HOME VIDEO GAME BURN-IN TESTER

The Burn-In Tester performs functional as well as static tests on the operation of the home video game.

The functional tests performed check for correct operation of system read only memory, random access memory, custom functions as data, shift, flop, expand, OR and XOR.

Static tests performed exercise all the system I/O ports by reading and writing to them.

Included in the tester are 8 routines to enable the user to generate constant CPU signals for checking data and control logic circuitry, monitor activity on system input ports, generate color display, and enter a program directly into system RAM for execution.

While the Burn-In Tester is in operation the LED display on the tester module will blink the number of hours the unit has been under test (this also indicates the unit is working).

Ex. LED's blink

-0 test is in its first hour

10 test has been running for 10 hours

The hours counter will display up to "99" hours before recycling back to "-0".

Home Video Game Burn-In Tester Manual and Sourcecode
Version 1.0 - Released Nov 10, 2000

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ERROR DETECTION

If an error is detected while the Burn-In Test is running the LED display will change to the following:

NN - Error Code Number
XX - Information Byte
"HE"
"LP"
HRS - Number of Hours Tester Has Been Running

"--"

Possible error codes -- see error code description sheets for further information as to meaning:

Error Code # 1 - Key Pad Error
2 - Screen Interrupt Error
3 - ROM Checksum Error
4 - RAM Error
5 - Shifter Error
6 - Rotator Error (not implemented)
7 - Flopper Error
8 - OR Error
9 - XOR Error
10 - OR Intercept Error
11 - XOR Intercept Error
12 - Expander Error
13 - Trigger/Joystick Error
14 - Pot Error

The information byte gives information to held isolate the error condition. Please see the error code description sheets for more detailed information.

SPECIAL FUNCTIONS:

	1	2	3	4
Key Pad Layout	5	6	7	8
	9	A	B	C
	D	E	F	Ø
	Q/S	X	X	X
	CE	X	X	GO

While the Burn-In Tester is running the user can access the special routines by pressing one of the following keys:

Key #1 - Memory Read Routine
2 - Memory Write Routine
3 - Input Port Read Routine
4 - Output Port Write Routine
5 - Memory Read & Write Routine
6 - Display All Input Devices
7 - Rainbow Color Display
8 - Enter Machine Code From Key Pad

See Key Pad description sheets for details on individual routines.

Function Keys:

Q/S - This key operates differently in the rack tester than in the bench tester.

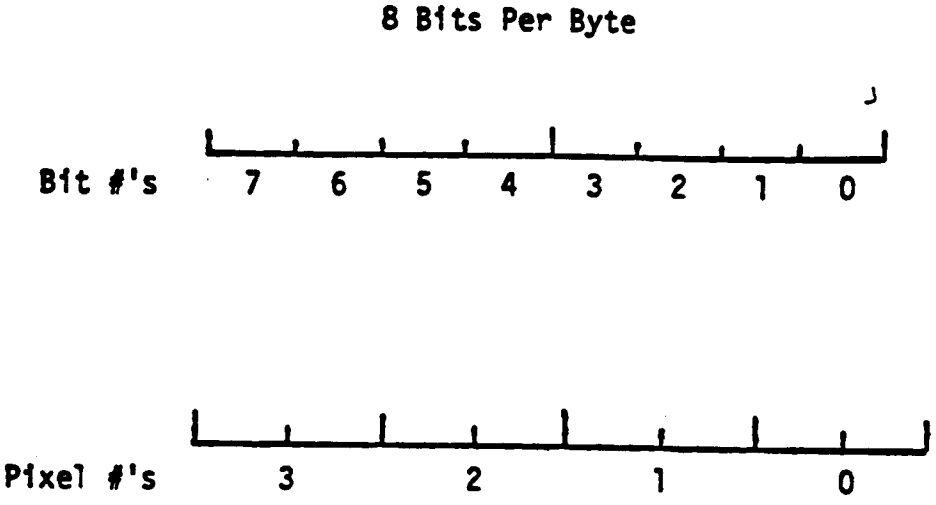
Rack Tester—When the tester starts running it will stay in operation, burning in the unit, until reset or one of the 8 special function keys are pressed. If the "Q/S" key is pressed while the tester is running, the program will execute 3 more passes and terminate displaying an "E1" in the LEDS, indicating the unit is okay.

Bench Tester—In this version the program will execute 4 complete passes and then terminate displaying an "E1", if the unit is okay. If the "Q/S" key is pressed the tester program will execute indefinitely, or until reset or one of the special function keys are pressed.

CE - Used as "Clear Entry" in special function routines.

GO - Used only in Routine #8 of the special functions, used to execute user typed machine code.

Byte Layout



Decimal	Hexi-Decimal	Binary
0	0	0 0000
1	1	0 0001
2	2	0 0010
3	3	0 0011
4	4	0 0100
5	5	0 0101
6	6	0 0110
7	7	0 0111
8	8	0 1000
9	9	0 1001
10	A	0 1010
11	B	0 1011
12	C	0 1100
13	D	0 1101
14	E	0 1110
15	F	0 1111
16	10	1 0000

OR Function

X	Y	Result
0	0	0
0	1	1
1	0	1
1	1	1

XOR Function

X	Y	Result
0	0	0
0	1	1
1	0	1
1	1	0

INPUT PORTS

Port # (HEX)	
8	Intercept Feedback
E	Vertical Line Feedback
F	Horizontal Address Feedback
10	Player Handle Ø (Trigger & Joystick)
11	Player Handle 1 (Trigger & Joystick)
12	Player Handle 2 (Trigger & Joystick)
13	Player Handle 3 (Trigger & Joystick)
14	Keyboard Column Ø (Right)
15	Keyboard Column 1
16	Keyboard Column 2
17	Keyboard Column 3 (Left)
1C	Player Pot Ø
1D	Player Pot 1
1E	Player Pot 2
1F	Player Pot 3

OUTPUT PORTS

Port # (HEX)	
0	Color Register Ø
1	Color Register 1
2	Color Register 2
3	Color Register 3
4	Color Register 4
5	Color Register 5
6	Color Register 6
7	Color Register 7
8	Low/High Resolution
9	Horizontal Color Boundary, Background Color
A	Vertical Blank Register
B	Color Block Transfer
C	Magic Register
D	Interrupt Feedback Register
E	Interrupt Enable and Mode
F	Interrupt Line
10	Master Oscillator
11	Tone A
12	Tone B
13	Tone C
14	Vibrato Register
15	Tone C Volume, Noise Modulation Control

OUTPUT PORTS (Continued)

16	Tone A, B Volume
17	Noise Volume Register
18	Sound Block Transfer
19	Expand Register

ERROR CODE 1

KEY PAD TEST ROUTINE

FUNCTION:

When the test program is started the key pad is immediately checked for keys in the on ("1") position. Normally a key is in the "0" (off) state until pressed.

LED DISPLAY:

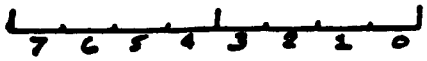
Error Code "1"

Info Byte xx = Input port # of stuck switch, this will localize error to particular key pad column.

FURTHER TEST:

If position of bad switch is needed, use the "Display Input Device" routine. This will display the hexidecimal contents of the key pad ports (ports 14 thru 17). If any are non-zero the bad key can be determined from the following chart.

ERROR CODE 1
KEY PAD TEST ROUTINE



BIT NUMBER

PORT NUMBER	5	4	3	2	1	ø
17	CE	1	4	7	MR	C
16	ø	2	5	8	MS	↑
15	.	3	6	9	CH.	↓
14	=	+	-	×	÷	%

HOME GAME KEY-PAD

BIT NUMBER

PORT NUMBER	5	4	3	2	1	ø
17	CE	Q/S	D	9	5	1
16			E	A	6	2
15			F	B	7	3
14	GO		ø	C	8	4

TESTER KEY-PAD

ERROR CODE 2

SCREEN LINE INTERRUPT ERROR

FUNCTION:

This routine checks the operation of the screen line interrupt. This function generates an interrupt when the raster scan matches a software selected line number. This routine enables screen interrupts, waits one second, then checks if any interrupts occurred.

LED DISPLAY:

Error Code "2"

Info Byte Blank - Indication no screen interrupts occurred.

This test is a go/no-go test on the screen interrupt function.

ERROR CODE 3

ROM CHECKSUM ERROR

FUNCTION:

This routine adds the contents of each byte per 2K block of system ROM and tester ROM. The total for each 2048 byte block of ROM should be "FF" hex. If that value is not obtained, an error is indicated.

LED DISPLAY:

Error Code "3"

Info Byte xx = High 8 bits of 16 bit starting address of bad 2K block.

xx = -Ø	Hex ØØØØ	System ROM 1 Bad
= Ø8	Ø8ØØ	System ROM 2 Bad
= 1Ø	1ØØØ	System ROM 3 Bad
= 18	18ØØ	System ROM 4 Bad
= 2Ø	2ØØØ	Tester ROM Bad

This test will determine if a ROM has been blasted correctly.

ERROR CODE 4

RAM ERROR

FUNCTION:

This test checks for bad bits in the RAM array of the video game. A pattern starting with "1" and ending with "80H" is written into RAM (the complement is also written) and checked that the correct pattern was stored.

LED DISPLAY:

Error Code "4"

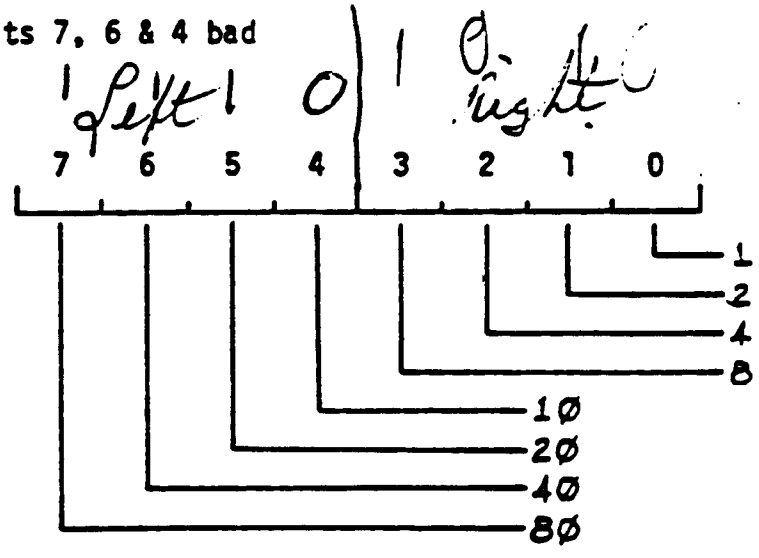
Info Byte xx - Hex value of bad bit.

xx = 6 bits 1 & 2 bad

= 80 bit 7 bad

= 1 bit 0 bad

= L0 bits 7, 6 & 4 bad



NOTE:

Display

- = A (1010)
E = B (1011)
H = C (1100)
L = D (1101)
P = E (1110)
= F (1111)

Number displayed in LED's if bit is bad.

xxIf a "48" is displayed bit's 6 & 3 are bad.

ERROR CODE 5

SHIFT ERROR

FUNCTION:

This routine checks the shifter function of the data chip shifts pixels Ø, 1, 2, and 3 pixel's right.

LED DISPLAY:

Error Code "5"

Info Byte xx - Amount of shift when error occurred.

xx = Blank - Error on Ø pixel shift

= 1 - Error on 1 pixel shift

= 2 - Error on 2 pixel shift

= 3 - Error on 3 pixel shift

ERROR CODE 6

ROTATE ERROR

Since this error code cannot be produced by the tester program (hardware and software rotate function not implemented) the code should not display. If it comes up, your test ROM is probably growing back to its original pre-programmed STATE, AND IT SHOULD CAUSE A ROM checksum error anyway. Get a new tester ROM.

ERROR CODE 7

FLOPPER ERROR

FUNCTION:

This tests the data chip's hardware flop function. A pixel byte containing "00 00 00 01" will get changed to "01 00 00 00" when written thru the flopper.

LED DISPLAY:

Error Code "7"

Info Byte xx - Data byte being flopped when error occurred.

xx = 1 - Error when writing 00 00 00 01

= 7♭ - Error when writing 01 11 11 11

= E♭ - Error when writing 10 11 11 11

= L♭ - Error when writing 11 01 11 11

= P♭ - Error when writing 11 10 11 11

= ♭7 - Error when writing 11 11 01 11

= ♭E - Error when writing 11 11 10 11

= ♭L - Error when writing 11 11 11 01

= ♭P - Error when writing 11 11 11 10

♭ = Blank (Hexidecimal "F")

NOTE DISPLAY:

- = A (1010)
E = B (1011)
H = C (1100)
L = D (1101)
P = E (1110)
= F (1111)

ERROR CODE 8 OR WRITE ERROR
ERROR CODE 9 XOR WRITE ERROR
ERROR CODE 10 OR INTERCEPT ERROR
ERROR CODE 11 XOR INTERCEPT ERROR

FUNCTION:

These tests perform the logical "OR" and "XOR" function on data being written thru the data and address chips with data already stored in RAM. The intercept function signals a bit in the intercept input port whenever indicating the pixel in which the intercept occurred.

