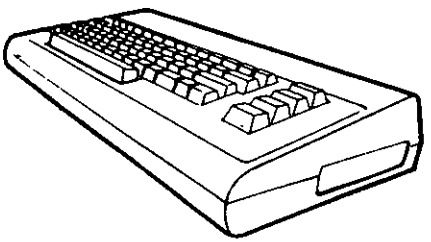
IL SISTEMA OPERATIVO DEL

COMMODORE 64



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INTRODUZIONE

Per la prima volta sui Personal Computer viene fornita l' elenco disassemblato del Sistema Operativo. Si tratta in effetti di un' elenco di routines e locazioni che permettono per la prima volta a chiunque desideri operare con questo computer di poter effettuare un lavoro serio e sopratutto di non essere costretti a perdere giorni e giorni di tentativi e prove.
Naturalmente e' richiesta una certa conoscenza del linguaggio macchina e dell' Assembler per il quale ci permettiamo di consigliare il volume CORSO DI ASSEMBLER PER IL CBM64 che viene consegnato insieme ad una cassetta (o disco a richieat) contenente il Monitor, l' Assembler, il Disassembler ecc.
Lo scopo di questo libro e' quello di fornire una lista dettagliata del contenuto delle ROM e quindi di TUTTO il Sistema Operativo del computer CBM64.
Poiche' esistono due aree di ROM, che vanno rispettivamente da A000 a BFFF e da E000 a FFFF e che possono essere disabilitate separatamente, i listati che costituiscono la parte centrale del volume, sono stati distinti in due parti ad ognuna delle quali e' allegato anche il relativi Cross Reference.

A parte i listati relativi alle pagine 0/1/2/3, le colonne devono essere lette nella seguente maniera:

1. Indirizzo
2. Codice oggetto
3. Numero di linea
4. Label
5. Istruzione mnemonica
6. Operando
7. Commenti

Tutte le Label hanno un suffisso di quattro caratteri esadecimali (due per la pagina zero) che rappresentano l' indirizzo attuale.
Il prefisso di un un solo carattere puo' avere il seguente significato:

B - Branch label
J - Jump label
S - Subroutine label
T - Table (data) label

W - Word label
Z - Zero page label
X - External label

Alla fine di ognuno dei due listati, rispettivamente dell' Interprete Basic e del Sistema Operativo vero e proprio si trova un Cross Reference. Per ciascuna Label, messe in ordine alfabetico, si trova l' indirizzo della Label stessa e tutti i numeri di salto della Label.

A) Le pagine 1-3 contengono la parte del Sistema Operativo relativo alle pagine 0/1/2/3 della memoria utilizzata dall' Interprete Basic.

B) Da pagina 5 a 105 e' presente il listato disassemblato e commentato dell' Inteprete Basic, mentre da pagina 106 a 121 il relativo Cross Reference.

C) Da pagina 122 a pagina 126 sono presenti le pagine 0/1/2/3 della memoria utilizzate dal Sistema Operativo (parte KERNAL).

D) Da pagina 127 a pagina 222 le periferiche di I/O e le routines Kernal disassemblate. Da pagina 223 a 224 i Vettori Kernal.

E) Le pagine da 225 a 239 contengono il Cross Reference relativo alle routines Kernal mentre da pagina 239 a 242 il Cross Reference della pagina zero usata dal Sistema Operativo.

