

5. System Generation

The generation and installation of a complete MULTI8 system is accomplished in two phases: 1. generation of a parameter and a batch file; 2. execution of a batch file which assembles, loads and task-builds all components. The end-product is an OS/8 system device with the following files:

MULTI8.SV the system in runnable form,
MS .PA definitions of Monitor Symbols for external task assembly,
MONDUM.SV the monitor dump utility.

Once this disk image is available, MULTI8 can be started simply by typing R MULTI8.

5.1 Configuration

In this section the configuration process will be described. Configuring defines the hardware/software environment to which the MULTI8 system has to be adapted. MULTI8 is configured by means of conditional assembly.

Assembly of MULTI8 starts with the Monitor and internal tasks, contained in the files M1.PA - M5.PA. A symbol table file is generated as side-effect, which contains all symbols unique for this configuration. This file is transformed into a global symbol file, MS.PA (for Monitor Symbols) which in turn is used to assemble all other components.

The initial assembly of the Monitor requires a parameter file supplied by the user. This file is called the configuration file (CONFIG.PA) and specifies the user's machine and requirements. The contents of CONFIG.PA is the subject of this paragraph.

CONFIG.PA consists of symbol definitions only. The file is created by the program M8GEN.SV, which interactively determines the user's needs. M8GEN also creates a batchfile (MULTI8.BI) that will assemble the complete system. Both CONFIG.PA and MULTI8.BI may later be modified with EDIT or TECO if desired.

The following is a sample run of M8GEN. All user replies are underlined. Note that M8GEN needs the file CONFIG.DA on DSK:. In the example CR designates a reply of just carriage return.

.R M8GEN

--- MULTI8 SYSTEM CONFIGURATOR V1 ---

ANSWER ALL QUESTIONS WITH Y, N, A NUMBER OR RETURN
RETURN GIVES THE VALUE INDICATED IN SQUARE BRACKETS (//)

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HOW MUCH MEMORY DO YOU NEED FOR THE FOREGROUND /8K/ ? CR

DO YOU HAVE AN EAE (EXT. ARITHM. ELEMENT) /NO/ ? YES

HOW MANY TERMINALS DO YOU HAVE /1/ ? 4

DEVICE CODE FOR TERMINAL 1 IS 03

IS THIS A VIDEO TERMINAL /YES/ ? CR

WHAT IS ITS BACKSPACE CODE /210/ ? CR

WHAT IS ITS ESCAPE CODE /233/ ? CR

DOES IT NEED FILLER CHARACTERS /NO/ ? CR

ENTER DEVICE CODE FOR TERMINAL 2 /30/ CR

IS THIS A VIDEO TERMINAL /YES/ ? NO

WHAT IS ITS ESCAPE CODE /233/ ? 375

DOES IT NEED FILLER CHARACTERS /NO/ ? YES

HOW MANY FILLER CHARACTERS ? 4

AFTER WHAT CHARACTER CODE /212/ ? CR

ENTER DEVICE CODE FOR TERMINAL 3 /32/ 44

IS THIS A VIDEO TERMINAL /YES/ ? CR

WHAT IS ITS BACKSPACE CODE /210/ ? 225

WHAT IS ITS ESCAPE CODE /233/ ? CR

DOES IT NEED FILLER CHARACTERS /NO/ ? CR

ENTER DEVICE CODE FOR TERMINAL 4 /46/ CR

IS THIS A VIDEO TERMINAL /YES/ ? CR

WHAT IS ITS BACKSPACE CODE /210/ ? CR

WHAT IS ITS ESCAPE CODE /233/ ? CR

DOES IT NEED FILLER CHARACTERS /NO/ ? CR

HOW MANY BACKGROUNDS DO YOU NEED. THERE CAN BE MORE BACKGROUNDS THAN TERMINALS, BUT NO MORE THAN 7 6

WHAT TYPE OF SYSTEM DISK DO YOU HAVE ?

SELECT ONE OF THE FOLLOWING AND ENTER THE NUMBER:

0 = RK8E

1 = RF08

2 = SYSTEM INDUSTRIES 3040 CONTROLER

3 = RL01

YOUR NUMBER /0(=RK8E)/ 3

WHAT TYPE OF (LINE-) CLOCK DO YOU HAVE ?

SPECIFY ONE OF:

0 = DK8EA

1 = DK8EC

2 = DK8EP

3 = DKC8AA

YOUR NUMBER ? /0(=DK8EA)/ 3

DO YOU HAVE A PROGRAMMABLE CLOCK (DK8EP) AS WELL ? /NO/ CR

WHAT IS THE LINE FREQUENCY HERE ? /50 HERTZ/ CR

HOW LARGE SHOULD THE VIRTUAL MEMORY BE /16K/ ? 32

DO YOU WANT NON-STANDARD DISK ALLOCATION /NO/ ? CR

NOW COMES A LIST OF PERIPHERAL OPTIONS. FOR EACH DEVICE ANSWER YES IF THAT DEVICE IS PRESENT IN YOUR CONFIGURATION. JUST RETURN MEANS NO.

LINEPRINTER ? YES
ENTER NUMBER OF COLLUMS (DECIMAL) /80/ 132
DOES IT HAVE LOWER-CASE CHARACTERS /YES/? CR
DO YOU WANT THE PRINTER SPOOLED /YES/? CR
IS AN LS8E INTERFACE /NO/? CR
KL8E /NO/? CR
DKC8AA /NO/? CR
PP8E PAPERTAPE PUNCH ? CR
PR8E PAPERTAPE READER ? CR
TC08 DECTAPE (DATABREAK) ? CR
TD8E DECTAPE (NON-DATABREAK) ? CR
CR8E CARDREADER ? CR
XY8E INCREMENTAL PLOTTER ? YES
 DEVICE CODE ? 50
TM8E MAGTAPE ? CR
TC58 MAGTAPE ? CR
RX01 FLOPPY DISK (RX01/02/04) ? YES

For the normal configurations this will prove sufficient. In that case you may now skip to section 5.2 to proceed with the assembly of the system. For more complicated installations (eg. user implemented tasks), we continue with a more detailed description of the configuration parameters.

N O T E

Currently the KL8A multiplexer is not supported by M8GEN.

Here follows a list of all parameter symbols and their meaning. Almost all parameters obtain default values if not defined in CONFIG.PA.

