SDK-85
System Design Kit
User's Manual

Manual Order Number 9800451B

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Figure 1-1. SDK-85 System Design Kit

CHAPTER 1
DESCRIPTION

The MCS-85 System Design Kit (SDK-85) contains all the parts with which you can build a complete 8085 microcomputer system on a single board, and a library of MCS-85 literature to help you learn to use it. The finished computer has the following built-in features:

- High-performance, 3-MHz 8085A cpu (1.3 μs instruction cycle)
- Popular 8080A Instruction Set
- Direct Teletypewriter Interface
- Interactive LED Display
- Large Wire-Wrap Area for Custom-Designed Circuit
- System Monitor Software in ROM

You can assemble the kit in as little as 3 to 5 hours, depending upon your skill and experience at building electronic kits. Only a 5 Volt power source capable of delivering 1.3 Amperes is then needed to make the computer operate, using its built-in display and keyboard. If you wish to interface a Teletypewriter to the SDK-85, you will also need a −10 Volt power supply. After you have completed the basic kit, you may expand both memory and I/O by adding more RAM-I/O or ROM-I/O devices in the spaces provided for that purpose. Other spaces are allocated for bus expansion drivers and buffers that allow you to address and use external devices located either in the wire-wrap area of the board or off the board. You can, for example, access up to 64K of external memory via the expansion bus.

SDK-85 SPECIFICATIONS

Central Processor

CPU: 8085A

Instruction Cycle: 1.3 microsecond

T_{CY}: 330 ns

Memory

ROM: 2K bytes (expandable to 4K bytes) 8355 or 8755

RAM: 256 bytes (expandable to 512 bytes) 8155

Addressing: ROM 0000-07FF (expandable to 0FFF with an additional 8355 or 8755) RAM 2000-20FF (2800-28FF available with an additional 8155)

Input/Output

Parallel: 38 lines (expandable to 76 lines).

Serial: Through SID/SOD ports of 8085. Software generated baud rate.

Baud Rate: 110

Interfaces

Bus: All signals TTL compatible.

Parallel I/O: All signals TTL compatible.

Serial I/O: 20 mA current loop TTY.

Note: By populating the buffer area of the board, you have access to all bus signals which enable you to design custom system expansions into the kit's wire-wrap area.

Interrupts

Three Levels: (RST 7.5) - Keyboard Interrupt
(RST 6.5) - TTL Input
(INTR) - TTL Input

DMA

Hold Request: Jumper selectable. TTL compatible input.

Software

System Monitor: Preprogrammed 8755 or 8355 ROM

Addresses: 0000-07FF

I/O: Keyboard/Display or TTY (serial I/O)

Literature

Design Library (Provided with kit):

- SDK-85 User's Manual
- Microcomputer Systems Databook
- MCS-85 User's Manual
- 8080/8085 Assembly Language Programming Manual

Physical Characteristics

Width: 12.0 in.

Height: 10 in.

Depth 0.50 in.

Weight: approx. 12 oz.

Electrical Characteristics (DC Power Required)

V_{CC}: +5V ± 5%	1.3A
V_{TTY}: −10V ± 10%	0.3A

(V_{TTY} required only if teletypewriter is to be connected to the kit)

Environmental

Operating Temperature: 0-55°C

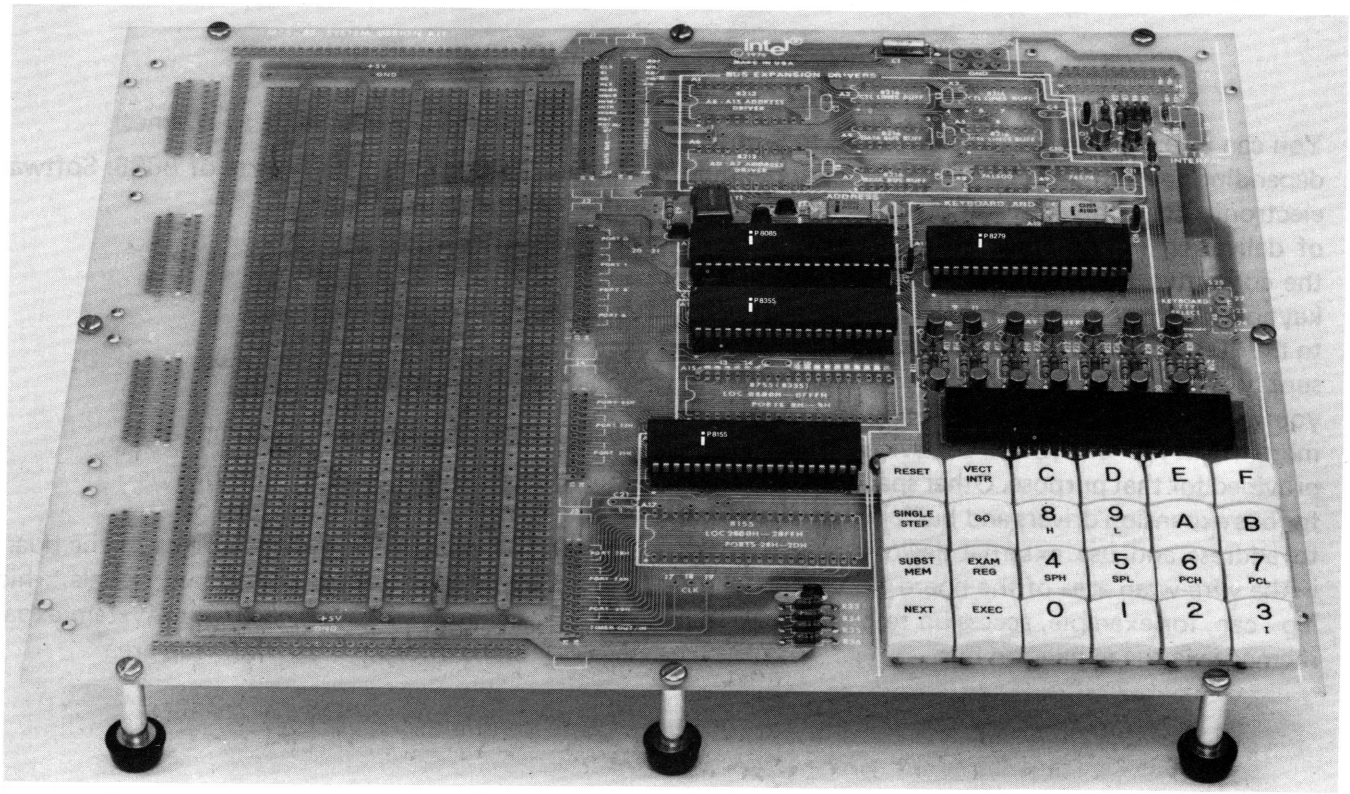


Figure 1-2. Finished Computer

CHAPTER 2
HOW TO ASSEMBLE THE KIT

2-1 GENERAL

Don't unpack your parts yet. Do a little reading first, and you may save yourself time and expense.

CAUTION

The metal-oxide-semiconductor (MOS) devices in this kit are susceptible to static electricity. Do not remove them from the protective, black foam backing sheet until you have read the precautions and instructions in paragraph 2-4.

This manual was published only after the assembly of several kits by a number of persons of varying experience. In this chapter you will find virtually everything you need to know to put together your MCS-85 System Design Kit.

There are suggestions for laying out an efficient work area. All of the tools and materials you need are described in a checklist. There is a complete and detailed parts list. Basic assembly and soldering techniques are reviewed. Following the step-by-step assembly instructions in this chapter, you can't go wrong.

If you're an experienced kitbuilder, you already know that it's not a bad idea to read through this entire chapter first, before starting the job. That way, there won't be any surprises later. Take your time. Don't rush, and don't skip over quality-checking each step you perform. Desoldering, removing, and replacing just one DIP component because it was not oriented properly when first installed will cost you more time than double-checking **all** of them. Your objective is surely to produce a working computer, not to win a race.

2-2 GETTING ORGANIZED

Before starting work, it's a good idea to plan and organize your workplace. Be sure you have room to accommodate this book, lying open, and also the circuit board, along with tools and the hot soldering pencil. Unless you have the cordless, battery-powered soldering instrument, you'll want to arrange its cord out of the way to keep from accidentally pulling the soldering pencil off its holder. A muffin pan, an egg carton, or some small boxes could be used to sort parts into, if you don't have the traditional plastic, compartmented parts boxes. It might be helpful, too, to write the part values and reference designators on small cards as you sort them, and put these with the parts for quick identification. Arrange everything within comfortable reach, and you'll do the job quickly with little chance of errors.

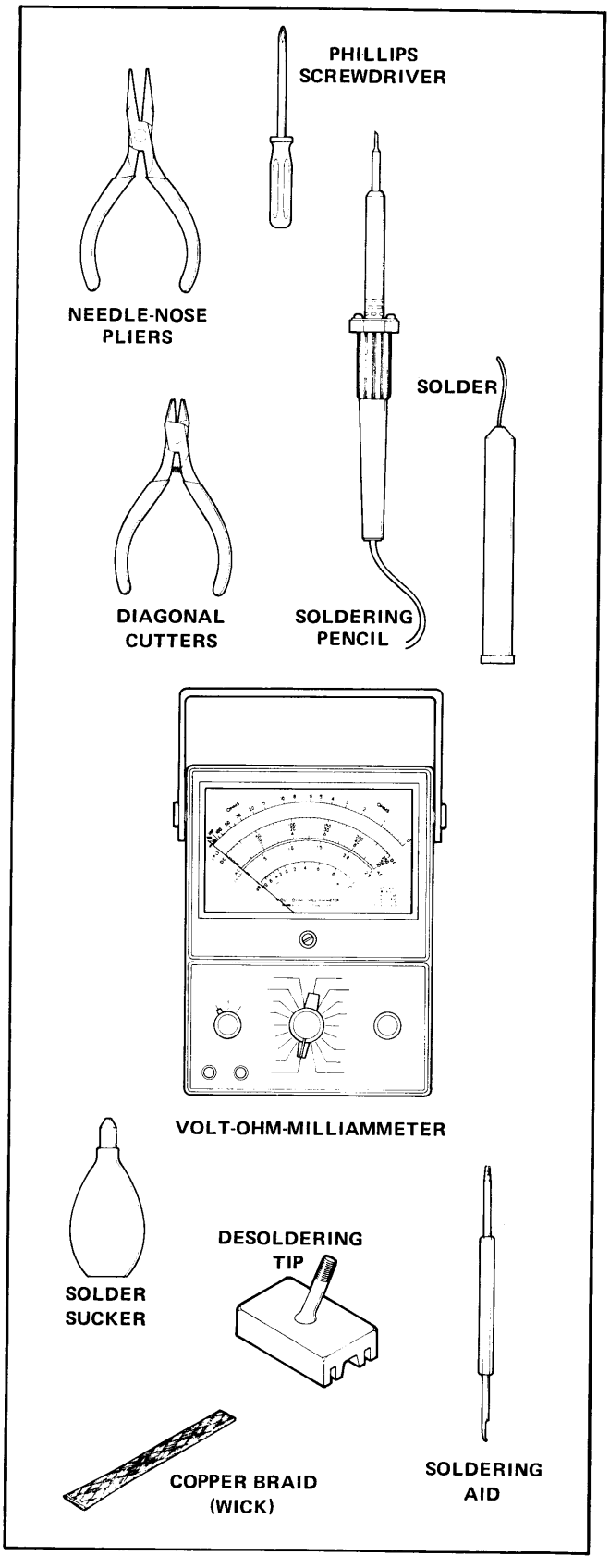
2-3 SELECTING TOOLS AND MATERIALS

These tools and materials will be required to assemble the kit:

- ☐ Needle-nose pliers
- ☐ Small Phillips screwdriver
- ☐ Small diagonal cutters
- ☐ Soldering pencil, not more than 30 watts, with extra-small-diameter tip. (1/16 in. isn't too small.) You should also have a secure holder for it.
- ☐ Rosin-core solder, 60:40 (60% tin), small diameter (.05 in. or less) wire

  Note: Soldering paste is not needed. The solder will contain sufficient flux.

- ☐ Volt-Ohm-Milliammeter



It is also useful to have the following:

- ☐ Soldering aid, with a small-tipped fork at one end and a reamer at the other, to help in coaxing component leads into holes and manipulating small parts.

If you should happen to make a soldering error and have to remove solder from joints, the job will be made much, much easier if you have the following:

- ☐ Solder sucking device, either the bulb variety (shown) or the pump variety
- ☐ Large-area desoldering tip for your soldering pencil, to spread heat over several leads of an IC device at the same time
- ☐ Length of copper braid to sop up solder like a sponge

  Note: It is extremely difficult to remove DIP components using just a soldering pencil.

2-4 UNPACKING AND SORTING PARTS

The MCS-85 System Design Kit is shipped skin-packed on a card that includes a conductive backing to protect its metal-oxide-semiconductor (MOS) devices from static charge. Don't remove the four larger-size Intel devices from the foam backing until you have completed all of the instructions in this chapter and are ready to place them on the board. As a further protection against possible damage, these four devices are to be installed in sockets, rather than soldered on the board.

With a knife or sharp-pointed scissors, slit the film around the edges of the small-parts bags in the lower left corner of the skin-pack and remove them. First, open the bag of hardware and check to be sure you have:

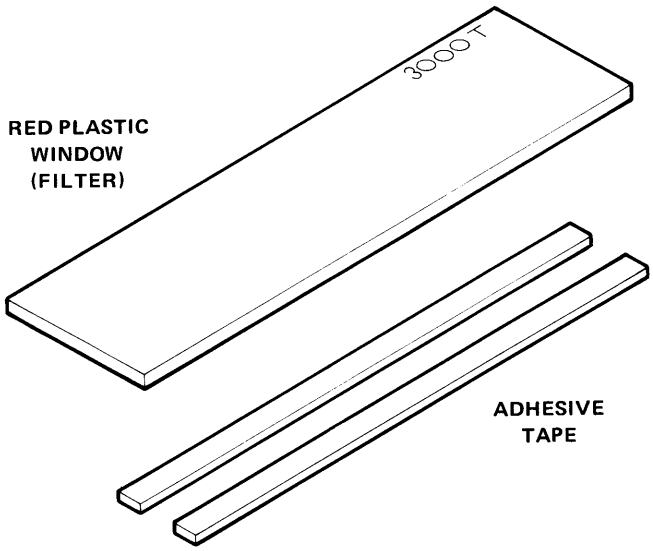
- ☐ 9 rubber feet 
- ☐ 9 Nylon spacers, 7/16 in. long 
- ☐ 9 screws, 3/4 in. long 
- ☐ 18 Nylon washers 
- ☐ 9 nuts 

CAUTION

Don't remove the other components from the skin-pack. The black foam backing is an electrically conductive material that protects the integrated-circuit devices from static electricity as well as from physical damage to their leads and ceramic substrates.

Underneath the two bags of small parts and hardware will be found:

- ☐ Red plastic window (covered with protective paper)
- ☐ Two strips of double-coated adhesive tape

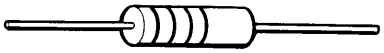


Next, open the bag of electrical parts and sort them out by type and value. Give yourself plenty of unobstructed work space and try not to let tiny parts skitter away from you. The bag should yield the following:

Resistors, 1/4 Watt

☐	8	24 Ohm (red-yellow-black)	R11, 14, 17, 20, 23, 26, 27, 30
☐	1	47 Ohm (yellow-violet-black)	R5
☐	1	200 Ohm (red-black-brown)	R33
☐	6	270 Ohm (red-violet-brown)	R10, 13, 16, 19, 22, 25
☐	2	1k (1,000) Ohm (brown-black-red)	R4, 31
☐	1	1.6k Ohm (brown-blue-red)	R3
☐	1	2.7k Ohm (red-violet-red)	R6
☐	9	3k Ohm (orange-black-red)	R7, 9, 12, 15, 18, 21, 24, 28, 29
☐	1	3.9k Ohm (orange-white-red)	R8
☐	1	4.7k Ohm (yellow-violet-red)	R2
☐	1	51k Ohm (green-brown-orange)	R32

Resistor, 1/2 Watt

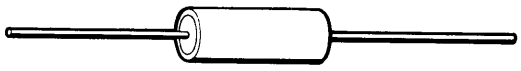


☐	1	100 Ohm (brown-black-brown)	R1

Resistors, 1 Watt

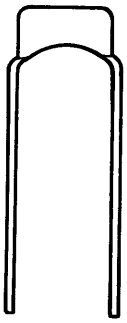
☐	1	200 Ohm (red-black-brown)	R34
☐	1	430 Ohm (yellow-orange-brown)	R35

Capacitor, tantalum



☐	1	22 μf, 15V	C1

Capacitor, mono



☐	2	1 μf, 25V	C5, 20

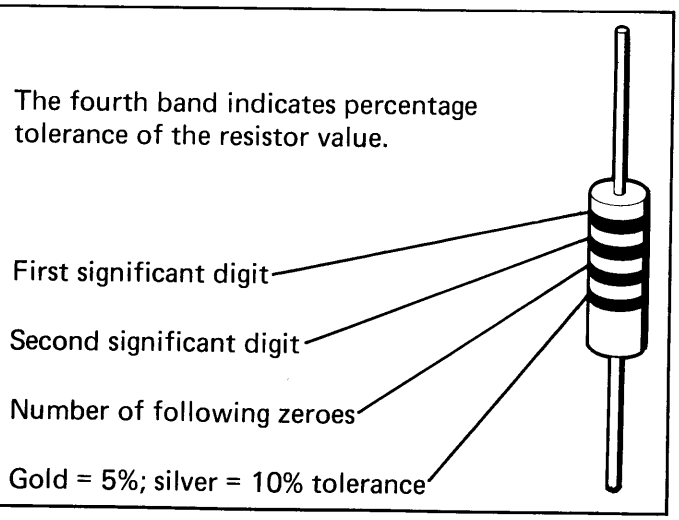
Resistor Color Code

Resistors are commonly identified by means of a code using color bands. Each color represents a number.

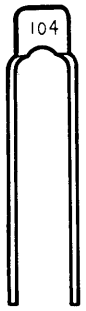
The first three bands employ the color code below:

Black	0	Green	5
Brown	1	Blue	6
Red	2	Violet	7
Orange	3	Gray	8
Yellow	4	White	9

The fourth band indicates percentage tolerance of the resistor value.

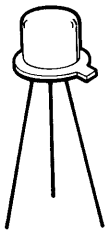


Capacitor, ceramic



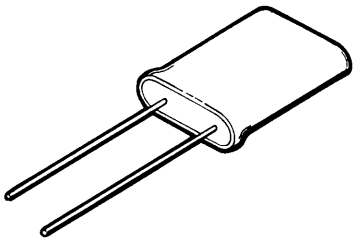
☐ 7 0.1 μf C11-16, 18

Transistor



☐ 16 2N2907 transistors Q1-16

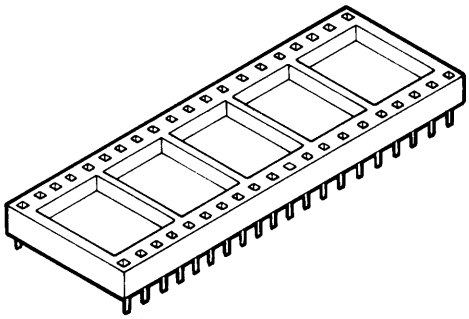
Crystal, clock



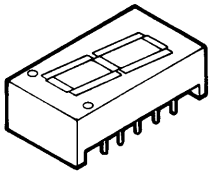
☐ 1 6.144 MHz Y1

Besides the small-parts bags, the skin-pack contains:

☐ 4 40-pin DIP (dual in-line package) sockets for the four large integrated circuits included in the kit

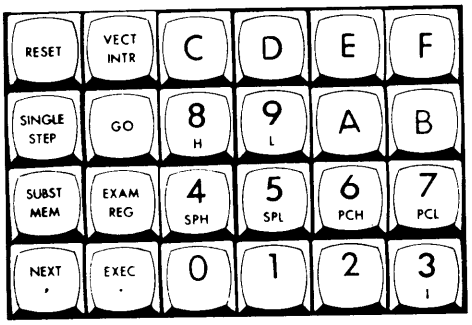


☐ 6 alphanumeric LED (light-emitting diode) displays



DS1-6

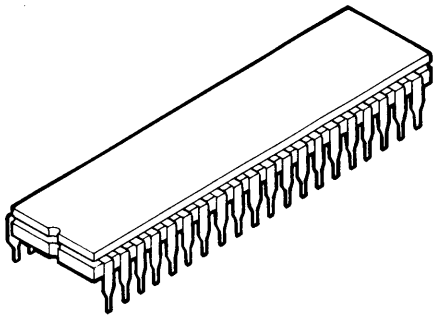
☐ 24 pushbutton switches, with keycaps labeled



S1-24

Note: It's a good idea to check all switches with the ohmmeter before installing. If one is bad, you'll save a lot of work.

Large, 40-pin ICs (integrated circuits)



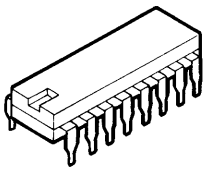
☐ 1 8085A microprocessor (cpu) A11

☐ 1 8355 (or 8755) ROM (read-only memory) with I/O (input/output) ports A14

☐ 1 8155 RAM (random-access, read-write memory) with I/O ports and timer A16

☐ 1 8279 keyboard/display interface A13

Small, 16-pin ICs



☐	1	8205 address decoder	A10
☐	1	74LS156 scan decoder	A12

CAUTION

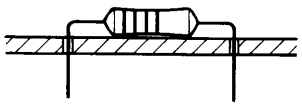
Large-scale integrated circuits are fragile! Dropping, twisting, or uneven pressure may break them. The discharge of static electricity can destroy them internally. Leave them embedded in the conductive-foam backing sheet until ready to install on the board. Never press down hard upon, twist, or bend the larger devices. Touch the exposed metal traces of the board with your hand before inserting one in its socket. The soldering of large devices directly on the circuit board is not recommended.

2-5 A REVIEW OF BASIC ASSEMBLY AND SOLDERING TECHNIQUES

The steps to producing a professional quality assembled circuit board are:

1. Have your work area organized before starting work, and keep it that way. (See paragraph 2-2.) Sort all parts into bins, cups, trays or boxes so they will be easily located by value when needed.

2. To prepare a part for soldering, bend its leads carefully with needle-nose pliers to make the part fit exactly the way you want it to.



It is good practice to orient color-coded resistors so that the codes are readily read, top-to-bottom or left-to-right, and to form the leads of parts with values printed on them so that the values are legible after assembly.

3. Fit each part in place and see that no undue stress is placed on the leads. Double-check and be sure you have the correct part inserted in the correct holes, properly oriented. Don't trim leads before soldering.

4. When ready to solder, be sure your soldering pencil is hot enough to melt solder quickly. Then turn the board face-down on your work surface. If necessary, hold the parts you are about to solder in place while turning it over so they won't fall out, and place something under the board to hold the parts in position while you solder on the back surface of the board. Some people prefer to crimp the leads to hold the parts in place. That's all right, too.

5. Bring the point of your soldering pencil into contact with the pad to be soldered, simultaneously also touching the lead.

6. At once, touch the end of the solder wire to the pad and lead, opposite the pencil tip. The amount of time required to melt the solder will depend upon the amount of foil surface there is on the board to carry away heat by conduction. The smallest pads will heat up in less than a second with a 25- or 30-watt pencil; large, ground-plane areas may require over five seconds.

7. The instant you see and feel the solder start to melt, withdraw the solder wire from the joint. Only a tiny drop of solder is needed to make a good joint.

8. The instant you see the solder draw into the hole, become shiny, and spread smoothly over the surface of both pad and lead, withdraw the soldering pencil. It will take only a moment for this to happen after step 7.

9. Don't reheat a joint unless there's something wrong with it: not enough solder, too much solder (causing a "bridge" to an adjacent pad or trace), or a "cold solder joint," which

appears dull on the surface or does not surround the lead completely and fill the hole.

Note: A little rosin from the solder core, remaining on the board, does no harm. Don't try to clean it off.

10. Clip off the excess length of lead that projects beyond the solder "bead," within 1/8 inch of the board. Save cut ends to use for strapping optional connections. (See paragraph 3-2.)

WARNING

Avoid eye injury when clipping excess lead ends. Hold lead end as you clip it, so it can't fly up in your face.

There are two important conditions that govern good soldering technique. They are:

1. Use no more heat than absolutely the minimum that will make a solid joint.

2. Use enough heat to cause solder to flow into the hole in the board and around the lead that's being soldered into it.

These conditions are both met simultaneously and easily only if you are careful, have the proper tools, and arrange your workplace so that the circuit board can lie flat while you apply steady, firm (but not hard) pressure with the soldering pencil without slipping. A small-diameter soldering tip is a **must!** Likewise, small-diameter solder wire is essential to achieving satisfactory results.

Note: Do not apply soldering paste to the work. Fluxing is not required in printed-circuit soldering, as the boards and component leads are plated or tinned to prevent oxidation of the copper.

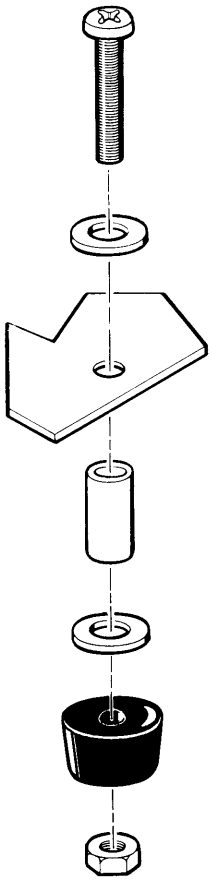
Always inspect carefully for cold solder joints, solder bridges, or (perish the thought!) lifted traces after each soldering operation. A good way to check for solder bridges is to hold the newly-soldered connection up to a light. If you can't see light between the soldered pad and any adjacent pads or traces that aren't supposed to be connected to it, it might be well to slip a solder-sucker or wick over the lead under examination, quickly remelt the solder and draw off the excess.

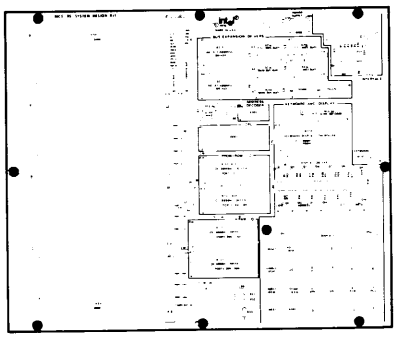
2-6 ASSEMBLY PROCEDURE

Follow these instructions in order and make a check mark in the box opposite each step when it is completed.

☐ First, place the board on your work surface, lettered side up.

☐ Install the nine rubber feet. Eight go around the edge of the board, and one goes near the middle of the board, to the left of the keyboard and display area. At each location, press a nut into the recess in a rubber foot, string a washer on a screw, and insert the screw through the hole in the board from the top. Place a spacer, then another washer on the screw, then place the nut and foot on the end of the screw, and tighten, with the screwdriver, just enough to hold the foot firmly.

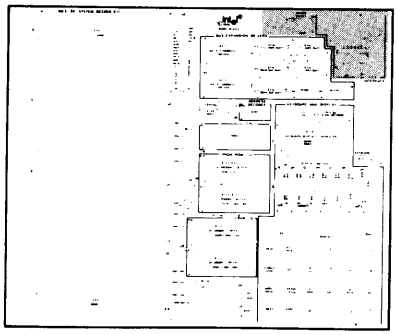




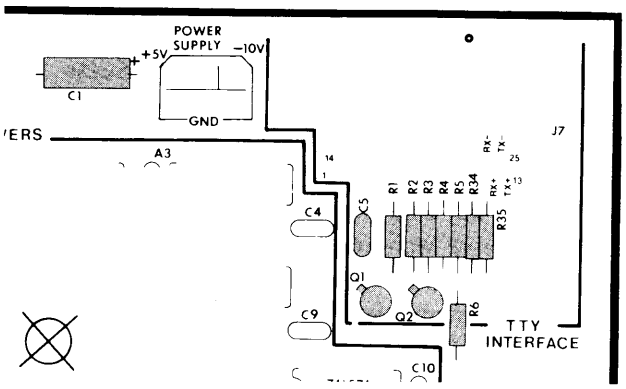
- ☐ Install capacitor C1 near the top edge of the board.
- ☐ Solder C1 in place. Clip excess lead ends.

WARNING

Avoid eye injury. Hold lead ends as you clip them so they can't fly up at you.



Assembly of TTY Interface Area—



- ☐ Install a 100 Ohm, 1/2 Watt resistor (brown-black-brown) at R1.
- ☐ Install a 4.7k Ohm resistor (yellow-violet-red) at R2.
- ☐ Install a 1.6k Ohm resistor (brown-blue-red) at R3.
- ☐ Install a 1k Ohm resistor (brown-black-red) at R4.
- ☐ Install a 47 Ohm resistor (yellow-violet-black) at R5.
- ☐ Install a 2.7k Ohm resistor (red-violet-red) at R6.
- ☐ Solder the six resistors in place, then clip their excess lead ends.
- ☐ Install a 1 uf capacitor at C5, and solder and clip it.
- ☐ Install a 200 Ohm, 1 Watt resistor (red-black-brown) at R34.
- ☐ Install a 430 Ohm resistor (yellow-orange-brown) at R35.
- ☐ Solder these two resistors in place, then clip their excess lead ends.
- ☐ Install transistors Q1 and Q2, and solder and clip them.

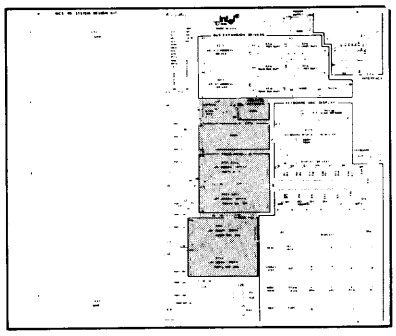
Assembly of Processing Area

The processing area includes the clock crystal, address decoder, cpu, RAM-I/O and ROM-I/O areas, and related components.

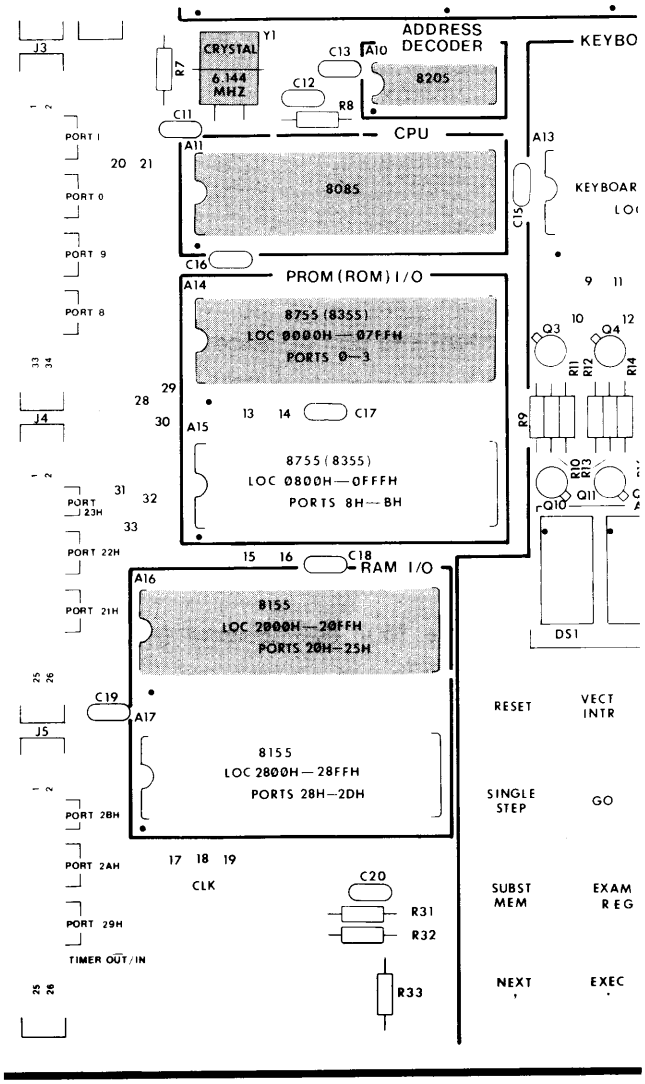
- ☐ Install the crystal at Y1, with its leads bent so that the device lies flat on the board in the space outlined for it.
- ☐ Take a piece of scrap wire trimmed from a component previously mounted on the board. Bend it into the shape of a staple. Install it over the crystal, to hold it firmly in place.
- ☐ Solder the four connections just made.
- ☐ Install the 8205 address decoder at A10 and solder it.

Install three DIP sockets, crimping the corner leads of each to hold in place, at:

- ☐ A11, for the 8085 cpu.
- ☐ A14, for the PROM (ROM)-I/O device, an 8755 or 8355.



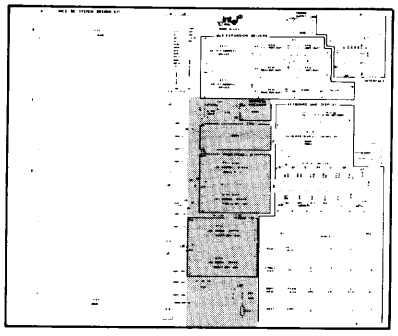
- ☐ A16, for the RAM-I/O device, an 8155.
- ☐ Solder the three sockets in, and check carefully for solder bridges.



- ☐ Install a 3k Ohm resistor (orange-black-red) at R7.
- ☐ Install a 3.9k Ohm resistor (orange-white-red) at R8.
- ☐ Solder these two resistors and clip off their lead ends.

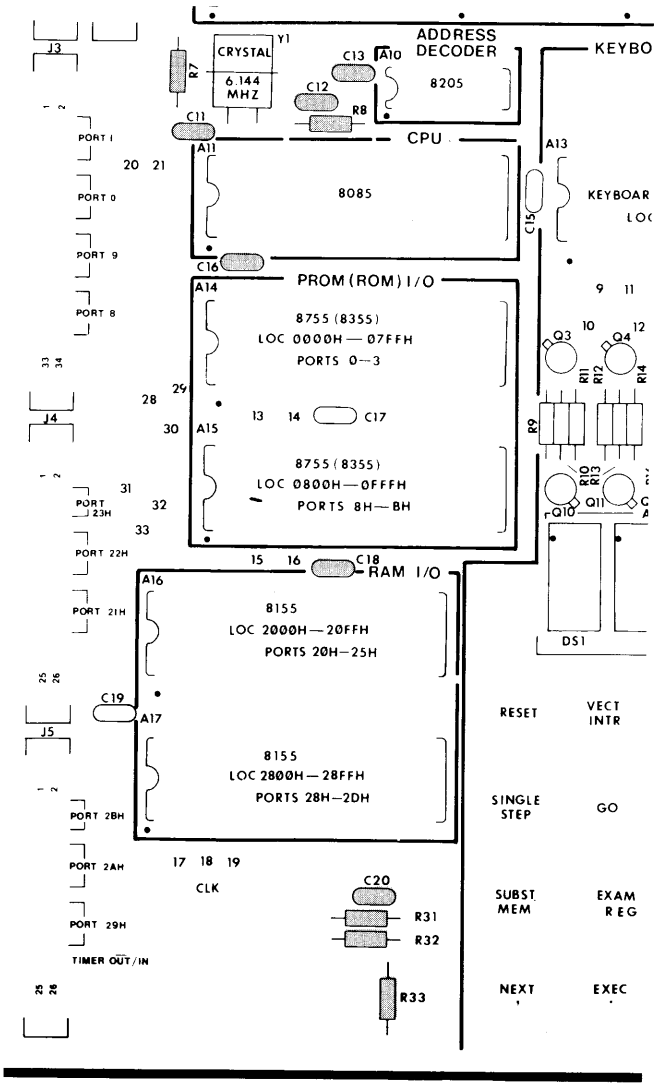
Install three 0.1 uf ceramic capacitors at:

- ☐ C11
- ☐ C12
- ☐ C13
- ☐ Solder them and clip off excess lead length.
- ☐ Install a 1 uf capacitor at C20.
- ☐ Install a 1k resistor (brown-black-red) at R31.
- ☐ Install a 51k resistor (green-brown-orange) at R32.
- ☐ Install a 200 Ohm resistor (red-black-brown) at R33.
- ☐ Solder these four components in place and trim their leads.



Install 0.1 uf ceramic capacitors at:

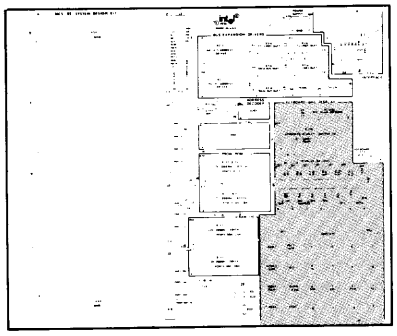
- ☐ C16
- ☐ C18
- ☐ Now solder the capacitors you have installed, and clip off their excess lead ends.

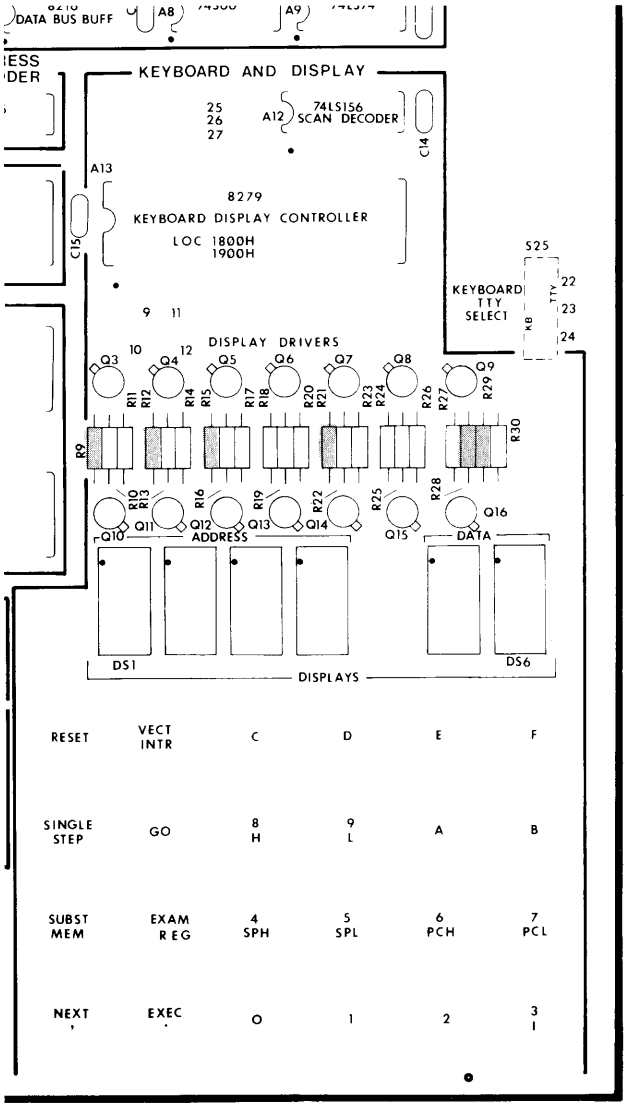


Assembly of Keyboard and Display Area

Find where the row of resistors, R9 through R30, go. Install eight 3k resistors (orange-black-red) at:

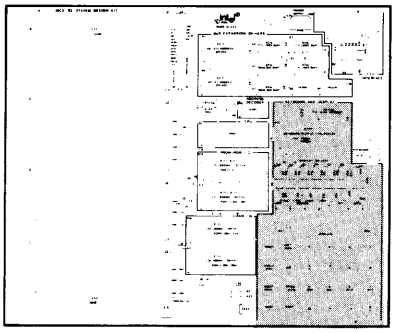
- ☐ R9
- ☐ R12
- ☐ R15
- ☐ R18
- ☐ R21
- ☐ R24
- ☐ R28 (Careful—the location pattern changes here!)
- ☐ R29
- ☐ Now solder all eight resistors in place and clip their excess lead ends.

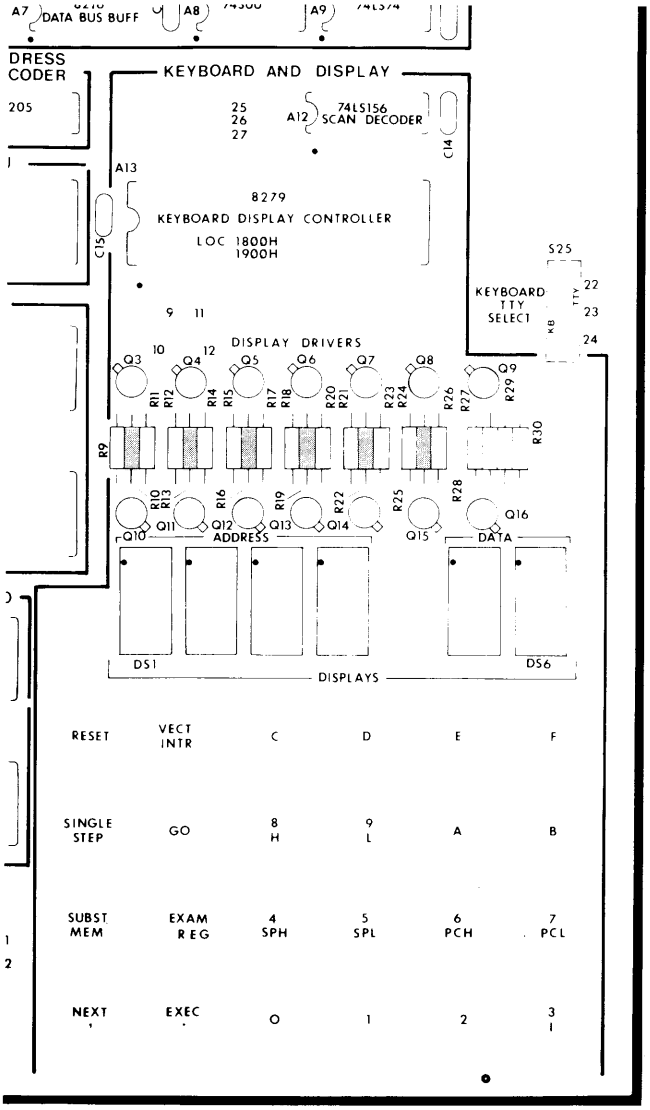




Install six 270 Ohm resistors (red-violet-brown) at:

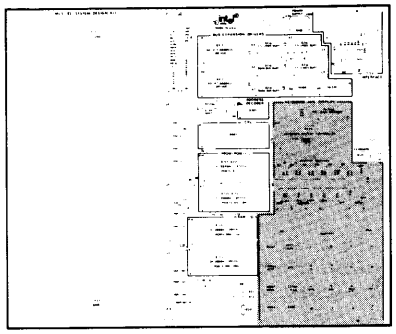
- ☐ R10
- ☐ R13
- ☐ R16
- ☐ R19
- ☐ R22
- ☐ R25
- ☐ Solder these six resistors and clip their excess lead ends.

