USER'S MANUAL

Machine Language Manager

for the Bally® Arcade

The Bit Fiddlers™

Computer Products For Work and Play

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MACHINE LANGUAGE MANAGER

For The

BALLY® ARCADE

Published by

THE BIT FIDDLERS T.M.
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CHAPTER ONE

INTRODUCTION

Congratulations! You have just stepped into the world of Machine Language. No longer are the secrets of fast graphics and infinite program control held out of your grasp.

But let's not be hasty! For along with this new found flexibility comes additional responsibilities and tedious frustrations you may not have experienced before. So, before we get too far along let me say a few words about who this new cartridge is aimed at.

You may have been aware of the efforts of many so-called "hackers" to break the bonds of BASIC and to add new and useful hardware and capabilities to the BALLY ARCADE. It is to these restless explorers that the Machine Language Manager is primarily dedicated.

But let me not dissuade the adventuresome who may not yet be familiar with the ways and wiles of machine language. There are a number of books available (some even written in English) that can take the uninitiated through the conventions used by nearly all microprocessors. A couple of good references are Programming the Z-80 by Rodnay Zaks and Z-80 Software Gourmet Guide & Cookbook published by SCELBI. Personally, I use The Z-80 Handbook by ZILOG, mainly because they have an alphabetical and numeric listing of all the instructions and op-codes for the Z-80 in the back. For more specific information on the BALLY ARCADE, I strongly recommend the Bally On-Board ROM Sub-Routines manual available from the ARCADIAN newsletter. Of even more utility was the on-board ROM description by Dave Nutting Associates (143 pages worth, with the complete source listing thrown in on top), also available from the ARCADIAN. A lot of information used in creating the MLM was taken from the latter of these two publications.

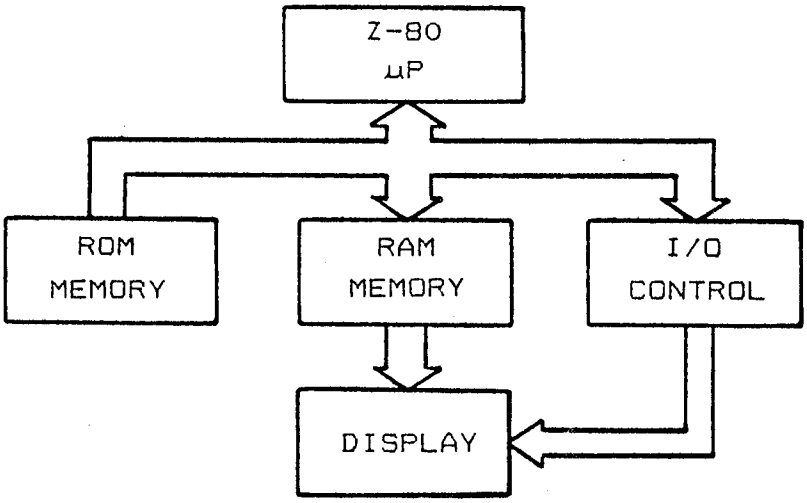
For those who wish to jump in without the aid of the aforementioned references, the next chapter holds a brief discussion of the conventions used throughout the rest of this manual.

CHAPTER TWO

BACKGROUND INFORMATION

Hardware Overview

First a few words about how the Bally Arcade is organized.



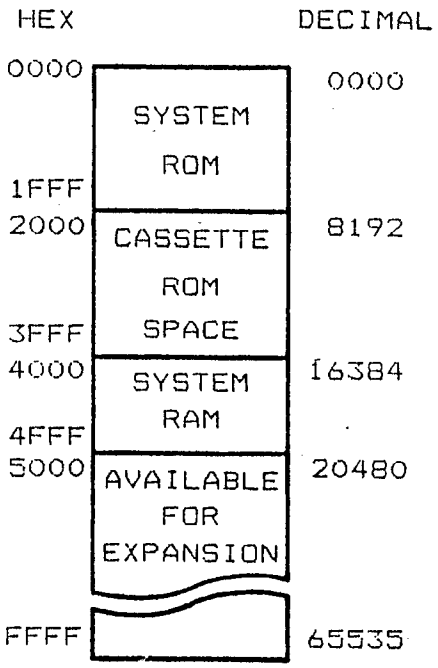
The above is a functional block diagram as I see it. The Z-80 microprocessor is directed by instructions (referred to as opcodes) taken from either Read-Only Memory (ROM) or Random Access Memory (RAM). Instructions and data in RAM are changeable, those in ROM are not. Why not all RAM, you ask? Data and instructions in ROM are permanent and don't go away when power is turned off. RAM, however, is "volatile" and goes blank when the power is removed.

The I/O control block represents all the circuitry needed for the Z-80 to make its actions known to the outside world and allows control actions in from outside. This includes reading and writing to the cassette tape port, screen image control, and reading the keypad and hand controls.

The ROM memory block represents all of the control memory that is dedicated to the system: the on-board games (like Gunfight), the animation and printout routines, and other housekeeping routines that are available to keep things flowing smoothly. Also included as part of the ROM block are the game cassettes which direct the workings of the on-board ROM and RAM. A small portion of the RAM is used by the on-board routines to keep track of variables, status, and the like.

All memory, both ROM and RAM, is made up of a continuous string of 8-bit clumps (bytes) any one of which can be made available to the Z-80. This is done by presenting memory with the unique 16 bit address of the desired byte. Don't worry about this point, the Z-80 does it automatically. All you have to do is get the right information in order. But more on this later.

There are over twenty thousand (4FFF Hexadecimal) bytes in the Bally Arcade arranged in the following manner.



The first 8K (thousand) are system ROM used as explained earlier. The next 8K are available for cassette ROM memory. Starting at byte 16384 (4000H) and continuing to 20479 (4FFFH) is system RAM memory. Beyond this is empty space available for those with the know-how to add more memory.

At this point the relationship between RAM and the TV screen should be discussed. Basically, the TV shares RAM with the system. That is, anything you wish to appear on the screen must be stored into RAM as a series of specific values. These values determine the colors of corresponding blocks (pixels) on the screen. Thus changing images is a matter of changing values in RAM. All of the RAM can be displayed on the screen.

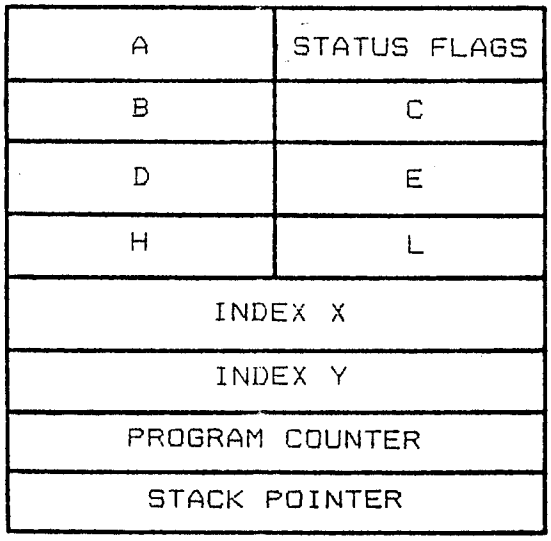
But where do user programs go? Well, way back when the BALLY ARCADE was developed, memory was not as cheap as it is today, so they designed in the amount of memory they thought they could afford for the selling price of the ARCADE. In order to get reasonable graphics capability out of the limited amount of RAM, the developers opted to make all of the RAM displayable on the screen. This is great for ROM cassette programs, which need very little RAM, but not so good when you're trying to put programs into RAM. As a result, user programs must share the available RAM with the TV images. Bally Basic gets around this by using some tricks that result in half the memory being totally available to both screen and program, but limit displayable colors to two. The Machine Language Manager handles the RAM in a different way, separating it into two areas--program and graphics. This way we can have full use of all four colors for graphics. But more on this later.

Z-80 Specifics

To aid the Z-80 in executing a string of instructions in memory, a Program Counter (often "P-counter" or PC) holds the address that the Z-80 is working from and increments the address when the Z-80 needs the next instruction. Z-80 instructions can be 1, 2, 3, or 4 bytes long. The P-counter automatically keeps track of where the next legal instruction starts.

Speaking of legal instructions, there is no distinction between data bytes and instruction bytes in memory. This means that if you should, by some wild chance, direct the P-counter into the middle of a data table, the Z-80 won't know any better and will try to execute the data as if they were instructions. The results can be both beautiful and disastrous.

Besides the P-counter, there are other variable areas on the Z-80 chip known as "registers". These serve as intermediate storage and working areas. It is easier to shuffle data between them than between memory locations. They can hold 8 bits individually as the A, B, C, D, E, H, and L registers or operate on 16 bit quantities as the BC, DE, and HL Register Pairs. All 8 bit arithmetic and logical results are stored in the A register. Most 16 bit results are stored in H and L.



Z-80 Register Set

For a deeper and better discussion of Z-80 registers and instruction set, see any of the previously listed references.

Conventions

The Machine Language Manager is a number-oriented tool, working directly with values the Z-80 can understand. So as to set things straight at the start, we will be using Hexadecimal (Base 16) numbers throughout this manual.

If you're not familiar with Hex representation, don't worry, it's not as bad as it sounds. In Decimal, each number position can hold a single digit value from 0 to 9. Hexadecimal extends this to 15 by using the letters A through F for the numbers beyond 9. Each number column then represents powers of 16, the same way Decimal columns represent powers of 10. Thus the number 12 in Decimal is 0C in Hex. Leading zeros are often used to avoid confusing Hex numbers with alphabetics. We'll also be putting an "H" on the end of Hex numbers to avoid confusion with Decimal numbers.

Converting numbers from Hex to Decimal is relatively easy. Take the number 123H. It can be represented as

$$1 \times 16^2 + 2 \times 16^1 + 3 \times 1$$

which is 291 Decimal.

There are charts available to help in conversion, if you really need to, in any self-respecting Machine Language book. The reason Hexadecimal is used is that numbers 0 through F can be represented by 4 bits with no leftovers.

For instance, the number 15 in Decimal can be shown in 4 bits as 1111. This Binary representation is what the Z-80 ultimately understands. Since the Z-80 uses 8 bit quantities, the whole thing would be 00001111. By splitting it into 4 bit segments again, we can show it as 0 for the first 4 bits, and F for the second using Hex notation. Thus the value of one byte can be shown as 2 Hex digits instead of 8 individual bits or a Decimal number between 0 and 255.

So much for math. Another convention worth noting is that of assembler code. An assembler is a program that uses quasi-English notation to put together a machine language program. Unfortunately, we are not privileged to have such a tool and can only work with numbers. We can still, however, put the notation to good use.

An example of assembler code:

```
LD A,B
```

Literally, "Load A from B", this means "copy the data out of register B into register A". Register B will still have its original value but A will also have B's value.

Most of the notation used is straight-forward (at least I think so) and will only be expanded upon if the function is not obvious from the notation.

A point of possible confusion should be noted here. When referring to an address, such as 4000H, the most significant byte will be shown first (40 00). When used in an instruction, such as a Jump to 4000H, Z-80 convention requires the least significant byte to be first:

```
OPCODE      INSTRUCTION     COMMENT
------      -----------     -------
C3 00 40    JP 4000H        ;JUMP TO 4000H
```

This will always be true when representing any 2-byte quantity.

What you see under "OPCODE" are the Hex values for the instructions. This is the way we have to do things, since the Z-80 only understands numbers. In the example, the value "C3" was taken from one of the Z-80 books mentioned earlier. So, the "C3" is what the Z-80 knows as a "Jump" instruction. The two values after it are the address of where we want to jump, "lower" byte first.

I realize that this has been a pretty quick coverage of the Z-80 and probably doesn't answer many questions, but to adequately cover it would take more space than is available in a manual of this type. I strongly suggest that you go to an electronics store, a computer store, or just about any good bookstore and thumb through a few of the Z-80 books. When you find one that is readable and suits your needs, buy it and USE IT.

CHAPTER THREE

NEW BUSINESS

This is where we say Hello to those people who like to thumb through and skip over the introductory material. We'll try to explain the workings of the Machine Language Manager (MLM for short), in this chapter.

STARTUP

Put the cartridge in and press RESET. The screen should show:

```
0140 BYTES AVAILABLE STARTING AT 4E10
OK
```

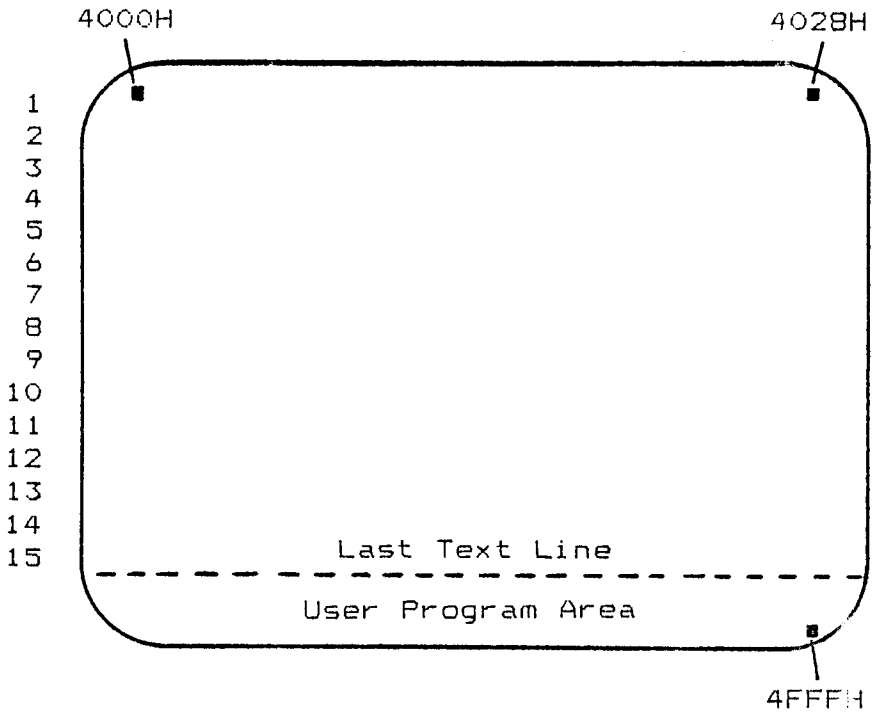
You've probably noticed that the characters look different and are a little smaller than Bally Basic's. In order to get more information on the screen and provide a reasonable LIST function, we opted to use our own character set rather than the one residing in the Bally system ROM. With this set we are able to put 39 characters on a single line.

Ok, so much for looks, what does it mean?

We've set up the screen RAM so that the display and program areas are physically separated. How much RAM is available for programming is up to the user (see Chapter 4 for specifics on changing it). Right now, the screen is set at 0FH (15 Decimal) text lines. This means that the screen will accomodate 15 lines of text before scrolling everything upward. Program memory starts at the first address available after the last text line of the screen. In this case it's address 4E10H. The amount of memory available is calculated from this address to the start of variables in RAM used by MLM and the Bally system. So this message says there are 140H "empty" bytes (320 Decimal) available for your use, starting at 4E10.

Decreasing the number of displayable text lines will increase the number of bytes available, and vice versa. For instance, setting the number of text lines at 3 will give 0C80H (3200 Decimal) free bytes available for your program. The impact of setting the screen text area to a certain length is to limit the space on the screen that will be cleared or scrolled, so that your program is not affected by these two operations. With text set at 3 lines, a Clear Screen operation will only wipe clean the area from the top of the screen to the bottom of the 3rd text line. The program area (starting where text line 4 usually is) will be left intact.

The minimum number of text lines allowed the user is 1. The maximum is 15.



Screen RAM starts at address 4000H and goes to 4FFFH. User area starts after last displayable text line.

While it is still possible to put programs into the text area, it's not advisable. Once the text starts scrolling, so will your program! The area set aside for programs is made immune to scrolling, screen clearing and accidental RESETs. Hit the RESET button a few times. The MLM knows if it's been awake so it doesn't try to set everything brand new. If you had a program in it, it would still be intact.

KEYS

Hopefully by now you will have put on the keypad overlay. Look at it closely. The numbers 0-9 and letters A-F are all Hexadecimal digits and have no other meanings. The keys on the right side and bottom are command keys.

NUMBERS

The MLM handles numbers in a different way than most systems. Each digit that is entered is shifted into the least significant digit of a 4 digit Input Register in memory. This register only remembers the last 4 digits entered and usually only needs to remember the last 2. In the absence of an ERASE or Clear Entry key this comes in handy. If an error is made, say you entered 25 when you wanted 2F, just enter what you meant to, in this case 2F, after the mistake and before pressing any of the command keys. For instance, enter the numbers:

12345AB

The numbers MLM will use for byte information are AB. The numbers used for address information are 45AB. The rest are thrown away.

The convention used by MLM commands that need number entries is to enter the numbers first, then the command key.

COMMANDS

(ADDR)

The ADDRESS key is used to tell the MLM where in memory you want the next operations to be performed. If you want to READ, WRITE, LIST or run a program at, say, 4E54H, you must begin with

4E54 (ADDR)

The ADDRESS key will put a colon (:) on the screen to show that this value has been loaded into the MLM Address Pointer.

(WRITE)

The WRITE key is used to put information into memory a byte at a time. For instance, let's say that at address 4E54H we wanted to put 3 bytes of data: 11, 22, 33. We would enter:

4E54 (ADDR) 11 (WRITE) 22 (WRITE) 33 (WRITE)

The screen would show:

4E54:11 22 33

MLM puts a space on the screen each time WRITE is pushed as a visual feedback that the command has been performed and to make the display more readable. The WRITE key also increments the Address Pointer automatically so that in the above example, 4E54H contains 11, 4E55 contains 22, and 4E56 contains 33 with the Address Pointer containing 4E57 for the next WRITE, READ or LIST.

(READ)

The READ key allows us to examine the contents of memory anywhere in the Bally system. Thus you can examine system ROM, or MLM (which is at address 2000H), or anywhere in RAM. For the example above, to verify that the data is really there, we would enter:

4E54 (ADDR) (READ) (READ) (READ)

The display will show:

4E54:11 22 33

Again, spaces are inserted and the Address Pointer is updated automatically.

(LIST)

The LIST key allows a more rapid and better formatted method of examining memory. In our example above, if no numbers have been entered since the last ADDR push, the numbers 4E54 should still be in the MLM Input Register, but the Address Pointer will have changed, pointing to successive bytes with each READ push. Pushing ADDR again should put 4E54 back into the Address Pointer. Type:

(ADDR) (LIST)

The screen should show:

```
4E54:11 22 33 :
4E54: 11 22 33 00 ....."3.
```

The information following the contents of address 4E57 is the ASCII interpretation of the data in addresses 4E50 to 4E57. Codes that are not in the ASCII character set produce "." for this portion. The LIST command is organized to show 8 bytes at a time, breaking so as to start with xxx0: or xxx8:. Hit the LIST key again. It should show:

```
4E58: 00 00 00 00 00 00 00 00 ........
```

The LIST command automatically updates the Address Pointer for the next 8 bytes.

Suppose you wanted to list a range of memory but didn't want to repeatedly push the LIST key. Type in the following:

2000 (ADDR) 2020 (LIST)

What you see is the first 40 bytes of MLM. Using this type of sequence you can list the entire contents of ROM and RAM with a single command! If perchance you should accidentally get caught in a longer list than you wanted or just want to stop a list in progress, hit the RESET button. That's right, the RESET button. Since RESET no longer clears memory, all it does is halt the operation in progress and returns control to MLM.

Do a list from 2628 to 2688. This is where MLM messages are stored, and shows the use of the ASCII section of LIST.

(INS)

The "INS" key is for inserting a byte between two other bytes. This command and the DELETE command are the two most dangerous commands in MLM. To properly use the INSERT key, one step must be performed first: There is in MLM system RAM, a pointer called END. This pointer (address 4FC1) must have a value greater than the one in the Address Pointer to work properly. The purpose of END is to tell the INSERT and DELETE commands where the end of the program is. INSERT works by copying each byte in the range (from where the Address Pointer points to where END points), into the next higher location.

Type in the following:

4FC1 (ADDR) 57 (WRITE) 4E (WRITE)

4E54 (ADDR) 77 (INS)

the first line points END at the proper byte, the second sticks a 77 at the beginning of our example above. Now LIST at 4E54:

4E54: 77 11 22 33 ....."3

END now has in it 4E58 (check it out). Whatever was in 4E57 is now gone. Note that END is updated automatically ONLY when INSERT and DELETE are used, so it should be kept track of and used with caution. Failing to do so can result in some strange things in your program.

Some tips:

If you're not strapped for memory space, it's good practice to sprinkle NOPs (NO-OP, opcode 00H), a do-nothing instruction, throughout your program. This is analogous to making line numbers in multiples of 10 in BASIC. It allows relatively painless expansion without having to move too many other instructions. The result is not having to use INSERT very often. Another good trick is to physically space subroutines and data tables away from the program. This allows the program room to grow.

```
4E50: -------
      -------  Main Program
      -------
4E60:  RET

  (EMPTY SPACE)

4E70: -------
      -------   Subroutine
      -------
4E7A:  RET


4E80: -------
      -------   Data table
      -------
```

This way you can point END to one of the gaps, 4E61 in this case, and not have to change any of the call and table addresses in the main program as it expands.

One last bit of background about INSERT. The INSERT routine does a check to see if the Address Pointer is less than the contents of END. If END is smaller, it is changed to the value in the Address Pointer +1. This means that you can "build" your program using INSERT instead of WRITE and not have to worry about END, but only in this case. If you've just loaded in your routine from tape, END won't know where the end of your program is.

(CALL)

The CALL key is used to transfer control to a program or subroutine in memory. It's how you get your program to run. The convention for using it is to enter the address, then hit CALL. Simple, huh? For instance,

2347 (CALL)

calls MLM's clear screen routine at 2347.

The CALL routines in MLM also provide for the return process. That is, if the routine you've just transferred control to ends with an RET (Return, opcode C9), control will flow smoothly back to MLM when your routine is finished. If you don't want to give control back, well, that's your problem. To halt any program in progress, just hit RESET. If your program is scrambled at this point, it's in your code, not mine!

(REG)

This stands for "register", which is what this key acts on...the Z-80 register set. This command and associated subcommands allow you to preset values into the registers, as is usually needed during testing. For instance, a print subroutine may need the character value in the A register. By using this command, the A register may be preset to any value, after which the subroutine can be called to see the results. Pressing the REG key causes the keypad to alter its operations slightly. Hit the REG key. MLM will print:

A:

and wait. If you choose to change the present value of the A register, enter the value and press WRITE. If you choose not to, press READ. In either case MLM will print:

BC:

and you have the same options.

Some notes: READ does not produce the contents of A. To view the contents of the run-time registers, follow REG with LIST.

16 bit values like those required for BC are entered most significant byte first. That is, if BC is to have the value 4E54, then 4E54 is entered, followed by WRITE. This puts 4E in B and 54 in C.

The registers asked for, in order, are A, BC, DE, and HL. After HL is changed (but not after passing it using READ), MLM prints the present values of all the registers and present Address Pointer:

A:02 BC:0503 DE:4E50 HL:1004 ADDR:4E54

If no values were changed, pressing

(REG) (LIST)

would have given the same results.

To cancel the REG command at any point, simply press the LIST key. This is helpful if you only want to change the A register and skip the rest.

(*)

The last key on the overlay is marked "*". This is MLM's "shift" key, and it affects the other command keys in the following ways:

(*) (WRITE) --Tape Output

This combination opens the tape output port in much the same way as Bally Basic. Type in "*" and WRITE. MLM shows a red "T" to indicate Tape Output mode. Now do a list of a few lines. Notice how the print speed has slowed down? This is to accomodate the 300 Baud cassette rate. Note also that the ASCII portion is no longer shown. This is to keep MLM from reacting to false ADDR and WRITE commands. More on this later.

To record data onto tape, type in "*" and WRITE, then set up a list of the area you want saved. Before pressing LIST, start your recorder, allowing 1 or 2 seconds of "dead" time, then hit LIST. All the information sent to the screen is also sent to the tape.

To cancel the Tape Output mode once you've stored all your data, type in

(*) (WRITE)

again. MLM will respond with a green "T" signifying everything's back to normal.

(*) (READ) --Tape Input

Typing in this sequence opens the cassette tape input port. At this point you can read in an MLM-generated tape. MLM responds to colons (:) as Address commands, and spaces as Writes. This way, a listing on tape is all that's needed, and it maintains the listing format as it's read in.

MLM handles this function a little differently than Bally Basic. Basic's :INPUT makes the cursor go away, taking information only from the tape port. Pressing any key during :INPUT will cancel the tape input mode. MLM allows key inputs after *READ so that screen formatting, or whatever, can be done without having to re-open the tape input port. If you intend to use a full size ASCII keyboard, this allows commands to enter from either the keyboard or the keypad. However, only ADDRESS (colon) and WRITE (space) are supported. Note that this doesn't prevent you from writing your own keyboard driver program.

To cancel Tape Input mode, simply type "**". The green "*" says all is well again. RESET will also cancel this mode.

The Bit Fiddlers
P.O. Box 11023
San Diego, CA 92111-0010

April 6, 1982

Dear MLM Owner,

Since the introduction of the Machine Language Manager, we have been aware of the problem of cassette storage for those users who do not have access to the original Bally Basic 300 Baud cassette interface. It has been proposed that the 2000 Baud interface be incorporated into the MLM, and this remains the most logical answer to the problem.

