PRIME

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PRIME ENGINEERING HANDBOOK

for

PRIME P400, P500; PRIMOS IV, V

June, 1978

PE-T-500 REV 0

PRIME ENGINEERING HANDBOOK

This revision corresponds to PRIMOS REV 15.

This is the initial release of the Prime Engineering Handbook, a document produced and maintained by Prime Computer Research and Development. Comments and requests to be added to the distribution list for handbook updates should be addressed to Maggie Chianese, Documentation Administrator, Prime Computer Research and Development, 3 Newton Executive Park, Newton, MA 02162 (617-964-1730, x215).

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PE-T-500 REV 0

Table of Contents

1 INTRODUCTION

OVERVIEW

This handbook provides a summary of information needed for the development and maintenance of Prime P400 and P500 hardware and software systems. While this book contains information useful to a general user community, the information is presented in very condensed form. It is assumed that the reader has had prior contact with this material and, therefore, that detailed descriptions are unnecessary.

Some of the information contained herein pertains only to the latest revision of PRIMOS. This information will be updated on a regular basis as new revisions are released. (Refer to the inside of the cover for the revision currently reflected in this version of the handbook.) Readers are strongly urged to report errors, discrepancies, and omissions as soon as they are noticed.

SYNTAX

The descriptions of commands and external programs use the following syntax:

Abbreviations

Uppercase letters represent minimal abbreviations for commands and options. (When actually typing the command or option, either uppercase or lowercase can usually be used. Exceptions are noted.) For example:

```
COMOutput
```

specifies the COMOUTPUT command. COMO, COMOU, COMOUTP, etc., also specify this command.

Command Line Variables

Greater-than (>) and lesser-than (<) signs surrounding a string indicate a variable for which specific information is to be substituted; for example:

```
<filename>
```

should be replaced with a valid filename. Notice, however, that the use of greater-than and lesser-than signs in treenames is literal.

Optional Parameters

Brackets enclose optional parameters for a command; for example:

```
SHutdn [ ALL ]
```

Alternative Operand Specification, Defaults

When an operand has more than one possible specification, choices are stacked. A default option, if any, is underscored; for example:

```
OPRpri [ 1 ]
       [ 0 ]
```

The OPRPRI command accepts a single parameter of 1 or 0. If none is specified, the default parameter is 0.

Repeated Operands

Ellipsis indicate an operand that may be repeated one or more times; for example:

```
Close <funit> ...
```

The CLOSE command accepts one or more file unit specifications (separated by blanks or commas).

2 CENTRAL PROCESSING UNIT

ARGUMENT POINTER (AP)

```
1                 16 1                16
|B|BBB|I-Z|ZLS|---|---|P|PPP|PPW|WWW|WWW|WWW|
```

BBBB	Bit Number	
I	Indirect	
ZZ	Base Register:	00 - PB
		01 - SB
		10 - LB
		11 - XB
L	Last AP in arglist	
S	Store	
P..W	Page/Word Disp from Base Reg	

Typical values, first word:

100	PB Rel.	4100	PB Rel. Indirect
300	PB Rel. Last	4300	PB Rel. Indirect Last
500	SB Rel.	4500	SB Rel. Indirect
700	SB Rel. Last	4700	SB Rel. Indirect Last
1100	LB Rel.	5100	LB Rel. Indirect
1300	LB Rel. Last	5300	LB Rel. Indirect Last
1500	XB Rel.	5500	XB Rel. Indirect
1700	XB Rel. Last	5700	XB Rel. Indirect Last

CHECKS

CHECK HEADER (4 WORDS): PBH,PBL,KEYS,MODALS

4/200	Power Fail
4/270	Memory Parity
4/300	Machine Check
4/310	Missing Memory Module

On entry to fault handler, mode=64V, MCM=0 for all but ECCC, for which MCM=MCM-at-check - 1.

MMOD interrupts any other check in progress.

MCHK and ECCU interrupt ECCU in progress if MCM=2 (QUIET).

CONCEALED STACK/QUEUE

(Valid only between time of fault and subsequent CALF instruction.)

PCB+'74 --> FIRST	+0	PBH
PCB+'75 --> NEXT	+1	PBL
PCB+'76 --> LAST	+2	KEYS
	+3	FCODE
	+4	FADDRH
	+5	FADDRL

(PB, KEYS are those of procedure causing the fault.)

DIAGNOSTIC STATUS WORD (DSW)

DSWRMA: R34 DSWSTAT: R35 DSWPB: R36

DSWSTATH:

1	100000	CI - Check Immediate
2	040000	MC - Machine Check
3	020000	MP - Memory Parity (ECC)
4	010000	MM - Missing Memory
5-7	007000	Machine Check Code (Valid if bit 8=1):
		xx0xxx Peripheral Data (BPD) Output
		xx1xxx Peripheral Addr (BPA) Input
		xx2xxx Memory Data (BMD) Output
		xx3xxx Cache Data (RCD)
		xx4xxx Peripheral Addr (BPA) Output
		xx5xxx RDX-BPD Input
		xx6xxx Memory Address (BMA)
		xx7xxx Register File (RF)
8	000400	Not RCM Parity (P500, XCS)
9	000200	ECCU -- ECC Uncorrectable Error
10	000100	ECCC -- ECC Correctable Error
11	000040	BUP Invalid -- RP Backup Count Invalid
12-14	000034	RP Backup Count -- Sub from DSWPB
15	000002	Check During DMX
16	000001	IO Bus -- DMX, PIO, u-code check

DSWSTATL:

1-5	174000	ECCC Syndrome*:	
		000xxx MB	100xxx MB
		004xxx MB	104xxx 7
		010xxx MB	110xxx MB
		014xxx 15	114xxx 3
		020xxx MB	120xxx MB
		024xxx 14	124xxx 2
		030xxx 13	130xxx 1
		034xxx 9	134xxx C2
		040xxx MB	140xxx 8
		044xxx MB	144xxx 6
		050xxx MB	150xxx 5
		054xxx 12	154xxx C5
		060xxx 16	160xxx 4
		064xxx 11	164xxx C4
		070xxx 10	170xxx C3
		074xxx RP,C1	174xxx NE
6	002000	OP -- Overall Parity	
7	001000	Unused	
8	000400	Mod # (L.O. addr bit of module in err)	
9	000200	RMA Invalid	
10	000100	Unused	
11-16	000077	U-Verify Test Number	

*** U-Verify Test Number ***
to be supplied at next update

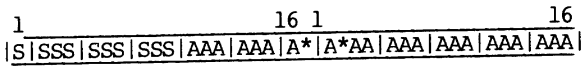
* MB=Multibit, RP,LP=Right/Left Parity,
Cn=Check Bit n, NE=No Errors

See Micro Code Handbook for additional information.

DMQ

See DMX under Peripheral I/O.

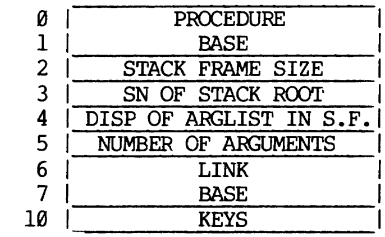
DESCRIPTOR TABLE ADDRESS REGISTER (DTAR)



S...S 1024 - # SDWs in Table.
A...A High Order 21 bits of Physical Addr of Table.
(Bit 22 taken as zero.)

*: bits 1 and 2 of the second word must be equal.

ENTRY CONTROL BLOCK (ECB)



Locations '11 through '17 are set to 0.

FAULTS

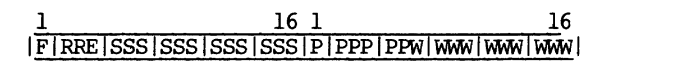
FCODEH: CRS 26H FADDR: CRS 27

FAULT	#	OFFSET	VECT	FCODEH	FADDR	RING	SAVED PB
RXM	0	0	62	---	addr	curr	backed
PROCESS	1	4	63	ABFLAGS	---	0	curr
PAGE	2	10	64	---	addr	0	backed
SVC	3	14	65	---	---	curr	backed
UII	4	20	66	cur PBL	addr	curr	backed
ILL	10	40	72	cur PBL	addr	curr	backed
ACCESS	11	44	73	code	addr	0	backed
ARITH	12	50	74	code	addr	curr	curr
STACK	13	54	75	code	addr	0	backed
SEGMENT	14	60	76	code	addr	0	backed
POINTER	15	64	77	code	ptr addr	curr	backed

INSTRUCTION SET

See Section 5.

INDIRECT POINTER (IP)



F 1 => Missing Pointer
RR Ring Number (00-11)
E 1 => Word 3 = bit number: BBBB----------
S..S Segment Number
P..W Page Number/Word Number

(As effective address in a base reg, F,E ignored.)

KEYS, MODALS

(CRS 24 RFILE 124,164 CRASH 50,150)

KEYSH (Keys):

1	100000	C Bit
2	040000	Double Precision
3	020000	Link Bit (L)
4-6	016000	Addressing Mode: x00xxx 16S x02xxx 32S x04xxx 64R x06xxx 32R x10xxx 32I x14xxx 64V
7	001000	FLEX (0 => Allow Fault)
8	000400	IEX (Integer Exception)
9	000200	CCLT (condition code)
10	000100	CCEQ (condition code)
11-14	000074	Unused
15	000002	ID (In Dispatcher)
16	000001	SD (Save Done)

KEYSL (Modals):

1	100000	ENB (1 => Enable Interrupts)
2	040000	VIM (1 => Vectored Int. Mode)
3-8	037400	Unused
9-11	000340	CRS: xxx00x => Reg File 2 xxx04x => Reg File 3
12	000020	MIO (1 => Mapped I/O)
13	000010	PXM (1 => Process Exchange Mode)
14	000004	SEG (1 => Segmentation Mode)
15-16	000003	MCM (Machine Check Mode): xxxxx0 None xxxxx1 Memory Parity xxxxx2 Quiet xxxxx3 Record

MODALS

See KEYS (KEYSL).

PAGE MAPS (HMAP, LMAP)

Starts at 4/4000. HMAP, LMAP interleaved in 64-word chunks, thus 128 words/segment in system.

HMAP (Hardware Map):

1	100000	1 => Page Resident.
2	040000	1 => Page Referenced.
3	020000	0 => Page Modified.
4	010000	1 => Shared Page (inhibits cache).
5-16	007777	H.O. 12 bits of physical page addr. (Bits 13-22 taken as zero.)

If non-resident, bits 3,5 software defined:

3,5	024000	Page status: 000000 Not resident, copy on disk 020000 Not resident, no copy on disk 004000 In transition, coming in 024000 In transition, going out

LMAP (Software Map -- HMAP+'100):

1-2	140000	Lock ctr 0 = unlock, not 0 = locked
3	020000	First Time (just paged in)
4	010000	Use alternate paging device
5-16	007777	Record index (1 val/8 pages)

SEGMENT	PAGE MAP LOCATION
0	4000
1	4200
4	4400
5	4600
6	5000
7	5200
10	5400
11	5600
12	6000
6000	6200

PANEL

See MEMORY/REGISTER DISPLAY under OPERATIONAL PROCEDURES.

PROCESS CONTROL BLOCK (PCB)

(See also PCBs under PRIMOS IV.)

Ø	LEVEL (IN READY LIST)	4Ø	GR7
1	LINK (NEXT PCB IN LIST)	41	"
2	WAIT LIST SN (Ø=>READY)	42	FPØ
3	WAIT LIST WORD NUMBER	43	"
4	ABORT FLAGS	44	"
5	RESERVED	45	"
6	RESERVED	46	FP1
7	RESERVED	47	"
1Ø	ELAPSED TIMER (LOW)	5Ø	"
11	ELAPSED TIMER (HIGH)	51	"
12	DTAR2H	52	PBH
13	DTAR2L	53	PBL
14	DTAR3H	54	SBH
15	DTAR3L	55	SBL
16	INTERVAL TIMER	56	LBH
17	RESERVED	57	LBL
2Ø	SAVE MASK	6Ø	XBH
21	KEYS	61	XBL
22	GRØ	62	FAULT VECTOR, RING Ø
23	"	63	"
24	GR1	64	FAULT VECTOR, RING 1
25	"	65	"
26	GR2	66	RESERVED
27	"	67	"
3Ø	GR3	7Ø	FAULT VECTOR, RING 3
31	"	71	"
32	GR4	72	PAGE FAULT VECTOR
33	"	73	"
34	GR5	74	CONCEALED STACK FIRST
35	"	75	CONCEALED STACK NEXT
36	GR6	76	CONCEALED STACK LAST
37	"	77	RESERVED

READY LIST

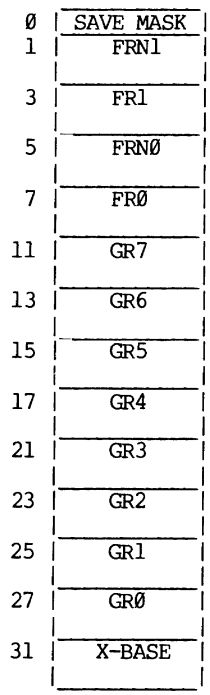
PPA current level/current PCB
PPB next level/next PCB
LEVELn --> FIRST PCB ON LEVELn
LEVELn+1 --> LAST PCB ON LEVELn
PCB+Ø --> LEVEL THIS PCB IS ON
PCB+1 --> NEXT PCB, Ø IF LAST

Ready list in Segment 4, starting at 4/6ØØ:

LEVEL	PCBS ON LEVEL
6ØØ	CLOCK PROCESS
6Ø2	SMLC PROCESS
6Ø4	AMLC PROCESS
6Ø6	MPC, MP2 PROCESSES
61Ø	VERSATEC PROCESS
612	IPC PROCESS
614	RINGNET PROCESS
616	SPARE1, SPARE2 PROCESSES
62Ø	SUPERVISOR PROCESS (USER 1)
622	PRIORITY 3 USER PROCESSES
624	PRIORITY 2 USER PROCESSES
626	PRIORITY 1 USER PROCESSES (NORMAL LEVEL)
63Ø	PRIORITY Ø USER PROCESSES
632	BACKSTOP PROCESS

RSAV FORMAT

Registers as saved/restored by the RSAV/RRST instructions.



SAVE MASK (1=>REG SAVED):

1-4	170000	Unused
5	004000	FRN1
6	002000	FR1
7	001000	FRN0
8	000400	FR0
9	000200	GR7
10	000100	GR6
11	000040	GR5
12	000020	GR4
13	000010	GR3
14	000004	GR2
15	000002	GR1
16	000001	GR0

(XB always saved.)

SECTOR 0 (P300 only)

0	X Register (Index Register)
1	A Register (Arithmetic, Shifts, I/O)
2	B Register (Ext Arithmetic, Shifts)
3	Stack Pointer
4	FLPH (Floating Point High)
5	FLPL (Floating Point Low)
6	VSC (Visible Shift Counter)
7	P Register (Program Counter)
10	PMAR (Page Map Address Register)
11	Microcode Scratch Location
12	EAS (Effective Addr Save - ILL, UII, Ints)
13	Microcode Scratch Location
14	Y Register Save (Control Panel, DMA)
15	M Register Save (Control Panel, DMA)
16	Microcode Scratch Location
17	Microcode Scratch Location
20-37	DMA Range/Start Address Pairs
40-47	Reserved for DMC Channel Pairs
60	PFI (Power Fail Int, Watchdog Timer)
61	RTCI (Real Time Clock Increment)
62	REVI (Restricted Execution Violation Int.)
63	Standard Interrupt (Compatible Mode)
64	Page Fault Interrupt
65	SVC Interrupt
66	UII (Unimplemented Instruction Interrupt)
67	Memory Data Parity Error
70	Machine Check
71	Missing Memory Module
72	Illegal Instruction Interrupt
73	Page Write Violation
74	FLEX (Floating Point Exception)
75	Procedure Stack Underflow (300 Only)
76-100	Debugging Scratch Area
101-177	Interrupt Vectors (Vectored Interrupt Mode)
200-777	General Cross Sector Links

SEGMENT DESCRIPTOR WORD (SDW)

P...0	Page number/Word number of pagemap	
F	Fault, 1 => No segment or missing pagemap	
AAA	Access controls for Ring 1:	000 No access
BBB	Access controls for Ring 2	001 Gate
CCC	Access controls for Ring 3	010 Read
		011 Read/Write
		100 Reserved
		101 Reserved
		110 Read/XEQ
		111 R/W/XEQ

REGISTERS

RFIL ADDR = Address in Register File
CRASH ADDR = Disp in hardware register save area.

RFIL ADDR	HIGH	LOW	CRASH ADDR	RFIL ADDR	HIGH	LOW	CRASH ADDR
0	TR0	-	300	40			200
1	TR1	-	302	41			202
2	TR2	-	304	42			204
3	TR3	-	306	43			206
4	TR4	-	310	44			210
5	TR5	-	312	45			212
6	TR6	-	314	46			214
7	TR7(PB)	-	316	47			216
10	GRMX1	-	320	50			220
11	GRMX2	-	322	51			222
12		RATMPL	324	52			224
13	RSGT1	-	326	53			226
14	RSGT2	-	330	54			230
15	RECC1	-	332	55			232
16	RECC2	-	334	56			234
17		REOIV	336	57			236
20	ZERO	ONE	340	60	(20)	(21)	240
21	PBSAVE	-	342	61			242
22	GRMX3	-	344	62	(22)	(23)	244
23	GRMX4	-	346	63			246
24	C377		350	64	(24)	(25)	250
25			352	65			252
26			354	66	(26)	(27)	254
27			356	67			256
30	PSWPB	-	360	70	(30)	(31)	260
31	PSWKEYS	-	362	71			262
32	PLA:PPA	PCBA	364	72	(32)	(33)	264
33	PLB:PPB	PCBB	366	73			266
34	DSWRMA	-	370	74	(34)	(35)	270
35	DSWSTAT	-	372	75			272
36	DSWPB	-	374	76	(36)	(37)	274
37	RSAVPTR	-	376	77			276

() indicate P300 address mapping

TR7 PB at machine halt
PSWPB PB at last interrupt
PSWKEYS Keys at last interrupt
PPA Current level/current PCB
PPB Next level/next PCB
RSAVPTR Reg save area ptr. 0 => regs saved.

See Micro Code Handbook for additional information.

CRS ADDR	HIGH	LOW	RF2 ADDR	CRASH ADDR2	RF3 ADDR	CRASH ADDR3
0	GR0:OLTL	-	100	0	140	100
1	GR1:PTS	-	101	2	141	102
2	GR2(1,A,LH)	-(2,B,LL)	102	4	142	104
3	GR3(EH)	-(EL)	103	6	143	106
4	GR4	-	104	10	144	110
5	GR5(3,S,Y)	-	105	12	145	112
6	GR6	-	106	14	146	114
7	GR7(0,X)	-	107	16	147	116
10	FAR1(13)	-	110	20	150	120
11	FLR1	-	111	22	151	122
12	FAR2(4)	-(5)	112	24	152	124
13	FLR2(6)	-	113	26	153	126
14	PB	-(0=>CRS)*	114	30	154	130
15	SB(14)	-(15)	115	32	155	132
16	LB(16)	-(17)	116	34	156	134
17	XB	-	117	36	157	136
20	DTAR3(10)	-	120	40	160	140
21	DTAR2	-	121	42	161	142
22	DTAR1	-	122	44	162	144
23	DTAR0	-	123	46	163	146
24	KEYS	MODALS	124	50	164	150
25	OWNER	-	125	52	165	152
26	FCODE(11)	-	126	54	166	154
27	FADDR	-(12)	127	56	167	156
30	TIMER	-	130	60	170	160
31			131	62	171	162
32			132	64	172	164
33			133	66	173	166
34			134	70	174	170
35			135	72	175	172
36			136	74	176	174
37			137	76	177	176

* Current PBL at halt in TR7L -- R7.

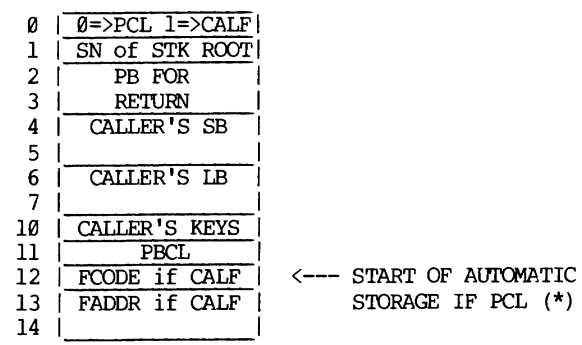
CPU

SEMAPHORES

+Ø # WAITS - # NOTIFIES, e.g., <Ø => notifies outstanding, >Ø => processes waiting, =Ø => wait list empty.

+1 Pointer to first waiting PCB on queue.

STACK FRAME, STACK ROOT



*: First Argument Ptr pointed to by ECB+4.

STACK ROOT HEADER (WORD Ø OF SEGMENT)

Ø,1 - FREE POINTER (SN/WN)
2,3 - FIRST EXTENSION (SN/WN)

STACK EXTENSION HEADER (WORD Ø OF SEGMENT)

Ø,1 - Ø/Ø
2,3 - NEXT EXTENSION (SN/WN)

WAIT LIST

SEMAPHORE+Ø = COUNT OF WAITING PCBS
SEMAPHORE+1 --> FIRST PCB

PCB+1(LINK) --> NEXT PCB ON WAIT LIST
LAST PCB+1 --> Ø

PCB+2,3 --> SEMAPHORE PROCESS IS WAITING ON

Note: wait list ordered by increasing ready list level, i.e., highest priority processes first in list.

3 COMMANDS

ADDISK -- ADD DISKS TO SYSTEM

```
ADdisk <dvno> ...
```

System user only.
Internal command.

AMLC -- SET AMLC LINE CHARACTERISTICS

```
AMlc [ Tty   ] <line> [<config>] [<lword>]
     [ TRan  ]
     [TTYHs  ]
     [TRANHS]
     [TTYNop]
```

If 2≤USER≤TRMUSR, <line>=USER-2.

<config>:

2033 -	100 BAUD
2213 -	300 BAUD
2313 -	1200 BAUD
2413 -	9600 BAUD

<lword>:

bit	Meaning when on
1 100000	Half duplex
2 040000	No LF after CR
3 020000	XOFF/XON Recognition
4 010000	XOFF Received
5-8 007400	Reserved
9-16 000377	User number

System user only.
Internal command.

ASRCWD -- SET VIRTUAL ASR CONTROL WORD

```
ASRcwd [ 0 ]  Terminal (Port 1)
       [ 2 ]  Centronics Printer #2 (Port 3)
       [ 4 ]  Centronics Printer #1 (Port 2)
```

Internal command.

ASSIGN -- ASSIGN PERIPHERAL DEVICE

```
ASsign AMLC [<protocol>] <line> [<config>] [<lword>]
       Cenpr  [-WAIT]
       CE2pr  [-WAIT]
       CArdr  [-WAIT]
       Ptr    [-WAIT]
       PUnch  [-WAIT]
       PRn    [-WAIT]    (where n=0,1)
       CR1    [-WAIT]
       MTn    [-WAIT]    (where n=0,7)
       SMLCnn [-WAIT]    (where nn=00,03)
       PLot   [-WAIT]
       Disk   <dvno> [-WAIT]
       SMLC   [-WAIT] <line>
```

<config> and <lword> described under AMLC on previous page.

<protocol>:
Tty
TTYHs
TRan
TRANHs
TTYNop

Internal command.

ATTACH -- ATTACH TO UFD

```
Attach [<ufdname>] [<passwd>] [<dvno>] [<option>]
                              [100000] [   2    ]
                              [177777] [   1    ]
                                       [ 177777 ]
```

<dvno>:
100000 => search all started devices,
177777 => search MFD of current device

<option>:
2 => set home UFD after attach to subUFD
1 => dont set home UFD after attach to subUFD
177777 => attach to UFD and dont set home

Internal command.

AVAIL -- TYPE DISK USAGE STATISTICS

```
AVAIL [<packname>]
      [<currdisk>]
      [    *     ]      (All Started Disks)
      [   ONE    ]      (Logical disk #1)
          ...
      [SEVENTEEN ]
```

External command.

BASIC

```
BASIC [<filename>]
```

See BASIC Interpretive Language User Guide, MAN1813.

External command.

BASICV -- VIRTUAL MEMORY BASIC

```
BASICV [<filename>]
```

See the BASIC/VM Guide.

External command.

BASINP -- READ PAPER TAPE

```
BASINP <filename>
```

External command.

BINARY -- OPEN FILE UNIT 3 FOR BINARY OUTPUT

```
Binary <filename>
```

Internal command.

CHAP -- CHANGE USER PRIORITY

```
CHap -<usrno> [<level>] [<timeslice>]
       ALL    [   1   ] [     3     ]
```

<timeslice> is in tenths-of-a-second. Defaults taken only for ALL option, else unchanged.

System user only.
Internal command.

CLOSE -- CLOSE FILE UNIT(S)

```
Close <funit>...
      <filename>
          ALL
```

Unit '21 (COMOUTPUT) must be closed explicitly.

Internal command.

CMPF -- COMPARE ASCII FILES

```
CMPF <tree1> <tree2> [... <tree5>] [<option>...]
```

Options can be:

```
-MINL [<n>]   (default = 3)
-BRief
-REPORT <report-file-name>
```

External command.

CMPRES -- COMPRESS SOURCE FILE

```
CMPRES <intreename> [<outtreename>]
                    [ <intreename>]
```

External command.

CNAME -- CHANGE NAME OF FILE

```
CName <oldfilename> <newfilename>
```

Internal command.

CNVTMA -- CONVERT LOAD MAP FOR PMA

```
CNVTMA <in-file> <out-file>
```

Converts load map into format usable by PSD 'LS' command.

External command.

COBOL

```
COBOL <treename> [<option>...]

     or

COBOL [<option>...] -I <treename> [...<option>]
```

Options can be:

-Binary
Define binary file/device.

-B <treename>
Create binary file with specified treename.

-B NO
Do not create a binary file.

-B YES
Create binary file in current UFD.

-EXPlist
Generate an expanded listing file.

-Input
Define input file/device.

-I <treename>
<treename> is source program.

-Listing
Define listing file.

-L <treename>
<treename> is listing file.

-L NO
Do not create a listing file.

-L YES
Create listing file in current UFD.

-L TTY
Print listing at terminal.

-L SPOOL
Spool listing file to line printer.

-NOEXPLIST
Do not generate expanded listing file.

-64R
Generate relative-addressed code.

-64V
Generate segmented-addresssed code.

External command.

COMINP -- START COMMAND INPUT FILE

```
COminp <filename> [<ufdname>] [<funit>]
       [-]PAUSE                [   6   ]
       [-]CONTIN
       [-]TTY
       -Start
       -End
```

'-S' = 'S' + 'CO CONTIN'. '-E' = 'TTY'.

Internal command.

COMOUTPUT -- CONTROL ROUTING OF TERMINAL OUTPUT

```
COMOutput [<filenamel>] <option>...
```

Options can be:

-Ntty	-Contin
-Tty	-Pause
-End	

Internal command.

X.CONCAT -- CONCATENATE FILES

```
CONCAT [<outtreename>]
```

No name => unit 2 assumed open.

Follow with list of files to be cancatenated together. '=' starts line to be used as header. Null line terminates list (unit 2 left open if open on entry).

External command.

COPY -- COPY DISK

```
COPY

Prompts:

FROM PHYSICAL DISK=  (Enter DVNO-see Disk Addresses.)
1.5M WORD PACK?   (Enter Yes or No.)
TO PHYSICAL DISK=  (Enter DVNO)
1.5M WORD PACK?   (Answer as to FROM...)
FROM,TO,RECORDS= <from-dvno> <to-dvno> <rec-in-dec>
PARAMETERS OK?  (Yes or No. No => reenter all.)

External command.
```

CPMPC -- PUNCH FILE ON CARD PUNCH

```
CPMPC <treename> [<option>...]

Options can be:
     -PRINT
     -CRØ
     -CR1

External command.
```

CREATE -- CREATE SUBUFD IN CURRENT UFD

```
CReate <ufdname>

Internal command.
```

CRMPC -- READ CARDS

```
CRMPC <treename> [<option>...]

Options can be:
     -PRINT
     -CRØ
     -CR1

External command.
```

CRSER -- READ FROM SERIAL CARD READER

```
CRSER <treename>

External command.
```


CX -- SEQUENTIAL JOB MONITOR

```
CX [<filename>] [<option>...]

Options can be:
  -A
     list entire audit file.
  -Dxx
     drop job numbered xx.
  -ON <dvno>
     submit CX job on <dvno> specified.
  -P
     list personal jobs in queue and audit file.
  -Q
     list queue.
  -Sxx
     list status of job numbered xx.

External command.
```

DATE -- PRINT DATE AND TIME

```
DATE

External command.
```

DELAY -- SET TERMINAL DELAY CHARACTERISTICS

```
DELAY [<min>] [<max>] [<width>]
      [  6  ] [  12 ] [   72  ]

Can issue prior to login.
Internal command.
```

DELETE -- DELETE FILE

```
DELETE <filename>

Internal command.
```

DELSEG -- DELETE SEGMENT(S)

```
DELSeg <segno>
         ALL

segno > '2000 and not '6000

Internal command.
```

DISKS -- SPECIFY ASSIGNABLE DISKS

DIsks [NOT] <dvno> ...

System user only.
Internal command.

ED -- EDITOR

ED [<filename>] (no <filename> => new file)

(<str> - text string)
(/ = unique delimiter not in string)

SUBCOMMANDS

.CR. = INPUT TTY

Append <str>
  Append to current line.

Bottom
  Go to bottom of file.

BRief
  Don't display changes.

Change/<strl>/<str2>[/] [<n>] [G]
  Change <strl> to <str2> for first occurrence on line, for all occurrences if G present, for <n> lines if <n> present.

Delete [<n>]
  Delete <n> (1) lines.

Delete TO <str>
  Delete to line containing <str>.

DUnload <fname> [<n>]
  Unload/delete <n> (1) lines.

DUload <fname> TO <str>
  Unload/delete up to (not incl) line containing <str> to <fname>.

Erase <char>
  Make <char> the erase character (").

FILe [<fname>]
  Write updated file to <fname>.

Find <str>
  Find line starting with <str>.

Gmodify <subcmnds>
  Modify line w/subcommands:
    A/<str>/ - Append
    B<n> - Back <n> chars
    C<c> - Copy up to (not inc) char <c>
    D<c> - Delete up to char <c>
    E<n> - Delete next <n> chars
    F - Copy to end of line
    I/<str>/ - Insert <str> at curr pos.
    M<n> - Copy <n> chars
    Nxx - Negate criteria of cmnd xx
    O/<str>/ - Overlay at current position
    R/<str>/ - Retype at current position
    S - Reset to start of line

Insert <str>
  Insert line (.NULL. => input mode).

INPUT [ASR] [PTR] [TTY]
  Input text from specified device.

Kill <char>
  Make <char> new kill character.

LINesz <n>
  Set max line size to <n> chars.

LOAd <fname>
  Insert contents of <fname>.

Locate <str>
  Locate line containing <str>.

MODE <arg>
  Set editor mode. <arg> can be:
    PRUPPER, PRALL, PRLOWER,
    PROMPT, NPROMPT,
    COUNT, NCOUNT,
    NUMBER, NNUMBER,
    COLUMN, NCOLUMN.

Modify /<strl>/<str2>[/] [G] [<n>]
  Copy <str2> on top of <strl> starting with first char.

MOVe <bufl> <buf2>
  Move contents of <buf2> to <bufl>.

MOVe <bufl> <str>
  Move contents of <str> to <bufl>. Buffers are EDLIN (command line), INLIN (current line to be editted), STR.1, ..., STR.1Ø.

Next [<n>]
  Advance <n> (1) lines.

NFind <str>
  Find line not starting with <str>.

OUTput [DISPLAY] [TTY]
  Send verification output to specified device.

Overlay <str>
  Overlay line with <str>. Blank leaves current char, WILD becomes blank.

PAuse
  Back to PRIMOS, restart w/'S'.

POint <n>
  Go to line <n>.

Print [<n>]
  Print <n> (1) lines

PSymbol
  Print symbols.

PUnch [<n>] [ASR] [PTP]
  Punch n lines on indicated device.

Quit
   Exit without filing.
Retype <str>
   Replace line with <str>.
Symbol <name> <char>
   Define <name> symbol. <name>: BLANK (#), CPROMPT ($), COUNTER (@), DPROMPT (&), ERASE ("), ESCAPE (^), KILL (?), SEMICO (;), TAB (\), WILD (!).
TAbset <tabl>...
   Set tab positions.
Top
   Go to top of file.
Unload <fname> [<n>]
   Unload <n> line into <fname>.
Unload <fname> TO <str>
   Unload lines up to (but not incl) <str> to <fname>.
Verify
   Display all changed lines.
Where
   Print current line number.
Xeq <buff>
   Execute contents of buffer.
*[<n>]
   Repeat <n> (until bottom or forever) times.

External command.