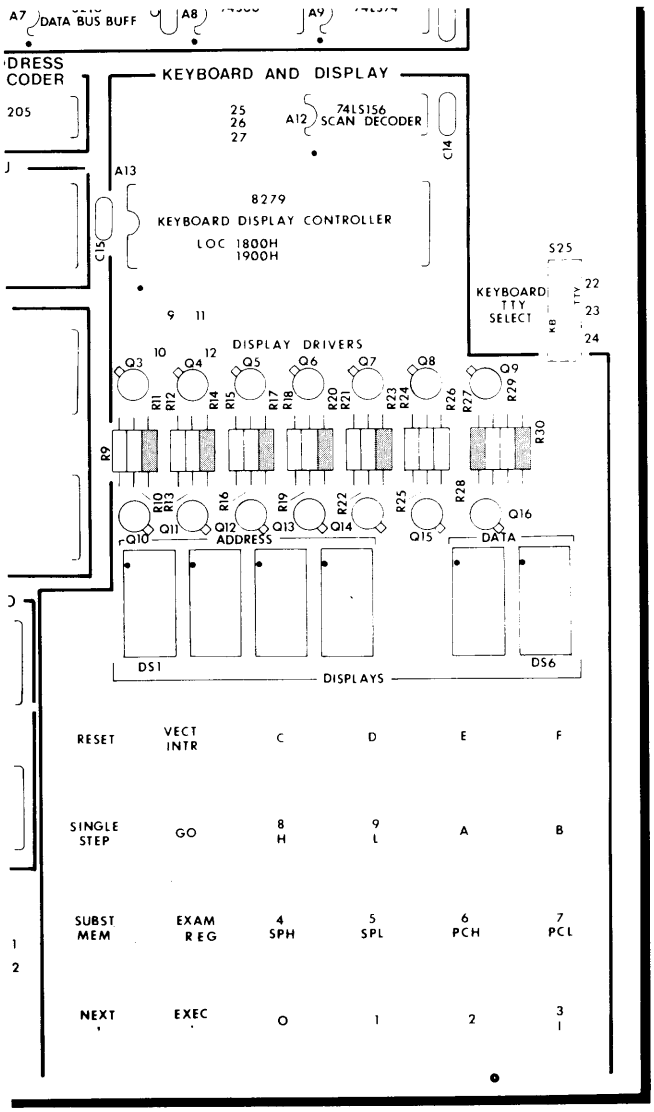




Install eight 24 Ohm resistors (red-yellow-black) at:

- ☐ R11
- ☐ R14
- ☐ R17
- ☐ R20
- ☐ R23
- ☐ R26
- ☐ R27 (Again, note the change in location pattern.)
- ☐ R30
- ☐ Solder these eight resistors and clip their excess lead ends.



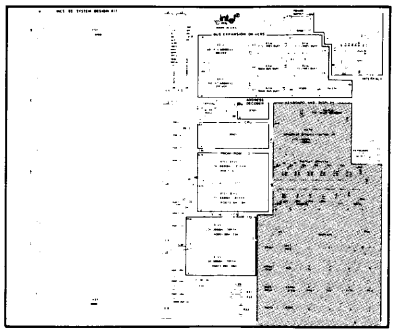


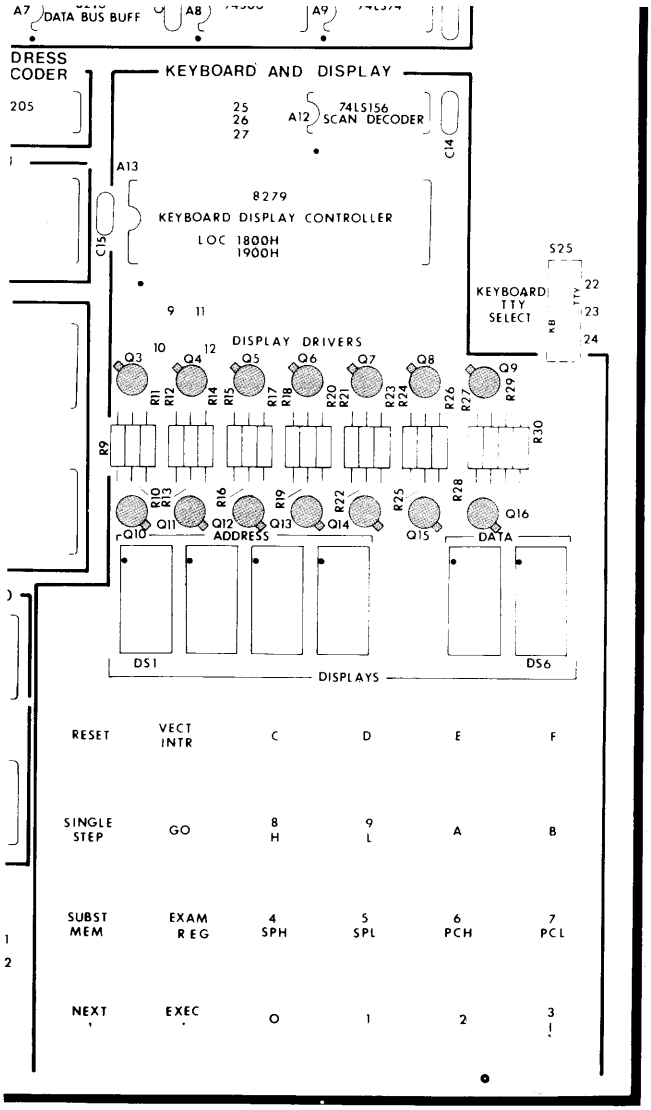
Install fourteen 2N2907 transistors in two rows. Position the seven transistors in the top row so that their indexing tabs point upward and to the left, at:

- ☐ Q3
- ☐ Q4
- ☐ Q5
- ☐ Q6
- ☐ Q7
- ☐ Q8
- ☐ Q9

Position the seven transistors in the bottom row so that their indexing tabs point down and to the right, at:

- ☐ Q10
- ☐ Q11
- ☐ Q12
- ☐ Q13
- ☐ Q14
- ☐ Q15
- ☐ Q16
- ☐ Press all of the transistors down to about 1/8 inch from the surface of the board. Let them stand approximately straight up. Then, turn the board over and solder all of their leads in place and trim the lead ends.





- ☐ Install one of the 40-pin DIP sockets, for the 8279 Keyboard-Display Controller, at A13, and solder it in.
- ☐ Install the 74LS156 scan decoder at A12, and solder it.

Be careful to orient the six alphanumeric LED displays so that the decimal points are even with the **bottom** of the digits and install at:

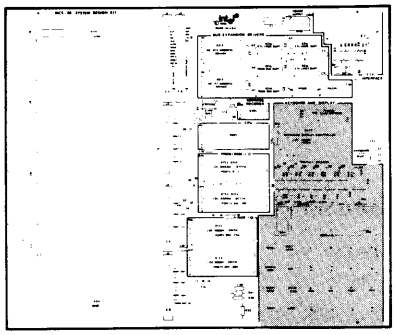
- ☐ DS1
- ☐ DS2
- ☐ DS3
- ☐ DS4
- ☐ DS5
- ☐ DS6

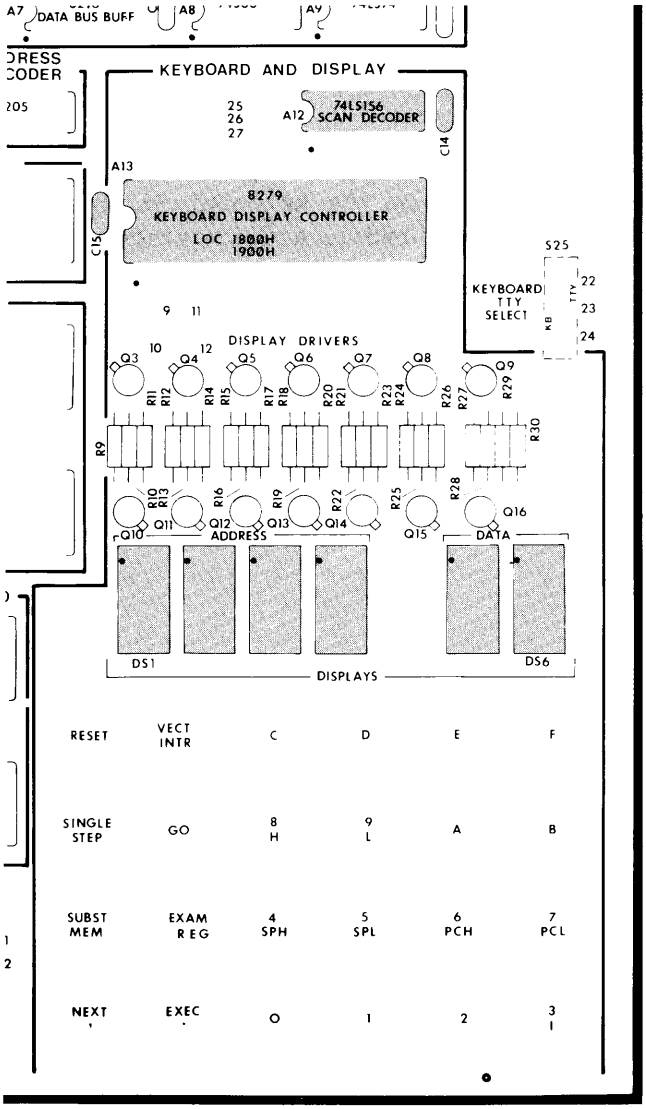
Note: If these components are provided with long, wirewrap leads, you will probably find it easiest to insert, solder, and clip them one at a time because of crowded quarters. The order shown above with the board turned bottomside up will be most convenient for you if you hold the soldering pencil in your left hand. If you solder right-handed, you may prefer to work from DS6 to DS1.

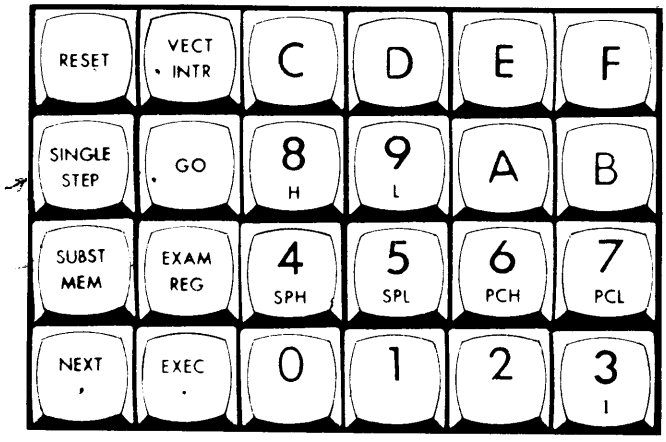
Note: Don't install the red filter over the display yet. It's a good idea to wait until after final assembly and checkout to do this, on the remote chance that you might have to remove one of the character displays.

Install two 0.1 uf ceramic capacitors at:

- ☐ C14
- ☐ C15
- ☐ Solder the leads and clip them off close to the board.







☐ Install the twenty-four pushbutton switches that make up the keyboard. Be sure each button is rightside up and in its proper position before soldering.

The easiest method of doing this is to insert each button in its turn, bend its leads over on the back of the board to hold it in place, and go on until all buttons are in place, then solder all of them in one pass, with the board lying flat on the work surface and weighted down to make sure the switches are uniformly held firmly against the front surface of the board.

☐ RESET	☐ VECT INTR	☐ C	☐ D	☐ E	☐ F
☐ SINGLE STEP	☐ GO	☐ 8 H	☐ 9 L	☐ A	☐ B
☐ SUBST MEM	☐ EXAM REG	☐ 4 SPH	☐ 5 SPL	☐ 6 PCH	☐ 7 PCL
☐ NEXT ,	☐ EXEC .	☐ 0	☐ 1	☐ 2	☐ 3 I

☐ All soldered in place

CHAPTER 3
FINAL ASSEMBLY AND CHECKOUT

3-1 GENERAL

Now that most of the components are soldered on your circuit board, it's time to give your handiwork a quick visual check to make sure all of the devices are oriented correctly. The notched ends of the ICs should all be toward your left, and the decimal points of the LED displays should be at the bottom line of the characters.

It is recommended that the basic kit computer be checked out using the procedure in this chapter before adding any external options such as teletypewriter or expansion memory. It is well for you to have the assurance that you have a working cpu and display-keyboard before you add peripherals to your system. It is therefore recommended that you first wire the strapping options in Table 3-1 for the 8355 (or 8755) ROM-I/O that was furnished with the kit (and contains the SDK-85 System Monitor). Then install the strap in Table 3-2 for keyboard operation, and in Table 3-4 for the basic kit without expansion memory. (See paragraph 3-2.)

Paragraph 3-3 tells you how to hook up power to the MCS-85 System Design Kit, and paragraph 3-4 tells you how to start it up and see if it's working right. The subsequent paragraphs list the add-on options you can use without inventing any new circuitry on the board or off.

3-2 STRAPPING INSTRUCTIONS

The MCS-85 System Design Kit will accept 8355 or 8755 ROM-I/O devices at positions A14 and A15. These different devices are not completely electrically interchangeable, so you must make the strapping connections in Table 3-1, appropriate to the type of device in each socket.

To make a strapping connection (jumper), bend a short length of bare wire (such as the excess lead end cut from a resistor) to fit between the two holes you wish to strap together, insert the ends of the wire in the holes, and solder them. Then clip the remaining excess ends, just as you did with the components. When you install a jumper and solder it, be sure it doesn't touch any intervening traces or pads.

IMPORTANT: For normal operation of the SDK-85, it is *mandatory* to strap the following:

1. One of the three options in Table 3-1.
2. One of the two options in Table 3-2.
3. The two jumpers listed in Table 3-3.
4. Either basic kit operation or one of several expansion options listed in Table 3-4.

The keyboard-teletypewriter selection function may be done with a miniature printed circuit-board mount, single-pole, double-throw switch, S25, not furnished in the kit, or may be strapped with wire. Table 3-2 lists the connections. Table 3-3 lists keyboard strapping connections always made.

Tables 3-5 through 3-10 list all of the bus and port expansion connector pinouts. Table 3-11 lists suggested connector types.

3-3 POWER SUPPLY WIRING (See Figure 3-6.)

Connect a +5 Volt, regulated power supply with its positive output at the +5V POWER SUPPLY point on the board. A 6-pin Molex connector will fit the

(Text continues on page 3-4.)

TABLE 3-1
ROM/PROM STRAPPING

Device Location	8355 Figure 3-1	8755 Figure 3-2a	8755A Figure 3-2b
A14 (The SDK-85 Monitor ROM)	No Straps Required	Strap 28-29	Strap 29-30
A15		Strap 31-32	Strap 32-33

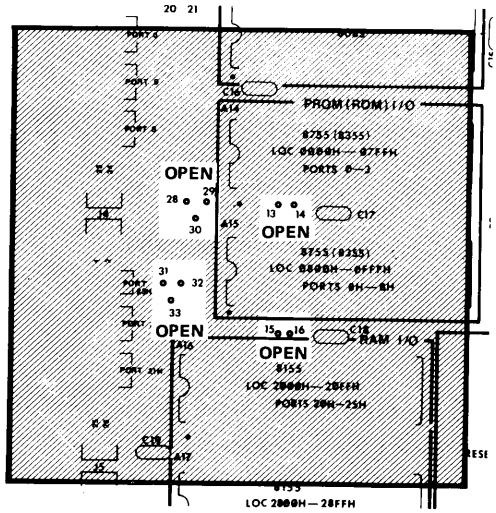


Figure 3-1 No Strapping Required for 8355 ROMs

TABLE 3-2
TELETYPEWRITER-KEYBOARD STRAPPING

TELETYPEWRITER Figure 3-3	KEYBOARD Figure 3-4
Strap 22-23	Strap 23-24

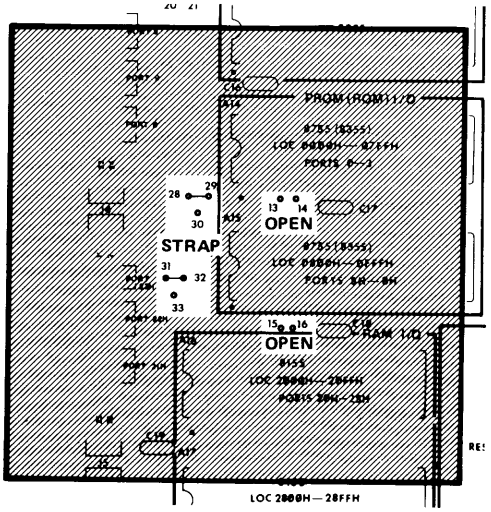


Figure 3-2a Strapping Connections for 8755 PROMS

TABLE 3-3
DISABLING UNUSED KEYBOARD CONTROLLER FUNCTIONS

Figure 3-5
Always strap 9-10.
Always strap 11-12.

Note: These two straps not usually removed, since the MCS-85 System Design Kit does not have SHIFT or CONTROL keys on its keyboard. These straps have no effect on operation of the corresponding key functions on a teletypewriter or other ASCII terminal that is connected to the TTY interface. They are provided for your use if you wish to modify the SDK-85's keyboard functions and replace its monitor software with your own.

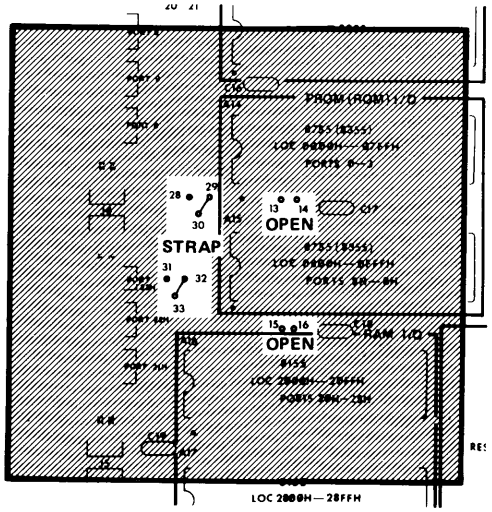


Figure 3-2b Strapping Connections for 8755A PROMS

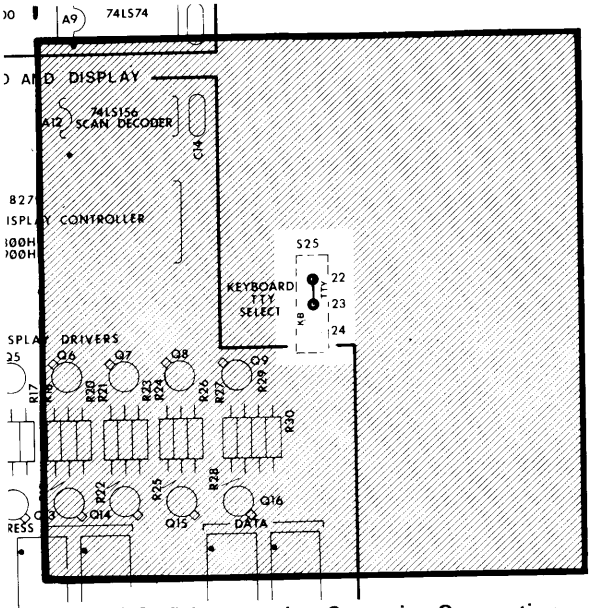


Figure 3-3 Teletypewriter Strapping Connection

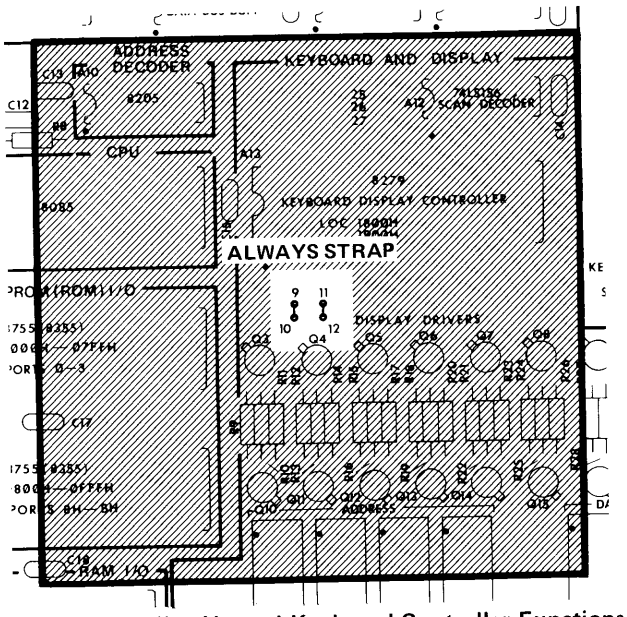


Figure 3-5 Disabling Unused Keyboard Controller Functions

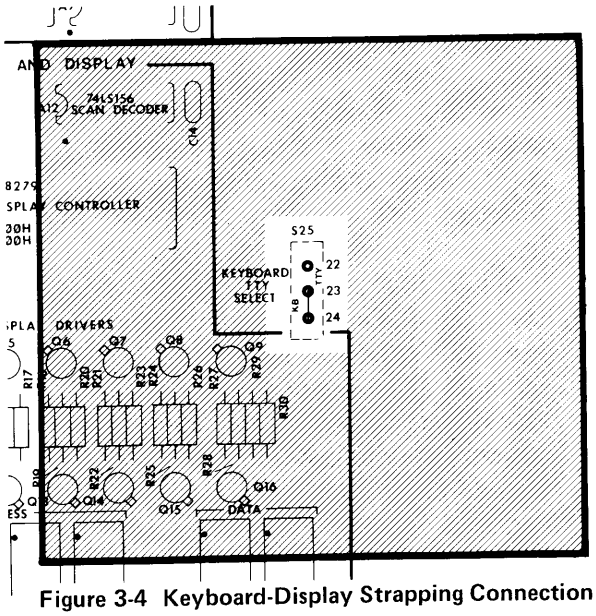


Figure 3-4 Keyboard-Display Strapping Connection

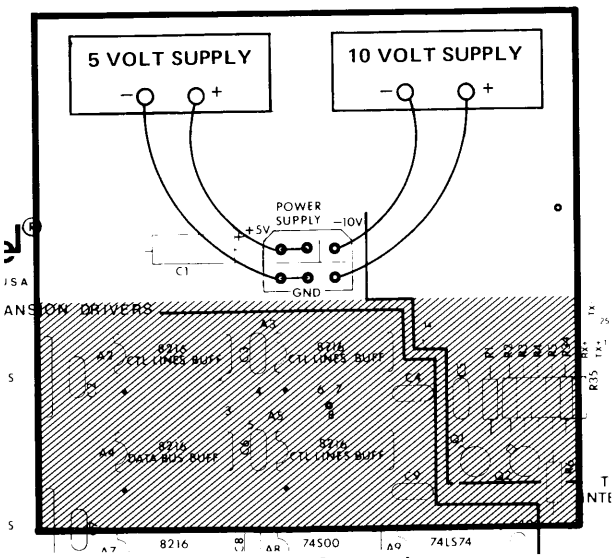


Figure 3-6 Power Supply Connections

hole pattern on the board (see p. 3-13 for the part number). If you are going to use a teletypewriter, connect a -10 Volt power supply with its negative output at the -10V point on the board. Connect the positive side of the -10 Volt power supply to the GND bus.

CAUTION

Do not turn on power until instructed to do so.

3-4 INSTALLING LARGE IC DEVICES

When you've finished all soldering operations on the board and are ready to fire it up, then it's time to plug in the large ICs. Once more, please make note of the precautions for handling these large MOS devices.

(Text continues on page 3-6.)

TABLE 3-4
BUS EXPANSION STRAPPING

FUNCTION	BASIC KIT WITHOUT EXPANSION MEMORY (Figure 3-7)	AUGMENTED KIT WITH EXPANSION MEMORY (Figure 3-8) (Also See Paragraph 3-7.)
RST 6.5	Strap 3-5	Strap 3-4 if no input is connected to J1-20. Leave 3, 4, and 5 not strapped if input is to be supplied for this restart function.
HOLD	Strap 6-8	Strap 7-8 if no input is connected to J1-14. Leave 6, 7, and 8 not strapped if input is to be supplied for this function.
INTR	Strap 20-21	Strap 20-21 if no input is connected to J1-18. Leave 20-21 not strapped if input is to be supplied for this function.
Memory Address Locations	Leave 25-26-27 unstrapped.	Strap 25-26 if all memory locations are external, i.e., addressed via bus expansion drivers.* (See Figure 3-9.) Strap 25-27 to enable the bus expansion drivers only when the upper 32K memory locations (8000H-FFFFH) are addressed. (See Figure 3-10.)

*Note: No devices may be installed in positions A13, A14, A15, A16, and A17 if this option is strapped.

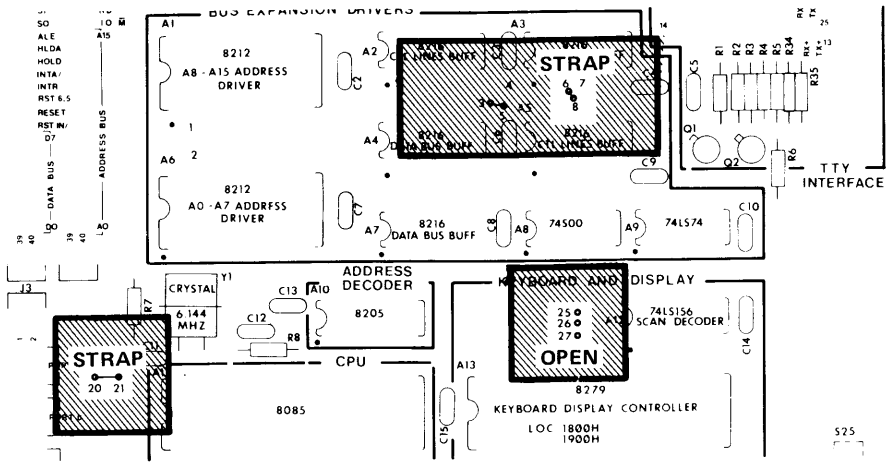


Figure 3-7 Strapping Required for Basic Kit (No Bus Expansion)

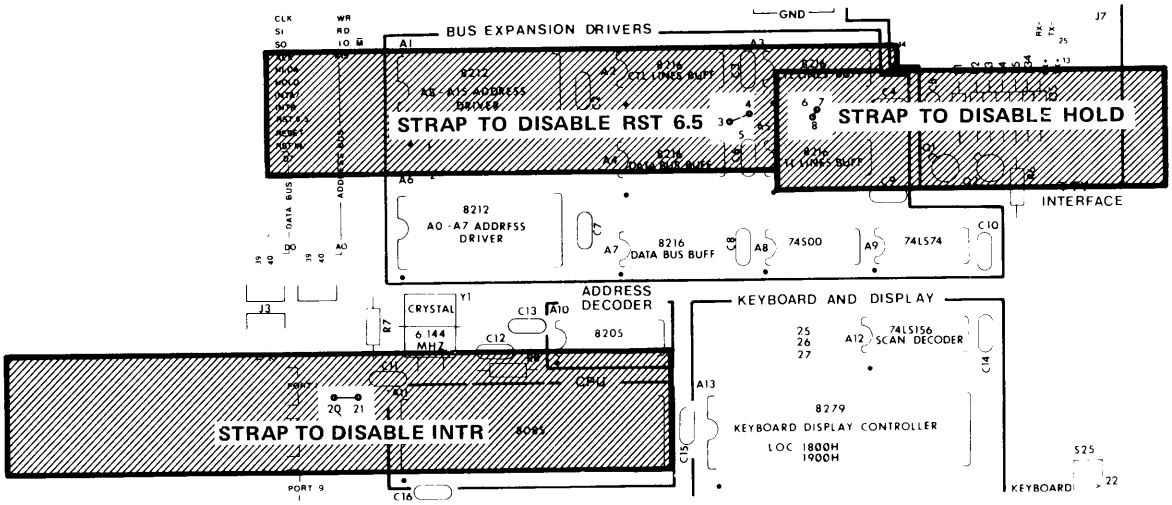


Figure 3-8 Strapping Options for Bus Expansion Control Lines

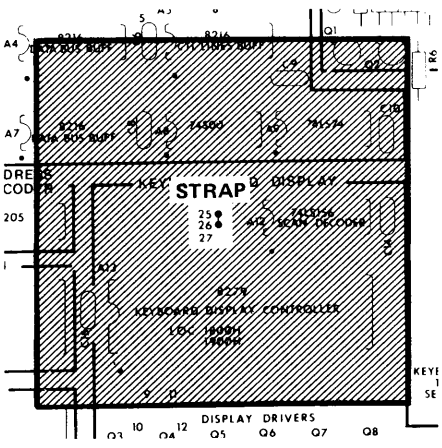


Figure 3-9 Strapping Options for all External Memory

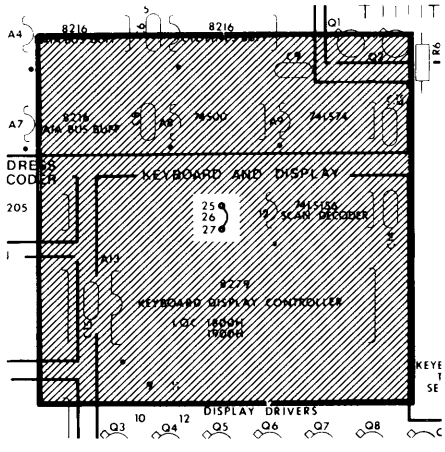


Figure 3-10 Strapping Options for Internal/External Memory

CAUTION

Large-scale integrated circuits are fragile! Dropping, twisting, or uneven pressure may break them. The discharge of static electricity can destroy them internally. Leave them embedded in the conductive-foam backing sheet until ready to install on the board. Never press down hard upon, twist, or bend the larger devices. Touch the exposed metal traces of the board with your hand before inserting one in its socket. The soldering of large devices directly on the circuit board is not recommended. If your Kit is provided with 8755 EPROM, do not remove the opaque sticker covering the window. Ultraviolet radiation including sunlight, can erase the monitor software contained in the device.

Inspect each IC to see that its leads are reasonably straight. (It's okay for the device to be a bit bow-legged.) The forked end of the soldering aid is a good tool for straightening bent leads. Carefully place an IC on its intended socket, oriented properly, with one row of its pins resting lightly in the socket holes. With your fingers or with the soldering aid, gently tease the other row of pins into their socket holes. Be sure no single pins have escaped. Once all pins have started, press down gently with fingers or with something flat to seat the device in its socket.

Each device must be oriented properly in its socket or it won't work. Every DIP device made has either a notch of some kind or a dot at one end. On the SDK-85 board, each notch or mark must face to the left. The markings on the board indicate this orientation. They also show which device type goes where. (See the pictorials on pages 2-9 and 2-15.)

3-5 STARTING THE FIRST TIME

Once you are certain that all parts are properly installed, the correct strapping options are soldered, and the power supplies connected, you are ready to start your MCS-85 System Design Computer. Clear the surface of your work table of any tools or wire that could come in contact with the underside of the circuit board and short it, and be sure there aren't any wire clippings on top of the board by accident.

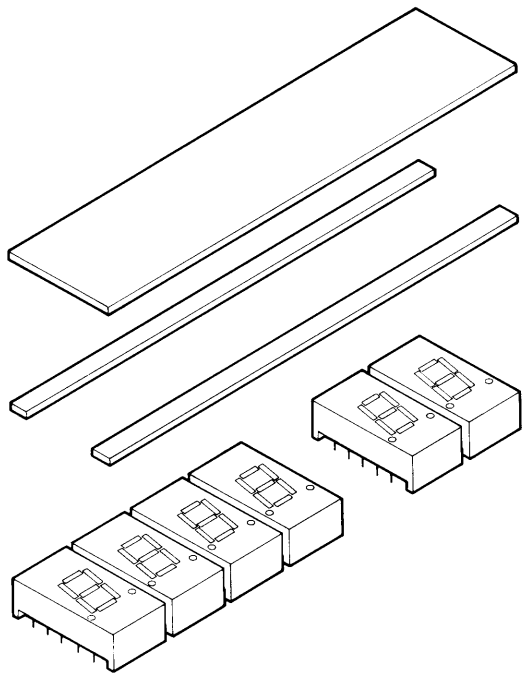
Peel the coverings from the red window and lay it on the display. (Don't stick it down yet.)

Energize the +5 Volt power supply.

Press the RESET button on the keyboard. The display should respond by reading out "– 80 85."

If the above readout appears, go on to Chapter 4 of this book and try out each button and function. Verify that each command produces the specified result, and that all segments of each 7-segment character display light.

Once you know the displays are all working right, peel the backing from the two strips of double-sided tape and use them to stick the red window in place.



3-6 WHAT IF IT DOESN'T?

If there is no response to the [RESET] command,

- ☐ Use the multimeter to check for the presence and proper polarity of +5 Volts on the board.
- ☐ Check all of the strapping connections, and be sure they are in the right places for the configuration you chose.
- ☐ Check carefully the seating of each and every pin of each of the four large ICs. Be sure no pins have accidentally bent over and missed the socket.
- ☐ Go back over the Chapter 2 assembly procedure and scan and check off all of the component values and all of the solder connections.
- ☐ Check the orientation of all semiconductor devices.
- ☐ Inspect for solder bridges or loose solder joints.

If all devices are properly soldered or firmly in their sockets and still there's no result, it can be presumed that there is a bad part somewhere. The keyboard switches can be checked using the multimeter, as mentioned in Chapter 2. If all switches are closing positively when pressed, and opening when released, further effective troubleshooting can be accomplished if you have a dual-trace oscilloscope of at least 5 MHz bandwidth, or a logic analyzer.

- ☐ Pin 37 of cpu A11 (8085) should show a clock output of 3.072 MHz (326 ns period). If it doesn't, there's something wrong with the 8085 or the crystal.
- ☐ Pin 30 of A11 should have a positive-going pulse about 160 ns wide every μs or so. This is the ALE pulse that indicates that the cpu is executing instructions.
- ☐ Pin 1 of address decoder A10 (8205) should pulse. If not, your 8085 is probably bad.
- ☐ If pin 1 of A10 pulses, check pin 15 of A10. If A10-15 doesn't follow A10-1, or has bad output voltage levels, the 8205 is either bad or installed wrong.
- ☐ If all else fails, call the Intel Service Hotline and describe the results of the foregoing procedure.

The numbers are:

(800) - 538-8014 when calling from out-
(800) - 538-8015 side California

(800) - 672-3507 California only

Note: The Service Hotline is available to provide limited support to help you get your kit running. If we can't help you over the phone, you may be directed to return your kit to us and we'll fix it for a flat fee and send it back to you. **The Service Hotline is available Monday through Friday, between 8 AM and 3:30 PM, Pacific time.**

IMPORTANT: The Service Hotline *is not* able to provide help to you in writing programs for your kit or in making hardware modifications. Please rely on the documentation provided with your kit for assistance.

TABLE 3-5
INTERFACE CONNECTOR J7
PIN ASSIGNMENTS

PIN		MARKING	ASSIGNMENT
1		–	Open
	14	–	Open
2		–	Open
	15	–	Open
3		–	Open
	16	–	Open
4		–	Open
	17	–	Open
5		–	Open
	18	–	Open
6		–	Open
	19	–	Open
7		–	Ground
	20	–	Open
8		–	Open
	21	–	Open
9		–	Open
	22	–	Open
10		–	Open
	23	–	Open
11		–	Open
	24	RX–	Receive Return (–)
12		RX+	Receive (+)
	25	TX–	Transmit Return (–)
13		TX+	Transmit (+)

3-7 CONNECTING A TELETYPEWRITER

If you wish to use a teletypewriter with your SDK-85 computer, connect it at Interface Connector J7 as shown in Table 3-5. You may use either a male connector or a female connector. (See Table 3-11.) Only four pins of this connector are assigned for Teletypewriter use; the remaining pins may be wire-wrapped to serve any function you choose.

TABLE 3-6
BUS EXPANSION CONNECTOR J1 PIN ASSIGNMENTS

ASSIGNMENT	PIN	PIN	MARKING	ASSIGNMENT	I/O
GND	1	2	—	OPEN	—
GND	3	4	CLK	Buffered CLK	O
GND	5	6	S1	Buffered S1	O
GND	7	8	S0	Buffered S0	O
GND	9	10	ALE	Buffered ALE	O
GND	11	12	HLDA	Buffered HLDA	O
GND	13	14	HOLD	Buffered HOLD	I
GND	15	16	INTA/	Buffered $\overline{\text{INTA}}$	O
GND	17	18	INTR	INTR	I
GND	19	20	RST 6.5	Buffered RST 6.5	I
GND	21	22	RST	Buffered RESET OUT	O
GND	23	24	RST IN/	$\overline{\text{RESET INPUT}}$	I
GND	25	26	D7	Buffered D7	I/O
GND	27	28	— DATA BUS —	Buffered D6	I/O
GND	29	30		Buffered D5	I/O
GND	31	32		Buffered D4	I/O
GND	33	34		Buffered D3	I/O
GND	35	36		Buffered D2	I/O
GND	37	38		Buffered D1	I/O
GND	39	40	D0	Buffered D0	I/O

TABLE 3-7
BUS EXPANSION CONNECTOR J2 PIN ASSIGNMENTS

ASSIGNMENT	PIN	PIN	MARKING	ASSIGNMENT	I/O
GND	1	2	RDY	READY	I
GND	3	4	WR/	Buffered $\overline{WR}$	O
GND	5	6	RD/	Buffered $\overline{RD}$	O
GND	7	8	IO/$\overline{M}$	Buffered IO/$\overline{M}$	O
GND	9	10	A15	Buffered A15	O
GND	11	12		Buffered A14	O
GND	13	14		Buffered A13	O
GND	15	16		Buffered A12	O
GND	17	18		Buffered A11	O
GND	19	20		Buffered A10	O
GND	21	22		Buffered A9	O
GND	23	24		Buffered A8	O
GND	25	26		Buffered A7	O
GND	27	28		Buffered A6	O
GND	29	30		Buffered A5	O
GND	31	32		Buffered A4	O
GND	33	34		Buffered A3	O
GND	35	36		Buffered A2	O
GND	37	38		Buffered A1	O
GND	39	40	A0	Buffered A0	O

ADDRESS BUS

TABLE 3-8
I/O PORT CONNECTOR J3 PIN ASSIGNMENTS

ASSIGNMENT	PIN	PIN	MARKING	ASSIGNMENT
P1-6*	1	2	PORT 1	P1-7
P1-4	3	4		P1-5
P1-2	5	6		P1-3
P1-0	7	8		P1-1
P0-6	9	10	PORT 0	P0-7
P0-4	11	12		P0-5
P0-2	13	14		P0-3
P0-0	15	16		P0-1
P9-6	17	18	PORT 9	P9-7
P9-4	19	20		P9-5
P9-2	21	22		P9-3
P9-0	23	24		P9-1
P8-6	25	26	PORT 8	P8-7
P8-4	27	28		P8-5
P8-2	29	30		P8-3
P8-0	31	32		P8-1
GROUND	33	34		GROUND

*Note: 1. Pn-m stands for PORT n Bit m (e.g. P9-6 means PORT 9H Bit 6).
2. Ports 0 & 1 are Ports A and B of 8355 (A14).
3. Ports 8 & 9 are Ports A and B of 8755 (A15).

TABLE 3-9
I/O PORT CONNECTOR J4 PIN ASSIGNMENTS

ASSIGNMENT	PIN	PIN	MARKING	ASSIGNMENT
P23H-4	1	2	⎤	P23H-5
P23H-2	3	4	PORT 23H	P23H-3
P23H-0	5	6	⎦	P23H-1
P22H-6	7	8	⎤	P22H-7
P22H-4	9	10	PORT 22H	P22H-5
P22H-2	11	12		P22H-3
P22H-0	13	14	⎦	P22H-1
P21H-6	15	16	⎤	P21H-7
P21H-4	17	18	PORT 21H	P21H-5
P21H-2	19	20		P21H-3
P21H-0	21	22	⎦	P21H-1
OPEN	23	24		OPEN
GROUND	25	26		GROUND

Note: Port 21H is Port A
Port 22H is Port B
Port 23H is Port C
} of 8155 (A16).

TABLE 3-10
I/O PORT AND TIMER CONNECTOR J5 PIN ASSIGNMENTS

ASSIGNMENT	PIN	PIN	MARKING	ASSIGNMENT
P2BH-4	1	2	⌐	P2BH-5
P2BH-2	3	4	PORT 2BH	P2BH-3
P2BH-0	5	6	⌙	P2BH-1
P2AH-6	7	8	⌐	P2AH-7
P2AH-4	9	10	PORT 2AH	P2AH-5
P2AH-2	11	12		P2AH-3
P2AH-0	13	14	⌙	P2AH-1
P29H-6	15	16	⌐	P29H-7
P29H-4	17	18	PORT 29H	P29H-5
P29H-2	19	20		P29H-3
P29H-0	21	22	⌙	P29H-1
Timer $\overline{OUT}$	23	24	TIMER $\overline{OUT}$/IN	Timer In
GROUND	25	26		GROUND

Note: Port 29H is Port A
Port 2AH is Port B
Port 2BH is Port C
} of expansion RAM 8155 (A17).
Timer is on the same 8155 (A17).

TABLE 3-11
SUGGESTED CONNECTOR TYPES

REFERENCE DESIGNATION	FUNCTION	NO. OF PINS	MFR.	MFR'S. PART NO.
J1	Bus Expansion	40	Spectra Strip	800-576
J2	Bus Expansion	40	Spectra Strip	800-576
J3	I/O Ports	34	Spectra Strip	800-579
J4	I/O Ports	26	Spectra Strip	800-583
J5	I/O Ports and Timer	26	Spectra Strip	800-583
J6	Not Used			
J7	TTY Interface	25		
	Female } Optional		AMP	206584
	Male } Optional		AMP	206604
—	Power Supply	6	Molex	Model No. 1261
	Recepticle			03-09-1064
	Plug			03-09-2062

CHAPTER 4
OPERATING INSTRUCTIONS

4-1 WHAT IT DOES

The things you can do with the basic SDK-85 kit are:

- Examine the contents of all memory and register locations
- Deposit program steps or data in RAM or register locations
- Execute programs or subroutines upon command
- Reset (start) the monitor upon command
- Interrupt and start operation at a location you specify upon command

You may select either the keyboard and display on the board or a teletypewriter as the console device by operating a switch or by placing a jumper wire at the appropriate place on the board. (See Chapter 3.) Keyboard/display operation and teletypewriter operation are described separately in the following paragraphs.

Two of the keyboard buttons continue to function in teletypewriter mode, as well as in keyboard/display mode. These are the [RESET] and the [VECT INTR] keys.

4-2 THE BUTTONS AND DISPLAYS

Keyboard/display operation is done by pressing keys on the keypad. Responses are displayed either by echoing the key pressed or by prompting you with a message or prompt. When the [RESET] button is pressed, the monitor is ready to accept commands. For numeric arguments, the valid range is from 1 to 4 hexadecimal digits for address information and 1 to 2 hex digits for register and memory data.

Longer numbers may be entered, but such numbers will be evaluated modulo 2^{16} or 2^{8} respectively, i.e., only the last four or the last two digits entered will be accepted.

As noted, the number system being used in the SDK-85 is the hexadecimal, or base-16 number system. Table 4-1 lists the hexadecimal, decimal (base 10), and binary (base two) equivalents. The table also shows how each hex digit will appear in the seven-segment LED displays.

TABLE 4-1
NUMBER SYSTEMS

HEX	DECIMAL	BINARY	LED DISPLAY
0	0	0000	0
1	1	0001	1
2	2	0010	2
3	3	0011	3
4	4	0100	4
5	5	0101	5
6	6	0110	6
7	7	0111	7
8	8	1000	8
9	9	1001	9
A	10	1010	A
B	11	1011	b
C	12	1100	C
D	13	1101	d
E	14	1110	E
F	15	1111	F

Whenever the monitor expects a command, the display shows a dash ("–") at the left edge of the address field (possibly along with an error message). When the monitor expects a parameter, a decimal point will be displayed at the right edge of the field into which the argument will be placed. A parameter will be either an address or a byte of data which is used during the execution of a command.

In the descriptions of the command modes, upper case letters and numbers enclosed in boxes represent keyboard keys. Words or phrases in lower case enclosed in brackets "<>" describe the nature of the command parameters you may input.

The () in the Format Statement indicates an optional argument.

Reset:

The [RESET] key causes a hardware reset, and starts the monitor. The message "–80 85" will be displayed across the address and data field of the display if you are in display-keyboard mode. If in teletypewriter mode, the sign on message "SDK-85 VER X.X" will be printed. The monitor is ready to accept a command after a reset, and saves no information about the state of any user program before the reset.