There is, however, one minor problem with this solution. The ROMs used in producing the MLM have no more available programming space. This can be worked around using larger ROMs, but would require a whole new development cycle, for both hardware and software. This is not to say that we will leave MLM in its present state forever. Rather, it is to point out the fact that major changes in the product cannot appear before several months have elapsed.

In an effort to relieve this problem, we have developed a procedure for using MLM with Astrovision Basic's 2000 Baud cassette interface. This involves loading a tape using the Basic cartridge, then replacing it with the MLM cartridge. The full details are on the enclosed pages.

Admittedly, this is not the cleanest approach, but it has been found to be totally reliable. And much faster than 300 Baud.

An outgrowth of this method is that we are now able to produce tapes that auto-start when loaded using the 2000 Baud interface. Again, see the enclosed pages for details and limitations.

We hope that you find this information useful. We will continue to keep you informed of any future developments.

Sincerely,

Andy Guevara

Andy Guevara, Owner

MACHINE LANGUAGE MANAGER

UPDATE NUMBER 1
APRIL 6, 1982

PURPOSE:

The purpose of this update is to give users sufficient information to use the Machine Language Manager in cooperation with the Astrovision Basic 2000 Baud cassette interface. If you do not have the Astrovision Basic cartridge with built-in cassette interface, you do not need this update.

This entire update should be read carefully before experimenting with the programs provided. But don't worry, it's not as hard as it looks.

THEORY:

The theory behind the following procedure is that it is possible to put a program into a tight loop with interrupts locked out. This means that the system will not respond to keypad or joystick inputs, or even realize that the cartridge may have been removed from the unit. Therein lies the key.

The following short programs, based on this theory, allow you to maintain all the data in the Arcade while swapping one cartridge for another. Thus to store an MLM program using the 2000 Baud interface, you would run a specific short program, swap cartridges, start the recorder, then hit a specified key on the keypad. Once the key is hit, the program executes a jump into the area of the Astrovison Basic cartridge dealing with making recordings (the :PRINT program). In 25 seconds or so, the entire MLM environment, with the exception of register contents and color values, will have been recorded on tape.

The reverse situation, loading from tape, is similar in concept. There is a byte in memory where Basic expects to find an interrupt routine. It jumps to this routine when it has finished reading in a program tape, and before it tries to evaluate anything. If we replace this routine with information of our own, we can 1) put the machine into a tight loop so that we can swap cartridges, or 2) tell the machine that the interrupt routine is really the start of our main program. Since we have control of what information gets put on the tape, including how much memory the tape represents, we can do the above operations quite nicely.

STORING PROGRAMS ON TAPE:

A. THE PLAYBACK PROGRAM

When preparing to store your program on tape, you also have to consider how you're going to handle the playback process. Since all of screen memory gets put on tape, the playback program must be in memory when the tape gets made.

Entering the following program will take care of the playback process:

```
4E95:  AF          XOR A        ;CLEAR A TO 0
       D3 04       OUT (04),A   ;OUTPUT TO COLOR PORT 4
       C3 95 4E    JP 4E95H     ;JUMP BACK TO BEGINNING
```

Here's what's happening.

Astrovision Basic uses address 4E95H for storing its screen interrupt vector. Since interrupts are not responded to during the loading of a tape, the system will IMMEDIATELY respond once an Enable Interrupts instruction occurs. In Astrovision Basic, the EI happens just after the last byte has been read in.

So, once the last byte comes in, the system will execute an immediate jump to address 4E95H, starting the tight loop. The loop holds our data for us, so we can now take out the Astrovision Basic cartridge and put in MLM. That's all there is to it!

Line 2 is for correcting the background color. It can be extended to correct ports 6 and 7 for red and green, but this is left up to you.

No Disable Interrupts instruction is needed, because the DI is automatically issued by the system when answering an interrupt. So it's not necessary for us to do it.

B. THE RECORDING PROGRAM

Now that the proper playback program is in place, enter the following recording program:

```
4EA0:  F3          DI           ;DISABLE INTERRUPTS
       DB 17       IN A,(14H)   ;INPUT TO A FROM PORT 17H
       A7          AND A        ;TEST IF 0
       CA A0 4E    JP Z,4EA0H   ;IF SO GO BACK TO START
       3E C3       LD A,0C3H    ;OTHERWISE FIX MLM INTERRUPTS
       21 B1 4F    LD HL,4FB1H
       77          LD (HL),A
       22 B2 4F    LD (4FB2H),HL
       21 CA 0F    LD HL,0FCAH  ;SET UP REGISTERS
       11 00 40    LD DE,4000H  ;FOR :PRINT
       C3 48 20    JP 2048H     ;AND JUMP INTO :PRINT
```

The starting address of 4EA0H was chosen for convenience, being physically close to the playback code which MUST appear at 4E95H. Actually, the recording routine can be put anywhere in memory that is convenient for you. The only thing to be careful about is that the 'JP Z,' instruction in line 4, must always refer to the starting address of the routine. In this case it was 4EA0H.

What this program does is 1) Disable Interrupts, 2) checks to see if a key in the left column of the keypad is hit, and 3) if not, goes back to the Disable Interrupts instruction. If one of the left keys has been hit, it loads the registers with starting address and count information, then jumps into the :PRINT program in the Astrovision Basic cartridge. Lines 5 through 8 are a special case explained a little later.

For the :PRINT routine to work properly, it must have the DE and HL registers set with the right information. In order to save the entire MLM environment, DE must have the starting address of 4000H, and HL must have the number of bytes to save. In this case it is 0FCAH. 4FCAH is the last variable used by MLM, so that 4FCAH - 4000H = 0CFAH for the total number of bytes.

Lines 5, 6, 7, and 8 deal with keeping your program intact after the :PRINT program is done. What they do is write a small 'jump-self' program at MLM's interrupt vector location. Even though the cartridges will be changed, the system will retain the old vectors as long as the RESET button isn't hit. As a result of all this, once your recording is made, you can put MLM back in the Arcade, hit RESET, and be right back where you left off.

THE RECORDING PROCESS

When all of the above coding has been entered, you can follow this procedure:

1. Start the record program by typing its address, then CALL. In our case above, it would be 4EA0 CALL.

2. Remove the MLM cartridge. Carefully.

3. Insert the Astrovision Basic cartridge, and connect the MIC cord to the cassette jack. DO NOT HIT RESET.

4. Start your recorder.

5. Hit the '*' key.

The recording process will be complete in less than 25 seconds. Timing it is the only way to know when it's done.

6. Put MLM back into the Arcade and hit RESET.

You should now be exactly where you were before you ran the program.

THE PLAYBACK PROCESS:

As you might have guessed, all we have to do to get our information back is to:

1. Put the Astrovision Basic cartridge in the system, and hit RESET. Connect the speaker output cord to the cassette jack in the cartridge.

2. Type in :INPUT or :RUN, either one. Don't type GO yet.

3. Cue the tape. Volume level should be about 9 on a scale of 10.

4. With the tape running, hit GO.

5. Once the tape is loaded, the LED will go dim or out, and the screen colors will change. DON'T HIT RESET YET.

6. Replace the Basic cartridge with MLM.

7. Now hit RESET. Your system should now be exactly as it was when you recorded it.

AUTO-START PROGRAM TAPES:

An auto-start program is one that starts as soon as the tape finishes loading. Automatically.

The obvious limitation on this is that the program cannot depend on MLM for any of its internal workings. That is, the program must be self-sufficient, and only use routines that are in the system ROM.

All that has to be done to make a program auto-start, once it has been adequately debugged, is put a jump instruction to the starting address of your program in address 4E95H in memory. For instance, if my program starts at 4E10H, at 4E95H I would type in:

```
4E95:  C3 10 4E      JP 4E10H
```

From here I can make my recording as usual. But when the program is read back in, it will start automatically.

SPECIAL CONSIDERATIONS:

In setting up the system to record, any starting address and number of bytes can be used. The system will happily oblige.

This is particularly useful if you are using extended memory such as Viper or Blue Ram. The only thing to be careful about is that starting addresses other than 4000H must be specified before playing back the tape. This is easily accomplished by using the form :INPUT %(NNNNN), where NNNNN is the Decimal address of the program.

For instance, if our program starts at address 6000H, and we made the recording with this as the first address, then we would type in:

```
:INPUT %(24576)
```

24576 is the Decimal form of 6000H. If we were to simply type in :INPUT or :RUN, the program would be loaded at address 4000H.

One last limitation on this format. Due to the way that Basic stores information into screen RAM, this method will not work with addresses above 7FFFH (32767 Decimal). However, this doesn't prevent you from using 7FFFH as your starting point for both recording and playback.

SOME SUGGESTIONS:

We highly recommend trying out these procedures with no other programs in memory at the same time. At least none that aren't already saved somewhere else. Experimenting, when a program you've just spent 2 hours polishing is in memory, is inviting disaster.

Once you've mastered the process, it might be useful to keep a cassette with nothing else but these routines on it. That way, as a preparation for entering a new program, you could load in the tape routines first. That way they'll always be right, and ready for storing your interim results.

We also suggest using the routines as written, to save the entire MLM working environment each time. Since it only takes 25 seconds, setting up for a smaller area will be impractical in most cases.

Happy Recording.

(*)(INS) --Delete

If you haven't guessed by now, *INS produces the DELETE function. As discussed earlier in the INSERT section, it is very important to keep track of the END pointer. Aiming END at the last byte of your program +1 will take care of almost everything. I say "almost" because you still have to make sure that jumps and calls are made to the proper places.

Suppose that at 4E54 the following data was found:

4E54: 11 22 33 44 00

and you wish to remove the center 2 bytes.

Assuming that 44 is the last byte in your program:

4FC1 (ADDR) 58 (WRITE) 4E (WRITE) (puts 4E58 in END)

4E54 (ADDR) (READ) (*) (INS) (*) (INS) (deletes bytes 2 & 3)

The screen should now show:

4FC1:58 4E 4E54:11 *<*<

The "<" indicates something's been taken out.

Since no numbers have been entered, press ADDR, and READ or LIST the data area again. It should look like:

:
4E54: 11 44 00 00 ....

END will have 4E56 in it.

An alternative to DELETE, if you're not too comfortable with it, is to change the errant values to 00 (NOP) using the WRITE command. Be sure, though, not to just zero out the first byte of a 2 or 3 byte instruction. They've all got to go.

(*) (LIST) --Print

For those of you who have a printer connected to the Bally, this action is the same as Bally Basic's *PRINT. Anything printed on the screen is sent to the printer port.

Actually, the printer and tape output ports are the same. The difference lies in the fact that *LIST filters out any unprintable characters before letting the data out the port. *WRITE has no filter and can send out any 8 bit quantity as a "character". However, most printers go bananas when you feed them the wrong codes. To cancel this mode, repeat *LIST.

(*) (REG) --Tape Display

The last one. This function fully duplicates the function of Bally Basic's :LIST. It is used to display information that's on tape without disturbing actual memory contents. This is helpful in locating one routine on a tape holding several, by watching for the addresses of the routine you're looking for as they're displayed. If you have a full ASCII keyboard, you could put the program title on tape before recording the program listing.

CHAPTER FOUR

UTILITY PROGRAMS

A couple of utility programs are included in MLM that do not operate as single keystrokes. For this reason they're discussed here separately.

Screen Specification Program

Called Screen Spec for short, it is most easily run by first hitting RESET, then CALL. What happens is that the address of Screen Spec is put into the MLM Input Register every time RESET is hit. Try it. The screen will print the following:

TEXT LINES:

Proper values are 1 through F. Zero acts the same as 1. Any number of numbers can be entered, only the last one will count. Entering nothing counts as entering F, which is the default value. End the input with WRITE.

The display should now show:

COLOR BOUNDARY:

The default value (if you don't enter anything) is 2CH. This value gets set into port 09, setting the right/left color boundary to the far right and giving us 4 colors to work with. Entering 12 will move the boundary to about the center of the screen and allow 4 colors for each side, for a total of 8. The upper 2 bits of the value entered into this port define which of the four colors for each side will frame the outside of the printable screen. Zeros indicate the frame will match the background color. 01 in the upper 2 bits will make the frame the same as the foreground color. Pressing WRITE ends this input.

The screen should now show:

BACKGROUND COLOR:

The default value is 00. This is the value for Black. If you don't like Black, key in any other number from 00 to FF. See if there's one you might like better. Blue is FA. End the input with WRITE.

MLM will now display:

FOREGROUND:

The choices are the same. Default in this case enters 07 into the color register for color #1. This is the value for White.

Once you've entered your choice and WRITE, MLM will clear the screen, limit the number of displayed text lines (and take care of scrolling properly), and set the foreground, background, and right/left parameters as you requested.

If you get into the middle of the program and decide that you didn't like an answer you already gave, or maybe don't want to change anything after all, just hit RESET. None of your choices will be entered into the system unless you go through the whole program.

To see the effect of this program, do the following:

1) Hit RESET, then CALL
2) After TEXT LINES: enter 5 then WRITE
3) Enter 3 more WRITEs
4) Now put in the following program:

```
ADDR  OPCODE       INSTRUCTION      COMMENTS
----  ------       -----------      --------
4E50: 3E FF        LD A,0FFH        ;LOAD A WITH 0FFH
      D3 0A        OUT (0AH),A      ;OUTPUT A TO PORT 0AH
      C9           RET              ;GO BACK TO MLM
```

This will drop the "curtain" that hides the program area from being displayed. It's identical to &(10)=255 in Bally Basic. Now run the program by typing

```
4E50  CALL
```

and you will see what was not affected by the Clear Screen operation. Hit list a couple of times to see the action of the scrolling function. To put it back to normal, hit RESET and 4 WRITEs and everything will be as it was.

Breakpoint Program

Often (I know, I start a lot of things this way) when testing a program, the programmer finds that his routine causes the CPU to go off into Never-Never Land. To help him find out where the bad coding is, a breakpoint facility has been built into MLM.

The process for using breakpoints is simple: Find a place in your program that you wish to make sure that the CPU is getting to. Replace the opcode of that instruction with "CF". When (if?) the CPU runs across this code it will print the following:

```
BKPT ADDR: 1234          (Address where you put the breakpoint code)
A:11 BC:22 DE:33 HL:44 ADDR:5555
```

where the numbers indicate register values at the time the CPU ran across the breakpoint code. ADDR: indicates the contents of the Address Pointer.

At this point the register values should be checked against what you would expect at this point in your program. If all is well, replace the breakpoint code with your original opcode and put the breakpoint further downstream in your program.

CHAPTER FIVE

USING THE LISTING AS A SOURCE OF INFORMATION

There is a lot of good information and insight to be gained by just looking through the source listing of MLM. Granted, machine language is not exactly crystal clear to read and understand, even with a lot of comments by the author, but it can be valuable in a tight situation.

As an aid to understanding the interface between pure machine code and the Bally system ROM routines, a few good words are in order.

The Bally programmers, in their infinite wisdom, have made access to the bulk of the background tasks necessary in generating almost any game program relatively easy. These tasks include shape generation, animation, sound generation, timing and scoring among many others.

The method by which these on-board routines are called was made as universal as possible, so that different revisions of the system would be compatible. That is to say, normally a given subroutine is called by its address in memory, but when changes are made to a large program, the subroutine's address will also most likely change. The Bally people have found a way around this.

By way of the User Program Interface, any routine can call a system subroutine in the same way regardless of the revision level of the system.

To accomplish this feat, they have used the opcode "FF" as a sentinal to indicate a system call. This sentinal is immediately followed by the number of the subroutine to be called. For instance,

```
ADDR  OPCODE        INSTRUCTION      COMMENTS
----  ------        -----------      --------
4E40: 01 03 05      LD BC,0503H      ;RECTANGLE SIZE
      3E FF         LD A,0FFH        ;COLOR MASK (GREEN)
      ED 5B C3 4F   LD DE,(COORD)    ;WHERE
      FF            DEFB SYSTEM      ;SYSTEM SENTINAL
      1C            DEFB RECTAN      ;ROUTINE NUMBER
      C9            RET
```

is one way to have the system draw a 3x5 pixel rectangle at the positions determined by the value in COORD (at 4FC3). The value in A is the color mask. That is, every byte used to draw the rectangle will have the binary value 11111111, meaning each pixel (whose color is defined by 2 bits) will be color #3, which was set to Green by MLM.

But back to the system interface. The alternative method of calling RECTAN is

```
ADDR  OPCODE        INSTRUCTION     COMMENTS
----  ------        -----------     --------
4E40: FF            DEFB SYSSUK     ;SENTINAL
      1D            DEFB RECTAN     ;ROUTINE NO. PLUS 1
      10            DEFB 10H        ;X COORD.
      10            DEFB 10H        ;Y COORD.
      03            DEFB 03         ;X SIZE
      05            DEFB 05         ;Y SIZE
      FF            DEFB 0FFH       ;COLOR MASK
      C9            RET
```

Note that the sentinal is the same, but the routine number is different. Even-numbered routines expect the values to already be preset in the registers for use. Odd-numbered routines (1 greater than their counterparts) expect the variables to follow the subroutine number. This latter form is useful if none of the variables change, like walls or borders. If things need to be different the next time through, the first method is the way to go.

Note also the change in name of the sentinal from SYSTEM to SYSSUK. This was done to be consistent with the way Bally does things. SYSSUK uses an on-board subroutine called SUCK, which loads the Z-80 registers with the data following the sentinal. Which registers are used and what data is needed depends on the individual subroutine.

Subroutine 00 is of special interest. This is actually an additional sentinal that indicates entering an "interpreter" mode. Once entered, several system calls can be made successively without using the "FF" sentinal. Look at address 2026H in the listing. The subroutines FILL, SETOUT, MOVE BYTES, and COLSET are called in sequence, with no intermediate steps. The sentinals 02 and 03 (either one) are used to exit the interpreter and return to machine language.

A lot of processing can be done in just a few bytes by using system calls wherever possible.

CHAPTER SIX

MLM Routines As Utilities

In building MLM, it became apparent that a lot of the functions we were putting in would be very useful in user programs and would save a lot of programming time and space. This is why we include a full listing at the back of this manual, in case there's a routine you might need that we haven't explained.

Most, if not all, MLM routines can be coded as calls from within your programs or directly CALLed from the keypad. A more concise table of MLM routines can be found in Chapter 9.

Clearing The Screen

The subroutine for clearing the screen is at 2347H. It calculates how much to clear and only affects the text area, leaving the program area untouched. In your program:

```
      .           .
      .           .
      .           .
CD 47 23    CALL CLEAR
      .           .
      .           .
```

From the keypad:

2347 (CALL)

Character Display

To display an ASCII character, the A register must be loaded with the ASCII value. Following this with opcode "D7" will display your character and return. For instance:

```
ADDR  OPCODE       INSTRUCTION      COMMENTS
----  ------       -----------      --------
4E40: 3E 42        LD A,42H         ;LOAD ASCII 'B'
      21 10 10     LD HL,1010H      ;X,Y COORDS
      22 C3 4F     LD (COORD),HL    ;STORE INTO MLM RAM
      D7           DEFB DISP        ;CALL DISPLAY ROUTINE
      C9           RET              ;GO BACK TO MLM
```

will place a "B" at coordinates (10,10) 16 pixels down and 16 over.

Once coordinates have been established, they are automatically updated for the next space to the right, and will do a carriage return and line feed when the edge of the screen is reached.

To print the larger 5x7 characters by way of the Bally system ROM, the following format must be used:

```
ADDR  OPCODE        INSTRUCTION      COMMENTS
----  ------        -----------      --------
4E40: 11 10 10      LD DE,1010H      ;X,Y COORDS
      0E 04         LD C,04H         ;OPTIONS (0100)
      3E 42         LD A,'B'         ;ASCII CHARACTER
      FF            DEFB SYSTEM      ;SYSTEM SENTINAL
      32            DEFB CHRDIS      ;DISPLAY ROUTINE
      C9            RET
```

Or alternatively:

```
4E40: FF            DEFB SYSSUK      ;DATA IN LINE
      33            DEFB CHRDIS      ;ROUTINE # PLUS 1
      10            DEFB 10H         ;X COORD
      10            DEFB 10H         ;Y COORD
      04            DEFB 0100B       ;OPTIONS
      42            DEFB 'B'         ;CHARACTER
      C9            RET
```

The system ROM returns the updated coordinates in DE for you to change or keep as you see fit.

String Displays

To display a string of ASCII characters, like a word or a sentence, the following format should be used:

```
4E39: DF            DEFB STRING      ;CALL STRING
      40 4E         DEFW 4E40H       ;MESSAGE ADDRESS
      C9            RET

4E40: 48 45 4C 50 00          ;ASCII 'HELP'
```

This will print "HELP" at wherever the Coordinate Pointer points. Coordinates are in 4FC3, X coordinate first. Each string must end with 00 to operate properly.

To print the same string in the larger character set, do the following:

```
4E50: 21 40 4E      LD HL,4E40H      ;MESSAGE ADDRESS
      11 10 10      LD DE,1010H      ;XY COORDS
      0E 04         LD C,04H         ;OPTIONS
      FF            DEFB SYSTEM
      34            DEFB STRDIS      ;STRING ROUTINE
      C9            RET
```

Or alternatively:

```
4E50: FF            DEFB SYSSUK      ;PARAMETERS TO FOLLOW
      35            DEFB STRDIS      ;ROUTINE #+1
      10 10         DEFW 1010H       ;XY COORDS
      04            DEFB 0100B       ;OPTIONS
      40 4E         DEFW 4E40H       ;MESSAGE ADDRESS
      C9            RET
```

In both cases, the string must end with 00.

Displaying the Value in a Register

Often the results of a calculation are to be displayed. This is helped along by use of the RGDIS routine at 245E.

RGDIS expects the value to be displayed to be in the A register, and the coordinates (at 4FC3) to be previously set. For instance, to show the contents of HL, the routine HLIST looks like this:

```
246F: 7C            LD A,H           ;H TO A
      CD 5E 24      CALL RGDIS       ;DISPLAY IT
      7D            LD A,L           ;L TO A
      CD 5E 24      CALL RGDIS       ;DISPLAY IT
      C9            RET              ;GO HOME
```

Reading the Keypad

To read the keypad, the routine KEYGET was written. What this routine does is scan the keypad until a key is pressed. It then evaluates the key to a number and returns with the key value in B. Note that nothing else can happen while KEYGET is running unless that something is interrupt driven.

Keys are organized as follows:

01	02	03	04
05	06	07	08
09	0A	0B	0C
0D	0E	0F	10
11	12	13	14
15	16	17	18

This routine prints out the key numbers:

```
4E40: CD 05 24      CALL CRLF       ;NEXT LINE
      CD 96 24      CALL KEYGET     ;ADDRESS 2496
      78            LD A,B          ;VALUE TO A
      CD 5E 24      CALL RGDIS      ;DISPLAY IT
      CD 51 24      CALL SPACE      ;PRINT A SPACE
      C3 43 4E      JP 4E43         ;LOOP BACK
```

To get out of it, hit RESET.

Changing the Screen Colors

There are a couple of ways to do this, depending on what you're trying to do. If you want to change the colors you're working with in MLM, say you wanted to change the Red and Green to Blue and Yellow, the easiest way is to change the values MLM holds in RAM, then call the routine that sets them into the I/O circuitry. The color list is at 4FC6, with the first color being color #3 (Green) and working backward to color #0 (Black). Load any values you like, then call subroutine M33 at address 25F2. This will take MLM through partial initialization, clearing the screen and putting up the opening message. Don't worry about your program getting messed up by this. The program area doesn't get touched by this operation.

That's one way. If you wanted to set the colors as part of your program, the following method works better. Somewhere in memory you'll have to put together a color list with color #3 being first. You can use MLM's area at 4FC6 if you are only going to use 4 colors.

From here you do a system call:

```
FF          DEFB SYSSUK
19          DEFB 19H          ;DO COLSET
C6 4F       DEFW COLIST       ;ADDRESS OF COLOR LIST
.  .        (The rest of your program)
.  .          .                  .
```

To get a better idea, take a look at the Standard Color Generator program in Chapter 7.

A third method is by changing the color ports directly. There are 8 color ports--4 for each side of the screen. With the color boundary set to the far right side, only the last 4 will affect what you see on the screen. Ports 4, 5, 6, and 7 change colors 0, 1, 2, and 3 respectively, on the left side of the boundary. That is, any pixel of value 00 will have color 0, value 01 will have color 1, value 10 will have color 2, and value 11 will have color 3. At this point, a small program that loads the A register with the color wanted and outputs it to the proper port is all that's needed.

Auto-Start Tapes

This feature was added to MLM to allow self-starting programs to be loaded from tape. It's similar in action to having RUN be the last statement on a Bally Basic tape.

The steps necessary to make this happen are:

1) Record your program on tape in the manner outlined in Chapter 3.

2) After the last byte of information is on tape, with the tape still recording, type in

   4FCA (ADDR)

   then the starting address of your program, least significant byte first. That is, if your program starts at 4E20, then you would type in (colon meaning ADDR):

   4FCA:20 4E

3) Type in the following (tape still recording):

```
4FAD:04
```

which sets the MLM operating mode to 4.

4) You can turn off your recorder now.

