SOFTWARE OPERATING PROCEDURES

BASIC CONTROL SYSTEM

PREREQUISITE SOP MODULES:

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Peripheral Equipment Manual Functions (5951-1373)

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BASIC CONTROL SYSTEM

This module covers procedures for creating and using a Basic Control System (BCS) on an HP computer. BCS is a core-based operating system that requires at least 4K of memory and a teleprinter.

PROCEDURE 1

HOW TO GENERATE A BASIC CONTROL SYSTEM

The stand-alone program Prepare Control System (PCS) is used to generate BCS. The following parameters must be specified during generation (all numbers typed in octal):

1. First Word of Available Memory (FWA MEM)

   This is the lowest memory location that is available to PCS for BCS construction. It should be higher than the last linkage location used in the Interrupt Table and if the BCS is to be used within MTS (Magnetic Tape System) it must be set to exactly 110_8 (to allow for MTS linkage locations). (Interrupt Table must be pre-planned before running PCS, since (FWA MEM) depends upon Interrupt Table length.)

2. Last Word of Available Memory (LWA MEM)

   This is the highest memory location available to BCS. This value depends on the core size and the context as follows:

Core Size	Last Word BCS	BCS in MTS
4K	7677	
8K	17677	15777
16K	37677	35777
24K	57677	
32K	77677	

3. Equipment Table (EQT)

   A table of varying size whose entries are numbered sequentially starting with 7. The user relates each entry to a specific I/O device and to an I/O driver. There must be at least one EQT entry per device to be used in BCS.

4. Standard Unit Table (SQT)

   A set of 6 numbers (chosen from the EQT) that specify devices for standard functions (i.e., keyboard, list output, etc.).

5. Interrupt Table

The set of memory locations where interrupts may occur and a matching set of linkage locations (one per interrupt location). Also, an entry point into a driver is associated with each interrupt.

Each interrupt location corresponds directly to the select code of the device, i.e., if the teleprinter select code is 10_8, the interrupt location in memory is 10_8. The linkage location associated with the device must be higher than the highest select code (interrupt location) used.

6. Driver Identification Codes

Driver Identification codes are required when creating the EQT and the Interrupt Table. These are the currently defined driver codes:

Table BCS-1. Driver Codes

ØØ to Ø7 Paper Tape Devices:
- ØØ Teleprinter
- Ø1 Tape Reader
- Ø2 Tape Punch

1Ø to 17 Unit Record Devices:
- 1Ø Calcomp Plotter
- 11 Card Reader
- 12 Line Printer
- 15 Mark Sense Card Reader (uses DMA)
- 16 80-Column Line Printer

2Ø to 37 Magnetic Tape/Mass Storage Devices:
- 21 HP 2Ø2Ø (A or B) Magnetic Tape (7-Track)
- 22 HP 3Ø3Ø G Magnetic Tape (9-Track) (uses DMA with character packing)
- 23 HP 797Ø (A or B) Magnetic Tape (9-Track)

4Ø to 77 Instruments

OPERATING INSTRUCTIONS

1. Turn on all desired equipment.

2. Load PREPARE CONTROL SYSTEM (PCS) using the Basic Binary Loader (BBL) or Basic Binary Disc Loader (BBDL).

3. Set starting address 2000_8.

4. Set all switch register bits off; then set switches 5 through 0 to the octal select code (I/O channel) of the teleprinter.

5. Start program execution.

6. Set all switch register bits off.

7. PCS asks for the high-speed input device. (Remember to terminate each reply with a *return* and *linefeed*.)*..... HS INP?

   Reply with the select code of the high-speed input unit for PCS ~~(either tape reader or teleprinter)~~ OR, if TTY used, enter 0.....

Amb. Dec 72

8. PCS asks for high-speed punch.....HS PUN?

   Type the select code of the high speed tape punch or ~~tele-printer to be used by PCS.....~~ if TTY used, enter 0.

9. PCS asks for the first word of available memory.....FWA MEM?

   Type the octal address beyond the last address necessary for interrupt linkages.....

10. PCS asks for the last word of available memory.....LWA MEM?

    Type the octal address of last available memory address (first digit must be non-zero).....

11. PCS prints.....*LOAD and halts.

    At this point, load the appropriate BCS drivers (Magnetic tape first, if present)

**Terminate any reply typed on the keyboard throughout PCS execution with return linefeed. If an error occurs while typing a response, press RUBOUT, return linefeed, then retype the response.*

one at a time. Place the driver tape in the reader and press RUN.

PCS prints the driver name and absolute memory bounds, then prints *LOAD and halts for the next tape.