Inoltre in Appendice sono riportate sia le locazioni delle pagine 0/1/2/3/4 le routines mnemoniche relative al CBM64, al VIC ed alle serie 3000 e 4000.
Lo stesso e' stato fatto per routines del Sistema Operativo con un breve commento.

```
                    1         .L
                    2         .H
                    3 ;CBM-64-Part One
                    4 ;
                    5 ;
0000                6 Z00   =   $00       ;6510 data direction register
0001                7 Z01   =   $01       ;6510 I/O register
                    8 ;     bit 0 (output) 0=RAM at $A000-$BFFF (BASIC area)
                    9 ;     bit 1 (output) 0=RAM at $E000-$EFFF (Kernal area)
                   10 ;     bit 2 (output) 0=access CRT shapes at $D000-$DFFF
                   11 ;     bit 3 (output) cassette write line
                   12 ;     bit 4 (input)  cassette sense line
                   13 ;     bit 5 (output) cassette motor control
                   14 ;     bit 6 unused
                   15 ;     bit 7 unused
0002               16 Z02   =   $02       ;dummy address for offset
0003               17 Z03   =   $03       ;fixed-float vector
0004               18 Z04   =   $04       ;high byte of same
0007               19 Z07   =   $07       ;separator/terminator/work field
0008               20 Z08   =   $08       ;terminator/AND work field
0009               21 Z09   =   $09       ;character position for TAB
000B               22 Z0B   =   $0B       ;length BASIC line/AND-OR switch/# DIM
000C               23 Z0C   =   $0C       ;reference/declaraction flag
000D               24 Z0D   =   $0D       ;type: FF=string, 00=numeric
000E               25 Z0E   =   $0E       ;type: 80=integer, 00=floating point
000F               26 Z0F   =   $0F       ;DATA/string/error flag
0010               27 Z10   =   $10       ;subscript/fn flag/integers-arrays flag
0011               28 Z11   =   $11       ;0=input, $40=get, $98=read
0012               29 Z12   =   $12       ;<=> operator
0013               30 Z13   =   $13       ;CMD file number
0014               31 Z14   =   $14       ;integer value (work)
0015               32 Z15   =   $15       ;high byte of same
0016               33 Z16   =   $16       ;string descriptor stack index
0017               34 Z17   =   $17       ;previous string descriptor stack index
0018               35 Z18   =   $18       ;high byte of same
0019               36 Z19   =   $19       ;bottom of string descriptor stack
0022               37 Z22   =   $22       ;utility pointer area
0023               38 Z23   =   $23       ; "                 "
0024               39 Z24   =   $24       ; "                 "
0025               40 Z25   =   $25       ; "                 "
0026               41 Z26   =   $26       ;product for multiplication
0027               42 Z27   =   $27       ; "                 "
0028               43 Z28   =   $28       ; "                 "
0029               44 Z29   =   $29       ; "                 "
002B               45 Z2B   =   $2B       ;pointer to start of BASIC
002C               46 Z2C   =   $2C       ;high byte of same
002D               47 Z2D   =   $2D       ;pointer start of variables
002E               48 Z2E   =   $2E       ;high byte of same
002F               49 Z2F   =   $2F       ;pointer to start of arrays
0030               50 Z30   =   $30       ;high byte of same
0031               51 Z31   =   $31       ;pointer to end of arrays
0032               52 Z32   =   $32       ;high byte of same
0033               53 Z33   =   $33       ;pointer to start of string storage
0034               54 Z34   =   $34       ;high byte of same
0035               55 Z35   =   $35       ;utility string pointer
0036               56 Z36   =   $36       ;high byte of same
0037               57 Z37   =   $37       ;pointer to limit of memory
0038               58 Z38   =   $38       ;high byte of same
0039               59 Z39   =   $39       ;current BASIC line number
```

```
003A          60 Z3A  =  $3A     ;high byte of same
003B          61 Z3B  =  $3B     ;previous BASIC line number
003C          62 Z3C  =  $3C     ;high byte of same
003D          63 Z3D  =  $3D     ;pointer to BASIC statement for CONT
003E          64 Z3E  =  $3E     ;high byte of same
003F          65 Z3F  =  $3F     ;current DATA line number
0040          66 Z40  =  $40     ;high byte of same
0041          67 Z41  =  $41     ;current DATA address
0042          68 Z42  =  $42     ;high byte of same
0043          69 Z43  =  $43     ;temporary read pointer
0044          70 Z44  =  $44     ;high byte of same
0045          71 Z45  =  $45     ;current variable name
0046          72 Z46  =  $46     ;second byte of same
0047          73 Z47  =  $47     ;current variable address
0048          74 Z48  =  $48     ;high byte of same
0049          75 Z49  =  $49     ;variable pointer for FOR/NEXT
004A          76 Z4A  =  $4A     ;high byte of same
004B          77 Z4B  =  $4B     ;save area
004C          78 Z4C  =  $4C     ;high byte of same
004D          79 Z4D  =  $4D     ;comparison symbol accumulator
004E          80 Z4E  =  $4E     ;misc. work area
004F          81 Z4F  =  $4F     ; "          "
0050          82 Z50  =  $50     ; "          "
0051          83 Z51  =  $51     ; "          "
0053          84 Z53  =  $53     ; "          "
0055          85 Z55  =  $55     ; "          "
0056          86 Z56  =  $56     ; "          "
0057          87 Z57  =  $57     ;misc. numeric work area
0058          88 Z58  =  $58     ; "          "
0059          89 Z59  =  $59     ; "          "
005A          90 Z5A  =  $5A     ; "          "
005B          91 Z5B  =  $5B     ; "          "
005C          92 Z5C  =  $5C     ; "          "
005D          93 Z5D  =  $5D     ; "          "
005E          94 Z5E  =  $5E     ; "          "
005F          95 Z5F  =  $5F     ; "          "
0060          96 Z60  =  $60     ; "          "
0061          97 Z61  =  $61     ;floating point accu # 1 - exponent
0062          98 Z62  =  $62     ;flp # 1 - mantissa
0063          99 Z63  =  $63     ; "          "
0064         100 Z64  =  $64     ; "          "
0065         101 Z65  =  $65     ; "          "
0066         102 Z66  =  $66     ;flp # 1 - sign
0067         103 Z67  =  $67     ;saved sign of flp accu
0068         104 Z68  =  $68     ;flp accu # 1 padding
0069         105 Z69  =  $69     ;flp accu # 2 thru Z6E
006A         106 Z6A  =  $6A
006B         107 Z6B  =  $6B
006C         108 Z6C  =  $6C
006D         109 Z6D  =  $6D
006E         110 Z6E  =  $6E
006F         111 Z6F  =  $6F     ;sign comparison accu #1 vs accu # 2
0070         112 Z70  =  $70     ;work pointer/guard bit
0071         113 Z71  =  $71     ;output index
0072         114 Z72  =  $72     ;high byte of same
007A         115 Z7A  =  $7A     ;current character address
007B         116 Z7B  =  $7B     ;high byte of same
```

```
0054          118 X0054 =   $54        ;JMP vector for functions
0073          119 X0073 =   $73        ;get next character
0079          120 X0079 =   $79        ;get current character
0080          121 X0080 =   $80        ;check for numeric character
0100          122 X0100 =   $0100      ;bottom of stack
0101          123 X0101 =   $0101      ;work area for flp to string conversion
0102          124 X0102 =   $0102      ; "          "
0103          125 X0103 =   $0103      ; "          "
0104          126 X0104 =   $0104      ; "          "
01FE          127 X01FE =   $01FE      ;line number for line in input buffer
01FF          128 X01FF =   $01FF      ;high byte of same
0200          129 X0200 =   $0200      ;BASIC input buffer
              130 ;
              131 ;Operating System vector table
              132 ;
0300          133 X0300 =   $0300      ;error message link, std value = $E38B
0302          134 X0302 =   $0302      ;BASIC warm start vector, std = $A483
0304          135 X0304 =   $0304      ;crunch BASIC tokens, std = $A57C
0306          136 X0306 =   $0306      ;print tokens vector, std value = $A71A
0308          137 X0308 =   $0308      ;execute stmt vector, std value = $A7E4
030A          138 X030A =   $030A      ;get arithmetic element, std = $AE86
0310          139 X0310 =   $0310      ;USR JMP vector, std value = $B248
0314          140 W0314 =   $0314      ;IRQ vector, std value = $EA31
0316          141 W0316 =   $0316      ;BRK vector, std value = $FE66
0318          142 W0318 =   $0318      ;NMI vector, std value = $FE47
031A          143 W031A =   $031A      ;OPEN vector, std value = $F34A
031C          144 W031C =   $031C      ;CLOSE vector, std value = $F291
031E          145 W031E =   $031E      ;set input vector, std value = $F20E
0320          146 W0320 =   $0320      ;set output vector, std value = $F250
0322          147 W0322 =   $0322      ;restore I/O vector, std value = $F333
0324          148 W0324 =   $0324      ;INPUT vector, std value = $F157
0326          149 W0326 =   $0326      ;OUTPUT vector, std value = $F1CA
0328          150 W0328 =   $0328      ;test Stop Key vector, std value = $F6ED
032A          151 W032A =   $032A      ;GET vector, std value = $F13E
032C          152 W032C =   $032C      ;close files and channels, std = $F32F
032E          153 W032E =   $032E      ;unused vector, std value = $FE66 (BRK)
0330          154 W0330 =   $0330      ;Load RAM vector, std value = $F4A5
0332          155 W0332 =   $0332      ;Save RAM vector, std value = $F5ED
              156 ;
033C          157         .OR $33C
033C          158         .DS 192      ;cassette buffer
03FC          159         .DS 4
0400          160         .DS 1000     ;video RAM
07E8          161         .DS 24       ;sprite pointers
0800          162         .DS $8800    ;standard BASIC text area
```

```
9FEA          164 X9FEA =   $9FEA     ;address to access function jump table
E000          165 XE000 =   $E000     ;continuation of RND routine
E043          166 XE043 =   $E043     ;compute odd degrees for SIN and ATN
E097          167 WE097 =   $E097     ;RND command
E10C          168 XE10C =   $E10C     ;output a character
E112          169 XE112 =   $E112     ;input a character
E118          170 XE118 =   $E118     ;set output device
E11E          171 XE11E =   $E11E     ;set input device
E124          172 XE124 =   $E124     ;get a character from current device
E12A          173 WE12A =   $E12A     ;SYS command
E156          174 WE156 =   $E156     ;SAVE command
E165          175 WE165 =   $E165     ;VERIFY command
E168          176 WE168 =   $E168     ;LOAD command
E1BE          177 WE1BE =   $E1BE     ;OPEN command
E1C7          178 WE1C7 =   $E1C7     ;CLOSE command
E264          179 WE264 =   $E264     ;COS command
E26B          180 WE26B =   $E26B     ;SIN command
E2B4          181 WE2B4 =   $E2B4     ;TAN command
E30E          182 WE30E =   $E30E     ;ATN command
E37B          183 WE37B =   $E37B     ;Warm Start entry
E386          184 XE386 =   $E386     ;print message READY
E394          185 WE394 =   $E394     ;RESET routine
FF90          186 XFF90 =   $FF90     ;control kernal messages
FFB7          187 XFFB7 =   $FFB7     ;read I/O status word
FFCC          188 XFFCC =   $FFCC     ;restore I/O devices to default
FFDB          189 XFFDB =   $FFDB     ;set real time clock
FFDE          190 XFFDE =   $FFDE     ;read real time clock
FFE1          191 XFFE1 =   $FFE1     ;check Stop key
FFE7          192 XFFE7 =   $FFE7     ;Close all channels and files
FFF0          193 XFFF0 =   $FFF0     ;Read/Set XY cursor position
```

```
A000          195         .OR $A000
A000 94E3     196         .W  WE394       ;RESET address
A002 7BE3     197         .W  WE37B       ;Warm Start address
              198 ;
              199 ;program identifier (not tested)
              200 ;
A004 43424D   201         .BY 'C,'B,'M,'B,'A,'S,'I,'C
              202 ;
              203 ;address table for BASIC commands
              204 ;address - 1 used since routines reached via RTS
              205 ;
A00C 30A8     206 TA00C .W  WA831-1     ;END
A00E 41A7     207         .W  WA742-1     ;FOR
A010 1DAD     208         .W  WAD1E-1     ;NEXT
A012 F7A8     209         .W  WA8F8-1     ;DATA
A014 A4AB     210         .W  WABA5-1     ;INPUT#
A016 BEAB     211         .W  WABBF-1     ;INPUT
A018 80B0     212         .W  WB081-1     ;DIM
A01A 05AC     213         .W  WAC06-1     ;READ
A01C A4A9     214         .W  WA9A5-1     ;LET
A01E 9FA8     215         .W  WA8A0-1     ;GOTO
A020 70A8     216         .W  WA871-1     ;RUN
A022 27A9     217         .W  WA928-1     ;IF
A024 1CA8     218         .W  WA81D-1     ;RESTORE
A026 82A8     219         .W  WA883-1     ;GOSUB
A028 D1A8     220         .W  WA8D2-1     ;RETURN
A02A 3AA9     221         .W  WA93B-1     ;REM
A02C 2EA8     222         .W  WA82F-1     ;STOP
A02E 4AA9     223         .W  WA94B-1     ;ON
A030 2CB8     224         .W  WB82D-1     ;WAIT
A032 67E1     225         .W  WE168-1     ;LOAD
A034 55E1     226         .W  WE156-1     ;SAVE
A036 64E1     227         .W  WE165-1     ;VERIFY
A038 B2B3     228         .W  WB3B3-1     ;DEF
A03A 23B8     229         .W  WB824-1     ;POKE
A03C 7FAA     230         .W  WAA80-1     ;PRINT#
A03E 9FAA     231         .W  WAAA0-1     ;PRINT
A040 56A8     232         .W  WA857-1     ;CONT
A042 9BA6     233         .W  WA69C-1     ;LIST
A044 5DA6     234         .W  WA65E-1     ;CLR
A046 85AA     235         .W  WAA86-1     ;CMD
A048 29E1     236         .W  WE12A-1     ;SYS
A04A BDE1     237         .W  WE1BE-1     ;OPEN
A04C C6E1     238         .W  WE1C7-1     ;CLOSE
A04E 7AAB     239         .W  WAB7B-1     ;GET
A050 41A6     240         .W  WA642-1     ;NEW
```

```
                    242 ;address table for BASIC functions
                    243 ;
A052 39BC           244         .W  WBC39       ;SGN
A054 CCBC           245         .W  WBCCC       ;INT
A056 58BC           246         .W  WBC58       ;ABS
A058 1003           247         .W  X0310       ;USR
A05A 7DB3           248         .W  WB37D       ;FRE
A05C 9EB3           249         .W  WB39E       ;POS
A05E 71BF           250         .W  WBF71       ;SQR
A060 97E0           251         .W  WE097       ;RND
A062 EAB9           252         .W  WB9EA       ;LOG
A064 EDBF           253         .W  WBFED       ;EXP
A066 64E2           254         .W  WE264       ;COS
A068 6BE2           255         .W  WE26B       ;SIN
A06A B4E2           256         .W  WE2B4       ;TAN
A06C 0EE3           257         .W  WE30E       ;ATN
A06E 0DB8           258         .W  WB80D       ;PEEK
A070 7CB7           259         .W  WB77C       ;LEN
A072 65B4           260         .W  WB465       ;STR$
A074 ADB7           261         .W  WB7AD       ;VAL
A076 8BB7           262         .W  WB78B       ;ASC
A078 ECB6           263         .W  WB6EC       ;CHR$
A07A 00B7           264         .W  WB700       ;LEFT$
A07C 2CB7           265         .W  WB72C       ;RIGHT$
A07E 37B7           266         .W  WB737       ;MID$
                    267 ;
                    268 ;table of priorities and addresses
                    269 ;for diadic operators
                    270 ;
A080 79             271 TA080 .BY $79
A081 69B8           272         .W  WB86A-1     ;plus
                    273 ;
A083 79             274         .BY $79
A084 52B8           275         .W  WB853-1     ;minus
                    276 ;
A086 7B             277         .BY $7B
A087 2ABA           278         .W  WBA2B-1     ;times
                    279 ;
A089 7B             280         .BY $7B
A08A 11BB           281         .W  WBB12-1     ;divided by
                    282 ;
A08C 7F             283         .BY $7F
A08D 7ABF           284         .W  WBF7B-1     ;raise to power
                    285 ;
A08F 50             286         .BY $50
A090 E8AF           287         .W  WAFE9-1     ;logical AND
                    288 ;
A092 46             289         .BY $46
A093 E5AF           290         .W  WAFE6-1     ;logical OR
                    291 ;
A095 7D             292         .BY $7D
A096 B3BF           293         .W  WBFB4-1     ;monadic minus
                    294 ;
A098 5A             295         .BY $5A
A099 D3AE           296         .W  WAED4-1     ;monadic NOT
                    297 ;
A09B 64             298         .BY $64
A09C 15B0           299         .W  WB016-1     ;> = <
```

```
                301 ;table of keywords
                302 ;same sequence as address table TA00C
                303 ;
A09E 454EC4     304 TA09E .BY 'E,'N,'D+$80
A0A1 464FD2     305       .BY 'F,'O,'R+$80
A0A4 4E4558     306       .BY 'N,'E,'X,'T+$80
A0A8 444154     307       .BY 'D,'A,'T,'A+$80
A0AC 494E50     308       .BY 'I,'N,'P,'U,'T,'#+$80
A0B2 494E50     309       .BY 'I,'N,'P,'U,'T+$80
A0B7 4449CD     310       .BY 'D,'I,'M+$80
A0BA 524541     311       .BY 'R,'E,'A,'D+$80
A0BE 4C45D4     312       .BY 'L,'E,'T+$80
A0C1 474F54     313       .BY 'G,'O,'T,'O+$80
A0C5 5255CE     314       .BY 'R,'U,'N+$80
A0C8 49C6       315       .BY 'I,'F+$80
A0CA 524553     316       .BY 'R,'E,'S,'T,'O,'R,'E+$80
A0D1 474F53     317       .BY 'G,'O,'S,'U,'B+$80
A0D6 524554     318       .BY 'R,'E,'T,'U,'R,'N+$80
A0DC 5245CD     319       .BY 'R,'E,'M+$80
A0DF 53544F     320       .BY 'S,'T,'O,'P+$80
A0E3 4FCE       321       .BY 'O,'N+$80
A0E5 574149     322       .BY 'W,'A,'I,'T+$80
A0E9 4C4F41     323       .BY 'L,'O,'A,'D+$80
A0ED 534156     324       .BY 'S,'A,'V,'E+$80
A0F1 564552     325       .BY 'V,'E,'R,'I,'F,'Y+$80
A0F7 4445C6     326       .BY 'D,'E,'F+$80
A0FA 504F4B     327       .BY 'P,'O,'K,'E+$80
A0FE 505249     328       .BY 'P,'R,'I,'N,'T,'#+$80
A104 505249     329       .BY 'P,'R,'I,'N,'T+$80
A109 434F4E     330       .BY 'C,'O,'N,'T+$80
A10D 4C4953     331       .BY 'L,'I,'S,'T+$80
A111 434CD2     332       .BY 'C,'L,'R+$80
A114 434DC4     333       .BY 'C,'M,'D+$80
A117 5359D3     334       .BY 'S,'Y,'S+$80
A11A 4F5045     335       .BY 'O,'P,'E,'N+$80
A11E 434C4F     336       .BY 'C,'L,'O,'S,'E+$80
A123 4745D4     337       .BY 'G,'E,'T+$80
A126 4E45D7     338       .BY 'N,'E,'W+$80
```

```
                340 ;table of functions
                341 ;
A129 544142     342         .BY "T,"A,"B,"(+$80
A12D 54CF       343         .BY "T,"O+$80
A12F 46CE       344         .BY "F,"N+$80
A131 535043     345         .BY "S,"P,"C,"(+$80
A135 544845     346         .BY "T,"H,"E,"N+$80
A139 4E4FD4     347         .BY "N,"O,"T+$80
A13C 535445     348         .BY "S,"T,"E,"P+$80
A140 AB         349         .BY "++$80
A141 AD         350         .BY "-+$80
A142 AA         351         .BY "*+$80
A143 AF         352         .BY "/+$80
A144 DE         353         .BY $DE         ;exponent sign
A145 414EC4     354         .BY "A,"N,"D+$80
A148 4FD2       355         .BY "O,"R+$80
A14A BE         356         .BY ">+$80
A14B BD         357         .BY "=+$80
A14C BC         358         .BY "<+$80
A14D 5347CE     359         .BY "S,"G,"N+$80
A150 494ED4     360         .BY "I,"N,"T+$80
A153 4142D3     361         .BY "A,"B,"S+$80
A156 5553D2     362         .BY "U,"S,"R+$80
A159 4652C5     363         .BY "F,"R,"E+$80
A15C 504FD3     364         .BY "P,"O,"S+$80
A15F 5351D2     365         .BY "S,"Q,"R+$80
A162 524EC4     366         .BY "R,"N,"D+$80
A165 4C4FC7     367         .BY "L,"O,"G+$80
A168 4558D0     368         .BY "E,"X,"P+$80
A16B 434FD3     369         .BY "C,"O,"S+$80
A16E 5349CE     370         .BY "S,"I,"N+$80
A171 5441CE     371         .BY "T,"A,"N+$80
A174 4154CE     372         .BY "A,"T,"N+$80
A177 504545     373         .BY "P,"E,"E,"K+$80
A17B 4C45CE     374         .BY "L,"E,"N+$80
A17E 535452     375         .BY "S,"T,"R,"$+$80
A182 5641CC     376         .BY "V,"A,"L+$80
A185 4153C3     377         .BY "A,"S,"C+$80
A188 434852     378         .BY "C,"H,"R,"$+$80
A18C 4C4546     379         .BY "L,"E,"F,"T,"$+$80
A191 524947     380         .BY "R,"I,"G,"H,"T,"$+$80
A197 4D4944     381         .BY "M,"I,"D,"$+$80
                382 ;
                383 ;other commands
                384 ;
A19B 47CF       385         .BY "G,"O+$80
A19D 00         386         .BY $00         ;end of keywords
```

```
                388 ;error messages
                389 ;
A19E 544F4F     390 TA19E .BY 'T,'O,'O,' ,'M,'A,'N,'Y,' ,'F,'I,'L,'E,'S+$80
A1AC 46494C     391 TA1AC .BY 'F,'I,'L,'E,' ,'O,'P,'E,'N+$80
A1B5 46494C     392 TA1B5 .BY 'F,'I,'L,'E,' ,'N,'O,'T,' ,'O,'P,'E,'N+$80
A1C2 46494C     393 TA1C2 .BY 'F,'I,'L,'E,' ,'N,'O,'T,' ,'F,'O,'U,'N,'D+$80
A1D0 444556     394 TA1D0 .BY 'D,'E,'V,'I,'C,'E,' ,'N,'O,'T,'
A1DB 505245     395       .BY 'P,'R,'E,'S,'E,'N,'T+$80
A1E2 4E4F54     396 TA1E2 .BY 'N,'O,'T,' ,'I,'N,'P,'U,'T,' ,'F,'I,'L,'E+$80
A1F0 4E4F54     397 TA1F0 .BY 'N,'O,'T,' ,'O,'U,'T,'P,'U,'T,' ,'F,'I,'L,'E+$80
A1FF 4D4953     398 TA1FF .BY 'M,'I,'S,'S,'I,'N,'G,' ,'F,'I,'L,'E,'
A20C 4E414D     399       .BY 'N,'A,'M,'E+$80
A210 494C4C     400 TA210 .BY 'I,'L,'L,'E,'G,'A,'L,' ,'D,'E,'V,'I,'C,'E,'
A21F 4E554D     401       .BY 'N,'U,'M,'B,'E,'R+$80
A225 4E4558     402 TA225 .BY 'N,'E,'X,'T,' ,'W,'I,'T,'H,'O,'U,'T
A231 20464F     403       .BY ' ,'F,'O,'R+$80
A235 53594E     404 TA235 .BY 'S,'Y,'N,'T,'A,'X+$80
A23B 524554     405 TA23B .BY 'R,'E,'T,'U,'R,'N,' ,'W,'I,'T,'H,'O,'U,'T,'
A24A 474F53     406       .BY 'G,'O,'S,'U,'B+$80
A24F 4F5554     407 TA24F .BY 'O,'U,'T,' ,'O,'F,' ,'D,'A,'T,'A+$80
A25A 494C4C     408 TA25A .BY 'I,'L,'L,'E,'G,'A,'L
A261 205155     409       .BY ' ,'Q,'U,'A,'N,'T,'I,'T,'Y+$80
A26A 4F5645     410 TA26A .BY 'O,'V,'E,'R,'F,'L,'O,'W+$80
A272 4F5554     411 TA272 .BY 'O,'U,'T,' ,'O,'F,' ,'M,'E,'M,'O,'R,'Y+$80
A27F 554E44     412 TA27F .BY 'U,'N,'D,'E,'F,$27,'D,'
A287 535441     413       .BY 'S,'T,'A,'T,'E,'M,'E,'N,'T+$80
A290 424144     414 TA290 .BY 'B,'A,'D,' ,'S,'U,'B,'S,'C,'R,'I,'P,'T+$80
A29D 524544     415 TA29D .BY 'R,'E,'D,'I,'M,$27,'D,' ,'A,'R,'R,'A,'Y+$80
A2AA 444956     416 TA2AA .BY 'D,'I,'V,'I,'S,'I,'O,'N,' ,'B,'Y
A2B5 205A45     417       .BY ' ,'Z,'E,'R,'O+$80
A2BA 494C4C     418 TA2BA .BY 'I,'L,'L,'E,'G,'A,'L,' ,'D,'I,'R,'E,'C,'T+$80
A2C8 545950     419 TA2C8 .BY 'T,'Y,'P,'E,' ,'M,'I,'S,'M,'A,'T,'C,'H+$80
A2D5 535452     420 TA2D5 .BY 'S,'T,'R,'I,'N,'G,' ,'T,'O,'O,' ,'L,'O,'N,'G+$80
A2E4 46494C     421 TA2E4 .BY 'F,'I,'L,'E,' ,'D,'A,'T,'A+$80
A2ED 464F52     422 TA2ED .BY 'F,'O,'R,'M,'U,'L,'A,' ,'I,'O,'O,'
A2F9 434F4D     423       .BY 'C,'O,'M,'P,'L,'E,'X+$80
A300 43414E     424 TA300 .BY 'C,'A,'N,$27,'T,' ,'C,'O,'N,'T,'I,'N,'U,'E+$80
A30E 554E44     425 TA30E .BY 'U,'N,'D,'E,'F,$27,'D
A315 204655     426       .BY ' ,'F,'U,'N,'C,'T,'I,'O,'N+$80
A31E 564552     427 TA31E .BY 'V,'E,'R,'I,'F,'Y+$80
A324 4C4F41     428 TA324 .BY 'L,'O,'A,'D+$80
```

```
                430 ;error message address table
                431 ;index 01-1E loaded into X to reference message table
                432 ;
A328 9EA1       433 TA328 .W  TA19E      ;01 Too Many Files
A32A ACA1       434       .W  TA1AC      ;02 File Open
A32C B5A1       435       .W  TA1B5      ;03 File Not Open
A32E C2A1       436       .W  TA1C2      ;04 File Not Found
A330 D0A1       437       .W  TA1D0      ;05 Device Not Present
A332 E2A1       438       .W  TA1E2      ;06 Not Input File
A334 F0A1       439       .W  TA1F0      ;07 Not Output File
A336 FFA1       440       .W  TA1FF      ;08 Missing File Name
A338 10A2       441       .W  TA210      ;09 Illegal Device Number
A33A 25A2       442       .W  TA225      ;0A Next Without For
A33C 35A2       443       .W  TA235      ;0B Syntax
A33E 3BA2       444       .W  TA23B      ;0C Return Without Gosub
A340 4FA2       445       .W  TA24F      ;0D Out Of Data
A342 5AA2       446       .W  TA25A      ;0E Illegal Quantity
A344 6AA2       447       .W  TA26A      ;0F Overflow
A346 72A2       448       .W  TA272      ;10 Out Of Memory
A348 7FA2       449       .W  TA27F      ;11 Undef'd Statement
A34A 90A2       450       .W  TA290      ;12 Bad Subscript
A34C 9DA2       451       .W  TA29D      ;13 Redim'd Array
A34E AAA2       452       .W  TA2AA      ;14 Division By Zero
A350 BAA2       453       .W  TA2BA      ;15 Illegal Direct
A352 C8A2       454       .W  TA2C8      ;16 Type Mismatch
A354 D5A2       455       .W  TA2D5      ;17 String Too Long
A356 E4A2       456       .W  TA2E4      ;18 File Data
A358 EDA2       457       .W  TA2ED      ;19 Formula Too Complex
A35A 00A3       458       .W  TA300      ;1A Can't Continue
A35C 0EA3       459       .W  TA30E      ;1B Undef'd Function
A35E 1EA3       460       .W  TA31E      ;1C Verify
A360 24A3       461       .W  TA324      ;1D Load
A362 83A3       462       .W  TA383      ;1E Break
                463 ;
A364 0D4F4B     464 TA364 .BY $0D,'O,'K,$0D,$00
A369 202045     465 TA369 .BY ' ,' ,'E,'R,'R,'O,'R,$00
A371 20494E     466 TA371 .BY ' ,'I,'N,' ,$00
A376 0D0A52     467 TA376 .BY $0D,$0A,'R,'E,'A,'D,'Y,'.,$0D,$0A,$00
A381 0D0A       468 TA381 .BY $0D,$0A
A383 425245     469 TA383 .BY 'B,'R,'E,'A,'K,$00,$A0
```

```
                471 ;search for "FOR" blocks on stack (code 81)
                472 ;
                473 ;if Z49/Z4A > $00FF, get FOR block with address = Z49/Z4A
                474 ;if Z49/Z4A < $0100, get highest FOR block in Z49/Z4A
                475 ;upon exit, X = stack above FOR block
                476 ;Z=1 when FOR block found
                477 ;Z=0 when FOR block not found
                478 ;A=code of block found
                479 ;
A38A BA         480 SA38A TSX
A38B E8         481       INX
A38C E8         482       INX
A38D E8         483       INX
A38E E8         484       INX             ;point to highest block
A38F BD0101     485 BA38F LDA X0101,X
A392 C981       486       CMP $81         ;if no FOR block
A394 D021       487       BNE BA3B7       ;return with Z=0
A396 A54A       488       LDA Z4A
A398 D00A       489       BNE BA3A4       ;if no address
A39A BD0201     490       LDA X0102,X     ;get address from highest block
A39D 8549       491       STA Z49
A39F BD0301     492       LDA X0103,X
A3A2 854A       493       STA Z4A
A3A4 DD0301     494 BA3A4 CMP X0103,X     ;compare address to block
A3A7 D007       495       BNE BA3B0
A3A9 A549       496       LDA Z49
A3AB DD0201     497       CMP X0102,X
A3AE F007       498       BEQ BA3B7       ;return with Z=1 if equal
A3B0 8A         499 BA3B0 TXA             ;if not equal
A3B1 18         500       CLC
A3B2 6912       501       ADC $12         ;skip a FOR block
A3B4 AA         502       TAX
A3B5 D0D8       503       BNE BA38F       ;and try again
A3B7 60         504 BA3B7 RTS
```

```
                    506 ;move bytes after a check for space
                    507 ;
A3B8 2008A4         508 SA3B8 JSR SA408     ;do array area overflow check for AY
A3BB 8531           509       STA Z31       ;set new end of array area
A3BD 8432           510       STY Z32
                    511 ;
                    512 ;move bytes routine
                    513 ;source address in Z5F/Z60
                    514 ;end of source address in Z5A/Z5B
                    515 ;end of destination address in Z58/Z59
                    516 ;
                    517 ;highest bytes moved first
                    518 ;X and Y at 0 upon return
                    519 ;
A3BF 38             520 SA3BF SEC
A3C0 A55A           521       LDA Z5A
A3C2 E55F           522       SBC Z5F
A3C4 8522           523       STA Z22       ;compute length of area to be moved
A3C6 A8             524       TAY           ;Y=low order 8 bits
A3C7 A55B           525       LDA Z5B
A3C9 E560           526       SBC Z60
A3CB AA             527       TAX           ;X=high order 8 bits
A3CC E8             528       INX
A3CD 98             529       TYA
A3CE F023           530       BEQ BA3F3     ;if multiple of 256, skip remainder
A3D0 A55A           531       LDA Z5A
A3D2 38             532       SEC
A3D3 E522           533       SBC Z22
A3D5 855A           534       STA Z5A
A3D7 B003           535       BCS BA3DC     ;Z5A/Z5B points to start source block
A3D9 C65B           536       DEC Z5B
A3DB 38             537       SEC
A3DC A558           538 BA3DC LDA Z58
A3DE E522           539       SBC Z22
A3E0 8558           540       STA Z58
A3E2 B008           541       BCS BA3EC
A3E4 C659           542       DEC Z59       ;Z58/Z59 points to destination
A3E6 9004           543       BCC BA3EC
A3E8 B15A           544 BA3E8 LDA (Z5A),Y   ;fetch a byte from source
A3EA 9158           545       STA (Z58),Y   ;move it to destination
A3EC 88             546 BA3EC DEY
A3ED D0F9           547       BNE BA3E8     ;repeat for all 256 bytes in a page
A3EF B15A           548       LDA (Z5A),Y   ;also last byte
A3F1 9158           549       STA (Z58),Y
A3F3 C65B           550 BA3F3 DEC Z5B       ;point to lower block of source
A3F5 C659           551       DEC Z59       ;point to lower block of destination
A3F7 CA             552       DEX
A3F8 D0F2           553       BNE BA3EC     ;repeat for all blocks
A3FA 60             554       RTS
```

```
                556 ;test for 2 * A bytes available on the stack
                557 ;
                558 ;allow 62 bytes extra for interrupt processing
                559 ;indicate fatal error if not enough space left
                560 ;
A3FB 0A         561 SA3FB ASL A          ;multiply A * 2
A3FC 693E       562       ADC $3E        ;62 bytes extra
A3FE B035       563       BCS BA435      ;error if overflow
A400 8522       564       STA Z22
A402 BA         565       TSX
A403 E422       566       CPX Z22        ;if stack above result
A405 902E       567       BCC BA435      ;overflow error
A407 60         568       RTS
                569 ;
                570 ;array area overflow check
                571 ;
A408 C434       572 SA408 CPY Z34        ;if A below string storage pointer
A40A 9028       573       BCC BA434      ;return
A40C D004       574       BNE BA412
A40E C533       575       CMP Z33
A410 9022       576       BCC BA434
A412 48         577 BA412 PHA            ;save AY
A413 A209       578       LDX $09
A415 98         579       TYA
A416 48         580 BA416 PHA
A417 B557       581       LDA Z57,X      ;save Z58-Z61 on stack
A419 CA         582       DEX
A41A 10FA       583       BPL BA416
A41C 2026B5     584       JSR SB526      ;perform string cleanup
A41F A2F7       585       LDX $F7
A421 68         586 BA421 PLA
A422 9561       587       STA Z61,X      ;restore Z58-Z61 from stack
A424 E8         588       INX
A425 30FA       589       BMI BA421
A427 68         590       PLA
A428 A8         591       TAY
A429 68         592       PLA            ;restore AY
A42A C434       593       CPY Z34        ;if AY still above string pointer,
A42C 9006       594       BCC BA434      ;then error OUT OF MEMORY
A42E D005       595       BNE BA435
A430 C533       596       CMP Z33
A432 B001       597       BCS BA435
A434 60         598 BA434 RTS
                599 ;
                600 ;fatal error OUT OF MEMORY
                601 ;
A435 A210       602 BA435 LDX $10        ;point to error OUT OF MEMORY
```

```
                    604 ;handle error messages
                    605 ;
                    606 ;X points to error message address table TA328
                    607 ;
A437 6C0003         608 JA437 JMP (X0300)   ;handle error message (normally A43A)
                    609 ;
                    610 ;standard error message handler
                    611 ;
A43A 8A             612       TXA
A43B 0A             613       ASL A
A43C AA             614       TAX
A43D BD26A3         615       LDA TA328-2,X ;fetch address from error message table
A440 8522           616       STA Z22
A442 BD27A3         617       LDA TA328-1,X
A445 8523           618       STA Z23
A447 20CCFF         619       JSR XFFCC     ;restore I/O devices to default
A44A A900           620       LDA $00
A44C 8513           621       STA Z13       ;set default CMD output file
A44E 20D7AA         622       JSR SAAD7     ;end line on CMD output file
A451 2045AB         623       JSR SAB45     ;print question mark on output file
A454 A000           624       LDY $00
A456 B122           625 BA456 LDA (Z22),Y
A458 48             626       PHA
A459 297F           627       AND $7F
A45B 2047AB         628       JSR SAB47     ;print a character on output file
A45E C8             629       INY
A45F 68             630       PLA
A460 10F4           631       BPL BA456     ;repeat if end of message not reached
A462 207AA6         632       JSR SA67A     ;reset stack and program pointers
A465 A969           633       LDA <TA369
A467 A0A3           634       LDY >TA369    ;set AY to mesage ERROR
A469 201EAB         635 JA469 JSR SAB1E     ;print message from AY
A46C A43A           636       LDY Z3A       ;if in direct mode
A46E C8             637       INY
A46F F003           638       BEQ BA474     ;restart BASIC
A471 20C2BD         639       JSR SBDC2     ;else print IN STATEMENT and #
A474 A976           640 BA474 LDA <TA376
A476 A0A3           641       LDY >TA376    ;set AY to message READY
A478 201EAB         642       JSR SAB1E     ;print READY message
A47B A980           643       LDA $80
A47D 2090FF         644       JSR XFF90     ;set kernal msg flag for direct mode
A480 6C0203         645 BA480 JMP (X0302)   ;perform warm start (normally A483)
                    646 ;
                    647 ;standard warm start routine (BASIC Interpreter)
                    648 ;
A483 2060A5         649       JSR SA560     ;get statement into the input buffer
A486 867A           650       STX Z7A       ;move beginning of line address
A488 847B           651       STY Z7B       ;to current character address
A48A 207300         652       JSR X0073     ;get next character of statement
A48D AA             653       TAX
A48E F0F0           654       BEQ BA480     ;skip statement if end of line
A490 A2FF           655       LDX $FF
A492 863A           656       STX Z3A       ;set Run/Direct switch to Direct
A494 9006           657       BCC BA49C     ;if no line number,
A496 2079A5         658       JSR SA579     ;encode keywords in statement
A499 4CE1A7         659       JMP JA7E1     ;and go execute statement
```

```
                661 ;numbered statements
                662 ;
A49C 206BA9     663 BA49C JSR SA96B     ;gather line number into Z14/Z15
A49F 2079A5     664       JSR SA579     ;encode keywords in statement
A4A2 840B       665       STY Z0B       ;save index for end of line
A4A4 2013A6     666       JSR SA613     ;search for statement in program
A4A7 9044       667       BCC BA4ED     ;if not found, insert line
                668 ;
                669 ;delete old statement (indexed from Z5F/Z60)
                670 ;
A4A9 A001       671       LDY $01
A4AB B15F       672       LDA (Z5F),Y   ;move low of pointer to next statement
A4AD 8523       673       STA Z23
A4AF A52D       674       LDA Z2D       ;move low of ptr beyond last statement
A4B1 8522       675       STA Z22
A4B3 A560       676       LDA Z60       ;move byte of ptr to current statement
A4B5 8525       677       STA Z25
A4B7 A55F       678       LDA Z5F       ;low byte of ptr to current statement
A4B9 88         679       DEY           ;-low byte of pointer to next statement
A4BA F15F       680       SBC (Z5F),Y   ;=length of gap in 2's complement
A4BC 18         681       CLC
A4BD 652D       682       ADC Z2D       ;+ low byte ptr beyond last statement
A4BF 852D       683       STA Z2D       ;= new pointer beyond last statement
A4C1 8524       684       STA Z24       ;also saved
A4C3 A52E       685       LDA Z2E       ;high byte of ptr beyond last statement
A4C5 69FF       686       ADC $FF       ;+ carry
A4C7 852E       687       STA Z2E       ;= new high of pointer beyond last stmt
A4C9 E560       688       SBC Z60       ;-high of pointer to current stmt
A4CB AA         689       TAX           ;=high byte of # of bytes to move
A4CC 38         690       SEC
A4CD A55F       691       LDA Z5F       ;low byte of ptr to current statement
A4CF E52D       692       SBC Z2D       ;-low of pointer beyond last statement
A4D1 A8         693       TAY           ;=number of bytes to move
A4D2 B003       694       BCS BA4D7     ;if necessary,
A4D4 E8         695       INX           ;adjust carry
A4D5 C625       696       DEC Z25       ;also adjust low end pointer
A4D7 18         697 BA4D7 CLC
A4D8 6522       698       ADC Z22
A4DA 9003       699       BCC BA4DF
A4DC C623       700       DEC Z23
A4DE 18         701       CLC
A4DF B122       702 BA4DF LDA (Z22),Y   ;get byte from low end
A4E1 9124       703       STA (Z24),Y   ;move to new low end
A4E3 C8         704       INY
A4E4 D0F9       705       BNE BA4DF     ;repeat until page moved
A4E6 E623       706       INC Z23       ;update page pointers
A4E8 E625       707       INC Z25
A4EA CA         708       DEX
A4EB D0F2       709       BNE BA4DF     ;repeat until last block moved
```

```
                711 ;insert new line at location indicated by Z5F/Z60
                712 ;
A4ED 2059A6     713 BA4ED JSR SA659      ;reset program pointers
A4F0 2033A5     714       JSR SA533      ;relink BASIC lines
A4F3 AD0002     715       LDA X0200      ;if first byte of new line is a null,
A4F6 F088       716       BEQ BA480      ;don't insert
A4F8 18         717       CLC
A4F9 A52D       718       LDA Z2D        ;get low byte of pointer to end of line
A4FB 855A       719       STA Z5A        ;save as end pointer for move
A4FD 650B       720       ADC Z0B        ;add length of line to be inserted
A4FF 8558       721       STA Z58        ;save as end outpout pointer for move
A501 A42E       722       LDY Z2E        ;save high bytes also
A503 845B       723       STY Z5B
A505 9001       724       BCC BA508
A507 C8         725       INY
A508 8459       726 BA508 STY Z59
A50A 20B8A3     727       JSR SA3B8      ;move bytes and check for overflow
A50D A514       728       LDA Z14        ;move line number
A50F A415       729       LDY Z15
A511 8DFE01     730       STA X01FE      ;to fields preceeding input buffer
A514 8CFF01     731       STY X01FF
A517 A531       732       LDA Z31        ;use new upper limit
A519 A432       733       LDY Z32
A51B 852D       734       STA Z2D        ;as new end of program
A51D 842E       735       STY Z2E
A51F A40B       736       LDY Z0B        ;get length of line to be inserted
A521 88         737       DEY
A522 B9FC01     738 BA522 LDA X0200-4,Y ;move new line
A525 915F       739       STA (Z5F),Y    ;into gap
A527 88         740       DEY
A528 10F8       741       BPL BA522      ;loop until line moved
A52A 2059A6     742       JSR SA659      ;reset program pointers
A52D 2033A5     743       JSR SA533      ;relink BASIC lines
A530 4C80A4     744       JMP BA480      ;go back to BASIC
```

```
                746 ;relink BASIC
                747 ;
A533 A52B       748 SA533 LDA Z2B       ;get pointer to beginning of BASIC text
A535 A42C       749       LDY Z2C
A537 8522       750       STA Z22       ;hold in temporary pointer
A539 8423       751       STY Z23
A53B 18         752       CLC
A53C A001       753 BA53C LDY $01
A53E B122       754       LDA (Z22),Y   ;get byte at current statement + 1
A540 F01D       755       BEQ BA55F     ;if at 0, end of program reached
A542 A004       756       LDY $04       ;set start index
A544 C8         757 BA544 INY           ;increment index
A545 B122       758       LDA (Z22),Y
A547 D0FB       759       BNE BA544     ;scan to end of line
A549 C8         760       INY
A54A 98         761       TYA
A54B 6522       762       ADC Z22       ;compute pointer to next statement
A54D AA         763       TAX
A54E A000       764       LDY $00
A550 9122       765       STA (Z22),Y   ;set link in beginning of statement
A552 A523       766       LDA Z23
A554 6900       767       ADC $00
A556 C8         768       INY
A557 9122       769       STA (Z22),Y   ;set new current statement address
A559 8622       770       STX Z22
A55B 8523       771       STA Z23
A55D 90DD       772       BCC BA53C     ;repeat until all statements processed
A55F 60         773 BA55F RTS
                774 ;
                775 ;get statement into input buffer
                776 ;
A560 A200       777 SA560 LDX $00       ;start with index=0
A562 2012E1     778 BA562 JSR XE112     ;get clean character from CMD file
A565 C90D       779       CMP $0D       ;if Return,
A567 F00D       780       BEQ BA576     ;go end line
A569 9D0002     781       STA X0200,X   ;else store character in input buffer
A56C E8         782       INX
A56D E059       783       CPX $59       ;if statement not too long
A56F 90F1       784       BCC BA562     ;repeat
A571 A217       785       LDX $17       ;else point to messge STRING TOO LONG
A573 4C37A4     786       JMP JA437     ;and print error message
                787 ;
A576 4CCAAA     788 BA576 JMP JAACA     ;go end line
```

```
A579 6C0403   790 SA579 JMP (X0304)   ;crunch tokens (normally A57C)
              791 ;
              792 ;crunch tokens routine
              793 ;
A57C A67A     794       LDX Z7A       ;get input index
A57E A004     795       LDY $04       ;set output index -5
A580 840F     796       STY Z0F       ;set not a DATA statement
A582 BD0002   797 BA582 LDA X0200,X   ;get next character
A585 1007     798       BPL BA58E
A587 C9FF     799       CMP $FF       ;check for PI
A589 F03E     800       BEQ BA5C9
A58B E8       801       INX           ;other codes above $7F are ignored
A58C D0F4     802       BNE BA582
A58E C920     803 BA58E CMP $20       ;move blanks
A590 F037     804       BEQ BA5C9
A592 8508     805       STA Z08       ;save possible quote
A594 C922     806       CMP ""
A596 F056     807       BEQ BA5EE     ;move string when between quotes
A598 240F     808       BIT Z0F       ;move character if in DATA statement
A59A 702D     809       BVS BA5C9
A59C C93F     810       CMP $3F       ;if question mark
A59E D004     811       BNE BA5A4
A5A0 A999     812       LDA $99       ;replace by code for PRINT
A5A2 D025     813       BNE BA5C9
A5A4 C930     814 BA5A4 CMP "0        ;move if numeric
A5A6 9004     815       BCC BA5AC
A5A8 C93C     816       CMP $3C
A5AA 901D     817       BCC BA5C9
A5AC 8471     818 BA5AC STY Z71       ;save output index
A5AE A000     819       LDY $00       ;initialize table index
A5B0 840B     820       STY Z0B       ;initialize keyword count
A5B2 88       821       DEY
A5B3 867A     822       STX Z7A       ;save input index
A5B5 CA       823       DEX
A5B6 C8       824 BA5B6 INY           ;next character in table
A5B7 E8       825       INX           ;next character in line
A5B8 BD0002   826 BA5B8 LDA X0200,X   ;get character from input buffer
A5BB 38       827       SEC
A5BC F99EA0   828       SBC TA09E,Y   ;if equal to table character
A5BF F0F5     829       BEQ BA5B6     ;try next
A5C1 C980     830       CMP $80       ;if equal to character without bit 7
A5C3 D030     831       BNE BA5F5
A5C5 050B     832       ORA Z0B       ;save keyword count + $80
A5C7 A471     833 BA5C7 LDY Z71       ;restore output index
A5C9 E8       834 BA5C9 INX           ;advance input index
A5CA C8       835       INY           ;advance output index
A5CB 99FB01   836       STA X0200-5,Y ;store character or code
A5CE B9FB01   837       LDA X0200-5,Y
A5D1 F036     838       BEQ BA609     ;if zero, end of string
A5D3 38       839       SEC
A5D4 E93A     840       SBC ":        ;if colon, set flag to not data
A5D6 F004     841       BEQ BA5DC
A5D8 C949     842       CMP $49       ;if code for DATA, set flag
A5DA D002     843       BNE BA5DE
A5DC 850F     844 BA5DC STA Z0F
A5DE 38       845 BA5DE SEC
A5DF E955     846       SBC $55       ;if REM
A5E1 D09F     847       BNE BA582
A5E3 8508     848       STA Z08       ;set 00 as terminator
A5E5 BD0002   849 BA5E5 LDA X0200,X   ;get next character from input buffer
```

```
A5E8 F0DF    850          BEQ BA5C9      ;end upon zero
A5EA C508    851          CMP Z08
A5EC F0DB    852          BEQ BA5C9      ;or terminator (")
A5EE C8      853 BA5EE    INY            ;advance output index
A5EF 99FB01  854          STA X0200-5,Y  ;move character
A5F2 E8      855          INX            ;advance input index
A5F3 D0F0    856          BNE BA5E5      ;repeat
A5F5 A67A    857 BA5F5    LDX Z7A        ;at end of keyword from table
A5F7 E60B    858          INC Z0B        ;increment count
A5F9 C8      859 BA5F9    INY            ;advance table pointer
A5FA B99DA0  860          LDA TA09E-1,Y  ;beyond end of last keyword
A5FD 10FA    861          BPL BA5F9
A5FF B99EA0  862          LDA TA09E,Y    ;if not at end of table
A602 D0B4    863          BNE BA5B8
A604 BD0002  864          LDA X0200,X    ;restore input character
A607 10BE    865          BPL BA5C7      ;repeat
A609 99FD01  866 BA609    STA X0200-3,Y  ;set end of line
A60C C67B    867          DEC Z7B        ;set current character pointer
A60E A9FF    868          LDA $FF
A610 857A    869          STA Z7A        ;to beginning of input buffer again
A612 60      870          RTS
```

```
                    872 ;search for a statement in the program
                    873 ;
                    874 ;line number search argument in Z14/Z15
                    875 ;exit with C=1/0 for found/not found
                    876 ;Z5F/Z60 set to address of statement found, or next higher
                    877 ;
A613 A52B           878 SA613 LDA Z2B       ;get pointer to beginning of BASIC
A615 A62C           879       LDX Z2C
A617 A001           880 BA617 LDY $01
A619 855F           881       STA Z5F       ;save pointer to current statement
A61B 8660           882       STX Z60
A61D B15F           883       LDA (Z5F),Y   ;get link address in current statement
A61F F01F           884       BEQ BA640     ;0=end of program
A621 C8             885       INY
A622 C8             886       INY
A623 A515           887       LDA Z15
A625 D15F           888       CMP (Z5F),Y   ;compare statement numbers
A627 9018           889       BCC BA641     ;return if search high (not found)
A629 F003           890       BEQ BA62E     ;since high matches, check low
A62B 88             891       DEY
A62C D009           892       BNE BA637     ;continue since statement number low
A62E A514           893 BA62E LDA Z14
A630 88             894       DEY
A631 D15F           895       CMP (Z5F),Y   ;compare low order of statement numbers
A633 900C           896       BCC BA641     ;return if high
A635 F00A           897       BEQ BA641     ;return if equal
A637 88             898 BA637 DEY
A638 B15F           899       LDA (Z5F),Y   ;get pointer to next statement in AY
A63A AA             900       TAX
A63B 88             901       DEY
A63C B15F           902       LDA (Z5F),Y
A63E B0D7           903       BCS BA617     ;repeat
A640 18             904 BA640 CLC
A641 60             905 BA641 RTS
```

```
                907 ;"NEW" command
                908 ;
A642 D0FD       909 WA642 BNE BA641     ;if parameters present, SYNTAX Error
A644 A900       910       LDA $00
A646 A8         911       TAY
A647 912B       912       STA (Z2B),Y   ;store zero's
A649 C8         913       INY
A64A 912B       914       STA (Z2B),Y   ;in first 2 bytes of BASIC program area
A64C A52B       915       LDA Z2B       ;pointer to start of BASIC
A64E 18         916       CLC
A64F 6902       917       ADC $02       ;+ 2
A651 852D       918       STA Z2D       ;becomes pointer to end of BASIC
A653 A52C       919       LDA Z2C
A655 6900       920       ADC $00
A657 852E       921       STA Z2E
A659 208EA6     922 SA659 JSR SA68E     ;re-initialize current character ptr
A65C A900       923       LDA $00       ;Z = 1
                924 ;
                925 ;"CLR" command
                926 ;
A65E D02D       927 WA65E BNE BA68D     ;if parameters present, SYNTAX Error
A660 20E7FF     928 SA660 JSR XFFE7     ;close all channels and files
A663 A537       929       LDA Z37       ;get memory limit in AY
A665 A438       930       LDY Z38
A667 8533       931       STA Z33       ;reset string storage pointer
A669 8434       932       STY Z34
A66B A52D       933       LDA Z2D       ;move pointer to variables in AY
A66D A42E       934       LDY Z2E
A66F 852F       935       STA Z2F       ;into pointer to start of arrays
A671 8430       936       STY Z30
A673 8531       937       STA Z31       ;also into pointer to end of arrays
A675 8432       938       STY Z32
A677 201DA8     939       JSR SA81D     ;perform RESTORE
                940 ;
                941 ;reset stack and program pointers
                942 ;
A67A A219       943 SA67A LDX <Z19
A67C 8616       944       STX Z16       ;reset string descriptor stack index
A67E 68         945       PLA           ;get own return address in AY
A67F A8         946       TAY
A680 68         947       PLA
A681 A2FA       948       LDX $FA
A683 9A         949       TXS           ;reset stack pointer
A684 48         950       PHA           ;put own return address back on stack
A685 98         951       TYA
A686 48         952       PHA
A687 A900       953       LDA $00
A689 853E       954       STA Z3E       ;clear pointer for CONTinue
A68B 8510       955       STA Z10       ;also subscript flag
A68D 60         956 BA68D RTS
```

```
                    958 ;set current character pointer to beginning of program -1
                    959 ;
A68E 18             960 SA68E CLC
A68F A52B           961       LDA Z2B       ;get pointer to beginning of BASIC area
A691 69FF           962       ADC $FF       ;-1
A693 857A           963       STA Z7A       ;store into current character pointer
A695 A52C           964       LDA Z2C       ;same for high byte
A697 69FF           965       ADC $FF
A699 857B           966       STA Z7B
A69B 60             967       RTS
                    968 ;
                    969 ;"LIST" command
                    970 ;
A69C 9006           971 WA69C BCC BA6A4     ;parameter must be numeric,
A69E F004           972       BEQ BA6A4     ;or else none at all
A6A0 C9AB           973       CMP $AB       ;or "-"
A6A2 D0E9           974       BNE BA68D     ;if none of above, SYNTAX Error
A6A4 206BA9         975 BA6A4 JSR SA96B     ;gather decimal number into Z14/Z15
A6A7 2013A6         976       JSR SA613     ;search for statement in program
A6AA 207900         977       JSR X0079     ;get current character
A6AD F00C           978       BEQ BA6BB     ;if not at end of statement
A6AF C9AB           979       CMP $AB       ;or "-"
A6B1 D08E           980       BNE BA641     ;then SYNTAX Error
A6B3 207300         981       JSR X0073     ;get next character after "-"
A6B6 206BA9         982       JSR SA96B     ;gather decimal number into Z14/Z15
A6B9 D086           983       BNE BA641     ;if not end of statement, SYNTAX Error
A6BB 68             984 BA6BB PLA           ;remove return address from stack
A6BC 68             985       PLA
A6BD A514           986       LDA Z14       ;if last parameter zero (missing)
A6BF 0515           987       ORA Z15
A6C1 D006           988       BNE BA6C9
A6C3 A9FF           989       LDA $FF
A6C5 8514           990       STA Z14       ;set it to 65535
A6C7 8515           991       STA Z15
```

```
                993 ;list statement from Z5F/Z60 thru Z14/Z15
                994 ;
A6C9 A001       995 BA6C9 LDY $01       ;set string switch to not a string
A6CB 840F       996       STY Z0F
A6CD B15F       997       LDA (Z5F),Y   ;get high byte of link address for line
A6CF F043       998       BEQ BA714     ;0=end of program, go restart BASIC
A6D1 202CA8     999       JSR SA82C     ;check for Stop Key
A6D4 20D7AA    1000       JSR SAAD7     ;end line on CMD output file
A6D7 C8        1001       INY
A6D8 B15F      1002       LDA (Z5F),Y
A6DA AA        1003       TAX           ;set AX to statement #
A6DB C8        1004       INY
A6DC B15F      1005       LDA (Z5F),Y
A6DE C515      1006       CMP Z15       ;compare to end of list statement
A6E0 D004      1007       BNE BA6E6
A6E2 E414      1008       CPX Z14
A6E4 F002      1009       BEQ BA6E8
A6E6 B02C      1010 BA6E6 BCS BA714     ;if higher, stop
A6E8 8449      1011 BA6E8 STY Z49       ;save index in statement
A6EA 20CDBD    1012       JSR SBDCD     ;print statement # from AX
A6ED A920      1013       LDA $20       ;insert a blank
A6EF A449      1014 BA6EF LDY Z49       ;restore index in statement
A6F1 297F      1015       AND $7F       ;clear bit 7
A6F3 2047AB    1016 BA6F3 JSR SAB47     ;print character from A on CMD file
A6F6 C922      1017       CMP ""        ;if a quote character
A6F8 D006      1018       BNE BA700
A6FA A50F      1019       LDA Z0F
A6FC 49FF      1020       EOR $FF       ;flip string switch
A6FE 850F      1021       STA Z0F
A700 C8        1022 BA700 INY           ;advance index
A701 F011      1023       BEQ BA714     ;if line too long, restart BASIC
A703 B15F      1024       LDA (Z5F),Y
A705 D010      1025       BNE BA717     ;if not end of line, go print it
A707 A8        1026       TAY           ;if end of line,
A708 B15F      1027       LDA (Z5F),Y   ;get pointer to next statement in AX
A70A AA        1028       TAX
A70B C8        1029       INY
A70C B15F      1030       LDA (Z5F),Y
A70E 865F      1031       STX Z5F       ;and reset line address
A710 8560      1032       STA Z60
A712 D0B5      1033       BNE BA6C9     ;then loop back for next line
A714 4C86E3    1034 BA714 JMP XE386     ;go restart BASIC
```

```
A717 6C0603 1036 BA717 JMP (X0306)   ;go print tokens (normally A71A)
             1037 ;
             1038 ;print tokens
             1039 ;
A71A 10D7   1040       BPL BA6F3     ;if bit 7 clear, print one character
A71C C9FF   1041       CMP $FF       ;if code for PI,
A71E F0D3   1042       BEQ BA6F3     ;print PI
A720 240F   1043       BIT Z0F       ;if in string mode
A722 30CF   1044       BMI BA6F3     ;also print shifted codes
A724 38     1045       SEC
A725 E97F   1046       SBC $7F       ;compute keyword #
A727 AA     1047       TAX
A728 8449   1048       STY Z49       ;save index in statement
A72A A0FF   1049       LDY $FF
A72C CA     1050 BA72C DEX           ;if keyword found
A72D F008   1051       BEQ BA737     ;go print keyword
A72F C8     1052 BA72F INY
A730 B99EA0 1053       LDA TA09E,Y   ;else get character from keyword table
A733 10FA   1054       BPL BA72F
A735 30F5   1055       BMI BA72C     ;until bit 7 set (end of keyword)
             1056 ;
             1057 ;print keyword
             1058 ;
A737 C8     1059 BA737 INY
A738 B99EA0 1060       LDA TA09E,Y   ;get next character from keyword table
A73B 30B2   1061       BMI BA6EF     ;if bit 7 set go print last character
A73D 2047AB 1062       JSR SAB47     ;print character on CMD file
A740 D0F5   1063       BNE BA737     ;and repeat
```

```
                1065 ;"FOR" command
                1066 ;
A742 A980       1067 WA742 LDA $80       ;set flag for
A744 8510       1068       STA Z10       ;no integer variables or array elements
A746 20A5A9     1069       JSR SA9A5     ;execute comand LET
A749 208AA3     1070       JSR SA38A     ;get FOR block of variable used
A74C D005       1071       BNE BA753
A74E 8A         1072       TXA           ;if found,
A74F 690F       1073       ADC $0F       ;drop stack ptr below that FOR block
A751 AA         1074       TAX
A752 9A         1075       TXS
A753 68         1076 BA753 PLA           ;remove return address from stack
A754 68         1077       PLA
A755 A909       1078       LDA $09       ;9 addresses on stack needed
A757 20FBA3     1079       JSR SA3FB     ;else OUT OF MEMORY Error
A75A 2006A9     1080       JSR SA906     ;get offset to end of statement
A75D 18         1081       CLC
A75E 98         1082       TYA
A75F 657A       1083       ADC Z7A       ;compute pointer to end of statement
A761 48         1084       PHA
A762 A57B       1085       LDA Z7B
A764 6900       1086       ADC $00
A766 48         1087       PHA           ;save on stack
A767 A53A       1088       LDA Z3A
A769 48         1089       PHA
A76A A539       1090       LDA Z39
A76C 48         1091       PHA           ;save current statement # on stack
A76D A9A4       1092       LDA $A4
A76F 20FFAE     1093       JSR SAEFF     ;if not TO, then SYNTAX Error
A772 208DAD     1094       JSR SAD8D     ;initial value must be non-string
A775 208AAD     1095       JSR SAD8A     ;get next non-string value (TO value)
A778 A566       1096       LDA Z66       ;move sign of flp accu
A77A 097F       1097       ORA $7F
A77C 2562       1098       AND Z62
A77E 8562       1099       STA Z62       ;into most significant bit
A780 A98B       1100       LDA <WA78B
A782 A0A7       1101       LDY >WA78B
A784 8522       1102       STA Z22       ;set return address for continuation
A786 8423       1103       STY Z23
A788 4C43AE     1104       JMP JAE43     ;round and save flp accu (TO value)
                1105 ;
A78B A9BC       1106 WA78B LDA <TB9BC    ;set AY to default step (1)
A78D A0B9       1107       LDY >TB9BC
A78F 20A2BB     1108       JSR SBBA2     ;load default step
A792 207900     1109       JSR X0079     ;get next character
A795 C9A9       1110       CMP $A9       ;if STEP
A797 D006       1111       BNE BA79F
A799 207300     1112       JSR X0073     ;get next character
A79C 208AAD     1113       JSR SAD8A     ;get next non-string value
A79F 202BBC     1114 BA79F JSR SBC2B     ;get SGN of flp accu
A7A2 2038AE     1115       JSR SAE38     ;round flp accu and save on stack
A7A5 A54A       1116       LDA Z4A       ;save pointer to FOR variable
A7A7 48         1117       PHA
A7A8 A549       1118       LDA Z49
A7AA 48         1119       PHA
A7AB A981       1120       LDA $81       ;save code for FOR block
A7AD 48         1121       PHA
```

```
                1123 ;execute next statement
                1124 ;
A7AE 202CA8     1125 JA7AE JSR SA82C     ;check Stop Key
A7B1 A57A       1126       LDA Z7A
A7B3 A47B       1127       LDY Z7B       ;get ptr to end of old statement in AY
A7B5 C002       1128       CPY $02
A7B7 EA         1129       NOP
A7B8 F004       1130       BEQ BA7BE     ;if not direct mode,
A7BA 853D       1131       STA Z3D       ;store pointer for possible CONT
A7BC 843E       1132       STY Z3E
A7BE A000       1133 BA7BE LDY $00
A7C0 B17A       1134       LDA (Z7A),Y   ;get last byte
A7C2 D043       1135       BNE BA807     ;if not 0, check for ":"
A7C4 A002       1136       LDY $02
A7C6 B17A       1137       LDA (Z7A),Y   ;get high of pointer to next statement
A7C8 18         1138       CLC
A7C9 D003       1139       BNE BA7CE
A7CB 4C4BA8     1140       JMP JA84B     ;0=end of program
                1141 ;
A7CE C8         1142 BA7CE INY
A7CF B17A       1143       LDA (Z7A),Y   ;move statement # into Z39/Z3A
A7D1 8539       1144       STA Z39
A7D3 C8         1145       INY
A7D4 B17A       1146       LDA (Z7A),Y
A7D6 853A       1147       STA Z3A
A7D8 98         1148       TYA           ;advance pointer over statement header
A7D9 657A       1149       ADC Z7A
A7DB 857A       1150       STA Z7A
A7DD 9002       1151       BCC JA7E1
A7DF E67B       1152       INC Z7B
A7E1 6C0803     1153 JA7E1 JMP (X0308)   ;go execute a statement (normally A7E4)
                1154 ;
                1155 ;execute a statement
                1156 ;
A7E4 207300     1157       JSR X0073     ;get next character
A7E7 20EDA7     1158       JSR SA7ED     ;execute command in A
A7EA 4CAEA7     1159       JMP JA7AE     ;go execute next statement
```

```
                1161 ;execute command in A
                1162 ;
A7ED F03C       1163 SA7ED BEQ BA82B      ;if Z = 1, return (dummy statement)
A7EF E980       1164 JA7EF SBC $80        ;if A < $80
A7F1 9011       1165       BCC BA804      ;perform LET
A7F3 C923       1166       CMP $23        ;if A = > A3 (highest command)
A7F5 B017       1167       BCS BA80E      ;then check for GOTO
A7F7 0A         1168       ASL A          ;get 2 * (A - 80) as index to table
A7F8 A8         1169       TAY
A7F9 B90DA0     1170       LDA TA00C+1,Y ;move routine address onto stack
A7FC 48         1171       PHA
A7FD B90CA0     1172       LDA TA00C,Y
A800 48         1173       PHA
A801 4C7300     1174       JMP X0073      ;get first char of parameters and go
                1175 ;
A804 4CA5A9     1176 BA804 JMP SA9A5      ;execute command LET
                1177 ;
A807 C93A       1178 BA807 CMP ':         ;if character is a colon,
A809 F0D6       1179       BEQ JA7E1      ;execute next command
A80B 4C08AF     1180 BA80B JMP JAF08      ;else print SYNTAX Error
                1181 ;
A80E C94B       1182 BA80E CMP $4B        ;if not code for GO
A810 D0F9       1183       BNE BA80B      ;then SYNTAX Error
A812 207300     1184       JSR X0073      ;else get next character
A815 A9A4       1185       LDA $A4        ;set code for TO
A817 20FFAE     1186       JSR SAEFF      ;if equal
A81A 4CA0A8     1187       JMP JA8A0      ;go do command GOTO
```

```
                1189 ;"RESTORE" command
                1190 ;
A81D            1191 WA81D =   *
A81D 38         1192 SA81D SEC
A81E A52B       1193       LDA Z2B      ;get pointer to beginning of BASIC
A820 E901       1194       SBC $01      ;-1
A822 A42C       1195       LDY Z2C      ;into AY
A824 B001       1196       BCS BA827
A826 88         1197       DEY
A827 8541       1198 BA827 STA Z41      ;store AY in current DATA address
A829 8442       1199       STY Z42
A82B 60         1200 BA82B RTS
                1201 ;
A82C 20E1FF     1202 SA82C JSR XFFE1    ;test Stop Key
                1203 ;
                1204 ;"STOP" command
                1205 ;
A82F B001       1206 WA82F BCS BA832    ;preserve C flag
                1207 ;
                1208 ;"END" command
                1209 ;
A831 18         1210 WA831 CLC          ;clear C flag
A832 D03C       1211 BA832 BNE BA870    ;if parameters present, SYNTAX Error
A834 A57A       1212       LDA Z7A      ;set AY to address of current line
A836 A47B       1213       LDY Z7B
A838 A63A       1214       LDX Z3A
A83A E8         1215       INX
A83B F00C       1216       BEQ BA849    ;if not in direct mode,
A83D 853D       1217       STA Z3D      ;save pointer for possible CONT
A83F 843E       1218       STY Z3E
A841 A539       1219       LDA Z39      ;AY=current statement #
A843 A43A       1220       LDY Z3A
A845 853B       1221       STA Z3B      ;move current statement #
A847 843C       1222       STY Z3C      ;to previous statement #
A849 68         1223 BA849 PLA          ;remove own return address
A84A 68         1224       PLA
A84B A981       1225 JA84B LDA <TA381   ;set AY to BREAK message
A84D A0A3       1226       LDY >TA381
A84F 9003       1227       BCC BA854    ;if STOP command,
A851 4C69A4     1228       JMP JA469    ;print message and restart BASIC
A854 4C86E3     1229 BA854 JMP XE386    ;else restart BASIC
```

```
                1231 ;"CONT" command
                1232 ;
A857 D017       1233 WA857 BNE BA870     ;if parameters present, SYNTAX Error
A859 A21A       1234       LDX $1A       ;point to message CAN'T CONTINUE
A85B A43E       1235       LDY Z3E       ;get pointer to current statement in AY
A85D D003       1236       BNE BA862     ;if pointer=0,
A85F 4C37A4     1237       JMP JA437     ;fatal error
                1238 ;
A862 A53D       1239 BA862 LDA Z3D       ;move saved character pointer
A864 857A       1240       STA Z7A       ;into current character pointer
A866 847B       1241       STY Z7B
A868 A53B       1242       LDA Z3B       ;move previous statement #
A86A A43C       1243       LDY Z3C
A86C 8539       1244       STA Z39       ;into current statement #
A86E 843A       1245       STY Z3A
A870 60         1246 BA870 RTS
                1247 ;
                1248 ;"RUN" command
                1249 ;
A871 08         1250 WA871 PHP
A872 A900       1251       LDA $00
A874 2090FF     1252       JSR XFF90     ;set kernal messages flag to RUN mode
A877 28         1253       PLP
A878 D003       1254       BNE BA87D     ;if no parameters,
A87A 4C59A6     1255       JMP SA659     ;do CLR and start program
                1256 ;
A87D 2060A6     1257 BA87D JSR SA660     ;else do CLR and then
A880 4C97A8     1258       JMP JA897     ;do GOTO
                1259 ;
                1260 ;"GOSUB" command
                1261 ;
A883 A903       1262 WA883 LDA $03       ;need 3 address on stack
A885 20FBA3     1263       JSR SA3FB     ;else error OUT OF MEMORY
A888 A57B       1264       LDA Z7B
A88A 48         1265       PHA
A88B A57A       1266       LDA Z7A       ;save pointer to current character
A88D 48         1267       PHA           ;on the stack
A88E A53A       1268       LDA Z3A
A890 48         1269       PHA
A891 A539       1270       LDA Z39
A893 48         1271       PHA           ;save current statement # on stack
A894 A98D       1272       LDA $8D
A896 48         1273       PHA           ;save code for GOSUB
A897 207900     1274 JA897 JSR X0079     ;get current character
A89A 20A0A8     1275       JSR JA8A0     ;execute command GOTO
A89D 4CAEA7     1276       JMP JA7AE     ;execute next statement
```

```
                1278 ;"GOTO" command
                1279 ;
A8A0            1280 WA8A0 =   *
A8A0 206BA9     1281 JA8A0 JSR SA96B     ;gather decimal number into Z14/Z15
A8A3 2009A9     1282       JSR SA909     ;get offset to end of line in Y
A8A6 38         1283       SEC
A8A7 A539       1284       LDA Z39       ;fetch current statement number
A8A9 E514       1285       SBC Z14
A8AB A53A       1286       LDA Z3A
A8AD E515       1287       SBC Z15       ;if forward jump,
A8AF B00B       1288       BCS BA8BC     ;let current character pointer
A8B1 98         1289       TYA           ;point to next statement
A8B2 38         1290       SEC
A8B3 657A       1291       ADC Z7A
A8B5 A67B       1292       LDX Z7B       ;also start search there
A8B7 9007       1293       BCC BA8C0
A8B9 E8         1294       INX
A8BA B004       1295       BCS BA8C0
A8BC A52B       1296 BA8BC LDA Z2B       ;else start at beginning of BASIC
A8BE A62C       1297       LDX Z2C
A8C0 2017A6     1298 BA8C0 JSR BA617     ;search for statement starting at AX
A8C3 901E       1299       BCC BA8E3     ;if not found, UNDEF'D STATEMENT
A8C5 A55F       1300       LDA Z5F       ;move pointer to statement found
A8C7 E901       1301       SBC $01       ;-1
A8C9 857A       1302       STA Z7A       ;into current character pointer
A8CB A560       1303       LDA Z60
A8CD E900       1304       SBC $00
A8CF 857B       1305       STA Z7B
A8D1 60         1306 BA8D1 RTS
                1307 ;
                1308 ;"RETURN" command
                1309 ;
A8D2 D0FD       1310 WA8D2 BNE BA8D1     ;if parameters present, SYNTAX Error
A8D4 A9FF       1311       LDA $FF
A8D6 854A       1312       STA Z4A
A8D8 208AA3     1313       JSR SA38A     ;get FOR block
A8DB 9A         1314       TXS           ;remove everything above current block
A8DC C98D       1315       CMP $8D       ;and the block found must be a GOSUB
A8DE F00B       1316       BEQ BA8EB
A8E0 A20C       1317       LDX $0C       ;else point to RETURN WITHOUT GOSUB
A8E2 2C         1318       .BY $2C       ;skip next instruction
A8E3 A211       1319 BA8E3 LDX $11       ;point to UNDEF'D STATEMENT message
A8E5 4C37A4     1320       JMP JA437     ;go print error message
                1321 ;
A8E8 4C08AF     1322 BA8E8 JMP JAF08     ;print SYNTAX Error message
                1323 ;
A8EB 68         1324 BA8EB PLA           ;remove GOSUB block from stack
A8EC 68         1325       PLA
A8ED 8539       1326       STA Z39       ;remove statement number
A8EF 68         1327       PLA
A8F0 853A       1328       STA Z3A
A8F2 68         1329       PLA
A8F3 857A       1330       STA Z7A       ;restore current character pointer
A8F5 68         1331       PLA
A8F6 857B       1332       STA Z7B
```

```
                1334 ;"DATA" command
                1335 ;
A8F8            1336 WA8F8 =   *
A8F8 2006A9     1337 JA8F8 JSR SA906      ;get offset to next ":"
A8FB 98         1338 BA8FB TYA
A8FC 18         1339       CLC
A8FD 657A       1340       ADC Z7A        ;add offset to current character pointer
A8FF 857A       1341       STA Z7A        ;(skips statement)
A901 9002       1342       BCC BA905
A903 E67B       1343       INC Z7B
A905 60         1344 BA905 RTS
                1345 ;
                1346 ;get end of statement (":" SA906)
                1347 ;get end of line (00, SA909)
                1348 ;
A906 A23A       1349 SA906 LDX #":         ;set statement separator
A908 2C         1350       .BY $2C        ;skip next instruction
A909 A200       1351 SA909 LDX $00         ;set line separator
A90B 8607       1352       STX Z07        ;save separator character
A90D A000       1353       LDY $00
A90F 8408       1354       STY Z08        ;save alternate separator
A911 A508       1355 BA911 LDA Z08
A913 A607       1356       LDX Z07
A915 8507       1357       STA Z07        ;swap separators
A917 8608       1358       STX Z08
A919 B17A       1359 BA919 LDA (Z7A),Y    ;get next character
A91B F0E8       1360       BEQ BA905      ;if end of line
A91D C508       1361       CMP Z08        ;or separator reached
A91F F0E4       1362       BEQ BA905      ;exit with Y=length scanned
A921 C8         1363       INY            ;else advance pointer
A922 C922       1364       CMP #""        ;if character = quote
A924 D0F3       1365       BNE BA919      ;swap separators and continue
A926 F0E9       1366       BEQ BA911      ;continue
                1367 ;
                1368 ;"IF" command
                1369 ;
A928 209EAD     1370 WA928 JSR SAD9E      ;evaluate expression
A92B 207900     1371       JSR X0079      ;get current character
A92E C989       1372       CMP $89        ;if not code for GOTO
A930 F005       1373       BEQ BA937
A932 A9A7       1374       LDA $A7        ;or code for THEN
A934 20FFAE     1375       JSR SAEFF      ;then SYNTAX Error
A937 A561       1376 BA937 LDA Z61        ;if result of condition true, do action
A939 D005       1377       BNE BA940      ;else skip by dropping through to REM
```

```
                1379 ;"REM" command
                1380 ;
A93B 2009A9     1381 WA93B JSR SA909      ;get offset to end of line
A93E F0BB       1382       BEQ BA8FB      ;go advance current character pointer
                1383 ;
                1384 ;THEN part of IF
                1385 ;
A940 207900     1386 BA940 JSR X0079      ;get current character
A943 B003       1387       BCS BA948      ;if numeric
A945 4CA0A8     1388       JMP JA8A0      ;then execute command GOTO
A948 4CEDA7     1389 BA948 JMP SA7ED      ;else execute command in A
                1390 ;
                1391 ;"ON" command
                1392 ;
A94B 209EB7     1393 WA94B JSR SB79E      ;get next integer value into X
A94E 48         1394       PHA            ;save current character
A94F C98D       1395       CMP $8D        ;if not GOSUB
A951 F004       1396       BEQ BA957
A953 C989       1397 BA953 CMP $89        ;or GOTO
A955 D091       1398       BNE BA8E8      ;then SYNTAX Error
A957 C665       1399 BA957 DEC Z65        ;decrement index
A959 D004       1400       BNE BA95F      ;if zero
A95B 68         1401       PLA            ;restore GOTO or GOSUB code in A
A95C 4CEFA7     1402       JMP JA7EF      ;and execute command in A
A95F 207300     1403 BA95F JSR X0073      ;else get next character
A962 206BA9     1404       JSR SA96B      ;gather decimal number into Z14/Z15
A965 C92C       1405       CMP ",         ;if ends with a comma
A967 F0EE       1406       BEQ BA957      ;then repeat
A969 68         1407       PLA            ;else must be end of statement
A96A 60         1408 BA96A RTS            ;otherwise force SYNTAX Error
```

```
                1410 ;gather decimal number into Z14/Z15
                1411 ;
                1412 ;gathered from current statement
                1413 ;expects A, C and Z to reflect current character
                1414 ;returns with A, C and Z reflecting new
                1415 ;current character (first character after number)
                1416 ;
A96B A200       1417 SA96B LDX $00       ;set answer area to zero
A96D 8614       1418       STX Z14
A96F 8615       1419       STX Z15
A971 B0F7       1420 JA971 BCS BA96A     ;stop at first non-decimal character
A973 E92F       1421       SBC $2F       ;convert decimal to binary
A975 8507       1422       STA Z07       ;save it
A977 A515       1423       LDA Z15
A979 8522       1424       STA Z22       ;save old high order
A97B C919       1425       CMP $19       ;if # gathered so far >= 6400
A97D B0D4       1426       BCS BA953     ;then SYNTAX Error
A97F A514       1427       LDA Z14
A981 0A         1428       ASL A         ;* 2
A982 2622       1429       ROL Z22
A984 0A         1430       ASL A         ;* 4
A985 2622       1431       ROL Z22
A987 6514       1432       ADC Z14       ;+ original = * 5
A989 8514       1433       STA Z14
A98B A522       1434       LDA Z22
A98D 6515       1435       ADC Z15
A98F 8515       1436       STA Z15
A991 0614       1437       ASL Z14       ;* 2 = * 10
A993 2615       1438       ROL Z15
A995 A514       1439       LDA Z14
A997 6507       1440       ADC Z07       ;add new digit
A999 8514       1441       STA Z14
A99B 9002       1442       BCC BA99F
A99D E615       1443       INC Z15
A99F 207300     1444 BA99F JSR X0073     ;get next character
A9A2 4C71A9     1445       JMP JA971     ;and repeat
```

```
                1447 ;"LET" command
                1448 ;
A9A5            1449 WA9A5 =   *
A9A5 208BB0     1450 SA9A5 JSR SB08B     ;gather name and get ptr to variable
A9A8 8549       1451       STA Z49       ;save variable pointer
A9AA 844A       1452       STY Z4A
A9AC A9B2       1453       LDA $B2       ;load code for "="
A9AE 20FFAE     1454       JSR SAEFF     ;must be next character
A9B1 A50E       1455       LDA Z0E
A9B3 48         1456       PHA           ;save integer flag of variable
A9B4 A50D       1457       LDA Z0D
A9B6 48         1458       PHA           ;save string flag of variable
A9B7 209EAD     1459       JSR SAD9E     ;evaluate expression
A9BA 68         1460       PLA           ;restore string flag of variable
A9BB 2A         1461       ROL A         ;also into C flag
A9BC 2090AD     1462       JSR SAD90     ;check value for same type
A9BF D018       1463       BNE BA9D9     ;branch if string to be assigned
A9C1 68         1464       PLA           ;restore integer flag of variable
A9C2 1012       1465 SA9C2 BPL BA9D6     ;branch if flp accu to be stored
                1466 ;
                1467 ;assign to integer
                1468 ;
A9C4 201BBC     1469       JSR SBC1B     ;round flp accu according to guard bit
A9C7 20BFB1     1470       JSR SB1BF     ;convert flp accu to integer
A9CA A000       1471       LDY $00
A9CC A564       1472       LDA Z64       ;get most significant byte of integer
A9CE 9149       1473       STA (Z49),Y   ;store into + 0 of variable
A9D0 C8         1474       INY
A9D1 A565       1475       LDA Z65       ;get least significant byte of integer
A9D3 9149       1476       STA (Z49),Y   ;store into + 1 of variable
A9D5 60         1477       RTS
                1478 ;
                1479 ;assign to flp
                1480 ;
A9D6 4CD0BB     1481 BA9D6 JMP JBBD0     ;go store flp value
                1482 ;
                1483 ;assign to string
                1484 ;
A9D9 68         1485 BA9D9 PLA           ;remove integer flag from stack
A9DA A44A       1486 SA9DA LDY Z4A       ;if high byte of pointer to variable
A9DC C0BF       1487       CPY $BF       ;not same as address of dummy variable
A9DE D04C       1488       BNE BAA2C     ;then go do normal variable
```

```
                1490 ;assign to TI$
                1491 ;
A9E0 20A6B6     1492        JSR SB6A6     ;de-allocate temporary string
A9E3 C906       1493        CMP $06       ;should be 6 characters long
A9E5 D03D       1494        BNE BAA24     ;else ILLEGAL QUANTITY Error
A9E7 A000       1495        LDY $00
A9E9 8461       1496        STY Z61       ;store 0 in flp accu
A9EB 8466       1497        STY Z66
A9ED 8471       1498 BA9ED  STY Z71       ;set index in string
A9EF 201DAA     1499        JSR SAA1D     ;add next digit to flp accu
A9F2 20E2BA     1500        JSR SBAE2     ;multiply flp accu by 10
A9F5 E671       1501        INC Z71       ;increment index
A9F7 A471       1502        LDY Z71
A9F9 201DAA     1503        JSR SAA1D     ;add next digit to flp accu
A9FC 200CBC     1504        JSR SBC0C     ;move rounded flp accu to 2nd flp accu
A9FF AA         1505        TAX           ;get exponent
AA00 F005       1506        BEQ BAA07     ;if zero, skip next multiplication
AA02 E8         1507        INX           ;increment exponent
AA03 8A         1508        TXA           ;*2 in second flp accu
AA04 20EDBA     1509        JSR SBAED     ;add 2nd flp accu to flp accu and *2
AA07 A471       1510 BAA07  LDY Z71       ;get index
AA09 C8         1511        INY
AA0A C006       1512        CPY $06       ;repeat until 6 characters processed
AA0C D0DF       1513        BNE BA9ED
AA0E 20E2BA     1514        JSR SBAE2     ;multiply flp accu by 10
AA11 209BBC     1515        JSR SBC9B     ;convert flp accu to 4 byte integer
AA14 A664       1516        LDX Z64
AA16 A463       1517        LDY Z63
AA18 A565       1518        LDA Z65
AA1A 4CDBFF     1519        JMP XFFDB     ;set real time clock
                1520 ;
                1521 ;add next digit to flp accu
                1522 ;
AA1D B122       1523 SAA1D  LDA (Z22),Y   ;get character from string
AA1F 208000     1524        JSR X0080     ;check for numeric character
AA22 9003       1525        BCC BAA27
AA24 4C48B2     1526 BAA24  JMP JB248      ;ILLEGAL QUANTITY Error if not
                1527 ;
AA27 E92F       1528 BAA27  SBC $2F        ;convert decimal to binary
AA29 4C7EBD     1529        JMP JBD7E     ;add signed integer from A to flp accu
```

```
                1531 ;assign to normal string variable
                1532 ;
AA2C A002       1533 BAA2C LDY $02
AA2E B164       1534       LDA (Z64),Y   ;if pointer to string
AA30 C534       1535       CMP Z34
AA32 9017       1536       BCC BAA4B     ;below allocated string area
AA34 D007       1537       BNE BAA3D
AA36 88         1538       DEY
AA37 B164       1539       LDA (Z64),Y
AA39 C533       1540       CMP Z33
AA3B 900E       1541       BCC BAA4B     ;then move descriptor
AA3D A465       1542 BAA3D LDY Z65
AA3F C42E       1543       CPY Z2E
AA41 9008       1544       BCC BAA4B     ;below end of program
AA43 D00D       1545       BNE BAA52     ;(descriptor stack)
AA45 A564       1546       LDA Z64
AA47 C52D       1547       CMP Z2D
AA49 B007       1548       BCS BAA52
AA4B A564       1549 BAA4B LDA Z64       ;then go move descriptor
AA4D A465       1550       LDY Z65
AA4F 4C68AA     1551       JMP JAA68
                1552 ;
AA52 A000       1553 BAA52 LDY $00       ;else
AA54 B164       1554       LDA (Z64),Y   ;get length of string
AA56 2075B4     1555       JSR SB475     ;allocate area
AA59 A550       1556       LDA Z50       ;store string pointer
AA5B A451       1557       LDY Z51
AA5D 856F       1558       STA Z6F
AA5F 8470       1559       STY Z70
AA61 207AB6     1560       JSR SB67A     ;move string into allocated area
AA64 A961       1561       LDA <Z61      ;set AY to new descriptor
AA66 A000       1562       LDY >Z61
                1563 ;
                1564 ;move descriptor into variable
                1565 ;
AA68 8550       1566 JAA68 STA Z50       ;set pointer to descriptor from AY
AA6A 8451       1567       STY Z51
AA6C 20DBB6     1568       JSR SB6DB     ;check descriptor stack
AA6F A000       1569       LDY $00
AA71 B150       1570       LDA (Z50),Y   ;move descriptor
AA73 9149       1571       STA (Z49),Y   ;to variable
AA75 C8         1572       INY
AA76 B150       1573       LDA (Z50),Y
AA78 9149       1574       STA (Z49),Y   ;also + 1
AA7A C8         1575       INY
AA7B B150       1576       LDA (Z50),Y
AA7D 9149       1577       STA (Z49),Y   ;and + 2
AA7F 60         1578       RTS
```

```
                1580 ;"PRINT#" command
                1581 ;
AA80 2086AA     1582 WAA80 JSR SAA86     ;execute CMD and PRINT
AA83 4CB5AB     1583       JMP JABB5     ;reset CMD output file #
                1584 ;
                1585 ;"CMD" command
                1586 ;
AA86            1587 WAA86 =   *
AA86 209EB7     1588 SAA86 JSR SB79E     ;get next integer value in X
AA89 F005       1589       BEQ BAA90     ;if more parameters
AA8B A92C       1590       LDA #,        ;next parameter must be a comma
AA8D 20FFAE     1591       JSR SAEFF
AA90 08         1592 BAA90 PHP           ;save flags
AA91 8613       1593       STX Z13       ;store new CMD file #
AA93 2018E1     1594       JSR XE118     ;select output device
AA96 28         1595       PLP           ;restore flags
AA97 4CA0AA     1596       JMP JAAA0     ;execute command PRINT
                1597 ;
AA9A 2021AB     1598 BAA9A JSR SAB21     ;print BASIC string from Z22/Z23
AA9D 207900     1599 BAA9D JSR X0079     ;get current character
                1600 ;
                1601 ;"PRINT" command
                1602 ;
AAA0            1603 WAAA0 =   *
AAA0 F035       1604 JAAA0 BEQ SAAD7     ;if no parameters, end line on CMD file
AAA2 F043       1605 JAAA2 BEQ BAAE7     ;if end of statement, return
AAA4 C9A3       1606       CMP $A3       ;if TAB(
AAA6 F050       1607       BEQ BAAF8     ;do TAB/SPC routine
AAA8 C9A6       1608       CMP $A6       ;if SPC(
AAAA 18         1609       CLC
AAAB F04B       1610       BEQ BAAF8     ;do TAB/SPC routine
AAAD C92C       1611       CMP #,        ;if comma
AAAF F037       1612       BEQ BAAE8     ;go do fixed tab
AAB1 C93B       1613       CMP #;        ;if semicolon
AAB3 F05E       1614       BEQ BAB13     ;ignore
AAB5 209EAD     1615       JSR SAD9E     ;evaluate expression
AAB8 240D       1616       BIT Z0D       ;if string
AABA 30DE       1617       BMI BAA9A     ;print BASIC string
AABC 20DDBD     1618       JSR SBDDD     ;convert flp accu to string
AABF 2087B4     1619       JSR SB487     ;get descriptor of string in flp accu
AAC2 2021AB     1620       JSR SAB21     ;print BASIC string from Z22/Z23
AAC5 203BAB     1621       JSR SAB3B     ;print Cursor Right on CMD output file
AAC8 D0D3       1622       BNE BAA9D     ;repeat
```

```
                1624 ;end statement in buffer and on screen
                1625 ;
                1626 ;X=index beyond last byte in buffer
                1627 ;
AACA A900       1628 JAACA LDA $00        ;add 00 to statement in buffer
AACC 9D0002     1629       STA X0200,X
AACF A2FF       1630       LDX $FF
AAD1 A001       1631       LDY $01        ;reset index to beginning of statement
AAD3 A513       1632       LDA Z13        ;if CMD output file = default
AAD5 D010       1633       BNE BAAE7      ;then end line on CMD output file
                1634 ;
                1635 ;end line on CMD output file
                1636 ;
AAD7 A90D       1637 SAAD7 LDA $0D        ;print a Return
AAD9 2047AB     1638       JSR SAB47      ;on CMD output file
AADC 2413       1639       BIT Z13        ;if file number < 128
AADE 1005       1640       BPL BAAE5      ;do not add Linefeed
AAE0 A90A       1641       LDA $0A        ;else print a Linefeed on CMD file
AAE2 2047AB     1642       JSR SAB47
AAE5 49FF       1643 BAAE5 EOR $FF        ;condition flags
AAE7 60         1644 BAAE7 RTS
                1645 ;
                1646 ;routine for printing blanks and tabs
                1647 ;
                1648 ;fixed tabs at BAAE8
                1649 ;TAB( & SPC( at BAAF8
                1650 ;
AAE8 38         1651 BAAE8 SEC
AAE9 20F0FF     1652       JSR XFFF0      ;read cursor position into XY
AAEC 98         1653       TYA
AAED 38         1654       SEC
AAEE E90A       1655 BAAEE SBC $0A        ;convert column to modulo 10 (-10 to -1)
AAF0 B0FC       1656       BCS BAAEE
AAF2 49FF       1657       EOR $FF        ;complement
AAF4 6901       1658       ADC $01        ;A = # blanks to insert
AAF6 D016       1659       BNE BAB0E      ;skip if zero
AAF8 08         1660 BAAF8 PHP            ;save status
AAF9 38         1661       SEC
AAFA 20F0FF     1662       JSR XFFF0      ;read cursor position again
AAFD 8409       1663       STY Z09        ;save column
AAFF 209BB7     1664       JSR SB79B      ;evaluate expression into X
AB02 C929       1665       CMP ")         ;if not ending with ")"
AB04 D059       1666       BNE BAB5F      ;then SYNTAX Error
AB06 28         1667       PLP            ;restore status
AB07 9006       1668       BCC BAB0F      ;if code for TAB(
AB09 8A         1669       TXA            ;get value in A
AB0A E509       1670       SBC Z09        ;subtract current character position
AB0C 9005       1671       BCC BAB13      ;skip if negative
AB0E AA         1672 BAB0E TAX
AB0F E8         1673 BAB0F INX
AB10 CA         1674 BAB10 DEX
AB11 D006       1675       BNE BAB19      ;if zero
AB13 207300     1676 BAB13 JSR X0073      ;get next character
AB16 4CA2AA     1677       JMP JAAA2      ;return to PRINT
AB19 203BAB     1678 BAB19 JSR SAB3B      ;print Cursor Right on CMD output file
AB1C D0F2       1679       BNE BAB10      ;X times
```

```
            1681 ;print string from AY
            1682 ;
AB1E 2087B4 1683 SAB1E JSR SB487     ;move string descriptor into flp accu
            1684 ;
            1685 ;print BASIC string from Z22/Z23
            1686 ;
AB21 20A6B6 1687 SAB21 JSR SB6A6     ;get text pointer into Z22/Z23
AB24 AA     1688       TAX           ;save string length
AB25 A000   1689       LDY $00
AB27 E8     1690       INX
AB28 CA     1691 BAB28 DEX           ;decrement length pending
AB29 F0BC   1692       BEQ BAAE7     ;exit upon completion
AB2B B122   1693       LDA (Z22),Y   ;get next character
AB2D 2047AB 1694       JSR SAB47     ;print it on CMD output file
AB30 C8     1695       INY           ;advance pointer
AB31 C90D   1696       CMP $0D       ;if character printed was a Return
AB33 D0F3   1697       BNE BAB28
AB35 20E5AA 1698       JSR BAAE5     ;then do dummy instruction
AB38 4C28AB 1699       JMP BAB28     ;repeat
            1700 ;
            1701 ;print a character on CMD output file
            1702 ;
AB3B A513   1703 SAB3B LDA Z13       ;if CMD output file is default
AB3D F003   1704       BEQ BAB42     ;print Cursor Right
AB3F A920   1705       LDA $20       ;else use space
AB41 2C     1706       .BY $2C       ;skip next instruction
AB42 A91D   1707 BAB42 LDA $1D       ;load Cursor Right
AB44 2C     1708       .BY $2C       ;skip next instruction
AB45 A93F   1709 SAB45 LDA $3F       ;load "?"
AB47 200CE1 1710 SAB47 JSR XE10C     ;output a character
AB4A 29FF   1711       AND $FF       ;and exit with flags corresponding
AB4C 60     1712       RTS           ;to original A
```

```
                1714 ;read errors
                1715 ;
AB4D A511       1716 JAB4D LDA Z11
AB4F F011       1717       BEQ BAB62      ;skip if INPUT
AB51 3004       1718       BMI BAB57      ;if GET
AB53 A0FF       1719       LDY $FF        ;set statement # invalid
AB55 D004       1720       BNE BAB5B
AB57 A53F       1721 BAB57 LDA Z3F        ;for READ
AB59 A440       1722       LDY Z40        ;get DATA statement #
AB5B 8539       1723 BAB5B STA Z39        ;store statement #
AB5D 843A       1724       STY Z3A
AB5F 4C08AF     1725 BAB5F JMP JAF08      ;SYNTAX Error
AB62 A513       1726 BAB62 LDA Z13        ;if INPUT and not default CMD file
AB64 F005       1727       BEQ BAB6B
AB66 A218       1728       LDX $18        ;point to FILE DATA message
AB68 4C37A4     1729       JMP JA437      ;print error
                1730 ;
AB6B A90C       1731 BAB6B LDA <TADOC     ;if INPUT and default CMD output file
AB6D A0AD       1732       LDY >TADOC     ;index REDO FROM START message
AB6F 201EAB     1733       JSR SAB1E      ;print message
AB72 A53D       1734       LDA Z3D        ;move pointer to current statement
AB74 A43E       1735       LDY Z3E
AB76 857A       1736       STA Z7A        ;into current character pointer
AB78 847B       1737       STY Z7B
AB7A 60         1738       RTS
                1739 ;
                1740 ;"GET" command
                1741 ;
AB7B 20A6B3     1742 WAB7B JSR SB3A6      ;check for direct mode
AB7E C923       1743       CMP #'#        ;if next character is # sign
AB80 D010       1744       BNE BAB92
AB82 207300     1745       JSR X0073      ;then get next character
AB85 209EB7     1746       JSR SB79E      ;and next integer value in X
AB88 A92C       1747       LDA #',
AB8A 20FFAE     1748       JSR SAEFF      ;next character must be a comma
AB8D 8613       1749       STX Z13        ;set new CMD input file
AB8F 201EE1     1750       JSR XE11E      ;open device for input
AB92 A201       1751 BAB92 LDX $01        ;set pointer to end of line
AB94 A002       1752       LDY $02
AB96 A900       1753       LDA $00
AB98 8D0102     1754       STA X0200+1    ;set character string terminator
AB9B A940       1755       LDA $40        ;set code for GET
AB9D 200FAC     1756       JSR SAC0F      ;interpret data
ABA0 A613       1757       LDX Z13        ;get CMD output file
ABA2 D013       1758       BNE BABB7      ;if not default go reset it
ABA4 60         1759       RTS
                1760 ;
                1761 ;"INPUT#" command
                1762 ;
ABA5 209EB7     1763 WABA5 JSR SB79E      ;get next integer value in X
ABA8 A92C       1764       LDA #',
ABAA 20FFAE     1765       JSR SAEFF      ;next character must be a comma
ABAD 8613       1766       STX Z13        ;set CMD file #
ABAF 201EE1     1767       JSR XE11E      ;open device for input
ABB2 20CEAB     1768       JSR SABCE      ;do Input
ABB5 A513       1769 JABB5 LDA Z13        ;get CMD file number
ABB7 20CCFF     1770 BABB7 JSR XFFCC      ;deselect all devices
ABBA A200       1771       LDX $00
ABBC 8613       1772       STX Z13        ;set CMD file to default
ABBE 60         1773       RTS
```

```
                1775 ;"INPUT" command
                1776 ;
ABBF C922       1777 WABBF CMP #'"      ;if next character is a quote
ABC1 D00B       1778       BNE SABCE
ABC3 20BDAE     1779       JSR SAEBD    ;get descriptor of literal prompt string
ABC6 A93B       1780       LDA #';      ;if next character is not a ";"
ABC8 20FFAE     1781       JSR SAEFF
ABCB 2021AB     1782       JSR SAB21    ;then SYNTAX Error
ABCE 20A6B3     1783 SABCE JSR SB3A6    ;print prompt string
ABD1 A92C       1784       LDA #',      ;place a comma before input string
ABD3 8DFF01     1785       STA X01FF
ABD6 20F9AB     1786 BABD6 JSR SABF9    ;get input line into input buffer
ABD9 A513       1787       LDA Z13      ;if CMD file
ABDB F00D       1788       BEQ BABEA    ;is not default
ABDD 20B7FF     1789       JSR XFFB7    ;and ST does not show
ABE0 2902       1790       AND #$02     ;a Read Error
ABE2 F006       1791       BEQ BABEA
ABE4 20B5AB     1792       JSR JABB5    ;reset CMD file to default
ABE7 4CF8A8     1793       JMP JA8F8    ;execute command DATA
                1794 ;
ABEA AD0002     1795 BABEA LDA X0200    ;else if not a null line
ABED D01E       1796       BNE BAC0D    ;interpret data
ABEF A513       1797       LDA Z13      ;if null line and CMD file not default
ABF1 D0E3       1798       BNE BABD6    ;skip null line
ABF3 2006A9     1799       JSR SA906    ;get end of line
ABF6 4CFBA8     1800       JMP BA8FB    ;skip rest of statement
                1801 ;
                1802 ;get line into input buffer
                1803 ;
ABF9 A513       1804 SABF9 LDA Z13      ;if CMD file = default
ABFB D006       1805       BNE BAC03
ABFD 2045AB     1806       JSR SAB45    ;print "?" on CMD file
AC00 203BAB     1807       JSR SAB3B    ;print Cursor Right on CMD file
AC03 4C60A5     1808 BAC03 JMP SA560    ;go get statement into input buffer
                1809 ;
                1810 ;"READ" command
                1811 ;
AC06 A641       1812 WAC06 LDX Z41      ;get current DATA address into XY
AC08 A442       1813       LDY Z42
AC0A A998       1814       LDA #$98     ;set READ code
AC0C 2C         1815       .BY $2C,     ;skip next instruction
AC0D A900       1816 BAC0D LDA #$00     ;for INPUT, set A to 0
AC0F 8511       1817 SAC0F STA Z11      ;save entry mode
AC11 8643       1818       STX Z43      ;save XY into temporary read pointer
AC13 8444       1819       STY Z44
AC15 208BB0     1820 JAC15 JSR SB08B    ;gather name & get pointer to variable
AC18 8549       1821       STA Z49      ;store pointer
AC1A 844A       1822       STY Z4A
AC1C A57A       1823       LDA Z7A      ;get current character pointer
AC1E A47B       1824       LDY Z7B
AC20 854B       1825       STA Z4B      ;save it
AC22 844C       1826       STY Z4C
AC24 A643       1827       LDX Z43      ;get temporary read pointer
AC26 A444       1828       LDY Z44
AC28 867A       1829       STX Z7A      ;use it as current character pointer
AC2A 847B       1830       STY Z7B
AC2C 207900     1831       JSR X0079    ;get current character
AC2F D020       1832       BNE BAC51    ;if end of statement, get next character
AC31 2411       1833       BIT Z11      ;if GET mode
AC33 500C       1834       BVC BAC41
```

```
AC35 2024E1 1835        JSR XE124     ;get a character from CMD file
AC38 8D0002 1836        STA X0200     ;save character in input buffer
AC3B A2FF   1837        LDX $FF
AC3D A001   1838        LDY $01       ;move buffer address - 1 into XY
AC3F D00C   1839        BNE BAC4D
AC41 3075   1840 BAC41  BMI BACB8     ;if READ go get next DATA element
AC43 A513   1841        LDA Z13       ;for INPUT if CMD file = default
AC45 D003   1842        BNE BAC4A
AC47 2045AB 1843        JSR SAB45     ;print "?" on CMD file
AC4A 20F9AB 1844 BAC4A  JSR SABF9     ;get new input line
AC4D 867A   1845 BAC4D  STX Z7A       ;store pointer into current pointer
AC4F 847B   1846        STY Z7B
AC51 207300 1847 BAC51  JSR X0073     ;get next pointer
AC54 240D   1848        BIT Z0D       ;if not a string variable
AC56 1031   1849        BPL BAC89
AC58 2411   1850        BIT Z11       ;and GET mode
AC5A 5009   1851        BVC BAC65
AC5C E8     1852        INX
AC5D 867A   1853        STX Z7A       ;skip character
AC5F A900   1854        LDA $00       ;set null as terminator
AC61 8507   1855        STA Z07
AC63 F00C   1856        BEQ BAC71     ;if string variable and READ or INPUT
AC65 8507   1857 BAC65  STA Z07       ;store character as terminator
AC67 C922   1858        CMP '"        ;if not quote character
AC69 F007   1859        BEQ BAC72     ;store ":" as terminator
AC6B A93A   1860        LDA ':
AC6D 8507   1861        STA Z07
AC6F A92C   1862        LDA ',
AC71 18     1863 BAC71  CLC
AC72 8508   1864 BAC72  STA Z08       ;and "," as an alternative terminator
AC74 A57A   1865        LDA Z7A
AC76 A47B   1866        LDY Z7B
AC78 6900   1867        ADC $00       ;skip initial quote if any
AC7A 9001   1868        BCC BAC7D
AC7C C8     1869        INY
AC7D 208DB4 1870 BAC7D  JSR SB48D     ;get descriptor of string into flp accu
AC80 20E2B7 1871        JSR SB7E2     ;move text pointer into current pointer
AC83 20DAA9 1872        JSR SA9DA     ;assign to string
AC86 4C91AC 1873        JMP JAC91
            1874 ;
AC89 20F3BC 1875 BAC89  JSR SBCF3     ;convert string  into flp accu
AC8C A50E   1876        LDA Z0E       ;load integer flag
AC8E 20C2A9 1877        JSR SA9C2     ;assign to integer or real
AC91 207900 1878 JAC91  JSR X0079     ;get current character
AC94 F558   298-        FTK F:A-U     Xjqfh ca ael rp fhihajaeh
AC96 C92C   1880        CMP ',        ;or a comma
AC98 F003   1881        BEQ BAC9D
AC9A 4C4DAB 1882        JMP JAB4D     ;else read error
            1883 ;
AC9D A57A   1884 BAC9D  LDA Z7A       ;move current character pointer
AC9F A47B   1885        LDY Z7B
ACA1 8543   1886        STA Z43       ;into temporary read pointer
ACA3 8444   1887        STY Z44
ACA5 A54B   1888        LDA Z4B       ;move saved current character pointer
ACA7 A44C   1889        LDY Z4C
ACA9 857A   1890        STA Z7A       ;to current character pointer
ACAB 847B   1891        STY Z7B
ACAD 207900 1892        JSR X0079     ;get current character
ACB0 F02D   1893        BEQ BACDF     ;must be end of statement
ACB2 20FDAE 1894        JSR SAEFD     ;or a comma
```

```
ACB5 4C15AC 1895        JMP JAC15       ;if so repeat read
             1896 ;
ACB8 2006A9 1897 BACB8 JSR SA906       ;if end of line during READ, get index
ACBB C8     1898        INY             ;to end of statement and bump it
ACBC AA     1899        TAX             ;move last character
ACBD D012   1900        BNE BACD1       ;if zero,
ACBF A20D   1901        LDX $0D         ;point to OUT OF DATA message
ACC1 C8     1902        INY
ACC2 B17A   1903        LDA (Z7A),Y     ;if high of ptr to next statement zero
ACC4 F06C   1904        BEQ BAD32       ;fatal error
ACC6 C8     1905        INY
ACC7 B17A   1906        LDA (Z7A),Y     ;move low byte of next statement #
ACC9 853F   1907        STA Z3F         ;into DATA statement #
ACCB C8     1908        INY
ACCC B17A   1909        LDA (Z7A),Y     ;high byte also
ACCE C8     1910        INY
ACCF 8540   1911        STA Z40
ACD1 20FBA8 1912 BACD1 JSR BA8FB       ;add offset to current character pointer
ACD4 207900 1913        JSR X0079       ;get current character
ACD7 AA     1914        TAX
ACD8 E083   1915        CPX $83         ;if not code for DATA
ACDA D0DC   1916        BNE BACB8       ;go skip statement
ACDC 4C51AC 1917        JMP BAC51       ;set READ pointer
             1918 ;
ACDF A543   1919 BACDF LDA Z43         ;at end of READ statement
ACE1 A444   1920        LDY Z44         ;get temporary read pointer
ACE3 A611   1921        LDX Z11         ;if GET or READ mode
ACE5 1003   1922        BPL BACEA
ACE7 4C27A8 1923        JMP BA827       ;go set READ pointer
             1924 ;
ACEA A000   1925 BACEA LDY $00         ;if INPUT
ACEC B143   1926        LDA (Z43),Y     ;must be end of line
ACEE F00B   1927        BEQ BACFB
ACF0 A513   1928        LDA Z13         ;else, if CMD file = default
ACF2 D007   1929        BNE BACFB
ACF4 A9FC   1930        LDA <TACFC      ;set AY to message EXRTA IGNORED
ACF6 A0AC   1931        LDY >TACFC
ACF8 4C1EAB 1932        JMP SAB1E       ;print message
             1933 ;
ACFB 60     1934 BACFB RTS
             1935 ;
             1936 ;messages used during READ
             1937 ;
ACFC 3F4558 1938 TACFC .BY $3F,'E,'X,'T,'R,'A,' ,'I,'G,'N,'O,'R,'E,'D,$0D,$00
AD0C 3F5245 1939 TAD0C .BY $3F,'R,'E,'D,'O,' ,'F,'R,'O,'M,' ,'S,'T,'A,'R,'T
AD1C 0D00   1940        .BY $0D,$00
```

```
                1942 ;"NEXT" command
                1943 ;
AD1E D004       1944 WAD1E BNE SAD24      ;if no parameters
AD20 A000       1945       LDY $00        ;set index pointer to variable
AD22 F003       1946       BEQ BAD27
AD24 208BB0     1947 SAD24 JSR SB08B      ;else gather name & get ptr to variable
AD27 8549       1948 BAD27 STA Z49        ;save pointer
AD29 844A       1949       STY Z4A
AD2B 208AA3     1950       JSR SA38A      ;get corresponding FOR block
AD2E F005       1951       BEQ BAD35
AD30 A20A       1952       LDX $0A        ;if not found,
AD32 4C37A4     1953 BAD32 JMP JA437      ;error NEXT WITHOUT FOR
                1954 ;
AD35 9A         1955 BAD35 TXS            ;if found remove everything on top
AD36 8A         1956       TXA
AD37 18         1957       CLC
AD38 6904       1958       ADC $04
AD3A 48         1959       PHA            ;get stack index of STEP value (+ 3)
AD3B 6906       1960       ADC $06
AD3D 8524       1961       STA Z24
AD3F 68         1962       PLA            ;save stack index of TO value (+ 9)
AD40 A001       1963       LDY $01        ;high order byte of stack pointer
AD42 20A2BB     1964       JSR SBBA2      ;restore flp accu
AD45 BA         1965       TSX            ;get top index
AD46 BD0901     1966       LDA X0100+9,X  ;get sign of STEP value (+ 8)
AD49 8566       1967       STA Z66        ;restore sign byte of flp accu
AD4B A549       1968       LDA Z49
AD4D A44A       1969       LDY Z4A        ;AY points to FOR variable
AD4F 2067B8     1970       JSR SB867      ;add flp accu to # at AY
AD52 20D0BB     1971       JSR JBBD0      ;store flp accu into FOR variable
AD55 A001       1972       LDY $01
AD57 205DBC     1973       JSR SBC5D      ;compare flp accu to upper limit
AD5A BA         1974       TSX            ;get top index
AD5B 38         1975       SEC
AD5C FD0901     1976       SBC X0100+9,X  ;if different from sign of STEP
AD5F F017       1977       BEQ BAD78
AD61 BD0F01     1978       LDA X0100+15,X
AD64 8539       1979       STA Z39        ;restore statement # to start of loop
AD66 BD1001     1980       LDA X0100+16,X
AD69 853A       1981       STA Z3A
AD6B BD1201     1982       LDA X0100+18,X
AD6E 857A       1983       STA Z7A        ;restore character ptr to start of loop
AD70 BD1101     1984       LDA X0100+17,X
AD73 857B       1985       STA Z7B
AD75 4CAEA7     1986 BAD75 JMP JA7AE      ;go execute next statement
                1987 ;
AD78 8A         1988 BAD78 TXA
AD79 6911       1989       ADC $11        ;add 17 to stack pointer
AD7B AA         1990       TAX            ;to remove FOR block
AD7C 9A         1991       TXS
AD7D 207900     1992       JSR X0079      ;get current character
AD80 C92C       1993       CMP ",         ;if a comma then execute next statement
AD82 D0F1       1994       BNE BAD75
AD84 207300     1995       JSR X0073      ;else get next character
AD87 2024AD     1996       JSR SAD24      ;and go repeat NEXT statement
```

```
                1998 ;get next non-string value
                1999 ;
AD8A 209EAD     2000 SAD8A JSR SAD9E      ;get next value
                2001 ;
AD8D 18         2002 SAD8D CLC            ;set string not wanted
AD8E 24         2003       .BY $24        ;skip next instruction
                2004 ;
                2005 ;check value to be string
                2006 ;
AD8F 38         2007 SAD8F SEC            ;set string wanted
                2008 ;
                2009 ;check value accoring to C flag
                2010 ;
AD90 240D       2011 SAD90 BIT Z0D        ;test string flag
AD92 3003       2012       BMI BAD97      ;if not string
AD94 B003       2013       BCS BAD99      ;and string wanted, error
AD96 60         2014 BAD96 RTS            ;else return
                2015 ;
AD97 B0FD       2016 BAD97 BCS BAD96      ;if string and string wanted, return
AD99 A216       2017 BAD99 LDX $16        ;if string and string not wanted, index
AD9B 4C37A4     2018       JMP JA437      ;TYPE MISMATCH and print error
                2019 ;
                2020 ;evaluate expression
                2021 ;
AD9E A67A       2022 SAD9E LDX Z7A        ;decrement character pointer
ADA0 D002       2023       BNE BADA4
ADA2 C67B       2024       DEC Z7B
ADA4 C67A       2025 BADA4 DEC Z7A
ADA6 A200       2026       LDX $00        ;initial priority
ADA8 24         2027       .BY $24        ;skip next instruction
ADA9 48         2028 JADA9 PHA            ;save <=> code
ADAA 8A         2029       TXA
ADAB 48         2030       PHA            ;save priority
ADAC A901       2031       LDA $01        ;one slot on stack wanted
ADAE 20FBA3     2032       JSR SA.        ;else error OUT OF MEMORY Error
ADB1 2083AE     2033       JSR SAE8       ;get value of next operand in flp accu
ADB4 A900       2034       LDA $00
ADB6 854D       2035       STA Z4D        ;initial <=> code for next diadic
ADB8 207900     2036 JADB8 JSR X0079      ;get current character
ADBB 38         2037 JADBB SEC
ADBC E9B1       2038       SBC $B1        ;subtract code for >
ADBE 9017       2039       BCC BADD7      ;branch if lower than >
ADC0 C903       2040       CMP $03
ADC2 B013       2041       BCS BADD7      ;or if higher than <
ADC4 C901       2042       CMP $01
ADC6 2A         2043       ROL A          ;compute bits for <=>
ADC7 4901       2044       EOR $01        ;bit 2 for <, 1 for = and 0 for >
ADC9 454D       2045       EOR Z4D        ;add to existing <=> code
ADCB C54D       2046       CMP Z4D        ;if bit added for the second time
ADCD 9061       2047       BCC BAE30      ;then SYNTAX Error
ADCF 854D       2048       STA Z4D
ADD1 207300     2049       JSR X0073      ;get next character
ADD4 4CBBAD     2050       JMP JADBB      ;and repeat
                2051 ;
ADD7 A64D       2052 BADD7 LDX Z4D
ADD9 D02C       2053       BNE BAE07      ;if no <=> code
ADDB B07B       2054       BCS BAE58      ;then end at non-diadic character
ADDD 6907       2055       ADC $07        ;diadic index 0-6
ADDF 9077       2056       BCC BAE58
ADE1 650D       2057       ADC Z0D        ;add string flag + carry
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```
ADE3 D003   2058        BNE BADE8     ;if still zero
ADE5 4C3DB6 2059        JMP JB63D     ;apply diadic operator "+" on strings
            2060 ;
ADE8 69FF   2061 BADE8  ADC $FF       ;make index 0-6 again
ADEA 8522   2062        STA Z22
ADEC 0A     2063        ASL A
ADED 6522   2064        ADC Z22       ;* 3
ADEF A8     2065        TAY
ADF0 68     2066 BADF0  PLA           ;restore priority of stacked diadic
ADF1 D980A0 2067        CMP TA080,Y   ;compare to priority of current diadic
ADF4 B067   2068        BCS BAE5D     ;if stacked higher, apply operator
ADF6 208DAD 2069        JSR SAD8D     ;TYPE MISMATCH if string operand
ADF9 48     2070 BADF9  PHA           ;save priority again
ADFA 2020AE 2071 JADFA  JSR SAE20     ;recursive call to evaluate expression
ADFD 68     2072        PLA           ;restore priority again
ADFE A44B   2073        LDY Z4B       ;restore index of current diadic
AE00 1017   2074        BPL BAE19     ;if at end
AE02 AA     2075        TAX           ;and priority = 0
AE03 F056   2076        BEQ BAE5B     ;stop
AE05 D05F   2077        BNE BAE66     ;else apply
AE07 460D   2078 BAE07  LSR Z0D       ;get string flag
AE09 8A     2079        TXA
AE0A 2A     2080        ROL A         ;add to <=> code
AE0B A67A   2081        LDX Z7A
AE0D D002   2082        BNE BAE11     ;decrement character pointer
AE0F C67B   2083        DEC Z7B
AE11 C67A   2084 BAE11  DEC Z7A
AE13 A01B   2085        LDY $1B       ;get index (3*9)
AE15 854D   2086        STA Z4D       ;save <=> code
AE17 D0D7   2087        BNE BADF0     ;and go check priorities
AE19 D980A0 2088 BAE19  CMP TA080,Y   ;if true diadic, compare priorities
AE1C B048   2089        BCS BAE66     ;if stacked priority higher, apply it
AE1E 90D9   2090        BCC BADF9     ;else repeat
            2091 ;
            2092 ;recursive entry for evaluation of expressions
            2093 ;
AE20 B982A0 2094 SAE20  LDA TA080+2,Y ;save pointer to routine for diadic
AE23 48     2095        PHA
AE24 B981A0 2096        LDA TA080+1,Y
AE27 48     2097        PHA
AE28 2033AE 2098        JSR SAE33     ;save rounded value of left operand
AE2B A54D   2099        LDA Z4D       ;get <=> code
AE2D 4CA9AD 2100        JMP JADA9     ;and restart evaluation
            2101 ;
AE30 4C08AF 2102 BAE30  JMP JAF08     ;print SYNTAX Error
            2103 ;
            2104 ;save rounded value of left operand
            2105 ;
AE33 A566   2106 SAE33  LDA Z66       ;get sign of flp accu
AE35 BE80A0 2107        LDX TA080,Y   ;get priority of diadic
AE38 A8     2108 SAE38  TAY
AE39 68     2109        PLA
AE3A 8522   2110        STA Z22       ;save return address in Z22/Z23
AE3C E622   2111        INC Z22
AE3E 68     2112        PLA
AE3F 8523   2113        STA Z23
AE41 98     2114        TYA
AE42 48     2115        PHA           ;save sign of flp accu
AE43 201BBC 2116 JAE43  JSR SBC1B     ;round flp accu
AE46 A565   2117        LDA Z65       ;save flp accu on stack
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AE48 48       2118          PHA
AE49 A564     2119          LDA Z64
AE4B 48       2120          PHA
AE4C A563     2121          LDA Z63
AE4E 48       2122          PHA
AE4F A562     2123          LDA Z62
AE51 48       2124          PHA
AE52 A561     2125          LDA Z61
AE54 48       2126          PHA
AE55 6C2200   2127          JMP (Z22)      ;return to caller
              2128 ;
              2129 ;apply diadic operator
              2130 ;
AE58 A0FF     2131 BAE58     LDY $FF        ;at expression end, set negative index
AE5A 68       2132          PLA            ;restore diadic priority from stack
AE5B F023     2133 BAE5B     BEQ BAE80      ;if zero, stop
AE5D C964     2134 BAE5D     CMP $64        ;if not priority of <=>
AE5F F003     2135          BEQ BAE64
AE61 208DAD   2136          JSR SAD8D      ;then TYPE MISMATCH if string
AE64 844B     2137 BAE64     STY Z4B        ;save index of current diadic
AE66 68       2138 BAE66     PLA            ;remove string flag
AE67 4A       2139          LSR A
AE68 8512     2140          STA Z12        ;save <=> code for <=> routine
AE6A 68       2141          PLA            ;restore left operand
AE6B 8569     2142          STA Z69        ;to second flp accu
AE6D 68       2143          PLA
AE6E 856A     2144          STA Z6A
AE70 68       2145          PLA
AE71 856B     2146          STA Z6B
AE73 68       2147          PLA
AE74 856C     2148          STA Z6C
AE76 68       2149          PLA
AE77 856D     2150          STA Z6D
AE79 68       2151          PLA
AE7A 856E     2152          STA Z6E
AE7C 4566     2153          EOR Z66        ;Exclusive OR of both signs
AE7E 856F     2154          STA Z6F
AE80 A561     2155 BAE80     LDA Z61        ;return with A = exponent of result
AE82 60       2156          RTS
```

```
AE83 6C0A03 2158 SAE83 JMP (X030A)   ;get arithmetic element (normally AE86)
            2159 ;
            2160 ;get arithmetic element into flp accu
            2161 ;
AE86 A900   2162       LDA $00       ;set string flag to not string
AE88 850D   2163       STA Z0D
AE8A 207300 2164 BAE8A JSR X0073     ;get next character
AE8D B003   2165       BCS BAE92     ;if numeric,
AE8F 4CF3BC 2166 BAE8F JMP SBCF3     ;gather number
            2167 ;
AE92 2013B1 2168 BAE92 JSR SB113     ;check for alphabetic character
AE95 9003   2169       BCC BAE9A
AE97 4C28AF 2170       JMP JAF28     ;if so, get value for variable
            2171 ;
AE9A C9FF   2172 BAE9A CMP $FF       ;if code for PI
AE9C D00F   2173       BNE BAEAD
AE9E A9A8   2174       LDA <TAEA8    ;let AY point to value for PI
AEA0 A0AE   2175       LDY >TAEA8
AEA2 20A2BB 2176       JSR SBBA2     ;load value into flp accu
AEA5 4C7300 2177       JMP X0073     ;get next charcter
            2178 ;
            2179 ;flp value for PI
            2180 ;
AEA8 82490F 2181 TAEA8 .BY $82,$49,$0F,$DA,$A1
            2182 ;
AEAD C92E   2183 BAEAD CMP '.        ;if decimal point
AEAF F0DE   2184       BEQ BAE8F     ;gather number
AEB1 C9AB   2185       CMP $AB       ;if minus sign
AEB3 F058   2186       BEQ BAF0D     ;do recursive get value
AEB5 C9AA   2187       CMP $AA       ;if plus
AEB7 F0D1   2188       BEQ BAE8A     ;ignore
AEB9 C922   2189       CMP '"        ;if quote
AEBB D00F   2190       BNE BAECC
AEBD A57A   2191 SAEBD LDA Z7A       ;get pointer to first char of string
AEBF A47B   2192       LDY Z7B
AEC1 6900   2193       ADC $00       ;into Y
AEC3 9001   2194       BCC BAEC6
AEC5 C8     2195       INY
AEC6 2087B4 2196 BAEC6 JSR SB487     ;get ptr to desc of constant string
AEC9 4CE2B7 2197       JMP SB7E2     ;set current ptr after string
            2198 ;
AECC C9A8   2199 BAECC CMP $A8       ;if NOT
AECE D013   2200       BNE BAEE3
AED0 A018   2201       LDY $18       ;set index for NOT
AED2 D03B   2202       BNE BAF0F     ;do recursive get value
```

```
                2204 ;monadic "NOT" command
                2205 ;
AED4 20BFB1     2206 WAED4 JSR SB1BF      ;convert flp to integer
AED7 A565       2207       LDA Z65
AED9 49FF       2208       EOR $FF        ;get complement of low byte into A
AEDB A8         2209       TAY
AEDC A564       2210       LDA Z64        ;get complement of high byte in A
AEDE 49FF       2211       EOR $FF
AEE0 4C91B3     2212       JMP JB391      ;convert integer to flp
                2213 ;
                2214 ;continuation of GET operand
                2215 ;
AEE3 C9A5       2216 BAEE3 CMP $A5        ;if FN
AEE5 D003       2217       BNE BAEEA
AEE7 4CF4B3     2218       JMP JB3F4      ;expand function
                2219 ;
AEEA C9B4       2220 BAEEA CMP $B4        ;if code for SGN or higher
AEEC 9003       2221       BCC BAEF1
AEEE 4CA7AF     2222       JMP JAFA7      ;go apply function
                2223 ;
AEF1 20FAAE     2224 BAEF1 JSR SAEFA      ;SYNTAX Error if no "(" present
AEF4 209EAD     2225       JSR SAD9E      ;evaluate expression
                2226 ;
                2227 ;check and skip characters
                2228 ;
AEF7 A929       2229 SAEF7 LDA #")"       ;check for ")"
AEF9 2C         2230       .BY $2C        ;skip next instruction
AEFA A928       2231 SAEFA LDA #"("       ;check for "("
AEFC 2C         2232       .BY $2C        ;skip next instruction
AEFD A92C       2233 SAEFD LDA #","       ;check for ","
AEFF A000       2234 SAEFF LDY $00        ;check for code in A
AF01 D17A       2235       CMP (27A),Y    ;if current character < > to parameter
AF03 D003       2236       BNE JAF08      ;then SYNTAX Error
AF05 4C7300     2237       JMP X0073      ;else get next character and return
                2238 ;
AF08 A20B       2239 JAF08 LDX $0B        ;point to SYNTAX Error message
AF0A 4C37A4     2240       JMP JA437      ;print message
                2241 ;
                2242 ;recursive get value
                2243 ;
AF0D A015       2244 BAF0D LDY $15        ;set index for "-"
AF0F 68         2245 BAF0F PLA            ;remove own return address
AF10 68         2246       PLA
AF11 4CFAAD     2247       JMP JADFA      ;do pseudo diadic
                2248 ;
                2249 ;check variable pointer range
                2250 ;
AF14 38         2251 SAF14 SEC
AF15 A564       2252       LDA Z64
AF17 E900       2253       SBC $00
AF19 A565       2254       LDA Z65
AF1B E9A0       2255       SBC $A0
AF1D 9008       2256       BCC BAF27      ;exit with C clear if pointer < $A000
AF1F A9A2       2257       LDA $A2
AF21 E564       2258       SBC Z64
AF23 A9E3       2259       LDA $E3
AF25 E565       2260       SBC Z65        ;clear C if $E342 < pointer
AF27 60         2261 BAF27 RTS
```

```
                2263 ;get value of variable
                2264 ;
AF28 2088B0     2265 JAF28 JSR SB08B     ;gather name and get pointer to variable
AF2B 8564       2266       STA Z64       ;save pointer to variable
AF2D 8465       2267       STY Z65
AF2F A645       2268       LDX Z45       ;get name of variable
AF31 A446       2269       LDY Z46
AF33 A50D       2270       LDA Z0D       ;if not a string
AF35 F026       2271       BEQ BAF5D     ;go check for integer and flp
AF37 A900       2272       LDA $00
AF39 8570       2273       STA Z70
AF3B 2014AF     2274       JSR SAF14     ;check for pointer < $A000 or > $E342
AF3E 901C       2275       BCC BAF5C     ;yes, return
AF40 E054       2276       CPX "T        ;if first character of variable not T,
AF42 D018       2277       BNE BAF5C     ;return
AF44 C0C9       2278       CPY $C9       ;if second character = "I$"
AF46 D014       2279       BNE BAF5C
AF48 2084AF     2280       JSR SAF84     ;get time in flp accu
AF4B 845E       2281       STY Z5E       ;clear exponent base 10
AF4D 88         2282       DEY
AF4E 8471       2283       STY Z71       ;initialize output index
AF50 A006       2284       LDY $06       ;and # of digits before decimal point
AF52 845D       2285       STY Z5D
AF54 A024       2286       LDY $24       ;set table index for time conversion
AF56 2068BE     2287       JSR SBE68     ;convert flp to string
AF59 4C6FB4     2288       JMP JB46F     ;get description of string into flp accu
                2289 ;
AF5C 60         2290 BAF5C RTS
                2291 ;
AF5D 240E       2292 BAF5D BIT Z0E       ;if integer variable
AF5F 100D       2293       BPL BAF6E
AF61 A000       2294       LDY $00
AF63 B164       2295       LDA (Z64),Y   ;get integer value in AY
AF65 AA         2296       TAX
AF66 C8         2297       INY
AF67 B164       2298       LDA (Z64),Y
AF69 A8         2299       TAY
AF6A 8A         2300       TXA
AF6B 4C91B3     2301       JMP JB391     ;convert integer to flp
                2302 ;
AF6E 2014AF     2303 BAF6E JSR SAF14     ;if not normal variable
AF71 902D       2304       BCC BAFA0
AF73 E054       2305       CPX "T        ;and if first character is T
AF75 D01B       2306       BNE BAF92
AF77 C049       2307       CPY "I        ;and second character is I
AF79 D025       2308       BNE BAFA0
AF7B 2084AF     2309       JSR SAF84     ;get time into flp accu
AF7E 98         2310       TYA
AF7F A2A0       2311       LDX $A0       ;set exponent
AF81 4C4FBC     2312       JMP JBC4F     ;sign and guard bits
```

```
                2314 ;get time in flp accu
                2315 ;
AF84 20DEFF     2316 SAF84 JSR XFFDE     ;fetch time
AF87 8664       2317       STX Z64
AF89 8463       2318       STY Z63       ;store time
AF8B 8565       2319       STA Z65
AF8D A000       2320       LDY $00
AF8F 8462       2321       STY Z62
AF91 60         2322       RTS
                2323 ;
                2324 ;continue to get value of variable
                2325 ;
AF92 E053       2326 BAF92 CPX "S        ;if first character is S
AF94 D00A       2327       BNE BAFA0
AF96 C054       2328       CPY "T        ;and second character is T
AF98 D006       2329       BNE BAFA0
AF9A 20B7FF     2330       JSR XFFB7     ;get status word
AF9D 4C3CBC     2331       JMP JBC3C     ;move signed # from A into flp accu
                2332 ;
AFA0 A564       2333 BAFA0 LDA Z64       ;for normal variables, put pointer in AY
AFA2 A465       2334       LDY Z65
AFA4 4CA2BB     2335       JMP SBBA2     ;load flp accu from AY
                2336 ;
                2337 ;apply function
                2338 ;
AFA7 0A         2339 JAFA7 ASL A         ;index byte * 2
AFA8 48         2340       PHA           ;save index
AFA9 AA         2341       TAX
AFAA 207300     2342       JSR X0073     ;get next character
AFAD E08F       2343       CPX $8F       ;if function with more than 1 parameter
AFAF 9020       2344       BCC BAFD1
AFB1 20FAAE     2345       JSR SAEFA     ;next character must be "("
AFB4 209EAD     2346       JSR SAD9E     ;evaluate expression
AFB7 20FDAE     2347       JSR SAEFD     ;next character must be ","
AFBA 208FAD     2348       JSR SAD8F     ;result must be a string value
AFBD 68         2349       PLA           ;restore index
AFBE AA         2350       TAX
AFBF A565       2351       LDA Z65       ;save pointer to description on stack
AFC1 48         2352       PHA
AFC2 A564       2353       LDA Z64
AFC4 48         2354       PHA
AFC5 8A         2355       TXA           ;save index again
AFC6 48         2356       PHA
AFC7 209EB7     2357       JSR SB79E     ;get next integer value into X
AFCA 68         2358       PLA           ;restore index
AFCB A8         2359       TAY           ;index in Y
AFCC 8A         2360       TXA
AFCD 48         2361       PHA           ;save integer parameter
AFCE 4CD6AF     2362       JMP JAFD6
                2363 ;
AFD1 20F1AE     2364 BAFD1 JSR BAEF1     ;get value in parenthesis
AFD4 68         2365       PLA           ;restore index
AFD5 A8         2366       TAY
AFD6 B9EA9F     2367 JAFD6 LDA X9FEA,Y   ;get pointer to function routine
AFD9 8555       2368       STA Z55       ;into Z55/Z56
AFDB B9EB9F     2369       LDA X9FEA+1,Y
AFDE 8556       2370       STA Z56
AFE0 205400     2371       JSR X0054     ;perform function
AFE3 4C8DAD     2372       JMP SAD8D     ;return with correct string flag
```

```
                2374 ;"OR" command
                2375 ;
AFE6 A0FF       2376 WAFE6 LDY $FF        ;set parameter to complement operands
AFE8 2C         2377       .BY $2C        ;skip next instruction
                2378 ;
                2379 ;"AND" command
                2380 ;
AFE9 A000       2381 WAFE9 LDY $00        ;set no complement of operands
AFEB 840B       2382       STY Z0B        ;store the parameter
AFED 20BFB1     2383       JSR SB1BF      ;convert left operand to integer
AFF0 A564       2384       LDA Z64        ;get high byte
AFF2 450B       2385       EOR Z0B        ;complement if OR
AFF4 8507       2386       STA Z07        ;save result
AFF6 A565       2387       LDA Z65        ;get low byte
AFF8 450B       2388       EOR Z0B        ;complement if OR
AFFA 8508       2389       STA Z08        ;save result
AFFC 20FCBB     2390       JSR BBFC       ;move accu to fac1
AFFF 20BFB1     2391       JSR SB1BF      ;convert right operand to integer
