

WARNING

THIS MANUAL CONTAINS SERVICING INSTRUCTIONS THAT ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRICAL SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CALLED OUT IN THE OPERATORS MANUAL UNLESS QUALIFIED TO DO SO.

TEKTRONIX®

401
DIGITAL READOUT MODULE
WITH OPTIONS

SERVICE

JUN 13 1980

INSTRUCTION MANUAL

Tektronix, Inc.
P.O. Box 500
Beaverton, Oregon 97077

Serial Number _____

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SAFETY INFORMATION

This manual contains specific safety information which you as a service person must follow to ensure your safety and to protect the instrument. Notes marked **WARNING** are intended for personal safety, whereas, notes marked **CAUTION** are intended for instrument protection.

The following general safety precautions, which apply to the monitor and 401 as a system, and are not included elsewhere in this manual, must be applied during all phases of operation and maintenance. Additional information can be found in the monitor service manual.

WARNING

DO NOT OPERATE MONITOR IN AN EXPLOSIVE ATMOSPHERE

Do not operate the monitor in the presence of flammable gasses or anesthetics. Explosion can result from operation in such an environment. Safety document NFPA 56A, Standard for the Use of Inhalation Anesthetics, paragraphs 2411(c) and 24032, states that with the appropriate precautions, portable electronic equipment may safely be operated at five feet (or more) above the floor in anesthetic locations.

USE AC OUTLET WITH PROTECTIVE-GROUND CONTACT

The monitor is compatible with isolated power systems as used in operating rooms. In nonisolated power systems, this monitor is intended to be operated from a single-phase, earth-referenced power source having one current-carrying conductor (the neutral or grounded conductor) near earth potential. Operation from power sources where both current-carrying conductors are live with respect to earth (such as phase-to-phase on a three-wire system) is not recommended, since only the line (or ungrounded) conductor has over-current (fuse) protection within the monitor.

The monitor has a three-wire (18-gauge, SJT-grade) power cord and is normally supplied with a three-terminal polarized plug (Hospital Grade) for connection to the power source and Protective ground. The protective-ground (earth) terminal of the plug is directly connected to the frame of the monitor. For electric-shock protection, insert this plug only in a mating "Hospital Grade" power outlet with a protective-ground contact. Do not defeat the grounding connection. Any interruption of the grounding connection can create an electric-shock hazard.

Inspect the power cord periodically for fraying or other damage. Do not operate the monitor from an ac power source if the power cord or plug is damaged.

The power cord on the monitor is color-coded to conform to IEC (International Electrotechnical Commission) requirements as follows:

CONDUCTOR	COLOR
Line (ungrounded)	Brown
Neutral (grounded)	Light blue
Protective Ground (grounding)	Green or green w./yellow stripe

USE ONLY SAFE METHODS OF INTERCONNECTION

To ensure protection against electrical shock from the monitor cabinet, whenever auxiliary line-operated equipment is electrically connected to the monitor, the monitor must be properly grounded. When the monitor is connected to other line-operated equipment, battery operation should be avoided. If it cannot be avoided, the monitor must be grounded using the terminal provided on the rear panel. It is extremely important that equipment interconnections are made in accordance with NFPA 76B-T, Tentative Standard for the Use of Electricity in Patient Care Areas of Health Care Facilities, section 3038, "Signal Transmission Between Appliances."

NOTE

Within certain governmental jurisdictions, all interconnected accessory equipment must be labeled by an approved testing laboratory. After interconnection with accessory equipment, leakage current and grounding requirements must be maintained.