An intercept is defined as the writing of a non-zero pixel in a pixel location that previously contained a non-zero pixel.

LED DISPLAY:

Error Code "8" for OR Error
"9" for XOR Error
"10" for OR Intercept Error
"11" for XOR Intercept Error

Info Byte xx - 8 bit data pattern being written.

NOTE DISPLAY:

- = A (1010)
E = B (1011)
H = C (1100)
L = D (1101)
P = E (1110)
= F (1111)

ERROR CODE 12

EXPANDER ERROR

FUNCTION:

This routine tests the expander function of the data chip. The expander turns a 8-bit, 4 pixel byte into a 16-bit, 8 pixel word, each bit of the 8-bit byte expands into a 2-bit pixel. The 2-bit pattern that is obtained is determined by program software.

LED DISPLAY:

Error Code "12"

Info Byte xx = Data being expanded.

ERROR CODE 13 TRIGGER/JOYSTICK ERROR

ERROR CODE 14 POT ERROR

FUNCTION:

These two tests are in the program section that reads all the system input ports. During burn-in when the handles are not connected the pot ports and the trigger ports are checked for "FF" and "ØØ" respectively.

****NOTE: The triggers and joysticks are on the same input ports so if an error is detected use the "display device" routine to determine which part is bad.

LED DISPLAY:

Error Code "13" for Trigger and/or Joystick
"14" for Pots

Info Byte xx = Port number of bad input port.

xx = 10 - Player handle Ø Trigger or Joystick
= 11 - Player handle 1 Trigger or Joystick
= 12 - Player handle 2 Trigger or Joystick
= 13 - Player handle 3 Trigger or Joystick

xx = 1H (Port 1C) Player Ø Pot
= 1L (Port 1D) Player 1 Pot
= 1P (Port 1E) Player 2 Pot
= 1 (Port 1F) Player 3 Pot

NOTE DISPLAY:

- = A (1010)
E = B (1011)
H = C (1100)
L = D (1101)
P = E (1110)
= F (1111)

KEY #1 ROUTINE

MEMORY READ LOOP

FUNCTION:

This test does an infinite read from a user specified location. This is useful to check the $\overline{\text{MREQ}}$ (memory request), $\overline{\text{RD}}$ (memory read), and the address lines of the CPU.

LED DISPLAY: None

EXAMPLE: Enter 4-digit Hex Addr

42ØF

This will read from hex location 42ØF until reset is pressed.

Entry errors can be corrected by using "CE" or reset.

Reset to restart program.

KEY #2 ROUTINE

MEMORY WRITE LOOP

FUNCTION:

This test performs an infinite write to a memory location. Both the data written and the location is input by the user.

LED DISPLAY:

Displays the data being written.

EXAMPLE: Enter 2-digit hex data

Ø1

Enter 4-digit hex addr

4ØØØ

This will write a "Ø1" to system RAM location "4ØØØ" hex.

Entry errors can be corrected by using "CE" or reset.

Reset to restart program.

KEY #3

INPUT PORT READ LOOP

FUNCTION:

Perform infinite read from user specified port.

LED DISPLAY: None

EXAMPLE: Enter 2-digit hex read port

10

This will read input port 10 until reset is pressed.

Reset to restart program.

KEY #4

OUTPUT PORT WRITE LOOP

FUNCTION:

This executes an infinite write to an output port. The data written and the port # are input by the user.

LED DISPLAY:

Displays data byte being written.

EXAMPLE: Enter 2-digit hex data

60

Enter 2-digit write port

10

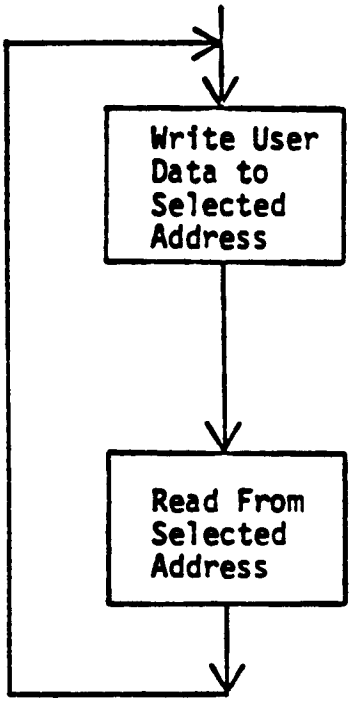
This will write a "60" hex to output port 10 until reset is pressed.

KEY #5

MEMORY WRITE & READ LOOP

FUNCTION:

This routine is similar to the previous (output port write) except the data is written to a 4-digit (16-bit) hex memory location.



KEY #6

DEVICE DISPLAY ROUTINE

FUNCTION:

This routine displays the current contents of all the video game device input ports.

Format: Port Number = Current Contents

Ports Displayed:

ØE - Light Pen Vertical Line Feedback
ØF - Light Pen Horizontal Addr Feedback

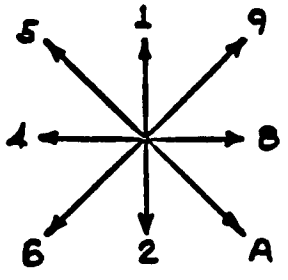
10 - Player Handle Ø Trigger & Joystick
11 - Player Handle 1 Trigger & Joystick
12 - Player Handle 2 Trigger & Joystick
13 - Player Handle 3 Trigger & Joystick

14 - Key Pad Column Ø
15 - Key Pad Column 1
16 - Key Pad Column 2
17 - Key Pad Column 3

1C - Player Pot Ø
1D - Player Pot 1
1E - Player Pot 2
1F - Player Pot 3

***NOTE: The light pen ports are blank until a light pen interrupt is detected.

Low 4-bits of ports 10-13 are Joystick and should read as follows:



KEY PAD #7

RAINBOW DISPLAY

FUNCTION:

This will display all possible color that the system can generate on the monitor simultaneously.

This color generation checks functions on the data chip.

KEY PAD #8

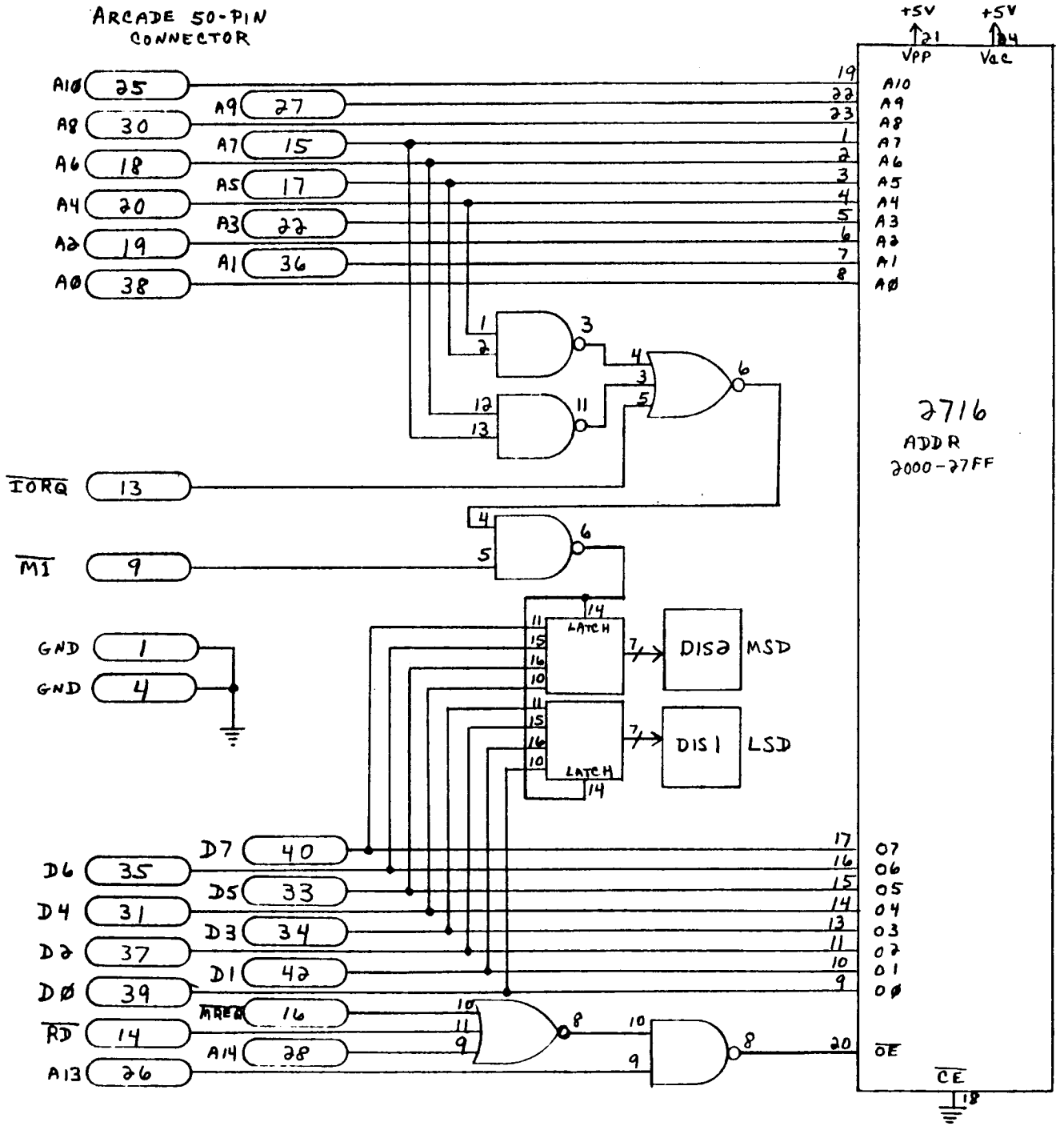
PROGRAM ENTRY

FUNCTION:

This routine enables direct entry of Z-80 machine code into RAM and executes it.

The user is prompted to enter a 4-digit hex starting address (4000 is good [it is also lowest starting address possible] since it is the first byte of RAM), he is then prompted to enter his code one byte at a time. If a mistake is made entering the second digit of the code byte, reset must be hit to start over. If the mistake is made on the first digit use "CE" to correct.

When code is entered press "Go" to execute.



