SDK-86
MCS-86 SYSTEM DESIGN KIT
ASSEMBLY MANUAL

Manual Order No: 9800697B

Intel Corporation, 3065 Bowers Avenue, Santa Clara, California 95051

Printed in U.S.A./ B142/1178/5K WHM

CONTENTS

CHAPTER 1
GETTING STARTED

1-1. BEFORE STARTING

If you haven't already noticed, all of the parts for your MCS-86 System Design Kit (SDK-86) have been included in a skin-wrapped package. Don't open the package yet! Do a little reading first, and you may save yourself time and expense.

CAUTION

The metal-oxide semiconductor (MOS) integrated circuits included in your kit can be permanently damaged by static electricity. Do not remove an integrated circuit from its protective, black foam backing until you have read the precautions and until you have been instructed to do so.

This manual has been prepared 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 in order to assemble your SDK-86.

Included within this chapter are suggestions for laying out an efficient work area. All of the tools and materials that you will need are described in a check list, and there is a complete and detailed parts list. Basic soldering and assembly techniques also are reviewed. By carefully reading this book and by faithfully following the step-by-step assembly instructions, your chances for a mistake will be reduced greatly.

If you're an experienced kit builder, you already know that it's a good idea to read through this manual before starting your project. When you start to assemble your kit, take your time, don't rush and be sure to recheck each part you install before soldering it in place. Removing and replacing just one integrated circuit because it was installed in the wrong spot or because it was installed backwards can take more time than double-checking all of the parts on the board. Also, don't attempt to complete the assembly of your kit in just one sitting. Spread out your time and take breaks. As with any project, becoming overtired can increase the chances of a mistake and can show a marked decrease in craftsmanship. Your goal is to build a working computer, not to win a race!

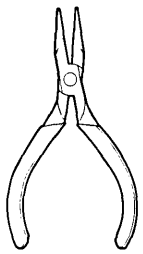
1-2. GETTING ORGANIZED

Before you get started, it's a good idea to plan and organize your work space. Be sure you have ample room to accommodate this manual, lying open, and the circuit board, tools and your soldering pencil. If you don't have the traditional plastic, compartmented parts boxes, a muffin pan, an egg carton or some small boxes or jars can be used for parts sorting. It also might prove helpful to write the part values on small cards as you identify each part and place the card with the part for quick identification. Be organized and arrange everything within easy reach and you'll do the job quickly and minimize your chances for an error.

1-3. THE TOOLS YOU WILL NEED

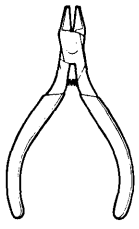
You will need the following tools and materials to assemble your kit:

☐ Needle-nose pliers

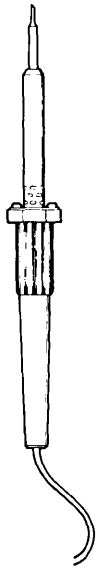


☐ Small Phillips screwdriver

☐ Small diagonal wire cutters



☐ Soldering pencil. Not more than 30 watts with an extra-small diameter tip (1/16 inch)

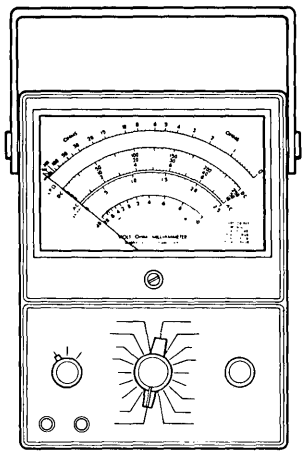


☐ Rosin-core solder. 60-40 (60% tin, 40% lead), small diameter (0.05 inch or less)

NOTE

Soldering paste or flux is not needed. The solder contains a sufficient amount of flux.

☐ Volt-Ohm-Milliameter



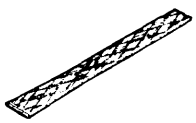
It also may prove useful to have a:

☐ Soldering aid with a small-tipped fork at one end and a reamer at the other. This tool will help to maneuver leads into holes and to manipulate small parts.

In the event that you happen to make an error and must remove a part that has been soldered from the circuit board, the following items will simplify the operation:

☐ Desoldering device, either the bulb variety (shown) or the pump variety.

☐ Length of copper braid ("solder wick") to draw solder out of a hole or to remove a solder bridge between circuits.



1-4. UNPACKING AND SORTING PARTS

The MCS-86 System Design Kit is shipped in a skin-wrapped, low-profile package that includes a conductive foam backing under the top template to protect the MOS integrated circuits from static charges. Do *not* remove an integrated circuit from the foam backing until you have read the precautions in this chapter and until you have been instructed to do so.

Using a sharp knife or razor blade, slice and remove the skin-wrapping over the large, unlabeled template pocket that contains the small integrated circuits, integrated circuit sockets, connector, resistor packs and the two bags of small parts.

Open the bag containing the hardware, binding posts, headers and miscellaneous parts. Check to be sure that the following items (and correct quantities) have been included. After each part is identified and counted, put a checkmark in the box to the left of the part description.

When unpacking and sorting parts, if a part is missing, contact the:

Intel Customer Support Department
3065 Bowers Avenue
Santa Clara, California 95051
(408) 987-8818

Note that the five-digit (or, in some cases, the seven-digit) number in parentheses is the Intel part number for the part and that this number should be referenced in all communications with the Customer Support Department.

HARDWARE

☐ 12 rubber pads (82-069)

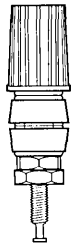
☐ 12 nylon sleeves, 7/16 inch long (82-072)

☐ 12 screws, 3/4 inch long (84-086)

☐ 24 nylon washers (84-059)

☐ 12 nuts (84-069)

BINDING POSTS

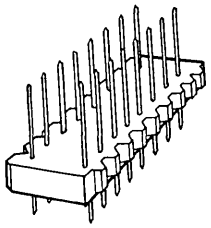


☐ 1 binding post, white (82-012)

☐ 1 binding post, black (82-013)

☐ 1 binding post, red (82-014)

HEADERS



☐ 1 2-pin (68-254)

☐ 1 3-pin (68-251)

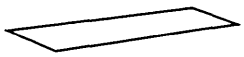
☐ 1 2- by 3-pin (68-308)

☐ 2 2- by 8-pin (68-098)

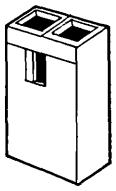
☐ 1 2- by 18-pin (68-302)

☐ 4 2- by 25-pin (68-236)

MISCELLANEOUS PARTS



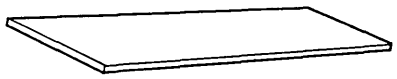
☐ 4 adhesive strips, 3 inches long (3001483)



☐ 16 shorting plugs
(68-211)

☐ 1 bus wire, 2.4 inches long
(86-026)

Check the pocket that the bag was removed from for the following item:



☐ 1 red display filter
(3001944)

Next, open the bag containing the resistors, capacitors, diodes and single in-line resistor packs and check to be sure that the following parts and quantities have been included. Refer to the resistor color code to determine the values of the resistors and to the capacitor value code to determine the values of the capacitors.

RESISTORS, 1/4 WATT, 5%

☐ 4 22 ohms (red-red-black)
(56-003)

☐ 2 47 ohms (yellow-violet-black)
(56-006)

☐ 3 110 ohms (brown-brown-brown)
(56-009)

☐ 1 220 ohms (red-red-brown)
(56-011)

☐ 4 1k ohms (brown-black-red)
(56-024)

☐ 2 2.7k ohms (red-violet-red)
(56-033)

☐ 1 4.7k ohms (yellow-violet-red)
(56-038)

☐ 1 5.1k ohms (green-brown-red)
(56-039)

☐ 2 560k ohms (green-blue-yellow)
(56-209)

RESISTORS, 1 WATT, 5%

☐ 1 330 ohms (orange-orange-brown)
(56-327)

☐ 1 430 ohms (marked 430Ω)
(56-106)

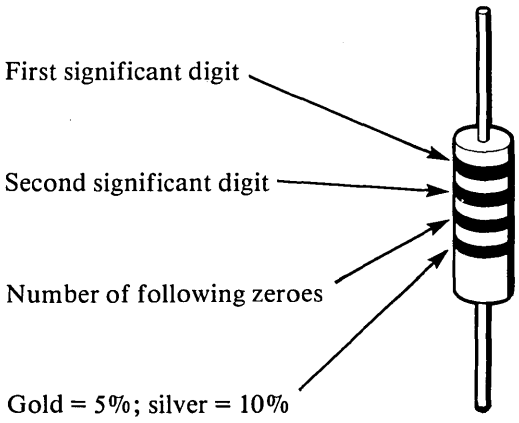
RESISTOR COLOR CODE

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

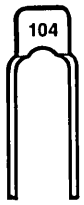
The first three bands follow the color code below:

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

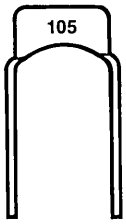
The fourth band indicates the percentage of tolerance for the resistor value and, for all resistors in the kit, will be gold (5% tolerance).



CAPACITORS

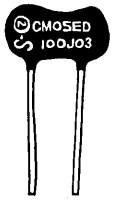


☐ 44 0.1 μF, ceramic (code 104)
(64-050)



☐ 2 1 μF, ceramic (code 105)
(64-058)

☐ 2 22 μF, electrolytic (code 227)
(64-012)

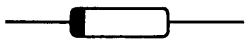


☐ 1 10 pF, dipped mica (code 100)
(64-052)

CAPACITOR VALUE CODE

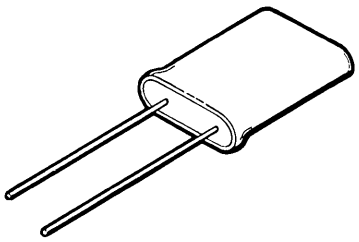
The capacitors supplied in your kit, depending on their manufacturer, will be marked either with their value or with a value code. The code used to indicate the value of a capacitor consists of three numbers which are interpreted something like the resistor color code. The first two numbers are the first and second significant digits, and the third number is the number of zeroes that follow with the value given in picofarads. For example, the 1 microfarad (1.0 μF) capacitors in your kit, if coded, would be marked with the digits "105." Applying the code, the value would be 10 with five zeroes or "1000000" picofarads. Moving the decimal point six places to the left (to convert from picofarads to microfarads), the value would be 1.000000 microfarads or simply 1.0 microfarad.

DIODES



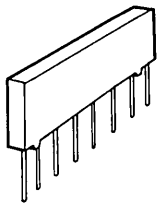
☐ 3 1N914 or TI914
(60-003)

CRYSTAL



☐ 1 14.7456 MHz
(62-032)

SINGLE IN-LINE RESISTOR PACKS



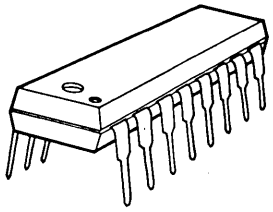
☐ 1 2.2k ohms, 8-pin
(56-288)

☐ 1 2.2k ohms, 10-pin
(56-103)

☐ 1 22k ohms, 8-pin
(56-323)

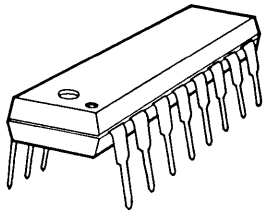
Now that the contents of both bags of small parts have been identified and counted, check to see that the rest of the pocket contains the following parts. Note that only the integrated circuit identifying numbers and letters are listed and that the prefix or suffix letters stamped on the part itself are omitted from the following list. For example, an SN74LS20N integrated circuit is identified only as a 74LS20 (the "SN" prefix and the "N" suffix are omitted). The integrated circuits in this area are *not* MOS devices and therefore can be handled (carefully). However, it may make your job easier if you leave these parts in their foam backing until you are ready to install them.