B002 A565       2392       LDA Z65        ;get low byte
B004 450B       2393       EOR Z0B        ;complement if OR
B006 2508       2394       AND Z08        ;AND with left operand
B008 450B       2395       EOR Z0B        ;complement if OR
B00A A8         2396       TAY            ;save result
B00B A564       2397       LDA Z64        ;get high byte
B00D 450B       2398       EOR Z0B        ;complement if OR
B00F 2507       2399       AND Z07        ;AND with other operand
B011 450B       2400       EOR Z0B        ;complement if OR
B013 4C91B3     2401       JMP JB391      ;convert integer from AY to flp accu
```

```
                2403 ;"<=>" command
                2404 ;
B016 2090AD     2405 WB016 JSR SAD90     ;check value of A
B019 B013       2406       BCS BB02E     ;if string, go compare strings
B01B A56E       2407       LDA Z6E       ;include sign bit
B01D 097F       2408       ORA $7F
B01F 256A       2409       AND Z6A       ;into byte 1
B021 856A       2410       STA Z6A       ;of fraction of second flp accu
B023 A969       2411       LDA <Z69
B025 A000       2412       LDY >Z69      ;set AY to second flp accu
B027 205BBC     2413       JSR SBC5B     ;compare AY with flp accu
B02A AA         2414       TAX           ;save result of comparison
B02B 4C61B0     2415       JMP JB061     ;check with <=> code
                2416 ;
B02E A900       2417 BB02E LDA $00
B030 850D       2418       STA Z0D       ;reset string flag
B032 C64D       2419       DEC Z4D       ;also remove saved string flag
B034 20A6B6     2420       JSR SB6A6     ;de-allocate temp. string (right op)
B037 8561       2421       STA Z61
B039 8662       2422       STX Z62
B03B 8463       2423       STY Z63
B03D A56C       2424       LDA Z6C       ;get text pointer of left operand
B03F A46D       2425       LDY Z6D
B041 20AAB6     2426       JSR SB6AA     ;de-allocate temp. string (left op)
B044 866C       2427       STX Z6C       ;save text pointer
B046 846D       2428       STY Z6D
B048 AA         2429       TAX           ;save length of left operand
B049 38         2430       SEC
B04A E561       2431       SBC Z61       ;compare lengths (left-right)
B04C F008       2432       BEQ BB056     ;if equal, A=0
B04E A901       2433       LDA $01       ;set A to 1
B050 9004       2434       BCC BB056     ;if left operand longer,
B052 A661       2435       LDX Z61       ;get length of shorter string
B054 A9FF       2436       LDA $FF       ;and set A to -1
B056 8566       2437 BB056 STA Z66       ;save sign of left-right
B058 A0FF       2438       LDY $FF       ;set start index into strings
B05A E8         2439       INX
B05B C8         2440 BB05B INY           ;point to next character
B05C CA         2441       DEX
B05D D007       2442       BNE BB066     ;if more characters, compare
B05F A666       2443       LDX Z66       ;if not, restore sign of left-right
B061 300F       2444 JB061 BMI BB072
B063 18         2445       CLC           ;set correct C bit
B064 900C       2446       BCC BB072     ;JMP
B066 B16C       2447 BB066 LDA (Z6C),Y   ;get character from left string
B068 D162       2448       CMP (Z62),Y   ;compare to character from right string
B06A F0EF       2449       BEQ BB05B     ;if equal, repeat
B06C A2FF       2450       LDX $FF       ;X = -1 if character from left higher
B06E B002       2451       BCS BB072
B070 A201       2452       LDX $01       ;X = 1 if character from left lower
B072 E8         2453 BB072 INX           ;X = 0, 1 or 2 for left > = <
B073 8A         2454       TXA
B074 2A         2455       ROL A         ;convert to 1, 2 or 4
B075 2512       2456       AND Z12       ;mask with <=> code
B077 F002       2457       BEQ BB07B     ;if zero, result = false (0)
B079 A9FF       2458       LDA $FF       ;if non-zero, result = true (-1)
B07B 4C3CBC     2459 BB07B JMP JBC3C     ;go get signed # from A into flp accu
```

```
                2461 ;"DIM" command
                2462 ;
B07E 20FDAE     2463 BB07E JSR SAEFD     ;SYNTAX Error if not ","
B081 AA         2464 WB081 TAX
B082 2090B0     2465       JSR SB090     ;gather name and pointer to variable
B085 207900     2466       JSR X0079     ;get current character
B088 D0F4       2467       BNE BB07E     ;if not end of statement, repeat
B08A 60         2468       RTS
                2469 ;
                2470 ;get name and pointer to a variable
                2471 ;
B08B A200       2472 SB08B LDX $00       ;set code for ref, not declaration
B08D 207900     2473       JSR X0079     ;get current character
B090 860C       2474 SB090 STX Z0C       ;set reference/declaration flag
B092 8545       2475 SB092 STA Z45       ;store first character of name
B094 207900     2476       JSR X0079     ;get current character
B097 2013B1     2477       JSR SB113     ;if not alphabetic
B09A B003       2478       BCS BB09F
B09C 4C08AF     2479 BB09C JMP JAF08     ;then SYNTAX Error message
                2480 ;
B09F A200       2481 BB09F LDX $00       ;set flags
B0A1 860D       2482       STX Z0D       ;to not string
B0A3 860E       2483       STX Z0E       ;and not integer
B0A5 207300     2484       JSR X0073     ;get next character
B0A8 9005       2485       BCC BB0AF     ;if numeric
B0AA 2013B1     2486       JSR SB113
B0AD 900B       2487       BCC BB0BA     ;or alphabetic
B0AF AA         2488 BB0AF TAX           ;save second character in X
B0B0 207300     2489 BB0B0 JSR X0073     ;get next character
B0B3 90FB       2490       BCC BB0B0     ;until first non-numeric character
B0B5 2013B1     2491       JSR SB113
B0B8 B0F6       2492       BCS BB0B0     ;not alphabetic
B0BA C924       2493 BB0BA CMP "$        ;if terminator is "$"
B0BC D006       2494       BNE BB0C4
B0BE A9FF       2495       LDA $FF
B0C0 850D       2496       STA Z0D       ;then set flag for strings
B0C2 D010       2497       BNE BB0D4
B0C4 C925       2498 BB0C4 CMP "%        ;if terminator is "%"
B0C6 D013       2499       BNE BB0DB
B0C8 A510       2500       LDA Z10       ;and integers not allowed
B0CA D0D0       2501       BNE BB09C     ;then SYNTAX Error
B0CC A980       2502       LDA $80
B0CE 850E       2503       STA Z0E       ;else set integer flag and
B0D0 0545       2504       ORA Z45       ;add bit 7 to first char of name
B0D2 8545       2505       STA Z45
B0D4 8A         2506 BB0D4 TXA           ;add bit 7 to 2nd char of name
B0D5 0980       2507       ORA $80       ;for both string and integer
B0D7 AA         2508       TAX
B0D8 207300     2509       JSR X0073     ;get next character
B0DB 8646       2510 BB0DB STX Z46       ;save second character name
B0DD 38         2511       SEC
B0DE 0510       2512       ORA Z10       ;if arrays allowed
B0E0 E928       2513       SBC "(        ;and next character is "("
B0E2 D003       2514       BNE BB0E7
B0E4 4CD1B1     2515       JMP JB1D1     ;handle dimensioned variable
                2516 ;
B0E7 A000       2517 BB0E7 LDY $00
B0E9 8410       2518       STY Z10       ;reset no integers or arrays switch
B0EB A52D       2519       LDA Z2D
B0ED A62E       2520       LDX Z2E       ;AX=pointer to variable name table
```

```
B0EF 8660   2521 BB0EF STX Z60
B0F1 855F   2522 BB0F1 STA Z5F
B0F3 E430   2523       CPX Z30        ;if at end of name table
B0F5 D004   2524       BNE BB0FB
B0F7 C52F   2525       CMP Z2F
B0F9 F022   2526       BEQ BB11D      ;then variable not found
B0FB A545   2527 BB0FB LDA Z45
B0FD D15F   2528       CMP (Z5F),Y    ;if name matches
B0FF D008   2529       BNE BB109
B101 A546   2530       LDA Z46
B103 C8     2531       INY
B104 D15F   2532       CMP (Z5F),Y
B106 F07D   2533       BEQ BB185      ;then variable found
B108 88     2534       DEY
B109 18     2535 BB109 CLC
B10A A55F   2536       LDA Z5F        ;set AX to entry + 7
B10C 6907   2537       ADC $07
B10E 90E1   2538       BCC BB0F1
B110 E8     2539       INX
B111 D0DC   2540       BNE BB0EF      ;continue search
            2541 ;
            2542 ;check character in A
            2543 ;
            2544 ;return with C=1 if alphabetic
            2545 ;return with C=0 if not
            2546 ;
B113 C941   2547 BB113 CMP "A         ;if character < "A"
B115 9005   2548       BCC BB11C      ;return with C = 0
B117 E95B   2549       SBC "Z+1       ;if character > "Z" then C = 0
B119 38     2550       SEC
B11A E9A5   2551       SBC $A5        ;else return with C=1
B11C 60     2552 BB11C RTS
            2553 ;
            2554 ;variable not found
            2555 ;
B11D 68     2556 BB11D PLA
B11E 48     2557       PHA            ;if low byte of return address = $2A
B11F C92A   2558       CMP $2A        (if called from GET VALUE OF VARIABLE)
B121 D005   2559       BNE BB128
B123 A913   2560 BB123 LDA $13        ;return with AY pointing to
B125 A0BF   2561       LDY $BF        ;a dummy variable (value 0)
B127 60     2562       RTS
            2563 ;
B128 A545   2564 BB128 LDA Z45
B12A A446   2565       LDY Z46
B12C C954   2566       CMP "T         ;if name = TI$
B12E D00B   2567       BNE BB13B
B130 C0C9   2568       CPY $C9
B132 F0EF   2569       BEQ BB123      ;return with dummy value
B134 C049   2570       CPY "I         ;if name=TI
B136 D003   2571       BNE BB13B
B138 4C08AF 2572 BB138 JMP JAF08      ;then SYNTAX Error
            2573 ;
B13B C953   2574 BB13B CMP "S         ;if name=ST
B13D D004   2575       BNE BB143
B13F C054   2576       CPY "T
B141 F0F5   2577       BEQ BB138      ;then SYNTAX Error
B143 A52F   2578 BB143 LDA Z2F        ;set AY to pointer to end of name table
B145 A430   2579       LDY Z30
B147 855F   2580       STA Z5F        ;and save as start of input for move
```

```
B149 8460    2581         STY Z60
B14B A531    2582         LDA Z31        ;AY=pointer to end of array area
B14D A432    2583         LDY Z32
B14F 855A    2584         STA Z5A
B151 845B    2585         STY Z5B
B153 18      2586         CLC
B154 6907    2587         ADC $07        ;add 7 to pointer for one entry
B156 9001    2588         BCC BB159
B158 C8      2589         INY
B159 8558    2590 BB159   STA Z58        ;into pointer to end of output for move
B15B 8459    2591         STY Z59
B15D 20B8A3  2592         JSR SA3B8      ;check for space and move bytes
B160 A558    2593         LDA Z58
B162 A459    2594         LDY Z59        ;AY=beginning of output area
B164 C8      2595         INY
B165 852F    2596         STA Z2F        ;for move routine
B167 8430    2597         STY Z30        ;move to pointer to end of name table
B169 A000    2598         LDY $00
B16B A545    2599         LDA Z45
B16D 915F    2600         STA (Z5F),Y    ;store first byte of name in byte 0
B16F C8      2601         INY
B170 A546    2602         LDA Z46
B172 915F    2603         STA (Z5F),Y    ;store second byte of name in byte 1
B174 A900    2604         LDA $00
B176 C8      2605         INY
B177 915F    2606         STA (Z5F),Y    ;clear bytes 2-6 (value)
B179 C8      2607         INY
B17A 915F    2608         STA (Z5F),Y
B17C C8      2609         INY
B17D 915F    2610         STA (Z5F),Y
B17F C8      2611         INY
B180 915F    2612         STA (Z5F),Y
B182 C8      2613         INY
B183 915F    2614         STA (Z5F),Y
             2615 ;
             2616 ;variable found
             2617 ;
B185 A55F    2618 BB185   LDA Z5F
B187 18      2619         CLC            ;return pointer to entry
B188 6902    2620         ADC $02        ;plus 2
B18A A460    2621         LDY Z60
B18C 9001    2622         BCC BB18F
B18E C8      2623         INY
B18F 8547    2624 BB18F   STA Z47        ;in variable address and AY
B191 8448    2625         STY Z48
B193 60      2626         RTS
```

```
                2628 ;compute pointer to array body
                2629 ;
B194 A50B       2630 SB194 LDA Z0B       ;get # of dimensions
B196 0A         2631       ASL A         ;* 2
B197 6905       2632       ADC $05       ;add fixed overhead
B199 655F       2633       ADC Z5F       ;add low byte of array pointer
B19B A460       2634       LDY Z60       ;get high byte of array pointer
B19D 9001       2635       BCC BB1A0
B19F C8         2636       INY           ;increment if carry
B1A0 8558       2637 BB1A0 STA Z58       ;save pointer to body of array
B1A2 8459       2638       STY Z59
B1A4 60         2639       RTS
                2640 ;
                2641 ;flp number for conversion to integer
                2642 ;
B1A5 908000     2643 TB1A5 .BY $90,$80,$00,$00,$00
                2644 ;
                2645 ;routine to convert floating point number to fixed point
                2646 ;
B1AA 20BFB1     2647       JSR SB1BF     ;convert flp to fixed point
B1AD A564       2648       LDA Z64
B1AF A465       2649       LDY Z65       ;return with value in AY
B1B1 60         2650       RTS
                2651 ;
                2652 ;convert value from statement into integer
                2653 ;
B1B2 207300     2654 SB1B2 JSR X0073     ;get next character
B1B5 209EAD     2655       JSR SAD9E     ;get value from statement
B1B8 208DAD     2656 SB1B8 JSR SAD8D     ;check for non-string
B1BB A566       2657       LDA Z66       ;if flp accu negative,
B1BD 300D       2658       BMI BB1CC     ;ILLEGAL QUANTITY Error
                2659 ;
                2660 ;convert flp number to integer
                2661 ;
B1BF A561       2662 SB1BF LDA Z61       ;get exponent
B1C1 C990       2663       CMP $90       ;if < 16
B1C3 9009       2664       BCC BB1CE     ;convert
B1C5 A9A5       2665       LDA <TB1A5    ;let AY point to flp value -32768
B1C7 A0B1       2666       LDY >TB1A5
B1C9 205BBC     2667       JSR SBC5B     ;compare AY to flp accu
B1CC D07A       2668 BB1CC BNE JB248     ;if not >, ILLEGAL QUANTITY Error
B1CE 4C9BBC     2669 BB1CE JMP SBC9B     ;convert flp accu to 4 byte integer
```

```
                2671 ;get pointer to dimensioned variable
                2672 ;
B1D1 A50C       2673 JB1D1 LDA Z0C       ;save reference flag
B1D3 050E       2674       ORA Z0E       ;and integer flag
B1D5 48         2675       PHA
B1D6 A50D       2676       LDA Z0D       ;save string flag
B1D8 48         2677       PHA
B1D9 A000       2678       LDY $00       ;initialize count # of dimensions
B1DB 98         2679 BB1DB TYA
B1DC 48         2680       PHA           ;save count
B1DD A546       2681       LDA Z46
B1DF 48         2682       PHA           ;save second character of name
B1E0 A545       2683       LDA Z45
B1E2 48         2684       PHA           ;save first character of name
B1E3 20B2B1     2685       JSR SB1B2     ;convert value from statement to integer
B1E6 68         2686       PLA
B1E7 8545       2687       STA Z45       ;restore first character of name
B1E9 68         2688       PLA
B1EA 8546       2689       STA Z46       ;restore second character of name
B1EC 68         2690       PLA
B1ED A8         2691       TAY           ;restore count
B1EE BA         2692       TSX           ;get stack pointer
B1EF BD0201     2693       LDA X0102,X
B1F2 48         2694       PHA           ;move saved flags to top of stack
B1F3 BD0101     2695       LDA X0101,X
B1F6 48         2696       PHA
B1F7 A564       2697       LDA Z64       ;save array index in their place
B1F9 9D0201     2698       STA X0102,X
B1FC A565       2699       LDA Z65
B1FE 9D0101     2700       STA X0101,X
B201 C8         2701       INY           ;increment dimension pointer
B202 207900     2702       JSR X0079     ;get current character
B205 C92C       2703       CMP ',        ;if ","
B207 F0D2       2704       BEQ BB1DB     ;repeat for next array index
B209 840B       2705       STY Z0B       ;save total number of dimensions
B20B 20F7AE     2706       JSR SAEF7     ;skip ")"
B20E 68         2707       PLA
B20F 850D       2708       STA Z0D       ;restore string flag
B211 68         2709       PLA
B212 850E       2710       STA Z0E       ;restore integer flag
B214 297F       2711       AND $7F
B216 850C       2712       STA Z0C       ;and reference flag
B218 A62F       2713       LDX Z2F
B21A A530       2714       LDA Z30       ;AX = pointer to array area
B21C 865F       2715 BB21C STX Z5F
B21E 8560       2716       STA Z60       ;save in temporary pointer
B220 C532       2717       CMP Z32
B222 D004       2718       BNE BB228
B224 E431       2719       CPX Z31       ;if end of array area reached
B226 F039       2720       BEQ BB261     ;then array not found
B228 A000       2721 BB228 LDY $00
B22A B15F       2722       LDA (Z5F),Y   ;get first character of name
B22C C8         2723       INY
B22D C545       2724       CMP Z45       ;if equal
B22F D006       2725       BNE BB237
B231 A546       2726       LDA Z46
B233 D15F       2727       CMP (Z5F),Y   ;and second character of name also
B235 F016       2728       BEQ BB24D     ;then array found
B237 C8         2729 BB237 INY
B238 B15F       2730       LDA (Z5F),Y   ;get low byte of length
```

```
B23A 18      2731         CLC
B23B 655F    2732         ADC Z5F        ;add to array pointer
B23D AA      2733         TAX            ;and save result in X
B23E C8      2734         INY
B23F B15F    2735         LDA (Z5F),Y    ;get high byte of length
B241 6560    2736         ADC Z60        ;add to array pointer
B243 90D7    2737         BCC BB21C      ;repeat if not overflow
B245 A212    2738 BB245   LDX $12        ;point to BAD SUBSCRIPT Error message
B247 2C      2739         .BY $2C        ;skip next instruction
             2740 ;
B248 A20E    2741 JB248   LDX $0E        ;point to ILLEGAL QUANTITY Error message
B24A 4C37A4  2742 BB24A   JMP JA437      ;print message
B24D A213    2743 BB24D   LDX $13        ;point to BAD SUBSCRIPT Error message
B24F A50C    2744         LDA Z0C        ;if declaration
B251 D0F7    2745         BNE BB24A      ;then fatal error
B253 2094B1  2746         JSR SB194      ;compute pointer to array body
B256 A50B    2747         LDA Z0B        ;if actual # of dimensions
B258 A004    2748         LDY $04
B25A D15F    2749         CMP (Z5F),Y    ;not equal to declared #
B25C D0E7    2750         BNE BB245      ;then error
B25E 4CEAB2  2751         JMP JB2EA      ;else compute array reference
```

```
                2753 ;allocate array
                2754 ;
B261 2094B1     2755 BB261 JSR SB194     ;compute pointer to virtual array body
B264 2008A4     2756       JSR SA408     ;check array area for overflow
B267 A000       2757       LDY $00
B269 8472       2758       STY Z72       ;initialize high byte of length
B26B A205       2759       LDX $05       ;set length per element
B26D A545       2760       LDA Z45       ;get first character of name
B26F 915F       2761       STA (Z5F),Y   ;into + 0 of array header
B271 1001       2762       BPL BB274     ;if integer
B273 CA         2763       DEX           ;adjust length per element
B274 C8         2764 BB274 INY
B275 A546       2765       LDA Z46       ;move second character of name
B277 915F       2766       STA (Z5F),Y   ;into + 1 of array header
B279 1002       2767       BPL BB27D     ;if integer or string
B27B CA         2768       DEX
B27C CA         2769       DEX           ;correct length per element
B27D 8671       2770 BB27D STX Z71       ;set initial low byte of length
B27F A50B       2771       LDA Z0B       ;move # of dimensions
B281 C8         2772       INY
B282 C8         2773       INY
B283 C8         2774       INY
B284 915F       2775       STA (Z5F),Y   ;into + 4 of array header
B286 A20B       2776 BB286 LDX $0B       ;set default dimension (11)
B288 A900       2777       LDA $00
B28A 240C       2778       BIT Z0C       ;if declaration
B28C 5008       2779       BVC BB296     ;skip
B28E 68         2780       PLA           ;else get limit from stack
B28F 18         2781       CLC
B290 6901       2782       ADC $01       ;add 1 for element # 0
B292 AA         2783       TAX
B293 68         2784       PLA           ;limit into AX
B294 6900       2785       ADC $00
B296 C8         2786 BB296 INY
B297 915F       2787       STA (Z5F),Y   ;move limit into next byte of header
B299 C8         2788       INY
B29A 8A         2789       TXA
B29B 915F       2790       STA (Z5F),Y   ;low byte also
B29D 204CB3     2791       JSR SB34C     ;AX = length * limit
B2A0 8671       2792       STX Z71
B2A2 8572       2793       STA Z72       ;save into length
B2A4 A422       2794       LDY Z22       ;restore index into array header
B2A6 C60B       2795       DEC Z0B       ;decrement # of dimensions
B2A8 D0DC       2796       BNE BB286     ;repeat until done
B2AA 6559       2797       ADC Z59       ;add high byte of length to body pointer
B2AC B05D       2798       BCS BB30B     ;if overflow, OUT OF MEMORY Error
B2AE 8559       2799       STA Z59       ;save pointer to end of body
B2B0 A8         2800       TAY           ;also in Y
B2B1 8A         2801       TXA
B2B2 6558       2802       ADC Z58       ;add low byte of length to body pointer
B2B4 9003       2803       BCC BB2B9     ;if overflow
B2B6 C8         2804       INY           ;increment high byte
B2B7 F052       2805       BEQ BB30B     ;if overflow, OUT OF MEMORY Error
B2B9 2008A4     2806 BB2B9 JSR SA408     ;check array area for overflow
B2BC 8531       2807       STA Z31
B2BE 8432       2808       STY Z32       ;set new end of array area
B2C0 A900       2809       LDA $00
B2C2 E672       2810       INC Z72       ;get length
B2C4 A471       2811       LDY Z71
B2C6 F005       2812       BEQ BB2CD     ;if low byte of length not zero
```

```
B2C8 88      2813 BB2C8 DEY            ;decrement index
B2C9 9158    2814       STA (Z58),Y    ;store zero in array byte
B2CB D0FB    2815       BNE BB2C8      ;until low byte of length is zero
B2CD C659    2816 BB2CD DEC Z59        ;then set pointer to next block of 256
B2CF C672    2817       DEC Z72        ;and decrement high byte of length
B2D1 D0F5    2818       BNE BB2C8      ;repeat until length is zero
B2D3 E659    2819       INC Z59
B2D5 38      2820       SEC
B2D6 A531    2821       LDA Z31        ;get address of end of array area
B2D8 E55F    2822       SBC Z5F        ;minus pointer to array area
B2DA A002    2823       LDY $02
B2DC 915F    2824       STA (Z5F),Y    ;store low byte in + 2 of array header
B2DE A532    2825       LDA Z32        ;move high byte of difference
B2E0 C8      2826       INY
B2E1 E560    2827       SBC Z60
B2E3 915F    2828       STA (Z5F),Y    ;into + 3 of array header
B2E5 A50C    2829       LDA Z0C        ;if declaration
B2E7 D062    2830       BNE BB34B      ;then return
B2E9 C8      2831       INY            ;else point to declared # of dimentions
             2832 ;
             2833 ;compute reference to array element
             2834 ;
B2EA B15F    2835 JB2EA LDA (Z5F),Y    ;get # of dimensions from array header
B2EC 850B    2836       STA Z0B        ;save it
B2EE A900    2837       LDA $00
B2F0 8571    2838       STA Z71        ;initialize offset in body
B2F2 8572    2839 BB2F2 STA Z72
B2F4 C8      2840       INY
B2F5 68      2841       PLA            ;get low byte of index from stack
B2F6 AA      2842       TAX            ;into X
B2F7 8564    2843       STA Z64        ;and flp accu
B2F9 68      2844       PLA            ;get high byte of index from stack
B2FA 8565    2845       STA Z65        ;into A and flp accu
B2FC D15F    2846       CMP (Z5F),Y    ;compare index to limit
B2FE 900E    2847       BCC BB30E      ;if lower, OK
B300 D006    2848       BNE BB308      ;if higher, BAD SUBSCRIPT Error
B302 C8      2849       INY            ;if equal
B303 8A      2850       TXA
B304 D15F    2851       CMP (Z5F),Y    ;compare low bytes
B306 9007    2852       BCC BB30F      ;if lower, OK
B308 4C45B2  2853 BB308 JMP BB245      ;else BAD SUBSCRIPT Error
B30B 4C35A4  2854 BB30B JMP BA435      ;OUT OF MEMORY Error
             2855 ;
B30E C8      2856 BB30E INY
B30F A572    2857 BB30F LDA Z72        ;if total index so far = 0
B311 0571    2858       ORA Z71
B313 18      2859       CLC
B314 F00A    2860       BEQ BB320      ;skip multiplication
B316 204CB3  2861       JSR SB34C      ;XY = offset * limit
B319 8A      2862       TXA
B31A 6564    2863       ADC Z64        ;add low byte of array index to A
B31C AA      2864       TAX
B31D 98      2865       TYA
B31E A422    2866       LDY Z22        ;restore index to array header
B320 6565    2867 BB320 ADC Z65        ;add high byte of array index to A
B322 8671    2868       STX Z71        ;save low byte of new offset
B324 C60B    2869       DEC Z0B        ;if not last index,
B326 D0CA    2870       BNE BB2F2      ;repeat for next index
B328 8572    2871       STA Z72        ;save high byte of offset
B32A A205    2872       LDX $05        ;set length per element for flp #
```

```
B32C A545    2873         LDA Z45
B32E 1001    2874         BPL BB331      ;if integer
B330 CA      2875         DEX            ;correct length per element
B331 A546    2876 BB331   LDA Z46
B333 1002    2877         BPL BB337      ;if integer or string
B335 CA      2878         DEX
B336 CA      2879         DEX            ;correct length per element
B337 8628    2880 BB337   STX Z28
B339 A900    2881         LDA $00
B33B 2055B3  2882         JSR SB355      ;XY = offset * length per element
B33E 8A      2883         TXA
B33F 6558    2884         ADC Z58        ;add to pointer to array body
B341 8547    2885         STA Z47        ;store result into variable address
B343 98      2886         TYA
B344 6559    2887         ADC Z59
B346 8548    2888         STA Z48        ;high byte also
B348 A8      2889         TAY
B349 A547    2890         LDA Z47        ;return with AY = variable address
B34B 60      2891 BB34B   RTS
```

```
                2893 ;XY = XA = length * limit from array data
                2894 ;
B34C 8422       2895 SB34C STY Z22        ;save index in array header
B34E B15F       2896       LDA (Z5F),Y    ;get low byte of limit
B350 8528       2897       STA Z28        ;save it
B352 88         2898       DEY
B353 B15F       2899       LDA (Z5F),Y    ;get high byte of limit
B355 8529       2900 SB355 STA Z29        ;and save it too
B357 A910       2901       LDA $10        ;set # bits for multiplication
B359 855D       2902       STA Z5D
B35B A200       2903       LDX $00        ;initialize result fields
B35D A000       2904       LDY $00
B35F 8A         2905 BB35F TXA
B360 0A         2906       ASL A          ;XY * 2
B361 AA         2907       TAX
B362 98         2908       TYA
B363 2A         2909       ROL A
B364 A8         2910       TAY
B365 B0A4       2911       BCS BB30B      ;if overflow, OUT OF MEMORY Error
B367 0671       2912       ASL Z71
B369 2672       2913       ROL Z72        ;shift high bit out of length
B36B 900B       2914       BCC BB378
B36D 18         2915       CLC            ;if set
B36E 8A         2916       TXA
B36F 6528       2917       ADC Z28        ;add low byte of limit to XY
B371 AA         2918       TAX
B372 98         2919       TYA
B373 6529       2920       ADC Z29        ;high byte also
B375 A8         2921       TAY
B376 B093       2922       BCS BB30B      ;if overflow, OUT OF MEMORY Error
B378 C65D       2923 BB378 DEC Z5D
B37A D0E3       2924       BNE BB35F      ;repeat for all bits of length
B37C 60         2925       RTS
```

```
                2927 ;"FRE" command
                2928 ;
B37D A50D       2929 WB37D LDA Z0D       ;if string flag set
B37F F003       2930       BEQ BB384
B381 20A6B6     2931       JSR SB6A6     ;de-allocate temporary string storage
B384 2026B5     2932 BB384 JSR SB526     ;perform garbage clean-up
B387 38         2933       SEC
B388 A533       2934       LDA Z33       ;compute difference between
B38A E531       2935       SBC Z31       ;pointer to allocated string area
B38C A8         2936       TAY           ;and pointer to end of array area
B38D A534       2937       LDA Z34
B38F E532       2938       SBC Z32       ;convert length into flp accu
                2939 ;
                2940 ;routine to convert integer to floating point
                2941 ;
B391 A200       2942 JB391 LDX $00
B393 860D       2943       STX Z0D       ;clear string flag
B395 8562       2944       STA Z62       ;store integer from AY into flp accu
B397 8463       2945       STY Z63
B399 A290       2946       LDX $90       ;load exponent (16)
B39B 4C44BC     2947       JMP JBC44     ;convert to floating point #
                2948 ;
                2949 ;"POS" command
                2950 ;
B39E 38         2951 WB39E SEC           ;set carry to read cursor position
B39F 20F0FF     2952       JSR XFFF0     ;perform read cursor position into XY
B3A2 A900       2953 JB3A2 LDA $00
B3A4 F0EB       2954       BEQ JB391     ;convert integer into flp accu
                2955 ;
                2956 ;check for non-direct mode
                2957 ;
B3A6 A63A       2958 SB3A6 LDX Z3A       ;get program/direct flag
B3A8 E8         2959       INX
B3A9 D0A0       2960       BNE BB34B     ;if direct,
B3AB A215       2961       LDX $15       ;point to ILLEGAL DIRECT Error message
B3AD 2C         2962       .BY $2C       ;skip next instruction
B3AE A21B       2963 BB3AE LDX $1B       ;point to UNDEF'D FUNCTION Error message
B3B0 4C37A4     2964       JMP JA437     ;print error
```

```
                2966 ;"DEF" command
                2967 ;
B3B3 20E1B3     2968 WB3B3 JSR SB3E1     ;get function name
B3B6 20A6B3     2969       JSR SB3A6     ;check for non-direct mode
B3B9 20FAAE     2970       JSR SAEFA     ;next character must be "("
B3BC A980       2971       LDA $80
B3BE 8510       2972       STA Z10       ;set no integers/array elements allowed
B3C0 208BB0     2973       JSR SB08B     ;gather name and get pointer to variable
B3C3 208DAD     2974       JSR SAD8D     ;check value to be non-string
B3C6 20F7AE     2975       JSR SAEF7     ;next value must be ")"
B3C9 A9B2       2976       LDA $B2
B3CB 20FFAE     2977       JSR SAEFF     ;next character must be "="
B3CE 48         2978       PHA           ;save first character of definition
B3CF A548       2979       LDA Z48       ;save pointer to variable of function
B3D1 48         2980       PHA
B3D2 A547       2981       LDA Z47
B3D4 48         2982       PHA
B3D5 A57B       2983       LDA Z7B       ;save current character pointer
B3D7 48         2984       PHA
B3D8 A57A       2985       LDA Z7A
B3DA 48         2986       PHA
B3DB 20F8A8     2987       JSR JA8F8     ;execute command DATA
B3DE 4C4FB4     2988       JMP JB44F     ;set value for function name
                2989 ;
                2990 ;get function name
                2991 ;
B3E1 A9A5       2992 SB3E1 LDA $A5       ;if next character not code for FN
B3E3 20FFAE     2993       JSR SAEFF     ;then SYNTAX Error
B3E6 0980       2994       ORA $80       ;else set bit 7 of
B3E8 8510       2995       STA Z10       ;no integers or array elements flag
B3EA 2092B0     2996       JSR SB092     ;gather name and get pointer to variable
B3ED 854E       2997       STA Z4E       ;save pointer to variable
B3EF 844F       2998       STY Z4F
B3F1 4C8DAD     2999       JMP SAD8D     ;check value to be non-string
                3000 ;
                3001 ;expand FN call
                3002 ;
B3F4 20E1B3     3003 JB3F4 JSR SB3E1     ;get function name
B3F7 A54F       3004       LDA Z4F
B3F9 48         3005       PHA           ;save pointer to name on variable stack
B3FA A54E       3006       LDA Z4E
B3FC 48         3007       PHA
B3FD 20F1AE     3008       JSR BAEF1     ;get parathensized value
B400 208DAD     3009       JSR SAD8D     ;check that value is non-string
B403 68         3010       PLA
B404 854E       3011       STA Z4E       ;restore pointer to variable name
B406 68         3012       PLA
B407 854F       3013       STA Z4F
B409 A002       3014       LDY $02
B40B B14E       3015       LDA (Z4E),Y   ;get index to variable
B40D 8547       3016       STA Z47       ;save pointer to formal parameters
B40F AA         3017       TAX
B410 C8         3018       INY
B411 B14E       3019       LDA (Z4E),Y   ;high byte also
B413 F099       3020       BEQ BB3AE     ;if data byte + 3 is zero, fatal error
B415 8548       3021       STA Z48
B417 C8         3022       INY
B418 B147       3023 BB418 LDA (Z47),Y   ;save formal parameters on stack
B41A 48         3024       PHA
B41B 88         3025       DEY
```

```
B41C 10FA    3026         BPL BB418
B41E A448    3027         LDY Z48        ;get pointer to formal parameters in XY
B420 20D4BB  3028         JSR SBBD4      ;store flp accu into formal parameters
B423 A57B    3029         LDA Z7B
B425 48      3030         PHA            ;save current character pointer on stack
B426 A57A    3031         LDA Z7A
B428 48      3032         PHA
B429 B14E    3033         LDA (Z4E),Y    ;move current pointer of definition
B42B 857A    3034         STA Z7A        ;into current character pointer
B42D C8      3035         INY
B42E B14E    3036         LDA (Z4E),Y
B430 857B    3037         STA Z7B
B432 A548    3038         LDA Z48
B434 48      3039         PHA
B435 A547    3040         LDA Z47
B437 48      3041         PHA
B438 208AAD  3042         JSR SAD8A      ;get next non-string value
B43B 68      3043         PLA            ;set pointer to formal parameters
B43C 854E    3044         STA Z4E
B43E 68      3045         PLA
B43F 854F    3046         STA Z4F
B441 207900  3047         JSR X0079      ;get current character
B444 F003    3048         BEQ BB449      ;if not zero or ":"
B446 4C08AF  3049         JMP JAF08      ;SYNTAX Error
             3050 ;
B449 68      3051 BB449   PLA
B44A 857A    3052         STA Z7A        ;restore current character pointer
B44C 68      3053         PLA
B44D 857B    3054         STA Z7B        ;and restore formal parameters
B44F A000    3055 JB44F   LDY $00        ;set index into variable
B451 68      3056         PLA
B452 914E    3057         STA (Z4E),Y    ;save stack into variable, byte + 0
B454 68      3058         PLA
B455 C8      3059         INY
B456 914E    3060         STA (Z4E),Y    ;byte + 1
B458 68      3061         PLA
B459 C8      3062         INY
B45A 914E    3063         STA (Z4E),Y    ;byte + 2
B45C 68      3064         PLA
B45D C8      3065         INY
B45E 914E    3066         STA (Z4E),Y    ;byte + 3
B460 68      3067         PLA
B461 C8      3068         INY
B462 914E    3069         STA (Z4E),Y    ;byte + 4
B464 60      3070         RTS
```

```
                3072 ;"STR$" command
                3073 ;
B465 208DAD     3074 WB465 JSR SAD8D      ;check if parameter non-string
B468 A000       3075       LDY $00        ;start output area at $00FF
B46A 20DFBD     3076       JSR SBDDF      ;convert to string
B46D 68         3077       PLA            ;remove own return address
B46E 68         3078       PLA
B46F A9FF       3079 JB46F LDA $FF        ;set AY to point to string
B471 A000       3080       LDY $00        ;on bottom of stack
B473 F012       3081       BEQ SB487      ;get description of constant string
B475 A664       3082 SB475 LDX Z64        ;move pointer to string description
B477 A465       3083       LDY Z65
B479 8650       3084       STX Z50        ;into Z50/Z51
B47B 8451       3085       STY Z51
                3086 ;
                3087 ;allocate area according to A
                3088 ;
B47D 20F4B4     3089 SB47D JSR SB4F4      ;allocate area
B480 8662       3090       STX Z62        ;store pointer
B482 8463       3091       STY Z63
B484 8561       3092       STA Z61        ;store length
B486 60         3093       RTS
```

```
                3095 ;get description of constant string into flp accu
                3096 ;
B487 A222       3097 SB487 LDX #""
B489 8607       3098       STX Z07       ;set both termintors
B48B 8608       3099       STX Z08
B48D 856F       3100 SB48D STA Z6F       ;store pointer to beginning of string
B48F 8470       3101       STY Z70       ;in temporary pointer
B491 8562       3102       STA Z62       ;and in flp accu
B493 8463       3103       STY Z63
B495 A0FF       3104       LDY #$FF      ;initialize string index
B497 C8         3105 BB497 INY
B498 B16F       3106       LDA (Z6F),Y   ;get next character
B49A F00C       3107       BEQ BB4A8     ;if zero
B49C C507       3108       CMP Z07
B49E F004       3109       BEQ BB4A4     ;or first terminator,
B4A0 C508       3110       CMP Z08
B4A2 D0F3       3111       BNE BB497     ;or second terminator, then end found
B4A4 C922       3112 BB4A4 CMP #""       ;if terminator = quote
B4A6 F001       3113       BEQ BB4A9
B4A8 18         3114 BB4A8 CLC
B4A9 8461       3115 BB4A9 STY Z61       ;save length
B4AB 98         3116       TYA
B4AC 656F       3117       ADC Z6F
B4AE 8571       3118       STA Z71       ;and set pointer beyond string
B4B0 A670       3119       LDX Z70
B4B2 9001       3120       BCC BB4B5
B4B4 E8         3121       INX
B4B5 8672       3122 BB4B5 STX Z72
B4B7 A570       3123       LDA Z70       ;if from statement in Direct mode,
B4B9 F004       3124       BEQ BB4BF
B4BB C902       3125       CMP $02
B4BD D00B       3126       BNE BB4CA
B4BF 98         3127 BB4BF TYA           ;get length
B4C0 2075B4     3128       JSR SB475     ;allocate area
B4C3 A66F       3129       LDX Z6F
B4C5 A470       3130       LDY Z70       ;save pointer to it
B4C7 2088B6     3131       JSR SB688     ;move string into it
```

```
                3133 ;save descriptor from Z61-Z63 to descriptor stack
                3134 ;
B4CA A616       3135 BB4CA LDX Z16        ;get descriptor stack index
B4CC E022       3136       CPX <Z22       ;if at $22
B4CE D005       3137       BNE BB4D5
B4D0 A219       3138       LDX $19        ;point to FORMULA TOO COMPLEX Error
B4D2 4C37A4     3139 BB4D2 JMP JA437      ;print error
B4D5 A561       3140 BB4D5 LDA Z61        ;else move descriptor
B4D7 9500       3141       STA Z00,X      ;to descriptor stack
B4D9 A562       3142       LDA Z62
B4DB 9501       3143       STA Z01,X
B4DD A563       3144       LDA Z63
B4DF 9502       3145       STA Z02,X
B4E1 A000       3146       LDY $00        ;set pointer to descriptor
B4E3 8664       3147       STX Z64        ;in flp accu
B4E5 8465       3148       STY Z65
B4E7 8470       3149       STY Z70        ;clear guard bit
B4E9 88         3150       DEY
B4EA 840D       3151       STY Z0D        ;set string flag
B4EC 8617       3152       STX Z17        ;set previous descriptor stack index
B4EE E8         3153       INX
B4EF E8         3154       INX
B4F0 E8         3155       INX
B4F1 8616       3156       STX Z16        ;set new descriptor stack index
B4F3 60         3157       RTS
```

```
                3159 ;allocate # of bytes in A
                3160 ;
B4F4 460F       3161 SB4F4 LSR Z0F        ;clear error flag
B4F6 48         3162 BB4F6 PHA            ;save length
B4F7 49FF       3163       EOR $FF
B4F9 38         3164       SEC
B4FA 6533       3165       ADC Z33        ;subtract length from string storage ptr
B4FC A434       3166       LDY Z34
B4FE B001       3167       BCS BB501
B500 88         3168       DEY            ;high byte also
B501 C432       3169 BB501 CPY Z32        ;if above
B503 9011       3170       BCC BB516      ;array area
B505 D004       3171       BNE BB50B
B507 C531       3172       CMP Z31
B509 900B       3173       BCC BB516
B50B 8533       3174 BB50B STA Z33        ;set new string storage pointer
B50D 8434       3175       STY Z34
B50F 8535       3176       STA Z35        ;set utility string pointer also
B511 8436       3177       STY Z36
B513 AA         3178       TAX            ;and set AX
B514 68         3179       PLA            ;restore length
B515 60         3180       RTS
                3181 ;
B516 A210       3182 BB516 LDX $10
B518 A50F       3183       LDA Z0F        ;if no memory left
B51A 30B6       3184       BMI BB4D2      ;print OUT OF MEMORY Error
B51C 2026B5     3185       JSR SB526      ;else perform garbage clean-up
B51F A980       3186       LDA $80
B521 850F       3187       STA Z0F        ;clear flag
B523 68         3188       PLA            ;restore # bytes to allocate
B524 D0D0       3189       BNE BB4F6      ;and perform allocation
                3190 ;
                3191 ;string garbage clean-up
                3192 ;
B526 A637       3193 SB526 LDX Z37        ;get memory limit
B528 A538       3194       LDA Z38
B52A 8633       3195 JB52A STX Z33        ;set new string storage pointer
B52C 8534       3196       STA Z34
B52E A000       3197       LDY $00        ;set no descriptor of highest text yet
B530 844F       3198       STY Z4F
B532 844E       3199       STY Z4E
B534 A531       3200       LDA Z31        ;get end of array area
B536 A632       3201       LDX Z32
B538 855F       3202       STA Z5F        ;initialize value for highest text ptr
B53A 8660       3203       STX Z60
B53C A919       3204       LDA <Z19       ;AX = ptr to bottom of descriptor stack
B53E A200       3205       LDX >Z19
B540 8522       3206       STA Z22        ;and store in temporary pointer
B542 8623       3207       STX Z23
B544 C516       3208 BB544 CMP Z16
B546 F005       3209       BEQ BB54D      ;if not top index of descriptor stack
B548 20C7B5     3210       JSR SB5C7      ;find highest text area
B54B F0F7       3211       BEQ BB544
B54D A907       3212 BB54D LDA $07        ;set step to 7
B54F 8553       3213       STA Z53
B551 A52D       3214       LDA Z2D        ;move pointer to name table
B553 A62E       3215       LDX Z2E
B555 8522       3216       STA Z22        ;into temporary pointer
B557 8623       3217       STX Z23
B559 E430       3218 BB559 CPX Z30
```

```
B55B D004   3219         BNE BB561      ;if end of name table
B55D C52F   3220         CMP Z2F        ;not reached yet
B55F F005   3221         BEQ BB566
B561 20BDB5 3222 BB561   JSR SB5BD      ;find highest text area
B564 F0F3   3223         BEQ BB559
B566 8558   3224 BB566   STA Z58        ;save pointer into array area
B568 8659   3225         STX Z59
B56A A903   3226         LDA $03        ;reset step to 3
B56C 8553   3227         STA Z53
B56E A558   3228 BB56E   LDA Z58        ;get pointer to next array
B570 A659   3229         LDX Z59
B572 E432   3230 BB572   CPX Z32
B574 D007   3231         BNE BB57D      ;if end of array area
B576 C531   3232         CMP Z31
B578 D003   3233         BNE BB57D
B57A 4C06B6 3234         JMP JB606      ;move text area
B57D 8522   3235 BB57D   STA Z22        ;else save array pointer
B57F 8623   3236         STX Z23        ;into temporary pointer
B581 A000   3237         LDY $00
B583 B122   3238         LDA (Z22),Y
B585 AA     3239         TAX            ;save first character of name
B586 C8     3240         INY
B587 B122   3241         LDA (Z22),Y
B589 08     3242         PHP            ;save status of second character of name
B58A C8     3243         INY
B58B B122   3244         LDA (Z22),Y    ;add length of array
B58D 6558   3245         ADC Z58
B58F 8558   3246         STA Z58        ;to array pointer
B591 C8     3247         INY
B592 B122   3248         LDA (Z22),Y
B594 6559   3249         ADC Z59        ;high byte also
B596 8559   3250         STA Z59
B598 28     3251         PLP            ;second character of variable name
B599 10D3   3252         BPL BB56E      ;must have bit 7 set for string
B59B 8A     3253         TXA            ;first character of variable name
B59C 30D0   3254         BMI BB56E      ;must have bit 7 low for string
B59E C8     3255         INY
B59F B122   3256         LDA (Z22),Y    ;get # of dimensions
B5A1 A000   3257         LDY $00        ;and initialize Y
B5A3 0A     3258         ASL A          ;compute offset to first element
B5A4 6905   3259         ADC $05
B5A6 6522   3260         ADC Z22
B5A8 8522   3261         STA Z22        ;point to first element
B5AA 9002   3262         BCC BB5AE
B5AC E623   3263         INC Z23
B5AE A623   3264 BB5AE   LDX Z23
B5B0 E459   3265 BB5B0   CPX Z59        ;if not pointing beyond last element
B5B2 D004   3266         BNE BB5B8
B5B4 C558   3267         CMP Z58
B5B6 F0BA   3268         BEQ BB572
B5B8 20C7B5 3269 BB5B8   JSR SB5C7      ;find highest text address
B5BB F0F3   3270         BEQ BB5B0      ;and repeat for next address
```

```
                3272 ;check string pointed to by Z22/Z23
                3273 ;as being highest string area outside allocated area
                3274 ;
B5BD B122       3275 SB5BD LDA (Z22),Y   ;if name has bit 7 of first char = 0
B5BF 3035       3276       BMI BB5F6
B5C1 C8         3277       INY
B5C2 B122       3278       LDA (Z22),Y   ;and bit 7 of second character = 1
B5C4 1030       3279       BPL BB5F6
B5C6 C8         3280       INY           ;drop thru
                3281 ;
                3282 ;check string indexed by descriptor
                3283 ;for being highest string area
                3284 ;outside of allocated area
                3285 ;
B5C7 B122       3286 SB5C7 LDA (Z22),Y   ;if length = 0
B5C9 F02B       3287       BEQ BB5F6     ;then no text area
B5CB C8         3288       INY
B5CC B122       3289       LDA (Z22),Y
B5CE AA         3290       TAX           ;get pointer to text into AX
B5CF C8         3291       INY
B5D0 B122       3292       LDA (Z22),Y
B5D2 C534       3293       CMP Z34       ;if pointer is
B5D4 9006       3294       BCC BB5DC     ;above string storage area
B5D6 D01E       3295       BNE BB5F6
B5D8 E433       3296       CPX Z33
B5DA B01A       3297       BCS BB5F6     ;then string is not highest
B5DC C560       3298 BB5DC CMP Z60       ;if pointer is
B5DE 9016       3299       BCC BB5F6     ;below previous highest
B5E0 D004       3300       BNE BB5E6
B5E2 E45F       3301       CPX Z5F
B5E4 9010       3302       BCC BB5F6     ;then not highest
B5E6 865F       3303 BB5E6 STX Z5F
B5E8 8560       3304       STA Z60       ;save pointer to new highest
B5EA A522       3305       LDA Z22
B5EC A623       3306       LDX Z23       ;get pointer to variable or descriptor
B5EE 854E       3307       STA Z4E
B5F0 864F       3308       STX Z4F       ;save pointer to winner
B5F2 A553       3309       LDA Z53       ;save step size of winner
B5F4 8555       3310       STA Z55
B5F6 A553       3311 BB5F6 LDA Z53       ;add step
B5F8 18         3312       CLC
B5F9 6522       3313       ADC Z22       ;to variable or descriptor pointer
B5FB 8522       3314       STA Z22
B5FD 9002       3315       BCC BB601
B5FF E623       3316       INC Z23
B601 A623       3317 BB601 LDX Z23       ;variable or descriptor pointer in AX
B603 A000       3318       LDY $00
B605 60         3319       RTS
```

```
                3321 ;continuation of string garbage clean-up
                3322 ;
B606 A54F       3323 JB606 LDA Z4F        ;if no pointer to descriptor
B608 054E       3324       ORA Z4E        ;of highest string yet,
B60A F0F5       3325       BEQ BB601      ;return
B60C A555       3326       LDA Z55
B60E 2904       3327       AND $04        ;compute offset to descriptor
B610 4A         3328       LSR A
B611 A8         3329       TAY
B612 8555       3330       STA Z55
B614 B14E       3331       LDA (Z4E),Y    ;get length of text
B616 655F       3332       ADC Z5F        ;add to pointer to beginning of text
B618 855A       3333       STA Z5A        ;store in high limit for move routine
B61A A560       3334       LDA Z60        ;high bytes also
B61C 6900       3335       ADC $00
B61E 855B       3336       STA Z5B
B620 A533       3337       LDA Z33        ;move current string storage pointer
B622 A634       3338       LDX Z34
B624 8558       3339       STA Z58        ;into high limit of output for move
B626 8659       3340       STX Z59
B628 20BFA3     3341       JSR SA3BF      ;move bytes
B62B A455       3342       LDY Z55        ;get offset to descriptor
B62D C8         3343       INY
B62E A558       3344       LDA Z58
B630 914E       3345       STA (Z4E),Y    ;let descriptor point to moved text area
B632 AA         3346       TAX
B633 E659       3347       INC Z59
B635 A559       3348       LDA Z59
B637 C8         3349       INY
B638 914E       3350       STA (Z4E),Y    ;high byte also
B63A 4C2AB5     3351       JMP JB52A      ;repeat for next string
```

```
                3353 ;diadic operator "+" for strings
                3354 ;
B63D A565       3355 JB63D LDA Z65
B63F 48         3356       PHA             ;save pointer to left operand
B640 A564       3357       LDA Z64
B642 48         3358       PHA
B643 2083AE     3359       JSR SAE83       ;get value of next operand in flp accu
B646 208FAD     3360       JSR SAD8F       ;must be string
B649 68         3361       PLA
B64A 856F       3362       STA Z6F
B64C 68         3363       PLA
B64D 8570       3364       STA Z70         ;restore  temporary string address
B64F A000       3365       LDY $00
B651 B16F       3366       LDA (Z6F),Y     ;get length of left operand
B653 18         3367       CLC
B654 7164       3368       ADC (Z64),Y     ;add length of right operand
B656 9005       3369       BCC BB65D       ;if => 256
B658 A217       3370       LDX $17         ;point to STRING TOO LONG Error
B65A 4C37A4     3371       JMP JA437       ;print error
                3372 ;
B65D 2075B4     3373 BB65D JSR SB475       ;allocate area for sum of lengths
B660 207AB6     3374       JSR SB67A       ;move left operand
B663 A550       3375       LDA Z50
B665 A451       3376       LDY Z51         ;get descriptor  of right operand
B667 [illegible]           JSR SB6AA       ;de-allocate old area
B66A 208CB6     3378       JSR SB68C       ;move right operand
B66D A56F       3379       LDA Z6F
B66F A470       3380       LDY Z70
B671 20AAB6     3381       JSR SB6AA       ;de-allocate old area
B674 20CAB4     3382       JSR BB4CA       ;save descriptor on stack
B677 4CB8AD     3383       JMP JADB8       ;go back to expression evaluation
```

```
                3385 ;move string with descriptor pointed by Z6F/Z70
                3386 ;into last allocated area
                3387 ;
B67A A000       3388 SB67A LDY $00
B67C B16F       3389       LDA (Z6F),Y
B67E 48         3390       PHA            ;save length from descriptor
B67F C8         3391       INY
B680 B16F       3392       LDA (Z6F),Y
B682 AA         3393       TAX            ;pointer from descriptor
B683 C8         3394       INY
B684 B16F       3395       LDA (Z6F),Y
B686 A8         3396       TAY            ;into XY
B687 68         3397       PLA            ;length into A
                3398 ;
                3399 ;move string with length in A, pointer in XY
                3400 ;into last allocated area
                3401 ;
B688 8622       3402 SB688 STX Z22        ;save pointer in temporary pointer area
B68A 8423       3403       STY Z23
B68C A8         3404 SB68C TAY            ;if length = 0
B68D F00A       3405       BEQ BB699      ;don't move
B68F 48         3406       PHA            ;save length
B690 88         3407 BB690 DEY            ;for every character
B691 B122       3408       LDA (Z22),Y    ;move from string
B693 9135       3409       STA (Z35),Y    ;to last allocated area
B695 98         3410       TYA
B696 D0F8       3411       BNE BB690      ;until no more characters
B698 68         3412       PLA            ;restore length
B699 18         3413 BB699 CLC            ;set Z35/Z36 to end of allocated area
B69A 6535       3414       ADC Z35
B69C 8535       3415       STA Z35
B69E 9002       3416       BCC BB6A2
B6A0 E636       3417       INC Z36
B6A2 60         3418 BB6A2 RTS
```

```
                3420 ;de-allocate a temporary string
                3421 ;
B6A3 208FAD     3422 SB6A3 JSR SAD8F      ;check if value is a string
B6A6 A564       3423 SB6A6 LDA Z64
B6A8 A465       3424       LDY Z65        ;set AY to pointer to descriptor
B6AA 8522       3425 SB6AA STA Z22        ;and store in temporary pointer
B6AC 8423       3426       STY Z23
B6AE 20DBB6     3427       JSR SB6DB      ;check descriptor stack
B6B1 08         3428       PHP            ;save status (Z=1 when desc on stack)
B6B2 A000       3429       LDY $00
B6B4 B122       3430       LDA (Z22),Y
B6B6 48         3431       PHA            ;save string length
B6B7 C8         3432       INY
B6B8 B122       3433       LDA (Z22),Y
B6BA AA         3434       TAX            ;pointer to string in XY
B6BB C8         3435       INY
B6BC B122       3436       LDA (Z22),Y
B6BE A8         3437       TAY
B6BF 68         3438       PLA            ;string length into A
B6C0 28         3439       PLP            ;restore status
B6C1 D013       3440       BNE BB6D6      ;branch if descriptor on stack
B6C3 C434       3441       CPY Z34        ;if pointer to string
B6C5 D00F       3442       BNE BB6D6
B6C7 E433       3443       CPX Z33        ;= string storage pointer
B6C9 D00B       3444       BNE BB6D6
B6CB 48         3445       PHA            ;save length
B6CC 18         3446       CLC
B6CD 6533       3447       ADC Z33        ;add length to string storage pointer
B6CF 8533       3448       STA Z33        ;to form new string storage pointer
B6D1 9002       3449       BCC BB6D5      ;(de-allocates string)
B6D3 E634       3450       INC Z34
B6D5 68         3451 BB6D5 PLA            ;restore length
B6D6 8622       3452 BB6D6 STX Z22        ;save pointer to string
B6D8 8423       3453       STY Z23
B6DA 60         3454       RTS
                3455 ;
                3456 ;check descriptor stack
                3457 ;
B6DB C418       3458 SB6DB CPY Z18
B6DD D00C       3459       BNE BB6EB      ;if descriptor pointer
B6DF C517       3460       CMP Z17        ;same as previous descriptor stack ptr
B6E1 D008       3461       BNE BB6EB
B6E3 8516       3462       STA Z16        ;then set descriptor stack index
B6E5 E903       3463       SBC $03        ;to point to it
B6E7 8517       3464       STA Z17        ;set previous descriptor index below it
B6E9 A000       3465       LDY $00        ;leave new descriptor pointer in AY
B6EB 60         3466 BB6EB RTS
```

```
                3468 ;"CHR$" command
                3469 ;
B6EC 20A1B7     3470 WB6EC JSR SB7A1     ;get integer paramenter into X
B6EF 8A         3471       TXA
B6F0 48         3472       PHA           ;and save
B6F1 A901       3473       LDA $01       ;set length
B6F3 207DB4     3474       JSR SB47D     ;allocate area
B6F6 68         3475       PLA           ;restore integer
B6F7 A000       3476       LDY $00
B6F9 9162       3477       STA (Z62),Y   ;save character in allocated area
B6FB 68         3478       PLA
B6FC 68         3479       PLA           ;remove own return address
B6FD 4CCAB4     3480       JMP BB4CA     ;save descriptor on descriptor stack
                3481 ;
                3482 ;"LEFT$" command
                3483 ;
B700 2061B7     3484 WB700 JSR SB761     ;get 2 parameters
B703 D150       3485       CMP (Z50),Y   ;compare length wanted to stack length
B705 98         3486       TYA           ;A = initial index in text
B706 9004       3487 JB706 BCC BB70C     ;if length requested >= string length
B708 B150       3488       LDA (Z50),Y
B70A AA         3489       TAX           ;use string length instead
B70B 98         3490       TYA
B70C 48         3491 BB70C PHA           ;save initial index
B70D 8A         3492 BB70D TXA           ;get length wanted
B70E 48         3493 BB70E PHA           ;and save it
B70F 207DB4     3494       JSR SB47D     ;de-allocate area
B712 A550       3495       LDA Z50
B714 A451       3496       LDY Z51       ;set AY to point to first parameter
B716 20AAB6     3497       JSR SB6AA     ;de-allocate temporary string
B719 68         3498       PLA           ;restore length requested
B71A A8         3499       TAY
B71B 68         3500       PLA           ;restore initial index in text
B71C 18         3501       CLC
B71D 6522       3502       ADC Z22       ;add to text pointer
B71F 8522       3503       STA Z22
B721 9002       3504       BCC BB725
B723 E623       3505       INC Z23
B725 98         3506 BB725 TYA           ;for length requested,
B726 208CB6     3507       JSR SB68C     ;move string into allocated area
B729 4CCAB4     3508       JMP BB4CA     ;save descriptor on descriptor stack
                3509 ;
                3510 ;"RIGHT$" command
                3511 ;
B72C 2061B7     3512 WB72C JSR SB761     ;get 2 parameters
B72F 18         3513       CLC
B730 F150       3514       SBC (Z50),Y   ;compute length - length requested
B732 49FF       3515       EOR $FF
B734 4C06B7     3516       JMP JB706     ;go do tail end of LEFT$
```

```
                3518 ;"MID$" command
                3519 ;
B737 A9FF       3520 WB737 LDA $FF       ;set default 3rd parameter to 255
B739 8565       3521       STA Z65
B73B 207900     3522       JSR X0079     ;get current character
B73E C929       3523       CMP ")"       ;if not ")"
B740 F006       3524       BEQ BB748
B742 20FDAE     3525       JSR SAEFD     ;must be ","
B745 209EB7     3526       JSR SB79E     ;get next integer
B748 2061B7     3527 BB748 JSR SB761     ;get first 2 parameters
B74B F04B       3528       BEQ BB798     ;if 2nd parameter = 0, ILLEGAL QUANTITY
B74D CA         3529       DEX           ;decrement index
B74E 8A         3530       TXA
B74F 48         3531       PHA           ;and save it on stack
B750 18         3532       CLC
B751 A200       3533       LDX $00
B753 F150       3534       SBC (Z50),Y   ;compute index - length
B755 B0B6       3535       BCS BB70D     ;if larger, get null string
B757 49FF       3536       EOR $FF       ;if # characters remaining
B759 C565       3537       CMP Z65
B75B 90B1       3538       BCC BB70E     ;less than 3rd parameter,
B75D A565       3539       LDA Z65       ;take # of characters remaining instead
B75F B0AD       3540       BCS BB70E     ;do tail end of LEFT$
                3541 ;
                3542 ;get first two prameters for LEFT$, RIGHT$ and MID$
                3543 ;
B761 20F7AE     3544 SB761 JSR SAEF7     ;next character must be ")"
B764 68         3545       PLA
B765 A8         3546       TAY           ;save return address
B766 68         3547       PLA
B767 8555       3548       STA Z55
B769 68         3549       PLA           ;remove return address
B76A 68         3550       PLA
B76B 68         3551       PLA           ;restore 2nd parameter (integer)
B76C AA         3552       TAX
B76D 68         3553       PLA
B76E 8550       3554       STA Z50       ;move 1st parameter (ptr to descriptor)
B770 68         3555       PLA           ;into Z50/Z51
B771 8551       3556       STA Z51
B773 A555       3557       LDA Z55
B775 48         3558       PHA           ;restore return address
B776 98         3559       TYA
B777 48         3560       PHA
B778 A000       3561       LDY $00
B77A 8A         3562       TXA           ;set flags according to 2nd parameter
B77B 60         3563       RTS
```

```
                3565 ;"LEN$" command
                3566 ;
B77C 2082B7     3567 WB77C JSR SB782     ;de-allocate parameter, get length in Y
B77F 4CA2B3     3568       JMP JB3A2     ;convert integer in Y to flp
                3569 ;
B782 20A3B6     3570 SB782 JSR SB6A3     ;de-allocate temp string (parameter)
B785 A200       3571       LDX $00
B787 860D       3572       STX Z0D       ;reset string flag
B789 A8         3573       TAY           ;move length to Y
B78A 60         3574       RTS
                3575 ;
                3576 ;"ASC$" command
                3577 ;
B78B 2082B7     3578 WB78B JSR SB782     ;de-allocate parameter, get length in Y
B78E F008       3579       BEQ BB798     ;if null string, ILLEGAL QUANTITY Error
B790 A000       3580       LDY $00
B792 B122       3581       LDA (Z22),Y   ;get first character of string
B794 A8         3582       TAY           ;move into Y
B795 4CA2B3     3583       JMP JB3A2     ;convert integer in Y to flp
                3584 ;
B798 4C48B2     3585 BB798 JMP JB248     ; print error
                3586 ;
                3587 ;fetch integer value in X and check range
                3588 ;
B79B 207300     3589 SB79B JSR X0073     ;get next character
B79E 208AAD     3590 SB79E JSR SAD8A     ;get next non-string value
B7A1 20B8B1     3591 SB7A1 JSR SB1B8     ;convert positive flp accu to integer
B7A4 A664       3592       LDX Z64       ;if not in range 0 - 255
B7A6 D0F0       3593       BNE BB798     ;print error ILLEGAL QUANTITY
B7A8 A665       3594       LDX Z65       ;load value into X
B7AA 4C7900     3595       JMP X0079     ;get current character again and return
```

```
                3597 ;"VAL" command
                3598 ;
B7AD 2082B7     3599 WB7AD JSR SB782     ;de-allocate parameter, get length in Y
B7B0 D003       3600       BNE BB7B5     ;if length zero,
B7B2 4CF7B8     3601       JMP JB8F7     ;set result zero
B7B5 A67A       3602 BB7B5 LDX Z7A       ;move current character pointer
B7B7 A47B       3603       LDY Z7B
B7B9 8671       3604       STX Z71       ;to temporary pointer
B7BB 8472       3605       STY Z72
B7BD A622       3606       LDX Z22       ;move low byte of text pointer
B7BF 867A       3607       STX Z7A       ;into current character pointer
B7C1 18         3608       CLC
B7C2 6522       3609       ADC Z22       ;add length
B7C4 8524       3610       STA Z24       ;to create pointer to end of string
B7C6 A623       3611       LDX Z23       ;move high byte of text pointer
B7C8 867B       3612       STX Z7B       ;into high byte of current character ptr
B7CA 9001       3613       BCC BB7CD
B7CC E8         3614       INX           ;add carry of length
B7CD 8625       3615 BB7CD STX Z25       ;set high byte of ptr to end of string
B7CF A000       3616       LDY $00
B7D1 B124       3617       LDA (Z24),Y   ;get first byte beyond string
B7D3 48         3618       PHA           ;and save it on stack
B7D4 98         3619       TYA
B7D5 9124       3620       STA (Z24),Y   ;set null instead
B7D7 207900     3621       JSR X0079     ;get current character
B7DA 20F3BC     3622       JSR SBCF3     ;convert string to flp
B7DD 68         3623       PLA           ;restore first byte beyond string
B7DE A000       3624       LDY $00
B7E0 9124       3625       STA (Z24),Y   ;and restore
B7E2 A671       3626 SB7E2 LDX Z71       ;get new value for current character ptr
B7E4 A472       3627       LDY Z72
B7E6 867A       3628       STX Z7A       ;and store it as current character ptr
B7E8 847B       3629       STY Z7B
B7EA 60         3630       RTS
                3631 ;
                3632 ;get address into Z14/Z15 and integer into X
                3633 ;
B7EB 208AAD     3634 SB7EB JSR SAD8A     ;get non-string value from statement
B7EE 20F7B7     3635       JSR SB7F7     ;convert flp accu to integer at Z14/Z15
B7F1 20FDAE     3636 SB7F1 JSR SAEFD     ;next character must be ","
B7F4 4C9EB7     3637       JMP SB79E     ;get next integer from statement into X
```

```
                3639 ;convert floating point into integer in Z14/Z15
                3640 ;
B7F7 A566       3641 SB7F7 LDA Z66        ;if negative
B7F9 309D       3642       BMI BB798
B7FB A561       3643       LDA Z61
B7FD C991       3644       CMP $91        ;or exponent > 16
B7FF B097       3645       BCS BB798      ;then ILLEGAL QUANTITY Error
B801 209BBC     3646       JSR SBC9B      ;convert flp accu to integer at Z64/Z65
B804 A564       3647       LDA Z64
B806 A465       3648       LDY Z65
B808 8414       3649       STY Z14        ;and into result field
B80A 8515       3650       STA Z15
B80C 60         3651       RTS
                3652 ;
                3653 ;"PEEK" command
                3654 ;
B80D A515       3655 WB80D LDA Z15
B80F 48         3656       PHA
B810 A514       3657       LDA Z14        ;save contents of Z14/Z15
B812 48         3658       PHA
B813 20F7B7     3659       JSR SB7F7      ;convert flp accu to integer in Z14/Z15
B816 A000       3660       LDY $00
B818 B114       3661       LDA (Z14),Y    ;get byte
B81A A8         3662       TAY            ;and save in Y
B81B 68         3663       PLA            ;then restore Z14/Z15
B81C 8514       3664       STA Z14
B81E 68         3665       PLA
B81F 8515       3666       STA Z15
B821 4CA2B3     3667       JMP JB3A2      ;convert integer in Y to flp
                3668 ;
                3669 ;"POKE" command
                3670 ;
B824 20EBB7     3671 WB824 JSR SB7EB      ;get address in Z14/Z15, integer in X
B827 8A         3672       TXA
B828 A000       3673       LDY $00
B82A 9114       3674       STA (Z14),Y    ;move integer from X to address
B82C 60         3675       RTS
```

```
                3677 ;"WAIT" command
                3678 ;
B82D 20EBB7     3679 WB82D JSR SB7EB      ;get address in Z14/Z15, integer in X
B830 8649       3680       STX Z49        ;save mask
B832 A200       3681       LDX $00        ;default pattern = 00
B834 207900     3682       JSR X0079      ;get current character
B837 F003       3683       BEQ BB83C      ;if not end of statement
B839 20F1B7     3684       JSR SB7F1      ;get next integer from statement into X
B83C 864A       3685 BB83C STX Z4A        ;save pattern
B83E A000       3686       LDY $00
B840 B114       3687 BB840 LDA (Z14),Y    ;get byte
B842 454A       3688       EOR Z4A        ;Exclusive OR with pattern
B844 2549       3689       AND Z49        ;mask
B846 F0F8       3690       BEQ BB840      ;repeat until non-zero
B848 60         3691 BB848 RTS
                3692 ;
                3693 ;add 0.5 to flp accu (half rounding)
                3694 ;
B849 A911       3695 SB849 LDA <TBF11
B84B A0BF       3696       LDY >TBF11     ;set AY to point to value 0.5
B84D 4C67B8     3697       JMP SB867      ;add to flp accu
                3698 ;
                3699 ;"MINUS" operator
                3700 ;
B850 208CBA     3701 SB850 JSR SBA8C      ;subtract flp accu from # indexed by AY
                3702 ;
                3703 ;diadic operator "-"
                3704 ;
B853 A566       3705 WB853 LDA Z66
B855 49FF       3706       EOR $FF        ;complement sign
B857 8566       3707       STA Z66
B859 456E       3708       EOR Z6E
B85B 856F       3709       STA Z6F        ;also adjust Exclusive OR of both signs
B85D A561       3710       LDA Z61        ;fetch exponent of flp accu
B85F 4C6AB8     3711       JMP JB86A      ;go apply diadic operator "+"
```

```
B862 2099B9 3713 BB862 JSR SB999      ;perform preshifts according to A
B865 903C   3714       BCC BB8A3      ;do addition or subtraction
            3715 ;
            3716 ;add flp # indexed by AY to flp accu
            3717 ;
B867 208CBA 3718 SB867 JSR SBA8C      ;perform addition
            3719 ;
            3720 ;"PLUS" operator
            3721 ;
B86A        3722 WB86A =   *
B86A D003   3723 JB86A BNE BB86F      ;if flp accu = 0
B86C 4CFCBB 3724       JMP SBBFC      ;move 2nd flp accu into flp accu
            3725 ;
B86F A670   3726 BB86F LDX Z70        ;save guard bit
B871 8656   3727       STX Z56
B873 A269   3728       LDX $69        ;X = pointer to smaller
B875 A569   3729       LDA Z69        ;get exponent of 2nd flp accu
B877 A8     3730 SB877 TAY            ;if zero
B878 F0CE   3731       BEQ BB848      ;result already in flp accu
B87A 38     3732       SEC
B87B E561   3733       SBC Z61        ;compute difference in exponents
B87D F024   3734       BEQ BB8A3      ;if zero, go act on fractions
B87F 9012   3735       BCC BB893      ;if second flp accu higher
B881 8461   3736       STY Z61        ;set exponent of result
B883 A46E   3737       LDY Z6E        ;and sign of result
B885 8466   3738       STY Z66
B887 49FF   3739       EOR $FF
B889 6900   3740       ADC $00        ;two's complement of difference
B88B A000   3741       LDY $00
B88D 8456   3742       STY Z56        ;set guard bit to 0 for higher
B88F A261   3743       LDX $61        ;point to smaller
B891 D004   3744       BNE BB897
B893 A000   3745 BB893 LDY $00        ;if second flp accu lower
B895 8470   3746       STY Z70        ;move 0 to guard bit of lower
B897 C9F9   3747 BB897 CMP $F9        ;if difference more than 8
B899 30C7   3748       BMI BB862      ;do preshifts
B89B A8     3749       TAY            ;save number of preshifts
B89C A570   3750       LDA Z70        ;get guard bit
B89E 5601   3751       LSR Z01,X      ;pad with zero
B8A0 20B0B9 3752       JSR SB9B0      ;do preshifts
B8A3 246F   3753 BB8A3 BIT Z6F        ;if both signs are the same
B8A5 1057   3754       BPL BB8FE      ;add fractions
```

```
                3756 ;negate flp accu if borrow, and postshift
                3757 ;
B8A7 A061       3758        LDY $61       ;let Y point
B8A9 E069       3759        CPX $69
B8AB F002       3760        BEQ BB8AF
B8AD A069       3761        LDY $69       ;to higher
B8AF 38         3762 BB8AF  SEC
B8B0 49FF       3763        EOR $FF       ;compute initial borrow
B8B2 6556       3764        ADC Z56       ;from guard bit
B8B4 8570       3765        STA Z70
B8B6 B90400     3766        LDA Z04,Y
B8B9 F504       3767        SBC Z04,X     ;compute difference, byte 4
B8BB 8565       3768        STA Z65
B8BD B90300     3769        LDA Z03,Y
B8C0 F503       3770        SBC Z03,X     ;byte 3
B8C2 8564       3771        STA Z64
B8C4 B90200     3772        LDA Z02,Y
B8C7 F502       3773        SBC Z02,X     ;byte 2
B8C9 8563       3774        STA Z63
B8CB B90100     3775        LDA Z01,Y
B8CE F501       3776        SBC Z01,X     ;and byte 1
B8D0 8562       3777        STA Z62
B8D2 B003       3778 JB8D2  BCS BB8D7     ;if borrow
B8D4 2047B9     3779        JSR SB947     ;negate result
B8D7 A000       3780 BB8D7  LDY $00       ;initialize parameters
B8D9 98         3781        TYA
B8DA 18         3782        CLC           ;for postshift
B8DB A662       3783 BB8DB  LDX Z62       ;if most significant byte 0
B8DD D04A       3784        BNE BB929
B8DF A663       3785        LDX Z63       ;shift fraction over one byte
B8E1 8662       3786        STX Z62
B8E3 A664       3787        LDX Z64
B8E5 8663       3788        STX Z63
B8E7 A665       3789        LDX Z65
B8E9 8664       3790        STX Z64
B8EB A670       3791        LDX Z70
B8ED 8665       3792        STX Z65
B8EF 8470       3793        STY Z70
B8F1 6908       3794        ADC $08       ;correct exponent by 8
B8F3 C920       3795        CMP $20
B8F5 D0E4       3796        BNE BB8DB     ;repeat until 4 bytes shifted
B8F7 A900       3797 JB8F7  LDA $00       ;because then result = 0
B8F9 8561       3798 JB8F9  STA Z61
B8FB 8566       3799 JB8FB  STA Z66
B8FD 60         3800        RTS
```

```
                3802 ;add fractions
                3803 ;
 B8FE 6556      3804 BB8FE ADC Z56      ;compute initial fraction
 B900 8570      3805       STA Z70      ;also set guard bit
 B902 A565      3806       LDA Z65
 B904 656D      3807       ADC Z6D      ;compute sum, byte 4
 B906 8565      3808       STA Z65
 B908 A564      3809       LDA Z64
 B90A 656C      3810       ADC Z6C      ;byte 3
 B90C 8564      3811       STA Z64
 B90E A563      3812       LDA Z63
 B910 656B      3813       ADC Z6B      ;byte 2
 B912 8563      3814       STA Z63
 B914 A562      3815       LDA Z62
 B916 656A      3816       ADC Z6A      ;byte 1
 B918 8562      3817       STA Z62
 B91A 4C36B9    3818       JMP JB936    ;go adjust for carry outside byte 1
                3819 ;
                3820 ;postshift
                3821 ;
 B91D 6901      3822 BB91D ADC $01      ;add 1 to exponent
 B91F 0670      3823       ASL Z70      ;shift left 1 bit
 B921 2665      3824       ROL Z65      ;over whole fraction
 B923 2664      3825       ROL Z64
 B925 2663      3826       ROL Z63
 B927 2662      3827       ROL Z62
 B929 10F2      3828 BB929 BPL BB91D    ;repeat until MSB = 1
 B92B 38        3829       SEC          ;subtract correction from exponent
 B92C E561      3830       SBC Z61      ;underflow causes zero result
 B92E B0C7      3831       BCS JB8F7
 B930 49FF      3832       EOR $FF
 B932 6901      3833       ADC $01      ;store new exponent
 B934 8561      3834       STA Z61      ;carry means overflow in fraction
 B936 900E      3835 JB936 BCC BB946    ;so increment exponent
 B938 E661      3836 JB938 INC Z61      ;unless exponent overflows
 B93A F042      3837       BEQ BB97E    ;and shift right by one bit
 B93C 6662      3838       ROR Z62
 B93E 6663      3839       ROR Z63
 B940 6664      3840       ROR Z64
 B942 6665      3841       ROR Z65
 B944 6670      3842       ROR Z70      ;including guard bit
 B946 60        3843 BB946 RTS
```

```
                3845 ;negate flp accu
                3846 ;
B947 A566       3847 SB947 LDA Z66
B949 49FF       3848       EOR $FF       ;complement sign
B94B 8566       3849       STA Z66
B94D A562       3850 SB94D LDA Z62
B94F 49FF       3851       EOR $FF       ;complement fraction byte 4
B951 8562       3852       STA Z62
B953 A563       3853       LDA Z63
B955 49FF       3854       EOR $FF       ;byte 3
B957 8563       3855       STA Z63
B959 A564       3856       LDA Z64
B95B 49FF       3857       EOR $FF       ;byte 2
B95D 8564       3858       STA Z64
B95F A565       3859       LDA Z65
B961 49FF       3860       EOR $FF       ;and byte 1
B963 8565       3861       STA Z65
B965 A570       3862       LDA Z70
B967 49FF       3863       EOR $FF       ;and guard bit
B969 8570       3864       STA Z70       ;if guard bit 0
B96B E670       3865       INC Z70
B96D D00E       3866       BNE BB97D     ;then increment fraction
                3867 ;
                3868 ;increment fraction
                3869 ;
B96F E665       3870 SB96F INC Z65       ;increment byte 4
B971 D00A       3871       BNE BB97D     ;if 0
B973 E664       3872       INC Z64       ;byte 3 also
B975 D006       3873       BNE BB97D     ;if 0
B977 E663       3874       INC Z63       ;byte 2 also
B979 D002       3875       BNE BB97D     ;if 0
B97B E662       3876       INC Z62       ;byte 1 also
B97D 60         3877 BB97D RTS           ;zero here means overflow
                3878 ;
B97E A20F       3879 BB97E LDX $0F       ;point to OVERFLOW Error
B980 4C37A4     3880       JMP JA437     ;print message
```

```
                3882 ;preshift
                3883 ;
B983 A225       3884 JB983 LDX $25
B985 B404       3885 BB985 LDY Z04,X     ;shift whole fraction
B987 8470       3886       STY Z70       ;right one byte
B989 B403       3887       LDY Z03,X
B98B 9404       3888       STY Z04,X
B98D B402       3889       LDY Z02,X
B98F 9403       3890       STY Z03,X
B991 B401       3891       LDY Z01,X
B993 9402       3892       STY Z02,X
B995 A468       3893       LDY Z68       ;high order padding
B997 9401       3894       STY Z01,X
B999 6908       3895 SB999 ADC $08       ;add 8 to exponent
B99B 30E8       3896       BMI BB985     ;if still <= 0
B99D F0E6       3897       BEQ BB985     ;shift another byte
B99F E908       3898       SBC $08       ;compensate for correction
B9A1 A8         3899       TAY
B9A2 A570       3900       LDA Z70       ;check guard bit
B9A4 B014       3901       BCS BB9BA     ;if exponent zero now, stop shifting
B9A6 1601       3902 BB9A6 ASL Z01,X     ;else
B9A8 9002       3903       BCC BB9AC
B9AA F601       3904       INC Z01,X
B9AC 7601       3905 BB9AC ROR Z01,X
B9AE 7601       3906       ROR Z01,X     ;shift fraction right one bit
B9B0 7602       3907 SB9B0 ROR Z02,X
B9B2 7603       3908       ROR Z03,X
B9B4 7604       3909       ROR Z04,X
B9B6 6A         3910       ROR A         ;last bit into A
B9B7 C8         3911       INY
B9B8 D0EC       3912       BNE BB9A6     ;until # of shifts zero
B9BA 18         3913 BB9BA CLC
B9BB 60         3914       RTS
```

```
                3916 ;1, also used as default FOR step
B9BC 810000     3917 TB9BC .BY $81,$00,$00,$00,$00
                3918 ;polynome table for LOG
B9C1 03         3919 TB9C1 .BY $03
                3920 ;0.434255942
B9C2 7F5E56     3921       .BY $7F,$5E,$56,$CB,$79
                3922 ;0.576584541
B9C7 80139B     3923       .BY $80,$13,$9B,$0B,$64
                3924 ;0.961800759
B9CC 807638     3925       .BY $80,$76,$38,$93,$16
                3926 ;2.88539007
B9D1 8238AA     3927       .BY $82,$38,$AA,$3B,$20
                3928 ;0.5 * SQR(2)
B9D6 803504     3929 TB9D6 .BY $80,$35,$04,$F3,$34
                3930 ;SQR(2)
B9DB 813504     3931 TB9DB .BY $81,$35,$04,$F3,$34
                3932 ;-0.5
B9E0 808000     3933 TB9E0 .BY $80,$80,$00,$00,$00
                3934 ;LOG(2)
B9E5 803172     3935 TB9E5 .BY $80,$31,$72,$17,$F8
                3936 ;
                3937 ;"LOG" command
                3938 ;
B9EA            3939 WB9EA =   *
B9EA 202BBC     3940 SB9EA JSR SBC2B     ;get sign of flp accu into A
B9ED F002       3941       BEQ BB9F1
B9EF 1003       3942       BPL BB9F4     ;if > 0, OK
B9F1 4C48B2     3943 BB9F1 JMP JB248     ;else ILLEGAL QUANTITY Error
                3944 ;
B9F4 A561       3945 BB9F4 LDA Z61       ;get exponent
B9F6 E97F       3946       SBC $7F       ;corrrect for excess of 128
B9F8 48         3947       PHA           ;and save result
B9F9 A980       3948       LDA $80
B9FB 8561       3949       STA Z61       ;set exponent
B9FD A9D6       3950       LDA <TB9D6
B9FF A0B9       3951       LDY >TB9D6    ;set AY to point to 0.5 * SQR(2)
BA01 2067B8     3952       JSR SB867     ;add to flp accu
BA04 A9DB       3953       LDA <TB9DB
BA06 A0B9       3954       LDY >TB9DB    ;set AY to point to SQR(2)
BA08 200FBB     3955       JSR SBB0F     ;divide AY by flp accu
BA0B A9BC       3956       LDA <TB9BC
BA0D A0B9       3957       LDY >TB9BC    ;set AY to point to 1
BA0F 2050B8     3958       JSR SB850     ;subtract flp accu from AY
BA12 A9C1       3959       LDA <TB9C1
BA14 A0B9       3960       LDY >TB9C1    ;set AY to polynome table
BA16 2043E0     3961       JSR XE043     ;compute odd polynome
BA19 A9E0       3962       LDA <TB9E0
BA1B A0B9       3963       LDY >TB9E0    ;set AY to point to -0.5
BA1D 2067B8     3964       JSR SB867     ;add to flp accu
BA20 68         3965       PLA           ;restore exponent
BA21 207EBD     3966       JSR JBD7E     ;add exponent to flp accu
BA24 A9E5       3967       LDA <TB9E5
BA26 A0B9       3968       LDY >TB9E5    ;set AY to LOG(2)
BA28 208CBA     3969 SBA28 JSR SBA8C     ;multiply AY times flp accu
```

```
                3971 ;"*" operator
                3972 ;
BA2B D003       3973 WBA2B BNE BBA30      ;if flp accu = 0, return
BA2D 4C8BBA     3974       JMP JBA8B
                3975 ;
BA30 20B7BA     3976 BBA30 JSR SBAB7      ;add exponents
BA33 A900       3977       LDA $00
BA35 8526       3978       STA Z26        ;set flp accu extension to zero
BA37 8527       3979       STA Z27
BA39 8528       3980       STA Z28
BA3B 8529       3981       STA Z29
BA3D A570       3982       LDA Z70        ;get guard bit
BA3F 2059BA     3983       JSR SBA59      ;* second flp accu added to flp accu ext
BA42 A565       3984       LDA Z65
BA44 2059BA     3985       JSR SBA59      ;same for byte 4
BA47 A564       3986       LDA Z64
BA49 2059BA     3987       JSR SBA59      ;same for byte 3
BA4C A563       3988       LDA Z63
BA4E 2059BA     3989       JSR SBA59      ;and byte 2
BA51 A562       3990       LDA Z62
BA53 205EBA     3991       JSR SBA5E      ;and byte 1
BA56 4C8FBB     3992       JMP JBB8F      ;post-normalize and return
                3993 ;
                3994 ;add second flp accu * A to flp extension
                3995 ;
BA59 D003       3996 SBA59 BNE SBA5E      ;if a zero
BA5B 4C83B9     3997       JMP JB983      ;perform pre-shift
                3998 ;
BA5E 4A         3999 SBA5E LSR A          ;shift LSB of A into carry
BA5F 0980       4000       ORA $80        ;set to $80 only after 8 shifts
BA61 A8         4001 BBA61 TAY            ;save A
BA62 9019       4002       BCC BBA7D      ;if low bit set
BA64 18         4003       CLC
BA65 A529       4004       LDA Z29
BA67 656D       4005       ADC Z6D        ;add second flp fraction
BA69 8529       4006       STA Z29        ;to flp extension
BA6B A528       4007       LDA Z28
BA6D 656C       4008       ADC Z6C
BA6F 8528       4009       STA Z28        ;also byte 2
BA71 A527       4010       LDA Z27
BA73 656B       4011       ADC Z6B
BA75 8527       4012       STA Z27        ;and byte 3
BA77 A526       4013       LDA Z26
BA79 656A       4014       ADC Z6A
BA7B 8526       4015       STA Z26        ;and byte 4
BA7D 6626       4016 BBA7D ROR Z26        ;shift flp extension right 1 bit
BA7F 6627       4017       ROR Z27
BA81 6628       4018       ROR Z28
BA83 6629       4019       ROR Z29
BA85 6670       4020       ROR Z70        ;including guard bit
BA87 98         4021       TYA            ;restore A
BA88 4A         4022       LSR A          ;get low bit of A into carry
BA89 D0D6       4023       BNE BBA61      ;repeat until zero
BA8B 60         4024 JBA8B RTS
```

```
                4026 ;move flp # indexed by AY into second flp accu
                4027 ;
BA8C 8522       4028 SBA8C STA Z22        ;save AY index
BA8E 8423       4029       STY Z23
BA90 A004       4030       LDY $04
BA92 B122       4031       LDA (Z22),Y    ;move byte 4 of fraction
BA94 856D       4032       STA Z6D
BA96 88         4033       DEY
BA97 B122       4034       LDA (Z22),Y
BA99 856C       4035       STA Z6C        ;byte 3
BA9B 88         4036       DEY
BA9C B122       4037       LDA (Z22),Y
BA9E 856B       4038       STA Z6B        ;byte 2
BAA0 88         4039       DEY
BAA1 B122       4040       LDA (Z22),Y
BAA3 856E       4041       STA Z6E        ;and byte 1
BAA5 4566       4042       EOR Z66        ;into sign
BAA7 856F       4043       STA Z6F        ;also Exclusive OR with sign of flp accu
BAA9 A56E       4044       LDA Z6E
BAAB 0980       4045       ORA $80
BAAD 856A       4046       STA Z6A        ;byte 1 always has bit 7 set
BAAF 88         4047       DEY
BAB0 B122       4048       LDA (Z22),Y
BAB2 8569       4049       STA Z69        ;save exponent
BAB4 A561       4050       LDA Z61        ;show exponent of flp accu in A, Z and N
BAB6 60         4051       RTS
```

```
                4053 ;add exponents
                4054 ;
BAB7 A569       4055 SBAB7 LDA Z69      ;get exp. of 2nd flp accu (left operand)
BAB9 F01F       4056       BEQ BBADA    ;if zero, set zero result
BABB 18         4057       CLC
BABC 6561       4058       ADC Z61      ;add to exponent of flp accu
BABE 9004       4059       BCC BBAC4    ;if carry set
BAC0 301D       4060       BMI BBADF    ;and negative, true overflow
BAC2 18         4061       CLC          ;else correct for excess 128
BAC3 2C         4062       .BY $2C      ;skip next instructiion
BAC4 1014       4063 BBAC4 BPL BBADA    ;if C = 1 and positive, real underflow
BAC6 6980       4064       ADC $80      ;else correct for excess 128
BAC8 8561       4065       STA Z61      ;store resulting exponent
BACA D003       4066       BNE BBACF    ;if zero
BACC 4CFBB8     4067       JMP JB8FB    ;set sign positive
                4068 ;
BACF A56F       4069 BBACF LDA Z6F      ;Exclusive OR of signs
BAD1 8566       4070       STA Z66      ;is sign of result
BAD3 60         4071       RTS
                4072 ;
BAD4 A566       4073       LDA Z66      ;get sign of flp accu
BAD6 49FF       4074       EOR $FF
BAD8 3005       4075       BMI BBADF    ;if positive, overflow
BADA 68         4076 BBADA PLA          ;remove own return address
BADB 68         4077       PLA
BADC 4CF7B8     4078       JMP JB8F7    ;and set result zero
                4079 ;
BADF 4C7EB9     4080 BBADF JMP BB97E    ;OVERFLOW Error
                4081 ;
                4082 ;multiply flp accu by 10
                4083 ;
BAE2 200CBC     4084 SBAE2 JSR SBC0C    ;move rounded flp into second flp accu
BAE5 AA         4085       TAX          ;get exponent
BAE6 F010       4086       BEQ BBAF8    ;if flp accu is zero, return
BAE8 18         4087       CLC
BAE9 6902       4088       ADC $02      ;exponent of second flp + 2 (# * 4)
BAEB B0F2       4089       BCS BBADF    ;exit if overflow
BAED A200       4090 SBAED LDX $00
BAEF 866F       4091       STX Z6F      ;set signs same
BAF1 2077B8     4092       JSR SB877    ;add second flp accu to flp (# * 5)
BAF4 E661       4093       INC Z61      ;add 1 to exponent (# * 10)
BAF6 F0E7       4094       BEQ BBADF    ;exit if overflow
BAF8 60         4095 BBAF8 RTS
                4096 ;
                4097 ;flp constant 10 for division
BAF9 842000     4098 TBAF9 .BY $84,$20,$00,$00,$00
                4099 ;
                4100 ;divide flp accu by 10
                4101 ;
BAFE 200CBC     4102 SBAFE JSR SBC0C    ;move rounded flp accu to 2nd flp accu
BB01 A9F9       4103       LDA <TBAF9
BB03 A0BA       4104       LDY >TBAF9   ;set AY to flp value 10
BB05 A200       4105       LDX $00
BB07 866F       4106       STX Z6F      ;set signs the same
BB09 20A2BB     4107       JSR SBBA2    ;load flp accu from AY
BB0C 4C12BB     4108       JMP JBB12    ;perform division
```

```
                4110 ;divide number (indexed by AY) by flp accu
                4111 ;
BB0F 208CBA     4112 SB0F JSR SBA8C     ;fetch # indexedby AY into 2nd flp accu
                4113 ;
                4114 ;"/" operator
                4115 ;
BB12            4116 WBB12 =  *
BB12 F076       4117 JBB12 BEQ BBB8A    ;if flp accu = 0, DIVISION BY ZERO Error
BB14 201BBC     4118       JSR SBC1B    ;round flp accu according to guard bit
BB17 A900       4119       LDA $00
BB19 38         4120       SEC
BB1A E561       4121       SBC Z61      ;compute 2's complement of exponent
BB1C 8561       4122       STA Z61
BB1E 20B7BA     4123       JSR SBAB7    ;add exponents
BB21 E661       4124       INC Z61      ;correct exponent
BB23 F0BA       4125       BEQ BBADF    ;exit if overflow
BB25 A2FC       4126       LDX $FC      ;set initial index into flp extension
BB27 A901       4127       LDA $01      ;assure 8 loops per byte
BB29 A46A       4128 BBB29 LDY Z6A
BB2B C462       4129       CPY Z62      ;compare fractions, byte 1
BB2D D010       4130       BNE BBB3F
BB2F A46B       4131       LDY Z6B
BB31 C463       4132       CPY Z63      ;byte 2
BB33 D00A       4133       BNE BBB3F
BB35 A46C       4134       LDY Z6C
BB37 C464       4135       CPY Z64      ;byte 3
BB39 D004       4136       BNE BBB3F
BB3B A46D       4137       LDY Z6D
BB3D C465       4138       CPY Z65      ;byte 4
BB3F 08         4139 BBB3F PHP          ;save result of comparison
BB40 2A         4140       ROL A        ;shift result into A
BB41 9009       4141       BCC BBB4C    ;after 8 shifts
BB43 E8         4142       INX
BB44 9529       4143       STA Z29,X    ;save result into flp extension
BB46 F032       4144       BEQ BBB7A    ;after byte 4, do guard byte
BB48 1034       4145       BPL BBB7E    ;after guard byte, exit
BB4A A901       4146       LDA $01      ;again, 8 iterations per byte
BB4C 28         4147 BBB4C PLP          ;restore result of comparison
BB4D B00E       4148       BCS BBB5D    ;if dividend larger, subtract
BB4F 066D       4149 JBB4F ASL Z6D      ;shift dividend left 1 bit
BB51 266C       4150       ROL Z6C
BB53 266B       4151       ROL Z6B
BB55 266A       4152       ROL Z6A
BB57 B0E6       4153       BCS BBB3F    ;if C = 1 comparison result will be 1
BB59 30CE       4154       BMI BBB29    ;if C = 0 and MSB = 1, compare
BB5B 10E2       4155       BPL BBB3F    ;if C = 0 and MSB = 0, comp. result = 0
BB5D A8         4156 BBB5D TAY          ;if dividend larger
BB5E A56D       4157       LDA Z6D
BB60 E565       4158       SBC Z65      ;subtract divisor
BB62 856D       4159       STA Z6D
BB64 A56C       4160       LDA Z6C
BB66 E564       4161       SBC Z64      ;byte 2
BB68 856C       4162       STA Z6C
BB6A A56B       4163       LDA Z6B
BB6C E563       4164       SBC Z63      ;byte 3
BB6E 856B       4165       STA Z6B
BB70 A56A       4166       LDA Z6A
BB72 E562       4167       SBC Z62      ;byte 4
BB74 856A       4168       STA Z6A
BB76 98         4169       TYA
```

```
BB77 4C4FBB 4170        JMP JBB4F       ;repeat
            4171 ;
BB7A A940   4172 BBB7A LDA $40          ;two more iterations for guard bit
BB7C D0CE   4173        BNE BBB4C
BB7E 0A     4174 BBB7E ASL A            ;after guard byte computation,
BB7F 0A     4175        ASL A           ;shift result left 6 bits
BB80 0A     4176        ASL A
BB81 0A     4177        ASL A
BB82 0A     4178        ASL A
BB83 0A     4179        ASL A
BB84 8570   4180        STA Z70         ;set new guard bit
BB86 28     4181        PLP             ;remove result of last comparison
BB87 4C8FBB 4182        JMP JBB8F       ;and save result
            4183 ;
BB8A A214   4184 BBB8A LDX $14          ;point to DIVISION BY ZERO Error
BB8C 4C37A4 4185        JMP JA437       ;print error
            4186 ;
BB8F A526   4187 JBB8F LDA Z26          ;move flp accu extension
BB91 8562   4188        STA Z62         ;into flp fraction
BB93 A527   4189        LDA Z27
BB95 8563   4190        STA Z63         ;byte 2
BB97 A528   4191        LDA Z28
BB99 8564   4192        STA Z64         ;byte 3
BB9B A529   4193        LDA Z29
BB9D 8565   4194        STA Z65         ;byte 4
BB9F 4CD7B8 4195        JMP BB8D7       ;do post-normalization
            4196 ;
            4197 ;load flp accu with constant indexed by AY
            4198 ;
BBA2 8522   4199 SBBA2 STA Z22
BBA4 8423   4200        STY Z23         ;save AY
BBA6 A004   4201        LDY $04
BBA8 B122   4202        LDA (Z22),Y     ;load byte + 4
BBAA 8565   4203        STA Z65         ;into flp accu + 4
BBAC 88     4204        DEY
BBAD B122   4205        LDA (Z22),Y     ;byte + 3
BBAF 8564   4206        STA Z64
BBB1 88     4207        DEY
BBB2 B122   4208        LDA (Z22),Y     ;byte + 2
BBB4 8563   4209        STA Z63
BBB6 88     4210        DEY
BBB7 B122   4211        LDA (Z22),Y     ;byte + 1
BBB9 8566   4212        STA Z66         ;into sign byte
BBBB 0980   4213        ORA $80         ;and with bit 7 set
BBBD 8562   4214        STA Z62         ;into flp accu + 1
BBBF 88     4215        DEY
BBC0 B122   4216        LDA (Z22),Y     ;byte + 0
BBC2 8561   4217        STA Z61         ;into exponent of flp accu
BBC4 8470   4218        STY Z70         ;clear guard bit
BBC6 60     4219        RTS
```

```
                4221 ;store flp accu at Z5C-Z60
                4222 ;
BBC7 A25C       4223        LDX <Z5C        ;initialize low byte of pointer
BBC9 2C         4224        .BY $2C         ;skip next instruction
                4225 ;
                4226 ;store flp accu at Z57-Z5B
                4227 ;
BBCA A257       4228        LDX <Z57        ;initialize low byte of pointer
BBCC A000       4229        LDY >Z57        ;initialize high byte of pointer
BBCE F004       4230        BEQ SBBD4       ;JMP
                4231 ;
                4232 ;store flp accu into area indexed by Z49/Z4A
                4233 ;
BBD0 A649       4234 JBBD0 LDX Z49          ;set area pointer in XY
BBD2 A44A       4235        LDY Z4A
                4236 ;
                4237 ;store flp accu in area indexed by XY
                4238 ;
BBD4 201BBC     4239 SBBD4 JSR SBC1B        ;round flp accu
BBD7 8622       4240        STX Z22         ;store XY in temporary pointer
BBD9 8423       4241        STY Z23
BBDB A004       4242        LDY $04
BBDD A565       4243        LDA Z65         ;move byte 4 of fraction
BBDF 9122       4244        STA (Z22),Y
BBE1 88         4245        DEY
BBE2 A564       4246        LDA Z64
BBE4 9122       4247        STA (Z22),Y     ;byte 3
BBE6 88         4248        DEY
BBE7 A563       4249        LDA Z63
BBE9 9122       4250        STA (Z22),Y     ;byte 2
BBEB 88         4251        DEY
BBEC A566       4252        LDA Z66         ;combine sign
BBEE 097F       4253        ORA $7F
BBF0 2562       4254        AND Z62         ;and byte 1
BBF2 9122       4255        STA (Z22),Y     ;into byte 1 of area
BBF4 88         4256        DEY
BBF5 A561       4257        LDA Z61         ;move exponent
BBF7 9122       4258        STA (Z22),Y
BBF9 8470       4259        STY Z70         ;clear guard bit
BBFB 60         4260        RTS
                4261 ;
                4262 ;move second flp accu into first flp accu
                4263 ;
BBFC A56E       4264 SBBFC LDA Z6E          ;move sign
BBFE 8566       4265 SBBFE STA Z66
BC00 A205       4266        LDX $05         ;loop counter
BC02 B568       4267 BBC02 LDA Z68,X        ;move 5 bytes
BC04 9560       4268        STA Z60,X
BC06 CA         4269        DEX
BC07 D0F9       4270        BNE BBC02
BC09 8670       4271        STX Z70         ;set product of signs to "+"
BC0B 60         4272        RTS
```

```
                4274 ;move rounded flp accu into second flp accu
                4275 ;
BC0C 201BBC     4276 SBC0C JSR SBC1B     ;round flp accu
BC0F A206       4277       LDX $06       ;set # bytes to move
BC11 B560       4278 BBC11 LDA Z60,X     ;move 6 bytes
BC13 9568       4279       STA Z68,X
BC15 CA         4280       DEX
BC16 D0F9       4281       BNE BBC11
BC18 8670       4282       STX Z70       ;store zero into guard bit
BC1A 60         4283 BBC1A RTS
                4284 ;
                4285 ;round flp accu according to guard bit
                4286 ;
BC1B A561       4287 SBC1B LDA Z61       ;if flp accu = 0
BC1D F0FB       4288       BEQ BBC1A     ;leave it at 0
BC1F 0670       4289       ASL Z70       ;if guard bit not set
BC21 90F7       4290       BCC BBC1A     ;status quo
BC23 206FB9     4291 SBC23 JSR SB96F     ;increment fraction
BC26 D0F2       4292       BNE BBC1A     ;if no overflow, leave it
BC28 4C38B9     4293       JMP JB938     ;else shift fraction right 1 bit
                4294 ;
                4295 ;get sign of flp accu in A
                4296 ;
BC2B A561       4297 SBC2B LDA Z61       ;if exponent zero
BC2D F009       4298       BEQ BBC38     ;sign = 0
BC2F A566       4299 BBC2F LDA Z66       ;move sign bit
BC31 2A         4300 JBC31 ROL A         ;into C bit
BC32 A9FF       4301       LDA $FF       ;if C = 1, sign = FF
BC34 B002       4302       BCS BBC38
BC36 A901       4303       LDA $01       ;if C = 0, sign = 01
BC38 60         4304 BBC38 RTS
                4305 ;
                4306 ;"SGN" command
                4307 ;
BC39 202BBC     4308 WBC39 JSR SBC2B     ;get SGN of flp accu into A
                4309 ;
                4310 ;move signed number from A into flp accu
                4311 ;
BC3C 8562       4312 JBC3C STA Z62       ;store # in most significant byte
BC3E A900       4313       LDA $00
BC40 8563       4314       STA Z63       ;and 0 into byte 2
BC42 A288       4315       LDX $88       ;load exponent
BC44 A562       4316 JBC44 LDA Z62
BC46 49FF       4317       EOR $FF       ;complement sign
BC48 2A         4318       ROL A         ;and move into C flag
BC49 A900       4319 SBC49 LDA $00
BC4B 8565       4320       STA Z65       ;clear byte 3
BC4D 8564       4321       STA Z64       ;and byte 4
BC4F 8661       4322 JBC4F STX Z61       ;store exponent
BC51 8570       4323       STA Z70       ;move sign to guard bit
BC53 8566       4324       STA Z66       ;and to sign bit
BC55 4CD2B8     4325       JMP JB8D2     ;negate flp accu if borrow and post-shift
```

```
                4327 ;"ABS" command
                4328 ;
BC58 4666       4329 WBC58 LSR Z66        ;set sign of flp accu positive
BC5A 60         4330       RTS
                4331 ;
                4332 ;compare flp accu to flp # indexed by AY
                4333 ;
BC5B 8524       4334 SBC5B STA Z24        ;save index to variable
BC5D 8425       4335 SBC5D STY Z25
BC5F A000       4336       LDY $00
BC61 B124       4337       LDA (Z24),Y    ;get exponent of variable
BC63 C8         4338       INY
BC64 AA         4339       TAX
BC65 F0C4       4340       BEQ SBC2B      ;if zero, get sign of flp accu
BC67 B124       4341       LDA (Z24),Y    ;get byte 1 of fraction
BC69 4566       4342       EOR Z66        ;if different from sign of flp accu
BC6B 30C2       4343       BMI BBC2F      ;get sign of flp accu
BC6D E461       4344       CPX Z61        ;compare exponents
BC6F D021       4345       BNE BBC92      ;if not equal, set sign according to C
BC71 B124       4346       LDA (Z24),Y
BC73 0980       4347       ORA $80        ;get byte 1
BC75 C562       4348       CMP Z62        ;compare to byte 1 of flp accu
BC77 D019       4349       BNE BBC92      ;if not equal, set sign according to C
BC79 C8         4350       INY
BC7A B124       4351       LDA (Z24),Y    ;get byte 2
BC7C C563       4352       CMP Z63        ;compare to byte 2 of flp accu
BC7E D012       4353       BNE BBC92      ;if not equal, set sign according to C
BC80 C8         4354       INY
BC81 B124       4355       LDA (Z24),Y    ;get byte 3
BC83 C564       4356       CMP Z64        ;compare to byte 3 of flp accu
BC85 D00B       4357       BNE BBC92      ;if not equal, set sign accoring to C
BC87 C8         4358       INY
BC88 A97F       4359       LDA $7F        ;set borrow
BC8A C570       4360       CMP Z70        ;according to guard bit
BC8C B124       4361       LDA (Z24),Y
BC8E E565       4362       SBC Z65        ;compute difference between bytes 4
BC90 F028       4363       BEQ BBCBA      ;if equal, return with A = 0
BC92 A566       4364 BBC92 LDA Z66        ;else compute sign according to C
BC94 9002       4365       BCC BBC98
BC96 49FF       4366       EOR $FF
BC98 4C31BC     4367 BBC98 JMP JBC31      ;and set A accordingly
```

```
            4369 ;convert flp accu to a 4 byte signed integer
            4370 ;
BC9B A561   4371 SBC9B LDA Z61       ;get exponent
BC9D F04A   4372       BEQ BBCE9     ;if zero fill fraction with zeros
BC9F 38     4373       SEC
BCA0 E9A0   4374       SBC $A0       ;calculate exponent - 32
BCA2 2466   4375       BIT Z66       ;if result negative
BCA4 1009   4376       BPL BBCAF
BCA6 AA     4377       TAX           ;save A
BCA7 A9FF   4378       LDA $FF       ;set padding to ones
BCA9 8568   4379       STA Z68
BCAB 204DB9 4380       JSR SB94D     ;negate flp fraction
BCAE 8A     4381       TXA           ;restore A
BCAF A261   4382 BBCAF LDX $61
BCB1 C9F9   4383       CMP $F9       ;if < 8 places to be shifted
BCB3 1006   4384       BPL BBCBB
BCB5 2099B9 4385       JSR SB999     ;do shift
BCB8 8468   4386       STY Z68       ;and reset padding
BCBA 60     4387 BBCBA RTS
            4388 ;
BCBB A8     4389 BBCBB TAY           ;if > = 8 places to be shifted
BCBC A566   4390       LDA Z66
BCBE 2980   4391       AND $80
BCC0 4662   4392       LSR Z62       ;set parameters
BCC2 0562   4393       ORA Z62
BCC4 8562   4394       STA Z62       ;and MSB
BCC6 20B0B9 4395       JSR SB9B0     ;to do byte shifts first
BCC9 8468   4396       STY Z68       ;and then reset padding
BCCB 60     4397       RTS
            4398 ;
            4399 ;"INT" command
            4400 ;
BCCC        4401 WBCCC = *
BCCC A561   4402 SBCCC LDA Z61       ;get exponent
BCCE C9A0   4403       CMP $A0       ;if > = 32
BCD0 B020   4404       BCS BBCF2     ;then no conversion necessary
BCD2 209BBC 4405       JSR SBC9B     ;convert flp accu to 4 byte integer
BCD5 8470   4406       STY Z70       ;clear guard bit
BCD7 A566   4407       LDA Z66       ;get sign
BCD9 8466   4408       STY Z66       ;set sign positive
BCDB 4980   4409       EOR $80       ;invert sign
BCDD 2A     4410       ROL A         ;and move into carry
BCDE A9A0   4411       LDA $A0
BCE0 8561   4412       STA Z61       ;set exponent to 32
BCE2 A565   4413       LDA Z65       ;move least significant bit
BCE4 8507   4414       STA Z07       ;into even/odd switch
BCE6 4CD2B8 4415       JMP JB8D2     ;negate flp accu if borrow
            4416 ;
            4417 ;clear flp accu
            4418 ;
BCE9 8562   4419 BBCE9 STA Z62       ;move A into every byte of fraction
BCEB 8563   4420       STA Z63
BCED 8564   4421       STA Z64
BCEF 8565   4422       STA Z65
BCF1 A8     4423       TAY
BCF2 60     4424 BBCF2 RTS
```

```
                4426 ;convert string to flp # in flp accu
                4427 ;
BCF3 A000       4428 SBCF3 LDY $00
BCF5 A20A       4429       LDX $0A       ;loop counter, 11 bytes to be cleared
BCF7 945D       4430 BBCF7 STY Z5D,X     ;clear flp accu and 5 more
BCF9 CA         4431       DEX
BCFA 10FB       4432       BPL BBCF7
BCFC 900F       4433       BCC BBD0D     ;if first character not numeric
BCFE C92D       4434       CMP '-        ;check for minus
BD00 D004       4435       BNE BBD06     ;if so,
BD02 8667       4436       STX Z67       ;set flag for negative #
BD04 F004       4437       BEQ BBD0A
BD06 C92B       4438 BBD06 CMP '+        ;check for positive number
BD08 D005       4439       BNE BBD0F     ;if not, go try others
BD0A 207300     4440 BBD0A JSR X0073     ;get next character
BD0D 905B       4441 BBD0D BCC BBD6A     ;if numeric, gather number
BD0F C92E       4442 BBD0F CMP '.        ;if decimal point,
BD11 F02E       4443       BEQ BBD41     ;set flag
BD13 C945       4444       CMP 'E        ;if exponent character
BD15 D030       4445       BNE BBD47
BD17 207300     4446       JSR X0073     ;get next character
BD1A 9017       4447       BCC BBD33     ;if numeric, gather exponent value
BD1C C9AB       4448       CMP $AB       ;if code for "-"
BD1E F00E       4449       BEQ BBD2E
BD20 C92D       4450       CMP '-        ;or "-" itself
BD22 F00A       4451       BEQ BBD2E     ;set flag
BD24 C9AA       4452       CMP $AA       ;if code for "+"
BD26 F008       4453       BEQ BBD30
BD28 C92B       4454       CMP '+        ;or "+" itself
BD2A F004       4455       BEQ BBD30     ;skip
BD2C D007       4456       BNE BBD35     ;else combine fraction & exponent
BD2E 6660       4457 BBD2E ROR Z60       ;set flag for negative exponent
BD30 207300     4458 BBD30 JSR X0073     ;get next character
BD33 905C       4459 BBD33 BCC BBD91     ;if numeric, gather exponent value
BD35 2460       4460 BBD35 BIT Z60       ;at end of exponent
BD37 100E       4461       BPL BBD47     ;if sign of exponent negative
BD39 A900       4462       LDA $00
BD3B 38         4463       SEC
BD3C E55E       4464       SBC Z5E       ;get two's complement of exponent
BD3E 4C49BD     4465       JMP JBD49     ;combine
                4466 ;
BD41 665F       4467 BBD41 ROR Z5F       ;set code for "." found
BD43 245F       4468       BIT Z5F
BD45 50C3       4469       BVC BBD0A     ;if already set, this is end of number
BD47 A55E       4470 BBD47 LDA Z5E       ;get exponent, base 10
BD49 38         4471 JBD49 SEC
BD4A E55D       4472       SBC Z5D       ;minus # of digits after "."
BD4C 855E       4473       STA Z5E       ;save
BD4E F012       4474       BEQ BBD62     ;if zero, no adjustment
BD50 1009       4475       BPL BBD5B     ;if positive, multiply by 10
BD52 20FEBA     4476 BBD52 JSR SBAFE     ;if negative, divide flp accu by 10
BD55 E65E       4477       INC Z5E       ;increment exponent, base 10
BD57 D0F9       4478       BNE BBD52     ;and repeat if not zero
BD59 F007       4479       BEQ BBD62
BD5B 20E2BA     4480 BBD5B JSR SBAE2     ;if positive, multiply flp accu by 10
BD5E C65E       4481       DEC Z5E       ;decrement exponent, base 10
BD60 D0F9       4482       BNE BBD5B     ;and repeat if not zero
BD62 A567       4483 BBD62 LDA Z67       ;get sign of flp #
BD64 3001       4484       BMI BBD67     ;if positive,
BD66 60         4485       RTS           ;return
```

```
                4486 ;
BD67 4CB4BF     4487 BBD67 JMP JBFB4      ;else apply monadic "-"
                4488 ;
BD6A 48         4489 BBD6A PHA            ;save numeric digit
BD6B 245F       4490       BIT Z5F        ;if "." found
BD6D 1002       4491       BPL BBD71
BD6F E65D       4492       INC Z5D        ;increment # of digits after "."
BD71 20E2BA     4493 BBD71 JSR SBAE2      ;multiply flp accu by 10
BD74 68         4494       PLA            ;restore numeric digit
BD75 38         4495       SEC
BD76 E930       4496       SBC #0         ;convert from ASCII to binary
BD78 207EBD     4497       JSR JBD7E      ;add signed integer from A to flp accu
BD7B 4C0ABD     4498       JMP BBD0A      ;repeat for next character
                4499 ;
                4500 ;add signed integer from A to flp accu
                4501 ;
BD7E 48         4502 JBD7E PHA            ;save integer
BD7F 200CBC     4503       JSR SBC0C      ;move rounded flp accu to 2nd flp accu
BD82 68         4504       PLA            ;restore integer
BD83 203CBC     4505       JSR JBC3C      ;get signed # from A into flp accu
BD86 A56E       4506       LDA Z6E
BD88 4566       4507       EOR Z66        ;compute Exclusive OR of signs
BD8A 856F       4508       STA Z6F
BD8C A661       4509       LDX Z61        ;let Z and N reflect exponent
BD8E 4C6AB8     4510       JMP JB86A      ;apply diadic operator "+"
                4511 ;
                4512 ;get exponent of number from a string
                4513 ;
BD91 A55E       4514 BBD91 LDA Z5E        ;get exponent gathered so far
BD93 C90A       4515       CMP $0A        ;if => 10
BD95 9009       4516       BCC BBDA0
BD97 A964       4517       LDA $64        ;and sign of exponent is positive
BD99 2460       4518       BIT Z60
BD9B 3011       4519       BMI BBDAE      ;then overflow
BD9D 4C7EB9     4520       JMP BB97E      ;print error
                4521 ;
BDA0 0A         4522 BBDA0 ASL A          ;exponent * 2
BDA1 0A         4523       ASL A          ;exponent * 4
BDA2 18         4524       CLC
BDA3 655E       4525       ADC Z5E        ;exponent * 5
BDA5 0A         4526       ASL A          ;exponent * 10
BDA6 18         4527       CLC
BDA7 A000       4528       LDY $00
BDA9 717A       4529       ADC (Z7A),Y    ;add current character
BDAB 38         4530       SEC
BDAC E930       4531       SBC #0         ;convert from ASCII to binary
BDAE 855E       4532 BBDAE STA Z5E        ;save exponent
BDB0 4C30BD     4533       JMP BBD30      ;repeat for next character
```

```
            4535 ;constants for flp to string conversion
            4536 ;
            4537 ;999999.9
BDB3 9B3EBC 4538 TBDB3 .BY $9B,$3E,$BC,$1F,$FD
            4539 ;999999999
BDB8 9E6E6B 4540 TBDB8 .BY $9E,$6E,$6B,$27,$FD
            4541 ;1000000000
BDBD 9E6E6B 4542 TBDBD .BY $9E,$6E,$6B,$28,$00
            4543 ;
            4544 ;print IN follwed by statement #
            4545 ;
BDC2 A971   4546 SBDC2 LDA <TA371     ;set AY to IN message
BDC4 A0A3   4547       LDY >TA371
BDC6 20DABD 4548       JSR SBDDA     ;print message
BDC9 A53A   4549       LDA Z3A       ;get current statement # into AX
BDCB A639   4550       LDX Z39
            4551 ;
            4552 ;print # from AX
            4553 ;
BDCD 8562   4554 SBDCD STA Z62       ;move AX into flp accu
BDCF 8663   4555       STX Z63
BDD1 A290   4556       LDX $90       ;set exponent to 16
BDD3 38     4557       SEC
BDD4 2049BC 4558       JSR SBC49     ;pad out flp accu
BDD7 20DFBD 4559       JSR SBDDF     ;convert flp accu to string
BDDA 4C1EAB 4560 SBDDA JMP SAB1E     ;and go print string
            4561 ;
            4562 ;convert # in flp accu to string
            4563 ;
BDDD A001   4564 SBDDD LDY $01       ;initial output index
BDDF A920   4565 SBDDF LDA $20       ;set first character to a space
BDE1 2466   4566       BIT Z66       ;but if sign negative
BDE3 1002   4567       BPL BBDE7
BDE5 A92D   4568       LDA "-        ;set first character to "-"
BDE7 99FF00 4569 BBDE7 STA X0100-1,Y ;store sign into output area
BDEA 8566   4570       STA Z66       ;set sign positive
BDEC 8471   4571       STY Z71       ;save output index
BDEE C8     4572       INY
BDEF A930   4573       LDA "0        ;assume 0
BDF1 A661   4574       LDX Z61       ;if exponent 0
BDF3 D003   4575       BNE BBDF8
BDF5 4C04BF 4576       JMP JBF04     ;output 0 and end string
            4577 ;
BDF8 A900   4578 BBDF8 LDA $00       ;clear exponent, base 10
BDFA E080   4579       CPX $80
BDFC F002   4580       BEQ BBE00     ;if exponent, base 2, = 0
BDFE B009   4581       BCS BBE09     ;or < 0
BE00 A9BD   4582 BBE00 LDA <TBDBD    ;set AY to point to 1000000000
BE02 A0BD   4583       LDY >TBDBD
BE04 2028BA 4584       JSR SBA28     ;multiply by flp accu
BE07 A9F7   4585       LDA $F7       ;set exponent base 10 to -9
BE09 855D   4586 BBE09 STA Z5D       ;save exponent base 10
BE0B A9B8   4587 BBE0B LDA <TBDB8
BE0D A0BD   4588       LDY >TBDB8    ;set AY to index 999999999
BE0F 205BBC 4589       JSR SBC5B     ;compare flp accu to AY
BE12 F01E   4590       BEQ BBE32     ;if equal, no need to adjust exonent
BE14 1012   4591       BPL BBE28     ;if flp accu >, adjust accordingly
BE16 A9B3   4592 BBE16 LDA <TBDB3    ;if flp accu <,
BE18 A0BD   4593       LDY >TBDB3    ;set AY to point to 999999.9
BE1A 205BBC 4594       JSR SBC5B     ;and compare flp accu to # indexed by AY
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```
BE1D F002   4595         BEQ BBE21
BE1F 100E   4596         BPL BBE2F      ;if flp accu <, no more adjustment
BE21 20E2BA 4597 BBE21   JSR SBAE2      ;else multiply flp accu by 10
BE24 C65D   4598         DEC Z5D        ;decrement exponent base 10
BE26 D0EE   4599         BNE BBE16      ;and repeat
BE28 20FEBA 4600 BBE28   JSR SBAFE      ;divide flp accu by 10
BE2B E65D   4601         INC Z5D        ;increment exponent, base 10
BE2D D0DC   4602         BNE BBE0B      ;repeat
BE2F 2049B8 4603 BBE2F   JSR SB849      ;do half rounding of flp accu
BE32 209BBC 4604 BBE32   JSR SBC9B      ;convert flp accu to 4 byte integer
BE35 A201   4605         LDX $01        ;set position of decimal point
BE37 A55D   4606         LDA Z5D        ;get exponent, base 10
BE39 18     4607         CLC
BE3A 690A   4608         ADC $0A        ;add 10
BE3C 3009   4609         BMI BBE47      ;if still < 0, do exponential notation
BE3E C90B   4610         CMP $0B        ;if > 10
BE40 B006   4611         BCS BBE48      ;do exponential notation
BE42 69FF   4612         ADC $FF
BE44 AA     4613         TAX            ;else set new position of decimal point
BE45 A902   4614         LDA $02        ;and set exponent base 10 accordingly
BE47 38     4615 BBE47   SEC
BE48 E902   4616 BBE48   SBC $02        ;correct exponent, base 10
BE4A 855E   4617         STA Z5E        ;save exponent
BE4C 865D   4618         STX Z5D        ;save position of decimal point
BE4E 8A     4619         TXA
BE4F F002   4620         BEQ BBE53      ;if position of decimal point > 0
BE51 1013   4621         BPL BBE66      ;no extra adjustment needed
BE53 A471   4622 BBE53   LDY Z71        ;get output index
BE55 A92E   4623         LDA #'.        ;set decimal point
BE57 C8     4624         INY
BE58 99FF00 4625         STA X0100-1,Y  ;store it
BE5B 8A     4626         TXA            ;if position of decimal point < 0
BE5C F006   4627         BEQ BBE64
BE5E A930   4628         LDA #'0        ;set a 0
BE60 C8     4629         INY
BE61 99FF00 4630         STA X0100-1,Y  ;and store it
BE64 8471   4631 BBE64   STY Z71        ;save output index
BE66 A000   4632 BBE66   LDY $00        ;set initial table index
BE68 A280   4633 SBE68   LDX $80        ;initial table phase negative
BE6A A565   4634 BBE6A   LDA Z65        ;add table entry
BE6C 18     4635         CLC
BE6D 7919BF 4636         ADC TBF16+3,Y  ;to fraction, byte 4
BE70 8565   4637         STA Z65
BE72 A564   4638         LDA Z64
BE74 7918BF 4639         ADC TBF16+2,Y  ;byte 3
BE77 8564   4640         STA Z64
BE79 A563   4641         LDA Z63
BE7B 7917BF 4642         ADC TBF16+1,Y  ;byte 2
BE7E 8563   4643         STA Z63
BE80 A562   4644         LDA Z62
BE82 7916BF 4645         ADC TBF16,Y    ;byte 1
BE85 8562   4646         STA Z62
BE87 E8     4647         INX            ;increment digit
BE88 B004   4648         BCS BBE8E
BE8A 10DE   4649         BPL BBE6A      ;if no overflow and positive, repeat
BE8C 3002   4650         BMI BBE90
BE8E 30DA   4651 BBE8E   BMI BBE6A      ;if overflow and negative phase, repeat
BE90 8A     4652 BBE90   TXA            ;if positive phase
BE91 9004   4653         BCC BBE97
BE93 49FF   4654         EOR $FF        ;get 10 - digit
```

```
BE95 690A   4655         ADC $0A
BE97 692F   4656 BBE97   ADC $2F        ;convert to ASCII
BE99 C8     4657         INY
BE9A C8     4658         INY
BE9B C8     4659         INY
BE9C C8     4660         INY            ;point to next table entry
BE9D 8447   4661         STY Z47        ;save table index
BE9F A471   4662         LDY Z71        ;get output index
BEA1 C8     4663         INY
BEA2 AA     4664         TAX            ;save digit
BEA3 297F   4665         AND $7F        ;remove phase bit
BEA5 99FF00 4666         STA X0100-1,Y  ;store digit
BEA8 C65D   4667         DEC Z5D        ;decrement position of decimal point
BEAA D006   4668         BNE BBEB2      ;if position reached
BEAC A92E   4669         LDA '.         ;set decimal point
BEAE C8     4670         INY
BEAF 99FF00 4671         STA X0100-1,Y  ;and store it at next output location
BEB2 8471   4672 BBEB2   STY Z71        ;save output index
BEB4 A447   4673         LDY Z47        ;restore table index
BEB6 8A     4674         TXA
BEB7 49FF   4675         EOR $FF        ;inverse phase bit
BEB9 2980   4676         AND $80        ;reset digit
BEBB AA     4677         TAX
BEBC C024   4678         CPY $24        ;if table index not at 9 (* 4)
BEBE F004   4679         BEQ BBEC4
BEC0 C03C   4680         CPY $3C        ;and not at 15 (* 4)
BEC2 D0A6   4681         BNE BBE6A      ;repeat
BEC4 A471   4682 BBEC4   LDY Z71        ;if end of segment, restore output index
BEC6 B9FF00 4683 BBEC6   LDA X0100-1,Y  ;get last digit
BEC9 88     4684         DEY
BECA C930   4685         CMP '0         ;if a "0"
BECC F0F8   4686         BEQ BBEC6      ;remove and repeat
BECE C92E   4687         CMP '.         ;if decimal point
BED0 F001   4688         BEQ BBED3      ;remove, but do not repeat
BED2 C8     4689         INY
BED3 A92B   4690 BBED3   LDA '+         ;set "+"
BED5 A65E   4691         LDX Z5E        ;get exponent, base 10
BED7 F02E   4692         BEQ BBF07      ;if zero, go end string
BED9 1008   4693         BPL BBEE3
BEDB A900   4694         LDA $00        ;if negative,
BEDD 38     4695         SEC
BEDE E55E   4696         SBC Z5E        ;compute complement of exponent
BEE0 AA     4697         TAX
BEE1 A92D   4698         LDA '-         ;and set "-"
BEE3 990101 4699 BBEE3   STA X0101,Y    ;store sign of exponent in output area
BEE6 A945   4700         LDA 'E         ;set sign for exponential notation
BEE8 990001 4701         STA X0100,Y    ;and store it
BEEB 8A     4702         TXA
BEEC A22F   4703         LDX $2F        ;get ASCII base for first exponent digit
BEEE 38     4704         SEC
BEEF E8     4705 BBEEF   INX            ;increment
BEF0 E90A   4706         SBC $0A        ;subtract 10 from exponent
BEF2 B0FB   4707         BCS BBEEF      ;if not a borrow, repeat
BEF4 693A   4708         ADC $3A        ;convert second exponent digit to ASCII
BEF6 990301 4709         STA X0103,Y    ;store second digit
BEF9 8A     4710         TXA
BEFA 990201 4711         STA X0102,Y    ;store first digit
BEFD A900   4712         LDA $00
BEFF 990401 4713         STA X0104,Y    ;store end of string
BF02 F008   4714         BEQ BBF0C      ;and exit
```

```
BF04 99FF00 4715 JBF04 STA X0100-1,Y ;store A at current output position
BF07 A900   4716 BBF07 LDA $00
BF09 990001 4717       STA X0100,Y   ;store end of string
BF0C A900   4718 BBF0C LDA <X0100
BF0E A001   4719       LDY >X0100    ;set AY to point to string text
BF10 60     4720       RTS
            4721 ;
            4722 ;constants for conversions
            4723 ;
            4724 ;0.5 for rounding, SQR and dummy variable
BF11 800000 4725 TBF11 .BY $80,$00,$00,$00,$00
            4726 ;
            4727 ;divisors for decimal conversion
            4728 ;
            4729 ;-100000000
BF16 FA0A1F 4730 TBF16 .BY $FA,$0A,$1F,$00
            4731 ;+10000000
BF1A 009896 4732       .BY $00,$98,$96,$80
            4733 ;-1000000
BF1E FFF0BD 4734       .BY $FF,$F0,$BD,$C0
            4735 ;+100000
BF22 000186 4736       .BY $00,$01,$86,$A0
            4737 ;-10000
BF26 FFFFD8 4738       .BY $FF,$FF,$D8,$F0
            4739 ;+1000
BF2A 000003 4740       .BY $00,$00,$03,$E8
            4741 ;-100
BF2E FFFFFF 4742       .BY $FF,$FF,$FF,$9C
            4743 ;+10
BF32 000000 4744       .BY $00,$00,$00,$0A
            4745 ;-1
BF36 FFFFFF 4746       .BY $FF,$FF,$FF,$FF
            4747 ;
            4748 ;divisors for time conversion
            4749 ;
            4750 ;-10 * 6 * 10 * 6 * 10 * 60
BF3A FFDF0A 4751       .BY $FF,$DF,$0A,$80
            4752 ;+6 * 10 * 6 * 10 * 60
BF3E 00034B 4753       .BY $00,$03,$4B,$C0
            4754 ;-10 * 6 * 10 * 60
BF42 FFFF73 4755       .BY $FF,$FF,$73,$60
            4756 ;+6 * 10 * 60
BF46 00000E 4757       .BY $00,$00,$0E,$10
            4758 ;-10 * 60
BF4A FFFFFD 4759       .BY $FF,$FF,$FD,$A8
            4760 ;+60
BF4E 000000 4761       .BY $00,$00,$00,$3C
            4762 ;
            4763 ;unused area follows
            4764 ;
BF52 ECAAAA 4765       .BY $EC,$AA,$AA,$AA,$AA,$AA,$AA,$AA
BF5A AAAAAA 4766       .BY $AA,$AA,$AA,$AA,$AA,$AA,$AA,$AA
BF62 AAAAAA 4767       .BY $AA,$AA,$AA,$AA,$AA,$AA,$AA,$AA
BF6A AAAAAA 4768       .BY $AA,$AA,$AA,$AA,$AA,$AA,$AA
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                4770 ;"SQR" command
                4771 ;
BF71 200CBC     4772 WBF71 JSR SBC0C     ;move rounded flp accu into 2nd flp accu
BF74 A911       4773       LDA <TBF11
BF76 A0BF       4774       LDY >TBF11    ;let AY point to value 0.5
BF78 20A2BB     4775       JSR SBBA2     ;load flp accu from AY
                4776 ;
                4777 ;"EXPONENT" operation
                4778 ;
BF7B F070       4779 WBF7B BEQ BBFED     ;if right operand zero, do EXP(0)
BF7D A569       4780       LDA Z69       ;if left operand zero
BF7F D003       4781       BNE BBF84
BF81 4CF9B8     4782       JMP JB8F9     ;set result zero
                4783 ;
BF84 A24E       4784 BBF84 LDX <Z4E
BF86 A000       4785       LDY >Z4E      ;set AY to Z4E
BF88 20D4BB     4786       JSR SBBD4     ;store flp accu there
BF8B A56E       4787       LDA Z6E       ;get sign of left operand
BF8D 100F       4788       BPL BBF9E     ;if negative
BF8F 20CCBC     4789       JSR SBCCC     ;perform INT
BF92 A94E       4790       LDA <Z4E
BF94 A000       4791       LDY >Z4E      ;set AY to Z4E again
BF96 205BBC     4792       JSR SBC5B     ;compare AY with flp accu
BF99 D003       4793       BNE BBF9E     ;if equal, right operand = integer
BF9B 98         4794       TYA           ;set positive
BF9C A407       4795       LDY Z07       ;set sign change flag
BF9E 20FEBB     4796 BBF9E JSR SBBFE     ;move second flp accu into flp accu with
BFA1 98         4797       TYA
BFA2 48         4798       PHA           ;save sign change flag
BFA3 20EAB9     4799       JSR SB9EA     ;perform LOG
BFA6 A94E       4800       LDA <Z4E
BFA8 A000       4801       LDY >Z4E      ;set AY to Z4E
BFAA 2028BA     4802       JSR SBA28     ;multiply AY by flp accu
BFAD 20EDBF     4803       JSR BBFED     ;perform EXP
BFB0 68         4804       PLA           ;restore sign change flag
BFB1 4A         4805       LSR A         ;shift into carry
BFB2 900A       4806       BCC BBFBE     ;return if not set, else do monadic "-"
                4807 ;
                4808 ;"MINUS" operator
                4809 ;
BFB4            4810 WBFB4 =   *
BFB4 A561       4811 JBFB4 LDA Z61       ;if number = 0
BFB6 F006       4812       BEQ BBFBE     ;so is result
BFB8 A566       4813       LDA Z66
BFBA 49FF       4814       EOR $FF       ;else invert sign
BFBC 8566       4815       STA Z66
BFBE 60         4816 BBFBE RTS
```

```
                4818 ;floating point numbers for EXP
                4819 ;
                4820 ;1/LOG(2)
BFBF 8138AA     4821 TBFBF .BY $81,$38,$AA,$3B,$29
BFC4 07         4822       .BY $07        ;polynome table for EXP
                4823 ;0.0000214987637
BFC5 713458     4824       .BY $71,$34,$58,$3E,$56
                4825 ;0.000143523140
BFCA 74167E     4826       .BY $74,$16,$7E,$B3,$1B
                4827 ;0.00134226348
BFCF 772FEE     4828       .BY $77,$2F,$EE,$E3,$85
                4829 ;0.00961401701
BFD4 7A1D84     4830       .BY $7A,$1D,$84,$1C,$2A
                4831 ;0.0555051269
BFD9 7C6359     4832       .BY $7C,$63,$59,$58,$0A
                4833 ;0.240226385
BFDE 7E75FD     4834       .BY $7E,$75,$FD,$E7,$C6
                4835 ;0.693147186
BFE3 803172     4836       .BY $80,$31,$72,$18,$10
                4837 ;1.0
BFE8 810000     4838       .BY $81,$00,$00,$00,$00
                4839 ;
                4840 ;"EXP" command
                4841 ;
BFED            4842 WBFED =   *
BFED A9BF       4843 BBFED LDA <TBFBF
BFEF A0BF       4844       LDY >TBFBF     ;let AY point to 1/LOG(2)
BFF1 2028BA     4845       JSR SBA28      ;multiply AY times flp accu
BFF4 A570       4846       LDA Z70
BFF6 6950       4847       ADC $50        ;according to guard byte + 80
BFF8 9003       4848       BCC BBFFD
BFFA 2023BC     4849       JSR SBC23      ;round flp accu
BFFD 4C00E0     4850 BBFFD JMP XE000      ;continue in part 2
```