BALLY ARCADE
BURN-IN TESTER
4/28/80
TRW

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BALCHECK Bally Board tester 4/29/80

```
                        0002 ;*****************************************************
                        0003 ;*                                                   *
                        0004 ;*                  B A L C H E C K                  *
                        0005 ;*                                                   *
                        0006 ;*             Check Bally Mother-boards             *
                        0007 ;*                                                   *
                        0008 ;*                     4/29/80                       *
                        0009 ;*                                                   *
                        0010 ;*****************************************************
                        0011 ;
      (00FF)            0012 DSPLY    EQU     0FFH            ; Test unit display port
                        0013                                  ; Display patterns
                        0014                                  ; 0 = 0
                        0015                                  ; .   .
                        0016                                  ; .   .
                        0017                                  ; 9 = 9
                        0018                                  ; A = -
                        0019                                  ; B = E
                        0020                                  ; C = H
                        0021                                  ; D = L
                        0022                                  ; E = P
                        0023                                  ; F = blank
                        0641          LIST    ON
                        0642 ;
4FFF                    0643          ORG     FIRSTC
                        0644 ;
2000  C3AD20            0645          JP      BCHK            ; Go start testing
                        0646 ;
                        0647 ; Multiply A by 16; Shift A left 4
2003  87                0648 A2003    ADD     A,A             ; x2
2004  87                0649          ADD     A,A             ; x4
2005  87                0650          ADD     A,A             ; x8
2006  87                0651          ADD     A,A             ; x16
2007  C9                0652          RET
                        0653 ;
2008  2F                0654 T2008    DB      00101111B       ; Key masks
2009  0F                0655          DB      00001111B
200A  0F                0656          DB      00001111B
200B  2F                0657          DB      00101111B
                        0658 ;
                        0659 ; Expander Test patterns
200C  0055AAFF          0660 T200C    DB      0,55H,0AAH,0FFH
                        0661 ;
                        0662 ; Interrupt vectors
2010  2827              0663 T2010    DW      A2728           ; Display all input devices
2012  7727              0664 T2012    DW      A2777           ; Rainbow Interrupt Routine
2014  1620              0665 T2014    DW      A2016           ; Normal Interrupt  Routine
                        0666 ;
                        0667 ; Normal Interrupt routine
                        0668                                  ; Keypad Layout
                        0669                                  ; Port  17 16 15 14
                        0670                                  ; Bit 0  1  2  3  4
                        0671                                  ;     1  5  6  7  8
                        0672                                  ;     2  9  A  B  C
                        0673                                  ;     3  D  E  F  0
                        0674                                  ;     4 Q/S x  x  x
                        0675                                  ;     5 CE  x  x Go
```

```
2016  F3          0676 A2016  DI
2017  08          0677        EX      AF,AF'          ; Using only A reg.
2018  DB15        0678        IN      A,(KEY1)
201A  A7          0679        AND     A
201B  2029        0680        JR      NZ,A2046        ; 3 or 7
201D  DB16        0681        IN      A,(KEY2)
201F  A7          0682        AND     A
2020  2030        0683        JR      NZ,A2052        ; 2 or 6
2022  DB17        0684        IN      A,(KEY3)
2024  A7          0685        AND     A
2025  200F        0686        JR      NZ,A2036        ; 1 or 5 or Q/S
2027  DB14        0687        IN      A,(KEY0)
2029  A7          0688        AND     A
202A  2836        0689        JR      Z,A2062
202C  FE01        0690        CP      1               ; 4 or 8
202E  CA2726      0691        JP      Z,A2627         ; Output Port Write routine
2031  FE02        0692        CP      2
2033  CABA27      0693        JP      Z,A27BA         ; Enter machine code from keys
2036  FE01        0694 A2036  CP      1
2038  CAD925      0695        JP      Z,A25D9         ; Memory Read routine
203B  FE02        0696        CP      2
203D  CA4F26      0697        JP      Z,A264F         ; Memory Read & Write routine
2040  FE10        0698        CP      10H
2042  2818        0699        JR      Z,A205C         ; Q/S
2044  181C        0700        JR      A2062           ; None of the above
                  0701 ;
2046  FE01        0702 A2046  CP      1
2048  CA1126      0703        JP      Z,A2611         ; Input Port Read routine
204B  FE02        0704        CP      2
204D  CA4827      0705        JP      Z,A2748         ; Rainbow Color Display
2050  1810        0706        JR      A2062
                  0707 ;
2052  FE01        0708 A2052  CP      1
2054  CAEA25      0709        JP      Z,A25EA         ; Memory Write routine
2057  FE02        0710        CP      2
2059  CA7326      0711        JP      Z,A2673         ; Display all input devices
                  0712 ;
205C  D9          0713 A205C  EXX                     ; Q/S key
205D  79          0714        LD      A,C
205E  E60F        0715        AND     0FH             ; Remove bit 7
2060  4F          0716        LD      C,A
2061  D9          0717        EXX
                  0718 ;
2062  D9          0719 A2062  EXX
2063  14          0720        INC     D               ; 1/60 sec counter
2064  7A          0721        LD      A,D
2065  FE3C        0722        CP      60
2067  2040        0723        JR      NZ,A20A9        ; Jp if no overflow to seconds
2069  1600        0724        LD      D,0             ; Reset 1/60 sec counter
206B  CB43        0725        BIT     0,E
206D  2011        0726        JR      NZ,A2080        ; Jp if odd second
206F  79          0727        LD      A,C
2070  FE84        0728        CP      84H
2072  2004        0729        JR      NZ,A2078        ; Jp if test not done
2074  3EB1        0730        LD      A,0B1H          ; "E1" on display
2076  1809        0731        JR      A2081
                  0732 ;
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2078  78          0733 A2078   LD      A,B
2079  A7          0734         AND     A
207A  2005        0735         JR      NZ,A2081
207C  3EA0        0736         LD      A,0A0H          ; "-0" on display
207E  1801        0737         JR      A2081
                  0738 ;
2080  AF          0739 A2080   XOR     A               ; "00" on display
2081  D3FF        0740 A2081   OUT     (DSPLY),A
2083  1C          0741         INC     E               ; Increment 1 second counter
2084  7B          0742         LD      A,E
2085  FE3C        0743         CP      60
2087  2020        0744         JR      NZ,A20A9        ; Jp if no seconds overflow
2089  1E00        0745         LD      E,0             ; Reset seconds
208B  24          0746         INC     H               ; Increment minutes
208C  7C          0747         LD      A,H
208D  FE3C        0748         CP      60
208F  2018        0749         JR      NZ,A20A9        ; Jp if no minutes overflow
2091  2600        0750         LD      H,0             ; Reset minutes
2093  2C          0751         INC     L               ; Increment hours
2094  7D          0752         LD      A,L
2095  CD0320      0753         CALL    A2003           ; Mul A by 16
2098  FEA0        0754         CP      0A0H
209A  2004        0755         JR      NZ,A20A0        ; Jp if not 10 hours
209C  78          0756         LD      A,B
209D  C606        0757         ADD     A,6
209F  47          0758         LD      B,A
20A0  04          0759 A20A0   INC     B
20A1  78          0760         LD      A,B
20A2  FE99        0761         CP      99H
20A4  2003        0762         JR      NZ,A20A9
20A6  AF          0763         XOR     A
20A7  47          0764         LD      B,A
20A8  6F          0765         LD      L,A
20A9  D9          0766 A20A9   EXX
20AA  08          0767         EX      AF,AF'
20AB  FB          0768         EI
20AC  C9          0769         RET
                  0770 ;
                  0771 ; Start of program
20AD  F3          0772 BCHK    DI
20AE  D9          0773         EXX
20AF  AF          0774         XOR     A
20B0  47          0775         LD      B,A
20B1  0E81        0776         LD      C,81H
20B3  57          0777         LD      D,A
20B4  5F          0778         LD      E,A
20B5  67          0779         LD      H,A
20B6  6F          0780         LD      L,A
20B7  D9          0781         EXX
20B8  3EAA        0782         LD      A,0AAH
20BA  D3FF        0783         OUT     (DSPLY),A       ; Set display to "--"
20BC  3E00        0784         LD      A,0
20BE  D308        0785         OUT     (CONCM),A       ; Set Consumer Mode
20C0  3EC8        0786         LD      A,100 SHL 1
20C2  D30A        0787         OUT     (VERBL),A       ; Update = 100 lines
                  0788 ;
                  0789 ; 1. Ensure keypad isn't stuck
```

```
20C4  AF          0790          XOR     A
20C5  0E14        0791          LD      C,KEY0
20C7  ED78        0792 A20C7    IN      A,(C)          ; Ensure no keys stuck
20C9  A7          0793          AND     A
20CA  2008        0794          JR      NZ,A20D4       ; Have a stuck key
20CC  0C          0795          INC     C              ; Check all columns
20CD  79          0796          LD      A,C
20CE  FE18        0797          CP      KEY3+1
20D0  2809        0798          JR      Z,A20DB        ; Keyboard has no stuck keys
20D2  18F3        0799          JR      A20C7
                  0800 ; Have a stuck keyboard key
20D4  1E01        0801 A20D4    LD      E,1            ; Error Code 1
20D6  21EF23      0802          LD      HL,T23EF
20D9  186C        0803          JR      A2147
                  0804 ;
                  0805 ; 2. Test RAM at 4F00 - 4FFF
20DB  FD21E220    0806 A20DB    LD      IY,T20E2
20DF  C36421      0807          JP      A2164
                  0808 ;
20E2  1804        0809 T20E2    JR      A20E8
20E4  4E          0810          DB      78
20E5  50          0811          DB      80
20E6  004F        0812          DW      NORMEM+3840
                  0813 ;
                  0814 ; 3. Check screen interrupts
20E8  31C84F      0815 A20E8    LD      SP,BEGRAM-6
20EB  3E08        0816          LD      A,8
20ED  D30E        0817          OUT     (INMOD),A      ; Set interrupt mode
20EF  211420      0818          LD      HL,T2014       ; Initialize interrupt routine
20F2  7C          0819          LD      A,H
20F3  ED47        0820          LD      I,A
20F5  7D          0821          LD      A,L
20F6  D30D        0822          OUT     (INFBK),A
20F8  AF          0823          XOR     A
20F9  D30F        0824          OUT     (INLIN),A      ; Interrupt on line 0
20FB  ED5E        0825          IM      2
20FD  FB          0826          EI
20FE  1601        0827          LD      D,1
2100  CDCF25      0828          CALL    A25CF          ; Delay
2103  F3          0829          DI
2104  D9          0830          EXX
2105  7A          0831          LD      A,D            ; 1/60 seconds
2106  A7          0832          AND     A
2107  200E        0833          JR      NZ,A2117       ; Must have gotten screen int.
2109  7B          0834          LD      A,E            ; Seconds
210A  A7          0835          AND     A
210B  2008        0836          JR      NZ,A2117       ; Must have gotten screen int.
210D  D9          0837          EXX
210E  1E02        0838          LD      E,2            ; Error 2 Screen line Int. err.
2110  0EFF        0839          LD      C,0FFH         ; Info byte = blank
2112  21EF23      0840          LD      HL,T23EF       ; Where to continue test
2115  1830        0841          JR      A2147
                  0842 ;
2117  0E80        0843 A2117    LD      C,80H          ; Set loop counter
2119  D9          0844          EXX
211A  FB          0845          EI
                  0846 ;
```