Substitute Memory:

[SUBST MEM] <address> [NEXT] (<data>) [NEXT] (<data>) . . . [EXEC]

The substitute memory command allows you to read the contents of ROM memory and to examine and modify the contents of RAM memory locations.

The address argument denotes the contents of the memory address to be examined, and may be from 1 to 4 hex digits. If you enter longer numbers, only the last 4 digits entered are used). As soon as the number is terminated by the [NEXT] key, the contents of that location are shown in the data field, along with a decimal point at the right edge of the field. Entering a new number will cause that number to be displayed in the data field; however, the contents of the memory location will not be changed until an [EXEC] or [NEXT] key is pressed.

Pressing [NEXT] will place the contents displayed in the data field into the displayed memory address. Then the address and contents of the next higher memory location will automatically be shown. Pressing [EXEC] will place the contents displayed in the data field into the memory address displayed in the address field, and will also terminate the command.

Pressing [NEXT] while the address FFFF is being displayed will cause address 0000 to be displayed.

Whenever the command changes the contents of a memory location, it also verifies that the change has occurred correctly. If the contents of the location do not agree with what the new value should be (i.e., if the memory location is in ROM or is nonexistent), an error message is generated.

SUBSTITUTE MEMORY EXAMPLE 1

Using [SUBST MEM] to list the first few Monitor locations:

KEY	ADDR	DATA
[SUBST MEM]	.	
[0]	0000.	
[NEXT]	0000	3E.
[NEXT]	0001	00.
[NEXT]	0002	32.
[NEXT]	0003	00.
[EXEC]	–	

SUBSTITUTE MEMORY EXAMPLE 2

Using [SUBST MEM] to enter a small program:

KEY	ADDR	DATA
[SUBST MEM]	.	
[2]	0002.	
[0]	0020.	
[0]	0200.	
[0]	2000.	
[NEXT]	2000	**.
[3 I]	2000	03.
[E]	2000	3E.
[NEXT]	2001	**.
[4 SPH]	2001	04.
[7 PCL]	2001	47.
[NEXT]	2002	**.
[C]	2002	0C.
[F]	2002	CF.
[EXEC]	–	

NOTE: ** represents unpredictable values.

After loading the above program, use [SUBST MEM] again to go back and check locations 2000-2002 to see that they contain:

ADDRESS	DATA	CORRESPONDING 8085 ASSEMBLY LANGUAGE INSTRUCTIONS
2000	3E	MVI A, 47H
2001	47	
2002	CF	RST 1

This program will load the A register with the number 47 and jump back to the monitor.

Examine Registers:

[EXAM REG] <reg> [NEXT] (<data>) [NEXT] (<data>) . . . [EXEC]

The examine command allows you to display and modify the contents of the 8085 CPU registers. Pressing the [EXAM REG] key blanks both the address and data fields, and displays a decimal point at the right edge of the address field. At this point, you must press a register key (register names are denoted by legends on the keyboard). Any other key will generate an error response.

If a register key is pressed, the name of the register will appear in the address field, and the contents of the register will appear in the data field, along with a decimal point at the right hand edge. Entering a number will cause the number to be displayed in the data field; however, the contents of the register will not be changed until an [EXEC] or [NEXT] key is pressed.

Pressing [NEXT] will place the contents displayed in the data field into the register named in the address field, then will display the name and contents of the next register in sequence (See Table 4-2). Pressing [EXEC] will place the contents displayed in the data field in the register named in the address field, and will also terminate the command.

Pressing [NEXT] while register PCL is being displayed has the same effect as pressing [EXEC].

The format for the I register is the lower 4 bits of the accumulator following execution of a RIM instruction. A "1" in an interrupt mask field denotes a masked condition. A "0" must be entered to use that interrupt.

The format for the I register is:

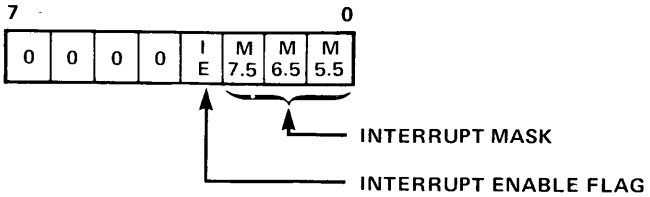
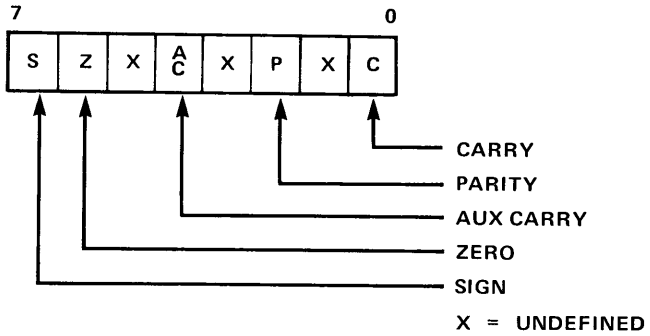


TABLE 4-2
REGISTER DISPLAY SEQUENCE

KEY/DISPLAY CODE	REGISTER
A	CPU register A
B	CPU register B
C	CPU register C
D	CPU register D
E	CPU register E
F	CPU flags byte
I	interrupt mask
H	CPU register H
L	CPU register L
SPH	most significant byte of stack pointer
SPL	least significant byte of stack pointer
PCH	most significant byte of program counter
PCL	least significant byte of program counter

The flag byte contains the 8085 CPU's condition flags.

The format for the flag byte is:



For more information about the 8085's flags and interrupt mask feature, consult the **MCS-85 User's Manual.**

EXAMINE REGISTER EXAMPLE 1

Using [EXAM REG] to initialize the 8085's stack pointer to 20C2:

KEY	ADDR	DATA
[EXAM REG]	.	
[4 SPH]	SPH	**.
[2]	SPH	02.
[0]	SPH	20.
[NEXT]	SPL	**.
[C]	SPL	0C.
[2]	SPL	C2.
[EXEC]	–	

EXAMINE REGISTER EXAMPLE 2

Using [EXAM REG] to examine the contents of the 8085's Registers:

KEY	ADDR	DATA
[EXAM REG]	.	
[A]	A	**.
[NEXT]	b	**.
[NEXT]	C	**.
[NEXT]	d	**.
[NEXT]	E	**.
[NEXT]	F	**.
[NEXT]	I	**.
[NEXT]	H	**.
[NEXT]	L	**.
[NEXT]	SPH	**.
[NEXT]	SPL	**.
[NEXT]	PCH	**.
[NEXT]	PCL	**.
[NEXT] or [EXEC]	–	

NOTE: ** represents the contents of the register whose name is in the address field of the display.

Go:

[GO] (<address>) [EXEC]

Pressing the [GO] key causes the contents of the program counter (PCH and PCL) to be displayed in the addressed field, along with a decimal point at the right edge of the field. The program counter is available for change, and any number entered (a number is optional) becomes the new contents of the program counter.

Pressing the [EXEC] key transfers control of the CPU to the address in the address field (contents of the program counter). Before the transfer of control, the address and data display fields are cleared, and an 'E' is displayed at the left edge of the address field.

Pressing any other key but [EXEC] generates an error message.

The monitor regains control of the CPU only after a [RESET] or after execution of an RST 0, RST 1, or JMP 0 instruction in program.

IMPORTANT:

Note that because of the way the GO and SINGLE STEP commands are implemented in the Monitor, [GO] and [SINGLE STEP] will not work unless the 8085's stack pointer is pointing to an existing portion of RAM memory. If at any time these two commands don't seem to be working, set SPH to 20 and SPL to C2 using [EXAM REG] , then try it again. (Locations 20C2 to 20FF are reserved for the monitor program, therefore the stack pointer must be set to 20C2 or lower so as not to interfere with the monitor.)

GO COMMAND EXAMPLE

Now you can execute the program you entered in Example 2 of the [SUBST MEM] command. First, check to make sure the 3- location program is in memory, then the program will be executed.

KEY	ADDR	DATA	COMMENTS
[SUBST MEM]	.		
[2]	0002.		
[0]	0020.		
[0]	0200.		
[0]	2000.		
[NEXT]	2000	3E.	MVI A, 47
[NEXT]	2001	47.	
[NEXT]	2002	CF.	RST 1
[EXEC]	–		
[GO]	****.	**	
[2]	0002.		
[0]	0020.		
[0]	0200.		
[0]	2000.		
[EXEC]	– 80	85	

NOTE: **** denotes "don't care" values

Recall that this small program loads the A register with the number 47 and restarts the monitor. To verify that the A register now holds 47 and to get more practice using [EXAM REG], try the following sequence:

KEY	ADDR	DATA	COMMENT
[EXAM REG]	.		
[A]	A	47.	A reg now holds 47.
[0]	A	00.	
[EXEC]	–		Now A holds 0
[GO]	****.	**	
[2]	0002.		
[0]	0020.		Run the small Program again
[0]	0200.		
[0]	2000.		
[EXEC]	– 80	85	
[EXAM REG]	.		
[A]	A	47	Now A holds 47 again

Now try placing other values in location 2001 using [SUBST MEM] and use [GO] to execute the program again, seeing how those values are loaded into the A register after execution.

Single Step:

[SINGLE STEP] (<address>) [NEXT] [NEXT] . . . [EXEC]

Pressing the [SINGLE STEP] key causes the contents of the program counter (PCH and PCL) to be displayed in the address field of the display along with a decimal point at the right hand edge of the field. The data field contains the contents of the address denoted by the contents of the program counter. The program counter is made available for change, and any number entered (a number is optional) becomes the new contents of the program counter.

Pressing the [NEXT] key causes the CPU to execute the one instruction pointed to by the program counter. After execution the monitor regains control of the CPU, and the address and data fields show the new contents of the program counter (address of next instruction to execute) and contents of the byte addressed by the program counter, respectively. The decimal point is turned on at the right hand edge of the address field, indicating that the program counter is available again.

If the [EXEC] key is pressed, no instruction is executed. The address displayed in the address field is made the contents of the program counter and the single step command is terminated. You may now examine or modify registers and memory locations to verify program execution. Pressing the [SINGLE STEP] key takes you back to the single step mode, and subsequent pressing of the [NEXT] key allows you to continue, instruction by instruction, through your program.

Single stepping is implemented in the SDK-85 hardware by repeatedly interrupting the processor. Since interrupts cannot be recognized during the EI and DI instructions of the 8085, single step will not stop at either of these instructions.

SINGLE STEP EXAMPLE

Single stepping through the SDK-85 Monitor. This is what you should see on the display:

KEY	ADDR	DATA
[SINGLE STEP]	****.	**
[8 H]	0008.	
[NEXT]	000b.	E1
[NEXT]	000C.	22
[NEXT]	000F.	F5
[NEXT]	0010.	E1

To resume full speed operation at this point, do the following:

[EXEC]	-	
[GO]	0010.	E1
[EXEC]	- 80	85

Vector Interrupt:

The [VECT INTR] key is similar to the [GO] key in the respect that it takes control away from the monitor and gives it to another program. The interrupt key causes immediate recognition of RST 7.5 interrupt and control passes to location 3C in the monitor. This location contains an unconditional branch to instruction location 20CE in user RAM. You may place any instruction you wish in Locations 20CE thru 20D0 (e.g., a branch to a keyboard interrupt routine). The monitor does not regain control without specific action (a [RESET] command, or a RST 0, RST 1, or JMP 0 program instruction). In branching back to the monitor, unless the RST 1 instruction is executed, the monitor loses all past information about the user program.

Since an interrupt is recognized by the hardware, the monitor cannot clear the display; thus the display may remain unchanged after interrupt.

IMPORTANT: Two conditions must be satisfied for the Vector Interrupt feature to be enabled:

1. Interrupts must be enabled (by executing an EI instruction).

2. RST 7.5 must be unmasked (mask reset by the SIM instruction or by modifying the I-Register).

Program Debugging — The Use of Breakpoints

Along with the "cold start" reset caused when the [RESET] button is pressed, the monitor also implements a "warm start" procedure. Execution of an RST 1 instruction will cause the monitor to enter this "warm start" routine. The monitor will display the same message as a [RESET] ('–80 85'), but all registers and user memory will be preserved in the state they were in at the time of execution of the RST 1. No system reset or initialization will be performed.

By placing RST 1 instructions at key RAM locations where you want to examine the CPU status, you can break from your program and then examine and set memory locations and registers, or single-step a portion of your program.

To resume execution of the user program, press [GO]. The PC value of the next instruction appears in the address field of the display. Then press [EXEC] to continue execution.

Error Conditions — Illegal Key

If a key is pressed which is illegal in its context (e.g., a command key is pressed when the monitor is expecting a number), the command is aborted and an error message is generated. This message takes the form "–Err", displayed in the address field. The monitor is then ready to accept a command. The error message will be cleared when a command key is pressed. Therefore, you can cancel a command before you press [NEXT] or [EXEC] by pressing any illegal key instead.

Memory Substitution Errors

If the substitute memory command determines that the contents of a memory location were not changed correctly (i.e. location is in ROM or is nonexistent), the command is aborted and an error message is generated. This message also takes the form "–Err", displayed in the address field. The monitor is then ready to accept a new command. The error message will be cleared when a command key is pressed.

4-3 TELETYPEWRITER OPERATION

Console Commands

This portion of the SDK-85 monitor communicates via a teletypewriter (console). Operation consists of dialogue between the operator and the monitor in the monitor's command language. After you press the [RESET] button on the SDK-85 keypad, the monitor begins the dialogue by typing a sign-on message on the console ("MCS-85 Kit") and then requests a command by typing a prompt character ("."). Commands are in the form of a single alphabetic character specifying the command, followed by a list of numeric or alphabetic parameters. Numeric parameters are entered as hexadecimal numbers. The monitor recognizes the characters 0 through 9 and A through F as legal hexadecimal digits. Longer numbers may be entered, but only the last four digits will be retained.

The only command requiring an alphabetic parameter is the "X" command. The nature of such parameters will be discussed in the section explaining the command.

Use of the Monitor for Programming and Checkout

The monitor allows you to enter, check out, and execute small programs. It contains facilities for memory display and modification, 8085 CPU register display and modification, program loading from the console device, and program initiation with a breakpoint facility. In addition, the [RST 7] key on the keyboard may be used to initiate your own keyboard interrupt routine.

Command Structure

In the following paragraphs, the monitor command language is discussed. Each command is described, and examples of its use are included for clarity. Error conditions that may be encountered while operating the monitor are described on page 4-13.

The monitor requires each command to be terminated by a carriage return. With the exception of the "S" and 'X" commands, the command is not acted upon until the carriage return is sensed. Therefore, you may abort any command, before entering the carriage return, by typing any illegal character (such as RUBOUT).

Except where indicated otherwise, a single space is synonymous with the comma for use as a delimiter. Consecutive spaces or commas, or a space or comma immediately following the command letter, are illegal in all commands except the "X" command (see below).

Items enclosed in parentheses "( )" are optional.

Display Memory Command, D:

D <low address>, <high address>

Selected areas of addressable memory may be accessed and displayed by the D command. The D command produces a formatted listing of the memory contents between <low address> and <high address>, inclusive, on the console. Each line of the listing begins with the address of the first memory location displayed on that line, represented as 4 hexadecimal digits, followed by up to 16 memory locations, each one represented by 2 hexadecimal digits.

Program Execute Command, G:

G (<entry point>)

Control of the CPU is transferred from the monitor to the user program by means of the program execute command G. The entry point should be an address in RAM which contains an instruction in the program. If no entry point is specified, the monitor uses, as an address, the value on top of the stack when the monitor was entered.

G COMMAND EXAMPLE

G2000

Control is passed to location 2000.

D COMMAND EXAMPLE

```
D9, 26
0009  EF  20  E1  22  F2  20  F5
0010  E1  22  ED  20  21  00  00  39  22  F4  20  21  ED  20  F9  C5
0020  D5  C3  3F  00  C3  57  01
```

Insert Instructions into RAM, I:

I <address>
<data>

Single instructions, or an entire user program, are entered into RAM with the I command. After sensing the carriage return terminating the command line, the monitor waits for the user to enter a string of hexadecimal digits (0 to 9, A to F). Each digit in the string is converted into its binary value, and then loaded into memory, beginning at the starting address specified and continuing into sequential memory locations. Two hexadecimal digits are loaded into each byte of memory.

Separators between digits (spaces, commas, carriage returns) are ignored; illegal characters, however, will terminate the command with an error message (see page 4-13). The character ESC or ALT-MODE (which is echoed to the console as "$") terminates the digit string.

I COMMAND EXAMPLE 1

I2010

1122334455667788 99$

This command puts the following pattern into RAM:

2010 11 22 33 44 55 66 77 88 99

I COMMAND EXAMPLE 2

I2040

123456789$

This command puts the following pattern into RAM:

2040 12 34 56 78 90

Note that since an odd number of hexadecimal digits was entered initially, a zero was appended to the digit string.

Move Memory Command, M:

M <low address>, <high address>, <destination>

The M command moves the contents of memory between <low address> and <high address> inclusive, to the area of RAM beginning at <destination>. The contents of the source field remain undisturbed, unless the receiving field overlaps the source field.

The move operation is performed on a byte-by-byte basis, beginning at <low address>. Care should be taken if <destination> is between <low address> and <high address>. For example, if location 2010 contains 1A, the command M2010, 201F 2011 will result in locations 2010 to 2020 containing "1A1A1A . . .", and the original contents of memory will be lost.

The monitor will continue to move data until the source field is exhausted, or until it reaches address FFFF. If the monitor reaches FFFF without exhausting the source field, it will move data into this location, then stop.

M COMMAND EXAMPLE

M2010, 204F, 2050

64 bytes of memory are moved from 2010-204F to 2050-208F by this command.

Substitute Memory Command, S:

S <address> (<data>)

The S command allows you to examine and optionally modify memory locations individually. The command functions as follows:

1. Type an S, followed by the hexadecimal address of the first memory location you wish to examine, followed by a space or comma.

2. The contents of the location are displayed, followed by a dash (–).

3. To modify the contents of the location displayed, type in the new data, followed by a space, comma, or carriage return. If you do not wish to modify the location, type only the space, comma, or carriage return. The next higher memory location will automatically be displayed as in step (2).

4. Type a carriage return. The S command will be terminated.

S COMMAND EXAMPLE

S2050 AA- BB-CC 01-13 23-24

Location 2050, which contains AA, is unchanged, but location 2051 (which used to contain BB) now contains CC, 2052 (which used to contain 01) now contains 13, and 2053 (which used to contain 23) now contains 24.

Examine/Modify CPU Registers Command, X:

X (<register identifier>)

Display and modification of the CPU registers is accomplished via the X command. The X command uses <register identifier> to select the particular register to be displayed. A register identifier is a single alphabetic character denoting a register, as defined in Table 4-3.

TABLE 4-3
X COMMAND REGISTER IDENTIFIERS

IDENTIFIER CODE	REGISTER
A	Register A
B	Register B
C	Register C
D	Register D
E	Register E
F	Flags byte
I	Interrupt Mask
H	Register H
L	Register L
M	Registers H and L combined
S	Stack Pointer
P	Program Counter

The command operates as follows:

1. Type an X, followed by a register identifier or a carriage return.

2. The contents of the register are displayed (two hexadecimal digits for A, B, C, D, E, F, I, H, and L, four hexadecimal digits for M, S, & P), followed by a dash (–).

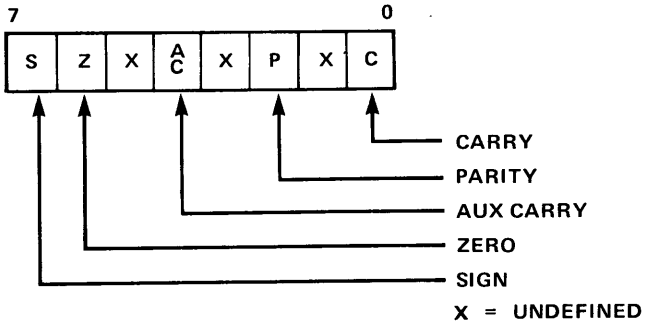
3. The register may be modified at this time by typing the new value, followed by a space, comma, or carriage return. If no modification is desired, type only the space, comma, or carriage return.

4. If a space or comma is typed in step (3), the next register in sequence will be displayed as in step 2 (unless P was just displayed which case the command is terminated). If a carriage return is entered in step 3, the X command is terminated.

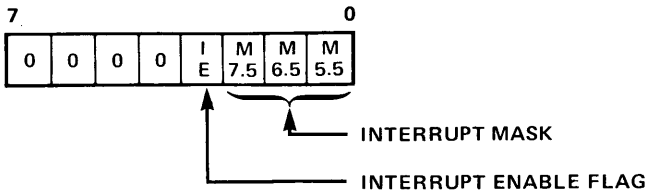
5. If a carriage return is typed in step (1) above, an annotated list of all registers and their contents is displayed.

   Note: The bits in the flag byte (F) and interrupt mask (I) are encoded as follows:

The format for the F register:



The format for the I register:



Note: For more information on the 8085's interrupt masks, please consult the **MCS-85 User's Manual.**

Program Debugging — Breakpoint Facility

The monitor treats the RST 1 instruction (CF) as a special sequence initiator. Upon execution of an RST 1 instruction the monitor will automatically save the complete CPU status and output the sign-on message "MCS-85 Kit" to the console. You may at that time display the contents of the CPU status register by initiating an "X" command. After examining the machine status and making any necessary changes you can resume execution of the program by inputting "G" and Carriage Return on the console. You can step through large portions of your program by inserting RST 1 instructions at key locations.

Error Conditions — Invalid Characters

Each character is checked as it is entered from the console. As soon as the monitor determines that the last character entered is illegal in its context, it aborts the command and issues an "*" to indicate the error.

INVALID CHARACTER EXAMPLE

D2000, 205G*

The character G was encountered in a parameter list where only hexadecimal digits and delimiters are valid.

Address Value Errors

Some commands require an address pair of the form <low address>, <high address>. If, on these commands, the value of <low address> is greater than or equal to the value of <high address>, the action indicated by the command will be performed on the data at low address only. Addresses are evaluated modulo 2^{16}. Thus, if a hexadecimal address greater than FFFF is entered, only the last 4 hex digits will be used. Another type of address error may occur when you specify a part of memory in a command which does not exist in the hardware configuration you are using.

In general, if a nonexistent portion of memory is specified as the source field for an instruction, the data fetched will be unpredictable. If a nonexistent portion of memory is given as the destination field in a command, the command has no effect.

CHAPTER 5
THE HARDWARE

5-1 OVERVIEW

This portion of the SDK-85 User's Manual should provide you with sufficient knowledge to write programs to exercise the basic system as well as providing capability to use the basic kit as a nucleus around which you can build larger systems.

Figure 5-1 is a functional block diagram of the SDK-85. The components enclosed in dashed boxes have places in the SDK-85 printed circuit board, but these are not needed for a minimum system and are not included in the kit. In addition, some control lines have been omitted from the block diagram for the sake of simplicity. The full SDK-85 schematic diagrams have been included in an appendix for your reference.

The text to follow describes each of the elements in the system:

5-2 SYSTEM COMPONENTS

The 8085 CPU & The System Buses

The 8085 CPU is an evolutionary enhancement of Intel's industry standard 8080A. It is 100% software compatible with the 8080A while offering the benefits of single power supply, higher integration, higher performance, and improved system timing.

The 8085 CPU is fully described in the Intel® **MCS-85™ User's Manual** so a detailed description will not be repeated here.

As the system block diagram shows, the 8085 derives its timing inputs directly from a crystal. In addition the 8085 drives the system with control signals available on-chip. No additional status decoding circuitry is required for most small- to medium-sized systems. The 8085 multiplexes its data bus with the low 8 bits of its address bus. The 8155 and 8355/8755 Memory I/O components in the kit are designed to be compatible with this bus structure, precluding the need for external bus latches.

Four vectored interrupt inputs are available in addition to the standard 8080A-type interrupt. There is also a serial input and serial output data line pair that is exercised under program control to provide the SDK-85's simple teletype I/O.

The basic clock frequency of the 8085 in the kit is 3.072 MHz (internally divided by 2 from the 6.144 MHz crystal input).

The 8155

The 8155 is a highly integrated chip designed for compatibility with the 8085's bus structure. It contains 256 bytes of static RAM memory, 22 programmable I/O lines, and a 14-bit timer/counter. The function of the 8155 is described in detail in the Intel **MCS-85 User's Manual.**

One 8155 is included with the SDK-85 kit and space for another has been provided on the circuit board. The RAM memory in the 8155 is available for storage of user programs as well as for temporary storage of information needed by system programs.

The 8155's timer is used by the SDK-85 monitor's Single Step routine to interrupt the processor following the execution of each instruction.

The 8355 & 8755

The 8355 and 8755 are two more chips specially designed for compatibility with 8085 systems. The 8355 contains 2048 bytes of mask programmed read only memory (ROM) and 16 I/O lines. The 8755 has an identical function and pinout to the 8355, but contains ultraviolet erasable and reprogrammable read only memory (EPROM) instead of the ROM.

The SDK-85 contains either one 8355 or one 8755 that is programmed with the system monitor. Space for a second 8755 or 8355 has been allocated on the PC board.

The 8279

The 8279 is a keyboard/display controller chip that handles the interface between the 8085 and the keypad and LED display on the SDK-85 board. The 8279 refreshes the display from an internal memory while scanning the keyboard to detect keyboard inputs. The 8279 is described in detail in the **MCS-85 User's Manual.**

The 8205

The basic SDK-85 also contains an 8205 chip (one-out-of-8 decoder) that decodes the 8085's memory address bits to provide chip enables for the 8155, the 8355/8755, and the 8279.

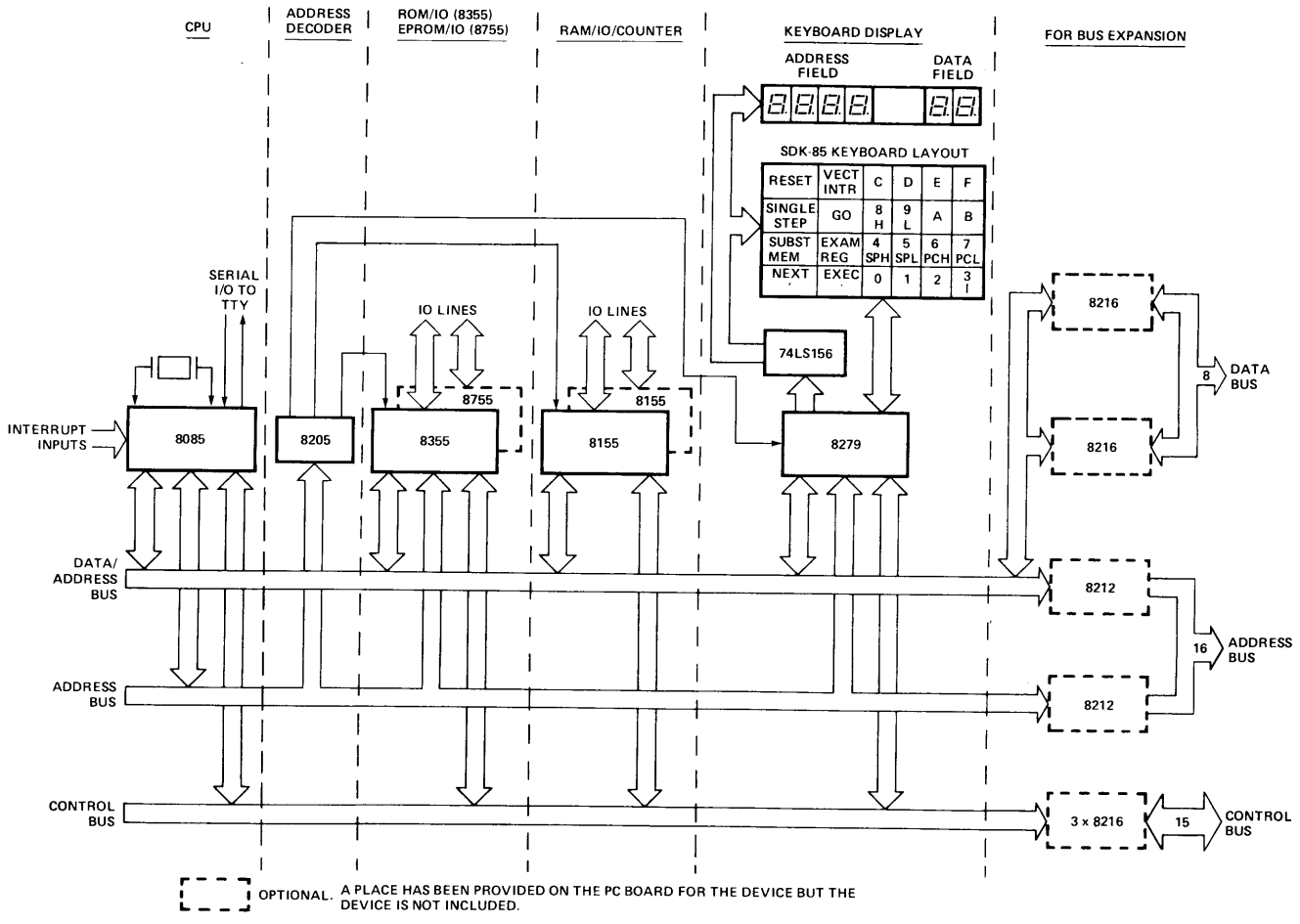


Figure 5-1 SDK-85 Functional Block Diagram

TABLE 5-1
8205 CHIP ENABLES

OUTPUT	ACTIVE ADDRESS RANGE	SELECTED DEVICE
CS0	0000-07FF	8755/8355 MONITOR ROM (A14)
CS1	0800-0FFF	8755/8355 EXPANSION ROM (A15)
CS2	1000-17FF	N/C
CS3	1800-1FFF	8279 KEYBOARD/DISPLAY CONTROLLER (A13)
CS4	2000-27FF	8155 BASIC RAM (A16)
CS5	2800-2FFF	8155 EXPANSION RAM (A17)
CS6	3000-37FF	N/C
CS7	3800-3FFF	N/C

AXX = IC# on schematic diagram in Appendix
N/C = not connected — avilable for user expansion

5-3 SDK-85 MEMORY ADDRESSING

Each memory/I/O chip in the basic SDK-85 System of Figure 5-1 is enabled by a signal coming from the 8205 address decoder. Table 5-1 lists each chip enable output accompanied by the address space over which it is active and the SDK-85 device that is selected.

Note that the 8279 is really an input/output device that is communicated with by the 8085 as though it were a series of memory locations.

The above chip enable table can be expanded to form a memory map that illustrates the active portions of the SDK memory (see Figure 5-2). Using the terminology of Figure 5-2, the basic SDK-85 with no additional memory/I/O chips provides the memory blocks marked MONITOR ROM and BASIC RAM. You must confine your programs to a subset of the space available in the BASIC RAM, the remainder of BASIC RAM being required for monitor storage locations. A list of the monitor-reserved RAM locations is provided in Table 5-2.

Note that RAM memory locations 20C2 through 20D0 are places for jump instructions pointing to the places in memory for the computer to go following the execution of an RST 5 instruction, an RST 6 instruction, an interrupt signal on the RST 6.5 input, etc. If you do not use any of these instructions or interrupt lines, then this RAM area is available for other programming.

When you add an expansion 8155 in the space provided on the SDK-85 board, the RAM locations shown in Figure 5-2 as EXPANSION RAM are made available for programming. The monitor reserves no space in the EXPANSION RAM, so all 256 locations are available for programming.

An extra 8355 or 8755 device when plugged into the appropriate spot on the board gives you program memory space in the area denoted EXPANSION ROM in the memory map.

The areas marked "FOLD BACK" in Figure 5-2 indicate address space that is unused, but unavailable for expansion, because these locations are multiple mappings of the basic locations.

TABLE 5-2
MONITOR-RESERVED RAM LOCATIONS

LOC.	CONTENTS	
20C2	User may place a JMP instr. to a RST 5 routine in locs 20C2 – 20C4.	Loaded by user
20C5	JMP to RST 6 routine	
20C8	JMP to RST 6.5 routine (hardwired user interrupt)	
20CB	JMP to RST 7 routine	
20CE	JMP to "VECT INTR" key routine	
20D1-20E8	Monitor Stack (temporary storage used by monitor)	
20E9	E Register	storage for user register images
20EA	D Register	
20EB	C Register	
20EC	B Register	
20ED	Flags	
20EE	A Register	
20EF	L Register	
20F0	H Register	
20F1	Interrupt Mask	
20F2	Prog. Cntr. – Low byte	
20F3	Prog. Cntr. – HI byte	
20F4	Stack Ptr. – Low byte	
20F5	Stack Ptr. – Hi byte	
20F6	Current Address	
20F8	Current Data	
20F9-20FC	Output buffer & Temp Locs.	
20FD	Register Pointer	
20FE	Input Buffer	
20FF	8155 Command/Status Register image	

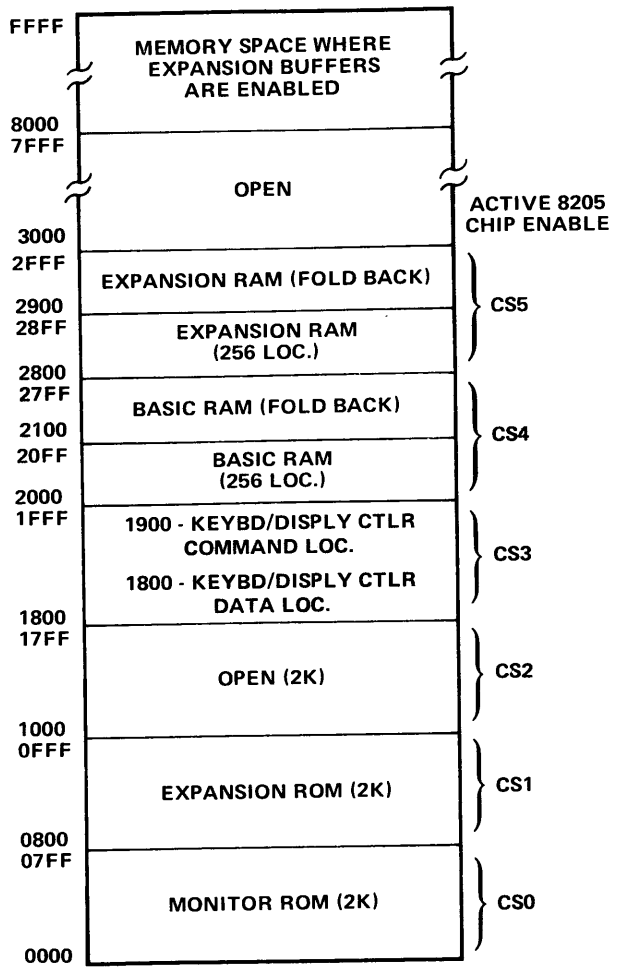


Figure 5-2 SDK-85 Memory Map

Any of the areas marked "OPEN" in Figure 5-2 are free for expansion. You may mount extra memory chips in the wire-wrap area of the SDK-85 board or on other circuit boards. The 8205 address decoder has 3 uncommitted chip select lines to allow the addition of three 2048-byte memory blocks without additional decoding circuitry.

If you want to expand on the basic SDK-85 you don't have to stick to the multiplexed-bus MCS 85 memory/I/O family. Mounting pads are present on the circuit board that accommodate an 8212 latch for address/data bus demultiplexing. To provide the current drive capability to operate much larger systems, spaces are also allocated for another 8212 to buffer the unmultiplexed half of the address and five 8216 buffer/drivers to buffer the data bus, and control signals. The function of these components is described in detail in the 8085 manual. The functional positioning of the optional latch, buffers, and drivers in the SDK-85 system structure is shown in Figure 5-1.

IMPORTANT:
As Figure 5-2 indicates, the optional expansion buffers leading to the SDK-85 board's prototyping area are enabled only over the address range 8000-FFFF. If you desire to use any of the "OPEN" expansion areas shown in Figure 5-2 (enabled by the 8205 chip selects), you will have to become familiar with the SDK-85 schematics at the back of this manual and implement custom modifications to the SDK-85 circuitry.

5-4 INPUT/OUTPUT PORT AND PERIPHERAL DEVICE ADDRESSING

As mentioned before, the 8155 and 8355/8755 that come with the SDK-85 Kit have on-board input/output ports. These ports are accessed using the IN and OUT instructions of the 8085. Each individual port being referenced has a unique 8-bit address. Table 5-3 contains all the port addresses for an expanded SDK-85 containing two 8155's and two 8355/8755's.

Please consult the **MCS-85 User's Manual** for the use of the various special purpose registers referred to in the table (Direction Registers, Command/Status Registers, etc.), and for complete instructions for exercising the memory-I/O chips (8155/8355/8755).

Hardware Note: The timer/counter of the first 8155 (RAM) is dedicated as a timer. It is hardwired to receive the 8085's system clock (3.072 MHz CLK) as its count input. This timer is used by the keyboard monitor's SINGLE STEP function, so you should beware of timer conflicts if you desire to count and use the SINGLE STEP function at the same time. (See paragraph 6-2.)

Accessing the 8279 Keyboard/Display Controller

As was mentioned in the memory addressing sections, the 8279 is a peripheral chip that is selected using memory-mapped I/O. Table 5-4 shows the two memory locations that are used to communicate with the 8279. Consult the **MCS-85 User's Manual** for detailed operating instructions.

TABLE 5-3
SDK-85 I/O PORT MAP

PORT	FUNCTION
00	Monitor ROM PORT A
01	Monitor ROM PORT B
02	Monitor ROM PORT A Data Direction Register
03	Monitor ROM PORT B Data Direction Register
08	Expansion ROM PORT A
09	Expansion ROM PORT B
0A	Expansion ROM PORT A Data Direction Register
0B	Expansion ROM PORT B Data Direction Register
20	BASIC RAM COMMAND/STATUS Register
21	BASIC RAM PORT A
22	BASIC RAM PORT B
23	BASIC RAM PORT C
24	BASIC RAM Low Order Byte of Timer Count
25	BASIC RAM High Order Byte of Timer Count
28	EXPANSION RAM COMMAND/STATUS Register
29	EXPANSION RAM PORT A
2A	EXPANSION RAM PORT B
2B	EXPANSION RAM PORT C
2C	EXPANSION RAM Low Order Byte of Timer Count
2D	EXPANSION RAM High Order Byte of Timer Count

The data format for character bytes being displayed by the 8279 is one bit corresponding to each of the seven LED segments plus one bit for the decimal point. Figure 5-3 shows the bit configuration.

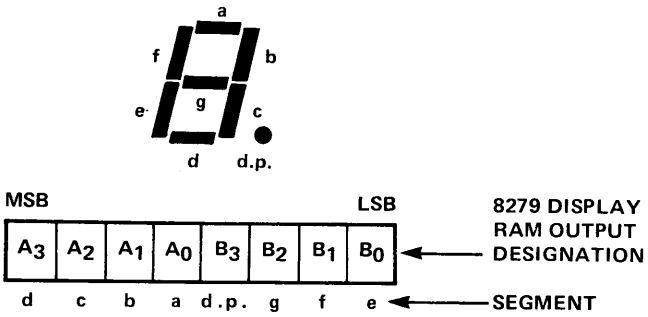


Figure 5-3 Data Format

The hardware is designed so that writing a zero into a bit position turns on the corresponding LED segment.

Example: a "4" would be represented as
1001 1001 = 99 (Hex)

These are six active LED displays available for use. They are configured in a four-place address field and a two-place data field as in Figure 5-4.

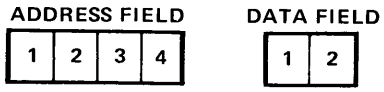


Figure 5-4 Display Configuration

TABLE 5-4
ACCESSING THE 8279
KEYBOARD DISPLAY CONTROLLER

LOCATION	READ/ WRITE	FUNCTION
1800	Read	Read Keyboard FIFO
	Write	Write Data to Display
1900	Read	Read Status Word
	Write	Write Command Word

The display digits are stored within the 8279 display RAM in the locations listed in Table 5-5.

TABLE 5-5

8279 DISPLAY RAM LOCATION	PURPOSE
0	Address digit 1
1	2
2	3
3	4
4	Data Digit 1
5	2
6	UNUSED
7	UNUSED

5-5 PROCESSOR INTERRUPT ALLOCATION

The 8085 has four Vector Interrupt input pins in addition to an 8080A-compatible interrupt input. The name of each interrupt and its function in the SDK-85 hardware is listed in Table 5-6.

The function of the on-chip interrupts is described in detail in the 8085 Manual.

TABLE 5-6
8085 ON-CHIP INTERRUPT ALLOCATION

INPUT	FUNCTION
RST 5.5	Dedicated to 8279
RST 6.5	Available User Interrupt
RST 7.5	VECT INTR button interrupt
TRAP	8155 Timer Interrupt
INTR	Available User Interrupt

5-6 THE SERIAL DATA INTERFACE

The SDK-85 has the capability of communicating with a teletype, using the 8085 serial input and serial output data lines (SID and SOD respectively) to send and receive the serial bit strings that encode data characters.

To send data to the teletype, the 8085 must toggle the SOD line in a set/reset fashion controlled by software timing routines in the SDK-85 monitor.

Input data is obtained by monitoring and timing changes in the level of the SID pin. Again, a monitor routine is called upon to do the job.

These teletype communications routines are accessible to the user.

Both subroutines communicate at a data rate of 110 baud, the standard rate for teletypewriters.

Since the 8085 serial input and output lines are designed for communicating with other integrated circuits, additional electronic circuitry is needed before they can be connected to a terminal. The TTY interface in the top right corner of the board allows the SDK-85 to be connected to any teletype that uses 20 mA "current-loop" input and output.

5-7 CONVERTER CIRCUIT FOR RS232C SERIAL PORT

If you are fortunate enough to have a CRT terminal that can operate at a 110-baud rate, and wish to use it with the SDK-85 computer, you may find that it is compatible only with "RS232c" voltage-level serial ports and not with current loops. If this is the case,

- ☐ Wire the MC1488 and MC1489 converter circuit (shown in Figure 5-5) into the wire-wrap area of the SDK-85 board.
- ☐ Remove R6, and connect the input line of the converter circuit to its lower pad. (You could put a switch in this line if you wanted to.)
- ☐ Open both the TTY and KEYBOARD jumpers, and connect the output line of the converter to the middle pad, which is strapping point 23. (If you are using a switch, one with a center off position could be used.)
- ☐ Connect your CRT as shown in Figure 5-5.
- ☐ Connect the 3 different voltages to the circuit.

5-8 ADDITIONAL INTERFACES

Additional interface considerations are discussed in Intel Application Note AP-29, which also describes a low-cost cassette tape-recorder interface, that can be added to your SDK-85 kit. AP-29 can be ordered by sending $1.00 to: Literature Department, Intel Corp., 3065 Bowers Ave., Santa Clara, Ca. 95051.