BA38F	A38F	503						
BA3A4	A3A4	489						
BA3B0	A3B0	495						
BA3B7	A3B7	487	498					
BA3DC	A3DC	535						
BA3E8	A3E8	547						
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X0103     0103  492  494 4709
X0104     0104 4713
X01FE     01FE  730
X01FF     01FF  731 1785
X0200     0200  715  738  781  797  826  836  837  849  854  864  866 1629
                1754 1795 1836
X0300     0300  608
X0302     0302  645
X0304     0304  790
X0306     0306 1036
X0308     0308 1153
X030A     030A 2158
X0310     0310  247
X9FEA     9FEA 2367 2369
XE000     E000 4850
XE043     E043 3961
XE10C     E10C 1710
XE112     E112  778
XE118     E118 1594
XE11E     E11E 1750 1767
XE124     E124 1835
XE386     E386 1034 1229
XFF90     FF90  644 1252
XFFB7     FFB7 1789 2330
XFFCC     FFCC  619 1770
XFFDB     FFDB 1519
XFFDE     FFDE 2316
XFFE1     FFE1 1202
XFFE7     FFE7  928
XFFF0     FFF0 1652 1662 2952
Z00       0000 3141
Z01       0001 3143 3751 3775 3776 3891 3894 3902 3904 3905 3906
Z02       0002 3145 3772 3773 3889 3892 3907
Z03       0003 3769 3770 3887 3890 3908
Z04       0004 3766 3767 3885 3888 3909
Z07       0007 1352 1356 1357 1422 1440 1855 1857 1861 2386 2399 3098 3108
                4414 4795
Z08       0008  805  848  851 1354 1355 1358 1361 1864 2389 2394 3099 3110
Z09       0009 1663 1670
Z0B       000B  665  720  736  820  832  858 2382 2385 2388 2393 2395 2398
                2400 2630 2705 2747 2771 2795 2836 2869
Z0C       000C 2474 2673 2712 2744 2778 2829
Z0D       000D 1457 1616 1848 2011 2057 2078 2163 2270 2418 2482 2496 2676
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                2708 2929 2943 3151 3572
Z0E      000E 1455 1876 2292 2483 2503 2674 2710
Z0F      000F  796  808  844  996 1019 1021 1043 3161 3183 3187
Z10      0010  955 1068 2500 2512 2518 2972 2995
Z11      0011 1716 1817 1833 1850 1921
Z12      0012 2140 2456
Z13      0013  621 1593 1632 1639 1703 1726 1749 1757 1766 1769 1772 1787
                1797 1804 1841 1928
Z14      0014  728  893  986  990 1008 1285 1418 1427 1432 1433 1437 1439
                1441 3649 3657 3661 3664 3674 3687
Z15      0015  729  887  987  991 1006 1287 1419 1423 1435 1436 1438 1443
                3650 3655 3666
Z16      0016  944 3135 3156 3208 3462
Z17      0017 3152 3460 3464
Z18      0018 3458
Z19      0019  943 3204 3205
Z22      0022  523  533  539  564  566  616  625  675  698  702  750  754
                758  762  765  769  770 1102 1424 1429 1431 1434 1523 1693
                2062 2064 2110 2111 2127 2794 2866 2895 3136 3206 3216 3235
                3238 3241 3244 3248 3256 3260 3261 3275 3278 3286 3289 3292
                3305 3313 3314 3402 3408 3425 3430 3433 3436 3452 3502 3503
                3581 3606 3609 4028 4031 4034 4037 4040 4048 4199 4202 4205
                4208 4211 4216 4240 4244 4247 4250 4255 4258
Z23      0023  618  673  700  706  751  766  771 1103 2113 3207 3217 3236
                3263 3264 3306 3316 3317 3403 3426 3453 3505 3611 4029 4200
                4241
Z24      0024  684  703 1961 3610 3617 3620 3625 4334 4337 4341 4346 4351
                4355 4361
Z25      0025  677  696  707 3615 4335
Z26      0026 3978 4013 4015 4016 4187
Z27      0027 3979 4010 4012 4017 4189
Z28      0028 2880 2897 2917 3980 4007 4009 4018 4191
Z29      0029 2900 2920 3981 4004 4006 4019 4143 4193
Z2B      002B  748  878  912  914  915  961 1193 1296
Z2C      002C  749  879  919  964 1195 1297
Z2D      002D  674  682  683  692  718  734  918  933 1547 2519 3214
Z2E      002E  685  687  722  735  921  934 1543 2520 3215
Z2F      002F  935 2525 2578 2596 2713 3220
Z30      0030  936 2523 2579 2597 2714 3218
Z31      0031  509  732  937 2582 2719 2807 2821 2935 3172 3200 3232
Z32      0032  510  733  938 2583 2717 2808 2825 2938 3169 3201 3230
Z33      0033  575  596  931 1540 2934 3165 3174 3195 3296 3337 3443 3447
                3448
Z34      0034  572  593  932 1535 2937 3166 3175 3196 3293 3338 3441 3450
Z35      0035 3176 3409 3414 3415
Z36      0036 3177 3417
Z37      0037  929 3193
Z38      0038  930 3194
Z39      0039 1090 1144 1219 1244 1270 1284 1326 1723 1979 4550
Z3A      003A  636  656 1088 1147 1214 1220 1245 1268 1286 1328 1724 1981
                2958 4549
Z3B      003B 1221 1242
Z3C      003C 1222 1243
Z3D      003D 1131 1217 1239 1734
Z3E      003E  954 1132 1218 1235 1735
Z3F      003F 1721 1907
Z40      0040 1722 1911
Z41      0041 1198 1812
Z42      0042 1199 1813
Z43      0043 1818 1827 1886 1919 1926
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Z44	0044	1819 1828 1887 1920
Z45	0045	2268 2475 2504 2505 2527 2564 2599 2683 2687 2724 2760 2873
Z46	0046	2269 2510 2530 2565 2602 2681 2689 2726 2765 2876
Z47	0047	2624 2885 2890 2981 3016 3023 3040 4661 4673
Z48	0048	2625 2888 2979 3021 3027 3038
Z49	0049	491 496 1011 1014 1048 1118 1451 1473 1476 1571 1574 1577 1821 1948 1968 3680 3689 4234
Z4A	004A	488 493 1116 1312 1452 1486 1822 1949 1969 3685 3688 4235
Z4B	004B	1825 1888 2073 2137
Z4C	004C	1826 1889
Z4D	004D	2035 2045 2046 2048 2052 2086 2099 2419
Z4E	004E	2997 3006 3011 3015 3019 3033 3036 3044 3057 3060 3063 3066 3069 3199 3307 3324 3331 3345 3350 4784 4785 4790 4791 4800 4801
Z4F	004F	2998 3004 3013 3046 3198 3308 3323
Z50	0050	1556 1566 1570 1573 1576 3084 3375 3485 3488 3495 3514 3534 3554
Z51	0051	1557 1567 3085 3376 3496 3556
Z53	0053	3213 3227 3309 3311
Z55	0055	2368 3310 3326 3330 3342 3548 3557
Z56	0056	2370 3727 3742 3764 3804
Z57	0057	581 4228 4229
Z58	0058	538 540 545 549 721 2590 2593 2637 2802 2814 2884 3224 3228 3245 3246 3267 3339 3344
Z59	0059	542 551 726 2591 2594 2638 2797 2799 2816 2819 2887 3225 3229 3249 3250 3265 3340 3347 3348
Z5A	005A	521 531 534 544 548 719 2584 3333
Z5B	005B	525 536 550 723 2585 3336
Z5C	005C	4223
Z5D	005D	2285 2902 2923 4430 4472 4492 4586 4598 4601 4606 4618 4667
Z5E	005E	2281 4464 4470 4473 4477 4481 4514 4525 4532 4617 4691 4696
Z5F	005F	522 672 678 680 691 739 881 883 888 895 899 902 997 1002 1005 1024 1027 1030 1031 1300 2522 2528 2532 2536 2580 2600 2603 2606 2608 2610 2612 2614 2618 2633 2715 2722 2727 2730 2732 2735 2749 2761 2766 2775 2787 2790 2822 2824 2828 2835 2846 2851 2896 2899 3202 3301 3303 3332 4467 4468 4490
Z60	0060	526 676 688 882 1032 1303 2521 2581 2621 2634 2716 2736 2827 3203 3298 3304 3334 4268 4278 4457 4460 4518
Z61	0061	587 1376 1496 1561 1562 2125 2155 2421 2431 2435 2662 3092 3115 3140 3643 3710 3733 3736 3798 3830 3834 3836 3945 3949 4050 4058 4065 4093 4121 4122 4124 4217 4257 4287 4297 4322 4344 4371 4402 4412 4509 4574 4811
Z62	0062	1098 1099 2123 2321 2422 2448 2944 3090 3102 3142 3477 3777 3783 3786 3815 3817 3827 3838 3850 3852 3876 3990 4129 4167 4188 4214 4254 4312 4316 4348 4392 4393 4394 4419 4554 4644 4646
Z63	0063	1517 2121 2318 2423 2945 3091 3103 3144 3774 3785 3788 3812 3814 3826 3839 3853 3855 3874 3988 4132 4164 4190 4209 4249 4314 4352 4420 4555 4641 4643
Z64	0064	1472 1516 1534 1539 1546 1549 1554 2119 2210 2252 2258 2266 2295 2298 2317 2333 2353 2384 2397 2648 2697 2843 2863 3082 3147 3357 3368 3423 3592 3647 3771 3787 3790 3809 3811 3825 3840 3856 3858 3872 3986 4135 4161 4192 4206 4246 4321 4356 4421 4638 4640
Z65	0065	1399 1475 1518 1542 1550 2117 2207 2254 2260 2267 2319 2334 2351 2387 2392 2649 2699 2845 2867 3083 3148 3355 3424 3521 3537 3539 3594 3648 3768 3789 3792 3806 3808 3824 3841 3859 3861 3870 3984 4138 4158 4194 4203 4243 4320 4362 4413 4422 4634 4637

