

OS, Operating System, Revision 3, Version 2 for 600XL / 800XL / 1450XLD

The document itself begins on the next page.

Document source:

Original backup tapes owned by Dutchman2000, obtained by Atarimania.

Documentary research and PDF layout by Laurent Delsarte.

Note that these backup tapes contain A LOT of information spread out in many folders, meaning it will take time to process the important bits.

Document identification:

Original file name:	OS.ASM found in SYSTEMS\OS\REV3\VER2
Title of document:	OS, Operating System, Revision 3, Version 2 for 600XL / 800XL / 1450XLD
Author(s):	Multiple authors. Last update by Y. T. JANG (YING-TZU JANG, Olivia) & V. WU (WU, Vincent H)
Original file date:	1984-05-15 (found in source code)
Type of document:	Software, commented source code
Target audience:	Internal
Status:	Ready
Reference (Atari):	(unknown)
Reference (Laurent Delsarte):	For any discussion, this PDF has been given the reference BKUP-1984-05-15-SOFT-0015A-A which should be quoted in any communication.
Tags:	#Atari #8bit #6502 #600XL #800XL #1450XLD #OS

Additional details from "Information" file:

OS Rev. 3 Version 2 is based on OS Rev. 3 Version 1 and incorporates continued clean up of the documentation.

Comments:

This is the printout of the original source code, fully commented.

Typos were corrected in comments. The source code was left unaltered.

According to the introduction, this OS Revision 3 Version 2 is dated 1984-02-22. But that doesn't make sense; in any case, this version must be dated after "Revision 3, Version 1". I therefore assume that the date 1984-05-15, which appears in the "IIR – Process Immediate IRQ" section, must be the correct one, or at least closer to the truth.

What makes this document so interesting is all these valuable comments.

Formatting:

- Comments are in grey, so that the black text (code source) stands out.
- Conditional compilation IF ELSE ENDIF sections have a pale orange background.
- Presentation / Description of source code in blue.
- Presentation / Description of tables & data in green.
- Important 6502 instructions are highlighted in fluo.

JMP JSR RTS BEQ BNE BMI BPL BCS BCC BVS BVC

AI Comparison:

I asked Claude to summarise for me the main differences between R3V1 & R3V2, and this is the output that I received:

The whole story is one feature: splitting parallel-device IRQ status into "external" vs "internal." R3V2 adds a dated, attributed changelog entry — *"Revision 3, Version 2 (600XL/800XL/1450XLD)"*, credited to Y. T. Jang and V. Wu — and the code matches it exactly, equate for equate:

Change	Detail
New equate IPDVI = \$D1CF	"internal parallel device IRQ status" — twin of the existing PDVI (\$D1FF), now re-commented "external parallel device IRQ status"
New equate IPDIMK = \$0254	"internal parallel device IRQ selection mask" — carved out of the byte that used to open the "23 bytes reserved for Atari" block (now 22 bytes, starting at \$0255); PDIMSK (\$0249) re-commented "external parallel device IRQ selection mask"
IIR (Interrupt Handler) logic	Was LDA PDVI / AND PDIMSK / BEQ IIR2. Now also masks the internal side and ORs it in: STA ABUFPT (external result parked in scratch) → LDA IPDVI / AND IPDIMK → ORA ABUFPT → same BEQ IIR2. Matches the changelog note verbatim: mask each side, OR the results, then dispatch.
PRS (Preset Memory) cold-start fix	New STA PDVI ;PDVI = 0 right after the RAM-size loop, with the comment <i>"Initialize due to unknown flip flop state with BARBARA; otherwise potential ROM checksum error on power up."</i> This matches the changelog's "On cold start, initialize PDVI = 0, to avoid potential checksum error" exactly. "BARBARA" reads as an internal codename for a PBI-related hardware component — I checked and can't independently confirm what it refers to, so I'll leave it at that rather than guess.
ID stamp	IDDAY/IDMON \$27/\$03 (Mar 27) → \$15/\$05 (May 15)

A couple of details that round out the picture:

- **IIR gets its own dated MODS entry**, and it doesn't match the top-of-file date: 2. Y.T. Jang 1984-05-15. That's the same May 15 date now stamped into IDDAY/IDMON, while the top-level changelog note itself is dated 1984-02-22. Read together, this suggests Feb 22 is when the change was specified and May 15 is when it actually shipped in this ROM build — the source lets you triangulate that even though it never says so directly.
- **PRS gets no matching MODS entry** for its PDVI=0 fix — unlike IIR, its header still only lists the 1983-11-01 coding-standard pass. The code and comment changed; the paper trail wasn't updated to match.
- **A formatting fingerprint:** every new line in this patch (IPDVI, IPDIMK, and the four new instructions in IIR) is aligned with runs of literal spaces instead of the tabs used everywhere else in the file — consistent with this patch coming from a different author/toolchain than R. K. Nordin's surrounding Revision 3 work, which lines up with the changelog crediting it to Jang/Wu instead.
- The model list in the changelog (600XL/800XL/1450XLD) lines up with the PBI being present specifically on the 600XL, 800XL, and the unreleased 1400XL and 1450XLD — so this is squarely 1450XLD-era PBI work, not anything relevant to later 130XE hardware.

36 of 41 sections are byte-for-byte identical — verified directly, not inferred: everything untouched includes all six ROM patches again, both character sets, all the vector tables, and every handler except Interrupt Handler and Initialization. The reconstruction's ??? uncertainty-marker count didn't move at all this round (588 → 588) — no comment churn, no wording reverts like last time. This is the cleanest of the three diffs: one coherent, self-documenting feature addition, nothing left unaccounted for.

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OS, Operating System, Revision 3, Version 2 for 600XL / 800XL / 1450XLD

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OS - Operating System

Notes

This source is currently being refined. Areas which need work are indicated by question marks ("???").

Modifications

Revision A (400/800)

D. Crane/A. Miller/L. Kaplan/R. Whitehead ??? – ??/??/??

Revision B (400/800)

Fix several problems.

M. Mahar/R. S. Scheiman ??? – ??/??/??

Revision 10 (1200XL)

Support 1200XL, add new features.

H. Stewart/L. Winner ???/R. S. Scheiman/Y. M. Chen/M. W. Colburn – 1982-10-26

Revision 11 (1200XL)

Fix several problems.

R. S. Scheiman – 1982-12-23

Revision 1 (600XL/800XL)

Support PBI and on-board BASIC.

R. S. Scheiman/R. K. Nordin/Y. M. Chen – 1983-03-11

Revision 2 (600XL/800XL)

Fix several problems.

R. S. Scheiman – 1983-05-10

Bring closer to Coding Standard (object unchanged).

R. K. Nordin – 1983-11-01

Revision 3 (600XL/800XL/1450XLD)

Fix MAXDEV, problems resulting from CRASS65 version, initial address for RAM sizing, "Boot Error" message, initial address for cartridge equivalence checksum, mishandling of SIO NAK, initializing of CHKSUM, and initialization of PORTB.

R. K. Nordin – 1984-03-27

Revision 3, Version 2 (600XL/800XL/1450XLD)

Dedicate PDVI (\$D1FF) to external parallel device IRQ status

Dedicate IPDVI (\$D1CF) to internal parallel device IRQ status

Using PDIMSK (\$0249) for external parallel device IRQ selection mask

Using IPDIMK (\$0254) for internal parallel device IRQ selection mask

After masking (PDVI, PDIMSK) & (IPDVI, IPDIMK), OR the result together, prior to processing parallel device IRQ

On cold start, initialize PDVI = 0, to avoid potential checksum error.

Y. T. Jang,/V. Wu – 1984-02-22

Program Structure

The sections of the OS appear in the following order with corresponding subtitles:

Equates and Definitions

- System Symbol Equates

- System Address Equates

- Miscellaneous Address Equates

- Macro Definitions

Code and Data

- First 8K ROM Identification and Checksum

- Interrupt Handler

- Initialization

- Disk Input/Output

- Relocating Loader

- Self-test, Part 1

- Parallel Input/Output

- Peripheral Handler Loading Facility, Part 1

- Self-test, Part 2

- Peripheral Handler Loading Facility, Part 2

- International Character Set

- Self-test, Part 3

- Floating Point Package

- Domestic Character Set

- Device Handler Vector Tables

- Jump Vectors

- Generic Parallel Device Handler Vector Table

- \$E4C0 Patch

- Central Input/Output

- Peripheral Handler Loading Facility, Part 3

- \$E912 Patch

Peripheral Handler Loading Facility, Part 4
\$E959 Patch
Serial Input/Output
Keyboard, Editor and Screen Handler, Part 1
Peripheral Handler Loading Facility, Part 5
\$EF6B Patch
Keyboard, Editor and Screen Handler, Part 2
\$F223 Patch
Keyboard, Editor and Screen Handler, Part 3
\$FCD8 Patch
Cassette Handler
Printer Handler
Self-test, Part 4

Second 8K ROM Identification and Checksum
6502 Machine Vectors

System Symbol Equates

** Assembly Option Equates

```
FALSE EQU 0
TRUE EQU not FALSE

VGC SET TRUE ;virtual game controllers
RAMSYS SET FALSE ;not RAM based system
LNBUG SET FALSE ;no LNBUG interface
ACMI SET FALSE ;no asynchronous communications module interface
```

** Identification Equates

```
IDREV EQU $03 ;identification revision number
IDDAY EQU $15 ;identification day
IDMON EQU $05 ;identification month
IDYEAR EQU $84 ;identification year
IDCPU EQU $02 ;identification CPU series
IDPN1 EQU 'B' ;identification part number field 1
IDPN2 EQU 'B' ;identification part number field 2
IDPN3 EQU $00 ;identification part number field 3
IDPN4 EQU $00 ;identification part number field 4
IDPN5 EQU $02 ;identification part number field 5
```

** Configuration Equates

```
MAXDEV EQU 30 ;offset to last possible entry of HATABS
IOCBSZ EQU 16 ;length of IOCB

SEIOCB EQU 0*IOCBSZ ;screen editor IOCB index
MAXIOC EQU 8*IOCBSZ ;first invalid IOCB index

DSCTSZ EQU 128 ;disk sector size

LEDGE EQU 2 ;left edge
REDGE EQU 39 ;right edge

INIML EQU $0700 ;initial MEMLO

ICSORG EQU $CC00 ;international character set origin
DCSORG EQU $E000 ;domestic character set origin
```

** IOCB Command Code Equates

```
OPEN EQU $03 ;open
GETREC EQU $05 ;get record
GETCHR EQU $07 ;get character(s)
PUTREC EQU $09 ;put record
PUTCHR EQU $0B ;put character(s)
CLOSE EQU $0C ;close
STATIS EQU $0D ;status
SPECIL EQU $0E ;special
```

**** Special Entry Command Equates**

; Screen Commands

DRAWLN EQU \$11 ;draw line
FILLIN EQU \$12 ;draw line with right fill

**** ICAX1 Auxiliary Byte 1 Equates**

APPEND EQU \$01 ;open write append (D:) or screen read (E:)
DIRECT EQU \$02 ;open for directory access (D:)
OPNIN EQU \$04 ;open for input (all devices)
OPNOT EQU \$08 ;open for output (all devices)
MXDMOD EQU \$10 ;open for mixed mode (E:, S:)
INSCLR EQU \$20 ;open for input without clearing screen (E:, S:)

**** Device Code Equates**

CASSET EQU 'C' ;cassette
DISK EQU 'D' ;disk
SCREDT EQU 'E' ;screen editor
KBD EQU 'K' ;keyboard
PRINTR EQU 'P' ;printer
DISPLAY EQU 'S' ;screen display

**** Character and Key Code Equates**

CLS EQU \$7D ;clear screen
EOL EQU \$9B ;end of line (RETURN)

HELP EQU \$11 ;key code for HELP
CNTLF1 EQU \$83 ;key code for CTRL-F1
CNTLF2 EQU \$84 ;key code for CTRL-F2
CNTLF3 EQU \$93 ;key code for CTRL-F3
CNTLF4 EQU \$94 ;key code for CTRL-F4
CNTL1 EQU \$9F ;key code for CTRL-1

**** Status Code Equates**

SUCCESS EQU 1 ;successful operation

BRKABT EQU 128 ;BREAK key abort
PRVOPN EQU 129 ;IOCB already open error
NONDEV EQU 130 ;nonexistent device error
WRONLY EQU 131 ;IOCB opened for write only error
NVALID EQU 132 ;invalid command error
NOTOPN EQU 133 ;device/file not open error
BADIOC EQU 134 ;invalid IOCB index error
RONLY EQU 135 ;IOCB opened for read only error
EOFERR EQU 136 ;end of file error
TRNRCD EQU 137 ;truncated record error
TIMEOUT EQU 138 ;peripheral device timeout error
DNACK EQU 139 ;device does not acknowledge command error
FRMERR EQU 140 ;serial bus framing error
CRSROR EQU 141 ;cursor overrange error
OVRRUN EQU 142 ;serial bus data overrun error
CHKERR EQU 143 ;serial bus checksum error
DERROR EQU 144 ;device done (operation incomplete) error
BADMOD EQU 145 ;bad screen mode number error
FNCNOT EQU 146 ;function not implemented in handler error

SCRMEM EQU 147 ;insufficient memory for screen mode error

** DCB Device Bus ID Equates

DISKID EQU \$31 ;disk bus ID
PDEVN EQU \$40 ;printer bus ID
CASET EQU \$60 ;cassette bus ID

** Bus Command Equates

FOMAT EQU '!' ;format command
PUTSEC EQU 'P' ;put sector command
READ EQU 'R' ;read command
STATC EQU 'S' ;status command
WRITE EQU 'W' ;write command

** Command Auxiliary Byte Equates

DOUBLE EQU 'D' ;print 20 characters double width
NORMAL EQU 'N' ;print 40 characters normally
PLOT EQU 'P' ;plot
SIDWAY EQU 'S' ;print 16 characters sideways

** Bus Response Equates

ACK EQU 'A' ;device acknowledged
COMPLT EQU 'C' ;device successfully completed operation
ERROR EQU 'E' ;device incurred error in attempted operation
NACK EQU 'N' ;device did not understand

** Floating Point Package Miscellaneous Equates

FPREC EQU 6 ;precision
FMPREC EQU FPREC-1 ;length of mantissa

** Cassette Record Type Equates

HDR EQU \$FB ;header
DTA EQU \$FC ;data record
DT1 EQU \$FA ;last data record
EOT EQU \$FE ;end of tape (file)

TONE1 EQU 2 ;record
TONE2 EQU 1 ;playback

** Cassette Timing Equates

WLEADN EQU 1152 ;NTSC 19.2 second WRITE file leader
RLEADN EQU 576 ;NTSC 9.6 second READ file leader
WIRGLN EQU 180 ;NTSC 3.0 second WRITE IRG
RIRGLN EQU 120 ;NTSC 2.0 second READ IRG
WSIRGN EQU 15 ;NTSC 0.25 second WRITE short IRG
RSIRGN EQU 10 ;NTSC 0.16 second READ short IRG
BEEPNN EQU 30 ;NTSC 0.5 second beep duration
BEEPFN EQU 10 ;NTSC 0.16 second beep separation

WLEADP EQU 960 ;PAL 19.2 second WRITE file leader

RLEADP EQU	480	;PAL 9.6 second READ file leader
WIRGLP EQU	150	;PAL 3.0 second WRITE IRG
RIRGLP EQU	100	;PAL 2.0 second READ IRG
WSIRGP EQU	13	;PAL 0.25 second WRITE short IRG
RSIRGP EQU	8	;PAL 0.16 second READ short IRG
BEEPNP EQU	25	;PAL 0.5 second beep duration
BEEFPF EQU	8	;PAL 0.16 second beep separation
WIRGHI EQU	0	;high WRITE IRG
RIRGHI EQU	0	;high READ IRG

** Power-up Validation Byte Value Equates

PUPVL1 EQU	\$5C	;power-up validation value 1
PUPVL2 EQU	\$93	;power-up validation value 2
PUPVL3 EQU	\$25	;power-up validation value 3

** Relocating Loader Miscellaneous Equates

DATAER EQU	156	;end of record appears before END record error
MEMERR EQU	157	;memory insufficient for load error

** Miscellaneous Equates

IOCFRE EQU	\$FF	;IOCB free indicator
B19200 EQU	\$0028	;19200 baud POKEY counter value
B00600 EQU	\$05CC	;600 baud POKEY counter value
HITONE EQU	\$05	;FSK high freq. POKEY counter value (5326 Hz)
LOTONE EQU	\$07	;FSK low freq. POKEY counter value (3995 Hz)
NCOMLO EQU	\$34	;PIA lower NOT COMMAND line command
NCOMHI EQU	\$3C	;PIA raise NOT COMMAND line command
MOTRGO EQU	\$34	;PIA cassette motor ON command
MOTRST EQU	\$3C	;PIA cassette motor OFF command
NODAT EQU	\$00	;SIO immediate operation
GETDAT EQU	\$40	;SIO read data frame
PUTDAT EQU	\$80	;SIO write data frame
CRETRI EQU	13	;number of command frame retries
DRETRI EQU	1	;number of device retries
CTIM EQU	2	;command frame ACK timeout
NBUFSZ EQU	40	;print normal buffer size
DBUFSZ EQU	20	;print double buffer size
SBUFSZ EQU	29	;print sideways buffer size

System Address Equates

** Page Zero Address Equates

```
LNFLG EQU    $0000 ;1-byte LNBUG flag (0 = not LNBUG)
NGFLAG EQU    $0001 ;1-byte memory status (0 = failure)

;      Not Cleared

CASINI EQU    $0002 ;2-byte cassette program initialization address
RAMLO EQU     $0004 ;2-byte RAM address for memory test
TRAMSZ EQU    $0006 ;1-byte RAM size temporary
CMCMD EQU     $0007 ;1-byte command communications

;      Cleared upon Coldstart Only

WARMST EQU    $0008 ;1-byte warmstart flag (0 = coldstart)
BOOT? EQU     $0009 ;1-byte successful boot flags
DOSVEC EQU    $000A ;2-byte disk program start vector
DOSINI EQU    $000C ;2-byte disk program initialization address
APPMHI EQU    $000E ;2-byte applications memory high limit

;      Cleared upon Coldstart or Warmstart

INTZBS EQU    $0010 ;first page zero location to clear

POKMSK EQU    $0010 ;1-byte IRQEN shadow
BRKKEY EQU    $0011 ;1-byte BREAK key flag (0 = no BREAK)
RTCLOK EQU    $0012 ;3-byte real time clock (16 millisecond units)
BUFADR EQU    $0015 ;2-byte disk interface buffer address
ICCOMT EQU    $0017 ;1-byte CIO command table index
DSKFMS EQU    $0018 ;2-byte DOS File Management System pointer
DSKUTL EQU    $001A ;2-byte DOS utility pointer
ABUFPT EQU    $001C ;4-byte ACMI buffer pointer area

ZIOCB EQU     $0020 ;address of page zero IOCB
IOCBAS EQU    $0020 ;16-byte page zero IOCB
ICHIDZ EQU    $0020 ;1-byte handler ID ($FF = IOCB free)
ICDNOZ EQU    $0021 ;1-byte device number
ICCOMZ EQU    $0022 ;1-byte command code
ICSTAZ EQU    $0023 ;1-byte status of last action
ICBALZ EQU    $0024 ;1-byte low buffer address
ICBAHZ EQU    $0025 ;1-byte high buffer address
ICPTLZ EQU    $0026 ;1-byte low PUT-BYTE routine address-1
ICPTHZ EQU    $0027 ;1-byte high PUT-BYTE routine address-1
ICBL LZ EQU   $0028 ;1-byte low buffer length
ICBLHZ EQU    $0029 ;1-byte high buffer length
ICAX1Z EQU    $002A ;1-byte first auxiliary information
ICAX2Z EQU    $002B ;1-byte second auxiliary information
ICSPRZ EQU    $002C ;4-byte spares

ENTVEC EQU    $002C ;2-byte (not used)
ICIDNO EQU    $002E ;1-byte IOCB index (IOCB number times IOCBSZ)
CIOCHR EQU    $002F ;1-byte character for current CIO operation

STATUS EQU    $0030 ;1-byte SIO operation status
CHKSUM EQU    $0031 ;1-byte checksum (single byte sum with carry)
BUFRLO EQU    $0032 ;1-byte low data buffer address
BUFRHI EQU    $0033 ;1-byte high data buffer address
BFENLO EQU    $0034 ;1-byte low data buffer end address
BFENHI EQU    $0035 ;1-byte high data buffer end address
LTEMP EQU     $0036 ;2-byte relocating loader temporary
BUFRFL EQU    $0038 ;1-byte data buffer full flag (0 = not full)
RECVDN EQU    $0039 ;1-byte receive-frame done flag (0 = not done)
XMTDON EQU    $003A ;1-byte transmit-frame done flag (0 = not done)
```

CHKSNT EQU	\$003B	;1-byte checksum sent flag (0 = not sent)
NOCKSM EQU	\$003C	;1-byte no checksum follows data flag (0 = does)
BPTR EQU	\$003D	;1-byte cassette buffer pointer
FTYPE EQU	\$003E	;1-byte cassette IRG type (neg. = continuous)
FEOF EQU	\$003F	;1-byte cassette EOF flag (0 = no EOF)
FREQ EQU	\$0040	;1-byte cassette beep counter
SOUNDR EQU	\$0041	;1-byte noisy I/O flag (0 = quiet)
CRITIC EQU	\$0042	;1-byte critical section flag (0 = not critical)
FMSZPG EQU	\$0043	;7-byte reserved for DOS File Management System
ZCHAIN EQU	\$004A	;2-byte handler linkage chain pointer
DSTAT EQU	\$004C	;1-byte display status
ATTRACT EQU	\$004D	;1-byte attract-mode timer and flag
DRKMSK EQU	\$004E	;1-byte attract-mode dark (luminance) mask
COLRSH EQU	\$004F	;1-byte attract-mode color shift
TMPCHR EQU	\$0050	;1-byte temporary character
HOLD1 EQU	\$0051	;1-byte temporary
LMARGN EQU	\$0052	;1-byte text column left margin
RMARGN EQU	\$0053	;1-byte text column right margin
ROWCRS EQU	\$0054	;1-byte cursor row
COLCRS EQU	\$0055	;2-byte cursor column
DINDEX EQU	\$0057	;1-byte display mode
SAVMSC EQU	\$0058	;2-byte saved memory scan counter
OLDROW EQU	\$005A	;1-byte prior row
OLDCOL EQU	\$005B	;2-byte prior column
OLDCHR EQU	\$005D	;1-byte saved character under cursor
OLDADR EQU	\$005E	;2-byte saved cursor memory address
FKDEF EQU	\$0060	;2-byte function key definition table address
PALNTS EQU	\$0062	;1-byte PAL/NTSC indicator (0 = NTSC, PAL = 1)
LOGCOL EQU	\$0063	;1-byte logical line cursor column
ADRESS EQU	\$0064	;2-byte temporary address
MLTTMP EQU	\$0066	;1-byte temporary
OPNTMP EQU	\$0066	;1-byte open temporary
TOADR EQU	\$0066	;2-byte destination address
SAVADR EQU	\$0068	;2-byte saved address
FRMADR EQU	\$0068	;2-byte source address
RAMTOP EQU	\$006A	;1-byte RAM size
BUFCNT EQU	\$006B	;1-byte buffer count (logical line size)
BUFSTR EQU	\$006C	;2-byte buffer start pointer
BITMSK EQU	\$006E	;1-byte bit mask for bit map operation
SHFAMT EQU	\$006F	;1-byte shift amount for pixel justification
ROWAC EQU	\$0070	;2-byte draw working row
COLAC EQU	\$0072	;2-byte draw working column
ENDPT EQU	\$0074	;2-byte end point
DELTAR EQU	\$0076	;1-byte row difference
DELTAC EQU	\$0077	;2-byte column difference
KEYDEF EQU	\$0079	;2-byte key definition table address
SWPFLG EQU	\$007B	;1-byte split screen swap flag (0 = not swapped)
HOLDCH EQU	\$007C	;1-byte temporary character
INSDAT EQU	\$007D	;1-byte temporary
COUNTR EQU	\$007E	;2-byte draw iteration count

; Reserved for Application and Floating Point Package

; EQU \$0080 ;128 bytes reserved for application and FPP

** Floating Point Package Page Zero Address Equates
--

```

FR0    EQU    $00D4 ;6-byte register 0
FR0M   EQU    $00D5 ;5-byte register 0 mantissa
QTEMP  EQU    $00D9 ;1-byte temporary

FRE    EQU    $00DA ;6-byte (internal) register E

FR1    EQU    $00E0 ;6-byte register 1
FR1M   EQU    $00E1 ;5-byte register 1 mantissa

FR2    EQU    $00E6 ;6-byte (internal) register 2

FRX    EQU    $00EC ;1-byte temporary

EEXP   EQU    $00ED ;1-byte value of exponent

FRSIGN EQU    $00EE ;1-byte floating point sign
NSIGN  EQU    $00EE ;1-byte sign of number

PLYCNT EQU    $00EF ;1-byte polynomial degree
ESIGN  EQU    $00EF ;1-byte sign of exponent

SGNFLG EQU    $00F0 ;1-byte sign flag
FCHFLG EQU    $00F0 ;1-byte first character flag

XFMFLG EQU    $00F1 ;1-byte transform flag
DIGRT  EQU    $00F1 ;1-byte number of digits after decimal point

CIX    EQU    $00F2 ;1-byte current input index
INBUFF EQU    $00F3 ;2-byte line input buffer

ZTEMP1 EQU    $00F5 ;2-byte temporary
ZTEMP4 EQU    $00F7 ;2-byte temporary
ZTEMP3 EQU    $00F9 ;2-byte temporary

FLPTR  EQU    $00FC ;2-byte floating point number pointer
FPTR2  EQU    $00FE ;2-byte floating point number pointer

```

** Page One (Stack) Address Equates
--

```

;      EQU    $0100 ;256-byte stack

```

** Page Two Address Equates

```

INTABS EQU    $0200 ;42-byte interrupt handler table

VDSLST EQU    $0200 ;2-byte display list NMI vector
VPRCED EQU    $0202 ;2-byte serial I/O proceed line IRQ vector
VINTER EQU    $0204 ;2-byte serial I/O interrupt line IRQ vector
VBREAK EQU    $0206 ;2-byte BRK instruction IRQ vector
VKEYBD EQU    $0208 ;2-byte keyboard IRQ vector
VSERIN EQU    $020A ;2-byte serial input ready IRQ vector
VSEROR EQU    $020C ;2-byte serial output ready IRQ vector
VSEROC EQU    $020E ;2-byte serial output complete IRQ vector
VTIMR1 EQU    $0210 ;2-byte POKEY timer 1 IRQ vector
VTIMR2 EQU    $0212 ;2-byte POKEY timer 2 IRQ vector
VTIMR4 EQU    $0214 ;2-byte POKEY timer 4 IRQ vector
VIMIRQ EQU    $0216 ;2-byte immediate IRQ vector
CDTMV1 EQU    $0218 ;2-byte countdown timer 1 value
CDTMV2 EQU    $021A ;2-byte countdown timer 2 value
CDTMV3 EQU    $021C ;2-byte countdown timer 3 value
CDTMV4 EQU    $021E ;2-byte countdown timer 4 value

```

```

CDTMV5 EQU    $0220 ;2-byte countdown timer 5 value
VVBKLI EQU    $0222 ;2-byte immediate VBLANK NMI vector
VVBKLD EQU    $0224 ;2-byte deferred VBLANK NMI vector
CDTMA1 EQU    $0226 ;2-byte countdown timer 1 vector
CDTMA2 EQU    $0228 ;2-byte countdown timer 2 vector

CDTMF3 EQU    $022A ;1-byte countdown timer 3 flag (0 = expired)
SRTIMR EQU    $022B ;1-byte software key repeat timer
CDTMF4 EQU    $022C ;1-byte countdown timer 4 flag (0 = expired)
INTMP EQU     $022D ;1-byte temporary
CDTMF5 EQU    $022E ;1-byte countdown timer 5 flag (0 = expired)
SDMCTL EQU    $022F ;1-byte DMACTL shadow
SDLSTL EQU    $0230 ;1-byte DLISTL shadow
SDLSTH EQU    $0231 ;1-byte DLISTH shadow
SSKCTL EQU    $0232 ;1-byte SKCTL shadow
LCOUNT EQU    $0233 ;1-byte relocating loader record length counter
LPENH EQU     $0234 ;1-byte light pen horizontal value
LPENV EQU     $0235 ;1-byte light pen vertical value
BRKKY EQU     $0236 ;2-byte BREAK key vector
VPIRQ EQU     $0238 ;2-byte parallel device IRQ vector
CDEVIC EQU    $023A ;1-byte command frame device ID
CCOMND EQU    $023B ;1-byte command frame command
CAUX1 EQU     $023C ;1-byte command auxiliary 1
CAUX2 EQU     $023D ;1-byte command auxiliary 2

TEMP EQU      $023E ;1-byte temporary

        ASSERT low TEMP<>$FF          ;may not be the last word on a page

ERRFLG EQU    $023F ;1-byte I/O error flag (0 = no error)

        ASSERT low ERRFLG<>$FF        ;may not be the last word on a page

DFLAGS EQU    $0240 ;1-byte disk flags from sector 1
DBSECT EQU    $0241 ;1-byte disk boot sector count
BOOTAD EQU    $0242 ;2-byte disk boot memory address
COLDST EQU    $0244 ;1-byte coldstart flag (0 = complete)
RECLN EQU     $0245 ;1-byte relocating loader record length
DSKTIM EQU    $0246 ;1-byte disk format timeout
PDVMSK EQU    $0247 ;1-byte parallel device selection mask
SHPDVS EQU    $0248 ;1-byte parallel device selection shadow
PDIMSK EQU    $0249 ;1-byte external parallel device IRQ selection mask
RELADR EQU    $024A ;2-byte relocating loader relative address
PPTMPA EQU    $024C ;1-byte parallel device handler temporary
PPTMPX EQU    $024D ;1-byte parallel device handler temporary
DSKCNT EQU    $024E ;1-byte parallel disk device count
TOPSLT EQU    $024F ;1-byte highest parallel disk device slot
SPBCTL EQU    $0250 ;1-byte PBICTL shadow
NRINGS EQU    $0251 ;1-byte parallel modem ring detect counter
VPCTR EQU     $0252 ;1-byte parallel voice phoneme counter
VMCTR EQU     $0253 ;1-byte parallel voice marker counter
IPDIMK EQU    $0254 ;1-byte internal parallel device IRQ selection mask

;      EQU     $0255 ;22 bytes reserved for Atari

CHSALT EQU    $026B ;1-byte character set alternate
VSFLAG EQU    $026C ;1-byte fine vertical scroll count
KEYDIS EQU    $026D ;1-byte keyboard disable
FINE EQU      $026E ;1-byte fine scrolling mode
GPRIOR EQU    $026F ;1-byte PRIOR shadow

PADDL0 EQU    $0270 ;1-byte potentiometer 0
PADDL1 EQU    $0271 ;1-byte potentiometer 1
PADDL2 EQU    $0272 ;1-byte potentiometer 2
PADDL3 EQU    $0273 ;1-byte potentiometer 3
PADDL4 EQU    $0274 ;1-byte potentiometer 4
PADDL5 EQU    $0275 ;1-byte potentiometer 5

```

PADDL6 EQU	\$0276	;1-byte potentiometer 6
PADDL7 EQU	\$0277	;1-byte potentiometer 7
STICK0 EQU	\$0278	;1-byte joystick 0
STICK1 EQU	\$0279	;1-byte joystick 1
STICK2 EQU	\$027A	;1-byte joystick 2
STICK3 EQU	\$027B	;1-byte joystick 3
PTRIG0 EQU	\$027C	;1-byte paddle trigger 0
PTRIG1 EQU	\$027D	;1-byte paddle trigger 1
PTRIG2 EQU	\$027E	;1-byte paddle trigger 2
PTRIG3 EQU	\$027F	;1-byte paddle trigger 3
PTRIG4 EQU	\$0280	;1-byte paddle trigger 4
PTRIG5 EQU	\$0281	;1-byte paddle trigger 5
PTRIG6 EQU	\$0282	;1-byte paddle trigger 6
PTRIG7 EQU	\$0283	;1-byte paddle trigger 7
STRIG0 EQU	\$0284	;1-byte joystick trigger 0
STRIG1 EQU	\$0285	;1-byte joystick trigger 1
STRIG2 EQU	\$0286	;1-byte joystick trigger 2
STRIG3 EQU	\$0287	;1-byte joystick trigger 3
HIBYTE EQU	\$0288	;1-byte relocating loader high byte value
WMODE EQU	\$0289	;1-byte cassette WRITE mode (\$80 = writing)
BLIM EQU	\$028A	;1-byte cassette buffer limit
IMASK EQU	\$028B	;1-byte (not used)
JVECK EQU	\$028C	;2-byte jump vector or temporary
NEWADR EQU	\$028E	;2-byte relocating address
TXTR0W EQU	\$0290	;1-byte split screen text cursor row
TXTCOL EQU	\$0291	;2-byte split screen text cursor column
TINDEX EQU	\$0293	;1-byte split scree text mode
TXTMSC EQU	\$0294	;2-byte split screen memory scan counter
TXOLD EQU	\$0296	;6-byte OLDROW, OLDCOL, OLDCHR, OLDADR for text
CRETRY EQU	\$029C	;1-byte number of command frame retries
HOLD3 EQU	\$029D	;1-byte temporary
SUBTMP EQU	\$029E	;1-byte temporary
HOLD2 EQU	\$029F	;1-byte (not used)
DMASK EQU	\$02A0	;1-byte display (pixel location) mask
TMPLBT EQU	\$02A1	;1-byte (not used)
ESCFLG EQU	\$02A2	;1-byte escape flag (\$80 = ESC detected)
TABMAP EQU	\$02A3	;15-byte (120-bit) tab stop bit map
LOGMAP EQU	\$02B2	;8-byte (32-bit) logical line bit map
INVFLG EQU	\$02B6	;1-byte inverse video flag (\$80 = inverse)
FILFLG EQU	\$02B7	;1-byte right fill flag (0 = no fill)
TMPROW EQU	\$02B8	;1-byte temporary row
TMPCOL EQU	\$02B9	;2-byte temporary column
SCRFLG EQU	\$02BB	;1-byte scroll occurrence flag (0 = not occurred)
HOLD4 EQU	\$02BC	;1-byte temporary
DRETRY EQU	\$02BD	;1-byte number of device retries
SHFLOK EQU	\$02BE	;1-byte shift/control lock flags
BOTSCR EQU	\$02BF	;1-byte screen bottom (24 = normal, 4 = split)
PCOLR0 EQU	\$02C0	;1-byte player-missile 0 color/luminance
PCOLR1 EQU	\$02C1	;1-byte player-missile 1 color/luminance
PCOLR2 EQU	\$02C2	;1-byte player-missile 2 color/luminance
PCOLR3 EQU	\$02C3	;1-byte player-missile 3 color/luminance
COLOR0 EQU	\$02C4	;1-byte playfield 0 color/luminance
COLOR1 EQU	\$02C5	;1-byte playfield 1 color/luminance
COLOR2 EQU	\$02C6	;1-byte playfield 2 color/luminance
COLOR3 EQU	\$02C7	;1-byte playfield 3 color/luminance
COLOR4 EQU	\$02C8	;1-byte background color/luminance
PARMBL EQU	\$02C9	;6-byte relocating loader parameter block
RUNADR EQU	\$02C9	;2-byte run address
HIUSED EQU	\$02CB	;2-byte highest non-zero page address

ZHIUSE EQU	\$02CD	;2-byte highest zero page address
OLDPAR EQU	\$02CF	;6-byte relocating loader parameter block
GBYTEA EQU	\$02CF	;2-byte GET-BYTE routine address
LOADAD EQU	\$02D1	;2-byte non-zero page load address
ZLOADA EQU	\$02D3	;2-byte zero page load address
DSCTLN EQU	\$02D5	;2-byte disk sector length
ACMISR EQU	\$02D7	;2-byte ACMI interrupt service routine address
KRPDEL EQU	\$02D9	;1-byte auto-repeat delay
KEYREP EQU	\$02DA	;1-byte auto-repeat rate
NOCLIK EQU	\$02DB	;1-byte key click disable
HELPPG EQU	\$02DC	;1-byte HELP key flag (0 = no HELP)
DMASAV EQU	\$02DD	;1-byte SDMCTL save/restore
PBPNT EQU	\$02DE	;1-byte printer buffer pointer
PBUFSZ EQU	\$02DF	;1-byte printer buffer size
;		
EQU	\$02E0	;4-byte reserved for DOS
RAMSIZ EQU	\$02E4	;1-byte high RAM size
MEMTOP EQU	\$02E5	;2-byte top of available user memory
MEMLO EQU	\$02E7	;2-byte bottom of available user memory
HNDLOD EQU	\$02E9	;1-byte user load flag (0 = no handler load)
DVSTAT EQU	\$02EA	;4-byte device status buffer
CBAUDL EQU	\$02EE	;1-byte low cassette baud rate
CBAUDH EQU	\$02EF	;1-byte high cassette baud rate
CRSINH EQU	\$02F0	;1-byte cursor inhibit (0 = cursor on)
KEYDEL EQU	\$02F1	;1-byte key debounce delay timer
CH1 EQU	\$02F2	;1-byte prior keyboard character
CHACT EQU	\$02F3	;1-byte CHACTL shadow
CHBAS EQU	\$02F4	;1-byte CHBASE shadow
NEWROW EQU	\$02F5	;1-byte draw destination row
NEWCOL EQU	\$02F6	;2-byte draw destination column
ROWINC EQU	\$02F8	;1-byte draw row increment
COLINC EQU	\$02F9	;1-byte draw column increment
CHAR EQU	\$02FA	;1-byte internal character
ATACHR EQU	\$02FB	;1-byte ATASCII character or plot point
CH EQU	\$02FC	;1-byte keyboard code (buffer)
FILDAT EQU	\$02FD	;1-byte right fill data
DSPFLG EQU	\$02FE	;1-byte control character display flag (0 = no)
SSFLAG EQU	\$02FF	;1-byte start/stop flag (0 = not stopped)

**** Page Three Address Equates**

DCB EQU	\$0300	;12-byte device control block
DDEVIC EQU	\$0300	;1-byte unit 1 bus ID
DUNIT EQU	\$0301	;1-byte unit number
DCOMND EQU	\$0302	;1-byte bus command
DSTATS EQU	\$0303	;1-byte command type/status return
DBUFLO EQU	\$0304	;1-byte low data buffer address
DBUFHI EQU	\$0305	;1-byte high data buffer address
DTIMLO EQU	\$0306	;1-byte timeout (seconds)
DUNUSE EQU	\$0307	;1-byte (not used)
DBYTLO EQU	\$0308	;1-byte low number of bytes to transfer
DBYTHI EQU	\$0309	;1-byte high number of bytes to transfer
DAUX1 EQU	\$030A	;1-byte first command auxiliary
DAUX2 EQU	\$030B	;1-byte second command auxiliary
TIMER1 EQU	\$030C	;2-byte initial baud rate timer value
JMPERS EQU	\$030E	;1-byte jumper options
CASFLG EQU	\$030F	;1-byte cassette I/O flag (0 = not cassette I/O)
TIMER2 EQU	\$0310	;2-byte final baud rate timer value
TEMP1 EQU	\$0312	;2-byte temporary

```

TEMP2 EQU    $0313 ;1-byte temporary
PTIMOT EQU   $0314 ;1-byte printer timeout
TEMP3 EQU    $0315 ;1-byte temporary
SAVIO EQU    $0316 ;1-byte saved serial data input indicator
TIMFLG EQU   $0317 ;1-byte timeout flag (0 = timeout)
STACKP EQU   $0318 ;1-byte SI0 saved stack pointer
TSTAT EQU    $0319 ;1-byte temporary status

HATABS EQU   $031A ;35-byte handler address table

PUPBT1 EQU   $033D ;1-byte power-up validation byte 1
PUPBT2 EQU   $033E ;1-byte power-up validation byte 2
PUPBT3 EQU   $033F ;1-byte power-up validation byte 3

IOCB EQU     $0340 ;128-byte I/O control blocks area
ICHID EQU    $0340 ;1-byte handler ID ($FF = free)
ICDNO EQU    $0341 ;1-byte device number
ICCOM EQU    $0342 ;1-byte command code
ICSTA EQU    $0343 ;1-byte status of last action
ICBAL EQU    $0344 ;1-byte low buffer address
ICBAH EQU    $0345 ;1-byte high buffer address
ICPTL EQU    $0346 ;1-byte low PUT-BYTE routine address-1
ICPTH EQU    $0347 ;1-byte high PUT-BYTE routine address-1
ICBL L EQU   $0348 ;1-byte low buffer length
ICBLH EQU    $0349 ;1-byte high buffer length
ICAX1 EQU    $034A ;1-byte first auxiliary information
ICAX2 EQU    $034B ;1-byte second auxiliary information
ICSPR EQU    $034C ;4-byte work area

PRNBUF EQU   $03C0 ;40-byte printer buffer
SUPERF EQU   $03E8 ;1-byte editor super function flag (0 = not)
CKEY EQU     $03E9 ;1-byte cassette boot request flag (0 = not)
CASSBT EQU   $03EA ;1-byte cassette boot flag (0 = not)
CARTCK EQU   $03EB ;1-byte cartridge equivalence checksum
DERRF EQU    $03EC ;1-byte screen OPEN error flag (0 = not)

;      Remainder of Page Three Not Cleared upon Reset

ACMVAR EQU   $03ED ;11 bytes reserved for ACMI
BASICF EQU   $03F8 ;1-byte BASIC switch flag (0 = BASIC enabled)
MINTLK EQU   $03F9 ;1-byte ACMI module interlock
GINTLK EQU   $03FA ;1-byte cartridge interlock
CHLINK EQU   $03FB ;2-byte loaded handler chain link
CASBUF EQU   $03FD ;3-byte first 3 bytes of cassette buffer

```

**** Page Four Address Equates**

```

;      EQU    $0400 ;128-byte remainder of cassette buffer

;      Reserved for Application

USAREA EQU   $0480 ;128 bytes reserved for application

```

**** Page Five Address Equates**

```

;      Reserved for Application and Floating Point Package

;      EQU    $0500 ;256 bytes reserved for application and FPP

```

**** Floating Point Package Address Equates**

LBPR1 EQU \$057E ;1-byte LBUFF preamble
LBPR2 EQU \$057F ;1-byte LBUFF preamble
LBUFF EQU \$0580 ;128-byte line buffer

PLYARG EQU \$05E0 ;6-byte floating point polynomial argument
FPSCR EQU \$05E6 ;6-byte floating point temporary
FPSCR1 EQU \$05EC ;6-byte floating point temporary

**** Page Six Address Equates**

; Reserved for Application
;
; EQU \$0600 ;256 bytes reserved for application

**** LNBUG Address Equates**

LNBUG IF LNBUG
LNORG EQU \$6000 ;LNBUG origin
LNIRQ EQU \$6033 ;LNBUG IRQ entry
LNNMI EQU \$8351 ;LNBUG NMI vector
LNBUG ENDIF

**** Cartridge Address Equates**

CARTCS EQU \$BFFA ;2-byte cartridge coldstart address
CART EQU \$BFFC ;1-byte cartridge present indicator
CARTFG EQU \$BFFD ;1-byte cartridge flags
CARTAD EQU \$BFFE ;2-byte cartridge start vector

**** CTIA/GTIA Address Equates**

CTIA EQU \$D000 ;CTIA/GTIA area
;
; Read/Write Addresses

CONSOL EQU \$D01F ;console switches and speaker control
;
; Read Addresses

M0PF EQU \$D000 ;missile 0 and playfield collision
M1PF EQU \$D001 ;missile 1 and playfield collision
M2PF EQU \$D002 ;missile 2 and playfield collision
M3PF EQU \$D003 ;missile 3 and playfield collision

P0PF EQU \$D004 ;player 0 and playfield collision
P1PF EQU \$D005 ;player 1 and playfield collision
P2PF EQU \$D006 ;player 2 and playfield collision
P3PF EQU \$D007 ;player 3 and playfield collision

M0PL EQU \$D008 ;missile 0 and player collision
M1PL EQU \$D009 ;missile 1 and player collision
M2PL EQU \$D00A ;missile 2 and player collision
M3PL EQU \$D00B ;missile 3 and player collision

P0PL EQU \$D00C ;player 0 and player collision
P1PL EQU \$D00D ;player 1 and player collision
P2PL EQU \$D00E ;player 2 and player collision
P3PL EQU \$D00F ;player 3 and player collision

```

TRIG0 EQU    $D010 ;joystick trigger 0
TRIG1 EQU    $D011 ;joystick trigger 1

TRIG2 EQU    $D012 ;cartridge interlock
TRIG3 EQU    $D013 ;ACMI module interlock

PAL    EQU    $D014 ;PAL/NTSC indicator

;      Write Addresses

HPOSP0 EQU    $D000 ;player 0 horizontal position
HPOSP1 EQU    $D001 ;player 1 horizontal position
HPOSP2 EQU    $D002 ;player 2 horizontal position
HPOSP3 EQU    $D003 ;player 3 horizontal position

HPOSM0 EQU    $D004 ;missile 0 horizontal position
HPOSM1 EQU    $D005 ;missile 1 horizontal position
HPOSM2 EQU    $D006 ;missile 2 horizontal position
HPOSM3 EQU    $D007 ;missile 3 horizontal position

SIZEP0 EQU    $D008 ;player 0 size
SIZEP1 EQU    $D009 ;player 1 size
SIZEP2 EQU    $D00A ;player 2 size
SIZEP3 EQU    $D00B ;player 3 size

SIZEM EQU     $D00C ;missile sizes

GRAFP0 EQU    $D00D ;player 0 graphics
GRAFP1 EQU    $D00E ;player 1 graphics
GRAFP2 EQU    $D00F ;player 2 graphics
GRAFP3 EQU    $D010 ;player 3 graphics

GRAFM EQU     $D011 ;missile graphics

COLPM0 EQU    $D012 ;player-missile 0 color/luminance
COLPM1 EQU    $D013 ;player-missile 1 color/luminance
COLPM2 EQU    $D014 ;player-missile 2 color/luminance
COLPM3 EQU    $D015 ;player-missile 3 color/luminance

COLPF0 EQU    $D016 ;playfield 0 color/luminance
COLPF1 EQU    $D017 ;playfield 1 color/luminance
COLPF2 EQU    $D018 ;playfield 2 color/luminance
COLPF3 EQU    $D019 ;playfield 3 color/luminance

COLBK EQU     $D01A ;background color/luminance

PRIOR EQU     $D01B ;priority select
VDELAY EQU    $D01C ;vertical delay
GRCTL EQU     $D01D ;graphic control
HITCLR EQU    $D01E ;collision clear

```

** PBI Address Equates

```

PBI    EQU     $D100 ;parallel bus interface area

;      Read/Write Addresses

VSTB   EQU     $D104 ;parallel voice strobe
PBICTL EQU     $D108 ;parallel bus control
PMDATA EQU     $D10C ;parallel modem transmit/receive
PMCMD  EQU     $D10E ;parallel modem command
PMCTL  EQU     $D10F ;parallel modem control
DISKWR EQU     $D110 ;parallel disk write
DISKRD EQU     $D114 ;parallel disk read

```

; Read Addresses

PMSTAT EQU \$D10D ;parallel modem status
PDVI EQU \$D1FF ;external parallel device IRQ status
IPDVI EQU \$D1CF ;internal parallel device IRQ status

; Write Addresses

VOICE1 EQU \$D100 ;parallel voice data/interrupt control
DMST EQU \$D108 ;parallel disk/modem status
PDVS EQU \$D1FF ;parallel device select

** POKEY Address Equates

POKEY EQU \$D200 ;POKEY area

; Read Addresses

POT0 EQU \$D200 ;potentiometer 0
POT1 EQU \$D201 ;potentiometer 1
POT2 EQU \$D202 ;potentiometer 2
POT3 EQU \$D203 ;potentiometer 3
POT4 EQU \$D204 ;potentiometer 4
POT5 EQU \$D205 ;potentiometer 5
POT6 EQU \$D206 ;potentiometer 6
POT7 EQU \$D207 ;potentiometer 7

ALLPOT EQU \$D208 ;potentiometer port state
KBCODE EQU \$D209 ;keyboard code
RANDOM EQU \$D20A ;random number generator
SERIN EQU \$D20D ;serial port input
IRQST EQU \$D20E ;IRQ interrupt status
SKSTAT EQU \$D20F ;serial port and keyboard status

; Write Addresses

AUDF1 EQU \$D200 ;channel 1 audio frequency
AUDC1 EQU \$D201 ;channel 1 audio control

AUDF2 EQU \$D202 ;channel 2 audio frequency
AUDC2 EQU \$D203 ;channel 2 audio control

AUDF3 EQU \$D204 ;channel 3 audio frequency
AUDC3 EQU \$D205 ;channel 3 audio control

AUDF4 EQU \$D206 ;channel 4 audio frequency
AUDC4 EQU \$D207 ;channel 4 audio control

AUDCTL EQU \$D208 ;audio control
STIMER EQU \$D209 ;start timers
SKRES EQU \$D20A ;reset SKSTAT status
POTGO EQU \$D20B ;start potentiometer scan sequence
SEROUT EQU \$D20D ;serial port output
IRQEN EQU \$D20E ;IRQ interrupt enable
SKCTL EQU \$D20F ;serial port and keyboard control

** PIA Address Equates

PIA EQU \$D300 ;PIA area

; Read/Write Addresses

PORTA EQU \$D300 ;port A direction register or jacks 0 and 1

```

PORTB EQU    $D301 ;port B direction register or memory control

PACTL EQU    $D302 ;port A control
PBCTL EQU    $D303 ;port B control

```

** ANTIC Address Equates

```

ANTIC EQU    $D400 ;ANTIC area

;      Read Addresses

VCOUNT EQU   $D40B ;vertical line counter
PENH  EQU    $D40C ;light pen horizontal position
PENV  EQU    $D40D ;light pen vertical position
NMIST EQU    $D40F ;NMI interrupt status

;      Write Addresses

DMACTL EQU   $D400 ;DMA control
CHACTL EQU   $D401 ;character control
DLISTL EQU   $D402 ;low display list address
DLISTH EQU   $D403 ;high display list address
HSCROL EQU   $D404 ;horizontal scroll
VSCROL EQU   $D405 ;vertical scroll
PMBASE EQU   $D407 ;player-missile base address
CHBASE EQU   $D409 ;character base address
WSYNC EQU    $D40A ;wait for HBLANK synchronization
NMIEN EQU    $D40E ;NMI enable
NMIRES EQU   $D40F ;NMI interrupt status reset

```

** PBI RAM Address Equates

```

PBIRAM EQU   $D600 ;parallel bus interface RAM area

```

** ACMI Address Equates

```

ACMI  IF      ACMI
AMVTAD EQU    $D7EA ;vector table
AMINIT EQU    $D7F6 ;initialization address
AMNAME EQU    $D7F9 ;ACMI device code
AMISRA EQU    $D7FA ;interrupt service routine address
AMFLAG EQU    $D7FF ;ACMI flags
ACMI  ENDIF

```

** Floating Point Package Address Equates

```

AFP    EQU    $D800 ;convert ASCII to floating point
FASC   EQU    $D8E6 ;convert floating point to ASCII
IFP    EQU    $D9AA ;convert integer to floating point
FPI    EQU    $D9D2 ;convert floating point to integer
ZFR0   EQU    $DA44 ;zero FR0
ZF1    EQU    $DA46 ;zero floating point number
FSUB   EQU    $DA60 ;subtract floating point numbers
FADD   EQU    $DA66 ;add floating point numbers
FMUL   EQU    $DADB ;multiply floating point numbers
FDIV   EQU    $DB28 ;divide floating point numbers
PLYEVL EQU    $DD40 ;evaluate floating point polynomial
FLD0R  EQU    $DD89 ;load floating point number
FLD0P  EQU    $DD8D ;load floating point number
FLD1R  EQU    $DD98 ;load floating point number
FLD1P  EQU    $DD9C ;load floating point number
FST0R  EQU    $DDA7 ;store floating point number

```

```

FST0P EQU    $DDAB ;store floating point number
FMOVE EQU    $DDB6 ;move floating point number
LOG EQU      $DECD ;calculate floating point logarithm
LOG10 EQU    $DED1 ;calculate floating point base 10 logarithm
EXP EQU      $DDC0 ;calculate floating point exponentiation
EXP10 EQU    $DDCC ;calculate floating point base 10 exponentiation

```

** Parallel Device Address Equates

```

PDID1 EQU    $D803 ;parallel device ID 1
PDIOV EQU    $D805 ;parallel device I/O vector
PDIRQV EQU   $D808 ;parallel device IRQ vector
PDID2 EQU    $D80B ;parallel device ID 2
PDVV EQU     $D80D ;parallel device vector table

```

** Device Handler Vector Table Address Equates

```

EDITRV EQU   $E400 ;editor handler vector table
SCRENV EQU   $E410 ;screen handler vector table
KEYBDV EQU   $E420 ;keyboard handler vector table
PRINTV EQU   $E430 ;printer handler vector table
CSETV EQU    $E440 ;cassette handler vector table

```

** Jump Vector Address Equates

```

DINITV EQU   $E450 ;vector to initialize DIO
DSKINV EQU   $E453 ;vector to DIO
CIOV EQU     $E456 ;vector to CIO
SIOV EQU     $E459 ;vector to SIO
SETVBV EQU   $E45C ;vector to set VBLANK parameters
SYSVBV EQU   $E45F ;vector to process immediate VBLANK NMI
XITVBV EQU   $E462 ;vector to process deferred VBLANK NMI
SIOINV EQU   $E465 ;vector to initialize SIO
SENDEV EQU   $E468 ;vector to enable SEND
INTINV EQU   $E46B ;vector to initialize interrupt handler
CIOINV EQU   $E46E ;vector to initialize CIO
BLKBDV EQU   $E471 ;vector to power-up display (formerly memo pad)
WARMSV EQU   $E474 ;vector to warmstart
COLDSV EQU   $E477 ;vector to coldstart
RBLOKV EQU   $E47A ;vector to read cassette block
CSOPIV EQU   $E47D ;vector to open cassette for input
PUPDIV EQU   $E480 ;vector to power-up display
SLFTSV EQU   $E483 ;vector to self-test
PHENTV EQU   $E486 ;vector to enter peripheral handler
PHUNLV EQU   $E489 ;vector to unlink peripheral handler
PHINIV EQU   $E48C ;vector to initialize peripheral handler

```

** Generic Parallel Device Handler Vector Table Address Equates

```

GPDVV EQU    $E48F ;generic parallel device handler vector table

```

Miscellaneous Address Equates

** Self-test Page Zero Address Equates

```
STTIME EQU    $0080 ;2-byte main screen timeout timer
STAUT  EQU    $0082 ;1-byte auto-mode flag
STJMP  EQU    $0083 ;3-byte ANTIC jump instruction
STSEL  EQU    $0086 ;1-byte selection
STPASS EQU    $0087 ;1-byte pass
STSPP  EQU    $0088 ;1-byte SELECT previously pressed flag
;      EQU    $0089 ;1-byte (not used)
STKST  EQU    $008A ;1-byte keyboard self-test flag (0 = not)
STCHK  EQU    $008B ;2-byte checksum
STSMM  EQU    $008D ;1-byte screen memory mask
STSMP  EQU    $008E ;1-byte screen memory pointer
ST1K   EQU    $008F ;1-byte current 1K of memory to test
STPAG  EQU    $0090 ;2-byte current page to test
STPC   EQU    $0092 ;1-byte page count
STMVAL EQU    $0093 ;1-byte correct value for memory test
STSKP  EQU    $0094 ;1-byte simulated keypress index
STTMP1 EQU    $0095 ;2-byte temporary
STVOC  EQU    $0097 ;1-byte current voice indicator
STNOT  EQU    $0098 ;1-byte current note counter
STCDI  EQU    $0099 ;1-byte cleft display pointer
STCDA  EQU    $009A ;1-byte cleft data pointer
STTMP2 EQU    $009B ;2-byte temporary
STTMP3 EQU    $009D ;1-byte temporary
STADR1 EQU    $009E ;2-byte temporary address
STADR2 EQU    $00A0 ;2-byte temporary address
STBL   EQU    $00A2 ;1-byte blink counter
STTMP4 EQU    $00A3 ;1-byte temporary
STLM   EQU    $00A4 ;1-byte LED mask
STTMP5 EQU    $00A5 ;1-byte temporary
```

** Self-test Address Equates

```
ST3000 EQU    $3000 ;screen memory
ST3002 EQU    $3002 ;cleft display
ST3004 EQU    $3004 ;"VOICE #" text display
ST300B EQU    $300B ;voice number display
ST301C EQU    $301C ;START key display
ST301E EQU    $301E ;SELECT key display
ST3020 EQU    $3020 ;OPTION key display, first 8K ROM display
ST3021 EQU    $3021 ;keyboard character display
ST3022 EQU    $3022 ;keyboard text display
ST3024 EQU    $3024 ;second 8K ROM display
ST3028 EQU    $3028 ;"RAM" text display
ST3038 EQU    $3038 ;RAM display
ST303C EQU    $303C ;fifth note display
ST304C EQU    $304C ;"B S" text display
ST3052 EQU    $3052 ;tab key display
ST3062 EQU    $3062 ;cleft display
ST306D EQU    $306D ;return key display
ST3072 EQU    $3072 ;control key display
ST3092 EQU    $3092 ;"SH" text display
ST309E EQU    $309E ;sixth note display
ST30AB EQU    $30AB ;"SH" text display
ST30B7 EQU    $30B7 ;"S P A C E   B A R" text display
ST30C1 EQU    $30C1 ;cleft display
ST30C2 EQU    $30C2 ;cleft display
ST30C7 EQU    $30C7 ;third note display
ST30CA EQU    $30CA ;fourth note display
ST30F8 EQU    $30F8 ;third note display
```

ST3100 EQU	\$3100	;screen memory
ST3121 EQU	\$3121	;cleft display
ST3122 EQU	\$3122	;cleft display
ST313C EQU	\$313C	;fifth note display
ST3150 EQU	\$3150	;first line of staff display
ST3154 EQU	\$3154	;first note display
ST3181 EQU	\$3181	;cleft display
ST3182 EQU	\$3182	;cleft display
ST3186 EQU	\$3186	;second note display
ST318C EQU	\$318C	;fifth note display
ST31B0 EQU	\$31B0	;second line of staff display
ST31C2 EQU	\$31C2	;cleft display
ST31CA EQU	\$31CA	;fourth note display
ST31EE EQU	\$31EE	;sixth note display
ST31F1 EQU	\$31F1	;cleft display
ST3210 EQU	\$3210	;third line of staff display
ST321A EQU	\$321A	;fourth note display
ST3248 EQU	\$3248	;third note display
ST3270 EQU	\$3270	;fourth line of staff display
ST32D0 EQU	\$32D0	;fifth line of staff display

Macro Definitions

```
**      FIX - Fix Address
*
*      FIX sets the origin counter to the value specified as an
*      argument.  If the current origin counter is less than the
*      argument, FIX fills the intervening bytes with zero and
*      issues a message to document the location and number of
*      bytes that are zero filled.
*
*      ENTRY  FIX      address
*
*
*      EXIT
*          Origin counter set to specified address.
*          Message issued if zero fill required.
*
*      CHANGES
*          -none-
*
*      CALLS
*          -none-
*
*      NOTES
*          Due to ECHO limitation of 255 iterations, FIX is
*          recursive.
*          If the current origin counter value is beyond the
*          argument, FIX generates an error.
*
*      MODS
*          R. K. Nordin 1983-11-01
```

```
FIX      MACRO  address
IF      %1 <> *0
IF      %1 > *0
IF      %1 - *0 < 256
MSG      '$',%1 - *0,' free bytes from $',*0,' to $',%1 - 1
ECHO     %1 - *0
DB      0
ENDM
ELSE
FIX      *0 + 255
FIX      %1
ENDIF
ELSE
ERR              ;%1 precedes current origin counter value
ENDIF
ENDIF
ORG      *0
ENDM
```

First 8K ROM Identification and Checksum

ORG \$C000

** First 8K ROM Identification and Checksum
--

DW	\$0000	;reserved for checksum
DB	IDDAY, IDMON, IDYEAR	;date (day, month, year)
DB	IDCPU	;CPU series
DB	IDPN1, IDPN2, IDPN3, IDPN4, IDPN5	;part number
DB	IDREV	;revision number

Interrupt Handler

```
**      IIH - Initialize Interrupt Handler
*
*      ENTRY JSR      IIH
*              TRIG3 = ACMI module interlock
*              TRIG2 = cartridge interlock
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01
```

```
IIH      =      *      ;entry

      LDA      #$40
      STA      NMIIEN ;disable DLI and enable VBLANK NMI

      LDA      TRIG3 ;cartridge interlock
      STA      GINTLK ;cartridge interlock status
```

```
ACMI     IF      ACMI
      LDA      TRIG2 ;ACMI module interlock
      STA      MINTLK ;ACMI module interlock status
ACMI     ENDIF
```

```
      RTS      ;return
```

```
**      NMI - Process NMI
*
*      ENTRY JMP      NMI
*              ??
*
*      EXIT
*              Exits via appropriate vector to process NMI
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01
```

```
NMI      =      *      ;entry

      ASSERT $C0=high NMI ;for compatibility with LNBUG

;      Check for display list NMI.
```

```

        BIT    NMIST
        BPL    NMI1            ;if not display list NMI

        JMP    (VDSLST)        ;process display list NMI, return

;    Initialize.

NMI1    CLD

;    Save registers.

        PHA            ;save A
        TXA            ;save X
        TYA            ;save Y
        PHA            ;save Y

;    Reset NMI status.

        STA    NMIRES        ;reset NMI status

;    Process NMI.

LNBUG    IF    LNBUG
        LDA    LNFLG        ;LNBUG flag
        BNE    NMI2        ;if LNBUG

        JMP    (VVBLKI)        ;process immediate VBLANK NMI, return

NMI2    JMP    (LNNMI)        ;invoke LNBUG NMI routine, return
LNBUG    ELSE
        JMP    (VVBLKI)        ;process immediate VBLANK NMI, return
LNBUG    ENDIF

```

```

**    IRQ - Process IRQ
*
*    ENTRY    JMP    IRQ
*            ??
*
*    EXIT
*            Exits via VIMIRQ vector
*            ??
*
*    CHANGES
*            ??
*
*    CALLS
*            ??
*
*    MODS
*            Original Author Unknown    ??/??/??
*            1. Bring closer to Coding Standard (object unchanged).
*            R. K. Nordin    1983-11-01

```

```

IRQ    =    *            ;entry

;    Initialize.

        CLD

;    Process IRQ.