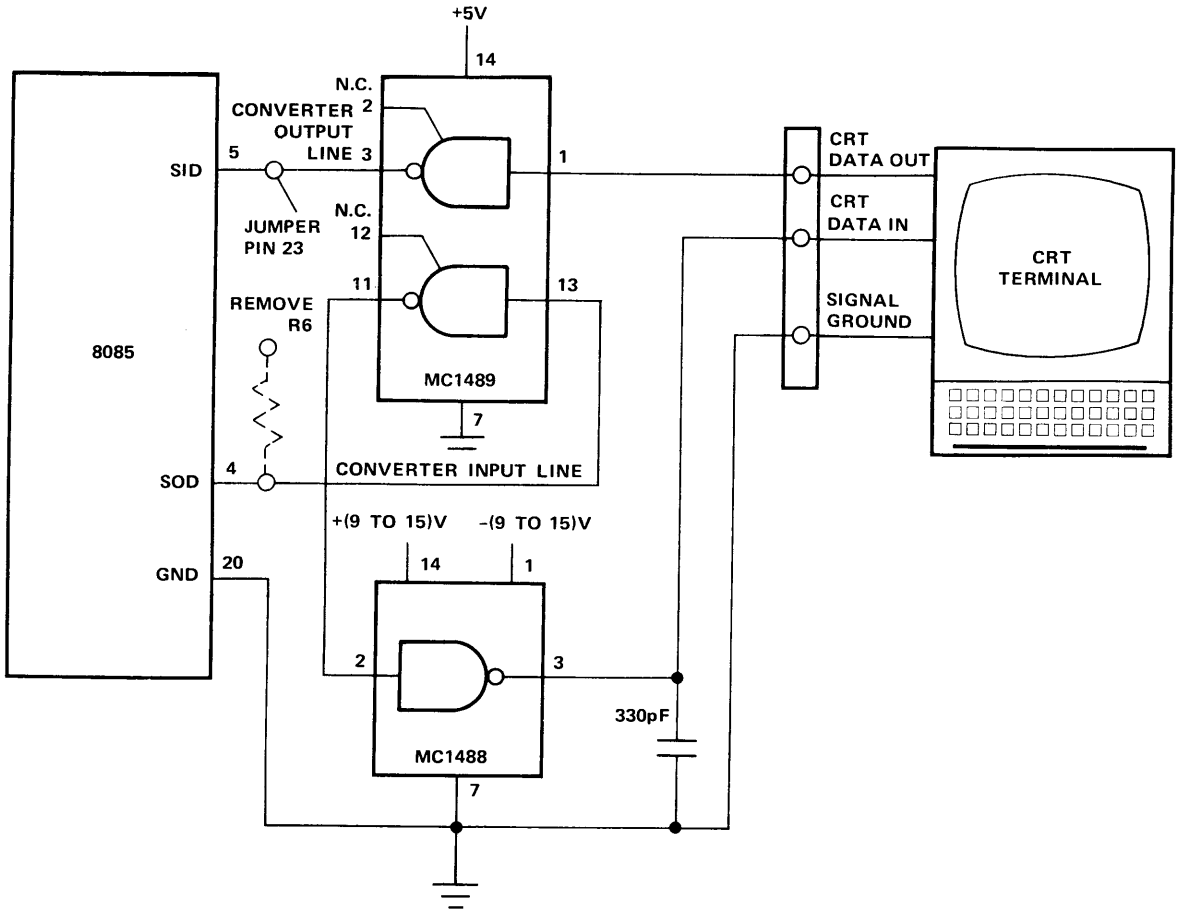


Figure 5-5 Modification for RS-232c Operation

CHAPTER 6
THE SOFTWARE

6-1 THE SDK-85 MONITOR

The SDK-85 monitor program provides utility functions employing either a teletypewriter or the kit's on-board keyboard and display as console. The program resides in 2k (k = 1024) bytes of the ROM memory, between location 0 and location 7FF. the routines that service each console device are independent; the two devices do not function simultaneously. You may select either the keyboard and display or the teletypewriter as the console device by actuating a switch (not furnished) or by changing strapping connections. Both can be used to perform substantially the same tasks. (See Chapter 4.)

6-2 PROGRAMMING HINTS

Stack Pointer

The 8085 makes use of a 16-bit internal register called the Stack Pointer to point to an area of memory called the stack. The 8085's stack is used for saving many things, such as memory addresses for returns from subroutines.

It is important always to define the stack pointer at the beginning of your program to avoid storing data in the wrong place. Locations 20C2 through 20D0 in RAM are reserved by the monitor for jump instructions when all interrupts are used. Thus, you should set the stack pointer initially at 20C2 (by the use of the program instruction LXI SP, 20C2H (31 C2 20), the keyboard command [EXAM REG] [4 SPH] (20) [NEXT] (C2) [EXEC], or the teletypewriter "XS" command) in order to keep your own stack clear of data and programs you want to protect. If less than the full complement of interrupts is utilized, some or all of the unused space above 20C2 can be allocated to stack as described above. Remember that the stack must still occupy an unbroken string of contiguous memory locations.

RAM-I/O Command Status Register (CSR)

The basic 8155 command status register (port 20) is used to set up the on-chip I/O ports and timer. It can only be written to; it cannot be read. You can write to this register in your programs, but there is a precaution you should take: at any time when you write to the CSR in the basic RAM, you should also write the same pattern to RAM location 20FF. The reason is this: The [SINGLE STEP] command causes the monitor to change the CSR in order to set up the timer for execution of the command. If it is not told what value you previously put there (by saving the value in 20FF), that value will inevitably be overwritten and lost. Following each single step, the monitor reads location 20FF, logically ORs its timer command to the content of that location, and writes the CSR with the new command, thereby retrieving your previous configuration.

Access to Monitor Routines

You may "borrow" several of the SDK-85 monitor routines to simplify your programming task. Table 6-1 provides descriptions and calling addresses for these routines.

6-3 PROGRAMMING EXAMPLES

The programming examples presented at the end of this chapter demonstrate how to use the monitor routines to operate the keyboard and display.

TABLE 6-1
MONITOR ROUTINE CALLING ADDRESSES

Calling Address	Mnemonic	Description
07FD	CI	**Console Input** This routine returns a character (in ASCII code – see 8085/8080 reference card for codes) received from the teletype to the caller in the A register. The A register and CPU condition codes are affected by this operation
07FA	CO	**Console Output** This routine transmits a character (in ASCII code), passed from the caller in the C register, to the teletypewriter. The A and C registers, and the CPU condition codes are affected.
05EB	CROUT	**Carriage Return, Line Feed** CROUT sends carriage return and line feed characters to the teletype. The contents of the A, B, and C registers are destroyed and the CPU condition codes are affected.
06C7	NMOUT	**Hex Number Printer** NMOUT converts the 8-bit unsigned integer in the A register into 2 ASCII characters representing the 2 hex digits and prints the two digits on the teletypewriter. The contents of the A, B and C registers and the condition code flags are affected.
0363	UPDAD	**Update Address** Update address field of the display. The contents of the D-E register pair are displayed in the address field of the display. The contents of all the CPU registers and flags are affected.
036E	UPDDT	**Update Data** Update data field of the display. The contents of the A register are displayed in hex notation in the data field of the display. The contents of all of the CPU registers and flags are affected.
02E7	RDKBD	**Read Keyboard** This routine waits until a character is entered on the hex keypad and upon return places the value of the character in the A register. The A, H, and L registers and the flag flip flops are affected. NOTE: For RDKBD to work correctly, you must first: 1. Unmask RST 5.5 using the SIM instruction.
05F1	DELAY	**Time Delay** This routine takes the 16-bit contents of register pair DE and counts down to zero, then returns to the calling program. The A, D, and E registers and the flags are affected.

TABLE 6-1
MONITOR ROUTINE CALLING ADDRESSES (CONT'D)

Calling Address	Mnemonic	Description
02B7	OUTPT	**Output Characters to Display** The routine sends characters to the display with the parameters set up by registers A, B, H and L. Reg A = 0 = use address field = 1 = use data field Reg B = 0 = decimal point off = 1 = decimal point at right edge of field Reg HL = starting address of characters to to sent.

Character Displayed	Hexadecimal memory content pointed to by the HL register
0	00
1	01
2	02
3	03
4	04
5	05
6	06
7	07
8	08
9	09
A	0A
b	0B
C	0C
d	0D
E	0E
F	0F
H	10
L	11
P	12
I	13
r	14
S	05
Blank	15

PROGRAM EXAMPLE – RDKBD

After executing [GO] 2000, the program waits until a key is pressed. Then the value of the key is placed in the A register and the monitor is restarted. Use [EXAM REG] to see that the key value is now in the A register.

ADDRESS	DATA	SYMBOLIC	COMMENTS
2000	31	LXI SP, 20C2H	; define stack pointer
2001	C2		
2002	20		
2003	3E	MVI A, 08H	
2004	08		
2005	30	SIM	; unmask interrupt
2006	CD	CALL RDKBD	; read keyboard value
2007	E7		; into Reg A
2008	02		
2009	CF	RST 1	; break point, go back to monitor

PROGRAM EXAMPLE – UPDDT

Display FF in data field of display.

ADDRESS	DATA	SYMBOLIC	COMMENTS
2000	31	LXI SP, 20C2H	; define stack pointer
2001	C2		
2002	20		
2003	3E	MVI A, FFH	; load FF into Reg A
2004	FF		
2005	CD	CALL UPDDT	; output Reg A to data field
2006	6E		
2007	03		
2008	76	HLT	; HALT

To change the display value use [SUBST MEM] to vary the content of location 2004

PROGRAM EXAMPLE – RDKBD, UPDDT

Putting the two preceding examples together into one program causes the display to show the key value.

ADDRESS	DATA	SYMBOLIC	COMMENTS
2000	31C220	LXI SP, 20C2H	; define stack pointer
2003	3E08	MVI A, 08H	
2005	30	SIM	; unmask interrupt
2006	CDE702	LOOP: CALL RDKBD	; read keyboard value into Reg A
2009	CD6E03	CALL UPDDT	; output Reg A to data field
200C	C30620	JMP LOOP	; keep looping

PROGRAM EXAMPLE – ADD TWO NUMBERS IN HEX NOTATION

This program is an adaptation of the program above. The computer reads in two one-digit numbers using RDKBD. Then it adds them, and displays the sum (base 16) on the LED display using UPDDT.

ADDRESS	DATA		SYMBOLIC	COMMENTS
2000	31C220		LXI SP, 20C2H	; initialize stack pointer
2003	3E08		MVI A, 08H	
2005	30		SIM	; unmask interrupts
2006	CDE702	LOOP:	CALL RDKBD	; get first number
2009	47		MOV B,A	; save number in B reg.
200A	CDE702		CALL RDKBD	; get second number
200D	80		ADD B	; add the two numbers
200E	CD6E03		CALL UPDDT	; display the sum
2011	C30620		JMP LOOP	; keep looping

Note: for decimal (base10) addition of digits 0-9, insert the DAA instruction (opcode 27) between ADD B and CALL UPDDT in the above program.
Additional Suggestion: Try modifying this program to perform 2-digit decimal number addition. (Hint: use the 8085's RLC instruction.)

PROGRAM EXAMPLE – 4-DIGIT HEX COUNTER

This program displays a 4-digit hexadecimal (base 16) count in the address field of the display using the UPDAD routine from the monitor.

ADDRESS	DATA		SYMBOLIC	COMMENTS
2000	31C220		LXI SP 20C2	; initialize stack pointer
2003	13	LOOP:	INX D	; add 1 to the 16-bit count
2004	D5		PUSH D	; save the count in the stack
2005	CD6303		CALL UPDAD	; display the count
2008	110018		LXID, 1800	; set delay count
200B	CDF105		CALL DELAY	; wait out the delay
200E	D1		POP D	; restore the count to D & E regs
200F	C30320		JMP LOOP	; keep counting

PROGRAM EXAMPLE – DECIMAL COUNTER

The following program displays a count in the data field of the display. The count may be stopped by pressing the [VECT INTR] button. The count resumes when any other key (except [RESET]) is pressed. The "E" in the address field of the display signifies that a user program is executing.

ADDRESS	DATA	SYMBOLIC	COMMENTS
2000	31	LXI SP, 2080H	; INITIALIZE STACK POINTER.
2001	80		
2002	20		
2003	3E	MVI A, 08	; USE THE 8085's SIM INSTR TO
2004	08		; ENABLE THE VECT INTR BUTTON.
2005	30	SIM	
2006	FB	LOOP: EI	
2007	78	MOV A, B	
2008	3C	INR A	; INCREMENT AND ADJUST THE COUNT
2009	27	DAA	; FOR DECIMAL COUNTING.
200A	47	MOV B, A	
200B	C5	PUSH B	
200C	CD	CALL UPDDT	; DISPLAY COUNT IN DATA FIELD OF
200D	6E		; DISPLAY.
200E	03		
200F	16	MVI D, 18H	
2010	18		
2011	CD	CALL DELAY	; WAIT OUT A PROGRAMMABLE DELAY
2012	F1		; PERIOD BEFORE CONTINUING.
2013	05		
2014	C1	POP B	
2015	C3	JMP LOOP	; GO BACK TO THE BEGINNING.
2016	06		
2017	20		
—			
20CE	FB	EI	; CONTROL BRANCHES TO LOCATION
			; 20CE WHEN VECT INTR IS PRESSED.
20CF	76	HLT	; WAIT HERE FOR KEY DEPRESSION.
20D0	C9	RET	; RESUME THE COUNT.

To execute the program, type in [GO] 2000 [EXEC].

Try to stop the count right at 00 using the [VECT INTR] key.

Change the speed of the count by using [SUBST MEM] to vary the contents of location 2010.

Additional Suggestions:

This counter can be turned into a digital stopwatch second counter by *inserting* the following instructions between DAA and MOV B, A in the above program:

200A	FE60	CPI A, 60	; check to see if count = 60
200C	C21020	JNZ 2010	; continue if count ≠ 60.
200F	AF	XRA A	; if count = 60 then set the count = 0

In addition, you will have to insert another MVI D and CALL DELAY before POP B and vary both delay counts in order to get exactly one second between counts on the LED display.

Additional Programming Idea: Expand on the digital stopwatch program by displaying hours and minutes in the address field of the LED display.

PROGRAM EXAMPLE – FLASH HELP

Load into Locations 2000 through 2007 (use the Substitute Memory command) the following data: 10, OE, 11, 12, 15, 15, 15, 15. Then load and execute the following program ([GO]2010[EXEC]). The display will flash "HELP".

ADDRESS	DATA	SYMBOLIC	COMMENTS
2010	31C220	LXI SP, 20C2H	; define stack pointer
2013	3E01	MVI A, 1	; use data field
2015	0600	MVI B, 0	; no decimal indicator
2017	210620	LXI H, 2006H	; use characters starting ; at Location 2006
201A	CDB702	CALL OUTPT	; output the two characters ; to data field
		DPY:	
201D	3E00	MVI A, 0	; use address field
201F	0600	MVI B, 0	; no decimal indicator
2021	210020	LXI H, 2000H	; use characters starting ; at Location 2000
2024	CDB702	CALL OUTPT	; output the four characters ; to address field
		;	
2027	11FFFF	LXI D, 0FFFFH*	; set up delay value
202A	CDF105	CALL DELAY	; time delay
		;	
202D	3E00	MOV A, 0	;
202F	0600	MOV B, 0	;
2031	210420	LXI H, 2004H	; output BLANKS to
2034	CDB702	CALL OUTPT	; Display
		;	
2037	11FFFF	LXI D, 0FFFFH	;
203A	CDF105	CALL DELAY	; time Delay
203D	C31D20	JMP DPY	; REPEAT

*Delay time proportional to value. Any number from 1 through FFFF may be chosen.

Additional Suggestions:

You may select any other 4-letter word from the characters on p. 6-3 and place the hex codes for those letters in memory locations 2000-2003. Then restart the program from location 2010 and your new word will flash on the display.

In addition, you may place the hex codes from p. 6-3 for a 2-letter word (like "HI") in memory locations 2004 and 2005, and the 2-letter word will flash in between the flashes of the 4-letter word.

PROGRAM EXAMPLE – USING THE 8155 AND 8355 DEVICE OUTPUT PORTS

ADDRESS	DATA		SYMBOLIC	COMMENTS
2000	31C220		LXI SP, 20C2H	; initialize stack pointer
2003	3E03		MVI A, 03	; put 8155 command in A reg.
2005	D320		OUT 20H	; program the 8155 CSR
2007	3EFF		MVI A, FF	; put 8355 DDR value in A reg.
2009	D302		OUT 02	; program PORT A DDR
200B	D303		OUT 03	; program PORT B DDR
200D	03	LOOP:	INXB	; increment 16-bit count
200E	79		MOV A, C	;
200F	D321		OUT 21	; send low byte of count
2011	D300		OUT 0	; to 8155 PORT A and
				; to 8355 port A
2013	78		MOV A, B	;
2014	D322		OUT 22	; send hi byte of
				; count to 8155 port B
2016	D301		OUT 01	; send hi byte of
				; count to 8355 port B
2018	C30D20		JMP LOOP	; loop back.

This program is an example showing how to configure the input/output ports of the 8155 and 8355 devices as output ports. The command register of the 8155 is loaded with the value 03 at the beginning of the program to signify that both 8155 ports A and B will be outputs. Likewise, both ports A and B of the 8355 are programmed to be outputs by writing all one's (FF) to both Data Direction Registers in the 8355.

The program increments a 16-bit binary count and sends the count out through the ports of the 8155 and 8355. If you have a logic probe or oscilloscope, you can look at the corresponding outputs on connector pads J3 and J4 on the SDK-85 PC board.

