXI H,BOOTMSG
CALL ERROR
JMP WBOOT ;FOR ANOTHER TRY
;
; BOOTMSG.
DB 'CANNOT BOOT',0
;
; CONST. ;CONSOLE STATUS TO REG-A
; (EXACTLY THE SAME AS MDS CALL)
JMP CSTS
;
; CONIN. ;CONSOLE CHARACTER TO REG-A

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31> 15FB CD03F8      CALL  CI
32> 15FE E67F      ANI   7FH      ;REMOVE PARITY BIT
33> 1600 C9         RET
34>
35>
36> CONOUT, ;CONSOLE CHARACTER FROM C TO CONSOLE OUT
; SAME AS MDS CALL, BUT WAIT FOR SLOW CONSOLES ON LINE FEED
37> 1601 79      MOV   A,C      ;GET CHARACTER TO ACCUM
38> 1602 FE8A    CPI   LF      ;END OF LINE?
39> 1604 F5      PUSH  PSM     ;SAVE CONDITION FOR LATER
40> 1605 CD09F8  CALL  C0      ;SEND THE CHARACTER (MAY BE LINE FEED)
41> 1600 F1      POP   PSW
42> 1605 C0      RNZ          ;RETURN IF IT WASN'T A LINE FEED
43>
44>
45> WAIT 13 CHARACTER TIMES (AT 2400 BAUD) FOR LINE FEED TO HAPPEN
; (THIS WORKS OUT TO ABOUT 50 MILLISECS)
46> 160A 0632    MVI   B,50    ;NUMBER OF MILLISECS TO WAIT
47> 160C 0E86    T1,  MVI   C,182 ;COUNTER TO CONTROL 1 MILLISEC LOOP
48> 160E 00      DCR   C      ;1 CYCLE = .5 USEC
49> 160F C20E16  JNZ   T2      ;10 CYCLES= 5.5 USEC
50>
51>
52>
53> DCR   B      = 5.5 USEC PER LOOP* 182 = 1001 USEC
54> 1612 05      JNZ   T1      ;FOR ANOTHER LOOP
55> 1613 C20C16  RET
56>
57> LIST, ;LIST DEVICE OUT
; (EXACTLY THE SAME AS MDS CALL)
58> 1617 C30FF8  JMP   LD
59>
60> PUNCH, ;PUNCH DEVICE OUT
; (EXACTLY THE SAME AS MDS CALL)
61> 161A C38CF8  JMP   PD
62>
63>
64> READER, ;READER CHARACTER IN TO REG-A
; (EXACTLY THE SAME AS MDS CALL)
65> 161D C306F8  JMP   RI
66>
67>
68> HOME, ;MOVE TO HOME POSITION
; TREAT AS TRACK 00 SEEK
69> 1620 0E00    MVI   C,0
70> 1622 C33816  JMP   SETTRK
71>
72>
73> SELDSK, ;SELECT DISK GIVEN BY REGISTER C
; CP/M HAS CHECKED FOR DISK SELECT 0 OR 1, BUT WE MAY HAVE
; A SINGLE DRIVE MDS SYSTEM, SO CHECK AGAIN AND GIVE ERROR
; BY CALLING MOH00
74>
75>
76>
77> 1625 79      MOV   A,C
78> 1626 FE02    CPI   HDISKS ;TOO LARGE?
79> 1628 D40FFF  CHC   RM0H00 ;GIVES #ADDR MESSAGE AT CONSOLE
80>
81>
82> RAL
83> RAL
84> RAL
85> RAL
86> 162F E610    ANI   10000H ;UNIT NUMBER IN POSITION
87> 1631 4F      MOV   C,A     ;SAVE IT
88> 1632 218E16  LXI   H,10F  ;IO FUNCTION
89> 1635 7E      MOV   A,M
90> 1636 E6CF    ANI   11001111H ;MASK OUT DISK NUMBER
91> 1638 81      ORA   C      ;MASK IN NEW DISK NUMBER