EDB -- BINARY EDITOR

EDB <intreename> [<outtreename>]
        PTR   PTR

SUBCOMMANDS
  BRIEF
     No names printed.
  Copy <name>
     Copies up to (but not incl) <name>.
  Copy ALL
     Copies to end of file.
  Find <name>
     Position to <name>.
  Find ALL
     Position to end of file.
  Insert <treename>
     Insert <treename>.
  Newinf <name>
     Open new input file.
  OPEN <name>
     Open output file.
  Replac
     Replace <fname> with <treename>.
  RFL
     Reset Force Load flag.
  SFL
     Set Force Load flag.
  TERSE
     Print lst name in blocks.
  Top
     Top of input file.
  VERIFY
     Print all names.

To replace <name>:

EDB <oldlib> <newlib>
R <name> <treename>
C ALL
ET
QUIT

External command.

ELIGTS -- SET ELIGIBILITY TIMESLICE

ELIGTS <tenths>
3

Internal command.

EXPAND -- EXPAND (COMPRESSED) SOURCE FILE

EXPAND <intreename> <outtreename>

External command.

FILMEM -- ZERO MEMORY

FILMEM [ALL]

No 'ALL' => '100 - '77777 excluding DOS zeroed.

External command.

FILVER -- COMPARE BINARY FILES

FILVER [<treenamel>] [<treename2>]

Prompts if no names entered.

External command.

FIXRAT -- FIX RECORD AVAILABILITY TABLE

FIXRAT [<option>...]

Prompts:

FIX DISK? (Enter Yes or No.)
PHYSICAL DISK DRIVE= (Enter DVNO-see Disk Addresses.)
If 'OPTIONS' specified:
TYPE DIRECTORIES TO LEVEL (Enter level.)
TYPE FILENAMES (Enter Yes or No.)
TYPE FILE CHAINS (Enter Yes for disk addrs.)

External command.

FTN -- FORTRAN

FTN [-Input] <itree> [-B <btree>] [-L <ltree>]
[-B B<-<itree>] [-L L<-<itree>]
[<options>] [<a-reg>] [<b-reg>]
[1/1707] [2/0]

Option	Function
-64v	Generate 64V mode object code
-64R	Generate 64R mode object code
-32r	Generate 32R mode object code
-Big	Dummy arrays may cross segment boundaries
-NOBig	
-DClvar	Flag undeclared variables
-NODclvar	
-Debase	Conserve loader base areas
-DYnm	allocate locxal storage in stack frame
-ERRlist	Generate errors-only listing
-ERRTty	Print errors on terminal
-NOErrtty	
-Explist	Generate expanded listing
-Fp	Generate floating-pt skip instr
-NOFp	
-Intl	INTEGER*4 default
-INTS	INTEGER*2 default
-SAve	Allocate local storage in linkage frame
-Spo	System programmer option
-Trace	Generate code for trace output
-Notrace	
-XREFL	Generate cross reference listing
-Xrefs	Generate abbreviated cross ref listing
-NOXref	

A-REG		ON-OPTION	OFF-OPTION
1	100000	Spo	--
2	040000	Explist	ERlist
3	020000	ERlist	Explist
4	010000	Trace	Notrace
5	004000	64r	32R,64V,DYnm,Big
6	002000	Debase	--
7	001000	ERRTty	NOErrtty
8-10	000700	Input device (see below)	
11-13	000070	Explist,Erlist,Xrefs,XREFL (listing)	
14-16	000007	Binary device	--

B-REG			
1	100000	(Debug triad dump)	--
2	040000	Unused	--
3	020000	SAve,DYnm	--
4-7	017000	Unused	--
8	000400	64V,DYnm,Big	64r,32r,Debase
9	000200	Big	NOBig
10	000100	Intl	INTS
11	000040	Unused	--
12	000020	Xrefs	XREFL,NOXref
13	000010	Xrefs,XREFL	NOXref
14	000004	Unused	--
15	000002	NOFp	Fp
16	000001	Spo,DClvar	NODclvar

Device codes for Input, Listing, Binary:

0 - None	4 - Line Printer
1 - ASR	5 - Magtape
2 - PTR/PTP	6 - Cassette
3 - Card reader	7 - Disk

External command.

FUTIL — FILE SYSTEM UTILITY

```
FUTIL

N.B.: command names must be in upper case.

Attach <treename>    ('*' => home ufd)
CLEAN <prefix> [<level>]
Copy <file> [<newname>] [,<file>[<newname>]] ...
COPYSam <file> [<newname>] [,<file>[<newname>]] ...
COPYDam <file> [<newname>] [,<file>[<newname>]] ...
CReate <ufdname> [<owner> [<non-owner>]]
DELETE <file> [,<file>] ...
FOrce ON or OFF
From <treename>     ('*' => home ufd)
Listf [<level>] [First] [LISTFIL] [PROtect] [Size]
      [Type] [Date] [Rwlock] [PAssw]
LISTSave <filename> [<options as for Listf>]
Protect <file> [<owner>] [<non-owner>]
Quit
Scan <file> [<options as for Listf>]
SRwloc <file> <lockno>
To <treename>
TRECpy <ufd> [<newname>] [,<ufdname>[<newname>]]...
TREDEL <ufdname> [,<ufdname>] ...
TREPro <ufdname> [<owner> [<non-owner>]]
TRESrw <ufdname> <lockno>
Ufdcpy
UFDDEL
UFDPro [<owner> [<non-owner>]]
UFDSrw <lockno> <level>

<lockno>:
  0    use system read/write lock (SYS)
  1    n readers or 1 writer (W/NR)
  2    n readers and 1 writer (1WNR)
  3    n readers and n writer (NWNR)


External command.
```

HPSD -- HIGH PSD

```
HPSD

SA, EA = 147760, 156552.
Start of initial P counter = 150000.
For internal commands, see PSD.

External command.
```

INPUT -- OPEN FILE UNIT 1 FOR INPUT

Input <filename>

Internal command

LISTF -- LIST FILES IN CURRENT UFD

Listf

(Note: LISTING command with no name => LISTF.)
Internal command.

LISTING -- OPEN FILE UNIT 2 FOR LISTING OUTPUT

Listing <filename>

(Note: <filename> omitted => LISTF.)
Internal command.

LOAD

LOAD

ATtach [<ufd>] [<password>] [<ldisk>] [<key>]
<key>=0=>don't set home, 1=>set home.
AUtomatic [<n>] Linkareas of length <n> around module. <n>=0 turns feature off.
CHeck [<symbol>] [<parl ... par9>]
COmmon <address> Set COMMON TOP - 1
DC [END]
ENtire <treename>
ERror [<num>]; <num> = 0, 1, or 2
EXecute [<a>] [<b>] [<x>] Uses START entry
FOrceload <treename> [<addr>] [<linkstart>] [<linkrange>]
F/ Force prefix for FO, LO, LI commands.
HArdware <definition>
177700 Must be zero
000040 1=>Prime 400 instruction set
000020 Unused
000010 1=>Double prec. fl. pt.
000004 1=>Single prec. fl. pt.
000002 1=>Prime 300 instruction set
000001 1=>High speed arithmetic
INitialize <treename> [<addr>] [<linkstart>] [<linklen>]
Resets everything and loads <treename>.
LIbrary [<treename>] [<addr>]
[LIB>FTNLIB]
LOad <treename> [<bareal>]...[<barea8>]
<treename> [<bareal>]...[<barea9>]
<treename> <symbol> [<bareal>]...[<barea9>]

MAp [<treename>] [<option>]
[$F] <option> = 0=>full map, 1=>load state, 2=>load state and link info, 3=>unresolved references, 4=>same as 0, 5=>system programmer map, 6=>sorted unresolved references, 7=>sorted full map, 10=>symbol map for PSD.
MOde [D32R] [D64R] [D16S] [D32S] [D64V] [D32I]
P/ Page boundary prefix for FO, LO, LI commands.
PAuse
PBrk [<symbol>] [<parl ... par9>]
* <parl> [<par2 ... par9>]
QUit Back to PRIMOS
SAve <fname> [<a>] [<b>] [<x>] [<keys>]
SEtbase [<linkstart>] [<linklen>]
* [end of sector] (*=>current sector)
SS <symbol>
SYmbol <symbol> <oldsym> [<parl ... par6>]
<symbol> <addr> [<par2 ... par6>]
<symbol> * [<parl ... par3>]
parameters can contain + and - signs
SZ [NO] or SZ YES
VIrtualbase <linkstart> <tosector>
XPunge [<y>] [<z>] <y>: 0=>all but undefined symbols, 1=>all but undefined and COMMON.
<z>: 0=>all defined base areas, 1=>all but sector 0, 2=>return all.

External command.

LOGIN -- LOGIN TO UFD

LOGIN <ufdname> <passwd> [<dvno>] [-ON <nodename>]

Internal command.

LOGOUT -- LOGOUT USER

LOgout [-<usrno>]
ALL (System user only)

<usrno> must have same login name as user unless issued by System user.

Internal command.

LOGPRT — PRINT LOGREC

```
LOGPRT [<outfile>] [<option>...]
       [  LOGLST ] [ -Help ]
       [   Tty   ] [ -From <mmddyy> ]
                   [ -Type Cold
                           Warm
                           Timdat
                           CHecks
                           Disk
                           DSKnam
                           Overfl
                           Shutdn
                           CHK300
                           Par300
                           Mod300
                           TYPE10-TYPE15 ]
                   [ -Spool  ]
                   [ -Delete ]
                   [ -PURGE  ]
```

Prompts for input treename, default (just .CR.) is CMDNCO>LOGREC.

External command.

LOOK -- MAP SEGMENT TO USER 1

```
LOOk [-<usrno>] [<segno>] [<access>] [<mapseg>]
     [-   1   ] [  6000 ] [   200  ] [  4001  ]
```

System user only.
OPRPRI 1.
Internal command.

X.LS -- LIST FILE CHARACTERISTICS

LS [<filename>] [<option>]...

Filename can be a wild card name containing % and + signs:

- % matches any number of characters (including none) in the filename;
- + matches any one character in the filename.

Options can be:

-DIM	-TYPE
-PR	-RWLK

External command.

MACHK -- TURNS ON MACHINE CHECK MODE

MACHK

External command.

MAGNET -- TRANSFER DATA TO AND FROM TAPE

MAGNET

PROMPTS	RESPONSES
OPTION:	POSITION or READ or WRITE or COPY
Depending on the option, MAGNET may prompt any of the following --	
MTU # =	#/7 or #/9; 0≤#≤7
ABSOLUTE OR RELATIVE?	A or R
FILE # =	if # if A mode, #≥1; if R mode, # can be either positive or negative
RECORD # =	if A mode, #≥1; if R mode, #≥0
MT FILE # =	#≥0
LOGICAL RECORD SIZE =	≤ 10K bytes for PRIMOS II (DOS), IV, V or ≤ 2K bytes for PRIMOS III
BLOCKING FACTOR =	# of line images in one tape record
ASCII, BCD, BINARY or EBCDIC?	ASCII or EBCDIC or BCD or BINARY
FULL OR PARTIAL RECORD TRANSLATION?	FULL or PARTIAL
OUTPUT FILE NAME:	<filename>
INPUT FILE NAME:	<filename>
STARTING FILE # =	
# FILES TO COPY =	

External command.

MAGRST -- MAGTAPE RESTORE

MAGRST [-7TRK]
-9TRK

PROMPTS	RESPONSES
TAPE UNIT:	0 - 7
ENTER LOGICAL TAPE NUMBER:	0 -- tape already positioned 1 -- first logical tape 2 -- second logical tape etc.
READY TO RESTORE:	Yes (yes) No (no) PA (partial) $I [<filename>] [<level>] (turn on indexing) NW [<level>] (index only)
TREE NAME:	<treename> (often partial) or list of treenames, 1 per line, end with null line

External command.

MAGSAV -- MAGTAPE SAVE

MAGSAV [<option>...]

Options can be:

-LONG
1024 word records (default is 512).

-7TRK
use 7 track tape format (default is 9 track).

-INC
incremental save (only save files that have been modified since last save).

-UPDT
set dumped bit in the UFD entry (default is not to set the dumped bit).

PROMPTS	RESPONSES
TAPE UNIT:	0 -7
ENTER LOGICAL TAPE NUMBER:	0 -- tape already positioned 1 -- first logical tape 2 -- second logical tape etc.
TAPE NAME:	<6-character name>
DATE:	MM DD YY or .CR. for today's date (under PRIMOS III and IV)
REV NO:	<an arbitrary integer>
NAME:	<filename> $A [<UFDname>] (attach) $Q (terminate tape and return to PRIMOS) $R (terminate tape, rewind, and return to PRIMOS) $I [<filename>] [<level>] (print index to indicated level) MFD (save entire disk) * (save current directory)

External command.

X.MAIL

MAIL [<ufdname>]

If no <ufdname> is specified, the mail command checks mail for the user issuing the command.

When sending mail to another user, end message with '$'.

External command.

MAKE -- FORMAT DISK

MAKE [OLD]
[NEW]

PROMPT	RESPONSES
PHYSICAL DISK	physical disk number
1.5 WORD PACK?	yes or no
SPLIT DISK?	yes or no
PAGING RECORDS (DECIMAL)	number of records to be used for paging (see paging records tables, below)
<DISK NUMBER> <FILE RECORDS> <PAGING RECORDS> OK?	yes or no
BADSPOTS ON DISK?	yes or no
TRACK=	track of badspot or 0 to terminate
HEAD=	head of badspot or 9 to terminate
prints list of badspot HEAD and TRACK numbers: PARAMETERS OK?	yes or no
VIRGIN DISK?	yes or no
VERIFY DISK?	yes or no

PAGING RECORDS TABLE

Disk	Decimal Records
Diskette	460
1.5 million word disk	3248
3.0 million word pack	6496
30 million word disk	64960
128 K word fixed head disk (32 trk)	256
256 K word fixed head disk (64 trk)	524
512 K word fixed head disk (128 tk)	1024
1025 K word fixed head disk (256 tk)	4096

RECORDS PARAMETERS FOR 30-MILLION WORD DISK

Partition	Dev Addr 23 Disk Number	Dev Addr 21 Disk Number	Records
2 hd (deflt)	XX025X	XX005X	6496
2 hd (explicit)	XX065X	XX045X	6496
4 hd	XX125X	XX105X	12992
6 hd	XX165X	XX145X	19488
8 hd	XX225X	XX205X	25984
10 hd	XX265X	XX245X	32480
12 hd	XX325X	XX305X	38976
14 hd	XX365X	XX345X	45472
16 hd	XX425X	XX405X	51968
18 hd	XX465X	XX445X	58464
20 hd	XX525X	XX505X	64960

External command.

! MAXSCH -- SET SCHEDULING CONSTANT

MAXSch <n>
3

System user only.
Internal command.

! MAXUSR -- LIMIT NUMBER LOGGED-IN USERS

MAxusr [<number>]
[64]

System user only.
Internal command.

MDL -- MEMORY DUMP/LOAD

MDL

MDL command requests parameters. Respond with the following data separated by spaces or commas and terminate with a CR or LF:

PARAMETER	DEFINITION
SA	first location to be punched, must be ≥ '34.
EA	last location to be punched, must be ≤ '177777.
P	auto-start address or 0.
K	keys (default is 16S mode). bit 14: 0 punch end of tape (EOT). 1 omit EOT. bit 15: 0 punch begin of tape (BOT). 1 omit BOT. bit 16: 0 high speed punch. 1 ASR punch
L	loader address (default is sector in which MDL resides); if ASR, avoid folowing loader address: ' 10400 thru ' 11600 '110400 thru '111600

Internal command.

MESSAGE -- SEND MESSAGE TO USER(S) OR SYSTEM

Message -<usrno> [NOW]
[-1]
ALL
NET
<nodename>

End command with .CR., enter message on next line, end message with .CR.

System user for all but 'M' (user to operator).
Internal command.

MRGF -- MERGE ASCII FILES

```
MRGF <tree1> <tree2> [...<tree5>] outtree [<opts>]

Options can be:
       -MINL [<n>]    (default = 3)
       -BRief
       -FORCE
       -REPORT <report-file-name>
```

External command.

NUMBER -- (RE)NUMBER BASIC FILE

```
NUMBER
```

External command.

OPEN -- OPEN FILE ON SPECIFIED UNIT

```
Open [<filename>] <unit> <key>
```

<key>: 1-Read, 2-Write, 3-R/W, 4-Close, 5-Delete, 6-Exist, 7-Rewind, 10-Truncate + 0000-New SAM, 2000-New DAM, 4000-New SAM segment, 6000-New DAM segment, 10000-New UFD. <filename> optional only for Rewind and Truncate.

Internal command.

OPRPRI -- SET OPERATOR PRIORITY

```
OPRpri  [ 1 ]
        [ 0 ]
```

System user only.
Internal command.

PASSWD -- SET PASSWORDS ON CURRENT UFD

```
PASSWD [<owner-password>] [<non-owner-password>]
       [     blanks     ] [       blanks       ]
```

Internal command.

PHANTOM -- START PHANTOM USER

```
PHantom <filename> [<funit>]
                   [  6  ]
```

Phantom file should end with 'CO TTY' command.

Internal command.

PM -- PRINT USER REGISTER VECTOR

```
Pm
```

Internal command.

PMA -- PRIME MACRO ASSEMBLER

```
PMA [-Input] <itree> [-B    <btree>] [-L    <ltree>]
                     [-B B<-<itree>] [-L L<-<itree>]
    [<options>] [<a-reg>] [<b-reg>] [<x-reg>]
                [ 1/777 ] [  2/0  ] [  3/0  ]
```

External command.

Options:

Errlist Errors-only listing
EXplist Expanded listing

A-REG		ON-OPTION	OFF-OPTION
1	100000	Unused	--
2	040000	Errlist	EXplist
3	020000	EXplist	Errlist
4-7	017000	Unused	--
8-10	000700	Input device (see below)	
11-13	000070	Errlist,EXplist (normal listing)	
14-17	000007	Binary device	--

Device codes (Input, Listing Binary:

0 - None	4 - Line Printer
1 - ASR	5 - Magtape
2 - PTR/PTP	6 - Cassette
3 - Card Reader	7 - Disk

B-REG (PRIMOS IV BUILD):

11-13	000020	64-user version
	000000	16-user version
16	000001	Large 16-user version

PMA ERROR CODES:

C: INST IMPROPERLY TERMINATED.
F: BAD MACRO EXPR TERMINATOR, ILLEGAL OP ON STACK PUSH/POP, FAIL PSEUDO-OP.
G: GOTO ERROR WITHIN MACRO, END/ENDM IN 'GOTO' SKIP AREA.
I: GENERIC, I/O, OR SHIFT HAS TAG, TAG ON 32I FIELD INSTR, SHORT INSTR SPEC (#) IMPOSSIBLE, 64V LDX CLASS BAD TAG, 64V TAG ON BRANCH ILLEGAL, SEG EXT REF BAD INDIRECT OR INDEX, AP/IP, INDEX SPECIFIER INVALID, TAG ON 32I BRANCH.
L: BAD LABEL, EXTERNAL VARIABLE IN LITERAL, BAD ARG IN EQU. SET, OR XSET,
M: MULTIPLY DEFINED LABEL.
N: 'END' WITHIN MACRO OR IF.
O: BAD OPCODE, 64V MEMORY REFERENCE WHEN NOT IN 64V MODE, S/R MODE MEMORY REFERENCE NOT IN S/R MODE.
P: MISMATCHED PARENTHESIS.
Q: AP, NOT IN 64V/32I MODE, IP, NOT IN 64V/32I MODE, ENDM PSEUDO-OP NOT IN MACRO.
R: STACK OVERFLOW, MULT DEF MACRO OR NAME EMPTY.
S: 'LOAD' MODE, INSTR NEEDS DSECT, INDIRECT DAC IN C64R MODE.
T: 32I MODE TAG MOD SYNTAX ERROR.
U: UNDEF VAR IN ADR FIELD/EXP, UNDEFINED VARIABLE IN ORG/SETB.
V: BIT FIELD OUT OF RANGE, UNRECOGNIZED OPERATOR IN EXPRESSION, FIELD ADR INST, OUT OF RANGE, I/O INSTR FIELD OUT OF RANGE, INST, SHIFT COUNT OUT OF RANGE, NO COMMA FOLLOWING FAR SPEC, 32I NO COMMA AFTER REGISTER #, 32I NO COMMA AFTER BIT #, 32I BAD DELIMITER, 32I SHIFT INSTR, BAD DELIM, BAD COUNT IN 32I SHIFT INSTR, BAD TAG MODIFIER IN 32I SHIFT, BAD DELIM AFTER REG # 32I PIO, OPEN PAREN MISSING ON DFTB ARG, CLOSE PAREN MISSING ON DFTB ARG, NO LAB IFTF, IFTT, IFVT, IFVF, NO NAME IFTF, IFTT, IFVT, IFVF, ABS/REL ILLEGAL IN SEG MODE, SEG/SEGR AFTER CODE GENED, PROC/LINK OUTSIDE OF SEG MODE, FIELD OUT OF RANGE ON DDM, BAD ARGUMENT FOLLOWING 'EXT', 'END' WITHIN MACRO, SYNTAX ERR IN 'DYNM' PSEUDO-OP, BAD ARG ON SUBR STATEMENT, VFD PSEUDO-OP, 16 BITS NOT DEFINED, UNTERMINATED CHARACTER STRING, EXPRESSION OVERFLOW ON FL PT NORMALIZE, EXPRESSION OVERFLOW ON FL PT RE-NORMALIZE, SCALED BINARY LOSS OF SIG, FL POINT NUMBER OUT OF RANGE, BCI REPEAT COUNT ERROR, BCI COUNT VARIABLE TYPE ERROR, MUNG IN ADDR FIELD OF CALL, BAD ADDR FIELD ON COMN, REPEAT COUNT ERROR, DEC/OCT PSEUDO OP HAS BAD OP, RLIT FOUND AFTER CODE GENED, NO LABEL ON DFTB.
X: 32I MODE GPR SPEC ERROR.
Y: PHASE ERROR.
Z: ILLEGAL ABS REF IN SEG MODE, SEG MODE ABS REF NOT Ø-7, AP/IP, ABSOLUTE REF INVALID, TOO MANY EXT NAMES IN EXPR, BAD EXPR MODE FOR INSTR, EXPRESSION MODE ERROR, >1 NON-ABS/REL OPERATOR, RIGHT-HAND OP NOT ABS/REL, EXTERNAL NAME NOT PERMITTED.

PRERR -- PRINT ERRVEC AND LAST ERROR MESSAGE

PRerr

Internal command.

PRMPC -- PRINT FILE ON LINE PRINTER

PRMPC <treename>

External command.

PROTECT -- SET PROTECTION ON FILE

PROtec [<owner-rights>] [<non-owner-rights>]
[Ø] [Ø]

Ø-No access, 1-Read, 2-Write, 3-R/W,
4-Delete/Truncate, 5-D/T/R, 6-D/T/W, 7-All.
Default on file creation equals 7 Ø.

Internal command.

PRSER -- PRINT FILE ON SERIAL LINE PRINTER

PRSER <treename>

External command.

PRVER -- PRINT FILE ON VERSATEC

PRVER <treename>

External command.

PSD -- PRIME SYMBOLIC DEBUGGER

PSD [<token>...]

(NOTE: VPSD has: segment, base register operations, does not have: symbols, trace.)

TERMINATORS for 'A'		MODES	
.CR.	*+1	:A	ASCII
,	*+1	:B	BINARY
^	*-1 (uparrow)	:H	HEXIDECIMAL
.n	*+n	:O	OCTAL
.-n	*-n	:S	SYMBOLIC
@	Effective address	:D	DECIMAL
\	Back to last @	:P	AP
(	To contents of *	:L	LONG OCTAL INTEGER

```
)    Back to last defined (
=    EA + contents, no update of *
/    Return, do not close *
?    return, do not close *
!    Return, close *
```

Expressions: Locations can be expressions including:

```
    * (current location)
    [+]number-in-current-mode
    >number-relative to relocation constant
```

SUBCOMMANDS

```
Access <loc>
   Access location.
Breakpoint <loc>
   Set breakpoint (up to 10).
BR
   Print base registers.
Copy <from> <to> <new-addr>
   Copy block of memory to new location.
Define <sym> <val>
   Define symmbol.
Dump <from> <to> [<ncol>] [<mode>]
   Dump contents of memory.
Effective <from> <to> <match> [<mask>]
   Search for effective address.
Execute <addr> [<a>] [<b>] [<x>]
   Search for effective address.
EXecute
   Execute segmented program.
FAddress <fld-addr-reg-no>
   Access field address register.
FLength <fld-len-reg-no>
   Access field address register.
Fill <from> <to> <val>
   Fill memory block with <val>.
GO [<count>] [<a>] [<b>] [<x>] [<k>]
   Continue at breakpoint.
Jumptrace [<start>] [<a>] [<b>]
   Execute obj prog and produce diagnostic listing.
Keys <value>
   Set keys to value.
List <loc>
   list location.
LB <sn> <wn>
   Set link base.
LS
   Load symbols (unit 1).
```



```
MAp
   Print load map symbols.
MO [D16S] [D32R] [D64R] [D64V] [D32S] [D32I]
   Set address mode.
Monitor [<start>] [<a>] [<b>] <addr>
   Trace obj prog for mem ref instr.
Not-equal <from> <to> <nmatch> [<mask>]
   Negative serarch.
Open <fname> <unit> <key>
   Open unit.
PATCH <locl> <loc2>
   Patch instr  in <loc2> into <locl>.
Print
   Print brkpt, contents, a, b, x,
   keys, relocation.
PRoceed [<newbrk>] [<a>] [<b>] [<x>] [<k>]
   Set new brkpt and resume execution.
Quit
   Quit.
RElocate <reloc-val>
   Set relocation constant.
Run [<loc>] [<a>][<b>][<x>][<keys>]
   Run program.
SB <sn> <wn>
   Set stack base.
Search <from> <to> <match> [<mask>]
   Search memory block.
SN <sn>
   Set segment number.
SY 0
   Symbol mode off.
SY 1
   Symbol mode on.
Trace [<addr>] [<a>] [<b>] [<val>] [-l <interval>]
   Trace program.
Update <loc> <val>
   Update location.
Verify <from> <to> <copy-addr>
   Verify block of memory.
VErsion
   Print version, restart address.
Where
   Display brkpts and proceed counts.
X <reloc-val>
   Set relocation constant.
XB <sn> <wn>
   Set X base.
XR <val>
   Set X register.
YR <val>
   Set Y register.
Zero [<brk-loc>]
   Remove brkpt (current)
```

External command.

PTBOOT -- PAPER TAPE BOOT

PTBOOT

External command.

PTCPY -- PAPER TAPE COPY

PTCPY

External command.

PUSS -- COMPARE SOURCE FILES

PUSS

PROMPTS	RESPONSES
DIFF FILE, OMISSIONS?	name of difference file followed by a space plus YES, NO, or carriage return
OLD-FILE TREE-NAME:	<treename>
NEW-FILE TREE-NAME:	<treename>

Obsolete -- use CMPF.
External command.

RESTORE -- RESTORE EXTERNAL PROGRAM

RESTore <filename> [<sa>] [<ea>] [<p>] [<a>]
[<b>] [<x>] [<k>]

Internal command.

RESUME -- RUN EXTERNAL PROGRAM

REsume <filename> [<token>...] [<sa>] [<ea>] [<p>]
[<a>] [<b>] [<x>] [<k>]

Internal command.

RPG -- REPORT PROGRAM GENERATOR

RPG <filename> [<option>...]

Options can be:
-SEQCHK, -NOSEQCHK
-BANNER, -NOBANNER
-OBDATA, -NOOBDATA
-STATUS, -NOSTATUS
-ERRTTY, -NOERRTTY
-LISTING
-BINARY

Error Message Format:

****ERROR, LINE (xxxx) COL yy-zz [contents]-message.
**WARNING, LINE (xxxx) COL yy-zz [contents]-message.

xxxx = Line number of statement in error
yy-zz = Beginning and ending column number of
the field in error. If yy is the same
as zz, the zz portion is omitted
[contents] = contents of columns yy-zz
message = comments about the field in error

External command.

RUNOFF -- TEXT FORMATTER

RUNOFF [<filename>]

Notes:

1) When imbedded in text, all runoff command lines begin with a period; when issued at command level, runoff commands do not begin with a period.
2) In the table below, some runoff command actions are followed by brk, ejt, and/or deflt to indicate the command causes a break, ejects a page, and/or is the default. Also, if the runoff command has a default value, that value is specified.

(<str> = text string)

SUBCOMMANDS

.NULL.
   Start processing (from command mode).
* <str>
   Comment line.
+ <str>
   Enter verbatim string.
/-/-/-/
   /Left/Center/Right/ strings.
> <str>
   Center string.
Adjust
   Enter adjust/fill modes (brk, deflt).
BLank <char>
   Define blank substitute character (.NULL.).
BMargin <n>
   Set bottom margin (brk, ejt, 5).
Break
   Break (start new line).
CMargin <n>
   Set column margin (brk, ejt, 5).
Column
   Set number of columns (brk, ejt, 1).
DD <str>
   Down Decimal level.
DDS <str>
   Down decimal level, no decimal number.
Define <sym> <str>
   Define symbol value.
DI <lev> <before> <after>
   Set decimal indents. Ø => all levels
DLevel <n>
   Go to decimal level <n> (1).
DLI <n>
   Set highest decimal level to appear in Table of Contents (all).
DN <str>
   Next heading on current decimal level.

DNS <str>
   Next heading on current decimal level, suppress number.
DR <n>
   Reset number on decimal level <n>.
DS <lev> <before> <after>
   Set decimal heading skip values.
   Ø => all; -1 => eject before
DU [<n>]
   Go up <n> decimal levels (1).
EFooter /-/-/-/
   Define even-page footer.
EHeader /-/-/-/
   Define even-page header.
Eject
   Page eject (brk, ejt).
ERase <char>
   Define cmnd mode erase char.
ERRgo
   Continue on error.
FILE <fn>
   Specify output file.
Fill
   Enter fill mode.
FLoat <fn>
   Floating insert of <fn>.
FOoter /-/-/-/
   Define footer for all pages.
FRom <n>
   First page number to output.
Header /-/-/-/
   Define header for all pages.
HYphen <char>
   Define phantom hyphen char (.RUBOUT.).
Indent <n>
   Indent left margin (5).
INDEX <str>
   Write <str> and page number to index.
INS <fn> [(<parms>]
   Insert <fn>.
INS <unit>
   Insert from <unit>.
IXfile <fn>
   Define index file (16).
Kill <char>
   Define command line kill char (?).
Length
   Specify physical page length (brk, ejt, 66).
NAdjust
   Leave adjust mode (brk).
Need <n>
   Eject if < <n> lines (1).
NERrgo
   Stop on error encountered (deflt).

NFill
   Leave fill and adjust modes (brk).
NFILE
   No output to file.
NIXfile
   Stop output to index file.
NParagraph
   No paragraph indentation (deflt).
NPAUse
   No pause between pages (deflt).
NPErforate
   No perforation marks (deflt).
NTty
   No output to TTY (deflt).
OFooter /-/-/-/
   Define odd-page footer.
OHeader /-/-/-/
   Define odd-page header.
PAGen <n>
   Set page number (1).
Paragraph [<n>] [<m>]
   Start paragraph, skip <n>, indent <m>.
PAUse
   Pause between output pages.
PErforate
   Print perforation marks.
PIcture <n>
   Leave <n> lines together (1).
PUrge
   Force in outstanding floats.
Quit
   Exit RUNOFF (brk, ejt).
RBar [ON]
   Start revision bars.
RBar [OFF]
   Stop revision bars.
REturn <n>
   Return to prev input file (Ø).
Rindent <n>
   Indent right margin (5).
RUndent <n>
   Undent right margin (Ø).
Skip <n>
   Skip <n> lines (brk, 1).
SM <n>
   Specify side margins (brk, ejt, 7).
SO <n>
   Print <n>th source line # (1).
Space <n>
   Specify single/double, etc. spacing (1).
STop
   Conditional .QUIT/.RETURN.
SYchar <char>
   Define symbol delimiter (%).

Tab <char> <nl> ...
   Set tab character and stops.
TMargin <n>
   Specify top margin (brk, ejt, 7).
TO <n>
   Specify last page to print (32767).
TOFc <fn> <lim>
   Specify table of contents file.
TOFc [<opt>]
   Close, stop, start table of contents for <opt>=omitted, Ø, 1.
TTOfc <str>
   Enter string in table of contents.
TTy
   Output to TTY.
UNDEFine <sym>
   Undefine symbol.
Undent <n>
   Undent left margin.
WIDOw <n>
   Specify allowable widow size (Ø).
Width <n>
   Specify paper width (brk, ejt, 85).

External command.

SAVE -- SAVE MEMORY IMAGE

SAve <filename> [<sa>] [<ea>] [<p>] [<a>] [<b>] [<x>] [<k>]

Do not use SAve with 64V segmented files.

Internal command.

X.SAVER -- COMPARE RUNFILES

SAVER [<treenamel>] [<treename2>]

Prompts if no names entered.

External command.

SEG -- SEGMENTED LOADER

SEG [<filename>]

SUBCOMMANDS

DELETE [<filename>]
deletes runfile.

HElp
print list of SEG commands.

LOad [<treename>]
define runfile and invoke loader for creation.

LOad * [<treename>]
define runfile and invoke loader for appending.

ATtach [<UFDname>] [<password>] [<ldisk>] [<key>]
attach to UFD.