APPENDIX A
MONITOR LISTING

```
ASM80 :F1:SDK85.SRC MACROFILE MOD85 XREF PRINT(:F1:SDK85.LST)

ISIS-II 8080/8085 MACRO ASSEMBLER, X108         SDK85    PAGE    1

 LOC  OBJ          SEQ         SOURCE STATEMENT

                     1 ;*****************************************************************************
                     2 ;
                     3 ;                         PROGRAM: SDK-85 MONITOR    VER 2.1
                     4 ;
                     5 ;                         COPYRIGHT (C) 1977
                     6 ;                         INTEL CORPORATION
                     7 ;                         3065 BOWERS AVENUE
                     8 ;                         SANTA CLARA, CALIFORNIA  95051
                     9 ;
                    10 ;*****************************************************************************
                    11 ;
                    12 ; ABSTRACT
                    13 ; ========
                    14 ;
                    15 ; THIS PROGRAM IS A SMALL MONITOR FOR THE INTEL 8085 KIT AND
                    16 ; PROVIDES A MINIMUM LEVEL OF UTILITY FUNCTIONS FOR THE USER EMPLOYING
                    17 ; EITHER AN INTER-ACTIVE CONSOLE (I.E. TELETYPE) OR THE KIT'S
                    18 ; KEYBOARD/LED DISPLAY. THE KEYBOARD MONITOR ALLOWS THE USER TO PERFORM
                    19 ; SUCH FUNCTIONS AS MEMORY AND REGISTER MANIPULATION, PROGRAM LOADING,
                    20 ; PROGRAM EXECUTION, INTERRUPTION OF AN EXECUTING PROGRAM, AND
                    21 ; SYSTEM RESET.
                    22 ;
                    23 ; PROGRAM ORGANIZATION
                    24 ; ======= ============
                    25 ;
                    26 ; THE PROGRAM IS ORGANIZED AS FOLLOWS :-
                    27 ;       1) COLD START ROUTINE (RESET)
                    28 ;       2) WARM START - REGISTER SAVE ROUTINE
                    29 ;       3) INTERRUPT VECTORS
                    30 ;       4) KEYBOARD MONITOR
                    31 ;       5) TTY MONITOR
                    32 ;       6) LAYOUT OF RAM USAGE
                    33 ;
                    34 ; THE KEYBOARD MONITOR BEGINS WITH THE COMMAND RECOGNIZER, FOLLOWED BY
                    35 ; THE COMMAND ROUTINE SECTION, UTILITY ROUTINE SECTION AND MONITOR
                    36 ; TABLES. THE COMMAND AND UTILITY ROUTINES ARE IN ALPHABETICAL ORDER
                    37 ; WITHIN THEIR RESPECTIVE SECTIONS.
                    38 ; THROUGHOUT THE KEYBOARD MONITOR, A COMMENT FIELD BEGINNING
                    39 ; WITH "ARG - " INDICATES A STATEMENT WHICH LOADS A VALUE INTO
                    40 ; A REGISTER AS AN ARGUMENT FOR A FUNCTION. WHEN THE DESIRED VALUE
                    41 ; LIST OF KEYBOARD MONITOR ROUTINES
                    42 ; ==== == ======== ======= ========
                    43 ;
                    44 ; CMMND
                    45 ; -----
                    46 ; EXAM
                    47 ; GOCMD
                    48 ; SSTEP
                    49 ; SUBST
                    50 ; -----
                    51 ; CLEAR
                    52 ; CLDIS
                    53 ; CLDST
                    54 ; DISPC
                    55 ; ERR
                    56 ; GTHEX
                    57 ; HXDSP
                    58 ; ININT
                    59 ; INSDG
                    60 ; NXTRG
                    61 ; OUTPT
                    62 ; RDKBD
                    63 ; RETF
                    64 ; RETT
                    65 ; RGLOC
                    66 ; RSTOR
                    67 ; SETRG
                    68 ; UPDAD
                    69 ; UPDDT
                    70 ;
                    71         NAME    SDK85
                    72 ;
                    73 ;*****************************************************************************
                    74 ;
                    75 ;                         SET CONDITIONAL ASSEMBLY FLAG
                    76 ;
                    77 ;*****************************************************************************
                    78 ;
                    79 ;
0000                80 WAITS   SET     0       ;0=NO WAIT STATES
                    81                         ;1=A WAIT STATE IS GENERATED FOR EVERY M CYCLE
                    82                         ;THE APPROPRIATE DELAY TIME MUST BE USED FOR
                    83                                 ;TTY DELAY OR SET UP SINGLE
                    84                                 ;STEP TIMER FOR EACH CASE
                    85 ;
                    86 ;
                    87 ;*****************************************************************************
                    88 ;
                    89 ;                         MONITOR EQUATES
                    90 ;
                    91 ;*****************************************************************************
                    92 ;
2000                93 RAMST   EQU     2000H   ; START ADDRESS OF RAM - THIS PROGRAM ASSUMES
                    94 ; THAT 256 BYTES OF RANDOM ACCESS MEMORY BEGIN AT THIS ADDRESS.
                    95 ; THE PROGRAM USES STORAGE AT THE END OF THIS SPACE FOR VARIABLES,
                    96 ; SAVING REGISTERS AND THE PROGRAM STACK
                    97 ;
```

```
LOC  OBJ          SEQ         SOURCE STATEMENT

0017                98 RMUSE   EQU     23      ; RAM USAGE - CURRENTLY, 23 BYTES ARE USED FOR
                    99                         ; /SAVING REGISTERS AND VARIABLES
                   100 ;
0018               101 SKLN    EQU     24      ; MONITOR STACK USAGE - MAX OF 12 LEVELS
                   102 ;
000F               103 UBRLN   EQU     15      ; 5 USER BRANCHES - 3 BYTES EACH
                   104 ;
0000               105 ADFLD   EQU     0       ; INDICATES USE OF ADDRESS FIELD OF DISPLAY
0090               106 ADISP   EQU     90H     ; CONTROL CHARACTER TO INDICATE OUTPUT TO
                   107                         ; /ADDRESS FIELD OF DISPLAY
1900               108 CNTRL   EQU     1900H   ; ADDRESS FOR SENDING CONTROL CHARACTERS TO
                   109                         ; /DISPLAY CHIP
0011               110 COMMA   EQU     11H     ; COMMA FROM KEYBOARD
0000               111 CSNIT   EQU     0       ; INITIAL VALUE FOR COMMAND STATUS REGISTER
0020               112 CSR     EQU     20H     ; OUTPUT PORT FOR COMMAND STATUS REGISTER
0094               113 DDISP   EQU     94H     ; CONTROL CHARACTER TO INDICATE OUTPUT TO
                   114                         ; /DATA FIELD OF DISPLAY
0001               115 DOT     EQU     1       ; INDICATOR FOR DOT IN DISPLAY
1800               116 DSPLY   EQU     1800H   ; ADDRESS FOR SENDING CHARACTERS TO DISPLAY
0001               117 DTFLD   EQU     1       ; INDICATES USE OF DATA FIELD OF DISPLAY
0008               118 DTMSK   EQU     08H     ; MASK FOR TURNING ON DOT IN DISPLAY
0080               119 EMPTY   EQU     80H     ; HIGH ORDER 1 INDICATES EMPTY INPUT BUFFER
00CC               120 KBNIT   EQU     0CCH    ; CONTROL CHARACTER TO SET DISPLAY OUTPUT TO
                   121                         ; /ALL ONES DURING BLANKING PERIOD
0000               122 KMODE   EQU     0       ; CONTROL CHAR. TO SET KEYBOARD/DISPLAY MODE
                   123                         ; (2 KEY ROLLOVER, 8 CHARACTER LEFT ENTRY)
20E9               124 MNSTK   EQU     RAMST + 256 - RMUSE     ;START OF MONITOR STACK
0000               125 NODOT   EQU     0       ; INDICATOR FOR NO DOT IN DISPLAY
                   126 ;NUMC - DEFINED LATER   ; NUMBER OF COMMANDS
                   127 ;NUMRG - DEFINED LATER  ; NUMBER OF REGISTER SAVE LOCATIONS
0010               128 PERIO   EQU     10H     ; PERIOD FROM KEYBOARD
00FB               129 PRMPT   EQU     0FBH    ; PROMPT CHARACTER FOR DISPLAY (DASH)
0040               130 READ    EQU     40H     ; CONTROL CHARACTER TO INDICATE INPUT FROM
                   131                         ; /KEYBOARD
0025               132 TIMHI   EQU     25H     ; OUTPUT PORT FOR HIGH ORDER BYTE OF TIMER VALUE
0024               133 TIMLO   EQU     24H     ; OUTPUT PORT FOR LOW ORDER BYTE OF TIMER VALUE
0040               134 TMODE   EQU     40H     ; TIMER MODE - SQUARE WAVE, AUTO RELOAD
00C0               135 TSTRT   EQU     0C0H    ; START TIMER
000E               136 UNMSK   EQU     0EH     ; UNMASK INPUT INTERRUPT
20C2               137 USRBR   EQU     RAMST + 256 - (RMUSE + SKLN + UBRLN)     ; START OF USER
                   138                                                          ; /BRANCH LOCATIONS
                   139         IF      1-WAITS ;TIMER VALUE FOR SINGLE STEP IF NO WAIT STATE
00C5               140 TIMER   EQU     197
                   141         ENDIF
                   142         IF      WAITS   ;TIMER VALUE FOR SINGLE STEP IF ONE WAIT STATE INSERTED
                   143 TIMER   EQU     237
                   144         ENDIF
                   145 ;
                   146 ;*****************************************************************************
                   147 ;
                   148 ;                           MONITOR MACROS
                   149 ;
                   150 ;*****************************************************************************
                   151 ;
                   152 TRUE    MACRO   WHERE   ; BRANCH IF FUNCTION RETURNS TRUE
                   153         JC      WHERE
                   154         ENDM
                   155 ;
                   156 FALSE   MACRO   WHERE   ; BRANCH IF FUNCTION RETURNS FALSE
                   157         JNC     WHERE
                   158         ENDM
                   159 ;
                   160 ;
                   161 ;*****************************************************************************
                   162 ;
                   163 ; ***** "RESET" KEY ENTRY POINT - COLD START
                   164 ; ***** RST 0 ENTRY POINT
                   165 ;
0000 3E00          166         MVI     A,KMODE ; GET CONTROL CHARACTER
0002 320019        167         STA     CNTRL   ; SET KEYBOARD/DISPLAY MODE
0005 C3F101        168         JMP     CLDST   ; GO FINISH COLD START
                   169 CLDBK:                  ; THEN JUMP BACK HERE
                   170 ;
                   171 ; ***** RST 1 ENTRY POINT - WARM START
                   172 ;
0008               173         ORG     8
                   174 ;       SAVE REGISTERS
0008 22EF20        175         SHLD    LSAV    ; SAVE H & L REGISTERS
000B E1            176         POP     H       ; GET USER PROGRAM COUNTER FROM TOP OF STACK
000C 22F220        177         SHLD    PSAV    ; /AND SAVE IT
000F F5            178         PUSH    PSW
0010 E1            179         POP     H
0011 22ED20        180         SHLD    FSAV    ; SAVE FLIP/FLOPS & REGISTER A
0014 210000        181         LXI     H,0     ; CLEAR H & L
0017 39            182         DAD     SP      ; GET USER STACK POINTER
0018 22F420        183         SHLD    SSAV    ; /AND SAVE IT
001B 21ED20        184         LXI     H,BSAV+1 ; SET STACK POINTER FOR SAVING
001E F9            185         SPHL            ; /REMAINING REGISTERS
001F C5            186         PUSH    B       ; SAVE B & C
0020 D5            187         PUSH    D       ; SAVE D & E
0021 C33F00        188         JMP     RES10   ; LEAVE ROOM FOR VECTORED INTERRUPTS
                   189 ;
                   190 ; ***** TIMER INTERRUPT (TRAP) ENTRY POINT (RST 4.5)
0024               191         ORG     24H
0024 C35701        192         JMP     STP25   ; BACK TO SINGLE STEP ROUTINE
                   193 ;
                   194 ; ***** RST 5 ENTRY POINT
                   195 ;
0028               196         ORG     28H
```

```
LOC  OBJ          SEQ          SOURCE STATEMENT

0028 C3C220       197          JMP     RSET5   ; BRANCH TO RST 5 LOCATION IN RAM
                  198 ;
                  199 ; ***** INPUT INTERRUPT ENTRY POINT (RST 5.5)
                  200 ;
002C              201          ORG     2CH
002C C38E02       202          JMP     ININT   ; BRANCH TO INPUT INTERRUPT ROUTINE
                  203 ;
                  204 ; ***** RST 6 ENTRY POINT
                  205 ;
0030              206          ORG     30H
0030 C3C520       207          JMP     RSET6   ; BRANCH TO RST 6 LOCATION IN RAM
                  208 ;
                  209 ; ***** HARD WIRED USER INTERRUPT ENTRY POINT (RST 6.5)
                  210 ;
0034              211          ORG     34H
0034 C3C820       212          JMP     RST65   ; BRANCH TO RST 6.5 LOCATION IN RAM
                  213 ;
                  214 ; ***** RST 7 ENTRY POINT
                  215 ;
0038              216          ORG     38H
0038 C3CB20       217          JMP     RSET7   ; BRANCH TO RST 7 LOCATION IN RAM
                  218 ;
                  219 ; ***** "VECTORED INTERRUPT" KEY ENTRY POINT (RST 7.5)
003C              220          ORG     3CH
003C C3CE20       221          JMP     USINT   ; BRANCH TO USER INTERRUPT LOCATION IN RAM
                  222 ;
                  223 RES10:  ; CONTINUE SAVING USER STATUS
003F 20           224          RIM             ; GET USER INTERRUPT STATUS AND INTERRUPT MASK
0040 E60F         225          ANI     0FH     ; KEEP STATUS & MASK BITS
0042 32F120       226          STA     ISAV    ; SAVE INTERRUPT STATUS & MASK
0045 3E0E         227          MVI     A,UNMSK ; UNMASK INTERRUPTS FOR MONITOR USE
0047 30           228          SIM
0048 F3           229          DI              ; INTERRUPTS DISABLED WHILE MONITOR IS RUNNING
                  230                          ; (EXCEPT WHEN WAITING FOR INPUT)
0049 20           231          RIM             ; TTY OR KEYBOARD MONITOR ?
004A 07           232          RLC             ; IS TTY CONNECTED ?
004B DAFA03       233          JC      GO      ; YES - BRANCH TO TTY MONITOR
                  234                          ; NO - ENTER KEYBOARD MONITOR
                  235 ;
                  236 ;*****************************************************************
                  237 ;
                  238 ;                        BEGINNING OF KEYBOARD MONITOR CODE
                  239 ;
                  240 ;*****************************************************************
                  241 ;
                  242 ;       OUTPUT SIGN-ON MESSAGE
004E AF           243          XRA     A       ; ARG - USE ADDRESS FIELD OF DISPLAY
004F 0600         244          MVI     B,NODOT ; ARG - NO DOT IN ADDRESS FIELD
0051 21A603       245          LXI     H,SGNAD ; ARG - GET ADDRESS OF ADDRESS FIELD PORTION OF
                  246                          ; /SIGN-ON MESSAGE
0054 CDB702       247          CALL    OUTPT   ; OUTPUT SIGN-ON MESSAGE TO ADDRESS FIELD
0057 3E01         248          MVI     A,DTFLD ; ARG - USE DATA FIELD OF DISPLAY
0059 0600         249          MVI     B,NODOT ; ARG - NO DOT IN DATA FIELD
005B 21AA03       250          LXI     H,SGNDT ; ARG - GET ADDRESS OF DATA FIELD PORTION OF
                  251                          ; /SIGN-ON MESSAGE
005E CDB702       252          CALL    OUTPT   ; OUTPUT SIGN-ON MESSAGE TO DATA FIELD
0061 3E80         253          MVI     A,EMPTY
0063 32FE20       254          STA     IBUFF   ; SET INPUT BUFFER EMPTY FLAG
                  255 ;
                  256 ;*****************************************************************
                  257 ;
                  258 ; FUNCTION: CMMND - COMMAND RECOGNIZER
                  259 ; INPUTS: NONE
                  260 ; OUTPUTS: NONE
                  261 ; CALLS: RDKBD,ERR,SUBST,EXAM,GOCMD,SSTEP
                  262 ; DESTROYS: A,B,C,D,E,H,L,F/F'S
                  263 ;
                  264 CMMND:
0066 21E920       265          LXI     H,MNSTK ; INITIALIZE MONITOR STACK POINTER
0069 F9           266          SPHL
                  267                          ; OUTPUT PROMPT CHARACTER TO DISPLAY
006A 210019       268          LXI     H,CNTRL ; GET ADDRESS FOR CONTROL CHARACTER
006D 3690         269          MVI     M,ADISP ; OUTPUT CONTROL CHARACTER TO USE ADDRESS FIELD
006F 25           270          DCR     H       ; ADDRESS FOR OUTPUT CHARACTER
0070 36FB         271          MVI     M,PRMPT ; OUTPUT PROMPT CHARACTER
0072 CDE702       272          CALL    RDKBD   ; READ KEYBOARD
0075 010400       273          LXI     B,NUMC  ; COUNTER FOR NUMBER OF COMMANDS IN C
0078 217803       274          LXI     H,CMDTB ; GET ADDRESS OF COMMAND TABLE
                  275 CMD10:
007B BE           276          CMP     M       ; RECOGNIZE THE COMMAND ?
007C CA8700       277          JZ      CMD15   ; YES - GO PROCESS IT
007F 23           278          INX     H       ; NO - NEXT COMMAND TABLE ENTRY
0080 0D           279          DCR     C       ; END OF TABLE ?
0081 C27B00       280          JNZ     CMD10   ; NO - GO CHECK NEXT ENTRY
                  281                          ; YES - COMMAND UNKNOWN
0084 C31502       282          JMP     ERR     ; DISPLAY ERROR MESSAGE AND GET ANOTHER COMMAND
                  283 CMD15:
0087 217C03       284          LXI     H,CMDAD ; GET ADDRESS OF COMMAND ADDRESS TABLE
008A 0D           285          DCR     C       ; ADJUST COMMAND COUNTER
                  286                          ; COUNTER ACTS AS POINTER TO COMMAND ADDRESS TABLE
008B 09           287          DAD     B       ; ADD POINTER TO TABLE ADDRESS TWICE BECAUSE
008C 09           288          DAD     B       ; TABLE HAS 2 BYTE ENTRIES
008D 7E           289          MOV     A,M     ; GET LOW ORDER BYTE OF COMMAND ADDRESS
008E 23           290          INX     H
008F 66           291          MOV     H,M     ; GET HIGH ORDER BYTE OF COMMAND ADDRESS IN H
0090 6F           292          MOV     L,A     ; PUT LOW ORDER BYTE IN L
                  293                          ; COMMAND ROUTINE ADDRESS IS NOW IN H & L
0091 E9           294          PCHL            ; BRANCH TO ADDRESS IN H & L
                  295 ;
```

```
LOC  OBJ          SEQ          SOURCE STATEMENT

                     296 ;*****************************************************************************
                     297 ;
                     298 ;                          COMMAND ROUTINES
                     299 ;
                     300 ;*****************************************************************************
                     301 ;
                     302 ; FUNCTION: EXAM - EXAMINE AND MODIFY REGISTERS
                     303 ; INPUTS: NONE
                     304 ; OUTPUTS: NONE
                     305 ; CALLS: CLEAR,SETRG,ERR,RGNAM,RGLOC,UPDDT,GTHEX,NXTRG
                     306 ; DESTROYS: A,B,C,D,E,H,L,F/F'S
                     307 ;
                     308 EXAM:
0092 0601            309          MVI     B,DOT    ; ARG - DOT IN ADDRESS FIELD OF DISPLAY
0094 CDD701          310          CALL    CLEAR    ; CLEAR DISPLAY
0097 CD4403          311          CALL    SETRG    ; GET REGISTER DESIGNATOR FROM KEYBOARD AND
                     312                           ;/SET REGISTER POINTER ACCORDINGLY
                     313                           ; WAS CHARACTER A REGISTER DESIGNATOR?
                     314          FALSE   ERR      ; NO - DISPLAY ERROR MSG. AND TERMINATE COMMAND
009A D21502          315+         JNC     ERR
                     316 EXM05:
009D CD0903          317          CALL    RGNAM    ; OUTPUT REGISTER NAME TO ADDRESS FIELD
00A0 CDFC02          318          CALL    RGLOC    ; GET REGISTER SAVE LOCATION IN H & L
00A3 7E              319          MOV     A,M      ; GET REGISTER CONTENTS
00A4 32F820          320          STA     CURDT    ; STORE REGISTER CONTENTS AT CURRENT DATA
00A7 0601            321          MVI     B,DOT    ; ARG - DOT IN DATA FIELD
00A9 CD6B03          322          CALL    UPDDT    ; UPDATE DATA FIELD OF DISPLAY
00AC 0601            323          MVI     B,DTFLD  ; ARG - USE DATA FIELD OF DISPLAY
00AE CD2B02          324          CALL    GTHEX    ; GET HEX DIGITS - WERE ANY DIGITS RECEIVED?
                     325          FALSE   EXM10    ; NO - DO NOT UPDATE REGISTER CONTENTS
00B1 D2B800          326+         JNC     EXM10
00B4 CDFC02          327          CALL    RGLOC    ; YES - GET REGISTER SAVE LOCATION IN H & L
00B7 73              328          MOV     M,E      ; UPDATE REGISTER CONTENTS
                     329 EXM10:
00B8 FE10            330          CPI     PERIO    ; WAS LAST CHARACTER A PERIOD ?
00BA CAE901          331          JZ      CLDIS    ; YES - CLEAR DISPLAY AND TERMINATE COMMAND
00BD FE11            332          CPI     COMMA    ; WAS LAST CHARACTER ',' ?
00BF C21502          333          JNZ     ERR      ; NO - DISPLAY ERROR MSG. AND TERMINATE COMMAND
00C2 CDA802          334          CALL    NXTRG    ; YES - ADVANCE REGISTER POINTER TO
                     335                           ;/NEXT REGISTER
                     336                           ; ANY MORE REGISTERS ?
                     337          TRUE    EXM05    ; YES - CONTINUE PROCESSING WITH NEXT REGISTER
00C5 DA9D00          338+         JC      EXM05
00C8 C3E901          339          JMP     CLDIS    ; NO - CLEAR DISPLAY AND TERMINATE COMMAND
                     340 ;
                     341 ;*****************************************************************************
                     342 ;
                     343 ; FUNCTION: GOCMD - EXECUTE USER PROGRAM
                     344 ; INPUTS: NONE
                     345 ; OUTPUTS: NONE
                     346 ; CALLS: DISPC,RDKBD,CLEAR,GTHEX,ERR,OUTPT
                     347 ; DESTROYS: A,B,C,D,E,H,L,F/F'S
                     348 ;
                     349 GOCMD:
00CB CD0002          350          CALL    DISPC    ; DISPLAY USER PROGRAM COUNTER
00CE CDE702          351          CALL    RDKBD    ; READ FROM KEYBOARD
00D1 FE10            352          CPI     PERIO    ; IS CHARACTER A PERIOD ?
00D3 CAEC00          353          JZ      G10      ; YES - GO EXECUTE THE COMMAND
                     354                           ; NO - ARG - CHARACTER IS STILL IN A
00D6 32FE20          355          STA     IBUFF    ; REPLACE CHARACTER IN INPUT BUFFER
00D9 0601            356          MVI     B,DOT    ; ARG - DOT IN ADDRESS FIELD
00DB CDD701          357          CALL    CLEAR    ; CLEAR DISPLAY
00DE 0600            358          MVI     B,ADFLD  ; ARG - USE ADDRESS FIELD
00E0 CD2B02          359          CALL    GTHEX    ; GET HEX DIGITS
00E3 FE10            360          CPI     PERIO    ; WAS LAST CHARACTER A PERIOD ?
00E5 C21502          361          JNZ     ERR      ; NO - DISPLAY ERROR MSG. AND TERMINATE COMMAND
00E8 EB              362          XCHG             ; PUT HEX VALUE FROM GTHEX TO H & L
00E9 22F220          363          SHLD    PSAV     ; HEX VALUE IS NEW USER PC
                     364 G10:
00EC 0600            365          MVI     B,NODOT  ; YES - ARG - NO DOT IN ADDRESS FIELD
00EE CDD701          366          CALL    CLEAR    ; CLEAR DISPLAY
00F1 AF              367          XRA     A        ; ARG - USE ADDRESS FIELD OF DISPLAY
00F2 0600            368          MVI     B,NODOT  ; ARG - NO DOT IN ADDRESS FIELD
00F4 21A203          369          LXI     H,EXMSG  ; GET ADDRESS OF EXECUTION MESSAGE IN H & L
00F7 CDB702          370          CALL    OUTPT    ; DISPLAY EXECUTION MESSAGE
00FA C31B03          371          JMP     RSTOR    ; RESTORE USER REGISTERS INCL. PROGRAM COUNTER
                     372                           ;/I.E. BEGIN EXECUTION OF USER PROGRAM
                     373 ;
                     374 ;*****************************************************************************
                     375 ;
                     376 ; FUNCTION: SSTEP - SINGLE STEP (EXECUTE ONE USER INSTRUCTION)
                     377 ; INPUTS: NONE
                     378 ; OUTPUTS: NONE
                     379 ; CALLS: DISPC,RDKBD,CLEAR,GTHEX,ERR
                     380 ; DESTROYS: A,B,C,D,E,H,L,F/F'S
                     381 ;
                     382 SSTEP:
00FD CD0002          383          CALL    DISPC    ; DISPLAY USER PROGRAM COUNTER
0100 CDE702          384          CALL    RDKBD    ; READ FROM KEYBOARD
0103 FE10            385          CPI     PERIO    ; WAS CHARACTER A PERIOD ?
0105 CAE901          386          JZ      CLDIS    ; YES - CLEAR DISPLAY AND TERMINATE COMMAND
0108 FE11            387          CPI     COMMA    ; WAS LAST CHARACTER ',' ?
010A CA2601          388          JZ      STP20    ; YES - GO SET TIMER
                     389          ; NO - CHARACTER FROM KEYBOARD WAS NEITHER PERIOD NOR COMMA
010D 32FE20          390          STA     IBUFF    ; REPLACE THE CHARACTER IN THE INPUT BUFFER
0110 0601            391          MVI     B,DOT    ; ARG - DOT IN ADDRESS FIELD
0112 CDD701          392          CALL    CLEAR    ; CLEAR DISPLAY
0115 0600            393          MVI     B,ADFLD  ; ARG - USE ADDRESS FIELD OF DISPLAY
0117 CD2B02          394          CALL    GTHEX    ; GET HEX DIGITS - WERE ANY DIGITS RECEIVED ?
                     395          FALSE   ERR      ; NO - DISPLAY ERROR MSG. AND TERMINATE COMMAND
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LOC  OBJ          SEQ          SOURCE STATEMENT

011A D21502        396+         JNC      ERR
011D EB            397          XCHG                ; HEX VALUE FROM GTHEX TO H & L
011E 22F220        398          SHLD     PSAV       ; HEX VALUE IS NEW USER PC
0121 FE10          399          CPI      PERIO      ; WAS LAST CHARACTER FROM GTHEX A PERIOD ?
0123 CAE901        400          JZ       CLDIS      ; YES - CLEAR DISPLAY AND TERMINATE COMMAND
                   401                               ; NO - MUST HAVE BEEN A COMMA
                   402 STP20:
0126 3AF120        403          LDA      ISAV       ; GET USER INTERRUPT MASK
0129 E608          404          ANI      08H        ; KEEP INTERRUPT STATUS
012B 32FD20        405          STA      TEMP       ; SAVE USER INTERRUPT STATUS
012E 2AF220        406          LHLD     PSAV       ; GET USER PC
0131 7E            407          MOV      A,M        ; GET USER INSTRUCTION
0132 FEF3          408          CPI      (DI)       ; DI INSTRUCTION ?
0134 C23B01        409          JNZ      STP21      ; NO
0137 AF            410          XRA      A          ; YES - RESET USER INTERRUPT STATUS
0138 C34201        411          JMP      STP22
                   412 STP21:
013B FEFB          413          CPI      (EI)       ; EI INSTRUCTION ?
013D C24501        414          JNZ      STP23      ; NO
0140 3E08          415          MVI      A,08H      ; YES - SET USER INTERRUPT STATUS
                   416 STP22:
0142 32FD20        417          STA      TEMP       ; SAVE NEW USER INTERRUPT STATUS
                   418 STP23:
0145 3E40          419          MVI      A,(TIMER SHR 8) OR TMODE ; HIGH ORDER BITS OF TIMER VALUE
                   420                                        ; /OR'ED WITH TIMER MODE
0147 D325          421          OUT      TIMHI
0149 3EC5          422          MVI      A,TIMER AND 0FFH ; LOW ORDER BITS OF TIMER VALUE
014B D324          423          OUT      TIMLO
014D 3AFF20        424          LDA      USCSR      ; GET USER IMAGE OF WHAT'S IN CSR
0150 F6C0          425          ORI      TSTRT      ; SET TIMER COMMAND BITS TO START TIMER
0152 D320          426          OUT      CSR        ; START TIMER
0154 C31B03        427          JMP      RSTOR      ; RESTORE USER REGISTERS
                   428 ;
                   429 STP25:                      ; BRANCH HERE WHEN TIMER INTERRUPTS AFTER
                   430                             ;/ONE USER INSTRUCTION
0157 F5            431          PUSH     PSW        ; SAVE PSW
0158 3AFF20        432          LDA      USCSR      ; GET USER IMAGE OF WHAT'S IN CSR
015B E63F          433          ANI      3FH        ; CLEAR 2 HIGH ORDER BITS
015D F640          434          ORI      40H        ; SET TIMER STOP BIT
015F D320          435          OUT      CSR        ; STOP TIMER
0161 F1            436          POP      PSW        ; RETRIEVE PSW
0162 22EF20        437          SHLD     LSAV       ; SAVE H & L
0165 E1            438          POP      H          ; GET USER PROGRAM COUNTER FROM TOP OF STACK
0166 22F220        439          SHLD     PSAV       ; SAVE USER PC
0169 F5            440          PUSH     PSW
016A E1            441          POP      H
016B 22ED20        442          SHLD     FSAV       ; SAVE FLIP/FLOPS AND A REGISTER
016E 210000        443          LXI      H,0        ; CLEAR H & L
0171 39            444          DAD      SP         ; GET USER STACK POINTER
0172 22F420        445          SHLD     SSAV       ; SAVE USER STACK POINTER
0175 21ED20        446          LXI      H,BSAV+1          ; SET MONITOR STACK POINTER FOR
0178 F9            447          SPHL                ;/SAVING REMAINING USER REGISTERS
0179 C5            448          PUSH     B          ; SAVE B & C
017A D5            449          PUSH     D          ; SAVE D & E
017B 20            450          RIM                 ; GET USER INTERRUPT MASK
017C E607          451          ANI      07H        ; KEEP MASK BITS
017E 21FD20        452          LXI      H,TEMP     ; GET USER INTERRUPT STATUS
0181 B6            453          ORA      M          ; OR IT INTO MASK
0182 32F120        454          STA      ISAV       ; SAVE INTERRUPT STATUS & MASK
0185 3E0E          455          MVI      A,UNMSK    ; UNMASK INTERRUPTS FOR MONITOR USE
0187 30            456          SIM
0188 C3FD00        457          JMP      SSTEP      ; GO GET READY FOR ANOTHER INSTRUCTION
                   458 ;
                   459 ;*************************************************************************
                   460 ;
                   461 ; FUNCTION: SUBST -  SUBSTITUTE MEMORY
                   462 ; INPUTS: NONE
                   463 ; OUTPUTS: NONE
                   464 ; CALLS: CLEAR,GTHEX,UPDAD,UPDDT,ERR
                   465 ; DESTROYS: A,B,C,D,E,H,L,F/F'S
                   466 ;
                   467 SUBST:
018B 0601          468          MVI      B,DOT      ; ARG - DOT IN ADDRESS FIELD
018D CDD701        469          CALL     CLEAR      ; CLEAR THE DISPLAY
0190 0600          470          MVI      B,ADFLD    ; ARG - USE ADDRESS FIELD OF DISPLAY
0192 CD2B02        471          CALL     GTHEX      ; GET HEX DIGITS - WERE ANY DIGITS RECEIVED?
                   472          FALSE    ERR        ; NO - DISPLAY ERROR MSG. AND TERMINATE COMMAND
0195 D21502        473+         JNC      ERR
0198 EB            474          XCHG                ; ASSIGN HEX VALUE RETURNED BY GTHEX TO
0199 22F620        475          SHLD     CURAD      ; / CURRENT ADDRESS
                   476 SUB05:
019C FE11          477          CPI      COMMA      ; WAS ',' THE LAST CHARACTER FROM KEYBOARD?
019E C2CF01        478          JNZ      SUB15      ; NO - GO TERMINATE THE COMMAND
01A1 0600          479          MVI      B,NODOT    ; ARG - NO DOT IN ADDRESS FIELD
01A3 CD5F03        480          CALL     UPDAD      ; UPDATE ADDRESS FIELD OF DISPLAY
01A6 2AF620        481          LHLD     CURAD      ; GET CURRENT ADDRESS IN H & L
01A9 7E            482          MOV      A,M        ; GET DATA BYTE POINTED TO BY CURRENT ADDRESS
01AA 32F820        483          STA      CURDT      ; STORE DATA BYTE AT CURRENT DATA
01AD 0601          484          MVI      B,DOT      ; ARG - DOT IN DATA FIELD
01AF CD6B03        485          CALL     UPDDT      ; UPDATE DATA FIELD OF DISPLAY
01B2 0601          486          MVI      B,DTFLD    ; ARG - USE DATA FIELD
01B4 CD2B02        487          CALL     GTHEX      ; GET HEX DIGITS - WERE ANY HEX DIGITS RECEIVED?
01B7 F5            488          PUSH     PSW        ; (SAVE LAST CHARACTER)
                   489          FALSE    SUB10      ; NO - LEAVE DATA UNCHANGED AT CURRENT ADDRESS
01B8 D2C401        490+         JNC      SUB10
01BB 2AF620        491          LHLD     CURAD      ; YES - GET CURRENT ADDRESS IN H & L
01BE 73            492          MOV      M,E        ; STORE NEW DATA AT CURRENT ADDRESS
                   493                   ; MAKE SURE DATA WAS ACTUALLY STORED IN CASE
                   494                   ;/CURRENT ADDRESS IS IN ROM OR IS NON-EXISTANT
01BF 7B            495          MOV      A,E        ; DATA TO A FOR COMPARISON
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LOC  OBJ          SEQ          SOURCE STATEMENT

01C0 BE            496          CMP     M        ; WAS DATA STORED CORRECTLY?
01C1 C21502        497          JNZ     ERR      ; NO - DISPLAY ERROR MSG. AND TERMINATE COMMAND
                   498 SUB10:
01C4 2AF620        499          LHLD    CURAD    ; INCREMENT CURRENT ADDRESS
01C7 23            500          INX     H
01C8 22F620        501          SHLD    CURAD
01CB F1            502          POP     PSW      ; RETRIEVE LAST CHARACTER
01CC C39C01        503          JMP     SUB05    ;
                   504 SUB15:
01CF FE10          505          CPI     PERIO    ; WAS LAST CHARACTER '.' ?
01D1 C21502        506          JNZ     ERR      ; NO - DISPLAY ERROR MSG. AND TERMINATE COMMAND
01D4 C3E901        507          JMP     CLDIS    ; YES - CLEAR DISPLAY AND TERMINATE COMMAND
                   508 ;
                   509 ;
                   510 ;*****************************************************************************
                   511 ;
                   512 ;                          UTILITY ROUTINES
                   513 ;
                   514 ;*****************************************************************************
                   515 ;
                   516 ; FUNCTION: CLEAR - CLEAR THE DISPLAY
                   517 ; INPUTS: B - DOT FLAG - 1 MEANS PUT DOT IN ADDRESS FIELD OF DISPLAY
                   518 ;                       - 0 MEANS NO DOT
                   519 ; OUTPUTS: NONE
                   520 ; CALLS: OUTPT
                   521 ; DESTROYS: A,B,C,D,E,H,L,F/F'S
                   522 ; DESCRIPTION:  CLEAR SENDS BLANK CHARACTERS TO BOTH THE ADDRESS FIELD
                   523 ;               AND THE DATA FIELD OF THE DISPLAY. IF THE DOT FLAG IS
                   524 ;               SET THEN A DOT WILL APPEAR AT THE RIGHT EDGE OF THE
                   525 ;               ADDRESS FIELD.
                   526 ;
                   527 CLEAR:
01D7 AF            528          XRA     A        ; ARG - USE ADDRESS FIELD OF DISPLAY
                   529                           ; ARG - FLAG FOR DOT IN ADDR. FIELD IS IN B
01D8 219A03        530          LXI     H,BLNKS  ; ARG - ADDRESS OF BLANKS FOR DISPLAY
01DB CDB702        531          CALL    OUTPT    ; OUTPUT BLANKS TO ADDRESS FIELD
01DE 3E01          532          MVI     A,DTFLD  ; ARG - USE DATA FIELD OF DISPLAY
01E0 0600          533          MVI     B,NODOT  ; ARG - NO DOT IN DATA FIELD
01E2 219A03        534          LXI     H,BLNKS  ; ARG - ADDRESS OF BLANKS FOR DISPLAY
01E5 CDB702        535          CALL    OUTPT    ; OUTPUT BLANKS TO DATA FIELD
01E8 C9            536          RET              ; RETURN
                   537 ;
                   538 ;*****************************************************************************
                   539 ;
                   540 ; FUNCTION: CLDIS - CLEAR DISPLAY AND TERMINATE COMMAND
                   541 ; INPUTS: NONE
                   542 ; OUTPUTS: NONE
                   543 ; CALLS: CLEAR
                   544 ; DESTROYS: A,B,C,D,E,H,L,F/F'S
                   545 ; DESCRIPTION: CLDIS IS JUMPED TO BY COMMAND ROUTINES WISHING TO
                   546 ;                TERMINATE NORMALLY. CLDIS CLEARS THE DISPLAY AND
                   547 ;                BRANCHES TO THE COMMAND RECOGNIZER.
                   548 ;
                   549 CLDIS:
01E9 0600          550          MVI     B,NODOT  ; ARG - NO DOT IN ADDRESS FIELD
01EB CDD701        551          CALL    CLEAR    ; CLEAR THE DISPLAY
01EE C36600        552          JMP     CMMND    ; GO GET ANOTHER COMMAND
                   553 ;
                   554 ;*****************************************************************************
                   555 ;
                   556 ; FUNCTION: CLDST - COLD START
                   557 ; INPUTS: NONE
                   558 ; OUTPUTS: NONE
                   559 ; CALLS: NOTHING
                   560 ; DESTROYS: A
                   561 ; DESCRIPTION:  CLDST IS JUMPED TO BY THE MAIN COLD START PROCEDURE,
                   562 ;                COMPLETES COLD START INITIALIZATION, AND JUMPS BACK
                   563 ;                TO THE MAIN COLD START PROCEDURE.
                   564 ;
                   565 CLDST:
01F1 3ECC          566          MVI     A,KBNIT  ; GET CONTROL CHARACTER
01F3 320019        567          STA     CNTRL    ; INITIALIZE KEYBOARD/DISPLAY BLANKING
01F6 3E00          568          MVI     A,CSNIT  ; INITIAL VALUE OF COMMAND STATUS REGISTER
01F8 D320          569          OUT     CSR      ; INITIALIZE CSR
01FA 32FF20        570          STA     USCSR    ; INITIALIZE USER CSR VALUE
01FD C30800        571          JMP     CLDBK    ; BACK TO MAIN PROCEDURE
                   572 ;
                   573 ;*****************************************************************************
                   574 ;
                   575 ; FUNCTION: DISPC - DISPLAY PROGRAM COUNTER
                   576 ; INPUTS: NONE
                   577 ; OUTPUTS: NONE
                   578 ; CALLS: UPDAD,UPDDT
                   579 ; DESTROYS: A,B,C,D,E,H,L,F/F'S
                   580 ; DESCRIPTION: DISPC DISPLAYS THE USER PROGRAM COUNTER IN THE ADDRESS
                   581 ;               FIELD OF THE DISPLAY, WITH A DOT AT THE RIGHT EDGE
                   582 ;               OF THE FIELD. THE BYTE OF DATA ADDRESSED BY THE PROGRAM
                   583 ;               COUNTER IS DISPLAYED IN THE DATA FIELD OF THE DISPLAY.
                   584 ;
                   585 DISPC:
0200 2AF220        586          LHLD    PSAV     ; GET USER PROGRAM COUNTER
0203 22F620        587          SHLD    CURAD    ; MAKE IT THE CURRENT ADDRESS
0206 7E            588          MOV     A,M      ; GET THE INSTRUCTION AT THAT ADDRESS
0207 32F820        589          STA     CURDT    ; MAKE IT THE CURRENT DATA
020A 0601          590          MVI     B,DOT    ; ARG - DOT IN ADDRESS FIELD
020C CD5F03        591          CALL    UPDAD    ; UPDATE ADDRESS FIELD OF DISPLAY
020F 0600          592          MVI     B,NODOT  ; ARG - NO DOT IN DATA FIELD
0211 CD6B03        593          CALL    UPDDT    ; UPDATE DATA FIELD OF DISPLAY
0214 C9            594          RET
                   595 ;
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LOC  OBJ          SEQ         SOURCE STATEMENT

                  596 ;*****************************************************************************
                  597 ;
                  598 ; FUNCTION: ERR - DISPLAY ERROR MESSAGE
                  599 ; INPUTS: NONE
                  600 ; OUTPUTS: NONE
                  601 ; CALLS: OUTPT
                  602 ; DESTROYS: A,B,C,D,E,H,L,F/F'S
                  603 ; DESCRIPTION:  ERR IS JUMPED TO BY COMMAND ROUTINES WISHING TO
                  604 ;               TERMINATE BECAUSE OF AN ERROR.
                  605 ;               ERR OUTPUTS AN ERROR MESSAGE TO THE DISPLAY AND
                  606 ;               BRANCHES TO THE COMMAND RECOGNIZER.
                  607 ;
                  608 ERR:
0215 AF           609         XRA     A       ; ARG - USE ADDRESS FIELD
0216 0600         610         MVI     B,NODOT ; ARG - NO DOT IN ADDRESS FIELD
0218 219E03       611         LXI     H,ERMSG ; ARG - ADDRESS OF ERROR MESSAGE
021B CDB702       612         CALL    OUTPT   ; OUTPUT ERROR MESSAGE TO ADDRESS FIELD
021E 3E01         613         MVI     A,DTFLD ; ARG - USE DATA FIELD
0220 0600         614         MVI     B,NODOT ; ARG - NO DOT IN DATA FIELD
0222 219A03       615         LXI     H,BLNKS ; ARG - ADDRESS OF BLANKS FOR DISPLAY
0225 CDB702       616         CALL    OUTPT   ; OUTPUT BLANKS TO DATA FIELD
0228 C36600       617         JMP     CMMND   ; GO GET A NEW COMMAND
                  618 ;
                  619 ;*****************************************************************************
                  620 ;
                  621 ; FUNCTION: GTHEX - GET HEX DIGITS
                  622 ; INPUTS: B - DISPLAY FLAG - 0 MEANS USE ADDRESS FIELD OF DISPLAY
                  623 ;                           - 1 MEANS USE DATA FIELD OF DISPLAY
                  624 ; OUTPUTS: A - LAST CHARACTER READ FROM KEYBOARD
                  625 ;          DE - HEX DIGITS FROM KEYBOARD EVALUATED MODULO 2**16
                  626 ;          CARRY - SET IF AT LEAST ONE VALID HEX DIGIT WAS READ
                  627 ;                - RESET OTHERWISE
                  628 ; CALLS: RDKBD,INSDG,HXDSP,OUTPT
                  629 ; DESTROYS: A,B,C,D,E,H,L,F/F'S
                  630 ; DESCRIPTION:  GTHEX ACCEPTS A STRING OF HEX DIGITS FROM THE KEYBOARD,
                  631 ;               DISPLAYS THEM AS THEY ARE RECEIVED, AND RETURNS THEIR
                  632 ;               VALUE AS A 16 BIT INTEGER. IF MORE THAN 4 HEX DIGITS
                  633 ;               ARE RECEIVED, ONLY THE LAST 4 ARE USED. IF THE DISPLAY
                  634 ;               FLAG IS SET, THE LAST 2 HEX DIGITS ARE DISPLAYED IN THE
                  635 ;               DATA FIELD OF THE DISPLAY. OTHERWISE, THE LAST 4 HEX
                  636 ;               DIGITS ARE DISPLAYED IN THE ADDRESS FIELD OF THE
                  637 ;               DISPLAY. IN EITHER CASE, A DOT WILL BE DISPLAYED AT THE
                  638 ;               RIGHTMOST EDGE OF THE FIELD. A CHARACTER WHICH IS NOT
                  639 ;               A HEX DIGIT TERMINATES THE STRING AND IS RETURNED AS
                  640 ;               AN OUTPUT OF THE FUNCTION. IF THE TERMINATOR IS NOT
                  641 ;               A PERIOD OR A COMMA THEN ANY HEX DIGITS WHICH MAY HAVE
                  642 ;               BEEN RECEIVED ARE CONSIDERED TO BE INVALID. THE
                  643 ;               FUNCTION RETURNS A FLAG INDICATING WHETHER OR NOT ANY
                  644 ;               VALID HEX DIGITS WERE RECEIVED.
                  645 ;
                  646 GTHEX:
022B 0E00         647         MVI     C,0     ; RESET HEX DIGIT FLAG
022D C5           648         PUSH    B       ; SAVE DISPLAY AND HEX DIGIT FLAGS
022E 110000       649         LXI     D,0     ; SET HEX VALUE TO ZERO
0231 D5           650         PUSH    D       ; SAVE HEX VALUE
                  651 GTH05:
0232 CDE702       652         CALL    RDKBD   ; READ KEYBOARD
0235 FE10         653         CPI     10H     ; IS CHARACTER A HEX DIGIT?
0237 D25502       654         JNC     GTH20   ; NO - GO CHECK FOR TERMINATOR
                  655                         ; YES - ARG - NEW HEX DIGIT IS IN A
023A D1           656         POP     D       ; ARG - RETRIEVE HEX VALUE
023B CD9F02       657         CALL    INSDG   ; INSERT NEW DIGIT IN HEX VALUE
023E C1           658         POP     B       ; RETRIEVE DISPLAY FLAG
023F 0E01         659         MVI     C,1     ; SET HEX DIGIT FLAG
                  660                         ;/(I.E. A HEX DIGIT HAS BEEN READ)
0241 C5           661         PUSH    B       ; SAVE DISPLAY AND HEX DIGIT FLAGS
0242 D5           662         PUSH    D       ; SAVE HEX VALUE
0243 78           663         MOV     A,B     ; TEST DISPLAY FLAG
0244 0F           664         RRC             ; SHOULD ADDRESS FIELD OF DISPLAY BE USED ?
0245 D24902       665         JNC     GTH10   ; YES - USE HEX VALUE AS IS
                  666                         ; NO - ONLY LOW ORDER BYTE OF HEX VALUE SHOULD
                  667                         ; /BE USED FOR DATA FIELD OF DISPLAY
0248 53           668         MOV     D,E     ; PUT LOW ORDER BYTE OF HEX VALUE IN D
                  669 GTH10:
                  670                         ; ARG - HEX VALUE TO BE EXPANDED IS IN D & E
0249 CD6C02       671         CALL    HXDSP   ; EXPAND HEX VALUE FOR DISPLAY
                  672                         ; ARG - ADDRESS OF EXPANDED HEX VALUE IN H & L
024C 78           673         MOV     A,B     ; ARG - PUT DISPLAY FLAG IN A
024D 0601         674         MVI     B,DOT   ; ARG - DOT IN APPROPRIATE FIELD
024F CDB702       675         CALL    OUTPT   ; OUTPUT HEX VALUE TO DISPLAY
0252 C33202       676         JMP     GTH05   ; GO GET NEXT CHARACTER
                  677 GTH20:                  ; LAST CHARACTER WAS NOT A HEX DIGIT
0255 D1           678         POP     D       ; RETRIEVE HEX VALUE
0256 C1           679         POP     B       ; RETRIEVE HEX DIGIT FLAG IN C
0257 FE11         680         CPI     COMMA   ; WAS LAST CHARACTER ',' ?
0259 CA6702       681         JZ      GTH25   ; YES - READY TO RETURN
025C FE10         682         CPI     PERIO   ; NO - WAS LAST CHARACTER '.' ?
025E CA6702       683         JZ      GTH25   ; YES - READY TO RETURN
                  684                         ; NO - INVALID TERMINATOR - IGNORE ANY HEX DIGITS READ
0261 110000       685         LXI     D,0     ; SET HEX VALUE TO ZERO
0264 C3F702       686         JMP     RETF    ; RETURN FALSE
                  687 GTH25:
0267 47           688         MOV     B,A     ; SAVE LAST CHARACTER
0268 79           689         MOV     A,C     ; SHIFT HEX DIGIT FLAG TO
0269 0F           690         RRC             ;/CARRY BIT
026A 78           691         MOV     A,B     ; RESTORE LAST CHARACTER
026B C9           692         RET             ; RETURN
                  693 ;
                  694 ;*****************************************************************************
                  695 ;
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 LOC  OBJ          SEQ         SOURCE STATEMENT

                    696 ; FUNCTION: HXDSP - EXPAND HEX DIGITS FOR DISPLAY
                    697 ; INPUTS: DE - 4 HEX DIGITS
                    698 ; OUTPUTS: HL - ADDRESS OF OUTPUT BUFFER
                    699 ; CALLS: NOTHING
                    700 ; DESTROYS: A,H,L,F/F'S
                    701 ; DESCRIPTION: HXDSP EXPANDS EACH INPUT BYTE TO 2 BYTES IN A FORM
                    702 ;              SUITABLE FOR DISPLAY BY THE OUTPUT ROUTINES. EACH INPUT
                    703 ;              BYTE IS DIVIDED INTO 2 HEX DIGITS. EACH HEX DIGIT IS
                    704 ;              PLACED IN THE LOW ORDER 4 BITS OF A BYTE WHOSE HIGH
                    705 ;              ORDER 4 BITS ARE SET TO ZERO. THE RESULTING BYTE IS
                    706 ;              STORED IN THE OUTPUT BUFFER. THE FUNCTION RETURNS THE
                    707 ;              ADDRESS OF THE OUTPUT BUFFER.
                    708 ;
                    709 HXDSP:
 026C 7A            710         MOV     A,D     ; GET FIRST DATA BYTE
 026D 0F            711         RRC             ; CONVERT 4 HIGH ORDER BITS
 026E 0F            712         RRC             ; /TO A SINGLE CHARACTER
 026F 0F            713         RRC
 0270 0F            714         RRC
 0271 E60F          715         ANI     0FH
 0273 21F920        716         LXI     H,OBUFF ; GET ADDRESS OF OUTPUT BUFFER
 0276 77            717         MOV     M,A     ; STORE CHARACTER IN OUTPUT BUFFER
 0277 7A            718         MOV     A,D     ; GET FIRST DATA BYTE AND CONVERT 4 LOW ORDER
 0278 E60F          719         ANI     0FH     ; /BITS TO A SINGLE CHARACTER
 027A 23            720         INX     H       ; NEXT BUFFER POSITION
 027B 77            721         MOV     M,A     ; STORE CHARACTER IN BUFFER
 027C 7B            722         MOV     A,E     ; GET SECOND DATA BYTE
 027D 0F            723         RRC             ; CONVERT 4 HIGH ORDER BITS
 027E 0F            724         RRC             ; /TO A SINGLE CHARACTER
 027F 0F            725         RRC
 0280 0F            726         RRC
 0281 E60F          727         ANI     0FH
 0283 23            728         INX     H       ; NEXT BUFFER POSITION
 0284 77            729         MOV     M,A     ; STORE CHARACTER IN BUFFER
 0285 7B            730         MOV     A,E     ; GET SECOND DATA BYTE AND CONVERT LOW ORDER
 0286 E60F          731         ANI     0FH     ; /4 BITS TO A SINGLE CHARACTER
 0288 23            732         INX     H       ; NEXT BUFFER POSITION
 0289 77            733         MOV     M,A     ; STORE CHARACTER IN BUFFER
 028A 21F920        734         LXI     H,OBUFF ; RETURN ADDRESS OF OUTPUT BUFFER IN H & L
 028D C9            735         RET
                    736 ;
                    737 ;*****************************************************************
                    738 ;
                    739 ; FUNCTION: ININT - INPUT INTERRUPT PROCESSING
                    740 ; INPUTS: NONE
                    741 ; OUTPUTS: NONE
                    742 ; CALLS: NOTHING
                    743 ; DESTROYS: NOTHING
                    744 ; DESCRIPTION:  ININT IS ENTERED BY MEANS OF AN INTERRUPT VECTOR (IV2C)
                    745 ;               WHEN THE READ KEYBOARD ROUTINE IS WAITING FOR A
                    746 ;               CHARACTER AND THE USER HAS PRESSED A KEY ON THE
                    747 ;               KEYBOARD (EXCEPT "RESET" OR "VECTORED INTERRUPT").
                    748 ;               ININT STORES THE INPUT CHARACTER IN THE INPUT BUFFER AND
                    749 ;               RETURNS CONTROL TO THE READ KEYBOARD ROUTINE.
                    750 ;
                    751 ININT:
 028E E5            752         PUSH    H       ; SAVE H & L
 028F F5            753         PUSH    PSW     ; SAVE F/F'S & REGISTER A
 0290 210019        754         LXI     H,CNTRL ; ADDRESS FOR CONTROL CHARACTER OUTPUT
 0293 3640          755         MVI     M,READ  ; OUTPUT CONTROL CHARACTER FOR READING
                    756                         ; /FROM KEYBOARD
 0295 25            757         DCR     H       ; ADDRESS FOR CHARACTER INPUT
 0296 7E            758         MOV     A,M     ; READ A CHARACTER
 0297 E63F          759         ANI     3FH     ; ZERO 2 HIGH ORDER BITS
 0299 32FE20        760         STA     IBUFF   ; STORE CHARACTER IN INPUT BUFFER
 029C F1            761         POP     PSW     ; RESTORE F/F'S & REGISTER A
 029D E1            762         POP     H       ; RESTORE H & L
 029E C9            763         RET
                    764 ;
                    765 ;*****************************************************************
                    766 ;
                    767 ; FUNCTION: INSDG - INSERT HEX DIGIT
                    768 ; INPUTS: A - HEX DIGIT TO BE INSERTED
                    769 ;         DE - HEX VALUE
                    770 ; OUTPUTS: DE - HEX VALUE WITH DIGIT INSERTED
                    771 ; CALLS: NOTHING
                    772 ; DESTROYS: A,F/F'S
                    773 ; DESCRIPTION: INSDG SHIFTS THE CONTENTS OF D & E LEFT 4 BITS
                    774 ;              (1 HEX DIGIT) AND INSERTS THE HEX DIGIT IN A IN THE LOW
                    775 ;              ORDER DIGIT POSITION OF THE RESULT. A IS ASSUMED TO
                    776 ;              CONTAIN A SINGLE HEX DIGIT IN THE LOW ORDER 4 BITS AND
                    777 ;              ZEROS IN THE HIGH ORDER  4 BITS.
                    778 ;
                    779 INSDG:
 029F EB            780         XCHG            ; PUT D & E IN H & L
 02A0 29            781         DAD     H       ; SHIFT H & L LEFT 4 BITS
 02A1 29            782         DAD     H
 02A2 29            783         DAD     H
 02A3 29            784         DAD     H
 02A4 85            785         ADD     L       ; INSERT LOW ORDER DIGIT
 02A5 6F            786         MOV     L,A
 02A6 EB            787         XCHG            ; PUT H & L BACK IN D & E
 02A7 C9            788         RET
                    789 ;
                    790 ;*****************************************************************
                    791 ;
                    792 ; FUNCTION: NXTRG - ADVANCE REGISTER POINTER TO NEXT REGISTER
                    793 ; INPUTS: NONE
                    794 ; OUTPUTS: CARRY - 1 IF POINTER IS ADVANCED SUCCESSFULLY
```

```
LOC  OBJ          SEQ          SOURCE STATEMENT

                   795 ;                  - 0 OTHERWISE
                   796 ; CALLS: NOTHING
                   797 ; DESTROYS: A,F/F'S
                   798 ; DESCRIPTION:  IF THE REGISTER POINTER POINTS TO THE LAST REGISTER IN
                   799 ;               THE EXAMINE REGISTER SEQUENCE, THE POINTER IS NOT
                   800 ;               CHANGED AND THE FUNCTION RETURNS FALSE. IF THE REGISTER
                   801 ;               POINTER DOES NOT POINT TO THE LAST REGISTER THEN THE
                   802 ;               POINTER IS ADVANCED TO THE NEXT REGISTER IN THE SEQUENCE
                   803 ;               AND THE FUNCTION RETURNS TRUE.
                   804 ;
                   805 NXTRG:
02A8 3AFD20        806         LDA     RGPTR   ; GET REGISTER POINTER
02AB FE0C          807         CPI     NUMRG-1 ; DOES POINTER POINT TO LAST REGISTER?
02AD D2F702        808         JNC     RETF    ; YES - UNABLE TO ADVANCE POINTER - RETURN FALSE
02B0 3C            809         INR     A       ; NO - ADVANCE REGISTER POINTER
02B1 32FD20        810         STA     RGPTR   ; SAVE REGISTER POINTER
02B4 C3FA02        811         JMP     RETT    ; RETURN TRUE
                   812 ;
                   813 ;*****************************************************************
                   814 ;
                   815 ; FUNCTION: OUTPT - OUTPUT CHARACTERS TO DISPLAY
                   816 ; INPUTS: A - DISPLAY FLAG - 0 = USE ADDRESS FIELD
                   817 ;                             1 = USE DATA FIELD
                   818 ;          B - DOT FLAG - 1 = OUTPUT DOT AT RIGHT EDGE OF FIELD
                   819 ;                         0 = NO DOT
                   820 ;          HL - ADDRESS OF CHARACTERS TO BE OUTPUT
                   821 ; CALLS: NOTHING
                   822 ; DESTROYS: A,B,C,D,E,H,L,F/F'S
                   823 ; DESCRIPTION:  OUTPT SENDS CHARACTERS TO THE DISPLAY. THE ADDRESS
                   824 ;               OF THE CHARACTERS IS RECEIVED AS AN ARGUMENT. EITHER
                   825 ;               2 CHARACTERS ARE SENT TO THE DATA FIELD, OR 4 CHARACTERS
                   826 ;               ARE SENT TO THE ADDRESS FIELD, DEPENDING ON THE
                   827 ;               DISPLAY FLAG ARGUMENT. THE DOT FLAG ARGUMENT DETERMINES
                   828 ;               WHETHER OR NOT A DOT (DECIMAL POINT) WILL BE SENT
                   829 ;               ALONG WITH THE LAST OUTPUT CHARACTER.
                   830 ;
                   831 OUTPT:
02B7 0F            832         RRC             ; USE DATA FIELD ?
02B8 DAC202        833         JC      OUT05   ; YES - GO SET UP TO USE DATA FIELD
02BB 0E04          834         MVI     C,4     ; NO - COUNT FOR ADDRESS FIELD
02BD 3E90          835         MVI     A,ADISP ; CONTROL CHARACTER FOR OUTPUT TO ADDRESS
                   836                         ; /FIELD OF DISPLAY
02BF C3C602        837         JMP     OUT10
                   838 OUT05:
02C2 0E02          839         MVI     C,2     ; COUNT FOR DATA FIELD
02C4 3E94          840         MVI     A,DDISP ; CONTROL CHARACTER FOR OUTPUT TO DATA FIELD
                   841                         ; /OF DISPLAY
                   842 OUT10:
02C6 320019        843         STA     CNTRL
                   844 OUT15:
02C9 7E            845         MOV     A,M     ; GET OUTPUT CHARACTER
02CA EB            846         XCHG            ; SAVE OUTPUT CHARACTER ADDRESS IN D & E
02CB 218403        847         LXI     H,DSPTB ; GET DISPLAY FORMAT TABLE ADDRESS
02CE 85            848         ADD     L       ; USE OUTPUT CHARACTER AS A POINTER TO
02CF 6F            849         MOV     L,A     ; /DISPLAY FORMAT TABLE
02D0 7E            850         MOV     A,M     ; GET DISPLAY FORMAT CHARACTER FROM TABLE
02D1 61            851         MOV     H,C     ; TEST COUNTER WITHOUT CHANGING IT
02D2 25            852         DCR     H       ; IS THIS THE LAST CHARACTER ?
02D3 C2DC02        853         JNZ     OUT20   ; NO - GO OUTPUT CHARACTER AS IS
02D6 05            854         DCR     B       ; YES - IS DOT FLAG SET ?
02D7 C2DC02        855         JNZ     OUT20   ; NO - GO OUTPUT CHARACTER AS IS
02DA F608          856         ORI     DTMSK   ; YES - OR IN MASK TO DISPLAY DOT WITH
                   857                         ; /LAST CHARACTER
                   858 OUT20:
02DC 2F            859         CMA             ; COMPLEMENT OUTPUT CHARACTER
02DD 320018        860         STA     DSPLY   ; SEND CHARACTER TO DISPLAY
02E0 EB            861         XCHG            ; RETRIEVE OUTPUT CHARACTER ADDRESS
02E1 23            862         INX     H       ; NEXT OUTPUT CHARACTER
02E2 0D            863         DCR     C       ; ANY MORE OUTPUT CHARACTERS ?
02E3 C2C902        864         JNZ     OUT15   ; YES - GO PROCESS ANOTHER CHARACTER
02E6 C9            865         RET             ; NO - RETURN
                   866 ;
                   867 ;*****************************************************************
                   868 ;
                   869 ; FUNCTION: RDKBD - READ KEYBOARD
                   870 ; INPUTS: NONE
                   871 ; OUTPUTS: A - CHARACTER READ FROM KEYBOARD
                   872 ; CALLS: NOTHING
                   873 ; DESTROYS: A,H,L,F/F'S
                   874 ; DESCRIPTION:  RDKBD DETERMINES WHETHER OR NOT THERE IS A CHARACTER IN
                   875 ;               THE INPUT BUFFER. IF NOT, THE FUNCTION ENABLES
                   876 ;               INTERRUPTS AND LOOPS UNTIL THE INPUT INTERRUPT
                   877 ;               ROUTINE STORES A CHARACTER IN THE BUFFER. WHEN
                   878 ;               THE BUFFER CONTAINS A CHARACTER, THE FUNCTION FLAGS
                   879 ;               THE BUFFER AS EMPTY AND RETURNS THE CHARACTER
                   880 ;               AS OUTPUT.
                   881 ;
                   882 RDKBD:
02E7 21FE20        883         LXI     H,IBUFF ; GET INPUT BUFFER ADDRESS
02EA 7E            884         MOV     A,M     ; GET BUFFER CONTENTS
                   885                         ; HIGH ORDER BIT = 1 MEANS BUFFER IS EMPTY
02EB B7            886         ORA     A       ; IS A CHARACTER AVAILABLE ?
02EC F2F302        887         JP      RDK10   ; YES - EXIT FROM LOOP
02EF FB            888         EI              ; NO - READY FOR CHARACTER FROM KEYBOARD
02F0 C3E702        889         JMP     RDKBD
                   890 RDK10:
02F3 3680          891         MVI     M,EMPTY ; SET BUFFER EMPTY FLAG
02F5 F3            892         DI              ; RETURN WITH INTERRUPTS DISABLED
02F6 C9            893         RET
```

```
LOC  OBJ        SEQ        SOURCE STATEMENT

                894 ;
                895 ;*****************************************************************************
                896 ;
                897 ; FUNCTION: RETF - RETURN FALSE
                898 ; INPUTS: NONE
                899 ; OUTPUTS: CARRY = 0 (FALSE)
                900 ; CALLS: NOTHING
                901 ; DESTROYS: CARRY
                902 ; DESCRIPTION: RETF IS JUMPED TO BY FUNCTIONS WISHING TO RETURN FALSE.
                903 ;              RETF RESETS CARRY TO 0 AND RETURNS TO THE CALLER OF
                904 ;              THE ROUTINE INVOKING RETF.
                905 ;
                906 RETF:
02F7 37         907         STC             ; SET CARRY TRUE
02F8 3F         908         CMC             ; COMPLEMENT CARRY TO MAKE IT FALSE
02F9 C9         909         RET
                910 ;
                911 ;*****************************************************************************
                912 ;
                913 ; FUNCTION: RETT - RETURN TRUE
                914 ; INPUTS: NONE
                915 ; OUTPUTS: CARRY = 1 (TRUE)
                916 ; CALLS: NOTHING
                917 ; DESTROYS: CARRY
                918 ; DESCRIPTION: RETT IS JUMPED TO BY ROUTINES WISHING TO RETURN TRUE.
                919 ;              RETT SETS CARRY TO 1 AND RETURNS TO THE CALLER OF
                920 ;              THE ROUTINE INVOKING RETT.
                921 ;
                922 RETT:
02FA 37         923         STC             ; SET CARRY TRUE
02FB C9         924         RET
                925 ;
                926 ;*****************************************************************************
                927 ;
                928 ; FUNCTION: RGLOC - GET REGISTER SAVE LOCATION
                929 ; INPUTS: NONE
                930 ; OUTPUTS: HL - REGISTER SAVE LOCATION
                931 ; CALLS: NOTHING
                932 ; DESTROYS: B,C,H,L,F/F'S
                933 ; DESCRIPTION:  RGLOC RETURNS THE SAVE LOCATION OF THE REGISTER
                934 ;              INDICATED BY THE CURRENT REGISTER POINTER VALUE.
                935 ;
                936 RGLOC:
02FC 2AFD20     937         LHLD    RGPTR   ; GET REGISTER POINTER
02FF 2600       938         MVI     H,0     ; /IN H & L
0301 01ED03     939         LXI     B,RGTBL ; GET REGISTER SAVE LOCATION TABLE ADDRESS
0304 09         940         DAD     B       ; POINTER INDEXES TABLE
0305 6E         941         MOV     L,M     ; GET LOW ORDER BYTE OF REGISTER SAVE LOC.
0306 2620       942         MVI     H,(RAMST SHR 8) ; GET HIGH ORDER BYTE OF
                943                                 ; /REGISTER SAVE LOCATION
0308 C9         944         RET
                945 ;
                946 ;*****************************************************************************
                947 ;
                948 ; FUNCTION: RGNAM - DISPLAY REGISTER NAME
                949 ; INPUTS: NONE
                950 ; OUTPUTS: NONE
                951 ; CALLS: OUTPT
                952 ; DESTROYS: A,B,C,D,E,H,L,F/F'S
                953 ; DESCRIPTION: RGNAM DISPLAYS, IN THE ADDRESS FIELD OF THE DISPLAY,
                954 ;              THE REGISTER NAME CORRESPONDING TO THE CURRENT
                955 ;              REGISTER POINTER VALUE.
                956 ;
                957 RGNAM:
0309 2AFD20     958         LHLD    RGPTR   ; GET REGISTER POINTER
030C 2600       959         MVI     H,0
030E 29         960         DAD     H       ; MULTIPLY POINTER VALUE BY 4
030F 29         961         DAD     H       ;/(REGISTER NAME TABLE HAS 4 BYTE ENTRIES)
0310 01B903     962         LXI     B,NMTBL ; GET ADDRESS OF START OF REGISTER NAME TABLE
0313 09         963         DAD     B       ; ARG - ADD TABLE ADDRESS TO POINTER - RESULT IS
                964                         ;/ADDRESS OF APPROPRIATE REGISTER NAME IN H & L
0314 AF         965         XRA     A       ; ARG - USE ADDRESS FIELD OF DISPLAY
0315 0600       966         MVI     B,NODOT ; ARG - NO DOT IN ADDRESS FIELD
0317 CDB702     967         CALL    OUTPT   ; OUTPUT REGISTER NAME TO ADDRESS FIELD
031A C9         968         RET
                969 ;
                970 ;*****************************************************************************
                971 ;
                972 ; FUNCTION: RSTOR - RESTOR USER REGISTERS
                973 ; INPUTS: NONE
                974 ; OUTPUTS: NONE
                975 ; CALLS: NOTHING
                976 ; DESTROYS: A,B,C,D,E,H,L,F/F'S
                977 ; DESCRIPTION:  RSTOR RESTORES ALL CPU REGISTERS, FLIP/FLOPS,
                978 ;              INTERRUPT STATUS, INTERRUPT MASK, STACK POINTER
                979 ;              AND PROGRAM COUNTER FROM THEIR RESPECTIVE
                980 ;             SAVE LOCATIONS IN MEMORY. BY RESTORING THE PROGRAM
                981 ;             COUNTER, THE ROUTINE EFFECTIVELY TRANSFERS CONTROL TO
                982 ;             THE ADDRESS IN THE PROGRAM COUNTER SAVE LOCATION.
                983 ;
                984 ;              THE TIMING OF THIS ROUTINE IS CRITICAL TO THE
                985 ;              CORRECT OPERATION OF THE SINGLE STEP ROUTINE.
                986 ;              IF ANY MODIFICATION CHANGES THE NUMBER OF CPU
                987 ;              STATES NEEDED TO EXECUTE THIS ROUTINE THEN THE
                988 ;              TIMER VALUE MUST BE ADJUSTED BY THE SAME NUMBER.
                989 ;
                990 ; ***** THIS IS ALSO THE ENTRY POINT FOR THE TTY MONITOR
                991 ;       TO RESTORE REGISTERS.
                992 ;
                993 RSTOR:
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LOC  OBJ          SEQ          SOURCE STATEMENT

031B 3AF120        994          LDA     ISAV    ; GET USER INTERRUPT MASK
031E F618          995          ORI     18H     ; ENABLE SETTING OF INTERRUPT MASK AND
                   996                          ; /RESET RST7.5 FLIP FLOP
0320 30            997          SIM             ; RESTORE USER INTERRUPT MASK
                   998 ;        RESTORE USER INTERRUPT STATUS
0321 3AF120        999          LDA     ISAV    ; GET USER INTERRUPT MASK
0324 E608         1000          ANI     08H     ; SHOULD USER INTERRUPTS BE ENABLED ?
0326 CA2D03       1001          JZ      RSR05   ; NO - LEAVE INTERRUPTS DISABLED
0329 FB           1002          EI              ; YES - ENABLE INTERRUPTS FOR USER PROGRAM
032A C33103       1003          JMP     RSR10
                  1004 RSR05:
032D 37           1005          STC             ; DUMMY INSTRUCTIONS - WHEN SINGLE STEP ROUTINE
032E D23103       1006          JNC     RSR10   ; /IS BEING USED, THE TIMER IS RUNNING AND
                  1007                          ; /EXECUTE TIME FOR THIS ROUTINE MUST NOT
                  1008                          ; /VARY.
                  1009 RSR10:
0331 21E920       1010          LXI     H,MNSTK ; SET MONITOR STACK POINTER TO START OF STACK
0334 F9           1011          SPHL            ; /WHICH IS ALSO END OF REGISTER SAVE AREA
0335 D1           1012          POP     D       ; RESTORE REGISTERS
0336 C1           1013          POP     B
0337 F1           1014          POP     PSW
0338 2AF420       1015          LHLD    SSAV    ; RESTORE USER STACK POINTER
033B F9           1016          SPHL
033C 2AF220       1017          LHLD    PSAV
033F E5           1018          PUSH    H       ; PUT USER PROGRAM COUNTER ON STACK
0340 2AEF20       1019          LHLD    LSAV    ; RESTORE H & L REGISTERS
0343 C9           1020          RET             ; JUMP TO USER PROGRAM COUNTER
                  1021 ;
                  1022 ;*****************************************************************
                  1023 ;
                  1024 ; FUNCTION: SETRG - SET REGISTER POINTER
                  1025 ; INPUTS: NONE
                  1026 ; OUTPUTS: CARRY - SET IF CHARACTER FROM KEYBOARD IS A REGISTER DESIGNATOR
                  1027 ;                 RESET OTHERWISE
                  1028 ; CALLS: RDKBD
                  1029 ; DESTROYS: A,B,C,H,L,F/F'S
                  1030 ; DESCRIPTION: SETRG READS A CHARACTER FROM THE KEYBOARD. IF THE
                  1031 ;              CHARACTER IS A REGISTER DESIGNATOR, IT IS CONVERTED TO
                  1032 ;              THE CORRESPONDING REGISTER POINTER VALUE, THE POINTER IS
                  1033 ;              SAVED, AND THE FUNCTION RETURNS 'TRUE'. OTHERWISE, THE
                  1034 ;              FUNCTION RETURNS 'FALSE'.
                  1035 ;
                  1036 SETRG:
0344 CDE702       1037          CALL    RDKBD   ; READ FROM KEYBOARD
0347 FE10         1038          CPI     10H     ; IS CHARACTER A DIGIT?
0349 D2F702       1039          JNC     RETF    ; NO - RETURN FALSE - CHARACTER IS NOT A
                  1040                          ; /REGISTER DESIGNATOR
034C D603         1041          SUI     3       ; YES - TRY TO CONVERT REGISTER DESIGNATOR TO
                  1042                          ; / INDEX INTO REGISTER POINTER TABLE
                  1043                          ; WAS CONVERSION SUCCESSFUL?
034E DAF702       1044          JC      RETF    ; NO - RETURN FALSE
0351 4F           1045          MOV     C,A     ; INDEX TO B & C
0352 0600         1046          MVI     B,0     ;
0354 21AC03       1047          LXI     H,RGPTB ; GET ADDRESS OF REGISTER POINTER TABLE
0357 09           1048          DAD     B       ; INDEX POINTS INTO TABLE
0358 7E           1049          MOV     A,M     ; GET REGISTER POINTER FROM TABLE
0359 32FD20       1050          STA     RGPTR   ; SAVE REGISTER POINTER
035C C3FA02       1051          JMP     RETT    ; RETURN TRUE
                  1052 ;
                  1053 ;*****************************************************************
                  1054 ;
                  1055 ; FUNCTION: UPDAD - UPDATE ADDRESS FIELD OF DISPLAY
                  1056 ; INPUTS: B - DOT FLAG - 1 MEANS PUT DOT AT RIGHT EDGE OF FIELD
                  1057 ;                       0 MEANS NO DOT
                  1058 ; OUTPUTS: NONE
                  1059 ; CALLS: HXDSP,OUTPT
                  1060 ; DESTROYS: A,B,C,D,E,H,L,F/F'S
                  1061 ; DESCRIPTION: UPDAD UPDATES THE ADDRESS FIELD OF THE DISPLAY USING
                  1062 ;              THE CURRENT ADDRESS.
                  1063 ;
                  1064 UPDAD:
035F 2AF620       1065          LHLD    CURAD   ; GET CURRENT ADDRESS
0362 EB           1066          XCHG            ; ARG - PUT CURRENT ADDRESS IN D & E
0363 CD6C02       1067          CALL    HXDSP   ; EXPAND CURRENT ADDRESS FOR DISPLAY
                  1068                          ; ARG - ADDRESS OF EXPANDED ADDRESS IS IN H & L
0366 AF           1069          XRA     A       ; ARG - USE ADDRESS FIELD OF DISPLAY
                  1070                          ; ARG - DOT FLAG IS IN B
0367 CDB702       1071          CALL    OUTPT   ; OUTPUT CURRENT ADDRESS TO ADDRESS FIELD
036A C9           1072          RET
                  1073 ;
                  1074 ;*****************************************************************
                  1075 ;
                  1076 ; FUNCTION: UPDDT - UPDATE DATA FIELD OF DISPLAY
                  1077 ; INPUTS: B - DOT FLAG - 1 MEANS PUT DOT AT RIGHT EDGE OF FIELD
                  1078 ;                       0 MEANS NO DOT
                  1079 ; OUTPUTS: NONE
                  1080 ; CALLS: HXDSP,OUTDT
                  1081 ; DESTROYS: A,B,C,D,E,H,L,F/F'S
                  1082 ; DESCRIPTION: UPDDT UPDATES THE DATA FIELD OF THE DISPLAY USING
                  1083 ;              THE CURRENT DATA BYTE.
                  1084 ;
                  1085 UPDDT:
036B 3AF820       1086          LDA     CURDT   ; GET CURRENT DATA
036E 57           1087          MOV     D,A     ; ARG - PUT CURRENT DATA IN D
036F CD6C02       1088          CALL    HXDSP   ; EXPAND CURRENT DATA FOR DISPLAY
                  1089                          ; ARG - ADDRESS OF EXPANDED DATA IS IN H & L
0372 3E01         1090          MVI     A,DTFLD ; ARG - USE DATA FIELD OF DISPLAY
                  1091                          ; ARG - DOT FLAG IS IN B
0374 CDB702       1092          CALL    OUTPT   ; OUTPUT CURRENT DATA TO DATA FIELD
```

