

**Tektronix®**  
COMMITTED TO EXCELLENCE

**832**  
**Data Comm**  
**Tester**  
**With Options**

INSTRUCTION MANUAL

Tektronix, Inc.  
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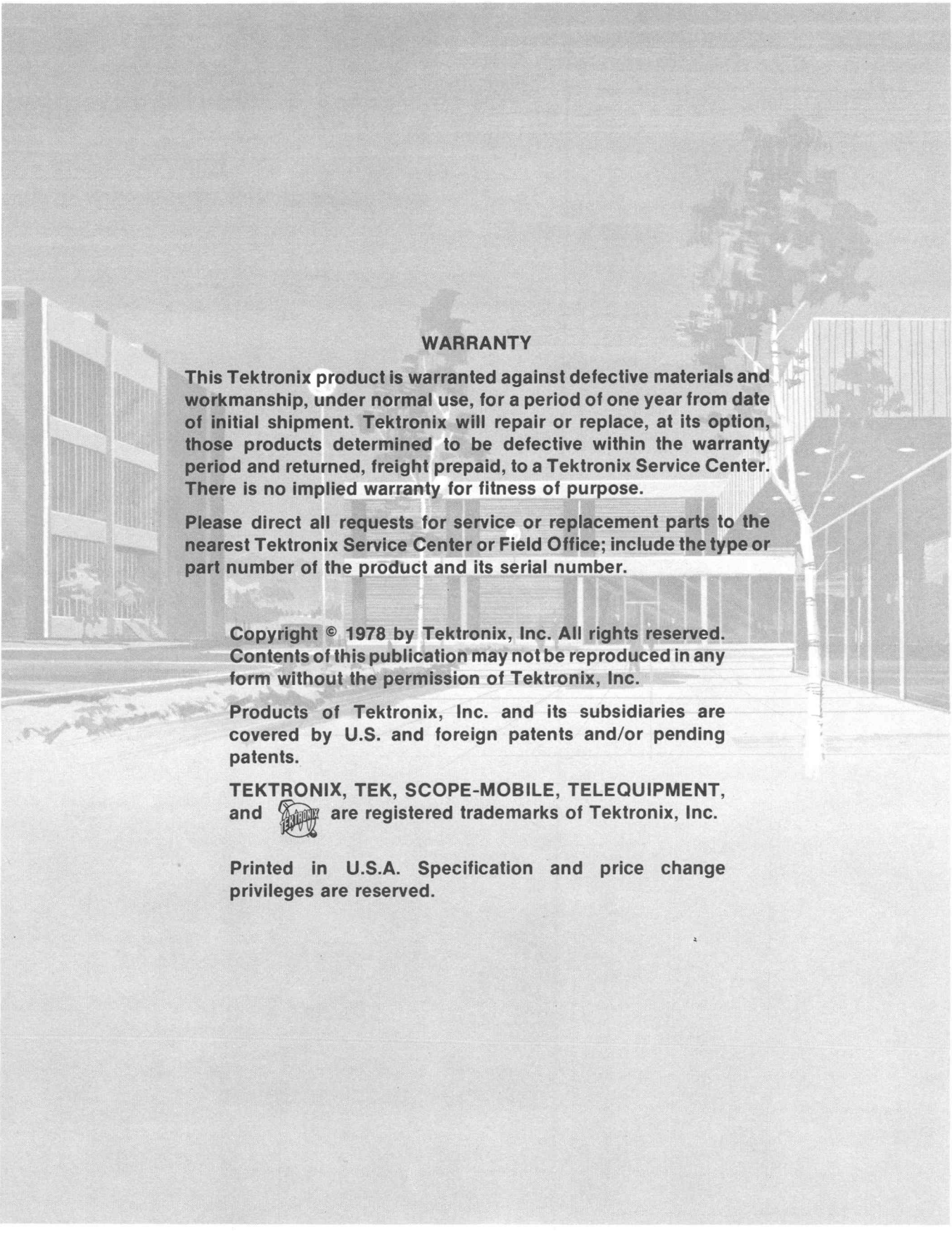
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## WARNING

THE REMAINING PORTION OF THIS TABLE OF CONTENTS LISTS THE SERVICING INSTRUCTIONS. THESE SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRICAL SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CALLED OUT IN THE OPERATING INSTRUCTIONS UNLESS QUALIFIED TO DO SO.

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# OPERATORS SAFETY SUMMARY

The general safety information in this part of the summary is for both operating and servicing personnel. Specific warnings and cautions will be found throughout the manual where they apply, but may not appear in this summary.

## TERMS

### In This Manual

CAUTION statements identify conditions or practices that could result in damage to the equipment or other property.

WARNING statements identify conditions or practices that could result in personal injury or loss of life.

### As Marked on Equipment

CAUTION indicates a personal injury hazard not immediately accessible as one reads the marking, or a hazard to property including the equipment itself.

DANGER indicates a personal injury hazard immediately accessible as one reads the marking.

## SYMBOLS

### In This Manual

 This symbol indicates where applicable cautionary or other information is to be found.

### As Marked on Equipment

 DANGER — High voltage.

 Protective ground (earth) terminal.

 ATTENTION — refer to manual.

### Grounding the Product

This product is grounded through the grounding conductor of the power cord. To avoid electrical shock, plug the power cord into a properly wired receptacle before connecting to the product input or output terminals. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

### Use the Proper Power Cord

Use only the power cord and connector specified for your product.  
Use only a power cord that is in good condition.

For detailed information on power cords and connectors, see Figure 2-4 on page 2-3.

Refer cord and connector changes to qualified service personnel.

**Use the Proper Fuse**

To avoid fire hazard, use only the fuse specified in the parts list for your product, and which is identical in type, voltage rating, and current rating.

Refer fuse replacement to qualified service personnel.

**Do Not Operate in Explosive Atmospheres**

To avoid explosion, do not operate this product in an atmosphere of explosive gases unless it has been specifically certified for such operation.

**Do Not Remove Covers or Panels**

To avoid personal injury, do not remove the product covers or panels. Do not operate the product without the covers and panels properly installed.

## **SERVICING SAFETY SUMMARY**

### ***FOR QUALIFIED SERVICE PERSONNEL ONLY***

*Refer also to the preceding Operators Safety Summary.*

**Do Not Service Alone**

Do not perform internal service or adjustment of this product unless another person capable of rendering first aid and resuscitation is present.

**Use Care When Servicing With Power On**

Dangerous voltages exist at several points in this product. To avoid personal injury, do not touch exposed connections and components while power is on.

Disconnect power before removing protective panels, soldering, or replacing components.

**Power Source**

This produce is intended to operate from a power source that will not apply more than 250 volts rms between the supply conductors or between either supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.



The 832 Data Comm Tester.

# GENERAL INFORMATION

## INTRODUCTION

### DESCRIPTION

The 832 Data Comm Tester is a portable instrument for monitoring, analyzing, testing and troubleshooting data communications interfaces that conform to EIA Standard RS-232 or C.C.I.T.T. V.24 (The International Telegraph and Telephone Consultative Committee). Figure 1-1 shows the typical location of an interface within a data communications system.

The 832 can operate as a serial data transmission monitor or as a modem simulator for off-line testing of Data Terminal Equipment (DTE). Microprocessor control, 256-character buffer storage, LED displays, prerecorded test messages, and an easy-to-operate keypad enable users to quickly configure and execute customized tests and view the results in seconds. When the tester is connected into an interface, or to Data Terminal Equipment, an interface Breakout Panel gives the user direct access to the interface lines.

Self-contained routines provide users with easy-to-select and operate instrument self tests for checking the operation of the 832. Other more detailed self tests provide service technicians with a means to rapidly troubleshoot and repair the instrument.

The control panel cover and a separate bottom compartment provide storage space for standard accessories, except for the Service manual.

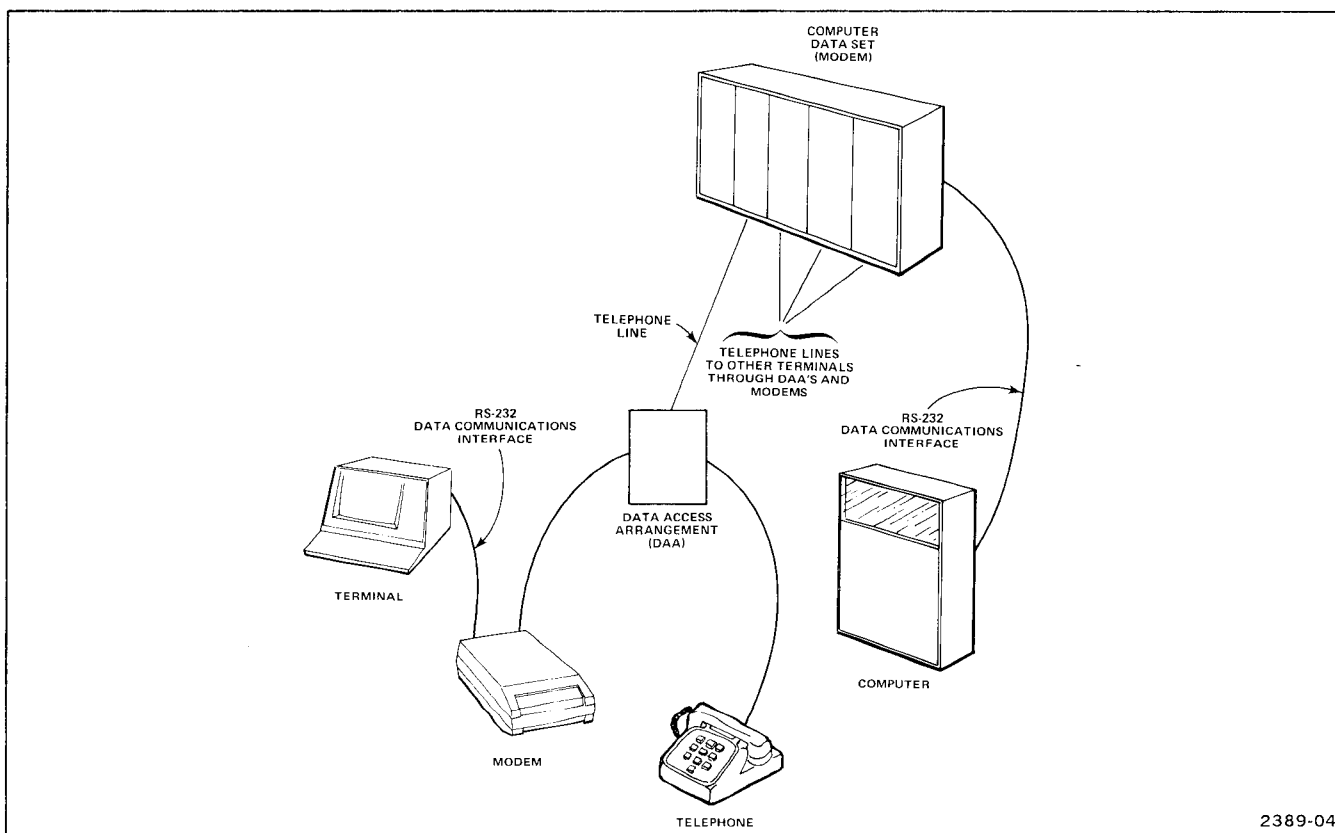


Figure 1-1. RS-232 interfaces of a typical terminal-to-computer dial-up data communications link.

## MODES OF OPERATION

The 832 has two modes of operation:

Serial Data Transmission Monitor

Modem Simulator

### Serial Data Transmission Monitor

Connected as shown in Figure 1-2A, the 832 monitors and records the activity of an interface without interfering with that interface. Recording occurs on user programmed trigger characters or START/STOP key command. Once data is stored, it can be selectively recalled and displayed on a digital readout and signal line status indicators for analysis.

### Modem Simulator

Connected as shown in Figure 1-2B, the 832 performs as a Data Communications Equipment (DCE — modem simulator for testing Data Terminal Equipment (DTE). Simulation testing is done in one of three modes:

**SIMULATE.** The tester records data, sends a message to the DTE once and records the DTE response for analysis.

**ECHO.** Same as SIMULATE, except the tester sends back to the DTE (echoes), any character sent by the DTE. This mode is intended primarily for asynchronous communications links.

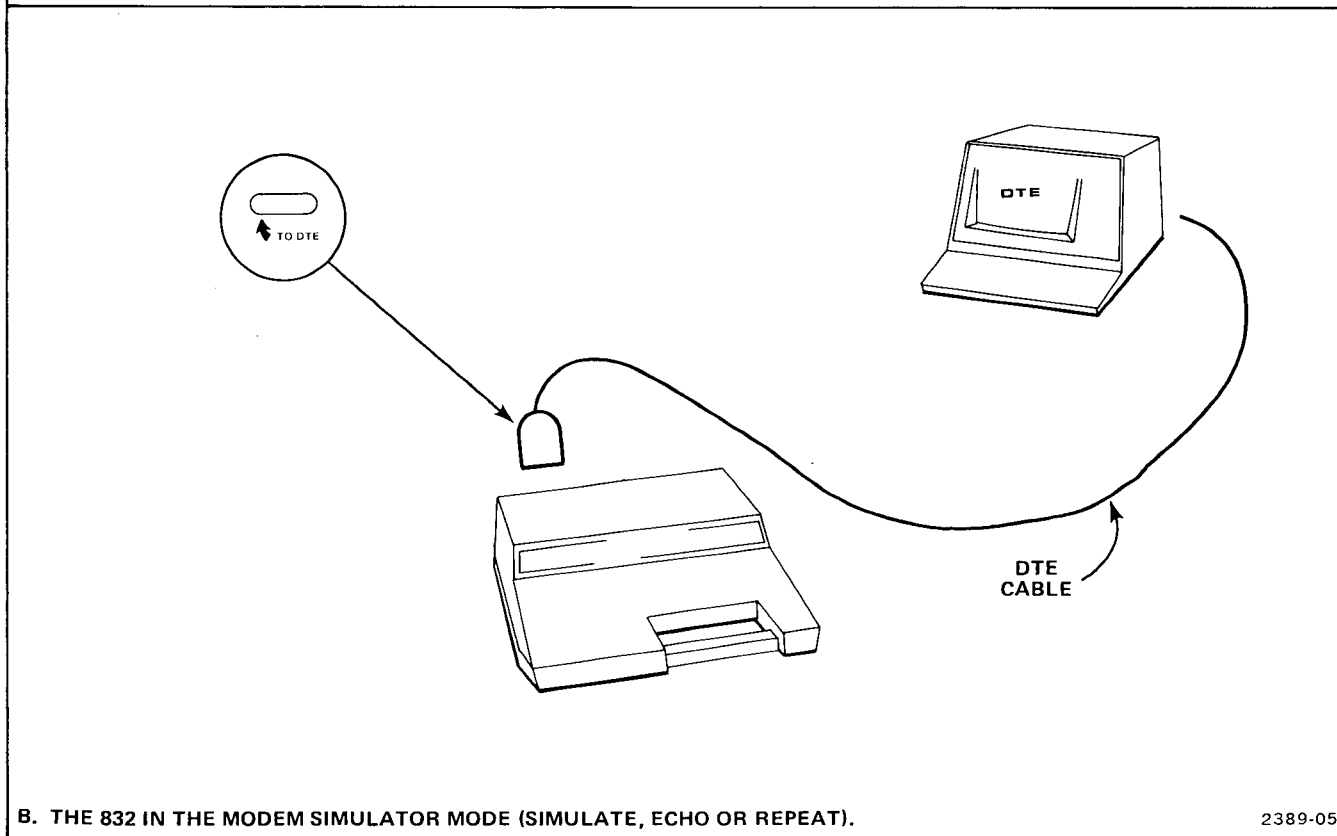
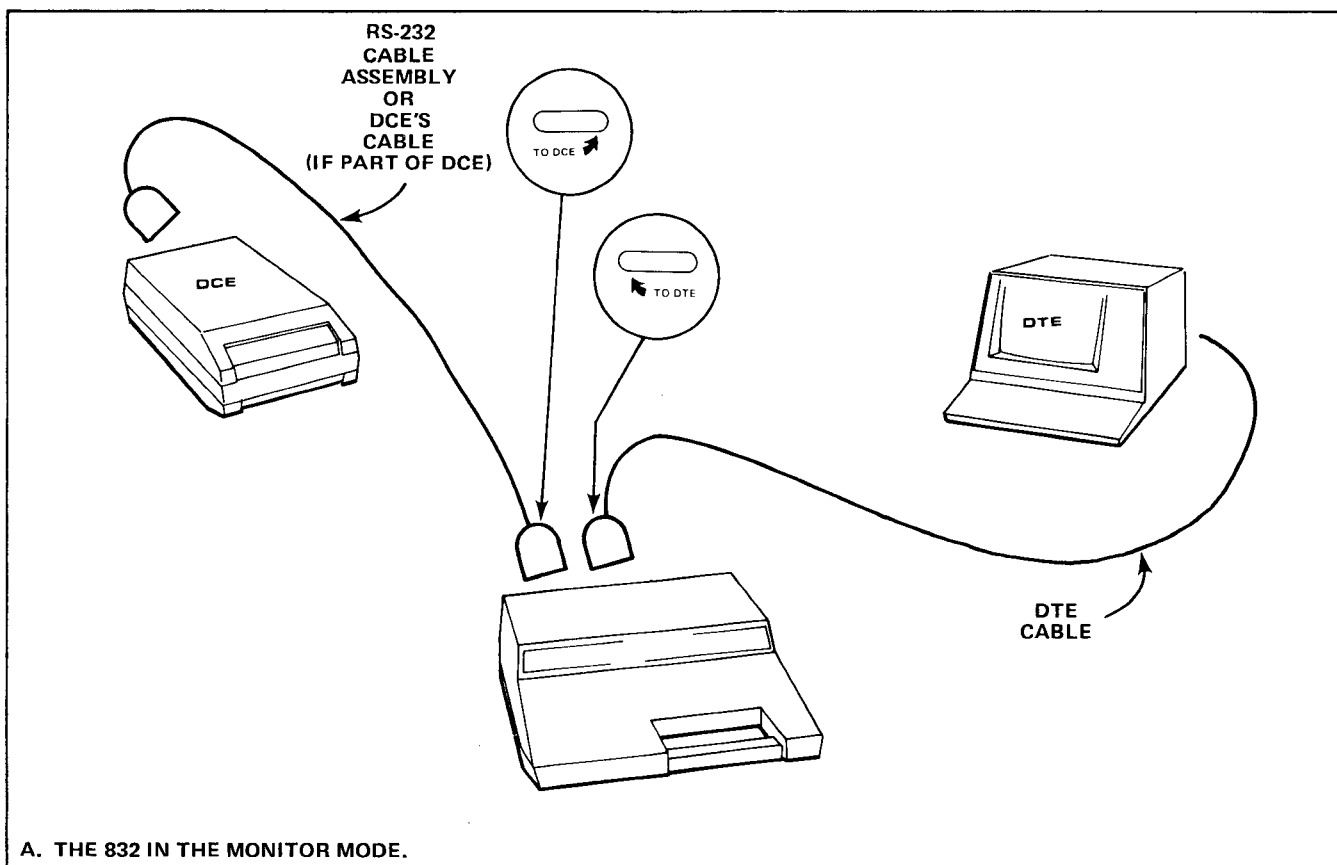
**REPEAT.** Similar to SIMULATE, except the tester sends a message to the DTE once, then once again each time a user programmed trigger occurs, or repeatedly if there is no trigger programmed.

## COMMUNICATIONS PARAMETERS

Most of the communications parameters of the 832 can be selected or programmed by the user. These parameters seldom need to be changed once they are set up for a particular application. The significant parameters are:

|                               |                                                                                                                                                                                                        |
|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Data Transfer Rate            | <p>832 provided:</p> <p>50, 75, 110, 134.5, 150, 200, 300, 600, 1200, 1800, 2400 and 4800 baud (bits per second).<br/>9600 baud at 8 BITS/CHAR only.</p> <p>Externally provided: DCE or DTE clock.</p> |
| Communications Mode           | Half or full duplex.                                                                                                                                                                                   |
| Data Transmission Timing      | Synchronous or asynchronous.                                                                                                                                                                           |
| Bits Per Character            | 5, 6, 7, or 8 (includes PARITY bit, if selected).                                                                                                                                                      |
| Parity                        | Odd, even, or none.                                                                                                                                                                                    |
| Synchronizing Character (SYN) | Programmable or ASCII SYN default.                                                                                                                                                                     |
| Stop Bits                     | Responds to 1 or more; transmits 2.                                                                                                                                                                    |
| Line Turnaround Delay         | Programmable up to 255 milliseconds or defaults to 200 milliseconds.                                                                                                                                   |





2389-05

Figure 1-2. The modes of operation for the 832.

# SPECIFICATIONS

Tables 1-1 through 1-3 list the electrical, environmental and physical characteristics of the instrument. The electrical characteristics are valid under these conditions: (1) the instrument has been adjusted as described in Section 7 (Performance Check and Calibration) at an ambient temperature between +20 and +30 degrees Centigrade (+68 to +86 degrees Fahrenheit); (2) the instrument is operating in an ambient temperature between 0 and +50 degrees Centigrade (+32 to +122 degrees Fahrenheit); and (3) the instrument has warmed up for at least five minutes.

**TABLE 1-1**  
**Electrical Characteristics**

| Characteristic                                           | Performance Requirement                                                                                                              |              |                          |
|----------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|--------------|--------------------------|
| OPERATING CHARACTERISTICS                                |                                                                                                                                      |              |                          |
| Data Transmission Timing                                 | Synchronous and asynchronous.                                                                                                        |              |                          |
| Communications Mode                                      | Half-duplex or full-duplex.                                                                                                          |              |                          |
| Bits Per Character                                       | 5, 6, 7, or 8. Includes parity bit if selected; 5 cannot be selected with parity.                                                    |              |                          |
| Data Transfer Rates                                      | 50, 75, 110, 134.5, 150, 200, 300, 600, 1200, 1800, 2400 and 4800 baud (bits per second).<br>9600 baud at 8 bits per character only. |              |                          |
| Internal (crystal controlled)                            |                                                                                                                                      |              |                          |
| Accuracy                                                 | Within 0.5%.                                                                                                                         |              |                          |
| External                                                 | Determined by the DCE or DTE clock.                                                                                                  |              |                          |
|                                                          | External clock sources (from RS-232 interface):                                                                                      |              |                          |
|                                                          | Mode                                                                                                                                 | RDATA Timing | TDATA Timing             |
|                                                          | Monitor                                                                                                                              | DCE—Pin 17   | DCE—Pin 15<br>DTE—Pin 24 |
|                                                          | Simulate, Echo, and Repeat                                                                                                           | DTE—Pin 24   | DTE—Pin 24               |
| Parity                                                   | Odd, even, or none. Parity cannot be selected with 5 BITS/CHAR.                                                                      |              |                          |
| Synchronizing Character<br>(SYN) (Synchronous Mode only) | Programmable to require one character, or two equal characters. If not programmed, defaults to ASCII SYN character.                  |              |                          |

TABLE 1-1 (cont)

| Characteristic                          | Performance Requirement                                                                   |
|-----------------------------------------|-------------------------------------------------------------------------------------------|
| <b>OPERATING CHARACTERISTICS (cont)</b> |                                                                                           |
| RTS/CTS Delay (Half-duplex Mode only)   | Programmable from 0 to 255 milliseconds. If not programmed, defaults to 200 milliseconds. |
| Accuracy                                | Within 1% $\pm$ 1 millisecond.                                                            |
| Stop Bits (Asynchronous Mode only)      | Responds to one or more. Transmits 2.                                                     |
| Trigger                                 | Programmable to require a sequence of 1, 2, or 3 characters.                              |
| Trigger Position                        | Location of last trigger character in the RECV Buffer:                                    |
| Post Trigger or Start                   | 000                                                                                       |
| Center Trigger                          | 127                                                                                       |
| Pre Trigger or Stop                     | 255                                                                                       |

**NOTE**

RS-232 Signal Definitions:

| Notation            | Interface Voltage |          |
|---------------------|-------------------|----------|
|                     | Negative          | Positive |
| Signal Condition    | Mark              | Space    |
| Binary State (Data) | 1                 | 0        |
| Function (Control)  | OFF               | ON       |

**RS-232 DCE CONNECTOR**

|                                                        |                                                                         |
|--------------------------------------------------------|-------------------------------------------------------------------------|
| Inputs:                                                |                                                                         |
| Pin 3 Received Data                                    | MARK or OFF: $-25\text{ V} \leq V_{in} \leq +0.75\text{ V}$ .           |
| Pin 5 Clear To Send                                    | SPACE or ON: $+1.5\text{ V} \leq V_{in} \leq +25\text{ V}$ .            |
| Pin 6 Data Set Ready                                   | Input Impedance: $3\text{ k}\Omega \leq Z_{in} \leq 7\text{ k}\Omega$ . |
| Pin 8 Data Carrier Detect                              |                                                                         |
| Pin 15 Transmission Signal Element Timing (DCE source) |                                                                         |
| Pin 17 Receiver Signal Element Timing (DCE source)     |                                                                         |

TABLE 1-1 (cont)

| Characteristic                                       | Performance Requirement                                                                                                                                                                                                       |
|------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>RS-232 DCE CONNECTOR (cont)</b>                   |                                                                                                                                                                                                                               |
| Inputs (cont):                                       |                                                                                                                                                                                                                               |
| Pin 20 Data Terminal Ready                           | MARK or OFF: $-25\text{ V} \leq V_{in} \leq -3\text{ V}$ .                                                                                                                                                                    |
| Pin 24 Transmit Signal Element Timing (DTE source)   | SPACE or ON: $+3\text{ V} \leq V_{in} \leq +25\text{ V}$ .<br><br>Input impedance with corresponding pin in DTE connector disconnected:<br>pin 20 $Z_{in} > 40\text{ k}\Omega$ .<br>pin 24 $Z_{in} \geq 100\text{ k}\Omega$ . |
| Outputs:                                             |                                                                                                                                                                                                                               |
| Pin 2 Transmitted Data                               | MARK or OFF: $V_{out} \leq -7.5\text{ V}$ .                                                                                                                                                                                   |
| Pin 4 Request To Send                                | SPACE or ON: $V_{out} \geq +7.5\text{ V}$ .<br><br>With Load Impedance: $R_L \geq 3\text{ k}\Omega$ .                                                                                                                         |
| Other:                                               |                                                                                                                                                                                                                               |
| Pin 1 Ground                                         | Connected to pin 1 of DTE connector.                                                                                                                                                                                          |
| Pin 7 Signal Ground                                  | Connected to instrument ground.                                                                                                                                                                                               |
| Pins 9 through 14, 16, 18, 19, 21 through 23, and 25 | Connected through switches (Breakout Panel DIP switches) to their corresponding pins in the DTE connector.                                                                                                                    |

**RS-232 DTE CONNECTOR**

|                                                    |                                                                                                                                                                            |
|----------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Inputs:                                            |                                                                                                                                                                            |
| Pin 2 Transmitted Data                             | MARK or OFF: $-25\text{ V} \leq V_{in} \leq +0.75\text{ V}$ .                                                                                                              |
| Pin 4 Request To Send                              | SPACE or ON: $+1.5\text{ V} \leq V_{in} \leq +25\text{ V}$ .<br><br>Input Impedance: $3\text{ k}\Omega \leq Z_{in} \leq 7\text{ k}\Omega$ .                                |
| Pin 20 Data Terminal Ready                         | MARK or OFF: $-25\text{ V} \leq V_{in} \leq -3\text{ V}$ .                                                                                                                 |
| Pin 24 Transmit Signal Element Timing (DTE source) | SPACE or ON: $+3\text{ V} \leq V_{in} \leq +25\text{ V}$ .<br><br>Input Impedance with corresponding pin in DCE connector disconnected: $Z_{in} \geq 100\text{ k}\Omega$ . |

TABLE 1-1 (cont)

| Characteristic                                         | Performance Requirement                                                                                    |
|--------------------------------------------------------|------------------------------------------------------------------------------------------------------------|
| <b>RS-232 DTE CONNECTOR (cont)</b>                     |                                                                                                            |
| Outputs:                                               |                                                                                                            |
| Pin 3 Received Data                                    | MARK or OFF: $V_{out} \leq -7.5 \text{ V}$ .                                                               |
| Pin 5 Clear To Send                                    | SPACE or ON: $V_{out} \geq +7.5 \text{ V}$ .                                                               |
| Pin 6 Data Set Ready                                   | With Load Impedance: $R_L \geq 3 \text{ k}\Omega$ .                                                        |
| Pin 8 Data Carrier Detect                              |                                                                                                            |
| Pin 15 Transmission Signal Element Timing (DCE source) |                                                                                                            |
| Pin 17 Receiver Signal Element Timing (DCE source)     |                                                                                                            |
| Other:                                                 |                                                                                                            |
| Pin 1 Ground                                           | Connected to pin 1 of DCE connector.                                                                       |
| Pin 7 Signal Ground                                    | Connected to instrument ground.                                                                            |
| Pins 9 through 14, 16, 18, 19, 21 through 23, and 25   | Connected through switches (Breakout Panel DIP switches) to their corresponding pins in the DCE connector. |

**BREAKOUT PANEL**

|                  |                                                              |
|------------------|--------------------------------------------------------------|
| PROBE Indicator  |                                                              |
| SPACE            | $+3 \text{ V} \leq V_{in} \leq +25 \text{ V}$ .              |
| MARK             | $-25 \text{ V} \leq V_{in} \leq -3 \text{ V}$ .              |
| Input Impedance  | $\geq 50 \text{ k}\Omega$ .                                  |
| MARKER Indicator |                                                              |
| Off              | MARK or OFF: $-25 \text{ V} \leq V_{in} \leq -3 \text{ V}$ . |
| On               | SPACE or ON: $+3 \text{ V} \leq V_{in} \leq +25 \text{ V}$ . |
| +12 Volt Source  | $+12 \text{ V} \pm 1 \text{ V}$ (no load).                   |
| Output Impedance | Approximately $3 \text{ k}\Omega$ (each pin).                |
| −12 Volt Source  | $-12 \text{ V} \pm 1 \text{ V}$ (no load).                   |
| Output Impedance | Approximately $3 \text{ k}\Omega$ (each pin).                |

TABLE 1-1 (cont)

| Characteristic            | Performance Requirement |
|---------------------------|-------------------------|
| <b>POWER REQUIREMENTS</b> |                         |
| Line Voltage Ranges       |                         |
| 115 V                     | 90 to 132 volts.        |
| 230 V                     | 180 to 250 volts.       |
| Line Frequency Range      | 48 to 440 hertz.        |
| Power Consumption         | Approximately 15 watts. |

TABLE 1-2

## Environmental Characteristics

| Characteristic | Performance Requirement                                                                                                                                                                                      |
|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Temperature    |                                                                                                                                                                                                              |
| Operating      | 0° to +50° C (+32° to +122° F).                                                                                                                                                                              |
| Nonoperating   | –55° to +75° C (–67° to +167° F).                                                                                                                                                                            |
| Humidity       | 5 cycles (120 hours), 30° to 60° C, 95% relative humidity.                                                                                                                                                   |
| Altitude       |                                                                                                                                                                                                              |
| Operating      | To 15,000 feet (4500 m).                                                                                                                                                                                     |
| Nonoperating   | To 50,000 feet (15,000 m).                                                                                                                                                                                   |
| Vibration      | Cycled from 10 to 55 to 10 Hz for a duration of 15 minutes in each major axis at a displacement of 0.025 inches (0.64 mm) peak to peak. Dwelled for 10 minutes in each major axis at any resonant frequency. |
| Shock          | 50 g's, 1/2-sine, 11 ms duration, three shocks in each major axis for a total of 18 shocks.                                                                                                                  |

TABLE 1-3  
Physical Characteristics

| Characteristic           | Description                                                             |
|--------------------------|-------------------------------------------------------------------------|
| Overall Dimensions       | See Dimensional drawing, Figure 1-3.                                    |
| Weight (instrument only) | Not more than 11 pounds (4.95 kg).                                      |
| Transportation           | Meets the limits of National Safe Transit Committee test procedures 1A. |

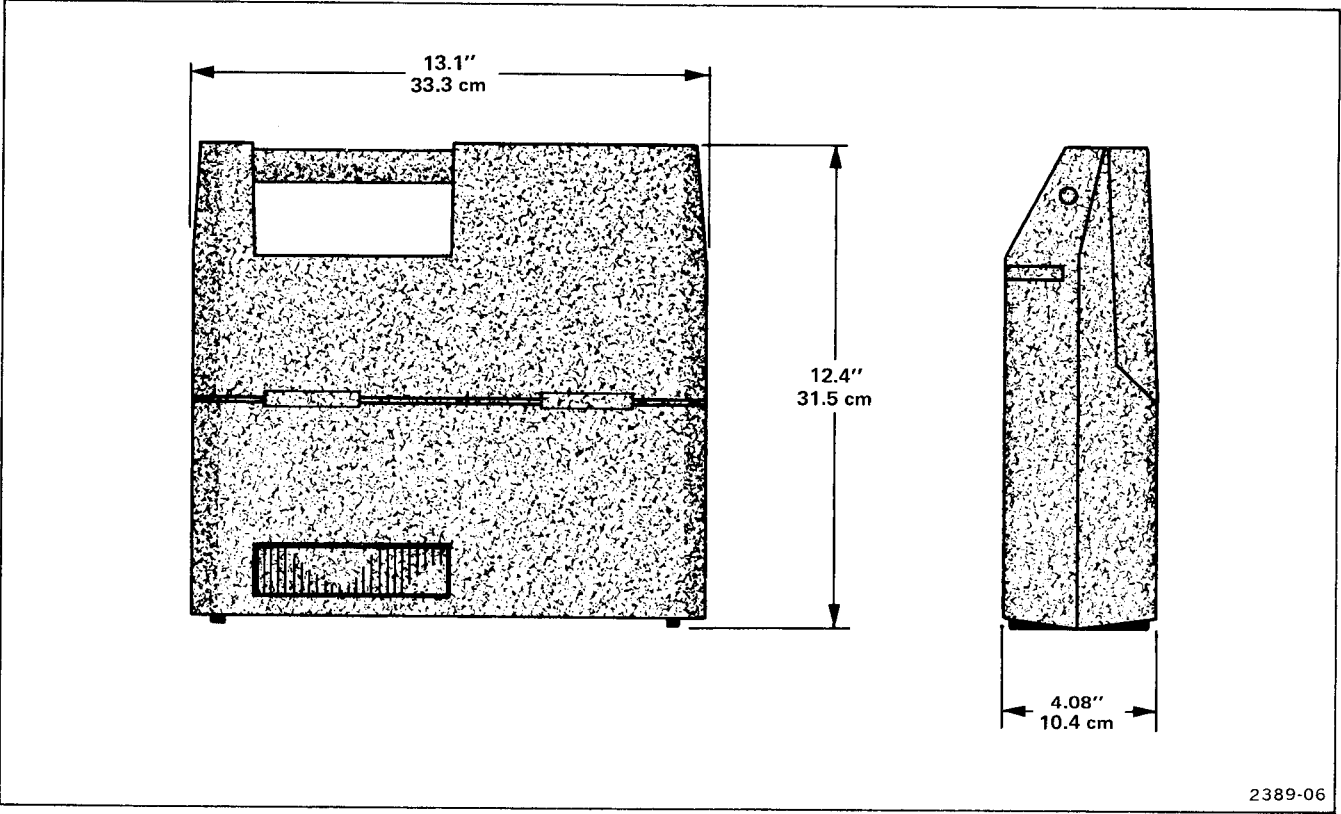


Figure 1-3. Dimensional drawing.

2389-06

## STANDARD ACCESSORIES

- |                                                            |                     |
|------------------------------------------------------------|---------------------|
| 1 RS-232 Cable Assembly                                    | 1 Operator's Manual |
| 1 Power Cord (detachable)                                  | 1 Service Manual    |
| 1 Jumper Wire Set (3 single and 2 double series-connected) |                     |

### NOTE

*Refer to the tabbed Accessories page in the back of this manual for standard accessory part numbers.*



# OPERATING INSTRUCTIONS

## INSTALLATION

Installation consists of checking the selected operating voltage and connecting the instrument to a power source and an interface.

### POWER REQUIREMENTS

This instrument operates from a nominal single-phase power source of 115 or 230 volts, 48 to 440 hertz. Before connecting the instrument to a power source, check that the line voltage indicator on the bottom of the instrument is showing the correct voltage for the source to be used (refer to Figure 2-1).

#### CAUTION

*If the line voltage indicator shows the wrong voltage for the power source to be used, refer the instrument to qualified service personnel.*

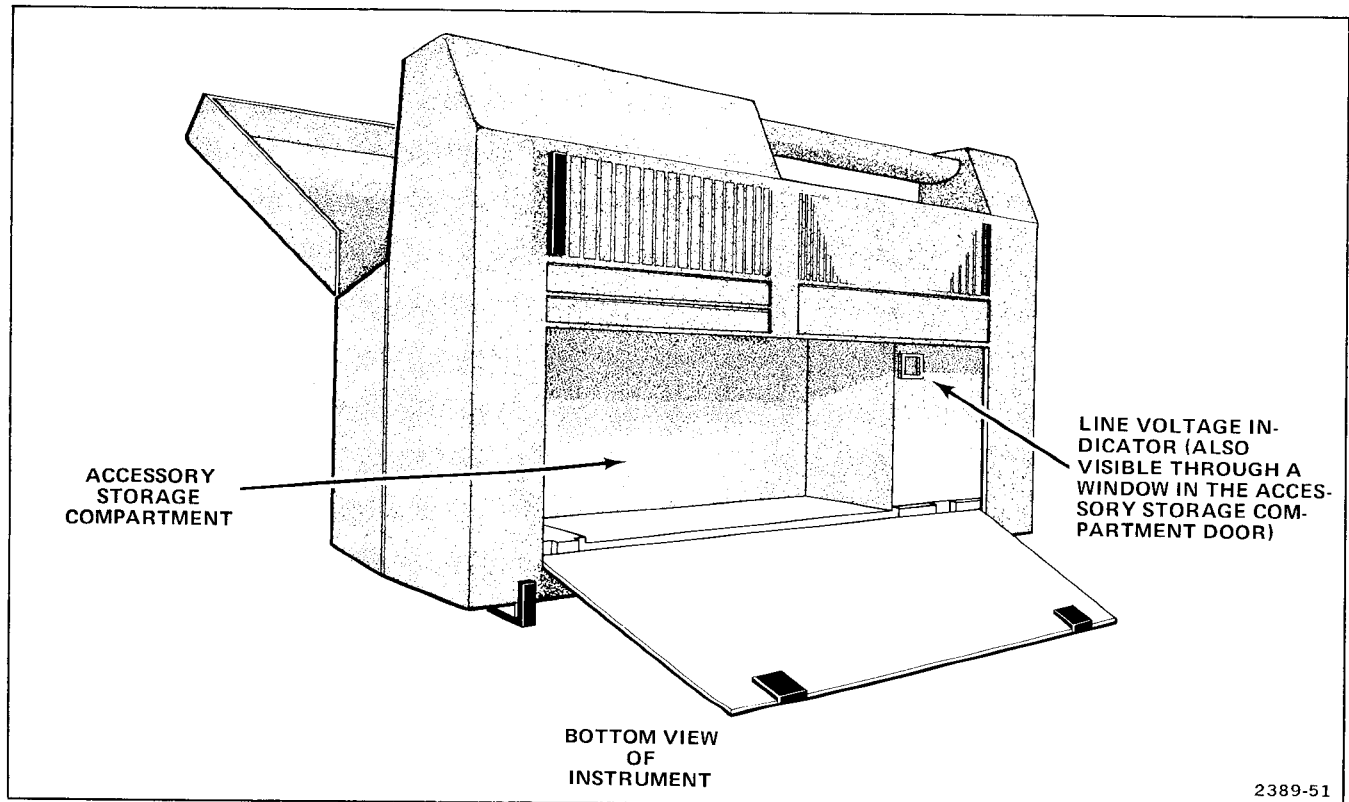


Figure 2-1. Location of the line voltage indicator.

## POWER CORD

This equipment has a 3-wire power cord with a 3-contact plug for connection to the power source and to protective ground. The plug protective-ground contact connects (through the power cord protective-grounding conductor) to the accessible metal parts of the equipment. For electric-shock protection, insert this plug into a socket outlet that has a securely grounded protective-ground contact.

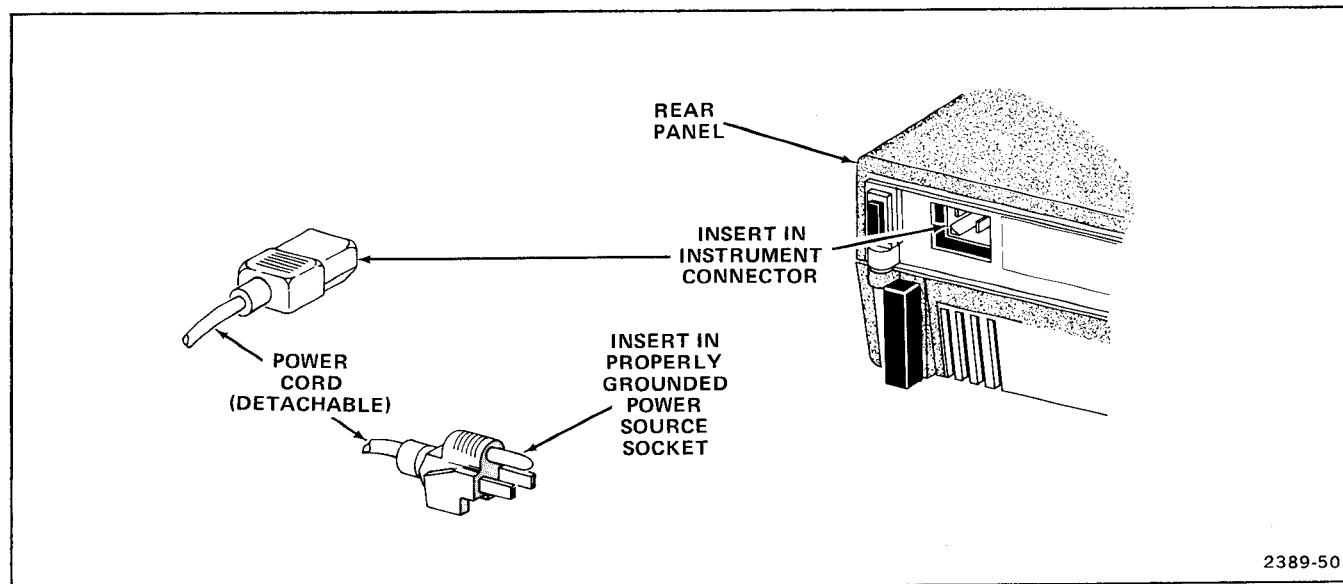


Figure 2-2. Connecting the power cord.

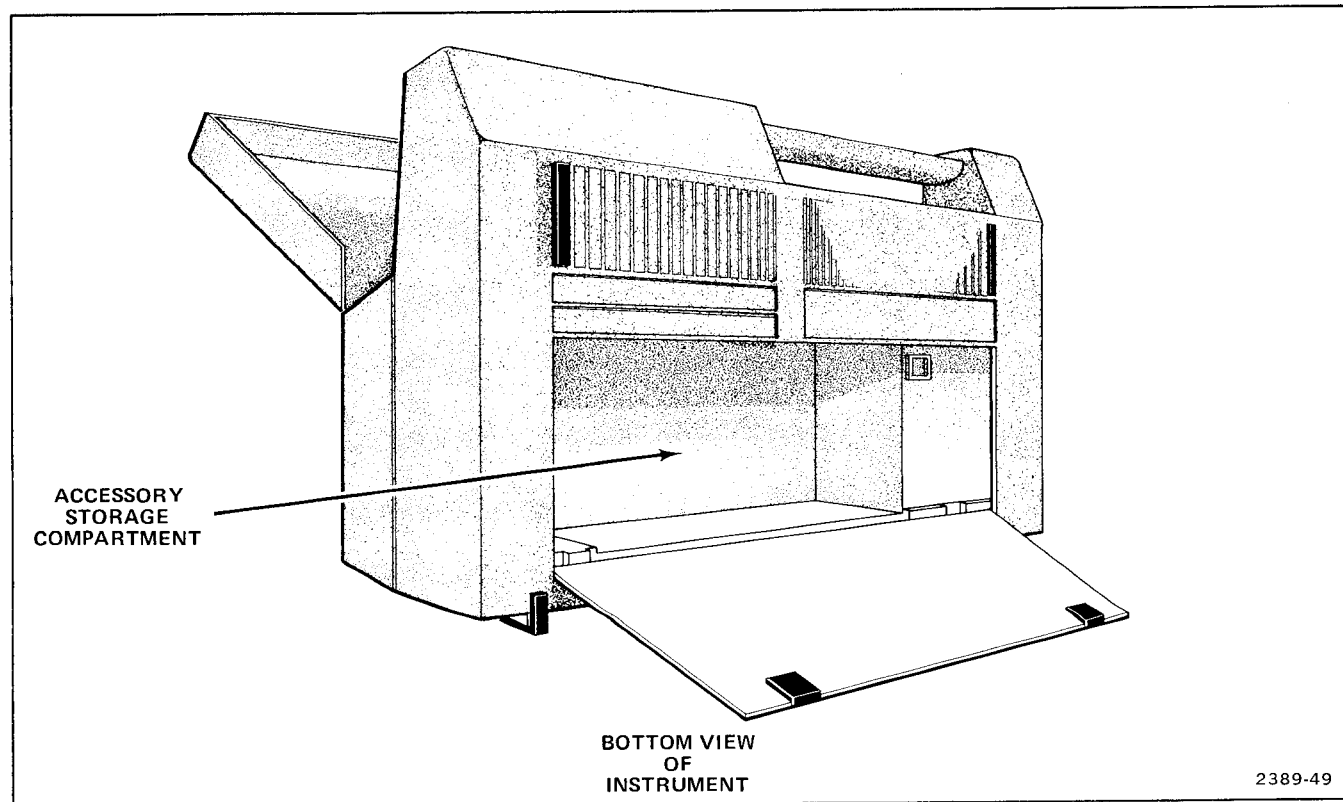


Figure 2-3. Location of the accessories storage cabinet.

**WARNING**

*For confirmation that the socket-outlet ground contact is securely grounded, refer to qualified service personnel.*

The power cord is detachable (refer to Figure 2-2). When not in use, it can be stored in the accessory cabinet located on the bottom of the instrument (refer to Figure 2-3).

Instruments are usually shipped with a 115 volt power cord unless otherwise ordered. Other power cords that can be used with the tester are shown in Figure 2-4. For part number information on power cords contact your Tektronix representative or local Field Service Office.

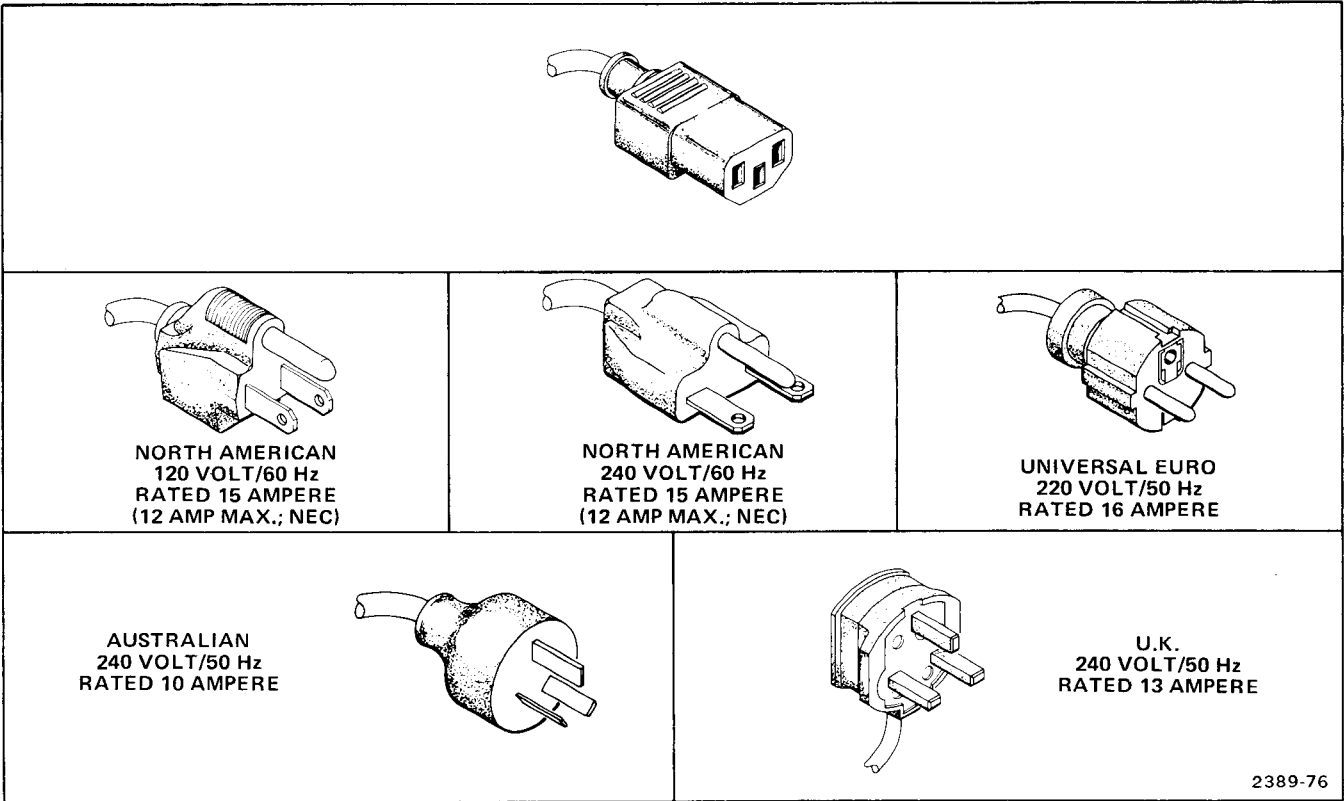


Figure 2-4. Power cords for the 832.

**INTERFACE CONNECTIONS**

An RS-232 Cable Assembly for connecting the instrument to an interface, or to Data Terminal Equipment (DTE), is located in the accessory cabinet (refer to Figure 2-3). Figure 2-5 shows how the cable may be used for connection to an interface.

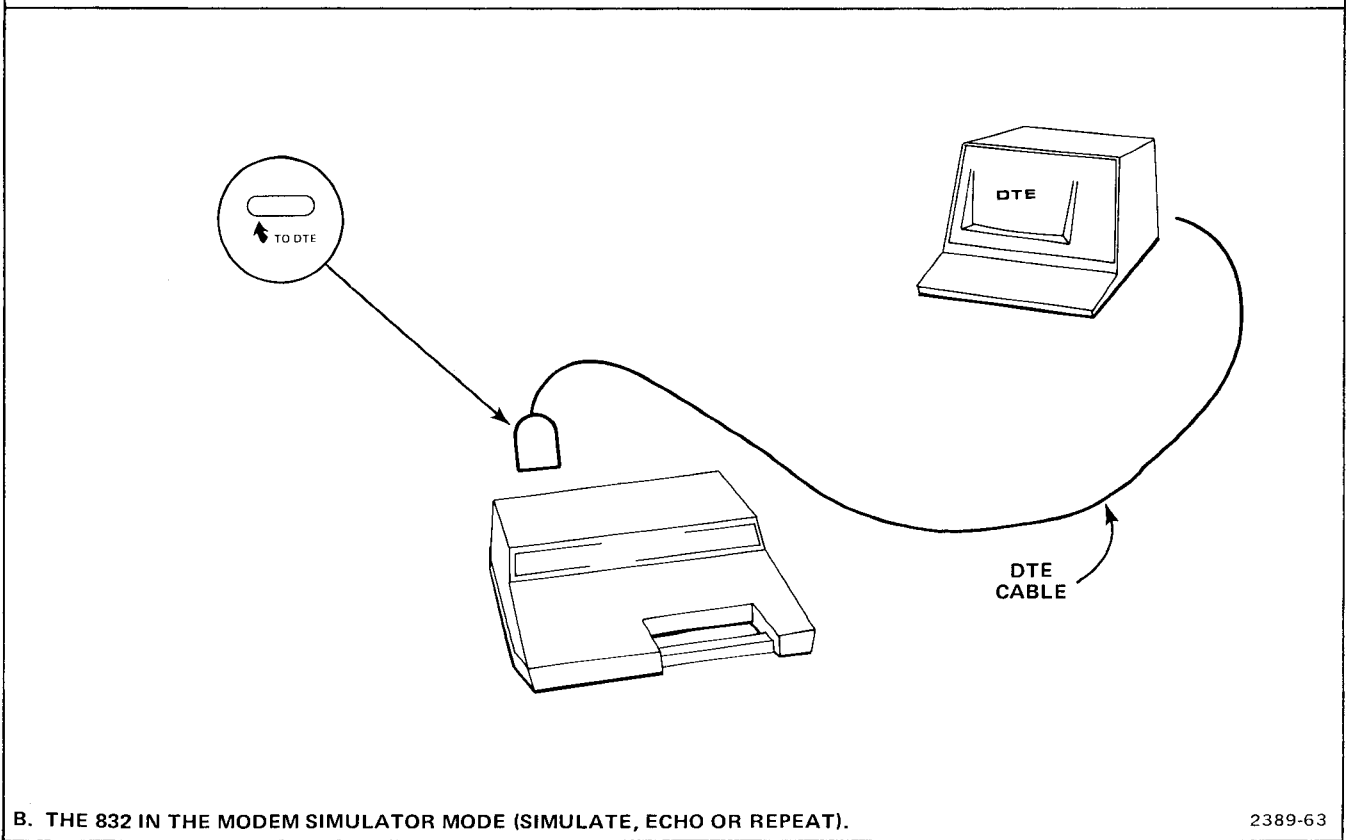
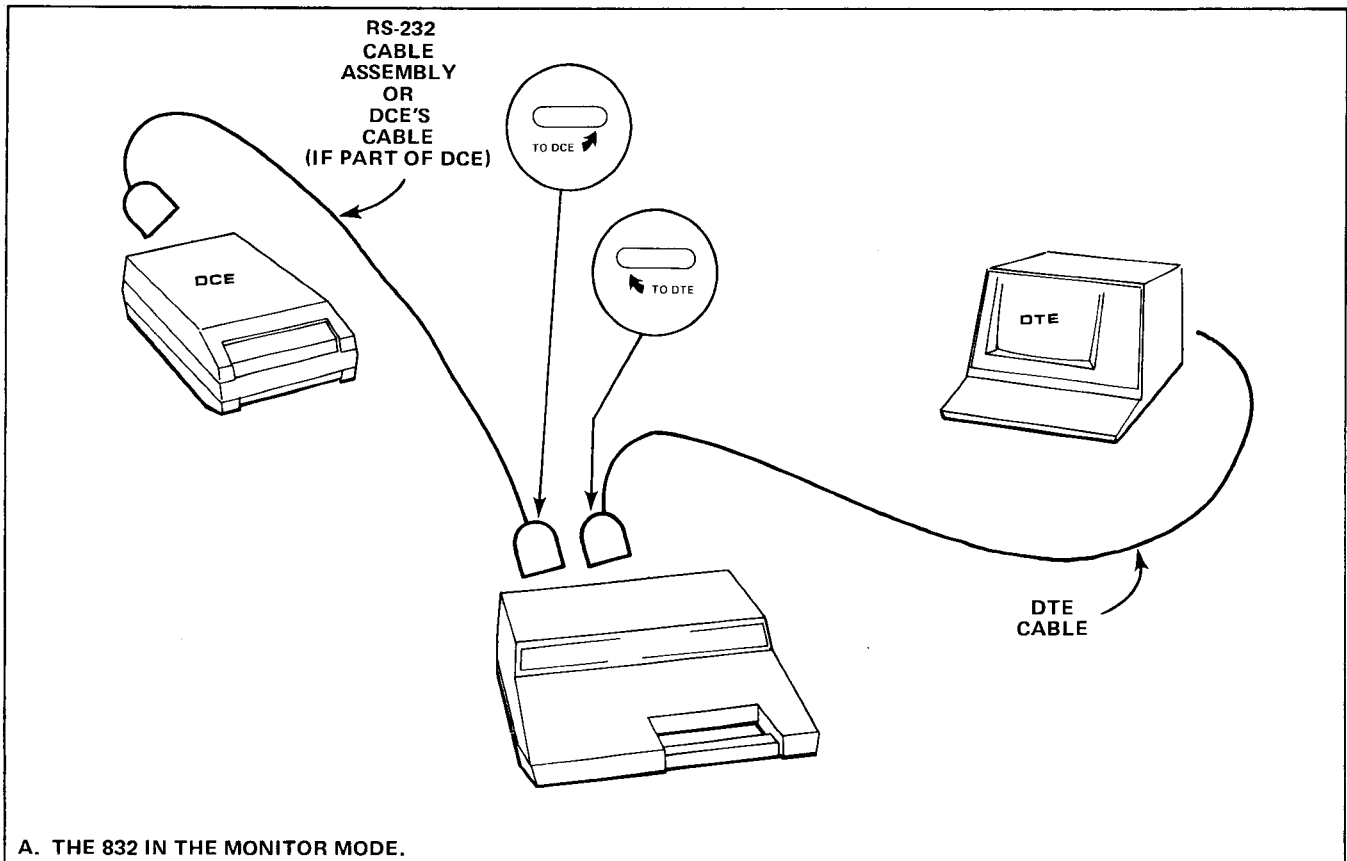


Figure 2-5. Connecting the 832 to an interface.

# LOCATION AND OPERATION OF CONTROLS, CONNECTORS, AND INDICATORS

The location and general group identification of controls, connectors and indicators are shown on Figure 10-1 in the foldout section at the rear of this manual. These foldout pages can be pulled out and used with the following descriptive paragraphs. Also, to provide easy reference for the user, the names of the general groups of controls are used as title headers for the descriptive paragraphs. The front panel controls, connectors and indicators are protected with a front panel lid. To open this lid press the buttons on the side of the lid and lift it.

## POWER

- ① **POWER.** Turns the instrument on and off. Push on; push off. When the instrument is ON, the top of the POWER switch is yellow; when OFF it's black.

## SETUP CONTROLS

### NOTE

*The LOCATION display is always DECIMAL and the CONTENT display is always HEXADECIMAL. Table 2-1 shows the character set generated on the digital displays by keypad entries and character displays. Where illustrations show operating conditions, an illuminated LED is shown as follows:*



*Section 3 (Supplemental Operating Data) contains tables to convert ASCII or EBCDIC codes to hexadecimal codes.*

TABLE 2-1

Digital Displays for Keypad Entries and Other Displays

| Keyboard Entry | 7-Segment Display | Keyboard Entry | 7-Segment Display |
|----------------|-------------------|----------------|-------------------|
| 0              |                   | 8              |                   |
| 1              |                   | 9              |                   |
| 2              |                   | A              |                   |
| 3              |                   | B              |                   |
| 4              |                   | C              |                   |
| 5              |                   | D              |                   |
| 6              |                   | E              |                   |
| 7              |                   | F              |                   |

- 2 **BAUD.** Selects the rate and source of data transfer timing as shown in Table 2-2. Numbered rates are generated by an internal crystal controlled source and external rates (DCE and DTE) are obtained from the interface lines.

**TABLE 2-2**  
**Source of 832 Clock for Data Transfer Timing**

| BAUD<br>Switch<br>Position | Data<br>Being<br>Transferred | Timing Source |                     |
|----------------------------|------------------------------|---------------|---------------------|
|                            |                              | MONITOR Mode  |                     |
|                            |                              | SYNC          | ASYNC               |
| Any<br>Baud<br>Rate        | RDATA                        | Pin 17        | Baud Rate Generator |
|                            | TDATA                        | Pin 15        |                     |
| DTE (EXT)                  | RDATA                        | Pin 17        | Pin 24              |
|                            | TDATA                        | Pin 24        |                     |
| DCE (EXT)                  | RDATA                        | Pin 17        | Pin 15              |
|                            | TDATA                        | Pin 15        |                     |

- 3 **ASYNC, SYNC AND SYN.** Selects the timing mode or programs the synchronizing character.

**ASYNC:** Selects an asynchronous timing mode. In this mode, characters are sent and received one at a time with each character framed by a start bit and at least one stop bit. Asynchronous formats using more than one stop bit also are recognized. When sending a message, the tester always sends two stop bits.

**SYNC:** Selects a synchronous timing mode; used with SYN below. In this mode, characters are sent and received in contiguous blocks (one following the other in a character string). Each block is preceded by at least one synchronizing character, and depending on the communications protocol, may be framed by special control characters (e.g., STX—Start of Text, ETX—End of Text, etc.). Bit timing synchronization is provided by a separate clock line between the DCE and DTE. Timing on this line is derived by the DCE from the incoming data.

#### NOTE

*In synchronous operation, a line idle condition may consist of continuous MARK, SPACE, or SYN characters.*

*After five consecutive MARK or SPACE characters are received and recorded, the 832 breaks synchronization and hunts for the SYN character(s).*

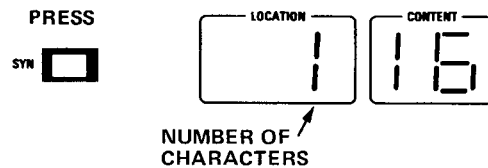
*After four consecutive SYN characters are received and recorded (does not include the one or two characters that precede the data string, which are never recorded), the 832 does not record further consecutive SYN characters, but does maintain synchronization.*

SYN: Used with the keypad to program or verify the synchronizing character for the synchronous (SYNC) timing mode. Any character that can be defined with two hexadecimal digits may be programmed.

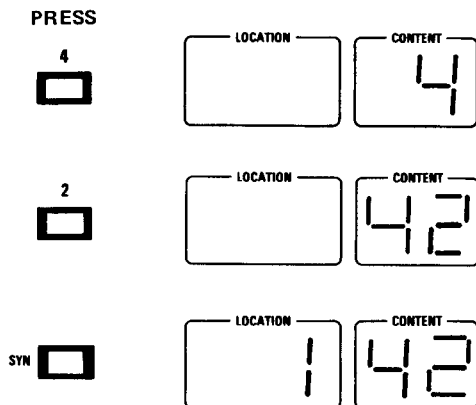
# NOTE

*The tester uses the programmed SYN character(s) to synchronize to the received data only. If SYN characters are to be sent by the tester, they must be included in the SEND Buffer message.*

When the tester is turned on, it defaults to a single ASCII synchronizing character. This can be verified by pressing SYN, which causes a display of the SYN character's hexadecimal value and whether one or two are programmed.

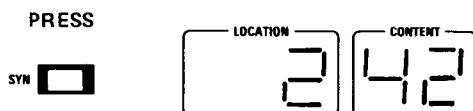


2389-09



2389-10

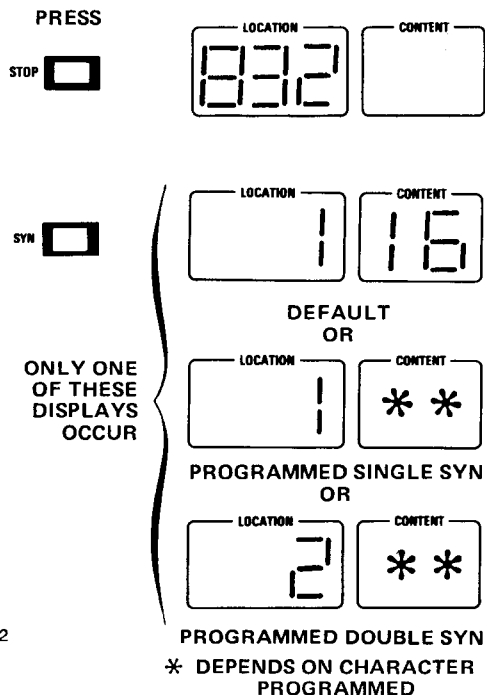
A new synchronizing character may be programmed by entering its hexadecimal value from the keypad, then pressing SYN.



2389-11

If double synchronizing character recognition is desired, press SYN a second time.

The programmed synchronizing character may be displayed at any time by pressing STOP, then SYN.



2389-12

4 FDX, HDX and DELAY. Used to select the communications mode or program a half-duplex line turnaround delay.

FDX: Selects a full-duplex communications mode.

HDX: Selects a half-duplex communications mode; used with DELAY below.

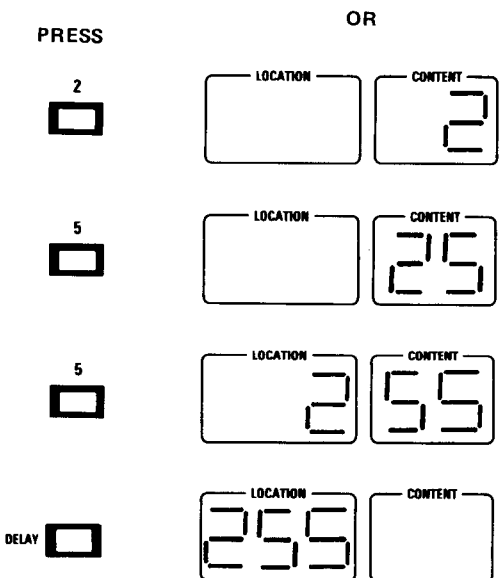
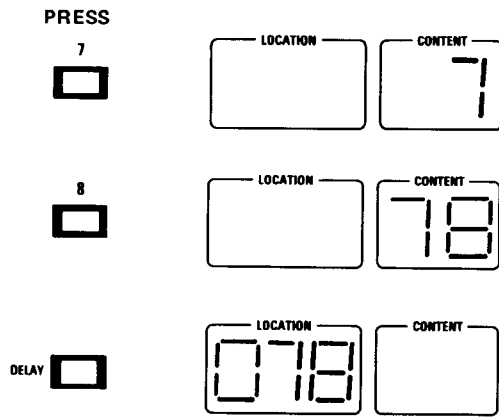
DELAY: Used with the keypad to program or verify a HDX line turnaround delay. This delay is generated only in the modem simulator mode (SIMULATE, ECHO or REPEAT) and occurs between receiving an RTS (Request to Send) signal from the DTE and transmitting a CTS (Clear to Send) signal to the DTE. Also, the delay occurs between receiving the falling edge of the RTS signal from the DTE and transmitting the rising edge of the CD (Carrier Detect) signal.

When the tester is turned on, it defaults to a 200 millisecond delay. This can be verified by pressing DELAY, which causes a display of the DELAY value in milliseconds.



2389-13

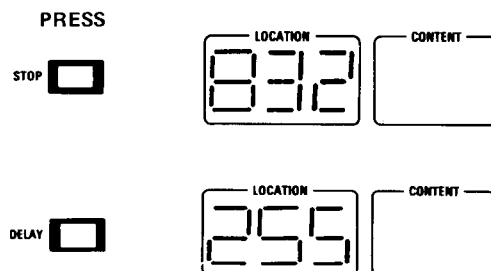




2389-14

A new delay of up to 255 milliseconds may be programmed by entering the decimal value of the delay (0 to 255) from the keypad, then pressing DELAY.

The programmed delay may be displayed at any time by pressing STOP, then DELAY.



2389-15

- 5 **BITS/CHAR.** Used with the keypad to select or verify the total number of bits for each character. The parity bit, if used, is included in this count (e.g., if 7 bits are required for a character, and parity is used, 8 bits per character would be selected). The valid selections are 5, 6, 7 and 8. All except 5 may be selected with parity. If 5 is selected with parity, the tester defaults to 8 bits per character and displays a blinking display error code (008).

When the tester is turned on, it defaults to 8 bits per character. This can be verified by pressing BITS/CHAR.

PRESS  
BITS/  
CHAR 

| LOCATION | CONTENT |
|----------|---------|
| 008      |         |

2389-16

PRESS  
6  


| LOCATION | CONTENT |
|----------|---------|
|          | 6       |

BITS/  
CHAR 

| LOCATION | CONTENT |
|----------|---------|
| 006      |         |

2389-17

New bits per character may be programmed by entering the value from the keypad, then pressing BITS/CHAR.

The programmed bits per character may be displayed at any time by pressing STOP, then BITS/CHAR.

PRESS  
STOP 

| LOCATION | CONTENT |
|----------|---------|
| 832      |         |

BITS/  
CHAR 

| LOCATION | CONTENT |
|----------|---------|
| 006      |         |

2389-18

- 6 **PARITY.** Selects a received data parity error detection mode or turns off the parity error detection feature. Also adds a parity bit to data transmitted by the tester, when the parity feature is selected.

EVEN: Selects the even parity error detection and transmission feature.

OFF: Turns off the parity error detection and transmission feature.

ODD: Selects the odd parity error detection and transmission feature.

## KEYPAD

- 7 **KEYPAD.** A 16-key hexadecimal keypad for selecting buffers and entering data into them. Also used for making entries for BITS/CHAR, self test routine selection, buffer READ jumps, etc.

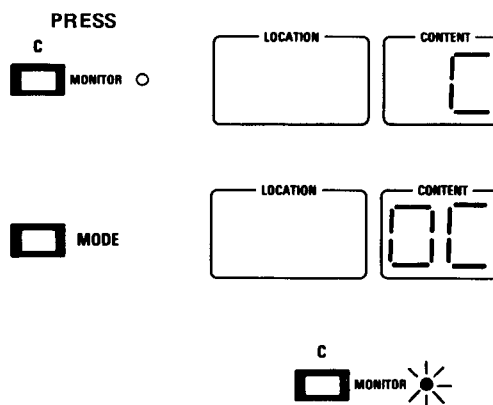
## OPERATING MODE

Selection of an operating mode requires pushing two keys—a mode selection key and the MODE entry key.

- 8 **MODE, MONITOR, SIMULATE, ECHO and REPEAT.** Selects an operating mode or enters the selection, which is indicated by an LED. In each mode, the tester records (RECV Buffer) a data window of up to 256 characters from the interface activity. The location of the recorded data window in the interface activity is determined by the MEMORY CONTROL selection, a trigger (DCE or DTE TRIG), if programmed, and the MODE selection.

MODE: Enters the selected operating mode.

MONITOR: Selects the serial data transmission monitoring mode of operation. In this mode, the tester monitors interface signal activity, and records (RECV Buffer) a data window of up to 256 characters from that activity.



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## NOTE

*In the modem simulator modes (SIMULATE, ECHO and REPEAT), the DTE must assert (turn on) DTR before the 832 can send a message. If the DTE does not do this, it can be done with a jumper at the Breakout Panel.*

**SIMULATE:** Selects the first of three modem simulator modes of operation. In this mode, the tester records interface activity, sends and records a message once and records any DTE response to the message.

**ECHO:** Selects the second of three modem simulator modes of operation. This mode is intended to be used in the asynchronous (ASYN) communications mode and is like SIMULATE mode, but with an added ECHO feature. This feature causes the tester to send back to the DTE (echo) any character sent by the DTE. The echoed character is also recorded.

**REPEAT:** Selects the third of three modem simulator modes of operation. This mode is similar to the SIMULATE mode, but adds these REPEAT features:

- a. The message is sent to the DTE once as soon as START is pushed.
- b. The message is sent again each time a trigger occurs, or repeatedly if no trigger is programmed.
- c. Always records the last 256 characters received before STOP is pushed.

## NOTE

*For more detailed information on these operating modes, see both Data Acquisition and The Operating Modes.*

## BUFFER CONTROLS

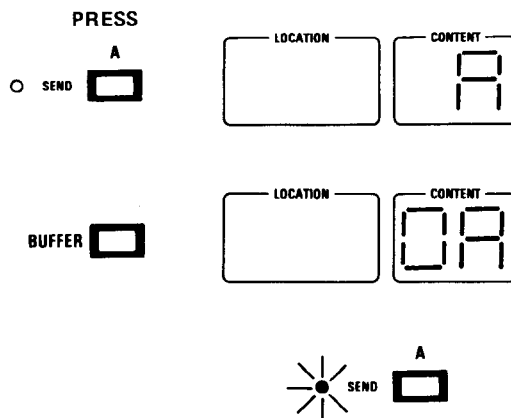
### Buffer Selection

Selection of a buffer requires pushing two or three keys—the buffer selection key(s) (one or two) and the BUFFER entry key.

- 9 **BUFFER, SEND, DCE TRIG, DTE TRIG, RECV, Stored Message Buffer Keys and User-Definable Message Buffer Keys.** Selects a buffer or enters the selection for programming, reading, message generation, etc. An LED or digital display indicates which buffer is selected.

**BUFFER:** Enters the selected buffer.

**SEND:** Selects the programmable Send Buffer for programming or reading. This buffer is used in the SIMULATE, ECHO or REPEAT mode to store a message of up to 255 characters for transmission to the DTE.



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**DTE TRIG:** Selects the programmable DTE Trigger Buffer for programming or reading. This buffer is used in all modes to store up to three trigger characters. When a valid DTE trigger occurs, the tester sets the recorded data window and records data (MONITOR mode) or sends a message and then records data (SIMULATE, ECHO or REPEAT mode).

**DCE TRIG:** Selects the programmable DCE Trigger Buffer for programming or reading. This buffer is used only in the MONITOR mode to store up to three trigger characters. When a valid DCE trigger occurs, the tester sets the recorded data window and records data.

### NOTE

*Programming one trigger buffer clears the other. Clearing either trigger buffer clears both buffers. For more detailed information on triggers, see Programming A Trigger.*

**RECV:** Selects the receive buffer, which is used in all operating modes to store up to 256 characters of Transmitted and Received Data from the interface.

### NOTE

*For more detailed information on the buffers, see both Buffer Operation and Data Acquisition.*

Keypad selections listed in Table 2-3 are used with the BUFFER key to select Stored Message Buffers. These buffers contain pre-recorded messages (read only) that can be transferred to the SEND Buffer for transmission to the DTE in the SIMULATE, ECHO or REPEAT mode. A list of the characters in each Stored Message Buffer is contained in Section 3 (Supplemental Operating Data).

**TABLE 2-3**  
**Key Selections for Stored Message Buffers**

| Key Selection | Buffer Contents                                           |
|---------------|-----------------------------------------------------------|
| 0             | ASCII FOX Message (63 characters + CR + LF)               |
| 2             | Uppercase ASCII Character Set (63 characters + CR + LF)   |
| 5             | Full ASCII Character Set (96 characters + CR + LF)        |
| 8             | 132 Uppercase ASCII characters (132 characters + CR + LF) |
| B             | EBCDIC FOX Message (63 characters + CR + LF)              |
| D             | Uppercase EBCDIC Character Set (62 characters + CR + LF)  |
| E             | Full EBCDIC Character Set (88 characters + CR + LF)       |

**NOTE:** All patterns are followed by a CR (carriage return) and LF (line feed).

When a User Defined Message EPROM has been installed in the instrument, keypad entries using two hexadecimal digits (10 through FF) are used with the BUFFER key to select User Defined Message Buffers. These message buffers, like the Stored Message Buffers, may be selected and transferred to the SEND Buffer for transmission to the DTE.

#### NOTE

*Detailed information on programming this EPROM is contained in Section 4 (Programming). Refer installation of the User Defined Message EPROM to qualified maintenance personnel.*

#### Buffer Function Controls

- 10 ENTER.** Used with the keypad to insert characters into a selected programmable buffer (SEND, DTE TRIG or DCE TRIG). When a character is entered, the buffer location and character entered are displayed for about one-third second. Then the next buffer location is displayed with two decimal points, except as follows:
- If the location where the new character is inserted contained a character, that character is pushed-down and displayed in the next buffer location.
  - When an entered character fills a buffer, the last location and its character remain displayed.
  - When a buffer is full, the next character entered causes a blinking display error condition (013). This error condition doesn't change the contents of the buffer, but the new character is not entered. At least one character must be cleared from a full buffer before another character can be entered (see CLEAR below).

#### NOTE

*Any attempt to load characters into a read-only buffer (RECV, Stored Message or User Defined Message Buffer) causes a blinking display error condition (012). To clear the error, push CLEAR or STOP.*

**11 CLEAR.** Performs these clearing functions:

- a. Clears the entire contents of a selected buffer when CLEAR is pushed immediately following BUFFER in the selection process (e.g., SEND + BUFFER + CLEAR).
- b. Clears any keypad entry that requires selection of another key to complete the entry (e.g., entries made with ENTER, BUFFER, BITS/CHAR, etc.). CLEAR must be pushed before the key that completes the entry. When CLEAR is pushed, the displayed entry is replaced with two decimal points, which signifies a new entry may be made (e.g., If during DTE TRIG buffer selection, SEND was pushed first, push CLEAR. Then when the two decimal points appear, push DTE TRIG + BUFFER).
- c. Deletes the character in a specific buffer location. The buffer is selected and READ is used to scroll to the location of the character to be deleted. Then CLEAR is pushed to delete the displayed character. If the deleted character was the last character in the buffer, two decimal points are displayed; otherwise, the subsequent character closes-up to fill the vacated location and is displayed.
- d. Clears a blinking display error condition.

**NOTE**

*Any attempt to clear a read-only buffer (RECV, Stored Message or User Defined Message Buffer) causes a blinking display error condition (011). To clear the error, push CLEAR or STOP. The RECV Buffer clears automatically when START is pushed.*

**12 TRANSFER.** Transfers the contents of a selected buffer to the SEND Buffer when the TRANSFER key is pushed immediately after the BUFFER key.

**13 READ.** Sequentially selects buffer locations for display. Each key has an associated directional arrow to determine its sequencing direction. The right pointing arrow identifies the incrementing key and the left pointing arrow identifies the decrementing key. Holding either key down causes locations to autoincrement or autodecrement. Multiple increments or decrements may be made by entering the multiple value from the keypad before pressing a READ key.

**NOTE**

*For a more detailed explanation on the use of the Buffer Function controls, see BUFFER OPERATION.*

## MEMORY

- 14 **MEMORY CONTROL.** During data acquisition in the MONITOR, SIMULATE and ECHO modes, this control determines where in the interface activity the RECV Buffer records a storage window of up to 256 characters. If a trigger is programmed, this storage window is determined by the first trigger received after START is pushed. Without a programmed trigger, the storage window is determined when the START or STOP key is pushed.

### NOTE

*In the REPEAT mode, the MEMORY CONTROL has no effect on the location of data in the RECV Buffer. The storage window is always the last 256 characters received before the STOP key is pushed.*

**POST TRIG OR START:** If a trigger has been programmed, the last character of the trigger is recorded in RECV Buffer location 000 and the following 255 characters are recorded in locations 001 through 255.

Without a programmed trigger, the first 256 characters received after the START key is pushed are recorded in RECV Buffer locations 000 through 255.

**CENTER:** If a trigger has been programmed, the last character of the trigger is recorded in RECV Buffer location 127, the preceding 127 characters are recorded in locations 000 through 126, and the following 128 characters are recorded in locations 128 through 255. If more than one trigger character is programmed, they are recorded just ahead of location 127.

Without a programmed trigger, the last 256 characters received before the STOP key is pushed are recorded in locations 000 through 255.

**PRE TRIG OR STOP:** If a trigger has been programmed, the last trigger character is recorded in RECV Buffer location 255 and the preceding 255 characters are recorded in locations 000 through 254.

Without a programmed trigger, the 256 characters received before the STOP key is pushed are recorded in locations 000 through 255.

### NOTE

*For more detailed information on the location of the trigger character(s) and data in the RECV Buffer, see Data Acquisition.*

## START AND STOP

- 15 **START.** Clears the RECV Buffer, activates the tester in its selected operating mode and locks out any new keypad or control selections until recording ends. Activation is indicated by a single decimal point in the CONTENT display.
- 16 **STOP.** Stops tester operation, loads an idle display (832) into the LOCATION display and assumes an idle state (waiting for a user instruction to be generated by a key selection). If STOP is pushed after START, the RECV Buffer is automatically selected before the idle state is assumed.

## DISPLAY

### Display Selection

- 17 **DISPLAY.** Selects which recorded data is displayed.
- DCE: Selects data received from the Data Communications Equipment (DCE) (MONITOR mode), or data transmitted by the tester (SIMULATE, ECHO or REPEAT mode) for display.
- BOTH: Selects all data for display. The data is displayed in the same sequence as recorded from the interface. If a DTE and DCE character occur simultaneously on the interface in FDX operation, the DTE character is usually recorded first.
- DTE: Selects data received from the Data Terminal Equipment (DTE) for display.

### Digital Displays and LED Indicators

- 18 **LOCATION.** Three digital displays, which are always decimal values that indicate:
- Numeric locations within a buffer (displays when READ is pushed)—000 to 254 for the SEND Buffer; 000 to 255 for the RECV Buffer or 000 to 002 for the DCE or DTE TRIG Buffer.
  - An error condition—A blinking display indicates an error condition, which is usually caused by an illegal keypad entry. To recover, press CLEAR or STOP. See Section 3 (Supplemental Operating Data) for a listing of Error Codes.
  - A power-up display check condition—Indicated by an 8.8.8. display. A display other than 8.8.8. indicates a fault condition.
  - The number of default or programmed synchronizing (SYN) characters (displays when SYN is pushed)—1 or 2.
  - The amount of default or programmed half-duplex (HDX) line turnaround delay (DELAY) in milliseconds (displays when DELAY is pushed)—000 to 255.
  - The number of default or programmed bits per character (BITS/CHAR) (displays when BITS/CHAR is pushed)—005 to 008.
  - An idle display—832.



- 19 CONTENT.** Two digital displays, which are always hexadecimal values that indicate:
- a. Keypad entries—While the tester is being programmed, all keypad entries are displayed.
  - b. Buffer number (displays when BUFFER is pushed)—01 (RECV), 04 (DTE TRIG), 07 (DCE TRIG), 0A (SEND), etc. (see BUFFER CONTROLS for other displays).
  - c. Buffer contents (displays when READ is pushed)—Two hexadecimal digits 00 to FF (see BUFFER OPERATION).
  - d. A power-up display check condition—Indicated by an 8.8. display. A display other than 8.8. indicates a fault condition.
  - e. START has been pushed, data can be acquired and the keypad and other front panel controls are locked out (cannot be changed until the STOP key is pushed)—Indicated by a single decimal point display (see START above).
  - f. A keypad entry has been cleared by pressing the CLEAR key—Indicated by a double decimal point display (see BUFFER OPERATION).
  - g. The end of data in a buffer—Indicated by a double decimal point, which signifies another character may be entered.
- 20 SOURCE.** Two LED's that show the source of the character being displayed in the CONTENT display. Valid only during data acquisition and when reading the RECV Buffer.
- DCE: Indicates that the character in the CONTENT display was received from the Data Communications Equipment (DCE) device (MONITOR mode), or transmitted by the tester (SIMULATE, ECHO or REPEAT mode).
- DTE: Indicates that the character in the CONTENT display was received from the Data Terminal Equipment (DTE) device.
- 21 ERROR.** Two LED's that show when errors are associated with the character in the CONTENT display.
- PARITY: Indicates that the parity of the character in the CONTENT display does not agree with the PARITY selection.
- FRAME: Used in the asynchronous (ASYNC) mode to indicate that the character in the CONTENT display was not properly framed by start and stop bits.
- 22 NO SYN.** An LED used in the synchronous (SYNC) mode to show that the tester has not received the synchronizing (SYN) character and has not established synchronizaton with the data.
- 23 NO TRIG.** An LED that shows when a trigger has not been received. Used in all modes when the tester is expected to respond or record data in response to a programmed trigger (DCE or DTE TRIG).
- 24 Line Status Indicators.** LED's that show the status of an interface line. An illuminated LED indicates an asserted (ON) condition for the corresponding line. During data acquisition (after START is pushed), the indicators show the real time status of their corresponding interface lines, which also is recorded. After STOP is pushed, and the RECV Buffer is being read, the CD, RTS, CTS, and MARKER LED's show the status of their respective interface line at the time the character in the CONTENT display was received.
- DTR: Data Terminal Ready. Signal from DTE to DCE. Indicates that the DTE is ready to transmit and receive data.

#### NOTE

*In the modem simulator modes (SIMULATE, ECHO and REPEAT), the DTE must assert (turn on) DTR before the 832 can send a message. If the DTE does not do this, it can be done with a jumper at the Breakout Panel.*

DSR: Data Set Ready. Signal from DCE to DTE. Indicates that the DCE is ready to transmit and receive data.

RTS: Request to Send. Signal from DTE to DCE. Used with CTS to indicate the status of the handshake between the DTE and DCE. A transition from OFF to ON indicates that the DTE has instructed the DCE to place the communications channel into a transmit mode (see CTS below), which usually turns on the DCE carrier. A transition from ON to OFF indicates that the DTE has instructed the DCE to complete the transmission of data previously transferred to it, then assume an idle or receive mode, which usually turns off the DCE carrier.

CTS: Clear to Send. Signal from DCE to DTE. Used with RTS to indicate the status of the handshake between the DCE and DTE. The ON condition indicates that the DCE carrier is on and the DCE is ready to accept data for transmission on the channel. Also, it is a positive response to an RTS ON condition (see RTS above).

CD: Carrier Detect (RS-232 interface name is Received Line Signal Detector). Signal from the DCE to DTE. The ON condition indicates that the DCE is receiving a valid carrier signal from the distant end, which indicates that the distant end should be ready to send data.

MARKER: An LED indicator that can be connected to any interface line (at the Breakout Panel). The ON condition indicates a HIGH logic level (positive voltage) or SPACE condition on the interface line. The OFF condition indicates a LOW logic level (negative voltage) or MARK condition on the interface line. The MARKER condition is recorded (with each character that is recorded).

- 25 **PROBE.** Two LED's that can be connected to any interface line (at the Breakout Panel) to show its logic level. The condition shown is real time only and not recorded.

SPACE: Indicates a HIGH logic level when the signal is greater than +3 volts.

MARK: Indicates a LOW logic level when the signal is less than -3 volts.

## INTERFACE BREAKOUT PANEL

- 26 **Line Disconnect Switches.** 24 two-position (open or closed) DIP (Dual In-line Package) switches used to control throughput to the DTE.

- 27 **Line Patch Pins.** Jumper pins that are electrically connected to each side of the Line Disconnect Switches. These may be used for crossconnecting interface lines, attaching jumpers for the PROBE or MARKER LED's, connecting jumpers to the Mark (-12) or Space (+12) reference voltages, etc.

- 28 **PROBE.** Jumper pin for connecting the PROBE LED circuit to any interface line.

- 29 **MARKER.** Jumper pin for connecting the MARKER LED circuit to any interface line.

- 30 **Mark and Space Voltage Reference Levels.** Jumper pins that provide Mark or Space reference voltages.

-12V: Mark reference voltage.

+12V: Space reference voltage.

## CONNECTORS

- 31 **RS-232.** Two 25-pin connectors (one male; one female) for connecting the tester to the Data Communications Equipment (DCE) device (male pins connector) and Data Terminal Equipment (DTE) device (female sockets connector).
- 32 **Power Connector.** Provides power to the instrument through a detachable power cord.

## ERROR CODES

When operating the 832, there are a few invalid control selection combinations and operating conditions that cause a blinking display error condition. The displays that may occur and their meaning are shown below and in Section 3 (Supplemental Operating Data).

- 008 5 BITS/CHAR selected with parity.
- 009 Illegal BITS/CHAR selection.
- 010 Illegal decimal entry.
- 011 Attempted to clear a read-only buffer (ROM).
- 012 Attempted to load a read-only buffer (ROM).
- 013 Attempted to load a full buffer.
- 014 Illegal buffer selection (nonexistent).
- 015 Illegal mode selection (nonexistent).
- 016 Overrun error.

### NOTE

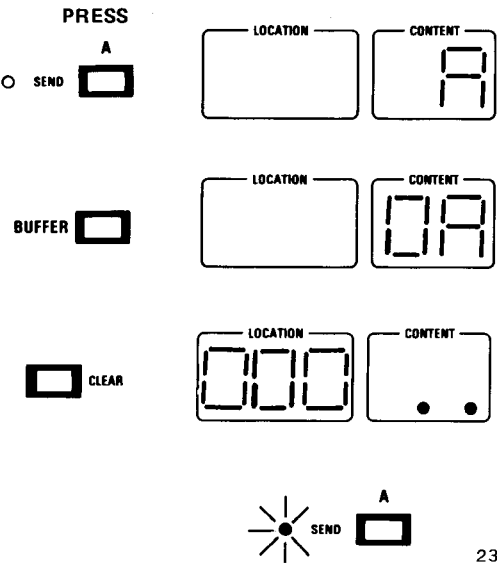
*Overrun error is when the incoming data rate exceeds the data transfer rate of the 832. This error should not occur when any of the specific rates on the BAUD switch are selected (e.g., 1.2K, 9.6K, etc.). It could occur with a DCE or DTE BAUD switch selection whenever the external rate exceeds 9600 baud (4800 baud if less than 8 bits per character).*

# BUFFER OPERATION

The following paragraphs explain in detail how to CLEAR, ENTER, TRANSFER and READ the SEND, DCE TRIG, DTE TRIG and RECV buffers. The TRANSFER and READ keys also may be used with the Stored Message Buffers and the User Defined Message Buffers.

## CLEARING A BUFFER (EXCEPT RECV)

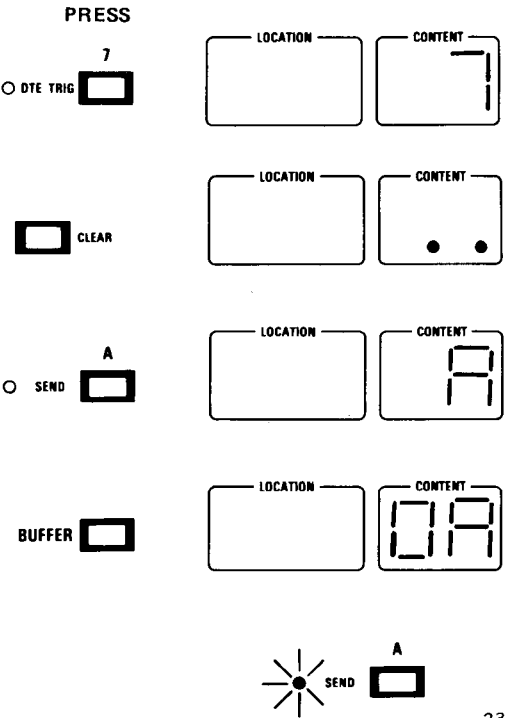
The SEND, DCE TRIG and DTE TRIG buffers are cleared by selecting a buffer, then pressing CLEAR immediately after BUFFER.



2389-21

### NOTE

Any attempt to clear a read-only buffer (RECV, Stored Message or User Defined Message Buffer) causes a blinking display error condition (011). To exit the condition, push CLEAR or STOP, which causes the tester to assume an idle state (832).



2389-22

If the wrong buffer key is selected on the keypad, and BUFFER has not been pushed, the entry may be cleared by pushing CLEAR. When this is done, two decimal points appear in the CONTENT display. These decimal points signify that a new keypad entry may be entered.

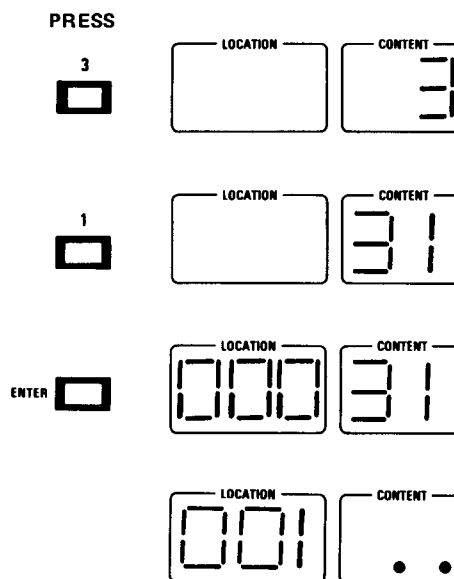
## CLEARING AND LOADING THE RECV BUFFER

The RECV Buffer is automatically cleared when the START key is pushed and records whenever a trigger occurs or the STOP key is pushed (as determined by the programmed trigger or triggers and the MEMORY CONTROL selection).

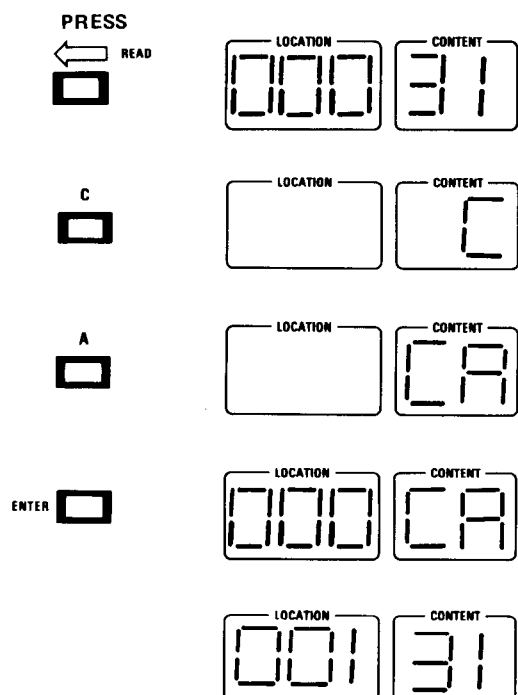
## LOADING THE SEND OR TRIGGER BUFFERS

After the SEND, DCE TRIG or DTE TRIG buffer is selected, it is loaded by entering characters from the hexadecimal keypad, then pressing ENTER.

Entered data is displayed for about one-third second, then if the buffer isn't full, the next buffer location is displayed with two decimal points (end of data mark) in the CONTENT display, except as follows:



2389-23



2389-24

1. When the buffers are not full, and the location where the character is inserted already contains a character, that character is pushed-down in the buffer and displayed when the next location display occurs.

2. When the buffers are full, the next character entered causes a blinking display error condition (013). To exit the condition, push CLEAR or STOP.

PRESS

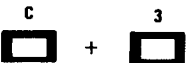


BLINKING  
DISPLAY



2389-25A

PRESS



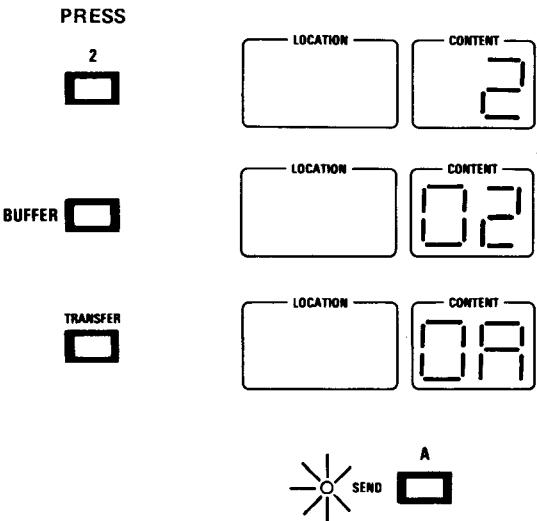
During the process of loading characters, if a wrong keypad entry is made, it may be cleared by pressing CLEAR. When this is done, two decimal points appear in the CONTENT display. These decimal points signify that a new keypad entry may be made.

2389-26

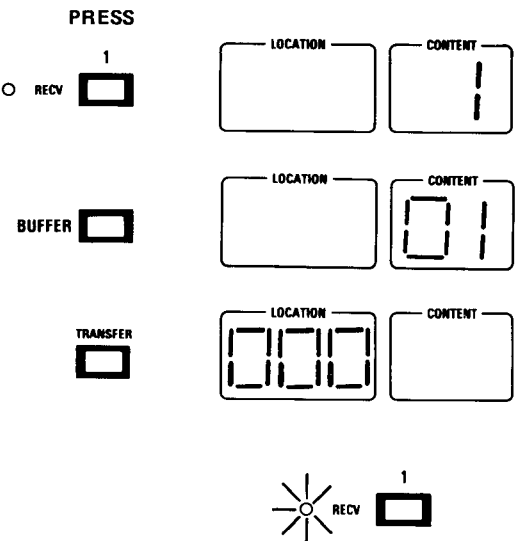
TRANSFERRING A BUFFER

Transferring a buffer requires selecting a buffer and transferring a copy of its contents to the SEND Buffer by pushing TRANSFER immediately following BUFFER. The SEND Buffer is cleared before the new contents are transferred to it, but the contents of the selected buffer are not destroyed by the transfer action. Any buffer in the tester can be selected for transfer, including the RECV Buffer (see NOTE below), Stored Message Buffers, and User Defined Message Buffers, if installed.

If the selected buffer contains data when TRANSFER is pushed, a copy of the data is transferred to the SEND Buffer and the SEND Buffer is automatically selected.



2389-27



2389-28

If the selected buffer is empty (contains no data) when TRANSFER is pushed, the tester defaults to a simple buffer selection only, and displays the first location of the selected buffer as empty.

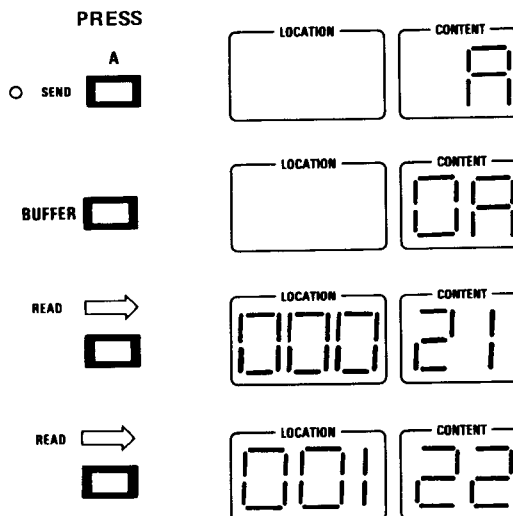
NOTE

The SEND Buffer only contains 255 locations; therefore, if a full RECV Buffer (256 characters) is transferred to the SEND Buffer, the last character is lost.

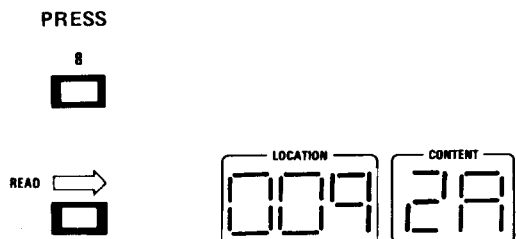
## READING BUFFERS (EXCEPT RECV)

Reading the SEND, Trigger, Stored Message or User Defined Message buffers requires selecting a buffer and scrolling through its locations with the incrementing and decrementing READ keys. The hexadecimal character in each location will appear in the CONTENT display.

When a buffer is selected and a READ key (either one) pushed, the first location in the buffer is displayed. The user may now scroll through the buffer locations one at a time by pressing the incrementing READ key once for each new location. The incrementing READ key also may be held down, which will cause an autoincrement until it is released.



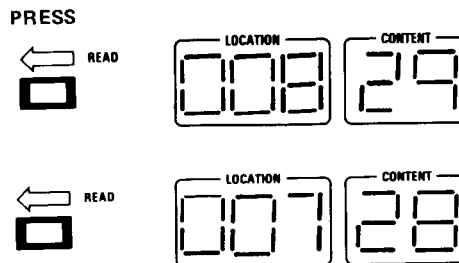
2389-29



2389-30

For multiple location increments, enter the number of increment jumps from the keypad, then press the incrementing READ key.

To look at previous locations, press the decrementing READ key once for each decrement, or hold the key down to autodecrement.



2389-31



PRESS



2389-32

For multiple location decrements, enter the number of decrement jumps from the keypad, then press the decrementing READ key.

A user can return to the first character location in the buffer by pressing zero (0), then the decrementing READ key; conversely, the user can go to the last character location in the buffer by pressing zero (0), then the incrementing READ key.

PRESS



END OF BUFFER  
MARK

2389-33

PRESS



2389-34

Whenever an empty buffer is selected, the first location in the buffer is displayed with two decimal points in the CONTENT display, and the location cannot be incremented or decremented.

## READING THE RECV BUFFER

The RECV Buffer is read similar to the other buffers, except the first READ command is intended to display the trigger point. The displays that occur are dependent upon the MEMORY CONTROL selection at the time the RECV Buffer recorded data; whether a trigger is programmed, and if programmed, if it occurs; the type of READ selections made (single increment, multiple increment, 0 + READ, etc.); and if the buffer is full (contains 256 characters).

## NOTE

*Illustrations shown are for a RECV Buffer that is not completely full.*

## POST TRIG OR START:

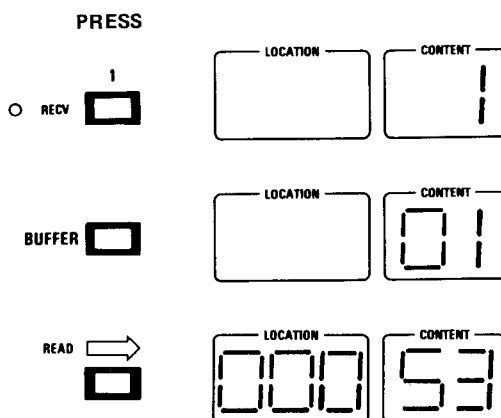
When MEMORY CONTROL is set to POST TRIG OR START, and less than 256 characters are received, the first READ (either) will display the trigger point (or START) location (000).

PRESS



2389-36

If zero (0) then the decrementing READ key are pushed the display returns to the trigger point (or START) location (000).



2389-35

When zero (0) then the incrementing READ key are pushed, the display goes to the location of the last character and cannot be incremented to the last buffer location (255).

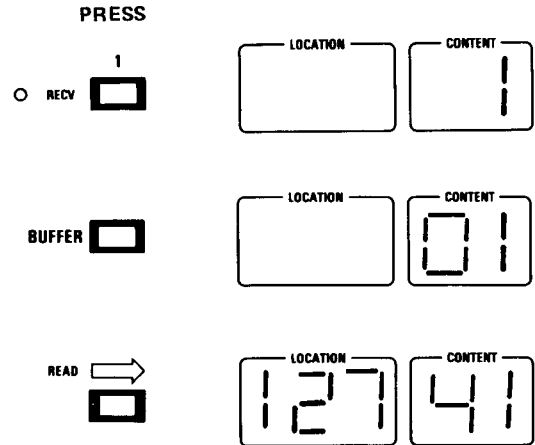
PRESS



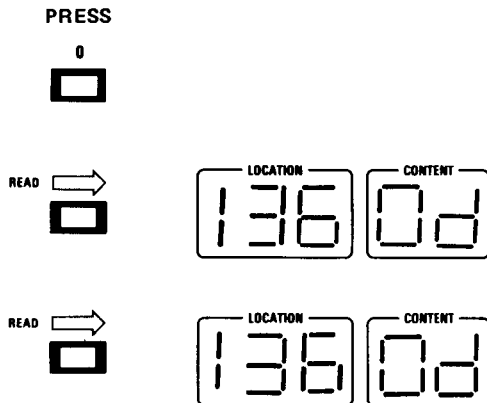
2389-37

CENTER:

When MEMORY CONTROL is set to CENTER, and the data received before and after the trigger is not sufficient to fill the buffer on either side of the trigger, the first READ (either) will display the trigger point location (127).



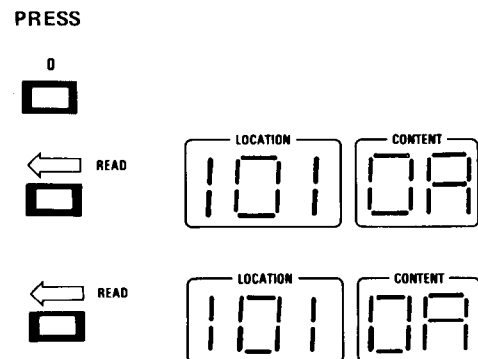
2389-38



2389-39

If zero (0) then the incrementing READ key are pushed, the display will go only to the location of the last character and cannot be incremented to the last buffer location (255).

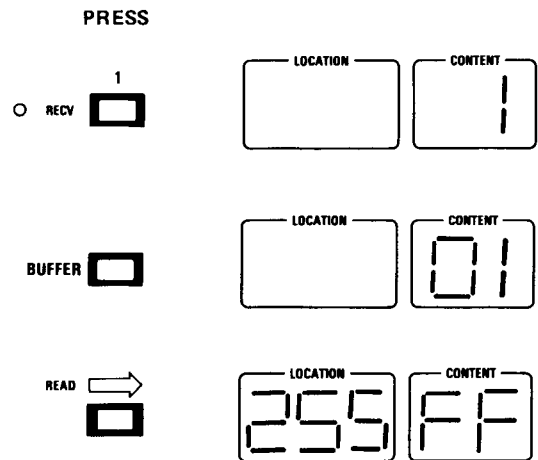
If zero (0) then the decrementing READ key are pushed, the display will return only to the location of the first character and cannot be decremented to the first buffer location (000).



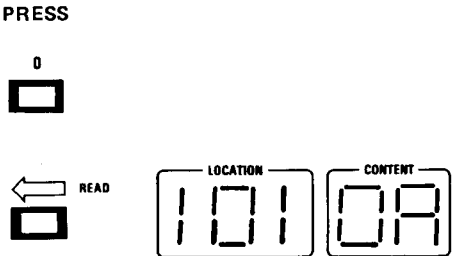
2389-40

PRE TRIG OR STOP:

When MEMORY CONTROL is set to PRE TRIG OR STOP, and less than 256 characters are received, the first READ (either) will display the trigger point (or STOP) location (255).



2389-41



2389-42

If zero (0) then the decrementing READ key are pushed, the buffer will decrement to the location of the first character and cannot be decremented to the first buffer location (000).

NOTE

*When scrolling through the RECV Buffer, you can return to the trigger point at any time by pushing the BUFFER key, then either READ key.*

# INITIAL TURN-ON

## CAUTION

*Before installing the power cord and turning on the instrument, read the INSTALLATION subsection.*

Connect the instrument to a power source and turn it on (push on the POWER switch). Check for these conditions:

1. The self-contained POWER switch indicator should show an ON condition (yellow).
2. An 8.8.8.8.8. should be displayed in the digital displays and all LED's, except PROBE, should be lit.

## NOTE

*If these conditions don't exist, note the faults and have the instrument serviced. If all the initial turn-on conditions above are correct, proceed to Instrument Self Tests.*

## INSTRUMENT SELF TESTS

The Instrument Self Tests consist of a group of selectable routines, which may be used to determine the instrument's operational status. These routines are listed in Table 2-4. When a routine is selected and the START key is pushed, the routine becomes active and ends either in a looping test (Self Test Routine 0) or remains operator executable until the STOP key is pushed (Self Test Routines 1 and 2). With this selection and execution process, the user may run any single routine or all of the routines in any order desired.

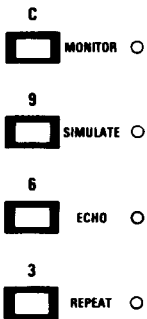
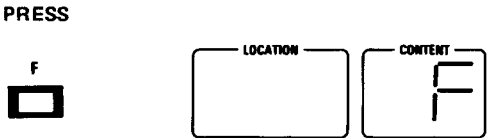
**TABLE 2-4**  
**Self Test Routines**

| Self Test Number | Function Tested                          |
|------------------|------------------------------------------|
| 0                | RAM, ROM, USART'S and Displays.          |
| 1                | Slide switches and push-button switches. |
| 2                | BAUD switch and Baud rate generator.     |

SELF TEST ROUTINE CALL AND EXIT PROCEDURES

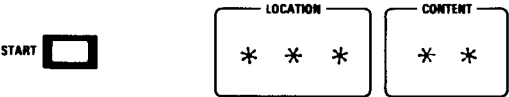
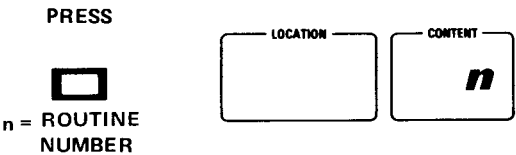
Selection of the self test routines requires pushing several keys as follows:

1. To enter the self test mode, push F, then MODE.



NOTE THESE ARE ALL  
OFF IN SELF TEST  
MODE

2389-43



\*DISPLAY DEPENDS  
ON ROUTINE  
SELECTED

2389-44

2. To select and start a self test routine, push n (where n is the self test routine number, see Table 2-4), then push START.