```

```

LNBUG    IF    LNBUG
        BIT    LNFLG
        BMI    IRQ1        ;if LNBUG on

```

```

        JMP      (VIMIRQ)      ;process immediate IRQ, return
IRQ1    JMP      LNIRQ         ;invoke LNBUG IRQ routine, return
LNBUG   ELSE
        JMP      (VIMIRQ)      ;process immediate IRQ, return
LNBUG   ENDIF

```

```

**      IIR - Process Immediate IRQ
*
*      ENTRY  JMP      IIR
*            ??
*
*      EXIT
*            Exits via appropriate vector to process IRQ
*            ??
*
*      CHANGES
*            ??
*
*      CALLS
*            ??
*
*      MODS
*            Original Author Unknown   ??/??/??
*            1. Bring closer to Coding Standard (object unchanged).
*               R. K. Nordin      1983-11-01
*            2. Y.T. Jang      1984-05-15

```

```

IIR      =      *      ;entry
;      Initialize.

        PHA          ;save A
;      Check for serial input ready IRQ.

        LDA      IRQST ;IRQ status
        AND      #$20  ;serial input ready
        BNE      IIR1  ;if not serial input ready
;      Process serial input IRQ.

        LDA      #not $20 ;all other interrupts
        STA      IRQEN   ;enable all other interrupts
        LDA      POKMSK
        STA      IRQEN
        JMP      (VSERIN) ;process serial input ready IRQ, return
;      Process possible ACMI IRQ.

IIR1
ACMI     IF      ACMI
        JSR      AIR      ;process possible ACMI IRQ
        BCS      BIR1     ;if interrupt processed, return
ACMI     ENDIF

```

```

;      Initialize further.

        TXA
        PHA          ;save X
;      Check for parallel device IRQ.

        LDA      PDVI  ;external parallel device IRQ statuses

```

```

AND    PDIMSK ;select desired external IRQ statuses
STA    ABUFPT ;temp 4 bytes reserved for parallel device IRQ area

LDA     IPDVI ;internal parallel device IRQ statuses
AND     IPDIMK
ORA     ABUFPT
BEQ     IIR2 ;if no desired IRQ

;      Process parallel device IRQ.

JMP     (VPIRQ) ;process parallel device IRQ, return

;      Check other types of IRQ.

IIR2   LDX     #TIRQL-1-1 ;offset to next to last entry

IIR3   LDA     TIRQ,X      ;IRQ type
CPX     #5                ;offset to serial out complete
BNE     IIR4              ;if not serial out complete

AND     POKMSK            ;and with POKEY IRQ enable
BEQ     IIR5              ;if serial out complete not enabled

IIR4   BIT     IRQST       ;IRQ interrupt status
BEQ     IIR6              ;if interrupt found

IIR5   DEX
BPL     IIR3              ;if not done

;      Continue IRQ processing.

JMP     CIR               ;continue IRQ processing, return

;      Enable other interrupts.

IIR6   EOR     #$FF        ;complement mask
STA     IRQEN             ;enable all others
LDA     POKMSK            ;POKEY IRQ mask
STA     IRQEN             ;enable indicated IRQ's

;      Check for BREAK key IRQ.

CPX     #0
BNE     IIR7              ;if not BREAK key IRQ

;      Check for keyboard disabled.

LDA     KEYDIS
BNE     CIR               ;if keyboard disabled, continue, return

;      Process IRQ.

IIR7   LDA     TOIH,X      ;offset to interrupt handler
TAX
LDA     INTABS,X          ;interrupt handler address
STA     JVECK
LDA     INTABS+1,X
STA     JVECK+1
PLA
TAX                      ;restore X
JMP     (JVECK)           ;process interrupt, return

```

```

**      BIR - Process BREAK Key IRQ
*
*      ENTRY  JMP      BIR
*              ??
*
*      EXIT
*              Exits via RTI
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

BIR      =      *      ;entry

;      Process BREAK.

      LDA      #0
      STA      BRKKEY ;clear BREAK key flag
      STA      SSFLAG ;clear start/stop flag
      STA      CRSINH ;enable cursor
      STA      ATTRACT ;turn off attract-mode

;      Exit.

BIR1     PLA      ;restore A
          RTI      ;return

```

```

**      CIR - Continue IRQ Processing
*
*      ENTRY  JMP      CIR
*              ??
*
*      EXIT
*              Exits via appropriate vector to process IRQ or to XIR
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

CIR      =      *      ;entry

;      Initialize.

      PLA      ;saved ???
      TAX

;      Check for port A interrupt.

```

```

    BIT    PACTL      ;port A control
    BPL    CIR1        ;if not port A interrupt

;    Process proceed line IRQ.

    LDA    PORTA      ;clear interrupt status bit
    JMP    (VPRCED)    ;process proceed line IRQ, return

;    Check for port B interrupt.

CIR1  BIT    PBCTL      ;port B control
      BPL    CIR2        ;if not port B interrupt

;    Process interrupt line IRQ.

    LDA    PORTB      ;clear interrupt status bit
    JMP    (VINTER)    ;process interrupt line IRQ, return

;    Check for BRK instruction IRQ.

CIR2  PLA
      STA    JVECK      ;save ???

      PLA              ;saved P
      PHA              ;resave P
      AND    #$10       ;B bit of P register
      BEQ    CIR3        ;if not BRK instruction IRQ

;    Process BRK instruction IRQ.

    LDA    JVECK      ;saved ???
    PHA
    JMP    (VBREAK)    ;process BRK instruction IRQ, return

;    Exit IRQ processing.

CIR3  LDA    JVECK      ;saved ???
      PHA
;      JMP    XIR        ;exit IRQ processing, return

```

```

**    XIR - Exit IRQ Processing
*
*    ENTRY  JMP    XIR
*           ??
*
*    EXIT
*           Exits to RIR
*           ??
*
*    CHANGES
*           ??
*
*    CALLS
*           ??
*
*    MODS
*           Original Author Unknown    ??/??/??
*           1. Bring closer to Coding Standard (object unchanged).
*           R. K. Nordin    1983-11-01

```

```

XIR  =    *    ;entry
      PLA      ;restore A
;      JMP    RIR    ;return from interrupt

```

```
**      RIR - Return from Interrupt
*
*      ENTRY  JMP      RIR
*             ??
*
*      EXIT
*             Exits via RTI
*             ??
*
*      CHANGES
*             ??
*
*      CALLS
*             ??
*
*      MODS
*             Original Author Unknown   ??/??/??
*             1. Bring closer to Coding Standard (object unchanged).
*             R. K. Nordin      1983-11-01
```

```
RIR      =      *      ;entry
          RTI      ;return
```

```
**      AIR - Process ACMI IRQ
*
*      ENTRY  JSR      AIR
*             ??
*
*      EXIT
*             ??
*
*      CHANGES
*             ??
*
*      CALLS
*             ??
*
*      MODS
*             Original Author Unknown   ??/??/??
*             1. Bring closer to Coding Standard (object unchanged).
*             R. K. Nordin      1983-11-01
```

```
ACMI     IF      ACMI
AIR      =      *      ;entry
          JMP      (ACMISR) ;process ACMI interrupt, return
ACMI     ENDIF
```

```
**      TIRQ - Table of IRQ Types
*
*      Entry n is the interrupt indicator of priority n (0 is lowest).
*
*      NOTES
*      Problem: entry 7 (serial input ready) not used.
```

```
TIRQ     DB      $80      ;0 - BREAK key IRQ
          DB      $40      ;1 - keyboard IRQ
          DB      $04      ;2 - timer 4 IRQ
          DB      $02      ;3 - timer 2 IRQ
          DB      $01      ;4 - timer 1 IRQ
          DB      $08      ;5 - serial output complete IRQ
          DB      $10      ;6 - serial output ready IRQ
          DB      $20      ;7 - serial input ready IRQ
```

```
TIRQQL   =      *-TIRQ ;length
```

```

**      TOIH - Table of Offsets to Interrupt Handlers
*
*      Entry n is the offset to the interrupt handler vector
*      corresponding to entry n of TIRQ.
*
*      NOTES
*      Problem: entry 7 (serial input ready) not used.

```

```

TOIH  DB    BRKKY-INTABS ;0 - BREAK key IRQ
      DB    VKEYBD-INTABS;1 - keyboard IRQ
      DB    VTIMR4-INTABS;2 - timer 4 IRQ
      DB    VTIMR2-INTABS;3 - timer 2 IRQ
      DB    VTIMR1-INTABS;4 - timer 1 IRQ
      DB    VSEROC-INTABS;5 - serial output complete IRQ
      DB    VSEROR-INTABS;6 - serial output ready IRQ
      DB    VSERIN-INTABS;7 - serial input ready IRQ

```

```

**      WFR - Wait for RESET
*
*      WFR loops forever.
*
*      ENTRY JMP    WFR
*
*      EXIT
*      Does not exit
*
*      CHANGES
*      ??
*
*      CALLS
*      ??
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin    1983-11-01

```

```

WFR    =      *      ;entry

;      Loop forever, waiting for RESET.

WFR1   JMP     WFR1   ;loop

```

```

**      IVNM - Process Immediate VBLANK NMI
*
*      ENTRY JSR      IVNM
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

IVNM = * ;entry

;      Increment frame counter and attract-mode counter.

      INC      RTCLOK+2      ;increment low frame counter
      BNE      IVN1          ;if low counter not zero

      INC      ATTRACT      ;increment attract-mode counter/flag
      INC      RTCLOK+1      ;increment middle frame counter
      BNE      IVN1          ;if middle counter not zero

      INC      RTCLOK        ;increment high frame counter

;      Set attract-mode effects.

IVN1  LDA      #$FE          ;select no luminance change
      LDX      #0            ;select no color shift
      LDY      ATTRACT      ;attract-mode timer/flag
      BPL      IVN2          ;if not attract-mode

      STA      ATTRACT      ;ensure continued attract-mode
      LDX      RTCLOK+1      ;select color shift
      LDA      #$F6          ;select lower luminance

IVN2  STA      DRKMSK        ;attract-mode luminance
      STX      COLRSH        ;attract-mode color shift

;      Update COLPF1 (in case fine scrolling and critical section).

      LDA      COLOR1        ;playfield 1 color
      EOR      COLRSH        ;modify color with attract-mode color shift
      AND      DRKMSK        ;modify with attract-mode luminance
      STA      COLPF1        ;set playfield 1 color/luminance

;      Process countdown timer 1.

      LDX      #0            ;indicate countdown timer 1
      JSR      DCT           ;decrement countdown timer
      BNE      IVN3          ;if timer not expired

      JSR      PT0           ;process countdown timer 1 expiration

;      Check for critical section.

IVN3  LDA      CRITIC
      BNE      IVN4          ;if critical section

```

```

;      Check for IRQ enabled.

      TSX                ;stack pointer
      LDA    $0104,X     ;stacked P
      AND    #$04        ;I (IRQ disable) bit
      BEQ    IVN5        ;if IRQ enabled

;      Exit.

IVN4   JMP     DVNM      ;process deferred VBLANK NMI, return

;      Process IRQ enabled non-critical section.

IVN5

;      Check for ACMI module change.

ACMI   IF      ACMI
      LDA     TRIG2      ;ACMI module interlock
      CMP     MINTLK     ;previous ACMI module interlock status
      BNE     WFR        ;if ACMI module change, wait for RESET
ACMI   ENDIF

;      Check for cartridge change.

      LDA     TRIG3      ;cartridge interlock
      CMP     GINTLK     ;previous cartridge interlock status
      BNE     WFR        ;if cartridge change, wait for RESET

;      Set hardware registers from shadows.

      LDA     PENV
      STA     LPENV      ;light pen vertical position
      LDA     PENH
      STA     LPENH      ;light pen vertical position
      LDA     SDLSTH
      STA     DLISTH     ;high display list address
      LDA     SDLSTL
      STA     DLISTL     ;low display list address
      LDA     SDMCTL
      STA     DMACTL     ;DMA control
      LDA     GPRIOR
      STA     PRIOR      ;priority select

;      Check for vertical scroll enabled.

      LDA     VSFLAG     ;vertical scroll count
      BEQ     IVN6      ;if vertical scroll not enabled

;      Scroll one line.

      DEC     VSFLAG     ;decrement vertical scroll count
      LDA     #8         ;scroll one line
      SEC
      SBC     VSFLAG     ;subtract vertical scroll count
      AND     #07
      STA     VSCROL     ;set vertical scroll

;      Turn off speaker.

IVN6   LDX     #$08      ;speaker off
      STX     CONSOL     ;set speaker control

;      Set color registers from shadows.

;      LDX     #8         ;offset to background color

```

```

IVN7  CLI
      LDA    PCOLR0,X      ;color register shadow
      EOR    COLRSH        ;modify with attract-mode color shift
      AND    DRKMSK        ;modify with attract-mode luminance
      STA    COLPM0,X      ;set color register
      DEX
      BPL    IVN7          ;if not done

;      Set character set control.

      LDA    CHBAS
      STA    CHBASE
      LDA    CHACT
      STA    CHACTL

;      Process countdown timer 2.

      LDX    #2            ;indicate countdown timer 2
      JSR    DCT            ;decrement countdown timer
      BNE    IVN8          ;if timer not expired

      JSR    PTT            ;process countdown timer 2 expiration

;      Process timers 3, 4 and 5.

IVN8  LDX    #2            ;preset offset to timer 2

IVN9  INX
      INX            ;offset to countdown timer
      LDA    CDTMV3-4,X    ;countdown timer
      ORA    CDTMV3+1-4,X
      BEQ    IVN10         ;if countdown timer already expired

      JSR    DCT            ;decrement countdown timer
      STA    CDTMF3-4,X    ;indicate timer expiration status

IVN10 CPX    #8            ;offset to timer 5
      BNE    IVN9          ;if all timers not done

;      Check debounce counter.

      LDA    SKSTAT        ;keyboard status
      AND    #$04          ;key down indicator
      BEQ    IVN11         ;if key down

;      Process key up.

      LDA    KEYDEL        ;key delay counter
      BEQ    IVN11         ;if counted down already

      DEC    KEYDEL        ;decrement key delay counter

;      Check software key repeat timer.

IVN11 LDA    SRTIMR        ;key repeat timer
      BEQ    IVN13         ;if key repeat timer expired

      LDA    SKSTAT        ;keyboard status
      AND    #$04          ;key down indicator
      BNE    IVN12         ;if key no longer down

      DEC    SRTIMR        ;decrement key repeat timer
      BNE    IVN13         ;if key repeat timer not expired

;      Process key repeat timer expiration.

```

```

    LDA    KEYDIS    ;keyboard disable flag
    BNE    IVN13     ;if keyboard disabled, no repeat

    LDA    KEYREP    ;initial timer value
    STA    SRTIMR    ;reset key repeat timer
    LDA    KBCODE    ;key code

;    Check for hidden codes.

    CMP    #CNTL1
    BEQ    IVN13     ;if CTRL-1

    CMP    #CNTLF1
    BEQ    IVN13     ;if CTRL-F1

    CMP    #CNTLF2
    BEQ    IVN13     ;if CTRL-F2

    CMP    #CNTLF4
    BEQ    IVN13     ;if CTRL-F4

    AND    #$3F
    CMP    #HELP
    BEQ    IVN13     ;if HELP

;    Set key code.

    LDA    KBCODE    ;key code
    STA    CH        ;set key code
    JMP    IVN13     ;continue

;    Zero key repeat timer.
IVN12 LDA    #0
    STA    SRTIMR    ;zero key repeat timer

;    Read joysticks.
IVN13 LDA    PORTA    ;joystick readings
    LSR    A
    LSR    A
    LSR    A
    LSR    A        ;joystick 1 reading
    STA    STICK1    ;set joystick 1 reading
VGC   IF      VGC
    STA    STICK3    ;simulate joystick 3 reading
VGC   ENDIF

    LDA    PORTA    ;joystick readings
    AND    #$0F    ;joystick 0 reading
    STA    STICK0    ;set joystick 0 reading
VGC   IF      VGC
    STA    STICK2    ;simulate joystick 2 reading
VGC   ENDIF

;    Read joystick triggers.

    LDA    TRIG0    ;trigger 0 indicator
    STA    STRIG0    ;set trigger 0 indicator
VGC   IF      VGC
    STA    STRIG2    ;simulate trigger 2 indicator
VGC   ENDIF

    LDA    TRIG1    ;trigger 1 indicator
    STA    STRIG1    ;set trigger 1 indicator
VGC   IF      VGC
    STA    STRIG3    ;simulate trigger 3 indicator
VGC   ENDIF

```

```

;      Read potentiometers.

      LDX    #3          ;offset to last potentiometer
IVN14 LDA    POT0,X       ;potentiometer reading
      STA    PADDL0,X    ;set potentiometer reading
VGC   IF     VGC
VGC   STA    PADDL4,X    ;simulate potentiometer reading
      ENDF
      DEX
      BPL    IVN14       ;if not done

;      Start potentiometers for next time.

      STA    POTG0       ;start potentiometers

;      Read paddle triggers.

      LDX    #2          ;offset to paddle trigger reading
      LDY    #1          ;offset to joystick reading
IVN15 LDA    STICK0,Y     ;joystick reading
      LSR    A
      LSR    A
      LSR    A           ;paddle trigger reading
      STA    PTRIG1,X    ;set paddle trigger reading
VGC   IF     VGC
VGC   STA    PTRIG5,X    ;simulate paddle trigger reading
      ENDF

      LDA    #0
      ROL    A           ;paddle trigger reading
      STA    PTRIG0,X    ;set paddle trigger reading
VGC   IF     VGC
VGC   STA    PTRIG4,X    ;simulate paddle trigger reading
      ENDF
      DEX
      DEX
      DEY
      BPL    IVN15       ;if not done

;      Process deferred VBLANK NMI.

      JMP    (VVBLKD)    ;process deferred VBLANK NMI, return

```

```

**      PTO - Process Countdown Timer One Expiration
*
*      ENTRY JSR      PTO
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

PTO      =      *      ;entry
          JMP      (CDTMA1) ;process countdown timer 1 expiration

```

```

**      PTT - Process Countdown Timer Two Expiration
*
*      ENTRY JSR      PTT
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

PTT      =      *      ;entry
          JMP      (CDTMA2) ;process countdown timer 2 expiration

```

```

**      DCT - Decrement Countdown Timer
*
*      ENTRY JSR      DCT
*              X = offset to timer value
*
*      EXIT
*              A = 0, if timer expired
*              = $FF, if timer did not expire
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

DCT      =      *      ;entry
          LDY     CDTMV1,X      ;low timer value
          BNE     DCT1          ;if low timer value not zero

          LDY     CDTMV1+1,X    ;high timer value
          BEQ     DCT2          ;if timer value zero, exit

          DEC     CDTMV1+1,X    ;decrement high timer value

DCT1     DEC     CDTMV1,X      ;decrement low timer value
          BNE     DCT2          ;if low timer value not zero

          LDY     CDTMV1+1,X    ;high timer value
          BNE     DCT2          ;if high timer value not zero

          LDA     #0            ;indicate timer expired
          RTS                      ;return

DCT2     LDA     #$FF          ;indicate timer did not expire
          RTS                      ;return

```

```

**      SVP - Set Vertical Blank Parameters
*
*      SVP sets countdown timers and VBLANK vectors.
*
*      ENTRY JSR      SVP
*              X = high initial timer value or high vector address
*              Y = low initial timer value or low vector address
*              A = 1, if timer 1 value
*                  2, if timer 2 value
*                  3, if timer 3 value
*                  4, if timer 4 value
*                  5, if timer 5 value
*                  6, if immediate VBLANK vector
*                  7, if deferred VBLANK vector
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown    ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

SVP      =      *              ;entry

;      Initialize.

      ASL      A              ;compute offset+2 to value or vector
      STA      INTEMP        ;offset+2 to value or vector
      TXA              ;high timer value or high vector address

;      Ensure no VBLANK in progress by delaying after HBLANK.

      LDX      #5              ;20 CPU cycles
      STA      WSYNC          ;wait for HBLANK synchronization

SVP1     DEX
      BNE      SVP1          ;if not done delaying

;      Set timer value or vector address.

      LDX      INTEMP        ;offset+2 to value or vector
      STA      CDTMV1-2+1,X  ;high timer value or high vector address
      TYA
      STA      CDTMV1-2,X    ;low timer value or low vector address
      RTS                  ;return

```

```

**      DVNM - Process Deferred VBLANK NMI
*
*      ENTRY   ??? JSR DVNM
*              ??
*
*      EXIT
*              Exits via RTI
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

DVNM  =      *      ;entry
      PLA
      TAY      ;restore Y
      PLA
      TAX      ;restore X
      PLA      ;restore A
      RTI      ;return

```

Initialization

```
**      PWS - Perform Warmstart
*
*      ENTRY  JMP      PWS
*              ??
*
*      EXIT
*              Exits to PCS or PRS
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01
```

```
PWS      =      *      ;entry
;      Initialize.
      SEI
;      Check for cartridge change.
      LDA      TRIG3 ;cartridge interlock
      CMP      GINTLK ;previous cartridge interlock status
      BNE      PCS      ;if cartridge changed, perform coldstart
;      Check for cartridge.
      ROR      A
      BCC      PWS1      ;if no cartridge
;      Verify no change in cartridge.
      JSR      CCE      ;check cartridge equivalence
      BNE      PCS      ;if different cartridge, coldstart
;      Check coldstart status.
PWS1     LDA      COLDST ;coldstart status
      BNE      PCS      ;if coldstart was in progress, perform coldstart
;      Perform warmstart.
      LDA      #$FF      ;indicate warmstart
      BNE      PRS      ;preset memory, return
```

```

**      RES - Process RESET
*
*      ENTRY  JMP      RES
*              ??
*
*      EXIT
*              Exits to PCS, if coldstart, or PWS, if warmstart
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

RES      =      *      ;entry
;      Initialize.

      SEI

;      Delay 0.1 second for RESET bounce.

      LDX      #140      ;0.1 second delay
RES1     DEY
      BNE      RES1      ;if inner loop not done

      DEX
      BNE      RES1      ;if outer loop not done
;      Check power-up validation bytes.

      LDA      PUPBT1
      CMP      #PUPVL1
      BNE      PCS      ;if validation byte 1 differs, coldstart

      LDA      PUPBT2
      CMP      #PUPVL2
      BNE      PCS      ;if validation byte 2 differs, coldstart

      LDA      PUPBT3
      CMP      #PUPVL3
      BEQ      PWS      ;if all bytes validated, perform warmstart
;      TRP      PCS      ;perform coldstart, return

```

```

**      PCS - Perform Coldstart
*
*      ENTRY  JMP      PCS
*              ??
*
*      EXIT
*              Exits to PRS
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown    ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

PCS      =      *      ;entry
          LDA      #0      ;indicate coldstart
          ;      JMP      PRS      ;preset memory, return

```

```

**      PRS - Preset Memory
*
*      ENTRY  JMP      PRS
*              ??
*
*      EXIT
*              Exits to EMS, if memory bad
*              Exits via CARTCS vector or DOSVEC vector
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown    ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

PRS      =      *      ;entry
;
;      Update warmstart flag.
          STA      WARMST      ;update warmstart flag
;
;      Set initial conditions.
          SEI
          CLD
          LDX      #$FF
          TXS              ;set stack pointer
;
;      Initialize LNBUG flag, if necessary.

```

```

LNBUG    IF      LNBUG
          LDY      #0          ;assume no LNBUG
          LDA      LNORG      ;first byte of LNBUG
          CMP      #$4C      ;JMP instruction

```

```

    BNE    PRS2        ;if ZMP not present, indicate no LNBUG

    INC    LNORG        ;try to increment test byte
    CMP    LNORG        ;original contents of test byte
    BEQ    PRS1        ;if no change, LNBUG present

    DEC    LNORG        ;restore test byte
    BNE    PRS2        ;indicate no LNBUG

PRS1    DEY            ;LNBUG present indicator

PRS2    STY    LNFLAG    ;LNBUG flag
LNBUG    ENDIF

;    Perform miscellaneous initialization.

    JSR    PMI            ;perform miscellaneous initialization

;    Initialize memory status.

    LDA    #1            ;no failure indicator
    STA    NGFLAG        ;memory status flag

;    Check type.

    LDA    WARMST        ;warmstart flag
    BNE    PRS8        ;if warmstart

;    Zero all RAM (except beginning of page zero).

    LDA    #0
    LDY    #WARMST        ;initial offset into page zero
    STA    RAMLO
    STA    RAMLO+1        ;initialize RAM pointer

PRS3    LDA    #$FF
    STA    (RAMLO),Y        ;attempt to store $FF
    CMP    (RAMLO),Y
    BEQ    PRS4        ;if $FF stored successfully

    LSR    NGFLAG        ;indicate memory failure

PRS4    LDA    #$00
    STA    (RAMLO),Y        ;attempt to store $00
    CMP    (RAMLO),Y
    BEQ    PRS5        ;if $00 stored successfully

    LSR    NGFLAG        ;indicate memory failure

PRS5    INY
    BNE    PRS3        ;if not end of page

;    Advance to next page and check for completion.

    INC    RAMLO+1        ;advance RAM pointer to next page
    LDX    RAMLO+1
    CPX    TRAMSZ        ;RAM size
    BNE    PRS3        ;if not at end of RAM

;    Initialize due to unknown flip flop state
;    with BARBARA; otherwise potential ROM checksum error
;    on power up

    STA    PDVI            ;PDVI = 0

;    Initialize DOSVEC.

```

```

    LDA    #low PPD      ;power-up display routine address
    STA    DOSVEC        ;initialize DOS vector
    LDA    #high PPD
    STA    DOSVEC+1

;    Verify ROM checksums.

    LDA    PORTB
    AND    #$7F          ;select self-test ROM
    STA    PORTB          ;port B memory control

    JSR    VFR            ;verify first 8K ROM
    BCS    PRS6            ;if first 8K ROM bad

    JSR    VSR            ;verify second 8K ROM
    BCC    PRS7            ;if second 8K ROM good

PRS6    LSR    NGFLAG      ;indicate memory bad

PRS7    LDA    PORTB
    ORA    #$80          ;disable self-test ROM
    STA    PORTB          ;update port B memory control

;    Indicate coldstart in progress.

    LDA    #$FF
    STA    COLDST        ;indicate coldstart in progress
    BNE    PRS12          ;continue with coldstart procedures

;    Perform warmstart procedures.

PRS8    LDX    #0

    LDA    DERRF          ;screen OPEN error flag
    BEQ    PRS9            ;if in screen OPEN

;    Clean up APPMHI.

    STX    APPMHI
    STX    APPMHI+1
    TXA

;    Clear page 2 and part of page 3.

PRS9    STA    $0200,X      ;clear byte of page 2

    CPX    #low ACMVAR    ;start of page 3 locations not to clear
    BCS    PRS10          ;if not to clear this page 3 location

    STA    $0300,X      ;clear byte of page 3

PRS10   DEX
    BNE    PRS9            ;if not done

;    Clear part of page 0.

    LDX    #INTZBS        ;offset to first page 0 byte to clear

PRS11   STA    $0000,X      ;clear byte of page 0
    INX
    BPL    PRS11          ;if not done

;    Record BASIC status.

PRS12   LDX    #0          ;initially assume BASIC enabled
    LDA    PORTB          ;port B memory control
    AND    #$02          ;BASIC enabled indicator

```

```

    BEQ    PRS13        ;if BASIC enabled

    INX                    ;indicate BASIC disabled

PRS13 STX    BASICF        ;BASIC flag

;    Establish power-up validation bytes.

    LDA    #PUPVL1
    STA    PUPBT1        ;validation byte 1
    LDA    #PUPVL2
    STA    PUPBT2        ;validation byte 2
    LDA    #PUPVL3
    STA    PUPBT3        ;validation byte 3

;    Establish screen margins.

    LDA    #LEDGE
    STA    LMARGN        ;left margin
    LDA    #REDGE
    STA    RMARGN        ;right margin

;    Establish parameters for NTSC or PAL.

    LDA    PAL            ;GTIA flag bits
    AND    #$0E          ;PAL/NTSC indicator
    BNE    PRS14        ;if NTSC

    LDA    #5            ;PAL key repeat delay
    LDX    #1            ;PAL indicator
    LDY    #40          ;PAL key repeat initial delay
    BNE    PRS15        ;set parameters

PRS14 LDA    #6            ;NTSC key repeat delay
    LDX    #0            ;NTSC indicator
    LDY    #48          ;NTSC key repeat initial delay

PRS15 STA    KEYREP        ;set key repeat rate
    STX    PALNTS        ;set PAL/NTSC status
    STY    KRPDEL        ;set key repeat initial delay

;    Initialize missing controller ports, if not simulated.

VGC    IF    not VGC
    LDA    #$0F          ;joystick centered
    STA    STICK2
    STA    STICK3
    LDA    #$01          ;trigger not pressed
    STA    STRIG2
    STA    STRIG3

    LDX    #3            ;offset to last controller

PRS16 LDA    #$E4          ;paddle fully counter-clockwise
    STA    PADDL4,X
    LDA    #$01          ;trigger not pressed
    STA    PTRIG4,X
    DEX
    BPL    PRS16        ;if not done
VGC    ENDIF

;    Copy interrupt vector table from ROM to RAM.

    LDX    #TIHVL-1      ;offset to last byte of table

PRS17 LDA    TIHV,X        ;byte of table of interrupt vectors
    STA    INTABS,X        ;byte of RAM table

```

```

    DEX
    BPL    PRS17        ;if not done

;    Copy handler vector table from ROM to RAM.

    LDX    #THAVL-1    ;offset to last byte of table

PRS18 LDA    THAV,X      ;byte of handler vector table
    STA    HATABS,X    ;byte of RAM table
    DEX
    BPL    PRS18        ;if not done

;    Initialize software.

    JSR    ISW          ;initialize software

;    Initialize ACMI module, if present.

ACMI IF    ACMI
    LDA    TRIG2
    ROR    A
    BCS    PRS19        ;if ACMI module not inserted

    LDA    AMFLAG
    BMI    PRS19        ;if not to install handler

;    Install ACMI handler.

    LDA    AMNAME      ;device code
    STA    HATABS+THAVL
    LDA    #low AMVTAD ;vector table address
    STA    HATABS+THAVL+1
    LDA    #high AMVTAD
    STA    HATABS+THAVL+2

;    Set ACMI interrupt service routine.

    LDA    AMISRA      ;interrupt service routine address
    STA    ACMISR
    LDA    AMISRA+1
    STA    ACMISR+1

;    Initialize ACMI.

    JSR    AMINIT      ;initialize ACMI
    JMP    PRS20        ;continue

;    Set ACMI interrupt routine.

PRS19 LDA    #low PAI   ;ACMI interrupt routine address
    STA    ACMISR
    LDA    #high PAI
    STA    ACMISR+1

;    Continue.

PRS20
ACMI ENDF

;    Enable IRQ interrupts.

    CLI

;    Check for memory problems.

    LDA    NGFLAG      ;memory status
    BNE    PRS21        ;if memory good

```

```

; Perform memory self-test on bad memory.

LDA    PORTB
AND    #$7F          ;enable self-test ROM
STA    PORTB          ;update port B memory control
LDA    #2
STA    CHACT          ;CHACTL (character control) shadow
LDA    #high DCSORG   ;high domestic character set origin
STA    CHBAS          ;CHBASE (character base) shadow
JMP    EMS            ;execute memory self-test

; Check for cartridge.

PRS21  LDX    #0
STX    TRAMSZ          ;clear cartridge flag

LDX    RAMSIZ          ;RAM size
CPX    #high $B000     ;start of cartridge area
BCS    PRS22          ;if RAM in cartridge area

LDX    CART
BNE    PRS22          ;if no cartridge

INC    TRAMSZ          ;set cartridge flag
JSR    CCE            ;check cartridge equivalence
JSR    ICS            ;initialize cartridge software

; Open screen editor.

PRS22  LDA    #OPEN
LDX    #SEIOCB         ;screen editor IOCB index
STA    ICCOM,X         ;command
LDA    #low SEDS       ;screen editor device specification
STA    ICBAL,X         ;buffer address
LDA    #high SEDS
STA    ICBAH,X
LDA    #OPNIN+OPNOT    ;open for input/output
STA    ICAX1,X         ;auxiliary information 1
JSR    CIOV            ;vector to CIO
BPL    PRS23          ;if no error

; Process error (which should never happen).

JMP    RES            ;retry power-up

; Delay, ensuring VBLANK.

PRS23  INX
BNE    PRS23          ;if inner loop not done

INY
BPL    PRS23          ;if outer loop not done

; Attempt cassette boot.

JSR    ACB            ;attempt cassette boot

; Check cartridge for disk boot.

LDA    TRAMSZ
BEQ    PRS24          ;if no cartridge

LDA    CARTFG         ;cartridge mode flags
ROR    A
BCC    PRS25          ;if disk boot not desired

```

```

;      Attempt disk boot.
PRS24 JSR    ADB            ;attempt disk boot
;      Initialize peripheral handler loading facility.
      JSR    PHR            ;poll, load, relocate, initialize
;      Indicate coldstart complete.
PRS25 LDA    #0
      STA    COLDST        ;indicate coldstart complete
;      Check cartridge for execution.
      LDA    TRAMSZ
      BEQ    PRS26          ;if no cartridge
      LDA    CARTFG        ;cartridge mode flags
      AND    #$04
      BEQ    PRS26          ;if execution not desired
;      Execute cartridge.
      JMP    (CARTCS)       ;execute cartridge
;      Exit to power-up display or booted program.
PRS26 JMP    (DOSVEC)       ;vector to booted program

```

```

**      ICS - Initialize Cartridge Software
*
*      ENTRY JSR    ICS
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin    1983-11-01

```

```

ICS    =      *      ;entry
      JMP    (CARTAD)    ;initialize cartridge software

```

```
** PAI - Process ACMI Interrupt
*
* PAI does nothing.
*
* ENTRY JSR PAI
*      ??
*
* EXIT
*      ??
*
* CHANGES
*      ??
*
* CALLS
*      ??
*
* NOTES
*      Problem: this code is unneeded unless ACMI assembly
*      option is selected.
*
* MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01
```

```
PAI      =      *      ;entry
          CLC
          RTS      ;return
```

```
** THAV - Table of Handler Vectors
*
* NOTES
*      THAV is moved to RAM table HATABS.
```

```
THAV      DB      PRINTR      ;printer device code
          DW      PRINTV      ;printer handler vector table

          DB      CASSET      ;cassette device code
          DW      CASETV      ;cassette handler vector table

          DB      SCREDIT      ;editor device code
          DW      EDITRV      ;editor handler vector table

          DB      DISPLAY      ;screen device code
          DW      SCRENV      ;screen handler vector table

          DB      KBD          ;keyboard device code
          DW      KEYBDV      ;keyboard handler vector table

THAVL     =      *-THAV      ;length
```

```
** BMSG - Boot Error Message
*
* NOTES
*      Problem: should use lower case in message.
```

```
BMSG      DB      'Boot Error',EOL
```

```
** Screen Editor Device Specification
```

```
SEDS      DB      'E:',EOL
```

```

**      TIHV - Table of Interrupt Handler Vectors
*
*      NOTES
*      TIHV is moved to RAM table INTABS.

```

```

TIHV  DW      RIR      ;VDSLST - display list NMI vector
      DW      XIR      ;VPRCED - proceed line IRQ vector
      DW      XIR      ;VINTER - interrupt line IRQ vector
      DW      XIR      ;VBREAK - BRK instruction IRQ vector
      DW      KIR      ;VKEYBD - keyboard IRQ vector
      DW      IRIR     ;VSERIN - serial input ready IRQ vector
      DW      ORIR     ;VSEROR - serial output ready IRQ vector
      DW      OCIR     ;VSEROC - serial output complete IRQ vector
      DW      XIR      ;VTIMR1 - POKEY timer 1 IRQ vector
      DW      XIR      ;VTIMR2 - POKEY timer 2 IRQ vector
      DW      XIR      ;VTIMR4 - POKEY timer 4 IRQ vector
      DW      IIR      ;VIMIRQ - immediate IRQ vector
      DW      0        ;CDTMV1 - countdown timer 1 vector
      DW      0        ;CDTMV2 - countdown timer 2 vector
      DW      0        ;CDTMV3 - countdown timer 3 vector
      DW      0        ;CDTMV4 - countdown timer 4 vector
      DW      0        ;CDTMV5 - countdown timer 5 vector
      DW      IVNM     ;VVBLKI - immediate VBLANK NMI vector
      DW      DVNM     ;VVBLKD - deferred VBLANK NMI vector

```

```

TIHVL =      *-TIHV ;length

```

```

**      PMI - Perform Miscellaneous Initialization
*
*      ENTRY JSR      PMI
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*          R. K. Nordin      1983-11-01
*      2. Fix initial address for RAM sizing.
*          R. K. Nordin      1984-03-23

```

```

PMI    =      *      ;entry

;      Check for cartridge special execution case.

      LDA      TRIG3
      ROR      A
      BCC      PMI1      ;if cartridge not inserted

      LDA      CART
      BNE      PMI1      ;if not cartridge

      LDA      CARTFG ;cartridge flags
      BPL      PMI1      ;if special execution not desired

;      Execute cartridge.

```

```

    JMP    (CARTAD)      ;execute cartridge

;    Initialize hardware.

PMI1    JSR    IHW      ;initialize hardware

;    Disable BASIC.

    LDA    PORTB
    ORA    #$02      ;disable BASIC
    STA    PORTB      ;update port B memory control

;    If warmstart, check previous BASIC status.

    LDA    WARMST
    BEQ    PMI2      ;if coldstart

    LDA    BASICF ;BASIC flag
    BNE    PMI4      ;if BASIC not previously enabled

    BEQ    PMI3      ;enable BASIC

;    Check OPTION key.

PMI2    LDA    CONSOL ;console switches
    AND    #$04      ;OPTION key indicator
    BEQ    PMI4      ;if OPTION key pressed, do not enable BASIC

;    Enable BASIC.

PMI3    LDA    PORTB
    AND    #$FD      ;disable BASIC
    STA    PORTB      ;update port B memory control

;    Determine size of RAM.

RAMSYS IF      RAMSYS
PMI4    LDA    #high $4000 ;16K
    STA    TRAMSZ          ;set RAM size
    RTS                    ;return
RAMSYS ELSE
PMI4    LDA    #low $4000  ;initial low address
    TAY                    ;offset to first byte of page
    STA    TRAMSZ-1        ;set initial low address

    LDA    #high $4000    ;initial RAM size
    STA    TRAMSZ          ;set initial RAM size (high address)

PMI5    LDA    (TRAMSZ-1),Y ;first byte of page
    EOR    #$FF            ;complement
    STA    (TRAMSZ-1),Y    ;attempt to store complement
    CMP    (TRAMSZ-1),Y
    BNE    PMI6            ;if complement not stored

    EOR    #$FF            ;original value
    STA    (TRAMSZ-1),Y    ;attempt to store original value
    CMP    (TRAMSZ-1),Y
    BNE    PMI6            ;if original value not stored

    INC    TRAMSZ          ;increment high address
    BNE    PMI5            ;continue

;    Exit.

PMI6    RTS                ;return
RAMSYS ENDIF

```

```

**      CCE - Check Cartridge Equivalence
*
*      ENTRY JSR      CCE
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown    ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*                  R. K. Nordin      1983-11-01
*              2. Fix initial address for equivalence checksum.
*                  R. K. Nordin      1984-03-23

```

```

CCE      =      *      ;entry

;      Initialize.

      LDA      #0      ;initial sum
      TAX      ;offset to first byte
      CLC

;      Checksum 256 bytes of cartridge area.

CCE1     ADC      $BF00,X      ;add in byte
      INX
      BNE      CCE1      ;if not done

;      Exit.

      CMP      CARTCK ;previous checksum
      STA      CARTCK ;new checksum
      RTS      ;return

```

```

**      IHW - Initialize Hardware
*
*      ENTRY JSR      IHW
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*          R. K. Nordin      1983-11-01
*      2. Change initialization of PORTB.
*          R. K. Nordin 1984-03-27

```

```

IHW      =      *      ;entry

;      Initialize CTIA, ANTIC, POKEY and PIA registers.

      LDA      #0          ;initialization value
      TAX          ;initial offset
      STA      PBCTL      ;set for direction register first

IHW1     STA      CTIA,X      ;initialize CTIA/GTIA area register
      STA      ANTIC,X      ;initialize ANTIC area register
      STA      POKEY,X      ;initialize POKEY area register
      CPX      #low PORTB
      BEQ      IHW2        ;if port B, don't initialize

      STA      PIA,X        ;initialize PIA area register

IHW2     INX
      BNE      IHW1        ;if not done

;      Initialize PIA.

      LDA      #$3C
      STA      PBCTL      ;precondition port B outputs
      LDA      #$CF
      STA      PORTB      ;initialize port B
      LDA      #$38
      STA      PACTL      ;select data direction register
      STA      PBCTL      ;select data direction register
      LDA      #$00
      STA      PORTA      ;all inputs
      LDA      #$FF
      STA      PORTB      ;all outputs
      LDA      #$3C
      STA      PACTL      ;back to port
      STA      PBCTL      ;back to port
      LDA      PORTB      ;clear interrupts
      LDA      PORTA      ;clear interrupts

;      Initialize POKEY.

      LDA      #$22      ;get POKEY out of initialize mode and set ch. 4
      STA      SKCTL      ;set serial port control

      LDA      #$A0      ;pure tone, no volume

```

```

STA  AUDC3 ;turn off channel 3
STA  AUDC4 ;turn off channel 4

LDA  #$28 ;clock ch. 3 with 1.79 MHz, ch. 4 with ch. 3
STA  AUDCTL ;set audio control

LDA  #$FF
STA  SEROUT ;start bit only

RTS          ;return

```

```

**      ISW - Initialize Software
*
*      ENTRY JSR      ISW
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

ISW      =      *          ;entry

;      Initialize BREAK key handling.

DEC      BRKKEY          ;turn off BREAK key flag

LDA      #low BIR
STA      BRKKY          ;set BREAK key IRQ routine address
LDA      #high BIR
STA      BRKKY+1

;      Initialize RAMSIZ and MEMTOP.

LDA      TRAMSZ          ;determined size of RAM
STA      RAMSIZ          ;size of RAM
STA      MEMTOP+1        ;high top of memory
LDA      #$00
STA      MEMTOP          ;low top of memory

;      Initialize MEMLO.

LDA      #low INIML      ;initial MEMLO address
STA      MEMLO
LDA      #high INIML
STA      MEMLO+1

;      Initialize device handlers.

JSR      EDITRV+12        ;initialize editor handler
JSR      SCRENV+12        ;initialize screen handler
JSR      KEYBDV+12        ;initialize keyboard handler
JSR      PRINTV+12        ;initialize printer handler
JSR      CASETV+12        ;initialize cassette handler

;      Initialize various routines.

```

```

JSR    CIOINV      ;initialize CIO
JSR    SIOINV      ;initialize SIO
JSR    INTINV      ;initialize interrupt handler
JSR    DINITV      ;initialize DIO

;      Initialize generic parallel device handler.

LDA     #low PIR
STA     VPIRQ      ;parallel device IRQ routine address
LDA     #high PIR
STA     VPIRQ+1

JSR     GPDVV+12    ;initialize parallel device handler

;      Set status of START key.

LDA     CONSOL      ;console switches
AND     #$01        ;START key indicator
EOR     #$01        ;START key status
STA     CKEY        ;cassette boot request flag

RTS                      ;return

```

```

**      ADB - Attempt Disk Boot
*
*      ENTRY JSR    ADB
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

ADB     =      *      ;entry

;      Check type of reset.

LDA     WARMST
BEQ     ADB1      ;if not warmstart

;      Process warmstart.

LDA     BOOT?    ;successful boot flags
AND     #$01     ;successful disk boot indicator
BEQ     BAI2     ;if disk boot not successful, return

;      Initialize disk booted software.

JMP     IBS      ;initialize booted software

;      Process coldstart.

ADB1    LDA     #1
STA     DUNIT    ;disk unit number
LDA     #STATC   ;status

```

```

    STA    DCOMND ;command
    JSR    DSKINV ;issue command
    BMI    BAI2   ;if error, return

;    Boot.

;    JNE    ABI    ;attempt boot and initialize

```

```

**    ABI - Attempt Boot and Initialize
*
*    ENTRY  JSR    ABI
*           ??
*
*    EXIT
*           ??
*
*    CHANGES
*           ??
*
*    CALLS
*           ??
*
*    MODS
*           Original Author Unknown   ??/??/??
*           1. Bring closer to Coding Standard (object unchanged).
*           R. K. Nordin      1983-11-01

```

```

ABI    =    *                ;entry

    LDA    #high 1
    STA    DAUX2
    LDA    #low 1           ;sector number
    STA    DAUX1

    LDA    #low [CASBUF+3]   ;buffer address
    STA    DBUFLO
    LDA    #high [CASBUF+3]
    STA    DBUFHI

;    JNE    BAI            ;boot and initialize

```

```

**    BAI - Boot and Initialize
*
*    ENTRY  JSR    BAI
*           ??
*
*    EXIT
*           ??
*
*    CHANGES
*           ??
*
*    CALLS
*           ??
*
*    MODS
*           Original Author Unknown   ??/??/??
*           1. Bring closer to Coding Standard (object unchanged).
*           R. K. Nordin      1983-11-01

```

```

BAI    =    *                ;entry

;    Read first sector.

```

```

    JSR    GNS      ;get next sector
    BPL    CBI      ;if no error, complete boot and initialize

;      Process error.

BAI1    JSR    DBE      ;display boot error message

        LDA    CASSBT
        BEQ    ABI      ;if not cassette boot, try again

;      Exit.

BAI2    RTS          ;return

```

```

**      CBI - Complete Boot and Initialize
*
*      ENTRY JSR    CBI
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*
*          Original Author Unknown    ??/??/??
*          1. Bring closer to Coding Standard (object unchanged).
*          R. K. Nordin      1983-11-01

```

```

CBI      =      *      ;entry

;      Transfer flags.

        LDX    #3

CBI1    LDA    CASBUF+3,X    ;byte from buffer
        STA    DFLAGS,X    ;flag byte
        DEX
        BPL    CBI1        ;if not done

;      Transfer sector.

        LDA    BOOTAD
        STA    RAMLO        ;set boot address
        LDA    BOOTAD+1
        STA    RAMLO+1

        LDA    CASBUF+7
        STA    DOSINI        ;establish initialization address
        LDA    CASBUF+8
        STA    DOSINI+1

CBI2    LDY    #127        ;offset to last byte of sector

CBI3    LDA    CASBUF+3,Y    ;byte of sector buffer
        STA    (RAMLO),Y    ;byte of boot program
        DEY
        BPL    CBI3        ;if not done

;      Increment loader buffer pointer.

```

```

CLC
LDA    RAMLO
ADC    #$80
STA    RAMLO
LDA    RAMLO+1
ADC    #0
STA    RAMLO+1      ;increment boot loader buffer pointer

;      Decrement and check number of sectors.

DEC    DBSECT      ;decrement number of sectors
BEQ    CBI5        ;if no more sectors

;      Get next sector.

INC    DAUX1      ;increment sector number

CBI4   JSR    GNS    ;get next sector
      BPL    CBI2    ;if status OK

;      Process error.

      JSR    DBE      ;display boot error message
      LDA    CASSBT
      BNE    BAI1     ;if cassette, start over

      BEQ    CBI4     ;try sector again

;      Clean up.

CBI5   LDA    CASSBT
      BEQ    CBI6     ;if not cassette boot

      JSR    GNS      ;get EOF record (but do not use it)

;      Execute boot loader.

CBI6   JSR    EBL     ;execute boot loader
      BCS    BAI1     ;if bad boot, try again

;      Initialize booted software.

      JSR    IBS      ;initialize booted software
      INC    BOOT?    ;indicate boot success
      RTS            ;return

```

```

**      EBL - Execute Boot Loader
*
*      ENTRY JSR      EBL
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

EBL      =      *              ;entry
;      Move boot loader start address to RAMLO.

      CLC
      LDA      BOOTAD
      ADC      #6
      STA      RAMLO              ;boot loader start address
      LDA      BOOTAD+1
      ADC      #0
      STA      RAMLO+1

;      Execute boot loader.

      JMP      (RAMLO)          ;execute boot loader

```

```

**      IBS - Initialize Booted Software
*
*      ENTRY JSR      IBS
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

IBS      =      *              ;entry
      JMP      (DOSINI)        ;initialize booted software

```

```

**      DBE - Display Boot Error Message
*
*      ENTRY JSR      DBE
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      NOTES
*              Problem: bytes wasted by LDX/TXA and LDY/TYA
*              combinations.
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

DBE      =      *              ;entry

;      Set up IOCB.

      LDX      #low BMSG      ;boot error message
      LDY      #high BMSG
      TXA
      LDX      #SEIOCB        ;screen editor IOCB index
      STA      ICBAL,X        ;low buffer address
      TYA
      STA      ICBAH,X        ;high buffer address
      LDA      #PUTREC
      STA      ICCOM,X        ;command
      LDA      #$FF
      STA      ICBLL,X        ;buffer length

;      Perform CIO.

      JMP      CIOV           ;vector to CIO, return

```

```

**      GNS - Get Next Sector
*
*      ENTRY JSR      GNS
*           ??
*
*      EXIT
*           ??
*
*      CHANGES
*           ??
*
*      CALLS
*           ??
*
*      MODS
*           Original Author Unknown   ??/??/??
*           1. Bring closer to Coding Standard (object unchanged).
*           R. K. Nordin      1983-11-01

```

```

GNS      =      *      ;entry
;      Check type of boot.

      LDA      CASSBT
      BEQ      GNS1      ;if not cassette boot

;      Read block from cassette.

      JMP      RBLOKV ;vector to read cassette block routine, return

;      Read sector from disk.

GNS1     LDA      #READ
      STA      DCOMND ;command
      LDA      #1      ;drive number 1
      STA      DUNIT   ;set drive number
      JMP      DSKINV ;vector to DIO, return

```

```

**      ACB - Attempt Cassette Boot
*
*      ENTRY JSR      ACB
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

ACB      =      *      ;entry

;      Check type.

      LDA      WARMST ;warmstart flag
      BEQ      ACB1   ;if coldstart

;      Perform warmstart procedures.

      LDA      BOOT?  ;successful boot flags
      AND      #$02   ;successful cassette boot indicator
      BEQ      ACB2   ;if cassette boot not successful

      JMP      ACB3   ;initialize cassette

;      Perform coldstart procedures.

ACB1     LDA      CKEY  ;cassette boot request flag
      BEQ      ACB2   ;if cassette boot not requested, return

;      Boot cassette.

      LDA      #$80
      STA      FTYPE  ;set long IRG type
      INC      CASSBT ;set cassette boot flag
      JSR      CSOPIV ;open cassette for input
      JSR      BAI    ;boot and initialize
      LDA      #0
      STA      CASSBT ;clear cassette boot flag
      STA      CKEY   ;clear cassette boot request flag
      ASL      BOOT?  ;indicate successful cassette boot

      LDA      DOSINI
      STA      CASINI ;cassette software initialization address
      LDA      DOSINI+1
      STA      CASINI+1

;      Exit.

ACB2     RTS          ;return

;      Initialize cassette booted program.

ACB3     JMP      (CASINI) ;initialize cassette booted program

```

Disk Input/Output

```
**      IDIO - Initialize DIO
*
*      ENTRY JSR      IDIO
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01
```

```
IDIO  =      *              ;entry
      LDA    #160           ;160 second timeout
      STA    DSKTIM         ;set initial disk timeout
      LDA    #low DSCTSZ    ;disk sector size
      STA    DSCTLN
      LDA    #high DSCTSZ
      STA    DSCTLN+1
      RTS                  ;return
```

```
**      DIO - Disk I/O
*
*      ENTRY JSR      DIO
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01
```

```
DIO    =      *              ;entry
;      Initialize.

      LDA    #DISKID        ;disk bus ID
      STA    DDEVIC         ;device bus ID
      LDA    DSKTIM         ;timeout
      LDX    DCOMND         ;command
      CPX    #FOMAT
      BEQ    DIO1           ;if FORMAT command

      LDA    #7              ;set timeout to 7 seconds
DIO1   STA    DTIMLO        ;timeout
```

```

;      Set SIO command.

      LDX    #GETDAT      ;assume GET DATA

      LDA    DCOMND       ;command
      CMP    #PUTSEC
      BEQ    DI02         ;if PUT SECTOR command

      CMP    #WRITE
      BNE    DI03         ;if not WRITE command
DI02   LDX    #PUTDAT      ;select PUT DATA

;      Check command.

DI03   CMP    #STATC
      BNE    DI04         ;if not STATUS command

;      Set up STATUS command.

      LDA    #low DVSTAT
      STA    DBUFLO       ;buffer address
      LDA    #high DVSTAT
      STA    DBUFHI
      LDY    #low 4       ;low byte count
      LDA    #high 4      ;high byte count
      BEQ    DI05         ;perform SIO

;      Set up other commands.

DI04   LDY    DSCTLN       ;low byte count
      LDA    DSCTLN+1     ;high byte count

;      Perform SIO.

DI05   STX    DSTATS      ;SIO command
      STY    DBYTLO       ;low byte count
      STA    DBYTHI       ;high byte count
      JSR    SIOV         ;vector to SIO
      BPL    DI06         ;if no error

;      Process error.

      RTS                ;return

;      Process successful operation.

DI06   LDA    DCOMND       ;command
      CMP    #STATC
      BNE    DI07         ;if not STATUS command

      JSR    SBA          ;set buffer address
      LDY    #2
      LDA    (BUFADR),Y   ;timeout status
      STA    DSKTIM       ;disk timeout

;      Set byte count.

DI07   LDA    DCOMND
      CMP    #FOMAT
      BNE    DI010        ;if not FORMAT command

      JSR    SBA          ;set buffer address
      LDY    #$FE         ;initial buffer pointer
DI08   INY                ;increment buffer pointer

```

```

        INY                ;increment buffer pointer
DI09   LDA    (BUFADR),Y    ;low bad sector data
        CMP    #$FF
        BNE    DI08        ;if low not $FF

        INY
        LDA    (BUFADR),Y    ;high bad sector data
        INY
        CMP    #$FF
        BNE    DI09        ;if high not $FF

        DEY
        DEY
        STY    DBYTLO        ;low bad sector byte count
        LDA    #0
        STA    DBYTHI        ;high bad sector byte count

;      Exit.

DI010  LDY    DSTATS        ;status
        RTS                ;return

```

```

**      SBA - Set Buffer Address
*
*      ENTRY JSR    SBA
*           ??
*
*      EXIT
*           ??
*
*      CHANGES
*           ??
*
*      CALLS
*           ??
*
*      MODS
*           Original Author Unknown   ??/??/??
*           1. Bring closer to Coding Standard (object unchanged).
*           R. K. Nordin      1983-11-01

```

```

SBA    =      *            ;entry
        LDA    DBUFLO
        STA    BUFADR        ;buffer address
        LDA    DBUFHI
        STA    BUFADR+1
        RTS                ;return

```

Relocating Loader

```
**      RLR - Relocate Routine
*
*      RLR relocates a relocatable routine which is assembled at
*      origin 0.
*
*      ENTRY JSR      RLR
*              GBYTEA - GBYTEA+1 = address of get-byte routine
*              ??
*
*      EXIT      ??
*
*      CHANGES  ??
*
*      CALLS     ??
*
*      MODS
*              Y. M. Chen   1982-04-??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin 1983-11-01
```

```
RLR      =      *              ;entry
;      Clear parameter block.

      LDX      #5              ;offset to last parameter

RLR1     LDA      #0
      STA      PARMBL,X        ;clear byte of parameter block
      DEX
      BPL      RLR1            ;if not done

;      Get a new record type and set the subroutine vectors.

RLR2     LDA      #0
      STA      LCOUNT          ;process 0th byte of a record
      JSR      GBY              ;get type ID
      LDY      #DATAER
      BCS      RLR4            ;if EOF before END record

      STA      HIBYTE           ;save type ID
      JSR      GBY              ;get record length
      LDY      #DATAER
      BCS      RLR4            ;if EOF before END record

      STA      RECLEN
      LDA      HIBYTE           ;get type ID
      CMP      #$0B            ;END record
      BEQ      END              ;if END record

      ROL      A                ;set subroutine vectors
      TAX
      LDA      TRPR,X
      STA      RUNADR
      LDA      TRPR+1,X
      STA      RUNADR+1

RLR3     LDA      RECLEN          ;LCOUNT=RECLEN then get next new record
      CMP      LCOUNT
      BEQ      RLR2            ;if ???
```

```

JSR   GBY           ;get next byte
LDY   #DATAER
BCS   RLR4           ;if EOF before END record

JSR   CAL           ;call record subroutine
INC   LCOUNT
BNE   RLR3           ;???

RLR4    RTS           ;return

```

```

**      END - ???
*
*      END handles record type of
*      1.End Record
*
*      Record format:
*      Byte 0      Type ID
*      Byte 1      Self-start flag
*      Bytes 2-3   Run address
*
*      Process formula
*
*      RUNADR+LOADAD ==> Start Execution Address n Loader-Caller
*      parameter block.
*
*      End record calculates the start execution address by adding
*      RUNADR with LOADAD, and returns to the Caller with parameter
*      block and a status byte in the Y register. Y=1 means operation
*      successful, else is a data structure error.
*
*      ENTRY JSR      END
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Y. M. Chen   1982-04-??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin 1983-11-01

```

```

END      =      *      ;entry
JSR   GBY           ;get low byte of the RUNADR
LDY   #DATAER
BCS   END3           ;if EOF before END record

STA   RUNADR
JSR   GBY           ;get high byte of the RUNADR
LDY   #DATAER
BCS   END3           ;if EOF before END record

STA   RUNADR+1
LDA   RECLEN ;RECLEN here is self-start flag
CMP   #1
BEQ   END2           ;if 1, an absolute RUNADR, no fixup

BCC   END4           ;if 0, this is not a self-start program

;      Process relative start.

```

```

        CLC
        LDA    RUNADR      ;execution address, needs fixup
        ADC    LOADAD
        TAY
        LDA    RUNADR+1
        ADC    LOADAD+1    ;A= high byte, Y=low byte

END1    STY    RUNADR      ;set up Loader-Caller parameter block
        STA    RUNADR+1

END2    LDY    #SUCCE$    ;Y=1 successful operation

END3    RTS                ;return

END4    LDY    #0          ;fill self-start parameter with 0
        LDA    #0          ;for non-self start program
        BEQ    END1        ;???
```

```

**      GBY - ???
*
*      ENTRY JSR    GBY
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Y. M. Chen    1982-04-??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin    1983-11-01
```

```

GBY      =      *          ;entry
        JMP      (GBYTEA)  ;get byte, return
```

```

**      CAL - ???
*
*      ENTRY JSR    CAL
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Y. M. Chen    1982-04-??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin    1983-11-01
```

```

CAL      =      *          ;entry
        JMP      (RUNADR)  ;process record, return
```

```

**      TEX - ???
*
*      Text Record Subroutine handles record types of
*
*      1.Non-zero page relocatable text
*      2.Zero page relocatable text
*      3.Absolute text
*
*      Record format
*
*      ???
*      |Type |Length          |Relative addr.   |text |
*      |ID  |(RECLen)      |(RELADR)        |      |
*
*      Process formula
*      A register ==> (NEWADR+LCOUNT)
*
*      Relocate object text into fixed address of NEWADR+LCOUNT.
*
*      There are 4 notes about this routine
*
*      1.The relocating address (NEWADR) for absolute text is the
*      relative address (RELADR), relocating address fixup is not
*      needed.
*      2.There is no need to compare MEMTOP for processing zero page
*      text.
*      3.X register is used as an indexing to zero page variables
*      or non-zero page variables.      X=0 means pointing to non-zero
*      page variable, whereas X=2 means pointing to zero page
*      variables.
*      4.Each byte of the object text comes in A register.
*
*      ENTRY JSR    TEX
*            ??
*
*      EXIT
*            ??
*
*      CHANGES
*            ??
*
*      CALLS
*            ??
*
*      MODS
*            Y. M. Chen    1982-04-??
*            1. Bring closer to Coding Standard (object unchanged).
*            R. K. Nordin    1983-11-01

```

```

TEX      =      *      ;entry
LDY      LCOUNT ;A register=data coming in
CPY      #$01
BEQ      TEX1    ;if 1, process highest used address

BCS      FTX     ;if 2 or greater, relocate object text

STA      RELADR
STA      NEWADR ;for absolute text NEWADR=RELADR
BCC      TEX8    ;???

;      Set highest used address.

TEX1     STA      RELADR+1    ;save high byte of RELADR
          STA      NEWADR+1    ;for absolute text NEWADR=RELADR
          LDX      #0          ;X=an index to non-zero or zero variable

```

```

    LDA    HIBYTE          ;HIBYTE=Type ID
    BEQ    TEX2            ;if 0, process non-zero page text record
    CMP    #$0A
    BEQ    TEX3            ;if $0A, needs no relative address fixup

    LDX    #2              ;X=2 for zero page text record

TEX2    CLC                ;fix relocating addr. for non-zero page
    LDA    RELADR          ;text & zero page text
    ADC    LOADAD,X        ;NEWADR=RELADR+LOADAD
    STA    NEWADR
    LDA    RELADR+1
    ADC    LOADAD+1,X
    STA    NEWADR+1        ;Loader start relocating

TEX3    CLC
    LDA    NEWADR          ;NEWADR+RECLEN is the last used memory
    ADC    RECLEN          ;for this particular record
    PHA
    LDA    #0              ;A=high byte, S=low byte
    ADC    NEWADR+1
    TAY                    ;high byte
    PLA                    ;low byte
    SEC
    SBC    #2              ;skip unwanted 2 bytes of relative address info
    BCS    TEX4            ;if ???Y=high byte, A=low byte

    DEY

TEX4    PHA
    TYA
    CMP    HIUSED+1,X      ;HIUSED stores the highest used memory
    PLA
    BCC    TEX6            ;if HIUSED>(NEWADR+RECLEN), check memory
    BNE    TEX5            ;if HIUSED<=(NEWADR+RECLEN)

    CMP    HIUSED,X
    BCC    TEX6            ;if ???

;    Update HIUSED.

TEX5    STA    HIUSED,X    ;update HIUSED
    PHA
    TYA
    STA    HIUSED+1,X
    PLA

TEX6    LDX    HIBYTE
    CPX    #$01
    BEQ    TEX8            ;if zero page text

;    Check MEMTOP.

    CPY    MEMTOP+1        ;MEMTOP>HIUSED, OK
    BCC    TEX8            ;if ???
    BNE    TEX7            ;if ???

    CMP    MEMTOP
    BCC    TEX8            ;if ???

TEX7    PLA                ;MEMTOP<=HIUSED then error
    PLA                ;do a force return to caller
    LDY    #MEMERR        ;set memory insufficient flag

TEX8    RTS                ;return

```

```

**      FTX - ???
*
*      relocate text into memory.
*
*      ENTRY JSR      FTX
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      NOTES
*      Problem: bytes wasted by JMP to RTS.
*
*      MODS
*      Y. M. Chen      1982-04-??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin    1983-11-01

```

```

FTX      =      *      ;entry
SEC
PHA              ;A register has object text
LDA      LCOUNT ;LCOUNT counts 2 bytes of relative address
SBC      #2      ;-2 is the total bytes of object text
CLC
ADC      NEWADR
STA      LTEMP   ;A ==>(NEWADR+LCOUNT-2)
LDA      #0
ADC      NEWADR+1
STA      LTEMP+1
PLA
LDY      #0
STA      (LTEMP),Y
JMP      TEX8    ;return

```

```

**      WOR - ???
*
*      Word Subroutine handles record types of
*
*      1.Non-zero page word references to non-zero page.
*      2.Zero page word references to non-zero page.
*
*      Record format
*
*      ???
*      |Type |Length          |Offset1|Offset2|Offsetn|
*      | ID  |(RECLen)    |A Reg.  |      |      |
*
*      Process formula
*
*      (A register +NEWADR)W +LOADAD ==> (NEWADR+ A register)
*
*      Count, the offset from the start relocating address, is the
*      low byte
*      of a word needing to be fixed. The fixup process is to get the
*      content of the word and add loading address, then restore the
*      fixed word.
*

```

```

*      Offset information comes in A register.
*
*      ENTRY JSR    WOR
*             ??
*
*      EXIT
*             ??
*
*      CHANGES
*             ??
*
*      CALLS
*             ??
*
*      MODS
*             Y. M. Chen    1982-04-??
*             1. Bring closer to Coding Standard (object unchanged).
*             R. K. Nordin  1983-11-01

```

```

WOR    =      *      ;entry
        CLC
        ADC     NEWADR    ;offset in A register
        STA     LTEMP
        LDA     #0
        ADC     NEWADR+1
        STA     LTEMP+1    ;offset +NEWADR= LTEMP
        LDY     #0
        LDA     (LTEMP),Y    ;get low byte content of what in LTEMP
        CLC
        ADC     LOADAD     ;fix low byte of a word
        STA     (LTEMP),Y
        INC     LTEMP       ;increment LTEMP pointer by one
        BNE     WOR1        ;if low not zero

        INC     LTEMP+1     ;increment high

WOR1    LDA     (LTEMP),Y    ;fix high byte of a word
        ADC     LOADAD+1
        STA     (LTEMP),Y    ;restore processed content
        RTS                ;return

```

```

**      L00 - ???
*
*      Low byte and one byte subroutine handles record types of
*
*      1.Non-zero page low byte references to non-zero page.
*      2.Zero page low byte references to non-zero page.
*      3.Non-zero page one byte references to zero page.
*      4.Zero page one byte references to zero page.
*
*      Record format
*
*      ???
*      |Type |Length           |Offset1|Offset2|Offsetn|
*      |ID   |(RECLen)       |A Reg. |A Reg.  |       |
*
*      The process formula for non-zero page low byte references to
*      non-zero page record and zero page low byte references to
*      non-zero page record is
*
*      (offset + NEWADR)+LOADAD ==> (offset +NEWADR)
*
*      The process formula for non-zero page one byte references to
*      zero
*      page record and zero page one byte references to zero page

```

```

*      record
*      is
*
*      (offset + NEWADR)+LOADADZ ==> (offset + NEWADR)
*
*      Count from the offset from the start relocating address is the
*      low byte or one byte need to be fixed. Get the content of the
*      low byte or one byte and add either LOADAD or LOADADZ (Zero
*      page loading address), then restore the value.
*
*      The offset comes in A register.
*
*      The X register for this routine points to either non-zero page
*      variables or zero page variables. Record type 2 & 3 needs
*      non-zero page variable, type 4 & 5 needs zero page variable.
*
*
*      X=2 points to zero page variable.
*
*      ENTRY JSR    L00
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Y. M. Chen    1982-04-??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin    1983-11-01

```

```

L00      =      *      ;entry
LDX      #0      ;X=0 points to non-zero page variable
LDY      HIBYTE  ;HIBYTE has Type ID
CPY      #4      ;type 4 & 5 needs zero page variable
BCC      L001    ;if type 2 or 3, need non-zero page variable

LDX      #2      ;point to zero page variable

L001     CLC      ;offset is in A register
ADC      NEWADR  ;offset+NEWADR=the byte needs fixup
STA      LTEMP
LDA      #0
ADC      NEWADR+1
STA      LTEMP+1
LDY      #0
LDA      (LTEMP),Y ;get the content of offset+NEWADR
CLC
ADC      LOADAD,X ;do relocating fixup
STA      (LTEMP),Y ;restore the being fixed value
RTS      ;return

```

```

**      HIG - ???
*
*      High byte subroutine handles record types of
*
*      1.Non-zero page high bytes references to non-zero page.
*      2.Zero page high bytes references to non-zero page.
*
*      Record format
*
*      ???
*      |Type |Length           |Offset1|Low Byte|Offset2|Low...|
*      |ID   |(RECLen)       |HIBYTE |A Reg.  |(HIBYTE)|  |
*
*      Process formula
*
*      (HIBYTE+NEWADR)+[[LOADAD+A]/256] ==> (HIBYTE+NEWADR)
*
*      Count the offset from the start relocating address is the high
*      byte needs to be fixed. Get the low byte information in the
*      A register, then add the low byte with LOADAD and set the C
*      flag depending on the calculation. Next do an addition of
*      high byte, NEWADR and the C flag. Restore the addition result
*      back to the high byte location in memory.
*
*      HIBYTE is not Type ID here. HIBYTE is used to store the high
*      byte value.
*
*      ENTRY JSR    HIG
*             ??
*
*      EXIT
*             ??
*
*      CHANGES
*             ??
*
*      CALLS
*             ??
*
*      NOTES
*      Problem: many instances of jumping to RTS instruction
*      wastes bytes.
*
*      MODS
*      Y. M. Chen    1982-04-??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin  1983-11-01

```

```

HIG      =      *      ;entry
;      Initialize.
      PHA      ;save offset pointing to high byte
;      Check LCOUNT odd or even.
      LDA      LCOUNT      ;???
      ROR      A
      PLA
      BCS      HIG2      ;if even number, process low byte
;      Process high byte.
      CLC
      ADC      NEWADR

```

```

        STA    LTEMP          ;get high byte value
        LDA    #0
        ADC    NEWADR+1
        STA    LTEMP+1
        LDY    #0
        LDA    (LTEMP),Y
        STA    HIBYTE        ;save high byte content

HIG1    RTS                    ;return

;      Process low byte.

HIG2    CLC
        ADC    LOADAD        ;add low byte with LOADAD
        LDA    #0
        ADC    LOADAD+1
        ADC    HIBYTE        ;C flag+LOADAD(high byte)+HIBYTE
        LDY    #0
        STA    (LTEMP),Y    ;store being fixed high byte value
        BEQ    HIG1        ;???