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                        0847 ; Start repetative tests
                        0848 ; Checksum check ROMs
211B  010008            0849 A211B   LD      BC,2048
211E  210000            0850         LD      HL,SCREEN       ; Start with low memory
2121  AF                0851 A2121   XOR     A               ; Initialize checksum
2122  86                0852 A2122   ADD     A,(HL)          ; Accumulate checksum
2123  57                0853         LD      D,A
2124  23                0854         INC     HL
2125  0D                0855         DEC     C
2126  20FA              0856         JR      NZ,A2122
2128  05                0857         DEC     B
2129  20F7              0858         JR      NZ,A2122
212B  7A                0859         LD      A,D
212C  FEFF              0860         CP      0FFH
212E  200A              0861         JR      NZ,A213A        ; Checksum bad
2130  010008            0862         LD      BC,800H
2133  7C                0863         LD      A,H
2134  FE28              0864         CP      [FIRSTC+2048] SHR 8
2136  2812              0865         JR      Z,A214A         ; Done with checksum test
2138  18E7              0866         JR      A2121           ; Do next checksum
                        0867 ;
213A  1E03              0868 A213A   LD      E,3             ; Error 3 ROM checksum err.
213C  7C                0869         LD      A,H
213D  D608              0870         SUB     8
213F  4F                0871         LD      C,A
2140  2002              0872         JR      NZ,A2144
2142  0EA0              0873         LD      C,0A0H          ; "-0" on display
2144  214A21            0874 A2144   LD      HL,A214A        ; Where to continue testing
2147  C3E623            0875 A2147   JP      A23E6
                        0876 ;
                        0877 ; Test RAM
214A  F3                0878 A214A   DI
214B  FD215121          0879         LD      IY,T2151        ; Test 4F00 - 4FFF
214F  1813              0880         JR      A2164
                        0881 ;
2151  1804              0882 T2151   JR      A2157
2153  4E                0883         DB      78
2154  50                0884         DB      80
2155  004F              0885         DW      NORMEM+3840
                        0886 ;
2157  FB                0887 A2157   EI
2158  FD215E21          0888         LD      IY,T215E        ; Test 4000 - 4EFF
215C  1806              0889         JR      A2164
                        0890 ;
215E  1868              0891 T215E   JR      A21C8
2160  3F                0892         DB      63
2161  4F                0893         DB      79
2162  0040              0894         DW      NORMEM
                        0895 ;
                        0896 ; Memory test routine
2164  0E00              0897 A2164   LD      C,0
2166  0601              0898         LD      B,1
2168  FD6605            0899 A2168   LD      H,(IY+5)
216B  FD6E04            0900         LD      L,(IY+4)
216E  70                0901 A216E   LD      (HL),B
216F  7E                0902         LD      A,(HL)
2170  A8                0903         XOR     B
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2171  2806          0904          JR      Z,A2179
2173  DD217921      0905          LD      IX,A2179
2177  184B          0906          JR      A21C4
                    0907 ;
2179  23            0908 A2179    INC     HL
217A  7C            0909          LD      A,H
217B  FDBE03        0910          CP      (IY+3)
217E  20EE          0911          JR      NZ,A216E
2180  2B            0912 A2180    DEC     HL
2181  7C            0913          LD      A,H
2182  FDBE02        0914          CP      (IY+2)
2185  2816          0915          JR      Z,A219D
2187  7E            0916          LD      A,(HL)
2188  A8            0917          XOR     B
2189  2806          0918          JR      Z,A2191
218B  DD219121      0919          LD      IX,A2191
218F  1833          0920          JR      A21C4
                    0921 ;
2191  78            0922 A2191    LD      A,B
2192  2F            0923          CPL
2193  77            0924          LD      (HL),A
2194  AE            0925          XOR     (HL)
2195  28E9          0926          JR      Z,A2180
2197  DD218021      0927          LD      IX,A2180
219B  1827          0928          JR      A21C4
                    0929 ;
219D  23            0930 A219D    INC     HL
219E  7C            0931          LD      A,H
219F  FDBE03        0932          CP      (IY+3)
21A2  280F          0933          JR      Z,A21B3
21A4  78            0934          LD      A,B
21A5  2F            0935          CPL
21A6  AE            0936          XOR     (HL)
21A7  2806          0937          JR      Z,A21AF
21A9  DD21AF21      0938          LD      IX,A21AF
21AD  1815          0939          JR      A21C4
                    0940 ;
21AF  AF            0941 A21AF    XOR     A
21B0  77            0942          LD      (HL),A
21B1  18EA          0943          JR      A219D
                    0944 ;
21B3  CB20          0945 A21B3    SLA     B
21B5  30B1          0946          JR      NC,A2168
21B7  79            0947          LD      A,C
21B8  A7            0948          AND     A
21B9  2002          0949          JR      NZ,A21BD
21BB  FDE9          0950          JP      (IY)
                    0951 ;
21BD  1E04          0952 A21BD    LD      E,4             ; Error 4 RAM error
21BF  21C821        0953          LD      HL,A21C8
21C2  184F          0954          JR      A2213
                    0955 ;
21C4  B1            0956 A21C4    OR      C
21C5  4F            0957          LD      C,A
21C6  DDE9          0958          JP      (IX)
                    0959 ;
                    0960 ; Shifter test
```

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21C8  FD211008      0961 A21C8   LD      IY,2064
21CC  DD211048      0962         LD      IX,NORMEM+2064
21D0  AF            0963         XOR     A
21D1  4F            0964         LD      C,A             ; Init shift count
21D2  0601          0965 A21D2   LD      B,1
21D4  79            0966 A21D4   LD      A,C
21D5  D30C          0967         OUT     (MAGIC),A       ; Set shifter
21D7  AF            0968         XOR     A
21D8  67            0969         LD      H,A             ; Expected first byte
21D9  6F            0970         LD      L,A
21DA  FD7700        0971         LD      (IY),A
21DD  78            0972         LD      A,B
21DE  68            0973         LD      L,B             ; Expected first byte
21DF  FD7700        0974         LD      (IY),A
21E2  AF            0975         XOR     A
21E3  FD7701        0976         LD      (IY+1),A
21E6  79            0977         LD      A,C
21E7  A7            0978         AND     A
21E8  280B          0979         JR      Z,A21F5         ; Jr if shift = 0
21EA  CB1D          0980 A21EA   RR      L
21EC  CB1C          0981         RR      H
21EE  CB1D          0982         RR      L
21F0  CB1C          0983         RR      H
21F2  3D            0984         DEC     A
21F3  20F5          0985         JR      NZ,A21EA        ; Shift proper number of times
21F5  DD7E00        0986 A21F5   LD      A,(IX)          ; Pick resulting RAM data
21F8  BD            0987         CP      L
21F9  2013          0988         JR      NZ,A220E        ; Shifter error
21FB  DD7E01        0989         LD      A,(IX+1)        ; Second resulting byte
21FE  BC            0990         CP      H
21FF  200D          0991         JR      NZ,A220E        ; Shifter error
2201  CB10          0992         RL      B               ; Store pattern left 1 bit
2203  30CF          0993         JR      NC,A21D4        ; Keep trying
2205  79            0994         LD      A,C             ; Done 8 patterns
2206  3C            0995         INC     A
2207  4F            0996         LD      C,A
2208  FE04          0997         CP      4
220A  20C6          0998         JR      NZ,A21D2        ; Jr if not all shifter sets
220C  1807          0999         JR      A2215
                    1000 ;
220E  1E05          1001 A220E   LD      E,5             ; Error 5 Shifter error
2210  211522        1002         LD      HL,A2215
2213  1833          1003 A2213   JR      A2248
                    1004 ;
                    1005 ; Floppy test
2215  3E40          1006 A2215   LD      A,01000000B
2217  D30C          1007         OUT     (MAGIC),A       ; Set floppy
2219  111048        1008         LD      DE,NORMEM+2064
221C  214A22        1009         LD      HL,T224A
221F  0E01          1010         LD      C,1             ; Write 1s
2221  79            1011 A2221   LD      A,C
2222  FD7700        1012         LD      (IY),A
2225  1A            1013         LD      A,(DE)
2226  BE            1014         CP      (HL)
2227  201A          1015         JR      NZ,A2243        ; Bad Flop
2229  23            1016         INC     HL
222A  CB21          1017         SLA     C
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222C  30F3      1018          JR      NC,A2221        ; Do all 8 bits
222E  CB19      1019          RR      C               ; Shift back to Hi bit
2230  79        1020 A2230    LD      A,C             ; Write 0s
2231  2F        1021          CPL
2232  FD7700    1022          LD      (IY),A
2235  1A        1023          LD      A,(DE)
2236  BE        1024          CP      (HL)
2237  2007      1025          JR      NZ,A2240        ; Bad flop
2239  23        1026          INC     HL
223A  CB39      1027          SRL     C
223C  30F2      1028          JR      NC,A2230        ; Do all 8
223E  181A      1029          JR      A225A
                1030 ;
2240  79        1031 A2240    LD      A,C
2241  2F        1032          CPL
2242  4F        1033          LD      C,A
2243  1E07      1034 A2243    LD      E,7             ; Error 7 Flopper error
2245  215A22    1035          LD      HL,A225A
2248  1847      1036 A2248    JR      A2291
                1037 ;
                1038 ; Expected flopper patterns
224A  40        1039 T224A    DB      01000000B
224B  80        1040          DB      10000000B
224C  10        1041          DB      00010000B
224D  20        1042          DB      00100000B
224E  04        1043          DB      00000100B
224F  08        1044          DB      00001000B
2250  01        1045          DB      00000001B
2251  02        1046          DB      00000010B
2252  FD        1047          DB      11111101B
2253  FE        1048          DB      11111110B
2254  F7        1049          DB      11110111B
2255  FB        1050          DB      11111011B
2256  DF        1051          DB      11011111B
2257  EF        1052          DB      11101111B
2258  7F        1053          DB      01111111B
2259  BF        1054          DB      10111111B
                1055 ;
                1056 ; Expander test
225A  3E08      1057 A225A    LD      A,8
225C  D30C      1058          OUT     (MAGIC),A       ; Set Expander
225E  AF        1059          XOR     A
225F  4F        1060          LD      C,A
2260  57        1061          LD      D,A
2261  210C20    1062          LD      HL,T200C
2264  D319      1063 A2264    OUT     (XPAND),A
2266  0604      1064          LD      B,4
2268  7E        1065 A2268    LD      A,(HL)
2269  FD7700    1066          LD      (IY),A          ; Expand M. S. nybble
226C  FD7701    1067          LD      (IY+1),A        ; Expand L. S. nybble
226F  DD7E00    1068          LD      A,(IX)          ; Resulting data
2272  BA        1069          CP      D
2273  2017      1070          JR      NZ,A228C        ; Bad expand
2275  DD7E01    1071          LD      A,(IX+1)
2278  BA        1072          CP      D
2279  2011      1073          JR      NZ,A228C        ; Bad expand
227B  23        1074          INC     HL
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227C  10EA          1075          DJNZ    A2268
227E  7A            1076          LD      A,D
227F  C655          1077          ADD     A,01010101B
2281  57            1078          LD      D,A
2282  79            1079          LD      A,C
2283  C605          1080          ADD     A,0101B
2285  4F            1081          LD      C,A
2286  FE14          1082          CP      14H
2288  20DA          1083          JR      NZ,A2264
228A  1807          1084          JR      A2293
                    1085 ;
228C  1E12          1086 A228C    LD      E,12H           ; Error 12 Expander error
228E  219322        1087          LD      HL,A2293
2291  1838          1088 A2291    JR      A22CB
                    1089 ;
                    1090 ; OR/XOR write, OR/XOR Intercept test
2293  3E10          1091 A2293    LD      A,10H           ; Set for OR write
2295  CDCE22        1092          CALL    A22CE
2298  CDE322        1093          CALL    A22E3
229B  FE01          1094          CP      1
229D  281C          1095          JR      Z,A22BB         ; OR write error
229F  FE02          1096          CP      2
22A1  2814          1097          JR      Z,A22B7         ; OR intercept error
22A3  3E20          1098 T22A3    LD      A,20H           ; Set for XOR write
22A5  CDCE22        1099          CALL    A22CE
22A8  2C            1100          INC     L
22A9  CDE322        1101          CALL    A22E3
22AC  FE01          1102          CP      1
22AE  2812          1103          JR      Z,A22C2         ; XOR Write error
22B0  FE02          1104          CP      2
22B2  2812          1105          JR      Z,A22C6         ; XOR intercept error
22B4  C33A23        1106          JP      A233A
                    1107 ;
22B7  1E10          1108 A22B7    LD      E,10H           ; Error 10 OR intercept err.
22B9  1802          1109          JR      A22BD
                    1110 ;
22BB  1E08          1111 A22BB    LD      E,8             ; Error 8 OR Write error
22BD  21A322        1112 A22BD    LD      HL,T22A3
22C0  1809          1113          JR      A22CB
                    1114 ;
22C2  1E09          1115 A22C2    LD      E,9             ; Error 9 XOR Write error
22C4  1802          1116          JR      A22C8
                    1117 ;
22C6  1E11          1118 A22C6    LD      E,11H           ; Error 11 XOR intercept err.
22C8  213A23        1119 A22C8    LD      HL,A233A
22CB  C3E623        1120 A22CB    JP      A23E6
                    1121 ;
22CE  D30C          1122 A22CE    OUT     (MAGIC),A
22D0  DB08          1123          IN      A,(INTST)       ; Clear intercept status
22D2  210401        1124          LD      HL,104H
22D5  AF            1125          XOR     A
22D6  57            1126          LD      D,A
22D7  5F            1127          LD      E,A
22D8  4F            1128          LD      C,A
22D9  6F            1129          LD      L,A
22DA  0604          1130          LD      B,4
22DC  C9            1131          RET
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                        1132 ;
22DD  3E01              1133 A22DD   LD      A,1             ; Write error
22DF  C9                1134         RET
                        1135 ;
22E0  3E02              1136 A22E0   LD      A,2             ; Intercept error
22E2  C9                1137         RET
                        1138 ;
22E3  CD3323            1139 A22E3   CALL    A2333
22E6  CD3323            1140         CALL    A2333
22E9  CD3323            1141         CALL    A2333
22EC  AF                1142         XOR     A
22ED  BD                1143         CP      L
22EE  2004              1144         JR      NZ,A22F4
22F0  7A                1145         LD      A,D
22F1  B1                1146         OR      C
22F2  1802              1147         JR      A22F6
                        1148 ;
22F4  7A                1149 A22F4   LD      A,D
22F5  A9                1150         XOR     C
22F6  DDBE00            1151 A22F6   CP      (IX)
22F9  20E2              1152         JR      NZ,A22DD        ; Write error
22FB  79                1153         LD      A,C
22FC  A7                1154         AND     A
22FD  2807              1155         JR      Z,A2306         ; 0 write = no intercept check
22FF  DB08              1156         IN      A,(INTST)       ; Get intercept status
2301  BB                1157         CP      E
2302  20DC              1158         JR      NZ,A22E0        ; Intercept error
2304  1805              1159         JR      A230B
                        1160 ;
2306  DB08              1161 A2306   IN      A,(INTST)
2308  B9                1162         CP      C
2309  20D5              1163         JR      NZ,A22E0        ; Intercept error
230B  79                1164 A230B   LD      A,C
230C  84                1165         ADD     A,H
230D  4F                1166         LD      C,A
230E  10D3              1167         DJNZ    A22E3
2310  010004            1168         LD      BC,400H
2313  CB3B              1169         SRL     E
2315  CB24              1170         SLA     H
2317  CB24              1171         SLA     H
2319  30C8              1172         JR      NC,A22E3
231B  CB14              1173         RL      H
231D  7B                1174         LD      A,E
231E  A7                1175         AND     A
231F  2004              1176         JR      NZ,A2325
2321  1E88              1177         LD      E,88H
2323  1802              1178         JR      A2327
                        1179 ;
2325  CB3B              1180 A2325   SRL     E
2327  7A                1181 A2327   LD      A,D
2328  C655              1182         ADD     A,55H
232A  57                1183         LD      D,A
232B  010004            1184         LD      BC,400H
232E  1E88              1185         LD      E,88H
2330  30B1              1186         JR      NC,A22E3
2332  C9                1187         RET
                        1188 ;
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2333  DD7200      1189 A2333   LD      (IX),D
2336  FD7100      1190         LD      (IY),C
2339  C9          1191         RET
                  1192 ;
                  1193 ; Tritter/Joystick test
233A  06FF        1194 A233A   LD      B,255
233C  DB0E        1195 A233C   IN      A,(VERAF)       ; Clear feedback resisters
233E  DB0F        1196         IN      A,(HORAF)
2340  0E10        1197         LD      C,SW0
2342  ED78        1198 A2342   IN      A,(C)
2344  A7          1199         AND     A
2345  C2C823      1200         JP      NZ,A23C8        ; Error 13
2348  0C          1201         INC     C
2349  79          1202         LD      A,C
234A  FE14        1203         CP      SW3+1
234C  20F4        1204         JR      NZ,A2342
                  1205 ;
234E  DB14        1206 T234E   IN      A,(KEY0)
2350  DB15        1207         IN      A,(KEY1)
2352  DB16        1208         IN      A,(KEY2)
2354  DB17        1209         IN      A,(KEY3)
2356  0E1C        1210         LD      C,POT0
2358  ED78        1211 A2358   IN      A,(C)
235A  FEFF        1212         CP      0FFH
235C  2071        1213         JR      NZ,A23CF        ; Error 14
235E  0C          1214         INC     C
235F  79          1215         LD      A,C
2360  FE20        1216         CP      POT3+1
2362  20F4        1217         JR      NZ,A2358
2364  10D6        1218         DJNZ    A233C
                  1219 ; Exercise output ports
2366  06FF        1220         LD      B,255
2368  3E00        1221 A2368   LD      A,0
236A  D308        1222         OUT     (CONCM),A       ; Set consumer mode
236C  78          1223         LD      A,B
236D  D300        1224         OUT     (COL0R),A
236F  D304        1225         OUT     (COL0L),A
2371  D301        1226         OUT     (COL1R),A
2373  D305        1227         OUT     (COL1L),A
2375  D302        1228         OUT     (COL2R),A
2377  D306        1229         OUT     (COL2L),A
2379  D303        1230         OUT     (COL3R),A
237B  D307        1231         OUT     (COL3L),A
237D  3E14        1232         LD      A,20
237F  D309        1233         OUT     (HORCB),A
2381  3EC8        1234         LD      A,100+2
2383  D30A        1235         OUT     (VERBL),A
2385  50          1236         LD      D,B
2386  21DE23      1237         LD      HL,T23DE
2389  0608        1238         LD      B,8
238B  0E0B        1239         LD      C,COLBX         ; Color multiple port
238D  EDB3        1240         OTIR
238F  21D623      1241         LD      HL,T23D6
2392  0608        1242         LD      B,8
2394  0E18        1243         LD      C,SNDBX         ; Sound multiple port
2396  EDB3        1244         OTIR
2398  3EFF        1245         LD      A,0FFH
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239A  D317          1246          OUT     (VOLN),A
239C  D316          1247          OUT     (VOLAB),A
239E  D314          1248          OUT     (VIBRA),A
23A0  7A            1249          LD      A,D
23A1  D310          1250          OUT     (TONMO),A
23A3  D311          1251          OUT     (TONEA),A
23A5  D312          1252          OUT     (TONEB),A
23A7  D313          1253          OUT     (TONEC),A
23A9  D315          1254          OUT     (VOLC),A
23AB  42            1255          LD      B,D
23AC  10BA          1256          DJNZ    A2368
23AE  F3            1257          DI
23AF  D9            1258          EXX
23B0  79            1259          LD      A,C
23B1  CB7F          1260          BIT     7,A
23B3  280A          1261          JR      Z,A23BF
23B5  0C            1262          INC     C               ; Increment loop counter
23B6  79            1263          LD      A,C
23B7  FE84          1264          CP      84H
23B9  2008          1265          JR      NZ,A23C3        ; Not done
23BB  D9            1266          EXX                     ; Done with tests
23BC  FB            1267          EI
23BD  18FE          1268 A23BD    JR      A23BD           ; Hang
                    1269 ;
23BF  A7            1270 A23BF    AND     A               ; C,7=0 and 6-0 not 0
23C0  2001          1271          JR      NZ,A23C3
23C2  0C            1272          INC     C
23C3  D9            1273 A23C3    EXX
23C4  FB            1274          EI
23C5  C31B21        1275          JP      A211B           ; Start tests over
                    1276 ;
23C8  1E13          1277 A23C8    LD      E,13H           ; Error 13 Trigger/Joystick
23CA  214E23        1278          LD      HL,T234E
23CD  1817          1279          JR      A23E6
                    1280 ;
23CF  1E14          1281 A23CF    LD      E,14H           ; Error 14 Pot Error
23D1  216823        1282          LD      HL,A2368
23D4  1810          1283          JR      A23E6
                    1284 ;
                    1285 ; Sound port values
23D6  48            1286 T23D6    DB      48H             ; 17H
23D7  44            1287          DB      44H             ; 16H
23D8  34            1288          DB      34H             ; 15H
23D9  00            1289          DB      0               ; 14H
23DA  FF            1290          DB      0FFH            ; 13H
23DB  FD            1291          DB      0FDH            ; 12H
23DC  F5            1292          DB      0F5H            ; 11H
23DD  F5            1293          DB      0F5H            ; 10H
                    1294 ;
                    1295 ; Color port values
23DE  DB            1296 T23DE    DB      0DBH            ; 07
23DF  92            1297          DB      92H             ; 06
23E0  49            1298          DB      49H             ; 05
23E1  00            1299          DB      0               ; 04
23E2  DB            1300          DB      0DBH            ; 03
23E3  92            1301          DB      92H             ; 02
23E4  49            1302          DB      49H             ; 01
```

```
23E5  00          1303          DB      0               ; 00
                  1304 ;
                  1305 ; Error routine.  Enter E = error code #, C = error data
23E6  F3          1306 A23E6    DI
23E7  D9          1307          EXX
23E8  79          1308          LD      A,C
23E9  D9          1309          EXX
23EA  E60F        1310          AND     0FH
23EC  A7          1311          AND     A
23ED  2850        1312          JR      Z,A243F
23EF  7B          1313 T23EF    LD      A,E
23F0  D3FF        1314          OUT     (DSPLY),A       ; Send error code
23F2  21F723      1315          LD      HL,T23F7
23F5  1839        1316          JR      A2430
                  1317 ;
23F7  79          1318 T23F7    LD      A,C
23F8  D3FF        1319          OUT     (DSPLY),A
23FA  21FF23      1320          LD      HL,T23FF
23FD  1831        1321          JR      A2430
                  1322 ;
23FF  3ECB        1323 T23FF    LD      A,0CBH          ; "HE"
2401  D3FF        1324          OUT     (DSPLY),A
2403  210824      1325          LD      HL,T2408
2406  1828        1326          JR      A2430
                  1327 ;
2408  3EDE        1328 T2408    LD      A,0DEH          ; "LP"
240A  D3FF        1329          OUT     (DSPLY),A
240C  211124      1330          LD      HL,T2411
240F  181F        1331          JR      A2430
                  1332 ;
2411  D9          1333 T2411    EXX
2412  78          1334          LD      A,B
2413  D9          1335          EXX
2414  212024      1336          LD      HL,T2420
2417  A7          1337          AND     A
2418  2002        1338          JR      NZ,A241C
241A  3EA0        1339          LD      A,0A0H          ; "-0"
241C  D3FF        1340 A241C    OUT     (DSPLY),A
241E  1810        1341          JR      A2430
                  1342 ;
2420  3EAA        1343 T2420    LD      A,0AAH          ; "--"
2422  D3FF        1344          OUT     (DSPLY),A
2424  212924      1345          LD      HL,T2429
2427  1807        1346          JR      A2430
                  1347 ;
2429  3EAA        1348 T2429    LD      A,0AAH          ; "--"
242B  D3FF        1349          OUT     (DSPLY),A
242D  21EF23      1350          LD      HL,T23EF        ; Circle back for error report
                  1351 ; Display delay routine
2430  1602        1352 A2430    LD      D,2
2432  3EFF        1353 A2432    LD      A,255
2434  06FF        1354 A2434    LD      B,255
2436  10FE        1355 A2436    DJNZ    A2436
2438  3D          1356          DEC     A
2439  20F9        1357          JR      NZ,A2434
243B  15          1358          DEC     D
243C  20F4        1359          JR      NZ,A2432
```

```
243E  E9          1360          JP      (HL)
                  1361 ;
243F  FB          1362 A243F    EI
2440  E9          1363          JP      (HL)
```

```
2441 454E5452      1365 T2441   DB      'ENTR 4-DIGT HEX',0
     20342D44
     49475420
     48455800
2451 52454144      1366 T2451   DB      'READ ADDR',0
     20414444
     5200
245B 57524954      1367 T245B   DB      'WRITE ADDR',0
     45204144
     445200
2466 454E5452      1368 T2466   DB      'ENTR 2-DIGT HEX',0
     20322D44
     49475420
     48455800
2476 52454144      1369 T2476   DB      'READ PORT',0
     20504F52
     5400
2480 57524954      1370 T2480   DB      'WRITE PORT',0
     4520504F
     525400
248B 53545254      1371 T248B   DB      'STRT ADDR',0
     20414444
     5200
2495 454E5452      1372 T2495   DB      'ENTR 2-DIGT HEX',0
     20322D44
     49475420
     48455800
24A5 44415441      1373 T24A5   DB      'DATA',0
     00
24AA 42595445      1374 T24AA   DB      'BYTE TO WRITE',0
     20544F20
     57524954
     4500
24B8 2A2A00        1375 T24B8   DB      '**',0
24BB 2A2A2A2A      1376 T24BB   DB      '****',0
     00
                   1377 ;
24C0 30453D        1378 T24C0   DB      '0E='
24C3 30463D        1379         DB      '0F='
24C6 202020        1380         DB      '   '
24C9 202020        1381         DB      '   '
24CC 31303D        1382         DB      '10='
24CF 31313D        1383         DB      '11='
24D2 31323D        1384         DB      '12='
24D5 31333D        1385         DB      '13='
24D8 31343D        1386 T24D8   DB      '14='
24DB 31353D        1387         DB      '15='
24DE 31363D        1388         DB      '16='
24E1 31373D        1389         DB      '17='
24E4 202020        1390         DB      '   '
24E7 31433D        1391         DB      '1C='
24EA 31443D        1392         DB      '1D='
24ED 31453D        1393         DB      '1E='
24F0 31463D        1394         DB      '1F='
24F3 22474F22      1395 T24F3   DB      '"GO" TO RUN',0
     20544F20
     52554E00
```

```
                    1396 ;
                    1397 ; GENERAL USE SUBROUTINES
                    1398 ;
                    1399 ; Set colors for special routines
24FF  AF            1400 A24FF   XOR     A
2500  D304          1401         OUT     (COL0L),A
2502  D300          1402         OUT     (COL0R),A
2504  D309          1403         OUT     (HORCB),A
2506  3E0F          1404         LD      A,0FH
2508  D301          1405         OUT     (COL1R),A
250A  D302          1406         OUT     (COL2R),A
250C  D303          1407         OUT     (COL3R),A
250E                1408         SYSSUK  FILL
250E  FF            1409+        RST     38H
250F  1B            1410+        DB      FILL+1
2510  0040          1414         DW      NORMEM
2512  B00F          1415         DW      4016
2514  00            1416         DB      0
2515  C9            1417         RET
                    1418 ;
2516                1419 A2516   SYSSUK  STRDIS
2516  FF            1420+        RST     38H
2517  35            1421+        DB      STRDIS+1
2518  04            1425         DB      4
2519  28            1426         DB      40
251A  0C            1427         DB      00001100B
251B  4124          1428         DW      T2441           ; 'ENTR 4-DIGT HEX'
251D  C9            1429         RET
                    1430 ;
251E                1431 A251E   SYSSUK  STRDIS
251E  FF            1432+        RST     38H
251F  35            1433+        DB      STRDIS+1
2520  04            1437         DB      4
2521  32            1438         DB      50
2522  0C            1439         DB      00001100B
2523  5124          1440         DW      T2451           ; 'READ ADDR'
2525  C9            1441         RET
                    1442 ;
2526                1443 A2526   SYSSUK  STRDIS
2526  FF            1444+        RST     38H
2527  35            1445+        DB      STRDIS+1
2528  04            1449         DB      4
2529  28            1450         DB      40
252A  0C            1451         DB      00001100B
252B  6624          1452         DW      T2466           ; 'ENTR 2-DIGT HEX'
252D  C9            1453         RET
                    1454 ;
252E                1455 A252E   SYSSUK  STRDIS
252E  FF            1456+        RST     38H
252F  35            1457+        DB      STRDIS+1
2530  04            1461         DB      4
2531  28            1462         DB      40
2532  0C            1463         DB      00001100B
2533  9524          1464         DW      T2495           ; 'ENTR 2-DIGT HEX'
2535                1465         SYSSUK  STRDIS
2535  FF            1466+        RST     38H
2536  35            1467+        DB      STRDIS+1
```

```
2537  04          1471          DB      4
2538  32          1472          DB      50
2539  0C          1473          DB      00001100B
253A  AA24        1474          DW      T24AA           ; 'BYTE TO WRITE'
253C  C9          1475          RET
                  1476 ;
                  1477 ; Display character in A
253D  0E0C        1478 A253D    LD      C,00001100B
253F  DD210D02    1479 A253F    LD      IX,FNTSML       ; Unnecessary instruction
2543              1480          SYSTEM  CHRDIS
2543  FF          1481+         RST     38H
2544  32          1482+         DB      CHRDIS
2545  C9          1486          RET
                  1487 ;
                  1488 ; Hex nybble to ASCII byte
2546  FE0A        1489 A2546    CP      10
2548  FA4D25      1490          JP      M,A254D         ; Could be JR C,
254B  C607        1491          ADD     A,7
254D  C630        1492 A254D    ADD     A,'0'
254F  C9          1493          RET
                  1494 ;
2550  D5          1495 A2550    PUSH    DE
2551  E5          1496          PUSH    HL
2552  3EFF        1497          LD      A,255
2554  32EC4F      1498          LD      (TIMOUT),A      ; 4 min 15 sec timeout
2557              1499 A2557    SYSSUK  SENTRY
2557  FF          1500+         RST     38H
2558  43          1501+         DB      SENTRY+1
2559  0820        1505          DW      T2008
255B  FE13        1506          CP      SKYD
255D  20F8        1507          JR      NZ,A2557        ; Wait for key
255F  78          1508          LD      A,B
2560  FE10        1509          CP      16
2562  2001        1510          JR      NZ,A2565
2564  AF          1511          XOR     A
2565  FE14        1512 A2565    CP      20
2567  F26E25      1513          JP      P,A256E         ; Keys 20-24
256A  47          1514          LD      B,A             ; Keys 1-19
256B  CD4625      1515          CALL    A2546
256E  E1          1516 A256E    POP     HL
256F  D1          1517          POP     DE
2570  C9          1518          RET
                  1519 ;
                  1520 ; Get 2 or 4 hex disits from keypad.
                  1521 ; A=0=2 disits
2571  F5          1522 A2571    PUSH    AF
2572  A7          1523          AND     A
2573  2009        1524          JR      NZ,A257E
2575              1525 A2575    SYSSUK  STRDIS          ; Display 2 asterisks
2575  FF          1526+         RST     38H
2576  35          1527+         DB      STRDIS+1
2577  48          1531          DB      72
2578  46          1532          DB      70
2579  0C          1533          DB      00001100B
257A  B824        1534          DW      T24B8           ; '**'
257C  1807        1535          JR      A2585
                  1536 ;
```

```
257E                    1537 A257E   SYSSUK  STRDIS          ; Display 4 asterisks
257E  FF                1538+        RST     38H
257F  35                1539+        DB      STRDIS+1
2580  48                1543         DB      72
2581  46                1544         DB      70
2582  0C                1545         DB      00001100B
2583  BB24              1546         DW      T24BB           ; '****'
2585  210000            1547 A2585   LD      HL,0
2588  CD5025            1548         CALL    A2550
258B  FE18              1549         CP      24
258D  283E              1550         JR      Z,A25CD         ; "GO" key
258F  FE15              1551         CP      21
2591  28E2              1552         JR      Z,A2575         ; "CE" key
2593                    1553         XYRELL  DE,72,70
2593  114846            1554+        LD      DE,70 SHL 8+(72)
2596  CD3D25            1555         CALL    A253D
2599  78                1556         LD      A,B
259A  CD0320            1557         CALL    A2003           ; Mul A by 16
259D  67                1558         LD      H,A             ; First nybble
259E  CD5025            1559         CALL    A2550
25A1  FE15              1560         CP      21
25A3  28D0              1561         JR      Z,A2575         ; "CE" key
25A5  CD3D25            1562         CALL    A253D
25A8  7C                1563         LD      A,H
25A9  B0                1564         OR      B
25AA  67                1565         LD      H,A             ; Second nybble
25AB  F1                1566         POP     AF
25AC  A7                1567         AND     A
25AD  2001              1568         JR      NZ,A2580
25AF  C9                1569         RET
                        1570 ;
2580  F5                1571 A2580   PUSH    AF
2581  CD5025            1572         CALL    A2550
2584  FE15              1573         CP      21
2586  28C6              1574         JR      Z,A257E         ; "CE" key
2588  CD3D25            1575         CALL    A253D
258B  78                1576         LD      A,B
258C  CD0320            1577         CALL    A2003           ; Mul A by 16
258F  6F                1578         LD      L,A
25C0  CD5025            1579         CALL    A2550
25C3  FE15              1580         CP      21
25C5  28B7              1581         JR      Z,A257E         ; "CE" key
25C7  CD3D25            1582         CALL    A253D
25CA  7D                1583         LD      A,L
25CB  B0                1584         OR      B
25CC  6F                1585         LD      L,A
25CD  F1                1586 A25CD   POP     AF
25CE  C9                1587         RET
                        1588 ;
                        1589 ; Fixed delay routine
25CF  3EFF              1590 A25CF   LD      A,255
25D1  06FF              1591 A25D1   LD      B,255
25D3  10FE              1592 A25D3   DJNZ    A25D3
25D5  3D                1593         DEC     A
25D6  20F9              1594         JR      NZ,A25D1
25D8  C9                1595         RET
                        1596 ;
```