A self test routine remains selected until STOP is pushed, which returns the system to a self test mode idle display (832). In this state, any routine may be selected and started (self test routine number + START).



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NOTE

*When the tester is in the self test mode (either operating or idle), none of the MODE LED's are on.*

To exit the self test mode, select any other operating mode (MONITOR, SIMULATE, ECHO or REPEAT + MODE).

## SELF TEST ROUTINE EXECUTION

## NOTE

*Before starting any self test routine, close all DIP (Dual In-line Package) switches. Any fault conditions that occur during any of the self test routines should be noted for the service technician.*

## Self Test Routine 0

This routine performs four types of checks—a RAM check, a ROM check, a USART check, and a display check.

## NOTE

*When using this routine, select SYNC and 9.6K BAUD. Also connect a jumper between pins 2 and 3 on the Breakout Panel and another jumper between the PROBE pin and pin 8 on the Breakout Panel.*

To execute the routine:

1. Select the self test mode (F + MODE).
2. Select and start the routine (0 + START).
3. Check Figure 2-6 through 2-8 for the correct displays.
4. To exit the routine, push STOP.
5. Remove all jumpers.

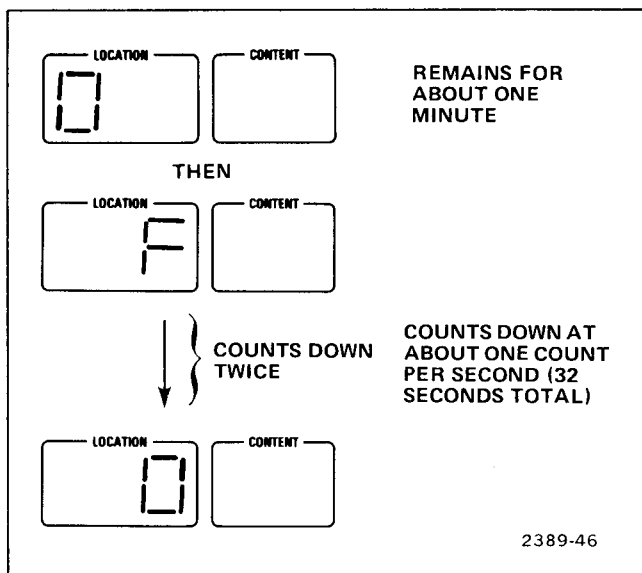


Figure 2-6. RAM check display.

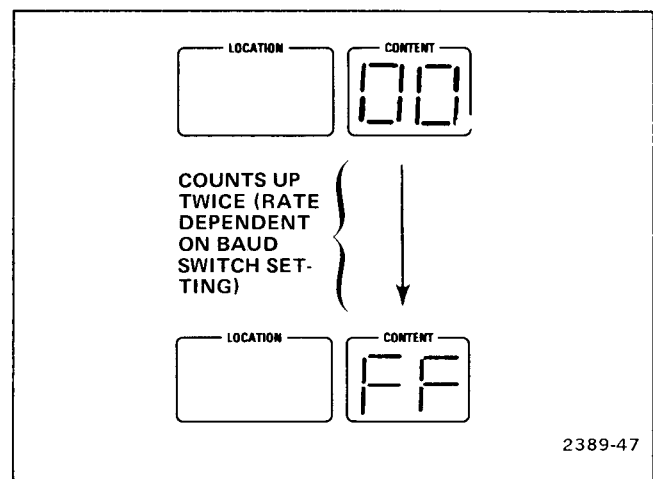
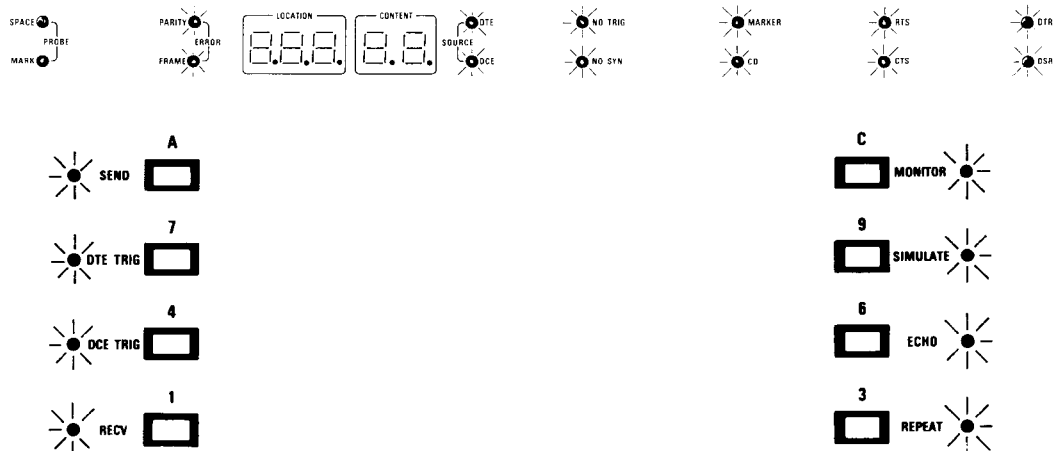
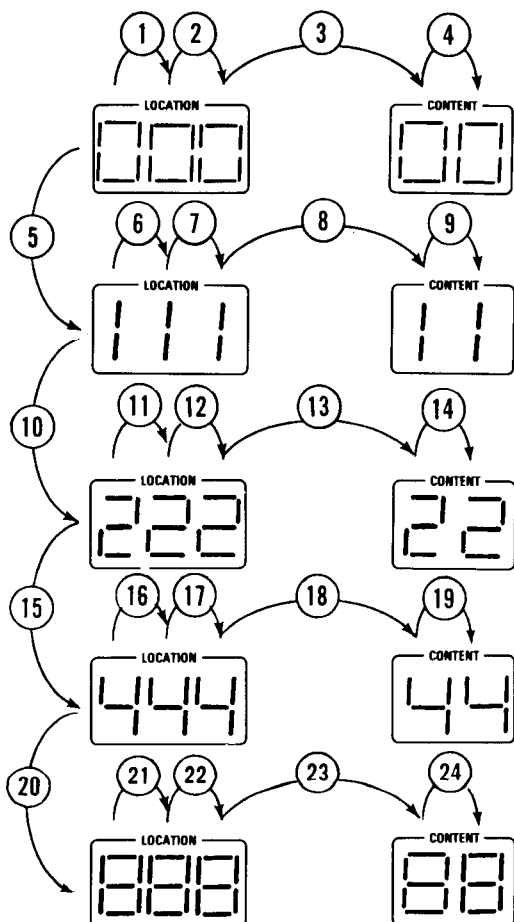


Figure 2-7. USART check display.

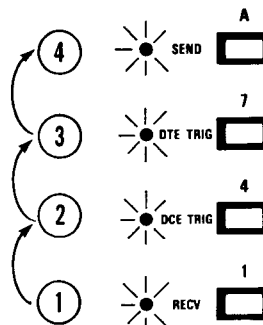
1. All digital displays and LED's on.



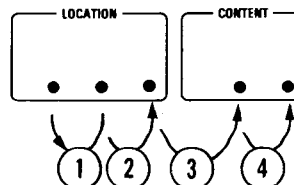
2. Digits 0, 1, 2, 4 and 8 sequence through LOCATION and CONTENT display as shown:



3. Buffer LED's light in sequence shown:



4. A decimal point sequences through LOCATION and CONTENT display as shown:

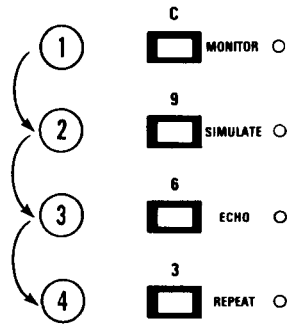


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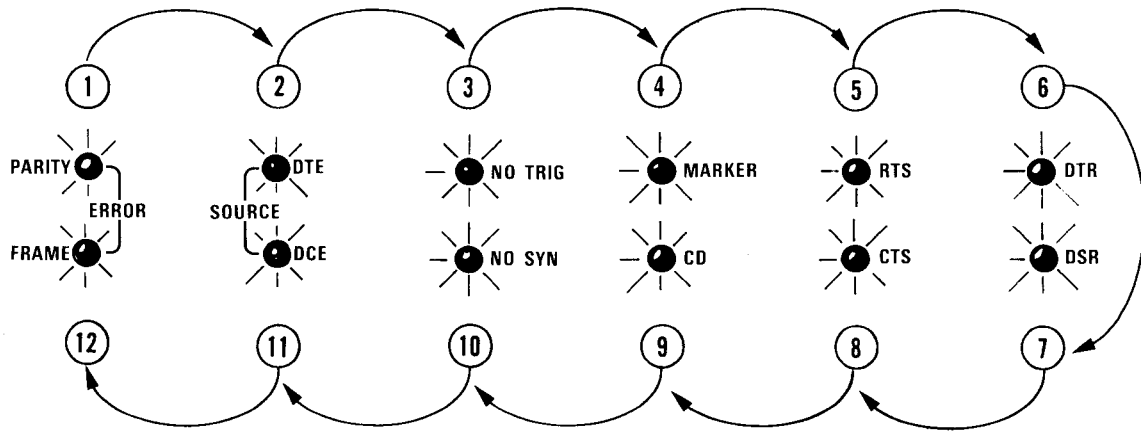
Figure 2-8. Display check sequence and displays (sheet 1 of 2).



5. Mode LED's light in sequence shown:

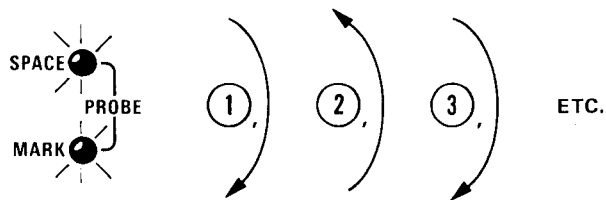


6. Status LED's light in sequence shown:



NOTE

THE PROBE LED'S TOGGLE DURING THE DISPLAY CHECK.



2389-48

Figure 2-8. Display check sequence and displays (sheet 2 of 2).

## Self Test Routine 1

This routine is an operator activated check of all slide switches and push buttons. Each display depends upon the slide switch positions or an operator selected push button.

To execute the routine:

1. Select the self test mode (F + MODE).
2. Select and start the routine (1 + START).

## NOTE

*The check of slide switches must be performed in a specific sequence, or a blinking display error condition (009) will appear in the LOCATION display.*

3. Perform the slide switch check by selecting the slide switch positions in the sequence listed in Table 2-5 and checking for the correct displays shown in the table.

TABLE 2-5  
Displays for Slide Switch Position Combinations

| SWITCH POSITIONS     | SWITCHES                            |                                 |                            |                                 |                                                | LOCATION DISPLAYS | SWITCH POSITIONS                                                         | SWITCHES                            |                                 |                            |                                 |                                                | LOCATION DISPLAYS |
|----------------------|-------------------------------------|---------------------------------|----------------------------|---------------------------------|------------------------------------------------|-------------------|--------------------------------------------------------------------------|-------------------------------------|---------------------------------|----------------------------|---------------------------------|------------------------------------------------|-------------------|
|                      | M<br>E<br>M<br><br>C<br>O<br>N<br>T | D<br>I<br>S<br>P<br>L<br>A<br>Y | P<br>A<br>R<br>I<br>T<br>Y | H<br>D<br>X<br>/<br>F<br>D<br>X | A<br>S<br>Y<br>N<br>C<br>/<br>S<br>Y<br>N<br>C |                   |                                                                          | M<br>E<br>M<br><br>C<br>O<br>N<br>T | D<br>I<br>S<br>P<br>L<br>A<br>Y | P<br>A<br>R<br>I<br>T<br>Y | H<br>D<br>X<br>/<br>F<br>D<br>X | A<br>S<br>Y<br>N<br>C<br>/<br>S<br>Y<br>N<br>C |                   |
| UP<br>MIDDLE<br>DOWN | X                                   | X                               | X                          | X                               | X                                              | 000               | UP<br>MIDDLE<br>DOWN                                                     |                                     |                                 |                            | X                               | X                                              | 005               |
|                      |                                     |                                 |                            |                                 |                                                |                   |                                                                          |                                     |                                 | X                          |                                 |                                                |                   |
|                      |                                     |                                 |                            |                                 |                                                |                   |                                                                          | X                                   | X                               |                            |                                 |                                                |                   |
| UP<br>MIDDLE<br>DOWN |                                     | X                               | X                          | X                               | X                                              | 001               | UP<br>MIDDLE<br>DOWN                                                     |                                     |                                 |                            | X                               | X                                              | 006               |
|                      | X                                   |                                 |                            |                                 |                                                |                   |                                                                          |                                     |                                 |                            |                                 |                                                |                   |
|                      |                                     |                                 |                            |                                 |                                                |                   |                                                                          | X                                   | X                               | X                          |                                 |                                                |                   |
| UP<br>MIDDLE<br>DOWN |                                     | X                               | X                          | X                               | X                                              | 002               | UP<br>MIDDLE<br>DOWN                                                     |                                     |                                 |                            |                                 | X                                              | 007               |
|                      |                                     |                                 |                            |                                 |                                                |                   |                                                                          |                                     |                                 |                            |                                 |                                                |                   |
|                      | X                                   |                                 |                            |                                 |                                                |                   |                                                                          | X                                   | X                               | X                          | X                               |                                                |                   |
| UP<br>MIDDLE<br>DOWN |                                     |                                 | X                          | X                               | X                                              | 003               | UP<br>MIDDLE<br>DOWN                                                     |                                     |                                 |                            |                                 |                                                | 008               |
|                      |                                     | X                               |                            |                                 |                                                |                   |                                                                          |                                     |                                 |                            |                                 |                                                |                   |
|                      | X                                   |                                 |                            |                                 |                                                |                   |                                                                          | X                                   | X                               | X                          | X                               | X                                              |                   |
| UP<br>MIDDLE<br>DOWN |                                     |                                 | X                          | X                               | X                                              | 004               | SWITCH MALFUNCTION, OR ANY SWITCH POSITION COMBINATIONS NOT SHOWN ABOVE. |                                     |                                 |                            |                                 | 009                                            |                   |
|                      |                                     |                                 |                            |                                 |                                                |                   |                                                                          |                                     |                                 |                            |                                 |                                                |                   |
|                      | X                                   | X                               |                            |                                 |                                                |                   |                                                                          |                                     |                                 |                            |                                 |                                                |                   |

4. Perform the push-button switch check by pushing in and holding each push button, then checking the CONTENT display against Table 2-6. These switches can be checked in any order desired.
5. To exit the routine, push STOP.

**TABLE 2-6**  
Push-button Self Test Displays

| Push Button | CONTENT Display | Push Button | CONTENT Display |
|-------------|-----------------|-------------|-----------------|
| 0 thru F    | 0 thru F        | TRANSFER    | 16              |
| SYNC        | 10              | CLEAR       | 17              |
| DELAY       | 11              | MODE        | 18              |
| START       | 12              | BUFFER      | 19              |
| BITS/CHAR   | 14              | READ>       | 1A              |
| ENTER       | 15              | READ<       | 1B              |

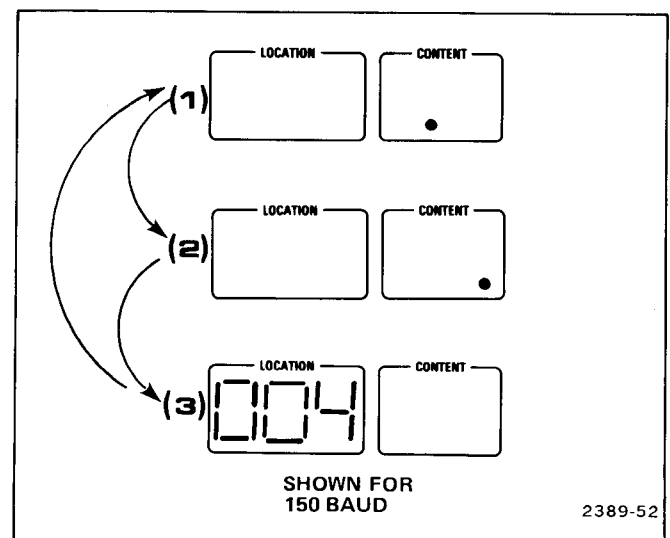
**NOTE:** 13 is not used; therefore, there is a sequence break between the display numbers 12 and 14.

### Self Test Routine 2

This routine is an operator activated check of the BAUD switch positions and BAUD rate generator circuit. Each display that occurs during the check depends on the BAUD rate selected and the position of the SYNC/ASYNCR switch. When a BAUD rate is selected, the display and sequence shown in Figure 2-9 occurs.

To execute the routine:

1. Select the self test mode (F + MODE).
2. Select and start the routine (2 + START).
3. Select each BAUD switch and SYN or ASYNCR position listed in Table 2-7 and check for the displays shown in the table.



**Figure 2-9.** Display sequence for self test routine 2.

### NOTE

*For BAUD rates above 600, it is difficult to observe an actual sequencing of the display as each sequence seems to appear simultaneously.*

4. To exit the routine, push STOP.

**TABLE 2-7**  
**BAUD Switch Self Test Displays**

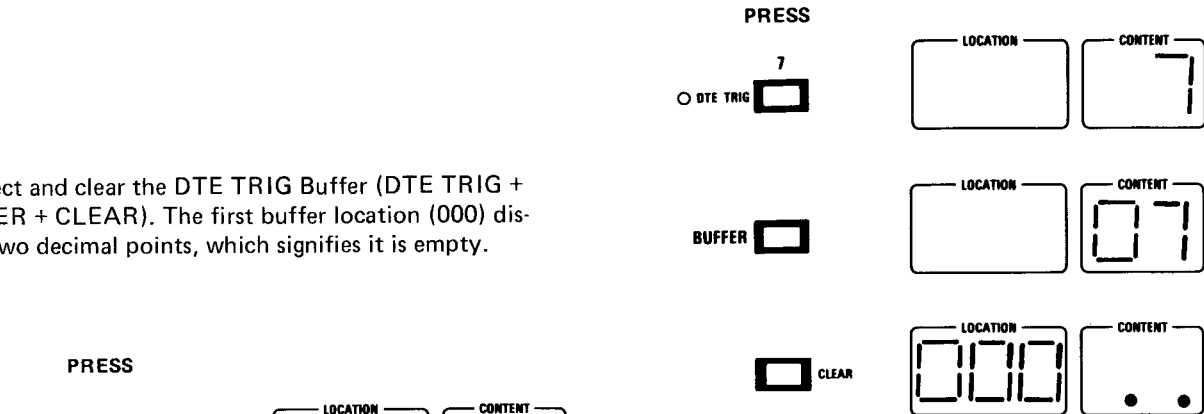
| BAUD Switch Position | LOCATION Display*                                         | Timing Switch Position |
|----------------------|-----------------------------------------------------------|------------------------|
| 50                   | 000                                                       | SYNC                   |
| 75                   | 001                                                       |                        |
| 110                  | 002                                                       |                        |
| 134.5                | 003                                                       |                        |
| 150                  | 004                                                       |                        |
| 200                  | 005                                                       |                        |
| 300                  | 006                                                       |                        |
| 600                  | 007                                                       |                        |
| 1.2K                 | 008                                                       |                        |
| 1.8K                 | 009                                                       |                        |
| 2.4K                 | 010                                                       |                        |
| 4.8K                 | 011                                                       |                        |
| 9.6K                 | 012                                                       |                        |
| DTE                  | None (display is a decimal point in left CONTENT display) |                        |
| DCE                  |                                                           |                        |
| 75                   | 008                                                       | ASync                  |
| 110                  | 009                                                       |                        |
| 150                  | 010                                                       |                        |
| 300                  | 011                                                       |                        |
| 600 and above        | 012                                                       |                        |

**\*013 is a malfunction display.**

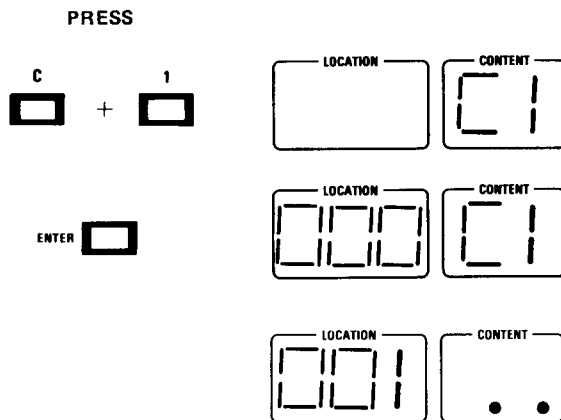
# PROGRAMMING A TRIGGER

Programming a trigger requires selecting either the DTE TRIG or DCE TRIG Buffer and entering one to three trigger characters. The following examples show how characters are entered, deleted or manipulated in either trigger buffer.

Select and clear the DTE TRIG Buffer (DTE TRIG + BUFFER + CLEAR). The first buffer location (000) displays two decimal points, which signifies it is empty.

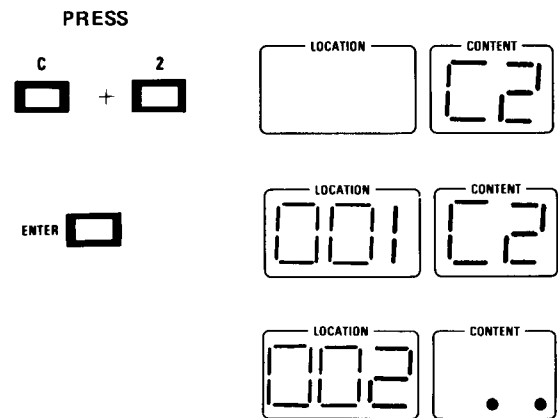


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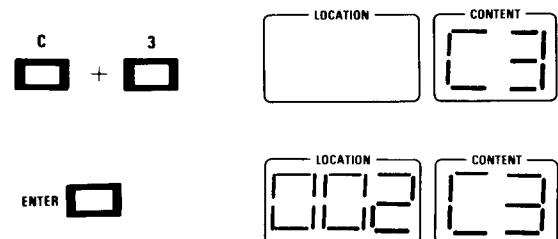


2389-56

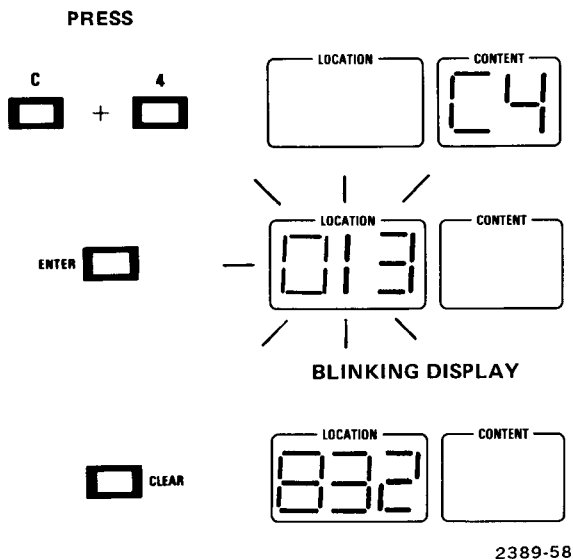
Enter an 8-bit ASCII 'A' as the first trigger character (C1 + ENTER). The entered character displays for about one-third second, then the next location (001) displays two decimal points, which indicates the end of data in an unfilled buffer and that the next trigger character may be entered.



Enter the ASCII characters 'B' and 'C' (C2 + ENTER, C3 + ENTER). When the C3 is entered, the last location (002) and character (C3) remain displayed, which indicates the buffer is full.



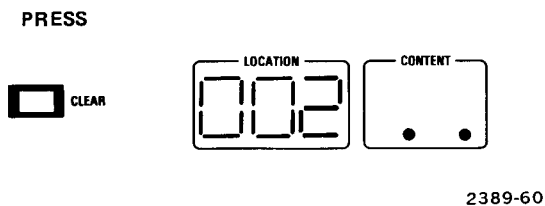
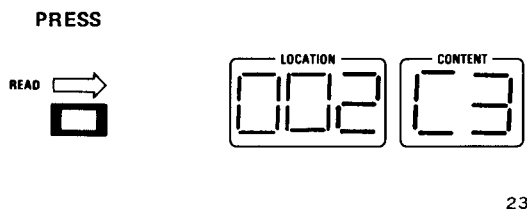
2389-57



Enter another character (C4 + ENTER). A blinking display error condition (013) should appear, which indicates that an attempt was made to enter another character in an already full buffer. Push CLEAR and an 832 display replaces the blinking display error condition.

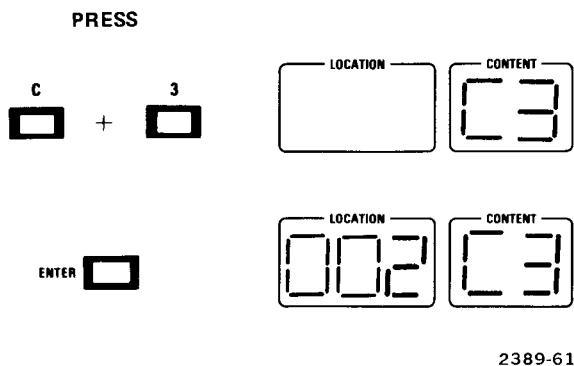
To observe the buffer editing feature of the 832, proceed with the following control selections.

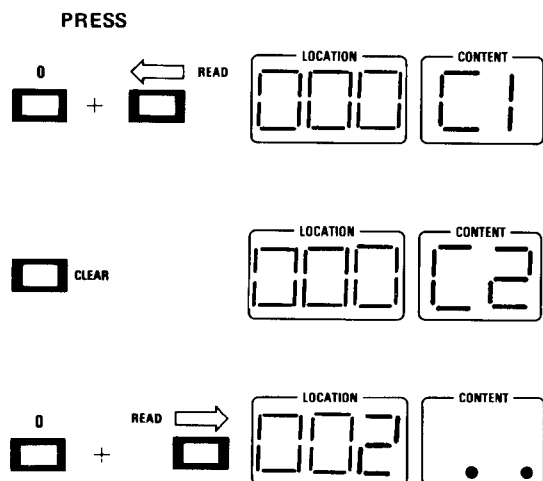
Push either READ key. The last trigger buffer location (002) and character (C3) appear.



Push CLEAR. The last trigger character (C3) is deleted and a double decimal point is displayed in the last trigger location (002). This signifies that a new trigger character may be entered in the location shown.

Re-enter the character C3 in the last trigger location (C3 + ENTER). The buffer should again be full and displaying the last location (002) and trigger character (C3).





Push 0 and the decrementing READ to get to location 000. The character displayed is C1 (ASCII A), which was the first trigger character entered.

Push CLEAR. The character (C1) disappears and the next character (C2) appears in the display. This signifies that the character C1 was deleted and the subsequent character (C2) closed-up to fill the vacated location (C2 was previously programmed as the second trigger character).

Push 0 and the incrementing READ key. Two decimal points appear at location 002, which indicates that the buffer is not full.

2389-62

## DATA ACQUISITION

In the MONITOR, SIMULATE, ECHO and REPEAT modes, up to 256 characters of interface activity can be recorded in the RECV Buffer anytime after START is pushed. When START is pushed, a decimal point appears in the CONTENT display, which indicates that the 832 is in recording condition. The location within the activity where the 256 characters are recorded is determined by (1) the MEMORY CONTROL selection; (2) whether or not a trigger is programmed, and if programmed, if it occurs; and (3) when the STOP key is pushed.

### NOTE

*When the STOP key is pushed, all data acquisition stops regardless of any other control or programmed selection.*

Figures 2-10 through 2-17 show which 256 characters within the interface activity are recorded in the RECV Buffer under various operating conditions and control selections. The operating conditions and control selections are listed on each illustration.

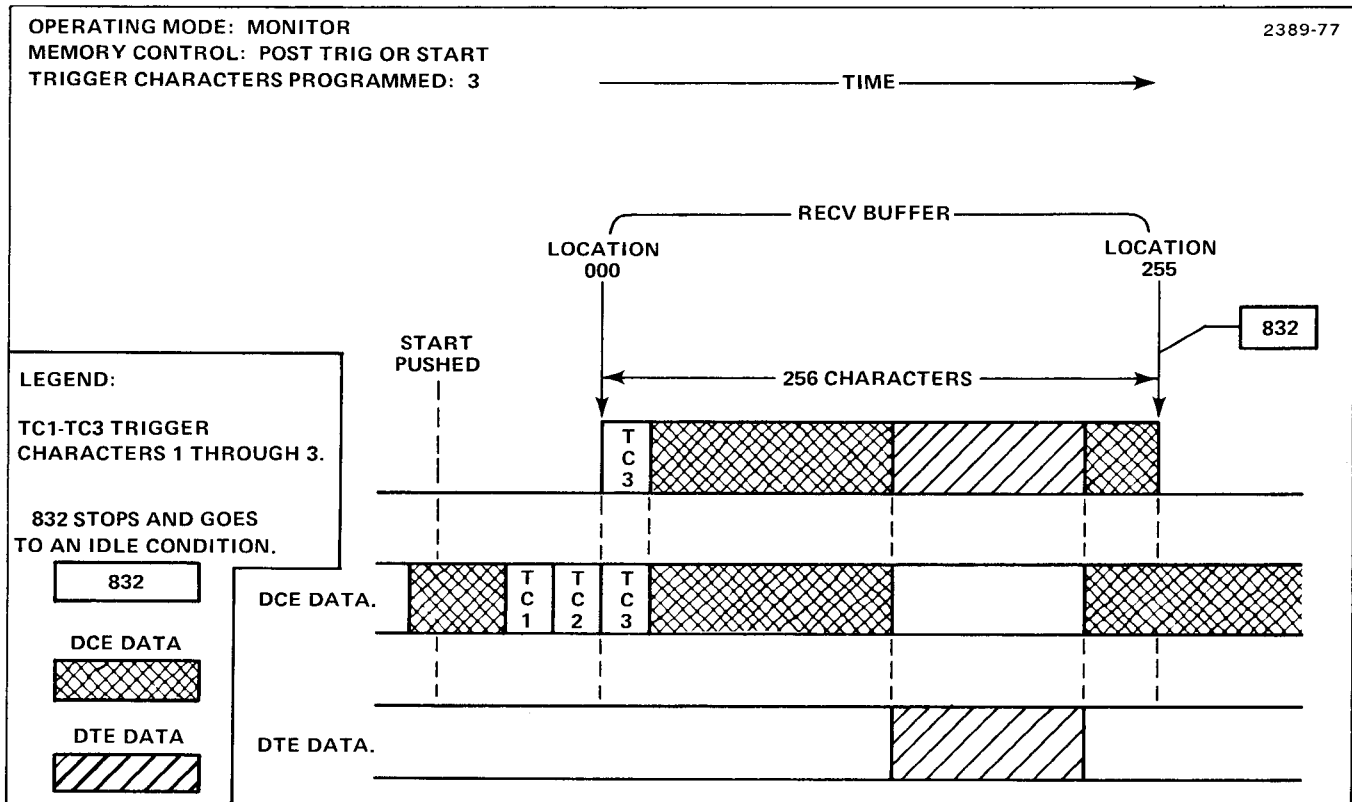


Figure 2-10. MONITOR mode recording in POST TRIG OR START with a trigger.

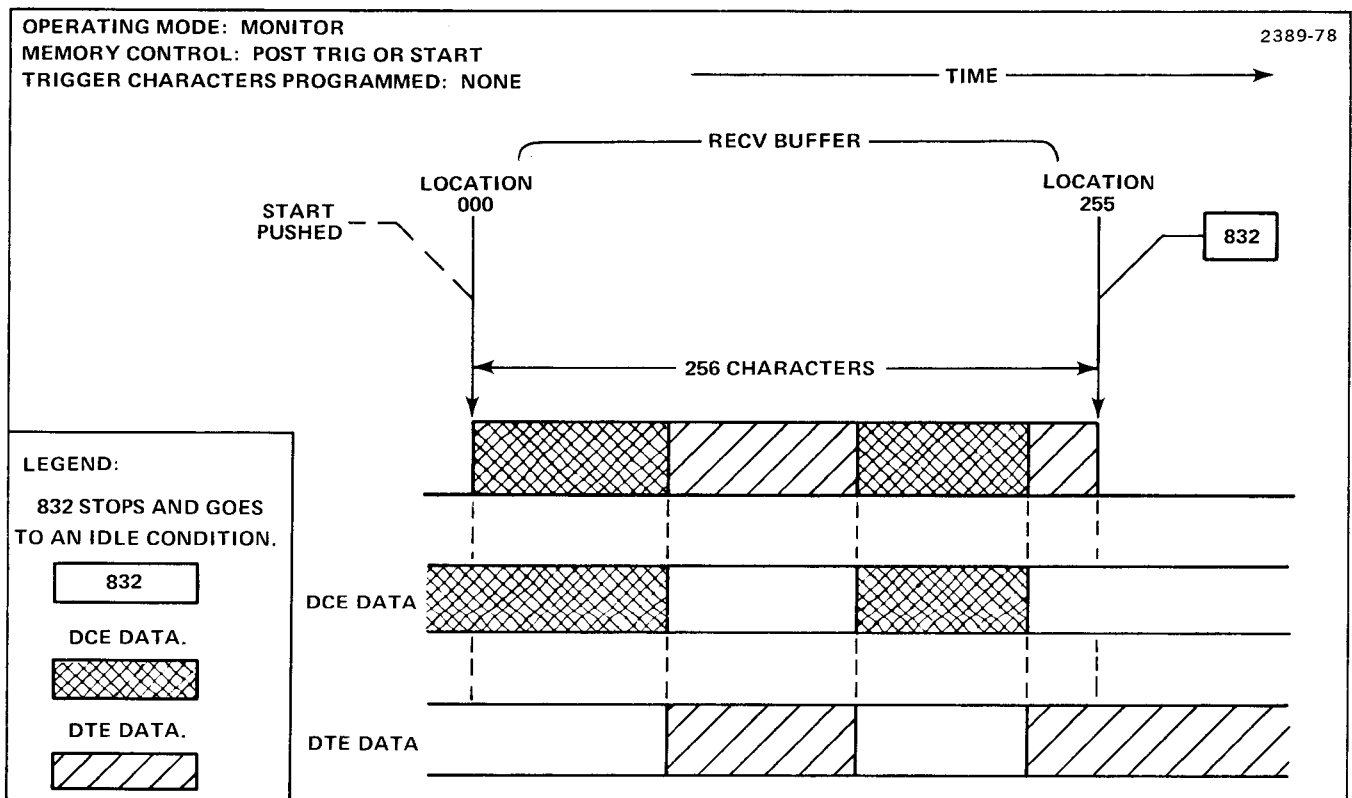


Figure 2-11. MONITOR mode recording in POST TRIG OR START without a trigger.



OPERATING MODE: MONITOR  
 MEMORY CONTROL: CENTER  
 TRIGGER CHARACTERS PROGRAMMED: 3

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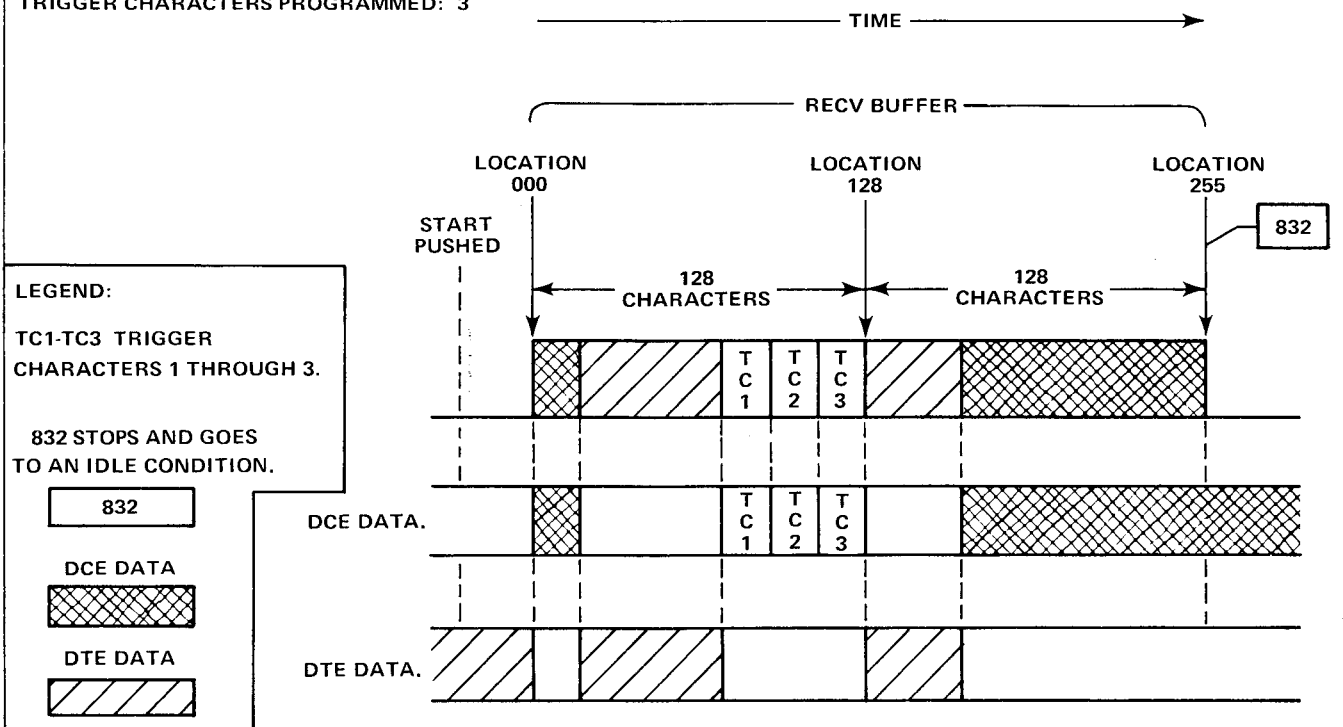


Figure 2-12. MONITOR mode recording in CENTER with a trigger.

OPERATING MODE: MONITOR  
 MEMORY CONTROL: PRE TRIG OR STOP  
 TRIGGER CHARACTERS PROGRAMMED: 3

2389-80

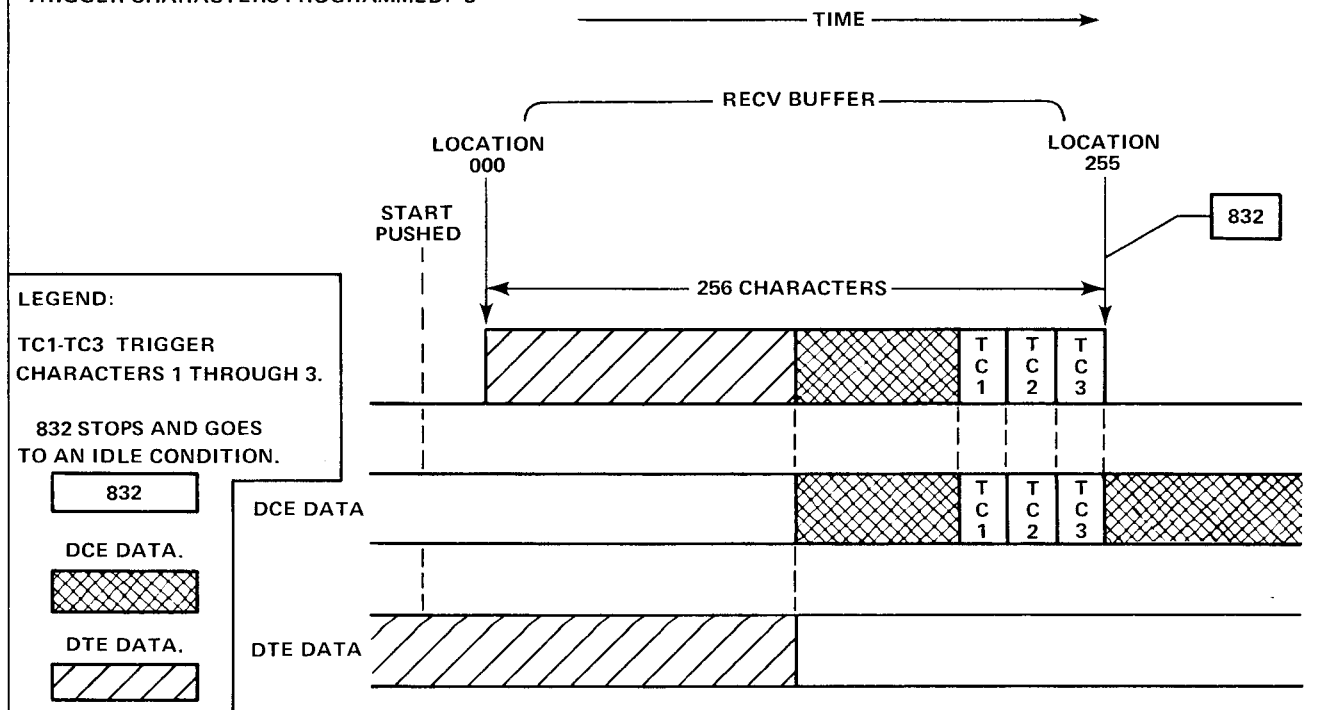


Figure 2-13. MONITOR mode recording in PRE TRIG OR STOP with a trigger.

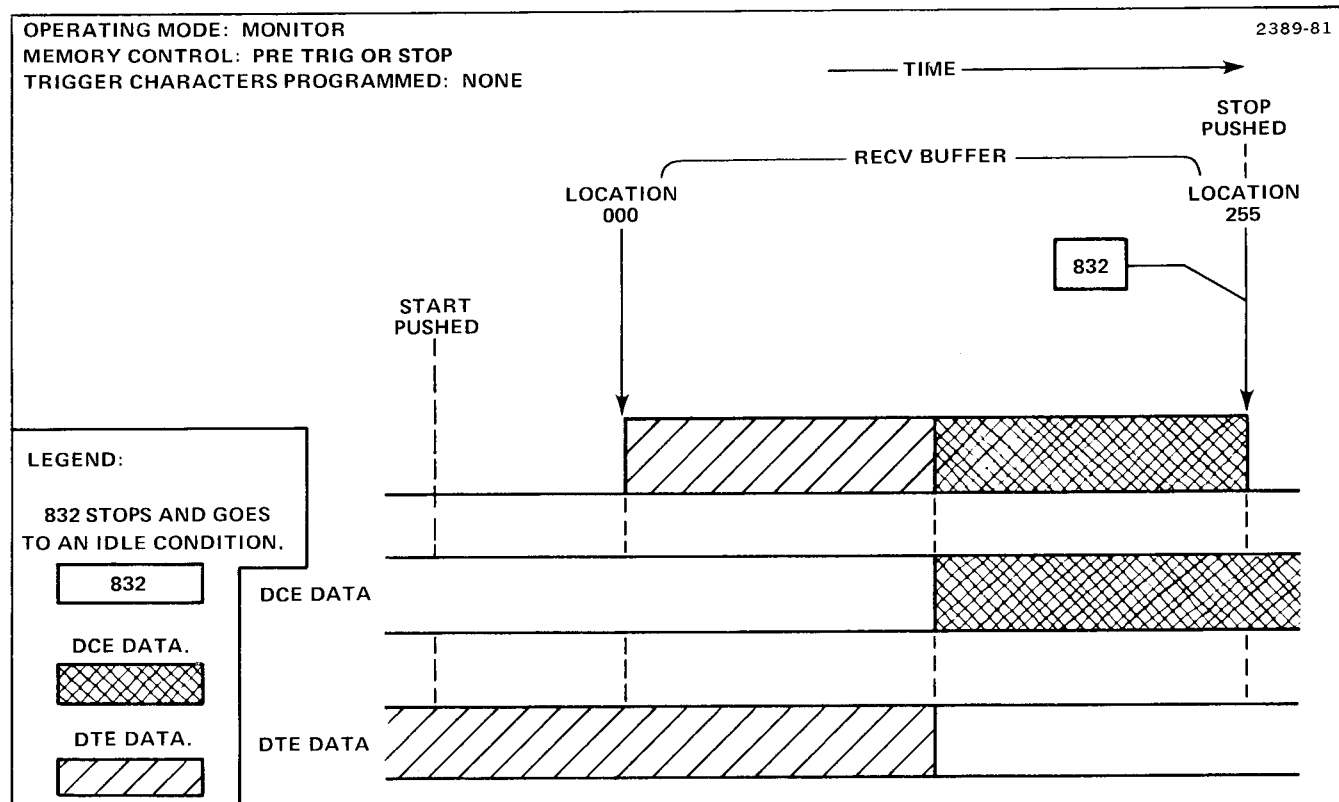


Figure 2-14. MONITOR mode recording in PRE TRIG OR STOP without a trigger.

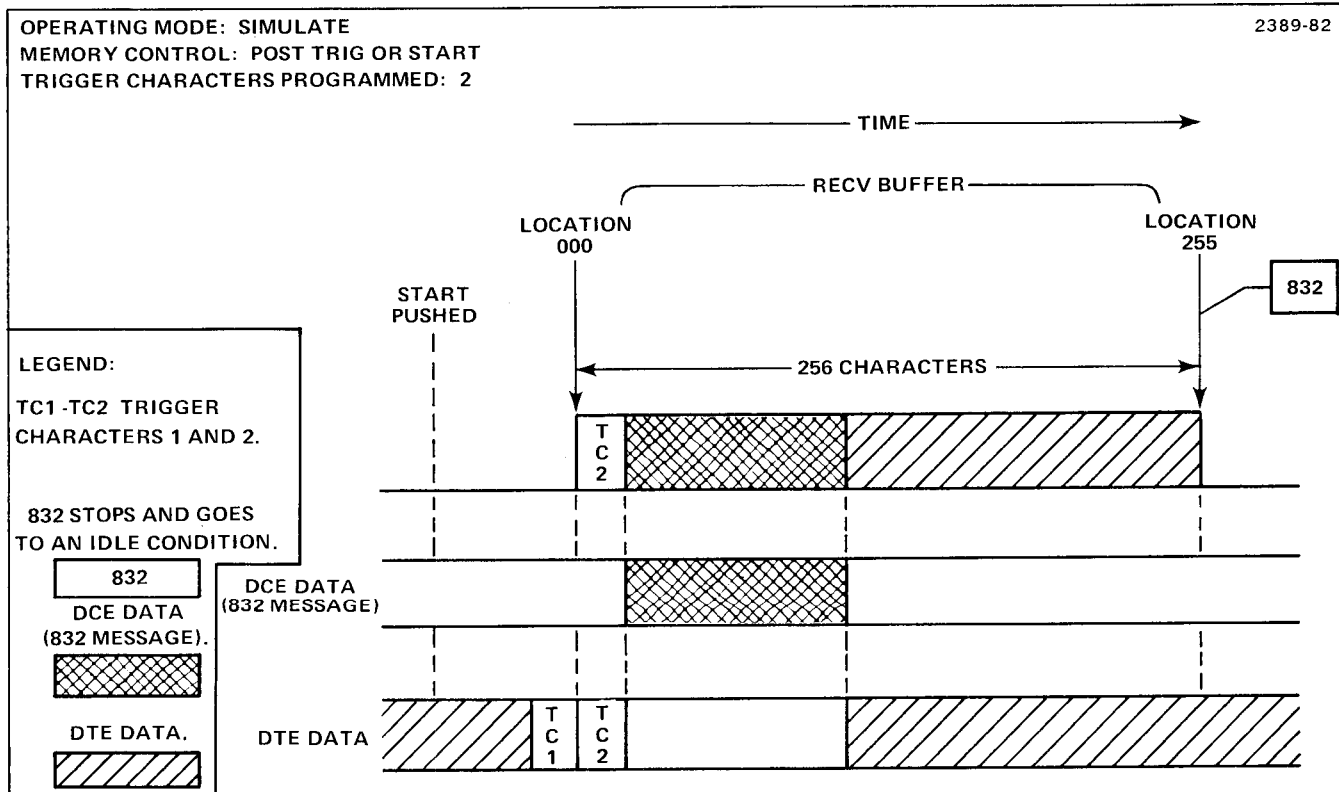


Figure 2-15. SIMULATE mode recording in POST TRIG OR START with a trigger.

2389-83

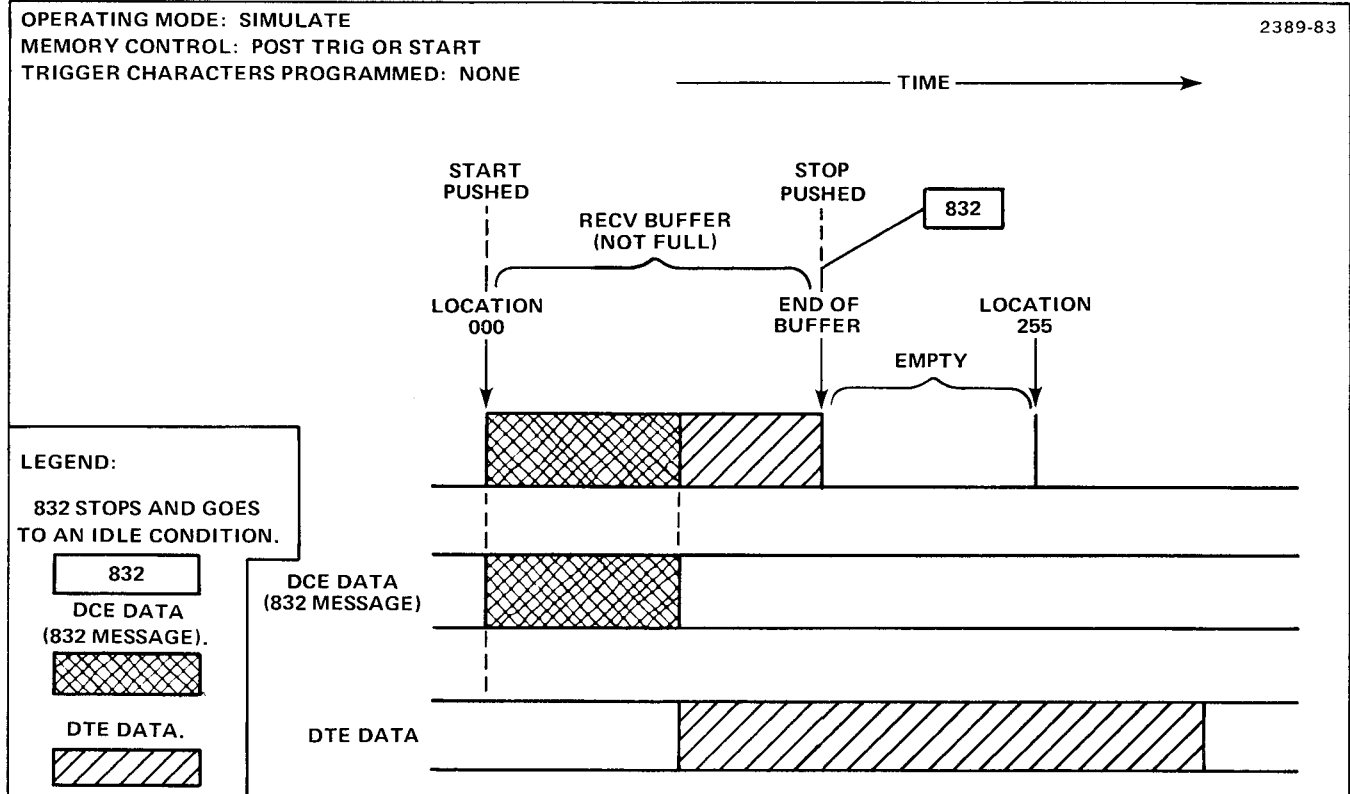


Figure 2-16. SIMULATE mode recording in POST TRIG OR START without a trigger.

2389-84

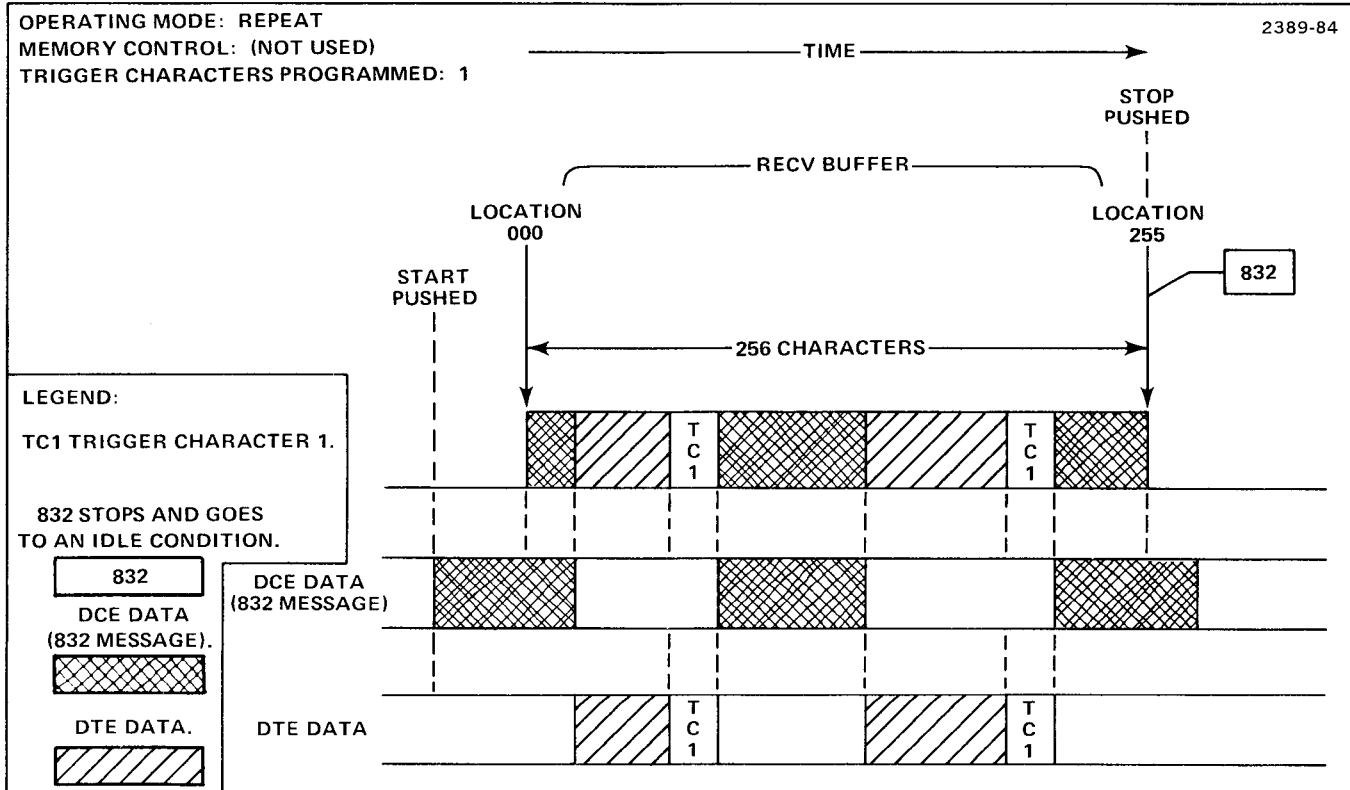


Figure 2-17. REPEAT mode recording with a trigger.

## THE OPERATING MODES

This subsection provides instructions for setting up and using the 832 in its four operating modes—MONITOR, SIMULATE, ECHO and REPEAT. Along with these instructions are some typical examples of setups and the resultant tester operation. In many cases, one or two minor setup changes (such as a change in BAUD rate, BITS/CHAR or PARITY selection) are all that are needed for user application.

### NOTE

*After the START key is pushed in any operating mode, the 832 will not recognize any control changes until the STOP key is pushed. All examples assume the tester has been turned on and self-tested.*

### MONITOR MODE

In the MONITOR Mode, the 832 is connected to an interface between the DCE (typically a modem) and the DTE (typically some type of terminal) to monitor and record the activity on that interface. This mode is set up and operated as follows:

1. Connect the 832 to the interface as shown in Figure 2-18 (this example was performed with a Tektronix Model 4023 Graphics Terminal connected to an interactive computer system through a modem on a dial-up data access arrangement). Observe that the DTR, DSR and RTS LED's are on.

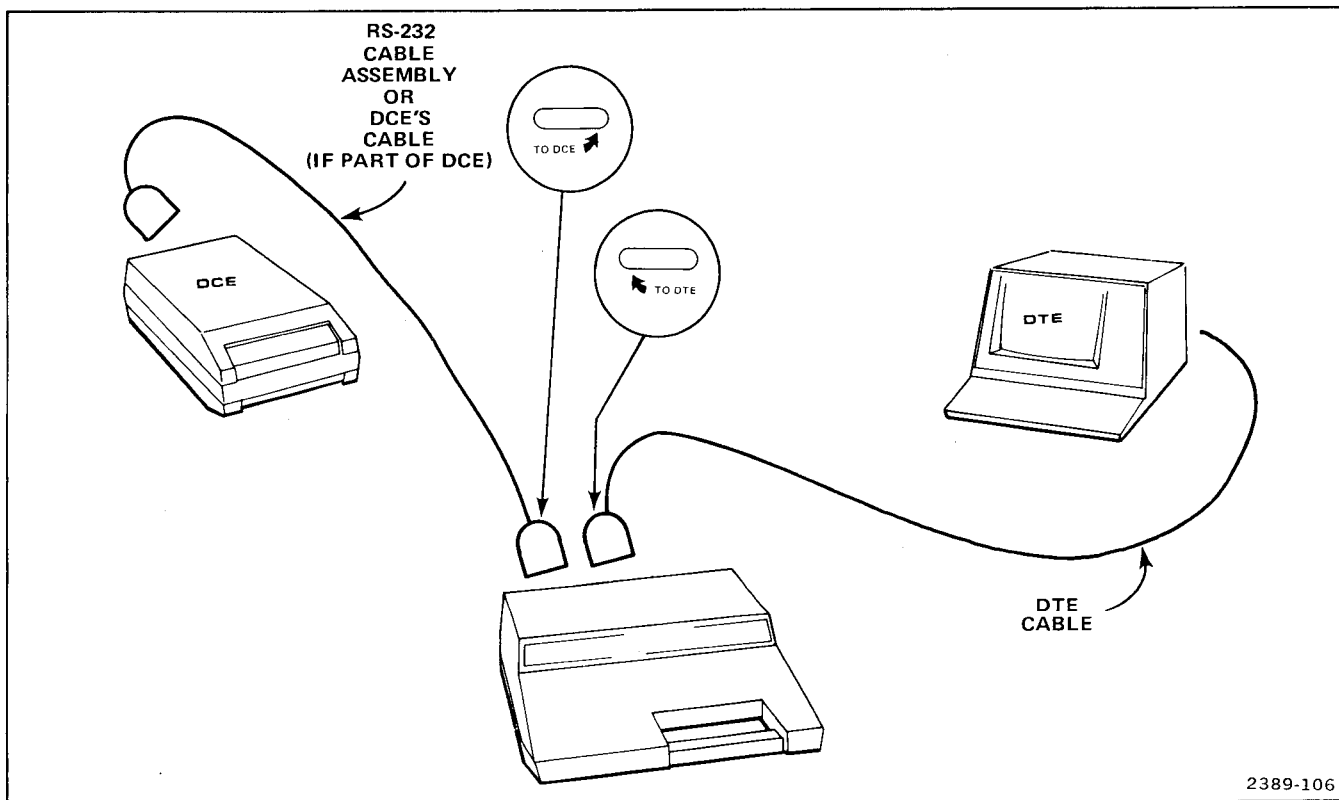
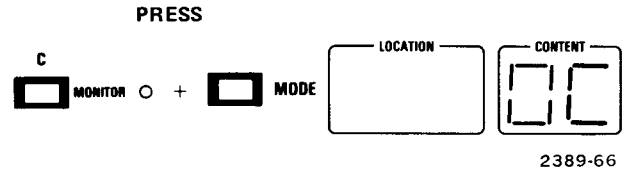


Figure 2-18. Connecting the 832 for the MONITOR mode.

2. Select the MONITOR Mode (MONITOR + MODE).



3. Set the controls as follows:

#### NOTE

*Controls that usually change from application to application are identified with an asterisk (\*).*

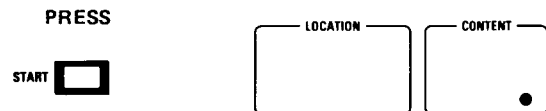
MEMORY CONTROL  
DISPLAY  
PARITY\*  
HDX/FDX\*  
ASYNC/SYNC\*  
BITS/CHAR\*  
DELAY\*  
SYN\*  
BAUD\*

POST TRIG OR START  
BOTH  
EVEN (see NOTE below)  
FDX  
ASYNC  
8 + BITS/CHAR (see NOTE below)  
Default (200 ms)  
(not used in ASYNC)  
1200 (Terminal is also set to 1200)

#### NOTE

*In this example, the computer communicated in even parity ASCII and the terminal in 8-bit ASCII, which created no data interchange problems, but the PARITY ERROR LED had to be ignored when the DTE SOURCE LED was on. This could be a common situation in user applications as well.*

4. Push START. At this point the 832 is ready to record any activity from the interface between the DCE (modem) and DTE (terminal). Observe the decimal point in the CONTENT display.



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5. Generate a terminal message that requires a computer response. Observe these conditions: (1) the CD LED is on when the dial-up computer access is established through the DCE to the DTE; (2) the DTE SOURCE LED is on when terminal is sending to the computer and the DCE SOURCE LED is on when the computer is responding; and (3) the CONTENT display is active, which indicates that the 832 is recording data from the interface.

6. Push STOP. At this point the 832 is in an idle state (832); controls may be changed or the buffers read.



2389-64

## Operating Instructions—832

7. Push READ >.

LOCATION = First RECV Buffer location containing data (000).

CONTENT = Character in the LOCATION above.

8. Increment and decrement through the RECV Buffer using <READ and READ> to compare the recorded data with the DTE message and the computer response in step 5 above.

### NOTE

*Observe the condition of the SOURCE LED's as each character is displayed. When the DTE LED lights, it indicates the character was received from the DTE device; when the DCE LED lights, it indicates the character was received from the DCE device.*

9. To display the last character location, press 0 + READ>. To return to the first character location, press 0 + <READ.
10. Push STOP to change controls or before entering another operating mode.

## MODEM SIMULATOR MODES

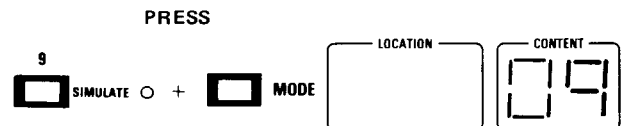
### NOTE

*In the modem simulator modes (SIMULATE, ECHO or REPEAT), DTR must be asserted (turned on) by the DTE before the 832 can send a message.*

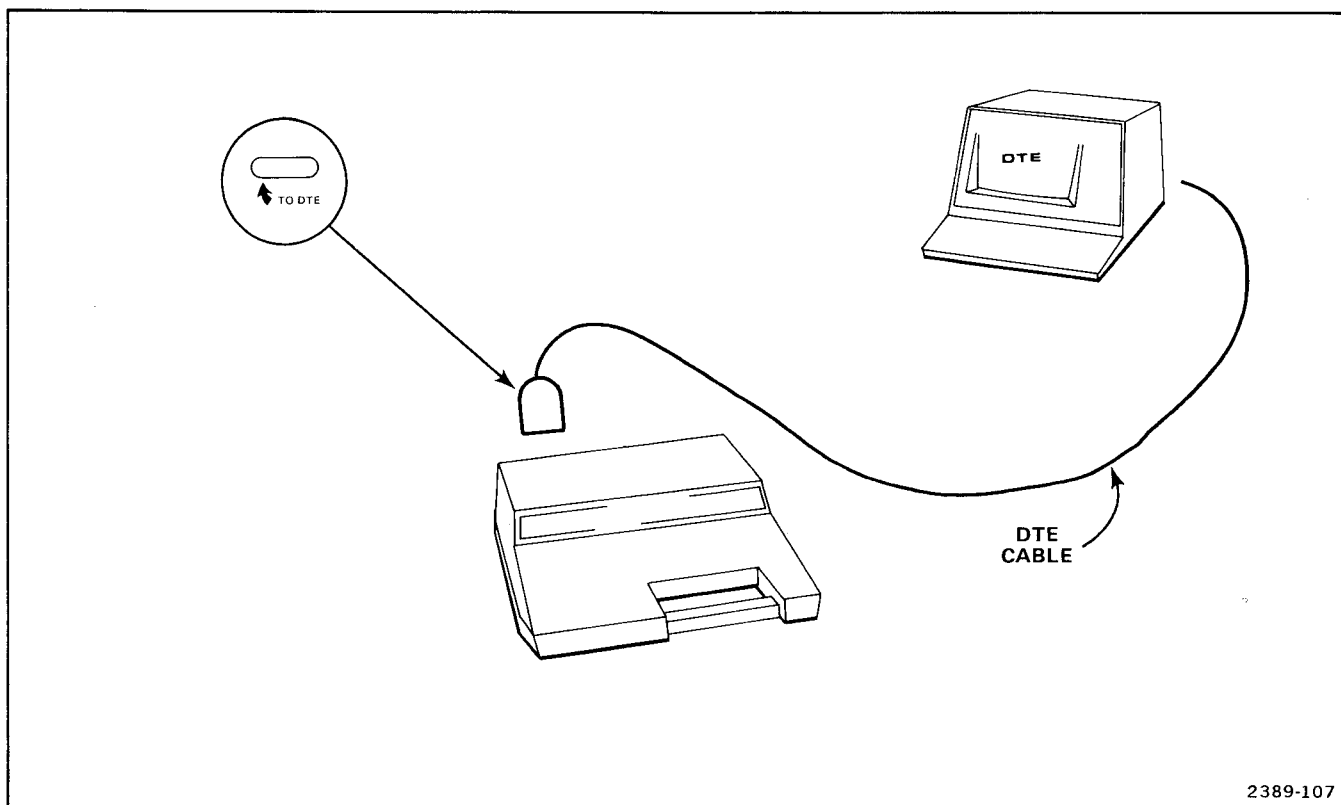
### Simulate Mode

SIMULATE is the first of three modem simulator modes in which the 832 is connected such that it responds to the DTE like a modem. In SIMULATE Mode, the 832 sends a message to the DTE once, and records the message and the DTE's response. This mode is set up and operated as follows:

1. Connect the 832 to the DTE as shown in Figure 2-19 (this example was performed with a Tektronix Model 4023 Graphics Terminal as the DTE).
2. Select the MONITOR Mode (MONITOR + MODE). Push START. Observe that only the DTR and RTS LED's are on. Push STOP.
3. Select the SIMULATE Mode (SIMULATE + MODE). Push START. Observe that now the DTR, RTS, DSR, CTS and CD LED's are on. Push STOP.



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Figure 2-19. Connecting the 832 for the modem simulator modes.

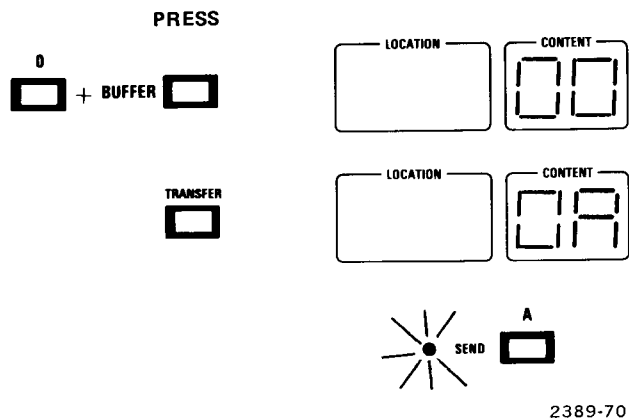
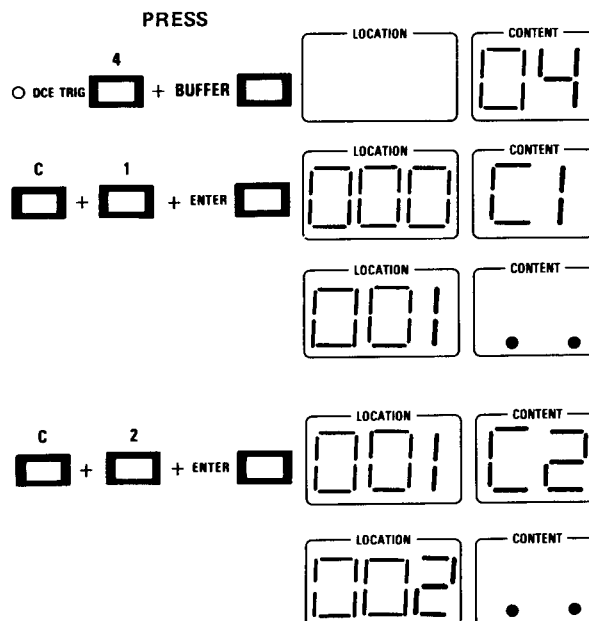
4. Set the controls as follows (note that only MEMORY CONTROL is different from the controls in MONITOR Mode):

## NOTE

*Controls that usually change from application to application are identified with an asterisk (\*).*

|                |                                          |
|----------------|------------------------------------------|
| MEMORY CONTROL | CENTER                                   |
| DISPLAY        | BOTH                                     |
| PARITY*        | OFF                                      |
| HDX/FDX*       | FDX                                      |
| ASYNC/SYNC*    | ASYNC                                    |
| BITS/CHAR*     | 8 + BITS/CHAR                            |
| DELAY*         | (not used in FDX)                        |
| SYN*           | (not used in ASYNC)                      |
| BAUD*          | 1200 (the terminal was also set to 1200) |

5. Select the DTE TRIG Buffer (DTE TRIG + BUFFER) and load an 8-bit ASCII 'AB' trigger sequence (C1 + ENTER, C2 + ENTER).

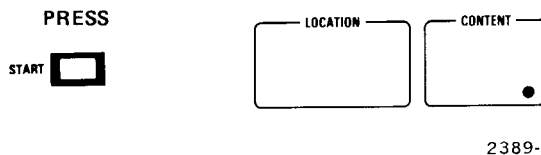


6. Select the ASCII FOX test message buffer and transfer it to the SEND Buffer (0 + BUFFER + TRANSFER).

7. Push START.

At this point the 832 is ready to record up to the last 126 characters it receives from the DTE before the two trigger characters (AB) are received, then to send and record the ASCII FOX test message and any additional characters from the DTE (including the ASCII FOX test message) up to 128 characters.

Observe that the NO TRIG LED is on, which indicates the 832 has not received a trigger from the DTE.





8. Send this message from the DTE and observe that the DTE SOURCE LED is on while the message is being sent:

SEND A MESSAGE—AB

Observe that the tester recorded the characters from the DTE and that as soon as the trigger (AB) was sent from the DTE the SOURCE LED changed to DCE, the NO TRIG LED turned off and the tester sent and recorded the ASCII FOX test message. Now send the DTE trigger (AB) again and observe that it is recorded but the ASCII FOX test message is not sent again.

9. Push STOP. At this point the 832 is in an idle state (832); controls may be changed or the buffers read.

10. Push either READ key. Observe that the LOCATION display shows 127 (the trigger point) and the CONTENT display shows C2 (ASCII B), the second trigger character.

PRESS



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PRESS



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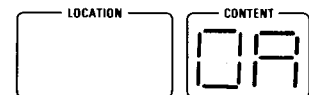
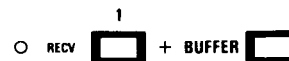
11. Push the decrement READ key. Note that the location is 126 and the CONTENT display shows C1 (ASCII A), the first trigger character.

12. Increment and decrement through the RECV Buffer using READ> and <READ to compare the recorded data to the DTE message and trigger (AB), ASCII FOX test message and second DTE trigger (AB) sent in step 8. above.

Observe that the DTE message and first trigger character is recorded ahead of the trigger point (last trigger character—location 127) and the ASCII FOX message from the 832 is recorded after the trigger point. Also, observe the SOURCE LED's. When the DTE LED is on, the displayed character was received from the DTE; when the DCE LED is on, the displayed character was sent by the 832.

13. Transfer the RECV Buffer to the SEND Buffer (RECV + BUFFER + TRANSFER).

PRESS



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14. Transmit the contents of the SEND Buffer to the DTE (START + AB from the DTE + STOP). Note that the message sent includes the original message from the DTE, the trigger (AB), the ASCII FOX test message, and the trigger (AB) again, but not a second ASCII FOX test message.

15. Push STOP to change controls or before entering another operating mode.

### Echo Mode

ECHO is the second of three modem simulator modes. This mode is set up and operated like the SIMULATE Mode. The operational difference is the 832 echoes (sends back to the DTE) each character sent by the DTE and records the echoed characters.

Echo Mode is set up and operated by performing steps 1 through 9 and 12 through 14 of the SIMULATE Mode, but selecting the ECHO Mode (ECHO + MODE) in step 2. Note the echoed characters in the message and trigger from the DTE.

When scrolling through the RECV Buffer, observe that location 127 (the trigger point) contains the last trigger character C2 (ASCII B), and so does location 128. Location 128 is the echo of the last trigger character, but it is recorded as the first datum character because the 832 set the trigger point on the first trigger occurrence, which was before the last trigger character was echoed.

### Repeat Mode

REPEAT is the third of three modem simulator modes. This mode is set up and operated like the SIMULATE Mode. The operational difference is the 832 will send the message in the SEND Buffer to the DTE once when START is pushed, then once again each time a trigger is received. If there is no trigger programmed into the DTE TRIG Buffer, the message is sent repeatedly. Repeat mode is set up and operated as follows:

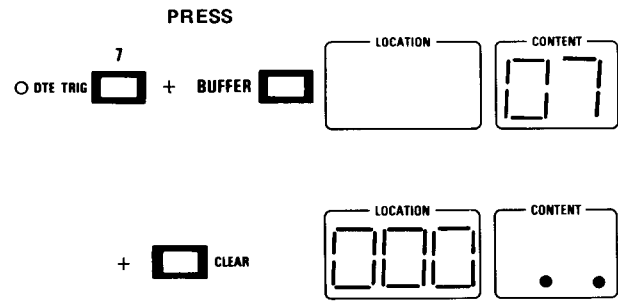
1. Perform steps 1 through 8 of the SIMULATE Mode, but select the REPEAT Mode (REPEAT + MODE) in step 2.

#### NOTE

*Observe in step 8 that the message in the SEND Buffer was sent each time the trigger (AB) was sent from the DTE.*

2. Send the trigger (AB) from the DTE again and note that the message in the 832 SEND Buffer is sent again.
3. Push STOP.

4. Select the DTE TRIG Buffer and clear it (DTE TRIG + BUFFER + CLEAR).



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5. Push START. At this point there is no trigger programmed (cleared in step 4. above) and the 832 should be repeatedly sending the message in the SEND Buffer.

6. Push STOP. At this point the 832 controls may be changed, buffers loaded and read, or new tests performed.

[illegible]

# SUPPLEMENTAL OPERATING DATA

This section contains a number of tables that have been placed here for easy reference by the operators or service technicians when familiarizing themselves with the instrument.

TABLE 3-1

## Error Codes

| Display                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Meaning                                                         |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|
| 008                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 5 BITS/CHAR selected with parity.                               |
| 009                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Illegal BITS/CHAR selection.                                    |
| 010                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Illegal decimal entry <sup>a</sup> .                            |
| 011                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Attempted to clear a read-only buffer (ROM) or the RECV Buffer. |
| 012                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Attempted to load a read-only buffer (ROM) or the RECV Buffer.  |
| 013                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Attempted to load a full buffer.                                |
| 014                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Illegal buffer selection (nonexistent).                         |
| 015                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Illegal mode selection (nonexistent).                           |
| 016                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Overflow error <sup>b</sup> .                                   |
| <p>a. Includes such errors as programming an excess DELAY (greater than 255 milliseconds); using a hexadecimal entry instead of a decimal entry for DELAY; entering a READ jump in excess of 256; and using a hexadecimal entry instead of a decimal entry for buffer jumps.</p> <p>b. An overflow error occurs when the incoming data rate exceeds the data transfer rate of the 832. This error should never occur when any of the specific rates on the BAUD switch are selected (e.g., 1.2K, 9.6K, etc.). It could occur with a DCE or DTE Baud selection if the external rate exceeds 9600 baud (4800 baud if less than 8 bits per character).</p> |                                                                 |

**TABLE 3-2**  
**Hex-ASCII Conversion Chart**

| 1st HEX<br>DIGIT | 2nd HEX DIGIT |     |     |     |     |     |     |     |     |    |     |     |    |    |    |     |
|------------------|---------------|-----|-----|-----|-----|-----|-----|-----|-----|----|-----|-----|----|----|----|-----|
|                  | 0             | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9  | A   | B   | C  | D  | E  | F   |
| 0                | NUL           | SOH | STX | ETX | EOT | ENQ | ACK | BEL | BS  | HT | LF  | VT  | FF | CR | SO | SI  |
| 1                | DLE           | DC1 | DC2 | DC3 | DC4 | NAK | SYN | ETB | CAN | EM | SUB | ESC | FS | GS | RS | US  |
| 2                | SP            | !   | "   | #   | \$  | %   | &   | '   | (   | )  | *   | +   | ,  | -  | .  | /   |
| 3                | 0             | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9  | :   | ;   | <  | =  | >  | ?   |
| 4                | @             | A   | B   | C   | D   | E   | F   | G   | H   | I  | J   | K   | L  | M  | N  | O   |
| 5                | P             | Q   | R   | S   | T   | U   | V   | W   | X   | Y  | Z   | [   | \  | ]  | ^  | _   |
| 6                | \             | a   | b   | c   | d   | e   | f   | g   | h   | i  | j   | k   | l  | m  | n  | o   |
| 7                | p             | q   | r   | s   | t   | u   | v   | w   | x   | y  | z   | {   |    | }  | ~  | DEL |

**TABLE 3-3**  
**Hex-EBCDIC Conversion Chart**

| 1st HEX<br>DIGIT | 2nd HEX DIGIT |     |     |     |     |    |     |     |     |     |     |    |     |     |     |     |
|------------------|---------------|-----|-----|-----|-----|----|-----|-----|-----|-----|-----|----|-----|-----|-----|-----|
|                  | 0             | 1   | 2   | 3   | 4   | 5  | 6   | 7   | 8   | 9   | A   | B  | C   | D   | E   | F   |
| 0                | NUL           | SOH | STX | ETX | PF  | HT | LC  | DEL |     | RLF | SMM | VT | FF  | CR  | SO  | SI  |
| 1                | DLE           | DC1 | DC2 | DC3 | RES | NL | BS  | IL  | CAN | EM  | CC  |    | IFS | IGS | IRS | IUS |
| 2                | DS            | SOS | FS  |     | BYP | LF | ETB | ESC |     |     | SM  |    |     | ENQ | ACK | BEL |
| 3                |               |     | SYN |     | PN  | RS | UC  | EOT |     |     |     |    | DC4 | NAK |     | SUB |
| 4                | SP            |     |     |     |     |    |     |     |     |     | Ø   | .  | <   | (   | +   |     |
| 5                | &             |     |     |     |     |    |     |     |     |     | !   | \$ | *   | )   | ;   |     |
| 6                | -             | /   |     |     |     |    |     |     |     |     | !   | ,  | %   | _   | >   | ?   |
| 7                |               |     |     |     |     |    |     |     |     | \   | :   | #  | @   | '   | =   | "   |
| 8                |               | a   | b   | c   | d   | e  | f   | g   | h   | i   |     |    |     |     |     |     |
| 9                |               | j   | k   | l   | m   | n  | o   | p   | q   | r   |     |    |     |     |     |     |
| A                | ~             |     | s   | t   | u   | v  | w   | x   | y   | z   |     |    |     |     |     |     |
| B                |               |     |     |     |     |    |     |     |     |     |     |    |     |     |     |     |
| C                | }             | A   | B   | C   | D   | E  | F   | G   | H   | I   |     |    |     |     |     |     |
| D                | }             | J   | K   | L   | M   | N  | O   | P   | Q   | R   |     |    |     |     |     |     |
| E                | \             |     | S   | T   | U   | V  | W   | X   | Y   | Z   |     |    |     |     |     |     |
| F                | 0             | 1   | 2   | 3   | 4   | 5  | 6   | 7   | 8   | 9   |     |    |     |     |     |     |

TABLE 3-4  
Contents of the Stored Message Buffers

BUFFER 0

(ASCII FOX TEST)

|               |                                                                                  |
|---------------|----------------------------------------------------------------------------------|
| HEX CHARACTER | 54 48 45 20 51 55 49 43 4B 20 42 52 4F 57 4E 20 46 4F 58 20 4A 55 4D 50 45 44 20 |
| MSG CHARACTER | T H E S Q U I C K S B R O W N S F O X S J U M P E D S<br>P P P P P               |

|               |                                                                               |
|---------------|-------------------------------------------------------------------------------|
| HEX CHARACTER | 4F 56 45 52 20 54 48 45 20 4C 41 5A 59 20 44 4F 47 27 53 20 42 41 43 4B 2E 20 |
| MSG CHARACTER | O V E R S T H E S L A Z Y S D O G ' S S B A C K . S<br>P P P P P              |

|               |                                     |
|---------------|-------------------------------------|
| HEX CHARACTER | 30 31 32 33 34 35 36 37 38 39 0D 0A |
| MSG CHARACTER | 0 1 2 3 4 5 6 7 8 9 C L<br>R F      |

BUFFER 2

(UPPER CASE ASCII CHARACTERS)

|               |                                                                         |
|---------------|-------------------------------------------------------------------------|
| HEX CHARACTER | 21 22 23 24 25 26 27 28 29 2A 2B 2C 2D 2E 2F 30 31 32 33 34 35 36 37 38 |
| MSG CHARACTER | ! " # \$ % & ' ( ) * + , - . / 0 1 2 3 4 5 6 7 8                        |

|               |                                                                         |
|---------------|-------------------------------------------------------------------------|
| HEX CHARACTER | 39 3A 3B 3C 3D 3E 3F 40 41 42 43 44 45 46 47 48 49 4A 4B 4C 4D 4E 4F 50 |
| MSG CHARACTER | 9 : ; < = > ? @ A B C D E F G H I J K L M N O P                         |

|               |                                                    |
|---------------|----------------------------------------------------|
| HEX CHARACTER | 51 52 53 54 55 56 57 58 59 5A 5B 5C 5D 5E 5F 0D 0A |
| MSG CHARACTER | Q R S T U V W X Y Z [ \ ] ^ _ C L<br>R F           |

TABLE 3-4 (cont)

## BUFFER 5

## (FULL ASCII CHARACTER SET)

|               |                                                                         |
|---------------|-------------------------------------------------------------------------|
| HEX CHARACTER | 20 21 22 23 24 25 26 27 28 29 2A 2B 2C 2D 2E 2F 30 31 32 33 34 35 36 37 |
| MSG CHARACTER | S ! " # \$ % & ' ( ) * + , - . / 0 1 2 3 4 5 6 7<br>P                   |

|               |                                                                         |
|---------------|-------------------------------------------------------------------------|
| HEX CHARACTER | 38 39 3A 3B 3C 3D 3E 3F 40 41 42 43 44 45 46 47 48 49 4A 4B 4C 4D 4E 4F |
| MSG CHARACTER | 8 9 : ; < = > ? @ A B C D E F G H I J K L M N O                         |

|               |                                                                         |
|---------------|-------------------------------------------------------------------------|
| HEX CHARACTER | 50 51 52 53 54 55 56 57 58 59 5A 5B 5C 5D 5E 5F 60 61 62 63 64 65 66 67 |
| MSG CHARACTER | P Q R S T U V W X Y Z [ \ ] ^ _ ` a b c d e f g                         |

|               |                                                                         |
|---------------|-------------------------------------------------------------------------|
| HEX CHARACTER | 68 69 6A 6B 6C 6D 6E 6F 70 71 72 73 74 75 76 77 78 79 7A 7B 7C 7D 7E 7F |
| MSG CHARACTER | h i j k l m n o p q r s t u v w x y z {   } ~ D<br>E<br>L               |

|               |            |
|---------------|------------|
| HEX CHARACTER | 0D 0A      |
| MSG CHARACTER | C L<br>R F |

## BUFFER 8

## (132 UPPER CASE ASCII CHARACTERS)

|               |                                                                         |
|---------------|-------------------------------------------------------------------------|
| HEX CHARACTER | 21 22 23 24 25 26 27 28 29 2A 2B 2C 2D 2E 2F 30 31 32 33 34 35 36 37 38 |
| MSG CHARACTER | ! " # \$ % & ' ( ) * + , - . / 0 1 2 3 4 5 6 7 8                        |

|               |                                                                         |
|---------------|-------------------------------------------------------------------------|
| HEX CHARACTER | 39 3A 3B 3C 3D 3E 3F 40 41 42 43 44 45 46 47 48 49 4A 4B 4C 4D 4E 4F 50 |
| MSG CHARACTER | 9 : ; < = > ? @ A B C D E F G H I J K L M N O P                         |

|               |                                                                               |
|---------------|-------------------------------------------------------------------------------|
| HEX CHARACTER | 51 52 53 54 55 56 57 58 59 5A 5B 5C 5D 5E 5F (21 through 5F is repeated here) |
| MSG CHARACTER | Q R S T U V W X Y Z [ \ ] ^ _                                                 |

|               |                         |
|---------------|-------------------------|
| HEX CHARACTER | 21 22 23 24 25 26 0D 0A |
| MSG CHARACTER | ! " # \$ % & C L<br>R F |



TABLE 3-4 (cont)

## BUFFER B

## (EBCDIC FOX TEST)

|               |                                                             |
|---------------|-------------------------------------------------------------|
| HEX CHARACTER | E3 C8 C5 40 D8 E4 C9 C3 D2 40 C2 D9 D6 E6 D5 40 C6 D6 E7 40 |
| MSG CHARACTER | T H E S Q U I C K S B R O W N S F O X S<br>P P P P P P P P  |

|               |                                                                |
|---------------|----------------------------------------------------------------|
| HEX CHARACTER | D1 E4 D4 D7 C5 C4 40 D6 E5 C5 D9 40 E3 C8 C5 40 D3 C1 E9 E8 40 |
| MSG CHARACTER | J U M P E D S O V E R S T H E S L A Z Y S<br>P P P P P P P P   |

|               |                                                                         |
|---------------|-------------------------------------------------------------------------|
| HEX CHARACTER | C4 D6 C7 7D E2 40 C2 C1 C3 D2 4B 40 F0 F1 F2 F3 F4 F5 F6 F7 F8 F9 0D 25 |
| MSG CHARACTER | D O G ' S S B A C K . S 0 1 2 3 4 5 6 7 8 9 C L<br>P P P P P P P P R F  |

## BUFFER D

## (UPPER CASE EBCDIC CHARACTERS)

|               |                                                                         |
|---------------|-------------------------------------------------------------------------|
| HEX CHARACTER | 40 4A 4B 4C 4D 4E 4F 50 5A 5B 5C 5D 5E 5F 60 61 6B 6C 6D 6E 6F 7A 7B 7C |
| MSG CHARACTER | S ¢ . < ( +   & ! \$ * ) ; 7 - / , % _ > ? : # @<br>P                   |

|               |                                                                         |
|---------------|-------------------------------------------------------------------------|
| HEX CHARACTER | 7D 7E 7F C1 C2 C3 C4 C5 C6 C7 C8 C9 D1 D2 D3 D4 D5 D6 D7 D8 D9 E2 E3 E4 |
| MSG CHARACTER | ' = " A B C D E F G H I J K L M N O P Q R S T U                         |

|               |                                                 |
|---------------|-------------------------------------------------|
| HEX CHARACTER | E5 E6 E7 E8 E9 F0 F1 F2 F3 F4 F5 F6 F7 F8 0D 25 |
| MSG CHARACTER | V W X Y Z 0 1 2 3 4 5 6 7 8 C L<br>R F          |

TABLE 3-4 (cont)

## BUFFER E

## (FULL EBCDIC CHARACTER SET)

|               |                                                                         |
|---------------|-------------------------------------------------------------------------|
| HEX CHARACTER | 40 4A 4B 4C 4D 4E 4F 50 5A 5B 5C 5D 5E 5F 60 61 6B 6C 6D 6E 6F 7A 7B 7C |
| MSG CHARACTER | S $\phi$ . < ( +   & ! \$ * ) ; $\neg$ - / , % _ > ? : # @<br>P         |

|               |                                                                         |
|---------------|-------------------------------------------------------------------------|
| HEX CHARACTER | 7D 7E 7F 81 82 83 84 85 86 87 88 89 91 92 93 94 95 96 97 98 99 A2 A3 A4 |
| MSG CHARACTER | ' = " a b c d e f g h i j k l m n o p q r s t u                         |

|               |                                                                         |
|---------------|-------------------------------------------------------------------------|
| HEX CHARACTER | A5 A6 A7 A8 A9 C1 C2 C3 C4 C5 C6 C7 C8 C9 D1 D2 D3 D4 D5 D6 D7 D8 D9 E2 |
| MSG CHARACTER | v w x y z A B C D E F G H I J K L M N O P Q R S                         |

|               |                                                       |
|---------------|-------------------------------------------------------|
| HEX CHARACTER | E3 E4 E5 E6 E7 E8 E9 F0 F1 F2 F3 F4 F5 F6 F7 F8 0D 25 |
| MSG CHARACTER | T U V W X Y Z 0 1 2 3 4 5 6 7 8 C L<br>R F            |

NOTE 1: Message characters shown vertically (such as  $\begin{smallmatrix} S \\ P \end{smallmatrix}$ ) are control characters only and would not be displayed on a graphics terminal or printed on a printer terminal: SP = space; CR = carriage return; and LF - line feed.

NOTE 2: The number '9' was inadvertently left out of the Buffer D and E messages therefore, if this character is missing on your instrument message it is not an instrument malfunction. The messages shown in this table are actual messages in the instrument. This error may or may not be corrected at a later date as it does not affect the operation of the instrument.

# PROGRAMMING A USER-DEFINED MESSAGE PROM

This section explains how to format and program a user-definable message PROM (Programmable Read-Only Memory).

## INTRODUCTION

The 832 Data Comm Tester has the capability of storing frequently used test patterns in a user-definable 2K (8 X 2048) INTEL 2716 EPROM (ultraviolet-erasable, programmable read-only memory), which is inserted into a spare ROM socket on the CPU Board.

### **WARNING**

*Installation of the EPROM requires removal of the instrument covers and must be referred to qualified service personnel.*

This stored test message feature is a convenience for users who have special test patterns (control characters, data or graphics) for Data Terminal Equipment (DTE), but no easy way to send them from a computer during on-site maintenance. An example of a commonly used test pattern is the following phrase followed by a carriage return and line feed:

“THE QUICK BROWN FOX JUMPED OVER THE LAZY DOG’S BACK”

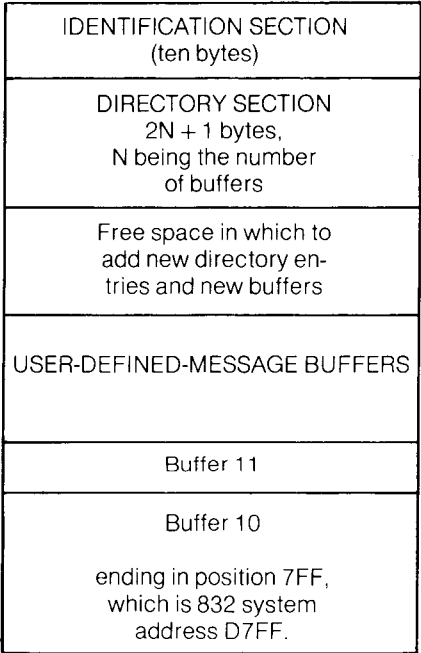
This is one of the test patterns already included in your 832 as Stored Memory Buffer 0.

# PROM FORMAT

As shown in Figure 4-1, the basic format of the PROM consists of an identification section, a directory section and the user-defined message buffer section, which contains the variable-length test patterns. Figure 4-2 shows the specific format of the PROM.

Each test pattern is a selectable buffer (10 to FF); therefore, the PROM could contain as many as 240 patterns (hexadecimal numbers available between 10 and FF). To be transmittable by the 832 SEND Buffer (holds 255 characters), each pattern is limited to 255 bytes as shown in Figure 4-3. From the number of available buffer numbers (240) and the maximum length of each buffer pattern (255 bytes), it is easy to see that there isn't enough space in the EPROM (2048 bytes) for 240 patterns of 255 bytes each.

The identification and directory sections must start in the first locations of the PROM. Although the buffers sections can begin immediately following the directory section, it is a good idea to stack these buffers beginning at the end of the PROM. This leaves any unused space between the end of the directory and the last buffer entered. The benefit of this arrangement is that when new buffers are added, the previously entered buffers need not be changed or moved to make room for the expanded directory sections. Also, the only change needed to the old PROM is an update of the number of the last buffer (POSITION 00A in Figure 4-2). Figure 4-4 is an example of a PROM with a single message in it.



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Figure 4-1. Generalized layout of the user-defined message PROM.

| POSITION   | DATA (shown in Hex)            | DESCRIPTION                                                                                                                                                                                                                                                                         |
|------------|--------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 000-001    | 55AA                           | IDENTIFICATION SECTION<br>The first byte can be any number; the second byte must be the complement of the first. When the PROM is installed in the 832, position 000 in the PROM is at 832 system address D000.                                                                     |
| 002-007    |                                | A 6-byte identification area, which can contain anything the user wants. For example:<br>0832 —identifying the 832.<br>01 —version 1 of the instrument.<br>03 —ROM number 3.<br>08 —indicating a 2K ROM.<br>( $800_{16} = 2048_{10}$ )<br>nn —a single-byte, user-defined checksum. |
| 008-009    | FFFF                           | Unused at present; must be FFFF.                                                                                                                                                                                                                                                    |
| 00A        | NN                             | DIRECTORY SECTION<br>Number of the last buffer used. The first user-defined-message buffer is number $10_{16}$ . If there were five user-defined-message buffers, their numbers would be 10, 11, 12, 13, and 14. The number of the last buffer would then be 14.                    |
| 00B-00C    | DXXX<br>(address of buffer 10) | The 832 system address for the first byte of buffer 10. DXXX = D7FF — xx (see buffer 10 below).                                                                                                                                                                                     |
| 00D-00E    | DXXX                           | The 832 system address for the first byte of buffer 11.                                                                                                                                                                                                                             |
| ...        | DXXX                           | System addresses for remaining buffers.                                                                                                                                                                                                                                             |
| "END"      | DXXX                           | The 832 system address for the first byte of buffer NN (the last buffer).                                                                                                                                                                                                           |
| "END" + 2  | FF                             | UNUSED AREA<br>Beginning of the area in which new user-defined buffers and their corresponding directory entries can be added.                                                                                                                                                      |
|            | ...                            |                                                                                                                                                                                                                                                                                     |
|            | FF                             |                                                                                                                                                                                                                                                                                     |
| XXX        | zz                             | USER-DEFINED-MESSAGE BUFFER SECTION<br>Buffer NN (the last buffer).                                                                                                                                                                                                                 |
|            | XX                             |                                                                                                                                                                                                                                                                                     |
| ...        | ...                            |                                                                                                                                                                                                                                                                                     |
| XXX        | XX                             |                                                                                                                                                                                                                                                                                     |
| ...        | ...                            | Remaining buffers.                                                                                                                                                                                                                                                                  |
| XXX        | yy                             | Number of message bytes in buffer 11.                                                                                                                                                                                                                                               |
| ...        | XX                             | The first message byte in buffer 11.                                                                                                                                                                                                                                                |
|            | ...                            |                                                                                                                                                                                                                                                                                     |
| XXX        | XX                             | Last message byte in buffer 11.                                                                                                                                                                                                                                                     |
| 7FF-xx     | xx                             | Number of message bytes in buffer 10.                                                                                                                                                                                                                                               |
| 7FF-xx + 1 | XX                             | First message byte in buffer 10.                                                                                                                                                                                                                                                    |
| ...        | ...                            |                                                                                                                                                                                                                                                                                     |
| 7FF        | XX                             | Last message byte in buffer 10.                                                                                                                                                                                                                                                     |

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Figure 4-2. Specific format of the user-defined message PROM.

|                  | Byte<br>Count<br>(n) | Relative<br>Address<br>In Send<br>Buffer When<br>Transferred | Description                                                                                                           |
|------------------|----------------------|--------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|
| n                |                      | None-Ends up<br>as Send Buffer<br>Count Byte.                | n = Number of bytes in pattern.                                                                                       |
| D <sub>0</sub>   | 1                    | 000                                                          | D <sub>0</sub> = First data byte of pattern.<br><br>D <sub>0</sub> through D <sub>n</sub> = Data bytes of<br>pattern. |
| D <sub>1</sub>   | 2                    | 001                                                          |                                                                                                                       |
| D <sub>2</sub>   | 3                    | 002                                                          |                                                                                                                       |
| D <sub>3</sub>   | 4                    | 003                                                          |                                                                                                                       |
| D <sub>4</sub>   | 5                    | 004                                                          |                                                                                                                       |
| D <sub>5</sub>   | 6                    | 005                                                          |                                                                                                                       |
| D <sub>6</sub>   | 7                    | 006                                                          |                                                                                                                       |
| D <sub>7</sub>   | 8                    | 007                                                          |                                                                                                                       |
| D <sub>8</sub>   | 9                    | 008                                                          |                                                                                                                       |
| D <sub>9</sub>   | 10                   | 009                                                          |                                                                                                                       |
| D <sub>10</sub>  | 11                   | 010                                                          |                                                                                                                       |
| ⋮                | ↓                    | ↓                                                            |                                                                                                                       |
| D <sub>n-1</sub> | n (max<br>is<br>255) | n-1 (max<br>is<br>254)                                       | D <sub>n-1</sub> = Last data byte of pattern.                                                                         |

2389-144

Figure 4-3. Layout of a buffer test pattern in the user-defined message PROM.

|                               |                                                                                                                                                                                                                                                                                                            |                                  |
|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| 000-001<br>002-007<br>008-009 | 55AA<br>0832010308xx<br>FFF                                                                                                                                                                                                                                                                                | IDENTIFICATION<br>SECTION        |
| 00A<br>00B-00C                | 10<br>D7D5                                                                                                                                                                                                                                                                                                 | DIRECTORY<br>(NOTE SINGLE ENTRY) |
| 00D-7D4                       | ALL FF'S                                                                                                                                                                                                                                                                                                   | UNUSED AREA                      |
| 7D5                           | 24                                                                                                                                                                                                                                                                                                         | BUFFER 10—<br>LENGTH IN HEX      |
| 7D6-7FF                       | 0A LF<br>0D CR<br>54 T<br>45 E<br>4B K<br>54 T<br>52 R<br>4F O<br>4E N<br>49 I<br>58 X<br>2C .<br>20 SPACE<br>43 C<br>4F O<br>4D M<br>4D M<br>49 I<br>54 T<br>54 T<br>45 E<br>44 D<br>20 SPACE<br>54 T<br>4F O<br>20 SPACE<br>45 E<br>58 X<br>43 C<br>45 E<br>4C L<br>4C L<br>45 E<br>4E N<br>43 C<br>45 E |                                  |

2389-90

Figure 4-4. Example of a single pattern user-defined message PROM.

## PROGRAMMING THE USER PROM

For the many users who have the capability to program their own 2716 erasable PROM's, Figure 4-5 presents a series of standard Motorola 6800 Assembler directives, which are data definitions and address constants. In this example, the buffers followed the directory rather than being stacked at the end of the PROM. This arrangement is acceptable and may be easier to work with if an assembler is used to format the user PROM. A programmer can easily take this example as a model for formatting user PROM's on a computer, to be downloaded later into a PROM burning device.

For users who prefer to have their PROM's processed elsewhere, many vendors provide this service. Preferred formats for submitting requests vary from vendor to vendor, but paper tape and punched cards are two of the more common ones. To select the best method consult your vendor.



```

1      000A      LF      EQU      $0A      LINE FEED
2      000D      CR      EQU      $0D      CARRIAGE RETURN
3      *
4      D000      D000      ORG      $D000      NOTE:MUST BE $D000 FOR ASSEMBLER
5      DC23      FDB      $DC23      USER LABEL (DC) AND COMPLEMENT (23)
6      *      **NOTE: 2ND TWO DIGITS MUST BE COMPLEMENT OF 1ST TWO FOR THE 832
7      *      HOWEVER, 1ST DIGITS ARE THE CHOICE OF THE USER.***
8      *
9      *      THE FOLLOWING ARE OPTIONAL (I.E. NOT LOOKED AT BY 832
10     *      FIRMWARE BUT MIGHT BE USEFUL TO A USER OWNED PROM TESTER).
11     *      **NOTE: THE 832 IGNORES THESE 6 LOCATIONS, THEREFORE,
12     *      IF NOT USED BLANKS MUST BE PROVIDED.***
13     D002      0832      FDB      $0832      IDENTIFIES ROM WITH 832
14     D004      01      FCB      $01      INDICATES VERSION 1 OF EPROM
15     D005      03      FCB      $03      INDICATES ROM #3 IN 832
16     D006      08      FCB      $08      IDENTIFIES EPROM = 2K ROM (8 PAGES)
17     D007      00      *      FCB      $00      IDENTIFIES A SINGLE BYTE CHECK SUM FOR USER
                                           OWNED PROM TESTER
18     *
19     *      THESE ARE REQUIRED
20     D008      FFFF      FDB      $FFFF      MUST BE $FFFF AT ADDRESS LOCATION $X008
21     D00A      12      FCB      $12      HEX SELECTION NO. OF LAST USER DEFINED
22     *      MESSAGE BUFFER ($10-$FF). THERE ARE 3
23     *      MESSAGES IN THIS EXAMPLE ($10, $11, $12).
24     D00B      D011      FDB      FIRST      BEGINNING ADDRESS OF FIRST USER DEFINED
25     *      MESSAGE BUFFER. (COMPUTED BY ASSEMBLER)
26     D00D      D057      FDB      SECOND     BEGINNING ADDRESS OF SECOND
27     D00F      D07E      FDB      THIRD
28     *
29     *      THE FIRST MESSAGE (DIRECTORY)
30     *
31     D011      45      FIRST      FCB      END1-FIRST THE FIRST BYTE OF ANY MESSAGE BUFFER
32     *      CONTAINS THE TOTAL NO. OF BYTES (IN HEX)
33     *      IN THE MESSAGE. NOTE THE ASSEMBLER
34     *      COMPUTES THIS NUMBER AND STORES IN "FIRST".
35     *
36     D012      42      FCC      /BUFFER 10 = DIRECTROY/
37     D029      0A      FCB      LF,CR
38     D02B      42      FCC      /BUFFER 11= ALPHANUMERIC/
39     D043      0A      FCB      LF,CR
40     D045      42      FCC      /BUFFER 12 = FOX/
41     D055      0A      FCB      LF
42     D056      0D      END1      FCB      CR
43     *
44     *      THE SECOND MESSAGE (ALPHANUMERIC)
45     *
46     D057      26      SECOND      FCB      END2-SECOND
47     D058      41      FCC      /ABCDEFGHJKLMNPQRSTUVWXYZ0123456789/
48     D07C      0A      FCB      LF
49     D07D      0D      END2      FCB      CR
50     *
51     *      THE THIRD MESSAGE (FOX)
52     *
53     D07E      34      THIRD      FCB      END3-THIRD
54     D07F      54      FCC      /THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG'S BACK/
55     D0B1      0A      FCB      LF
56     D0B2      0D      END3      FCB      CR
57     0000      END      $D000

```

2389-91A

Figure 4-5. Motorola 6800 assembler directives for a sample user-defined message PROM.

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# THEORY OF OPERATION

## SYSTEM ARCHITECTURE

### MICROPROCESSOR UNIT (MPU)

The 832 Data Comm Tester is a serial data communications interface (RS-232) tester based on a microcomputer system (see Block Diagram located in the foldout section at the rear of the manual). A Motorola 6800 microprocessor unit (MPU) provides control logic; function selection; and data acquisition, manipulation and display capability to the 832.

The bit patterns are usually grouped into blocks of instructions to provide a complete function, and are commonly referred to as *routines* or *subroutines*. An example of the routines in the 832 and their interrelation is shown in Figure 5-1. Each of these routines may have a number of subroutines, which only they use, or some which are shared with the other routines.

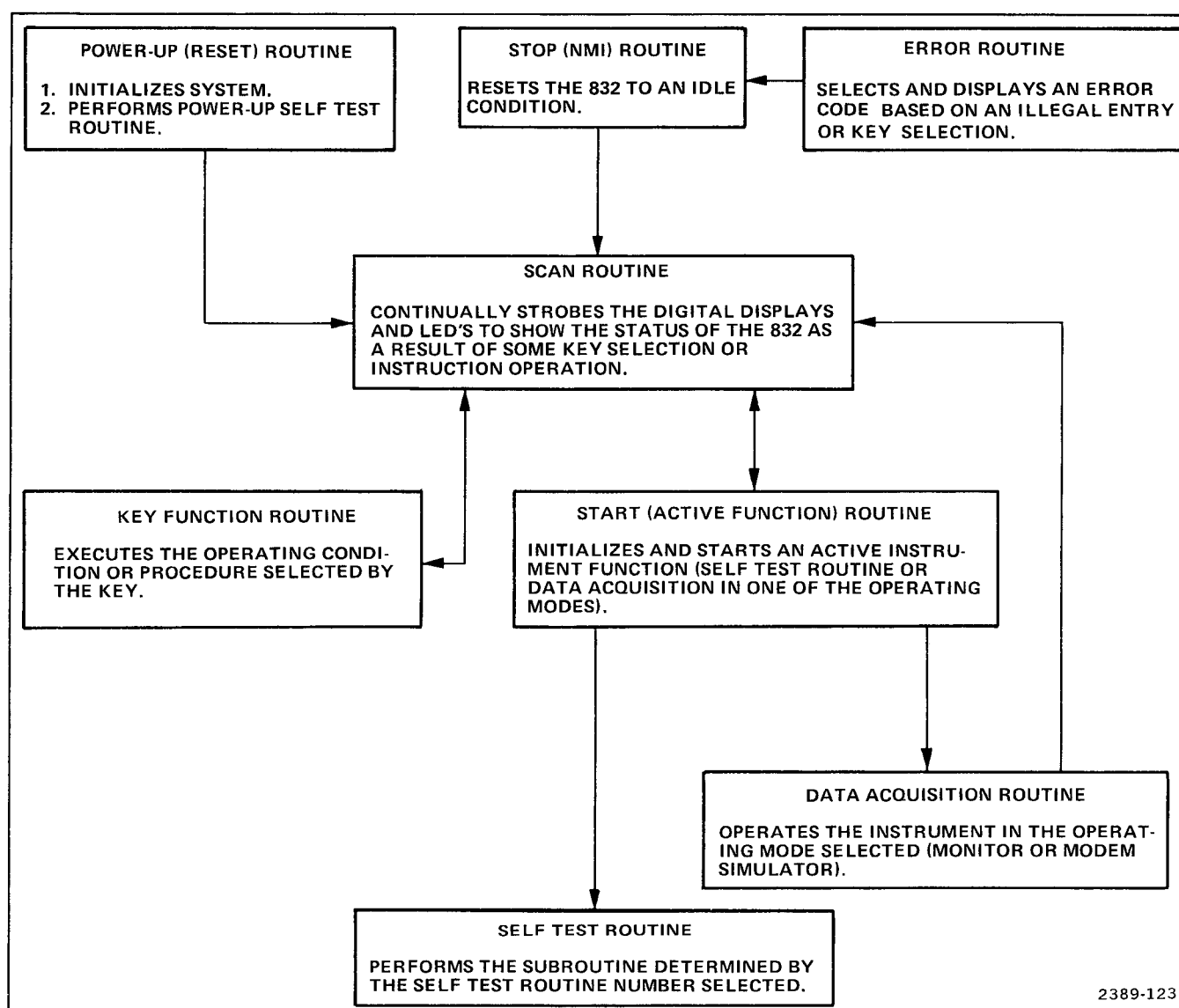


Figure 5-1. Example of block structured routines in 832.