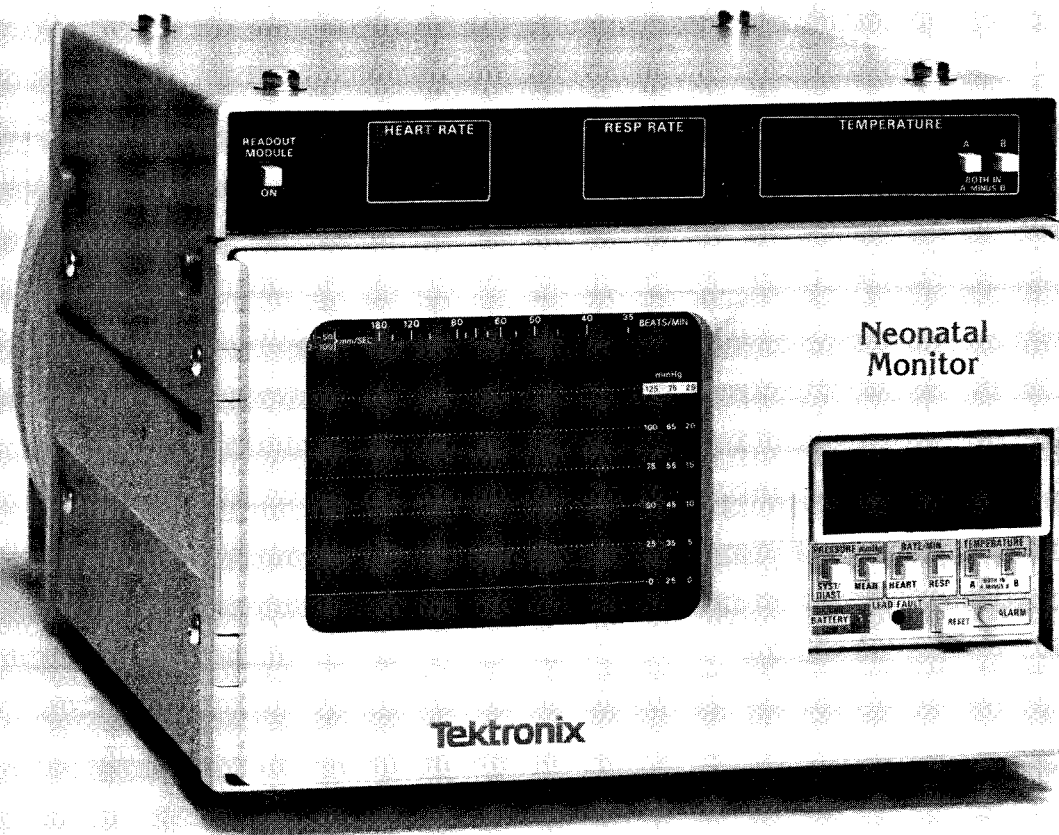
DO NOT REMOVE INSTRUMENT COVERS

High voltage is present inside the monitor. To avoid electric-shock hazard, operating personnel must not remove the protective instrument covers. Component replacement and internal adjustments must be made by qualified service personnel only.

DO NOT MOUNT 401 MONITOR DIRECTLY ABOVE PATIENT

Place monitor in a location where it cannot harm the patient should it fall from its shelf or other mount.

[illegible]



2497-1

401 Digital Readout Module with 413 Monitor

GENERAL INFORMATION

DESCRIPTION

The TEKTRONIX 401 Digital Readout Module (Standard, Option 1, or Option 2) provides three additional dedicated digital readouts of vital signs to supplement the single, switch-selectable readout in a 413, 414, or 414 Option 21 Monitor respectively.

The Standard 401 displays heart rate, respiration rate, and temperature. Temperature A, B, or A minus B can be selected by front panel pushbuttons.

The Option 1 displays heart rate, temperature, and blood pressure. Systolic, diastolic, or mean pressure can be selected by frontpanel pushbuttons.

The Option 2 displays heart rate, temperature, and arterial/venous (A/V) channel blood pressure. Systolic, diastolic, or mean A/V blood pressure can be selected by front-panel pushbuttons.

The 401 is attached to the top of the monitor and is an integral part of the monitor system. It adds about 3.5 cm (1/3 in) to the overall height. Internal power is supplied to the 401 by the monitor batteries (F cells required). Normal battery operating times and charge rates are affected when the 401 is turned on (front-panel pushbutton); refer to the Power Consideratons heading in the Section 2, Operating Information.