Keep loading driver tapes until all are loaded. Then load the Input/Output Control routine (IOC), either buffered or non-buffered.

NOTE: If driver D.21 (HP 2020 (A or B) Magnetic Tape Unit) is loaded, only non-buffered IOC can be used; D.21 turns off the interrupt system. D.11 (Card Reader Driver) and D.23 (HP 7970 (A or B) Magnetic Tape Unit) also require non-buffered IOC when used without DMA.

IOC

12. PCS prints IOC and the memory bounds and then asks for Equipment Table entries by printing.....*TABLE ENTRY EQT? and halts.

Press RUN. Then type in the required EQT entries, one per line (each entry followed by *return* and *linefeed*). Remember that the entries are implicitly assigned octal numbers, starting with 7_8, as they are entered..... *xx*,D.*yy*[,D[,U1]]

NOTE: Elements in brackets "[ ]" are omitted according to the driver requirements.

where

xx = high priority select code of the device

D.yy = driver identification number (see chart).

D = uses DMA; omit if device does not use DMA.

U1 = file protect mode for mass storage device; omit if file protect is not desired.

Terminate the EQT by typing...../E

13. PCS asks for the Standard Unit Table.....SQT?
and requests octal EQT entry numbers (7,10,11,...) for the
following standard functions:

    1. Keyboard input..... -KYBD?
    2. Teleprinter..... -TTY?
    3. Library subroutine input at load-time..... -LIB?
    4. Punch output.....-PUNCH?
    5. Standard input.....-INPUT?
    6. Standard list output..... -LIST?

Respond to each request by typing the EQT entry number of the
device that is most appropriate for the specific function.

14. PCS requests information about the availability of
Direct Memory Access.....DMA?

    Respond by typing 0 (no DMA), 6 (one channel DMA),
    or 6,7 (two channel DMA)

15. PCS halts after typing.....*LOAD

    Place the BCS Relocating Loader in the reader
    and press RUN.

16. PCS loads the Relocating Loader, then prints.....LOADR
and the loader's memory bounds.....*xxxxx yyyyy*
PCS then asks for the Interrupt Linkage Table
by printing.....INTERRUPT LINKAGE?
and halts.

    Press RUN. Type the Interrupt Linkage Table
    entries for each device, one per line, in order
    of ascending select codes.

For a device using only one select code (I/O channel) type.....*xx,yy*,I.*zz*

where

xx = select code of the device. (Lower numbered of two select codes if device is mass storage.)

yy = octal address of interrupt linkage memory word for the device.

zz = driver identification number (see Table BCS-1).

Example: 10,16,I.00

For a mass storage device using two select codes (I/O channels)
type.....*xx,yy*,I.*zz*
qq,rr,C.*zz*

where

qq = the lower priority (higher numbered) select code (*xx* = higher priority, lower numbered select code).

rr = octal address of the interrupt linkage memory word for the device (different from *yy*).

zz = driver identification number (same as for I.*zz*)

Example: 11,17,I.21
12,20,C.21

To put an octal instruction (i.e., a precautionary halt instruction) in an unused interrupt location (select code) type.....*xx,bbbbbb*

where

xx = select code

bbbbbb = an octal instruction (*b* = 0-7).

Example: 15,102055 (halt instruction; 55 = halt number)

PCS checks each entry after it is typed. If the driver name was typed incorrectly, PCS types.....*ERROR

If the driver was not loaded earlier (step 11) then PCS types.....*UN *name*

In either of the above cases, refer to Procedure 2 to continue.

Terminate the Equipment Table by typing...../E

17. PCS determines whether there are any undefined references (e.g., to drivers that were not loaded). If none, PCS goes on to the next step.

    If some symbols are undefined, PCS prints.....*UNDEFINED SYMBOLS: followed by a list of entry points for drivers which have been referenced in tables but not loaded..... I.*xx*
    :

    If the drivers were not loaded during step 11 but should have been, restart PCS from step 1. To leave the references unresolved and load in the driver tapes at load-time, (Procedure 3) continue PCS processing with step 18.

    NOTE: Drivers that use DMA or entry point IOERR in the loader cannot be left undefined (must be loaded during step 11).

18. PCS lists the entry points of BCS and prints the system linkage area.....*SYSTEM LINK
    xxxxx yyyyy

19. PCS then prints.....*BCS ABSOLUTE OUTPUT and halts.
    Check that the tape punch is operable and press RUN.
    PCS punches a configured BCS tape and halts.
    To punch additional copies, set switch register bit 15 on and press RUN.