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                        1597 ; Special routine 1     Memory Read Routine
25D9  CDFF24            1598 A25D9   CALL    A24FF           ; Set colors
25DC  CD1625            1599         CALL    A2516           ; "ENTR 4-DIGT HEX"
25DF  CD1E25            1600         CALL    A251E           ; "READ ADDR"
25E2  3E01              1601         LD      A,1             ; Get 4 digits
25E4  CD7125            1602         CALL    A2571
25E7  7E                1603 A25E7   LD      A,(HL)
25E8  18FD              1604         JR      A25E7           ; Loop forever
                        1605 ;
                        1606 ; Special routine 2     Memory Write Routine
25EA  CDFF24            1607 A25EA   CALL    A24FF           ; Set colors
25ED  CD2E25            1608         CALL    A252E           ; "ENTR 2-DIGT BYTE TO WRITE"
25F0  AF                1609         XOR     A               ; Get 2 digits
25F1  CD7125            1610         CALL    A2571
25F4  E5                1611         PUSH    HL              ; Save
25F5  7C                1612         LD      A,H
25F6  D3FF              1613         OUT     (DSPLY),A       ; Put digits on display
25F8  CDCF25            1614         CALL    A25CF           ; Delay
25FB  CDFF24            1615         CALL    A24FF           ; Clear screen
25FE  CD1625            1616         CALL    A2516           ; "ENTR 4-DIGT HEX"
2601                    1617         SYSSUK  STRDIS
2601  FF                1618+        RST     38H
2602  35                1619+        DB      STRDIS+1
2603  04                1623         DB      4
2604  32                1624         DB      50
2605  0C                1625         DB      00001100B
2606  5B24              1626         DW      T245B           ; 'WRITE ADDR'
2608  3E01              1627         LD      A,1             ; Get 4 digits
260A  CD7125            1628         CALL    A2571
260D  C1                1629         POP     BC
260E  70                1630 A260E   LD      (HL),B
260F  18FD              1631         JR      A260E           ; Loop forever
                        1632 ;
                        1633 ; Special routine 3     Input Port Read Routine
2611  CDFF24            1634 A2611   CALL    A24FF           ; Set colors
2614  CD2625            1635         CALL    A2526           ; "ENTR 2-DIGT HEX"
2617                    1636         SYSSUK  STRDIS
2617  FF                1637+        RST     38H
2618  35                1638+        DB      STRDIS+1
2619  04                1642         DB      4
261A  32                1643         DB      50
261B  0C                1644         DB      00001100B
261C  7624              1645         DW      T2476           ; 'READ PORT'
261E  AF                1646         XOR     A
261F  CD7125            1647         CALL    A2571
2622  4C                1648         LD      C,H
2623  ED78              1649 A2623   IN      A,(C)
2625  18FC              1650         JR      A2623           ; Loop forever
                        1651 ;
                        1652 ; Special Routine 4     Output Port Write Routine
2627  CDFF24            1653 A2627   CALL    A24FF           ; Set colors
262A  CD2625            1654         CALL    A2526           ; "ENTR 2-DIGT HEX"
262D                    1655         SYSSUK  STRDIS
262D  FF                1656+        RST     38H
262E  35                1657+        DB      STRDIS+1
262F  04                1661         DB      4
2630  32                1662         DB      50
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2631  0C          1663          DB      00001100B
2632  8024        1664          DW      T2480           ; 'WRITE PORT'
2634  AF          1665          XOR     A
2635  CD7125      1666          CALL    A2571
2638  E5          1667          PUSH    HL
2639  7C          1668          LD      A,H
263A  D3FF        1669          OUT     (DSPLY),A
263C  CDCF25      1670          CALL    A25CF
263F  CDFF24      1671          CALL    A24FF
2642  CD2E25      1672          CALL    A252E           ; "ENTR 2-DIGT BYTE TO WRITE"
2645  AF          1673          XOR     A
2646  CD7125      1674          CALL    A2571
2649  C1          1675          POP     BC
264A  48          1676          LD      C,B
264B  ED61        1677 A264B    OUT     (C),H
264D  18FC        1678          JR      A264B
                  1679 ;
                  1680 ; Special Routine 5     Memory Read and Write Routine
264F  CDFF24      1681 A264F    CALL    A24FF           ; Set colors
2652  CD2E25      1682          CALL    A252E           ; "ENTR 2-DIGT BYTE TO WRITE"
2655  AF          1683          XOR     A               ; Get 2 digits
2656  CD7125      1684          CALL    A2571
2659  E5          1685          PUSH    HL              ; Save
265A  7C          1686          LD      A,H
265B  D3FF        1687          OUT     (DSPLY),A       ; Send to display
265D  CDCF25      1688          CALL    A25CF           ; Delay
2660  CDFF24      1689          CALL    A24FF           ; Clear screen
2663  CD1625      1690          CALL    A2516           ; "ENTR 4-DIGT HEX"
2666  CD1E25      1691          CALL    A251E           ; "READ ADDR"
2669  3E01        1692          LD      A,1             ; Get 4 digits
266B  CD7125      1693          CALL    A2571
266E  C1          1694          POP     BC
266F  70          1695 A266F    LD      (HL),B
2670  7E          1696          LD      A,(HL)
2671  18FC        1697          JR      A266F           ; Loop forever
                  1698 ;
                  1699 ;'Special Routine 6     Display All Input Devices
2673  CDFF24      1700 A2673    CALL    A24FF
2676  21C024      1701          LD      HL,T24C0        ; Labels
2679              1702          XYRELL  DE,4,10
2679  11040A      1703+         LD      DE,10 SHL 8+(4)
267C  CDFB26      1704          CALL    A26FB
267F  21D824      1705          LD      HL,T24D8        ; Labels
2682              1706          XYRELL  DE,80,0
2682  115000      1707+         LD      DE,0 SHL 8+(80)
2685  CDFB26      1708          CALL    A26FB
2688  08          1709          EX      AF,AF'
2689  AF          1710          XOR     A
268A  08          1711          EX      AF,AF'
268B  211020      1712          LD      HL,T2010        ; Set interrupt routine adrs.
268E  7C          1713          LD      A,H
268F  ED47        1714          LD      I,A
2691  7D          1715          LD      A,L
2692  D30D        1716          OUT     (INFBK),A
2694  3E03        1717          LD      A,3
2696  D30E        1718          OUT     (INMOD),A
2698  FB          1719          EI
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2699  DB10        1720 A2699   IN      A,(SW0)
269B              1721         XYRELL  DE,28,50
269B  111C32      1722+        LD      DE,50 SHL 8+(28)
269E  CD1127      1723         CALL    A2711
26A1  DB11        1724         IN      A,(SW1)
26A3              1725         XYRELL  DE,28,60
26A3  111C3C      1726+        LD      DE,60 SHL 8+(28)
26A6  CD1127      1727         CALL    A2711
26A9  DB12        1728         IN      A,(SW2)
26AB              1729         XYRELL  DE,28,70
26AB  111C46      1730+        LD      DE,70 SHL 8+(28)
26AE  CD1127      1731         CALL    A2711
26B1  DB13        1732         IN      A,(SW3)
26B3              1733         XYRELL  DE,28,80
26B3  111C50      1734+        LD      DE,80 SHL 8+(28)
26B6  CD1127      1735         CALL    A2711
26B9  DB14        1736         IN      A,(KEY0)
26BB              1737         XYRELL  DE,104,0
26BB  116800      1738+        LD      DE,0 SHL 8+(104)
26BE  CD1127      1739         CALL    A2711
26C1  DB15        1740         IN      A,(KEY1)
26C3              1741         XYRELL  DE,104,10
26C3  11680A      1742+        LD      DE,10 SHL 8+(104)
26C6  CD1127      1743         CALL    A2711
26C9  DB16        1744         IN      A,(KEY2)
26CB              1745         XYRELL  DE,104,20
26CB  116814      1746+        LD      DE,20 SHL 8+(104)
26CE  CD1127      1747         CALL    A2711
26D1  DB17        1748         IN      A,(KEY3)
26D3              1749         XYRELL  DE,104,30
26D3  11681E      1750+        LD      DE,30 SHL 8+(104)
26D6  CD1127      1751         CALL    A2711
26D9  DB1C        1752         IN      A,(POT0)
26DB              1753         XYRELL  DE,104,50
26DB  116832      1754+        LD      DE,50 SHL 8+(104)
26DE  CD1127      1755         CALL    A2711
26E1  DB1D        1756         IN      A,(POT1)
26E3              1757         XYRELL  DE,104,60
26E3  11683C      1758+        LD      DE,60 SHL 8+(104)
26E6  CD1127      1759         CALL    A2711
26E9  DB1E        1760         IN      A,(POT2)
26EB              1761         XYRELL  DE,104,70
26EB  116846      1762+        LD      DE,70 SHL 8+(104)
26EE  CD1127      1763         CALL    A2711
26F1  DB1F        1764         IN      A,(POT3)
26F3              1765         XYRELL  DE,104,80
26F3  116850      1766+        LD      DE,80 SHL 8+(104)
26F6  CD1127      1767         CALL    A2711
26F9  189E        1768         JR      A2699          ; Loop forever
                  1769 ;
                  1770 ; Display input port lables
26FB  0603        1771 A26FB   LD      B,3            ; 3 char/line
26FD  7E          1772 A26FD   LD      A,(HL)         ; Get character
26FE  CD3D25      1773         CALL    A253D          ; Display
2701  23          1774         INC     HL
2702  10F9        1775         DJNZ    A26FD          ; Do all 3
2704  7B          1776         LD      A,E            ; Get horizontal pos'n
```