SPECIFICATIONS

The electrical specifications in Table 1-1 apply when the following conditions are met: (1) The 401 Digital Readout Module must have been mated to an appropriate Tektronix monitor (Standard 401 to 413 Monitor, 401 Option 1 to 414 Monitor, and 401 Option 2 to 414 Option 21 Monitor), (2) the instrument must have been adjusted to an ambient temperature between +20 and +30° C (+68 and +86°F), (3) the instrument must be operating in an ambient temperature between 0 and +50°C (+32 and +122°F), and (4) the monitor must be accurately adjusted.

TABLE 1-1
Electrical Characteristics

Characteristics	Performance Requirements	Supplemental Information
DIGITAL DISPLAY The Standard 401 digital-display specifications are same as those for 413 digital display except as follows: DEVIATION FROM MONITOR¹		
Heart Rate	5 beats/minute or less.	
Respiration Rate	5 breaths/minute or less.	
Temperature	0.5° (C or F) or less.	
The Option 1 digital-display specifications are same as those for 414 digital display except as follows: DEVIATION FROM MONITOR¹		
Heart Rate	5 beats/minute or less.	
Pressure	5 mmHg or less.	
Temperature	0.5° (C or F) or less.	
The Option 2 digital display specifications are same as those for 414 Option 21 digital display except as follows: DEVIATION FROM MONITOR¹		
Heart Rate	5 beats/minute or less.	
Pressure A/V	5 mmHg or less.	
Temperature	0.5° (C or F) or less.	
POWER SOURCE	Monitor batteries.	When monitor is ac-operated, 401 may be used indefinitely.

¹For instrument ambient temperature range of +15 to +35°C.

TABLE 1-2
Environmental Characteristics

Environmental specifications are the same as those for the monitor on which the 401 is being used. Refer to the specific monitor service manual.

TABLE 1-3
Physical Characteristics

Characteristics	Description
WEIGHT	1.024 kg. (2 lbs. 4 Oz.)
HEIGHT	
401 only	3.43 cm. (1.35 in.)
401 w/monitor (including feet)	18.8 cm. (7.4 in.)
WIDTH	22.9 cm. (9 in.)
DEPTH	
401 only	25.4 cm. (10 in.)
401 w/monitor including cord wraps and knob protrusions)	
413	32.4 cm. (12.75 in.)
414	29.8 cm. (11.7 in.)