- EAE If your machine has an Extended Arithmetic Element installed (multiply/devide option), define the symbol EAE. Its value has no particular meaning.
- FIELDS specifies the number of fields to be used for the foreground. FIELDS=2 means that 8K will be used for the foreground, including the Monitor. (Default FIELDS=2)
- BGMAX defines the number of backgrounds (timesharing users). The values 0 (no background at all), 1 to 7 are supported. Note that you may have more backgrounds than there are terminals. However, remember that each background needs its own disk area. (By default BGMAX=1).
- BGCORE defines the dize of the virtual memories. Each additional field costs one word in each dataarea, plus 4K disk space for each user.

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- MAXNAM defines the length of the task name table, and thus the total number of tasks that can be installed. A default value is assigned, based on further parameters in the configuration. This will allow for several extra tasks. Define MAXNAM only if you need exceptionally many tasks.
- SY.... the system disk driver is a resident task, part of the monitor source file. To select the proper handler one of the following symbols must be specified:
- SYRF08 for RF08 systems (equate to number of platters)
 - SYRK8E for RK8E/RK05 systems
 - SY3040 for 6.7M diskdrives interfaced with System Industries 3040 controller.
 - SYRL01 for RL01 disk.
- HWTICK should be equated to the number of interrupts generated by the realtime clock (DK8EA: 100/120 (50/60 Hz); DK8EC: 50/500/5000 (jumper selectable); DK8EP: 100; RFCLOCK: 25/30 (50/60 Hz)). (These figures are decimal). For the mentioned clocks HWTICK is automatically set (50 Hz for DK8EA). Note that the photocell interrupt of the RF08 disk is not a regular flag: it can not be cleared by instructions. Depending on system activity, photocell interrupts may be seen twice, resulting in a too fast clock. A higher value for HWTICK may be chosen to compensate this effect.
- TnCHAR (n = terminal number) For any terminal one character may be identified which requires one or more filler characters for proper timing. TnCHAR should be equated to the ASCII-code for that character (with the paritybit SET). TnFILL should be equated to the number of filler characters needed. Example: T3CHAR=212; T3FILL=4 will give 4 filler characters after each linefeed on terminal 3.
- TnESCP defines what code must be converted to ESC (233) for terminal n.
- TnBACK defines the code code for the backspace function for terminal n.
- BRKCHR is equated to the system break character. normal (default) value is 206 (CONTROL/F).
- GIGAMX defines the length of the table holding special functions called from the background by execution of the 'giant IOT'. Default is 30 (octal). Codes 0-17 are reserved for system functions. Additional functions should be assigned codes 20 and up.
- COMLNG defines the length of system common. System common is not used by MULTI8 but is an area reserved in the monitor dataarea in field 0 to be used by user tasks. This common area may be defined (in CONFIG.PA) as follows:
- NOPUNCH /ONLY SYMBOL DEFINITIONS TO OCCUR...
 - *0
- A, 0

```
B3,      ZBLOCK 3
C,       0

          COMLNG=.      /THIS IS THE ONLY IMPORTANT THING TO
                          /MULTI8.
          ENPUNCH      /(DON'T FORGET !)
```

This code will define the symbols A, B3 and C and give them values according to their relative position in common (e.g. 0, 1, 4). In addition the symbol COMLNG is defined and gets the value 5. MULTI8 will reserve 5 words, starting at location COMMON. If you add the symbols A, B3 and C to SYMBOLS.GS then they will appear in MS.PA and your tasks may be coded like:

```
.....
TAD I (COMMON+A
DCA I (COMMON+C
.....
```

Now we come to the specification of the devices present in the system configuration. A device is included by defining its DEC option code. In some cases the value assigned has a meaning. Each device gets associated zero or more events, one for each interrupting flag.

- LE8E Lineprinter, events LPT and LPTERR. The value assigned has the following meaning:
 - Bit 0: if set, don't convert lowercase to uppercase;
 - Bit 1: set for LS8E type interface.
 - Bit 2: if set, the lineprinter is NOT spooled.
 - Bit 3: if set, the lineprinter is on an KL8E interface.
 - Bit 4-10: number of collums.
 - Bit 11 if set, the lineprinter is on the DKC8AA interface.

- PR8E papertape reader - PTR.

- PP8E papertape puncher - PTP.

- TC08 TC08/TC01 DEctape control - DTA.

- TD8E TD8E DEctape control. No interrupt, no event.

- KL8En Terminal interface compatible with KL8E. n is 2, 3, 4, 5, 6, 7. Equate to device code, e.g. KL8En=0030 for 03/04 codes. Events TTYn and KBn. The console teletype (device code 03/04) is automatically included in the system).

- KL8A1 equate to the device code for the first KL8A terminal multiplexer. The first KL8A is assigned the terminals beyond the last KL8E-TYPE interface.

- KL8A2 idem. Follows KL8A1.

- VC8E point plot interface - DPL.

- XY8E incremental plotter interface - PLOT.

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KL8E RICOH GP-10 plotter via KL8E interface - PLOT.

TM8E PDP8/E magtape control - MTA.

TC58 IO-bus magtape interface - MTA.

CR8E cardreader or marksensing card reader - CRD.

KV08 KV8/I or KV8/L display. Events DPL, JOY (=joystick).

RX01 Floppy disk controller (RX01/02/04) - RXA.

Every MULTI8 system must have at least one of the following clocks:

DK8EA line frequency clock (100/120 Hz) - TIMER.

DK8EC cristal clock (50/500/5000 Hz) - TIMER.

DKC8EP programmable clock, set to 10 Hz - TIMER.

DKC8AA cristal clock on PDP8/A option board - TIMER.

Special interfaces:

AX08 AX08 laboratory interfacing system. Events: AX08AD (AD-done flag), AX08RC (RCclock flag), AX08SM (smitt trigger interrupt), AX08ER (ADC-overflow flag), AX08XT (cristal clock flag).

DR8EA1 12 channel buffered digital I/O. Event IREG1. Because the DR8EA can be strapped to be non-interrupting, an entry in the skipchain is only generated if the symbol IREG1 is defined.

DR8EA2 second DR8EA, event is IREG2.

AD8EA AD-converter. Events ADC, ADCER.

DP8EA synchronous modem interface. Events DP8ECD (character detected flag), DP8ERO (receive wordcount overflow), DP8ETO (transmit wordcount overflow), DP8ERG (ring flag), DP8ECA (carrier on/off), DP8EBE (bus error).