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LOC  OBJ       SEQ        SOURCE STATEMENT

0377 C9        1093         RET
               1094 ;
               1095 ;*****************************************************************************
               1096 ;
               1097 ;                          MONITOR TABLES
               1098 ;
               1099 ;*****************************************************************************
               1100 ;
               1101 ; COMMAND TABLE
               1102 ;   COMMAND CHARACTERS AS RECEIVED FROM KEYBOARD
               1103 CMDTB:
0378 12        1104         DB      12H     ; GO COMMAND
0379 13        1105         DB      13H     ; SUBSTITUTE MEMORY COMMAND
037A 14        1106         DB      14H     ; EXAMINE REGISTERS COMMAND
037B 15        1107         DB      15H     ; SINGLE STEP COMMAND
0004           1108 NUMC    EQU     $-CMDTB ; NUMBER OF COMMANDS
               1109 ;
               1110 ;*****************************************************************************
               1111 ;
               1112 ; COMMAND ROUTINE ADDRESS TABLE
               1113 ; (MUST BE IN REVERSE ORDER OF COMMAND TABLE)
               1114 CMDAD:
037C FD00      1115         DW      SSTEP   ; ADDRESS OF SINGLE STEP ROUTINE
037E 9200      1116         DW      EXAM    ; ADDRESS OF EXAMINE REGISTERS ROUTINE
0380 8B01      1117         DW      SUBST   ; ADDRESS OF SUBSTITUTE MEMORY ROUTINE
0382 CB00      1118         DW      GOCMD   ; ADDRESS OF GO ROUTINE
               1119 ;
               1120 ;*****************************************************************************
               1121 ;
               1122 DSPTB:  ; TABLE FOR TRANSLATING CHARACTERS FOR OUTPUT
               1123 ;
               1124 ;              DISPLAY
               1125 ;              FORMAT   CHARACTER
               1126 ;              =======  =========
               1127 ;
0000           1128 ZERO    EQU     $ - DSPTB
0384 F3        1129         DB      0F3H    ; 0
0385 60        1130         DB       60H    ; 1
0386 B5        1131         DB      0B5H    ; 2
0387 F4        1132         DB      0F4H    ; 3
0388 66        1133         DB       66H    ; 4
0005           1134 FIVE    EQU     $ - DSPTB
0005           1135 LETRS   EQU     $ - DSPTB
0389 D6        1136         DB      0D6H    ; 5 AND S
038A D7        1137         DB      0D7H    ; 6
038B 70        1138         DB       70H    ; 7
0008           1139 EIGHT   EQU     $ - DSPTB
038C F7        1140         DB      0F7H    ; 8
038D 76        1141         DB       76H    ; 9
000A           1142 LETRA   EQU     $ - DSPTB
038E 77        1143         DB       77H    ; A
000B           1144 LETRB   EQU     $ - DSPTB
038F C7        1145         DB      0C7H    ; B (LOWER CASE)
000C           1146 LETRC   EQU     $ - DSPTB
0390 93        1147         DB       93H    ; C
000D           1148 LETRD   EQU     $ - DSPTB
0391 E5        1149         DB      0E5H    ; D (LOWER CASE)
000E           1150 LETRE   EQU     $ - DSPTB
0392 97        1151         DB       97H    ; E
000F           1152 LETRF   EQU     $ - DSPTB
0393 17        1153         DB       17H    ; F
0010           1154 LETRH   EQU     $ - DSPTB
0394 67        1155         DB       67H    ; H
0011           1156 LETRL   EQU     $ - DSPTB
0395 83        1157         DB       83H    ; L
0012           1158 LETRP   EQU     $ - DSPTB
0396 37        1159         DB       37H    ; P
0013           1160 LETRI   EQU     $ - DSPTB
0397 60        1161         DB       60H    ; I
0014           1162 LETRR   EQU     $ - DSPTB
0398 05        1163         DB       05H    ; R (LOWER CASE)
0015           1164 BLANK   EQU     $ - DSPTB
0399 00        1165         DB       00H    ; BLANK
               1166 ;
               1167 ;*****************************************************************************
               1168 ;
               1169 ; MESSAGES FOR OUTPUT TO DISPLAY
               1170 ;
039A 15        1171 BLNKS:  DB      BLANK,BLANK,BLANK,BLANK ; FOR ADDRESS OR DATA FIELD
039B 15
039C 15
039D 15
039E 15        1172 ERMSG:  DB      BLANK,LETRE,LETRR,LETRR ; ERROR MESSAGE FOR ADDR. FIELD
039F 0E
03A0 14
03A1 14
03A2 0E        1173 EXMSG:  DB      LETRE,BLANK,BLANK,BLANK ; EXECUTION MESSAGE
03A3 15
03A4 15
03A5 15
               1174                                         ; /FOR ADDRESS FIELD
03A6 15        1175 SGNAD:  DB      BLANK,BLANK,EIGHT,ZERO  ; SIGN ON MESSAGE (ADDR. FIELD)
03A7 15
03A8 08
03A9 00
03AA 08        1176 SGNDT:  DB      EIGHT,FIVE              ; SIGN ON MESSAGE (DATA FIELD)
03AB 05
               1177 ;
               1178 ;*****************************************************************************
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LOC  OBJ          SEQ         SOURCE STATEMENT

                  1179 ;
                  1180 RGPTB:  ; REGISTER POINTER TABLE
                  1181                ; THE ENTRIES IN THIS TABLE ARE IN THE SAME ORDER
                  1182                ; AS THE REGISTER DESIGNATOR KEYS ON THE KEYBOARD.
                  1183                ; EACH ENTRY CONTAINS THE REGISTER POINTER VALUE WHICH
                  1184                ; CORRESPONDS TO THE REGISTER DESIGNATOR. REGISTER
                  1185                ; POINTER VALUES ARE USED TO POINT INTO THE REGISTER
                  1186                ; NAME TABLE (NMTBL) AND REGISTER SAVE LOCATION
                  1187                ; TABLE (RGTBL).
                  1188 ;
03AC 06           1189          DB    6         ; INTERRUPT MASK
03AD 09           1190          DB    9         ; SPH
03AE 0A           1191          DB    10        ; SPL
03AF 0B           1192          DB    11        ; PCH
03B0 0C           1193          DB    12        ; PCL
03B1 07           1194          DB    7         ; H
03B2 08           1195          DB    8         ; L
03B3 00           1196          DB    0         ; A
03B4 01           1197          DB    1         ; B
03B5 02           1198          DB    2         ; C
03B6 03           1199          DB    3         ; D
03B7 04           1200          DB    4         ; E
03B8 05           1201          DB    5         ; FLAGS
                  1202 ;
                  1203 ;*****************************************************************************
                  1204 ;
                  1205 NMTBL:             ; REGISTER NAME TABLE
                  1206                    ; NAMES OF REGISTERS IN DISPLAY FORMAT
03B9 15           1207          DB        BLANK,BLANK,BLANK,LETRA  ; A REGISTER
03BA 15
03BB 15
03BC 0A
03BD 15           1208          DB        BLANK,BLANK,BLANK,LETRB  ; B REGISTER
03BE 15
03BF 15
03C0 0B
03C1 15           1209          DB        BLANK,BLANK,BLANK,LETRC  ; C REGISTER
03C2 15
03C3 15
03C4 0C
03C5 15           1210          DB        BLANK,BLANK,BLANK,LETRD  ; D REGISTER
03C6 15
03C7 15
03C8 0D
03C9 15           1211          DB        BLANK,BLANK,BLANK,LETRE  ; E REGISTER
03CA 15
03CB 15
03CC 0E
03CD 15           1212          DB        BLANK,BLANK,BLANK,LETRF  ; FLAGS
03CE 15
03CF 15
03D0 0F
03D1 15           1213          DB        BLANK,BLANK,BLANK,LETRI  ; INTERRUPT MASK
03D2 15
03D3 15
03D4 13
03D5 15           1214          DB        BLANK,BLANK,BLANK,LETRH  ; H REGISTER
03D6 15
03D7 15
03D8 10
03D9 15           1215          DB        BLANK,BLANK,BLANK,LETRL  ; L REGISTER
03DA 15
03DB 15
03DC 11
03DD 15           1216          DB        BLANK,LETRS,LETRP,LETRH  ; STACK POINTER HIGH ORDER BYTE
03DE 05
03DF 12
03E0 10
03E1 15           1217          DB        BLANK,LETRS,LETRP,LETRL  ; STACK POINTER LOW ORDER BYTE
03E2 05
03E3 12
03E4 11
03E5 15           1218          DB        BLANK,LETRP,LETRC,LETRH  ; PROGRAM COUNTER HIGH BYTE
03E6 12
03E7 0C
03E8 10
03E9 15           1219          DB        BLANK,LETRP,LETRC,LETRL  ; PROGRAM COUNTER LOW BYTE
03EA 12
03EB 0C
03EC 11
                  1220 ;
                  1221 ;*****************************************************************************
                  1222 ;
                  1223 ; REGISTER SAVE LOCATION TABLE
                  1224 ; ADDRESSES OF SAVE LOCATIONS OF REGISTERS IN THE ORDER IN WHICH
                  1225 ; THE REGISTERS ARE DISPLAYED BY THE EXAMINE COMMAND
                  1226 ;
                  1227 RGTBL:
03ED EE           1228          DB        ASAV AND 0FFH   ; A REGISTER
03EE EC           1229          DB        BSAV AND 0FFH   ; B REGISTER
03EF EB           1230          DB        CSAV AND 0FFH   ; C REGISTER
03F0 EA           1231          DB        DSAV AND 0FFH   ; D REGISTER
03F1 E9           1232          DB        ESAV AND 0FFH   ; E REGISTER
03F2 ED           1233          DB        FSAV AND 0FFH   ; FLAGS
03F3 F1           1234          DB        ISAV AND 0FFH   ; INTERRUPT MASK
03F4 F0           1235          DB        HSAV AND 0FFH   ; H REGISTER
03F5 EF           1236          DB        LSAV AND 0FFH   ; L REGISTER
03F6 F5           1237          DB        SPHSV AND 0FFH  ; STACK POINTER HIGH ORDER BYTE
03F7 F4           1238          DB        SPLSV AND 0FFH  ; STACK POINTER LOW ORDER BYTE
03F8 F3           1239          DB        PCHSV AND 0FFH  ; PROGRAM COUNTER HIGH ORDER BYTE
```

```
LOC  OBJ          SEQ         SOURCE STATEMENT

 03F9 F2           1240          DB      PCLSV AND 0FFH  ; PROGRAM COUNTER LOW ORDER BYTE
 000D              1241 NUMRG    EQU     ($ - RGTBL)     ; NUMBER OF ENTRIES IN
                   1242                                  ; /REGISTER SAVE LOCATION TABLE
                   1243 ;
                   1244 ;*****************************************************************************
                   1245 ;*****************************************************************************
                   1246 ;
                   1247 ;                          SDK-85 TTY MONITOR
                   1248 ;
                   1249 ;*****************************************************************************
                   1250 ;*****************************************************************************
                   1251 ;
                   1252 ;
                   1253 ; ABSTRACT
                   1254 ; ========
                   1255 ;
                   1256 ; THIS PROGRAM WAS ADAPTED, WITH FEW CHANGES, FROM THE SDK-80 MONITOR.
                   1257 ; THIS PROGRAM RUNS ON THE 8085 BOARD AND IS DESIGNED TO PROVIDE
                   1258 ; THE USER WITH A MINIMAL MONITOR.  BY USING THIS PROGRAM,
                   1259 ; THE USER CAN EXAMINE AND CHANGE MEMORY OR CPU REGISTERS, LOAD
                   1260 ; A PROGRAM (IN ABSOLUTE HEX) INTO RAM, AND EXECUTE INSTRUCTIONS
                   1261 ; ALREADY IN MEMORY.  THE MONITOR ALSO PROVIDES THE USER WITH
                   1262 ; ROUTINES FOR PERFORMING CONSOLE I/O.
                   1263 ;
                   1264 ;
                   1265 ; PROGRAM ORGANIZATION
                   1266 ; ======= ============
                   1267 ;
                   1268 ; THE LISTING IS ORGANIZED IN THE FOLLOWING WAY.  FIRST THE COMMAND
                   1269 ; RECOGNIZER, WHICH IS THE HIGHEST LEVEL ROUTINE IN THE PROGRAM.
                   1270 ; NEXT THE ROUTINES TO IMPLEMENT THE VARIOUS COMMANDS.  FINALLY,
                   1271 ; THE UTILITY ROUTINES WHICH ACTUALLY DO THE DIRTY WORK.  WITHIN
                   1272 ; EACH SECTION, THE ROUTINES ARE ORGANIZED IN ALPHABETICAL
                   1273 ; ORDER, BY ENTRY POINT OF THE ROUTINE.
                   1274 ;
                   1275 ; MACROS USED IN THE TTY MONITOR ARE DEFINED IN THE KEYBOARD MONITOR.
                   1276 ;
                   1277 ; LIST OF FUNCTIONS
                   1278 ; ==== == =========
                   1279 ;
                   1280 ;     GETCM
                   1281 ;     -----
                   1282 ;
                   1283 ;     DCMD
                   1284 ;     GCMD
                   1285 ;     ICMD
                   1286 ;     MCMD
                   1287 ;     SCMD
                   1288 ;     XCMD
                   1289 ;     -----
                   1290 ;
                   1291 ;     CI
                   1292 ;     CNVBN
                   1293 ;     CO
                   1294 ;     CROUT
                   1295 ;     DELAY
                   1296 ;     ECHO
                   1297 ;     ERROR
                   1298 ;     FRET
                   1299 ;     GETCH
                   1300 ;     GETHX
                   1301 ;     GETNM
                   1302 ;     HILO
                   1303 ;     NMOUT
                   1304 ;     PRVAL
                   1305 ;     REGDS
                   1306 ;     RGADR
                   1307 ;     SRET
                   1308 ;     STHF0
                   1309 ;     STHLF
                   1310 ;     VALDG
                   1311 ;     VALDL
                   1312 ;     -----
                   1313 ;
                   1314 ;
                   1315 ;*****************************************************************
                   1316 ;
                   1317 ;
                   1318 ;                       MONITOR EQUATES
                   1319 ;
                   1320 ;
                   1321 ;*****************************************************************
                   1322 ;
                   1323 ;
 001B              1324 BRCHR    EQU     1BH     ; CODE FOR BREAK CHARACTER (ESCAPE)
 07FA              1325 BRTAB    EQU     07FAH   ; LOCATION OF START OF BRANCH TABLE IN ROM
 000D              1326 CR       EQU     0DH     ; CODE FOR CARRIAGE RETURN
 001B              1327 ESC      EQU     1BH     ; CODE FOR ESCAPE CHARACTER
 000F              1328 HCHAR    EQU     0FH     ; MASK TO SELECT LOWER HEX CHAR FROM BYTE
 00FF              1329 INVRT    EQU     0FFH    ; MASK TO INVERT HALF BYTE FLAG
 000A              1330 LF       EQU     0AH     ; CODE FOR LINE FEED
 0000              1331 LOWER    EQU     0       ; DENOTES LOWER HALF OF BYTE IN ICMD
                   1332 ;LSGNON  EQU     ---     ; LENGTH OF SIGNON MESSAGE - DEFINED LATER
                   1333 ;MNSTK   EQU     ---     ; START OF MONITOR STACK - DEFINED IN
                   1334                          ; /KEYBOARD MONITOR
                   1335 ;NCMDS   EQU     ---     ; NUMBER OF VALID COMMANDS - DEFINED LATER
 000F              1336 NEWLN    EQU     0FH     ; MASK FOR CHECKING MEMORY ADDR DISPLAY
 007F              1337 PRTY0    EQU     07FH    ; MASK TO CLEAR PARITY BIT FROM CONSOLE CHAR
                   1338 ;RAMST   EQU     ---     ; START ADDRESS OF RAM - DEFINED IN
                   1339                          ; KEYBOARD MONITOR
```

```
LOC  OBJ          SEQ          SOURCE STATEMENT

                  1340 ;RTABS  EQU     ---     ; SIZE OF ENTRY IN RTAB TABLE
0080              1341 SSTRT   EQU     80H     ; SHIFTED START BIT
0040              1342 STOPB   EQU     40H     ; STOP BIT
00C0              1343 STRT    EQU     0C0H    ; UNSHIFTED START BIT
001B              1344 TERM    EQU     1BH     ; CODE FOR ICMD TERMINATING CHARACTER (ESCAPE)
00FF              1345 UPPER   EQU     0FFH    ; DENOTES UPPER HALF OF BYTE IN ICMD
                  1346
                  1347 ;DELAY VALUES IF NO WAIT STATE
                  1348 ;
                  1349         IF      1-WAITS
048C              1350 IBTIM   EQU     1164    ;INTER-BIT TIME DELAY
048C              1351 OBTIM   EQU     1164    ;OUTPUT INTER-BIT TIME DELAY
1230              1352 TIM4    EQU     4656    ;4 BIT TIME DELAY
0246              1353 WAIT    EQU     582     ;DELAY UNTIL READY TO SAMPLE BITS
                  1354         ENDIF
                  1355 ;
                  1356 ;DELAY VALUES IF ONE WAIT STATE
                  1357 ;
                  1358         IF      WAITS
                  1359 IBTIM   EQU     930     ;INTER-BIT DELAY
                  1360 OBTIM   EQU     930     ;OUTPUT INTER-BIT TIME DELAY
                  1361 TIM4    EQU     3720    ;4 BIT TIME DELAY
                  1362 WAIT    EQU     465     ;DELAY UNTIL READY TO SAMPLE BITS
                  1363         ENDIF
                  1364 ;
                  1365 ;
                  1366 ;*****************************************************************
                  1367 ;
                  1368 ;
                  1369 ;                       RESTART ENTRY POINT
                  1370 ;
                  1371 ;
                  1372 ;*****************************************************************
                  1373 ;
                  1374 ;
                  1375 ;
                  1376 ;*************************************************************
                  1377 ;
                  1378 ;
                  1379 ;                       PRINT SIGNON MESSAGE
                  1380 ;
                  1381 ;
                  1382 ;*************************************************************
                  1383 ;
                  1384 ;
                  1385 GO:
03FA 218C07       1386         LXI     H,SGNON ; GET ADDRESS OF SIGNON MESSAGE
03FD 0614         1387         MVI     B,LSGNON        ; COUNTER FOR CHARACTERS IN MESSAGE
                  1388 MSGL:
03FF 4E           1389         MOV     C,M     ; FETCH NEXT CHAR TO C REG
0400 CDC405       1390         CALL    CO      ; SEND IT TO THE CONSOLE
0403 23           1391         INX     H       ; POINT TO NEXT CHARACTER
0404 05           1392         DCR     B       ; DECREMENT BYTE COUNTER
0405 C2FF03       1393         JNZ     MSGL    ; RETURN FOR NEXT CHARACTER
                  1394 ;
                  1395 ;
                  1396 ;*****************************************************************
                  1397 ;
                  1398 ;
                  1399 ;                   COMMAND RECOGNIZING ROUTINE
                  1400 ;
                  1401 ;
                  1402 ;*****************************************************************
                  1403 ;
                  1404 ; FUNCTION: GETCM
                  1405 ; INPUTS: NONE
                  1406 ; OUTPUTS: NONE
                  1407 ; CALLS: GETCH,ECHO,ERROR
                  1408 ; DESTROYS: A,B,C,H,L,F/F'S
                  1409 ; DESCRIPTION: GETCM RECEIVES AN INPUT CHARACTER FROM THE USER
                  1410 ;              AND ATTEMPTS TO LOCATE THIS CHARACTER IN ITS COMMAND
                  1411 ;              CHARACTER TABLE.  IF SUCCESSFUL, THE ROUTINE
                  1412 ;              CORRESPONDING TO THIS CHARACTER IS SELECTED FROM
                  1413 ;              A TABLE OF COMMAND ROUTINE ADDRESSES, AND CONTROL
                  1414 ;              IS TRANSFERRED TO THIS ROUTINE.  IF THE CHARACTER
                  1415 ;              DOES NOT MATCH ANY ENTRIES, CONTROL IS PASSED TO
                  1416 ;              THE ERROR HANDLER.
                  1417 ;
                  1418 GETCM:
0408 21E920       1419         LXI     H,MNSTK ; ALWAYS WANT TO RESET STACK PTR TO MONITOR
040B F9           1420         SPHL         ; /STARTING VALUE SO ROUTINES NEEDN'T CLEAN UP
040C 0E2E         1421         MVI     C,'.'   ; PROMPT CHARACTER TO C
040E CDF805       1422         CALL    ECHO    ; SEND PROMPT CHARACTER TO USER TERMINAL
0411 C31404       1423         JMP     GTC03   ; WANT TO LEAVE ROOM FOR RST BRANCH
                  1424 GTC03:
0414 CD1F06       1425         CALL    GETCH   ; GET COMMAND CHARACTER TO A
0417 CDF805       1426         CALL    ECHO    ; ECHO CHARACTER TO USER
041A 79           1427         MOV     A,C     ; PUT COMMAND CHARACTER INTO ACCUMULATOR
041B 010600       1428         LXI     B,NCMDS ; C CONTAINS LOOP AND INDEX COUNT
041E 21AE07       1429         LXI     H,CTAB  ; HL POINTS INTO COMMAND TABLE
                  1430 GTC05:
0421 BE           1431         CMP     M       ; COMPARE TABLE ENTRY AND CHARACTER
0422 CA2D04       1432         JZ      GTC10   ; BRANCH IF EQUAL - COMMAND RECOGNIZED
0425 23           1433         INX     H       ; ELSE, INCREMENT TABLE POINTER
0426 0D           1434         DCR     C       ; DECREMENT LOOP COUNT
0427 C22104       1435         JNZ     GTC05   ; BRANCH IF NOT AT TABLE END
042A C31106       1436         JMP     ERROR   ; ELSE, COMMAND CHARACTER IS ILLEGAL
                  1437 GTC10:
042D 21A007       1438         LXI     H,CADR  ; IF GOOD COMMAND, LOAD ADDRESS OF TABLE
                  1439                         ; /OF COMMAND ROUTINE ADDRESSES
```

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LOC  OBJ        SEQ         SOURCE STATEMENT

0430 09         1440          DAD     B       ; ADD WHAT IS LEFT OF LOOP COUNT
0431 09         1441          DAD     B       ; ADD AGAIN - EACH ENTRY IN CADR IS 2 BYTES LONG
0432 7E         1442          MOV     A,M     ; GET LSP OF ADDRESS OF TABLE ENTRY TO A
0433 23         1443          INX     H       ; POINT TO NEXT BYTE IN TABLE
0434 66         1444          MOV     H,M     ; GET MSP OF ADDRESS OF TABLE ENTRY TO H
0435 6F         1445          MOV     L,A     ; PUT LSP OF ADDRESS OF TABLE ENTRY INTO L
0436 E9         1446          PCHL            ; NEXT INSTRUCTION COMES FROM COMMAND ROUTINE
                1447 ;
                1448 ;
                1449 ;*****************************************************************************
                1450 ;
                1451 ;
                1452 ;             COMMAND IMPLEMENTING ROUTINES
                1453 ;
                1454 ;
                1455 ;*****************************************************************************
                1456 ;
                1457 ;
                1458 ; FUNCTION: DCMD
                1459 ; INPUTS: NONE
                1460 ; OUTPUTS: NONE
                1461 ; CALLS: ECHO,NMOUT,HILO,GETCM,CROUT,GETNM
                1462 ; DESTROYS: A,B,C,D,E,H,L,F/F'S
                1463 ; DESCRIPTION: DCMD IMPLEMENTS THE DISPLAY MEMORY (D) COMMAND
                1464 ;
                1465 DCMD:
0437 0E02       1466          MVI     C,2     ; GET 2 NUMBERS FROM INPUT STREAM
0439 CD5B06     1467          CALL    GETNM
043C D1         1468          POP     D       ; ENDING ADDRESS TO DE
043D E1         1469          POP     H       ; STARTING ADDRESS TO HL
                1470 DCM05:
043E CDEB05     1471          CALL    CROUT   ; ECHO CARRIAGE RETURN/LINE FEED
0441 7C         1472          MOV     A,H     ; DISPLAY ADDRESS OF FIRST LOCATION IN LINE
0442 CDC706     1473          CALL    NMOUT
0445 7D         1474          MOV     A,L     ; ADDRESS IS 2 BYTES LONG
0446 CDC706     1475          CALL    NMOUT
                1476 DCM10:
0449 0E20       1477          MVI     C,' '
044B CDF805     1478          CALL    ECHO    ; USE BLANK AS SEPARATOR
044E 7E         1479          MOV     A,M     ; GET CONTENTS OF NEXT MEMORY LOCATION
044F CDC706     1480          CALL    NMOUT   ; DISPLAY CONTENTS
0452 CDA006     1481          CALL    HILO    ; SEE IF ADDRESS OF DISPLAYED LOCATION IS
                1482                          ; /GREATER THAN OR EQUAL TO ENDING ADDRESS
                1483          FALSE   DCM15   ; IF NOT, MORE TO DISPLAY
0455 D25E04     1484+         JNC     DCM15
0458 CDEB05     1485          CALL    CROUT   ; CARRIAGE RETURN/LINE FEED TO END LINE
045B C30804     1486          JMP     GETCM   ; ALL DONE
                1487 DCM15:
045E 23         1488          INX     H       ; IF MORE TO GO, POINT TO NEXT LOC TO DISPLAY
045F 7D         1489          MOV     A,L     ; GET LOW ORDER BITS OF NEW ADDRESS
0460 E60F       1490          ANI     NEWLN   ; SEE IF LAST HEX DIGIT OF ADDRESS DENOTES
                1491                          ; /START OF NEW LINE
0462 C24904     1492          JNZ     DCM10   ; NO - NOT AT END OF LINE
0465 C33E04     1493          JMP     DCM05   ; YES - START NEW LINE WITH ADDRESS
                1494 ;
                1495 ;
                1496 ;*****************************************************************
                1497 ;
                1498 ;
                1499 ; FUNCTION: GCMD
                1500 ; INPUTS: NONE
                1501 ; OUTPUTS: NONE
                1502 ; CALLS: ERROR,GETHX,RSTTF
                1503 ; DESTROYS: A,B,C,D,E,H,L,F/F'S
                1504 ; DESCRIPTION: GCMD IMPLEMENTS THE BEGIN EXECUTION (G) COMMAND.
                1505 ;
                1506 GCMD:
0468 CD2606     1507          CALL    GETHX   ; GET ADDRESS (IF PRESENT) FROM INPUT STREAM
                1508          FALSE   GCM05   ; BRANCH IF NO NUMBER PRESENT
046B D27D04     1509+         JNC     GCM05
046E 7A         1510          MOV     A,D     ; ELSE, GET TERMINATOR
046F FE0D       1511          CPI     CR      ; SEE IF CARRIAGE RETURN
0471 C21106     1512          JNZ     ERROR   ; ERROR IF NOT PROPERLY TERMINATED
0474 21F220     1513          LXI     H,PSAV  ; WANT NUMBER TO REPLACE SAVE PGM COUNTER
0477 71         1514          MOV     M,C
0478 23         1515          INX     H
0479 70         1516          MOV     M,B
047A C38304     1517          JMP     GCM10
                1518 GCM05:
047D 7A         1519          MOV     A,D     ; IF NO STARTING ADDRESS, MAKE SURE THAT
047E FE0D       1520          CPI     CR      ; /CARRIAGE RETURN TERMINATED COMMAND
0480 C21106     1521          JNZ     ERROR   ; ERROR IF NOT
                1522 GCM10:
0483 C31B03     1523          JMP     RSTOR   ; RESTORE REGISTERS AND BEGIN EXECUTION
                1524                          ; (RSTOR IS IN KEYBOARD MONITOR)
                1525 ;
                1526 ;
                1527 ;*****************************************************************
                1528 ;
                1529 ;
                1530 ; FUNCTION: ICMD
                1531 ; INPUTS: NONE
                1532 ; OUTPUTS: NONE
                1533 ; CALLS: ERROR,ECHO,GETCH,VALDL,VALDG,CNVBN,STHLF,GETNM,CROUT
                1534 ; DESTROYS: A,B,C,D,E,H,L,F/F'S
                1535 ; DESCRIPTION: ICMD IMPLEMENTS THE INSERT CODE INTO MEMORY (I) COMMAND.
                1536 ;
                1537 ICMD:
0486 0E01       1538          MVI     C,1
```

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LOC  OBJ        SEQ         SOURCE STATEMENT