```

**	TRPR - Table of Record Processing Routines
----	--

```

TRPR    DW     TEX    ;0 - non-zero page relocatable text
        DW     TEX    ;1 - zero page relocatable text
        DW     L00    ;2 - non-zero page low byte to non-zero page
        DW     L00    ;3 - zero page low byte to non-zero page
        DW     L00    ;4 - non-zero page one byte to zero page
        DW     L00    ;5 - zero page one byte to zero page
        DW     WOR    ;6 - non-zero page word to non-zero page
        DW     WOR    ;7 - zero page word to non-zero page
        DW     HIG    ;8 - non-zero page high byte to non-zero page
        DW     HIG    ;9 - zero page high byte to non-zero page
        DW     TEX    ;10 - absolute text
        DW     END    ;11 - end record

```

Self-test, Part 1

```
**      SES - Select and Execute Self-test
*
*      SES selects the self-test ROM and executes the self-test.
*
*      ENTRY  JSR      SES
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      NOTES
*              Problem: this could be contiguous with other OS ROM
*              self-test code (near TST0).
*
*      MODS
*              Original Author Unknown    ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01
```

```
SES      =      *      ;entry

      LDA      #$FF
      STA      COLDST ;force coldstart on RESET

      LDA      PORTB
      AND      #$7F   ;enable self-test ROM
      STA      PORTB  ;update port B memory control

      JMP      SLFTSV ;vector to self-test
```

Parallel Input/Output

```
**      GIN - Initialize Generic Parallel Device
*
*      ENTRY JSR      GIN
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      A. Chen      1983-02-18
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin 1983-11-01
```

```
GIN      =      *      ;entry

;      Initialize.

      LDA      #$01      ;initially select device 0
      STA      SHPDVS ;device select shadow

;      For each potential device, initialize if device present.

GIN1     LDA      SHPDVS ;device select shadow
      STA      PDVS      ;device select

      LDA      PDID1      ;first ID
      CMP      #$80      ;required value
      BNE      GIN2      ;if first ID not verified

      LDA      PDID2      ;second ID
      CMP      #$91      ;required value
      BNE      GIN2      ;if second ID not verified

      JSR      PDVV+12      ;initialize parallel device handler

GIN2     ASL      SHPDVS ;advance to next device
      BNE      GIN1      ;if devices remain

;      Exit.

      LDA      #$00      ;select FPP (deselect device)
;      STA      SHPDVS ;device select shadow
      STA      PDVS      ;device select
      RTS                ;return
```

```

**      PIO - Parallel Input/Output
*
*      ENTRY JSR      PIO
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

PIO      =      *      ;entry

;      Initialize.

      LDA      #1
      STA      CRITIC ;indicate critical section
      LDA      DUNIT ;device unit number
      PHA      ;save device unit number
      LDA      PDVMSK ;device selection mask
      BEQ      PI02 ;if no device to select

;      For each device, pass request to device I/O routine.

      LDX      #TPDSL ;offset to first byte beyond table

PI01     JSR      SNP      ;select next parallel device
      BEQ      PI02 ;if no device selected

      TXA
      PHA      ;save offset
      JSR      PDIOV ;perform parallel device I/O
      PLA      ;saved offset
      TAX      ;restore offset
      BCC      PI01 ;if device did not field request

;      Restore Floating Point Package.

      LDA      #$00 ;select FPP (deselect device)
      STA      SHPDVS ;device select shadow
      STA      PDVS ;device select
      BEQ      PI03 ;exit

;      Perform SI0.

PI02     JSR      SI0      ;perform SI0

;      Exit.

PI03     PLA      ;saved device unit number
      STA      DUNIT ;restore device unit number
      LDA      #0
      STA      CRITIC ;indicate non-critical section
      STY      DSTATS
      LDY      DSTATS ;status (re-establish N)
      RTS      ;return

```

```

**      PIR - Handle Parallel Device IRQ
*
*      ENTRY  JMP      PIR
*              ??
*
*      EXIT
*              Exits via RTI
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

PIR      =      *      ;entry
;      Determine which device made IRQ, in order of priority.

      LDX      #TPDSL ;offset to first byte beyond table

PIR1     ROR      A
      BCS      PIR2 ;if IRQ of that device

      DEX
      BNE      PIR1 ;if devices remain

;      Select device and process IRQ.

PIR2     LDA      SHPDVS      ;current device selection
      PHA
      LDA      TPDS-1,X      ;device selection desired
      STA      SHPDVS      ;device select shadow
      STA      PDVS         ;device select
      JSR      PDIRQV      ;process IRQ

;      Exit.

      PLA
      STA      SHPDVS      ;saved device selection
      STA      PDVS         ;restore device select shadow
      PLA
      TAX
      PLA
      RTI

```

```

**      GOP - Perform Generic Parallel Device OPEN
*
*      ENTRY JSR      GOP
*           ??
*
*      EXIT
*           ??
*
*      CHANGES
*           ??
*
*      CALLS
*           ??
*
*      MODS
*           Original Author Unknown   ??/??/??
*           1. Bring closer to Coding Standard (object unchanged).
*           R. K. Nordin      1983-11-01

```

```

GOP      =      *      ;entry
          LDY     #1      ;offset for OPEN
          JMP     EPC      ;execute parallel device handler command, return

```

```

**      GCL - Perform Generic Parallel Device CLOSE
*
*      ENTRY JSR      GCL
*           ??
*
*      EXIT
*           ??
*
*      CHANGES
*           ??
*
*      CALLS
*           ??
*
*      MODS
*           Original Author Unknown   ??/??/??
*           1. Bring closer to Coding Standard (object unchanged).
*           R. K. Nordin      1983-11-01

```

```

GCL      =      *      ;entry
          LDY     #3      ;offset for CLOSE
          JMP     EPC      ;execute parallel device handler command, return

```

```

**      GGB - Perform Generic Parallel Device GET-BYTE
*
*      ENTRY  JSR      GGB
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

GGB      =      *      ;entry
          LDY     #5      ;offset for GET-BYTE
          JMP     EPC      ;execute parallel device handler command, return

```

```

**      GPB - Perform Generic Parallel Device PUT-BYTE
*
*      ENTRY  JSR      GPB
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

GPB      =      *      ;entry
          LDY     #7      ;offset for PUT-BYTE
          JMP     EPC      ;execute parallel device handler command, return

```

```

**      GST - Perform Generic Parallel Device STATUS
*
*      ENTRY  JSR      GST
*             ??
*
*      EXIT
*             ??
*
*      CHANGES
*             ??
*
*      CALLS
*             ??
*
*      MODS
*
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

GST      =      *      ;entry
          LDY    #9      ;offset for STATUS
          JMP    EPC      ;execute parallel device handler command, return

```

```

**      GSP - Perform Generic Parallel Device SPECIAL
*
*      ENTRY  JSR      GSP
*             ??
*
*      EXIT
*             ??
*
*      CHANGES
*             ??
*
*      CALLS
*             ??
*
*      MODS
*
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

GSP      =      *      ;entry
          LDY    #11     ;offset for SPECIAL
          JMP    EPC      ;execute parallel device handler command, return

```

```

**      SNP - Select Next Parallel Device
*
*      ENTRY JSR      SNP
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

SNP      =      *      ;entry

;      Decrement and check offset.

SNP1     DEX      ;decrement offset
        BPL      SNP2 ;if devices remain

;      Exit.

        LDA      #$00 ;select FPP (deselect device)
        STA      SHPDVS ;device select shadow
        STA      PDVS ;device select
        RTS

;      Ensure device is indicated by selection mask.

SNP2     LDA      PDVMSK ;device selection mask
        AND      TPDS,X ;device select
        BEQ      SNP1 ;if device not indicated for selection

;      Select device.

        STA      SHPDVS ;device select shadow
        STA      PDVS ;device select
        RTS

```

```

**      IPH - Invoke Parallel Device Handler
*
*      ENTRY JSR      IPH
*              Y = offset into parallel device vector table
*              PPTMPA = original A value
*              PPTMPX = original X value
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      NOTES
*              Problem: wasted byte for DEY.
*
*      MODS
*              Original Author Unknown    ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

IPH      =      *      ;entry
          LDA      PDVV,Y ;high routine address-1
          PHA              ;place on stack
          DEY
          LDA      PDVV,Y ;low routine address-1
          PHA              ;place on stack
          LDA      PPTMPA ;restore A for handler
          LDY      PPTMPX ;restore X for handler
          LDY      #FNCNOT ;preset status
          RTS              ;invoke handler routine (address on stack)

```

```

**      EPC - Execute Parallel Device Handler Command
*
*      ENTRY JSR      EPC
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown    ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

EPC      =      *      ;entry
;      Initialize.

          STA      PPTMPA ;save data byte
          STX      PPTMPX ;save X
          LDA      CRITIC
          PHA              ;save critical section status
          LDA      #1
          STA      CRITIC ;indicate critical section

```

```

;      For each device, pass request to device handler.

      LDX      #TPDSL ;offset to first byte beyond table

EPC1  JSR      SNP      ;select next device
      BEQ      EPC2     ;if no device selected, return error

      TXA
      PHA
      TYA
      PHA
      JSR      IPH      ;invoke parallel device handler
      BCC      EPC4     ;if device did not field, try next device

;      Clean up.

      STA      PPTMPA ;save possible data byte
      PLA
      PLA
      JMP      EPC3     ;exit

;      Return Nonexistent Device error.

EPC2  LDY      #NONDEV

;      Restore Floating Point Package.

EPC3  LDA      #$00     ;select FPP (deselect device)
      STA      SHPDVS ;device select shadow
      STA      PDVS    ;device select
      PLA
      CRITIC ;saved critical section status
      LDA      PPTMPA ;restore critical section status
      STY      PPTMPX
      LDY      PPTMPX ;status (re-establish N)
      RTS
;      Prepare to try next device.

EPC4  PLA
      TAY
      PLA
      TAX
      BCC      EPC1     ;try next device

```

```

**      TPDS - Table of Parallel Device Selects
*
*      NOTES
*      Problem: bytes wasted by replication of this table
*      elsewhere.

```

```

TPDS  DB      $80      ;0 - device 7 (lowest priority)
      DB      $40      ;1 - device 6
      DB      $20      ;2 - device 5
      DB      $10      ;3 - device 4
      DB      $08      ;4 - device 3
      DB      $04      ;5 - device 2
      DB      $02      ;6 - device 1
      DB      $01      ;7 - device 0 (highest priority)

TPDSL =      *-TPDS ;length

```

Peripheral Handler Loading Facility, Part 1

```
**      PHL - Load and Initialize Peripheral Handler
*
*      Subroutine to load, relocate, initialize and open a
*      "provisionally" opened IOCB. This routine is called
*      upon first I/O attempt following provisional open.
*      It does the final opening by simulating the first
*      part of a normal CIO OPEN and then finishing with
*      code which is in CIO.
*
*      Input parameters:
*      ICIDNO (specifies which IOCB);
*      various values in the provisionally-opened IOCB:
*          ICSPR (handler name)
*          ICSPR+1 (serial address for loading);
*      whatever the called subroutines require.
*
*      Output parameters:
*      None. (Error returns are all handled by called subroutines--
*          in fact, all returns are handled by called subroutines.)
*
*      Modified:
*      ICHID in both calling IOCB and ZIOCB (part of completing OPEN);
*      ICCOMT (a CIO variable);
*      Registers not saved.
*
*      Subroutines called:
*      LPH (does the loading);
*      PHC (initializes the loaded handler);
*      FDH (a CIO entry--finds handler table entry of
*          newly loaded/initialized handler);
*      IIO (a CIO entry--finishes full proper opening of IOCB,
*          including calling handler OPEN entry--IIO returns
*          to PHL's caller);
*      IND (a CIO entry--returns with error to PHL's caller).
*
*      ENTRY JSR    PHL
*             ??
*
*      EXIT
*             ??
*
*      CHANGES
*             ??
*
*      CALLS
*             ??
*
*      MODS
*      R. S. Scheiman      1982-04-??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin       1983-11-01
```

```
PHL      =      *              ;entry
;
;      Load peripheral handler.
;
LDX      ICIDNO              ;IOCB index
LDA      ICSPR+1,X
JSR      LPH                  ;load peripheral handler
BCS      PHL1                 ;if error
;
;      Initialize peripheral handler.
```

```

CLC                                ;indicate zero handler size
JSR    PHC                        ;initialize peripheral handler
BCS    PHL1                      ;if error

;    Find device handler.

LDX    ICIDNO                    ;IOCB index
LDA    ICSPR,X
JSR    FDH                      ;find device handler
BCS    PHL1                      ;if not found

;    Set handler ID.

LDX    ICIDNO                    ;IOCB index
STA    ICHID,X                  ;handler ID
STA    ICHIDZ

;    Simulate initial CIO OPEN processing.

LDA    #OPEN                    ;OPEN command
STA    ICCOMT                   ;command
JMP    IIO                      ;initialize IOCB for OPEN, return

;    Indicate nonexistent device error.

PHL1   JMP    IND                ;indicate nonexistent device error, return

```

Self-test, Part 2

** TXT0 - Table of Self-test Text Offsets
--

TST0	DB	TXT0-TTXT	;0 - offset to "MEMORY TEST ROM" text
	DB	TXT1-TTXT	;1 - offset to "RAM" text
	DB	TXT2-TTXT	;2 - offset to "KEYBOARD TEST" text
	DB	TXT3-TTXT	;3 - offset to "S P A C E B A R" text
	DB	TXT4-TTXT	;4 - offset to "SH" text
	DB	TXT5-TTXT	;5 - offset to "SH" text
	DB	TXT6-TTXT	;6 - offset to "B S" text
	DB	TXT7-TTXT	;7 - offset to keyboard text
	DB	TXT8-TTXT	;8 - offset to control key text
	DB	TXT9-TTXT	;9 - offset to "VOICE #" text

** TTXT - Table of Text Sequences
--

TTXT = *

** TXT0 - "MEMORY TEST ROM" Text

TXT0	DB	\$00,\$00	
	DB	\$2D,\$25,\$2D,\$2F,\$32,\$39	; "MEMORY"
	DB	\$00	
	DB	\$34,\$25,\$33,\$34	; "TEST"
	DB	\$00,\$00,\$00	
	DB	\$32,\$2F,\$2D	; "ROM"

TXT0L = *-TXT0 ;length

** TXT1 - "RAM" Text

TXT1	DB	\$32,\$21,\$2D	; "RAM"
------	----	----------------	---------

TXT1L = *-TXT1 ;length

** TXT2 - "KEYBOARD TEST" Text

TXT2	DB	\$00,\$00	
	DB	\$2B,\$25,\$39,\$22,\$2F,\$21,\$32,\$24	; "KEYBOARD"
	DB	\$00	
	DB	\$34,\$25,\$33,\$34	; "TEST"
	DB	\$00,\$00,\$00	
	DB	\$B2	

TXT2L = *-TXT2 ;length

** TXT7 - Keyboard

TXT7 = *

; First Row (Function Keys)

DB	\$91	; "1"
DB	\$00	
DB	\$92	; "2"
DB	\$00	
DB	\$93	; "3"

```

DB      $00
DB      $94          ;"4"
DB      $00
DB      $A8          ;"H"
DB      $00
DB      $A1          ;"A"
DB      $00
DB      $A2          ;"B"
DB      $00,$00,$00

;      Second Row ("1 2 3 4 5 6 7 8 9 0 < >")

```

```

DB      $5B
DB      $00
DB      $11          ;"1"
DB      $00
DB      $12          ;"2"
DB      $00
DB      $13          ;"3"
DB      $00
DB      $14          ;"4"
DB      $00
DB      $15          ;"5"
DB      $00
DB      $16          ;"6"
DB      $00
DB      $17          ;"7"
DB      $00
DB      $18          ;"8"
DB      $00
DB      $19          ;"9"
DB      $00
DB      $10          ;"0"
DB      $00
DB      $1C          ;"<"
DB      $00
DB      $1E          ;">"
DB      $00
DB      $A2          ;"B"
DB      $80
DB      $B3          ;"S"
DB      $00,$00,$00

```

```

;      Third Row ("Q W E R T Y U I O P - =")

```

```

DB      $FF
DB      $FF
DB      $00
DB      $31          ;"Q"
DB      $00
DB      $37          ;"W"
DB      $00
DB      $25          ;"E"
DB      $00
DB      $32          ;"R"
DB      $00
DB      $34          ;"T"
DB      $00
DB      $39          ;"Y"
DB      $00
DB      $35          ;"U"
DB      $00
DB      $29          ;"I"
DB      $00
DB      $2F          ;"O"
DB      $00
DB      $30          ;"P"

```

```

DB      $00
DB      $0D          ; "-"
DB      $00
DB      $1D          ; "="
DB      $00
DB      $B2          ; "R"
DB      $B4          ; "T"
DB      $00,$00,$00

```

```

;      Fourth Row ("A S D F G H J K L ; + *")

```

```

DB      $80
DB      $DC
DB      $80
DB      $00
DB      $21          ; "A"
DB      $00
DB      $33          ; "S"
DB      $00
DB      $24          ; "D"
DB      $00
DB      $26          ; "F"
DB      $00
DB      $27          ; "G"
DB      $00
DB      $28          ; "H"
DB      $00
DB      $2A          ; "J"
DB      $00
DB      $2B          ; "K"
DB      $00
DB      $2C          ; "L"
DB      $00
DB      $1B          ; ";"
DB      $00
DB      $0B          ; "+"
DB      $00
DB      $0A          ; "*"
DB      $00
DB      $A3          ; "C"
DB      $00,$00,$00

```

```

;      Fifth Row ("Z X C V B N M , . /")

```

```

DB      $80
DB      $B3          ; "S"
DB      $A8          ; "H"
DB      $80
DB      $00
DB      $3A          ; "Z"
DB      $00
DB      $38          ; "X"
DB      $00
DB      $23          ; "C"
DB      $00
DB      $36          ; "V"
DB      $00
DB      $22          ; "B"
DB      $00
DB      $2E          ; "N"
DB      $00
DB      $2D          ; "M"
DB      $00
DB      $0C          ; ", "
DB      $00
DB      $0E          ; ". "
DB      $00

```

```

DB      $0F          ;"/"
DB      $00
DB      $80
DB      $B3          ;"S"
DB      $A8          ;"H"
DB      $80
DB      $00,$00,$00

```

; Sixth Row (Space Bar)

```

DB      $00,$00,$00,$00,$00
DB      $80
DB      $B3          ;"S"
DB      $80
DB      $B0          ;"P"
DB      $80
DB      $A1          ;"A"
DB      $80
DB      $A3          ;"C"
DB      $80
DB      $A5          ;"E"
DB      $80
DB      $80
DB      $80
DB      $A2          ;"B"
DB      $80
DB      $A1          ;"A"
DB      $80
DB      $B2          ;"R"
DB      $80

```

TXT7L = *-TXT7 ;length

**	TXT3 - "S P A C E B A R" Text
----	-------------------------------

```

TXT3  DB      $00
      DB      $33          ;"S"
      DB      $00
      DB      $30          ;"P"
      DB      $00
      DB      $21          ;"A"
      DB      $00
      DB      $23          ;"C"
      DB      $00
      DB      $25          ;"E"
      DB      $00
      DB      $00
      DB      $00
      DB      $22          ;"B"
      DB      $00
      DB      $21          ;"A"
      DB      $00
      DB      $32          ;"R"
      DB      $00

```

TXT3L = *-TXT3 ;length

**	TXT4 - "SH" Text
----	------------------

```

TXT4  DB      $00
      DB      $33,$28      ;"SH"
      DB      $00

```

TXT4L = *-TXT4 ;length

** TXT5 - "SH" Text

TXT5 = TXT4
TXT5L = TXT4L ;length

** TXT6 - "B S" Text

TXT6 DB \$22 ;"B"
 DB \$00
 DB \$33 ;"S"

TXT6L = *-TXT6 ;length

** TXT8 - Control Key

TXT8 DB \$00
 DB \$5C
 DB \$00

TXT8L = *-TXT8 ;length

** TXT9 - "VOICE #" Text

TXT9 DB \$36,\$2F,\$29,\$23,\$25 ;"VOICE"
 DB \$00
 DB \$03 ;"#"

TXT9L = *-TXT9 ;length

Peripheral Handler Loading Facility, Part 2

```
**      CLT - Checksum Linkage Table
*
*      ENTRY JSR    CLT
*              ZCHAIN - ZCHAIN+1 = address of linkage table
*
*      EXIT
*              A = checksum of linkage table
*
*      CHANGES
*              Y
*
*      CALLS
*              -none-
*
*      MODS
*              R. S. Scheiman      1982-04-??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01
```

```
CLT      =      *              ;entry
          LDY     #17          ;offset to last byte to sum
          LDA     #0           ;initial sum
          CLC
CLT1     ADC     (ZCHAIN),Y    ;add byte
          DEY
          BPL     CLT1         ;if not done
          ADC     #0           ;add final carry
          EOR     #$FF         ;complement
          RTS                ;return
```

International Character Set

FIX ICSORG

** International Character Set

DB	\$00,\$00,\$00,\$00,\$00,\$00,\$00,\$00	;\$00 - space
DB	\$00,\$18,\$18,\$18,\$18,\$00,\$18,\$00	;\$01 - !
DB	\$00,\$66,\$66,\$66,\$66,\$00,\$00,\$00	;\$02 - "
DB	\$00,\$66,\$FF,\$66,\$66,\$FF,\$66,\$00	;\$03 - #
DB	\$18,\$3E,\$60,\$3C,\$06,\$7C,\$18,\$00	;\$04 - \$
DB	\$00,\$66,\$6C,\$18,\$30,\$66,\$46,\$00	;\$05 - %
DB	\$1C,\$36,\$1C,\$38,\$6F,\$66,\$3B,\$00	;\$06 - &
DB	\$00,\$18,\$18,\$18,\$00,\$00,\$00,\$00	;\$07 - '
DB	\$00,\$0E,\$1C,\$18,\$18,\$1C,\$0E,\$00	;\$08 - (
DB	\$00,\$70,\$38,\$18,\$18,\$38,\$70,\$00	;\$09 -)
DB	\$00,\$66,\$3C,\$FF,\$3C,\$66,\$00,\$00	;\$0A - asterisk
DB	\$00,\$18,\$18,\$7E,\$18,\$18,\$00,\$00	;\$0B - plus
DB	\$00,\$00,\$00,\$00,\$00,\$18,\$18,\$30	;\$0C - comma
DB	\$00,\$00,\$00,\$7E,\$00,\$00,\$00,\$00	;\$0D - minus
DB	\$00,\$00,\$00,\$00,\$00,\$18,\$18,\$00	;\$0E - period
DB	\$00,\$06,\$0C,\$18,\$30,\$60,\$40,\$00	;\$0F - /
DB	\$00,\$3C,\$66,\$6E,\$76,\$66,\$3C,\$00	;\$10 - 0
DB	\$00,\$18,\$38,\$18,\$18,\$18,\$7E,\$00	;\$11 - 1
DB	\$00,\$3C,\$66,\$0C,\$18,\$30,\$7E,\$00	;\$12 - 2
DB	\$00,\$7E,\$0C,\$18,\$0C,\$66,\$3C,\$00	;\$13 - 3
DB	\$00,\$0C,\$1C,\$3C,\$6C,\$7E,\$0C,\$00	;\$14 - 4
DB	\$00,\$7E,\$60,\$7C,\$06,\$66,\$3C,\$00	;\$15 - 5
DB	\$00,\$3C,\$60,\$7C,\$66,\$66,\$3C,\$00	;\$16 - 6
DB	\$00,\$7E,\$06,\$0C,\$18,\$30,\$30,\$00	;\$17 - 7
DB	\$00,\$3C,\$66,\$3C,\$66,\$66,\$3C,\$00	;\$18 - 8
DB	\$00,\$3C,\$66,\$3E,\$06,\$0C,\$38,\$00	;\$19 - 9
DB	\$00,\$00,\$18,\$18,\$00,\$18,\$18,\$00	;\$1A - colon
DB	\$00,\$00,\$18,\$18,\$00,\$18,\$18,\$30	;\$1B - semicolon
DB	\$06,\$0C,\$18,\$30,\$18,\$0C,\$06,\$00	;\$1C - <
DB	\$00,\$00,\$7E,\$00,\$00,\$7E,\$00,\$00	;\$1D - =
DB	\$60,\$30,\$18,\$0C,\$18,\$30,\$60,\$00	;\$1E - >
DB	\$00,\$3C,\$66,\$0C,\$18,\$00,\$18,\$00	;\$1F - ?
DB	\$00,\$3C,\$66,\$6E,\$6E,\$60,\$3E,\$00	;\$20 - @
DB	\$00,\$18,\$3C,\$66,\$66,\$7E,\$66,\$00	;\$21 - A
DB	\$00,\$7C,\$66,\$7C,\$66,\$66,\$7C,\$00	;\$22 - B
DB	\$00,\$3C,\$66,\$60,\$60,\$66,\$3C,\$00	;\$23 - C
DB	\$00,\$78,\$6C,\$66,\$66,\$6C,\$78,\$00	;\$24 - D
DB	\$00,\$7E,\$60,\$7C,\$60,\$60,\$7E,\$00	;\$25 - E
DB	\$00,\$7E,\$60,\$7C,\$60,\$60,\$60,\$00	;\$26 - F
DB	\$00,\$3E,\$60,\$60,\$6E,\$66,\$3E,\$00	;\$27 - G
DB	\$00,\$66,\$66,\$7E,\$66,\$66,\$66,\$00	;\$28 - H
DB	\$00,\$7E,\$18,\$18,\$18,\$18,\$7E,\$00	;\$29 - I
DB	\$00,\$06,\$06,\$06,\$06,\$66,\$3C,\$00	;\$2A - J
DB	\$00,\$66,\$6C,\$78,\$78,\$6C,\$66,\$00	;\$2B - K
DB	\$00,\$60,\$60,\$60,\$60,\$60,\$7E,\$00	;\$2C - L
DB	\$00,\$63,\$77,\$7F,\$6B,\$63,\$63,\$00	;\$2D - M
DB	\$00,\$66,\$76,\$7E,\$7E,\$6E,\$66,\$00	;\$2E - N
DB	\$00,\$3C,\$66,\$66,\$66,\$66,\$3C,\$00	;\$2F - O
DB	\$00,\$7C,\$66,\$66,\$7C,\$60,\$60,\$00	;\$30 - P
DB	\$00,\$3C,\$66,\$66,\$66,\$6C,\$36,\$00	;\$31 - Q
DB	\$00,\$7C,\$66,\$66,\$7C,\$6C,\$66,\$00	;\$32 - R
DB	\$00,\$3C,\$60,\$3C,\$06,\$06,\$3C,\$00	;\$33 - S
DB	\$00,\$7E,\$18,\$18,\$18,\$18,\$18,\$00	;\$34 - T
DB	\$00,\$66,\$66,\$66,\$66,\$66,\$7E,\$00	;\$35 - U
DB	\$00,\$66,\$66,\$66,\$66,\$3C,\$18,\$00	;\$36 - V

DB	\$00,\$63,\$63,\$6B,\$7F,\$77,\$63,\$00	;\$37 - W
DB	\$00,\$66,\$66,\$3C,\$3C,\$66,\$66,\$00	;\$38 - X
DB	\$00,\$66,\$66,\$3C,\$18,\$18,\$18,\$00	;\$39 - Y
DB	\$00,\$7E,\$0C,\$18,\$30,\$60,\$7E,\$00	;\$3A - Z
DB	\$00,\$1E,\$18,\$18,\$18,\$18,\$1E,\$00	;\$3B - [
DB	\$00,\$40,\$60,\$30,\$18,\$0C,\$06,\$00	;\$3C - \
DB	\$00,\$78,\$18,\$18,\$18,\$18,\$78,\$00	;\$3D -]
DB	\$00,\$08,\$1C,\$36,\$63,\$00,\$00,\$00	;\$3E - ^
DB	\$00,\$00,\$00,\$00,\$00,\$00,\$FF,\$00	;\$3F - underline
DB	\$0C,\$18,\$3C,\$06,\$3E,\$66,\$3E,\$00	;\$40 - acute accent a
DB	\$30,\$18,\$00,\$66,\$66,\$66,\$3E,\$00	;\$41 - acute accent u
DB	\$36,\$6C,\$00,\$76,\$76,\$7E,\$6E,\$00	;\$42 - tilde N
DB	\$0C,\$18,\$7E,\$60,\$7C,\$60,\$7E,\$00	;\$43 - acute accent E
DB	\$00,\$00,\$3C,\$60,\$60,\$3C,\$18,\$30	;\$44 - cedilla c
DB	\$3C,\$66,\$00,\$3C,\$66,\$66,\$3C,\$00	;\$45 - circumflex o
DB	\$30,\$18,\$00,\$3C,\$66,\$66,\$3C,\$00	;\$46 - grave accent o
DB	\$30,\$18,\$00,\$38,\$18,\$18,\$3C,\$00	;\$47 - grave accent i
DB	\$1C,\$30,\$30,\$78,\$30,\$30,\$7E,\$00	;\$48 - U.K. currency
DB	\$00,\$66,\$00,\$38,\$18,\$18,\$3C,\$00	;\$49 - diaeresis i
DB	\$00,\$66,\$00,\$66,\$66,\$66,\$3E,\$00	;\$4A - umlaut u
DB	\$36,\$00,\$3C,\$06,\$3E,\$66,\$3E,\$00	;\$4B - umlaut a
DB	\$66,\$00,\$3C,\$66,\$66,\$66,\$3C,\$00	;\$4C - umlaut O
DB	\$0C,\$18,\$00,\$66,\$66,\$66,\$3E,\$00	;\$4D - grave accent u
DB	\$0C,\$18,\$00,\$3C,\$66,\$66,\$3C,\$00	;\$4E - acute accent o
DB	\$00,\$66,\$00,\$3C,\$66,\$66,\$3C,\$00	;\$4F - umlaut o
DB	\$66,\$00,\$66,\$66,\$66,\$66,\$7E,\$00	;\$50 - umlaut U
DB	\$3C,\$66,\$1C,\$06,\$3E,\$66,\$3E,\$00	;\$51 - circumflex a
DB	\$3C,\$66,\$00,\$66,\$66,\$66,\$3E,\$00	;\$52 - circumflex u
DB	\$3C,\$66,\$00,\$38,\$18,\$18,\$3C,\$00	;\$53 - circumflex i
DB	\$0C,\$18,\$3C,\$66,\$7E,\$60,\$3C,\$00	;\$54 - acute accent e
DB	\$30,\$18,\$3C,\$66,\$7E,\$60,\$3C,\$00	;\$55 - grave accent e
DB	\$36,\$6C,\$00,\$7C,\$66,\$66,\$66,\$00	;\$56 - tilde n
DB	\$3C,\$C3,\$3C,\$66,\$7E,\$60,\$3C,\$00	;\$57 - circumflex e
DB	\$18,\$00,\$3C,\$06,\$3E,\$66,\$3E,\$00	;\$58 - ring a
DB	\$30,\$18,\$3C,\$06,\$3E,\$66,\$3E,\$00	;\$59 - grave accent a
DB	\$18,\$00,\$18,\$3C,\$66,\$7E,\$66,\$00	;\$5A - ring A
DB	\$78,\$60,\$78,\$60,\$7E,\$18,\$1E,\$00	;\$5B - display escape
DB	\$00,\$18,\$3C,\$7E,\$18,\$18,\$18,\$00	;\$5C - up arrow
DB	\$00,\$18,\$18,\$18,\$7E,\$3C,\$18,\$00	;\$5D - down arrow
DB	\$00,\$18,\$30,\$7E,\$30,\$18,\$00,\$00	;\$5E - left arrow
DB	\$00,\$18,\$0C,\$7E,\$0C,\$18,\$00,\$00	;\$5F - right arrow
DB	\$18,\$00,\$18,\$18,\$18,\$18,\$18,\$00	;\$60 - Spanish !
DB	\$00,\$00,\$3C,\$06,\$3E,\$66,\$3E,\$00	;\$61 - a
DB	\$00,\$60,\$60,\$7C,\$66,\$66,\$7C,\$00	;\$62 - b
DB	\$00,\$00,\$3C,\$60,\$60,\$60,\$3C,\$00	;\$63 - c
DB	\$00,\$06,\$06,\$3E,\$66,\$66,\$3E,\$00	;\$64 - d
DB	\$00,\$00,\$3C,\$66,\$7E,\$60,\$3C,\$00	;\$65 - e
DB	\$00,\$0E,\$18,\$3E,\$18,\$18,\$18,\$00	;\$66 - f
DB	\$00,\$00,\$3E,\$66,\$66,\$3E,\$06,\$7C	;\$67 - g
DB	\$00,\$60,\$60,\$7C,\$66,\$66,\$66,\$00	;\$68 - h
DB	\$00,\$18,\$00,\$38,\$18,\$18,\$3C,\$00	;\$69 - i
DB	\$00,\$06,\$00,\$06,\$06,\$06,\$06,\$3C	;\$6A - j
DB	\$00,\$60,\$60,\$6C,\$78,\$6C,\$66,\$00	;\$6B - k
DB	\$00,\$38,\$18,\$18,\$18,\$18,\$3C,\$00	;\$6C - l
DB	\$00,\$00,\$66,\$7F,\$7F,\$6B,\$63,\$00	;\$6D - m
DB	\$00,\$00,\$7C,\$66,\$66,\$66,\$66,\$00	;\$6E - n
DB	\$00,\$00,\$3C,\$66,\$66,\$66,\$3C,\$00	;\$6F - o
DB	\$00,\$00,\$7C,\$66,\$66,\$7C,\$60,\$60	;\$70 - p
DB	\$00,\$00,\$3E,\$66,\$66,\$3E,\$06,\$06	;\$71 - q
DB	\$00,\$00,\$7C,\$66,\$60,\$60,\$60,\$00	;\$72 - r
DB	\$00,\$00,\$3E,\$60,\$3C,\$06,\$7C,\$00	;\$73 - s
DB	\$00,\$18,\$7E,\$18,\$18,\$18,\$0E,\$00	;\$74 - t
DB	\$00,\$00,\$66,\$66,\$66,\$66,\$3E,\$00	;\$75 - u

DB	\$00,\$00,\$66,\$66,\$66,\$3C,\$18,\$00	;\$76 - v
DB	\$00,\$00,\$63,\$6B,\$7F,\$3E,\$36,\$00	;\$77 - w
DB	\$00,\$00,\$66,\$3C,\$18,\$3C,\$66,\$00	;\$78 - x
DB	\$00,\$00,\$66,\$66,\$66,\$3E,\$0C,\$78	;\$79 - y
DB	\$00,\$00,\$7E,\$0C,\$18,\$30,\$7E,\$00	;\$7A - z
DB	\$66,\$66,\$18,\$3C,\$66,\$7E,\$66,\$00	;\$7B - umlaut A
DB	\$18,\$18,\$18,\$18,\$18,\$18,\$18,\$18	;\$7C -
DB	\$00,\$7E,\$78,\$7C,\$6E,\$66,\$06,\$00	;\$7D - display clear
DB	\$08,\$18,\$38,\$78,\$38,\$18,\$08,\$00	;\$7E - display backspace
DB	\$10,\$18,\$1C,\$1E,\$1C,\$18,\$10,\$00	;\$7F - display tab

Self-test, Part 3

FIX \$D000
LOC \$5000 ;\$D000 - \$D7FF mapped to \$5000 - \$57FF

```
**      STH - Self-test Hardware
*
*      ENTRY JSR      STH
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      NOTES
*          Problem: this is superfluous; SLFTSV could vector to
*          EST.
*
*      MODS
*          M. W. Colburn      1982-10-26
*          1. Bring closer to Coding Standard (object unchanged).
*          R. K. Nordin      1983-11-01
```

STH = * ;entry
 JMP EST ;execute self-test

```
**      EMS - Execute Memory Self-test
*
*      ENTRY JSR      EMS
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*          M. W. Colburn      1982-10-26
*          1. Bring closer to Coding Standard (object unchanged).
*          R. K. Nordin      1983-11-01
```

EMS = * ;entry
 JSR IST ;initialize self-test
 JMP STM ;self-test memory

```

**      EST - Execute Self-test
*
*      ENTRY JSR      EST
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      M. W. Colburn      1982-10-26
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

EST      =      *      ;entry
          JSR      IST      ;initialize self-test
          ;      JWP      SEL      ;self-test

```

```

**      SEL - Self-test
*
*      ENTRY JSR      SEL
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      M. W. Colburn      1982-10-26
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

SEL      =      *      ;entry
;      Initialize.

LDA      #0
STA      STTIME      ;clear main screen timeout timer
STA      STTIME+1
STA      STAUT      ;clear auto-mode flag
STA      AUDCTL      ;initialize audio control register
LDA      #$03      ;initialize POKEY
STA      SKCTL      ;serial port control
JSR      SAS      ;silence all sounds
LDA      #$40      ;disable DLI
STA      NMIEEN      ;NMI enable
LDX      #0      ;main screen colors
JSR      SUC      ;set up colors
LDX      #low DISL1 ;display list for main screen
LDY      #high DISL1
JSR      SDL      ;set up display list
LDA      #low PMD      ;process main screen DLI routine
STA      VDSLST      ;display list NMI address
LDA      #high PMD

```

```

    STA    VDSLST+1
    LDX    #3*4          ;main screen bold lines
    LDA    #$AA          ;color 1
    JSR    SVR           ;set value in range

;    Wait for all screen DLI's to clear and for VBLANK.

    LDX    #0

SEL1  STX    WSYNC          ;wait for HBLANK synchronization
      INX
      BNE    SEL1          ;if not done waiting

;    Wait until beam close to top (main screen DLI near).

SEL2  LDA    VCOUNT
      CMP    #24
      BCS    SEL2          ;if not done waiting

;    Preset for self-test type determination.

    LDA    #$10          ;initially select memory test
    STA    STPASS        ;pass indicator
    LDA    #$C0          ;enable DLI
    STA    NMIEEN

;    Determine type of self-test.

SEL3  LDA    CONSOL        ;console switches
      AND    #$01        ;START key indicator
      BNE    SEL3        ;if START key not pressed

      LDA    #$FF        ;clear character
      STA    CH

      LDA    STSEL        ;selection
      AND    #$0F        ;selection
      CMP    #$01        ;memory test indicator
      BEQ    SEL5        ;if memory test

      CMP    #$02        ;
      BEQ    SEL6        ;if audio-visual test

      CMP    #$04        ;
      BEQ    SEL7        ;if keyboard test

;    Self-test all.

SEL4  LDA    #$88          ;indicate all tests
      STA    STSEL        ;selection
      LDA    #$FF        ;auto-mode indicator
      STA    STAUT        ;auto-mode flag

;    Self-test memory.

SEL5  JMP    STM           ;self-test memory

;    Self-test audio-visual.

SEL6  JMP    STV           ;self-test audio-visual

;    Self-test keyboard.

SEL7  JMP    STK           ;self-test keyboard

```

```

**      IST - Initialize Self-test
*
*      ENTRY JSR      IST
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*
*          M. W. Colburn      1982-10-26
*          1. Bring closer to Coding Standard (object unchanged).
*          R. K. Nordin      1983-11-01

```

```

IST      =      *          ;entry
          LDA      #$11    ;indicate memory test
          STA      STSEL   ;selection
          LDA      #$21
          STA      SDMCTL  ;select small size playfield
          LDA      #$C0
          STA      NMIE    ;enable DLI
          LDA      #$41
          STA      STJMP   ;ANTIC jump instruction
          LDA      #$FF    ;clear code indicator
          STA      CH      ;key code
          RTS           ;return

```

```

**      SDL - Set Up Display List
*
*      ENTRY JSR      SDL
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*
*          M. W. Colburn      1982-10-26
*          1. Bring closer to Coding Standard (object unchanged).
*          R. K. Nordin      1983-11-01

```

```

SDL      =      *          ;entry

          STA      STKST    ;keyboard self-test flag
          TYA
          PHA              ;save high address
          TXA
          PHA              ;save low address
          LDA      #0
          STA      SDMCTL   ;DMACTL (DMA control) shadow
          STA      HELPG    ;HELP key flag
          LDA      #low POD ;process DLI routine
          STA      VDSLST
          LDA      #high POD

```

```

STA   VDSLST+1
LDX   #0*4           ;screen memory
TXA                   ;value is 0
JSR   SVR             ;set value in range
PLA                   ;saved low address
TAX
PLA                   ;saved high address
TAY
STX   SDLSTL          ;low display list address
STX   STJMP+1         ;low display list address
STY   SDLSTH          ;high display list address
STY   STJMP+2         ;high display list address
LDA   #$21
STA   SDMCTL
RTS                   ;return

```

```

**      PMD - Process Main Screen DLI
*
*      1) IF MAIN SCREEN IS ON FOR MORE than FIVE MINUTES
*      THEN 'ALL TESTS' SELECTION IS SELECTED AND EXECUTED
*      2) COLORS FOR CURRENTLY SELECTED CHOICE AND THE
*      NON-SELECTED CHOICES ARE DISPLAYED ON FLY
*      3) SELECTION PROCESS IS HANDLED
*
*      ENTRY  JMP      PMD
*             ??
*
*      EXIT
*             Exits via RTI
*             ??
*
*      CHANGES
*             ??
*
*      CALLS
*             ??
*
*      MODS
*      M. W. Colburn      1982-10-26
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

PMD      =      *      ;entry
;      Initialize.

      PHA          ;save A
      TXA
      PHA          ;save X

;      Check for 4th time.

PMD1     LDX      #$7A  ;assume non-selected color
      LDA      STPASS ;pass indicator
      CMP      #$01    ;4th time indicator
      BEQ      PMD3    ;if 4th time

;      Check for selection.

      AND      #$01    ;selection indicator
      BEQ      PMD2    ;if selected

;      Increment and check blink counter.

      INC      STBL    ;increment blink counter

```

```

    LDA    STBL    ;blink counter
    AND    #$20    ;blink indicator
    BEQ    PMD2    ;if not to blink

    LDX    #$2C    ;use selected color

;    Set color.

PMD2    STX    WSYNC ;wait for HBLANK synchronization
    STX    COLPF0 ;playfield 0 color
    CLC
    ROR    STPASS ;advance pass indicator
    LDA    #0
    STA    ATTRACT

;    Exit.

    PLA
    TAX            ;restore X
    PLA            ;restore A
    RTI            ;return

;    Check for SELECT previously pressed.

PMD3    LDA    STSPP ;SELECT previously pressed flag
    BNE    PMD4    ;if SELECT previously pressed

;    Check for SELECT pressed.

    LDA    CONSOL ;console switches
    AND    #$02    ;SELECT key indicator
    BNE    PMD5    ;if SELECT not pressed, exit

;    Process SELECT pressed.

    LDA    STSEL    ;current selection
    ROL    A        ;???
    ROL    STSEL    ;next selection
    LDA    #$20    ;blink indicator
    STA    STBL    ;blink counter
    LDA    #$FF    ;SELECT previously pressed indicator
    STA    STSPP    ;SELECT previously pressed flag
    BNE    PMD5    ;???

;    Process SELECT previously pressed.

PMD4    LDA    CONSOL ;console switches
    AND    #$02    ;SELECT key indicator
    BEQ    PMD5    ;if SELECT still pressed

    LDA    #0        ;SELECT not previously pressed indicator
    STA    STSPP    ;SELECT previously pressed flag

;    ???every 4th time???

PMD5    LDA    STSEL ;selection
    AND    #$0F    ;???
    ORA    #$10    ;reset indicate memory test???
    STA    STPASS ;pass indicator

;    Advance main screen timer.

    INC    STTIME
    BNE    PMD6    ;if low not zero

    INC    STTIME+1

```

```

;      Check main screen timer.

PMD6  LDA    STTIME+1
      CMP    #250    ;main screen timeout
      BNE    PMD7    ;if main screen timed out

;      Process main screen timeout.

      CLI
      JMP     SEL4    ;self-test all

;      Continue.

PMD7  JMP     PMD1    ;continue

```

** DISL1 - Display List for Main Screen

```

DISL1 DB      $70,$70,$70,$70,$70
      DB      $47
      DW      SMEM1
      DB      $70,$70,$70
      DB      $4E
      DW      ST3000
      DB      $70
      DB      $F0
      DB      $C6
      DW      SMEM2
      DB      $70,$86
      DB      $70,$86
      DB      $70,$06
      DB      $70,$70
      DB      $4E
      DW      ST3000
      DB      $70,$70,$70
      DB      $42
      DW      SMEM3
      DB      $41
      DW      DISL1

```

** SMEM1 - "SELF TEST" Text

```

SMEM1 DB      $00,$00,$00,$00
      DB      $33,$25,$2C,$26    ;"SELF"
      DB      $00
      DB      $34,$25,$33,$34    ;"TEST"
      DB      $00,$00,$00

```

** SMEM2 - "MEMORY AUDIO-VISUAL KEYBOARD ALL TESTS" Text

```

SMEM2 DB      $00,$00
      DB      $2D,$25,$2D,$2F,$32,$39    ;"MEMORY"
      DB      $00,$00,$00,$00,$00
      DB      $00,$00,$00,$00,$00
      DB      $21,$35,$24,$29,$2F        ;"AUDIO"
      DB      $0D                        ;"-"
      DB      $36,$29,$33,$35,$21,$2C    ;"VISUAL"
      DB      $00,$00,$00,$00
      DB      $2B,$25,$39,$22,$2F,$21,$32,$24 ;"KEYBOARD"
      DB      $00,$00,$00,$00,$00,$00,$00,$00
      DB      $21,$2C,$2C                ;"ALL"
      DB      $00
      DB      $34,$25,$33,$34,$33        ;"TESTS"
      DB      $00,$00,$00,$00,$00

```

**** SMEM3 - "SELECT,START OR RESET" Text**

```
SMEM3 DB    $00,$00,$00,$00
      DB    $42
      DB    $B3,$A5,$AC,$A5,$A3,$B4    ;"SELECT"
      DB    $56
      DB    $0C                        ;", "
      DB    $42
      DB    $B3,$B4,$A1,$B2,$B4        ;"START"
      DB    $56
      DB    $2F,$32                    ;"OR"
      DB    $42
      DB    $B2,$A5,$B3,$A5,$B4        ;"RESET"
      DB    $56
      DB    $00,$00,$00
```

**** DISL2 - Display List for Memory Test**

```
DISL2 DB    $70,$70,$70
      DB    $46
      DW    ST3000
      DB    $70
      DB    $70,$06
      DB    $70,$08
      DB    $70
      DB    $70,$06
      DB    $70,$08
      DB    $70,$08
      DB    $70,$08
      DB    $70,$08
      DB    $70,$70,$70
      DB    $01
      DW    DISL3
```

**** DISL3 - Display List for Exit Text**

```
DISL3 DB    $A0,$40
      DB    $42
      DW    SMEM4
      DB    $01
      DW    STJMP
```

**** SMEM4 - "RESET OR HELP TO EXIT" Text**

```
SMEM4 DB    $00,$00,$00,$00,$00
      DB    $42
      DB    $B2,$A5,$B3,$A5,$B4        ;"RESET"
      DB    $56
      DB    $2F,$32                    ;"OR"
      DB    $42
      DB    $A8,$A5,$AC,$B0            ;"HELP"
      DB    $56
      DB    $34,$2F                    ;"TO"
      DB    $00
      DB    $25,$38,$29,$34            ;"EXIT"
      DB    $00,$00,$00,$00,$00
```

** DISL4 - Display List for Keyboard Test

```
DISL4 DB    $70,$70,$70,$70
      DB    $46
      DW    ST3000
      DB    $70,$70,$70
      DB    $70,$02
      DB    $70
      DB    $70,$02
      DB    $70,$02
      DB    $70,$02
      DB    $70,$02
      DB    $70,$02
      DB    $70,$70
      DB    $01
      DW    DISL3
```

** DISL5 - Display List for Audio-visual Test

```
DISL5 DB    $70,$70,$70,$70
      DB    $46
      DW    SMEM5
      DB    $70,$06
      DB    $70,$70
      DB    $4B
      DW    ST3100
      DB    $0B,$0B,$0B,$0B,$0B,$0B,$0B,$0B
      DB    $0B,$0B,$0B,$0B,$0B,$0B,$0B,$0B
      DB    $0B,$0B,$0B,$0B,$0B,$0B,$0B,$0B
      DB    $0B,$0B,$0B,$0B,$0B,$0B,$0B,$0B
      DB    $0B,$0B,$0B,$0B,$0B,$0B,$0B,$0B
      DB    $0B,$0B
      DB    $70
      DB    $46
      DW    ST3000
      DB    $70
      DB    $01
      DW    DISL3
```

** SMEM5 - "AUDIO-VISUAL TEST" Text

```
SMEM5 DB    $00,$00
      DB    $21,$35,$24,$29,$2F      ;"AUDIO"
      DB    $0D                      ;"- "
      DB    $36,$29,$33,$35,$21,$2C  ;"VISUAL"
      DB    $00,$00,$00,$00
      DB    $00,$00,$00,$00
      DB    $34,$25,$33,$34          ;"TEST"
      DB    $00,$00,$00,$00,$00,$00
```

```

**      STM - Self-test Memory
*
*      STM verifies ROM and RAM by verifying the ROM checksums and
*      writing and reading all possible values to each byte of RAM.
*
*      ENTRY JSR      STM
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      NOTES
*      Problem: searches beyond end of TMNT.
*
*      MODS
*      M. W. Colburn      1982-10-26
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

STM      =      *      ;entry

;      Initialize.

      LDX      #low DISL2      ;memory test display list
      LDY      #high DISL2
      LDA      #0              ;indicate not keyboard self-test
      JSR      SDL              ;set up display list
      LDX      #1              ;memory test colors
      JSR      SUC              ;set up colors
      LDX      #0              ;offset to "MEMORY TEST ROM" test
      JSR      SSM              ;set screen memory
      LDX      #1              ;offset to "RAM" text
      JSR      SSM              ;set screen memory

;      Test first 8K ROM.

STM1     LDA      ST3020        ;???
      CMP      #$AA            ;color 1 for failure
      BEQ      STM4            ;if first 8K ROM already failed

      LDA      #$55            ;color 0 for test
      JSR      DFS              ;display first ROM status
      JSR      DMW              ;delay a middling while
      JSR      VFR              ;verify first 8K ROM
      BCS      STM2            ;if ROM failed

      LDA      #$FF            ;color 2 for success
      JMP      STM3

STM2     LDA      #$AA            ;color 1 for failure

STM3     JSR      DFS              ;display first ROM status

;      Test second 8K ROM.

STM4     LDA      ST3024        ;???
      CMP      #$AA            ;color 1 for failure
      BEQ      STM7            ;if second 8K ROM already failed

```

```

    LDA    #$55          ;color 0 for test
    JSR    DSS           ;display second ROM status
    JSR    DMW           ;delay a middling while
    JSR    VSR           ;verify second 8K ROM
    BCS    STM5          ;if ROM failed

    LDA    #$FF          ;color 2 for success
    JMP    STM6

STM5    LDA    #$AA      ;color 1 for failure

STM6    JSR    DSS       ;display second ROM status

;    Test RAM.

STM7    LDA    #$C0      ;mask for left side of a screen byte
    STA    STSMM         ;???
    LDA    #$04          ;initially select LED 1 off
    STA    STLM          ;LED mask
    LDA    #0
    STA    STSMP         ;initialize ???
    STA    STPAG         ;initialize current page
    STA    STPAG+1
    STA    ST1K          ;initialize current 1K to test

;    Test 1K of RAM.

STM8    LDX    STSMP      ;screen memory pointer
    LDA    ST3038,X      ;???
    AND    STSMM
    CMP    #$80
    BEQ    STM17         ;if already failed

    CMP    #$08
    BEQ    STM17         ;if already failed

    LDA    #$44          ;color 0 for test
    JSR    DRS           ;display RAM block status
    LDA    STLM          ;LED mask
    JSR    SLD           ;set LED's
    LDA    STLM          ;current LED mask
    EOR    #$0C          ;complement LED's selected
    STA    STLM          ;update LED mask

;    Check for memory not to test.

    LDX    #TMNTL-1+2    ;2 bytes beyond last byte of table

STM9    LDA    TMNT,X     ;range to test
    CMP    STPAG+1       ;high current page
    BEQ    STM15         ;if not to test, indicate success

    DEX
    BPL    STM9          ;if not done

;    Test 1K of RAM.

    LDA    #4            ;number of pages to test
    STA    STPC          ;page count

;    Write initial list to page.

STM10   LDX    #0        ;initial value to write

;    Write list to page.

STM11   LDY    #0        ;offset to first byte of page

```

```

STM12 TXA      (STPAG),Y      ;byte of page
      STA
      INX
      INY
      BNE      STM12          ;if not done writing page

;      Verify list written to page.

      STX      STMVAL          ;first correct value to test
      LDY      #0              ;offset to first byte of page

STM13 LDA      (STPAG),Y      ;byte of page
      CMP      STMVAL          ;correct value
      BNE      STM14          ;if not correct value

      INC      STMVAL          ;increment value to test
      INY
      BNE      STM13          ;if not done verifying page

;      Increment and test initial value to write.

      INX
      BNE      STM11          ;increment initial value to write
                                ;if not done, write another list

;      Decrement and test page counter.

      INC      STPAG+1          ;increment high current page
      DEC      STPC            ;decrement page count
      BNE      STM10          ;if not done testing pages

      BEQ      STM16          ;indicate success

;      Display failure.

STM14 JSR      DMW              ;delay a middling while
      LDA      #$88            ;color 1 for failure
      JSR      DRS              ;display RAM block status
      JMP      STM17            ;???

;      Delay for simulating test of memory not to test.

STM15 JSR      DLW              ;delay a long while

;      Display success.

STM16 LDA      #$CC            ;color 2 for success
      JSR      DRS              ;display RAM block status

;      ???

STM17 LDA      STSMM            ;???
      BMI      STM20            ;if ???

      LDA      #$C0
      STA      STSMM            ;???
      INC      STSMP            ;increment screen memory pointer

;      ???

STM18 CLC
      LDA      ST1K              ;current 1K to test
      ADC      #high $0400        ;add 1K
      STA      STPAG+1            ;high current page
      STA      ST1K              ;update current 1K to test
      CMP      RAMSIZ            ;RAM size
      BNE      STM8              ;if not done testing RAM

```

```

;      Check for auto-mode.

      LDA    STAUT      ;auto-mode flag
      BNE    STM19      ;if auto-mode, perform audio-visual test

;      Test memory again.

      JMP     STM1       ;test memory again

;      Process auto-mode.

STM19  LDA    #$0C      ;indicate LED 1 and 2 off
      JSR     SLD        ;set LED's
      JSR     DLW        ;delay a long while
      JMP     STV        ;self-test audio-visual

;      ???

STM20  LDA    #$0C      ;???
      STA     STSMM      ;???
      BNE     STM18      ;???

```

```

**      DFS - Display First ROM Status
*
*      ENTRY JSR      DFS
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      M. W. Colburn      1982-10-26
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

DFS    =      *          ;entry
      LDX     #1*4      ;first 8K ROM display
      JSR     SVR        ;set value in range
      AND     #$FC      ;???
      STA     ST3020+3   ;???
      RTS                    ;return

```

```

**      DSS - Display Second ROM Status
*
*      ENTRY JSR      DSS
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              M. W. Colburn      1982-10-26
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

DSS      =      *              ;entry
          LDX      #2*4          ;second 8K ROM display
          JSR      SVR           ;set value in range
          AND      #$FC          ;???
          STA      ST3024+3      ;???
          RTS                    ;return

```

```

**      SLD - Set LED's
*
*      ENTRY JSR      SLD
*              A = LED mask (bit 3 - LED 2, bit 2 - LED 1)
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              M. W. Colburn      1982-10-26
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

SLD      =      *              ;entry
          STA      STTMP5        ;save LED mask
          LDA      PORTB
          AND      #$F3          ;clear LED control
          ORA      STTMP5        ;set LED control according to mask
          STA      PORTB        ;update port B memory control
          RTS                    ;return

```

```

**      DMW - Delay a Middling While
*
*      ENTRY JSR      DMW
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*          M. W. Colburn      1982-10-26
*          1. Bring closer to Coding Standard (object unchanged).
*          R. K. Nordin      1983-11-01

```

```

DMW      =      *          ;entry
          LDX      #60      ;60-VBLANK delay
          BNE      DAW      ;delay a while

```

```

**      DLW - Delay a Long While
*
*      ENTRY JSR      DLW
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*          M. W. Colburn      1982-10-26
*          1. Bring closer to Coding Standard (object unchanged).
*          R. K. Nordin      1983-11-01

```

```

DLW      =      *          ;entry
          LDX      #150     ;150-VBLANK delay
          JMP      DAW      ;delay a while, return
;

```

```

**      DAW - Delay a While
*
*      ENTRY JSR      DAW
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              M. W. Colburn      1982-10-26
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

DAW      =      *              ;entry

DAW1     LDY      #$FF              ;initialize inner loop counter

DAW2     STY      WSYNC              ;wait for HBLANK synchronization
        DEY
        BNE      DAW2              ;if inner loop not done

        DEX
        BNE      DAW1              ;if outer loop not done

        RTS                      ;return

```

```

**      DRS - Display RAM Block Status
*
*      ENTRY JSR      DRS
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              M. W. Colburn      1982-10-26
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

DRS      =      *              ;entry
        PHA              ;save color
        LDX      STSMP      ;???
        LDA      STSMM      ;???
        EOR      #$FF      ;complement ???
        AND      ST3038,X    ;???
        STA      ST3038,X    ;???
        PLA              ;saved color
        AND      STSMM      ;???
        ORA      ST3038,X    ;???
        STA      ST3038,X    ;???
        RTS              ;return

```

```

**      POD - Process Other DLI's
*
*      POD turns the last line on the screen into white on black,
*      handles keyboard self-test display of console switches, handles
*      HELP key for exit, and ensures no attract-mode.
*
*      ENTRY  JMP      POD
*              ??
*
*      EXIT
*              Exits via RTI
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              M. W. Colburn      1982-10-26
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

POD      =      *      ;entry
;      Initialize.

      PHA              ;save A
;      Select ???.

      LDA      #$0C    ;white color
      STA      COLPF1 ;playfield 1 color
      LDA      COLOR4 ;background color
      STA      COLPF2 ;playfield 2 color
;      Ensure no attract-mode.

      LDA      #0      ;no attract-mode
      STA      ATRACT ;attract-mode timer/flag
;      Check HELP key.

      LDA      HELPPFG ;HELP key flag
      BEQ      POD1    ;if HELP not pressed
;      Process HELP key.

      LDA      #0      ;HELP key not pressed indicator
      STA      HELPPFG ;HELP key flag
      LDA      #$0C    ;LED's off
      JSR      SLD     ;set LED's
      CLI
      JMP      SEL     ;start over with main screen
;      Check for keyboard self-test.

POD1     LDA      STKST ;keyboard self-test flag
      BEQ      POD10  ;if not keyboard self-test, exit
;      Set display of console switches pressed.

      LDA      CONSOL ;console switches
      AND      #$01   ;START key indicator

```

```

        BEQ     POD2     ;if START key pressed

        LDA     #$B3
        BNE     POD3     ;set display
POD2    LDA     #$33
POD3    STA     ST301C ;set START key display

        LDA     CONSOL ;console switches
        AND     #$02   ;SELECT key indicator
        BEQ     POD4     ;if SELECT key pressed

        LDA     #$F3
        BNE     POD5     ;set display
POD4    LDA     #$73
POD5    STA     ST301E ;set SELECT key display

        LDA     CONSOL ;console switches
        AND     #$04   ;OPTION key indicator
        BEQ     POD6     ;if OPTION key pressed

        LDA     #$AF
        BNE     POD7     ;set display
POD6    LDA     #$2F
POD7    STA     ST3020 ;set OPTION key display

;       Sound tone if console switches pressed.

        LDA     CONSOL ;console switches
        AND     #$07   ;key indicators
        CMP     #$07   ;no keys pressed
        BEQ     POD8     ;if no keys pressed

        LDA     #100   ;frequency
        STA     AUDF2   ;set frequency of voice 2
        LDA     #$A8   ;pure tone, half volume
        BNE     POD9     ;set control of voice 2
POD8    LDA     #0      ;zero volume
POD9    STA     AUDC2   ;set control of voice 2

;       Exit.
POD10   PLA          ;restore A
        RTI          ;return

```

```

**      TMNT - Table of Memory Not to Test
*
*      NOTES
*      Problem: bytes wasted by redundant entries.