UDEVn (n=1,2,3 or 4) these are dummy devices used to generate extra skipchain entries without editing M1.PA. Each of these four symbols, when defined in CONFIG.PA, generates a skipchain entry of the following form:

```
SKPDVn      ///SKIP ON DEVICE FLAG
JMP .+3     ///FLAG NOT SET, GOTO NEXT ENTRY
CLR DVn     ///FLAG SET, CLEAR FLAG
JMS I ZHRDINT ///AND POST EVENT
```

Along with UDEVn you must define the instructions SKPDVn and CLR DVn, eg. SKPDV1=6441; CLR DV1=6442 for an KL8E interface with devicecode 44. By default UDEV1 and UDEV2 have the highest priority in the system, and UDEV3 and UDEV4 have medium priority.

Further, the priority ordering of the skipchain must be specified. This is done by assigning the events of the devices included in the configuration numbers ranging from 1 up. To prevent gaps in between (which would result in undefined code in your skipchain) or double assignments, you may use the following layout:

```
      NOPUNCH          /WE DON'T WANT TO GENERATE ANY CODE HERE ...
      *1              /START AT 1

EVENT1, .            /THIS EQUATES 'EVENT1' TO 1
EVENT2, .            /THIS EQUATES 'EVENT2' TO 2

      INTDEV=.        /THIS IS THE NUMBER OF CONNECTABLE DEVICES

EVENT3, .            /THIS EQUATES 'EVENT3' TO 3
.....

      SKPDEV=.        /TOTAL NUMBER OF SKIPCHAIN ENTRIES
      MAXDEV=.        /TOTAL NUMBER OF DEVICE-BOUND EVENT SLOTS
      ENPUNCH         /DON'T FORGET TO TURN ON BINARY OUTPUT AGAIN !
```

As you can see there are two types of skipchain entries, those that can be connected to and those that can't be connected. This is done to limit the length of the connect table holding the jumpaddresses. The following standard devices must be connectable: SYS, TRAP (the timeharing trap interrupt), DTA (TC08), TIMER, PTR, CRD. A sample declaration will follow:

```
      NOPUNCH
      *1

SYS, .
TRAP, .
TIMER, .
DTA, .
PTR, .

      INTDEV=.

LPT, .
PTP, .
KB1, .      /KEYBOARD OF FIRST TERMINAL (DEVICE CODE 03)
KB2, .      /KEYBOARD OF SECOND TERMINAL
TTY1, .     /PRINTER OF FIRST TERMINAL (DEVICE CODE 04)
TTY2, .     /PRINTER OF SECOND TERMINAL

      SKPDEV=.
      MAXDEV=.

      ENPUNCH
```

Generally the order should be: most timecritical devices - devices with highest interrupt rate - other devices. Note that TRAP should only be included for installations with BGMAX not equal to zero.

For each background four symbols define the user's disk area:
USYSn is the name of the relevant disk handler task. Default SY.
UNITn is the unit number. Default UNITn=n.
FROMn is the offset of virtual block 0, default =0.
SIZEn is the length of the user disk. by default SIZEn=SYLNLT, the length of a unit of the system disk, eg. 6260 (octal) for RK05.

5.2 System Generation

After finishing CONFIG.PA we will build the system. This is done by executing a batch file with the OS/8 batch program.

Here follows a sample MULTI8.BI. Note that the contents of this file depends on the devices you have specified in CONFIG.PA.

```
$JOB MULTI8 SYSTEM GENERATION FOR
.DEL SWPFIL.M8,MULTI8.SV,SPOOL.*
.PAL M,M<CONFIG,M1,M2,M3,M4,M5(NDG)
.R GLOBL
*MS.PA<SYMBLS.GS,M.LS
.PAL MS,MONDUM/L
.SAVE SYS MONDUM
.DEL M.LS,MONDUM.BN
.PAL CD<MS,CD.TK
.PAL OD<MS,OD.TK
.PAL PA<MS,PA.TK
.PAL MA<MS,MA.TK
.PAL DI<MS,DI.TK
.PAL LI<MS,LI.TK
.PAL IT<MS,IT.TK
.PAL BS<MS,BS.TK
.PAL BE<MS,BE.TK
.PAL CB<MS,CB.TK
.PAL ST<MS,ST.TK
.PAL TA<MS,TA.TK
.PAL DS<MS,DS.TK
.R MULTI8
*CD,OD,PA,MA,DI,LI,IT,BS,CB
*ST,TA,DS/N$

.PAL LP<MS,LP.TK
.PAL LE<MS,LE.TK
.R MULTI8
*LP,LE/N$

.PAL PP<MS,PP.TK
.PAL PE<MS,PE.TK
.R MULTI8
*PP,PE/N$

.PAL PR<MS,PR.TK
.PAL RE<MS,RE.TK
.R MULTI8
*PR,RE/N$
```



```
.PAL DT MS,DT.TK
.PAL TE MS,TE.TK
.R MULTI8
*DT,TE/N$
```

```
.PAL KR MS,KR.TK
.PAL KE MS,KE.TK
.R MULTI8
*KR,KE/N$
```

```
.PAL RX MS,RX.TK
.PAL FE MS,FE.TK
.R MULTI8
*RX,FE/N$
$END
```

The first part of the file MULTI8.SV contains the save-image of the resident part of MULTI8, along with a program that can load task image from binary files, and a startup program for the system. When the system is initially loaded with the binary loader, and then started at 00200, it will create the file MULTI8.SV, and save itself. Then the taskbuilding part is entered, which calls the OS/8 command decoder to obtain the file names of the task binaries. The following command decoder options apply:

ESC AFTER processing any files specified on this line, exit from the taskbuilding phase. Timesharing operation is started or the system returns to the OS/8 monitor, depending on the option N.
/N do not start the timesharing system.

At the end of each taskbuilding sequence, the image of the system is saved again to permanently record patches to the system made through the task preambles. This mechanism must be used whenever you want to modify the resident system, eg.

```
.GET MULTI8
.ODT
XXXX/ YYYY ZZZZ
^C
.START
*CD$
```

You have to (re-)load a task in order to have the system image resaved. NEVER try to save the system with the OS/8 save command; this creates a new file MULTI8.SV which does not contain the task library.

After the taskbuilding phase, the system starts with the lookup of SWPFIL.M8. If not found, it will create one, insuring that it is large enough to locate each field on a disktrack. Then the swaptracks are initialized so that each terminal will initially perform the RESTORE operation. Thus it is not necessary to initialize the user disk area's: each time the system is started each user obtains a fresh copy of the OS/8 system. At the same time, the boot and restore program, suitably configured for the present OS/8 configuration, is written in the OS/8 scratch blocks.

N O T E

You should never modify the OS/8 system on DSK0: on a running system (eg. with PIP/Y), as that will impair the BOOT and RESTORE functions.