A/SYmbol <sname> [<segtype>] <segno> <size>
define a symbol in memory and reserve space for it using absolute segment numbers.

COmmon [ABS] <segno>
relocate COMMON using absolute segment numbers.

COmmon REL <segno>
relocate COMMON using relative segment assignment.

D/IL (D = Ditto = use parms of previous cmnd.)

D/LCad

D/LIbrary

D/FOrceload

D/PL or D/RL
load using previous parameters. D/ and F/ may be combined.

EXecute
save load to disk and execute program.

F/xx [<filename>] [<addr psegno lsegno>]
forceload all routines in object file.

IL [addr psegno lsegno]
load impure FORTRAN library.

INitialize [<treename>]
initialize and restart loader.

LIbrary [<treename>] [addr psegno lsegno]
load library file.

LO [<treename>] [addr psegno lsegno]
load object file.

MAp [<filename>] <option>
generate load map.

MIxup [ON] or MIxup OFF
mixes procedure and static data.

MV
moves portion of loaded file. Will prompt for info.

Operator
relax/impose high-level restrictions

PL [addr psegno lsegno]
load pure FORTRAN library.

P/xx [<filename>] [<option>] [<psegno lsegno>]
load on a page boundary.

QUit
return to PRIMOS command level.

REturn
return to SEG command level.

RL <treename> [<addr psegno lsegno>]
reload a routine.

R/SYmbol <sname> [<segtype>] <segno> <size>
define symbol in memory and reserve space for relative segment assignment.

SAve [a] [b] [x]
save load to disk.

SE <segno> <len>
create base area for desectorization.

Split <segno><addr>
<addr>
<addr><ssegno><saddr> <esegno>
break data into data and procedure portions

SS <sname>
save symbol.

STack <size>
change stack size.

SYmbol [<sname>] <segno> <addr>
define a symbol at specific location in memory.

S/xx [<filename>] <addr> <psegno> <lsegno>
load a specific absolute segment.

XP <dsymbol> <dbase>
expunge symbols from symbol table and delete base information.

MAp <filename1> [<filename2>] <option>
ascending addr, ll=sym>

MOdify [<filename>] or SA [<filename>]
invoke modification subprocessor.
NEw <filename>
write new copy of runfile to disk.
PAtch
modify save range of existing segment.
REturn
return to SEG command level.
SK <ssize> or SK <segno> <addr>
alter stack size and/or location.
STart <segno> <addr>
change program execution start address.
WRite
write all segments to disk.
PArams [<filename>]
display parameters of runfile.
PSd
invoke VPSD debugging utility.
Quit
return to PRIMOS command level.
RESTore [<treename>]
bring runfile into user memory.
RESUme [<treename>]
restore runfile and begin execution.
SHare [<treename>]
create R mode runfiles for segments below '4001.
SIngle [<treename>] <segno>
create R mode file image of single segment.
TIme [<treename>]
print time and date of last runfile modification.
VERSION
display SEG version number.

External command.

SETIME -- SET DATE AND TIME

SEtime -<mmddyy> -<hhmm>

Must be issued before user logins possible.
System user only.
Internal command.

SFRWLK -- SET FILE READ/WRITE LOCK

SFRWLK

Prompts for filename, RWLOCK setting (0-3): 0 - use system lock, 1 - N readers or one writer, 2 - N readers and one writer, 3 - N readers and N writers.

External command.

SHARE -- SPECIFY SHARED SEGMENT

SHAre [<filename>] <segno> [<access>]
[600]

Omitted <filename> => change access only. <access>: 000-no access, 200-read access, 600-read/execute access, 700-read, write, execute access.
segno < '4000.

System user only.
OPRPRI 1 only.
Internal command.

SHUTDN -- SHUTDOWN DISK(S) OR SYSTEM

SHutdn [<node>] [<dvno> ...]
[ALL]

Do not shutdown logical device 0 -- contains CMDNC0.

System user only.
Internal command.

SIZE -- PRINT SIZE OF FILE

SIZE <treename>

External command.

SLIST -- PRINT FILE TO TERMINAL

SLIST [<treename>]

External command.

SORT

SORT [option1] [option2]

Options are: BRief, SPace, and MErge.

Prompts for: input filename, output filename, number of pairs of starting and ending columns, input pairs of starting and ending columns, reverse order, and data type. If merge option: number of files to be merged followed by input files, one per line.

External command.

SPOOL -- PRINT QUEUE MANAGER

```
SPOOL [ <treename> ] [<options>]
      [ %<treename>] [ -Lnum    ]  Line Numbers
                     [ -Ftn     ]  FTN Forms Ctl
                     [ -Expand  ]  Expand
                     [ -Nofmt   ]  No Format Ctl
                     [ -Plot <nw> ]  Plot
                     [ -Defer [<time>]] Defer to time
                     [ -Home    ]  Local Printer
                     [ -FOrm <name> ]  Forms type
                     [ -Open    ]  Open only
                     [ -FUnit <unit> ] From unit
                     [ -Tunit <unit> ]  To unit (2)
      [   -CMD     ]
      [ -CANCEL <filename> ]
      [ -LIST [ ALL ] ]
              [ OWN ]
              [DEFER]
              [ PLOT]
              [PRINT]
              [FORM <type>]  (For default, say: ' ')
```

Prompts for defer time (-D), form type (-T) if not entered. '-CMD' ('SYSTEM' only) allows internal commands:

```
USER <usrno-of-spooler>
ABORT     (Abort current file and restart later)
DROP      (Aborts and deletes)
BACK      (Backs up 100 lines and restarts)
RESTART   (Restart current file)
FORM <type>   (Specify new paper type)
HANG      (Stop now)
GO        (Restart after HANG, FINISH)
LENGTH <n>   (Specify paper length)
QUIT      (Exit SPOOL environment)
TIME <secs>     (To wait for phantom)
CANCEL <filename>
FINISH    (Stop when current file done)
LIST
```

External command.

START -- START EXECUTION

Start [<token>...] [<p>] [<a>] [<b>] [<x>] [<k>]

Internal command.

STARTUP -- STARTUP DISK(S)

STARTUp [<nodename>] <dvno> ...

System user only.
Internal command.

STATUS -- PRINT USER OR SYSTEM STATUS

```
STATus [ ALl ]
       [USers]
       [DIsks]
       [UNits]
       [ NEt ]
```

Internal command.

SVCSW -- SET USER SVC SWITCH (INTERNAL

```
SVcsw [ 1 ]
      [ 0 ]
```

1 => bounce (except class 5), 0 => don't bounce.

Internal command.

TA -- TREE ATTACH

TA <treename>

WARNING: Wipes out memory.

External command.

TAPXAM -- READ/WRITE MAGTAPE

TAPXAM

Allows examination of 7 or 9-track tapes at a single tape command level. Can be used to diagnose failing drive or controller. Prompts for drive number, 7 or 9 track indication, maximum record size to read or write. Defaults (just hit .CR.) are drive 0, 9 track, '1000 words. Displays command, status, and NW transferred after each operation. Internal commands:

BF or BT	Backspace one filemark (tapemark).
BS or BR	Backspace one record.
DS	Display Status. Interprets last status read in readable form.
Eol	Write MAGSAV-style End-Logical-Tape record. Must first read last record on tape (to get sequence number right).
FF or FT	Forward space to file mark.
FS or FR	Forward space one record.
In	Re-initialize (all prompts repeated).
Max [<n>]	Set max amt of data to display after reads -- 0-10 words, defaults to 0.
Psd	Enter PSD (to examine block just read). Prints addr of buffer, use 'Q' in PSD to return to TAPXAM.
Quit	Exit TAPXAM (tape is not rewound).
R[C][1] [<nw>]	Read [Binary] [1 char/word] or [Correct] [1 char/word].
RW	Rewind to load point.
St	Read current status.
W[C][1] [<nw>]	Write [Binary] [1 char/word] or [Correct] [1 char/word].
WF or WT	Write file mark (tape mark).
1600BPI	Set density to 1600 bpi. (only applicable for software settable density)
6250BPI	Set density to 6250 bpi. (only applicable for software settable density)

External command.

TERM -- SET TERMINAL CHARACTERISTICS

```
TERM [ DISPLA ]
     [ ERASE  <char> ]
     [ KILL   <char> ]
     [ BREAK ON  ]
     [       OFF ]
     [ HALF [NOLF] [XOFF] ]
     [ FULL [XOFF] ]
```

External command.

TIME -- PRINT TIME STATISTICS

Time

HH'MM logged in, MM'SS CPU time, MM'SS I/O time.

Internal command.

TRAMLC -- AMLC I/O

```
TRAMLC TRANSMIT <filename> <line> [T]
TRAMLC RECEIVE <filename> <line> [T]
```

External command.

UNASSIGN -- RELEASE PERIPHERAL DEVICE

Unassign <parameters-identical-to-ASSIGN-command>

Internal command.

UPCASE -- TRANSLATE FILE TO UPPER CASE

```
UPCASE <intreename> [<outtreename>]
                    [<file-open-on-unit 2>]
```

External command.

USERS -- PRINT CURRENT NUMBER OF USERS

USErs

Internal command.

USRASR -- CONNECT SYSTEM ASR TO USER

USRasr <usrno>

Must type full USRASR if not logged in.

System user only.
Internal command.

VPSD -- VIRTUAL MODE PSD

VPSD

Supports V-mode. For internal commands, see PSD.

External command.

VRTSSW -- SET VIRTUAL SENSE SWITCHES

Vrtssw [<sense-switch-setting>]
[0]

Internal command.

COMMANDS

4 FILE SYSTEM INTERNALS

The following describes the internal formats of all disk records for both the old and new file system partitions. All numbers are decimal unless preceded by a ':'. Where possible, field names are the same as those used by the internal file system routines.

DSKRAT FORMATS

DSKRAT Format -- Old Partitions

0	5	NUMBER OF WORDS IN DSKRAT HEADER = 5
1	RECSIZ	DISK RECORD SIZE (448 or 1040)
2	NMRECS	NUMBER RECORDS IN PARTITION
3	UNUSED	UNUSED
4	NHEADS	NUMBER HEADS IN PARTITION
5	DATA	START OF DKSRAT DATA (ONE BIT/RECORD)
	....	

DSKRAT Format -- New Partitions

0	8	NUMBER WORDS IN HEADER = 8
1	RECSIZ	RECORD SIZE
2	NMRECS	NUMBER RECORDS IN PARTITON (TWO WORDS)
4	NHEADS	NUMBER HEADS IN PARTITION
5	RESERVED	RESERVED
6	RESERVED	RESERVED
7	RESERVED	RESERVED
8	DATA	START OF DSKRAT DATA (ONE BIT/RECORD)
	....	

RECORD HEADER FORMATS

NOTE: record header formats are the same for new and old partitions. The format of a record header is a function of the physical record size.

Record Header Format -- 448-Word Records

0	REKCRA	RECORD ADDRESS (OF THIS RECORD)
1	REKBRA	RA OF DIRECTORY ENTRY OR FIRST RECORD
2	REKFPT	RA OF NEXT SEQUENTIAL RECORD
3	REKBPT	RA OF PREVIOUS RECORD
4	REKCNT	NUMBER DATA WORDS IN THIS RECORD
5	REKTYP	TYPE OF THIS FILE
6	REKLVL	INDEX LEVEL FOR NEW PART DAM FILES
7	RESERVED	RESERVED

Record Header Format -- 1040-Word Records

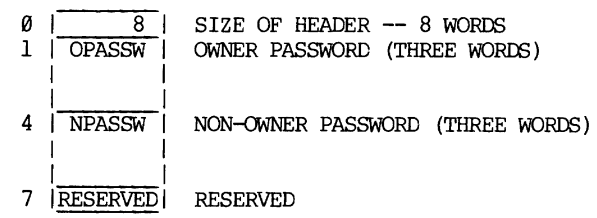
0	REKCRA	RECORD ADDR OF THIS RECORD (TWO WORDS)
2	REKBRA	BEGINNING RECORD ADDRESS (TWO WORDS)
		(BRA OF DIRECTORY IF FIRST RECORD)
4	REKCNT	NUMBER DATA WORDS IN THIS RECORD
5	REKTYP	TYPE OF THIS FILE
6	REKFPT	RA NEXT SEQUENTIAL RECORD (TWO WORDS)
		(0 IF LAST)
8	REKBPT	RA OF PREVIOUS RECORD (TWO WORDS)
		(0 IF FIRST)
10	REKLVL	INDEX LEVEL FOR NEW PART DAM FILES
11		
	RESERVED	RESERVED (FIVE WORDS)
15		

Notes

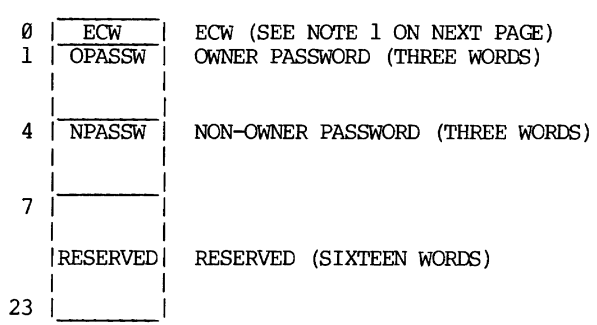
1) All disks except Storage Module have 448-word records. Storage Modules have 1040-word records.
2) The BRA of the first record in a file points to the beginning record address of the directory in which the file entry appears. In all other records, the BRA points to the first record of the file.
3) REKFPT contains the address of the next sequential record in the file or 0 if it is the last record in the file.
4) REKBPT contains the address of the previous record in sequence or 0 if it is the first record in the file.
5) REKTYP is valid only in the first record of a file. Legal values are:
   - 0 SAM File
   - 1 DAM File
   - 2 SAM Segment Directory
   - 3 DAM Segment Directory
   - 4 User File Directory (UFD)
6) If the file is the record zero bootstrap (BOOT) or the disk record availability table (DSKRAT or volume name) and the disk has a 1040 record size (Storage Module), bit 1 (:100000) of FILTYP will be set.
7) DAM files on new partitions are organized somewhat differently from the above -- see PE-T-276.

UFD HEADER AND ENTRY FORMATS

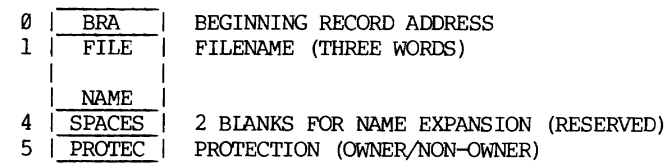
Old UFD Header Format



New UFD Header Format



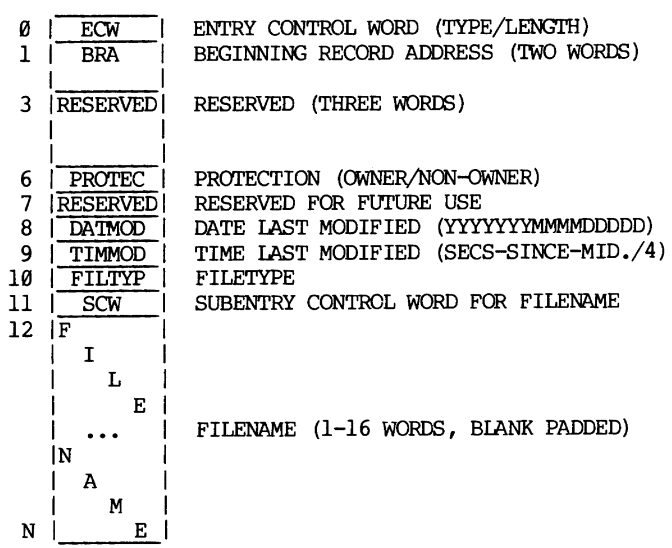
Old UFD Entry Format



Notes

In an old UFD, the high-order eight bits of PROTEC are the owner rights stored in complemented form (Ø=>owner has right). The low-order eight bits are non-owner protection, stored in true form (Ø=>no right). On creation, PROTEC=Ø. After a 'PROT 7 Ø', PROTEC=:174000.

New UFD Entry Format



Notes

1) The Entry Control Word (ECW) consists of two eight-bit subfields. The top eight bits indicate the type of the following entry as follows:

Ø	Old UFD Header
1	New UFD Header
2	Vacant Entry
3	New UFD File Entry

   The low-order eight bits give the size of the entry including the ECW itself.
2) The bits in PROTEC are stored in true form (Ø=> no right) for both owner and non-owner fields.
3) The file type field is as before (see Old Record Header Format) with following additional bits:

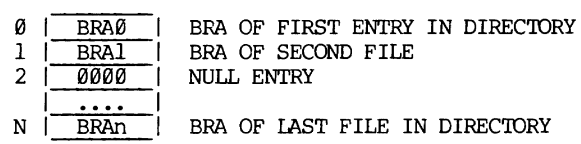
BIT	MEANING WHEN BIT IS ON
1	File has 16-word hdr (DSKRAT, BOOT only).
4	Special file (BOOT, DSKRAT, MFD, BADSPT).

4) The Subentry Control Word (SCW) consists of two eight-bit subfields. The top 8 bits are Ø, indicating subentry type Ø. The low-order 8 bits give the size of the subentry including the SCW itself.
5) N.B.: UFD entries are reused by the new file system. This means that a new entry will not necessarily appear at the end of the UFD.

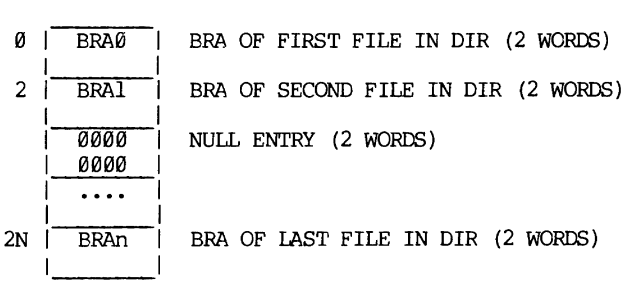
FILE SYSTEM INTERNALS

SEGMENT DIRECTORY FORMATS

Old Segment Directory Format



New Segment Directory Format



Notes

The only difference between old and new directories is that each entry in a new directory is two words. A null entry in a new directory is a 32-bit Ø.

5 INSTRUCTION SET

The following description applies only to P400 memory reference. The first number in the "opcode" column is the octal representation of instruction bits 3-6. The second number is the octal representation of bits 13-14 (bits 13-14 are inspected only if bits 6-11 are 11000, i.e., S=1 and -256 $\leq$ D < -224).

The 'type' column indicates the format and/or function of the operation as follows.

AP: Three-word operation, the last two words of which are an AP address pointer.
BR: Two-word operation, the second word of which is a word number within the current procedure segment to which to branch.
CON: Single-word control operation.
DA: Decimal arithmetic operation.
FE: Field and edit operation.
FLD: Single-word field operation.
FOP: Single-word floating-point operation.
FSK: Single-word floating-point skip operation.
IG: Single-word integrity operation.
IO: Single-word input/output operation.
LOG: Single-word logicize operation.
MOD: Single-word mode operation.
MR: Memory-reference operation.
OPR: Single-word miscellaneous operation.
PIO: Programmed input/output operation.
SH: Single-word shift operation.
SKP: Single-word skip operation.
VM: Virtual memory operation.

The 'C' column indicates the effect of the operation on the C-bit and the L-bit as follows.

-: C and L are unchanged by the operation.
1: C is unchanged, L is carry.
2: C is overflow, L is carry.
3: C is overflow, L is indeterminant.
4: C is shift extension, L is indeterminant.
5: C is a result of op, L is indeterminant.
6: C and L are indeterminant.
7: C and L are loaded by the operation.
8: C is cleared, L is indeterminant.

The 'cc' column indicates the effect of the operation on the condition codes as follows.

-: Cond. codes are unchanged.
1,4: Cond. codes result of arith op or compare.
5: Cond. codes indeterminant.
6: Cond. codes loaded by operation.
7: Cond. codes indicate result of operation.

The 'avail' column indicates in which addressing modes the operation is available as follows.

S: Available in 16S and 32S modes.
R: Available in 32R and 64R modes.
V: Available in 64V mode.
I: Available in 32I mode.
*: Restricted to Ring 0 execution.

PRIME 400 MEMORY-REFERENCE INSTRUCTIONS
(WHEN IN 64V MODE).

	INSTRUCTION BITS 13-14 (if S=1 and -256<=D<-224)			
INSTRUCTION BITS 3-6	00	01	10	11
0001	JMP	EAL	XEC	-
0010	LDA	FLD	DFLD	LDL
0011	ANA	STLR	ORA	ANL
0100	STA	FST	DFST	STL
0101	ERA	LDLR	-	ERL
0110	ADD	FAD	DFAD	ADL
0111	SUB	FSB	DFSB	SBL
1000	JST	-	PCL	-
1001	CAS	FCS	DFCS	CLS
1010	IRS	MIA	EAXB	-
1011	IMA	MIB	EALB	-
1100	JSY	EIO	JSXB	-
1101*	STX	FLX	DFLX	-
1101**	LDX	LDY	STY	JSX
1110	MPY	FMP	DFMP	MPL
1111	DIV	FDV	DFDV	DVL

Use column 00 if S (bit 7) is 0 or if D (bits 8-16) is not in the range -256 <= D < -224.

*: Use this row if bit 2 of instr. word is a 0. These instructions cannot be indexed.

**: Use this row if bit 2 of the instruction word is a 1. These instructions cannot be indexed.

MNEM	OPCODE	TYP	C	c	AVAIL	DESCRIPTION
A					I	ADD WORD.
A1A	141206	OPR	2	1	SRV	ADD 1 TO A REG. A+1=>A.
A2A	140304	OPR	2	1	SRV	ADD 2 TO A REGISTER. A+2=>A.
ABQ	50134	OPR	-	7	I	ADD TO BOTTOM OF QUEUE.
ABQ	141716	AP	-	6	SRV	ADD TO BOT OF Q. CCEQ => FULL.
ACA	141216	OPR	2	1	SRV	ADD CBIT TO A REG. CBIT+A=>A.
ADD	06	MR	2	1	SRV	ADD. (A) + [EA]16 => A.
ADL	06 03	MR	2	1	V	(A,B)+[EA]32=>A,B. (NO HOLE).
ADLL	141000	OPR	2	1	SRV	ADD LINK TO L REGISTER.
ADLR	50014	OPR	-	7	I	ADD LINK TO GR.
AH	12	MR	2	1	I	ADD HALFWD. RH+[EA16]=>RH.
ALFA	001301	FLD	6	5	SRV	ADD L TO FIELD ADDR REG. ZERO.
ALFA	001311	FLD	6	5	SRV	ADD L TO FIELD ADDR REG. ONE.
ALL	0414XX	SH	4	5	SRV	A LEFT LOGICAL.
ALR	0416XX	SH	4	5	SRV	A LEFT ROTATE.
ALS	0415XX	SH	4	5	SRV	A LEFT SHIFT (SHORT INT ARITH).
ANA	03	MR	-	-	SRV	AND. (A) .AND. [EA]16 => A.
ANL	03 03	MR	-	-	V	(A,B) .AND. [EA]32 => A,B.
ARFA	50161	FLD	-	7	I	ADD GR TO FIELD ADDR REG.
ARGT	000605	CON	-	-	SRV	ARG TRANSFER (USED WITH PCL).
ARL	0404XX	SH	4	5	SRV	A RIGHT LOGICAL.
ARR	0406XX	SH	4	5	SRV	A RIGHT ROTATE.
ARS	0405XX	SH	4	5	SRV	A RIGHT SHIFT (SHORT ARITH).
ATQ	50135	OPR	-	7	I	ADD TO TOP OF QUEUE.
ATQ	141717	AP	-	6	SRV	ADD TO TOP OF Q. CCEQ => FULL.
BCEQ	141602	BR	-	-	SRV	BRANCH ON CONDITION CODE .EQ.
BCGE	141605	BR	-	-	SRV	BRANCH ON CONDITION CODE .GE.
BCGT	141601	BR	-	-	SRV	BRANCH ON CONDITION CODE .GT.
BCLE	141600	BR	-	-	SRV	BRANCH ON CONDITION CODE .LE.
BCLT	141704	BR	-	-	SRV	BRANCH ON CONDITION CODE .LT.
BCNE	141603	BR	-	-	SRV	BRANCH ON CONDITION CODE .NE.
BCR	141705	BR	-	-	SRV	BRANCH ON CBIT RESET.
BCS	141604	BR	-	-	SRV	BRANCH ON CBIT SET.
BDX	140734	BR	-	-	SRV	BRANCH ON DECREMENTED X.
BDY	140724	BR	-	-	SRV	BRANCH ON DECREMENTED Y.
BEQ	140612	BR	-	4	SRV	BRANCH ON A REGISTER .EQ. 0.
BFEQ	50122	BR	-	4	I	BRANCH ON FLTG REG EQ.
BFEQ	141612	BR	-	4	SRV	BRANCH ON FAC .EQ. 0.
BFGE	50125	BR	-	4	I	BRANCH ON FLTG REG NE.
BFGE	141615	BR	-	4	SRV	BRANCH ON FAC .GE. 0.
BFGT	50121	BR	-	4	I	BRANCH ON FLTG REG LE.
BFGT	141611	BR	-	4	SRV	BRANCH ON FAC .GT. 0.
BFLE	50120	BR	-	4	I	BRANCH ON FLTG REG LT.
BFLE	141610	BR	-	4	SRV	BRANCH ON FAC .LE. 0.
BFLT	50124	BR	-	4	I	BRANCH on FLTG REG GT.
BFLT	141614	BR	-	4	SRV	BRANCH ON FAC .LT. 0.
BFNE	50123	BR	-	4	I	BRANCH ON FLTG REG GE.
BFNE	141613	BR	-	4	SRV	BRANCH ON FAC .NE. 0.
BGE	140615	BR	-	4	SRV	BRANCH ON A REGISTER .GE. 0.
BGT	140611	BR	-	4	SRV	BRANCH ON A REGISTER .GT. 0.
BHD1	50144	BR	-	-	I	BRANCH ON HALF REG DEC BY 1.
BHD2	50145	BR	-	-	I	BRANCH ON HALF REG DEC BY 2.

BHD4	50146	BR	-	-	I	BRANCH ON HALF REG DEC BY 4.
BHEQ	50112	BR	-	4	I	BRANCH ON HALF REG EQ.
BHGT	50111	BR	-	4	I	BRANCH ON HALF REG LE.
BHI1	50140	BR	-	-	I	BRANCH ON HALF REG INCR BY 1.
BHI2	50141	BR	-	-	I	BRANCH ON HALF REG INCR BY 2.
BHI4	50142	BR	-	-	I	BRANCH ON HALF REG INCR BY 4.
BHLE	50110	BR	-	4	I	BRANCH ON HALF REG LT.
BHLT	50104	BR	-	4	I	BRANCH ON HALF REG GT.
BHNE	50113	BR	-	4	I	BRANCH ON HALF REG GE.
BHNE	50105	BR	-	4	I	BRANCH ON HALF REG NE.
BIX	141334	BR	-	-	SRV	BRANCH ON INCREMENTED X.
BIY	141324	BR	-	-	SRV	BRANCH ON INCREMENTED Y.
BLE	140610	BR	-	4	SRV	BRANCH ON A REGISTER .LE. 0.
BLEQ	140702	BR	-	4	SRV	BRANCH ON L REGISTER .EQ. 0.
BLGE	140615	BR	-	4	SRV	BRANCH ON L REGISTER .GE. 0.
BLGT	140701	BR	-	4	SRV	BRANCH ON L REGISTER .GT. 0.
BLLE	140700	BR	-	4	SRV	BRANCH ON L REGISTER .LE. 0.
BLLT	140614	BR	-	4	SRV	BRANCH ON L REGISTER .LT. 0.
BLNE	140703	BR	-	4	SRV	BRANCH ON L REGISTER .NE. 0.
BLR	141707	BR	-	-	SRV	BRANCH ON LINK RESET.
BLS	141706	BR	-	-	SRV	BRANCH ON LINK SET.
BLT	140614	BR	-	4	SRV	BRANCH ON A REGISTER .LT. 0.
BMEQ	141602	BR	-	-	SRV	BRANCH ON MAG.-COND. L,CC .EQ.
BMGE	141706	BR	-	-	SRV	BRANCH ON MAG.-COND. L,CC .GE.
BMGT	141710	BR	-	-	SRV	BRANCH ON MAG.-COND. L,CC .GT.
BMLE	141711	BR	-	-	SRV	BRANCH ON MAG.-COND. L,CC .LE.
BMLT	141707	BR	-	-	SRV	BRANCH ON MAG.-COND. L,CC .LT.
BMNE	141603	BR	-	-	SRV	BRANCH ON MAG.-COND. L,CC .NE.
BNE	140613	BR	-	4	SRV	BRANCH ON A REGISTER .NE. 0.
BRBR	50040	BR	-	-	I	BRANCH ON REG BIT RESET.
BRBS	50000	BR	-	-	I	BRANCH ON REG BIT SET.
BGR1	50134	BR	-	-	I	BRANCH ON REG DEC BY 1.
BGR2	50135	BR	-	-	I	BRANCH ON REG DEC BY 2.
BGR4	50136	BR	-	-	I	BRANCH ON REG DEC BY 4.
BREQ	50102	BR	-	4	I	BRANCH ON REG EQ.
BRGE	50105	BR	-	4	I	BRANCH ON REG NE.
BRGT	50101	BR	-	4	I	BRANCH ON REG LE.
BRI1	50130	BR	-	-	I	BRANCH ON REG INCR BY 1.
BRI2	50131	BR	-	-	I	BRANCH ON REG INCR BY 2.
BRI4	50132	BR	-	-	I	BRANCH ON REG INCR BY 4.
BRLE	50100	BR	-	4	I	BRANCH ON REGISTER LT.
BRLT	50104	BR	-	4	I	BRANCH ON REGISTER GT.
BRNE	50103	BR	-	4	I	BRANCH ON REGISTER GE.
C	61	MR	1	1	I	COMPARE R WITH [EA32].
CAI	000411	IO	-	-	SRVI	*CLEAR ACTIVE INTERRUPT.
CAL	141050	OPR	-	-	SRV	CLEAR A REG. LEFT BYTE.
CALF	000705	AP	7	6	SRV	PROC CALL FROM FAULTING PROC.
CAR	141044	OPR	-	-	SRV	CLEAR A REG. RIGHT BYTE.
CAS	11	MR	1	1	SRV	SKIP 0,1,2 IF (A) >,=,< [EA]16.
CAZ	140214	OPR	1	1	SRV	SKIP 0,1,2 INST. IF A >,=,< 0.
CEA	000111	OPR	-	-	SRV	A AS EA=>A. (USELESS IN 64V).
CGT	50026	OPR	-	7	I	COMPUTED GOTO.
CGT	001314	-	6	5	SRV	COMPUTED GO TO.
CH	71	MR	1	1	I	COMPARE RH WITH [EA16].
CHS	50040	OPR	-	-	I	CHANGE SIGN -(1)=>GR(1).
CHS	140024	OPR	-	-	SRV	CHANGE SIGN OF A REGISTER.
CLS	11 03	MR	1	1	V	SKIP 0,1,2 IF (A,B)>,=,<[EA]32.

```
CMA   140401 OPR - - SRV  ONE'S COMPLEMENT A REGISTER.
CMH    50045 OPR - - I    COMP HALF REG. GRH=>GRH.
CMR    50044 OPR - - I    COMP REG. GR=>GR.
CR     50056 OPR - - I    CLEAR REG. 0 => GR.
CRA   140040 OPR - - SRV  CLEAR A REGISTER.  0=>A.
CRB   140015 OPR - - SRV  CLEAR B REGISTER.  0=>B.
CRBL   50062 OPR - - I    LEFT BYTE 0=>GRH(1-8).
CRBR   50063 OPR - - I    RIGHT BYTE 0=>GRH(9-16).
CRE   141404 OPR - - SRV  CLEAR E.  0=>E.
CREP  10 02  MR  - - R    (P) => [(S)+1]16, EA=>P.
CRL   140010 OPR - - SRV  CLEAR L REGISTER.  0=>L.
CRLE  141410 OPR - - SRV  CLEAR L AND E.  0=>L, 0=>E.
CSA   140320 OPR 5 - SRV  CPY SIGN OF A. A1=>CBIT,0=>A1.
CSR    50041 OPR - - I    COPY & SAVE SIGN. 1=>C,0=>GR1.
CXCS  001714 IG  - - V    CONTROL EXTENDED CONTROL STORE.
D     62     MR  3 1 I    DIV. (R,R+1)/[EA32=>R RMR=>R+1.
DAD   06(DP) MR  2 1 SR   (A,B)+[EA]32 => A,B.(W/HOLE).
DBL   000007 MOD - - SRV  ENTER DOUBLE-PREC MODE.
DBLE   50106 FOP - - I    CONV SINGLE TO DOUBLE FLTG PT.
DECH  70     MR  - 1 I    DECR HALFWD. [EA16]-1=>[EA16].
DFA   15 17  MR  3 1 I    DBLE FLTG ADD. DFR+[EA64]=>DFR.
DFAD  06 02  MR  3 5 RV   (DFAC) + [EA]64 => DFAC.
DFC   05 07  MR  - 1 I    DBLE FLTG COMP DRF TO [EA64].
DFCM   50144 FOP 3 1 I    DBL PRC FLTG COMP. -DFGR=>DFGR.
DFCM  140574 FOP 3 5 SRV  -DFAC=>DFAC.
DFCS  11 02  MR  6 5 RV   SKP 0,1,2 IF (DFAC)>,=.<[EA]64.
DFD   31,33  MR  3 1 I    DOUBLE FLTG DIVIDE.
DFDV  17 02  MR  3 5 RV   (DFAC) / [EA]64 => DFAC.
DFL   01 03  MR  - - I    DBLE FLTG LOAD. [EA643]=>DFR.
DFLD  02 02  MR  - - RV   [EA]64 => DFAC.
DFLX  15 02  MR  - - V    LD DFLT INDEX.  4*[EA]16 => X.
DFM   25 27  MR  3 1 I    DBL FLTG MULT. DFR/[EA64]=>DFR.
DFMP  16 02  MR  3 5 RV   (DFAC) * [EA]64 => DFAC.
DFS   21 23  MR  3 1 I    DBLE FLTG SUB. DFR-[EA64]=>DFR.
DFSB  07 02  MR  3 5 RV   (DFAC) - [EA]64 => DFAC.
DFST  11,13  MR  1 1 I    DBLE FLTG STORE. DFR=>[EA64].
DFST  04 02  MR  - - RV   (DFAC) => [EA]64.
DH    72     MR  3 1 I    DIV HW. R/[EA16]=>RH RM=>RL(2).
DH1    50130 OPR 2 1 I    DECR HALF REG BY 1. GRH-1=>GRH.
DH2    50131 OPR 2 1 I    DECR HALF REG BY 2. GRH-2=>GRH.
DIV   17     MR  3 5 V    (A,B)/[EA]16=>A,REM=>B.(NOHOLE)
DIV   17     MR  3 5 SR   (A,B)/[EA]16=>A;REM=>B.(W/HOLE)
DLD   02(DP) MR  - - SR   DOUBLE LOAD.  [EA]32 => A,B.
DM    60     MR  - 1 I    DECR. [EA32]-1=>[EA32].
DMH   70     MR  - 1 I    DECR HALDWD. [EA16]-1=>[EA16].
DR1    50124 OPR 2 1 I    DECR REG BY 1. GR-1=>GR.
DR2    50125 OPR 2 1 I    DECR REG BY 2. GR-2=>GR.
DRX   140210 OPR - - SRV  DECREMENT X AND SKIP IF 0.
DSB   07(DP) MR  2 1 SR   (A,B)-[EA]32 => A,B (W/HOLE).
DST   04(DP) MR  - - SR   DOUBLE STORE.  (A,B) => [EA]32.
DVL   17 03  MR  3 5 V    (A,B,E)/[EA]32=>A,B REM=>EH,EL.
E16S  000011 MOD - - SRV  ENTER P300 16K SECTORED MODE.
E32I  001010 MOD - - SRV  ENTER P500 321 MODE.
E32R  001013 MOD - - SRVI ENTER P300 32K RELATIVE MODE.
E32S  000013 MOD - - SRVI ENTER P300 32K SECTORED MODE.
E64R  001011 MOD - - SRVI ENTER P300 64K RELATIVE MODE.
E64V  000010 MOD - - SRVI ENTER P400 MODE.
```