INTEGRATED CIRCUITS



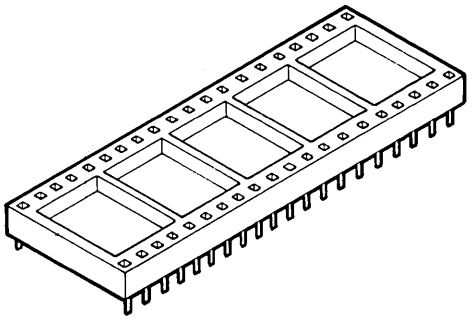
- ☐ 3 8286 or 8304 (52-178)
- ☐ 1 74LS00 (54-099)
- ☐ 1 74LS04 (54-096)
- ☐ 1 74LS10 (54-111)
- ☐ 1 74LS14 (54-211)
- ☐ 1 74LS20 (54-230)
- ☐ 1 74S30 (54-158)
- ☐ 1 7445 (54-258)
- ☐ 1 74LS74 (54-097)
- ☐ 1 74S133 (54-219)
- ☐ 1 74LS156 (54-213)
- ☐ 1 74LS164 (54-250)
- ☐ 1 74LS244 (54-205)
- ☐ 3 74S373 (54-206)
- ☐ 1 74LS393 (54-256)
- ☐ 1 ULN2003A or 75468 (54-257)

TRANSISTOR PACKS



- ☐ 3 Q2T2905 (54-161)

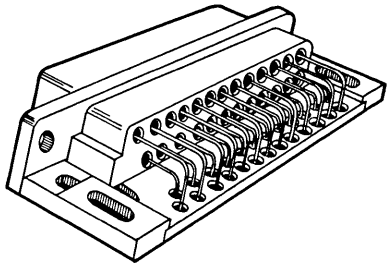
INTEGRATED CIRCUIT SOCKETS



40-Pin Socket Shown

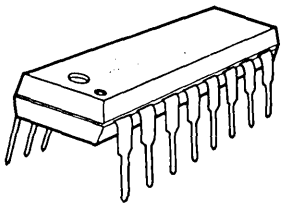
- ☐ 4 40 pin (68-009)
- ☐ 1 28 pin (68-177)
- ☐ 4 24 pin (68-007)
- ☐ 11 20 pin (68-277)
- ☐ 5 18 pin (68-003)
- ☐ 8 14 pin (68-005)

CONNECTORS



- ☐ 1 25-pin (68-198)

DUAL IN-LINE RESISTOR PACKS



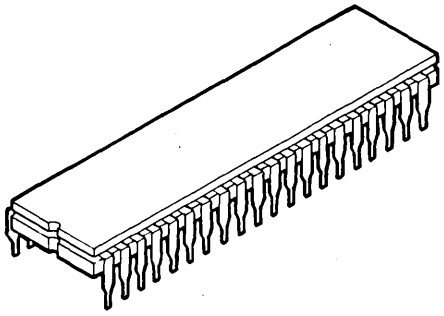
☐ 1 22 ohms, 14-pin
(56-326)

☐ 1 110 ohms, 16-pin
(56-325)

☐ 2 2.2k ohms, 16-pin,
(56-104)

Without removing the skin-wrapping that covers the individual parts in the other areas of the package, check to be sure that the following parts are included.

INTEGRATED CIRCUITS



40-Pin Integrated Circuit Shown

☐ 1 8086 CPU
(103965-001)

☐ 1 8284 Clock Generator
(52-198)

☐ 4 2142 RAM
(52-193)

☐ 2 8255A Parallel I/O
(52-116)

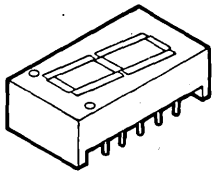
☐ 1 8251A USART
(52-188)

☐ 4 3625 Decoder PROM
A12 (9100148)
A22 (9100147)
A26 (9100149)
A29 (9100150)

☐ 4 2316, 2616 or 2716 Monitor ROM
9100167 (KEYPAD A)
9100168 (KEYPAD B)
104531-001 (SERIAL A)
104532-001 (SERIAL B)

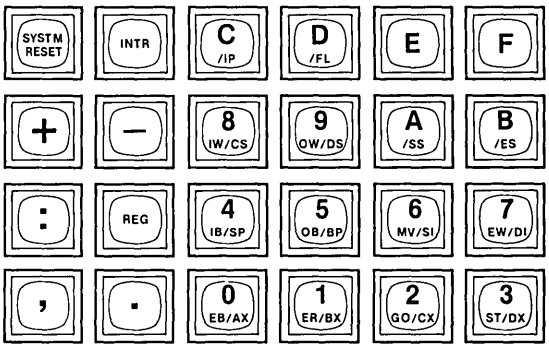
☐ 1 8279 Keyboard Display Controller
(52-115)

DISPLAY ELEMENTS



☐ 8 7-segment display elements
(60-035)

SWITCHES



☐ 1 Set (24 each) pushbutton switches
(66-053)

Now that you have checked and counted all of the parts, carefully slice the skin-wrapping around the perimeter of the template and remove the circuit board from between the black foam backing and the bottom cardboard.

CAUTION

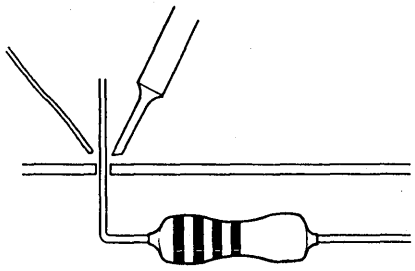
Be very careful not to cut the circuit board while slicing around the template.

1-5. BASIC SOLDERING TECHNIQUES

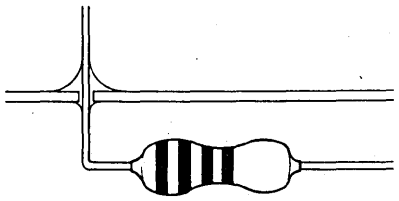
It can not be overstressed that the proper soldering pencil and solder are essential to good soldering. The soldering pencil (not soldering "iron" or soldering "gun") must be rated at no more than 30 watts, the tip must be small (1/16 inch or less), and small-diameter (0.05 inch) 60-40 solder must be used.

In addition to the right soldering equipment, a little care for the tip of the pencil certainly is worth mentioning. When soldering, the tip must be kept clean. If your pencil holder does not include a sponge and basin, dampen an old sponge with water and keep it on a plate or ashtray near the holder. When residue or excess solder builds up on the tip, draw the tip over the sponge a few times. When clean, "tin" the tip by melting a small amount of solder directly on the tip. A clean and properly tinned tip is very shiny.

If you are right-handed, hold the pencil in your right hand and, conversely, if you are left-handed, hold the pencil in your left hand. (Since most people have better control with their "natural" hand, the chances of slipping with the pencil and damaging the board or burning yourself are much less.) To solder a part, place the tip of the pencil on the pad and against the lead at the same time (this causes both the pad and lead to be heated evenly).

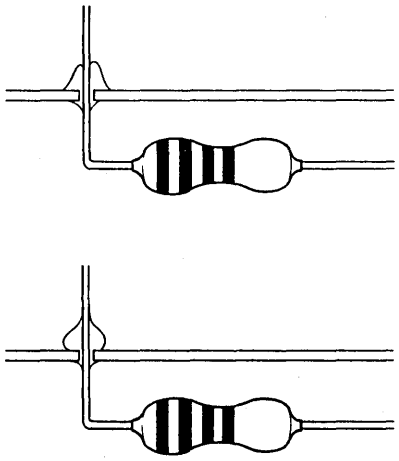


Apply solder from the side opposite the tip. Allow the solder to melt against the lead and pad and then remove both the solder and tip. Only a small amount of solder is needed for a good bond between the lead and pad. The following illustrations show a cross-section view of good and bad solder bonds or "joints." A good solder joint will be bright (shiny) and the solder around the lead and pad (referred to as the "fillet") will be distributed evenly. The shape of the fillet will range from being slightly concave to being slightly convex, and a small amount of solder usually will be drawn down through the hole and will be visible on the lead on the other side of the circuit board.



GOOD SOLDER JOINT

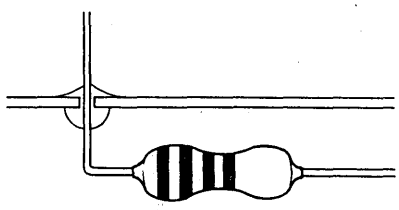
The bad soldering joints shown are typical of "cold" solder joints and usually are caused by not heating both the pad and lead uniformly or by allowing the solder to melt directly on the tip before the lead and pad have been heated properly.



BAD SOLDER JOINTS

Generally, a cold solder joint is dull gray in color and the bond at either the lead or pad will recede slightly.

Caution again must be emphasized in the selection of solder pencil wattage and tip size. Excessive (or prolonged) heat can damage a part internally. When soldering, if the fillet between the pad and lead tends to "flatten out" and if an excessive amount of solder forms on the other side of the circuit board where the lead enters the hole, excessive heat may be indicated.



EXCESSIVE HEAT

1-6. BASIC ASSEMBLY TECHNIQUES

Now that you have reviewed the basic soldering techniques, thoroughly familiarize yourself with the following sections on basic assembly techniques before you start to assemble your kit.

1-7. CIRCUIT BOARD LAYOUT

Pick up the circuit board and notice that one side has been silkscreened with component reference designations and position outlines, major circuit areas and other information. This side of the board will be referred to as the "top," and the unlabeled side will be referred to as the "bottom." Parts are inserted in the board from the top (over their outlines), the board is turned over, and the parts are soldered from the bottom.

1-8. PART ORIENTATION

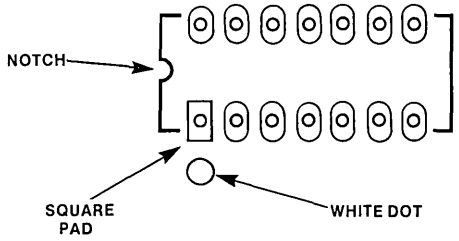
A number of the parts in your kit are "polarized." That is, they must be installed in a certain direction. Polarized parts include the following:

- Integrated Circuits
- Diodes
- Electrolytic Capacitors
- Resistor Packs
- Transistor Packs

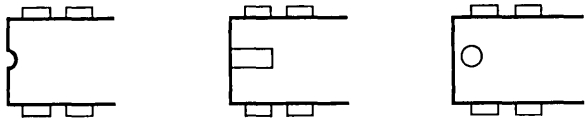
INTEGRATED CIRCUITS

When installing an integrated circuit into its designated circuit board location, always align pin 1 of the integrated circuit with pad 1 of the circuit board location.

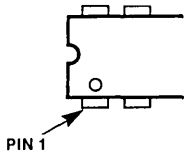
Looking at one of the silkscreened integrated circuit outlines on the top of the board, notice that one of the two outlines is "notched," and that a white dot appears near one of the pads. Looking at the pad next to the dot, notice that it is square-shaped and that the other pads have rounded corners. This is pad 1.



Now look at one of the small integrated circuits. One end of the circuit has a "notch." Depending on the manufacturer of the integrated circuit, the "notch" will look like one of the following:



Additionally, some manufacturers mark pin 1 with a small dot, dimple or bump.



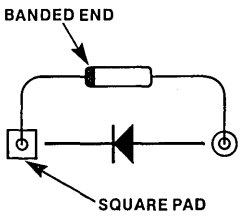
Whether or not pin 1 is marked, it is always in the same position with respect to the notch.

CAUTION

Be very careful to install integrated circuits correctly. Once an integrated circuit has been soldered in place, the recommended way to remove the integrated circuit is to cut it out (which destroys the circuit).

DIODES

Diodes also must be installed in the proper direction. Looking at one of the diodes, one end has a black band (this end is called the "cathode"). The circuit board pad for the cathode is square. Also, the part location line silkscreened on the board includes the diode logic symbol. The banded end of the diode goes to the square pad in the direction of the arrowhead.



ELECTROLYTIC CAPACITORS

Electrolytic capacitors have a positive and a negative end. Looking at the leads of one of the electrolytic capacitors, the negative lead is in direct contact with the body of the capacitor, and the positive lead is insulated from the body and is noticeably larger at the point where the lead touches the body. On the circuit board, a small plus sign (+) is silkscreened near the positive hole to indicate the position of the capacitor's positive lead.

RESISTOR PACKS

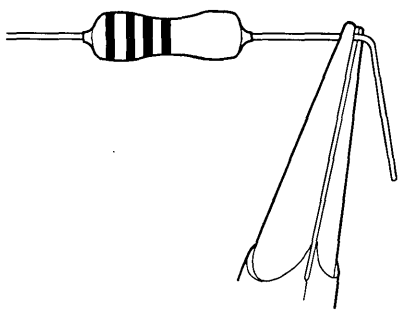
Two styles of resistor packs are included in the kit, and both must be installed correctly in the circuit board. Pin 1 of a single in-line resistor pack, depending on the manufacturer, will be noted by a dot, the number "1", or all pins will be numbered. Pad 1 on the circuit board is noted by a square pad. The dual in-line resistor pack follows the same pin 1 designations as the integrated circuits. Note that some dual in-line resistor packs are not notched. In this case, pin 1 will be labeled clearly.

TRANSISTOR PACKS

Transistor packs are installed the same way as integrated circuits.

1-9. LEAD BENDING

The leads of resistors, diodes, electrolytic capacitors and the crystal will have to be bent in order to insert the part into the circuit board. The correct way to bend a lead is to grip the lead with your needle-nose pliers and, using the pliers only to hold the lead (like a vise), bend the free-end of the lead with your other hand.

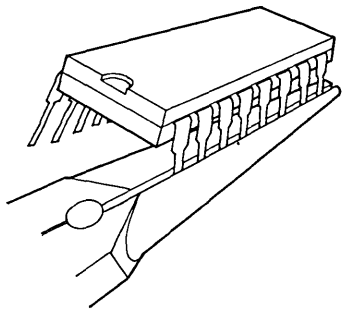


Never bend a lead with the pliers as the stress can fracture the part. Try to bend the leads so that when the part is inserted into the board, it is centered between the two pads. Also, when bending the leads of parts with values printed on them, bend the leads so that the value is visible when installed.

1-10. INSERTING PARTS

Before you insert any part in the circuit board, be sure that you have picked up the right part. When inserting the part, be sure that you put it in the right location and, if it is polarized, that you insert it in the proper direction. The top of the circuit board has been labeled with the part position, its reference number and, if it's an integrated circuit, with the integrated circuit part number. For small (two-lead) parts, a line has been silkscreened between its two associated pads, while with the larger (multi-pin) parts, the part outline has been silkscreened directly on the board.

Before inserting an integrated circuit, socket or transistor or resistor pack, check to be sure that all of the pins are straight. If necessary, straighten any bent pins with your needle-nose pliers. Occasionally, the pins of an integrated circuit may be spread too far apart to be inserted easily into the board. If this happens, carefully grip the pins on one side, in mass, with your needle-nose pliers and gently bend the pins inward.