## READ-ONLY MEMORY (ROM)

The operating system (instructions, permanent data, pre-recorded messages and data conversion tables) is contained in two 2K (2048 X 8-bit) ROM's. These ROM's have static memory (need no clocking or refresh cycles) and are organized in an 8-bit byte format with 11 address lines and a chip select. The address lines and eight data line outputs are compatible for direct connection to the MPU and common busses without additional drivers. Data in the ROM's are placed in the devices during the manufacturing process and cannot be changed by the functions of the MPU. The data and instructions in these ROM's cannot be changed without placing a new programmed device into the instrument.

The 832 contains a spare ROM socket for acceptance of an Intel® 2716 (or equivalent) (2048 X 8-bit) EPROM (Ultraviolet-Erasable Programmable Read-Only Memory), which is used for user-definable messages (test patterns).

## RANDOM ACCESS MEMORY (RAM)

Memory space for storage of temporary data (recorded from the interface) is provided by eight 2102 (1024 X 1-bit) RAM's. Like the ROM's, these RAM's have static memory (need no clocking or refresh cycles) and are organized in a 1-bit format with 10 address lines and a chip select. The address lines, data input line and data output line are compatible for direct connection to the MPU and common busses without additional drivers. However, the data output is buffered to the data bus to prevent a RAM input and output conflict.

Data in the RAM's is not permanent and is destroyed whenever the instrument is turned off. It is also meaningless when power is initially applied to the system as the data occurs as random bits. During operation of the instrument, the MPU places data into the RAM at various addresses for later recall and use. This process of storing data into the RAM requires the MPU to perform a data storage or write operation to a specified address location for each byte of data to be stored.

## UNIVERSAL SYNCHRONOUS/ASYNCHRONOUS RECEIVER/TRANSMITTER (USART)

Communications between the tester and the interface is accomplished through two Intel® 8251A Programmable Communications Interfaces (USART's) and an RS-232 Interface section with an interface Breakout Panel.

USART's accept serial data from the RS-232 interface section and covert it to parallel data, which appears on the Data Bus for use by the MPU. They also accept parallel data placed on the Data Bus by the MPU and convert it to serial data for transmission on the RS-232 interface. Other internal functions of the USART signal the MPU whenever it can accept data for transmission, has received data for the MPU, detects a parity or framing error on incoming serial data, or experiences an over-run error (caused when the USART is receiving data faster than it is being transferred to the MPU).

The RS-232 Interface section contains the line drivers, line receivers and multiplexers that allow the tester to be connected into an external RS-232 Interface without intering with that interface.

The Interface Breakout Panel contains line disconnect switches, line patch pins, reference voltages and other jumper pins for user access to and manipulation of the RS-232 Interface lines that are connected to the tester.

## DISPLAY

Display of the tester's operation is provided by five 7-segment digital displays and 22 LED's.

## SYSTEM ADDRESSING

All ROM, RAM, USART and displays reside in the addressable memory space of the MPU. Available address space of the MPU is 65,536. Those used, and their beginning and ending addresses, are shown in Figure 5-2 in hexadecimal notation.

| ADDRESS | DEVICE ADDRESSED<br>AND SIZE         | ADDRESS<br>BOUNDARIES | NUMBER OF<br>ADDRESSES USED |
|---------|--------------------------------------|-----------------------|-----------------------------|
| 000     | RAM (1K) (STANDARD)                  | 000–3FF               | ALL                         |
| 400     | (RESERVED FOR RAM<br>EXPANSION) (3K) | 400–4FF               | 4                           |
| 1000    | 7-SEGMENT DIGITAL<br>DISPLAY (4K)    | 1000–1FFF             |                             |
| 2000    | (NOT USED) (4K)                      | 2000–2FFF             |                             |
| 3000    | USART A (U1332)<br>(4K)              | 3000–3FFF             | 2                           |
| 4000    | USART B (U1325)<br>(4K)              | 4000–4FFF             | 2                           |
| 5000    | LED'S (4K)                           | 5000–5FFF             | 2                           |
| 6000    | (NOT USED) (20K)                     | 6000–AFFF             |                             |
| B000    | KEYBOARD INPUT<br>(4K)               | B000–BFFF             | 1                           |
| C000    | RS-232 CONTROL LINE<br>INPUT (4K)    | C000–CFFF             | 1                           |
| D000    | USER DEFINABLE<br>MESSAGE ROM (4K)   | D000–DFFF             | ALL                         |
| E000    | ROM (OPERATING<br>SYSTEM) (8K)       | E000–FFFF             | ALL                         |

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Figure 5-2. Memory allocation map for the 832.

## CIRCUIT DESCRIPTION

### POWER SUPPLIES

The 832 contains three regulated power supplies: +12 Volt, -12 Volt and +5 Volt. Each supply is driven from a common power input section that provides about +17 volts unregulated to the +5 Volt and +12 Volt supplies and -18 volts unregulated to the -12 volt supply. The common input section consists of all components between J400, the power source input, and CR4111 through CR4114, the rectifier section. The outputs from the rectifiers are filtered by C4116 and C4124 before being applied to the regulator sections of the power supplies.

#### +12 Volt Power Supply

The +12 volt regulated output is provided from a +17 volt input to a three-terminal voltage regulator, U4112. This regulator provides its own internal current limiting and thermal shutdown circuitry.

R4108 provides a current shunt path for U4112 so it doesn't have to pass the entire load current, while still maintaining output regulation. If the load on the +12 volt output is highly capacitive, CR4115 protects U4112 from reverse voltage breakdown when the power supply is turned off, or F4016 blows. C4115 and C4231 are bypassing capacitors and also prevent regulator self-oscillation.

#### -12 Volt Power Supply

The -12 volt power supply is the same as the +12 volt supply, except it uses a negative voltage regulator, U4032, and does not use a current shunt resistor.

## +5 Volt Power Supply

The +5 volt power supply is a high-efficiency, series-switching regulated supply (Figure 5-3). Switching transistor, Q4028, is switched on and off at a rate that maintains a constant +5 volt output at up to 1.4 amperes of load. When Q4028 is off, the T-Coil, T4128, and Output Capacitor, C4125, provide sustaining drive to keep the output voltage constant. The switching rate of Q4028 is controlled through the Driver, Q4034, and by Voltage Comparator Q4130 and Q4128. As the output voltage goes above +5 volts, which corresponds to a lighter load, the switching rate decreases; conversely, the rate increases as the output voltage decreases with a heavier load. For the remainder of the explanation on this supply, refer to diagram 6 in the foldout section at the rear of the manual.

When S950 has just been turned on, the +12 volt supply provides base voltage to Q4130 through the Reference Voltage divider R4224, R4116 and R4223. Since there is no output voltage at this time, Q4128 is off and Q4130 emitter is at ground potential. When base voltage is applied to Q4130, it starts to turn on and provide base drive to Q4034. With base drive, Q4034 also starts to turn on and provide base drive to Q4028. As Q4028 starts to turn on, the voltage at its collector begins to build a field in T4128 and charge C4125. As soon as the field in T4128 starts to build up, positive feedback from T4128-1,6 through R4134 and C4134 causes Q4130 to immediately snap-on. When Q4130 snaps-on, Q4034 also snaps-on causing Q4028 to saturate. This start-up and snap-on action of Q4130 and Q4034, and saturation of Q4028 takes about 30 nanoseconds. During this initial start up, Q4128 is off.

When the output voltage starts to exceed +5 volts (established by reference voltage adjustment—R4116), Q4128 turns on pulling emitter current away from Q4130, turning it off. As soon as Q4130 turns off, Q4034 turns off removing base drive from Q4028. Since Q4028 was highly saturated when on, its stored base charge is sufficient to keep it on for some time after Q4034 turns off. As a result, it keeps pumping energy into T4128 and C4125. As soon as base drive is removed from Q4034 and Q4028, resistors R4028 and R4022 begin to pull the base charge out of their respective bases. When Q4028 turns off, T4128 provides normal inductive action trying to maintain output current at its existing level.

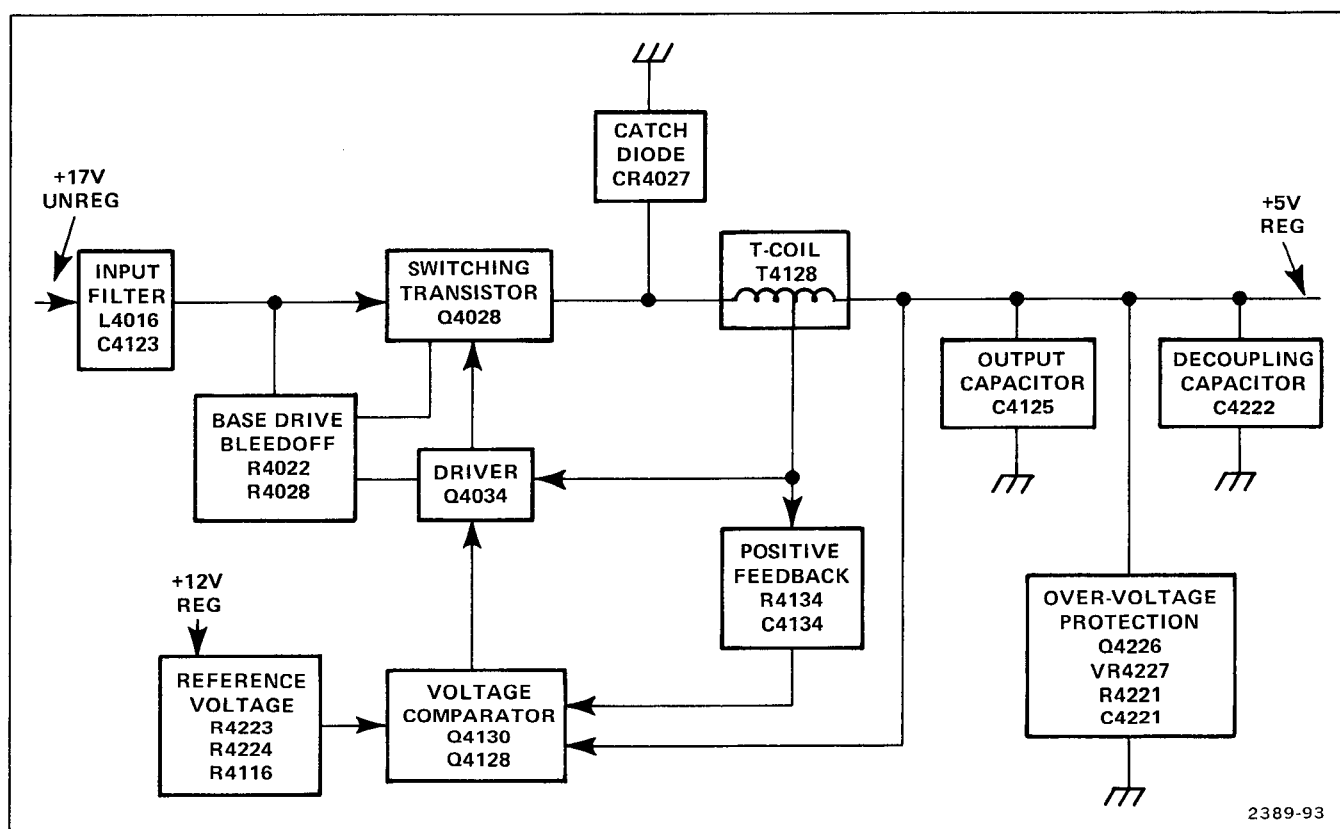


Figure 5-3. Block diagram of +5 volt power supply.

When Q4028 was on, the voltage at its collector (T4128-4) was about +17 volts with +5 volts on T4128-3. As soon as Q4028 turned off, the normal inductor action of T4128 caused its voltage polarity to reverse itself such that T4128-4 becomes negative with respect to T4128-3. At the instant the voltages reverse themselves, CR4027 acts as a catch diode and prevents T4128-4 from going any more negative than ground. After the field on T4128 collapses to a point where the output voltage begins to go below +5 volts, Q4128 turns off, which places a ground on the emitter of Q4130. This starts the turn-on sequence for Q4130, Q4034 and Q4028 again. The rate at which this sequence repeats itself is determined by the load on the +5 volt supply. As the load increases, the rate increases and as the load decreases, the rate decreases (see Figure 5-4).

Figure 5-4 shows the idealized waveforms for the collector of Q4028. With Q4028 rapidly switching on and off, L4016 and C4123 prevent fast switching transients from being coupled back through the common supply to the power line as electromagnetic interference (EMI). C4222 is a bypassing capacitor to prevent voltage transients from affecting both the load or the regulator.

Overvoltage protection is provided by a crowbar voltage protection circuit consisting of Q4226, VR4227 and their associated circuitry. As soon as the output voltage exceeds the zener voltage (5.6 volts) of VR4227, current will flow through R4221 creating a gate voltage for Q4226, which turns on. As soon as Q4226 turns on, the +5 volt output is shorted to ground, which causes the regulator to draw excess current and blow F4016.

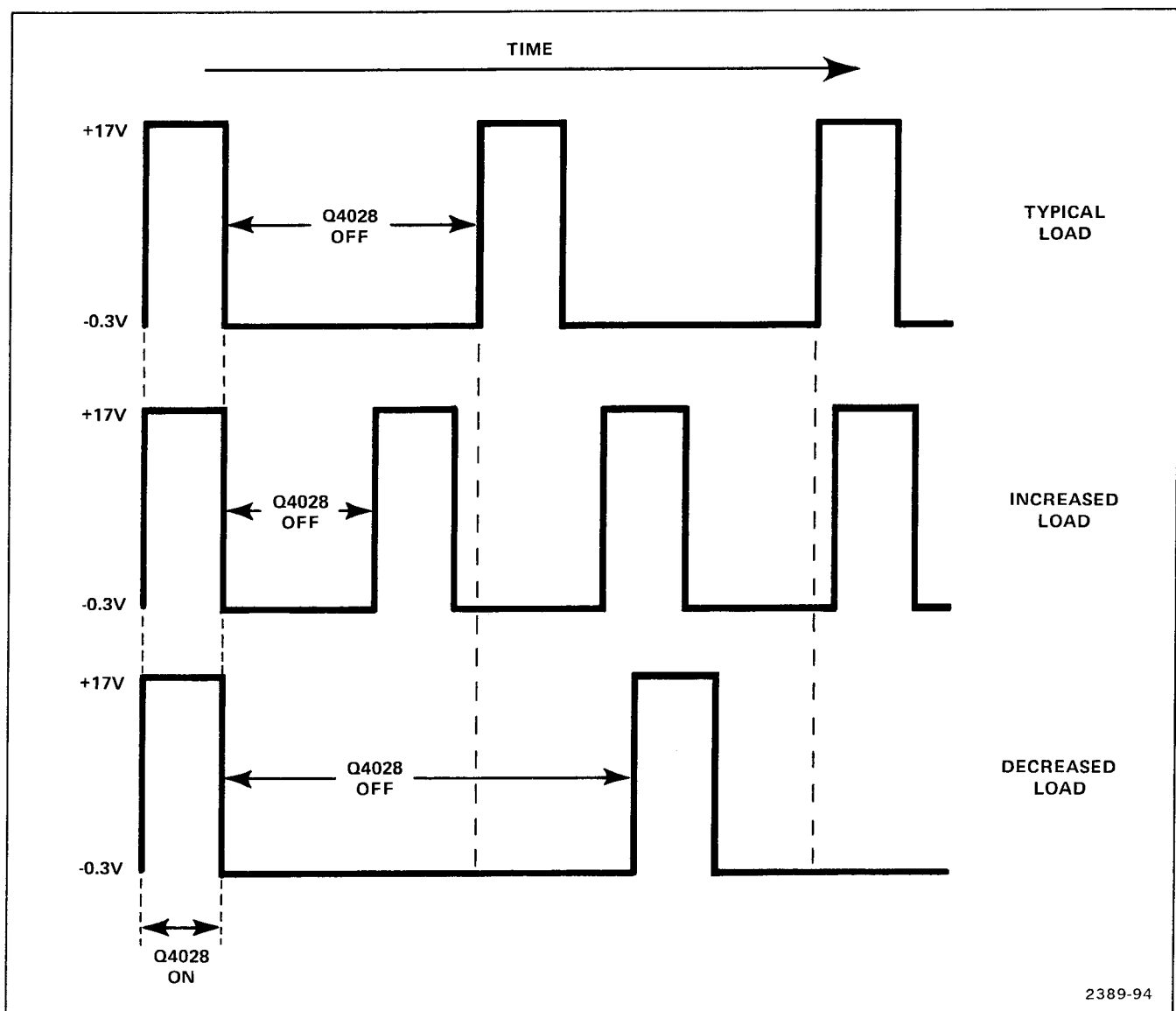


Figure 5-4. Idealized waveform at collector of Q4028.



CENTRAL PROCESSOR UNIT (CPU) 2

For the purpose of the following discussion, the CPU will consist of the microprocessor unit (MPU) and its directly connected circuitry.

When power is applied to the MPU (U1155), it must have its RESET input (pin 40) held LO for at least eight clock cycles (Ø1 and Ø2) after the power supply reaches +4.75 volts before it can start its reset and initialization process. These eight clock cycles are to allow the MPU to stabilize. U1044D and U1044E which form a Schmitt trigger, and their associated circuitry pull U1155-40 LO at power up and hold it LO for the required eight clock cycles.

At power up, U1044E-11 is LO causing U1044D-8 to be LO, which holds U1155-40 LO. The power supply almost instantaneously reaches +4.75 volts, but C1046 and R1046 cause a short time delay that is long enough for U1155-40 to be held LO for eight or more clock cycles. At that time U1044E-11 goes HI reflecting a HI at U1044D-8 and U1155-40, which starts the MPU reset and initialization process. If a momentary loss of power occurs, CR1044 discharges C1046 so a new delay will be imposed on power up. TP1044 may be grounded to cause a forcible reset while power is still applied.

When RESET (U1155-40) goes HI after eight clock cycles, the following conditions will have been set and the MPU will execute its reset and initialization routine: VMA is LO, the data bus outputs are in a high impedance state (HI Z), R/W is HI (read state) and the address bus will contain the address FFFE.

The NMI input (U1155-6) through U1044A and U1044B is the same type of Schmitt input as for RESET, but has a shorter time delay with C1045 and R1044. This circuit is actually used as a switch debounce circuit for the STOP push button (S2056).

The IRQ input (U1155-4) is not used during normal operation and is tied to the +5 volt power supply to keep it inactive. For the service technician, TP1049 can be grounded to force Self Test Routine 5 to be selected and executed. This interrupt is a hardware access to a software routine.

The VMA and R/W outputs from the MPU are a function of the MPU instruction cycle, which is related to memory access for the M6800. Basically, the VMA output goes HI when the address on the address bus is stable and valid. The R/W output goes HI to signal the peripheral devices when the MPU is in a Read cycle and LO when its in a Write cycle.

The pull-up resistors on all the address and data bus lines from U1155 are used to provide a greater HI and LO voltage swing than standard TTL levels. These are required to drive the various MOS devices connected to the buses.

The A15 (U1155-25) and R/W (U1155-34) outputs go to U1276B which controls one enable line to the Address Decoder (U1345-19). The output of U1276B, is used as a write disable input that prevents the MPU from attempting to write on any of the upper half of the memory addresses (8000 through FFFF) which are intended as read-only addresses. The VMA (U1155-5) output is inverted through U1035D and applied to the other enable line (U1345-18) of the Address Decoder. This prevents buss components from seeing illegal addresses from the MPU.

When the J1041 service jumper is removed the address decoder is disabled and the only device servicing the buses is the MPU. Then when the jumper is placed on P1471, it grounds data bit 7 causing a 7F operational code to be executed by the MPU. This code causes the MPU to read three successive memory locations, which creates a 7F7F address, then go to that address and execute the instruction. That instruction causes all data line to be cleared to a 0. Then the MPU returns to the next instruction, which is a 7F again, and repeats the clearing function. This procedure is used in the troubleshooting charts.

The R/W (U1155-34) output that goes through U1172C, U1072C and U1172F to the gate inputs of the tri-state buffers from the RAM's is used to disable the buffers when writing to the RAM's. This is done because the RAM also outputs previous data when it is being written to, which would cause a conflict with the new data being written into the RAM.

## TIMING

Timing for the 832 is separated into microprocessor unit (MPU) timing, baud rate timing and address decoding.

## Microprocessor Unit (MPU) Timing



Microprocessor timing, which controls all operations and functions performed by the MPU, requires a two phase ( $\phi 1$  and  $\phi 2$ ), non-overlapping, complementary, five volt clock. The MPU also requires a signal to enable its data bus buffers for transferring its internal data out onto the data bus (DBE—Data Bus Enable). The  $\phi 1$  and  $\phi 2$  clock (see bottom waveforms in Figure 5-5) is generated by a crystal oscillator and a Johnson counter. The DBE signal (see Figure 5-5) is derived from the out outputs of the Johnson counter.

Inverters U1035A and U1035E are connected to form a crystal controlled multivibrator oscillator that operates at 4.9152 MHz. These inverters are biased into their active region to operate as a feedback amplifier with clipping. At power-up, one of the inverters begins to conduct before the other (inherent difference) starting to cutoff the other. As one starts to cutoff, it drives the one conducting harder until it reaches the power supply voltage (the clipping point). At that time feedback stops and the conduction of the clipped inverter starts to decrease. This decrease lets the other inverter start to conduct, which feedback and further reduces the conduction of the clipped inverter. When the other inverter reaches the supply voltage it also clips at that point. The cycle then repeats. With the inverters biased into their active region, the output waveform is not quite a perfect square wave. U1035F is a buffer that isolates the oscillator output from the load and also shapes the output waveform into a more perfect square wave.

Inverters have a characteristic of being able to make a very fast transition from just conducting to saturation, which could cause them to overrun the desired operating frequency. C1032 is provided to reduce the speed of the state change so the circuit won't oscillate faster than the crystal frequency. The crystal Y1027 controls the rate of feedback and also provides the trigger necessary to reverse the cycle at the specific frequency of the crystal. Should the electrical characteristics of the inverters be so close that the oscillator wouldn't start, the crystal would provide the trigger to start the oscillation.

P1072 is a service jumper that can be removed for the testing the oscillator output. TP1071 is provided very close to P1072 for grounding a test probe when checking the oscillator output. The buffered oscillator output waveform is represented by the top waveform in Figure 5-5.

U1176A, B and C make up a Johnson counter, which is actually a series of three edge triggered D flip-flops. The outputs of the counter are connected through a fourth edge triggered flip-flop (U1076) and two NOR gates (U1072B and U1072D) to form the  $\phi 1$  and  $\phi 2$  clock for the MPU. Typical of a Johnson counter is that the Q output of each flip-flop is connected to the input of the next flip-flop and the inverted output ( $\bar{Q}$ ) of the last flip-flop is connected to the data input (D) of the first flip-flop.

For the remainder of this discussion on Johnson counters, refer to the waveforms on Figure 5-5. These waveforms represent a condition where all flip-flop Q outputs start at a 0 condition, which may be the result of normal operation or a reset from an illegal state condition of the counter.

When all the flip-flops are in a 0 condition the  $\bar{Q}$  inverted output of the last flip-flop is in a 1 condition. On the next clock, the first flip-flop will change to a 1. Then each flip-flop will change to a 1 on each successive clock until the last counter is a 1. At that time the last counter's  $\bar{Q}$  output is a 0, which will cause the first flip-flop to change to 0 at the next clock. This cycle then repeats until all flip-flops are again all 0's. The flip-flops change state on the rising edge of the clock. Only one flip-flop changes state on each clock so there are no erroneous outputs during the counting cycle.

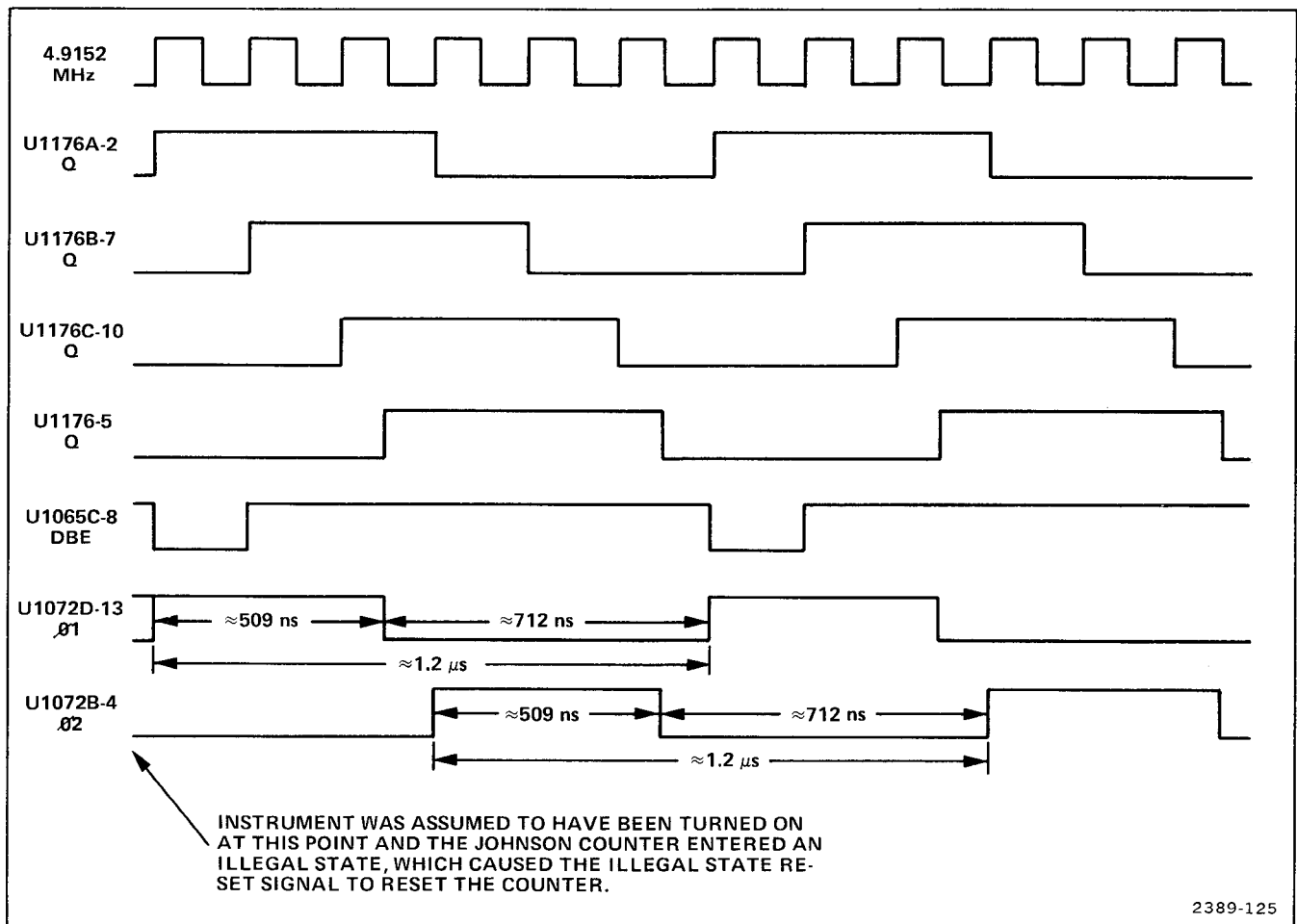


Figure 5-5. Timing diagram for Ø1 and Ø2 MPU clock.

The counter doesn't use all of its possible binary states; therefore, it may enter an unwanted state sequence on power-up or from a false noise trigger. If this occurs, the counter could become locked into an unwanted state sequence. U1276A, a three-input AND gate, is used to prevent this condition. It is driven from counter outputs that represent the illegal state. When that state occurs, a HI output from U1276A is inverted by U1172E to a LO (ILLEGAL STATE RESET), which resets all counters and U1076 to a 0 state.

On power-up, if the Johnson counter doesn't enter an illegal state, it will self correct its sequence within a few clock cycles.

The Date Bus Enable (DBE) signal shown on Figure 5-5 is derived through a two-input NAND gate U1065C from the Q and  $\bar{Q}$  outputs of U1176A and U1176B, respectively.

Baud Rate Timing **1** & **5**

Baud rate timing controls the rate of transfer of all Transmitted Data (TDATA) and Received Data (RDATA) between the RS-232 Interface and the USART's. Figure 5-6 is a simplified diagram of the baud rate timing circuits. Table 5-1 lists the timing source for TDATA and RDATA for the various BAUD switch and operating mode selections. Table 5-2 lists the logic conditions of U1332-23 (RTS) and U1332-24 (DTR) for the various operating mode and timing selections.

**TABLE 5-1**  
**Source of 832 Clock for Data Transfer Timing**

| BAUD Switch Position | Data Being Transferred | Timing Source |                     | SIMULATE, ECHO or REPEAT Mode |
|----------------------|------------------------|---------------|---------------------|-------------------------------|
|                      |                        | MONITOR Mode  |                     |                               |
|                      |                        | SYNC          | ASYNC               |                               |
| Any Baud Rate        | RDATA                  | Pin 17        | Baud Rate Generator |                               |
|                      | TDATA                  | Pin 15        |                     |                               |
| DTE (EXT)            | RDATA                  | Pin 17        | Pin 24              |                               |
|                      | TDATA                  | Pin 24        |                     |                               |
| DCE (EXT)            | RDATA                  | Pin 17        | Pin 15              |                               |
|                      | TDATA                  | Pin 15        |                     |                               |

**TABLE 5-2**  
**Logic Conditions for Selecting Source of Data Transfer Timing**

| LOGIC SIGNAL LOCATION | MONITOR MODE |       | MODEM SIMULATOR MODE |
|-----------------------|--------------|-------|----------------------|
|                       | SYNC         | ASYNC |                      |
| U1332-23 (RTS)        | LO           | LO    | HI                   |
| U1332-24 (DTR)        | HI           | LO    | LO                   |

Figure 5-6 shows the 832 connected into an RS-232 Interface between a DCE device (typically a modem) and a DTE device (typically a terminal) for operation in the MONITOR mode. That portion of the diagram between the two 832 connectors (DCE and DTE) is a partial diagram of the RS-232 interface circuitry of the 832. It shows only the timing and data portions of the interface, but not the control lines. The figure also shows the name relationships between the EIA Standard RS-232 signal names and those of the 832. When the 832 is used in the modem simulator modes (SIMULATE, ECHO or REPEAT), the shaded portion of the figure would not be connected to the 832.

In the MONITOR mode, all signals between the DCE and DTE devices must be passed to each other as if the 832 were not connected. This is accomplished by connecting the inputs to the 832 from the DCE and DTE devices to line receivers (U1205A, B, and D and U1105B), then through the MONITOR mode to Modem Simulator mode multiplexers (U1312A, B, C, and D) and out to the respective DCE and DTE device through line drivers (U1305A, B, and C and U1212A). One circuit (TDATA) is not multiplexed and two others (AUX CLK and DTR) are wired directly through the 832 and picked off by a Schmitt Trigger (U1112B).

During MONITOR mode operation, TDATA and RDATA from the interface are being serially transferred into the USART's (U1325 and U1332) at a rate determined by the DTE CLK and DCE CLK inputs (U1325-25 and U1332-25, respectively).

#### NOTE

*Operation of the USART's (U1325 and U1332) and how they transfer data to 832 RAM memory is covered later under Input/Output (I/O) Hardware.*

As shown on Figure 5-6, the DTE CLK and DCE CLK inputs to U1325 and U1332 come from a fairly complex network consisting of the Programmable Bit Rate Generator (U1022), BAUD switching (S2190), clock multiplexing (U1265E, U1265F, U1272E and U1272F) and the interface. For discussion on the clocks, we are going to start at U1325 and U1332 and progress backward through the circuitry to the source of the clocks.

The final clock source selection is made by multiplexer pairs U1265E and U1265F or U1272E and U1272F. They are selected whenever their pin 15 input goes LO based on the output from U1332-24 (DTR) (see Table 5-2). When U1332-24 is LO, U1265E and U1265F are selected and both clocks (DTE and DCE) are provided by the output from U1022. With U1332-24 HI, U1272E and U1272F are selected and (1) the DCE CLK is provided from the interface DCE CLK input (pin 17) and (2) the DTE CLK is provided from either the DTE CLK input (pin 15) or the AUX CLK input (pin 24) depending on the position of the BAUD switch S2190.

When the U1022 clock is used, its output may be the input from interface pins 15 or 24, or from its internal rate generator. Its output is determined by the position of the BAUD switch, the input clock frequency at pin 5 and the logic input on pins 11, 12, 13 and 14 (S3 through S0, respectively). Table 5-3 shows how the output rate is decoded.

**TABLE 5-3**  
**Programmable Bit Rate Generator Outputs**

| S3 | S2 | S1 | S0 | OUTPUT<br>RATE (Z)* |
|----|----|----|----|---------------------|
| L  | L  | L  | L  | IM Input            |
| L  | L  | L  | H  | IM Input            |
| L  | L  | H  | L  | 50 Baud             |
| L  | L  | H  | H  | 75 Baud             |
| L  | H  | L  | L  | 134.5 Baud          |
| L  | H  | L  | H  | 200 Baud            |
| L  | H  | H  | L  | 600 Baud            |
| L  | H  | H  | H  | 2400 Baud           |
| H  | L  | L  | L  | 9600 Baud           |
| H  | L  | L  | H  | 4800 Baud           |
| H  | L  | H  | L  | 1800 Baud           |
| H  | L  | H  | H  | 1200 Baud           |
| H  | H  | L  | L  | 2400 Baud           |
| H  | H  | L  | H  | 300 Baud            |
| H  | H  | H  | L  | 150 Baud            |
| H  | H  | H  | H  | 110 Baud            |

\*When the input clock (CP) is 2.4576 MHz, the actual output frequency is 16 times the indicated output rate above.

As noted in Table 5-3, the output rate of U1022 is 16 times the indicated rate when the U1022 clock is 2.4576 MHz, which is the clock rate for ASYNC operation. When ASYNC is selected, U1028B-4 is held LO (its output stays HI) keeping U1028B from passing the 153.6 kHz frequency at its input. U1035 inverts the LO to a HI at U1028C-10, which allows the output of U1028C to follow the 2.4576 MHz input frequency. With U1028B providing a HI to U1028D, its output also follows the 2.4576 MHz input frequency, which becomes the clock input for U1022. When SYNC is selected, U1028B-4 goes HI and U1022C-10 goes LO. This reverses the role of U1028B and U1028C making the clock input to U1022 a 153.6 kHz frequency. With a 153.6 kHz clock, the output of U1022 is the actual rate listed in Table 5-3.

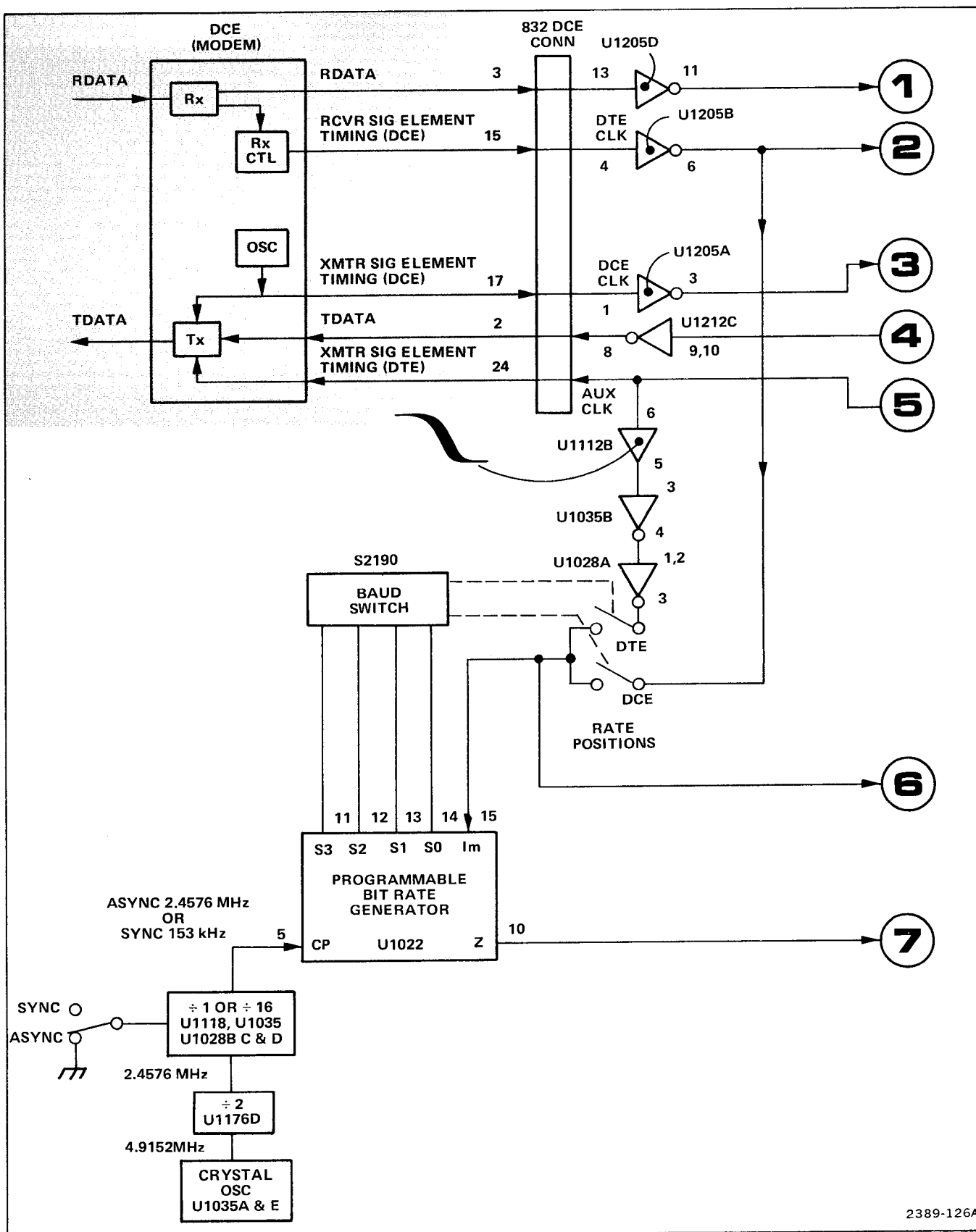
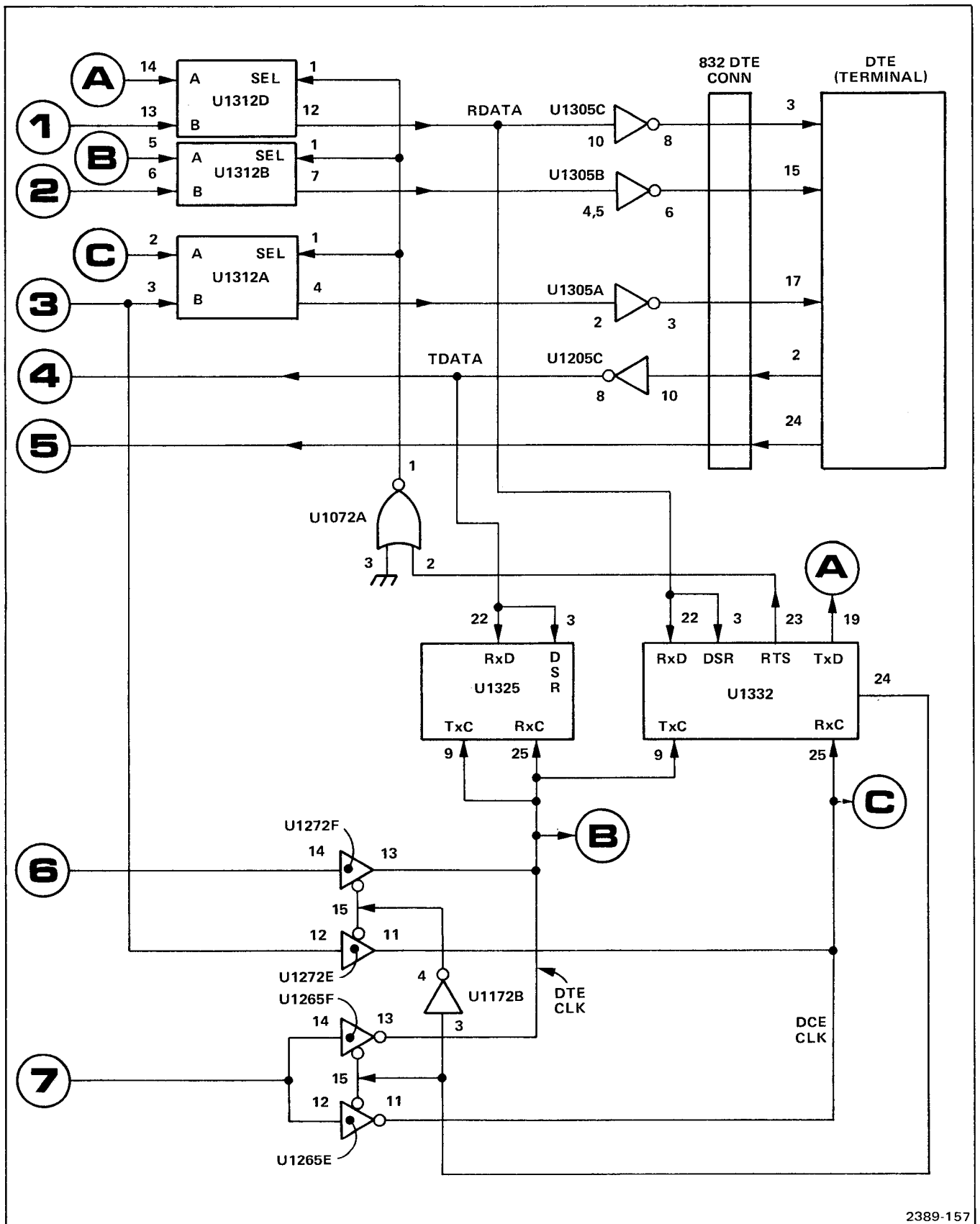


Figure 5-6. Simplified diagram of the baud rate timing circuitry (sheet 1 of 2).



2389-157

Figure 5-6. Simplified diagram of the baud rate timing circuitry (sheet 2 of 2).

Address Decoding **2**

Address decoding controls the selection of a specific device that is to be read from or written to by the MPU. This selection is made by a single line output from U1345, a 4-line to 16-line decoder/demultiplexer. U1345 takes a 4-bit binary coded input (MPU address lines A12 through A15) and generates 16 exclusive outputs. Table 5-4 shows the binary inputs and the 832 hexadecimal address equivalents for the various line selections.

**TABLE 5-4**  
**Address Decoder Outputs**

| INPUTS |    |   |   |   |   | 832<br>HEX ADDRESS<br>EQUIVALENTS | OUTPUTS |   |   |   |   |   |   |   |   |   |  |
|--------|----|---|---|---|---|-----------------------------------|---------|---|---|---|---|---|---|---|---|---|--|
| G1     | G2 | D | C | B | A |                                   | 0       | 1 | 3 | 4 | 5 | B | C | D | E | F |  |
| L      | L  | L | L | L | L | 0xxx                              | L       | H | H | H | H | H | H | H | H | H |  |
| L      | L  | L | L | L | H | 1xxx                              | H       | L | H | H | H | H | H | H | H | H |  |
| L      | L  | L | L | H | H | 3xxx                              | H       | H | L | H | H | H | H | H | H | H |  |
| L      | L  | L | H | L | L | 4xxx                              | H       | H | H | L | H | H | H | H | H | H |  |
| L      | L  | L | H | L | H | 5xxx                              | H       | H | H | H | L | H | H | H | H | H |  |
| L      | L  | H | L | H | H | Bxxx                              | H       | H | H | H | H | L | H | H | H | H |  |
| L      | L  | H | H | L | L | Cxxx                              | H       | H | H | H | H | H | L | H | H | H |  |
| L      | L  | H | H | L | H | Dxxx                              | H       | H | H | H | H | H | H | L | H | H |  |
| L      | L  | H | H | H | L | Exxx                              | H       | H | H | H | H | H | H | H | L | H |  |
| L      | L  | H | H | H | H | Fxxx                              | H       | H | H | H | H | H | H | H | H | L |  |
| L      | H  | x | x | x | x | ---                               | H       | H | H | H | H | H | H | H | H | H |  |
| H      | L  | x | x | x | x | ---                               | H       | H | H | H | H | H | H | H | H | H |  |
| H      | H  | x | x | x | x | ---                               | H       | H | H | H | H | H | H | H | H | H |  |

H = HI                      L = LO                      x = Don't Care

**NOTE:** This table is not a complete truth table for U1345. It contains only the decoding outputs used for the 832.

Two gates on the U1345 (G1 and G2) further determine exactly when the output line is activated. These gates are controlled by the MPU so that address decoding is directly related to the processing of data by the MPU. These gates are active when they are LO and are controlled from the VMA and R/W outputs on the MPU. The exact timing of the VMA and R/W outputs from the MPU are a function of the MPU instruction cycle, which is related to ROM programming for the M6800 MPU. Basically, the VMA output is HI when the address on the address bus is stable and valid and the R/W output is HI when the MPU is in a Read cycle and LO when in a Write Cycle. For further information on these outputs, refer to the manufactures literature on programming the M6800.

Figure 5-7 is a simplified diagram of the address decoding circuitry. The particular device connected to the output of U1345 is selected when the output line is LO (see Table 5-4).

Jumper J1041 is a service jumper that can be removed to disable the address decoder so the only device driving the buses is the MPU. When the jumper is placed on P1471, it provides an MPU instruction for servicing. This was previously covered under the CPU discussion.



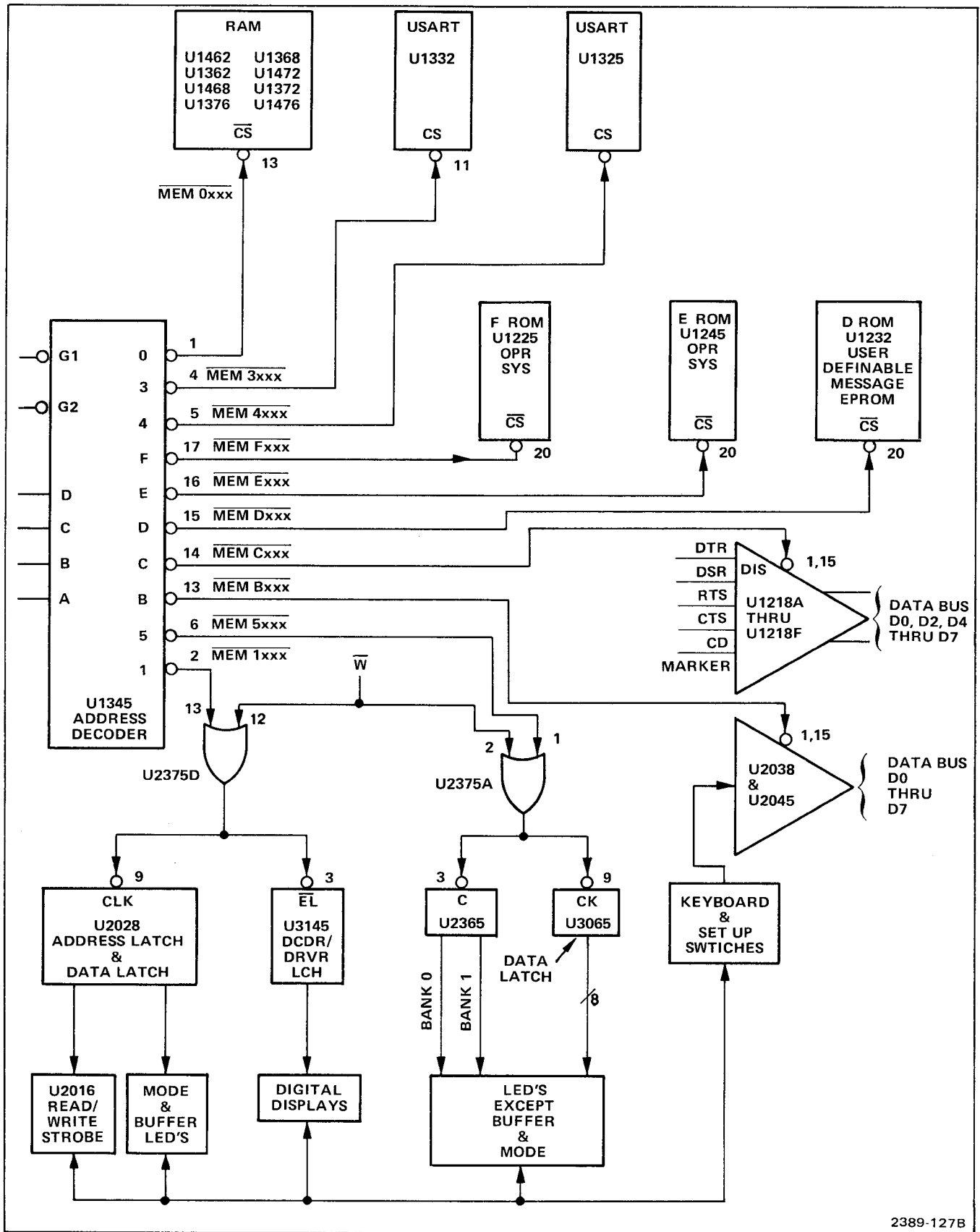


Figure 5-7. Simplified diagram of the address decoding circuitry.

## RANDOM ACCESS MEMORY (RAM) 2

The random access memories (RAM) are U1462, U1362, U1468, U1376, U1368, U1472, U1372 and U1476. They are each 1-bit X 1024 word devices with ten address line inputs (A0 through A9). Hexadecimal addresses 000 through 3FF covers the 1024 locations in each RAM.

The CS input (pin 13) has already been covered under Address Decoding. Also as previously covered, the R/W output from the MPU (U1155) controls the tri-state buffers connected to the Dout line of each RAM (pin 12), which prevents a data conflict between the Din and Dout data when writing to the RAM. This conflict is easier understood through Table 5-5, which shows the status of the Din and Dout lines and the RAM action for the various CS and R/W input conditions.

**TABLE 5-5**  
**RAM Din/Dout Truth Table**

| CS | R/W | Din | Dout | RAM Action                          |
|----|-----|-----|------|-------------------------------------|
| H  | x   | x   | HI Z | Not selected.                       |
| L  | L   | L   | L    | Writes a 0 into address location.   |
| L  | L   | H   | H    | Writes a 1 into address location.   |
| L  | H   | x   | Dout | Reads data out of address location. |

**H = HI      L = LO      x - Don't Care**

## READ-ONLY MEMORY (ROM) 2

The read-only memories (ROM) are U1245 and U1225, which are referred to as the 'E' ROM and 'F' ROM, respectively. The 'F' ROM contains the power-up and self test routines. U1232 is a spare ROM socket for insertion of the user definable message EPROM, which is referred to as the 'D' ROM. Further information on that ROM is contained in Section 4, Programming A User Defined Message PROM.

The  $\overline{\text{CS}}$  input to the ROM's (pin 20) has been covered previously under Address Decoding.

Each ROM is an 8-bit X 2048 word device with eleven address lines. This provides a total hexadecimal equivalent addressing capability of 000 through FFF for each ROM with 000 through 7FF being sufficient for the available ROM locations. The 'E' ROM is addressed from E000 through E7FF and the 'F' ROM is addressed from F000 through F7FF. The 'D' Rom, when installed, is addressed from D000 through D7FF.

## INPUT/OUTPUT (I/O) HARDWARE

### Digital Displays 3 & 4

Figure 5-8 is a simplified diagram of the digital display circuitry. The digital displays (U3022, U3024, U3026, U3032 and U3034) are common cathode devices with both pins 1 and 6 internally connected to the common cathode. The cathode for each display is connected to a separate enabling line ( $\overline{\text{ENABLE 0}}$  through  $\overline{\text{ENABLE 4}}$ ) from U2016, which must be LO before any segment in a display can be turned on. U2016 is a BCD to decimal decoder with three of its BCD inputs connected through address latch U2028 to MPU address lines A0 through A2. Its fourth BCD input (pin 11) is kept LO by being tied to ground. Table 5-6 is truth table for U2016. Addresses present at the inputs to U2028 are latched into the device when the clock (U2028-9) goes LO, which occurs when U2375-11 is LO. U2375D is an OR gate whose output is LO when both  $\overline{\text{W}}$  (pin 12) and  $\overline{\text{MEM 1xxx}}$  (pin 13) are LO.  $\overline{\text{W}}$  is LO when the MPU is in a Write cycle and  $\overline{\text{MEM 1xxx}}$  is LO whenever the MPU addresses the digital displays through U1345, the address decoder.

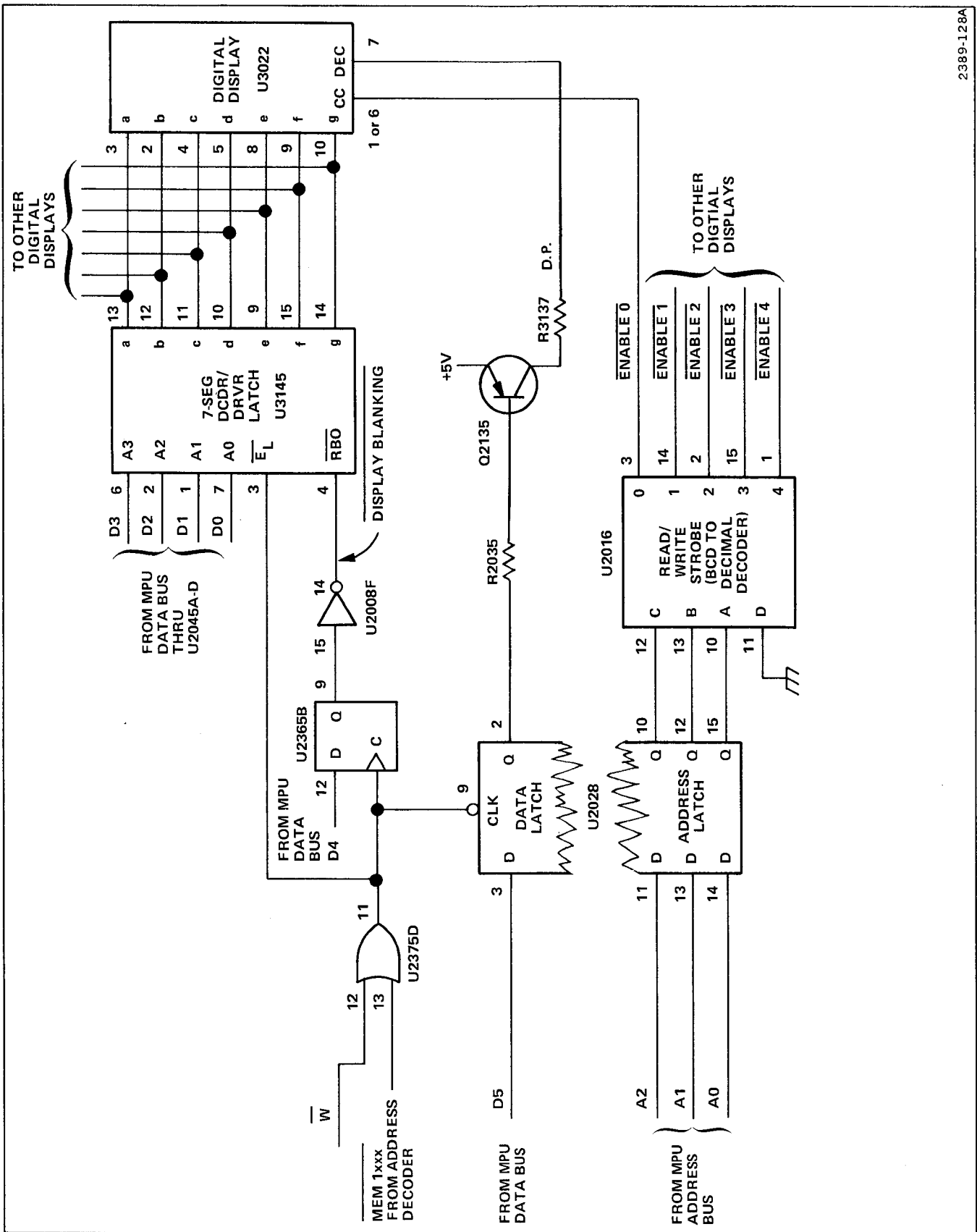


Figure 5-8. Simplified diagram of the digital display circuitry.

**TABLE 5-6**  
**BCD To Decimal Output For U2016**

| INPUTS |   |   | OUTPUTS |   |   |   |         |
|--------|---|---|---------|---|---|---|---------|
| C      | B | A | 0       | 1 | 2 | 3 | 4       |
| 0      | 0 | 0 | 1       | 0 | 0 | 0 | 0       |
| 0      | 0 | 1 | 0       | 1 | 0 | 0 | 0       |
| 0      | 1 | 0 | 0       | 0 | 1 | 0 | 0       |
| 0      | 1 | 1 | 0       | 0 | 0 | 1 | 0       |
| 1      | 0 | 0 | 0       | 0 | 0 | 0 | 1       |
| 1      | 0 | 1 |         |   |   |   |         |
| 1      | 1 | 0 |         |   |   |   | ALL 0's |
| 1      | 1 | 1 |         |   |   |   |         |

**NOTE:** Only those outputs used by the 832 are shown.

The anode of each display segment is paralleled to the same segment anode in all displays. These anodes must be HI when the common cathodes are LO for a segment to be turned on. Control of the segments (anodes) is provided by U3145, a 7-segment decoder/driver latch. U3145 takes a BCD input and converts it to HI segment driving outputs. Table 5-7 lists the BCD to 7-segment decoder outputs. Whatever is on the BCD input when  $\overline{EL}$  (U3145-3) goes LO is latched into U3145 and decoded to drive the segments.  $\overline{EL}$  is provided by OR gate U2375D, which will be LO whenever both  $\overline{W}$  is LO (the MPU is in a Write cycle) and  $\overline{MEM\ 1xxx}$  from the address decoder is LO (the MPU has addressed the digital displays). Then when the displays are strobed by the  $\overline{ENABLE}$  lines they turn on.

**TABLE 5-7**  
**BCD To 7-Segment Decoder Output For U3145**

| INPUTS |    |    |    | OUTPUTS            |   |   |   |   |   |   |   | DISPLAY |
|--------|----|----|----|--------------------|---|---|---|---|---|---|---|---------|
| A3     | A2 | A1 | A0 | $\overline{RBO}^*$ | a | b | c | d | e | f | g |         |
| X      | X  | X  | X  | L                  | L | L | L | L | L | L | L | BLANK   |
| L      | L  | L  | L  | H                  | H | H | H | H | H | H | L | 0       |
| L      | L  | L  | H  | H                  | H | H | H | L | L | L | L | 1       |
| L      | L  | H  | L  | H                  | H | H | L | H | H | L | H | 2       |
| L      | L  | H  | H  | H                  | H | H | H | H | L | L | H | 3       |
| L      | H  | L  | L  | H                  | L | H | H | L | L | H | H | 4       |
| L      | H  | L  | H  | H                  | H | L | H | H | L | H | H | 5       |
| L      | H  | H  | L  | H                  | H | L | H | H | H | H | H | 6       |
| L      | H  | H  | H  | H                  | H | H | H | L | L | L | L | 7       |
| H      | L  | L  | L  | H                  | H | H | H | H | H | H | H | 8       |
| H      | L  | L  | H  | H                  | H | H | H | L | L | H | H | 9       |
| H      | L  | H  | L  | H                  | H | H | H | L | H | H | H | A       |
| H      | L  | H  | H  | H                  | L | L | H | H | H | H | H | b       |
| H      | H  | L  | L  | H                  | H | L | L | H | H | H | L | C       |
| H      | H  | L  | H  | H                  | L | H | H | H | H | H | H | d       |
| H      | H  | H  | L  | H                  | H | L | L | H | H | H | H | E       |
| H      | H  | H  | H  | H                  | H | L | L | L | H | H | H | F       |

\* $\overline{RBO}$  used as an input overrides all other inputs.

The  $\overline{DISPLAY\ BLANKING}$  input to U3145-4 is used when the MPU wants to blank the digital displays even though there are valid segment outputs from U3145. When the blanking input is LO, the digital displays are blanked (see Table 5-7).

## LED Displays (except PROBE)

3

&amp;

4

Fig. 5-9 is a simplified diagram of the LED display circuitry. The LED's are turned on similar to the digital displays in that one of their elements (cathode or anode) is latched in its active state by data latches U2028 and U3065. Then they are turned on by either the Read/Write Strobe (U2016) through U2008, or Bank Strobes (U2365A).

The Buffer and Mode LED's have their anodes tied through transistor drivers Q2235 and Q2335 to data latch U2028. These LED's are turned on when their anodes are HI and one of the  $\overline{\text{ENABLE}}$  lines goes LO. These are the same  $\overline{\text{ENABLE}}$  lines used for the digital displays and are activated in the same manner from the MPU address bus through address latch U2028. This arrangement lets one digital display, one Buffer LED and one Mode LED be displayed simultaneously.

The other LED's have their cathodes connected through inverters (U3180) to U3065, a data latch. Since U3065 is a 6-bit latch, only six LED's at a time can be turned on. This is accomplished by using U2365A as a Bank Strobe to turn on one bank of LED's or the other (BANK 0 or BANK 1). A LED bank is on when the U3180 outputs are LO (U3065 outputs HI) and either the Q or  $\overline{Q}$  output from U2365A is HI. The Bank Strobe U2365A changes state whenever address line A0 changes state and a clock pulse occurs at U2365A-3.

CR2108 and CR2238 prevent the LED's from ghosting (lighting from leakage currents).

## PROBE LED Display

3

The PROBE LED's (MARK and SPACE) are connected into a positive and negative voltage follower network whose turn-on threshold is +3 volts and -3 volts. With a positive voltage input the threshold is set by the emitter-to-base voltage drop of Q3014 (+0.7 V), CR3012 (+0.7 V) and DS3010 (+1.6 V) for a +3 volt threshold. These same relative voltage drops occur with Q3114, CR3011 and DS3110, but in a negative direction for a -3 volt threshold.

## Push Buttons and Slide Switches

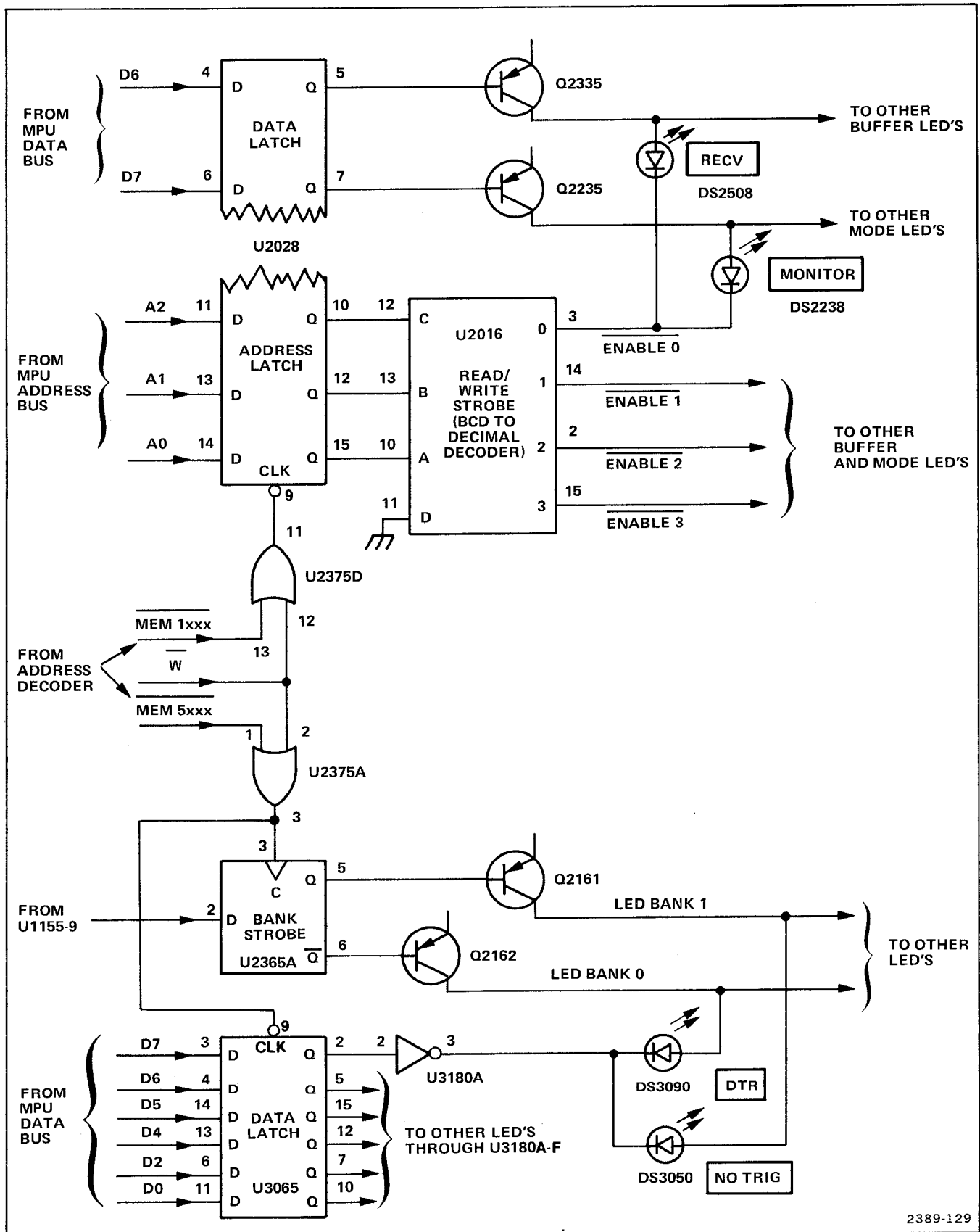
4

Push button and slide switch selections, except STOP, are sampled by the MPU through tri-state buffers to cause specific programmed routines or instructions to be performed. These switches are strobed by the same  $\overline{\text{ENABLE}}$  lines as the Buffer and Mode LED's; therefore, a switch selection can be read on the same  $\overline{\text{ENABLE}}$  cycle that turns on LED's. All that is required to do this is for the MPU to change from a Write cycle to a Read cycle and to address the tri-state buffers for the switches U2038 and U2045 ( $\overline{\text{Bxxx}}$ ).

Diodes CR2147, CR2075, CR2253, CR2268 and CR2254 isolate the data inputs of the slide switches from that of the push buttons. This is required because the slide switches may always represent a LO to the data bus input, which could cause a false indication that a push button has been pressed.

Besides being a data input to the MPU, the ASYNC/SYNC switch selects the clock input rate to U1022, the Programmable Bit Rate Generator (see diagram 1). In the ASYNC position, U1028C-10 is held HI, which lets the 2.4576 MHz clock pass through it to U1028D and eventually U1022. In the SYNC position, U1028B-4 is HI, which lets the 153.6 kHz clock pass. The other two positions of the switch (HDLC and NRZI) are reserved for Option 1, which is covered in Section 8, Options when available.

The STOP switch S2056 is connected through a Schmitt trigger U1044A and U1044B (see diagram 2) to the NMI input of the MPU U1155. This circuit acts as a switch debounce circuit. When STOP is pushed, it causes an immediate response from the MPU to enter the idle state. R2053 limits the peak current when C1045 discharges.



2389-129

Figure 5-9. Simplified diagram of the LED display circuitry.

## RS-232 Control Line Inputs/Outputs 5 & 7

The control line inputs/outputs to be covered here are RTS (Request to Send), J1405-4 and J908-4; CTS (Clear to Send), J1405-5 and J908-5; DSR (Data Set Ready), J1405-6 and J908-6; CD (Carrier Detect), J1405-8 and J908-8 and DTR (Data Terminal Ready), J1405-20 and J908-20. In the MONITOR Mode, inputs on each of these control lines, except DTR, enter from the RS-232 interface through line receivers (U1105A, B, C and D) that convert the RS-232 signal voltage (may be as high as  $\pm 25$  volts) to TTL levels for use by the 832.

DTR is input directly through a NORTON operational amplifier (U1112A) configured as a Schmitt trigger with a  $\pm 2$  volt input threshold. U1112A is a current differencing amplifier that will accept input voltages well in excess of its power supply voltage. R1112 and R1008 determine the voltage difference between the thresholds. R1004 and R1012 set the center point of the thresholds and are 1% tolerance resistors. When the DTR input is left floating, R1005 forces the DTR input to U1218 HI, which will turn off the DTR LED.

In the MONITOR mode, the U1312C SEL input (pin 1) is HI allowing the CTS input U1312C-10 to pass through the device to its Y output (U1312C-9). This same HI is blocked by CR1304, which leaves U1105A-2 essentially an open. This lets U1105A pass its CD input through to U1212D and U1276C. Then, when U1325-24 is HI the CD signal passes through U1212D and U1276C. The output of U1325-24 is set by a command instruction from the MPU through data bus line D1. In the MONITOR mode, it is always set HI so the output of U1212D and U1276C follow the CD signal.

In the modem simulator mode (SIMULATE, ECHO or REPEAT), the U1312C SEL line (pin 1) is LO and the CTS input is provided from U1325-23. This output is set by a command instruction from the MPU. In full-duplex operation, U1325-23 is always set LO, while in half-duplex operation, it is set LO after receiving a RTS from the DTE device and the line turnaround delay occurs.

A LO on the U1312C SEL line also causes a LO at U1105A-2 through CR1304. This sets U1105-3 HI, which lets U1212D and U1276C pass the CD control signal generated by U1325-24. In full-duplex operation U1325-24 is always HI, while in half-duplex operation it goes HI just before the 832 sends its message. As soon as the 832 message is sent, U1325-24 goes LO.

Once the control line inputs are converted to TTL levels, they are input to the MPU through tri-state buffers U1218A through U1218F. These buffers are turned on when pin 1 (or pin 15) is pulled LO by the address decoder output MEM Cxxx.

The MARKER input has the same NORTON operational amplifier Schmitt trigger circuit as DTR.

In addition to the 832 picking off the TTL control signal levels, they are reconverted to RS-232 signal levels by line drivers (U1212A, B, C, and D and U1305A, B, C, and D) and reinserted on the RS-232 interface.

Depending on the direction of control line signal flow (from DTE to DCE, or DCE to DTE), the signals pass through the interface Breakout Panel at the DTE end of the circuitry (see diagram 5). This Breakout Panel contains the line patch pins (J2003, J2006, J2203, J2206, J2403 and J2406) and DIP (Dual In-line Package) switches (S2005, S2205 and S2405).

## Programmable Communications Interface 5

The programmable communications interface consists of U1325 and U1332. These devices are Universal Synchronous/Asynchronous Receiver/Transmitters (USART's) that are specially designed for microcomputer systems involving data communications. As previously covered under Baud Rate Timing, U1325 and U1332 perform all data transfers (TDATA and RDATA) between the RS-232 interface and the MPU.

In addition to performing the serial-to-parallel and parallel-to-serial conversion for all data transfers, the USART's provide these functions:

1. Controls the character length in bits.
2. Inserts the start and stop bits for asynchronous transmissions.
3. Enables or disables the parity function.
4. Detects parity errors (RDATA inputs), if parity function is enabled.
5. Generates parity bits (TDATA outputs), if parity function is enabled.
6. Checks incoming data (RDATA inputs) for single or double synchronizing characters (synchronous only).
7. Detects overrun errors. These are errors that occur when the incoming data rate exceeds the data transfer rate between the USART's and the MPU.
8. Detects framing error (asynchronous only). These are errors where the received character may not be properly framed with a start bit and at least one stop bit. It also may be caused by a baud rate or bits per character mismatch.

The first five of these functions are programmed into the USART's by the MPU as a mode instruction (see Figures 5-10 and 5-11), while the next three are outputs from the USART's as a result of some operation. These last three functions are read by the MPU during a USART status read instruction (see Figure 5-12).

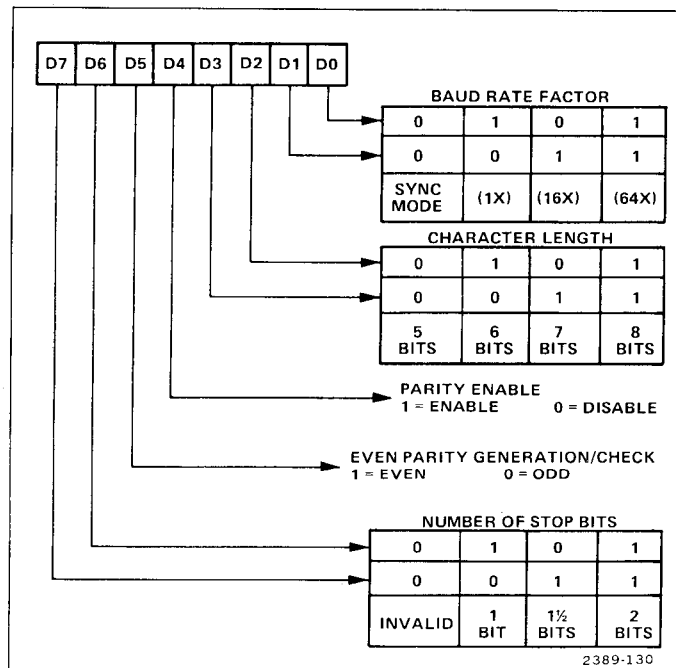


Figure 5-10. Asynchronous mode instruction format.

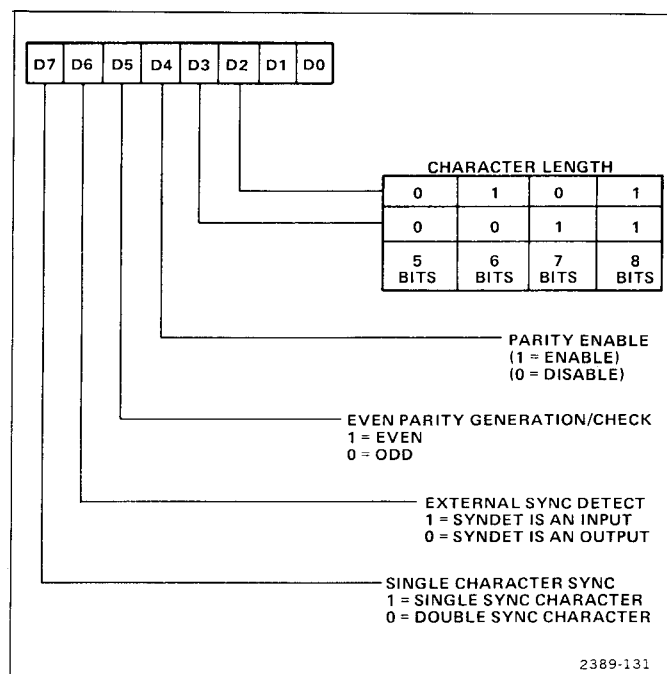


Figure 5-11. Synchronous mode instruction format.



Mode instructions can be input only during an external or internal USART reset. The external reset (pin 21) is tied to the same Schmitt trigger circuit as the MPU. The minimum reset time for the USART's is six clock cycles (two less than for the MPU). The internal reset is a software reset generated by a command instruction from the MPU to the USART. This instruction automatically returns the USART to a condition of awaiting a mode instruction. Figure 5-13 shows the arrangement of a typical data block for USART control.

The WR inputs (pin 10) are pulled LO when the MPU is writing to the USART (data, mode instruction or command instruction).

The RD inputs (pin 13) are pulled LO when the MPU is reading from the USART (data or status information).

The C/D inputs (pin 12P) are set to one or the other logic levels (HI or LO) to tell whether the information on the data bus is data, mode instructions, command instructions, or status information. A LO represents data and a HI represents instructions or status information.

The CS inputs are pulled LO to enable the USART's. This input is provided from the address decoder U3145-4 (MEM 3xxx).

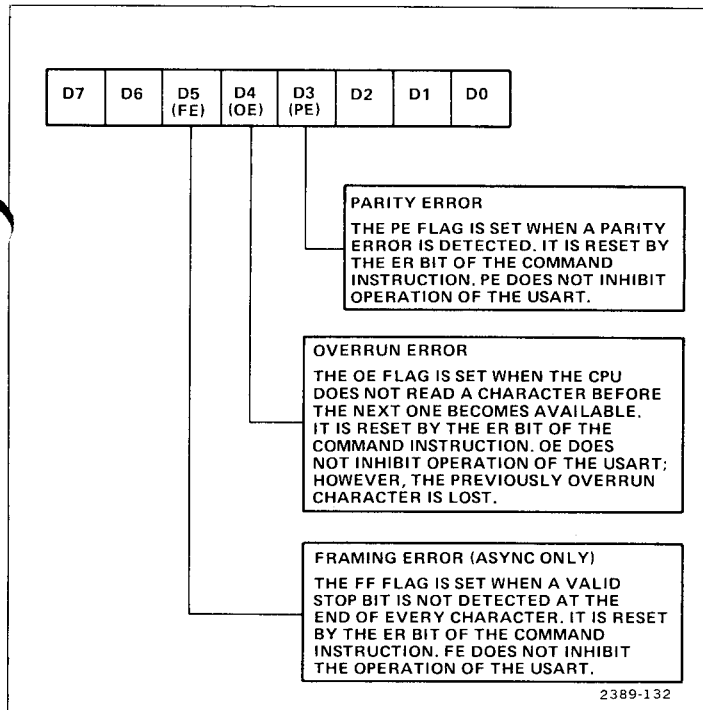


Figure 5-12. Status information format.

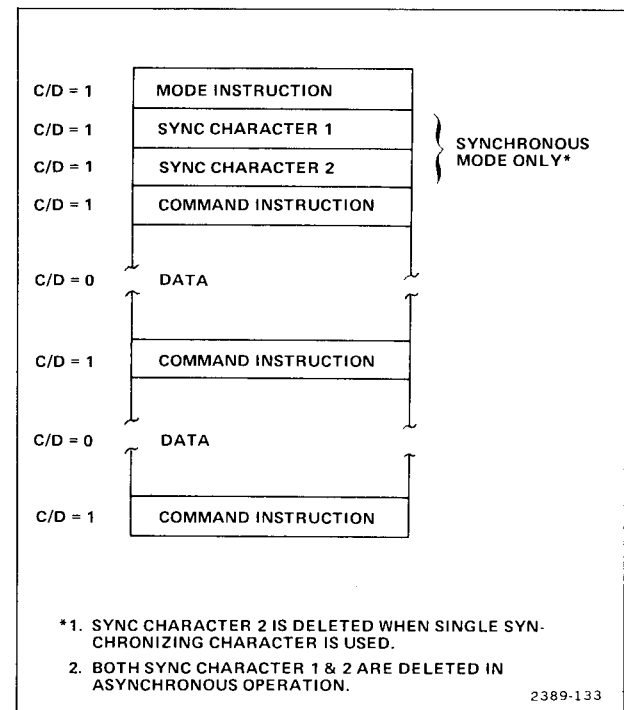


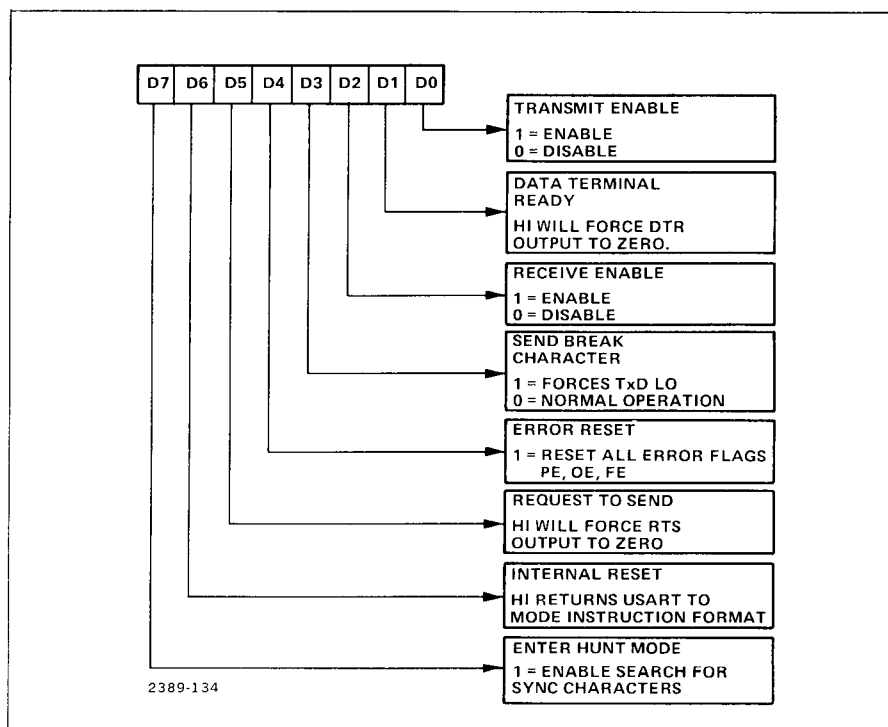
Figure 5-13. Typical data block for a USART.

A summary of the various logic conditions of the C/D, RD, WR and CS lines and the resultant USART action are shown in Table 5-8.

**TABLE 5-8**  
**Read/Write Control Logic for USART's**

| Control Inputs |    |    |    | USART Action                                                  |
|----------------|----|----|----|---------------------------------------------------------------|
| C/D            | RD | WR | CS |                                                               |
| 0              | 0  | 1  | 0  | USART transfers data to data bus.                             |
| 0              | 1  | 0  | 0  | USART receives data from data bus.                            |
| 1              | 0  | 1  | 0  | USART Status information transferred to data bus.             |
| 1              | 1  | 0  | 0  | USART takes information from data bus as control information. |
| x              | 1  | 1  | 0  | USART data bus is in high impedance state.                    |
| x              | x  | x  | 1  | USART data bus is in high impedance state.                    |

Once the USART functions have been set by the mode instruction, then the command instruction (see Figure 5-14) and the CLK are used to control the actual operation of the USART. The CLK input was not covered previously under timing as its only purpose is to provide internal timing for the USART's. Its only criteria is that its rate must exceed the TxC clock rates by at least 30 times (for synchronous operation) or 4.5 times (for asynchronous operation).



**Figure 5-14. Command instruction format.**

# MAINTENANCE

## INTRODUCTION

### TEKTRONIX FIELD SERVICE

Tektronix, Inc. maintains repair and recalibration facilities at its local Field Service Centers and the Factory Service Center. For further information or assistance, contact your local Tektronix Field Office or representative.

### REPACKAGING FOR SHIPMENT

If the instrument is to be shipped to a Tektronix Service Center or the Factory Service Center for repair or calibration, attach a tag showing owner (with address) and the name of an individual at your firm that can be contacted, complete instrument serial number and description of the service required.

Save and reuse the package in which your instrument was shipped. If the original packaging is unfit for use or not available, repackage the instrument as follows:

1. Surround the instrument with polyethylene sheeting to protect the finish of the instrument.
2. Obtain a carton of corrugated cardboard of the correct carton strength and having inside dimensions of no less than six inches more than the instrument dimensions. The carton test strength for your instrument is 275 pounds.
3. Cushion the instrument by tightly packing three inches of dunnage or urethane foam between carton and instrument on all sides.
4. Seal carton with shipping tape or industrial stapler.

### INTERNAL INSTRUMENT ACCESS

**WARNING**

*Electric shock hazards inside the instrument may be exposed when the covers are removed. Disconnect the instrument from any power source before removing the covers.*

To gain access to the inside of the instrument, see Bottom Cover removal instructions under Component Removal and Replacement.

## MAINTENANCE PRECAUTIONS

### Soldering

Most of the components in the instrument are soldered in place. Use a 15-watt soldering iron to prevent heat damage to the circuit boards or components. Excessive heat will lift the circuit runs on the circuit board.

The flux in the solder may leave a residue on the circuit board, which can provide a high resistance leakage path and affect instrument operation. Be sure to clean off this residue. Isopropyl alcohol may be used.

### Light-Emitting Diodes (LED)

Damage to a LED due to mishandling may not be immediately apparent but can result in failure at some future time. Always keep soldering time and temperature to a minimum. Do not bend leads or apply force when inserting leads into circuit board holes (clean holes of all excess solder before attempting to install a new LED).

### Static-Discharge Damage (special handling required)

There are a number of static sensitive devices in the 832 that can be damaged by improper handling. The following types are especially susceptible:

|        |       |      |       |              |
|--------|-------|------|-------|--------------|
| MC6800 | 8251A | 2102 | 80C97 | 74Cxx series |
| 4069   | 4702  |      |       |              |

Other devices that are not sensitive to normal TTL-like handling, but are vulnerable to high-voltage static arcs to the metal parts of the front panel and the RS-232 connector shells are the DS1488 and DS1489 line receivers and line drivers. These devices are more likely to be damaged during use than when being serviced.

### NOTE

*To help prevent the possibility of damage caused by high-voltage static arcs to the front panel and RS-232 connector shells, a ground wire has been connected internally between them and the power supply chassis. When servicing the instrument, be sure these are not left disconnected.*

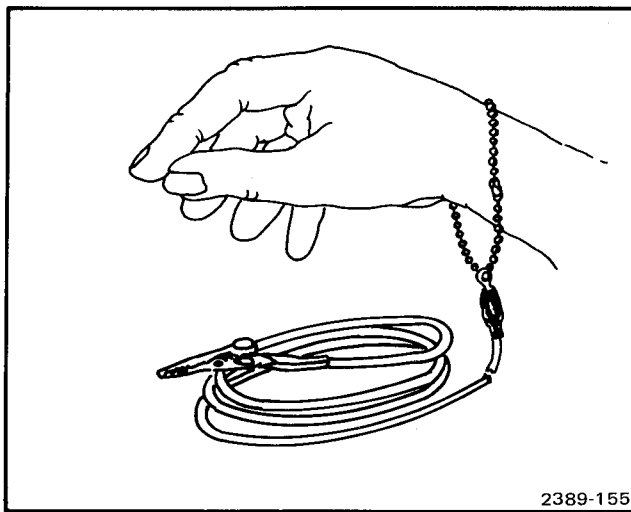


Figure 6-1. Wrist strap for use in handling static sensitive parts.

**CAUTION**

*Static discharge can damage any semiconductor component in this instrument.*

The following chart lists relative susceptibility of various classes of semiconductors. Static voltages of 1 kV to 30 kV are common in unprotected environments.

| Relative Susceptibility to<br>Static Discharge Damage                                                |                                                   |
|------------------------------------------------------------------------------------------------------|---------------------------------------------------|
| Semiconductor Classes                                                                                | Relative<br>Susceptibility<br>Levels <sup>a</sup> |
| MOS or CMOS microcircuits or discretes,<br>or linear microcircuits with MOS inputs. (Most Sensitive) | 1                                                 |
| ECL                                                                                                  | 2                                                 |
| Schottky signal diodes                                                                               | 3                                                 |
| Schottky TTL                                                                                         | 4                                                 |
| High-frequency bipolar transistors                                                                   | 5                                                 |
| JFETs                                                                                                | 6                                                 |
| Linear microcircuits                                                                                 | 7                                                 |
| Low-power Schottky TTL                                                                               | 8                                                 |
| TTL (Least Sensitive)                                                                                | 9                                                 |

<sup>a</sup>Voltage equivalent for levels:

1 = 100 to 500 V

4 = 500 V

7 = 400 to 1000 V (est.)

2 = 200 to 500 V

5 = 400 to 600 V

8 = 900 V

3 = 250 V

6 = 600 to 800 V

9 = 1200 V

(Voltage discharged from a 100 pF capacitor through a resistance of 100 ohms.)

Observe the following precautions to avoid damage.

1. Minimize handling of static-sensitive components.
2. Transport and store static-sensitive components or assemblies in their original containers, on a metal rail, or on conductive foam. Label any package that contains static-sensitive assemblies or components.
3. Discharge the static voltage from your body by wearing a wrist strap while handling these components (see Figure 6-1). Servicing static-sensitive assemblies or components should be performed only at a static-free work station by qualified personnel.
4. Nothing capable of generating or holding a static charge should be allowed on the work station surface.
5. Keep the component leads shorted together whenever possible.
6. Pick up components by the body, never by the leads.
7. Do not slide the components over any surface.
8. Avoid handling components in areas that have a floor or work-surface covering capable of generating a static charge.
9. Use a soldering iron that is connected to earth ground.
10. Use only special antistatic suction type or wick type desoldering tools.

TOOLS REQUIRED

The tools required to service the instrument are those most commonly found in a technicians tool box. The following list is provided to help select those the technician may want readily at hand to service the instrument (items marked with an \* are optional).

1. Soldering Iron, 15-watt.

2. Rosin Core Solder, 60/40.

3. Screwdriver, Phillips, 3-inch, #1 point.

4. Screwdriver, 1/8-inch blade.

5. Nutdriver, 3/16 inch and 3/8 inch.

6. Pliers, longnose.

7. Isopropyl alcohol.

8. Lint-free dust cloth.

9. Soft-bristle brush.

10. Integrated Circuit Extractor\*  
(Tektronix Part 003-0619-00).

11. Kit, Circuit Board Pin\* (Tektronix Part 040-0542-00).

12. Desolder Tool\* (Tektronix Part 003-0652-00).

13. Solder Wick\* (Tektronix Part 006-1356-00).

TEST EQUIPMENT REQUIRED

Test equipment required to service the instrument is listed under Troubleshooting Equipment in the Troubleshooting subsection.

PREVENTIVE MAINTENANCE

Preventive maintenance consists of cleaning and inspection. When performed regularly, it can prevent instrument failure and prolong useful life.

PREVENTIVE MAINTENANCE SCHEDULE

Preventive maintenance schedules are usually established by a combination of user policies, equipment uses and environmental conditions. Lacking these guidelines, Table 6-1 is a recommended preventive maintenance schedule for instruments in continuous use.

TABLE 6-1

Preventive Maintenance Schedule

| Maintenance Item    | As Required | Monthly | Semiannually or 1000 Instrument Hours |
|---------------------|-------------|---------|---------------------------------------|
| External Cleaning   | X           |         |                                       |
| External Inspection |             | X       |                                       |
| Internal Cleaning   |             |         | X                                     |
| Internal Inspection |             |         | X                                     |
| Calibration         |             |         | X                                     |

## CLEANING

### Exterior

Dust the exterior surfaces with a dry, lint-free cloth or a soft bristle brush. If hard dirt remains, use a cloth or swab dampened with warm water and a mild detergent. The swab also is useful for cleaning in narrow spaces around the controls. Do not use abrasive cleaning compounds.

#### CAUTION

*To prevent getting water inside the instrument during external cleaning, use only enough water to dampen the cloth or swab.*

*DO NOT use chemical cleaning agents as they may damage the plastics used in the instrument. In particular, avoid chemicals that contain benzene, toluene, xylene, acetone or similar solvents.*

### Interior

Internal cleaning should be done with a dry, low-velocity stream of air. A soft-bristle brush or swab is useful for cleaning around components. If a liquid must be used for minor internal cleaning, use isopropyl alcohol.

Should the interior of the instrument be so dirty as to require a thorough cleaning, it can be washed according to the wash procedure below.

### Instrument Washing

#### CAUTION

*DO NOT wash the BAUD switch assembly or the POWER switch. The BAUD switch assembly can be removed before washing (see Component Removal and Replacement), but the POWER switch must be covered.*

*When washing near unsealed electromechanical components, such as push-button and slide switches, use as little washing action as possible. This is to prevent washing the lubricant out of the switches and getting an excess of detergent into the contact areas of the switches.*

*DO NOT use fluoro-carbon base spray cleaners or silicone spray lubricants on switches or switch contacts. These sprays may damage the circuit board material or plastic parts and leave a dust collecting residue. If necessary, New Improved NO NOISE may be used as a lubricant.*

1. Remove the bottom cover.
2. Remove the power supply (cover the POWER switch).
3. Remove the processor board and control board without unsoldering any cables.
4. Remove the BAUD switch board assembly (do not wash).
5. Remove the display board.
6. Remove easily accessible shields and covers.
7. Spray wash components with a 5% solution of mild detergent and water (Kelite, or equivalent, is a usable mild detergent).

#### NOTE

*When performing the next three steps, take extra care to perform them on the connectors between the display board and control board. Any detergent residue left on these connectors could cause the instrument to malfunction.*

8. Thoroughly rinse components with clean water.
9. Blow-dry components with low-velocity air.
10. Spray all switch contact areas and connectors with isopropyl alcohol, wait 60 seconds, then blow dry with low-velocity air.
11. Heat dry components in an oven or compartment using circulating air at  $+51.7^{\circ}$  to  $+65.6^{\circ}$  C ( $+125^{\circ}$  to  $+150^{\circ}$  F).
12. If necessary, slide switch detent springs may be lubricated with silicone grease. Also, the contact areas of the slide switches and push-button switches can be lubricated with New Improved NO NOISE.

#### WARNING

*Silicone grease can cause eye irritation; therefore, handle it with care and avoid getting in the eyes. Wash hands thoroughly after use.*

#### INSPECTION

Inspect the instrument for broken connections, frayed wires, poorly seated components, leaking capacitors, damaged hardware and heat-damaged components.

Repair any obvious problems. However, take particular care if you find any heat-damaged parts. Overheating usually indicates other circuit problems. To prevent a recurrence of the damage, find and correct the cause of the overheating (see the Troubleshooting subsection).



# TROUBLESHOOTING

## TROUBLESHOOTING EQUIPMENT

The following equipment, or equivalent, is recommended for troubleshooting the instrument:

1. Self Test Adapter (Tektronix Part 067-0878-00; this part is also used for calibration).
2. Tektronix 851 Digital Tester.
3. RS-232 Cable Assembly (provided with the 832 as a standard accessory).
4. Interface Breakout Panel jumpers (provided with the 832 as standard accessories).

## TROUBLESHOOTING AIDS

### Diagrams

Complete circuit and wiring diagrams are contained in the Diagrams and Circuit Board Illustrations section at the rear of the manual.

### Circuit Board Illustrations

Each circuit board identified on a circuit diagram has an associated circuit board illustration. The illustration may be located on the back of the facing foldout page or on the back of an earlier foldout page. Each component shown on the circuit diagram is identified on the circuit board illustration by its circuit number. Circuit numbers on the circuit board illustration are located with an associated grid index chart.

### Self Test Routines

The instrument contains an automatic power-up self test routine and eight selectable self test routines, which can be used for operational testing or troubleshooting of the instrument.

The displays and procedures for executing the power-up routine and self test routines are contained in the Self Test Routines subsection. These routines are used with the procedures and charts for troubleshooting and repairing the instrument.

### Troubleshooting Charts

Extensive troubleshooting charts are contained in the Troubleshooting Procedures and Charts subsection.

## Circuit Board Locator

The location and assembly number identification for all circuit boards are shown in Figure 6-2. This figure is also repeated near each circuit diagram for reference.

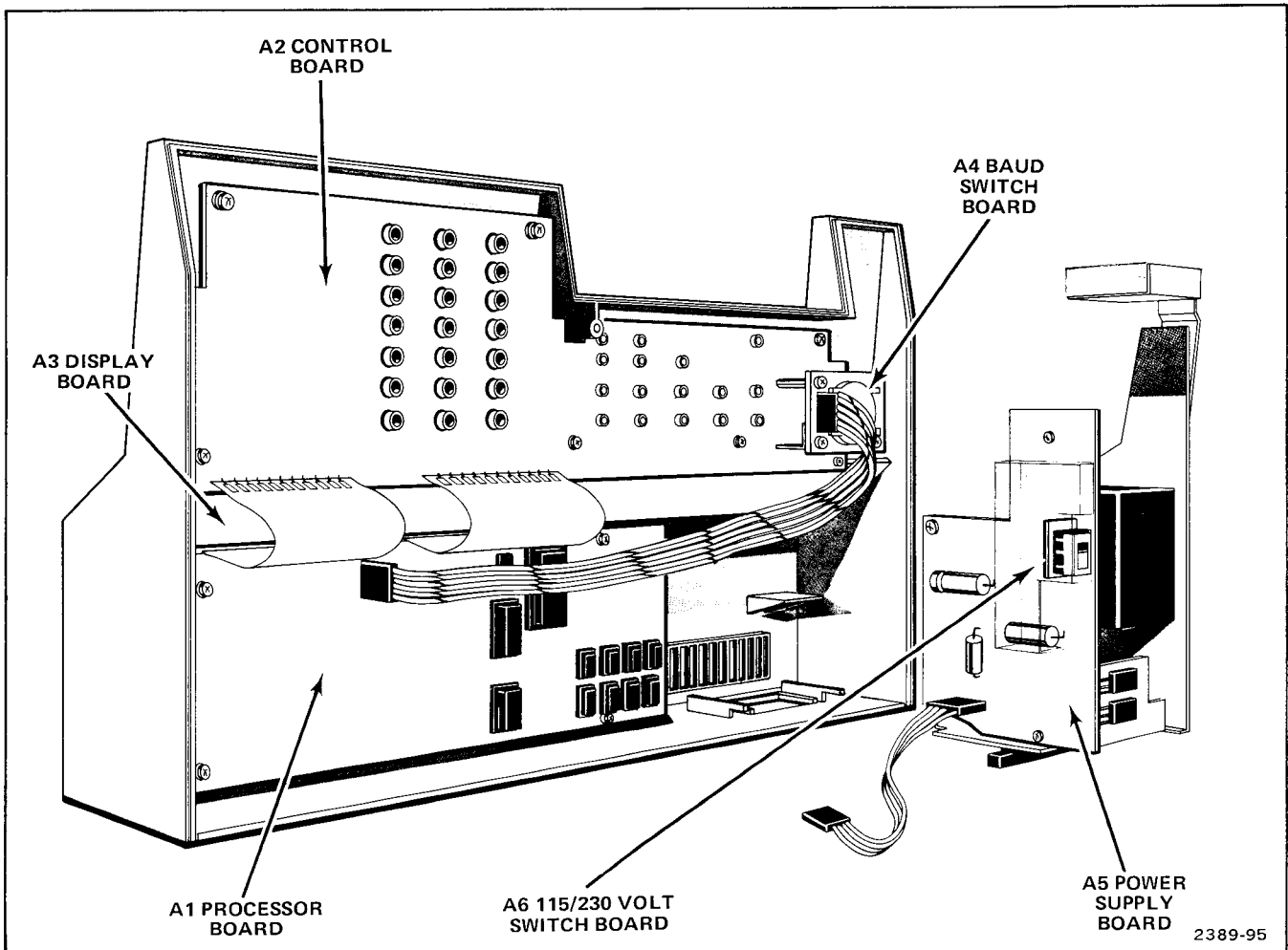


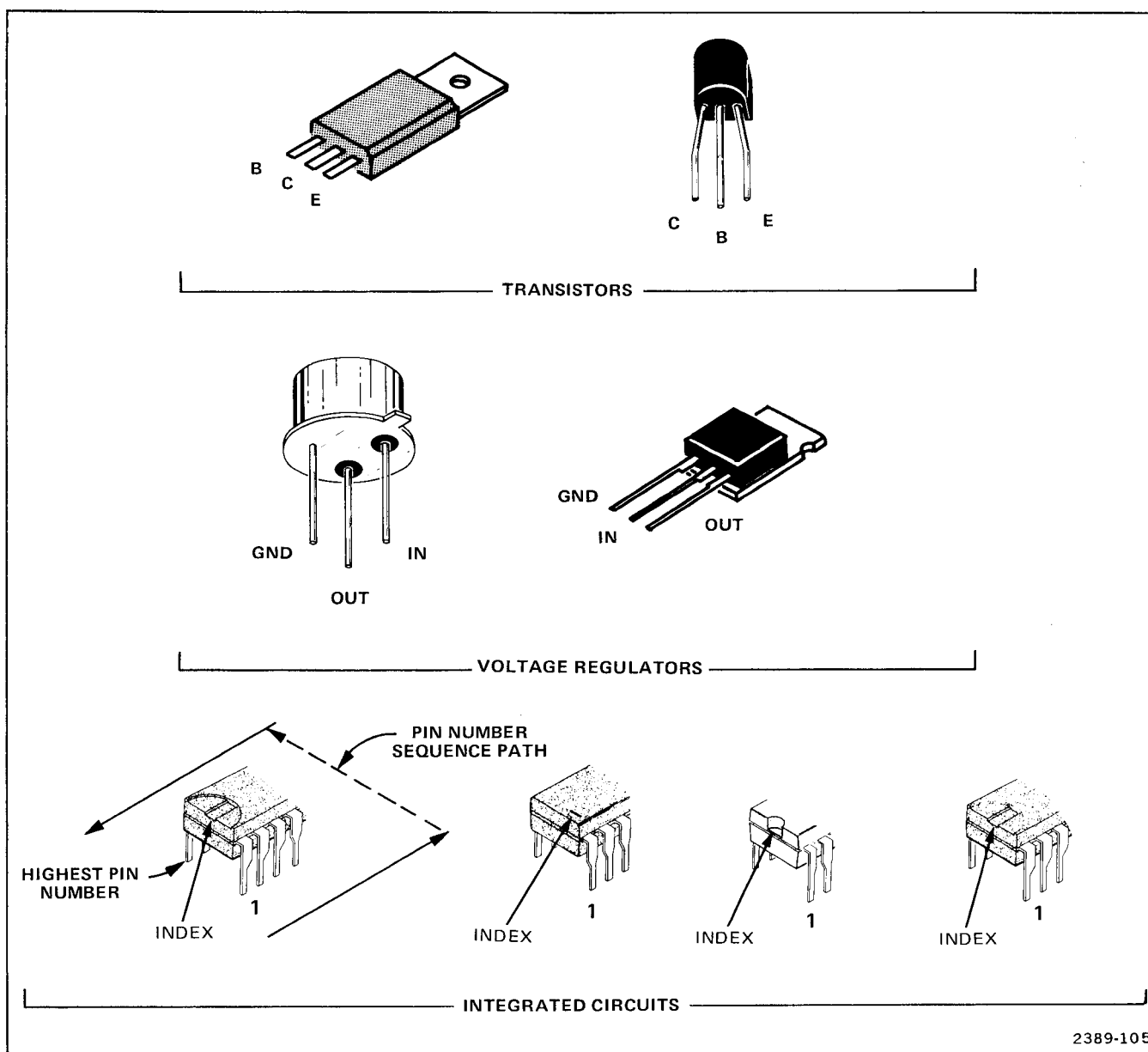
Figure 6-2. Circuit board locator.

## Semiconductor and Integrated Circuit Lead Configurations

Typical semiconductor and integrated circuit lead configurations shown in Figure 6-3.

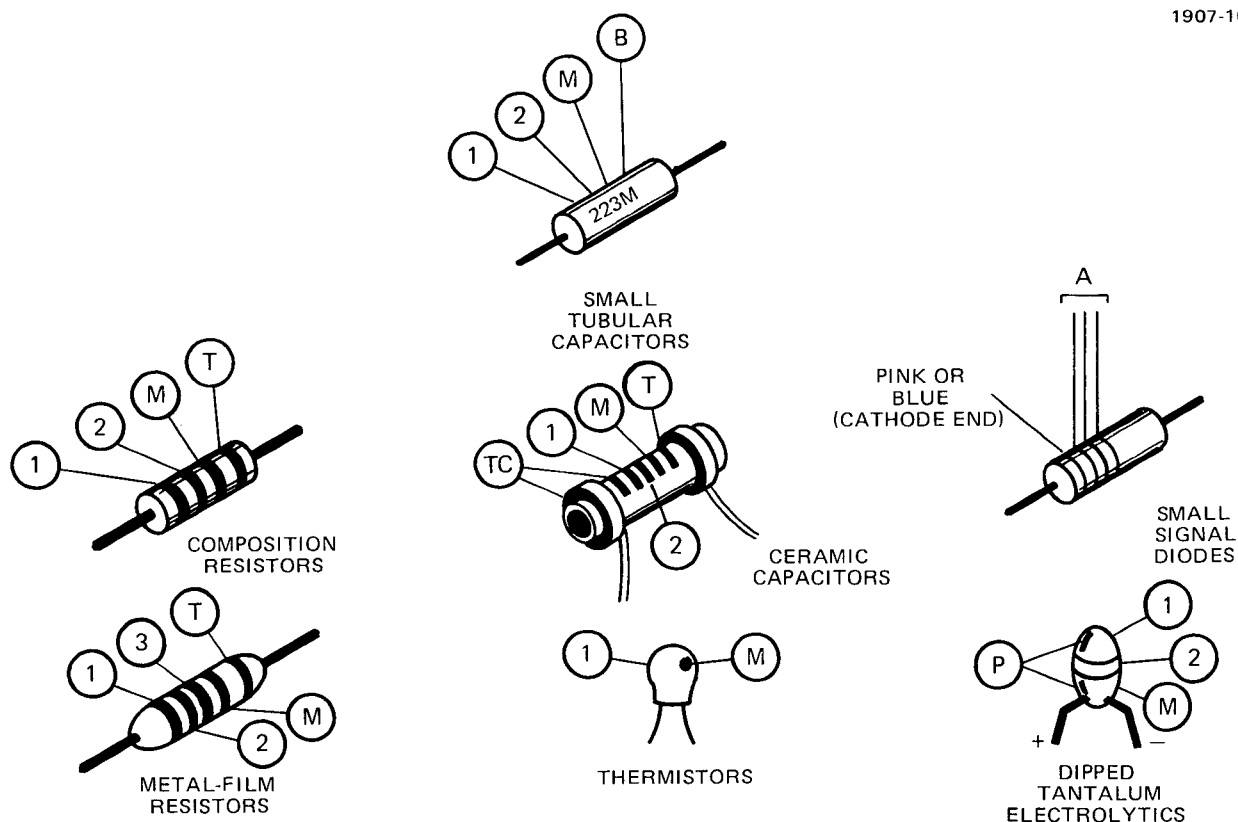
## Component Value Identification

Values of most of the capacitors, diodes and resistors used in this instrument are identified by direct numerical values or by a color code scheme. Figure 6-4 shows the color code and numerical value schemes used.



2389-105

Figure 6-3. Semiconductor and integrated circuit lead configurations.