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EAA   01 01  MR  - - R    EFF. ADDR TO A-REG.  EA => A.
EAFA  001300 AP  - - SRVI EFF. ADDR TO FIELD REG 0.
EAFA  001310 AP  - - SRVI EFF. ADDR TO FIELD REG 1.
EAL   01 01  MR  - - V    LOAD EFFECTIVE ADDR.  EA => L.
EALB  42     MR  - - I    EFF ADDR to LB. EA=>LB.
EALB  13 02  MR  - - V    EFF. ADDR TO LB. EA => LB.
EAR   63     MR  - - I    EFF ADDR (EA32)TO R.
EAXB  52     MR  - - I    EFF ADDR TO XB. EA=>XB.
EAXB  12 02  MR  - - V    EFF. ADDR TO XB. EA => XB.
EIO   34     MR  - 2 I    EXECUTE ADDR TO BASE REG.
EIO   14 01  MR  - 7 V*   EXEC EA AS I/O INSTR.CCEQ=>SKP.
EMCM  000503 IG  - - SRVI*ENTER MACH CHK MODE.
ENB   000401 IO  - - SRVI*ENABLE INTERRUPTS.
ENTR  01 03  MR  - - R    (S)=>[(S)-EA]16, (S)-EA=>S.
EPMJ  000217 VM  - - SR   ENT PAGE MODE AND JUMP (P300).
EPMX  000237 VM  - - SR   ENT PAG MOD & JMP TO MICROCODE.
ERA   05     MR  - - SRV  (A) .XOR. [EA]16 => A.
ERL   05 03  MR  - - V    (A,B) .XOR. [EA]32 => A,B.
ERMJ  000701 VM  - - SR   ENTER RESTR MODE & JUMP (P300).
ERMX  000721 VM  - - SR   RESTR MOD & JUMP TO MICROCODE.
ESIM  000415 MOD - - SRVI*ENTER STANDAGR INTERRUPT MODE.
EVIM  000417 MOD - - SRVI*ENTER VECTORED INTERUPT MODE.
EVMJ  000703 VM  - - SR   ENT VIRT MODE AND JUMP (P300).
EVMX  000723 VM  - - SR   VIRT MOD & JUMP TO MICROCODE.
FA    14,16  MR  3 1 I    FLTG ADD. FR+[EA32]=>FR.
FAD   06 01  MR  3 5 RV   (FAC) + [EA]32 => FAC.
FC    04,06  MR  - 1 I    FLTG COMPARE FR TO [EA32]
FCM    50100 FOP 3 1 I    FLTG COMP. -FGR=>FGR.
FCM   140530 FOP 3 5 SRV  FLOATING COMP.  -FAC=>FAC.
FCS   11 01  MR  6 5 RV   SKIP 0,1,2 IF (FAC)>,=.<[EA]32.
FD    30,32  MR  3 1 I    FLTG DIV. -FR/[EA32]=>FR.
FDBL  140016 FOP - - SRV  FAC=>DFAC.
FDV   17 01  MR  3 5 RV   (FAC) / [EA]32 => FAC.
FLD   02 01  MR  - - RV   FLOATING LOAD.  [EA]32 => FAC.
FLOT  140550 FOP 6 5 SRV  FLOT(A,B)=>FAC. (A,B) W/HOLE
FLT    50105 FOP - - I    CONV INT TO FLTG PT FLOAT.
FLTA  140532 FOP 3 5 SRV  FLOT(A)=>FAC.
FLTH   50102 FOP - - I    CNV HALF WD INT TO FLTG PT.
FLTL  140535 FOP 8 5 SRV  FLOT(L)=>FAC. (L W/NO HOLE)
FLX   15 01  MR  - - RV   2*[EA]16 => X.
FM    24,26  MR  3 1 I    FLTG MULT. FR*[EA32]=>FR.
FMP   16 01  MR  3 5 RV   (FAC) * [EA]32 => FAC.
FRN    50107 FOP 3 1 I    FLOATING ROUND UP.
FRN   140534 FOP 3 5 SRV  FLOATING ROUND UP.
FS    20,22  MR  3 1 I    FLTG SUB. FR-[EA32]=>FR.
FSB   07 01  MR  3 5 RV   (FAC) - [EA]32 => FAC.
FSGT  140515 FSK - 4 SRV  FLOATING SKIP IF .GT. 0.
FSLE  140514 FSK - 4 SRV  FLOATING SKIP IF .LE. 0.
FSMI  140512 FSK - 4 SRV  FLOATING SKIP IF .LT. 0.
FSNZ  140511 FSK - 4 SRV  FLOATING SKIP IF .NE. 0.
FSPL  140513 FSK - 4 SRV  FLOATING SKIP IF .GE. 0.
FST   10,12  MR  - - I    FLTG STORE. FR=>[EA32].
FST   04 01  MR  6 6 RV   (FAC) => [EA]32.
FSZE  140510 FSK - 4 SRV  FLOATING SKIP IF .EQ. 0.
HLT   000000 CON - - SRVI*HALT COMPUTER OPERATION.
I     41     MR  - - I    INTERCHANGE R WITH [EA32].
IAB   000201 OPR - - SRV  EXCHANGE A AND B  A=>B & B=>A.
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ICA  141340 OPR - - SRV  INTERCHANGE BYTES OF A REG.
ICBL  50065 OPR - - I    GRH(1-8)=>GRH(9-16), Ø=>R.
ICBR  50066 OPR - - I    GRH(9-16)=>GRH(1-8), Ø=>
ICHL  50060 OPR - - I    GRH=>GRL, Ø=>GRH.
ICHR  50061 OPR - - I    GRL=>GRH, Ø=>GRL.
ICL  141140 OPR - - SRV  EXCHANGE BYTES OF A, CLR LEFT.
ICR  141240 OPR - - SRV  EXCHANGE BYTES OF A, CLR RIGHT.
IH    51     MR  - - I    INTERCHANGE RH WITH [EA16].
IH1   50126 OPR 2 1 I    GRH+1=>GRH.
IH2   50127 OPR 2 1 I    GRH+2=>GRH.
ILE  141414 OPR - - SRV  EXCHANGE L AND E.  L=>E & E=>L.
IM    40     I   - 1 I    INCR. [EA31]+1=>[EA32].
IMA   13     MR  - - SRV  EXCHANGE MEMORY AND A-REGISTER.
IMH   Ø      MR  - 1 I    INCR HALF WD. [EA16]+1=>[EA16].
INA   54     PIO - - SR*  INPUT TO A-REGISTER.
INBC 001217 AP  6 5 SRVI*NTIFY IN INT, LIFO, DO CAI.
INBN 001215 AP  6 5 SRVI*NTIFY IN INT, LIFO, NO CAI.
INEC 001216 AP  6 5 SRVI*NTIFY IN INT, FIFO Q, DO CAI.
INEN 001214 AP  6 5 SRVI*NTIFY IN INT, FIFO Q, NO CAI.
INH  001001 IO  - - SRVI*INHIBIT INTERRUPTS.
INK   50070 OPR - - I    MOVE KEYS TO REG KEYS.
INK  000043 OPR - - SRV  INPUT P-300 KEYS INTO A REG.
INT   50103 FOP - - I    INT(FRS)=>GR.
INT  140554 FOP 3 5 SRV  INT(FAC)=>A,B W/HOLE.
INTA 140531 FOP 3 5 SRV  INT(FAC)=>A.
INTH  50101 FOP - - I    INT(FRS)=>GRH.
INTL 140533 FOP 3 5 SRV  INT(FAC)=>L.
IR1   50122 OPR 2 1 I    INCR REG BY 1. GR+1=>GR.
IR2   50123 OPR 2 1 I    INCR REG BY 2. GR+2=>GR.
IRB   50062 OPR - - I    BYTES GRH(1-8)=>GRH(9-16)
IRH   50057 OPR - - I    GRH=>GRL, GRL=>GRH.
IRS   12     MR  - - SRV  INC, REPLACE, AND SKIP IF ZERO.
IRTC 000603 CON 7 6 SRVI*INTERRUPT RETURN, DO CAI.
IRTN 000601 CON 7 6 SRVI*INTERRUPT RETURN, NO CAI.
IRX  140114 OPR - - SRV  INCREMENT X AND SKIP IF Ø.
ITLB 000615 CON - - SRVI*INVAL STLB ENTRY, L = VADDR.
JDX   15 Ø2  MR  - - R    JUMP ON DECREMENTED X-R ZERO.
JEQ   Ø2 Ø3  MR  - - R    IF (A) .EQ. Ø, EA => P.
JGE   Ø7 Ø3  MR  - - R    IF (A) .GE. Ø, EA => P.
JGT   Ø5 Ø3  MR  - - R    IF (A) .GT. Ø, EA => P.
JIX   15 Ø3  MR  - - R    JUMP ON INCREMENTED X-REG ZERO.
JLE   Ø4 Ø3  MR  - - R    IF (A) .LE. Ø, EA => P.
JLT   Ø6 Ø3  MR  - - R    IF (A) .LT. Ø, EA => P.
JMP   51     MR  - - I    JUMP. EA=>RP.
JMP   Ø1     MR  - - SRV  UNCOND JUMP.  EA => PB,P.
JNE   Ø3 Ø3  MR  - - R    IF (A) .NE. Ø, EA => P.
JSR   73     MR  - - I    RPL=>RH, EA32=>RP
JST   1Ø     MR  - - SRV  (P) => [EA]16, EA+1 => P.
JSX   35 Ø3  MR  - - RV   (P) => X, EA => P.
JSXB  61     MR  - - I    RP=>XB, EA=>RP.
JSXB  14 Ø2  MR  - - V    (PB,P) => XB, EA => PB,P.
JSY   14     MR  - - V    (P) => Y, EA => P.
L     Ø1     MR  - - I    LOAD. [EA32]=>R.
LCEQ   50153 LOG - - I    IF .EQ., 1=>GRH, ELSE Ø=>GRH.
LCEQ 141503 LOG - - SRV  IF CC.EQ.,1=>A. ELSE Ø=>A.
LCGE   50154 LOG - - I    IF .GE.,1=>GRH, ELSEØ=>GRH.
LCGE 141504 LOG - - SRV  IF CC.GE.,1=>A. ELSE Ø=>A.
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LCGT   50155 LOG - - I    IF .GT., 1=>GRH, ELSE Ø=>GRH.
LCGT 141505 LOG - - SRV  IF CC.GT.,1=>A. ELSE Ø=>A.
LCLE   50151 LOG - - I    IF .LE., 1=>GRH, ELSE Ø=>GRH.
LCLE 141501 LOG - - SRV  IF CC.LE.,1=>A. ELSE Ø=>A.
LCLT   50150 LOG - - I    IF .LT., 1=>GRH, ELSE Ø=>GRH.
LCLT 141500 LOG - - SRV  IF CC.LT.,1=>A. ELSE Ø=>A.
LCNE   50152 LOG - - I    IF .NE.,1=>GRH, ELSE Ø=>GRH.
LCNE 141502 LOG - - SRV  IF CC.NE.,1=>A. ELSE Ø=>A.
LDA   Ø2     MR  - - SRV  LOAD A-REGISTER.  [EA]16 => A.
LDAR  44     MR  - - I    LOAD ADDR REGISTER.
LDC    50162 FLD - 7 I    LOAD CHAR TO GRH.
LDC   001312 FLD - 7 SRV  LOAD CHAR TO A REG PER FAR 1.
LDC   001302 FLD - 7 SRV  LOAD CHAR TO A REG VIA FAR Ø.
LDL   Ø2 Ø3  MR  - - V    LOAD LONG.  [EA]32 => A,B.
LDLR  Ø5 Ø1  MR  - - V    LOAD LONG FROM RFILE LOC EA.
LDX   35     MR  - - SRV  LOAD X-REGISTER.  [EA]16 => X.
LDY   35 Ø1  MR  - - V    LOAD Y-REGISTER.  [EA]16 => Y.
LEQ    50003 LOG - 4 I    IF GR=Ø TN 1=>GRH,ELSE Ø=>GRH.
LEQ   140413 LOG - 4 SRV  IF A.EQ.Ø, 1=>A. ELSE Ø=>A.
LF     50016 LOG - 4 I    LOGICIZE .F. Ø=>GRH.
LF    140416 LOG - 5 SRV  LOGICIZE FALSE.  Ø=>A.
LFEQ   50023 LOG - 4 I   IF FRS=Ø TN 1=>GRH,ELSE Ø=>GRH.
LFEQ 141113 LOG - 4 SRV  IF FAC.EQ.Ø, 1=>A. ELSE Ø=>A.
LFGE   50024 LOG - 4 I    IF FRS>=Ø T 1=>GRH,ELSE Ø=>GRH.
LFGE 141114 LOG - 4 SRV  IF FAC.GE.Ø, 1=>A. ELSE Ø=>A.
LFGT   50025 LOG - 4 I    IF FRS>Ø TN 1=>GRH,ELSE Ø=>GRH.
LFGT 141115 LOG - 4 SRV  IF FAC.GT.Ø, 1=>A. ELSE Ø=>A.
LFLE   50021 LOG - 4 I    IF FRS<=Ø T 1=>GRH,ELSE Ø=>GRH.
LFLE 141111 LOG - 4 SRV  IF FAC.LE.Ø, 1=>A. ELSE Ø=>A.
LFLI  001313 -   - - SRV  LOAD FIELD LEN REG IMM ONE.
LFLI  001303 -   - - SRV  LOAD FIELD LEN REG IMM ZERO.
LFLT   50020 LOG - 4 I    IF FRS<Ø T 1=>GRH,ELSE Ø=>GRH.
LFLT 141110 LOG - 4 SRV  IF FAC.LT.Ø, 1=>A. ELSE Ø=>A.
LFNE   50022 LOG - 4 I    IF FRS<>Ø T 1=>GRH,ELSE Ø=>GRH.
LFNE 141112 LOG - 4 SRV  IF FAC.NE.Ø, 1=>A. ELSE Ø=>A.
LGE    50004 LOG - 4 I    IF GR>=Ø TN 1=>GRH,ELSE Ø=>GRH.
LGE   140414 LOG - 4 SRV  IF A.GE.Ø, 1=>A. ELSE Ø=>A.
LGT    50005 LOG - 4 I    IF GR>Ø TN 1=>GRH, ELSE Ø=>GRH.
LGT   140415 LOG - 4 SRV  IF A.GT.Ø, 1=>A. ELSE Ø=>A.
LH    11     MR  - - I    LOAD HALF WD. [EA16]=>RH.
LHEQ   50013 LOG - 4 I    IF GRH=Ø TN 1=>GRH,ELSE Ø=>GRH.
LHGE   50004 LOG - 4 I    IF GRH>=Ø T 1=>GRH,ELSE Ø=>GRH.
LHGT   50015 LOG - 4 I    IF GRH>Ø TN 1=>GRH,ELSE Ø=>GRH.
LHL1  Ø4     MR  - - I    SHIFTED 1 [EA16] .LS. 1=>GRH.
LHL2  14     MR  - - I    SHIFTED 2 [EA16] .LS. 2=>GRH.
LHLE   50011 LOG - 4 I    IF GRH<=Ø T 1=>GRH,ELSE Ø=>GRH.
LHLT   50000 LOG - 4 I    IF GR<Ø TN 1=>GRH,ELSE Ø=>GRH.
LHNE   50012 LOG - 4 I    IF GRH<>Ø T 1=>GRH,ELSE Ø=>GRH.
LLE    50001 LOG - 4 I    IF GR<=Ø TN 1=>GRH,ELSE Ø=>GRH.
LLE   140411 LOG - 4 SRV  IF A.LE.Ø, 1=>A. ELSE Ø=>A.
LLEQ  141513 LOG - 4 SRV  IF L.EQ.Ø, 1=>A. ELSE Ø=>A.
LLGE  140414 LOG - 4 SRV  IF L.GE.Ø, 1=>A. ELSE Ø=>A.
LLGT  141515 LOG - 4 SRV  IF L.GT.Ø, 1=>A. ELSE Ø=>A.
LLL   0410XX SH  4 5 SRV  LONG LEFT LOGICAL.
LLLE  141511 LOG - 4 SRV  IF L.LE.Ø, 1=>A. ELSE Ø=>A.
LLLT  140410 LOG - 4 SRV  IF L.LT.Ø, 1=>A. ELSE Ø=>A.
LLNE  141512 LOG - 4 SRV  IF L.NE.Ø, 1=>A. ELSE Ø=>A.
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LLR  0412XX SH  4 5 SRV  LONG LEFT ROTATE.
LLS  0411XX SH  4 5 SRV  LNG LSFT 64V=>LNG INT,ELSE HOLE
LLT   50000 LOG - 4 I    IF GR<Ø TN 1=> GRH,ELSE Ø=>GRH.
LLT  140410 LOG - 4 SRV  IF A.LT.Ø, 1=>A. ELSE Ø=>A.
LMCM 000501 IG  - - SRVI*LEAVE MACHINE CHECK MODE.
LNE   50002 LOG - 4 I    IF GR<>Ø TN 1=>GRH,ELSE Ø=>GRH.
LNE  140412 LOG - 4 SRV  IF A.NE.Ø, 1=>A. ELSE Ø=>A.
LPID 000617 CON - - SRVI*LOAD PROCESS ID FROM A01-A12.
LPMJ 000215 VM  - - SR   LEAVE PAGE MODE & JUMP (P300).
LPMX 000235 VM  - - SR   LVE PAG MOD & JMP TO MICROCODE.
LPSW 000711 AP  7 6 SRVI*LOAD PSW (SN,WN,KEYS,MODALS).
LRL  0400XX SH  4 5 SRV  LONG RIGHT LOGICAL.
LRR  0402XX SH  4 5 SRV  LONG RIGHT ROTATE.
LRS  0401XX SH  4 5 SRV  LNG RSFT.64V=LNG INT,ELSE HOLE.
LT   140417 LOG - 5 SRV  LOGICIZE TRUE.  1=>A.
LWCS 001710 IG  - - V    LOAD WRITABLE CONTROL STORE.
M     42    MR  3 1 I    MULT. R*[EA32]=>(R,R+1).
MDEI 001304 IG  - - SRVI*MEM DIAG ENABLE INTERLEAVE.
MDII 001305 IG  - - SRVI*MEM DIAGN INHIBIT INTERLEAVE.
MDIW 0013?? IG  - - SRVI*MEM DIAG WRT INTERLV.  L=>[E].
MDRS 001306 IG  - - SRVI*MEM DIAG READ SYNDROME BITS.
MDWC 001307 IG  - - SRV* MEM DIAG LOAD WRITE CTL REG.
MH    52    MR  3 1 I    RH*[EA16}=>R.
MIA   64    MR  - - I    MICROCODE EXECUTE A.
MIA   12 01 MR  - - V    MICROCODE ENTRANCE.
MIB   74    MR  - - I    MICROCODE EXECUTE B.
MIB   13 01 MR  - - V    MICROCODE ENTRANCE.
MPL   16 03 MR  - 1 V    (A,B) * [EA]16 => A,B.(NOHOLE)
MPY   16    MR  - 1 V    (A) * [EA]16 => A,B. (NOHOLE).
MPY   16    MR  3 1 SR   (A) * [EA]16 => A,B. (HOLE).
N     03    MR  - - I    R .AND. [EA32]=>R.
NFYB 001211 AP  6 5 SRVI*NOTIFY ON SEM AT AP.  LIFO Q.
NFYE 001210 AP  6 5 SRVI*NOTIFY ON SEM AT AP.  FIFO Q.
NH    13    MR  - - I    RH .AND. [EA16]=>RH.
NOP  000001 OPR - - SRV  NO OPERATION.
NRM  000101 OPR - - SRV  NORMALIZE A,B AS ON P-300.
O     23    MR  - - I    R .OR. [EA32]=>R.
OCP   14    PIO - - SR*  OUTPUT CONTROL PULSE.
OH    33    MR  - - I    RH .OR. [EA16]=>RH.
ORA   03 02 MR  - - V    (A) .OR. [EA]16 => A.
OTA   74    PIO - - SR*  OUTPUT FROM A-REGISTER.
OTK   50071 OPR 7 S I    SET KEYS FROM REGISTER
OTK  000405 OPR 7 6 SRV  OUTPUT A TO 300 KEYS, SHFT CTR.
PCL   41    MR  - - I    PROCEDURE CALL.
PCL   10 02 MR  7 6 V    P-400 PROCEDURE CALL.
PID   50052 OPR - - I    GR=>GRN, (1)=>GR(2-32).
PID  000211 OPR - - SRV  SHORT INT TO DP INT W/HOLE.
PIDA 000115 OPR - - SRV  SHORT TO LONG INT CONV. A=>L.
PIDH  50053 OPR - - I    GRH=>GRL,GRH(1)=>GRH(2-16).
PIDL 000305 OPR - - SRV  CONVERT LONG INT TO 64 BIT INT.
PIM   50050 OPR 2 1 I    POS REG AFTER INT MULTIPLY.
PIM  000205 OPR - - SRV  DP INT WITH HOLE TO SHORT INT.
PIMA 000015 OPR 3 5 SRV  L=>A. IEX ON PREC LOSS.
PIMH  50051 OPR 2 1 I    POS HALF REG AFTER INT MULT.
PIML 000301 OPR 3 5 SRV  64BIT INT TO LONG INT.(L,E)=>L.
PRTN 000611 CON 7 6 SRVI PROCEDURE RETURN.
RBQ   50133 OPR - 7 I    REMOVE FROM BOTTOM OF QUEUE.
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RBQ  141715 AP  - 6 SRV  RMV BOT OF Q. EMP=>A=Ø, CCEQ
RCB  140200 OPR 5 - SRV  RESET CBIT.  Ø=>CBIT.
RMC  000021 IG  - - SRVI*RESET MACHINE CHECK FLAG.
RRST 000717 AP  - - SRV  REST REGS (GEN, FLT, XB).
RSAV 000715 AP  - - SRV  SAVE REGS (GEN, FLT, XB).
RTN  000105 OPR - - SRV  RETURN FROM P-300 RECUR PROC.
RTQ   50132 OPR - 7 I    REMOVE FROM TOP OF QUEUE.
RTQ  141714 AP  - 6 SRV  RMV TOP OF Q. EMP=>A=Ø, CCEQ.
S     22    MR  2 1 I    SUB. R-[EA32]=>R.
S1A  140110 OPR 2 1 SRV  SUB 1 FROM A REGISTER.  A-1=>A.
S2A  140310 OPR 2 1 SRV  SUB 2 FROM A REGISTER.  A-2=>A.
SAR  10026X SKP - - SRV  SKIP IF A REG. BIT N RESET.
SAS  101260 SKP - - SRV  SKIP IF A REG. BIT N SET.
SBL  07 03  MR  2 1 V    (A,B) - [EA]32 => A,B.(NOHOLE)
SCA  000041 OPR - - SRV  LOAD P-300 SHFT CTR INTO A REG.
SCB  140600 OPR 5 - SRV  SET CBIT.  1=>CBIT.
SGL  000005 MOD - - SRV  ENTER SINGLE-PRECISION MODE.
SGT  100220 SKP - - SRV  SKIP IF A REG. .GT. Ø.
SH    32    MR  2 1 I    SUB HALF WD. RH-[EA16]=>RH.
SHA   15    MR  4 - I    ARITHMETIC SHIFT.
SHL   05    MR  4 - I    LOGICAL SHIFT.
SHL1   50076 OPR 4 1 I    GRH .LS. 1 => GRH.
SHL2   50077 OPR 4 1 I    GRH .LS. 2 => GRH.
SHR1   50120 OPR 4 1 I    GRH .RS. 1 => GRH.
SHR2   50121 OPR 4 1 I    GRH .RS. 2 => GRH.
SKP  100000 SKP - - SRV  SKIP ONE WORD.
SKS   34    PIO - - SR   SKIP IF CONDITION SET.
SL1    50072 OPR 4 1 I    GR .LS. 1 => GR.
SL2    50073 OPR 4 1 I    GR .LS. 2 => GR.
SLE  101220 SKP - - SRV  SKIP IF A REG. .LE. Ø.
SLN  101100 SKP - - SRV  SKIP IF A REG. BIT 16 SET.
SLZ  100100 SKP - - SRV  SKIP IF A REG. BIT 16 .EQ. Ø.
SMCR 100200 SKP - - SRV  SKIP IF MACHINE CHECK RESET.
SMCS 101200 SKP - - SRV  SKIP IF MACHINE CHECK SET.
SMI  101400 SKP - - SRV  SKIP IF A REG. .LT. Ø.
SMK  170020 PIO - - SR*  SET INTERRUPT MASKS.
SNR  10024X SKP - - SRV* SKIP IF SENSE SWITCH N RESET.
SNS  101240 SKP - - SRV* SKIP IF SENSE SWITCH N SET.
SNZ  101040 SKP - - SRV  SKIP IF A REG. NE. Ø.
SPL  100400 SKP - - SRV  SKIP IF A REG. .GE. Ø.
SR1    50074 OPR 4 1 I    GR .RS. 1 => GR.
SR1  100020 SKP - - SRV* SKIP IF SENSE SWITCH 1 RESET.
SR2    50075 OPR 4 1 I    GR .RS. 2 => GR.
SR2  100010 SKP - - SRV* SKIP IF SENSE SWITCH 2 RESET.
SR3  100004 SKP - - SRV* SKIP IF SENSE SWITCH 3 RESET.
SR4  100002 SKP - - SRV* SKIP IF SENSE SWITCH 4 RESET.
SRC  100001 SKP - - SRV  SKIP IF CBIT RESET.
SS1  101020 SKP - - SRV* SKIP IF SENSE SWITCH 1 SET.
SS2  101010 SKP - - SRV* SKIP IF SENSE SWITCH 2 SET.
SS3  101004 SKP - - SRV* SKIP IF SENSE SWITCH 3 SET.
SS4  101002 SKP - - SRV* SKIP IF SENSE SWITCH 4 SET.
SSC  101001 SKP - - SRV  SKIP IF CBIT SET.
SSM   50042 OPR - - I    SET SIGN. MINUS 1=>(1).
SSM  140500 OPR - - SRV  SET SIGN OF A MINUS. 1=>A1.
SSP   50043 OPR - - I    SET SIGN. PLUS Ø=>(1).
SSP  140100 OPR - - SRV  SET SIGN OF A PLUS.  Ø=>ABIT1.
SSR  100036 SKP - - SRV* SKIP IF SSWI 1,2,3 AND 4 RESET.
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SSS   101036 SKP - - SRV* SKIP IF SSWI 1,2,3 AND 4 SET.
ST    21     MR  - - I    STORE. R=>[EA32].
STA   04     MR  - - SRV  STORE A-REG.  (A) => [EA]16.
STAC  001200 AP  - 7 SRV  ST A COND ON B=[EA16].CCEQ= OK.
STAR  54     MR  - - I    STORE ADDRESSED REGISTER.
STC    50166 FLD - 7 I    STORE CHARACTER FROM GRH.
STC   001332 FLD - 7 SRV  STORE CHAR FROM A (SEE FAR1).
STC   001322 FLD - 7 SRV  STORE CHAR FROM A  (SEE FAR0).
STCD   50137 OPR - 7 I    GR+1=[EA16].
STCH   50136 OPR - 7 I    GRL=[EA16].
STEX   50027 OPR - 7 I    STACK EXTEND.
STEX  001315 OPR 6 5 SRV  STK EXTEND. L REG HAS EXTENT.
STFA  001330 AP  - - SRVI STORE FIELD ADDR REG 1.
STFA  001320 AP  - - SRVI STORE FIELD ADDR REG 0.
STH   31     MR  - - I    STORE HALF WD. RH=>[EA16].
STL   04 03  MR  - - V    STORE LONG.  (A,B) => [EA]32.
STLC  001204 AP  - 7 SRV  ST L COND ON E=[EA32].CCEQ=OK.
STLR  03 01  MR  - - V    STORE LONG INTO RFILE LOC EA.
STX   15     MR  - - SRV  STORE X-REG.  (X) => [EA]16.
STY   35 02  MR  - - V    STORE Y-REG.  (Y) => [EA]16.
SUB   07     MR  2 1 SRV  SUBTRACT.  (A) - [EA]16 => A.
SVC   000505 CON - - SRVI SUPERVISOR CALL.
SZE   100040 SKP - - SRV  SKIP IF A REG .EQ. 0.
TAB   140314 OPR - - SRV  TRANSFER A TO B REG.  A=>B.
TAK   001015 OPR 7 6 SRV  TRANSFER A TO KEYS.
TAX   140504 OPR - - SRV  TRANS A REG TO X REG.  A=>X.
TAY   140505 OPR - - SRV  TRANS A REG TO Y REG.  A=>Y.
TBA   140604 OPR - - SRV  TRANS B REG TO A REG.  B=>A.
TC     50047 OPR 3 1 I    -GR+1=>GR.
TCA   140407 OPR 2 1 SRV  TWO'S COMPLEMENT A.  -A=>A.
TCH    50047 OPR 3 1 I    -GRH+1=>GRH.
TCL   141210 OPR 2 1 SRV  TWO'S COMPLEMENT L.  -L=>L.
TFLL  001333 FLD - - SRV  XFER FLD LEN REG TO L REG 1.
TFLL  001323 FLD - - SRV  XFER FLD LEN REG TO L REG 0.
TFLR   50163 FLD - 7 I    TRANSFER FLD LENGTH REG TO GR.
TKA   001005 OPR - - SRV  TRANSFER KEYS TO A.
TLFL  001321 FLD - - SRV  TRANS L TO FLD LEN REG 0.
TLFL  001331 FLD - - SRV  TRANSFER L TO FLD LEN REG 1.
TM    44     MR  - 1 I    REST MEM. [EA32]::0=>CC.
TRFL   50165 FLD - 7 I    TRANSFER GR TO FLD LENGTH REG.
TSTQ   50104 OPR - 7 I    TEST QUEUE.
TSTQ  141757 AP  - 6 SRV  TEST Q. A=# ITEMS. CCEQ=> EMP.
TXA   141034 OPR - - SRV  TRANS X REG TO A REG.  X=>A.
TYA   141124 OPR - - SRV  TRANS Y REG TO A REG.  Y=>A.
VIRY  000311 IG  5 6 SRV* EXECUTE VERIFICATON ROUTINE.
WAIT  000315 AP  - - SRV* WAIT ON SEMAPHORE AT AP.
WCS   0016XX -   - - SRV* WCS ENTRANCES.  UII ON NO WCS.
X     43     MR  - - I    EXC OR. R .XOR. [EA32]=>R.
XAD   001100 DA  X X VI   ADD TWO DECIMAL FLDS.
XBTD  001145 DA  X X VI   CONV BI DEC VALUE TO DEC FLD.
XCA   140104 OPR - - SRV  EXCHG AND CLR A. A=>B, 0=>A.
XCB   140204 OPR - - SRV  EXCHG AND CLR B. B=>A, 0=>B.
XEC   01 02  MR  - - RV   EXECUTE INSTRUCTION AT EA.
XCM   001102 DA  X X VI   COMP TWO NUMERIC FLDS.
XDTB  001146 DA  X X VI   CONV DEC FLD TO BI REG VALUE.
XDZ   001107 DA  X X VI   DIV DEST FLD BY SOURCE FLD.
XEC   01 02  MR  - - RV   EX EFF ADDR CONT AS THIS INST.
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XED   001112 FE  X X VI   EDIT NUMERIC FIELD.
XH    52     MR  - - I    RH .XOR. [EA16]=>RH.
XMP   001104 DA  X X VI   MULTIPLY TWO DEC FLDS.
XMV   001101 DA  X X VI   MOVE NUM SOURCE FLD TO DST FLD.
ZCM   001117 CS  X X VI   COMP TWO CHAR STR FIELDS.
ZED   001111 FE  X X VI   EDIT CHAR STR FIELD.
ZFIL  011116 CS  X X VI   FILL CHAR STR FLD WITH CHAR.
ZM    43     MR  - - I    ZERO MEM. 0=>[EA32].
ZMH   53     MR  - - I    ZERO MEM. HALF WD. 0=>[EA16].
ZMV   001114 CS  X X VI   CPY FRM SOURCE FLD TO DEST FLD.
ZMVD  001115 -   X X VI   CPY FROM SOURCE FLD TO DEST
                          FLD OF EQUAL LENGTH.
ZTRN  001110 CS  X X VI   TRANS SRCE STR FLD TO DEST FLD.
xxx   140014 OPR - - SRV  OBSOLETE. CLRS B, LSW OF DFAC.
```

INSTRUCTION SET GROUPED BY FUNCTION

Miscellaneous Operations