Now when you read in this tape, your program will start automatically.

Note:

It is important to turn off tape interrupts in the first part of your program so that they don't interfere with the way your program runs. The code for doing this is:

```
3E 08        LD A,08H        ;08 INTO A REGISTER
D3 0E        OUT (0EH),A     ;OUTPUT TO PORT 0E
```

The system will now ignore any interrupt requests from the tape port.

THE "CRITTER" PROGRAM

The following is a modified version of the "CRITTER" program of the Oct. 80 issue of CURSOR. Turn KN(1) to change the speed of the "critter".

```
4E40: F3            DI
      E5            PUSH HL
      21 4F 4E      LD HL,4E4FH      ;LOAD SCREEN INTERRUPT VECTOR
      22 B2 4F      LD (SCINT),HL    ;WITH ADDRESS OF ROUTINE
      CD 47 23      CALL CLEAR
      E1            POP HL
      FB            EI
      C9            RET

4E4F: F5            PUSH AF
      C5            PUSH BC
      D5            PUSH DE
      E5            PUSH HL
      DD E5         PUSH IX
      FD E5         PUSH IY
      DB 1C         IN A,(1CH)       ;GET KN(1) VALUE
      32 97 4E      LD (4E97H),A     ;PUT IN VECTOR BLOCK (TIME BASE)
      FF            DEFB SYSTEM      ;START INTERPRETER
      00            DEFB INTPC
      07 75 4E      MCALL (4E75H)    ;CALL VWRITE ROUTINE
      3F 95 4E 7C 4E  VECT           ;MOVE VECTOR
      07 75 4E      MCALL (4E75H)    ;CALL VWRITE
      02            DEFB EXIT        ;STOP INTERPRETER
      FD E1         POP IY           ;CLEAN UP AND GO HOME
      DD E1         POP IX
      E1            POP HL
      D1            POP DE
      C1            POP BC
      F1            POP AF
      FB            EI
4E73: C9            RET

4E75: 1F 95 4E 80 4E  VWRITE
      08

4E7C: 00 98         ;X BOUNDARIES
      00 50         ;Y BOUNDARIES
      00 00         ;PATTERN 0,0 POSITION
      02 08         ;2 BYTE WIDE, 8 LINE LONG PATTERN SIZE
      0A A0 22 88   ;PATTERN
      AA AA 2A A8
      08 20 20 08
      08 20 00 00
```

"Critter" program continued...

```
                ;VECTOR BLOCK:

4E95: 20        ;MAGIC REGISTER VALUE
      80        ;VECTOR STATUS
      00        ;TIME BASE
      05 00     ;DELTA X
      00 00     ;X POSITION
      03        ;X CHECKS MASK
      05 00     ;DELTA Y
      00 00     ;Y POSITION
4EA1: 03        ;Y CHECKS MASK
```

Standard Color Generator

This program generates 8 standard colors used in TV work.

```
4EAD: CD 47 23      CALL CLEAR        ;CLEAR SCREEN
      FF            DEFB SYSSUK       ;START INTERPRETER
      00            DEFB INTPC
      17            DO SETOUT
      B6                              ;BLANK LINE
      13                              ;R/L BOUNDS
      08                              ;INTERRUPT LINE
      19            DO COLSET
      EB 4E                           ;COLOR LIST AT 4EEB
      03            DEFB EXIT         ;STOP INTERPRETER
      01 6E 48      LD BC,486EH       ;WHITE BORDER
      3E 55         LD A,55H          ;COLOR #1
      11 14 06      LD DE, 0614H      ;POSITION
      FF            DEFB SYSTEM
      1C            DEFB RECTAN
      21 DA 4E      LD HL,4EDAH       ;TABLE ADDRESS
      16 09         LD D,09H          ;Y POSITION OF BARS
      06 08         LD B,08H          ;# OF BARS
4ECB: C5            PUSH B            ;SAVE IT
      7E            LD A,(HL)         ;GET COLOR FROM TABLE
      23            INC HL
      5E            LD E,(HL)         ;GET X POS'N
      23            INC HL
      01 0E 42      LD BC,420EH       ;BAR SIZE
      FF            DEFB SYSTEM
      1C            DEFB RECTAN
      C1            POP B             ;GET BACK COUNT
      10 F3         DJNZ 4ECBH        ;LOOP BACK
      C9            RET               ;ALL DONE

TABLE:
4EDA: 00 17         ;COLOR 00, AT X=17H
      55 24
      AA 33
      FF 3F
      00 4C
      55 57
      AA 64
      FF 71

COLOR LIST:
4EEB: AC            ;GREEN---┐
      86            ;YELLOW  ├-- LEFT COLORS
      07            ;WHITE   │
      00            ;BLACK---┘
      CD            ;CYAN----┐
      5A            ;RED     ├-- RIGHT COLORS
      2B            ;MAGENTA │
4EF2: F9            ;BLUE----┘
```

256 Color Program

This is a modified version of the program submitted by Jerry Burianyk in the Jan/Feb '81 issue of CURSOR. Turn KN(1) to change the number of displayed colors. To restore the screen, hit RESET, CALL, and four WRITES.

```
4EF5: F3           DI                ;
      F5           PUSH AF
      3E 4F        LD A,4FH          ;LOAD SCREEN INTERRUPT VECTOR
      ED 47        LD I,A            ;WITH 4F10H
      3E 10        LD A,10H
      D3 0D        OUT (0DH),A
      CD 47 23     CALL CLEAR        ;CLEAR SCREEN
      3E FF        LD A,0FFH         ;SET INTERRUPT LINE
      D3 0F        OUT (0FH),A       ;TO 256
      3E 12        LD A,12H          ;SET R/L BOUNDARY
      D3 09        OUT (09H),A       ;TO MIDDLE OF SCREEN
      F1           POP AF
      FB           EI
      C9           RET

4F10: 12 4F        ;ADDRESS OF ROUTINE

4F12: F3           DI
      F5           PUSH AF
      D5           PUSH DE
4F15: DB 1C        IN A,(1CH)        ;GET KN(1) VALUE
      D3 00        OUT (00),A        ;SEND TO COLOR
      D3 01        OUT (01),A        ;PORTS 0-3
      D3 02        OUT (02),A
      D3 03        OUT (03),A
      3D           DEC A             ;DECREMENT KN(1) VALUE
      20 F5        JR NZ,4F15H       ;COUNT KN(1) VALUE TO ZERO
      D1           POP DE            ;CLEAN UP, GO HOME
      F1           POP AF
      FB           EI
4F25: C9           RET
```

ASCII Character Set

This little routine will print the entire MLM 3x5 pixel character set.

```
4F30: CD 05 24      CALL CRLF       ;GO TO NEXT LINE
      06 3B         LD B,3BH        ;SET UP COUNTER
      3E 20         LD A,20H        ;FIRST CHARACTER
HERE: D7            DEFB DISP       ;PRINT IT
      3C            INC A           ;GET NEXT ONE
      10 FC         DJNZ HERE       ;LOOP BACK
4F3B: C9            RET             ;GO HOME
```

A word of explanation...

DJNZ uses the B register as a counter. Whatever is in B, when this instruction takes place, is decremented. If the result is not zero, the displacement after the '10' opcode is added to the P-counter. In this case it's 0FCH or -4 Decimal. Since the P-counter has moved on to the next full instruction at 4F3B, the displacement is added to this number to produce the address 4F37 which we have dubbed "HERE".

If the result of decrementing the B register is zero, no displacement is added to the P-counter and execution continues with the next instruction.

CHAPTER EIGHT

QUICK REFERENCE FOR MLM COMMANDS

In the following examples, # stands for a number, 0 to F. (KEY) means push indicated key.

(ADDR)

Sets Address Pointer to ####.

(WRITE)

Replaces byte at pointed address with ##, increments Address Pointer.

(READ)

Returns value of byte at pointed address, increments Address Pointer.

(INS)

Inserts ## at pointed address. Original contents of pointed address are moved to pointed address+1. Shifting continues until reaching address pointed to by End of File marker, END (address 4FC1H). END must be set prior to using INS.

(ADDR) (LIST)

Displays one line of data and ASCII interpretation of data starting at pointed address. Address Pointer is updated to next line.

(LIST)

Displays subsequent line. Address Pointer is updated.

####(1) (ADDR) ####(2) (LIST)

Displays data lines continuously starting at ####(1), continuing to ####(2).

(REG)

Makes run-time registers available for inspection and change. ## (WRITE) changes indicated registers. (READ) skips to next register pair. (LIST) cancels REG command and lists register and Address Pointer contents.

(CALL)

Transfers CPU control to program at ####. If program ends with 'C9', control returns to MLM.

(*)

Alters command for certain keys.

(*) (WRITE)

Opens tape output port. All new data displayed on TV screen is output to port. Repeating (*) (WRITE) cancels this mode.

(*) (READ)

Opens tape input port. Programs created with *WRITE command will load properly. (*) (*) cancels this mode.

(*) (INS)

Deletes character at pointed address. END must be set prior to use. Data at pointed address+1 is shifted into pointed address. This continues until data pointed to by END is reached.

(*) (LIST)

Opens printer output port. All data displayed on TV screen is output to port. Retyping (*) (LIST) cancels this mode.

(*) (REG)

Opens tape input port for display. Data on tape is displayed without disturbing memory. (*) (*) cancels this mode.

[RESET]

Halts routine in progress. Resets interrupt vectors. Places address of Screen Specification program into Input Register for subsequent CALL command.

Error Messages

WARNING

Indicates next INS will force data into the MLM variable area.

ERR

Indicates the above situation has taken place.

CHAPTER NINE

USEFUL MEMORY LOCATIONS

LOCATIONS

4FAD	MODE BYTE
4FB0	LIGHT PEN INTERRUPT VECTOR
4FB2	SCREEN INTERRUPT VECTOR
4FB4	INPUT REGISTER
4FB6	ADDRESS POINTER
4FC1	END OF FILE MARKER
4FC3	Y-X COORDINATES FOR DISPLAY OUTPUT
4FC5	DISPLAY OPTIONS BYTE
4FC6	COLOR LIST
4FCA	ENTRY ADDRESS FOR MODE 4

SUBROUTINES

ADDRESS	NAME	DESCRIPTION
2347	CLEAR	CLEAR SCREEN ROUTINE
2409	CRLF	OUTPUT CARRIAGE RETURN, LINE FEED
23C3	GREEN	PRINT IN GREEN
23CB	RED	PRINT IN RED
23D0	NORM	PRINT IN NORMAL COLOR
2455	ERR	PRINT ERROR MESSAGE
2451	SPACE	PRINT A SPACE
246F	HLIST	DISPLAY CONTENTS OF HL
24C5	ININT	INITIALIZE INTERRUPTS
2496	KEYGET	GET KEYPAD ENTRY
245E	RGDIS	DISPLAY CONTENTS OF A
23DE	SCROLL	SCROLL TEXT SCREEN

SINGLE BYTE CALLS

D7	DISP	DISPLAY CHARACTER IN A
DF	STRING	PRINT STRING LOCATED AT FOLLOWING ADDRESS
CF	BREAKPOINT	ENTER BREAKPOINT ROUTINE

APPENDIX A:

Machine Language Manager

Source Listing

```
ADDR  CODE      STMT SOURCE STATEMENT

                0001 ************************************************************
                0002 *                                                          *
                0003 *            BALLY ARCADE UTILITY PACKAGE                  *
                0004 *                        OR                                *
                0005 *  "HOW TO GET STUFF IN AND OUT IN MACHINE LANGUAGE"       *
                0006 *                                                          *
                0007 * (C) 1981 ANDY GUEVARA                  JULY 29, 1981 *
                0008 ************************************************************
                0009 ;
                0010 ;
                0011 ;
 >0013          0012 SKYD     EQU     0013H
 >00D7          0013 DISP     EQU     0D7H      ;RST 10
 >00DF          0014 STRING   EQU     0DFH      ;RST 18
 >00FF          0015 SYSSUK   EQU     0FFH
 >00FF          0016 SYSTEM   EQU     0FFH
 >4F50          0017 UPRAM    EQU     4F50H     ;BEGINNING OF U.P. RAM
                0018                            ;ROOM FOR STACK
                0019 ;
 >4FAC          0020          ORG     4FACH
'4FAC  00       0021 UPSTK    DEFB    0         ;U.P.STACK-GROWS DOWNWARD
'4FAD  00       0022 MODE     DEFB    0         ;MODE REGISTER
'4FAE  00       0023 IOB      DEFB    0         ;I/O INFORMATION BYTE
'4FAF  00       0024 KEYN     DEFB    0         ;KEY INPUT NUMBER
'4FB0  0000     0025 LPINT    DEFW    0         ;LIGHT PEN INTERRUPT VECTOR
'4FB2  0000     0026 SCINT    DEFW    0         ;SCREEN INTERRUPT VECTOR
'4FB4  00       0027 IN1      DEFB    0         ;INPUT REGISTERS
'4FB5  00       0028 IN2      DEFB    0
'4FB6  00       0029 ADRG1    DEFB    0         ;ADDRESS REGISTERS
'4FB7  00       0030 ADRG2    DEFB    0
'4FB8  0000     0031 SCRN     DEFW    0         ;SCREEN SIZE-BYTES
'4FBA  00       0032 SCRLN    DEFB    0         ;SCRATCH AT THIS LINE AND BELOW
'4FBB  00       0033 HRZCB    DEFB    0         ;HORIZONTAL COLOR BOUNDARY
'4FBC  00       0034 LFLG     DEFB    0         ;LIST FLAG
'4FBD  00       0035 RFG      DEFB    0         ;REGISTER FLAG
'4FBE  0000     0036 PWRUP    DEFW    0         ;POWER UP SIGNATURE
'4FC0  00       0037 PW2      DEFB    0         ;3RD BYTE
'4FC1  0000     0038 END      DEFW    0         ;END OF FILE MARKER
'4FC3  0000     0039 COORD    DEFW    0         ;XY COORDS FOR SCREEN
                0040                            ;D IS Y COORDINATE
'4FC5  00       0041 POPT     DEFB    0         ;PRINT OPTIONS BYTE
'4FC6  00       0042 COLORS   DEFB    0         ;COLOR 3
'4FC7  00       0043 C2       DEFB    0         ;COLOR 2
'4FC8  00       0044 FCOL     DEFB    0         ;FOREGROUND COLOR (1)
'4FC9  00       0045 BCOL     DEFB    0         ;BACKGROUND COLOR (0)
'4FCA  0000     0046 M4BA     DEFW    0         ;ENTRY ADDRESS FOR MODE 4
 >2000          0047          ORG     2000H
'2000  C31020'  0048 START    JP      INIT
 >2003          0049          DEFS    03        ;EMPTY SPACE
'2006  17       0050          DEFB    23        ;BUP REVISION LEVEL 2.3
'2007  C36E25'  0051 BPE      JP      BRKPT     ;BREAKPOINT ENTRY
'200A  C35923'  0052 DEP      JP      DISPLAY   ;DISPLAY ENTRY POINT
'200D  C3B523'  0053 SEP      JP      STRDIS    ;STRING DISPLAY
'2010  F3       0054 INIT     DI      ;DISABLE INTERUPTS
'2011  31AC4F'  0055          LD      SP,UPSTK  ;RESET STACK
'2014  2ABE4F'  0056          LD      HL,(PWRUP)  ;CHECK IF BEEN AWAKE
'2017  1100AA   0057          LD      DE,0AA00H  ;SIGNATURE VALUE
'201A  B7       0058          OR      A         ;CLEAR CARRY
```

```
 ADDR  CODE      STMT SOURCE STATEMENT

'201B  ED52      0059         SBC     HL,DE
'201D  2007      0060         JR      NZ,STSPC  ;BEEN ASLEEP, SET VALUES
               0061 ;OK SO FAR
'201F  3AC04F'   0062         LD      A,(PW2) ;3RD BYTE
'2022  FEFA      0063         CP      0FAH
'2024  2828      0064         JR      Z,CONT  ;JUMP IF OK
'2026  FF        0065 STSPC   DEFB    SYSSUK  ;ASLEEP, SET DEFAULT SPECS
'2027  00        0066         DEFB    00H     ;START INTERPRETER
'2028  1B        0067         DEFB    1BH     ;DO FILL
'2029  AD4F'     0068         DEFW    MODE    ;SYSTEM RAM START
'202B  2300      0069         DEFW    23H     ;HOW MANY
'202D  00        0070         DEFB    00H     ;WITH WHAT
'202E  17        0071         DEFB    17H     ;DO SETOUT
'202F  B4        0072         DEFB    90.SHL.1  ;BLANK LINE 90 DECIM. AND BELO
               0073                         ;THIS ALLOWS 360 BYTES OF RAM
'2030  2C        0074         DEFB    2CH     ;44 DECIMAL--MOVE R/L BOUNDARY
               0075                         ;TO FAR RIGHT
'2031  08        0076         DEFB    8H      ;INTERRUPT MODE 8
'2032  5F        0077         DEFB    5FH     ;MOVE BYTES
'2033  C64F'     0078         DEFW    COLORS  ;TO WHERE
'2035  0400      0079         DEFW    04H     ;HOW MANY
'2037  B926'     0080         DEFW    COLIST  ;FROM WHERE
'2039  19        0081         DEFB    19H     ;COLSET--SET COLORS
'203A  C64F'     0082         DEFW    COLORS  ;ADDR OF COLOR LIST
'203C  03        0083         DEFB    03H     ;EXIT INTERPRETER
'203D  21100E    0084         LD      HL,0E10H  ;DEFAULT VALUE OF SCREEN SIZE
'2040  22B84F'   0085         LD      (SCRN),HL
'2043  3E5A      0086         LD      A,90    ;90 DEC.
'2045  32BA4F'   0087         LD      (SCRLN),A  ;VERT BLANK LINE
'2048  CD4723'   0088         CALL    CLEAR   ;WIPE SCREEN CLEAN
'204B  CD7824'   0089         CALL    READY
'204E  FF        0090 CONT    DEFB    SYSSUK
'204F  15        0091         DEFB    15H     ;DO EMUSIC--STOP MUSIC
'2050  CDC524'   0092         CALL    ININT   ;SET UP INTERRUPTS
'2053  2100AA    0093         LD      HL,0AA00H  ;WRITE POWER UP SIGNATURE
'2056  22BE4F'   0094         LD      (PWRUP),HL
'2059  3EFA      0095         LD      A,0FAH
'205B  32C04F'   0096         LD      (PW2),A
'205E  218225'   0097         LD      HL,SCRSP  ;SET UP CALL TO
'2061  22B44F'   0098         LD      (IN1),HL  ;SCREEN SPEC PROGRAM
'2064  CD1921'   0099         CALL    INAD    ;KEEPS LIST FROM RUNNING AWAY
'2067  AF        0100         XOR     A       ;CLEAR FLAGS AND MODE
'2068  32AE4F'   0101         LD      (IOB),A ;CLEAR I/O BYTE
'206B  32AD4F'   0102         LD      (MODE),A
'206E  32C54F'   0103         LD      (POPT),A
'2071  32BC4F'   0104         LD      (LFLG),A
'2074  32BD4F'   0105         LD      (RFG),A
'2077  CD0524'   0106         CALL    CRLF
'207A  DF        0107         DEFB    STRING
'207B  B626'     0108         DEFW    OKM     ;SYSTEM PROMPT
               0109 ;
'207D  217D20'   0110 MAIN    LD      HL,MAIN  ; MAIN LOOP
'2080  E5        0111         PUSH    HL      ;THIS CAUSES RETURNS FROM
               0112                         ;MAIN ROUTINES TO RETURN HERE
'2081  CD9624'   0113         CALL    KEYGET  ;RETURNS WITH KEY NO. IN A
               0114                         ;USED AS A
               0115 ;                       ;DISPLACEMENT IN JUMP TABLE
'2084  FF        0116         DEFB    SYSSUK  ;INTERPRETER CALL
```

```
 ADDR  CODE      STMT SOURCE STATEMENT

'20??  5D        0117          DEFB    5DH       ;INDEXB--BYTE TABLE LOOKUP
'2?    9720'     0118          DEFW    TTT-1     ;RETURNS WITH KEY TYPE IN
                 0119                            ; HI NIBBLE
                 0120                            ;TRANSLATION IN LOW NIBBLE
                 0121                            ;TYPE=0 MEANS NUMBER,
                 0122                            ;=1 MEANS COMMAND
                 0123 ;NOTE: THE -1 IS FOR THE ZERO ENTRY THAT DOESN'T EXIST
'2088  E60F      0124          AND     0FH       ;ISOLATE TRANSLATION
'208A  4F        0125          LD      C,A       ;COPY DIGIT TO C
'208B  AE        0126          XOR     (HL)      ;PICK OUT TYPE
'208C  CAF220'   0127          JP      Z,NUMBER   ;IF TYPE 0, SKIP AHEAD
'208F  3AAD4F'   0128          LD      A,(MODE)   ;IF NOT THEN MUST BE TYPE 1
                 0129                            ;FIND MODE
'2092  FF        0130          DEFB    SYSSUK
'2093  5B        0131          DEFB    5BH       ;INDEXW--WORD TABLE LOOKUP
'2094  B020'     0132          DEFW    MDTBL     ;MODE TABLE
'2096  D5        0133          PUSH    DE
'2097  C9        0134          RET               ;SNEAKY WAY TO JUMP TO COMMAND
                 0135 ;
                 0136 ;
                 0137 ********TYPE-TRANSLATE TABLE**************************
                 0138 ;
'2098  0D        0139 TTT      DEFB    0DH       ; 1  D
'2099  0E        0140          DEFB    0EH       ; 2  E
'209A  0F        0141          DEFB    0FH       ; 3  F
'20?9  12        0142          DEFB    12H       ; 4 CALL
'2?    0A        0143          DEFB    0AH       ; 5  A
'209D  0B        0144          DEFB    0BH       ; 6  B
'209E  0C        0145          DEFB    0CH       ; 7  C
'209F  15        0146          DEFB    15H       ; 8 REG (*TAPE DISPLAY)
'20A0  07        0147          DEFB    07H       ; 9  7
'20A1  08        0148          DEFB    08H       ; 10  8
'20A2  09        0149          DEFB    09H       ; 11  9
'20A3  13        0150          DEFB    13H       ; 12 LIST (*PRINT)
'20A4  04        0151          DEFB    04H       ; 13  4
'20A5  05        0152          DEFB    05H       ; 14  5
'20A6  06        0153          DEFB    06H       ; 15  6
'20A7  17        0154          DEFB    17H       ; 16 INS (*DELETE)
'20A8  01        0155          DEFB    01H       ; 17  1
'20A9  02        0156          DEFB    02H       ; 18  2
'20AA  03        0157          DEFB    03H       ; 19  3
'20AB  11        0158          DEFB    11H       ; 20 READ (*TAPE INPUT)
'20AC  16        0159          DEFB    16H       ; 21  *
'20AD  00        0160          DEFB    00H       ; 22  0
'20AE  14        0161          DEFB    14H       ; 23 WRITE (*TAPE OUTPUT)
'20AF  10        0162          DEFB    10H       ; 24 ADDR
                 0163 ;
                 0164 ;
                 0165 *********MODE JUMP TABLE****************
'20B0  0021'     0166 MDTBL    DEFW    MODE0     ;NORMAL COMMANDS
'20??  0721'     0167          DEFW    MODE1     ;REGISTER COMMANDS
'2     BB22'     0168          DEFW    MODE2     ;STAR (2ND SET) COMMANDS
'20B6  9725'     0169          DEFW    MODE3     ;SCREEN SPECIFICATIONS
'20B8  4323'     0170          DEFW    MODE4     ;EXTERNAL (USER) COMMANDS
                 0171 ;
                 0172 ;
                 0173 **********JUMP TABLE FOR MODE 0************************
                 0174 ;
```

```
 ADDR   CODE      STMT SOURCE STATEMENT

                  0175 ;                  ROUTINE KEY VAL.
'20BA   0E21'     0176 M0JT     DEFW      ADDR      ; 0, ADDRESS
'20BC   2421'     0177          DEFW      READ      ; 1, READ AND INCREMENT
'20BE   8F21'     0178          DEFW      ACALL     ; 2, CALL
'20C0   AC21'     0179          DEFW      LIST      ; 3, LIST
'20C2   3321'     0180          DEFW      WRITE     ; 4, WRITE TO MEMORY
'20C4   0622'     0181          DEFW      REG       ; 5, LOAD REGISTERS
'20C6   9D21'     0182          DEFW      STAR0     ; 6, SET OPTIONS FLAG
'20C8   4221'     0183          DEFW      INS       ; 7, INSERT IN MEMORY
                  0184 ;
                  0185 ************MODE 1 JUMP TABLE*****************************
                  0186 ;
                  0187 ;                  ROUTINE KEY VAL.
'20CA   0D21'     0188 M1JT     DEFW      M1RT      ; 0, IGNORE 'ADDR' KEYPUSH
'20CC   5122'     0189          DEFW      RPLUS     ; 1, SKIP TO NEXT REGISTER
'20CE   0D21'     0190          DEFW      M1RT      ; 2, IGNORE 'CALL'
'20D0   7322'     0191          DEFW      RLIST     ; 3, LIST REGISTERS
'20D2   1B22'     0192          DEFW      RWRT      ; 4, CHANGE REGISTER CONTENTS
'20D4   0D21'     0193          DEFW      M1RT      ; 5, IGNORE 2ND 'REG'
'20D6   0D21'     0194          DEFW      M1RT      ; 6, IGNORE '*'
'20D8   0D21'     0195          DEFW      M1RT      ; 7, IGNORE 'INS'
                  0196 ;
                  0197 ***********MODE 2 JUMP TABLE****************
                  0198 ;
'20DA   0E21'     0199 M2JT     DEFW      ADDR      ;0
'20DC   C222'     0200          DEFW      TAPIN     ;1
'20DE   8F21'     0201          DEFW      ACALL     ;2
'20E0   F822'     0202          DEFW      PRINT     ;3
'20E2   DD22'     0203          DEFW      TAPOUT    ;4
'20E4   D222'     0204          DEFW      TADIS     ;5
'20E6   1323'     0205          DEFW      STAR2     ;6
'20E8   2523'     0206          DEFW      DEL       ;7
                  0207 ;
                  0208 ;
                  0209 ;
                  0210 ********MODE 3 JUMP TABLE****************
'20EA   A725'     0211 M3JT     DEFW      M30
'20EC   CA25'     0212          DEFW      M31
'20EE   DE25'     0213          DEFW      M32
'20F0   F225'     0214          DEFW      M33
                  0215 ;
                  0216 ;  NUMBER INPUT
                  0217 ;
'20F2   21B44F'   0218 NUMBER   LD        HL,IN1    ;SET UP IN1
'20F5   79        0219          LD        A,C       ;DIGIT IN LO HALF OF C
'20F6   ED6F      0220          RLD
                  0221 ;RLD: A 4-BIT SHIFT AS FOLLOWS--
                  0222 ;LOW A -> LOW IN1, LOW IN1 -> HI IN1, HI IN1 -> LOW A
                  0223 ;THE EFFECT IS TO SHIFT INDIVIDUAL HEX DIGITS INTO IN1.
                  0224 ;ONLY THE LAST 4 ARE REMEMBERED IN IN1 & IN2.
                  0225 ;
'20F8   23        0226          INC       HL        ;BINK POINTER (TO IN2)
'20F9   ED6F      0227          RLD                 ;DO IT AGAIN
'20FB   79        0228          LD        A,C       ;RELOAD A WITH DIGIT
'20FC   CDD423'   0229          CALL      NUMDIS    ;DISPLAY IT
'20FF   C9        0230          RET                 ;AND GO HOME
                  0231 ;
                  0232 ;
```

```
 ADDR  CODE      STMT SOURCE STATEMENT

'2100  79        0233 MODE0   LD      A,C       ;MODE 0,GET DISPLACEMENT
'2     FF        0234         DEFB    SYSSUK
'2102  5B        0235         DEFB    5BH       ;INDEXW--WORD TABLE LOOKUP
'2103  BA20'     0236         DEFW    M0JT      ;JUMP TABLE ADDRESS
'2105  D5        0237         PUSH    DE
'2106  C9        0238         RET               ;JUMP TO COMMAND
                 0239 ;
'2107  79        0240 MODE1   LD      A,C       ;PUT DISPLACEMENT IN A
'2108  FF        0241         DEFB    SYSSUK    ;REG OPERATIONS
'2109  5B        0242         DEFB    5BH       ;INDEXW
'210A  CA20'     0243         DEFW    M1JT      ;JUMP TABLE ADDRESS
'210C  D5        0244         PUSH    DE        ;JUMP TO PROCESS
'210D  C9        0245 M1RT    RET
                 0246 ;
                 0247 ;
                 0248 ;ADDRESS ROUTINE
                 0249 ;
'210E  CD1921'   0250 ADDR    CALL    INAD      ;MOVE DATA FROM INPUT TO ADDR REG
'2111  3E3A      0251         LD      A,':'     ;COLON TO A
'2113  D7        0252         DEFB    DISP
'2114  AF        0253         XOR     A         ;CLEAR LIST FLAG
'2115  32BC4F'   0254         LD      (LFLG),A
'2118  C9        0255         RET               ;AND GO HOME
                 0256 ;
'2119  11B64F'   0257 INAD    LD      DE,ADRG1  ;MOVE ADRESS TO ADRG1
'211C  21B44F'   0258         LD      HL,IN1    ;FROM INPUT REGISTER 1
'2     EDA0      0259         LDI               ;SINGLE INSTRUCTION MOVE
'21?1  EDA0      0260         LDI               ;BETWEEN MEMORY LOCATIONS
                 0261                           ;IT'S DONE TWICE BECAUSE TWO BYTES
                 0262                           ;OF INFO ARE BEING MOVED
'2123  C9        0263         RET
                 0264 ;
'2124  2AB64F'   0265 READ    LD      HL,(ADRG1)  ;LOAD ADDRESS
'2127  7E        0266         LD      A,(HL)    ;LOAD CONTENTS TO A
'2128  23        0267         INC     HL        ;INCREMENT CONTENTS
'2129  22B64F'   0268         LD      (ADRG1),HL  ;STORE BACK
'212C  CD5E24'   0269         CALL    RGDIS     ;DISPLAY WHAT'S IN A
'212F  CD5124'   0270         CALL    SPACE
'2132  C9        0271         RET
                 0272 ;
                 0273 ;WRITE TO MEMORY
                 0274 ;
'2133  2AB64F'   0275 WRITE   LD      HL,(ADRG1)  ;PICK UP ADDRESS
'2136  3AB44F'   0276         LD      A,(IN1)   ;PICK UP INPUT BYTE
'2139  77        0277         LD      (HL),A    ;STORE IT
'213A  23        0278         INC     HL        ;BINK ADDRESS
'213B  22B64F'   0279         LD      (ADRG1),HL  ;STORE IT BACK
'213E  CD5124'   0280         CALL    SPACE     ;OUTPUT A SPACE
'2141  C9        0281         RET               ;GO HOME
                 0282 ;
                 0283 ;INSERT INTO MEMORY
                 0284 ;
                 0285 ;THIS ROUTINE MAKES USE OF AN END OF FILE MARKER (END)
                 0286 ;THAT SHOULD POINT TO THE LAST BYTE IN A PROGRAM +1.
                 0287 ;THE ROUTINE TESTS FOR ATTEMPTS TO WRITE INTO THE
                 0288 ;STACK, AND MAKES ALLOWANCES FOR ADDED MEMORY.
                 0289 ;IF 'END' IS LESS THAN THE PRESENT ADDRESS REGISTER
                 0290 ;CONTENTS, THE ROUTINE WILL UPDATE IT TO (ADRG1)+1.
```

```
 ADDR  CODE       STMT SOURCE STATEMENT

                  0291 ;
'2142  2AC14F'    0292 INS     LD       HL,(END)   ;GET ADDRESS
'2145  11504F     0293         LD       DE,UPRAM   ;TEST IF PUSHING SYSTEM RAM
'2148  B7         0294         OR       A          ;CLEAR CARRY FLAG FOR SBC
'2149  ED52       0295         SBC      HL,DE
'214B  381B       0296         JR       C,INS2     ;ADDRESS IS LESS THAN UPRAM
'214D  200B       0297         JR       NZ,INS1    ;ADDRESS IS GREATER
'214F  CDCB23'    0298         CALL     RED        ;IF THE SAME ISSUE WARNING
'2152  DF         0299         DEFB     STRING
'2153  5926'      0300         DEFW     WAM
'2155  CDD023'    0301         CALL     NORM       ;BACK TO NORMAL PRINT
'2158  180E       0302         JR       INS2       ;AND GO ON
'215A  11FF4F     0303 INS1    LD       DE,4FFFH   ;SEE IF INTO ADDED MEMORY
'215D  2AB64F'    0304         LD       HL,(ADRG1)
'2160  ED52       0305         SBC      HL,DE
'2162  3004       0306         JR       NC,INS2    ;OK IF POSITIVE
'2164  CD5524'    0307         CALL     ERR        ;OTHERWISE OOPS
'2167  C9         0308         RET
                  0309 ;
'2168  2AC14F'    0310 INS2    LD       HL,(END)   ;GET THE END OF FILE
'216B  ED5BB64F'  0311         LD       DE,(ADRG1) ;SEE IF END>ADRG1
'216F  B7         0312         OR       A          ;CLEAR CARRY
'2170  ED52       0313         SBC      HL,DE      ;(HL)-(DE)
'2172  44         0314         LD       B,H
'2173  4D         0315         LD       C,L        ;MOVE RESULT TO BC (COUNTER)
'2174  3008       0316         JR       NC,INS3    ;ALL SET
'2176  EB         0317         EX       DE,HL      ;HL=(ADRG1)
'2177  23         0318         INC      HL         ;OTHERWISE END=ADRG+1
'2178  22C14F'    0319         LD       (END),HL
'217B  010100     0320         LD       BC,01H     ;SET COUNT TO 1
'217E  ED5BC14F'  0321 INS3    LD       DE,(END)
'2182  D5         0322         PUSH     DE
'2183  E1         0323         POP      HL
'2184  2B         0324         DEC      HL         ;HL=END-1
'2185  EDB8       0325         LDDR                ;COPY FROM (HL) TO (DE),
                  0326                             ;(BC) TIMES
                  0327                             ;AND DECREMENT EACH TIME.
'2187  CD3321'    0328         CALL     WRITE      ;STUFF THE INFO
'218A  21C14F'    0329         LD       HL,END     ;INC. END
'218D  34         0330         INC      (HL)
'218E  C9         0331         RET                 ;AND GO HOME
                  0332 ;
                  0333 ;
                  0334 ;EXECUTE A PROGRAM
                  0335 ;NOTE: CALL AND TAPE INPUT ARE INCOMPATIBLE FOR USE
                  0336 ;AT THE SAME TIME BECAUSE BOTH USE ALTERNATE REGISTER
                  0337 ;SET.
                  0338 ;
'218F  219A21'    0339 ACALL   LD       HL,CART    ;SET UP RETURN PROCESS
'2192  E5         0340         PUSH     HL         ;ON STACK
'2193  2AB44F'    0341         LD       HL,(IN1)   ;GET ADDRESS OF PROGRAM
'2196  E5         0342         PUSH     HL
'2197  08         0343         EX       AF,AF'     ;EXCHANGE 'A' REGISTER
                  0344                             ;FOR ITS ALTERNATE 'A' REGISTER
'2198  D9         0345         EXX                 ;EXCHANGE THE REST OF
                  0346                             ;THE REGS FOR THEIR ALTERNATES
'2199  C9         0347         RET                 ;POP THE ADDRESS OFF THE STACK
                  0348                             ;AND JUMP TO THE PROGRAM
```