If it still does not fit, bend the pins inward on the other side. After inserting an integrated circuit (or transistor or resistor pack), carefully check to be sure that:

1. The correct part has been inserted.
2. The part is facing the right direction.
3. There are no bent pins (all pins must be visible from the bottom of the board).

Only when the above conditions have been checked carefully should the part be soldered in place. Remember that once an incorrectly installed integrated circuit has been soldered in place, the recommended method of removal is to cut out the integrated circuit.

NOTE

Although resistors can be inserted in either direction, it is good practice to insert all color-coded resistors so that the color bands are always read from the same direction (for instance, top-to-bottom or left-to-right).

1-11. HANDLING MOS INTEGRATED CIRCUITS

IMPORTANT

In Chapters 2 and 3, when you are instructed to install any of the large MOS integrated circuits, always observe the following precautions before you remove the skin-wrap and pick up the circuit:

1. Touch the black foam backing. Simply put your fingers on any exposed foam area.
2. Rub your fingers across the pads where you are going to insert the integrated circuit. If the circuit is to be inserted into a socket, *touch* the socket pins on the bottom of the board.
3. Avoid touching the pins of the integrated circuit as much as possible.
4. Avoid getting up and walking around (which could build up a static charge on your body) until you have inserted the integrated circuit in the board or into its socket.

1-12. SOLDERING PARTS

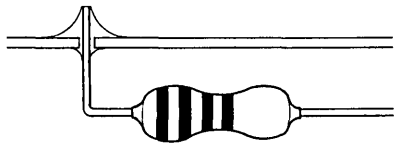
After a part or group of parts is inserted within an area, the board is turned over and the parts are soldered in place. To prevent parts from slipping or falling out when turning the board over, a piece of foam (about 1 foot square) can be placed over the parts to hold them in place or, if desired, parts can be taped down on the board with masking or similar type tape.

Small components (particularly the tiny capacitors) can be "tack" soldered (applying just enough solder to form a bond between one of the leads and its pad) on the top of the board. Once tacked in place, the board can be turned over, and the leads can be soldered. When soldering from the bottom, be sure to solder the "untacked" lead first. Notice that even though the rubber "feet" raise the board above the work surface, the leads of many of the small parts that can be tack soldered still may be too long. When this is the case, the leads can be clipped to about 3/4 of an inch before the part is inserted.

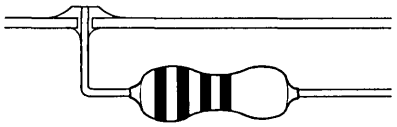
When soldering any of the multi-pin parts, first solder the pins at two diagonally opposite corners and then check to be sure that the part is all the way down on the board. If the part has slipped and is not down completely, remelt both solder joints while lightly pressing down on the component. Solder the remaining pins and then resolder the first two pins.

1-13. CLIPPING LEADS

After soldering, the leads of most of the small parts must be clipped using diagonal wire cutters. Care should be taken to avoid clipping the solder fillet (which could possibly "fracture" the solder joint). When properly soldered and clipped, a lead should extend from 1/16 to 1/8 of an inch above the board. The following examples picture correct and improper lead clipping.



CORRECT



IMPROPER

Integrated circuit pins should not be clipped (the shock from clipping can cause an internal fracture).

WARNING

To avoid eye injury when clipping leads, hold the lead end so it can't fly into your face.

1-14. REMOVING PARTS

Although the assembly instructions have been prepared carefully, the possibility of human error always exists. If you should happen to install a part incorrectly, it must be removed. Depending on the part itself, it either can be removed and reused or it should be cut out and replaced.

Small (two-lead) parts usually can be removed successfully from the board with little danger of damage, provided that the proper tools are used and care is taken. To remove a small part, find its leads on the bottom of the board. With your soldering pencil in one hand and the desoldering device in the other, heat one of the joints. When the solder melts, quickly move the pencil out of the way and remove the solder from the joint with the desoldering device. If done successfully, the hole in the pad will be visible. If solder still remains in the hole, first add additional solder to the joint before repeating the operation. After the solder has been removed from both joints, grasp each lead with your needle-nose pliers (from the bottom of the board) and wiggle the lead back and forth in order to break it loose from the hole. When both leads are free, remove the part. If a lead will not break free from its hole, resolder the lead and repeat the solder extraction operation.

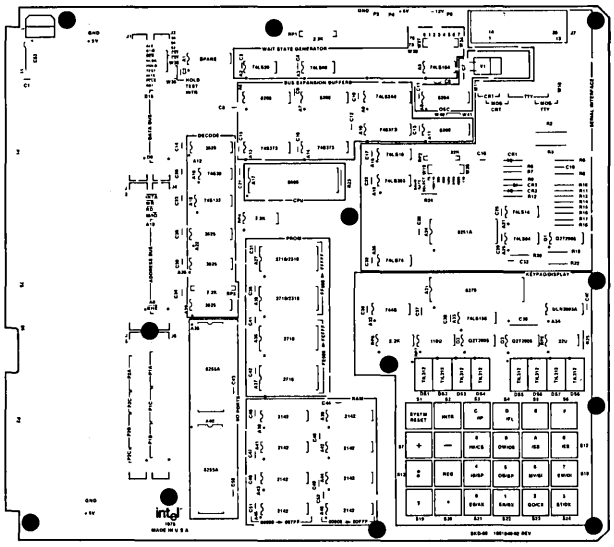
While it is possible to remove an integrated circuit from the board without damaging the part, this practice is *not* recommended as the possibility of board damage (lifted pads or traces) is extremely high. When an integrated circuit must be removed, it is recommended that the circuit be clipped out and the pins then be removed individually. To remove an integrated circuit, follow the steps outlined below.

1. Using your diagonal wire cutters and working from the top of the board, carefully clip each lead of the integrated circuit near where the pin enters the case.
2. While still working from the top of the board, carefully remove each individual lead using your soldering pencil and needle-nose pliers.
3. With your soldering pencil and solder, fill each hole with additional solder. (This will make it easier to remove all of the solder from the hole.)
4. Remove the solder from each hole using a desoldering device or solder wick. If solder still remains in the hole, add more solder and repeat this step.
5. Install the correct replacement integrated circuit and make sure that pin 1 is oriented correctly.
6. Turn the board over and, checking first to be sure that all of the pins are visible, solder the circuit in place.

CHAPTER 2
ASSEMBLING YOUR KIT

2-1. INTRODUCTION

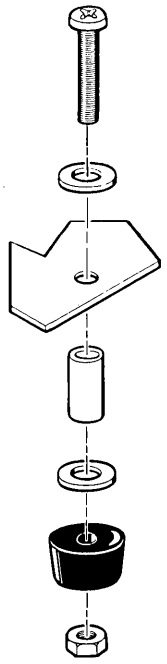
Now that you have familiarized yourself with the information in Chapter 1, you are ready to assemble your kit. The step-by-step assembly instructions in this chapter are arranged so that you install all of the parts in one of the outlined sections or "areas" before moving on to the next area. For each area to be assembled, there are two pictures. The shaded portion of the small picture shows the board location of the area to be assembled, and the large picture shows the actual parts that you are to install within the area.



As you begin the assembly procedures, you will notice a small box to the left of each instruction or "step." AS YOU COMPLETE EACH STEP, PUT A CHECKMARK IN THE BOX! Remember that your goal is to build a working computer, not to see how fast you can install the parts. Take your time, work carefully and don't let yourself become overtired.

2-2. ASSEMBLY PROCEDURES

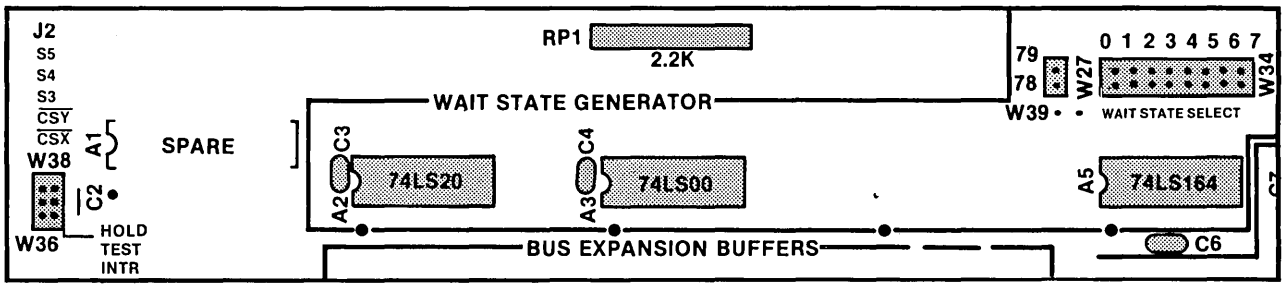
Plug in your soldering pencil and, while you're waiting for it to heat-up, install the 12 rubber feet.

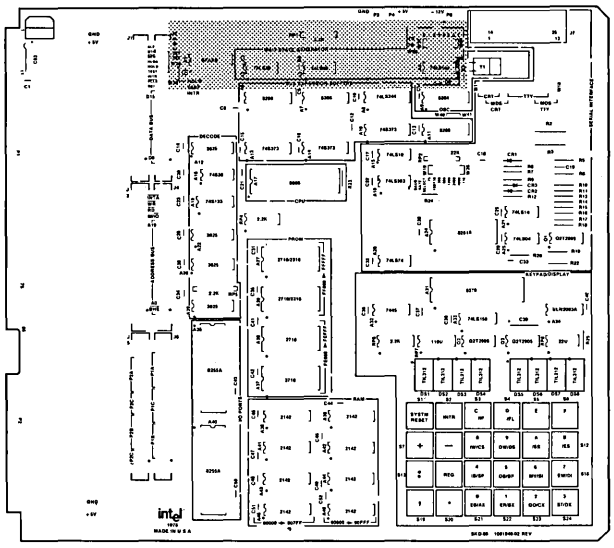


☐ Insert a nut into the recessed hole in the bottom of each of the 12 rubber pads. The eraser on the end of a pencil can be used to push the nut down into the rubber pad.

☐ Place the board on your work surface, top side up and with the "keyboard/display" area in the lower right-hand corner. Looking at the drawing of the board, the locations for the rubber feet are marked with black dots. At each of the 12 locations, slide a nylon washer onto a screw and then insert the screw through the hole from the top of the board. In order, place a sleeve and another nylon washer on the screw from the bottom of the board, and twist a pad onto the screw. With your screwdriver, tighten the screw just enough to hold the pad firmly.

ASSEMBLY OF THE WAIT STATE GENERATOR AREA





☐ Insert (do *not* solder) the 74LS20 integrated circuit at A2.

☐ Insert the 74LS00 integrated circuit at A3.

☐ Insert the 74LS164 integrated circuit at A5.

☐ Check the orientation of the three integrated circuits. The notch of each integrated circuit should be to your left and pin 1 should be aligned with the white dot silkscreened on the board.

☐ Turn the board over and solder each integrated circuit in place. Do *not* clip the pins.

Insert a 0.1 μF ceramic capacitor at the following three locations:

☐ C3

☐ C4

☐ C6 (watch the holes)

☐ Solder the three capacitors in place and clip their leads.

WARNING

Avoid possible eye injury by holding the end of the lead in your hand while clipping.

☐ Insert the 2- by 3-pin header at W36-W38. (The short pins are inserted into the board.)

☐ Insert a 2- by 8-pin header at W27-W34.

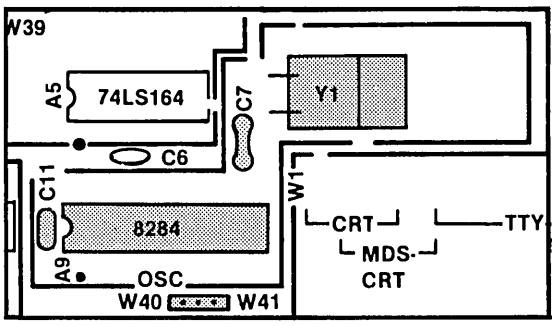
☐ Insert the 2-pin header at W39.

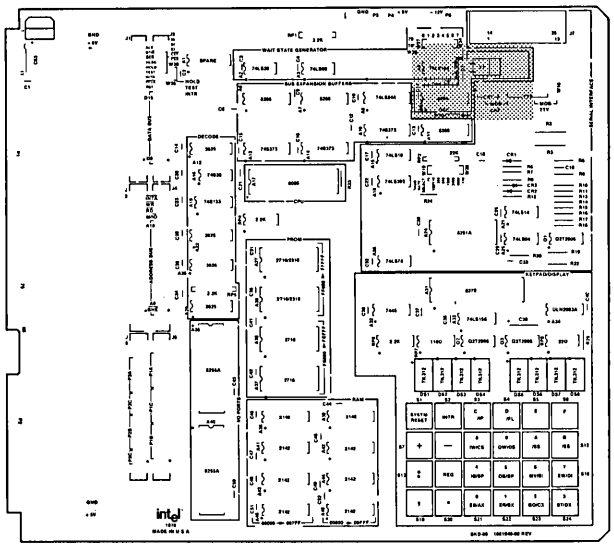
☐ Solder the three headers in place.

☐ Insert the 2.2k ohm, 8-pin single in-line resistor pack at RP1. (Be sure that pin 1 of the pack is inserted into pad 1).

☐ Solder the resistor pack in place and, if necessary, clip the leads.