Further MULTI8 will patch the device length tables of PIP.SV on SYS:, if available, for devices 50 to 57. These device types have been assigned for the user disks and this patch thus allows PIP to give each user a proper directory after SQUISH or ZERO. It is mandatory that users use a shortsaver version of PIP, rather than a - possibly unpatched - copy. During system startup a number of errors may occur, resulting in one of the following messages:

?VIRTUAL MACHINE?

You are already executing in the background of MULTI8. (If not, you probably have a hardware problem in the console terminal interface; The sequence TCF; TSF did skip!).

?READING BLOCK 0?

An I/O error occurred while the system was reading block 0 of the system device.

?WRITING SYS:?

An I/O error occurred while the system was writing to the OS/8 scratch blocks. Note that the system device must be write-enabled!

?NO ROOM FOR MULTI8.SV?

This error only occurs during the initial start of a newly loaded system. There is insufficient room on SYS: to create the file MULTI8.SV, which contains both the core image of the system and the tasklibrary.

?NO ROOM FOR SWPFIL.M8?

If no suitable file SWPFIL.M8 exists, the system tries to create one (on SYS:). The length of SWPFIL.M8 is found by multiplying the number of backgrounds, the number of fields in each virtual memory and the number 16. Eg. a system with 4 backgrounds, each having a 20K virtual memory needs $4*5*16=320$ blocks (decimal). The actual file may be upto 15 blocks longer because the system insures that each 4K field starts at a physical disk track.

?MULTI8.SV NOT ON SYS:?

The file MULTI8.SV must be on SYS: because it contains the task library.

?MEMORY MANAGEMENT?

The memory management hardware is not present.

?NON-RESIDENT HANDLER?

Binary tasks to be loaded must reside on a device whose handler is (co-)resident with SYS:.

?READ ERROR?

A device read error occurred while loading tasks.

?PREAMBLE ERROR?

During loading of a task a task preamble was found to be in error. (See section 2.4)

?BAD BINARY?

A checksum error was detected during loading of a task.

?MULTI8.SV TOO SHORT?

The file MULTI8.SV is too short to contain the image of the task that is loaded.

?CHECKSUM?

A checksum error was detected during loading of a task.

?TASK LENGTH?

The actual task length does not agree with the length specified in the task header.

?TASK LIBRARY FULL?

There is no room to accommodate the new task in the bitmap of the task library. This bitmap is used to allocate the diskblocks in MULTI8.SV and can hold about 240 blocks. This problem could be caused by fragmentation of the map; try to reload all tasks in an empty system.

?NAME LIST FULL?

The number of task control blocks is exhausted: regenerate a system with MAXNAM set to a larger value.

?WRITE ERROR?

An IO error occurred while writing a newly loaded task to the tasklibrary.

?UNDEFINED ERROR?

The error handler in the MULTI8 initializer was called from an undefined point. Please notify WESTVRIES.

If the system does not run, check the following: Were there any error messages in the batch log? All programs and tasks should assemble without any error, without any 'links generated'. A number of checks are built in the Monitor source, that result in US (Undefined Symbol) errors of PAL8. See appendix A for an explanation of these errors.

5.3 MULT8 - OS/8 interfaces.

In this section we will describe the sometimes rather complicated relation between MULTI8 and OS/8. At first sight, the virtual machine concept would make these systems independent, but for two reasons they are not.

First, the MULTI8 system needs some base from which it can be launched. OS/8 give us all the facilities necessary to assemble, load and start the system. Second, by anticipating the properties of the system running on the virtual machine, the performance of the timesharing system can be much improved. For instance, MULTI8 makes use of the fact that the end of a program or program step is marked by OS/8 reading the Keyboard Monitor or the Command Decoder into certain sections of memory. Because all disk requests pass through the hands of the timesharing subsystem, this is able to release claimed input/output devices (e.g. lineprinter) automatically. Without this knowledge of the system running on the virtual machines, the users would be forced to release devices by explicit commands to the timesharing system. Indeed, there are situations where a truly system-independent emulation is impossible.

The more subtle interactions between MULTI8 and OS/8 occur during the startup phase of MULTI8. It is at that point that a large number of links between the systems are made.

The I/O performed by background programs runs along two different lines. Some devices like the terminal are emulated more or less straightforward, that is, each IOT executed in the background is simulated in the foreground. For other devices like disk and DECTape, another solution is chosen, called the 'fakehandler'.

During the startup phase of MULTI8, the OS/8 system is interogated with INQUIRE requests, in order to see which devices are present in the OS/8 configuration and with what internal device numbers. The virtual field 0 top page of the background's memory, where normally

the OS/8 system handler resides, is overlaid with a dummy system handler, which incorporates a large number of extra entry points. The function of this so called 'fakehandler' is only, to pass the parameters of the I/O request to the foreground, along with an indication of the desired device and unit number. The top-page of OS/8 field 1 contains a table, called the Device Residency Table, which is used by the USR to keep track of where handlers are loaded. When an entry in this table is larger than 7600, it is assumed that the corresponding handler is co-resident with the system handler (like RKBO) and thus always present in memory. This table is filled with the addresses of the extra fakehandler entrypoints for all devices that are not downright emulated: SYS:, DSK:, LPT: and DTAn:. All this is table driven and can easily be adapted or extended for special situations.

A copy of the adapted top-pages is kept in the OS/8 scratch blocks on DSK0: and is used by the BOOT and RESTORE commands.

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6. Utility programs.

Along with MULTI8 come a few utility programs:

MONDUM.SV	crash-dump generator.
SHSAVE.SV	a program to generate SHort SAVEfiles.
GLOBL .SV	generates symbol definitions from a symbol table.
XCL .SV	extension to CCL.SV.

6.1 MONDUM.SV

The monitor dump program is a tool for the system programmer who needs information on the state of the system, either during its running or after a system crash. MONDUM.PA is assembled with the monitor symbol definitions file (MS.PA) and therefore 'knows' where all kind of system variables are located. If the program runs in the MULTI8 background, it will obtain these variables through the PEEK IOT. In the background MONDUM loads in virtual field 0.

MONDUM can also be used as a true crash dump program. When the machine is stopped and manually started at 07757, MONDUM is loaded in the first background field, eg. field 2 normally. In this case MONDUM obtains its data from real memory, and prints a report that describes the situation when the machine was stopped.

The output of MONDUM goes to the lineprinter if a lineprinter is part of the MULTI8 configuration, otherwise it goes to the console terminal. Next follows an example of MONDUM output.