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 ADDR  CODE       STMT SOURCE STATEMENT

                  0349 ;
                  0350 ;
'219A  08         0351 CART    EX       AF,AF'   ;CALL RETURN PROCESS
'219B  D9         0352          EXX               ;GET BACK ORIG. SET
'219C  C9         0353          RET               ;ALL DONE, GO HOME
                  0354 ;
                  0355 ;SET UP FOR MODE 2
                  0356 ;
'219D  3E02       0357 STARO   LD       A,02H
'219F  32AD4F'    0358          LD       (MODE),A  ;SET MODE 2
'21A2  CDCB23'    0359          CALL     RED
'21A5  3E2A       0360          LD       A,'*'
'21A7  D7         0361          DEFB     DISP      ;TELL OPERATOR
'21A8  CDD023'    0362          CALL     NORM
'21AB  C9         0363          RET
                  0364 ;
                  0365 ;
                  0366 ;LIST ROUTINE
                  0367 ;
                  0368 ;LFLAG INDICATES BEING IN THE MIDDLE OF SUCCESSIVE SINGLE
                  0369 ;LIST OPERATIONS. IT'S CLEARED BY THE ADDRESS KEY.
                  0370 ;
'21AC  3ABC4F'    0371 LIST    LD       A,(LFLG)  ;TEST THE FLAG
'21AF  A7         0372          AND      A
'21B0  201D       0373          JR       NZ,OUTLN  ;IF SET, DO A LINE AND GO HOME
                  0374 ;
'2      3E0D      0375          LD       A,0DH     ;OTHERWISE END THIS LINE
'21B4  D7         0376          DEFB     DISP
'21B5  ED5BB44F'  0377          LD       DE,(IN1)  ;CHECK IF END ADDR WAS INPUT
'21B9  2AB64F'    0378          LD       HL,(ADRG1)
'21BC  ED52       0379          SBC      HL,DE
'21BE  280F       0380          JR       Z,OUTLN   ;IF SAME, DO A LINE AND GO HOME
                  0381 ;
                  0382 ;MULTI-LINE LIST
                  0383 ;
'21C0  CDCF21'    0384 MLIST   CALL     OUTLN     ;EA WAS INPUT, DO A LINE AND
                  0385                            ;COME BACK.
                  0386 ;
'21C3  2AB44F'    0387          LD       HL,(IN1)  ;ENDING ADDRESS
'21C6  ED5BB64F'  0388          LD       DE,(ADRG1)  ;NEW BEGINNING ADDRESS
'21CA  ED52       0389          SBC      HL,DE     ;SUBTRACT BA FROM EA
'21CC  30F2       0390          JR       NC,MLIST  ;IF POS, DO ANOTHER LINE
'21CE  C9         0391          RET               ;ELSE, GO BACK
                  0392 ;
                  0393 ;OUTPUT A LINE
                  0394 ;
'21CF  3EFF       0395 OUTLN   LD       A,0FFH    ;SET FLAG
'21D1  32BC4F'    0396          LD       (LFLG),A
'21D4  2AB64F'    0397          LD       HL,(ADRG1)  ;PICK UP BEG. ADDR.
'21D7  CD6F24'    0398          CALL     HLIST     ;DISPLAY 1ST BYTE ADDRESS
'21DA  3E3A       0399          LD       A,':'
'2      D7        0400          DEFB     DISP
'21DD  CD5124'    0401          CALL     SPACE
'21E0  CD2421'    0402 OL1     CALL     READ      ;GET AND DISPLAY DATA
'21E3  7D         0403          LD       A,L       ;CHECK FOR END OF LINE
'21E4  E607       0404          AND      07H       ;BIT MASK
                  0405                            ;IF 00 OR 08H,
                  0406                            ; THE LAST 3 BITS ARE ZERO
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 ADDR  CODE      STMT SOURCE STATEMENT

'21E6  20F8      0407          JR      NZ,OL1   ;IF NOT, GO BACK
                 0408 ;END OF LINE
'21E8  3AAE4F'   0409          LD      A,(IOB) ;CHECK IF TAPE OUT
'21EB  CB47      0410          BIT     0,A     ;TURNED ON
'21ED  2802      0411          JR      Z,LASC  ;IF NOT, DO ASCII PART
'21EF  1811      0412          JR      LA3     ;AND EXIT
                 0413 ;
                 0414 ;LIST ASCII INTERPRETATION
                 0415 ;
'21F1  010800    0416 LASC     LD      BC,08H  ;BACK UP POINTER 8 BYTES
'21F4  ED42      0417          SBC     HL,BC
'21F6  41        0418          LD      B,C     ;B=8 AS A COUNTER
'21F7  7E        0419 LA1      LD      A,(HL)  ;DISPLAY ASCII INTERPRETATION
'21F8  FE0D      0420          CP      0DH     ;DON'T DISPLAY A CR
'21FA  2002      0421          JR      NZ,LA2
'21FC  3E2E      0422          LD      A,'.'   ;DO A DOT INSTEAD
'21FE  D7        0423 LA2      DEFB    DISP
'21FF  23        0424          INC     HL      ;INC. POINTER
'2200  10F5      0425          DJNZ    LA1     ;DECR. COUNT & LOOP
'2202  3E0D      0426 LA3      LD      A,0DH   ;CARRIAGE RETURN
'2204  D7        0427          DEFB    DISP
'2205  C9        0428          RET             ;GO HOME
                 0429 ;
                 0430 ;LOAD REGISTERS
                 0431 ;
'2206  3E01      0432 REG      LD      A,01H
'2208  32AD4F'   0433          LD      (MODE),A  ;SET MODE TO 1
'220B  DF        0434          DEFB    STRING
'220C  2826'     0435          DEFW    AFM     ;PUT OUT MESSAGE
'220E  AF        0436          XOR     A
'220F  32BD4F'   0437          LD      (RFG),A ;TABLE INITIALIZATION
'2212  C9        0438          RET
                 0439 ;
                 0440 ;
                 0441 **********REGISTER TABLE********
                 0442 ;                   ADDR     RFG
'2213  2422'     0443 RGTBL    DEFW    AFG     ; 0
'2215  2C22'     0444          DEFW    BCG     ; 1
'2217  3822'     0445          DEFW    DEG     ; 2
'2219  4422'     0446          DEFW    HLG     ; 3
                 0447 ;
                 0448 ;RFG OFFSET DETERMINES WHICH REGS TO PULL
                 0449 ;
                 0450 ;REGISTER WRITE ROUTINE
                 0451 ;
'221B  3ABD4F'   0452 RWRT     LD      A,(RFG)
'221E  FF        0453          DEFB    SYSSUK
'221F  5B        0454          DEFB    5BH     ;INDEXW--WORD TABLE LOOKUP
'2220  1322'     0455          DEFW    RGTBL   ;GET JUMP ADDRESS
'2222  D5        0456          PUSH    DE      ;SET UP JUMP
'2223  C9        0457          RET             ;POP, JUMP
'2224  3AB44F'   0458 AFG      LD      A,(IN1) ;LOAD NEW VALUE
'2227  08        0459          EX      AF,AF'  ;PUT IN ALTERNATE A
'2228  CD5122'   0460          CALL    RPLUS   ;OUTPUT DESIGNATOR AND UPDATE RP
'222B  C9        0461          RET
'222C  ED4BB44F' 0462 BCG      LD      BC,(IN1)  ;GET NEW VALUES
'2230  C5        0463          PUSH    BC
'2231  D9        0464          EXX             ;EXCHANGE REGISTER SETS
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ADDR  CODE       STMT SOURCE STATEMENT

2?  ?  C1        0465          POP     BC        ;PUT IN NEW VALUES
2.  ,  D9        0466          EXX               ;SWAP BACK
2234   CD5122'   0467          CALL    RPLUS
2237   C9        0468          RET
2238   ED5BB44F' 0469 DEG      LD      DE,(IN1)
223C   D5        0470          PUSH    DE
223D   D9        0471          EXX
223E   D1        0472          POP     DE
223F   D9        0473          EXX
2240   CD5122'   0474          CALL    RPLUS
2243   C9        0475          RET
2244   2AB44F'   0476 HLG      LD      HL,(IN1)
2247   E5        0477          PUSH    HL
2248   D9        0478          EXX
2249   E1        0479          POP     HL
224A   D9        0480          EXX
224B   AF        0481          XOR     A         ;CLEAR A
224C   32BD4F'   0482          LD      (RFG),A   ;CLEAR FLAG
224F   1822      0483          JR      RLIST     ;LIST THE REG SET
               0484 ;
2251   3ABD4F'   0485 RPLUS    LD      A,(RFG)
2254   FE03      0486          CP      03H       ;DONE YET?
2256   280C      0487          JR      Z,RP1     ;SKIP AHEAD IF SO
2258   3C        0488          INC     A
2259   32BD4F'   0489          LD      (RFG),A
2?  ?  FF        0490          DEFB    SYSSUK
2.     5B        0491          DEFB    5BH       ;INDEXW, GET MESSAGE ADDR
225E   6B22'     0492          DEFW    RMTBL     ;REGISTER MSG TABLE
2260   CDBB23'   0493          CALL    STR1      ;PUT OUT MESSAGE
2263   C9        0494          RET
2264   AF        0495 RP1      XOR     A
2265   32BD4F'   0496          LD      (RFG),A   ;CLEAR FLAG
2268   C38022'   0497          JP      MODO      ;GO HOME
               0498 ;
               0499 ;
226B   2826'     0500 RMTBL    DEFW    AFM       ;0
226D   2B26'     0501          DEFW    BCM       ;1
226F   3026'     0502          DEFW    DEM       ;2
2271   3526'     0503          DEFW    HLM       ;3
               0504 ;
               0505 ;OUTPUT REGISTER CONTENTS
               0506 ;
2273   AF        0507 RLIST    XOR     A
2274   32BD4F'   0508          LD      (RFG),A   ;CLR FLAG
2277   CD0524'   0509          CALL    CRLF
227A   DF        0510          DEFB    STRING
227B   2826'     0511          DEFW    AFM       ;OUTPUT DESIGNATOR
227D   08        0512          EX      AF,AF'    ;GET REG CONTENTS
227E   F5        0513          PUSH    AF
227F   08        0514          EX      AF,AF'
2?  ?  F1        0515          POP     AF
2.     CD5E24'   0516          CALL    RGDIS
2284   CD5122'   0517          CALL    RPLUS     ;DESIGNATOR & RFG UPDATE
2287   D9        0518          EXX               ;ALTERNATE SET
2288   C5        0519          PUSH    BC        ;SAVE REGISTER
2289   CDA422'   0520          CALL    SWDIS     ;SWAP AND DISPLAY
228C   D5        0521          PUSH    DE
228D   CDA422'   0522          CALL    SWDIS
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 ADDR  CODE      STMT SOURCE STATEMENT

'2290  E5        0523          PUSH    HL
'2291  CDA422'   0524          CALL    SWDIS
'2294  D9        0525          EXX             ;BACK TO NORMAL SET
'2295  DF        0526          DEFB    STRING
'2296  3A26'     0527          DEFW    ADM
'2298  2AB64F'   0528          LD      HL,(ADRG1)
'229B  CD6F24'   0529          CALL    HLIST   ;DISPLAY ADDRESS REGISTER
'229E  CD0524'   0530          CALL    CRLF
'22A1  C3B022'   0531          JP      MODO
                 0532 ;
                 0533 ;SWAP AND DISPLAY A REGISTER
                 0534 ;
'22A4  D9        0535 SWDIS    EXX             ;NORMAL SET
'22A5  D1        0536          POP     DE
'22A6  E1        0537          POP     HL      ;GET CONTENTS
'22A7  D5        0538          PUSH    DE      ;PUT BACK RETURN ADDR
'22A8  CD6F24'   0539          CALL    HLIST   ;SHOW CONTENTS
'22AB  CD5122'   0540          CALL    RPLUS   ;DESIG. AND RFG UPDATE
'22AE  D9        0541          EXX             ;ALTERNATE SET
'22AF  C9        0542          RET
                 0543 ;
                 0544 ;CLEAN UP AND RESET MODE 0
'22B0  AF        0545 MODO     XOR     A       ;CLEAR A TO ZERO
'22B1  32AD4F'   0546          LD      (MODE),A  ;SET MODE TO 0
'22B4  32BC4F'   0547          LD      (LFLG),A  ;CLEAR LIST FLAG
'22B7  32C54F'   0548          LD      (POPT),A  ;CLEAR PRINT OPTONS
'22BA  C9        0549          RET             ;GO HOME
                 0550 ;
                 0551 **********MODE 2 OPERATIONS***********
                 0552 ;
'>22BB           0553 MODE2
'22BB  79        0554          LD      A,C     ;GET DISPLACEMENT
'22BC  FF        0555          DEFB    SYSSUK
'22BD  5B        0556          DEFB    5BH     ;INDEXW
'22BE  DA20'     0557          DEFW    M2JT    ;JUMP TABLE
'22C0  D5        0558          PUSH    DE
'22C1  C9        0559          RET             ;POP, JUMP
                 0560 ;
                 0561 ;
'>22C2           0562 TAPIN
'22C2  F3        0563          DI              ;INITIALIZE INTERRUPTS
'22C3  D9        0564          EXX
'22C4  06FC      0565          LD      B,0FCH  ;SET COUNT
'22C6  D9        0566          EXX
'22C7  3E18      0567          LD      A,18H   ;INT. ENABLE AND MODE
'22C9  D30E      0568          OUT     (0EH),A
'22CB  FB        0569          EI
'22CC  CD0524'   0570          CALL    CRLF
'22CF  C3B022'   0571          JP      MODO    ;CLEAN UP AND GO HOME
                 0572 ;
'>22D2           0573 TADIS
'22D2  CDC222'   0574          CALL    TAPIN   ;INIT INTERRUPTS
'22D5  21AE4F'   0575          LD      HL,IOB  ;SET TAPE DISPLAY BIT
'22D8  CBDE      0576          SET     3,(HL)
'22DA  C3B022'   0577          JP      MODO
                 0578 ;
                 0579 ;
                 0580 ;WRITE TO TAPE
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ADDR  CODE       STMT SOURCE STATEMENT