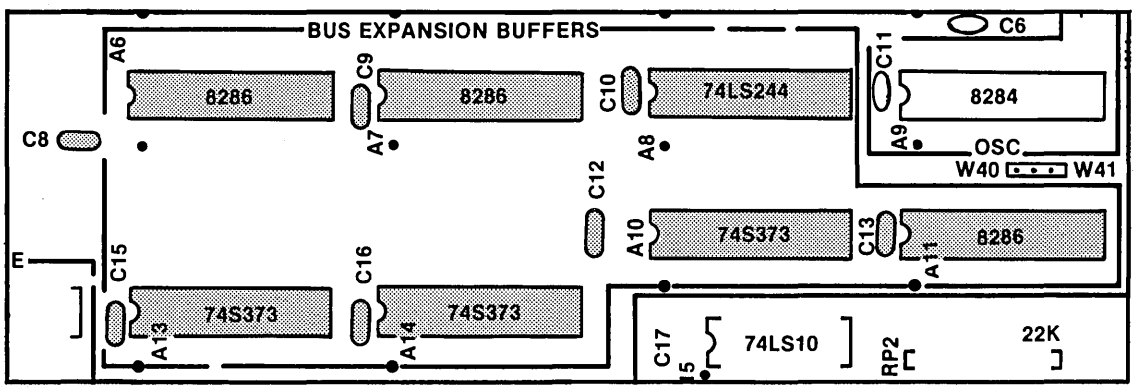
ASSEMBLY OF THE OSC (OSCILLATOR) AREA

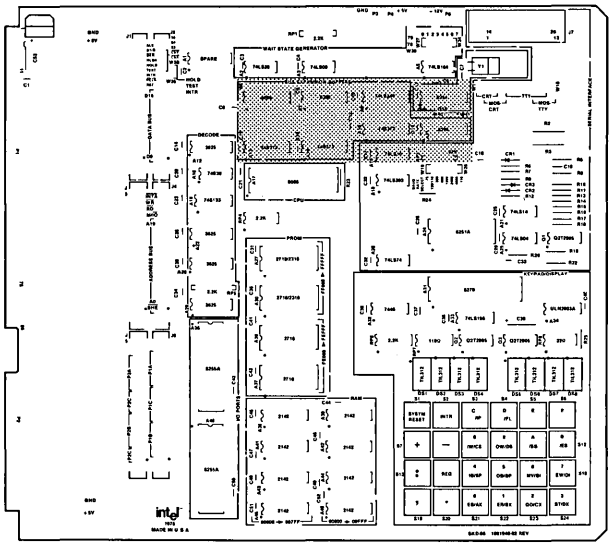




- ☐ Insert an 18-pin integrated circuit socket at A9. Notice that while a socket can be inserted in either direction, some sockets are marked with a pin 1 reference. When marked (usually with a "notch" or "sliced" corner), socket pin 1 should be aligned with the square pad.
- ☐ Check to ensure that all the socket pins come through the board and solder the socket in place.
- ☐ Insert the crystal at Y1. Bend the leads so that the crystal is directly over its silkscreened outline.
- ☐ Solder the crystal in place and clip the leads.
- ☐ With your needle-nose pliers and the bus wire from the kit, form a U-shaped strap to hold the crystal in place.
- ☐ Insert the strap over the crystal, solder it in place and clip the leads.
- ☐ Insert the 10 pF dipped mica capacitor at C7, solder it in place and clip its leads.
- ☐ Insert a 0.1 μF ceramic capacitor at C11, solder it in place and clip its leads.
- ☐ Insert the 3-pin header at W40,41 and solder it in place.

ASSEMBLY OF THE BUS EXPANSION BUFFERS AREA





Insert a 20-pin integrated circuit socket at the following seven locations:

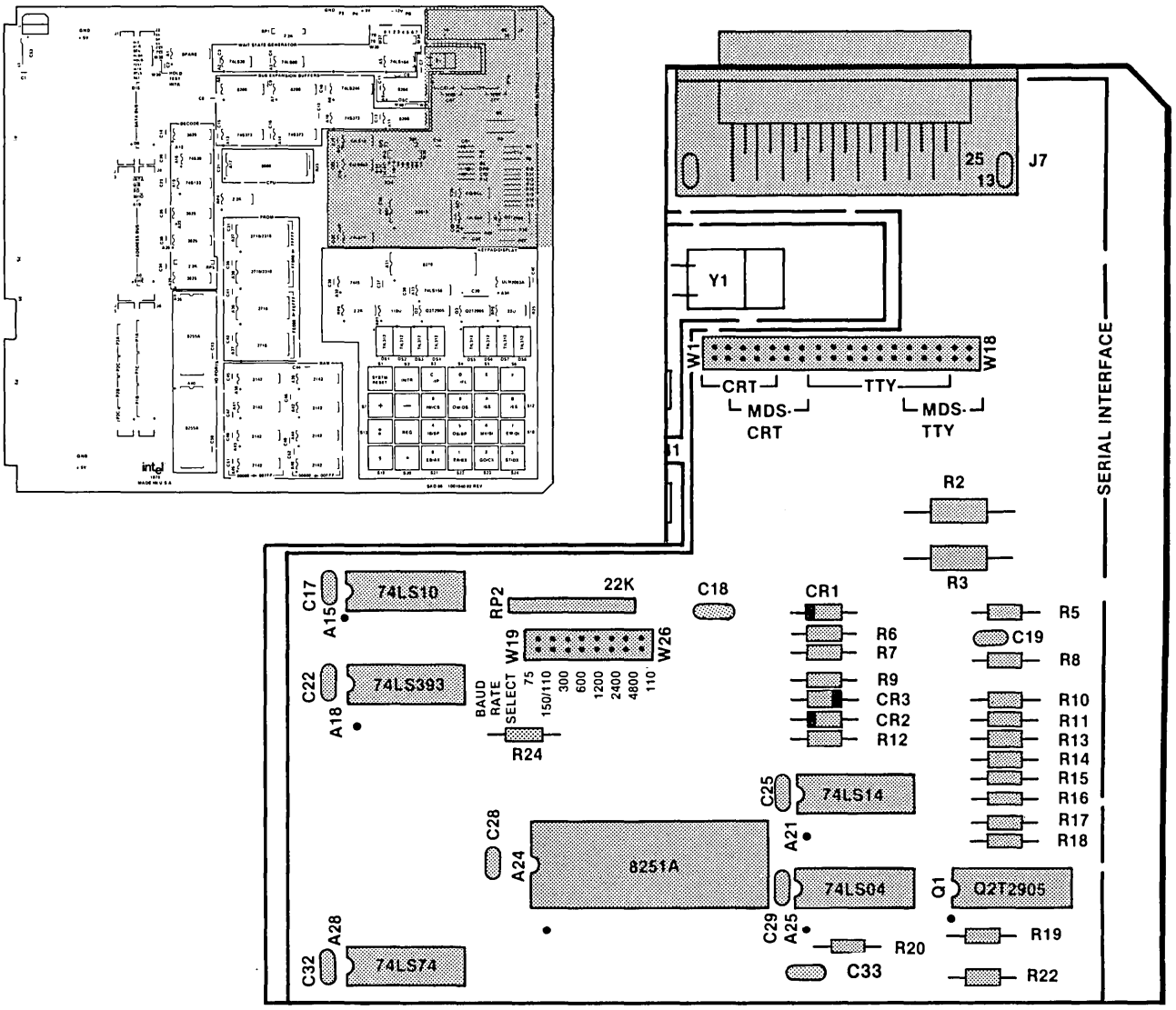
- ☐ A6
- ☐ A7
- ☐ A8
- ☐ A10
- ☐ A11
- ☐ A13
- ☐ A14
- ☐ Solder the seven sockets in place.

Insert a 0.1 μF ceramic capacitor at the following seven locations:

- ☐ C8
- ☐ C9
- ☐ C10
- ☐ C12
- ☐ C13
- ☐ C15
- ☐ C16

- ☐ Solder the seven capacitors in place and clip their leads.

ASSEMBLY OF THE SERIAL INTERFACE AREA



☐ Insert the 430 ohm, 1 watt resistor at R2.

☐ Insert the 330 ohm (orange-orange-brown), 1-watt resistor at R3.

☐ Solder the two resistors in place and clip their leads.

Insert a 1N914 or TI914 diode at the following three locations:

☐ CR1

☐ CR2

☐ CR3

When correctly inserted, the band will be towards the square pad.

☐ Solder the three diodes in place and clip their leads.

☐ Insert a 560k ohm (green-blue-yellow) resistor at R6.

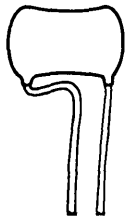
☐ Insert a 110 ohm (brown-brown-brown) resistor at R7.

☐ Insert the 4.7k ohm (yellow-violet-red) resistor at R9.

- ☐ Insert a 1k ohm (brown-black-red) resistor at R12.
- ☐ Solder the four resistors in place and clip their leads.
- ☐ Insert a 47 ohm (yellow-violet-black) resistor at R5.
- ☐ Insert a 1k ohm (brown-black-red) resistor at R8.
- ☐ Insert a 22 ohm (red-red-black) resistor at R10.
- ☐ Insert a 22 ohm (red-red-black) resistor at R11.
- ☐ Insert the 220 ohm (red-red-brown) resistor at R13.
- ☐ Insert the 5.1k ohm (green-brown-red) resistor at R14.
- ☐ Insert a 1k ohm (brown-black-red) resistor at R15.
- ☐ Insert a 47 ohm (yellow-violet-black) resistor at R16.
- ☐ Insert a 2.7k ohm (red-violet-red) resistor at R17.
- ☐ Insert the other 2.7k ohm (red-violet-red) resistor at R18.
- ☐ Solder the ten resistors in place and clip their leads.
- ☐ Insert a 22 ohm (red-red-black) resistor at R19.
- ☐ Insert a 560k ohm (green-blue-yellow) resistor at R20.
- ☐ Insert a 110 ohm (brown-brown-brown) resistor at R22.
- ☐ Insert a 1k ohm (brown-black-red) resistor at R24.
- ☐ Solder the four resistors in place and clip their leads.
- ☐ Insert the 74LS10 integrated circuit at A15.
- ☐ Insert the 74LS393 integrated circuit at A18.
- ☐ Insert the 74LS14 integrated circuit at A21.
- ☐ Insert the 74LS74 integrated circuit at A28.
- ☐ Insert the 74LS04 integrated circuit at A25.
- ☐ Check the orientation of the five integrated circuits and solder each one in place.
- ☐ Insert the 28-pin integrated circuit socket at A24.
- ☐ Solder the socket in place.
- ☐ Insert a Q2T2905 transistor pack at Q1, check proper orientation and solder the pack in place.
- ☐ Insert one of the two 1 μF ceramic capacitors at C18.

NOTE

Depending on the lead spacing, it may be necessary to bend one lead of each ceramic capacitor so that the leads line up with the pads on the board.



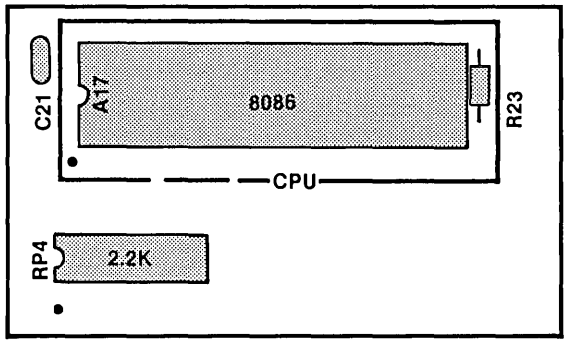
- ☐ Insert the other 1 μF ceramic capacitor at C33.
- ☐ Solder the two capacitors in place and clip their leads.

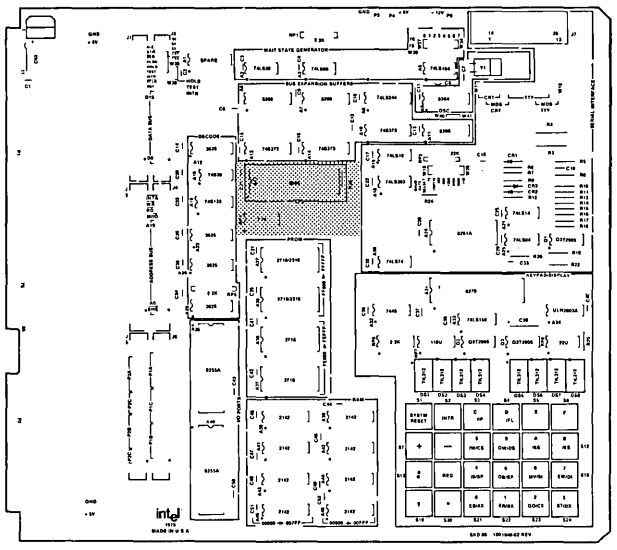
Insert a 0.1 μF ceramic capacitor at the following seven locations:

- ☐ C17
- ☐ C19
- ☐ C22
- ☐ C25
- ☐ C28
- ☐ C29
- ☐ C32

- ☐ Solder the seven capacitors in place and clip their leads.
- ☐ Insert a 2- by 8-pin header at W19-W26 and solder it in place.
- ☐ Insert the 2- by 18-pin header at W1-W18 and solder it in place.
- ☐ Insert the 8-pin, single in-line 22k ohm resistor pack at RP2.
- ☐ Check the orientation of pin 1, solder the pack in place and, if necessary, clip its leads.
- ☐ Insert the 25-pin connector at J7 and solder it in place.