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MULTI8 V7A MONITOR DUMP. DATE 07/02/79 TIME 13:31

CURTSK 4513 FCFREE 0020 ERRTSK 0000 AT 0000 ERRLOG 0000 ERSTAT 000
 BJOB 3521 SJOB 3521 LJOB 3521

FREE 0152 5247 5227 5237 5217 5207 5177 5257
 5267 5277 5307 5317 5327 5337 5347 5357
 5367
 INTQ 0153
 PRIQ 0155
 CORQ 0157

SYSQUEUE

*3400 2047 1403 2047 1403 2050 0360 2047 0526
 *3410 0047 5070 0047 4660 2047 1403 2047 1403

COREMAP

0	\$\$	\$\$	\$\$	\$\$	\$\$	\$\$	\$\$	\$\$	\$\$	\$\$	\$\$	\$\$	\$\$	\$\$	\$\$	\$\$	\$\$
0	\$\$	\$\$	\$\$	\$\$	\$\$	\$\$	BS	BS	BS	BS	TE	-DT	-DT	..	..	\$\$	\$\$
1	\$\$	\$\$	\$\$	\$\$	\$\$	\$\$	\$\$	\$\$	\$\$	\$\$	\$\$	\$\$	\$\$	\$\$	\$\$	\$\$	\$\$
1	\$\$	\$\$	\$\$	\$\$	\$\$	L8	L8	L8	-PO	-PO	LE	LE	LE	..	..	\$\$	\$\$
2	\$\$	LP	LP	LP	LP	LP	..	..	..	..	..	..	..	..	..	..	..
2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
3	\$\$																

BG 1	STAT	MQ	SC	PC	LUID	AC	INST	SW
*3323	0710	2400	5500	2056	1100	0314	6212	0000
*3333	0627	0671	4200	3044	0000	5167	5167	0000
*3343	4331	4331	4373	4403	2631	4511	2631	6230
*3353	2631	6232	0000	0000	0000	0000	0000	0000
*3363	0000	0000	0000	4233	4223	7760	0110	2271
*3373	0000	3375						

BG 2	STAT	MQ	SC	PC	LUID	AC	INST	SW
*3375	0710	0000	5000	0453	1100	0000	6213	0001
*3405	0627	0232	1000	4124	0035	4003	4702	0000
*3415	4057	4057	4423	4433	2631	4522	2631	6230
*3425	2631	6236	0000	0000	0000	0000	0000	0000
*3435	0000	0000	0000	4253	4243	7747	0111	0352
*3445	0003	3447						

BG 3	STAT	MQ	SC	PC	LUID	AC	INST	SW
*3447	4600	0000	7700	1210	5100	0000	6031	0000
*3457	3323	1033	0000	0007	0000	5157	5157	0000
*3467	4207	4207	4453	4463	2631	4533	2631	6230
*3477	0000	0000	0000	0000	0000	0000	0000	0000
*3507	0000	0000	0000	4273	4263	7733	0112	1723
*3517	0002	3521						

BG 4	STAT	MQ	SC	PC	LUID	AC	INST	SW
*3521	2200	1300	0000	0315	1100	3526	6264	0000
*3531	0627	0740	0000	6253	0000	4434	4434	0000
*3541	4502	4502	4503	4513	2631	4544	2631	6230
*3551	0000	0000	0000	0000	0000	0050	0000	0000
*3561	0000	0000	0215	4313	4303	7717	0113	0067
*3571	0000	3573						

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BG 5	STAT	MQ	SC	PC	LUID	AC	INST	SW
*3573	2310	7371	3700	7727	5100	0010	6000	0000
*3603	0627	4210	0200	1137	0000	4601	4601	0000
*3613	4752	4752	4533	4543	2631	4555	2631	6230
*3623	0000	0000	0000	0000	0000	0040	0070	0000
*3633	0000	0000	0000	4333	4323	0041	0114	3167
*3643	0015	3645						

BG 6	STAT	MQ	SC	PC	LUID	AC	INST	SW
*3645	4600	0000	5000	7727	5100	0012	6000	0000
*3655	4743	3620	0000	0714	0000	4631	4631	0000
*3665	4403	4403	4563	4573	2631	4566	2631	6230
*3675	0000	0000	0000	0000	0000	0000	0000	0000
*3705	0000	0000	0000	4353	4343	7751	0115	2471
*3715	0005	3323						

TCBTAB	BLNK	THRD	S.A.	BLK	STAT	FLD	AC	PC	NAME
*4177	0001	0000	3314	0000	0000	3100	7773	3350	TI
*4207	0000	4510	3000	0000	0000	7110	0526	3000	SY
*4217	0000	0000	0200	3013	0010	7104	0000	0303	T1
*4227	4364	4410	0336	3025	0010	3104	7775	0346	K1
*4237	0000	0000	0200	3027	0010	7104	0000	0303	T2
*4247	4414	0000	0336	3041	0010	7104	7771	0346	K2
*4257	0000	0000	0200	3043	0010	7104	0000	0303	T3
*4267	4444	0000	0336	3055	0010	3104	7775	0346	K3
*4277	0000	0000	0200	3057	0010	7104	0000	0303	T4
*4307	4474	4330	0336	3071	0010	3104	7775	0346	K4
*4317	0000	0000	0200	3073	0010	7104	0000	0303	T5
*4327	4524	0000	0336	3105	0010	3104	7775	0346	K5
*4337	0000	0000	0200	3107	0010	7104	0000	0303	T6
*4347	4554	0000	0336	3121	0010	3104	7775	0346	K6
*4357	0001	4470	1603	3323	0010	3104	7775	1642	I1
*4367	0000	0000	2403	3323	0010	3104	0000	2425	O1
*4377	0001	0000	1504	3323	0010	7104	0000	0704	E1
*4407	0001	4420	1603	3375	0010	7104	7771	1642	I2
*4417	0000	4270	2403	3375	0010	3104	1614	2403	O2
*4427	0001	0000	1504	3375	0010	7104	0000	0704	E2
*4437	0001	0000	1603	3447	0010	3104	7775	1642	I3
*4447	0000	0000	2403	3447	0010	3104	0000	2425	O3
*4457	0000	0000	1504	3447	0010	3100	0000	2353	E3
*4467	0001	4520	1603	3521	0010	3104	7775	1642	I4
*4477	0000	0000	2403	3521	0010	3104	0000	2425	O4
*4507	0001	0000	1504	3521	0010	3104	0000	1020	E4
*4517	0001	4230	1603	3573	0010	3104	7775	1642	I5
*4527	0000	0000	2403	3573	0010	3104	0000	2425	O5
*4537	0001	0000	1504	3573	0010	3100	0000	2353	E5
*4547	0001	0000	1603	3645	0010	3104	7775	1642	I6
*4557	0000	0000	2403	3645	0010	3104	0000	2425	O6
*4567	0001	0000	1504	3645	0010	3104	3645	1020	E6
*4577	0001	4550	5407	2577	0400	7104	7777	6016	BS
*4607	0001	5110	6403	2601	0111	3104	0000	6407	CD
*4617	0000	0000	0003	2602	0131	3100	0000	0000	OD
*4627	4513	0000	6406	2603	0310	3104	3521	6406	LE
*4637	0000	0000	3013	2605	0321	3100	0000	3272	CB
*4647	0000	0000	6603	2607	0101	3104	0000	6714	IN
*4657	0000	0000	1406	2610	0321	3100	0000	1442	DI
*4667	0000	0200	7204	2612	0201	3104	3375	7204	BE
*4677	0000	0000	7206	2613	0201	7100	0000	7304	RE