```
CGT   001314 -   6 5 SRV  COMPUTED GO TO.
LFLI  001313 -   - - SRV  LOAD FIELD LEN REG IMM ONE.
LFLI  001303 -   - - SRV  LOAD FIELD LEN REG IMM ZERO.
WCS   0016XX -   - - SRV* WCS ENTRANCES.  UII ON NO WCS.
ZMVD  001115 -   X X VI   CPY FROM SOURCE FLD TO DEST
```

Address Pointer Operations

```
ABQ   141716 AP  - 6 SRV  ADD TO BOT OF Q.  CCEQ => FULL.
ATQ   141717 AP  - 6 SRV  ADD TO TOP OF Q.  CCEQ => FULL.
CALF  000705 AP  7 6 SRV  PROC CALL FROM FAULTING PROC.
EAFA  001300 AP  - - SRVI EFF. ADDR TO FIELD REG 0.
EAFA  001310 AP  - - SRVI EFF. ADDR TO FIELD REG 1.
INBC  001217 AP  6 5 SRVI*NTFY IN INT, LIFO, DO CAI.
INBN  001215 AP  6 5 SRVI*NTFY IN INT, LIFO, NO CAI.
INEC  001216 AP  6 5 SRVI*NTFY IN INT, FIFO Q, DO CAI.
INEN  001214 AP  6 5 SRVI*NTFY IN INT, FIFO Q, NO CAI.
LPSW  000711 AP  7 6 SRVI*LOAD PSW (SN,WN,KEYS,MODALS).
NFYB  001211 AP  6 5 SRVI*NOTIFY ON SEM AT AP.  LIFO Q.
NFYE  001210 AP  6 5 SRVI*NOTIFY ON SEM AT AP.  FIFO Q.
RBQ   141715 AP  - 6 SRV  RMV BOT OF Q. EMP=>A=0, CCEQ
RRST  000717 AP  - - SRV  REST REGS (GEN, FLT, XB).
RSAV  000715 AP  - - SRV  SAVE REGS (GEN, FLT, XB).
RTQ   141714 AP  - 6 SRV  RMV TOP OF Q. EMP=>A=0, CCEQ.
STAC  001200 AP  - 7 SRV  ST A COND ON B=[EA16].CCEQ= OK.
STFA  001330 AP  - - SRVI STORE FIELD ADDR REG 1.
STFA  001320 AP  - - SRVI STORE FIELD ADDR REG 0.
STLC  001204 AP  - 7 SRV  ST L COND ON E=[EA32].CCEQ=OK.
TSTQ  141757 AP  - 6 SRV  TEST Q. A=# ITEMS. CCEQ=> EMP.
WAIT  000315 AP  - - SRV* WAIT ON SEMAPHORE AT AP.
```

Branch Operations

```
BCEQ  141602 BR  - - SRV  BRANCH ON CONDITION CODE .EQ.
BCGE  141605 BR  - - SRV  BRANCH ON CONDITION CODE .GE.
```

```
BCGT 141601 BR  - - SRV  BRANCH ON CONDITION CODE .GT.
BCLE 141600 BR  - - SRV  BRANCH ON CONDITION CODE .LE.
BCLT 141704 BR  - - SRV  BRANCH ON CONDITION CODE .LT.
BCNE 141603 BR  - - SRV  BRANCH ON CONDITION CODE .NE.
BCR  141705 BR  - - SRV  BRANCH ON CBIT RESET.
BCS  141604 BR  - - SRV  BRANCH ON CBIT SET.
BDX  140734 BR  - - SRV  BRANCH ON DECREMENTED X.
BDY  140724 BR  - - SRV  BRANCH ON DECREMENTED Y.
BEQ  140612 BR  - 4 SRV  BRANCH ON A REGISTER .EQ. 0.
BFEQ  50122 BR  - 4 I    BRANCH ON FLTG REG EQ.
BFEQ 141612 BR  - 4 SRV  BRANCH ON FAC .EQ. 0.
BFGE  50125 BR  - 4 I    BRANCH ON FLTG REG NE.
BFGE 141615 BR  - 4 SRV  BRANCH ON FAC .GE. 0.
BFGT  50121 BR  - 4 I    BRANCH ON FLTG REG LE.
BFGT 141611 BR  - 4 SRV  BRANCH ON FAC .GT. 0.
BFLE  50120 BR  - 4 I    BRANCH  ON FLTG REG LT.
BFLE 141610 BR  - 4 SRV  BRANCH ON FAC .LE. 0.
BFLT  50124 BR  - 4 I    BRANCH on FLTG REG GT.
BFLT 141614 BR  - 4 SRV  BRANCH ON FAC .LT. 0.
BFNE  50123 BR  - 4 I    BRANCH ON FLTG REG GE.
BFNE 141613 BR  - 4 SRV  BRANCH ON FAC .NE. 0.
BGE  140615 BR  - 4 SRV  BRANCH ON A REGISTER .GE. 0.
BGT  140611 BR  - 4 SRV  BRANCH ON A REGISTER .GT. 0.
BHD1  50144 BR  - - I    BRANCH ON HALF REG DEC BY 1.
BHD2  50145 BR  - - I    BRANCH ON HALF REG DEC BY 2.
BHD4  50146 BR  - - I    BRANCH ON HALF REG DEC BY 4.
BHEQ  50112 BR  - 4 I    BRANCH ON HALF REG EQ.
BHGT  50111 BR  - 4 I    BRANCH ON HALF REG LE.
BHI1  50140 BR  - - I    BRANCH ON HALF REG INCR BY 1.
BHI2  50141 BR  - - I    BRANCH ON HALF REG INCR BY 2.
BHI4  50142 BR  - - I    BRANCH ON HALF REG INCR BY 4.
BHLE  50110 BR  - 4 I    BRANCH ON HALF REG LT.
BHLT  50104 BR  - 4 I    BRANCH ON HALF REG GT.
BHNE  50113 BR  - 4 I    BRANCH ON HALF REG GE.
BHNE  50105 BR  - 4 I    BRANCH ON HALF REG NE.
BIX  141334 BR  - - SRV  BRANCH ON INCREMENTED X.
BIY  141324 BR  - - SRV  BRANCH ON INCREMENTED Y.
BLE  140610 BR  - 4 SRV  BRANCH ON A REGISTER .LE. 0.
BLEQ 140702 BR  - 4 SRV  BRANCH ON L REGISTER .EQ. 0.
BLGE 140615 BR  - 4 SRV  BRANCH ON L REGISTER .GE. 0.
BLGT 140701 BR  - 4 SRV  BRANCH ON L REGISTER .GT. 0.
BLLE 140700 BR  - 4 SRV  BRANCH ON L REGISTER .LE. 0.
BLLT 140614 BR  - 4 SRV  BRANCH ON L REGISTER .LT. 0.
BLNE 140703 BR  - 4 SRV  BRANCH ON L REGISTER .NE. 0.
BLR  141707 BR  - - SRV  BRANCH ON LINK RESET.
BLS  141706 BR  - - SRV  BRANCH ON LINK SET.
BLT  140614 BR  - 4 SRV  BRANCH ON A REGISTER .LT. 0.
BMEQ 141602 BR  - - SRV  BRANCH ON MAG.-COND. L,CC .EQ.
BMGE 141706 BR  - - SRV  BRANCH ON MAG.-COND. L,CC .GE.
BMGT 141710 BR  - - SRV  BRANCH ON MAG.-COND. L,CC .GT.
BMLE 141711 BR  - - SRV  BRANCH ON MAG.-COND. L,CC .LE.
BMLT 141707 BR  - - SRV  BRANCH ON MAG.-COND. L,CC .LT.
BMNE 141603 BR  - - SRV  BRANCH ON MAG.-COND. L,CC .NE.
BNE  140613 BR  - 4 SRV  BRANCH ON A REGISTER .NE. 0.
BRBR  50040 BR  - - I    BRANCH ON REG BIT RESET.
BRBS  50000 BR  - - I    BRANCH ON REG BIT SET.
BGR1  50134 BR  - - I    BRANCH ON REG DEC BY 1.
```



```
BGR2  50135 BR  - - I    BRANCH ON REG DEC BY 2.
BGR4  50136 BR  - - I    BRANCH ON REG DEC BY 4.
BREQ  50102 BR  - 4 I    BRANCH ON REG EQ.
BRGE  50105 BR  - 4 I    BRANCH ON REG NE.
BRGT  50101 BR  - 4 I    BRANCH ON REG LE.
BRI1  50130 BR  - - I    BRANCH ON REG INCR BY 1.
BRI2  50131 BR  - - I    BRANCH ON REG INCR BY 2.
BRI4  50132 BR  - - I    BRANCH ON REG INCR BY 4.
BRLE  50100 BR  - 4 I    BRANCH ON REGISTER LT.
BRLT  50104 BR  - 4 I    BRANCH ON REGISTER GT.
BRNE  50103 BR  - 4 I    BRANCH ON REGISTER GE.
```

Control Operations

```
ARGT 000605 CON - - SRV  ARG TRANSFER (USED WITH PCL).
HLT  000000 CON - - SRVI*HALT COMPUTER OPERATION.
IRTC 000603 CON 7 6 SRVI*INTERRUPT RETURN, DO CAI.
IRTN 000601 CON 7 6 SRVI*INTERRUPT RETURN, NO CAI.
ITLB 000615 CON - - SRVI*INVAL STLB ENTRY, L = VADDR.
LPID 000617 CON - - SRVI*LOAD PROCESS ID FROM A01-A12.
PRTN 000611 CON 7 6 SRVI PROCEDURE RETURN.
SVC  000505 CON - - SRVI SUPERVISOR CALL.
```

Character String Operations

```
ZCM  001117 CS  X X VI   COMP TWO CHAR STR FIELDS.
ZFIL 011116 CS  X X VI   FILL CHAR STR FLD WITH CHAR.
ZMV  001114 CS  X X VI   CPY FRM SOURCE FLD TO DEST FLD.
ZTRN 001110 CS  X X VI   TRANS SRCE STR FLD TO DEST FLD.
```

Decimal Arithmetic

```
XAD  001100 DA  X X VI   ADD TWO DECIMAL FLDS.
XBTD 001145 DA  X X VI   CONV BI DEC VALUE TO DEC FLD.
XCM  001102 DA  X X VI   COMP TWO NUMERIC FLDS.
XDTB 001146 DA  X X VI   CONV DEC FLD TO BI REG VALUE.
XDZ  001107 DA  X X VI   DIV DEST FLD BY SOURCE FLD.
XMP  001104 DA  X X VI   MULTIPLY TWO DEC FLDS.
XMV  001101 DA  X X VI   MOVE NUM SOURCE FLD TO DST FLD.
```

Field and Edit Operations

```
XED  001112 FE  X X VI   EDIT NUMERIC FIELD.
ZED  001111 FE  X X VI   EDIT CHAR STR FIELD.
```

Field Operations

```
ALFA 001301 FLD 6 5 SRV  ADD L TO FIELD ADDR REG. ZERO.
ALFA 001311 FLD 6 5 SRV  ADD L TO FIELD ADDR REG. ONE.
ARFA  50161 FLD - 7 I    ADD GR TO FIELD ADDR REG.
LDC   50162 FLD - 7 I    LOAD CHAR TO GRH.
LDC  001312 FLD - 7 SRV  LOAD CHAR TO A REG PER FAR 1.
LDC  001302 FLD - 7 SRV  LOAD CHAR TO A REG VIA FAR 0.
STC   50166 FLD - 7 I    STORE CHARACTER FROM GRH.
STC  001332 FLD - 7 SRV  STORE CHAR FROM A (SEE FAR1).
STC  001322 FLD - 7 SRV  STORE CHAR FROM A  (SEE FAR0).
TFLL 001333 FLD - - SRV  XFER FLD LEN REG TO L REG 1.
```

```
TFLL 001323 FLD - - SRV  XFER FLD LEN REG TO L REG Ø.
TFLR  50163 FLD - 7 I    TRANSFER FLD LENGTH REG TO GR.
TLFL 001321 FLD - - SRV  TRANS L TO FLD LEN REG Ø.
TLFL 001331 FLD - - SRV  TRANSFER L TO FLD LEN REG 1.
TRFL  50165 FLD - 7 I    TRANSFER GR TO FLD LENGTH REG.
```

Floating-point Operations

```
DBLE  50106 FOP - - I    CONV SINGLE TO DOUBLE FLTG PT.
DFCM  50144 FOP 3 1 I    DBL PRC FLTG COMP. -DFGR=>DFGR.
DFCM 140574 FOP 3 5 SRV  -DFAC=>DFAC.
FCM   50100 FOP 3 1 I    FLTG COMP. -FGR=>FGR.
FCM  140530 FOP 3 5 SRV  FLOATING COMP.  -FAC=>FAC.
FDBL 140016 FOP - - SRV  FAC=>DFAC.
FLTH  50192 FOP - - I    // HALF WD INT TO FLTG PT.
FLOT 140550 FOP 6 5 SRV  FLOT(A,B)=>FAC. (A,B) W/HOLE
FLT   50105 FOP - - I    CONV INT TO FLTG PT FLOAT.
FLTA 140532 FOP 3 5 SRV  FLOT(A)=>FAC.
FLTL 140535 FOP 8 5 SRV  FLOT(L)=>FAC. (L W/NO HOLE)
FRN   50107 FOP 3 1 I    FLOATING ROUND UP.
FRN  140534 FOP 3 5 SRV  FLOATING ROUND UP.
INT   50103 FOP - - I    INT(FRS)=>GR.
INT  140554 FOP 3 5 SRV  INT(FAC)=>A,B W/HOLE.
INTA 140531 FOP 3 5 SRV  INT(FAC)=>A.
INTH  50101 FOP - - I    INT(FRS)=>GRH.
INTL 140533 FOP 3 5 SRV  INT(FAC)=>L.
```

Floating-point Skip Operations

```
FSGT 140515 FSK - 4 SRV  FLOATING SKIP IF .GT. Ø.
FSLE 140514 FSK - 4 SRV  FLOATING SKIP IF .LE. Ø.
FSMI 140512 FSK - 4 SRV  FLOATING SKIP IF .LT. Ø.
FSNZ 140511 FSK - 4 SRV  FLOATING SKIP IF .NE. Ø.
FSPL 140513 FSK - 4 SRV  FLOATING SKIP IF .GE. Ø.
FSZE 140510 FSK - 4 SRV  FLOATING SKIP IF .EQ. Ø.
```

Integrity Operations

```
CXCS 001714 IG  - - V    CONTROL EXTENDED CONTROL STORE.
EMCM 000503 IG  - - SRVI*ENTER MACH CHK MODE.
LMCM 000501 IG  - - SRVI*LEAVE MACHINE CHECK MODE.
LWCS 001710 IG  - - V    LOAD WRITABLE CONTROL STORE.
MDEI 001304 IG  - - SRVI*MEM DIAG ENABLE INTERLEAVE.
MDII 001305 IG  - - SRVI*MEM DIAGN INHIBIT INTERLEAVE.
MDIW 0013?? IG  - - SRVI*MEM DIAG WRT INTERLV.  L=>[E].
MDRS 001306 IG  - - SRVI*MEM DIAG READ SYNDROME BITS.
MDWC 001307 IG  - - SRV* MEM DIAG LOAD WRITE CTL REG.
RMC  000021 IG  - - SRVI*RESET MACHINE CHECK FLAG.
VIRY 000311 IG  5 6 SRV* EXECUTE VERIFICATON ROUTINE.
```

Input/Output Operations

```
CAI  000411 IO  - - SRVI*CLEAR ACTIVE INTERRUPT.
ENB  000401 IO  - - SRVI*ENABLE INTERRUPTS.
INH  001001 IO  - - SRVI*INHIBIT INTERRUPTS.
```

Logicize Operations


```
LCEQ  50153 LOG - - I    IF .EQ., 1=>GRH, ELSE Ø=>GRH.
LCEQ 141503 LOG - - SRV  IF CC.EQ.,1=>A. ELSE Ø=>A.
LCGE  50154 LOG - - I    IF .GE.,1=>GRH, ELSEØ=>GRH.
LCGE 141504 LOG - - SRV  IF CC.GE.,1=>A. ELSE Ø=>A.
LCGT  50155 LOG - - I    IF .GT., 1=>GRH, ELSE Ø=>GRH.
LCGT 141505 LOG - - SRV  IF CC.GT.,1=>A. ELSE Ø=>A.
LCLE  50151 LOG - - I    IF .LE., 1=>GRH, ELSE Ø=>GRH.
LCLE 141501 LOG - - SRV  IF CC.LE.,1=>A. ELSE Ø=>A.
LCLT  50150 LOG - - I    IF .LT., 1=>GRH, ELSE Ø=>GRH.
LCLT 141500 LOG - - SRV  IF CC.LT.,1=>A. ELSE Ø=>A.
LCNE  50152 LOG - - I    IF .NE.,1=>GRH, ELSE Ø=>GRH.
LCNE 141502 LOG - - SRV  IF CC.NE.,1=>A. ELSE Ø=>A.
LEQ   50003 LOG - 4 I    IF GR=Ø TN 1=>GRH,ELSE Ø=>GRH.
LEQ  140413 LOG - 4 SRV  IF A.EQ.Ø, 1=>A. ELSE Ø=>A.
LF    50016 LOG - 4 I    LOGICIZE .F. Ø=>GRH.
LF   140416 LOG - 5 SRV  LOGICIZE FALSE.  Ø=>A.
LFEQ  50023 LOG - 4 I    IF FRS=Ø TN1=>GRH,ELSE Ø=>GRH.
LFEQ 141113 LOG - 4 SRV  IF FAC.EQ.Ø, 1=>A. ELSE Ø=>A.
LFGE  50024 LOG - 4 I    IF FRS>=Ø T 1=>GRH,ELSE Ø=>GRH.
LFGE 141114 LOG - 4 SRV  IF FAC.GE.Ø, 1=>A. ELSE Ø=>A.
LFGT  50025 LOG - 4 I    IF FRS>Ø TN 1=>GRH,ELSE Ø=>GRH.
LFGT 141115 LOG - 4 SRV  IF FAC.GT.Ø, 1=>A. ELSE Ø=>A.
LFLE  50021 LOG - 4 I    IF FRS<=Ø T 1=>GRH,ELSE Ø=>GRH.
LFLE 141111 LOG - 4 SRV  IF FAC.LE.Ø, 1=>A. ELSE Ø=>A.
LFLT  50020 LOG - 4 I    IF FRS<Ø T 1=>GRH,ELSE Ø=>GRH.
LFLT 141110 LOG - 4 SRV  IF FAC.LT.Ø, 1=>A. ELSE Ø=>A.
LFNE  50022 LOG - 4 I    IF FRS<>Ø T 1=>GRH,ELSE Ø=>GRH.
LFNE 141112 LOG - 4 SRV  IF FAC.NE.Ø, 1=>A. ELSE Ø=>A.
LGE   50004 LOG - 4 I    IF GR>=Ø TN 1=>GRH,ELSE Ø=>GRH.
LGE  140414 LOG - 4 SRV  IF A.GE.Ø, 1=>A. ELSE Ø=>A.
LGT   50005 LOG - 4 I    IF GR>Ø TN 1=>GRH, ELSE Ø=>GRH.
LGT  140415 LOG - 4 SRV  IF A.GT.Ø, 1=>A. ELSE Ø=>A.
LHEQ  50013 LOG - 4 I    IF GRH=Ø TN 1=>GRH,ELSE Ø=>GRH.
LHGE  50004 LOG - 4 I    IF GRH>=Ø T 1=>GRH,ELSE Ø=>GRH.
LHGT  50015 LOG - 4 I    IF GRH>Ø TN 1=>GRH,ELSE Ø=>GRH.
LHLE  50011 LOG - 4 I    IF GRH<=Ø T 1=>GRH,ELSE Ø=>GRH.
LHLT  50000 LOG - 4 I    IF GR<Ø TN 1=>GRH,ELSE Ø=>GRH.
LHNE  50012 LOG - 4 I    IF GRH<>Ø T 1=>GRH,ELSE Ø=>GRH.
LLE   50001 LOG - 4 I    IF GR<=Ø TN 1=>GRH,ELSE Ø=>GRH.
LLE  140411 LOG - 4 SRV  IF A.LE.Ø, 1=>A. ELSE Ø=>A.
LLEQ 141513 LOG - 4 SRV  IF L.EQ.Ø, 1=>A. ELSE Ø=>A.
LLGE 140414 LOG - 4 SRV  IF L.GE.Ø, 1=>A. ELSE Ø=>A.
LLGT 141515 LOG - 4 SRV  IF L.GT.Ø, 1=>A. ELSE Ø=>A.
LLLE 141511 LOG - 4 SRV  IF L.LE.Ø, 1=>A. ELSE Ø=>A.
LLLT 140410 LOG - 4 SRV  IF L.LT.Ø, 1=>A. ELSE Ø=>A.
LLNE 141512 LOG - 4 SRV  IF L.NE.Ø, 1=>A. ELSE Ø=>A.
LLT   50000 LOG - 4 I    IF GR<Ø TN 1=> GRH,ELSE Ø=>GRH.
LLT  140410 LOG - 4 SRV  IF A.LT.Ø, 1=>A. ELSE Ø=>A.
LNE   50002 LOG - 4 I    IF GR<>Ø TN 1=>GRH,ELSE Ø=>GRH.
LNE  140412 LOG - 4 SRV  IF A.NE.Ø, 1=>A. ELSE Ø=>A.
LT   140417 LOG - 5 SRV  LOGICIZE TRUE.  1=>A.
```

Mode Operations

```
DBL  000007 MOD - - SRV  ENTER DOUBLE-PREC MODE.
E16S 000011 MOD - - SRV  ENTER P300 16K SECTORED MODE.
```

```
E32I 001010 MOD - - SRV  ENTER P500 321 MODE.
E32R 001013 MOD - - SRVI ENTER P300 32K RELATIVE MODE.
E32S 000013 MOD - - SRVI ENTER P300 32K SECTORED MODE.
E64R 001011 MOD - - SRVI ENTER P300 64K RELATIVE MODE.
E64V 000010 MOD - - SRVI ENTER P400 MODE.
ESIM 000415 MOD - - SRVI*ENTER STANDAGR INTERRUPT MODE.
EVIM 000417 MOD - - SRVI*ENTER VECTORED INTERUPT MODE.
SGL  000005 MOD - - SRV  ENTER SINGLE-PRECISION MODE.
```

Memory-reference Operations

```
ADD   06     MR  2 1 SRV  ADD.  (A) + [EA]16 => A.
ADL   06 03  MR  2 1 V    (A,B)+[EA]32=>A,B. (NO HOLE).
AH    12     MR  2 1 I    ADD HALFWD. RH+[EA16]=>RH.
ANA   03     MR  - - SRV  AND.  (A) .AND. [EA]16 => A.
ANL   03 03  MR  - - V    (A,B) .AND. [EA]32 => A,B.
C     61     MR  1 1 I    COMPARE R WITH [EA32].
CAS   11     MR  1 1 SRV  SKIP 0,1,2 IF (A) >,=.< [EA]16.
CH    71     MR  1 1 I    COMPARE RH WITH [EA16].
CLS   11 03  MR  1 1 V    SKIP 0,1,2 IF (A,B)>,=.<[EA]32.
CREP  10 02  MR  - - R    (P) => [(S)+1]16, EA=>P.
D     62     MR  3 1 I    DIV. (R,R+1)/[EA32=>R RMR=>R+1.
DAD   06(DP) MR  2 1 SR   (A,B)+[EA]32 => A,B.(W/HOLE).
DFA   15 17  MR  3 1 I    DBLE FLTG ADD. DFR+[EA64]=>DFR.
DFAD  06 02  MR  3 5 RV   (DFAC) + [EA]64 => DFAC.
DFC   05 07  MR  - 1 I    DBLE FLTG COMP DRF TO [EA64].
DFCS  11 02  MR  6 5 RV   SKP 0,1,2 IF (DFAC)>,=.<[EA]64.
DFD   31,33  MR  3 1 I    DOUBLE FLTG DIVIDE.
DFDV  17 02  MR  3 5 RV   (DFAC) / [EA]64 => DFAC.
DFL   01 03  MR  - - I    DBLE FLTG LOAD. [EA643]=>DFR.
DFLD  02 02  MR  - - RV   [EA]64 => DFAC.
DFLX  15 02  MR  - - V    LD DFLT INDEX.  4*[EA]16 => X.
DFM   25 27  MR  3 1 I    DBL FLTG MULT. DFR/[EA64]=>DFR.
DFMP  16 02  MR  3 5 RV   (DFAC) * [EA]64 => DFAC.
DFS   21 23  MR  3 1 I    DBLE FLTG SUB. DFR-[EA64]=>DFR.
DFSB  07 02  MR  3 5 RV   (DFAC) - [EA]64 => DFAC.
DFST  11,13  MR  1 1 I    DBLE FLTG STORE. DFR=>[EA64].
DFST  04 02  MR  - - RV   (DFAC) => [EA]64.
DH    72     MR  3 1 I    DIV HW. R/[EA16]=>RH RM=>RL(2).
DIV   17     MR  3 5 V    (A,B)/[EA]16=>A,REM=>B.(NOHOLE)
DIV   17     MR  3 5 SR   (A,B)/[EA]16=>A;REM=>B.(W/HOLE)
DLD   02(DP) MR  - - SR   DOUBLE LOAD.  [EA]32 => A,B.
DM    60     MR  - 1 I    DECR. [EA32]-1=>[EA32].
DMH   70     MR  - 1 I    DECR HALDWD. [EA16]-1=>[EA16].
DSB   07(DP) MR  2 1 SR   (A,B)-[EA]32 => A,B (W/HOLE).
DST   04(DP) MR  - - SR   DOUBLE STORE.  (A,B) => [EA]32.
DVL   17 03  MR  3 5 V    (A,B,E)/[EA]32=>A,B REM=>EH,EL.
EAA   01 01  MR  - - R    EFF. ADDR TO A-REG.  EA => A.
EAL   01 01  MR  - - V    LOAD EFFECTIVE ADDR.  EA => L.
EALB  42     MR  - - I    EFF ADDR to LB. EA=>LB.
EALB  13 02  MR  - - V    EFF. ADDR TO LB. EA => LB.
EAR   63     MR  - - I    EFF ADDR (EA32)TO R.
EAXB  52     MR  - - I    EFF ADDR TO XB. EA=>XB.
EAXB  12 02  MR  - - V    EFF. ADDR TO XB. EA => XB.
EIO   34     MR  - 2 I    EXECUTE ADDR TO BASE REG.
EIO   14 01  MR  - 7 V*   EXEC EA AS I/O INSTR.CCEQ=>SKP.
ENTR  01 03  MR  - - R    (S)=>[(S)-EA]16, (S)-EA=>S.
```