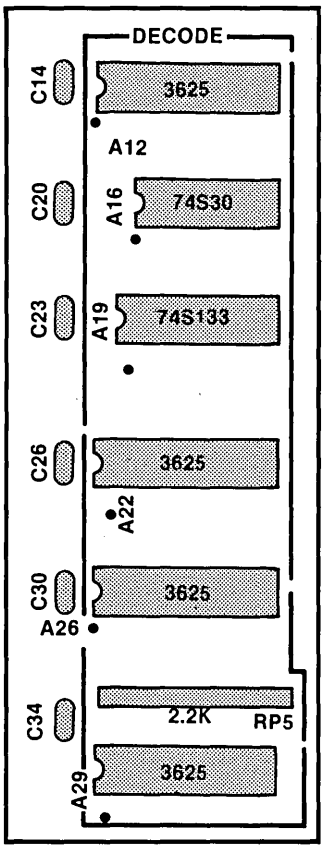
ASSEMBLY OF THE CPU AREA





- ☐ Insert a 110 ohm (brown-brown-brown) resistor at R23, solder it in place and clip its leads.
- ☐ Insert a 40-pin integrated circuit socket at A17.
- ☐ Solder the socket in place.
- ☐ Insert a 2.2k ohm dual in-line resistor pack at RP4 and make sure that pin 1 of the pack is aligned with pad 1 on the board.
- ☐ Solder the resistor pack in place.
- ☐ Insert a 0.1 μF ceramic capacitor at C21, solder it in place and clip its leads.

ASSEMBLY OF THE DECODE AREA

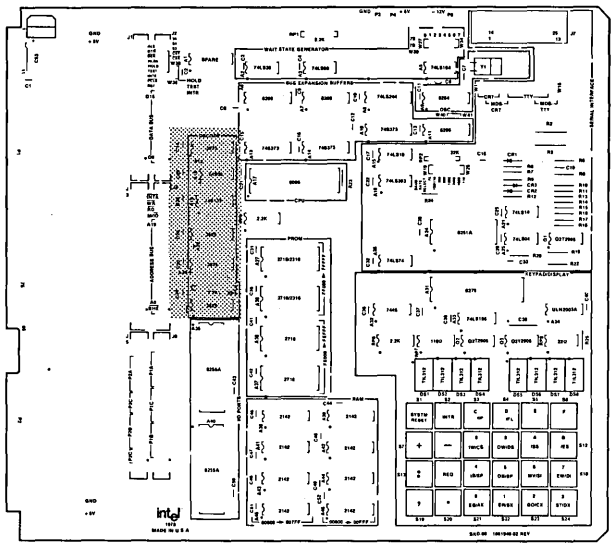


Insert an 18-pin integrated circuit socket at the following four locations:

- ☐ A12
- ☐ A22
- ☐ A26
- ☐ A29

☐ Solder the four sockets in place.

☐ Insert the 74S30 integrated circuit at A16.



☐ Insert the 74S133 integrated circuit at A19.

☐ Check the orientation of pin 1 of both integrated circuits and solder the two integrated circuits in place.

Insert a 0.1 μF ceramic capacitor at the following six locations:

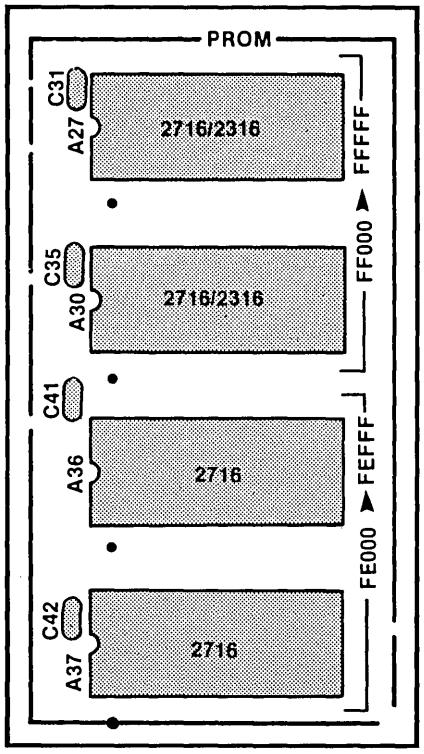
- ☐ C14
- ☐ C20
- ☐ C23
- ☐ C26
- ☐ C30
- ☐ C34

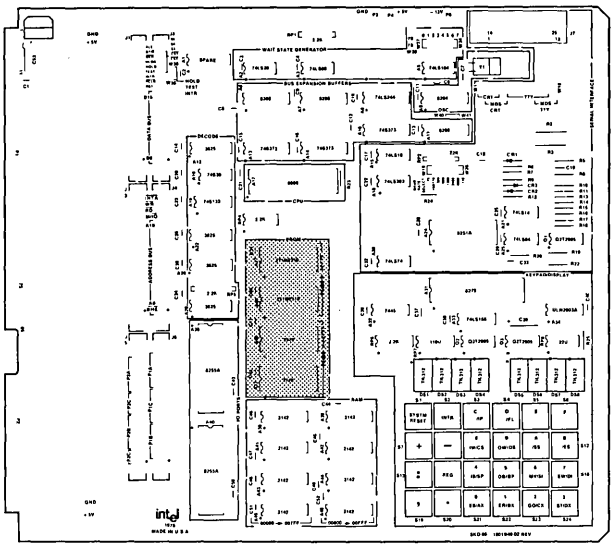
☐ Solder the six capacitors in place and clip their leads.

☐ Insert the 2.2k ohm, 10-pin, single in-line resistor pack at RP5. Make sure that pin 1 of the pack is aligned with pad 1 on the board.

☐ Solder the resistor pack in place and, if necessary, clip its leads.

ASSEMBLY OF THE PROM AREA





Insert a 24-pin integrated circuit socket at the following four locations:

- ☐ A27
- ☐ A30
- ☐ A36
- ☐ A37

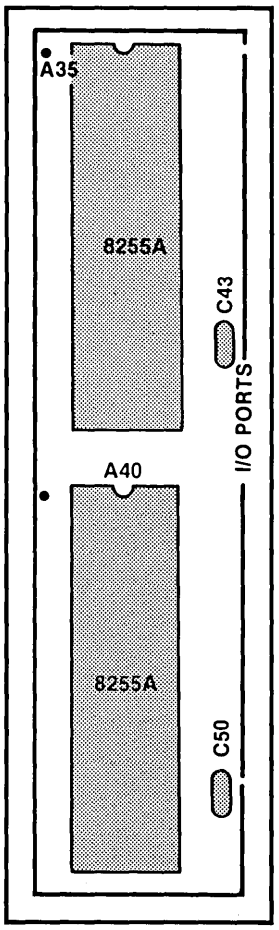
☐ Solder the four sockets in place.

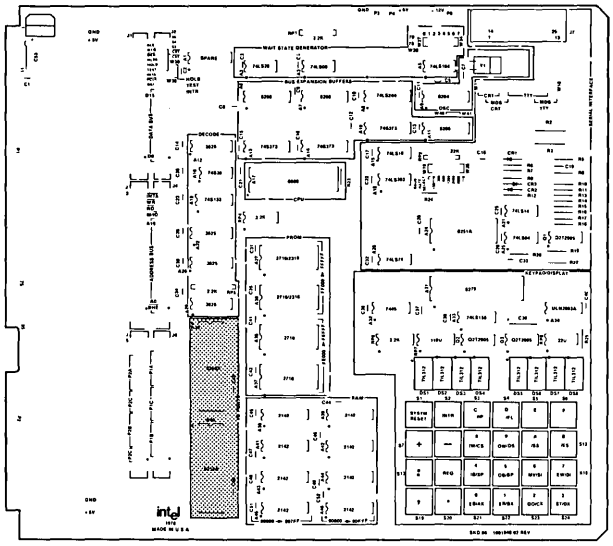
Insert a 0.1 μF ceramic capacitor at the following four locations:

- ☐ C31
- ☐ C35
- ☐ C41
- ☐ C42

☐ Solder the four capacitors in place and clip their leads.

ASSEMBLY OF THE I/O PORTS AREA





Insert a 40-pin integrated circuit socket at the following two locations

- ☐ A35
- ☐ A40

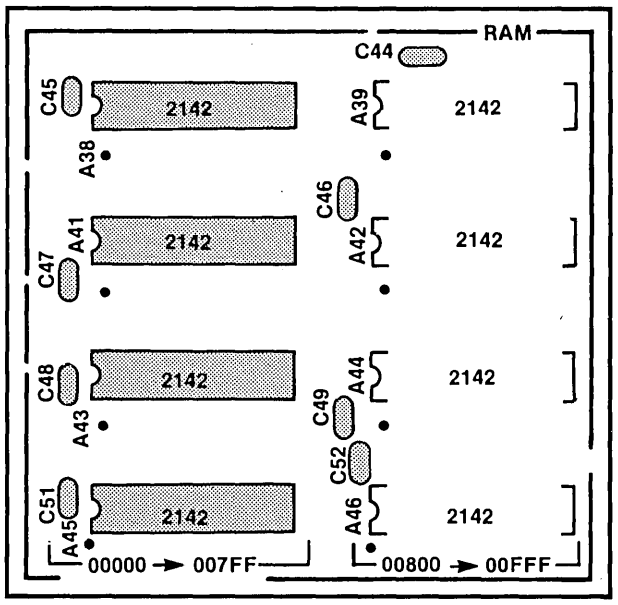
☐ Solder the two sockets in place.

Insert a 0.1 μF ceramic capacitor at the following two locations:

- ☐ C43
- ☐ C50

☐ Solder the two capacitors in place and clip their leads.

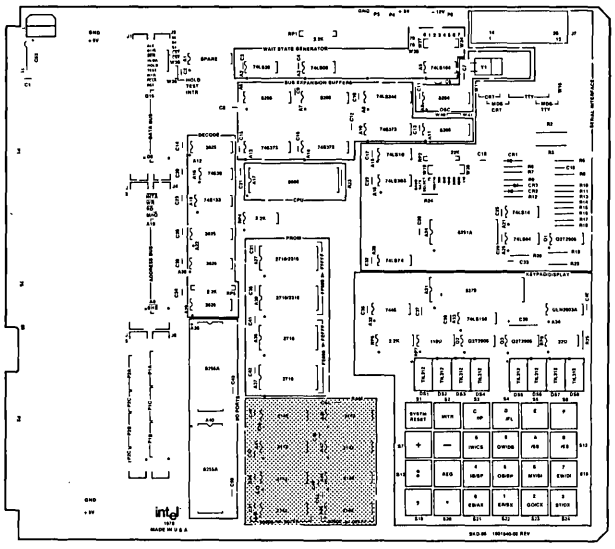
ASSEMBLY OF THE RAM AREA



Insert a 20-pin integrated circuit socket at the following four locations:

- ☐ A38
- ☐ A41
- ☐ A43
- ☐ A45

☐ Solder the four sockets in place.

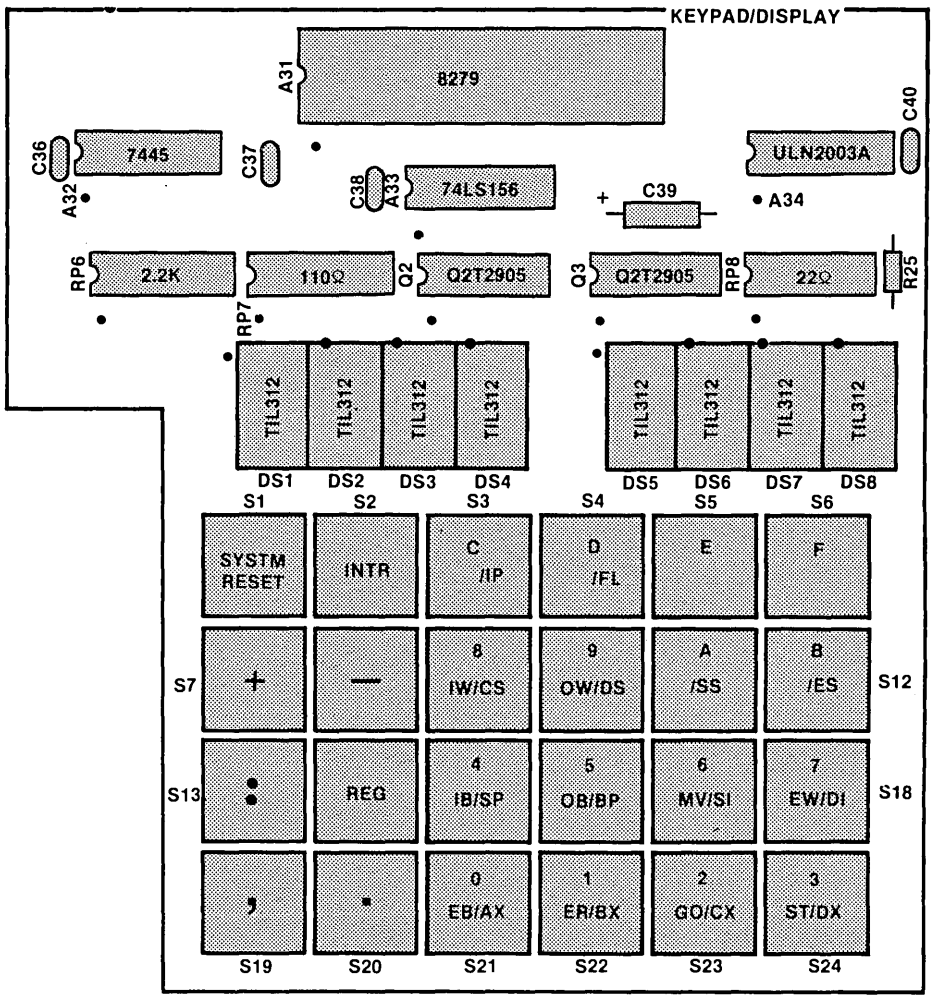


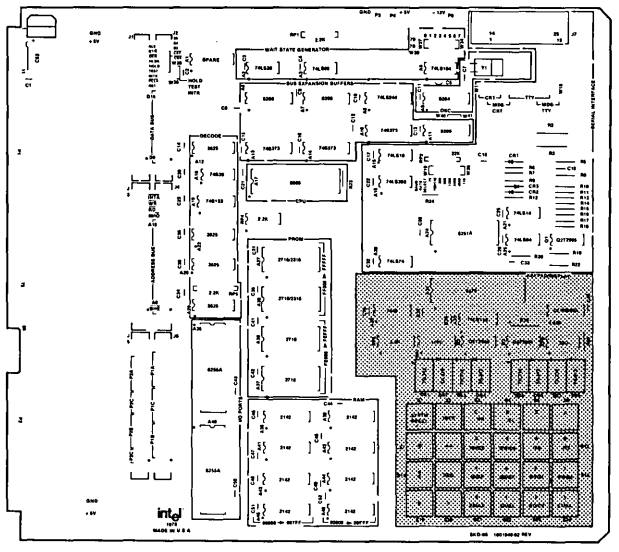
Insert a 0.1 μF ceramic capacitor at the following eight locations:

- ☐ C45
- ☐ C47
- ☐ C48
- ☐ C51
- ☐ C44
- ☐ C46
- ☐ C49
- ☐ C52

☐ Solder the eight capacitors in place and clip their leads.

ASSEMBLY OF THE KEYPAD/DISPLAY AREA





- ☐ Insert a 22 ohm (red-red-black) resistor at R25, solder it in place and clip its leads.
- ☐ Insert a 40-pin integrated circuit socket at A31 and solder it in place.
- ☐ Insert the 7445 integrated circuit at A32.
- ☐ Insert the 74LS156 integrated circuit at A33.
- ☐ Insert the ULN2003A or 75468 integrated circuit at A34.
- ☐ Solder the three integrated circuits in place.
- ☐ Insert a 2.2k ohm dual in-line resistor pack at RP6.

☐ Insert the 110 ohm dual in-line resistor pack at RP7.

☐ Insert the 22 ohm dual in-line resistor pack at RP8.

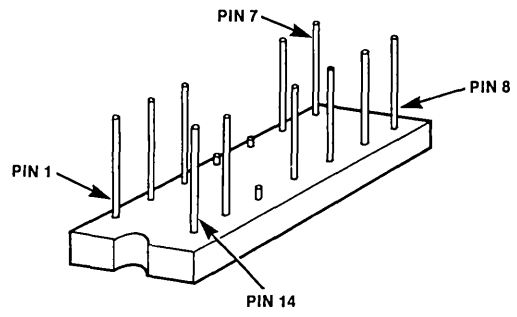
☐ Check the orientation of pin 1 on the three resistor packs and solder the packs in place.

☐ Insert a Q2T2905 transistor pack at Q2.

☐ Insert a Q2T2905 transistor pack at Q3.

☐ Solder the two transistor packs in place.

☐ In order to insert the eight 14-pin integrated circuit sockets into the board, three of the pins must first be clipped off. Using your diagonal wire cutters and referring to the following picture, clip pins 4, 5 and 12 as close to the socket as possible.



Insert a 14-pin integrated circuit socket at each of the following locations:

☐ DS1
☐ DS2
☐ DS3
☐ DS4
☐ DS5
☐ DS6
☐ DS7
☐ DS8

☐ Solder the eight sockets in place and, if necessary, clip their leads.

☐ Insert a 22 μF electrolytic capacitor at C39. Be sure to insert the positive lead of the capacitor into the pad marked with the "+" sign.

☐ Solder the capacitor in place and clip its leads.

Insert a 0.1 μF ceramic capacitor at the following four locations:

☐ C36
☐ C37
☐ C38
☐ C40

☐ Solder the four capacitors in place and clip their leads.

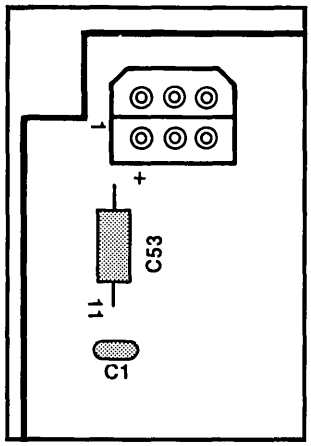
You now are ready to install the twenty-four pushbutton switches that make up the keypad. After slicing the skin-wrap around the switch set, it is suggested that you check the operation of each switch before soldering. To check a switch, take a resistance reading across the two pins with your volt-ohm-milliammeter. When the switch is not being pressed, the reading should be infinite, and when being pressed, the reading should be around zero ohms.

When installing the switches, it is recommended that you insert and solder a column of switches at a time. Be sure that the switches are in their proper positions, that they are right side up and that they are down completely on the board before soldering.

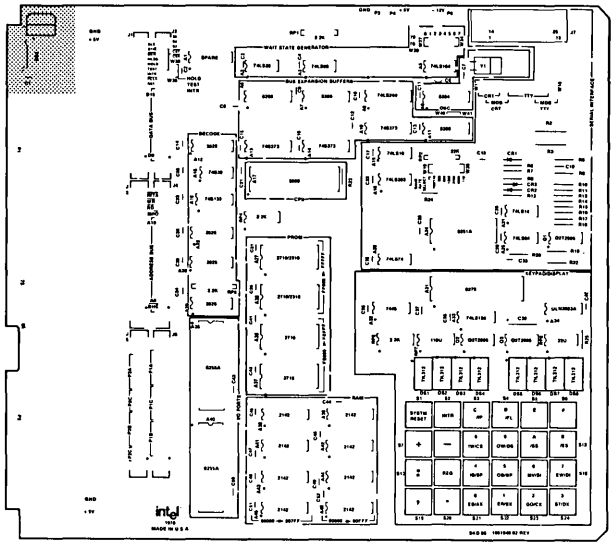
Insert and solder switches as follows:

☐ SYSTEM RESET	☐ INTR	☐ C /IP
☐ +	☐ -	☐ 8 IW/CS
☐ :	☐ REG	☐ 4 IB/SP
☐ ,	☐	☐ 0 EB/AX
☐ D /FL	☐ E	☐ F
☐ 9 OW/DS	☐ A /SS	☐ B /ES
☐ 5 OB/BP	☐ 6 MV/SI	☐ 7 EW/DI
☐ 1 ER/BX	☐ 2 GO/CX	☐ 3 ST/DX

ASSEMBLY OF PARTS IN UNMARKED AREAS



- ☐ Insert a 22 μF electrolytic capacitor at C53. Be sure to insert the positive lead of the capacitor into the pad marked with the "+" sign.
- ☐ Solder the capacitor in place and clip its leads.
- ☐ Insert a 0.1 μF ceramic capacitor at C1, solder it in place and clip its leads.



This completes all the soldering steps required for normal application of the kit. The four remaining 2-by 25-pin headers should be retained for user-designed CPU bus and parallel I/O port expansion. Proceed with the final assembly and checkout provided in Chapter 3.

CHAPTER 3
FINAL ASSEMBLY AND CHECKOUT

3-1. INTRODUCTION

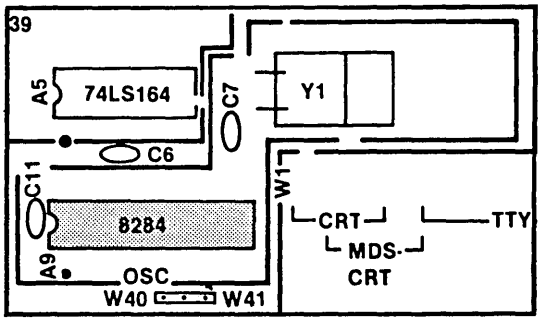
Now that you have completed soldering your kit, it's time to insert the rest of the parts into their sockets, to get your kit ready to test and, finally, to check your success.

3-2. INSERTING PARTS

Before you slice the skin-wrap from the rest of the parts, remember to observe the handling precautions for MOS integrated circuits. Large integrated circuits are fragile! Dropping, twisting or applying uneven pressure can break or permanently damage an integrated circuit. When inserting an integrated circuit into its socket, first make sure that the pins line up with the holes in the socket and then push the integrated circuit down into the socket with firm, even pressure. Once the pins start to go down into the socket, check to be sure that no pins have been bent and then push the circuit the rest of the way down.

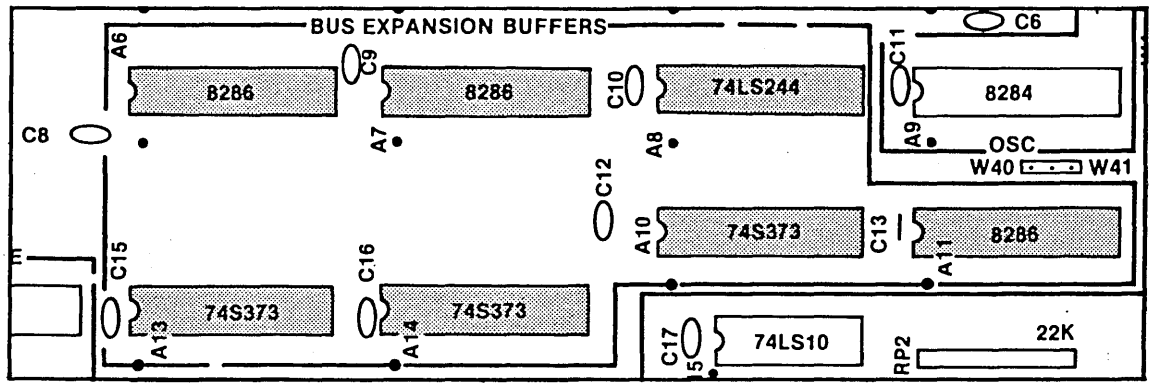
If you find that you must remove an integrated circuit from its socket, insert the blade of a small screwdriver between the integrated circuit and socket at one end and gently pry the circuit up a little. Insert the blade from the other end and again pry gently. Continue to pry from each end until the circuit is free.

8284 CLOCK GENERATOR



☐ Remove the skin-wrap from the 8284 Clock Generator. Following the precautions for handling MOS integrated circuits, insert the 8284 in socket A9.