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*4707	0000	0110	6406	2614	0111	7100	0000	6406	PR	OM	TAT2	
*4717	0000	0000	7203	2615	0101	7104	0000	7343	TA			
*4727	4744	0000	6615	2616	0200	3100	0000	7032	DT			
*4737	4574	0000	6404	2617	0100	7100	0000	6536	TE			
*4747	0000	0000	0006	2620	0531	3100	0000	0000	QP			
*4757	0000	0000	0006	2623	0131	3100	0000	0000	QE			
*4767	0000	0000	0003	2624	0131	3100	0000	0000	PP			
*4777	0000	0000	0005	2625	0331	3100	0000	0000	PE			
*5007	0000	0000	0215	2627	0421	7110	0000	0561	PL	OM	TAT2	
*5017	0000	0000	6406	2631	0311	3110	7777	6526	GE			
*5027	0000	0000	7210	2633	0201	3104	4215	7411	ST			
*5037	0001	0300	6611	2634	0301	3100	0000	6614	Z8			
*5047	5063	0000	0233	2636	1121	3110	0002	0310	LH			
*5057	0000	4210	7212	2643	0201	7104	3645	7212	CE			
*5067	4633	5250	0207	2644	0520	3110	0000	0311	LP			
*5077	0000	0000	0003	2647	0131	3100	0000	0000	PA			
*5107	0000	0000	7203	2650	0101	3104	0000	7321	MA	TH	BLK	TAT2
*5117	0000	0000	6404	2651	0101	3100	0000	6475	IT			
*5127	0001	4270	5215	2652	0310	3104	7766	5432	L8			
*5137	5153	0000	6615	2654	0311	7100	0000	7150	AX			
*5147	0000	0000	6404	2656	0111	3104	0000	6536	AE			
*5157	0001	0000	6005	2657	0211	3100	6674	6011	PO			
*5167	0000	4440	0215	2660	0421	3110	0002	0307	IO			
*5177	5257	0000	0000	0000	0000	7100	0000	2411				
*5207	5177	0000	0000	0000	0000	3100	0000	2411				
*5217	5207	0000	0000	0000	0000	3100	0000	2411				
*5227	5237	0000	1412	0000	0000	3100	0000	2411				
*5237	5217	0000	0000	0000	0000	7100	0000	2411				
*5247	0001	0000	0412	0000	0020	3110	0001	0746				
*5257	5267	0000	0000	0000	0000	0000	0000	0000				
*5267	5277	0000	0000	0000	0000	0000	0000	0000				
*5277	5307	0000	0000	0000	0000	0000	0000	0000				
*5307	5317	0000	0000	0000	0000	0000	0000	0000				
*5317	5327	0000	0000	0000	0000	0000	0000	0000				
*5327	5337	0000	0000	0000	0000	0000	0000	0000				
*5337	5347	0000	0000	0000	0000	0000	0000	0000				
*5347	5357	0000	0000	0000	0000	0000	0000	0000				
*5357	5367	0000	0000	0000	0000	0000	0000	0000				
*5367	0000	0000	0000	0000	0000	0000	0000	0000				

PAGE ZERO REGISTERS, FIELD 0000

*0000	0315	5177	6014	3023	1107	6202	5407	1000
*0010	3570	0256	3745	3526	5256	0000	0000	0000
*0020	3505	7770	1020	0000	7104	0040	4627	4513
*0030	3645	0031	1100	0000	0107	0110	0111	0600
*0040	0647	0002	0003	0004	0007	0017	0037	0070
*0050	0077	0100	0177	0200	0212	0215	0240	0260
*0060	3700	6201	7000	7400	7563	7600	7700	7770
*0070	7771	7774	7775	7776	7777	0000	6203	5500
*0100	1634	7227	0047	1061	3105	6251	5501	6201
*0110	6202	6203	0721	3020	1420	5512	0000	0613
*0120	0473	0671	3521	3645	3645	4513	6700	6700
*0130	6642	0000	0000	0000	0431	0000	6505	0000
*0140	7040	1714	2012	2056	1674	2120	2120	6715
*0150	0000	0000						

PAGE ZERO REGISTERS, FIELD 0010

*0000	0000	0240	6436	3023	1107	6202	5407	1000
-------	------	------	------	------	------	------	------	------

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*0010	3562	3562	0000	0000	3526	0000	0000	0000
*0020	0020	0714	3524	3525	3526	0315	6251	3527
*0030	3521	0000	0000	0000	0107	0110	0111	0600
*0040	0647	0002	0003	0004	0007	0017	0037	0070
*0050	0077	0100	0177	0200	0212	0215	0240	0260
*0060	3700	6201	7000	7400	7563	7600	7700	7770
*0070	7771	7774	7775	7776	7777	0000	6203	5500
*0100	1634	1244	0047	1061	3105	6251	5501	6211
*0110	6212	6213	2146	3020	1420	5512	3760	1112
*0120	3521	1022	6201	7260	1532	3030	1430	3030
*0130	6211	5521	0125	0664	1533	2133	1030	3020
*0140	1420	5533	1360	3133	1542	2142	1030	3020
*0150	1133	3420						

PAGE ZERO REGISTERS, FIELD 0020

*0000	0000	5177	0744	3023	1107	6202	5407	1000
*0010	7177	1777	0000	0000	0000	1132	1612	0000
*0020	0000	4020	0001	0000	0000	0000	0000	3305
*0030	3447	0000	0000	0000	0107	0110	0111	0600
*0040	0647	0002	0003	0004	0007	0017	0037	0070
*0050	0077	0100	0177	0200	0212	0215	0240	0260
*0060	3700	6201	7000	7400	7563	7600	7700	7770
*0070	7771	7774	7775	7776	7777	0000	6203	5500
*0100	1634	0465	0047	1061	3105	6211	5501	6221
*0110	6222	6223	1054	3020	1420	5512	0000	7457
*0120	1300	1463	0000	0214	1300	1472	1073	0257
*0130	1301	0677	0663	1360	1302	0045	0000	7441
*0140	1302	0674	0000	7403	1304	1346	0070	0121
*0150	1304	1346						