Z66	0066	1096	1497	1967	2106	2153	2437	2443	2657	3641	3705	3707	3738
		3799	3847	3849	4042	4070	4073	4212	4252	4265	4299	4324	4329
		4342	4364	4375	4390	4407	4408	4507	4566	4570	4813	4815	
Z67	0067	4436	4483										
Z68	0068	3893	4267	4279	4379	4386	4396						
Z69	0069	2142	2411	2412	3729	4049	4055	4780					
Z6A	006A	2144	2409	2410	3816	4014	4046	4128	4152	4166	4168		
Z6B	006B	2146	3813	4011	4038	4131	4151	4163	4165				
Z6C	006C	2148	2424	2427	2447	3810	4008	4035	4134	4150	4160	4162	
Z6D	006D	2150	2425	2428	3807	4005	4032	4137	4149	4157	4159		
Z6E	006E	2152	2407	3708	3737	4041	4044	4264	4506	4787			
Z6F	006F	1558	2154	3100	3106	3117	3129	3362	3366	3379	3389	3392	3395
		3709	3753	4043	4069	4091	4106	4508					
Z70	0070	1559	2273	3101	3119	3123	3130	3149	3364	3380	3726	3746	3750
		3765	3791	3793	3805	3823	3842	3862	3864	3865	3886	3900	3982
		4020	4180	4218	4259	4271	4282	4289	4323	4360	4406	4846	
Z71	0071	818	833	1498	1501	1502	1510	2283	2770	2792	2811	2838	2858
		2868	2912	3118	3604	3626	4571	4622	4631	4662	4672	4682	
Z72	0072	2758	2793	2810	2817	2839	2857	2871	2913	3122	3605	3627	
Z7A	007A	650	794	822	857	869	963	1083	1126	1134	1137	1143	1146
		1149	1150	1212	1240	1266	1291	1302	1330	1340	1341	1359	1736
		1823	1829	1845	1853	1865	1884	1890	1903	1906	1909	1983	2022
		2025	2081	2084	2191	2235	2985	3031	3034	3052	3602	3607	3628
		4529											
Z7B	007B	651	867	966	1085	1127	1152	1213	1241	1264	1292	1305	1332
		1343	1737	1824	1830	1846	1866	1885	1891	1985	2024	2083	2192
		2983	3029	3037	3054	3603	3612	3629					

```
                1       .L
                2       .H
                3 ;CBM-64-Part Two

                5 ;
0000            6 Z00   =   $00       ;6510 data direction register
0001            7 Z01   =   $01       ;6510 I/O register
                8 ;     bit 0 (output) 0 = RAM at $A000-$BFFF (BASIC area)
                9 ;     bit 1 (output) 0 = RAM at $E000-$EFFF (Kernal area)
               10 ;     bit 2 (output) 0 = access CRT shapes at $D000-$DFFF
               11 ;     bit 3 (output) cassette write line
               12 ;     bit 4 (input)  cassette sense line
               13 ;     bit 5 (output) cassette motor control
               14 ;     bit 6 unused
               15 ;     bit 7 unused
0002           16 Z02   =   $02       ;dummy address for offset
0003           17 Z03   =   $03       ;fixed-float vector
0004           18 Z04   =   $04       ;high byte of same
0005           19 Z05   =   $05       ;fixed/float vector
0006           20 Z06   =   $06       ;high byte of same
0007           21 Z07   =   $07       ;search character
000A           22 Z0A   =   $0A       ;0=load, 1=verify
0012           23 Z12   =   $12       ;sign flag
0013           24 Z13   =   $13       ;CMD file number
0016           25 Z16   =   $16       ;pointer into temporary string stack
0018           26 Z18   =   $18       ;high byte of last temp string vector
0022           27 Z22   =   $22       ;utility pointer area
0023           28 Z23   =   $23       ;   "       "       "
002B           29 Z2B   =   $2B       ;pointer to start of BASIC
002C           30 Z2C   =   $2C       ;high byte of same
002D           31 Z2D   =   $2D       ;pointer start of variables
002E           32 Z2E   =   $2E       ;high byte of same
0033           33 Z33   =   $33       ;pointer to start of string storage
0034           34 Z34   =   $34       ;high byte of same
0037           35 Z37   =   $37       ;pointer to limit of memory
0038           36 Z38   =   $38       ;high byte of same
0049           37 Z49   =   $49       ;file/device save area
004A           38 Z4A   =   $4A       ;second file/device save area
004E           39 Z4E   =   $4E       ;misc. work area
0053           40 Z53   =   $53       ;default step value
0054           41 Z54   =   $54       ;JMP vector for functions
0056           42 Z56   =   $56       ;   "       "
0057           43 Z57   =   $57       ;misc. numeric work area
005C           44 Z5C   =   $5C       ;   "       "
0061           45 Z61   =   $61       ;floating point accu # 1 - exponent
0062           46 Z62   =   $62       ;flp # 1 - mantissa
0063           47 Z63   =   $63       ;   "           "
0064           48 Z64   =   $64       ;   "           "
0065           49 Z65   =   $65       ;   "           "
0066           50 Z66   =   $66       ;flp # 1 - sign
0067           51 Z67   =   $67       ;series evaluation constant pointer
0068           52 Z68   =   $68       ;flp accu # 1 overflow
0069           53 Z69   =   $69       ;flp accu # 2 thru Z6E
006E           54 Z6E   =   $6E
006F           55 Z6F   =   $6F       ;sign comparison flp accu #1 vs accu # 2
0070           56 Z70   =   $70       ;flp accu # 1 guard byte
0071           57 Z71   =   $71       ;table pointer for EXP/SIN/ATN
0072           58 Z72   =   $72       ;high byte of same
0073           59 Z73   =   $73       ;character fetch code, beginning address
```

```
007A          60 Z7A   =   $7A      ;current character address
007B          61 Z7B   =   $7B      ;high byte of same
008B          62 Z8B   =   $8B      ;RND seed value
0090          63 Z90   =   $90      ;status word ST
0091          64 Z91   =   $91      ;keyboard scan results
0092          65 Z92   =   $92      ;tape timing speed correction
0093          66 Z93   =   $93      ;load=0, verify=1
0094          67 Z94   =   $94      ;serial output deferred character flag
0095          68 Z95   =   $95      ;serial deferred character
0096          69 Z96   =   $96      ;tape sync established flag
0097          70 Z97   =   $97      ;register save area
0098          71 Z98   =   $98      ;number of files open
0099          72 Z99   =   $99      ;input device
009A          73 Z9A   =   $9A      ;output device
009B          74 Z9B   =   $9B      ;tape character parity
009C          75 Z9C   =   $9C      ;tape byte available flag
009D          76 Z9D   =   $9D      ;direct/run mode (80/00)
009E          77 Z9E   =   $9E      ;tape pass 1 error log/char buffer
009F          78 Z9F   =   $9F      ;tape pass 2 error log
00A0          79 ZA0   =   $A0      ;jiffy clock - high byte
00A1          80 ZA1   =   $A1      ;jiffy clock - middle byte
00A2          81 ZA2   =   $A2      ;jiffy clock - low byte
00A3          82 ZA3   =   $A3      ;serial bit count/EOI flag
00A4          83 ZA4   =   $A4      ;serial byte read/tape cycle count
00A5          84 ZA5   =   $A5      ;serial bit count/tape hdr block count
00A6          85 ZA6   =   $A6      ;tape buffer pointer
00A7          86 ZA7   =   $A7      ;tape leader count/RS-232 input bit
00A8          87 ZA8   =   $A8      ;tape write new byte/read error/bit count
00A9          88 ZA9   =   $A9      ;tape write cycle/read error/start bit
00AA          89 ZAA   =   $AA      ;RS-232 input byte/tape scan/hdr count
00AB          90 ZAB   =   $AB      ;write leader length/read checksum/parity
00AC          91 ZAC   =   $AC      ;tape buffer/scrolling/I-O pointer
00AD          92 ZAD   =   $AD      ;high byte of same
00AE          93 ZAE   =   $AE      ;tape end address/end of I/O area
00AF          94 ZAF   =   $AF      ;high byte of same
00B0          95 ZB0   =   $B0      ;tape speed correction value
00B1          96 ZB1   =   $B1      ;work area for tape speed correction
00B2          97 ZB2   =   $B2      ;tape buffer pointer
00B3          98 ZB3   =   $B3      ;high byte of same
00B4          99 ZB4   =   $B4      ;RS-232 transmit bit count/tape sync
00B5         100 ZB5   =   $B5      ;RS-232 next bit to send/saved tape sync
00B6         101 ZB6   =   $B6      ;read char error/RS-232 output buffer
00B7         102 ZB7   =   $B7      ;number of characters in file name
00B8         103 ZB8   =   $B8      ;current logical file
00B9         104 ZB9   =   $B9      ;current secondary address
00BA         105 ZBA   =   $BA      ;current device
00BB         106 ZBB   =   $BB      ;pointer to file name
00BC         107 ZBC   =   $BC      ;high byte of same
00BD         108 ZBD   =   $BD      ;RS-232 xmit parity/tape read-write buffe
00BE         109 ZBE   =   $BE      ;tape phase
00BF         110 ZBF   =   $BF      ;tape input byte buffer
00C0         111 ZC0   =   $C0      ;tape motor interlock
00C1         112 ZC1   =   $C1      ;I/O start address/work address
00C2         113 ZC2   =   $C2      ;high byte of same
00C3         114 ZC3   =   $C3      ;kernal setup pointer
00C4         115 ZC4   =   $C4      ;high byte of same
00C5         116 ZC5   =   $C5      ;last key pressed
00C6         117 ZC6   =   $C6      ;keyboard buffer count
00C7         118 ZC7   =   $C7      ;reverse video switch
00C8         119 ZC8   =   $C8      ;end of line pointer for input
```

```
00C9    120 ZC9  =  $C9     ;input cursor, line number
00CA    121 ZCA  =  $CA     ;input cursor, position on line
00CB    122 ZCB  =  $CB     ;key pressed - $40 if no key
00CC    123 ZCC  =  $CC     ;cursor enable - 0 = flash
00CD    124 ZCD  =  $CD     ;cursor flash timing countdown
00CE    125 ZCE  =  $CE     ;character under cursor
00CF    126 ZCF  =  $CF     ;cursor blink phase
00D0    127 ZD0  =  $D0     ;screen-kbd flag/screen line length
00D1    128 ZD1  =  $D1     ;pointer to screen line
00D2    129 ZD2  =  $D2     ;high byte of same
00D3    130 ZD3  =  $D3     ;position of cursor on line
00D4    131 ZD4  =  $D4     ;string flag
00D5    132 ZD5  =  $D5     ;screen line length current line
00D6    133 ZD6  =  $D6     ;cursor line number
00D7    134 ZD7  =  $D7     ;character-bit buffer/checksum
00D8    135 ZD8  =  $D8     ;# of outstanding inserts
00D9    136 ZD9  =  $D9     ;screen line table thru $F0
00DA    137 ZDA  =  $DA     ;  "     "     "    "
00F1    138 ZF1  =  $F1     ;dummy screen link
00F3    139 ZF3  =  $F3     ;color memory pointer
00F4    140 ZF4  =  $F4     ;high byte of same
00F5    141 ZF5  =  $F5     ;keyboard table address
00F6    142 ZF6  =  $F6     ;high byte of same
00F7    143 ZF7  =  $F7     ;RS-232 receive buffer base address
00F8    144 ZF8  =  $F8     ;high byte of same
00F9    145 ZF9  =  $F9     ;RS-232 transmit buffer base address
00FA    146 ZFA  =  $FA     ;high byte of same
```

```
0014          148 X0014 =   $0014     ;integer value (SYS address)
0079          149 X0079 =   $0079     ;fetch current character
0100          150 X0100 =   $0100     ;flp to ASCII work area/tape error log
01FC          151 X01FC =   $01FC     ;prefix to line in input buffer
01FD          152 X01FD =   $01FD     ;high byte of same
0200          153 X0200 =   $0200     ;BASIC input buffer
0259          154 X0259 =   $0259     ;logical file table
0263          155 X0263 =   $0263     ;device # table
026D          156 X026D =   $026D     ;secondary address table
0277          157 X0277 =   $0277     ;keyboard buffer
0281          158 X0281 =   $0281     ;start of memory for operating system
0282          159 X0282 =   $0282     ;high byte of same
0283          160 X0283 =   $0283     ;top of memory for operating system
0284          161 X0284 =   $0284     ;high byte of same
0285          162 X0285 =   $0285     ;serial bus timeout flag (not used)
0286          163 X0286 =   $0286     ;current color code
0287          164 X0287 =   $0287     ;color under cursor
0288          165 X0288 =   $0288     ;screen memory page
0289          166 X0289 =   $0289     ;maximum size of keyboard buffer (10)
028A          167 X028A =   $028A     ;key repeat flag ($8X=repeat all keys)
028B          168 X028B =   $028B     ;repeat key frequency counter
028C          169 X028C =   $028C     ;repeat key delay counter
028D          170 X028D =   $028D     ;keyboard shift/control flag
028E          171 X028E =   $028E     ;last keyboard shift pattern
028F          172 X028F =   $028F     ;address of keyboard decode routine
0290          173 X0290 =   $0290     ;high byte of same
0291          174 X0291 =   $0291     ;shift mode switch ($80=locked)
0292          175 X0292 =   $0292     ;auto scroll flag ($00=on)
0293          176 X0293 =   $0293     ;RS-232 Control Register
0294          177 X0294 =   $0294     ;RS-232 Command Register
0295          178 X0295 =   $0295     ;non-standard bit time
0296          179 X0296 =   $0296     ;high byte of same
0297          180 X0297 =   $0297     ;RS-232 Status Register
0298          181 X0298 =   $0298     ;number of bits to send/receive
0299          182 X0299 =   $0299     ;baud rate
029A          183 X029A =   $029A     ;high byte of same
029B          184 X029B =   $029B     ;RS-232 receive buffer input pointer
029C          185 X029C =   $029C     ;RS-232 receive buffer output pointer
029D          186 X029D =   $029D     ;RS-232 transmit buffer input pointer
029E          187 X029E =   $029E     ;RS-232 transmit buffer output pointer
029F          188 X029F =   $029F     ;IRQ vector save area
02A0          189 X02A0 =   $02A0     ;high byte of same
02A1          190 X02A1 =   $02A1     ;internal ICR2 activity register
02A2          191 X02A2 =   $02A2     ;internal CRB1 activity register
02A3          192 X02A3 =   $02A3     ;ICR1 save area
02A4          193 X02A4 =   $02A4     ;CRA1 save area
02A5          194 X02A5 =   $02A5     ;pos first 40 column line after cursor
02A6          195 X02A6 =   $02A6     ;US/Intl machine flag ($00 = US)
0300          196 X0300 =   $0300     ;error message link
030C          197 X030C =   $030C     ;save area for A register
030D          198 X030D =   $030D     ;save area for X register
030E          199 X030E =   $030E     ;save area for Y register
030F          200 X030F =   $030F     ;save area for SR (flag) register
0310          201 X0310 =   $0310     ;USR jump link
0311          202 X0311 =   $0311     ;low byte of USR jump address
0312          203 X0312 =   $0312     ;high byte of USR jump address
0314          204 X0314 =   $0314     ;IRQ vector
0315          205 X0315 =   $0315     ;high byte if IRQ vector
0316          206 X0316 =   $0316     ;BRK vector
0318          207 X0318 =   $0318     ;NMI vector
```

```
031A        208 X031A =  $031A     ;OPEN vector
031C        209 X031C =  $031C     ;CLOSE vector
031E        210 X031E =  $031E     ;set input vector
0320        211 X0320 =  $0320     ;set output vector
0322        212 X0322 =  $0322     ;restore I/O devices to default vector
0324        213 X0324 =  $0324     ;input vector
0326        214 X0326 =  $0326     ;output vector
0328        215 X0328 =  $0328     ;test STOP Key vector
032A        216 X032A =  $032A     ;GET vector
032C        217 X032C =  $032C     ;close all files and channels vector
0330        218 X0330 =  $0330     ;load RAM vector
0332        219 X0332 =  $0332     ;save RAM vector
```

```
8000          221 X8000 =  $8000     ;cartridge RESET vector
8002          222 X8002 =  $8002     ;cartridge RESTORE (warm start) vector
8004          223 X8004 =  $8004     ;cartridge identifier
A000          224 XA000 =  $A000     ;begin BASIC vector
A002          225 XA002 =  $A002     ;BASIC warm start vector
A364          226 TA364 =  $A364     ;message OK
A376          227 TA376 =  $A376     ;message READY
A408          228 XA408 =  $A408     ;array area overflow check
A437          229 XA437 =  $A437     ;error message link
A43A          230 XA43A =  $A43A     ;print error message
A474          231 XA474 =  $A474     ;print READY, do warm start
A483          232 WA483 =  $A483     ;standard BASIC warm start
A52A          233 XA52A =  $A52A     ;reset program ptrs and relink BASIC
A533          234 XA533 =  $A533     ;relink BASIC
A57C          235 WA57C =  $A57C     ;crunch tokens
A644          236 XA644 =  $A644     ;perform NEW
A663          237 XA663 =  $A663     ;perform CLR
A677          238 XA677 =  $A677     ;perform RESTORE, reset stack/pgm ptrs
A67A          239 XA67A =  $A67A     ;reset stack and program pointers
A68E          240 XA68E =  $A68E     ;re-initialize current character ptr
A71A          241 WA71A =  $A71A     ;print tokens
A7E4          242 WA7E4 =  $A7E4     ;execute a statement
AB1E          243 XAB1E =  $AB1E     ;print string from AY
AD8A          244 XAD8A =  $AD8A     ;get next non-string value
AD9E          245 XAD9E =  $AD9E     ;evaluate expression
AE86          246 WAE86 =  $AE86     ;fetch arithmetic element
AEFD          247 XAEFD =  $AEFD     ;check next character for ","
AF08          248 XAF08 =  $AF08     ;print SYNTAX Error
B1AA          249 WB1AA =  $B1AA     ;flp-fixed routine
B248          250 WB248 =  $B248     ;print ILLEGAL QUANTITY Error
B391          251 WB391 =  $B391     ;fixed-flp routine
B6A3          252 XB6A3 =  $B6A3     ;de-allocate temporary string storage
B79E          253 XB79E =  $B79E     ;fetch integer value in X, check range
B7F7          254 XB7F7 =  $B7F7     ;convert flp to integer
B849          255 XB849 =  $B849     ;half round flp accu
B850          256 XB850 =  $B850     ;subtract flp accu from # indexed by AY
B853          257 XB853 =  $B853     ;perform diadic minus
B867          258 XB867 =  $B867     ;add flp accu to # indexed by AY
B8D7          259 XB8D7 =  $B8D7     ;perform postshift
B9BC          260 TB9BC =  $B9BC     ;flp literal 1
BA28          261 XBA28 =  $BA28     ;multiply flp accu times # indexed by AY
BAB9          262 XBAB9 =  $BAB9     ;add exponents
BAD4          263 XBAD4 =  $BAD4     ;check sign of flp accu
BB07          264 XBB07 =  $BB07     ;divide flp accu by # indexed by AY
BB0F          265 XBB0F =  $BB0F     ;divide # indexed by AY by flp accu
BBA2          266 XBBA2 =  $BBA2     ;load flp accu with # indexed by AY
BBC7          267 XBBC7 =  $BBC7     ;store flp accu at Z5C-60
BBCA          268 XBBCA =  $BBCA     ;store flp accu at Z57-5B
BBD4          269 XBBD4 =  $BBD4     ;store flp accu in area indexed by XY
BC0C          270 XBC0C =  $BC0C     ;move rounded flp accu into 2nd flp accu
BC0F          271 XBC0F =  $BC0F     ;move flp accu into 2nd flp accu
BC2B          272 XBC2B =  $BC2B     ;get sign of flp accu into A
BCCC          273 XBCCC =  $BCCC     ;perform INT
BDCD          274 XBDCD =  $BDCD     ;print # from AX
BFB4          275 XBFB4 =  $BFB4     ;minus operator
BFC4          276 TBFC4 =  $BFC4     ;polynome table for EXP
```

```
                278 ;6567 video chip
                279 ;
D000            280 XD000 =   $D000     ;6567 video chip base address
D011            281 XD011 =   $D011     ;bit 4 = 0 to disable video chip
D012            282 XD012 =   $D012     ;Raster Register
D016            283 XD016 =   $D016     ;bit 5 = 0 to reset video chip
D018            284 XD018 =   $D018     ;memory pointers for video chip
D019            285 XD019 =   $D019     ;Interrupt Register
D021            286 XD021 =   $D021     ;Background # 0 color
                287 ;
                288 ;6581 Sound Interface Device
                289 ;
D418            290 XD418 =   $D418     ;mode/volume for SID chip
                291 ;
                292 ;6526 CIA1
                293 ;
DC00            294 XDC00 =   $DC00     ;PA1 port A
DC01            295 XDC01 =   $DC01     ;PB1 port B
DC02            296 XDC02 =   $DC02     ;DDRA1 direction bits for port A
DC03            297 XDC03 =   $DC03     ;DDRB1 direction bits for port B
DC04            298 XDC04 =   $DC04     ;TAL1 timer A low
DC05            299 XDC05 =   $DC05     ;TAH1 timer A high
DC06            300 XDC06 =   $DC06     ;TBL1 timer B low
DC07            301 XDC07 =   $DC07     ;TBH1 timer B high
DC0D            302 XDC0D =   $DC0D     ;ICR1 interrupt control register
DC0E            303 XDC0E =   $DC0E     ;CRA1 control register for port A
DC0F            304 XDC0F =   $DC0F     ;CRB1 control register for port B
                305 ;
                306 ;6526 CIA2
                307 ;
DD00            308 XDD00 =   $DD00     ;PA2 port A
DD01            309 XDD01 =   $DD01     ;PB2 port B
DD02            310 XDD02 =   $DD02     ;DDRA2 direction bits for port A
DD03            311 XDD03 =   $DD03     ;DDRB2 direction bits for port B
DD04            312 XDD04 =   $DD04     ;TAL2 timer A low
DD05            313 XDD05 =   $DD05     ;TAH2 timer A high
DD06            314 XDD06 =   $DD06     ;TBL2 timer B low
DD07            315 XDD07 =   $DD07     ;TBH2 timer B high
DD0D            316 XDD0D =   $DD0D     ;ICR2 interrupt control register
DD0E            317 XDD0E =   $DD0E     ;CRA2 control register for port A
DD0F            318 XDD0F =   $DD0F     ;CRB2 control register for port B
```

```
                320 ;continuation of "EXP" routine
                321 ;
E000            322         .OR $E000
E000 8556       323         STA Z56         ;set guard byte for second flp accu
E002 200FBC     324         JSR XBC0F       ;copy flp accu into second flp accu
E005 A561       325         LDA Z61         ;get exponent
E007 C988       326         CMP $88         ;if => 8
E009 9003       327         BCC BE00E
E00B 20D4BA     328 BE00B   JSR XBAD4       ;then either 0 or overflow
E00E 20CCBC     329 BE00E   JSR XBCCC       ;perform INT
E011 A507       330         LDA Z07         ;get least significant byte
E013 18         331         CLC
E014 6981       332         ADC $81         ;if = 127
E016 F0F3       333         BEQ BE00B       ;then also overflow
E018 38         334         SEC
E019 E901       335         SBC $01         ;remove excess 128
E01B 48         336         PHA             ;and save it
E01C A205       337         LDX $05
E01E B569       338 BE01E   LDA Z69,X       ;move second flp accu into flp accu
E020 B461       339         LDY Z61,X
E022 9561       340         STA Z61,X       ;and vice versa
E024 9469       341         STY Z69,X
E026 CA         342         DEX
E027 10F5       343         BPL BE01E
E029 A556       344         LDA Z56
E02B 8570       345         STA Z70         ;restore copied guard byte
E02D 2053B8     346         JSR XB853       ;apply diadic "-"
E030 20B4BF     347         JSR XBFB4       ;then minus operator
E033 A9C4       348         LDA <TBFC4
E035 A0BF       349         LDY >TBFC4      ;set AY to polynome table
E037 2059E0     350         JSR SE059       ;and compute polynome
E03A A900       351         LDA $00
E03C 856F       352         STA Z6F         ;clear XOR of signs
E03E 68         353         PLA             ;add saved integral part
E03F 20B9BA     354         JSR XBAB9       ;to exponent
E042 60         355         RTS
```

```
                357 ;compute odd degrees for SIN and ATN
                358 ;
E043 8571       359 JE043 STA Z71       ;save table pointer
E045 8472       360       STY Z72
E047 20CABB     361       JSR XBBCA     ;store flp accu at Z57
E04A A957       362       LDA <Z57      ;set AY to Z57
E04C 2028BA     363       JSR XBA28     ;multiply flp accu by # indexed by AY
E04F 205DE0     364       JSR SE05D     ;compute polynome
E052 A957       365       LDA <Z57      ;set AY to Z57
E054 A000       366       LDY >Z57
E056 4C28BA     367       JMP XBA28     ;multiply flp accu by Z57
                368 ;
                369 ;computepolynome according to table indexed by AY
                370 ;
E059 8571       371 SE059 STA Z71       ;save table pointer
E05B 8472       372       STY Z72
E05D 20C7BB     373 SE05D JSR XBBC7     ;store flp accu at Z5C
E060 B171       374       LDA (Z71),Y
E062 8567       375       STA Z67       ;save order
E064 A471       376       LDY Z71
E066 C8         377       INY           ;add 1 to table pointer
E067 98         378       TYA
E068 D002       379       BNE BE06C
E06A E672       380       INC Z72
E06C 8571       381 BE06C STA Z71       ;save updated pointer
E06E A472       382       LDY Z72       ;and restore AY
E070 2028BA     383 BE070 JSR XBA28     ;multiply flp accu by # indexed by AY
E073 A571       384       LDA Z71       ;restore AY
E075 A472       385       LDY Z72
E077 18         386       CLC
E078 6905       387       ADC $05       ;add 5 to table pointer
E07A 9001       388       BCC BE07D
E07C C8         389       INY
E07D 8571       390 BE07D STA Z71       ;save table pointer
E07F 8472       391       STY Z72
E081 2067B8     392       JSR XB867     ;add # indexed by AY to flp accu
E084 A95C       393       LDA <Z5C
E086 A000       394       LDY >Z5C      ;set AY to Z5C
E088 C667       395       DEC Z67       ;decrement order
E08A D0E4       396       BNE BE070     ;and repeat until 0
E08C 60         397       RTS
```

```
                399 ;floating point numbers for RND
                400 ;
                401 ; flp number for multiplication
E08D 983544     402 TE08D .BY $98,$35,$44,$7A,$00
                403 ; flp number for addition
E092 6828B1     404 TE092 .BY $68,$28,$B1,$46,$00
                405 ;
                406 ;"RND" command
                407 ;
E097 202BBC     408 WE097 JSR XBC2B     ;get sign of flp accu into A
E09A 3037       409       BMI BE0D3     ;if < 0 use parameter as seed
E09C D020       410       BNE BE0BE     ;if > 0 use old seed
E09E 20F3FF     411       JSR SFFF3     ;get base address of I/O devices
E0A1 8622       412       STX Z22
E0A3 8423       413       STY Z23
E0A5 A004       414       LDY $04
E0A7 B122       415       LDA (Z22),Y   ;TAL1 timer value
E0A9 8562       416       STA Z62
E0AB C8         417       INY
E0AC B122       418       LDA (Z22),Y   ;TAH2 timer vaue
E0AE 8564       419       STA Z64
E0B0 A008       420       LDY $08
E0B2 B122       421       LDA (Z22),Y   ;tenths of a second
E0B4 8563       422       STA Z63
E0B6 C8         423       INY
E0B7 B122       424       LDA (Z22),Y   ;seconds
E0B9 8565       425       STA Z65
E0BB 4CE3E0     426       JMP JE0E3     ;garble flp set from CIA1 timer/clock
                427 ;
E0BE A98B       428 BE0BE LDA <Z8B      ;let AY point to Z8B (current seed)
E0C0 A000       429       LDY >Z8B
E0C2 20A2BB     430       JSR XBBA2     ;load flp accu from Z8B-Z8F
E0C5 A98D       431       LDA <TE08D    ;set AY to RND factor
E0C7 A0E0       432       LDY >TE08D
E0C9 2028BA     433       JSR XBA28     ;multiply flp accu times RND factor
E0CC A992       434       LDA <TE092    ;set AY to RND addition value
E0CE A0E0       435       LDY >TE092
E0D0 2067B8     436       JSR XB867     ;add RND factor to result in flp accu
E0D3 A665       437 BE0D3 LDX Z65       ;exchange byte 4 and byte 1
E0D5 A562       438       LDA Z62
E0D7 8565       439       STA Z65
E0D9 8662       440       STX Z62
E0DB A663       441       LDX Z63       ;exchange byte 2 and byte 3
E0Dp A564       442       LDA Z64
E0DF 8563       443       STA Z63
E0E1 8664       444       STX Z64
E0E3 A900       445 JE0E3 LDA $00       ;set sign positive
E0E5 8566       446       STA Z66
E0E7 A561       447       LDA Z61
E0E9 8570       448       STA Z70       ;set guard byte
E0EB A980       449       LDA $80       ;move 0 to exponent
E0ED 8561       450       STA Z61
E0EF 20D7B8     451       JSR XB8D7     ;perform postshift
E0F2 A28B       452       LDX <Z8B      ;set XY to RND seed value
E0F4 A000       453       LDY >Z8B
E0F6 4CD4BB     454 SE0F6 JMP XBBD4     ;store flp accu as new seed
```

```
                456 ;handle errors for direct I/O calles from BASIC interpreter
                457 ;
E0F9 C9F0       458 BE0F9 CMP $F0       ;if open for RS-232,
E0FB D007       459       BNE BE104
E0FD 8438       460       STY Z38       ;set new top of memory limit
E0FF 8637       461       STX Z37
E101 4C63A6     462       JMP XA663     ;CLR, back to basic
                463 ;
E104 AA         464 BE104 TAX
E105 D002       465       BNE BE109     ;if no error message indexed,
E107 A21E       466       LDX $1E       ;select BREAK message
E109 4C37A4     467 BE109 JMP XA437     ;go print message
                468 ;
E10C 20D2FF     469       JSR SFFD2     ;output a character
E10F B0E8       470       BCS BE0F9     ;if no errors,
E111 60         471       RTS           ;return
                472 ;
E112 20CFFF     473       JSR SFFCF     ;input a character on current device
E115 B0E2       474       BCS BE0F9     ;if no errors,
E117 60         475       RTS           ;return
                476 ;
E118 20ADE4     477       JSR SE4AD     ;set output device
E11B B0DC       478       BCS BE0F9     ;if no errors,
E11D 60         479       RTS           ;return
                480 ;
E11E 20C6FF     481       JSR SFFC6     ;set input device
E121 B0D6       482       BCS BE0F9     ;if no errors,
E123 60         483       RTS           ;return
                484 ;
E124 20E4FF     485       JSR SFFE4     ;get a character from current device
E127 B0D0       486       BCS BE0F9     ;if no errors,
E129 60         487       RTS           ;return
```

```
                489 ;"SYS" command
                490 ;
E12A 208AAD     491 WE12A JSR XAD8A     ;get next non-string value
E12D 20F7B7     492       JSR XB7F7     ;convert to integer in Z14/15
E130 A9E1       493       LDA >WE147-1
E132 48         494       PHA
E133 A946       495       LDA <WE147-1
E135 48         496       PHA           ;set return address
E136 AD0F03     497       LDA X030F
E139 48         498       PHA           ;save flag register on stack
E13A AD0C03     499       LDA X030C
E13D AE0D03     500       LDX X030D     ;restore A, X & Y
E140 AC0E03     501       LDY X030E     ;to status of exit from last SYS
E143 28         502       PLP
E144 6C1400     503       JMP (X0014)   ;do SYS routine
                504 ;
E147 08         505 WE147 PHP           ;save flag register on stack
E148 8D0C03     506       STA X030C     ;save A
E14B 8E0D03     507       STX X030D     ;save X
E14E 8C0E03     508       STY X030E     ;save Y
E151 68         509       PLA
E152 8D0F03     510       STA X030F     ;save Flag register
E155 60         511       RTS
```

```
                513 ;"SAVE" command
                514 ;
E156 20D4E1     515 WE156 JSR SE1D4     ;set file parameters
E159 A62D       516       LDX Z2D       ;set end address of BASIC text
E15B A42E       517       LDY Z2E
E15D A92B       518       LDA <Z2B      ;set address of start address
E15F 20D8FF     519       JSR SFFD8     ;save RAM to a device
E162 B095       520       BCS BE0F9     ;if no errors,
E164 60         521       RTS           ;return
                522 ;
                523 ;"VERIFY" command
                524 ;
E165 A901       525 WE165 LDA $01       ;set value for Verify
E167 2C         526       .BY $2C       ;skip next instruction
                527 ;
                528 ;"LOAD" command
                529 ;
E168 A900       530 WE168 LDA $00       ;set value for Load
E16A 850A       531       STA Z0A       ;set load/verify flag
E16C 20D4E1     532       JSR SE1D4     ;fetch file parameters
E16F A50A       533       LDA Z0A       ;fetch load/verify flag
E171 A62B       534       LDX Z2B       ;set start address in XY
E173 A42C       535       LDY Z2C
E175 20D5FF     536       JSR SFFD5     ;load device to RAM
E178 B057       537       BCS BE1D1     ;exit upon error
E17A A50A       538       LDA Z0A
E17C F017       539       BEQ BE195     ;if verify pass,
E17E A21C       540       LDX $1C       ;index Verify Error message
E180 20B7FF     541       JSR SFFB7     ;read ST
E183 2910       542       AND $10       ;if ST indicates a mismatch,
E185 D017       543       BNE BE19E     ;go print error
E187 A57A       544       LDA Z7A
E189 C902       545       CMP $02
E18B F007       546       BEQ BE194     ;exit if in RUN mode, else
E18D A964       547       LDA <TA364    ;set AY to point to message OK
E18F A0A3       548       LDY >TA364
E191 4C1EAB     549       JMP XAB1E     ;print message OK
E194 60         550 BE194 RTS
                551 ;
E195 20B7FF     552 BE195 JSR SFFB7     ;if load pass
E198 29BF       553       AND $BF       ;and ST indicates an error
E19A F005       554       BEQ BE1A1
E19C A21D       555       LDX $1D       ;index Load Error message
E19E 4C37A4     556 BE19E JMP XA437     ;print message
                557 ;
E1A1 A57B       558 BE1A1 LDA Z7B       ;check high addr of current character
E1A3 C902       559       CMP $02
E1A5 D00E       560       BNE BE1B5     ;if in direct mode
E1A7 862D       561       STX Z2D       ;move end of program address
E1A9 842E       562       STY Z2E       ;to end of BASIC address
E1AB A976       563       LDA <TA376    ;set AY to READY message
E1AD A0A3       564       LDY >TA376
E1AF 201EAB     565       JSR XAB1E     ;print READY
E1B2 4C2AA5     566       JMP XA52A     ;relink BASIC, exit
                567 ;
                568 ;end of load/verify from within a program
                569 ;
E1B5 208EA6     570 BE1B5 JSR XA68E     ;move start of program to next char addr
E1B8 2033A5     571       JSR XA533     ;relink BASIC
E1BB 4C77A6     572       JMP XA677     ;restore, clear pointers, return
```

```
                574 ;"OPEN" command
                575 ;
E1BE 2019E2     576 WE1BE JSR SE219     ;fetch parameters
E1C1 20C0FF     577       JSR SFFC0     ;perform open
E1C4 B00B       578       BCS BE1D1     ;if no errors,
E1C6 60         579       RTS           ;return
                580 ;
                581 ;"CLOSE" command
                582 ;
E1C7 2019E2     583 WE1C7 JSR SE219     ;fetch parameters
E1CA A549       584       LDA Z49       ;restore file #
E1CC 20C3FF     585       JSR SFFC3     ;perform close
E1CF 90C3       586       BCC BE194     ;exit if no errors
E1D1 4CF9E0     587 BE1D1 JMP BE0F9     ;error
                588 ;
                589 ;set parameters for load/verify/save
                590 ;
E1D4 A900       591 SE1D4 LDA $00       ;assume no file name
E1D6 20BDFF     592       JSR SFFBD     ;set file name parameters
E1D9 A201       593       LDX $01       ;assume device 1
E1DB A000       594       LDY $00       ;and secondary address 0
E1DD 20BAFF     595       JSR SFFBA     ;set logical file, device & sec. addr
E1E0 2006E2     596       JSR SE206     ;fetch current character
E1E3 2057E2     597       JSR SE257     ;evaluate expression
E1E6 2006E2     598       JSR SE206     ;fetch current character
E1E9 2000E2     599       JSR SE200     ;skip comma and fetch integer into X
E1EC A000       600       LDY $00       ;secondary address still 0
E1EE 8649       601       STX Z49       ;save device #
E1F0 20BAFF     602       JSR SFFBA     ;set logical file, device & sec. addr
E1F3 2006E2     603       JSR SE206     ;fetch current character
E1F6 2000E2     604       JSR SE200     ;skip comma and fetch integer into X
E1F9 8A         605       TXA
E1FA A8         606       TAY           ;set secondary address
E1FB A649       607       LDX Z49       ;restore device
E1FD 4CBAFF     608       JMP SFFBA     ;set logical file, device & sec. addr
                609 ;
                610 ;skip comma and fetch integer into X
                611 ;
E200 200EE2     612 SE200 JSR SE20E     ;check for and skip comma
E203 4C9EB7     613       JMP XB79E     ;fetch integer value into X
                614 ;
                615 ;fetch current character and check for end of line
                616 ;
E206 207900     617 SE206 JSR X0079     ;fetch current character
E209 D002       618       BNE BE20D
E20B 68         619       PLA           ;if end of line, delete own return addr
E20C 68         620       PLA
E20D 60         621 BE20D RTS
                622 ;
                623 ;check for a comma and skip it
                624 ;
E20E 20FDAE     625 SE20E JSR XAEFD     ;check for and skip ","
E211 207900     626 SE211 JSR X0079     ;fetch current character
E214 D0F7       627       BNE BE20D
E216 4C08AF     628       JMP XAF08     ;SYNTAX Error if end of line reached
```

```
                630 ;get Open/Close parameters
                631 ;
E219 A900       632 SE219 LDA $00       ;assume no file name
E21B 20BDFF     633       JSR SFFBD     ;set file name parameters
E21E 2011E2     634       JSR SE211     ;fetch current character
E221 209EB7     635       JSR XB79E     ;get next non-string value into X
E224 8649       636       STX Z49       ;save file number
E226 8A         637       TXA
E227 A201       638       LDX $01       ;assume device 1
E229 A000       639       LDY $00       ;and secondary address 0
E22B 20BAFF     640       JSR SFFBA     ;set currrent file, device & sec. addr
E22E 2006E2     641       JSR SE206     ;fetch current character
E231 2000E2     642       JSR SE200     ;skip comma and fetch integer value into X
E234 864A       643       STX Z4A       ;save device number
E236 A000       644       LDY $00       ;secondary still 0
E238 A549       645       LDA Z49
E23A E003       646       CPX $03
E23C 9001       647       BCC BE23F     ;if device number > 3
E23E 88         648       DEY           ;secondary = $FF
E23F 20BAFF     649 BE23F JSR SFFBA     ;set logical file, device & sec. addr
E242 2006E2     650       JSR SE206     ;fetch current character
E245 2000E2     651       JSR SE200     ;skip comma,]fetch integer value in X
E248 8A         652       TXA
E249 A8         653       TAY           ;set secondary address
E24A A64A       654       LDX Z4A       ;restore device
E24C A549       655       LDA Z49       ;and file
E24E 20BAFF     656       JSR SFFBA     ;set logical file, device & sec. addr
E251 2006E2     657       JSR SE206     ;fetch current character
E254 200EE2     658       JSR SE20E     ;check for and skip ","
E257 209EAD     659 SE257 JSR XAD9E     ;evaluate expression
E25A 20A3B6     660       JSR XB6A3     ;de-allocate temporary string
E25D A622       661       LDX Z22
E25F A423       662       LDY Z23       ;XY = address of file name
E261 4CBDFF     663       JMP SFFBD     ;set file name parameters
```

```
                665 ;"COS" command
                666 ;
E264 A9E0       667 WE264 LDA <TE2E0    ;set AY to point to 0.5 * PI
E266 A0E2       668       LDY >TE2E0
E268 2067B8     669       JSR XB867     ;add to flp accu then do SIN
                670 ;
                671 ;"SIN" command
                672 ;
E26B 200CBC     673 SE26B JSR XBC0C     ;move rounded flp accu to 2nd flp accu
E26E A9E5       674       LDA <TE2E5    ;set AY to 2 * PI
E270 A0E2       675       LDY >TE2E5
E272 A66E       676       LDX Z6E       ;get sign
E274 2007BB     677       JSR XBB07     ;divide flp accu by 2 * PI
E277 200CBC     678       JSR XBC0C     ;move rounded flp accu to 2nd flp accu
E27A 20CCBC     679       JSR XBCCC     ;call function INT
E27D A900       680       LDA $00
E27F 856F       681       STA Z6F       ;set XOR of signs to be the same
E281 2053B8     682       JSR XB853     ;apply diadic operator "-"
E284 A9EA       683       LDA <TE2EA    ;set AY to point to 0.25
E286 A0E2       684       LDY >TE2EA
E288 2050B8     685       JSR XB850     ;subtract flp accu from 0.25
E28B A566       686       LDA Z66       ;flp accu # 1 - sign
E28D 48         687       PHA           ;save sign
E28E 100D       688       BPL BE29D     ;if negative
E290 2049B8     689       JSR XB849     ;do half rounding (add 0.5)
E293 A566       690       LDA Z66       ;get sign
E295 3009       691       BMI BE2A0
E297 A512       692       LDA Z12       ;if positive, complement flag
E299 49FF       693       EOR $FF
E29B 8512       694       STA Z12
E29D 20B4BF     695 BE29D JSR XBFB4     ;apply monadic operator "-"
E2A0 A9EA       696 BE2A0 LDA <TE2EA    ;set AY to 0.25
E2A2 A0E2       697       LDY >TE2EA
E2A4 2067B8     698       JSR XB867     ;add 0.25 to flp accu
E2A7 68         699       PLA           ;restore original sign
E2A8 1003       700       BPL BE2AD     ;if negative,
E2AA 20B4BF     701       JSR XBFB4     ;perform monadic "-" again
E2AD A9EF       702 BE2AD LDA <TE2EF    ;set AY to polynome table
E2AF A0E2       703       LDY >TE2EF
E2B1 4C43E0     704       JMP JE043     ;go compute odd degrees
```

```
                706 ;"TAN" command
                707 ;
E2B4 20CABB     708 WE2B4 JSR XBBCA     ;store flp accu at Z57-5B
E2B7 A900       709       LDA $00
E2B9 8512       710       STA Z12       ;clear sign flag
E2BB 206BE2     711       JSR SE26B     ;perform SIN
E2BE A24E       712       LDX <Z4E      ;set AY to Z4E
E2C0 A000       713       LDY >Z4E
E2C2 20F6E0     714       JSR SE0F6     ;store flp accu at Z4E
E2C5 A957       715       LDA <Z57      ;set AY to Z57
E2C7 A000       716       LDY >Z57
E2C9 20A2BB     717       JSR XBBA2     ;move flp accu there
E2CC A900       718       LDA $00
E2CE 8566       719       STA Z66       ;clear sign of flp accu
E2D0 A512       720       LDA Z12       ;fetch sign flag
E2D2 20DCE2     721       JSR SE2DC     ;compute COS of flp accu
E2D5 A94E       722       LDA <Z4E      ;set AY to Z4E
E2D7 A000       723       LDY >Z4E
E2D9 4C0FBB     724       JMP XBB0F     ;divide number at Z4E by flp accu, exit
                725 ;
E2DC 48         726 SE2DC PHA
E2DD 4C9DE2     727       JMP BE29D     ;compute COS of flp accu then return
                728 ;
                729 ;flp numbers for SIN, COS and TAN
                730 ;
                731 ;0.5 * PI
E2E0 81490F     732 TE2E0 .BY $81,$49,$0F,$DA,$A2
                733 ;2 * PI
E2E5 83490F     734 TE2E5 .BY $83,$49,$0F,$DA,$A2
                735 ;0.25
E2EA 7F0000     736 TE2EA .BY $7F,$00,$00,$00,$00
                737 ;
E2EF 05         738 TE2EF .BY $05       ;polynome table for SIN
                739 ;-14.3813907
E2F0 84E61A     740       .BY $84,$E6,$1A,$2D,$1B
                741 ; 42.0077971
E2F5 862807     742       .BY $86,$28,$07,$FB,$F8
                743 ;-76.7041703
E2FA 879968     744       .BY $87,$99,$68,$89,$01
                745 ; 81.6052237
E2FF 872335     746       .BY $87,$23,$35,$DF,$E1
                747 ;-41.3417021
E304 86A55D     748       .BY $86,$A5,$5D,$E7,$28
                749 ;  6.28318531
E309 83490F     750       .BY $83,$49,$0F,$DA,$A2
```

```
                752 ;"ATN" command
                753 ;
E30E A566       754 WE30E LDA Z66       ;save sign
E310 48         755       PHA
E311 1003       756       BPL BE316     ;if negative,
E313 20B4BF     757       JSR XBFB4     ;apply monadic operator "-"
E316 A561       758 BE316 LDA Z61
E318 48         759       PHA           ;save exponent
E319 C981       760       CMP $81       ;if => 1
E31B 9007       761       BCC BE324
E31D A9BC       762       LDA <TB9BC    ;let AY point to 1
E31F A0B9       763       LDY >TB9BC
E321 200FBB     764       JSR XBB0F     ;divide 1 by flp accu
E324 A93E       765 BE324 LDA <TE33E    ;set AY to polynome table for ATN
E326 A0E3       766       LDY >TE33E
E328 2043E0     767       JSR JE043     ;compute odd degrees
E32B 68         768       PLA
E32C C981       769       CMP $81       ;if exponent => 1
E32E 9007       770       BCC BE337
E330 A9E0       771       LDA <TE2E0    ;set AY to 0.5 * PI
E332 A0E2       772       LDY >TE2E0
E334 2050B8     773       JSR XB850     ;subtract flp accu from 0.5 * PI
E337 68         774 BE337 PLA
E338 1003       775       BPL BE33D     ;if sign negative
E33A 4CB4BF     776       JMP XBFB4     ;apply monadic operator "-"
                777 ;
E33D 60         778 BE33D RTS
                779 ;
                780 ;flp numbers for ATN
                781 ;
E33E 0B         782 TE33E .BY $0B
                783 ;-0.000684793912
E33F 76B383     784       .BY $76,$B3,$83,$BD,$D3
                785 ; 0.00485094216
E344 791EF4     786       .BY $79,$1E,$F4,$A6,$F5
                787 ;-0.0131117018
E349 7B83FC     788       .BY $7B,$83,$FC,$B0,$10
                789 ; 0.034209638
E34E 7C0C1F     790       .BY $7C,$0C,$1F,$67,$CA
                791 ;-0.0542791328
E353 7CDE53     792       .BY $7C,$DE,$53,$CB,$C1
                793 ; 0.0724571965
E358 7D1464     794       .BY $7D,$14,$64,$70,$4C
                795 ;-0.0898023954
E35D 7DB7EA     796       .BY $7D,$B7,$EA,$51,$7A
                797 ; 0.110932413
E362 7D6330     798       .BY $7D,$63,$30,$88,$7E
                799 ;-0.142839808
E367 7E9244     800       .BY $7E,$92,$44,$99,$3A
                801 ; 0.19999912
E36C 7E4CCC     802       .BY $7E,$4C,$CC,$91,$C7
                803 ;-0.333333316
E371 7FAAAA     804       .BY $7F,$AA,$AA,$AA,$13
                805 ; 1
E376 810000     806       .BY $81,$00,$00,$00,$00
```

```
                808 ;warm start entry (stop/restore)
                809 ;
E37B 20CCFF     810         JSR SFFCC       ;close all files, set default devices
E37E A900       811         LDA $00
E380 8513       812         STA Z13         ;clear CMD file number flag
E382 207AA6     813         JSR XA67A       ;reset pointers
E385 58         814         CLI             ;allow IRQ
E386 A280       815 BE386   LDX $80         ;index default message READY
E388 6C0003     816         JMP (X0300)     ;print message (normally E38B)
                817 ;
                818 ;handle error messages
                819 ;
E38B 8A         820 WE38B   TXA
E38C 3003       821         BMI BE391       ;if X < $80
E38E 4C3AA4     822         JMP XA43A       ;print BASIC message
                823 ;
E391 4C74A4     824 BE391   JMP XA474       ;else print READY message
                825 ;
                826 ;RESET routine
                827 ;
E394 2053E4     828         JSR SE453       ;initialize O/S vectors
E397 20BFE3     829         JSR SE3BF       ;initialize BASIC interpreter
E39A 2022E4     830         JSR SE422       ;print BASIC start-up messages
E39D A2FB       831         LDX $FB
E39F 9A         832         TXS             ;initialize stack pointer
E3A0 D0E4       833         BNE BE386       ;print message READY
                834 ;
                835 ;character fetch code for page zero 0073-008F
                836 ;
E3A2 E67A       837 TE3A2   INC Z7A         ;bump character pointer (low)
E3A4 D002       838         BNE BE3A8       ;if overflow,
E3A6 E67B       839         INC Z7B         ;bump character pointer (high)
E3A8 AD60EA     840 BE3A8   LDA BEA61-1     ;fetch character from modified address
E3AB C93A       841         CMP #'9+1       ;if above numerics
E3AD B00A       842         BCS BE3B9       ;return with C = 1 (and Z = 1 if ":")
E3AF C920       843         CMP $20         ;if character is a space,
E3B1 F0EF       844         BEQ TE3A2       ;ignore and get next character
E3B3 38         845         SEC
E3B4 E930       846         SBC #'0         ;if below numerics
E3B6 38         847         SEC             ;return with C = 1 (and Z = 1 if $00)
E3B7 E9D0       848         SBC $D0         ;if numeric, return with C = 0
E3B9 60         849 BE3B9   RTS             ;return with flags set and char in A
                850 ;
                851 ;first RND seed value
                852 ;
E3BA 804FC7     853         .BY $80,$4F,$C7,$52,$58
```

```
                855 ;initialization for BASIC interpreter
                856 ;
E3BF A94C       857 SE3BF LDA $4C       ;set JMP instruction
E3C1 8554       858       STA Z54       ;for functions
E3C3 8D1003     859       STA X0310     ;and USR vector
E3C6 A948       860       LDA <WB248    ;default USR jump address
E3C8 A0B2       861       LDY >WB248    ;(ILLEGAL QUANTITY Error)
E3CA 8D1103     862       STA X0311     ;set USR jump address, low byte
E3CD 8C1203     863       STY X0312     ;USR jump address, high byte
E3D0 A991       864       LDA <WB391
E3D2 A0B3       865       LDY >WB391
E3D4 8505       866       STA Z05       ;set fixed-float vector
E3D6 8406       867       STY Z06       ;& high byte
E3D8 A9AA       868       LDA <WB1AA
E3DA A0B1       869       LDY >WB1AA
E3DC 8503       870       STA Z03       ;set float-fixed vector
E3DE 8404       871       STY Z04       ;& high byte
E3E0 A21C       872       LDX $1C
E3E2 BDA2E3     873 BE3E2 LDA TE3A2,X   ;move character fetch code to $73-8A
E3E5 9573       874       STA Z73,X     ;and first RND seed into Z8B-Z8F
E3E7 CA         875       DEX
E3E8 10F8       876       BPL BE3E2
E3EA A903       877       LDA $03
E3EC 8553       878       STA Z53       ;set default step
E3EE A900       879       LDA $00
E3F0 8568       880       STA Z68       ;clear flp accu overflow area
E3F2 8513       881       STA Z13       ;set CMD file number to default
E3F4 8518       882       STA Z18       ;clear high of string descriptor index
E3F6 A201       883       LDX $01
E3F8 8EFD01     884       STX X01FD
E3FB 8EFC01     885       STX X01FC     ;prefix input buffer with dummy pointer
E3FE A219       886       LDX $19
E400 8616       887       STX Z16       ;set pointer to temporary string stack
E402 38         888       SEC
E403 209CFF     889       JSR SFF9C     ;read bottom of memory address
E406 862B       890       STX Z2B       ;to set BASIC bottom of memory
E408 842C       891       STY Z2C
E40A 38         892       SEC
E40B 2099FF     893       JSR SFF99     ;read top of memory address
E40E 8637       894       STX Z37       ;to set BASIC memory limit
E410 8438       895       STY Z38
E412 8633       896       STX Z33       ;set string storage address
E414 8434       897       STY Z34       ;& high byte
E416 A000       898       LDY $00
E418 98         899       TYA
E419 912B       900       STA (Z2B),Y   ;move a 0 to bottom of memory
E41B E62B       901       INC Z2B       ;add 1 to start of BASIC address
E41D D002       902       BNE BE421
E41F E62C       903       INC Z2C       ;& high byte upon overflow
E421 60         904 BE421 RTS
```

```
                    906 ;print BASIC start-up messages
                    907 ;
E422 A52B           908 SE422 LDA Z2B       ;set AY to start of BASIC
E424 A42C           909       LDY Z2C
E426 2008A4         910       JSR XA408     ;perform array area overflow check
E429 A973           911       LDA <TE473    ;set AY to message COMMODORE 64 BASIC...
E42B A0E4           912       LDY >TE473
E42D 201EAB         913       JSR XAB1E     ;print message
E430 A537           914       LDA Z37       ;use limit of memory
E432 38             915       SEC
E433 E52B           916       SBC Z2B       ;- pointer to start of BASIC
E435 AA             917       TAX
E436 A538           918       LDA Z38       ;& high bytes
E438 E52C           919       SBC Z2C       ;to calculate bytes free
E43A 20CDBD         920       JSR XBDCD     ;convert to string
E43D A960           921       LDA <TE460    ;set AY to message BYTES FREE
E43F A0E4           922       LDY >TE460
E441 201EAB         923       JSR XAB1E     ;print # then BYTES FREE
E444 4C44A6         924       JMP XA644     ;perform NEW, print READY
                    925 ;
                    926 ;vectors for $0300-$030B
                    927 ;
E447 8BE3           928 TE447 .W  WE38B     ;error message vector
E449 83A4           929       .W  WA483     ;warm start vector
E44B 7CA5           930       .W  WA57C     ;crunch BASIC tokens vector
E44D 1AA7           931       .W  WA71A     ;print tokens vector
E44F E4A7           932       .W  WA7E4     ;execute a statement vector
E451 86AE           933       .W  WAE86     ;get arithmetic element vector
                    934 ;
                    935 ;initialize vectors at $0300-$030B
                    936 ;
E453 A20B           937 SE453 LDX $0B
E455 BD47E4         938 BE455 LDA TE447,X   ;fetch a byte from table
E458 9D0003         939       STA X0300,X   ;and move it to vector area
E45B CA             940       DEX
E45C 10F7           941       BPL BE455     ;repeat until 6 vectors stored
E45E 60             942       RTS
                    943 ;
E45F 00             944       .BY $00
E460 204241         945 TE460 .BY ' ,'B,'A,'S,'I,'C,' ,'B,'Y,'T,'E,'S,' ,'F,'R,'E,'E
E471 0D00           946       .BY $0D,$00
E473 930D20         947 TE473 .BY $93,$0D,' ,' ,' ,'
E479 2A2A2A         948       .BY '*,'*,'*,'*,' ,'C,'O,'M,'M,'O,'D,'O,'R,'E
E487 203634         949       .BY ' ,'6,'4,' ,'B,'A,'S,'I,'C,' ,'V,'2
E493 202A2A         950       .BY ' ,'*,'*,'*,'*,$0D,$0D
E49A 203634         951       .BY ' ,'6,'4,'K,' ,'R,'A,'M,' ,'S,'Y,'S,'T,'E,'M,' ,'
E4AB 005C           952       .BY $00,$5C
```

```
                954 ;set output device (patch)
                955 ;
E4AD 48         956 SE4AD PHA
E4AE 20C9FF     957       JSR SFFC9     ;perform actual open for output
E4B1 AA         958       TAX           ;save possible error code
E4B2 68         959       PLA           ;restore entry accumulator
E4B3 9001       960       BCC BE4B6     ;if an error encountered,
E4B5 8A         961       TXA           ;return with error number in A
E4B6 60         962 BE4B6 RTS
                963 ;
                964 ;unused area follows
                965 ;
E4B7 AAAAAA     966       .BY $AA,$AA,$AA,$AA,$AA,$AA,$AA,$AA
E4BF AAAAAA     967       .BY $AA,$AA,$AA,$AA,$AA,$AA,$AA,$AA
E4C7 AAAAAA     968       .BY $AA,$AA,$AA,$AA,$AA,$AA,$AA,$AA
E4CF AAAAAA     969       .BY $AA,$AA,$AA,$AA,$AA,$AA,$AA,$AA
E4D7 AAAAAA     970       .BY $AA,$AA,$AA
                971 ;
                972 ;clear a byte in color RAM
                973 ;
E4DA AD21D0     974 SE4DA LDA XD021     ;use background # 0 color
E4DD 91F3       975       STA (ZF3),Y   ;to clear color RAM
E4DF 60         976       RTS
                977 ;
                978 ;pause after finding a file on cassette
                979 ;
E4E0 6902       980 SE4E0 ADC $02       ;set maximum pause to 256 - 512 jiffies
E4E2 A491       981 BE4E2 LDY Z91       ;check keyboard scan result
E4E4 C8         982       INY
E4E5 D004       983       BNE BE4EB     ;exit if a key depressed
E4E7 C5A1       984       CMP ZA1
E4E9 D0F7       985       BNE BE4E2     ;repeat until delay complete
E4EB 60         986 BE4EB RTS
```

```
                988 ;baud rate factor table for International machines
                989 ;((clock frequency/baud rate/2)-100)
                990 ;
E4EC 1926       991 TE4EC .WO $2619      ;50 baud
E4EE 4419       992       .WO $1944      ;75
E4F0 1A11       993       .WO $111A      ;110
E4F2 E80D       994       .WO $0DE8      ;134.5
E4F4 700C       995       .WO $0C70      ;150
E4F6 0606       996       .WO $0606      ;300
E4F8 D102       997       .WO $02D1      ;600
E4FA 3701       998       .WO $0137      ;1200
E4FC AE00       999       .WO $00AE      ;1800
E4FE 6900      1000       .WO $0069      ;2400
               1001 ;
               1002 ;read base address of I/O devices into XY
               1003 ;
E500 A200      1004 JE500 LDX $00
E502 A0DC      1005       LDY $DC        ;point to CIA1 in XY
E504 60        1006       RTS
               1007 ;
               1008 ;read screen organization into XY
               1009 ;
E505 A228      1010 JE505 LDX $28        ;# columns
E507 A019      1011       LDY $19        ;# rows
E509 60        1012       RTS
               1013 ;
               1014 ;read/set XY cursor position
               1015 ;
E50A B007      1016 JE50A BCS BE513      ;if carry set, read cursor position
E50C 86D6      1017       STX ZD6        ;set cursor line # from X
E50E 84D3      1018       STY ZD3        ;set position of cursor on line from Y
E510 206CE5    1019       JSR SE56C      ;set address of current screen line
E513 A6D6      1020 BE513 LDX ZD6        ;read cursor line number into X
E515 A4D3      1021       LDY ZD3        ;read position of cursor on line into Y
E517 60        1022       RTS
```

```
                1024 ;initialize screen and keyboard
                1025 ;
E518 20A0E5     1026 SE518 JSR SE5A0     ;initialize video chip, set default I/O
E51B A900       1027       LDA $00
E51D 8D9102     1028       STA X0291     ;enable shift mode
E520 85CF       1029       STA ZCF       ;clear cursor blink phase
E522 A948       1030       LDA <WEB48
E524 8D8F02     1031       STA X028F     ;set address of keyboard decode routine
E527 A9EB       1032       LDA >WEB48
E529 8D9002     1033       STA X0290     ;& high byte
E52C A90A       1034       LDA $0A
E52E 8D8902     1035       STA X0289     ;set maximum length of keyboard buffer
E531 8D8C02     1036       STA X028C     ;set repeat key delay counter
E534 A90E       1037       LDA $0E
E536 8D8602     1038       STA X0286     ;set current color code
E539 A904       1039       LDA $04
E53B 8D8B02     1040       STA X028B     ;set repeat key frequency counter
E53E A90C       1041       LDA $0C
E540 85CD       1042       STA ZCD       ;set cursor flash timer
E542 85CC       1043       STA ZCC       ;disable cursor flash
E544 AD8802     1044 SE544 LDA X0288     ;fetch screen memory start page
E547 0980       1045       ORA $80       ;set bit 7 to indicate 40 char line
E549 A8         1046       TAY
E54A A900       1047       LDA $00
E54C AA         1048       TAX
E54D 94D9       1049 BE54D STY ZD9,X     ;build screen line address table
E54F 18         1050       CLC
E550 6928       1051       ADC $28
E552 9001       1052       BCC BE555
E554 C8         1053       INY
E555 E8         1054 BE555 INX
E556 E01A       1055       CPX $1A
E558 D0F3       1056       BNE BE54D     ;repeat for 25 lines
E55A A9FF       1057       LDA $FF
E55C 95D9       1058       STA ZD9,X
E55E A218       1059       LDX $18       ;line count - 1
E560 20FFE9     1060 BE560 JSR SE9FF     ;clear a line
E563 CA         1061       DEX
E564 10FA       1062       BPL BE560     ;loop till screen cleared
E566 A000       1063 JE566 LDY $00
E568 84D3       1064       STY ZD3       ;cursor at position 0
E56A 84D6       1065       STY ZD6       ;and line 0
```

```
                1067 ;set address of current screen line
                1068 ;
E56C A6D6       1069 SE56C LDX ZD6        ;get cursor line number in X
E56E A5D3       1070       LDA ZD3        ;and position of cursor on line in A
E570 B4D9       1071 BE570 LDY ZD9,X      ;check screen line address table
E572 3008       1072       BMI BE57C
E574 18         1073       CLC            ;if on an 80 character line,
E575 6928       1074       ADC $28        ;add 40 to
E577 85D3       1075       STA ZD3        ;position of cursor on line
E579 CA         1076       DEX            ;point to preceeding line
E57A 10F4       1077       BPL BE570      ;and repeat if screen top not reached
E57C B5D9       1078 BE57C LDA ZD9,X      ;fetch high byte of screen line address
E57E 2903       1079       AND $03        ;strip 40/80 character line flag
E580 0D8802     1080       ORA X0288      ;add screen memory page
E583 85D2       1081       STA ZD2        ;to set high of pointer to screen line
E585 BDF0EC     1082       LDA TECF0,X    ;use line number and table of low bytes
E588 85D1       1083       STA ZD1        ;to set low byte of ptr to screen line
E58A A927       1084       LDA $27        ;set initial max length of current line
E58C E8         1085       INX
E58D B4D9       1086 BE58D LDY ZD9,X
E58F 3006       1087       BMI BE597      ;exit if on a 40 character line
E591 18         1088       CLC
E592 6928       1089       ADC $28        ;else add 40
E594 E8         1090       INX
E595 10F6       1091       BPL BE58D      ;and repeat one time
E597 85D5       1092 BE597 STA ZD5        ;save maximum length current line
E599 60         1093       RTS
                1094 ;
E59A 20A0E5     1095       JSR SE5A0      ;not referenced!!
E59D 4C66E5     1096       JMP JE566
```

```
                1098 ;set video chip to std values and I/O devices to default
                1099 ;
E5A0 A903       1100 SE5A0 LDA $03
E5A2 859A       1101       STA Z9A        ;set output device (screen)
E5A4 A900       1102       LDA $00
E5A6 8599       1103       STA Z99        ;set input device (keyboard)
E5A8 A22F       1104       LDX $2F
E5AA BDB8EC     1105 BE5AA LDA TECB9-1,X ;use standard table values to
E5AD 9DFFCF     1106       STA XD000-1,X ;initialize video chip
E5B0 CA         1107       DEX
E5B1 D0F7       1108       BNE BE5AA      ;repeat to move all 47 values
E5B3 60         1109       RTS
                1110 ;
                1111 ;fetch a character from keyboard buffer
                1112 ;
E5B4 AC7702     1113 SE5B4 LDY X0277      ;save bottom char of keyboard buffer
E5B7 A200       1114       LDX $00
E5B9 BD7802     1115 BE5B9 LDA X0277+1,X ;move keyboard queue down one
E5BC 9D7702     1116       STA X0277,X
E5BF E8         1117       INX
E5C0 E4C6       1118       CPX ZC6        ;check length of queue
E5C2 D0F5       1119       BNE BE5B9      ;loop until all moved
E5C4 C6C6       1120       DEC ZC6        ;subtract one from length of queue
E5C6 98         1121       TYA            ;return with character in A
E5C7 58         1122       CLI            ;allow IRQ's again
E5C8 18         1123       CLC            ;clear error flag
E5C9 60         1124       RTS
```

```
                1126 ;wait for a Return from keyboard
                1127 ;
E5CA 2016E7     1128 BE5CA JSR SE716      ;echo character on screen
E5CD A5C6       1129 BE5CD LDA ZC6        ;move keyboard count
E5CF 85CC       1130       STA ZCC        ;to cursor enable flag (00=flash)
E5D1 8D9202     1131       STA X0292      ;and auto scroll down flag
E5D4 F0F7       1132       BEQ BE5CD      ;loop until something arrives from kbd
E5D6 78         1133       SEI
E5D7 A5CF       1134       LDA ZCF        ;if cursor blink phase 1
E5D9 F00C       1135       BEQ BE5E7
E5DB A5CE       1136       LDA ZCE        ;get character under cursor
E5DD AE8702     1137       LDX X0287      ;& color of character under cursor
E5E0 A000       1138       LDY $00
E5E2 84CF       1139       STY ZCF        ;clear cursor blink phase
E5E4 2013EA     1140       JSR SEA13      ;store character on screen
E5E7 20B4E5     1141 BE5E7 JSR SE5B4      ;fetch a character from the keyboard buffer
E5EA C983       1142       CMP $83        ;check for shift of Run/Stop key
E5EC D010       1143       BNE BE5FE
E5EE A209       1144       LDX $09        ;if so, set count for move
E5F0 78         1145       SEI
E5F1 86C6       1146       STX ZC6        ;force keyboard buffer count
E5F3 BDE6EC     1147 BE5F3 LDA TECE7-1,X  ;move "Load/Run" into keyboard buffer
E5F6 9D7602     1148       STA X0277-1,X
E5F9 CA         1149       DEX
E5FA D0F7       1150       BNE BE5F3      ;repeat until all characters moved
E5FC F0CF       1151       BEQ BE5CD      ;go get first char from forced string
                1152 ;
E5FE C90D       1153 BE5FE CMP $0D        ;if Return,
E600 D0C8       1154       BNE BE5CA
E602 A4D5       1155       LDY ZD5        ;move screen line length
E604 84D0       1156       STY ZD0        ;to save area
E606 B1D1       1157 BE606 LDA (ZD1),Y    ;check for blanks at end of line
E608 C920       1158       CMP $20
E60A D003       1159       BNE BE60F
E60C 88         1160       DEY            ;and remove them
E60D D0F7       1161       BNE BE606
E60F C8         1162 BE60F INY
E610 84C8       1163       STY ZC8        ;set end of line pointer for input
E612 A000       1164       LDY $00
E614 8C9202     1165       STY X0292      ;enable auto scroll flag
E617 84D3       1166       STY ZD3        ;set position of cursor on line
E619 84D4       1167       STY ZD4        ;clear string flag
E61B A5C9       1168       LDA ZC9        ;get saved screen line number
E61D 301B       1169       BMI BE63A      ;if valid
E61F A6D6       1170       LDX ZD6
E621 20EDE6     1171       JSR SE6ED      ;and equal to original
E624 E4C9       1172       CPX ZC9
E626 D012       1173       BNE BE63A
E628 A5CA       1174       LDA ZCA
E62A 85D3       1175       STA ZD3        ;set char position to original value
E62C C5C8       1176       CMP ZC8        ;if char position is past end of line,
E62E 900A       1177       BCC BE63A      ;get character from screen
E630 B02B       1178       BCS BE65D      ;else exit with a return
```

```
                1180 ;get character from device 0 or 3 (keyboard or screen)
                1181 ;
E632 98         1182 JE632 TYA
E633 48         1183       PHA
E634 8A         1184       TXA             ;save XY on stack
E635 48         1185       PHA
E636 A5D0       1186       LDA ZD0         ;test saved screen line length
E638 F093       1187       BEQ BE5CD       ;if zero, wait for return
                1188 ;
                1189 ;get character from current screen line
                1190 ;
E63A A4D3       1191 BE63A LDY ZD3         ;get position of cursor on current line
E63C B1D1       1192       LDA (ZD1),Y     ;then current screen character
E63E 85D7       1193       STA ZD7         ;and save it
E640 293F       1194       AND $3F         ;save low order 6 bits
E642 06D7       1195       ASL ZD7         ;if bit 6 is set in original
E644 24D7       1196       BIT ZD7
E646 1002       1197       BPL BE64A
E648 0980       1198       ORA $80         ;set bit 7 in converted character
E64A 9004       1199 BE64A BCC BE650       ;if bit 7 is set in original
E64C A6D4       1200       LDX ZD4         ;and in a string
E64E D004       1201       BNE BE654       ;then don't change bit 6
E650 7002       1202 BE650 BVS BE654       ;if bit 5 is clear in original
E652 0940       1203       ORA $40         ;set bit 6 in converted character
E654 E6D3       1204 BE654 INC ZD3         ;increment position of cursor on line
E656 2084E6     1205       JSR SE684       ;check for a quote
E659 C4C8       1206       CPY ZC8         ;if end of line reached
E65B D017       1207       BNE BE674
E65D A900       1208 BE65D LDA $00
E65F 85D0       1209       STA ZD0         ;clear copy of screen line length
E661 A90D       1210       LDA $0D         ;force a Return
E663 A699       1211       LDX Z99
E665 E003       1212       CPX $03         ;if input device is 3 (screen)
E667 F006       1213       BEQ BE66F       ;echo character on screen
E669 A69A       1214       LDX Z9A
E66B E003       1215       CPX $03         ;if output device is screen
E66D F003       1216       BEQ BE672       ;replace character with a Return
E66F 2016E7     1217 BE66F JSR SE716       ;echo character on screen
E672 A90D       1218 BE672 LDA $0D         ;replace character with a Return
E674 85D7       1219 BE674 STA ZD7         ;and save as last character
E676 68         1220       PLA
E677 AA         1221       TAX
E678 68         1222       PLA
E679 A8         1223       TAY             ;restore XY
E67A A5D7       1224       LDA ZD7
E67C C9DE       1225       CMP $DE         ;if character is PI
E67E D002       1226       BNE BE682
E680 A9FF       1227       LDA $FF         ;return with code for PI
E682 18         1228 BE682 CLC
E683 60         1229       RTS
```

```
                1231 ;check for a quote mark and set flag
                1232 ;
E684 C922       1233 SE684 CMP #""          ;if character is a quote
E686 D008       1234       BNE BE690
E688 A5D4       1235       LDA ZD4
E68A 4901       1236       EOR $01          ;complement string flag
E68C 85D4       1237       STA ZD4
E68E A922       1238       LDA #""          ;and restore quote code in A
E690 60         1239 BE690 RTS
                1240 ;
                1241 ;fill screen at current position
                1242 ;
E691 0940       1243 JE691 ORA $40          ;map shifted characters
E693 A6C7       1244 JE693 LDX ZC7          ;if reverse switch is on
E695 F002       1245       BEQ BE699
E697 0980       1246 JE697 ORA $80          ;add reverse video bit
E699 A6D8       1247 BE699 LDX ZD8          ;if any pending inserts
E69B F002       1248       BEQ BE69F
E69D C6D8       1249       DEC ZD8          ;decrement pending inserts count
E69F AE8602     1250 BE69F LDX X0286        ;fetch current color code
E6A2 2013EA     1251       JSR SE[illegible] ;add character to screen
E6A5 20B6E6     1252       JSR SE6B6        ;get/insert new line
                1253 ;
                1254 ;return from output to the screen
                1255 ;
E6A8 68         1256 BE6A8 PLA
E6A9 A8         1257       TAY
E6AA A5D8       1258       LDA ZD8          ;if any pending inserts,
E6AC F002       1259       BEQ BE6B0
E6AE 46D4       1260       LSR ZD4          ;reset string mode flag
E6B0 68         1261 BE6B0 PLA
E6B1 AA         1262       TAX              ;restore XA
E6B2 68         1263       PLA
E6B3 18         1264       CLC
E6B4 58         1265       CLI              ;allow IRQ's
E6B5 60         1266       RTS
```

```
                1268 ;get/insert new line
                1269 ;
E6B6 20B3E8     1270 SE6B6 JSR SE8B3     ;check for end of a screen line
E6B9 E6D3       1271       INC ZD3       ;advance cursor position
E6BB A5D5       1272       LDA ZD5
E6BD C5D3       1273       CMP ZD3       ;if beyond maximum position,
E6BF B03F       1274       BCS BE700     ;exit
E6C1 C94F       1275       CMP $4F       ;if not at 79
E6C3 F032       1276       BEQ BE6F7
E6C5 AD9202     1277       LDA X0292     ;and in auto scroll mode
E6C8 F003       1278       BEQ BE6CD     ;continue
E6CA 4C67E9     1279       JMP JE967     ;else insert a blank line in screen RAM
                1280 ;
E6CD A6D6       1281 BE6CD LDX ZD6       ;if in auto scroll mode
E6CF E019       1282       CPX $19       ;and cursor is on line 25
E6D1 9007       1283       BCC BE6DA
E6D3 20EAE8     1284       JSR SE8EA     ;scroll screen
E6D6 C6D6       1285       DEC ZD6       ;subtract 1 from cursor line #
E6D8 A6D6       1286       LDX ZD6
E6DA 16D9       1287 BE6DA ASL ZD9,X     ;set an 80 character line
E6DC 56D9       1288       LSR ZD9,X
E6DE E8         1289       INX
E6DF B5D9       1290       LDA ZD9,X     ;set following line to 40 characters
E6E1 0980       1291       ORA $80
E6E3 95D9       1292       STA ZD9,X
E6E5 CA         1293       DEX
E6E6 A5D5       1294       LDA ZD5
E6E8 18         1295       CLC
E6E9 6928       1296       ADC $28       ;add 40 to line length of current line
E6EB 85D5       1297       STA ZD5
E6ED B5D9       1298 SE6ED LDA ZD9,X
E6EF 3003       1299       BMI BE6F4     ;if current line is not 80 char line
E6F1 CA         1300       DEX           ;decrement line count
E6F2 D0F9       1301       BNE SE6ED     ;and repeat
E6F4 4CF0E9     1302 BE6F4 JMP SE9F0     ;reset screen line address and return
                1303 ;
E6F7 C6D6       1304 BE6F7 DEC ZD6       ;decrement cursor line #
E6F9 207CE8     1305       JSR SE87C     ;set next line number
E6FC A900       1306       LDA $00
E6FE 85D3       1307       STA ZD3       ;set cursor position on line to 0
E700 60         1308 BE700 RTS
                1309 ;
                1310 ;move backwards over a line boundary
                1311 ;
E701 A6D6       1312 SE701 LDX ZD6       ;if at top of screen
E703 D006       1313       BNE BE70B
E705 86D3       1314       STX ZD3       ;set cursor position to line 0
E707 68         1315       PLA
E708 68         1316       PLA           ;remove own return address
E709 D09D       1317       BNE BE6A8     ;and exit
E70B CA         1318 BE70B DEX           ;else back up one line
E70C 86D6       1319       STX ZD6
E70E 206CE5     1320       JSR SE56C     ;set address of current screen line
E711 A4D5       1321       LDY ZD5       ;move line length of current line
E713 84D3       1322       STY ZD3       ;to position of cursor on line
E715 60         1323       RTS
```

```
                1325 ;put a character to screen (device 3)
                1326 ;
E716 48         1327 SE716 PHA          ;save character on stack
E717 85D7       1328       STA ZD7      ;and in temporary field
E719 8A         1329       TXA
E71A 48         1330       PHA
E71B 98         1331       TYA
E71C 48         1332       PHA          ;save XY
E71D A900       1333       LDA $00
E71F 85D0       1334       STA ZD0      ;set saved screen line length to 0
E721 A4D3       1335       LDY ZD3      ;get character position
E723 A5D7       1336       LDA ZD7      ;and character
E725 1003       1337       BPL BE72A
E727 4CD4E7     1338       JMP JE7D4    ;if shifted character, skip following
                1339 ;
E72A C90D       1340 BE72A CMP $0D      ;if Return
E72C D003       1341       BNE BE731
E72E 4C91E8     1342       JMP JE891    ;perform Return function
                1343 ;
E731 C920       1344 BE731 CMP $20      ;if printable character
E733 9010       1345       BCC BE745
E735 C960       1346       CMP $60
E737 9004       1347       BCC BE73D
E739 29DF       1348       AND $DF
E73B D002       1349       BNE BE73F    ;and not a space
E73D 293F       1350 BE73D AND $3F      ;map to screen code
E73F 2084E6     1351 BE73F JSR SE684    ;check for a quote
E742 4C93E6     1352       JMP JE693    ;and fill screen
                1353 ;
E745 A6D8       1354 BE745 LDX ZD8      ;if non-printable
E747 F003       1355       BEQ BE74C    ;and inserts pending
E749 4C97E6     1356       JMP JE697    ;do not use code
                1357 \
E74C C914       1358 BE74C CMP $14      ;if Delete code
E74E D02E       1359       BNE BE77E
E750 98         1360       TYA
E751 D006       1361       BNE BE759    ;and not beyond left margin
E753 2001E7     1362       JSR SE701    ;go backwards over line boundary
E756 4C73E7     1363       JMP JE773    ;insert a blank
                1364 ;
E759 20A1E8     1365 BE759 JSR SE8A1    ;check for cursor at line beginning
E75C 88         1366       DEY
E75D 84D3       1367       STY ZD3      ;adjust cursor position on line
E75F 2024EA     1368       JSR SEA24    ;set color memory address
E762 C8         1369 BE762 INY
E763 B1D1       1370       LDA (ZD1),Y  ;compress screen line
E765 88         1371       DEY
E766 91D1       1372       STA (ZD1),Y
E768 C8         1373       INY
E769 B1F3       1374       LDA (ZF3),Y  ;and color memory
E76B 88         1375       DEY
E76C 91F3       1376       STA (ZF3),Y
E76E C8         1377       INY
E76F C4D5       1378       CPY ZD5      ;up to end of line
E771 D0EF       1379       BNE BE762
E773 A920       1380 JE773 LDA $20      ;and insert blank
E775 91D1       1381       STA (ZD1),Y  ;at end
E777 AD8602     1382       LDA X0286    ;insert current color code
E77A 91F3       1383       STA (ZF3),Y  ;in color memory
E77C 104D       1384       BPL BE7CB
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E77E A6D4    1385 BE77E LDX ZD4       ;if in string mode
E780 F003    1386       BEQ BE785     ;don't use control functions
E782 4C97E6  1387       JMP JE697
             1388 ;
E785 C912    1389 BE785 CMP $12       ;if Reverse key
E787 D002    1390       BNE BE78B
E789 85C7    1391       STA ZC7       ;set reverse video switch
E78B C913    1392 BE78B CMP $13       ;if Home key
E78D D003    1393       BNE BE792
E78F 2066E5  1394       JSR JE566     ;re-initialize cursor position
E792 C91D    1395 BE792 CMP $1D       ;if Cursor Right
E794 D017    1396       BNE BE7AD
E796 C8      1397       INY
E797 20B3E8  1398       JSR SE8B3     ;increment character position
E79A 84D3    1399       STY ZD3
E79C 88      1400       DEY
E79D C4D5    1401       CPY ZD5       ;if at line end
E79F 9009    1402       BCC BE7AA
E7A1 C6D6    1403       DEC ZD6       ;decrement cursor line number
E7A3 207CE8  1404       JSR SE87C     ;go to next line
E7A6 A000    1405       LDY $00
E7A8 84D3    1406 BE7A8 STY ZD3       ;set position of cursor on line
E7AA 4CA8E6  1407 BE7AA JMP BE6A8     ;and exit
             1408 ;
E7AD C911    1409 BE7AD CMP $11       ;if Cursor Down
E7AF D01D    1410       BNE BE7CE
E7B1 18      1411       CLC
E7B2 98      1412       TYA
E7B3 6928    1413       ADC $28       ;advance 40 positions
E7B5 A8      1414       TAY
E7B6 E6D6    1415       INC ZD6       ;increment cursor line number
E7B8 C5D5    1416       CMP ZD5       ;if not beyond line end
E7BA 90EC    1417       BCC BE7A8
E7BC F0EA    1418       BEQ BE7A8     ;exit
E7BE C6D6    1419       DEC ZD6       ;else back up one line
E7C0 E928    1420 BE7C0 SBC $28       ;decrease character position by 40
E7C2 9004    1421       BCC BE7C8     ;exit if underflow
E7C4 85D3    1422       STA ZD3       ;else reset position of cursor on line
E7C6 D0F8    1423       BNE BE7C0
E7C8 207CE8  1424 BE7C8 JSR SE87C     ;set next line number
E7CB 4CA8E6  1425 BE7CB JMP BE6A8     ;exit
             1426 ;
E7CE 20CBE8  1427 BE7CE JSR SE8CB     ;check for a color code
E7D1 4C44EC  1428       JMP JEC44     ;check for special CHR$ codes, return
```

```
                1430 ;put shifted characters to screen
                1431 ;
E7D4 297F       1432 JE7D4 AND $7F        ;remove shift bit
E7D6 C97F       1433       CMP $7F        ;if code for PI
E7D8 D002       1434       BNE BE7DC
E7DA A95E       1435       LDA $5E        ;set screen code for PI
E7DC C920       1436 BE7DC CMP $20        ;if printable
E7DE 9003       1437       BCC BE7E3
E7E0 4C91E6     1438       JMP JE691      ;go fill screen
                1439 ;
E7E3 C90D       1440 BE7E3 CMP $0D        ;if shifted Return
E7E5 D003       1441       BNE BE7EA
E7E7 4C91E8     1442       JMP JE891      ;do Return function
                1443 ;
E7EA A6D4       1444 BE7EA LDX ZD4        ;if in string mode
E7EC D03F       1445       BNE BE82D      ;do not perform control functions
E7EE C914       1446       CMP $14        ;if Insert key
E7F0 D037       1447       BNE BE829
E7F2 A4D5       1448       LDY ZD5
E7F4 B1D1       1449       LDA (ZD1),Y
E7F6 C920       1450       CMP $20        ;and last character of line is a blank
E7F8 D004       1451       BNE BE7FE
E7FA C4D3       1452       CPY ZD3        ;and not also current char position
E7FC D007       1453       BNE BE805      ;then enough space on this line
E7FE C04F       1454 BE7FE CPY $4F        ;if last character of line not blank
E800 F024       1455       BEQ BE826      ;and 80 character line, ignore
E802 2065E9     1456       JSR SE965      ;else insert a blank line in screen RAM
E805 A4D5       1457 BE805 LDY ZD5        ;get new maximum character position
E807 2024EA     1458       JSR SEA24      ;set color memory address
E80A 88         1459 BE80A DEY            ;from new maximum character position
E80B B1D1       1460       LDA (ZD1),Y    ;move characters
E80D C8         1461       INY
E80E 91D1       1462       STA (ZD1),Y    ;towards end of line
E810 88         1463       DEY
E811 B1F3       1464       LDA (ZF3),Y    ;plus color memory
E813 C8         1465       INY
E814 91F3       1466       STA (ZF3),Y
E816 88         1467       DEY
E817 C4D3       1468       CPY ZD3        ;up to current position
E819 D0EF       1469       BNE BE80A
E81B A920       1470       LDA $20
E81D 91D1       1471       STA (ZD1),Y    ;insert a blank