```
2705  D618        1777          SUB     18H             ; Reduce 3 char positions
2707  5F          1778          LD      E,A
2708  7A          1779          LD      A,D             ; Get vertical position
2709  C60A        1780          ADD     A,10            ; Increment by 1 line
270B  57          1781          LD      D,A             ;  (10 pixels)
270C  FE5A        1782          CP      90
270E  20EB        1783          JR      NZ,A26FB        ; Line 80 is last line
2710  C9          1784          RET
                  1785 ;
                  1786 ; Display A in ASCII
2711  67          1787 A2711    LD      H,A             ; Save input value
2712  E6F0        1788          AND     0F0H            ; M. S. nybble first
2714  0F          1789          RRCA
2715  0F          1790          RRCA
2716  0F          1791          RRCA
2717  0F          1792          RRCA
2718  CD4625      1793          CALL    A2546           ; Convert to ASCII
271B  CD3D25      1794          CALL    A253D           ; Display
271E  7C          1795          LD      A,H             ; L. S. nybble last
271F  E60F        1796          AND     0FH
2721  CD4625      1797          CALL    A2546           ; Convert to ASCII
2724  CD3D25      1798          CALL    A253D           ; Display
2727  C9          1799          RET
                  1800 ;
                  1801 ; Interrupt routine for Display All Input Devices
2728  F3          1802 A2728    DI
2729  08          1803          EX      AF,AF'
272A  A7          1804          AND     A
272B  2817        1805          JR      Z,A2744
272D  08          1806          EX      AF,AF'
272E  DB0E        1807          IN      A,(VERAF)       ; Get vertical Lite Pen
2730  CB3F        1808          SRL     A
2732              1809          XYRELL  DE,28,10
2732  111C0A      1810+         LD      DE,10 SHL 8+(28)
2735  CD1127      1811          CALL    A2711
2738  DB0F        1812          IN      A,(HORAF)       ; Get horizontal Lite Pen
273A  D608        1813          SUB     8
273C              1814          XYRELL  DE,28,20
273C  111C14      1815+         LD      DE,20 SHL 8+(28)
273F  CD1127      1816          CALL    A2711
2742  FB          1817 A2742    EI
2743  C9          1818          RET
                  1819 ;
2744  3C          1820 A2744    INC     A
2745  08          1821          EX      AF,AF'
2746  18FA        1822          JR      A2742
                  1823 ;
                  1824 ; Special Routine 7     Rainbow Color Display
2748  110040      1825 A2748    LD      DE,NORMEM
274B  21A627      1826          LD      HL,T27A6
274E  011400      1827          LD      BC,20
2751  EDB0        1828          LDIR                    ; Put up rainbow pattern
2753  210040      1829          LD      HL,NORMEM
2756  01DC0F      1830          LD      BC,0FDCH
2759  EDB0        1831          LDIR                    ; Fill rest of screen
275B  211220      1832          LD      HL,T2012        ; Set up interrupt adrs
275E  7C          1833          LD      A,H
```