                 0581 ;
'>   D           0582 TAPOUT
'22DD  21AE4F'   0583          LD      HL,IOB   ;GET I/O INFO
'22E0  CB46      0584          BIT     0,(HL)   ;TAPE OUT SET?
'22E2  2009      0585          JR      NZ,TO1   ;YES, CLEAR IT
'22E4  CBC6      0586          SET     0,(HL)   ;NO, SET IT
'22E6  CB8E      0587          RES     1,(HL)   ;CLEAR PRINT BIT
'22E8  CDCB23'   0588          CALL    RED
'22EB  1805      0589          JR      TO2
'22ED  CB86      0590 TO1      RES     0,(HL)
'22EF  CDC323'   0591          CALL    GREEN
'22F2  3E54      0592 TO2      LD      A,'T'
'22F4  D7        0593          DEFB    DISP
'22F5  C3B022'   0594          JP      MODO
                 0595 ;
                 0596 ;
'>22F8           0597 PRINT
'22F8  21AE4F'   0598          LD      HL,IOB   ;GET I/O BYTE
'22FB  CB4E      0599          BIT     1,(HL)   ;PRINT BIT CLEAR?
'22FD  2807      0600          JR      Z,PR1    ;YES, SET IT
'22FF  CB8E      0601          RES:    1,(HL)   ;NO, CLEAR IT
'2301  CDC323'   0602          CALL    GREEN
'2304  1807      0603          JR      PR2
'2306  CDCB23'   0604 PR1      CALL    RED
'2309  CBCE      0605          SET     1,(HL)   ;SET PRINT BIT
'230B  CB86      0606          RES     0,(HL)   ;CLEAR TAPE BIT
'2     3E50      0607 PR2      LD      A,'P'
'230F  D7        0608          DEFB    DISP
'2310  C3B022'   0609          JP      MODO     ;GO HOME
                 0610 ;
                 0611 ;
'>2313           0612 STAR2
'2313  3E08      0613          LD      A,08H    ;DISABLE TAPE INPUT
'2315  D30E      0614          OUT     (0EH),A
'2317  21AE4F'   0615          LD      HL,IOB   ;GET I/O INFO
'231A  CB9E      0616          RES     3,(HL)   ;CLEAR TAPE DISPLAY MODE
'231C  CDC323'   0617          CALL    GREEN
'231F  3E2A      0618          LD      A,'*'
'2321  D7        0619          DEFB    DISP
'2322  C3B022'   0620          JP      MODO
                 0621 ;
                 0622 ;
                 0623 ;DELETE
                 0624 ;
'>2325           0625 DEL
'2325  B7        0626          OR      A        ;FIX CARRY FLAG
'2326  2AC14F'   0627          LD      HL,(END)
'2329  ED5BB64F' 0628          LD      DE,(ADRG1)
'232D  ED52      0629          SBC     HL,DE    ;GET NUMBER TO MOVE
'232F  44        0630          LD      B,H
'2330  4D        0631          LD      C,L      ;COUNT TO BC
'2     62        0632          LD      H,D
'2332  6B        0633          LD      L,E
'2333  23        0634          INC     HL       ;(ADRG1)+1 TO HL
'2334  EDB0      0635          LDIR             ;COPY FROM (HL) TO (DE),
                 0636                           ;(BC) TIMES
'2336  3E3C      0637          LD      A,'<'    ;A MARKER
'2338  CDCB23'   0638          CALL    RED
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 ADDR  CODE      STMT SOURCE STATEMENT

'233B  D7        0639          DEFB    DISP
'233C  21C14F'   0640          LD      HL,END  ;UPDATE END
'233F  35        0641          DEC     (HL)
'2340  C3B022'   0642          JP      MODO    ;GO HOME
                 0643 ;********MODE 4 OPERATIONS***********
                 0644 ;
                 0645 ;MODE 4 IS AVAILABLE FOR REDEFINING THE KEYPAD FOR
                 0646 ;OTHER USES.  USER MUST ENTER THE ADDRESS OF HIS
                 0647 ;KEYPAD HANDLING ROUTINE IN M4BA (ADDRESS 4FC8),
                 0648 ;LOWER HALF FIRST.  SETTING THE MODE TO 4
                 0649 ;IN THE STARTUP ROUTINE WILL ROUTE CONTROL IN THIS
                 0650 ;DIRECTION.
                 0651 ;
'>2343           0652 MODE4
'2343  2ACA4F'   0653          LD      HL,(M4BA)  ;GET ENTRY ADDRESS
'2346  E9        0654          JP      (HL)    ;JUMP TO IT
                 0655 ;
                 0656 ;
                 0657 *******DISPLAY CONTROL ROUTINES*******
                 0658 ;
'>2347           0659 CLEAR
'2347  ED4BB84F' 0660          LD      BC,(SCRN)  ;SIZE OF SCREEN
'234B  110040    0661          LD      DE,4000H  ;START OF SCREEN
'234E  3E00      0662          LD      A,0H    ;DATA TO FILL WITH
'2350  FF        0663          DEFB    SYSTEM
'2351  1A        0664          DEFB    1AH     ;DO NT FILL--CLEAR SCREEN
'2352  210000    0665          LD      HL,00H
'2355  22C34F'   0666          LD      (COORD),HL  ;SET COORDINATES TO 0,0
'2358  C9        0667          RET
                 0668 ;
                 0669 ;DISPLAY IS THE GENERAL DISPLAY ROUTINE FOR THE
                 0670 ;SYSTEM. IT TAKES CARE OF THE SCREEN, TAPE, AND PRINTER
                 0671 ;PORTS. PRINT DIFFERS FROM TAPE ONLY IN THAT
                 0672 ;NONPRINTABLES ARE FILTERED OUT AND LINE FEEDS
                 0673 ;ARE INSERTED.
                 0674 ;
'>2359           0675 DISPLAY
'2359  E5        0676          PUSH    HL
'235A  D5        0677          PUSH    DE
'235B  C5        0678          PUSH    BC
'235C  F5        0679          PUSH    AF
'235D  21AE4F'   0680          LD      HL,IOB  ;TEST FOR TAPE OR PRINT OUT
'2360  CB46      0681          BIT     0,(HL)  ;TAPE OUT BIT
'2362  C42724'   0682          CALL    NZ,TWRT ;DO IT
                 0683 ;SIMPLE DISPLAY
'2365  F1        0684          POP     AF      ;RESTORE CHARACTER
'2366  F5        0685          PUSH    AF      ;PUT IT BACK
'2367  FE0D      0686          CP      0DH     ;CHECK IF CARR. RETURN
'2369  200A      0687          JR      NZ,D1   ;IF NOT, GO AHEAD
'236B  CB4E      0688          BIT     1,(HL)  ;PRINT ON?
'236D  C42724'   0689          CALL    NZ,TWRT ;YES, SEND CR TO PRINTER
'2370  CD0524'   0690 DO       CALL    CRLF    ;DO IT ON SCREEN
'2373  182F      0691          JR      DRET
'2375  FE20      0692 D1       CP      20H     ;CHECK IF PRINTABLE
'2377  3804      0693          JR      C,DOT   ;JUMP IF MINUS
'2379  FE5B      0694          CP      5BH     ;UPPER LIMIT
'237B  3802      0695          JR      C,OK    ;JUMP IF NEG.
'237D  3E2E      0696 DOT      LD      A,'.'   ;DO A DOT IF NOT PRINTABLE
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 ADDR  CODE       STMT SOURCE STATEMENT
'237F  F5         0697 OK      PUSH    AF       ;SAVE IT
'2     CB4E       0698         BIT     1,(HL)   ;PRINT ON?
'2382  C42724'    0699         CALL    NZ,TWRT  ;YEP, DO IT
'2385  ED5BC34F'  0700         LD      DE,(COORD)  ;GET X,Y COORDINATES
'2389  3AC54F'    0701         LD      A,(POPT)         ;PICK UP OPTIONS, IF ANY
'238C  4F         0702         LD      C,A      ;PUT IN C
'238D  A7         0703         AND     A
'238E  2002       0704         JR      NZ,OK1   ;IF NONZERO, USE IT
'2390  0E04       0705         LD      C,04H    ;OTHERWISE STANDARD PRINT
'2392  F1         0706 OK1     POP     AF       ;GET CHAR BACK
'2393  EE80       0707         XOR     80H      ;ALTERNATE FONT INDICATOR
'2395  DD21BD26'  0708         LD      IX,SMLFNT  ;SMALL CHAR. FONT DESCRIPTOR
'2399  FF         0709         DEFB    SYSTEM
'239A  32         0710         DEFB    32H      ;CHRDIS--OUTPUT CHARACTER ROUTINE
                  0711                          ;RETURNS WITH UPDATED XY COORDS
                  0712                          ;IN DE, D=Y, E=X
'239B  3E9B       0713         LD      A,9BH    ;TEST FOR END OF LINE
'239D  BB         0714         CP      E
'239E  DC1024'    0715         CALL    C,CLF    ;IF SO,SET UP NEXT LINE
'23A1  CDA923'    0716         CALL    CON      ;PAINT CURSOR
'23A4  F1         0717 DRET    POP     AF       ;AND GO HOME
'23A5  C1         0718         POP     BC
'23A6  D1         0719         POP     DE
'23A7  E1         0720         POP     HL
'23A8  C9         0721         RET
                  0722 ;
'2     010305     0723 CON     LD      BC,0503H  ;PAINT 3X5 CURSOR
'23AC  3E55       0724         LD      A,55H    ;BINARY 01010101 COLOR MASK
                  0725                          ; (COLOR #1)
'23AE  ED53C34F'  0726         LD      (COORD),DE  ;STORE COORDS BACK
'23B2  FF         0727         DEFB    SYSTEM
'23B3  1C         0728         DEFB    1CH      ;RECTAN--PAINT RECTANGLE
'23B4  C9         0729         RET
                  0730 ;
                  0731 ;NOTE: STRING CLOBBERS ALMOST EVERYTHING, USE WITH CARE
                  0732 ;
'>23B5            0733 STRDIS
'23B5  E3         0734         EX      (SP),HL ;GET ADDRESS FROM CALLING ROUTINE
'23B6  5E         0735         LD      E,(HL)
'23B7  23         0736         INC     HL
'23B8  56         0737         LD      D,(HL)
'23B9  23         0738         INC     HL
'23BA  E3         0739         EX      (SP),HL ;FIX THE STACK
'23BB  1A         0740 STR1    LD      A,(DE)   ;PICK UP CHARACTER
'23BC  FE00       0741         CP      00H      ;IF NULL, END
'23BE  C8         0742         RET     Z
'23BF  D7         0743         DEFB    DISP     ;DISPLAY CHARACTER
'23C0  13         0744         INC     DE       ;INCREMENT ADDRESS
'23C1  18F8       0745         JR      STR1   ;DO ANOTHER
                  0746 ;
                  0747 ;COLOR CHANGES
                  0748 ;
'23C3  F5         0749 GREEN   PUSH    AF
'23C4  3E0C       0750         LD      A,0CH    ;GREEN ON BLACK OPTION
'23C6  32C54F'    0751 G1      LD      (POPT),A
'23C9  F1         0752         POP     AF
'23CA  C9         0753         RET
                  0754 ;
```

```
ADDR  CODE       STMT SOURCE STATEMENT

23CB  F5         0755 RED     PUSH    AF
23CC  3E08       0756         LD      A,08H    ;RED ON BLACK
23CE  18F6       0757         JR      G1
                 0758 ;
23D0  F5         0759 NORM    PUSH    AF
23D1  AF         0760         XOR     A        ;BACK TO NORMAL
23D2  18F2       0761         JR      G1
                 0762 ;
                 0763 ;NUMERICAL DISPLAY ROUTINE
                 0764 ;
23D4  FE0A       0765 NUMDIS  CP      0AH      ;CHECK IF WITHIN NUMERICAL LIMITS
23D6  3802       0766         JR      C,NUM1   ;JUMP IF NEG.
                 0767                          ;ELSE NUMBER IS >= 'A' (HEX)
23D8  C607       0768         ADD     A,07H    ;SET UP FOR ASCII
23DA  C630       0769 NUM1    ADD     A,30H    ;MAKE IT ASCII
23DC  D7         0770         DEFB    DISP
23DD  C9         0771         RET
                 0772 ;
                 0773 ;CHECK AND SCROLL IF NEEDED
                 0774 ;
23DE  3ABA4F'    0775 SCROLL  LD      A,(SCRLN)
23E1  D606       0776         SUB     6        ;SCRLN-6 IS LOWER LIMIT OF SCREEN
23E3  BA         0777         CP      D        ;D IS Y COORDINATE
23E4  F0         0778         RET     P        ;GO HOME IF NOT THERE YET
23E5  F5         0779         PUSH    AF       ;SAVE THIS VALUE
23E6  AF         0780         XOR     A        ;CLEAR A AND CARRY FLAG
23E7  2AB84F'    0781         LD      HL,(SCRN)  ;GET SCREEN SIZE
23EA  01F000     0782         LD      BC,0F0H ;MINUS 1 LINE'S WORTH
23ED  ED42       0783         SBC     HL,BC
23EF  280A       0784         JR      Z,SCR1   ;IF ZERO, JUST BLANK TOP LINE
23F1  E5         0785         PUSH    HL
23F2  C1         0786         POP     BC       ;HOW MANY TO MOVE
23F3  21F040     0787         LD      HL,40F0H  ;SOURCE
23F6  110040     0788         LD      DE,4000H  ;DESTINATION
23F9  EDB0       0789         LDIR             ;MOVE (HL) TO (DE) BC TIMES
23FB  01A006     0790 SCR1    LD      BC,06A0H  ;BLACK OUT LAST LINE
23FE  5F         0791         LD      E,A
23FF  F1         0792         POP     AF       ;RESET COORDS
2400  57         0793         LD      D,A
2401  AF         0794         XOR     A        ;DATA FOR RECTANGLE
2402  FF         0795         DEFB    SYSTEM
2403  1C         0796         DEFB    1CH      ;RECTAN
2404  C9         0797         RET              ;GO HOME
                 0798 ;
2405  ED5BC34F'  0799 CRLF    LD      DE,(COORD)  ;GET CURSOR COORDS
2409  010305     0800         LD      BC,0503H  ;PAINT 3X5 BLANK
240C  3E00       0801         LD      A,00H    ;COLOR 0
240E  FF         0802         DEFB    SYSTEM
240F  1C         0803         DEFB    1CH      ;RECTAN
                 0804                          ;UPDATE COORDINATES
2410  1E00       0805 CLF     LD      E,0      ;'CARRIAGE RETURN'
2412  3E06       0806         LD      A,6H     ;'LINE FEED'
2414  82         0807         ADD     A,D
2415  57         0808         LD      D,A
2416  CDDE23'    0809         CALL    SCROLL
2419  CDA923'    0810         CALL    CON      ;PAINT CURSOR
241C  21AE4F'    0811         LD      HL,IOB
241F  CB46       0812         BIT     0,(HL)   ;TAPE WRITE IN PROGRESS?
```

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 ADDR   CODE       STMT SOURCE STATEMENT

'2421   C8         0813         RET      Z         ;NOPE, GO HOME
'2      FF         0814         DEFB     SYSSUK
'2423   51         0815         DEFB     51H       ;PAWS
'2424   08         0816         DEFB     8         ;4 CHARACTERS' WORTH
'2425   C9         0817         RET                ;AND GO HOME
'2426   C9         0818         RET
                   0819 ;
                   0820 ;THIS ROUTINE OUTPUTS ANY 8 BIT VALUE IN THE A REGISTER
                   0821 ;TO THE TAPE OUTPUT PORT.
                   0822 ;NOTE:  THE TAPE PORT IS THE SAME AS THE PRINTER PORT
                   0823 ;SO IT IS SUGGESTED THAT FOR PRINTING THE PRINT COMMAND
                   0824 ;BE USED SO THAT THE PRINTER DOESN'T GO BANANAS.
                   0825 ;
'>2427             0826 TWRT                          ;WRITE TO TAPE
'2427   4F         0827         LD       C,A       ;CHAR. TO C
'2428   CB01       0828         RLC      C         ;SHIFT LEFT ONCE
'242A   DB12       0829 TW1     IN       A,(12H)   ;TAPE PORT FEEDBACK
'242C   E602       0830         AND      2         ;WAIT FOR CLOCK HIGH
'242E   28FA       0831         JR       Z,TW1
'2430   060A       0832         LD       B,0AH     ;BIT COUNTER
'2432   3EC0       0833 TW2     LD       A,0C0H    ;TIME COUNTER (192 DECIMAL)
'2434   3D         0834 TW3     DEC      A
'2435   20FD       0835         JR       NZ,TW3    ;1.72 MSEC., HALF OF 300 HZ
                   0836                            ;CLOCK NOW LOW
'2437   05         0837         DEC      B         ;START COUNTING BITS
'2438   C8         0838         RET      Z         ;GO HOME IF ALL DONE
'2      DB12       0839         IN       A,(12H)   ;IS FEEDBACK STILL SAME STATE?
'243B   5F         0840         LD       E,A       ;IF SO, THEN CLOCK IS LOW
'243C   DB12       0841 TW4     IN       A,(12H)
'243E   AB         0842         XOR      E         ;IF SAME, RESULT IS 0
'243F   E602       0843         AND      2         ;ELSE RESULT IS 2
'2441   28F9       0844         JR       Z,TW4     ;TRY AGAIN
                   0845 ;CLOCK HIGH
'2443   7B         0846         LD       A,E       ;OLD BIT TO A
'2444   A9         0847         XOR      C         ;SEE IF NEED TO CHANGE STATE
'2445   E602       0848         AND      2         ;OF OUTPUT
'2447   2802       0849         JR       Z,TW5     ;NO, SKIP AHEAD
'2449   DB12       0850         IN       A,(12H)   ;TOGGLE OUTPUT
'244B   CBC9       0851 TW5     SET      1,C       ;PUT IN STOP BITS
'244D   CB09       0852         RRC      C         ;SET FOR NEXT BIT
'244F   18E1       0853         JR       TW2       ;DO IT AGAIN
                   0854 ;
                   0855 ;
                   0856 ;
                   0857 ;
                   0858 ;
'2451   3E20       0859 SPACE   LD       A,20H     ;ASCII SPACE
'2453   D7         0860         DEFB     DISP
'2454   C9         0861         RET
                   0862 ;
                   0863 ;
'2      CDCB23'    0864 ERR     CALL     RED
'2458   DF         0865         DEFB     STRING
'2459   B226'      0866         DEFW     ERM
'245B   C3B022'    0867         JP       MODO
                   0868 ;
                   0869 ;THIS ROUTINE DISPLAYS THE CONTENTS OF THE A REGISTER.
                   0870 ;THUS ANY BYTE OF DATA CAN BE DISPLAYED BY PUTTING IT
```

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ADDR  CODE       STMT SOURCE STATEMENT

                 0871 ;IN A AND CALLING RGDIS.
245E  F5         0872 RGDIS   PUSH    AF       ;DISPLAY REGISTER CONTENTS
245F  E6F0       0873         AND     0F0H     ;MASK OUT LOWER HALF
2461  07         0874         RLCA
2462  07         0875         RLCA
2463  07         0876         RLCA
2464  07         0877         RLCA
2465  CDD423'    0878         CALL    NUMDIS
2468  F1         0879         POP     AF
2469  E60F       0880         AND     0FH      ;MASK OFF UPPER HALF
246B  CDD423'    0881         CALL    NUMDIS
246E  C9         0882         RET
                 0883 ;
246F  7C         0884 HLIST   LD      A,H      ;SHOW HL ROUTINE
2470  CD5E24'    0885         CALL    RGDIS
2473  7D         0886         LD      A,L
2474  CD5E24'    0887         CALL    RGDIS
2477  C9         0888         RET
                 0889 ;
                 0890 ;
>2478            0891 READY
2478  ED5BB84F'  0892         LD      DE,(SCRN)  ;HOW MANY SCREEN BYTES
247C  21504F     0893         LD      HL,UPRAM  ;1ST SYSTEM SCRATCH BYTE
247F  CBB4       0894         RES     6,H      ;MAKE INTO A RELATIVE NUMBER
2481  B7         0895         OR      A        ;CLEAR CARRY FLAG
2482  ED52       0896         SBC      HL,DE   ; (TOTAL RAM-SCREEN RAM)
2484  CD6F24'    0897         CALL    HLIST    ;DISPLAY IT
2487  DF         0898         DEFB    STRING
2488  6326'      0899         DEFW    RMSG     ;STRING TO GO ALONG WITH IT
248A  2AB84F'    0900         LD      HL,(SCRN)
248D  CBF4       0901         SET      6,H     ;FUDGE IT INTO AN ADDRESS
248F  CD6F24'    0902         CALL    HLIST    ;DUMP IT OUT
2492  CD0524'    0903         CALL    CRLF
2495  C9         0904         RET
                 0905 ;
                 0906 ;
                 0907 **********KEYBOARD INTERFACE**********
                 0908 ;
                 0909 ;SCANS THE KEYPAD UNTIL A KEY IS PRESSED.  RETURNS WITH
                 0910 ;THE NUMBER OF THE KEY IN B.  NUMBERS ARE ROW-WISE
                 0911 ;RIGHT TO LEFT, 1 THROUGH 24.
                 0912 ;
2496  219624'    0913 KEYGET  LD      HL,KEYGET  ;SAVE THIS ADDRESS
2499  E5         0914         PUSH    HL
249A  FF         0915         DEFB    SYSSUK   ;
249B  51         0916         DEFB    51H      ;PAWS--KEY DEBOUNCER, HOLD FOR
249C  02         0917         DEFB    02H      ;2/60 OF A SECOND
                 0918 ;KEYPAD INPUT RETURNS WITH KEY NO. IN A
249D  11AF4F'    0919         LD      DE,KEYN  ;OLD KEY NUMBER
24A0  011404     0920         LD      BC,414H  ;B=COUNT, C=STARTING PORT
24A3  ED78       0921 KG1     IN      A,(C)    ;CHECK OUT PORT
24A5  E63F       0922         AND     3FH      ;GET RID OF EXTRANEOUS BITS
24A7  2006       0923         JR      NZ,KG2   ;JUMP IF GOT A GOOD ONE
24A9  0C         0924         INC     C        ;NOPE, DO ANOTHER
24AA  10F7       0925         DJNZ    KG1
24AC  AF         0926         XOR     A        ;NONE AT ALL
24AD  12         0927         LD      (DE),A   ;KEEP TRACK OF LAST KEY
24AE  C9         0928         RET              ;BACK TO KEYGET
```

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ADDR  CODE      STMT SOURCE STATEMENT

              0929 ;
'2'   05      0930 KG2     DEC     B
'24B0 0E00    0931         LD      C,0
'24B2 0F      0932 KG3     RRCA                ;FIND THE RIGHT BIT
'24B3 3803    0933         JR      C,KG4
'24B5 0C      0934         INC     C
'24B6 18FA    0935         JR      KG3
'24B8 79      0936 KG4     LD      A,C         ;BIT #
'24B9 07      0937         RLCA                ;MULT BY 4
'24BA 07      0938         RLCA
'24BB B0      0939         OR      B
'24BC 3C      0940         INC     A           ;NOW HAVE KEY NO.
'24BD 47      0941         LD      B,A
'24BE 1A      0942         LD      A,(DE)      ;OLD NUMBER
'24BF A8      0943         XOR     B           ;COMPARE
'24C0 C8      0944         RET     Z
'24C1 78      0945         LD      A,B         ;DIFFERENT, UPDATE
'24C2 12      0946         LD      (DE),A
'24C3 E1      0947         POP     HL          ; FIX THE STACK
'24C4 C9      0948         RET                 ;AND GO BACK
              0949 ;
              0950 **********INTERRUPT ROUTINES*****************
              0951 ;
              0952 ;
              0953 ;INITIALIZE INTERRUPTS
              0954 ;
'2'   DB12    0955 ININT   IN      A,(12H)  ;TAPE INPUT PORT
'24'' E602    0956         AND     2        ;MAKE SURE IT'S SET TO 0
'24C9 20FA    0957         JR      NZ,ININT
'24CB F3      0958         DI                  ;DISABLE INTERRUPTS
'24CC ED5E    0959         IM      2           ;INTERRUPT MODE
'24CE 3E4F    0960         LD      A,4FH       ;SET INTERRUPT PAGE
'24D0 ED47    0961         LD      I,A
'24D2 3EB2    0962         LD      A,0B2H      ;SCREEN INTERRUPT VECTOR
'24D4 D30D    0963         OUT     (0DH),A
'24D6 3E08    0964         LD      A,08
'24D8 D30E    0965         OUT     (0EH),A  ;SCREEN INTS ONLY
'24DA 3EC8    0966         LD      A,200
'24DC D30F    0967         OUT     (0FH),A  ;SCREEN INT. EVERY 200 LINES
'24DE 21EC24' 0968         LD      HL,TAPINT   ;LOAD INTERRUPT VECTORS
'24E1 22B04F' 0969         LD      (LPINT),HL
'24E4 216C25' 0970         LD      HL,SCRINT
'24E7 22B24F' 0971         LD      (SCINT),HL
'24EA FB      0972         EI                  ;ENABLE INTERRUPTS
'24EB C9      0973         RET
              0974 ;
              0975 *****LIGHT PEN INTERRUPT HANDLER*******
              0976 ;
              0977 ;THE TAPE INPUT HANDLER RECOGNIZES A COLON AS AN
              0978 ;ADDRESS DIRECTIVE, AND SPACE AND CR AS WRITE DIRECTIVES.
              0979 ;
'>'   C       0980 TAPINT
'24EC F5      0981         PUSH    AF
'24ED D9      0982         EXX
'24EE CD4A25' 0983         CALL    COLL     ;GET A CHARACTER
'24F1 21AE4F' 0984 TI1     LD      HL,IOB   ;TEST TAPE DISPLAY BIT
'24F4 CB5E    0985         BIT     3,(HL)
'24F6 2045    0986         JR      NZ,TID   ;IF SET, GO DISPLAY
```