20. Terminate PCS by setting all switch register bits to zero and pressing RUN. PCS prints.....*END and halts.

PROCEDURE 2

PREPARE CONTROL SYSTEM ERROR HALTS AND MESSAGES

Message	Meaning	Action
*EOT	End-of-tape	Place next tape in tape reader and press RUN to continue loading.
*ERROR	A non-numeric parameter or illegal numeric parameter has been entered.	Retype the entire entry correctly.
I/O DRIVER? D.*rr*		
	A driver has been named in EQT entry but has not been loaded.	1. If the driver is to be loaded with user's program at load-time, type an exclamation mark (!). The driver name is added to the loader's LST. 2. If the driver should have been loaded, restart PCS.
*LØ1	Checksum error	To reread record, reposition tape to beginning of record and press RUN. If computer halts again, tape must be replaced.
*LØ2	Illegal record read: The last record read was not recognized as a valid relocatable format record.	To reread record, reposition tape to beginning of record and press RUN. If computer halts again, tape must be replaced.
*LØ3	Memory overflow: The length of BCS exceeds available memory.	Abort PCS. Reduce the number of core resident I/O drivers or increase memory.
*LØ4	System linkage area overflow in Base Page.	Abort PCS. Reduce the number of, or reorder the core resident I/O drivers.
*LØ5	Loader symbol table overflow: The number of EXT/ ENT symbols exceeds available memory.	Abort PCS. Reduce the number of, or reorder the core resident I/O drivers.
*LØ6	PCS interprets the program length of BCS to be zero.	Abort PCS.
*LØ7	Duplicate entry points; an entry point in the current program matches a previously loaded entry point.	Eliminate an entry point. Check to see if the same program was loaded twice.

Message	Meaning	Action
*UNDEFINED SYMBOL: *symbol*	An entry point in a BCS module cannot be located.	If the subroutine should have been loaded, rerun PCS.
*UN *name*	The name I.*ee* is not defined as an entry point in any I/O driver previously loaded.	1. If the driver name was typed incorrectly, retype the entire entry correctly. 2. If the driver is to be loaded with the user's program at load-time, type an exclamation mark (!).

Halt Code

1Ø2Ø55	A line is about to be printed on the teleprinter.	Turn punch unit OFF. Press RUN.
1Ø2Ø56	A line has been printed while the teleprinter punch unit was off.	Turn punch unit ON. Press RUN.
1Ø2Ø66	Tape supply low on tape punch which is producing absolute binary output. Trailer follows last valid output.	Place new reel of tape in unit. Press RUN. Leader is punched.
1Ø2Ø77	BCS tape is punched.	To produce additional copies, set switch 15 on.

PROCEDURE 3

HOW TO USE BCS TO RELOCATE AND RUN PROGRAMS

BCS performs two main functions: 1) relocates and links subroutines to main programs, and 2) executes programs.

Starting with relocatable code produced by an assembler or compiler, there are two possible methods to accomplish function 1 and reach function 2:

a. BCS relocates the code (including subroutines) into core memory directly and then executes it.

b. BCS relocates the code (including subroutines) and punches it onto an absolute tape along with the necessary system routines, drivers, tables, etc. This absolute tape can then be loaded into core through BBL or BBDL and executed.

Method (a) is faster, but does not provide a permanent, runnable copy of the program. Not only does the program code have to be relocated each time the program is to be run, but less core is available because the Relocating Loader occupies a part of memory.

Method (b) takes longer the first time, but provides a permanent copy of the program that can be executed. Also, more core is available since the program can (at run-time) use the space occupied by the Relocating Loader at load-time.

OPERATING INSTRUCTIONS

1. Load a configured BCS into core with BBL or BBDL. (See Procedure 1 for generation of a configured BCS.)
2. Set a starting address of 2_8.

3. Set all switch register bits off, then select the following options:

   Bit 15 on (suppress memory allocation listing)
   off (include memory allocation listing)

   Bit 14 on (punch absolute tape copy of program)
   off (relocate into core, do not punch tape)

   If Bit 14 on and a teleprinter is to be used for punching, then

   Bit 13 on (teleprinter is a 2754B and can print and punch separately; set teleprinter mode to KT)

   off (teleprinter cannot print and punch separately; BCS halts before and after each line of printing so that the operator can turn on/off punch unit to avoid punching list output, then punch the absolute binary output).

4. Place the first relocatable program tape into the reader. Press PRESET and RUN. BCS reads and relocates the binary code on the tape. If switch register bit 14 is on, an absolute binary tape is punched. (Otherwise, BCS relocates the program in memory.)