- (A) COLORS IDENTIFY SIGNIFICANT DIGITS IN TEKTRONIX PART NUMBER (E.G. BROWN, GRAY, GREEN STRIPES INDICATE PART NUMBER 152-0185-00)
- (B) TOLERANCE; F=±1%, J=5%, K=10%, M=20%
- (1) (2) and (3) 1ST, 2ND, AND 3RD SIGNIFICANT FIGS.
- (T) AND/OR (TC) COLOR CODE MAY NOT BE PRESENT ON SOME CAPACITORS;
- (M) MULTIPLIER (T) TOLERANCE;
- (P) POLARITY AND VOLTAGE RATING
- (TC) TEMPERATURE COEFFICIENT.

| COLOR  | SIGNIFICANT FIGURES | RESISTORS (Ω)            |           | CAPACITORS (pF)              |            |             | DIPPED TANTALUM VOLTAGE RATING |
|--------|---------------------|--------------------------|-----------|------------------------------|------------|-------------|--------------------------------|
|        |                     | MULTIPLIER               | TOLERANCE | MULTIPLIER                   | TOLERANCE  |             |                                |
|        |                     |                          |           |                              | over 10 pF | under 10 pF |                                |
| BLACK  | 0                   | 1                        | ----      | 1                            | ±20%       | ±2 pF       | 4 VDC                          |
| BROWN  | 1                   | 10                       | ±1%       | 10                           | ±1%        | ±0.1 pF     | 6 VDC                          |
| RED    | 2                   | 10 <sup>2</sup> or 100   | ±2%       | 10 <sup>2</sup> or 100       | ±2%        | ----        | 10 VDC                         |
| ORANGE | 3                   | 10 <sup>3</sup> or 1 K   | ±3%       | 10 <sup>3</sup> or 1000      | ±3%        | ----        | 15 VDC                         |
| YELLOW | 4                   | 10 <sup>4</sup> or 10 K  | ±4%       | 10 <sup>4</sup> or 10,000    | +100% –9%  | ----        | 20 VDC                         |
| GREEN  | 5                   | 10 <sup>5</sup> or 100 K | ±½%       | 10 <sup>5</sup> or 100,000   | ±5%        | ±0.5 pF     | 25 VDC                         |
| BLUE   | 6                   | 10 <sup>6</sup> or 1 M   | ±¼%       | 10 <sup>6</sup> or 1,000,000 | ----       | ----        | 35 VDC                         |
| VIOLET | 7                   | ----                     | ±1/10%    | ----                         | ----       | ----        | 50 VDC                         |
| GRAY   | 8                   | ----                     | ----      | 10 <sup>-2</sup> or 0.01     | +80% –20%  | ±0.25 pF    | ----                           |
| WHITE  | 9                   | ----                     | ----      | 10 <sup>-1</sup> or 0.1      | ±10%       | ±1 pF       | 3 VDC                          |
| GOLD   | —                   | 10 <sup>-1</sup> or 0.1  | ±5%       | ----                         | ----       | ----        | ----                           |
| SILVER | —                   | 10 <sup>-2</sup> or 0.01 | ±10%      | ----                         | ----       | ----        | ----                           |
| NONE   | —                   | ----                     | ±20%      | ----                         | ±10%       | ±1 pF       | ----                           |

Figure 6-4. Component value identification.

## SELF TEST ROUTINES

This subsection is divided into two parts. The first part tells how to select each self test routine and its normal and failure displays and the second part contains a description of each routine.

### NOTE

*For those technicians already familiar with the Self Test Routines, Table 6-2 may be used as a quick reference guide for using the routines.*

*TABLE 6-2 STARTS ON NEXT PAGE*

*TEXT CONTINUES ON PAGE 6-17*

TABLE 6-2  
Self Test Routine Summary

| Routine Number | How to Select          | Type of Test                                                                | Normal Display                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Error Display                                                                                                                                                                                                                                                          | Remarks                                                                                                                         |
|----------------|------------------------|-----------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|
| Power Up       | Turn on Power          | 1. RAM March Test<br>2. RAM Bit Independence Check<br>3. ROM Check Sum Test | 8.8.8.8.8. in LOCATION and CONTENT, all other LED's on, except PROBE.                                                                                                                                                                                                                                                                                                                                                                                                                                            | 0-7 (RAM BIT), A (ROM's Swapped), B (Bus Buffer), or E-F (ROM).                                                                                                                                                                                                        |                                                                                                                                 |
| 0              | F + MODE;<br>0 + START | 1. RAM WALK Test and RAM SOAK Test                                          | 1. 0 in left digit of LOCATION for about one minute. Countdown F-0 twice in far right digit of LOCATION at about one count per second (32 seconds total).                                                                                                                                                                                                                                                                                                                                                        | 1. 0-7 (RAM BIT) in right digit of CONTENT.                                                                                                                                                                                                                            | 1. Connect jumpers from probe to pin 8 and from pin 2 to pin 3 on DCE side of Breakout Panel.<br>2. Select SYNC and 9.6 K BAUD. |
|                |                        | 2. USART Check                                                              | 2. Countup 00-FF twice in CONTENT.                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 2. Count stops at 00-FF in CONTENT and<br>a. Right LOCATION decimal point off—USART A (U1332) probably bad, or<br>b. Decimal point in right LOCATION digit—USART B (U1325) probably bad, or<br>c. 0 in left LOCATION digit—USART A (U1332) bad or no clock at USART A. |                                                                                                                                 |
|                |                        | 3. Display Loop Check                                                       | 3. Looping display sequence of:<br>a. 8.8.8.8. in LOCATION and CONTENT. All other LED's on, except PROBE.<br>b. Left to right sequence of 0 in LOCATION and CONTENT; followed in turn by 1, 2, 4 and 8.<br>c. Buffer LED's light from bottom to top.<br>d. Left to right sequence of a decimal point in LOCATION and CONTENT.<br>e. Mode LED's light from top to bottom.<br>f. Top row of LED's light from left to right starting at PARITY.<br>g. Bottom row of LED's light from right to left ending at FRAME. | 3. Incorrect sequence, missing display characters, or LED's not lighting.                                                                                                                                                                                              |                                                                                                                                 |

TABLE 6-2 (cont)

| Routine Number | How to Select          | Type of Test       | Normal Display                                                           |               |               |             |               |                     |                   |     | Error Display | Remarks          |                                                     |
|----------------|------------------------|--------------------|--------------------------------------------------------------------------|---------------|---------------|-------------|---------------|---------------------|-------------------|-----|---------------|------------------|-----------------------------------------------------|
| 1              | F + MODE,<br>1 + START | Slide Switch Check | SWITCH POSITIONS                                                         | SWITCHES      |               |             |               |                     |                   |     |               | 009 in LOCATION. | Start check with all slide switches in UP position. |
|                |                        |                    |                                                                          | M E M C O N T | D I S P L A Y | P A R I T Y | H D X / F D X | A S Y N C / S Y N C | LOCATION DISPLAYS |     |               |                  |                                                     |
|                |                        |                    |                                                                          | X             | X             | X           | X             | X                   | X                 | 000 |               |                  |                                                     |
|                |                        |                    |                                                                          |               |               |             |               |                     |                   |     |               |                  |                                                     |
|                |                        |                    |                                                                          | X             |               | X           | X             | X                   | X                 | 001 |               |                  |                                                     |
|                |                        |                    |                                                                          |               |               |             |               |                     |                   |     |               |                  |                                                     |
|                |                        |                    |                                                                          |               | X             | X           | X             | X                   | X                 | 002 |               |                  |                                                     |
|                |                        |                    |                                                                          |               |               |             |               |                     |                   |     |               |                  |                                                     |
|                |                        |                    |                                                                          | X             |               | X           | X             | X                   | X                 | 003 |               |                  |                                                     |
|                |                        |                    |                                                                          |               |               |             |               |                     |                   |     |               |                  |                                                     |
|                |                        |                    |                                                                          |               | X             |             | X             | X                   | 004               |     |               |                  |                                                     |
|                |                        |                    | X                                                                        | X             |               |             |               |                     |                   |     |               |                  |                                                     |
|                |                        |                    |                                                                          |               |               | X           | X             | X                   | 005               |     |               |                  |                                                     |
|                |                        |                    | X                                                                        | X             |               |             |               |                     |                   |     |               |                  |                                                     |
|                |                        |                    |                                                                          |               |               |             | X             | X                   | 006               |     |               |                  |                                                     |
|                |                        |                    | X                                                                        | X             | X             |             |               |                     |                   |     |               |                  |                                                     |
|                |                        |                    |                                                                          |               |               |             |               | X                   | 007               |     |               |                  |                                                     |
|                |                        |                    |                                                                          |               |               |             | X             |                     |                   |     |               |                  |                                                     |
|                |                        |                    | X                                                                        | X             | X             |             |               |                     | 008               |     |               |                  |                                                     |
|                |                        |                    |                                                                          |               |               |             |               |                     |                   |     |               |                  |                                                     |
|                |                        |                    | X                                                                        | X             | X             | X           | X             | X                   | 009               |     |               |                  |                                                     |
|                |                        |                    | SWITCH MALFUNCTION, OR ANY SWITCH POSITION COMBINATIONS NOT SHOWN ABOVE. |               |               |             |               |                     |                   |     |               |                  |                                                     |

TABLE 6-2 (cont)

| Routine Number | How to Select          | Type of Test      | Normal Display                                                                                    |                                                            |                        |                  | Error Display                  | Remarks |
|----------------|------------------------|-------------------|---------------------------------------------------------------------------------------------------|------------------------------------------------------------|------------------------|------------------|--------------------------------|---------|
| 1<br>(cont)    |                        | Push-Button Check | Push Button                                                                                       | Content Display                                            | Push Button            | Content Display  | Any display other than listed. |         |
|                |                        |                   | 0 thru F                                                                                          | 0 thru F                                                   | TRANSFER               | 16               |                                |         |
|                |                        |                   | SYNC                                                                                              | 10                                                         | CLEAR                  | 17               |                                |         |
|                |                        |                   | DELAY                                                                                             | 11                                                         | MODE                   | 18               |                                |         |
|                |                        |                   | START                                                                                             | 12                                                         | BUFFER                 | 19               |                                |         |
|                |                        |                   | BITS/CHAR                                                                                         | 14                                                         | READ >                 | 1A               |                                |         |
|                |                        |                   | ENTER                                                                                             | 15                                                         | READ <                 | 1B               |                                |         |
|                |                        |                   | NOTE: 13 is not used; therefore, there is a sequence break between the display numbers 12 and 14. |                                                            |                        |                  |                                |         |
|                |                        |                   |                                                                                                   |                                                            |                        |                  |                                |         |
|                |                        |                   |                                                                                                   |                                                            |                        |                  |                                |         |
| 2              | F + MODE,<br>2 + START | BAUD Switch Check | BAUD Switch Position                                                                              | LOCATION Display                                           | Timing Switch Position | 013 in LOCATION. |                                |         |
|                |                        |                   | 50                                                                                                | 000                                                        | SYNC                   |                  |                                |         |
|                |                        |                   | 75                                                                                                | 001                                                        |                        |                  |                                |         |
|                |                        |                   | 110                                                                                               | 002                                                        |                        |                  |                                |         |
|                |                        |                   | 134.5                                                                                             | 003                                                        |                        |                  |                                |         |
|                |                        |                   | 150                                                                                               | 004                                                        |                        |                  |                                |         |
|                |                        |                   | 200                                                                                               | 005                                                        |                        |                  |                                |         |
|                |                        |                   | 300                                                                                               | 006                                                        |                        |                  |                                |         |
|                |                        |                   | 600                                                                                               | 007                                                        |                        |                  |                                |         |
|                |                        |                   | 1.2 K                                                                                             | 008                                                        |                        |                  |                                |         |
|                |                        |                   | 1.8 K                                                                                             | 009                                                        |                        |                  |                                |         |
|                |                        |                   | 2.4 K                                                                                             | 010                                                        |                        |                  |                                |         |
|                |                        |                   | 4.8 K                                                                                             | 011                                                        |                        |                  |                                |         |
|                |                        |                   | 9.6 K                                                                                             | 012                                                        |                        |                  |                                |         |
|                |                        |                   | DTE                                                                                               | None (display is a decimal point in left CONTENT display). |                        |                  |                                |         |
|                |                        |                   | DCE                                                                                               |                                                            |                        |                  |                                |         |
|                |                        |                   | 75                                                                                                | 008                                                        | ASync                  |                  |                                |         |
|                |                        |                   | 110                                                                                               | 009                                                        |                        |                  |                                |         |
|                |                        |                   | 150                                                                                               | 010                                                        |                        |                  |                                |         |
|                |                        |                   | 300                                                                                               | 011                                                        |                        |                  |                                |         |
|                |                        |                   | 600 and above                                                                                     | 012                                                        |                        |                  |                                |         |



TABLE 6-2 (cont)

| Routine Number | How to Select                                                                                                          | Type of Test                                                                                         | Normal Display                          | Error Display                                                                                                     |                                                          | Remarks                                                                                                                                                       |
|----------------|------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|-----------------------------------------|-------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3              | F + MODE,<br>3 + MODE                                                                                                  | Interface circuit and connector check, Breakout Panel and RS-232 Cable Assembly check.               | 00.                                     | CONTENT Display                                                                                                   | Malfunction                                              | 1. Connect Self Test Adapter (STA) and RS-232 Cable Assembly between the DTE and DCE connectors.<br>2. Connect STA red lead to -12 V and gray lead to MARKER. |
|                |                                                                                                                        |                                                                                                      |                                         | 01                                                                                                                | Red lead from STA not connected to -12 on Breakout Panel |                                                                                                                                                               |
|                |                                                                                                                        |                                                                                                      |                                         | 02                                                                                                                | CTS multiplexer is stuck HIGH                            |                                                                                                                                                               |
|                |                                                                                                                        |                                                                                                      |                                         | 03                                                                                                                | CTS multiplexer is stuck LOW                             |                                                                                                                                                               |
|                |                                                                                                                        |                                                                                                      |                                         | 04                                                                                                                | RDATA multiplexer malfunction (HIGH)                     |                                                                                                                                                               |
|                |                                                                                                                        |                                                                                                      |                                         | 05                                                                                                                | RDATA multiplexer malfunction (LOW)                      |                                                                                                                                                               |
|                |                                                                                                                        |                                                                                                      |                                         | other                                                                                                             | Determined by the status word byte                       |                                                                                                                                                               |
| 4              | F + MODE,<br>4 + START                                                                                                 | Checks Auxiliary Clock Schmitt input (DTE pin 24) and clock multiplexer inputs (DCE pins 15 and 17). | Displays a 4. in LOCATION.              | Any display except 4.                                                                                             |                                                          | Requires two jumpers (see 1, 2 and 3 in How to Select column).                                                                                                |
|                |                                                                                                                        |                                                                                                      |                                         |                                                                                                                   |                                                          |                                                                                                                                                               |
|                |                                                                                                                        |                                                                                                      |                                         | 1. Both PROBE LED's are on. (They are actually toggling at such a rate that they appear to be on simultaneously). |                                                          |                                                                                                                                                               |
|                | 2a. Connect pins 8 and 24 of Breakout Panel together. Connect pin 15 of Breakout Panel to PROBE.<br>b. Set BAUD to DTE | Check Auxiliary Clock Input and DCE pin 15 multiplexer.                                              | 2. Both PROBE LED's lit as in 1. above. | LED's not lit, or only one LED lit.                                                                               |                                                          |                                                                                                                                                               |

TABLE 6-2 (cont)

| Routine Number | How to Select                                                                                                                                | Type of Test                                      | Normal Display                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Error Display                             | Remarks                                                                                     |           |        |          |   |          |     |         |   |          |         |          |   |          |         |          |   |          |         |         |   |          |           |          |    |          |          |         |    |          |              |          |    |          |     |          |    |          |     |          |            |           |     |                                                                                |                                                   |
|----------------|----------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|---------------------------------------------------------------------------------------------|-----------|--------|----------|---|----------|-----|---------|---|----------|---------|----------|---|----------|---------|----------|---|----------|---------|---------|---|----------|-----------|----------|----|----------|----------|---------|----|----------|--------------|----------|----|----------|-----|----------|----|----------|-----|----------|------------|-----------|-----|--------------------------------------------------------------------------------|---------------------------------------------------|
| 4<br>(cont)    | 3a. Connect pin 8 of Breakout Panel to pin 17 of the DCE RS-232 connector. Connect pin 17 of Breakout Panel to PROBE.<br>b. Set BAUD to DCE. | Checks DCE pin 17 multiplexer.                    | 3. Both PROBE LED's lit as in 1. above.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | LED's not lit, or only one LED lit.       |                                                                                             |           |        |          |   |          |     |         |   |          |         |          |   |          |         |          |   |          |         |         |   |          |           |          |    |          |          |         |    |          |              |          |    |          |     |          |    |          |     |          |            |           |     |                                                                                |                                                   |
| 5              | F + MODE,<br>5 + START                                                                                                                       | CPU Board Trouble-shooting.                       | Provides measurable pulse or frequency as follows:<br><table><tr><th>Test Point</th><th>REF Pulse + n Pulses</th><th>Frequency</th><th>Device</th></tr><tr><td>U1462-13</td><td>0</td><td>0.37 kHz</td><td>RAM</td></tr><tr><td>U1345-2</td><td>1</td><td>0.75 kHz</td><td>DISPLAY</td></tr><tr><td>U1332-11</td><td>3</td><td>1.51 kHz</td><td>USART A</td></tr><tr><td>U1325-11</td><td>4</td><td>1.88 kHz</td><td>USART B</td></tr><tr><td>U1345-6</td><td>5</td><td>2.26 kHz</td><td>LED Latch</td></tr><tr><td>U1345-13</td><td>11</td><td>4.52 kHz</td><td>Keyboard</td></tr><tr><td>U1218-1</td><td>12</td><td>4.91 kHz</td><td>RS-232 Input</td></tr><tr><td>U1245-20</td><td>13</td><td>5.27 kHz</td><td>ROM</td></tr><tr><td>U1232-20</td><td>14</td><td>5.66 kHz</td><td>ROM</td></tr><tr><td>U1225-20</td><td>nonvisible</td><td>139.2 kHz</td><td>ROM</td></tr></table> | Test Point                                | REF Pulse + n Pulses                                                                        | Frequency | Device | U1462-13 | 0 | 0.37 kHz | RAM | U1345-2 | 1 | 0.75 kHz | DISPLAY | U1332-11 | 3 | 1.51 kHz | USART A | U1325-11 | 4 | 1.88 kHz | USART B | U1345-6 | 5 | 2.26 kHz | LED Latch | U1345-13 | 11 | 4.52 kHz | Keyboard | U1218-1 | 12 | 4.91 kHz | RS-232 Input | U1245-20 | 13 | 5.27 kHz | ROM | U1232-20 | 14 | 5.66 kHz | ROM | U1225-20 | nonvisible | 139.2 kHz | ROM | Incorrect pulse or frequency indicates device or circuit failure listed below: | Test requires a Frequency Counter or Oscilloscope |
| Test Point     | REF Pulse + n Pulses                                                                                                                         | Frequency                                         | Device                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                           |                                                                                             |           |        |          |   |          |     |         |   |          |         |          |   |          |         |          |   |          |         |         |   |          |           |          |    |          |          |         |    |          |              |          |    |          |     |          |    |          |     |          |            |           |     |                                                                                |                                                   |
| U1462-13       | 0                                                                                                                                            | 0.37 kHz                                          | RAM                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                           |                                                                                             |           |        |          |   |          |     |         |   |          |         |          |   |          |         |          |   |          |         |         |   |          |           |          |    |          |          |         |    |          |              |          |    |          |     |          |    |          |     |          |            |           |     |                                                                                |                                                   |
| U1345-2        | 1                                                                                                                                            | 0.75 kHz                                          | DISPLAY                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                           |                                                                                             |           |        |          |   |          |     |         |   |          |         |          |   |          |         |          |   |          |         |         |   |          |           |          |    |          |          |         |    |          |              |          |    |          |     |          |    |          |     |          |            |           |     |                                                                                |                                                   |
| U1332-11       | 3                                                                                                                                            | 1.51 kHz                                          | USART A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                           |                                                                                             |           |        |          |   |          |     |         |   |          |         |          |   |          |         |          |   |          |         |         |   |          |           |          |    |          |          |         |    |          |              |          |    |          |     |          |    |          |     |          |            |           |     |                                                                                |                                                   |
| U1325-11       | 4                                                                                                                                            | 1.88 kHz                                          | USART B                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                           |                                                                                             |           |        |          |   |          |     |         |   |          |         |          |   |          |         |          |   |          |         |         |   |          |           |          |    |          |          |         |    |          |              |          |    |          |     |          |    |          |     |          |            |           |     |                                                                                |                                                   |
| U1345-6        | 5                                                                                                                                            | 2.26 kHz                                          | LED Latch                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                           |                                                                                             |           |        |          |   |          |     |         |   |          |         |          |   |          |         |          |   |          |         |         |   |          |           |          |    |          |          |         |    |          |              |          |    |          |     |          |    |          |     |          |            |           |     |                                                                                |                                                   |
| U1345-13       | 11                                                                                                                                           | 4.52 kHz                                          | Keyboard                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                           |                                                                                             |           |        |          |   |          |     |         |   |          |         |          |   |          |         |          |   |          |         |         |   |          |           |          |    |          |          |         |    |          |              |          |    |          |     |          |    |          |     |          |            |           |     |                                                                                |                                                   |
| U1218-1        | 12                                                                                                                                           | 4.91 kHz                                          | RS-232 Input                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                           |                                                                                             |           |        |          |   |          |     |         |   |          |         |          |   |          |         |          |   |          |         |         |   |          |           |          |    |          |          |         |    |          |              |          |    |          |     |          |    |          |     |          |            |           |     |                                                                                |                                                   |
| U1245-20       | 13                                                                                                                                           | 5.27 kHz                                          | ROM                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                           |                                                                                             |           |        |          |   |          |     |         |   |          |         |          |   |          |         |          |   |          |         |         |   |          |           |          |    |          |          |         |    |          |              |          |    |          |     |          |    |          |     |          |            |           |     |                                                                                |                                                   |
| U1232-20       | 14                                                                                                                                           | 5.66 kHz                                          | ROM                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                           |                                                                                             |           |        |          |   |          |     |         |   |          |         |          |   |          |         |          |   |          |         |         |   |          |           |          |    |          |          |         |    |          |              |          |    |          |     |          |    |          |     |          |            |           |     |                                                                                |                                                   |
| U1225-20       | nonvisible                                                                                                                                   | 139.2 kHz                                         | ROM                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                           |                                                                                             |           |        |          |   |          |     |         |   |          |         |          |   |          |         |          |   |          |         |         |   |          |           |          |    |          |          |         |    |          |              |          |    |          |     |          |    |          |     |          |            |           |     |                                                                                |                                                   |
| 6              | F + MODE,<br>6 + START                                                                                                                       | USART and Display Check from Self Test Routine 0. | Same as 2. and 3. in Self Test Routine 0.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Same as 2. and 3. in Self Test Routine 0. | 1. Connect jumper between pins 2 and 3 on Breakout Panel.<br>2. Select SYNC and 9.6 K BAUD. |           |        |          |   |          |     |         |   |          |         |          |   |          |         |          |   |          |         |         |   |          |           |          |    |          |          |         |    |          |              |          |    |          |     |          |    |          |     |          |            |           |     |                                                                                |                                                   |
| 7              | F + MODE,<br>7 + START                                                                                                                       | Display Check from Self Test Routine 0.           | Same as 3. in Self Test Routine 0.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Same as 3. in Self Test Routine 0.        |                                                                                             |           |        |          |   |          |     |         |   |          |         |          |   |          |         |          |   |          |         |         |   |          |           |          |    |          |          |         |    |          |              |          |    |          |     |          |    |          |     |          |            |           |     |                                                                                |                                                   |
| 8              | F + MODE,<br>8 + START                                                                                                                       | Breakout Panel and Interface Trouble-shooting.    | Display an 8. in LOCATION.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Any display except 8.                     |                                                                                             |           |        |          |   |          |     |         |   |          |         |          |   |          |         |          |   |          |         |         |   |          |           |          |    |          |          |         |    |          |              |          |    |          |     |          |    |          |     |          |            |           |     |                                                                                |                                                   |
|                | Connect Breakout Panel pin 8 (approx. 400 hertz signal) to any interface line.                                                               |                                                   | Signal can be traced throughout circuitry. Signal lights corresponding control line LED's.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                           |                                                                                             |           |        |          |   |          |     |         |   |          |         |          |   |          |         |          |   |          |         |         |   |          |           |          |    |          |          |         |    |          |              |          |    |          |     |          |    |          |     |          |            |           |     |                                                                                |                                                   |

## SELF TEST ROUTINE SELECTION AND DISPLAYS

### Power-Up Self Test Routine

**SELECTION AND NORMAL DISPLAYS.** See Initial Turn On in the Operating Instructions section.

#### NOTE

*If any push button is held down, or is shorted, on power-up, the tester defaults to Self Test Routine 1.*

**FAILURE DISPLAYS.** If a RAM or ROM fails the power-up routine, the CONTENT display identifies the failed device as shown in Table 6-3.

**TABLE 6-3**  
Failure Displays for Power-Up Self Test Routine

| CONTENT Display | Failed Device                               |
|-----------------|---------------------------------------------|
| 0               | RAM bit 0 / U1462                           |
| 1               | RAM bit 1 / U1362                           |
| 2               | RAM bit 2 / U1468                           |
| 3               | RAM bit 3 / U1376                           |
| 4               | RAM bit 4 / U1368                           |
| 5               | RAM bit 5 / U1472                           |
| 6               | RAM bit 6 / U1372                           |
| 7               | RAM bit 7 / U1476                           |
| A               | ROM's swapped (e.g., ROM E in ROM F Socket) |
| B               | Bus buffers (U1265 or U1272)                |
| E               | ROM E / U1245                               |
| F               | ROM F / U1225                               |

#### NOTE

*When performing the Self Test Routines, be sure to close all the DIP (Dual In-Line Package) switches on the Breakout Panel.*

### Self Test Routine 0 (RAM, ROM, USART and Display Check)

**SELECTION AND NORMAL DISPLAYS.** See Self Test Routine 0 in the Operating Instructions section.

#### NOTE

*The USART outputs (USART A, U1332 pins 19, 23, and 24; USART B, U1325 pins 23 and 24) toggle (change states) between each change of display.*

#### FAILURE DISPLAYS.

1. If a RAM fails, the CONTENT display identifies the failed device by the 0 through 7 displays shown in Table 6-3.
2. If a USART fails, the CONTENT display shows the byte count (in hexadecimal) at which the failure occurred. If the failure occurred during the first 00 to FF count-up, it is a synchronous timing failure; if during the second 00 to FF count-up, it is an asynchronous timing failure.

#### NOTE

*If the failure occurs during the synchronous count-up, the USART may still be transmitting an ASCII SYN character.*

3. Display failures are identified when they don't appear, or appear in the wrong sequence. The failure of a single segment in a digital display or an LED is most likely to be a display device failure; whereas, a complete digital display failure or a multiple failure of LED's would probably be the result of failure of another device (driver, decoder, latch, etc.).

### Self Test Routine 1 (Slide Switch and Push Button Check)

**SELECTION AND NORMAL DISPLAYS.** See Self Test Routine 1 in the Operating Instruction section.

#### FAILURE DISPLAYS.

1. A 009 appears in the LOCATION display if a slide switch malfunctions, or an improper sequence of switch positions is selected.
2. Push button malfunctions appear in the CONTENT display and are indicated by a wrong display, no display or an intermittent display.

### Self Test Routine 2 (BAUD Switch and Rate Generator Check)

**SELECTION AND NORMAL DISPLAYS.** See Self Test Routine 2 in the Operating Instructions section.

#### NOTE

*The frequency output of the Baud rate generator can be measured (frequency counter or oscilloscope) on pins 15 and 17 of the Breakout Panel (DCE side if the line switches are open).*

**FAILURE DISPLAY.** A 013 appears in the LOCATION display if a BAUD switch or rate generator malfunction occurs. Any number that doesn't correspond to the one listed in the table for a particular BAUD switch position is also an error.

### Self Test Routine 3 (Interface, Breakout Panel and RS-232 Cable Assembly Check)

#### SELECTION.

1. Connect the Self Test Adapter to the DTE RS-232 connector. Connect the adapter's red lead to  $-12\text{ V}$  and the gray lead to MARKER on the Breakout Panel.

#### NOTE

*Diagram 9 in the foldout section at the rear of the manual shows how the Self Test Adapter interconnects the DTE and DCE RS-232 connectors on the instrument for testing.*

2. Connect the RS-232 Cable Assembly between the Self Test Adapter and the DCE RS-232 connector.

#### NOTE

*The Self Test Adapter has the correct connection directions screened on the circuit board between the connectors. The word 'DTE' indicates that the end of the adapter should be connected to the DTE RS-232 connector and the word 'CABLE' indicates that end of the adapter should be connected to the RS-232 Cable Assembly.*

3. Select the Self Test mode (F + MODE).
4. Select and start the routine (3 + START).
5. To exit the routine, push STOP.
6. Remove the cable and adapter when finished.

**NORMAL DISPLAY.** A 00 should appear in the CONTENT display.

**FAILURE DISPLAYS.** See the five specific CONTENT displays shown in Table 6-4. For any displays other than these, go to Self Test Routine 8 and troubleshoot.

**TABLE 6-4**  
Self Test Routine 3 Failure Displays

| CONTENT Display | Failed Device                                                                          |
|-----------------|----------------------------------------------------------------------------------------|
| 01              | Red lead from Self Test Adapter not connected to $-12\text{ V}$ on the Breakout Panel. |
| 02              | CTS multiplexer is stuck HIGH.                                                         |
| 03              | CTS multiplexer is stuck LOW.                                                          |
| 04              | RDATA multiplexer malfunction (HIGH).                                                  |
| 05              | RDATA multiplexer malfunction (LOW).                                                   |

## Self Test Routine 4 (External Clock Input and Multiplexer Check)

### SELECTION.

1. Select the Self Test mode (F + MODE).
2. Select and start the routine (4 + START).

### NORMAL DISPLAYS.

1. A 4. appears in the LOCATION display when START is pushed.
2. Connect a jumper between pin 8 and the PROBE pin on the Breakout Panel. Both PROBE LED's should be on indicating the presence of a test signal (they are actually toggling at such a rate as to appear to be on simultaneously).
3. Set BAUD switch to DTE. Connect a jumper between pins 8 and 24, and between pin 15 and the PROBE pin on the Breakout Panel. Both PROBE LED's should be on as in 2. above. Remove jumpers.
4. Set BAUD switch to DCE. Connect a jumper between pin 17 (DCE side) and the PROBE pin on the Breakout Panel. Connect pin 8 (DCE side) on the Breakout Panel to pin 17 of the DCE RS-232 connector. Both PROBE LED's should be on as in 2. above. Remove jumpers.
5. Repeat step 4 above using pin 15 (DCE side) and pin 15 of DCE RS-232 connector. The same PROBE indication should occur. Remove jumpers.

### NOTE

*One method of connecting pin 8 of the Breakout Panel to pins 15 or 17 of the DCE RS-232 connector is as follows:*

*1. Open all DIP switches.*

*2. Connect the RS-232 Cable Assembly between the RS-232 connectors.*

*3. Connect the jumper from pin 8 (DCE side) of Breakout Panel to pin 14 (DTE side) of panel (this is same as pin 15 in DCE connector) or pin 16 (DTE side) of panel (this is same as pin 17 in DCE connector). For a better understanding of what this connecting procedure does, see diagram 9 at the rear of the manual.*

6. To exit the routine, push STOP.
7. Remove the cable, adapter and jumpers when finished.

**FAILURE DISPLAYS.** Any display other than indicated in NORMAL DISPLAYS above.

## Self Test Routine 5 (Processor Circuit Board Troubleshooting)

A frequency counter or oscilloscope is required to perform this routine.

1. Remove the bottom cover (see Bottom Cover under Component Removal and Replacement in the Corrective Maintenance subsection).

### WARNING

*Electric shock hazards inside the instrument may be exposed when operating the instrument with the covers removed. Be careful not to touch components in and around the power supply when the instrument is connected to a power source.*

2. Select the Self Test mode (F + MODE).
3. Select and start the routine (5 + START).
4. To exit the routine, push STOP.
5. Replace the bottom cover.

### NOTE

*This routine also can be forcibly entered by grounding TP1049 (IRQ input to U1155—see diagram 2).*

**NORMAL DISPLAYS.** A normal display consists of a measurable frequency or a waveform consisting of a reference pulse and number of identifier pulses. The frequency and number of identifier pulses, and their respective test points, are listed in Table 6-5. A sample waveform of the reference pulse and identifier pulses is shown in Figure 6-5.

**FAILURE DISPLAYS.** Any display other than a NORMAL DISPLAY.

TABLE 6-5

Identification Pulses and Frequencies for Self Test Routine 5

| Identification Pulses | Item Tested  | Test Point | Frequency <sup>1</sup> |
|-----------------------|--------------|------------|------------------------|
| 0                     | RAM          | U1462-13   | 0.37 kHz               |
| 1                     | DISPLAY      | U1345-2    | 0.75 kHz               |
| 3                     | USART A      | U1332-11   | 1.51 kHz               |
| 4                     | USART B      | U1325-11   | 1.88 kHz               |
| 5                     | LED LATCH    | U1345-6    | 2.26 kHz               |
| 11                    | KEYBOARD     | U1345-13   | 4.52 kHz               |
| 12                    | RS-232 INPUT | U1218-1    | 4.91 kHz               |
| 13                    | ROM          | U1245-20   | 5.27 kHz               |
| 14                    | ROM          | U1232-20   | 5.66 kHz               |
| 15 <sup>2</sup>       | ROM          | U1225-20   | 139.2 kHz              |

<sup>1</sup> Measurable with a frequency counter.

<sup>2</sup> Not visible with oscilloscope measurement. The self test routines will not run without this ROM being operational.

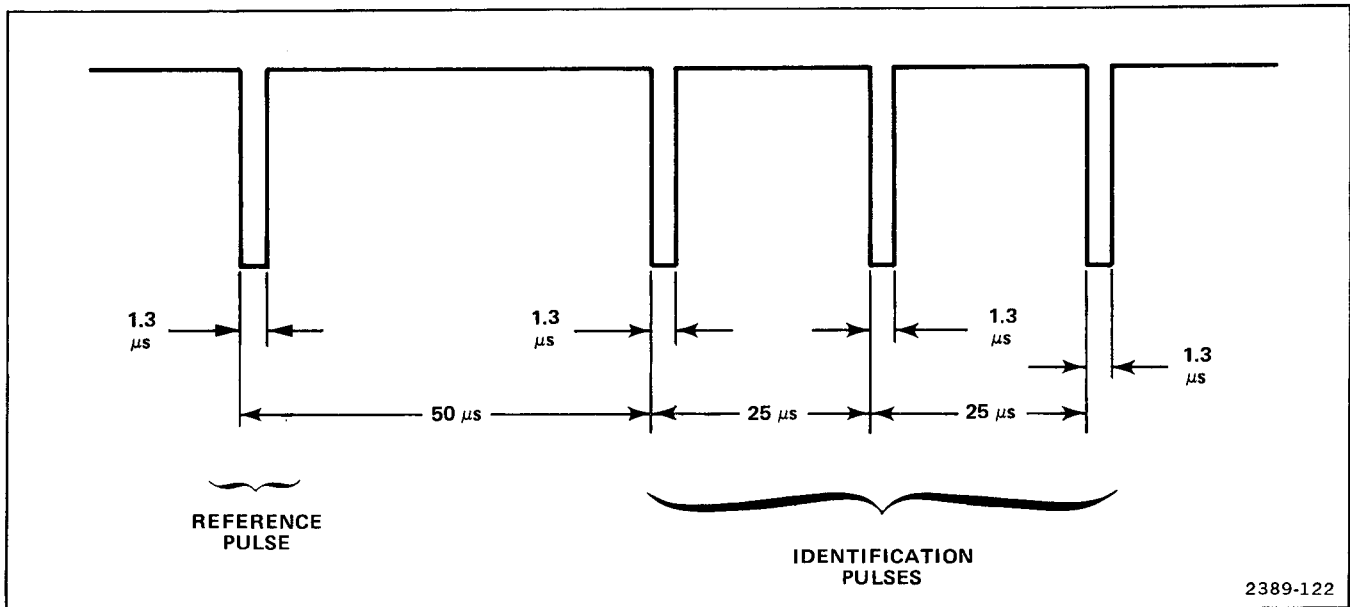


Figure 6-5. Example of reference pulse and identification pulses for Self Test Routine 5.

### Self Test Routine 6 (USART and Display Check)

This routine contains the USART and display check part of Self Test Routine 0.

#### SELECTION.

1. Connect a jumper between pins 2 and 3 (or install the Self Test Adapter on the DTE RS-232 connector), and between pin 8 and the PROBE pin on the Breakout Panel.
2. Select the Self Test mode (F + MODE).
3. Select and start the routine (6 + START).
4. To exit the routine, push STOP.

**NORMAL DISPLAYS.** See Figures 2-7 and 2-8 under Self Test Routine 0 in the Operating Instructions section.

**FAILURE DISPLAYS.** See paragraphs 2. and 3. under FAILURE DISPLAYS for Self Test Routine 0 above.



### Self Test Routine 7 (Display Check)

This routine contains the display check part of Self Test Routine 0.

#### SELECTION.

1. Connect a jumper between pin 8 and the PROBE pin on the Breakout Panel.
2. Select the Self Test mode (F + MODE).
3. Select and start the routine (7 + START).
4. To exit the routine, push STOP.

**NORMAL DISPLAYS.** See Figure 2-8 under Self Test Routine 0 in the Operating Instructions section.

**FAILURE DISPLAYS.** See paragraph 3. under FAILURE DISPLAYs for Self Test Routine 0 above.

### Self Test Routine 8 (Breakout Panel and Interface Troubleshooting)

This routine provides an approximate 400 hertz signal at pin 8 of the Breakout Panel, which can be injected at the RS-232 connectors or Breakout Panel and traced through the instrument circuitry.

#### NOTE

*When performing this routine, you may want access inside the instrument. If so, refer to paragraph 1. and its associated WARNING under Self Test Routine 5 above.*

#### SELECTION.

1. Select the Self Test mode (F + MODE).
2. Select and start the routine (8 + START).

#### NORMAL DISPLAYS.

1. An 8. appears in the LOCATION display when START is pushed.
2. Connect pin 8 to the PROBE pin on the Breakout Panel. Both PROBE LED's should be on to indicate the 400 hertz signal has successfully traversed the entire signal path.

#### NOTE

*The signal can be verified with a frequency counter or oscilloscope, if desired.*

**FAILURE DISPLAYS.** Any display other than a NORMAL DISPLAY above.

## SELF TEST ROUTINE DESCRIPTIONS

### Power-Up Diagnostic Routine

The power-up routine consists of a RAM MARCH test, a RAM bit independence check and a ROM CHECK SUM test.

In the MARCH test a background pattern of FF is written into each RAM memory cell. The cell is then addressed and its contents compared to FF; next the cell is complemented, read, and compared to 0. This process continues for each cell and ensures that each cell can be written and read as either a 1 or 0, and also checks the address decoders.

In the bit independence check, one byte of RAM is written with a background pattern of 0's, then written to and read eight times. Each time it is written to and read, a different bit is set to 1. This test checks for any bit-to-bit interaction of the bus buffers.

In the CHECK SUM test, a shift left and add with carry of all ROM bytes (except the eight byte header block) is performed. The result is tested against the correct Check Sum stored in the eighth byte of the header block.

### Self Test Routine 0

Self Test routine 0 consists of three parts—extended RAM check, USART check and looping display test. The routine executes automatically when selected.

**EXTENDED RAM CHECK.** The extended RAM check consists of two parts which are designed to test the 2102 RAM chips in their most common failure modes. Also included is a check of the RAM's chip select inputs and bus buffers.

The first part is a RAM WALK test. In this test a background pattern of 0's is written into each memory cell. Next a byte (address) is selected and complemented, then every other byte (address) is tested for its original background and finally the selected byte (address) is restored to its original background pattern. This process continues until every byte (address) has been tested. Then the background pattern is changed to 1's and the test procedure repeated. This test results in a thorough test of each RAM cell and address decoder.

The second part is a RAM SOAK test. In this test, a background pattern of 1's is written into each memory cell, held for approximately 16 seconds, then tested for the original background pattern. Next the background pattern is changed to 0's and the test repeated. This particular test checks the dynamic behavior of the RAM for a failure mode characterized by the loss of a bit state (forgets) in a RAM cell. When completed the self test continues to the USART check.

**USART CHECK.** The USART check tests the data transfer ability, receiver ready flags, clock inputs, and some of the interface circuitry of the 8251 USART devices.

In this test, an entire hexadecimal character set (00 through FF) is transferred out of the USART A Transmitter Data output (U1332) and into both USART Receiver Data inputs (USART A-U1332 and USART B-U1325). The transfer is made in both the synchronous and asynchronous modes at a rate determined by the setting of the SYNC, ASYNC and BAUD switches; SYNC and 9.6K BAUD setting are recommended. If the ASYNC setting is selected, a maximum BAUD setting of 600 is required for the synchronous part of the test to function. The asynchronous element of the test doesn't care whether SYNC or ASYNC is selected.

After the transmitting USART is initialized, it sends an ASCII SYN character to synchronize the USART receivers. The first hexadecimal character set (00) is sent to the receivers and checked to ensure it was received. If the character set was received, the next character set (01) is sent and checked. This process continues until all character sets through FF have been sent, received and verified. The entire test is then repeated in the asynchronous mode, except that no SYN character is sent. When the USART check is completed, the self test continues to the looping display check.

**LOOPING DISPLAY CHECK.** The looping display check provides the operator a visual check of all displays. However, it also provides a secondary servicing function by toggling the USART outputs (USART A/U1332 pins 19, 23, and 24 and USART B/U1325 pins 23 and 24) between each change of display.

In this test, the program writes data that sequentially turns on, then off, every LED or LED segment in the display. Between the time each display turns off and the next one turns on, the USART outputs are toggled. This test continually repeats itself until the STOP key is pushed.

### Self Test Routine 1

Self test routine 1 checks the operation of instrument push buttons and slide switches. After the routine is selected and started, it requires operator execution.

When the routine is selected and started, the push-button and slide switches are scanned and their respective selection condition displayed in the LOCATION and CONTENT displays. The display for push-button conditions occur, and remain in the CONTENT display only as long as the push button is held down. During the scan portion of the push button routine, the conditions on the RS-232 control lines also are scanned and displayed on their corresponding LED's. If there is nothing connected to the RS-232 control lines, the displays on these LED's are random.

### Self Test Routine 2

Self test routine 2 checks the operation of the BAUD switch and its associated rate generator. For this routine, the synchronous (SYNC) timing mode must be selected. After the routine is selected and started, it requires operator execution.

The routine measures the rate generator output (clock frequency) by timing the first two data bits of eleven that are shifted out of the USART A (U1332) Transmitter Data output. The timing measurement determines a number (count), which is related to the BAUD switch position, and displayed in LOCATION. During the measurement portion of the routine, the logic state of the USART A Transmitter Data output is displayed as decimal points in CONTENT.

As a secondary servicing function, the actual BAUD rate generator frequency output also appears on pins 15 and 17 of the DCE side of the Breakout Panel.

### Self Test Routine 3

Self test routine 3 is a servicing routine that performs a GO, NO-GO test of the 832 to RS-232 interface circuits and connectors, the Breakout Panel and the RS-232 Cable Assembly.

A Self Test Adapter connects the interface lines in series with each other such that a signal inserted into one pin on the Breakout Panel (pin 8) will pass in series through all of the interface circuits and connectors, the Breakout Panel and RS-232 Cable Assembly. Then the signal exits through another Breakout Panel pin (pin 25), which is connected to the MARKER input. The MARKER input is then tested and if the correct signal appears, it causes a 00 in the CONTENT display.

During part of the routine, all interface multiplexers are passively set to let the signal pass through them as if in the MONITOR mode. During another part of the routine, the interactive mode of the RDATA and CTS multiplexers (pins 3 and 5, respectively) are selected and checked as if in the modem simulator mode. As the signal passes through the circuitry its bit pattern on the control lines is checked to establish a word byte that determines the CONTENT display (00). The word byte should consist of all 1's, except bit-0, which is 0. If a malfunction occurs, one of five specific displays (01 through 05 may occur). If any other display occurs, self test routine 8 should be used for troubleshooting.

### Self Test Routine 4

Self test routine 4 is a servicing routine for checking the Schmitt input of the Auxillary Clock (DTE RS-232 pin 24) and interactive mode of the multiplexers on the clock line inputs (DCE RS-232 pins 15 and 17). This routine is service technician executed.

In this routine, a signal output is provided on pin 8 of the Breakout Panel. This signal is intended for injection into pin 24 of the Breakout Panel and detection at pin 15 of the Breakout Panel, or injection into pins 15 or 17 of the DCE RS-232 connector and detection at pins 15 or 17, respectively, of the Breakout Panel. The PROBE LED input can be used to detect this signal.

### Self Test Routine 5

Self test routine 5 is a servicing routine for troubleshooting the Processor board. It doesn't generate any front panel displays. This routine generates a pulse pattern through the address decoder (U1345), which is measurable at various devices. The pulse pattern consists of a reference pulse followed by a series of identifier pulses (may be 0 or up to 14 identifier pulses), which can be measured with a frequency counter or an oscilloscope.

### Self Test Route 6

Self test routine 6 is the USART and display check routines from self test routine 0.

### Self Test Routine 7

Self test routine 7 is the display check routine from self test routine 0.

### Self Test Routine 8

Self test routine 8 is a servicing routine for troubleshooting the Breakout Panel and Interface circuits in a passive mode, and is service technician executed. A signal of approximately 400 hertz is provided on pin 8 of the Breakout Panel, which can be used for injection into and tracing through the circuitry with the PROBE input, or an oscilloscope. Any signal placed on the RS-232 control line inputs should be reflected on the corresponding Line Status LED's.

# TROUBLESHOOTING PROCEDURE AND CHARTS

## INTRODUCTION

The 832 troubleshooting procedure uses the 851 Digital Tester as the only test instrument and the 832 self test routines as test signal generators. Many of the tests in the procedure use only the 832 and its self test capability for troubleshooting. These self tests assume that only the microprocessor and the section of ROM containing the self test routines are operational.

The troubleshooting procedure is divided into two parts. The first part troubleshoots the “kernel” of the instrument (the power supply; the microprocessor, including the clock and reset circuits; and the display). This part relies on symptoms discovered during the power-up self test routine to guide the troubleshooter to a part of the procedure for finding and correcting the malfunction.

Once the “kernel” of the instrument is operating, the second part of the troubleshooting procedure uses the selectable self test routines to completely troubleshoot the 832.

### Power Supply Troubleshooting

#### CAUTION

*The power supply may be damaged if power is applied to it without being connected to the instrument or to an external load.*

Whenever troubleshooting the power supply, it can be left connected to the instrument or removed and connected to an external load. Table 6-6 shows the external load values recommended and the required operating parameters of the power supplies. These operating parameters should be used whenever one of the troubleshooting steps calls for a power supply output to be checked.

**TABLE 6-6**  
Power Supply Operating Parameters

| Power Supply | Test Point | Recommended External Loading                                       | Output Accuracy | Ripple               |
|--------------|------------|--------------------------------------------------------------------|-----------------|----------------------|
| +5 V         | P4234-5    | 3.6 $\Omega$ , 7.0 watt minimum. This provides about a 1.4 A load. | $\pm 0.1$ V     | Less than 0.1 V p-p. |
| +12 V        | P4234-4    | 200 $\Omega$ , 1 watt minimum. This provides about a 60 mA load.   | $\pm 0.6$ V     | Less than 0.2 V p-p. |
| –12 V        | P4234-2    | 141 $\Omega$ , 2 watt minimum. This provides about an 85 mA load.  | $\pm 0.6$ V     | Less than 0.2 V p-p. |

## 851 Digital Tester Control Settings for Troubleshooting

After the 851 has been turned on and self tested, preset the controls as follows for troubleshooting the 832:

|                  |      |
|------------------|------|
| DISPLAY          | NORM |
| RANGE            | AUTO |
| SLOPE (all)      | POS  |
| INPUT FILTER     | OFF  |
| THRESHOLDS (all) | TTL  |

Other control settings and Function switch selections are included in the troubleshooting steps. All measurements are made with the CHANNEL A probe unless otherwise stated.

### TROUBLESHOOTING POWER-UP FAILURES

The power-up self test routine executes each time the instrument is turned-on. It checks the “kernel” of the instrument. To determine if the instrument was powered-up properly and the correct display is present, see Initial Turn-On in the Operating Instructions section. If the Initial Turn-On procedures were followed and the power-up display failure still exists, refer to Table 6-7 and its associated troubleshooting charts.

#### NOTE

*When a troubleshooting action calls for replacement of U1155 (the MPU), you may want to perform the Hardware Self Test listed below to better verify that the MPU is faulty.*

#### Hardware Self Test

Refer to diagram 2 at the rear of the manual for the location of the test points referenced in this procedure. This hardware self test is useful in determining if the MPU (U1155) and its address and data buses are functioning properly. To execute the test remove the service jumper P1041 and install it on P1471. This disables the address decoder U1345, which makes the MPU the only device exercising the address and data buses. The jumper creates a hardware CLR (7F7F) operational code, which clears the address lines and generates these measurable outputs from the MPU (U1155):

|    |           |     |          |
|----|-----------|-----|----------|
| A0 | 204 kHz   | A6  | 70.4 kHz |
| A1 | 136.5 kHz | A7  | 69.3 kHz |
| A2 | 102.4 kHz | A8  | 68.8 kHz |
| A3 | 85.3 kHz  | A9  | 68.5 kHz |
| A4 | 76.8 kHz  | A10 | 68.4 kHz |
| A5 | 72.5 kHz  | A11 | 68.3 kHz |

D0 through D6 136.5 kHz

#### NOTE

*Beyond address line A11, the frequency difference between the address lines becomes too small to be readily distinguishable. The most important factor of the measurements is that no two lines are the same, which would indicate a short in the MPU, or the address lines. The other factor is that the data lines are moving.*

**TABLE 6-7**  
**Power-Up Failures**

| <b>Display Indication</b>                                                                                                                       | <b>Troubleshooting Action</b>                                                                                                             |
|-------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| Digital displays blank, no LED's on or one decimal point in LOCATION with the SIMULATE and RECV LED's on.                                       | Go to Troubleshooting Chart 1 (Figure 6-6).                                                                                               |
| 0 to 7 in right digit of CONTENT display.                                                                                                       | RAM bit error; number indicates which RAM. Go to Troubleshooting Chart 5 (Figure 6-10).                                                   |
| B in right digit of CONTENT display.                                                                                                            | Bus buffer error. Indicates two lines are moving together. Check for shorts between lines at U1265, U1272.                                |
| A in right digit of CONTENT display.                                                                                                            | ROM's are swapped, check U1225 and U1232 for proper part number, in proper socket.                                                        |
| E in right digit of CONTENT display.                                                                                                            | A check-sum error in the "E" ROM (U1232). If there is an "F" ROM in the "E" ROM socket, this will be the error indication. Replace U1232. |
| F in right digit of CONTENT display.                                                                                                            | A check-sum error in the "F" ROM. Replace U1225.                                                                                          |
| All digital displays are 8's, but one or more LED's are out; digital display segments are bright or missing; or one digital display is missing. | See Table 6-8, Digital Display and LED Failures.                                                                                          |
| 000 or 009 in the LOCATION display; all slide switches are in the "up" position.                                                                | Switch malfunction. Go to Troubleshooting Chart 11 (Figure 6-16).                                                                         |
| None of the above, but there is an ambiguous or nonsense display.                                                                               | Go to Troubleshooting Chart 4 (Figure 6-9).                                                                                               |

**TABLE 6-8**  
**Digital Display and LED Failures**

| Display Indication                                                                                                                                          | Troubleshooting Action                                                                                                                                                                                                                                  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| One digital display out.                                                                                                                                    | Go to Troubleshooting Chart 6A (Figure 6-11).                                                                                                                                                                                                           |
| One bright digital display segment in each character.                                                                                                       | Replace U3145. If it is the 'f' segment, look for a short to +5 V at U3145-15.                                                                                                                                                                          |
| One or more digital display segments missing.                                                                                                               | One segment missing—replace digital display.                                                                                                                                                                                                            |
|                                                                                                                                                             | More than one, but less than 5 displays involved—check for a circuit board problem, then check displays.                                                                                                                                                |
|                                                                                                                                                             | Same segment missing on all digital displays—Go to Troubleshooting Chart 6B (Figure 6-11).                                                                                                                                                              |
| Single LED out.                                                                                                                                             | Replace LED.                                                                                                                                                                                                                                            |
| All 6 LED's on right side of display out (DTR, DSR, RTS, CTS, CD and MARKER).                                                                               | Go to Troubleshooting Chart 7 (Figure 6-12) for Bank 0.                                                                                                                                                                                                 |
| All 4 LED's in center out (NO TRIG, DTE, DCE and NO SYN) and 2 LED's left of LOCATION out (FRAME and PARITY).                                               | Go to Troubleshooting Chart 7 (Figure 6-12) for Bank 1.                                                                                                                                                                                                 |
| All LED's out.                                                                                                                                              | Go to Troubleshooting Chart 8A (Figure 6-13).                                                                                                                                                                                                           |
| LED pairs out (one from Bank 0 and one from Bank 1)<br>NO TRIG and DTR<br>DTE and DSR<br>DCE and RTS<br>NO SYN and CTS<br>FRAME and MARKER<br>PARITY and CD | If the listed points are moving replace U3180, if not, replace U3065. Check:<br>Pin 2 of U3065 and U3180<br>Pin 5 of U3065 and U3180<br>Pin 15 of U3065 and U3180<br>Pin 12 of U3065 and U3180<br>Pin 7 of U3065 and U3180<br>Pin 10 of U3065 and U3180 |
| MODE LED's out.                                                                                                                                             | Go to Troubleshooting Chart 8B (Figure 6-13).                                                                                                                                                                                                           |
| BUFFER LED's out.                                                                                                                                           | Go to Troubleshooting Chart 9A (Figure 6-14).                                                                                                                                                                                                           |
| One or more decimal points out.                                                                                                                             | Go to Troubleshooting Chart 9B (Figure 6-14).                                                                                                                                                                                                           |



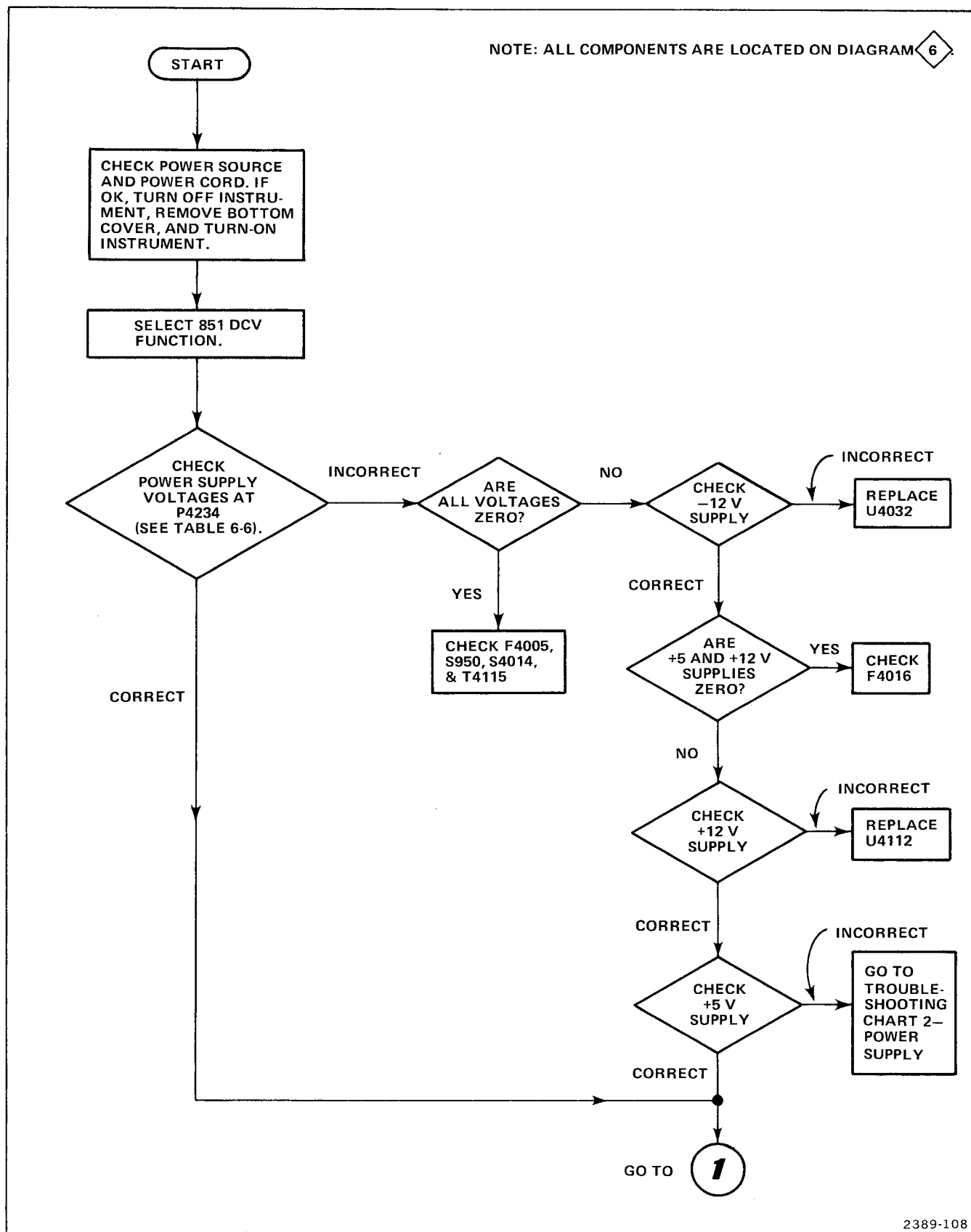


Figure 6-6. Troubleshooting Chart 1—Power-up Failure (sheet 1 of 5).

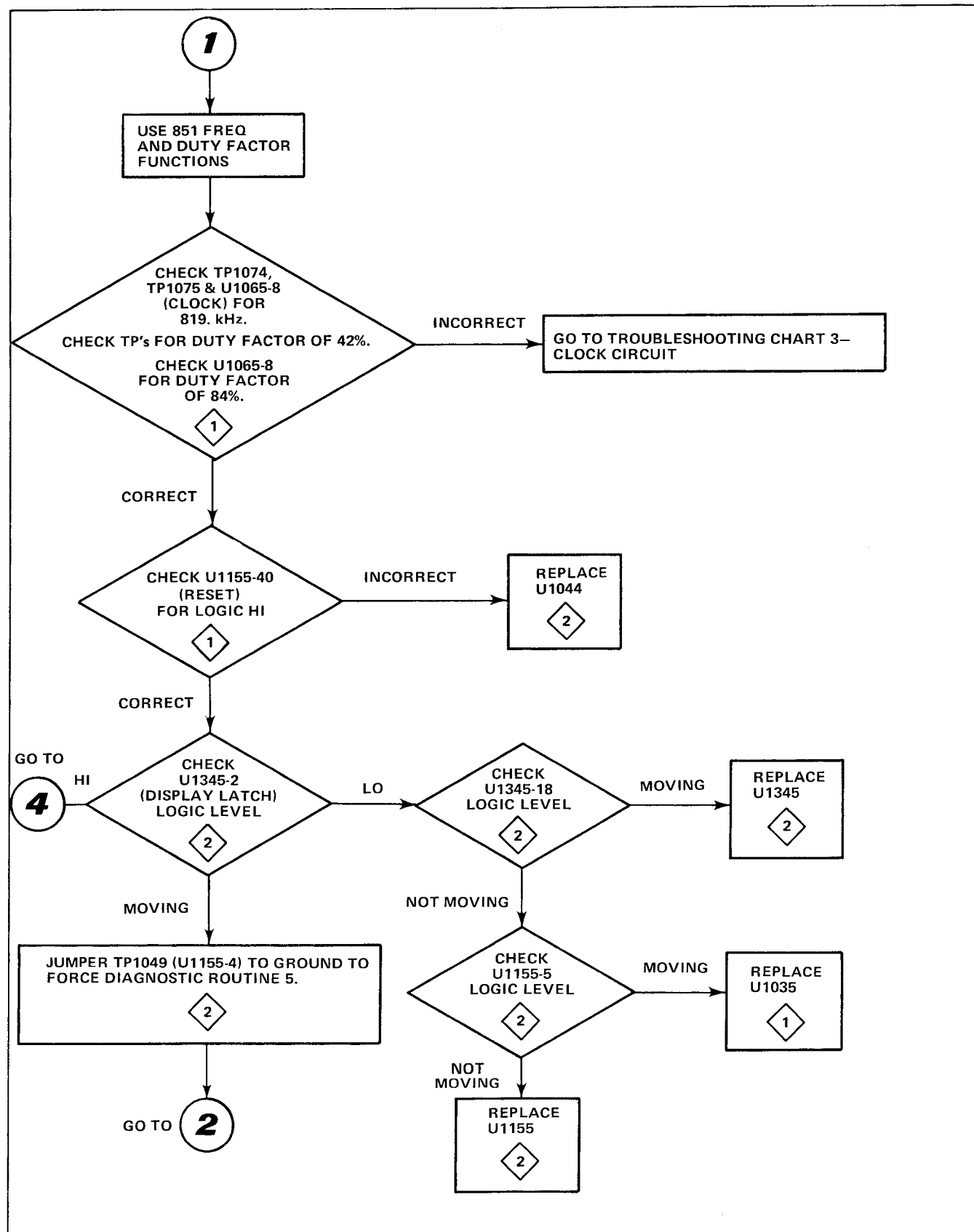


Figure 6-6. Troubleshooting Chart 1—Power-up Failure (sheet 2 of 5).

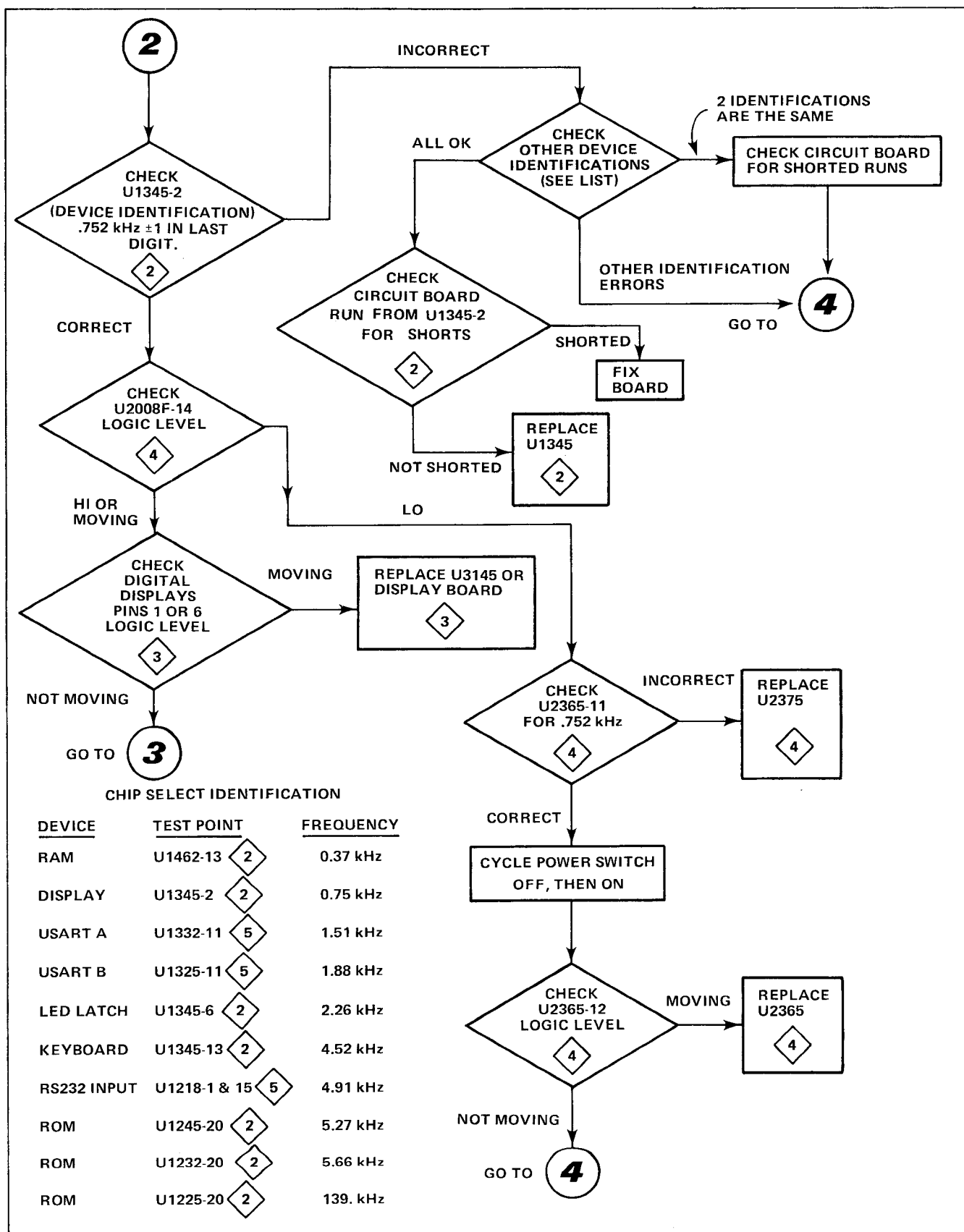


Figure 6-6. Troubleshooting Chart 1—Power-up Failure (sheet 3 of 5).

\*WHEN CHECKING LOGIC LEVELS ON THESE DEVICES, SET:  
HI THRESHOLD = 3.5 V; LO THRESHOLD = 1.5 V. BE SURE  
TO RESET TO TTL FOR OTHER DEVICES.

NOTE: ALL COMPONENTS ARE LOCATED ON DIAGRAM

4

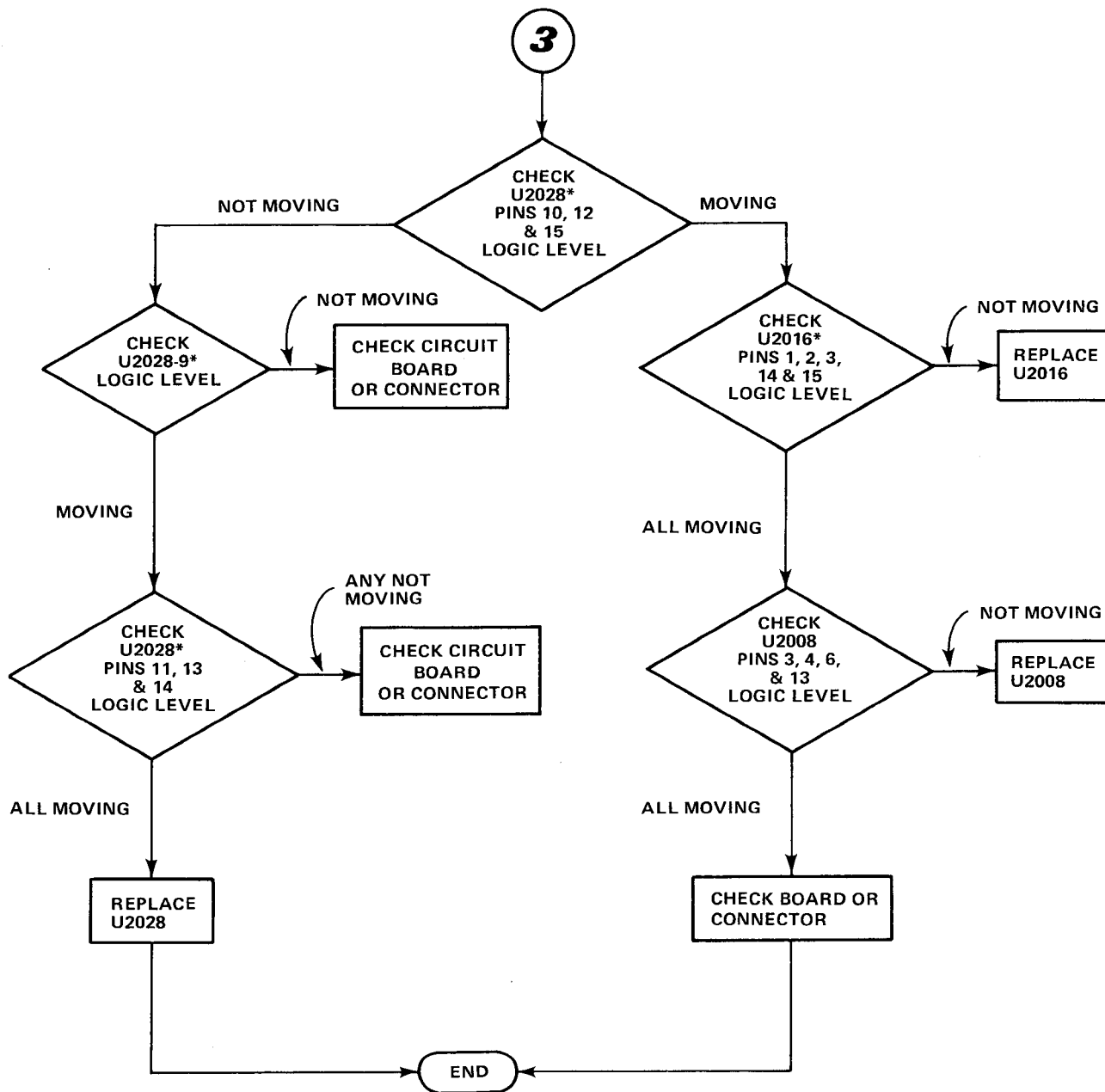


Figure 6-6. Troubleshooting Chart 1—Power-up Failure (sheet 4 of 5).

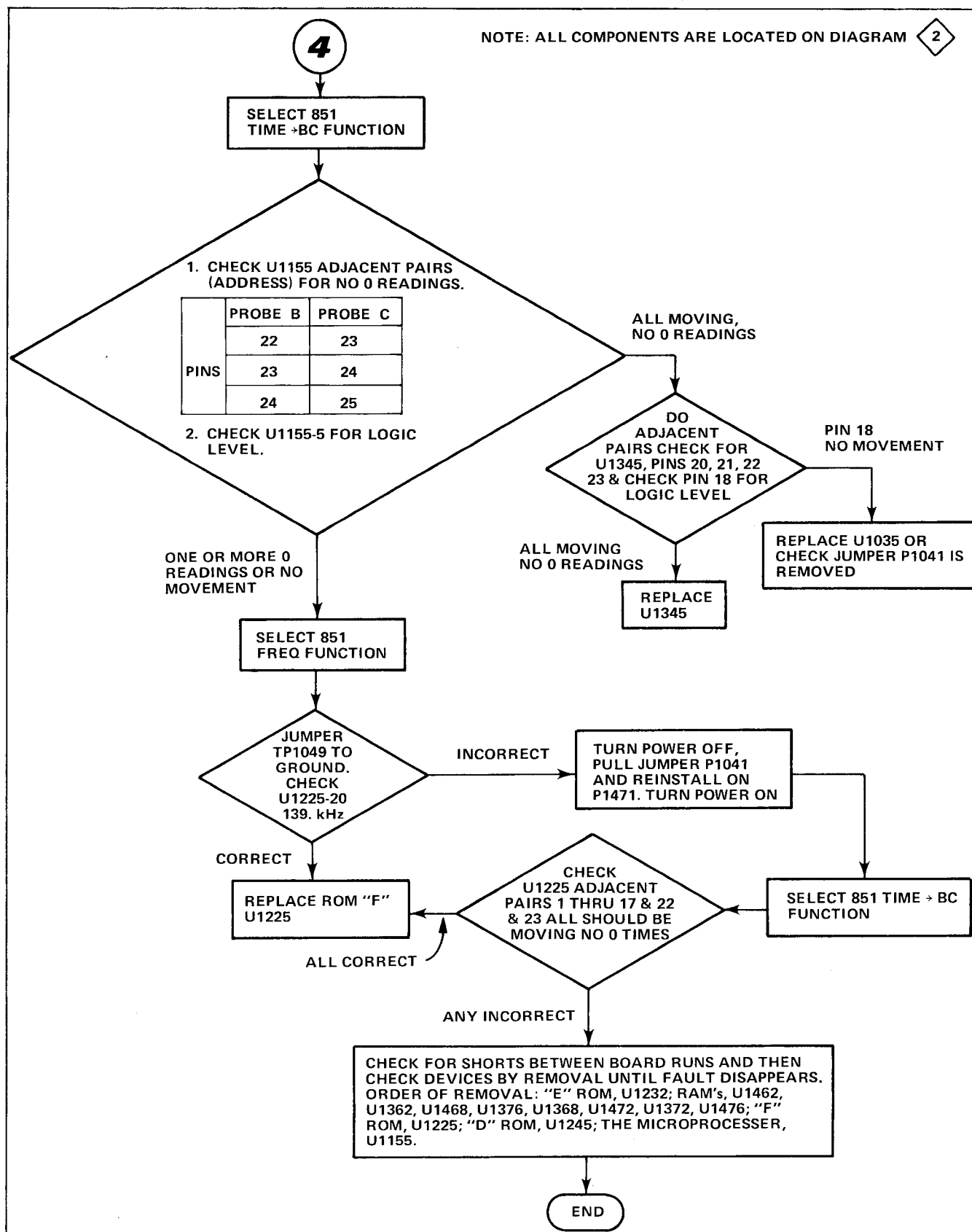
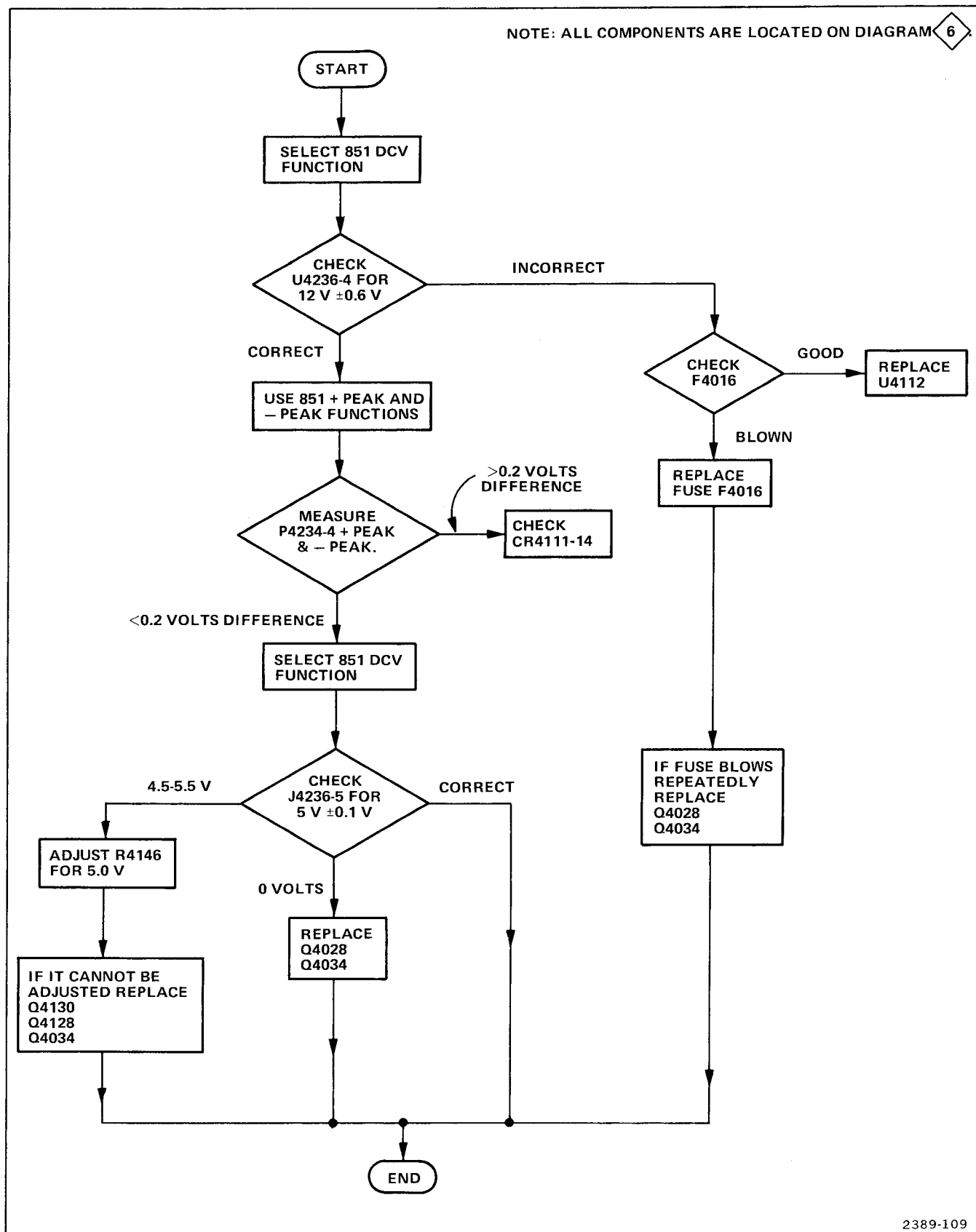


Figure 6-6. Troubleshooting Chart 1—Power-up Failure (sheet 5 of 5).

NOTE: ALL COMPONENTS ARE LOCATED ON DIAGRAM 6

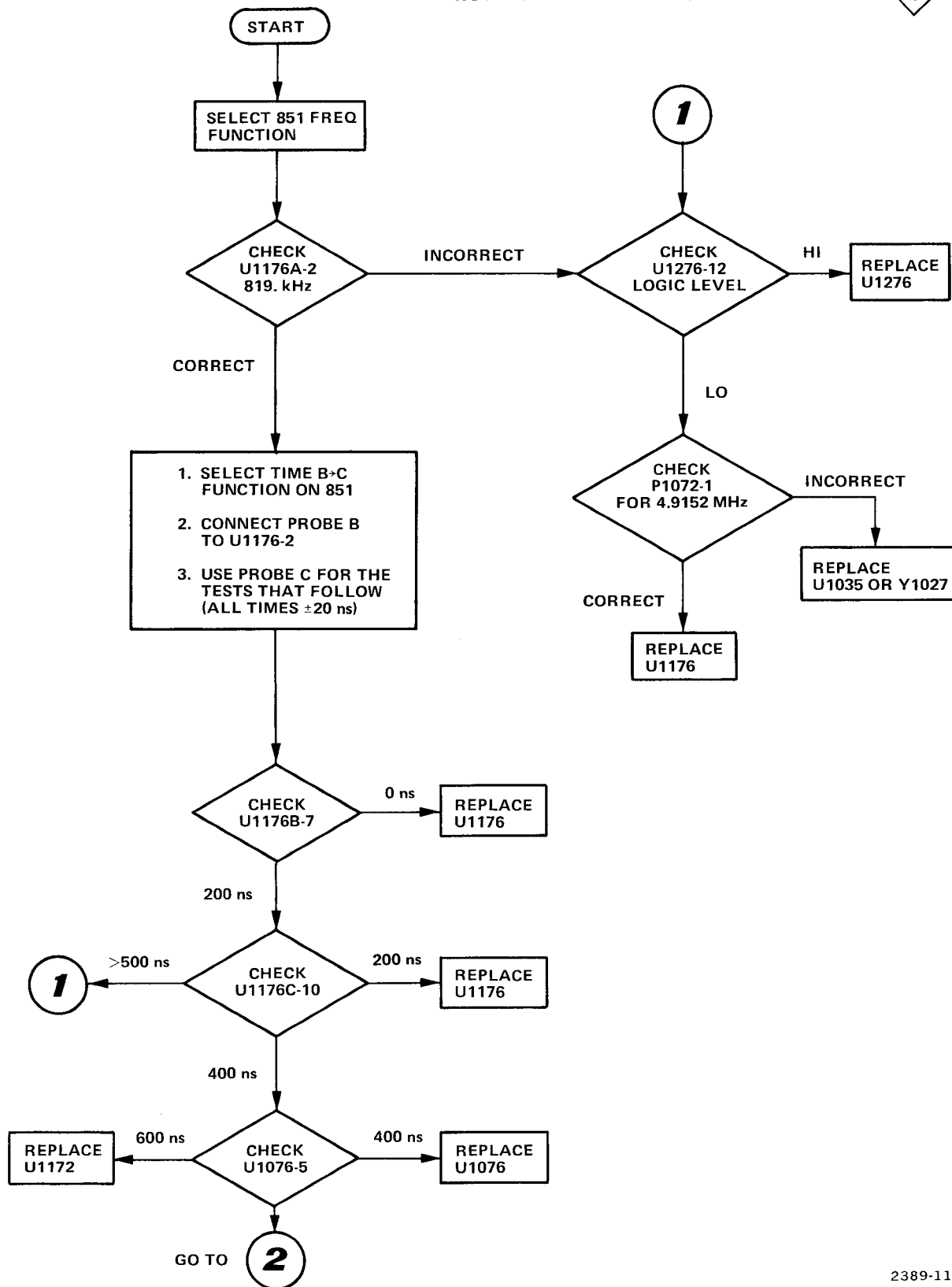


2389-109

Figure 6-7. Troubleshooting Chart 2—Power Supply.

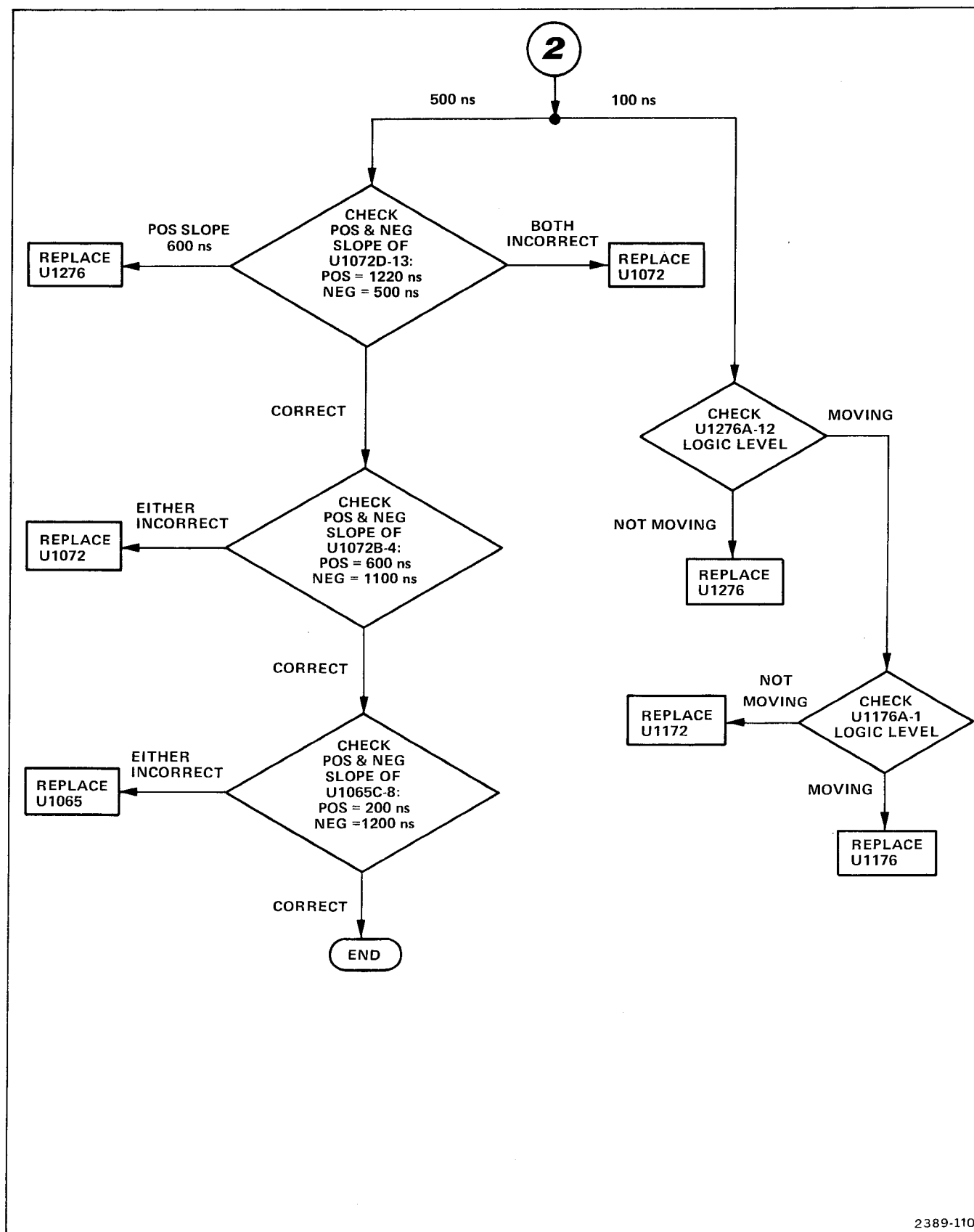
NOTE: ALL DEVICES ARE LOCATED ON DIAGRAM

1



2389-110

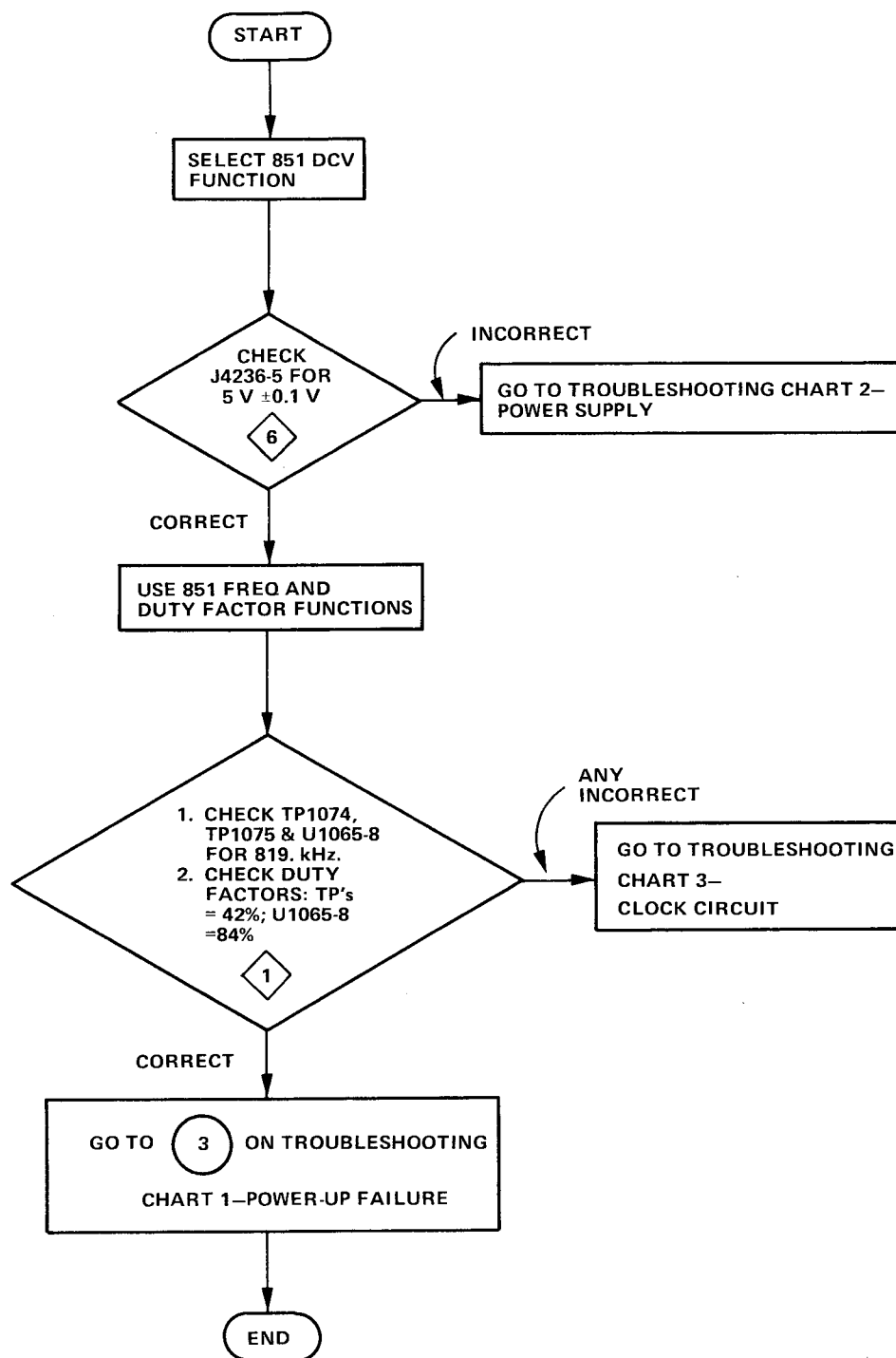
Figure 6-8. Troubleshooting Chart 3—Clock Circuit (sheet 1 of 2).



2389-110

Figure 6-8. Troubleshooting Chart 3—Clock Circuit (sheet 2 of 2).





2389-111

Figure 6-9. Troubleshooting Chart 4—Ambiguous Display.

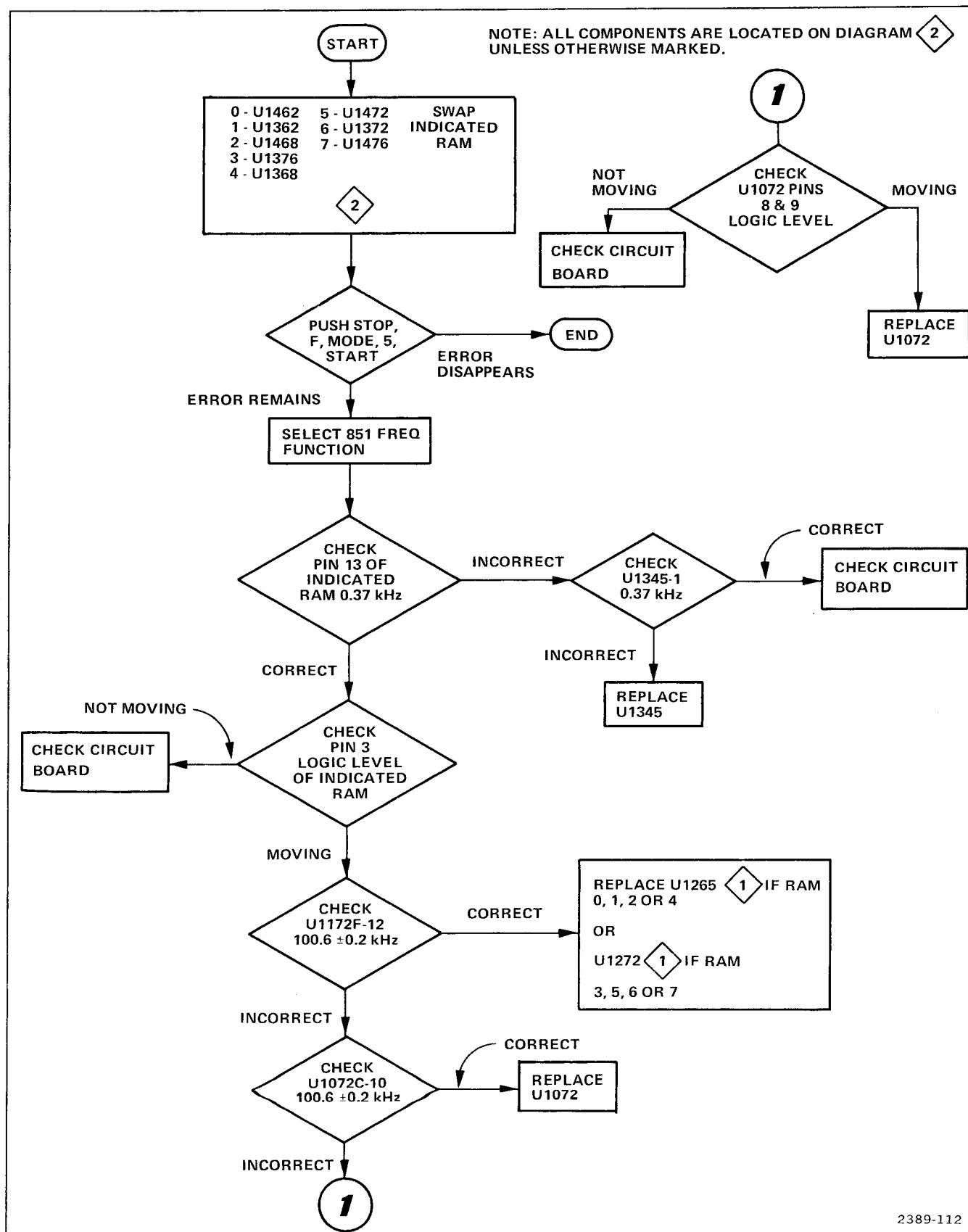


Figure 6-10. Troubleshooting Chart 5—RAM Error.

\*WHEN CHECKING THE LOGIC LEVEL ON THIS DEVICE, SET:  
HI THRESHOLD = 3.5 V; LO THRESHOLD = 1.5 V.  
BE SURE TO RESET TO TTL FOR OTHER DEVICES.

NOTE: ALL COMPONENTS ARE LOCATED ON DIAGRAM  
UNLESS OTHERWISE MARKED.

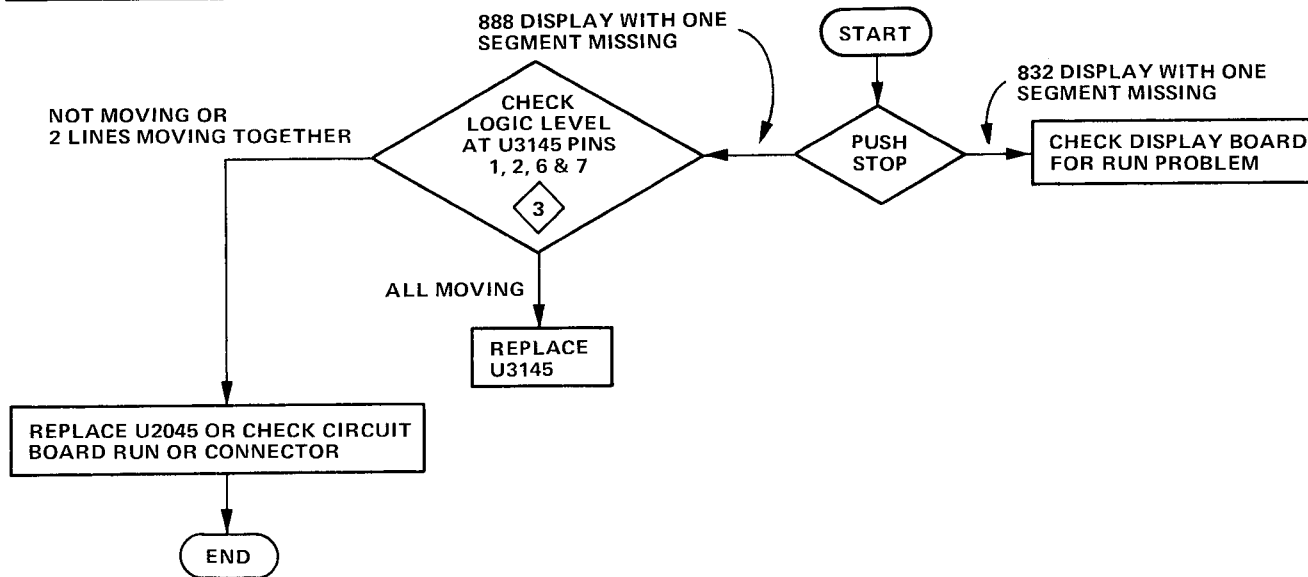
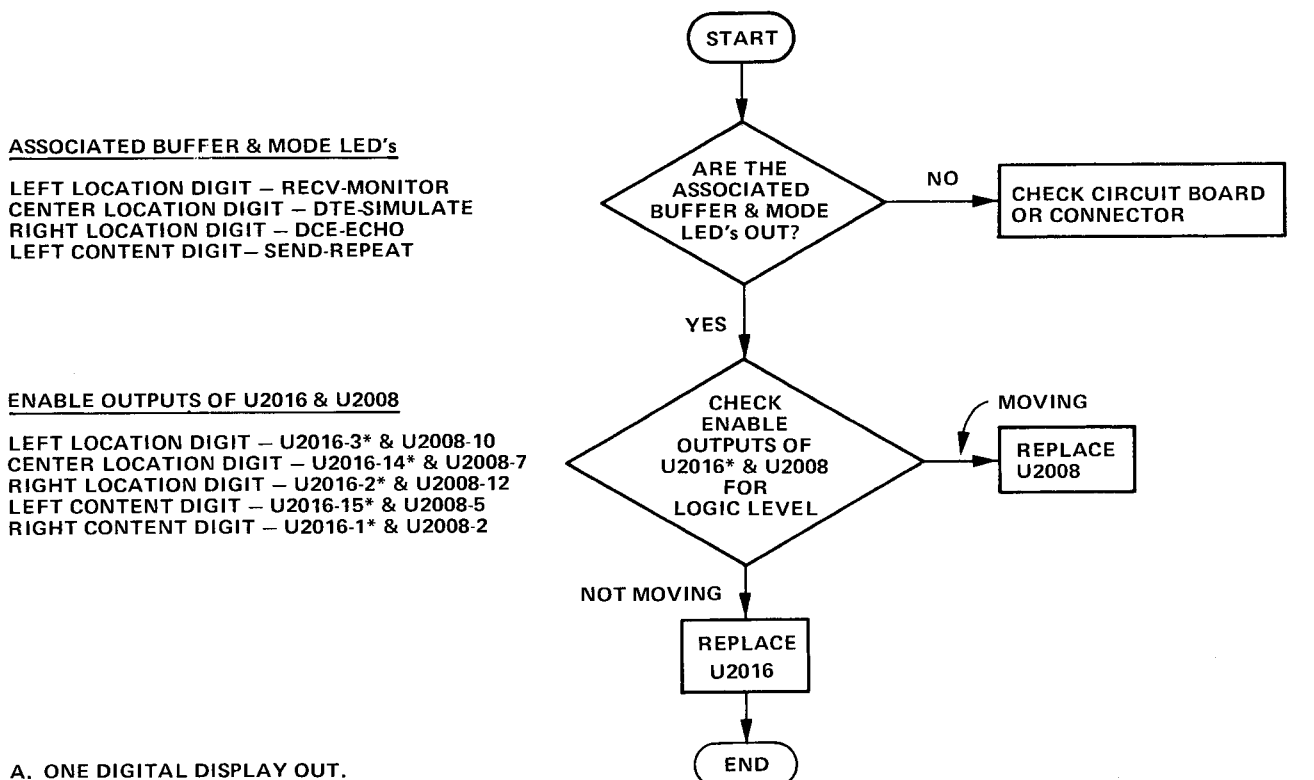
4

#### ASSOCIATED BUFFER & MODE LED's

LEFT LOCATION DIGIT — RECV-MONITOR  
CENTER LOCATION DIGIT — DTE-SIMULATE  
RIGHT LOCATION DIGIT — DCE-ECHO  
LEFT CONTENT DIGIT — SEND-REPEAT

#### ENABLE OUTPUTS OF U2016 & U2008

LEFT LOCATION DIGIT — U2016-3\* & U2008-10  
CENTER LOCATION DIGIT — U2016-14\* & U2008-7  
RIGHT LOCATION DIGIT — U2016-2\* & U2008-12  
LEFT CONTENT DIGIT — U2016-15\* & U2008-5  
RIGHT CONTENT DIGIT — U2016-1\* & U2008-2



2389-113

Figure 6-11. Troubleshooting Chart 6—Digital Display Failures.

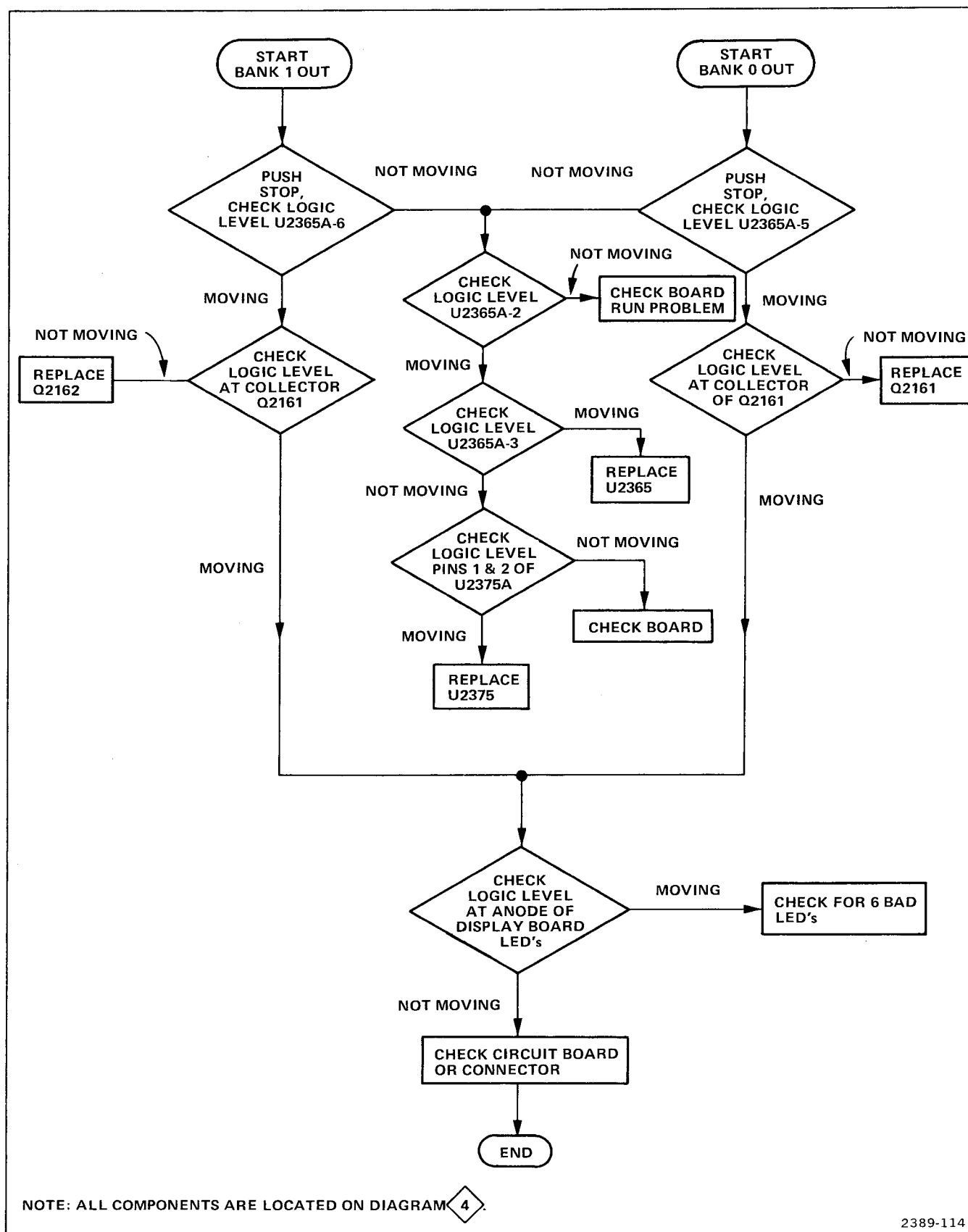
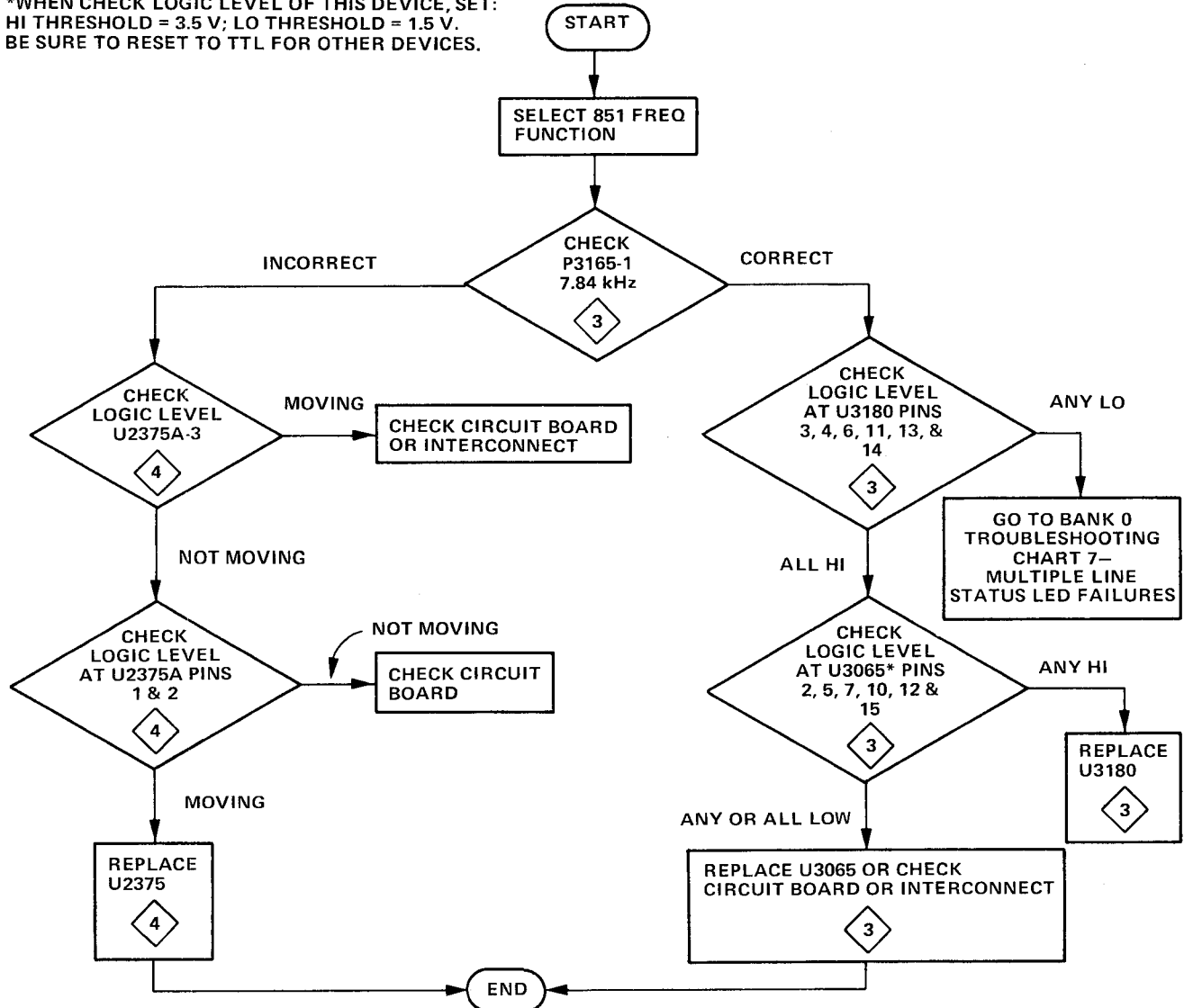


Figure 6-12. Troubleshooting Chart 7—Multiple Line Status LED Failures.