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 ADDR  CODE      STMT SOURCE STATEMENT

'24F8  FE0D      0987         CP      0DH      ;ELSE TEST FOR CR
'24FA  2007      0988         JR      NZ,TI2   ;SKIP IF NOT
'24FC  CD3321'   0989         CALL    WRITE    ;DO A WRITE
'24FF  3E0D      0990         LD      A,0DH    ;REPLACE CR
'2501  183A      0991         JR      TID      ;DISPLAY IT
'2503  FE20      0992 TI2     CP      20H      ;ELSE, ACT ON IT
'2505  3836      0993         JR      C,TID    ;EXIT IF NOT DISPLAYABLE
'2507  200B      0994         JR      NZ,TI3   ;ZERO MEANS A SPACE
'2509  CB7E      0995         BIT     7,(HL)
                 0996 ;BIT 7 IN IOB IS ADDR FLAG MEANING IGNORE 1ST SPACE
                 0997 ;FOLLOWING COLON
'250B  E5        0998         PUSH    HL       ;SAVE IOB
'250C  CC3321'   0999         CALL    Z,WRITE  ;IF CLEAR
'250F  E1        1000         POP     HL
'2510  CBBE      1001         RES     7,(HL)   ;CLEAR THE BIT
'2512  182A      1002         JR      TIX      ;EXIT
                 1003 ;
'2514  CBBE      1004 TI3     RES     7,(HL)   ;CLEAR BIT IF NOT A SPACE
'2516  FE30      1005         CP      30H      ;CHECK NUMBER LIMITS
'2518  3823      1006         JR      C,TID    ;LESS THAN
'251A  FE3A      1007         CP      3AH
'251C  3008      1008         JR      NC,TI4   ;>=
'251E  E60F      1009 TI3A    AND     0FH      ;STRIP AWAY ASCII
'2520  4F        1010         LD      C,A
'2521  CDF220'   1011         CALL    NUMBER
'2524  1818      1012         JR      TIX
'2526  2009      1013 TI4     JR      NZ,TI5   ;JUMP IF NOT A COLON
'2528  E5        1014         PUSH    HL       ;SAVE IOB
'2529  CD0E21'   1015         CALL    ADDR
'252C  E1        1016         POP     HL
'252D  CBFE      1017         SET     7,(HL)   ;IGNORE NEXT SPACE
'252F  180D      1018         JR      TIX      ;EXIT
'2531  FE41      1019 TI5     CP      41H      ;'A'
'2533  3808      1020         JR      C,TID
'2535  FE47      1021         CP      47H      ;'G'
'2537  3004      1022         JR      NC,TID
'2539  C609      1023         ADD     A,09H    ;SET UP FOR NUMBER
'253B  18E1      1024         JR      TI3A     ;GO TO IT
'253D  D7        1025 TID     DEFB    DISP
'253E  3AAD4F'   1026 TIX     LD      A,(MODE)
'2541  FE04      1027         CP      4        ;MODE 4 SET?
'2543  CA4323'   1028         JP      Z,MODE4  ;SKIP OUT
'2546  F1        1029         POP     AF
'2547  D9        1030         EXX
'2548  FB        1031         EI
'2549  C9        1032         RET
                 1033 ;
'254A  DB12      1034 COLL    IN      A,(12H)  ;COLLECT BITS FROM TAPE
'254C  1F        1035         RRA              ;BIT TO CARRY
'254D  79        1036         LD      A,C      ;BITS SO FAR
'254E  1F        1037         RRA              ;NEW BIT SHIFTED IN
'254F  4F        1038         LD      C,A
'2550  78        1039         LD      A,B      ;COUNT
'2551  A7        1040         AND     A
'2552  380A      1041         JR      C,CO1    ;NEG.
'2554  2012      1042         JR      NZ,CO2   ;NONZERO
'2556  CB79      1043         BIT     7,C      ;ZERO, TEST HIGHEST BIT
'2558  200B      1044         JR      NZ,EXIT  ;NOT READY YET
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 ADDR  CODE      STMT SOURCE STATEMENT

'255A  0608      1045         LD      B,08H    ;GOT ONE
'255C  1807      1046         JR      EXIT
'255E  04        1047 C01     INC     B        ;NEG. COUNT LOOP
'255F  CB79      1048         BIT     7,C      ;STILL COLLECTING BITS
'2561  2002      1049         JR      NZ,EXIT
'2563  06FC      1050         LD      B,0FCH   ;A ZERO CAME THRU WITH
                 1051                          ;COUNT WRONG
'2565  E1        1052 EXIT    POP     HL       ;DROP RETURN ADDRESS
'2566  18D6      1053         JR      TIX      ;AND GET OUT
                 1054 ;
'2568  10FB      1055 C02     DJNZ    EXIT     ;POS COUNT, NOT DONE YET
'256A  79        1056         LD      A,C      ;DONE
'256B  C9        1057         RET
                 1058 ;
                 1059 ***********SCREEN INTERRUPT HANDLER************
                 1060 ;
'256C  FB        1061 SCRINT  EI       ;ENABLE INTERRUPTS
'256D  C9        1062         RET      ;AND GO BACK
                 1063 ;
                 1064 ;
                 1065 ;
                 1066 **********UTILITY PROGRAMS**********
                 1067 ;
                 1068 ;
                 1069 ;BREAKPOINTS ARE SET BY WRITING 'CF' AT DESIRED LOCATIONS
                 1070 ;
'25[illegible]  CD9A21'  1071 BRKPT    CALL    CART     ;BREAKPOINT ROUTINE
'25[illegible]  CD0524'  1072         CALL    CRLF     ;CART GETS ORIGINAL REG SET
'2574  DF        1073         DEFB    STRING
'2575  4126'     1074         DEFW    BKM
'2577  E1        1075         POP     HL       ;GET BRKPT ADDR
'2578  2B        1076         DEC     HL       ;BACK OFF ONE
'2579  CD6F24'   1077         CALL    HLIST    ;SHOW IT
'257C  CD7322'   1078         CALL    RLIST    ;SHOW REGISTERS
'257F  C30020'   1079         JP      START
                 1080 ;
                 1081 ;
                 1082 ;
                 1083 ;SET SCREEN SPECIFICATIONS
                 1084 ;
'2582  CD0524'   1085 SCRSP    CALL    CRLF     ;OUTPUT A CARRIAGE RETURN
'2585  3E5A      1086         LD      A,90     ;DEFAULT VALUE
'2587  32B44F'   1087         LD      (IN1),A  ;TO INPUT REGISTER
'258A  DF        1088         DEFB    STRING
'258B  8126'     1089         DEFW    BLM      ;BLANK SPECS MESSAGE
'258D  AF        1090         XOR     A        ;USE REG TYPE SEQUENCE
'258E  32BD4F'   1091         LD      (RFG),A
'2591  3E03      1092         LD      A,3
'2593  32AD4F'   1093         LD      (MODE),A  ;SET MODE 3
'2596  C9        1094         RET
                 1095 ;
                 1096 ;THE FOLLOWING SECTION WILL BE ENTERED EACH TIME A 'W' IS
                 1097 ;INPUT WHILE IN MODE 3
                 1098 ;
'2597  79        1099 MODE3    LD      A,C      ;GET KEY VALUE
'2598  FE04      1100         CP      4H
'259A  C0        1101         RET     NZ       ;ACCEPT WRITE ONLY
'259B  3ABD4F'   1102         LD      A,(RFG)  ;PICK UP FLAG
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 ADDR  CODE      STMT SOURCE STATEMENT

'259E  FF        1103          DEFB    SYSSUK
'259F  5B        1104          DEFB    5BH       ;INDEXW-JUMP BASED ON FLAG
'25A0  EA20'     1105          DEFW    M3JT      ;JUMP TABLE
'25A2  D5        1106          PUSH    DE        ;RETURNED ADDRESS
'25A3  3AB44F'   1107          LD      A,(IN1)   ;GET INPUT VALUE
'25A6  C9        1108          RET               ;JUMP TO ROUTINE
                 1109 ;
'>25A7           1110 M30                        ;CALCULATE WHERE BLANKING
                 1111                            ;SHOULD START
'25A7  FE5A      1112          CP      5AH       ;IF 90 DECIMAL
'25A9  280B      1113          JR      Z,M302    ;LEAVE ALONE
'25AB  E60F      1114          AND     0FH       ;MASK OUT UPPER DIGIT
'25AD  2001      1115          JR      NZ,M300    ;IF ZERO, MAKE IT ONE
'25AF  3C        1116          INC     A
'25B0  47        1117 M300     LD      B,A       ;NO. OF TEXT LINES INPUT
'25B1  AF        1118          XOR     A
'25B2  C606      1119 M301     ADD     A,06H     ;CHARACTER FRAME SIZE
'25B4  10FC      1120          DJNZ    M301
'25B6  32B64F'   1121 M302     LD      (ADRG1),A  ;TEMP. LINE STORAGE
'25B9  3E2C      1122          LD      A,2CH     ;44 DECIMAL
'25BB  32B44F'   1123          LD      (IN1),A ;HORIZONTAL COLOR BOUNDARY
'25BE  CD0524'   1124          CALL    CRLF
'25C1  DF        1125          DEFB    STRING
'25C2  8E26'     1126          DEFW    CBM
'25C4  3E01      1127          LD      A,1       ;INCREMENT PROCESS POINTER
'25C6  32BD4F'   1128          LD      (RFG),A
'25C9  C9        1129          RET               ;GET THE NEXT SPEC.
                 1130 ;
'25CA  32BB4F'   1131 M31      LD      (HRZCB),A  ;NO LIMIT CHECKS
'25CD  3E00      1132          LD      A,00H     ;DEFAULT BACK COLOR
'25CF  32B44F'   1133          LD      (IN1),A
'25D2  CD0524'   1134          CALL    CRLF
'25D5  DF        1135          DEFB    STRING
'25D6  9F26'     1136          DEFW    BCLM      ;BACK COLOR MESSAGE
'25D8  3E02      1137          LD      A,2       ;SET UP FOR NEXT PROCESS
'25DA  32BD4F'   1138          LD      (RFG),A
'25DD  C9        1139          RET               ;GO BACK
                 1140 ;
'25DE  32C94F'   1141 M32      LD      (BCOL),A  ;SET BCOLOR
'25E1  3E07      1142          LD      A,07H     ;FORE COLOR
'25E3  32B44F'   1143          LD      (IN1),A
'25E6  CD0524'   1144          CALL    CRLF
'25E9  DF        1145          DEFB    STRING
'25EA  4C26'     1146          DEFW    FCLM      ;FORE COLOR MESSAGE
'25EC  3E03      1147          LD      A,3       ;SET UP FOR NEXT PROCESS
'25EE  32BD4F'   1148          LD      (RFG),A
'25F1  C9        1149          RET
                 1150 ;THIS IS THE ACTION OF THE LAST KEYPUSH OF THE
                 1151 ;SCREEN SPEC. ROUTINE
'25F2  32C84F'   1152 M33      LD      (FCOL),A  ;SET FCOLOR
'25F5  3AB64F'   1153          LD      A,(ADRG1)  ;GET BLANK LINE #
'25F8  32BA4F'   1154          LD      (SCRLN),A  ;INTO ITS PROPER PLACE
'25FB  07        1155          RLCA              ;SETOUT NEEDS IT
                 1156                            ;SHIFTED LEFT ONE BIT
'25FC  57        1157          LD      D,A
'25FD  3ABB4F'   1158          LD      A,(HRZCB)  ;COLOR BOUNDARY
'2600  47        1159          LD      B,A
'2601  3E08      1160          LD      A,08H     ;INTERRUPT MODE
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```
 ADDR   CODE       STMT SOURCE STATEMENT

'260?   FF         1161          DEFB    SYSTEM
'2.     16         1162          DEFB    16H       ;DO NT SETOUT
'2605   21C64F'    1163          LD      HL,COLORS  ;GET ADDRESS OF COLOR LIST
'2608   FF         1164          DEFB    SYSTEM
'2609   18         1165          DEFB    18H       ;COLSET
'260A   210000     1166          LD      HL,00H    ;CALCULATE SCREEN SIZE
                   1167                            ;FROM NO. OF LINES DISPLAYED
'260D   3ABA4F'    1168          LD      A,(SCRLN)
'2610   47         1169          LD      B,A
'2611   112800     1170          LD      DE,40     ;DECIMAL BYTES PER LINE
'>2614             1171 M331
'2614   19         1172          ADD     HL,DE
'2615   10FD       1173          DJNZ    M331      ;FIGURE OUT
'2617   22B84F'    1174          LD      (SCRN),HL  ;NO. OF BYTES IN SCREEN
'261A   CD4723'    1175          CALL    CLEAR     ;CLEAR SCREEN
'261D   CD7824'    1176          CALL    READY
'2620   AF         1177          XOR     A         ;CLEAN UP
'2621   32BD4F'    1178          LD      (RFG),A
'2624   32AD4F'    1179          LD      (MODE),A
'2627   C9         1180          RET               ;GO HOME
                   1181 ********MESSAGE TABLE********
'2628   413A       1182 AFM      DEFM    'A:'
'262A   00         1183          DEFB    00
'262B   2042433A   1184 BCM      DEFM    ' BC:'
'262F   00         1185          DEFB    00
'2630   2044453A   1186 DEM      DEFM    ' DE:'
'2.     00         1187          DEFB    00
'2635   20484C3A   1188 HLM      DEFM    ' HL:'
'2639   00         1189          DEFB    00
'263A   20414444   1190 ADM      DEFM    ' ADDR:'
        523A
'2640   00         1191          DEFB    00
'2641   424B5054   1192 BKM      DEFM    'BKPT ADDR:'
        20414444
        523A
'264B   00         1193          DEFB    00
'264C   464F5245   1194 FCLM     DEFM    'FOREGROUND: '
        47524F55
        4E443A20
'2658   00         1195          DEFB    00
'2659   2A574152   1196 WAM      DEFM    '*WARNING*'
        4E494E47
        2A
'2662   00         1197          DEFB    00
'2663   20425954   1198 RMSG     DEFM    ' BYTES AVAILABLE STARTING AT '
        45532041
        5641494C
        41424C45
        20535441
        5254494E
        47204154
        20
'2680   00         1199          DEFB    00
'2681   54455854   1200 BLM      DEFM    'TEXT LINES: '
        204C494E
        45533A20
'268D   00         1201          DEFB    00
'268E   434F4C4F   1202 CBM      DEFM    'COLOR BOUNDARY: '
```

```
 ADDR  CODE      STMT SOURCE STATEMENT

       5220424F
       554E4441
       52593A20
'269E  00        1203          DEFB    00
'269F  4241434B  1204 BCLM     DEFM    'BACKGROUND COLOR: '
       47524F55
       4E442043
       4F4C4F52
       3A20
'26B1  00        1205          DEFB    00
'26B2  455252    1206 ERM      DEFM    'ERR'
'26B5  00        1207          DEFB    00
'26B6  4F4B      1208 OKM      DEFM    'OK'
'26B8  00        1209          DEFB    00
                 1210 ;
                 1211 ;
                 1212 **********COLOR LIST*********
'26B9  A3        1213 COLIST   DEFB    0A3H    ;GREEN
'26BA  52        1214          DEFB    52H     ;RED
'26BB  07        1215          DEFB    07H     ;WHITE
'26BC  00        1216          DEFB    00H     ;BLACK
                 1217 ;
                 1218 ;
                 1219 *******SMALL CHARACTER FONT DESCRIPTOR*****
'26BD  A0        1220 SMLFNT   DEFB    0A0H    ;1ST CHARACTER
'26BE  04        1221          DEFB    4       ;X FRAME SIZE
'26BF  06        1222          DEFB    6       ;Y FRAME SIZE
'26C0  01        1223          DEFB    1       ;NO. OF BYTES X PATTERN
'26C1  05        1224          DEFB    5       ;NO. OF BYTES Y PATTERN
'26C2  C426'     1225          DEFW    SMLCHR  ;ADDRESS OF CHARACTER TABLE
                 1226 ;
                 1227 ;
                 1228 ******CHARACTER TABLE********
'26C4  00000000  1229 SMLCHR   DEFB    00,00,00,00,00          ;SPACE
       00
'26C9  20202000  1230          DEFB    20H,20H,20H,00,20H      ; !
       20
'26CE  A0A00000  1231          DEFB    0A0H,0A0H,00,00,00      ; "
       00
'26D3  A0E0A0E0  1232          DEFB    0A0H,0E0H,0A0H,0E0H,0A0H  ; #
       A0
'26D8  00000000  1233          DEFB    0,0,0,0,0               ;UNDEFINED
       00
'26DD  A0204080  1234          DEFB    0A0H,20H,40H,80H,0A0H   ; %
       A0
'26E2  00000000  1235          DEFB    0,0,0,0,0               ;UNDEFINED
       00
'26E7  40800000  1236          DEFB    40H,80H,0,0,0           ; '
       00
'26EC  40808080  1237          DEFB    40H,80H,80H,80H,40H     ; (
       40
'26F1  40202020  1238          DEFB    40H,20H,20H,20H,40H     ; )
       40
'26F6  00A040A0  1239          DEFB    00H,0A0H,40H,0A0H,00H   ; *
       00
'26FB  0040E040  1240          DEFB    00H,40H,0E0H,40H,00H    ; +
       00
'2700  00000040  1241          DEFB    00H,00H,00H,40H,80H     ; ,
```

```
ADDR  CODE      STMT SOURCE STATEMENT

      80
'2.   0000E000  1242        DEFB    00H,00H,0E0H,00H,00H    ; -
      00
'270A 0000000   1243        DEFB    00H,00H,00H,00H,40H     ; .
      040
'270F 2020408   1244        DEFB    20H,20H,40H,80H,80H     ; /
      080
'2714 40A0A0A   1245        DEFB    40H,0A0H,0A0H,0A0H,40H  ; 0
      040
'2719 4040404   1246        DEFB    40H,40H,40H,40H,40H     ; 1
      040
'271E E020E08   1247        DEFB    0E0H,20H,0E0H,80H,0E0H  ; 2
      0E0
'2723 E020602   1248        DEFB    0E0H,20H,60H,20H,0E0H   ; 3
      0E0
'2728 A0A0E02   1249        DEFB    0A0H,0A0H,0E0H,20H,20H  ; 4
      020
'272D E080E02   1250        DEFB    0E0H,80H,0E0H,20H,0E0H  ; 5
      0E0
'2732 E080E0A   1251        DEFB    0E0H,80H,0E0H,0A0H,0E0H ; 6
      0E0
'2737 E020202   1252        DEFB    0E0H,20H,20H,20H,20H    ; 7
      020
'273C E0A0E0A   1253        DEFB    0E0H,0A0H,0E0H,0A0H,0E0H  ; 8
      0E0
'2741 E0A0E02   1254        DEFB    0E0H,0A0H,0E0H,20H,20H  ; 9
      020
'2746 0040004   1255        DEFB    00H,40H,00H,40H,00H     ; :
      000
'274B 0040004   1256        DEFB    00H,40H,00H,40H,80H     ; ;
      080
'2750 2040804   1257        DEFB    20H,40H,80H,40H,20H     ; <
      020
'2755 00E000E   1258        DEFB    00H,0E0H,00H,0E0H,00H   ; =
      000
'275A 8040204   1259        DEFB    80H,40H,20H,40H,80H     ; >
      080
'275F E020604   1260        DEFB    0E0H,20H,60H,40H,40H    ; ?
      040
'2764 E0A020E   1261        DEFB    0E0H,0A0H,20H,0E0H,0E0H ; @
      0E0
'2769 40A0E0A   1262        DEFB    40H,0A0H,0E0H,0A0H,0A0H ; A
      0A0
'276E C0A0C0A   1263        DEFB    0C0H,0A0H,0C0H,0A0H,0C0H  ; B
      0C0
'2773 E080808   1264        DEFB    0E0H,80H,80H,80H,0E0H   ; C
      0E0
'2778 C0A0A0A   1265        DEFB    0C0H,0A0H,0A0H,0A0H,0C0H  ; D
      0C0
'277D E080C08   1266        DEFB    0E0H,80H,0C0H,80H,0E0H  ; E
      0E0
'2    E080C08   1267        DEFB    0E0H,80H,0C0H,80H,80H   ; F
      080
'2787 E080A0A   1268        DEFB    0E0H,80H,0A0H,0A0H,0E0H ; G
      0E0
'278C A0A0E0A   1269        DEFB    0A0H,0A0H,0E0H,0A0H,0A0H  ; H
      0A0
'2791 4040404   1270        DEFB    40H,40H,40H,40H,40H     ; I
      040
```

```
ADDR  CODE      STMT SOURCE STATEMENT
      40
'2796 202020A0  1271          DEFB    20H,20H,20H,0A0H,0E0H   ; J
      E0
'279B A0A0C0A0  1272          DEFB    0A0H,0A0H,0C0H,0A0H,0A0H  ; K
      A0
'27A0 80808080  1273          DEFB    80H,80H,80H,80H,0E0H    ; L
      E0
'27A5 A0E0A0A0  1274          DEFB    0A0H,0E0H,0A0H,0A0H,0A0H  ; M
      A0
'27AA 80E0E0A0  1275          DEFB    80H,0E0H,0E0H,0A0H,0A0H ; N
      A0
'27AF E0A0A0A0  1276          DEFB    0E0H,0A0H,0A0H,0A0H,0E0H  ; O
      E0
'27B4 E0A0E080  1277          DEFB    0E0H,0A0H,0E0H,80H,80H  ; P
      80
'27B9 E0A0A0E0  1278          DEFB    0E0H,0A0H,0A0H,0E0H,20H ; Q
      20
'27BE E0A0C0A0  1279          DEFB    0E0H,0A0H,0C0H,0A0H,0A0H  ; R
      A0
'27C3 6080E020  1280          DEFB    60H,80H,0E0H,20H,0C0H   ; S
      C0
'27C8 E0404040  1281          DEFB    0E0H,40H,40H,40H,40H    ; T
      40
'27CD A0A0A0A0  1282          DEFB    0A0H,0A0H,0A0H,0A0H,0E0H  ; U
      E0
'27D2 A0A0A0A0  1283          DEFB    0A0H,0A0H,0A0H,0A0H,40H ; V
      40
'27D7 A0A0A0E0  1284          DEFB    0A0H,0A0H,0A0H,0E0H,0A0H  ; W
      A0
'27DC A0A040A0  1285          DEFB    0A0H,0A0H,40H,0A0H,0A0H ; X
      A0
'27E1 A0A04040  1286          DEFB    0A0H,0A0H,40H,40H,40H   ; Y
      40
'27E6 E0204080  1287          DEFB    0E0H,20H,40H,80H,0E0H   ; Z
      E0
                1288 ;
'27EB 28432920  1289          DEFM    '(C) 1981 A. GUEVARA'
      31393831
      20412E20
      47554556
      415241
'27FE 00        1290          DEFB    00
                1291 ;
                1292          END
```

ADDR CODE STMT SOURCE STATEMENT

C. S REFERENCE LISTING

SYMBOL	VALUE	TYPE	STMT	STATEMENT REFERENCES
ACALL	218F		0339	0201 0178
ADDR	210E		0250	1015 0199 0176
ADM	263A		1190	0527
ADRG1	4FB6		0029	1153 1121 0628 0528 0397 0388 0378 0311 - 0304 0279 0275 0268 0265 0257
ADRG2	4FB7		0030	
AFG	2224		0458	0443
AFM	2628		1182	0511 0500 0435
BCG	222C		0462	0444
BCLM	269F		1204	1136
BCM	262B		1184	0501
BCOL	4FC9		0045	1141
BKM	2641		1192	1074
BLM	2681		1200	1089
BPE	2007		0051	
BRKPT	256E		1071	0051
C2	4FC7		0043	
CART	219A		0351	1071 0339
CBM	268E		1202	1126
CLEAR	2347		0659	1175 0088
CLF	2410		0805	0715
C	255E		1047	1041
CO2	2568		1055	1042
COLIST	26B9		1213	0080
COLL	254A		1034	0983
COLORS	4FC6		0042	1163 0082 0078
CON	23A9		0723	0810 0716
CONT	204E		0090	0064
COORD	4FC3		0039	0799 0726 0700 0666
CRLF	2405		0799	1144 1134 1124 1085 1072 0903 0690 0570 - 0530 0509 0106
D0	2370		0690	
D1	2375		0692	0687
DEG	2238		0469	0445
DEL	2325		0625	0206
DEM	2630		1186	0502
DEP	200A		0052	
DISP	00D7		0013	1025 0860 0770 0743 0639 0619 0608 0593 - 0427 0423 0400 0376 0361 0252
DISPLA	2359		0675	0052
DOT	237D		0696	0693
DRET	23A4		0717	0691
END	4FC1		0038	0640 0627 0329 0321 0319 0310 0292
ERM	26B2		1206	0866
ERR	2455		0864	0307
EXIT	2565		1052	1055 1049 1046 1044
F	264C		1194	1146
FCOL	4FC8		0044	1152
G1	23C6		0751	0761 0757
GREEN	23C3		0749	0617 0602 0591
HLG	2244		0476	0446
HLIST	246F		0884	1077 0902 0897 0539 0529 0398
HLM	2635		1188	0503
HRZCR	4FBB		0033	1158 131