```
275F  ED47        1834         LD      I,A
2761  7D          1835         LD      A,L
2762  D30D        1836         OUT     (INFBK),A
2764  3E14        1837         LD      A,20
2766  D309        1838         OUT     (HORCB),A       ; Middle of screen
2768              1839         XYRELL  BC,INLIN,0F8H   ; Output port, mask
2768  010FF8      1840+        LD      BC,0F8H SHL 8+(INLIN)
276B              1841         XYRELL  DE,0,32
276B  110020      1842+        LD      DE,32 SHL 8+(0)
276E  210050      1843         LD      HL,NORMEM+4096
2771  3E04        1844         LD      A,4             ; Color 0, intensity 4
2773  ED59        1845         OUT     (C),E           ; Interrupt line 0
2775  FB          1846         EI
2776  76          1847         HALT                    ; Wait for interrupt
                  1848 ;
2777  F3          1849 A2777   DI
2778  D300        1850         OUT     (COL0R),A       ; Intensity 4
277A  3C          1851         INC     A
277B  D301        1852         OUT     (COL1R),A       ; Intensity 5
277D  3C          1853         INC     A
277E  D302        1854         OUT     (COL2R),A       ; Intensity 6
2780  3C          1855         INC     A
2781  D303        1856         OUT     (COL3R),A       ; Intensity 7
2783  A0          1857         AND     B               ; Reset to intensity 0
2784  D304        1858         OUT     (COL0L),A       ; Intensity 0
2786  3C          1859         INC     A
2787  D305        1860         OUT     (COL1L),A       ; Intensity 1
2789  3C          1861         INC     A
278A  D306        1862         OUT     (COL2L),A       ; Intensity 2
278C  3C          1863         INC     A
278D  D307        1864         OUT     (COL3L),A       ; Intensity 3
278F  C609        1865         ADD     A,9             ; Intensity 4, next color
2791  1C          1866         INC     E               ; Increment interrupt line #
2792  1C          1867         INC     E
2793  1C          1868         INC     E
2794  1C          1869         INC     E
2795  1C          1870         INC     E
2796  1C          1871         INC     E
2797  15          1872         DEC     D
2798  C2A027      1873         JP      NZ,A27A0        ; Finish 32 bands
279B              1874         XYRELL  DE,0,32         ; Reset to top
279B  110020      1875+        LD      DE,32 SHL 8+(0)
279E  3E04        1876         LD      A,4             ; Reset to color 0, intens 4
27A0  ED59        1877 A27A0   OUT     (C),E           ; Line 5,10,15,...155
                  1878                                 ; (32 different bands)
27A2  DDE1        1879         POP     IX              ; Clear stack
27A4  FB          1880         EI
27A5  76          1881         HALT                    ; Wait for next interrupt
                  1882 ;
                  1883 ; Rainbow Pixel pattern
27A6  00000000    1884 T27A6   DB      0,0,0,0,0                       ; Color 0
      00
27AB  55555555    1885         DB      55H,55H,55H,55H,55H             ; Color 1
      55
27B0  AAAAAAAA    1886         DB      0AAH,0AAH,0AAH,0AAH,0AAH        ; Color 2
      AA
27B5  FFFFFFFF    1887         DB      0FFH,0FFH,0FFH,0FFH,0FFH        ; Color 3
```

```
      FF
                        1888 ;
                        1889 ; Special Routine 8     Enter Machine Code From Keypad
27BA  CDFF24            1890 A27BA    CALL    A24FF           ; Set colors.
27BD  CD1625            1891          CALL    A2516           ; "ENTR 4-DIGT HEX"
27C0                    1892          SYSSUK  STRDIS
27C0  FF                1893+         RST     38H
27C1  35                1894+         DB      STRDIS+1
27C2  04                1898          DB      4
27C3  32                1899          DB      50
27C4  0C                1900          DB      00001100B
27C5  8B24              1901          DW      T248B           ; 'STRT ADDR'
27C7  3E01              1902          LD      A,1             ; Get 4 digits
27C9  CD7125            1903          CALL    A2571
27CC  E5                1904          PUSH    HL              ; Save start
27CD  E5                1905          PUSH    HL
27CE  CDCF25            1906          CALL    A25CF
27D1  CDFF24            1907          CALL    A24FF
27D4                    1908          SYSSUK  STRDIS
27D4  FF                1909+         RST     38H
27D5  35                1910+         DB      STRDIS+1
27D6  04                1914          DB      4
27D7  28                1915          DB      40
27D8  0C                1916          DB      00001100B
27D9  9524              1917          DW      T2495           ; 'ENTR 2-DIGT HEX'
27DB                    1918          SYSSUK  STRDIS
27DB  FF                1919+         RST     38H
27DC  35                1920+         DB      STRDIS+1
27DD  04                1924          DB      4
27DE  32                1925          DB      50
27DF  0C                1926          DB      00001100B
27E0  A524              1927          DW      T24A5           ; 'DATA'
27E2                    1928          SYSSUK  STRDIS
27E2  FF                1929+         RST     38H
27E3  35                1930+         DB      STRDIS+1
27E4  04                1934          DB      4
27E5  5A                1935          DB      90
27E6  0C                1936          DB      00001100B
27E7  F324              1937          DW      T24F3           ; '"GO" TO RUN'
27E9  CDCF25            1938 A27E9    CALL    A25CF           ; Delay
27EC  AF                1939          XOR     A               ; Get 2 digits
27ED  CD7125            1940          CALL    A2571
27F0  78                1941          LD      A,B
27F1  FE18              1942          CP      24
27F3  2003              1943          JR      NZ,A27F8
27F5  E1                1944          POP     HL              ; "GO" key
27F6  E1                1945          POP     HL
27F7  E9                1946          JP      (HL)
                        1947 ;
27F8  D1                1948 A27F8    POP     DE
27F9  7C                1949          LD      A,H
27FA  12                1950          LD      (DE),A
27FB  13                1951          INC     DE
27FC  D5                1952          PUSH    DE
27FD  18EA              1953          JR      A27E9
                        1954 ;
27FF  37                1955          DB      37H             ; Checksum byte
```

```
                    1956 ;
2000  (0000)        1957          END

Errors              0
```

CROSS REFERENCE LISTING

```
A0      0500
A1      0512
A2      0524
A2003   0648  0753 1557 1577
A2016   0676  0665
A2036   0694  0686
A2046   0702  0680
A2052   0708  0683
A205C   0713  0699
A2062   0719  0689 0700 0706
A2078   0733  0729
A2080   0739  0726
A2081   0740  0731 0735 0737
A20A0   0759  0755
A20A9   0766  0723 0744 0749 0762
A20C7   0792  0799
A20D4   0801  0794
A20DB   0806  0798
A20E8   0815  0809
A2117   0843  0833 0836
A211B   0849  1275
A2121   0851  0866
A2122   0852  0856 0858
A2139   0868  0861
A2144   0874  0872
A2147   0875  0803 0841
A214A   0878  0865 0874
A2157   0887  0882
A2164   0897  0807 0880 0889
A2168   0899  0946
A216E   0901  0911
A2179   0908  0904 0905
A2180   0912  0926 0927
A2191   0922  0918 0919
A219D   0930  0915 0943
A21AF   0941  0937 0938
A21B3   0945  0933
A21BD   0952  0949
A21C4   0956  0906 0920 0928 0939
A21C8   0961  0891 0953
A21D2   0965  0998
A21D4   0966  0993
A21EA   0980  0985
A21F5   0986  0979
A220E   1001  0988 0991
A2213   1003  0954
A2215   1006  0999 1002
A2221   1011  1018
A2230   1020  1028
A2240   1031  1025
A2243   1034  1015
A2248   1036  1003
A225A   1057  1029 1035
A2264   1063  1083
A2268   1065  1075
A228C   1086  1070 1073
A2291   1088  1036
```

CROSS REFERENCE LISTING