```

```

TMNT    DB      high $0000   ;$0000 - $03FF, zero page and stack
        DB      high $5000   ;$5000 - $53FF, self-test ROM
        DB      high $5400   ;$5400 - $57FF, self-test ROM
        DB      high ST3000   ;ST3000 - ST3000+$03FF, screen memory
        DB      high ST3000   ;ST3000 - ST3000+$03FF, screen memory
        DB      high ST3000   ;ST3000 - ST3000+$03FF, screen memory

```

```

TMNTL   =      *-TMNT ;length

```

```

**      STK - Self-test Keyboard
*
*      STK verifies the operation of the keyboard by displaying
*      keys as they are pressed.  In auto-mode, the verification
*      is simulated.
*
*      ENTRY JSR      STK
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      NOTES
*      Problem: one too many bytes taken from TSKP table???
*      Problem: wasted bytes for extra LDA CH???
*      Problem: logic is convoluted (due to SBT and SAS
*      subroutines appearing in the middle of STK).
*
*      MODS
*      M. W. Colburn      1982-10-26
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

STK      =      *      ;entry

;      Initialize.

      LDX      #0
      STX      STSKP      ;initialize simulated keypress index
      LDX      #3      ;keyboard test colors
      JSR      SUC      ;set up colors
      LDX      #low DISL4      ;keyboard display list
      LDY      #high DISL4
      LDA      #$FF      ;indicate keyboard self-test
      JSR      SDL      ;set up display list

;      Test keyboard.

STK1     LDX      #2      ;offset to "KEYBOARD TEST" text
      JSR      SSM      ;set screen memory
      LDX      #7      ;offset to keyboard text
      JSR      SSM      ;set screen memory

;      Check auto-mode.

      LDA      STAUT      ;auto-mode flag
      BEQ      STK3      ;if not auto-mode

;      Simulate keypress.

STK2     LDX      STSKP      ;offset to next simulated keypress
      LDA      TSKP,X      ;simulated keypress
      INC      STSKP      ;advance offset to simulated keypress
      LDX      STSKP      ;offset to simulated keypress
      CPX      #TSKPL+1      ;last offset+1+1
      BNE      STK4      ;if last keypress not processed

;      Self-test memory.

```

```

    JSR    DLW          ;delay a long while
    JMP    STM          ;self-test memory

;    Get a keypress.

STK3    LDA    CH          ;key code
        CMP    #$FF        ;clear code indicator
        BEQ    STK3        ;if no key pressed

        CMP    #$C0
        BCS    STK3        ;if ???

        LDA    CH          ;key code

;    Process keypress.

STK4    LDX    #$FF        ;clear code indicator
        STX    CH          ;key code
        PHA                    ;save key code
        AND    #$80
        BEQ    STK5        ;if not CTRL

        LDX    #8          ;offset to control key text
        JSR    SSM        ;set screen memory

;    Check for shift key.

STK5    PLA                    ;saved key code
        PHA                    ;save key code
        AND    #$40
        BEQ    STK6        ;if not shift key

;    Process keyboard shift key display.

        LDX    #5          ;offset to "SH"
        JSR    SSM        ;set screen memory
        LDX    #4          ;offset to "SH"
        JSR    SSM        ;set screen memory

;    Check for special keys.

STK6    PLA                    ;saved key code
        AND    #$3F
        CMP    #$21
        BEQ    KSB          ;if space bar, process display

        CMP    #$2C
        BEQ    KTK          ;if tab key, process display

        CMP    #$34
        BEQ    KBK          ;if backspace key, process display

        CMP    #$0C
        BEQ    KRK          ;if return key, process display

;    Process other key displays.

        TAX                    ;key code
        LDA    TSMC,X        ;display character
        PHA                    ;save display character

        LDA    #low ST3021
        STA    STTMP1        ;screen pointer
        LDA    #high ST3021
        STA    STTMP1+1

;    Find display character in screen memory.

```

```

        PLA                ;saved display character
        LDY    #$FF        ;preset offset

STK7    INY
        CMP    (STTMP1),Y  ;???
        BNE    STK7        ;if not found

;      Display inverse video.

        LDA    (STTMP1),Y  ;???
        EOR    #$80        ;invert video
        STA    (STTMP1),Y  ;update ???

;      Check auto-mode.

STK8    LDA    STAUT        ;auto-mode flag
        BEQ    STK9        ;if not auto-mode

;      Process auto-mode.

        JSR    SBT          ;sound beep tone
        LDX    #20          ;20-VBLANK delay
        JSR    DAW          ;delay a while
        JSR    SAS          ;silence all sounds
        LDX    #10          ;10-VBLANK delay
        JSR    DAW          ;delay a while
        JMP    STK1         ;get next simulated keypress

;      Process manual mode.

STK9    JSR    SBT          ;sound beep tone

STK10   LDA    SKSTAT       ;???
        AND    #$04
        BEQ    STK10        ;if ???

        JSR    SAS          ;silence all sounds
        JMP    STK1         ;get next keypress

```

```

**      SBT - Sound Beep Tone
*
*      ENTRY JSR    SBT
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      M. W. Colburn      1982-10-26
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

SBT    =    *      ;entry
        LDA    #$64    ;frequency
        STA    AUDF1    ;set frequency
        LDA    #$A8    ;pure tone, half volume
        STA    AUDC1    ;set control
        RTS            ;return

```

```

**      SAS - Silence All Sounds
*
*      ENTRY JSR      SAS
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*          M. W. Colburn      1982-10-26
*          1. Bring closer to Coding Standard (object unchanged).
*          R. K. Nordin      1983-11-01

```

```

SAS      =      *      ;entry
          LDA      #0      ;volume 0
          STA      AUDC1    ;silence voice 1
          STA      AUDC2    ;silence voice 2
          STA      AUDC3    ;silence voice 3
          STA      AUDC4    ;silence voice 4
          RTS

```

```

**      KSB - Process Keyboard Space Bar Display
*
*      ENTRY JSR      KSB
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*          M. W. Colburn      1982-10-26
*          1. Bring closer to Coding Standard (object unchanged).
*          R. K. Nordin      1983-11-01

```

```

KSB      =      *      ;entry
          LDX      #3      ;offset to "S P A C E   B A R" text
          JSR      SSM      ;set screen memory
          JMP      STK8     ;continue

```

```

**      KBK - Process Keyboard Backspace Key Display
*
*      ENTRY JSR      KBK
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*          M. W. Colburn      1982-10-26
*          1. Bring closer to Coding Standard (object unchanged).
*          R. K. Nordin      1983-11-01

```

```

KBK      =      *      ;entry
          LDX      #6      ;offset to "B S" text
          JSR      SSM      ;set screen memory
          JMP      STK8     ;continue

```

```

**      KTK - Process Keyboard Tab Key Display
*
*      ENTRY JSR      KTK
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*          M. W. Colburn      1982-10-26
*          1. Bring closer to Coding Standard (object unchanged).
*          R. K. Nordin      1983-11-01

```

```

KTK      =      *      ;entry
          LDA      #$7F     ;???
          STA      ST3052
          STA      ST3052+1
          BNE      STK8     ;continue

```

```

**      KRK - Process Keyboard Return Key Display
*
*      ENTRY JSR      KRK
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      M. W. Colburn      1982-10-26
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

KRK      =      *      ;entry
          LDA      #$32      ;???
          STA      ST306D
          LDA      #$34      ;???
          STA      ST306D+1
          BNE      STK8      ;continue

```

** TSKP - Table of Simulated Keypresses

```

TSKP      DB      $52,$08,$0A,$2B,$28,$0D,$3D,$39,$2D      ;"Copyright"
          DB      $1F,$30,$35,$18                          ;"1984"
          DB      $7F,$2D,$3F,$28,$0D                      ;"Atari"

TSKPL      =      *-TSKP ;length

```

```

**      STV - Self-test Audio-visual
*
*      STV verifies the operation of the display and voices by
*      displaying and playing a tune.
*
*      ENTRY JSR      STV
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS      M. W. Colburn      1982-10-26
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

STV      =      *      ;entry

;      Initialize.

          LDX      #2      ;audio-visual test colors
          JSR      SUC      ;set up colors

;      Test audio-visual.

```

```

STV1  LDA    #0
      STA    STVOC          ;initialize voice indicator

;      Test voice.

STV2  LDA    #0
      STA    STNOT          ;initialize note counter
      LDX    #low DISL5     ;audio-visual display list
      LDY    #high DISL5
      LDA    #0             ;indicate not keyboard self-test
      JSR    SDL            ;set up display list

;      Display voice number.

      LDX    #9             ;offset to "VOICE #" text
      JSR    SSM            ;set screen memory
      LDA    STVOC          ;voice indicator
      LSR    A              ;voice number
      CLC
      ADC    #$11           ;adjust for screen memory
      STA    ST300B         ;voice number display

;      Display staff.

      LDX    #$0F          ;offset to last byte of staff lines

STV3  LDA    #$FF           ;color 2
      STA    ST3150,X       ;byte of first line of staff
      STA    ST31B0,X       ;byte of second line of staff
      STA    ST3210,X       ;byte of third line of staff
      STA    ST3270,X       ;byte of fourth line of staff
      STA    ST32D0,X       ;byte of fifth line of staff
      DEX
      BPL    STV3           ;if not done

;      Display cleft.

      LDA    #0             ;offset to first cleft display address
      STA    STCDI          ;cleft display pointer
      LDA    #2*6
      STA    STCDA          ;cleft data pointer

STV4  LDX    STCDI          ;cleft display pointer
      LDA    TCDA+1,X       ;high address of cleft display
      TAY
      LDA    TCDA,X         ;low address of cleft display
      TAX
      LDA    STCDA          ;cleft data pointer
      JSR    DVN            ;display ???
      CLC
      LDA    STCDA          ;cleft data pointer
      ADC    #6
      STA    STCDA          ;update cleft data pointer
      INC    STCDI          ;increment cleft display pointer
      INC    STCDI
      LDA    STCDI          ;cleft display pointer
      CMP    #TCDAL         ;length of cleft display table
      BNE    STV4          ;if not done

;      Delay.

      JSR    DMW            ;delay a middling while

;      Display and play first note.

      LDX    #low ST3154    ;first note ???

```

```

LDY    #high ST3154
LDA     #0*6
JSR     DVN             ;display ???

LDA     #$51             ;first note frequency
JSR     SVN             ;sound ???

;      Display and play second note.

LDX     #low ST3186      ;second note ???
LDY     #high ST3186
LDA     #0*6
JSR     DVN             ;display ???

LDA     #$5B             ;second note frequency
JSR     SVN             ;sound ???

;      Display and play third note.

LDX     #low ST30F8      ;third note ???
LDY     #high ST30F8
LDA     #12*6
JSR     DVN             ;display ???
LDX     #low ST30C7      ;third note ???
LDY     #high ST30C7
LDA     #14*6
JSR     DVN             ;display ???
LDX     #low ST3248      ;third note ???
LDY     #high ST3248
LDA     #13*6
JSR     DVN             ;display ???

LDA     #$44             ;third note frequency
JSR     SVN             ;sound ???

;      Display and play fourth note.

LDX     #low ST30CA      ;fourth note ???
LDY     #high ST30CA
LDA     #12*6
JSR     DVN             ;display ???
LDX     #low ST321A      ;fourth note ???
LDY     #high ST321A
LDA     #13*6
JSR     DVN             ;display ???
LDX     #low ST31CA      ;fourth note ???
LDY     #high ST31CA
LDA     #1*6
JSR     DVN             ;display ???

LDA     #$3C             ;fourth note frequency
JSR     SVN             ;sound ???

;      Display and play fifth note.

LDX     #low ST303C      ;fifth note ???
LDY     #high ST303C
LDA     #12*6
JSR     DVN             ;display ???
LDX     #low ST318C      ;fifth note ???
LDY     #high ST318C
LDA     #13*6
JSR     DVN             ;display ???
LDX     #low ST313C      ;fifth note ???
LDY     #high ST313C
LDA     #1*6
JSR     DVN             ;display ???

```

```

    LDA    #$2D          ;fifth note frequency
    JSR    SVN           ;sound ???

;    Display and play sixth note.

    LDX    #low ST309E   ;sixth note ???
    LDY    #high ST309E
    LDA    #12*6
    JSR    DVN           ;display ???
    LDX    #low ST31EE   ;sixth note ???
    LDY    #high ST31EE
    LDA    #13*6
    JSR    DVN           ;display ???

    LDA    #$35          ;sixth note frequency
    JSR    SVN           ;sound ???

;    Delay.

    JSR    DLW           ;delay a long while

;    Advance to next voice.

    INC     STV0C         ;increment voice indicator
    INC     STV0C
    LDA     STV0C         ;voice indicator
    CMP     #8            ;last voice indicator
    BNE     STV5          ;if all voices not processed

;    Process test completion.

    LDA     STAUT         ;auto-mode flag
    BNE     STV6          ;if auto-mode, perform keyboard test

    JMP     STV1          ;repeat audio-visual test

;    Test next voice.

STV5    JMP     STV2      ;test next voice

;    Self-test keyboard.

STV6    JSR     DLW       ;delay a long while
        JMP     STK       ;self-test keyboard

```

```

**      SVN - Sound ???
*
*      ENTRY JSR      SVN
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              M. W. Colburn      1982-10-26
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

SVN      =      *              ;entry

;      Sound note.

LDY      STVOC              ;current voice indicator
STA      AUDF1,Y            ;set frequency
LDA      #$A8              ;pure tone, half volume
STA      AUDC1,Y            ;set control

;      Delay a while.

LDX      STNOT              ;current note
LDA      TNDD,X            ;delay time
TAX
JSR      DAW                ;delay a while

;      Increment note counter.

INC      STNOT              ;increment note counter

;      Exit.

JSR      SAS                ;silence all sounds
RTS                        ;return

```

```

**      DVN - Display ???
*
*      ENTRY JSR      DVN
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      M. W. Colburn      1982-10-26
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

DVN      =      *      ;entry
          STX      STTMP2      ;???
          STY      STTMP2+1    ;???
          TAX      ;offset to ???
          LDY      #0
          LDA      #16      ;???
          STA      STTMP3      ;???
          LDA      #6      ;???
          STA      STTMP4      ;???

DVN1     LDA      TAVD,X      ;byte of ???
          ORA      (STTMP2),Y ;???
          STA      (STTMP2),Y ;update ???
          JSR      AST      ;add 16
          DEC      STTMP3      ;???
          BNE      DVN1      ;if ???

          INC      STTMP3      ;???
          INX
          DEC      STTMP4
          BNE      DVN1      ;if ???

          RTS      ;return

```

```

**      AST - Add Sixteen
*
*      ENTRY JSR      AST
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      M. W. Colburn      1982-10-26
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

AST      =      *      ;entry
          CLC

```

```

LDA STTMP2 ;current low value
ADC #16 ;add 16
STA STTMP2 ;new low value
BCC AST1 ;if no carry

INC STTMP2+1 ;adjust high value

AST1 RTS ;return

```

** TNDD - Table of Note Duration Delays

```

TNDD DB 32 ;0 - first note
      DB 32 ;1 - second note
      DB 32 ;2 - third note
      DB 16 ;3 - fourth note
      DB 16 ;4 - fifth note
      DB 32 ;5 - sixth note

```

** TAVD - Table of Audio-visual Test Display Data

```

TAVD DB $01,$1F,$3F,$7F,$3E,$1C ;0 - ???
      DB $00,$41,$42,$4C,$70,$40 ;1 - ???
      DB $00,$01,$02,$04,$08,$10 ;2 - ???
      DB $00,$43,$44,$48,$48,$48 ;3 - ???
      DB $00,$44,$22,$10,$08,$07 ;4 - ???
      DB $00,$04,$08,$05,$02,$00 ;5 - ???
      DB $00,$30,$48,$88,$84,$84 ;6 - ???
      DB $00,$88,$88,$90,$A0,$C0 ;7 - ???
      DB $00,$F0,$88,$84,$82,$82 ;8 - ???
      DB $00,$82,$82,$84,$88,$F0 ;9 - ???
      DB $00,$00,$00,$00,$00,$80 ;10 - ???
      DB $80,$80,$80,$80,$80,$80 ;11 - ???
      DB $00,$1C,$3E,$7F,$7E,$7C ;12 - ???
      DB $40,$00,$00,$00,$00,$00 ;13 - ???
      DB $00,$04,$04,$06,$05,$06 ;14 - ???

```

** TCDA - Table of Cleft Display Addresses

```

TCDA DW ST30C1 ;0 - ???
      DW ST3121 ;1 - ???
      DW ST3181 ;2 - ???
      DW ST31F1 ;3 - ???
      DW ST3002 ;4 - ???
      DW ST3062 ;5 - ???
      DW ST3122 ;6 - ???
      DW ST3182 ;7 - ???
      DW ST30C2 ;8 - ???
      DW ST31C2 ;9 - ???

TCDAL = *-TCDA ;length

```

```

**      SVR - Set Value in Range
*
*      ENTRY JSR      SVR
*              A = value to set
*              X = offset to TARS range
*
*      EXIT
*              A = value set
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              M. W. Colburn      1982-10-26
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

SVR      =      *      ;entry
;      Initialize.

      PHA      ;save value
;      Set address range.

      LDA      TARS,X      ;start of range
      STA      STADR1
      LDA      TARS+1,X
      STA      STADR1+1
      LDA      TARS+2,X      ;end of range
      STA      STADR2
      LDA      TARS+3,X
      STA      STADR2+1

;      Set value in range.

      LDY      #0      ;offset to first byte

SVR1     PLA      ;saved value
      STA      (STADR1),Y ;byte of range
      INC      STADR1    ;increment low address
      BNE      SVR2     ;if no carry

      INC      STADR1+1  ;adjust high address

SVR2     PHA      ;save value
      LDA      STADR1   ;low current address
      CMP      STADR2   ;low end of range
      BNE      SVR1     ;if definitely not done

      LDA      STADR1+1 ;high current address
      CMP      STADR2+1 ;high end of range
      BNE      SVR1     ;if not done

;      Exit.

      PLA      ;restore value
      RTS      ;return

```

```

**      SSM - Set Screen Memory
*
*      ENTRY JSR      SSM
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*
*          M. W. Colburn      1982-10-26
*          1. Bring closer to Coding Standard (object unchanged).
*          R. K. Nordin      1983-11-01

```

```

SSM      =      *              ;entry
          LDA      TST0,X      ;offset to source
          TAY
          LDA      TSTL,X      ;length of source
          STA      STADR1      ;length
          LDA      TSTD,X      ;offset to destination
          TAX

SSM1     LDA      TTX0,Y      ;byte of source
          STA      ST3000,X    ;byte of destination
          INY
          INX
          DEC      STADR1      ;decrement length
          BNE      SSM1        ;if not done

          RTS                  ;return

```

```

**      SUC - Set Up Colors
*
*      ENTRY JSR      SUC
*              X = 0, if main screen colors
*              = 1, if memory test colors
*              = 2, if keyboard test colors
*              = 3, if audio-visual test colors
*
*      EXIT
*              COLOR0, COLOR1, COLOR2 and COLOR4 set.
*
*      CHANGES
*              A
*
*      CALLS
*              -none-
*
*      MODS
*
*          M. W. Colburn      1982-10-26
*          1. Bring closer to Coding Standard (object unchanged).
*          R. K. Nordin      1983-11-01

```

```

SUC      =      *              ;entry

          LDA      SUCA,X
          STA      COLOR0 ;playfield 0 color

          LDA      SUCB,X

```

```

STA    COLOR1 ;playfield 1 color

LDA    SUCC,X
STA    COLOR2 ;playfield 2 color

LDA    SUCD,X
STA    COLOR4 ;background color

RTS          ;return

```

```

SUCA    DB    $2C    ;0 - main screen playfield 0 color
        DB    $0C    ;1 - memory test playfield 0 color
        DB    $2A    ;2 - keyboard test playfield 0 color
        DB    $18    ;3 - audio-visual test playfield 0 color

SUCB    DB    $0F    ;0 - main screen playfield 1 color
        DB    $32    ;1 - memory test playfield 1 color
        DB    $0C    ;2 - keyboard test playfield 1 color
        DB    $0E    ;3 - audio-visual test playfield 1 color

SUCC    DB    $D2    ;0 - main screen playfield 2 color
        DB    $D6    ;1 - memory test playfield 2 color
        DB    $00    ;2 - keyboard test playfield 2 color
        DB    $B4    ;3 - audio-visual test playfield 2 color

SUCD    DB    $D2    ;0 - main screen background color
        DB    $A0    ;1 - memory test background color
        DB    $30    ;2 - keyboard test background color
        DB    $B4    ;3 - audio-visual test background color

```

```

**      TSMC - Table of Screen Memory Character Codes
*
*      Entry n is the screen memory character code for key code n.

```

```

TSMC    DB    $2C    ;$00 - L key
        DB    $2A    ;$01 - J key
        DB    $1B    ;$02 - semicolon key
        DB    $91    ;$03 - ???
        DB    $92    ;$04 - ???
        DB    $2B    ;$05 - K key
        DB    $0B    ;$06 - plus key
        DB    $0A    ;$07 - asterisk key
        DB    $2F    ;$08 - 0 key
        DB    $00    ;$09
        DB    $30    ;$0A - P key
        DB    $35    ;$0B - U key
        DB    $B2    ;$0C - RETURN key
        DB    $29    ;$0D - I key
        DB    $0D    ;$0E - minus key
        DB    $1D    ;$0F - = key

        DB    $36    ;$10 - V key
        DB    $A8    ;$11 - ???
        DB    $23    ;$12 - C key
        DB    $93    ;$13 - ???
        DB    $94    ;$14 - ???
        DB    $22    ;$15 - B key
        DB    $38    ;$16 - X key
        DB    $3A    ;$17 - Z key
        DB    $14    ;$18 - 4 key
        DB    $00    ;$19
        DB    $13    ;$1A - 3 key
        DB    $16    ;$1B - 6 key
        DB    $5B    ;$1C - ESC key

```

DB	\$15	;\$1D - 5 key
DB	\$12	;\$1E - 2 key
DB	\$11	;\$1F - 1 key
DB	\$0C	;\$20 - comma key
DB	\$00	;\$21 - space key
DB	\$0E	;\$22 - period key
DB	\$2E	;\$23 - N key
DB	\$00	;\$24
DB	\$2D	;\$25 - M key
DB	\$0F	;\$26 - / key
DB	\$A1	;\$27 - inverse video key
DB	\$32	;\$28 - R key
DB	\$00	;\$29
DB	\$25	;\$2A - E key
DB	\$39	;\$2B - Y key
DB	\$FF	;\$2C - TAB key
DB	\$34	;\$2D - T key
DB	\$37	;\$2E - W key
DB	\$31	;\$2F - Q key
DB	\$19	;\$30 - 9 key
DB	\$00	;\$31
DB	\$10	;\$32 - 0 key
DB	\$17	;\$33 - 7 key
DB	\$A2	;\$34 - backspace key
DB	\$18	;\$35 - 8 key
DB	\$1C	;\$36 - < key
DB	\$1E	;\$37 - > key
DB	\$26	;\$38 - F key
DB	\$28	;\$39 - H key
DB	\$24	;\$3A - D key
DB	\$00	;\$3B
DB	\$A3	;\$3C - CAPS key
DB	\$27	;\$3D - G key
DB	\$33	;\$3E - S key
DB	\$21	;\$3F - A key

**** TARS - Table of Address Ranges to Set**

TARS	DW	ST3000,ST3000+\$0EFF	;0 - screen memory
	DW	ST3020,ST3020+4	;1 - memory test first 8K ROM
	DW	ST3024,ST3024+4	;2 - memory test second 8K ROM
	DW	ST3000,ST3000+32	;3 - main screen bold lines

**** TSTL - Table of Self-test Text Lengths**

TSTL	DB	TXT0L	;0 - length of "MEMORY TEST ROM" text
	DB	TXT1L	;1 - length of "RAM" text
	DB	TXT2L	;2 - length of "KEYBOARD TEST" text
	DB	TXT3L	;3 - length of "S P A C E B A R" text
	DB	TXT4L	;4 - length of "SH" text
	DB	TXT5L	;5 - length of "SH" text
	DB	TXT6L	;6 - length of "B S" text
	DB	TXT7L	;7 - length of keyboard text
	DB	TXT8L	;8 - length of control key text
	DB	TXT9L	;9 - length of "VOICE #" text

**	TSTD - Table of Self-test Text Destination Offsets
----	---

TSTD	DB	ST3000-ST3000;0	- offset to "MEMORY TEST ROM" text
	DB	ST3028-ST3000;1	- offset to "RAM" text
	DB	ST3000-ST3000;2	- offset to "KEYBOARD TEST" text
	DB	ST30B7-ST3000;3	- offset to "S P A C E B A R" text
	DB	ST3092-ST3000;4	- offset to "SH" text
	DB	ST30AB-ST3000;5	- offset to "SH" text
	DB	ST304C-ST3000;6	- offset to "B S" text
	DB	ST3022-ST3000;7	- offset to keyboard text
	DB	ST3072-ST3000;8	- offset to control key text
	DB	ST3004-ST3000;9	- offset to "VOICE #" text

Floating Point Package

```
*** (C) Copyright 1978 Shepardson Microsystems, Inc.???
```

```
FIX $D800
```

```
*** FPP - Floating Point Package
*
* FPP is a collection of routines for floating point
* computations. A floating point number is represented
* in 6 bytes:
*
* Byte 0
*      Bit 7      Sign of mantissa
*      Bits 0 - 6  BCD exponent, biased by $40
*
* Bytes 1 - 5      BCD mantissa
*
* MODS
*      Shepardson Microsystems 1978-??-??
*
*      Produce 2K version.
*      M. Lorenzen 1981-09-06
```

```
FIX AFP
```

```
** AFP - Convert ASCII to Floating Point
*
* ENTRY JSR AFP
*      INBUFF = line buffer pointer
*      CIX = offset to first byte of number
*      ??
*
* EXIT
*      C clear, if valid number
*      C set, if invalid number
*      ??
*
* CHANGES
*      ??
*
* CALLS
*      ??
*
* NOTES
*      Problem: bytes wasted by check for "-", near AFP7.
*
* MODS
*      Original Author Unknown ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin 1983-11-01
```

```
;AFP = * ;entry
; Initialize.
FIX SLB ;skip leading blanks
; Check for number.
FIX TVN ;test for valid number character
```

```

    BCS    AFP5    ;if not number character

;    Set initial values.

    LDX    #EEXP    ;exponent
    LDY    #4        ;indicate 4 bytes to clear
    JSR    ZXLY    ;zero ???
    LDX    #$FF
    STX    DIGRT    ;number of digits after decimal point
    JSR    ZFR0    ;zero FR0
    BEQ    AFP2    ;get first character

;    Indicate not first character.

AFP1    LDA    #$FF    ;indicate not first character
    STA    FCHFLG    ;first character flag

;    Get next character.

AFP2    JSR    GNC    ;get next character
    BCS    AFP6    ;if character not numeric

;    Process numeric character.

    PHA                    ;save digit
    LDX    FR0M            ;first byte
    BNE    AFP3            ;if not zero

;    ???

    JSR    S0L            ;shift FR0 left 1 digit
    PLA                    ;saved digit
    ORA    FR0M+FMPREC-1    ;insert into last byte
    STA    FR0M+FMPREC-1    ;update last byte

;    Check for decimal point.

    LDX    DIGRT    ;number of digits after decimal point
    BMI    AFP1    ;if no decimal point, process next character

;    Increment number of digits after decimal point.

    INX                    ;increment number of digits
    STX    DIGRT    ;number of digits after decimal point
    BNE    AFP1    ;process next character

;    Increment exponent, if necessary.

AFP3    PLA                    ;clean stack
    LDX    DIGRT    ;number of digits after decimal point
    BPL    AFP4    ;if already have decimal point

    INC    EEXP    ;increment number of digits more than 9

;    Process next character.

AFP4    JMP    AFP1    ;process next character

;    Exit.

AFP5    RTS                    ;return

;    Process non-numeric character.

AFP6    CMP    #'. '
    BEQ    AFP8    ;if ".", process decimal point

```

```

    CMP    #'E'
    BEQ    AFP9    ;if "E", process exponent

    LDX    FCHFLG ;first character flag
    BNE    AFP16   ;if not first character, process end of input

    CMP    #'+'
    BEQ    AFP1    ;if "+", process next character

    CMP    #'-'
    BEQ    AFP7    ;if "-", process negative sign

;    Process negative sign.

AFP7    STA    NSIGN ;sign of number
    BEQ    AFP1    ;process next character

;    Process decimal point.

AFP8    LDX    DIGRT ;number of digits after decimal point
    BPL    AFP16   ;if already have decimal point

    INX
    STX    DIGRT ;number of digits after decimal point
    BEQ    AFP1    ;process next character

;    Process exponent.

AFP9    LDA    CIX    ;offset to character
    STA    FRX    ;save offset to character
    JSR
    BCS    AFP13   ;if not numeric

;    Process numeric character in exponent.

AFP10   TAX
    LDA    EEXP    ;first character of exponent
    PHA
    STX    EEXP    ;number of digits more than 9
    PHA
    STX    EEXP    ;save number of digits more than 9
    STX    EEXP    ;first character of exponent

;    Process second character of exponent.

    JSR
    BCS    AFP11   ;if not numeric, no second digit

    PHA
    LDA    EEXP    ;save second digit
    ASL    A        ;first digit
    STA    A        ;2 times first digit
    ASL    A        ;2 times first digit
    STA    A        ;4 times first digit
    ASL    A        ;4 times first digit
    STA    A        ;8 times first digit
    ASL    A        ;8 times first digit
    ADC    EEXP    ;add 2 times first digit
    STA    EEXP    ;save 10 times first digit
    PLA
    CLC
    ADC    EEXP    ;insert in exponent
    STA    EEXP    ;update exponent

;    Process third character of exponent???

    LDY    CIX    ;offset to third character
    JSR
    IXC    ;increment offset

AFP11   LDA    ESIGN ;sign of exponent
    BEQ    AFP12   ;if no sign on exponent

;    Process negative exponent.

```

```

    LDA    EEXP    ;exponent
    EOR    #$FF    ;complement exponent
    CLC
    ADC    #1      ;add 1 for 2's complement
    STA    EEXP    ;update exponent

;      Add in number of digits more than 9.

AFP12 PLA                ;saved number of digits more than 9
    CLC
    ADC    EEXP    ;add exponent
    STA    EEXP    ;update exponent
    BNE    AFP16    ;process end of input

;      Process non-numeric in exponent.

AFP13 CMP    #'+'
    BEQ    AFP14    ;if "+", process next character

    CMP    #'-'
    BNE    AFP15    ;if not "-", ???

    STA    ESIGN    ;save sign of exponent

;      Process next character.

AFP14 JSR    GNC      ;get next character
    BCC    AFP10      ;if numeric, process numeric character

;      Process other non-numeric in exponent.

AFP15 LDA    FRX      ;saved offset
    STA    CIX      ;restore offset

;      Process end of input.

AFP16 DEC    CIX      ;decrement offset
    LDA    EEXP    ;exponent
    LDX    DIGRT    ;number of digits after decimal point
    BMI    AFP17      ;if no decimal point

    BEQ    AFP17      ;if no digits after decimal point

    SEC
    SBC    DIGRT      ;subtract number of digits after decimal point

AFP17 PHA                ;save adjusted exponent
    ROL    A          ;set C with sign of exponent
    PLA                ;saved adjusted exponent
    ROR    A          ;shift right
    STA    EEXP    ;save power of 100
    BCC    AFP18      ;if no carry, process even number

    JSR    S0L        ;shift FR0 left 1 digit

AFP18 LDA    EEXP    ;exponent
    CLC
    ADC    #$40+4    ;add bias plus 4 for normalization
    STA    FR0        ;save exponent

    JSR    NORM        ;normalize number
    BCS    AFP20      ;if error

;      Check sign of number.

    LDX    NSIGN      ;sign of number

```

```

    BEQ    AFP19    ;if sign of number not negative
;        Process negative number.

    LDA    FR0      ;first byte of mantissa
    ORA    #$80     ;indicate negative
    STA    FR0      ;update first byte of mantissa

;        Exit.
AFP19    CLC        ;indicate valid number
AFP20    RTS        ;return
FIX      FASC

```

```

**      FASC - Convert Floating Point Number to ASCII
*
*      ENTRY JSR    FASC
*              FR0 - FR0+5 = number to convert
*              ??
*
*      EXIT
*              INBUFF = pointer to start of number
*              High order bit of last character set
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown    ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin    1983-11-01

```

```

;FASC =      *      ;entry

;        Initialize.

    JSR    ILP      ;initialize line buffer pointer
    LDA    #'0'
    STA    LBPR2    ;put "0" in front of line buffer

;        Check for E format required.

    LDA    FR0      ;exponent
    BEQ    FASC2     ;if exponent zero, number zero

    AND    #$7F     ;clear sign
    CMP    #$40-1   ;bias-1
    BCC    FASC3     ;if exponent < bias-1, E format required

    CMP    #$40+5   ;bias+5
    BCS    FASC3     ;if >= bias+5, E format required

;        Process E format not required.

    SEC
    SBC    #$40-1   ;subtract bias-1, yielding decimal position
    JSR    C0A      ;convert FR0 to ASCII
    JSR    FNZ      ;find last non-zero character
    ORA    #$80     ;set high order bit

```

```

    STA    LBUF,X      ;update last character
    LDA    LBUF      ;first character
    CMP    #'.'
    BEQ    FASC1      ;if decimal point

    JMP    FASC10 ;???

FASC1    JSR    DLP      ;decrement line buffer pointer
    JMP    FASC11 ;perform final adjustment

;      Process zero.

FASC2    LDA    #$80+'0'      ;"0" with high order bit set
    STA    LBUF      ;put zero character in line buffer
    RTS              ;return

;      Process E format required.

FASC3    LDA    #1      ;GET DECIMAL POSITION???
    JSR    C0A      ;convert FR0 to ASCII
    JSR    FNZ      ;find last non-zero character
    INX              ;increment offset to last character
    STX    CIX      ;save offset to last character

;      Adjust exponent.

    LDA    FR0      ;exponent
    ASL    A      ;double exponent
    SEC
    SBC    #$40*2 ;subtract 2 times bias

;      Check first character for "0".

    LDX    LBUF      ;first character
    CPX    #'0'
    BEQ    FASC5      ;if "0"

;      Put decimal after first character.

    LDX    LBUF+1      ;second character
    LDY    LBUF+2      ;decimal point
    STX    LBUF+2      ;decimal point
    STY    LBUF+1      ;third character
    LDX    CIX      ;offset
    CPX    #2      ;former offset to decimal point
    BNE    FASC4      ;if offset pointed to second character

    INC    CIX      ;increment offset

FASC4    CLC
    ADC    #1      ;adjust exponent for movement of decimal point

;      Convert exponent to ASCII.

FASC5    STA    EEXP      ;exponent
    LDA    #'E'
    LDY    CIX      ;offset
    JSR    SAL      ;store ASCII character in line buffer
    STY    CIX      ;save offset
    LDA    EEXP      ;exponent
    BPL    FASC6      ;if exponent positive

    LDA    #0
    SEC
    SBC    EEXP      ;complement exponent
    STA    EEXP      ;update exponent
    LDA    #'-'

```

```

        BNE     FASC7 ;store "-"
FASC6 LDA     #'+'
FASC7 JSR     SAL      ;store ASCII character in line buffer
        LDX     #0      ;initial number of 10's
        LDA     EEXP     ;exponent

FASC8 SEC
        SBC     #10     ;subtract 10
        BCC     FASC9   ;if < 0, done

        INX
        BNE     FASC8   ;increment number of 10's
                        ;continue

FASC9 CLC
        ADC     #10     ;add back 10
        PHA
        TXA
        JSR     SNL     ;store number in line buffer
        PLA
        ORA     #$80    ;set high order bit
        JSR     SNL     ;store number in line buffer

;      Perform final adjustment.

FASC10 LDA    LBUF      ;first character
        CMP     #'0'
        BNE     FASC11 ;if not "0", ???

;      Increment pointer to point to non-zero character.

        CLC
        LDA     INBUFF   ;line buffer pointer
        ADC     #1       ;add 1
        STA     INBUFF   ;update line buffer pointer
        LDA     INBUFF+1
        ADC     #0
        STA     INBUFF+1

;      Check for positive exponent.

FASC11 LDA    FR0       ;exponent
        BPL     FASC12   ;if exponent positive, exit

;      Process negative exponent.

        JSR     DLP      ;decrement line buffer pointer
        LDY     #0       ;offset to first character
        LDA     #'-'
        STA     (INBUFF),Y ;put "-" in line buffer

;      Exit.

FASC12 RTS              ;return

```

FIX IFP

```
** IFP - Convert Integer to Floating Point Number
*
* ENTRY JSR IFP
* FR0 - FR0+1 = integer to convert
* ??
*
* EXIT
* FR0 - FR0+5 = floating point number
* ??
*
* CHANGES
* ??
*
* CALLS
* ??
*
* MODS
* Original Author Unknown ??/??/??
* 1. Bring closer to Coding Standard (object unchanged).
* R. K. Nordin 1983-11-01
```

```
;IFP = * ;entry
; Initialize.
LDA FR0 ;low integer
STA ZTEMP4+1 ;save low integer
LDA FR0+1 ;high integer
STA ZTEMP4 ;save high integer
JSR ZFR0 ;zero FR0
; Convert to floating point.
SED
LDY #16 ;number of bits in integer
IFP1 ASL ZTEMP4+1 ;shift integer
ROL ZTEMP4 ;shift integer, setting C if bit present
LDX #3 ;offset to last possible byte of number
IFP2 LDA FR0,X ;byte of number
ADC FR0,X ;double byte, adding in carry
STA FR0,X ;update byte of number
DEX
BNE IFP2 ;if not done
DEY
BNE IFP1 ;if not done
CLD
; Set exponent.
LDA #$40+2 ;indicate decimal after last digit
STA FR0 ;exponent
; Exit.
JMP NORM ;normalize ???, return
```

FIX **FPI**

```

**      FPI - Convert Floating Point Number to Integer
*
*      ENTRY JSR    FPI
*              FR0 - FR0+5 = floating point number
*              ??
*
*      EXIT
*              C set, if error
*              C clear, if no error
*              FR0 - FR0+1 = integer
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown    ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin    1983-11-01

```

```

;FPI  =      *      ;entry

;      Initialize.

      LDA    #0
      STA    ZTEMP4      ;zero integer
      STA    ZTEMP4+1

;      Check exponent.

      LDA    FR0          ;exponent
      BMI    FPI4          ;if sign of exponent is negative, error

      CMP    #$40+3        ;bias+3
      BCS    FPI4          ;if number too big, error

      SEC
      SBC    #$40          ;subtract bias
      BCC    FPI2          ;if number less than 1, test for round

;      Compute number of digits to convert.

      ADC    #0            ;add carry
      ASL    A              ;2 times exponent-$40+1???
      STA    ZTEMP1        ;number of digits to convert

;      Convert.

FPI1  JSR    SIL            ;shift integer left
      BCS    FPI4          ;if number too big, error

      LDA    ZTEMP4        ;2 times integer
      STA    ZTEMP3        ;save 2 times integer
      LDA    ZTEMP4+1
      STA    ZTEMP3+1
      JSR    SIL            ;shift integer left
      BCS    FPI4          ;if number too big, error

      JSR    SIL            ;shift integer left

```

```

    BCS    FPI4            ;if number too big, error

    CLC
    LDA    ZTEMP4+1        ;8 times integer
    ADC    ZTEMP3+1        ;add 2 times integer
    STA    ZTEMP4+1        ;10 times integer
    LDA    ZTEMP4
    ADC    ZTEMP3
    STA    ZTEMP4
    BCS    FPI4            ;if overflow???, error

    JSR    GND              ;get next digit
    CLC
    ADC    ZTEMP4+1        ;insert digit in ???
    STA    ZTEMP4+1        ;update ???
    LDA    ZTEMP4          ;???
    ADC    #0              ;add carry
    BCS    FPI4            ;if overflow, error

    STA    ZTEMP4          ;update ???
    DEC    ZTEMP1          ;decrement count of digits to convert
    BNE    FPI1            ;if not done

;    Check for round required.

FPI2    JSR    GND          ;get next digit
        CMP    #5
        BCC    FPI3        ;if digit less than 5, do not round

;    Round.

    CLC
    LDA    ZTEMP4+1        ;???
    ADC    #1              ;add 1 to round
    STA    ZTEMP4+1        ;update ???
    LDA    ZTEMP4
    ADC    #0
    STA    ZTEMP4

;    Return integer.

FPI3    LDA    ZTEMP4+1    ;low integer
        STA    FR0         ;low integer result
    LDA    ZTEMP4          ;high integer
    STA    FR0+1          ;high integer result
    CLC
    RTS                    ;return

;    Return error.

FPI4    SEC                ;indicate error
        RTS                ;return

```

FIX ZFR0

```
**      ZFR0 - Zero FR0
*
*      ENTRY JSR      ZFR0
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01
```

```
;ZFR0 =      *      ;entry

      LDX      #FR0      ;indicate zero FR0
;      SWP      ZF1      ;zero floating point number, return

FIX      ZF1
```

```
**      ZF1 - Zero Floating Point Number
*
*      ENTRY JSR      ZF1
*              X = offset to register
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01
```

```
;ZF1 =      *      ;entry

      LDY      #6      ;number of bytes to zero
;      SWP      ZXY      ;zero bytes, return
```

```

**      ZXLY - Zero Page Zero Location X for Length Y
*
*      ENTRY JSR    ZXLY
*              X = offset
*              Y = length
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin    1983-11-01

```

```

ZXLY  =      *      ;entry

      LDA    #0
ZXLY1 STA    $0000,X      ;zero byte
      INX
      DEY
      BNE    ZXLY1 ;if not done
      RTS      ;return

```

```

**      ILP - Initialize Line Buffer Pointer
*
*      ENTRY JSR    ILP
*
*      EXIT
*              INBUFF - INBUFF+1 = line buffer address
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin    1983-11-01

```

```

ILP   =      *      ;entry
      LDA    #high LBUFF ;high buffer address
      STA    INBUFF+1    ;high line buffer pointer
      LDA    #low LBUFF  ;low buffer address
      STA    INBUFF      ;low line buffer pointer
      RTS      ;return

```

```

**      SIL - Shift Integer Left
*
*      ENTRY JSR      SIL
*              ZTEMP4 - ZTEMP4+1 = number (high, low) to shift
*              ??
*
*      EXIT
*              ZTEMP4 - ZTEMP4+1 shifted left 1
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown    ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

SIL      =      *      ;entry
          CLC
          ROL     ZTEMP4+1    ;shift low
          ROL     ZTEMP4      ;shift high
          RTS
          FIX      FSUB

```

```

**      FSUB - Perform Floating Point Subtract
*
*      FSUB subtracts FR1 from FR0.
*
*      ENTRY JSR      FSUB
*              FR0 - FR0+5 = minuend
*              FR1 - FR1+5 = subtrahend
*              ??
*
*      EXIT
*              C set, if error
*              C clear, if no error
*              FR0 - FR0+5 = difference
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown    ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

;FSUB =      *      ;entry
;
;      Complement sign of subtrahend and add.
          LDA     FR1      ;subtrahend exponent
          EOR     #$80     ;complement sign of subtrahend
          STA     FR1      ;update subtrahend exponent
;          LDX     FADD     ;perform add, return

```

FIX FADD

```

**      FADD - Perform Floating Point Add
*
*      ENTRY JSR      FADD
*              FR0 - FR0+5 = augend
*              FR1 - FR1+5 = addend
*              ??
*
*      EXIT
*              C set, if error
*              C clear, if no error
*              FR0 - FR0+5 = sum
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown    ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

;FADD =      *      ;entry

;      Initialize.

FADD1 LDA      FR1      ;exponent of addend
      AND      #$7F     ;clear sign of addend mantissa
      STA      ZTEMP4   ;save addend exponent
      LDA      FR0      ;exponent of augend
      AND      #$7F     ;clear sign of augend mantissa
      SEC
      SBC      ZTEMP4   ;subtract addend exponent
      BPL      FADD3    ;if augend exponent >= addend exponent

;      Swap augend and addend.

      LDX      #FPREC-1 ;offset to last byte

FADD2 LDA      FR0,X     ;byte of augend
      LDY      FR1,X     ;byte of addend
      STA      FR1,X     ;move byte of augend to addend
      TYA
      STA      FR0,X     ;move byte of addend to augend
      DEX
      BPL      FADD2     ;if not done
      BMI      FADD1     ;re-initialize

;      Check alignment.

FADD3 BEQ      FADD4     ;if exponent difference zero, already aligned

      CMP      #FMPREC   ;mantissa precision
      BCS      FADD6     ;if exponent difference < mantissa precision

;      Align.

      JSR      S1R       ;shift FR1 right

;      Check for like signs of mantissas.

```

```

FADD4 SED
      LDA    FR0      ;augend exponent
      EOR    FR1      ;EOR with addend exponent
      BMI    FADD8    ;if signs differ, subtract

;      Add.

      LDX    #FMPREC-1    ;offset to last byte of mantissa
      CLC

FADD5 LDA    FR0M,X    ;byte of augend mantissa
      ADC    FR1M,X    ;add byte of addend mantissa
      STA    FR0M,X    ;update byte of result mantissa
      DEX
      BPL    FADD5     ;if not done

      CLD
      BCS    FADD7     ;if carry, process carry

;      Exit.

FADD6 JMP    NORM      ;normalize ???, return

;      Process carry.

FADD7 LDA    #1        ;indicate shift 1
      JSR    S0R        ;shift FR0 right
      LDA    #1        ;carry
      STA    FR0M       ;set carry in result

;      Exit.

      JMP    NORM      ;normalize ???, return

;      Subtract.

FADD8 LDX    #FMPREC-1    ;offset to last byte of mantissa
      SEC

FADD9 LDA    FR0M,X    ;byte of augend mantissa
      SBC    FR1M,X    ;subtract byte of addend mantissa
      STA    FR0M,X    ;update byte of result mantissa
      DEX
      BPL    FADD9     ;if not done

      BCC    FADD10    ;if borrow, process borrow

;      Exit.

      CLD
      JMP    NORM      ;normalize ???, return

;      Process borrow.

FADD10 LDA    FR0      ;result exponent
      EOR    #$80      ;complement sign of result
      STA    FR0      ;update result exponent

      SEC
      LDX    #FMPREC-1    ;offset to last byte of mantissa

FADD11 LDA    #0
      SBC    FR0M,X    ;complement byte of result mantissa
      STA    FR0M,X    ;update byte of result mantissa
      DEX
      BPL    FADD11    ;if not done

```

```
;      Exit.

      CLD
      JMP  NORM      ;normalize ???, return

      FIX  FMUL
```

```
**      FMUL - Perform Floating Point Multiply
*
*      ENTRY JSR      FMUL
*              FR0 - FR0+5 = multiplicand
*              FR1 - FR1+5 = multiplier
*              ??
*
*      EXIT
*              C set, if error
*              C clear, if no error
*              FR0 - FR0+5 = product
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01
```

```
;FMUL =      *      ;entry

;      Check for zero multiplicand.

      LDA  FR0      ;multiplicand exponent
      BEQ  FMUL8     ;if multiplicand exponent zero, result is zero

;      Check for zero multiplier.

      LDA  FR1      ;multiplier exponent
      BEQ  FMUL7     ;if multiplier exponent zero, result is zero

;      ???

      JSR  SUE      ;set up exponent???
      SEC
      SBC  #$40     ;subtract bias
      SEC
      ADC  FR1      ;add multiplier exponent
      BMI  FMUL9     ;if overflow, error

;      Set up.

      JSR  SUP      ;set up

;      Compute number of times to add multiplicand.

FMUL1 LDA  FRE+FPREC-1 ;last byte of FRE
      AND  #$0F      ;extract low order digit
      STA  ZTEMP1+1   ;???

;      Check for completion???
```

```

FMUL2 DEC    ZTEMP1+1    ;decrement counter???
      BMI    FMUL3      ;if done

      JSR    FRA10      ;add FR1 to FR0
      JMP    FMUL2      ;continue

;      Compute number of times to add 10 times multiplicand.

FMUL3 LDA    FRE+FPREC-1 ;last byte of FRE
      LSR    A
      LSR    A
      LSR    A
      LSR    A          ;high order digit
      STA    ZTEMP1+1    ;???

;      Check for completion.

FMUL4 DEC    ZTEMP1+1    ;decrement counter
      BMI    FMUL5      ;if done

      JSR    FRA20      ;add FR2 to FR0
      JMP    FMUL4      ;continue

;      Set up for next set of adds.

FMUL5 JSR    S0ER        ;shift FR0/FRE right

;      Decrement counter and test for completion.

      DEC    ZTEMP1      ;decrement ???
      BNE    FMUL1      ;if not done

;      Set exponent.

FMUL6 LDA    EEXP        ;exponent
      STA    FR0         ;result exponent
      JMP    N0E         ;normalize ???, return

;      Return zero result.

FMUL7 JSR    ZFR0        ;zero FR0

;      Return no error.

FMUL8 CLC              ;indicate no error
      RTS              ;return

;      Return error.

FMUL9 SEC              ;indicate error
      RTS              ;return

```

FIX **FDIV**

```
**      FDIV - Perform Floating Point Divide
*
*      ENTRY JSR      FDIV
*              FR0 - FR0+5 = dividend
*              FR1 - FR1+5 = divisor
*              ??
*
*      EXIT
*              C clear, if no error
*              C set, if error
*              FR0 - FR0+5 = quotient
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01
```

```
;FDIV =      *      ;entry
;      Check for zero divisor.

      LDA      FR1      ;divisor exponent
      BEQ      FMUL9    ;if divisor exponent zero, error

;      Check for zero dividend.

      LDA      FR0      ;dividend exponent
      BEQ      FMUL8    ;if dividend exponent zero, result is zero

;      ???

      JSR      SUE      ;set up exponent
      SEC
      SBC      FR1      ;subtract divisor exponent
      CLC
      ADC      #$40     ;add bias
      BMI      FMUL9    ;if overflow, error

;      ???

      JSR      SUP      ;set up
      INC      ZTEMP1   ;divide requires extra pass
      JMP      FDIV3    ;skip shift

;      Shift FR0/FRE left one byte.

FDIV1 LDX      #0        ;offset to first byte to shift

FDIV2 LDA      FR0+1,X    ;byte to shift
      STA      FR0,X     ;byte of destination
      INX
      CPX      #FMPREC*2+2 ;number of bytes to shift
      BNE      FDIV2     ;if not done

;      Subtract 2 times divisor from dividend.
```

```

FDIV3 LDY    #FPREC-1    ;offset to last byte
      SEC
      SED

FDIV4 LDA    FRE,Y        ;byte of dividend
      SBC    FR2,Y        ;subtract byte of 2*divisor
      STA    FRE,Y        ;update byte of dividend
      DEY
      BPL    FDIV4        ;if not done

      CLD
      BCC    FDIV5        ;if difference < 0

      INC    QTEMP        ;increment ???
      BNE    FDIV3        ;continue

;      Adjust.

FDIV5 JSR    FRA2E        ;add FR2 to FR0

;      Shift last byte of quotient left one digit.

      ASL    QTEMP
      ASL    QTEMP
      ASL    QTEMP
      ASL    QTEMP

;      Subtract divisor from dividend.

FDIV6 LDY    #FPREC-1    ;offset to last byte
      SEC
      SED

FDIV7 LDA    FRE,Y        ;byte of dividend
      SBC    FR1,Y        ;subtract byte of divisor
      STA    FRE,Y        ;update byte of dividend
      DEY
      BPL    FDIV7        ;if not done

      CLD
      BCC    FDIV8        ;if difference < 0

      INC    QTEMP        ;increment
      BNE    FDIV6        ;continue

;      Adjust.

FDIV8 JSR    FRA1E        ;add FR1 to FR0
      DEC    ZTEMP1      ;decrement ???
      BNE    FDIV1        ;if not done

;      Clear exponent???

      JSR    S0ER        ;shift FR0/FRE right

;      Exit.

      JMP    FMUL6        ;???, return

```

```

**      GNC - Get Next Character
*
*      ENTRY JSR      GNC
*              INBUFF - INBUFF+1 = line buffer pointer
*              CIX = offset to character
*              ??
*
*      EXIT
*              C set, if character not numeric
*              A = non-numeric character
*              C clear, if character numeric
*              CIX = offset to next character
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

GNC      =      *      ;entry
          JSR      TNC      ;test for numeric character
          LDY      CIX      ;offset
          BCC      ICX      ;if numeric, increment offset, return
          LDA      (INBUFF),Y ;character
          INP      ICX      ;increment offset, return
;

```

```

**      ICX - Increment Character Offset
*
*      ENTRY JSR      ICX
*              Y = offset
*              ??
*
*      EXIT
*              CIX = offset to next character
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

ICX      =      *      ;entry
          INY      ;increment offset
          STY      CIX ;offset
          RTS      ;return

```

```

**      SLB - Skip Leading Blanks
*
*      ENTRY JSR      ???
*              INBUFF - INBUFF+1 = line buffer pointer
*              CIX = offset
*              ??
*
*      EXIT
*              CIX = offset to first non-blank character
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown    ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

SLB      =      *              ;entry

;      Initialize.

      LDY      CIX              ;offset to character
      LDA      #' '

;      Search for first non-blank character.

SLB1     CMP      (INBUFF),Y    ;character
      BNE      SLB2            ;if non-blank character

      INY
      BNE      SLB1            ;if not done

;      Exit.

SLB2     STY      CIX           ;offset to first non-blank character
      RTS                    ;return

```

```

**      TNC - Test for Numeric Character
*
*      ENTRY JSR      TNC
*              INBUFF - INBUFF+1 = line buffer pointer
*              CIX = offset
*              ??
*
*      EXIT
*              C set, if numeric
*              C clear if non-numeric
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

TNC      =      *      ;entry
LDY      CIX      ;offset
LDA      (INBUFF),Y ;character
SEC
SBC      #'0'
BCC      TVN2      ;if < "0", return failure

CMP      #'9'-'0'+1 ;return success or failure
RTS      ;return

```

```

**      TVN - Test for Valid Number Character
*
*      ENTRY JSR      TVN
*              ??
*
*      EXIT
*              C set, if not number
*              C clear, if number
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      NOTES
*              Problem: bytes wasted by BCC TVN5.
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

TVN      =      *      ;entry

;      Initialize.

LDA      CIX      ;offset
PHA      ;save offset

```

```

;      Check next character.

JSR    GNC      ;get next character
BCC    TVN5     ;if numeric, return success

CMP    #'.'
BEQ    TVN4     ;if ".", check next character

CMP    #'+'
BEQ    TVN3     ;if "+", check next character

CMP    #'-'
BEQ    TVN3     ;if "-", check next character

;      Clean stack.
TVN1   PLA      ;clean stack

;      Return failure.
TVN2   SEC      ;indicate failure
RTS    ;return

;      Check character after "+" or "-".
TVN3   JSR    GNC      ;get next character
BCC    TVN5     ;if numeric, return success

CMP    #'.'
BNE    TVN1     ;if not ".", return failure

;      Check character after ".".
TVN4   JSR    GNC      ;get next character
BCC    TVN5     ;if numeric, return success

BCS    TVN1     ;return failure

;      Return success.
TVN5   PLA      ;saved offset
STA    CIX      ;restore offset
CLC      ;indicate success
RTS    ;return

```

```

**      S2L - Shift FR2 Left One Digit
*
*      ENTRY JSR      S2L
*            ??
*
*      EXIT
*            ??
*
*      CHANGES
*            ??
*
*      CALLS
*            ??
*
*      MODS
*            Original Author Unknown   ??/??/??
*            1. Bring closer to Coding Standard (object unchanged).
*            R. K. Nordin      1983-11-01

```

```

S2L      =      *      ;entry
          LDX     #FR2+1 ;indicate shift of FR2 mantissa
          BNE     SML     ;shift mantissa left 1 digit, return

```

```

**      S0L - Shift FR0 Left One Digit
*
*      ENTRY JSR      S0L
*            ??
*
*      EXIT
*            ??
*
*      CHANGES
*            ??
*
*      CALLS
*            ??
*
*      MODS
*            Original Author Unknown   ??/??/??
*            1. Bring closer to Coding Standard (object unchanged).
*            R. K. Nordin      1983-11-01

```

```

S0L      =      *      ;entry
          LDX     #FR0M  ;indicate shift of FR0 mantissa
          JMP     SML     ;shift mantissa left 1 digit, return
;

```

```

**      SML - Shift Mantissa Left One Digit
*
*      ENTRY JSR      SML
*              ??
*
*      EXIT
*              FRX = excess digit
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown    ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

SML      =      *      ;entry
LDY      #4      ;number of bits to shift

```

```

SML2     CLC
ROL      $0004,X      ;shift 5th byte left 1 bit
ROL      $0003,X      ;shift 4th byte left 1 bit
ROL      $0002,X      ;shift 3rd byte left 1 bit
ROL      $0001,X      ;shift 2nd byte left 1 bit
ROL      $0000,X      ;shift 1st byte left 1 bit
ROL      FRX      ;shift excess digit left 1 bit
DEY
BNE      SML2      ;if not done
RTS

```

```

**      NORM - Normalize FR0
*
*      ENTRY JSR      NORM
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown    ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

NORM      =      *      ;entry
LDX      #0
STX      FRE      ;byte to shift in
;      UNF      N0E      ;normalize FR0/FRE, return

```

```

**      N0E - Normalize FR0/FRE
*
*      ENTRY JSR      N0E
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

N0E      =      *      ;entry
          LDX      #FMPREC-1 ;mantissa size
          LDA      FR0      ;exponent
          BEQ      N0E5      ;if exponent zero, number is zero

```

```

N0E1     LDA      FR0M      ;first byte of mantissa
          BNE      N0E3      ;if not zero, no shift

```

```

;      Shift mantissa left 1 byte.

          LDY      #0      ;offset to first byte of mantissa

```

```

N0E2     LDA      FR0M+1,Y  ;byte to shift
          STA      FR0M,Y   ;byte of destination
          INY
          CPY      #FMPREC  ;size of mantissa
          BCC      N0E2      ;if not done

```

```

;      Decrement exponent and check for completion.

```

```

          DEC      FR0      ;decrement exponent
          DEX
          BNE      N0E1      ;if not done

```

```

;      Check first byte of mantissa.

```

```

          LDA      FR0M      ;first byte of mantissa
          BNE      N0E3      ;if mantissa not zero

```

```

;      Zero exponent.

```

```

          STA      FR0      ;zero exponent
          CLC
          RTS              ;return

```

```

;      Check for overflow.

```

```

N0E3     LDA      FR0      ;exponent
          AND      #$7F     ;clear sign
          CMP      #$40+49  ;bias+49
          BCC      N0E4      ;if exponent < 49, no overflow

```

```

;      Return error.