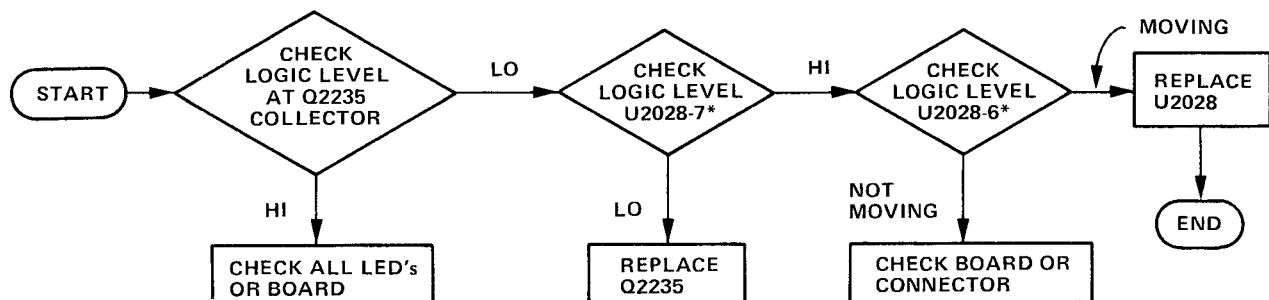
\*WHEN CHECK LOGIC LEVEL OF THIS DEVICE, SET:  
HI THRESHOLD = 3.5 V; LO THRESHOLD = 1.5 V.  
BE SURE TO RESET TO TTL FOR OTHER DEVICES.



#### A. COMPLETE LINE STATUS LED FAILURE.

\*(SEE COMMENT IN A ABOVE)

NOTE: ALL DEVICES ARE LOCATED ON DIAGRAM



#### B. MODE LED FAILURES.

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Figure 6-13. Troubleshooting Chart 8—Line Status LED's or MODE LED Failures.

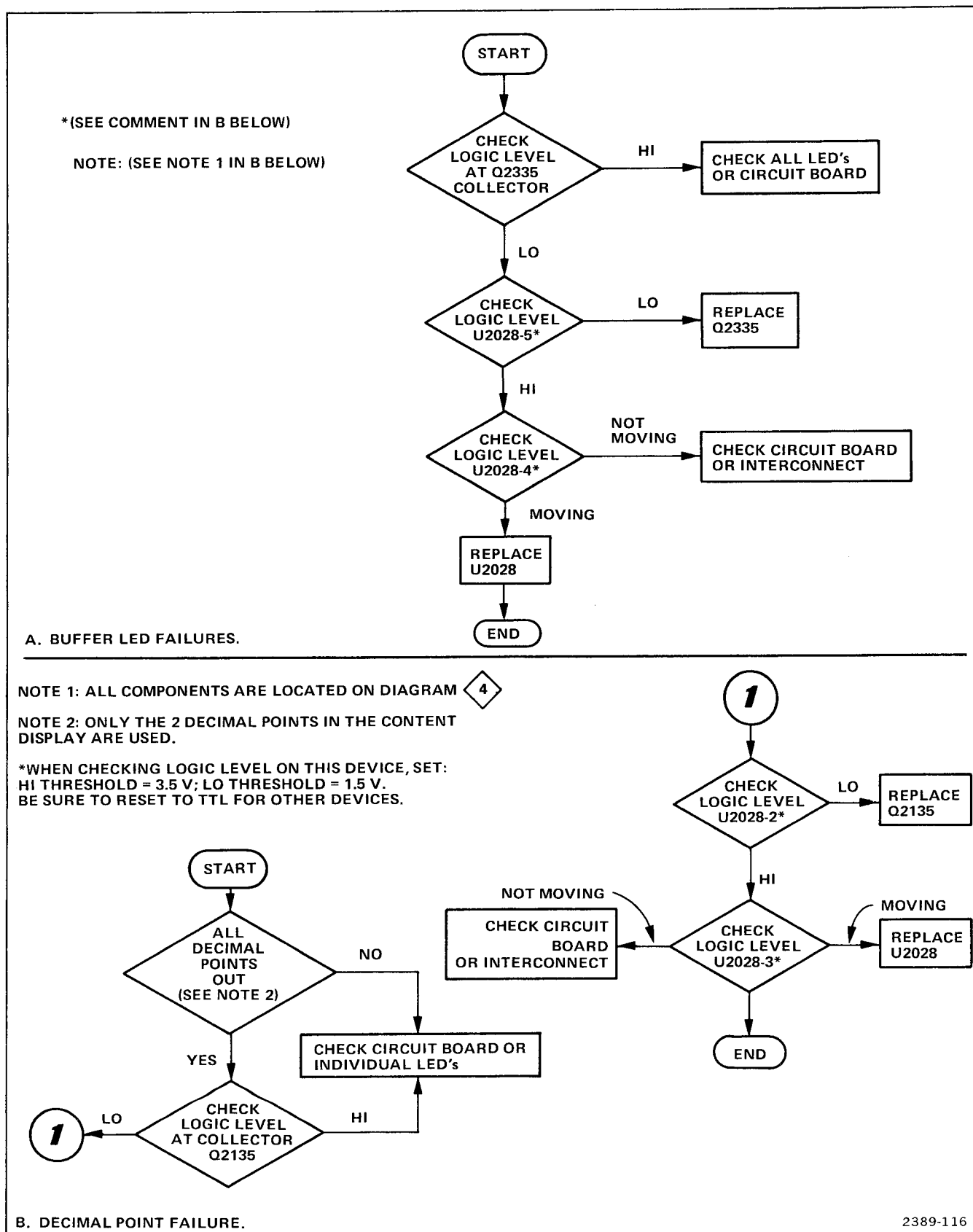


Figure 6-14. Troubleshooting Chart 9—BUFFER LED or Digital Display Decimal Point Failures.

**TROUBLESHOOTING SELF TEST ROUTINE FAILURES**

When failures occur while running self test routines 0 through 4, refer to Table 6-9 for the troubleshooting action.

**TABLE 6-9**  
**Self Test Routine Failures**

| <b>Self Test Routine</b> | <b>Troubleshooting Action</b>                 |
|--------------------------|-----------------------------------------------|
| 0                        | Go to Troubleshooting Chart 10 (Figure 6-15). |
| 1                        | Go to Troubleshooting Chart 11 (Figure 6-16). |
| 2                        | Go to Troubleshooting Chart 12 (Figure 6-17). |
| 3                        | Go to Troubleshooting Chart 13 (Figure 6-18). |
| 4                        | Go to Troubleshooting Chart 14 (Figure 6-19). |

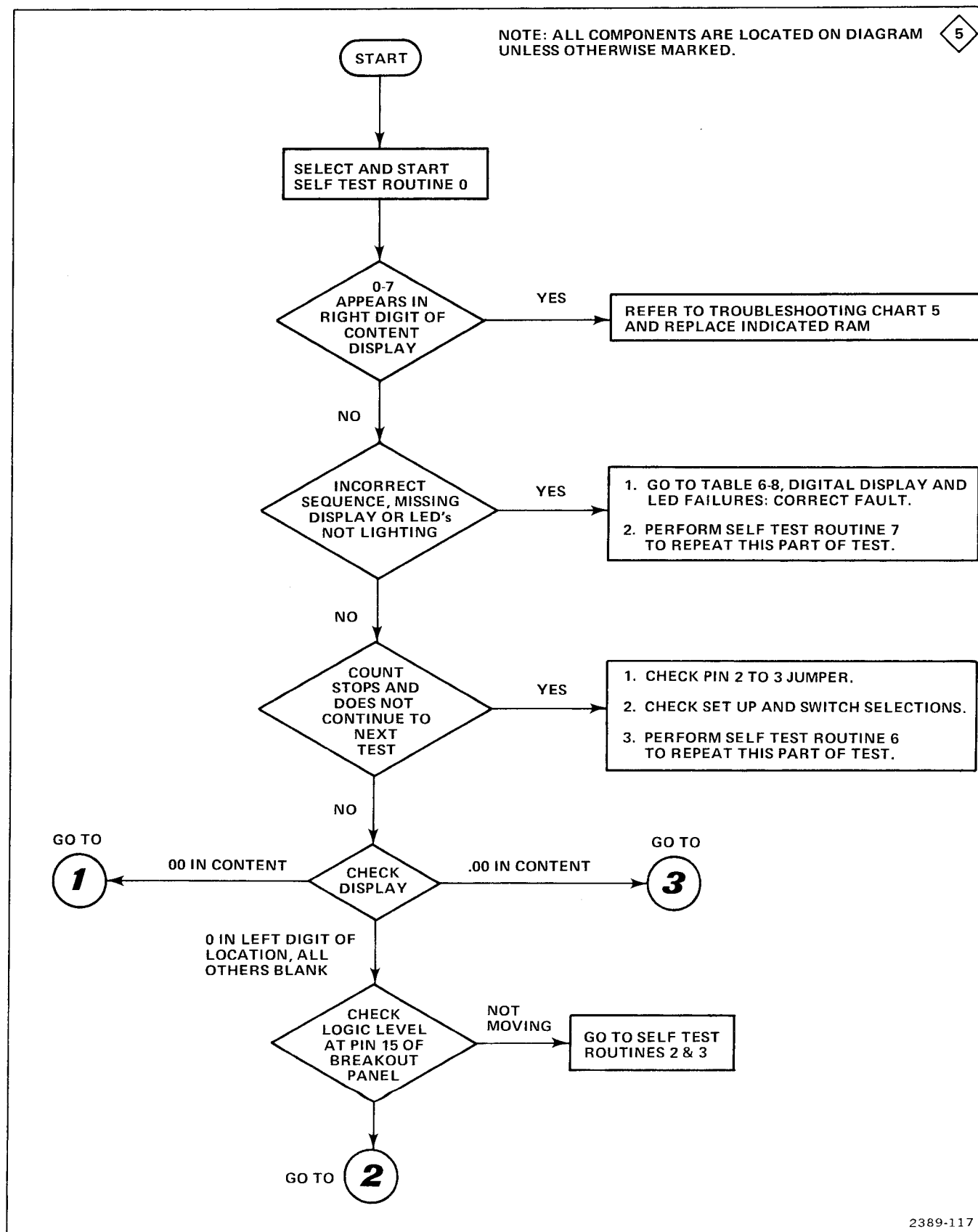
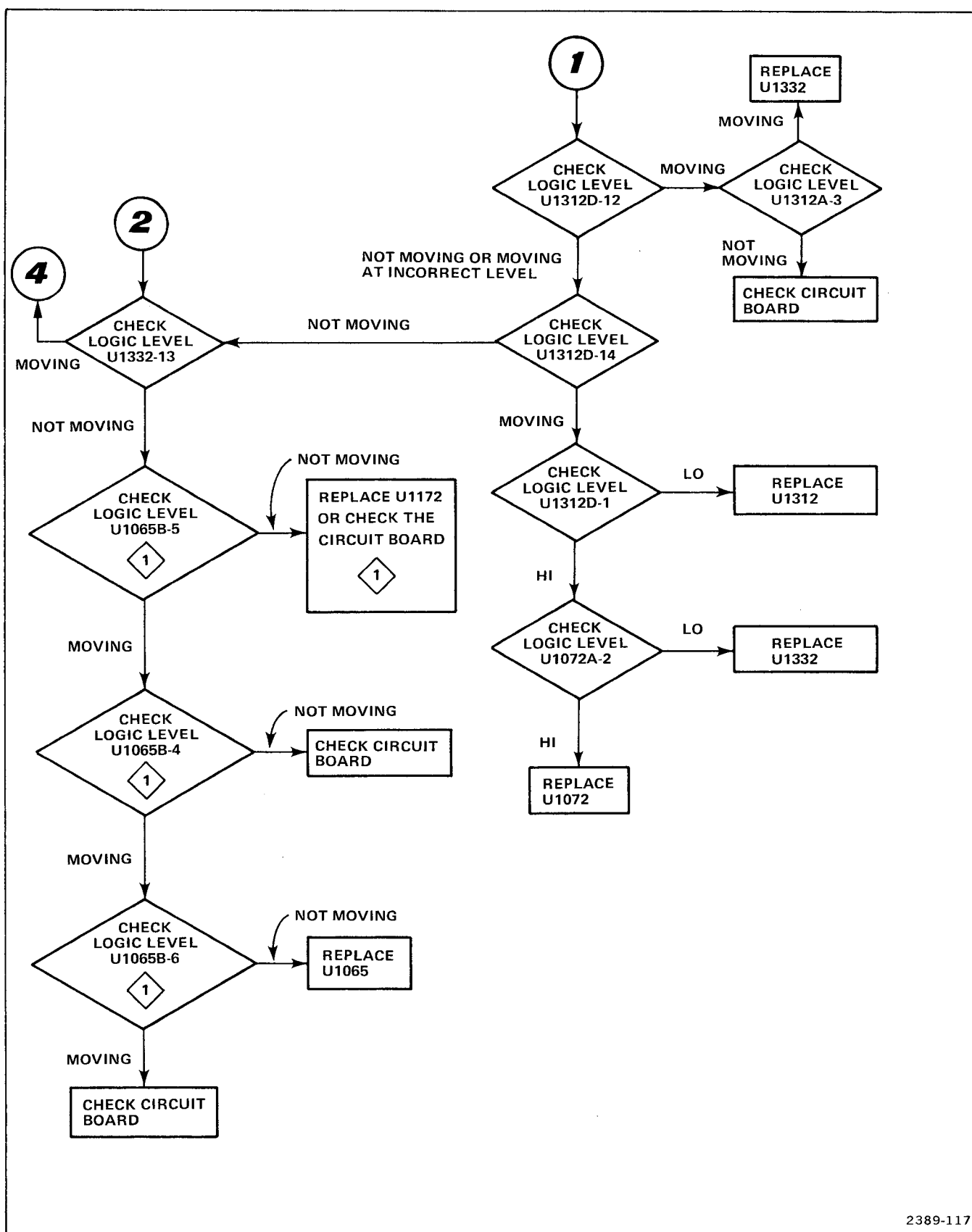


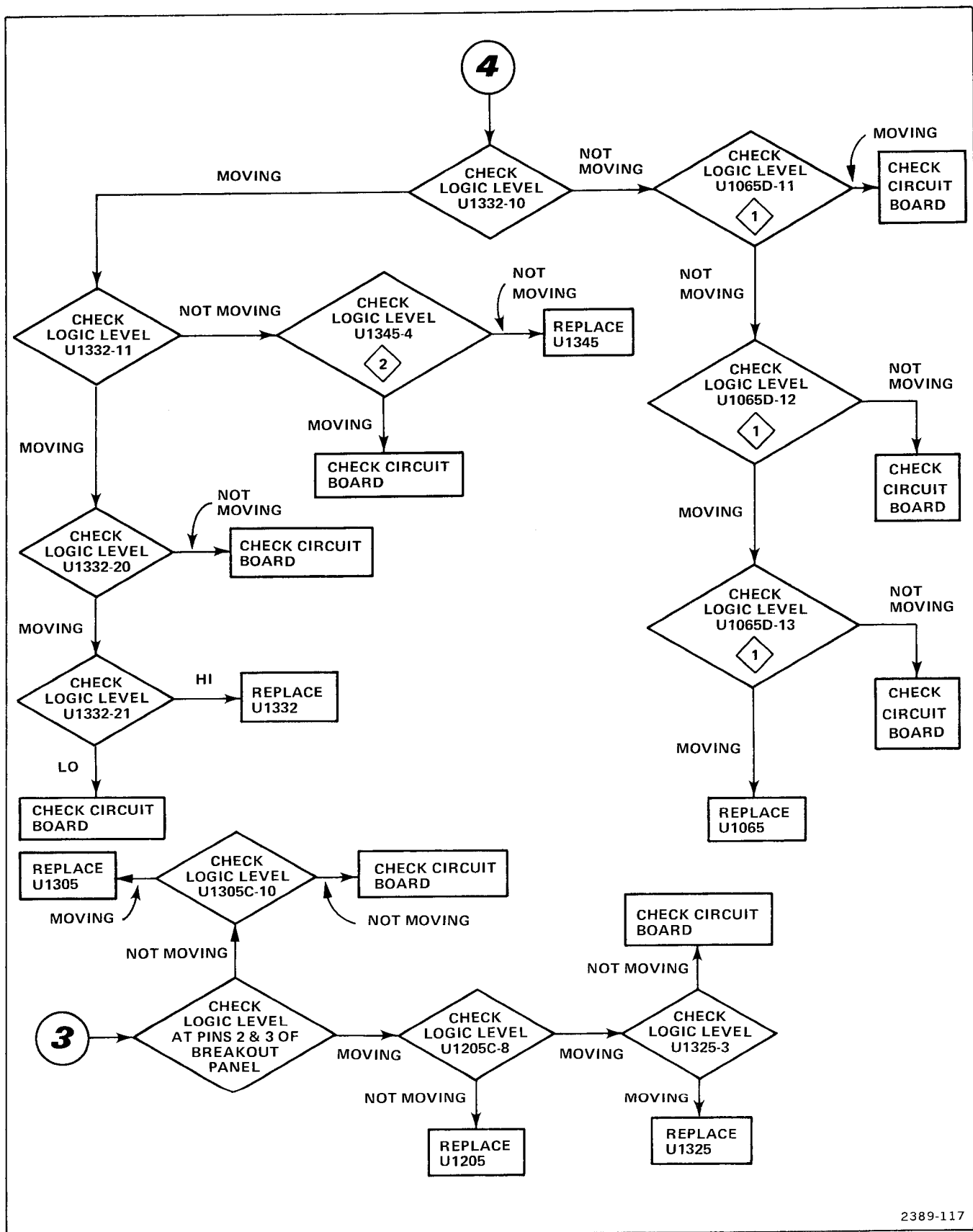
Figure 6-15. Troubleshooting Chart 10—Self Test Routine 0 (sheet 1 of 3).





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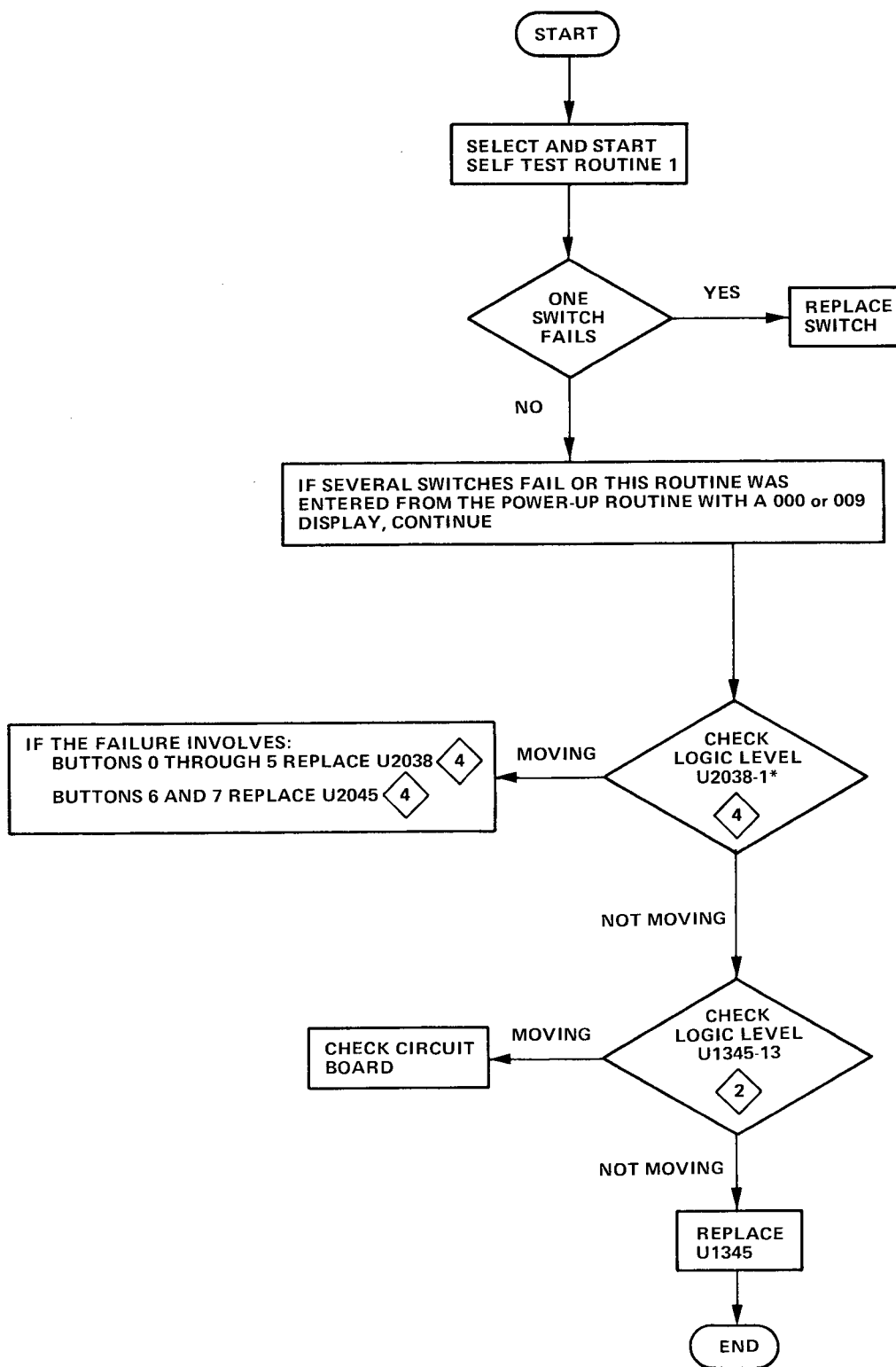
Figure 6-15. Troubleshooting Chart 10—Self Test Routine 0 (sheet 2 of 3).



2389-117

Figure 6-15. Troubleshooting Chart 10—Self Test Routine 0 (sheet 3 of 3).

\*WHEN CHECK LOGIC LEVEL ON THIS DEVICE, SET  
HI THRESHOLD = 3.5 V; LO THRESHOLD = TTL.  
BE SURE TO RESET TO TTL FOR OTHER DEVICES.



2389-118

Figure 6-16. Troubleshooting Chart 11—Self Test Routine 1.

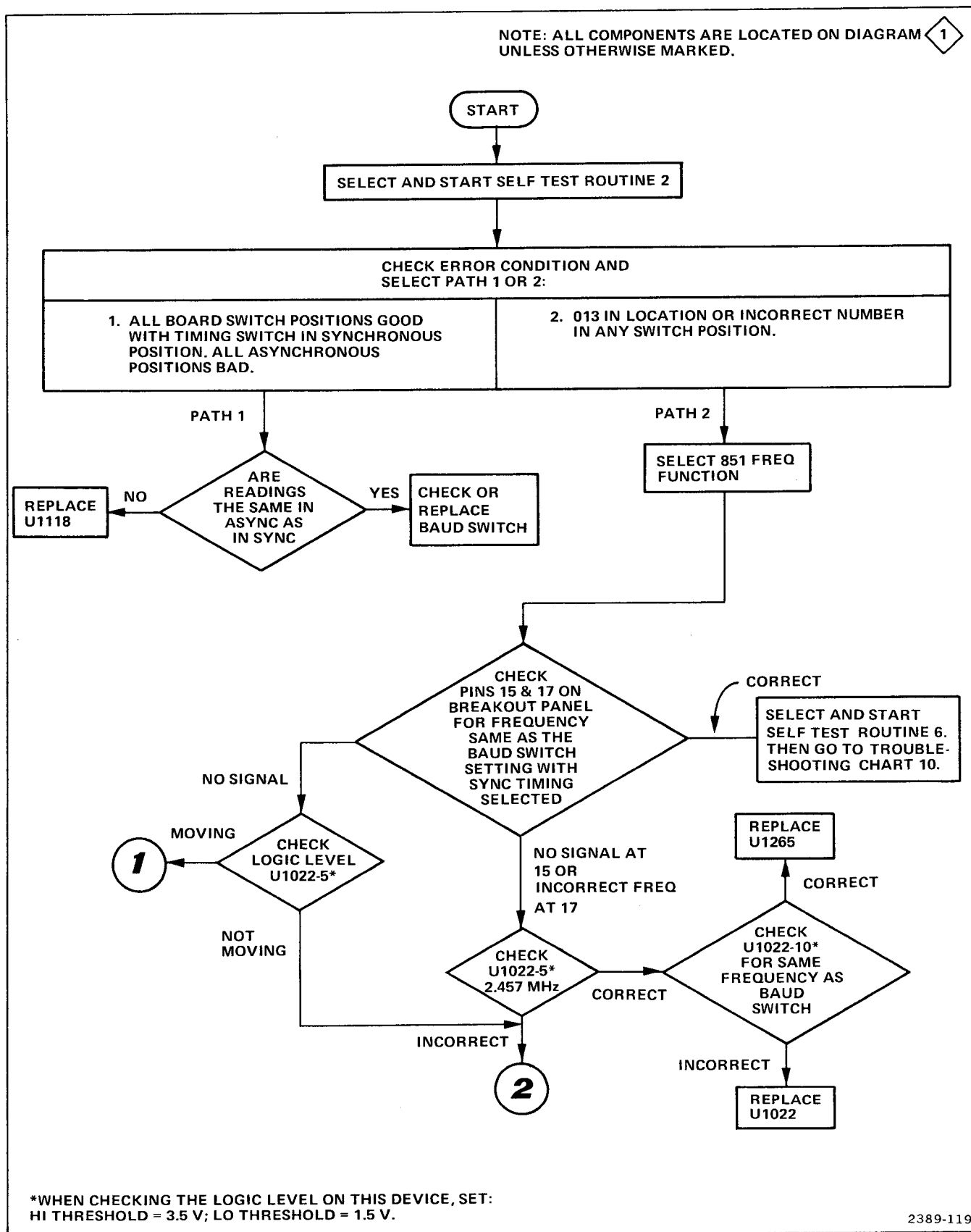
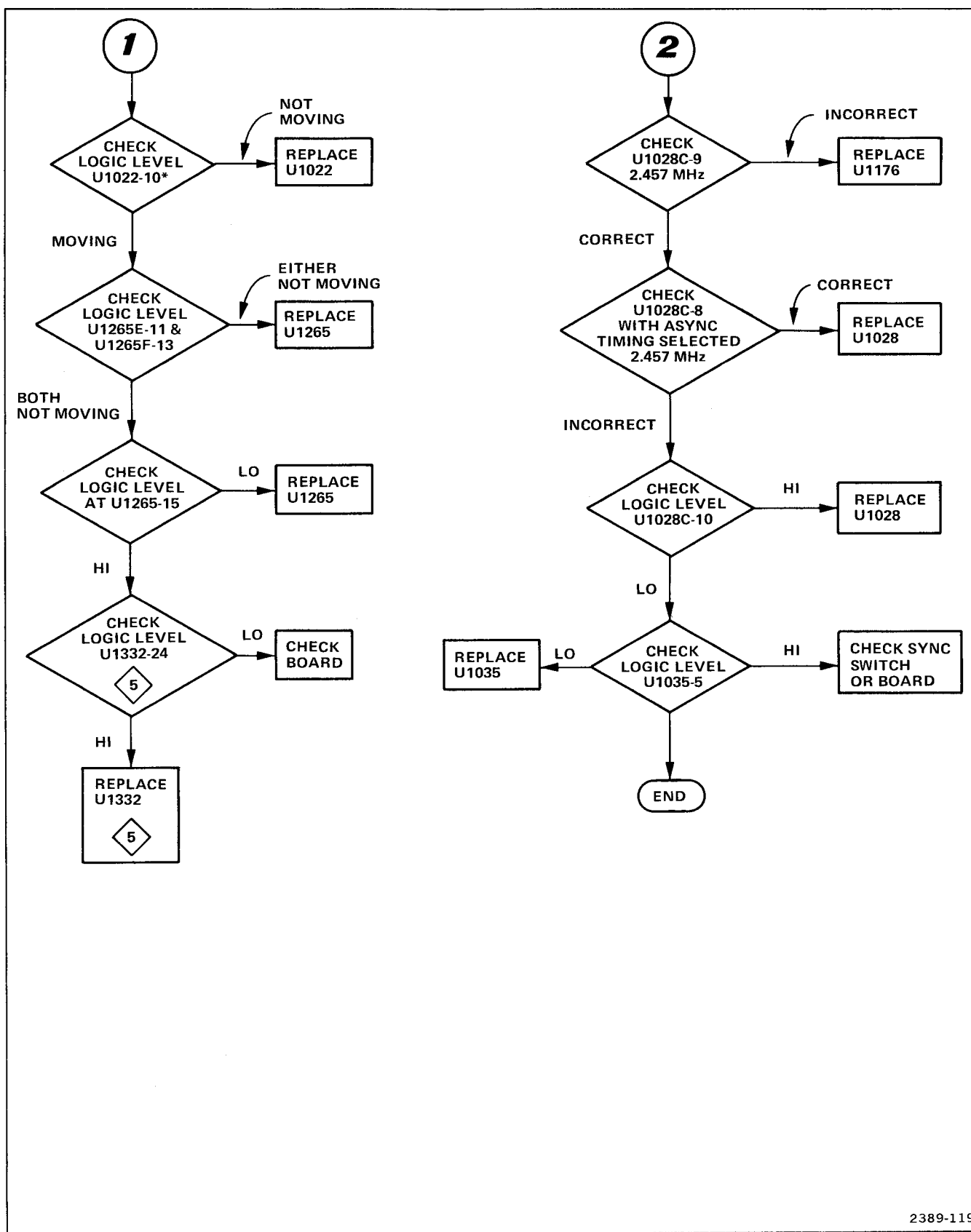


Figure 6-17. Troubleshooting Chart 12—Self Test Routine 2 (sheet 1 of 2).



2389-119

Figure 6-17. Troubleshooting Chart 12—Self Test Routine 2 (sheet 2 of 2).

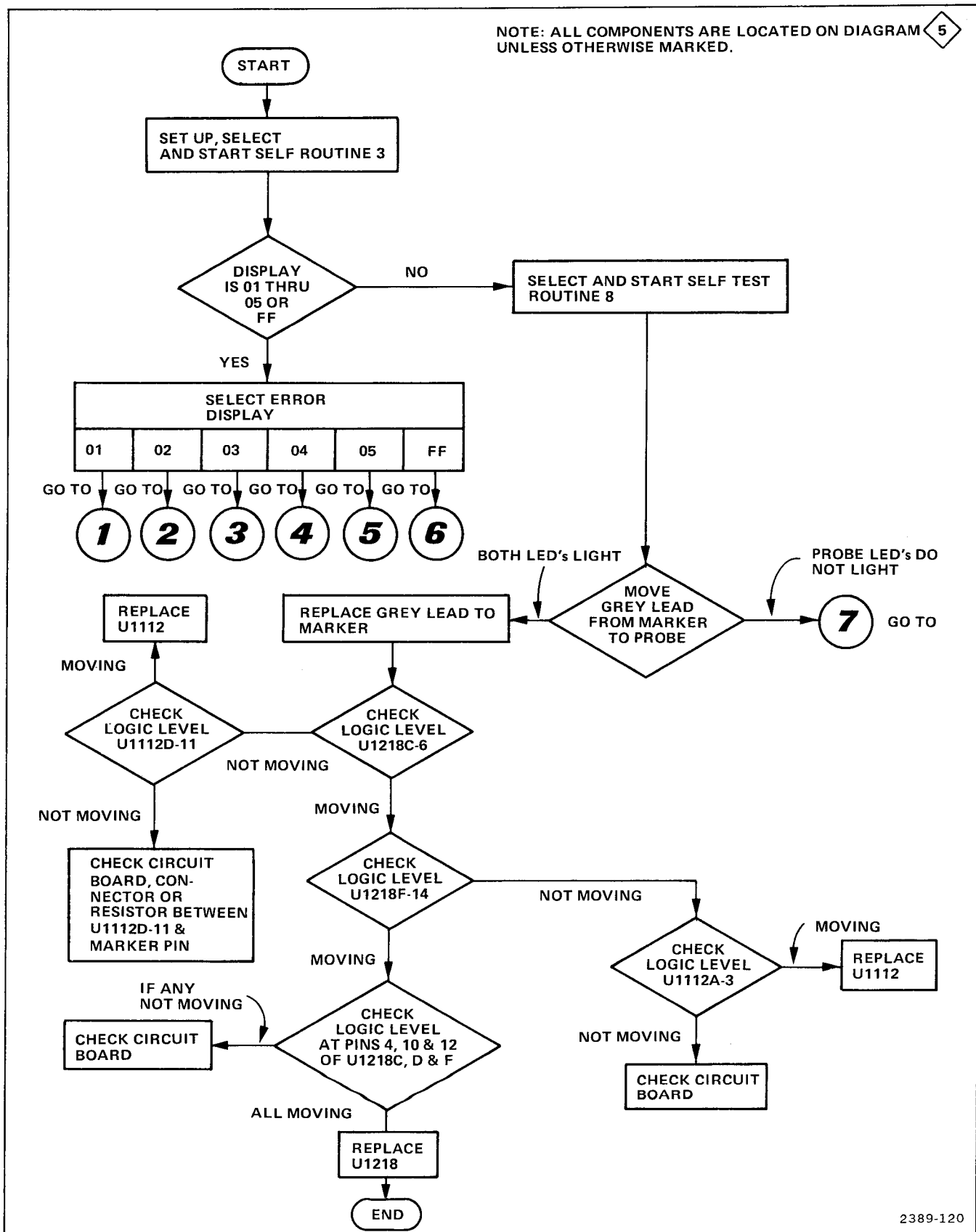


Figure 6-18. Troubleshooting Chart 13--Self Test Routine 3 (sheet 1 of 3).

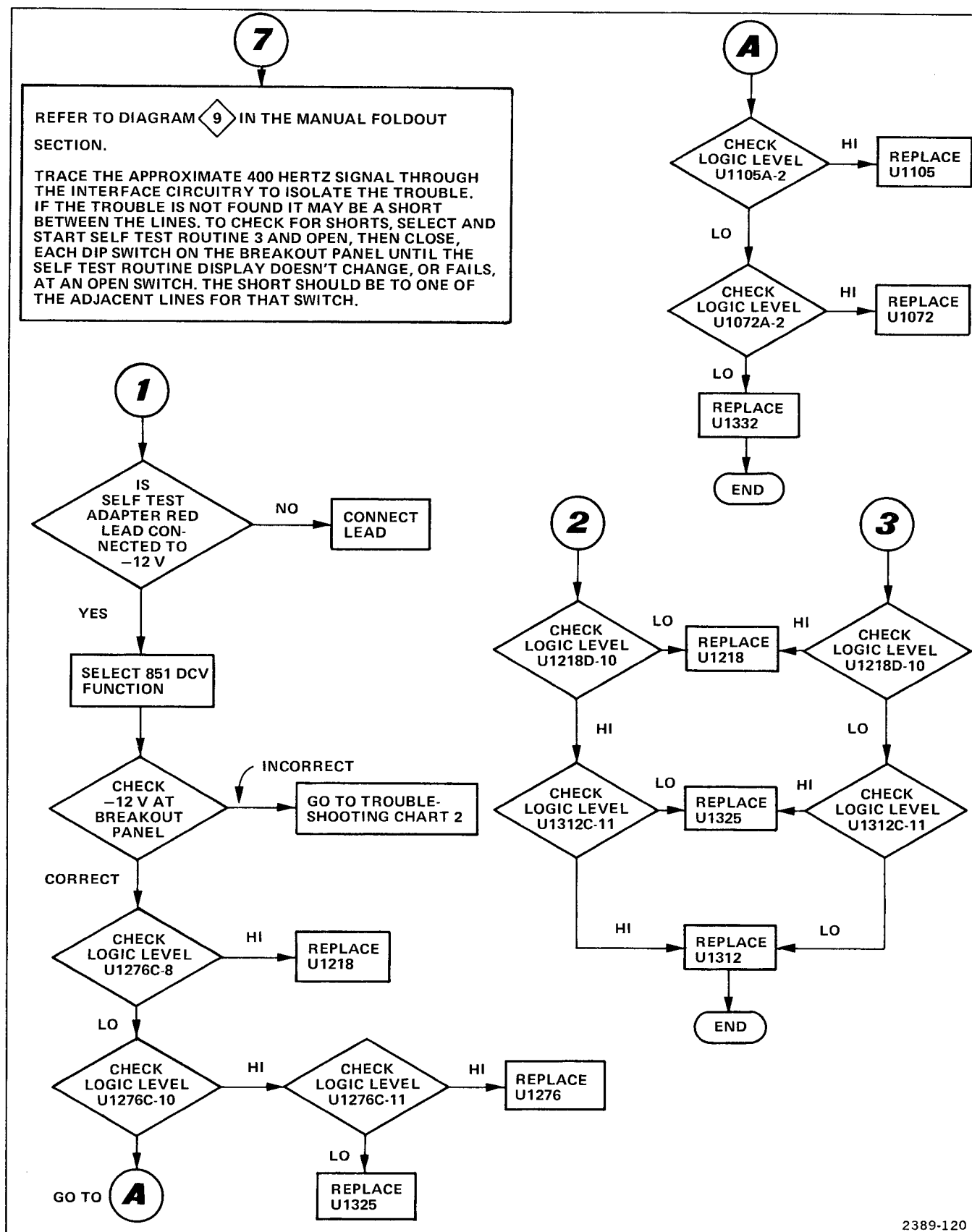
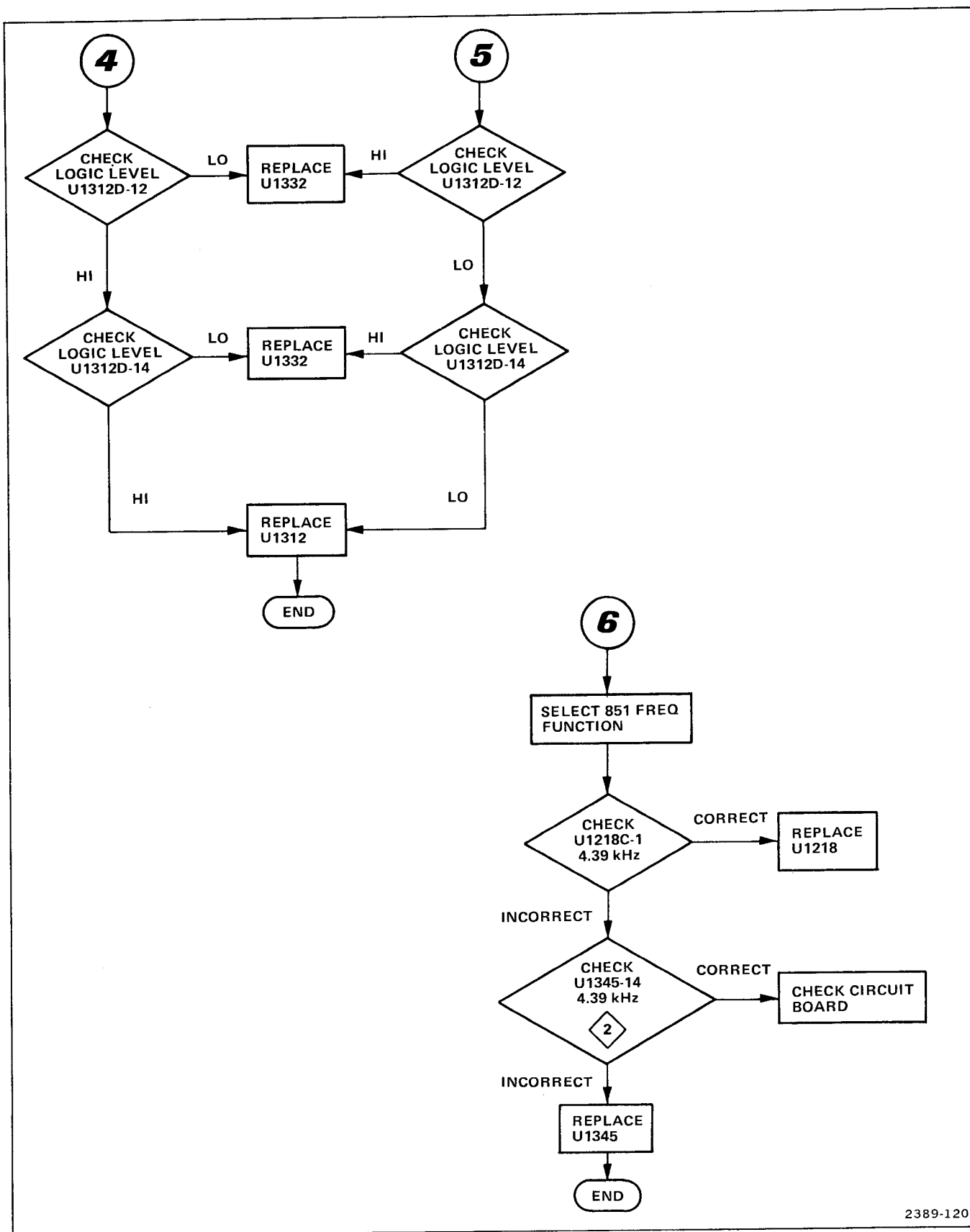


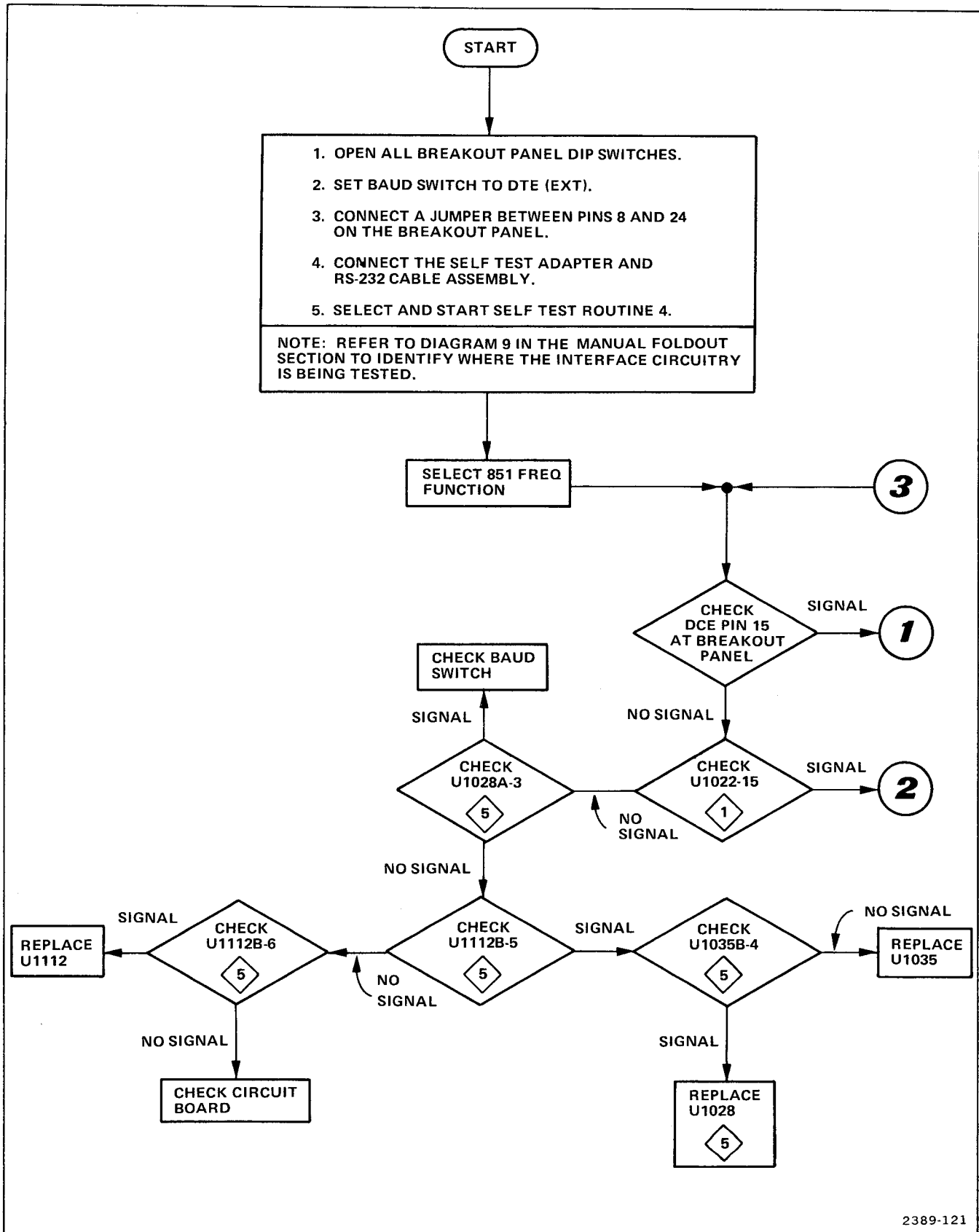
Figure 6-18. Troubleshooting Chart 13—Self Test Routine 3 (sheet 2 of 3).



2389-120

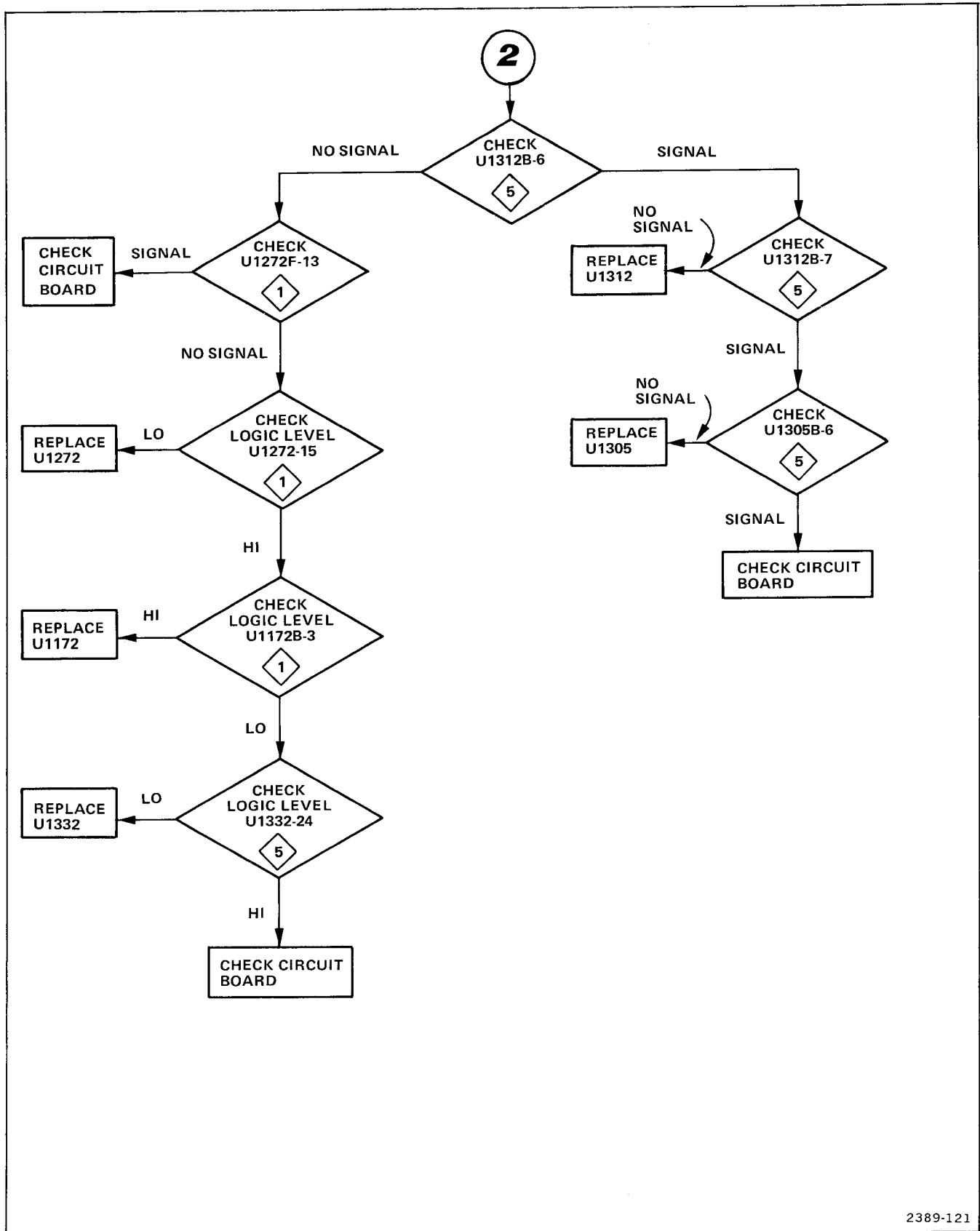
Figure 6-18. Troubleshooting Chart 13—Self Test Routine 3 (sheet 3 of 3).





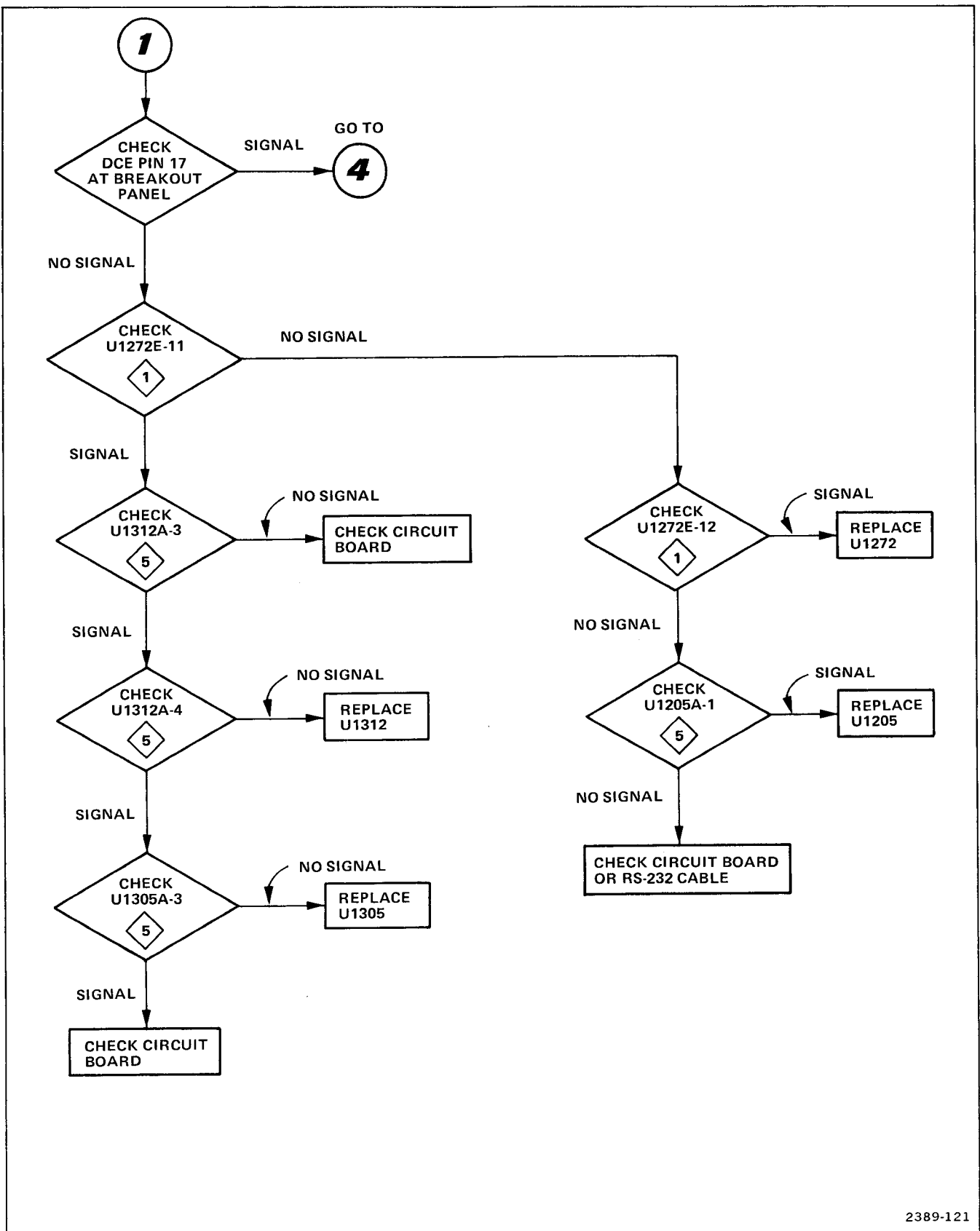
2389-121

Figure 6-19. Troubleshooting Chart 14—Self Test Routine 4 (sheet 1 of 4).



2389-121

Figure 6-19. Troubleshooting Chart 14—Self Test Routine 4 (sheet 2 of 4).



2389-121

Figure 6-19. Troubleshooting Chart 14—Self Test Routine 4 (sheet 3 of 4).

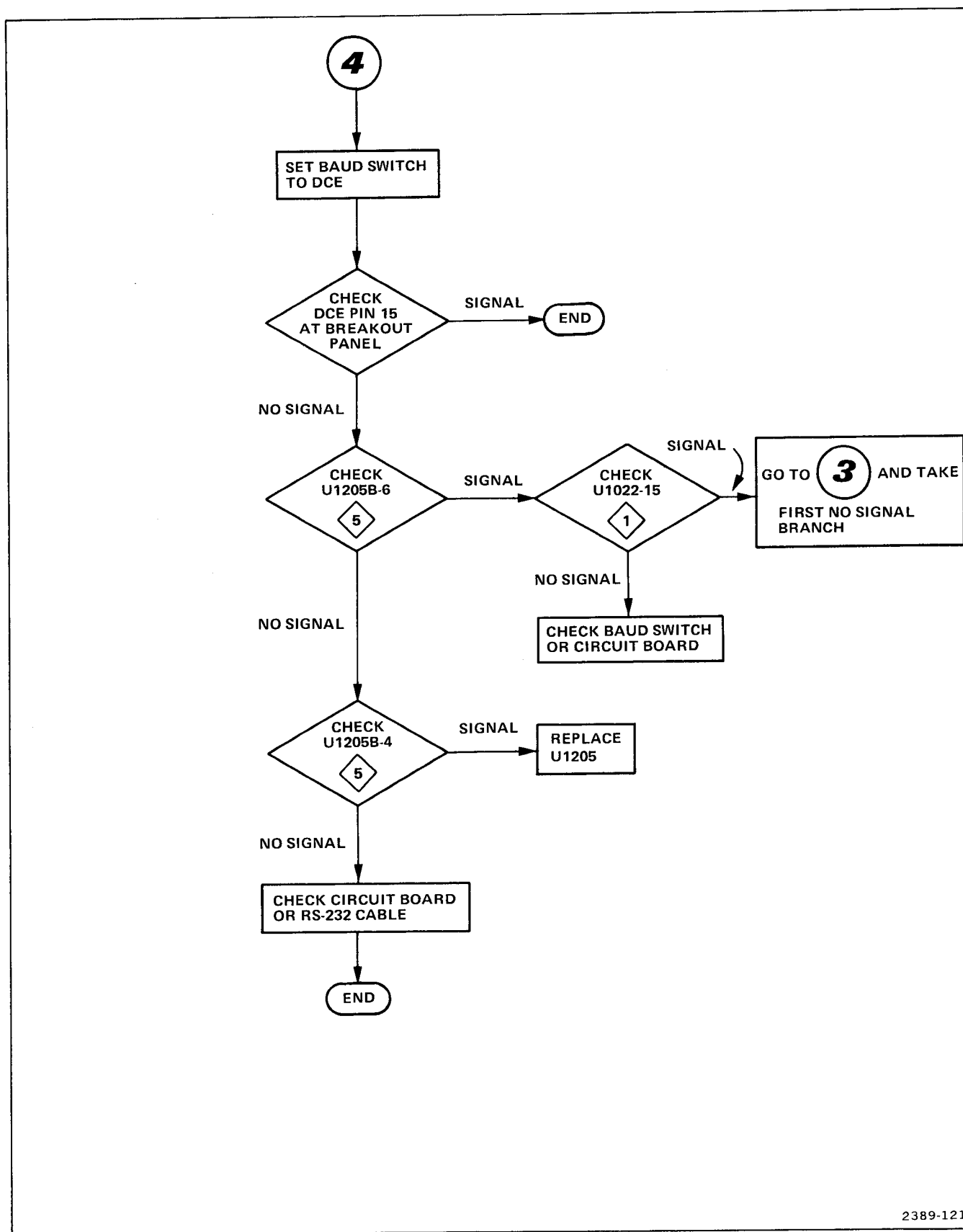


Figure 6-19. Troubleshooting Chart 14—Self Test Routine (sheet 4 of 4).

# CORRECTIVE MAINTENANCE

## OBTAINING REPLACEMENT PARTS

All electrical and mechanical replaceable parts for the instrument can be obtained through your Tektronix Field Office or representative. However, many of the standard electrical components can be obtained locally in less time than is required to order them from Tektronix, Inc. Before purchasing an ordinary part, check the parts list for value, tolerance, rating and description.

### NOTE

*When selecting replacement parts, it is important to remember that the physical size and shape of a component may affect its performance in the instrument. All replaceable parts should be direct replacements unless it is known that a different component will not adversely affect instrument performance.*

Some parts are manufactured or selected by Tektronix, Inc., to satisfy particular requirements, or are manufactured for Tektronix, Inc., to our specifications. Most of the mechanical parts have been manufactured by Tektronix, Inc. To determine the manufacturer of a part, refer to the Parts List Cross Index of Code Number to Manufacturer. This is found in the parts list.

When ordering replacement parts from Tektronix, Inc., include the following information:

1. Instrument type.
2. Instrument serial number.
3. A description of the part (if electrical, include circuit number).
4. Tektronix part number.

## COMPONENT REMOVAL AND REPLACEMENT

### Bottom Cover

For bottom cover removal, see Figure 6-20.

### Fuse Replacement

The line fuse is located on the power supply board and is accessible after removal of the bottom cover.

### Line Voltage Selector Switch

The line voltage selector switch is mounted on the power supply board and is accessible after removal of the bottom cover.

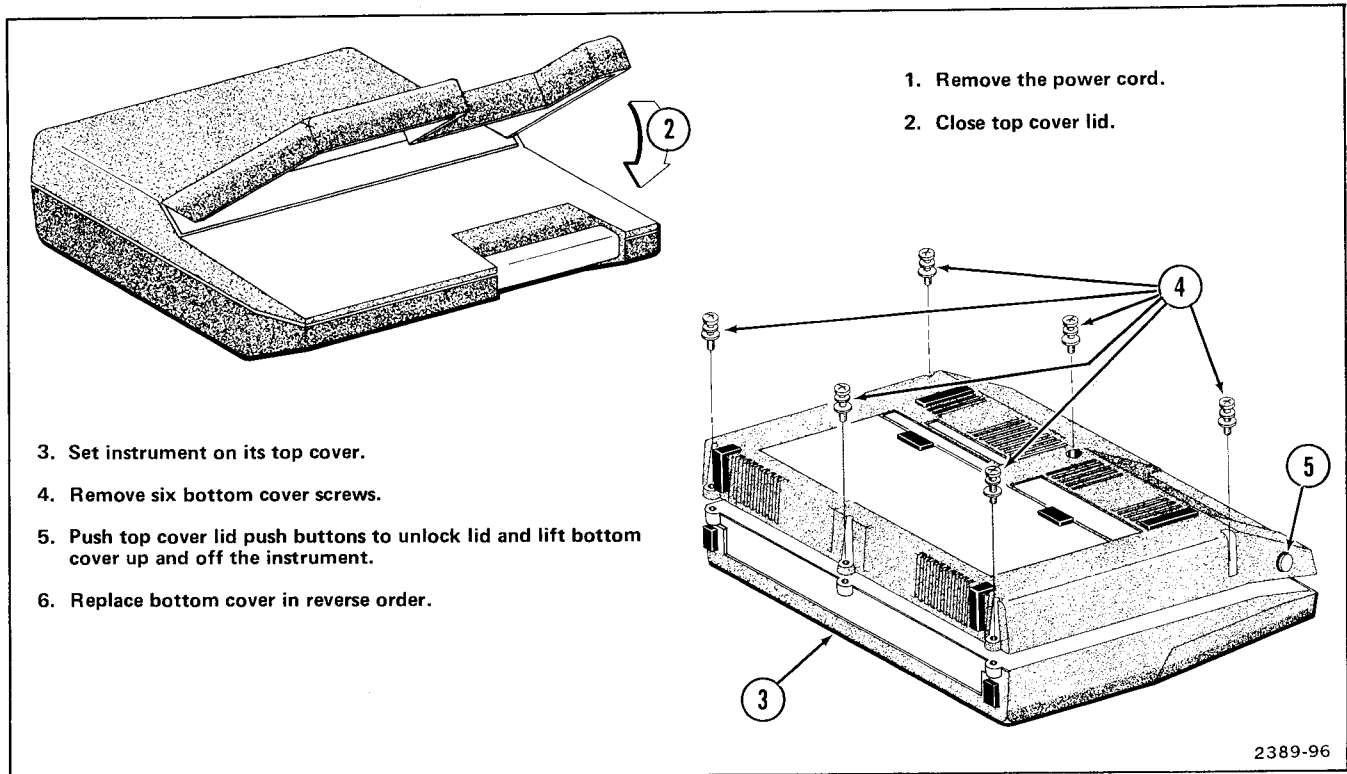


Figure 6-20. Bottom cover removal and replacement.

### Power Supply (Figure 6-21)

1. Remove the bottom cover.
2. Remove the single power supply screw.
3. Disconnect one of the power supply connectors.
4. Remove the two screws on the power supply chassis that connect the ground wires from the RS-232 connector shells and the metal part of the front panel.
5. Lift the power supply up and out of the instrument cover.

#### CAUTION

*The power supply may be damaged if power is applied without an external load. For additional information, see Power Supply Troubleshooting in the Troubleshooting subsection.*

6. Replace the power supply in reverse order.

#### CAUTION

*Be sure to replace the power supply connector with the correct pin orientation (see Figure 6-27). Also be sure to reconnect the ground wires from the metal part of the front panel and the RS-232 connector shells.*

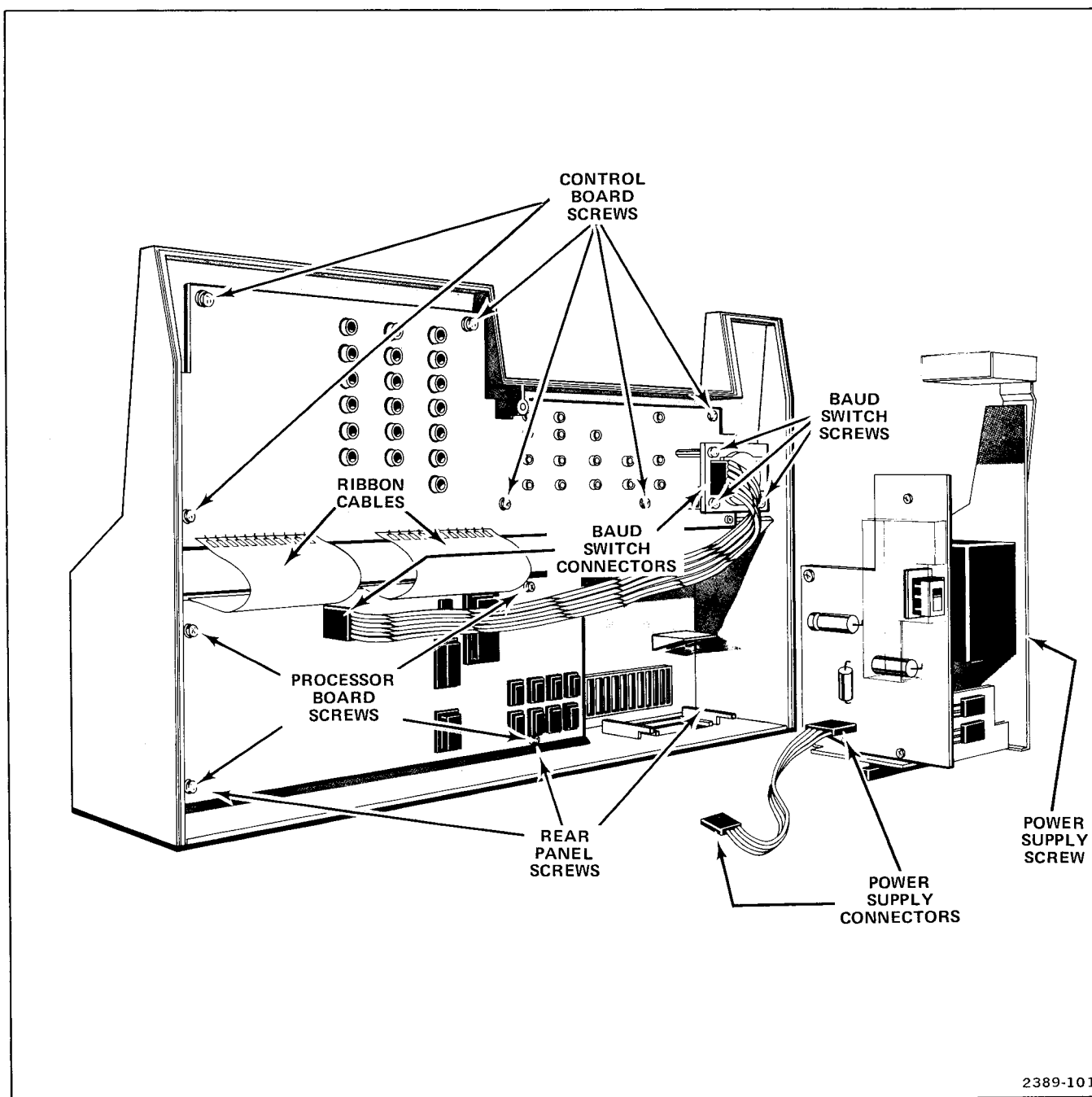


Figure 6-21. Hardware locations needed for circuit board removal and replacement.

## Power Supply Board

1. Remove the bottom cover.
2. Remove the power supply.
3. Remove the two screws through the voltage regulator tabs.

### NOTE

*Be careful not to lose the small mica insulators under the regulator tabs or the insulating washers inserted in the tab holes.*

4. Remove the small screw holding the board to the chassis and the large screw holding the board to the post spacer on the corner of the transformer.
5. Remove the three screws and nuts and fourth screw and post holding the transformer to the chassis.

### NOTE

*At this point you should have access to both sides of the board or any component for removal or unsoldering. Further disassembly of the board requires unsoldering of connecting wires.*

6. Replace the power supply board in reverse order.

### CAUTION

*Be sure to replace the mica insulators (coated with a thin film of silicone grease) under the regulator tabs and insert the insulating washers in the tab holes before installing the screws.*

### WARNING

*Silicone grease can cause eye irritation; therefore, handle it with care and avoid getting in the eyes. Wash hands thoroughly after use.*

## Processor Board (Figure 6-21)

1. Remove bottom cover.
2. Remove power supply.
3. Remove the four screws and nuts holding the RS-232 connectors to the rear panel. Pull the DTE female sockets RS-232 connector out of the rear panel and place it and its cable out of the way.
4. Remove the four processor board screws.



5. Carefully move the board toward the ribbon cables until the DCE connector clears the rear panel. Then slightly lift the ribbon cable side of the board up and out of the instrument until the DCE connector side of the board can be lifted up past the rear panel.

#### NOTE

*Removal of the processor board to this point should provide access to either side of the board and any component for removal or unsoldering. If the board must be completely removed, continue to the next steps.*

6. Disconnect one of the baud switch connectors.
7. Unsolder one end of each of the ribbon cables.
8. Replace the processor board in reverse order.

#### CAUTION

*Be sure to replace the baud switch connector with the correct pin orientation (see Figure 6-27).*

### Control Board (Figure 6-21)

1. Remove the bottom cover.
2. Remove the power supply.
3. Remove the six control board screws.

#### NOTE

*Removal of the control board to this point provides access to either side of the board and any component for removal or unsoldering. If the board must be completely removed, continue with the remaining steps.*

4. Remove the two screws holding the display board brackets to the control board (these are the two screws that go through the control board, *not* the two that go through the display board).
5. Carefully unplug the display board from the control board.
6. Remove the two screws and nuts holding the DTE connector to the rear panel.
7. Remove the two screws holding the BAUD switch assembly to the control board (these are the two screws that go through the control board, not those that go through the BAUD switch board).
8. Unsolder the two ribbon cables from the control board.
9. Remove the board from the instrument.
10. Replace the control board in reverse order.

## Display Board

1. To partially remove the display board, perform steps 1 through 3 of the Control Board procedures.

### NOTE

*At this point you should have access to either side of the display board and any component for removal or unsoldering. If the display board must be completely removed, continue with the next steps.*

2. To finish removing the display board, perform steps 4 and 5 of the Control Board procedures.
3. Replace the display board in reverse order.

## Rear Panel (Figure 6-21)

1. Remove the bottom cover.
2. Remove the power supply.
3. Remove the processor board.
4. Remove the last screw holding the rear panel.
5. Lift the rear panel up and out of the instrument.
6. Replace the rear panel in reverse order.

## Top Cover

1. Remove the bottom cover.
2. Remove the power supply.
3. Remove the processor board and control board without unsoldering the ribbon cable between them.
4. Remove the rear panel.
5. To remove the front panel (keyboard panel), remove the four screws that secure it to the top cover. The top cover is now free of all parts except the display panel, which is attached with adhesive and is difficult to remove without damage. If the top cover is being replaced, it is recommended that a new display panel be ordered along with the new top cover.
6. Replace parts into the top cover in reverse order.

## Baud Switch Assembly (Figure 6-21)

1. Remove bottom cover.
2. Remove power supply.
3. Disconnect one of the baud switch connectors.
4. Remove the three baud switch screws.
5. Lift the baud switch assembly out of the instrument.

### NOTE

*Do not disassemble the baud switch assembly as the internal parts may be lost or damaged. If the switch is faulty, replace the complete assembly.*

6. Replace the baud switch in reverse order.

## 7-Segment Digital Displays

If the 7-segment digital displays need to be replaced, it is recommended that the entire display board be replaced.

For those who intend to replace their own displays, the following information is provided:

1. The part number shown in the parts list for the displays is for a matched set of five displays.
2. If only one display is replaced, its brightness probably will not match the other displays.
3. When installing the display, push it fully down onto the board so it is flush with the other displays. If all displays were removed be sure the new ones are pushed fully down onto the board (each display has small feet that hold it off the board at its desired height).
4. The top of the displays have a series of grooves in them to identify that part of the display as the top. The display is inserted with these grooves facing away from the side of the display board that is adjacent to the control board (the grooves face the top of the instrument when the display board is installed in the instrument).

## Light-Emitting Diodes (LED's) (Figure 6-22)

When replacing LED's, the cathode is identified by a notch or a flat side on the LED. The cathode position on the circuit board is identified with a square pad.

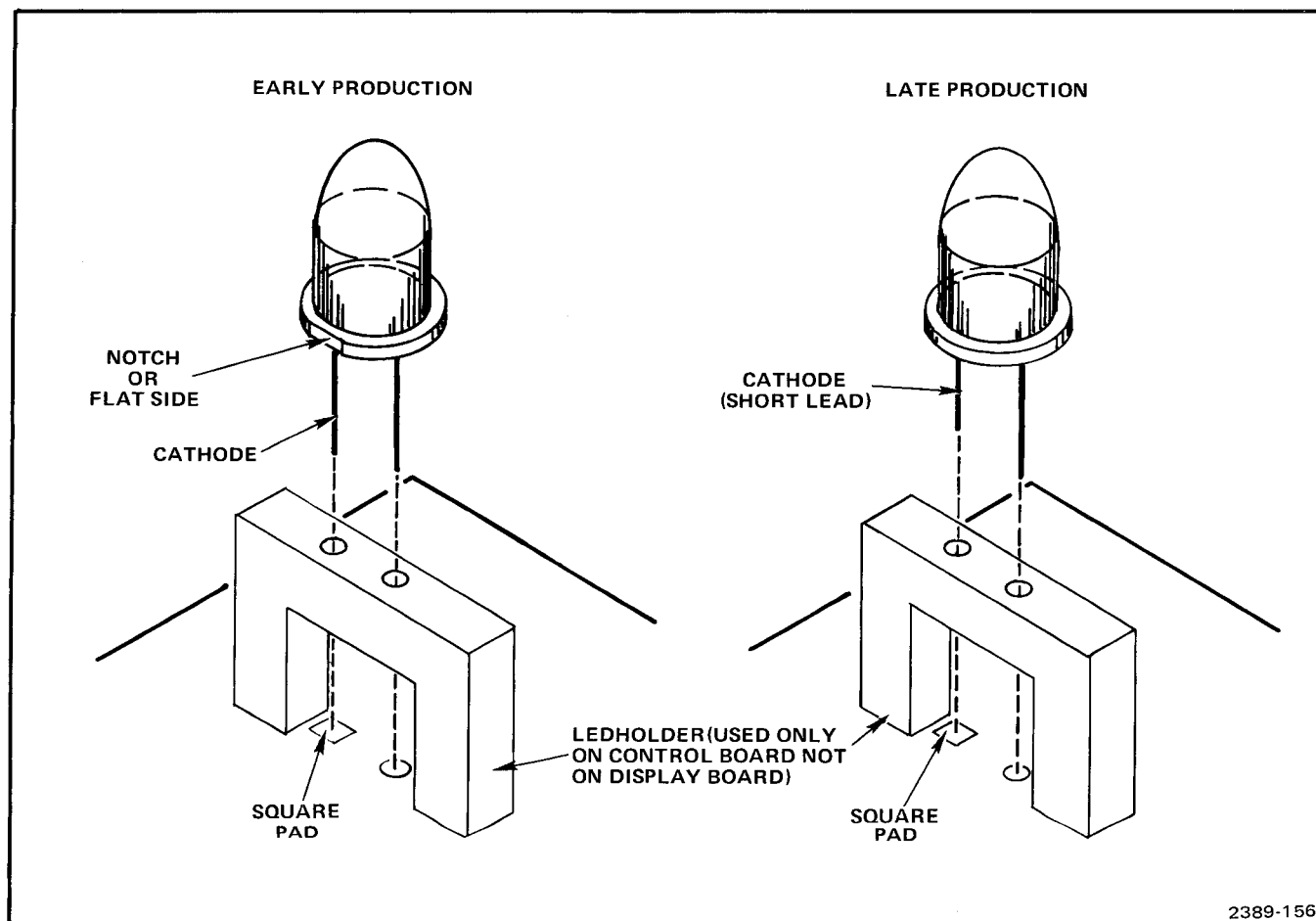


Figure 6-22. LED removal and replacement.

### Slide Switches (Figure 6-23)

Slide switches must be replaced as complete assemblies. However, if they become noisy or need cleaning, they can be removed and replaced as follows.

#### REMOVAL AND DISASSEMBLY

1. Remove the control board through step 3.
2. Pry off the push-on nuts (requires a thin non-flexible device similar to a knife blade).

#### CAUTION

*When the switch assembly is removed from the board, the electrical contacts can fall free and be lost or damaged. They are held in place only by a friction fit of the cover. When removing the assembly in the next step, hold the cover and switch housing together.*

3. Pull the entire switch assembly out of its board mounting holes.

#### CAUTION

*When disassembling the switch in the next step, there is a small detent spring under the electrical contacts, which could fall free and be lost.*

4. Disassemble the switch by pulling off the cover and ring spacer. The electrical contacts can now be removed through the bottom of the switch housing.

#### REASSEMBLY AND REPLACEMENT

5. Install the detent spring and electrical contacts in the switch housing as shown.
6. Install the ring spacer and cover.
7. Insert the switch into the circuit board with the contacts pointing toward the triangle key on the board as shown.

#### NOTE

*The ASYNC/SYNC switch is slightly different than the other slide switches in that its contacts can be inserted in either direction and still work properly (if you have an Option 1 instrument, see the Option section). The inside of the switch has two compartments where the contacts can be installed. Install them in the compartment closest to the instrument handle. Also, be sure to install the cover for this switch with the short side toward the instrument handle.*

8. While holding the switch housing tightly against the circuit board, install the push-on nuts (a 3/16 inch nutdriver may be used).

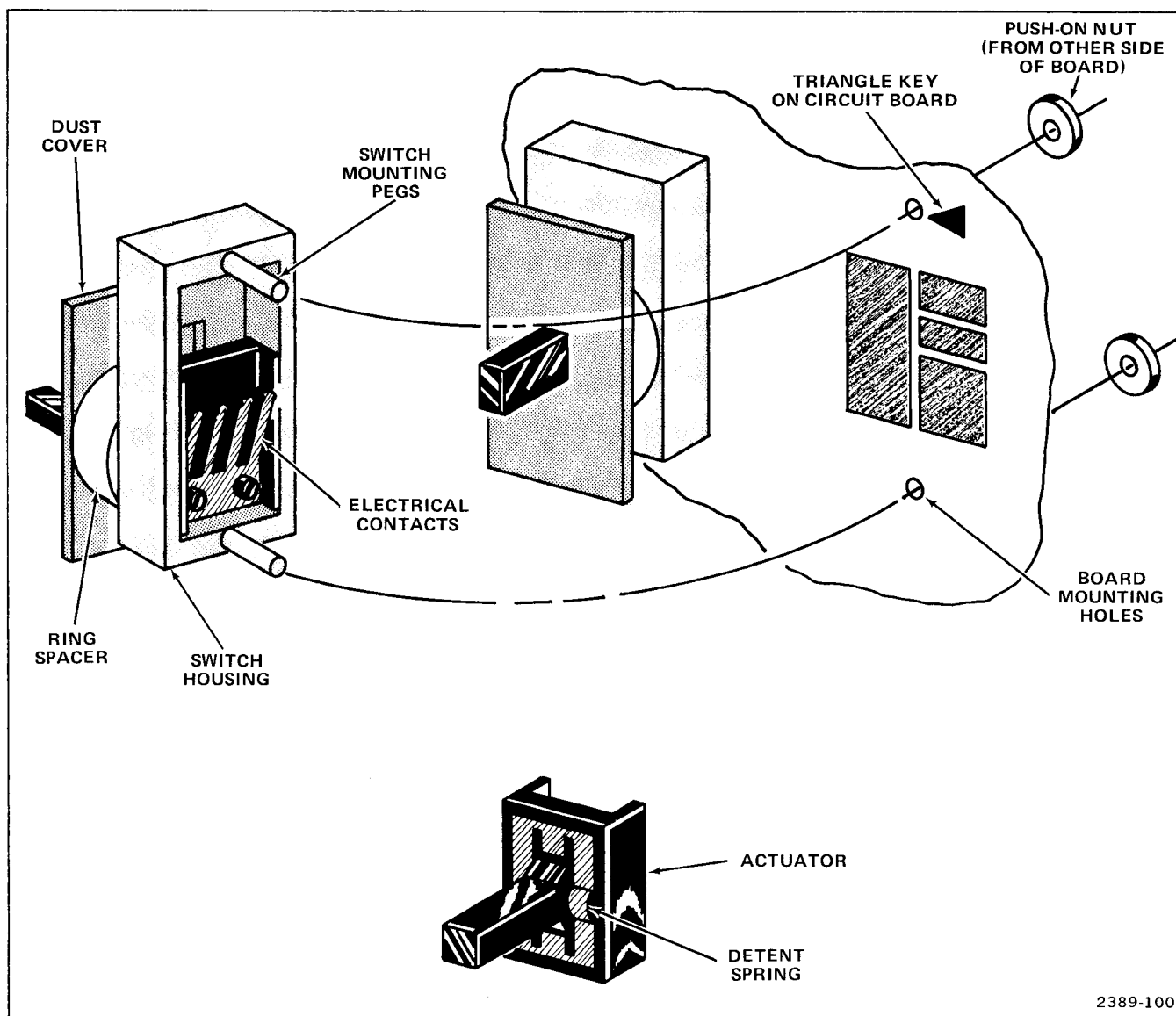


Figure 6-23. Slide switch removal and replacement.

### Push-Button Switches

1. Remove the control board through step 3.
2. Push buttons are installed with a friction fit only and should remove by pushing them out of the circuit board with finger pressure. If they are difficult to remove with finger pressure, use a small blunt instrument and push on the large center tube of the switch (*DO NOT* push them out with a cross-point screwdriver as the center tube may be damaged).
3. To reinstall the switches, set them into their mounting holes in the circuit board and press them down into the board with finger pressure (try to apply the installation pressure to the base of the switch rather than the push button).

## Front Cover

For front cover removal, see Figure 6-24.

## Front Cover Hinges

1. Remove the bottom cover.
2. Remove the power supply.
3. Remove the processor board through step 5.
4. Remove the one screw in each hinge.
5. Carefully pull the front cover with hinges attached out of their top cover slots.
6. Remove the hinges from the front cover as shown in Figure 6-24.

## Accessory Box and Accessory Box Latch

For accessory box and accessory box latch removal, see Figure 6-25.

## Accessory Box Hinges

The accessory box hinges are permanently installed. If they need to be replaced the entire accessory box must be replaced as a unit.

## Circuit-Board Pins (Figure 6-26)

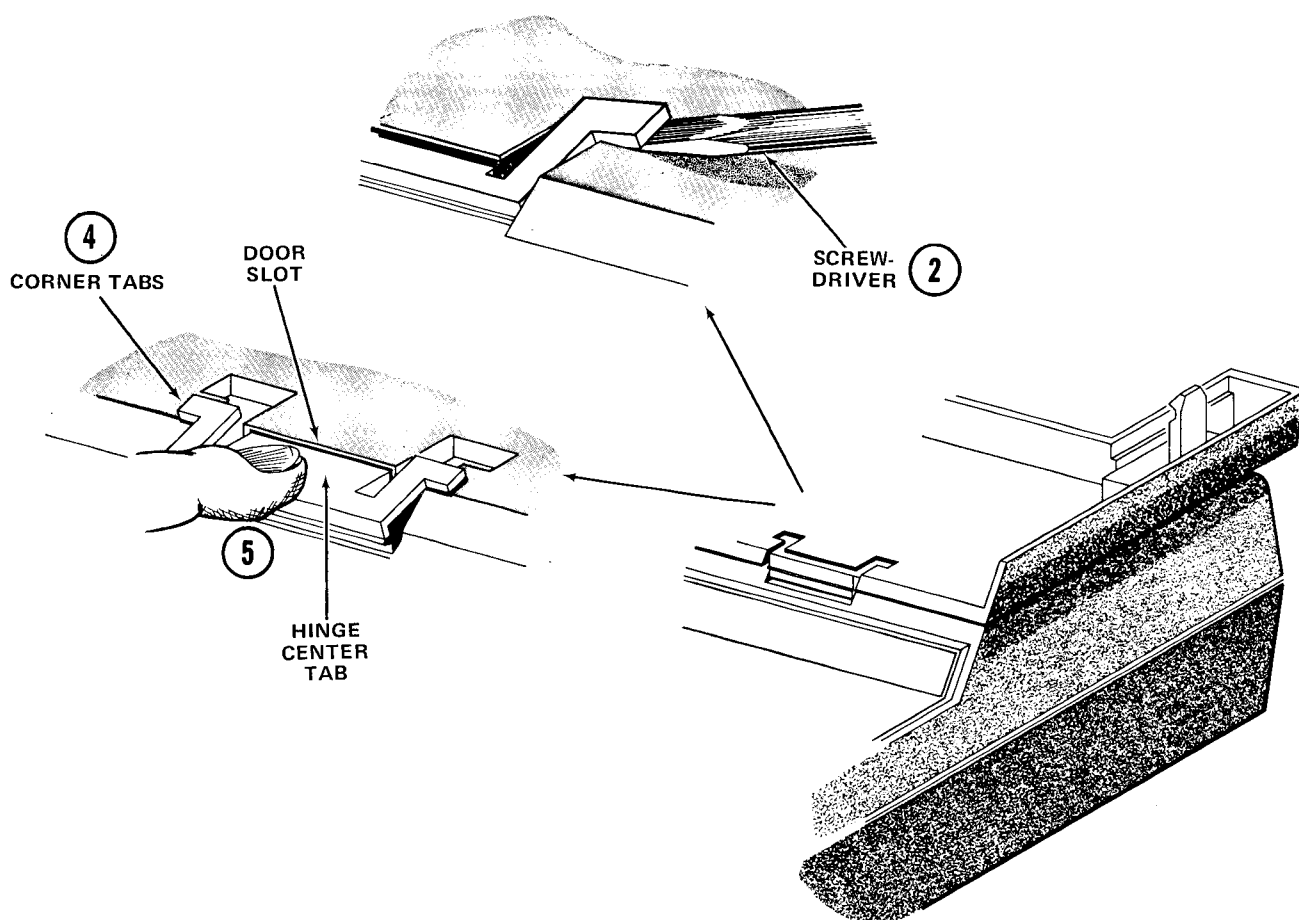
A circuit-board pin replacement kit, including necessary tools, instructions and replacement pins with attached spare ferrules, is available from Tektronix, Inc. as Tektronix part 040-0542-00.

### CAUTION

*Replace circuit-board pins on multi-layer circuit board with extreme care. These boards have conductive paths laminated between the top and bottom board layers. All soldering and removal and reinsertion of the pins must be done with care to prevent breaking any of the electrical paths between the boards.*

To replace the pins:

1. Use a 15-watt soldering iron to unsolder the pin while pulling it out of the board with a pair of pliers. If the pin is too short to use the pliers, it can be pushed out with any round device not over 0.028 inch in diameter.
2. If the ferrule remained in the board, carefully ream the solder out of it with a 0.031 inch drill. If the ferrule came out with the pin, clean the excess solder out of the hole with solder-removing wick and a scribe.
3. If the ferrule remained in the board, remove the ferrule from the new pin and insert the pin into the old ferrule in the same orientation as the old pin. If the ferrule came out with the old pin, insert the new pin with ferrule in the same orientation as the old pin.
4. When the new pin is properly position in the circuit board, carefully solder it on both sides of the board.

**COVER REMOVAL:**

1. UNLATCH COVER AND OPEN IT (PRESS IN BUTTONS ON BOTH SIDES OF BOTTOM COVER).
2. USING A SMALL BLADED SCREWDRIVER (1/8" BLADE), CAREFULLY PRY THE HINGE CORNER TABS UP AND OUT OF THEIR RECESSES ON BOTH HINGES.
3. PULL THE DOOR AWAY FROM THE HINGES.

**COVER REPLACEMENT:**

4. SET THE HINGE CORNER TABS ON THE INSIDE FACE OF THE DOOR.
5. WITH A FINGER, GENTLY PRESS THE HINGE CENTER TABS DOWN AND GUIDE THEM INTO THE DOOR SLOTS.
6. PUSH THE DOOR TOWARD THE HINGES UNTIL THE CORNER TABS DROP INTO THEIR LOCKING RECESSES.

**NOTE**

IF THE CORNER TABS DON'T DROP INTO THEIR LOCKING RECESSES, CAREFULLY PUSH THEM TOWARD THE CENTER OF THE DOOR UNTIL THEY DROP INTO THE RECESSES AND LOCK THE HINGES IN PLACE.

2389-98

Figure 6-24. Front cover removal and replacement.

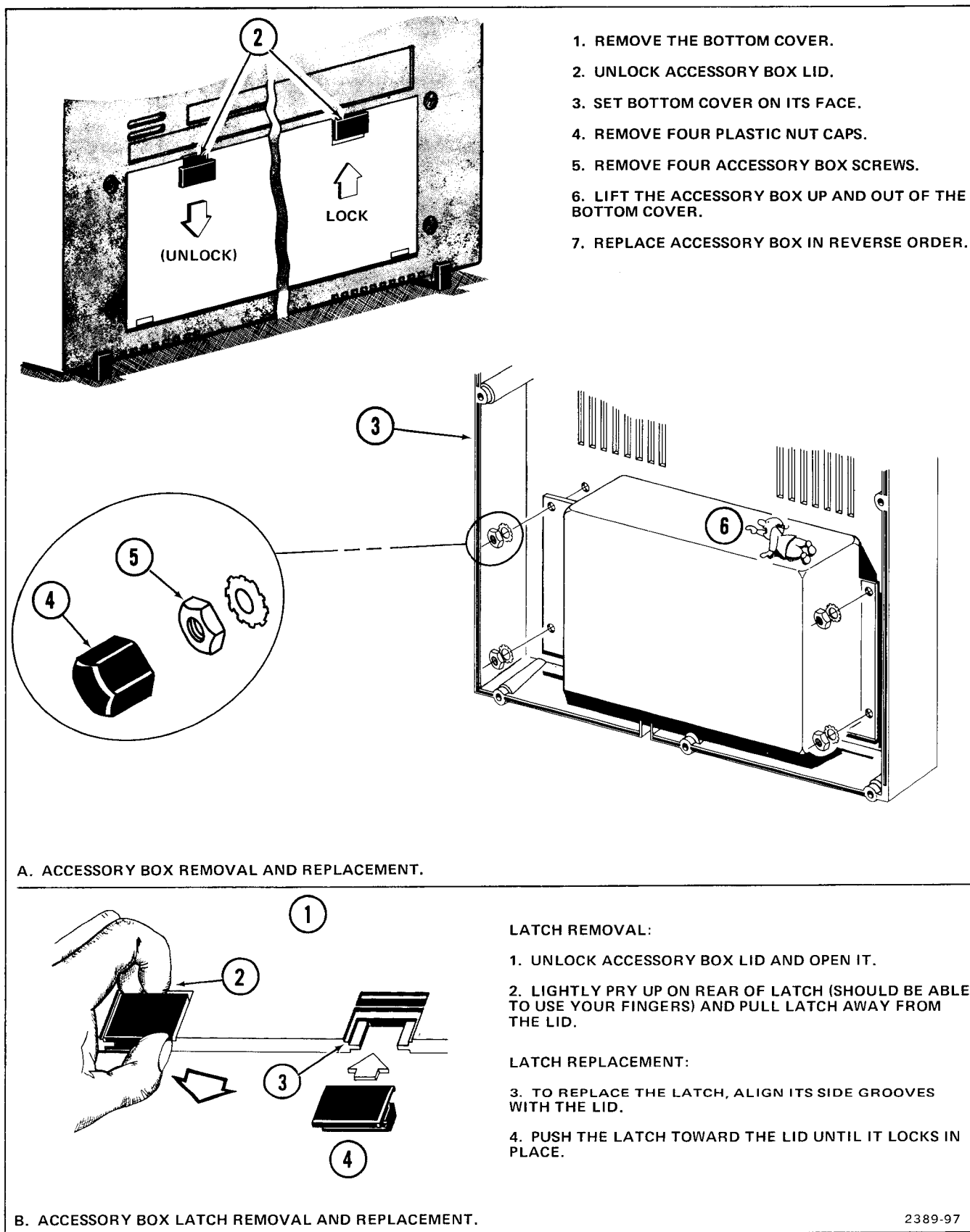


Figure 6-25. Accessory box and latch removal and replacement.



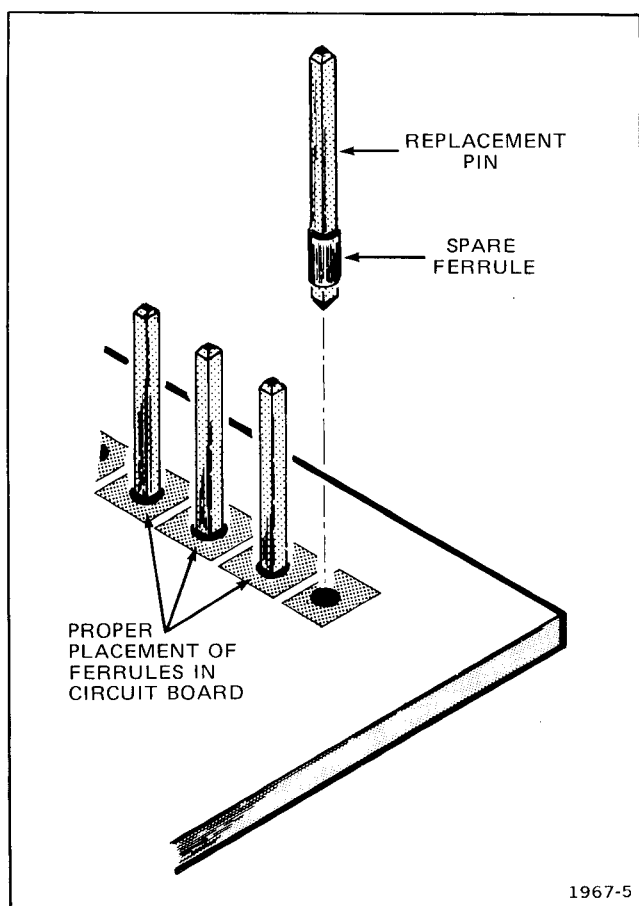


Figure 6-26. Circuit board pin and ferrule.

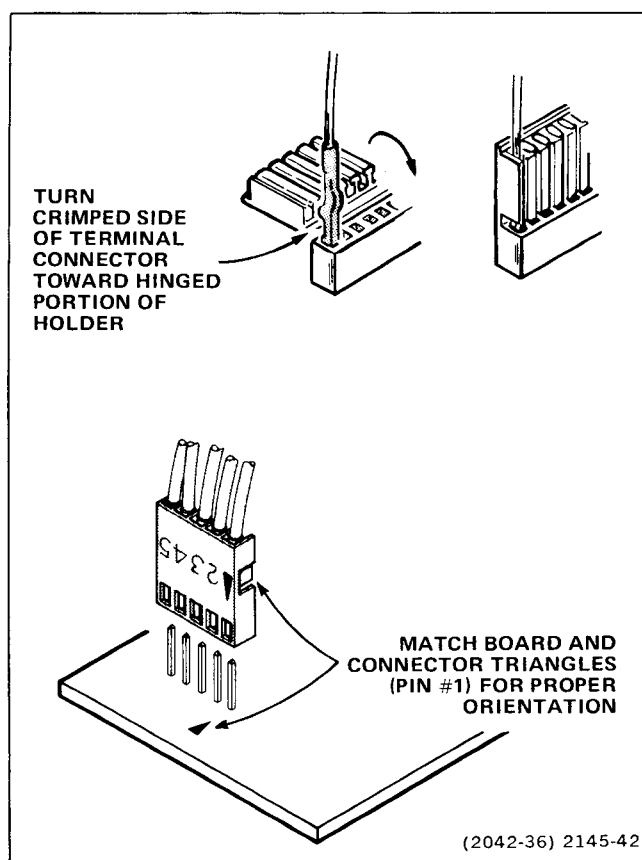


Figure 6-27. Multiconductor terminal connectors.

### Interconnecting Cables and Terminal Connectors

Two of the interconnecting cable assemblies in the instrument consist of multiple-conductor cable with machine-installed terminal connectors, mounted in plastic holders (Figure 6-27). The plastic holders can be replaced easily; however, if the cable is defective it must be replaced as a complete cable assembly. If one of the terminal connectors come loose from the plastic holder, they can be reinstalled as shown. When reinstalling the connector onto the circuit-board pins, be sure to match the triangle on the connector holder with the triangle on the circuit board.

Two other circuit board interconnecting cables are ribbon cables, which are soldered into the circuit board on both ends. Each cable must be replaced as an assembly.

The last interconnecting cable is connected to the RS-232 DTE connector. If defective, this cable and connectors should be replaced as an assembly.

### CALIBRATION AFTER REPAIR

Whenever repairs involve the power supplies or instrument disassembly, the instrument should be calibrated.



# CALIBRATION

This section contains procedures for adjusting the instrument and checking its performance to verify correct operation. These procedures also may be useful as a preliminary troubleshooting aid.

## INTRODUCTION

### CALIBRATION INTERVAL

To ensure correct instrument operation, check calibration every 1000 hours of operation, or every 6 months if used infrequently. Before performing the calibration procedures, perform the preventive maintenance procedures as outlined in the Maintenance section.

### USING THIS PROCEDURE

#### Index

An index precedes the calibration procedure as an aid in locating individual procedures.

#### Control Settings and Test Setups

Control settings and test setups are included at the beginning of each procedure, if required. Titles for external instrument controls are fully capitalized (e.g., BAUD switch) and internal components or adjustments are initial capitalized (e.g., +5 V Adjust).

### EQUIPMENT REQUIRED

The test equipment and accessories required for the calibration procedures are listed in Table 7-1. Test equipment is assumed to be correctly calibrated and operating within its design specifications. Detailed operating instructions for the test equipment are not given in the procedures. Refer to the instruction manual for the test equipment if more information is needed.

TABLE 7-1

Test Equipment, Tools and Accessories

| Description                  | Minimum Specifications                                                                                              | Usage                                    | Example of Applicable Test Equipment     |
|------------------------------|---------------------------------------------------------------------------------------------------------------------|------------------------------------------|------------------------------------------|
| 1. Variable Auto-Transformer | Capable of supplying at least 1A over a range of 90 to 132 volts.                                                   | Check line voltage range.                | General Radio W8MT3VM.                   |
| 2. Digital Tester            | Dc volts range to $\pm 12$ V. Peak voltage range to +13 and -16 volts. Frequency measuring to 10 kHz and 153.6 kHz. | Check Baud Rate Generator.               | Tektronix 851 Digital Tester.            |
| 3. Self Test Adapter         |                                                                                                                     | Used when performing self test routines. | Tektronix Part 067-0878-00.              |
| 4. RS-232 Cable Assembly     |                                                                                                                     | Used when performing self test routines. | Provided as Standard Accessory with 832. |
| 5. Jumper Set                |                                                                                                                     | Used when performing self test routines. | Provided as Standard Accessory with 832. |
| 6. Screw-driver              | Three inch shaft and 3/32 inch bit.                                                                                 | Adjust +5 volt power supply.             | Xcelite R-3323.                          |

## EQUIPMENT PREPARATION

For the best overall performance, the instrument should be calibrated in an ambient temperature of +20° to +30° C (+68° to +86° F).

Remove the instrument bottom cover (see Component Removal and Replacement in the Maintenance section).

**WARNING**

*To prevent electrical shock with the cover removed, do not touch exposed connections or components when the instrument is turned on, or connected to a power source.*

Turn on the instrument and allow it at least five minutes to stabilize in the ambient temperature.

## INDEX TO CALIBRATION PROCEDURES

|                                                                                                                                              | Page |
|----------------------------------------------------------------------------------------------------------------------------------------------|------|
| 1. Adjust +5 Volt Power Supply                                                                                                               | 7-3  |
| 2. Check $\pm 12$ Volt Power Supplies                                                                                                        | 7-3  |
| 3. Check Line Voltage Range                                                                                                                  | 7-3  |
| 4. Check RAM, ROM, USART's and Displays                                                                                                      | 7-4  |
| 5. Check Push-Button Switches and Slide Switches                                                                                             | 7-7  |
| 6. Check BAUD Switch and ASYNC/SYNC Switch                                                                                                   | 7-8  |
| 7. Check Self Test Adapter, RS-232 Cable Assembly, Line Receivers and Drivers, Multiplexers, Breakout Panel DIP Switches and Schmitt Inputs. | 7-8  |
| 8. Check Self Test Signal Source, AUX CLK input, DTE CLK input, DCE CLK input, DTR input and MARKER input.                                   | 7-8  |
| 9. Check Baud Rate Generator                                                                                                                 | 7-9  |
| 10. Transmit Message Check                                                                                                                   | 7-10 |

# PROCEDURES

## 1. ADJUST +5 VOLT POWER SUPPLY

- a. Set the 851 FUNCTION switch to DCV.
- b. Turn on the 832.
- c. Connect the 851 DMM leads between P1173-5 (Figure 7-1) and ground.
- d. ADJUST—R4146 for +5.00 (Figure 7-1).
- e. Disconnect the 851 leads.

## 2. CHECK $\pm 12$ VOLT POWER SUPPLIES AND REFERENCE VOLTAGE PINS

- a. Connect the 851 DMM leads between P1173-4 (Figure 7-1) and ground.
- b. CHECK—Reading is +11.4 to +12.6.

- c. Connect the 851 DMM leads between P1173-2 (Figure 7-1) and ground.

- d. CHECK—Reading is  $-11.4$  to  $-12.6$ .

- e. Connect the 851 DMM leads between each of the +12 V pins and ground on the Breakout Panel.

- f. CHECK—Reading of +11.4 to +12.6 for each pin.

- g. Connect the 851 DMM leads between each of the  $-12$  V pins and ground on the Breakout Panel.

- h. CHECK—Reading of  $-11.4$  to  $-12.6$  for each pin.

- i. Disconnect the 851 leads.

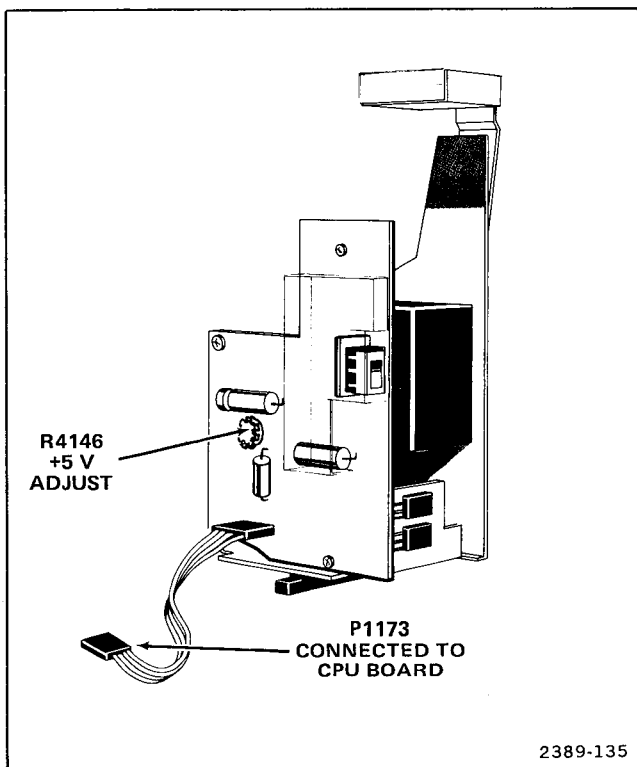


Figure 7-1. Power supply test point and adjustment locations.

## 3. CHECK LINE VOLTAGE RANGES

- a. Set the 832 Line Voltage Selector switch, S4014, to 115 V.
- b. Connect both the 851 Digital Tester and 832 to a power source through the variable auto transformer (variac).
- c. Set the 851 FUNCTION switch to LINE, turn it on and adjust the variac for a reading of 90 volts.
- d. Turn on the 832.
- e. Set the 851 FUNCTION switch to  $-PEAK$  V.
- f. Connect the 851 Probe A to the F4016 side of L4016 (Figure 7-1).
- g. CHECK—Reading is at least +14.5.
- h. Turn off the 832.

**CAUTION**

*When making the next test with the 832 Line Voltage Selector switch set to 230 V, DO NOT apply power to the 832 any longer than necessary, and NOT LONGER THAN ONE MINUTE as the instrument may be damaged.*

- i. Set the 832 Line Voltage Selector switch to 230 V.
- j. Set the 851 FUNCTION switch to LINE.
- k. Adjust the variac to 132 volts.
- l. Set the 851 FUNCTION switch to +PEAK V.
- m. Connect the 851 Probe A to the F4016 side of L4016 (Figure 7-1).
- n. Turn on the 832.
- o. CHECK—Reading is 11.6 to 12.4 volts.
- p. Turn off the 832.
- q. Disconnect the 851 Probe A.
- r. Set the 832 Line Voltage Selector switch to 115 V.
- s. Set the 851 FUNCTION switch to LINE.
- t. Adjust the variac to 111 volts.
- u. Install the bottom cover.

#### 4. CHECK RAM, ROM, USART'S AND DISPLAYS

- a. Turn the 832 off, allow a few seconds for the MPU reset circuit to discharge, then turn on the 832.
- b. CHECK—All LED's except MARK and SPACE are on. All digital display segments and decimal points are on.
- c. Connect a jumper from a +12 V pin to the PROBE pin on the Breakout panel.
- d. CHECK—The SPACE LED is on.
- e. Move the +12 V end of the jumper to -12 on the Breakout Panel.
- f. CHECK—The MARK LED is on.
- g. Disconnect the jumper.

h. Set the BAUD switch to 9.6K and SYNC/ASYNC switch to SYNC.

i. Connect jumpers between pins 2 and 3 and between pin 8 (on the DCE side of the Breakout Panel) and the PROBE pin.

j. Select and start self test routine 0 (F + MODE + 0 + START).

k. CHECK—Displays shown in Figure 7-2 through 7-4 occur.

l. Push STOP.

m. CHECK—An 832 is displayed in the CONTENT display.

n. Remove jumpers.

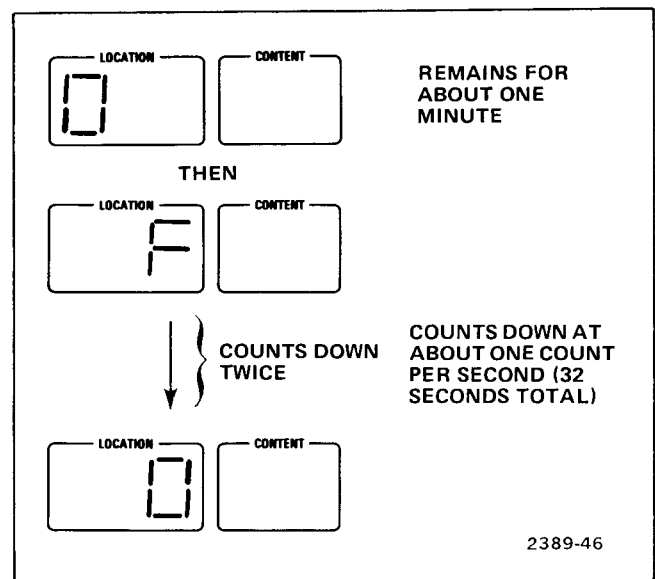


Figure 7-2. RAM check display.