```
A2293   1091  1084 1087
A22B7   1108  1097
A22BB   1111  1095
A22BD   1112  1109
A22C2   1115  1103
A22C6   1118  1105
A22C8   1119  1116
A22CB   1120  1088 1113
A22CE   1122  1092 1099
A22DD   1133  1152
A22E0   1136  1158 1163
A22E3   1139  1093 1101 1167 1172 1186
A22F4   1149  1144
A22F6   1151  1147
A2306   1161  1155
A230B   1164  1159
A2325   1180  1176
A2327   1181  1178
A2333   1189  1139 1140 1141
A233A   1194  1106 1119
A233C   1195  1218
A2342   1198  1204
A2358   1211  1217
A2368   1221  1256 1282
A23BD   1268  1268
A23BF   1270  1261
A23C3   1273  1265 1271
A23C8   1277  1200
A23CF   1281  1213
A23E6   1306  0875 1120 1279 1283
A241C   1340  1338
A2430   1352  1316 1321 1326 1331 1341 1346
A2432   1353  1359
A2434   1354  1357
A2436   1355  1355
A243F   1362  1312
A24FF   1400  1598 1607 1615 1634 1653 1671 1681 1689 1700 1890 1907
A2516   1419  1599 1616 1690 1891
A251E   1431  1600 1691
A2526   1443  1635 1654
A252E   1455  1608 1672 1682
A253D   1478  1555 1562 1575 1582 1773 1794 1798
A253F   1479
A2546   1489  1515 1793 1797
A254D   1492  1490
A2550   1495  1548 1559 1572 1579
A2557   1499  1507
A2565   1512  1510
A256E   1516  1513
A2571   1522  1602 1610 1628 1647 1666 1674 1684 1693 1903 1940
A2575   1525  1552 1561
A257E   1537  1524 1574 1581
A2585   1547  1535
A25B0   1571  1568
A25CD   1586  1550
A25CF   1590  0828 1614 1670 1688 1906 1938
A25D1   1591  1594
```

CROSS REFERENCE LISTING

```
A25D3   1592  1592
A25D9   1598  0695
A25E7   1603  1604
A25EA   1607  0709
A260E   1630  1631
A2611   1634  0703
A2623   1649  1650
A2627   1653  0691
A264B   1677  1678
A264F   1681  0697
A266F   1695  1697
A2673   1700  0711
A2699   1720  1768
A26FB   1771  1704 1708 1783
A26FD   1772  1775
A2711   1787  1723 1727 1731 1735 1739 1743 1747 1751 1755 1759 1763 1767 1811 1816
A2728   1802  0663
A2742   1817  1822
A2744   1820  1805
A2748   1825  0705
A2777   1849  0664
A27A0   1877  1873
A27BA   1890  0693
A27E9   1933  1953
A27F8   1948  1943
A3      0535
A4      0548
A5      0554
ACTINT  0244  0245
ALKEYS  0049
AS0     0501
AS1     0513
AS2     0525
AS3     0537
B0      0502
B1      0514
B2      0526
B3      0538
BCDADD  0300  0301
BCDCHS  0304  0305
BCDDIV  0303  0304
BCDMUL  0302  0303
BCDNEG  0305  0306
BCDSUB  0301  0302
BCHK    0772  0645
BEGRAM  0589  0639 0815
BITSPL  0042
BLANK   0264  0265
BMUSIC  0249  0250
BYTEPL  0041
C1      0503
C2      0515
C3      0527
C4      0539
C5      0549
C6      0555
C7      0558
```

CROSS REFERENCE LISTING

```
CBH     0133
CBB     0131
CBC     0130
CBD     0129
CBE     0128
CBFLAG  0132
CBH     0135
CBIXH   0127
CBIXL   0126
CBIYH   0125
CBIYL   0124
CBL     0134
CHDOWN  0120
CHLEFT  0119
CHRDIS  0269  0270 1482 1483
CHRIGH  0118
CHTRIG  0117
CHUP    0121
CNT     0609
COL0L   0180  1225 1401 1853
COL0R   0176  1224 1402 1850
COL1L   0181  1227 1860
COL1R   0177  1226 1405 1852
COL2L   0182  1229 1862
COL2R   0178  1228 1406 1854
COL3L   0183  1231 1864
COL3R   0179  1230 1407 1856
COLBX   0184  1239
COLLST  0620
COLSET  0255  0256
CONCM   0203  0785 1222
CS1     0504
CS2     0516
CS3     0528
CS4     0540
CS5     0550
CT0     0599
CT1     0600
CT2     0601
CT3     0602
CT4     0603
CT5     0604
CT6     0605
CT7     0606
CTIMER  0046
D1      0505
D2      0517
D3      0529
D4      0541
DABS    0308  0309
DADD    0306  0307
DECCTS  0245  0248
DISNUM  0271  0273
DISTIM  0289  0290
DOIT    0282  0283
DOITB   0283  0284
DS1     0506
```

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DS2     0518
DS3     0530
DS4     0542
DS5     0551
DS6     0556
DSMG    0307  0308
DSPLY   0012  0740 0783 1314 1319 1324 1329 1340 1344 1349 1613 1669 1687
DURAT   0623
E1      0507
E2      0519
E3      0531
E4      0543
EMUSIC  0250  0253
END     0369
ENDSCR  0632
F1      0508
F2      0520
F3      0532
F4      0544
F5      0552
FILL    0256  0257 1410 1411
FIRSTC  0039  0643 0864
FNTSML  0048  1479
FNTSYS  0047
FS1     0509
FS2     0521
FS3     0533
FS4     0545
FTBASE  0100
FTBYTE  0103
FTFSX   0101
FTFSY   0102
FTPTH   0106
FTPTL   0105
FTYSIZ  0104
G0      0498
G1      0510
G2      0522
G3      0534
G4      0546
G5      0553
G6      0557
G7      0559
G8      0560
GAMSTB  0634
GETNUM  0287  0288
GETPAR  0286  0287
GS0     0499
GS1     0511
GS2     0523
GS3     0535
GS4     0547
GSBEND  0064
GSBSCR  0063
GSBTIM  0062
GTMINS  0627
GTSECS  0626
```

CROSS REFERENCE LISTING

```
HORAF   0210  1196 1812
HORCB   0185  1233 1403 1839
HUMANR  0279  0280
INCSCR  0290  0293
INDEXB  0297  0298
INDEXN  0294  0295
INDEXW  0296  0297
INFBR   0200  0822 1716 1836
INLIN   0202  0824 1840
INMOD   0201  0817 1718
INTPC   0234  0235 1411 1422 1434 1446 1458 1468 1483 1502 1528 1540 1620 1639 1658 1895
              1911 1921 1931
INTST   0208  1123 1156 1161
KCTASC  0280  0281
KEY0    0223  0687 0791 1206 1736
KEY1    0224  0678 1207 1740
KEY2    0225  0681 1208 1744
KEY3    0226  0684 0797 1209 1748
KEYSEX  0615
MAGIC   0204  0967 1007 1058 1122
MATH    0293  0294
MCALL   0237  0238
MENU    0285  0286
MENUST  0050
MJUMP   0239  0240
MOVE    0298  0299
MRET    0238  0239
MRFLOP  0109
MRLOCK  0633
MROR    0111
MRROT   0113
MRSHFT  0114
MRXOR   0110
MRXPND  0112
MSKTD   0314
MUZAK   0248  0249
MUZPC   0592
MUZSP   0593
MXSCR   0051
NEGT    0309  0310
NOGAME  0053
NOPLAY  0052
NORMEM  0038  0812 0835 0894 0962 1008 1414 1825 1829 1843
NUMPLY  0631
NWHDWR  0034
OA1     0569
OA2     0570
OA3     0571
OA4     0572
OA5     0573
OB0     0563
OC0     0564
OD1     0565
OE1     0566
OF1     0567
OG1     0568
OPOT0   0611
```

```
OPOT1   0612
OPOT2   0613
OPOT3   0614
OSW0    0616
OSW1    0617
OSW2    0618
OSW3    0619
PAWS    0288  0289
PIZBRK  0284  0285
POT0    0217  1210 1752
POT1    0218  1756
POT2    0219  1760
POT3    0220  1216 1764
PRIOR   0635
PSWCY   0059
PSWPV   0058
PSWSGN  0056
PSWZRO  0057
PVOLAB  0594
PVOLMC  0595
QUIT    0311  0312
RANGED  0310  0311
RANGHT  0630
RCALL   0236  0237
RECTAN  0257  0258
RELAB1  0274  0275
RELABS  0273  0274
RESTOR  0266  0267
SAVE    0265  0266
SCHEDR  0243  0244
SCREEN  0040  0850
SCROLL  0267  0269
SCRSTR  0253  0254
SCT0    0139
SCT1    0140
SCT2    0141
SCT3    0142
SCT4    0143
SCT5    0144
SCT6    0145
SCT7    0146
SEMI4S  0610
SENFLG  0636
SENTRY  0281  0282 1501 1502
SETB    0312  0313
SETOUT  0254  0255
SETW    0313  0314
SF0     0147
SF1     0148
SF2     0149
SF3     0150
SF4     0151
SF5     0152
SF6     0153
SF7     0154
SHIFTU  0299  0300
SJ0     0159
```

CROSS REFERENCE LISTING

```
SJ1     0161
SJ2     0163
SJ3     0165
SKYD    0157  1506
SKYU    0156
SNDBX   0197  1243
SNUL    0139
SP0     0166
SP1     0167
SP2     0168
SP3     0169
SSEC    0155
ST0     0158
ST1     0160
ST2     0162
ST3     0164
STIMER  0045
STOREN  0295  0296
STRDIS  0270  0271 1421 1422 1433 1434 1445 1446 1457 1458 1467 1468 1527 1528 1539 1540
              1619 1620 1638 1639 1657 1658 1894 1895 1910 1911 1920 1921 1930 1931
SUCK    0240  0243
SW0     0213  1197 1720
SW1     0214  1724
SW2     0215  1728
SW3     0216  1203 1732
SYSRAM  0639
T2000   0654  1505
T200C   0660  1062
T2010   0663  1712
T2012   0664  1832
T2014   0665  0818
T20E2   0809  0806
T2151   0882  0879
T215E   0891  0888
T224A   1039  1009
T22A3   1098  1112
T234E   1206  1278
T23D6   1286  1241
T23DE   1296  1237
T23EF   1313  0802 0840 1350
T23F7   1318  1315
T23FF   1323  1320
T2408   1328  1325
T2411   1333  1330
T2420   1343  1336
T2429   1348  1345
T2441   1365  1428
T2451   1366  1440
T245B   1367  1626
T2466   1368  1452
T2476   1369  1645
T2480   1370  1664
T248B   1371  1901
T2495   1372  1464 1917
T24A5   1373  1927
T24AA   1374  1474
T24B3   1375  1534
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CROSS REFERENCE LISTING

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T24BB   1376  1546
T24C0   1378  1701
T24D8   1386  1705
T24F3   1395  1937
T27A6   1884  1826
TIMOUT  0625  1498
TMR60   0624
TONEA   0190  1251
TONEB   0191  1252
TONEC   0192  1253
TONMO   0189  1250
UMARGT  0637
UPISTR  0233  0234
USERTB  0638
VBBLNK  0092
VBCCHK  0088
VBCH    0087
VBCL    0086
VBCLAT  0097
VBCLMT  0095
VBCREV  0096
VBDCH   0085
VBDCL   0084
VBDXH   0071
VBDXL   0070
VBDYH   0076
VBDYL   0075
VBLANK  0263  0264
VBMR    0067
VBOAH   0081
VBOAL   0080
VBSACT  0091
VBSTAT  0068
VBTIMB  0069
VBXCHK  0074
VBXH    0073
VBXL    0072
VBYCHK  0079
VBYH    0078
VBYL    0077
VECT    0276  0279
VECTC   0275  0276
VERAF   0209  1195 1807
VERBL   0186  0787 1235
VIBRA   0193  1248
VOICES  0596
VOLAB   0195  1247
VOLC    0194  1254
VOLN    0196  1246
VWRITR  0258  0259
WASTE   0579  0580
WASTER  0580
WRIT    0261  0262
WRITA   0262  0263
WRITP   0260  0261
WRITR   0259  0260
XINTC   0235  0236
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CROSS REFERENCE LISTING

XPAND 0205 1063
XPNDON 0033