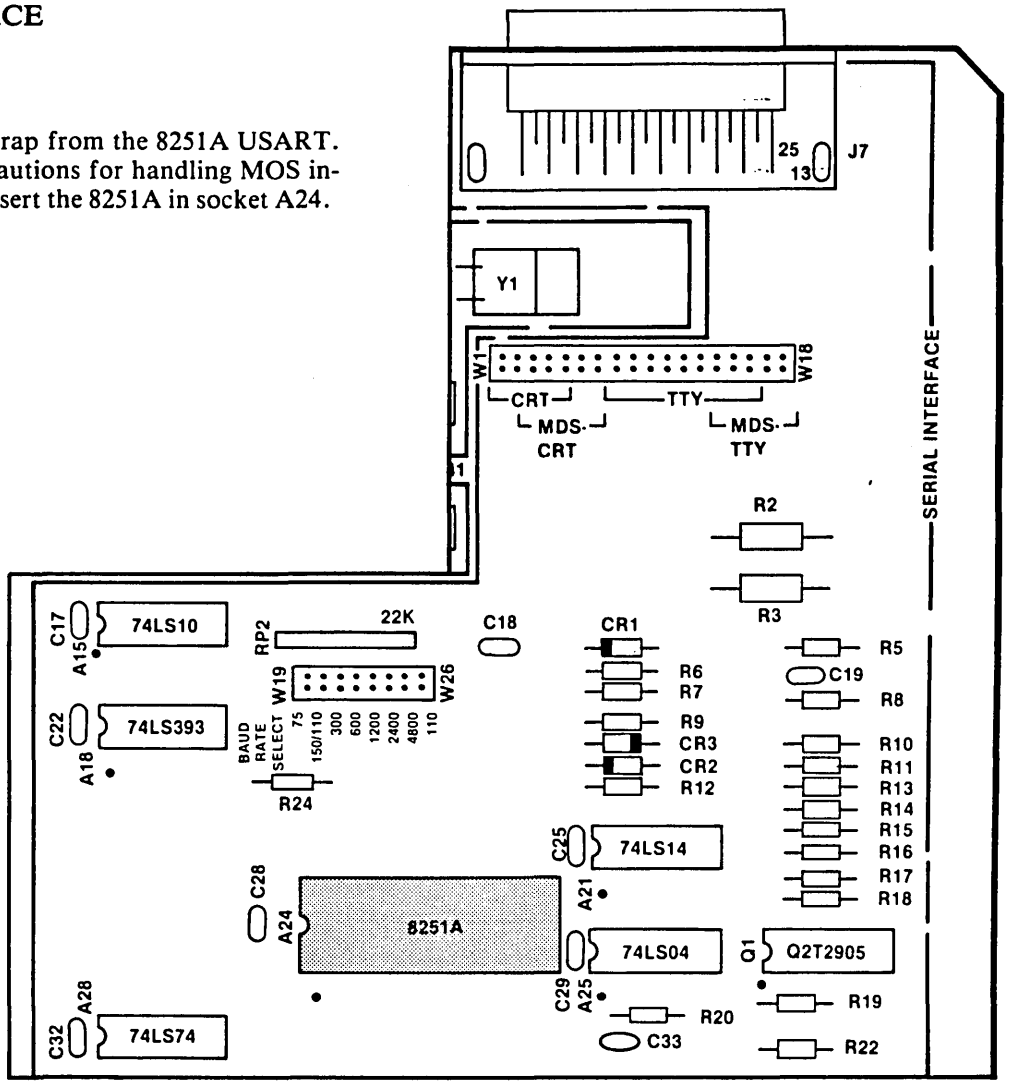
BUS EXPANSION BUFFERS



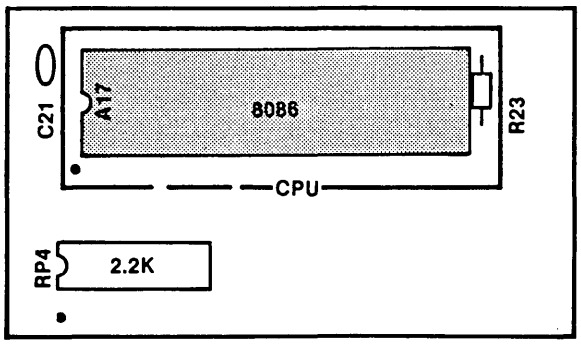
- ☐ Insert an 8286 or 8304 integrated circuit in socket A6.
- ☐ Insert an 8286 or 8304 integrated circuit in socket A7.
- ☐ Insert the 74LS244 integrated circuit in socket A8.
- ☐ Insert a 74S373 integrated circuit in socket A10.
- ☐ Insert an 8286 or 8304 integrated circuit in socket A11.
- ☐ Insert a 74S373 integrated circuit in socket A13.
- ☐ Insert a 74S373 integrated circuit in socket A14.

SERIAL INTERFACE

☐ Remove the skin-wrap from the 8251A USART. Following the precautions for handling MOS integrated circuits, insert the 8251A in socket A24.

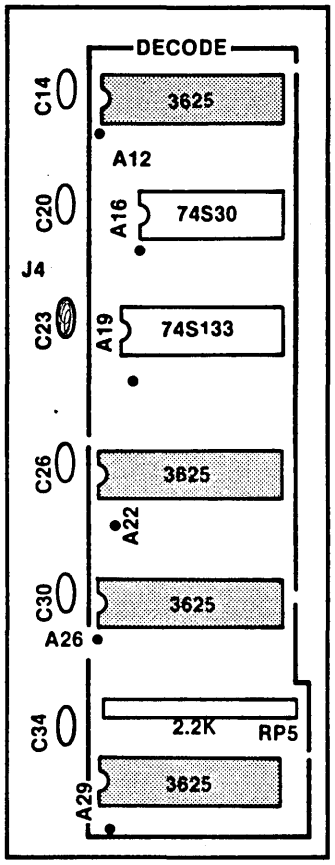


8086 CPU



☐ Remove the skin-wrap from the 8086 CPU. Following the precautions for handling MOS integrated circuits, insert the 8086 in socket A17.

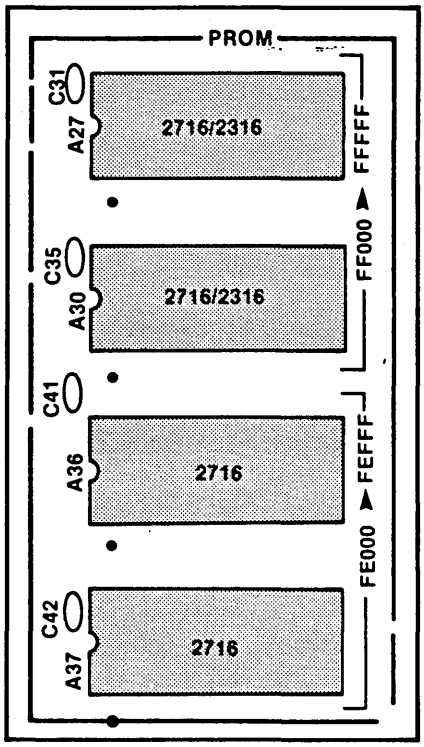
DECODER PROMS



Remove the skin-wrap from the four 3625 Decoder PROMs. Each PROM is marked with its corresponding socket location. Following the precautions for handling MOS integrated circuits, install the four Decoder PROMs as follows:

- ☐ Insert the PROM marked A12 (9100148) in socket A12. 101593
- ☐ Insert the PROM marked A22 (9100147) in socket A22. 101592
- ☐ Insert the PROM marked A26 (9100149) in socket A26. 101594
- ☐ Insert the PROM marked A29 (9100150) in socket A29. 101595

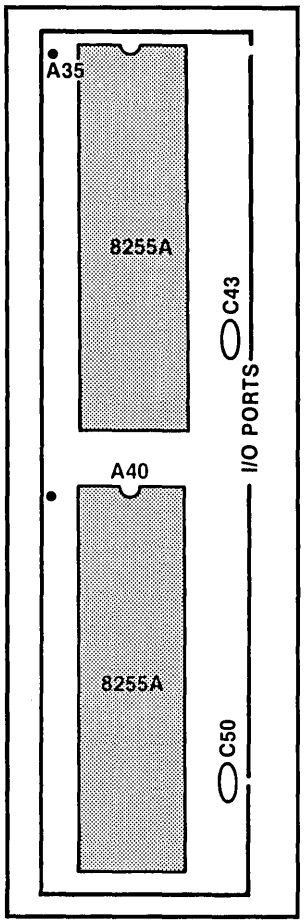
MONITOR ROMS



Remove the skin-wrap from the four 2316, 2616 or 2716 Monitor ROMs. The Monitor ROMs are in "matched" sets. The ROMs marked "9100167" and "9100168" (the KEYPAD ROMs) are a set, and the ROMs marked "104531-001" and "104532-001" (the SERIAL ROMs) are a set. Following the precautions for handling MOS integrated circuits, install the four ROMs as follows:

- ☐ Insert ROM 9100167 (KEYPAD A) in socket A27. 102042
- ☐ Insert ROM 9100168 (KEYPAD B) in socket A30. 102043
- ☐ Insert ROM 104531-001 (SERIAL A) in socket A36. 104531
- ☐ Insert ROM 104531-001 (SERIAL B) in socket A37. 104532

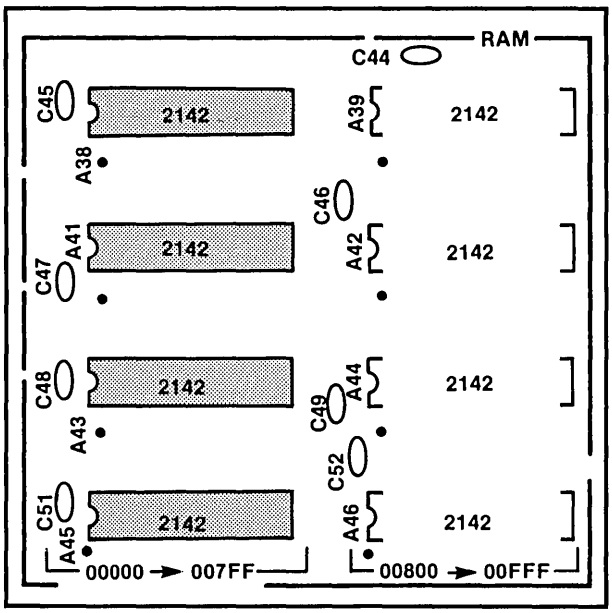
PARALLEL I/O



Remove the skin-wrap from the two 8255A Parallel I/O integrated circuits. Following the precautions for handling MOS integrated circuits, install an 8255A in each of the following two locations:

- ☐ A35
- ☐ A40

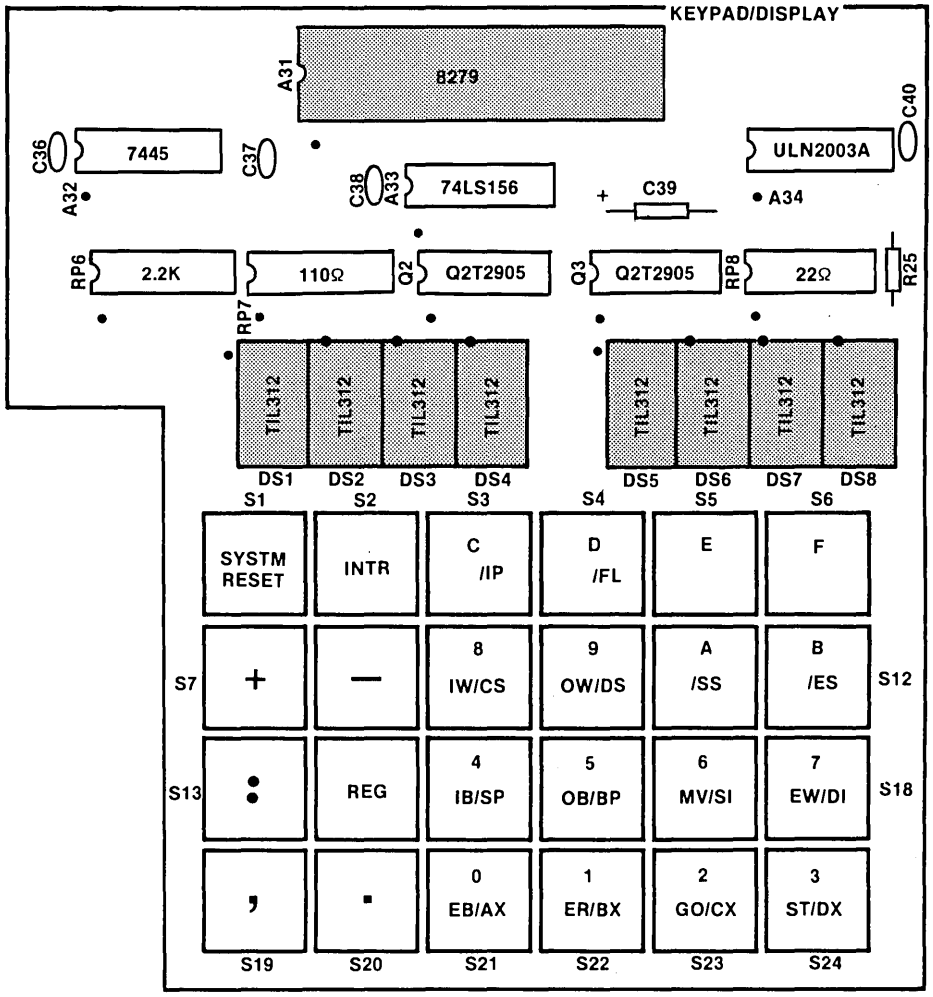
2142 RAMS



Remove the skin-wrap from the four 2142 RAM integrated circuits. Following the precautions for handling MOS integrated circuits, install a 2142 in each of the following four locations:

- ☐ A38
- ☐ A41
- ☐ A43
- ☐ A45

KEYBOARD/DISPLAY



☐ Remove the skin-wrap from the 8279 Keyboard Display Controller. Following the precautions for handling MOS integrated circuits, install the 8279 in socket A31.

Remove the skin-wrap from the eight Display elements and insert one element in each of the following locations (make sure that the decimal point on either side of the "8" is toward the keypad):

☐ DS1	☐ DS5
☐ DS2	☐ DS6
☐ DS3	☐ DS7
☐ DS4	☐ DS8

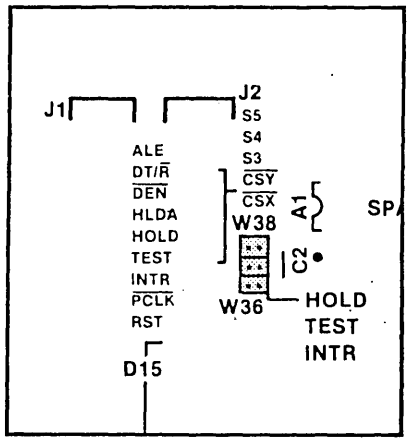
Notice that the Display elements do not go all the way down into the sockets; they insert only about 1/8 of an inch.

3-3. BOARD CONFIGURATION

Now that all of the electrical parts have been installed, a few of the shorting plugs must be inserted over certain header pins. Five of the sixteen shorting plugs will be required for basic operation; retain the remaining shorting plugs for later possible use.

At 2- by 3-pin header W36-W38 (to the left of the wait state generator):

- ☐ Insert a shorting plug at W36.
- ☐ Insert a shorting plug at W37.
- ☐ Insert a shorting plug at W38.