```
ERA   05     MR  - - SRV  (A) .XOR. [EA]16 => A.
ERL   05 03  MR  - - V    (A,B) .XOR. [EA]32 => A,B.
FA    14,16  MR  3 1 I    FLTG ADD. FR+[EA32]=>FR.
FAD   06 01  MR  3 5 RV   (FAC) + [EA]32 => FAC.
FC    04,06  MR  - 1 I    FLTG COMPARE FR TO [EA32]
FCS   11 01  MR  6 5 RV   SKIP 0,1,2 IF (FAC)>,=.<[EA]32.
FD    30,32  MR  3 1 I    FLTG DIV. -FR/[EA32]=>FR.
FDV   17 01  MR  3 5 RV   (FAC) / [EA]32 => FAC.
FLD   02 01  MR  - - RV   FLOATING LOAD.  [EA]32 => FAC.
FLX   15 01  MR  - - RV   2*[EA]16 => X.
FM    24,26  MR  3 1 I    FLTG MULT. FR*[EA32]=>FR.
FMP   16 01  MR  3 5 RV   (FAC) * [EA]32 => FAC.
FS    20,22  MR  3 1 I    FLTG SUB. FR-[EA32]=>FR.
FSB   07 01  MR  3 5 RV   (FAC) - [EA]32 => FAC.
FST   10,12  MR  - - I    FLTG STORE. FR=>[EA32].
FST   04 01  MR  6 6 RV   (FAC) => [EA]32.
I     41     MR  - - I    INTERCHANGE R WITH [EA32].
IH    51     MR  - - I    INTERCHANGE RH WITH [EA16].
IM    40     MR  - 1 I    INCR. [EA32]+1=>[EA32].
IMA   13     MR  - - SRV  EXCHANGE MEMORY AND A-REGISTER.
IMH   0      MR  - 1 I    INCR HALD WD> [EA16]+1=>[EA16].
IRS   12     MR  - - SRV  INC, REPLACE, AND SKIP IF ZERO.
JDX   15 02  MR  - - R    JUMP ON DECREMENTED X-R ZERO.
JEQ   02 03  MR  - - R    IF (A) .EQ. 0, EA => P.
JGE   07 03  MR  - - R    IF (A) .GE. 0, EA => P.
JGT   05 03  MR  - - R    IF (A) .GT. 0, EA => P.
JIX   15 03  MR  - - R    JUMP ON INCREMENTED X-REG ZERO.
JLE   04 03  MR  - - R    IF (A) .LE. 0, EA => P.
JLT   06 03  MR  - - R    IF (A) .LT. 0, EA => P.
JMP   51     MR  - - I    JUMP. EA=>RP.
JMP   01     MR  - - SRV  UNCOND JUMP.  EA => PB,P.
JNE   03 03  MR  - - R    IF (A) .NE. 0, EA => P.
JSR   73     MR  - - I    RPL=>RH, EA32=>RP
JST   10     MR  - - SRV  (P) => [EA]16, EA+1 => P.
JSX   35 03  MR  - - RV   (P) => X, EA => P.
JSXB  61     MR  - - I    RP=>XB, EA=>RP.
JSXB  14 02  MR  - - V    (PB,P) => XB, EA => PB,P.
JSY   14     MR  - - V    (P) => Y, EA => P.
L     01     MR  - - I    LOAD. [EA32]=>R.
LDA   02     MR  - - SRV  LOAD A-REGISTER.  [EA]16 => A.
LDAR  44     MR  - - I    LOAD ADDR REGISTER.
LDL   02 03  MR  - - V    LOAD LONG.  [EA]32 => A,B.
LDLR  05 01  MR  - - V    LOAD LONG FROM RFILE LOC EA.
LDX   35     MR  - - SRV  LOAD X-REGISTER.  [EA]16 => X.
LDY   35 01  MR  - - V    LOAD Y-REGISTER.  [EA]16 => Y.
LH    11     MR  - - I    LOAD HALF WD. [EA16]=>RH.
LHL1  04     MR  - - I    SHIFTED 1 [EA16] .LS. 1=>GRH.
LHL2  14     MR  - - I    SHIFTED 2 [EA16] .LS. 2=>GRH.
M     42     MR  3 1 I    MULT. R*[EA32]=>(R,R+1).
MH    52     MR  3 1 I    RH*[EA16}=>R.
MIA   64     MR  - - I    MICROCODE EXECUTE A.
MIA   12 01  MR  - - V    MICROCODE ENTRANCE.
MIB   74     MR  - - I    MICROCODE EXECUTE B.
MIB   13 01  MR  - - V    MICROCODE ENTRANCE.
MPL   16 03  MR  - 1 V    (A,B) * [EA]16 => A,B.(NOHOLE)
MPY   16     MR  - 1 V    (A) * [EA]16 => A,B. (NOHOLE).
MPY   16     MR  3 1 SR   (A) * [EA]16 => A,B. (HOLE).
```

N	Ø3		MR	- -	I	R .AND. [EA32]=>R.
NH	13		MR	- -	I	RH .AND. [EA16]=>RH.
O	23		MR	- -	I	R .OR. [EA32]=>R.
OH	33		MR	- -	I	RH .OR. [EA16]=>RH.
ORA	Ø3	Ø2	MR	- -	V	(A) .OR. [EA]16 => A.
PCL	41		MR	- -	I	PROCEDURE CALL.
PCL	1Ø	Ø2	MR	7 6	V	P-4ØØ PROCEDURE CALL.
S	22		MR	2 1	I	SUB. R-[EA32]=>R.
SBL	Ø7	Ø3	MR	2 1	V	(A,B) - [EA]32 => A,B.(NOHOLE)
SH	32		MR	2 1	I	SUB HALF WD. RH-[EA16]=>RH.
SHA	15		MR	4 -	I	ARITHMETIC SHIFT.
SHL	Ø5		MR	4 -	I	LOGICAL SHIFT.
ST	21		MR	- -	I	STORE. R=>[EA32].
STA	Ø4		MR	- -	SRV	STORE A-REG. (A) => [EA]16.
STAR	54		MR	- -	I	STORE ADDRESSED REGISTER.
STH	31		MR	- -	I	STORE HALF WD. RH=>[EA16].
STL	Ø4	Ø3	MR	- -	V	STORE LONG. (A,B) => [EA]32.
STLR	Ø3	Ø1	MR	- -	V	STORE LONG INTO RFILE LOC EA.
STX	15		MR	- -	SRV	STORE X-REG. (X) => [EA]16.
STY	35	Ø2	MR	- -	V	STORE Y-REG. (Y) => [EA]16.
SUB	Ø7		MR	2 1	SRV	SUBTRACT. (A) - [EA]16 => A.
TM	44		MR	- 1	I	REST MEM. [EA32]::Ø=>CC.
X	43		MR	- -	I	EXC OR. R .XOR. [EA32]=>R.
XEC	Ø1	Ø2	MR	- -	RV	EXECUTE INSTRUCTION AT EA.
XEC	Ø1	Ø2	MR	- -	RV	EX EFF ADDR CONT AS THIS INST.
XH	52		MR	- -	I	RH .XOR. [EA16]=>RH.
ZM	43		MR	- -	I	ZERO MEM. Ø=>[EA32].
ZMH	53		MR	- -	I	ZERO MEM. HALF WD. Ø=>[EA16].

Miscellaneous Operations

A1A	141206	OPR	2 1	SRV		ADD 1 TO A REG. A+1=>A.
A2A	140304	OPR	2 1	SRV		ADD 2 TO A REGISTER. A+2=>A.
ABQ	50134	OPR	- 7	I		ADD TO BOTTOM OF QUEUE.
ACA	141216	OPR	2 1	SRV		ADD CBIT TO A REG. CBIT+A=>A.
ADLL	141000	OPR	2 1	SRV		ADD LINK TO L REGISTER.
ADLR	50014	OPR	- 7	I		ADD LINK TO GR.
ATQ	50135	OPR	- 7	I		ADD TO TOP OF QUEUE.
CAL	141050	OPR	- -	SRV		CLEAR A REG. LEFT BYTE.
CAR	141044	OPR	- -	SRV		CLEAR A REG. RIGHT BYTE.
CAZ	140214	OPR	1 1	SRV		SKIP Ø,1,2 INST. IF A >,=,< Ø.
CEA	ØØØ111	OPR	- -	SRV		A AS EA=>A. (USELESS IN 64V).
CGT	50026	OPR	- 7	I		COMPUTED GOTO.
CHS	50040	OPR	- -	I		CHANGE SIGN -(1)=>GR(1).
CHS	140024	OPR	- -	SRV		CHANGE SIGN OF A REGISTER.
CMA	140401	OPR	- -	SRV		ONE'S COMPLEMENT A REGISTER.
CMH	50045	OPR	- -	I		COMP HALF REG. GRH=>GRH.
CMR	50044	OPR	- -	I		COMP REG. GR=>GR.
CR	50056	OPR	- -	I		CLEAR REG. Ø => GR.
CRA	140040	OPR	- -	SRV		CLEAR A REGISTER. Ø=>A.
CRB	140015	OPR	- -	SRV		CLEAR B REGISTER. Ø=>B.
CRBL	50062	OPR	- -	I		LEFT BYTE Ø=>GRH(1-8).
CRBR	50063	OPR	- -	I		RIGHT BYTE Ø=>GRH(9-16).
CRE	141404	OPR	- -	SRV		CLEAR E. Ø=>E.
CRL	140010	OPR	- -	SRV		CLEAR L REGISTER. Ø=>L.
CRLE	141410	OPR	- -	SRV		CLEAR L AND E. Ø=>L, Ø=>E.
CSA	140320	OPR	5 -	SRV		CPY SIGN OF A. A1=>CBIT,Ø=>A1.

CSR	50041	OPR	- -	I	COPY & SAVE SIGN. 1=>C,Ø=>GR1.
DH1	50130	OPR	2 1	I	DECR HALF REG BY 1. GRH-1=>GRH.
DH2	50131	OPR	2 1	I	DECR HALF REG BY 2. GRH-2=>GRH.
DR1	50124	OPR	2 1	I	DECR REG BY 1. GR-1=>GR.
DR2	50125	OPR	2 1	I	DECR REG BY 2. GR-2=>GR.
DRX	140210	OPR	- -	SRV	DECREMENT X AND SKIP IF Ø.
IAB	ØØØ201	OPR	- -	SRV	EXCHANGE A AND B A=>B & B=>A.
ICA	141340	OPR	- -	SRV	INTERCHANGE BYTES OF A REG.
ICBL	50065	OPR	- -	I	GRH(1-8)=>GRH(9-16), Ø=>R.
ICBR	50066	OPR	- -	I	GRH(9-16)=>GRH(1-8), Ø=>
ICHL	50060	OPR	- -	I	GRH=>GRL, Ø=>GRH.
ICHR	50061	OPR	- -	I	GRL=>GRH, Ø=>GRL.
ICL	141140	OPR	- -	SRV	EXCHANGE BYTES OF A, CLR LEFT.
ICR	141240	OPR	- -	SRV	EXCHANGE BYTES OF A, CLR RIGHT.
IH1	50126	OPR	2 1	I	GRH+1=>GRH.
IH2	50127	OPR	2 1	I	GRH+2=>GRH.
ILE	141414	OPR	- -	SRV	EXCHANGE L AND E. L=>E & E=>L.
INK	50070	OPR	- -	I	MOVE KEYS TO REG KEYS.
INK	ØØØØ43	OPR	- -	SRV	INPUT P-3ØØ KEYS INTO A REG.
IR1	50122	OPR	2 1	I	INCR REG BY 1. GR+1=>GR.
IR2	50123	OPR	2 1	I	INCR REG BY 2. GR+2=>GR.
IRB	50062	OPR	- -	I	BYTES GRH(1-8)=>GRH(9-16)
IRH	50057	OPR	- -	I	GRH=>GRL, GRL=>GRH.
IRX	140114	OPR	- -	SRV	INCREMENT X AND SKIP IF Ø.
NOP	ØØØØØ1	OPR	- -	SRV	NO OPERATION.
NRM	ØØØ101	OPR	- -	SRV	NORMALIZE A,B AS ON P-3ØØ.
OTK	50071	OPR	7 S	I	SET KEYS FROM REGISTER
OTK	ØØØ405	OPR	7 6	SRV	OUTPUT A TO 3ØØ KEYS, SHFT CTR.
PID	50052	OPR	- -	I	GR=>GRN, (1)=>GR(2-32).
PID	ØØØ211	OPR	- -	SRV	SHORT INT TO DP INT W/HOLE.
PIDA	ØØØ115	OPR	- -	SRV	SHORT TO LONG INT CONV. A=>L.
PIDH	50053	OPR	- -	I	GRH=>GRL,GRH(1)=>GRH(2-16).
PIDL	ØØØ305	OPR	- -	SRV	CONVERT LONG INT TO 64 BIT INT.
PIM	50050	OPR	2 1	I	POS REG AFTER INT MULTIPLY.
PIM	ØØØ205	OPR	- -	SRV	DP INT WITH HOLE TO SHORT INT.
PIMA	ØØØ015	OPR	3 5	SRV	L=>A. IEX ON PREC LOSS.
PIMH	50051	OPR	2 1	I	POS HALF REG AFTER INT MULT.
PIML	ØØØ301	OPR	3 5	SRV	64BIT INT TO LONG INT.(L,E)=>L.
RBQ	50133	OPR	- 7	I	REMOVE FROM BOTTOM OF QUEUE.
RCB	140200	OPR	5 -	SRV	RESET CBIT. Ø=>CBIT.
RTN	ØØØ105	OPR	- -	SRV	RETURN FROM P-3ØØ RECUR PROC.
RTQ	50132	OPR	- 7	I	REMOVE FROM TOP OF QUEUE.
S1A	140110	OPR	2 1	SRV	SUB 1 FROM A REGISTER. A-1=>A.
S2A	140310	OPR	2 1	SRV	SUB 2 FROM A REGISTER. A-2=>A.
SCA	ØØØØ41	OPR	- -	SRV	LOAD P-3ØØ SHFT CTR INTO A REG.
SCB	140600	OPR	5 -	SRV	SET CBIT. 1=>CBIT.
SHL1	50076	OPR	4 1	I	GRH .LS. 1 => GRH.
SHL2	50077	OPR	4 1	I	GRH .LS. 2 => GRH.
SHR1	50120	OPR	4 1	I	GRH .RS. 1 => GRH.
SHR2	50121	OPR	4 1	I	GRH .RS. 2 => GRH.
SL1	50072	OPR	4 1	I	GR .LS. 1 => GR.
SL2	50073	OPR	4 1	I	GR .LS. 2 => GR.
SR1	50074	OPR	4 1	I	GR .RS. 1 => GR.
SR2	50075	OPR	4 1	I	GR .RS. 2 => GR.
SSM	50042	OPR	- -	I	SET SIGN. MINUS 1=>(1).
SSM	140500	OPR	- -	SRV	SET SIGN OF A MINUS. 1=>A1.
SSP	50043	OPR	- -	I	SET SIGN. PLUS Ø=>(1).

```
SSP  140100 OPR - - SRV  SET SIGN OF A PLUS.  Ø=>ABIT1.
STCD  50137 OPR - 7 I    GR+1=[EA16].
STCH  50136 OPR - 7 I    GRL=[EA16].
STEX  50027 OPR - 7 I    STACK EXTEND.
STEX 001315 OPR 6 5 SRV  STK EXTEND. L REG HAS EXTENT.
TAB  140314 OPR - - SRV  TRANSFER A TO B REG.  A=>B.
TAK  001015 OPR 7 6 SRV  TRANSFER A TO KEYS.
TAX  140504 OPR - - SRV  TRANS A REG TO X REG.  A=>X.
TAY  140505 OPR - - SRV  TRANS A REG TO Y REG.  A=>Y.
TBA  140604 OPR - - SRV  TRANS B REG TO A REG.  B=>A.
TC    50047 OPR 3 1 I    -GR+1=>GR.
TCA  140407 OPR 2 1 SRV  TWO'S COMPLEMENT A.  -A=>A.
TCH   50047 OPR 3 1 I    -GRH+1=>GRH.
TCL  141210 OPR 2 1 SRV  TWO'S COMPLEMENT L.  -L=>L.
TKA  001005 OPR - - SRV  TRANSFER KEYS TO A.
TSTQ  50104 OPR - 7 I    TEST QUEUE.
TXA  141034 OPR - - SRV  TRANS X REG TO A REG.  X=>A.
TYA  141124 OPR - - SRV  TRANS Y REG TO A REG.  Y=>A.
XCA  140104 OPR - - SRV  EXCHG AND CLR A. A=>B, Ø=>A.
XCB  140204 OPR - - SRV  EXCHG AND CLR B. B=>A, Ø=>B.
xxx  140014 OPR - - SRV  OBSOLETE. CLRS B, LSW OF DFAC.
```

Programmed I/O Operations

```
INA   54     PIO - - SR*  INPUT TO A-REGISTER.
OCP   14     PIO - - SR*  OUTPUT CONTROL PULSE.
OTA   74     PIO - - SR*  OUTPUT FROM A-REGISTER.
SKS   34     PIO - - SR   SKIP IF CONDITION SET.
SMK  170020 PIO - - SR*  SET INTERRUPT MASKS.
```

Shift Operations

```
ALL  0414XX SH  4 5 SRV  A LEFT LOGICAL.
ALR  0416XX SH  4 5 SRV  A LEFT ROTATE.
ALS  0415XX SH  4 5 SRV  A LEFT SHIFT (SHORT INT ARITH).
ARL  0404XX SH  4 5 SRV  A RIGHT LOGICAL.
ARR  0406XX SH  4 5 SRV  A RIGHT ROTATE.
ARS  0405XX SH  4 5 SRV  A RIGHT SHIFT (SHORT ARITH).
LLL  0410XX SH  4 5 SRV  LONG LEFT LOGICAL.
LLR  0412XX SH  4 5 SRV  LONG LEFT ROTATE.
LLS  0411XX SH  4 5 SRV  LNG LSFT 64V=>LNG INT,ELSE HOLE
LRL  0400XX SH  4 5 SRV  LONG RIGHT LOGICAL.
LRR  0402XX SH  4 5 SRV  LONG RIGHT ROTATE.
LRS  0401XX SH  4 5 SRV  LNG RSFT.64V=LNG INT,ELSE HOLE.
```

Skip Operations

```
SAR  10026X SKP - - SRV  SKIP IF A REG. BIT N RESET.
SAS  101260 SKP - - SRV  SKIP IF A REG. BIT N SET.
SGT  100220 SKP - - SRV  SKIP IF A REG. .GT. Ø.
SKP  100000 SKP - - SRV  SKIP ONE WORD.
SLE  101220 SKP - - SRV  SKIP IF A REG. .LE. Ø.
SLN  101100 SKP - - SRV  SKIP IF A REG. BIT 16 SET.
SLZ  100100 SKP - - SRV  SKIP IF A REG. BIT 16 .EQ. Ø.
SMCR 100200 SKP - - SRV  SKIP IF MACHINE CHECK RESET.
SMCS 101200 SKP - - SRV  SKIP IF MACHINE CHECK SET.
SMI  101400 SKP - - SRV  SKIP IF A REG. .LT. Ø.
```



```
SNR  10024X SKP - - SRV* SKIP IF SENSE SWITCH N RESET.
SNS  101240 SKP - - SRV* SKIP IF SENSE SWITCH N SET.
SNZ  101040 SKP - - SRV  SKIP IF A REG. NE. Ø.
SPL  100400 SKP - - SRV  SKIP IF A REG. .GE. Ø.
SR1  100020 SKP - - SRV* SKIP IF SENSE SWITCH 1 RESET.
SR2  100010 SKP - - SRV* SKIP IF SENSE SWITCH 2 RESET.
SR3  100004 SKP - - SRV* SKIP IF SENSE SWITCH 3 RESET.
SR4  100002 SKP - - SRV* SKIP IF SENSE SWITCH 4 RESET.
SRC  100001 SKP - - SRV  SKIP IF CBIT RESET.
SS1  101020 SKP - - SRV* SKIP IF SENSE SWITCH 1 SET.
SS2  101010 SKP - - SRV* SKIP IF SENSE SWITCH 2 SET.
SS3  101004 SKP - - SRV* SKIP IF SENSE SWITCH 3 SET.
SS4  101002 SKP - - SRV* SKIP IF SENSE SWITCH 4 SET.
SSC  101001 SKP - - SRV  SKIP IF CBIT SET.
SSR  100036 SKP - - SRV* SKIP IF SSWI 1,2,3 AND 4 RESET.
SSS  101036 SKP - - SRV* SKIP IF SSWI 1,2,3 AND 4 SET.
SZE  100040 SKP - - SRV  SKIP IF A REG .EQ. Ø.
```

Virtual-memory Operations

```
EPMJ 000217 VM  - - SR   ENT PAGE MODE AND JUMP (P300).
EPMX 000237 VM  - - SR   ENT PAG MOD & JMP TO MICROCODE.
ERMJ 000701 VM  - - SR   ENTER RESTR MODE & JUMP (P300).
ERMX 000721 VM  - - SR   RESTR MOD & JUMP TO MICROCODE.
EVMJ 000703 VM  - - SR   ENT VIRT MODE AND JUMP (P300).
EVMX 000723 VM  - - SR   VIRT MOD & JUMP TO MICROCODE.
LPMJ 000215 VM  - - SR   LEAVE PAGE MODE & JUMP (P300).
LPMX 000235 VM  - - SR   LVE PAG MOD & JMP TO MICROCODE.
```

6 OPERATIONAL PROCEDURES

BOOT PROCEDURES

Master clear, select LOAD, raise data switches 1-16 as follows ('-' => don't care):

```
 1                 16
|A|AAA|AAA|AAA|---|000| Start at 'AAAAAAAAAA000000
|S|SSS|SSS|DDP|---|001| ASR Paper Tape
|S|SSS|SSS|DDP|---|010| High Speed Paper Tape
|H|HHH|HHH|H--|--0|011| Option B  FHD
|H|HHH|HHH|H--|-01|011| Option B' FHD, DA='21
|H|HHH|HHH|H--|-11|011| Option B' FHD, DA='23
|H|HHH|HHH|H--|0-0|100| Option B  Upper MHD
|H|HHH|HHH|H--|1-0|100| Option B  Lower MHD
|H|HHH|HHH|H-0|001|100| Option B' Upper MHD, DA='21
|H|HHH|HHH|H-0|101|100| Option B' Lower MHD, DA='21
|H|HHH|HHH|H-0|011|100| Option B' Upper MHD, DA='23
|H|HHH|HHH|H-0|111|100| Option B' Lower MHD, DA='23
|H|HHH|HHH|H-1|-01|100| Storage Module, DA='26
|H|HHH|HHH|H-1|-11|100| Storage Module, DA='27
|N|NNN|NNN|RRS|CT-|101| Magtape
|-|---|---|---|---|110| Diskette (Floppy)
|-|---|---|---|---|111| Unused
```

A..A Addr/'100 to start at
S..S Sector for boot loader relocation
DD Displacement for boot loader relocation
P 1 => suppress auto-start
C 1 => halt to allow baud rate change
H..H DOS select:
  00000000 Highest that will fit
  010----- *DOS16
  011----- *DOS64
  100----- *DOS32
N..N File number to load (0=>prompts)
RR Relocation of boot program to ending address of:
  00 - end of physical memory
  01 - 16K
  10 - 32K
  11 - 48K
T 0 - 9-track
  1 - 7-track

BOOT TERMINAL SPEED SELECTION

Parameter 4 (B Register)
  '110 for 110 BAUD
  '1010 for 300 BAUD
  '2010 for 1200 BAUD
  '3410 for 9600 BAUD

Parameter 5 (X Register)
  '27 for 110 BAUD
  '76 for 300 BAUD
  '373 for 1200 BAUD
  '3735 for 9600 BAUD

Parameter 6 (Keys)
  '740** for 110 BAUD
  '340** for 1200 - 9600 BAUD

** = number of delays after .CR.

TYPICAL SWITCH SETTINGS FOR DISK BOOTS

DVNO	Switches
0	--0004
1	--0044
10	--0003
20	--0006
30	--0014
31	--0054
40	--0014
---050	--0014
---051	--0054
---250	--0034
---251	--0074
---460	--0114

Hit START to initiate load sequence. Select RUN after load has started.

COLD START (PRIMOS IV,V)

1) Boot in PRIMOS II (see 'BOOT' above), startup disk containing UFD with PRIMOS IV (typically PR4.64, PR4.16, PR4L16). Attach to UFD containing PRIMOS IV.

2) Type 'R PRIMOS'. If there is a C_PRMO file in the current CMDNCØ the configuration will be taken from that file. Else enter CONFIG command:

CONFIG -- SET SYSTEM CONFIGURATION PARAMETERS

CONFIG [<node>] <ntusr> <pagdev> <comdev>
[<memsiz>] [<altdev>] [<namlc>] [<npusr>]
[<nrusr>] [<slmcon>]

-or-

CONFIG -DATA <config-filename>

Commands for latter form documented in PE-T-412.

Cold start command only.

3) If PRIMOS IV halts at 1507 (151Ø in address lights), it has encountered bad memory during initial memory scan (see HALTS). Hit start to map out the bad page and continue.

4) After the introductory messages, enter the date and time:

SEtime -<mmddyy> -<hhmm>

Users may now log into the system.

HALTS

ON MACHINE HALT:

1) Select STOP/STEP mode (rotary switch).
2) Place ADDRESS/DATA switch on ADDRESS and note the address displayed in lights. To determine the segment number of the halt, select FETCH, depress DATA CLEAR, set data switches to '14, raise switches 1 and 4, depress START, note displayed segment number.
3) Refer to latest load map of PRIMOS IV and/or the following list of load map entries to determine subsequent actions. (NOTE: the address displayed at the halt will always be one location higher than the corresponding halt location address.)

PRIMOS IV HALT LOCATIONS

(Addresses marked with a '+' are those most likely to change when PRIMOS is reloaded. The letters in parentheses refer to subsequent actions that should be taken and are described following the list.)

AMLCI_	+6/12714	Bad AMLC Interrupt.	(D,W)
BDMEM_	4/1507	Parity error during cold start.	(M,C)
BOOTØ_	+6/1Ø634	Halt after SHUTDN ALL command.	(C)
IFLTB_	+4/115204	Fault in interrupt handler.	(D,C)
INTRT_	+4/115357	Too many PRINs.	(D,C)
IPAGE_	+4/115321	Page flt in interrupt process.	(D,C)
MCHK_	4/3Ø5	Machine check.	(D,W)
MEMH2_	4/317	Halt after mapout of bad page.	(W*)
MEMPA_	4/276	Uncorrected mem parity error.	(M,W*)
MMOD_	4/315	Missing memory module.	(D,C)
PAGFB_	6/3577	Illegal page fault.	(D,C)
REFLØ_	6/3663	Illegal FLEX, UII, PSU.	(D,C)
RMCFØ_	6/3545	Illegal restricted mode fault.	(D,C)
SVCFØ_	6/376Ø	Illegal SVC.	(D,C)
WARMH_	4/1Ø22	Can't warm start	(C)
Any other location.			(D,C)

ACTIONS TO TAKE AFTER HALT CONDITION IS DETERMINED

D -- Note down register set (if RSAVPTR.NE.Ø) and take a tape dump.
C -- Cold start.
W -- Warm start.
W* -- Warm start is possible only if a user page got the parity error.
M -- Map out bad page.

MEMORY PARITY ERRORS

On halt (at MEMPA_): X = user number, A = physical page number, B = word number. Hit start to automatically map out bad page.

c(MMAP+PPN) --> HMAP for page (< '6200 => supervisor page).

c(PTUSEG+(PHMAP.RS.6-'40)=user number

Manual mapout: MMAP+PPN<-- -1, HMAP <-- 0

MEMORY/REGISTER DISPLAY

1) Select FETCH Y on rotary switch (this stops the machine).
2) Select ADDRESS on ADDRESS/DATA toggle, hit DATA CLEAR, and depress address or register number in switches as shown below.
3) After switches depressed/set, select DATA and depress START. The lights now show contents of selected location on register.

For memory references, raised switches are in top row, dialed switches in bottom row. 'H/L' selects high (raised) or low (middle position) side of register.

```
                    1                 12  16
300 REGS:          |0|000|000|000|0RR|RRR|
                                     REG #

                    1     5<--SEG NUM->16
MAPPED MEMORY:     |0|000|SSS|SSS|SSS|SSS|
                   |W|WWW|WWW|WWW|WWW|WWW|
                    <--WORD NUMBER------>

                    1   4           11   16
ABSOLUTE MEMORY:   |0|001|000|000|WWW|WWW|
                   |W|WWW|WWW|WWW|WWW|WWW|
                    <----WORD NUMBER---->

                    1   4           12  16
CURR. REG. SET:    |1|00H/L|000|000|0RR|RRR|
                                     REG #

                    1 2 4           11   16
ABSOLUTE REG.:     |1|10H/L|000|00R|RRR|RRR|
                                     REG #
```


Virtual addresses (but not absolute memory or registers) can be displayed while PRIMOS IV is running. Place ADDRESS/DATA toggle on DATA and enter segment number/word number as follows ('D' => depress switch):

```
                    1 2                 16
CLEAR SEGNO:       |D|D00|000|000|000|000|

                    1     5             16
DEPRESS SEGNO:     |D|000|DDD|DDD|DDD|DDD|
                           <---SEG NUM--->

                    1                   16
RAISE WRDNO:       |W|WWW|WWW|WWW|WWW|WWW|
                    <----WORD NUMBER---->
```

NOTE: If referenced page is not in memory, zeroes will be displayed (i.e., page faults are ignored).

MEMORY SCAN

1) Master clear, load '777 into the PC (location 7), select RUN, place ADDRESS/DATA switch on DATA, data switches in neutral position, hit START. (PRIMOS IV must be in memory.)
2) When the data lights change, a bad memory location has been found. The display with all switches neutral is the word number within the page. To display the physical page number, raise switch 15. To display the contents of the location, raise switch 14 (drop switch 15).
3) To continue the memory scan, type any character on the system console (ASR).
4) The scan will halt when the end of memory is reached. Hitting START will restart the scan.

TAPE DUMP

1) Mount non-write-protected tape on first magtape controller, drive 1. Ensure only one unit dialed to 1. Tape should be at load point and online. (PRIMOS IV or V must be in memory.)
2) Master clear, set PC (location 7) from '1000 to '776, select RUN, hit START.
3) When done, the tape dump program will rewind the tape and halt. Perform WARM or COLD START as appropriate.

OPERATIONAL PROCEDURES

WARM START

Master clear, select RUN, hit START twice.

NOTE: Warm start is possible only on CPUs with REV 10 microcode or later, otherwise an immediate halt at WARMH_ will occur.

7 PERIPHERAL I/O

ADDRESSES

00	Polling	40	PRIMAD (AIS)
01	Paper Tape Reader	41	Digital Input 1
02	Paper Tape Punch	42	Digital Input 2
03	Unit Record Controller 1	43	Digital Output 1
04	TTY	44	Digital Output 2
05	Unit Record Controller 2	45	Analog Output
06	Interproc. Channel (IPC)	46	Computer Prod. IF
07	--	47	CAMAC Interface
10	--	50	HSSMLC 1
11	--	51	HSSMLC 2
12	Diskette	52	AMLC 3
13	Magtape Controller 2	53	AMLC 2
14	Magtape Controller 1	54	AMLC 1
15	RIOX I/O Bus Switch	55	MACI Autocall
16	RIOX MPS	56	SMLC
17	--	57	--
20	Panel, Real Time Clock	60	Gen. Purp. IF Board
21	Disk (4002 Controller)	61	Ringnet Controller
22	Fixed Head Disk	62	GPIB
23	30 Megabyte Disk	63	GPIB
24	Writeable Control Store	64	GPIB
25	Moveable Head Disk	65	GPIB
26	Storage Module 1	66	GPIB
27	Storage Module 2	67	GPIB
30	IOC 1 (Parallel I/O)	70	GPIB Test
31	IOC 2	71	ADAGE GP/400 IF
32	--	72	--
33	VERSATEC	73	--
34	VERSATEC	74	--
35	AMLC 4	75	--
36	ELFBUS Controller 1	76	--
37	ELFBUS Controller 2	77	I/O Bus Test

AMLC

OTA 01 -- Set Line Configuration

1-4	170000	Line Number
5	004000	Unused
6	002000	Data Set Control
7	001000	Loop Line
8-10	000700	Line Speed: xxx0xx - 110 BAUD xxx1xx - 134.5 xxx2xx - 300 xxx3xx - 1200 xxx4xx - Pgmed Clock xxx5xx - Pgmed Clock xxx6xx - Pgmed Clock xxx7xx - Pgmed Clock
11	000040	Unused
12	000020	0 => 1 Stop Bit, 1 => 2
13	000010	1 => Disable Parity
14	000004	0 => Odd Parity, 1 => Even
15-16	000003	Char Len: xxxxx0 - 5 Bits xxxxx1 - 7 Bits xxxxx2 - 6 Bits xxxxx3 - 8 Bits

OTA 02 -- Set Line Control

1-4	170000	Line Number
5-10	007700	Unused
11	000040	1 => Enable Char Time Interrupt
12	000020	Unused
13	000010	1 => Enable Transmit
14	000004	1 => Enable Echo Back
15	000002	1 => Receive Off, Report Break
16	000001	1 => Enable Receive

ASR

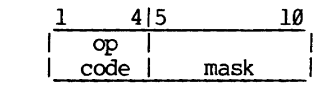
BAUD	OPTION-A	SOC CTL 1	SOC CTL 2
110	110	27	740**
300	1010	76	340**
1200	2010	373	340**
9600	3410	3735	340**

** = number of delays used by BOOT, PRIMOS

DISK CONTROLLERS

Disk Channel Program Definitions

Mnem	Op Code	Execution Time (u-s)	Order	Fields	
DHLT	Ø	6	Halt		
SFORM	2		Format	Rec Size	13-16
				Track Addr	23-32
				# Records	33-4Ø
				Head Addr	44-48
SSEEK	3	7.5	Seek	Restore	17
				Clear	18
				Track Addr	23-32
DSEL	4	7.5	Select	MHD	29-32
SREAD	5		Read	Rec Size	13-16
				Offset	17-2Ø
				SR	21
				Track Addr	23-32
				Rec Addr	33-4Ø
				Head Addr	44-48
SWRITE	6			Rec Size	13-16
				Track Addr	23-32
				Rec Addr	33-4Ø
				Head Addr	44-48
DSTALL	7	21Ø	Stall		
DSTAT	9	9	Input Status	Mem Addr	17-32
SSTOR	A	9	Store	Diag Addr	16
				Mem Addr	17-32
DOAR	B	9	Input OAR	Mem Addr	16
SLOAD	C	9	Load	Diag Addr	16
				Mem Addr	17-32
SDMA	D	6	Channel Address	Chain	13-16
				Chan Addr	17-32
DINT	E	6+CPU	Interrupt	Vect Addr	17-32
DTRAN	F	6	Transfer	Trans Addr	17-32



bit 5 = Ø, do not execute inst if:
bit 5 = 1, execute inst if:

set bit	
6	No function but reserved for "selected diskfile is write protected."
6	Last read or write record inst caused a DMA overrun, check error, controller parity error or header check failure (status word bits 2,4,5, or 6 set).
8	Selected MHD is seeking.
9	Selected diskfile has an error condition (status word bits 14, 15, or 16 are set).
1Ø	For dual port operation only. Selected diskfile is busy servicing the "other" controller.

Disk Device Numbers (DVNO)

1-4	17ØØØØ	(Offset to First Head)/2
5-8	ØØ74ØØ	(Number of Heads)/2
9	ØØØ2ØØ	Ø=>Controller 1, 1=>Controller 2
1Ø-13	ØØØ17Ø	Type of Controller: xxxØØx 4ØØØ MHD xxxØ1x 4ØØØ FHD xxxØ2x Diskette xxxØ3x 4ØØ3 8 Sectors/Track xxxØ4x 4ØØ3 FHD xxxØ5x 4ØØ3 32 Sectors/Track xxxØ6x 4ØØ4 Storage Module xxxØ7x-xxx17x Undefined
14-15	ØØØØØ6	Unit (Inc. bit 16 for Diskette)
16	ØØØØØ1	Diskette: Low Bit of Unit 4ØØ3 Controller: Ø => Top, 1 => Bottom Storage Module: LSB of Number Heads

Disk Errors

Option B (4000 Controller)

--	177777	Bad Record Identifier
--	177776	Device Not Ready
1	100000	Data Transfer Complete
2	040000	R/W Past End of Record
3	020000	Unused
4	010000	Stack Available
5	004000	Seek Complete OK
6	002000	Write Protect Violation
7	001000	Not Ready
8	000400	Command Error
9	000200	Checksum Error
10	000100	DMX Overrun
11	000040	Stack Overflow
12-15	000036	Unused
16	000001	Not Ready (Software)
--	000000	Redundant Int. (Warm Start)

Option B-Prime (4001 Controller)

--	177777	Bad Record Identifier
--	177776	Device Not Ready
--	177775	Memory Parity Error During DMX
1	100000	Bit 1 Always Set
2	040000	DMX Overrun
3	020000	Write Protect Status
4	010000	Checksum Error
5-9	007600	Unused
10	000100	Unit 1 Seeking
11	000040	Unit 2 Seeking
12	000020	Unit 3 Seeking
13	000010	Unit 4 Seeking
14	000004	Illegal Seek
15	000002	Malfunction Detected
16	000001	Not Ready (Software)
--	000000	Redundant Int. (Warm Start)

Diskette Controller

--	177777	Bad Record Identifier
--	177776	Device Not Ready
1	100000	Normal End of Instruction
2	040000	Sector Not Found
3	020000	Checksum Error on Sector ID
4	010000	Track Error (head misposition)
5	004000	Bad CTA or Not Ready
6	002000	Deleted Data Mark Read
7	001000	DMX Overrun
8	000400	Chksum err, Write Prot. Violation, Inoperable on Write or Format
9-15	000376	Unused
16	000001	Not Ready
--	000000	Redundant Int. (Warm Start)

Storage Module (4004 Controller)

--	177777	Bad Record Identifier
--	177776	Device Not Ready
--	177775	Memory Parity Error During DMX
1	100000	Bit 1 Always On
2	040000	DMA Overrun
3	020000	Write Protect
4	010000	Read Check
5	004000	Data Parity Error
6	002000	Header Check
7-10	001700	Unused
11	000040	Busy (Dual Port Only)
12	000020	Unused
13	000010	Seeking
14	000004	Illegal Seek
15	000002	Select Error
16	000001	Not Ready
--	000000	Redundant Int. (Warm Start)

Disk Sizes

*** Disk types and sizes ***
to be supplied at next update

DMX CONTROL WORDS

DMA