0488 CD5B06     1539        CALL    GETNM   ; GET SINGLE NUMBER FROM INPUT STREAM
048B 3EFF       1540        MVI     A,UPPER
048D 32FD20     1541        STA     TEMP    ; TEMP WILL HOLD THE UPPER/LOWER HALF BYTE FLAG
0490 D1         1542        POP     D       ; ADDRESS OF START TO DE
                1543 ICM05:
0491 CD1F06     1544        CALL    GETCH   ; GET A CHARACTER FROM INPUT STREAM
0494 4F         1545        MOV     C,A
0495 CDF805     1546        CALL    ECHO    ; ECHO IT
0498 79         1547        MOV     A,C     ; PUT CHARACTER BACK INTO A
0499 FE1B       1548        CPI     TERM    ; SEE IF CHARACTER IS A TERMINATING CHARACTER
049B CAC704     1549        JZ      ICM25   ; IF SO, ALL DONE ENTERING CHARACTERS
049E CD7907     1550        CALL    VALDL   ; ELSE, SEE IF VALID DELIMITER
                1551        TRUE    ICM05   ; IF SO SIMPLY IGNORE THIS CHARACTER
04A1 DA9104     1552+       JC      ICM05
04A4 CD5E07     1553        CALL    VALDG   ; ELSE, CHECK TO SEE IF VALID HEX DIGIT
                1554        FALSE   ICM20   ; IF NOT, BRANCH TO HANDLE ERROR CONDITION
04A7 D2C104     1555+       JNC     ICM20
04AA CDBB05     1556        CALL    CNVBN   ; CONVERT DIGIT TO BINARY
04AD 4F         1557        MOV     C,A     ; MOVE RESULT TO C
04AE CD3F07     1558        CALL    STHLF   ; STORE IN APPROPRIATE HALF WORD
04B1 3AFD20     1559        LDA     TEMP    ; GET HALF BYTE FLAG
04B4 B7         1560        ORA     A       ; SET F/F'S
04B5 C2B904     1561        JNZ     ICM10   ; BRANCH IF FLAG SET FOR UPPER
04B8 13         1562        INX     D       ; IF LOWER, INC ADDRESS OF BYTE TO STORE IN
                1563 ICM10:
04B9 EEFF       1564        XRI     INVRT   ; TOGGLE STATE OF FLAG
04BB 32FD20     1565        STA     TEMP    ; PUT NEW VALUE OF FLAG BACK
04BE C39104     1566        JMP     ICM05   ; PROCESS NEXT DIGIT
                1567 ICM20:
04C1 CD3407     1568        CALL    STHF0   ; ILLEGAL CHARACTER
04C4 C31106     1569        JMP     ERROR   ; MAKE SURE ENTIRE BYTE FILLED THEN ERROR
                1570 ICM25:
04C7 CD3407     1571        CALL    STHF0   ; HERE FOR ESCAPE CHARACTER - INPUT IS DONE
04CA CDEB05     1572        CALL    CROUT   ; ADD CARRIAGE RETURN
04CD C30804     1573        JMP     GETCM
                1574 ;
                1575 ;
                1576 ;*****************************************************************
                1577 ;
                1578 ;
                1579 ; FUNCTION: MCMD
                1580 ; INPUTS: NONE
                1581 ; OUTPUTS: NONE
                1582 ; CALLS: GETCM,HILO,GETNM
                1583 ; DESTROYS: A,B,C,D,E,H,L,F/F'S
                1584 ; DESCRIPTION: MCMD IMPLEMENTS THE MOVE DATA IN MEMORY (M) COMMAND.
                1585 ;
                1586 MCMD:
04D0 0E03       1587        MVI     C,3
04D2 CD5B06     1588        CALL    GETNM   ; GET 3 NUMBERS FROM INPUT STREAM
04D5 C1         1589        POP     B       ; DESTINATION ADDRESS TO BC
04D6 E1         1590        POP     H       ; ENDING ADDRESS TO HL
04D7 D1         1591        POP     D       ; STARTING ADDRESS TO DE
                1592 MCM05:
04D8 E5         1593        PUSH    H       ; SAVE ENDING ADDRESS
04D9 62         1594        MOV     H,D
04DA 6B         1595        MOV     L,E     ; SOURCE ADDRESS TO HL
04DB 7E         1596        MOV     A,M     ; GET SOURCE BYTE
04DC 60         1597        MOV     H,B
04DD 69         1598        MOV     L,C     ; DESTINATION ADDRESS TO HL
04DE 77         1599        MOV     M,A     ; MOVE BYTE TO DESTINATION
04DF 03         1600        INX     B       ; INCREMENT DESTINATION ADDRESS
04E0 78         1601        MOV     A,B
04E1 B1         1602        ORA     C       ; TEST FOR DESTINATION ADDRESS OVERFLOW
04E2 CA0804     1603        JZ      GETCM   ; IF SO, CAN TERMINATE COMMAND
04E5 13         1604        INX     D       ; INCREMENT SOURCE ADDRESS
04E6 E1         1605        POP     H       ; ELSE, GET BACK ENDING ADDRESS
04E7 CDA006     1606        CALL    HILO    ; SEE IF ENDING ADDR>=SOURCE ADDR
                1607        FALSE   GETCM   ; IF NOT, COMMAND IS DONE
04EA D20804     1608+       JNC     GETCM
04ED C3D804     1609        JMP     MCM05   ; MOVE ANOTHER BYTE
                1610 ;
                1611 ;
                1612 ;*****************************************************************
                1613 ;
                1614 ;
                1615 ; FUNCTION: SCMD
                1616 ; INPUTS: NONE
                1617 ; OUTPUTS: NONE
                1618 ; CALLS: GETHX,GETCM,NMOUT,ECHO
                1619 ; DESTROYS: A,B,C,D,E,H,L,F/F'S
                1620 ; DESCRIPTION: SCMD IMPLEMENTS THE SUBSTITUTE INTO MEMORY (S) COMMAND.
                1621 ;
                1622 SCMD:
04F0 CD2606     1623        CALL    GETHX   ; GET A NUMBER, IF PRESENT, FROM INPUT
04F3 C5         1624        PUSH    B
04F4 E1         1625        POP     H       ; GET NUMBER TO HL - DENOTES MEMORY LOCATION
                1626 SCM05:
04F5 7A         1627        MOV     A,D     ; GET TERMINATOR
04F6 FE20       1628        CPI     ' '     ; SEE IF SPACE
04F8 CA0005     1629        JZ      SCM10   ; YES - CONTINUE PROCESSING
04FB FE2C       1630        CPI     ','     ; ELSE, SEE IF COMMA
04FD C20804     1631        JNZ     GETCM   ; NO - TERMINATE COMMAND
                1632 SCM10:
0500 7E         1633        MOV     A,M     ; GET CONTENTS OF SPECIFIED LOCATION TO A
0501 CDC706     1634        CALL    NMOUT   ; DISPLAY CONTENTS ON CONSOLE
0504 0E2D       1635        MVI     C,'-'
0506 CDF805     1636        CALL    ECHO    ; USE DASH FOR SEPARATOR
0509 CD2606     1637        CALL    GETHX   ; GET NEW VALUE FOR MEMORY LOCATION, IF ANY
```

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LOC  OBJ        SEQ         SOURCE STATEMENT


                1638        FALSE   SCM15   ; IF NO VALUE PRESENT, BRANCH
050C D21005     1639+       JNC     SCM15
050F 71         1640        MOV     M,C     ; ELSE, STORE LOWER 8 BITS OF NUMBER ENTERED
                1641 SCM15:
0510 23         1642        INX     H       ; INCREMENT ADDRESS OF MEMORY LOCATION TO VIEW
0511 C3F504     1643        JMP     SCM05
                1644 ;
                1645 ;
                1646 ;*****************************************************************
                1647 ;
                1648 ;
                1649 ; FUNCTION: XCMD
                1650 ; INPUTS: NONE
                1651 ; OUTPUTS: NONE
                1652 ; CALLS: GETCH,ECHO,REGDS,GETCM,ERROR,RGADR,NMOUT,CROUT,GETHX
                1653 ; DESTROYS: A,B,C,D,E,H,L,F/F'S
                1654 ; DESCRIPTION: XCMD IMPLEMENTS THE REGISTER EXAMINE AND CHANGE (X)
                1655 ;              COMMAND.
                1656 ;
                1657 XCMD:
0514 CD1F06     1658        CALL    GETCH   ; GET REGISTER IDENTIFIER
0517 4F         1659        MOV     C,A
0518 CDF805     1660        CALL    ECHO    ; ECHO IT
051B 79         1661        MOV     A,C
051C FE0D       1662        CPI     CR
051E C22705     1663        JNZ     XCM05   ; BRANCH IF NOT CARRIAGE RETURN
0521 CDEA06     1664        CALL    REGDS   ; ELSE, DISPLAY REGISTER CONTENTS
0524 C30804     1665        JMP     GETCM   ; THEN TERMINATE COMMAND
                1666 XCM05:
0527 4F         1667        MOV     C,A     ; GET REGISTER IDENTIFIER TO C
0528 CD1B07     1668        CALL    RGADR   ; CONVERT IDENTIFIER INTO RTAB TABLE ADDR
052B C5         1669        PUSH    B
052C E1         1670        POP     H       ; PUT POINTER TO REGISTER ENTRY INTO HL
052D 0E20       1671        MVI     C,' '
052F CDF805     1672        CALL    ECHO    ; ECHO SPACE TO USER
0532 79         1673        MOV     A,C
0533 32FD20     1674        STA     TEMP    ; PUT SPACE INTO TEMP AS DELIMITER
                1675 XCM10:
0536 3AFD20     1676        LDA     TEMP    ; GET TERMINATOR
0539 FE20       1677        CPI     ' '     ; SEE IF A BLANK
053B CA4305     1678        JZ      XCM15   ; YES - GO CHECK POINTER INTO TABLE
053E FE2C       1679        CPI     ','     ; NO - SEE IF COMMA
0540 C20804     1680        JNZ     GETCM   ; NO - MUST BE CARRIAGE RETURN TO END COMMAND
                1681 XCM15:
0543 7E         1682        MOV     A,M
0544 B7         1683        ORA     A       ; SET F/F'S
0545 C24E05     1684        JNZ     XCM18   ; BRANCH IF NOT AT END OF TABLE
0548 CDEB05     1685        CALL    CROUT   ; ELSE, OUTPUT CARRIAGE RETURN LINE FEED
054B C30804     1686        JMP     GETCM   ; AND EXIT
                1687 XCM18:
054E E5         1688        PUSH    H       ; PUT POINTER ON STACK
054F 5E         1689        MOV     E,M
0550 1620       1690        MVI     D,RAMST SHR 8    ; ADDRESS OF SAVE LOCATION FROM TABLE
0552 23         1691        INX     H
0553 46         1692        MOV     B,M     ; FETCH LENGTH FLAG FROM TABLE
0554 D5         1693        PUSH    D       ; SAVE ADDRESS OF SAVE LOCATION
0555 D5         1694        PUSH    D
0556 E1         1695        POP     H       ; MOVE ADDRESS TO HL
0557 C5         1696        PUSH    B       ; SAVE LENGTH FLAG
0558 7E         1697        MOV     A,M     ; GET 8 BITS OF REGISTER FROM SAVE LOCATION
0559 CDC706     1698        CALL    NMOUT   ; DISPLAY IT
055C F1         1699        POP     PSW     ; GET BACK LENGTH FLAG
055D F5         1700        PUSH    PSW     ; SAVE IT AGAIN
055E B7         1701        ORA     A       ; SET F/F'S
055F CA6705     1702        JZ      XCM20   ; IF 8 BIT REGISTER, NOTHING MORE TO DISPLAY
0562 2B         1703        DCX     H       ; ELSE, FOR 16 BIT REGISTER, GET LOWER 8 BITS
0563 7E         1704        MOV     A,M
0564 CDC706     1705        CALL    NMOUT   ; DISPLAY THEM
                1706 XCM20:
0567 0E2D       1707        MVI     C,'-'
0569 CDF805     1708        CALL    ECHO    ; USE DASH AS SEPARATOR
056C CD2606     1709        CALL    GETHX   ; SEE IF THERE IS A VALUE TO PUT INTO REGISTER
                1710        FALSE   XCM30   ; NO - GO CHECK FOR NEXT REGISTER
056F D28705     1711+       JNC     XCM30
0572 7A         1712        MOV     A,D
0573 32FD20     1713        STA     TEMP    ; ELSE, SAVE THE TERMINATOR FOR NOW
0576 F1         1714        POP     PSW     ; GET BACK LENGTH FLAG
0577 E1         1715        POP     H       ; PUT ADDRESS OF SAVE LOCATION INTO HL
0578 B7         1716        ORA     A       ; SET F/F'S
0579 CA7E05     1717        JZ      XCM25   ; IF 8 BIT REGISTER, BRANCH
057C 70         1718        MOV     M,B     ; SAVE UPPER 8 BITS
057D 2B         1719        DCX     H       ; POINT TO SAVE LOCATION FOR LOWER 8 BITS
                1720 XCM25:
057E 71         1721        MOV     M,C     ; STORE ALL OF 8 BIT OR LOWER 1/2 OF 16 BIT REG
                1722 XCM27:
057F 110300     1723        LXI     D,RTABS ; SIZE OF ENTRY IN RTAB TABLE
0582 E1         1724        POP     H       ; POINTER INTO REGISTER TABLE RTAB
0583 19         1725        DAD     D       ; ADD ENTRY SIZE TO POINTER
0584 C33605     1726        JMP     XCM10   ; DO NEXT REGISTER
                1727 XCM30:
0587 7A         1728        MOV     A,D     ; GET TERMINATOR
0588 32FD20     1729        STA     TEMP    ; SAVE IN MEMORY
058B D1         1730        POP     D       ; CLEAR STACK OF LENGTH FLAG AND ADDRESS
058C D1         1731        POP     D       ; /OF SAVE LOCATION
058D C37F05     1732        JMP     XCM27   ; GO INCREMENT REGISTER TABLE POINTER
                1733 ;
                1734 ;
```

```
LOC  OBJ          SEQ         SOURCE STATEMENT

                  1735 ;*****************************************************************
                  1736 ;
                  1737 ;
                  1738 ;                   UTILITY ROUTINES
                  1739 ;
                  1740 ;*****************************************************************
                  1741 ;
                  1742 ;
                  1743 ;
                  1744 ; FUNCTION: CI
                  1745 ; INPUTS: NONE
                  1746 ; OUTPUTS: A - CHARACTER FROM TTY
                  1747 ; CALLS: DELAY
                  1748 ; DESTROYS: A,F/F'S
                  1749 ; DESCRIPTION: CI WAITS UNTIL A CHARACTER HAS BEEN ENTERED AT THE
                  1750 ;               TTY AND THEN RETURNS THE CHARACTER, VIA THE A
                  1751 ;               REGISTER, TO THE CALLING ROUTINE.  THIS ROUTINE
                  1752 ;               IS CALLED BY THE USER VIA A JUMP TABLE IN RAM.
                  1753 ;
                  1754 CI:
0590 F3           1755          DI
0591 D5           1756          PUSH    D         ; SAVE DE
                  1757 CI05:
0592 20           1758          RIM               ; GET INPUT BIT
0593 17           1759          RAL               ; INTO CARRY WITH IT
0594 DA9205       1760          JC      CI05      ; BRANCH IF NO START BIT
0597 114602       1761          LXI     D,WAIT    ; WAIT UNTIL MIDDLE OF BIT
059A CDF105       1762          CALL    DELAY
059D C5           1763          PUSH    B         ; SAVE BC
059E 010800       1764          LXI     B,8       ; B<--0, C<--# BITS TO RECEIVE
                  1765 CI10:
05A1 118C04       1766          LXI     D,IBTIM
05A4 CDF105       1767          CALL    DELAY     ; WAIT UNTIL MIDDLE OF NEXT BIT
05A7 20           1768          RIM               ; GET THE BIT
05A8 17           1769          RAL               ; INTO CARRY
05A9 78           1770          MOV     A,B       ; GET PARTIAL RESULT
05AA 1F           1771          RAR               ; SHIFT IN NEXT DATA BIT
05AB 47           1772          MOV     B,A       ; REPLACE RESULT
05AC 0D           1773          DCR     C         ; DEC COUNT OF BITS TO GO
05AD C2A105       1774          JNZ     CI10      ; BRANCH IF MORE LEFT
05B0 118C04       1775          LXI     D,IBTIM   ; ELSE, WANT TO WAIT OUT STOP BIT
05B3 CDF105       1776          CALL    DELAY
05B6 78           1777          MOV     A,B       ; GET RESULT
05B7 C1           1778          POP     B
05B8 D1           1779          POP     D         ; RESTORE SAVED REGISTERS
05B9 FB           1780          EI
05BA C9           1781          RET               ; THAT'S IT
                  1782 ;
                  1783 ;
                  1784 ;*****************************************************************
                  1785 ;
                  1786 ;
                  1787 ; FUNCTION: CNVBN
                  1788 ; INPUTS: C - ASCII CHARACTER '0'-'9' OR 'A'-'F'
                  1789 ; OUTPUTS: A - 0 TO F HEX
                  1790 ; CALLS: NOTHING
                  1791 ; DESTROYS: A,F/F'S
                  1792 ; DESCRIPTION: CNVBN CONVERTS THE ASCII REPRESENTATION OF A HEX
                  1793 ;               CNVBN INTO ITS CORRESPONDING BINARY VALUE.  CNVBN
                  1794 ;               DOES NOT CHECK THE VALIDITY OF ITS INPUT.
                  1795 ;
                  1796 CNVBN:
05BB 79           1797          MOV     A,C
05BC D630         1798          SUI     '0'       ; SUBTRACT CODE FOR '0' FROM ARGUMENT
05BE FE0A         1799          CPI     10        ; WANT TO TEST FOR RESULT OF 0 TO 9
05C0 F8           1800          RM                ; IF SO, THEN ALL DONE
05C1 D607         1801          SUI     7         ; ELSE, RESULT BETWEEN 17 AND 23 DECIMAL
05C3 C9           1802          RET               ; SO RETURN AFTER SUBTRACTING BIAS OF 7
                  1803 ;
                  1804 ;
                  1805 ;*****************************************************************
                  1806 ;
                  1807 ;
                  1808 ; FUNCTION: CO
                  1809 ; INPUTS: C - CHARACTER TO OUTPUT TO TTY
                  1810 ; OUTPUTS: C - CHARACTER OUTPUT TO TTY
                  1811 ; CALLS: DELAY
                  1812 ; DESTROYS: A,F/F'S
                  1813 ; DESCRIPTION: CO SENDS ITS INPUT ARGUMENT TO THE TTY.
                  1814 ;
                  1815 CO:
05C4 F3           1816          DI
05C5 C5           1817          PUSH    B         ; SAVE BC
05C6 D5           1818          PUSH    D         ; SAVE DE
05C7 3EC0         1819          MVI     A,STRT    ; START BIT MASK
05C9 0607         1820          MVI     B,7       ; B WILL COUNT BITS TO SEND
                  1821 CO05:
05CB 30           1822          SIM               ; SEND A BIT
05CC 118C04       1823          LXI     D,OBTIM   ; WAIT FOR TTY TO HANDLE IT
05CF CDF105       1824          CALL    DELAY
05D2 79           1825          MOV     A,C       ; PICK UP BITS LEFT TO SEND
05D3 1F           1826          RAR               ; LOW ORDER BIT TO CARRY
05D4 4F           1827          MOV     C,A       ; PUT REST BACK
05D5 3E80         1828          MVI     A,SSTRT   ; SHIFTED ENABLE BIT
05D7 1F           1829          RAR               ; SHIFT IN DATA BIT
05D8 EE80         1830          XRI     80H       ; COMPLEMENT DATA BIT
05DA 05           1831          DCR     B         ; DEC COUNT
05DB F2CB05       1832          JP      CO05      ; SEND IF MORE BITS NEED TO BE SENT
05DE 3E40         1833          MVI     A,STOPB   ; ELSE, SEND STOP BITS
05E0 30           1834          SIM
```

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LOC  OBJ       SEQ   SOURCE STATEMENT

05E1 113012    1835          LXI     D,TIM4  ; WAIT 4 BIT TIME (FAKE PARITY + 3 STOP BITS)
05E4 CDF105    1836          CALL    DELAY
05E7 D1        1837          POP     D
05E8 C1        1838          POP     B       ; RESTORE SAVED REGISTERS
05E9 FB        1839          EI
05EA C9        1840          RET             ; ALL DONE
               1841 ;
               1842 ;
               1843 ;*****************************************************************
               1844 ;
               1845 ;
               1846 ; FUNCTION CROUT
               1847 ; INPUTS: NONE
               1848 ; OUTPUTS: NONE
               1849 ; CALLS: ECHO
               1850 ; DESTROYS: A,B,C,F/F'S
               1851 ; DESCRIPTION: CROUT SENDS A CARRIAGE RETURN (AND HENCE A LINE
               1852 ;              FEED) TO THE CONSOLE.
               1853 ;
               1854 CROUT:
05EB 0E0D      1855          MVI     C,CR
05ED CDF805    1856          CALL    ECHO
05F0 C9        1857          RET
               1858 ;
               1859 ;
               1860 ;*****************************************************************
               1861 ;
               1862 ;
               1863 ; FUNCTION: DELAY
               1864 ; INPUTS: DE - 16 BIT INTEGER DENOTING NUMBER OF TIMES TO LOOP
               1865 ; OUTPUTS: NONE
               1866 ; CALLS: NOTHING
               1867 ; DESTROYS: A,D,E,F/F'S
               1868 ; DESCRIPTION: DELAY DOES NOT RETURN TO CALLER UNTIL INPUT ARGUMENT
               1869 ;              IS COUNTED DOWN TO 0.
               1870 ;
               1871 DELAY:
05F1 1B        1872          DCX     D       ; DECREMENT INPUT ARGUMENT
05F2 7A        1873          MOV     A,D
05F3 B3        1874          ORA     E
05F4 C2F105    1875          JNZ     DELAY   ; IF ARGUMENT NOT 0, KEEP GOING
05F7 C9        1876          RET
               1877 ;
               1878 ;
               1879 ;*****************************************************************
               1880 ;
               1881 ;
               1882 ; FUNCTION: ECHO
               1883 ; INPUTS: C - CHARACTER TO ECHO TO TERMINAL
               1884 ; OUTPUTS: C - CHARACTER ECHOED TO TERMINAL
               1885 ; CALLS: CO
               1886 ; DESTROYS: A,B,F/F'S
               1887 ; DESCRIPTION: ECHO TAKES A SINGLE CHARACTER AS INPUT AND, VIA
               1888 ;              THE MONITOR, SENDS THAT CHARACTER TO THE USER
               1889 ;              TERMINAL.  A CARRIAGE RETURN IS ECHOED AS A CARRIAGE
               1890 ;              RETURN LINE FEED, AND AN ESCAPE CHARACTER IS ECHOED AS $.
               1891 ;
               1892 ECHO:
05F8 41        1893          MOV     B,C     ; SAVE ARGUMENT
05F9 3E1B      1894          MVI     A,ESC
05FB B8        1895          CMP     B       ; SEE IF ECHOING AN ESCAPE CHARACTER
05FC C20106    1896          JNZ     ECH05   ; NO - BRANCH
05FF 0E24      1897          MVI     C,'$'   ; YES - ECHO AS $
               1898 ECH05:
0601 CDC405    1899          CALL    CO      ; DO OUTPUT THROUGH MONITOR
0604 3E0D      1900          MVI     A,CR
0606 B8        1901          CMP     B       ; SEE IF CHARACTER ECHOED WAS A CARRIAGE RETURN
0607 C20F06    1902          JNZ     ECH10   ; NO - NO NEED TO TAKE SPECIAL ACTION
060A 0E0A      1903          MVI     C,LF    ; YES - WANT TO ECHO LINE FEED, TOO
060C CDC405    1904          CALL    CO
               1905 ECH10:
060F 48        1906          MOV     C,B     ; RESTORE ARGUMENT
0610 C9        1907          RET
               1908 ;
               1909 ;
               1910 ;*****************************************************************
               1911 ;
               1912 ;
               1913 ; FUNCTION: ERROR
               1914 ; INPUTS: NONE
               1915 ; OUTPUTS: NONE
               1916 ; CALLS: ECHO,CROUT,GETCM
               1917 ; DESTROYS: A,B,C,F/F'S
               1918 ; DESCRIPTION: ERROR PRINTS THE ERROR CHARACTER (CURRENTLY AN ASTERISK)
               1919 ;              ON THE CONSOLE, FOLLOWED BY A CARRIAGE RETURN-LINE FEED,
               1920 ;              AND THEN RETURNS CONTROL TO THE COMMAND RECOGNIZER.
               1921 ;
               1922 ERROR:
0611 0E2A      1923          MVI     C,'*'
0613 CDF805    1924          CALL    ECHO    ; SEND * TO CONSOLE
0616 CDEB05    1925          CALL    CROUT   ; SKIP TO BEGINNING OF NEXT LINE
0619 C30804    1926          JMP     GETCM   ; TRY AGAIN FOR ANOTHER COMMAND
               1927 ;
               1928 ;
               1929 ;*****************************************************************
               1930 ;
               1931 ;
               1932 ; FUNCTION: FRET
               1933 ; INPUTS: NONE
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LOC  OBJ          SEQ         SOURCE STATEMENT

                  1934 ; OUTPUTS: CARRY - ALWAYS 0
                  1935 ; CALLS: NOTHING
                  1936 ; DESTROYS: CARRY
                  1937 ; DESCRIPTION: FRET IS JUMPED TO BY ANY ROUTINE THAT WISHES TO
                  1938 ;              INDICATE FAILURE ON RETURN.  FRET SETS THE CARRY
                  1939 ;              FALSE, DENOTING FAILURE, AND THEN RETURNS TO THE
                  1940 ;              CALLER OF THE ROUTINE INVOKING FRET.
                  1941 ;
                  1942 FRET:
061C 37           1943        STC             ; FIRST SET CARRY TRUE
061D 3F           1944        CMC             ; THEN COMPLEMENT IT TO MAKE IT FALSE
061E C9           1945        RET             ; RETURN APPROPRIATELY
                  1946 ;
                  1947 ;
                  1948 ;*****************************************************************
                  1949 ;
                  1950 ;
                  1951 ; FUNCTION: GETCH
                  1952 ; INPUTS: NONE
                  1953 ; OUTPUTS: C - NEXT CHARACTER IN INPUT STREAM
                  1954 ; CALLS: CI
                  1955 ; DESTROYS: A,C,F/F'S
                  1956 ; DESCRIPTION: GETCH RETURNS THE NEXT CHARACTER IN THE INPUT STREAM
                  1957 ;              TO THE CALLING PROGRAM.
                  1958 ;
                  1959 GETCH:
061F CD9005       1960        CALL    CI      ; GET CHARACTER FROM TERMINAL
0622 E67F         1961        ANI     PRTY0   ; TURN OFF PARITY BIT IN CASE SET BY CONSOLE
0624 4F           1962        MOV     C,A     ; PUT VALUE IN C REGISTER FOR RETURN
0625 C9           1963        RET
                  1964 ;
                  1965 ;
                  1966 ;*****************************************************************
                  1967 ;
                  1968 ;
                  1969 ; FUNCTION: GETHX
                  1970 ; INPUTS: NONE
                  1971 ; OUTPUTS: BC - 16 BIT INTEGER
                  1972 ;          D - CHARACTER WHICH TERMINATED THE INTEGER
                  1973 ;          CARRY - 1 IF FIRST CHARACTER NOT DELIMITER
                  1974 ;                - 0 IF FIRST CHARACTER IS DELIMITER
                  1975 ; CALLS: GETCH,ECHO,VALDL,VALDG,CNVBN,ERROR
                  1976 ; DESTROYS: A,B,C,D,E,F/F'S
                  1977 ; DESCRIPTION: GETHX ACCEPTS A STRING OF HEX DIGITS FROM THE INPUT
                  1978 ;              STREAM AND RETURNS THEIR VALUE AS A 16 BIT BINARY
                  1979 ;              INTEGER.  IF MORE THAN 4 HEX DIGITS ARE ENTERED,
                  1980 ;              ONLY THE LAST 4 ARE USED.  THE NUMBER TERMINATES WHEN
                  1981 ;              A VALID DELIMITER IS ENCOUNTERED.  THE DELIMITER IS
                  1982 ;              ALSO RETURNED AS AN OUTPUT OF THE FUNCTION.  ILLEGAL
                  1983 ;              CHARACTERS (NOT HEX DIGITS OR DELIMITERS) CAUSE AN
                  1984 ;              ERROR INDICATION.  IF THE FIRST (VALID) CHARACTER
                  1985 ;              ENCOUNTERED IN THE INPUT STREAM IS NOT A DELIMITER,
                  1986 ;              GETHX WILL RETURN WITH THE CARRY BIT SET TO 1;
                  1987 ;              OTHERWISE, THE CARRY BIT IS SET TO 0 AND THE CONTENTS
                  1988 ;              OF BC ARE UNDEFINED.
                  1989 ;
                  1990 GETHX:
0626 E5           1991        PUSH    H       ; SAVE HL
0627 210000       1992        LXI     H,0     ; INITIALIZE RESULT
062A 1E00         1993        MVI     E,0     ; INITIALIZE DIGIT FLAG TO FALSE
                  1994 GHX05:
062C CD1F06       1995        CALL    GETCH   ; GET A CHARACTER
062F 4F           1996        MOV     C,A
0630 CDF805       1997        CALL    ECHO    ; ECHO THE CHARACTER
0633 CD7907       1998        CALL    VALDL   ; SEE IF DELIMITER
                  1999        FALSE   GHX10   ; NO - BRANCH
0636 D24506       2000+       JNC     GHX10
0639 51           2001        MOV     D,C     ; YES - ALL DONE, BUT WANT TO RETURN DELIMITER
063A E5           2002        PUSH    H
063B C1           2003        POP     B       ; MOVE RESULT TO BC
063C E1           2004        POP     H       ; RESTORE HL
063D 7B           2005        MOV     A,E     ; GET FLAG
063E B7           2006        ORA     A       ; SET F/F'S
063F C23207       2007        JNZ     SRET    ; IF FLAG NON-0, A NUMBER HAS BEEN FOUND
0642 CA1C06       2008        JZ      FRET    ; ELSE, DELIMITER WAS FIRST CHARACTER
                  2009 GHX10:
0645 CD5E07       2010        CALL    VALDG   ; IF NOT DELIMITER, SEE IF DIGIT
                  2011        FALSE   ERROR   ; ERROR IF NOT A VALID DIGIT, EITHER
0648 D21106       2012+       JNC     ERROR
064B CDBB05       2013        CALL    CNVBN   ; CONVERT DIGIT TO ITS BINARY VALUE
064E 1EFF         2014        MVI     E,0FFH  ; SET DIGIT FLAG NON-0
0650 29           2015        DAD     H       ; *2
0651 29           2016        DAD     H       ; *4
0652 29           2017        DAD     H       ; *8
0653 29           2018        DAD     H       ; *16
0654 0600         2019        MVI     B,0     ; CLEAR UPPER 8 BITS OF BC PAIR
0656 4F           2020        MOV     C,A     ; BINARY VALUE OF CHARACTER INTO C
0657 09           2021        DAD     B       ; ADD THIS VALUE TO PARTIAL RESULT
0658 C32C06       2022        JMP     GHX05   ; GET NEXT CHARACTER
                  2023 ;
                  2024 ;
                  2025 ;*****************************************************************
                  2026 ;
                  2027 ;
                  2028 ; FUNCTION: GETNM
                  2029 ; INPUTS: C - COUNT OF NUMBERS TO FIND IN INPUT STREAM
                  2030 ; OUTPUTS: TOP OF STACK - NUMBERS FOUND IN REVERSE ORDER (LAST ON TOP
                  2031 ;                        OF STACK)
                  2032 ; CALLS: GETHX,HILO,ERROR
                  2033 ; DESTROYS: A,B,C,D,E,H,L,F/F'S
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LOC  OBJ          SEQ          SOURCE STATEMENT

                   2034 ; DESCRIPTION: GETNM FINDS A SPECIFIED COUNT OF NUMBERS, BETWEEN 1
                   2035 ;              AND 3, INCLUSIVE,  IN THE INPUT
                   2036 ;              STREAM AND RETURNS THEIR VALUES ON THE STACK.  IF 2
                   2037 ;              OR MORE NUMBERS ARE REQUESTED, THEN THE FIRST MUST BE
                   2038 ;              LESS THAN OR EQUAL TO THE SECOND, OR THE FIRST AND
                   2039 ;              SECOND NUMBERS WILL BE SET EQUAL.  THE LAST NUMBER
                   2040 ;              REQUESTED MUST BE TERMINATED BY A CARRIAGE RETURN
                   2041 ;              OR AN ERROR INDICATION WILL RESULT.
                   2042 ;
                   2043 GETNM:
 065B 2E03         2044          MVI     L,3       ; PUT MAXIMUM ARGUMENT COUNT INTO L
 065D 79           2045          MOV     A,C       ; GET THE ACTUAL ARGUMENT COUNT
 065E E603         2046          ANI     3         ; FORCE TO MAXIMUM OF 3
 0660 C8           2047          RZ                ; IF 0, DON'T BOTHER TO DO ANYTHIING
 0661 67           2048          MOV     H,A       ; ELSE, PUT ACTUAL COUNT INTO H
                   2049 GNM05:
 0662 CD2606       2050          CALL    GETHX     ; GET A NUMBER FROM INPUT STREAM
                   2051          FALSE   ERROR     ; ERROR IF NOT THERE - TOO FEW NUMBERS
 0665 D21106       2052+         JNC     ERROR
 0668 C5           2053          PUSH    B         ; ELSE, SAVE NUMBER ON STACK
 0669 2D           2054          DCR     L         ; DECREMENT MAXIMUM ARGUMENT COUNT
 066A 25           2055          DCR     H         ; DECREMENT ACTUAL ARGUMENT COUNT
 066B CA7706       2056          JZ      GNM10     ; BRANCH IF NO MORE NUMBERS WANTED
 066E 7A           2057          MOV     A,D       ; ELSE, GET NUMBER TERMINATOR TO A
 066F FE0D         2058          CPI     CR        ; SEE IF CARRIAGE RETURN
 0671 CA1106       2059          JZ      ERROR     ; ERROR IF SO - TOO FEW NUMBERS
 0674 C36206       2060          JMP     GNM05     ; ELSE, PROCESS NEXT NUMBER
                   2061 GNM10:
 0677 7A           2062          MOV     A,D       ; WHEN COUNT 0, CHECK LAST TERMINATOR
 0678 FE0D         2063          CPI     CR
 067A C21106       2064          JNZ     ERROR     ; ERROR IF NOT CARRIAGE RETURN
 067D 01FFFF       2065          LXI     B,0FFFFH          ; HL GETS LARGEST NUMBER
 0680 7D           2066          MOV     A,L       ; GET WHAT'S LEFT OF MAXIMUM ARG COUNT
 0681 B7           2067          ORA     A         ; CHECK FOR 0
 0682 CA8A06       2068          JZ      GNM20     ; IF YES, 3 NUMBERS WERE INPUT
                   2069 GNM15:
 0685 C5           2070          PUSH    B         ; IF NOT, FILL REMAINING ARGUMENTS WITH 0FFFFH
 0686 2D           2071          DCR     L
 0687 C28506       2072          JNZ     GNM15
                   2073 GNM20:
 068A C1           2074          POP     B         ; GET THE 3 ARGUMENTS OUT
 068B D1           2075          POP     D
 068C E1           2076          POP     H
 068D CDA006       2077          CALL    HILO      ; SEE IF FIRST >= SECOND
                   2078          FALSE   GNM25     ; NO - BRANCH
 0690 D29506       2079+         JNC     GNM25
 0693 54           2080          MOV     D,H
 0694 5D           2081          MOV     E,L       ; YES - MAKE SECOND EQUAL TO THE FIRST
                   2082 GNM25:
 0695 E3           2083          XTHL              ; PUT FIRST ON STACK - GET RETURN ADDR
 0696 D5           2084          PUSH    D         ; PUT SECOND ON STACK
 0697 C5           2085          PUSH    B         ; PUT THIRD ON STACK
 0698 E5           2086          PUSH    H         ; PUT RETURN ADDRESS ON STACK
                   2087 GNM30:
 0699 3D           2088          DCR     A         ; DECREMENT RESIDUAL COUNT
 069A F8           2089          RM                ; IF NEGATIVE, PROPER RESULTS ON STACK
 069B E1           2090          POP     H         ; ELSE, GET RETURN ADDR
 069C E3           2091          XTHL              ; REPLACE TOP RESULT WITH RETURN ADDR
 069D C39906       2092          JMP     GNM30     ; TRY AGAIN
                   2093 ;
                   2094 ;
                   2095 ;*****************************************************************
                   2096 ;
                   2097 ;
                   2098 ; FUNCTION: HILO
                   2099 ; INPUTS: DE - 16 BIT INTEGER
                   2100 ;         HL - 16 BIT INTEGER
                   2101 ; OUTPUTS: CARRY - 0 IF HL<DE
                   2102 ;                 1 IF HL>=DE
                   2103 ; CALLS: NOTHING
                   2104 ; DESTROYS: F/F'S
                   2105 ; DESCRIPTION: HILO COMPARES THE 2 16 BIT INTEGERS IN HL AND DE.  THE
                   2106 ;              INTEGERS ARE TREATED AS UNSIGNED NUMBERS.  THE CARRY
                   2107 ;              BIT IS SET ACCORDING TO THE RESULT OF THE COMPARISON.
                   2108 ;
                   2109 HILO:
 06A0 C5           2110          PUSH    B         ; SAVE BC
 06A1 47           2111          MOV     B,A       ; SAVE A IN B REGISTER
 06A2 E5           2112          PUSH    H         ; SAVE HL PAIR
 06A3 7A           2113          MOV     A,D       ; CHECK FOR DE = 0000H
 06A4 B3           2114          ORA     E
 06A5 CAC106       2115          JZ      HIL05     ; WE'RE AUTOMATICALLY DONE IF IT IS
 06A8 23           2116          INX     H         ; INCREMENT HL BY 1
 06A9 7C           2117          MOV     A,H       ; WANT TO TEST FOR 0 RESULT AFTER
 06AA B5           2118          ORA     L         ; /INCREMENTING
 06AB CAC106       2119          JZ      HIL05     ; IF SO, HL MUST HAVE CONTAINED 0FFFFH
 06AE E1           2120          POP     H         ; IF NOT, RESTORE ORIGINAL HL
 06AF D5           2121          PUSH    D         ; SAVE DE
 06B0 3EFF         2122          MVI     A,0FFH    ; WANT TO TAKE 2'S COMPLEMENT OF DE CONTENTS
 06B2 AA           2123          XRA     D
 06B3 57           2124          MOV     D,A
 06B4 3EFF         2125          MVI     A,0FFH
 06B6 AB           2126          XRA     E
 06B7 5F           2127          MOV     E,A
 06B8 13           2128          INX     D         ; 2'S COMPLEMENT OF DE TO DE
 06B9 7D           2129          MOV     A,L
 06BA 83           2130          ADD     E         ; ADD HL AND DE
 06BB 7C           2131          MOV     A,H
 06BC 8A           2132          ADC     D         ; THIS OPERATION SETS CARRY PROPERLY
 06BD D1           2133          POP     D         ; RESTORE ORIGINAL DE CONTENTS
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LOC  OBJ          SEQ          SOURCE STATEMENT

06BE 78           2134           MOV     A,B      ; RESTORE ORIGINAL CONTENTS OF A
06BF C1           2135           POP     B        ; RESTORE ORIGINAL CONTENTS OF BC
06C0 C9           2136           RET              ; RETURN WITH CARRY SET AS REQUIRED
                  2137 HIL05:
06C1 E1           2138           POP     H        ; IF HL CONTAINS 0FFFFH, THEN CARRY CAN
06C2 78           2139           MOV     A,B      ;  /ONLY BE SET TO 1
06C3 C1           2140           POP     B        ; RESTORE ORIGINAL CONTENTS OF REGISTERS
06C4 C33207       2141           JMP     SRET     ; SET CARRY AND RETURN
                  2142 ;
                  2143 ;
                  2144 ;*****************************************************************************
                  2145 ;
                  2146 ;
                  2147 ; FUNCTION: NMOUT
                  2148 ; INPUTS: A - 8 BIT INTEGER
                  2149 ; OUTPUTS: NONE
                  2150 ; CALLS: ECHO,PRVAL
                  2151 ; DESTROYS: A,B,C,F/F'S
                  2152 ; DESCRIPTION: NNMOUT CONVERTS THE 8 BIT, UNSIGNED INTEGER IN THE
                  2153 ;              A REGISTER INTO 2 ASCII CHARACTERS.  THE ASCII CHARACTERS
                  2154 ;              ARE THE ONES REPRESENTING THE 8 BITS.  THESE TWO
                  2155 ;              CHARACTERS ARE SENT TO THE CONSOLE AT THE CURRENT PRINT
                  2156 ;              POSITION OF THE CONSOLE.
                  2157 ;
                  2158 NMOUT:
06C7 E5           2159           PUSH    H        ; SAVE HL - DESTROYED BY PRVAL
06C8 F5           2160           PUSH    PSW      ; SAVE ARGUMENT
06C9 0F           2161           RRC
06CA 0F           2162           RRC
06CB 0F           2163           RRC
06CC 0F           2164           RRC              ; GET UPPER 4 BITS TO LOW 4 BIT POSITIONS
06CD E60F         2165           ANI     HCHAR    ; MASK OUT UPPER 4 BITS - WANT 1 HEX CHAR
06CF 4F           2166           MOV     C,A
06D0 CDE206       2167           CALL    PRVAL    ; CONVERT LOWER 4 BITS TO ASCII
06D3 CDF805       2168           CALL    ECHO     ; SEND TO TERMINAL
06D6 F1           2169           POP     PSW      ; GET BACK ARGUMENT
06D7 E60F         2170           ANI     HCHAR    ; MASK OUT UPPER 4 BITS - WANT 1 HEX CHAR
06D9 4F           2171           MOV     C,A
06DA CDE206       2172           CALL    PRVAL
06DD CDF805       2173           CALL    ECHO
06E0 E1           2174           POP     H        ; RESTORE SAVED VALUE OF HL
06E1 C9           2175           RET
                  2176 ;
                  2177 ;
                  2178 ;*****************************************************************************
                  2179 ;
                  2180 ;
                  2181 ; FUNCTION;  PRVAL
                  2182 ; INPUTS: C - INTEGER, RANGE 0 TO F
                  2183 ; OUTPUTS: C - ASCII CHARACTER
                  2184 ; CALLS: NOTHING
                  2185 ; DESTROYS: B,C,H,L,F/F'S
                  2186 ; DESCRIPTION: PRVAL CONVERTS A NUMBER IN THE RANGE 0 TO F HEX TO
                  2187 ;              THE CORRESPONDING ASCII CHARACTER, 0-9,A-F.  PRVAL
                  2188 ;              DOES NOT CHECK THE VALIDITY OF ITS INPUT ARGUMENT.
                  2189 ;
                  2190 PRVAL:
06E2 21B407       2191           LXI     H,DIGTB ; ADDRESS OF TABLE
06E5 0600         2192           MVI     B,0     ; CLEAR HIGH ORDER BITS OF BC
06E7 09           2193           DAD     B       ; ADD DIGIT VALUE TO HL ADDRESS
06E8 4E           2194           MOV     C,M     ; FETCH CHARACTER FROM MEMORY
06E9 C9           2195           RET
                  2196 ;
                  2197
                  2198 ;*****************************************************************************
                  2199 ;
                  2200 ;
                  2201 ; FUNCTION: REGDS
                  2202 ; INPUTS: NONE
                  2203 ; OUTPUTS: NONE
                  2204 ; CALLS: ECHO,NMOUT,ERROR,CROUT
                  2205 ; DESTROYS: A,B,C,D,E,H,L,F/F'S
                  2206 ; DESCRIPTION: REGDS DISPLAYS THE CONTENTS OF THE REGISTER SAVE
                  2207 ;              LOCATIONS, IN FORMATTED FORM, ON THE CONSOLE.  THE
                  2208 ;              DISPLAY IIS DRIVEN FROM A TABLE, RTAB, WHICH CONTAINS
                  2209 ;              THE REGISTER'S PRINT SYMBOL, SAVE LOCATION ADDRESS,
                  2210 ;              AND LENGTH (8 OR 16 BITS).
                  2211 ;
                  2212 REGDS:
06EA 21C407       2213           LXI     H,RTAB  ; LOAD HL WITH ADDRESS OF START OF TABLE
                  2214 REG05:
06ED 4E           2215           MOV     C,M     ; GET PRINT SYMBOL OF REGISTER
06EE 79           2216           MOV     A,C
06EF B7           2217           ORA     A       ; TEST FOR 0 - END OF TABLE
06F0 C2F706       2218           JNZ     REG10   ; IF NOT END, BRANCH
06F3 CDEB05       2219           CALL    CROUT   ; ELSE, CARRIAGE RETURN/LINE FEED TO END
06F6 C9           2220           RET             ; /DISPLAY
                  2221 REG10:
06F7 CDF805       2222           CALL    ECHO    ; ECHO CHARACTER
06FA 0E3D         2223           MVI     C,'='
06FC CDF805       2224           CALL    ECHO    ; OUTPUT EQUALS SIGN, I.E. A=
06FF 23           2225           INX     H       ; POINT TO START OF SAVE LOCATION ADDRESS
0700 5E           2226           MOV     E,M     ; GET LSP OF SAVE LOCATION ADDRESS TO E
0701 1620         2227           MVI     D,RAMST SHR 8    ; PUT MSP OF SAVE LOC ADDRESS INTO D
0703 23           2228           INX     H       ; POINT TO LENGTH FLAG
0704 1A           2229           LDAX    D       ; GET CONTENTS OF SAVE ADDRESS
0705 CDC706       2230           CALL    NMOUT   ; DISPLAY ON CONSOLE
0708 7E           2231           MOV     A,M     ; GET LENGTH FLAG
0709 B7           2232           ORA     A       ; SET SIGN F/F
070A CA1207       2233           JZ      REG15   ; IF 0, REGISTER IS 8 BITS
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LOC  OBJ        SEQ         SOURCE STATEMENT

070D 1B         2234          DCX     D       ; ELSE, 16 BIT REGISTER SO MORE TO DISPLAY
070E 1A         2235          LDAX    D       ; GET LOWER 8 BITS
070F CDC706     2236          CALL    NMOUT   ; DISPLAY THEM
                2237 REG15:
0712 0E20       2238          MVI     C,' '
0714 CDF805     2239          CALL    ECHO
0717 23         2240          INX     H       ; POINT TO START OF NEXT TABLE ENTRY
0718 C3ED06     2241          JMP     REG05   ; DO NEXT REGISTER
                2242 ;
                2243 ;
                2244 ;*****************************************************************
                2245 ;
                2246 ;
                2247 ; FUNCTION: RGADR
                2248 ; INPUTS: C - CHARACTER DENOTING REGISTER
                2249 ; OUTPUTS: BC - ADDRESS OF ENTRY IN RTAB CORRESPONDING TO REGISTER
                2250 ; CALLS: ERROR
                2251 ; DESTROYS: A,B,C,D,E,H,L,F/F'S
                2252 ; DESCRIPTION: RGADR TAKES A SINGLE CHARACTER AS INPUT.  THIS CHARACTER
                2253 ;              DENOTES A REGISTER.  RGADR SEARCHES THE TABLE RTAB
                2254 ;              FOR A MATCH ON THE INPUT ARGUMENT.  IF ONE OCCURS,
                2255 ;              RGADR RETURNS THE ADDRESS OF THE ADDRESS OF THE
                2256 ;              SAVE LOCATION CORRESPONDING TO THE REGISTER.  THIS
                2257 ;              ADDRESS POINTS INTO RTAB.  IF NO MATCH OCCURS, THEN
                2258 ;              THE REGISTER IDENTIFIER IS ILLEGAL AND CONTROL IS
                2259 ;              PASSED TO THE ERROR ROUTINE.
                2260 ;
                2261 RGADR:
071B 21C407     2262          LXI     H,RTAB  ; HL GETS ADDRESS OF TABLE START
071E 110300     2263          LXI     D,RTABS ; DE GET SIZE OF A TABLE ENTRY
                2264 RGA05:
0721 7E         2265          MOV     A,M     ; GET REGISTER IDENTIFIER
0722 B7         2266          ORA     A       ; CHECK FOR TABLE END (IDENTIFIER IS 0)
0723 CA1106     2267          JZ      ERROR   ; IF AT END OF TABLE, ARGUMENT IS ILLEGAL
0726 B9         2268          CMP     C       ; ELSE, COMPARE TABLE ENTRY AND ARGUMENT
0727 CA2E07     2269          JZ      RGA10   ; IF EQUAL, WE'VE FOUND WHAT WE'RE LOOKING FOR
072A 19         2270          DAD     D       ; ELSE, INCREMENT TABLE POINTER TO NEXT ENTRY
072B C32107     2271          JMP     RGA05   ; TRY AGAIN
                2272 RGA10:
072E 23         2273          INX     H       ; IF A MATCH, INCREMENT TABLE POINTER TO
072F 44         2274          MOV     B,H     ; /SAVE LOCATION ADDRESS
0730 4D         2275          MOV     C,L     ; RETURN THIS VALUE
0731 C9         2276          RET
                2277 ;
                2278 ;
                2279 ;*****************************************************************
                2280 ;
                2281 ;
                2282 ; FUNCTION: SRET
                2283 ; INPUTS: NONE
                2284 ; OUTPUTS: CARRY = 1
                2285 ; CALLS: NOTHING
                2286 ; DESTROYS: CARRY
                2287 ; DESCRIPTION: SRET IS JUMPED TO BY ROUTINES WISHING TO RETURN SUCCESS.
                2288 ;              SRET SETS THE CARRY TRUE AND THEN RETURNS TO THE
                2289 ;              CALLER OF THE ROUTINE INVOKING SRET.
                2290 ;
                2291 SRET:
0732 37         2292          STC             ; SET CARRY TRUE
0733 C9         2293          RET             ; RETURN APPROPRIATELY
                2294 ;
                2295 ;
                2296 ;*****************************************************************
                2297 ;
                2298 ;
                2299 ; FUNCTION: STHF0
                2300 ; INPUTS: DE - 16 BIT ADDRESS OF BYTE TO BE STORED INTO
                2301 ; OUTPUTS: NONE
                2302 ; CALLS: STHLF
                2303 ; DESTROYS: A,B,C,H,L,F/F'S
                2304 ; DESCRIPTION: STHF0 CHECKS THE HALF BYTE FLAG IN TEMP TO SEE IF
                2305 ;              IT IS SET TO LOWER.  IF SO, STHF0 STORES A 0 TO
                2306 ;              PAD OUT THE LOWER HALF OF THE ADDRESSED BYTE;
                2307 ;              OTHERWISE, THE ROUTINE TAKES NO ACTION.
                2308 ;
                2309 STHF0:
0734 3AFD20     2310          LDA     TEMP    ; GET HALF BYTE FLAG
0737 B7         2311          ORA     A       ; SET F/F'S
0738 C0         2312          RNZ             ; IF SET TO UPPER, DON'T DO ANYTHING
0739 0E00       2313          MVI     C,0     ; ELSE, WANT TO STORE THE VALUE 0
073B CD3F07     2314          CALL    STHLF   ; DO IT
073E C9         2315          RET
                2316 ;
                2317 ;
                2318 ;*****************************************************************
                2319 ;
                2320 ;
                2321 ; FUNCTION: STHLF
                2322 ; INPUTS: C - 4 BIT VALUE TO BE STORED IN HALF BYTE
                2323 ;         DE - 16 BIT ADDRESS OF BYTE TO BE STORED INTO
                2324 ; OUTPUTS: NONE
                2325 ; CALLS: NOTHING
                2326 ; DESTROYS: A,B,C,H,L,F/F'S
                2327 ; DESCRIPTION: STHLF TAKES THE 4 BIT VALUE IN C AND STORES IT IN
                2328 ;              HALF OF THE BYTE ADDRESSED BY REGISTERS DE.  THE
                2329 ;              HALF BYTE USED (EITHER UPPER OR LOWER) IS DENOTED
                2330 ;              BY THE VALUE OF THE FLAG IN TEMP.  STHLF ASSUMES
                2331 ;              THAT THIS FLAG HAS BEEN PREVIOUSLY SET
                2332 ;              (NOMINALLY BY ICMD).
                2333 ;
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LOC  OBJ          SEQ          SOURCE STATEMENT