E81F AD8602     1472       LDA X0286
E822 91F3       1473       STA (ZF3),Y    ;insert current color in color memory
E824 E6D8       1474       INC ZD8        ;add 1 to pending inserts count
E826 4CA8E6     1475 BE826 JMP BE6A8      ;and exit
                1476 ;
E829 A6D8       1477 BE829 LDX ZD8        ;if any pending inserts
E82B F005       1478       BEQ BE832
E82D 0940       1479 BE82D ORA $40        ;add screen shift bit
E82F 4C97E6     1480       JMP JE697      ;go fill screen
                1481 ;
E832 C911       1482 BE832 CMP $11        ;if Cursor Up key
E834 D016       1483       BNE BE84C
E836 A6D6       1484       LDX ZD6
E838 F03?       1485       BEQ BE87?      ;and cursor not on top screen line
E83A C6D6       1486       DEC ZD6
E83C A5D3       1487       LDA ZD3
E83E 38         1488       SEC
E83F E928       1489       SBC $28
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E841 9004   1490         BCC BE847     ;and current cursor position >= 40
E843 85D3   1491         STA ZD3       ;decrease count by 40
E845 102A   1492         BPL BE871     ;and exit
E847 206CE5 1493 BE847   JSR SE56C     ;set address of current screen line
E84A D025   1494         BNE BE871
E84C C912   1495 BE84C   CMP $12       ;if Reverse Off key
E84E D004   1496         BNE BE854
E850 A900   1497         LDA $00
E852 85C7   1498         STA ZC7       ;clear reverse video switch
E854 C91D   1499 BE854   CMP $1D       ;if Cursor Left
E856 D012   1500         BNE BE86A
E858 98     1501         TYA
E859 F009   1502         BEQ BE864     ;and cursor not beyond left margin,
E85B 20A1E8 1503         JSR SE8A1     ;check for left edge of a screen line
E85E 88     1504         DEY           ;back up cursor one position
E85F 84D3   1505         STY ZD3       ;and set cursor to new position
E861 4CA8E6 1506         JMP BE6A8     ;and exit
            1507 ;
E864 2001E7 1508 BE864   JSR SE701     ;go backwards over line boundary
E867 4CA8E6 1509         JMP BE6A8     ;and exit
            1510 ;
E86A C913   1511 BE86A   CMP $13       ;if CLR key
E86C D006   1512         BNE BE874
E86E 2044E5 1513         JSR SE544     ;re-initialize screen
E871 4CA8E6 1514 BE871   JMP BE6A8     ;and exit
            1515 ;
E874 0980   1516 BE874   ORA $80       ;restore code to original value
E876 20CBE8 1517         JSR SE8CB     ;check for a color change keystroke
E879 4C4FEC 1518         JMP JEC4F     ;check for special CHR$ values and return
            1519 ;
            1520 ;set next line number
            1521 ;
E87C 46C9   1522 SE87C   LSR ZC9       ;set saved line # on screen invalid
E87E A6D6   1523         LDX ZD6       ;get current line number
E880 E8     1524 BE880   INX           ;and increment it
E881 E019   1525         CPX $19       ;if at end of screen
E883 D003   1526         BNE BE888
E885 20EAE8 1527         JSR SE8EA     ;scroll screen
E888 B5D9   1528 BE888   LDA ZD9,X     ;if 80 character line,
E88A 10F4   1529         BPL BE880     ;repeat
E88C 86D6   1530         STX ZD6       ;store new line number
E88E 4C6CE5 1531         JMP SE56C     ;set addr of current screen line and return
```

```
                1533 ;action for Return
                1534 ;
E891 A200       1535 JE891 LDX $00
E893 86D8       1536       STX ZD8       ;clear pending inserts count
E895 86C7       1537       STX ZC7       ;reset reverse video switch
E897 86D4       1538       STX ZD4       ;reset string flag
E899 86D3       1539       STX ZD3       ;set cursor to position 0 on line
E89B 207CE8     1540       JSR SE87C     ;set next line number
E89E 4CA8E6     1541       JMP BE6A8     ;and exit
                1542 ;
                1543 ;move cursor to previous line if at start of a screen line
                1544 ;
E8A1 A202       1545 SE8A1 LDX $02
E8A3 A900       1546       LDA $00
E8A5 C5D3       1547 BE8A5 CMP ZD3       ;if cursor is not
E8A7 F007       1548       BEQ BE8B0     ;at the left edge of a screen line,
E8A9 18         1549       CLC
E8AA 6928       1550       ADC $28       ;set A for next left edge
E8AC CA         1551       DEX
E8AD D0F6       1552       BNE BE8A5     ;and repeat a maximum of 2 times
E8AF 60         1553       RTS
                1554 ;
E8B0 C6D6       1555 BE8B0 DEC ZD6       ;since cursor at left edge,
E8B2 60         1556       RTS           ;move cursor to previous line
                1557 ;
                1558 ;move cursor to next line if at end of a screen line
                1559 ;
E8B3 A202       1560 SE8B3 LDX $02
E8B5 A927       1561       LDA $27
E8B7 C5D3       1562 BE8B7 CMP ZD3       ;if cursor is not at the end of a line
E8B9 F007       1563       BEQ BE8C2
E8BB 18         1564       CLC
E8BC 6928       1565       ADC $28       ;point to next end of screen line
E8BE CA         1566       DEX
E8BF D0F6       1567       BNE BE8B7     ;and repeat a maximum of 2 times
E8C1 60         1568       RTS
                1569 ;
E8C2 A6D6       1570 BE8C2 LDX ZD6       ;since cursor at right edge,
E8C4 E019       1571       CPX $19
E8C6 F002       1572       BEQ BE8CA
E8C8 E6D6       1573       INC ZD6       ;add 1 to cursor line number
E8CA 60         1574 BE8CA RTS           ;if cursor not on last screen line
                1575 ;
                1576 ;check for a color change keystroke
                1577 ;
E8CB A20F       1578 SE8CB LDX $0F
E8CD DDDAE8     1579 BE8CD CMP TE8DA,X   ;compare keystroke to color codes
E8D0 F004       1580       BEQ BE8D6
E8D2 CA         1581       DEX
E8D3 10F8       1582       BPL BE8CD     ;repeat for all 16 codes
E8D5 60         1583       RTS
                1584 ;
E8D6 8E8602     1585 BE8D6 STX X0286     ;set current color code upon a match
E8D9 60         1586       RTS
                1587 ;
E8DA            1588 TE8DA =   *         ;color codes
E8DA 90051C     1589       .BY $90,$05,$1C,$9F,$9C,$1E,$1F,$9E
E8E2 819596     1590       .BY $81,$95,$96,$97,$98,$99,$9A,$9B
```

```
                1592 ;scroll screen
                1593 ;
E8EA A5AC       1594 SE8EA LDA ZAC       ;save I/O pointers on stack
E8EC 48         1595       PHA
E8ED A5AD       1596       LDA ZAD
E8EF 48         1597       PHA
E8F0 A5AE       1598       LDA ZAE
E8F2 48         1599       PHA
E8F3 A5AF       1600       LDA ZAF
E8F5 48         1601       PHA
E8F6 A2FF       1602 BE8F6 LDX $FF       ;initialize line pointer
E8F8 C6D6       1603       DEC ZD6       ;move cursor to previous line
E8FA C6C9       1604       DEC ZC9       ;also input cursor
E8FC CEA502     1605       DEC X02A5     ;and position of first 40 char line
E8FF E8         1606 BE8FF INX
E900 20F0E9     1607       JSR SE9F0     ;set screen address
E903 E018       1608       CPX $18
E905 B00C       1609       BCS BE913     ;if 24 lines not moved up,
E907 BDF1EC     1610       LDA TECF0+1,X ;use screen line address table
E90A 85AC       1611       STA ZAC       ;to set next source address
E90C B5DA       1612       LDA ZDA,X     ;high byte also
E90E 20C8E9     1613       JSR SE9C8     ;move one line up
E911 30EC       1614       BMI BE8FF     ;and repeat
E913 20FFE9     1615 BE913 JSR SE9FF     ;clear last screen line
E916 A200       1616       LDX $00
E918 B5D9       1617 BE918 LDA ZD9,X
E91A 297F       1618       AND $7F       ;set a line to 80 character
E91C B4DA       1619       LDY ZDA,X     ;if next line is 80 characters
E91E 1002       1620       BPL BE922
E920 0980       1621       ORA $80       ;set to 40 character line
E922 95D9       1622 BE922 STA ZD9,X
E924 E8         1623       INX
E925 E018       1624       CPX $18
E927 D0EF       1625       BNE BE918     ;repeat until bottom of screen reached
E929 A5F1       1626       LDA ZF1       ;set bottom line to 40 character
E92B 0980       1627       ORA $80
E92D 85F1       1628       STA ZF1
E92F A5D9       1629       LDA ZD9       ;if top line is 80 characters,
E931 10C3       1630       BPL BE8F6     ;then scroll up again
E933 E6D6       1631       INC ZD6       ;else add 1 to cursor line number
E935 EEA502     1632       INC X02A5     ;and position of first 40 char line
E938 A97F       1633       LDA $7F
E93A 8D00DC     1634       STA XDC00
E93D AD01DC     1635       LDA XDC01
E940 C9FB       1636       CMP $FB       ;if CTRL key is depressed,
E942 08         1637       PHP
E943 A97F       1638       LDA $7F
E945 8D00DC     1639       STA XDC00
E948 28         1640       PLP
E949 D00B       1641       BNE BE956
E94B A000       1642       LDY $00
E94D EA         1643 BE94D NOP           ;delay to slow scrolling down
E94E CA         1644       DEX
E94F D0FC       1645       BNE BE94D
E951 88         1646       DEY
E952 D0F9       1647       BNE BE94D
E954 84C6       1648       STY ZC6       ;clear keyboard buffer count
E956 A6D6       1649 BE956 LDX ZD6       ;put cursor line number in X
E958 68         1650 JE958 PLA
E959 85AF       1651       STA ZAF       ;restore I/O area from stack
```

```
E95B 68      1652         PLA
E95C 85AE    1653         STA ZAE
E95E 68      1654         PLA
E95F 85AD    1655         STA ZAD
E961 68      1656         PLA
E962 85AC    1657         STA ZAC
E964 60      1658         RTS
             1659 ;
             1660 ;insert a blank line in screen RAM
             1661 ;
E965 A6D6    1662 SE965 LDX ZD6        ;start from current cursor line position
E967 E8      1663 JE967 INX
E968 B5D9    1664         LDA ZD9,X
E96A 10FB    1665         BPL JE967    ;skip 80 column lines
E96C 8EA502  1666         STX X02A5    ;save position of first 40 column line
E96F E018    1667         CPX $18      ;if line 24
E971 F00E    1668         BEQ BE981
E973 900C    1669         BCC BE981
E975 20EAE8  1670         JSR SE8EA    ;scroll screen
E978 AEA502  1671         LDX X02A5    ;first 40 column line beyond cursor
E97B CA      1672         DEX          ;minus 1 = new cursor line number
E97C C6D6    1673         DEC ZD6      ;decrement cursor line number
E97E 4CDAE6  1674         JMP BE6DA    ;and go reset screen line pointers
             1675 ;
E981 A5AC    1676 BE981 LDA ZAC        ;save I/O pointers on the stack
E983 48      1677         PHA
E984 A5AD    1678         LDA ZAD
E986 48      1679         PHA
E987 A5AE    1680         LDA ZAE
E989 48      1681         PHA
E98A A5AF    1682         LDA ZAF
E98C 48      1683         PHA
E98D A219    1684         LDX $19      ;initialize to line 25
E98F CA      1685 BE98F DEX
E990 20F0E9  1686         JSR SE9F0    ;set true screen address in ZD1/2
E993 ECA502  1687         CPX X02A5    ;if not past first 40 column line,
E996 900E    1688         BCC BE9A6
E998 F00C    1689         BEQ BE9A6
E99A BDEFEC  1690         LDA TECF0-1,X ;use screen line address
E99D 85AC    1691         STA ZAC      ;to set source address
E99F B5D8    1692         LDA ZD8,X
E9A1 20C8E9  1693         JSR SE9C8    ;move one line up
E9A4 30E9    1694         BMI BE98F    ;and repeat
E9A6 20FFE9  1695 BE9A6 JSR SE9FF     ;clear screen line
E9A9 A217    1696         LDX $17
E9AB ECA502  1697 BE9AB CPX X02A5     ;if first 40 column line = 24 or 25,
E9AE 900F    1698         BCC BE9BF
E9B0 B5DA    1699         LDA ZDA,X
E9B2 297F    1700         AND $7F      ;set next line to 40 column
E9B4 B4D9    1701         LDY ZD9,X
E9B6 1002    1702         BPL BE9BA    ;if current line is 80 column,
E9B8 0980    1703         ORA $80      ;make into 40 column
E9BA 95DA    1704 BE9BA STA ZDA,X
E9BC CA      1705         DEX
E9BD D0EC    1706         BNE BE9AB    ;and repeat
E9BF AEA502  1707 BE9BF LDX X02A5     ;get first 40 column line beyond cursor
E9C2 20DAE6  1708         JSR BE6DA    ;adjust line pointers
E9C5 4C58E9  1709         JMP JE958    ;and exit
```

```
                1711 ;move one screen line
                1712 ;
E9C8 2903       1713 SE9C8 AND $03        ;adjust addr to clear 40/80 column flag
E9CA 0D8802     1714       ORA X0288      ;add screen memory page
E9CD 85AD       1715       STA ZAD        ;and save high part of addrsss
E9CF 20E0E9     1716       JSR SE9E0      ;set color memory address in ZAE/F
E9D2 A027       1717       LDY $27
E9D4 B1AC       1718 BE9D4 LDA (ZAC),Y    ;move screen byte
E9D6 91D1       1719       STA (ZD1),Y
E9D8 B1AE       1720       LDA (ZAE),Y    ;move color memory byte
E9DA 91F3       1721       STA (ZF3),Y
E9DC 88         1722       DEY
E9DD 10F5       1723       BPL BE9D4      ;repeat for one screen line
E9DF 60         1724       RTS
                1725 ;
                1726 ;set color and screen addresses
                1727 ;
E9E0 2024EA     1728 SE9E0 JSR SEA24      ;set color memory pointer in ZF3/4
E9E3 A5AC       1729       LDA ZAC        ;move low byte of screen address
E9E5 85AE       1730       STA ZAE
E9E7 A5AD       1731       LDA ZAD        ;get high byte of screen address
E9E9 2903       1732       AND $03        ;strip 40/80 column flag
E9EB 09D8       1733       ORA $D8        ;add screen page for color memory
E9ED 85AF       1734       STA ZAF        ;and store result
E9EF 60         1735       RTS
                1736 ;
                1737 ;fetch screen address, depending on X
                1738 ;
E9F0 BDF0EC     1739 SE9F0 LDA TECF0,X    ;set low byte of screen address
E9F3 85D1       1740       STA ZD1
E9F5 B5D9       1741       LDA ZD9,X      ;fetch high byte
E9F7 2903       1742       AND $03        ;strip 40/80 column flag
E9F9 0D8802     1743       ORA X0288      ;add screen memory page
E9FC 85D2       1744       STA ZD2        ;and store result
E9FE 60         1745       RTS
```

```
                1747 ;clear one screen line
                1748 ;
E9FF A027       1749 SE9FF LDY $27
EA01 20F0E9     1750       JSR SE9F0      ;set true screen RAM address
EA04 2024EA     1751       JSR SEA24      ;set color memory address
EA07 A920       1752 BEA07 LDA $20
EA09 91D1       1753       STA (ZD1),Y    ;clear a byte in video RAM
EA0B 20DAE4     1754       JSR SE4DA      ;clear a byte in color memory
EA0E EA         1755       NOP            ;(length adjustment for patch)
EA0F 88         1756       DEY
EA10 10F5       1757       BPL BEA07      ;repeat for one line
EA12 60         1758       RTS
                1759 ;
                1760 ;set cursor flash timing and color memory address
                1761 ;
EA13 A8         1762 SEA13 TAY
EA14 A902       1763       LDA $02
EA16 85CD       1764       STA ZCD        ;init cursor flash timing countdown
EA18 2024EA     1765       JSR SEA24      ;set color memory address
EA1B 98         1766       TYA
                1767 ;
                1768 ;store a character to the screen
                1769 ;
EA1C A4D3       1770 SEA1C LDY ZD3        ;fetch position on line
EA1E 91D1       1771       STA (ZD1),Y    ;move char to current screen address
EA20 8A         1772       TXA            ;fetch character color
EA21 91F3       1773       STA (ZF3),Y    ;move to color memory
EA23 60         1774       RTS
                1775 ;
                1776 ;set color memory address parallel to screen
                1777 ;
EA24 A5D1       1778 SEA24 LDA ZD1        ;move low screen address
EA26 85F3       1779       STA ZF3        ;to low of color memory address
EA28 A5D2       1780       LDA ZD2        ;fetch high of screen address
EA2A 2903       1781       AND $03        ;clear 40/80 column flag
EA2C 09D8       1782       ORA $D8        ;adjust to color memory area
EA2E 85F4       1783       STA ZF4        ;set high of color memory address
EA30 60         1784       RTS
```

```
                1786 ;standard IRQ entry
                1787 ;
EA31 20EAFF     1788 WEA31 JSR SFFEA     ;bump real time clock
EA34 A5CC       1789       LDA ZCC       ;check cursor flash enable flag
EA36 D029       1790       BNE BEA61     ;don't flash if non-zero
EA38 C6CD       1791       DEC ZCD       ;decrement cursor flash countdown
EA3A D025       1792       BNE BEA61     ;and skip if not finished (flash delay)
EA3C A914       1793       LDA $14       ;reset jiffy count for next cursor flip
EA3E 85CD       1794       STA ZCD
EA40 A4D3       1795       LDY ZD3       ;fetch cursor position
EA42 46CF       1796       LSR ZCF       ;shift cursor flash phase
EA44 AE8702     1797       LDX X0287     ;fetch color under cursor
EA47 B1D1       1798       LDA (ZD1),Y   ;get character under cursor
EA49 B011       1799       BCS BEA5C     ;branch if not first entry for character
EA4B E6CF       1800       INC ZCF       ;set cursor flash phase to 1
EA4D 85CE       1801       STA ZCE       ;save character under cursor
EA4F 2024EA     1802       JSR SEA24     ;set color memory address
EA52 B1F3       1803       LDA (ZF3),Y
EA54 8D8702     1804       STA X0287     ;save color under cursor
EA57 AE8602     1805       LDX X0286     ;get current color code
EA5A A5CE       1806       LDA ZCE       ;get current character
EA5C 4980       1807 BEA5C EOR $80       ;invert character
EA5E 201CEA     1808       JSR SEA1C     ;display on screen
EA61 A501       1809 BEA61 LDA Z01       ;check cassette sense line
EA63 2910       1810       AND $10
EA65 F00A       1811       BEQ BEA71     ;if no buttons pressed
EA67 A000       1812       LDY $00
EA69 84C0       1813       STY ZC0       ;clear tape motor flag
EA6B A501       1814       LDA Z01
EA6D 0920       1815       ORA $20       ;turn motor off
EA6F D008       1816       BNE BEA79     ;JMP
EA71 A5C0       1817 BEA71 LDA ZC0       ;check tape motor flag
EA73 D006       1818       BNE BEA7B
EA75 A501       1819       LDA Z01       ;if flag shows motor should be on,
EA77 291F       1820       AND $1F       ;turn cassette motor on
EA79 8501       1821 BEA79 STA Z01
EA7B 2087EA     1822 BEA7B JSR SEA87     ;scan keyboard
EA7E AD0DDC     1823       LDA XDC0D     ;clear any pending IRQ's in ICR1
EA81 68         1824       PLA           ;restore all registers
EA82 A8         1825       TAY
EA83 68         1826       PLA
EA84 AA         1827       TAX
EA85 68         1828       PLA
EA86 40         1829       RTI           ;return from IRQ
```

```
                1831 ;scan keyboard
                1832 ;
EA87 A900       1833 SEA87 LDA $00
EA89 8D8D02     1834       STA X028D      ;clear shift/control flag
EA8C A040       1835       LDY $40
EA8E 84CB       1836       STY ZCB        ;set key pressed flag to default
EA90 8D00DC     1837       STA XDC00      ;clear row
EA93 AE01DC     1838       LDX XDC01      ;check column
EA96 E0FF       1839       CPX $FF
EA98 F061       1840       BEQ BEAFB      ;if a key pressed
EA9A A8         1841       TAY            ;save in Y
EA9B A981       1842       LDA <TEB81     ;set address of standard keyboard table
EA9D 85F5       1843       STA ZF5        ;in keyboard table pointer
EA9F A9EB       1844       LDA >TEB81
EAA1 85F6       1845       STA ZF6        ;& high byte
EAA3 A9FE       1846       LDA $FE
EAA5 8D00DC     1847       STA XDC00      ;set first row
EAA8 A208       1848 BEAA8 LDX $08        ;column count
EAAA 48         1849       PHA            ;save current row on stack
EAAB AD01DC     1850 BEAAB LDA XDC01      ;read a column
EAAE CD01DC     1851       CMP XDC01
EAB1 D0F8       1852       BNE BEAAB      ;wait until steady
EAB3 4A         1853 BEAB3 LSR A
EAB4 B016       1854       BCS BEACC      ;if a key is pressed,
EAB6 48         1855       PHA            ;save on stack
EAB7 B1F5       1856       LDA (ZF5),Y    ;fetch keyboard table contents
EAB9 C905       1857       CMP $05
EABB B00C       1858       BCS BEAC9      ;if < 5
EABD C903       1859       CMP $03        ;check for Commodore key
EABF F008       1860       BEQ BEAC9
EAC1 0D8D02     1861       ORA X028D      ;add possible shift/control flag
EAC4 8D8D02     1862       STA X028D      ;to set keyboard shift/control flag
EAC7 1002       1863       BPL BEACB
EAC9 84CB       1864 BEAC9 STY ZCB        ;set key pressed
EACB 68         1865 BEACB PLA            ;restore last code read
EACC C8         1866 BEACC INY
EACD C041       1867       CPY $41
EACF B00B       1868       BCS BEADC      ;if scan not complete,
EAD1 CA         1869       DEX
EAD2 D0DF       1870       BNE BEAB3      ;check next bit in column data
EAD4 38         1871       SEC
EAD5 68         1872       PLA            ;else restore row position
EAD6 2A         1873       ROL A          ;select next row
EAD7 8D00DC     1874       STA XDC00
EADA D0CC       1875       BNE BEAA8      ;and repeat
EADC 68         1876 BEADC PLA            ;restore code
EADD 6C8F02     1877       JMP (X028F)    ;perform kbd decode routine (EB48)
                1878 ;
EAE0 A4CB       1879 JEAE0 LDY ZCB        ;fetch key pressed
EAE2 B1F5       1880       LDA (ZF5),Y    ;decode via keyboard table
EAE4 AA         1881       TAX
EAE5 C4C5       1882       CPY ZC5        ;if not the same as the last key,
EAE7 F007       1883       BEQ BEAF0
EAE9 A010       1884       LDY $10
EAEB 8C8C02     1885       STY X028C      ;set repeat key delay counter
EAEE D036       1886       BNE BEB26      ;and skip repeat logic
                1887 ;
EAF0 297F       1888 BEAF0 AND $7F
EAF2 2C8A02     1889       BIT X028A      ;if repeat flag has
EAF5 3016       1890       BMI BEB0D      ;bit 7 set, repeat all keys
```

```
EAF7 7049   1891         BVS BEB42     ;exit when flag > 63
EAF9 C97F   1892         CMP $7F
EAFB F029   1893 BEAFB   BEQ BEB26
EAFD C914   1894         CMP $14       ;delete
EAFF F00C   1895         BEQ BEB0D
EB01 C920   1896         CMP $20       ;space
EB03 F008   1897         BEQ BEB0D
EB05 C91D   1898         CMP $1D       ;cursor right/left
EB07 F004   1899         BEQ BEB0D
EB09 C911   1900         CMP $11       ;cursor down/up
EB0B D035   1901         BNE BEB42     ;if none of above, don't repeat
EB0D AC8C02 1902 BEB0D   LDY X028C     ;check repeat key delay counter
EB10 F005   1903         BEQ BEB17     ;countdown complete
EB12 CE8C02 1904         DEC X028C     ;subtract 1 from repeat key delay ctr
EB15 D02B   1905         BNE BEB42
EB17 CE8B02 1906 BEB17   DEC X028B     ;subtract 1 from repeat key freq ctr
EB1A D026   1907         BNE BEB42
EB1C A004   1908         LDY $04
EB1E 8C8B02 1909         STY X028B     ;reset repeat key frequency counter
EB21 A4C6   1910         LDY ZC6       ;check keyboard buffer count
EB23 88     1911         DEY
EB24 101C   1912         BPL BEB42     ;branch if something in keyboard queue
EB26 A4CB   1913 BEB26   LDY ZCB       ;move current key
EB28 84C5   1914         STY ZC5       ;to last key
EB2A AC8D02 1915         LDY X028D     ;move shift/control flag
EB2D 8C8E02 1916         STY X028E     ;to last shift pattern
EB30 E0FF   1917         CPX $FF
EB32 F00E   1918         BEQ BEB42
EB34 8A     1919         TXA
EB35 A6C6   1920         LDX ZC6       ;check keyboard queue length
EB37 EC8902 1921         CPX X0289     ;against maximum allowed
EB3A B006   1922         BCS BEB42     ;branch if buffer full
EB3C 9D7702 1923         STA X0277,X   ;else move character to keybord queue
EB3F E8     1924         INX
EB40 86C6   1925         STX ZC6       ;add 1 to length of keyboard queue
EB42 A97F   1926 BEB42   LDA $7F       ;set PA1 bits high
EB44 8D00DC 1927         STA XDC00
EB47 60     1928         RTS
            1929 ;
EB48 AD8D02 1930 WEB48   LDA X028D     ;check shift/control flag
EB4B C903   1931         CMP $03       ;for Commodore key and shift depressed
EB4D D015   1932         BNE BEB64     ;if so, and code is different
EB4F CD8E02 1933         CMP X028E     ;from last keyboard shift pattern
EB52 F0EE   1934         BEQ BEB42
EB54 AD9102 1935         LDA X0291     ;and not in shift lock mode
EB57 301D   1936         BMI BEB76
EB59 AD18D0 1937         LDA XD018
EB5C 4902   1938         EOR $02       ;then toggle lower case/upper case bit
EB5E 8D18D0 1939         STA XD018     ;set video chip bit for proper display
EB61 4C76EB 1940         JMP BEB76     ;exit
```

```
                1942 ;select new keyboard table
                1943 ;
EB64 0A         1944 BEB64 ASL A          ;double entry index
EB65 C908       1945       CMP $08        ;if index is too high,
EB67 9002       1946       BCC BEB6B
EB69 A906       1947       LDA $06        ;select "Control Key" keyboard
EB6B AA         1948 BEB6B TAX
EB6C BD79EB     1949       LDA TEB79,X    ;fetch low byte from table
EB6F 85F5       1950       STA ZF5        ;and set keyboard table pointer
EB71 BD7AEB     1951       LDA TEB79+1,X
EB74 85F6       1952       STA ZF6        ;& high byte
EB76 4CE0EA     1953 BEB76 JMP JEAE0      ;exit
                1954 ;
                1955 ;table of keyboard table addresses
                1956 ;
EB79 81EB       1957 TEB79 .W  TEB81      ;Standard keyboard
EB7B C2EB       1958       .W  TEBC2      ;"Shift" keyboard
EB7D 03EC       1959       .W  TEC03      ;"Commodore Key" keyboard
EB7F 78EC       1960       .W  TEC78      ;"Control" keyboard
                1961 ;
                1962 ;standard keyboard
                1963 ;
EB81 140D1D     1964 TEB81 .BY $14,$0D,$1D,$88,$85,$86,$87,$11
EB89 335741     1965       .BY $33,$57,$41,$34,$5A,$53,$45,$01
EB91 355244     1966       .BY $35,$52,$44,$36,$43,$46,$54,$58
EB99 375947     1967       .BY $37,$59,$47,$38,$42,$48,$55,$56
EBA1 39494A     1968       .BY $39,$49,$4A,$30,$4D,$4B,$4F,$4E
EBA9 2B504C     1969       .BY $2B,$50,$4C,$2D,$2E,$3A,$40,$2C
EBB1 5C2A3B     1970       .BY $5C,$2A,$3B,$13,$01,$3D,$5E,$2F
EBB9 315F04     1971       .BY $31,$5F,$04,$32,$20,$02,$51,$03,$FF
                1972 ;
                1973 ;"Shift" keyboard table
                1974 ;
EBC2 948D9D     1975 TEBC2 .BY $94,$8D,$9D,$8C,$89,$8A,$8B,$91
EBCA 23D7C1     1976       .BY $23,$D7,$C1,$24,$DA,$D3,$C5,01
EBD2 25D2C4     1977       .BY $25,$D2,$C4,$26,$C3,$C6,$D4,$D8
EBDA 27D9C7     1978       .BY $27,$D9,$C7,$28,$C2,$C8,$D5,$D6
EBE2 29C9CA     1979       .BY $29,$C9,$CA,$30,$CD,$CB,$CF,$CE
EBEA DBD0CC     1980       .BY $DB,$D0,$CC,$DD,$3E,$5B,$BA,$3C
EBF2 A9C05D     1981       .BY $A9,$C0,$5D,$93,$01,$3D,$DE,$3F
EBFA 215F04     1982       .BY $21,$5F,$04,$22,$A0,$02,$D1,$83,$FF
                1983 ;
                1984 ;"Commodore Key" keyboard table
                1985 ;
EC03 948D9D     1986 TEC03 .BY $94,$8D,$9D,$8C,$89,$8A,$8B,$91
EC0B 96B3B0     1987       .BY $96,$B3,$B0,$97,$AD,$AE,$B1,$01
EC13 98B2AC     1988       .BY $98,$B2,$AC,$99,$BC,$BB,$A3,$BD
EC1B 9AB7A5     1989       .BY $9A,$B7,$A5,$9B,$BF,$B4,$B8,$BE
EC23 29A2B5     1990       .BY $29,$A2,$B5,$30,$A7,$A1,$B9,$AA
EC2B A6AFB6     1991       .BY $A6,$AF,$B6,$DC,$3E,$5B,$A4,$3C
EC33 A8DF5D     1992       .BY $A8,$DF,$5D,$93,$01,$3D,$DE,$3F
EC3B 815F04     1993       .BY $81,$5F,$04,$95,$A0,$02,$AB,$83,$FF
```

```
                1995 ;check for special CHR$ values
                1996 ;
EC44 C90E       1997 JEC44 CMP $0E       ;if CHR$(14) to be printed,
EC46 D007       1998       BNE JEC4F
EC48 AD18D0     1999       LDA XD018
EC4B 0902       2000       ORA $02       ;set value for unshift/shift
EC4D D009       2001       BNE BEC58     ;reset address and exit
EC4F C98E       2002 JEC4F CMP $8E       ;if CHR$(142) to be printed,
EC51 D00B       2003       BNE BEC5E
EC53 AD18D0     2004       LDA XD018
EC56 29FD       2005       AND $FD       ;set value for shift/graphics
EC58 8D18D0     2006 BEC58 STA XD018     ;reset video chip register
EC5B 4CA8E6     2007 BEC5B JMP BE6A8     ;exit
                2008 ;
EC5E C908       2009 BEC5E CMP $08       ;if CHR$(8) to be printed,
EC60 D007       2010       BNE BEC69
EC62 A980       2011       LDA $80       ;set shift mode to locked
EC64 0D9102     2012       ORA X0291
EC67 3009       2013       BMI BEC72     ;and exit
EC69 C909       2014 BEC69 CMP $09       ;if CHR$(9) to be printed,
EC6B D0EE       2015       BNE BEC5B
EC6D A97F       2016       LDA $7F       ;clear shift lock flag
EC6F 2D9102     2017       AND X0291
EC72 8D9102     2018 BEC72 STA X0291     ;condition shift lock flag
EC75 4CA8E6     2019       JMP BE6A8     ;exit
                2020 ;
                2021 ;"Control Key" keyboard table
                2022 ;
EC78 FFFFFF     2023 TEC78 .BY $FF,$FF,$FF,$FF,$FF,$FF,$FF,$FF
EC80 1C1701     2024       .BY $1C,$17,$01,$9F,$1A,$13,$05,$FF
EC88 9C1204     2025       .BY $9C,$12,$04,$1E,$03,$06,$14,$18
EC90 1F1907     2026       .BY $1F,$19,$07,$9E,$02,$08,$15,$16
EC98 12090A     2027       .BY $12,$09,$0A,$92,$0D,$0B,$0F,$0E
ECA0 FF100C     2028       .BY $FF,$10,$0C,$FF,$FF,$1B,$00,$FF
ECA8 1CFF1D     2029       .BY $1C,$FF,$1D,$FF,$FF,$1F,$1E,$FF
ECB0 9006FF     2030       .BY $90,$06,$FF,$05,$FF,$FF,$11,$FF,$FF
```

```
                2032 ;standard values for video chip
                2033 ;
ECB9 00         2034 TECB9 .BY $00       ;+ 00, MOB 0 X position
ECBA 00         2035       .BY $00       ;+ 01, MOB 0 Y position
ECBB 00         2036       .BY $00       ;+ 02, MOB 1 X position
ECBC 00         2037       .BY $00       ;+ 03, MOB 1 Y position
ECBD 00         2038       .BY $00       ;+ 04, MOB 2 X position
ECBE 00         2039       .BY $00       ;+ 05, MOB 2 Y position
ECBF 00         2040       .BY $00       ;+ 06, MOB 3 X position
ECC0 00         2041       .BY $00       ;+ 07, MOB 3 Y position
ECC1 00         2042       .BY $00       ;+ 08, MOB 4 X position
ECC2 00         2043       .BY $00       ;+ 09, MOB 4 Y position
ECC3 00         2044       .BY $00       ;+ 0A, MOB 5 X position
ECC4 00         2045       .BY $00       ;+ 0B, MOB 5 Y position
ECC5 00         2046       .BY $00       ;+ 0C, MOB 6 X position
ECC6 00         2047       .BY $00       ;+ 0D, MOB 6 Y position
ECC7 00         2048       .BY $00       ;+ 0E, MOB 7 X position
ECC8 00         2049       .BY $00       ;+ 0F, MOB 7 Y position
ECC9 00         2050       .BY $00       ;+ 10, MSB of X position
ECCA 9B         2051       .BY $9B       ;+ 11, RC3, DEN, RSEL, Y1 and Y0 set
ECCB 37         2052       .BY $37       ;+ 12, Raster Register
ECCC 00         2053       .BY $00       ;+ 13, Light Pen X
ECCD 00         2054       .BY $00       ;+ 14, Light Pen Y
ECCE 00         2055       .BY $00       ;+ 15, MOB Enable
ECCF 08         2056       .BY $08       ;+ 16, CSEL set
ECD0 00         2057       .BY $00       ;+ 17, MOB Y expand
ECD1 14         2058       .BY $14       ;+ 18, Memory Pointers
ECD2 0F         2059       .BY $0F       ;+ 19, Interrupt Register
ECD3 00         2060       .BY $00       ;+ 1A, Enable Interrupts
ECD4 00         2061       .BY $00       ;+ 1B, MOB-Data priority
ECD5 00         2062       .BY $00       ;+ 1C, MOB Multi-Color selection
ECD6 00         2063       .BY $00       ;+ 1D, MOB X-expand
ECD7 00         2064       .BY $00       ;+ 1E, MOB-MOB collision
ECD8 00         2065       .BY $00       ;+ 1F, MOB-Data collision
ECD9 0E         2066       .BY $0E       ;+ 20, Exterior color
ECDA 06         2067       .BY $06       ;+ 21, Background # 0 color
ECDB 01         2068       .BY $01       ;+ 22, Background # 1 color
ECDC 02         2069       .BY $02       ;+ 23, Background # 2 color
ECDD 03         2070       .BY $03       ;+ 24, Background # 3 color
ECDE 04         2071       .BY $04       ;+ 25, MOB Multi-Color # 0
ECDF 00         2072       .BY $00       ;+ 26, MOB Multi-Color # 1
ECE0 01         2073       .BY $01       ;+ 27, MOB 0 color
ECE1 02         2074       .BY $02       ;+ 28, MOB 1 color
ECE2 03         2075       .BY $03       ;+ 29, MOB 2 color
ECE3 04         2076       .BY $04       ;+ 2A, MOB 3 color
ECE4 05         2077       .BY $05       ;+ 2B, MOB 4 color
ECE5 06         2078       .BY $06       ;+ 2C, MOB 5 color
ECE6 07         2079       .BY $07       ;+ 2D, MOB 6 color
                2080 ;+2E, MOB 7 color initialized to $4C
                2081 ;
                2082 ;keyboard buffer entry for shift of Run/Stop key
                2083 ;
ECE7 4C4F41     2084 TECE7 .BY 'L,'O,'A,'D,$0D
ECEC 52554E     2085       .BY 'R,'U,'N,$0D
                2086 ;
                2087 ;table of low bytes of screen line addresses
                2088 ;
ECF0 002850     2089 TECF0 .BY $00,$28,$50,$78,$A0,$C8,$F0,$18
ECF8 406890     2090       .BY $40,$68,$90,$B8,$E0,$08,$30,$58
ED00 80A8D0     2091       .BY $80,$A8,$D0,$F8,$20,$48,$70,$98,$C0
```

```
            2093 ;send TALK on serial bus
            2094 ;
ED09 0940   2095 SED09 ORA $40       ;add offset for TALK
ED0B 2C     2096       .BY $2C       ;skip next instruction
            2097 ;
            2098 ;send LISTEN on serial bus
            2099 ;
ED0C 0920   2100 SED0C ORA $20       ;add offset for LISTEN
ED0E 20A4F0 2101       JSR SF0A4     ;protect against RS-232 NMI's
ED11 48     2102 SED11 PHA           ;save code to transmit
ED12 2494   2103       BIT Z94       ;if no data is pending
ED14 100A   2104       BPL BED20
ED16 38     2105       SEC
ED17 66A3   2106       ROR ZA3       ;set EOI flag
ED19 2040ED 2107       JSR SED40     ;output byte on serial bus
ED1C 4694   2108       LSR Z94       ;clear data pending flag
ED1E 46A3   2109       LSR ZA3       ;clear EOI flag
ED20 68     2110 BED20 PLA           ;move code to transmit
ED21 8595   2111       STA Z95       ;into the output buffer
ED23 78     2112       SEI
ED24 2097EE 2113       JSR SEE97     ;set serial bus data line low
ED27 C93F   2114       CMP $3F
ED29 D003   2115       BNE BED2E     ;if not UNLISTEN
ED2B 2085EE 2116       JSR SEE85     ;set serial clock low
ED2E AD00DD 2117 BED2E LDA XDD00
ED31 0908   2118       ORA $08
ED33 8D00DD 2119       STA XDD00     ;set serial ATN line high
ED36 78     2120 SED36 SEI           ;disable IRQ
ED37 208EEE 2121       JSR SEE8E     ;set serial clock high
ED3A 2097EE 2122       JSR SEE97     ;set serial data low
ED3D 20B3EE 2123       JSR SEEB3     ;delay 1 millisecond
```

```
            2125 ;send a byte from Z95 on serial bus
            2126 ;
ED40 78     2127 SED40 SEI          ;disable IRQ
ED41 2097EE 2128       JSR SEE97    ;set serial data low
ED44 20A9EE 2129       JSR SEEA9    ;test data level
ED47 B064   2130       BCS BEDAD    ;if high, indicate device not present
ED49 2085EE 2131       JSR SEE85    ;set serial clock low
ED4C 24A3   2132       BIT ZA3
ED4E 100A   2133       BPL BED5A    ;if EOI flag is set
ED50 20A9EE 2134 BED50 JSR SEEA9
ED53 90FB   2135       BCC BED50    ;wait for data high
ED55 20A9EE 2136 BED55 JSR SEEA9
ED58 B0FB   2137       BCS BED55    ;wait for data low
ED5A 20A9EE 2138 BED5A JSR SEEA9
ED5D 90FB   2139       BCC BED5A    ;wait for data high (end of EOI pulse)
ED5F 208EEE 2140       JSR SEE8E    ;set output clock high
ED62 A908   2141       LDA $08
ED64 85A5   2142       STA ZA5      ;initialize bit count
ED66 AD00DD 2143 BED66 LDA XDD00
ED69 CD00DD 2144       CMP XDD00
ED6C D0F8   2145       BNE BED66    ;wait for PA2 to steady
ED6E 0A     2146       ASL A        ;if data high not received,
ED6F 903F   2147       BCC BEDB0    ;indicate a timeout
ED71 6695   2148       ROR Z95      ;fetch bit to send
ED73 B005   2149       BCS BED7A    ;if bit is a 0,
ED75 20A0EE 2150       JSR SEEA0    ;send a 0
ED78 D003   2151       BNE BED7D
ED7A 2097EE 2152 BED7A JSR SEE97    ;else send a 1
ED7D 2085EE 2153 BED7D JSR SEE85    ;set serial clock low
ED80 EA     2154       NOP
ED81 EA     2155       NOP
ED82 EA     2156       NOP          ;hold clock/data lines for 8 usec
ED83 EA     2157       NOP
ED84 AD00DD 2158       LDA XDD00
ED87 29DF   2159       AND $DF      ;set serial data line low
ED89 0910   2160       ORA $10      ;and clock high
ED8B 8D00DD 2161       STA XDD00
ED8E C6A5   2162       DEC ZA5      ;if 8 bits not sent
ED90 D0D4   2163       BNE BED66    ;repeat
ED92 A904   2164       LDA $04
ED94 8D07DC 2165       STA XDC07    ;set TBHl to $04xx
ED97 A919   2166       LDA $19      ;set CBl to force load, one shot and TBl
ED99 8D0FDC 2167       STA XDC0F
ED9C AD0DDC 2168       LDA XDC0D    ;clear pending IRQ bits in ICRl
ED9F AD0DDC 2169 BED9F LDA XDC0D
EDA2 2902   2170       AND $02
EDA4 D00A   2171       BNE BEDB0    ;if underflow on TB, indicate
EDA6 20A9EE 2172       JSR SEEA9
EDA9 B0F4   2173       BCS BED9F    ;repeat test until data line is low
EDAB 58     2174       CLI          ;enable IRQ
EDAC 60     2175       RTS
            2176 ;
EDAD A980   2177 BEDAD LDA $80      ;set Device Not Present
EDAF 2C     2178       .BY $2C      ;skip next instruction
EDB0 A903   2179 BEDB0 LDA $03      ;set Timeout bits (read and write)
EDB2 201CFE 2180 JEDB2 JSR SFE1C    ;add bits in A to ST
EDB5 58     2181       CLI
EDB6 18     2182       CLC
EDB7 904A   2183       BCC BEE03    ;set ATN low and exit
```

```
                2185 ;send Secondary Address (after LISTEN) on serial bus
                2186 ;
EDB9 8595       2187 SEDB9 STA Z95        ;save serial deferred character
EDBB 2036ED     2188       JSR SED36      ;send on serial bus
EDBE AD00DD     2189 SEDBE LDA XDD00
EDC1 29F7       2190       AND $F7        ;set ATN low
EDC3 8D00DD     2191       STA XDD00
EDC6 60         2192       RTS
                2193 ;
                2194 ;send Secondary Address (after TALK) on serial bus
                2195 ;
EDC7 8595       2196 SEDC7 STA Z95        ;save serial deferred character
EDC9 2036ED     2197       JSR SED36      ;send on serial bus
EDCC 78         2198 SEDCC SEI
EDCD 20A0EE     2199       JSR SEEA0      ;set serial data high
EDD0 20BEED     2200       JSR SEDBE      ;set ATN high
EDD3 2085EE     2201       JSR SEE85      ;set serial clock low
EDD6 20A9EE     2202 BEDD6 JSR SEEA9      ;read serial clock
EDD9 30FB       2203       BMI BEDD6      ;loop until serial clock goes low
EDDB 58         2204       CLI            ;enable IRQ
EDDC 60         2205       RTS
                2206 ;
                2207 ;output byte on serial bus
                2208 ;
EDDD 2494       2209 JEDDD BIT Z94
EDDF 3005       2210       BMI BEDE6      ;if no data buffered,
EDE1 38         2211       SEC
EDE2 6694       2212       ROR Z94        ;set serial deferred flag
EDE4 D005       2213       BNE BEDEB
EDE6 48         2214 BEDE6 PHA            ;else save character on stack
EDE7 2040ED     2215       JSR SED40      ;send deferred character on serial bus
EDEA 68         2216       PLA
EDEB 8595       2217 BEDEB STA Z95        ;save new serial deferred character
EDED 18         2218       CLC
EDEE 60         2219       RTS
                2220 ;
                2221 ;send TALK on serial bus
                2222 ;
EDEF 78         2223 SEDEF SEI            ;disable IRQ
EDF0 208EEE     2224       JSR SEE8E      ;set serial clock low
EDF3 AD00DD     2225       LDA XDD00
EDF6 0908       2226       ORA $08        ;set serial ATN high
EDF8 8D00DD     2227       STA XDD00
EDFB A95F       2228       LDA $5F        ;set A to code for TALK
EDFD 2C         2229       .BY $2C        ;skip next instruction
                2230 ;
                2231 ;send UNLISTEN on serial bus
                2232 ;
EDFE A93F       2233 SEDFE LDA $3F        ;set A to code for UNLISTEN
EE00 2011ED     2234       JSR SED11      ;send code in A on serial bus
EE03 20BEED     2235 BEE03 JSR SEDBE      ;set ATN low
EE06 8A         2236 SEE06 TXA
EE07 A20A       2237       LDX $0A
EE09 CA         2238 BEE09 DEX
EE0A D0FD       2239       BNE BEE09      ;pause 52 microseconds
EE0C AA         2240       TAX
EE0D 2085EE     2241       JSR SEE85      ;set serial clock low
EE10 4C97EE     2242       JMP SEE97      ;set serial data low and return
```

```
                2244 ;input byte on serial bus
                2245 ;
EE13 78         2246 JEE13 SEI          ;disable IRQ
EE14 A900       2247       LDA $00
EE16 85A5       2248       STA ZA5      ;clear bit count
EE18 2085EE     2249       JSR SEE85    ;set serial clock low
EE1B 20A9EE     2250 BEE1B JSR SEEA9    ;read serial clock
EE1E 10FB       2251       BPL BEE1B    ;and loop until high
EE20 A901       2252 BEE20 LDA $01
EE22 8D07DC     2253       STA XDC07    ;prime TBHl with $01xx
EE25 A919       2254       LDA $19
EE27 8D0FDC     2255       STA XDC0F    ;set CBl to force load, one shot & TBl
EE2A 2097EE     2256       JSR SEE97    ;set serial data low
EE2D AD0DDC     2257       LDA XDC0D    ;clear pending IRQ bits in ICRl
EE30 AD0DDC     2258 BEE30 LDA XDC0D
EE33 2902       2259       AND $02
EE35 D007       2260       BNE BEE3E    ;if not underflow in TB
EE37 20A9EE     2261       JSR SEEA9    ;read serial clock and data
EE3A 30F4       2262       BMI BEE30    ;repeat if clock still low
EE3C 1018       2263       BPL BEE56    ;else go receive byte
EE3E A5A5       2264 BEE3E LDA ZA5      ;when underflow on TB and not first bit,
EE40 F005       2265       BEQ BEE47
EE42 A902       2266       LDA $02      ;set read timeout in ST
EE44 4CB2ED     2267       JMP JEDB2
                2268 ;
EE47 20A0EE     2269 BEE47 JSR SEEA0    ;set serial data high
EE4A 2085EE     2270       JSR SEE85    ;set serial clock low
EE4D A940       2271       LDA $40
EE4F 201CFE     2272       JSR SFE1C    ;set EOI in ST
EE52 E6A5       2273       INC ZA5      ;add one to bit count
EE54 D0CA       2274       BNE BEE20    ;and repeat
EE56 A908       2275 BEE56 LDA $08
EE58 85A5       2276       STA ZA5      ;set bit count to 8
EE5A AD00DD     2277 BEE5A LDA XDD00
EE5D CD00DD     2278       CMP XDD00
EE60 D0F8       2279       BNE BEE5A    ;wait until PA2 is steady
EE62 0A         2280       ASL A
EE63 10F5       2281       BPL BEE5A    ;loop until clock bit rises
EE65 66A4       2282       ROR ZA4      ;add data bit to byte being read
EE67 AD00DD     2283 BEE67 LDA XDD00
EE6A CD00DD     2284       CMP XDD00
EE6D D0F8       2285       BNE BEE67    ;wait until PA2 is steady
EE6F 0A         2286       ASL A
EE70 30F5       2287       BMI BEE67    ;and for clock line to fall
EE72 C6A5       2288       DEC ZA5
EE74 D0E4       2289       BNE BEE5A    ;loop until 8 bits read
EE76 20A0EE     2290       JSR SEEA0    ;set serial data high
EE79 2490       2291       BIT Z90
EE7B 5003       2292       BVC BEE80    ;if EOI is high
EE7D 2006EE     2293       JSR SEE06    ;pause 52 usec, set clock and data low
EE80 A5A4       2294 BEE80 LDA ZA4      ;restore byte read
EE82 58         2295       CLI          ;enable IRQ
EE83 18         2296       CLC
EE84 60         2297       RTS
```

```
                2299 ;set serial clock line low
                2300 ;
EE85 AD00DD     2301 SEE85 LDA XDD00
EE88 29EF       2302       AND $EF
EE8A 8D00DD     2303       STA XDD00
EE8D 60         2304       RTS
                2305 ;
                2306 ;set serial clock line high
                2307 ;
EE8E AD00DD     2308 SEE8E LDA XDD00
EE91 0910       2309       ORA $10
EE93 8D00DD     2310       STA XDD00
EE96 60         2311       RTS
                2312 ;
                2313 ;set serial data line low
                2314 ;
EE97 AD00DD     2315 SEE97 LDA XDD00
EE9A 29DF       2316       AND $DF
EE9C 8D00DD     2317       STA XDD00
EE9F 60         2318       RTS
                2319 ;
                2320 ;set serial data line high
                2321 ;
EEA0 AD00DD     2322 SEEA0 LDA XDD00
EEA3 0920       2323       ORA $20
EEA5 8D00DD     2324       STA XDD00
EEA8 60         2325       RTS
                2326 ;
                2327 ;wait for PA2 to steady
                2328 ;exit with data bit in C
                2329 ;and clock bit in N
                2330 ;
EEA9 AD00DD     2331 SEEA9 LDA XDD00
EEAC CD00DD     2332       CMP XDD00
EEAF D0F8       2333       BNE SEEA9      ;wait until PA2 is steady
EEB1 0A         2334       ASL A          ;shift data into C and clock into N
EEB2 60         2335       RTS
                2336 ;
                2337 ;delay 1 millisecond
                2338 ;
EEB3 8A         2339 SEEB3 TXA            ;save A
EEB4 A2B8       2340       LDX $B8        ;initialize delay counter
EEB6 CA         2341 BEEB6 DEX
EEB7 D0FD       2342       BNE BEEB6      ;perform delay of 1 millisecond
EEB9 AA         2343       TAX            ;restore A
EEBA 60         2344       RTS
```

```
                2346 ;set next bit to transmit on RS-232 bus
                2347 ;
EEBB A5B4       2348 SEEBB LDA ZB4        ;check pending bit count
EEBD F047       2349       BEQ BEF06      ;if byte finished, send stop bit(s)
EEBF 303F       2350       BMI BEF00      ;if not stop bit,
EEC1 46B6       2351       LSR ZB6        ;shift next bit to send into C
EEC3 A200       2352       LDX $00
EEC5 9001       2353       BCC BEEC8      ;X=00/FF for 0/1 to send
EEC7 CA         2354       DEX
EEC8 8A         2355 BEEC8 TXA
EEC9 45BD       2356       EOR ZBD        ;compute parity of word being sent
EECB 85BD       2357       STA ZBD
EECD C6B4       2358       DEC ZB4        ;decrement bit count
EECF F006       2359       BEQ BEED7      ;if word finished, handle parity
EED1 8A         2360 BEED1 TXA
EED2 2904       2361       AND $04
EED4 85B5       2362       STA ZB5        ;set next bit to send
EED6 60         2363       RTS
                2364 ;
EED7 A920       2365 BEED7 LDA $20        ;check RS-232 Command Register
EED9 2C9402     2366       BIT X0294      ;for parity option
EEDC F014       2367       BEQ BEEF2      ;no parity
EEDE 301C       2368       BMI BEEFC      ;transmit mark or space parity
EEE0 7014       2369       BVS BEEF6      ;transmit even parity
EEE2 A5BD       2370       LDA ZBD        ;make parity odd
EEE4 D001       2371       BNE BEEE7
EEE6 CA         2372 BEEE6 DEX
EEE7 C6B4       2373 BEEE7 DEC ZB4        ;decrement bit count
EEE9 AD9302     2374       LDA X0293      ;check RS-232 Control Register
EEEC 10E3       2375       BPL BEED1      ;and branch if only one stop bit needed
EEEE C6B4       2376       DEC ZB4        ;else decrement bit count
EEF0 D0DF       2377       BNE BEED1      ;and send first of 2 stop bits
EEF2 E6B4       2378 BEEF2 INC ZB4        ;increment bit count
EEF4 D0F0       2379       BNE BEEE6
EEF6 A5BD       2380 BEEF6 LDA ZBD        ;use computed parity
EEF8 F0ED       2381       BEQ BEEE7      ;to set X for even parity
EEFA D0EA       2382       BNE BEEE6
EEFC 70E9       2383 BEEFC BVS BEEE7      ;transmit space parity
EEFE 50E6       2384       BVC BEEE6      ;transmit mark parity
EF00 E6B4       2385 BEF00 INC ZB4        ;bump bit count
EF02 A2FF       2386       LDX $FF
EF04 D0CB       2387       BNE BEED1      ;go send a stop bit
EF06 AD9402     2388 BEF06 LDA X0294      ;check RS-232 Command Register
EF09 4A         2389       LSR A
EF0A 9007       2390       BCC BEF13      ;and skip if in 3-line mode
EF0C 2C01DD     2391       BIT XDD01
EF0F 101D       2392       BPL BEF2E      ;error if DSR signal missing
EF11 501E       2393       BVC BEF31      ;or CTS signal missing
EF13 A900       2394 BEF13 LDA $00
EF15 85BD       2395       STA ZBD        ;clear parity
EF17 85B5       2396       STA ZB5        ;clear next bit to send
EF19 AE9802     2397       LDX X0298      ;move number of bits to send
EF1C 86B4       2398       STX ZB4        ;to bit count
EF1E AC9D02     2399       LDY X029D      ;if RS-232 transmit buffer is not empty
EF21 CC9E02     2400       CPY X029E
EF24 F013       2401       BEQ BEF39
EF26 B1F9       2402       LDA (ZF9),Y    ;move next byte to send
EF28 85B6       2403       STA ZB6        ;to character buffer
EF2A EE9D02     2404       INC X029D      ;bump RS-232 transmit buffer output ptr
EF2D 60         2405       RTS
```

```
                2407 ;handle RS-232 errors
                2408 ;
EF2E A940       2409 BEF2E LDA $40        ;add DSR signal missing error bit
EF30 2C         2410       .BY $2C        ;skip next instruction
EF31 A910       2411 BEF31 LDA $10        ;add CTS signal missing error bit
EF33 0D9702     2412       ORA X0297      ;to RS-232 Status Register
EF36 8D9702     2413       STA X0297
EF39 A901       2414 BEF39 LDA $01        ;clear TA2 IRQ mask
EF3B 8D0DDD     2415 JEF3B STA XDD0D      ;set/clear ICR2 flags depending on A
EF3E 4DA102     2416       EOR X02A1
EF41 0980       2417       ORA $80
EF43 8DA102     2418       STA X02A1      ;set ICR2 activity register
EF46 8D0DDD     2419       STA XDD0D      ;and ICR2
EF49 60         2420       RTS
                2421 ;
                2422 ;check control register to set word length
                2423 ;
EF4A A209       2424 SEF4A LDX $09        ;start with a length of 9
EF4C A920       2425       LDA $20
EF4E 2C9302     2426       BIT X0293      ;check RS-232 Control Register
EF51 F001       2427       BEQ BEF54      ;and branch if word length is 6 or 8
EF53 CA         2428       DEX            ;else set X to 8
EF54 5002       2429 BEF54 BVC BEF58      ;if word length is 7 or 8, exit
EF56 CA         2430       DEX
EF57 CA         2431       DEX
EF58 60         2432 BEF58 RTS            ;exit with length in X
                2433 ;
                2434 ;add bit input on RS-232 bus to word being input
                2435 ;
EF59 A6A9       2436 JEF59 LDX ZA9        ;check receiver start bit flag
EF5B D033       2437       BNE BEF90      ;if a bit is ready,
EF5D C6A8       2438       DEC ZA8        ;decrement input bit count
EF5F F036       2439       BEQ BEF97      ;if word is not complete,
EF61 300D       2440       BMI BEF70
EF63 A5A7       2441       LDA ZA7        ;use receiver input bit
EF65 45AB       2442       EOR ZAB        ;to calculate parity
EF67 85AB       2443       STA ZAB
EF69 46A7       2444       LSR ZA7        ;shift bit received
EF6B 66AA       2445       ROR ZAA        ;into byte being read
EF6D 60         2446 BEF6D RTS
                2447 ;
                2448 ;handle end of word for RS-232 input
                2449 ;
EF6E C6A8       2450 BEF6E DEC ZA8        ;decrement input bit count
EF70 A5A7       2451 BEF70 LDA ZA7        ;check receiver input bit
EF72 F067       2452       BEQ BEFDB      ;if somethine read
EF74 AD9302     2453       LDA X0293      ;use RS-232 Control Register to
EF77 0A         2454       ASL A          ;shift stop bit count flag into C
EF78 A901       2455       LDA $01
EF7A 65A8       2456       ADC ZA8        ;add possible second stop bit
EF7C D0EF       2457       BNE BEF6D      ;to input bit count and exit
```

```
                2459 ;enable byte reception
                2460 ;
EF7E A990       2461 BEF7E LDA $90
EF80 8D0DDD     2462       STA XDD0D      ;set Flag bit mask in ICR2
EF83 0DA102     2463       ORA X02A1      ;plus ICR2 activity register
EF86 8DA102     2464       STA X02A1      ;to form new ICR2 activity register
EF89 85A9       2465       STA ZA9        ;and receiver start bit flag
EF8B A902       2466       LDA $02
EF8D 4C3BEF     2467       JMP JEF3B      ;set TB2 mask in ICR2 and exit
                2468 ;
                2469 ;receiver start bit test
                2470 ;
EF90 A5A7       2471 BEF90 LDA ZA7        ;test receiver input bit
EF92 D0EA       2472       BNE BEF7E      ;if start read,
EF94 85A9       2473       STA ZA9        ;clear start bit flag
EF96 60         2474       RTS
                2475 ;
                2476 ;put received data into RS-232 receive buffer
                2477 ;
EF97 AC9B02     2478 BEF97 LDY X029B      ;if RS-232 receive buffer input pointer
EF9A C8         2479       INY
EF9B CC9C02     2480       CPY X029C      ;= RS-232 receive buffer output pointer
EF9E F02A       2481       BEQ BEFCA      ;then receive buffer overrun error
EFA0 8C9B02     2482       STY X029B      ;bump RS-232 receive buffer input ptr
EFA3 88         2483       DEY
EFA4 A5AA       2484       LDA ZAA        ;fetch byte received so far in A
EFA6 AE9802     2485       LDX X0298      ;and number of bits to receive in X
EFA9 E009       2486 BEFA9 CPX $09
EFAB F004       2487       BEQ BEFB1
EFAD 4A         2488       LSR A          ;right justify input byte
EFAE E8         2489       INX
EFAF D0F8       2490       BNE BEFA9
EFB1 91F7       2491 BEFB1 STA (ZF7),Y    ;store received byte in receive buffer
EFB3 A920       2492       LDA $20        ;check RS-232 Command Register
EFB5 2C9402     2493       BIT X0294      ;for parity options
EFB8 F0B4       2494       BEQ BEF6E      ;no parity
EFBA 30B1       2495       BMI BEF6D      ;parity check disabled
EFBC A5A7       2496       LDA ZA7        ;fetch receiver parity bit
EFBE 45AB       2497       EOR ZAB        ;check against calculated parity
EFC0 F003       2498       BEQ BEFC5      ;odd parity received
EFC2 70A9       2499       BVS BEF6D      ;exit if even parity required
EFC4 2C         2500       .BY $2C        ;skip next instruction
EFC5 50A6       2501 BEFC5 BVC BEF6D      ;exit if odd parity required
EFC7 A901       2502       LDA $01        ;else indicate Parity Error
EFC9 2C         2503       .BY $2C        ;skip next instruction
EFCA A904       2504 BEFCA LDA $04        ;indicate Receiver Buffer Overrun error
EFCC 2C         2505       .BY $2C        ;skip next instruction
EFCD A980       2506 BEFCD LDA $80        ;indicate Break Detected error
EFCF 2C         2507       .BY $2C        ;skip next instruction
EFD0 A902       2508 BEFD0 LDA $02        ;Framing error
EFD2 0D9702     2509       ORA X0297      ;plus original RS-232 Status Register
EFD5 8D9702     2510       STA X0297      ;makes new RS-232 Status Register
EFD8 4C7EEF     2511       JMP BEF7E      ;enable byte reception and exit
                2512 ;
EFDB A5AA       2513 BEFDB LDA ZAA        ;if byte received so far is non-zero
EFDD D0F1       2514       BNE BEFD0      ;indicate framing error
EFDF F0EC       2515       BEQ BEFCD      ;or break detected error
```

```
                2517 ;output on RS-232 device
                2518 ;
EFE1 859A       2519 JEFE1 STA Z9A        ;set output device
EFE3 AD9402     2520       LDA X0294      ;check RS-232 Command Register
EFE6 4A         2521       LSR A          ;for 3-line or X-line m cc
EFE7 9029       2522       BCC BF012      ;and skip if 3-line
EFE9 A902       2523       LDA $02
EFEB 2C01DD     2524       BIT XDD01
EFEE 101D       2525       BPL BF00D      ;indicate error if DSR signal missing
EFF0 D020       2526       BNE BF012      ;exit if RTS present
EFF2 ADA102     2527 BEFF2 LDA X02A1      ;check ICR2 activity register
EFF5 2902       2528       AND $02
EFF7 D0F9       2529       BNE BEFF2      ;and loop until byte received
EFF9 2C01DD     2530 BEFF9 BIT XDD01
EFFC 70FB       2531       BVS BEFF9      ;wait for CTS signal
EFFE AD01DD     2532       LDA XDD01
F001 0902       2533       ORA $02
F003 8D[illegible]         STA XDD01      ;set RTS signal
F006 2C01DD     2535 BF006 BIT XDD01
F009 7007       2536       BVS BF012      ;exit if CTS is high
F00B 30F9       2537       BMI BF006      ;loop if DSR is high
F00D A940       2538 BF00D LDA $40        ;set DSR Signal Missing Error
F00F 8D9702     2539       STA X0297      ;in RS-232 Status Register
F012 18         2540 BF012 CLC
F013 60         2541       RTS
                2542 ;
                2543 ;buffer character to output on RS-232
                2544 ;
F014 2028F0     2545 BF014 JSR SF028      ;schedule TA2 if not transmitting
F017 AC9E02     2546 SF017 LDY X029E
F01A C8         2547       INY            ;if no room in the RS-232 buffer
F01B CC9D02     2548       CPY X029D
F01E F0F4       2549       BEQ BF014      ;wait until there is room
F020 8C9E02     2550       STY X029E      ;bump RS-232 transmit buffer output ptr
F023 88         2551       DEY
F024 A59E       2552       LDA Z9E        ;move, buffered character
F026 91F9       2553       STA (ZF9),Y    ;to transmsit buffer
F028 ADA102     2554 SF028 LDA X02A1      ;check ICR2 activity register
F02B 4A         2555       LSR A
F02C B01E       2556       BCS BF04C      ;if not transmitting,
F02E A910       2557       LDA $10
F030 8D0EDD     2558       STA XDD0E      ;force load into CRA2
F033 AD9902     2559       LDA X0299      ;move baud rate full bit time
F036 8D04DD     2560       STA XDD04      ;into TAL2
F039 AD9A02     2561       LDA X029A
F03C 8D05DD     2562       STA XDD05      ;and TAH2
F03F A981       2563       LDA $81
F041 203BEF     2564       JSR JEF3B      ;set TA2 mask bit in ICR2
F044 2006EF     2565       JSR BEF06      ;perform initialization for new byte
F047 A911       2566       LDA $11        ;set force load and start TA2 in CRA2
F049 8D0EDD     2567       STA XDD0E
F04C 60         2568 BF04C RTS
```

```
                2570 ;initialize RS-232 input
                2571 ;
F04D 8599       2572 JF04D STA Z99        ;set input device
F04F AD9402     2573       LDA X0294      ;check RS-232 Command Register
F052 4A         2574       LSR A          ;for 3-line or X-line mode
F053 9028       2575       BCC BF07D      ;and skip if 3-line
F055 2908       2576       AND $08        ;check for full/half duplex mode
F057 F024       2577       BEQ BF07D      ;and skip if full duplex
F059 A902       2578       LDA $02
F05B 2C01DD     2579       BIT XDD01
F05E 10AD       2580       BPL BF00D      ;error if DSR signal not present
F060 F022       2581       BEQ BF084
F062 ADA102     2582 BF062 LDA X02A1      ;check ICR2 activity register
F065 4A         2583       LSR A
F066 B0FA       2584       BCS BF062      ;if not transmitting,
F068 AD01DD     2585       LDA XDD01
F06B 29FD       2586       AND $FD        ;clear RTS line
F06D 8D01DD     2587       STA XDD01
F070 AD01DD     2588 BF070 LDA XDD01
F073 2904       2589       AND $04
F075 F0F9       2590       BEQ BF070      ;wait for DSR
F077 A990       2591 BF077 LDA $90
F079 18         2592       CLC
F07A 4C3BEF     2593       JMP JEF3B      ;set Flag bit mask in ICR2 and return
                2594 ;
F07D ADA102     2595 BF07D LDA X02A1      ;fetch ICR2 activity register
F080 2912       2596       AND $12        ;if receiving/waiting for receiver edge,
F082 F0F3       2597       BEQ BF077      ;set Flag mask
F084 18         2598 BF084 CLC
F085 60         2599       RTS
                2600 ;
                2601 ;get next character from RS-232 input buffer
                2602 ;
F086 AD9702     2603 SF086 LDA X0297      ;A = contents of RS-232 Status Register
F089 AC9C02     2604       LDY X029C
F08C CC9B02     2605       CPY X029B      ;if receiver buffer is empty,
F08F F00B       2606       BEQ BF09C      ;set flag in RS-232 status register
F091 29F7       2607       AND $F7        ;else clear Receiver Buffer Empty flag
F093 8D9702     2608       STA X0297      ;in RS-232 Status Register
F096 B1F7       2609       LDA (ZF7),Y    ;fetch character from buffer
F098 EE9C02     2610       INC X029C      ;bump RS-232 receive buffer output ptr
F09B 60         2611       RTS
                2612 ;
F09C 0908       2613 BF09C ORA $08        ;indicate Receiver Buffer Empty
F09E 8D9702     2614       STA X0297      ;in RS-232 Status Register
F0A1 A900       2615       LDA $00        ;and return with a null character
F0A3 60         2616       RTS
```

```
                2618 ;protect serial/cassette routine from RS-232 NMI's
                2619 ;
F0A4 48         2620 SF0A4 PHA             ;save A
F0A5 ADA102     2621       LDA X02A1       ;if no activity in ICR2
F0A8 F011       2622       BEQ BF0BB       ;exit
F0AA ADA102     2623 BF0AA LDA X02A1
F0AD 2903       2624       AND $03
F0AF D0F9       2625       BNE BF0AA       ;else wait until not sending/receiving
F0B1 A910       2626       LDA $10
F0B3 8D0DDD     2627       STA XDD0D       ;clear Flag bit mask in ICR2
F0B6 A900       2628       LDA $00
F0B8 8DA102     2629       STA X02A1       ;clear ICR2 activity register
F0BB 68         2630 BF0BB PLA             ;restore A
F0BC 60         2631       RTS
                2632 ;
                2633 ;Kernal I/O messages
                2634 ;
F0BD 0D492F     2635 TF0BD .BY $0D,"I,"/,"O," ,"E,"R,"R,"O,"R," ,"#+$80
F0C9 0D5345     2636 TF0C9 .BY $0D,"S,"E,"A,"R,"C,"H,"I,"N,"G," +$80
F0D4 464F52     2637 TF0D4 .BY "F,"O,"R," +$80
F0D8 0D5052     2638 TF0D8 .BY $0D,"P,"R,"E,"S,"S," ,"P,"L,"A,"Y," ,"O,"N,"
F0E7 544150     2639       .BY "T,"A,"P,"E+$80
F0EB 505245     2640 TF0EB .BY "P,"R,"E,"S,"S," ,"R,"E,"C,"O,"R,"D," ,"&,"
F0FA 504C41     2641       .BY "P,"L,"A,"Y," ,"O,"N," ,"T,"A,"P,"E+$80
F106 0D4C4F     2642 TF106 .BY $0D,"L,"O,"A,"D,"I,"N,"G+$80
F10E 0D5341     2643 TF10E .BY $0D,"S,"A,"V,"I,"N,"G," +$80
F116 0D5645     2644 TF116 .BY $0D,"V,"E,"R,"I,"F,"Y,"I,"N,"G+$80
F120 0D464F     2645 TF120 .BY $0D,"F,"O,"U,"N,"D," +$80
F127 0D4F4B     2646 TF127 .BY $0D,"O,"K,$8D
                2647 ;
                2648 ;print kernal message indexed by Y
                2649 ;
F12B 249D       2650 JF12B BIT Z9D         ;exit if not in direct mode
F12D 100D       2651       BPL BF13C
F12F B9BDF0     2652 BF12F LDA TF0BD,Y     ;fetch a character from message table
F132 08         2653       PHP
F133 297F       2654       AND $7F         ;strip bit 7
F135 20D2FF     2655       JSR SFFD2       ;print character
F138 C8         2656       INY             ;advance index
F139 28         2657       PLP             ;if last char did not contain bit 7,
F13A 10F3       2658       BPL BF12F       ;repeat
F13C 18         2659 BF13C CLC
F13D 60         2660       RTS
                2661 ;
                2662 ;get a character
                2663 ;
F13E A599       2664 WF13E LDA Z99         ;if input device
F140 D008       2665       BNE BF14A       ;is the keyboard
F142 A5C6       2666       LDA ZC6         ;and keyboard buffer
F144 F00F       2667       BEQ BF155       ;is not empty
F146 78         2668       SEI             ;disable IRQ
F147 4CB4E5     2669       JMP SE5B4       ;then fetch char from keyboard queue
                2670 ;
F14A C902       2671 BF14A CMP $02         ;if input device is RS-232
F14C D018       2672       BNE BF166
F14E 8497       2673 SF14E STY Z97         ;save Y
F150 2086F0     2674       JSR SF086       ;get a char from RS-232 input buffer
F153 A497       2675       LDY Z97         ;restore Y
F155 18         2676 BF155 CLC
F156 60         2677       RTS
```

```
                2679 ;input a character
                2680 ;
F157 A599       2681 WF157 LDA Z99       ;if the input device
F159 D00B       2682       BNE BF166     ;is the keyboard
F15B A5D3       2683       LDA ZD3       ;move position of cursor on line
F15D 85CA       2684       STA ZCA       ;to input cursor postion on line
F15F A5D6       2685       LDA ZD6       ;move cursor line number
F161 85C9       2686       STA ZC9       ;to input cursor line number
F163 4C32E6     2687       JMP JE632     ;and go input from the keyboard
                2688 ;
F166 C903       2689 BF166 CMP $03       ;if input device is the screen
F168 D009       2690       BNE BF173
F16A 85D0       2691       STA ZD0       ;set screen/keyboard flag to screen
F16C A5D5       2692       LDA ZD5       ;move screen line length
F16E 85C8       2693       STA ZC8       ;to end of line pointer
F170 4C32E6     2694       JMP JE632     ;and go input from the screen
                2695 ;
F173 B038       2696 BF173 BCS BF1AD     ;if device > 3 (serial bus), handle
F175 C902       2697       CMP $02
F177 F03F       2698       BEQ BF1B8     ;if input device is RS-232, handle
F179 8697       2699       STX Z97       ;input device is tape, save X
F17B 2099F1     2700       JSR SF199     ;fetch a byte from tape buffer
F17E B016       2701       BCS BF196     ;exit upon error
F180 48         2702       PHA           ;save byte on stack
F181 2099F1     2703       JSR SF199     ;look ahead in tape buffer
F184 B00D       2704       BCS BF193     ;and exit upon error
F186 D005       2705       BNE BF18D     ;if at end of file,
F188 A940       2706       LDA $40       ;set end of file bit
F18A 201CFE     2707       JSR SFE1C     ;in ST
F18D C6A6       2708 BF18D DEC ZA6       ;adjust tape buffer ptr back to normal
F18F A697       2709       LDX Z97       ;restore X
F191 68         2710       PLA           ;restore byte read
F192 60         2711       RTS
                2712 ;
F193 AA         2713 BF193 TAX
F194 68         2714       PLA           ;set stack straight
F195 8A         2715       TXA
F196 A697       2716 BF196 LDX Z97       ;restore X
F198 60         2717       RTS           ;error exit with C set
```

```
                2719 ;read a byte from the cassette buffer
                2720 ;
F199 200DF8     2721 SF199 JSR SF80D     ;add 1 to buffer pointer
F19C D00B       2722       BNE BF1A9     ;if end of buffer,
F19E 2041F8     2723       JSR SF841     ;read next block
F1A1 B011       2724       BCS BF1B4     ;and exit upon error
F1A3 A900       2725       LDA $00
F1A5 85A6       2726       STA ZA6       ;reset tape buffer pointer
F1A7 F0F0       2727       BEQ SF199     ;and loop back
F1A9 B1B2       2728 BF1A9 LDA (ZB2),Y   ;fetch byte from tape buffer
F1AB 18         2729       CLC           ;indicate no error
F1AC 60         2730       RTS           ;and return
                2731 ;
F1AD A590       2732 BF1AD LDA Z90       ;if ST indicates Device Not Present
F1AF F004       2733       BEQ BF1B5
F1B1 A90D       2734 BF1B1 LDA $0D       ;force a return
F1B3 18         2735 BF1B3 CLC
F1B4 60         2736 BF1B4 RTS
                2737 ;
                2738 ;read a byte from the serial bus
                2739 ;
F1B5 4C13EE     2740 BF1B5 JMP JEE13     ;input byte from serial bus and return
                2741 ;
                2742 ;read a byte from the RS-232 bus
                2743 ;
F1B8 204EF1     2744 BF1B8 JSR SF14E     ;get a char from RS-232 input buffer
F1BB B0F7       2745       BCS BF1B4     ;exit upon error
F1BD C900       2746       CMP $00
F1BF D0F2       2747       BNE BF1B3     ;exit if receive buffer not empty
F1C1 AD9702     2748       LDA X0297     ;if RS-232 Status Register
F1C4 2960       2749       AND $60       ;indicates DSR Missing,
F1C6 D0E9       2750       BNE BF1B1     ;force a Return
F1C8 F0EE       2751       BEQ BF1B8     ;else repeat
```

```
                2753 ;output a character
                2754 ;
F1CA 48         2755 WF1CA PHA             ;save character on stack
F1CB A59A       2756       LDA Z9A         ;if output device
F1CD C903       2757       CMP $03         ;is the screen
F1CF D004       2758       BNE BF1D5
F1D1 68         2759       PLA             ;restore character
F1D2 4C16E7     2760       JMP SE716       ;and output to screen
                2761 ;
F1D5 9004       2762 BF1D5 BCC BF1DB       ;if output device > 3
F1D7 68         2763       PLA             ;restore character
F1D8 4CDDED     2764       JMP JEDDD       ;and output to serial bus
                2765 ;
F1DB 4A         2766 BF1DB LSR A           ;set C to 1 for cassette
F1DC 68         2767       PLA             ;move character to output
F1DD 859E       2768 SF1DD STA Z9E         ;to temporary storage
F1DF 8A         2769       TXA
F1E0 48         2770       PHA
F1E1 98         2771       TYA
F1E2 48         2772       PHA             ;save XY on stack
F1E3 9023       2773       BCC BF208       ;if output device is cassette
F1E5 200DF8     2774       JSR SF80D       ;add one to tape buffer index
F1E8 D00E       2775       BNE BF1F8       ;if buffer is full, (192 bytes)
F1EA 2064F8     2776       JSR SF864       ;write block to cassette
F1ED B00E       2777       BCS BF1FD       ;and exit upon error
F1EF A902       2778       LDA $02         ;use use Data code
F1F1 A000       2779       LDY $00
F1F3 91B2       2780       STA (ZB2),Y     ;in beginning of next tape buffer
F1F5 C8         2781       INY
F1F6 84A6       2782       STY ZA6         ;initialize tape buffer pointer
F1F8 A59E       2783 BF1F8 LDA Z9E         ;move character to output
F1FA 91B2       2784       STA (ZB2),Y     ;into the tape buffer
F1FC 18         2785 JF1FC CLC             ;clear error flag
F1FD 68         2786 BF1FD PLA
F1FE A8         2787       TAY
F1FF 68         2788       PLA
F200 AA         2789       TAX             ;restore XY
F201 A59E       2790       LDA Z9E         ;restore character just output
F203 9002       2791       BCC BF207       ;exit if no errors
F205 A900       2792       LDA $00         ;else return with A=0
F207 60         2793 BF207 RTS
                2794 ;
F208 2017F0     2795 BF208 JSR SF017       ;out a character to RS-232 channel
F20B 4CFCF1     2796       JMP JF1FC       ;and exit
```

```
                2798 ;set input device
                2799 ;
F20E 200FF3     2800 WF20E JSR SF30F     ;check X against logical file table
F211 F003       2801       BEQ BF216     ;if not matched,
F213 4C01F7     2802       JMP JF701     ;indicate File Not Open
                2803 ;
F216 201FF3     2804 BF216 JSR SF31F     ;set logical file, device and sec. adr
F219 A5BA       2805       LDA ZBA       ;if device is keyboard,
F21B F016       2806       BEQ BF233     ;exit
F21D C903       2807       CMP $03       ;if device is screen,
F21F F012       2808       BEQ BF233     ;exit
F221 B014       2809       BCS BF237     ;handle if device is serial bus (> 3)
F223 C902       2810       CMP $02
F225 D003       2811       BNE BF22A     ;if device is RS-232,
F227 4C4DF0     2812       JMP JF04D     ;initialize RS-232 input
                2813 ;
F22A A6B9       2814 BF22A LDX ZB9       ;if input device is tape and sec. adr
F22C E060       2815       CPX $60       ;indicates that this is an input file
F22E F003       2816       BEQ BF233     ;great,
F230 4C0AF7     2817       JMP JF70A     ;else indicate Not Input File Error
                2818 ;
F233 8599       2819 BF233 STA Z99       ;set input device
F235 18         2820       CLC           ;clear error flag
F236 60         2821       RTS
                2822 ;
                2823 ;set serial bus input device
                2824 ;
F237 AA         2825 BF237 TAX
F238 2009ED     2826       JSR SED09     ;send TALK on serial bus
F23B A5B9       2827       LDA ZB9       ;if secondary address specified,
F23D 1006       2828       BPL BF245     ;send it
F23F 20CCED     2829       JSR SEDCC     ;else send dummy secondary address
F242 4C48F2     2830       JMP JF248
                2831 ;
F245 20C7ED     2832 BF245 JSR SEDC7     ;send secondard addr (after TALK)
F248 8A         2833 JF248 TXA
F249 2490       2834       BIT Z90
F24B 10E6       2835       BPL BF233     ;if ST shows device present, exit
F24D 4C07F7     2836       JMP JF707     ;else indicate error
```

```
                2838 ;set output device
                2839 ;
F250 200FF3     2840 WF250 JSR SF30F     ;check X against logical file table
F253 F003       2841       BEQ BF258
F255 4C01F7     2842       JMP JF701     ;File Not Open Error if not found
                2843 ;
F258 201FF3     2844 BF258 JSR SF31F     ;set  logical file, device and sec. adr
F25B A5BA       2845       LDA ZBA       ;if current device
F25D D003       2846       BNE BF262     ;indicates an input file
F25F 4C0DF7     2847 BF25F JMP JF70D     ;error Not Output File
                2848 ;
F262 C903       2849 BF262 CMP $03       ;if device is the screen
F264 F00F       2850       BEQ BF275     ;exit
F266 B011       2851       BCS BF279     ;if serial bus device, handle
F268 C902       2852       CMP $02       ;if device is RS-232
F26A D003       2853       BNE BF26F
F26C 4CE1EF     2854       JMP JEFE1     ;initialize RS-232 output
                2855 ;
F26F A6B9       2856 BF26F LDX ZB9       ;if secondary address
F271 E060       2857       CPX $60       ;indicates an input file
F273 F0EA       2858       BEQ BF25F     ;Not Output File Error
F275 859A       2859 BF275 STA Z9A       Xstore output device
F277 18         2860       CLC           ;clear error indication
F278 60         2861       RTS
                2862 ;
                2863 ;set serial bus output device
                2864 ;
F279 AA         2865 BF279 TAX
F27A 200CED     2866       JSR SED0C     ;send LISTEN on serial bus
F27D A5B9       2867       LDA ZB9       ;if secondary address specified,
F27F 1005       2868       BPL BF286     ;send it
F281 20BEED     2869       JSR SEDBE     ;else send dummy secondary address
F284 D003       2870       BNE BF289     ;skip next instruction
F286 20B9ED     2871 BF286 JSR SEDB9     ;send secondary addr after LISTEN
F289 8A         2872 BF289 TXA
F28A 2490       2873       BIT Z90       ;check ST
F28C 10E7       2874       BPL BF275     ;and set output device if no errors
F28E 4C07F7     2875       JMP JF707     ;else indicate Device Not Present Error
```

```
                2877 ;CLOSE a file
                2878 ;
F291 2014F3     2879 WF291 JSR SF314     ;check A against logical file table
F294 F002       2880       BEQ BF298     ;continue if found
F296 18         2881       CLC           ;else exit
F297 60         2882       RTS
                2883 ;
F298 201FF3     2884 BF298 JSR SF31F     ;set logical file, device and sec. adr
F29B 8A         2885       TXA
F29C 48         2886       PHA           ;save file index
F29D A5BA       2887       LDA ZBA       ;if current device is keyboard
F29F F050       2888       BEQ BF2F1
F2A1 C903       2889       CMP $03
F2A3 F04C       2890       BEQ BF2F1     ;or screen, skip to end
F2A5 B047       2891       BCS BF2EE     ;if serial bus device (> 3), handle
F2A7 C902       2892       CMP $02
F2A9 D01D       2893       BNE BF2C8     ;if RS-232 device,
F2AB 68         2894       PLA           ;restore file index
F2AC 20F2F2     2895       JSR SF2F2     ;re-organize file tables
F2AF 2083F4     2896       JSR SF483     ;re-initialize CIA2
F2B2 2027FE     2897       JSR SFE27     ;read top of memory into XY
F2B5 A5F8       2898       LDA ZF8       ;if high byte of RS-232 receive buffer
F2B7 F001       2899       BEQ BF2BA     ;base address is not 0,
F2B9 C8         2900       INY           ;add 1 to high byte of top of memory
F2BA A5FA       2901 BF2BA LDA ZFA       ;if high byte of RS-232 transmit buffer
F2BC F001       2902       BEQ BF2BF     ;base address is not 0
F2BE C8         2903       INY           ;add 1 to high byte of top of memory
F2BF A900       2904 BF2BF LDA $00       ;clear high byte of RS-232
F2C1 85F8       2905       STA ZF8       ;receive and transmit buffer
F2C3 85FA       2906       STA ZFA       ;base addresses
F2C5 4C7DF4     2907       JMP JF47D     ;set new top of memory from XY
```

```
                2909 ;close cassette device
                2910 ;
F2C8 A5B9       2911 BF2C8 LDA ZB9        ;if secondary address
F2CA 290F       2912       AND $0F        ;indicates an input file,
F2CC F023       2913       BEQ BF2F1      ;skip following
F2CE 20D0F7     2914       JSR SF7D0      ;else get tape buffer pointer in XY
F2D1 A900       2915       LDA $00
F2D3 38         2916       SEC
F2D4 20DDF1     2917       JSR SF1DD      ;close file with a $00
F2D7 2064F8     2918       JSR SF864      ;write last block to cassette
F2DA 9004       2919       BCC BF2E0
F2DC 68         2920       PLA            ;and return with C set upon error
F2DD A900       2921       LDA $00
F2DF 60         2922       RTS
                2923 ;
F2E0 A5B9       2924 BF2E0 LDA ZB9        ;if secondary address indicates that
F2E2 C962       2925       CMP $62        ;EOT marker to be written,
F2E4 D00B       2926       BNE BF2F1
F2E6 A905       2927       LDA $05
F2E8 206AF7     2928       JSR SF76A      ;write special block to tape with EOT
F2EB 4CF1F2     2929       JMP BF2F1      ;then re-organize file tables
                2930 ;
                2931 ;close serial bus device
                2932 ;
F2EE 2042F6     2933 BF2EE JSR SF642      ;close serial bus device
F2F1 68         2934 BF2F1 PLA            ;restore file index
                2935 ;
                2936 ;re-organize file tables
                2937 ;
F2F2 AA         2938 SF2F2 TAX
F2F3 C698       2939       DEC Z98        ;decrement # files open
F2F5 E498       2940       CPX Z98
F2F7 F014       2941       BEQ BF30D      ;exit if all files closed
F2F9 A498       2942       LDY Z98
F2FB B95902     2943       LDA X0259,Y    ;else move parameters of last entry
F2FE 9D5902     2944       STA X0259,X    ;(file, device and secondary address)
F301 B96302     2945       LDA X0263,Y    ;to slot of file being closed
F304 9D6302     2946       STA X0263,X    ;this removes file being closed
F307 B96D02     2947       LDA X026D,Y
F30A 9D6D02     2948       STA X026D,X
F30D 18         2949 BF30D CLC
F30E 60         2950       RTS
```

```
                2952 ;check X against logical file table
                2953 ;
F30F A900       2954 SF30F LDA $00
F311 8590       2955       STA Z90       ;clear status word ST
F313 8A         2956       TXA
F314 A698       2957 SF314 LDX Z98       ;use # of files open to begin search
F316 CA         2958 BF316 DEX
F317 3015       2959       BMI BF32E     ;exit if file not found
F319 DD5902     2960       CMP X0259,X
F31C D0F8       2961       BNE BF316     ;repeat if not matched
F31E 60         2962       RTS
                2963 ;
                2964 ;set file parameters depending on X
                2965 ;
F31F BD5902     2966 SF31F LDA X0259,X
F322 85B8       2967       STA ZB8       ;set current logical file
F324 BD6302     2968       LDA X0263,X
F327 85BA       2969       STA ZBA       ;set current device
F329 BD6D02     2970       LDA X026D,X
F32C 85B9       2971       STA ZB9       ;set current secondary address
F32E 60         2972 BF32E RTS
                2973 ;
                2974 ;close all files
                2975 ;
F32F A900       2976 WF32F LDA $00
F331 8598       2977       STA Z98       ;clear number of files open
                2978 ;
                2979 ;restore I/O to default devices
                2980 ;
F333 A203       2981 WF333 LDX $03
F335 E49A       2982       CPX Z9A       ;if output device is not the serial bus
F337 B003       2983       BCS BF33C
F339 20FEED     2984       JSR SEDFE     ;send UNLISTEN on serial bus
F33C E499       2985 BF33C CPX Z99       ;if input device is not on serial bus,
F33E B003       2986       BCS BF343
F340 20EFED     2987       JSR SEDEF     ;send TALK on serial bus
F343 869A       2988 BF343 STX Z9A       ;set output device to screen
F345 A900       2989       LDA $00
F347 8599       2990       STA Z99       ;set input device to keyboard
F349 60         2991       RTS
```

```
                2993 ;OPEN a file
                2994 ;
F34A A6B8       2995 WF34A LDX ZB8       ;if current logical file is 0
F34C D003       2996       BNE BF351