```
    1          12 13
 Ø |-WORD COUNT  0000|
 1 |STARTING ADDRESS |

            1    5 6          16
OTA '14dd: |N|NNN|Ø CHAN ADDRESS|
```

NNNN = Number of channels - 1.

DMC

```
    1            16
 Ø |START ADDRESS |
 1 | END  ADDRESS |

            1   4 5 6          16
OTA '14dd: |N|NNN|1 CHAN ADDRESS|
```

NNNN = Number channels - 1.

DMQ

```
    1                    16
 Ø |T|TTT|TTT|TTT|TTT|TTT|   (Read Pointer)
 1 |B|BBB|BBB|BBB|BBB|BBB|   (Write pointer)
 2 |Ø|---|---|---|PPP|PPP|   (H. O. bits phy addr)
 3 |M|MMM|MMM|MMM|MMM|MMM|   (mask)
```

mask = len-1 of Q
len = 2**K, 4≤K≤1Ø
(Queue must be on 2**K boundary.)

INPUT: End of Range if no room.
OUTPUT: EOR if empty (not w/last entry).

DMT

Device Defined.

MAGTAPE

Command Bit Definitions

1	100000	Select Transport (bits 9-12)
2	040000	Ø=>File Operation, 1=>Record Op
3	020000	Ø=>Read/Write Op, 1=>Spacing Op
4	010000	1=>9-Track Read and Correct
5	004000	Ø=>Binary, 1=>BCD (7-track only)
6	002000	Ø=>7-Track Transport, 1=>9-Track
7	001000	Unused
8	000400	1=>2 Characters per Word
9	000200	1=>Forward Motion (bits 1Ø,11=Ø)
1Ø	000100	1=>Reverse Motion (bits 9,11,12=Ø)
11	000040	1=>Rewind (bits 9,1Ø,12=Ø)
12	000020	1=>Write Order
13	000010	Select Transport Ø
14	000004	Select Transport 1
15	000002	Select Transport 2
16	000001	Select Transport 3

Magtape Commands

100000	Select Transport (7 and 9 track)
000040	Rewind to BOT (7 and 9 track)
022100	Backspace File Mark, 9-track
020100	Backspace File Mark, 7-track
062100	Backspace Record, 9-track
060100	Backspace Record, 7-track
022220	Write File Mark, 9-track
020220	Write File Mark, 7-track
062200	Forward Space Record, 9-track
060200	Forward Space Record, 7-track
022200	Forward Space File Mark, 9-track
020200	Forward Space File Mark, 7-track
042220	Write Record One Char/Word, 9-track
042620	Write Record Two Char/Word, 9-track
042200	Read Record One Char/Word, 9-track
042600	Read Record Two Char/Word, 9-track
052200	Read/Correct Record One Char/Word, 9-track
052600	Read/Correct Record Two Char/Word, 9-track
040220	Write Binary Record One Char/Word, 7-track
040620	Write Binary Record Two Char/Word, 7-track
044220	Write BCD Record One Char/Word, 7-track
044620	Write BCD Record Two Char/Word, 7-track
040200	Read Binary Record One Char/Word, 7-track
040600	Read Binary Record Two Char/Word, 7-track
044200	Read BCD Record One Char/Word, 7-track
044600	Read BCD Record Two Char/Word, 7-track

Magtape Status

1	100000	Parity Error
2	040000	Runaway Tape
3	020000	CRC Error
4	010000	LRC Error
5	004000	Low DMX Range
6	002000	Permanent Error
7	001000	Read-After-Write (RAW) Error
8	000400	File Mark Detected
9	000200	Ready
10	000100	Online
11	000040	End of Tape Detected
12	000020	Rewinding
13	000010	Beginning of Tape (at Load Point)
14	000004	Tape is Write-Protected
15	000002	DMX Overrun
16	000001	Rewind Complete

(000300 or 000304 - Normal Completion)

PROGRAMMED I/O (PIO)

OCP -- Output Control Pulse

03FFDD FF=Function, DD=Device Address

SKS -- Skip on Condition

13CCDD CC=Condition, DD=Device Address

INA -- Input to A-Register

07FFDD FF=Function, DD=Device Address

No skip for device '20
Always skips if status register input.

OTA -- Output from A=Register

17FFDD FF=Function, DD=Device Address

No skip if device '20.

Standard Functions

FF	OCP	SKS	INA	OTA
00		Ready	Data Reg	
01		Not Busy		
02				
03				
04		Not Interrupting		
05				
06				
07				
10				
11			Input ID	
12	Normal Mode			
13	Diagnostic Mode			
14	Ack Interrupt			DMX Channel
15	Set Int Mask			
16	Reset Int Mask			Int Vect Addr
17	Initialize			

8 PRIMOS IV

ABORT FLAGS

PCB+4, ABSAVE at 6000/10

100000	MINALM	ONE MINUTE ABORT FLAG
040000	SMLALM	SLMC ALARM
020000	NETALM	NETWORK ALARM
004000	WRMALM	WARM START ALARM
000200	MT1ALM	MTDONE, CONTROLLER 1
000100	MT2ALM	MTDONE, CONTROLLER 2
000020	LOGALM	FORCED LOGOUT ALARM
000010	DISALM	DISCONNECT ALARM
000004	TMOALM	TIMEOUT ALARM
000002	QUTALM	QUIT ALARM
000001	TSEALM	TIME SLICE END (FIRMWARE)

COMMONS

*** List of COMMONS ***
to be supplied at next update

ERRVEC

In PUDCOM at 6000/106

ERRVEC(1) ALTVAL
ERRVEC(2) ALTVAL(2)
ERRVEC(3) NAME (0=>NO NAME)
ERRVEC(4) "
ERRVEC(5) "
ERRVEC(6) "
ERRVEC(7) WORD NUMBER OF MSG OR 0
ERRVEC(8) LENGTH (IN CHARS) OF MSG
ERRVEC(9) SEGMENT NUMBER OF MSG

V-mode error messages saved in ERRVEC:

MESSAGE	ERRVEC(1-2)
ACCESS VIOLATION	PB of instr causing violation
ILLEGAL PAGE REF	32-bit ptr into ill page
ILLEGAL SEGNO	32-bit ptr into ill seg
POINTER FAULT	PB of instr causing fault
NO AVAIL SEGMENTS	32-bit ptr to seg that system attempted to create
UNDEFINED GATE	32-bit ptr into gate seg

FIGCOM

Starts at 4/700

LOC	NAME	DFLT	DEFINITION
700	LOUTQM	1000	INACTIVE MINUTES TO AUTO LOGOUT
701	RWLOCK	1	SYSTEM READ/WRITE LOCK: 0 - 1 READER OR 1 WRITER 1 - N READERS OR 1 WRITER 3 - N READERS AND 1 WRITER 5 - N READERS AND N WRITERS
702	DONSTP	0	0=>LOGOUT PHANTOMS ON WARM START 1=>CONTINUE PHANTOMS ON WARM START
703	DLOGOT	0	0=>IGNORE DISCONNECT 1=>FORCE LOGOUT ON DISCONNECT
704	DEFERA	242	DEFAULT ERASE CHARACTER = "
705	DEFKIL	277	DEFAULT KILL CHARACTER = ?
706	PRI500		1=>P500
707	VERSIO		PRIMOS REVISION ID (ASCII)
720	NLGPRT		1=>INHIBIT LOGIN MESSAGES
721	LOGOUT		1=>CAN'T LOGIN WHILE LOGGED IN
722	LRQUOT	10000	LOGREC QUOTA

INTERNAL CALLING SEQUENCES

AINIT VERSIO,MEMSIZ
ALCONF A,B
ALONF BNO
AMINIT --
ASRDIM --
BADDSK DISK (LOG FCN)
BFDEQU BUFCON,NW (FCN)
BFENQU BUFCON,NW
BFGETR BUFCON,NW (FCN)
BFRELS BUFCON
BOOT --
BRPDIM --
BRPONF FLAG
BRPOTA CHAR (LOG FCN)
BUFCHK BNO,NUMCHARS (LOG FCN)
BUFCLR BNO
CE2DIM --
CENDIM --
CGETBK SIZE,ADDR,COND,ALTRTN
CLNLUN USRBLK,LUNADR,STAT
CLOSE$ UNIT
CNFLCT KEY,PDEV (LOG FCN)
COMXIT --
COPYUP --
CRDONF FLAG
DATE$ XXX (FCN)
DELAY A,B,C,ALTRTN
DELBKQ QNM,BKN,ALTRTN
DEMOTE --
DEQUE NUM,ADDR,COUNT,ALTRTN

```
DEVCHK USR    (FCN)
DEVONF DEVNDX,FLAG
DISMSG USRBLK,LUNADR
DOSSUB --
DSKEQV DISKA,DISKB     (LOG FCN)
DUMF   FLAG
ENQUEB NUM,ADDR,COUNT
ENQUET NUM,ADDR,COUNT
ERRST$ LCODE,KEY,TEXT,TXTLEN,MYNAME,MYLEN
EXPNAM INNAME,NAMLEN,OUTNAM
F$HT   CODE
FAMERR --
FAMMSG FUNNO,FAMNO,RA,LOC32(A1),N1,LOC32(A2),N2,
       LOC32(A3),N3,LOC32(A4),N4,LOC32(A5),N5,
       LOC32(A6),N6
FMLIOB BNO,CHAR    (LOG FCN)
FNDLUN USRBLK,LSRCID,LUNADR,ALTRTN
FREEBL --
GCHAR  LOC32(ARRAY),CHARPTR
GET    LOC32(WORD)     (FCN)
GETBLK SIZE,ADDR,ALTRTN
GETCNT SIZE,COUNT
GETLUN USRBLK,SW,LUNADR,ALTRTN
GETRBK ALTRTN
GETREC RA32,DVNO,CODE   (INT*4 FCN)
GETREG TVEC
GETSBK BLKAD
GETSEG USR,SEGNO
GETTBK BLKAD,ALTRTN
GETUBK USRBLK,ALTRTN
GROSS  --
GTSTAT XXX     (FCN)
HCRONF FLAG
HDFILL TGIN,SRCN,TGTU,MSGBLK,LINTAB,NETHDR,FLGW
HPRCN0 FLAG
HPRCN1 FLAG
INETMN --
ININET --
INUSRC --
IPCPTM LINEN
ISPREM A,B,C   (FCN)
ITLBNZ --
LGET   LOC32(WORD)     (INT*4 FCN)
LINTST LINDFN,ALTRTN
LISTF  --
LOCATE KEY,RA32,LDEV
LOCK   KEY,SEMAPHORE     (LOG FCN)
LOCKFS --        (SHORT CALL)
LOCKPG USR,KEY,PTR32,NW
LOGEV1 MSG
LOGEV2 --
LOGIN  KEY,UNAME,NAMLEN,USNAME,LDEV
LSTORE LOC32(WORD),DATA
MAPIO  LOC32(USRBFR),NW,PAGE-MAP-ENTRY   (INT*4 FCN)
MAPNDX USR,SEGNO (FCN)
MISSIN ARG   (LOG FCN)
MISZER ARG   (FCN)
```



```
MODTS  DELTA
MOV32P LOC32(FROM),LOC32(TO),NW
MOVNAM INAME,ILEN,ONAME,OLEN,TRULEN
MOVS2S FRMSEG,LOC16(FROM),TOSEG,LOC16(TO),NW
MOVUTU FRMUSR,FRMSEG,LOC16(FROM),TOUSR,TOSEG,
       LOC16(TO),NW
MPINIT --
MSGOUT KEY,USR,LOC32(BFR)  (FCN)
MTDONE CTRLR-INDEX
NETALM --
NETMAN --
NETMSG FLGW,LUNADR
NETXEC --
NEWDAM DRWP,UNIT,NRAL,CODE
NOTIFY OPTION,SEMAPHORE
OERRTN ALTVAL,ALTRTN,CODE,TEXT,TXTLEN,NAME,NAMLEN
PABORT ABORT-FLAGS
PAGTUR LOC32(VIRTADR)
PHINIT --
PNDNAM SYSN,NETABL,ALTRTN
PRCFP  ABORT-FLAGS
PRIPC  --
PRSMLC --
PRWERR ALTVAL,CODEV
PTRAP  INSTRUCTION
PTRDIM --
PTRINA CHAR    (LOG FCN)
PTRONF FLAG
QCHECK NUM,ELQUED
QTRVRS NUM,BLKN,ADDR,COUNT,ALTRTN
QUITON --            (SHORT CALL)
RMANLZ INST,FT,OP,ACT,DEV
ROUTER RTNGBK,HDROFF,MSGBLK,COUNT
RTNBLK ADDR
RTNREC RA32,DVNO
RTNSEG SEGNO
RUNUSR FAMBLK,NW,ERVEC
SCHAR  LOC32(ARRAY),CPTR,CHAR
SCHED  RESET-VAL [,QUEUE-SEMAPHORE]
SDWNDX USR,SEGNO    (FCN)
SEEK   CYL,DVNO
SEMTN  SEMAPHORE,INT1,INT2,CODE
SEND   USR,LUNADR,ALTRTN
SETABT KEY,USR,ALARM
SETREG TVEC,PARFLG
SHUTDN --
SLABRT LPN
SLCLDB --
SLCONF FLAG
SLERF  KEY
SMLCEX SVCF,LPN
SRWREC KEY,PBAV,NWV,NCH,RA32,DVNO,ALTRTN
STAC   NEWVAL,OLDVAL,VAR     (LOG FCN)
STIMER TENTHS
STORE  LOC32(WORD),DATA
SYSERR --
TlOU   USR,CHAR
```

```
TEXTO$ NAME,NAMLEN,TRULEN,TEXTOK
TEXTOK FNAMEBFR
TIME   USR,TIM
TIME$  XXX     (FCN)
TODEC  USR,NUM,LEAD-CHAR/FIELDWIDTH
TOLIOB BNO,CHAR
TPIOS  KEY,PBA,PN,RA32,ALTRTN
TRNMSG LINTAB,MSGBLK,CNT,MSGVEC
TRUNC$ UNIT,CODE
TRWRAT KEY,LDEV
UMAPIO LOC32(USRBFR),NW
UNLKFS --      (SHORT CALL)
UNLOCK KEY,SEMAPHORE
UPDATE KEY,RA32,LDEV
UPUSR  LOC32(USRADDR),DATA,NWD
VALID  TNAME,NETTAB,ALTRTN,NODE
VGONF  FLAG
VGINIT --
WAIT   SEMAPHORE
WREC   PBA,NW,NCH,CRA32,DVNO,ALTRTN
XEQUSR --
*************************************************
```


LOCKS, LCKCOM

Locks are semaphores used to control access to serially reusable resources. Located in LCKCOM (SEG 4), source file NlLOCK.

*** Addition LOCK Information ***
to be supplied at next update

MMAP (MEMORY MAP)

One entry per physical page of memory.

MMAP + n:

< Ø => Page 'n' unavailable
= Ø => Page 'n' available
> Ø => In use, --> HMAP entry for page

MAXPAG = number pages memory in use.

PAGE MAPS

See under Section on CPU.

PTUSEG

PTUSEG(2,KSEG) (SEG 4)

PTUSEG(1,N) Owner of Page Map N
PTUSEG(2,N) Segment Number for Page Map N

PUDCOM

```
006000  SUPSTK     SN FOR SUPERVISOR STACK
002000  STKSIZ     ONE PAGE OF STACK

000000  PUDCOM SUPFRE(2),SUPEXT(2)

000004  CUSR       1  CURRENT USER NUMBER
000005  LUSR       1  USERCOM INDEX
000006  VRTSSW     1  VIRTUAL SENSE SWITCHES
000007  INHPRF     1  INHIBIT-PROCESS-FAULT COUNTER
000010  ABSAVE     1  SAVED ABORT FLAGS
000011  HILOCK     1  ADR HIGHEST OWNED ORDERED LOCK
000011  LCKOWN
000012  OWNFS      1  NUMBER ORDERED LOCKS OWNED
000013  QUITF      1  QUIT FLAG, INHIBIT COUNT
000014  ASRCWD     1  ASR CONTROLS
000015  ERASCH     1  CHARACTER ERASE CHARACTER
000016  KILLCH     1  LINE DELETE CHARACTER
000017  TKNSAV     1  RDTK$$ SAVEAREA
000020  COMPAR    40  COMMAND LINE INPUT BUFFER
000070  COMSWI     1  COMMAND INPUT SWITCH
000071  COMUNI     1  COMMAND INPUT UNIT
000072  COUSWI     1  COMMAND OUTPUT SWITCH
000073  COUPTR     1  COULIN CHARACTER POINTER
000074  COULIN    10  COMMAND OUTPUT BUFFER
000106  ERRVEC     9  ERRVEC
000117  XSAVE      1  TEMP SAVE FOR X IN FAULT RTES
000120  RVSA       1  START ADDRESS IN RVEC
000121  RVEA       1  END ADDRESS IN RVEC
000122  HMAPPP
000124  BUFNEW
000125  USRETM
000126  SUPSF      START OF FIRST RING 0 STACK FRAME
000130  RVPB       2  PBH AND PBL
000136  RVKEYS     1  KEYS
000137  RVPBCL     1  LOC(PCL)+2 ON RING 0 PCL ENTRY
000143  RVEC      29  REGISTER SAVEAREA
000143  RVMASK     1  SAVE MASK IN RVEC
000172  PUDEND     END OF PUDCOM
```


SEGMENT USAGE BY PRIMOS

SEGMENT	CONTENTS
0	LOC '61 (OPTION-A memory increment cell) DMC channels for AMLC, SMLC, MAG TAPE AMLC buffers DISK driver (DVDISK) Disk I/O windows (4 pages) Mag tape I/O windows (6 pages) Mag tape dump window (1 page) IPC I/O window (2 pages) SMLC I/O windows (12 pages)
1	Associative bfrs for file system (64 pages)
2,3	MOVU2U segment windows
4	Interrupt catchers (phantoms) Check catchers Semaphores Ready PCB list (loc '600) Configuration common (FIGCOM) (loc '700) Crash 9 trk magtape dump program (loc '776) Memory parity scanner (loc '777) WARM restart routine (loc '1000) COLD start routine (loc '1400) Memory usage map (MMAP) Page maps (HMAP, LMAP) Segment tables Process control blocks (PCBs) Interrupt fault table Interrupt stack
5	Gate segment for direct-entrance PCLs
6	TMAIN, including: Supervisor and user fault catchers SVC front-ends Supervisor locked data (SUPCOM) Clock process Kernel procedures
7	User terminal buffers
10	Per-user unlocked data (USRCOM)
11	File system procedures
12	Network data and procedures SMLC data and procedures
6000	Ring 0 stack segment (one per user)

SEMAPHORES (SEMCOM)

*** Refer to SEMAPHORES in Section II ***

*** Addition SEMAPHORE Information ***
to be supplied in next update

SVC INTERLUDE

```
ENTRY DAC    **
      SVC
      OCT    CODE
 1    100000 1 => interlude call
 2    040000 1 => bounce
3-4   030000 Unused
5-16  00**** SVC number
```

USRCOM

```
SEG 10/(USRNO-1)*'505 ...

+1   UNITAB:      0 ≤ UNIT ≤ '21
        +UNIT*17 +0  VSTAT
                 +1  VBRA(2)
                 +3  VDVNO
                 +4  VDCRA(2)
                 +6  VDRWP
                 +10 VCRA(2)
                 +12 VRWP
                 +13 VPRIV
                 +14 VPOPRA(2)
                 +16 VPOPRW
+417 CUFD:
     +0  CURRENT UFD NAME
     +20 CFDBRA(2)
     +22 CFDDEV
     +23 CFDPOP(2)
     +25 CFDOWN
     +26 CFDLEN
     +27 CFDPRA(2)
     +31 CFDPRW

+451 HOMUFD:
     +0  HOME UFD NAME
     +20 HOMBRA(2)
     +22 HOMDEV
     +23 HOMPOP(2)
     +25 HOMOWN
     +26 HOMLEN
     +27 HOMPRA(2)
     +31 HOMPRW

+503 LOGNAM(3)
```


VQUTM

1	1 MIN.	1 MINUTE (UPDATE, LOGEV2, ETC.)
2	16.5 MSEC	PUNCH DIM
3	--	DIGITAL INPUT
4	112 MSEC	ASR DIM
5	100 MSEC	TENTH SECOND (STIMER QUEUES)
6	--	UNUSED
7	--	UNUSED
8	--	UNUSED
9	--	UNUSED
10	1/2 SEC	SMLCEX ALARM
11	10 SEC	NETWORK GROSS TIMER
12	1 SEC	IPC PROTOCOL TIMER
13	1/2 SEC	REMOTE USER POLL

9 SVC INFORMATION

SVC CALLING SEQUENCES

* => Also Direct Entrance Call.

ATCH$$ -- Attach to UFD

```
CALL ATCH$$ (UFDNAM, NAMLEN, LDISK, PASSWD,
             KEY, CODE)                          (*1500)

CALL ATTAC$ (UFDNAM, NAMLEN, LDISK, PASSWD,
             KEY, LOC(CODE))                     (1400)

CALL ATTACH (UFDNAM, LDISK, PASSWD, KEY,
             ALTRTN)                             (0100)
```

```
             ****** KEY    ******
K$IMFD = :0         UFD IS IN MFD
K$ICUR = :2         UFD IS IN CURRENT UFD
             ****** KEYMOD ******
K$SETC = :0         SET CURRENT UFD (DO NOT SET HOME)
K$SETH = :1         SET HOME UFD (AS WELL AS CURRENT)
             ****** UFDNAM ******
K$HOME = :0         RETURN TO HOME UFD (KEY=K$IMFD)
             ****** LDISK  ******
K$ALLD = :100000    SEARCH ALL DISKS
K$CURR = :177777    SEARCH MFD OF CURRENT DISK
```

```
             ****** CODES  ******
             E$NATT         E$MTUD
             E$FMTF         E$DISK
             E$PTRM         E$BPAS
             E$BKEY         E$BUFD
```

BREAK$ -- Disable/Enable Quits

```
CALL BREAK$ (KEY)                                (*0507)
```

```
            ****** KEY    ******
              = :0    INHIBITS QUITS
              = :1    ENABLE QUITS
```


ClIN -- Read Character from Command Stream

```
CALL ClIN (CHAR)                                 (*0601)
```

CMREAD -- Read Last Command Line

```
CALL CMREAD (BUFF(18))                           (0602)

BUFF(1-3)    First name or blanks
BUFF(4-6)    Second name or blanks
BUFF(7-9)    Third name or blanks
BUFF(10)     First octal parameter or 0
  ...
BUFF(18)     Ninth octal parameter or 0
```

CNAM$$ -- Change a Filename

```
CALL CNAM$$ (OLDNAM, OLDLEN, NEWNAM, NEWLEN,
             CODE)                               (*1515)

CALL CNAME$ (OLDNAM, OLDLEN, NEWNAM, NEWLEN,
             LOC(CODE))                          (1415)

CALL CNAME (OLDNAM, NEWNAM, ALTRTN)              (0113)
```

```
             ****** CODES  ******
             E$BNAM         E$FNTF
             E$BUFD         E$IREM
             E$EOF          E$NRIT
             E$EXST
```

CNIN$ -- Raw Data Input from Command Stream

```
CALL CNIN$ (BUFF, CHARCNT, STATV(3))             (*0604)
```

COMANL -- Read Command Line

```
CALL COMANL                                      (*0600)
```

COMI$$ -- Switch Command Input Stream

```
CALL COMI$$ (FILNAM, NAMLEN, UNIT, CODE)          (*1516)

CALL COMIN$ (FILNAM, NAMLEN, UNIT, LOC(CODE))     (1416)

CALL COMINP (FILNAM, UNIT, ALTRTN)                (0603)
```

****** CODES ******

E$BDAM	E$NATT
E$BUFD	E$NRIT
E$DIRE	E$PTRM
E$FIUS	E$UIUS
E$FNTF	E$UNOP

COMO$$ -- Control Routing of Terminal Output

```
CALL COMO$$ (KEY, FILNAM, NAMLEN, 0, CODE)        (*1523)
```

****** KEY ******

:1	TURN TTY OUTPUT OFF
:2	TURN TTY OUTPUT ON
:4	(RESERVED)
:10	TURN FILE OUTPUT OFF
:20	TURN FILE OUTPUT ON
:40	APPEND IF TURNING ON, CLOSE IF TURNING OFF
:100	TRUNCATE IF TURNING ON

****** CODES ******

E$EOF

CONECT -- Connect Logical Unit Number

```
CALL CONECT (TGTNAM, TGTUSR, LUN, DATA, STATV,
             LINTYP)                              (0401)
```


CREA$$ -- Create New UFD in Current UFD

```
CALL CREA$$ (UFDNAM, NAMLEN, OPASS, NPASS,
             CODE)                                (*1501)

CALL CREAT$ (UFDNAM, NAMLEN, OPASS, NPASS,
             LOC(CODE))                           (1401)
```

****** CODES ******

E$NATT	E$DKFL
E$BNAM	E$EXST
E$DISK	E$PTRM
E$BUFD	

E$UIUS (bounce package only)
E$FIUS (bounce package only)
E$FDFL (old partition only)

D$INIT -- Initialize Disk Devices

```
CALL D$INIT (PDEV)                                (0506)
```

DISCON -- Disconnect Logical Unit Number

```
CALL DISCON (LUN, DATA, STATV)                    (0410)
```

DUPLX$ -- Set/Return Terminal Characteristics

```
Integer = DUPLX$ (LWORD)
```

LWORD Contents:

bit		Meaning when on
1	100000	Half duplex
2	040000	No LF after CR
3	020000	XOFF/XON Recognition
4	010000	XOFF Received
5-8	007400	Reserved
9-10	000377	user number

LWORD = -1 => no update of LWORD.
Integer set to new LWORD setting.

ERKL$$ -- Read/Set Kill and Erase Character

```
CALL ERKL$$ (KEY, ERASEC, KILLC, CODE)          (*1524)

            ****** KEYS   ******
                see COMO$$

            ****** CODES  ******
                  E$BKEY
                  E$BPAR
```

ERRPR$ -- Print Standard System Error Messages

```
CALL ERRPR$ (KEY, CODE, TEXT, TXTLEN, NAME,
             NAMLEN)                            (*1402)

            ****** KEY    ******
      K$NRTN = :0   NEVER RETURN TO USER
      K$SRTN = :1   RETURN AFTER START COMMAND
      K$IRTN = :2   IMMEDIATE RETURN TO USER

            ****** CODES  ******
                  E$EOF
                  E$LAST
```

ERRRTN -- Return Error Code

```
CALL ERRRTN (ALTRTN, NAME, MSG, MSGLEN)         (0106)
```

ERRSET -- Handle Error Messages

```
CALL ERRSET (ALTVAL, ALTRTN, NAME, MSG,
             MSGLEN)                            (0114)
```

EXIT -- Return to PRIMOS Command Level

```
CALL EXIT                                       (*0105)
```

FAMSVC -- (Called by FAM only)

```
CALL FAMSVC (A1, A2, A3, A4, A5, A6, ALTRTN)    (0400)
```


FORCEW -- Update Runit to Disk

```
CALL FORCEW (KEY, UNIT)                         (*0115)
```

GETCON -- Get Pending Connect Information

```
CALL GETCON (TARGET, USER, DATA, STATV)         (0402)
```

GETERR -- Get Error Messages

```
CALL GETERR (BUFF, NW)                          (0110)
```

GETERR is used after a return from PRWFIL:

On an alternate return:		On a normal return:
ERRVEC(1)	Error code	PRWFIL: ERRVEC(3) Record number ERRVEC(4) Word number
ERRVEC(2)	Alternate value	Key of read/write convenient: ERRVEC(2) No. of words transferred SEARCH: ERRVEC(2) File type

GINFO -- Return Operating System Information

```
CALL GINFO (BUFF, NW)
```

Return infomation for PRIMOS II:

BUFF(1)	Low bound of PRIMOS II and buffers (77777 octal if 64K PRIMOS II).
2	High bound of PRIMOS II (77777 octal if 64K PRIMOS II).
3	(not valid)
4	(not valid)
5	Low bound of PRIMOS II and buffer (64K PRIMOS II only).
6	High bound of 64K PRIMOS II.

Returned information for PrIMOS III, IV, and V:

xervec word	content
1	0
2	0
3-6	(not valid)

GPAS$$ -- Obtain UFD Passwords

```
CALL GPAS$$ (UFDNAM, NAMLEN, OPASS, NPASS,
             CODE)                                  (*1504)

CALL GPASS$ (UFDNAM, NAMLEN, OPASS, NPASS,
             CODE)                                  (1404)
```

```
             ****** CODES  ******
             E$NATT        E$NTUD
             E$FNTF        E$DISK
             E$PTRM        E$BUFD
             E$UIUS (bounce package only)
             E$FIUS (bounce package only)
```

NETLNK --

```
CALL NETLNK (STATV)                                 (0412)
```

NETWAT -- Put User to Sleep

```
CALL NETWAT                                         (0406)
```

NTSTAT -- Get Network Status

```
CALL NTSTAT (KEY, P1, P2, ARRAY)                    (0407)
```

PRERR -- Prints Error Messages

```
CALL PRERR                                          (0111)
```


PRWF$$ -- Read-Write-Position SAM/DAM File

```
CALL PRWF$$ (KEY, FUNIT, LOC(BUFF), BUFLEN,
             POS32, RNW, CODE)                      (*1506)

CALL PRWFL$ (KEY, UNIT, LOC(BUFF), NW, POS,
             RNW, LOC(CODE))                        (1406)

CALL PRWFIL (KEY, UNIT, LOC (BUFF), NW, POS,
             ALTRIN)                                (0300)
```

KEY = RWKEY + POSKEY + MODE

```
             ****** RWKEY  ******
K$READ = :1          READ
K$WRIT = :2          WRITE
K$POSN = :3          POSITION ONLY
K$TRNC = :4          TRUNCATE
K$RPOS = :5          READ CURRENT POSITION
             ****** POSKEY ******
K$PRER = :0          PRE-POSITION RELATIVE
K$PREA = :10         PRE-POSITION ABSOLUTE
K$POSR = :20         POST-POSITION RELATIVE
K$POSA = :30         POST-POSITION ABSOLUTE
             ****** MODE   ******
K$CONV = :400        CONVENIENT NUMBER OF WORDS
```

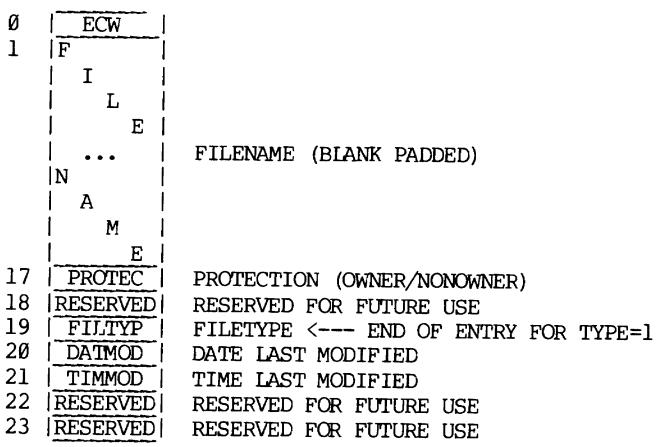
```
             ****** CODES  ******
             E$EOF         E$NOF
             E$UNOP        E$DKFL
             E$DISK        E$PTRM
             E$BUNT        E$BOF
             E$IREM        E$NTUD
             E$NTSD
```

RDEN$$ -- Read UFD Entry

```
CALL RDEN$$ (KEY, FUNIT, BUFF, BUFLEN, RNW,
             NAM32, NAMLN, CODE)                (*1507)

CALL RDENT$ (KEY, UNIT, BUFF, BUFLEN, RNW,
             NAME32, NAMELEN, LOC(CODE))        (1407)
```

Entry Format:



DATMOD = YYYYYYYMMMMDDDDD where:
YYYYYYY is the year module 100
MMMM is the month
DDDDD is the day

DATMOD is held in binary seconds-since-midnight divided by 4.