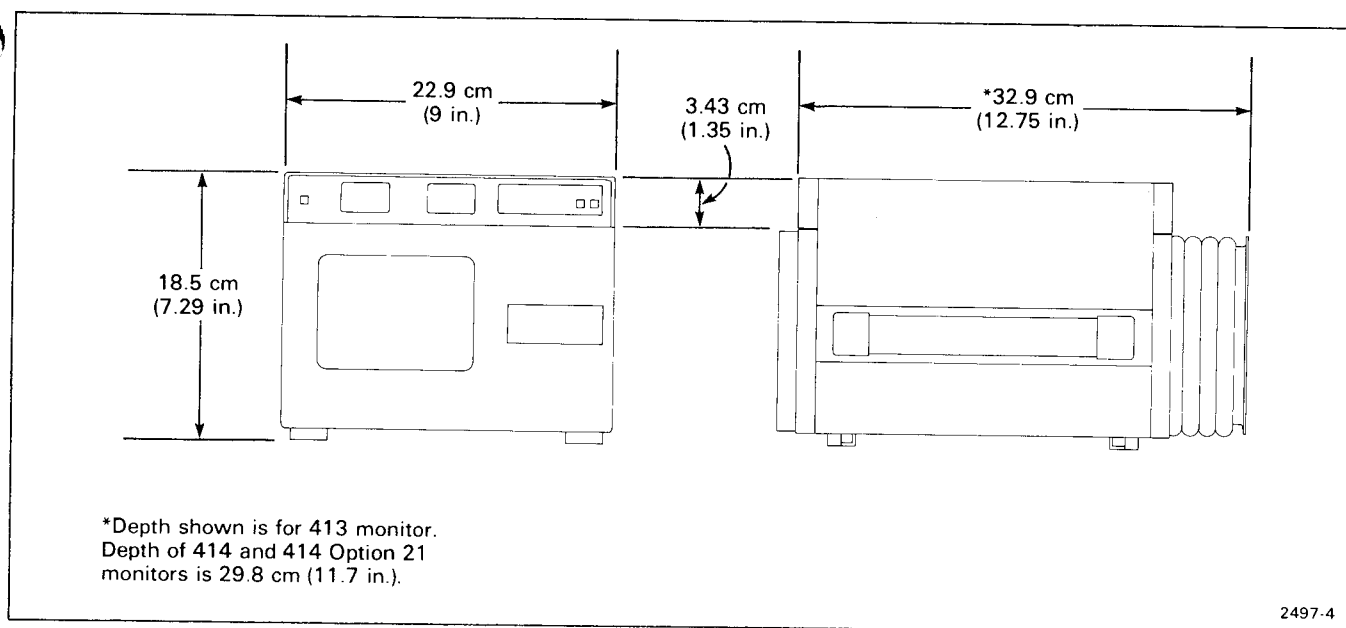


Figure 1-1. Dimensional outline drawing.

413 MONITOR/401 DIGITAL READOUT MODULE ADAPTER KIT INSTALLATION

NOTE

It is intended that this kit be installed only by Tektronix service personnel.

INTRODUCTION

The following step-by-step instructions describe how to install a 401 Digital Readout Module on a 413 Monitor using the 016-0391-00 Adapter Kit.

The 016-0391-00 Adapter Kit is shipped with the Standard 401 Digital Readout Module. Two different interconnecting cables are included in the kit. The shorter cable is to be used when the 401 is combined to a 413 Monitor only, while the longer cable is to be used for combining a 401 with a 413/400 Monitor/Recorder unit. Separate instructions are provided for each combination.

CONTENTS OF 016-0391-00 ADAPTER KIT

Quantity	Description	Tektronix Part No.
1	Interconnecting cable 31 1/2"	175-2154-00
1	Interconnecting cable 19"	175-2155-00
1	4-wire cable w/black conn.	175-2156-00
1	3-wire cable w/brown conn.	175-2158-00
4	Lockwasher, #4 internal	210-0004-00
4	Screw, 4-40 X 0.625" panhead	211-0016-00
1	Shield, preformed fishpaper	337-2538-00
1	Spacer, plate	361-0911-00
1	413 Operators Manual ¹	070-2276-00

¹The 413 Operators Manual is not part of the 016-0391-00 Adapter Kit, but is included with shipment of the 401 Digital Readout Module.

INSTALLATION INSTRUCTIONS

A. MONITOR PREPARATION

1. Disconnect monitor from ac-power source.

2. Remove top cover. Remove two screws on each side. Lift up left side of cover, make sure it has cleared the ECG LEAD CHECK terminals, and remove cover from monitor.

3. If present, remove 400 Recorder. Remove two screws on each side, which attach recorder adapter plates to monitor. Unplug red and black connectors from monitor battery pack. Disconnect multi-conductor interconnecting cable from both recorder and monitor. Discard interconnecting cable.

4. If a 400 Recorder is not present, remove bottom cover. Remove two screws on each side and pull cover straight off.

5. Unplug P1982 (battery cable) from monitor Main board. Dress battery cable between Main board and rear panel into monitor cavity; it will be connected in a later step.

6. Remove Conditioner board. Remove two mounting screws and spacer post (toward front of monitor).

7. Install 3-wire cable (with brown connector, from kit) as follows:

- a. Solder free end of white-brown wire to junction of R1937 and R1942. See Figure 1-2.

- b. Solder free end of white-red wire to junction of R1927 and R1928. See Figure 1-2.

- c. Dress white-brown and white-red wires toward rear panel. Dress wires such that they do not touch R1943 and CR1945.

- d. Install Conditioner board. Use previously removed hardware. Be sure to install spacer post in hole (toward front of monitor).