```
ADDR  CODE      STMT SOURCE STATEMENT

IN1   4FB4      0027    1143  1133  1123  1107  1087  0476  0469  0462
-                       0458  0387  0377  0341  0276  0258  0218  0098
-
IN2   4FB5      0028
INAD  2119      0257    0250  0099
ININT 24C5      0955    0957  0092
INIT  2010      0054    0048
INS   2142      0292    0183
INS1  215A      0303    0297
INS2  2168      0310    0306  0302  0296
INS3  217E      0321    0316
IOB   4FAE      0023    0984  0811  0680  0615  0598  0583  0575  0409
-                       0101
KEYGET 2496     0913    0913  0113
KEYN  4FAF      0024    0919
KG1   24A3      0921    0925
KG2   24AF      0930    0923
KG3   24B2      0932    0935
KG4   24B8      0936    0933
LA1   21F7      0419    0425
LA2   21FE      0423    0421
LA3   2202      0426    0412
LASC  21F1      0416    0411
LFLG  4FBC      0034    0547  0396  0371  0254  0104
LIST  21AC      0371    0179
LPINT 4FB0      0025    0969
M0JT  20BA      0176    0236
M1JT  20CA      0188    0243
M1RT  210D      0245    0195  0194  0193  0190  0188
M2JT  20DA      0199    0557
M30   25A7      1110    0211
M300  25B0      1117    1115
M301  25B2      1119    1120
M302  25B6      1121    1113
M31   25CA      1131    0212
M32   25DE      1141    0213
M33   25F2      1152    0214
M331  2614      1171    1173
M3JT  20EA      0211    1105
M4BA  4FCA      0046    0653
MAIN  207D      0110    0110
MDTBL 20B0      0166    0132
MLIST 21C0      0384    0390
MOD0  22B0      0545    0867  0642  0620  0609  0594  0577  0571  0531
-                       0497
MODE  4FAD      0022    1179  1093  1026  0546  0433  0358  0128  0102
-                       0068
MODE0 2100      0233    0166
MODE1 2107      0240    0167
MODE2 22BB      0553    0168
MODE3 2597      1099    0169
MODE4 2343      0652    1028  0170
NORM  23D0      0759    0362  0301
NUM1  23DA      0769    0766
NUMBER 20F2     0218    1011  0127
NUMDIS 23D4     0765    0881  0878  0229
OK    237F      0697    0695
OK1   2392      0706    0704
```

```
ADDR  CODE      STMT SOURCE STATEMENT

OI    26B6        1208    0108
OL1   21E0        0402    0407
OUTLN 21CF        0395    0384  0380  0373
POPT  4FC5        0041    0751  0701  0548  0103
PR1   2306        0604    0600
PR2   230D        0607    0603
PRINT 22F8        0597    0202
PW2   4FC0        0037    0096  0062
PWRUP 4FBE        0036    0094  0056
READ  2124        0265    0402  0177
READY 2478        0891    1176  0089
RED   23CB        0755    0864  0638  0604  0588  0359  0298
REG   2206        0432    0181
RFG   4FBD        0035    1178  1148  1138  1128  1102  1091  0508  0496
-                         0489  0485  0482  0452  0437  0105
RGDIS 245E        0872    0887  0885  0516  0269
RGTBL 2213        0443    0455
RLIST 2273        0507    1078  0483  0191
RMSG  2663        1198    0899
RMTBL 226B        0500    0492
RP1   2264        0495    0487
RPLUS 2251        0485    0540  0517  0474  0467  0460  0189
RWRT  221B        0452    0192
SCINT 4FB2        0026    0971
SCR1  23FB        0790    0784
SI    NT 256C     1061    0970
SCRLN 4FBA        0032    1168  1154  0775  0087
SCRN  4FB8        0031    1174  0900  0892  0781  0660  0085
SCROLL 23DE       0775    0809
SCRSP 2582        1085    0097
SEP   200D        0053
SKYD  0013        0012
SMLCHR 26C4       1229    1225
SMLFNT 26BD       1220    0708
SPACE 2451        0859    0401  0280  0270
STAR0 219D        0357    0182
STAR2 2313        0612    0205
START 2000        0048    1079
STR1  23BB        0740    0745  0493
STRDIS 23B5       0733    0053
STRING 00DF       0014    1145  1135  1125  1088  1073  0898  0865  0526
-                         0510  0434  0299  0107
STSPC 2026        0065    0060
SWDIS 22A4        0535    0524  0522  0520
SYSSUK 00FF       0015    1103  0915  0814  0555  0490  0453  0241  0234
-                         0130  0116  0090  0065
SYSTEM 00FF       0016    1164  1161  0802  0795  0727  0709  0663
TADIS 22D2        0573    0204
TAPIN 22C2        0562    0574  0200
TAPINT 24EC       0980    0968
T/    JT 22DD     0582    0203
TI1   24F1        0984
TI2   2503        0992    0988
TI3   2514        1004    0994
TI3A  251E        1009    1024
TI4   2526        1013    1008
TI5   2531        1019    1013
TID   253D        1025    10[illegible]  1020  1006  [illegible]  0991  0986
```

ADDR	CODE	STMT	SOURCE	STATEMENT			
TIX	253E		1026	1053	1018	1012	1002
TO1	22ED		0590	0585			
TO2	22F2		0592	0589			
TTT	2098		0139	0118			
TW1	242A		0829	0831			
TW2	2432		0833	0853			
TW3	2434		0834	0835			
TW4	243C		0841	0844			
TW5	244B		0851	0849			
TWRT	2427		0826	0699	0689	0682	
UPRAM	4F50		0017	0893	0293		
UPSTK	4FAC		0021	0055			
WAM	2659		1196	0300			
WRITE	2133		0275	0999	0989	0328	0180

ERRORS=0000

APPENDIX B:

Z-80 Instruction Set

```
     Z80 OPCODE LISTING                SD SYSTEMS Z80 ASSEMBLER PAGE 0001
ADDR  CODE      STMT SOURCE STATEMENT

                0002 ; PSEUDO OPS
                0003 ;
 >0000          0004        ORG     0         ;ORIGIN (STARTING ADDRESS)
                0005 ;
'0000  AA       0006        DEFB    0AAH      ;DEFINE BYTE
'0001  BBAA     0007        DEFW    0AABBH    ;DEFINE WORD
'0003  41424344 0008        DEFM    'ABCD'    ;DEFINE MESSAGE
 >0007          0009 NN     DEFS    2         ;DEFINE STORAGE (2 BYTES)
 >0005          0010 IND    EQU     5         ;DISPLACEMENT  (IX,IY)
 >0020          0011 N      EQU     20H       ;AN IMMEDIATE VALUE
 >0030          0012 DIS    EQU     30H       ;DISPLACEMENT FOR RELATIVE JUMPS
                0013 ;
                0014 ;
                0015 ;
                0016 ; Z80 OPCODES
                0017 ;
'0009  8E       0018        ADC     A,(HL)  ;ADD BYTE AT (HL) TO A W/CARRY
'000A  DD8E05   0019        ADC     A,(IX+IND)
'000D  FD8E05   0020        ADC     A,(IY+IND)  ;IND=05 FOR ASS'Y PURPOSES
'0010  8F       0021        ADC     A,A
'0011  88       0022        ADC     A,B
'0012  89       0023        ADC     A,C
'0013  8A       0024        ADC     A,D
'0014  8B       0025        ADC     A,E
'0015  8C       0026        ADC     A,H
'0016  8D       0027        ADC     A,L
'0     CE20     0028        ADC     A,N     ;N=20H FOR ASSEMBLY
'00.7  ED4A     0029        ADC     HL,BC   ;ADD HL TO BC W/CARRY
'001B  ED5A     0030        ADC     HL,DE
'001D  ED6A     0031        ADC     HL,HL
'001F  ED7A     0032        ADC     HL,SP
                0033 ;
'0021  86       0034        ADD     A,(HL)
'0022  DD8605   0035        ADD     A,(IX+IND)
'0025  FD8605   0036        ADD     A,(IY+IND)
'0028  87       0037        ADD     A,A
'0029  80       0038        ADD     A,B
'002A  81       0039        ADD     A,C
'002B  82       0040        ADD     A,D
'002C  83       0041        ADD     A,E
'002D  84       0042        ADD     A,H
'002E  85       0043        ADD     A,L
'002F  C620     0044        ADD     A,N
'0031  09       0045        ADD     HL,BC
'0032  19       0046        ADD     HL,DE
'0033  29       0047        ADD     HL,HL
'0034  39       0048        ADD     HL,SP
'0035  DD09     0049        ADD     IX,BC
'0037  DD19     0050        ADD     IX,DE
'0039  DD29     0051        ADD     IX,IX
'003B  DD39     0052        ADD     IX,SP
'0     FD09     0053        ADD     IY,BC
'00..  FD19     0054        ADD     IY,DE
'0041  FD29     0055        ADD     IY,IY
'0043  FD39     0056        ADD     IY,SP
                0057 ;
'0045  A6       0058        AND     (HL)    ;LOGICAL 'AND' A AND
                0059                        ;BYTE ADDR BY HL
```

```
 ADDR   CODE       STMT SOURCE STATEMENT

'0046   DDA605     0060          AND     (IX+IND)
'0049   FDA605     0061          AND     (IY+IND)
'004C   A7         0062          AND     A
'004D   A0         0063          AND     B
'004E   A1         0064          AND     C
'004F   A2         0065          AND     D
'0050   A3         0066          AND     E
'0051   A4         0067          AND     H
'0052   A5         0068          AND     L
'0053   E620       0069          AND     N
                   0070 ;
'0055   CB46       0071          BIT     0,(HL)   ;TEST BIT 0 IN BYTE ADDR BY HL
'0057   DDCB0546   0072          BIT     0,(IX+IND)
'005B   FDCB0546   0073          BIT     0,(IY+IND)
'005F   CB47       0074          BIT     0,A
'0061   CB40       0075          BIT     0,B
'0063   CB41       0076          BIT     0,C
'0065   CB42       0077          BIT     0,D
'0067   CB43       0078          BIT     0,E
'0069   CB44       0079          BIT     0,H
'006B   CB45       0080          BIT     0,L
                   0081 ;
'006D   CB4E       0082          BIT     1,(HL)
'006F   DDCB054E   0083          BIT     1,(IX+IND)
'0073   FDCB054E   0084          BIT     1,(IY+IND)
'0077   CB4F       0085          BIT     1,A
'0079   CB48       0086          BIT     1,B
'007B   CB49       0087          BIT     1,C
'007D   CB4A       0088          BIT     1,D
'007F   CB4B       0089          BIT     1,E
'0081   CB4C       0090          BIT     1,H
'0083   CB4D       0091          BIT     1,L
                   0092 ;
'0085   CB56       0093          BIT     2,(HL)
'0087   DDCB0556   0094          BIT     2,(IX+IND)
'008B   FDCB0556   0095          BIT     2,(IY+IND)
'008F   CB57       0096          BIT     2,A
'0091   CB50       0097          BIT     2,B
'0093   CB51       0098          BIT     2,C
'0095   CB52       0099          BIT     2,D
'0097   CB53       0100          BIT     2,E
'0099   CB54       0101          BIT     2,H
'009B   CB55       0102          BIT     2,L
                   0103 ;
'009D   CB5E       0104          BIT     3,(HL)
'009F   DDCB055E   0105          BIT     3,(IX+IND)
'00A3   FDCB055E   0106          BIT     3,(IY+IND)
'00A7   CB5F       0107          BIT     3,A
'00A9   CB58       0108          BIT     3,B
'00AB   CB59       0109          BIT     3,C
'00AD   CB5A       0110          BIT     3,D
'00AF   CB5B       0111          BIT     3,E
'00B1   CB5C       0112          BIT     3,H
'00B3   CB5D       0113          BIT     3,L
                   0114 ;
'00B5   CB66       0115          BIT     4,(HL)
'00B7   DDCB0566   0116          BIT     4,(IX+IND)
'00BB   FDCB0566   0117          BIT     4,(IY+IND)
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 ADDR  CODE      STMT SOURCE STATEMENT

*00??  CB67      0118          BIT     4,A
*0     CB60      0119          BIT     4,B
*00C3  CB61      0120          BIT     4,C
*00C5  CB62      0121          BIT     4,D
*00C7  CB63      0122          BIT     4,E
*00C9  CB64      0123          BIT     4,H
*00CB  CB65      0124          BIT     4,L
                 0125 ;
*00CD  CB6E      0126          BIT     5,(HL)
*00CF  DDCB056E  0127          BIT     5,(IX+IND)
*00D3  FDCB056E  0128          BIT     5,(IY+IND)
*00D7  CB6F      0129          BIT     5,A
*00D9  CB68      0130          BIT     5,B
*00DB  CB69      0131          BIT     5,C
*00DD  CB6A      0132          BIT     5,D
*00DF  CB6B      0133          BIT     5,E
*00E1  CB6C      0134          BIT     5,H
*00E3  CB6D      0135          BIT     5,L
                 0136 ;
*00E5  CB76      0137          BIT     6,(HL)
*00E7  DDCB0576  0138          BIT     6,(IX+IND)
*00EB  FDCB0576  0139          BIT     6,(IY+IND)
*00EF  CB77      0140          BIT     6,A
*00F1  CB70      0141          BIT     6,B
*00F3  CB71      0142          BIT     6,C
*00F5  CB72      0143          BIT     6,D
*0     CB73      0144          BIT     6,E
*00F9  CB74      0145          BIT     6,H
*00FB  CB75      0146          BIT     6,L
                 0147 ;
*00FD  CB7E      0148          BIT     7,(HL)
*00FF  DDCB057E  0149          BIT     7,(IX+IND)
*0103  FDCB057E  0150          BIT     7,(IY+IND)
*0107  CB7F      0151          BIT     7,A
*0109  CB78      0152          BIT     7,B
*010B  CB79      0153          BIT     7,C
*010D  CB7A      0154          BIT     7,D
*010F  CB7B      0155          BIT     7,E
*0111  CB7C      0156          BIT     7,H
*0113  CB7D      0157          BIT     7,L
                 0158 ;
*0115  DC0700'   0159          CALL    C,NN   ;CALL SUBROUTINE AT NN IF CARRY=1
*0118  FC0700'   0160          CALL    M,NN     ;CALL IF RESULT MINUS
*011B  D40700'   0161          CALL    NC,NN    ;CALL IF NO CARRY
*011E  CD0700'   0162          CALL    NN       ;UNCONDITIONAL CALL
*0121  C40700'   0163          CALL    NZ,NN    ;CALL IF RESULT NONZERO
*0124  F40700'   0164          CALL    P,NN     ;CALL IF RESULT POSITIVE
*0127  EC0700'   0165          CALL    PE,NN    ;IF PARITY EVEN
*012A  E40700'   0166          CALL    PO,NN    ;IF PARITY ODD
*012D  CC0700'   0167          CALL    Z,NN     ;IF RESULTS ZERO
                 0168 ;
*0     3F        0169          CCF              ;COMPLEMENT CARRY FLAG
                 0170 ;
*0131  BE        0171          CP      (HL)     ;COMPARE BYTE ADDR BY HL WITH A
                 0172          ;IF EQUAL, Z=1 (RESULTS ZERO)
                 0173          ;IF A GREATER, RESULTS POSITIVE
                 0174          ;IF A SMALLER, RESULTS NEGATIVE (CARRY=1)
*0132  DDBE05    0175          CP      (IX+IND)
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 ADDR   CODE      STMT SOURCE STATEMENT

'0135   FDBE05    0176         CP     (IY+IND)
'0138   BF        0177         CP     A
'0139   B8        0178         CP     B
'013A   B9        0179         CP     C
'013B   BA        0180         CP     D
'013C   BB        0181         CP     E
'013D   BC        0182         CP     H
'013E   BD        0183         CP     L
'013F   FE20      0184         CP     N
                  0185 ;
'0141   EDA9      0186         CPD   ;COMPARE BYTE AT (HL) WITH A, DECR HL & BC
'0143   EDB9      0187         CPDR     ;AS ABOVE, REPEAT UNTIL BC=0
'0145   EDA1      0188         CPI      ;AS ABOVE, INCR HL, DECR BC, NO REPEAT
'0147   EDB1      0189         CPIR     ;AS IN CPI, REPEAT UNTIL BC=0
                  0190 ;
'0149   2F        0191         CPL              ;1'S COMPEMENT A
                  0192 ;
'014A   27        0193         DAA      ;DECIMALLY ADJUST A (MAKE A BCD NUMBER)
                  0194 ;
'014B   35        0195         DEC      (HL)     ;DECREMENT BYTE AT (HL)
'014C   DD3505    0196         DEC      (IX+IND)
'014F   FD3505    0197         DEC      (IY+IND)
'0152   3D        0198         DEC      A
'0153   05        0199         DEC      B
'0154   0B        0200         DEC      BC
'0155   0D        0201         DEC      C
'0156   15        0202         DEC      D
'0157   1B        0203         DEC      DE
'0158   1D        0204         DEC      E
'0159   25        0205         DEC      H
'015A   2B        0206         DEC      HL
'015B   DD2B      0207         DEC      IX
'015D   FD2B      0208         DEC      IY
'015F   2D        0209         DEC      L
'0160   3B        0210         DEC      SP
                  0211 ;
'0161   F3        0212         DI               ;DISABLE INTERRUPTS
                  0213 ;
'0162   102E      0214         DJNZ     DIS  ;DECR. B, ADD 'DIS' TO PC IF B<>0
                  0215 ;
'0164   FB        0216         EI               ;ENABLE INTERRUPTS
                  0217 ;
'0165   E3        0218         EX       (SP),HL ;EXCHANGE BYTE POINTED TO
                  0219                          ;BY STACK POINTER WITH HL
'0166   DDE3      0220         EX       (SP),IX
'0168   FDE3      0221         EX       (SP),IY
'016A   08        0222         EX       AF,AF'  ;EXCHANGE A WITH ALTERNATE A REG
'016B   EB        0223         EX       DE,HL
'016C   D9        0224         EXX      ;EXCHANGE PRIMARY REG SET WITH ALTERNATE
                  0225 ;
'016D   76        0226         HALT     ;WAIT FOR INTERRUPT OR RESET
                  0227 ;
'016E   ED46      0228         IM       0        ;SET INTERRUPT MODE TO 0
'0170   ED56      0229         IM       1
'0172   ED5E      0230         IM       2
                  0231 ;
'0174   ED78      0232         IN       A,(C)    ;INPUT TO A FROM PORT SPEC'D BY (
'0176   DB20      0233         IN       A,(N)    ;AS ABOVE FROM PORT N,
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ADDR  CODE      STMT SOURCE STATEMENT

              0234                          ;WHERE N CAN TAKE ANY VALUE
'0    ED40      0235        IN      B,(C)
'01A  ED48      0236        IN      C,(C)
'017C ED50      0237        IN      D,(C)
'017E ED58      0238        IN      E,(C)
'0180 ED70      0239        IN      F,(C)
'0182 ED60      0240        IN      H,(C)
'0184 ED68      0241        IN      L,(C)
              0242 ;
'0186 34        0243        INC     (HL)    ;INCREMENT BYTE AT (HL)
'0187 FD3405    0244        INC     (IY+IND)
'018A DD3405    0245        INC     (IX+IND)
'018D 3C        0246        INC     A
'018E 04        0247        INC     B
'018F 03        0248        INC     BC
'0190 0C        0249        INC     C
'0191 14        0250        INC     D
'0192 13        0251        INC     DE
'0193 1C        0252        INC     E
'0194 24        0253        INC     H
'0195 23        0254        INC     HL
'0196 DD23      0255        INC     IX
'0198 FD23      0256        INC     IY
'019A 2C        0257        INC     L
'019B 33        0258        INC     SP
              0259 ;
'0    EDAA      0260        IND     ;LOAD BYTE AT (HL) WITH INPUT
              0261                ;FROM PORT (C), DECR. HL AND B
'019E EDBA      0262        INDR    ;AS ABOVE, REPEAT UNTIL B=0
'01A0 EDA2      0263        INI     ;AS ABOVE, INCR. HL, DECR. B,NO REPEAT
'01A2 EDB2      0264        INIR    ;AS INI, REPEAT UNTIL B=0
              0265 ;
'01A4 E9        0266        JP      (HL)    ;JUMP TO ADDRESS IN HL
'01A5 DDE9      0267        JP      (IX)
'01A7 FDE9      0268        JP      (IY)
'01A9 DA0700'   0269        JP      C,NN
'01AC FA0700'   0270        JP      M,NN
'01AF D20700'   0271        JP      NC,NN
'01B2 C30700'   0272        JP      NN
'01B5 C20700'   0273        JP      NZ,NN
'01B8 F20700'   0274        JP      P,NN
'01BB EA0700'   0275        JP      PE,NN
'01BE E20700'   0276        JP      PO,NN
'01C1 CA0700'   0277        JP      Z,NN
              0278 ;
'01C4 382E      0279        JR      C,DIS
'01C6 182E      0280        JR      DIS     ;ADD 'DIS' TO PC (JUMP RELATIVE)
'01C8 302E      0281        JR      NC,DIS  ;DIS=2EH FOR ASSEMBLY
'01CA 202E      0282        JR      NZ,DIS
'01CC 282E      0283        JR      Z,DIS
              0284 ;
'0    02        0285        LD      (BC),A  ;LOAD BYTE AT (BC) WITH A
'01CF 12        0286        LD      (DE),A
'01D0 77        0287        LD      (HL),A
'01D1 70        0288        LD      (HL),B
'01D2 71        0289        LD      (HL),C
'01D3 72        0290        LD      (HL),D
'01D4 73        0291        LD      (HL),E
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ADDR   CODE       STMT SOURCE STATEMENT

'01D5  74         0292          LD      (HL),H
'01D6  75         0293          LD      (HL),L
'01D7  3620       0294          LD      (HL),N
                  0295 ;
'01D9  DD7705     0296          LD      (IX+IND),A  ;LOAD BYTE AT (IX)
                  0297                              ;PLUS 'IND' WITH A
'01DC  DD7005     0298          LD      (IX+IND),B
'01DF  DD7105     0299          LD      (IX+IND),C
'01E2  DD7205     0300          LD      (IX+IND),D
'01E5  DD7305     0301          LD      (IX+IND),E
'01E8  DD7405     0302          LD      (IX+IND),H
'01EB  DD7505     0303          LD      (IX+IND),L
'01EE  DD360520   0304          LD      (IX+IND),N
                  0305 ;
'01F2  FD7705     0306          LD      (IY+IND),A
'01F5  FD7005     0307          LD      (IY+IND),B
'01F8  FD7105     0308          LD      (IY+IND),C
'01FB  FD7205     0309          LD      (IY+IND),D
'01FE  FD7305     0310          LD      (IY+IND),E
'0201  FD7405     0311          LD      (IY+IND),H
'0204  FD7505     0312          LD      (IY+IND),L
'0207  FD360520   0313          LD      (IY+IND),N
                  0314 ;
'020B  320700'    0315          LD      (NN),A  ;STORE A AT LOCATION NN
'020E  ED430700'  0316          LD      (NN),BC
'0212  ED530700'  0317          LD      (NN),DE
'0216  220700'    0318          LD      (NN),HL
'0219  DD220700'  0319          LD      (NN),IX
'021D  FD220700'  0320          LD      (NN),IY
'0221  ED730700'  0321          LD      (NN),SP
                  0322 ;
'0225  0A         0323          LD      A,(BC)  ;LOAD A FROM BYTE ADDR BY BC
'0226  1A         0324          LD      A,(DE)
'0227  7E         0325          LD      A,(HL)
'0228  DD7E05     0326          LD      A,(IX+IND)
'022B  FD7E05     0327          LD      A,(IY+IND)
'022E  3A0700'    0328          LD      A,(NN)
'0231  7F         0329          LD      A,A
'0232  78         0330          LD      A,B
'0233  79         0331          LD      A,C
'0234  7A         0332          LD      A,D
'0235  7B         0333          LD      A,E
'0236  7C         0334          LD      A,H
'0237  ED57       0335          LD      A,I
'0239  7D         0336          LD      A,L
'023A  3E20       0337          LD      A,N
'023C  ED5F       0338          LD      A,R
                  0339 ;
'023E  46         0340          LD      B,(HL)
'023F  DD4605     0341          LD      B,(IX+IND)
'0242  FD4605     0342          LD      B,(IY+IND)
'0245  47         0343          LD      B,A
'0246  40         0344          LD      B,B
'0247  41         0345          LD      B,C
'0248  42         0346          LD      B,D
'0249  43         0347          LD      B,E
'024A  44         0348          LD      B,H
'024B  45         0349          LD      B,L
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 ADDR   CODE       STMT SOURCE STATEMENT
'024C   0620       0350          LD      B,N
                   0351 ;
'024E   ED4B0700'  0352          LD      BC,(NN)
'0252   010700'    0353          LD      BC,NN
                   0354 ;
'0255   4E         0355          LD      C,(HL)
'0256   DD4E05     0356          LD      C,(IX+IND)
'0259   FD4E05     0357          LD      C,(IY+IND)
'025C   4F         0358          LD      C,A
'025D   48         0359          LD      C,B
'025E   49         0360          LD      C,C
'025F   4A         0361          LD      C,D
'0260   4B         0362          LD      C,E
'0261   4C         0363          LD      C,H
'0262   4D         0364          LD      C,L
'0263   0E20       0365          LD      C,N
                   0366 ;
'0265   56         0367          LD      D,(HL)
'0266   DD5605     0368          LD      D,(IX+IND)
'0269   FD5605     0369          LD      D,(IY+IND)
'026C   57         0370          LD      D,A
'026D   50         0371          LD      D,B
'026E   51         0372          LD      D,C
'026F   52         0373          LD      D,D
'0270   53         0374          LD      D,E
'0271   54         0375          LD      D,H
'0      55         0376          LD      D,L
'02     1620       0377          LD      D,N
                   0378 ;
'0275   ED5B0700'  0379          LD      DE,(NN)
'0279   110700'    0380          LD      DE,NN
                   0381 ;
'027C   5E         0382          LD      E,(HL)
'027D   DD5E05     0383          LD      E,(IX+IND)
'0280   FD5E05     0384          LD      E,(IY+IND)
'0283   5F         0385          LD      E,A
'0284   58         0386          LD      E,B
'0285   59         0387          LD      E,C
'0286   5A         0388          LD      E,D
'0287   5B         0389          LD      E,E
'0288   5C         0390          LD      E,H
'0289   5D         0391          LD      E,L
'028A   1E20       0392          LD      E,N
                   0393 ;
'028C   66         0394          LD      H,(HL)
'028D   DD6605     0395          LD      H,(IX+IND)
'0290   FD6605     0396          LD      H,(IY+IND)
'0293   67         0397          LD      H,A
'0294   60         0398          LD      H,B
'0295   61         0399          LD      H,C
'0      62         0400          LD      H,D
'0      63         0401          LD      H,E
'0298   64         0402          LD      H,H
'0299   65         0403          LD      H,L
'029A   2620       0404          LD      H,N
                   0405 ;
'029C   2A0700'    0406          LD      HL,(NN)
'029F   210700'    0407          LD      HL,NN
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 ADDR  CODE      STMT SOURCE STATEMENT