```
            ****** KEY    ******
K$READ = :1         READ NEXT ENTRY
K$RSUB = :2         READ NEXT SUB-ENTRY
K$GPOS = :3         RETURN CURRENT POSITION IN UFD
K$UPOS = :4         POSITION IN UFD
K$NAME = :5         READ ENTRY SPECIFIED BY NAME

            ****** CODES  ******
            E$EOF         E$NOF
            E$UNOP        E$DISK
            E$PTRM        E$BKEY
            E$BUNT        E$BUFD
            E$BFTS
```


RDLIN$ -- Read Line of Characters from ASCII File

```
CALL RDLIN$ (UNIT, LINE, NW, CODE)              (*1525)
                                                 1506)
CALL RDLIN (UNIT, LINE, NW, ALTRIN)             (0202)
                                                 406)
```

RDTK$$ -- Read Token from Command Line

```
                                                 300)
CALL RDTK$$ (KEY, INFO(8), BUFF, BUFLEN,
             CODE)                              (*1517)

CALL RDTKN$ (KEY, INFO(8), BUFF, BUFLEN,
             LOC(CODE))                         (1417)
```

INFO(1):
1 normal token
2 register setting parameter
5 null token
6 end of line

INFO(2): len in chars of token; null = 0 len

INFO(3): further info about token --

bit 1 (:100000)	dec conversion successful, value returned in INFO(4).
bit 2 (:040000)	oct conversion successful, value returned in INFO(5). This bit always set when token type is 2.
bit 3 (:020000)	token begins with unquoted minus sign.
bit 4 (:010000)	explicit postion for register setting given, value returned in INFO(4).
bits 5 - 16:	reserved for future use.

INFO(4): depend on flags set in INFO(3)

INFO(5): depend on flags in INFO(3)

INFO(6) - INFO(8): reserved for future use

```
            ****** CODES  ******
                   E$BKEY
                   E$BPAR
                   E$BFTS
```

RECEIV -- Receive Message from Remote System

```
CALL RECEIV (LUN, LOC(BUFF), NW, STATV)        (0404)
```

RECYCL -- Cycle to Next User

```
CALL RECYCL                                    (*0505)
```

REST$$ -- Restore Memory Image from File

```
CALL REST$$ (RVEC, NAME, NAMLEN, CODE)         (*1520)

CALL RESTO$ (RVEC, NAME, NAMLEN, LOC(CODE))    (1420)

CALL RESTOR (RVEC, NAME, ALTRTN)               (0103)

            ****** CODES  ******
               see SRCH$$
```

RESU$$ -- Resume Memory Image from File

```
CALL RESU$$ (NAME, NAMLEN)                     (*1521)

CALL RESUM$ (NAME, NAMLEN)                     (1420)

CALL RESUME (NAME)                             (0104)

            ****** CODES  ******
               see SRCH$$
```

RJCON -- Reject Pending Connect

```
CALL RJCON (TARGET, USER, STATV, NUMTYP)       (0403)
```

RREC -- Read Record From Disk to Memory

```
CALL RREC (LOC(BUFF), BUFLEN, N, RA, PDEV,
           ALTRTN)                             (0500)

CALL RRECL (LOC(BUFF), BUFLEN, N, RA32, PDEV,
            ALTRTN)                            (0516)
```


SATR$$ -- Set Attributes in UFD Entry

```
CALL SATR$$ (KEY, NAME, NAMLEN, ARRAY, CODE)   (*1510)
                                                    506)
CALL SATTR$ (KEY, NAME, NAMLEN, ARRAY,
             LOC(CODE))                        (1410)
                                                    06)

             ****** KEY    ******
K$PROT = :1         SET PROTECTION                  00)
K$DTIM = :2         SET DATE/TIME MODIFIED
K$DMPB = :3         SET DUMPED BIT
K$RWLK = :4         SET PER FILE READ/WRITE LOCK


             ****** CODES  ******
             E$NATT         E$FNTF
             E$DISK         E$PTRM
             E$BKEY         E$BUFD
             E$UIUS (bounce package only)
             E$FIUS (bounce package only)
             E$OLDP (old partition only)
```

SAVE$$ -- Save P300 Memory Image as a File

```
CALL SAVE$$ (RVEC, NAME, NAMLEN, CODE)         (*1522)

CALL SAVE$ (RVEC, NAME, NAMLEN, LOC(CODE))     (1422)

CALL SAVE (RVEC, NAME)                         (0102)
```

SEM$DR -- Drain Semaphore

```
CALL SEM$DR (SEMNUM, CODE)                     (* --)

            ****** CODES  ******
                   E$BPAR
```

SEM$NF -- Notify User Semaphore

```
CALL SEM$NF (SEMNUM, CODE)                     (* --)

            ****** CODES  ******
                   E$BPAR
                   E$SEMO
```

SEM$TN -- Setup Semaphore for Timed Notifies

```
CALL SEM$TN (SEMNUM, INT32, INT32, CODE)        (* —)

            ****** CODES  ******
                   E$BPAR
                   E$NTIM
```

SEM$TS -- Obtain Current Semaphore Value

```
CALL SEM$TS (SEMNUM, CODE (INT FCN))            (* —)

            ****** CODES  ******
                   E$BPAR
```

SEM$WT -- Wait on User Semaphore

```
CALL SEM$WT (SEMNUM, CODE)                      (* —)

            ****** CODES  ******
                   E$BPAR
```

SGDR$$ -- Position and Read Segment Directory Entries

```
CALL SGDR$$ (KEY, FUNIT, ENTRYA, ENTRYB,
             CODE)                              (*1512)

CALL SEGDR$ (KEY, UNIT, ENTRYA, ENTRYB,
             LOC(CODE))                         (1412)

            ****** KEY    ******
K$SPOS = :1        POSITION TO ENTRY NUM IN SEGDIR
K$GOND = :2        POSITION TO END OF SEGDIR
K$GPOS = :3        RETURN CURRENT ENTRY NUMBER
K$MSIZ = :4        MAKE SEGDIR GIVEN NR OF ENTRIES
K$MVNT = :5        MOVE FILE ENTRY TO DIFFERENT
K$FULL = :6        RETURN NEXT NONEMPTY ENTRY
k$FREE = :7        RETURN NEXT FREE ENTRY
                   POSITION
```


SLEEP$ -- Suspend Execution

```
CALL SLEEP$ (INT32)                             (* --)
```

06)

```
INT32 = number of milliseconds to delay
```

6)

SPAS$$ -- Set UFD Passwords

Ø)

```
CALL SPAS$$ (OPASS, NPASS, CODE)                (*1513)

CALL SPASS$ (OPASS, NPASS, LOC(CODE))           (1413)

            ****** CODES  ******
E$EOF              E$NOF
E$UNOP             E$DKFL
E$NRIT             E$FNTS
E$EXST             E$DISK
E$PTRM             E$BKEY
E$BUNT
```

SRCH$$ -- Open or Close a File

```
CALL SRCH$$ (KEY, NAME, NAMLEN, UNIT, TYPE,
             CODE)                              (*1511)

CALL SEARC$ (KEY, NAME, NAMLEN, UNIT, TYPE,
             LOC(CODE))                         (1411)

CALL SEARCH (KEY, NAME, UNIT, ALTRIN)           (Ø1Ø1)

     KEY = ACTION + REF+ NEWFIL


            ****** ACTION ******
K$READ = :1        OPEN FOR READ
K$WRIT = :2        OPEN FOR WRITE
K$RDWR = :3        OPEN FOR READING AND WRITING
K$CLOS = :4        CLOSE FILE UNIT
K$DELE = :5        DELETE FILE
K$EXST = :6        CHECK FILE'S EXISTENCE
            ****** REF    ******
K$IUFD = :Ø        FILE ENTRY IN UFD
K$ISEG = :1ØØ      FILE ENTRY IN SEGMENT DIRECTORY
K$CACC = :1ØØØ     CHANGE ACCESS
            ****** NEWFIL ******
K$NSAM = :Ø        NEW SAM FILE
K$NDAM = :2ØØØ     NEW DAM FILE
K$NSGS = :4ØØØ     NEW SAM SEGMENT DIRECTORY
K$NSGD = :6ØØØ     NEW DAM SEGMENT DIRECTORY
K$CURR = :177777   CURRENTLY ATTACHED UFD
```

****** CODES ******

E$NATT	E$DKFL	E$NRIT
E$FDEL	E$NTUD	E$NTSD
E$FNTF	E$BNAM	E$DNTE
E$DISK	E$BDAM	E$PTRM
E$BKEY	E$BUNT	E$BSUN
E$SUNO	E$BUFD	

E$UNOP (for K$CACC KEY only)
E$UIUS (not for E$EXST KEY)
E$FDFL (old partition only)
E$FIUS (not for E$EXST KEY)

T$AMLC -- AMLC Reveive/Transmit

```
CALL T$AMLC (LINE, LOC(BUFF), NW, INST,
             STATV)                          (*0513)
```

T$CMPC -- Move Card of Info to User's Space

```
CALL T$CMPC (UNIT, LOC(BUFF), NW, INST,
             STATV)                          (*0512)
```

T$LMPC -- Print Data

```
CALL T$LMPC (UNIT, LOC(BUFF), NW, INST,
             STATV)                          (*0511)
```

T$PMPC -- Punch Data

```
CALL T$PMPC (UNIT, LOC(BUFF), NW, INST,
             STATV)                          (*0515)
```

T$MT -- Move Raw Data from Magtape

```
CALL T$MT (UNIT, LOC(BUFF), NW, INST, STATV)  (*0510)
```

T$VG -- Print Data on Versatec Printer

```
CALL T$VG (UNIT, LOC(BUFF), NW, INST, STATV)  (*0514)
```


T$SLC -- Performs I/O Over SMLC Lines

```
CALL T$SLC (KEY, LINE, LOC(BUFF), NW)          (1001)
```

06)

TIMDAT --

6)

```
CALL TIMDAT (BUFF, BUFLEN)                     (*0502)
```

0)

TIMDAT returns information in BUFF as follows:

BUFF(1)	Two ASCII characters representing month
(2)	Two ASCII characters representing day.
(3)	Two ASCII characters representing year.
(4)	Integer time in minutes since midnight.
(5)	Integer time in seconds.
(6)	Integer time in ticks.
(7)	Integer CPU time used in seconds.
(8)	Integer CPU time used in ticks.
(9)	Integer disk I/O time used in seconds.
(10)	Integer disk I/O time used in ticks.
(11)	Integer number of ticks per second.
(12)	user number.
(13)	6-character login name, left justified.
(14)	
(15)	

TNOU -- Output CHARCNT Chars with CR and LF

```
CALL TNOU (MSG, CHARCNT)                       (*0702)
```

TNOUA -- Output CHARCNT Characters

```
CALL TNOUA (MSG, CHARCNT)                      (*0703)
```

TRNMIT -- Transmit Message to a Remote Machine

```
CALL TRNMIT (LUN, LOC(BUFF), CNT, STATV)       (0405)
```

UNLINK -- Disconnect All Logical Unit Numbers

```
CALL UNLINK                                    (0411)
```

WREC -- Write Record from Memory to Disk

```
CALL WREC (LOC(BUFF), BUFLEN, NW, RA, PDEV,
           ALTRTN)                                  (0501)

CALL WRECL (LOC(BUFF), BUFLEN, NW, RA32, PDEV,
            ALTRTN)                                 (0517
```

WTLIN$ --

```
CALL WTLIN$ (UNIT, LINE, NW, CODE)                  (*1526)

CALL WTLIN (UNIT, LINE, NW, ALTRTN)                 (0203)
```


SVC NUMBERS

* => PCLable

* --	SEM$DR	*0600	COMANL	06)
* --	SEM$NF	*0601	C1IN	
* --	SEM$TN	0602	CMREAD	
* --	SEM$TS	0603	COMINP	6)
* --	SEM$WT	*0604	CNIN$	
* --	SLEEP$			
		*0702	TNOU	0)
0100	ATTACH	*0703	TNOUA	
0101	SEARCH	*0705	DUPLX$	
0102	SAVE			
0103	RESTOR	1001	T$SLC	
0104	RESUME			
*0105	EXIT	1400	ATTAC$	
0106	ERRRTN	1401	CREAT$	
0110	GETERR	*1402	ERRPR$	
0111	PRERR	1404	GPASS$	
0112	GINFO	1406	PRWFL$	
0113	CNAME	1407	RDENT$	
0114	ERRSET	1410	SATTR$	
*0115	FORCEW	1411	SEARC$	
		1412	SEGDR$	
0202	RDLIN	1413	SPASS$	
0203	WTLIN	1415	CNAME$	
		1416	COMIN$	
0300	PWRFIL	1417	RDTKN$	
		1420	RESTO$	
0400	FAMSVC	1421	RESUM$	
0401	CONECT	1422	SAVE$	
0402	GETCON			
0403	RJCON	*1500	ATCH$$	
0404	RECEIV	*1501	CREA$$	
0405	TRNMIT	*1504	GPAS$$	
0406	NETWAT	*1506	PRWF$$	
0407	NTSTAT	*1507	RDEN$$	
0410	DISCON	*1510	SATR$$	
0411	UNLINK	*1511	SRCH$$	
0412	NETLNK	*1512	SGDR$$	
		*1513	SPAS$$	
0500	RREC	*1515	CNAM$$	
0501	WREC	*1516	COMI$$	
*0502	TIMDAT	*1517	RDTK$$	
*0505	RECYCL	*1520	REST$$	
0506	D$INIT	*1521	RESU$$	
*0507	BREAK$	*1522	SAVE$$	
*0510	T$MT	*1523	COMO$$	
*0511	T$LMPC	*1524	ERKL$$	
*0512	T$CMPC	*1525	RDLIN$	
*0513	T$AMLC	*1526	WTLIN$	
*0514	T$VG			
*0515	T$PMPC			
0516	RRECL			
0517	WRECL			

ERROR MESSAGES AND CODES (SYSCOM>ERRD.F)

E$EOF= 1	END OF FILE	PE
E$BOF= 2	BEGINNING OF FILE	PG
E$UNOP= 3	UNIT NOT OPEN	PD,SD
E$UIUS= 4	UNIT IN USE	SI
E$FIUS= 5	FILE IN USE	SI
E$BPAR= 6	BAD PARAMETER	SA
E$NATT= 7	NO UFD ATTACHED	SL,AL
E$FDFL= 8	UFD FULL	SK
E$DKFL= 9	DISK FULL	DJ
E$NRIT=10	NO RIGHT	SX
E$FDEL=11	FILE OPEN ON DELETE	SD
E$NTUD=12	NOT A UFD	AR
E$NTSD=13	NOT A SEGDIR	--
E$DIRE=14	IS A DIRECTORY	--
E$FNTF=15	(FILE) NOT FOUND	SH,AH
E$FNTS=16	(FILE) NOT FOUND IN SEGDIR	SQ
E$BNAM=17	ILLEGAL NAME	CA
E$EXST=18	ALREADY EXISTS	CZ
E$DNTE=19	DIRECTORY NOT EMPTY	--
E$SHUT=20	BAD SHUTDN (FAM ONLY)	BS
E$DISK=21	DISK I/O ERROR	WB
E$BDAM=22	BAD DAM FILE (FAM ONLY)	SS
E$PTRM=23	PTR MISMATCH (FAM ONLY)	PC,DC,AC
E$BPAS=24	BAD PASSWORD (FAM ONLY)	AN
E$BCOD=25	BAD CODE IN ERRVEC	--
E$BTRN=26	BAD TRUNCATE OF SEGDIR	--
E$OLDP=27	OLD PARTITION	--
E$BKEY=28	BAD KEY	--
E$BUNT=29	BAD UNIT NUMBER	--
E$BSUN=30	BAD SEGDIR UNIT	SA
E$SUNO=31	SEGDIR UNIT NOT OPEN	--
E$NMLG=32	NAME TOO LONG	--
E$SDER=33	SEGDIR ERROR	SQ
E$BUFD=34	BAD UFD	--
E$BFTS=35	BUFFER TOO SMALL	--
E$FITB=36	FILE TOO BIG	--
E$NULL=37	(NULL MESSAGE)	--
E$IREM=38	ILL REMOTE REF	--
E$DVIU=39	DEVICE IN USE	--
E$RLDN=40	REMOTE LINE DOWN	--
E$FUIU=41	ALL REMOTE UNITS IN USE	--
E$DNS=42	DEVICE NOT STARTED	--
E$TMUL=43	TOO MANY UFD LEVELS	--
E$FBST=44	FAM - BAD STARTUP	--
E$BSGN=45	BAD SEGMENT NUMBER	--
E$FIFC=46	INVALID FAM FUNCTION CODE	--
E$TMRU=47	MAX REMOTE USERS EXCEEDED	--
E$NASS=48	DEVICE NOT ASSIGNED	--
E$BFSV=49	BAD FAM SVC	--
E$SEMO=50	SEM OVERFLOW	--
E$NTIM=51	NO TIMER	--
E$FABT=52	FAM ABORT	--
E$FONC=53	FAM OP NOT COMPLETE	--

10 APPENDICES

ASCII CHARACTER SET

F => Valid file name char
R => Rsrved cmd line char
^ => ctrl key depressed

8-Bit Octal Code	Char		Code in Left Byte	8-Bit Octal Code	Char	Code in Left Byte
200	NUL		1000	240	Sp	1200
201	SOH	^A	1004	241	!	1204 R
202	STX	^B	1010	242	"	1210 R
203	ETX	^C	1014	243	#	1214 F
204	EOT	^D	1020	244	$	1220 F
205	ENQ	^E	1024	245	%	1224 R
206	ACK	^F	1030	246	&	1230 FR
207	BEL	^G	1034	247	'	1234 R
210	BS	^H	1040	250	(	1240 R
211	HT	^I	1044	251	)	1244 R
212	NL	^J	1050	252	*	1250 F
213	VT	^K	1054	253	+	1254
214	FF	^L	1060	254	,	1260 R
215	CR	^M	1064	255	-	1264 FR
216	RRS	^N	1070	256	.	1270 F
217	BRS	^O	1074	257	/	1274 F
220	RCP	^P	1100	260	0	1300 F
221	RHT	^Q	1104	261	1	1304 F
222	HLF	^R	1110	262	2	1310 F
223	RVT	^S	1114	263	3	1314 F
224	HLR	^T	1120	264	4	1320 F
225	NAK	^U	1124	265	5	1324 F
226	SYN	^V	1130	266	6	1330 F
227	ETB	^W	1134	267	7	1334 F
230	CAN	^X	1140	270	8	1340 F
231	EM	^Y	1144	271	9	1344 F
232	SUB	^Z	1150	272	:	1350 R
233	ESC	^UP-K	1154	273	;	1354 R
234	FS	^UP-L	1160	274	<	1360
235	GS	^UP-M	1164	275	=	1364 R
236	RS	^UP-N	1170	276	>	1370
237	US	^UP-O	1174	277	?	1374

8-Bit Octal Code	Char	Code in Left Byte	8-Bit Octal Code	Char	Code in Left Byte
300		1400 R	340		1600 R
301	A	1404 F	341	a	1604
302	B	1410 F	342	b	1610
303	C	1414 F	343	c	1614
304	D	1420 F	344	d	1620
305	E	1424 F	345	e	1624
306	F	1430 F	346	f	1630
307	G	1434 F	347	g	1634
310	H	1440 F	350	h	1640
311	I	1444 F	351	i	1644
312	J	1450 F	352	j	1650
313	K	1454 F	353	k	1654
314	L	1460 F	354	l	1660
315	M	1464 F	355	m	1664
316	N	1470 F	356	n	1670
317	O	1474 F	357	o	1674
320	P	1500 F	360	p	1700
321	Q	1504 F	361	q	1704
322	R	1510 F	362	r	1710
323	S	1514 F	363	s	1714
324	T	1520 F	364	t	1720
325	U	1524 F	365	u	1724
326	V	1530 F	366	v	1730
327	W	1534 F	367	w	1734
330	X	1540 F	370	x	1740
331	Y	1544 F	371	y	1744
332	Z	1550 F	372	z	1750
333	[	1554 R	373	{	1754 R
334	\	1560 R	374	|	1760
335	]	1564 R	375	}	1764 R
336	^	1570 R	376	~	1770 R
337	_	1574 F	377	DEL	1774

CONVERSION TABLES

OCTAL DECIMAL CONVERSION TABLE

Ø	Ø	1	2	3	4	5	6	7
10	8	9	10	11	12	13	14	15
20	16	17	18	19	20	21	22	23
30	24	25	26	27	28	29	30	31
40	32	33	34	35	36	37	38	39
50	40	41	42	43	44	45	46	47
60	48	49	50	51	52	53	54	55
70	56	57	58	59	60	61	62	63
100	64	65	66	67	68	69	70	71
110	72	73	74	75	76	77	78	79
120	80	81	82	83	84	85	86	87
130	88	89	90	91	92	93	94	95
140	96	97	98	99	100	101	102	103
150	104	105	106	107	108	109	110	111
160	112	113	114	115	116	117	118	119
170	120	121	122	123	124	125	126	127
200	128	129	130	131	132	133	134	135
210	136	137	138	139	140	141	142	143
220	144	145	146	147	148	149	150	151
230	152	153	154	155	156	157	158	159
240	160	161	162	163	164	165	166	167
250	168	169	170	171	172	173	174	175
260	176	177	178	179	180	181	182	183
270	184	185	186	187	188	189	190	191
300	192	193	194	195	196	197	198	199
310	200	201	202	203	204	205	206	207
320	208	209	210	211	212	213	214	215
330	216	217	218	219	220	221	222	223
340	224	225	226	227	228	229	230	231
350	232	233	234	235	236	237	238	239
360	240	241	242	243	244	245	246	247
370	248	249	250	251	252	253	254	255
400	256	257	258	259	260	261	262	263
410	264	265	266	267	268	269	270	271
420	272	273	274	275	276	277	278	279
430	280	281	282	283	284	285	286	287
440	288	289	290	291	292	293	294	295
450	296	297	298	299	300	301	302	303
460	304	305	306	307	308	309	310	311
470	312	313	314	315	316	317	318	319
500	320	321	322	323	324	325	326	327
510	328	329	330	331	332	333	334	335
520	336	337	338	339	340	341	342	343
530	344	345	346	347	348	349	350	351
540	352	353	354	355	356	357	358	359

Ø	Ø	1	2	3	4	5	6	7
550	360	361	362	363	364	365	366	367
560	368	369	370	371	372	373	374	375
570	376	377	378	379	380	381	382	383
600	384	385	386	387	388	389	390	391
610	392	393	394	395	396	397	398	399
620	400	401	402	403	404	405	406	407
630	408	409	410	411	412	413	414	415
640	416	417	418	419	420	421	422	423
650	424	425	426	427	428	429	430	431
660	432	433	434	435	436	437	438	439
670	440	441	442	443	444	445	446	447
700	448	449	450	451	452	453	454	455
710	456	457	458	459	460	461	462	463
720	464	465	466	467	468	469	470	471
730	472	473	474	475	476	477	478	479
740	480	481	482	483	484	485	486	487
750	488	489	490	491	492	493	494	495
760	496	497	498	499	500	501	502	503
770	504	505	506	507	508	509	510	511
1000	512	513	514	515	516	517	518	519
1010	520	521	522	523	524	525	526	527
1020	528	529	530	531	532	533	534	535
1030	536	537	538	539	540	541	542	543
1040	544	545	546	547	548	549	550	551
1050	552	553	554	555	556	557	558	559
1060	560	561	562	563	564	565	566	567
1070	568	569	570	571	572	573	574	575
1100	576	577	578	579	580	581	582	583
1110	584	585	586	587	588	589	590	591
1120	592	593	594	595	596	597	598	599
1130	600	601	602	603	604	605	606	607
1140	608	609	610	611	612	613	614	615
1150	616	617	618	619	620	621	622	623
1160	624	625	626	627	628	629	630	631
1170	632	633	634	635	636	637	638	639
1200	640	641	642	643	644	645	646	647
1210	648	649	650	651	652	653	654	655
1220	656	657	658	659	660	661	662	663
1230	664	665	666	667	668	669	670	671
1240	672	673	674	675	676	677	678	679
1250	680	681	682	683	684	685	686	687
1260	688	689	690	691	692	693	694	695
1270	696	697	698	699	700	701	702	703
1300	704	705	706	707	708	709	710	711
1310	712	713	714	715	716	717	718	719
1320	720	721	722	723	724	725	726	727
1330	728	729	730	731	732	733	734	735
1340	736	737	738	739	740	741	742	743
1350	744	745	746	747	748	749	750	751
1360	752	753	754	755	756	757	758	759
1370	760	761	762	763	764	765	766	767
1400	768	769	770	771	772	773	774	775
1410	776	777	778	779	780	781	782	783
1420	784	785	786	787	788	789	790	791
1430	792	793	794	795	796	797	798	799
1440	800	801	802	803	804	805	806	807

Ø	Ø	1	2	3	4	5	6	7
1450	808	809	810	811	812	813	814	815
1460	816	817	818	819	820	821	822	823
1470	824	825	826	827	828	829	830	831
1500	832	833	834	835	836	837	838	839
1510	840	841	842	843	844	845	846	847
1520	848	849	850	851	852	853	854	855
1530	856	857	858	859	860	861	862	863
1540	864	865	866	867	868	869	870	871
1550	872	873	874	875	876	877	878	879
1560	880	881	882	883	884	885	886	887
1570	888	889	890	891	892	893	894	895
1600	896	897	898	899	900	901	902	903
1610	904	905	906	907	908	909	910	911
1620	912	913	914	915	916	917	918	919
1630	920	921	922	923	924	925	926	927
1640	928	929	930	931	932	933	934	935
1650	936	937	938	939	940	941	942	943
1660	944	945	946	947	948	949	950	951
1670	952	953	954	955	956	957	958	959
1700	960	961	962	963	964	965	966	967
1710	968	969	970	971	972	973	974	975
1720	976	977	978	979	980	981	982	983
1730	984	985	986	987	988	989	990	991
1740	992	993	994	995	996	997	998	999
1750	1000	1001	1002	1003	1004	1005	1006	1007
1760	1008	1009	1010	1011	1012	1013	1014	1015
1770	1016	1017	1018	1019	1020	1021	1022	1023

POWERS OF TWO

POSITIVE POWERS OF TWO

n	2
1	2
2	4
3	8
4	16
5	32
6	64
7	128
8	256
9	512
10	1024
11	2048
12	4096
13	8192
14	16384
15	32768
16	65536
17	13107 2
18	26214 4
19	52428 8
20	10485 76
21	20971 52
22	41943 04
23	83886 08
24	16777 216
25	33554 432
26	67108 864
27	13421 7728
28	26843 5456
29	53687 0912
30	10737 41824
31	21474 83648
32	42949 67296
33	85899 34592
34	17179 86918 4
35	34359 73836 8
36	68719 47673 6
37	13743 89534 72
38	27487 79069 44
39	54975 58138 88
40	10995 11627 776
41	21990 23255 552
42	43980 46511 104
43	87960 93022 208
44	17592 18604 4416
45	35184 37208 8832
46	70368 74417 7664
47	14073 74883 55328
48	28147 49767 10656

APPENDICES

NEGATIVE POWERS OF TWO

n	2					
0	1.0					
1	0.5					
2	0.25					
3	0.125					
4	0.0625					
5	0.03125					
6	0.01562	5				
7	0.00781	25				
8	0.00390	625				
9	0.00195	3125				
10	0.00097	65625				
11	0.00048	82812	5			
12	0.00024	41406	25			
13	0.00012	20703	125			
14	0.00006	10351	5625			
15	0.00003	05175	78125			
16	0.00001	52587	89062	5		
17	0.00000	76293	94531	25		
18	0.00000	38146	97265	625		
19	0.00000	19073	48632	8125		
20	0.00000	09536	74316	40625		
21	0.00000	04768	37158	20312	5	
22	0.00000	02384	18579	10156	25	
23	0.00000	01192	09289	55078	125	
24	0.00000	00596	04644	77539	0625	
25	0.00000	00298	02322	38769	53125	
26	0.00000	00149	01161	19384	76562	5
27	0.00000	00074	50580	59692	38281	25
28	0.00000	00037	25290	29846	19140	625
29	0.00000	00018	62645	14923	09570	3125
30	0.00000	00009	31322	57461	54785	15625
31	0.00000	00004	65661	28730	77392	57812
32	0.00000	00002	32830	64356	28696	28906
33	0.00000	00001	16415	32182	69348	14453
34	0.00000	00000	58207	66091	34674	07226
35	0.00000	00000	29103	83045	67337	03613
36	0.00000	00000	14551	91522	83668	51806
37	0.00000	00000	07275	95761	41834	25903
38	0.00000	00000	03637	97880	70917	12951
39	0.00000	00000	01818	98940	35458	56475
40	0.00000	00000	00909	49470	17629	28237
41	0.00000	00000	00454	74735	08864	64118
42	0.00000	00000	00227	37367	54432	32059
43	0.00000	00000	00113	68683	77216	16029
44	0.00000	00000	00056	84341	88608	08014

11 GLOSSARY

ALTRTN
Alternate return.

BUFF
Buffer (usually INTEGER*2 array).

AP
argument pointer.

code
a value returned by a routine indicating either the success of or the reason for failure to accomplish the requested action.

command
a program called from command level. (See internal command and external command, below.)

command level
the process state in which input lines are interpreted by Primos as commands. A process is at command level when a user logs in and when a command either completes, encounters an error, or stops after a quit signal is issued.

crash
an unplanned interruption of system availability caused by problems in hardware and/or software.

CRASH ADDR
displacement in hardware register save area (pointed to by RSAVPTR -- R37).

CRS
Current register set.

DAM file
a direct access method file.

directory
a catalog of files and other subordinate directories. See MFD, UFD, and segment directory.

DSW
diagnostic status word.

DTAR
descriptor table address register.

DVNO
physical device number.

ECB
Entry Control Block.

external command
a command that executes in user address space.

FADDRH
fault address, high.

FADDRL
fault address, low.

fault
a hardware or softwre condition that causes system failure.

FCODE
fault code.

file
a sam or dam file.

filename
a name given to an item in a directory.

FUNIT
A file system unit number 0-'21.

internal command
a command that executes in the address space occupied by the Primos operating system.

interrupt
A signal received from a device in the external world (including clocks) indicating that the device either needs to be serviced or has completed an operation.

LB
linkage base register.

login name
A 6-character name by which each logged-in user is known to PRIMOS.

LSB
Least Significant Bit.

MFD
master file directory. An MFD contains information about each UFD on the disk.

MSB
Most Significant Bit.

NODE
the name of a system connected to PRIMENET.

NW
Number of words.

non-owner, NPASS
Non-owner password.

owner, OPASS
Owner password.

page
a 1Ø24 16-bit word block of data within a segment.

page control
the routines that manage the transfer of pages between secondary storage and main memory frames.

paged address space
nonvisible memory; allocation of physical memory.

password
a character string supplied by the user that controls his access to various files and directories. See owner and non-owner.

PB
procedure base register.

PBH
procedure base register, high side.

PBL
procedure base register, low side.

PCB
see process control block.

PDEV
physical device number.

physical volume
a disk pack.

PMNT
page map entry.

pointer
an address value either 16-bits or 32-bits in length.

procedure control block
64-word block describing current state of a process.

process
an address space and an execution point. Each logged-in user has his own process.

register file
128 32-bit registers partitioned into 4 32-register blocks. The first block is reserved for microcode use, the second block is used for DMA channels, the third and fourth blocks are process register sets.

RFIL, RFILE
Register file address.

ring
a level of privilege at which programs execute. Supervisor programs run in ring Ø; most user programs run in ring 3.

SAM file
a sequential access method file.

SB
stack base pointer.

SDW
Segment Descriptor Word.

segment directory
a directory that contains nothing but pointers to the first record of each file cataloged in it.

semaphore
a special purpose integer variable allocated in the universe in which the processes are embedded, to perform explicit mutual synchronization of parallel sequential processes.

segmented address space
visible memory; allocation of user's data/procedures.

stack
a pushdown list where active procedures maintain private regions used for temporary variables.

STATV
A three word vector used by the T$xxxx routines. STATV(1) set to Ø when operation completes, STATV(2) = device status, STATV(3) = number words transferred.

TRAP
An asynchronous interruption of sequential microcode execution.

treename, tree
a character string that specified a file by its position in the file system hierarchy. Valid treenames are of the form:

[<ldev>]ufdname[password][>ufdname ...]>filename

Use of < and > in a treename are literal and must be typed as shown. If the treename includes embedded blanks and is entered at PRIMOS command level, it should be surrounded by apostrophes.

UFD
: User File Directory. An UFD contains information about the location and content of each file cataloged in it.

UNIT
: See FUNIT.

wired page
: a page that remains in main memory at all times.

word
: a unit of information that is 16 bits in length.

XB
: temporary base register.

GLOSSARY

12 INDEX