- e. Solder free end of white-orange wire to junction of U1445-6 and R1447. See Figure 1-3.

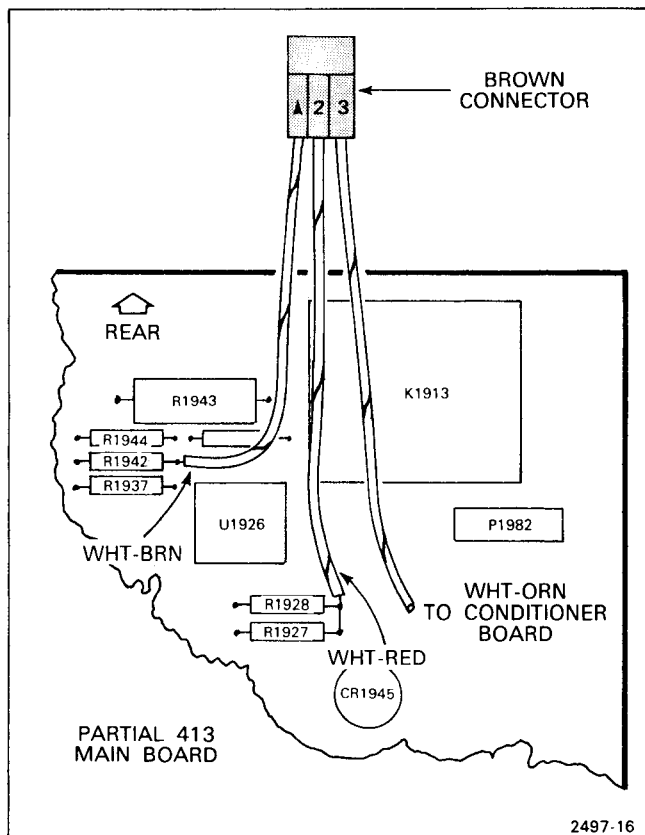


Figure 1-2. Adding wires to 413 Main board.

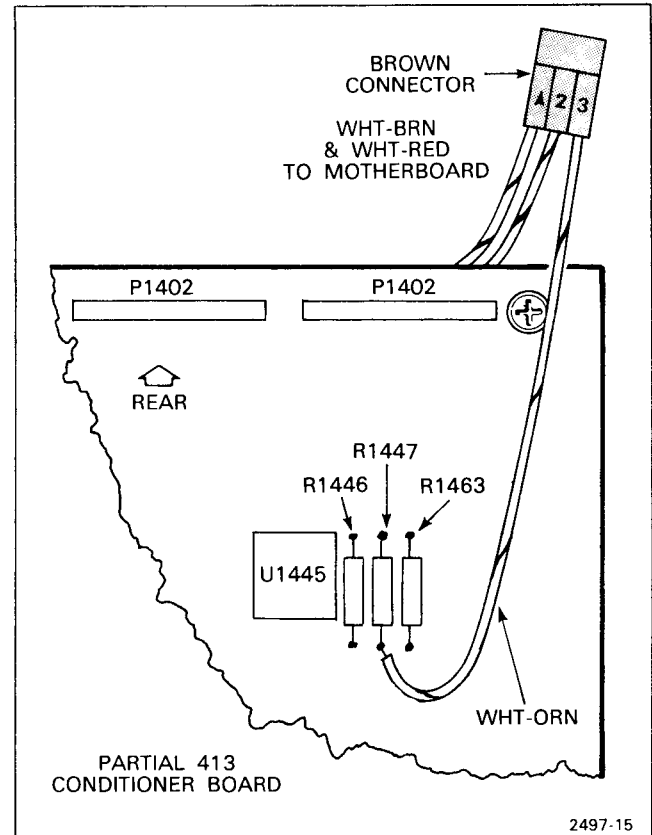


Figure 1-3. Adding wire to 413 Conditioner board.

f. Dress added 3-wire cable between Main board and rear panel and then up to top of monitor.