```

```

;      SEC              ;indicate error
          RTS              ;return

```

```

;      Check for underflow.

N0E4  CMP    #$40-49
      BCS    N0E5      ;if exponent >= -49, no underflow

;      Zero result.

      JSR    ZFR0      ;zero FR0

;      Exit.

N0E5  CLC                ;indicate no error
      RTS                ;return

```

```

**      S0R - Shift FR0 Right
*
*      ENTRY JSR    S0R
*              A = shift count
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown    ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin    1983-11-01

```

```

S0R    =      *      ;entry
      LDX    #FR0      ;indicate shift of FR0
      BNE    SRR        ;???, return

```

```

**      S1R - Shift FR1 Right
*
*      ENTRY JSR    S1R
*              A = shift count
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown    ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin    1983-11-01

```

```

S1R    =      *      ;entry
      LDX    #FR1      ;indicate shift of FR1
;      BNE    SRR        ;???, return

```

```

**      SRR - Shift Register Right
*
*      ENTRY JSR      SRR
*              X = offset to register
*              A = shift count
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

SRR      =      *      ;entry
          STX     ZTEMP3      ;register
          STA     ZTEMP4      ;shift count
          STA     ZTEMP4+1    ;save shift count

SRR1     LDY     #FMPREC-1    ;mantissa size-1

SRR2     LDA     $0004,X      ;byte to shift
          STA     $0005,X      ;byte of destination
          DEX
          DEY
          BNE     SRR2        ;if not done

          LDA     #0
          STA     $0005,X      ;first byte of mantissa
          LDX     ZTEMP3      ;register
          DEC     ZTEMP4      ;decrement shift count
          BNE     SRR1        ;if not done

;      Adjust exponent.

          LDA     $0000,X      ;exponent
          CLC
          ADC     ZTEMP4+1    ;subtract shift count
          STA     $0000,X      ;update exponent
          RTS

```

```

**      S0ER - Shift FR0/FRE Right
*
*      ENTRY JSR      S0ER
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

S0ER   =      *           ;entry
        LDX      #FMPREC*2 ;number of bytes to shift

S0ER1  LDA      FR0,X      ;byte to shift
        STA      FR0+1,X   ;byte of destination
        DEX
        BPL      S0ER1     ;if not done

        LDA      #0
        STA      FR0       ;shift in 0
        RTS              ;return

```

```

**      C0A - Convert FR0 to ASCII
*
*      ENTRY JSR      C0A
*              A = decimal point position
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

C0A    =      *           ;entry

;      Initialize.

        STA      ZTEMP4 ;decimal point position counter
        LDX      #0     ;offset to first byte of FROM
        LDY      #0     ;offset to first byte of LBUF

;      Convert next byte.

C0A1   JSR      TDP      ;test for decimal point
        SEC
        SBC      #1      ;decrement decimal point position

```

```

    STA    ZTEMP4 ;update decimal point position counter

;    Convert first digit of next byte.

    LDA    FROM,X ;byte
    LSR    A
    LSR    A
    LSR    A
    LSR    A      ;first digit
    JSR    SNL     ;store number in line buffer

;    Convert second digit of next byte.

    LDA    FROM,X ;byte
    AND    #$0F   ;extract second digit
    JSR    SNL     ;store number in line buffer
    INX
    CPX    #FMPREC ;number of bytes
    BCC    C0A1    ;if not done

;    Exit.

;    TDP     TDP    ;test for decimal point, return

```

```

**    TDP - Test for Decimal Point
*
*    ENTRY JSR    TDP
*           ZTEMP4 = decimal point position counter
*           ??
*
*    EXIT   ??
*
*    CHANGES
*           ??
*
*    CALLS
*           ??
*
*    MODS
*           Original Author Unknown   ??/??/??
*           1. Bring closer to Coding Standard (object unchanged).
*           R. K. Nordin      1983-11-01

```

```

TDP    =    *    ;entry

;    Check decimal point position counter.

    LDA    ZTEMP4 ;decimal point position counter
    BNE    TDP1   ;if not decimal point position, exit

;    Insert decimal point.

    LDA    #'.'
    JSR    SAL     ;store ASCII character in line buffer

;    Exit.

TDP1   RTS        ;return

```

```

**      SNL - Store Number in Line Buffer
*
*      ENTRY JSR    SNL
*              A = digit to store
*              Y = offset
*              ??
*
*      EXIT
*              ASCII digit placed in line buffer
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown    ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin    1983-11-01

```

```

SNL      =      *      ;entry
          ORA     #$30    ;convert digit to ASCII
          ;      LDD     SAL    ;store ASCII character in line buffer, return

```

```

**      SAL - Store ASCII Character in Line Buffer
*
*      ENTRY JSR    SAL
*              Y = offset
*              A = character
*              ??
*
*      EXIT
*              Character placed in line buffer
*              Y = incremented offset
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown    ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin    1983-11-01

```

```

SAL      =      *      ;entry
          STA     LBUF,Y    ;store character in line buffer
          INY     ;increment offset
          ;      RTS     ;return

```

```

**      FNZ - Find Last Non-zero Character in Line Buffer
*
*      FNZ returns the last non-zero character.  If the last
*      non-zero character is ".", FNZ returns the character
*      preceding the ".".  If no other non-zero character is
*      encountered, FNZ returns the first character.
*
*      ENTRY JSR      FNZ
*              ??
*
*      EXIT
*              A = character
*              X = offset to character
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

FNZ      =      *      ;entry
;      Initialize.

      LDX      #10      ;offset to last possible character
;      Check next character.
FNZ1     LDA      LBUFF,X      ;character
      CMP      #','
      BEQ      FNZ2      ;if ".", return preceding character

      CMP      #'0'
      BNE      FNZ3      ;if not "0", exit
;      Decrement offset and check for completion.

      DEX
      BNE      FNZ1      ;if not done
;      Return character preceding "." or first character.
FNZ2     DEX
      LDA      LBUFF,X      ;character
;      Exit.
FNZ3     RTS
;      ;return

```

```

**      GND - Get Next Digit
*
*      ENTRY JSR      GND
*              FR0 - FR0+5 = number
*              ??
*
*      EXIT
*              A = digit
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown    ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

GND      =      *      ;entry
          JSR      S0L      ;shift FR0 left 1 digit
          LDA      FRX      ;excess digit
          AND      #$0F      ;extract low order digit
          RTS                      ;return

```

```

**      DLP - Decrement Line Buffer Pointer
*
*      ENTRY JSR      DLP
*              INBUFF - INBUFF+1 = line buffer pointer
*              ??
*
*      EXIT
*              INBUFF - INBUFF+1 = incremented line buffer pointer
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown    ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

DLP      =      *      ;entry
          SEC
          LDA      INBUFF      ;line buffer pointer
          SBC      #1          ;subtract 1
          STA      INBUFF      ;update line buffer pointer
          LDA      INBUFF+1
          SBC      #0
          STA      INBUFF+1
          RTS                      ;return

```

```

**      SUE - Set Up Exponent for Multiply or Divide
*
*      ENTRY JSR      SUE
*              ??
*
*      EXIT
*              A = FR0 exponent (without sign)
*              FR1 = FR1 exponent (without sign)
*              FRSIGN = sign of result
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown    ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

SUE      =      *      ;entry
          LDA      FR0      ;FR0 exponent
          EOR      FR1      ;EOR with FR1 exponent
          AND      #$80      ;extract sign
          STA      FRSIGN    ;sign of result
          ASL      FR1      ;shift out FR1 sign
          LSR      FR1      ;FR1 exponent without sign
          LDA      FR0      ;FR0 exponent
          AND      #$7F      ;FR0 exponent without sign
          RTS                      ;return

```

```

**      SUP - Set Up for Multiply or Divide
*
*      ENTRY JSR      SUP
*              A = exponent
*              CC - SET BY ADD OR SUB TO GET A??????
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown    ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

SUP      =      *      ;entry
          ORA      FRSIGN    ;place sign in exponent
          STA      EEXP      ;exponent
          LDA      #0
          STA      FR0      ;clear FR0 exponent
          STA      FR1      ;clear FR0 exponent
          JSR      M12      ;move FR1 to FR2
          JSR      S2L      ;shift FR2 left 1 digit
          LDA      FRX      ;excess digit
          AND      #$0F      ;extract low order digit

```

```

STA    FR2    ;shift in low order digit
LDA    #FMPREC    ;mantissa size
STA    ZTEMP1 ;mantissa size
JSR    M0E     ;move FR0 to FRE
JSR    ZFR0    ;zero FR0
RTS                     ;return

```

```

**      FRA10 - Add FR1 to FR0
*
*      ENTRY JSR    FRA10
*              FR0 - FR0+5 = augend
*              FR1 - FR1+5 = addend
*              ??
*
*      EXIT
*              FR0 - FR0+5 = sum
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown    ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin    1983-11-01

```

```

FRA10 =      *      ;entry
LDX    #FR0+FPREC-1 ;offset to last byte of FR0
BNE    F1R      ;???

```

```

**      FRA20 - Add FR2 to FR0
*
*      ENTRY JSR    FRA20
*              FR0 - FR0+5 = augend
*              FR2 - FR2+5 = addend
*              ??
*
*      EXIT
*              FR0 - FR0+5 = sum
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown    ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin    1983-11-01

```

```

FRA20 =      *      ;entry
LDX    #FR0+FPREC-1 ;offset to last byte of FR0
BNE    F2R      ;???

```

```

**      FRA1E - Add FR1 to FRE
*
*      ENTRY JSR      FRA1E
*              FRE - FRE+5 = augend
*              FR1 - FR1+5 = addend
*              ??
*
*      EXIT
*              FRE - FRE+5 = sum
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

FRA1E = *          ;entry
LDX   #FRE+FPREC-1 ;offset to last byte of FRE
;     TMP F1R      ;???, return

```

```

**      F1R - Add FR1 to Register
*
*      ENTRY JSR      F1R
*              X = offset to last byte of augend register
*              FR1 - FR1+5 = addend
*              ??
*
*      EXIT
*              Sum in augend register
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

F1R = *          ;entry
LDY  #FR1+FPREC-1 ;offset to last byte of FR1
BNE  FARR         ;???

```

```

**      FRA2E - Add FR2 to FRE
*
*      ENTRY JSR      FRA2E
*              FRE - FRE+5 = augend
*              FR2 - FR2+5 = addend
*              ??
*
*      EXIT
*              FRE - FRE+5 = sum
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown    ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

FRA2E = *          ;entry
LDX   #FRE+FPREC-1 ;offset to last byte of FRE
;     F2R          ;???, return

```

```

**      F2R - Add FR2 to Register
*
*      ENTRY JSR      F2R
*              X = offset to last byte of augend register
*              FR2 - FR2+5 = addend
*              ??
*
*      EXIT
*              Sum in augend register
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown    ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

F2R   = *          ;entry
LDY   #FR2+FPREC-1 ;offset to last byte of FR2
;     FARR         ;???, return

```

```

**      FARR - Add Register to Register
*
*      ENTRY   JSR      FARR
*              X = offset to last byte of augend register
*              Y = offset to last byte of addend register
*              ??
*
*      EXIT
*              Sum in augend register
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

FARR  =      *              ;entry

;      Initialize.

      LDA      #FPREC-1      ;floating point number size-1
      STA      ZTEMP4        ;byte count
      CLC
      SED

;      Add.

FARR1 LDA      $0000,X        ;byte of augend
      ADC      $0000,Y        ;add byte of addend
      STA      $0000,X        ;update byte of augend
      DEX
      DEY
      DEC      ZTEMP4        ;decrement byte count
      BPL      FARR1         ;if not done

;      Exit.

      CLD
      RTS                    ;return

```

```

**      M12 - Move FR1 to FR2
*
*      ENTRY JSR      M12
*              FR1 - FR1+5 = number to move
*              ??
*
*      EXIT
*              FR2 - FR2+5 = moved number
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

M12      =      *              ;entry
          LDY      #FPREC-1    ;offset to last byte

M121     LDA      FR1,Y        ;byte of source
          STA      FR2,Y        ;byte of destination
          DEY
          BPL      M121         ;if not done
          RTS                  ;return

```

```

**      M0E - Move FR0 to FRE
*
*      ENTRY JSR      M0E
*              FR0 - FR0+5 = number to move
*              ??
*
*      EXIT
*              FRE - FRE+5 = moved number
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

M0E      =      *              ;entry
          LDY      #FPREC-1    ;offset to last byte

M0E1     LDA      FR0,Y        ;byte of source
          STA      FRE,Y        ;byte of destination
          DEY
          BPL      M0E1         ;if not done
          RTS                  ;return

```

FIX **PLYEVL**

```
**      PLYEVL - Evaluate Polynomial
*
*      Y = A(0)+A(1)*X+A(2)*X^2+...+A(N)*X^N
*
*      ENTRY JSR    PLYEVL
*              X = low address of coefficient table
*              Y = high address of coefficient table
*              FR0 - FR0+5 = X argument
*              A = N+1
*              ??
*
*      EXIT
*              FR0 - FR0+5 = Y result
*              ??
*
*      CHANGES
*              USES FPTR2, PLYCNT, PLYARG
*              ??
*
*      CALLS
*              CALLS FST0R, FMOVE, FLD1R, FADD, FMUL
*              ??
*
*      MODS
*              Original Author Unknown    ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01
```

```
;PLYEVL      =      *      ;entry

      STX      FPTR2      ;save pointer to coefficients
      STY      FPTR2+1
      STA      PLYCNT      ;degree
      LDX      #low PLYARG
      LDY      #high PLYARG
      JSR      FST0R      ;save argument
      JSR      FMOVE      ;move argument to FR1
      LDX      FPTR2
      LDY      FPTR2+1
      JSR      FLD0R      ;initialize sum in FR0
      DEC      PLYCNT      ;decrement degree
      BEQ      PLY3      ;if complete, exit

PLY1      JSR      FMUL      ;argument times current sum
      BCS      PLY3      ;if overflow

      CLC
      LDA      FPTR2      ;current low coefficient address
      ADC      #FPREC      ;add floating point number size
      STA      FPTR2      ;update low coefficient address
      BCC      PLY2

      LDA      FPTR2+1      ;current high coefficient address
      ADC      #0      ;adjust high coefficient address
      STA      FPTR2+1      ;update high coefficient address

PLY2      LDX      FPTR2      ;low coefficient address
      LDY      FPTR2+1      ;high coefficient address
      JSR      FLD1R      ;get next coefficient
      JSR      FADD      ;add coefficient to argument times sum
      BCS      PLY3      ;if overflow
```

```

DEC    PLYCNT    ;decrement degree
BEQ    PLY3      ;if complete, exit

LDX    #low PLYARG ;low argument address
LDY    #high PLYARG ;high argument address
JSR    FLD1R     ;get argument
BMI    PLY1      ;continue

PLY3   RTS              ;return

FIX    FLD0R

```

```

**      FLD0R - ???
*
*      ENTRY JSR    FLD0R
*              X = low pointer
*              Y = high pointer
*              ??
*
*      EXIT
*              FR0 loaded
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown    ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin    1983-11-01

```

```

;FLD0R =      *      ;entry
STX    FLPTR      ;low pointer
STY    FLPTR+1    ;high pointer
;      FLD0P      ;???, return

FIX    FLD0P

```

```

**      FLD0P - ???
*
*      ENTRY JSR    FLD0P
*              FLPTR - FLPTR+1 = pointer
*              ??
*
*      EXIT
*              FR0 loaded
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown    ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin    1983-11-01

```

```

;FLD0P =      *      ;entry

```

```

LDY    #FPREC-1    ;offset to last byte
FLD01  LDA    (FLPTR),Y    ;byte of source
      STA    FR0,Y    ;byte of destination
      DEY
      BPL    FLD01    ;if not done
      RTS            ;return
      FIX    FLD1R

```

```

**      FLD1R - ???
*
*      ENTRY JSR    FLD1R
*              X = low pointer
*              Y = high pointer
*              ??
*
*      EXIT
*              FR1 loaded
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown    ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin    1983-11-01

```

```

;FLD1R =      *      ;entry
      STX    FLPTR    ;low pointer
      STY    FLPTR+1    ;high pointer
;      JMP    FLD1P    ;???, return
      FIX    FLD1P

```

```

**      FLD1P - ???
*
*      ENTRY JSR    FLD1P
*              FLPTR - FLPTR+1 = pointer
*              ??
*
*      EXIT
*              FR1 loaded
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown    ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin    1983-11-01

```

```

;FLD1P =      *      ;entry
      LDY    #FPREC-1    ;offset to last byte

```

```

FLD11 LDA (FLPTR),Y ;byte of source
      STA FR1,Y ;byte of destination
      DEY
      BPL FLD11 ;if not done
      RTS ;return
      FIX FST0R

```

```

**      FST0R - ???
*
*      ENTRY JSR FST0R
*              FR0 - FR0+5 = number
*              X = low pointer
*              Y = high pointer
*              ??
*
*      EXIT
*              FR0 stored
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin 1983-11-01

```

```

;FST0R = * ;entry
      STX FLPTR ;low pointer
      STY FLPTR+1 ;high pointer
;      JMP FST0P ;???, return
      FIX FST0P

```

```

**      FST0P - ???
*
*      ENTRY JSR FST0P
*              FR0 - FR0+5 = number
*              FLPTR - FLPTR+1 = pointer
*              ??
*
*      EXIT
*              FR0 stored
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin 1983-11-01

```

```

;FST0P = * ;entry

```

```

        LDY    #FPREC-1      ;offset to last byte
FST01  LDA     FR0,Y          ;byte of source
        STA     (FLPTR),Y    ;byte of destination
        DEY
        BPL     FST01        ;if not done
        RTS
        FIX     FMOVE

```

```

**      FMOVE - ???
*
*      MOVE FR0 TO FR1
*
*      ENTRY JSR    FMOVE
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

;FMOVE =      *      ;entry

        LDX     #FPREC-1      ;offset to last byte
FM01  LDA     FR0,X          ;byte of source
        STA     FR1,X          ;byte of destination
        DEX
        BPL     FM01        ;if not done
        RTS
        ;return

```

FIX EXP

```
**      EXP - ???
*
*      ENTRY JSR      EXP
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01
```

```
;EXP  =      *      ;entry

;      Initialize.

      LDX    #low LOG10E  ;base 10 logarithm of e
      LDY    #high LOG10E
      JSR    FLD1R      ;load FR1

;      Compute X*LOG10(E).

      JSR    FMUL        ;multiply
      BCS    EXP6        ;if overflow, error

;      Compute result = 10^(X*LOG10(E)).

;      JMP    EXP10      ;???, return
```

FIX EXP10

```
** EXP10 - ???
*
* ENTRY JSR EXP10
*      ??
*
* EXIT
*      ??
*
* CHANGES
*      ??
*
* CALLS
*      ??
*
* MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01
*
;EXP10 =      *      ;entry

;      Initialize.

      LDA      #0
      STA      XFMFLG      ;zero integer part
      LDA      FR0
      STA      SGNFLG      ;save argument sign
      AND      #$7F      ;extract absolute value
      STA      FR0      ;update argument

;      Check for argument less than 1.

      SEC
      SBC      #$40      ;subtract bias
      BMI      EXP1      ;if argument < 1

;      Extract integer and fractional parts of exponent.

      CMP      #FPREC-2
      BPL      EXP6      ;if argument too big, error

      LDX      #low FPSCR
      LDY      #high FPSCR
      JSR      FST0R      ;save argument
      JSR      FPI      ;convert argument to integer
      LDA      FR0
      STA      XFMFLG      ;save integer part
      LDA      FR0+1      ;most significant byte of integer part
      BNE      EXP6      ;if integer part too large, error

      JSR      IFP      ;convert integer part to floating point
      JSR      FMOVE      ;???
      LDX      #low FPSCR
      LDY      #high FPSCR
      JSR      FLD0R      ;argument
      JSR      FSUB      ;subtract to get fractional part

;      Compute 10 to fractional exponent.

EXP1  LDA      #NPC0EF
      LDX      #low P10C0F
      LDY      #high P10C0F
```

```

    JSR    PLYEVL      ;P(X)
    JSR    FMOVE
    JSR    FMUL        ;P(X)*P(X)

;    Check integer part.

    LDA    XFMFLG      ;integer part
    BEQ    EXP4         ;if integer part zero

;    Compute 10 to integer part.

    CLC
    ROR    A           ;integer part divided by 2
    STA    FR1         ;exponent
    LDA    #1          ;assume mantissa 1
    BCC    EXP2         ;if integer part even

    LDA    #$10        ;substitute mantissa 10
EXP2  STA    FR1M       ;mantissa
    LDX    #FMPREC-1   ;offset to last byte of mantissa
    LDA    #0

EXP3  STA    FR1M+1,X   ;zero byte of mantissa
    DEX
    BPL    EXP3        ;if not done

    LDA    FR1         ;exponent
    CLC
    ADC    #$40        ;add bias
    BCS    EXP6        ;if too big, error

    BMI    EXP6        ;if underflow????, error

    STA    FR1         ;10 to integer part

;    Compute product of 10 to integer part and 10 to fractional part.

    JSR    FMUL        ;multiply to get result

;    Invert result if argument < 0.

EXP4  LDA    SGNFLG     ;argument sign
    BPL    EXP5         ;if argument >= 0

    JSR    FMOVE       ;???
    LDX    #low FONE
    LDY    #high FONE
    JSR    FLD0R       ;???
    JSR    FDIV        ;divide to get result

;    Exit.

EXP5  RTS              ;return

;    Return error.

EXP6  SEC              ;indicate error
    RTS                ;return

```

**** P10COF - ???**

```
P10COF DB    $3D,$17,$94,$19,$00,$00    ;0.0000179419
DB    $3D,$57,$33,$05,$00,$00    ;0.0000573305
DB    $3E,$05,$54,$76,$62,$00    ;0.0005547662
DB    $3E,$32,$19,$62,$27,$00    ;0.0032176227
DB    $3F,$01,$68,$60,$30,$36    ;0.0168603036
DB    $3F,$07,$32,$03,$27,$41    ;0.0732032741
DB    $3F,$25,$43,$34,$56,$75    ;0.2543345675
DB    $3F,$66,$27,$37,$30,$50    ;0.6627373050
DB    $40,$01,$15,$12,$92,$55    ;1.15129255
DB    $3F,$99,$99,$99,$99,$99    ;0.9999999999
```

NPC0EF = [*-P10COF]/FPREC

**** LOG10E - Base 10 Logarithm of e**

```
LOG10E DB    $3F,$43,$42,$94,$48,$19    ;base 10 logarithm of e
```

**** FONE - 1.0**

```
FONE  DB    $40,$01,$00,$00,$00,$00    ;1.0
```

```
**  XFORM - ???
*
*  Z = (X-C)/(X+C)
*
*  ENTRY JSR    XFORM
*        ??
*
*  EXIT
*        ??
*
*  CHANGES
*        ??
*
*  CALLS
*        ??
*
*  MODS
*
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin    1983-11-01
```

```
XFORM =    *                ;entry
STX    FPTR2
STY    FPTR2+1
LDX    #low PLYARG
LDY    #high PLYARG
JSR    FST0R    ;save argument
LDX    FPTR2
LDY    FPTR2+1
JSR    FLD1R    ;???
JSR    FADD     ;X+C
LDX    #low FPSCR
LDY    #high FPSCR
JSR    FST0R    ;???
LDX    #low PLYARG
LDY    #high PLYARG
JSR    FLD0R    ;???
LDX    FPTR2
LDY    FPTR2+1
```

```

JSR   FLD1R           ;???
JSR   FSUB            ;X-C
LDX     #low FPSCR
LDY     #high FPSCR
JSR   FLD1R           ;???
JSR   FDIV             ;divide to get result
RTS                   ;return

FIX   LOG

```

```

**      LOG - ???
*
*      ENTRY JSR      LOG
*              FR0 - FR0+5 = argument
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

;LOG = * ;entry

LDA     #1 ;indicate base e logarithm
BNE    LOGS ;compute logarithm, return

FIX    LOG10

```

```

**      LOG10 - ???
*
*      ENTRY JSR      LOG10
*              FR0 - FR0+5 = argument
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

;LOG10 = * ;entry

;      LDA     #0 ;indicate base 10 logarithm
;      BNE    LOGS ;compute logarithm, return

```

```

**      LOGS - Compute Logarithm
*
*      ENTRY JSR      LOGS
*              A = 0, if base 10 logarithm
*              = 1, if base e logarithm
*              FR0 - FR0+5 = argument
*              ??
*
*      EXIT
*              C set, if error
*              C clear, if no error
*              FR0 - FR0+5 = result
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

LOGS    =      *      ;entry

;      Initialize.

      STA      SGNFLG ;save logarithm base indicator

;      Check argument.

      LDA      FR0      ;argument exponent
      BEQ      LOGS1    ;if argument zero, error

      BMI      LOGS1    ;if argument negative, error

;      X = F*(10^Y), 1<F<10
;      10^Y HAS SAME EXP BYTE AS X
;      & MANTISSA BYTE = 1 OR 10

      JMP      LOGQ      ;???, return

;      Return error.

LOGS1   SEC                ;indicate error
      RTS                ;return

```

```

**      LOGC - Complete Computation of Logarithm
*
*      ENTRY JSR      LOGC
*              SGNFLG = 0, if base 10 logarithm
*                  = 1, if base e logarithm
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      NOTES
*      Problem: logic is convoluted because LOGQ code
*      was moved.
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

LOGC  =      *              ;entry
;      Initialize.

      SBC      #$40
      ASL      A
      STA      XFMFLG      ;save Y
      LDA      FR0+1
      AND      #$F0
      BNE      LOGC2      ;if ???

      LDA      #1          ;mantissa is 1
      BNE      LOGC3      ;set mantissa

LOGC2 INC      XFMFLG      ;increment Y
      LDA      #$10      ;mantissa is 10

LOGC3 STA      FR1M      ;mantissa
      LDX      #FMPREC-1 ;offset to last byte of mantissa
      LDA      #0

LOGC4 STA      FR1M+1,X   ;zero byte of mantissa
      DEX
      BPL      LOGC4      ;if not done

      JSR      FDIV      ;???X = X/(10^Y), S.B. IN (1,10)

;      Compute LOG10(X), 1 <= X <= 10.

      LDX      #low SQR10
      LDY      #high SQR10
      JSR      XFORM      ;Z = (X-C)/(X+C); C*C = 10
      LDX      #low FPSCR
      LDY      #high FPSCR
      JSR      FST0R      ;SAVE Z
      JSR      FMOVE      ;???
      JSR      FMUL       ;Z*Z
      LDA      #NLCOEF
      LDX      #low LGCOEF
      LDY      #high LGCOEF

```

```

JSR    PLYEVL        ;P(Z*Z)
LDX    #low FPSCR
LDY    #high FPSCR
JSR    FLD1R         ;???
JSR    FMUL          ;Z*P(Z*Z)
LDX    #low FHALF
LDY    #high FHALF
JSR    FLD1R
JSR    FADD          ;0.5 + Z*P(Z*Z)
JSR    FMOVE         ;???
LDA    #0
STA    FR0+1
LDA    XFMFLG
STA    FR0
BPL    LOGC5         ;if ???

EOR    #-$01         ;complement sign???
CLC
ADC    #1
STA    FR0

LOGC5 JSR    IFP        ;convert integer to floating point
      BIT    XFMFLG
      BPL    LOGC6         ;if ???

      LDA    #$80
      ORA    FR0
      STA    FR0          ;update exponent

LOGC6 JSR    FADD        ;LOG(X) = LOG(X)+Y

;      Check base of logarithm.

      LDA    SGNFLG        ;logarithm base indicator
      BEQ    LOGC7         ;if LOG10 (not LOG)

;      Compute base e logarithm.

      LDX    #low LOG10E   ;base 10 logarithm of e
      LDY    #high LOG10E
      JSR    FLD1R         ;???
      JSR    FDIV          ;result is LOG(X) divided by LOG10(e)

;      Exit.

LOGC7 CLC              ;indicate success
      RTS                ;return

```

** SQR10 - Square Root of 10

```

SQR10 DB    $40,$03,$16,$22,$77,$66    ;square root of 10

```

** FHALF - 0.5

```

FHALF DB    $3F,$50,$00,$00,$00,$00    ;0.5

```

** LGC0EF - Logarithm Coefficients

LGC0EF DB	\$3F,\$49,\$15,\$57,\$11,\$08	;0.4915571108
DB	\$BF,\$51,\$70,\$49,\$47,\$08	;-0.5170494708
DB	\$3F,\$39,\$20,\$57,\$61,\$95	;0.3920576195
DB	\$BF,\$04,\$39,\$63,\$03,\$55	;-0.0439630355
DB	\$3F,\$10,\$09,\$30,\$12,\$64	;0.1009301264
DB	\$3F,\$09,\$39,\$08,\$04,\$60	;0.0939080460
DB	\$3F,\$12,\$42,\$58,\$47,\$42	;0.1242584742
DB	\$3F,\$17,\$37,\$12,\$06,\$08	;0.1737120608
DB	\$3F,\$28,\$95,\$29,\$71,\$17	;0.2895297117
DB	\$3F,\$86,\$85,\$88,\$96,\$44	;0.8685889644

NLC0EF = [*-LGC0EF]/FPREC

** ATC0EF - Arctangent Coefficients

*
* NOTES
* Problem: not used.

DB	\$3E,\$16,\$05,\$44,\$49,\$00	;0.001605444900
DB	\$BE,\$95,\$68,\$38,\$45,\$00	;-0.009568384500
DB	\$3F,\$02,\$68,\$79,\$94,\$16	;0.0268799416
DB	\$BF,\$04,\$92,\$78,\$90,\$80	;-0.0492789080
DB	\$3F,\$07,\$03,\$15,\$20,\$00	;0.0703152000
DB	\$BF,\$08,\$92,\$29,\$12,\$44	;-0.0892291244
DB	\$3F,\$11,\$08,\$40,\$09,\$11	;0.1108400911
DB	\$BF,\$14,\$28,\$31,\$56,\$04	;-0.1428315604
DB	\$3F,\$19,\$99,\$98,\$77,\$44	;0.1999987744
DB	\$BF,\$33,\$33,\$33,\$31,\$13	;-0.3333333113
DB	\$3F,\$99,\$99,\$99,\$99,\$99	;0.9999999999
DB	\$3F,\$78,\$53,\$98,\$16,\$34	;pi/4 = arctan 1

```

** LOGQ - ???
*
* ENTRY JSR LOGQ
*      ??
*
* EXIT
*      ??
*
* CHANGES
*      ??
*
* CALLS
*      ??
*
* NOTES
*      Problem: logic is convoluted because this code was
*      moved.
*      Problem: for readability, this might be relocated
*      before tables.
*
* MODS
*      Original Author Unknown   ??/??/?
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

LOGQ  =      *      ;entry
      LDA     FR0    ;???
      STA     FR1    ;???
      SEC
      JMP     LOGC   ;???, return

```

Domestic Character Set

FIX DCSORG

** Domestic Character Set

DB	\$00,\$00,\$00,\$00,\$00,\$00,\$00,\$00	;\$00 - space
DB	\$00,\$18,\$18,\$18,\$18,\$00,\$18,\$00	;\$01 - !
DB	\$00,\$66,\$66,\$66,\$66,\$00,\$00,\$00	;\$02 - "
DB	\$00,\$66,\$FF,\$66,\$66,\$FF,\$66,\$00	;\$03 - #
DB	\$18,\$3E,\$60,\$3C,\$06,\$7C,\$18,\$00	;\$04 - \$
DB	\$00,\$66,\$6C,\$18,\$30,\$66,\$46,\$00	;\$05 - %
DB	\$1C,\$36,\$1C,\$38,\$6F,\$66,\$3B,\$00	;\$06 - &
DB	\$00,\$18,\$18,\$18,\$00,\$00,\$00,\$00	;\$07 - '
DB	\$00,\$0E,\$1C,\$18,\$18,\$1C,\$0E,\$00	;\$08 - (
DB	\$00,\$70,\$38,\$18,\$18,\$38,\$70,\$00	;\$09 -)
DB	\$00,\$66,\$3C,\$FF,\$3C,\$66,\$00,\$00	;\$0A - asterisk
DB	\$00,\$18,\$18,\$7E,\$18,\$18,\$00,\$00	;\$0B - plus
DB	\$00,\$00,\$00,\$00,\$00,\$18,\$18,\$30	;\$0C - comma
DB	\$00,\$00,\$00,\$7E,\$00,\$00,\$00,\$00	;\$0D - minus
DB	\$00,\$00,\$00,\$00,\$00,\$18,\$18,\$00	;\$0E - period
DB	\$00,\$06,\$0C,\$18,\$30,\$60,\$40,\$00	;\$0F - /
DB	\$00,\$3C,\$66,\$6E,\$76,\$66,\$3C,\$00	;\$10 - 0
DB	\$00,\$18,\$38,\$18,\$18,\$18,\$7E,\$00	;\$11 - 1
DB	\$00,\$3C,\$66,\$0C,\$18,\$30,\$7E,\$00	;\$12 - 2
DB	\$00,\$7E,\$0C,\$18,\$0C,\$66,\$3C,\$00	;\$13 - 3
DB	\$00,\$0C,\$1C,\$3C,\$6C,\$7E,\$0C,\$00	;\$14 - 4
DB	\$00,\$7E,\$60,\$7C,\$06,\$66,\$3C,\$00	;\$15 - 5
DB	\$00,\$3C,\$60,\$7C,\$66,\$66,\$3C,\$00	;\$16 - 6
DB	\$00,\$7E,\$06,\$0C,\$18,\$30,\$30,\$00	;\$17 - 7
DB	\$00,\$3C,\$66,\$3C,\$66,\$66,\$3C,\$00	;\$18 - 8
DB	\$00,\$3C,\$66,\$3E,\$06,\$0C,\$38,\$00	;\$19 - 9
DB	\$00,\$00,\$18,\$18,\$00,\$18,\$18,\$00	;\$1A - colon
DB	\$00,\$00,\$18,\$18,\$00,\$18,\$18,\$30	;\$1B - semicolon
DB	\$06,\$0C,\$18,\$30,\$18,\$0C,\$06,\$00	;\$1C - <
DB	\$00,\$00,\$7E,\$00,\$00,\$7E,\$00,\$00	;\$1D - =
DB	\$60,\$30,\$18,\$0C,\$18,\$30,\$60,\$00	;\$1E - >
DB	\$00,\$3C,\$66,\$0C,\$18,\$00,\$18,\$00	;\$1F - ?
DB	\$00,\$3C,\$66,\$6E,\$6E,\$60,\$3E,\$00	;\$20 - @
DB	\$00,\$18,\$3C,\$66,\$66,\$7E,\$66,\$00	;\$21 - A
DB	\$00,\$7C,\$66,\$7C,\$66,\$66,\$7C,\$00	;\$22 - B
DB	\$00,\$3C,\$66,\$60,\$60,\$66,\$3C,\$00	;\$23 - C
DB	\$00,\$78,\$6C,\$66,\$66,\$6C,\$78,\$00	;\$24 - D
DB	\$00,\$7E,\$60,\$7C,\$60,\$60,\$7E,\$00	;\$25 - E
DB	\$00,\$7E,\$60,\$7C,\$60,\$60,\$60,\$00	;\$26 - F
DB	\$00,\$3E,\$60,\$60,\$6E,\$66,\$3E,\$00	;\$27 - G
DB	\$00,\$66,\$66,\$7E,\$66,\$66,\$66,\$00	;\$28 - H
DB	\$00,\$7E,\$18,\$18,\$18,\$18,\$7E,\$00	;\$29 - I
DB	\$00,\$06,\$06,\$06,\$06,\$66,\$3C,\$00	;\$2A - J
DB	\$00,\$66,\$6C,\$78,\$78,\$6C,\$66,\$00	;\$2B - K
DB	\$00,\$60,\$60,\$60,\$60,\$60,\$7E,\$00	;\$2C - L
DB	\$00,\$63,\$77,\$7F,\$6B,\$63,\$63,\$00	;\$2D - M
DB	\$00,\$66,\$76,\$7E,\$7E,\$6E,\$66,\$00	;\$2E - N
DB	\$00,\$3C,\$66,\$66,\$66,\$66,\$3C,\$00	;\$2F - O
DB	\$00,\$7C,\$66,\$66,\$7C,\$60,\$60,\$00	;\$30 - P
DB	\$00,\$3C,\$66,\$66,\$66,\$6C,\$36,\$00	;\$31 - Q
DB	\$00,\$7C,\$66,\$66,\$7C,\$6C,\$66,\$00	;\$32 - R
DB	\$00,\$3C,\$60,\$3C,\$06,\$06,\$3C,\$00	;\$33 - S
DB	\$00,\$7E,\$18,\$18,\$18,\$18,\$18,\$00	;\$34 - T
DB	\$00,\$66,\$66,\$66,\$66,\$66,\$7E,\$00	;\$35 - U
DB	\$00,\$66,\$66,\$66,\$66,\$3C,\$18,\$00	;\$36 - V

DB	\$00,\$63,\$63,\$6B,\$7F,\$77,\$63,\$00	;\$37 - W
DB	\$00,\$66,\$66,\$3C,\$3C,\$66,\$66,\$00	;\$38 - X
DB	\$00,\$66,\$66,\$3C,\$18,\$18,\$18,\$00	;\$39 - Y
DB	\$00,\$7E,\$0C,\$18,\$30,\$60,\$7E,\$00	;\$3A - Z
DB	\$00,\$1E,\$18,\$18,\$18,\$18,\$1E,\$00	;\$3B - [
DB	\$00,\$40,\$60,\$30,\$18,\$0C,\$06,\$00	;\$3C - \
DB	\$00,\$78,\$18,\$18,\$18,\$18,\$78,\$00	;\$3D -]
DB	\$00,\$08,\$1C,\$36,\$63,\$00,\$00,\$00	;\$3E - ^
DB	\$00,\$00,\$00,\$00,\$00,\$00,\$FF,\$00	;\$3F - underline
DB	\$00,\$36,\$7F,\$7F,\$3E,\$1C,\$08,\$00	;\$40 - heart card
DB	\$18,\$18,\$18,\$1F,\$1F,\$18,\$18,\$18	;\$41 - mid left window
DB	\$03,\$03,\$03,\$03,\$03,\$03,\$03,\$03	;\$42 - right box
DB	\$18,\$18,\$18,\$F8,\$F8,\$00,\$00,\$00	;\$43 - low right window
DB	\$18,\$18,\$18,\$F8,\$F8,\$18,\$18,\$18	;\$44 - mid right window
DB	\$00,\$00,\$00,\$F8,\$F8,\$18,\$18,\$18	;\$45 - up right window
DB	\$03,\$07,\$0E,\$1C,\$38,\$70,\$E0,\$C0	;\$46 - right slant box
DB	\$0C,\$E0,\$70,\$38,\$1C,\$0E,\$07,\$03	;\$47 - left slant box
DB	\$01,\$03,\$07,\$0F,\$1F,\$3F,\$7F,\$FF	;\$48 - right slant solid
DB	\$00,\$00,\$00,\$00,\$0F,\$0F,\$0F,\$0F	;\$49 - low right solid
DB	\$80,\$C0,\$E0,\$F0,\$F8,\$FC,\$FE,\$FF	;\$4A - left slant solid
DB	\$0F,\$0F,\$0F,\$0F,\$00,\$00,\$00,\$00	;\$4B - up right solid
DB	\$F0,\$F0,\$F0,\$F0,\$00,\$00,\$00,\$00	;\$4C - up left solid
DB	\$FF,\$FF,\$00,\$00,\$00,\$00,\$00,\$00	;\$4D - top box
DB	\$00,\$00,\$00,\$00,\$00,\$00,\$FF,\$FF	;\$4E - bottom box
DB	\$00,\$00,\$00,\$00,\$F0,\$F0,\$F0,\$F0	;\$4F - low left solid
DB	\$00,\$1C,\$1C,\$77,\$77,\$08,\$1C,\$00	;\$50 - club card
DB	\$00,\$00,\$00,\$1F,\$1F,\$18,\$18,\$18	;\$51 - up left window
DB	\$00,\$00,\$00,\$FF,\$FF,\$00,\$00,\$00	;\$52 - mid box
DB	\$18,\$18,\$18,\$FF,\$FF,\$18,\$18,\$18	;\$53 - mid window
DB	\$00,\$00,\$3C,\$7E,\$7E,\$7E,\$3C,\$00	;\$54 - solid circle
DB	\$00,\$00,\$00,\$00,\$FF,\$FF,\$FF,\$FF	;\$55 - bottom solid
DB	\$0C,\$C0,\$C0,\$C0,\$C0,\$C0,\$C0,\$C0	;\$56 - left box
DB	\$00,\$00,\$00,\$FF,\$FF,\$18,\$18,\$18	;\$57 - up mid window
DB	\$18,\$18,\$18,\$FF,\$FF,\$00,\$00,\$00	;\$58 - low mid window
DB	\$F0,\$F0,\$F0,\$F0,\$F0,\$F0,\$F0,\$F0	;\$59 - left solid
DB	\$18,\$18,\$18,\$1F,\$1F,\$00,\$00,\$00	;\$5A - low left window
DB	\$78,\$60,\$78,\$60,\$7E,\$18,\$1E,\$00	;\$5B - display escape
DB	\$00,\$18,\$3C,\$7E,\$18,\$18,\$18,\$00	;\$5C - up arrow
DB	\$00,\$18,\$18,\$18,\$7E,\$3C,\$18,\$00	;\$5D - down arrow
DB	\$00,\$18,\$30,\$7E,\$30,\$18,\$00,\$00	;\$5E - left arrow
DB	\$00,\$18,\$0C,\$7E,\$0C,\$18,\$00,\$00	;\$5F - right arrow
DB	\$00,\$18,\$3C,\$7E,\$7E,\$3C,\$18,\$00	;\$60 - diamond card
DB	\$00,\$00,\$3C,\$06,\$3E,\$66,\$3E,\$00	;\$61 - a
DB	\$00,\$60,\$60,\$7C,\$66,\$66,\$7C,\$00	;\$62 - b
DB	\$00,\$00,\$3C,\$60,\$60,\$60,\$3C,\$00	;\$63 - c
DB	\$00,\$06,\$06,\$3E,\$66,\$66,\$3E,\$00	;\$64 - d
DB	\$00,\$00,\$3C,\$66,\$7E,\$60,\$3C,\$00	;\$65 - e
DB	\$00,\$0E,\$18,\$3E,\$18,\$18,\$18,\$00	;\$66 - f
DB	\$00,\$00,\$3E,\$66,\$66,\$3E,\$06,\$7C	;\$67 - g
DB	\$00,\$60,\$60,\$7C,\$66,\$66,\$66,\$00	;\$68 - h
DB	\$00,\$18,\$00,\$38,\$18,\$18,\$3C,\$00	;\$69 - i
DB	\$00,\$06,\$00,\$06,\$06,\$06,\$06,\$3C	;\$6A - j
DB	\$00,\$60,\$60,\$6C,\$78,\$6C,\$66,\$00	;\$6B - k
DB	\$00,\$38,\$18,\$18,\$18,\$18,\$3C,\$00	;\$6C - l
DB	\$00,\$00,\$66,\$7F,\$7F,\$6B,\$63,\$00	;\$6D - m
DB	\$00,\$00,\$7C,\$66,\$66,\$66,\$66,\$00	;\$6E - n
DB	\$00,\$00,\$3C,\$66,\$66,\$66,\$3C,\$00	;\$6F - o
DB	\$00,\$00,\$7C,\$66,\$66,\$7C,\$60,\$60	;\$70 - p
DB	\$00,\$00,\$3E,\$66,\$66,\$3E,\$06,\$06	;\$71 - q
DB	\$00,\$00,\$7C,\$66,\$60,\$60,\$60,\$00	;\$72 - r
DB	\$00,\$00,\$3E,\$60,\$3C,\$06,\$7C,\$00	;\$73 - s
DB	\$00,\$18,\$7E,\$18,\$18,\$18,\$0E,\$00	;\$74 - t
DB	\$00,\$00,\$66,\$66,\$66,\$66,\$3E,\$00	;\$75 - u

DB	\$00,\$00,\$66,\$66,\$66,\$3C,\$18,\$00	;\$76 - v
DB	\$00,\$00,\$63,\$6B,\$7F,\$3E,\$36,\$00	;\$77 - w
DB	\$00,\$00,\$66,\$3C,\$18,\$3C,\$66,\$00	;\$78 - x
DB	\$00,\$00,\$66,\$66,\$66,\$3E,\$0C,\$78	;\$79 - y
DB	\$00,\$00,\$7E,\$0C,\$18,\$30,\$7E,\$00	;\$7A - z
DB	\$00,\$18,\$3C,\$7E,\$7E,\$18,\$3C,\$00	;\$7B - spade card
DB	\$18,\$18,\$18,\$18,\$18,\$18,\$18,\$18	;\$7C -
DB	\$00,\$7E,\$78,\$7C,\$6E,\$66,\$06,\$00	;\$7D - display clear
DB	\$08,\$18,\$38,\$78,\$38,\$18,\$08,\$00	;\$7E - display backspace
DB	\$10,\$18,\$1C,\$1E,\$1C,\$18,\$10,\$00	;\$7F - display tab

Device Handler Vector Tables

FIX EDITRV

** EDITRV - Editor Handler Vector Table
--

```
DW EOP-1 ;perform editor OPEN
DW ECL-1 ;perform editor CLOSE
DW EGB-1 ;perform editor GET-BYTE
DW EPB-1 ;perform editor PUT-BYTE
DW SST-1 ;perform editor STATUS (screen STATUS)
DW ESP-1 ;perform editor SPECIAL
JMP SIN ;initialize editor (initialize screen)
DB 0 ;reserved
```

FIX SCRENV

** SCRENV - Screen Handler Vector Table
--

```
DW SOP-1 ;perform screen OPEN
DW ECL-1 ;perform screen CLOSE (editor CLOSE)
DW SGB-1 ;perform screen GET-BYTE
DW SPB-1 ;perform screen PUT-BYTE
DW SST-1 ;perform screen STATUS
DW SSP-1 ;perform screen SPECIAL
JMP SIN ;initialize screen
DB 0 ;reserved
```

FIX KEYBDV

** KEYBDV - Keyboard Handler Vector Table
--

```
DW SST-1 ;perform keyboard OPEN (screen STATUS)
DW SST-1 ;perform keyboard CLOSE (screen STATUS)
DW KGB-1 ;perform keyboard GET-BYTE
DW ESP-1 ;perform keyboard SPECIAL (editor SPECIAL)
DW SST-1 ;perform keyboard STATUS (screen STATUS)
DW ESP-1 ;perform keyboard SPECIAL (editor SPECIAL)
JMP SIN ;initialize keyboard (initialize screen)
DB 0 ;reserved
```

FIX PRINTV

** PRINTV - Printer Handler Vector Table

```
DW POP-1 ;perform printer OPEN
DW PCL-1 ;perform printer CLOSE
DW PSP-1 ;perform printer SPECIAL
DW PPB-1 ;perform printer PUT-BYTE
DW PST-1 ;perform printer STATUS
DW PSP-1 ;perform printer SPECIAL
JMP PIN ;initialize printer
DB 0 ;reserved
```

FIX CASETV

**	CASETV - Cassette Handler Vector Table
----	---

DW	COP-1	;perform cassette OPEN
DW	CCL-1	;perform cassette CLOSE
DW	CGB-1	;perform cassette GET-BYTE
DW	CPB-1	;perform cassette PUT-BYTE
DW	CST-1	;perform cassette STATUS
DW	CSP-1	;perform cassette SPECIAL
JMP	CIN	;initialize cassette
DB	0	;reserved

Jump Vectors

** Jump Vectors

FIX JMP	DINITV IDIO ;initialize DIO
FIX JMP	DSKINV DIO ;perform DIO
FIX JMP	CIOV CIO ;perform CIO
FIX JMP	SIOV PIO ;perform PIO
FIX JMP	SETVBV SVP ;set VBLANK parameters
FIX JMP	SYSVBV IVNM ;process immediate VBLANK NMI
FIX JMP	XITVBV DVNM ;process deferred VBLANK NMI
FIX JMP	SIOINV ISIO ;initialize SIO
FIX JMP	SENDEV ESS ;enable SIO SEND
FIX JMP	INTINV IIH ;initialize interrupt handler
FIX JMP	CIOINV ICIO ;initialize CIO
FIX JMP	BLKBDV PPD ;perform power-up display
FIX JMP	WARMSV PWS ;perform warmstart
FIX JMP	COLDSV PCS ;perform coldstart
FIX JMP	RBLOKV RCB ;read cassette block
FIX JMP	CSOPIV OCI ;open cassette for input
FIX JMP	PUPDIV PPD ;perform power-up display
FIX JMP	SLFTSV STH ;self-test hardware
FIX JMP	PHENTV PHE ;perform peripheral handler entry
FIX JMP	PHUNLV PHU ;perform peripheral handler unlinking ???

FIX	PHINIV
JMP	PHI ;perform peripheral handler initialization ???

Generic Parallel Device Handler Vector Table

FIX GPDVV

** GPDVV - Generic Parallel Device Handler Vector Table

DW	GOP-1	;perform generic parallel device OPEN
DW	GCL-1	;perform generic parallel device CLOSE
DW	GGB-1	;perform generic parallel device GET-BYTE
DW	GPB-1	;perform generic parallel device PUT-BYTE
DW	GST-1	;perform generic parallel device STATUS
DW	GSP-1	;perform generic parallel device SPECIAL
JMP	GIN	;initialize generic parallel device

\$E4C0 Patch

FIX \$E4C0

<pre>** E4C0 - \$E4C0 Patch * * For compatibility with OS Revision B, return.</pre>

RTS ;return

Central Input/Output

```
**      ICIO - Initialize CIO
*
*      ENTRY JSR      ICIO
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01
```

```
ICIO    =      *              ;entry
;      Initialize IOCB's.
        LDX      #0              ;index of first IOCB
ICIO1   LDA      #IOCFRE          ;IOCB free indicator
        STA      ICHID,X          ;set IOCB free
        LDA      #low [IIN-1]
        STA      ICPTL,X          ;initialize PUT-BYTE routine address
        LDA      #high [IIN-1]
        STA      ICPH,X
        TXA              ;index of current IOCB
        CLC
        ADC      #IOCBSZ          ;add IOCB size
        TAX              ;index of next IOCB
        CMP      #MAXIOC          ;index of first invalid IOCB
        BCC      ICIO1            ;if not done
        RTS              ;return
```

```
**      IIN - Indicate IOCB Not Open Error
*
*      ENTRY JSR      IIN
*
*      EXIT
*      Y = IOCB Not Open error code
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01
```

```
IIN     =      *              ;entry
        LDY      #NOTOPN          ;IOCB not open error
        RTS              ;return
```

```

**      CIO - Central Input/Output
*
*      ENTRY JSR      CIO
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown    ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

CIO      =      *      ;entry

;      Initialize.

      STA      CIOCHR ;save possible output byte value
      STX      ICIDNO ;save IOCB index

;      Check IOCB index validity.

      TXA      ;IOCB index
      AND      #$0F ;index modulo 16
      BNE      CIO1 ;if IOCB not multiple of 16, error

      CPX      #MAXIOC ;index of first invalid IOCB
      BCC      CIO2 ;if index within range

;      Indicate Invalid IOCB Index error.

CIO1     LDY      #BADIOC ;invalid IOCB index error
      JMP      SSC ;set status and complete operation, return

;      Move part of IOCB to zero page IOCB.

CIO2     LDY      #0 ;offset to first byte of page zero IOCB

CIO3     LDA      IOCB,X ;byte of IOCB
      STA      IOCBAS,Y ;byte of zero page IOCB
      INX
      INY
      CPY      #ICSPRZ-IOCBAS ;offset to first undesired byte
      BCC      CIO3 ;if not done

;      Check for provisionally open IOCB.

      LDA      ICHIDZ ;handler ID
      CMP      #$7F ;provisionally open indicator
      BNE      PCC ;if not provisionally open, perform command

;      Check for CLOSE command.

      LDA      ICCOMZ ;command
      CMP      #CLOSE
      BEQ      XCL ;if CLOSE command

;      Check handler load flag.

```

```

    LDA    HNDLOD ;???
    BNE    LHO    ;if handler load desired

;    Indicate nonexistent device error.

;    JMP    IND    ;indicate nonexistent device error, return

```

```

**    IND - Indicate Nonexistent Device Error
*
*    ENTRY JSR    IND
*           ??
*
*    EXIT
*           ??
*
*    CHANGES
*           ??
*
*    CALLS
*           ??
*
*    MODS
*           Original Author Unknown    ??/??/??
*           1. Bring closer to Coding Standard (object unchanged).
*           R. K. Nordin    1983-11-01

```

```

IND    =    *    ;entry
        LDY    #NONDEV    ;nonexistent device error

IND1    JMP    SSC    ;set status and complete operation, return

```

```

**    LHO - Load Peripheral Handler for OPEN
*
*    ENTRY JSR    LHO
*           ??
*
*    EXIT
*           ??
*
*    CHANGES
*           ??
*
*    CALLS
*           ??
*
*    MODS
*           Original Author Unknown    ??/??/??
*           1. Bring closer to Coding Standard (object unchanged).
*           R. K. Nordin    1983-11-01

```

```

LHO    =    *    ;entry
        JSR    PHL    ;load and initialize peripheral handler
        BMI    IND1    ;if error

;    JMP    PCC    ;perform CIO command, return

```

```

**      PCC - Perform CIO Command
*
*      ENTRY JSR      PCC
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

PCC      =      *      ;entry
;      Check command validity.

      LDY      #NVALID      ;assume invalid code
      LDA      ICCOMZ      ;command
      CMP      #OPEN      ;first valid command
      BCC      XOP1      ;if command invalid

      TAY      ;command

      CPY      #SPECIL      ;last valid command
      BCC      PCC1      ;if valid

      LDY      #SPECIL      ;substitute SPECIAL command
;      Obtain vector offset.

PCC1     STY      ICCOMT      ;save command
      LDA      TCV0-3,Y      ;vector offset for command
      BEQ      XOP      ;if OPEN command, process
;      Perform command.

      CMP      #2
      BEQ      XCL      ;if CLOSE command, process

      CMP      #8
      BCS      XSS      ;if STATUS or SPECIAL command, process

      CMP      #4
      BEQ      XGT      ;if GET command, process

      JMP      XPT      ;process PUT command, process

```

```

**      XOP - Execute OPEN Command
*
*      ENTRY JSR      XOP
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

XOP      =      *      ;entry
;      Check IOCB free.

      LDA      ICHIDZ ;handler ID
      CMP      #IOCFRE      ;IOCB free indicator
      BEQ      XOP2      ;if IOCB free
;      Process error.

      LDY      #PRVOPN      ;IOCB previously open error
XOP1     JMP      SSC      ;set status and complete operation, return
;      Check ???

XOP2     LDA      HNDLOD ;???
      BNE      PPO      ;if user wants unconditional poll
;      Search handler table.

      JSR      SHT      ;search handler table
      BCS      PPO      ;if not found, poll
;      Initialize status.

      LDA      #0
      STA      DVSTAT ;clear status
      STA      DVSTAT+1
;      Initialize IOCB.
;      JMP      IIO      ;initialize IOCB for OPEN, return

```

```

**      IIO - Initialize IOCB for OPEN
*
*      ENTRY JSR      IIO
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

IIO      =      *      ;entry

;      Compute handler entry point.

JSR      CEP      ;compute handler entry point
BCS      XOP1     ;if error

;      Execute command.

JSR      EHC      ;execute handler command

;      Set PUT-BYTE routine address in IOCB.

LDA      #PUTCHR
STA      ICCOMT ;command
JSR      CEP      ;compute handler entry point
LDA      ICSPRZ ;PUT-BYTE routine address
STA      ICPTLZ ;IOCB PUT-BYTE routine address
LDA      ICSPRZ+1
STA      ICPTHZ
JMP      CC0      ;complete CIO operation, return

```

```

**      PPO - Poll Peripheral for OPEN
*
*      ENTRY JSR      PPO
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

PPO      =      *      ;entry
JSR      PHO      ;poll
JMP      SSC      ;set status and complete operation, return

```

```

**      XCL - Execute CLOSE Command
*
*      ENTRY JSR      XCL
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

XCL      =      *              ;entry
;      Initialize.

      LDY      #SUCCES      ;assume success
      STY      ICSTAZ      ;status
      JSR      CEP          ;compute handler entry point
      BCS      XCL1        ;if error
;      Execute command.

      JSR      EHC          ;execute handler command
;      Close IOCB.

XCL1     LDA      #IOCFRE      ;IOCB free indicator
      STA      ICHIDZ      ;indicate IOCB free
      LDA      #high [IIN-1]
      STA      ICPTHZ      ;reset initial PUT-BYTE routine address
      LDA      #low [IIN-1]
      STA      ICPTLZ
      JMP      CC0          ;complete CIO operation, return

```

```

**      XSS - Execute STATUS and SPECIAL Commands
*
*      ???word about implicit OPEN and CLOSE.
*
*      ENTRY JSR    XSS
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin    1983-11-01

```

```

XSS      =      *      ;entry

;      Check IOCB free.

      LDA      ICHIDZ ;handler ID
      CMP      #IOCFRE
      BNE      XSS1    ;if IOCB not free

;      Open IOCB.

      JSR      SHT      ;search handler table
      BCS      XOP1    ;if error

;      Execute command.

XSS1     JSR      CEP      ;compute handler entry point
      JSR      EHC      ;execute handler command

;      Restore handler ID, in case IOCB implicitly opened.

      LDX      ICIDNO ;IOCB index
      LDA      ICHID,X    ;original handler ID
      STA      ICHIDZ ;restore zero page handler ID
      JMP      CCO      ;complete CIO operation, return

```

```

**      XGT - Execute GET Command
*
*      ENTRY JSR      XGT
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

XGT      =      *      ;entry
;      Check GET validity.

      LDA      ICCOMZ ;command
      AND      ICAX1Z ;???
      BNE      XGT2   ;if GET command valid

;      Process error.

      LDY      #WRONLY      ;IOCB opened for write only error
XGT1     JMP      SSC      ;set status and complete operation, return

;      Compute and check handler entry point.
XGT2     JSR      CEP      ;compute handler entry point
      BCS      XGT1      ;if error

;      Check buffer length.

      LDA      ICBLLZ      ;buffer length
      ORA      ICBLLZ+1
      BNE      XGT3      ;if buffer length non-zero

;      Get byte.

      JSR      EHC      ;execute handler command
      STA      CIOCHR ;data
      JMP      CC0      ;complete CIO operation, return

;      Fill buffer.

XGT3     JSR      EHC      ;execute handler command
      STA      CIOCHR      ;data
      BMI      XGT7      ;if error, end transfer

      LDY      #0
      STA      (ICBALZ),Y ;byte of buffer
      JSR      IBP      ;increment buffer pointer
      LDA      ICCOMZ      ;command
      AND      #$02
      BNE      XGT4      ;if GET RECORD command

;      Check for EOL.

```

```

        LDA    CIOCHR ;data
        CMP    #EOL
        BNE    XGT4    ;if not EOL

;      Process EOL.

        JSR    DBL      ;decrement buffer length
        JMP    XGT7      ;clean up

;      Check buffer full.

XGT4    JSR    DBL      ;decrement buffer length
        BNE    XGT3      ;if buffer not full, continue

;      Check command.

        LDA    ICCOMZ ;command
        AND    #$02
        BNE    XGT7      ;if GET CHARACTER command, clean up

;      Process GET RECORD.

XGT5    JSR    EHC      ;execute handler command
        STA    CIOCHR ;data
        BMI    XGT6      ;if error

;      Check for EOL.

        LDA    CIOCHR ;data
        CMP    #EOL
        BNE    XGT5      ;if not EOL, continue

;      Process end of record.

        LDA    #TRNRCD      ;truncated record error
        STA    ICSTAZ ;status

;      Process error.

XGT6    JSR    DBP          ;decrement buffer pointer
        LDY    #0
        LDA    #EOL
        STA    (ICBALZ),Y    ;set EOL in buffer
        JSR    IBP          ;increment buffer pointer

;      Clean up.

XGT7    JSR    SFL      ;set final buffer length
        JMP    CCO      ;complete CIO operation, return

```

```

**      XPT - Execute PUT Command
*
*      ENTRY JSR    XPT
*            ??
*
*      EXIT
*            ??
*
*      CHANGES
*            ??
*
*      CALLS
*            ??
*
*      MODS
*
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin    1983-11-01

```

```

XPT      =      *      ;entry
;      Check PUT validity.

      LDA      ICCOMZ ;command
      AND      ICAX1Z
      BNE      XPT2    ;if PUT command valid
;      Process error.

      LDY      #RDONLY      ;IOCB opened for read only error
XPT1     JMP      SSC      ;set status and complete operation, return
;      Compute and check handler entry point.
XPT2     JSR      CEP      ;compute handler entry point
      BCS      XPT1    ;if error
;      Check buffer length.

      LDA      ICBLLZ ;buffer length
      ORA      ICBLLZ+1
      BNE      XPT3    ;if buffer length non-zero
;      Put byte.

      LDA      CIOCHR ;data
      INC      ICBLLZ ;set buffer length to 1
      BNE      XPT4    ;transfer one byte
;      Transfer data from buffer to handler.
XPT3     LDY      #0
      LDA      (ICBALZ),Y ;byte from buffer
      STA      CIOCHR      ;data
XPT4     JSR      EHC      ;execute handler command
      PHP      ;save status
      JSR      IBP      ;increment buffer pointer
      JSR      DBL      ;decrement buffer length
      PLP      ;status
      BMI      XPT6    ;if error
;      Check command.