HRDLST

*3433	0000	4613	0000	0000	0000	0000	0000	0001
*3443	0000	0000	0000	0000	0000	0000	7774	4203
*3453	7772	5133	0000	0000	0000	0001	0000	0000
*3463	0000	0000	0002	0000	0000	0000	0000	0001
*3473	0000	0000	0000	0000	0000	5043	0000	0000
*3503	0000	0000	0001	5253	0000	0000	7777	4233
*3513	7774	4253	7776	4273	7775	4313	7775	4333
*3523	7775	4353	0000	0001	0000	0001	0000	0001
*3533	0000	0001	0000	0001	0000	0001	0000	0000
*3543	0000	0000	0000	0000	7026	5163	0000	4743
*3553	0000	0000	0000	0000	0000	0000	0000	0000
*3563	0000	0000	0000	0000	0000	0000	0000	0000
*3573	0000	0000	0000	0000	0000	0000	0000	0000
*3603	0000	0000	0000	0000	0000	0000	0000	0000
*3613	0000	0000	0000	0000	0000	0000	0000	0000
*3623	0000	0000	0000	0000	0000	0000	0000	0000
*3633	0000	0000	0000	0000	0000	0000	0000	0000
*3643	0000	0000	0000	0000	0000	0000	1502	0000
*3653	0030	0000	0000	4433	0030	0000	0070	0000
*3663	0000	4543	0030	0000				

The following notes apply to the interpretation of a dump:

CURTSK points to the task that was running at the moment that the system crashed. Often that is the task in error, but it can also be that an interrupt routine or databreak transfer has blown up the system. If CURTSK=1, a background program was in execution.

FCFREE is the number of free task control blocks in freecore.

When ERRTSK is non-zero, it is the TCBP of a task that was aborted by the system (via the monitor routine ALARM).

ERRLOG records the number of retries on the system disk, and ERSTAT holds the contents of the disk's status register at the time of the last disk error. Its interpretation depends on the type of system disk you have.

BJOB points to the data-area of the background that is currently in memory. SJOB and LJOB point to the interactive and the computebound running job, respectively.

FREE, INTQ, MAINQ and CORQ are the systems queues: queue of free task control blocks, queue of tasks activated by a hardware interrupt, queue of runnable tasks, queue of task waiting for memory space to get loaded.

SYSQUEUE is the contents of the system disk request queue. Each queue entry consists of two words. The first word contains the field of the request and the event number for completion in the form fff.00e.eee.eee; The second word is a pointer to the request parameters.

For the layout of the coremap see the description of the task MA, section 3.2.

BG n is a dump of the background data-area for each background in the system. See section 4.1 for the layout of this data-area.

TCBTAB is the Task Control Block Table. The format of the Task Control Block is described in section 2.2.

For each of the foreground fields part of page 0 is dumped. This allows you to check the ZTEM registers, X, the monitor entry point and the constants.

HRDLST holds the 2-word event variables.

Exercises for the reader: Was this dump produced in the background or stand-alone? If from the background, from which terminal? Why are both INTQ and MAINQ empty?

6.2 Short Savefile generator.

A common problem in all computer installations is lack of disk storage space. In a MULTI8 system, where each user has a private system device, system programs like PIP, EDIT, etc. tend to be present on each user disk. It is possible to place all system programs on the system disk area (DSK0:), but then these programs must be called with the RUN DSK0 XXX command. Also, chaining to programs on DSK0: is not possible. The program SHORTSAVE (SHSAVE.SV) makes it possible to have all system programs available on each user disk, without sacrificing

too much space: each savefile will be 2 blocks long. In fact these savefiles contain a small program that reads the real program from DSK0: and starts it.

SHSAVE starts with calling the Command Decoder. It takes up to 5 input file specifications, and the following options:

- /A All, combine option B, F, P, S, X and 4.
- /B BASIC programs: BASIC, BCOMP and BLOAD.
- /F Fortran II: FORT, SABR and LOADER.
- /L List all processed programs.
- /N Don't give error messages for programs that are not on DSK0:
- /P PAL8 programs: PAL8, ABSLDR, CREF and BITMAP.
- /Q Ask the user which programs to include.
- /S standard programs: FOTP, TECO, DIRECT, EDIT, PIP, SRCCOM and RESORC.
- /X Process a list of installation-specific programs.
- /4 Fortran IV: F4, PASS2, RALF, LOAD, FRTS and LIBRA.

Examples of usage:

```
.RUN DSK0 SHSAVE
*/B/L
BASIC.SV
BLOAD.SV
BCOMP.SV
*/P
*/P/Q
PAL8.SV ?Y
ABSLDR.SV ??Y
CREF.SV ?N
BITMAP.SV ?Y
*QQQQQ
QQQQQ.SV NOT FOUND
*PIP$
.
```

Note that some files of the BASIC and FORTRAN IV system must be on the users disk, because they are used as overlays, rather than being chained to. This applies to BASIC.UF, BASIC.SF, BASIC.AF, BASIC.FF, PASS20.SV and PASS3.SV. SHSAVE is largely table driven. If you want to include some local programs, this will not prove difficult. A special option has been predefined for this purpose (/X). Search SHSAVE.PA for the symbol 'XLST,', and insert the name(s) of your pet programs, eg.:

```
XLST,  FILENAME PROGRM.SV
        FILENAME FUNY.SV
        FILENAME SERIOU.SV
        0
```

SHSAVE may produce the following error messages:

ONLY IN MULTI-8

SHSAVE is restricted to use in MULTI8 timesharing only.

DSKO: NOT RESIDENT

Somehow CLOSE DSKO: has been issued, or possibly the name DSKO: is assigned to a non-resident handler.

xxxxxx.SV: NOT FOUND

The program xxxxxx.SV is not available on DSKO:

NO ROOM, SKIPPING xxxxxx.SV

There is no room for a two-block file on the user's SYS:

OUTPUT ERROR, SKIPPING xxxxxx.SV

CLOSE ERROR, SKIPPING xxxxxx.SV

ERROR READING xxxxxx.SV

xxxxxx.SV HAS TOO MUCH ENTRIES

SHSAVE can only handle savefiles that consist of 10 or less segments.