8. Plug 4-wire cable (with black connectors, from kit) on P1982 (battery connector on monitor Main board). Dress other end of cable between rear of Main board and rear panel and then up to top of monitor.

9. Remove four screws holding phone-jack mounting plate to monitor rear panel. Discard screws.

10. Pull phone-jack mounting plate away from rear panel.

11. Mark phone jacks to avoid confusion when replacing. Remove phone jacks from mounting plate. Retain hardware.

12. Insert phone jack through spacer plate (from kit).

13. Place preformed fishpaper shield (from kit) on mounting plate. Open side of fish paper should be up.

14. With shield in place, install phone jacks, in correct order, on mounting plate using previously removed

hardware (place lockwasher between mounting plate and phone jack). Be sure wired ends of phone jacks is covered with fishpaper shield. Mounting plate will be fastened to rear panel in a later step.

15. Some 413 Monitors have a press-mounted grounding stud and nut located on inside of rear panel directly behind upper rear corner of Respiration board.

If there is no such stud on your monitor, drill a 5/32 inch hole in upper left corner (viewing from rear) of rear panel as shown in Figure 1-4. Be careful not to drill into internal cables. Install 6-32 X 0.5 inch screw through hole from outside of rear panel. Secure screw with #6 nut.

NOTE

For remaining instructions refer to Part B for 401/monitor combination or Part C for 401/monitor/recorder combination.

B. 401/MONITOR COMBINATION

1. Locate the 19-inch interconnecting cable (with two connectors, from kit)

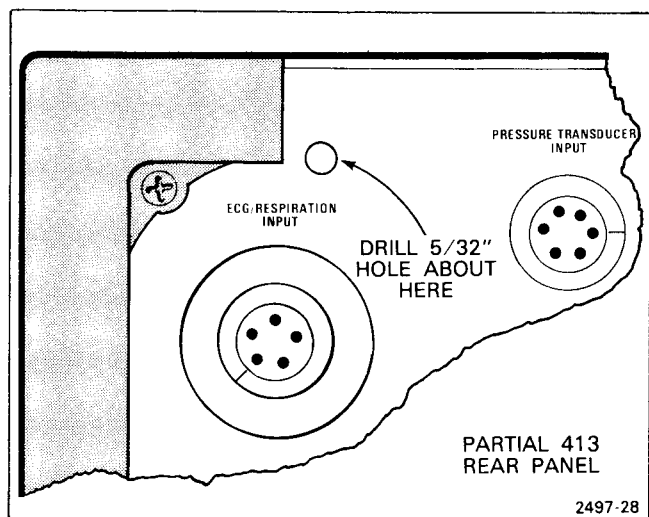


Figure 1-4. Drilling hole in 413 rear panel for grounding screw.

2. Fold cable as shown in drawing on bottom of 401 chassis. Be sure red stripe is in proper location.

3. Plug one end of cable on monitor Conditioner board, P2400, noting correct position of red stripe.

4. Retain folds which will lie on top of Conditioner board. Dress free end of cable between monitor Main board and rear panel. Dress cable horizontally to rear panel in area behind phone jacks and transformer.

5. Carefully dress wires on phone jacks into monitor rear panel opening. Attach phone jack mounting plate and spacer to rear panel using four 4-40 X 0.5 inch screws and four #4 lockwashers.

6. Attach 401 to monitor as follows:

a. Place 401 Digital Readout Module near monitor and connect solder lug (at end of green-yellow wire, from 401) to rear-panel grounding stud or screw.

If monitor has press-mounted stud, use nut supplied on stud. If a screw and nut were added to the rear panel in a previous step, secure solder lug to screw with an additional #6 nut from kit. (This places solder lug between two #6 nuts.)

b. With interconnecting cable folded as shown in Figure 1-5, connect to P4010 on 401 Main board. Note correct location of red stripe.

c. Connect 3-wire cable (with brown connector) to P4060. See Figure 1-5. Be sure to match triangle on connector with one on board.