                 0408 ;
'02A2  ED47      0409          LD      I,A
                 0410 ;
'02A4  DD2A0700' 0411          LD      IX,(NN)
'02A8  DD210700' 0412          LD      IX,NN
                 0413 ;
'02AC  FD2A0700' 0414          LD      IY,(NN)
'02B0  FD210700' 0415          LD      IY,NN
                 0416 ;
'02B4  6E        0417          LD      L,(HL)
'02B5  DD6E05    0418          LD      L,(IX+IND)
'02B8  FD6E05    0419          LD      L,(IY+IND)
'02BB  6F        0420          LD      L,A
'02BC  68        0421          LD      L,B
'02BD  69        0422          LD      L,C
'02BE  6A        0423          LD      L,D
'02BF  6B        0424          LD      L,E
'02C0  6C        0425          LD      L,H
'02C1  6D        0426          LD      L,L
'02C2  2E20      0427          LD      L,N
                 0428 ;
'02C4  ED4F      0429          LD      R,A
                 0430 ;
'02C6  ED7B0700' 0431          LD      SP,(NN)
'02CA  F9        0432          LD      SP,HL
'02CB  DDF9      0433          LD      SP,IX
'02CD  FDF9      0434          LD      SP,IY
'02CF  310700'   0435          LD      SP,NN
                 0436 ;
'02D2  EDA8      0437          LDD     ;LOAD BYTE AT (DE) WITH BYTE AT (HL)
                 0438                  ;DECR. DE, HL, BC
'02D4  EDB8      0439          LDDR    ;AS ABOVE, REPEAT UNTIL BC=0.
'02D6  EDA0      0440          LDI     ;AS LDD, BUT INCR. DE, HL, DECR. BC
'02D8  EDB0      0441          LDIR    ;AS LDI, REPEAT UNTIL BC=0
                 0442 ;
'02DA  ED44      0443          NEG             ;2'S COMPLEMENT A
                 0444 ;
'02DC  00        0445          NOP             ;NO-OP (DO NOTHING)
                 0446 ;
'02DD  B6        0447          OR      (HL)  ;LOGICAL 'OR' A AND BYTE AT (HL)
'02DE  DDB605    0448          OR      (IX+IND)
'02E1  FDB605    0449          OR      (IY+IND)
'02E4  B7        0450          OR      A
'02E5  B0        0451          OR      B
'02E6  B1        0452          OR      C
'02E7  B2        0453          OR      D
'02E8  B3        0454          OR      E
'02E9  B4        0455          OR      H
'02EA  B5        0456          OR      L
'02EB  F620      0457          OR      N
                 0458 ;
'02ED  EDBB      0459          OTDR    ;LOAD OUTPUT PORT (C) WITH BYTE AT (HL)
                 0460                  ;DECR. HL AND B, REPEAT UNTIL B=0
'02EF  EDB3      0461          OTIR    ;AS ABOVE, BUT INCR. HL
                 0462 ;
'02F1  ED79      0463          OUT     (C),A   ;OUTPUT A TO PORT SPEC'D BY C
'02F3  ED41      0464          OUT     (C),B
'02F5  ED49      0465          OUT     (C),C
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 ADDR   CODE       STMT SOURCE STATEMENT

*02F7   ED51       0466          OUT     (C),D
*02F9   ED59       0467          OUT     (C),E
*02FB   ED61       0468          OUT     (C),H
*02FD   ED69       0469          OUT     (C),L
*02FF   D320       0470          OUT     (N),A    ;OUTPUT A TO PORT N
                   0471 ;
*0301   EDAB       0472          OUTD    ;AS OTDR, BUT NO REPEAT
*0303   EDA3       0473          OUTI    ;AS OTIR, BUT NO REPEAT
                   0474 ;
*0305   F1         0475          POP     AF       ;RETRIEVE A FROM STACK
*0306   C1         0476          POP     BC
*0307   D1         0477          POP     DE
*0308   E1         0478          POP     HL
*0309   DDE1       0479          POP     IX
*030B   FDE1       0480          POP     IY
                   0481 ;
*030D   F5         0482          PUSH    AF       ;PUT A ON STACK
*030E   C5         0483          PUSH    BC
*030F   D5         0484          PUSH    DE
*0310   E5         0485          PUSH    HL
*0311   DDE5       0486          PUSH    IX
*0313   FDE5       0487          PUSH    IY
                   0488 ;
*0315   CB86       0489          RES     0,(HL)   ;RESET (MAKE 0) BIT 0
                   0490                           ;OF BYTE AT (HL)
*0317   DDCB0586   0491          RES     0,(IX+IND)
*031B   FDCB0586   0492          RES     0,(IY+IND)
*031F   CB87       0493          RES     0,A
*0321   CB80       0494          RES     0,B
*0323   CB81       0495          RES     0,C
*0325   CB82       0496          RES     0,D
*0327   CB83       0497          RES     0,E
*0329   CB84       0498          RES     0,H
*032B   CB85       0499          RES     0,L
                   0500 ;
*032D   CB8E       0501          RES     1,(HL)
*032F   DDCB058E   0502          RES     1,(IX+IND)
*0333   FDCB058E   0503          RES     1,(IY+IND)
*0337   CB8F       0504          RES     1,A
*0339   CB88       0505          RES     1,B
*033B   CB89       0506          RES     1,C
*033D   CB8A       0507          RES     1,D
*033F   CB8B       0508          RES     1,E
*0341   CB8C       0509          RES     1,H
*0343   CB8D       0510          RES     1,L
                   0511 ;
*0345   CB96       0512          RES     2,(HL)
*0347   DDCB0596   0513          RES     2,(IX+IND)
*034B   FDCB0596   0514          RES     2,(IY+IND)
*034F   CB97       0515          RES     2,A
*0351   CB90       0516          RES     2,B
*0353   CB91       0517          RES     2,C
*0355   CB92       0518          RES     2,D
*0357   CB93       0519          RES     2,E
*0359   CB94       0520          RES     2,H
*035B   CB95       0521          RES     2,L
                   0522 ;
*035D   CB9E       0523          RES     3,(HL)
```

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 ADDR   CODE       STMT SOURCE STATEMENT

'035F   DDCB059E   0524          RES     3,(IX+IND)
'0363   FDCB059E   0525          RES     3,(IY+IND)
'0367   CB9F       0526          RES     3,A
'0369   CB98       0527          RES     3,B
'036B   CB99       0528          RES     3,C
'036D   CB9A       0529          RES     3,D
'036F   CB9B       0530          RES     3,E
'0371   CB9C       0531          RES     3,H
'0373   CB9D       0532          RES     3,L
                   0533 ;
'0375   CBA6       0534          RES     4,(HL)
'0377   DDCB05A6   0535          RES     4,(IX+IND)
'037B   FDCB05A6   0536          RES     4,(IY+IND)
'037F   CBA7       0537          RES     4,A
'0381   CBA0       0538          RES     4,B
'0383   CBA1       0539          RES     4,C
'0385   CBA2       0540          RES     4,D
'0387   CBA3       0541          RES     4,E
'0389   CBA4       0542          RES     4,H
'038B   CBA5       0543          RES     4,L
                   0544 ;
'038D   CBAE       0545          RES     5,(HL)
'038F   DDCB05AE   0546          RES     5,(IX+IND)
'0393   FDCB05AE   0547          RES     5,(IY+IND)
'0397   CBAF       0548          RES     5,A
'0399   CBA8       0549          RES     5,B
'039B   CBA9       0550          RES     5,C
'039D   CBAA       0551          RES     5,D
'039F   CBAB       0552          RES     5,E
'03A1   CBAC       0553          RES     5,H
'03A3   CBAD       0554          RES     5,L
                   0555 ;
'03A5   CBB6       0556          RES     6,(HL)
'03A7   DDCB05B6   0557          RES     6,(IX+IND)
'03AB   FDCB05B6   0558          RES     6,(IY+IND)
'03AF   CBB7       0559          RES     6,A
'03B1   CBB0       0560          RES     6,B
'03B3   CBB1       0561          RES     6,C
'03B5   CBB2       0562          RES     6,D
'03B7   CBB3       0563          RES     6,E
'03B9   CBB4       0564          RES     6,H
'03BB   CBB5       0565          RES     6,L
                   0566 ;
'03BD   CBBE       0567          RES     7,(HL)
'03BF   DDCB05BE   0568          RES     7,(IX+IND)
'03C3   FDCB05BE   0569          RES     7,(IY+IND)
'03C7   CBBF       0570          RES     7,A
'03C9   CBB8       0571          RES     7,B
'03CB   CBB9       0572          RES     7,C
'03CD   CBBA       0573          RES     7,D
'03CF   CBBB       0574          RES     7,E
'03D1   CBBC       0575          RES     7,H
'03D3   CBBD       0576          RES     7,L
                   0577 ;
'03D5   C9         0578          RET                     ;RETURN FROM SUBROUTINE
'03D6   D8         0579          RET     C
'03D7   F8         0580          RET     M
'03D8   D0         0581          RET     NC
```

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 ADDR   CODE       STMT SOURCE STATEMENT

'03D9   C0         0582         RET     NZ
'0      F0         0583         RET     P
'03DB   E8         0584         RET     PE
'03DC   E0         0585         RET     PO
'03DD   C8         0586         RET     Z
                   0587 ;
'03DE   ED4D       0588         RETI    ;RETURN FROM INTERRUPT ROUTINE
'03E0   ED45       0589         RETN    ;RETURN FROM NONMASKABLE INTERRUPT
                   0590 ;
'03E2   CB16       0591         RL      (HL)  ;ROTATE LEFT THRU CY, BYTE AT (HL)
'03E4   DDCB0516   0592         RL      (IX+IND)
'03E8   FDCB0516   0593         RL      (IY+IND)
'03EC   CB17       0594         RL      A       ;ROTATE A LEFT THRU CARRY
'03EE   CB10       0595         RL      B
'03F0   CB11       0596         RL      C
'03F2   CB12       0597         RL      D
'03F4   CB13       0598         RL      E
'03F6   CB14       0599         RL      H
'03F8   CB15       0600         RL      L
                   0601 ;
'03FA   17         0602         RLA             ;SAME AS RL  A
                   0603 ;
'03FB   CB06       0604         RLC     (HL)
'03FD   DDCB0506   0605         RLC     (IX+IND)
'0401   FDCB0506   0606         RLC     (IY+IND)
'0405   CB07       0607         RLC     A  ;ROTATE A CIRCULAR WITHOUT CY
'0      CB00       0608         RLC     B
'0409   CB01       0609         RLC     C
'040B   CB02       0610         RLC     D
'040D   CB03       0611         RLC     E
'040F   CB04       0612         RLC     H
'0411   CB05       0613         RLC     L
                   0614 ;
'0413   07         0615         RLCA            ;SAME AS RLC  A
                   0616 ;
'0414   ED6F       0617         RLD     ;ROTATE DIGIT (4 BITS) LEFT AND RIGHT
                   0618                 ;BETWEEN A AND (HL)
                   0619 ;
'0416   CB1E       0620         RR      (HL)  ;ROTATE RT (THRU CY) BYTE AT (HL)
'0418   DDCB051E   0621         RR      (IX+IND)
'041C   FDCB051E   0622         RR      (IY+IND)
'0420   CB1F       0623         RR      A
'0422   CB18       0624         RR      B
'0424   CB19       0625         RR      C
'0426   CB1A       0626         RR      D
'0428   CB1B       0627         RR      E
'042A   CB1C       0628         RR      H
'042C   CB1D       0629         RR      L
                   0630 ;
'042E   1F         0631         RRA             ;SAME AS RR  A
                   0632 ;
'0      CB0E       0633         RRC     (HL)  ;ROTATE RT CIRCULAR BYTE AT (HL)
'0431   DDCB050E   0634         RRC     (IX+IND)
'0435   FDCB050E   0635         RRC     (IY+IND)
'0439   CB0F       0636         RRC     A
'043B   CB08       0637         RRC     B
'043D   CB09       0638         RRC     C
'043F   CB0A       0639         RRC     D
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 ADDR   CODE       STMT SOURCE STATEMENT

*0441   CB0B       0640          RRC     E
*0443   CB0C       0641          RRC     H
*0445   CB0D       0642          RRC     L
                   0643 ;
*0447   0F         0644          RRCA            ;SAME AS RRC  A
                   0645 ;
*0448   ED67       0646          RRD     ;ROTATE DIGIT RT AND LFT BETWEEN
                   0647                  ;A AND LOCATION (HL)
                   0648 ;
*044A   C7         0649          RST     0       ;RESTART TO LOCATION 00
*044B   CF         0650          RST     08H
*044C   D7         0651          RST     10H
*044D   DF         0652          RST     18H
*044E   E7         0653          RST     20H
*044F   EF         0654          RST     28H
*0450   F7         0655          RST     30H
*0451   FF         0656          RST     38H
                   0657 ;
*0452   9E         0658          SBC     A,(HL)  ;SUBTRACT WITH CY THE BYTE AT
                   0659                          ;(HL) FROM A
*0453   DD9E05     0660          SBC     A,(IX+IND)
*0456   FD9E05     0661          SBC     A,(IY+IND)
*0459   9F         0662          SBC     A,A
*045A   98         0663          SBC     A,B
*045B   99         0664          SBC     A,C
*045C   9A         0665          SBC     A,D
*045D   9B         0666          SBC     A,E
*045E   9C         0667          SBC     A,H
*045F   9D         0668          SBC     A,L
*0460   DE20       0669          SBC     A,N
                   0670 ;
*0462   ED42       0671          SBC     HL,BC   ;16 BIT SUBTRACT W/CY, BC FROM HL
*0464   ED52       0672          SBC     HL,DE
*0466   ED62       0673          SBC     HL,HL
*0468   ED72       0674          SBC     HL,SP
                   0675 ;
*046A   37         0676          SCF             ;SET CARRY FLAG (CY=1)
                   0677 ;
*046B   CBC6       0678          SET     0,(HL)  ;SET (TO 1) BIT 0 IN BYTE AT (HL)
*046D   DDCB05C6   0679          SET     0,(IX+IND)
*0471   FDCB05C6   0680          SET     0,(IY+IND)
*0475   CBC7       0681          SET     0,A
*0477   CBC0       0682          SET     0,B
*0479   CBC1       0683          SET     0,C
*047B   CBC2       0684          SET     0,D
*047D   CBC3       0685          SET     0,E
*047F   CBC4       0686          SET     0,H
*0481   CBC5       0687          SET     0,L
                   0688 ;
*0483   CBCE       0689          SET     1,(HL)
*0485   DDCB05CE   0690          SET     1,(IX+IND)
*0489   FDCB05CE   0691          SET     1,(IY+IND)
*048D   CBCF       0692          SET     1,A
*048F   CBC8       0693          SET     1,B
*0491   CBC9       0694          SET     1,C
*0493   CBCA       0695          SET     1,D
*0495   CBCB       0696          SET     1,E
*0497   CBCC       0697          SET     1,H
```

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 ADDR   CODE       STMT SOURCE STATEMENT

'0499   CBCD       0698          SET     1,L
                   0699 ;
'049B   CBD6       0700          SET     2,(HL)
'049D   DDCB05D6   0701          SET     2,(IX+IND)
'04A1   FDCB05D6   0702          SET     2,(IY+IND)
'04A5   CBD7       0703          SET     2,A
'04A7   CBD0       0704          SET     2,B
'04A9   CBD1       0705          SET     2,C
'04AB   CBD2       0706          SET     2,D
'04AD   CBD3       0707          SET     2,E
'04AF   CBD4       0708          SET     2,H
'04B1   CBD5       0709          SET     2,L
                   0710 ;
'04B3   CBDE       0711          SET     3,(HL)
'04B5   DDCB05DE   0712          SET     3,(IX+IND)
'04B9   FDCB05DE   0713          SET     3,(IY+IND)
'04BD   CBDF       0714          SET     3,A
'04BF   CBD8       0715          SET     3,B
'04C1   CBD9       0716          SET     3,C
'04C3   CBDA       0717          SET     3,D
'04C5   CBDB       0718          SET     3,E
'04C7   CBDC       0719          SET     3,H
'04C9   CBDD       0720          SET     3,L
                   0721 ;
'04CB   CBE6       0722          SET     4,(HL)
'04CD   DDCB05E6   0723          SET     4,(IX+IND)
'0       FDCB05E6   0724          SET     4,(IY+IND)
'04D5   CBE7       0725          SET     4,A
'04D7   CBE0       0726          SET     4,B
'04D9   CBE1       0727          SET     4,C
'04DB   CBE2       0728          SET     4,D
'04DD   CBE3       0729          SET     4,E
'04DF   CBE4       0730          SET     4,H
'04E1   CBE5       0731          SET     4,L
                   0732 ;
'04E3   CBEE       0733          SET     5,(HL)
'04E5   DDCB05EE   0734          SET     5,(IX+IND)
'04E9   FDCB05EE   0735          SET     5,(IY+IND)
'04ED   CBEF       0736          SET     5,A
'04EF   CBE8       0737          SET     5,B
'04F1   CBE9       0738          SET     5,C
'04F3   CBEA       0739          SET     5,D
'04F5   CBEB       0740          SET     5,E
'04F7   CBEC       0741          SET     5,H
'04F9   CBED       0742          SET     5,L
                   0743 ;
'04FB   CBF6       0744          SET     6,(HL)
'04FD   DDCB05F6   0745          SET     6,(IX+IND)
'0501   FDCB05F6   0746          SET     6,(IY+IND)
'0505   CBF7       0747          SET     6,A
'0507   CBF0       0748          SET     6,B
'0      CBF1       0749          SET     6,C
'050B   CBF2       0750          SET     6,D
'050D   CBF3       0751          SET     6,E
'050F   CBF4       0752          SET     6,H
'0511   CBF5       0753          SET     6,L
                   0754 ;
'0513   CBFE       0755          SET     7,(HL)
```

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 ADDR   CODE       STMT SOURCE STATEMENT

'0515   DDCB05FE   0756          SET     7,(IX+IND)
'0519   FDCB05FE   0757          SET     7,(IY+IND)
'051D   CBFF       0758          SET     7,A
'051F   CBF8       0759          SET     7,B
'0521   CBF9       0760          SET     7,C
'0523   CBFA       0761          SET     7,D
'0525   CBFB       0762          SET     7,E
'0527   CBFC       0763          SET     7,H
'0529   CBFD       0764          SET     7,L
                   0765 ;
'052B   CB26       0766          SLA     (HL)     ;SHIFT LEFT ARITHMETIC,
                   0767                           ;BYTE AT (HL)
'052D   DDCB0526   0768          SLA     (IX+IND)
'0531   FDCB0526   0769          SLA     (IY+IND)
'0535   CB27       0770          SLA     A
'0537   CB20       0771          SLA     B
'0539   CB21       0772          SLA     C
'053B   CB22       0773          SLA     D
'053D   CB23       0774          SLA     E
'053F   CB24       0775          SLA     H
'0541   CB25       0776          SLA     L
                   0777 ;
'0543   CB2E       0778          SRA     (HL)     ;SHIFT RT ARITH., BYTE AT (HL)
'0545   DDCB052E   0779          SRA     (IX+IND)
'0549   FDCB052E   0780          SRA     (IY+IND)
'054D   CB2F       0781          SRA     A
'054F   CB28       0782          SRA     B
'0551   CB29       0783          SRA     C
'0553   CB2A       0784          SRA     D
'0555   CB2B       0785          SRA     E
'0557   CB2C       0786          SRA     H
'0559   CB2D       0787          SRA     L
                   0788 ;
'055B   CB3E       0789          SRL     (HL)     ;SHIFT RT LOGICAL, BYTE AT (HL)
'055D   DDCB053E   0790          SRL     (IX+IND)
'0561   FDCB053E   0791          SRL     (IY+IND)
'0565   CB3F       0792          SRL     A
'0567   CB38       0793          SRL     B
'0569   CB39       0794          SRL     C
'056B   CB3A       0795          SRL     D
'056D   CB3B       0796          SRL     E
'056F   CB3C       0797          SRL     H
'0571   CB3D       0798          SRL     L
                   0799 ;
'0573   96         0800          SUB     (HL)     ;SUBTRACT (NO CARRY) BYTE AT
                   0801                           ;(HL) FROM A
'0574   DD9605     0802          SUB     (IX+IND)
'0577   FD9605     0803          SUB     (IY+IND)
'057A   97         0804          SUB     A
'057B   90         0805          SUB     B
'057C   91         0806          SUB     C
'057D   92         0807          SUB     D
'057E   93         0808          SUB     E
'057F   94         0809          SUB     H
'0580   95         0810          SUB     L
'0581   D620       0811          SUB     N
                   0812 ;
'0583   AE         0813          XOR     (HL)     ;'EXCLUSIVE OR' BYTE AT
```

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 ADDR   CODE      STMT SOURCE STATEMENT

                  0814                              ;(HL) WITH A
'05     DDAE05    0815          XOR     (IX+IND)
'0587   FDAE05    0816          XOR     (IY+IND)
'058A   AF        0817          XOR     A
'058B   A8        0818          XOR     B
'058C   A9        0819          XOR     C
'058D   AA        0820          XOR     D
'058E   AB        0821          XOR     E
'058F   AC        0822          XOR     H
'0590   AD        0823          XOR     L
'0591   EE20      0824          XOR     N         ;EXCLUSIVE OR A WITH VALUE 'N'
                  0825 ;
                  0826          END

ERRORS=0000
```

THE BIT FIDDLERS
SOFTWARE PROBLEM REPORT

Please use this form to report errors or problems in software supplied by The Bit Fiddlers. This form is designed to act as a transmittal sheet, and problem details can be described on additional pages.

Date:.....

Software Product Name:..... Version No.:.....

Computer Type:..... Memory Size:.....

Operating System:..... Version No.:.....

Number of Disk Drives:.....

Please describe the problem you have encountered. Include references to the manual if appropriate. Try to reduce the problem to a simple test case. Enclose any appropriate listings. If you have discovered a patch or interim solution please describe it.

This form may also be used to suggest enhancements to our software products.

PROBLEM DESCRIPTION:

Name:..... Phone:.....

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Return to: THE BIT FIDDLERS
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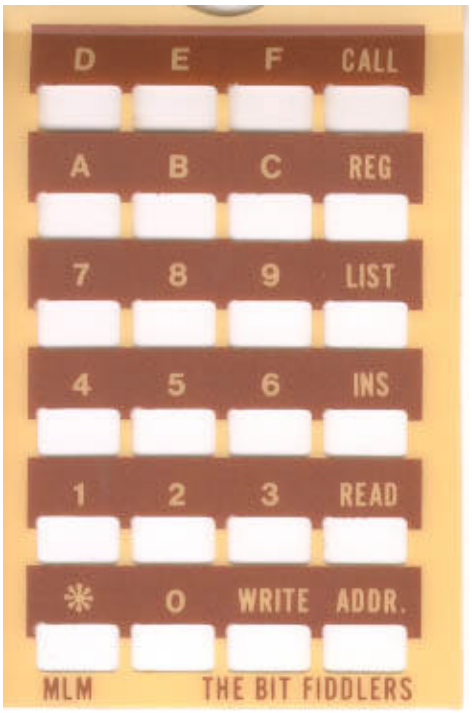
D E F CALL
A B C REG
7 8 9 LIST
4 5 6 INS
1 2 3 READ
* 0 WRITE ADDR.
MLM
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