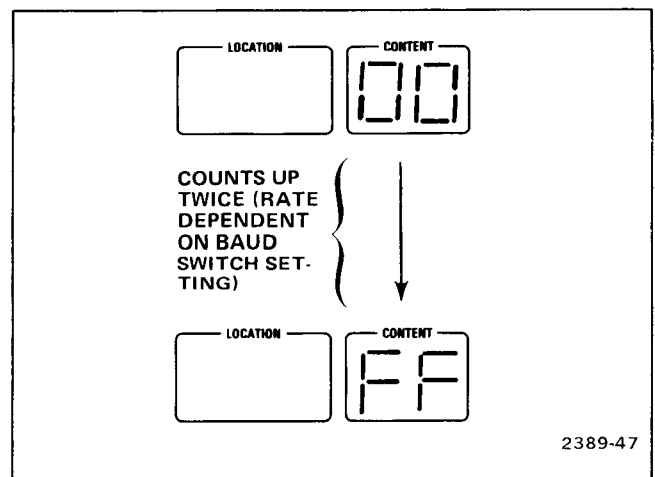
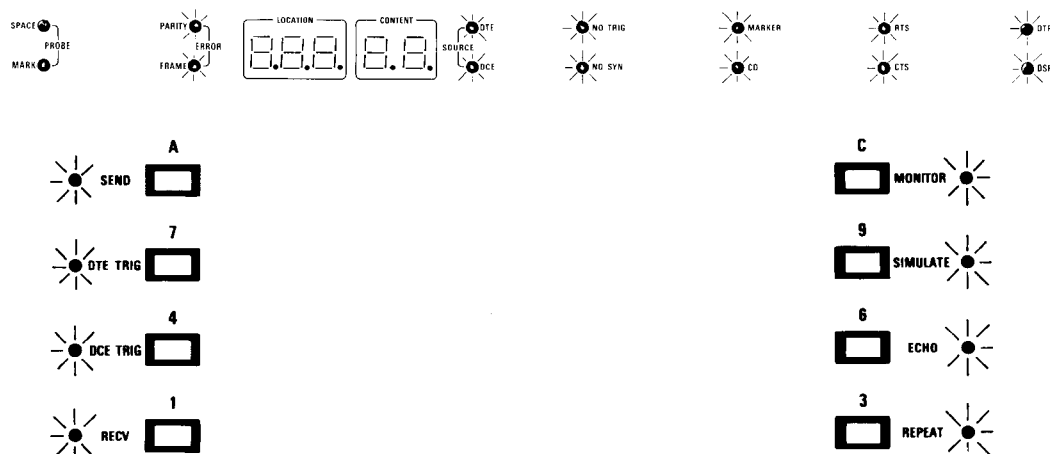
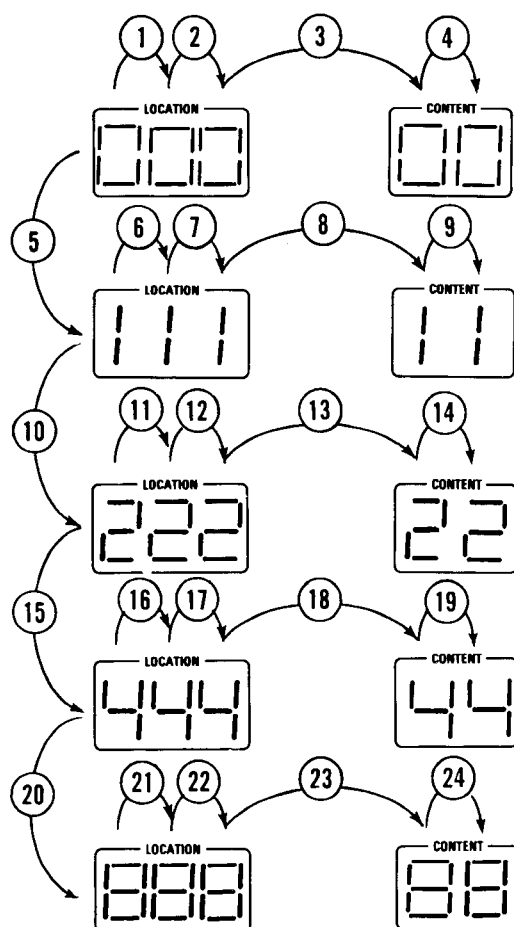


Figure 7-3. USART check display.

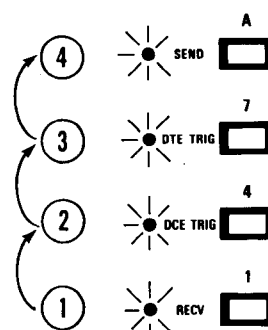
## 1. All digital displays and LED's on.



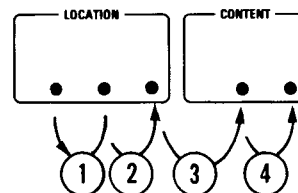
## 2. Digits 0, 1, 2, 4 and 8 sequence through LOCATION and CONTENT display as shown:



## 3. Buffer LED's light in sequence shown:



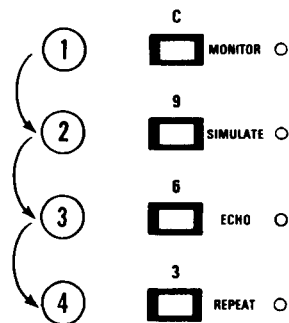
## 4. A decimal point sequences through LOCATION and CONTENT display as shown:



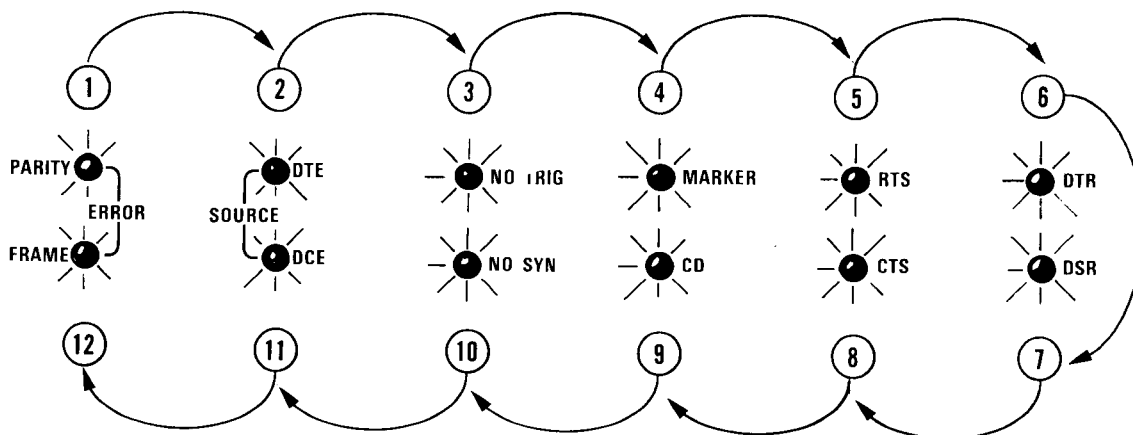
2389-48

Figure 7-4. Display check sequence and displays (sheet 1 of 2).

5. Mode LED's light in sequence shown:

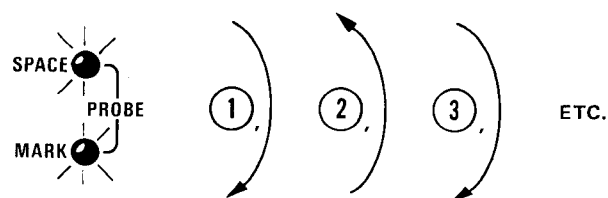


6. Status LED's light in sequence shown:



NOTE

THE PROBE LED'S TOGGLE DURING THE DISPLAY CHECK.



2389-48

Figure 7-4. Display check sequence and displays (sheet 2 of 2).



## 5. CHECK SLIDE SWITCHES AND PUSH-BUTTON SWITCHES

- a. Place all slide switches in their up position.
- b. Select and start self test routine 1 (F + MODE + 1 + START).

c. Select the slide switch positions shown in Table 7-2.

d. CHECK—Displays listed in Table 7-2.

**TABLE 7-2**  
Displays for Slide Switch Position Combinations

| SWITCH POSITIONS | SWITCHES         |                  |                |                  |                        | LOCATION DISPLAYS | SWITCH POSITIONS                                                         | SWITCHES         |                  |                |                  |                        | LOCATION DISPLAYS |
|------------------|------------------|------------------|----------------|------------------|------------------------|-------------------|--------------------------------------------------------------------------|------------------|------------------|----------------|------------------|------------------------|-------------------|
|                  | M E M<br>C O N T | D I S<br>P L A Y | P A R<br>I T Y | H D X<br>/ F D X | A S Y N C<br>/ S Y N C |                   |                                                                          | M E M<br>C O N T | D I S<br>P L A Y | P A R<br>I T Y | H D X<br>/ F D X | A S Y N C<br>/ S Y N C |                   |
| UP               | X                | X                | X              | X                | X                      | 000               | UP                                                                       |                  |                  |                | X                | X                      | 005               |
| MIDDLE           |                  |                  |                |                  |                        |                   | MIDDLE                                                                   |                  |                  | X              |                  |                        |                   |
| DOWN             |                  |                  |                |                  |                        |                   | DOWN                                                                     | X                | X                |                |                  |                        |                   |
| UP               |                  | X                | X              | X                | X                      | 001               | UP                                                                       |                  |                  |                | X                | X                      | 006               |
| MIDDLE           | X                |                  |                |                  |                        |                   | MIDDLE                                                                   |                  |                  |                |                  |                        |                   |
| DOWN             |                  |                  |                |                  |                        |                   | DOWN                                                                     | X                | X                | X              |                  |                        |                   |
| UP               |                  | X                | X              | X                | X                      | 002               | UP                                                                       |                  |                  |                |                  | X                      | 007               |
| MIDDLE           |                  |                  |                |                  |                        |                   | MIDDLE                                                                   |                  |                  |                |                  |                        |                   |
| DOWN             | X                |                  |                |                  |                        |                   | DOWN                                                                     | X                | X                | X              | X                |                        |                   |
| UP               |                  |                  | X              | X                | X                      | 003               | UP                                                                       |                  |                  |                |                  |                        | 008               |
| MIDDLE           |                  | X                |                |                  |                        |                   | MIDDLE                                                                   |                  |                  |                |                  |                        |                   |
| DOWN             | X                |                  |                |                  |                        |                   | DOWN                                                                     | X                | X                | X              | X                | X                      |                   |
| UP               |                  |                  | X              | X                | X                      | 004               | SWITCH MALFUNCTION, OR ANY SWITCH POSITION COMBINATIONS NOT SHOWN ABOVE. |                  |                  |                |                  | 009                    |                   |
| MIDDLE           |                  |                  |                |                  |                        |                   |                                                                          |                  |                  |                |                  |                        |                   |
| DOWN             | X                | X                |                |                  |                        |                   |                                                                          |                  |                  |                |                  |                        |                   |

e. Select the push buttons listed in Table 7-3.

f. CHECK—Displays listed in Table 7-3.

g. Push STOP.

**TABLE 7-3**  
Push-button Self Test Displays

| Push Button | CONTENT Display | Push Button | CONTENT Display |
|-------------|-----------------|-------------|-----------------|
| 0 thru F    | 0 thru F        | TRANSFER    | 16              |
| SYNC        | 10              | CLEAR       | 17              |
| DELAY       | 11              | MODE        | 18              |
| START       | 12              | BUFFER      | 19              |
| BITS/CHAR   | 14              | READ >      | 1A              |
| ENTER       | 15              | READ <      | 1B              |

NOTE: 13 is not used; therefore, there is a sequence break between the display numbers 12 and 14.

## 6. CHECK BAUD SWITCH AND ASYNC/SYNC SWITCH

- a. Select and start self test routine 2 (F + MODE + 2 + START).
- b. Select BAUD switch and ASYNC/SYNC switch positions shown on Table 7-4.
- c. CHECK—Displays listed in Table 7-4.

### NOTE

*The display is sequencing as shown in Figure 2-9, which is visible at BAUD switch settings of 600 and below.*

- d. Push STOP.

**TABLE 7-4**

**BAUD Switch Self Test Displays**

| BAUD Switch Position | LOCATION Display*                                         | Timing Switch Position |
|----------------------|-----------------------------------------------------------|------------------------|
| 50                   | 000                                                       | SYNC                   |
| 75                   | 001                                                       |                        |
| 110                  | 002                                                       |                        |
| 134.5                | 003                                                       |                        |
| 150                  | 004                                                       |                        |
| 200                  | 005                                                       |                        |
| 300                  | 006                                                       |                        |
| 600                  | 007                                                       |                        |
| 1.2K                 | 008                                                       |                        |
| 1.8K                 | 009                                                       |                        |
| 2.4K                 | 010                                                       |                        |
| 4.8K                 | 011                                                       |                        |
| 9.6K                 | 012                                                       |                        |
| DTE                  | None (display is a decimal point in left CONTENT display) | ASYNC                  |
| DCE                  |                                                           |                        |
| 75                   | 008                                                       |                        |
| 110                  | 009                                                       |                        |
| 150                  | 010                                                       |                        |
| 300                  | 011                                                       |                        |
| 600 and above        | 012                                                       |                        |

\*013 is a malfunction display.

## 7. CHECK SELF TEST ADAPTER, RS-232 CABLE ASSEMBLY, LINE RECEIVERS, LINE DRIVERS, MULTIPLEXERS, BREAKOUT PANEL DIP SWITCHES AND SCHMITT INPUTS

- a. Install the Self Test Adapter on the DTE RS-232 connector. Connect the red lead to -12 V and the gray lead to MARKER.
- b. Install the RS-232 Cable Assembly between the Self Test Adapter and the DCE RS-232 connector.
- c. Close all DIP switches on the Breakout Panel.
- d. Select and start self test routine 3 (F + MODE + 3 + START).
- e. CHECK—CONTENT display is 00.
- f. Open, the close each DIP switch.
- g. CHECK—CONTENT displays other than 00, while the switch is open, except for switch 7, which remains 00.
- h. Rotate BAUD switch through all positions.
- i. CHECK—CONTENT display remains 00.

## 8. CHECK SELF TEST SIGNAL SOURCE, AUX CLK INPUT, DTE CLK INPUT, DCE CLK INPUT, DTR INPUT AND MARKER INPUT

- a. Disconnect the gray and red leads of the Self Test Adapter from the MARKER and -12 V pins.
- b. Open Breakout Panel DIP switches 13, 15, 23 and 24.
- c. Select and start self test routine 4 (F + MODE + 4 + START).

### Self Test Signal Source

- d. Connect a jumper from pin 8 to PROBE on the Breakout Panel.
- e. CHECK—Both MARK and SPACE LED's are on.
- f. Disconnect the jumper.

**AUX CLK Input**

- g. Connect jumpers between pin 15 (DCE side) and PROBE, and between pins 8 and 24 (DCE side) on the Breakout Panel.
- h. Set BAUD to DTE (EXT).
- i. CHECK—Both MARK and SPACE LED's are on.
- j. Rotate the BAUD switch through all numbered positions and the DCE (EXT) position.
- k. CHECK—Only one PROBE LED on (may be MARK or SPACE).
- l. Disconnect the jumper between pins 8 and 24.

**DTE CLK Input**

- m. Connect a jumper between pins 8 and 14 on the Breakout Panel.
- n. Set BAUD switch to DTE (EXT).
- o. CHECK—Only one PROBE LED is on (MARK or SPACE).
- p. Rotate the BAUD switch through all numbered positions and the DCE (EXT) position.
- q. CHECK—Both PROBE LED's are on.
- r. Disconnect both jumpers.

**DCE CLK Input**

- s. Connect jumpers between pin 17 and PROBE, and between pins 8 and 16 on the Breakout Panel.
- t. Rotate the BAUD switch through all positions.
- u. CHECK—Both MARK and SPACE LED's are on.
- v. Disconnect all jumpers, the RS-232 Cable Assembly and the Self Test Adapter.

**DTR Input**

- w. Connect a jumper from +12 V to pin 20 on the Breakout Panel.
- x. CHECK—DTR LED is on.
- y. Disconnect the jumper from pin 20 only.
- z. CHECK—DTR LED is off.

**MARKER Input**

- aa. Connect the jumper from +12 V to MARKER.
- ab. CHECK—MARKER LED is on.
- ac. Disconnect the +12 V end of the jumper.
- ad. CHECK—MARKER LED is off.
- ae. Push STOP.
- af. Disconnect both jumpers.
- ag. Close all DIP switches.

**9. CHECK BAUD RATE GENERATOR**

- a. Select the 832 Simulate mode (SIMULATE + MODE).
- b. Set ASYNC/SYNC switch to SYNC and set BAUD switch to 9.6K.
- c. Set the 851 FUNCTION switch to FREQ.
- d. Connect the 851 Probe A to Breakout Panel pin 17.
- e. CHECK—Reading of 9.552 to 9.648 (kHz).
- f. Set ASYNC/SYNC switch to ASYNC.
- g. CHECK—Reading of 152.83 to 154.36 (kHz).
- h. Disconnect the 851 Probe A.

## 10. CHECK TRANSMIT MESSAGE

- a. Select the 832 Simulate mode (SIMULATE + MODE).
- b. Set the HDX/FDX switch to FDX, ASYNC/SYNC switch to ASYNC and the BAUD switch to 300.
- c. Connect a jumper from pin 20 to +12 V on the Breakout Panel.
- d. Load the 0 Buffer into the Send Buffer (0 + BUFFER + TRANSFER).
- e. Push START.
- f. CHECK—The LOCATION display increments from 000 to 064 and stops. During this time the CONTENT display also changes and stops at 0A.

### NOTE

*The rate at which the display changes is determined by the BAUD switch setting.*

- g. Push STOP.
- h. Select the Repeat mode (REPEAT + MODE).
- i. Push START.
- j. The LOCATION display increments from 000 to 255, then starts over again. The CONTENT display is constantly changing showing that the data is changing.
- k. Push STOP.
- l. The LOCATION display is 832.

# INSTRUMENT OPTIONS

Your instrument may be equipped with one or more instrument options. The information for these options was not available for early instrument manuals; therefore, when the options are installed in your instrument, you may receive an option information insert (in the Change Information section at the back of this manual or in a separate manual), or a new manual with the information in the Options section, depending on which is available at the time.

[illegible]

# REPLACEABLE ELECTRICAL PARTS

## PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

## SPECIAL NOTES AND SYMBOLS

X000 Part first added at this serial number  
00X Part removed after this serial number

## ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

## ABBREVIATIONS

|        |                      |          |                 |
|--------|----------------------|----------|-----------------|
| ACTR   | ACTUATOR             | PLSTC    | PLASTIC         |
| ASSY   | ASSEMBLY             | QTZ      | QUARTZ          |
| CAP    | CAPACITOR            | RECP     | RECEPTACLE      |
| CER    | CERAMIC              | RES      | RESISTOR        |
| CKT    | CIRCUIT              | RF       | RADIO FREQUENCY |
| COMP   | COMPOSITION          | SEL      | SELECTED        |
| CONN   | CONNECTOR            | SEMICOND | SEMICONDUCTOR   |
| ELCTLT | ELECTROLYTIC         | SENS     | SENSITIVE       |
| ELEC   | ELECTRICAL           | VAR      | VARIABLE        |
| INCAND | INCANDESCENT         | WW       | WIREWOUND       |
| LED    | LIGHT EMITTING DIODE | XFMR     | TRANSFORMER     |
| NONWIR | NON WIREWOUND        | XTAL     | CRYSTAL         |

## CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

| Mfr. Code | Manufacturer                                                             | Address                                  | City, State, Zip          |
|-----------|--------------------------------------------------------------------------|------------------------------------------|---------------------------|
| 00779     | AMP, INC.                                                                | P O BOX 3608                             | HARRISBURG, PA 17105      |
| 01121     | ALLEN-BRADLEY COMPANY                                                    | 1201 2ND STREET SOUTH                    | MILWAUKEE, WI 53204       |
| 01295     | TEXAS INSTRUMENTS, INC., SEMICONDUCTOR GROUP                             | P O BOX 5012, 13500 N CENTRAL EXPRESSWAY | DALLAS, TX 75222          |
| 03508     | GENERAL ELECTRIC COMPANY, SEMI-CONDUCTOR PRODUCTS DEPARTMENT             | ELECTRONICS PARK                         | SYRACUSE, NY 13201        |
| 04222     | AVX CERAMICS, DIVISION OF AVX CORP.                                      | P O BOX 867, 19TH AVE. SOUTH             | MYRTLE BEACH, SC 29577    |
| 04713     | MOTOROLA, INC., SEMICONDUCTOR PROD. DIV.                                 | 5005 E MCDOWELL RD, PO BOX 20923         | PHOENIX, AZ 85036         |
| 07263     | FAIRCHILD SEMICONDUCTOR, A DIV. OF FAIRCHILD CAMERA AND INSTRUMENT CORP. | 464 ELLIS STREET                         | MOUNTAIN VIEW, CA 94042   |
| 14433     | ITT SEMICONDUCTORS                                                       | 3301 ELECTRONICS WAY<br>P O BOX 3049     | WEST PALM BEACH, FL 33402 |
| 27014     | NATIONAL SEMICONDUCTOR CORP.                                             | 2900 SEMICONDUCTOR DR.                   | SANTA CLARA, CA 95051     |
| 33096     | COLORADO CRYSTAL CORPORATION                                             | 2303 W 8TH STREET                        | LOVELAND, CO 80537        |
| 34335     | ADVANCED MICRO DEVICES                                                   | 901 THOMPSON PL.                         | SUNNYVALE, CA 94086       |
| 50434     | HEWLETT-PACKARD COMPANY                                                  | 640 PAGE MILL ROAD                       | PALO ALTO, CA 94304       |
| 50522     | MONSANTO CO., ELECTRONIC SPECIAL PRODUCTS                                | 3400 HILLVIEW AVENUE                     | PALO ALTO, CA 94304       |
| 54473     | MATSUSHITA ELECTRIC, CORP. OF AMERICA                                    | 1 PANASONIC WAY                          | SECAUCUS, NJ 07094        |
| 56289     | SPRAGUE ELECTRIC CO.                                                     |                                          | NORTH ADAMS, MA 01247     |
| 71400     | BUSSMAN MFG., DIVISION OF MCGRAW-EDISON CO.                              | 2536 W. UNIVERSITY ST.                   | ST. LOUIS, MO 63107       |
| 72982     | ERIE TECHNOLOGICAL PRODUCTS, INC.                                        | 644 W. 12TH ST.                          | ERIE, PA 16512            |
| 73138     | BECKMAN INSTRUMENTS, INC., HELIPOT DIV.                                  | 2500 HARBOR BLVD.                        | FULLERTON, CA 92634       |
| 75915     | LITTELFUSE, INC.                                                         | 800 E. NORTHWEST HWY                     | DES PLAINES, IL 60016     |
| 80009     | TEKTRONIX, INC.                                                          | P O BOX 500                              | BEAVERTON, OR 97077       |
| 82389     | SWITCHCRAFT, INC.                                                        | 5555 N. ELSTON AVE.                      | CHICAGO, IL 60630         |
| 91637     | DALE ELECTRONICS, INC.                                                   | P. O. BOX 609                            | COLUMBUS, NE 68601        |



| Ckt No. | Tektronix<br>Part No. | Serial/Model No.<br>Eff Dscont | Name & Description                 | Mfr<br>Code | Mfr Part Number  |
|---------|-----------------------|--------------------------------|------------------------------------|-------------|------------------|
| A1      | 670-5318-00           | B010100 B019999                | CKT BOARD ASSY:PROCESSOR           | 80009       | 670-5318-00      |
| A1      | 670-5318-01           | B020000                        | CKT BOARD ASSY:PROCESSOR           | 80009       | 670-5318-01      |
| A2      | 670-5317-00           |                                | CKT BOARD ASSY:CONTROL             | 80009       | 670-5317-00      |
| A3      | 670-5382-00           |                                | CKT BOARD ASSY:DISPLAY             | 80009       | 670-5382-00      |
| A4      | -----                 |                                | CKT BOARD ASSY:BAUD RATE           |             |                  |
|         | -----                 |                                | (NOT REPLACEABLE, SEE S2190)       |             |                  |
| A5      | 670-5319-00           |                                | CKT BOARD ASSY:POWER SUPPLY        | 80009       | 670-5319-00      |
| A6      | 670-5620-00           |                                | CKT BOARD ASSY:110/220 SWITCH      | 80009       | 670-5620-00      |
| C1026   | 281-0775-00           |                                | CAP.,FXD,CER DI:0.1UF,20%,50V      | 72982       | 8005D9AABZ5U104M |
| C1032   | 281-0762-00           |                                | CAP.,FXD,CER DI:27PF,20%,100V      | 72982       | 8035D9AADC0G270M |
| C1038   | 281-0775-00           |                                | CAP.,FXD,CER DI:0.1UF,20%,50V      | 72982       | 8005D9AABZ5U104M |
| C1045   | 283-0203-00           |                                | CAP.,FXD,CER DI:0.47UF,20%,50V     | 72982       | 8131N075 E474M   |
| C1046   | 290-0525-00           |                                | CAP.,FXD,ELCTLT:4.7UF,20%,50V      | 56289       | 196D475X0050KA1  |
| C1129   | 281-0775-00           |                                | CAP.,FXD,CER DI:0.1UF,20%,50V      | 72982       | 8005D9AABZ5U104M |
| C1167   | 281-0775-00           |                                | CAP.,FXD,CER DI:0.1UF,20%,50V      | 72982       | 8005D9AABZ5U104M |
| C1178   | 281-0775-00           |                                | CAP.,FXD,CER DI:0.1UF,20%,50V      | 72982       | 8005D9AABZ5U104M |
| C1205   | 281-0775-00           |                                | CAP.,FXD,CER DI:0.1UF,20%,50V      | 72982       | 8005D9AABZ5U104M |
| C1305   | 281-0775-00           |                                | CAP.,FXD,CER DI:0.1UF,20%,50V      | 72982       | 8005D9AABZ5U104M |
| C1339   | 281-0775-00           |                                | CAP.,FXD,CER DI:0.1UF,20%,50V      | 72982       | 8005D9AABZ5U104M |
| C1356   | 281-0775-00           |                                | CAP.,FXD,CER DI:0.1UF,20%,50V      | 72982       | 8005D9AABZ5U104M |
| C1378   | 281-0775-00           |                                | CAP.,FXD,CER DI:0.1UF,20%,50V      | 72982       | 8005D9AABZ5U104M |
| C1401   | 281-0775-00           |                                | CAP.,FXD,CER DI:0.1UF,20%,50V      | 72982       | 8005D9AABZ5U104M |
| C1402   | 281-0775-00           |                                | CAP.,FXD,CER DI:0.1UF,20%,50V      | 72982       | 8005D9AABZ5U104M |
| C1428   | 281-0775-00           |                                | CAP.,FXD,CER DI:0.1UF,20%,50V      | 72982       | 8005D9AABZ5U104M |
| C1438   | 281-0775-00           |                                | CAP.,FXD,CER DI:0.1UF,20%,50V      | 72982       | 8005D9AABZ5U104M |
| C1451   | 281-0775-00           |                                | CAP.,FXD,CER DI:0.1UF,20%,50V      | 72982       | 8005D9AABZ5U104M |
| C1461   | 281-0775-00           |                                | CAP.,FXD,CER DI:0.1UF,20%,50V      | 72982       | 8005D9AABZ5U104M |
| C1471   | 281-0775-00           |                                | CAP.,FXD,CER DI:0.1UF,20%,50V      | 72982       | 8005D9AABZ5U104M |
| C1478   | 281-0775-00           |                                | CAP.,FXD,CER DI:0.1UF,20%,50V      | 72982       | 8005D9AABZ5U104M |
| C2011   | 281-0775-00           |                                | CAP.,FXD,CER DI:0.1UF,20%,50V      | 72982       | 8005D9AABZ5U104M |
| C2063   | 281-0775-00           |                                | CAP.,FXD,CER DI:0.1UF,20%,50V      | 72982       | 8005D9AABZ5U104M |
| C2378   | 281-0775-00           |                                | CAP.,FXD,CER DI:0.1UF,20%,50V      | 72982       | 8005D9AABZ5U104M |
| C3069   | 281-0775-00           |                                | CAP.,FXD,CER DI:0.1UF,20%,50V      | 72982       | 8005D9AABZ5U104M |
| C3141   | 281-0775-00           |                                | CAP.,FXD,CER DI:0.1UF,20%,50V      | 72982       | 8005D9AABZ5U104M |
| C3191   | 281-0775-00           |                                | CAP.,FXD,CER DI:0.1UF,20%,50V      | 72982       | 8005D9AABZ5U104M |
| C4031   | 290-0782-00           |                                | CAP.,FXD,ELCTLT:4.7UF,+75-10%,35V  | 56289       | 503D475G035AS    |
| C4115   | 290-0782-00           |                                | CAP.,FXD,ELCTLT:4.7UF,+75-10%,35V  | 56289       | 503D475G035AS    |
| C4116   | 290-0839-00           |                                | CAP.,FXD,ELCTLT:330UF,+50-10%,35V  | 54473       | ECE-B35V330LS    |
| C4123   | 285-0894-00           |                                | CAP.,FXD,PLSTC:5UF,5%,50V          | 56289       | LP68A1A505J      |
| C4124   | 290-0838-00           |                                | CAP.,FXD,ELCTLT:2200UF,+50-10%,35V | 54473       | ECE-B1VV222S     |
| C4125   | 290-0299-01           |                                | CAP.,FXD,ELCTLT:330UF,20%,10V      | 56289       | 0BD              |
| C4134   | 281-0809-00           |                                | CAP.,FXD,CER DI:200PF,5%,100V      | 72982       | 8013T2ADDC1G201J |
| C4221   | 281-0775-00           |                                | CAP.,FXD,CER DI:0.1UF,20%,50V      | 72982       | 8005D9AABZ5U104M |
| C4222   | 281-0775-00           |                                | CAP.,FXD,CER DI:0.1UF,20%,50V      | 72982       | 8005D9AABZ5U104M |
| C4229   | 283-0134-00           |                                | CAP.,FXD,CER DI:0.47UF,+80-20%,50V | 72982       | 8131N087Z5U0474Z |
| C4231   | 290-0782-00           |                                | CAP.,FXD,ELCTLT:4.7UF,+75-10%,35V  | 56289       | 503D475G035AS    |
| C4234   | 290-0782-00           |                                | CAP.,FXD,ELCTLT:4.7UF,+75-10%,35V  | 56289       | 503D475G035AS    |
| CR1044  | 152-0141-02           |                                | SEMICONV DEVICE:SILICON,30V,50NA   | 01295       | 1N4152R          |
| CR1304  | 152-0075-00           |                                | SEMICONV DEVICE:GE,25V,40MA        | 14433       | G866             |
| CR2075  | 152-0141-02           |                                | SEMICONV DEVICE:SILICON,30V,50NA   | 01295       | 1N4152R          |
| CR2108  | 152-0141-02           |                                | SEMICONV DEVICE:SILICON,30V,50NA   | 01295       | 1N4152R          |
| CR2147  | 152-0141-02           |                                | SEMICONV DEVICE:SILICON,30V,50NA   | 01295       | 1N4152R          |
| CR2238  | 152-0141-02           |                                | SEMICONV DEVICE:SILICON,30V,50NA   | 01295       | 1N4152R          |
| CR2253  | 152-0141-02           |                                | SEMICONV DEVICE:SILICON,30V,50NA   | 01295       | 1N4152R          |
| CR2254  | 152-0141-02           |                                | SEMICONV DEVICE:SILICON,30V,50NA   | 01295       | 1N4152R          |
| CR2268  | 152-0141-02           |                                | SEMICONV DEVICE:SILICON,30V,50NA   | 01295       | 1N4152R          |

# Replaceable Electrical Parts—832

| Ckt No. | Tektronix Part No. | Serial/Model No. Eff | Dscont  | Name & Description                                             | Mfr Code | Mfr Part Number |
|---------|--------------------|----------------------|---------|----------------------------------------------------------------|----------|-----------------|
| CR3011  | 152-0141-02        |                      |         | SEMICON D DEVICE:SILICON,30V,50NA                              | 01295    | 1N4152R         |
| CR3012  | 152-0141-02        |                      |         | SEMICON D DEVICE:SILICON,30V,50NA                              | 01295    | 1N4152R         |
| CR4027  | 152-0582-00        |                      |         | SEMICON D DEVICE:SILICON,20V,3A                                | 80009    | 152-0582-00     |
| CR4035  | 152-0066-00        |                      |         | SEMICON D DEVICE:SILICON,400V,750MA                            | 14433    | LG4016          |
| CR4111  | 152-0066-00        |                      |         | SEMICON D DEVICE:SILICON,400V,750MA                            | 14433    | LG4016          |
| CR4112  | 152-0066-00        |                      |         | SEMICON D DEVICE:SILICON,400V,750MA                            | 14433    | LG4016          |
| CR4113  | 152-0066-00        |                      |         | SEMICON D DEVICE:SILICON,400V,750MA                            | 14433    | LG4016          |
| CR4114  | 152-0066-00        |                      |         | SEMICON D DEVICE:SILICON,400V,750MA                            | 14433    | LG4016          |
| CR4115  | 152-0066-00        |                      |         | SEMICON D DEVICE:SILICON,400V,750MA                            | 14433    | LG4016          |
| DS2208  | 150-1036-00        | B010100              | B010189 | LAMP,LED:RED,3.0V,40MA                                         | 01295    | TIL 209A        |
| DS2208  | 150-1061-00        | B010190              |         | LT EMITTING DIO:RED 660NM,50MA MAX                             | 50434    | NSL5086         |
| DS2238  | 150-1036-00        | B010100              | B010189 | LAMP,LED:RED,3.0V,40MA                                         | 01295    | TIL 209A        |
| DS2238  | 150-1061-00        | B010190              |         | LT EMITTING DIO:RED 660NM,50MA,MAS                             | 50434    | NSL5086         |
| DS2308  | 150-1036-00        | B010100              | B010189 | LAMP,LED:RED,3.0V,40MA                                         | 01295    | TIL 209A        |
| DS2308  | 150-1061-00        | B010190              |         | LT EMITTING DIO:RED 660NM,50MA MAX                             | 50434    | NSL5086         |
| DS2338  | 150-1036-00        | B010100              | B010189 | LAMP,LED:RED,3.0V,40MA                                         | 01295    | TIL 209A        |
| DS2338  | 150-1061-00        | B010190              |         | LT EMITTING DIO:RED 660NM,50MA MAX                             | 50434    | NSL5086         |
| DS2408  | 150-1036-00        | B010100              | B010189 | LAMP,LED:RED,3.0V,40MA                                         | 01295    | TIL 209A        |
| DS2408  | 150-1061-00        | B010190              |         | LT EMITTING DIO:RED 660NM,50MA MAX                             | 50434    | NSL5086         |
| DS2438  | 150-1036-00        | B010100              | B010189 | LAMP,LED:RED,3.0V,40MA                                         | 01295    | TIL 209A        |
| DS2438  | 150-1061-00        | B010190              |         | LT EMITTING DIO:RED 660NM,50MA MAX                             | 50434    | NSL5086         |
| DS2508  | 150-1036-00        | B010100              | B010189 | LAMP,LED:RED,3.0V,40MA                                         | 01295    | TIL 209A        |
| DS2508  | 150-1061-00        | B010190              |         | LT EMITTING DIO:RED 660NM,50MA MAX                             | 50434    | NSL5086         |
| DS2538  | 150-1036-00        | B010100              | B010189 | LAMP,LED:RED,3.0V,40MA                                         | 01295    | TIL 209A        |
| DS2538  | 150-1061-00        | B010190              |         | LT EMITTING DIO:RED 660NM,50MA MAX                             | 50434    | NSL5086         |
| DS3010  | 150-1036-00        | B010100              | B010189 | LAMP,LED:RED,3.0V,40MA                                         | 01295    | TIL 209A        |
| DS3010  | 150-1061-00        | B010190              |         | LT EMITTING DIO:RED 660NM,50MA MAX                             | 50434    | NSL5086         |
| DS3020  | 150-1036-00        | B010100              | B010189 | LAMP,LED:RED,3.0V,40MA                                         | 01295    | TIL 209A        |
| DS3020  | 150-1061-00        | B010190              |         | LT EMITTING DIO:RED 660NM,50MA MAX                             | 50434    | NSL5086         |
| DS3040  | 150-1036-00        | B010100              | B010189 | LAMP,LED:RED,3.0V,40MA                                         | 01295    | TIL 209A        |
| DS3040  | 150-1061-00        | B010190              |         | LT EMITTING DIO:RED 660NM,50MA MAX                             | 50434    | NSL5086         |
| DS3050  | 150-1036-00        | B010100              | B010189 | LAMP,LED:RED,3.0V,40MA                                         | 01295    | TIL 209A        |
| DS3050  | 150-1061-00        | B010190              |         | LT EMITTING DIO:RED 660NM,50MA MAX                             | 50434    | NSL5086         |
| DS3060  | 150-1036-00        | B010100              | B010189 | LAMP,LED:RED,3.0V,40MA                                         | 01295    | TIL 209A        |
| DS3060  | 150-1061-00        | B010190              |         | LT EMITTING DIO:RED 660NM,50MA MAX                             | 50434    | NSL5086         |
| DS3070  | 150-1036-00        | B010100              | B010189 | LAMP,LED:RED,3.0V,40MA                                         | 01295    | TIL 209A        |
| DS3070  | 150-1061-00        | B010190              |         | LT EMITTING DIO:RED 660NM,50MA MAX                             | 50434    | NSL5086         |
| DS3090  | 150-1036-00        | B010100              | B010189 | LAMP,LED:RED,3.0V,40MA                                         | 01295    | TIL 209A        |
| DS3090  | 150-1061-00        | B010190              |         | LT EMITTING DIO:RED 660NM,50MA MAX                             | 50434    | NSL5086         |
| DS3110  | 150-1036-00        | B010100              | B010189 | LAMP,LED:RED,3.0V,40MA                                         | 01295    | TIL 209A        |
| DS3110  | 150-1061-00        | B010190              |         | LT EMITTING DIO:RED 660NM,50MA MAX                             | 50434    | NSL5086         |
| DS3120  | 150-1036-00        | B010100              | B010189 | LAMP,LED:RED,3.0V,40MA                                         | 01295    | TIL 209A        |
| DS3120  | 150-1061-00        | B010190              |         | LT EMITTING DIO:RED 660NM,50MA MAX                             | 50434    | NSL5086         |
| DS3140  | 150-1036-00        | B010100              | B010189 | LAMP,LED:RED,3.0V,40MA                                         | 01295    | TIL 209A        |
| DS3140  | 150-1061-00        | B010190              |         | LT EMITTING DIO:RED 660NM,50MA MAX                             | 50434    | NSL5086         |
| DS3150  | 150-1036-00        | B010100              | B010189 | LAMP,LED:RED,3.0V,40MA                                         | 01295    | TIL 209A        |
| DS3150  | 150-1061-00        | B010190              |         | LT EMITTING DIO:RED 660NM,50MA MAX                             | 50434    | NSL5086         |
| DS3160  | 150-1036-00        | B010100              | B010189 | LAMP,LED:RED,3.0V,40MA                                         | 01295    | TIL 209A        |
| DS3160  | 150-1061-00        | B010190              |         | LT EMITTING DIO:RED 660NM,50MA MAX                             | 50434    | NSL5086         |
| DS3170  | 150-1036-00        | B010100              | B010189 | LAMP,LED:RED,3.0V,40MA                                         | 01295    | TIL 209A        |
| DS3170  | 150-1061-00        | B010190              |         | LT EMITTING DIO:RED 660NM,50MA MAX                             | 50434    | NSL5086         |
| DS3190  | 150-1036-00        | B010100              | B010189 | LAMP,LED:RED,3.0V,40MA                                         | 01295    | TIL 209A        |
| DS3190  | 150-1061-00        | B010190              |         | LT EMITTING DIO:RED 660NM,50MA MAX                             | 50434    | NSL5086         |
| F4005   | 159-0044-00        |                      |         | FUSE,CARTRIDGE:3AG,0.2A,250V,SLOW-BLOW<br>(110 VOLT OPERATION) | 71400    | MDL 2/10        |
| F4016   | 159-0042-00        |                      |         | FUSE,CARTRIDGE:3AG,0.75A,250V,FAST-BLOW                        | 71400    | AGC 3/4         |
| F4016   | -----              |                      |         | (220 VOLT OPERATION)                                           |          |                 |

| Ckt No. | Tektronix<br>Part No. | Serial/Model No.<br>Eff | Dscont  | Name & Description                    | Mfr<br>Code | Mfr Part Number |
|---------|-----------------------|-------------------------|---------|---------------------------------------|-------------|-----------------|
| L4016   | 108-0337-00           |                         |         | COIL, RF: 25UH                        | 80009       | 108-0337-00     |
| Q2135   | 151-0220-00           |                         |         | TRANSISTOR: SILICON, PNP              | 80009       | 151-0220-00     |
| Q2161   | 151-0220-00           |                         |         | TRANSISTOR: SILICON, PNP              | 80009       | 151-0220-00     |
| Q2162   | 151-0220-00           |                         |         | TRANSISTOR: SILICON, PNP              | 80009       | 151-0220-00     |
| Q2235   | 151-0220-00           |                         |         | TRANSISTOR: SILICON, PNP              | 80009       | 151-0220-00     |
| Q2335   | 151-0220-00           |                         |         | TRANSISTOR: SILICON, PNP              | 80009       | 151-0220-00     |
| Q3014   | 151-0432-00           |                         |         | TRANSISTOR: SILICON, NPN              | 80009       | 151-0432-00     |
| Q3114   | 151-0342-00           |                         |         | TRANSISTOR: SILICON, PNP              | 80009       | 151-0342-00     |
| Q4028   | 151-0625-00           |                         |         | TRANSISTOR: SILICON, PNP              | 03508       | D45H11          |
| Q4034   | 151-0208-00           |                         |         | TRANSISTOR: SILICON, PNP              | 80009       | 151-0208-00     |
| Q4128   | 151-0190-00           |                         |         | TRANSISTOR: SILICON, NPN              | 07263       | S032677         |
| Q4130   | 151-0190-00           |                         |         | TRANSISTOR: SILICON, NPN              | 07263       | S032677         |
| Q4226   | 151-0506-00           |                         |         | SCR: SILICON                          | 03508       | C106B2X283      |
| R1004   | 321-0410-00           |                         |         | RES., FXD, FILM: 182K OHM, 1%, 0.125W | 91637       | MFF1816G18202F  |
| R1005   | 315-0563-00           |                         |         | RES., FXD, CMPSN: 56K OHM, 5%, 0.25W  | 01121       | CB5635          |
| R1007   | 321-0393-00           |                         |         | RES., FXD, FILM: 121K OHM, 1%, 0.125W | 91637       | MFF1816G12102F  |
| R1008   | 315-0184-00           |                         |         | RES., FXD, CMPSN: 180K OHM, 5%, 0.25W | 01121       | CB1845          |
| R1012   | 321-0393-00           |                         |         | RES., FXD, FILM: 121K OHM, 1%, 0.125W | 91637       | MFF1816G12102F  |
| R1014   | 315-0184-00           |                         |         | RES., FXD, CMPSN: 180K OHM, 5%, 0.25W | 01121       | CB1845          |
| R1016   | 321-0393-00           |                         |         | RES., FXD, FILM: 121K OHM, 1%, 0.125W | 91637       | MFF1816G12102F  |
| R1017   | 315-0184-00           |                         |         | RES., FXD, CMPSN: 180K OHM, 5%, 0.25W | 01121       | CB1845          |
| R1018   | 321-0410-00           |                         |         | RES., FXD, FILM: 182K OHM, 1%, 0.125W | 91637       | MFF1816G18202F  |
| R1019   | 315-0164-00           |                         |         | RES., FXD, CMPSN: 160K OHM, 5%, 0.25W | 01121       | CB1645          |
| R1020   | 315-0512-00           |                         |         | RES., FXD, CMPSN: 5.1K OHM, 5%, 0.25W | 01121       | CB5125          |
| R1021   | 315-0392-00           |                         |         | RES., FXD, CMPSN: 3.9K OHM, 5%, 0.25W | 01121       | CB3925          |
| R1022   | 315-0392-00           |                         |         | RES., FXD, CMPSN: 3.9K OHM, 5%, 0.25W | 01121       | CB3925          |
| R1023   | 315-0392-00           |                         |         | RES., FXD, CMPSN: 3.9K OHM, 5%, 0.25W | 01121       | CB3925          |
| R1024   | 315-0392-00           |                         |         | RES., FXD, CMPSN: 3.9K OHM, 5%, 0.25W | 01121       | CB3925          |
| R1025   | 315-0392-00           |                         |         | RES., FXD, CMPSN: 3.9K OHM, 5%, 0.25W | 01121       | CB3925          |
| R1032   | 315-0392-00           |                         |         | RES., FXD, CMPSN: 3.9K OHM, 5%, 0.25W | 01121       | CB3925          |
| R1037   | 315-0392-00           |                         |         | RES., FXD, CMPSN: 3.9K OHM, 5%, 0.25W | 01121       | CB3925          |
| R1038   | 315-0392-00           |                         |         | RES., FXD, CMPSN: 3.9K OHM, 5%, 0.25W | 01121       | CB3925          |
| R1042   | 315-0203-00           |                         |         | RES., FXD, CMPSN: 20K OHM, 5%, 0.25W  | 01121       | CB2035          |
| R1044   | 315-0103-00           | B010100                 | B019999 | RES., FXD, CMPSN: 10K OHM, 5%, 0.25W  | 01121       | CB1035          |
| R1044   | 315-0512-00           | B020000                 |         | RES., FXD, CMPSN: 5.1K OHM, 5%, 0.25W | 01121       | CB5125          |
| R1045   | 315-0512-00           | XB020000                |         | RES., FXD, CMPSN: 5.1K OHM, 5%, 0.25W | 01121       | CB5125          |
| R1046   | 315-0302-00           |                         |         | RES., FXD, CMPSN: 3K OHM, 5%, 0.25W   | 01121       | CB3025          |
| R1047   | 315-0302-00           |                         |         | RES., FXD, CMPSN: 3K OHM, 5%, 0.25W   | 01121       | CB3025          |
| R1049   | 315-0203-00           |                         |         | RES., FXD, CMPSN: 20K OHM, 5%, 0.25W  | 01121       | CB2035          |
| R1066   | 315-0151-00           |                         |         | RES., FXD, CMPSN: 150 OHM, 5%, 0.25W  | 01121       | CB1515          |
| R1067   | 315-0151-00           |                         |         | RES., FXD, CMPSN: 150 OHM, 5%, 0.25W  | 01121       | CB1515          |
| R1074   | 315-0102-00           |                         |         | RES., FXD, CMPSN: 1K OHM, 5%, 0.25W   | 01121       | CB1025          |
| R1112   | 315-0164-00           |                         |         | RES., FXD, CMPSN: 160K OHM, 5%, 0.25W | 01121       | CB1645          |
| R1115   | 315-0164-00           |                         |         | RES., FXD, CMPSN: 160K OHM, 5%, 0.25W | 01121       | CB1645          |
| R1121   | 321-0410-00           |                         |         | RES., FXD, FILM: 182K OHM, 1%, 0.125W | 91637       | MFF1816G18202F  |
| R1165   | 315-0103-00           |                         |         | RES., FXD, CMPSN: 10K OHM, 5%, 0.25W  | 01121       | CB1035          |
| R1215   | 315-0103-00           |                         |         | RES., FXD, CMPSN: 10K OHM, 5%, 0.25W  | 01121       | CB1035          |
| R1275   | 315-0103-00           |                         |         | RES., FXD, CMPSN: 10K OHM, 5%, 0.25W  | 01121       | CB1035          |
| R1312   | 315-0103-00           |                         |         | RES., FXD, CMPSN: 10K OHM, 5%, 0.25W  | 01121       | CB1035          |
| R1313   | 315-0103-00           |                         |         | RES., FXD, CMPSN: 10K OHM, 5%, 0.25W  | 01121       | CB1035          |
| R1314   | 315-0103-00           |                         |         | RES., FXD, CMPSN: 10K OHM, 5%, 0.25W  | 01121       | CB1035          |
| R1315   | 315-0103-00           |                         |         | RES., FXD, CMPSN: 10K OHM, 5%, 0.25W  | 01121       | CB1035          |
| R1318   | 315-0103-00           |                         |         | RES., FXD, CMPSN: 10K OHM, 5%, 0.25W  | 01121       | CB1035          |
| R1319   | 315-0103-00           |                         |         | RES., FXD, CMPSN: 10K OHM, 5%, 0.25W  | 01121       | CB1035          |
| R1351   | 315-0103-00           |                         |         | RES., FXD, CMPSN: 10K OHM, 5%, 0.25W  | 01121       | CB1035          |

# Replaceable Electrical Parts—832

| Ckt No. | Tektronix<br>Part No. | Serial/Model No.<br>Eff Dscont | Name & Description                    | Mfr<br>Code | Mfr Part Number |
|---------|-----------------------|--------------------------------|---------------------------------------|-------------|-----------------|
| R1352   | 315-0103-00           |                                | RES., FXD, CMPSN: 10K OHM, 5%, 0.25W  | 01121       | CB1035          |
| R1353   | 315-0103-00           |                                | RES., FXD, CMPSN: 10K OHM, 5%, 0.25W  | 01121       | CB1035          |
| R1354   | 315-0103-00           |                                | RES., FXD, CMPSN: 10K OHM, 5%, 0.25W  | 01121       | CB1035          |
| R1355   | 315-0103-00           |                                | RES., FXD, CMPSN: 10K OHM, 5%, 0.25W  | 01121       | CB1035          |
| R1421   | 315-0103-00           |                                | RES., FXD, CMPSN: 10K OHM, 5%, 0.25W  | 01121       | CB1035          |
| R1422   | 315-0103-00           |                                | RES., FXD, CMPSN: 10K OHM, 5%, 0.25W  | 01121       | CB1035          |
| R1451   | 315-0512-00           |                                | RES., FXD, CMPSN: 5.1K OHM, 5%, 0.25W | 01121       | CB5125          |
| R1452   | 315-0512-00           |                                | RES., FXD, CMPSN: 5.1K OHM, 5%, 0.25W | 01121       | CB5125          |
| R1453   | 315-0103-00           |                                | RES., FXD, CMPSN: 10K OHM, 5%, 0.25W  | 01121       | CB1035          |
| R1454   | 315-0103-00           |                                | RES., FXD, CMPSN: 10K OHM, 5%, 0.25W  | 01121       | CB1035          |
| R1455   | 315-0103-00           |                                | RES., FXD, CMPSN: 10K OHM, 5%, 0.25W  | 01121       | CB1035          |
| R1456   | 315-0103-00           |                                | RES., FXD, CMPSN: 10K OHM, 5%, 0.25W  | 01121       | CB1035          |
| R1457   | 315-0103-00           |                                | RES., FXD, CMPSN: 10K OHM, 5%, 0.25W  | 01121       | CB1035          |
| R1458   | 315-0512-00           |                                | RES., FXD, CMPSN: 5.1K OHM, 5%, 0.25W | 01121       | CB5125          |
| R2001   | 315-0302-00           |                                | RES., FXD, CMPSN: 3K OHM, 5%, 0.25W   | 01121       | CB3025          |
| R2002   | 315-0563-00           |                                | RES., FXD, CMPSN: 56K OHM, 5%, 0.25W  | 01121       | CB5635          |
| R2021   | 315-0243-00           |                                | RES., FXD, CMPSN: 24K OHM, 5%, 0.25W  | 01121       | CB2435          |
| R2022   | 315-0243-00           |                                | RES., FXD, CMPSN: 24K OHM, 5%, 0.25W  | 01121       | CB2435          |
| R2023   | 315-0243-00           |                                | RES., FXD, CMPSN: 24K OHM, 5%, 0.25W  | 01121       | CB2435          |
| R2032   | 315-0103-00           |                                | RES., FXD, CMPSN: 10K OHM, 5%, 0.25W  | 01121       | CB1035          |
| R2033   | 315-0103-00           |                                | RES., FXD, CMPSN: 10K OHM, 5%, 0.25W  | 01121       | CB1035          |
| R2034   | 315-0103-00           |                                | RES., FXD, CMPSN: 10K OHM, 5%, 0.25W  | 01121       | CB1035          |
| R2035   | 315-0272-00           |                                | RES., FXD, CMPSN: 2.7K OHM, 5%, 0.25W | 01121       | CB2725          |
| R2053   | 315-0510-00           |                                | RES., FXD, CMPSN: 51 OHM, 5%, 0.25W   | 01121       | CB5105          |
| R2061   | 315-0102-00           |                                | RES., FXD, CMPSN: 1K OHM, 5%, 0.25W   | 01121       | CB1025          |
| R2062   | 315-0102-00           |                                | RES., FXD, CMPSN: 1K OHM, 5%, 0.25W   | 01121       | CB1025          |
| R2064   | 315-0472-00           |                                | RES., FXD, CMPSN: 4.7K OHM, 5%, 0.25W | 01121       | CB4725          |
| R2082   | 315-0103-00           |                                | RES., FXD, CMPSN: 10K OHM, 5%, 0.25W  | 01121       | CB1035          |
| R2101   | 315-0302-00           |                                | RES., FXD, CMPSN: 3K OHM, 5%, 0.25W   | 01121       | CB3025          |
| R2143   | 315-0103-00           |                                | RES., FXD, CMPSN: 10K OHM, 5%, 0.25W  | 01121       | CB1035          |
| R2144   | 315-0103-00           |                                | RES., FXD, CMPSN: 10K OHM, 5%, 0.25W  | 01121       | CB1035          |
| R2145   | 315-0103-00           |                                | RES., FXD, CMPSN: 10K OHM, 5%, 0.25W  | 01121       | CB1035          |
| R2146   | 315-0103-00           |                                | RES., FXD, CMPSN: 10K OHM, 5%, 0.25W  | 01121       | CB1035          |
| R2201   | 315-0302-00           |                                | RES., FXD, CMPSN: 3K OHM, 5%, 0.25W   | 01121       | CB3025          |
| R2231   | 315-0272-00           |                                | RES., FXD, CMPSN: 2.7K OHM, 5%, 0.25W | 01121       | CB2725          |
| R2235   | 315-0101-00           |                                | RES., FXD, CMPSN: 100 OHM, 5%, 0.25W  | 01121       | CB1015          |
| R2262   | 315-0511-00           |                                | RES., FXD, CMPSN: 510 OHM, 5%, 0.25W  | 01121       | CB5115          |
| R2263   | 315-0511-00           |                                | RES., FXD, CMPSN: 510 OHM, 5%, 0.25W  | 01121       | CB5115          |
| R2278   | 315-0472-00           |                                | RES., FXD, CMPSN: 4.7K OHM, 5%, 0.25W | 01121       | CB4725          |
| R2316   | 315-0101-00           |                                | RES., FXD, CMPSN: 100 OHM, 5%, 0.25W  | 01121       | CB1015          |
| R2331   | 315-0272-00           |                                | RES., FXD, CMPSN: 2.7K OHM, 5%, 0.25W | 01121       | CB2725          |
| R2435   | 315-0332-00           |                                | RES., FXD, CMPSN: 3.3K OHM, 5%, 0.25W | 01121       | CB3325          |
| R2436   | 315-0332-00           |                                | RES., FXD, CMPSN: 3.3K OHM, 5%, 0.25W | 01121       | CB3325          |
| R2437   | 315-0332-00           |                                | RES., FXD, CMPSN: 3.3K OHM, 5%, 0.25W | 01121       | CB3325          |
| R2503   | 315-0302-00           |                                | RES., FXD, CMPSN: 3K OHM, 5%, 0.25W   | 01121       | CB3025          |
| R2504   | 315-0302-00           |                                | RES., FXD, CMPSN: 3K OHM, 5%, 0.25W   | 01121       | CB3025          |
| R2505   | 315-0302-00           |                                | RES., FXD, CMPSN: 3K OHM, 5%, 0.25W   | 01121       | CB3025          |
| R2535   | 315-0332-00           |                                | RES., FXD, CMPSN: 3.3K OHM, 5%, 0.25W | 01121       | CB3325          |
| R2536   | 315-0332-00           |                                | RES., FXD, CMPSN: 3.3K OHM, 5%, 0.25W | 01121       | CB3325          |
| R2635   | 315-0332-00           |                                | RES., FXD, CMPSN: 3.3K OHM, 5%, 0.25W | 01121       | CB3325          |
| R2636   | 315-0332-00           |                                | RES., FXD, CMPSN: 3.3K OHM, 5%, 0.25W | 01121       | CB3325          |
| R2637   | 315-0332-00           |                                | RES., FXD, CMPSN: 3.3K OHM, 5%, 0.25W | 01121       | CB3325          |
| R3052   | 315-0621-00           |                                | RES., FXD, CMPSN: 620 OHM, 5%, 0.25W  | 01121       | CB6215          |
| R3053   | 315-0103-00           |                                | RES., FXD, CMPSN: 10K OHM, 5%, 0.25W  | 01121       | CB1035          |
| R3054   | 315-0103-00           |                                | RES., FXD, CMPSN: 10K OHM, 5%, 0.25W  | 01121       | CB1035          |
| R3055   | 315-0103-00           |                                | RES., FXD, CMPSN: 10K OHM, 5%, 0.25W  | 01121       | CB1035          |
| R3056   | 315-0103-00           |                                | RES., FXD, CMPSN: 10K OHM, 5%, 0.25W  | 01121       | CB1035          |

| Ckt No. | Tektronix<br>Part No. | Serial/Model No.<br>Eff Dscont | Name & Description                        | Mfr<br>Code | Mfr Part Number |
|---------|-----------------------|--------------------------------|-------------------------------------------|-------------|-----------------|
| R3079   | 315-0101-00           |                                | RES., FXD, CMPSN:100 OHM, 5%, 0.25W       | 01121       | CB1015          |
| R3086   | 315-0101-00           |                                | RES., FXD, CMPSN:100 OHM, 5%, 0.25W       | 01121       | CB1015          |
| R3087   | 315-0101-00           |                                | RES., FXD, CMPSN:100 OHM, 5%, 0.25W       | 01121       | CB1015          |
| R3137   | 315-0101-00           |                                | RES., FXD, CMPSN:100 OHM, 5%, 0.25W       | 01121       | CB1015          |
| R3139   | 315-0513-00           |                                | RES., FXD, CMPSN:51K OHM, 5%, 0.25W       | 01121       | CB5135          |
| R3171   | 315-0101-00           |                                | RES., FXD, CMPSN:100 OHM, 5%, 0.25W       | 01121       | CB1015          |
| R3172   | 315-0101-00           |                                | RES., FXD, CMPSN:100 OHM, 5%, 0.25W       | 01121       | CB1015          |
| R3173   | 315-0101-00           |                                | RES., FXD, CMPSN:100 OHM, 5%, 0.25W       | 01121       | CB1015          |
| R4022   | 315-0430-00           |                                | RES., FXD, CMPSN:43 OHM, 5%, 0.25W        | 01121       | CB4305          |
| R4028   | 315-0181-00           |                                | RES., FXD, CMPSN:180 OHM, 5%, 0.25W       | 01121       | CB1815          |
| R4108   | 301-0681-00           |                                | RES., FXD, CMPSN:680 OHM, 5%, 0.50W       | 01121       | EB6815          |
| R4116   | 311-1563-00           |                                | RES., VAR, NONWIR:1K OHM, 20%, 0.50W      | 73138       | 91A R1K         |
| R4131   | 315-0431-00           |                                | RES., FXD, CMPSN:430 OHM, 5%, 0.25W       | 01121       | CB4315          |
| R4134   | 315-0681-00           |                                | RES., FXD, CMPSN:680 OHM, 5%, 0.25W       | 01121       | CB6815          |
| R4221   | 315-0271-00           |                                | RES., FXD, CMPSN:270 OHM, 5%, 0.25W       | 01121       | CB2715          |
| R4223   | 321-0222-00           |                                | RES., FXD, FILM:2K OHM, 1%, 0.125W        | 91637       | MFF1816G20000F  |
| R4224   | 321-0245-00           |                                | RES., FXD, FILM:3.48K OHM, 1%, 0.125W     | 91637       | MFF1816G34800F  |
| R4231   | 315-0121-00           |                                | RES., FXD, CMPSN:120 OHM, 5%, 0.25W       | 01121       | CB1215          |
| S950    | 260-1849-02           |                                | SWITCH, PUSH:DPDT, 4A, 250VAC, W/BACKET   | 80009       | 260-1849-02     |
| S2005   | 260-1721-00           |                                | SWITCH, ROCKER:8, SPST, 125MA, 30VDC      | 00779       | 435166-5        |
| S2011   | 263-0019-05           |                                | SWITCH, PB ASSY:MOMENTARY                 | 80009       | 263-0019-05     |
| S2021   | 263-0019-05           |                                | SWITCH, PB ASSY:MOMENTARY                 | 80009       | 263-0019-05     |
| S2031   | 263-0019-05           |                                | SWITCH, PB ASSY:MOMENTARY                 | 80009       | 263-0019-05     |
| S2052   | 263-0019-05           |                                | SWITCH, PB ASSY:MOMENTARY                 | 80009       | 263-0019-05     |
| S2056   | 263-0019-05           |                                | SWITCH, PB ASSY:MOMENTARY                 | 80009       | 263-0019-05     |
| S2065   | 263-0019-05           |                                | SWITCH, PB ASSY:MOMENTARY                 | 80009       | 263-0019-05     |
| S2075   | 263-0019-05           |                                | SWITCH, PB ASSY:MOMENTARY                 | 80009       | 263-0019-05     |
| S2082   | 263-0019-05           |                                | SWITCH, PB ASSY:MOMENTARY                 | 80009       | 263-0019-05     |
| S2111   | 263-0019-05           |                                | SWITCH, PB ASSY:MOMENTARY                 | 80009       | 263-0019-05     |
| S2121   | 263-0019-05           |                                | SWITCH, PB ASSY:MOMENTARY                 | 80009       | 263-0019-05     |
| S2131   | 263-0019-05           |                                | SWITCH, PB ASSY:MOMENTARY                 | 80009       | 263-0019-05     |
| S2152   | 263-0040-00           |                                | SWITCH SL ASSY:TRIG PT/DATA SOURCE/PARITY | 80009       | 263-0040-00     |
| S2156   | 263-0040-00           |                                | SWITCH SL ASSY:TRIG PT/DATA SOURCE/PARITY | 80009       | 263-0040-00     |
| S2165   | 263-0040-00           |                                | SWITCH SL ASSY:TRIG PT/DATA SOURCE/PARITY | 80009       | 263-0040-00     |
| S2175   | 263-0041-00           |                                | SWITCH SL ASSY:HALF AND FULLDUPLEX        | 80009       | 263-0041-00     |
| S2182   | 263-0043-00           |                                | SWITCH SL ASSY:SYNC-A SYNC                | 80009       | 263-0043-00     |
| S2190   | 263-0038-00           |                                | SWITCH, ROTARY:BAUD, 15/16 POSN           | 80009       | 263-0038-00     |
| S2205   | 260-1721-00           |                                | SWITCH, ROCKER:8, SPST, 125MA, 30VDC      | 00779       | 435166-5        |
| S2211   | 263-0019-05           |                                | SWITCH, PB ASSY:MOMENTARY                 | 80009       | 263-0019-05     |
| S2221   | 263-0019-05           |                                | SWITCH, PB ASSY:MOMENTARY                 | 80009       | 263-0019-05     |
| S2231   | 263-0019-05           |                                | SWITCH, PB ASSY:MOMENTARY                 | 80009       | 263-0019-05     |
| S2311   | 263-0019-05           |                                | SWITCH, PB ASSY:MOMENTARY                 | 80009       | 263-0019-05     |
| S2321   | 263-0019-05           |                                | SWITCH, PB ASSY:MOMENTARY                 | 80009       | 263-0019-05     |
| S2331   | 263-0019-05           |                                | SWITCH, PB ASSY:MOMENTARY                 | 80009       | 263-0019-05     |
| S2352   | 263-0019-05           |                                | SWITCH, PB ASSY:MOMENTARY                 | 80009       | 263-0019-05     |
| S2356   | 263-0019-05           |                                | SWITCH, PB ASSY:MOMENTARY                 | 80009       | 263-0019-05     |
| S2405   | 260-1721-00           |                                | SWITCH, ROCKER:8, SPST, 125MA, 30VDC      | 00779       | 435166-5        |
| S2411   | 263-0019-05           |                                | SWITCH, PB ASSY:MOMENTARY                 | 80009       | 263-0019-05     |
| S2421   | 263-0019-05           |                                | SWITCH, PB ASSY:MOMENTARY                 | 80009       | 263-0019-05     |
| S2431   | 263-0019-05           |                                | SWITCH, PB ASSY:MOMENTARY                 | 80009       | 263-0019-05     |
| S2511   | 263-0019-05           |                                | SWITCH, PB ASSY:MOMENTARY                 | 80009       | 263-0019-05     |
| S2521   | 263-0019-05           |                                | SWITCH, PB ASSY:MOMENTARY                 | 80009       | 263-0019-05     |
| S2531   | 263-0019-05           |                                | SWITCH, PB ASSY:MOMENTARY                 | 80009       | 263-0019-05     |
| S2611   | 263-0019-07           |                                | SWITCH PB ASSY:MOMENTARY                  | 80009       | 263-0019-07     |
| S2621   | 263-0019-05           |                                | SWITCH, PB ASSY:MOMENTARY                 | 80009       | 263-0019-05     |
| S2631   | 263-0019-08           |                                | SWITCH PB ASSY:MOMENTARY                  | 80009       | 263-0019-08     |
| S4014   | 260-1399-00           |                                | SWITCH, SLIDE:DPST, 5A, 125VAC            | 82389       | C46206LFE       |

# Replaceable Electrical Parts—832

| Ckt No.  | Tektronix Part No. | Serial/Model No. Eff | Dscont | Name & Description                        | Mfr Code | Mfr Part Number  |
|----------|--------------------|----------------------|--------|-------------------------------------------|----------|------------------|
| S6014    | 260-1811-00        |                      |        | SWITCH,SLIDE:DPDT,0.5A,125VAC DC          | 82389    | C56206L2         |
| T4115    | 120-1192-00        |                      |        | XFMR,PWR,STPDN:                           | 80009    | 120-1192-00      |
| T4128    | 120-1193-00        |                      |        | TRANSFORMER,RF:SWITCHING REGULATOR POT    | 80009    | 120-1193-00      |
| U1022    | 156-0850-00        |                      |        | MICROCIRCUIT,DI:PROGRAMMABLE BIT RATE GEN | 80009    | 156-0850-00      |
| U1028    | 156-0382-00        |                      |        | MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE    | 80009    | 156-0382-00      |
| U1035    | 156-0058-01        |                      |        | MICROCIRCUIT,DI:HEX INVERTER              | 80009    | 156-0058-01      |
| U1044    | 156-0745-00        |                      |        | MICROCIRCUIT,DI:HEX INVERTER              | 80009    | 156-0745-00      |
| U1065    | 156-0382-00        |                      |        | MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE    | 80009    | 156-0382-00      |
| U1072    | 156-0451-00        |                      |        | MICROCIRCUIT,DI:QUAD 2-INPUT NOR BUFFER   | 80009    | 156-0451-00      |
| U1076    | 156-0388-00        |                      |        | MICROCIRCUIT,DI:DUAL D-TYPE FLIP-FLOP     | 80009    | 156-0388-00      |
| U1105    | 156-0878-00        |                      |        | MICROCIRCUIT,DI:QUAD LINE RCVR            | 04713    | MC1489L          |
| U1112    | 156-1016-00        |                      |        | MICROCIRCUIT,LI:OPERATIONAL AMP/BFR       | 80009    | 156-1016-00      |
| U1118    | 156-0646-00        |                      |        | MICROCIRCUIT,DI:4 BIT BINARY COUNTER      | 01295    | SN74LS93N        |
| U1155    | 156-0426-03        |                      |        | MICROCIRCUIT,DI:MICROPROCESSOR            | 80009    | 156-0426-03      |
| U1172    | 156-0385-00        |                      |        | MICROCIRCUIT,DI:HEX. INVERTER             | 80009    | 156-0385-00      |
| U1176    | 156-0392-01        |                      |        | MICROCIRCUIT,DI:QUAD LATCH W/CLEAR        | 80009    | 156-0392-01      |
| U1205    | 156-0878-00        |                      |        | MICROCIRCUIT,DI:QUAD LINE RCVR            | 04713    | MC1489L          |
| U1212    | 156-0879-00        |                      |        | MICROCIRCUIT,DI:QUAD LINE DRVR            | 80009    | 156-0879-00      |
| U1218    | 156-0649-02        |                      |        | MICROCIRCUIT,DI:3 STATE HEX-NON INVT BFR  | 80009    | 156-0649-02      |
| U1225    | 160-0116-00        |                      |        | MICROCIRCUIT,DI:2048 X 8 ROM,CUSTOM MASK  | 80009    | 160-0116-00      |
| U1245    | 160-0117-00        |                      |        | MICROCIRCUIT,DI:2048 X 8 ROM,CUSTOM MASK  | 80009    | 160-0117-00      |
| U1265    | 156-0852-00        |                      |        | MICROCIRCUIT,DI:HEX BUS DRIVER W/3-STATE  | 01295    | SN74LS376N OR J  |
| U1272    | 156-0852-00        |                      |        | MICROCIRCUIT,DI:HEX BUS DRIVER W/3-STATE  | 01295    | SN74LS376N OR J  |
| U1276    | 156-0481-00        |                      |        | MICROCIRCUIT,DI:TRIPLE 3-INPUT AND GATE   | 07263    | 74LS11(PC OR DC) |
| U1305    | 156-0879-00        |                      |        | MICROCIRCUIT,DI:QUAD LINE DRVR            | 80009    | 156-0879-00      |
| U1312    | 156-0530-00        |                      |        | MICROCIRCUIT,DI:QUAD 2-INP MUX,16 PIN DIP | 80009    | 156-0530-00      |
| U1325    | 156-0877-00        |                      |        | MICROCIRCUIT,DI:UNIV SYN AS-SYN DRVR XMTR | 80009    | 156-0877-00      |
| U1332    | 156-0877-00        |                      |        | MICROCIRCUIT,DI:UNIV SYN AS-SYN DRVR XMTR | 80009    | 156-0877-00      |
| U1345    | 156-1026-00        |                      |        | MICROCIRCUIT,DI:4 LINE TO 1 LINE DECODER  | 80009    | 156-1026-00      |
| U1362    | 156-0893-00        |                      |        | MICROCIRCUIT,DI:RAM,1024 X 1 STATIC       | 80009    | 156-0893-00      |
| U1368    | 156-0893-00        |                      |        | MICROCIRCUIT,DI:RAM,1024 X 1 STATIC       | 80009    | 156-0893-00      |
| U1372    | 156-0893-00        |                      |        | MICROCIRCUIT,DI:RAM,1024 X 1 STATIC       | 80009    | 156-0893-00      |
| U1376    | 156-0893-00        |                      |        | MICROCIRCUIT,DI:RAM,1024 X 1 STATIC       | 80009    | 156-0893-00      |
| U1462    | 156-0893-00        |                      |        | MICROCIRCUIT,DI:RAM,1024 X 1 STATIC       | 80009    | 156-0893-00      |
| U1468    | 156-0893-00        |                      |        | MICROCIRCUIT,DI:RAM,1024 X 1 STATIC       | 80009    | 156-0893-00      |
| U1472    | 156-0893-00        |                      |        | MICROCIRCUIT,DI:RAM,1024 X 1 STATIC       | 80009    | 156-0893-00      |
| U1476    | 156-0893-00        |                      |        | MICROCIRCUIT,DI:RAM,1024 X 1 STATIC       | 80009    | 156-0893-00      |
| U2008A-F | 156-0888-00        |                      |        | MICROCIRCUIT,DI:HEX DIGIT DRIVER          | 80009    | 156-0888-00      |
| U2016    | 156-0756-00        |                      |        | MICROCIRCUIT,DI:BCD TO DECIMAL DECODER    | 80009    | 156-0756-00      |
| U2028    | 156-0682-02        |                      |        | MICROCIRCUIT,DI:HEX D FLIP-FLOP,SEL       | 80009    | 156-0682-02      |
| U2038A-F | 156-0649-02        |                      |        | MICROCIRCUIT,DI:3 STATE HEX-NON INVT BFR  | 80009    | 156-0649-02      |
| U2045A-F | 156-0649-02        |                      |        | MICROCIRCUIT,DI:3 STATE HEX-NON INVT BFR  | 80009    | 156-0649-02      |
| U2365A,B | 156-0388-01        |                      |        | MICROCIRCUIT,DI:DUAL D-TYPE FLIP-FLOP     | 80009    | 156-0388-01      |
| U2375A-D | 156-0479-01        |                      |        | MICROCIRCUIT,DI:QUAD 2-INP ORGATE         | 80009    | 156-0479-01      |
| U3022    | -----              |                      |        |                                           |          |                  |
| U3024    | -----              |                      |        |                                           |          |                  |
| U3026    | 150-1011-04        |                      |        | LAMP,LED,RDOUT:RED SINGLE DIGIT           | 80009    | 150-1011-04      |
| U3032    | -----              |                      |        | (MATCHED SET OF 5)                        |          |                  |
| U3034    | -----              |                      |        |                                           |          |                  |
| U3065    | 156-0682-02        |                      |        | MICROCIRCUIT,DI:HEX D FLIP-FLOP,SEL       | 80009    | 156-0682-02      |
| U3145    | 156-0493-00        |                      |        | MICROCIRCUIT,DI:BCD TO 7 SEG DEC/DRIVER   | 80009    | 156-0493-00      |
| U3180A-F | 156-0888-00        |                      |        | MICROCIRCUIT,DI:HEX DIGIT DRIVER          | 80009    | 156-0888-00      |
| U4028    | 156-0872-00        |                      |        | MICROCIRCUIT,LI:VOLTAGE REGULATOR         | 80009    | 156-0872-00      |
| U4032    | 156-0872-00        |                      |        | MICROCIRCUIT,LI:VOLTAGE REGULATOR         | 80009    | 156-0872-00      |
| U4112    | 156-1160-00        |                      |        | MICROCIRCUIT,LI:VOLTAGE REGULATOR         | 80009    | 156-1160-00      |
| VR4227   | 152-0175-00        |                      |        | SEMICOND DEVICE:ZENER,0.4W,5.6V,5%        | 80009    | 152-0175-00      |
| Y1027    | 158-0072-00        |                      |        | XTAL UNIT,QTZ:4.9152 MHZ,0.05%            | 33096    | 0BD              |

# DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

## Symbols and Reference Designators

Electrical components shown on the diagrams are in the following units unless noted otherwise:

Capacitors = Values one or greater are in picofarads (pF).  
Values less than one are in microfarads ( $\mu$ F).  
Resistors = Ohms ( $\Omega$ ).

Graphic symbols and class designation letters are based on ANSI Standard Y32.2-1975.

Logic symbology is based on ANSI Y32.14-1973 in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

The overline on a signal name indicates that the signal performs its intended function when it goes to the low state.

Abbreviations are based on ANSI Y1.1-1972.

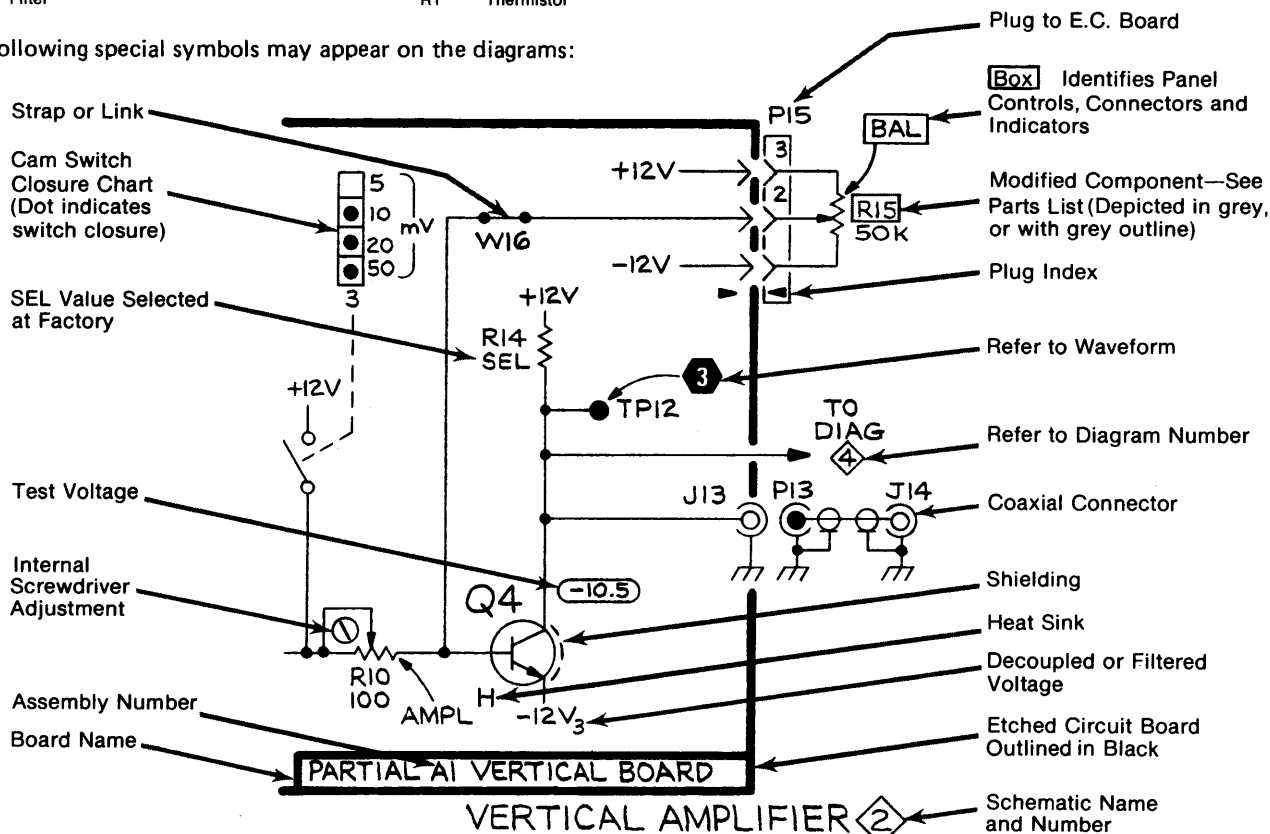
Other ANSI standards that are used in the preparation of diagrams by Tektronix, Inc. are:

Y14.15, 1966 Drafting Practices.  
Y14.2, 1973 Line Conventions and Lettering.  
Y10.5, 1968 Letter Symbols for Quantities Used in Electrical Science and Electrical Engineering.

The following prefix letters are used as reference designators to identify components or assemblies on the diagrams.

|    |                                                        |    |                                                         |    |                                                                    |
|----|--------------------------------------------------------|----|---------------------------------------------------------|----|--------------------------------------------------------------------|
| A  | Assembly, separable or repairable (circuit board, etc) | H  | Heat dissipating device (heat sink, heat radiator, etc) | S  | Switch or contactor                                                |
| AT | Attenuator, fixed or variable                          | HR | Heater                                                  | T  | Transformer                                                        |
| B  | Motor                                                  | HY | Hybrid circuit                                          | TC | Thermocouple                                                       |
| BT | Battery                                                | J  | Connector, stationary portion                           | TP | Test point                                                         |
| C  | Capacitor, fixed or variable                           | K  | Relay                                                   | U  | Assembly, inseparable or non-repairable (integrated circuit, etc.) |
| CB | Circuit breaker                                        | L  | Inductor, fixed or variable                             | V  | Electron tube                                                      |
| CR | Diode, signal or rectifier                             | M  | Meter                                                   | VR | Voltage regulator (zener diode, etc.)                              |
| DL | Delay line                                             | P  | Connector, movable portion                              | W  | Wirestrap or cable                                                 |
| DS | Indicating device (lamp)                               | Q  | Transistor or silicon-controlled rectifier              | Y  | Crystal                                                            |
| E  | Spark Gap, Ferrite bead                                | R  | Resistor, fixed or variable                             | Z  | Phase shifter                                                      |
| F  | Fuse                                                   | RT | Thermistor                                              |    |                                                                    |
| FL | Filter                                                 |    |                                                         |    |                                                                    |

The following special symbols may appear on the diagrams:







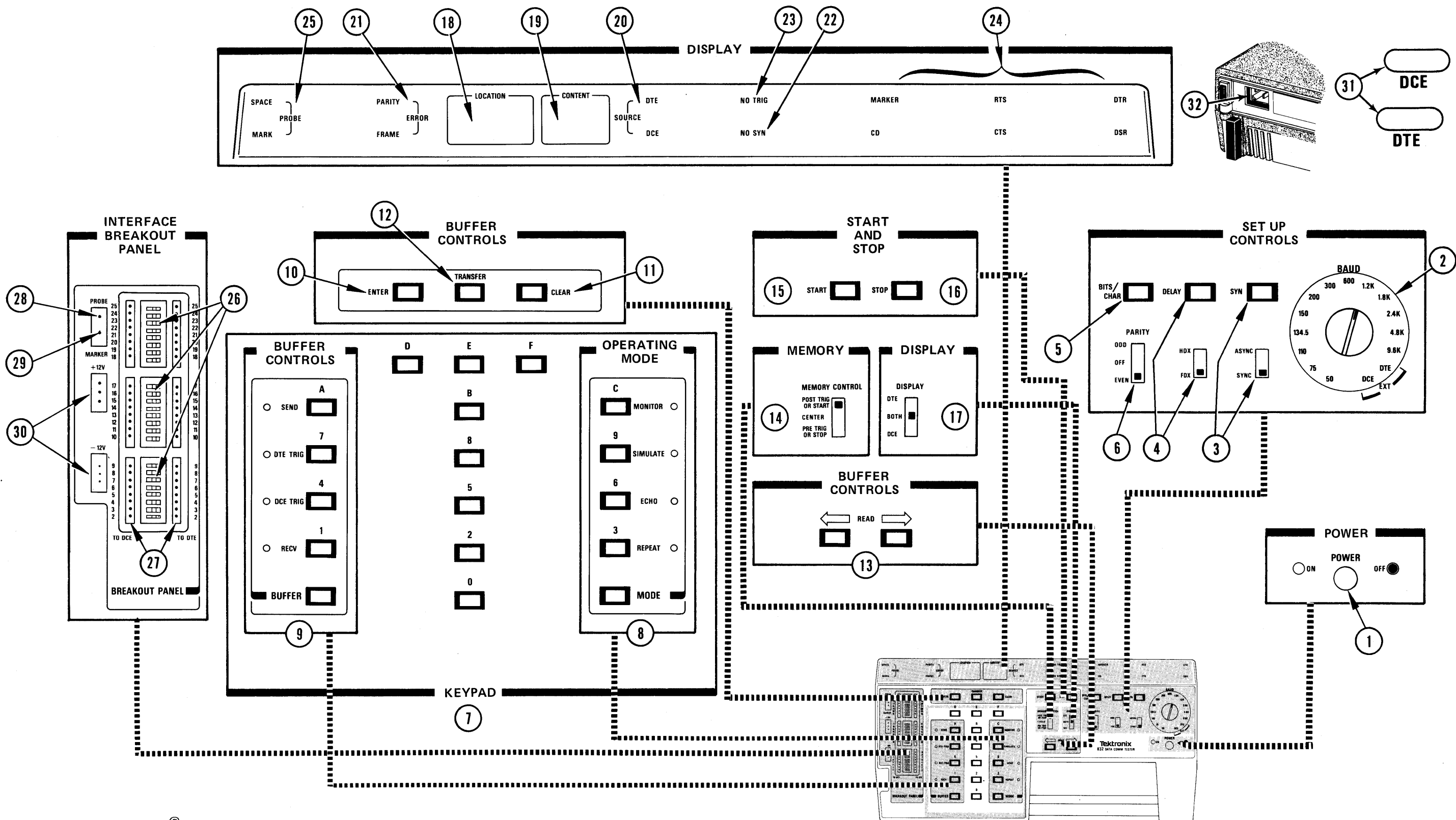
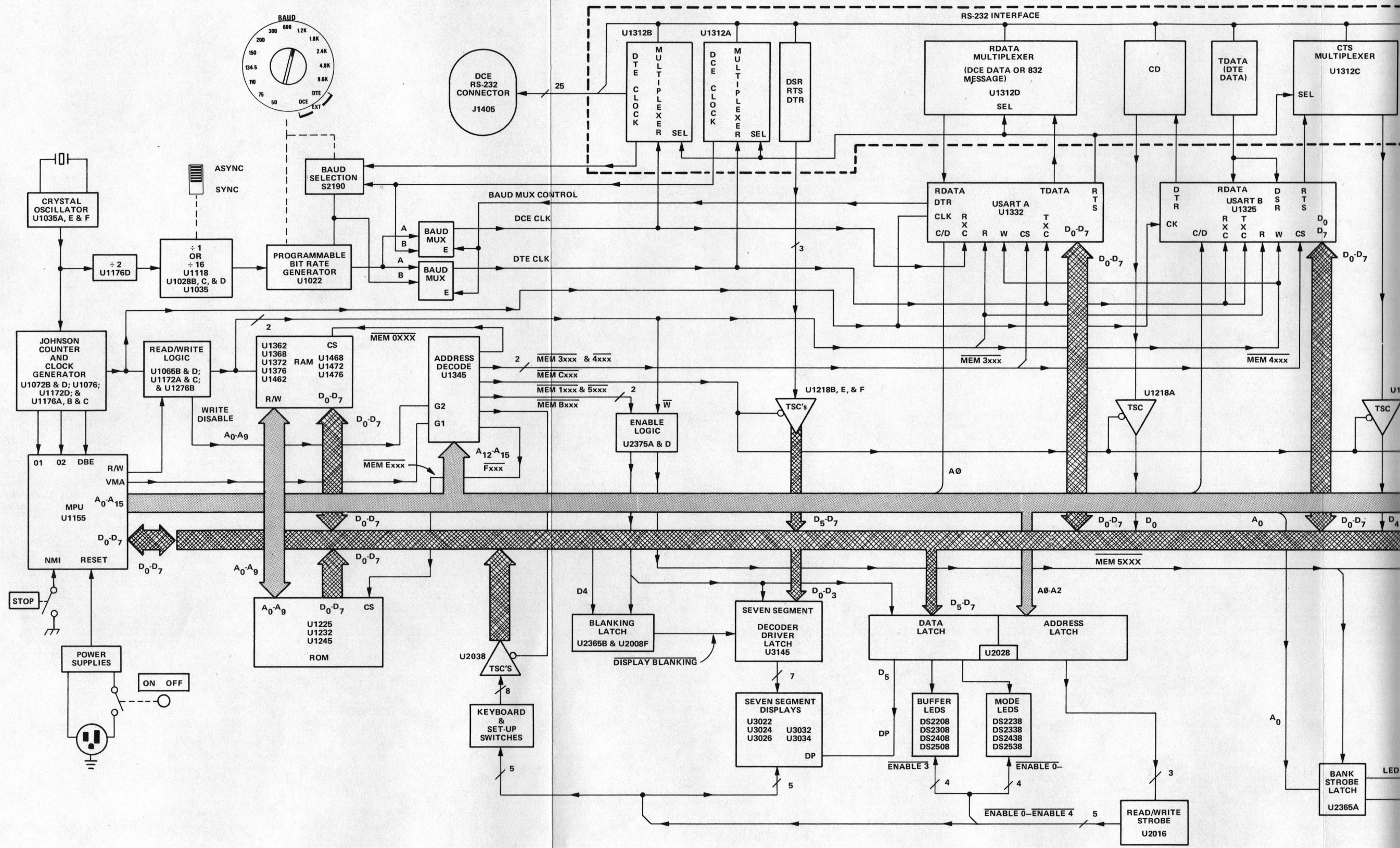
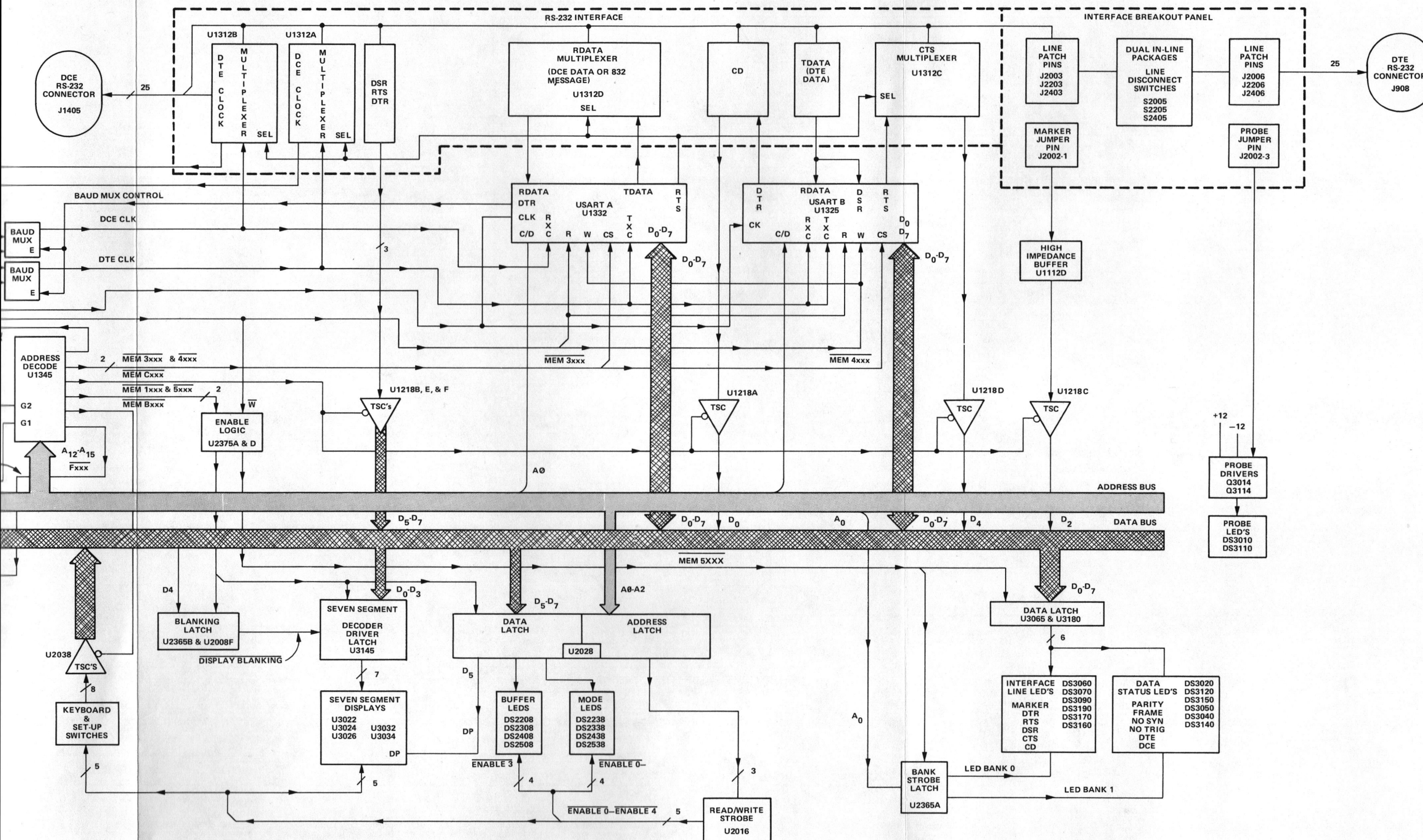


Figure 10-1. Front panel controls, connectors and indicators.









832 BLOCK DIAGRAM



A1 PROCESSOR BD &  
A4 BAUD SW BD

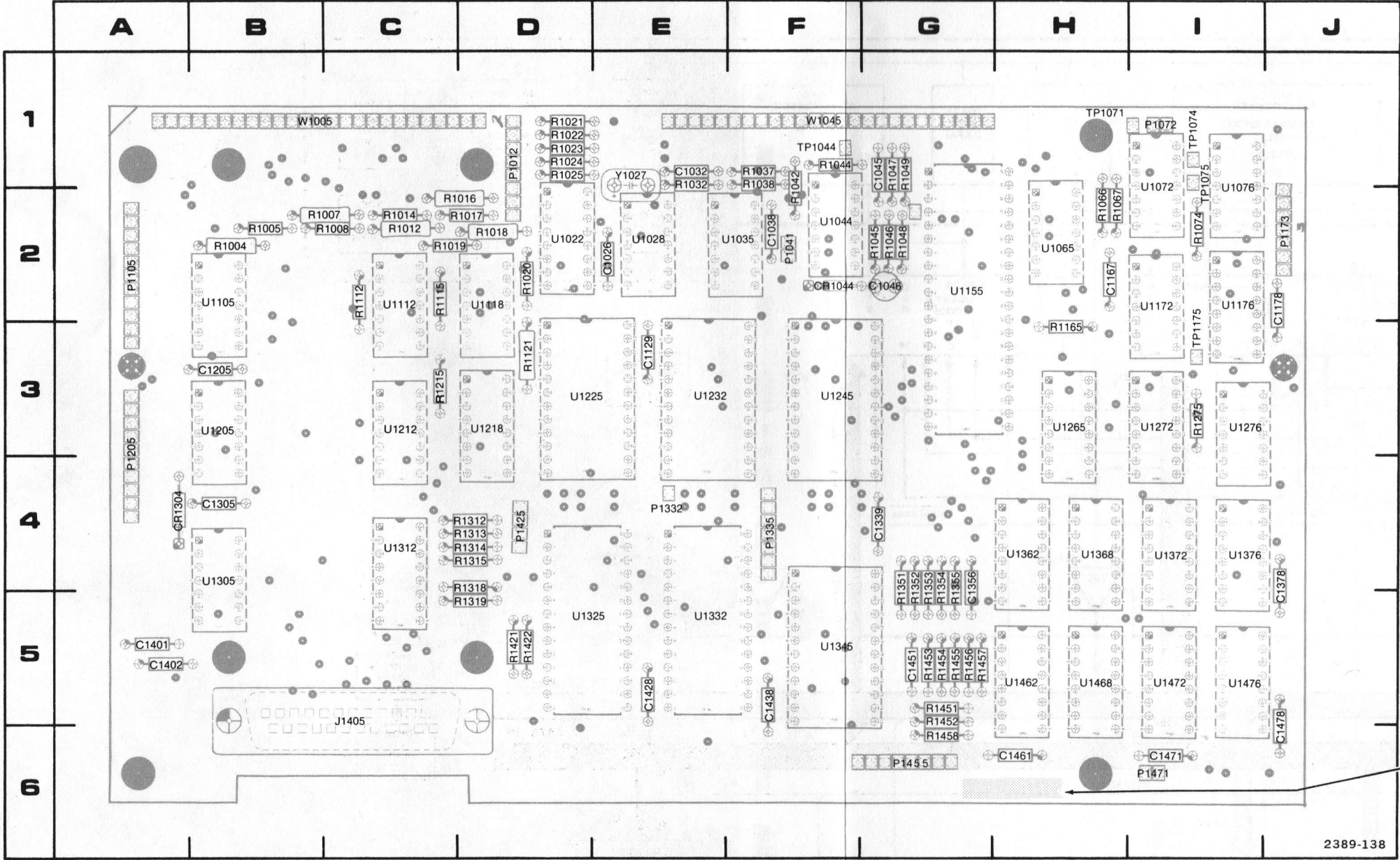


Figure 10-2. A1 processor board.

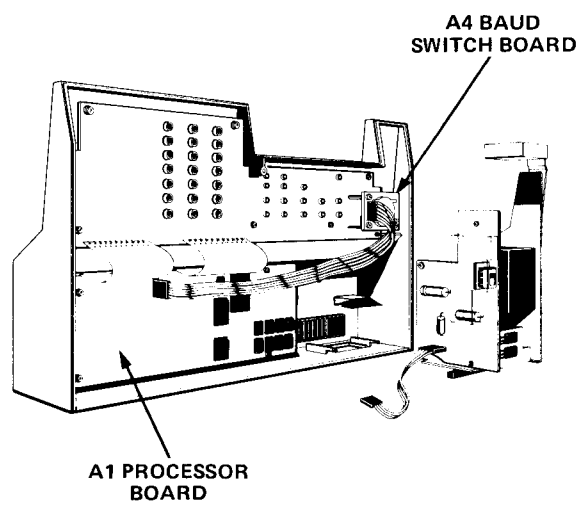
| CKT NO | GRID LOC | CKT NO | GRID LOC | CKT NO | GRID LOC | CKT NO | GRID LOC | CKT NO | GRID LOC | CKT NO | GRID LOC | CKT NO | GRID LOC | CKT NO | GRID LOC | CKT NO | GRID LOC |
|--------|----------|--------|----------|--------|----------|--------|----------|--------|----------|--------|----------|--------|----------|--------|----------|--------|----------|
| C1026  | 2E       | C1402  | 5A       | P1041  | 2F       | R1014  | 2C       | R1044  | 1F       | R1312  | 4D       | R1453  | 5G       | U1035  | 2F       | U1232  | 3E       |
| C1032  | 1E       | C1428  | 5E       | P1072  | 1J       | R1016  | 2D       | R1045  | 2G       | R1313  | 4D       | R1454  | 5G       | U1044  | 2F       | U1245  | 3F       |
| C1038  | 2F       | C1438  | 5F       | P1105  | 2A       | R1017  | 2D       | R1046  | 2G       | R1314  | 4D       | R1455  | 5G       | U1065  | 2H       | U1265  | 3H       |
| C1045  | 1G       | C1451  | 5G       | P1173  | 2J       | R1018  | 2D       | R1047  | 1G       | R1315  | 4D       | R1456  | 5G       | U1072  | 1I       | U1272  | 3I       |
| C1046  | 2G       | C1461  | 6H       | P1205  | 3A       | R1019  | 2C       | R1048  | 2G       | R1318  | 4D       | R1457  | 5G       | U1076  | 1I       | U1276  | 3I       |
| C1129  | 3E       | C1471  | 6I       | P1335  | 4F       | R1020  | 2D       | R1049  | 1G       | R1319  | 5D       | R1458  | 6G       | U1105  | 2B       | U1312  | 4C       |
| C1167  | 2H       | C1478  | 6J       | P1425  | 4D       | R1021  | 1D       | R1066  | 2H       | R1351  | 4G       |        |          | U1112  | 2C       | U1325  | 5D       |
| C1178  | 2J       |        |          | P1455  | 6G       | R1022  | 1D       | R1067  | 2H       | R1352  | 4G       | TP1044 | 1F       | U1118  | 2D       | U1332  | 5E       |
| C1205  | 3B       | CR1044 | 2F       | P1471  | 6I       | R1023  | 1D       | R1074  | 2I       | R1353  | 4G       | TP1071 | 1H       | U1155  | 2G       | U1345  | 5F       |
|        |          | CR1304 | 4A       |        |          | R1024  | 1D       | R1112  | 2C       | R1354  | 4G       | TP1074 | 1I       | U1172  | 2I       | U1362  | 4H       |
| C1305  | 4B       |        |          | R1004  | 2B       | R1025  | 1D       | R1115  | 2C       | R1355  | 4G       | TP1075 | 1I       | U1176  | 2I       | U1368  | 4H       |
| C1339  | 4G       | J1332  | 4E       | R1005  | 2B       | R1032  | 1E       | R1121  | 3D       | R1421  | 5D       | TP1175 | 3I       | U1205  | 3B       | U1372  | 4I       |
| C1356  | 4G       | J1405  | 5C       | R1007  | 2C       | R1037  | 1F       | R1165  | 3H       | R1422  | 5D       |        |          | U1212  | 3C       | U1376  | 4I       |
| C1378  | 4J       |        |          | R1008  | 2C       | R1215  | 1F       | R1215  | 3C       | R1451  | 5G       | U1022  | 2D       | U1218  | 3D       | U1462  | 5H       |
| C1401  | 5A       | P1012  | 1D       | R1012  | 2C       | R1042  | 1F       | R1275  | 3I       | R1452  | 5G       | U1028  | 2E       | U1225  | 3D       | U1468  | 5H       |

SERVICE NOTE

NOTE THE SCREENED-ON  
RAM BIT IDENTIFIER CHART.

NOTE

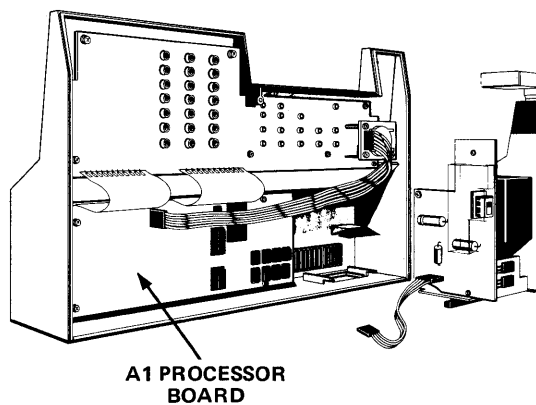
S2190 IS LOCATED ON THE  
A4 BAUD SWITCH BOARD.

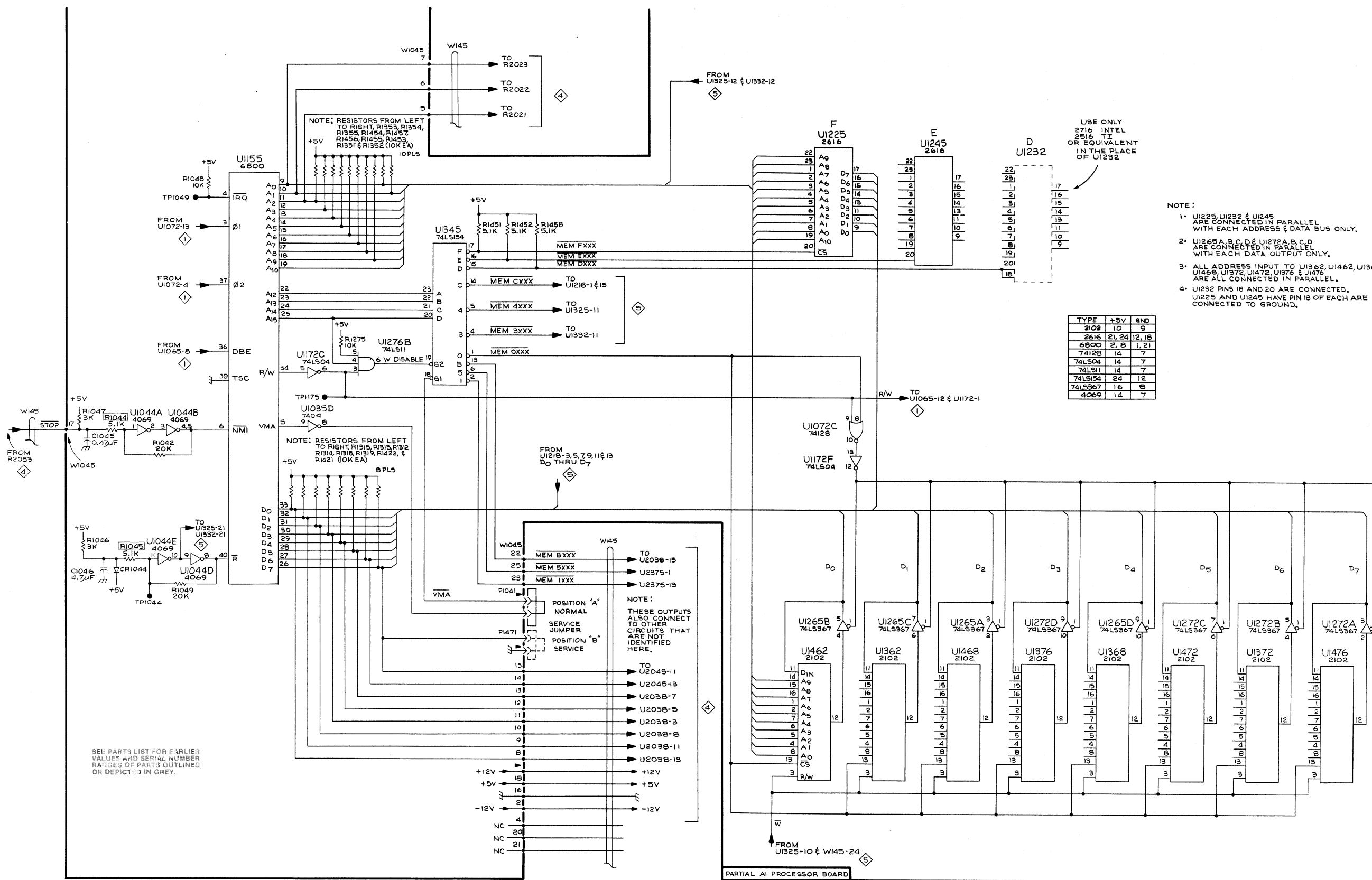




## NOTE

SEE A1 PROCESSOR BOARD  
FOLDOUT FOR COMPONENT  
LOCATIONS.