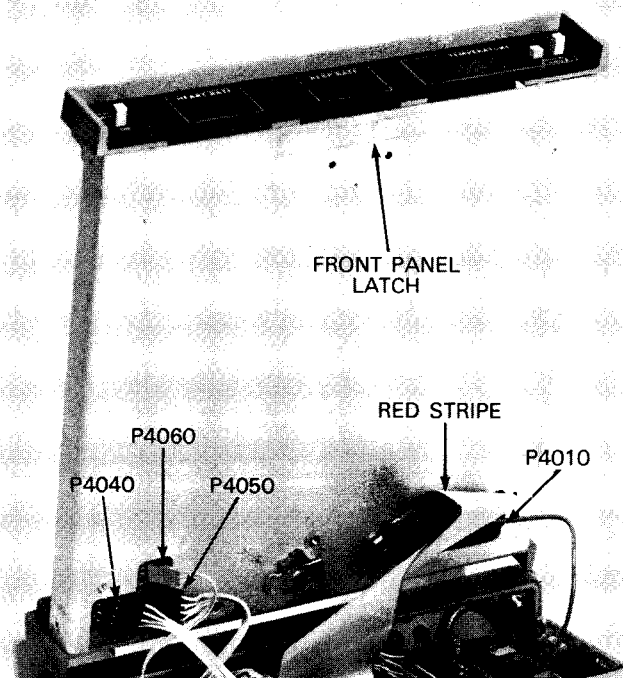


Figure 1-5. Attaching 401 to monitor.

d. Connect 4-wire cable (with black connector, from P1982 on monitor) to P4050. See Figure 1-5. Be sure pin 1 on the connector (white-brown wire) mates with pin 1 of P4050 (indicated by triangle).

e. Connect 4-wire cable (with black connector from monitor battery pack) to P4040. See Figure 1-5. Be sure pin 1 on the connector (white-brown wire) mates with pin 1 of P4040 (indicated by triangle).

f. Gently slide bracket on bottom front edge of 401 onto edge of monitor front casting to engage front latch.

g. Lower back of 401 to align rear fastener with rear latch and turn slotted fastener, located at rear of 401 chassis, 90 degrees clockwise.

h. Install bottom cover on monitor. Secure with two screws on each side.

i. Install top cover supplied with 401. Place right side of top cover over ECG LEAD CHECK terminals then spring left side out and slip it over left side of 401 and 413. Install two screws on each side of cover.

j. Turn on monitor and 401, and check for proper operation. Refer to Operating Information section.

k. Check monitor and 401 digital display calibration. Refer to Calibration section.

C. 401/MONITOR/RECORDER COMBINATION

1. Locate 31 1/2 inch interconnecting cable (with 3 connectors, from kit).
2. Fold 12 1/2 inch section of interconnecting cable as shown in drawing on top of recorder chassis. Make sure connectors and red stripe are in proper position.
3. Fold the 19 inch section of cable as shown in drawing on bottom of 401 chassis.
4. Plug center connector on monitor Conditioner board plug P2400, noting correct position of red strip.
5. Feed 19 inch section of cable between monitor Main board and rear panel. Dress cable horizontally to rear panel in area behind phone jacks and transformer.
6. Carefully dress wires on phone jacks into monitor rear panel opening. Attach phone-jack mounting plate and spacer to rear panel using four 4-40 X 0.5 inch screws and four #4 lockwashers.
7. Reinstall recorder as follows:
 - a. Route recorder power cable (red and black connectors) between monitor Main board and rear panel, in corner nearest power transistors, so that power cable plug can be pulled into vicinity of monitor battery pack.
 - b. Plug recorder end of interconnecting cable onto P2200 of recorder.
 - c. Carefully fit recorder to monitor. Dress interconnecting cable to lie flat on Conditioner board and pull recorder power cable into monitor cavity.
 - d. Connect recorder power cable to mating connector on side of battery pack.
 - e. Replace four screws which attach recorder adapter plates to monitor.
9. Attach 401 to Monitor/Recorder unit as follows:
 - a. Place 401 Digital Readout Module near 413/400 Monitor/Recorder unit and connect solder lug (at end of green-yellow wire, from 401) to rear-panel grounding stud or screw.