F34E 4C0AF7     2997       JMP JF70A     ;indicate Not Input File Error
                2998 ;
F351 200FF3     2999 BF351 JSR SF30F     ;check X against logical file table
F354 D003       3000       BNE BF359     ;if found,
F356 4CFEF6     3001       JMP JF6FE     ;File Open Error
                3002 ;
F359 A698       3003 BF359 LDX Z98       ;if # files open is 10 or more,
F35B E00A       3004       CPX $0A
F35D 9003       3005       BCC BF362
F35F 4CFBF6     3006       JMP JF6FB     ;Too Many Files Error
                3007 ;
F362 E698       3008 BF362 INC Z98       ;add 1 to # files open
F364 A5B8       3009       LDA ZB8       ;add current logical file
F366 9D5902     3010       STA X0259,X   ;to end of table of logical files open
F369 A5B9       3011       LDA ZB9       ;add secondary address
F36B 0960       3012       ORA $60       ;plus offset
F36D 85B9       3013       STA ZB9       ;to create current secondary address
F36F 9D6D02     3014       STA X026D,X   ;and enter into secondary address table
F372 A5BA       3015       LDA ZBA       ;add current device
F374 9D6302     3016       STA X0263,X   ;to current device table
F377 F05A       3017       BEQ BF3D3     ;and exit if device is keyboard
F379 C903       3018       CMP $03
F37B F056       3019       BEQ BF3D3     ;or screen
F37D 9005       3020       BCC BF384
F37F 20D5F3     3021       JSR SF3D5     ;for serial device (> 3), perform open
F382 904F       3022       BCC BF3D3     ;JMP
F384 C902       3023 BF384 CMP $02
F386 D003       3024       BNE BF38B
F388 4C09F4     3025       JMP JF409     ;for RS-232 device, perform open
                3026 ;
                3027 ;open for cassette device
                3028 ;
F38B 20D0F7     3029 BF38B JSR SF7D0     ;get tape buffer address in XY
F38E B003       3030       BCS BF393     ;if address too low,
F390 4C13F7     3031       JMP JF713     ;indicate Illegal Device #
                3032 ;
F393 A5B9       3033 BF393 LDA ZB9       ;get current secondary address
F395 290F       3034       AND $0F       ;mask low order 4 bits
F397 D01F       3035       BNE BF3B8     ;skip if open for output
F399 2017F8     3036       JSR SF817     ;handle msgs for cassette read
F39C B036       3037       BCS BF3D4     ;exit upon error
F39E 20AFF5     3038       JSR SF5AF     ;handle messages for load
F3A1 A5B7       3039       LDA ZB7       ;get # characters in file name
F3A3 F00A       3040       BEQ BF3AF
F3A5 20EAF7     3041       JSR SF7EA     ;if name present, search tape for file
F3A8 9018       3042       BCC BF3C2     ;if not matched
F3AA F028       3043       BEQ BF3D4     ;and not end of tape,
F3AC 4C04F7     3044 BF3AC JMP JF704     ;File Not Found Error
                3045 ;
F3AF 202CF7     3046 BF3AF JSR SF72C     ;since no name, get next tape data
F3B2 F020       3047       BEQ BF3D4     ;exit if end of tape
F3B4 900C       3048       BCC BF3C2     ;if no errors, continue
F3B6 B0F4       3049       BCS BF3AC     ;else indicate File Not Found Error
```

```
                3051 ;open cassette for output
                3052 ;
F3B8 2038F8     3053 BF3B8 JSR SF838     ;handle msgs for cassette write
F3BB B017       3054       BCS BF3D4     ;exit upon error
F3BD A904       3055       LDA $04
F3BF 206AF7     3056       JSR SF76A     ;write block with Data Header code
F3C2 A9BF       3057 BF3C2 LDA $BF       ;initialize buffer index
F3C4 A4B9       3058       LDY ZB9       ;check secondary address
F3C6 C060       3059       CPY $60       ;if tape opened for output
F3C8 F007       3060       BEQ BF3D1
F3CA A000       3061       LDY $00
F3CC A902       3062       LDA $02       ;put code for Data Block
F3CE 91B2       3063       STA (ZB2),Y   ;into first byte of buffer
F3D0 98         3064       TYA
F3D1 85A6       3065 BF3D1 STA ZA6       ;initialize tape buffer pointer
F3D3 18         3066 BF3D3 CLC
F3D4 60         3067 BF3D4 RTS
                3068 ;
                3069 ;open for serial bus devices (device > 3)
                3070 ;
F3D5 A5B9       3071 SF3D5 LDA ZB9       ;if current secondary address invalid,
F3D7 30FA       3072       BMI BF3D3     ;exit
F3D9 A4B7       3073       LDY ZB7       ;if name not present,
F3DB F0F6       3074       BEQ BF3D3     ;exit
F3DD A900       3075       LDA $00
F3DF 8590       3076       STA Z90       ;else clear ST
F3E1 A5BA       3077       LDA ZBA       ;set current device
F3E3 200CED     3078       JSR SED0C     ;send UNLISTEN on serial bus
F3E6 A5B9       3079       LDA ZB9       ;send current secondary address
F3E8 09F0       3080       ORA $F0       ;plus offset
F3EA 20B9ED     3081       JSR SEDB9     ;on serial bus
F3ED A590       3082       LDA Z90       ;check ST
F3EF 1005       3083       BPL BF3F6     ;if Device Not Present,
F3F1 68         3084       PLA           ;delete own return address
F3F2 68         3085       PLA
F3F3 4C07F7     3086       JMP JF707     ;indicate Device Not Present
                3087 ;
F3F6 A5B7       3088 BF3F6 LDA ZB7       ;if file name present
F3F8 F00C       3089       BEQ BF406
F3FA A000       3090       LDY $00       ;initialize index
F3FC B1BB       3091 BF3FC LDA (ZBB),Y
F3FE 20DDED     3092       JSR JEDDD     ;send file name on serial bus
F401 C8         3093       INY
F402 C4B7       3094       CPY ZB7
F404 D0F6       3095       BNE BF3FC     ;repeat for all characters of file name
F406 4C54F6     3096 BF406 JMP JF654     ;send UNLISTEN on serial bus and exit
```

```
                3098 ;OPEN RS-232 device
                3099 ;
F409 2083F4     3100 JF409 JSR SF483      ;initialize CIA2
F40C 8C9702     3101       STY X0297      ;clear RS-232 Status Register
F40F C4B7       3102 BF40F CPY ZB7        ;if pseudo file name present,
F411 F00A       3103       BEQ BF41D
F413 B1BB       3104       LDA (ZBB),Y    ;set Control & Command registers
F415 999302     3105       STA X0293,Y    ;and possible non-standard baud rate
F418 C8         3106       INY
F419 C004       3107       CPY $04
F41B D0F2       3108       BNE BF40F
F41D 204AEF     3109 BF41D JSR SEF4A      ;fetch word length and move to
F420 8E9802     3110       STX X0298      ;number of bits to send
F423 AD9302     3111       LDA X0293      ;check RS-232 Control Register
F426 290F       3112       AND $0F
F428 F01C       3113       BEQ BF446      ;if standard baud rate specified,
F42A 0A         3114       ASL A          ;calculate index into table
F42B AA         3115       TAX
F42C ADA602     3116       LDA X02A6      ;if US machine
F42F D009       3117       BNE BF43A
F431 BCC1FE     3118       LDY TFEC2-1,X ;use US table of baud rate
F434 BDC0FE     3119       LDA TFEC2-2,X
F437 4C40F4     3120       JMP JF440      ;go set baud rate
                3121 ;
F43A BCEBE4     3122 BF43A LDY TE4EC-1,X ;use Intl table of baud rate factors
F43D BDEAE4     3123       LDA TE4EC-2,X ;to fetch baud rate factor
F440 8C9602     3124 JF440 STY X0296      ;set baud rate factor
F443 8D9502     3125       STA X0295      ;low byte also
F446 AD9502     3126 BF446 LDA X0295
F449 0A         3127       ASL A
F44A 202EFF     3128       JSR SFF2E      ;continue to compute baud rate
F44D AD9402     3129       LDA X0294      ;check RS-232 Command Register
F450 4A         3130       LSR A          ;for 3-line or X-line mode
F451 9009       3131       BCC BF45C      ;and skip if in 3-line mode
F453 AD01DD     3132       LDA XDD01
F456 0A         3133       ASL A
F457 B003       3134       BCS BF45C      ;continue if DSR present, else
F459 200DF0     3135       JSR BF00D      ;DSR Signal Missing Error
                3136 ;
F45C AD9B02     3137 BF45C LDA X029B      ;move RS-232 receive buffer input ptr
F45F 8D9C02     3138       STA X029C      ;to RS-232 receive buffer output ptr
F462 AD9E02     3139       LDA X029E      ;move RS-232 transmit buffer input ptr
F465 8D9D02     3140       STA X029D      ;to RS-232 transmit buffer output ptr
F468 2027FE     3141       JSR SFE27      ;fetch top of memory in XY
F46B A5F8       3142       LDA ZF8        ;if high byte of RS-232 receive buffer
F46D D005       3143       BNE BF474      ;base address not initialized yet,
F46F 88         3144       DEY            ;subtract 1 from top of memory address
F470 84F8       3145       STY ZF8        ;use top of memory address to
F472 86F7       3146       STX ZF7        ;initialize receive buffer base address
F474 A5FA       3147 BF474 LDA ZFA        ;same operation for transmit buffer
F476 D005       3148       BNE JF47D      ;base address
F478 88         3149       DEY
F479 84FA       3150       STY ZFA
F47B 86F9       3151       STX ZF9
F47D 38         3152 JF47D SEC
F47E A9F0       3153       LDA $F0
F480 4C2DFE     3154       JMP JFE2D      ;reset top of memory pointers from XY
```

```
            3156 ;initialize CIA2
            3157 ;
F483 A97F   3158 SF483 LDA $7F
F485 8D0DDD 3159       STA XDD0D     ;clear any pending IRQ's in ICR2
F488 A906   3160       LDA $06
F48A 8D03DD 3161       STA XDD03     ;PB2 bits 1 and 2 as outputs
F48D 8D01DD 3162       STA XDD01     ;set DTR and RTS high
F490 A904   3163       LDA $04
F492 0D00DD 3164       ORA XDD00
F495 8D00DD 3165       STA XDD00     ;set RS-232 output to high (idle)
F498 A000   3166       LDY $00
F49A 8CA102 3167       STY X02A1     ;clear ICR2 activity register
F49D 60     3168       RTS
            3169 ;
            3170 ;load RAM from a device
            3171 ;
F49E 86C3   3172 JF49E STX ZC3       ;set destination address from XY
F4A0 84C4   3173       STY ZC4
F4A2 6C3003 3174       JMP (X0330)   ;load RAM (normally F4A5)
            3175 ;
            3176 ;standard load RAM entry
            3177 ;
F4A5 8593   3178 WF4A5 STA Z93       ;set load/verify switch to load
F4A7 A900   3179       LDA $00
F4A9 8590   3180       STA Z90       ;clear ST
F4AB A5BA   3181       LDA ZBA       ;if current device is the keyboard (0)
F4AD D003   3182       BNE BF4B2
F4AF 4C13F7 3183 BF4AF JMP JF713     ;indicate Illegal Device # Error
            3184 ;
F4B2 C903   3185 BF4B2 CMP $03       ;if current device is the screen
F4B4 F0F9   3186       BEQ BF4AF     ;indicate error
F4B6 907B   3187       BCC BF533     ;if not serial bus device
F4B8 A4B7   3188       LDY ZB7       ;and if no file name,
F4BA D003   3189       BNE BF4BF
F4BC 4C10F7 3190       JMP JF710     ;indicate File Name Missing Error
            3191 ;
F4BF A6B9   3192 BF4BF LDX ZB9       ;move X to secondary address
F4C1 20AFF5 3193       JSR SF5AF     ;handle load messages
F4C4 A960   3194       LDA $60       ;set current secondary address
F4C6 85B9   3195       STA ZB9
F4C8 20D5F3 3196       JSR SF3D5     ;perform open of serial bus device
F4CB A5BA   3197       LDA ZBA       ;let A = current device
F4CD 2009ED 3198       JSR SED09     ;send TALK on serial bus
F4D0 A5B9   3199       LDA ZB9       ;fetch secondary address
F4D2 20C7ED 3200       JSR SEDC7     ;and send on serial bus
F4D5 2013EE 3201       JSR JEE13     ;input a byte on serial bus
F4D8 85AE   3202       STA ZAE       ;set I/O end address
F4DA A590   3203       LDA Z90
F4DC 4A     3204       LSR A
F4DD 4A     3205       LSR A
F4DE B050   3206       BCS BF530     ;if ST doesn't indicate a timeout (read)
F4E0 2013EE 3207       JSR JEE13     ;input a byte on serial bus
F4E3 85AF   3208       STA ZAF       ;set high byte of end address
F4E5 8A     3209       TXA
F4E6 D008   3210       BNE BF4F0     ;if EOI is not low,
F4E8 A5C3   3211       LDA ZC3       ;use destination address
F4EA 85AE   3212       STA ZAE       ;as end address
F4EC A5C4   3213       LDA ZC4       ;ditto for high byte
F4EE 85AF   3214       STA ZAF
F4F0 20D2F5 3215 BF4F0 JSR SF5D2     ;print LOAD or VERIFY
```

```
F4F3 A9FD    3216 BF4F3 LDA $FD       ;clear timeout (read) bit
F4F5 2590    3217       AND Z90       ;in ST
F4F7 8590    3218       STA Z90
F4F9 20E1FF 3219       JSR SFFE1     ;check for Stop key
F4FC D003    3220       BNE BF501     ;if depressed
F4FE 4C33F6 3221       JMP JF633     ;abort load
             3222 ;
F501 2013EE 3223 BF501 JSR JEE13     ;input a byte on serial bus
F504 AA      3224       TAX
F505 A590    3225       LDA Z90       ;if Timeout (read) set in ST
F507 4A      3226       LSR A
F508 4A      3227       LSR A
F509 B0E8    3228       BCS BF4F3     ;abort load
F50B 8A      3229       TXA
F50C A493    3230       LDY Z93       ;if in verify mode
F50E F00C    3231       BEQ BF51C
F510 A000    3232       LDY $00
F512 D1AE    3233       CMP (ZAE),Y   ;compare byte read to memory
F514 F008    3234       BEQ BF51E
F516 A910    3235       LDA $10
F518 201CFE 3236       JSR SFE1C     ;and set verify error upon mismatch
F51B 2C      3237       .BY $2C       ;skip next instruction
F51C 91AE    3238 BF51C STA (ZAE),Y   ;load byte to memory
F51E E6AE    3239 BF51E INC ZAE       ;bump load address
F520 D002    3240       BNE BF524
F522 E6AF    3241       INC ZAF
F524 2490    3242 BF524 BIT Z90       ;if not end of file,
F526 50CB    3243       BVC BF4F3     ;repeat
F528 20EFED 3244       JSR SEDEF     ;else sent TALK on serial bus
F52B 2042F6 3245       JSR SF642     ;close serial bus
F52E 9079    3246       BCC BF5A9     ;and exit
F530 4C04F7 3247 BF530 JMP JF704     ;indicate File Not Found Error
             3248 ;
F533 4A      3249 BF533 LSR A         ;if input device is not 1 (cassette)
F534 B003    3250       BCS BF539
F536 4C13F7 3251       JMP JF713     ;indicate Illegal Device #
             3252 ;
F539 20D0F7 3253 BF539 JSR SF7D0     ;fetch tape buffer pointer
F53C B003    3254       BCS BF541
F53E 4C13F7 3255       JMP JF713     ;if invalid, indicate Illegal Device #
             3256 ;
F541 2017F8 3257 BF541 JSR SF817     ;display msgs and test buttons for read
F544 B068    3258       BCS BF5AE
F546 20AFF5 3259       JSR SF5AF     ;handle load messages
F549 A5B7    3260 BF549 LDA ZB7       ;if file name present
F54B F009    3261       BEQ BF556
F54D 20EAF7 3262       JSR SF7EA     ;search tape for file name
F550 900B    3263       BCC BF55D     ;if no errors, continue
F552 F05A    3264       BEQ BF5AE     ;exit if end of tape
F554 B0DA    3265       BCS BF530     ;error if not found
F556 202CF7 3266 BF556 JSR SF72C     ;since no file name, get next tape hdr
F559 F053    3267       BEQ BF5AE     ;exit if end of tape found
F55B B0D3    3268       BCS BF530     ;indicate File Not Found Error
F55D A590    3269 BF55D LDA Z90       ;check ST for unrecoverable read error
F55F 2910    3270       AND $10
F561 38      3271       SEC
F562 D04A    3272       BNE BF5AE     ;and exit if so
F564 E001    3273       CPX $01       ;if not Program Header
F566 F011    3274       BEQ BF579
F568 E003    3275       CPX $03
```

```
F56A D0DD   3276         BNE BF549
F56C A001   3277 BF56C  LDY $01
F56E B1B2   3278         LDA (ZB2),Y
F570 85C3   3279         STA ZC3      ;reset load address from tape buffer
F572 C8     3280         INY
F573 B1B2   3281         LDA (ZB2),Y  ;high byte also
F575 85C4   3282         STA ZC4
F577 B004   3283         BCS BF57D
F579 A5B9   3284 BF579   LDA ZB9
F57B D0EF   3285         BNE BF56C
F57D A003   3286 BF57D   LDY $03      ;index low byte of end address
F57F B1B2   3287         LDA (ZB2),Y
F581 A001   3288         LDY $01
F583 F1B2   3289         SBC (ZB2),Y  ;compute length of block to load
F585 AA     3290         TAX
F586 A004   3291         LDY $04
F588 B1B2   3292         LDA (ZB2),Y
F58A A002   3293         LDY $02
F58C F1B2   3294         SBC (ZB2),Y
F58E A8     3295         TAY
F58F 18     3296         CLC
F590 8A     3297         TXA
F591 65C3   3298         ADC ZC3
F593 85AE   3299         STA ZAE      ;and set end address of I/O area
F595 98     3300         TYA
F596 65C4   3301         ADC ZC4
F598 85AF   3302         STA ZAF
F59A A5C3   3303         LDA ZC3
F59C 85C1   3304         STA ZC1      ;set tape load address
F59E A5C4   3305         LDA ZC4
F5A0 85C2   3306         STA ZC2
F5A2 20D2F5 3307         JSR SF5D2    ;display load messages
F5A5 204AF8 3308         JSR SF84A    ;load from cassette
F5A8 24     3309         .BY $24      ;skip next instruction
F5A9 18     3310 BF5A9   CLC          ;clear error flag
F5AA A6AE   3311         LDX ZAE      ;exit with end address in XY
F5AC A4AF   3312         LDY ZAF
F5AE 60     3313 BF5AE   RTS
```

```
                3315 ;handle messages for a load operation
                3316 ;
F5AF A59D       3317 SF5AF LDA Z9D
F5B1 101E       3318       BPL BF5D1      ;exit if in Run mode
F5B3 A00C       3319       LDY $0C
F5B5 202FF1     3320       JSR BF12F      ;print SEARCHING
F5B8 A5B7       3321       LDA ZB7        ;if file name is present,
F5BA F015       3322       BEQ BF5D1
F5BC A017       3323       LDY $17
F5BE 202FF1     3324       JSR BF12F      ;print FOR
F5C1 A4B7       3325 JF5C1 LDY ZB7        ;if file name is present
F5C3 F00C       3326       BEQ BF5D1
F5C5 A000       3327       LDY $00
F5C7 B1BB       3328 BF5C7 LDA (ZBB),Y    ;print file name
F5C9 20D2FF     3329       JSR SFFD2
F5CC C8         3330       INY
F5CD C4B7       3331       CPY ZB7
F5CF D0F6       3332       BNE BF5C7      ;repeat for all characters in name
F5D1 60         3333 BF5D1 RTS
                3334 ;
                3335 ;handle Load/Verify message
                3336 ;
F5D2 A049       3337 SF5D2 LDY $49        ;assume Load
F5D4 A593       3338       LDA Z93
F5D6 F002       3339       BEQ BF5DA
F5D8 A059       3340       LDY $59        ;change to Verify if flag is non-zero
F5DA 4C2BF1     3341 BF5DA JMP JF12B      ;display message and return
```

```
                3343 ; Save RAM to a device
                3344 ;
F5DD 86AE       3345 JF5DD STX ZAE        ;set end of I/O area from XY
F5DF 84AF       3346       STY ZAF
F5E1 AA         3347       TAX            ;A = index to start address
F5E2 B500       3348       LDA Z00,X
F5E4 85C1       3349       STA ZC1        ;move start address to ZC1/2
F5E6 B501       3350       LDA Z01,X
F5E8 85C2       3351       STA ZC2
F5EA 6C3203     3352       JMP (X0332)    ;perform Save (normally F5ED)
                3353 ;
                3354 ;standard save RAM entry
                3355 ;
F5ED A5BA       3356 WF5ED LDA ZBA        ;if current device is keyboard (0)
F5EF D003       3357       BNE BF5F4
F5F1 4C13F7     3358 BF5F1 JMP JF713      ;indicate Illegal Device #
                3359 ;
F5F4 C903       3360 BF5F4 CMP $03        ;if current device is screen
F5F6 F0F9       3361       BEQ BF5F1      ;indicate error
F5F8 905F       3362       BCC BF659      ;skip if cassette
F5FA A961       3363       LDA $61        ;device must be serial bus,
F5FC 85B9       3364       STA ZB9        ;set temporary sec. adr to Output
F5FE A4B7       3365       LDY ZB7        ;if file name is not present
F600 D003       3366       BNE BF605
F602 4C10F7     3367       JMP JF710      ;indicate File Name Missing
                3368 ;
F605 20D5F3     3369 BF605 JSR SF3D5      ;perform open for serial bus device
F608 208FF6     3370       JSR SF68F      ;print Saving + file name
F60B A5BA       3371       LDA ZBA        ;get current device
F60D 200CED     3372       JSR SED0C      ;and send LISTEN on serial bus
F610 A5B9       3373       LDA ZB9        ;send secondary address
F612 20B9ED     3374       JSR SEDB9      ;on serial bus
F615 A000       3375       LDY $00
F617 208EFB     3376       JSR SFB8E      ;move ptr to I/O area into ZAC/D
F61A A5AC       3377       LDA ZAC
F61C 20DDED     3378       JSR JEDDD      ;send low of start address on serial bus
F61F A5AD       3379       LDA ZAD
F621 20DDED     3380       JSR JEDDD      ;then high byte
F624 20D1FC     3381 BF624 JSR SFCD1      ;if block is not finished
F627 B016       3382       BCS BF63F
F629 B1AC       3383       LDA (ZAC),Y    ;fetch next byte
F62B 20DDED     3384       JSR JEDDD      ;and send on serial bus
F62E 20E1FF     3385       JSR SFFE1      ;check for Stop key
F631 D007       3386       BNE BF63A
F633 2042F6     3387 JF633 JSR SF642      ;and close serial bus if depressed
F636 A900       3388       LDA $00
F638 38         3389       SEC
F639 60         3390       RTS
                3391 ;
F63A 20DBFC     3392 BF63A JSR SFCDB      ;increment address
F63D D0E5       3393       BNE BF624      ;and repeat
F63F 20FEED     3394 BF63F JSR SEDFE      ;send UNLISTEN on the serial bus
```

```
                3396 ;close serial bus device
                3397 ;
F642 24B9       3398 SF642 BIT ZB9        ;if secondary address valid,
F644 3011       3399       BMI BF657
F646 A5BA       3400       LDA ZBA        ;get current device
F648 200CED     3401       JSR SEDOC      ;and send LISTEN on serial bus
F64B A5B9       3402       LDA ZB9        ;fetch secondary address
F64D 29EF       3403       AND $EF        ;strip bit 4
F64F 09E0       3404       ORA $E0        ;force bits 7-5
F651 20B9ED     3405       JSR SEDB9      ;send secondary addr after LISTEN
F654 20FEED     3406 JF654 JSR SEDFE      ;send UNLISTEN on serial bus
F657 18         3407 BF657 CLC
F658 60         3408       RTS
                3409 ;
F659 4A         3410 BF659 LSR A          ;if device is not cassette
F65A B003       3411       BCS BF65F
F65C 4C13F7     3412       JMP JF713      ;indicate Illegal Device #
                3413 ;
                3414 ;save RAM to cassette
                3415 ;
F65F 20D0F7     3416 BF65F JSR SF7D0      ;set tape buffer pointer in XY
F662 908D       3417       BCC BF5F1      ;exit if address invalid
F664 2038F8     3418       JSR SF838      ;print msgs for cassette and test sense
F667 B025       3419       BCS BF68E
F669 208FF6     3420       JSR SF68F      ;print message Saving + file name
F66C A203       3421       LDX $03
F66E A5B9       3422       LDA ZB9
F670 2901       3423       AND $01        ;if secondary address is even,
F672 D002       3424       BNE BF676
F674 A201       3425       LDX $01        ;set secondary address to 1
F676 8A         3426 BF676 TXA
F677 206AF7     3427       JSR SF76A      ;write Program Header block to cassette
F67A B012       3428       BCS BF68E      ;exit upon error
F67C 2067F8     3429       JSR SF867      ;write block to cassette
F67F B00D       3430       BCS BF68E      ;again, exit upon error
F681 A5B9       3431       LDA ZB9        ;if write End-Of-Tape Mark specified,
F683 2902       3432       AND $02
F685 F006       3433       BEQ BF68D
F687 A905       3434       LDA $05        ;then write special block
F689 206AF7     3435       JSR SF76A
F68C 24         3436       .BY $24        ;skip next instruction
F68D 18         3437 BF68D CLC            ;indicate no errors
F68E 60         3438 BF68E RTS
                3439 ;
                3440 ;handle message Saving plus file name
                3441 ;
F68F A59D       3442 SF68F LDA Z9D
F691 10FB       3443       BPL BF68E      ;return if not in Direct mode
F693 A051       3444       LDY $51        ;point to message SAVING
F695 202FF1     3445       JSR BF12F      ;print message
F698 4CC1F5     3446       JMP JF5C1      ;then print file name
```

```
                3448 ;increment real time clock
                3449 ;
F69B A200       3450 JF69B LDX $00
F69D E6A2       3451       INC ZA2        ;bump low byte
F69F D006       3452       BNE BF6A7
F6A1 E6A1       3453       INC ZA1        ;then middle byte upon overflow
F6A3 D002       3454       BNE BF6A7
F6A5 E6A0       3455       INC ZA0        ;then high byte upon overflow
F6A7 38         3456 BF6A7 SEC
F6A8 A5A2       3457       LDA ZA2        ;check for full 24 hours
F6AA E901       3458       SBC $01
F6AC A5A1       3459       LDA ZA1
F6AE E91A       3460       SBC $1A
F6B0 A5A0       3461       LDA ZA0
F6B2 E94F       3462       SBC $4F
F6B4 9006       3463       BCC BF6BC
F6B6 86A0       3464       STX ZA0        ;yes, clear clock
F6B8 86A1       3465       STX ZA1
F6BA 86A2       3466       STX ZA2
F6BC AD01DC     3467 BF6BC LDA XDC01      ;read current keyboard scan line
F6BF CD01DC     3468       CMP XDC01
F6C2 D0F8       3469       BNE BF6BC      ;wait until steady
F6C4 AA         3470       TAX
F6C5 3013       3471       BMI BF6DA
F6C7 A2BD       3472       LDX $BD        ;select Stop key row
F6C9 8E00DC     3473       STX XDC00
F6CC AE01DC     3474 BF6CC LDX XDC01      ;read column
F6CF EC01DC     3475       CPX XDC01
F6D2 D0F8       3476       BNE BF6CC      ;wait until steady
F6D4 8D00DC     3477       STA XDC00
F6D7 E8         3478       INX
F6D8 D002       3479       BNE BF6DC
F6DA 8591       3480 BF6DA STA Z91        ;save scan result
F6DC 60         3481 BF6DC RTS
                3482 ;
                3483 ;read real time clock
                3484 ;
F6DD 78         3485 JF6DD SEI            ;kill IRQ to avoid interference
F6DE A5A2       3486       LDA ZA2        ;read low byte into A
F6E0 A6A1       3487       LDX ZA1        ;read middle byte into X
F6E2 A4A0       3488       LDY ZA0        ;and high byte into Y
                3489 ;
                3490 ;set real time clock
                3491 ;
F6E4 78         3492 JF6E4 SEI            ;disable IRQ to avoid interference
F6E5 85A2       3493       STA ZA2        ;set low byte from A
F6E7 86A1       3494       STX ZA1        ;set middle byte from X
F6E9 84A0       3495       STY ZA0        ;and set high byte from Y
F6EB 58         3496       CLI            ;enable IRQ's
F6EC 60         3497       RTS
```

```
                3499 ;test STOP key
                3500 ;
F6ED A591       3501 WF6ED LDA Z91
F6EF C97F       3502       CMP $7F       ;if Stop key is depressed
F6F1 D007       3503       BNE BF6FA
F6F3 08         3504       PHP           ;save flags on stack
F6F4 20CCFF     3505       JSR SFFCC     ;close files and set devices to default
F6F7 85C6       3506       STA ZC6       ;cancel keyboard queue
F6F9 28         3507       PLP           ;restore flags
F6FA 60         3508 BF6FA RTS
                3509 ;
                3510 ;handle I/O errors
                3511 ;
F6FB A901       3512 JF6FB LDA $01       ;Too Many Files
F6FD 2C         3513       .BY $2C
F6FE A902       3514 JF6FE LDA $02       ;File Open
F700 2C         3515       .BY $2C
F701 A903       3516 JF701 LDA $03       ;File Not Open
F703 2C         3517       .BY $2C
F704 A904       3518 JF704 LDA $04       ;File Not Found
F706 2C         3519       .BY $2C
F707 A905       3520 JF707 LDA $05       ;Device Not Present
F709 2C         3521       .BY $2C
F70A A906       3522 JF70A LDA $06       ;Not Input File
F70C 2C         3523       .BY $2C
F70D A907       3524 JF70D LDA $07       ;Not Output File
F70F 2C         3525       .BY $2C
F710 A908       3526 JF710 LDA $08       ;File Name Missing
F712 2C         3527       .BY $2C
F713 A909       3528 JF713 LDA $09       ;Illegal Device #
F715 48         3529       PHA           ;save error # on stack
F716 20CCFF     3530       JSR SFFCC     ;close files and set devices to default
F719 A000       3531       LDY $00
F71B 249D       3532       BIT Z9D
F71D 500A       3533       BVC BF729     ;if bit 6 in Direct/Run flag is set
F71F 202FF1     3534       JSR BF12F     ;print message I/O Error
F722 68         3535       PLA
F723 48         3536       PHA
F724 0930       3537       ORA $30
F726 20D2FF     3538       JSR SFFD2     ;followed by error #
F729 68         3539 BF729 PLA           ;restore error number
F72A 38         3540       SEC           ;set error flag
F72B 60         3541       RTS
```

```
                3543 ;get next file header from cassette
                3544 ;
F72C A593       3545 SF72C LDA Z93        ;save load/verify switch on stack
F72E 48         3546       PHA
F72F 2041F8     3547       JSR SF841      ;read a block from tape
F732 68         3548       PLA
F733 8593       3549       STA Z93        ;restore load/verify flag
F735 B032       3550       BCS BF769      ;exit if read error
F737 A000       3551       LDY $00
F739 B1B2       3552       LDA (ZB2),Y    ;get first character in tape buffer
F73B C905       3553       CMP $05        ;if code for End of Tape
F73D F02A       3554       BEQ BF769      ;return
F73F C901       3555       CMP $01
F741 F008       3556       BEQ BF74B      ;if not code for Program Header
F743 C903       3557       CMP $03        ;or "?"
F745 F004       3558       BEQ BF74B
F747 C904       3559       CMP $04
F749 D0E1       3560       BNE SF72C      ;or Data Header, try next block
F74B AA         3561 BF74B TAX
F74C 249D       3562       BIT Z9D        ;if in direct mode,
F74E 1017       3563       BPL BF767
F750 A063       3564       LDY $63        ;point to message FOUND
F752 202FF1     3565       JSR BF12F      ;and print it
F755 A005       3566       LDY $05
F757 B1B2       3567 BF757 LDA (ZB2),Y
F759 20D2FF     3568       JSR SFFD2      ;print a file name character
F75C C8         3569       INY
F75D C015       3570       CPY $15        ;and repeat for
F75F D0F6       3571       BNE BF757      ;all 21 characters
F761 A6:2       4683 FC872 DU: B:2
C874 35T5T0     4684       VES ETOT5      Xltfubiz ptba eija prn jid. 8.5 seconds
F766 EA         3574       NOP            ;filler for patch
F767 18         3575 BF767 CLC
F768 88         3576       DEY
F769 60         3577 BF769 RTS
```

```
                3579 ;write a special block to cassette with code from A
                3580 ;
F76A 859E       3581 SF76A STA Z9E       ;save code from A
F76C 20D0F7     3582       JSR SF7D0     ;set tape buffer index in XY
F76F 905E       3583       BCC BF7CF     ;exit if address invalid
F771 A5C2       3584       LDA ZC2       ;save I/O start address on stack
F773 48         3585       PHA
F774 A5C1       3586       LDA ZC1
F776 48         3587       PHA
F777 A5AF       3588       LDA ZAF       ;save ptr to end of I/O area on stack
F779 48         3589       PHA
F77A A5AE       3590       LDA ZAE
F77C 48         3591       PHA
F77D A0BF       3592       LDY $BF
F77F A920       3593       LDA $20
F781 91B2       3594 BF781 STA (ZB2),Y   ;clear cassette buffer with spaces
F783 88         3595       DEY
F784 D0FB       3596       BNE BF781
F786 A59E       3597       LDA Z9E       ;move routine entry code
F788 91B2       3598       STA (ZB2),Y   ;into first byte of cassette buffer
F78A C8         3599       INY
F78B A5C1       3600       LDA ZC1       ;move pointer to I/O area
F78D 91B2       3601       STA (ZB2),Y   ;+ 1
F78F C8         3602       INY
F790 A5C2       3603       LDA ZC2
F792 91B2       3604       STA (ZB2),Y   ;and + 2
F794 C8         3605       INY
F795 A5AE       3606       LDA ZAE       ;move pointer to end of I/O area into
F797 91B2       3607       STA (ZB2),Y   ;+ 3
F799 C8         3608       INY
F79A A5AF       3609       LDA ZAF
F79C 91B2       3610       STA (ZB2),Y   ;and + 4
F79E C8         3611       INY
F79F 849F       3612       STY Z9F       ;save index into tape buffer
F7A1 A000       3613       LDY $00
F7A3 849E       3614       STY Z9E       ;initialize file name index
F7A5 A49E       3615 BF7A5 LDY Z9E
F7A7 C4B7       3616       CPY ZB7       ;if not at end of file name
F7A9 F00C       3617       BEQ BF7B7
F7AB B1BB       3618       LDA (ZBB),Y   ;move file name
F7AD A49F       3619       LDY Z9F
F7AF 91B2       3620       STA (ZB2),Y   ;into tape buffer
F7B1 E69E       3621       INC Z9E       ;increment indexes
F7B3 E69F       3622       INC Z9F
F7B5 D0EE       3623       BNE BF7A5     ;and repeat
F7B7 20D7F7     3624 BF7B7 JSR SF7D7     ;set cassette buffer to I/O area
F7BA A969       3625       LDA $69
F7BC 85AB       3626       STA ZAB       ;set 105 sync patterns
F7BE 206BF8     3627       JSR SF86B     ;write block to tape
F7C1 A8         3628       TAY
F7C2 68         3629       PLA
F7C3 85AE       3630       STA ZAE       ;restore ptr to beginning of I/O area
F7C5 68         3631       PLA
F7C6 85AF       3632       STA ZAF
F7C8 68         3633       PLA
F7C9 85C1       3634       STA ZC1       ;restore pointer to end of I/O area
F7CB 68         3635       PLA
F7CC 85C2       3636       STA ZC2
F7CE 98         3637       TYA
F7CF 60         3638 BF7CF RTS
```

```
                3640 ;set tape buffer pointer in XY
                3641 ;
F7D0 A6B2       3642 SF7D0 LDX ZB2        ;move X to low part of tape buffer ptr
F7D2 A4B3       3643       LDY ZB3        ;and Y to high part
F7D4 C002       3644       CPY $02        ;set C if address invalid
F7D6 60         3645       RTS
                3646 ;
                3647 ;set cassette buffer to I/O area
                3648 ;
F7D7 20D0F7     3649 SF7D7 JSR SF7D0      ;set tape buffer address in XY
F7DA 8A         3650       TXA
F7DB 85C1       3651       STA ZC1        ;move to I/O start address
F7DD 18         3652       CLC
F7DE 69C0       3653       ADC $C0        ;add 192
F7E0 85AE       3654       STA ZAE        ;to form low part of end of I/O area
F7E2 98         3655       TYA
F7E3 85C2       3656       STA ZC2        ;move high byte also
F7E5 6900       3657       ADC $00
F7E7 85AF       3658       STA ZAF
F7E9 60         3659       RTS
                3660 ;
                3661 ;search tape for a file name
                3662 ;
F7EA 202CF7     3663 SF7EA JSR SF72C      ;read next file header from tape
F7ED B01D       3664       BCS BF80C      ;exit upon error
F7EF A005       3665       LDY $05
F7F1 849F       3666       STY Z9F        ;set temporary index in tape buffer
F7F3 A000       3667       LDY $00
F7F5 849E       3668       STY Z9E        ;set temporary index in file name
F7F7 C4B7       3669 BF7F7 CPY ZB7        ;if at end of file name
F7F9 F010       3670       BEQ BF80B      ;then name found
F7FB B1BB       3671       LDA (ZBB),Y    ;get character from file name
F7FD A49F       3672       LDY Z9F
F7FF D1B2       3673       CMP (ZB2),Y    ;and compare to tape buffer
F801 D0E7       3674       BNE SF7EA      ;if not equal, try next entry from tape
F803 E69E       3675       INC Z9E        ;else bump pointers
F805 E69F       3676       INC Z9F
F807 A49E       3677       LDY Z9E
F809 D0EC       3678       BNE BF7F7      ;and repeat test
F80B 18         3679 BF80B CLC            ;clear error flag
F80C 60         3680 BF80C RTS
                3681 ;
                3682 ;add 1 to tape index and test for overflow
                3683 ;
F80D 20D0F7     3684 SF80D JSR SF7D0      ;get tape buffer pointer in XY
F810 E6A6       3685       INC ZA6        ;and add 1
F812 A4A6       3686       LDY ZA6
F814 C0C0       3687       CPY $C0        ;set C if end of block
F816 60         3688       RTS
```

```
                3690 ;handle messages and test cassette buttons for read
                3691 ;
F817 202EF8     3692 SF817 JSR SF82E     ;test sense line
F81A F01A       3693       BEQ BF836     ;if no buttons depressed,
F81C A01B       3694       LDY $1B       ;point to message Press Play on Tape
F81E 202FF1     3695 BF81E JSR BF12F     ;and print message
F821 20D0F8     3696 BF821 JSR SF8D0     ;test Stop key
F824 202EF8     3697       JSR SF82E     ;test sense line
F827 D0F8       3698       BNE BF821     ;and repeat if no buttons depressed
F829 A06A       3699       LDY $6A       ;point to message OK
F82B 4C2FF1     3700       JMP BF12F     ;and print
                3701 ;
                3702 ;test sense line for a button depressed on cassette
                3703 ;
F82E A910       3704 SF82E LDA $10       ;set mask for sense line
F830 2401       3705       BIT Z01       ;test 6510 I/O register
F832 D002       3706       BNE BF836     ;exit with Z clear if nothing depressed
F834 2401       3707       BIT Z01       ;else set Z
F836 18         3708 BF836 CLC
F837 60         3709       RTS
                3710 ;
                3711 ;set messages and test cassette sense line for output
                3712 ;
F838 202EF8     3713 SF838 JSR SF82E     ;test sense switches
F83B F0F9       3714       BEQ BF836     ;if no buttons depressed
F83D A02E       3715       LDY $2E       ;index message Press Next & Play...
F83F D0DD       3716       BNE BF81E     ;print message, test sense and return
                3717 ;
                3718 ;read a block from cassette
                3719 ,
F841 A900       3720 SF841 LDA $00
F843 8590       3721       STA Z90       ;clear ST
F845 8593       3722       STA Z93       ;set load/verify switch to load
F847 20D7F7     3723       JSR SF7D7     ;set tape buffer to I/O area
F84A 2017F8     3724 SF84A JSR SF817     ;handle msgs and test sense for read
F84D B01F       3725       BCS BF86E
F84F 78         3726       SEI           ;disable IRQ
F850 A900       3727       LDA $00
F852 85AA       3728       STA ZAA       ;set gap
F854 85B4       3729       STA ZB4       ;set no sync established
F856 85B0       3730       STA ZB0       ;set no special speed correction yet
F858 859E       3731       STA Z9E       ;initialize error log index for pass 1
F85A 859F       3732       STA Z9F       ;and pass 2
F85C 859C       3733       STA Z9C       ;set no byte available yet
F85E A990       3734       LDA $90       ;set Flag mask
F860 A20E       3735       LDX $0E       ;index for cassette read IRQ address
F862 D011       3736       BNE BF875     ;JMP
```

```
            3738 ;write a block to cassette
            3739 ;
F864 20D7F7 3740 SF864 JSR SF7D7     ;initialize tape buffer pointer
F867 A914   3741 SF867 LDA $14
F869 85AB   3742       STA ZAB       ;20 sync patterns
F86B 2038F8 3743 SF86B JSR SF838     ;test sense and display msgs for output
F86E B06C   3744 BF86E BCS BF8DC
F870 78     3745       SEI
F871 A982   3746       LDA $82       ;mask for ICR1 to honor TB1
F873 A208   3747       LDX $08       ;IRQ index for cassette write, part 1
            3748 ;
            3749 ;common code for cassette read & write
            3750 ;
F875 A07F   3751 BF875 LDY $7F
F877 8C0DDC 3752       STY XDC0D     ;clear any pending masks in ICR1
F87A 8D0DDC 3753       STA XDC0D     ;then set mask for TB1
F87D AD0EDC 3754       LDA XDC0E
F880 0919   3755       ORA $19       ;+ force load, one shot and TB1 to CRA1
F882 8D0FDC 3756       STA XDC0F     ;to form CRB1
F885 2991   3757       AND $91
F887 8DA202 3758       STA X02A2     ;and CRB1 activity register
F88A 20A4F0 3759       JSR SF0A4     ;condition flag bit in ICR2
F88D AD11D0 3760       LDA XD011
F890 29EF   3761       AND $EF
F892 8D11D0 3762       STA XD011     ;disable the screen
F895 AD1403 3763       LDA X0314     ;save standard IRQ vector
F898 8D9F02 3764       STA X029F
F89B AD1503 3765       LDA X0315
F89E 8DA002 3766       STA X02A0
F8A1 20BDFC 3767       JSR SFCBD     ;set new IRQ for cassette depending on X
F8A4 A902   3768       LDA $02
F8A6 85BE   3769       STA ZBE       ;select phase 2
F8A8 2097FB 3770       JSR SFB97     ;initialize cassette I/O variables
F8AB A501   3771       LDA Z01
F8AD 291F   3772       AND $1F
F8AF 8501   3773       STA Z01       ;start cassette motor
F8B1 85C0   3774       STA ZC0       ;set tape motor interlock
F8B3 A2FF   3775       LDX $FF
F8B5 A0FF   3776 BF8B5 LDY $FF
F8B7 88     3777 BF8B7 DEY
F8B8 D0FD   3778       BNE BF8B7     ;delay .3 seconds
F8BA CA     3779       DEX
F8BB D0F8   3780       BNE BF8B5
F8BD 58     3781       CLI
F8BE ADA002 3782 JF8BE LDA X02A0     ;test high byte of IRQ save area
F8C1 CD1503 3783       CMP X0315     ;to determine if end of I/O
F8C4 18     3784       CLC
F8C5 F015   3785       BEQ BF8DC     ;exit if so
F8C7 20D0F8 3786       JSR SF8D0     ;else test Stop key
F8CA 20BCF6 3787       JSR BF6BC     ;scan keyboard
F8CD 4CBEF8 3788       JMP JF8BE     ;repeat
```

```
                3790 ;handle Stop key during cassette operations
                3791 ;
F8D0 20E1FF     3792 SF8D0 JSR SFFE1     ;test Stop key
F8D3 18         3793       CLC
F8D4 D00E       3794       BNE BF8E1
F8D6 2093FC     3795       JSR SFC93     ;if depressed, stop cassette operations
F8D9 38         3796       SEC
F8DA 68         3797       PLA           ;delete own return address
F8DB 68         3798       PLA
F8DC A900       3799 BF8DC LDA $00
F8DE 8DA002     3800       STA X02A0     ;clear high byte of IRQ save area
F8E1 60         3801 BF8E1 RTS
                3802 ;
                3803 ;schedule CIA1 Timer A depending in parmeter in X
                3804 ;
F8E2 86B1       3805 SF8E2 STX ZB1       ;save entry parameter
F8E4 A5B0       3806       LDA ZB0       ;get speed correction
F8E6 0A         3807       ASL A         ;* 2
F8E7 0A         3808       ASL A         ;* 4
F8E8 18         3809       CLC
F8E9 65B0       3810       ADC ZB0       ;add speed correction
F8EB 18         3811       CLC
F8EC 65B1       3812       ADC ZB1       ;and parameter
F8EE 85B1       3813       STA ZB1       ;save low order
F8F0 A900       3814       LDA $00
F8F2 24B0       3815       BIT ZB0       ;if speed correction is positive
F8F4 3001       3816       BMI BF8F7
F8F6 2A         3817       ROL A         ;get high order in A
F8F7 06B1       3818 BF8F7 ASL ZB1
F8F9 2A         3819       ROL A         ;* 2
F8FA 06B1       3820       ASL ZB1
F8FC 2A         3821       ROL A         ;* 4
F8FD AA         3822       TAX
F8FE AD06DC     3823 BF8FE LDA XDC06     ;wait until no chance of
F901 C916       3824       CMP $16       ;TBL1 changing
F903 90F9       3825       BCC BF8FE     ;while it still must be read
F905 65B1       3826       ADC ZB1       ;add low order offset to TBL1
F907 8D04DC     3827       STA XDC04     ;and store in TAL1
F90A 8A         3828       TXA
F90B 6D07DC     3829       ADC XDC07     ;add high order offset to TBH1
F90E 8D05DC     3830       STA XDC05     ;and store in TAH1
F911 ADA202     3831       LDA X02A2
F914 8D0EDC     3832       STA XDC0E     ;set CRA1 from CRB1 activity register
F917 8DA402     3833       STA X02A4     ;and save it
F91A AD0DDC     3834       LDA XDC0D
F91D 2910       3835       AND $10
F91F F009       3836       BEQ BF92A     ;if Flag bit is not set,
F921 A9F9       3837       LDA >BF92A    ;set exit address on stack
F923 48         3838       PHA
F924 A927       3839       LDA <BF92A
F926 48         3840       PHA
F927 4C43FF     3841       JMP JFF43     ;and simulate an IRQ
F92A 58         3842 BF92A CLI           ;else allow IRQ and exit
F92B 60         3843       RTS
```

```
                3845 ;cassette read IRQ routine
                3846 ;
F92C            3847 WF92C =   *
F92C AE07DC     3848 BF92C LDX XDC07     ;get TBH1
F92F A0FF       3849       LDY $FF
F931 98         3850       TYA           ;and complement of TBL1
F932 ED06DC     3851       SBC XDC06     ;(time elapsed)
F935 EC07DC     3852       CPX XDC07     ;if high byte not steady,
F938 D0F2       3853       BNE BF92C     ;repeat
F93A 86B1       3854       STX ZB1       ;else save high byte
F93C AA         3855       TAX
F93D 8C06DC     3856       STY XDC06     ;reset TBL1 to maximum
F940 8C07DC     3857       STY XDC07     ;ditto TBH1
F943 A919       3858       LDA $19       ;force load, one-shot and Timer B
F945 8D0FDC     3859       STA XDC0F     ;into CRB1
F948 AD0DDC     3860       LDA XDC0D
F94B 8DA302     3861       STA X02A3     ;save ICR1
F94E 98         3862       TYA
F94F E5B1       3863       SBC ZB1       ;complement high byte
F951 86B1       3864       STX ZB1       ;save low byte
F953 4A         3865       LSR A         ;elapsed time in A, ZB1
F954 66B1       3866       ROR ZB1       ;/ 2
F956 4A         3867       LSR A
F957 66B1       3868       ROR ZB1       ;/ 4
F959 A5B0       3869       LDA ZB0       ;get speed correction
F95B 18         3870       CLC
F95C 693C       3871       ADC $3C       ;+ 240 microseconds
F95E C5B1       3872       CMP ZB1       ;if cycle shorter
F960 B04A       3873       BCS BF9AC     ;dismiss
F962 A69C       3874       LDX Z9C       ;if byte available
F964 F003       3875       BEQ BF969
F966 4C60FA     3876       JMP JFA60     ;receive it
                3877 ;
F969 A6A3       3878 BF969 LDX ZA3       ;test bit count and if beyond last bit,
F96B 301B       3879       BMI BF988     ;do end of byte
F96D A200       3880       LDX $00       ;assume bit value of 0
F96F 6930       3881       ADC $30       ;add 432 microseconds
F971 65B0       3882       ADC ZB0       ;+ 2 * speed correction
F973 C5B1       3883       CMP ZB1       ;if cycle shorter
F975 B01C       3884       BCS BF993     ;record a 0
F977 E8         3885       INX           ;assume bit value of 1
F978 6926       3886       ADC $26       ;get 584 microseconds
F97A 65B0       3887       ADC ZB0       ;+ 3 * speed correction
F97C C5B1       3888       CMP ZB1       ;if cycle shorter
F97E B017       3889       BCS BF997     ;record a 1
F980 692C       3890       ADC $2C       ;get 760 microseconds
F982 65B0       3891       ADC ZB0       ;+ 4 * speed correction
F984 C5B1       3892       CMP ZB1       ;if cycle shorter
F986 9003       3893       BCC BF98B
F988 4C10FA     3894 BF988 JMP JFA10     ;go do end of byte
                3895 ;
F98B A5B4       3896 BF98B LDA ZB4       ;if sync established
F98D F01D       3897       BEQ BF9AC
F98F 85A8       3898       STA ZA8       ;set erroneous bits
F991 D019       3899       BNE BF9AC
F993 E6A9       3900 BF993 INC ZA9       ;for a 0, increment 0/1 balance
F995 B002       3901       BCS BF999
F997 C6A9       3902 BF997 DEC ZA9       ;for a 1, decrement 0/1 balance
F999 38         3903 BF999 SEC
F99A E913       3904       SBC $13       ;0/1 cutoff level
```

```
F99C E5B1   3905         SBC ZB1      ;- cycle width
F99E 6592   3906         ADC Z92
F9A0 8592   3907         STA Z92      ;accumulated for speed correction
F9A2 A5A4   3908         LDA ZA4
F9A4 4901   3909         EOR $01      ;flip cycle indication
F9A6 85A4   3910         STA ZA4
F9A8 F02B   3911         BEQ BF9D5    ;if first cycle,
F9AA 86D7   3912         STX ZD7      ;save bit value
F9AC A5B4   3913 BF9AC   LDA ZB4      ;if no sync yet
F9AE F022   3914         BEQ BF9D2    ;return from IRQ
F9B0 ADA302 3915         LDA X02A3    ;if ICR1 mask
F9B3 2901   3916         AND $01
F9B5 D005   3917         BNE BF9BC
F9B7 ADA402 3918         LDA X02A4    ;and last CRA1 mask shows no TA1 flag,
F9BA D016   3919         BNE BF9D2    ;exit from IRQ
F9BC A900   3920 BF9BC   LDA $00
F9BE 85A4   3921         STA ZA4      ;clear cycle count
F9C0 8DA402 3922         STA X02A4    ;and last CRA1 mask
F9C3 A5A3   3923         LDA ZA3      ;if bit count indicates end of byte,
F9C5 1030   3924         BPL BF9F7
F9C7 30BF   3925         BMI BF988    ;go do end of byte
F9C9 A2A6   3926 BF9C9   LDX $A6
F9CB 20E2F8 3927         JSR SF8E2    ;schedule timer
F9CE A59B   3928         LDA Z9B      ;if parity calculated does not match
F9D0 D0B9   3929         BNE BF98B    ;set erroneous bit flag
F9D2 4CBCFE 3930 BF9D2   JMP JFEBC    ;exit from IRQ
            3931 ;
F9D5 A592   3932 BF9D5   LDA Z92      ;if second cycle,
F9D7 F007   3933         BEQ BF9E0    ;check accumulated over/under time
F9D9 3003   3934         BMI BF9DE
F9DB C6B0   3935         DEC ZB0
F9DD 2C     3936         .BY $2C      ;skip next instruction
F9DE E6B0   3937 BF9DE   INC ZB0      ;adapt speed correction accordingly
F9E0 A900   3938 BF9E0   LDA $00
F9E2 8592   3939         STA Z92      ;reset accumulated over/under time
F9E4 E4D7   3940         CPX ZD7      ;if 2nd cycle = complement of cycle 1,
F9E6 D00F   3941         BNE BF9F7    ;include bit
F9E8 8A     3942         TXA
F9E9 D0A0   3943         BNE BF98B    ;if two 0 cycles
F9EB A5A9   3944         LDA ZA9      ;and 0/1 balance
F9ED 30BD   3945         BMI BF9AC
F9EF C910   3946         CMP $10      ;at least 16 "0" cycles extra
F9F1 90B9   3947         BCC BF9AC
F9F3 8596   3948         STA Z96      ;set sync detected
F9F5 B0B5   3949         BCS BF9AC
F9F7 8A     3950 BF9F7   TXA
F9F8 459B   3951         EOR Z9B      ;calculate parity
F9FA 859B   3952         STA Z9B
F9FC A5B4   3953         LDA ZB4      ;if no sync yet,
F9FE F0D2   3954         BEQ BF9D2    ;exit
FA00 C6A3   3955         DEC ZA3      ;decrement pending bit count
FA02 30C5   3956         BMI BF9C9    ;after last bit, check parity
FA04 46D7   3957         LSR ZD7      ;include bit
FA06 66BF   3958         ROR ZBF      ;in byte being read
FA08 A2DA   3959         LDX $DA
FA0A 20E2F8 3960         JSR SF8E2    ;schedule timer
FA0D 4CBCFE 3961         JMP JFEBC    ;exit from IRQ
            3962 ;
FA10 A596   3963 JFA10   LDA Z96      ;if sync detected
FA12 F004   3964         BEQ BFA18
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FA14 A5B4   3965         LDA ZB4       ;and not yet established
FA16 F007   3966         BEQ BFA1F
FA18 A5A3   3967 BFA18   LDA ZA3       ;or last bit done
FA1A 3003   3968         BMI BFA1F
FA1C 4C97F9 3969         JMP BF997     ;allow byte reception
            3970 ;
FA1F 46B1   3971 BFA1F   LSR ZB1       ;compute new speed correction value
FA21 A993   3972         LDA $93
FA23 38     3973         SEC
FA24 E5B1   3974         SBC ZB1
FA26 65B0   3975         ADC ZB0
FA28 0A     3976         ASL A
FA29 AA     3977         TAX
FA2A 20E2F8 3978         JSR SF8E2     ;schedule timer
FA2D E69C   3979         INC Z9C       ;indicate byte available
FA2F A5B4   3980         LDA ZB4       ;if not [illegible]
FA31 D011   3981         BNE BFA44
FA33 A596   3982         LDA Z96       ;but sync detected
FA35 F026   3983         BEQ BFA5D
FA37 85A8   3984         STA ZA8       ;set error bits
FA39 A900   3985         LDA $00
FA3B 8596   3986         STA Z96       ;clear sync detected
FA3D A981   3987         LDA $81       ;set TA1 bit
FA3F 8D0DDC 3988         STA XDC0D     ;in ICR1
FA42 85B4   3989         STA ZB4       ;set sync established
FA44 A596   3990 BFA44   LDA Z96       ;move sync status
FA46 85B5   3991         STA ZB5       ;to saved sync status
FA48 F009   3992         BEQ BFA53
FA4A A900   3993         LDA $00       ;if not detected,
FA4C 85B4   3994         STA ZB4       ;indicate sync not established
FA4E A901   3995         LDA $01
FA50 8D0DDC 3996         STA XDC0D     ;clear TA mask in ICR1
FA53 A?FI   [illegible]               ;save byte read
FA55 85BD   3998         STA ZBD
FA57 A5A8   3999         LDA ZA8
FA59 05A9   4000         ORA ZA9       ;accumulate possible errors
FA5B 85B6   4001         STA ZB6
FA5D 4CBCFE 4002 BFA5D   JMP JFEBC     ;exit from IRQ
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```
                4004 ;receive next byte from cassette
                4005 ;
FA60 2097FB     4006 JFA60 JSR SFB97     ;initialize cassette I/O variables
FA63 859C       4007       STA Z9C       ;indicate no byte available yet
FA65 A2DA       4008       LDX $DA
FA67 20E2F8     4009       JSR SF8E2     ;schedule Timer
FA6A A5BE       4010       LDA ZBE       ;if first or second phase being read,
FA6C F002       4011       BEQ BFA70
FA6E 85A7       4012       STA ZA7       ;copy into actual phase
FA70 A90F       4013 BFA70 LDA $0F
FA72 24AA       4014       BIT ZAA       ;if data beyond area
FA74 1017       4015       BPL BFA8D
FA76 A5B5       4016       LDA ZB5       ;and in second half
FA78 D00C       4017       BNE BFA86
FA7A A6BE       4018       LDX ZBE
FA7C CA         4019       DEX
FA7D D00B       4020       BNE BFA8A
FA7F A908       4021       LDA $08       ;indicate Long Block in ST
FA81 201CFE     4022       JSR SFE1C
FA84 D004       4023       BNE BFA8A     ;and exit
FA86 A900       4024 BFA86 LDA $00
FA88 85AA       4025       STA ZAA       ;set gap
FA8A 4CBCFE     4026 BFA8A JMP JFEBC     ;exit from IRQ
                4027 ;
FA8D 7031       4028 BFA8D BVS BFAC0     ;if data, go collect
FA8F D018       4029       BNE BFAA9     ;if header, decrement count
FA91 A5B5       4030       LDA ZB5       ;if gap and byte valid
FA93 D0F5       4031       BNE BFA8A
FA95 A5B6       4032       LDA ZB6       ;and no erroneous bits
FA97 D0F1       4033       BNE BFA8A
FA99 A5A7       4034       LDA ZA7       ;get actual phase
FA9B 4A         4035       LSR A         ;bit 7 of byte
FA9C A5BD       4036       LDA ZBD
FA9E 3003       4037       BMI BFAA3
FAA0 9018       4038       BCC BFABA
FAA2 18         4039       CLC
FAA3 B015       4040 BFAA3 BCS BFABA     ;must correspond to header phase
FAA5 290F       4041       AND $0F
FAA7 85AA       4042       STA ZAA       ;set header count
FAA9 C6AA       4043 BFAA9 DEC ZAA       ;decrement header count
FAAB D0DD       4044       BNE BFA8A     ;at end of header,
FAAD A940       4045       LDA $40
FAAF 85AA       4046       STA ZAA       ;set data
FAB1 208EFB     4047       JSR SFB8E     ;move beginning of I/O area into ZAC/D
FAB4 A900       4048       LDA $00
FAB6 85AB       4049       STA ZAB       ;clear checksum
FAB8 F0D0       4050       BEQ BFA8A
FABA A980       4051 BFABA LDA $80       ;if illegal header
FABC 85AA       4052       STA ZAA       ;set Data After Area
FABE D0CA       4053       BNE BFA8A
FAC0 A5B5       4054 BFAC0 LDA ZB5       ;if data, but data not valid
FAC2 F00A       4055       BEQ BFACE
FAC4 A904       4056       LDA $04       ;set Short Block Error
FAC6 201CFE     4057       JSR SFE1C     ;and indicate in ST
FAC9 A900       4058       LDA $00
FACB 4C4AFB     4059       JMP JFB4A     ;do end of block
                4060 ;
FACE 20D1FC     4061 BFACE JSR SFCD1     ;if at end of area,
FAD1 9003       4062       BCC BFAD6
FAD3 4C48FB     4063       JMP JFB48     ;set data after area
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                4064 ;
FAD6 A6A7       4065 BFAD6 LDX ZA7        ;if actual phase = 1
FAD8 CA         4066       DEX
FAD9 F02D       4067       BEQ BFB08      ;do error correction
FADB A593       4068       LDA Z93
FADD F00C       4069       BEQ BFAEB      ;if Verify pass
FADF A000       4070       LDY $00
FAE1 A5BD       4071       LDA ZBD
FAE3 D1AC       4072       CMP (ZAC),Y    ;compare byte to current character
FAE5 F004       4073       BEQ BFAEB
FAE7 A901       4074       LDA $01
FAE9 85B6       4075       STA ZB6        ;set error flag upon mismatch
FAEB A5B6       4076 BFAEB LDA ZB6        ;if errors
FAED F04B       4077       BEQ BFB3A
FAEF A23D       4078       LDX $3D
FAF1 E49E       4079       CPX Z9E        ;and error log table is not at maximum
FAF3 903E       4080       BCC BFB33
FAF5 A69E       4081       LDX Z9E
FAF7 A5AD       4082       LDA ZAD
FAF9 9D0101     4083       STA X0100+1,X ;store pointer into error log table
FAFC A5AC       4084       LDA ZAC
FAFE 9D0001     4085       STA X0100,X
FB01 E8         4086       INX
FB02 E8         4087       INX
FB03 869E       4088       STX Z9E        ;set new error log index
FB05 4C3AFB     4089       JMP BFB3A
                4090 ;
FB08 A69F       4091 BFB08 LDX Z9F
FB0A E49E       4092       CPX Z9E        ;if pass 2 error log index at maximum,
FB0C F03 :      4093       [illegible]    ;no correction possible
FB0E A5AC       4094       LDA ZAC        ;else
FB10 DD0001     4095       CMP X0100,X    ;check for match in error log table
FB13 D02E       4096       BNE BFB43
FB15 A5AD       4097       LDA ZAD
FB17 DD0101     4098       CMP X0100+1,X
FB1A D027       4099       BNE BFB43
FB1C E69F       4100       INC Z9F        ;if so, bump pass 2 error log index
FB1E E69F       4101       INC Z9F
FB20 A593       4102       LDA Z93        ;if Verify pass
FB22 F00B       4103       BEQ BFB2F
FB24 A5BD       4104       LDA ZBD
FB26 A000       4105       LDY $00
FB28 D1AC       4106       CMP (ZAC),Y    ;compare byte to current character
FB2A F017       4107       BEQ BFB43      ;set error if not equal
FB2C C8         4108       INY
FB2D 84B6       4109       STY ZB6
FB2F A5B6       4110 BFB2F LDA ZB6        ;if still an error
FB31 F007       4111       BEQ BFB3A
FB33 A910       4112 BFB33 LDA $10
FB35 201CFE     4113       JSR SFE1C      ;set Unrecoverable Read Error in ST
FB38 D009       4114       BNE BFB43
FB3A A593       4115 BFB3A LDA Z93        ;if Load,
FB3C D005       4116       BNE BFB43
FB3E A8         4117       TAY
FB3F A5BD       4118       LDA ZBD
FB41 91AC       4119       STA (ZAC),Y    ;store byte
FB43 20DBFC     4120 BFB43 JSR SFCDB      ;increment address
FB46 D043       4121       BNE BFB8B      ;and exit
FB48 A980       4122 JFB48 LDA $80        ;set data after area
FB4A 85AA       4123 JFB4A STA ZAA
```

```
FB4C 78     4124         SEI
FB4D A201   4125         LDX $01
FB4F 8E0DDC 4126         STX XDC0D      ;clear TA mask from ICR1
FB52 AE0DDC 4127         LDX XDC0D
FB55 A6BE   4128         LDX ZBE        ;if phase 1 or 2
FB57 CA     4129         DEX
FB58 3002   4130         BMI BFB5C
FB5A 86BE   4131         STX ZBE        ;decrement phase
FB5C C6A7   4132 BFB5C   DEC ZA7        ;decrement actual phase
FB5E F008   4133         BEQ BFB68      ;if not end of block
FB60 A59E   4134         LDA Z9E        ;and no errors encountered
FB62 D027   4135         BNE BFB8B      ;skip phase
FB64 85BE   4136         STA ZBE
FB66 F023   4137         BEQ BFB8B      ;if end of block,
FB68 2093FC 4138 BFB68   JSR SFC93      ;switch from cassette to default IRQ
FB6B 208EFB 4139         JSR SFB8E      ;move beginning of I/O area into ZAC/D
FB6E A000   4140         LDY $00
FB70 84AB   4141         STY ZAB        ;clear checksum value
FB72 B1AC   4142 BFB72   LDA (ZAC),Y    ;compute checksum
FB74 45AB   4143         EOR ZAB
FB76 85AB   4144         STA ZAB
FB78 20DBFC 4145         JSR SFCDB      ;bump address
FB7B 20D1FC 4146         JSR SFCD1      ;check for end of block
FB7E 90F2   4147         BCC BFB72
FB80 A5AB   4148         LDA ZAB
FB82 45BD   4149         EOR ZBD        ;if computed checksum does not match,
FB84 F005   4150         BEQ BFB8B
FB86 A920   4151         LDA $20
FB88 201CFE 4152         JSR SFE1C      ;set Checksum Error in ST
FB8B 4CBCFE 4153 BFB8B   JMP JFEBC      ;return from IRQ
```

```
                4155 ;move save/load address into ZAC/D
                4156 ;
FB8E A5C2       4157 SFB8E LDA ZC2        ;move high byte of save/load pointer
FB90 85AD       4158       STA ZAD
FB92 A5C1       4159       LDA ZC1        ;then low byte
FB94 85AC       4160       STA ZAC
FB96 60         4161       RTS
                4162 ;
                4163 ;initialize cassette read/write variables
                4164 ;
FB97 A908       4165 SFB97 LDA $08
FB99 85A3       4166       STA ZA3        ;set bit count
FB9B A900       4167       LDA $00
FB9D 85A4       4168       STA ZA4        ;clear cycle count
FB9F 85A8       4169       STA ZA8        ;clear byte start cycle 1
FBA1 859B       4170       STA Z9B        ;clear parity bit
FBA3 85A9       4171       STA ZA9        ;clear byte start cycle 2
FBA5 60         4172       RTS
                4173 ;
                4174 ;schedule ICR1 Timer B and invert cassette write line
                4175 ;
FBA6 A5BD       4176 SFBA6 LDA ZBD
FBA8 4A         4177       LSR A          ;move bit 0 of current character into C
FBA9 A960       4178       LDA $60        ;start with value for a 0
FBAB 9002       4179       BCC BFBAF
FBAD A9B0       4180 SFBAD LDA $B0        ;if a 1 to be sent, set value for a 1
FBAF A200       4181 BFBAF LDX $00
FBB1 8D06DC     4182 SFBB1 STA XDC06      ;TBL1 set to 0
FBB4 8E07DC     4183       STX XDC07      ;TBH1 set to $60/$B0
FBB7 AD0DDC     4184       LDA XDC0D
FBBA A919       4185       LDA $19        ;force load, one-shot and Timer B
FBBC 8D0FDC     4186       STA XDC0F      ;into CRB1
FBBF A501       4187       LDA Z01
FBC1 4908       4188       EOR $08        ;invert polarity of cassette write bit
FBC3 8501       4189       STA Z01
FBC5 2908       4190       AND $08        ;indicate polarity in A and Z
FBC7 60         4191       RTS
```

```
                4193 ;IRQ routine for cassette write, part 2 (at FBCD)
                4194 ;
                4195 ;used for byte start cycle and each half cycle per data bit
                4196 ;
FBC8 38         4197 BFBC8 SEC
FBC9 66B6       4198       ROR ZB6      ;set current byte pointer => 32K
FBCB 303C       4199       BMI BFC09    ;JMP
FBCD A5A8       4200 WFBCD LDA ZA8      ;if byte start cycle 1
FBCF D012       4201       BNE BFBE3
FBD1 A910       4202       LDA $10
FBD3 A201       4203       LDX $01      ;set AX to 272
FBD5 20B1FB     4204       JSR SFBB1    ;invert output and schedule timer
FBD8 D02F       4205       BNE BFC09    ;if output is zero again
FBDA E6A8       4206       INC ZA8      ;indicate cycle 1 finished
FBDC A5B6       4207       LDA ZB6      ;if current byte pointer => 32K
FBDE 1029       4208       BPL BFC09
FBE0 4C57FC     4209       JMP JFC57    ;switch to other cassette write IRQ
                4210 ;
FBE3 A5A9       4211 BFBE3 LDA ZA9      ;if byte start cycle 2
FBE5 D009       4212       BNE BFBF0
FBE7 20ADFB     4213       JSR SFBAD    ;invert output and schedule timer
FBEA D01D       4214       BNE BFC09    ;if output is zero again
FBEC E6A9       4215       INC ZA9      ;increment count for 2 cycles per bit
FBEE D019       4216       BNE BFC09
FBF0 20A6FB     4217 BFBF0 JSR SFBA6    ;invert output and schedule timer
FBF3 D014       4218       BNE BFC09    ;if output is zero again
FBF5 A5A4       4219       LDA ZA4
FBF7 4901       4220       EOR $01      ;increment count for 2 cycles per bit
FBF9 85A4       4221       STA ZA4
FBFB F00F       4222       BEQ BFC0C    ;if cycle is complete
FBFD A5BD       4223       LDA ZBD
FBFF 4901       4224       EOR $01      ;invert data bit for next cycle
FC01 85BD       4225       STA ZBD
FC03 2901       4226       AND $01      ;add bit
FC05 459B       4227       EOR Z9B      ;to parity
FC07 859B       4228       STA Z9B
FC09 4CBCFE     4229 BFC09 JMP JFEBC    ;and exit IRQ
                4230 ;
FC0C 46BD       4231 BFC0C LSR ZBD      ;if 2 cycles done,
FC0E C6A3       4232       DEC ZA3      ;decrement bit count
FC10 A5A3       4233       LDA ZA3
FC12 F03A       4234       BEQ BFC4E    ;after byte, send parity bit
FC14 10F3       4235       BPL BFC09    ;during byte, send next bit
FC16 2097FB     4236 BFC16 JSR SFB97    ;at end of byte, reset variables
FC19 58         4237       CLI          ;allow IRQ
FC1A A5A5       4238       LDA ZA5      ;if block header count
FC1C F012       4239       BEQ BFC30    ;not zero
FC1E A200       4240       LDX $00
FC20 86D7       4241       STX ZD7      ;clear checksum
FC22 C6A5       4242       DEC ZA5      ;decrement header count
FC24 A6BE       4243       LDX ZBE
FC26 E002       4244       CPX $02      ;if phase 2
FC28 D002       4245       BNE BFC2C
FC2A 0980       4246       ORA $80      ;add 128 to count
FC2C 85BD       4247 BFC2C STA ZBD      ;and send count as data for header
FC2E D0D9       4248       BNE BFC09    ;return from IRQ
FC30 20D1FC     4249 BFC30 JSR SFCD1    ;if end of data reached
FC33 900A       4250       BCC BFC3F    ;do next byte
FC35 D091       4251       BNE BFBC8    ;if beyond, waste time
FC37 E6AD       4252       INC ZAD      ;if at end, set pointer beyond end
```

```
FC39 A5D7   4253         LDA ZD7       ;get checksum
FC3B 85BD   4254         STA ZBD       ;and send it
FC3D B0CA   4255         BCS BFC09     ;return from IRQ
FC3F A000   4256 BFC3F   LDY $00
FC41 B1AC   4257         LDA (ZAC),Y   ;get next byte to write
FC43 85BD   4258         STA ZBD       ;and move to output character buffer
FC45 45D7   4259         EOR ZD7       ;compute checksum
FC47 85D7   4260         STA ZD7
FC49 20DBFC 4261         JSR SFCDB     ;advance address
FC4C D0BB   4262         BNE BFC09     ;return from IRQ
FC4E A59B   4263 BFC4E   LDA Z9B       ;get parity bit
FC50 4901   4264         EOR $01       ;invert it
FC52 85BD   4265         STA ZBD       ;put into output buffer
FC54 4CBCFE 4266 BFC54   JMP JFEBC     ;return from IRQ
            4267 ;
FC57 C6BE   4268 JFC57   DEC ZBE       ;decrement phase
FC59 D003   4269         BNE BFC5E     ;if phase is 0
FC5B 20CAFC 4270         JSR SFCCA     ;stop cassette operations
FC5E A950   4271 BFC5E   LDA $50       ;set # cycles per sync to 40
FC60 85A7   4272         STA ZA7
FC62 A208   4273         LDX $08
FC64 78     4274         SEI           ;set IRQ vector
FC65 20BDFC 4275         JSR SFCBD     ;for cassette write, part 1
FC68 D0EA   4276         BNE BFC54     ;return from IRQ
```

```
                4278 ;IRQ routine for cassette write, part 1
                4279 ;
                4280 ;entered for each block copy and for end of block
                4281 ;
FC6A A978       4282 WFC6A LDA $78
FC6C 20AFFB     4283       JSR BFBAF      ;invert output and schedule Timer
FC6F D0E3       4284       BNE BFC54      ;if output is zero again
FC71 C6A7       4285       DEC ZA7        ;decrement cycle count per sync
FC73 D0DF       4286       BNE BFC54      ;when zero,
FC75 2097FB     4287       JSR SFB97      ;reset cassette read/write variables
FC78 C6AB       4288       DEC ZAB        ;decrement sync count per block
FC7A 10D8       4289       BPL BFC54      ;if negative,
FC7C A20A       4290       LDX $0A        ;set IRQ vector
FC7E 20BDFC     4291       JSR SFCBD      ;to other cassette write routine
FC81 58         4292       CLI            ;enable IRQ
FC82 E6AB       4293       INC ZAB        ;sync count set to 0
FC84 A5BE       4294       LDA ZBE        ;if phase = 0
FC86 F030       4295       BEQ BFCB8      ;go terminate
FC88 208EFB     4296       JSR SFB8E      ;move start of I/O area to current addr
FC8B A209       4297       LDX $09
FC8D 86A5       4298       STX ZA5        ;set block header count
FC8F 86B6       4299       STX ZB6        ;and current byte pointer
FC91 D083       4300       BNE BFC16      ;go write block
                4301 ;
                4302 ;switch from cassette IRQ to default IRQ
                4303 ;
FC93 08         4304 SFC93 PHP            ;save flags
FC94 78         4305       SEI            ;disable IRQ
FC95 AD11D0     4306       LDA XD011
FC98 0910       4307       ORA $10        ;make screen visible again
FC9A 8D11D0     4308       STA XD011
FC9D 20CAFC     4309       JSR SFCCA      ;stop cassette motor
FCA0 A97F       4310       LDA $7F
FCA2 8D0DDC     4311       STA XDC0D      ;clear mask for all IRQ's in ICR1
FCA5 20DDFD     4312       JSR SFDDD      ;reset TA1 to 1/60 of a second
FCA8 ADA002     4313       LDA X02A0
FCAB F009       4314       BEQ BFCB6
FCAD 8D1503     4315       STA X0315      ;restore standard IRQ vector
FCB0 AD9F02     4316       LDA X029F
FCB3 8D1403     4317       STA X0314
FCB6 28         4318 BFCB6 PLP            ;restore flags
FCB7 60         4319       RTS
```

```
                4321 ;terminate cassette I/O
                4322 ;
FCB8 2093FC     4323 BFCB8 JSR SFC93       ;switch from cassette to default IRQ
FCBB F097       4324       BEQ BFC54       ;return from IRQ
                4325 ;
                4326 ;set IRQ vector depending upon X.
                4327 ;
FCBD BD93FD     4328 SFCBD LDA TFD9B-8,X ;move low byte of address
FCC0 8D1403     4329       STA X0314     ;into low byte of IRQ vector
FCC3 BD94FD     4330       LDA TFD9B-7,X ;then do high byte
FCC6 8D1503     4331       STA X0315
FCC9 60         4332       RTS
                4333 ;
                4334 ;stop cassette motor
                4335 ;
FCCA A501       4336 SFCCA LDA Z01
FCCC 0920       4337       ORA $20        ;set bit 5 high in 6510 I/O register
FCCE 8501       4338       STA Z01        ;to stop cassette motor
FCD0 60         4339       RTS
                4340 ;
                4341 ;compare ZAC/D with ZAE/F
                4342 ;
FCD1 38         4343 SFCD1 SEC
FCD2 A5AC       4344       LDA ZAC
FCD4 E5AE       4345       SBC ZAE        ;compare low parts
FCD6 A5AD       4346       LDA ZAD
FCD8 E5AF       4347       SBC ZAF        ;then high parts
FCDA 60         4348       RTS            ;C is clear when ZAC/D is low
                4349 ;
                4350 ;increment ZAC/D
                4351 ;
FCDB E6AC       4352 SFCDB INC ZAC        ;increment low
FCDD D002       4353       BNE BFCE1
FCDF E6AD       4354       INC ZAD        ;then high when necessary
FCE1 60         4355 BFCE1 RTS
```

```
                4357 ;Reset routine
                4358 ;
FCE2 A2FF       4359 WFCE2 LDX $FF
FCE4 78         4360       SEI             ;disable IRQ
FCE5 9A         4361       TXS             ;set stack pointer
FCE6 D8         4362       CLD             ;clear decimal mode
FCE7 2002FD     4363       JSR SFD02       ;test for a cartridge
FCEA D003       4364       BNE BFCEF
FCEC 6C0080     4365       JMP (X8000)     ;if found, execute cartridge Reset
                4366 ;
FCEF 8E16D0     4367 BFCEF STX XD016       ;clear RES bit in video chip
FCF2 20A3FD     4368       JSR SFDA3       ;initialize I/O devices
FCF5 2050FD     4369       JSR SFD50       ;initialize memory pointers
FCF8 2015FD     4370       JSR SFD15       ;restore I/O vectors
FCFB 205BFF     4371       JSR JFF5B       ;initialize screen and keyboard
FCFE 58         4372       CLI             ;enable IRQ
FCFF 6C00A0     4373       JMP (XA000)     ;begin execution
                4374 ;
                4375 ;check for the presence of a cartridge
                4376 ;
FD02 A205       4377 SFD02 LDX $05         ;set length of key
FD04 BD0FFD     4378 BFD04 LDA TFD10-1,X ;compare table contents
FD07 DD0380     4379       CMP X8004-1,X ;to cartridge contents
FD0A D003       4380       BNE BFD0F       ;exit with Z clear upon mismatch
FD0C CA         4381       DEX
FD0D D0F5       4382       BNE BFD04       ;repeat for 5 characters
FD0F 60         4383 BFD0F RTS             ;Z set upon match
                4384 ;
                4385 ;cartridge key for autostart and warm start possibilities
                4386 ;
FD10 C3C2CD     4387 TFD10 .BY 'C+$80,'B+$80,'M+$80,'8,'0
```

```
                4389 ;restore I/O vectors
                4390 ;
FD15 A230       4391 SFD15 LDX <TFD30     ;set XY to standard table
FD17 A0FD       4392       LDY >TFD30
FD19 18         4393       CLC            ;clear carry to use XY address
                4394 ;
                4395 ;set I/O vectors depending on XY
                4396 ;
FD1A 86C3       4397 JFD1A STX ZC3        ;store XY in temporary pointer
FD1C 84C4       4398       STY ZC4
FD1E A01F       4399       LDY $1F        ;set count for move
FD20 B91403     4400 BFD20 LDA X0314,Y
FD23 B002       4401       BCS BFD27      ;if carry set, don't fetch from XY addr
FD25 B1C3       4402       LDA (ZC3),Y    ;move one byte
FD27 91C3       4403 BFD27 STA (ZC3),Y
FD29 991403     4404       STA X0314,Y    ;to I/O vector
FD2C 88         4405       DEY
FD2D 10F1       4406       BPL BFD20      ;repeat for 32 bytes
FD2F 60         4407       RTS
                4408 ;
                4409 ;vectors for Operating System at $0314-0333
                4410 ;
FD30 31EA       4411 TFD30 .W  WEA31      ;IRQ
FD32 66FE       4412       .W  WFE66      ;BRK
FD34 47FE       4413       .W  WFE47      ;NMI
FD36 4AF3       4414       .W  WF34A      ;OPEN
FD38 91F2       4415       .W  WF291      ;CLOSE
FD3A 0EF2       4416       .W  WF20E      ;set input device
FD3C 50F2       4417       .W  WF250      ;set output device
FD3E 33F3       4418       .W  WF333      ;restore I/O
FD40 57F1       4419       .W  WF157      ;input
FD42 CAF1       4420       .W  WF1CA      ;output
FD44 EDF6       4421       .W  WF6ED      ;test Stop key
FD46 3EF1       4422       .W  WF13E      ;get
FD48 2FF3       4423       .W  WF32F      ;abort I/O
FD4A 66FE       4424       .W  WFE66      ;unused (BRK)
FD4C A5F4       4425       .W  WF4A5      ;load RAM
FD4E EDF5       4426       .W  WF5ED      ;save RAM
```

```
                4428 ;initialize memory pointers
                4429 ;
FD50 A900       4430 SFD50 LDA $00
FD52 A8         4431       TAY
FD53 990200     4432 BFD53 STA Z02,Y      ;clear page 0
FD56 990002     4433       STA X0200,Y    ;page 2
FD59 990003     4434       STA X0300,Y    ;and page 3
FD5C C8         4435       INY
FD5D D0F4       4436       BNE BFD53
FD5F A23C       4437       LDX $3C
FD61 A003       4438       LDY $03
FD63 86B2       4439       STX ZB2        ;set tape buffer pointer
FD65 84B3       4440       STY ZB3
FD67 A8         4441       TAY
FD68 A903       4442       LDA $03
FD6A 85C2       4443       STA ZC2        ,initialize page for RAM test
FD6C E6C2       4444 BFD6C INC ZC2        ;continue RAM test on next memory page
FD6E B1C1       4445 BFD6E LDA (ZC1),Y
FD70 AA         4446       TAX            ;save RAM contents
FD71 A955       4447       LDA $55
FD73 91C1       4448       STA (ZC1),Y
FD75 D1C1       4449       CMP (ZC1),Y
FD77 D00F       4450       BNE BFD88      ;if $55 not't read back, then end of RAM
FD79 2A         4451       ROL A
FD7A 91C1       4452       STA (ZC1),Y
FD7C D1C1       4453       CMP (ZC1),Y
FD7E D008       4454       BNE BFD88      ;if $AA not read back, then end of RAM
FD80 8A         4455       TXA
FD81 91C1       4456       STA (ZC1),Y    ;else restore original contents
FD83 C8         4457       INY            ;bump address
FD84 D0E8       4458       BNE BFD6E      ;continue on same page if not overflow
FD86 F0E4       4459       BEQ BFD6C      ;else continue test on next page
FD88 98         4460 BFD88 TYA
FD89 AA         4461       TAX
FD6A A4C2       4462       LDY ZC2
FD8C 18         4463       CLC
FD8D 202DFE     4464       JSR JFE2D      ;set top of memory pointer from X
FD90 A908       4465       LDA $08
FD92 8D8202     4466       STA X0282      ;set bottom of memory pointer
FD95 A904       4467       LDA $04
FD97 8D8802     4468       STA X0288      ;set s[illegible]
FD9A 60         4469       RTS
                4470 ;
                4471 ;IRQ vectors
                4472 ;
FD9B 6AFC       4473 TFD9B .W  WFC6A      ;X=$08, cassette write routine, part 1
FD9D CDFB       4474       .W  WFBCD      ;X=$0A cassette write routine, part 2
FD9F 31EA       4475       .W  WEA31      ;X=$0C standard IRQ routine
FDA1 2CF9       4476       .W  WF92C      ;X=$0E cassette read routine
```

```
                4478 ;initialize I/O devices
                4479 ;
FDA3 A97F       4480 SFDA3 LDA $7F       ;clear all mask bits in ICR1
FDA5 8D0DDC     4481       STA XDC0D
FDA8 8D0DDD     4482       STA XDD0D     ;and in ICR2
FDAB 8D00DC     4483       STA XDC00     ;set PA1 to $7F
FDAE A908       4484       LDA $08
FDB0 8D0EDC     4485       STA XDC0E     ;one-shot mode in CRA1
FDB3 8D0EDD     4486       STA XDD0E     ;and CRA2
FDB6 8D0FDC     4487       STA XDC0F     ;and CRB1
FDB9 8D0FDD     4488       STA XDD0F     ;and CRB2
FDBC A200       4489       LDX $00
FDBE 8E03DC     4490       STX XDC03     ;DDRB1 set to all inputs
FDC1 8E03DD     4491       STX XDD03     ;DDRB2 set to all inputs
FDC4 8E18D4     4492       STX XD418     ;kill volume in SID chip
FDC7 CA         4493       DEX
FDC8 8E02DC     4494       STX XDC02     ;DDRA1 set to all outputs
FDCB A907       4495       LDA $07
FDCD 8D00DD     4496       STA XDD00     ;PA2 bits 0-2 set high
FDD0 A93F       4497       LDA $3F
FDD2 8D02DD     4498       STA XDD02     ;DDRA2 bits 0-5 set to outputs
FDD5 A9E7       4499       LDA $E7
FDD7 8501       4500       STA Z01       ;initialize 6510 I/O register
FDD9 A92F       4501       LDA $2F
FDDB 8500       4502       STA Z00       ;and 6510 data direction register
                4503 ;
                4504 ;initialize TAL1/TAH1 for 1/60 of a second
                4505 ;
FDDD ADA602     4506 SFDDD LDA X02A6
FDE0 F00A       4507       BEQ BFDEC     ;if this is an Intl. machine,
FDE2 A925       4508       LDA $25       ;use Intl value for 1/60 second delay
FDE4 8D04DC     4509       STA XDC04     ;and store in TAL1
FDE7 A940       4510       LDA $40       ;high byte of value
FDE9 4CF3FD     4511       JMP JFDF3     ;go set high byte of timer
                4512 ;
FDEC A995       4513 BFDEC LDA $95       ;since this is US machine, use US value
FDEE 8D04DC     4514       STA XDC04     ;for 1/60 second to set TAL1
FDF1 A942       4515       LDA $42       ;high byte of value
FDF3 8D05DC     4516 JFDF3 STA XDC05     ;set TAH1
FDF6 4C6EFF     4517       JMP JFF6E     ;go set CRA1 for continuous timer IRQ's
                4518 ;
                4519 ;initialize file name parameters
                4520 ;
FDF9 85B7       4521 JFDF9 STA ZB7       ;set # of characters in file name
FDFB 86BB       4522       STX ZBB       ;set address of file name
FDFD 84BC       4523       STY ZBC       ;+ high byte
FDFF 60         4524       RTS
                4525 ;
                4526 ;initialize file parameters
                4527 ;
FE00 85B8       4528 JFE00 STA ZB8       ;set logical file
FE02 86BA       4529       STX ZBA       ;set current device
FE04 84B9       4530       STY ZB9       ;set secondary address
FE06 60         4531       RTS
```

```
                4533 ;read I/O status word
                4534 ;
FE07 A5BA       4535 JFE07 LDA ZBA
FE09 C902       4536       CMP $02        ;if RS-232 device,
FE0B D00D       4537       BNE BFE1A
FE0D AD9702     4538       LDA X0297      ;read RS-232 Status Register
FE10 48         4539       PHA
FE11 A900       4540       LDA $00
FE13 8D9702     4541       STA X0297      ;then clear RS-232 Status Register
FE16 68         4542       PLA            ;and restore original contents in A
FE17 60         4543       RTS
                4544 ;
                4545 ;control kernal messages
                4546 ;
FE18 859D       4547 JFE18 STA Z9D        ;set direct/run mode ($80/$00)
                4548 ;
                4549 ;read ST
                4550 ;
FE1A A590       4551 BFE1A LDA Z90        ;fetch current ST
                4552 ;
                4553 ;add A to current ST
                4554 ;
FE1C 0590       4555 SFE1C ORA Z90        ;add existing bits to A
FE1E 8590       4556       STA Z90        ;and store new ST
FE20 60         4557       RTS
                4558 ;
                4559 ;set timeout on serial bus
                4560 ;
FE21 8D8502     4561 JFE21 STA X0285      ;serial bus timeout flag (not used)
FE24 60         4562       RTS
                4563 ;
                4564 ;read/set top of memory
                4565 ;
FE25 9006       4566 JFE25 BCC JFE2D      ;if carry is clear, set pointers from XY
FE27 AE8302     4567 SFE27 LDX X0283      ;else fetch top of memory into XY
FE2A AC8402     4568       LDY X0284
FE2D 8E8302     4569 JFE2D STX X0283      ;set top of memory from X