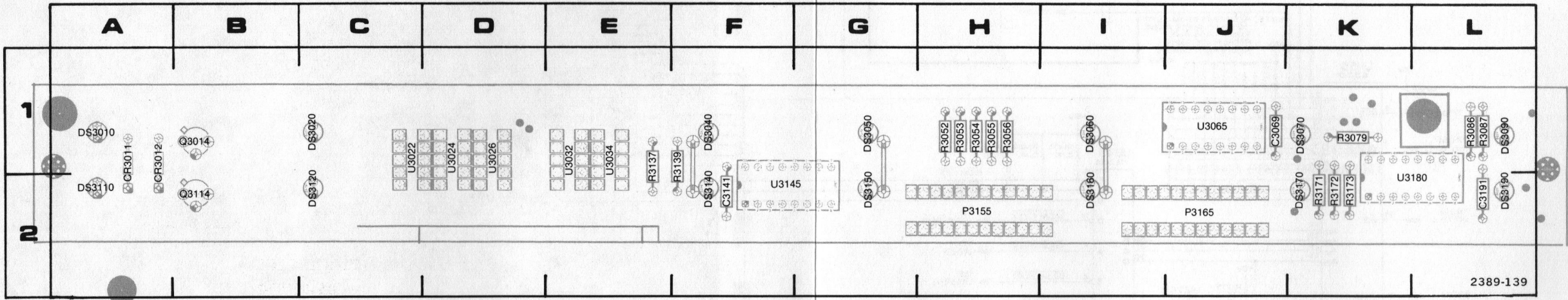
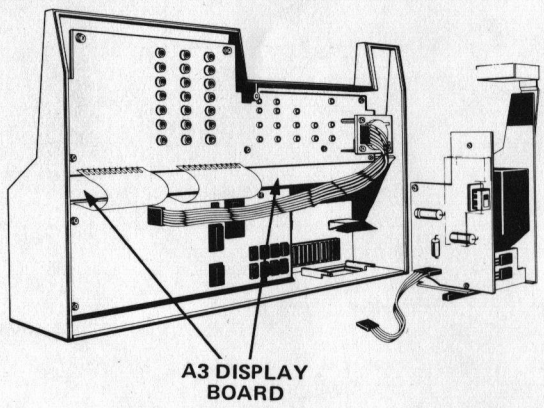
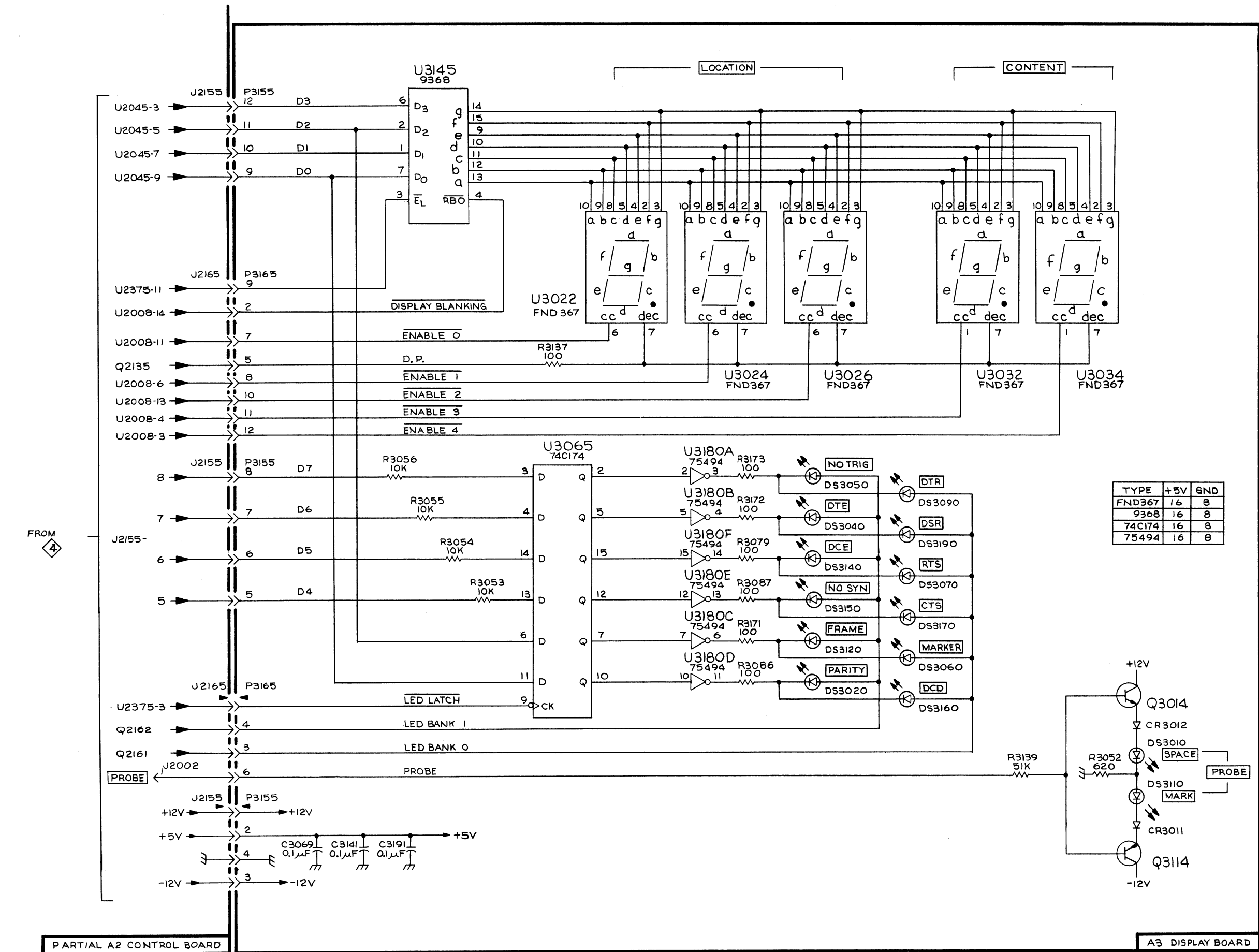
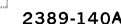


Figure 10-3. A3 display board.



| CKT<br>NO | GRID<br>LOC | CKT<br>NO | GRID<br>LOC |
|-----------|-------------|-----------|-------------|
| C3069     | 1J          | U3022     | 1C          |
| C3141     | 2F          | U3024     | 1D          |
| C3191     | 2L          | U3026     | 1D          |
|           |             | U3032     | 1E          |
| CR3011    | 1A          | U3034     | 1E          |
| CR3012    | 1A          | U3065     | 1J          |
|           |             | U3145     | 2F          |
|           |             | U3180     | 2L          |
| DS3010    | 1A          |           |             |
| DS3020    | 1C          |           |             |
| DS3040    | 1F          |           |             |
| DS3050    | 1G          |           |             |
| DS3060    | 1I          |           |             |
| DS3070    | 1K          |           |             |
| DS3090    | 1L          |           |             |
| DS3110    | 2A          |           |             |
| DS3120    | 2C          |           |             |
| DS3140    | 2F          |           |             |
| DS3150    | 2G          |           |             |
| DS3160    | 2I          |           |             |
| DS3170    | 2K          |           |             |
| DS3190    | 2L          |           |             |
| P3155     | 2H          |           |             |
| P3165     | 2J          |           |             |
| Q3014     | B1          |           |             |
| Q3114     | 2B          |           |             |
| R3052     | 1H          |           |             |
| R3053     | 1H          |           |             |
| R3054     | 1H          |           |             |
| R3055     | 1H          |           |             |
| R3056     | 1H          |           |             |
| R3079     | 1K          |           |             |
| R3086     | 1L          |           |             |
| R3087     | 1L          |           |             |
| R3137     | 1E          |           |             |
| R3139     | 1F          |           |             |
| R3171     | 2K          |           |             |
| R3172     | 2K          |           |             |
| R3173     | 2K          |           |             |



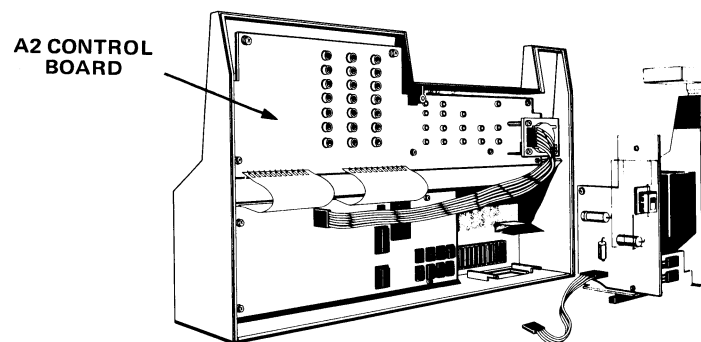


**Figure 10-4. A2 control board.**

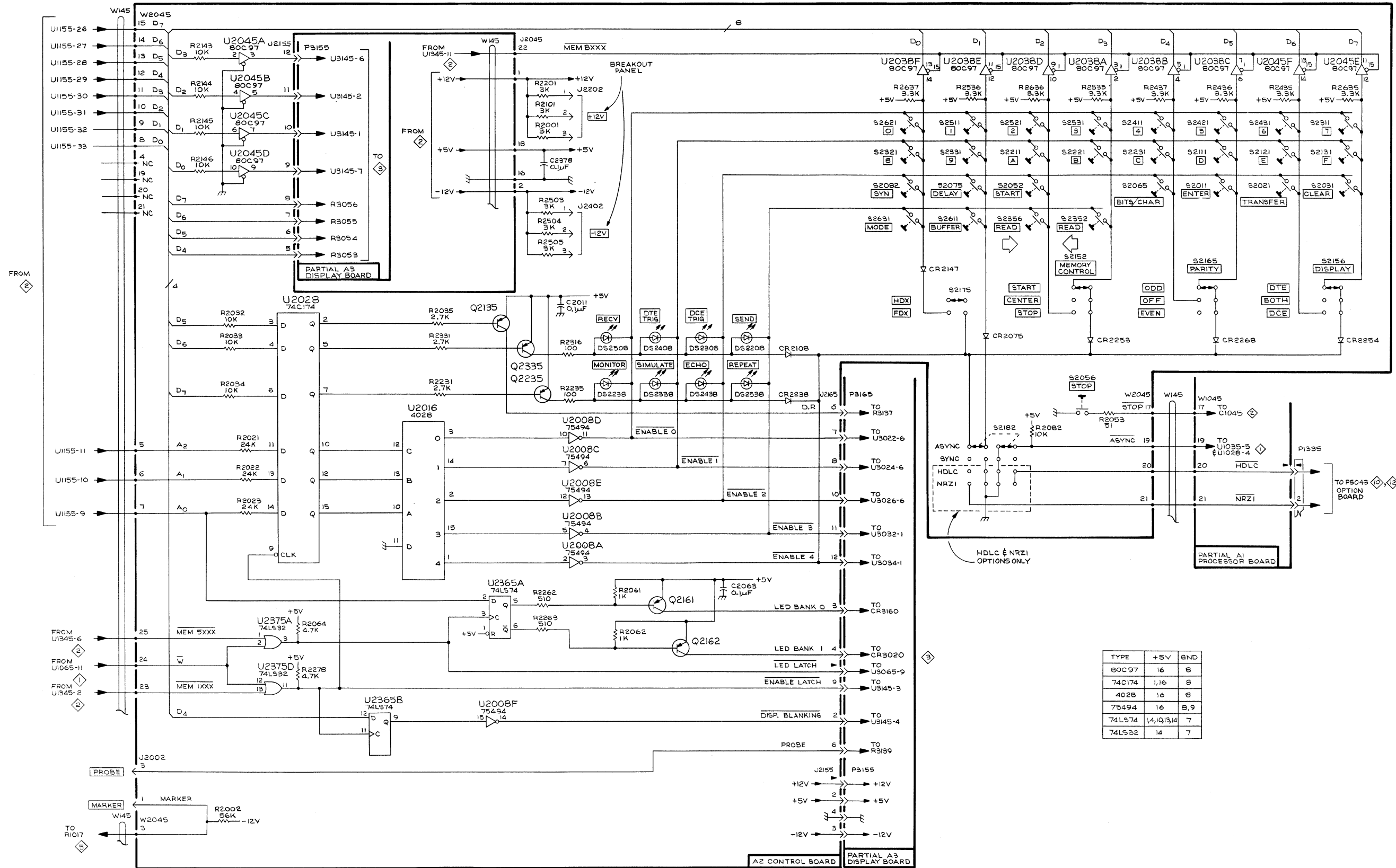
†Located on back of board.

[illegible]

REV A, JAN 1979

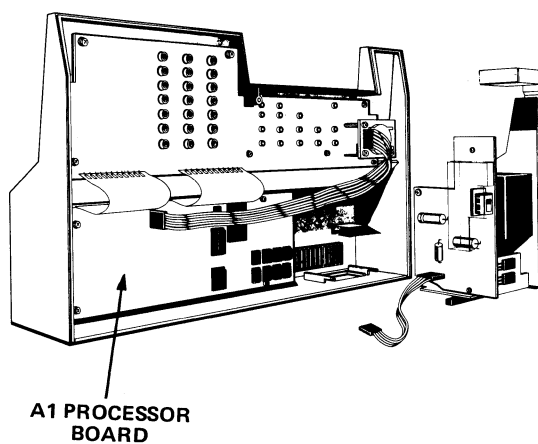






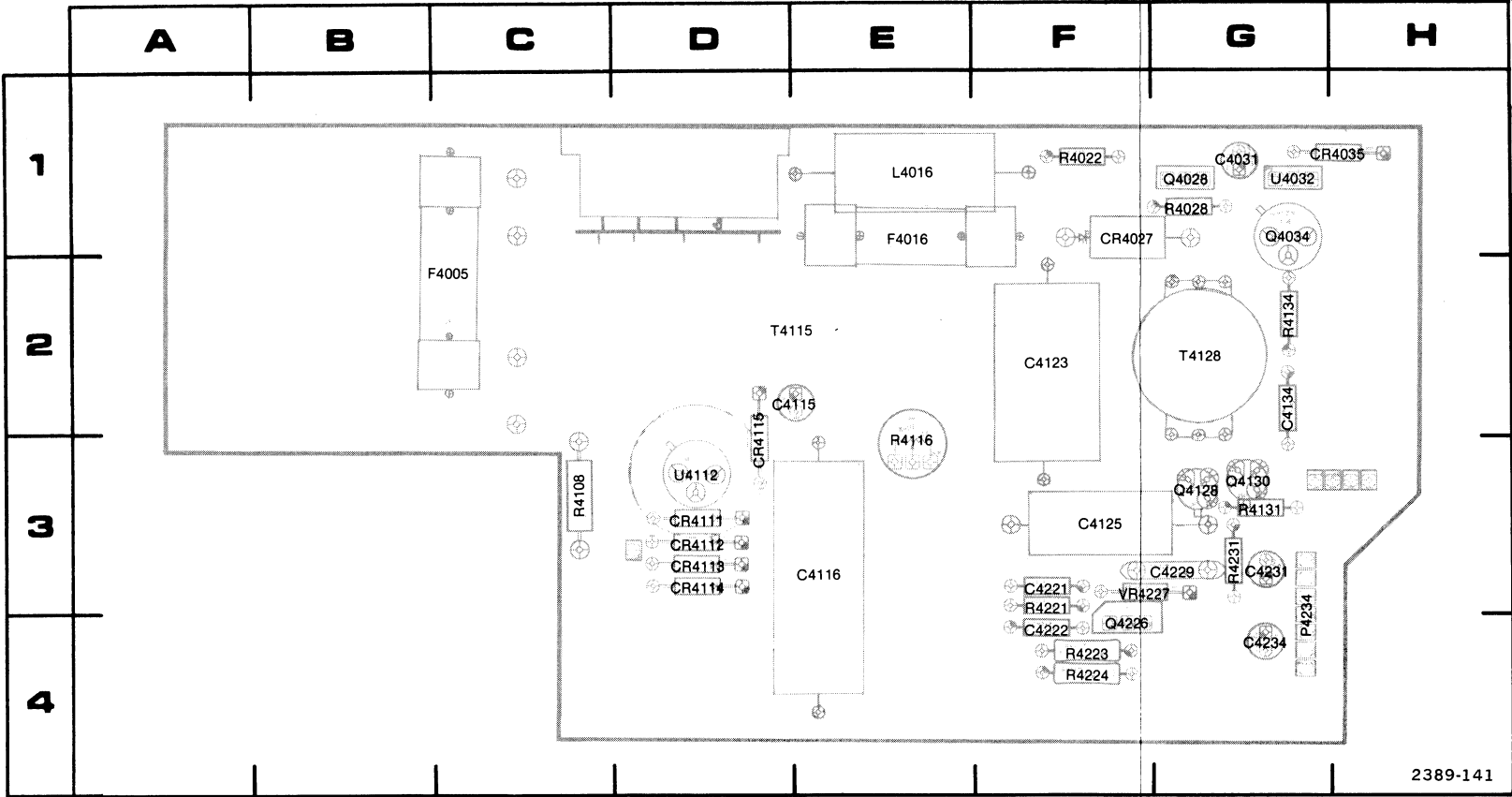
**NOTE**

**SEE A1 PROCESSOR BOARD  
FOR COMPONENT LOCATIONS.**





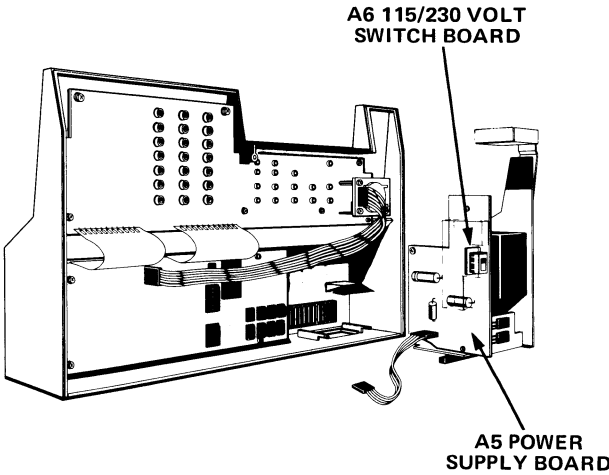




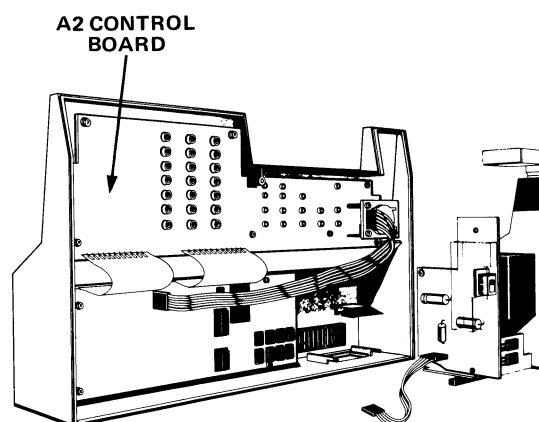
NOTE  
S4014 IS LOCATED ON THE A6  
115/230 SWITCH BOARD.

Figure 10-5. A5 power supply board.

| CKT NO | GRID LOC | CKT NO | GRID LOC |
|--------|----------|--------|----------|
| C4031  | 1G       | Q4130  | 3G       |
| C4115  | 2E       | Q4226  | 4F       |
| C4116  | 3E       |        |          |
| C4123  | 2F       | R4002  | 1F       |
| C4125  | 3F       | R4028  | 1G       |
| C4134  | 2G       | R4108  | 3C       |
| C4221  | 3F       | R4116  | 3E       |
| C4222  | 4F       | R4131  | 3G       |
| C4229  | 3G       | R4134  | 2G       |
| C4231  | 3G       | R4221  | 3F       |
| C4234  | 4G       | R4223  | 4F       |
|        |          | R4224  | 4F       |
|        |          | R4231  | 3G       |
| CR4027 | 1F       |        |          |
| CR4035 | 1H       |        |          |
| CR4111 | 3D       | T4115  | 2E       |
| CR4112 | 3D       | T4128  | 2G       |
| CR4113 | 3D       |        |          |
| CR4114 | 3D       | U4032  | 1G       |
| CR4115 | 3D       | U4112  | 3D       |
|        |          |        |          |
| F4005  | 2C       | VR4227 | 3F       |
| F4016  | 1E       |        |          |
|        |          |        |          |
| L4016  | 1E       |        |          |
|        |          |        |          |
| P4236  | 4G       |        |          |
|        |          |        |          |
| Q4034  | 1G       |        |          |
| Q4128  | 3G       |        |          |

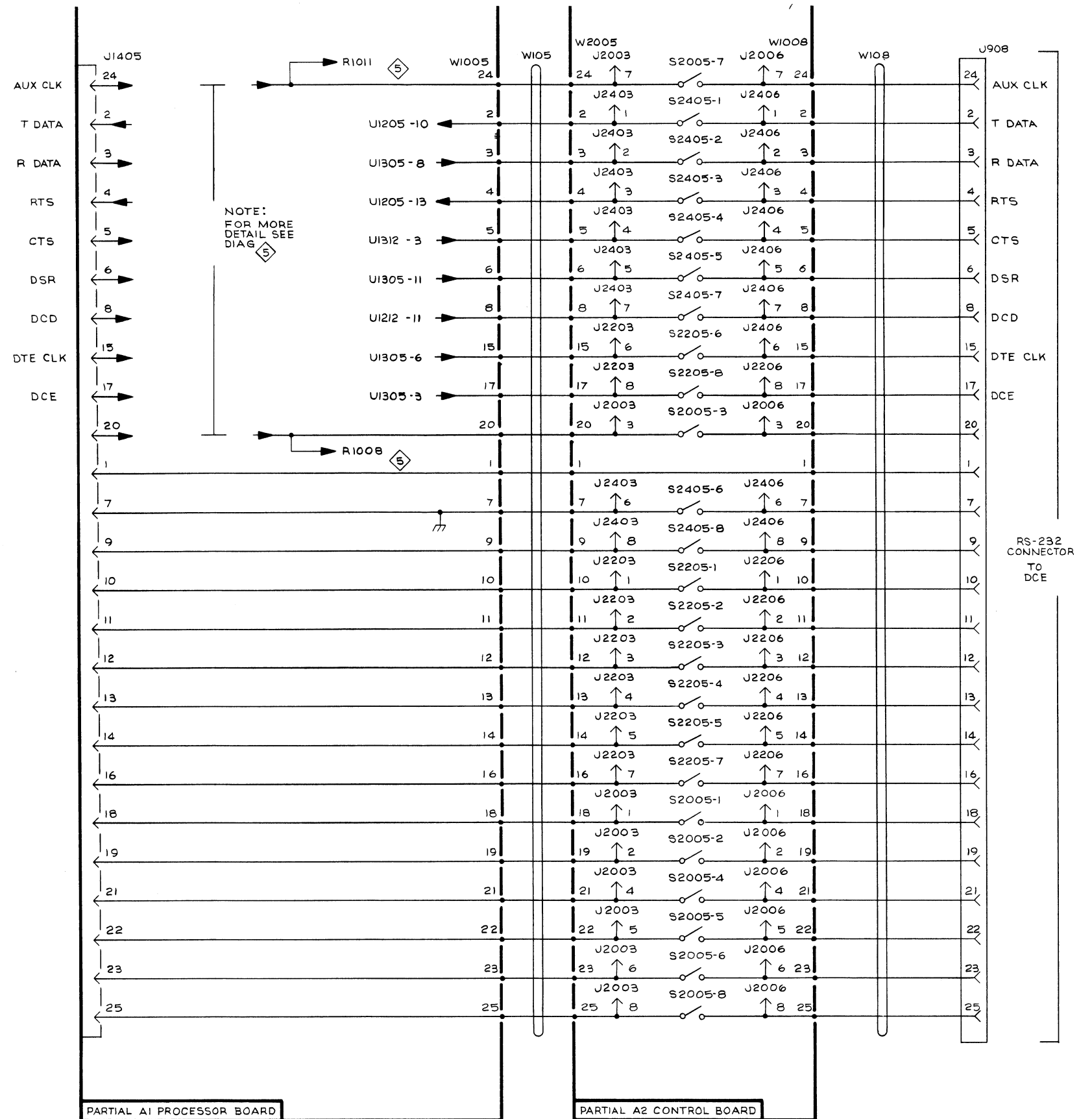


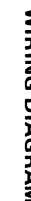
POWER SUPPLY 

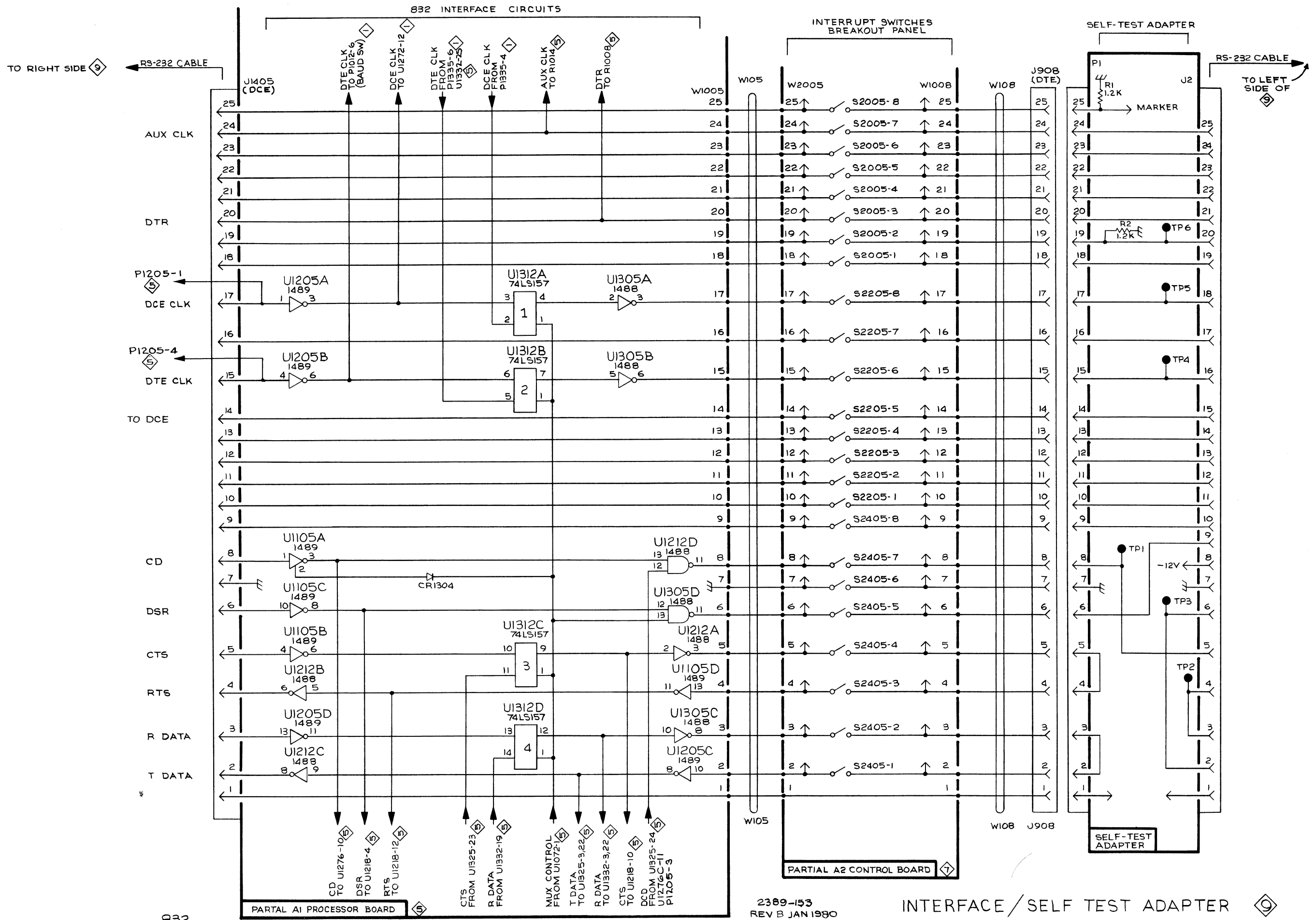


NOTE

SEE A2 CONTROL BOARD FOR  
COMPONENT LOCATIONS.







# REPLACEABLE MECHANICAL PARTS

## PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

## SPECIAL NOTES AND SYMBOLS

X000 Part first added at this serial number  
00X Part removed after this serial number

## FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations.

## INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the description column.

```

1 2 3 4 5      Name & Description
Assembly and/or Component
Attaching parts for Assembly and/or Component
    --- * ---
Detail Part of Assembly and/or Component
Attaching parts for Detail Part
    --- * ---
Parts of Detail Part
Attaching parts for Parts of Detail Part
    --- * ---
  
```

Attaching Parts always appear in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation. The separation symbol --- \* --- indicates the end of attaching parts.

**Attaching parts must be purchased separately, unless otherwise specified.**

## ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

## ABBREVIATIONS

|       |                    |         |                       |          |                      |         |                 |
|-------|--------------------|---------|-----------------------|----------|----------------------|---------|-----------------|
| "     | INCH               | ELCTRN  | ELECTRON              | IN       | INCH                 | SE      | SINGLE END      |
| #     | NUMBER SIZE        | ELEC    | ELECTRICAL            | INCAND   | INCANDESCENT         | SECT    | SECTION         |
| ACTR  | ACTUATOR           | ELCTLT  | ELECTROLYTIC          | INSUL    | INSULATOR            | SEMICON | SEMICONDUCTOR   |
| ADPTR | ADAPTER            | ELEM    | ELEMENT               | INTL     | INTERNAL             | SHLD    | SHIELD          |
| ALIGN | ALIGNMENT          | EPL     | ELECTRICAL PARTS LIST | LPHLDR   | LAMPHOLDER           | SHLDR   | SHOULDERED      |
| AL    | ALUMINUM           | EQPT    | EQUIPMENT             | MACH     | MACHINE              | SKT     | SOCKET          |
| ASSEM | ASSEMBLED          | EXT     | EXTERNAL              | MECH     | MECHANICAL           | SL      | SLIDE           |
| ASSY  | ASSEMBLY           | FIL     | FILLISTER HEAD        | MTG      | MOUNTING             | SLFLKG  | SELF-LOCKING    |
| ATTEN | ATTENUATOR         | FLEX    | FLEXIBLE              | NIP      | NIPPLE               | SLVG    | SLEEVEING       |
| AWG   | AMERICAN WIRE GAGE | FLH     | FLAT HEAD             | NON WIRE | NOT WIRE WOUND       | SPR     | SPRING          |
| BD    | BOARD              | FLTR    | FILTER                | OBD      | ORDER BY DESCRIPTION | SQ      | SQUARE          |
| BRKT  | BRACKET            | FR      | FRAME or FRONT        | OD       | OUTSIDE DIAMETER     | SST     | STAINLESS STEEL |
| BRS   | BRASS              | FSTNR   | FASTENER              | OVH      | OVAL HEAD            | STL     | STEEL           |
| BRZ   | BRONZE             | FT      | FOOT                  | PH BRZ   | PHOSPHOR BRONZE      | SW      | SWITCH          |
| BSHG  | BUSHING            | FXD     | FIXED                 | PL       | PLAIN or PLATE       | T       | TUBE            |
| CAB   | CABINET            | GSKT    | GASKET                | PLSTC    | PLASTIC              | TERM    | TERMINAL        |
| CAP   | CAPACITOR          | HDL     | HANDLE                | PN       | PART NUMBER          | THD     | THREAD          |
| CER   | CERAMIC            | HEX     | HEXAGON               | PNH      | PAN HEAD             | THK     | THICK           |
| CHAS  | CHASSIS            | HEX HD  | HEXAGONAL HEAD        | PWR      | POWER                | TNSN    | TENSION         |
| CKT   | CIRCUIT            | HEX SOC | HEXAGONAL SOCKET      | RCPT     | RECEPTACLE           | TPG     | TAPPING         |
| COMP  | COMPOSITION        | HLCP    | HELICAL COMPRESSION   | RES      | RESISTOR             | TRH     | TRUSS HEAD      |
| CONN  | CONNECTOR          | HLEXT   | HELICAL EXTENSION     | RGD      | RIGID                | V       | VOLTAGE         |
| COV   | COVER              | HV      | HIGH VOLTAGE          | RLF      | RELIEF               | VAR     | VARIABLE        |
| CPLG  | COUPLING           | IC      | INTEGRATED CIRCUIT    | RTNR     | RETAINER             | W/      | WITH            |
| CRT   | CATHODE RAY TUBE   | ID      | INSIDE DIAMETER       | SCH      | SOCKET HEAD          | WSHR    | WASHER          |
| DEG   | DEGREE             | IDNT    | IDENTIFICATION        | SCOPE    | OSCILLOSCOPE         | XFMR    | TRANSFORMER     |
| DWR   | DRAWER             | IMPLR   | IMPELLER              | SCR      | SCREW                | XSTR    | TRANSISTOR      |

## CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

| Mfr. Code | Manufacturer                                          | Address                                  | City, State, Zip         |
|-----------|-------------------------------------------------------|------------------------------------------|--------------------------|
| 000BC     | BADGLEY MFG. COMPANY                                  | 1620 NE ARGYLE                           | PORTLAND, OR 97211       |
| 000EO     | ZEPHER ELECTRONIC SALES CORP.                         | 647 INDUSTRY DRIVE                       | SEATTLE, WA 98188        |
| 00779     | AMP, INC.                                             | P O BOX 3608                             | HARRISBURG, PA 17105     |
| 01295     | TEXAS INSTRUMENTS, INC., SEMICONDUCTOR GROUP          | P O BOX 5012, 13500 N CENTRAL EXPRESSWAY | DALLAS, TX 75222         |
| 04713     | MOTOROLA, INC., SEMICONDUCTOR PROD. DIV.              | 5005 E MCDOWELL RD, PO BOX 20923         | PHOENIX, AZ 85036        |
| 04919     | COMPONENT MANUFACTURING SERVICE, INC.                 | 1 COMPONENT PARK WEST                    | BRIDGEWATER, MA 02379    |
| 05820     | WAKEFIELD ENGINEERING, INC.                           | AUDUBON ROAD                             | WAKEFIELD, MA 01880      |
| 08261     | SPECTRA-STRIP CORP.                                   | 7100 LAMPSON AVE.                        | GARDEN GROVE, CA 92642   |
| 13103     | THERMALLOY COMPANY, INC.                              | 2021 W VALLEY VIEW LANE<br>P O BOX 34829 | DALLAS, TEXAS 75234      |
| 22526     | BERG ELECTRONICS, INC.                                | YOUK EXPRESSWAY                          | NEW CUMBERLAND, PA 17070 |
| 28520     | HEYMAN MFG. CO.                                       | 147 N. MICHIGAN AVE.                     | KENILWORTH, NJ 07033     |
| 31918     | IEE/SCHADOW INC.                                      | 8081 WALLACE ROAD                        | EDEN PRAIRIE, MN 55343   |
| 49671     | RCA CORPORATION                                       | 30 ROCKEFELLER PLAZA                     | NEW YORK, NY 10020       |
| 52905     | SIMPLEX MFG. COMPANY                                  | 5224 NE 42ND AVENUE                      | PORTLAND, OREGON 97218   |
| 55210     | GETTIG ENG. AND MFG. COMPANY                          | PO BOX 85, OFF ROUTE 45                  | SPRING MILLS, PA 16875   |
| 70485     | ATLANTIC INDIA RUBBER WORKS, INC.                     | 571 W. POLK ST.                          | CHICAGO, IL 60607        |
| 71400     | BUSSMAN MFG., DIVISION OF MCGRAW-EDISON CO.           | 2536 W. UNIVERSITY ST.                   | ST. LOUIS, MO 63107      |
| 73743     | FISCHER SPECIAL MFG. CO.                              | 446 MORGAN ST.                           | CINCINNATI, OH 45206     |
| 73803     | TEXAS INSTRUMENTS, INC., METALLURGICAL MATERIALS DIV. | 34 FOREST STREET                         | ATTLEBORO, MA 02703      |
| 75915     | LITTELFUSE, INC.                                      | 800 E. NORTHWEST HWY                     | DES PLAINES, IL 60016    |
| 76545     | MUELLER ELECTRIC CO.                                  | 1583 EAST 31ST ST.                       | CLEVELAND, OH 44114      |
| 78189     | ILLINOIS TOOL WORKS, INC. SHAKEPROOF DIVISION         | ST. CHARLES ROAD                         | ELGIN, IL 60120          |
| 80009     | TEKTRONIX, INC.                                       | P O BOX 500                              | BEAVERTON, OR 97077      |
| 82389     | SWITCHCRAFT, INC.                                     | 5555 N. ELSTON AVE.                      | CHICAGO, IL 60630        |
| 82647     | TEXAS INSTRUMENTS, INC., CONTROL PRODUCTS DIV.        | 34 FOREST ST.                            | ATTLEBORO, MA 02703      |
| 83385     | CENTRAL SCREW CO.                                     | 2530 CRESCENT DR.                        | BROADVIEW, IL 60153      |
| 95987     | WECKESSER CO., INC.                                   | 4444 WEST IRVING PARK RD.                | CHICAGO, IL 60641        |



| Fig. &<br>Index<br>No. | Tektronix<br>Part No. | Serial/Model No.<br>Eff Dscont | Qty | 1 2 3 4 5 | Name & Description                                                                                                                                                                                                                      | Mfr<br>Code | Mfr Part Number |
|------------------------|-----------------------|--------------------------------|-----|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----------------|
| 1-1                    | 200-2200-00           |                                | 1   |           | COVER, TOP:<br>(ATTACHING PARTS)                                                                                                                                                                                                        | 80009       | 200-2200-00     |
| -2                     | 211-0648-00           |                                | 6   |           | SCR ASSEM WSHR: 6-32 X 0.625 INCH, PNH, STL<br>- - - * - - -                                                                                                                                                                            | 80009       | 211-0648-00     |
| -3                     | 131-2199-00           |                                | 1   |           | CONN, RCPT, ELEC: CKT CARD, 25 CONT, MALE, RIGHT<br>(ATTACHING PARTS)                                                                                                                                                                   | 00779       | 205857-1        |
| -4                     | 211-0012-00           |                                | 2   |           | SCREW, MACHINE: 4-40 X 0.375, PNH STL CD PL                                                                                                                                                                                             | 83385       | OBD             |
| -5                     | 210-0586-00           |                                | 2   |           | NUT, PLAIN, EXT W: 4-40 X 0.25 INCH, STL<br>- - - * - - -                                                                                                                                                                               | 78189       | 211-041800-00   |
| -6                     | 175-2197-00           |                                | 1   |           | CA ASSY, SP, ELEC: 25, 26 AWG, 13.7 L<br>(ATTACHING PARTS)                                                                                                                                                                              | 000EO       | 3349-25 CABLE   |
| -7                     | 211-0012-00           |                                | 2   |           | SCREW, MACHINE: 4-40 X 0.375, PNH STL CD PL                                                                                                                                                                                             | 83385       | OBD             |
| -8                     | 210-0586-00           |                                | 2   |           | NUT, PLAIN, EXT W: 4-40 X 0.25 INCH, STL<br>- - - * - - -                                                                                                                                                                               | 78189       | 211-041800-00   |
| -9                     | 334-3403-00           |                                | 1   |           | MARKER, IDENT: MARKED 25V MAX                                                                                                                                                                                                           | 80009       | 334-3403-00     |
| -10                    | 334-3402-00           |                                | 1   |           | MARKER, IDENT: MARKED VOLTAGE INFORMATION                                                                                                                                                                                               | 80009       | 334-3402-00     |
| -11                    | 348-0569-00           |                                | 2   |           | FOOT, CABINET: BLACK POLYURETHANE                                                                                                                                                                                                       | 80009       | 348-0569-00     |
| -12                    | 333-2452-00           |                                | 1   |           | PANEL, REAR:                                                                                                                                                                                                                            | 80009       | 333-2452-00     |
| -13                    | -----                 |                                | 1   |           | CKT BOARD ASSY: PROCESSOR (SEE A1 EPL)<br>(ATTACHING PARTS)                                                                                                                                                                             |             |                 |
| -14                    | 211-0658-00           |                                | 4   |           | SCR, ASSEM WSHR: 6-32 X 0.312 L, PNH, STL<br>- - - * - - -                                                                                                                                                                              | 78189       | OBD             |
| -15                    | 136-0694-00           |                                | -   |           | . CKT BOARD ASSY INCLUDES:                                                                                                                                                                                                              |             |                 |
| -16                    | 136-0623-00           |                                | 2   |           | . SKT, PL-IN ELEK: MICROCIRCUIT, 28 CONTACT                                                                                                                                                                                             | 73803       | CS9002-28       |
| -17                    | 136-0578-00           |                                | 1   |           | . SOCKET, PLUG-IN: 40 DIP, LOW PROFILE                                                                                                                                                                                                  | 73803       | CS9002-40       |
| -18                    | 136-0260-02           |                                | 4   |           | . SOCKET, PLUG-IN: 24 DIP, LOW PROFILE                                                                                                                                                                                                  | 73803       | CS9002-24       |
| -19                    | 131-0993-00           |                                | 12  |           | . SOCKET, PLUG-IN: 16 CONTACT, LOW CLEARANCE                                                                                                                                                                                            | 82647       | C9316-18        |
| -20                    | 131-0608-00           |                                | 6   |           | . BUS, CONDUCTOR: 2 WIRE BLACK                                                                                                                                                                                                          | 00779       | 530153-2        |
| -21                    | 131-2220-00           | B010100 B020947                | 68  |           | . TERMINAL, PIN: 0.365 L X 0.25 PH, BRZ, GOLD PL                                                                                                                                                                                        | 22526       | 47357           |
| -21                    | 131-2220-01           | B020948                        | 2   |           | . BUS, CONDUCTOR: 25 CONDUCTORS, 2.5 L                                                                                                                                                                                                  | 00779       | 2-86942-4       |
| -22                    | 136-0269-02           |                                | 2   |           | . BUS, CONDUCTOR: 25 CONDUCTORS, 1.5 L                                                                                                                                                                                                  | 80009       | 131-2220-01     |
| -23                    | -----                 |                                | 2   |           | . SOCKET, PLUG-IN: 14 CONTACT, LOW CLEARANCE                                                                                                                                                                                            | 01295       | C95140          |
| -24                    | 352-0522-00           | B010100 B010230X               | 1   |           | CKT BOARD ASSY: DISPLAY (SEE A3 EPL)                                                                                                                                                                                                    |             |                 |
| -25                    | 131-0566-00           |                                | 14  |           | . HOLDER, LED: POLYPROPYLENE                                                                                                                                                                                                            | 80009       | 352-0522-00     |
| -26                    | 131-1633-00           |                                | 2   |           | . LINK, TERM. CONNE: 0.086 DIA X 2.375 INCH L                                                                                                                                                                                           | 55210       | L-2007-1        |
| -27                    | 407-2129-00           |                                | 2   |           | . CONNECTOR, RCPT, : CKT CARD MTG                                                                                                                                                                                                       | 22526       | 65001-009       |
| -28                    | 211-0661-00           |                                | 2   |           | BRACKET, CKT BD: ALUMINUM<br>(ATTACHING PARTS)                                                                                                                                                                                          | 80009       | 407-2129-00     |
| -28                    | 211-0661-00           |                                | 4   |           | SCREW, MACHINE: 4-40 X 0.25 INCH, PNH, STL<br>- - - * - - -                                                                                                                                                                             | 83385       | OBD             |
| -28                    | 211-0658-00           |                                | 2   |           | SCR, ASSEM WSHR: 6-32 X 0.312 L, PNH, STL                                                                                                                                                                                               | 78189       | OBD             |
| -28                    | 210-3057-00           |                                | 2   |           | WASHER, FLAT: 0.170 ID X 0.375 OD                                                                                                                                                                                                       | 95987       | NW8-3753        |
| -29                    | -----                 |                                | 1   |           | CKT BOARD ASSY: CONTROL (SEE A2 EPL)<br>(ATTACHING PARTS)                                                                                                                                                                               |             |                 |
| -30                    | 211-0658-00           |                                | 6   |           | SCR, ASSEM WSHR: 6-32 X 0.312 L, PNH, STL<br>- - - * - - -                                                                                                                                                                              | 78189       | OBD             |
| -31                    | 200-2197-00           |                                | -   |           | . CKT BOARD ASSY INCLUDES:                                                                                                                                                                                                              |             |                 |
| -31                    | 200-2197-00           |                                | 1   |           | . COVER, SWITCH:<br>(ATTACHING PARTS)                                                                                                                                                                                                   | 80009       | 200-2197-00     |
| -32                    | 211-0180-00           |                                | 2   |           | . SCR, ASSEM WSHR: 2-56 X 0.25 INCH, PNH BRS                                                                                                                                                                                            | 83385       | OBD             |
| -33                    | 211-0014-00           |                                | 1   |           | . SCREW, MACHINE: 4-40 X 0.50 INCH, PNH STL<br>- - - * - - -                                                                                                                                                                            | 83385       | OBD             |
| -34                    | -----                 |                                | 3   |           | . SWITCH, PUSH: (SEE S2005, S2205, S2405 EPL)                                                                                                                                                                                           |             |                 |
| -35                    | 136-0260-02           |                                | 3   |           | . SOCKET, PLUG-IN: 16 CONTACT, LOW CLEARANCE                                                                                                                                                                                            | 82647       | C9316-18        |
| -36                    | 131-0589-00           |                                | 56  |           | . TERM, PIN: 0.46 L X 0.025 SQ. PH BRZ GL                                                                                                                                                                                               | 22526       | 47350           |
| -37                    | -----                 |                                | 1   |           | . SWITCH, PB ASSY: MOMENTARY, ORANGE (SEE S2611 EPL)                                                                                                                                                                                    |             |                 |
| -38                    | -----                 |                                | 26  |           | . SWITCH, PB ASSY: MOMENTARY<br>(SEE S2011, S2021, S2031, S2052, S2056, S2065,<br>S2075, S2082, S2111, S2121, S2131, S2211, S2221,<br>S2231, S2311, S2321, S2331, S2352, S2356, S2411,<br>S2421, S2431, S2511, S2521, S2531, S2621 EPL) |             |                 |
| -39                    | -----                 |                                | 1   |           | . SWITCH, PB ASSY: MOMENTARY, BLUE (SEE S2631 EPL)                                                                                                                                                                                      |             |                 |
| -40                    | 352-0522-01           |                                | 8   |           | . HOLDER, LED: POLYPROPYLENE                                                                                                                                                                                                            | 80009       | 352-0522-01     |
| -41                    | 220-0828-00           |                                | 1   |           | . SWITCH, SL ASSY: SYNC-A-SYNC (SEE S2182 EPL)<br>(ATTACHING PARTS)                                                                                                                                                                     |             |                 |
| -41                    | 220-0828-00           |                                | 2   |           | . PUSH ON NUT: 0.073 ID X 0.25 OD, PLASTIC<br>- - - * - - -                                                                                                                                                                             | 80009       | 220-0828-00     |

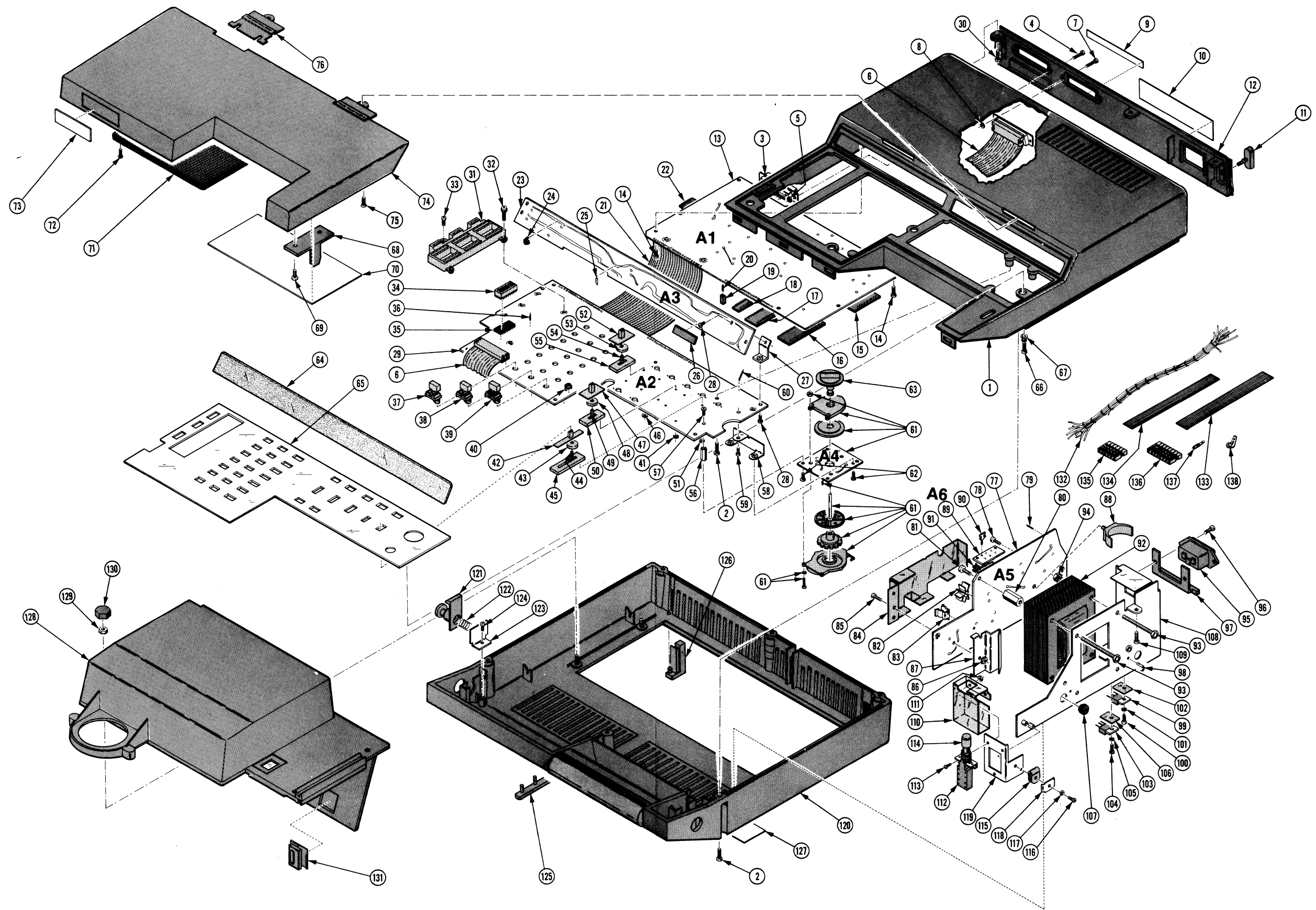
# Replaceable Mechanical Parts—832

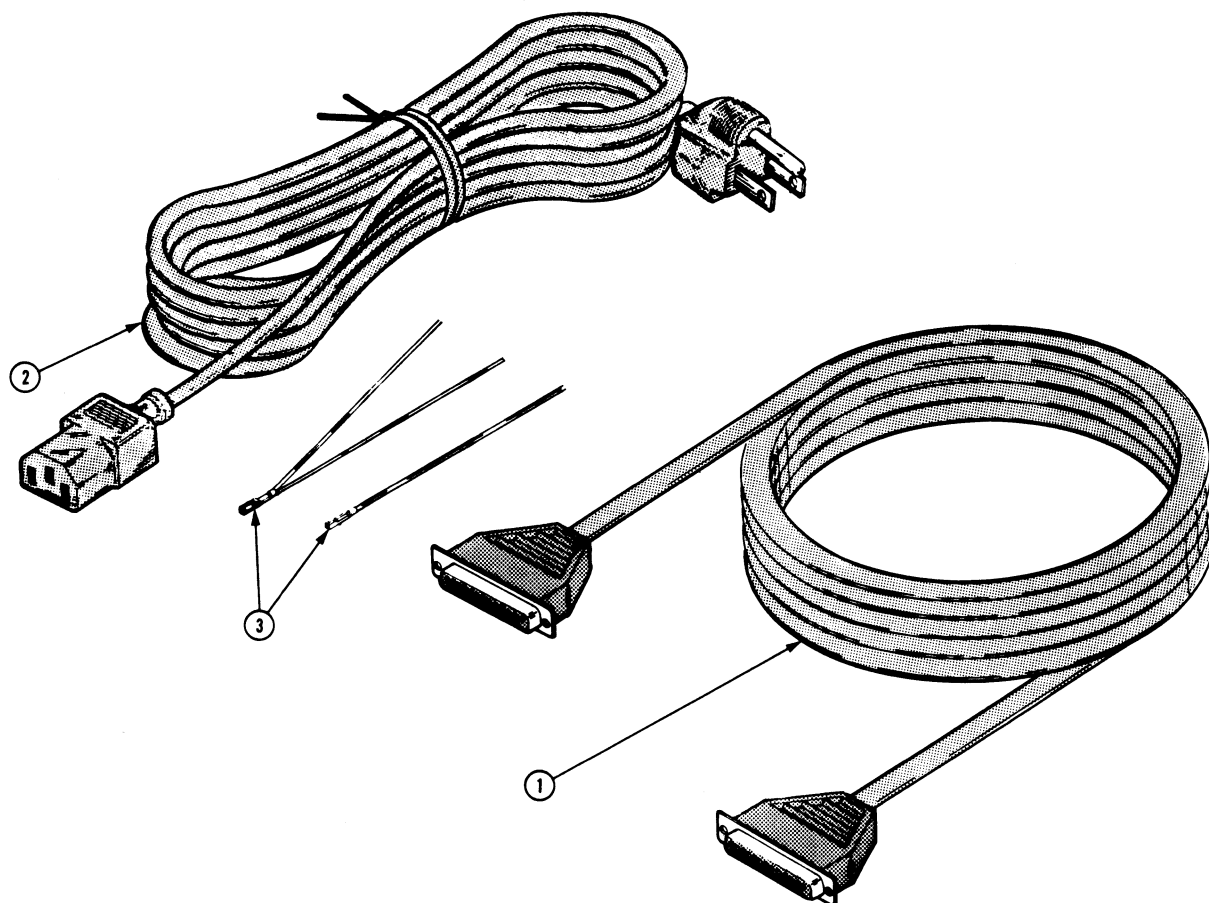
| Fig. &<br>Index<br>No. | Tektronix<br>Part No. | Serial/Model No.<br>Eff Dscont | Qty | 1 2 3 4 5 | Name & Description                             | Mfr<br>Code | Mfr Part Number |
|------------------------|-----------------------|--------------------------------|-----|-----------|------------------------------------------------|-------------|-----------------|
| 1-                     | -----                 |                                | -   | .         | SWITCH ASSY INCLUDES:                          |             |                 |
| -42                    | 200-2217-00           |                                | 1   | .         | COVER,SLIDE SW:PLASTIC                         | 80009       | 200-2217-00     |
| -43                    | 361-0934-00           |                                | 1   | .         | SPACER,SLEEVE:0.17 THK X 0.185 ID X 0.5 OD     | 80009       | 361-0934-00     |
| -44                    | 105-0780-00           |                                | 1   | .         | ACTUATOR,SL SW:                                | 80009       | 105-0780-00     |
| -45                    | 380-0541-00           |                                | 1   | .         | HOUSING,SL SW:2 OF 6 POSITION                  | 80009       | 380-0541-00     |
|                        | -----                 |                                | 1   | .         | SWITCH,SL ASSY:HALF AND FULL DX(SEE S2175 EPL) |             |                 |
|                        |                       |                                |     |           | (ATTACHING PARTS)                              |             |                 |
| -46                    | 220-0828-00           |                                | 2   | .         | PUSH ON NUT:0.073 ID X 0.25 OD,PLASTIC         | 80009       | 220-0828-00     |
|                        | -----                 |                                | -   | .         | SWITCH ASSY INCLUDES:                          |             |                 |
| -47                    | 200-2203-00           |                                | 1   | .         | COVER,SLIDE SW:3 OF 3 POSITION                 | 80009       | 200-2203-00     |
| -48                    | 361-0934-00           |                                | 1   | .         | SPACER,SLEEVE:0.17 THK X 0.185 ID X 0.5 OD     | 80009       | 361-0934-00     |
| -49                    | 105-0780-00           |                                | 1   | .         | ACTUATOR,SL SW:                                | 80009       | 105-0780-00     |
| -50                    | 380-0543-00           |                                | 1   | .         | HOUSING,SL SW:2 OF 3 POSITION                  | 80009       | 380-0543-00     |
|                        | -----                 |                                | 3   | .         | SWITCH,SL ASSY:(SEE S2152,S2156,S2165 EPL)     |             |                 |
|                        |                       |                                |     |           | (ATTACHING PARTS)                              |             |                 |
| -51                    | 220-0828-00           |                                | 2   | .         | PUSH ON NUT:0.073 ID X 0.25 OD,PLASTIC         | 80009       | 220-0828-00     |
|                        | -----                 |                                | -   | .         | SWITCH ASS INCLUDES:                           |             |                 |
| -52                    | 200-2203-00           |                                | 3   | .         | COVER,SLIDE SW:3 OF 3 POSITION                 | 80009       | 200-2203-00     |
| -53                    | 361-0934-00           |                                | 3   | .         | SPACER,SLEEVE:0.17 THK X 0.185 ID X 0.5 OD     | 80009       | 361-0934-00     |
| -54                    | 105-0780-00           |                                | 3   | .         | ACTUATOR,SL SW:                                | 80009       | 105-0780-00     |
| -55                    | 380-0540-00           |                                | 3   | .         | HOUSING,SL SW:3 OF 3 POSITION                  | 80009       | 380-0540-00     |
| -56                    | 129-0097-00           |                                | 1   | .         | SPACER,POST:0.560 L X 0.188 W/4-40 THD         | 80009       | 129-0097-00     |
|                        |                       |                                |     |           | (ATTACHING PARTS)                              |             |                 |
| -57                    | 211-0661-00           |                                | 1   | .         | SCREW,MACHINE:4-40 X 0.25 INCH,PNH,STL         | 83385       | OBD             |
|                        | -----                 |                                | -   | .         | BRACKET,CKT BD:ALUMINUM                        |             |                 |
| -58                    | 407-2134-00           |                                | 1   | .         | BRACKET,CKT BD:ALUMINUM                        | 80009       | 407-2134-00     |
|                        |                       |                                |     |           | (ATTACHING PARTS)                              |             |                 |
| -59                    | 211-0658-00           |                                | 1   | .         | SCR,ASSEM WSHR:6-32 X 0.312 L,PNH,STL          | 78189       | OBD             |
|                        | -----                 |                                | -   | .         | CONTACT,ELEC:0.71 INCH LONG                    |             |                 |
| -60                    | 131-0590-00           |                                | 24  | .         | CONTACT,ELEC:0.71 INCH LONG                    | 22526       | 47351           |
| -61                    | 263-0038-00           |                                | 1   | .         | SWITCH,ROTARY:BAUD,15/16 POSN                  | 80009       | 263-0038-00     |
|                        |                       |                                |     |           | (ATTACHING PARTS)                              |             |                 |
| -62                    | 211-0661-00           |                                | 3   | .         | SCREW,MACHINE:4-40 X 0.25 INCH,PNH,STL         | 83385       | OBD             |
|                        | -----                 |                                | -   | .         | KNOB:GY,1.0 H,X 0.7 DIA W/SHAFT                |             |                 |
| -63                    | 366-1761-00           |                                | 1   | .         | KNOB:GY,1.0 H,X 0.7 DIA W/SHAFT                | 80009       | 366-1761-00     |
| -64                    | 386-3940-00           |                                | 1   | .         | PANEL,DISPLAY:                                 | 80009       | 386-3940-00     |
| -65                    | 333-2461-00           |                                | 1   | .         | PANEL,FRONT:                                   | 80009       | 333-2461-00     |
|                        |                       |                                |     |           | (ATTACHING PARTS)                              |             |                 |
| -66                    | 211-0503-00           |                                | 4   | .         | SCREW,MACHINE:6-32 X 0.188 INCH,PNH STL        | 83385       | OBD             |
| -67                    | 210-0055-00           |                                | 4   | .         | WASHER,LOCK:SPLIT,0.145 ID X 0.253 OD,STL      | 83385       | OBD             |
|                        | -----                 |                                | -   | .         | LATCH,LTD:                                     |             |                 |
| -68                    | 105-0777-00           |                                | 2   | .         | LATCH,LTD:                                     | 80009       | 105-0777-00     |
|                        |                       |                                |     |           | (ATTACHING PARTS)                              |             |                 |
| -69                    | 211-0504-00           |                                | 4   | .         | SCREW,MACHINE:6-32 X 0.25 INCH,PNH STL         | 83385       | OBD             |
|                        | -----                 |                                | -   | .         | MARKER,IDENT:MARKED CONVERSION CHART           |             |                 |
| -70                    | 334-3436-00           |                                | 1   | .         | MARKER,IDENT:MARKED CONVERSION CHART           | 80009       | 334-3436-00     |
| -71                    | 016-0407-00           |                                | 1   | .         | POUCH,ACCESSORY:4.8 L X 4.0 W                  | 000BC       | OBD             |
|                        |                       |                                |     |           | (ATTACHING PARTS)                              |             |                 |
| -72                    | 211-0214-00           |                                | 2   | .         | SCREW,MACHINE:4-40 X 0.25 INCH,TRH STL         | 83385       | OBD             |
|                        | -----                 |                                | -   | .         | MARKER,IDENT:MARKED TEK 832 DATA COMM TEST     |             |                 |
| -73                    | 334-3401-00           |                                | 1   | .         | MARKER,IDENT:MARKED TEK 832 DATA COMM TEST     | 80009       | 334-3401-00     |
| -74                    | 200-2214-00           |                                | 1   | .         | COVER,FRONT:PLASTIC                            | 80009       | 200-2214-00     |
|                        |                       |                                |     |           | (ATTACHING PARTS)                              |             |                 |
| -75                    | 211-0538-00           |                                | 2   | .         | SCREW,MACHINE:6-32 X 0.312"100 DEG,FLH STL     | 83385       | OBD             |
|                        | -----                 |                                | -   | .         | HINGE,COVER:                                   |             |                 |
| -76                    | 214-2743-00           | B010100 B020946                | 2   | .         | HINGE,COVER:                                   | 80009       | 214-2743-00     |
|                        | 214-2743-02           | B020947                        | 2   | .         | HINGE,COVER:                                   | 80009       | 214-2743-02     |
| -77                    | -----                 |                                | 1   | .         | CKT BOARD ASSY:POWER SUPPLY(SEE A5 EPL)        |             |                 |
|                        |                       |                                |     |           | (ATTACHING PARTS)                              |             |                 |
| -78                    | 211-0207-00           |                                | 1   | .         | SCR,ASSEM WSHR:4-40 X 0.312 DOUBLE SEMS        | 83385       | OBD             |
|                        | -----                 |                                | -   | .         | CKT BOARD ASSY INCLUDES:                       |             |                 |
| -79                    | 131-0608-00           |                                | 12  | .         | TERMINAL,PIN:0.365 L X 0.25 PH,BRZ,GOLD PL     | 22526       | 47357           |

| Fig. &<br>Index<br>No. | Tektronix<br>Part No. | Serial/Model No.<br>Eff Dscont | Qty | 1 2 3 4 5 | Name & Description                                             | Mfr<br>Code | Mfr Part Number  |
|------------------------|-----------------------|--------------------------------|-----|-----------|----------------------------------------------------------------|-------------|------------------|
| 1-80                   | 129-0287-00           |                                | 1   | .         | POST,ELEC-MECH:0.75 INCH LONG X 0.375 HEX<br>(ATTACHING PARTS) | 80009       | 129-0287-00      |
| -81                    | 212-0518-00           |                                | 1   | .         | SCREW,MACHINE:10-32 X 0.312 INCH,PNH STL<br>- - - * - - -      | 83385       | OBD              |
| -82                    | 214-1291-00           |                                | 1   | .         | HEAT SINK,ELEC:XSTR,0.72 OD X 0.375"H                          | 05820       | 207-AB           |
| -83                    | 344-0286-00           |                                | 4   | .         | CLIP,ELECTRICAL:FOR 3AG FUSE,BRS                               | 75915       | 102069           |
| -84                    | 337-2593-00           |                                | 1   | .         | SHIELD,ELEC:POWER SUPPLY<br>(ATTACHING PARTS)                  | 80009       | 337-2593-00      |
| -85                    | 211-0012-00           | B010100 B010327                | 1   | .         | SCREW,MACHINE:4-40 X 0.375,PNH STL CD PL                       | 83385       | OBD              |
|                        | 211-0244-00           | B010328                        | 1   | .         | SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL                       | 78189       | OBD              |
| -86                    | 210-0586-00           | XB010328                       | 1   | .         | NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL<br>- - - * - - -          | 78189       | 211-041800-00    |
| -87                    | 337-2591-00           | B010100 B010327                | 1   | .         | SHIELD,ELEC:FUSE HOLDER                                        | 80009       | 337-2591-00      |
|                        | 337-2635-00           | B010328                        | 1   | .         | SHIELD,ELEC:POWER SUPPLY                                       | 80009       | 337-2635-00      |
| -88                    | 344-0244-00           |                                | 1   | .         | CLIP,CMPNT MTG:U/W 0.75 DIA CMPNT                              | 80009       | 344-0244-00      |
| -89                    | -----                 |                                | 1   | .         | CKT BOARD ASSY:110/220 SWITCH(SEE A6 EPL)                      |             |                  |
| -90                    | 131-1261-00           |                                | 4   | .         | CONTACT,ELEC:F-SHAPED                                          | 00779       | 1-380953-0       |
| -91                    | -----                 |                                | 1   | .         | SWITCH,SLIDE:DPST(SEE S4014 EPL)                               |             |                  |
| -92                    | -----                 |                                | 1   | .         | XFMR,PWR,STPDN:(SEE T4115 EPL)<br>(ATTACHING PARTS)            |             |                  |
| -93                    | 212-0517-00           |                                | 4   | .         | SCREW,MACHINE:10-32 X 1.750INCH,HEX HD STL                     | 83385       | OBD              |
| -94                    | 220-0410-00           |                                | 3   | .         | NUT,EXTENDED WA:10-32 X 0.375 INCH,STL<br>- - - * - - -        | 83385       | OBD              |
| -95                    | 131-1084-00           |                                | 1   | .         | CONNECTOR,RCPT,:3 BLADE,6A,250V<br>(ATTACHING PARTS)           | 82389       | EAC-302          |
| -96                    | 211-0012-00           |                                | 2   | .         | SCREW,MACHINE:4-40 X 0.375,PNH STL CD PL<br>- - - * - - -      | 83385       | OBD              |
| -97                    | 361-0912-00           |                                | 1   | .         | SPACER,RCPT:POWER                                              | 80009       | 361-0912-00      |
| -98                    | 343-0213-00           |                                | 2   | .         | CLAMP,LOOP:PRESS MT,PLASTIC                                    | 80009       | 343-0213-00      |
| -99                    | -----                 |                                | 1   | .         | MICROCIRCUIT,LI:(SEE U4032 EPL)<br>(ATTACHING PARTS)           |             |                  |
| -100                   | 211-0008-00           |                                | 1   | .         | SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL                         | 83385       | OBD              |
| -101                   | 210-1171-00           |                                | 1   | .         | WSHR,SHOULDERED:0.116 ID X 0.138 INCH OD<br>- - - * - - -      | 52905       | A7148516P2       |
| -102                   | 342-0163-00           |                                | 1   | .         | INSULATOR,PLATE:XSTR,0.675 X 0.625 X 0.001"                    | 80009       | 342-0163-00      |
| -103                   | -----                 |                                | 1   | .         | TRANSISTOR:SIL(SEE Q4028 EPL)<br>(ATTACHING PARTS)             |             |                  |
| -104                   | 211-0008-00           |                                | 1   | .         | SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL                         | 83385       | OBD              |
| -105                   | 210-1171-00           |                                | 1   | .         | WSHR,SHOULDERED:0.116 ID X 0.138 INCH OD<br>- - - * - - -      | 52905       | A7148516P2       |
| -106                   | 342-0163-00           |                                | 1   | .         | INSULATOR,PLATE:XSTR,0.675 X 0.625 X 0.001"                    | 80009       | 342-0163-00      |
| -107                   | 348-0517-00           |                                | 2   | .         | GROMMET,PLASTIC:BLACK,ROUND,0.25 ID                            | 28520       | SB-375-4         |
| -108                   | 441-1426-00           |                                | 1   | .         | CHAS,PWR SUPPLY:<br>(ATTACHING PARTS)                          | 80009       | 441-1426-00      |
| -109                   | 211-0504-00           |                                | 1   | .         | SCREW,MACHINE:6-32 X 0.25 INCH,PNH STL<br>- - - * - - -        | 83385       | OBD              |
| -110                   | 337-2594-00           |                                | 1   | .         | SHIELD,ELEC:POWER SWITCH<br>(ATTACHING PARTS)                  | 80009       | 337-2594-00      |
| -111                   | 210-0405-00           |                                | 2   | .         | NUT,PLAIN,HEX.:2-56 X 0.188 INCH,BRS<br>- - - * - - -          | 73743       | 2X12157-402      |
| -112                   | -----                 |                                | 1   | .         | SWITCH,PUSH DPDT:(SEE S950 EPL)<br>(ATTACHING PARTS)           |             |                  |
| -113                   | 211-0001-00           |                                | 2   | .         | SCREW,MACHINE:2-56 X 0.25 INCH,PNH STL<br>- - - * - - -        | 83385       | OBD              |
| -114                   | 366-1767-00           |                                | 1   | .         | PUSH BUTTON:BLACK,YELLOW INDICATOR                             | 31918       | FA201            |
| -115                   | 343-0002-00           |                                | 1   | .         | CLAMP,LOOP:0.188 INCH DIA<br>(ATTACHING PARTS)                 | 95987       | 3-16-6B          |
| -116                   | 211-0012-00           |                                | 1   | .         | SCREW,MACHINE:4-40 X 0.375,PNH STL CD PL                       | 83385       | OBD              |
| -117                   | 210-0004-00           |                                | 1   | .         | WASHER,LOCK:#4 INTL,0.015THK,STL CD PL                         | 78189       | 1204-00-00-0541C |
| -118                   | 210-0863-00           |                                | 1   | .         | WSHR,LOOP CLAMP:FOR 0.50" WIDE CLAMP,STL<br>- - - * - - -      | 95987       | C191             |
| -119                   | 441-1436-00           |                                | 1   | .         | CHASSIS,PWR SW:                                                | 80009       | 441-1436-00      |
| -120                   | 441-1358-02           |                                | 1   | .         | CHAS,PORT DMM:W/HARDWARE                                       | 80009       | 441-1358-02      |
| -121                   | 105-0778-00           |                                | 2   | .         | LATCH,COVER:RIGHT                                              | 80009       | 105-0778-00      |
| -122                   | 214-0428-00           |                                | 2   | .         | SPRING,HANDLE:0.375 OD X 0.4 L,CLOSED                          | 80009       | 214-0428-00      |

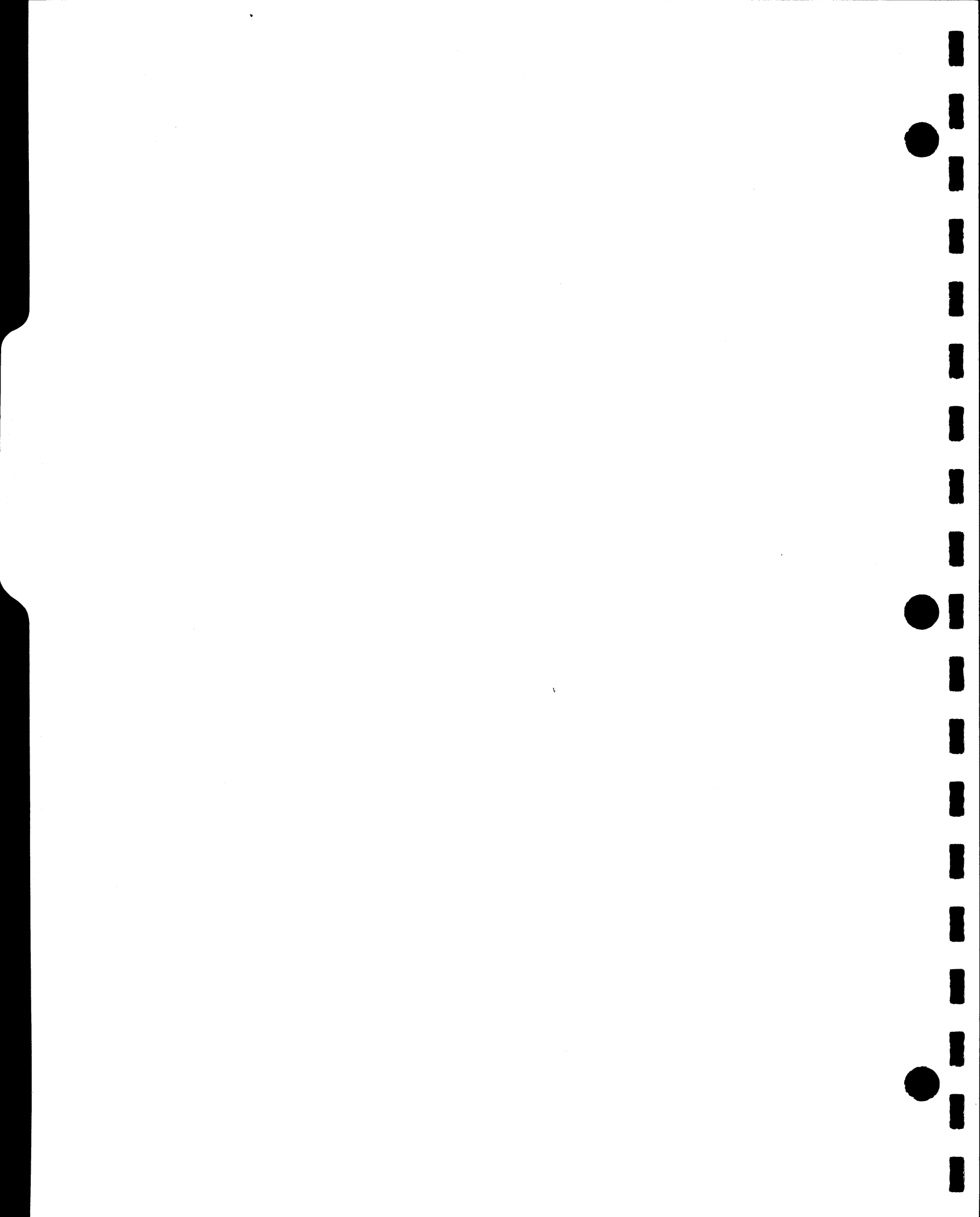
# Replaceable Mechanical Parts—832

| Fig. &<br>Index<br>No. | Tektronix<br>Part No. | Serial/Model No.<br>Eff | Discont | Qty | 1                                             | 2                                    | 3            | 4 | 5 | Name & Description | Mfr<br>Code | Mfr Part Number  |
|------------------------|-----------------------|-------------------------|---------|-----|-----------------------------------------------|--------------------------------------|--------------|---|---|--------------------|-------------|------------------|
| 1-123                  | 407-1920-00           |                         |         | 2   | .                                             | BRACKET, COV                         | LCH:ALUMINUM |   |   |                    | 80009       | 407-1920-00      |
|                        |                       |                         |         |     |                                               | (ATTACHING PARTS)                    |              |   |   |                    |             |                  |
| -124                   | 211-0504-00           |                         |         | 2   | .                                             | SCREW, MACHINE:6-32 X 0.25 INCH, PNH | STL          |   |   |                    | 83385       | OBD              |
|                        |                       |                         |         |     |                                               | - - - * - - -                        |              |   |   |                    |             |                  |
| -125                   | 348-0570-00           |                         |         | 2   | .                                             | FOOT, CABINET:BLACK, PLASTIC         |              |   |   |                    | 80009       | 348-0570-00      |
| -126                   | 348-0514-00           |                         |         | 2   | .                                             | FOOT, CABINET:POLYURETHANE, BLACK    |              |   |   |                    | 80009       | 348-0514-00      |
| -127                   | 334-3400-00           |                         |         | 1   | .                                             | MARKER, IDENT:MARKED CAUTION         |              |   |   |                    | 80009       | 334-3400-00      |
| -128                   | 202-0240-01           |                         |         | 1   | BOX, ACCESSORY:W/HARDWARE                     |                                      |              |   |   |                    | 80009       | 202-0240-01      |
|                        |                       |                         |         |     |                                               | (ATTACHING PARTS)                    |              |   |   |                    |             |                  |
| -129                   | 220-0410-00           |                         |         | 4   | NUT, EXTENDED WA:10-32 X 0.375 INCH, STL      |                                      |              |   |   |                    | 83385       | OBD              |
| -130                   | 200-2263-00           |                         |         | 4   | COVER, NUT:                                   |                                      |              |   |   |                    | 80009       | 200-2263-00      |
|                        |                       |                         |         |     |                                               | - - - * - - -                        |              |   |   |                    |             |                  |
| -131                   | 105-0779-00           |                         |         | 2   | LCH, ACCESS BOX:                              |                                      |              |   |   |                    | 80009       | 105-0779-00      |
| -132                   | 179-2641-00           |                         |         | 1   | WIRING HARNESS:POWER SUPPLY                   |                                      |              |   |   |                    | 80009       | 179-2641-00      |
|                        | 198-4001-00           |                         |         | 1   | . WIRE SET, ELEC:                             |                                      |              |   |   |                    | 80009       | 198-4001-00      |
|                        | 198-3984-00           |                         |         | 1   | WIRE SET, ELEC:                               |                                      |              |   |   |                    | 80009       | 198-3984-00      |
| -133                   | 175-0831-00           |                         |         | FT  | . WIRE, ELECTRICAL:8 WIRE RIBBON              |                                      |              |   |   |                    | 08261       | OBD              |
| -134                   | 175-0858-00           |                         |         | FT  | . WIRE, ELECTRICAL:7 WIRE RIBBON              |                                      |              |   |   |                    | 08261       | SS-0722-1910610C |
| -135                   | 352-0164-03           |                         |         | 1   | . CONN BODY, PL, EL:6 WIRE ORANGE             |                                      |              |   |   |                    | 80009       | 352-0164-03      |
|                        | 352-0164-05           |                         |         | 1   | . CONN BODY, PL, EL:6 WIRE GREEN              |                                      |              |   |   |                    | 80009       | 352-0164-05      |
| -136                   | 352-0166-01           |                         |         | 1   | . CONN BODY, PL, EL:8 WIRE BROWN              |                                      |              |   |   |                    | 80009       | 352-0166-01      |
|                        | 352-0166-02           |                         |         | 1   | . HLD, TERM CONN:8 WIRE, RED                  |                                      |              |   |   |                    | 80009       | 352-0166-02      |
| -137                   | 131-0707-00           |                         |         | 30  | . CONNECTOR, TERM.:22-26 AWG, BRS& CU BE GOLD |                                      |              |   |   |                    | 22526       | 47439            |
| -138                   | 210-0202-00           |                         |         | 5   | . TERMINAL, LUG:0.146 ID, LOCKING, BRZ TINNED |                                      |              |   |   |                    | 78189       | 2104-06-00-2520N |





| Fig. &<br>Index<br>No. | Tektronix<br>Part No. | Serial/Model No.<br>Eff Dscont | Qty | 1 | 2 | 3 | 4 | 5 | Name & Description                       | Mfr<br>Code | Mfr Part Number |
|------------------------|-----------------------|--------------------------------|-----|---|---|---|---|---|------------------------------------------|-------------|-----------------|
| -1                     | 012-0815-00           |                                | 1   |   |   |   |   |   | CABLE, INTCON: 2.0 METERS                | 04919       | OBD             |
|                        | 070-2388-00           |                                | 1   |   |   |   |   |   | MANUAL, TECH: OPERATORS                  | 80009       | 070-2388-00     |
|                        | 070-2389-00           |                                | 1   |   |   |   |   |   | MANUAL, TECH: SERVICE                    | 80009       | 070-2389-00     |
|                        | 159-0044-00           |                                | 1   |   |   |   |   |   | FUSE, CARTRIDGE: 3AG, 0.2A, 250V         | 71400       | MDL2/10         |
|                        | -----                 |                                | -   |   |   |   |   |   | (FOR 110V OPERATION)                     |             |                 |
|                        | 159-0048-00           |                                | 1   |   |   |   |   |   | FUSE, CARTRIDGE: 3AG, 0.1A, 250V         | 71400       | MDL1/10         |
|                        | -----                 |                                | -   |   |   |   |   |   | (FOR 220V OPERATION)                     |             |                 |
| -2                     | 161-0066-00           |                                | 1   |   |   |   |   |   | CABLE ASSY, PWR: 3, 18 AWG, 115V, 98.0 L | 80009       | 161-0066-00     |
| -3                     | 198-4006-00           |                                | 1   |   |   |   |   |   | WIRE SET, ELEC:                          | 80009       | 198-4006-00     |





## MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages.

A single change may affect several sections. Since the change information sheets are carried in the manual until all changes are permanently entered, some duplication may occur. If no such change pages appear following this page, your manual is correct as printed.

## SERVICE NOTE

Because of the universal parts procurement problem, some electrical parts in your instrument may be different from those described in the Replaceable Electrical Parts List. The parts used will in no way alter or compromise the performance or reliability of this instrument. They are installed when necessary to ensure prompt delivery to the customer. Order replacement parts from the Replaceable Electrical Parts List.



# CALIBRATION TEST EQUIPMENT REPLACEMENT

## Calibration Test Equipment Chart

This chart compares TM 500 product performance to that of older Tektronix equipment. Only those characteristics where significant specification differences occur, are listed. In some cases the new instrument may not be a total functional replacement. Additional support instrumentation may be needed or a change in calibration procedure may be necessary.

Comparison of Main Characteristics

|                                 |                                                                                                                      |                                                                                                                 |
|---------------------------------|----------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| DM 501 replaces 7D13            |                                                                                                                      |                                                                                                                 |
| PG 501 replaces 107             | PG 501 - Risetime less than 3.5 ns into 50 $\Omega$ .                                                                | 107 - Risetime less than 3.0 ns into 50 $\Omega$ .                                                              |
| 108                             | PG 501 - 5 V output pulse; 3.5 ns Risetime                                                                           | 108 - 10 V output pulse 1 ns Risetime                                                                           |
| PG 502 replaces 107             |                                                                                                                      |                                                                                                                 |
| 108                             | PG 502 - 5 V output                                                                                                  | 108 - 10 V output                                                                                               |
| 111                             | PG 502 - Risetime less than 1 ns; 10 ns Pretrigger pulse delay                                                       | 111 - Risetime 0.5 ns; 30 to 250 ns Pretrigger pulse delay                                                      |
| PG 508 replaces 114             | Performance of replacement equipment is the same or better than equipment being replaced.                            |                                                                                                                 |
| 115                             |                                                                                                                      |                                                                                                                 |
| 2101                            |                                                                                                                      |                                                                                                                 |
| PG 506 replaces 106             | PG 506 - Positive-going trigger output signal at least 1 V; High Amplitude output, 60 V.                             | 106 - Positive and Negative-going trigger output signal, 50 ns and 1 V; High Amplitude output, 100 V.           |
| 067-0502-01                     | PG 506 - Does not have chopped feature.                                                                              | 0502-01 - Comparator output can be alternately chopped to a reference voltage.                                  |
| SG 503 replaces 190, 190A, 190B | SG 503 - Amplitude range 5 mV to 5.5 V p-p.                                                                          | 190B - Amplitude range 40 mV to 10 V p-p.                                                                       |
| 191                             | SG 503 - Frequency range 250 kHz to 250 MHz.                                                                         | 0532-01 - Frequency range 65 MHz to 500 MHz.                                                                    |
| 067-0532-01                     |                                                                                                                      |                                                                                                                 |
| SG 504 replaces 067-0532-01     | SG 504 - Frequency range 245 MHz to 1050 MHz.                                                                        | 0532-01 - Frequency range 65 MHz to 500 MHz.                                                                    |
| 067-0650-00                     |                                                                                                                      |                                                                                                                 |
| TG 501 replaces 180, 180A       | TG 501 - Trigger output-slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time. | 180A - Trigger pulses 1, 10, 100 Hz; 1, 10, and 100 kHz. Multiple time-marks can be generated simultaneously.   |
| 181                             | TG 501 - Trigger output-slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time. | 181 - Multiple time-marks                                                                                       |
| 184                             |                                                                                                                      | 184 - Separate trigger pulses of 1 and 0.1 sec; 10, 1, and 0.1 ms; 10 and 1 $\mu$ s.                            |
| 2901                            | TG 501 - Trigger output-slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time. | 2901 - Separate trigger pulses, from 5 sec to 0.1 $\mu$ s. Multiple time-marks can be generated simultaneously. |

NOTE: All TM 500 generator outputs are short-proof. All TM 500 plug-in instruments require TM 500-Series Power Module.



Date: 6-27-79 Change Reference: C7/679Product: 832 Manual Part No.: 070-2389-00**DESCRIPTION****OPTION 2 INFORMATION**

The following pages (Option 2 Page 1 through Option 2 Page 30) contain complete operating and servicing information for the Option 2 portion of an 832 equipped with Option 2. Option 2 adds an A55 Connector board (some boards may be marked "HDLC OPTION") and a Current Loop Interface Adapter Assembly (marked "Current Loop Interface").

**NOTE**

Option 1 has been discontinued. All references to Option 1 (in diagrams and elsewhere in this manual) that affect Option 2 should be changed to read "A55 Connector Board". Any references to Option 1 that do not affect Option 2 should be ignored.



## OPTION 2

### INTRODUCTION

This portion of the 832 Options section describes the difference between an 832 equipped with Option 2 (includes the A55 Connector board and the Current Loop Interface Adapter Assembly) and the standard 832. Parts lists and schematic diagrams unique to Option 2 are located at the end of this description. Figure Option 2-1 illustrates the Current Loop Interface Adapter Assembly.

The Option 2 instrument, allows the 832 to monitor and send data using a current loop interface rather than the standard EIA RS-232 C interface. Both two-wire (single loop, simplex or half-duplex) and four-wire (two-loop-, full-duplex) capabilities are included. The current source for each of the two loops is selectable by the operator and can be either externally supplied by the unit under test or internally provided by the 832. This current loop testing capability is enabled whenever the 26-pin connector plug (P5100) on the end of the Current Loop Interface Adapter cable is inserted into connector receptacle J5100 on the rear panel of the 832 Option 2 instrument. All normal modes of asynchronous operation can be used.

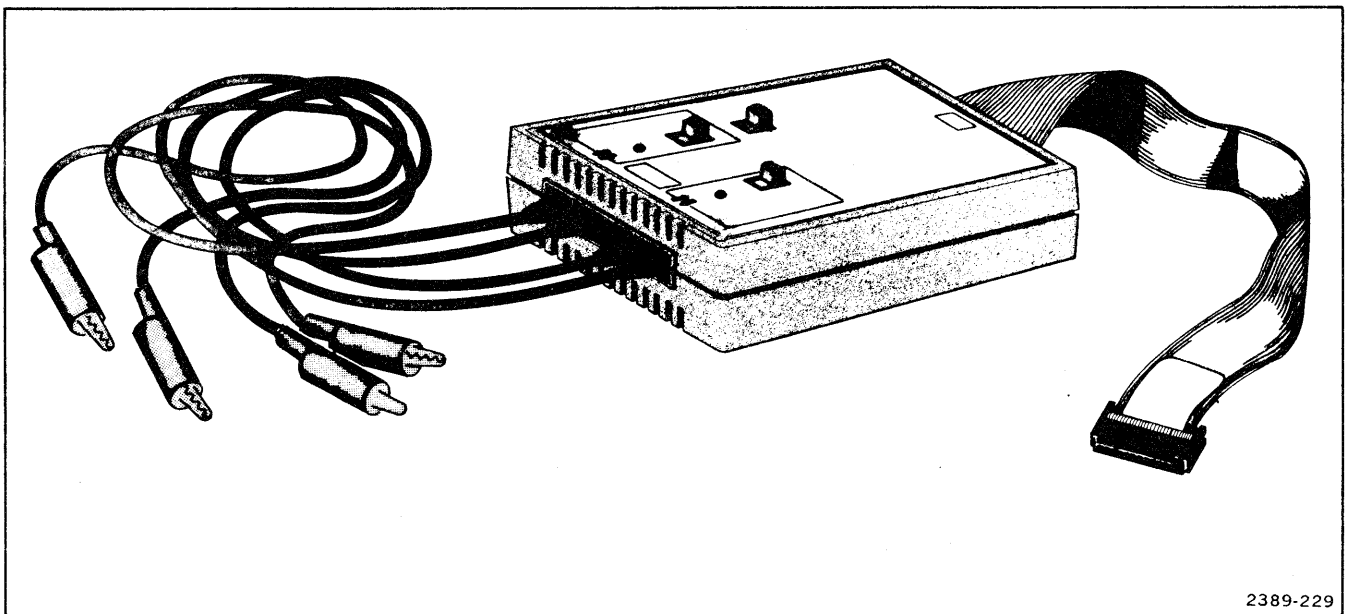


Figure Option 2-1. Current Loop Interface Adapter.

### SPECIFICATION

The electrical, environmental, and physical characteristics shown in Tables Option 2-1, Option 2-2, and Option 2-3 are applicable to the 832 Option 2 instrument. All other electrical, environmental, and physical characteristics previously presented in the Specification section of this manual remain applicable to both the basic 832 instrument and the 832 Option 2 instrument.

TABLE OPTION 2-1

## Current Loop Interface Adapter Electrical Characteristics

| Characteristics                    | Performance Requirements                                                                                                                                                         | Supplemental Information       |
|------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| Current Sources                    |                                                                                                                                                                                  |                                |
| Internal                           |                                                                                                                                                                                  | SPACE is for R-Data Loop only. |
| 20 mA                              | $18 \text{ mA} \leq \text{MARK} \leq 22 \text{ mA}$ .<br>$0 \text{ mA} \leq \text{SPACE} \leq 1.5 \text{ mA}$ .                                                                  |                                |
| 60 mA                              | $54 \text{ mA} \leq \text{MARK} \leq 66 \text{ mA}$ .<br>$0 \text{ mA} \leq \text{SPACE} \leq 1.5 \text{ mA}$ .<br>$\geq 8 \text{ V}$ can be supplied across current loop leads. |                                |
| External                           | $15 \text{ mA} \leq \text{MARK} \leq 80 \text{ mA}$ .<br>$0 \text{ mA} \leq \text{SPACE} \leq 1.5 \text{ mA}$ .<br>$\leq 2 \text{ V}$ required across current loop leads.        |                                |
| Current Loop Leads                 |                                                                                                                                                                                  |                                |
| Maximum Input Voltage              | 125 V peak between leads.<br>125 V peak between either lead and ground.                                                                                                          | External current source.       |
| Maximum Output Voltage             | $-30 \text{ V} \leq V_{\text{out}} \leq 0 \text{ V}$ .                                                                                                                           | Internal current source.       |
| Maximum Data Transfer Rate         |                                                                                                                                                                                  |                                |
| Seven and Eight Bits per Character | $\geq 9600$ bits per second.                                                                                                                                                     |                                |
| Five and Six Bits per Character    | $\geq 4800$ bits per second.                                                                                                                                                     |                                |

TABLE OPTION 2-2

## Current Loop Interface Adapter Environmental Characteristics

| Characteristics | Description                                                                                                                                                                                                                                                    |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Vibration       | Vibration frequency cycled from 10 to 55 to 10 Hz (linear or logarithmic sweep) for a duration of 15 minutes in each major axis at a displacement of 0.050 inches (1.27 mm) peak-to-peak. Dwelled for 10 minutes in each major axis at any resonant frequency. |
| Shock           | 150 g's, ½-sine, 9 ms duration, three shocks in each major axis for a total of 18 shocks.                                                                                                                                                                      |

TABLE OPTION 2-3  
Current Loop Interface Adapter Physical Characteristics

| Characteristics    | Description                      |
|--------------------|----------------------------------|
| Overall Dimensions |                                  |
| Length             | 5.4 inches (13.7 cm).            |
| Width              | 3.25 inches (8.25 cm).           |
| Height             | 1.6 inches (4.1 cm).             |
| Weight             | Not more than 1 pound (0.45 kg). |

CONTROLS, CONNECTORS, AND INDICATORS

The locations of the Current Loop Interface Adapter controls, connectors, and indicators are depicted in Figure Option 2-2 and are keyed to the following descriptions.

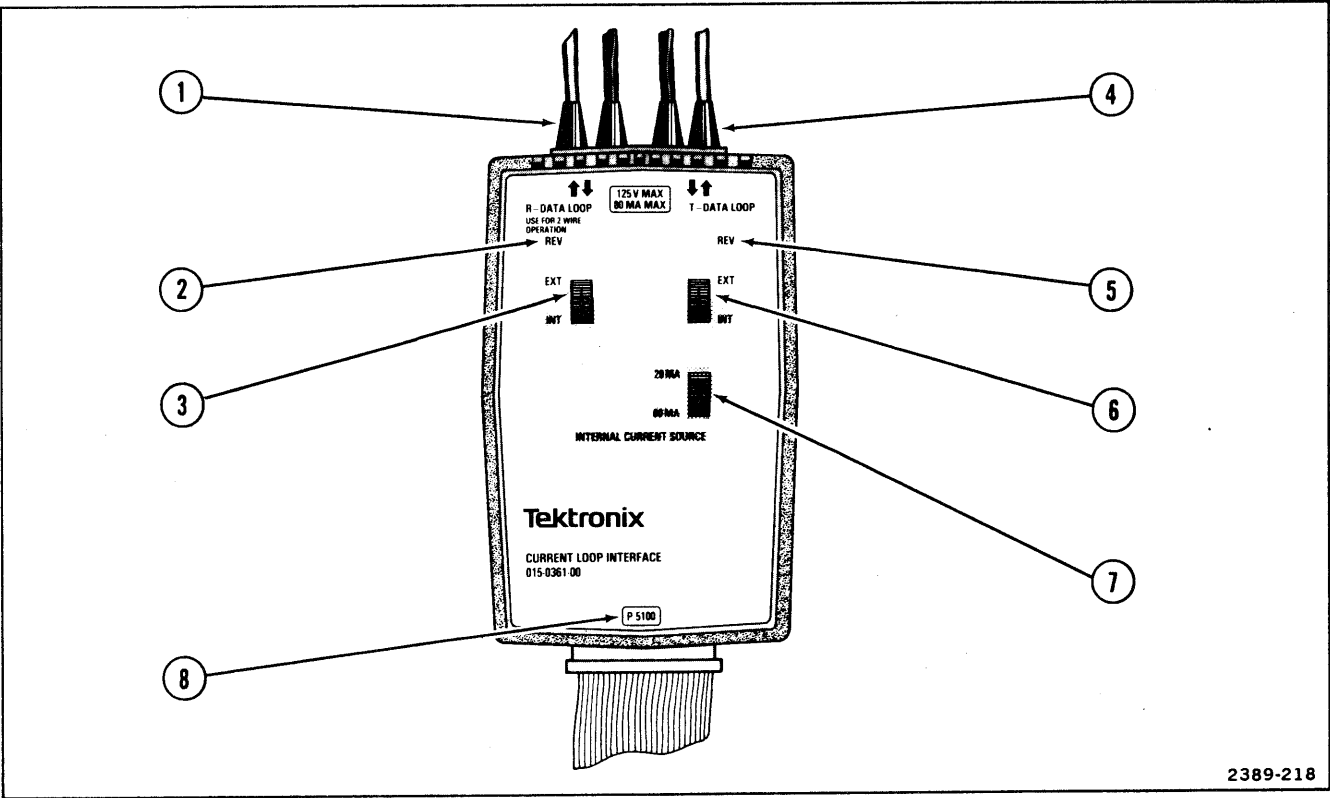


Figure Option 2-2. Location of Controls, Connectors, and Indicators on the Current Loop Interface Adapter.

R-DATA LOOP

- ① **Test Leads**—Two color-coded test leads are connected in series with the Recieve-Data Current Loop. Current flows into the black lead and out of the red lead, as marked by the direction of the arrows on the front panel. Data on this loop will be treated as DCE data by the 832. In the Simulate, Echo, and Repeat modes, data is transmitted by the 832 on this loop. In the two-wire mode, use this loop only and set the 832 for half-duplex (HDX) operation.

- ② **REV Indicator**—A reverse LED that illuminates whenever current is flowing backwards in the R-Data Loop, indicating that test leads should be reversed.
- ③ **EXT/INT Switch**—A two-position slide switch used to select the current source for the R-Data Loop.
  - EXT—Current is supplied by unit under test.
  - INT—Current is supplied by the Current Loop Interface Adapter.

## T-DATA LOOP

- ④ **Test Leads**—Two color-coded test leads are connected in series with the Transmit-Data Current Loop. Current flows into the black lead and out of the red lead, as marked by the direction of the arrows on the front panel. Data on this loop will be treated as DTE data by the 832. (The T-Data Loop cannot transmit information on the RS-232 C interface as the R-Data Loop does.)
- ⑤ **REV Indicator**—A reverse LED that illuminates whenever current is flowing backwards in the T-Data Loop, indicating that test leads should be reversed.
- ⑥ **EXT/INT Switch**—A two-position slide switch used to select the current source for the T-Data Loop.
  - EXT—Current is supplied by unit under test.
  - INT—Current is supplied by the Current Loop Interface Adapter.
- ⑦ **INTERNAL CURRENT SOURCE Switch**—A two-position slide switch used to select either 20 milliamperes or 60 milliamperes source current for both the T-Data Loop and the R-Data Loop whenever either or both EXT/INT switches are set to INT.
- ⑧ **P5100**—A 26-pin connector plug at the end of the flat cable and used to connect the Current Loop Interface Adapter to the 832.

## OPERATING INSTRUCTIONS

These instructions explain how to connect your Current Loop Interface Adapter and to operate the Option 2 instrument for testing external circuitry.

### INSTALLATION

Connect the Current Loop Interface Adapter to the 832 as follows:

1. Align connector plug P5100 at the end of the flat cable with connector jack J5100 on the rear panel of the 832 (see Figure Option 2-3). Note that the connector and plug are keyed to each other when properly aligned.

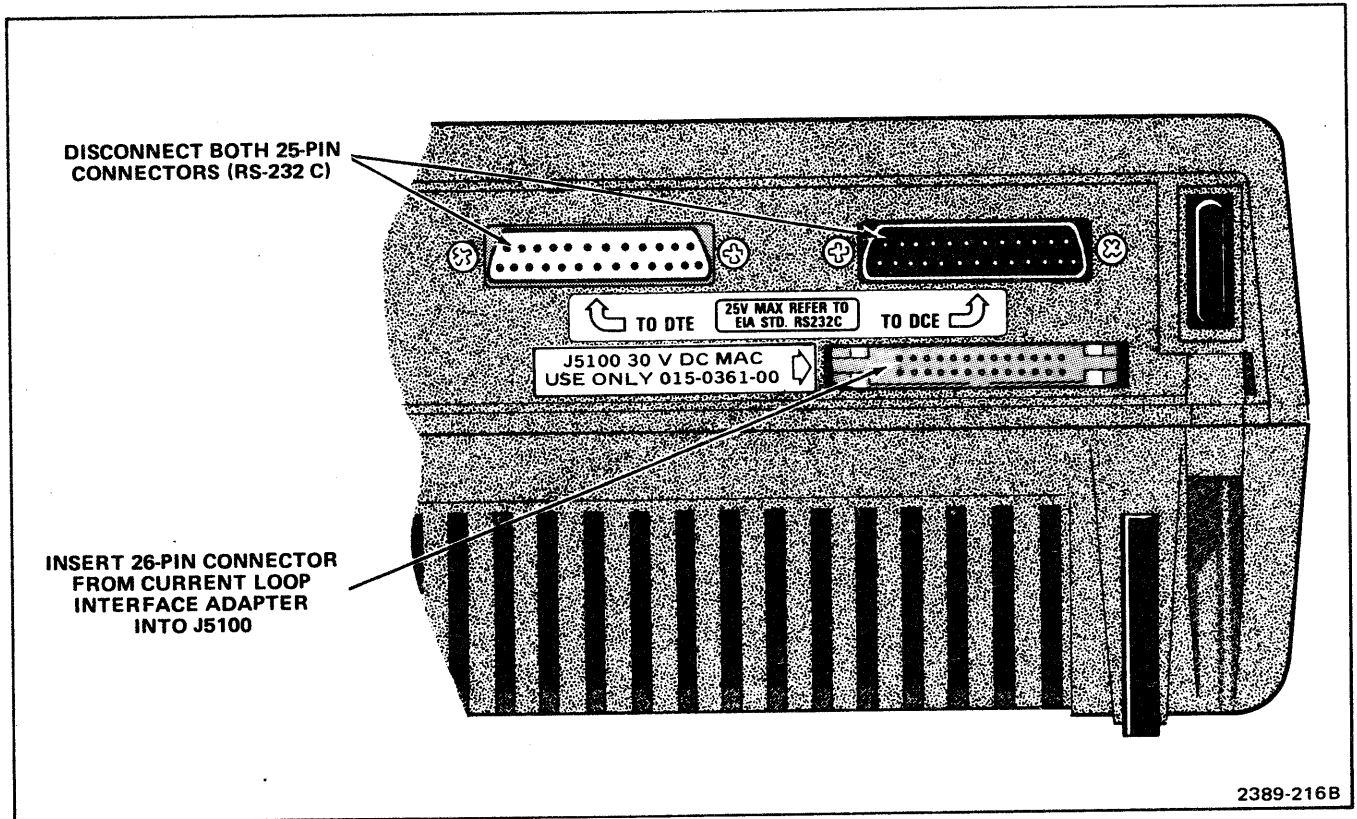


Figure Option 2-3. Partial 832 rear panel when equipped for Option 2.

### CAUTION

*Damage to terminals can result from forcing the connectors together.*

2. Carefully insert the plug into the jack without exerting excessive force.

### INOPERABLE 832 CONTROLS, CONNECTORS, AND INDICATORS

When the Current Loop Interface Adapter is connected to your 832 Data Comm Tester, remember that the following controls, connectors, and indicators on the 832 front panel are either disabled or have no effect in the operation of the 832 Option 2 instrument. Refer to Figure Option 2-4 for locations of these items on the 832 instrument front panel.



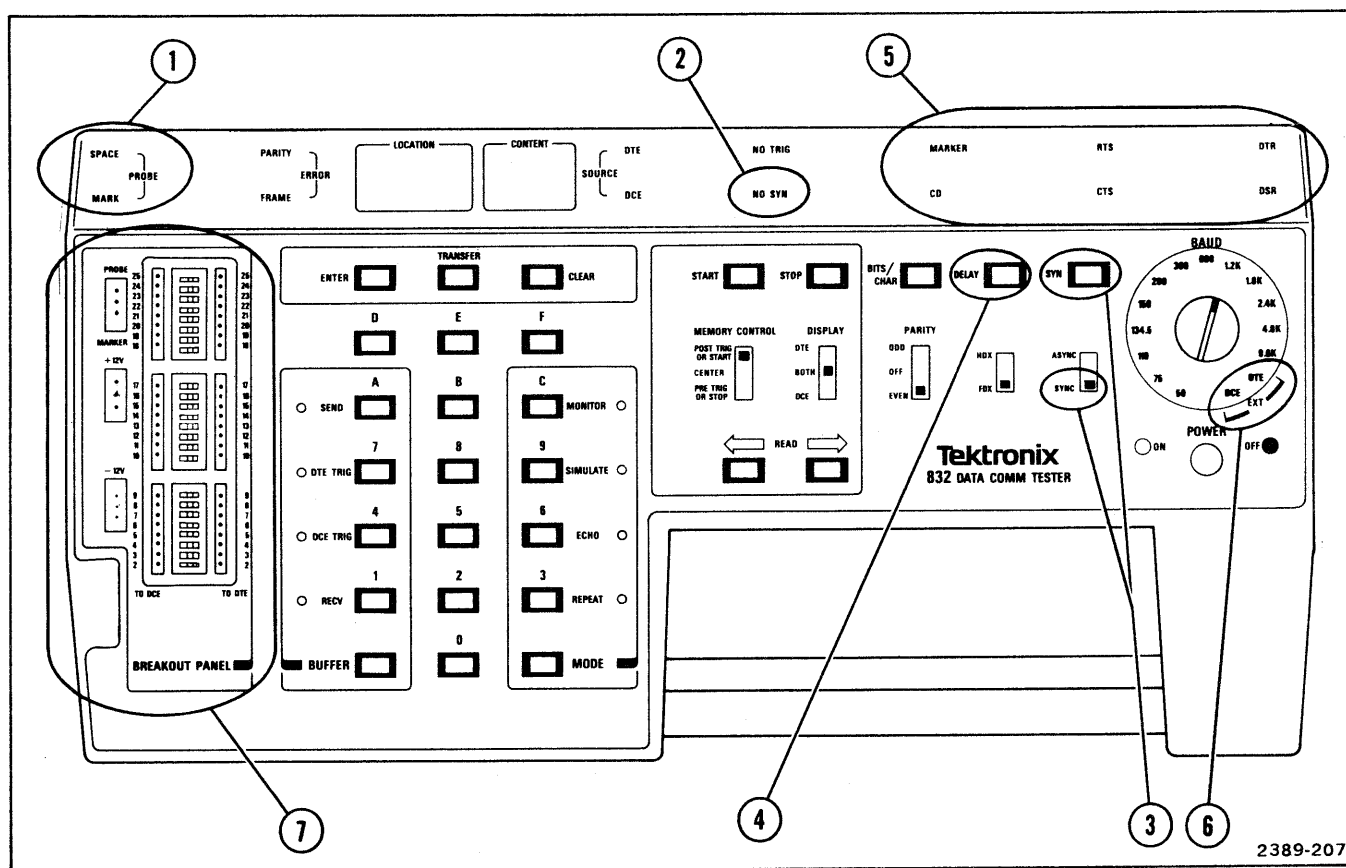


Figure Option 2-4. 832 Controls, Connectors, and Indicators that are inoperable with Option 2.

- 1** **PROBE Indicator**—There is no HIGH or LOW logic level at the Breakout Panel.
- 2** **NO SYN Indicator**—No synchronous character is used.
- 3** **ASYNC/SYNC and SYN Switches**—Only asynchronous timing is used with Option 2.
- 4** **DELAY Switch**—There is no programmed delay in the RTS/CTS mode.
- 5** **Line Status Indicators**—The light-emitting diodes (LED) that normally show the status of RS-232 C interface lines are disabled.
- 6** **BAUD Switch**—The DTE EXT and DCE EXT positions of this switch are not usable; there is no external clock.
- 7** **BREAKOUT PANEL Switches and Connectors**—The RS-232 C connectors at the rear of the 832 are not connected.

## OPERATION

A summary of the following instructions is printed on the bottom of the Current Loop Interface Adapter to provide the operator with a convenient reference guide.

### Preliminary

Perform the following steps which are common to both two-wire and four-wire operation.

1. Disconnect both 25-pin RS-232 C connectors (TO DTE and TO DCE) at the rear panel of the 832, since any data through these connectors will interfere with current loop interface operation provided by Option 2.
2. Remove all jumpers from the 832 BREAKOUT PANEL connectors.

### Two-Wire Operation

1. If the unit under test provides the current, set the R-DATA LOOP EXT/INT switch to EXT. If the unit under test does not provide current, set the R-DATA LOOP EXT/INT switch to INT.
2. If INT was selected in the preceding step, set the INTERNAL CURRENT SOURCE switch to either 20MA or 60MA, as required by the data communications interface.
3. Connect only the R-DATA LOOP test leads to the unit under test as shown in Figures Option 2-5 and Option 2-6.

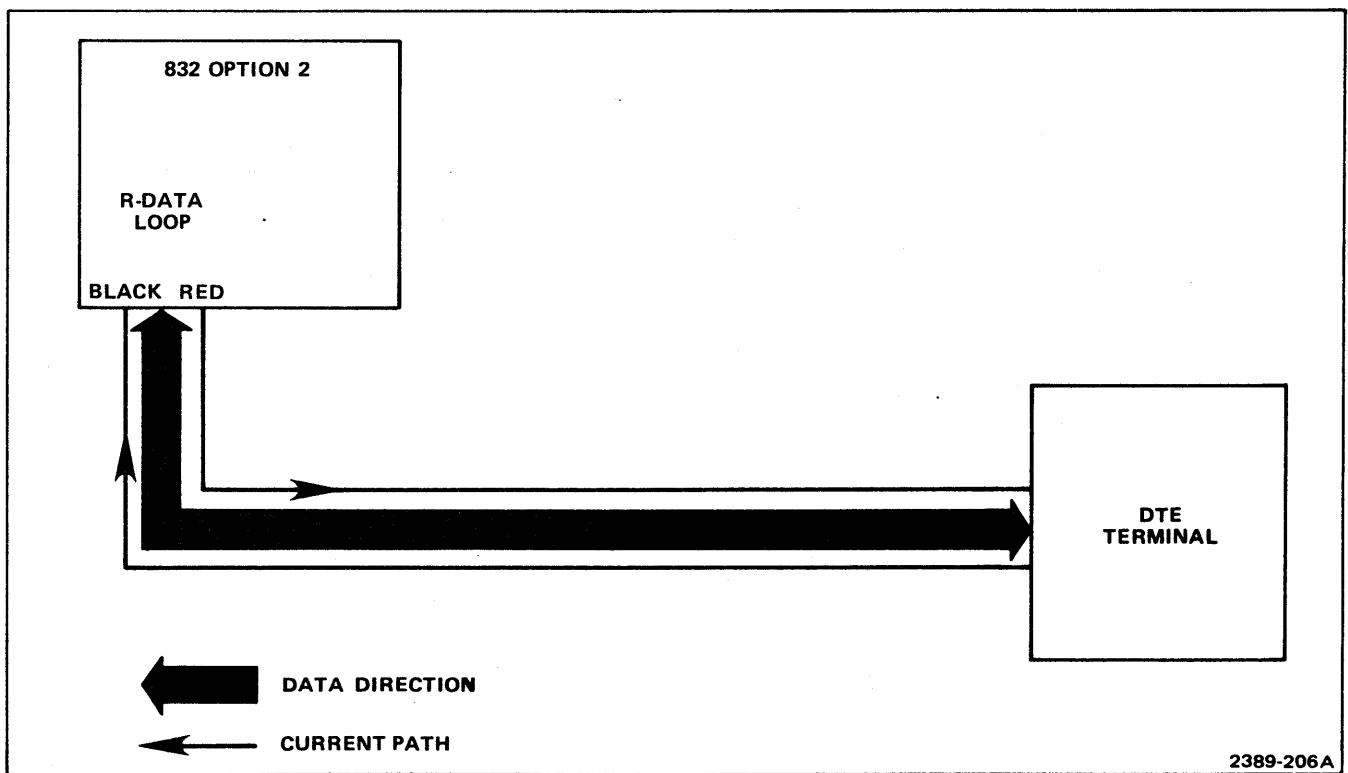


Figure Option 2-5. Half-Duplex (two-wire) Modem Simulator Mode.