                  2334 STHLF:
073F D5           2335         PUSH    D
0740 E1           2336         POP     H          ; MOVE ADDRESS OF BYTE INTO HL
0741 79           2337         MOV     A,C        ; GET VALUE
0742 E60F         2338         ANI     0FH        ; FORCE TO 4 BIT LENGTH
0744 4F           2339         MOV     C,A        ; PUT VALUE BACK
0745 3AFD20       2340         LDA     TEMP       ; GET HALF BYTE FLAG
0748 B7           2341         ORA     A          ; CHECK FOR LOWER HALF
0749 C25207       2342         JNZ     STH05      ; BRANCH IF NOT
074C 7E           2343         MOV     A,M        ; ELSE, GET BYTE
074D E6F0         2344         ANI     0F0H       ; CLEAR LOWER 4 BITS
074F B1           2345         ORA     C          ; OR IN VALUE
0750 77           2346         MOV     M,A        ; PUT BYTE BACK
0751 C9           2347         RET
                  2348 STH05:
0752 7E           2349         MOV     A,M        ; IF UPPER HALF, GET BYTE
0753 E60F         2350         ANI     0FH        ; CLEAR UPPER 4 BITS
0755 47           2351         MOV     B,A        ; SAVE BYTE IN B
0756 79           2352         MOV     A,C        ; GET VALUE
0757 0F           2353         RRC
0758 0F           2354         RRC
0759 0F           2355         RRC
075A 0F           2356         RRC                ; ALIGN TO UPPER 4 BITS
075B B0           2357         ORA     B          ; OR IN ORIGINAL LOWER 4 BITS
075C 77           2358         MOV     M,A        ; PUT NEW CONFIGURATION BACK
075D C9           2359         RET
                  2360 ;
                  2361 ;
                  2362 ;*****************************************************************
                  2363 ;
                  2364 ;
                  2365 ; FUNCTION: VALDG
                  2366 ; INPUTS: C - ASCII CHARACTER
                  2367 ; OUTPUTS: CARRY - 1 IF CHARACTER REPRESENTS VALID HEX DIGIT
                  2368 ;                - 0 OTHERWISE
                  2369 ; CALLS: NOTHING
                  2370 ; DESTROYS: A,F/F'S
                  2371 ; DESCRIPTION: VALDG RETURNS SUCCESS IF ITS INPUT ARGUMENT IS
                  2372 ;              AN ASCII CHARACTER REPRESENTING A VALID HEX DIGIT
                  2373 ;              (0-9,A-F), AND FAILURE OTHERWISE.
                  2374 ;
                  2375 VALDG:
075E 79           2376         MOV     A,C
075F FE30         2377         CPI     '0'        ; TEST CHARACTER AGAINST '0'
0761 FA1C06       2378         JM      FRET       ; IF ASCII CODE LESS, CANNOT BE VALID DIGIT
0764 FE39         2379         CPI     '9'        ; ELSE, SEE IF IN RANGE '0'-'9'
0766 FA3207       2380         JM      SRET       ; CODE BETWEEN '0' AND '9'
0769 CA3207       2381         JZ      SRET       ; CODE EQUAL '9'
076C FE41         2382         CPI     'A'        ; NOT A DIGIT - TRY FOR A LETTER
076E FA1C06       2383         JM      FRET       ; NO - CODE BETWEEN '9' AND 'A'
0771 FE47         2384         CPI     'G'
0773 F21C06       2385         JP      FRET       ; NO - CODE GREATER THAN 'F'
0776 C33207       2386         JMP     SRET       ; OKAY - CODE IS 'A' TO 'F', INCLUSIVE
                  2387 ;
                  2388 ;
                  2389 ;*************************************************************************
                  2390 ;
                  2391 ;
                  2392 ; FUNCTION: VALDL
                  2393 ; INPUTS: C - CHARACTER
                  2394 ; OUTPUTS: CARRY - 1 IF INPUT ARGUMENT VALID DELIMTER
                  2395 ;                - 0 OTHERWISE
                  2396 ; CALLS: NOTHING
                  2397 ; DESTROYS: A,F/F'S
                  2398 ; DESCRIPTION: VALDL RETURNS SUCCESS IF ITS INPUT ARGUMENT IS A VALID
                  2399 ;              DELIMITER CHARACTER (SPACE, COMMA, CARRIAGE RETURN) AND
                  2400 ;              FAILURE OTHERWISE.
                  2401 ;
                  2402 VALDL:
0779 79           2403         MOV     A,C
077A FE2C         2404         CPI     ','        ; CHECK FOR COMMA
077C CA3207       2405         JZ      SRET
077F FE0D         2406         CPI     CR         ; CHECK FOR CARRIAGE RETURN
0781 CA3207       2407         JZ      SRET
0784 FE20         2408         CPI     ' '        ; CHECK FOR SPACE
0786 CA3207       2409         JZ      SRET
0789 C31C06       2410         JMP     FRET       ; ERROR IF NONE OF THE ABOVE
                  2411 ;
                  2412 ;
                  2413 ;*****************************************************************
                  2414 ;
                  2415 ;
                  2416 ;                          MONITOR TABLES
                  2417 ;
                  2418 ;
                  2419 ;*****************************************************************
                  2420 ;
                  2421 ;
                  2422 SGNON:                    ; SIGNON MESSAGE
078C 0D           2423         DB      CR,LF,'SDK-85   VER 2.1',CR,LF
078D 0A
078E 53444B2D
0792 38352020
0796 20564552
079A 20322E31
079E 0D
079F 0A
0014              2424 LSGNON  EQU     $-SGNON ; LENGTH OF SIGNON MESSAGE
                  2425 ;
                  2426 CADR:                   ; TABLE OF ADDRESSES OF COMMAND ROUTINES
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LOC  OBJ          SEQ          SOURCE STATEMENT

 07A0 0000        2427          DW      0       ; DUMMY
 07A2 1405        2428          DW      XCMD
 07A4 F004        2429          DW      SCMD
 07A6 D004        2430          DW      MCMD
 07A8 8604        2431          DW      ICMD
 07AA 6804        2432          DW      GCMD
 07AC 3704        2433          DW      DCMD
                  2434 ;
                  2435 CTAB:                    ; TABLE OF VALID COMMAND CHARACTERS
 07AE 44          2436          DB      'D'
 07AF 47          2437          DB      'G'
 07B0 49          2438          DB      'I'
 07B1 4D          2439          DB      'M'
 07B2 53          2440          DB      'S'
 07B3 58          2441          DB      'X'
 0006             2442 NCMDS    EQU     $-CTAB  ; NUMBER OF VALID COMMANDS
                  2443 ;
                  2444 DIGTB:                   ; TABLE OF PRINT VALUES OF HEX DIGITS
 07B4 30          2445          DB      '0'
 07B5 31          2446          DB      '1'
 07B6 32          2447          DB      '2'
 07B7 33          2448          DB      '3'
 07B8 34          2449          DB      '4'
 07B9 35          2450          DB      '5'
 07BA 36          2451          DB      '6'
 07BB 37          2452          DB      '7'
 07BC 38          2453          DB      '8'
 07BD 39          2454          DB      '9'
 07BE 41          2455          DB      'A'
 07BF 42          2456          DB      'B'
 07C0 43          2457          DB      'C'
 07C1 44          2458          DB      'D'
 07C2 45          2459          DB      'E'
 07C3 46          2460          DB      'F'
                  2461 ;
                  2462 RTAB:                    ; TABLE OF REGISTER INFORMATION
 07C4 41          2463          DB      'A'     ; REGISTER IDENTIFIER
 07C5 EE          2464          DB      ASAV AND 0FFH   ; ADDRESS OF REGISTER SAVE LOCATION
 07C6 00          2465          DB      0       ; LENGTH FLAG - 0=8 BITS, 1=16 BITS
 0003             2466 RTABS    EQU     $-RTAB  ; SIZE OF AN ENTRY IN THIS TABLE
 07C7 42          2467          DB      'B'
 07C8 EC          2468          DB      BSAV AND 0FFH
 07C9 00          2469          DB      0
 07CA 43          2470          DB      'C'
 07CB EB          2471          DB      CSAV AND 0FFH
 07CC 00          2472          DB      0
 07CD 44          2473          DB      'D'
 07CE EA          2474          DB      DSAV AND 0FFH
 07CF 00          2475          DB      0
 07D0 45          2476          DB      'E'
 07D1 E9          2477          DB      ESAV AND 0FFH
 07D2 00          2478          DB      0
 07D3 46          2479          DB      'F'
 07D4 ED          2480          DB      FSAV AND 0FFH
 07D5 00          2481          DB      0
 07D6 49          2482          DB      'I'
 07D7 F1          2483          DB      ISAV AND 0FFH
 07D8 00          2484          DB      0
 07D9 48          2485          DB      'H'
 07DA F0          2486          DB      HSAV AND 0FFH
 07DB 00          2487          DB      0
 07DC 4C          2488          DB      'L'
 07DD EF          2489          DB      LSAV AND 0FFH
 07DE 00          2490          DB      0
 07DF 4D          2491          DB      'M'
 07E0 F0          2492          DB      HSAV AND 0FFH
 07E1 01          2493          DB      1
 07E2 53          2494          DB      'S'
 07E3 F5          2495          DB      SSAV+1 AND 0FFH
 07E4 01          2496          DB      1
 07E5 50          2497          DB      'P'
 07E6 F3          2498          DB      PSAV+1 AND 0FFH
 07E7 01          2499          DB      1
 07E8 00          2500          DB      0       ; END OF TABLE MARKERS
 07E9 00          2501          DB      0
                  2502 ;
 07FA             2503          ORG     BRTAB   ; BRANCH TABLE FOR USER ACCESSIBLE ROUTINES
                  2504 ;
 07FA C3C405      2505          JMP     CO      ; TTY CONSOLE OUTPUT
 07FD C39005      2506          JMP     CI      ; TTY CONSOLE  INPUT
                  2507
                  2508 ;*****************************************************************
                  2509 ;
                  2510 ; IN THE FOLLOWING LOCATIONS, THE USER MAY PLACE JUMP INSTRUCTIONS TO
                  2511 ; ROUTINES FOR HANDLING THE FOLLOWING:-
                  2512 ;       A) RST 5,6 & 7 INSTRUCTIONS
                  2513 ;       B) HARDWIRED USER INTERRUPT (RST 6.5)
                  2514 ;       C) KEYBOARD "VECTORED INTERRUPT" KEY (RST 7.5)
                  2515 ;
 20C2             2516          ORG     USRBR   ; START OF USER BRANCH LOCATIONS
                  2517 ;
 20C2 00          2518 RSET5:   DB      0,0,0   ; JUMP TO RST 5 ROUTINE
 20C3 00
 20C4 00
 20C5 00          2519 RSET6:   DB      0,0,0   ; JUMP TO RST 6 ROUTINE
 20C6 00
 20C7 00
 20C8 00          2520 RST65:   DB      0,0,0   ; JUMP TO RST 6.5 (HARDWIRED USER INTERRUPT)
 20C9 00
 20CA 00
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LOC  OBJ          SEQ          SOURCE STATEMENT

 20CB 00           2521 RSET7:  DB      0,0,0   ; JUMP TO RST 7 ROUTINE
 20CC 00
 20CD 00
 20CE 00           2522 USINT:  DB      0,0,0   ; JUMP TO "VECTORED INTERRUPT" KEY ROUTINE
 20CF 00
 20D0 00
                   2523 ;
                   2524 ;*****************************************************************
                   2525 ;
                   2526 ; SPACE IS RESERVED HERE FOR THE MONITOR STACK
                   2527 ;
                   2528 ;*****************************************************************
                   2529 ;
 20E9              2530         ORG     MNSTK   ; START OF MONITOR STACK
                   2531 ;
                   2532 ;       SAVE LOCATIONS FOR USER REGISTERS
                   2533 ;
 20E9 00           2534 ESAV:   DB      0       ; E REGISTER
 20EA 00           2535 DSAV:   DB      0       ; D REGISTER
 20EB 00           2536 CSAV:   DB      0       ; C REGISTER
 20EC 00           2537 BSAV:   DB      0       ; B REGISTER
 20ED 00           2538 FSAV:   DB      0       ; FLAGS
 20EE 00           2539 ASAV:   DB      0       ; A REGISTER
 20EF 00           2540 LSAV:   DB      0       ; L REGISTER
 20F0 00           2541 HSAV:   DB      0       ; H REGISTER
 20F1 00           2542 ISAV:   DB      0       ; INTERRUPT MASK
                   2543 PSAV:                   ; PROGRAM COUNTER
 20F2 00           2544 PCLSV:  DB      0       ;   LOW ORDER BYTE
 20F3 00           2545 PCHSV:  DB      0       ;   HIGH ORDER BYTE
                   2546 SSAV:                   ; STACK POINTER
 20F4 00           2547 SPLSV:  DB      0       ;   LOW ORDER BYTE
 20F5 00           2548 SPHSV:  DB      0       ;   HIGH ORDER BYTE
                   2549 ;
                   2550 ;*****************************************************************
                   2551 ;
                   2552 ; MONITOR STORAGE LOCATIONS
                   2553 ;
 20F6 0000         2554 CURAD:  DW      0       ; CURRENT ADDRESS
 20F8 00           2555 CURDT:  DB      0       ; CURRENT DATA
 0004              2556 OBUFF:  DS      4       ; OUTPUT BUFFER
                   2557 TEMP:                   ; TEMPORARY LOCATION FOR TTY MONITOR
                   2558                         ; TEMPORARY LOCATION FOR SINGLE STEP ROUTINE
 20FD 00           2559 RGPTR:  DB      0       ; REGISTER POINTER
 20FE 00           2560 IBUFF:  DB      0       ; INPUT BUFFER
 20FF 00           2561 USCSR:  DB      0       ; USER SHOULD STORE IMAGE OF CSR HERE EACH TIME
                   2562                         ; /CSR IS CHANGED. OTHERWISE, SINGLE STEP
                   2563                         ; /ROUTINE WILL DESTROY CSR CONTENTS.
                   2564         END

PUBLIC SYMBOLS

EXTERNAL SYMBOLS

USER SYMBOLS

ADFLD  A 0000   ADISP  A 0090   ASAV   A 20EE   BLANK  A 0015   BLNKS  A 039A   BRCHR  A 001B   BRTAB  A 07FA
BSAV   A 20EC   CADR   A 07A0   CI     A 0590   CI05   A 0592   CI10   A 05A1   CLDBK  A 0008   CLDIS  A 01E9
CLDST  A 01F1   CLEAR  A 01D7   CMD10  A 007B   CMD15  A 0087   CMDAD  A 037C   CMDTB  A 0378   CMMND  A 0066
CNTRL  A 1900   CNVBN  A 05BB   CO     A 05C4   CO05   A 05CB   COMMA  A 0011   CR     A 000D   CROUT  A 05EB
CSAV   A 20EB   CSNIT  A 0000   CSR    A 0020   CTAB   A 07AE   CURAD  A 20F6   CURDT  A 20F8   DCM05  A 043E
DCM10  A 0449   DCM15  A 045E   DCMD   A 0437   DDISP  A 0094   DELAY  A 05F1   DIGTB  A 07B4   DISPC  A 0200
DOT    A 0001   DSAV   A 20EA   DSPLY  A 1800   DSPTB  A 0384   DTFLD  A 0001   DTMSK  A 0008   ECH05  A 0601
ECH10  A 060F   ECHO   A 05F8   EIGHT  A 0008   EMPTY  A 0080   ERMSG  A 039E   ERR    A 0215   ERROR  A 0611
ESAV   A 20E9   ESC    A 001B   EXAM   A 0092   EXM05  A 009D   EXM10  A 00B8   EXMSG  A 03A2   FALSE  + 0001
FIVE   A 0005   FRET   A 061C   FSAV   A 20ED   G10    A 00EC   GCM05  A 047D   GCM10  A 0483   GCMD   A 0468
GETCH  A 061F   GETCM  A 0408   GETHX  A 0626   GETNM  A 065B   GHX05  A 062C   GHX10  A 0645   GNM05  A 0662
GNM10  A 0677   GNM15  A 0685   GNM20  A 068A   GNM25  A 0695   GNM30  A 0699   GO     A 03FA   GOCMD  A 00CB
GTC03  A 0414   GTC05  A 0421   GTC10  A 042D   GTH05  A 0232   GTH10  A 0249   GTH20  A 0255   GTH25  A 0267
GTHEX  A 022B   HCHAR  A 000F   HIL05  A 06C1   HILO   A 06A0   HSAV   A 20F0   HXDSP  A 026C   IBTIM  A 048C
IBUFF  A 20FE   ICM05  A 0491   ICM10  A 04B9   ICM20  A 04C1   ICM25  A 04C7   ICMD   A 0486   ININT  A 028E
INSDG  A 029F   INVRT  A 00FF   ISAV   A 20F1   KBNIT  A 00CC   KMODE  A 0000   LETRA  A 000A   LETRB  A 000B
LETRC  A 000C   LETRD  A 000D   LETRE  A 000E   LETRF  A 000F   LETRH  A 0010   LETRI  A 0013   LETRL  A 0011
LETRP  A 0012   LETRR  A 0014   LETRS  A 0005   LF     A 000A   LOWER  A 0000   LSAV   A 20EF   LSGNON A 0014
MCM05  A 04D8   MCMD   A 04D0   MNSTK  A 20E9   MSGL   A 03FF   NCMDS  A 0006   NEWLN  A 000F   NMOUT  A 06C7
NMTBL  A 03B9   NODOT  A 0000   NUMC   A 0004   NUMRG  A 000D   NXTRG  A 02A8   OBTIM  A 048C   OBUFF  A 20F9
OUT05  A 02C2   OUT10  A 02C6   OUT15  A 02C9   OUT20  A 02DC   OUTPT  A 02B7   PCHSV  A 20F3   PCLSV  A 20F2
PERIO  A 0010   PRMPT  A 00FB   PRTY0  A 007F   PRVAL  A 06E2   PSAV   A 20F2   RAMST  A 2000   RDK10  A 02F3
RDKBD  A 02E7   READ   A 0040   REG05  A 06ED   REG10  A 06F7   REG15  A 0712   REGDS  A 06EA   RES10  A 003F
RETF   A 02F7   RETT   A 02FA   RGA05  A 0721   RGA10  A 072E   RGADR  A 071B   RGLOC  A 02FC   RGNAM  A 0309
RGPTB  A 03AC   RGPTR  A 20FD   RGTBL  A 03ED   RMUSE  A 0017   RSET5  A 20C2   RSET6  A 20C5   RSET7  A 20CB
RSR05  A 032D   RSR10  A 0331   RST65  A 20C8   RSTOR  A 031B   RTAB   A 07C4   RTABS  A 0003   SCM05  A 04F5
SCM10  A 0500   SCM15  A 0510   SCMD   A 04F0   SETRG  A 0344   SGNAD  A 03A6   SGNDT  A 03AA   SGNON  A 078C
SKLN   A 0018   SPHSV  A 20F5   SPLSV  A 20F4   SRET   A 0732   SSAV   A 20F4   SSTEP  A 00FD   SSTRT  A 0080
STH05  A 0752   STHF0  A 0734   STHLF  A 073F   STOPB  A 0040   STP20  A 0126   STP21  A 013B   STP22  A 0142
STP23  A 0145   STP25  A 0157   STRT   A 00C0   SUB05  A 019C   SUB10  A 01C4   SUB15  A 01CF   SUBST  A 018B
TEMP   A 20FD   TERM   A 001B   TIM4   A 1230   TIMER  A 00C5   TIMHI  A 0025   TIMLO  A 0024   TMODE  A 0040
TRUE   + 0000   TSTRT  A 00C0   UBRLN  A 000F   UNMSK  A 000E   UPDAD  A 035F   UPDDT  A 036B   UPPER  A 00FF
USCSR  A 20FF   USINT  A 20CE   USRBR  A 20C2   VALDG  A 075E   VALDL  A 0779   WAIT   A 0246   WAITS  A 0000
XCM05  A 0527   XCM10  A 0536   XCM15  A 0543   XCM18  A 054E   XCM20  A 0567   XCM25  A 057E   XCM27  A 057F
XCM30  A 0587   XCMD   A 0514   ZERO   A 0000

ASSEMBLY COMPLETE,  NO ERRORS
```

```
ICM05  1543#  1552   1566
ICM10  1561   1563#
ICM20  1555   1567#
ICM25  1549   1570#
ICMD   1537#  2431
ININT   202    751#
INSDG   657    779#
INVRT  1329#  1564
ISAV    226    403    454    994    999   1234   2483   2542#
KBNIT   120#   566
KMODE   122#   166
LETRA  1142#  1207
LETRB  1144#  1208
LETRC  1146#  1209   1218   1219
LETRD  1148#  1210
LETRE  1150#  1172   1173   1211
LETRF  1152#  1212
LETRH  1154#  1214   1216   1218
LETRI  1160#  1213
LETRL  1156#  1215   1217   1219
LETRP  1158#  1216   1217   1218   1219
LETRR  1162#  1172   1172
LETRS  1135#  1216   1217
LF     1330#  1903   2423   2423
LOWER  1331#
LSAV    175    437   1019   1236   2489   2540#
LSGNON 1387   2424#
MCM05  1592#  1609
MCMD   1586#  2430
MNSTK   124#   265   1010   1419   2530
MSGL   1388#  1393
NCMDS  1428   2442#
NEWLN  1336#  1490
NMOUT  1473   1475   1480   1634   1698   1705   2158#  2230   2236
NMTBL   962   1205#
NODOT   125#   244    249    365    368    479    533    550    592    610    614    966
NUMC    273   1108#
NUMRG   807   1241#
NXTRG   334    805#
OBTIM  1351#  1823
OBUFF   716    734   2556#
OUT05   833    838#
OUT10   837    842#
OUT15   844#   864
OUT20   853    855    858#
OUTPT   247    252    370    531    535    612    616    675    831#   967   1071   1092
PCHSV  1239   2545#
PCLSV  1240   2544#
PERIO   128#   330    352    360    385    399    505    682
PRMPT   129#   271
PRTY0  1337#  1961
PRVAL  2167   2172   2190#
PSAV    177    363    398    406    439    586   1017   1513   2498   2543#
RAMST    93#   124    137    942   1690   2227
RDK10   887    890#
RDKBD   272    351    384    652    882#   889   1037
READ    130#   755
REG05  2214#  2241
REG10  2218   2221#
REG15  2233   2237#
REGDS  1664   2212#
RES10   188    223#
RETF    686    808    906#  1039   1044
RETT    811    922#  1051
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RGA10  2269   2272#
RGADR  1668   2261#
RGLOC   318    327    936#
RGNAM   317    957#
RGPTB  1047   1180#
RGPTR   806    810    937    958   1050   2559#
RGTBL   939   1227#  1241
RMUSE    98#   124    137
RSET5   197   2518#
RSET6   207   2519#
RSET7   217   2521#
RSR05  1001   1004#
RSR10  1003   1006   1009#
RST65   212   2520#
RSTOR   371    427    993#  1523
RTAB   2213   2262   2462#  2466
RTABS  1723   2263   2466#
SCM05  1626#  1643
SCM10  1629   1632#
SCM15  1639   1641#
SCMD   1622#  2429
SDK85    71
SETRG   311   1036#
SGNAD   245   1175#
SGNDT   250   1176#
SGNON  1386   2422#  2424
SKLN    101#   137
SPHSV  1237   2548#
SPLSV  1238   2547#
SRET   2007   2141   2291#  2380   2381   2386   2405   2407   2409
SSAV    183    445   1015   2495   2546#
SSTEP   382#   457   1115
SSTRT  1341#  1828
STH05  2342   2348#
STHF0  1568   1571   2309#
STHLF  1558   2314   2334#
STOPB  1342#  1833
STP20   388    402#
```

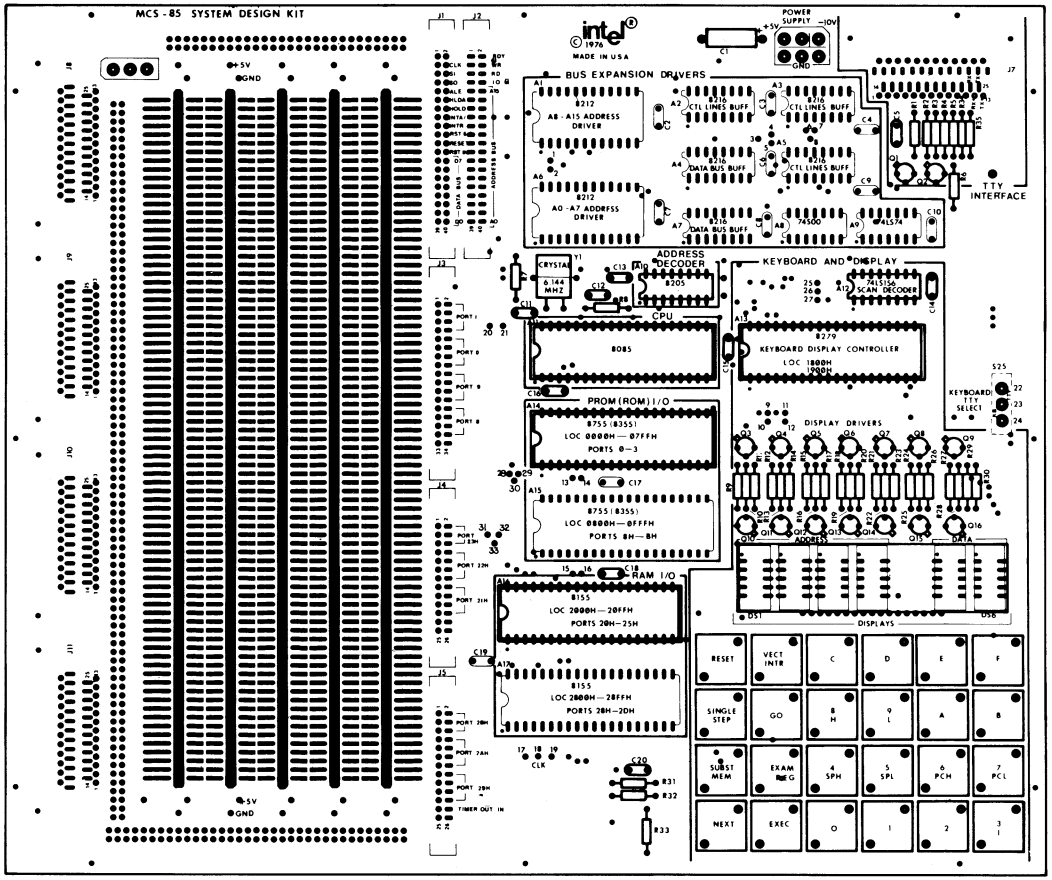
```
STP21   409    412#
STP22   411    416#
STP23   414    418#
STP25   192    429#
STRT   1343#  1819
SUB05   476#   503
SUB10   490    498#
SUB15   478    504#
SUBST   467#  1117
TEMP    405    417    452   1541   1559   1565   1674   1676   1713   1729   2310   2340   2557#
TERM   1344#  1548
TIM4   1352#  1835
TIMER   140#   419    422
TIMHI   132#   421
TIMLO   133#   423
TMODE   134#   419
TRUE    152#   337   1551
TSTRT   135#   425
UBRLN   103#   137
UNMSK   136#   227    455
UPDAD   480    591   1064#
UPDDT   322    485    593   1085#
UPPER  1345#  1540
USCSR   424    432    570   2561#
USINT   221   2522#
USRBR   137#  2516
VALDG  1553   2010   2375#
VALDL  1550   1998   2402#
WAIT   1353#  1761
WAITS    80#   139   1349
XCM05  1663   1666#
XCM10  1675#  1726
XCM15  1678   1681#
XCM18  1684   1687#
XCM20  1702   1706#
XCM25  1717   1720#
XCM27  1722#  1732
XCM30  1711   1727#
XCMD   1657#  2428
ZERO   1128#  1175

CROSS REFERENCE COMPLETE
```

```
RGNAM    317    957#
RGPTB   1047   1180#
RGPTR    806    810    937    958   1050   2559#
RGTBL    939   1227#  1241
RMUSE     98#   124    137
RSET5    197   2518#
RSET6    207   2519#
RSET7    217   2521#
RSR05   1001   1004#
RSR10   1003   1006   1009#
RST65    212   2520#
RSTOR    371    427    993#  1523
RTAB    2213   2262   2462#  2466
RTABS   1723   2263   2466#
SCM05   1626#  1643
SCM10   1629   1632#
SCM15   1639   1641#
SCMD    1622#  2429
SDK85     71
SETRG    311   1036#
SGNAD    245   1175#
SGNDT    250   1176#
SGNON   1386   2422#  2424
SKLN     101#   137
SPHSV   1237   2548#
SPLSV   1238   2547#
SRET    2007   2141   2291#  2380   2381   2386   2405   2407   2409
SSAV     183    445   1015   2495   2546#
SSTEP    382#   457   1115
SSTRT   1341#  1828
STH05   2342   2348#
STHF0   1568   1571   2309#
STHLF   1558   2314   2334#
STOPB   1342#  1833
STP20    388    402#
STP21    409    412#
STP22    411    416#
STP23    414    418#
STP25    192    429#
STRT    1343#  1819
SUB05    476#   503
SUB10    490    498#
SUB15    478    504#
SUBST    467#  1117
TEMP     405    417    452   1541   1559   1565   1674   1676   1713   1729   2310   2340   2557#
TERM    1344#  1548
TIM2    1352#  1835
TIMER    140#   419    422
TIMHI    132#   421
TIMLO    133#   423
TMODE    134#   419
TRUE     152#   337   1551
TSTRT    135#   425
UBRLN    103#   137
UNMSK    136#   227    455
UPDAD    480    591   1064#
UPDDT    322    485    593   1085#
UPPER   1345#  1540
USCSR    424    432    570   2561#
USINT    221   2522#
USRBR    137#  2516
VALDG   1553   2010   2375#
VALDL   1550   1998   2402#
WAIT    1353#  1761
WAITS     80#   139   1349
XCM05   1663   1666#
XCM10   1675#  1726
XCM15   1678   1681#
XCM18   1684   1687#
XCM20   1702   1706#
XCM25   1717   1720#
XCM27   1722#  1732
XCM30   1711   1727#
XCMD    1657#  2428
ZERO    1128#  1175
```

CROSS REFERENCE COMPLETE

APPENDIX B
DIAGRAMS



REVISIONS				
LTR	DESCRIPTION	SIGNATURE AND DATE DFT	CHK	ENGR
A	PROD REL	[illegible] 5/77	5/31/77	6/21/77

ITEM NO.	PART NUMBER	DESCRIPTION
	QUANTITY PER DASH NO.	PARTS LIST

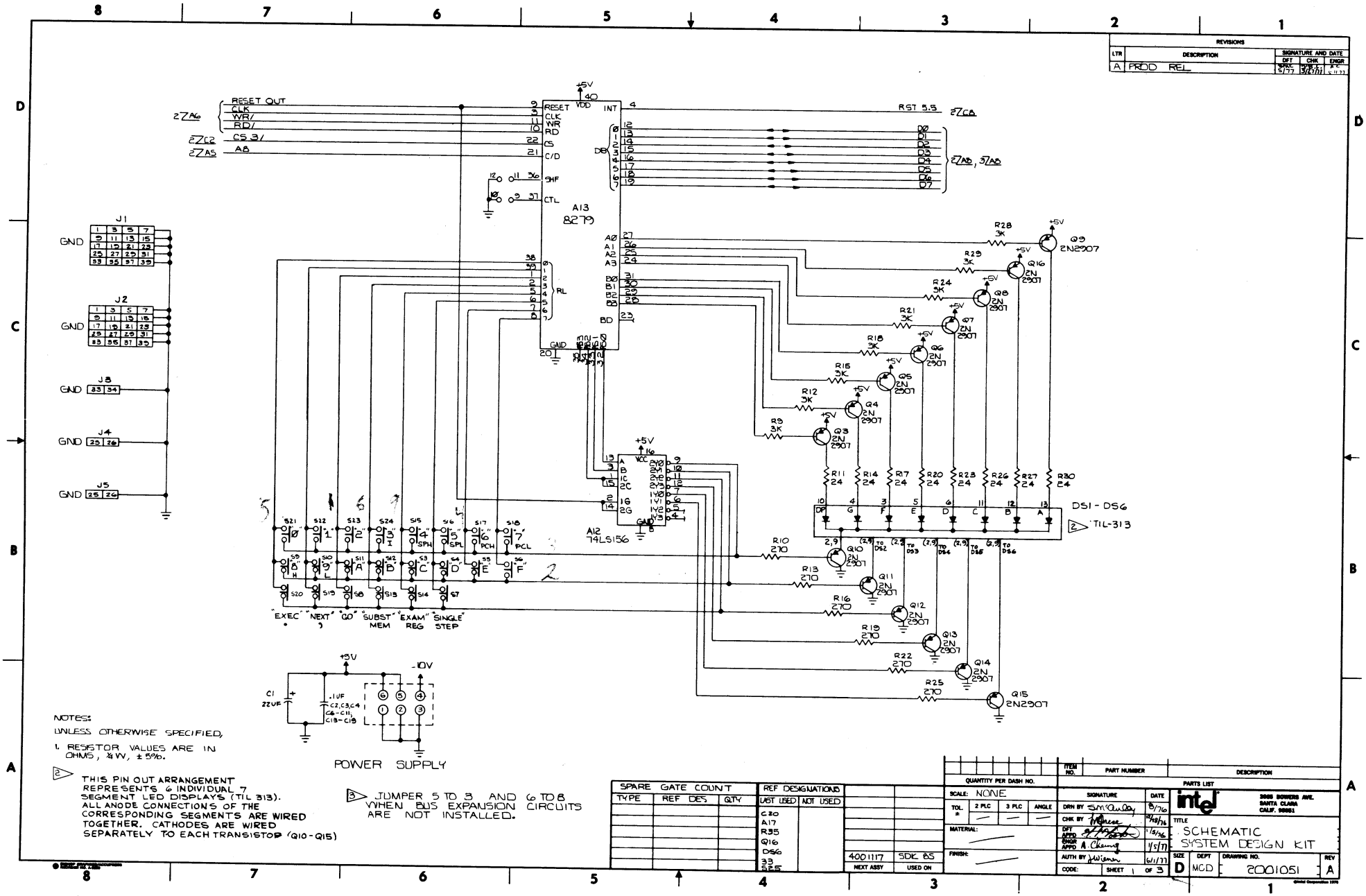
SCALE: NONE	
TOL ± 2 PLC / 3 PLC / ANGLE	
MATERIAL:	
FINISH:	
4001117 NEXT ASSY	SDK 85 USED ON

SIGNATURE	DATE
DRN BY [illegible]	5/77
CHK BY J.B. Chatwin	5/24/77
DFT APPD	
ENGR APPD A. Cheung	6/21/77
AUTH BY [illegible]	6/77
CODE: SHEET 1 OF 1	

intel 3065 BOWERS AVE. SANTA CLARA CALIF. 95051

TITLE: PWA SYSTEM DESIGN KIT

SIZE	DEPT	DRAWING NO.	REV
D	416	1001119	A



NOTES:

UNLESS OTHERWISE SPECIFIED,

1. RESISTOR VALUES ARE IN OHMS, ¼W, ±5%.

2. THIS PIN OUT ARRANGEMENT REPRESENTS 6 INDIVIDUAL 7 SEGMENT LED DISPLAYS (TIL 313). ALL ANODE CONNECTIONS OF THE CORRESPONDING SEGMENTS ARE WIRED TOGETHER. CATHODES ARE WIRED SEPARATELY TO EACH TRANSISTOR (Q10-Q15)

3. JUMPER 5 TO 3 AND 6 TO 8 WHEN BUS EXPANSION CIRCUITS ARE NOT INSTALLED.

REVISIONS				
LTR	DESCRIPTION	SIGNATURE AND DATE DFT	CHK	ENGR
A	PROD REL	5/77	3/6/78	

SPARE GATE COUNT		
TYPE	REF DES.	QTY

REF DESIGNATIONS	
USED	NOT USED
C20	
A17	
R35	
Q16	
DS6	
33	
S25	

4001117	SDK 85
NEXT ASSY	USED ON

QUANTITY PER DASH NO.	ITEM NO.	PART NUMBER	DESCRIPTION
		PARTS LIST	

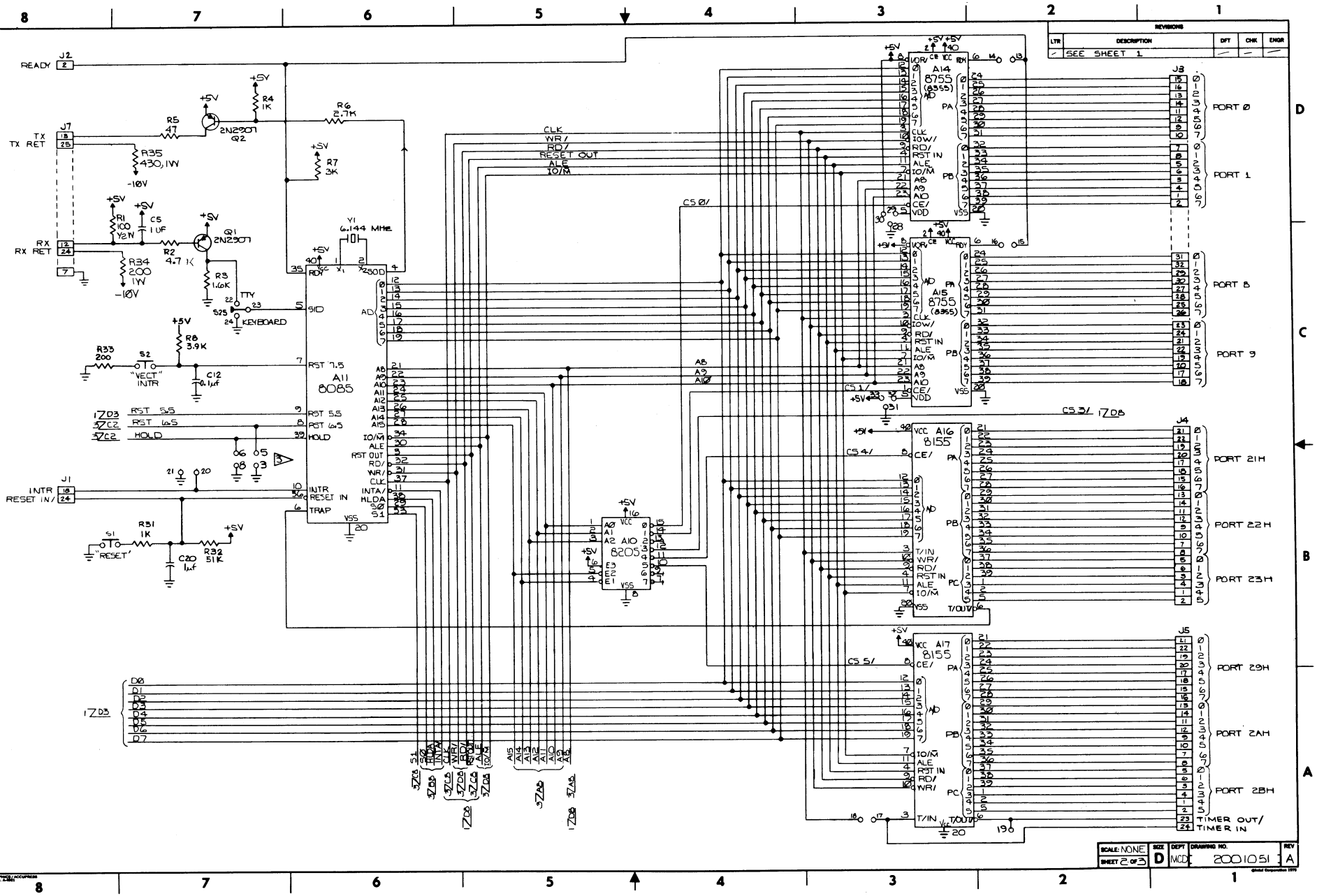
SCALE: NONE				
TOL. ±	2 PLC	3 PLC	ANGLE	
MATERIAL:				
FINISH:				

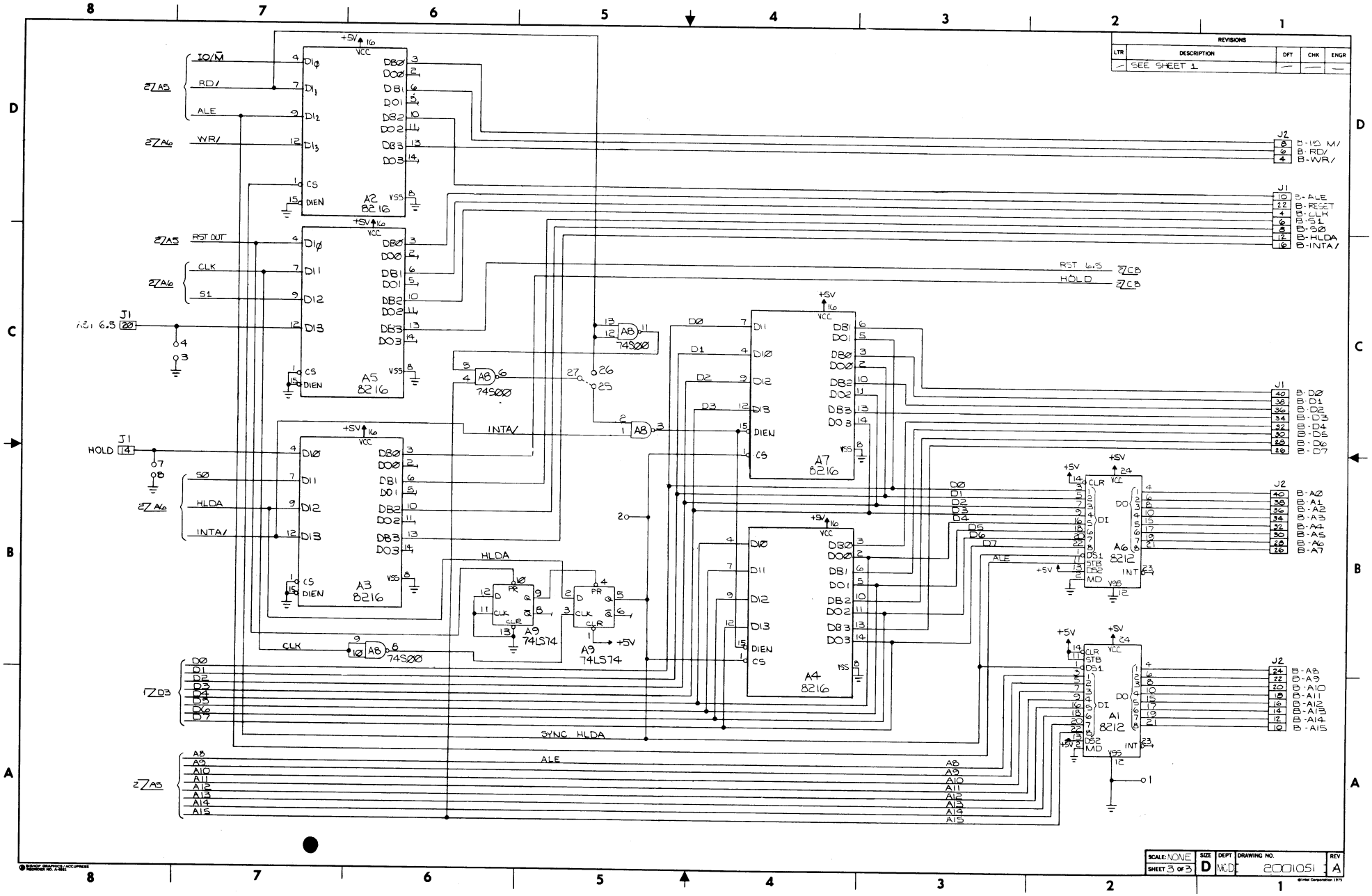
SIGNATURE	DATE
DRN BY SMQuan	8/7/76
CHK BY [illegible]	8/18/76
DFT APPD [illegible]	9/5/76
ENGR APPD A. Cheung	9/5/77
AUTH BY [illegible]	6/1/77
CODE:	SHEET 1 OF 3

intel 3065 BOWERS AVE. SANTA CLARA CALIF. 95051

TITLE: SCHEMATIC SYSTEM DESIGN KIT

SIZE	DEPT	DRAWING NO.	REV
D	MCD	2001051	A





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