FE30 8C8402     4570       STY X0284      ;and high byte from Y
FE33 60         4571       RTS
                4572 ;
                4573 ;read/set bottom of memory
                4574 ;
FE34 9006       4575 JFE34 BCC BFE3C      ;if carry is clear, set pointer from XY
FE36 AE8102     4576       LDX X0281      ;else fetch bottom of memory into XY
FE39 AC8202     4577       LDY X0282
FE3C 8E8102     4578 BFE3C STX X0281      ;set low byte bottom of memory from X
FE3F 8C8202     4579       STY X0282      ;and high byte from Y
FE42 60         4580       RTS
```

```
                4582 ;NMI entry
                4583 ;
FE43 78         4584 WFE43 SEI
FE44 6C1803     4585       JMP (X0318)    ;perform NMI (normally FE47)
                4586 ;
                4587 ;standard NMI routine
                4588 ;
FE47 48         4589 WFE47 PHA            ;save A on stack
FE48 8A         4590       TXA
FE49 48         4591       PHA            ;save X on stack
FE4A 98         4592       TYA
FE4B 48         4593       PHA            ;save Y on stack
FE4C A97F       4594       LDA $7F
FE4E 8D0DDD     4595       STA XDD0D      ;clear ICR2 IRQ mask bits
FE51 AC0DDD     4596       LDY XDD0D
FE54 301C       4597       BMI BFE72      ;if no IRQ's were present
FE56 2002FD     4598       JSR SFD02      ;check for a cartridge
FE59 D003       4599       BNE BFE5E      ;if cartridge present,
FE5B 6C0280     4600       JMP (X8002)    ;perform cartridge warm start
                4601 ;
FE5E 20BCF6     4602 BFE5E JSR BF6BC      ;scan the keyboard
FE61 20E1FF     4603       JSR SFFE1      ;check for Stop key
FE64 D00C       4604       BNE BFE72      ;and drop thru to BRK if depressed
                4605 ;
                4606 ;BRK routine
                4607 ;
FE66 2015FD     4608 WFE66 JSR SFD15      ;restore I/O vectors
FE69 20A3FD     4609       JSR SFDA3      ;initialize I/O devices
FE6C 2018E5     4610       JSR SE518      ;initialize screen and keyboard
FE6F 6C02A0     4611       JMP (XA002)    ;perform warm start
```

```
                4613 ;internal NMI
                4614 ;
FE72 98         4615 BFE72 TYA          ;get ICR2
FE73 2DA102     4616       AND X02A1    ;mask with ICR2 activity register
FE76 AA         4617       TAX          ;save results
FE77 2901       4618       AND $01
FE79 F028       4619       BEQ BFEA3    ;if transmitting
FE7B AD00DD     4620       LDA XDD00
FE7E 29FB       4621       AND $FB      ;clear RS-232 output data line
FE80 05B5       4622       ORA ZB5      ;and add bit to be transmitted
FE82 8D00DD     4623       STA XDD00    ;and send it
FE85 ADA102     4624       LDA X02A1    ;use ICR2 activity register
FE88 8D0DDD     4625       STA XDD0D    ;to set ICR2
FE8B 8A         4626       TXA
FE8C 2912       4627       AND $12      ;if not receiving/waiting receiver edge,
FE8E F00D       4628       BEQ BFE9D    ;send next bit on serial bus
FE90 2902       4629       AND $02
FE92 F006       4630       BEQ BFE9A    ;if not receiving,
FE94 20D6FE     4631       JSR SFED6    ;input next bit on RS-232
FE97 4C9DFE     4632       JMP BFE9D    ;then send next bit on RS-232 bus
                4633 ;
FE9A 2007FF     4634 BFE9A JSR SFF07    ;schedule TB2 using baud rate factor
FE9D 20BBEE     4635 BFE9D JSR SEEBB    ;send next bit on RS-232
FEA0 4CB6FE     4636       JMP JFEB6    ;exit from NMI
                4637 ;
FEA3 8A         4638 BFEA3 TXA
FEA4 2902       4639       AND $02
FEA6 F006       4640       BEQ BFEAE    ;if receiving data,
FEA8 20D6FE     4641       JSR SFED6    ;input next bit on RS-232, schedule TB2
FEAB 4CB6FE     4642       JMP JFEB6    ;exit from NMI
                4643 ;
FEAE 8A         4644 BFEAE TXA
FEAF 2910       4645       AND $10
FEB1 F003       4646       BEQ JFEB6    ;if waiting for receiver edge,
FEB3 2007FF     4647       JSR SFF07    ;schedule TB2 using baud rate factor
FEB6 ADA102     4648 JFEB6 LDA X02A1    ;use ICR2 activity register
FEB9 8D0DDD     4649       STA XDD0D    ;to set ICR2
FEBC 68         4650 JFEBC PLA
FEBD A8         4651       TAY          ;restore Y
FEBE 68         4652       PLA
FEBF AA         4653       TAX          ;restore X
FEC0 68         4654       PLA          ;restore A
FEC1 40         4655       RTI          ;and return from NMI
```

```
                4657 ;table of baud rate factors based upon
                4658 ;((clock frequency/baud rate/2)-100)
                4659 ;this table applies to US machine clock frequency
                4660 ;
FEC2 C127       4661 TFEC2 .W  $27C1      ;50 baud
FEC4 3E1A       4662       .W  $1A3E      ;75
FEC6 C511       4663       .W  $11C5      ;110
FEC8 740E       4664       .W  $0E74      ;134.5
FECA ED0C       4665       .W  $0CED      ;150
FECC 4506       4666       .W  $0645      ;300
FECE F002       4667       .W  $02F0      ;600
FED0 4601       4668       .W  $0146      ;1200
FED2 B800       4669       .W  $00B8      ;1800
FED4 7100       4670       .W  $0071      ;2400
                4671 ;
                4672 ;input next bit on RS-232 bus and schedule TB2
                4673 ;
FED6 AD01DD     4674 SFED6 LDA XDD01
FED9 2901       4675       AND $01        ;mask bit read
FEDB 85A7       4676       STA ZA7        ;and save in temporary storage area
FEDD AD06DD     4677       LDA XDD06      ;use TAL2
FEE0 E91C       4678       SBC $1C        ;and overhead
FEE2 6D9902     4679       ADC X0299      ;and baud rate full bit time
FEE5 8D06DD     4680       STA XDD06      ;to reset TBL2
FEE8 AD07DD     4681       LDA XDD07
FEEB 6D9A02     4682       ADC X029A
FEEE 8D07DD     4683       STA XDD07      ;and TBH2
FEF1 A911       4684       LDA $11
FEF3 8D0FDD     4685       STA XDD0F      ;set force load + start TB2 bits in CRB2
FEF6 ADA102     4686       LDA X02A1
FEF9 8D0DDD     4687       STA XDD0D      ;set ICR2 from ICR2 activity register
FEFC A9FF       4688       LDA $FF
FEFE 8D06DD     4689       STA XDD06      ;set TBL2
FF01 8D07DD     4690       STA XDD07      ;and TBH2 to maximum value
FF04 4C59EF     4691       JMP JEF59      ;add input bit to word being read
                4692 ;
                4693 ;schedule TB2 using baud rate factor
                4694 ;
FF07 AD9502     4695 SFF07 LDA X0295      ;move bit time
FF0A 8D06DD     4696       STA XDD06      ;to TBL2
FF0D AD9602     4697       LDA X0296
FF10 8D07DD     4698       STA XDD07      ;and TBH2
FF13 A911       4699       LDA $11
FF15 8D0FDD     4700       STA XDD0F      ;set force load and TB in CRB2
FF18 A912       4701       LDA $12
FF1A 4DA102     4702       EOR X02A1      ;invert waiting for receiver edge and
FF1D 8DA102     4703       STA X02A1      ;receiving data bits in activity reg
FF20 A9FF       4704       LDA $FF
FF22 8D06DD     4705       STA XDD06      ;set TBL2 to maximum value
FF25 8D07DD     4706       STA XDD07      ;set TBH2 to maximum value
FF28 AE9802     4707       LDX X0298
FF2B 86A8       4708       STX ZA8        ;set number of bits to send/receive
FF2D 60         4709       RTS
```

```
                4711 ;continuation of baud rate calcuation
                4712 ;
FF2E AA         4713 SFF2E TAX
FF2F AD9602     4714       LDA X0296
FF32 2A         4715       ROL A          ;multiply factor * 2
FF33 A8         4716       TAY
FF34 8A         4717       TXA
FF35 69C8       4718       ADC $C8        ;and add 200
FF37 8D9902     4719       STA X0299      ;to form baud rate
FF3A 98         4720       TYA
FF3B 6900       4721       ADC 0
FF3D 8D9A02     4722       STA X029A
FF40 60         4723       RTS
                4724 ;
FF41 EA         4725       NOP
FF42 EA         4726       NOP
                4727 ;
FF43 08         4728 JFF43 PHP
FF44 68         4729       PLA
FF45 29EF       4730       AND $EF        ;clear BRK status bit
FF47 48         4731       PHA
                4732 ;
                4733 ;IRQ entry point
                4734 ;
FF48 48         4735 WFF48 PHA            ;save A on stack
FF49 8A         4736       TXA
FF4A 48         4737       PHA            ;save X on stack
FF4B 98         4738       TYA
FF4C 48         4739       PHA            ;save Y on stack
FF4D BA         4740       TSX
FF4E BD0401     4741       LDA X0100+4,X ;check BRK bit
FF51 2910       4742       AND $10
FF53 F003       4743       BEQ BFF58
FF55 6C1603     4744       JMP (X0316)    ;perform BRK (normally FE66)
                4745 ;
FF58 6C1403     4746 BFF58 JMP (X0314)    ;else IRQ (normally EA31)
                4747 ;
                4748 ;addition to I/O device initialization
                4749 ;
FF5B 2018E5     4750 JFF5B JSR SE518      ;initialize screen and keyboard
FF5E AD12D0     4751 BFF5E LDA XD012
FF61 D0FB       4752       BNE BFF5E      ;wait for raster count to clear
FF63 AD19D0     4753       LDA XD019      ;use interrupt register
FF66 2901       4754       AND $01
FF68 8DA602     4755       STA X02A6      ;to set US/Intl machine flag (0=US)
FF6B 4CDDFD     4756       JMP SFDDD      ;set clock for 1/60 second IRQ's
                4757 ;
                4758 ;end of scheduling TA for 1/60 second IRQ's
                4759 ;
FF6E A981       4760 JFF6E LDA $81
FF70 8D0DDC     4761       STA XDC0D      ;set TA mask in ICR1
FF73 AD0EDC     4762       LDA XDC0E      ;use CRA1
FF76 2980       4763       AND $80        ;bit 7 (50/60 Hz flag)
FF78 0911       4764       ORA $11        ;+ force load, continuous mode and TA1
FF7A 8D0EDC     4765       STA XDC0E      ;to set CRA1
FF7D 4C8EEE     4766       JMP SEE8E      ;set serial clock line high and return
FF80 00         4767       .BY $00        ;filler
```

```
                4769 ;kernal vectors
                4770 ;
FF81 4C5BFF     4771        JMP JFF5B     ;initialize screen and keyboard
                4772 ;
FF84 4CA3FD     4773        JMP SFDA3     ;initialize I/O devices
                4774 ;
FF87 4C50FD     4775        JMP SFD50     ;initialize memory pointers
                4776 ;
FF8A 4C15FD     4777        JMP SFD15     ;restore I/O vectorsces
                4778 ;
FF8D 4C1AFD     4779        JMP JFD1A     ;set I/O vectors from XY
                4780 ;
FF90 4C18FE     4781        JMP JFE18     ;control kernal messages
                4782 ;
FF93 4CB9ED     4783        JMP SEDB9     ;send Secondary Address after Listen
                4784 ;
FF96 4CC7ED     4785        JMP SEDC7     ;send Secondary Address after Talk
                4786 ;
FF99 4C25FE     4787 SFF99 JMP JFE25      ;read/set top of memory
                4788 ;
FF9C 4C34FE     4789 SFF9C JMP JFE34      ;read/set bottom of memory
                4790 ;
FF9F 4C87EA     4791        JMP SEA87     ;scan keyboard
                4792 ;
FFA2 4C21FE     4793        JMP JFE21     ;set timeout for serial bus
                4794 ;
FFA5 4C13EE     4795        JMP JEE13     ;input byte on serial bus
                4796 ;
FFA8 4CDDED     4797        JMP JEDDD     ;output byte on serial bus
                4798 ;
FFAB 4CEFED     4799        JMP SEDEF     ;send Untalk on serial bus
                4800 ;
FFAE 4CFEED     4801        JMP SEDFE     ;send Unlisten on serial bus
                4802 ;
FFB1 4C0CED     4803        JMP SED0C     ;send Listen on serial bus
                4804 ;
FFB4 4C09ED     4805        JMP SED09     ;send Talk on serial bus
                4806 ;
FFB7 4C07FE     4807 SFFB7 JMP JFE07      ;read I/O status word
                4808 ;
FFBA 4C00FE     4809 SFFBA JMP JFE00      ;set file parameters
                4810 ;
FFBD 4CF9FD     4811 SFFBD JMP JFDF9      ;set file name parameters
                4812 ;
FFC0 6C1A03     4813 SFFC0 JMP (X031A)    ;open a file (F34A)
                4814 ;
FFC3 6C1C03     4815 SFFC3 JMP (X031C)    ;close a file (F291)
                4816 ;
FFC6 6C1E03     4817 SFFC6 JMP (X031E)    ;set input device (F20E)
                4818 ;
FFC9 6C2003     4819 SFFC9 JMP (X0320)    ;set output device (F250)
                4820 ;
FFCC 6C2203     4821 SFFCC JMP (X0322)    ;restore I/O devices to default (F333)
                4822 ;
FFCF 6C2403     4823 SFFCF JMP (X0324)    ;input char on current device (F157)
                4824 ;
FFD2 6C2603     4825 SFFD2 JMP (X0326)    ;output char to current device (F1CA)
                4826 ;
FFD5 4C9EF4     4827 SFFD5 JMP JF49E      ;load RAM from a device
                4828 ;
```

```
FFD8 4CDDF5 4829 SFFD8 JMP JF5DD     ;save RAM to a device
             4830 ;
FFDB 4CE4F6 4831       JMP JF6E4     ;set real time clock
             4832 ;
FFDE 4CDDF6 4833       JMP JF6DD     ;read real time clock
             4834 ;
FFE1 6C2803 4835 SFFE1 JMP (X0328)   ;check Stop key (F6ED)
             4836 ;
FFE4 6C2A03 4837 SFFE4 JMP (X032A)   ;get a character (F13E)
             4838 ;
FFE7 6C2C03 4839       JMP (X032C)   ;close all channels and files (F32F)
             4840 ;
FFEA 4C9BF6 4841 SFFEA JMP JF69B     ;increment real time clock
             4842 ;
FFED 4C05E5 4843       JMP JE505     ;read organization of screen into XY
             4844 ;
FFF0 4C0AE5 4845       JMP JE50A     ;read/set XY cursor position
             4846 ;
FFF3 4C00E5 4847 SFFF3 JMP JE500     ;read base address of I/O devices
             4848 ;
             4849 ;garbage
             4850 ;
FFF6 525242 4851       .BY $52,$52,$42,$59
             4852 ;
             4853 ;6510 fixed vectors
             4854 ;
FFFA 43FE   4855       .W  WFE43     ;NMI vector
FFFC E2FC   4856       .W  WFCE2     ;RESET vector
FFFE 48FF   4857       .W  WFF48     ;IRQ/BRK vector
```

```
BE00B   E00B  333
BE00E   E00E  327
BE01E   E01E  343
BE06C   E06C  379
BE070   E070  396
BE07D   E07D  388
BE0BE   E0BE  410
BE0D3   E0D3  409
BE0F9   E0F9  470  474  478  482  486  520  587
BE104   E104  459
BE109   E109  465
BE194   E194  546  586
BE195   E195  539
BE19E   E19E  543
BE1A1   E1A1  554
BE1B5   E1B5  560
BE1D1   E1D1  537  578
BE20D   E20D  618  627
BE23F   E23F  647
BE29D   E29D  688  727
BE2A0   E2A0  691
BE2AD   E2AD  700
BE316   E316  756
BE324   E324  761
BE337   E337  770
BE33D   E33D  775
BE386   E386  833
BE391   E391  821
BE3A8   E3A8  838
BE3B9   E3B9  842
BE3E2   E3E2  876
BE421   E421  902
BE455   E455  941
BE4B6   E4B6  960
BE4E2   E4E2  985
BE4EB   E4EB  983
BE513   E513 1016
BE54D   E54D 1056
BE555   E555 1052
BE560   E560 1062
BE570   E570 1077
BE57C   E57C 1072
BE58D   E58D 1091
BE597   E597 1087
BE5AA   E5AA 1108
BE5B9   E5B9 1119
BE5CA   E5CA 1154
BE5CD   E5CD 1132 1151 1187
BE5E7   E5E7 1135
BE5F3   E5F3 1150
BE5FE   E5FE 1143
BE606   E606 1161
BE60F   E60F 1159
BE63A   E63A 1169 1173 1177
BE64A   E64A 1197
BE650   E650 1199
BE654   E654 1201 1202
BE65D   E65D 1178
BE66F   E66F 1213
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BE672     E672 1216
BE674     E674 1207
BE682     E682 1226
BE690     E690 1234
BE699     E699 1245
BE69F     E69F 1248
BE6A8     E6A8 1317 1407 1425 1475 1506 1509 1514 1541 2007 2019
BE6B0     E6B0 1259
BE6CD     E6CD 1278
BE6DA     E6DA 1283 1674 1708
BE6F4     E6F4 1299
BE6F7     E6F7 1276
BE700     E700 1274
BE70B     E70B 1313
BE72A     E72A 1337
BE731     E731 1341
BE73D     E73D 1347
BE73F     E73F 1349
BE745     E745 1345
BE74C     E74C 1355
BE759     E759 1361
BE762     E762 1379
BE77E     E77E 1359
BE785     E785 1386
BE78B     E78B 1390
BE792     E792 1393
BE7A8     E7A8 1417 1418
BE7AA     E7AA 1402
BE7AD     E7AD 1396
BE7C0     E7C0 1423
BE7C8     E7C8 1421
BE7CB     E7CB 1384
BE7CE     E7CE 1410
BE7DC     E7DC 1434
BE7E3     E7E3 1437
BE7EA     E7EA 1441
BE7FE     E7FE 1451
BE805     E805 1453
BE80A     E80A 1469
BE826     E826 1455
BE829     E829 1447
BE82D     E82D 1445
BE832     E832 1478
BE847     E847 1490
BE84C     E84C 1483
BE854     E854 1496
BE864     E864 1502
BE86A     E86A 1500
BE871     E871 1485 1492 1494
BE874     E874 1512
BE880     E880 1529
BE888     E888 1526
BE8A5     E8A5 1552
BE8B0     E8B0 1548
BE8B7     E8B7 1567
BE8C2     E8C2 1563
BE8CA     E8CA 1572
BE8CD     E8CD 1582
BE8D6     E8D6 1580
BE8F6     E8F6 1630
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BE8FF     E8FF 1614
BE913     E913 1609
BE918     E918 1625
BE922     E922 1620
BE94D     E94D 1645 1647
BE956     E956 1641
BE981     E981 1668 1669
BE98F     E98F 1694
BE9A6     E9A6 1688 1689
BE9AB     E9AB 1706
BE9BA     E9BA 1702
BE9BF     E9BF 1698
BE9D4     E9D4 1723
BEA07     EA07 1757
BEA5C     EA5C 1799
BEA61     EA61  840 1790 1792
BEA71     EA71 1811
BEA79     EA79 1816
BEA7B     EA7B 1818
BEAA8     EAA8 1875
BEAAB     EAAB 1852
BEAB3     EAB3 1870
BEAC9     EAC9 1858 1860
BEACB     EACB 1863
BEACC     EACC 1854
BEADC     EADC 1868
BEAF0     EAF0 1883
BEAFB     EAFB 1840
BEB0D     EB0D 1890 1895 1897 1899
BEB17     EB17 1903
BEB26     EB26 1886 1893
BEB42     EB42 1891 1901 1905 1907 1912 1918 1922 1934
BEB64     EB64 1932
BEB6B     EB6B 1946
BEB76     EB76 1936 1940
BEC58     EC58 2001
BEC5B     EC5B 2015
BEC5E     EC5E 2003
BEC69     EC69 2010
BEC72     EC72 2013
BED20     ED20 2104
BED2E     ED2E 2115
BED50     ED50 2135
BED55     ED55 2137
BED5A     ED5A 2133 2139
BED66     ED66 2145 2163
BED7A     ED7A 2149
BED7D     ED7D 2151
BED9F     ED9F 2173
BEDAD     EDAD 2130
BEDB0     EDB0 2147 2171
BEDD6     EDD6 2203
BEDE6     EDE6 2210
BEDEB     EDEB 2213
BEE03     EE03 2183
BEE09     EE09 2239
BEE1B     EE1B 2251
BEE20     EE20 2274
BEE30     EE30 2262
BEE3E     EE3E 2260
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BEE47     EE47 2265
BEE56     EE56 2263
BEE5A     EE5A 2279 2281 2289
BEE67     EE67 2285 2287
BEE80     EE80 2292
BEEB6     EEB6 2342
BEEC8     EEC8 2353
BEED1     EED1 2375 2377 2387
BEED7     EED7 2359
BEEE6     EEE6 2379 2382 2384
BEEE7     EEE7 2371 2381 2383
BEEF2     EEF2 2367
BEEF6     EEF6 2369
BEEFC     EEFC 2368
BEF00     EF00 2350
BEF06     EF06 2349 2565
BEF13     EF13 2390
BEF2E     EF2E 2392
BEF31     EF31 2393
BEF39     EF39 2401
BEF54     EF54 2427
BEF58     EF58 2429
BEF6D     EF6D 2457 2495 2499 2501
BEF6E     EF6E 2494
BEF70     EF70 2440
BEF7E     EF7E 2472 2511
BEF90     EF90 2437
BEF97     EF97 2439
BEFA9     EFA9 2490
BEFB1     EFB1 2487
BEFC5     EFC5 2498
BEFCA     EFCA 2481
BEFCD     EFCD 2515
BEFD0     EFD0 2514
BEFDB     EFDB 2452
BEFF2     EFF2 2529
BEFF9     EFF9 2531
BF006     F006 2537
BF00D     F00D 2525 2580 3135
BF012     F012 2522 2526 2536
BF014     F014 2549
BF04C     F04C 2556
BF062     F062 2584
BF070     F070 2590
BF077     F077 2597
BF07D     F07D 2575 2577
BF084     F084 2581
BF09C     F09C 2606
BF0AA     F0AA 2625
BF0BB     F0BB 2622
BF12F     F12F 2658 3320 3324 3445 3534 3565 3695 3700
BF13C     F13C 2651
BF14A     F14A 2665
BF155     F155 2667
BF166     F166 2672 2682
BF173     F173 2690
BF18D     F18D 2705
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Z04       0004  871
Z05       0005  866
Z06       0006  867
Z07       0007  330
Z0A       000A  531  533  538
Z12       0012  692  694  710  720
Z13       0013  812  881
Z16       0016  887
Z18       0018  882
Z22       0022  412  415  418  421  424  661
Z23       0023  413  662
Z2B       002B  518  534  890  900  901  908  916
Z2C       002C  535  891  903  909  919
Z2D       002D  516  561
Z2E       002E  517  562
Z33       0033  896
Z34       0034  897
Z37       0037  461  894  914
Z38       0038  460  895  918
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Z49	0049	584	601	607	636	645	655								
Z4A	004A	643	654												
Z4E	004E	712	713	722	723										
Z53	0053	878													
Z54	0054	858													
Z56	0056	323	344												
Z57	0057	362	365	366	715	716									
Z5C	005C	393	394												
Z61	0061	325	339	340	447	450	758								
Z62	0062	416	438	440											
Z63	0063	422	441	443											
Z64	0064	419	442	444											
Z65	0065	425	437	439											
Z66	0066	446	686	690	719	754									
Z67	0067	375	395												
Z68	0068	880													
Z69	0069	338	341												
Z6E	006E	676													
Z6F	006F	352	681												
Z70	0070	345	448												
Z71	0071	359	371	374	376	381	384	390							
Z72	0072	360	372	380	382	385	391								
Z73	0073	874													
Z7A	007A	544	837												
Z7B	007B	558	839												
Z8B	008B	428	429	452	453										
Z90	0090	2291	2732	2834	2873	2955	3076	3082	3180	3203	3217	3218	3225		
		3242	3269	3721	4551	4555	4556								
Z91	0091	981	3480	3501											
Z92	0092	3906	3907	3932	3939										
Z93	0093	3178	3230	3338	3545	3549	3722	4068	4102	4115					
Z94	0094	2103	2108	2209	2212										
Z95	0095	2111	2148	2187	2196	2217									
Z96	0096	3948	3963	3982	3986	3990									
Z97	0097	2673	2675	2699	2709	2716									
Z98	0098	2939	2940	2942	2957	2977	3003	3008							
Z99	0099	1103	1211	2572	2664	2681	2819	2985	2990						
Z9A	009A	1101	1214	2519	2756	2859	2982	2988							
Z9B	009B	3928	3951	3952	4170	4227	4228	4263							
Z9C	009C	3733	3874	3979	4007										
Z9D	009D	2650	3317	3442	3532	3562	4547								
Z9E	009E	2552	2768	2783	2790	3581	3597	3614	3615	3621	3668	3675	3677		
		3731	4079	4081	4088	4092	4134								
Z9F	009F	3612	3619	3622	3666	3672	3676	3732	4091	4100	4101				
ZA0	00A0	3455	3461	3464	3488	3495									
ZA1	00A1	984	3453	3459	3465	3487	3494	3572							
ZA2	00A2	3451	3457	3466	3486	3493									
ZA3	00A3	2106	2109	2132	3878	3923	3955	3967	4166	4232	4233				
ZA4	00A4	2282	2294	3908	3910	3921	4168	4219	4221						
ZA5	00A5	2142	2162	2248	2264	2273	2276	2288	4238	4242	4298				
ZA6	00A6	2708	2726	2782	3065	3685	3686								
ZA7	00A7	2441	2444	2451	2471	2496	4012	4034	4065	4132	4272	4285	4676		
ZA8	00A8	2438	2450	2456	3898	3984	3999	4169	4200	4206	4708				
ZA9	00A9	2436	2465	2473	3900	3902	3944	4000	4171	4211	4215				
ZAA	00AA	2445	2484	2513	3728	4014	4025	4042	4043	4046	4052	4123			
ZAB	00AB	2442	2443	2497	3626	3742	4049	4141	4143	4144	4148	4288	4293		
ZAC	00AC	1594	1611	1657	1676	1691	1718	1729	3377	3383	4072	4084	4094		
		4106	4119	4142	4160	4257	4344	4352							
ZAD	00AD	1596	1655	1678	1715	1731	3379	4082	4097	4158	4252	4346	4354		
ZAE	00AE	1598	1653	1680	1720	1730	3202	3212	3233	3238	3239	3299	3311		

		3345 3590 3606 3630 3654 4345
ZAF	00AF	1600 1651 1682 1734 3208 3214 3241 3302 3312 3346 3588 3609 3632 3658 4347
ZB0	00B0	3730 3806 3810 3815 3869 3882 3887 3891 3935 3937 3975
ZB1	00B1	3805 3812 3813 3818 3820 3826 3854 3863 3864 3866 3868 3872 3883 3888 3892 3905 3971 3974
ZB2	00B2	2728 2780 2784 3063 3278 3281 3287 3289 3292 3294 3552 3567 3594 3598 3601 3604 3607 3610 3620 3642 3673 4439
ZB3	00B3	3643 4440
ZB4	00B4	2348 2358 2373 2376 2378 2385 2398 3729 3896 3913 3953 3965 3980 3989 3994
ZB5	00B5	2362 2396 3991 4016 4030 4054 4622
ZB6	00B6	2351 2403 4001 4032 4075 4076 4109 4110 4198 4207 4299
ZB7	00B7	3039 3073 3088 3094 3102 3188 3260 3321 3325 3331 3365 3616 3669 4521
ZB8	00B8	2967 2995 3009 4528
ZB9	00B9	2814 2827 2856 2867 2911 2924 2971 3011 3013 3033 3058 3071 3079 3192 3195 3199 3284 3364 3373 3398 3402 3422 3431 4530
ZBA	00BA	2805 2845 2887 2969 3015 3077 3181 3197 3356 3371 3400 4529 4535
ZBB	00BB	3091 3104 3328 3618 3671 4522
ZBC	00BC	4523
ZBD	00BD	2356 2357 2370 2380 2395 3998 4036 4071 4104 4118 4149 4176 4223 4225 4231 4247 4254 4258 4265
ZBE	00BE	3769 4010 4018 4128 4131 4136 4243 4268 4294
ZBF	00BF	3958 3997
ZC0	00C0	1813 1817 3774
ZC1	00C1	3304 3349 3586 3600 3634 3651 4159 4445 4448 4449 4452 4453 4456
ZC2	00C2	3306 3351 3584 3603 3636 3656 4157 4443 4444 4462
ZC3	00C3	3172 3211 3279 3298 3303 4397 4402 4403
ZC4	00C4	3173 3213 3282 3301 3305 4398
ZC5	00C5	1882 1914
ZC6	00C6	1118 1120 1129 1146 1648 1910 1920 1925 2666 3506
ZC7	00C7	1244 1391 1498 1537
ZC8	00C8	1163 1176 1206 2693
ZC9	00C9	1168 1172 1522 1604 2686
ZCA	00CA	1174 2684
ZCB	00CB	1836 1864 1879 1913
ZCC	00CC	1043 1130 1789
ZCD	00CD	1042 1764 1791 1794
ZCE	00CE	1136 1801 1806
ZCF	00CF	1029 1134 1139 1796 1800
ZD0	00D0	1156 1186 1209 1334 2691
ZD1	00D1	1083 1157 1192 1370 1372 1381 1449 1460 1462 1471 1719 1740 1753 1771 1778 1798
ZD2	00D2	1081 1744 1780
ZD3	00D3	1018 1021 1064 1070 1075 1166 1175 1191 1204 1271 1273 1307 1314 1322 1335 1367 1399 1406 1422 1452 1468 1487 1491 1505 1539 1547 1562 1770 1795 2683
ZD4	00D4	1167 1200 1235 1237 1260 1385 1444 1538
ZD5	00D5	1092 1155 1272 1294 1297 1321 1378 1401 1416 1448 1457 2692
ZD6	00D6	1017 1020 1065 1069 1170 1281 1285 1286 1304 1312 1319 1403 1415 1419 1484 1486 1523 1530 1555 1570 1573 1603 1631 1649 1662 1673 2685
ZD7	00D7	1193 1195 1196 1219 1224 1328 1336 3912 3940 3957 4241 4253 4259 4260
ZD8	00D8	1247 1249 1258 1354 1474 1477 1536 1692
ZD9	00D9	1049 1058 1071 1078 1086 1287 1288 1290 1292 1298 1528 1617 1622 1629 1664 1701 1741

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ZDA     00DA 1612 1619 1699 1704
ZF1     00F1 1626 1628
ZF3     00F3  975 1374 1376 1383 1464 1466 1473 1721 1773 1779 1803
ZF4     00F4 1783
ZF5     00F5 1843 1856 1880 1950
ZF6     00F6 1845 1952
ZF7     00F7 2491 2609 3146
ZF8     00F8 2898 2905 3142 3145
ZF9     00F9 2402 2553 3151
ZFA     00FA 2901 2906 3147 3150
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LABEL	ESA	DECIM.	VIC	B2B4	DESCRIZIONE
D6510	0000	0	----	----	Registro di indirizzo dati 6510
R6510	0001	1	----	----	Registro ingresso/uscita 6510
	0002	2	----	----	Non usato
ADRAY1	0003-0004	3-4	0003	----	Vettore di salto.Conv. da Floating/intero
ADRAY2	0005-0006	5-6	0005	----	Vettore di salto.Conv. da intero a Floating
CHARAC	0007	7	0007	0003	Ricerca carattere. Imm. temp. durante INT
ENDCHR	0008	8	0008	0004	Flag di ricerca apici a fine stringa
TRMPOS	0009	9	0009	----	Colonna video dopo ultimo TAB
VERCK	000A	10	000A	009D	Flag: se 0=LOAD se 1=VERIFY
COUNT	000B	11	000B	0005	Puntatore Buffer Ingresso/N. indice
DIMFLG	000C	12	000C	0006	Flag per mancanza dimens. matrici
VALTYP	000D	13	000D	0007	Flag categ. dati $FF=stringa $00=numerico
INTFLG	000E	14	000E	0008	Flag categ. dati $80=intero $00=virgola mobile
GARBFL	000F	15	000F	0009	Flag scans. DATA/LIST/Garbage collection
SUBFLG	0010	16	0010	000A	Flag indice riferimento chiamata funz. utente
INPFLG	0011	17	0011	000B	Flag per ingresso dati: $00=INPUT $40=GET $98=READ
TANSGN	0012	18	0012	000C	Flag per segno TAN/confronto risultati
CHANNL	0013	19	0013	000E	Flag per INPUT
LINNUM	0014-0015	20-21	0014	0011	Temp: valore intero
TEMPPT	0016	22	0016	0013	Puntatore tempo. allo Stack di stringa
LASTPT	0017-0018	23-24	0017	0014	Ultimo indirizzo, temporaneo di stringa
TEMPST	0019-0021	25-33	0019	0016	STACK tempo. per stringa
INDEX	0022-0025	34-37	0022	001F	Area di utilizzo puntatori
INDEX1	0022-0023	34-35	0022	001F	Primo Puntatore
INDEX2	0024-0025	36-37	0024	0021	Secondo Puntatore
RESHO	0026-002A	38-42	0026	0023	Risultato in virgola mobile di.moltiplicazione e divisione
TXTTAB	002B-002C	43-44	002B	0028	Puntatore: inizio programmma Basic
VARTAB	002D-002E	45-46	002D	002A	Puntatore: inizio variabili Basic
ARYTAB	002F-0030	47-48	002D	002C	Puntatore: inizio matrici del Basic
STREND	0031-0032	49-50	0031	002E	Puntatore: Fine matrici (+1)
FRETOP	0033-0034	51-52	0033	0030	Puntatore della fine zona Immag. Stringhe
FRESPC	0035-0036	53-54	0035	0032	Puntatore di utilita' generale per le stringhe
MEMSIZ	0037-0038	55-56	0037	0034	Puntatore indirizzo piu' alto usato

LABEL	ESA	DECIM.	VIC	B2B4	DESCRIZIONE
					dal Basic
CURLIN	0039-003A	57-58	0039	0036	Numero linea che il Basic sta trattando
OLDLIN	003B-003C	59-60	003B	0038	Numero linea che il Basic trattava prima dell' attuale
OLDTXT	003D-003E	61-62	003D	003A	Puntatore Basic per comando CONT
DATLIN	003F-0040	63-64	003F	003C	Numero di linea in cui e' l' attuale DATA
DATPTR	0041-0042	65-66	0041	003E	Puntatore dell' indirizzo del DATA attuale
INPPTR	0043-0044	67-68	0043	0040	Vettore per la routine di INPUT
VARNAM	0045-0046	69-70	0045	0042	Nome dell' attuale variabile
VARPNT	0047-0048	71-72	0047	0044	Puntatore dell'attuale variabile
FORPNT	0049-004A	73-74	0049	0046	Puntatore della variabile indice per FOR-NEXT
VARTXT	004B-004C	75-76	004B	0048	Immag. temp. per rout. TXTPTR durante READ,INPUT,GET
OPMASK	004d	77	004D	004A	MASK usata durante FRMEVL
TEMPF3	004E-0052	78-82	004E	004B	Immagazzinam. temp. per valore FLPT
FOUR6	0053	83	0053	0050	Lunghezza variabile stringa durante GARBAGE COLLECT
JMPER	0054-0056	84-86	0054	0051	Vett. salto usato in funz. JMP($4C) seguita da indir.
TEMPF1	0057-005B	87-91	0057	0054	Imm. temporaneo per valore FLPT
TEMPF2	005c-0060	92-96	005c	0059	Come sopra
FAC ---- Zona dell'accumulatore 1 per i valori in virgola mobile ----					
FACEXP	0061	97	0061	005E	FAC esponente
FACHO	0062-0065	98-101	0062	005F	FAC mantissa
FACSGN	0066	102	0066	0063	FAC segno
SGNFLG	0067	103	0067	0064	Puntatore: costante valutazione successiva
BITS	0068	104	0068	0065	Indicatore di OVERFLOW per FAC 1
AFAC---- Zona dell'accumulatore 2 per i valori in virgola mobile ----					
ARGEXP	0069	105	0069	0066	AFAC esponente
ARGHO	006A-006D	106-109	006A	0067	AFAC mantissa
ARGSGN	006E	110	006E	006A	AFAC segno
ARISGN	006F	111	006F	006C	Risultato confronto segni fra FAC e AFAC
FACOV	0070	112	0070	006D	Arrotondamento del valore di FAC
FBUFPT	0071-0072	113-114	0071	006E	Puntatore Buffer di cassetta
CHRGET	0073-008A	115-138	0073	0070	Subrout.: riceve il prossimo Byte del testo Basic
CHRGOT	0079	121	0079	0076	Entrata per ottenere ancora lo stesso Byte del testo
TXTPTR	007A-007B	122-123	007A	0079	Puntatore: Byte attuale del testo Ba

LABEL	ESA	DECIM.	VIC	B2B4	DESCRIZIONE
					sic
RNDX	008B-008F	139-143	008B	0088	Funzione RND mobile
STATUS	0090	144	0090	0096	Status W. per rout. Ker. in I/O
STKEY	0091	145	0091	009B	Flag per tasti STOP e RVS
SVXT	0092	146	0092	009C	Costante tempo. per nastro
VERCK	0093	147	0093	009D	Flags: 0=LOAD 1=VERIFY
C3PO	0094	148	0094	00A0	Flag: carattere in uscita sul Bus seriale Bufferizzato
BSOUR	0095	149	0095	00A5	Carattere memorizzato per uscita sul bus seriale
SYNO	0096	150	0096	00AB	Carattere di sincronizzazione da cassetta (vedi ST)
TEMPX	0097	151	0097	00AD	Immagazzinamento temp. di X durante l' esecuzione di CHRIN
TEMPY	0097	151	0097	00AD	Immagazz. tempo. di Y durante RS-232
LDTND	0098	152	0098	00AE	N. files aperti/ indice tavola Files
DFLNT	0099	153	0099	00AF	Standard ingresso dati (0=Tastiera)
DFLTO	009A	154	009A	00B0	Standard uscita dati(CMD) (3=video)
PRTY	009B	155	009B	00B1	Carattere di parita' del nastro
DPSW	009C	156	009C	00B2	Flag: ricevuto Byte da nastro
MSGFLG	009D	157	009D	----	Flag: $00=m. programma, soppressione messaggi di errore. $40=m. Kernal invio errori. $80=m.diretto, tutti gli errori
PTR1	009E	158	009E	00C0	Errore logico da nastro. Passo 1
PTR2	009F	159	009F	00C1	Errore logico da nastro. Passo 2
TIME	00A0-00A2	160-162	00A0	008D	Orologio Int.(CLOCK) in tempo reale
TSFCNT	00A3	163	00A3	00B7	Contat. per Bit da nastro R.o W./FLG
TBTCNT	00A4	164	00A4	00B9	Conteggio ciclo
BUFPNT	00A6	166	00A6	00BB	Puntatore: Buffer di I/O nastro
INBIT	00A7	167	00A7	----	RS232 imm. temp. ricez. bit/Temporizz. di cassetta
BITCI	00A8	168	00A8	00BE	RS232 contatore ingresso bit/tempo. di cassetta
RINONE	00A9	169	00A9	00BF	Flag per RS232: controllo bit di partenza
RIDATA	00AA	170	00AA	00C2	Buffer ingresso byte per RS232/Temporizzazione cassetta
RIPRTY	00AB	171	00AB	00C3	INPUT di parita' per RS232/Controllo cassetta
SAL	00AC-00AD	172-173	00AC	00C7	Puntatore: Buffer del nastro/scrolling di schermo
EAL	00AE-00AF	174-175	00AE	00C9	Indirizzo di fine nastro/ Fine del programma
TAPE1	00B2-00B3	178-179	00B2	00D6	Puntatore inizio Buffer nastro
BITTS	00B4	180	00B4	00CE	Cont. bit uscita per RS232/Flag temporizzazione lettura nastro

LABEL	ESA	DECIM.	VIC	B2B4	DESCRIZIONE
NXTBIT	00B5	181	00B5	00CF	Prossimo bit da inviare a RS232/Lett. nastro per EOT
RODATA	00B6	182	00B6	00D0	Buffer per Byte in uscita su RS232/Flag errore di lettura nastro
FNLEN	00B7	183	00B7	00D1	N. di caratteri del nome del File
LA	00B8	184	00B8	00B2	N. dell'attuale file logico
SA	00B9	185	00B9	00D3	Attuale indirizzo secondario
FA	00BA	186	00BA	00D4	Attuale n. di periferica
FNADR	00BB-00BC	187-188	00BB	00D5	Puntatore: attuale indirizzo del nome del file
HOPRTY	00BD	189	00BD	00DD	Parita' di uscita per RS232/Temp. di cassetta
FSBLK	00BE	190	00BE	00DE	Contatore dei blocchi in I/O per nastro
MYCH	00BF	191	00BF	00DF	Buffer per porta seriale
CAS1	00C0	192	00C0	00F9	Interruttore per motore cassetta
STAL	00C1-00C2	193-194	00C1	00FB	Indirizzo di partenza per LOAD e per scrittura cassetta
MEMUSS	00C3-00C4	195-196	00C3	----	Temp. di LOAD per cassetta
LSTX	00C5	197	00C5	0097	Valore ultimo tasto premuto. $40=ness un tasto (64/VIC), $FF=(PET)
NDX	00C6	198	00C6	009E	N. di caratteri nella coda di tastiera (BUFFER-QUEUE)
RVS	00C7	199	00C7	009F	Flag per REVERSE $01=ON $00=OFF
INDX	00C8	200	00C8	00A1	Puntatore fine linea per INPUT
LXSP	00C9-00CA	201-202	00C9	00A3	Posizioni X-Y cursore a inizio Input
SFDX	00CB	203	----	----	Flag: stampa caratteri shiftati
KEYVAL	----		00CB	00A6	Valore della matrice del tasto premuto durante l' ultima scansione di tastiera
BLNSW	00CC	204	00CC	00A7	Lampeggio cursore $00=Abilitato $01=disabilitato
BLNCT	00CD	205	00CD	00A8	Temporizzatore di conto alla rovescia per lampeggio cursore
GDBLN	00CE	206	00CE	00A9	Carattere presente sotto il cursore
BLNON	00CF	207	00CF	00AA	Flag di stato del cursore $00=OFF $01=ON
CRSW	00D0	208	00D0	00AC	Flag: Input da schermo=$03, da tastiera = $00
PNT	00D1-00D2	209-210	00D1	00C4	Puntatore all' attuale linea di indirizzo schermo
PNTR	00D3	211	00D3	00C6	Posizione del cursore sulla colonna dell' attuale linea
QTSW	00D4	212	00D4	00CD	Indicatore di cursore fra apici.$00=no
LNMX	00D5	213	00D5	00D5	Lunghezza dell' attuale linea di schermo

LABEL	ESA	DECIM.	VIC	B2B4	DESCRIZIONE
TBLX	00D6	214	00D6	00D8	Attuale linea di schermo del cursore
SCHAR	00D7	215	00D7	00D9	Valore dell' attuale carattere in ingresso/ Ultimo carattere uscito
INSRT	00D8	216	00D8	00DC	Flag: n. di volte dell' attuale tasto INST
LDTB1	00D9-00F2	217-242	00D9	00E0	Tavola di collegamento linee schermo/ Immagazzinamento temp. EDITOR
USER	00F3-00F4	243-244	00F3	----	Puntatore per attuale colore di schermo in RAM
KEYTAB	00F5-00F6	245-246	00F5	----	Vettore alla tavola di decodifica tastiera
RIBUF	00F7-00F8	247-248	00F7	----	Puntatore Buffer ingresso RS232
ROBUF	00F9-00FA	249-250	00F9	----	Puntatore Buffer usciita RS232
FREKZP	00FB-00FE	251-254	00FB	----	Spazio libero per programmi utentein pagina ZERO
BASZPT	00FF	255	00FF	----	Area per dati Basic
ASCWRK	00FF-010A	255-266	00FF	00FF	Area assembler per conversione virgola mobile in ASCII
BAD	0100-013E	256-***	0100	0100	Errore di input da nastro
STACK	0100-01FF	256-***	0100	0100	Area di STACK hardware per 6510
BSTACK	013F-01FF	319-***	013F	013F	Area di STACK per il Basic
BUF	0200-0258	512-600	0200	----	Buffer di INPUT di sistema/ Da 0200 a 0250 per PET
LAT	0259-0262	601-610	0259	0251	Tavola KERNAL: numero del file logico attivo
FAT	0263-026C	611-620	0263	0258	Tavola KERNAL: numero di periferica per ogni file
SAT	026D-0276	621-630	026D	0265	Tavola KERNAL: indirizzo secondario di ogni file
KEYD	0277-0280	631-640	0277	026F	Coda del BUFFER di tastiera. (metodo FIFO)
MEMSTR	0281-0282	641-642	0281	----	Puntatore al punto piu' basso della memoria per Sistema Operativo
MEMSIZ	0283-0284	643-644	0283	----	Puntatore al massimo della memoria per il Sistema Operativo
TIMOUT	0285	645	0285	----	Flag: variabile KERNAL per Fuori temporizzazione IEEE
COLOR	0286	646	0286	----	Codice dell' attuale colore del carattere
GDCOL	0287	647	0287	----	Colore di fondo sotto il cursore
HIBASE	0288	648	0288	----	Byte alto indirizzo memoria schermo
XMAX	0289	649	0289	----	Massimo numero di Bytes nel Buffer di tastiera
RPTFLG	028A	650	028A	----	Flag di REPEAT $00=Cursore, INST, spazio/$40=Nessun tasto/$80= Tutti i tasti
KOUNT	028B	651	028B	----	Contatore di velocita' di REPEAT

LABEL	ESA	DECIM.	VIC	B2B4	DESCRIZIONE
DELAY	028C	652	028C	----	Contatore del ritardo di REPEAT
SHFLAG	028D	653	028D	0098	Flag tasto SHIFT.$00=Nessun tasto $01 =Shift, $02=CBM, $04=CTRL (i valori s i sommano es. $07=SHIFT+CBM+CTRL)
LSTSHF	028E	654	028E	----	Ultimo tasto shift premuto
KEYLOG	028F-0290	655-656	028F	----	Vettore:Routine per determinare la ta vola di tastiera
MODE	0291	657	0291	----	Flag: cambiamento set-$00=disabilitat o,$80=abilitato
AUTODN	0292	658	0292	----	Flag: scorrimento video-$00=disabilit ato
M51CTR	0293	659	0293	----	RS232/registro di controllo immagini del 6551
M51CDR	0294	660	0294	----	RS232/registro di comando immagine de l 6551
M51AJB	0295-0296	661-662	0295	----	RS232/non-standard,non utilizzato nel VIC in EUROPA
RSSTAT	0297	663	0297	----	RS232/registro di immagine del 6551
BITNUM	0298	664	0298	----	Numero di bits rimasti da inviare
BAUDOF	0299-029A	665-666	0299	----	RS232 baud rate-bit in microsecondi
RIDBE	029B	667	029B	----	Indicatore RS232 al termine del buffe r di INPUT
RIDBS	029C	668	029C	----	Puntatore di RS232: Byte alto dell' i ndirizzo del buffer di ingresso dati
RODBS	029D	669	029D	----	Puntatore RS232: Byte alto dell' indi rizzo del buffer di uscita
RODBE	029E	670	029E	----	Indice RS232 al termine del buffer di uscita
IRQTMP	029F-02A0	671-672	029F	----	Immagazzinamento temporaneo del vetto re IRQ durante le operazioni su nastr o
ENABL	02A1	673	02A1	----	Abilitazione dell' RS232
TODSNS	02A2	674	----	----	Controllo sensore cassetta durante le operazioni di I/O
TRDTMP	02A3	675	----	----	Immagazzinamento temporaneo durante l a lettura nastro
TD1IRQ	02A4	676	----	----	Indicatore temporaneo di IRQ durante la lettura del nastro
TLNIDX	02A5	677	----	----	Indicatore temporaneo per indice line a di schermo
TVSFLG	02A6	678	----	----	Flag per TV-$00=NTSC, $01=PAL
	02A7-02FF	679-767	02A1	----	Area attualmente non utilizzata
IERROR	0300-0301	768-769	0300	----	Vettore: ingresso indiretto al messag gio di errore Basic,(X) indica il mes saggio. Il contenuto normale e', nel CBM64 $E38B

LABEL	ESA	DECIM.	VIC	B2B4	DESCRIZIONE
IMAIN	0302-0303	770-771	0302	----	Vettore: ingresso indiretto per linea Basic e decodifica. CBM64= $A483
ICRNCH	0304-0305	772-773	0304	----	Vettore: ingresso indiretto alla rout ine Basic codificata (TOKEN). CBM64=$ A57C
IQPLOP	0306-0307	774-775	0306	----	Vettore: ingresso indiretto alla rout ine Basic LIST. CBM64=$A71A
IGONE	0308-0309	776-777	0308	----	Vettore: ingresso indiretto per la ri cerca in Basic delle parole chiave. C BM64=$A7E4
IEVAL	030A-030B	778-779	030A	----	Vettore: ingresso indiretto al Basic per l' elaborazione dei comandi (TOKE N). CBM64=$AE86
SAREG	030C	780	030C	----	Immagazzinamento di A durante l' esec uzione di SYS
SXREG	030D	781	030D	----	Immagazzinamento di X durante l' esec uzione di SYS
SYREG	030E	782	030E	----	Immagazzinamento di Y durante l' esec uzione di SYS
SPREG	030F	783	030F	----	Immagazzinamento di SP durante l' ese cuzione di SYS
USRPOK	0310	784	0000	0000	Funzione USR per JMP
USRADD	0311-0312	785-786	0001	0001	Indirizzo USR Byte basso/Byte alto
	0313	787			Non usato
CINV	0314-0315	788-789	0314	0090	Vettore: indirizzo hardware per l' in terrupt di IRQ. CBM64=$EA31
CNBINV	0316-0317	790-791	0316	0092	Vettore: indirizzo di interrupt per l ' istruzione BRK. CBM64=$FE66
NMINV	0318-0319	792-793	0318	0094	Vettore: Indirizzo Hardware di interr upt per l' istruzione NMI. CBM64= $FE 47
IOPEN	031A-031B	794-795	031A	----	Vettore: ingresso indiretto per la ro utine Kernal OPEN. CBM64=$F34A
ICLOSE	031C-031D	796-797	031C	----	Vettore: ingresso indiretto per la ro utine Kernal CLOSE CBM64=$F291
ICHKIN	031E-031F	798-799	031E	----	Vettore: ingresso indiretto per la ro utine Kernal CHKIN.CBM64=$F20E
ICKOUT	0320-0321	800-801	0320	----	Vettore: ingresso indiretto per la ro utine Kernal CHKOUT.CBM64=$F250
ICLRCH	0322-0323	802-803	0322	----	Vettore: ingresso indiretto per la ro utine Kernal CLRCHN.CBM64=$F333
IBASIN	0324-0325	804-805	0324	----	Vettore: ingresso indiretto per la ro utine Kernal CHRIN.CBM64=$F157
IBSOUT	0326-0327	806-807	0326	----	Vettore: ingresso indiretto per la ro utine Kernal CHROUT.CBM64=$F1CA
ISTOP	0328-0329	808-809	0328	----	Vettore: ingresso indiretto per la ro

LABEL	ESA	DECIM.	VIC	B2B4	DESCRIZIONE
					utine Kernal STOP. CBM64=$F6ED
IGETIN	032A-032B	810-811	032A	----	Vettore: ingresso indiretto per la ro utine Kernal GETIN.CBM64=$F13E
ICLALL	032C-032D	812-813	032C	----	Vettore: ingresso indiretto per la ro utine Kernal CLALL.CBM64=$F32F
USRCMD	032E-032F	814-815	03FA	----	Vettore definito dall' utente. Il con tenuto normale e' $FE66
ILOAD	0330-0331	816-817	0330	----	Vettore: ingresso indiretto per la ro utine Kernal LOAD. CBM64=$F4A5
ISAVE	0332-0333	818-819	0332	----	Vettore: ingresso indiretto per la ro utine Kernal SAVE. CBM64=$F5ED
	0334-033B	820-827	0334	----	Normalmente non utilizzato
TBUFFR	033C-03FB	828-1019	033C	027A	Buffer del nastro per operazioni di I /O
	03FC-03FF	1020-1023	03FC	----	Normalmente non utilizzato
VICSCN	0400-07FF	1024-2047	1E00	8000	Area di memoria dello schermo

LABEL	C64	V20	B2.0	B4.0	DESCRIZIONE
BCOLD	A000	C000	----	----	Vettore Basic di RESET iniziale
BWARM	A002	C002	----	----	Vettore Basic di RESET con INTERRUPT
STMDSP	A00C	C00C	C000	B000	Tavola dei vettori dei comandi Basic
FUNDSP	A052	C052	C046	B066	Tavola dei vettori delle funzioni Basic
OPTAB	A080	C080	C074	B094	Vettore degli operatori Basic e tavola di priorita' - 2 bytes di indirizzo e 1 di priorita'
RESLST	A09E	C09E	C092	B0B2	Tavola delle parole chiave
MSCLST	A129	C129	C11D	B13D	Tavola mista delle aprole chiave
OPLIST	A140	C140	C134	B161	Tavola degli operatori delle parole chiave
FUNLST	A14D	C14D	C141	B16E	Tavola delle funzioni
ERRTAB	A19E	C19E	C192	B20D	Messaggi di errore
ERRPTR	A328	C328	----	----	Puntatori ai messaggi di errore
OKK	A364	C364	----	----	Nessun messaggio di errore-"ok","error","in"," ready","break".
FNDFOR	A38A	C38A	C2AA	B322	Cerca il punto di entrata di FOR nello Stack o saltalo per cercare l'entrata di GOSUB dopo un RETURN
BLTU	A3B8	C3B8	C2D8	B350	Sposta in alto un blocco di memoria-controllo per memoria sufficiente
BLTUC	A3BF	C3BF	C2DF	B357	Sposta un blocco da (LOWTR) a (HIGHTR)
GETSTK	A3FB	C3FB	C31B	B393	Controllo dello Stack per l'immissione di due bytes dell'accumulatore-errore di "OUT OF MEMORY" se non c'e' posto
REASON	A408	C408	C328	B3A0	Controllo che l'indirizzo (A/Y) sia minore dello spazio per le stringhe- se no...
OMERR	A435	C435	C355	B3CD	Stampa un messaggio di "OUT OF MEMORY"
ERROR	A437	C437	C357	B3CF	Stampa il messaggio di errore indicato da (X) poi ...
ERRFIN	A469	C469	C37A	B3F0	Stampa "ERROR" o "BREAK"
READY	A474	C474	C389	B3FF	Restart del BASIC - stampa "READY" poi ...
MAIN	A480	C480	C392	B406	Linea di INPUT - identifica un comando o una linea basic
MAINI	A4A2	C4A2	C3AB	B41F	Se e' una linea basic allora immetti il numero di linea e converti le parole chiave in TOKENS
INSLIN	A4A2	C4A2	C3B1	B47Q	Inserisci un testo dal buffer del Basic entro un programma - il numero di linea in (LINNUM) in entrata - La linea deve avere le parole chiave cambiate in tokens e la lunghezza della linea in (Y)- se (BBUFF)=$00 allora la linea sara' cancellata - la routine esiste come conseguenza di MAIN
FINI	A52A	C52A	C439	B4AD	Dopo l'inserimento di una nuova linea nel testo basic esegui le routine di RUNC,LNKPRG e rientra alla routine MAIN
LNKPRG	A533	C533	C442	B4B6	Ricostruisce i puntatori di LINK del testo BASIC
INLIN	A560	C560	C46F	B4E2	Inserisce una linea nel buffer del basic-immet

LABEL	C64	V20	B2.0	B4.0	DESCRIZIONE
					ti 00 al termine
RDCHR	----	----	C481	----	Immetti un carattere nell' accumulatore -se il carattere e' 0F cioe' LINE-FEED inverti il flag in 0D per cancellare l'uscita
CRUNCH	A579	C579	C495	B4FB	Cambia le parole chiave in Tokens - la linea in BBUFF -fissa TXTPTR a BBUFF- Y alla lunghezza della linea e TXTPTR a BBUFF-1 in uscita
FNDLIN	A613	C613	C52C	B5A3	Ricerca il testo BASIC dall' inizio per il numero della linea in (LINNUM)...oppure...
FNDLNC	A617	C617	C530	B5A7	Ricerca il testo BASIC da (A/X) per il numero di linea in (LINNUM)- se lo trova fissa C e (LINPTR) all' inizio della linea- azzera C
SCRATH	A642	C642	C55B	B5D2	Punto di entrata di NEW- controllo di sintassi poi.....
SCRTCH	A659	C659	C55D	B5D4	Metti il primo Byte di testo a 00-fissa(VARTAB) a (TXTTAB)+2 poi...
RUNC	A659	C659	C572	B5E9	Resetta l' esecuzione all' inizio del programma (STXPTR) e dopo esegui la routine CLEARC
CLEAR	A65E	C65E	C577	B5EE	Punto di entrata per CLEAR-controllo di sintassi poi....
CLEARC	A660	C660	C579	B5FC	Fissa (FRETOP) a (MEMSIZ)-chiude le funzioni di I/O-fissa (ARYTAB) a (VARTAB) poi...
LDCLR	A677	C677	C590	B60B	Esegui RESTOR-azzera (TEMPPT)-azzera lo STACK
STXPT	A68E	C68E	C5A7	B622	Metti (TXTPTR) al valore di (TXTTAB)-1 per resettare l' esecuzione all' inizio programma.
LIST	A69C	C69C	C5B5	B630	Punto di ingresso alla routine LIST
QPLOP	A717	C717	C63A	B6B5	Manipolazione dei caratteri in conseguenza del comando LIST-se trattasi di NON-TOKEN o TOKEN fra virgolette, allora stampali come sono. In caso contrario espandi i TOKENS e stampali
FOR	A742	C742	C658	B6DE	Punto di ingresso alla routine FOR-salva(TXTPTR), (CURLIN) ed il valore finale nello STACK, dopo....
NEWSTT	A7AE	C7AE	C6C4	B74A	Controllo per tasto di RUN/STOP premuto-
CKEOL	A7C4	C7C4	C6DA	B7F5	Controlla che la fine della linea sia anche la fine del testo - in caso contrario vai ai successivi parametri nella stessa linea
GONE	A7E1	C7E1	C6F7	B77C	Esegue il comando entro la linea
GONE3	A7ED	C7ED	C700	B785	Interpreta un comando basic e lo esegue
RESTOR	A81D	C81D	C730	B7B7	Punto di entrata per il comando RESTORE - azzera (DATPTR) all'inizio del basic
STOP	A82C	C82C	C73F	B7C6	Punto di ingresso per comando STOP - azzera il Carry per il messaggio di "Break" poi salta entro la routine di END
END	A82F	C82F	C741	B7C8	Punto di ingresso per il comando END - Fissa il Carry poi ....

LABEL	C64	V20	B2.0	B4.0	DESCRIZIONE
FINID	A834	C834	C744	B7CB	Se indiretto salva (TXTPTR) in (OLDTXT) poi..
STPEND	A841	C841	C751	B7D8	Salva (CURLIN) in (OLDLIN) e vai alla routine di READY se il Carry = END) se il Carry e' a z ero vai ERRFIN
CONT	A857	C857	C76B	B7EE	Punto di ingresso per il comando CONT - riposi ziona (TXTPTR) e (CURLINE) fino a quando (OLDT XT) non sia 0 (CAN'T CONTINUE)
RUN	A871	C871	C785	B808	Punto di ingresso per RUN - esegue CLR e poi G OTO
GOSUB	A883	C883	C790	B813	Punto di ingresso per GOSUB - salva (TXTPTR), (CURLIN) e il Flag di GOSUB (8D) nello Stack e poi esegue il GOTO
GOTO	A8A0	C8A0	C7AD	B830	Punto di ingresso per GOTO - legge il numero d al testo basic e lo inserisce in (LINNUM) poi. ..
GOTOC	A8A3	C8A3	C7B0	B833	Esegue la ricerca per la fine della linea attu ale - ricerca la linea (LINNUM) e fissa (TXTPT R) quando lo trova
RETURN	A8D2	C8D2	C7DA	B85D	Punto di ingresso per RETURN - controlla la si ntassi poi...
RTC	A8D4	C8D4	C7DC	B85F	Esegue l'azzeramento dello Stack fino al primo punto di entrata di gosub - fissa poi (TXTPTR) e (CURLIN) dallo Stack
DATA	A8F8	C8F8	C800	B883	Punto di ingresso per DATA - esegue la ricerca del testo per trovare la fine del comando
DATAN	A906	C906	C80E	B891	Fissa la ricerca per i delimitatori del comand o (Virgola o Byte 0) dopo ricerca ...
SERCHX	A90B	C90B	C811	B894	Ricerca nel testo (X) o Byte 0 - esce con (Y) fissato al numero di Byte da delimitare.
IF	A92B	C92B	C830	B8B3	Punto di ingresso per IF - valuta l' espressio ne esegue la routine REM se IF= (falso)
REM	A93B	C93B	C843	B8C6	Punto di ingresso per REM - esegue la ricerca per il Byte 0
DOCOND	A940	C940	C848	B8CB	Se la condizione relativa a IF e' non 0 (cioe' vera) allora esegui il comando o GOTO
ONGOTO	A94B	C94B	C853	B8D6	Punto di ingresso per ON - prende un numero da l testo e ricerca il numero di linea esegui GO TO o GOSUB
LINGET	A96B	C96B	C873	B8F6	Legge un intero dal testo e lo immette in (LIN NUM) - da un errore se il valore non fra 0 e 63999
LET	A9A5	C9A5	C8AD	B930	Punto di ingresso per LET - cerca la variabile obbiettivo nello spazio delle variabili e fiss a (FORPNT) con l'indirizzo della variabile - e labora l'espressione ed esegue PUTINT o PTFLPT o PUTTIM o GETSPT
PTFLPT	A9C4	C9C4	C8CC	B94F	Immette l'accumulatore in virgola mobile (FAC)

LABEL	C64	V20	B2.0	B4.0	DESCRIZIONE
					entro la variabile il cui indirizzo e' dato da (FORPNT).
PUTINT	A9D6	C9D6	C8DE	B961	Immette il valore intero contenuto in (FAC+3) entro la variabile il cui indirizzo e' in (FOR PNT)
PUTTIM	A9E3	C9E3	C8EB	B972	Fissa TI$-fissa(INDEX1) in modo taleche punti alla stringa e (A) a 6 che e' la lunghezza del la stringa
GETSPT	AA2C	CA2C	C937	B9BA	Immetti l' identificatore della stringa punato da (FAC+3) entro la variabile stringa a cui pu nta (FORPNT).
PRINTN	AA80	CA80	C98B	BA88	Punto di ingresso per PRINT£ - esegue CMD per abilitare il Device corrente di I/O (manda l' Unlisten alla IEEE se il numero di device e' 3)
CMD	AA86	CA86	C991	BA8E	Punto di ingresso per CMD - abilita al CMD il device definito dalla tavola di PRINT
STRDON	AA9A	CA9A	C9A5	BAA2	Routine di PRINT - stampa la stringa e control la per la fine della linea di PRINT
PRINT	AAA0	CAA0	C9AB	BAA8	Punto di ingresso per PRINT - identifica i par ametri di PRINT (SPC, TAB etc) - valuta l' esp ressione.
VAROP	AAB8	CAB8	C9C3	BAC0	Uscita variabile-(se numero lo converte iin st ringa)-uscita stringa
NUMDON	AABC	CABC	C9C7	BAC4	Stampa routine-stampa numerico
CRDO	AAD7	CAD7	C9E2	BADF	Uscita CR/LF-nel VIC e CBM64 se (CHANNL) maggi ore di 127 solo uscita CR
COMPTR	AAE8	CAE8	C9EF	BAF0	Stampa tabulazioni e spazi per delimitatori vi rgola-funzioni SPC o TAB
STROUT	AB1E	CB1F	CA1C	BB1D	Stampa la stringa puntata da (A/Y) fino a che non trova 1 byte a zero
STRPTR	AB21	CB21	CA1F	BB20	Stampa la stringa puntata da (FAC 3) finche' n on trova un Byte a zero
OUTSTR	AB24	CB24	CA22	BB23	Stampa la stringa puntata da (INDEX1) di lungh ezza (A)
OUTSPC	AB3B	CB3B	CA39	BB3A	Stampa spazio
PRTSPC	AB3F	CB3F	CA3D	BB3E	Stampa SEMPRE uno spazio
OUTSKP	AB42	CB42	CA40	BB41	Stampa sempre il cursore a destra
OUTQST	AB45	CB45	CA43	BB44	Stampa punto interrogativo
OUTDO	AB47	CB47	CA45	BB46	Stampa (A)
TRMNOK	AB4D	CB4D	CA4F	BB4C	Manipolazione dei messaggi di errore per GET,I NPUT e READ
GET	AB7B	CB7B	CA7D	BB7A	Punto di ingresso per GET- Controlla che non s ia un comando diretto, identifica GET£, immett e un carattere
INPUTN	ABA5	CBA5	CAA7	BBA4	Punto di ingresso per INPUT£-fissa la periferi ca di input, esegue l' input poi mette la IEEE

LABEL	C64	V20	B2.0	B4.0	DESCRIZIONE
					in UNLISTEN se la periferica e' maggiore di 3
INPUT	ABBF	CB8F	CAC1	BBBE	Punto di ingresso per comando INPUT- visualizz a un messaggio se esiste, esegue quindi l' inp ut
BUFFUL	ABEA	CBAE	CAED	BBE8	Legge l' input-se (BBUFF) e' zero, cioe' nessu na stringa in input il VIC 20 ed il CBM&$ salt ano, BASIC 2/4 arrestano l' operazione
QINLIN	ABF9	CBF9	CAFA	BBF5	Stampa ? e immette i dati nel buffer (BBUFF)
READ	AC06	CC06	CB07	BC02	Punto di ingresso per il comando READ-fissa il flag di READ(98) in (INPFLG), fissa (X/Y) =(DA TPTR)
INPCON	AC0D	CC0D	CB0E	BC09	Punto di ingresso a READ per INPUT-fissa il fl ag di INPUT(00) in (INPFLG), fissa (X/Y)=BUF
INPC01	AC0F	CC0F	CB10	BC0B	Punto di ingresso di READ per GET-fissa il
RDGET	AC35	CC35	CB36	BC31	Parte della routine READ che esegue il GET di 1 Byte
RDINP	AC43	CC43	CB44	BC3F	Parte della routine di READ che esegue il coma ndo INPUT usando la routine RDGET
DATLOP	AC88	CC88	CB89	BC84	Parte della routine di READ che esegue il READ dei DATA, usando RDGET
EXINT	ACFC	CCFC	CBFC	BCF7	Stringa ASCII-"?EXTRA IGNORED"
TRYAGN	AD0C	CD0C	CC0D	BD0T	Stringa ASCII-"?REDO FROM START"
NEXT	AD1E	CD1E	CC20	BD19	Punto di ingresso per NEXT-immette la successi va (NEXT) variabile e conferma che il corrispo ndente comando FOR sia nello STACK, calcola il prossimo valore di variabile ciclo
DONEXT	AD61	CD61	CC62	BD5B	Se il contatore di ciclo e' un valore valido, fissa(CURLIN) e (TXTPTR) dallo STACK e reimmet te il FOR nel ciclo
CHKNUM	AD8D	CD8D	CC8E	BD87	Controlla la routine (VALTYP) per i risulatati numerici provenienti da (FRMEVL-vedi dopo)-va in READY con un "TYPE MISMATCH" se e' rilevato un risultato numerico
CHKNUM	AD8F	CD8F	CC90	BD89	Controlla la routine (VALTYP) per risultato st ringa-il resto vedi preecedente
FRMNUM	AD8A	CD8A	CC8B	BD84	Valuta una espressionenumerica dal testo Basic , mette in funzionela routine FRMELV(vedi dopo) poi la (CHKNUM)
FRMEVL	AD9E	CD9E	CC9E	BD98	Immette e valuta una qualsiasi espressionedel testo Basic. Fiissa VALTYP (00 se numerica, FF se stringa) e INTFLG (00 se in virgola mobile, 80 se intero) Se l' espressione e' numerica in virgola mobil e, il risultato e' immesso in FAC. Se l' espre ssione e' un intero numerico, allora il risult ato e' riportato in FAC+3 nel formato HI/LO. S si tratta di un' espressione stringa, allora i

LABEL	C64	V20	B2.0	B4.0	DESCRIZIONE
					l puntatore alla descrizione della stringa e' riportato in (FAC+3). Questo e' di solito un c opia di VARPNT. In aggiunta se l' espressione e' una variabile semplice, allora la routine V ARNAM puntera' al primo Byte del nome. Per con cludere, se sara' rilevato un errore nell' esp ressione allora torneremo in Basic con READY p receduto da "SYNTAX ERROR"
EVAL	AE83	CE83	CD84	BE81	Valuta il singolo termine in un' espressione. Identifica le funzioni pi greco,TI,TI$, ecc.
PIVAL	AEA8	CEA8	CDA3	BEA0	Valore in virgola mobile di pi-greco nel forma to MFLPT.-3.1415965
QDOT	AEAD	CEAD	CDAB	BEA5	Valuta un termine non variabile in un' espress ione
PARCHK	AEF1	CEF1	CDEC	BEE9	Valuta un' espressione in parentesi
CHKCLS	AEF7	CEF7	CDF2	BEEF	Controlla che il carattere puntato(indirizzato) da TXTPTR sia una parentesi destra. Se non e ' cosi' stampa "SYNTAX ERROR"
CHKOPN	AEFA	CEFA	CDF5	BEF2	Controllo come sopra per parentesi sinistra
CHKCOM	AEFD	CEFD	CDF8	BEF5	Controlla che il carattere a cui punta TXTPTR sia una virgola. Se non e' visualizza "SYNTAX ERROR"
SYNCHR	AEFF	CEFF	CDFA	BEF7	Controlla che il carattere puntato da TXTPTR s ia lo stesso contenuto in Accumulatore, altrim enti vedi sopra
SYNERR	AF08	CF08	CE03	BF00	Stampa il messaggio di errore "SYNTAX ERROR" e ritorna in modo Basic con lla scritta Ready
RSVVAR	AF14	CF14	----	----	Setta il Carry se la variabile puntata da (FAC +3) e' una parola riservata es. ST,TI,TI$
ISVAR	AF28	CF28	CE0F	BF04	Cerca una variabilecon nome nel testo Basic.Fi ssa (VARNAM) a puntare al nome della variabile nella tavola se e' trovato.Immette un valore numerico in FAC, il puntatore stringa in (FAC 3).
TISASC	AF48	CF48	CE2E	BFAD	Converte TI in una stringa ASCII e fissa FAC+£ a puntare alla stringa
ISFUN	AFA7	CFA7	CE89	C037	Valuta la funzione. Riporta il valore numerico in FAC, il valore stringa come puntatore in FA C+3
STRFUN	AFB1	CFB1	CE93	C051	Salva l' indicatore stringa di una funzionestr inga nello Stack e lo valuta
NUMFUN	AFD1	CFD1	CEB3	C071	Valuta l' argomento di una funzione numerica e calcola il valore della funzione
OROP	AFE6	CFE6	CEC8	C086	Esegue OR. Fissa il flag di OR e usa ANDOP per la valutazione della funzione
ANDOP	AFE9	CFE9	CECB	C089	Esegue AND. Fissa il flag di AND poi converte il valore in virgola mobile a fisso, esegue AN

LABEL	C64	V20	B2.0	B4.0	DESCRIZIONE
					D (o OR se e' fissato il flag dii OR) poi ric onverte in virgola mobile
DOREL	B016	D016	CEF8	C0B6	Esegue una delle relazioni (maggiore, minore o uguale). Se e' un'espressione numerica usa NUM REL, se e' un' espressione stringa usa STRREL
NUMREL	B018	D01B	CEFD	C0BB	Esegue un confronto numerico
STRREL	B02E	D02E	CF10	C0CE	Esegue un confronto stringa
DIM	B081	D081	CF63	C121	Esegue DIM
PPTRGET	B08B	D08B	CF6D	C12B	Identifica una variabile con nome nel testo Ba sic e piazzail nome, non il puntatore al nome, in (VARNAM)
ORDVAR	B0E7	D0E7	CFC9	C187	Cerca una variabile il cui nome sia in VARNAM e fissa (VARPNT) perche' ci punti. Se necessar io usa NOTFNS per creare una nuova variabile
ISLETC	B113	D113	CFF7	C1B6	Setta il Carry se nell' accumulatore e' presen te una lettera
NOTFNS	B11D	D11D	D001	C1C0	Crea una nuova variabile con nome come in (VAR NAM), a meno che PTRGET sia chiamata in funzio ne da ISVAR
NOTEVL	B128	D128	D00C	C1CB	Crea una nuova variabile con nome come in (VAR NAM) e fissa (VARPNT) per puntare ad essa
FMAPTR	B194	D194	D078	C2C8	Fissa (ARYPNT) all' inizio della matrice ed im mette il numero di dimensioni della matrice in COUNT
N32768	B1A5	D1A5	D089	C2D9	Valore in virgola mobile di 32768 in formato F LPT
FACINX	B1AA	D1AA	----	----	Converte (FAC) in intero in (A/Y)
INTIDX	B1B2	D1B2	D08D	C2DD	Valuta un' espressione presente nel testo Basi c come intero nell' intervallo -32768 e +32767
AYINT	B1BF	D1BF	D09A	C2EA	Valuta l' espressione in testo Basic come inte ro positivo (da 0 a +32767)
ISARY	B1D1	D1D1	D0AC	C2FC	Prende i parametri delle matrici dal testo Bas ic e li immette nello Stack
FNDARY	B218	D218	D0F3	C343	Trova la matrice-il nome in VARNAM, i parametr i sono letti da ISARY
NOTFDD	B261	D261	D13C	C38C	Crea una matrice dai parmetri nello Stack
INLPN2	B30E	D30E	D1EA	C439	Fissa (VARPNT) per pntare ad un' elemento entr o la matrice
UMULT	B34C	D34C	D228	C447	Calcola il numero di Bytes nella dimensione (Y) della matrice con inizio a (VARPNT)
FRE	B37D	D37D	D259	C4A8	Punto di ingresso per la funzione FRE-esegue l a garbage collection e fissa il valore della f unzione a (FRETOP)-(STREND)
GIVAYF	B391	D391	D26D	C4BC	Converte l'intero in (A/Y) in FLPT in FAC nell intervallo fra 0 32767
SNGFT	B3A2	D3A2	D27C	C4CB	Converte (Y) a formato FLPT in (FAC) nell' int

LABEL	C64	V20	B2.0	B4.0	DESCRIZIONE
					ervallo da 0 a 255
ERRDIR	B3A6	D3A6	D280	C4CF	Stampa "ILLEGAL DIRECT", se e' in modo diretto - per esempio (CURLIN) =$FF
DEF	B3B3	D3B3	D28D	C4DC	Punto di ingresso per DEF-crea la funzione FN
GETFNM	B3E1	D3E1	D2BB	C50A	Controlla la sintassi di FN, localizza l' indicatore di FN e fissa DEFPNT perche' punti all' indicatore
FNDEOR	B3F4	D3F4	D2CE	C51D	Punto di ingresso per la funzione FN-riceve l' indicatore di FN, poi...
SETFNV	B423	D423	D2FD	C54C	Fissa (TXTPTR) all' inizio di FN nel testo, valuta l' espressione,resetta quindi (TXTPTR)
STRD	B465	D465	D33F	C58E	Punto di ingresso per la funzione STR$, valuta l' espressione e la converte in stringa ASCII
STRINI	B475	D475	D34F	C59E	Crea spazio per la stringa il cui indicatore e ' in FAC 3 e la cui lunghezza in (A). Termina con un nuovo indicatore in (DSCTMP) ed un puntatore al vecchio indicatore e' in (DSCPNT)
STRILT	B487	D487	D361	C5B0	Esamina la stringa che parte da (A/Y) e crea un indicatore. Termina con (FAC 3) che punta al l' indicatore
PUTNW1	B4D5	D4D5	D3AF	----	Fissa l' indicatore allo Stack indicatore e ricrea il puntatore
GETSPA	B4F4	D4F4	D3CE	C61D	Fissa (FRETOP) e (FRESPC) per una nuova stringa la cui lunghezza e' in (A)
GARBA2	B526	D526	D400	C66A	Esegue la GARBAGE COLLECTION-chiude lo spazio nella STRINGA SPAZIO utilizzata per le stringhe scartate
DVARS	B5BD	D5BD	D497	----	Ricerca le tavole di variabili e matrici per il successivo indicatore di stringa che deve essere salvato dalla GARBAGE COLLECTION
GRBPAS	B606	D606	D40E	----	Riutilizza lo spazio di stringhe cancellate durante la GARBAGE COLLECTION
CAT	B63D	D63D	D517	C74F	Concatena due stringhe in una espressione poi continua la valutazione dell' espressione
MOVINS	B67A	D67A	D554	C78C	Trasferisce la stringa il cui indicatore e' indicato da (STRNG1)
FRESTR	B6A3	D6A3	D57D	C7B5	Conferma del modo stringa poi...
FREFAC	B606	D606	D580	----	Esegue l' inquadramento e l' allocazione della stringa. Inizia con il puntatore all' indicatore della stringa in (FAC+3) ed esce con la lunghezza in (A) e (INDEX1) che punta all' inizio della stringa stessa
FRETMS	B6DB	D6DB	D5B5	C811	Aggiorna l'indicatore di stringa nello SP
CHRD	B6EC	D6EC	D5C6	C822	Punto di ingresso per la funzione CHR$
LEFTD	B700	D700	D5DA	C836	Punto di ingresso per la funzione LEFT$
RIGHTD	B72C	D72C	D600	C862	Punto di ingresso per la funzione RIGHT$
MIDD	B737	D737	D611	C86D	Punto di ingresso per la funzione MID$

LABEL	C64	V20	B2.0	B4.0	DESCRIZIONE
PREAM	B761	D761	D63B	C897	Estrae dallo Stack il puntatore all' indicator e stringa, lo immagazzina in (DSCPNT), immette il parametro stringa in (a)
LEN	B77C	D77C	D656	C8B2	Punto di ingresso per la funzione LEN
LEN1	B782	D782	D65C	C8B8	Esegue il posizionamento della stringa, dopo f orza l' entrata del modo numerico e quindi esc e con la lunghezza della stringa in (Y)
ASC	B78B	D78B	D665	C8C1	Punto di ingresso per la funzione ASC, prende il primo carattere nella stringa e lo converte in formato FLTP
GTBYTC	B79B	D79B	D657	C8D1	Valuta un' espressione nel testo. Controllo di validita' per intervallo da 0 a 255, in caso c ontrario visualizza un "ILLEGAL QUANTITY ERROR ". Riporta il valore in (X)
VAL	B7AD	D7AD	D687	C8E3	Punto di ingresso per la funzione VAL. Conferm a che l' argomento sia una stringa poi...
STRVAL	B7B5	D7B5	D68F	C8F5	Converte una stringa di inizio a (INDEX1) e di lunghezza (A) in valore FLTP in (FAC)
GETNUM	B7EB	D7EB	D6C6	C921	Legge i prametri dal testo Basic relativamente ai comandi POKE o WAIT, immagazzina il primo i ntero in (INDEX1), il secondo intero in (INDEX 2)
GETADR	B7F7	D7F7	D6D2	C92D	Converte FAC in intero nel (INDEX1) nell' inte rvallo da 0 a 65535
PEEK	B80D	D80D	D6EB	C943	Punto di ingresso per PEEK
POKE	B824	D824	D707	C95A	Punto di ingresso per POKE
WAIT	B82D	D82D	D710	C963	Punto di ingresso per WAIT
FADDH	B849	D849	D72C	C97F	Somma 0.5 al FAC
FSUB	B850	D850	D733	C986	Sottrazione in virgola mobile: (FAC)=MFLPT a (A/Y)- (FAC)
FSUBT	B853	D853	D736	C989	Punto di ingresso per sottrazione:(FAC)=(ARG)- (FAC)
FADD5	B862	D862	D76E	C998	Parte della routine di normalizzazione della s omma
FAD	B867	D867	D773	C99D	Somma in virgola mobile: (FAC)=MFLPT a (A/Y)+(FAC)
FADDT	B86A	D86A	D776	C9A0	Punto di ingresso per la somma:(FAC)=(ARG)+(FA C)
OVER	B97E	D97E	D88A	CAB4	Stampa il messaggio"OVERFLOW ERROR"
MULSHF	B983	D983	D88F	CAB9	Moltiplicazione di un Byte
FONE	B9BC	D9DC	D8C8	CAF2	Costante 1.0 nel formato MFLPT
	B9C1	D9C1	D8CD	CAF7	Diverse costanti usate per la valutazione di f unzioni
LOG	B9EA	D9EA	D8F6	CB20	Esegue la funzione LOG-controlla che l' argome nto della funzione sia positivo dopo calcola i l valore di LOG in base e
FMULT	BA28	DA28	D934	CB5E	Moltiplica il (FAC) per MPLPT il cui indirizzo

LABEL	C64	V20	B2.0	B4.0	DESCRIZIONE
					e' contenuto in (A/Y), risposta in (FAC)
FMULTT	BA30	DA30	D934	CB5E	Esegue la routine di moltiplicazione in virgola mobile. Moltiplica (FAC) per (AFAC) il risultato in (FAC)
MLTPLY	BA59	DA59	D965	CB8F	Moltiplica (FAC) per 1 Byte, il risultato in RESHO
CONUPK	BA8C	DA8C	D998	CBC2	Carica AFAC con il valore di MFLPT indirizzato da (A/Y)
MULDIV	BAB7	DAB7	D9C3	CBED	Subroutine di moltiplicazione per controllare FAC e AFAC per UNDERFLOW/OVERFLOW
MLDVEX	BAD4	DAD4	D9E0	CC0A	Manipola l' errore di OVERFLOW o di UNDERFLOW
MUL10	BAE2	DAE2	D9EE	CC18	Moltiplica il FAC per 10, il risultato in FAC
TENC	BAF9	DAF9	DA05	CC2F	Costante 10 nel formato MFLPT
DIV10	BAFE	DAFE	DA0A	CC34	Divide (FAC) per 10, la risposta in FAC
FDIVF	BB07	DB07	DA13	CC3D	Divide AFAC per il valore MFLPT indirizzato da (A/Y) e il cui segno e' contenuto in X. La risposta viene messa in FAC
FDIV	BB0F	DB0F	DA1B	CC45	Divide AFAC per MFLPT indirizzato da (A/Y). La risposta va in FAC
FDIVT	BB12	DB12	DA1E	CC48	Esegue la routine di divisione in virgola mobile-(AFAC) e' diviso da FAC, la risposta in FAC . All' ingresso della routine (A)=(FACEXP)
MOVFM	BBA2	DBA2	DAAE	CCD8	Carica FAC con MFLPT indirizzato da (A/Y)
MOV2F	BBC7	DBC7	DAD3	CCFD	Immagazzina il contenuto di FAC in TEMPF2
MOV1F	BBCA	DBCA	DAD6	CD00	Immagazzina il contenuto di FAC in TEMPF1
MOVXF	BBD0	DBD0	BADC	CD06	Immagazzina il contenuto di FAC nella locazione indirizzata da (FORPNT)
MOVMF	BBD4	DBD4	DAE0	CD06	Immagazzina FAC nella locazione ilcui indirizzo e' in (X/Y)
MOVFA	BBFC	DBFC	DB08	CD32	Carica FAC da AFAC
MOVAF	BC0C	DC0C	DB18	CD42	Carica AFAC da FAC
ROUND	BC1B	DC1B	DB27	CD51	Arrotonda il contenuto di FAC nel FAC stesso
SIGN	BC2B	DC2B	DB37	CD61	Trova il segno di FAC, il risultato e' immesso in A-$01=positivo,$00=zero,$FF=negativo
SGN	BC39	DC39	DB45	CD6F	Esegue la funzione SGN
ACTOFC	BC3C	DC3C	DB48	CD72	Immagazzina (A) in FAC
INTOFC	BC44	DC44	DB50	CD7A	Immagazzina un intero presente in (FAC+1) come FLTP nel FAC. In ingresso X dovrebbe contenere $90
ABS	BC58	DC58	DB64	CD8E	Esegue la funzione ABS
FCOMP	B5CB	DC5B	DB67	CD91	Confronta (FAC) con MFLPT indirizzato da (A/Y) il risultato e' riportato in A : $0=FAC maggiore del valore di MFLPT, $00=al valore di MFLPT , $FF=FAC minore di FLMPT
QINT	BC9B	DC9B	DBA7	CDD1	Converte un valore FLPT presente in FAC in quattro Bytes interi in FAC+1 nella forma HI LOW
INT	BCCC	DCCC	DBD8	CE02	Esegue INT- converte FAC in intero poi lo rico

LABEL	C64	V20	B2.0	B4.0	DESCRIZIONE
					nverte in FLPT e lo rimette in FAC
FIN	BCF3	DCF3	DBFF	CE29	Converte una stringa ASCII, il cui indirizzo n el testo BASIC e' indicato da TXTPTR, a FLPT n el FAC
	BDB3	DDB3	DCBF	CEE9	Costante MFLPT usata nella conversione in stri nga ASCII
INPRT	BDC2	DDC2	DCCE	CF7B	Stampa "IN" seguito dall' attuale numero di li nea. Esempio (CURLIN).
LINPRT	BDCD	DDCD	DCD9	CF83	Stampa l'attuale numero di linea da (CURLIN)
FACOUT	BDD7	DDD7	DCE3	CF8D	Stampa FAC come stringa ASCII
FOUT	BDDD	DDDD	DCE9	CF93	Converte FAC in stringa ASCII con inizio allo STACK e fine con Byte nullo
FYOUT	BDDF	DDDF	DCEB	CF95	Converte FAC in stringa ASCII di inizio a STAC K-1+Y
FOUTIM	BE68	DE68	DD74	D01E	Converte TI in stringa ASCII con partenza a ST ACK e fine con un Byte nullo.
	BF11	DF11	DE1D	D067	Costanti MFLPT usate in conversione ASCII
SQR	BF71	DF71	DE5E	D108	Esegue la funzione SQR
FPWRT	BF7B	DF7B	DE68	D112	Esegue l' Esponenziale. AFAC alla potenza di F AC risposta in FAC
NEGOP	BFB4	DFB4	DEA1	D14B	Negazione di FAC, risposta in FAC
	BFBF	DFDF	DEAC	D156	Costanti MFLPT per la routine EXP
EXP	BFED	DFED	DEDA	D184	Valuta la funzione EXP
POLYX	E043	E040	DF2D	D1D7	Valutazione ddi funzione. All' ingresso (A/Y) punta al singolo Byte che e' uguale a 1- il nu mero di costanti che lo segue.La routine inizi almente converte l' argomento in un intervallo compreso fra 0 e 0.999999999.
	E08D	E0BA	DF77	D221	Costanti MFLPT per valutazione RND
RND	E097	E094	DF7F	D229	Esegue RND
BOERR	E0F9	E0F6	----	----	Manipola un errore di I/O entro il basic
BCHOUT	E10C	E109	----	----	Routine di uscita carattere basic - usa la rou tine Kernal CHROUT
BCHIN	E112	E10F	----	----	Routine di ingresso carattere basic - usa la r outine Kernal CHRIN
BCKOUT	E118	E115	----	----	Routine di apertura di un canale basic in usci ta - usa la routine Kernal CKOUT
BCKIN	E11E	E11B	----	----	Routine basic di apertura xanale per INPUT - u sa la routine Kernal CHKIN
BGETIN	E124	E121	----	----	Routine di lettura di un carattere basic - usa la routine Kernal GETIN
SYS	E12A	E127	FFDE	FFDE	Esegue SYS - CBM64/VIC20 fissano (A,X,Y e SR) rispettivamente da (SYSA),(SYSX),(SYSY),(SYSS) prima di entrare nella routine in codice macch ina e ripristinano i nuovi valori al ritorno
SAVET	E156	E153	FFDB	FFDB	Esegue SAVE - CBM64 e VIC20 ricercano i parame tri dal testo basic prima della chiamata della

LABEL	C64	V20	B2.0	B4.0	DESCRIZIONE
					routine Kernal, anche la routine Kernal del Pe t legge i parametri
SAVER	E15F	E15C	F6A7	F6E3	Esegue il salvataggio della Ram su una data pe riferica - il CBM64 e il VIC20 saltano alla routine Kernal SAVE
VERFYT	E165	E162	FFDB	FFDB	Esegue VERIFY - il CBM64 e il VIC20 ricercano i parametri dal testo basic prima di saltare a lla routine Kernal.
LOADT	E168	E165	FFD5	FFD5	Esegue LOAD - il CBM64 e il VIC20 ricercano i parametri dal testo basic prima di saltare a lla routine Kernal.
LOADR	E175	E172	F322	F356	Carica la RAM da una periferica - il CBM64 e i l VIC20 ricercano i parametri dal testo basic prima di saltare alla routine Kernal.
OPENT	E1BE	E1BB	FFC0	FFC0	Esegue OPEN - il CBM64 e il VIC20 ricercano i parametri dal testo basic prima di saltare a lla routine Kernal.
CLOSET	E1C7	E1C4	FFC3	FFC3	Esegue CLOSE - il CBM64 e il VIC20 ricercano i parametri dal testo basic prima di saltare a lla routine Kernal.
CLOSER	E1CA	E1C7	F2AC	F2E0	Chiude un dato FILE
SLPARA	E1D4	E1D1	F43E	F47D	Prende i parametri dal testo basic per LOAD/SA VE/VERIFY
COMBYT	E200	E1FD	F460	F49F	Se (TXTPTR) e' indirizzato a una apice , leg ge un byte dal testo basic
DEFLT	E206	E203	F50E	F54D	Se viene trovato la fine di un comando esce se nza aver fissato i parametri.
CMMERR	E20E	E20B	F516	F555	Verifica che TXTPTR indirizzato all' apice n on sia seguito da virgola o da byte nullo - in caso contrario SYNTAX ERROR
OCPARA	E219	E216	F4CE	F50D	Ricerca i prametri dal testo Basic per le rout ines di OPEN e CLOSE
COS	E264	E261	DFD8	D282	Valuta la funzione COS- aggiunge pi greco/2 a FAC poi...
SIN	E26B	E268	DFDF	D289	Valuta la funzione SIN
TAN	E2B4	E2B1	E028	D2D2	Valuta la funzione TAN calcolando SIN/COS
PI2	E2E0	E2DD	E054	D2FE	Costante pi greco/2 di MFLPT
TWOPI	E2E5	E2E2	E059	D303	Costante 2*pi greco di MFLPT
FR4	E2EA	E2E7	E05E	D308	Costante 0.25 di MFLPT
	E2EF	E2EC	E063	D30D	Costante MFLPT per il calcolo della funzione S IN
ATN	E30E	E30B	E08C	D32C	Calcola la funzione ATN
	E33E	E33B	E0BC	D35C	Costante MFLPT per il calcolo di ATN
BASSFT	E37B	E467	----	----	Routine di restart (WARM) del Basic chiamata c on un BREAK se una istruzione BRK e' rilevata oppure se e' premuto RUN/STOP RESTORE. Chiude i canali, resetta le linee di I/O, resetta lo

LABEL	C64	V20	B2.0	B4.0	DESCRIZIONE
					STACK ed esce attraverso la routine IERROR con (X) = $80
INITV	E453	E45B	----	----	Copia BVTRS nel blocco 0 della RAM
INIT	E394	E378	----	----	Inizializza il Basic all' accensione-se viene chiamata INITV per settare i vettori Basic in $0300-$030B, allora....
ININV	E397	E37B	E116	D3B6	Chiama la routine di INITCZ per settare le variabili Basic nella pagina zero.(Il PET azzera il contenuto della memoria da $0400 a fine memoria, mentre cio' non avviene con CBM64 e VIC20). Chiama in funzione la routine INTMS, poi va in modo Basic.
INITAT	E3A2	E387	E0F9	D399	Copia principale della routine CHRGET - copia all' indietro in pagina ZERO da INITCZ
RNDSED	E3BA	E39F	E111	D3B1	Costante MFLPT=0.811635157 usata per il valore iniziale della funzione RND
INITCZ	E3BF	E3A4	----	----	Inizializza la RAM Basic- fissa USRPOK, ADRAY1, ADRAY2, copia INITAT e RNDSED in CHRGET e RNDX, fissa TXTTAB e FRETOP a (LORAM), (HIRAM), mette a zero il primo Byte del testo Basic
WORDS	E460	E429	E1B7	D44B	Testo "BYTES FREE"
FREMES	E473	E436	E1C4	D458	Testo"...COMMODORE BASIC..."
BVTRS	E447	E44F	----	----	Copia ROM dei vettori BASIC
IOBASK	E500	E500	----	----	Riporta in (X/Y) l' indirizzo del 6526 (CIA) utilizzato dalla routine IRQ.Questa e' la routine Kernal IOBASE
SCRNK	E505	E505	----	----	Riporta la disposizione organizzativa dello schermo-colonne (X), righe (Y). Entrata attraverso il vettore Kernal SCREEN
PLOTK	E50A	E50A	----	----	Fissaa/riporta la pposizione del cursore: le colonne di schermo attraverso (Y), le righe di schermo attraverso (X).Fissa il cursore se il Carry e' a 0, ne riporta invece la posizione se il Carry e' a 1. Ingresso attraverso il vettore Kernal PLOT.
INITIO	E518	E518	E1DE	E60F	Inizializza I/O. Questa routine e' chiamata tramite il vettore Kernal IOBASE
HOME	E566	E581	E257	E05F	Home di schermo, resetta la tavola di link delle linee di schermo
PLOTR	E56C	E587	E25D	E06F	Muove il cursore a (TBLX), (PNTR)
PANIC	E59A	E5B5	----	----	Resetta le linee di I/O, incluso i registri del VIC-II
DFLTIO	E5A0	E5BB	----	----	Resetta i canali di I/O poi....
VICINT	E5A8	E5C3	----	----	Ripristina i valori del 6567 (VIC-II)
KBGET	E5B4	E5CF	E285	E0A7	Prende un carattere dal Buffer di tastiera
KBINP	E5CA	E5E5	E29A	E0BC	Input di un carattere
KSINP	E632	E64F	E2F4	E116	Input di un carattere da tastiera o schermo

LABEL	C64	V20	B2.0	B4.0	DESCRIZIONE
SCINP	E63A	E657	E2FF	E121	Input di un carattere dallo schermo.
TGLQT	E684	E6B8	E33F	E16A	Congiunge il flag di virgolette (QTSW). Durant e la fase di INPUT arresta la codificazione (T OKEN) delle parole chiave quando queste sono f ra apici
SCPUT	E691	E6C5	E34C	E177	Stampa il contenuto di (A)sullo schermo. Utili zzata da SCNPNT
SCNPNT	E716	E742	E3D8	E202	Stampa un carattere sullo schermo, interpretan do sia i controlli di cursore, il cambio di co lore e il cambio di set di caratteri
CKDECL	E8A1	E8E8	----	----	Controlla il decremento del contatore linea.
CKINL	E8B3	E8FA	----	----	Controlla l' incremento del contatore linea.
SCNTABL	E8DA	E921	----	----	Tavola usata per la decodifica dello schermo
SCROLL	E8EA	E975	E53F	E3C8	Routine di scrolling schermo
IRQK	EA31	EA41	E61B	E442	Routine principale di manipolazione interrupt di IRQ.(CINV punta a queste locazioni di memo ria)
SCNKIK	EA87	EB1E	E68E	E4CD	Routine di scansione della tastiera, controllo di tasto premuto e immette il carattere nella coda di tastiera. Questa e' la routine indiriz zata dal vettore Kernal SCNKEY
KBDTBL	EB79	EC46	E6F8	E6D1	Tavola della matrice di tastiera. Utilizzata d a SCNKYK per convertire il tasto premuto nel c arattere ASCII
TALKK	EDO9	EE14	FOB6	FOD2	Esegue un OR con (A) per convertire il numero di periferica in un indirizzo di TALK per il B US IEEE e lo trasmette come comando. Questa e' la routine Kernal indirizzata da TALK
LSTNK	EDOC	EE17	FOBA	FOD5	Esegue un OR con (A) per convertire il numero di periferica in un indirizzo di LISTEN per il bus IEEE e lo trasmette come comando.Questa e' la routine Kernal indirizzata da LISTEN
SCNDK	EDB9	EECO	----	----	Converte (A) e lo trasmette come indirizzo sec ondario di LISTEN sul BUS IEEE. Questa e' la routine Kernal a cui si accede per mezzo di SE COND
TKSAK	EDC7	EECE	----	----	Converte (A) e lo trasmette come indirizzo sec ondario di TALK sul BUS IEEE. Questa e' la routine Kernal a cui si accede per mezzo di TK SA
CIOUTK	EDDO	EEE4	F16F	F19E	Trasmette un Byte sul BUS IEEE. Il carattere e ' bufferizzato cosi' che e' possibile eseguire un HANDSHAKING.Questa e' la CIOUT Kernal
UNTLKK	EDEF	EEF6	F17F	F1AE	Trasmette un comando di UNTALK sul BUS IEEE. Q uesta e' la routine Kernal che e' indirizzata dal vettore UNTALK
UNLSNK	EDFE	EF04	F183	F1B9	Trasmette un comando UNLISTEN sul BUS IEEE. Il

LABEL	C64	V20	B2.0	B4.0	DESCRIZIONE
					vettore Kernal UNLSN comincia di qui
ACPTRK	EE13	EF19	F18C	F1C0	Un byte e' in HANDSHAKEN dal BUS IEEE e immesso in A. Questa e' la routine Kernal ACPTR
NMICNT	EEBB	EFA3	----	----	Continuazione della Routine principale di INTERRUPT NMI usata per le periferiche RS232
RSWRT	EF06	EFEE	----	----	Uscita di un Byte su canale RS232
RSBLD	EF59	F036	----	----	Parte della Routine di interrupt NMI che costruisce il bit individuale proveniente dal canale RS232
KMSGTX	F0BD	F174	F000	F000	Testo relativo ad un errore Kernal e controllo del messaggio ivi immagazzinato
KMESSG	F12B	F1E2	F156	F158	Stampa un messaggio Kernal sullo schermo
GETINK	F13E	F1F5	F1D1	F205	Riceve un carattere da un canale e lo riporta in A. Se nessun carattere e' stato inviato riporta 0. Questa e' la routine Kernal GETIN
CHRINK	F157	F20E	F1E1	F215	Input di un carattere dal Buffer in A.questa e' la routine Kernal CHRIN
CHROTK	F1CA	F27A	F232	F266	Uscita del Byte contenuto in A nel canale di uscita. Questa e' la routine Kernal CHROUT
CHKINK	F20E	F2C7	F7BC	F7FE	Colloca il file dichiarato da X come canale di input. Questa e' la routine usata dal vettore Kernal CHKIN
CKOUTK	F250	F309	F770	F71F	Colloca il file dichiarato da Y come canale di uscita. Questa e' la routine usata dal vettore Kernal CHKOUT
CLOSEK	F291	F34A	F2AC	F2E0	A dichiara il file che deve essere chiuso. I particolari sono rimossi dalla tavola delle periferiche (SAT, FAT). Questa e' la routine Kernal CLOSE
CLALLK	F32F	F3EF	F26E	F2A2	Questa routine blocca tutti gli attuali I/O. Il numero di file aperto (LNTND) e' messo a zero e qualsiási file su IEEE e' messo in UNTALK o UNLISTEN.Questa e' la routine Kernal CLALL.
CLRCHK	F333	F3F3	F272	F2A6	Dealloca i canali di I/O e rifissa le periferiche (DFLNT=0,DFLTO=3). Questa e' la routine kernal CLRCHN
OPENK	F34A	F40A	F524	F563	Apre il file i cui dati sono immagazzinati in FNLEN,LA,SA,FNADR inserendo i dettagli nelle tavole di LAT,FAT e SAT e scegliendo le appropriate routine per la gestione di files su disco o cassetta. Questa e' la routine Kernal OPEN
LOADK	F49E	F542	F3CC	F40B	Carica il file negli indirizzi detti sopra. Il CBM64 ed il VIC 20 hanno un parametro addizionale che dichiara dove il file deve essere ricaricato. Questa e' la routine Kernal LOAD
SAVEK	F5DD	F675	F6A4	F6E3	Salva una data zona di memoria RAM (STAL e MEM

LABEL	C64	V20	B2.0	B4.0	DESCRIZIONE
					USS) su un file indentificato da (FNLEN,LA,FA, SA,FNADR). Questa e' la routine kernal SAVE
UDTIMK	F69B	F734	F729	F768	Parte della ruotine di servizio IRQ che posizi ona l' orologio in tempo reale. Inoltre immaga zzina l'attuale valore della matrice di tastie ra in STKEY che abilita la funzione di STOP. Q uesta e' la routine Kernal UDTIM
STOPK	F6ED	F770	F30F	F343	Controlla il valore immagazinato in STKEY e re stituisce il flag Z a 1 se il valore ivi immag azzinato rappresenta il tasto STOP. Questa e' la routine Kernal STOP
KERROR	F6EB	F77E	F315	F349	Errori controllati dalle routines Kernal. Ques ta routine entra in funzione per inviare il gi usto messaggio di errore
THEADR	F72C	F7AF	F5A6	F5E5	Cerca e legge il bloccodi testa del nastro.
TCNTL	F80D	F88A	F806	F84B	Le routines di controllo nastro risiedono in q uesto punto. Eseguono le funzioni come: contro llo del motore di cassetta, temporizzazione, e cc.
TREAD	F92C	F98A	F855	F89A	Routine di lettura nastro
TBYT	FA70	FABD	F931	F976	Routine di manipolazione di un Byte per lettur a nastro
TWRT	FBA6	FBEA	FB93	FBD8	Routine di scrittura nastro
COLD	FCE2	FD22	FCD1	FD16	Routine di inizializzazione utilizzata all' ac censione della macchina. Questa e' la routine che e' indirizzata via HARWARE dal vettore loc alizzato a $FFFC. La memoria e' inizializzata e tutte le periferiche di I/O sono fissate. La prima parte della routine controlla se un cart ridge e' caricato nel blocco 9 e se e' cosi' s alta al cartridge per la inizializzazione e la messa in funzione
MEMCHK	----	FE91	----	----	Questa routine nel VIC20 controlla quanta memo ria e' disponibile
NMIXCT	FE43	FEA9	----	----	Nel VIC e nel CBM 64 l' NMI Interrupt e' princ ipalmente usato per gestire le periferiche RS2 32. I PET invece non l' adoperano per niente
BAUDTD	----	FF5C	----	----	Tavola dei BAUD RATE per il VIC
INTRPT	FF48	FF72	E61B	E442	Questa routine entra in funzione quando viene rilevato un Interrupt. I registri sono salvati e la causa dell' Interrupt viene determinata (IRQ o BRK)
KVCTRS	FF81	FF8A	FFC0	FFC0	Tavola dei salti delle routines Kernal
NMIVEC	FFFA	FFFA	FFFA	FFFA	Vettore di Interrupt NMI
RSTVEC	FFFC	FFFC	FFFC	FFFC	Vettore di Reset
IRQVEC	FFFE	FFFE	FFFE	FFFE	Vettore di Interrupt IRQ

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