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291> 1639 77      MOV   M,A     ;SAVE IT IN IOPB
292> 163A C9      RET
293>
294>
295>
296> 163B 21C016  SETTRK, ;SET TRACK ADDRESS GIVEN BY C
297> 163E 71      LXI   H,10F
298> 163F C9      MOV   M,C
299>
300>
301> 1640 21C116  SETSEC, ;SET SECTOR NUMBER GIVEN BY C
302> 1643 71      LXI   H,10F
303> 1644 C9      MOV   M,C
304>
305>
306> 1645 69      SETDMA, ;SET DMA ADDRESS GIVEN BY REGS B,C
307> 1646 68      MOV   L,C
308> 1647 L2C216  MOV   H,B
309> 164A C9      SHLD 10D
310>
311>
312> 164B 0E04    READ, ;READ NEXT DISK RECORD (ASSUMING DISK/TRK/SEC/DMA SET)
313> 164D CD7B16  MVI   C,READF ;SET TO READ FUNCTION
314> 1650 CD8416  CALL  SETFUNC
315> 1653 C9      CALL  WAITIO ;PERFORM READ FUNCTION
316>
317>
318>
319> 1654 0E06    WRITE, ;DISK WRITE FUNCTION
320> 1656 CD7B16  MVI   C,WRITEF
321> 1659 CD8416  CALL  SETFUNC ;SET TO WRITE FUNCTION
322> 165C C9      CALL  WAITIO
323>
324>
325>
326>
327> 165D 7E      ;UTILITY SUBROUTINES
328> 165E B7      ;PRINT MESSAGE AT H.L TO 0
329> 165F C8      MOV   A,M
330>
331>
332> 1660 E5      ORA   A      ;ZERO?
333> 1661 4F      RZ
334>
335>
336> 1662 CD0116  ;MORE TO PRINT
337> 1665 E1      PUSH  H
338> 1666 23      MOV   C,A
339> 1667 C35D16  CALL  CONOUT
340>
341>
342>
343> 166D CDFB15  POP   H
344> 1670 0E00    INX   H
345> 1672 CD0116  JMP   PRMSG
346>
347>
348>
349>
350> 166A CD5D16  ;ERROR, ;ERROR MESSAGE ADDRESSES BY H.L
351>
352>
353>
354> 166D CDFB15  CALL  PRMSG
355> 1670 0E00    ;ERROR MESSAGE WRITTEN, WAIT FOR RESPONSE FROM CONSOLE
356> 1672 CD0116  CALL  CONIN
357> 1675 0E0A    MVI   C,CR   ;CARRIAGE RETURN
358> 1677 CD0116  CALL  CONOUT ;LINE FEED
359> 167A C9      JMP   RET    ;MAY BE RETURNING FOR ANOTHER RETRY
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01> 167E 7E      MOV    A,M      ;GET IT TO ACCUMULATOR FOR MASKING
02> 167F E6F8    ANI    11111000B ;REMOVE PREVIOUS COMMAND
03> 1681 01      ORA    C        ;SET TO NEW COMMAND
04> 1682 77      MOV    M,A      ;REPLACED IN IOPB
05> 1683 C9      RET
06>
07>
08> 1684 0E0A    ; WAIT0.
09> MVI    C,RETRY ;MAX RETRIES BEFORE PERM ERROR
10>
11> REWAI.
12> START THE I/O FUNCTION AND WAIT FOR COMPLETION
13> IN     RTYPE
14> IN     RBYTE ;CLEARS THE CONTROLLER
15>
16> MVI    A,IOPB AND 0FFH ;LOW ADDRESS FOR IOPB
17> OUT    LOW      ;TO THE CONTROLLER
18> MVI    A,IOPB SHR 8 ;HIGH ADDRESS FOR IOPB
19> OUT    HIGH     ;TO THE CONTROLLER, STARTS OPERATION
20>
21> WAIT0. IN     DSTAT ;WAIT FOR COMPLETION
22> ANI    IOPDY ;READY?
23> JZ     WAIT0
24>
25> CHECK IO COMPLETION OK
26> IN     RTYPE ;MUST BE I/O COMPLETE (00) UNLINKED
27> 00 UNLINKED I/O COMPLETE, 01 LINKED I/O COMPLETE (NOT USED)
28> 10 DISK STATUS CHANGED 11 (NOT USED)
29> CPI    100B ;READY STATUS CHANGE?
30> JZ     WREADY
31>
32> MUST BE 00 IN THE ACCUMULATOR
33> ORA    A
34> JNZ    WERROR ;SOME OTHER CONDITION, RETRY
35>
36> CHECK I/O ERROR BITS
37> IN     RBYTE
38> RAL
39> JC     WREADY ;UNIT NOT READY
40> RAR
41> ANI    11111100B ;ANY OTHER ERRORS? (DELETED DATA OK)
42> JNZ    WERROR
43>
44> READ OR WRITE IS OK, ACCUMULATOR CONTAINS ZERO
45> RET
46>
47> WREADY. ;NOT READY, TREAT AS ERROR FOR NOW
48> IN     RBYTE ;CLEAR RESULT BYTE
49> JMP    TRYCOUNT
50>
51> WERROR. ;RETURN HARDWARE MALFUNCTION (CRC, TRACK, SEEK, ETC.)
52> ; THE MDS CONTROLLER HAS RETURNED A BIT IN EACH POSITION
53> ; OF THE ACCUMULATOR, CORRESPONDING TO THE CONDITIONS,
54> ; 0 - DELETED DATA (ACCEPTED AS OK ABOVE)
55> ; 1 - CRC ERROR
56> ; 2 - SEEK ERROR
57> ; 3 - ADDRESS ERROR (HARDWARE MALFUNCTION)
58> ; 4 - DATA OVER/UNDER FLOW (HARDWARE MALFUNCTION)
59> ; 5 - WRITE PROTECT (TREATED AS NOT READY)

```

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08>
09>
10>
11>
112>
113>
114>
115>
116>
117>
118> 1686 0D
119> 1687 C2B616
120>
121>
122> 168A 3E01
123> 168C C9
124>
125>
126>
127>
128> 168D 00
129> 168E 04
130> 168F 01
131> 16C0 02
132> 16C1 01
133> 16C2 8000
134>
135>
136> 16C4

```

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6 - WRITE ERROR (HARDWARE MALFUNCTIONS)
7 - NOT READY
(ACCUMULATOR BITS ARE NUMBERED 7 6 5 4 3 2 1 0)

IT MAY BE USEFUL TO FILTER OUT THE VARIOUS CONDITIONS,
BUT WE WILL GET A PERMANENT ERROR MESSAGE IF IT IS NOT
RECOVERABLE. IN ANY CASE, THE NOT READY CONDITION IS
TREATED AS A SEPARATE CONDITION FOR LATER IMPROVEMENT

TRYCOUNT,
REGISTER C CONTAINS RETRY COUNT, DECREMENT 'TIL ZEPD
DCR    C
JNZ    REWAI ;FOR ANOTHER TRY

CANNOT RECOVER FROM ERROR
MVI    A,1 ;ERROR CODE
RET

DATA AREAS (MUST BE IN RAM)
IOPB. ;I/O PARAMETER BLOCK
DB     00H ;NORMAL I/O OPERATION
DB     01H ;I/O FUNCTION, INITIAL READ
DB     01H ;NUMBER OF SECTORS TO READ
DB     00H ;TRACK NUMBER
DB     01H ;SECTOR NUMBER
DB     00H ;I/O ADDRESS
END

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