6.3 Global Symbol Generator.

The program GLOBL translates a DDT compatible symbol table from PAL8 to symbol definitions that may be read by PAL8 on subsequent assemblies. GLOBL is started by the normal R command

.R GLOBL in response to the Command Decoder "*", the user should enter one output file specification and two input file specifications plus optional switches.

*DEV:FILE.EX<FILE1.EX,FILE2.EX/OPTIONS

The first input file should contain all symbols for which a symbol definition must be generated in the following format:

```
*  
SYMBL1  
SYMBL2  
SYMBL3
```

```
....  
SYMBLn  
*
```

The second input file should be a DDT-compatible symbol table produced by PAL8, e.g.

.PAL ,FILE2<PROG/N/D/H

The output of GLOBL has the following form:

```
XLIST  
IFNDEF MONITO <
```

```
SYMBL1=0001;    SYMBL2=0002;    SYMBL3=0003;    SYMBL4=0004
```

```
.....  
SYMBLn=nnnn >  
FIXTAB;XLIST
```

The condition IFNDEF MONITO insures that the symbol file is processed only during the first pass).

GLOBL has two options, /A and /V. /A means process All symbols. Nevertheless file1 must be specified. /V means inVerted mode; all symbols defined in FILE1 are NOT processed.

6.4 eXtended Command Language

The XCL program performs a number of functions needed or desirable in an OS/8 system that runs in a timesharing environment. Most of its functions are in fact extensions to CCL, which were implemented in a separate program rather than being packed into the already tight CCL itself.

With one exception all functions of XCL are invoked through new CCL commands. In these cases CLL is only made to know the command and chain to XCL, which then analyzes the command and performs the desired function.

The exception is the login procedure, which is activated when XCL is run. The login procedure is quite simple. It sets some locks to prevent the use of ^C, disables the MULTI8 echo, and asks for a password. You may want to extend this with a user name, recording of the beginning of a session for this user in an account file, etc. If the password is correctly entered, XCL tests whether it is running in the background or stand-alone. For stand-alone OS/8 the login is complete after typing a welcoming message on the terminal. In the MULTI8 background, XCL will start a batchfile, DSKO:LOGIN.BI. This file may contain any usefull initialisation commands, eg.:

```
$JOB LOGIN  
.TYPE DSKO:TODAY  
.SET SYS: NO INIT  
$END
```

The SET command complements another SET command that is executed at the end of a session (see below).

At the end of a terminal session the user may sign off with the command BYE. This command is accepted by CCL and passed to XCL. XCL will report the amount of cpu-time used and then ask for permission to delete a set of more or less temporary files:

```
CPU TIME USED 1 DAYS, 3 HOURS, 13 MINUTES, 16.5 SECONDS  
I WILL DELETE *.MP,*.LS,*.WU,*.BK,*.TM - OK ?
```

Depending on the users reply one of two batchfiles is started, LOGOUT.BI or QUIT.BI:

```
$JOB
.DEASSIGN
.CLOSE ALL
.OPEN DSKO
.DELETE *.TM,*.LS,*.WU,*.BK,*.MP
.RUN DSKO SHSAVE
*XCL.SV$
.SET SYS INIT R XCL
.SQUISH SYS:/O
.RUN DSKO:XCL
$END
```

```
$JOB
.DEASSIGN
.CLOSE ALL
.OPEN DSKO
.SQUISH SYS:/O
.SET SYS INIT R XCL
.RUN DSKO SHSAVE
*XCL.SV$
.RUN DSKO:XCL
$END
```

The SET command prevents that the user can escape from the password question by typing CONTROL/B, BOOT. On the other hand, it would be silly if you had to login each time you reboot your OS/8. So, once you are logged in, the INIT command is disabled.

A useful addition to these batch file could be a command like

```
.TALK 1 LOGGED IN
```

The effect would be that each time a user logs into the system, terminal 1 gets the message:

```
n: LOGGED IN
```

where n is the number of the terminal. Similarly a message can be generated when a users signs off.

This introduced another XCL command, TALK. TALK allows user to send a one-line message to another terminal, or to all terminals. Such a broadcast message is simply addressed to terminal 0. The message is then send to all terminals succesively, starting with terminal 1. If a terminal is locked by a foreground task, however, the TALK task times out and aborts.

The other XCL commands are OPEN and CLOSE and serve to create and delete access paths to other user's disks. OPEN inserts one of the user disks (DSKn:) into your OS/8 monitor, just as if you had activated a new handler with BUILD. If you use the option /W, the device will be read/write, otherwise it is a read-only device. Besides DSKO:, which is automatically opened, you can have two user disks open simultaneously. With the CLOSE command you remove a named user disk from your OS/8 system. CLOSE without device name, or CLOSE ALL will close all open user devices except DSKO:. Note that OPEN and

CLOSE affect your own system only.

MULTI8 Assembly Errors

The following is a list of the assembly error messages from 0/74-m.pq

ERR001 The priority of TIMER in the expansion should be higher than the priority of SYS. If the check in the EXP01 channel is interrupted.

ERR002 Page zero overflow. Try to reduce the number of expandable expansion entries (and thus the length of EXP01).

ERR003 The value of SMULTI8 is expected to be 200. Your's value is not. Try to change that.

ERR004 There are more internal tasks than 100 in the task table block table (TOBTAB). MAXNAM should be increased.

ERR005 The total code plus data entries in EXP01 exceed 100. Some of the parameters MAXNAM, FIELD or VICTIM.

ERR006 Either a BK foreground was specified (FIELD=1), or a virtual memory of BK (BACKGROUND), or a virtual memory of code (CODE=3) on a machine with only two foreground tasks.

Backgrounds.

MULTI8 Assembly Errors.

The following is a list of the possible assembly error messages from M1.PA-m5.pa.

- RFCERR The priority of TIMER in the skipchain should be higher than the priority of SYS, if the clock is the RF08 photocell interrupt.
- ZEROER Page zero overflow. Try to reduce the number of connectable skipchain entries (and thus the length of CONTAB).
- EMULER The value of EMULATE is expected to be 2000. You'd better not try to change that.
- TCBOVF There are more internal tasks than fit in the task control block table (TCBTAB). MAXNAM should be increased.
- ENDFOO The total code plus data tables in field 0 exceed 4K. Decrease some of the parameters MAXNAM, FIELDS or GIGAMX.
- NOCORE Either a 4K foreground was specified (FIELDS=1), or a virtual memory of 4K (BGCORE=1), or a virtual memory of more than 8K on a machine with only two fields available for the backgrounds.

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