```

```

        LDA    ICCOMZ ;command
        AND    #$02
        BNE    XPT5   ;if PUT RECORD command

;       Check for EOL.

        LDA    CIOCHR ;data
        CMP    #EOL
        BEQ    XPT6   ;if EOL, clean up

;       Check for buffer empty.

XPT5    LDA    ICBLLZ      ;buffer length
        ORA    ICBLLZ+1
        BNE    XPT3      ;if buffer not empty, continue

;       Check command.

        LDA    ICCOMZ ;command
        AND    #$02
        BNE    XPT6   ;if PUT CHARACTER command

;       Write EOL.

        LDA    #EOL
        JSR    EHC     ;execute handler command

;       Clean up.

XPT6    JSR    SFL     ;set final buffer length
        JMP    CC0     ;complete CIO operation, return

```

```

**      SSC - Set Status and Complete Operation
*
*      ENTRY JSR    SSC
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

SSC    =    *      ;entry
        STY    ICSTAZ ;status
;        JMP    CC0   ;complete CIO operation, return

```

```

**      CCO - ???
*
*      RETURNS WITH STATUS STORED IN ICSTAZ
*      MOVE IOCB IN ZERO PAGE BACK TO USER AREA
*
*      ENTRY JSR      CCO
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

CC0      =      *      ;entry

;      Initialize.

      LDY      ICIDNO      ;IOCB index

;      Restore buffer pointer.

      LDA      ICBAL,Y
      STA      ICBALZ      ;restore buffer pointer
      LDA      ICBAH,Y
      STA      ICBAHZ

;      Move part of zero page IOCB to IOCB.

      LDX      #0          ;first byte of zero page IOCB
      STX      HNDLOD      ;clear ???

CC01     LDA      IOCBAS,X      ;byte of zero page IOCB
      STA      IOCB,Y      ;byte of IOCB
      INX
      INY
      CPX      #ICSPRZ-IOCBAS      ;offset to first undesired byte
      BCC      CC01      ;if not done

;      Restore A, X and Y.

      LDA      CIOCHR      ;data
      LDX      ICIDNO      ;IOCB index
      LDY      ICSTAZ      ;status
      RTS      ;return

```

```

**      CEP - Compute Handler Entry Point
*
*      ENTRY JSR      CEP
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

CEP      =      *              ;entry

;      Check handler ID validity.

      LDY      ICHIDZ          ;handler ID
      CPY      #MAXDEV+1      ;first invalid ID
      BCC      CEP1           ;if handler ID within range

;      Process error.

      LDY      #NOTOPN        ;IOCB not open error
      BCS      CEP2           ;return

;      Compute entry point.

CEP1     LDA      HATABS+1,Y    ;low address
      STA      ICSPRZ
      LDA      HATABS+2,Y    ;high address
      STA      ICSPRZ+1
      LDY      ICCOMT         ;command
      LDA      TCV0-3,Y      ;vector offset for command
      TAY
      LDA      (ICSPRZ),Y     ;low vector address
      TAX
      INY
      LDA      (ICSPRZ),Y     ;high vector address
      STA      ICSPRZ+1      ;set high address
      STX      ICSPRZ        ;set low address
      CLC                  ;indicate success

;      Exit.

CEP2     RTS                  ;return

```

```

**      DBL - Decrement Buffer Length
*
*      Z FLAG = 0 ON RETURN IF LENGTH = 0 AFTER DECREMENT????
*
*      ENTRY JSR      DBL
*              ??
*
*      EXIT
*              Z set if buffer length = 0
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

DBL      =      *      ;entry
          LDA      ICBLLZ      ;low buffer length
          BNE      DBL1      ;if low buffer length non-zero

          DEC      ICBLLZ+1      ;decrement high buffer length

DBL1     DEC      ICBLLZ      ;decrement low buffer length
          LDA      ICBLLZ
          ORA      ICBLLZ+1      ;indicate buffer length status
          RTS

```

```

**      DBP - Decrement Buffer Pointer
*
*      ENTRY JSR      DBP
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

DBP      =      *      ;entry
          LDA      ICBALZ      ;low buffer address
          BNE      DBP1      ;if low buffer address non-zero

          DEC      ICBALZ+1      ;decrement high buffer address

DBP1     DEC      ICBALZ      ;decrement low buffer address
          RTS

```

```

**      IBP - Increment Buffer Pointer
*
*      ENTRY JSR      IBP
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

IBP      =      *           ;entry
          INC      ICBALZ    ;increment low buffer address
          BNE      IBP1      ;if low buffer address non-zero

          INC      ICBALZ+1   ;increment high buffer address

IBP1     RTS                ;return

```

```

**      SFL - Set Final Buffer Length
*
*      SET BUFFER LENGTH = BUFFER LENGTH - WORKING BYTE COUNT???
*
*      ENTRY JSR      SFL
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

SFL      =      *           ;entry
          LDX      ICIDNO    ;IOCB index
          SEC
          LDA      ICBLL,X    ;initial length
          SBC      ICBLLZ     ;subtract byte count
          STA      ICBLLZ     ;update length
          LDA      ICBLLH,X
          SBC      ICBLLZ+1
          STA      ICBLLH
          RTS                ;return

```

```

**      EHC - Execute Handler Command
*
*      Y= STATUS ON RETURN, N FLAG=1 IF ERROR ON RETURN
*
*      ENTRY JSR      EHC
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

EHC      =      *      ;entry
          LDY      #FNCNOT      ;assume function not defined error
          JSR      IDH          ;invoke device handler
          STY      ICSTAZ      ;status
          CPY      #0          ;set N accordingly
          RTS              ;return

```

```

**      IDH - Invoke Device Handler
*
*      ENTRY JSR      IDH
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

IDH      =      *      ;entry
          TAX              ;save A
          LDA      ICSPRZ+1 ;high vector
          PHA              ;put high vector on stack
          LDA      ICSPRZ   ;low vector
          PHA              ;put low vector on stack
          TXA              ;restore A
          LDX      ICIDNO   ;IOCB index
          RTS              ;invoke handler (address on stack)

```

```

**      SHT - Search Handler Table
*
*      ENTRY JSR      SHT
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

SHT      =      *      ;entry

;      Set device number.

      SEC
      LDY      #1
      LDA      (ICBALZ),Y      ;device number
      SBC      #'1'
      BMI      SHT1      ;if number less than "1"

      CMP      #'9'-'1'+1
      BCC      SHT2      ;if number in range "1" to "9"
SHT1     LDA      #0      ;substitute device number "1"
SHT2     STA      ICDNOZ      ;device number (0 through 8)
      INC      ICDNOZ      ;adjust number to range 1 through 9

;      Find device handler.

      LDY      #0      ;offset to device code
      LDA      (ICBALZ),Y      ;device code
;      JMP      FDH      ;find device handler, return

```

```

**      FDH - Find Device Handler
*
*      ENTRY JSR      FDH
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

FDH      =      *      ;entry
;      Check device code.
      BEQ      FDH2      ;if device code null
;      Search handler table for device.
      LDY      #MAXDEV      ;offset to last possible entry
FDH1     CMP      HATABS,Y      ;device code from table
      BEQ      FDH3      ;if device found
      DEY
      DEY
      DEY
      BPL      FDH1      ;if not done
;      Process device not found.
FDH2     LDY      #NONDEV      ;nonexistent device error
      SEC      ;indicate error
      RTS      ;return
;      Set handler ID.
FDH3     TYA
      STA      ICHIDZ      ;set handler ID
      CLC      ;indicate no error
      RTS      ;return

```

**	TCV0 - Table of Command Vector Offsets
*	
*	Entry n is the vector offset for command n+3.

TCV0	DB	0	;3 - open
	DB	4	;4 - get ???
	DB	4	;5 - get record
	DB	4	;6 - get ???
	DB	4	;7 - get byte(s)
	DB	6	;8 - put ???
	DB	6	;9 - put record
	DB	6	;10 - put ???
	DB	6	;11 - put byte(s)
	DB	2	;12 - close
	DB	8	;13 - status
	DB	10	;14 - special

Peripheral Handler Loading Facility, Part 3

```
**      PHR - ???
*
*      * Performs Power-up Polling, with Handler loading at MEMLO
*      and Initialization;
*      * Performs System Reset Re-initialization of all handlers.
*
*      Input Parameters:
*      WARMST (used to distinguish Cold and Warm Start).
*
*      Output Parameters:
*      None.
*
*      Modified:
*      Registers are not saved;
*      All kinds of side effects when any handler is loaded
*      (potentially MEMLO, DVSTAT thru DVSTAT+3, the DCB,
*      CHLINK, ZCHAIN, TEMP1, TEMP2, TEMP3.  This list may
*      not be complete.).
*
*      ENTRY  JSR    PHR
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              CLT, PHW, PHP, GNL, LPH, PHC.
*              ??
*
*      MODS
*              R. S. Scheiman      1982-04-??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin        1983-11-01
```

```
PHR      =      *      ;entry
;      Check for coldstart.

      LDA      WARMST      ;warmstart flag
      BEQ      PHR2        ;if coldstart

;      Process warmstart.

      LDA      #low [CHLINK-18]      ;???
      STA      ZCHAIN      ;???
      LDA      #high [CHLINK-18]
      STA      ZCHAIN+1

;      Check next link.

PHR1     LDY      #18          ;offset to link
      CLC
      LDA      (ZCHAIN),Y      ;low link
      TAX
      INY
      ADC      (ZCHAIN),Y      ;high link
      BEQ      PHR4          ;if forward link null

;      Re-initialize peripheral handler.
```

```

    LDA    (ZCHAIN),Y    ;high link
    STA    ZCHAIN+1      ;???
    STX    ZCHAIN        ;???
    JSR    CLT           ;checksum linkage table
    BNE    PHR4          ;if checksum bad

    JSR    PHW           ;re-initialize peripheral handler
    BCS    PHR4          ;if error

;    Continue with next handler.

    BCC    PHR1          ;continue with next handler

;    Process coldstart.

PHR2    LDA    #0
        STA    CHLINK    ;clear chain link
        STA    CHLINK+1
        LDA    #$4F      ;send POLL RESET poll
        BNE    PHR7      ;???

;    Perform type 3 poll.

PHR3    LDA    #0
        TAY
        JSR    PHP       ;???
        BPL    PHR5      ;if poll answered

;    Exit.

PHR4    RTS             ;return

;    Process answered poll.

PHR5    CLC            ;Is there room to load?
        LDA    MEMLO
        ADC    DVSTAT
        STA    TEMP1
        LDA    MEMLO+1
        ADC    DVSTAT+1
        STA    TEMP1+1   ;(TEMP2 := MEMLO + handler size)
        SEC
        LDA    MEMTOP
        SBC    TEMP1
        LDA    MEMTOP+1
        SBC    TEMP1+1   ;(subtract MEMTOP)
        BCS    PHR8      ;if ??? fits

;    Prepare for another poll.

PHR6    LDA    #$4E      ;Following any load or init fail,
                        ;prepare for another Type 3 Poll by
                        ;sending a "special" load command over
                        ;serial port.

;    Poll.

PHR7    TAY            ;Send either "special" load command or
        JSR    PHP     ;??? "Poll Reset" poll
        JMP    PHR3    ;go poll again

;    Load peripheral handler.

PHR8    LDA    DVSTAT+2   ;call the loader
        LDX    MEMLO
        STX    DVSTAT+2   ;(Parameter = load address)
        LDX    MEMLO+1

```

```

STX    DVSTAT+3
JSR    LPH          ;load peripheral handler
BMI    PHR6         ;if load error, poll again

SEC                    ;Call for initialize new handler:
JSR    PHC          ;(Parameter = add size to MEMLO)
BCS    PHR6         ;if init error, poll again

BCC    PHR3         ;poll again normally

```

```

**      PHP - ???
*
*      Polling subroutine calls SIO for Type 3 or 4 Poll.
*
*      Input Parameters:
*      A      Value for AUX1
*      Y      Value for AUX2
*
*      Output Parameters:
*      Y      SIO status from poll
*      DVSTAT: Device minimum size (low), if poll answered
*      DVSTAT+1: Device minimum size (high), if poll answered
*      DVSTAT+2: Device address for loading, if poll answered
*      DVSTAT+3: Device version number, if poll answered
*
*      Modified:
*      The registers are not saved.
*
*      Subroutines called:
*      SIO (performs poll and returns to PHP's caller).
*
*      ENTRY JSR    PHP
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      R. S. Scheiman      1982-04-??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin        1983-11-01

```

```

PHP    =      *          ;entry

;      Initialize.

      PHA          ;save parameter???

;      Set up DCB.

      LDX    #PHPAL-1    ;offset to last byte of DCB data
PHP1   LDA    PHPA,X      ;byte of DCB data
      STA    DCB,X        ;byte of DCB
      DEX
      BPL    PHP1        ;if not done

;      Set parameters in DCB auxiliary bytes.

```

```

        STY    DAUX2        ;???
        PLA          ;???
        STA    DAUX1        ;???

;      Perform SI0.

        JMP    SIOV          ;vector to SI0, return

;      DCB Poll Request Data

PHPA   DB      $4F          ;device bus ID
        DB      1           ;unit number
        DB      '@'        ;type 3 or 4 poll command
        DB      $40        ;I/O direction
        DW      DVSTAT      ;buffer
        DB      30         ;timeout
        DB      0
        DW      4           ;buffer length

PHPAL  =          *-PHPA ;length

```

```

**      LPH - Load Peripheral Handler
*
*      This subroutine calls the relocating loader to load
*      a handler from a peripheral.
*
*      Input parameters:
*      A      Peripheral serial address for load;
*      DVSTAT+2: Load address (low)
*      DVSTAT+3: Load address (high)
*
*      Output parameters:
*      From the relocating loader.
*
*      Modified:
*      TEMP1, TEMP2, TEMP3,
*      DVSTAT+3, DVSTAT+3 (forced even),
*      Relocating loader variables and parameters,
*      Registers not saved.
*
*      Subroutines called:
*      RLR (relocating loader).
*
*      ENTRY JSR    LPH
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*
*      R. S. Scheiman      1982-04-??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin        1983-11-01

```

```

LPH    =          *          ;entry

;      Initialize.

```

```

STA    TEMP2    ;save peripheral address
LDX    #0
STX    TEMP1    ;set starting block number
DEX
STX    TEMP3    ;set starting byte number

;      Ensure load address even.

LDA    DVSTAT+2    ;low load address
ROR    A
BCC    LPH1        ;if even

INC    DVSTAT+2    ;increment low load address
BNE    LPH1        ;if no carry

INC    DVSTAT+3    ;increment high load address

;      Set up relocating loader parameters.

LPH1   LDA    DVSTAT+2    ;load address
      STA    LOADAD
      LDA    DVSTAT+3
      STA    LOADAD+1
      LDA    #low PHG    ;get-byte routine address
      STA    GBYTEA
      LDA    #high PHG
      STA    GBYTEA+1
      LDA    #$80        ;loader page zero load address
      STA    ZLOADA

;      Relocate routine.

      JMP    RLR        ;relocate routine, return

```

```

**      PHG - Perform Peripheral Handler GET-BYTE
*
*      Get a byte subroutine for relocating loader passes
*      bytes from peripheral to relocating loader via
*      cassette buffer. Calls GNL each time new
*      buffer is needed.
*
*      Input parameters:
*      TEMP1: Next block number;
*      TEMP2: Peripheral address (for GNL);
*      TEMP3: Next byte number (index to CASBUF).
*
*      Output parameters (for relocating loader):
*      Carry bit on indicates error;
*      A      Next byte, if no error.
*
*      Modified:
*      Cassette buffer CASBUF;
*      TEMP3;
*      X, Y not saved.
*
*      Subroutines called:
*      GNL, which calls SIO to get load records.
*
*      ENTRY JSR    PHG
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??

```

```

*
* CALLS
*   ??
*
* MODS
*   R. S. Scheiman      1982-04-??
*   1. Bring closer to Coding Standard (object unchanged).
*   R. K. Nordin       1983-11-01

```

```

PHG  =      *      ;entry

;      Check for another byte in buffer.

      LDX      TEMP3 ;???
      INX
      STX      TEMP3 ;next ???
      BEQ      PHG2  ;if empty, load next block

;      Retrieve next byte.

PHG1  LDX      TEMP3      ;???
      LDA      CASBUF-$80,X ;byte
      CLC                      ;indicate no error
      RTS                      ;return

;      Load next block and retrieve next byte.

PHG2  LDA      #-128 ;offset to first byte
      STA      TEMP3 ;reset ???
      JSR      GNL      ;get next load block
      BPL      PHG1     ;if no error, retrieve next byte

;      Process error.

      SEC                      ;indicate error
      RTS                      ;return

```

```

**      GNL - Get Next Load Block
*
*      Subroutine to get a load block from the peripheral.
*
*      Input parameters:
*      TEMP1: Block number.
*
*      Output parameters:
*      Negative bit is set by SIO if I/O error occurs.
*
*      Modified:
*      TEMP1;
*      the DCB (SIO);
*      Registers not saved.
*
*      Subroutines called:
*      SIO.
*
*      ENTRY  JSR      GNL
*             ??
*
*      EXIT
*             ??
*
*      CHANGES
*             ??
*
*      CALLS

```

```

*           ??
*
*   MODS
*       R. S. Scheiman      1982-04-??
*       1. Bring closer to Coding Standard (object unchanged).
*       R. K. Nordin        1983-11-01

```

```

GNL      =      *           ;entry

;      Set up DCB.

      LDX      #GNLAL-1      ;offset to last DCB data byte

GNL1     LDA      GNLA,X      ;byte of DCB data
      STA      DCB,X      ;byte of DCB
      DEX
      BPL      GNL1      ;if not done

;      Set DCB parameters.

      LDX      TEMP1      ;block number
      STX      DAUX1      ;auxiliary 1
      INX
      STX      TEMP1      ;next block number
      LDA      TEMP2      ;device address
      STA      DDEVIC      ;device bus ID

;      Perform SIO.

      JMP      SIOV      ;vector to SIO, return

;      DCB Data

GNLA     DB      $00      ;dummy device bus ID
      DB      1      ;dummy unit number
      DB      '&'      ;load command
      DB      $40      ;I/O direction
      DW      CASBUF      ;buffer
      DB      30      ;timeout
      DB      0
      DW      128      ;buffer length
      DB      0      ;auxiliary 1
      DB      0      ;auxiliary 2

GNLAL    =      *-GNLA ;length

```

```

**      SHC - Search Handler Chain
*
*      Forward chain search searches for pointer to handler linkage
*      table whose address matches caller's parameter. If caller's
*      parameter is zero, this routine looks for the pointer to
*      the final linkage table since this table's forward pointer
*      is zero (null).
*
*      Input parameters:
*      A      Linkage table address to match (High)
*      Y      Linkage table address to match (Low)
*
*      Output parameters:
*      ZCHAIN points to linkage table whose forward pointer
*      contains the match (if match is found);
*      if the match is found just following the linkage
*      chain base CHLINK, then ZCHAIN points to CHLINK
*      minus 18;

```

```

*      If match successful, A (High) and X (Low) contain
*          matched address (equiv. to A and Y parms.);
*      Carry bit is set to indicate no match or checksum violation
*          along the chain. [Note: the linkage table pointed
*          to by ZCHAIN upon return is not checksum checked.]
*
*      Modified:
*      TEMP1, TEMP2, ZCHAIN;
*      The registers are not saved.
*
*      Subroutines called:
*      CLT.
*
*      ENTRY JSR SHC
*             ??
*
*      EXIT
*             ??
*
*      CHANGES
*             ??
*
*      CALLS
*             ??
*
*      MODS
*      R. S. Scheiman      1982-04-??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin       1983-11-01

```

```

SHC      =      *      ;entry

;      Initialize.

      STY      TEMP1      ;???save match parameters
      STA      TEMP1+1    ;???
      LDA      #low [CHLINK-18]
      STA      ZCHAIN      ;start ZCHAIN at proper offset
      LDA      #high [CHLINK-18]
      STA      ZCHAIN+1

;      Check for match.

SHC1     LDY      #18
      LDA      (ZCHAIN),Y      ;???
      TAX
      INY
      LDA      (ZCHAIN),Y      ;high chain pointer
      CMP      TEMP2      ;check for match with parameter
      BNE      SHC2      ;if no match

      CPX      TEMP1
      BNE      SHC2      ;if no match

;      Exit.

      CLC      ;indicate match
      RTS      ;return

;      Check for end of chain.

SHC2     CMP      #0      ;end of chain indicator
      BNE      SHC4      ;if not end of chain

      CPX      #0
      BNE      SHC4      ;if not end of chain

```

```

;      Process end of chain or checksum error.

SHC3  SEC          ;return error (checksum or end)
      RTS          ;return

;      Set link to new linkage table.

SHC4  STX  ZCHAIN ;link to new linkage table
      STA  ZCHAIN+1

      JSR  CLT    ;checksum linkage table
      BNE  SHC3   ;if error

;      Continue searching chain.

      BEQ  SHC1   ;continue searching chain

```

```

**      PHW - ???
*
*      Handler initialization subroutine.
*
*      * PHC is the main entry. This performs full initialization,
*        including adding the new linkage table into the linkage
*        table chain;
*      * PHW does all initialization except adding to the linkage
*        table chain (intended for warm start reinitialization);
*      * PHI is the full initialization entry for calling
*        init from outside the OS.
*
*      The code does the following:
*      1)   Links new handler to end of chain;
*      2)   Calls handler init subroutine in handler;
*      3)   If 2 failed, unlinks handler from chain,
*            and returns with carry;
*      4)   Else, conditionally zeroes handler size entry of
*            handler linkage table (per parameter);
*      5)   Adds handler size entry (possibly zeroed) to MEMLO;
*      6)   If handler size entry is nonzero, MEMLO is then
*            forced even;
*      7)   Calculates and enters linkage table checksum;
*      8)   Returns with carry clear.
*
*      ???
*      * PHC is called by PHR when loading handlers at cold
*        initialization; and by PHL when loading a handler under
*        application request under CIO;
*      * PHW is called by PHR to reinitialize a handler during
*        warm-start;
*      * PHI is vectored by OS vector at $E49E and is intended
*        for use by system-level applications which load
*        handlers (ie., AUTORUN.SYS handler loader, etc.).
*
*      Input parameters:
*      PHC:
*          DVSTAT, DVSTAT+1 contain handler size (for
*          handler init, not used by this routine);
*          DVSTAT+2, DVSTAT+3 contain handler linkage table
*          address.
*      PHW:
*          DVSTAT+2, DVSTAT+3 same;
*          DVSTAT, DVSTAT+1 undefined.
*      PHI:
*          A and Y contain handler linkage table address;
*          they are copied into DVSTAT+3 and DVSTAT+2;
*          DVSTAT, DVSTAT+1 may or may not be significant--
*          any concern about these are up to the programmer

```

```

*           of the peripheral handler init routine and whoever
*           is making use of the non-OS-caller entry PHI.
*
* For PHI and PHC, the Carry bit specifies whether
*           the handler size entry of the linkage table is to
*           be zeroed prior to adding to MEMLO: Carry set means
*           do NOT zero this entry.
*
* Output parameters:
* Carry indicates error (initialization failed);
* The registers are not saved.
*
* Modified:
* DVSTAT+2, DVSTAT+3 are modified by PHI;
* ZCHAIN, TEMP1, TEMP2;
* MEMLO, MEMLO+1 conditionally incremented by handler's size.
*
* Subroutines called:
* SHC (to find end of linkage table chain);
* PHU (to unlink handler if init. error);
* CLT (to insert linkage table checksum);
* loaded handler's INIT entry.
*
* ENTRY JSR    PHW
*        ??
*
* EXIT
*        ??
*
* CHANGES
*        ??
*
* CALLS
*        ??
*
* MODS
*        R. S. Scheiman    1982-04-??
*        1. Bring closer to Coding Standard (object unchanged).
*        R. K. Nordin     1983-11-01

```

```

PHW    =    *    ;entry
SEC    ;indicate not zeroing handler size
PHP    ;save ???
BCS    PHQ    ;skip chaining

```

```

**      PHI - ???
*
*      ENTRY JSR    PHI
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*          R. S. Scheiman      1982-04-??
*          1. Bring closer to Coding Standard (object unchanged).
*          R. K. Nordin        1983-11-01

```

```

PHI      =      *          ;entry
          STA    DVSTAT+3    ;high ???
          STY    DVSTAT+2    ;low ???
;          PHP      PHC      ;???, return

```

```

**      PHC - ???
*
*      ENTRY JSR    PHC
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*          R. S. Scheiman      1982-04-??
*          1. Bring closer to Coding Standard (object unchanged).
*          R. K. Nordin        1983-11-01

```

```

PHC      =      *          ;entry
;      Initialize.

          PHP          ;save ???

;      Search for end of chain.

          LDA    #0      ;indicate searching for end of chain
          TAY
          JSR    SHC      ;search handler chain
          BCS    PHQ1     ;if error, exit

;      Enter ??? at end of chain.

          LDY    #18      ;offset to ???
          LDA    DVSTAT+2
          STA    (ZCHAIN),Y ;low link
          TAX
          INY
          LDA    DVSTAT+3

```

```

    STA    (ZCHAIN),Y    ;high link
    STX    ZCHAIN        ;link to new table
    STA    ZCHAIN+1
    LDA    #0            ;indicate end of chain
    STA    (ZCHAIN),Y    ;low link
    DEY
    STA    (ZCHAIN),Y    ;high link

;    ???

;    JNE    PHQ          ;???, return

```

```

**    PHQ - ???
*
*    ENTRY JSR    PHQ
*           ??
*
*    EXIT
*           ??
*
*    CHANGES
*           ??
*
*    CALLS
*           ??
*
*    MODS
*           R. S. Scheiman    1982-04-??
*           1. Bring closer to Coding Standard (object unchanged).
*           R. K. Nordin     1983-11-01

```

```

PHQ    =    *            ;entry

;    Initialize handler.

    JSR    PHX            ;initialize handler
    BCC    PHQ2           ;if no error

;    Process error.

    LDA    DVSTAT+3       ;???
    LDY    DVSTAT+2       ;???
    JSR    PHU            ;unlink handler

;    Exit, indicating error.

PHQ1    PLP                ;fix stack
        SEC                ;indicate error
        RTS                ;return

;    Check for ???.

PHQ2    PLP                ;???
        BCS    PHQ3        ;if not to zero

;    Zero handler size.

    LDA    #0
    LDY    #16            ;offset to ???
    STA    (ZCHAIN),Y     ;zero size
    INY
    STA    (ZCHAIN),Y

;    Increase MEMLO by size.

```

```

PHQ3  CLC
      LDY    #16          ;offset to size
      LDA    MEMLO
      ADC    (ZCHAIN),Y   ;add low size
      STA    MEMLO        ;new low MEMLO
      INY
      LDA    MEMLO+1
      ADC    (ZCHAIN),Y   ;add high size
      STA    MEMLO+1      ;new high MEMLO

;      Put checksum in linkage table.

      LDY    #15          ;offset to checksum
      LDA    #0
      STA    (ZCHAIN),Y   ;clear checksum
      JSR    CLT          ;checksum linkage table
      LDY    #15          ;offset to checksum
      STA    (ZCHAIN),Y   ;checksum

;      Exit.

      CLC                ;indicate success
      RTS                ;return

```

```

**      PHX - ???
*
*      ENTRY JSR    PHX
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      R. S. Scheiman      1982-04-??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin       1983-11-01

```

```

PHX    =      *          ;entry
      CLC
      LDA    ZCHAIN
      ADC    #12
      STA    TEMP1        ;low handler initialization address
      LDA    ZCHAIN+1
      ADC    #0
      STA    TEMP1+1      ;high handler initialization address
      JMP    (TEMP1)      ;initialize handler, return

```

\$E912 Patch

FIX \$E912

****** E912 - \$E912 Patch

***** For compatibility with OS Revision B, set VBLANK parameters.

JMP SVP ;set VBLANK parameters, return

Peripheral Handler Loading Facility, Part 4

```
**      PHU - Perform Peripheral Handler Unlinking
*
*      Handler entry unlinking routine. This routine is called either
*      by the OS handler initialization to unlink a handler when its
*      initialization fails, or by the handler itself if it implements
*      the handler unload feature.      This routine is entered via the
*      OS vector at $E49B.
*
*      Input parameters:
*      A      Address of linkage table to unlink (High);
*      Y      Address of linkage table to unlink (Low).
*      COLDST: Tested to see if PHU is called during cold starting;
*              if so, chain entry is unlinked even if at MEMLO.
*
*      Output parameters:
*      Carry is set to indicate error; in this case,
*              no unlinking has occurred.
*
*      Modified:
*      TEMP1, TEMP2;
*      ZCHAIN,ZCHAIN+1;
*      The forward chain pointer in the predecessor of the linkage
*      table being removed is modified to point to the successor
*      of the removed table if the removal is successful--
*      this forward chain pointer may be CHLINK,CHLINK+1.
*
*      The registers are not saved.
*
*      Subroutines called:
*      SHC, CLT.
*
*      ENTRY JSR      PHU
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      R. S. Scheiman      1982-04-??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01
```

```
PHU      =      *      ;entry
;      Search handler chain.
;
;      JSR      SHC      ;search handler chain
;      BCS      PHU3     ;if error
;
;      ???
;
;      TAY
;      LDA      ZCHAIN    ;(Save return parm)
;      PHA
;      LDA      ZCHAIN+1  ;Save ZCHAIN (points to predecessor)
;      PHA
;      STX      ZCHAIN    ;Make ZCHAIN point to linkage table
```

```

    STY    ZCHAIN+1      ;to be removed
    LDA    COLDST        ;coldstart flag
    BNE    PHU1          ;if coldstart, unconditional unlink

    LDY    #16           ;Check if loaded at MEMLO...
    CLC                ;by checking if size is nonzero
    LDA    (ZCHAIN),Y
    INY
    ADC    (ZCHAIN),Y
    BNE    PHU2          ;if handler size non-zero???

;    not loaded at MEMLO.

    JSR    CLT          ;checksum linkage table
    BNE    PHU2          ;if checksum nonzero, bad checksum???

;    OK remove table...

PHU1  LDY    #18        ;Take link from table being removed...
      LDA    (ZCHAIN),Y
      TAX
      INY
      LDA    (ZCHAIN),Y
      TAY
      PLA                ;Make ZCHAIN point to the predecessor...
      STA    ZCHAIN+1
      PLA
      STA    ZCHAIN
      TYA                ;And put forward link from table being
      LDY    #19        ;removed into its predecessors link.
      STA    (ZCHAIN),Y
      DEY
      TXA
      STA    (ZCHAIN),Y
      CLC                ;indicate success
      RTS                ;return

;    Clean stack and process error.

PHU2  PLA                ;Error return--restore stack
      PLA

;    Process error.

PHU3  SEC                ;indicate error
      RTS                ;return

```

\$E959 Patch

FIX \$E959

****** E959 - \$E959 Patch

***** For compatibility with OS Revision B, perform PI0.

JMP PI0 ;perform PI0, return

Serial Input/Output

```
**      ISIO - Initialize SIO
*
*      ENTRY JSR      ISIO
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01
```

```
ISIO  =      *      ;entry

      LDA      #MOTRST
      STA      PACTL ;turn off motor

      LDA      #NCOMHI
      STA      PBCTL ;raise NOT COMMAND line

      LDA      #$03 ;POKEY out of initialize mode
      STA      SSKCTL ;SKCTL shadow
      STA      SOUND ;select noisy I/O
      STA      SKCTL ;???

      RTS      ;return
```

```
**      SIO - Serial Input/Output
*
*      ENTRY JSR      SIO
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01
```

```
SIO  =      *      ;entry

;      Initialize.

      TSX
      STX      STACKP ;save stack pointer
      LDA      #1      ;critical section indicator
      STA      CRITIC ;indicate critical section
```

```

;      Check device ID.

      LDA    DDEVIC ;device ID
      CMP    #CASET
      BNE    SI01    ;if not cassette

;      Process cassette.

      JMP    PCI      ;process cassette I/O, return

;      Process intelligent device.

SI01  LDA    #0
      STA    CASFLG ;indicate not cassette

      LDA    #DRETRI
      STA    DRETRY ;set device retry count

SI02  LDA    #CRETRI
      STA    CRETRY ;set command frame retry count

;      Send command frame.

SI03  LDA    #low B19200
      STA    AUDF3      ;set baud rate to 19200
      LDA    #high B19200
      STA    AUDF4

;      Set up command buffer.

      CLC
      LDA    DDEVIC      ;device ID
      ADC    DUNIT      ;add unit number
      ADC    #$FF        ;subtract 1
      STA    CDEVIC      ;device bus ID
      LDA    DCOMND      ;command
      STA    CCOMND
      LDA    DAUX1        ;auxiliary information 1
      STA    CAUX1
      LDA    DAUX2        ;auxiliary information 2
      STA    CAUX2

;      Set buffer pointer to command frame buffer.

      CLC
      LDA    #low CDEVIC ;low buffer address
      STA    BUFRLO      ;low buffer address
      ADC    #4
      STA    BFENLO      ;low buffer end address
      LDA    #high CDEVIC ;high buffer address
      STA    BUFRHI      ;high buffer address
      STA    BFENHI      ;high buffer end address

;      Send command frame to device.

      LDA    #NCOMLO
      STA    PBCTL        ;lower NOT COMMAND line
      JSR    SID          ;send command frame
      LDA    ERRFLG      ;error flag
      BNE    SI04        ;if error received

      TYA                ;status???
      BNE    SI05        ;if ACK received

;      Process NAK or timeout.

```

```

SI04  DEC    CRETRY ;decrement command frame retry count
      BPL    SI03   ;if retries not exhausted

;      Process command frame retries exhausted.

      JMP    SI010  ;process error

;      Process ACK.

SI05  LDA    DSTATS ;status???? type????
      BPL    SI06   ;if no data to send

;      Send data frame to device.

      LDA    #CRETRI
      STA    CRETRY ;set command frame retry count
      JSR    SBP    ;set buffer pointers
      JSR    SID    ;send data frame
      BEQ    SI010  ;if error

;      Wait for complete.

SI06  JSR    GT0    ;set device timeout
      LDA    #0
      STA    ERRFLG ;clear error flag
      JSR    STW    ;set timer and wait
      BEQ    SI08   ;if timeout

;      Process no timeout.

      BIT    DSTATS ;???
      BVS    SI07   ;if more data follows

      LDA    ERRFLG ;error flag
      BNE    SI010  ;if error

;      Process no error.

      BEQ    CS0    ;complete SIO operation

;      Receive data frame from device.

SI07  JSR    SBP    ;set buffer pointers
      JSR    REC    ;receive

;      Check error flag.

SI08  LDA    ERRFLG ;error flag
      BEQ    SI09   ;if no error preceded data

;      Process error.

      LDA    TSTAT  ;temporary status
      STA    STATUS ;status

;      Check status.

SI09  LDA    STATUS ;status
      CMP    #SUCCES
      BEQ    CS0    ;if successful, complete operation, return

;      Process error.

SI010 DEC    DRETRY ;decrement device retry count
      BMI    CS0    ;if retries exhausted, complete, return

;      Retry.

```

```
JMP SI02 ;retry
```

```
** CS0 - Complete SIO Operation
*
* ENTRY JSR CS0
*      ??
*
* EXIT
*      ??
*
* CHANGES
*      ??
*
* CALLS
*      ??
*
* MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01
```

```
CS0 = * ;entry
      JSR DSR ;disable SEND and RECEIVE
      LDA #0 ;not critical section indicator
      STA CRITIC ;critical section flag
      LDY STATUS ;status
      STY DSTATS ;status
      RTS ;return
```

```
** WCA - Wait for Completion or ACK
*
* ENTRY JSR WCA
*      ??
*
* EXIT
*      Y = 0, if failure
*      = $FF, if success
*      ??
*
* CHANGES
*      ??
*
* CALLS
*      ??
*
* MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01
*      2. Correct mishandling of NAK.
*      R. K. Nordin      1984-03-23
```

```
WCA = * ;entry
; Initialize.
      LDA #0
      STA ERRFLG ;clear error flag
; Set buffer pointer.
      CLC
      LDA #low TEMP ;low temporary address
```

```

    STA    BUFRLO        ;low buffer address
    ADC    #1
    STA    BFENLO        ;low buffer end address
    LDA    #high TEMP    ;high temporary address
    STA    BUFRHI        ;high buffer address
    STA    BFENHI        ;high buffer end address
    LDA    #$FF
    STA    NOCKSM        ;indicate no checksum follows
    JSR    REC            ;receive
    LDY    #$FF          ;assume success
    LDA    STATUS        ;status
    CMP    #SUCCE
    BNE    WCA2          ;if failure

    LDA    TEMP          ;byte received
    CMP    #ACK
    BEQ    WCA4          ;if ACK, exit

    CMP    #COMPLT
    BEQ    WCA4          ;if complete, exit

    CMP    #ERROR
    BNE    WCA1          ;if device did not send back

;    Process unrecognized response.

    LDA    #DERROR
    STA    STATUS        ;indicate device error
    BNE    WCA2          ;check for timeout

;    Process nothing sent back.

WCA1    LDA    #DNACK
    STA    STATUS        ;indicate NAK

;    Check for timeout.

WCA2    LDA    STATUS        ;status
    CMP    #TIMOUT
    BEQ    WCA3          ;if timeout

;    Process other error.?????

    LDA    #$FF          ;error indicator
    STA    ERRFLG        ;indicate error

;    Indicate failure.

WCA3    LDY    #0          ;failure indicator

;    Exit.

WCA4    LDA    STATUS        ;status
    STA    TSTAT        ;temporary status
    RTS                ;return

```

```

**      SEN - Send
*
*      SEN sends a buffer over the serial bus.
*
*      ENTRY JSR      SEN
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*          R. K. Nordin    1983-11-01
*      2. Initialize CHKSUM before transmitting first byte.
*          R. K. Nordin    1984-03-23

```

```

SEN      =      *      ;entry

;      Initialize.

      LDA      #SUCCES      ;assume success
      STA      STATUS      ;status
      JSR      ESS          ;enable SIO SEND
      LDY      #0
      STY      CHKSUM      ;clear checksum
      STY      CHKSNT      ;clear checksum sent flag
      STY      XMTDON      ;clear transmit-frame done flag

;      Initiate TRANSMIT.

      LDA      (BUFRLO),Y   ;first byte from buffer
      STA      CHKSUM      ;initialize checksum
      STA      SEROUT      ;serial output register

;      Check BREAK key.

SEN1     LDA      BRKKEY
      BNE      SEN2      ;if BREAK key not pressed

;      Process BREAK key.

      JMP      PBK        ;process BREAK key, return

;      Process BREAK key not pressed.

SEN2     LDA      XMTDON      ;transmit-frame done flag
      BEQ      SEN1      ;if transmit-frame not done

;      Exit.

      JSR      DSR          ;disable SEND and RECEIVE
      RTS

```

```

**      ORIR - Process Serial Output Ready IRQ
*
*      ENTRY JMP      ORIR
*          ??
*
*      EXIT
*          Exits via RTI
*          ??
*
*      CHANGES
*          ??
*
*      CALLS
*          ??
*
*      MODS
*          Original Author Unknown    ??/??/??
*          1. Bring closer to Coding Standard (object unchanged).
*          R. K. Nordin      1983-11-01

```

```

ORIR    =      *      ;entry

;      Initialize.

      TYA
      PHA          ;save Y
      INC    BUFRLO ;increment low buffer pointer
      BNE    ORI1  ;if low buffer pointer non-zero

      INC    BUFRHI ;increment high buffer pointer

;      Check end of buffer.

ORI1    LDA    BUFRLO ;buffer address
      CMP    BFENLO ;buffer end address
      LDA    BUFRHI
      SBC    BFENHI
      BCC    ORI4   ;if not past end of buffer

;      Process end of buffer.

      LDA    CHKSNT ;checksum sent flag
      BNE    ORI2   ;if checksum already sent

;      Send checksum.

      LDA    CHKSUM ;checksum
      STA    SEROUT ;serial output register
      LDA    #$FF
      STA    CHKSNT ;indicate checksum sent
      BNE    ORI3   ;???

;      Enable TRANSMIT done interrupt.

ORI2    LDA    POKMSK ;???
      ORA    #$08    ;???
      STA    POKMSK ;???
      STA    IRQEN  ;???

;      Exit.

ORI3    PLA
      TAY          ;restore Y
      PLA          ;restore A
      RTI          ;return

```

```

; Transmit next byte from buffer.
ORI4 LDY #0
LDA (BUFRLO),Y ;byte from buffer
STA SEROUT ;serial output register
CLC
ADC CHKSUM ;add byte to checksum
ADC #0
STA CHKSUM ;update checksum
JMP ORI3 ;exit

```

```

** OCIR - Process Serial Output Complete IRQ
*
* ENTRY JMP OCIR
* ??
*
* EXIT
* Exits via RTI
* ??
*
* CHANGES
* ??
*
* CALLS
* ??
*
* MODS
* Original Author Unknown ??/??/??
* 1. Bring closer to Coding Standard (object unchanged).
* R. K. Nordin 1983-11-01

```

```

OCIR = * ;entry
; Check checksum sent.
LDA CHKSNT ;checksum sent flag
BEQ OC11 ;if checksum not yet sent
; Process checksum sent.
STA XMTDON ;indicate transmit-frame done
; Disable TRANSMIT done interrupt.
LDA POKMSK ;???
AND #$F7 ;???
STA POKMSK ;???
STA IRQEN ;???
; Exit.
OC11 PLA ;restore A
RTI ;return

```

```

**      REC - Receive
*
*      ENTRY JSR      REC
*           ??
*
*      EXIT
*           ??
*
*      CHANGES
*           ??
*
*      CALLS
*           ??
*
*      MODS
*           Original Author Unknown   ??/??/??
*           1. Bring closer to Coding Standard (object unchanged).
*           R. K. Nordin      1983-11-01

```

```

REC      =      *      ;entry

;      Initialize.

      LDA      #0
      LDY      CASFLG
      BNE      REC1      ;if cassette

      STA      CHKSUM ;initialize checksum

REC1     STA      BUFRFL ;clear buffer full flag
      STA      RECVDN ;clear receive-frame done flag
      LDA      #SUCCE$      ;assume success
      STA      STATUS ;status
      JSR      ESR      ;enable SIO RECEIVE
      LDA      #NCOMHI
      STA      PBCTL      ;????

;      Check BREAK key.

REC2     LDA      BRKKEY
      BNE      REC3      ;if BREAK key not pressed

;      Process BREAK key.

      JMP      PBK      ;process BREAK key, return

;      Process BREAK key not pressed.

REC3     LDA      TIMFLG ;timeout flag
      BEQ      ITO      ;if timeout, indicate timeout

;      Process no timeout.

      LDA      RECVDN ;receive-frame done flag
      BEQ      REC2      ;if receive-frame done, continue

;      Exit.

      RTS              ;return

```

```

**      ITO - Indicate Timeout
*
*      ENTRY JSR      ITO
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

ITO      =      *      ;entry
          LDA      #TIMOUT      ;timeout indicator
          STA      STATUS ;indicate timeout
          RTS              ;return

```

```

**      IRIR - Process Serial Input Ready IRQ
*
*      ENTRY JMP      IRIR
*              ??
*
*      EXIT
*      Exits via RTI
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

IRIR      =      *      ;entry
;      Initialize.

          TYA
          PHA      ;save Y
          LDA      SKSTAT
          STA      SKRES ;reset status register

;      Check for frame error.
;      THIS MAY NOT BE THE PLACE TO DO IT ????????

          BMI      IRI1 ;if no frame error

;      Process frame error.

          LDY      #FRMERR      ;frame error
          STY      STATUS ;indicate frame error

;      Check for overrun error.

```

```

IRI1  AND    #$20
      BNE    IRI2    ;if no overrun error

;      Process overrun error.

      LDY    #OVRUN    ;overrun error
      STY    STATUS ;indicate overrun error

;      Check for buffer full.

IRI2  LDA    BUFRFL
      BEQ    IRI5    ;if buffer not yet full

;      Process buffer full.

      LDA    SERIN ;checksum from device
      CMP    CHKSUM ;computed checksum
      BEQ    IRI3    ;if checksums match

;      Process checksum error.

      LDY    #CHKERR    ;checksum error
      STY    STATUS ;indicate checksum error

;      Indicate receive-frame done.

IRI3  LDA    #$FF ;receive-frame done indicator
      STA    RECDN ;indicate receive-frame done

;      Exit.

IRI4  PLA
      TAY    ;restore Y
      PLA    ;restore A
      RTI    ;return

;      Process buffer not full.

IRI5  LDA    SERIN    ;serial input register
      LDY    #0
      STA    (BUFRLO),Y ;byte of buffer
      CLC
      ADC    CHKSUM    ;add byte to checksum
      ADC    #0
      STA    CHKSUM    ;update checksum
      INC    BUFRLO    ;increment low buffer pointer
      BNE    IRI6    ;if low buffer pointer non-zero

      INC    BUFRHI    ;increment high buffer pointer

;      Check end of buffer.

IRI6  LDA    BUFRLO    ;buffer address
      CMP    BFENLO    ;buffer end address
      LDA    BUFRHI
      SBC    BFENHI
      BCC    IRI4    ;if not past end of buffer

;      Process end of buffer.

      LDA    NOCKSM    ;no checksum follows flag
      BEQ    IRI7    ;if checksum will follow

;      Process no checksum will follow.

      LDA    #0

```

```

        STA    NOCKSM        ;clear no checksum follows flag
        BEQ    IRI3          ;indicate receive-frame done

;      Process checksum will follow.

IRI7    LDA    #$FF
        STA    BUFRFL        ;indicate buffer full
        BNE    IRI4          ;exit

```

```

**      SBP - Set Buffer Pointers
*
*      ENTRY JSR    SBP
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

SBP    =      *      ;entry
        CLC
        LDA    DBUFLO
        STA    BUFRLO ;low buffer address
        ADC    DBYTLO
        STA    BFENLO ;low buffer end address
        LDA    DBUFHI
        STA    BUFRHI ;high buffer address
        ADC    DBYTHI
        STA    BFENHI ;high buffer end address
        RTS      ;return

```

```

**      PCI - Process Cassette I/O
*
*      ENTRY JSR    PCI
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

PCI    =      *      ;entry

;      Check command type.

        LDA    DSTATS        ;command type

```

```

    BPL    PCI3            ;if READ
;    Write a record.
    LDA    #low B00600
    STA    AUDF3            ;set 600 baud
    LDA    #high B00600
    STA    AUDF4
    JSR    ESS              ;enable SIO SEND
    LDX    PALNTS          ;PAL/NTSC offset
    LDY    WSIRGX,X        ;low short WRITE IRG time
    LDA    DAUX2            ;IRG type
    BMI    PCI1            ;if short IRG is desired
    LDY    WIRGLX,X        ;low long WRITE IRG time
PCI1  LDX    #WIRGHI        ;high IRG time
    JSR    SSV              ;set SIO VBLANK parameters
    LDA    #MOTRGO
    STA    PACTL            ;turn on motor
PCI2  LDA    TIMFLG        ;timeout flag
    BNE    PCI2            ;if no timeout
    JSR    SBP              ;set buffer pointers
    JSR    SEN              ;send
    JMP    PCI6            ;exit
;    Read a record.
PCI3  LDA    #$FF          ;cassette I/O indicator
    STA    CASFLG          ;cassette I/O flag
    LDX    PALNTS          ;PAL/NTSC offset
    LDY    RSIRGX,X        ;low short READ IRG time
    LDA    DAUX2            ;IRG type
    BMI    PCI4            ;if short IRG desired
    LDY    RIRGLX,X        ;low long READ IRG time
PCI4  LDX    #RIRGHI        ;high READ IRG time
    JSR    SSV              ;set SIO VBLANK parameters
    LDA    #MOTRGO
    STA    PACTL            ;turn on motor
PCI5  LDA    TIMFLG        ;timeout flag
    BNE    PCI5            ;if no timeout
    JSR    SBP              ;set buffer pointers
    JSR    GT0              ;get device timeout
    JSR    SSV              ;set SIO VBLANK parameters
    JSR    SBR              ;set initial baud rate
    JSR    REC              ;receive
;    Exit.
PCI6  LDA    DAUX2          ;IRG type
    BMI    PCI7            ;if doing short IRG
    LDA    #MOTRST
    STA    PACTL            ;turn off motor
PCI7  JMP    CS0            ;complete SIO operation, return

```

```

**      PTE - Process Timer Expiration
*
*      ENTRY JSR      PTE
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

PTE      =      *      ;entry
          LDA      #0      ;timeout indicator
          STA      TIMFLG ;timeout flag
          RTS

```

```

**      ESS - Enable SIO SEND
*
*      ENTRY JSR      ESS
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

ESS      =      *      ;entry
;      ???

          LDA      #$07 ;mask off previous serail bus control bits
          AND      SSKCTL
          ORA      #$20 ;set SEND mode

;      Check device type.

          LDY      DDEVIC
          CPY      #CASET
          BNE      ESS1 ;if not cassette

;      Process cassette.

          ORA      #$08 ;set FSK output
          LDY      #LOTONE ;set FSK tone frequencies
          STY      AUDF2
          LDY      #HITONE
          STY      AUDF1

```

```
;      Set serial bus control.

ESS1  STA    SSKCTL ;SKCTL shadow
      STA    SKCTL  ;???
      LDA    #$C7   ;mask off previous serial bus interrupt bits
      AND    POKMSK ;and with POKEY IRQ enable
      ORA    #$10   ;enable output data needed interrupt
      JMP    SSR     ;set for SEND, return
```

```
**      ESR - Enable SIO RECEIVE
*
*      ENTRY JSR    ESR
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin    1983-11-01
```

```
ESR    =      *      ;entry
      LDA    #$07   ;mask off previous serial bus control bits
      AND    SSKCTL ;and with ???
      ORA    #$10   ;set receive mode asynchronous
      STA    SSKCTL ;SKCTL shadow
      STA    SKCTL  ;???
      STA    SKRES  ;???
      LDA    #$C7   ;mask off previous serial bus interrupt bits
      AND    POKMSK ;and with POKEY IRQ enable
      ORA    #$20   ;enable RECEIVE interrupt
;      JMP    SSR     ;set for RECEIVE, return
```

```
**      SSR - Set for SEND or RECEIVE
*
*      ENTRY JSR    SSR
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin    1983-11-01
```

```
SSR    =      *      ;entry

;      Initialize.
```

```

STA   POKMSK ;update POKEY IRQ enable
STA   IRQEN  ;IRQ enable
LDA   #$28   ;clock ch. 3 with 1.79 MHz, ch. 4 with ch. 3
STA   AUDCTL ;set audio control

;      Set voice controls.

LDX   #6      ;offset to last voice control
LDA   #$A8    ;pure tone, half volume
LDY   SOUNDR  ;noisy I/O flag
BNE   SSR1    ;if noisy I/O desired

LDA   #$A0    ;pure tone, no volume
SSR1  STA   AUDC1,X      ;set tone and volume
      DEX
      DEX
      BPL   SSR1    ;if not done

;      Turn off certain voices.

LDA   #$A0    ;pure tone, no volume
STA   AUDC3   ;turn off sound on voice 3
LDY   DDEVIC  ;device bus ID
CPY   #CASET  ;cassette device ID
BEQ   SSR2    ;if cassette device

STA   AUDC1   ;turn off sound on voice 1
STA   AUDC2   ;turn off sound on voice 2

SSR2  RTS      ;return

```

```

**      DSR - Disable SEND and RECEIVE
*
*      ENTRY JSR   DSR
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      NOTES
*      Problem: NOP necessary?
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

DSR   =      *      ;entry

;      Disable serial bus interrupts.

NOP
LDA   #$C7    ;mask to clear serial bus interrupts
AND   POKMSK  ;and with POKEY IRQ enable
STA   POKMSK  ;update POKEY IRQ enable
STA   IRQEN   ;IRQ enable

;      Turn off audio volume.

```

```

        LDX    #6      ;offset to last voice control
        LDA    #$00    ;no volume

DSR1   STA    AUDC1,X   ;turn off voice
        DEX
        DEX
        BPL    DSR1    ;if not done

        RTS           ;return

```

```

**      GTO - Get Device Timeout
*
*      ENTRY JSR    GTO
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin    1983-11-01

```

```

GTO    =      *      ;entry
        LDA    DTIMLO ;device timeout
        ROR    A
        ROR    A
        TAY    ;rotated timeout
        AND    #$3F  ;lower 6 bits
        TAX    ;high timeout
        TYA    ;rotated timeout
        ROR    A
        AND    #$C0  ;upper 2 bits
        TAY    ;low timeout
        RTS       ;return

```

```

**      TSIH - Table of SIO Interrupt Handlers
*
*      NOTES
*      Problem: not used.

```

```

TSIH   DW      IRIR   ;serial input ready IRQ
        DW      ORIR   ;serial output ready IRQ
        DW      OCIR   ;serial output complete IRQ

```

```

**      SID - Send to Intelligent Device
*
*      ENTRY JSR      SID
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      NOTES
*          Problem: bytes wasted by outer delay loop???
*
*      MODS
*          Original Author Unknown   ??/??/??
*          1. Bring closer to Coding Standard (object unchanged).
*          R. K. Nordin      1983-11-01

```

```

SID      =      *      ;entry

;      Delay.

      LDX      #1
SID1     LDY      #255
SID2     DEY
      BNE      SID2      ;if inner loop not done

      DEX
      BNE      SID1      ;if outer loop not done

;      Send data frame.

      JSR      SEN      ;send

;      Set timer and wait.

      LDY      #low CTIM      ;frame acknowledge timeout
      LDX      #high CTIM
;      JMP      STW      ;set timer and wait, return

```

```

*      STW - Set Timer and Wait
*
*      ENTRY JSR      STW
*             ??
*
*      EXIT
*             ??
*
*      CHANGES
*             ??
*
*      CALLS
*             ??
*
*      MODS
*
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

STW  =      *      ;entry
      JSR      SSV      ;set SIO VBLANK parameters
      JSR      WCA      ;wait for completion or ACK
      TYA      ;wait termination status
      RTS      ;return

```

```

**      CBR - Compute Baud Rate
*
*      CBR computes value for POKEY frequency for the baud rate as
*      measured by an interval of the VCOUNT timer.
*
*      ENTRY JSR      CBR
*             ??
*
*      EXIT
*             ??
*
*      CHANGES
*             ??
*
*      CALLS
*             ??
*
*      MODS
*
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

CBR  =      *      ;entry
      STA      TIMER2      ;save final timer value
      STY      TIMER2+1
      JSR      AVV      ;adjust VCOUNT value
      STA      TIMER2      ;save adjusted timer 2 value
      LDA      TIMER1
      JSR      AVV      ;adjust VCOUNT value
      STA      TIMER1      ;save adjusted timer 1 value
      LDA      TIMER2
      SEC
      SBC      TIMER1
      STA      TEMP1      ;save difference
      LDA      TIMER2+1
      SEC
      SBC      TIMER1+1
      TAY      ;difference
      LDX      PALNTS

```

```

        LDA    #0
        SEC
        SBC    CONS1X,X      ;???

CBR1    CLC
        ADC    CONS1X,X      ;accumulate product
        DEY
        BPL    CBR1          ;if not done

        CLC
        ADC    TEMP1         ;add to get total VCOUNT difference
        TAY                     ;total VCOUNT difference
        LSR    A
        LSR    A
        LSR    A
        ASL    A              ;interval divided by 4
        SEC
        SBC    #22            ;adjust offset
        TAX                     ;offset
        TYA                     ;total VCOUNT difference
        AND    #7             ;extract lower 3 bits of interval
        TAY                     ;lower 3 bits of interval
        LDA    #-11

CBR2    CLC
        ADC    #11            ;accumulate interpolation constant
        DEY
        BPL    CBR2          ;if done

        LDY    #0             ;assume no addition correction
        SEC
        SBC    #7             ;adjust interpolation constant
        BPL    CBR3          ;if ???

        DEY                     ;indicate addition correction

CBR3    CLC
        ADC    TPFV,X         ;add constant to table value
        STA    CBAUDL         ;low POKEY frequency value
        TYA
        ADC    TPFV+1,X       ;high POKEY frequency value
        STA    CBAUDH         ;high POKEY frequency value
        RTS                    ;return

```

```

**      AVV - Adjust VCOUNT Value
*
*      ENTRY JSR    AVV
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

AVV    =    *      ;entry
        CMP    #$7C

```

```

    BMI    AVV1    ;if >= $7C ???

    SEC
    SBC    #$7C
    RTS                    ;return

AVV1    CLC
    LDX    PALNTS
    ADC    CONS2X,X
    RTS                    ;return

```

```

**      SBR - Set Initial Baud Rate
*
*      INITIAL BAUD RATE MEASUREMENT -- USED TO SET THE
*      BAUD RATE AT THE START OF A RECORD.
*
*      IT IS ASSUMED THAT THE FIRST TWO BYTES OF EVERY
*      RECORD ARE $AA.
*
*      ENTRY JSR    SBR
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      NOTES
*      Problem: bytes wasted by branch around branch (SBR3).
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin    1983-11-01

```

```

SBR      =      *      ;entry

SBR1    LDA    BRKKEY
    BNE    SBR2      ;if BREAK key not pressed
    JMP    PBK      ;process BREAK key, return

SBR2    SEI
    LDA    TIMFLG      ;timeout flag
    BNE    SBR3      ;if no timeout
    BEQ    SBR5      ;process timeout

SBR3    LDA    SKSTAT      ;???
    AND    #$10      ;extract start bit???
    BNE    SBR1      ;if start bit

    STA    SAVIO      ;save serial data in
    LDX    VCOUNT      ;vertical line counter
    LDY    RTCLOCK+2      ;low byte of VBLANK clock
    STX    TIMER1
    STY    TIMER1+1      ;save initial timer value
    LDX    #1
    STX    TEMP3      ;set mode flag???
    LDY    #10      ;10 bits

```

SBR4	LDA	BRKKEY	;???
	BEQ	PBK	;if BREAK key pressed, process, return
	LDA	TIMFLG	;timeout flag
	BNE	SBR6	;if no timeout
SBR5	CLI		
	JMP	IT0	;indicate timeout, return
SBR6	LDA	SKSTAT	;???
	AND	#\$10	;extract ???
	CMP	SAVIO	;previous serial data in
	BEQ	SBR4	;if data in not changed
	STA	SAVIO	;save serial data in
	DEY		;decrement bit counter
	BNE	SBR4	;if not done
	DEC	TEMP3	;decrement mode???
	BMI	SBR7	;if done with both modes
	LDA	VCOUNT	;???
	LDY	RTCLOCK+2	;???
	JSR	CBR	;compute baud rate
	LDY	#9	;9 bits
	BNE	SBR4	;set bit counter
SBR7	LDA	CBAUDL	
	STA	AUDF3	
	LDA	CBAUDH	
	STA	AUDF4	;set POKEY baud rate
	LDA	#0	
	STA	SKSTAT	
	LDA	SSKCTL	
	STA	SKSTAT	;???initialize POKEY serial port
	LDA	#\$55	;???
	STA	(BUFRLO),Y	;first byte of buffer
	INY		
	STA	(BUFRLO),Y	;second byte of buffer
	LDA	#\$AA	;checksum for two bytes of \$AA???
	STA	CHKSUM	;checksum
	CLC		
	LDA	BUFRLO	
	ADC	#2	;add 2
	STA	BUFRLO	;update low buffer pointer
	LDA	BUFRHI	
	ADC	#0	
	STA	BUFRHI	;update high buffer pointer
	CLI		
	RTS		;return

```

**      PBK - Process BREAK Key
*
*      ENTRY JSR      PBK
*           ??
*
*      EXIT
*           ??
*
*      CHANGES
*           ??
*
*      CALLS
*           ??
*
*      MODS
*
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

PBK      =      *           ;entry
          JSR      DSR      ;disable SEND and RECEIVE
          LDA      #MOTRST
          STA      PACTL    ;turn off motor
          LDA      #NCOMHI
          STA      PBCTL    ;raise NOT COMMAND line
          LDA      #BRKABT   ;BREAK abort error
          STA      STATUS   ;status
          LDX      STACKP   ;saved stack pointer
          TXS        ;restore stack pointer
          DEC      BRKKEY   ;indicate BREAK
          CLI
          JMP      CS0      ;complete SIO operation, return to caller of SIO

```

```

**      SSV - Set SIO VBLANK Parameters
*
*      ENTRY JSR      SSV
*           ??
*
*      EXIT
*           ??
*
*      CHANGES
*           ??
*
*      CALLS
*           ??
*
*      MODS
*
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

SSV      =      *           ;entry
          LDA      #low PTE  ;timer expiration routine address
          STA      CDTMA1
          LDA      #high PTE
          STA      CDTMA1+1
          LDA      #1        ;timer 1
          SEI
          JSR      SETVBV    ;set VBLANK parameters
          LDA      #1        ;no timeout indicator
          STA      TIMFLG    ;timeout flag
          CLI
          RTS                ;return

```

```

**      TPFV - Table of POKEY Frequency Values
*
*      TPFV translates VCOUNT interval timer measurements to POKEY
*      frequency register values.
*
*      Table entries are AUDF+7.
*
*      Frequency-out is Frequency-in divided by 2*(AUDF+M), where
*      Frequency-in = 1.78979 MHz and M = 7.
*
*       $AUDF+7 = (11.365167) * T\text{-out}$ , where T-out is the number of counts
*      (127 used cd solution???) of VCOUNT for one character
*      time (10 bit times).
*
*      Baud rate is ????.

```

```

;      DW      636      ;baud rate 1407, VCOUNT interval 56
;      DW      727      ;baud rate 1231, VCOUNT interval 64
;      DW      818      ;baud rate 1094, VCOUNT interval 72
;      DW      909      ;baud rate 985, VCOUNT interval 80

TPFV   DW      1000     ;baud rate 895, VCOUNT interval 88
        DW      1091     ;baud rate 820, VCOUNT interval 96
        DW      1182     ;baud rate 757, VCOUNT interval 104
        DW      1273     ;baud rate 703, VCOUNT interval 112
        DW      1364     ;baud rate 656, VCOUNT interval 120
        DW      1455     ;baud rate 615, VCOUNT interval 128
        DW      1546     ;baud rate 579, VCOUNT interval 136
        DW      1637     ;baud rate 547, VCOUNT interval 144
        DW      1728     ;baud rate 518, VCOUNT interval 152
        DW      1818     ;baud rate 492, VCOUNT interval 160
        DW      1909     ;baud rate 469, VCOUNT interval 168
        DW      2000     ;baud rate 447, VCOUNT interval 176

;      DW      2091     ;baud rate 428, VCOUNT interval 184
;      DW      2182     ;baud rate 410, VCOUNT interval 192
;      DW      2273     ;baud rate 394, VCOUNT interval 200
;      DW      2364     ;baud rate 379, VCOUNT interval 208
;      DW      2455     ;baud rate 365, VCOUNT interval 216
;      DW      2546     ;baud rate 352, VCOUNT interval 224
;      DW      2637     ;baud rate 339, VCOUNT interval 232
;      DW      2728     ;baud rate 328, VCOUNT interval 240
;      DW      2819     ;baud rate 318, VCOUNT interval 248

```

** NTSC/PAL Constant Tables

```

WIRGLX DB      low WIRGLN      ;NTSC low long write IRG
        DB      low WIRGLP     ;PAL low long write IRG

RIRGLX DB      low RIRGLN      ;NTSC low long read IRG
        DB      low RIRGLP     ;PAL low long read IRG

WSIRGX DB      low WSIRGN      ;NTSC low short write IRG
        DB      low WSIRGP     ;PAL low short write IRG

RSIRGX DB      low RSIRGN      ;NTSC low short read IRG
        DB      low RSIRGP     ;PAL low short read IRG

CONS1X DB      131             ;NTSC ???
        DB      156             ;PAL ???

CONS2X DB      7               ;NTSC ???
        DB      32              ;PAL ???

```

Keyboard, Editor and Screen Handler, Part 1

```
**      TSMA - Table of Screen Memory Allocation
*
*      Entry n is the number of $40-byte blocks to allocate for
*      graphics mode n.
*
*      NOTES
*      Problem: For readability, this, and other tables in
*      this area, could be moved closer to the other parts of
*      the Keyboard, Editor and Screen Handler (just before
*      the EF6B patch).
```

```
TSMA  DB    24    ;0
      DB    16    ;1
      DB    10    ;2
      DB    10    ;3
      DB    16    ;4
      DB    28    ;5
      DB    52    ;6
      DB   100    ;7
      DB   196    ;8
      DB   196    ;9
      DB   196   ;10
      DB   196   ;11
      DB    28   ;12
      DB    16   ;13
      DB   100   ;14
      DB   196   ;15
```

```
**      TDLE - Table of Display List Entry Counts
*
*      Each entry is 2 bytes.  The first byte is ??????
```

```
TDLE  DB   23,23 ;0
      DB   11,23 ;1
      DB   47,47 ;2
      DB   95,95 ;3
      DB   97,97 ;4
      DB   97,97 ;5
      DB   23,11 ;6
      DB  191,97 ;7
      DB   19,19 ;8
      DB    9,19 ;9
      DB   39,39 ;10
      DB   79,79 ;11
      DB   65,65 ;12
      DB   65,65 ;13
      DB   19,9  ;14
      DB  159,65 ;15
```

```
**      TAGM - Table of ANTIC Graphics Modes
*
*      Entry n is the ANTIC graphics mode corresponding to internal
*      graphics mode n.
```

```
TAGM  DB   $02    ;internal 0 - 40x2x8 characters
      DB   $06    ;internal 1 - 20x5x8 characters
      DB   $07    ;internal 2 - 20x5x16 characters
      DB   $08    ;internal 3 - 40x4x8 graphics
      DB   $09    ;internal 4 - 80x2x4 graphics
      DB   $0A    ;internal 5 - 80x4x4 graphics
```

DB	\$0B	;internal 6 - 160x2x2 graphics
DB	\$0D	;internal 7 - 160x4x2 graphics
DB	\$0F	;internal 8 - 320x2x1 graphics
DB	\$0F	;internal 9 - 320x2x1 GTIA "lum" mode
DB	\$0F	;internal 10 - 320x2x1 GTIA "color/lum" mode
DB	\$0F	;internal 11 - 320x2x1 GTIA "color" mode
DB	\$04	;internal 12 - 40x5x8 characters
DB	\$05	;internal 13 - 40x5x16 characters
DB	\$0C	;internal 14 - 160x2x1 graphics
DB	\$0E	;internal 15 - 160x4x1 graphics

```

**      TDLV - Table of Display List Vulnerability
*
*      Entry n is non-zero if the display list for mode n cannot
*      cross a page boundary.

```

TDLV	DB	0	;0
	DB	0	;1
	DB	0	;2
	DB	0	;3
	DB	0	;4
	DB	0	;5
	DB	0	;6
	DB	1	;7
	DB	1	;8
	DB	1	;9
	DB	1	;10
	DB	1	;11
	DB	0	;12
	DB	0	;13
	DB	1	;14
	DB	1	;15

```

**      TLSC - Table of Left Shift Counts
*
*      Entry n is the NUMBER OF LEFT SHIFTS NEEDED TO MULTIPLY
*      COLCRS BY # BYTES/ROW ((ROWCRS*5)/(2**TLSC)) for mode n.???

```

TLSC	DB	3	;0
	DB	2	;1
	DB	2	;2
	DB	1	;3
	DB	1	;4
	DB	2	;5
	DB	2	;6
	DB	3	;7
	DB	3	;8
	DB	3	;9
	DB	3	;10
	DB	3	;11
	DB	3	;12
	DB	3	;13
	DB	2	;14
	DB	3	;15

```

**      TMCC - Table of Mode Column Counts
*
*      Entry n is the low column count for mode n.