5. BCS halts after typing.....*LOAD

   Load the user relocatable tapes as follows: Set switch register bits 2-0 off.

   Place the tape in the reader. Set switch register bit 15 on (if desired) to suppress memory allocation listing. Press RUN. When tape has been read, BCS halts after printing.....*LOAD

   If there are more user tapes to load, repeat step 5.

6. After all user program tapes have been loaded, there are several options:

   To read a library subroutine tape (and load only those subroutines which are necessary to resolve externals). (Step 7)

To list undefined externals (or bypass further loading if there are no undefined externals). (Step 8)

To bypass further loading even if undefined externals remain. (Step 9)

7. Set switch register bit 2 on (bits 1 and 0 off). Place the relocatable library tape in the reader (FORTRAN IV library must be loaded first). Set switch register bit 15 on to suppress the memory allocation listing, if desired. Press RUN.

   When the tape has been read, BCS halts after indicating:

   No undefined externals.....*LST
   (Set switch register bit 2 off
   and go to step 10.)

   or

   Undefined externals..... { *symbol* / *symbol* / : / *symbol* } *LOAD

   Return to Step 6 and select an option.

8. Set switch register bit 0 on (bits 1 and 2 off). Press RUN.

   BCS indicates whether undefined externals exist by printing either:

   No undefined externals.....*LST
   (Set switch register bit 2 off
   and go to Step 10)

   or

   Undefined externals..... { *symbol* / *symbol* / : / *symbol* } *LOAD

   Return to Step 6.

9. Set switch register bit 1 on (bits 2 and 0 off). Press RUN.

   BCS goes on to Step 10, even though undefined externals may still exist.

10. BCS has completed loading and is ready to print the Loader Symbol Table (LST), common bounds, and linkage area bounds. Set switch register bit 15 on to suppress listing of these items. Set bit 15 off to list them.

    If a 2754B Teleprinter is used, set the mode switch to "T" to enable the tape punch.

    Press RUN.

11. BCS completes listing (if requested by bit 15).

    If the program was relocated into core (bit 14 off),
    BCS prints.....*RUN.
    and halts.

    Press RUN to execute the program.

12. If the program was punched onto paper tape (bit 14 on),
    BCS prints.....*END
    and halts.

13. Tear off the absolute tape output and wind. To execute the program:

    Load the tape with BBL or BBDL.

    Start the program at location 2_8.

PROCEDURE 4

BCS LOAD-TIME ERROR HALTS AND MESSAGES

Message	Meaning	Action
*LØ1	Checksum error.	To reread record, reposition tape to beginning of record and press RUN. If computer halts again, tape must be replaced.
*LØ2	Illegal record read: The last record read was not recognized as a valid relocatable record tape.	To reread record, reposition tape to beginning of record and press RUN. If computer halts again, tape must be replaced.
*LØ3	Memory overflow: The length of BCS exceeds available memory.	Abort load. Reduce program size or increase memory.
*LØ4	System linkage area overflow in Base Page.	Abort load. Reduce program size or alter subprogram loading sequence.
*LØ5	Loader symbol table overflow: The number of EXT/ENT symbols exceeds available memory.	Abort load. Reduce program size or increase memory.
*LØ6	Common block error: The length of the common block in the current program is greater than the length of the first common block allocated.	Abort load. Reorder the programs during loading or make the common blocks the same length.
*LØ7	Duplicate entry points: An entry point in the current program matches a previously declared entry point.	Abort load. Eliminate an entry point. Check to see if the same program was loaded twice.
*LØ8	No transfer address: The initial starting location was not present in any of the programs which were loaded.	Load the absolute starting address into the A-register. Start program execution.

Message	Meaning	Action
*LØ9	Record out of sequence: A NAM record was encountered before the previous program was terminated with an END record.	1. Reload the program. 2. If program does not load properly, replace the binary tape for the program being loaded.

Error Code	Meaning	Action
1Ø2Ø55	A line is about to be printed on the teleprinter.	Turn punch unit OFF. Press RUN.
1Ø2Ø56	A line has just been printed on the teleprinter with the tape punch OFF.	Turn punch unit ON. Press RUN.
1Ø2Ø66	Tape supply low on tape punch which is producing absolute binary output. Trailer follows last valid output.	Place new reel of tape in unit. Press RUN. Leader is punched.

PROCEDURE 5

BCS RUN-TIME HALTS AND MESSAGES

Certain library routines, including the Formatter, produce error messages at run-time.

Halt Code	Meaning
1Ø6Ø55	Program has attempted to execute a non-program area of core. Warning-only. Program can be restarted.