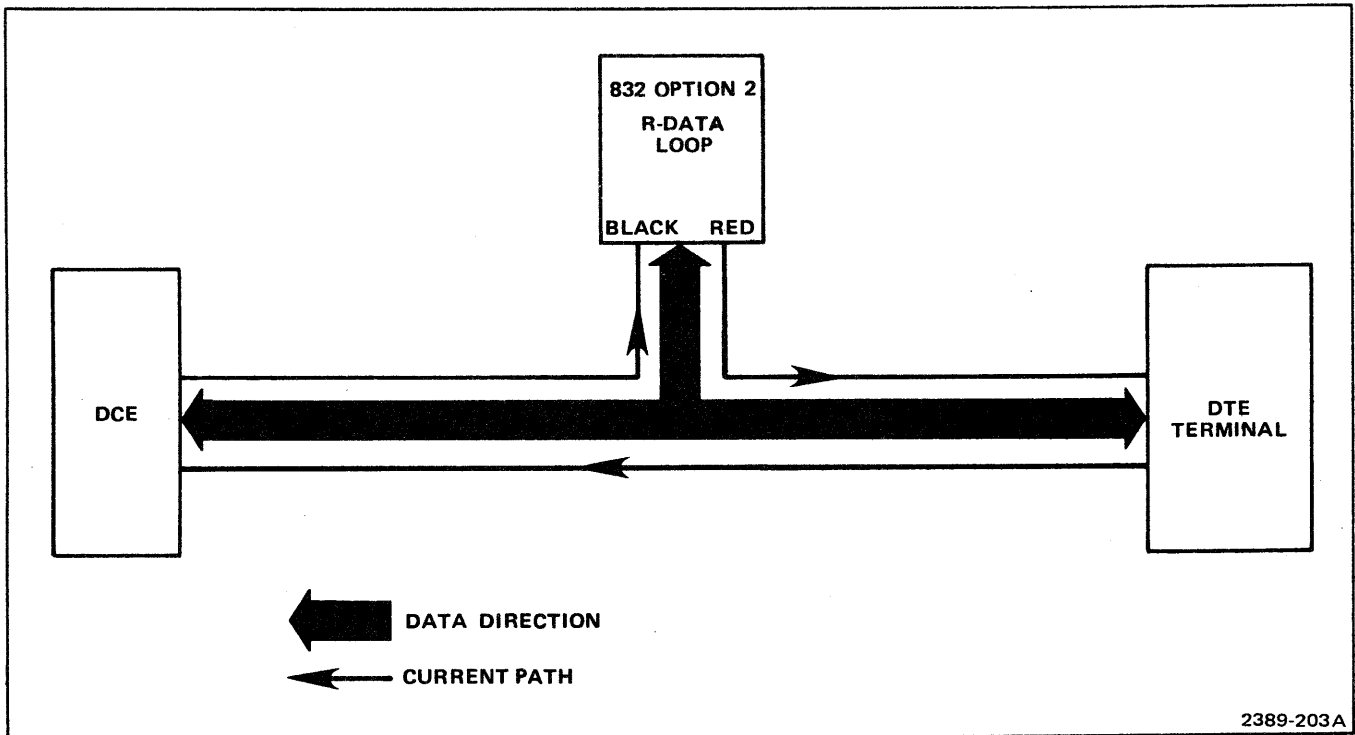


Figure Option 2-6. Half-Duplex (two-wire) Monitor Mode.

4. At the 832 front panel set the HDX/FDC switch to HDX. In this mode the 832 will accept data only on the R-Data Loop, rejecting data on the T-Data Loop.
5. At the 832 front panel set the DISPLAY switch to DCE. All data will be stored as DCE data.
6. The 832 may be operated normally as described in preceding sections of this manual except for the controls, connectors, and indicators that were disabled or rendered ineffective by connecting the Current Loop Interface Adapter.

#### Four-Wire Operation

1. If the unit under test provides the current, set both EXT/INT switches to EXT. If the unit under test does not provide current, set both EXT/INT switches to INT.
2. If INT was selected in the preceding step, set the INTERNAL CURRENT SOURCE switch to either 20MA or 60MA, as required by the data communication interface.
3. Connect both the R-DATA LOOP and T-DATA LOOP test leads to the unit under test as shown in Figures Option 2-7 and Option 2-8.
4. At the 832 front panel set the HDX/FDX switch to FDX. This allows both the R-Data Loop and T-Data Loop to accept data from the unit under test.

#### NOTE

*R-Data will be stored by the 832 as DCE Data, and T-Data will be stored as DTE Data.*

5. The 832 may be operated normally as described in preceding sections of this manual except for the controls, connectors, and indicators that were disabled or rendered ineffective by connecting the Current Loop Interface Adapter.

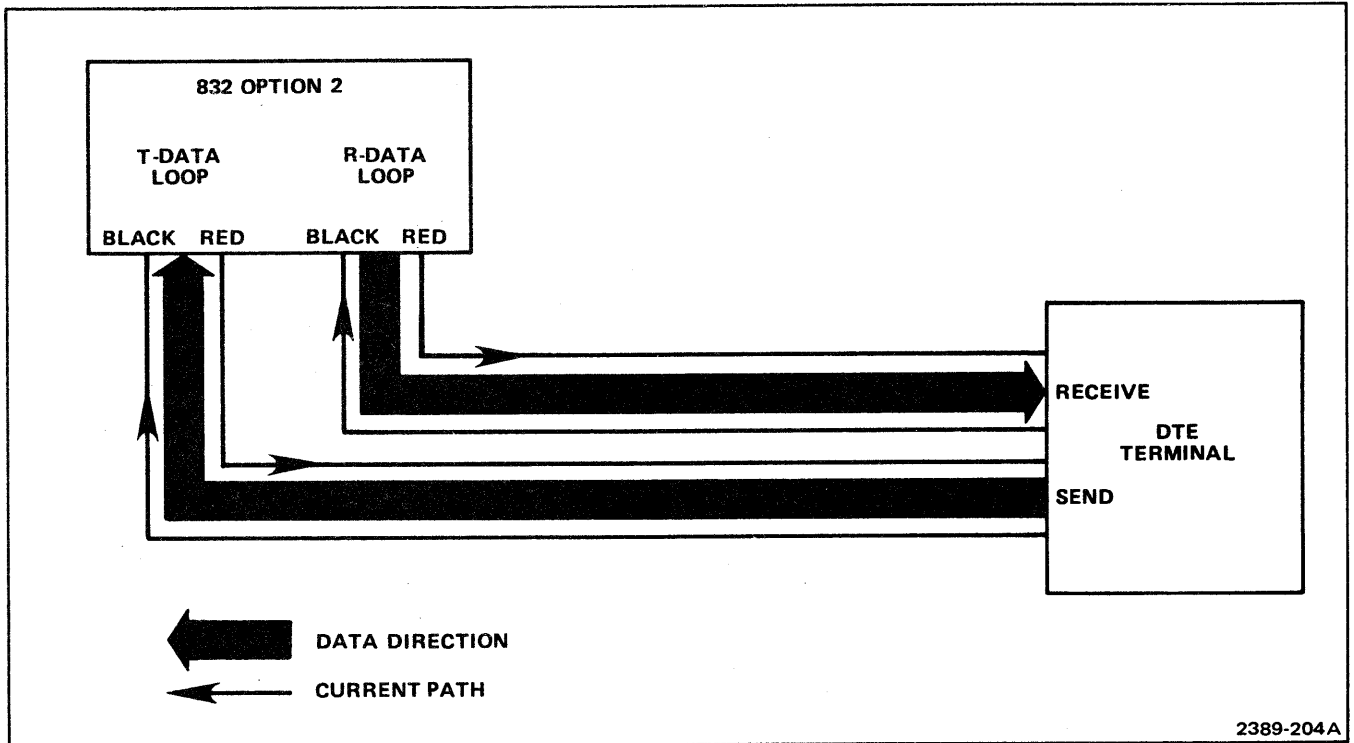


Figure Option 2-7. Full-Duplex (four-wire) Modem Simulator Mode.

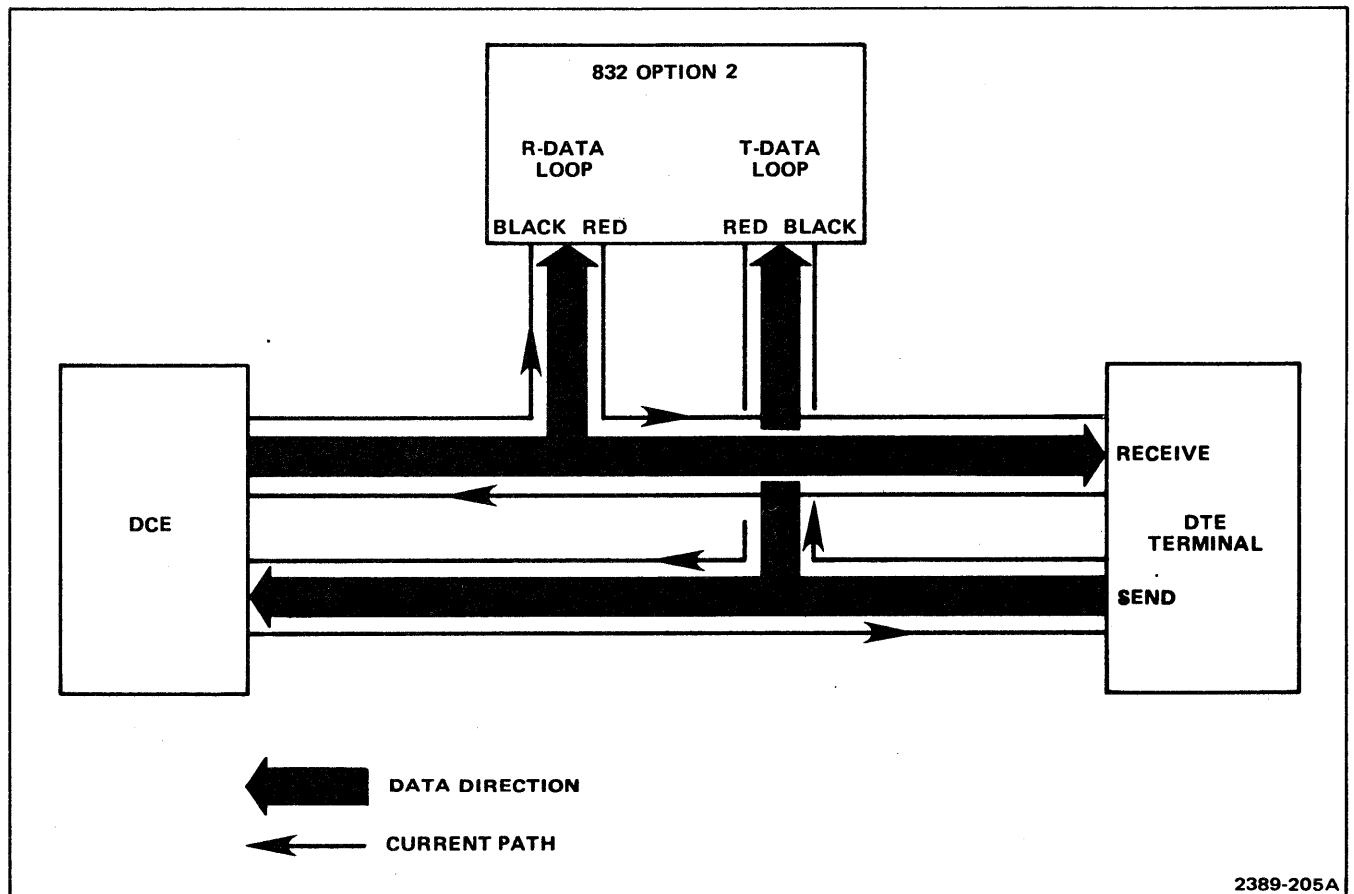


Figure Option 2-8. Full-Duplex (four-wire) Monitor Mode.

**WARNING**

*THE FOLLOWING SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID PERSONAL INJURY, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.*

## THEORY OF OPERATION

The Current Loop Interface Adapter and its associated internal 832 A55 Connector board circuitry extend the 832's monitoring and modem simulating capabilities for testing 20- and 60-milliampere current loop interfaces. For the purpose of the following descriptions, loop activity means that data is being imposed on the loop through unipolar loop current interruptions.

### BLOCK DIAGRAM DESCRIPTION

For the following description, refer to diagram 13 at the rear of this manual. The Current Loop Interface Adapter is located on the right-hand side of the diagram. Notice that the T-DATA (upper section) and R-DATA (lower section) circuit blocks are identical, except for the Optocoupler Loop Driver and Schmitt trigger blocks in the R-DATA section. Since the Optocoupler Loop Sensor sections and their associated blocks are identical, only the R-DATA loop will be fully explained in both the block diagram and circuit descriptions.

When the Current Loop Interface Adapter is connected to the 832, the -12 V Enable block completes circuitry that applies an unregulated -12 volts to the Current Loop Interface Adapter. When +5 volts is applied to the RS-232 C Disable circuitry (via the A55 Connector board), it disables the normal 832 RS-232 C data path.

The Current Loop Interface Adapter is connected in series into the current loop through T-DATA Probe Tips EP6134 and EP6032 and through R-DATA Probe Tips EP6136 and EP6235. If the Current Loop Interface Adapter is connected for full-duplex operation, both loops are connected. For half-duplex operation, only the R-DATA Probe Tips are connected. In the latter case, the R-DATA loop would be handling both R-DATA and T-DATA.

The position of R-DATA Loop switch S6226 selects the loop current source (either the loop under test or the Current Loop Interface Adapter). In most cases when the 832 is used in the MONITOR mode, the EXT position would be selected, and loop current would be supplied by the loop under test. In modem simulator modes the INT position would usually be selected, and the Current Loop Interface Adapter would provide the loop current from its internal Constant Current Supply. When this supply is used, INTERNAL CURRENT SOURCE switch S6014 selects a loop current output of either 20 or 60 milliamperes.

Since most current loops are polarized and the 832 Option 2 will operate properly only with one direction of a unipolar current loop, a Reverse Current Indicator (DS6232) turns on whenever current is flowing in the wrong direction.

Once the Current Loop Interface Adapter is properly connected and set up for operation, any loop activity is sensed by Optocoupler Loop Sensor U6127. This activity is passed to Schmitt trigger U6119D, which converts it to TTL levels that pass through Data Latch U5121A to U1332 (USART A in the 832). Once data enters U1332, it is processed and recorded normally by the 832.

This concludes the R-DATA loop sensing section of Option 2. The T-Data section of the option operates identically. The remainder of the block diagram description covers the 832's capability to transmit data to the loop in the modem simulator modes of operation.

Data transmitted by the 832 originates as a serial data stream, at TTL levels, from U1332 (USART A). These pass through the 832 interface multiplexer U1312D to Schmitt triggers U6119B and U6119C. These Schmitt triggers provide sufficient drive current to pass the transmitted data through Optocoupler Loop Driver U6226 and on to the loop. The Optocoupler Loop Driver passes data to the loop by turning Loop Interrupter Q6228 on and off to cause loop current interruptions.

## CIRCUIT DESCRIPTION

The circuit description for Option 2 covers diagrams 5, 10, and 11, with primary emphasis concentrated on diagram 11. To become more familiar with tracing the exact wiring circuitry of the option, you should refer to diagrams 8 and 12, the Wiring, and Interface diagrams for the 832 and Option 2, respectively.

### Power Supplies

Power for the Current Loop Interface Adapter is provided by the 832 through cable W510 and plug P5100 (see diagram 11). Pin 1 of P5100, the -12 V (UNREG) ENA line, connects the base of Q5201 to ground through R6009. This forward biases Q5201 causing it to saturate, which supplies an unregulated -12 volts to the Current Loop Interface Adapter. Test point TP1 is provided for monitoring this voltage.

While Option 2 is being used, +5 volts is returned through P5100-22 (via the A55 Connector board) to disable the normal RS-232 C data path. Because of this feature, the Current Loop Interface Adapter must be disconnected from the 832 whenever the normal RS-232 C features of the 832 are being used. The +5 volts also is applied to P5100-22 and eventually ends up on 832 data bus line D7, which imitates a normal RS-232 C DTR (Data Terminal Ready) signal. This signal tells the 832 system software to ignore any data on the T-DATA loop whenever the 832 is operating in a half-duplex communications mode.

### Constant-Current Supply

A constant-current generator is comprised of Q6221 and associated circuitry. It supplies either 20 or 60 milliamperes of current to the loop as selected by S6014. Zener diode VR6218 and resistor R6218 set a fixed bias at the base of Q6221, which generates an amount of constant current that is determined by the combination of current-limiting resistors (R6006 and R6008) selected by S6014. When R6006 is selected by S6014, Q6221 generates 20 milliamperes of current. When both R6006 and R6008 are selected, 60 milliamperes of current are generated.

Rapid saturation and current-spike damage to Q6221, as a result of normal loop activity, is prevented by CR6219 and CR6225. They also protect Q6221 whenever the Current Loop Interface Adapter is being connected to or disconnected from the loop. The current supply is protected by CR6226 and CR6228 if an external supply is inadvertently connected at the same time. Voltage is blocked by CR6228 and clamped to ground by CR6226.

### Reverse Current Indicator

Reverse current indicator DS6232 is a conventional LED circuit that turns on when properly biased. This happens whenever the loop is reverse connected. With the loop properly connected, the LED is reverse biased and remains off. An increase in the reverse voltage breakdown of the circuit is provided by CR6234, which protects the LED during normal operation. Resistor R6234 shunts any leakage current from CR6234 that also may cause a reverse voltage breakdown failure of the LED.

### Optocoupler Loop Sensor

For the following description of the optocoupler loop sensor, Q6234 will be considered to be on continuously. It is normally controlled by optocoupler loop driver U6226; therefore, its operation will be covered with its description.

When data is imposed on the loop, causing loop activity, current interruptions pass through pins 1 and 2 of R-DATA optocoupler U6127, R6133, and Q6234. These interruptions cause the optocoupler's LED to turn off and on. The LED status is sensed by the optocoupler phototransistor. With the phototransistor off, its emitter voltage is held at +2.5 volts by voltage divider R6125 and R6220. As soon as the phototransistor turns on, the emitter voltage goes to +5 volts. These

voltages can be measured at TP6. This emitter voltage swing represents data from the loop which is passed to Schmitt trigger U6119 for conversion to standard 832 TTL levels. The stored charge on the base-emitter junction of the phototransistor is discharged by R6127, causing it to turn off faster. Current through the LED is held to approximately 15 milliamperes by Q6128, CR6133, and R6133. Whenever the current exceeds 15 milliamperes, the voltage drop across R6133 biases Q6128 on, which causes the excess current to pass through Q6128 and CR6133.

Biasing by R6112, R6115, and R6116 causes U6119D to operate with about a 0.5-volt hysteresis curve within the +2.5- to +5-volt range. The output of U6119D is prevented from going more negative than one diode drop below ground by CR6112. The output of U6119D goes to U5121A-2 and is then clocked out through U5121A-6 to the R-DATA input of U1332 (USART A).

### Optocoupler Loop Driver

In modem simulator modes the 832 must be capable of transmitting data onto the current loop. This is done on the R-DATA loop through optocoupler loop driver U6226 and its associated circuitry.

Data is transferred onto the loop through loop interruptions caused by U6226 and Q6234. The data is transferred through U6226 in the same manner that U6127 extracted it from the loop (i.e., through its LED and phototransistor). Data to be transmitted comes from the 832 TxD output of U1332 (USART A), through 832 interface multiplexer U1312D and connector P1205-9, to Current Loop Interface Adapter connector P5100-16, then through R6217 to Schmitt triggers U6119B-7 and U6119C-9.

When the 832 is in the MONITOR mode, a logic high from the 832's interface multiplexers SEL lines appears at W510-10 and holds the inputs to the Schmitt triggers at a logic high. This holds the Schmitt trigger outputs high, which keep the optocoupler LED turned off. With the LED off, the phototransistor is off, allowing Q6228 to remain on. This keeps Q6234 on, permitting current to flow in the loop and through R-DATA loop sensor U6127.

As soon as one of the modem simulator modes is selected, W510-10 goes low, and any data received by U6119B-7 and U6119C-9 is transferred to the LED in U6226, turning it on and off. The activity of the LED is sensed by the phototransistor, which turns Q6228 on and off, thus passing data to the loop as loop current interruptions. The biasing network of R6118 and R6119 establish the operating threshold of U6119B and U6119C. Current through the optocoupler LED is limited by R6219. The output of the Schmitt triggers can be monitored at TP2.

CR6128 and CR6131 are one-milliampere constant-current diodes. When both the optocoupler LED and phototransistor are off, one milliampere of current will flow through CR6128, CR6131, R6226, R6128, and R6129. This biases Q6228 on, turning on Q6234 and allowing loop current to flow through U6127 and Q6128. When the loop driver LED turns on, Q6228 is biased off. This turns off Q6234, and the loop current is interrupted. In this manner, the marks and spaces of data received at U6119B and U6119C (and passed on to U6226) cause loop current to be interrupted in response to the data being transmitted.

Capacitor C6228, located between the base and collector of Q6228, prevents the loop interruptions of an external device from momentarily turning Q6228 off, then back on, during the modem simulator receive mode. Since CR6128 and CR6131 are rated only for 100 volts, they are placed in series to handle the loop voltage. Current-balancing resistors R6126 and R6131 ensure that CR6128 and CR6131 will not be damaged should one of them attempt to regulate at a lower current than the other.

## PERFORMANCE CHECK

The Performance Check procedure is used to verify that the Option 2 instrument meets its electrical performance requirements presented in the Specification portion of this Option 2 description.

### TEST EQUIPMENT REQUIRED

The following test instruments, or equivalent equipment, are required to perform these checks:

1. Tektronix 851 Digital Tester
2. Tektronix DM 501 Digital Multimeter (DMM)

### PERFORMANCE CHECK PROCEDURE

#### 1. Check Current Source

- a. Set the DMM to dc mA range to check 60 milliamperes of current.
- b. At the Current Loop Interface Adapter set both the R-DATA LOOP and T-DATA LOOP EXT/INT switches to EXT and set the INTERNAL CURRENT SOURCE switch to 60MA.
- c. Connect the T-DATA LOOP red test lead to the DMM High input and connect the T-DATA LOOP black test lead to the DMM Low input. Set the T-DATA LOOP EXT/INT switch to INT.
- d. CHECK—that the DMM reads 60 milliamperes  $\pm 4$  milliamperes.
- e. Set the INTERNAL CURRENT SOURCE switch to 20MA.
- f. CHECK—that the DMM reads 20 milliamperes  $\pm 2$  milliamperes.
- g. Disconnect both T-DATA LOOP test leads from the DMM.
- h. Connect the R-DATA LOOP red test lead to the DMM High input and connect the R-DATA LOOP black test lead to the DMM Low input. Set the R-DATA LOOP EXT/INT switch to INT.
- i. CHECK—that the DMM reads 20 milliamperes  $\pm 2$  milliamperes.
- j. Set the INTERNAL CURRENT SOURCE switch to 60MA.
- k. CHECK—that the DMM reads 60 milliamperes  $\pm 4$  milliamperes.

#### 2. Check R-Data Loop for Space Current

- a. With the same test setup established at preceding step 1, part h, set the ASYNC/SYNC switch on the 832 front panel to SYNC.
- b. Set the DMM to dc mA range to check 2 milliamperes of current.
- c. Press the following buttons in the sequence given: SEND - BUFFER - CLEAR - 0 - ENTER - REPEAT - MODE - START.
- d. CHECK—that the DMM reads between 0 and 1.5 milliamperes.
- e. At the Current Loop Interface Adapter set the INTERNAL CURRENT SOURCE switch to 20MA.
- f. CHECK—that the DMM reads between 0 and 1.5 milliamperes.
- g. Disconnect both R-DATA LOOP test leads from the DMM.



### 3. Check Loop Output Voltages

- a. Set the 851 Digital Tester Function switch to DCV.
- b. Connect the 851 DMM plus (+) lead to the T-DATA LOOP black test lead and connect the 851 DMM minus (—) lead to the T-DATA LOOP red test lead.
- c. At the Current Loop Interface Adapter set the INTERNAL CURRENT SOURCE switch to 60MA.
- d. CHECK—that the 851 reads between 0 and —30 volts.
- e. Set the INTERNAL CURRENT SOURCE switch to 20MA.
- f. CHECK—that the 851 reads between 0 and —30 volts.
- g. Disconnect the 851 DMM leads from the T-DATA LOOP test leads and connect them to the R-DATA LOOP test leads in the same manner specified in part b.
- h. Repeat parts c. through f.
- i. Disconnect the 851 DMM leads from the R-DATA LOOP test leads.

## MAINTENANCE

The general maintenance information and preventive maintenance instructions contained in the front part of the Maintenance section (Section 6) of this manual are applicable to the Option 2 instrument. Information for obtaining replacement parts may also be found in Section 6 under the heading Corrective Maintenance.

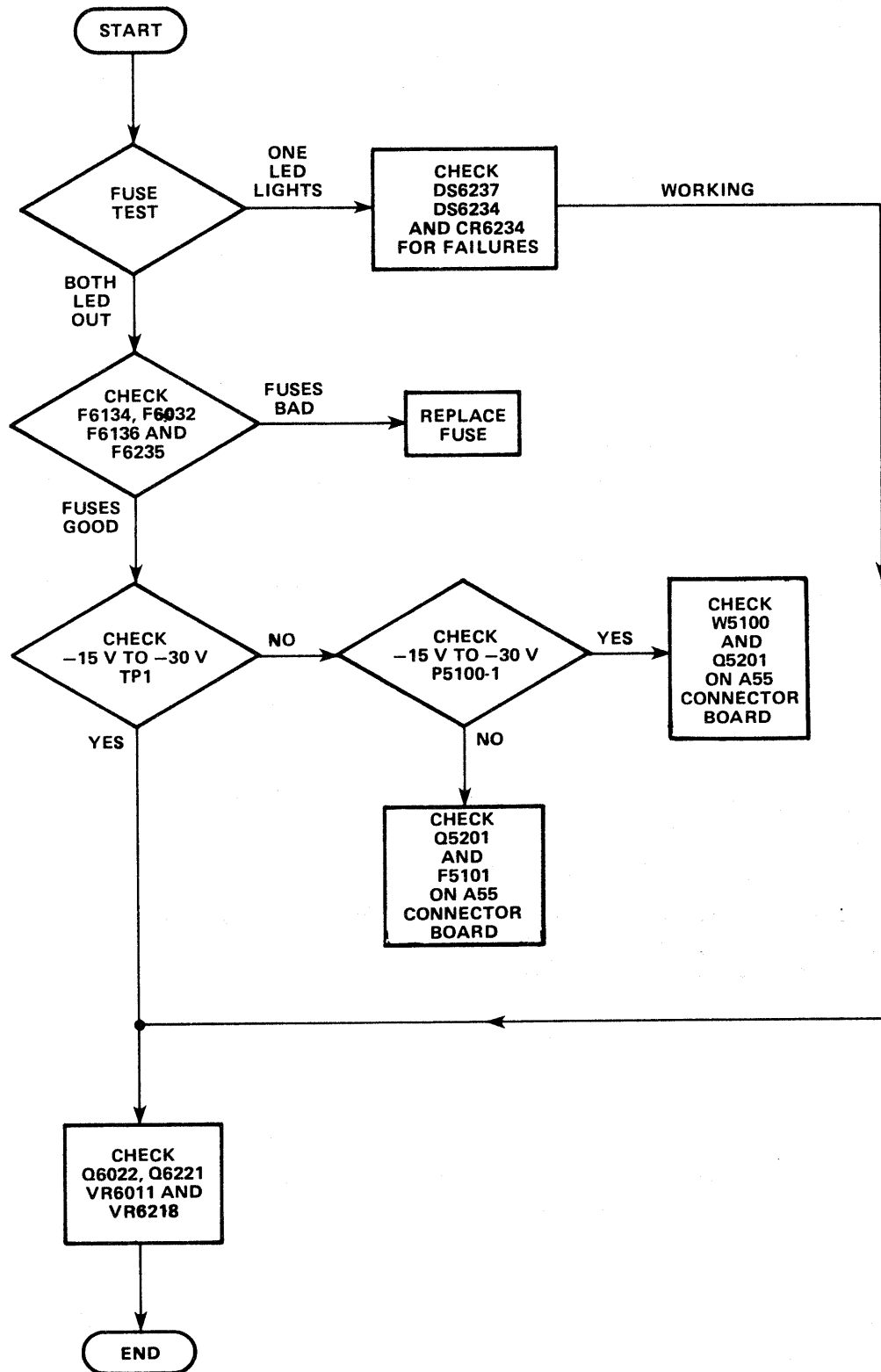
## TROUBLESHOOTING

Troubleshooting information unique to the Option 2 instrument is presented in this Option 2 information. Complete circuit and wiring diagrams and associated circuit board illustrations for the basic 832 are contained in the Diagrams section of the manual. Circuit and wiring diagrams and associated circuit board illustrations for the Option 2 additions are found at the end of this Option 2 information. The following procedure is provided to facilitate location of a fault in Option 2 circuitry. Refer to the Troubleshooting part of Section 6 for fault isolation information relating to the basic 832 instrument. In addition, the technical material presented in the Option 2 Theory of Operation may be helpful while troubleshooting. The Tektronix 851 Digital Tester, or equivalent equipment, is required to troubleshoot the 832 Option 2.

### Option 2 Troubleshooting Routine

**FUSE TEST.** The following procedure tests the fuses which are in series with the T-DATA LOOP and R-DATA LOOP test leads.

1. Set both the T-DATA LOOP and R-DATA LOOP EXT/INT switches to EXT.
2. Connect the T-DATA LOOP black test lead and the R-DATA LOOP black test lead together.
3. Connect the T-DATA LOOP red test lead and the R-DATA LOOP red test lead together.
4. Set INTERNAL CURRENT SOURCE switch to 60MA.
5. Set the T-DATA LOOP EXT/INT switch to INT and observe whether the R-DATA LOOP REV indicator illuminates.
6. Set the T-DATA LOOP EXT/INT switch to EXT and the R-DATA LOOP EXT/INT switch to INT. Observe whether the T-DATA LOOP REV indicator illuminates.
7. If either the T-DATA LOOP or the R-DATA LOOP REV indicator (or both indicators) did not illuminate, proceed to Figure Option 2-9, Troubleshooting Chart 1.



2389-2138

Figure Option 2-9. Troubleshooting Chart 1.

8. If both REV indicators illuminate, continue troubleshooting with the next test.
9. Disconnect loop leads from each other.

**OPTION 2 SELF TEST.** The basic 832 self test routines are used as signal generators for this test.

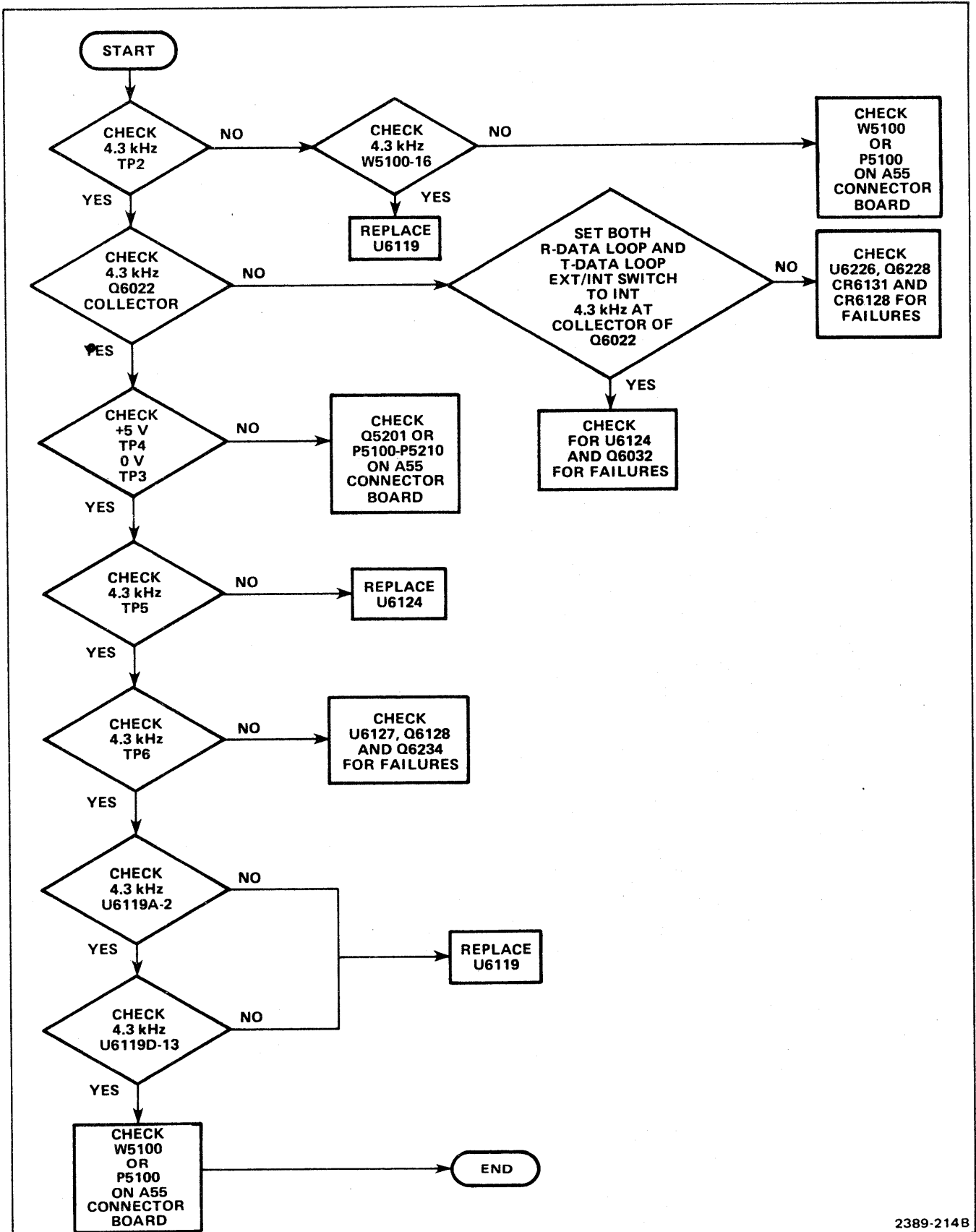
1. Preset the Current Loop Interface Adapter and 832 front panel switches as follows:

| Current Loop Interface Adapter |      | 832 Front Panel |       |
|--------------------------------|------|-----------------|-------|
| R-DATA LOOP EXT/INT            | EXT  | BAUD            | 9.6K  |
| T-DATA LOOP EXT/INT            | INT  | ASYNC/SYNC      | ASYNC |
| INTERNAL CURRENT               |      | HDX/FDX         | FDX   |
| SOURCE                         | 60MA | PARITY          | OFF   |
|                                |      | DISPLAY         | BOTH  |

2. Connect the Current Loop Interface Adapter test leads together as follows:

| R-DATA LOOP<br>Test Lead |    | T-DATA LOOP<br>Test Lead |
|--------------------------|----|--------------------------|
| Red                      | to | Black                    |
| Black                    | to | Red                      |

3. Press the following 832 buttons in the sequence given: SEND - BUFFER - CLEAR - 5 - 5 - ENTER - REPEAT - MODE - START - (momentary pause) - STOP.
4. The RECV Buffer should now contain 55 in all locations. Verify that the numerals 55 appear in the CONTENT display and that the SOURCE DCE and DTE indicators alternately illuminate as the RECV Buffer is read.
5. If the DCE and DTE indicators are not alternating, proceed to Figure Option 2-10, Troubleshooting Chart 2.



2389-214B

Figure Option 2-10. Troubleshooting Chart 2.

6. Set the 832 HDX/FDX switch to HDX.
7. Press the following 832 buttons in the sequence given: START - (momentary pause) - STOP - READ.
8. Verify that the SOURCE DCE indicator is illuminated and the SOURCE DTE indicator is off.
9. If you do not obtain the expected indication in step 8, proceed to Figure Option 2-11, Troubleshooting Chart 3.

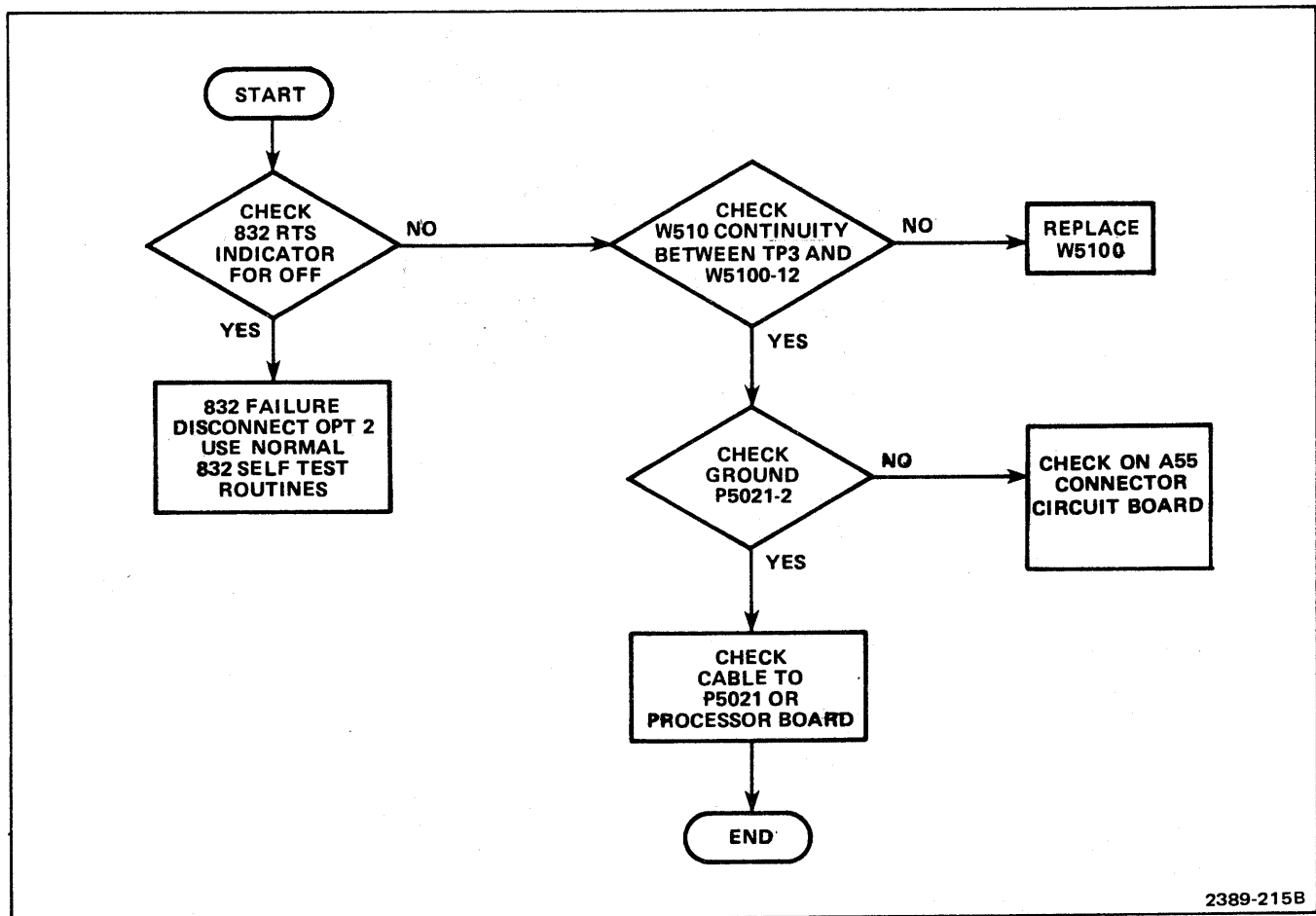


Figure Option 2-11. Troubleshooting Chart 3.

## CORRECTIVE MAINTENANCE

The following procedures describe how to remove and reinstall the Current Loop Interface Adapter circuit board for component replacement or repair.

### Removing the Current Loop Circuit Board

1. Set the Current Loop Interface Adapter on a flat surface with its four rubber feet facing upward.
2. Remove the four screws and rubber feet from the lower half of the Current Loop Interface Adapter case and lift off the lower case-half (see Figure Option 2-12).
3. Turn the upper case-half over so that the switches are on top. This will prevent the slide-switch covers from falling off when the circuit board is removed.

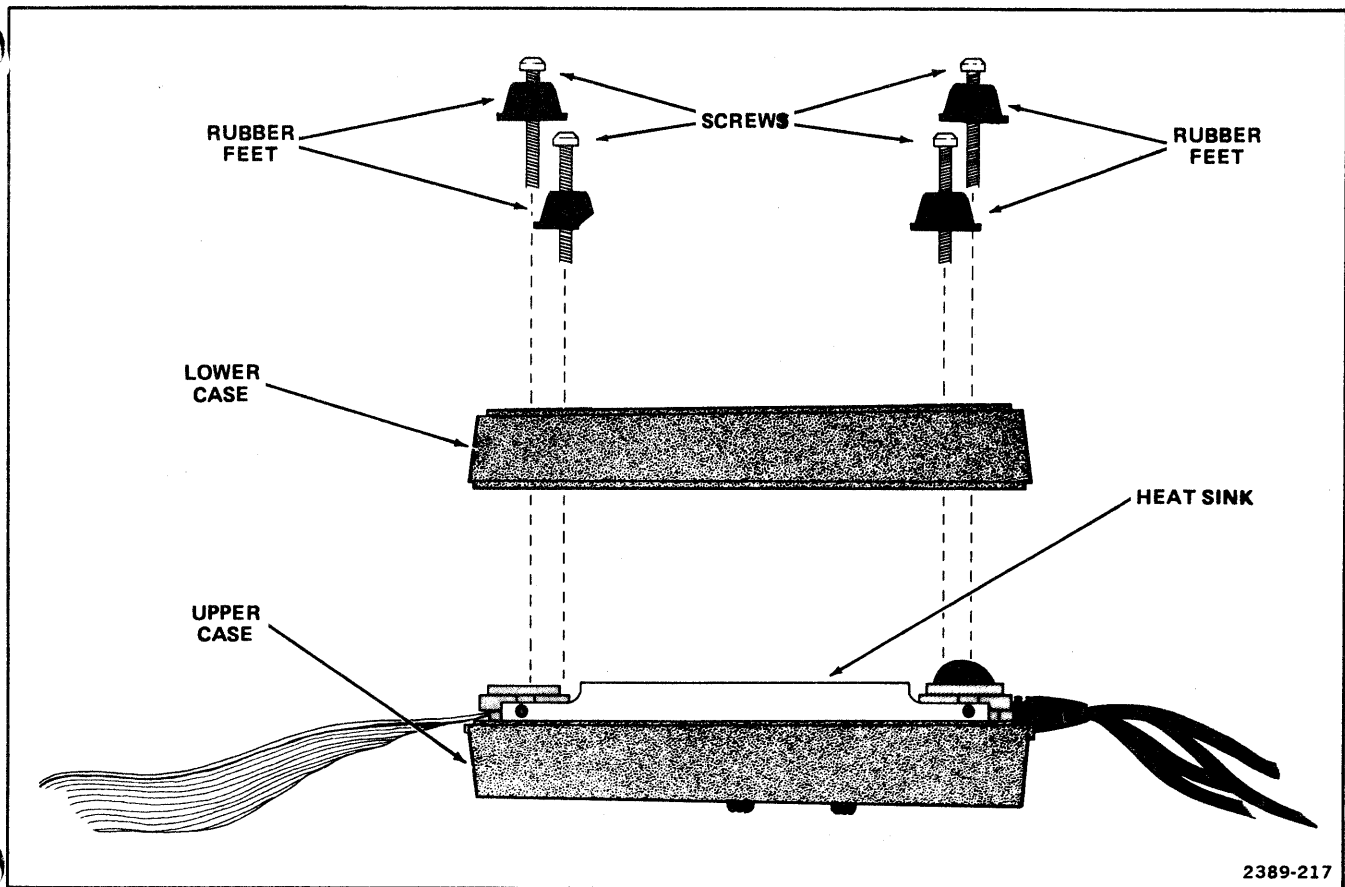


Figure Option 2-12. Disassembling the Current Loop Interface Adapter.

4. Grasp the heat sink with one hand and, holding the upper case-half with the other hand, separate the upper case-half from the circuit board.
5. Remove the slide-switch covers and set them aside.

#### Reassembling the Current Loop Interface Adapter

1. Hold the circuit board assembly with slide switches facing upward.
2. Replace covers on the slide switches.
3. Position the upper case-half over the circuit board.
4. Place the four grooved rubber test lead boots into appropriate detents on the back edge of the upper case-half.
5. Position the lower case-half into place, install the four rubber feet, and secure with the four screws.

## Instrument Options—832

ELECTRICAL PARTS LIST DIFFERENCES BETWEEN 832  
EQUIPPED WITH OPTION 2 AND STANDARD 832

| Ckt No.  | Tektronix<br>Part No. | Serial/Model No.<br>Eff Dscont | Name & Description                            | Mfr<br>Code | Mfr Part Number  |
|----------|-----------------------|--------------------------------|-----------------------------------------------|-------------|------------------|
| OPTION 2 |                       |                                |                                               |             |                  |
| A55      | 670-5320-01           |                                | CKT BOARD ASSY:CONNECTOR                      | 80009       | 670-5320-01      |
| A66      | 670-6113-00           |                                | CKT BOARD ASSY:CURRENT LOOP INTERFACE ADAPTER | 80009       | 670-6113-00      |
| A55      | -----                 |                                | CKT BOARD ASSY:CONNECTOR                      |             |                  |
| C5115    | 283-0421-00           |                                | CAP.,FXD,CER DI:0.1UF,+80-20%,50V             | 04222       | DG015E104Z       |
| C5145    | 283-0421-00           |                                | CAP.,FXD,CER DI:0.1UF,+80-20%,50V             | 04222       | DG015E104Z       |
| C5225    | 283-0421-00           |                                | CAP.,FXD,CER DI:0.1UF,+80-20%,50V             | 04222       | DG015E104Z       |
| C5325    | 283-0421-00           |                                | CAP.,FXD,CER DI:0.1UF,+80-20%,50V             | 04222       | DG015E104Z       |
| C5335    | 283-0421-00           |                                | CAP.,FXD,CER DI:0.1UF,+80-20%,50V             | 04222       | DG015E104Z       |
| C5345    | 283-0421-00           |                                | CAP.,FXD,CER DI:0.1UF,+80-20%,50V             | 04222       | DG015E104Z       |
| F5101    | 159-0028-00           |                                | FUSE,CARTRIDGE:3AG,0.25A,250V,FAST-BLOW       | 71400       | AGC 1/4          |
| Q5201    | 151-0464-00           |                                | TRANSISTOR:SILICON,NPN                        | 80009       | 151-0464-00      |
| R5101    | 315-0242-00           |                                | RES.,FXD,CMPSN:2.4K OHM,5%,0.25W              | 01121       | CB2425           |
| R5102    | 315-0102-00           |                                | RES.,FXD,CMPSN:1K OHM,5%,0.25W                | 01121       | CB1025           |
| R5103    | 315-0472-00           |                                | RES.,FXD,CMPSN:4.7K OHM,5%,0.25W              | 01121       | CB4725           |
| R5144    | 315-0102-00           |                                | RES.,FXD,CMPSN:1K OHM,5%,0.25W                | 01121       | CB1025           |
| R5301    | 315-0472-00           |                                | RES.,FXD,CMPSN:4.7K OHM,5%,0.25W              | 01121       | CB4725           |
| R5305    | 315-0102-00           |                                | RES.,FXD,CMPSN:1K OHM,5%,0.25W                | 01121       | CB1025           |
| U5121    | 156-0388-00           |                                | MICROCIRCUIT,DI:DUAL D-TYPE FLIP-FLOP         | 80009       | 156-0388-00      |
| U5131    | 156-0914-00           |                                | MICROCIRCUIT,DI:OCT ST BFR W/3 STATE OUT      | 80009       | 156-0914-00      |
| U5141    | 156-0388-00           |                                | MICROCIRCUIT,DI:DUAL D-TYPE FLIP-FLOP         | 80009       | 156-0388-00      |
| U5211    | 156-0381-00           |                                | MICROCIRCUIT,DI:QUAD 2-INPUT EXCL OR GATES    | 00295       | SN74LS86N        |
| U5221    | 156-0388-00           |                                | MICROCIRCUIT,DI:DUAL D-TYPE FLIP-FLOP         | 80009       | 156-0388-00      |
| U5231    | 156-0479-00           |                                | MICROCIRCUIT,DI:QUAD 2-INP OR GATE            | 80009       | 156-0479-00      |
| U5241    | 156-0481-00           |                                | MICROCIRCUIT,DI:TRIPLE 3-INPUT AND GATE       | 27014       | DM74LS11N        |
| U5311    | 156-0388-00           |                                | MICROCIRCUIT,DI:DUAL D-TYPE FLIP-FLOP         | 80009       | 156-0388-00      |
| U5321    | 156-0844-00           |                                | MICROCIRCUIT,DI:SYN 4-BIT BIN CNTR            | 80009       | 156-0844-00      |
| U5331    | 156-0844-00           |                                | MICROCIRCUIT,DI:SYN 4-BIT BIN CNTR            | 80009       | 156-0844-00      |
| A66      | -----                 |                                | CKT BOARD ASSY:CURRENT LOOP INTERFACE ADAPTER |             |                  |
| C6008    | 290-0145-00           |                                | CAP.,FXD,ELCTLT:10UF,+75-10%,50V              | 56289       | 30D106G050CB9    |
| C6202    | 290-0145-00           |                                | CAP.,FXD,ELCTLT:10UF,+75-10%,50V              | 56289       | 30D106G050CB9    |
| C6212    | 283-0198-00           |                                | CAP.,FXD,CER DI:0.22UF,20%,50V                | 72982       | 8121N083Z5U0224M |
| C6228    | 283-0108-00           |                                | CAP.,FXD,CER DI:1000PF,+100-0%,200V           | 72982       | 8111A208Z5U0102Z |
| CR6011   | 152-0061-00           |                                | SEMICON D DEVICE:SILICON,175V,100MA           | 80009       | 152-0061-00      |
| CR6021   | 152-0061-00           |                                | SEMICON D DEVICE:SILICON,175V,100MA           | 80009       | 152-0061-00      |
| CR6022   | 152-0061-00           |                                | SEMICON D DEVICE:SILICON,175V,100MA           | 80009       | 152-0061-00      |
| CR6024   | 152-0061-00           |                                | SEMICON D DEVICE:SILICON,175V,100MA           | 80009       | 152-0061-00      |
| CR6032   | 152-0061-00           |                                | SEMICON D DEVICE:SILICON,175V,100MA           | 80009       | 152-0061-00      |
| CR6112   | 152-0061-00           |                                | SEMICON D DEVICE:SILICON,175V,100MA           | 80009       | 152-0061-00      |
| CR6128   | 152-0460-00           |                                | SEMICON D DEVICE:100V,1MA                     | 04713       | 1N5299           |
| CR6131   | 152-0460-00           |                                | SEMICON D DEVICE:100V,1MA                     | 04713       | 1N5299           |
| CR6131   | 152-0061-00           |                                | SEMICON D DEVICE:SILICON,175V,100MA           | 80009       | 152-0061-00      |
| CR6213   | 152-0061-00           |                                | SEMICON D DEVICE:SILICON,175V,100MA           | 80009       | 152-0061-00      |

| Ckt No. | Tektronix<br>Part No. | Serial/Model No.<br>Eff Dscont | Name & Description                  | Mfr<br>Code | Mfr Part Number |
|---------|-----------------------|--------------------------------|-------------------------------------|-------------|-----------------|
| CR6217  | 152-0061-00           |                                | SEMICON D DEVICE:SILICON,175V,100MA | 80009       | 152-0061-00     |
| CR6219  | 152-0061-00           |                                | SEMICON D DEVICE:SILICON,175V,100MA | 80009       | 152-0061-00     |
| CR6223  | 152-0061-00           |                                | SEMICON D DEVICE:SILICON,175V,100MA | 80009       | 152-0061-00     |
| CR6226  | 152-0061-00           |                                | SEMICON D DEVICE:SILICON,175V,100MA | 80009       | 152-0061-00     |
| CR6228  | 152-0061-00           |                                | SEMICON D DEVICE:SILICON,175V,100MA | 80009       | 152-0061-00     |
| CR6234  | 152-0061-00           |                                | SEMICON D DEVICE:SILICON,175V,100MA | 80009       | 152-0061-00     |
| DS6032  | 150-1014-00           |                                | LAMP,LED:RED,50MA                   | 50522       | MU5054-1        |
| DS6232  | 150-1014-00           |                                | LAMP,LED:RED,50MA                   | 50522       | MU5054-1        |
| F6032   | 159-0056-00           |                                | FUSE,CARTRIDGE:0.1A,125V,FAST-BLOW  | 75915       | 279-100         |
| F6134   | 159-0056-00           |                                | FUSE,CARTRIDGE:0.1A,125V,FAST-BLOW  | 75915       | 279-100         |
| F6136   | 159-0056-00           |                                | FUSE,CARTRIDGE:0.1A,125V,FAST-BLOW  | 75915       | 279-100         |
| F6235   | 159-0056-00           |                                | FUSE,CARTRIDGE:0.1A,125V,FAST-BLOW  | 75915       | 279-100         |
| Q6022   | 151-0464-00           |                                | TRANSISTOR:SILICON,NPN              | 80009       | 151-0464-00     |
| Q6032   | 151-0224-00           |                                | TRANSISTOR:SILICON,NPN              | 80009       | 151-0224-00     |
| Q6128   | 151-0224-00           |                                | TRANSISTOR:SILICON,NPN              | 80009       | 151-0224-00     |
| Q6221   | 151-0464-00           |                                | TRANSISTOR:SILICON,NPN              | 80009       | 151-0464-00     |
| Q6228   | 151-0253-00           |                                | TRANSISTOR:SILICON,NPN              | 80009       | 151-0253-00     |
| Q6234   | 151-0253-00           |                                | TRANSISTOR:SILICON,NPN              | 80009       | 151-0253-00     |
| R6006   | 321-0130-00           |                                | RES.,FXD,FILM:221 OHM,1%,0.125W     | 91637       | MFF1816G221ROF  |
| R6008   | 321-0102-00           |                                | RES.,FXD,FILM:113 OHM,1%,0.125W     | 91637       | MFF1816G113ROF  |
| R6009   | 315-0102-00           |                                | RES.,FXD,CMPSN:1K OHM,5%,0.25W      | 01121       | CB1025          |
| R6012   | 321-0130-00           |                                | RES.,FXD,FILM:221 OHM,1%,0.125W     | 91637       | MFF1816G221ROF  |
| R6014   | 321-0102-00           |                                | RES.,FXD,FILM:113 OHM,1%,0.125W     | 91637       | MFF1816G113ROF  |
| R6015   | 301-0242-00           |                                | RES.,FXD,CMPSN:2.4K OHM,5%,0.50W    | 01121       | EB2425          |
| R6112   | 315-0303-00           |                                | RES.,FXD,CMPSN:30K OHM,5%,0.25W     | 01121       | CB3035          |
| R6114   | 315-0272-00           |                                | RES.,FXD,CMPSN:2.7K OHM,5%,0.25W    | 01121       | CB2725          |
| R6115   | 315-0103-00           |                                | RES.,FXD,CMPSN:10K OHM,5%,0.25W     | 01121       | CB1035          |
| R6116   | 315-0682-00           |                                | RES.,FXD,CMPSN:6.8K OHM,5%,0.25W    | 01121       | CB6825          |
| R6117   | 315-0103-00           |                                | RES.,FXD,CMPSN:10K OHM,5%,0.25W     | 01121       | CB1035          |
| R6118   | 315-0303-00           |                                | RES.,FXD,CMPSN:30K OHM,5%,0.25W     | 01121       | CB3035          |
| R6119   | 315-0103-00           |                                | RES.,FXD,CMPSN:10K OHM,5%,0.25W     | 01121       | CB1035          |
| R6120   | 315-0104-00           |                                | RES.,FXD,CMPSN:100K OHM,5%,0.25W    | 01121       | CB1045          |
| R6122   | 315-0104-00           |                                | RES.,FXD,CMPSN:100K OHM,5%,0.25W    | 01121       | CB1045          |
| R6123   | 315-0390-00           |                                | RES.,FXD,CMPSN:39 OHM,5%,0.25W      | 01121       | CB3905          |
| R6124   | 315-0104-00           |                                | RES.,FXD,CMPSN:100K OHM,5%,0.25W    | 01121       | CB1045          |
| R6125   | 315-0104-00           |                                | RES.,FXD,CMPSN:100K OHM,5%,0.25W    | 01121       | CB1045          |
| R6126   | 315-0105-00           |                                | RES.,FXD,CMPSN:1M OHM,5%,0.25W      | 01121       | CB1055          |
| R6127   | 315-0104-00           |                                | RES.,FXD,CMPSN:100K OHM,5%,0.25W    | 01121       | CB1045          |
| R6128   | 315-0204-00           |                                | RES.,FXD,CMPSN:100K OHM,5%,0.25W    | 01121       | CB1045          |
| R6129   | 315-0204-00           |                                | RES.,FXD,CMPSN:100K OHM,5%,0.25W    | 01121       | CB1045          |
| R6131   | 315-0105-00           |                                | RES.,FXD,CMPSN:1M OHM,5%,0.25W      | 01121       | CB1055          |
| R6133   | 315-0390-00           |                                | RES.,FXD,CMPSN:39 OHM,5%,0.25W      | 01121       | CB3905          |
| R6208   | 315-0272-00           |                                | RES.,FXD,CMPSN:2.7K OHM,5%,0.25W    | 01121       | CB2725          |
| R6212   | 315-0272-00           |                                | RES.,FXD,CMPSN:2.7K OHM,5%,0.25W    | 01121       | CB2725          |
| R6213   | 315-0303-00           |                                | RES.,FXD,CMPSN:30K OHM,5%,0.25W     | 01121       | CB3035          |
| R6215   | 315-0103-00           |                                | RES.,FXD,CMPSN:10K OHM,5%,0.25W     | 01121       | CB1035          |
| R6216   | 315-0682-00           |                                | RES.,FXD,CMPSN:6.8K OHM,5%,0.25W    | 01121       | CB6825          |
| R6217   | 315-0272-00           |                                | RES.,FXD,CMPSN:2.7K OHM,5%,0.25W    | 01121       | CB2725          |
| R6218   | 301-0242-00           |                                | RES.,FXD,CMPSN:2.4K OHM,5%,0.50W    | 01121       | EB2425          |
| R6219   | 315-0241-00           |                                | RES.,FXD,CMPSN:240 OHM,5%,0.25W     | 01121       | CB2415          |
| R6220   | 315-0104-00           |                                | RES.,FXD,CMPSN:100K OHM,5%,0.25W    | 01121       | CB1045          |
| R6226   | 315-0301-00           |                                | RES.,FXD,CMPSN:300 OHM,5%,0.25W     | 01121       | CB3015          |
| R6234   | 315-0102-00           |                                | RES.,FXD,CMPSN:1K OHM,5%,0.25W      | 01121       | CB1025          |



| Ckt No. | Tektronix<br>Part No. | Serial/Model No.<br>Eff Dscont | Name & Description                       | Mfr<br>Code | Mfr Part Number |
|---------|-----------------------|--------------------------------|------------------------------------------|-------------|-----------------|
| S6014   | 260-1811-00           |                                | SWITCH,SLIDE:DPDT,0.5A,125VAC DC         | 82389       | C56206L2        |
| S6024   | 260-1811-00           |                                | SWITCH,SLIDE:DPDT,0.5A,125VAC DC         | 82389       | C56206L2        |
| S6226   | 260-1811-00           |                                | SWITCH,SLIDE:DPDT,0.5A,125VAC DC         | 82389       | C56206L2        |
| U6119   | 156-0411-00           |                                | MICROCIRCUIT,LI:QUAD,COMPARATOR,SGL SPLY | 27014       | LM339N          |
| U6124   | 156-0885-00           |                                | MICROCIRCUIT,LI:OPTOELECTRONIC ISOLATOR  | 04713       | MOC1005         |
| U6127   | 156-0885-00           |                                | MICROCIRCUIT,LI:OPTOELECTRONIC ISOLATOR  | 04713       | MOC1005         |
| U6226   | 156-0885-00           |                                | MICROCIRCUIT,LI:OPTOELECTRONIC ISOLATOR  | 04713       | MOC1005         |
| VR6011  | 152-0662-00           |                                | SEMICOND DEVICE:ZENER,0.4W,5V,1%         | 04713       | SZG195          |
| VR6218  | 152-0662-00           |                                | SEMICOND DEVICE:ZENER,0.4W,5V,1%         | 04713       | SZG195          |

MECHANICAL PARTS LIST DIFFERENCES BETWEEN 832  
EQUIPPED WITH OPTION 2 AND STANDARD 832

# OPTION 2 EXPLODED

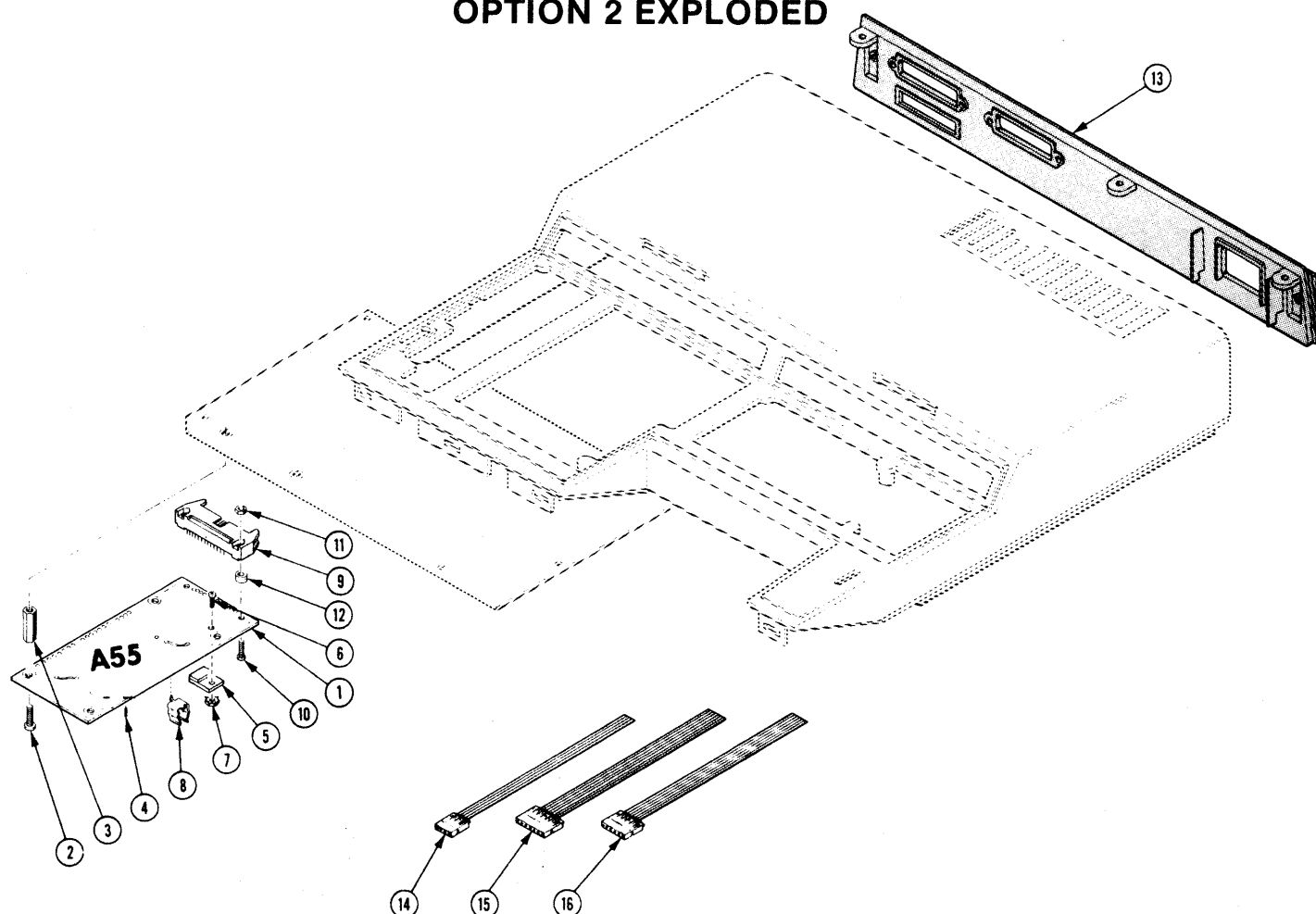
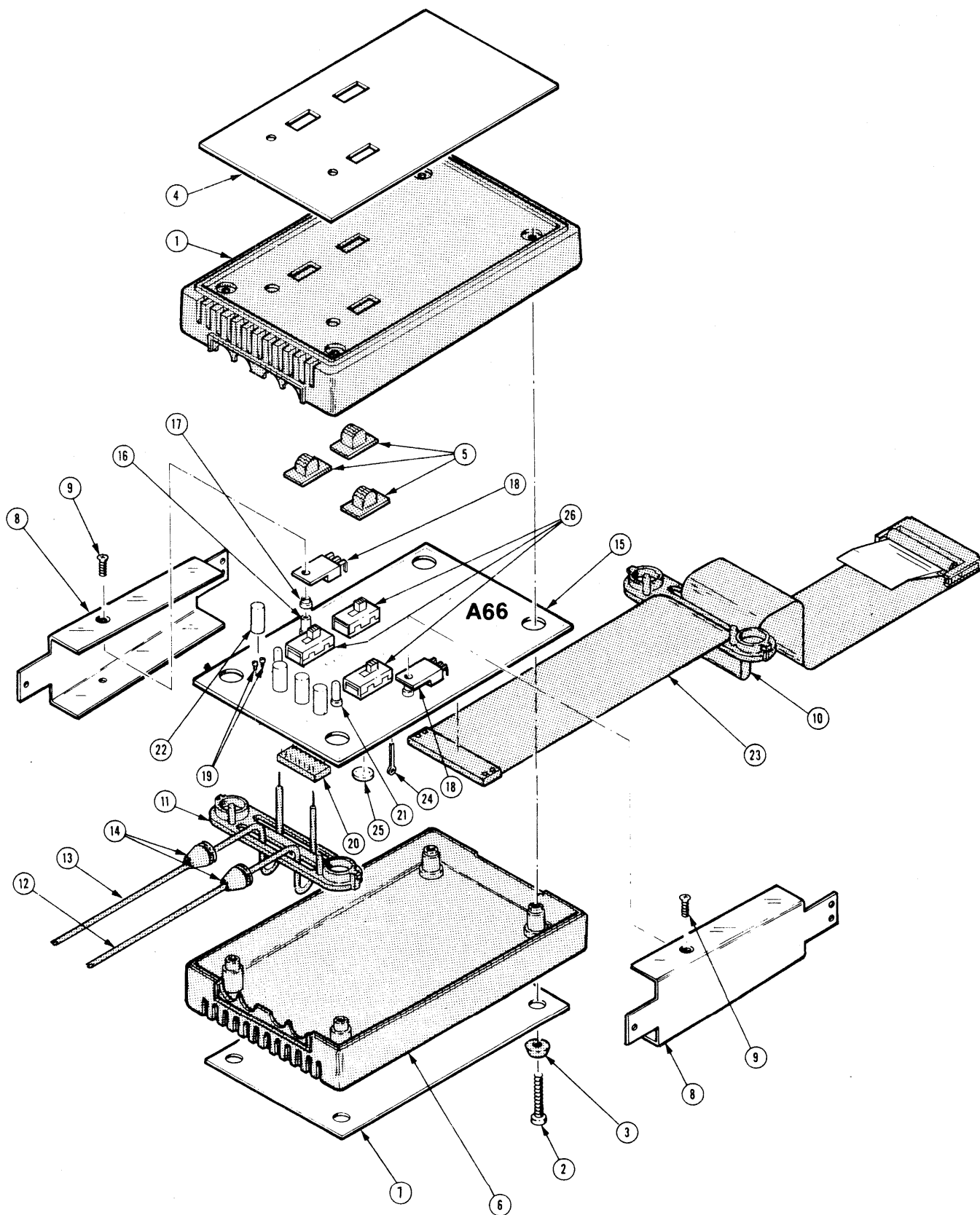


Fig. Option 2-13 Option 2 Mechanical Parts

| Fig. &<br>Index<br>No. | Tektronix<br>Part No. | Serial/Model No.<br>Eff Dscont | Qty | 1 | 2 | 3 | 4 | 5 | Name & Description                                            | Mfr<br>Code | Mfr Part Number |
|------------------------|-----------------------|--------------------------------|-----|---|---|---|---|---|---------------------------------------------------------------|-------------|-----------------|
| -1                     | -----                 |                                | 1   |   |   |   |   |   | CKT BOARD ASSY:CONNECTOR(SEE A55 EPL)<br>(ATTACHING PARTS)    |             |                 |
| -2                     | 211-0661-00           |                                | 8   |   |   |   |   |   | SCREW,MACHINE:4-40 X 0.25 INCH,PNH,STL                        | 83385       | OBD             |
| -3                     | 129-0198-00           |                                | 4   |   |   |   |   |   | POST,ELEC-MECH:0.188 HEX X 0.74 INCH L,BRS                    | 80009       | 129-0198-00     |
| -4                     | 131-0589-00           |                                | 26  |   |   |   |   |   | . TERM,PIN:0.46 L X 0.025 SQ.PH BRZ GL                        | 22526       | 47350           |
| -5                     | -----                 |                                | 1   |   |   |   |   |   | . TRANSISTOR:(SEE Q5201 EPL)<br>(ATTACHING PARTS)             |             |                 |
| -6                     | 211-0008-00           |                                | 1   |   |   |   |   |   | . SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL                      | 83385       | OBD             |
| -7                     | 210-0586-00           |                                | 1   |   |   |   |   |   | . NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL                        | 78189       | 211-041800-00   |
| -8                     | 344-0286-00           |                                | 2   |   |   |   |   |   | . CLIP,ELECTRICAL:FOR 3AG FUSE,BRS                            | 75915       | 102069          |
| -9                     | 131-2350-01           |                                | 1   |   |   |   |   |   | . CONN,RCPT,ELEC:CKT BD,2 X 13 CONT,MALE<br>(ATTACHING PARTS) | 22526       | 65483-002       |
| -10                    | 211-0259-00           |                                | 2   |   |   |   |   |   | . SCR,ASSEM WSHR:2-56 X 0.437,PNH,STL CD PL                   | 78189       | OBD             |
| -11                    | 210-0405-00           |                                | 2   |   |   |   |   |   | . NUT,PLAIN,HEX.:2-56 X 0.188 INCH,BRS                        | 73743       | 2X12157-402     |
| -12                    | 361-0219-00           |                                | 2   |   |   |   |   |   | . SPACER,SLEEVE:0.06 L X 0.093 ID,BRS NP                      | 80009       | 361-0219-00     |
| -13                    | 333-2452-02           |                                | 1   |   |   |   |   |   | PANEL,REAR:                                                   | 80009       | 333-2452-02     |
|                        | 334-3615-01           |                                | 1   |   |   |   |   |   | MARKER,IDENT:MARKED J5100,30V                                 | 80009       | 334-3615-01     |
| -14                    | 175-2528-00           |                                | 1   |   |   |   |   |   | CA ASSY,SP,ELEC:4,26 AWG,3.0 L                                | 80009       | 175-2528-00     |
| -15                    | 175-2526-00           |                                | 1   |   |   |   |   |   | CA ASSY,SP,ELEC:7,26 AWG,4.0 L                                | 80009       | 175-2526-00     |
| -16                    | 175-2525-00           |                                | 1   |   |   |   |   |   | CA ASSY,SP,ELEC:6,26 AWG,5.5 L                                | 80009       | 175-2525-00     |
|                        | 195-0418-00           |                                | 1   |   |   |   |   |   | CA ASSY,SP,ELEC:1,26 AWG,8.0 L                                | 80009       | 195-0418-00     |

# OPTION 2 EXPLODED



## OPTION 2

| Fig. &<br>Index<br>No. | Tektronix<br>Part No.                              | Serial/Model No.<br>Eff Dscont | Qty | 1 2 3 4 5 | Name & Description                                                                                                       | Mfr<br>Code | Mfr Part Number            |
|------------------------|----------------------------------------------------|--------------------------------|-----|-----------|--------------------------------------------------------------------------------------------------------------------------|-------------|----------------------------|
| -1                     | 015-0361-00<br>202-0253-01                         |                                | 1   |           | ADAPTER ASSY:CURRENT LOOP INTERFACE                                                                                      | 80009       | 015-0361-00                |
|                        |                                                    |                                | 1   |           | . CASE HALF,ADAPTER:<br>(ATTACHING PARTS)                                                                                | 80009       | 202-0253-01                |
| -2                     | 211-0020-00                                        |                                | 4   |           | . SCREW,MACHINE:4-40 X 1.125 INCH,PNH STL<br>- - - * - - -                                                               | 83385       | OBD                        |
| -3                     | 348-0037-00                                        |                                | 4   |           | . FOOT:RUBBER                                                                                                            | 70485       | 1059                       |
| -4                     | 333-2559-00                                        |                                | 1   |           | . PANEL,FRONT:                                                                                                           | 80009       | 333-2559-00                |
| -5                     | 200-2367-00                                        |                                | 3   |           | . COVER,SLIDE SW:                                                                                                        | 80009       | 200-2367-00                |
| -6                     | 202-0253-00                                        |                                | 1   |           | . CASE HALF,ADAPTER:                                                                                                     | 80009       | 202-0253-00                |
| -7                     | 333-2560-00                                        |                                | 1   |           | . PANEL,REAR:                                                                                                            | 80009       | 333-2560-00                |
| -8                     | 214-2913-00                                        |                                | 2   |           | . HEAT SINK,ELEC:<br>(ATTACHING PARTS)                                                                                   | 80009       | 214-2913-00                |
| -9                     | 211-0101-00                                        |                                | 2   |           | . SCREW,MACHINE:4-40 X 0.25" 100 DEG,FLH STL<br>- - - * - - -                                                            | 83385       | OBD                        |
| -10                    | 343-0814-00                                        |                                | 1   |           | . CLAMP,CABLE:1.4 INCHES LONG                                                                                            | 80009       | 343-0814-00                |
| -11                    | 343-0818-00                                        |                                | 1   |           | . CLAMP,CABLE:1.4 INCHES LONG                                                                                            | 80009       | 343-0818-00                |
| -12                    | 195-0375-00<br>-----<br>200-2410-00<br>344-0001-00 |                                | 2   |           | . LEAD,ELECTRICAL:18 AWG,48.0 INCHES LG(RED)<br>- . . EACH LEAD ASSY INCLUDES:<br>1 . . COVER,ELEC CLIP:ALIGATOR,BLACK   | 80009       | 195-0375-00<br>200-2410-00 |
| -13                    | 195-0376-00<br>-----<br>200-2410-00<br>344-0001-00 |                                | 1   |           | . . CLIP,ELECTRICAL:                                                                                                     | 76545       | 60                         |
|                        |                                                    |                                | 2   |           | . LEAD,ELECTRICAL:18 AWG,48.0 INCHES LG(BLACK)<br>- . . EACH LEAD ASSY INCLUDES:<br>1 . . COVER,ELEC CLIP:ALIGATOR,BLACK | 80009       | 195-0376-00<br>200-2410-00 |
|                        |                                                    |                                | 1   |           | . . CLIP,ELECTRICAL:                                                                                                     | 76545       | 60                         |
| -14                    | 200-0491-00                                        |                                | 4   |           | . COVER,CAL FXTR:0.148 ID X 0.625 L,BLACK                                                                                | 80009       | 200-0491-00                |
| -15                    | -----                                              |                                | 1   |           | . CKT BOARD ASSY:CURRENT LOOP(SEE A66 EPL)                                                                               |             |                            |
| -16                    | 129-0110-00                                        |                                | 2   |           | . . SPACER,POST:0.272 L X 0.219 W/4-40 THD                                                                               | 80009       | 129-0110-00                |
| -17                    | 210-1178-00                                        |                                | 2   |           | . . WSHR,SHOULDERED:FOR MTG TO-220 TRANSISTOR                                                                            | 49671       | DF 137A                    |
| -18                    | -----                                              |                                | 2   |           | . . TRANSISTOR:(SEE Q6022,Q6221 EPL)                                                                                     |             |                            |
| -19                    | 136-0613-00<br>136-0252-04                         |                                | 8   |           | . . SOCKET,PIN TERM:FOR 0.018-0.026 OD PIN                                                                               | 00779       | 1-331080-5                 |
| -20                    | 136-0269-02                                        |                                | 18  |           | . . SOCKET,PIN TERM:0.188 INCH LONG                                                                                      | 22526       | 75060-007                  |
| -21                    | -----                                              |                                | 1   |           | . . SOCKET,PLUG-IN:14 CONTACT,LOW CLEARANCE                                                                              | 01295       | C95140                     |
| -22                    | -----                                              |                                | 2   |           | . . LT EMITTING DIO:(SEE DS6032,DS6232 EPL)                                                                              |             |                            |
| -23                    | 175-2322-00                                        |                                | 4   |           | . . FUSE,CRTG:(SEE F6032,F6134,F6136,F6235 EPL)                                                                          |             |                            |
| -24                    | 214-0579-00                                        |                                | 1   |           | . . CA ASSY,SP,ELEC:26,28 AWG,18.0 L                                                                                     | 80009       | 175-2322-00                |
| -25                    | 342-0234-00                                        |                                | 6   |           | . . TERM.,TEST PT:BRS CD PL                                                                                              | 80009       | 214-0579-00                |
| -26                    | -----                                              |                                | 2   |           | . . INSULATOR,DISC:TO-5 TRANSISTOR                                                                                       | 13103       | 7717-5N-BLUE               |
|                        | 195-0422-00                                        |                                | 3   |           | . . SWITCH,SLIDE:(SEE S6014,S6024,S6226 EPL)                                                                             |             |                            |
|                        | 195-0423-00                                        |                                | 2   |           | . LEAD,ELECTRICAL:18 AWG,48.0 L,2-N                                                                                      | 80009       | 195-0422-00                |
|                        |                                                    |                                | 2   |           | . LEAD,ELECTRICAL:18 AWG,48.0 L,0-N                                                                                      | 80009       | 195-0423-00                |

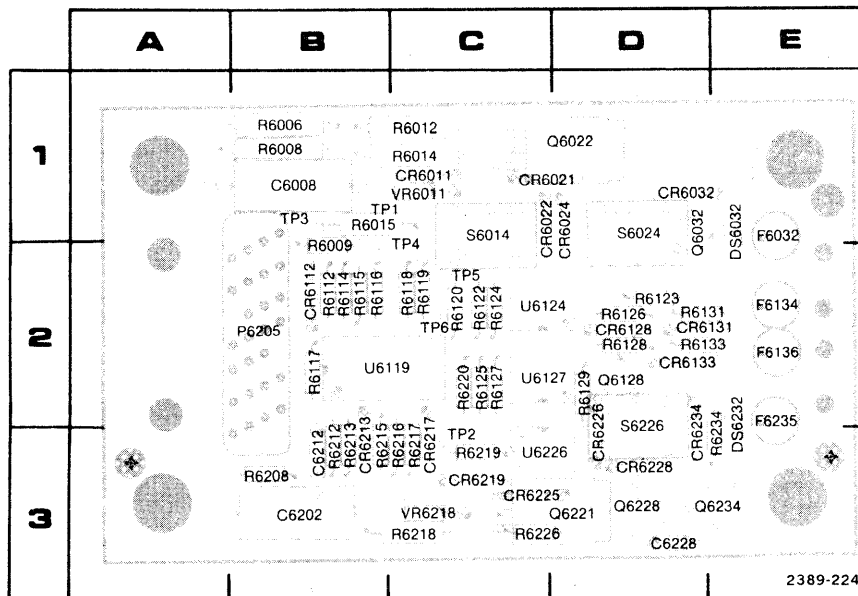


Figure Option 2-14. A66 Current Loop Interface Adapter Board component locations.

| CKT NO | GRID LOC | CKT NO | GRID LOC | CKT NO | GRID LOC | CKT NO | GRID LOC | CKT NO | GRID LOC | CKT NO | GRID LOC | CKT NO | GRID LOC |
|--------|----------|--------|----------|--------|----------|--------|----------|--------|----------|--------|----------|--------|----------|
| C6008  | 1B       | CR6133 | 2D       | F6032  | 1E       | R6006  | 1B       | R6120  | 2C       | R6215  | 3B       | TP1    | 1B       |
| C6202  | 3B       | CR6213 | 3B       | F6134  | 2E       | R6008  | 1B       | R6122  | 2C       | R6216  | 3C       | TP2    | 3C       |
| C6212  | 3B       | CR6217 | 3C       | F6136  | 2E       | R6009  | 2B       | R6123  | 2D       | R6217  | 3C       | TP3    | 1B       |
| C6228  | 3D       | CR6219 | 3C       | F6235  | 2E       | R6012  | 1C       | R6124  | 2C       | R6218  | 3C       | TP4    | 2C       |
|        |          | CR6225 | 3C       |        |          | R6014  | 1C       | R6125  | 2C       | R6219  | 3C       | TP5    | 2C       |
| CR6011 | 1C       | CR6226 | 3D       | P6205  | 2B       | R6015  | 1B       | R6126  | 2D       | R6220  | 2C       | TP6    | 2C       |
| CR6021 | 1C       | CR6228 | 3D       |        |          | R6112  | 2B       | R6127  | 2C       | R6226  | 3C       |        |          |
| CR6022 | 1C       | CR6234 | 3D       | Q6022  | 1D       | R6114  | 2B       | R6128  | 2D       | R6234  | 3E       | U6119  | 2B       |
| CR6024 | 1D       |        |          | Q6032  | 1D       | R6115  | 2B       | R6129  | 2D       |        |          | U6124  | 2C       |
| CR6032 | 1D       | DS6032 | 1E       | Q6128  | 2D       | R6116  | 2B       | R6131  | 2D       | S6014  | 1C       | U6127  | 2C       |
| CR6112 | 2B       | DS6232 | 2E       | Q6221  | 3D       | R6117  | 2B       | R6133  | 2D       | S6024  | 1D       | U6226  | 3C       |
| CR6128 | 2D       |        |          | Q6228  | 3D       | R6118  | 2C       | R6208  | 3B       | S6226  | 3D       |        |          |
| CR6131 | 2D       |        |          | Q6234  | 3E       | R6119  | 2C       | R6212  | 3B       |        |          | VR6011 | 1C       |
|        |          |        |          |        |          |        |          | R6213  | 3B       |        |          | VR6218 | 3C       |

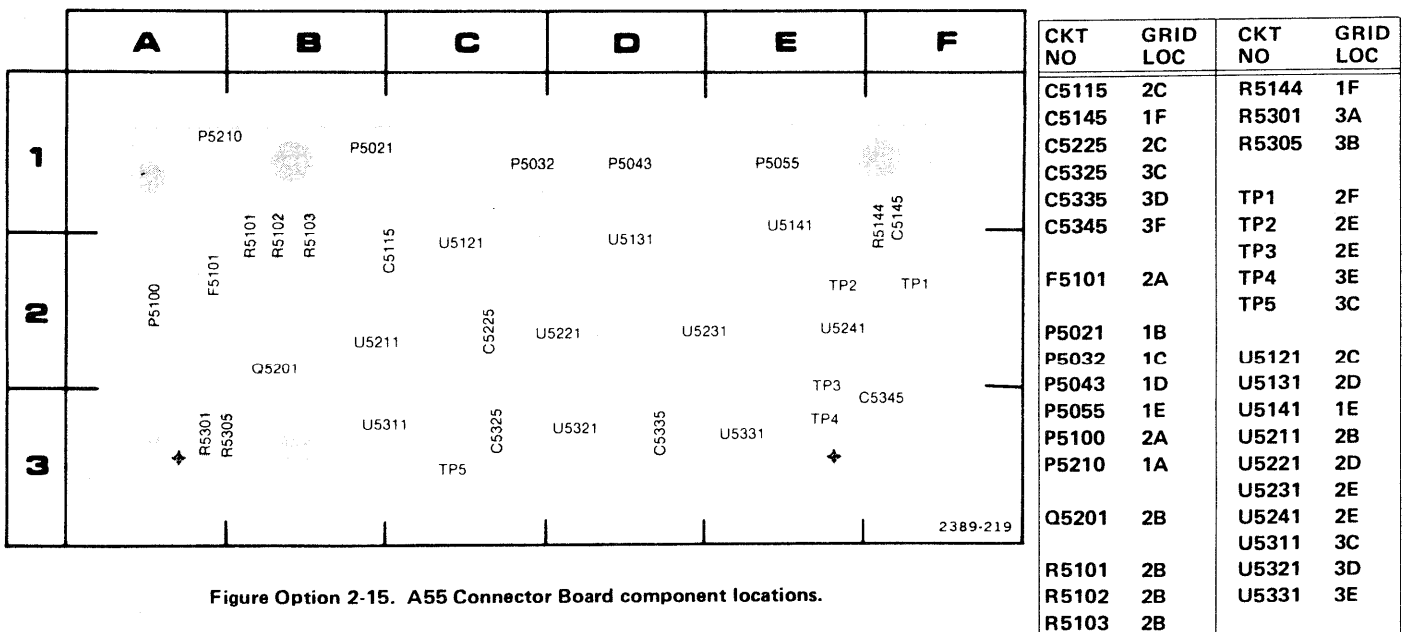
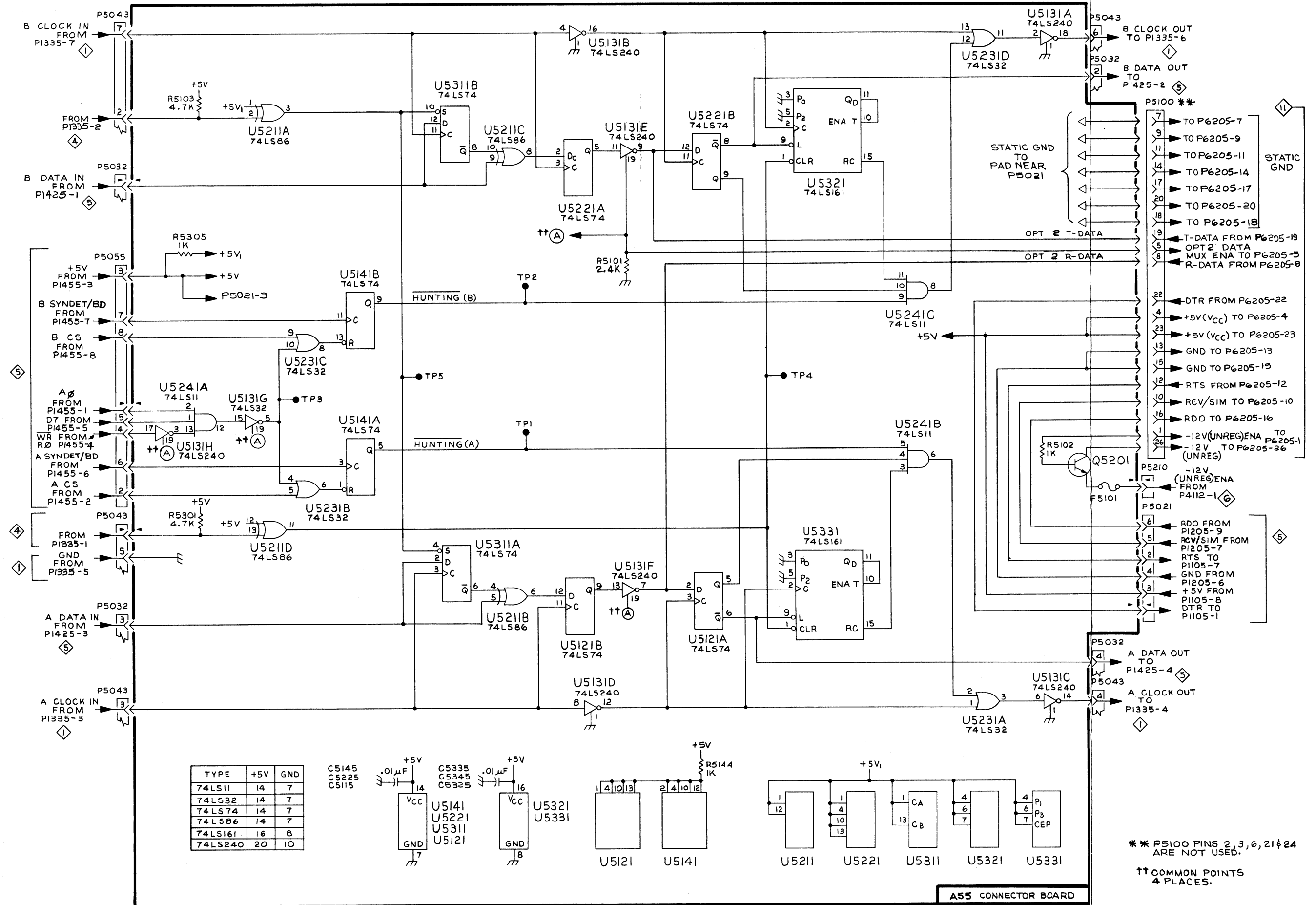
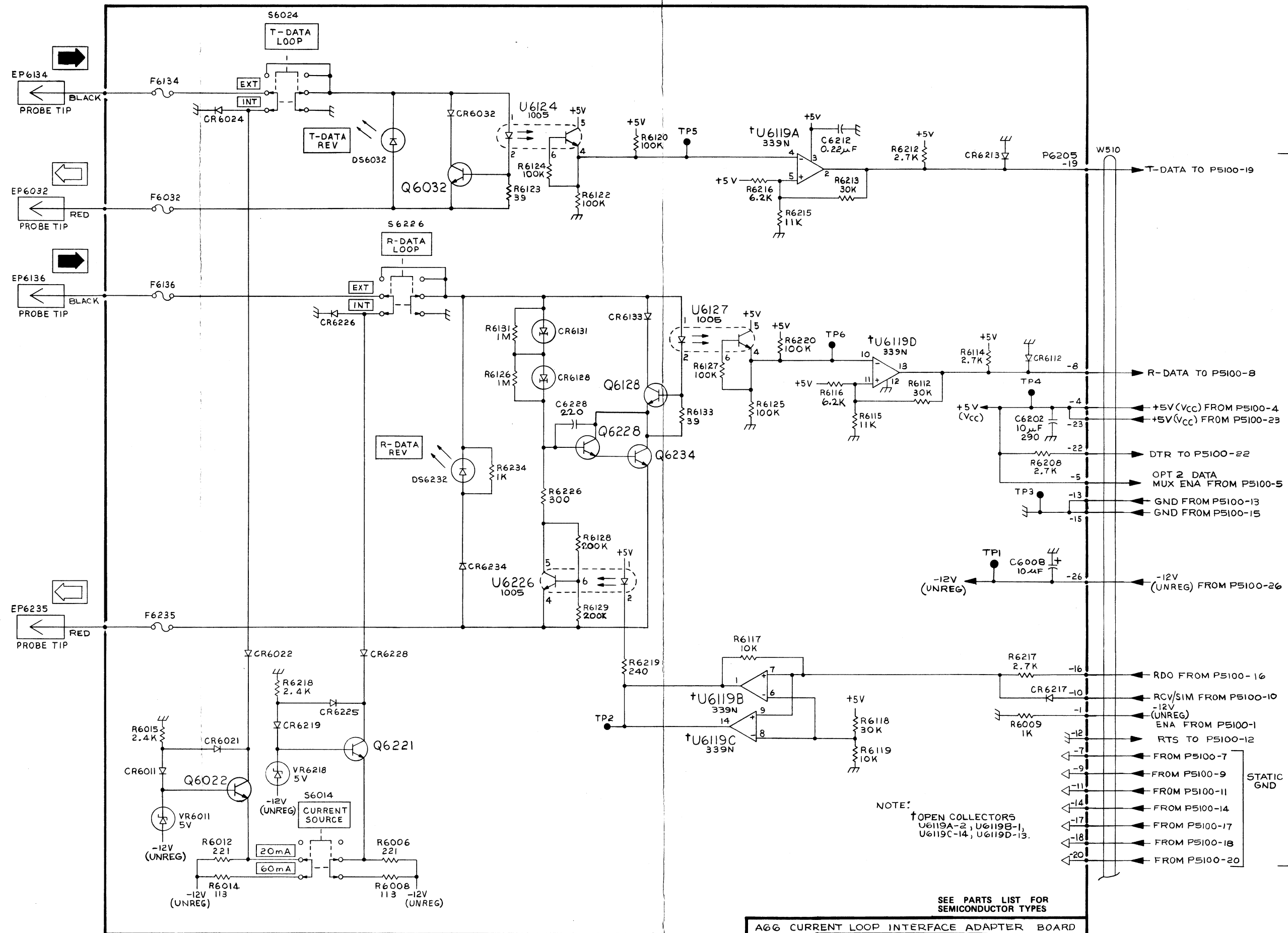
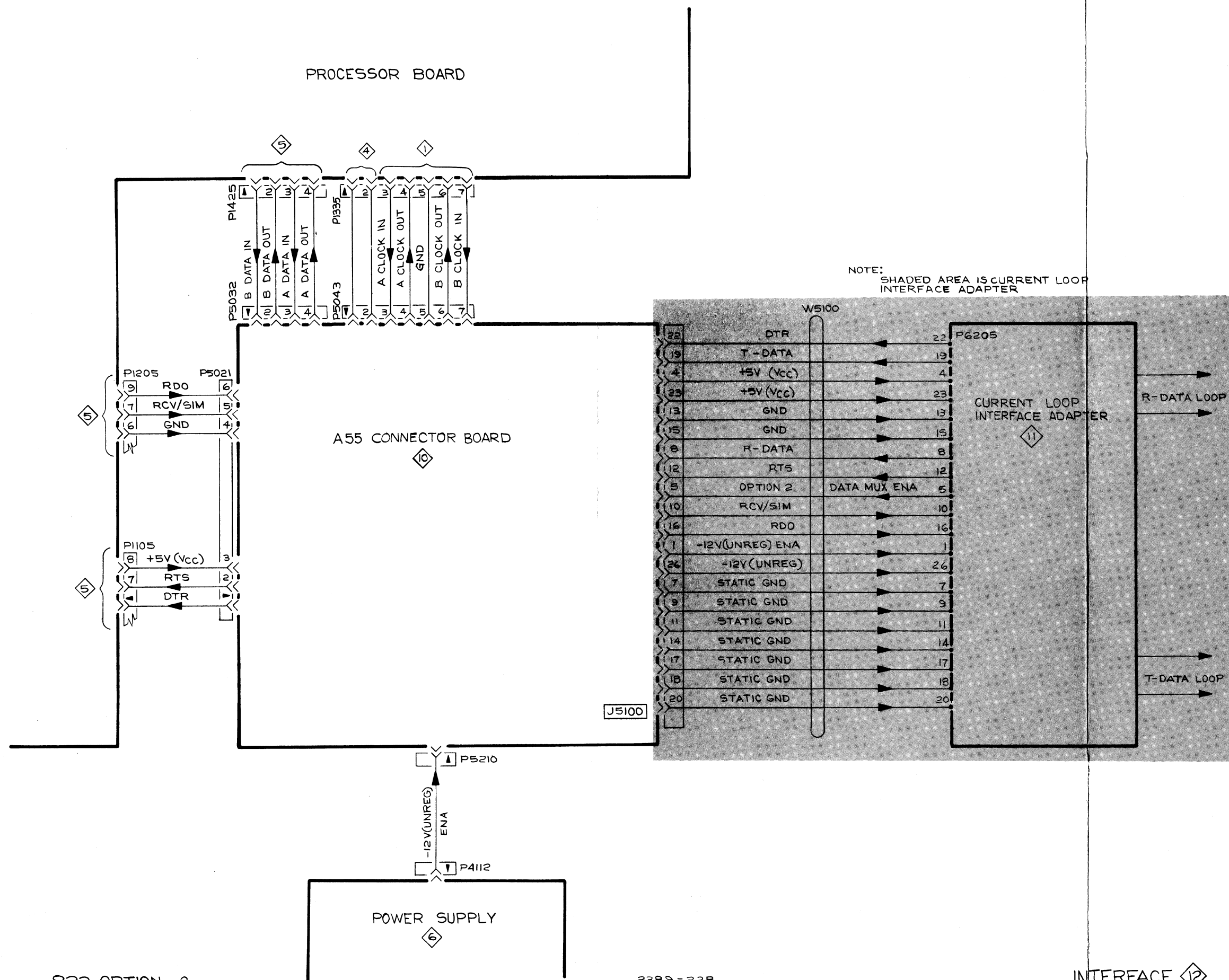


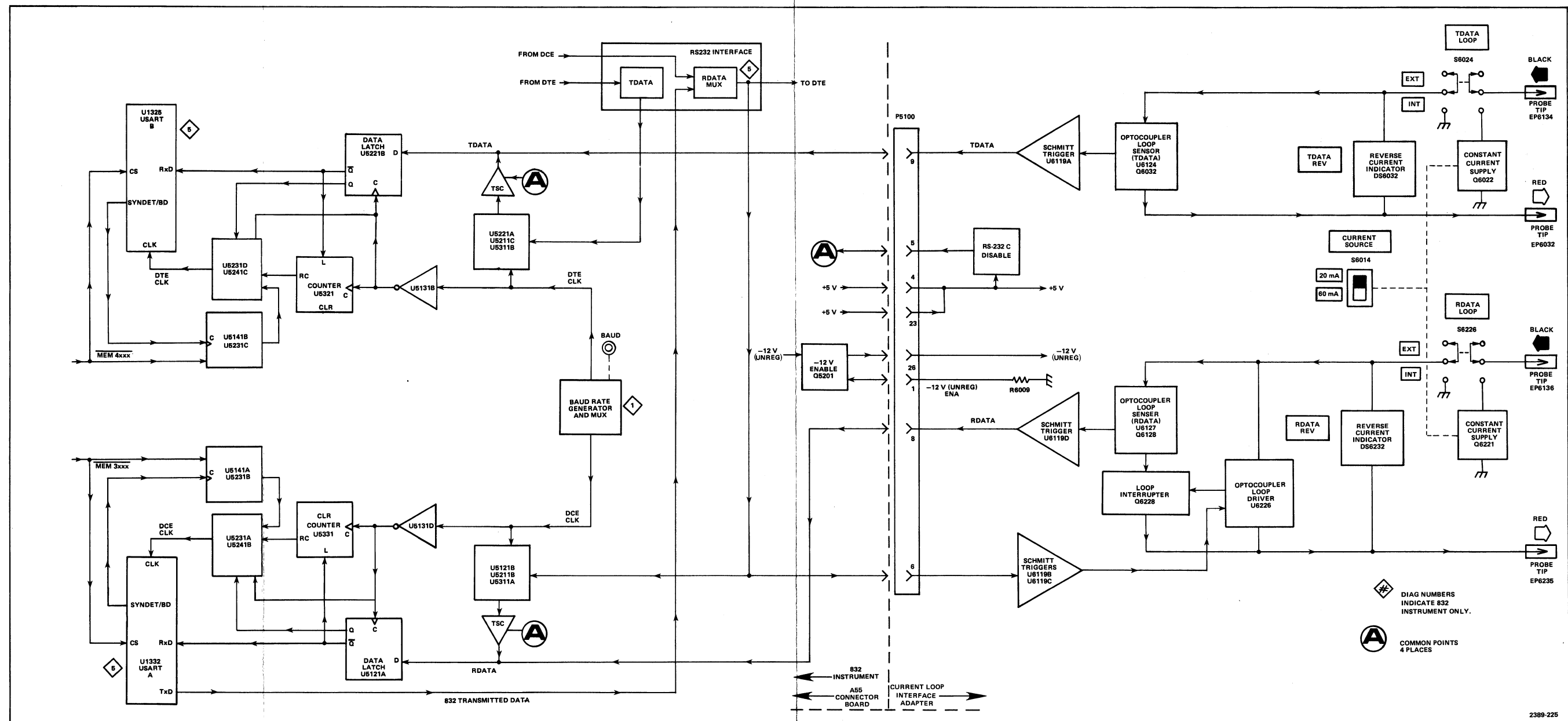
Figure Option 2-15. A55 Connector Board component locations.











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OPTION 2 PAGE 30

BLOCK DIAGRAM 13

### DESCRIPTION

#### 832 OPTION 2 ELECTRICAL PARTS LIST AND SCHEMATIC CHANGES

EFF ALL SN of 832 OPTION 2

CHANGE TO:

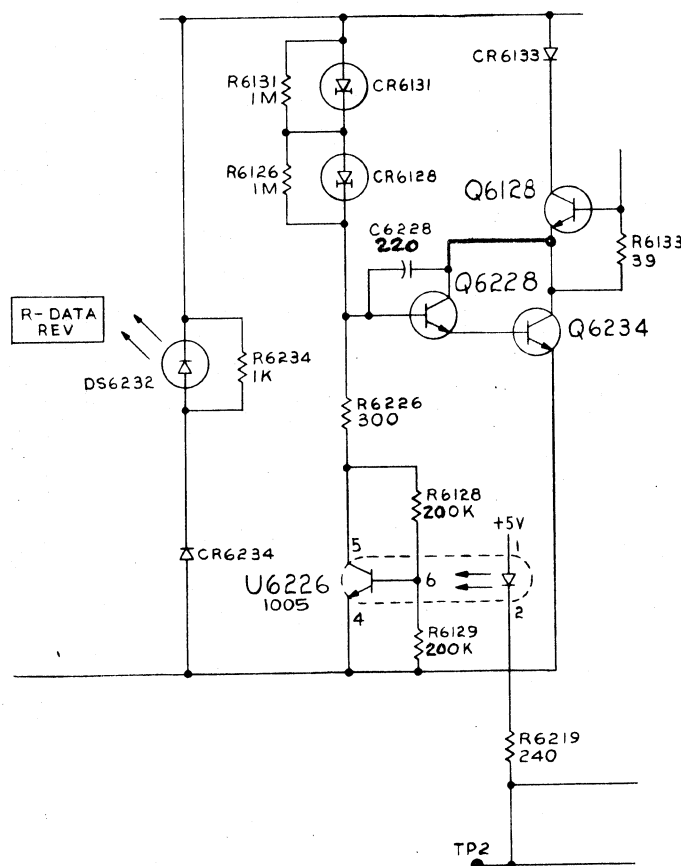
|       |             |                                    |
|-------|-------------|------------------------------------|
| C6228 | 283-0108-00 | CAP., FXD, CER DI:220PF,10%,200V   |
| R6128 | 315-0204-00 | RES., FXD, CMPSN:200K OHM,5%,0.25W |
| R6129 | 315-0204-00 | RES., FXD, CMPSN:200K OHM,5%,0.25W |

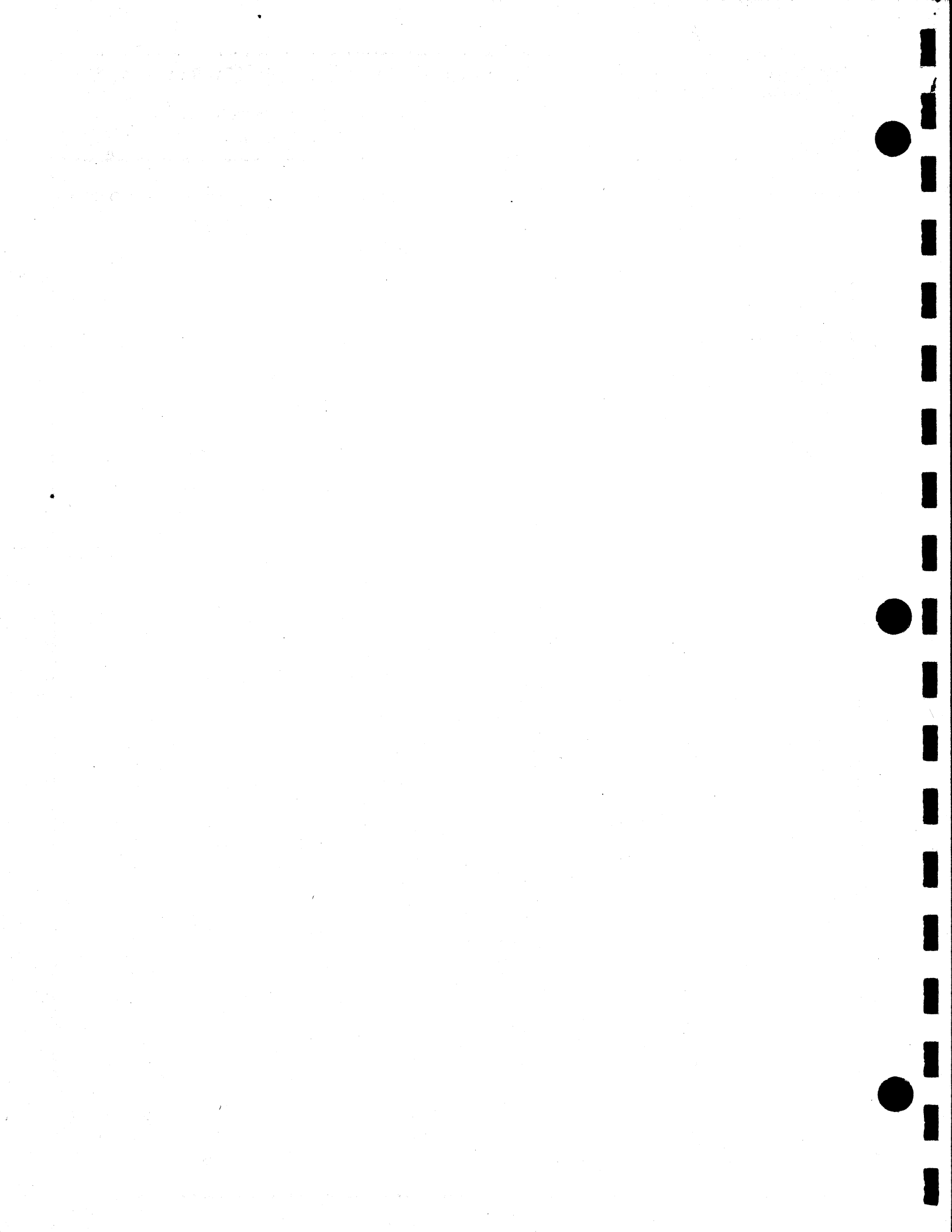
Above parts are located on the A66 Current Loop Interface Adapter board and are shown on Current Loop Interface Adapter diagram 11. See partial 832 Option 2 diagram 11 below for circuit changes.

#### PARTIAL A66 CURRENT LOOP INTERFACE ADAPTER BOARD

PARTIAL 832 OPTION 2

DIAGRAM 11





Date: 8-20-79Change Reference: C9/879Product: 832 INSTRUCTIONManual Part No.: 070-2389-00**DESCRIPTION**

Pilot Change #4

832 OPTION 2 ELECTRICAL PARTS LIST AND SCHEMATIC CHANGES

EFFECTIVE ALL SN OF 832 OPTION 2

CHANGE TO:

|       |             |                                      |
|-------|-------------|--------------------------------------|
| R6115 | 315-0113-00 | RES., FXD, CMPSN:11K OHM, 5%, 0.25W  |
| R6116 | 315-0622-00 | RES., FXD, CMPSN:6.2K OHM, 5%, 0.25W |
| R6215 | 315-0113-00 | RES., FXD, CMPSN:11K OHM, 5%, 0.25W  |
| R6216 | 315-0622-00 | RES., FXD, CMPSN:6.2K OHM, 5%, 0.25W |

Above parts are located on the A66 Current Loop Interface Adapter board  
and are shown on Current Loop Interface Adapter diagram 11.