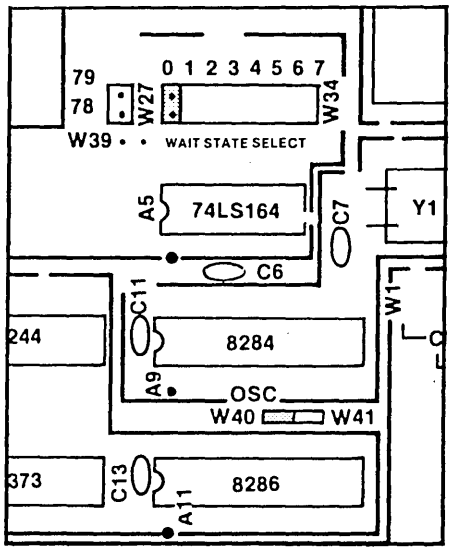


At 2- by 8-pin header W27-W34 (in the wait state area):

- ☐ Insert a shorting plug at W27.

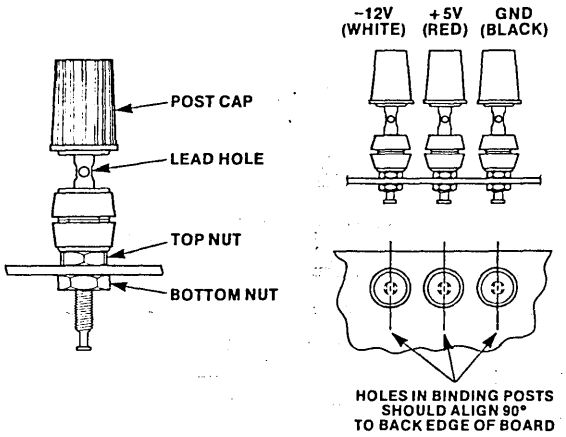
At 3-pin header W40, W41 (in the oscillator area):

- ☐ Insert a shorting plug at W40.



3-4. APPLYING POWER

The SDK-86 you have just assembled needs only an external dc source of +5 volts at 3.5 amperes for basic operation and checkout using the keypad and display. (A dc source of −12 volts will be needed if the serial I/O interface is to be used.) The black, red, and white binding posts provide a convenient method of connecting the power supplies to the board. Install the three binding posts as follows:



☐ Remove the bottom nut from all three binding posts. Using needle nose pliers, tighten the top nut (if necessary). Loosen (unscrew) the post cap on all three binding posts to expose the lead hole.

☐ Insert the white binding post through the −12V pad (P6). Install and tighten the bottom nut after making sure that the lead hole is oriented as shown.

☐ Insert the red binding post through the +5V pad (P4). Install and tighten the bottom nut after making sure that the lead hole is oriented as shown.

☐ Insert the black binding post through the GND pad (P3). Install and tighten the bottom nut after making sure that the lead hole is oriented as shown.

After you install the binding posts and before you connect the power supply, you should take a few resistance measurements to be sure that there are no shorts between the two supply inputs or between either supply input and ground. With your volt-ohm-milliammeter, measure the resistance between the following binding posts:

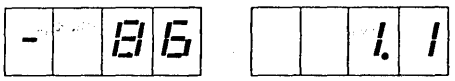
BINDING POSTS	TYPICAL RESISTANCE VALUES
+5V (P4) and GND (P3)	100 to 300 ohms
−12V (P6) and GND (P3)	2000 (2k) to 3000 (3k) ohms
+5V (P4) and −12V (P6)	2000 (2k) to 3000 (3k) ohms

CAUTION

If a short is present, the resistance reading will be near zero ohms. If this should happen, *do not connect the power supply!* Carefully check both the top and bottom of the board for solder bridges, pieces of wire or any conductive material that could cause a short.

If (or when) the resistance readings are OK, connect the power supply's positive 5 volt output to the +5V binding post (P4) and connect the supply's negative (common) output to the GND binding post (P3). Before you turn on the supply, place the red display filter temporarily on top of the display elements.

Turn on the power supply. If there are no major problems, you should see the following sign-on message on the display:



The number in the data field (1.1) denotes the current version of the keypad monitor program supplied with your kit. This number is subject to change to denote subsequent program revision.

NOTE

If random segments light up on the display elements, it's possible that you have reversed the positions of the two KEYPAD ROMs. Check to be sure that ROM 9100167 has been inserted into the socket at A27 and that ROM 9100168 has been inserted into the socket at A30.

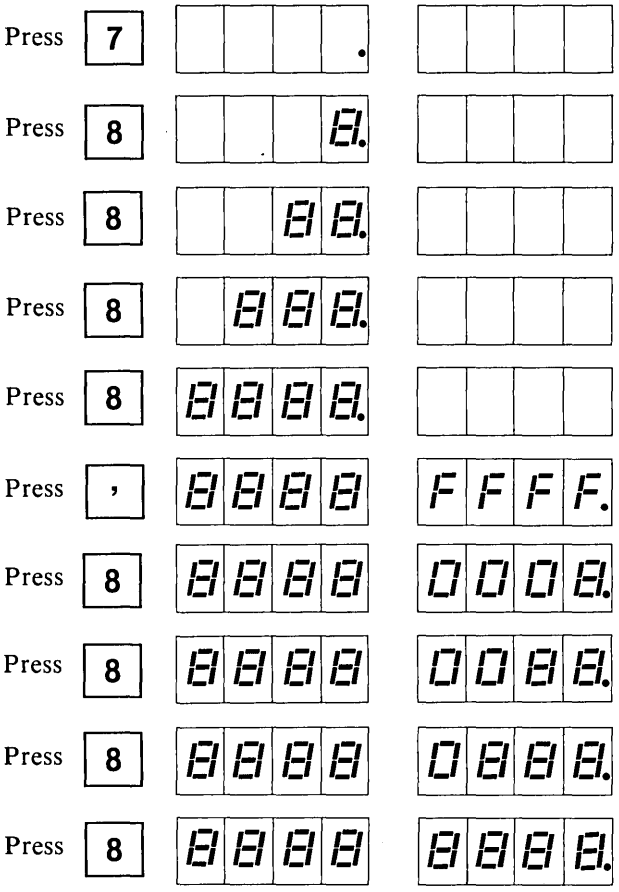
3-5. CHECKOUT PROCEDURE

The following checkout procedures are intended only to verify the operation of the display and the keypad switches.

DISPLAY ELEMENT CHECKOUT

The following keying sequence checks to be sure that each segment of each display element lights up.

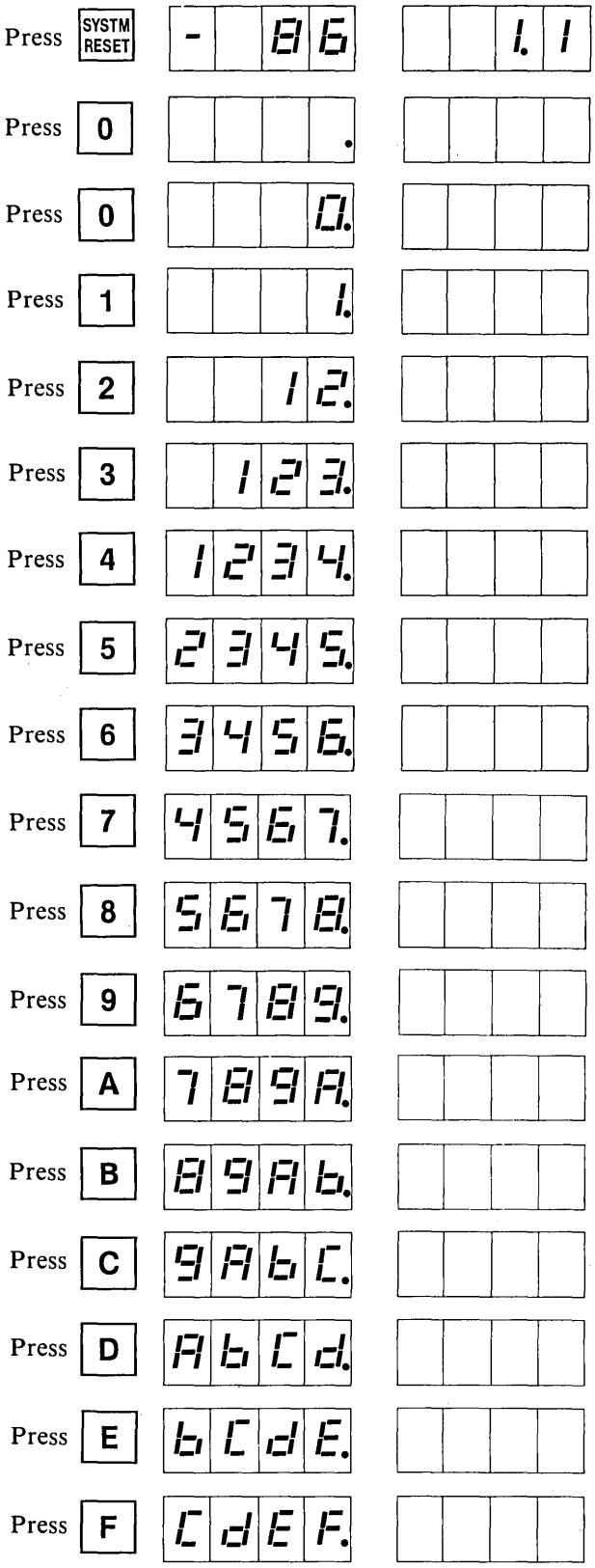
Press SYSTM RESET — The display will go out (blank) while the switch is depressed and will repeat the sign-on message when released.



If each segment of each element lights up, the red display filter can be mounted permanently in place. To mount the display filter, remove the covering from one side of each of the adhesive strips. Stick an adhesive strip across the bottom and across the top of each set of display elements and then remove the covering from the top of each strip. Remove the protective covering from the red display filter, center the filter over the display elements and push the filter down onto the adhesive strips.

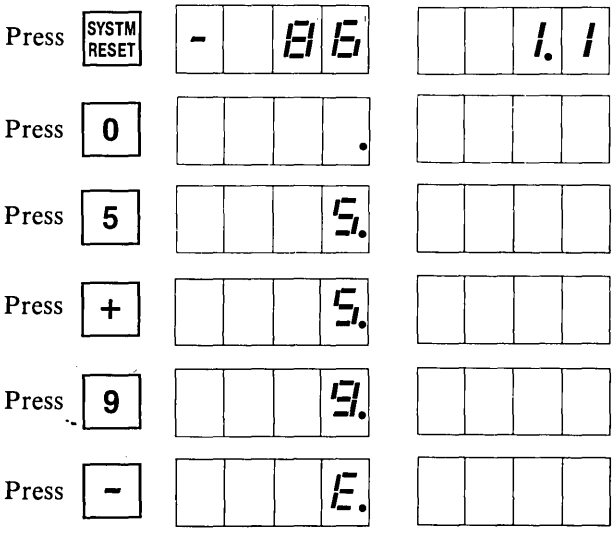
HEXADECIMAL KEYPAD CHECKOUT

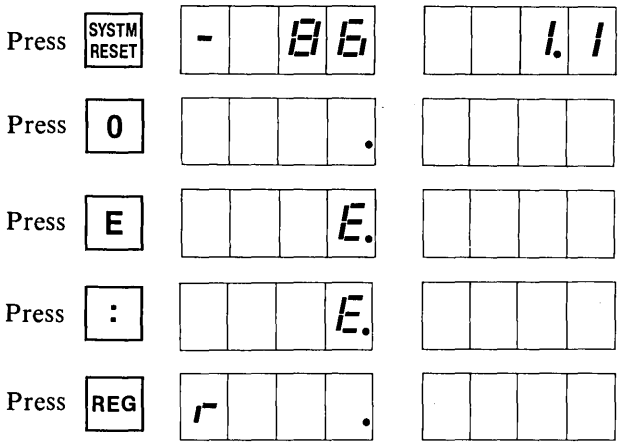
The following keying sequence checks to be sure that each of the sixteen hexadecimal keys function.



FUNCTION KEY CHECKOUT

The following keying sequence checks a number of the function keys.





Press 0 The left four display elements will light up with four hexadecimal characters.

This concludes the checkout procedures. Refer to the *SDK-86 User's Manual* for overall operation of your MCS-86 System Design Kit.

REQUEST FOR READER'S COMMENTS

The Microcomputer Division Technical Publications Department attempts to provide documents that meet the needs of all Intel product users. This form lets you participate directly in the documentation process.

Please restrict your comments to the usability, accuracy, readability, organization, and completeness of this document.

1. Please specify by page any errors you found in this manual.

2. Does the document cover the information you expected or required? Please make suggestions for improvement.

3. Is this the right type of document for your needs? Is it at the right level? What other types of documents are needed?

4. Did you have any difficulty understanding descriptions or wording? Where?

5. Please rate this document on a scale of 1 to 10 with 10 being the best rating. _____

NAME _____ DATE _____
TITLE _____
COMPANY NAME/DEPARTMENT _____
ADDRESS _____
CITY _____ STATE _____ ZIP CODE _____

Please check here if you require a written reply. ☐

WE'D LIKE YOUR COMMENTS . . .

This document is one of a series describing Intel products. Your comments on the back of this form will help us produce better manuals. Each reply will be carefully reviewed by the responsible person. All comments and suggestions become the property of Intel Corporation.

First Class
Permit No. 1040
Santa Clara, CA

BUSINESS REPLY MAIL

No Postage Stamp Necessary if Mailed in U.S.A.

Postage will be paid by:

Intel Corporation
3065 Bowers Avenue
Santa Clara, CA 95051

Attention: Technical Publications

INTEL CORPORATION, 3065 Bowers Avenue, Santa Clara, California 95051 (408) **987-8080**

Printed in U.S.A.