```

TMCC	DB	low 40	;0
	DB	low 20	;1
	DB	low 20	;2
	DB	low 40	;3

DB	low 80	;4
DB	low 80	;5
DB	low 160	;6
DB	low 160	;7
DB	low 320	;8
DB	low 80	;9
DB	low 80	;10
DB	low 80	;11
DB	low 40	;12
DB	low 40	;13
DB	low 160	;14
DB	low 160	;15

**	TMRC - Table of Mode Row Counts
*	
*	Entry n is the row count for mode n.

TMRC	DB	24	;0
	DB	24	;1
	DB	12	;2
	DB	24	;3
	DB	48	;4
	DB	48	;5
	DB	96	;6
	DB	96	;7
	DB	192	;8
	DB	192	;9
	DB	192	;10
	DB	192	;11
	DB	24	;12
	DB	12	;13
	DB	192	;14
	DB	192	;15

**	TRSC - Table of Right Shift Counts
*	
*	Entry n is ??? for mode n.
*	HOW MANY RIGHT SHIFTS FOR HCRSR FOR PARTIAL BYTE MODES

TRSC	DB	0	;0
	DB	0	;1
	DB	0	;2
	DB	2	;3
	DB	3	;4
	DB	2	;5
	DB	3	;6
	DB	2	;7
	DB	3	;8
	DB	1	;9
	DB	1	;10
	DB	1	;11
	DB	0	;12
	DB	0	;13
	DB	3	;14
	DB	2	;15

**	TDSM - Table of Display Masks
*	
*	NOTES
*	Includes TBTM - Table of Bit Masks.

TDSM	DB	\$FF	;1
	DB	\$F0	;2
	DB	\$0F	;3
	DB	\$C0	;4
	DB	\$30	;5
	DB	\$0C	;6
	DB	\$03	;7
TBTM	DB	\$80	;8 (0)
	DB	\$40	;9 (1)
	DB	\$20	;10 (2)
	DB	\$10	;11 (3)
	DB	\$08	;12 (4)
	DB	\$04	;13 (5)
	DB	\$02	;14 (6)
	DB	\$01	;15 (7)

Peripheral Handler Loading Facility, Part 5

```
**      PHE - Perform Peripheral Handler Entry
*
*      PHE attempts to enter a peripheral handler in the handler table.
*
*      ENTRY JSR    PHE
*              X = device code
*              A = high linkage table address
*              Y = low linkage table address
*
*      EXIT
*              Success:
*              C clear
*              Handler table entry made
*
*              Failure due to entry previously made:
*              C set
*              N clear
*              X = offset to second byte of duplicate entry
*              A, Y unchanged
*
*              Failure due to handler table full:
*              C set
*              N set
*
*      CHANGES
*              A X Y
*
*      CALLS
*              -none-
*
*      MODS
*              R. S. Scheiman    1982-04-??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01
```

```
PHE      =      *      ;entry
;      Initialize.
      PHA          ;save high linkage table address
      TYA
      PHA          ;save low linkage table address
;      Search for device code in handler table.
      TXA          ;device code
      LDX    #0      ;offset to first entry of table
PHE1     CMP    HATABS,X      ;device code from table
      BEQ    PHE3      ;if device code found
      INX
      INX
      INX
      CPX    #MAXDEV+1      ;offset+1 of last possible entry
      BMI    PHE1      ;if not done
;      Search for empty entry in handler table.
      LDX    #0      ;offset to first entry of table
      TAY          ;save device code
      LDA    #0
```

```

PHE2  CMP    HATABS,X      ;device code from table
      BEQ    PHE4          ;if empty entry found

      INX
      INX
      INX
      CPX    #MAXDEV+1     ;offset+1 of last possible entry
      BMI    PHE2          ;if not done

;      Return table full condition.

      PLA
      PLA                ;clean stack
      LDY    #$FF         ;indicate table full (set N)
      SEC
      RTS                ;indicate failure
                          ;return

;      Return device code found condition.

PHE3  PLA                ;saved Y
      TAY                ;restore Y
      PLA                ;restore A
      INX                ;indicate device code found (clear N)
      SEC                ;indicate failure
      RTS                ;return

;      Enter handler in table.

PHE4  TYA                ;device code
      STA    HATABS,X     ;enter device code
      PLA                ;saved low linkage table address
      STA    HATABS+1,X   ;low address
      PLA                ;saved high linkage table address
      STA    HATABS+2,X   ;high address

;      Return success condition.

      CLC                ;indicate success
      RTS                ;return

```

```

**      PH0 - Perform Peripheral Handler Poll at OPEN???
*
*      Subroutine to perform Type 4 Poll at OPEN time, and
*      "provisionally" open IOCB if peripheral answers.
*
*      Input parameters:
*      ICIDNO identifies calling IOCB;
*      From zero-page IOCB:
*          ICBALZ,ICBAHZ (buffer pointer)
*          ICDNOZ (device number from caller's filespec.);
*      From caller's buffer: device name (in filespec.).
*
*      Output parameters:
*      "No device" error returned if Poll not answered.
*      If poll is answered, the calling IOCB is "Provisionally"
*      opened (and successful status is returned)--
*          ICHIDZ set to mark provisional open
*          ICPTLZ,ICPTHZ points to PTL (special PUT-BYTE)
*          ICSPR in calling IOCB set to device name (from filespec)
*          ICSPR+1 in calling IOCB set to device serial load addr.
*
*      Modified:
*      Registers not saved.
*
*      Subroutines called:
*      PHP performs poll.

```

```

*
* ENTRY JSR PHO
*      ??
*
* EXIT
*      ??
*
* CHANGES
*      ??
*
* CALLS
*      ??
*
* MODS
*      R. S. Scheiman      1982-04-??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin       1983-11-01

```

```

PHO    =      *           ;entry
        LDY    #0         ;Call for Type 4 Poll with
        LDA    (ICBALZ),Y ;device name from user
        LDY    ICDNOZ     ;OPEN
        JSR    PHP        ;???
        BPL    PH01       ;if poll answered

        LDY    #NONDEV    ;Return "no device" error
        RTS          ;return

PH01   LDA    #$7F        ;"Provisionally" OPEN the IOCB...
        STA    ICHIDZ     ;(Mark "provisional")
        LDA    #low [PTL-1]
        STA    ICPTLZ     ;(Special put byte routine addr.)
        LDA    #high [PTL-1]
        STA    ICPTHZ
        LDA    DVSTAT+2    ;(Peripheral address for load)
        LDX    ICIDNO
        STA    ICSPR+1,X
        LDY    #0
        LDA    (ICBALZ),Y ;(Device name from user)
        STA    ICSPR,X
        LDY    #SUCCES    ;indicate success
        RTS          ;return

```

```

**      PTL - ???
*
*      Put byte entry for provisionally opened IOCB's.
*      This routine performs load, relocation, initialization,
*      and finishes OPEN, then calls handler's put byte entry.
*
*      Input parameters:
*      A      Byte to output;
*      X      IOCB index (IOCB number times 16);
*      Y      "Function not supported" error code $92.
*      AUX1 and AUX2 in zero-page IOCB are copied from the calling
*              IOCB prior to the call to PTL.
*
*      Output parameters:
*      Various errors may be returned if loading fails (either user
*      did not allow loading by setting HNDLOD flag, or there
*      was a loading error or calling error);
*      If no loading error, this routine returns nothing--anything
*      returned is returned by the loaded PUT-BYTE entry which
*      is called by this routine after the handler is loaded,
*      initialized, and opened.
*

```

```

*      Modified:
*      ICIDNO (a CIO variable);
*      all of the zero-page IOCB is copied from the calling IOCB;
*      normal CIO open-operation variables are affected;
*      after opening, the zero-page IOCB is copied to the calling IOCB;
*      Registers not saved if error return; if handler is loaded
*          and opened properly, the caller's A and X registers are
*          passed to the loaded handler's PUT-BYTE routine (and
*          Y is passed to that routine as $92)--then register state
*          on return is up to handler PUT-BYTE since it returns
*          directly to caller.
*
*      Subroutines called:
*      PHL (does loading, initializing and opening--calls CIO);
*      loaded handler's INIT, OPEN, and PUT-BYTE entries all called.
*      The PUT-BYTE entry returns directly to the PTL caller.
*
*      ENTRY JSR    PTL
*             ??
*
*      EXIT
*             ??
*
*      CHANGES
*             ??
*
*      CALLS
*             ??
*
*      MODS
*
*          R. S. Scheiman      1982-04-??
*          1. Bring closer to Coding Standard (object unchanged).
*          R. K. Nordin        1983-11-01

```

```

PTL      =      *      ;entry
          PHA      ;save byte to output
          TXA      ;IOCB index
          PHA      ;save IOCB index
          AND      #$0F ;IOCB index modulo 16
          BNE      PTL2 ;if IOCB not divisible by 16, error

          CPX      #MAXIOC
          BPL      PTL2 ;if IOCB index invalid

          LDA      HNDLOD ;???
          BNE      PTL3 ;if user wants loading

          LDY      #NONDEV ;indicate nonexistent device error

;      Return error.

PTL1     PLA      ;clean stack
          PLA
          CPY      #0 ;indicate failure (set N)
          RTS      ;return

PTL2     LDY      #BADIOC ;indicate bad IOCB number error
          BMI      PTL1 ;return error

;      Simulate beginning of CIO, since CIO bypassed.

PTL3     STX      ICIDNO ;IOCB index
          LDY      #0 ;offset to first byte of page zero IOCB

;      Copy IOCB to page zero IOCB.

```

```

PTL4  LDA    IOCB,X ;byte of IOCB
      STA    ZIOCB,Y      ;byte of page zero IOCB
      INX
      INY
      CPY    #12
      BMI    PTL4      ;if not done

      JSR    PHL      ;load and initialize peripheral handler
      BMI    PTL1      ;if error

      PLA
      TAX      ;Re-do the put byte call,
      PLA      ;this time calling real handler...
      TAY
      LDA    ICPTHZ
      PHA
      LDA    ICPTLZ      ;(Put byte entry address minus one)
      PHA
      TYA
      LDY    #FNCNOT
      RTS      ;invoke handler (address on stack)

```

\$EF6B Patch

FIX \$EF6B

<pre>** EF6B - \$EF6B Patch * * For compatibility with OS Revision B, initiate cassette READ.</pre>

JMP ICR ;initiate cassette READ, return

Keyboard, Editor and Screen Handler, Part 2

```
**      SIN - Initialize Screen
*
*      ENTRY JSR      SIN
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01
```

```
SIN      =      *              ;entry

      LDA      #$FF              ;clear code indicator
      STA      CH                ;key code

      LDA      RAMSIZ            ;size of RAM
      STA      RAMTOP            ;RAM size

      LDA      #$40              ;CAPS lock indicator
      STA      SHFLOK            ;shift/control lock flags

      LDA      #low TCKD          ;table of character key definitions
      STA      KEYDEF             ;key definition table address
      LDA      #high TCKD
      STA      KEYDEF+1

      LDA      #low TFKD          ;table of function key definitions
      STA      FKDEF              ;function key definition table address
      LDA      #high TFKD
      STA      FKDEF+1

      RTS                        ;return
```

```

**      SOP - Perform Screen OPEN
*
*      ENTRY JSR      SOP
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

SOP      =      *      ;entry
;      Check mode.

      LDA      ICAX2Z ;???
      AND      #$0F  ;???
      BNE      COC    ;if not mode 0, complete OPEN command, return
;      Process mode 0.
;      EOP      ;perform editor OPEN, return

```

```

**      EOP - Perform Editor OPEN
*
*      ENTRY JSR      EOP
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

EOP      =      *      ;entry
      LDA      ICAX1Z ;???
      AND      #$0F  ;???
      STA      ICAX1Z ;???
      LDA      #0     ;???
;      COC      ;complete OPEN command, return

```

```

**      COC - Complete OPEN Command
*
*      ENTRY JSR      COC
*              A = mode ???
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

COC      =      *      ;entry

;      Check mode.

      STA      DINDEX ;save mode
      CMP      #16
      BCC      COC1    ;if mode within range

;      Process invalid mode.

      LDA      #BADMOD      ;???
      JMP      COC17 ;???

;      Initialize for OPEN.

COC1     LDA      #high DCSORG ;high domestic character set origin
      STA      CHBAS      ;character set base
      LDA      #high ICSORG ;high international character set origin
      STA      CHSALT      ;alternate character set base
      LDA      #2
      STA      CHACT      ;???
      STA      SDMCTL      ;turn off DMA
      LDA      #SUCCES
      STA      DSTAT      ;clear status
      LDA      #$C0      ;enable IRQ???
      ORA      POKMSK      ;???
      STA      POKMSK      ;???
      STA      IRQEN      ;???

;      DLI???

      LDA      #$40      ;disable DLI
      STA      NMIEEN      ;???
      BIT      FINE      ;???
      BPL      COC2      ;if not fine scrolling (VBLANK only)

      LDA      #low FDL
      STA      VDSLST      ;??? DLI vector
      LDA      #high FDL
      STA      VDSLST+1
      LDA      #$C0

;      ???

COC2     STA      NMIEEN      ;???

```

```

;      Clear ???.

      LDA    #0
      STA    TINDEX      ;clear text index (must always be 0)
      STA    ADDRESS     ;???
      STA    SWPFLG      ;???
      STA    CRSINH      ;???

;      Set initial tab stops.

      LDY    #14          ;offset to last byte of bit map
      LDA    #$01         ;tab stop every 8 characters

COC3   STA    TABMAP,Y     ;set tab stop
      DEY
      BPL    COC3         ;if not done

;      Load initialize color register shadows.

      LDX    #4           ;offset to last color register shadow

COC4   LDA    TDSC,X       ;default screen color
      STA    COLOR0,X     ;set color register shadow
      DEX
      BPL    COC4         ;if not done

;      ???..

      LDY    RAMTOP       ;(high) RAM size
      DEY                ;decrement (high) RAM size
      STY    TXTMSC+1     ;high ???
      LDA    #low [$0000-160] ;low RAM size - 160
      STA    TXTMSC       ;low ???
      LDX    DINDEX       ;mode
      LDA    TAGM,X       ;convert to ANTIC code???
      STA    HOLD1        ;??? ANTIC code
      LDA    RAMTOP       ;(high) RAM size
      STA    ADDRESS+1    ;high ???

;      Allocate memory.

      LDY    TSMA,X       ;number of 40-byte blocks to allocate

COC5   LDA    #40         ;40 bytes
      JSR    DBS          ;perform double byte subtract
      DEY
      BNE    COC5         ;if not done

;      ????.

      LDA    GPRIOR       ;???
      AND    #$3F         ;clear GTIA modes
      STA    OPNTMP+1
      TAY

;      Determine mode.

      CPX    #8
      BCC    COC7         ;if mode < 8

      CPX    #15
      BEQ    COC6         ;if mode 15

      CPX    #12
      BCS    COC7         ;if mode >= 12

;      Process modes 9, 10 and 11.

```

```

TXA                ;mode
ROR    A
ROR    A
ROR    A
AND    #$C0        ;extract 2 low bits (in 2 high bits)
ORA    OPNTMP+1
TAY

;    Establish line boundary at X000.

COC6    LDA    #16        ;subtract 16 for page boundary
        JSR    DBS        ;perform double byte subtract

;    Check for mode 11.

        CPX    #11
        BNE    COC7        ;if mode 11

;    Set GTIA luminance.

        LDA    #6        ;GTIA luminance value
        STA    COLOR4    ;background color

;    ???

COC7    STY    GPRIOR        ;new priority
        LDA    ADDRESS    ;memory scan counter
        STA    SAVMSC        ;save memory scan counter
        LDA    ADDRESS+1
        STA    SAVMSC+1

;    Wait for VBLANK.

COC8    LDA    VCOUNT
        CMP    #$7A
        BNE    COC8        ;if VBLANK has not occurred

;    Put display list under RAM.

        JSR    DSD        ;perform double byte single decrement
        LDA    TDLV,X    ;display list vulnerability
        BEQ    COC9        ;if not vulnerable

        LDA    #$FF
        STA    ADDRESS
        DEC    ADDRESS+1    ;drop down 1 page

COC9    JSR    DDD        ;perform double byte double decrement
        LDA    ADDRESS    ;end of display list
        STA    SAVADR        ;save address
        LDA    ADDRESS+1
        STA    SAVADR+1

;    ???

        LDA    #$41        ;??? (ANTIC) wait for VBLANK and JSR
        JSR    SDI        ;store data indirect
        STX    OPNTMP
        LDA    #24        ;???
        STA    BOTSCR        ;???

;    Check for modes 9 ,10 and 11.

        LDA    DINDEX        ;mode
        CMP    #12
        BCS    COC10        ;if mode >= 12, mixed mode OK

```

```

    CMP    #9
    BCS    COC12        ;if mode >= 9, mixed mode not allowed

;    Check for mixed mode.

COC10 LDA    ICAX1Z        ;???
    AND    #MXDMOD
    BEQ    COC12        ;if not mixed mode

;    Process mixed mode.

    LDA    #4            ;???
    STA    BOTSCR        ;???
    LDX    #2            ;???
    LDA    FINE          ;???
    BEQ    COC11        ;if not fine scrolling

    JSR    SSE            ;set scrolling display list entry

COC11 LDA    #$02        ;???
    JSR    SDF            ;store data indirect for fine scrolling
    DEX
    BPL    COC11        ;if not done

;    Reload MSC for text.

    LDY    RAMTOP        ;(high) RAM size
    DEY                ;decrement (high) RAM size
    TYA
    JSR    SDI            ;store data indirect
    LDA    #low [$0000-160] ;low RAM size - 160
    JSR    SDI            ;store data indirect
    LDA    #$42          ;fine scrolling???
    JSR    SDF            ;store data indirect
    CLC
    LDA    #MXDMOD
    ADC    OPNTMP
    TAY
    LDX    TDLE,Y        ;???
    BNE    COC13        ;???

;    ???

COC12 LDY    OPNTMP
    LDX    TDLE,Y        ;number of display list entries
    LDA    DINDEX        ;mode
    BNE    COC13        ;if not mode 0

;    Check for fine scrolling.

    LDA    FINE          ;fine scrolling flag
    BEQ    COC13        ;if not fine scrolling

;    Process fine scrolling.

    JSR    SSE            ;set scrolling display list entry
    LDA    #$22
    STA    HOLD1        ;???

;    ???

COC13 LDA    HOLD1        ;???
    JSR    SDI            ;store data indirect
    DEX
    BNE    COC13        ;if ???

```

```

; Determine mode. MESSY 320x1 problem???

LDA    DINDEX        ;mode
CMP    #8
BCC    COC16          ;if mode < 8

CMP    #15
BEQ    COC14          ;if mode 15

CMP    #12
BCS    COC16          ;if mode >= 12

; Process modes 8, 9, 10, 11 and 15.

COC14  LDX    #93      ;remaining number of DLE's
LDA    RAMTOP        ;(high) RAM size
SEC
SBC    #high $1000    ;subtract 4K
JSR    SDI            ;store data indirect
LDA    #low $0000
JSR    SDI            ;store data indirect
LDA    HOLD1         ;ANTIC MSC code???
ORA    #$40
JSR    SDI            ;store data indirect

COC15  LDA    HOLD1    ;remaining DLE's ???
JSR    SDI            ;store data indirect
DEX
BNE    COC15          ;if DLE's remain

; Complete display list with LMS.

COC16  LDA    SAVMSC+1 ;high saved memory scan counter
JSR    SDI            ;store data indirect
LDA    SAVMSC         ;low saved memory scan counter
JSR    SDI            ;store data indirect
LDA    HOLD1         ;???
ORA    #$40
JSR    SDI            ;store data indirect
LDA    #$70          ;8 blank lines ???
JSR    SDI            ;store data indirect
LDA    #$70          ;8 blank lines ???
JSR    SDI            ;store data indirect
LDA    ADDRESS        ;display list address
STA    SDLSTL         ;save display list address
LDA    ADDRESS+1
STA    SDLSTL+1
LDA    #$70          ;8 blank lines
JSR    SDI            ;store data indirect
LDA    ADDRESS        ;display list address
STA    MEMTOP         ;update top of memory
LDA    ADDRESS+1
STA    MEMTOP+1
LDY    #1             ;offset to ???
LDA    SDLSTL         ;saved display list address
STA    (SAVADR),Y     ;???
INY
LDA    SDLSTL+1
STA    (SAVADR),Y

; Check status.

LDA    DSTAT          ;status
BPL    COC18          ;if no error

; Process error.

```

```

COC17 STA DERRF ;screen OPEN error flag
      JSR EOP ;perform editor OPEN
      LDA DERRF ;restore status
      LDY #0 ;no screen OPEN error indicator
      STY DERRF ;screen OPEN error flag
      TAY ;status
      RTS ;return

; Check clear inhibit.

COC18 LDA ICAX1Z ;???
      AND #$20 ;extract clear inhibit bit
      BNE COC19 ;if clear inhibited

; Clear screen.

      JSR CSC ;clear screen
      STA TXTROW ;set cursor at top row
      LDA LMARGN ;left margin
      STA TXTCOL ;set cursor at left margin

; Exit.

COC19 LDA #$22 ;??? turn on DMA control
      ORA SDMCTL ;???
      STA SDMCTL
      JMP SEC ;set exit conditions, return

```

```

** SGB - Perform Screen GET-BYTE
*
* ENTRY JSR SGB
* ??
*
* EXIT
* ??
*
* CHANGES
* ??
*
* CALLS
* ??
*
* MODS
* Original Author Unknown ??/??/??
* 1. Bring closer to Coding Standard (object unchanged).
* R. K. Nordin 1983-11-01

```

```

SGB = * ;entry
     JSR CCR ;check cursor range
     JSR GDC ;get data under cursor
     JSR CIA ;convert internal character to ATASCII
     JSR SZA ;set zero data and advance cursor
     JMP SST ;perform screen STATUS, return

```

```

**      GDC - Get Data under Cursor
*
*      ENTRY JSR      GDC
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

GDC      =      *      ;entry
          JSR      CCA      ;convert cursor row/column to address
          LDA      (ADDRESS),Y
          AND      DMASK

GDC1     LSR      SHFAMT ;shift data down to low bits
          BCS      GDC2   ;if done

          LSR      A
          BPL      GDC1   ;continue shifting

GDC2     STA      CHAR
          CMP      #0      ;retore flags
          RTS          ;return

```

```

**      SPB - Perform Screen PUT-BYTE
*
*      ENTRY JSR      SPB
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

SPB      =      STA      *      ;entry
          STA      ATACHR

;      JSR      ROD      ;restore old data under cursor???

          CMP      #CLS
          BNE      SPB1   ;if not clear screen

          JSR      CSC      ;clear screen
          JMP      SEC      ;set exit conditions, return

```

```

SPB1  JSR    CCR    ;check cursor range
;      CEL    ;check EOL, return

```

```

**      CEL - Check End of Line
*
*      ENTRY JSR    CEL
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin    1983-11-01

```

```

CEL      =      *      ;entry
        LDA    ATACHR
        CMP    #EOL
        BNE    CEL1    ;if not EOL

        JSR    RWS    ;return with scrolling
        JMP    SEC    ;set exit conditions, return

CEL1     JSR    PLO    ;plot point
        JSR    SEA    ;set EOL data and advance cursor
        JMP    SEC    ;set exit conditions, return

```

```

**      PLO - Plot Point
*
*      ENTRY JSR    PLO
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin    1983-11-01

```

```

PLO      =      *      ;entry

;      Wait for start/stop flag clear.

PLO0     LDA    SSFLAG    ;start/stop flag
        BNE    PLO0    ;if start/stop flag non-zero, loop

;      Save cursor row/column.

        LDX    #2      ;offset to last byte

```

```

PL01  LDA    ROWCRS,X    ;byte of cursor row/column
      STA    OLDROW,X    ;save byte of cursor row/column
      DEX
      BPL    PL01        ;if not done

;      Convert ATASCII character to internal.

      LDA    ATACHR      ;character
      TAY    ;character
      ROL    A
      ROL    A
      ROL    A
      ROL    A
      AND    #3
      TAX    ;index into TAIC
      TYA    ;character
      AND    #$9F        ;strip off column address
      ORA    TAIC,X      ;or in new column address
;      JMP    SPQ        ;???, return

```

```

**      SPQ - ???
*
*      ENTRY JSR    SPQ
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin    1983-11-01

```

```

SPQ    =    *            ;entry

;      Set CHAR.

      STA    CHAR        ;character

;      Convert cursor row/column to address.

      JSR    CCA        ;convert cursor row/column to address

;      Shift up to proper position.

      LDA    CHAR        ;character

SPQ1   LSR    SHFAMT      ;???
      BCS    SPQ2        ;if done

      ASL    A
      JMP    SPQ1        ;continue shifting

;      ???

SPQ2   AND    DMASK
      STA    TMPCHR      ;save shifted data
      LDA    DMASK      ;display mask
      EOR    #$FF        ;complement mdisplay mask

```

```

AND    (ADDRESS),Y    ;mask off old data
ORA    TMPCHR         ;or in new data
STA    (ADDRESS),Y    ;update data
RTS                               ;return

```

```

**      SEC - Set Exit Conditions
*
*      ENTRY JSR      SEC
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

SEC      =      *      ;entry
JSR      GDC      ;get data under cursor
STA      OLDCHR
LDX      DINDEX ;mode
BNE      SST      ;if graphics, no cursor

LDX      CRSINH ;cursor inhibit flag
BNE      SST      ;if cursor inhibited

EOR      #$80     ;TOGGLE MSB
JSR      SPQ      ;display
JMP      SST      ;???, return
;

```

```

**      SST - Perform Screen STATUS
*
*      ENTRY JSR      SST
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

SST      =      *      ;entry
LDY      DSTAT    ;status
JMP      SST1     ;continue

```

\$F223 Patch

FIX \$F223

<pre>** F223 - \$F223 Patch * * For compatibility with OS Revision B, perform power-up display.</pre>

```
PPD      =      *      ;entry
JMP     SES      ;select and execute self-test
```

Keyboard, Editor and Screen Handler, Part 3

```
;      Continue.

SST1  LDA    #SUCCES      ;indicate success
      STA    DSTAT      ;status
      LDA    ATACHR      ;data
;      RTS          ;return
```

```
**      ESP - Perform Editor SPECIAL
*
*      ESP does nothing.
*
*      ENTRY JSR    ESP
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin    1983-11-01
```

```
ESP    =      *      ;entry
      RTS          ;return
```

```
**      ECL - Perform Editor CLOSE
*
*      ENTRY JSR    ECL
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin    1983-11-01
```

```
ECL    =      *      ;entry
```

```
;      Check for fine scrolling.
```

```
      BIT    FINE      ;fine scrolling flag
      BPL    SST      ;if not fine scrolling, perform STATUS, return
```

```
;      Process fine scrolling.
```

```
      LDA    #$40
      STA    NMIE      ;disable DLI
```

```

LDA    #0            ;clear fine scrolling flag
STA    FINE
LDA    #low RIR      ;return from interrupt routine
STA    VDSLST        ;restore initial DLI vector value
LDA    #high RIR
STA    VDSLST+1
JMP    EOP          ;perform editor OPEN, return

```

```

**      EGB - Perform Editor GET-BYTE
*
*      ENTRY JSR      EGB
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

EGB    =    *        ;entry

;      Initialize.

JSR    SWA          ;???
JSR    CRE          ;check cursor range for editor
LDA     BUFCNT       ;buffer count
BNE    EGB4         ;if something in the buffer

;      Get line.

LDA     ROWCRS       ;cursor row
STA     BUFSTR       ;buffer start pointer
LDA     COLCRS       ;low cursor column
STA     BUFSTR+1     ;high buffer start pointer

EGB1   JSR    KGB      ;perform keyboard GET-BYTE
      STY     DSTAT   ;status
      LDA     ATACHR  ;ATASCII character
      CMP     #EOL
      BEQ    EGB3     ;if EOL

      JSR    PCH      ;process character
      JSR    SWA      ;??? (undo swap of PCH)
      LDA     LOGCOL  ;logical column
      CMP     #113   ;column near column 120
      BNE    EGB2     ;if not near column 120, no beep

      JSR    BEL      ;beep

EGB2   JMP    EGB1    ;process next character

;      Process EOL.

EGB3   JSR    ROD      ;restore old data under cursor
      JSR    CBC      ;compute buffer count
      LDA     BUFSTR   ;buffer start pointer
      STA     ROWCRS   ;cursor row

```

```

        LDA    BUFSTR+1    ;high buffer start pointer
        STA    COLCRS     ;low cursor column

;      Check buffer count.

EGB4    LDA    BUFCNT ;buffer count
        BEQ    EGB6      ;if buffer count zero

;      Decrement and check buffer count.

EGB5    DEC    BUFCNT ;decrement buffer count
        BEQ    EGB6      ;if buffer count zero

;      Check status.

        LDA    DSTAT ;status
        BMI    EGB5      ;if error, continue decrementing.

;      ???

        JSR    SGB      ;perform screen GET-BYTE
        STA    ATACHR ;ATASCII character
        JMP    SWA      ;swap ???, return

;      ???

EGB6    JSR    RWS      ;return with scrolling
        LDA    #EOL
        STA    ATACHR ;ATASCII character
        JSR    SEC      ;set exit conditions
        STY    DSTAT ;status
        JMP    SWA      ;???, return

```

```

**      IRA - Invoke Routine Pointed to by ADRESS
*
*      ENTRY JSR    IRA
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

IRA    =      *      ;entry
        JMP    (ADDRESS) ;execute, return

```

```

**      EPB - Perform Editor PUT-BYTE
*
*      ENTRY JSR      EPB
*            ??
*
*      EXIT
*            ??
*
*      CHANGES
*            ??
*
*      CALLS
*            ??
*
*      MODS
*
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

EPB      =      *      ;entry
          STA      ATACHR ;ATASCII character
          JSR      SWA      ;???
          JSR      CRE      ;check cursor range for editor
          LDA      #0
          STA      SUPERF ;clear super function flag
;          JMP      PCH      ;process character, return

```

```

**      PCH - Process Character
*
*      PCH displays the character or processes control characters and
*      super functions (shifted function keys).
*
*      ENTRY JSR      PCH
*            ??
*
*      EXIT
*            ??
*
*      CHANGES
*            ??
*
*      CALLS
*            ??
*
*      MODS
*
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

PCH      =      *      ;entry
          JSR      ROD      ;restore old data under cursor
          JSR      CCC      ;check for control character
          BEQ      PCH2     ;if control character

```

```

;      Display character.

```

```

PCH1     ASL      ESCFLG ;????? escape flag
          JSR      CEL      ;check EOL
          JMP      SWA      ;???, return

```

```

;      Process control character.

```

```

PCH2     LDA      DSPFLG ;display flag
          ORA      ESCFLG ;escape flag

```

```

    BNE    PCH1    ;if display or escape, display character
;    ???
    ASL    ESCFLG
    INX
;    Check for super function.
    LDA    SUPERF    ;???
    BEQ    PCH3    ;if not super function
;    Adjust for super function.
    TXA
    CLC
    ADC    #TSFR-TCCR-3
    TAX    ;adjusted offset
;    Process control character or super function.
PCH3  LDA    TCCR,X    ;low routine address
      STA    ADDRESS
      LDA    TCCR+1,X    ;high routine address
      STA    ADDRESS+1
      JSR    IRA    ;invoke routine pointed to by ADDRESS
      JSR    SEC    ;set exit conditions
      JMP    SWA    ;???, return

```

```

**      IGN - Ignore Character and Perform Keyboard GET-BYTE
*
*      ENTRY  JSR    IGN
*              ??
*
*      EXIT
*              CH = $FF
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              KGB
*
*      MODS
*              Original Author Unknown    ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin    1983-11-01

```

```

IGN    =    *    ;entry
      LDA    #$FF    ;clear code indicator
      STA    CH    ;key code
;      JMP    KGB    ;perform keyboard GET-BYTE, return

```

```

**      KGB - Perform Keyboard GET-BYTE
*
*      ENTRY JSR      KGB
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      NOTES
*      Problem: byte wasted by unnecessary TAX near KGB3.
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

KGB      =      *      ;entry

;      Initialize.

KGB1     LDA      #0
          STA      SUPERF ;clear super function flag

;      Check for special edit read mode???

          LDA      ICAX1Z ;???
          LSR      A
          BCS      KGB11 ;if special edit read mode

;      Check for BREAK abort.

          LDA      #BRKABT      ;assume BREAK abort
          LDX      BRKKEY ;BREAK key flag
          BEQ      KGB10 ;if BREAK abort, ???

;      Check for character.

          LDA      CH      ;key code
          CMP      #$FF    ;clear code indicator
          BEQ      KGB1    ;if no character

;      Process character.

          STA      HOLDCH ;save character
          LDX      #$FF    ;clear code indicator
          STX      CH      ;key code

;      Sound key click if desired.

          LDX      NOCLIK ;click inhibit flag
          BNE      KGB2    ;if click inhibited

          JSR      SKC      ;sound key click

;      Set offset to key definition.

KGB2     TAY      ;save character

;      Check for CTRL and SHIFT together.

```

```

    CPY    #$C0
    BCS    IGN    ;if CTRL and SHIFT together, ignore
;        Convert to ATASCII character.

    LDA    (KEYDEF),Y    ;ATASCII character
;        Set ATASCII character.

KGB3     STA    ATACHR ;ATASCII character
        TAX
        BMI    KGB4    ;if special key
        JMP    KGB17   ;process shift/control lock
;        Check for null character.

KGB4     CMP    #$80
        BEQ    IGN    ;if null, ignore
;        Check for inverse video key.

        CMP    #$81
        BNE    KGB5    ;if not inverse video key
;        Process inverse video key.

        LDA    INVFLG
        EOR    #$80
        STA    INVFLG
        BCS    IGN    ;ignore
;        Check for CAPS key.

KGB5     CMP    #$82
        BNE    KGB6    ;if not CAPS key
;        Process CAPS key.

        LDA    SHFLOK ;shift/control lock flags
        BEQ    KGB7    ;if no lock, process CAPS lock???

        LDA    #$00    ;no lock indicator
        STA    SHFLOK ;shift/control lock flags
        BEQ    IGN    ;ignore
;        Check for SHIFT-CAPS key.

KGB6     CMP    #$83
        BNE    KGB8    ;if not SHIFT-CAPS
;        Process SHIFT-CAPS key.

KGB7     LDA    #$40    ;CAPS lock indicator
        STA    SHFLOK ;shift/control lock flags
        BNE    IGN    ;ignore
;        Check for CTRL-CAPS key.

KGB8     CMP    #$84
        BNE    KGB9    ;if not CTRL-CAPS
;        Process CTRL-CAPS key.

        LDA    #$80    ;control lock indicator
        STA    SHFLOK ;shift/control lock flags

```

```

        JMP     IGN      ;ignore
;       Check for ??? key.
KGB9   CMP     #$85
        BNE     KGB12    ;if not ??? key.
;       Process ??? key.
        LDA     #EOFERR
;       Set status and BREAK key flag.
KGB10  STA     DSTAT    ;status
        STA     BRKKEY   ;BREAK key flag
;       Set EOL character.
KGB11  LDA     #EOL
        JMP     KGB19    ;set ATASCII character
;       Check for CTRL-F3 ??? key.
KGB12  CMP     #$89
        BNE     KGB14    ;if not CTRL-F3 ??? key
;       Process CTRL-F3 ??? key.
        LDA     NOCLIK  ;toggle keyclick status
        EOR     #$FF
        STA     NOCLIK
        BNE     KGB13    ;if click inhibited
        JSR     SKC      ;sound key click
KGB13  JMP     IGN      ;ignore
;       Check for function key.
KGB14  CMP     #$8E
        BCS     KGB16    ;if code >= $8E, not a function key ???
        CMP     #$8A
        BCC     KGB13    ;if code < $8A, not a function key, ignore ???
;       Process function key.
        SBC     #$8A      ;convert $8A - $8D TO 0 - 3
        ASL     HOLDCH   ;saved character
        BPL     KGB15    ;if no SHIFT
        ORA     #$04      ;convert 0 - 3 to 4 - 7
KGB15  TAY
        LDA     (FKDEF),Y ;offset to function key definition
        JMP     KGB3      ;function key
                           ;set ATASCII character
;       Check for super function.
KGB16  CMP     #$92
        BCS     KGB17    ;if code >= $92, process shift/control lock
        CMP     #$8E
        BCC     KGB13    ;if code < $8E, not super function, ignore
;       Process super function.

```

```

SBC    #$8E-$1C    ;convert $8E - $91 TO $1C - $1F
INC     SUPERF      ;set super function flag
BNE     KGB19       ;set ATASCII character

;      Process shift/control lock.

KGB17  LDA    HOLDCH ;saved character
CMP     #$40
BCS     KGB18       ;if not lower case

LDA     ATACHR ;ATASCII character
CMP     #'a'
BCC     KGB18       ;if < "a", do not process

CMP     #'z'+1
BCS     KGB18       ;if > "z", do not process

LDA     SHFLOK ;shift/control lock flags
BEQ     KGB18       ;if no lock

ORA     HOLDCH ;modify character
JMP     KGB2        ;reprocess character

;      Invert character, if necessary.

KGB18  JSR     CCC    ;check for control character
BEQ     KGB20       ;if control character, do not invert

LDA     ATACHR ;ATASCII character
EOR     INVFLG ;invert character

;      Set ATASCII character.

KGB19  STA     ATACHR ;ATASCII character

;      Exit.

KGB20  JMP     SST    ;perform screen status, return

```

```

**      ESC - Escape
*
*      ENTRY JSR     ESC
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin    1983-11-01

```

```

ESC    =      *      ;entry
LDA     #$80    ;indicate escape detected
STA     ESCFLG  ;escape flag
RTS     ;return

```

```

**      CUP - Move Cursor Up
*
*      ENTRY JSR      CUP
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

CUP      =      *      ;entry
DEC      ROWCRS ;decrement cursor row
BPL      CUP2   ;if row positive

LDX      BOTSCR ;screen bottom
DEX                      ;screen bottom - 1

CUP1     STX      ROWCRS ;update cursor row

CUP2     JMP      SBS      ;set buffer start and logical column, return

```

```

**      CDN - Move Cursor Down
*
*      ENTRY JSR      CDN
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

CDN      =      *      ;entry
INC      ROWCRS ;increment cursor row
LDA      ROWCRS ;cursor row
CMP      BOTSCR ;screen bottom
BCC      CUP2   ;if at bottom, set buffer start, return

LDX      #0
BEQ      CUP1   ;update cursor row, return

```

```

**      CLF - Move Cursor Left
*
*      ENTRY JSR      CLF
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

CLF      =      *      ;entry
DEC      COLCRS ;decrement low cursor column
LDA      COLCRS ;low cursor column
BMI      CRM    ;if ???, move cursor to right margin, return

CMP      LMARGN ;left margin
BCS      SCC1   ;if at left margin, set logical column, return

;      JMP      CRM    ;move cursor to right margin, return

```

```

**      CRM - Move Cursor to Right Margin
*
*      ENTRY JSR      CRM
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

CRM      =      *      ;entry
LDA      RMARGN ;right margin
;      JMP      SCC    ;set cursor column, return

```

```

**      SCC - Set Cursor Column
*
*      ENTRY JSR      SCC
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

SCC      =      *      ;entry
          STA      COLCRS ;set low cursor column

```

```

SCC1     JMP      SLC      ;set logical column, return

```

```

**      CRT - Move Cursor Right
*
*      ENTRY JSR      CRT
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

CRT      =      *      ;entry
          INC      COLCRS ;increment low cursor column
          LDA      COLCRS ;low cursor column
          CMP      RMARGN ;right margin
          BCC      SCC1   ;if before right margin, process, return

          BEQ      SCC1   ;if at right margin

;      JMP      CLM      ;move cursor to left margin, return

```

```

**      CLM - Move Cursor to Left Margin
*
*      ENTRY JSR      CLM
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

CLM      =      *      ;entry
          LDA      LMARGN ;left margin
          JMP      SCC      ;set cursor column, return

```

```

**      CSC - Clear Screen
*
*      ENTRY JSR      CSC
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

CSC      =      *      ;entry
;      Set memory scan counter address.
          JSR      SMS      ;set memory scan counter address
;      Clear ???.
          LDY      ADRESS      ;low ???
          LDA      #0
          STA      ADRESS      ;clear low ???
CSC1     STA      (ADRESS),Y    ;clear ???
          INY
          BNE      CSC1      ;if not done with page
          INC      ADRESS+1    ;increment high ???
          LDX      ADRESS+1
          CPX      RAMTOP      ;(high) RAM size
          BCC      CSC1      ;if not done
;      Clean up logical line bit map.

```

```

;     LDY     #0           ;offset to first byte of bit map
;     LDA     #$FF
CSC2  STA     LOGMAP,Y      ;byte of logical line bit map
;     INY
;     CPY     #4           ;4 bytes
;     BCC     CSC2         ;if not done
;
;     Exit.
;
;     JMP     CHM          ;move cursor home, return

```

```

**      CHM - Move Cursor Home
*
*      ENTRY JSR      CHM
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

CHM    =      *           ;entry
;     JSR     SCL          ;set cursor at left edge
;     STA     LOGCOL       ;logical column
;     STA     BUFSTR+1     ;high buffer start
;     LDA     #0
;     STA     ROWCRS       ;cursor row
;     STA     COLCRS+1     ;high cursor column
;     STA     BUFSTR       ;low buffer start pointer
;     RTS

```

```

**      BSP - Backspace
*
*      ENTRY JSR    BSP
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

BSP      =      *      ;entry
          LDA      LOGCOL ;logical column
          CMP      LMARGN ;left margin
          BEQ      BSP3   ;if at left margin

          LDA      COLCRS ;low cursor column
          CMP      LMARGN ;left margin
          BNE      BSP1   ;if not at left margin

          JSR      DWQ    ;see if line should be deleted???

BSP1     JSR      CLF     ;move cursor left
          LDA      COLCRS ;low cursor column
          CMP      RMARGN ;right margin
          BNE      BSP2   ;if not at right margin

          LDA      ROWCRS ;cursor row
          BEQ      BSP2   ;if row zero

          JSR      CUP    ;move cursor up

BSP2     LDA      #' '
          STA      ATACHR ;ATASCII character
          JSR      PLO    ;plot point

BSP3     JMP      SLC     ;set logical column, return

```

```

**      TAB - Tab
*
*      ENTRY JSR    TAB
*             ??
*
*      EXIT
*             ??
*
*      CHANGES
*             ??
*
*      CALLS
*             ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

TAB      =      *      ;entry

TAB1  JSR      CRT      ;move cursor right
      LDA      COLCRS ;low cursor column
      CMP      LMARGN ;left margin
      BNE      TAB2      ;if not at left margin

      JSR      RET      ;return
      JSR      BLG      ;get bit from logical line bit map
      BCS      TAB3      ;if end of logical line

;      Check for tab stop.

TAB2  LDA      LOGCOL ;logical column
      JSR      BMG      ;get bit from bit map
      BCC      TAB1      ;if not tab stop, keep looking

;      ???

TAB3  JMP      SLC      ;set logical column, return

```

```

**      STB - Set Tab
*
*      ENTRY JSR    STB
*             ??
*
*      EXIT
*             ??
*
*      CHANGES
*             ??
*
*      CALLS
*             ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

STB      =      *      ;entry
      LDA      LOGCOL ;logical column
      JMP      BMS      ;set bit in bit map, return

```

```

**      CTB - Clear Tab
*
*      ENTRY JSR      CTB
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

CTB      =      *      ;entry
          LDA     LOGCOL ;logical column
          JMP     BMC     ;clear bit in bit map, return

```

```

**      ICH - Insert Character
*
*      ENTRY JSR      ICH
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

ICH      =      *      ;entry
          JSR     SRC      ;save row and column
          JSR     GDC      ;get data under cursor
          STA     INSDAT ;???
          LDA     #0
          STA     SCRFLG

ICH1     JSR     SPQ      ;???store data
          LDA     LOGCOL  ;logical column
          PHA     ;save logical column
          JSR     ACC      ;advance cursor column
          PLA     ;saved logical column
          CMP     LOGCOL  ;logical column
          BCS     ICH2    ;if saved logical column >= logical column, exit

          LDA     INSDAT ;???
          PHA
          JSR     GDC      ;get data under cursor
          STA     INSDAT ;???
          PLA
          JMP     ICH1    ;???

```

```

;      Exit.

ICH2  JSR    RRC      ;restore row and column

ICH3  DEC    SCRFLG
      BMI    ICH4      ;if scroll occurred

      DEC    ROWCRS ;decrement cursor row
      BNE    ICH3      ;continue ???

ICH4  JMP    SLC      ;set logical column, return

```

```

**      DCH - Delete Character
*
*      ENTRY JSR    DCH
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

DCH    =      *              ;entry

;      Save row and column.

      JSR    SRC              ;save row and column

;      Get data to the right of cursor.

DCH1  JSR    CCA      ;convert cursor row/column to address
      LDA    ADDRESS
      STA    SAVADR ;save address
      LDA    ADDRESS+1
      STA    SAVADR+1
      LDA    LOGCOL ;logical column
      PHA              ;save logical column
      JSR    SZA      ;set zero data and advance cursor
      PLA              ;saved logical column
      CMP    LOGCOL ;logical column
      BCS    DCH2      ;if saved logical column >= logical column, exit

      LDA    ROWCRS      ;cursor row
      CMP    BOTSCR      ;screen bottom
      BCS    DCH2      ;if row off screen, exit

      JSR    GDC          ;get data under cursor
      LDY    #0
      STA    (SAVADR),Y   ;put data in previous position
      BEQ    DCH1          ;continue

DCH2  LDY    #0
      TYA
      STA    (SAVADR),Y   ;clear last position
      JSR    DQQ          ;try to delete a line
      JSR    RRC          ;restore row and column

```

```
JMP    SLC            ;set logical column, return
```

```

**      ILN - Insert Line
*
*      ENTRY JSR      ILN
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

ILN      =      *      ;entry
          SEC          ;NORMAL ILN PUTS "1" INTO BIT MAP
; JMP      ILN1      ;???, return

```

```

**      ILN1 - ???
*
*      ENTRY JSR      ILN1
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

ILN1     =      *      ;entry
JSR     ELL          ;extend logical line
LDA     LMARGN       ;left margin
STA     COLCRS       ;low cursor column
JSR     CCA          ;convert cursor row/column to address
JSR     MLN          ;move line
JSR     CLN          ;clear current line
JMP     SLC          ;set logical column, return

```

```

**      DLN - Delete Line
*
*      ENTRY JSR      DLN
*           ??
*
*      EXIT
*           ??
*
*      CHANGES
*           ??
*
*      CALLS
*           ??
*
*      MODS
*
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

DLN      =      *      ;entry
          JSR      SLC      ;set logical column
          LDY      HOLD1    ;???
          STY      ROWCRS   ;cursor row
;          JMP      DLN1     ;???, return

```

```

**      DLN1 - ???
*
*      ENTRY JSR      DLN1
*           ??
*
*      EXIT
*           ??
*
*      CHANGES
*           ??
*
*      CALLS
*           ??
*
*      MODS
*
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

DLN1      =      *      ;entry
DLN0      LDY      ROWCRS   ;cursor row
DLN2      TYA
          SEC
          JSR      BLG2      ;get next bit
          PHP      ;???
          TYA
          CLC
          ADC      #8*[LOGMAP-TABMAP] ;add offset for logical line
          PLP      ;???
          JSR      BMP      ;put bit in bit map
          INY
          CPY      #24
          BNE      DLN2      ;??? if not done

          LDA      LOGMAP+2
          ORA      #1        ;set least significant bit
          STA      LOGMAP+2   ;update logical line bit map

```

```

LDA    #0            ;delete line of data
STA    COLCRS        ;low cursor column
JSR    CCA            ;convert cursor row/column to address
JSR    SSD            ;scroll screen for delete

;    Check for new logical line.

JSR    BLG            ;get bit from logical line bit map
BCC    DLN0           ;if not new logical line

;    ???

JMP    CLM            ;move cursor to left margin, return

```

```

**    BEL - Sound Bell
*
*    ENTRY JSR    BEL
*           ??
*
*    EXIT
*           ??
*
*    CHANGES
*           ??
*
*    CALLS
*           ??
*
*    MODS
*           Original Author Unknown    ??/??/??
*           1. Bring closer to Coding Standard (object unchanged).
*           R. K. Nordin    1983-11-01

```

```

BEL    =    *        ;entry
        LDY    #$20

BEL1   JSR    SKC    ;sound key click
        DEY
        BPL    BEL1  ;if not done

        RTS         ;return

```

```

**    CBT - Move Cursor to Bottom
*
*    ENTRY JSR    CBT
*           ??
*
*    EXIT
*           ??
*
*    CHANGES
*           ??
*
*    CALLS
*           ??
*
*    MODS
*           Original Author Unknown    ??/??/??
*           1. Bring closer to Coding Standard (object unchanged).
*           R. K. Nordin    1983-11-01

```

```

CBT    =    *        ;entry
        JSR    CHM    ;move cursor home
        JMP    CUP    ;move cursor up, return

```

```

**      DDD - Perform Double Byte Double Decrement
*
*      ENTRY JSR      DDD
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown    ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

DDD      =      *      ;entry
          LDA      #2      ;indicate subtracting 2
          BNE      DBS      ;perform double byte subtract, return

```

```

**      SDF - Store Data Indirect for Fine Scrolling
*
*      ENTRY JSR      SDF
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown    ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

SDF      =      *      ;entry
          LDY      FINE      ;???
          BEQ      SDI      ;if not fine scrolling
          ORA      #$20      ;enable vertical scroll
          STY      SDI      ;store data indirect, return
;

```

```

**      SDI - Store Data Indirect
*
*      ENTRY JSR      SDI
*            ??
*
*      EXIT
*            ??
*
*      CHANGES
*            ??
*
*      CALLS
*            ??
*
*      MODS
*            Original Author Unknown   ??/??/??
*            1. Bring closer to Coding Standard (object unchanged).
*            R. K. Nordin      1983-11-01

```

```

SDI      =      *      ;entry
;      Check current status.

      LDY      DSTAT ;status
      BMI      DBS3 ;if error, return

;      Store data.

      LDY      #0
      STA      (ADRESS),Y

;      Decrement ????.

;      DSD      ;perform double byte single decrement, return

```

```

**      DSD - Perform Double Byte Single Decrement
*
*      ENTRY JSR      DSD
*            ??
*
*      EXIT
*            ??
*
*      CHANGES
*            ??
*
*      CALLS
*            ??
*
*      MODS
*            Original Author Unknown   ??/??/??
*            1. Bring closer to Coding Standard (object unchanged).
*            R. K. Nordin      1983-11-01

```

```

DSD      =      *      ;entry
      LDA      #1      ;indicate subtracting 1
;      DSD      DBS      ;perform double byte subtract, return

```

```

**      DBS - Perform Double Byte Subtract
*
*      ENTRY JSR      DBS
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

DBS      =      *      ;entry

;      Initialize.

      STA      SUBTMP

;      Check current status.

      LDA      DSTAT      ;status
      BMI      DBS3      ;if error

;      Subtract.

      LDA      ADRESS
      SEC
      SBC      SUBTMP
      STA      ADRESS
      BCS      DBS1      ;if no borrow
      DEC      ADRESS+1      ;adjust high byte

;      Check for overwriting APPMHI.
DBS1     LDA      APPMHI+1
      CMP      ADRESS+1
      BCC      DBS3      ;if not overwriting APPMHI
      BNE      DBS2      ;if overwriting APPMHI, error

      LDA      APPMHI
      CMP      ADRESS
      BCC      DBS3      ;if not overwriting APPMHI

;      Process error.

DBS2     LDA      #SCRMEM      ;indicate insufficient memory for screen
      STA      DSTAT      ;status

;      Exit.

DBS3     RTS      ;return

```

```

**      SSE - Set Scrolling Display List Entry
*
*      Store EXTRA LINE IN DISPLAY LIST FOR FINE SCROLLING MODES.
*
*      ENTRY JSR      SSE
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

SSE      =      *      ;entry
          LDA      #$02
          JSR      SDI      ;store data indirect
          LDA      #$A2      ;DLI on last visible line
          JSR      SDI      ;store data indirect
          DEX
          RTS          ;return

```

```

**      CCA - Convert Cursor Row/Column to Address
*
*      ENTRY JSR      CCA
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

CCA      =      *      ;entry
          LDX      #1
          STX      MLTTP      ;initialize ???
          DEX
          STX      ADRESS+1      ;clear high address
          LDA      ROWCRS      ;cursor row position
          ASL      A          ;2 times row position
          ROL      ADRESS+1
          ASL      A          ;4 time row position
          ROL      ADRESS+1
          ADC      ROWCRS      ;add to get 5 times row position
          STA      ADRESS
          BCC      CCA1      ;if ???
          INC      ADRESS+1

```

CCA1	LDY LDX	DINDEX TLSC,Y	;mode ;left shift count
CCA2	ASL ROL DEX BNE	ADRESS ADRESS+1 CCA2	;ADRESS = ADRESS*X ;divide ;if ???
	LDA LSR LDA LDX BEQ	COLCRS+1 A COLCRS TRSC,Y CCA4	;high cursor column ;save least significant bit ;low cursor column ;right shift count ;if no shift
CCA3	ROR ASL DEX BNE	A MLTTMP CCA3	;roll in carry ;shift index ;if ???
CCA4	ADC BCC	ADRESS CCA5	;add address??? ;if no carry
	INC	ADRESS+1	;adjust high address???
CCA5	CLC ADC STA STA LDA ADC STA STA	SAVMSC ADRESS OLDADR ADRESS+1 SAVMSC+1 ADRESS+1 OLDADR+1	;add saved memory scan counter ;update address??? ;save address
	LDX LDA AND ADC TAY LDA STA STA LDY	TRSC,Y TMSK,X COLCRS MLTTMP TDSM-1,Y DMASK SHFAMT #0	;??? ;??? ;and in low cursor column ;add ??? ;display mask ;display mask ;???
CCA6	RTS		;return

```

**      SZA - Set Zero Data and Advance Cursor Column
*
*      INCREMENT CURSOR AND DETECT BOTH END OF LINE AND END OF SCREEN
*
*      ENTRY JSR      SZA
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

SZA      =      *      ;entry
          LDA      #0
          BEQ      SDA      ;set data and advance cursor

```

```

**      SEA - Set EOL Data and Advance Cursor Column
*
*      ENTRY JSR      SEA
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

SEA      =      *      ;entry
          LDA      #EOL      ;special case eliminator???
          BEQ      SDA      ;set data and advance cursor, return

```

```

**      SDA - Set Data and Advance Cursor Column
*
*      ENTRY JSR      SDA
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

SDA      =      *      ;entry
          STA      INSDAT ;set data
          ;      ACC      ;advance cursor column, return

```

```

**      ACC - Advance Cursor Column
*
*      ENTRY JSR      ACC
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

ACC      =      *      ;entry
          INC      LOGCOL      ;increment logical column
          INC      COLCRS      ;increment low cursor column
          BNE      ACC1        ;if no carry

          INC      COLCRS+1    ;adjust high cursor column

ACC1     LDA      COLCRS      ;low cursor column
          LDX      DINDEX      ;mode
          CMP      TMCC,X      ;???
          BEQ      ACC2        ;if equal, process EOL

          CPX      #0
          BNE      CCA6        ;if not mode 0, exit

          CMP      RMARGN      ;right margin
          BEQ      CCA6        ;if at right margin, exit

          BCC      CCA6        ;if before right margin, exit

ACC2     CPX      #8
          BNE      ACC3        ;if not mode 8

```

```

        LDA    COLCRS+1    ;high cursor column
        BEQ    CCA6        ;if ONLY AT 64 SO DON'T DO IT???

ACC3    LDA    DINDEXT     ;mode
        BNE    RET        ;if mode 0, exit

        LDA    LOGCOL     ;logical column
        CMP    #81        ;???
        BCC    ACC4       ;if < 81, definitely not line 3

        LDA    INSDAT     ;???
        BEQ    RET        ;if non-zero, do not do log line???

        JSR    RWS        ;return with scrolling
        JMP    RET5       ;return

ACC4    JSR    RET        ;return
        LDA    ROWCRS     ;cursor row
        CLC
        ADC    #8*[LOGMAP-TABMAP] ;add offset for logical line
        JSR    BMG        ;get bit from bit map
        BCC    ACC5       ;if ???don't extend

        LDA    INSDAT     ;???
        BEQ    ACC5       ;if zero, do not extend???

        CLC
        JSR    ILN1       ;indicate ???
                          ;???

ACC5    JMP    SLC        ;set logical column, return

```

```

**      RWS - Return with Scrolling
*
*      ENTRY JSR    RWS
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin    1983-11-01

```

```

RWS    =      *      ;entry
        LDA    #EOL   ;select scrolling
        STA    INSDAT ;???
;        JMP    RET    ;return, return

```

```

**      RET - Return
*
*      ENTRY JSR      RET
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

RET      =      *      ;entry
          JSR      SCL      ;set cursor at left edge
          LDA      #0
          STA      COLCRS+1      ;high cursor column
          INC      ROWCRS      ;increment cursor row
          LDY      DINDEX
          LDY      #24      ;assume 24 lines
          BIT      SWPFLG
          BPL      RET1      ;if normal

          LDY      #4      ;substitute 4 lines
          TYA
          BNE      RET2      ;???

RET1     LDA      TMRC,X ;mode row count

RET2     CMP      ROWCRS ;cursor row
          BNE      RET5      ;if ???

          STY      HOLD3
          TXA      ;mode
          BNE      RET5      ;if mode not 0, do not scroll

          LDA      INSDAT ;???
          BEQ      RET5      ;if zero, do not scroll

;      If EOL, roll in a 0.

          CMP      #EOL      ;to extend bottom logical line ???
          BEQ      RET3      ;if EOL

          CLC

RET3     JSR      SCR      ;???
          INC      SCRFLG ;???
          DEC      BUFSTR ;???
          BPL      RET4      ;if ???

          INC      BUFSTR

RET4     DEC      HOLD3
          LDA      LOGMAP
          SEC      ;indicate ??? for partial line
          BPL      RET3      ;if partial logical line

          LDA      HOLD3 ;???

```

```

STA    ROWCRS ;cursor row

RET5   JMP     SLC      ;set logical column, return

```

```

**      SEP - ???
*
*      SUBTRACT ENDPT FROM ROWAC OR COLAC. (X=0 OR 2)
*
*      ENTRY JSR     SEP
*              X = ???
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

SEP    =      *      ;entry
SEC
LDA     ROWAC,X      ;low value from which to subtract
SBC     ENDPT
STA     ROWAC,X      ;new low value
LDA     ROWAC+1,X    ;high value from which to subtract
SBC     ENDPT+1
STA     ROWAC+1,X    ;new high value
RTS

```

```

**      CRE - Check Cursor Range for Editor
*
*      ENTRY JSR     CRE
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

CRE    =      *      ;entry

;      Check for mixed mode.

LDA     BOTSCR
CMP     #4      ;mixed mode indicator
BEQ     CCR     ;if mixed mode, check cursor range, return

;      Check for mode 0.

```

```

    LDA    DINDEX ;mode
    BEQ    CCR     ;if mode 0, check cursor range

;      Open editor.

    JSR    EOP     ;perform editor OPEN
    JMP    CCR     ;check cursor range, return

```

```

**      CCR - Check Cursor Range
*
*      ENTRY JSR    CCR
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin    1983-11-01

```

```

CCR      =      *              ;entry
          LDA    #39
          CMP    RMARGN        ;right margin
          BCS    CCR1          ;if 39 >= right margin

          STA    RMARGN        ;set right margin

CCR1     LDX    DINDEX
          LDA    TMRC,X        ;mode row count
          CMP    ROWCRS        ;cursor row
          BCC    CCR5          ;if count > row position, error

          BEQ    CCR5          ;if count = row position, error

          CPX    #8
          BNE    CCR2          ;if not mode 8

          LDA    COLCRS+1      ;high cursor column
          BEQ    CCR4          ;if high cursor column zero

          CMP    #1
          BNE    CCR5          ;if >1, bad

          BEQ    CCR3          ;if 1, check low

CCR2     LDA    COLCRS+1      ;high cursor column
          BNE    CCR5          ;if high cursor column non-zero, error

CCR3     LDA    TMCC,X        ;mode column count
          CMP    COLCRS        ;low cursor column
          BCC    CCR5          ;if count > column position, error

          BEQ    CCR5          ;if count = column position, error

CCR4     LDA    #SUCCES        ;success indicator
          STA    DSTAT         ;indicate success
          LDA    #BRKABT        ;assume BREAK abort

```

```

        LDX  BRKKEY      ;BREAK key status
        STA  BRKKEY      ;clear BREAK key status
        BEQ  CCR6        ;if BREAK

        RTS              ;return

;      Process range error.

CCR5    JSR    CHM        ;move cursor home
        LDA    #CRSROR    ;indicate cursor overrange

;      Exit.

CCR6    STA    DSTAT      ;status
        PLA                ;clean stack for return to CIO
        PLA
        LDA    SWPFLG
        BPL   CCR7        ;if not swapped

        JMP    SWA        ;swap ???, return

CCR7    JMP    SST        ;return (to CIO)

```

```

**      ROD - Restore Old Data under Cursor
*
*      ENTRY JSR    ROD
*          ??
*
*      EXIT
*          ??
*
*      CHANGES
*          ??
*
*      CALLS
*          ??
*
*      MODS
*          Original Author Unknown   ??/??/??
*          1. Bring closer to Coding Standard (object unchanged).
*          R. K. Nordin      1983-11-01

```

```

ROD      =      *          ;entry
        LDY    #0
        LDA    OLDADR+1
        BEQ    ROD1        ;if page zero

        LDA    OLDCHR      ;old data
        STA    (OLDADR),Y

ROD1     RTS              ;return

```

```

**      BMI - Initialize for Bit Map Operation
*
*      BMI sets the bit mask in BITMSK and byte offset in X.
*
*      ENTRY JSR      BMI
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

BMI      =      *      ;entry
PHA      ;save logical column
AND      #7      ;logical column modulo 8
TAX      ;offset to bit mask
LDA      TBTM,X ;bit mask
STA      BITMSK ;set bit mask
PLA      ;logical column
LSR      A
LSR      A
LSR      A      ;logical column divided by 8
TAX      ;offset
RTS      ;return

```

```

**      BLR - Rotate Logical Line Bit Map Left
*
*      BLR rotates the logical line bit map left, scrolling the
*      logical lines up.
*
*      ENTRY JSR      BLR
*              C = ???
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

BLR      =      *      ;entry
ROL      LOGMAP+2
ROL      LOGMAP+1
ROL      LOGMAP
RTS      ;return

```

```

**      BMP - Put Bit in Bit Map
*
*      PUT CARRY INTO BITMAP
*
*      ENTRY JSR      BMP
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

BMP      =      *      ;entry
          BCC      BMC      ;if C clear, clear bit in bit map, return
;          TMB      BMS      ;set bit in bit map, return

```

```

**      BMS - Set Bit in Bit Map
*
*      ENTRY JSR      BMS
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

BMS      =      *      ;entry
          JSR      BMI      ;initialize for bit mask operation
          LDA      TABMAP,X
          ORA      BITMSK      ;set bit
          STA      TABMAP,X      ;update bit map
          RTS      ;return

```

```

**      BMC - Clear Bit in Bit Map
*
*      ENTRY JSR      BMC
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

BMC      =      *      ;entry
          JSR      BMI      ;initialize for bit mask operation
          LDA      BITMSK
          EOR      #$FF
          AND      TABMAP,X      ;clear bit
          STA      TABMAP,X      ;update bit map
          RTS      ;return

```

```

**      BLG - Get Bit from Logical Line Bit Map
*
*      ENTRY JSR      BLG
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

BLG      =      *      ;entry
          LDA      ROWCRS      ;cursor row
          ;      BLG1      ;???, return

```

```

**      BLG1 - ???
*
*      ENTRY JSR      BLG1
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

BLG1    =      *      ;entry
        CLC
;        JMP      BLG2 ;???, return

```

```

**      BLG2 - ???
*
*      ENTRY JSR      BLG2
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

BLG2    =      *      ;entry
        ADC      #8*[LOGMAP-TABMAP] ;add offset for logical line
;        JMP      BMG      ;get bit from bit map, return

```

```

**      BMG - Get Bit from Bit Map
*
*      ENTRY JSR      BMG
*            ??
*
*      EXIT
*            C = ???
*            ??
*
*      CHANGES
*            ??
*
*      CALLS
*            ??
*
*      MODS
*            Original Author Unknown   ??/??/??
*            1. Bring closer to Coding Standard (object unchanged).
*            R. K. Nordin      1983-11-01

```

```

BMG      =      *      ;entry
          JSR      BMT      ;initialize for bit mask operation
          CLC
          LDA      TABMAP,X
          AND      BITMSK
          BEQ      BMG1      ;if ???

          SEC

BMG1     RTS          ;return

```

```

**      CIA - Convert Internal Character to ATASCII
*
*      ENTRY JSR      CIA
*            ??
*
*      EXIT
*            ??
*
*      CHANGES
*            ??
*
*      CALLS
*            ??
*
*      MODS
*            Original Author Unknown   ??/??/??
*            1. Bring closer to Coding Standard (object unchanged).
*            R. K. Nordin      1983-11-01

```

```

CIA      =      *      ;entry

;      Initialize.

          LDA      CHAR

;      Check mode.

          LDY      DINDEX ;mode
          CPY      #14
          BCS      CIA2      ;if mode >= 14

          CPY      #12
          BCS      CIA1      ;if mode 12 or 13

```

```

        CPY    #3
        BCS    CIA2    ;if mode >= 3

;      Convert internal character to ATASCII.

CIA1    ROL    A
        ROL    A
        ROL    A
        ROL    A
        AND    #3
        TAX
        LDA    CHAR    ;character
        AND    #$9F    ;strip off column address
        ORA    TIAC,X  ;or in new column address

;      Exit.

CIA2    STA    ATACHR ;ATASCII character

CIA3    RTS          ;return

```

```

**      MLN - Move Line
*
*      ENTRY JSR    MLN
*      ??
*
*      EXIT
*      ??
*
*      CHANGES
*      ??
*
*      CALLS
*      ??
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin    1983-11-01

```

```

MLN    =    *          ;entry

;      Initialize.

        LDX    RAMTOP    ;(high) RAM size
        DEX          ;decrement (high) RAM size
        STX    FRMADR+1  ;high source address
        STX    TOADR+1   ;high destination address
        LDA    #low [$0000-80]    ;low RAM size - 80
        STA    FRMADR    ;low source address
        LDA    #low [$0000-40]    ;low RAM size - 40
        STA    TOADR     ;low destination address

        LDX    ROWCRS    ;cursor row

;      Check for completion.

MLN1    INX
        CPX    BOTSCR    ;screen bottom
        BEQ    CIA3      ;if done, return

;      Move line.

        LDY    #39        ;offset to last byte

```

```

MLN2  LDA    (FRMADR),Y    ;byte of source
      STA    (TOADR),Y    ;byte of destination
      DEY
      BPL    MLN2          ;if not done

;      Adjust source and destination addresses.

      SEC
      LDA    FRMADR        ;source address
      STA    TOADR        ;update destination address
      SBC    #low 40       ;subtract 40
      STA    FRMADR        ;update source address
      LDA    FRMADR+1
      STA    TOADR+1
      SBC    #high 40
      STA    FRMADR+1

;      Continue.

      JMP    MLN1          ;continue

```

```

**      ELL - Extend Logical Line
*
*      ENTRY JSR    ELL
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin    1983-11-01

```

```

ELL    =      *      ;entry
      PHP      ;save bit
      LDY      #22    ;???

ELL1   TYA      ;???
      JSR      BLG1   ;???
      PHP      ;???
      TYA      ;???
      CLC
      ADC      #8*[LOGMAP-TABMAP]+1    ;add offset for logical line
      PLP      ;???
      JSR      BMP     ;put bit in bit map
      DEY
      BMI      ELL2    ;if ???

      CPY      ROWCRS ;cursor row
      BCS      ELL1    ;if ???

ELL2   LDA      ROWCRS ;cursor row
      CLC
      ADC      #8*[LOGMAP-TABMAP] ;add offset for logical line
      PLP      ;???
      JMP      BMP     ;put bit in bit map, return

```

```

**      CLN - Clear Line
*
*      ENTRY JSR      CLN
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

CLN      =      *      ;entry
          LDA      LMARGN ;left margin
          STA      COLCRS ;low cursor column
          JSR      CCA      ;convert cursor row/column to address
          SEC
          LDA      RMARGN ;right margin
          SBC      LMARGN ;subtract left margin
          TAY      ;screen width
          LDA      #0

CLN1     STA      (ADRESS),Y
          DEY
          BPL      CLN1      ;if not done
          RTS                ;return

```

```

**      SCR - ???
*
*      ENTRY JSR      SCR
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

SCR      =      *      ;entry
          JSR      BLR      ;rotate logical line bit map left
          LDA      FINE
          BEQ      SCR5      ;if not fine scrolling

SCR1     LDA      VSFLAG ;vertical scroll count
          BNE      SCR1      ;if prior scroll not yet done

          LDA      #8
          STA      VSFLAG ;vertical scroll count

```

```

;      Wait for scroll to complete.

SCR2   LDA    VSFLAG ;vertical scroll count
      CMP    #1      ;??? START OF LAST SDAN
      BNE    SCR2    ;if not done waiting for ???

SCR3   LDA    VCOUNT ;???
      CMP    #$40
      BCS    SCR3    ;if not done waiting for safe place ???

      LDX    #$0D    ;???
      LDA    BOTSCR
      CMP    #4
      BNE    SCR4    ;if not split screen

      LDX    #$70    ;???

SCR4   CPX    VCOUNT
      BCS    SCR4    ;if not done waiting for ???

;      ???

SCR5   JSR    SMS     ;set memory scan counter address
;      JMP    SSD     ;scroll screen for delete, return

```

```

**      SSD - Scroll Screen for Delete
*
*      ENTRY JSR    SSD
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin    1983-11-01

```

```

SSD    =      *              ;entry

;      Initialize.

      LDA    ADRESS          ;address
      LDX    ADRESS+1

;      Calculate number of bytes to move.

SSD1   INX
      CPX    RAMTOP
      BEQ    SSD2            ;if at RAMTOP

      SEC
      SBC    #$10
      JMP    SSD1            ;continue

SSD2   ADC    #39             ;(CLC and ADC #40)
      BNE    SSD3            ;if byte count non-zero

```

```

        LDX    ADDRESS+1
        INX
        CPX    RAMTOP
        BEQ    SSD6            ;if at RAMTOP

        CLC
        ADC    #$10

;    Adjust address.

SSD3    TAY            ;number of bytes
        STA    COUNTR    ;???
        SEC
        LDA    ADDRESS
        SBC    COUNTR    ;subtract ???
        STA    ADDRESS    ;update low address
        BCS    SSD4      ;if no borrow

        DEC    ADDRESS+1    ;adjust high address

;    Move data down.

SSD4    LDA    ADDRESS
        CLC
        ADC    #40
        STA    COUNTR    ;address + 40
        LDA    ADDRESS+1
        ADC    #0
        STA    COUNTR+1

SSD5    LDA    (COUNTR),Y    ;byte to move
        STA    (ADDRESS),Y    ;move byte
        INY
        BNE    SSD5        ;if not done (256-16 times)

        LDY    #256-240
        LDA    ADDRESS
        CMP    #-40
        BEQ    SSD6        ;if all done

        CLC
        ADC    #240
        STA    ADDRESS    ;update low address
        BCC    SSD4        ;if no carry

        INC    ADDRESS+1    ;adjust high address
        BNE    SSD4        ;continue

;    Clear last line.

SSD6    LDX    RAMTOP
        DEX
        STX    COUNTR+1
        LDX    #-40
        STX    COUNTR
        LDA    #0
        LDY    #39

SSD7    STA    (COUNTR),Y    ;clear byte of last line
        DEY
        BPL    SSD7        ;if not done

;    JMP    SLC            ;set logical column, return

```

```

**      SLC - Set Logical Column
*
*      ENTRY JSR      SLC
*           ??
*
*      EXIT
*           HOLD1 = ???
*           ??
*
*      CHANGES
*           ??
*
*      CALLS
*           ??
*
*      MODS
*           Original Author Unknown    ??/??/??
*           1. Bring closer to Coding Standard (object unchanged).
*           R. K. Nordin      1983-11-01

```

```

SLC      =      *      ;entry

;      Initialize.

      LDA      #0
      STA      LOGCOL ;initialize logical column
      LDA      ROWCRS ;cursor row
      STA      HOLD1 ;working row

;      Search for beginning of line.

SLC1     LDA      HOLD1 ;add in row component
      JSR      BLG1      ;???
      BCS      SLC2      ;if beginning of line found

      LDA      LOGCOL ;logical column
      CLC
      ADC      #40      ;add number of characters per line
      STA      LOGCOL ;update logical column
      DEC      HOLD1 ;decrement working row
      JMP      SLC1      ;continue

;      Add in cursor column.

SLC2     CLC
      LDA      LOGCOL ;logical column
      ADC      COLCRS ;add low cursor column
      STA      LOGCOL ;update logical column
      RTS                      ;return

```

```
**      CBC - Compute Buffer Count
*
*      CBC computes the buffer count as the number of bytes from the
*      buffer start to the end of the logical line (with trailing
*      spaces removed).
*
*      ENTRY JSR      CBC
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01
```

```
CBC      =      *      ;entry

;      Initialize.

JSR      SRC          ;save row and column
LDA      LOGCOL       ;logical column
PHA      ;save logical column
LDA      BUFSTR       ;start of buffer
STA      ROWCRS       ;cursor row
LDA      BUFSTR+1
STA      COLCRS       ;low cursor column
LDA      #1
STA      BUFCNT       ;initialize buffer count

;      Determine last line on screen.

CBC1     LDX      #23      ;normal last line on screen
LDA      SWPFLG       ;???
BPL      CBC2         ;if not swapped

LDX      #3           ;??? last line on screen

;      Check for cursor on last line of screen.

CBC2     CPX      ROWCRS ;cursor row
BNE      CBC3         ;if cursor on last line

LDA      COLCRS ;low cursor column
CMP      RMARGN ;right margin
BNE      CBC3         ;if not at right margin

INC      BUFCNT ;fake SEA to avoid scrolling???
JMP      CBC4         ;???

CBC3     JSR      SZA      ;set zero data and advance cursor
INC      BUFCNT
LDA      LOGCOL ;logical column
CMP      LMARGN ;left margin
BNE      CBC1         ;if not yet at left margin

DEC      ROWCRS ;decrement cursor row
JSR      CLF      ;move cursor left
```

```

CBC4  JSR    GDC    ;get data under cursor
      BNE    CBC6   ;if non-zero, quit

      DEC    BUFCNT ;DECREMENT COUNTER
      LDA    LOGCOL ;logical column
      CMP    LMARGN ;left margin
      BEQ    CBC6   ;if beginning of logical line, exit

      JSR    CLF    ;move cursor left
      LDA    COLCRS ;low cursor column
      CMP    RMARGN ;right margin
      BNE    CBC5   ;if cursor column not right margin

      DEC    ROWCRS ;decrement cursor row

CBC5  LDA    BUFCNT
      BNE    CBC4   ;if BUFCNT non-zero, continue????

CBC6  PLA                      ;saved logical column
      STA    LOGCOL ;restore logical column
      JMP    RRC    ;restore row and column, return

```

```

**      SBS - Set Buffer Start and Logical Column
*
*      ENTRY JSR    SBS
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

SBS    =      *           ;entry
      JSR    SLC          ;set logical column
      LDA    HOLD1        ;???
      STA    BUFSTR       ;???
      LDA    LMARGN       ;left margin
      STA    BUFSTR+1     ;???

SBS1   RTS              ;return

```

```

**      DQQ - ???
*
*      DQQ DELETES A LINE IF IT IS EMPTY AND AN EXTENSION
*
*      ENTRY JSR      DQQ
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

DQQ      =      *      ;entry
          LDA      LOGCOL ;logical column
          CMP      LMARGN ;left margin
          BNE      DQQ1   ;if not at left margin

          DEC      ROWCRS ;decrement cursor row

DQQ1     JSR      SLC      ;set logical column
          ;      DWQ      ;???, return

```

```

**      DWQ - ???
*
*      ENTRY JSR      DWQ
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

DWQ      =      *      ;entry
;      Check for left margin.

          LDA      LOGCOL ;logical column
          CMP      LMARGN ;left margin
          BEQ      SBS1   ;if at left margin, return

;      ???

          JSR      CCA      ;convert cursor row/column to address
          LDA      RMARGN ;right margin
          SEC
          SBC      LMARGN ;subtract left margin

```

```

        TAY          ;offset to last byte
;      ???
DWQ1   LDA    (ADDRESS),Y
        BNE     SBS1   ;if ???, return

        DEY
        BPL     DWQ1   ;if not done
;      Delete line.

        JMP     DLN1   ;delete line, return

```

```

**      CCC - Check for Control Character
*
*      ENTRY JSR     CCC
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

CCC     =      *      ;entry

        LDX     #TCCRL-3      ;offset to last entry

CCC1    LDA     TCCR,X         ;control character
        CMP     ATACHR        ;ATASCII character
        BEQ     CCC2         ;if character found, exit

        DEX
        DEX
        DEX
        BPL     CCC1         ;if not done, continue search

CCC2    RTS                  ;return

```

```

**      SRC - Save Row and Column
*
*      ENTRY JSR      SRC
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

SRC      =      *      ;entry
          LDX      #2      ;offset to last byte

SRC1     LDA      ROWCRS,X      ;byte of cursor row/column
          STA      TMPROW,X      ;save byte of cursor row/column
          DEX
          BPL      SRC1      ;if not done
          RTS      ;return

```

```

**      RRC - Restore Row and Column
*
*      ENTRY JSR      RRC
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

RRC      =      *      ;entry
          LDX      #2      ;offset to last byte

RRC1     LDA      TMPROW,X      ;byte of saved cursor row/column
          STA      ROWCRS,X      ;byte of cursor row/column
          DEX
          BPL      RRC1      ;if not done
          RTS      ;return

```

```

**      SWA - ???
*
*      IF MIXED MODE, swap ?????? CURSORS WITH REGULAR CURSORS
*
*      ENTRY JSR      SWA
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

SWA      =      *              ;entry

;      Check for split screen.

      LDA      BOTSCR          ;screen bottom
      CMP      #24             ;normal indicator
      BEQ      SWA2            ;if not split screen

;      Swap ??? parameters.

      LDX      #11             ;offset to last byte

SWA1     LDA      ROWCRS,X      ;??? parameter
      PHA                      ;save ??? parameter
      LDA      TXTRW,X         ;??? parameter
      STA      ROWCRS,X        ;update ???
      PLA                      ;saved ???
      STA      TXTRW,X         ;update ???
      DEX
      BPL      SWA1            ;if not done

;      Complement swap flag.

      LDA      SWPFLG          ;swap flag
      EOR      #$FF           ;complement swap flag
      STA      SWPFLG          ;update swap flag

;      Exit.

SWA2     JMP      SST          ;perform screen STATUS, return

```

```

**      SKC - Sound Key Click
*
*      ENTRY JSR      SKC
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

SKC      =      *      ;entry
;      Initialize.

      LDX      #2*63 ;2 times trip count
      PHA              ;save A

;      Turn loudspeaker on.
SKC1     STX      CONSOL ;turn loudspeaker on
;      Wait for VBLANK (loudspeaker off).

      LDA      VCOUNT ;vertical line counter
SKC2     CMP      VCOUNT ;current vertical line counter
      BEQ      SKC2 ;if vertical line not changed

;      Decrement and check trip count.

      DEX
      DEX
      BPL      SKC1 ;if not done

;      Exit.

      PLA              ;restore A
      RTS              ;return

```

```

**      SCL - Set Cursor at Left Edge
*
*      ENTRY JSR      SCL
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

SCL      =      *      ;entry

          LDA      #0      ;assume 0

          LDX      SWPFLG ;swap flag
          BNE      SCL1    ;if ???

          LDX      DINDEX ;mode
          BNE      SCL2    ;if not mode 0

SCL1     LDA      LMARGN ;use left margin instead of 0

SCL2     STA      COLCRS ;set low cursor column
          RTS

```

```

**      SMS - Set Memory Scan Counter Address
*
*      ENTRY JSR      SMS
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

SMS      =      *      ;entry
          LDA      SAVMSC ;saved low memory scan counter
          STA      ADRESS ;set low address
          LDA      SAVMSC+1 ;saved high memory scan counter
          STA      ADRESS+1 ;set high address
          RTS            ;return

```

```

**      SSP - Perform Screen SPECIAL
*
*      SSP draws a line from OLDROW/OLDCOL to NEWROW/NEWCOL.
*
*      ENTRY JSR      SSP
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

SSP      =      *      ;entry

;      Determine command.

      LDX      #0      ;assume no fill
      LDA      ICCOMZ   ;command
      CMP      #$11     ;DRAW command
      BEQ      SSP2     ;if DRAW command

      CMP      #$12     ;FILL command
      BEQ      SSP1     ;if FILL command

      LDY      #NVALID  ;invalid command error
      RTS                     ;return

SSP1     INX                     ;indicate fill

SSP2     STX      FILFLG      ;right fill flag

;      Set destination row/column.

      LDA      ROWCRS      ;cursor row
      STA      NEWROW
      LDA      COLCRS      ;cursor column
      STA      NEWCOL
      LDA      COLCRS+1
      STA      NEWCOL+1

;      Compute row increment and difference.

      LDA      #1      ;assume increment +1
      STA      ROWINC   ;row increment
      STA      COLINC   ;column increment
      SEC
      LDA      NEWROW   ;destination row
      SBC      OLDROW   ;subtract source row
      STA      DELTAR   ;row difference
      BCS      SSP3     ;if difference positive

;      Set row increment to -1 and complement row difference.

      LDA      #$FF     ;increment -1
      STA      ROWINC   ;update row increment
      LDA      DELTAR   ;row difference

```

```

EOR    #$FF
CLC
ADC     #1          ;add 1 for 2's complement
STA     DELTAR      ;update row difference

;      Compute column increment and difference.

SSP3   SEC
      LDA     NEWCOL      ;destination column
      SBC     OLDCOL      ;source column
      STA     DELTAC      ;column difference
      LDA     NEWCOL+1
      SBC     OLDCOL+1
      STA     DELTAC+1
      BCS     SSP4        ;if difference positive

;      Set column increment to -1 and complement column difference.

      LDA     #$FF        ;increment -1
      STA     COLINC      ;update column increment
      LDA     DELTAC      ;column difference
      EOR     #$FF        ;absolute value of column difference
      STA     DELTAC      ;update column difference
      LDA     DELTAC+1
      EOR     #$FF
      STA     DELTAC+1
      INC     DELTAC      ;add 1 for 2's complement
      BNE     SSP4        ;if no carry

      INC     DELTAC+1    ;adjust for 2's complement

;      Set up working row/column and cursor row/column.

SSP4   LDX     #2          ;offset to last byte
      LDY     #0
      STY     COLAC+1      ;zero high working column

SSP5   TYA
      STA     ROWAC,X      ;zero byte of working row/column
      LDA     OLDROW,X     ;byte of source row/column
      STA     ROWCRS,X     ;byte of cursor row/column
      DEX
      BPL     SSP5        ;if not done

;      Determine ???.

      LDA     DELTAC      ;low column difference
      INX
      TAY
      LDA     DELTAC+1    ;high column difference
      STA     COUNTR+1    ;initialize high iteration counter
      STA     ENDPT+1     ;initialize high end point
      BNE     SSP6        ;if high column difference > 0

      LDA     DELTAC      ;low column difference
      CMP     DELTAR      ;row difference
      BCS     SSP6        ;if column difference > row difference

      LDA     DELTAR      ;row difference
      LDX     #2          ;offset to working column
      TAY
      ;row difference

SSP6   TYA
      STA     COUNTR      ;low iteration counter
      STA     ENDPT       ;low end point
      PHA
      LDA     ENDPT+1     ;high end point

```

```

    LSR    A            ;C = LSB of high end point
    PLA            ;saved low end point
    ROR     A            ;???
    STA     ROWAC,X      ;low working row or column

;    Check for iteration counter zero.

SSP7  LDA     COUNTR      ;low iteration counter
      ORA     COUNTR+1    ;or in high iteration counter
      BNE     SSP8        ;if iteration counter is not zero

      JMP     SSP19       ;exit

;    ???

SSP8  CLC
      LDA     ROWAC        ;working row
      ADC     DELTAR       ;row difference
      STA     ROWAC        ;update working row
      BCC     SSP9         ;if no carry

      INC     ROWAC+1      ;adjust high working row

SSP9  LDA     ROWAC+1      ;high working row
      CMP     ENDPT+1      ;high end point
      BCC     SSP11        ;if high working row < high end point

      BNE     SSP10        ;if high working row > high end point

      LDA     ROWAC        ;low working row
      CMP     ENDPT        ;low end point
      BCC     SSP11        ;if low working row < low end point

SSP10 CLC
      LDA     ROWCRS       ;cursor row
      ADC     ROWINC       ;add row increment
      STA     ROWCRS       ;update cursor row
      LDX     #0           ;indicate subtract from working row
      JSR     SEP          ;subtract end pointer

SSP11 CLC
      LDA     COLAC        ;low working column
      ADC     DELTAC       ;add column difference
      STA     COLAC        ;update working column
      LDA     COLAC+1
      ADC     DELTAC+1
      STA     COLAC+1
      CMP     ENDPT+1      ;high end point
      BCC     SSP15        ;if high working column < high end point

      BNE     SSP12        ;if high working column > high end point

      LDA     COLAC        ;low working column
      CMP     ENDPT        ;low end point
      BCC     SSP15        ;if low working column < low end point

SSP12 BIT     COLINC       ;column increment
      BPL     SSP13        ;if column increment positive

      DEC     COLCRS       ;decrement low cursor column
      LDA     COLCRS       ;low cursor column
      CMP     #$FF
      BNE     SSP14        ;if ???

      LDA     COLCRS+1     ;high cursor column
      BEQ     SSP14        ;if zero, do not decrement

```

```

        DEC    COLCRS+1    ;decrement high cursor column
        BPL    SSP14      ;???

SSP13  INC    COLCRS      ;increment low cursor column
        BNE    SSP14      ;if no carry

        INC    COLCRS+1    ;adjust high cursor column

SSP14  LDX    #2          ;indicate subtract from working column
        JSR    SEP        ;subtract end pointer

;      Plot point.

SSP15  JSR    CCR         ;check cursor range
        JSR    PLO        ;plot point

;      Check for right fill.

        LDA    FILFLG     ;right fill flag
        BEQ    SSP18      ;if no right fill

;      Process right fill.

        JSR    SRC         ;save row and column
        LDA    ATACHR      ;plot point
        STA    HOLD4      ;save plot point

SSP16  LDA    ROWCRS      ;cursor row
        PHA                ;save cursor row
        JSR    ACC         ;advance cursor column
        PLA                ;saved cursor row
        STA    ROWCRS      ;restore cursor row
        JSR    CCR         ;check cursor range
        JSR    GDC         ;get data under cursor
        BNE    SSP17      ;if non-zero data encountered

        LDA    FILDAT     ;fill data
        STA    ATACHR      ;plot point
        JSR    PLO        ;plot point
        JMP    SSP16      ;continue

SSP17  LDA    HOLD4      ;saved plot point
        STA    ATACHR      ;restore plot point
        JSR    RRC        ;restore row and column

;      Subtract 1 from iteration counter.

SSP18  SEC
        LDA    COUNTR      ;iteration counter
        SBC    #1          ;subtract 1
        STA    COUNTR      ;update iteration counter
        LDA    COUNTR+1
        SBC    #0
        STA    COUNTR+1

;      Check for completion.

        BMI    SSP19      ;if iteration counter negative, exit

        JMP    SSP7       ;continue

;      Exit.

SSP19  JMP    SST         ;perform screen STATUS, return

```

** TMSK - ???

TMSK	DB	\$00	;0 - mask for no bits
	DB	\$01	;1 - mask for lower 1 bit
	DB	\$03	;2 - mask for lower 2 bits
	DB	\$07	;3 - mask for lower 3 bits

** TDSC - Table of Default Screen Colors

TDSC	DB	\$28	;default playfield 0 color
	DB	\$CA	;default playfield 1 color
	DB	\$94	;default playfield 2 color
	DB	\$46	;default playfield 3 color
	DB	\$00	;default background color

** TCCR - Table of Control Character Routines
*
*
*
*
*

Each entry is 3 bytes. The first byte is the control character; the second and third bytes are the address of the routine which processes the control character.

TCCR	DB	\$1B	
	DW	ESC	;escape
	DB	\$1C	
	DW	CUP	;move cursor up
	DB	\$1D	
	DW	CDN	;move cursor down
	DB	\$1E	
	DW	CLF	;move cursor left
	DB	\$1F	
	DW	CRT	;move cursor right
	DB	\$7D	
	DW	CSC	;clear screen
	DB	\$7E	
	DW	BSP	;backspace
	DB	\$7F	
	DW	TAB	;tab
	DB	\$9B	
	DW	RWS	;return with scrolling
	DB	\$9C	
	DW	DLN	;delete line
	DB	\$9D	
	DW	ILN	;insert line
	DB	\$9E	
	DW	CTB	;clear tab
	DB	\$9F	
	DW	STB	;set tab
	DB	\$FD	
	DW	BEL	;sound bell

```

DB    $FE
DW    DCH    ;delete character

```

```

DB    $FF
DW    ICH    ;insert character

```

```
TCCRL =    *-TCCR ;length
```

```

**    TSFR - Table of Super Function (Shifted Function Key) Routines
*
*    Each entry is 3 bytes. The first byte is the super function
*    character; the second and third bytes are the address of the
*    routine which processes the super function.

```

```

TSFR  DB    $1C
      DW    CHM    ;move cursor home

      DB    $1D
      DW    CBT    ;move cursor to bottom

      DB    $1E
      DW    CLM    ;move cursor to left margin

      DB    $1F
      DW    CRM    ;move cursor to right margin

```

```

**    TAIC - Table of ATASCII to Internal Conversion Constants

```

```

TAIC  DB    $40    ;0 - ???
      DB    $00    ;1 - ???
      DB    $20    ;2 - ???
      DB    $60    ;3 - ???

```

```

**    TIAC - Table of Internal to ATASCII Conversion Constants

```

```

TIAC  DB    $20    ;0 - ???
      DB    $40    ;1 - ???
      DB    $00    ;2 - ???
      DB    $60    ;3 - ???

```

```

**    TCKD - Table of Character Key Definitions
*
*    Entry n is the ATASCII equivalent of key code n.???

```

```

TCKD  =    *

;    Lower Case Characters

      DB    $6C    ;$00 - l
      DB    $6A    ;$01 - j
      DB    $3B    ;$02 - semicolon
      DB    $8A    ;$03 - F1
      DB    $8B    ;$04 - F2
      DB    $6B    ;$05 - k
      DB    $2B    ;$06 - +
      DB    $2A    ;$07 - *
      DB    $6F    ;$08 - o
      DB    $80    ;$09 - (invalid)
      DB    $70    ;$0A - p
      DB    $75    ;$0B - u
      DB    $9B    ;$0C - return
      DB    $69    ;$0D - i

```

DB	\$2D	;\$0E - -
DB	\$3D	;\$0F - =
DB	\$76	;\$10 - v
DB	\$80	;\$11 - (invalid)
DB	\$63	;\$12 - c
DB	\$8C	;\$13 - F3
DB	\$8D	;\$14 - F4
DB	\$62	;\$15 - b
DB	\$78	;\$16 - x
DB	\$7A	;\$17 - z
DB	\$34	;\$18 - 4
DB	\$80	;\$19 - (invalid)
DB	\$33	;\$1A - 3
DB	\$36	;\$1B - 6
DB	\$1B	;\$1C - escape
DB	\$35	;\$1D - 5
DB	\$32	;\$1E - 2
DB	\$31	;\$1F - 1

DB	\$2C	;\$20 - comma
DB	\$20	;\$21 - space
DB	\$2E	;\$22 - period
DB	\$6E	;\$23 - n
DB	\$80	;\$24 - (invalid)
DB	\$6D	;\$25 - m
DB	\$2F	;\$26 - /
DB	\$81	;\$27 - inverse
DB	\$72	;\$28 - r
DB	\$80	;\$29 - (invalid)
DB	\$65	;\$2A - e
DB	\$79	;\$2B - y
DB	\$7F	;\$2C - tab
DB	\$74	;\$2D - t
DB	\$77	;\$2E - w
DB	\$71	;\$2F - q

DB	\$39	;\$30 - 9
DB	\$80	;\$31 - (invalid)
DB	\$30	;\$32 - 0
DB	\$37	;\$33 - 7
DB	\$7E	;\$34 - backspace
DB	\$38	;\$35 - 8
DB	\$3C	;\$36 - <
DB	\$3E	;\$37 - >
DB	\$66	;\$38 - f
DB	\$68	;\$39 - h
DB	\$64	;\$3A - d
DB	\$80	;\$3B - (invalid)
DB	\$82	;\$3C - CAPS
DB	\$67	;\$3D - g
DB	\$73	;\$3E - s
DB	\$61	;\$3F - a

; Upper Case Characters

DB	\$4C	;\$40 - L
DB	\$4A	;\$41 - J
DB	\$3A	;\$42 - colon
DB	\$8A	;\$43 - SHIFT-F1
DB	\$8B	;\$44 - SHIFT-F2
DB	\$4B	;\$45 - K
DB	\$5C	;\$46 - \
DB	\$5E	;\$47 - ^
DB	\$4F	;\$48 - 0
DB	\$80	;\$49 - (invalid)
DB	\$50	;\$4A - P

DB	\$55	;\$4B - U
DB	\$9B	;\$4C - SHIFT-return
DB	\$49	;\$4D - I
DB	\$5F	;\$4E - _
DB	\$7C	;\$4F -
DB	\$56	;\$50 - V
DB	\$80	;\$51 - (invalid)
DB	\$43	;\$52 - C
DB	\$8C	;\$53 - SHIFT-F3
DB	\$8D	;\$54 - SHIFT-F4
DB	\$42	;\$55 - B
DB	\$58	;\$56 - X
DB	\$5A	;\$57 - Z
DB	\$24	;\$58 - \$
DB	\$80	;\$59 - (invalid)
DB	\$23	;\$5A - #
DB	\$26	;\$5B - &
DB	\$1B	;\$5C - SHIFT-escape
DB	\$25	;\$5D - %
DB	\$22	;\$5E - "
DB	\$21	;\$5F - !
DB	\$5B	;\$60 - [
DB	\$20	;\$61 - SHIFT-space
DB	\$5D	;\$62 -]
DB	\$4E	;\$63 - N
DB	\$80	;\$64 - (invalid)
DB	\$4D	;\$65 - M
DB	\$3F	;\$66 - ?
DB	\$81	;\$67 - SHIFT-inverse
DB	\$52	;\$68 - R
DB	\$80	;\$69 - (invalid)
DB	\$45	;\$6A - E
DB	\$59	;\$6B - Y
DB	\$9F	;\$6C - SHIFT-tab
DB	\$54	;\$6D - T
DB	\$57	;\$6E - W
DB	\$51	;\$6F - Q
DB	\$28	;\$70 - (
DB	\$80	;\$71 - (invalid)
DB	\$29	;\$72 -)
DB	\$27	;\$73 - '
DB	\$9C	;\$74 - SHIFT-delete
DB	\$40	;\$75 - @
DB	\$7D	;\$76 - SHIFT-clear
DB	\$9D	;\$77 - SHIFT-insert
DB	\$46	;\$78 - F
DB	\$48	;\$79 - H
DB	\$44	;\$7A - D
DB	\$80	;\$7B - (invalid)
DB	\$83	;\$7C - SHIFT-CAPS
DB	\$47	;\$7D - G
DB	\$53	;\$7E - S
DB	\$41	;\$7F - A

; Control Characters

DB	\$0C	;\$80 - CTRL-L
DB	\$0A	;\$81 - CTRL-J
DB	\$7B	;\$82 - CTRL-semicolon
DB	\$80	;\$83 - (invalid)
DB	\$80	;\$84 - (invalid)
DB	\$0B	;\$85 - CTRL-K
DB	\$1E	;\$86 - CTRL-left arrow
DB	\$1F	;\$87 - CTRL-right arrow

DB	\$0F	;\$88 - CTRL-0
DB	\$80	;\$89 - (invalid)
DB	\$10	;\$8A - CTRL-P
DB	\$15	;\$8B - CTRL-U
DB	\$9B	;\$8C - CTRL-return
DB	\$09	;\$8D - CTRL-I
DB	\$1C	;\$8E - CTRL-up arrow
DB	\$1D	;\$8F - CTRL-down arrow

DB	\$16	;\$90 - CTRL-V
DB	\$80	;\$91 - (invalid)
DB	\$03	;\$92 - CTRL-C
DB	\$89	;\$93 - CTRL-F3
DB	\$80	;\$94 - (invalid)
DB	\$02	;\$95 - CTRL-B
DB	\$18	;\$96 - CTRL-X
DB	\$1A	;\$97 - CTRL-Z
DB	\$80	;\$98 - (invalid)
DB	\$80	;\$99 - (invalid)
DB	\$85	;\$9A - ???
DB	\$80	;\$9B - (invalid)
DB	\$1B	;\$9C - CTRL-escape
DB	\$80	;\$9D - (invalid)
DB	\$FD	;\$9E - CTRL-2
DB	\$80	;\$9F - (invalid)

DB	\$00	;\$A0 - CTRL-comma
DB	\$20	;\$A1 - CTRL-space
DB	\$60	;\$A2 - CTRL-period
DB	\$0E	;\$A3 - CTRL-N
DB	\$80	;\$A4 - (invalid)
DB	\$0D	;\$A5 - CTRL-M
DB	\$80	;\$A6 - (invalid)
DB	\$81	;\$A7 - CTRL-inverse
DB	\$12	;\$A8 - CTRL-R
DB	\$80	;\$A9 - (invalid)
DB	\$05	;\$AA - CTRL-E
DB	\$19	;\$AB - CTRL-Y
DB	\$9E	;\$AC - CTRL-tab
DB	\$14	;\$AD - CTRL-T
DB	\$17	;\$AE - CTRL-W
DB	\$11	;\$AF - CTRL-Q

DB	\$80	;\$B0 - (invalid)
DB	\$80	;\$B1 - (invalid)
DB	\$80	;\$B2 - (invalid)
DB	\$80	;\$B3 - (invalid)
DB	\$FE	;\$B4 - CTRL-delete
DB	\$80	;\$B5 - (invalid)
DB	\$7D	;\$B6 - CTRL-clear
DB	\$FF	;\$B7 - CTRL-insert
DB	\$06	;\$B8 - CTRL-F
DB	\$08	;\$B9 - CTRL-H
DB	\$04	;\$BA - CTRL-D
DB	\$80	;\$BB - (invalid)
DB	\$84	;\$BC - CTRL-CAPS
DB	\$07	;\$BD - CTRL-G
DB	\$13	;\$BE - CTRL-S
DB	\$01	;\$BF - CTRL-A

```

**      TFKD - Table of Function Key Definitions
*
*      Entry n is the ATASCII equivalent of adjusted function key
*      code n.

```

```

TFKD  DB    $1C    ;0 - F1 key
      DB    $1D    ;1 - F2 key
      DB    $1E    ;2 - F3 key
      DB    $1F    ;3 - F4 key

      DB    $8E    ;4 - SHIFT-F1 key
      DB    $8F    ;5 - SHIFT-F2 key
      DB    $90    ;6 - SHIFT-F3 key
      DB    $91    ;7 - SHIFT-F4 key

```

```

**      KIR - Process Keyboard IRQ
*
*      ENTRY JMP     KIR
*              ??
*
*      EXIT
*              Exits via RTI
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin             1983-11-01

```

```

KIR    =      *      ;entry

;      Initialize.

      TXA
      PHA          ;save X
      TYA
      PHA          ;save Y
      LDY    PORTB ;port B memory control
      LDA    KBCODE ;keyboard code
      CMP    CH1   ;last key code
      BNE    KIR1  ;if not last key code

      LDX    KEYDEL ;keyboard debounce delay
      BNE    KIR8  ;if delay not expired, treat as bounce

;      Check for CTRL-F1.

KIR1   LDX    KEYDIS ;save keyboard disable flag
      CMP    #CNTLF1
      BNE    KIR4   ;if not CTRL-F1

;      Process CTRL-F1.

      TXA          ;keyboard disable flag
      EOR    #$FF  ;complement keyboard disable flag
      STA    KEYDIS ;update keyboard disable flag
      BNE    KIR2  ;if keyboard disabled

```

```

        TYA          ;port B memory control
        ORA    #$04  ;turn off LED 1
        BNE     KIR3  ;update port B memory control

KIR2    TYA          ;port B memory control
        AND     #$FB  ;turn on LED 1

KIR3    TAY          ;updated port B memory control
        BCS     KIR7  ;reset keyboard controls

;        Check keyboard disable.

KIR4    TXA          ;keyboard disable flag
        BNE     KIR9  ;if keyboard disabled, exit

;        Get character.

        LDA     KBCODE ;keyboard code
        TAX          ;character

;        Check for CTRL-1.

        CMP     #CNTL1
        BNE     KIR5  ;if not CTRL-1

;        Process CTRL-1.

        LDA     SSFLAG ;start/stop flag
        EOR     #$FF  ;complement start/stop flag
        STA     SSFLAG ;update start/stop flag
        BCS     KIR7  ;??? make CTRL-1 invisible

;        Check character.

KIR5    AND     #$3F  ;mask off shift and control bits
        CMP     #HELP
        BNE     KIR10 ;if not HELP key

;        Process HELP.

        STX     HELPPFG ;indicate HELP key pressed
        BEQ     KIR7  ;reset keyboard controls

;        Process character.

KIR6    STX     CH     ;key code
        STX     CH1    ;reset previous key code

;        Reset keyboard controls.

KIR7    LDA     #3
        STA     KEYDEL ;re-initialize for debounce
        LDA     #0
        STA     ATTRACT ;clear attract-mode timer/flag

;        Prepare to exit.

KIR8    LDA     KRPDEL ;auto-repeat delay
        STA     SRTIMR ;reset software key repeat timer
        LDA     SDMCTL ;DMA control
        BNE     KIR9  ;if DMA not disabled, exit

        LDA     DMASAV ;saved DMA control
        STA     SDMCTL ;DMA control

;        Exit.

```

```

KIR9  STY      PORTB ;update port B memory control
      PLA      ;saved Y
      TAY      ;restore Y
      PLA      ;saved X
      TAX      ;restore X
      PLA      ;restore A
      RTI      ;return

;      Check for CTRL-F2 or CTRL-F4.

KIR10 CPX      #CNTLF2
      BEQ      KIR12 ;if CTRL-F2

      CPX      #CNTLF4
      BNE      KIR6  ;if not CTRL-F4

;      Process CTRL-F4.

      LDA      CHBAS ;character set base
      LDX      CHSALT ;character set alternate
      STA      CHSALT ;update character set alternate
      STX      CHBAS ;update character set base

      CPX      #high ICSORG ;high international character set origin
      BEQ      KIR11      ;if international character set

      TYA      ;port B memory control
      ORA      #$08 ;turn off LED 2
      TAY      ;updated port B memory control
      BNE      KIR7  ;reset keyboard controls

KIR11 TYA      ;port B memory control
      AND      #$F7 ;turn on LED 2
      TAY      ;updated port B memory control
      JMP      KIR7  ;reset keyboard controls

;      Process CTRL-F2.

KIR12 LDA      SDMCTL ;DMA control
      BEQ      KIR9  ;if disabled, exit

      STA      DMASAV ;save DMA state
      LDA      #0      ;disable DMA
      STA      SDMCTL ;DMA control
      BEQ      KIR9  ;exit

```

```

**      FDL - Process Display List Interrupt for Fine Scrolling
*
*      ENTRY   ??? JSR FDL
*              ??
*
*      EXIT
*              Exits via RTI
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

FDL      =      *      ;entry
          PHA      ;save A
          LDA      COLOR2      ;playfield 2 color
          EOR      COLRSH      ;modify with attract-mode color shift
          AND      DRKMSK      ;modify with attract-mode luminance
          STA      WSYNC      ;wait for HBLANK synchronization
          STA      COLPF1      ;playfield 1 color/luminance
          PLA      ;restore A
          RTI      ;return

```

\$FCD8 Patch

FIX \$FCD8

**	FCD8 - \$FCD8 Patch
*	
*	For compatibility with OS Revision B, sound key click.

JMP SKC ;sound key click, return

Cassette Handler

```
**      CIN - Initialize Cassette
*
*      ENTRY JSR      CIN
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01
```

```
CIN      =      *      ;entry
          LDA      #low B00600 ;indicate 600 baud
          STA      CBAUDL      ;cassette baud rate
          LDA      #high B00600
          STA      CBAUDH
;      JMP      CSP      ;return
```

```
**      CSP - Perform Cassette SPECIAL
*
*      CSP does nothing.
*
*      ENTRY JSR      CSP
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01
```

```
CSP      =      *      ;entry
          RTS      ;return
```

```

**      COP - Perform Cassette OPEN
*
*      ENTRY JSR      COP
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

COP      =      *      ;entry

;      Set cassette IRG type.

      LDA      ICAX2Z ;second auxiliary information
      STA      FTYPE ;cassette IRG type

;      Check OPEN mode.

      LDA      ICAX1Z ;OPEN mode
      AND      #$0C ;open for input and output bits
      CMP      #$04 ;open for input bit
      BEQ      OCI ;if open for input, process, return

      CMP      #$08 ;open for output bit
      BEQ      OCO ;if open for output, process, return

;      Exit.

      RTS      ;return

```

```

**      OCI - Open Cassette for Input
*
*      ENTRY JSR      OCI
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

OCI      =      *      ;entry

;      Process open for input.

      LDA      #0      ;indicate reading

```

```

    STA    WMODE    ;WRITE mode
    STA    FEOF     ;indicate no EOF yet
    LDA    #TONE2   ;tone for pressing PLAY
    JSR    AUB      ;alert user with beep
    BMI    PBC1     ;if error

;    Initiate cassette READ.

;    JMP    ICR      ;initiate cassette READ, return

```

```

**    ICR - Initiate Cassette READ
*
*    ENTRY JSR    ICR
*           ??
*
*    EXIT
*           ??
*
*    CHANGES
*           ??
*
*    CALLS
*           ??
*
*    MODS
*    Original Author Unknown    ??/??/??
*    1. Bring closer to Coding Standard (object unchanged).
*    R. K. Nordin    1983-11-01

```

```

ICR    =    *            ;entry

;    Initialize.

    LDA    #MOTRGO      ;motor on
    STA    PACTL        ;port A control

;    Wait for leader read.

    LDX    PALNTS
    LDY    RLEADL,X      ;low READ leader
    LDA    RLEADH,X      ;high READ leader
    TAX
    LDA    #3
    STA    CDTMF3
    JSR    SETVBV        ;set up VBLANK timer

ICR1   LDA    CDTMF3
    BNE    ICR1          ;if not done waiting

;    Initialize ???.

    LDA    #128          ;buffer size
    STA    BPTR          ;initialize buffer pointer
    STA    BLIM          ;initialize buffer limit
    JMP    OC02          ;exit

```

```

**      PBC - Process BREAK for Cassette Operation
*
*      ENTRY JSR      PBC
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

PBC      =      *      ;entry
          LDY      #BRKABT      ;BREAK abort error???
          DEC      BRKKEY ;reset BREAK key flag

PBC1     LDA      #0      ;indicate reading
          STA      WMODE     ;WRITE mode
          RTS                      ;return

```

```

**      OCO - Open Cassette for Output
*
*      ENTRY JSR      OCO
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

OCO      =      *      ;entry

;      Initialize.

          LDA      #$80      ;indicate writing
          STA      WMODE     ;WRITE mode
          LDA      #TONE1    ;tone for ?????
          JSR      AUB        ;alert user with beep
          BMI      PBC1      ;if error, ???

;      Set baud rate to 600.

          LDA      #low B00600 ;600 baud
          STA      AUDF3
          LDA      #high B00600
          STA      AUDF4

;      ???

```

```

LDA    #$60
STA    DDEVIC
JSR    SENDEV ;TELL POKEY TO WRITE MARKS
LDA    #MOTRGO      ;WRITE 5 SEC BLANK TAPE
STA    PACTL

;      Wait for leader written.

LDX    PALNTS
LDY    WLEADL,X
LDA    WLEADH,X
TAX
LDA    #3
JSR    SETVBV ;set VBLANK parameters
LDA    #$FF
STA    CDTMF3

0C01   LDA    BRKKEY ;BREAK key flag
      BEQ    PBC      ;if BREAK during write leader, process BREAK

      LDA    CDTMF3
      BNE    0C01     ;if not done waiting

;      Initialize buffer pointer.

LDA    #0
STA    BPTR      ;buffer pointer

;      Indicate success.

0C02   LDY    #SUCCES      ;indicate success
      RTS          ;return

```

```

**      CGB - Perform Cassette GET-BYTE
*
*      ENTRY JSR    CGB
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

CGB    =      *          ;entry

;      Check for EOF.

LDA    FE0F          ;EOF flag
BMI    RCB3          ;if at EOF already

;      Check for end of buffer.

LDX    BPTR          ;buffer pointer
CPX    BLIM          ;buffer limit
BEQ    RCB            ;if end of buffer, read block, return

```

```

;      Get next byte.

      LDA    CASBUF+3,X    ;byte
      INC    BPTR          ;increment pointer
      LDY    #SUCCES      ;indicate success

CGB1  RTS                  ;return

```

```

**      RCB - Read Cassette Block
*
*      ENTRY JSR    RCB
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin    1983-11-01

```

```

RCB    =    *    ;entry

;      Perform READ.

      LDA    #'R'    ;read
      JSR    SCB      ;perform SIO on cassette buffer
      TYA
      BMI    CGB1     ;if SIO error

      LDA    #0
      STA    BPTR     ;reset pointer
      LDX    #$80     ;default number of bytes

;      Check for header.

      LDA    CASBUF+2
      CMP    #EOT
      BEQ    RCB2     ;if header, read again???

;      Check for last record.

      CMP    #DT1
      BNE    RCB1     ;if not last data record

      LDX    CASBUF+130 ;number of bytes

;      Set number of bytes.

RCB1   STX    BLIM

;      Perform cassette GET-BYTE.

      JMP    CGB      ;perform cassette GET-BYTE, return

;      ???

RCB2   DEC    EOF      ;set EOF flag

```

```
;      Exit.

RCB3  LDY    #EOFERR      ;end of file indicator
      RTS                      ;return
```

```
**      CPB - Perform Cassette PUT-BYTE
*
*      ENTRY JSR    CPB
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01
```

```
CPB    =      *              ;entry

;      Move data to buffer.

      LDX    BPTR      ;buffer pointer
      STA    CASBUF+3,X ;data
      INC    BPTR      ;increment buffer pointer
      LDY    #SUCCES   ;assume success

;      Check buffer full.

      CPX    #127      ;offset to last byte of buffer
      BEQ    CPB1      ;if buffer full

      RTS                      ;return

;      Write cassette buffer.

CPB1   LDA    #DTA      ;indicate data record type
      JSR    WCB        ;write cassette buffer
      LDA    #0
      STA    BPTR      ;reset buffer pointer
      RTS                      ;return
```

```

**      CST - Perform Cassette STATUS
*
*      ENTRY JSR      CST
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

CST      =      *      ;entry
          LDY      #SUCCES      ;indicate success
          RTS      ;return

```

```

**      CCL - Perform Cassette CLOSE
*
*      ENTRY JSR      CCL
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

CCL      =      *      ;entry
;      Check mode.

          LDA      WMODE      ;WRITE mode
          BMI      CCL2      ;if writing

;      Process reading.

          LDY      #SUCCES      ;indicate success

;      Exit.

CCL1     LDA      #MOTRST
          STA      PACTL      ;stop motor
          RTS      ;return

;      Process writing.

CCL2     LDX      BPTR      ;buffer pointer
          BEQ      CCL3      ;if no data bytes in buffer

```

```

    STX    CASBUF+130    ;number of bytes
    LDA    #DT1          ;indicate data record type
    JSR    WCB            ;write cassette buffer
    BMI    CCL1          ;if error, exit

;    Zero buffer.

CCL3    LDX    #127      ;offset to last byte in buffer
    LDA    #0

CCL4    STA    CASBUF+3,X ;zero byte
    DEX
    BPL    CCL4          ;if not done

;    ???

    LDA    #EOT          ;indicate EOT record type
    JSR    WCB            ;write cassette buffer
    JMP    CCL1          ;exit

```

```

**      AUB - Alert User with Beep
*
*      ON ENTRY A= FREQ
*
*      ENTRY JSR    AUB
*            ??
*
*      EXIT
*            ??
*
*      CHANGES
*            ??
*
*      CALLS
*            ??
*
*      MODS
*
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

AUB    =    *            ;entry

;    Initialize.

    STA    FREQ          ;frequency

;    Compute termination time of beep duration.

AUB1    LDA    RTCLK+2    ;current time
    CLC
    LDX    PALNTS
    ADC    BEEPNT,X      ;add constant for 1 second tone
    TAX                ;beep duration termination time

;    Turn on speaker.

AUB2    LDA    #$FF
    STA    CONSOL        ;turn on speaker
    LDA    #$00

;    Delay.

    LDY    #$F0

```

```

AUB3  DEY
      BNE    AUB3          ;if not done delaying

;      Turn off speaker.

      STA    CONSOL        ;turn off speaker

;      Delay.

      LDY    #$F0

AUB4  DEY
      BNE    AUB4          ;if not done delaying

;      Check for beep duration termination time.

      CPX    RTCLOK+2      ;compare current time
      BNE    AUB2          ;if termination time not reached

      DEC    FREQ          ;decrement frequency
      BEQ    AUB6          ;if all done, wait for another key

;      Compute termination time of beep separation.

      TXA
      CLC
      LDX    PALNTS
      ADC    BEEPFX,X      ;add constant for ???
      TAX          ;beep separation termination time

;      Wait for termination of beep separation.

AUB5  CPX    RTCLOK+2      ;compare current time
      BNE    AUB5          ;if termination time not reached

;      Beep again.

      BEQ    AUB1          ;beep again

;      Wait for key.

AUB6  JSR    WFK          ;wait for key
      TYA          ;status
      RTS          ;return

```

```

**      WFK - Wait for Key
*
*      ENTRY JSR      WFK
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      NOTES
*      Problem: bytes wasted by not doing LDA #high[KGB-1]
*      and LDA #low[KGB-1].
*      Problem: bytes wasted by this being a subroutine.
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

WFK      =      *      ;entry
          LDA      KEYBDV+5      ;keyboard GET-BYTE routine address
          PHA
          LDA      KEYBDV+4
          PHA
          RTS                  ;invoke keyboard GET-BYTE routine

```

```

**      SCB - Perform SIO on Cassette Buffer
*
*      ENTRY JSR      SCB
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      NOTES
*      Problem: byte wasted by JSR/RTS exit.
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

SCB      =      *      ;entry
          STA      DCOMND        ;command
          LDA      #high 131
          STA      DBYTHI        ;buffer length
          LDA      #low 131
          STA      DBYTLO
          LDA      #high CASBUF
          STA      DBUFHI        ;buffer address
          LDA      #low CASBUF
          STA      DBUFLO
          LDA      #$60          ;cassette bus ID

```

```

STA    DDEVIC
LDA    #0
STA    DUNIT
LDA    #35          ;timeout
STA    DTIMLO
LDA    DCOMND       ;command
LDY    #GETDAT      ;assume SIO GET-DATA command
CMP    #READ
BEQ    SCB1         ;if READ command

LDY    #PUTDAT      ;SIO PUT-DATA command

SCB1   STY    DSTATS ;SIO command
      LDA    FTYPE  ;IRG type
      STA    DAUX2  ;second auxiliary information
      JSR    SIOV   ;vector to SIO
      RTS          ;return

```

```

**      WCB - Write Cassette Buffer
*
*      ENTRY JSR    WCB
*          ??
*
*      EXIT
*          ??
*
*      CHANGES
*          ??
*
*      CALLS
*          ??
*
*      NOTES
*          Problem: byte wasted by JSR/RTS exit.
*
*      MODS
*          Original Author Unknown   ??/??/??
*          1. Bring closer to Coding Standard (object unchanged).
*          R. K. Nordin      1983-11-01

```

```

WCB    =      *          ;entry
      STA    CASBUF+2    ;record type
      LDA    #$55
      STA    CASBUF+0    ;???
      STA    CASBUF+1    ;???
      LDA    #'W'        ;write
      JSR    SCB         ;perform SIO on cassette buffer
      RTS               ;return

```

** NTSC/PAL Constant Tables

WLEADH DB	high WLEADN	;high NTSC WRITE file leader
DB	high WLEADP	;high PAL WRITE file leader
WLEADL DB	low WLEADN	;low NTSC WRITE file leader
DB	low WLEADP	;low PAL WRITE file leader
RLEADH DB	high RLEADN	;high NTSC READ file leader
DB	high RLEADP	;high PAL READ file leader
RLEADL DB	low RLEADN	;low NTSC READ file leader
DB	low RLEADP	;low PAL READ file leader
BEEPNX DB	BEEPNN	;NTSC beep duration
DB	BEEPNP	;PAL beep duration
BEEPFX DB	BEEPFN	;NTSC beep separation
DB	BEEFPF	;PAL beep separation

Printer Handler

```
**      PIN - Initialize Printer
*
*      ENTRY JSR      PIN
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01
```

```
PIN      =      *      ;entry
          LDA      #30      ;30 second timeout
          STA      PTIMOT ;printer timeout
          RTS
          ;return
```

```
**      Printer Handler Address Data
*
*      NOTES
*      Problem: bytes wasted by tables and code.  Load
*      Immediate instructions should be used.
```

```
PSTB      DW      DVSTAT ;status buffer address
```

```
PPRB      DW      PRNBUF ;printer buffer address
```

```
**      PST - Perform Printer STATUS
*
*      ENTRY JSR      PST
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01
```

```
PST      =      *      ;entry

;      Get status.

          LDA      #4      ;4 bytes for status
          STA      PBUFSZ ;buffer size
          LDX      PSTB    ;address of status buffer
```

```

LDY    PSTB+1
LDA    #STATC ;status command
STA    DCOMND ;command
STA    DAUX1
JSR    SDP    ;set up DCB for printer
JSR    SIOV   ;vector to SIO
BMI    PSP    ;if error, return

;      Exit.

JSR    STS    ;set printer timeout from status
JMP    PSP    ;return

```

```

**      PSP - Perform Printer SPECIAL
*
*      PSP does nothing.
*
*      ENTRY JSR    PSP
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

PSP      =      *      ;entry
RTS      ;return

```

```

**      POP - Perform Printer OPEN
*
*      ENTRY JSR    POP
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

POP      =      *      ;entry
JSR      PST      ;perform printer STATUS
LDA      #0
STA      PBPNT    ;clear printer buffer pointer
RTS      ;return

```

```

**      PPB - Perform Printer PUT-BYTE
*
*      ENTRY JSR      PPB
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

PPB      =      *              ;entry

;      Initialize.

      PHA              ;save data
      LDA      ICDNO,X    ;device number
      STA      ICDNOZ     ;device number
      JSR      PPM        ;process print mode

;      Put data in buffer.

      LDX      PBPNT      ;printer buffer pointer
      PLA              ;saved data
      STA      PRNBUF,X   ;put data in buffer
      INX

;      Check for buffer full.

      CPX      PBUFSZ     ;printer buffer size
      BEQ      PPP        ;if buffer full, perform PUT, return

;      Update printer buffer pointer.

      STX      PBPNT      ;printer buffer pointer

;      Check for EOL.

      CMP      #EOL
      BEQ      PPB1       ;if EOL, space fill

;      Exit.

      LDY      #SUCCES    ;indicate success
      RTS              ;return

;      Space fill buffer.

PPB1     LDA      #' '     ;indicate space fill
;      JSR      FPB        ;fill printer buffer, return

```

```

**      FPB - Fill Printer Buffer
*
*      ENTRY JSR      FPB
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

FPB      =      *              ;entry
;      Fill printer buffer.

FPB1     STA      PRNBUF,X      ;byte of printer buffer
        INX
        CPX      PBUFSZ        ;printer buffer size
        BNE      FPB1          ;if not done
;      Perform printer PUT.
;      JMP      PPP            ;perform printer PUT, return

```

```

**      PPP - Perform Printer PUT
*
*      ENTRY JSR      PPP
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01

```

```

PPP      =      *              ;entry
;      Clear printer buffer pointer.

        LDA      #0
        STA      PBPNT ;clear printer buffer pointer
;      Set up DCB.

        LDX      PPRB ;address of printer buffer
        LDY      PPRB+1
        JSR      SDP  ;set up DCB for printer

```

```
; Perform PUT.
JMP    SIOV    ;vector to SIO, return
```

```
**      PCL - Perform Printer CLOSE
*
*      ENTRY JSR    PCL
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin    1983-11-01
```

```
PCL    =        *        ;entry

;      Initialize.

JSR    PPM        ;process print mode

;      Check buffer pointer.

LDA     #EOL        ;indicate EOL fill
LDX     PBPNT        ;printer buffer pointer
BNE    FPB        ;if buffer pointer non-zero, fill buffer, return

;      Exit.

LDY     #SUCCES        ;indicate success
RTS                ;return
```

```
**      SDP - Set Up DCB for Printer
*
*      ENTRY JSR    SDP
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin    1983-11-01
```

```
SDP    =        *        ;entry
STX     DBUFLO        ;low buffer address
STY     DBUFHI        ;high buffer address
LDA     #PDEVN        ;printer device bus ID
STA     DDEVIC        ;device bus ID
```

```

LDA    ICDNOZ ;device number
STA    DUNIT  ;unit number
LDA    #$80   ;SIO WRITE command???
LDX    DCOMND ;I/O direction
CPX    #STATC ;STATUS command
BNE    SDP1   ;if STATUS command

LDA    #$40   ;SIO READ command???

SDP1   STA    DSTATS ;SIO command
LDA    PBUFSZ
STA    DBYTLO ;low buffer size
LDA    #0
STA    DBYTHI ;high buffer size
LDA    PTIMOT
STA    DTIMLO ;device timeout
RTS

```

```

**      STS - Set Printer Timeout from Status
*
*      ENTRY JSR    STS
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      NOTES
*      Problem: bytes wasted by this code's being a subroutine.
*
*      MODS
*      Original Author Unknown   ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

STS    =      *      ;entry
LDA    DVSTAT+2 ;timeout
STA    PTIMOT   ;set printer timeout
RTS      ;return

```

```

**      PPM - Process Print Mode
*
*      PPM sets up the DCB according to the print mode.
*
*      ENTRY JSR      PPM
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*      Original Author Unknown    ??/??/??
*      1. Bring closer to Coding Standard (object unchanged).
*      R. K. Nordin      1983-11-01

```

```

PPM      =      *      ;entry

;      Initialize.

      LDY      #WRITE ;WRITE command
      LDA      ICAX2Z ;print mode

;      Determine buffer size.

PPM1     CMP      #NORMAL      ;NORMAL mode
      BNE      PPM2      ;if not NORMAL mode

      LDX      #NBUFSZ      ;NORMAL mode buffer size
      BNE      PPM4      ;set buffer size

PPM2     CMP      #DOUBLE      ;DOUBLE mode
      BNE      PPM3      ;if not DOUBLE mode

      LDX      #DBUFSZ      ;DOUBLE mode buffer size
      BNE      PPM4      ;set buffer size

PPM3     CMP      #SIDWAY      ;SIDEWAYS mode
      BNE      PPM5      ;if not SIDEWAYS mode, assume NORMAL

      LDX      #SBUFSZ      ;SIDEWAYS mode buffer size

;      Set buffer size.

PPM4     STX      PBUFSZ ;set printer buffer size

;      Set DCB command and mode.

      STY      DCOMND ;command
      STA      DAUX1 ;print mode
      RTS      ;return

;      Assume NORMAL mode.

PPM5     LDA      #NORMAL      ;NORMAL mode
      BNE      PPM1      ;set buffer size

```

Self-test, Part 4

```
**      VFR - Verify First 8K ROM
*
*      ENTRY JSR      VFR
*              ??
*
*      EXIT
*              C clear, if verified
*              set, if not verified
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01
```

```
VFR      =      *      ;entry
;      Initialize.
      LDX      #0      ;offset to first region to checksum
      STX      STCHK   ;initial sum is zero
      STX      STCHK+1
;      Checksum ROM.
VFR1     JSR     CRR      ;checksum region of ROM
      CPX      #12
      BNE      VFR1     ;if not done
;      Compare result.
      LDA      $C000   ;low checksum in ROM
      LDX      $C001   ;high checksum in ROM
;      JMP     VCS      ;verify checksum, return
```

```
**      VCS - Verify Checksum
*
*      ENTRY JSR      VCS
*              ??
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown   ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin      1983-11-01
```

```
VCS      =      *      ;entry
      CMP      STCHK   ;low checksum
```

```

BNE    VCS1    ;if low checksum bad

CPX      STCHK+1    ;high checksum
BNE    VCS1    ;if high checksum bad

CLC                      ;indicate verified
RTS                      ;return

VCS1    SEC                      ;indicate not verified
RTS                      ;return

```

```

**      VSR - Verify Second 8K ROM
*
*      ENTRY JSR    VSR
*              ??
*
*      EXIT
*              C clear, if verified
*                  set, if not verified
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown    ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin    1983-11-01

```

```

VSR      =      *      ;entry
LDX      #0
STX      STCHK    ;initial sum is zero
STX      STCHK+1
LDX      #12    ;offset to first region to checksum
JSR     CRR      ;checksum region of ROM
JSR     CRR      ;checksum region of ROM
LDA      $FFF8    ;low checksum from ROM
LDX      $FFF9    ;high checksum from ROM
JMP     VCS      ;verify checksum, return

```

```

**      CRR - Checksum Region of ROM
*
*      ENTRY JSR    CRR
*              X = offset???
*
*      EXIT
*              ??
*
*      CHANGES
*              ??
*
*      CALLS
*              ??
*
*      MODS
*              Original Author Unknown    ??/??/??
*              1. Bring closer to Coding Standard (object unchanged).
*              R. K. Nordin    1983-11-01

```

```

CRR      =      *      ;entry

;      Transfer range addresses.

```

```

        LDY    #0
CRR1   LDA     TARV,X
        STA     STADR1,Y
        INX
        INY
        CPY     #4      ;4 bytes for 2 addresses
        BNE     CRR1    ;if not done

;       Checksum range.

        LDY    #0
CRR2   CLC
        LDA     (STADR1),Y
        ADC     STCHK
        STA     STCHK
        BCC     CRR3    ;if low value non-zero

        INC     STCHK+1      ;adjust high value
CRR3   INC     STADR1 ;advance address
        BNE     CRR4    ;if low address non-zero

        INC     STADR1+1      ;adjust high address
CRR4   LDA     STADR1 ;current address
        CMP     STADR2 ;end of range
        BNE     CRR2    ;if not done

        LDA     STADR1+1
        CMP     STADR2+1
        BNE     CRR2    ;if not done

        RTS          ;return

```

** TARV - Table of Address Ranges to Verify

TARV	DW	\$C002,\$D000	;first 8K ROM, \$C002 - \$CFFF
	DW	\$5000,\$5800	;first 8K ROM, \$D000 - \$D7FF
	DW	\$D800,\$E000	;first 8K ROM, \$D800 - \$DFFF
	DW	\$E000,\$FFF8	;second 8K ROM, \$E000 - \$FFF7
	DW	\$FFFA,\$0000	;second 8K ROM, \$FFFA - \$FFFF

Second 8K ROM Identification and Checksum

FIX \$FFEE

** Second 8K ROM Identification and Checksum
--

DB	IDDAY, IDMON, IDYEAR	;date (day, month, year)
DB	IDCPU	;CPU series
DB	IDPN1, IDPN2, IDPN3, IDPN4, IDPN5	;part number
DB	IDREV	;revision number
DW	\$0000	;reserved for checksum

6502 Machine Vectors

FIX \$FFFA

** 6502 Machine Vectors

DW NMI ;vector to process NMI
DW RES ;vector to process RESET
DW IRQ ;vector to process IRQ

END