If monitor has press-mounted stud, use nut supplied on stud. If a screw and nut were added to the rear panel in a previous step, secure solder lug to screw with an additional #6 nut from kit. (This places solder lug between two #6 nuts.)

- b. With interconnecting cable folded as shown in Figure 1-5, connect to P4010 on 401 Main board. Note correct location of red stripe.
- c. Connect 3-wire cable (with brown connector) to P4060. See Figure 1-5. Be sure to match triangle on the connector with one on the board.
- d. Connect 4-wire cable (with black connector) from P1982 on monitor to P4050. See Figure 1-5. Be sure pin 1 on the connector (white-brown wire) mates with pin 1 of P4050 (indicated by triangle).
- e. Connect 4-wire cable (with black connector) from monitor battery pack to P4040. See Figure 1-5. Be sure pin 1 on the connector (white-brown wire) mates with pin 1 of P4040 (indicated by triangle).
- f. Gently slide bracket on bottom front edge of 401 onto the edge of monitor front casting to engage front latch.
- g. Lower back of 401 to align rear fastener with rear latch and turn slotted fastener, at rear of 401 chassis, 90 degrees clockwise.
- h. Install bottom cover on monitor. Secure with two screws on each side.
- i. Install top cover supplied with 401. Place right side of cover over ECG LEAD CHECK terminals then spring left side out and slip it over left side of 401 and 413. Install two screws on each side of cover.
- j. Turn on monitor and 401, and check for proper operation. Refer to Operating Information section. Check recorder operation as deemed necessary.
- k. Check monitor and 401 digital display calibration. Refer to Calibration section.

414 MONITOR /401 DIGITAL READOUT MODULE ADAPTER KIT INSTALLATION

INTRODUCTION

NOTE

It is intended that this kit be installed only by Tektronix service personnel.

The following step-by-step instructions describe how to install a 401 Digital Readout Module on a 414 (or 414 Opt. 21) Monitor using the 016-0394-00 Adapter Kit.

The 016-0394-00 Adapter Kit is shipped with the Standard 401 Digital Readout Module. Two different interconnecting cables are included in the kit. The shorter cable is used when the 401 is combined with a 414 Monitor only, while the longer cable is used for combining a 401 with a 414/400 Monitor/Recorder unit. Separate instructions are provided for each combination.

BATTERY-PACK ORDERING INFORMATION

All monitors mated to 401 Digital Readout Modules must have F-cell battery packs for satisfactory operation. To replace D cells with F cells, order Tektronix part 040-0710-02. To replace F cells with F cells, order Tektronix part 119-0443-01.

NOTE

If a new battery pack is to be installed, the resistor which determines battery charging current may need to be replaced. Instructions and the proper resistor are packaged with each new battery pack.

CONTENTS OF 016-0394-00 ADAPTER KIT

414	Opt 21	Quantity	Description	Tektronix Part No.
X	X	2	Cable tie, plastic	006-0531-00
X	X	2	Spacer post	129-0123-00
	X	1	2-wire cable w/grn conn.	175-1965-00
X		1	4-wire cable w/grn conn.	175-1966-00
	X	1	8-wire cable w/red conn.	175-1968-00
X	X	1	5-wire cable w/orn conn.	175-1969-00
X	X	1	7-wire cable w/blu conn.	175-1970-00
X		1	2-wire cable w/brn conn.	175-1986-00
X	X	1	31 1/2 inch inter-connecting cable	175-2154-00
X	X	1	19 inch inter-connecting cable	175-2155-00
X	X	1	4-wire cable w/blk conn.	175-2156-00
X	X	1	White-yellow wire w/yel conn.	195-0169-00
X	X	1	White-violet wire w/vio conn.	195-0171-00
X		1	White-red wire w/red conn.	195-0187-00
X	X	1	White-violet wire w/gry/vio conn.	195-0233-00
X	X	1	White-brown wire w/brn conn.	195-0237-00
X	X	6	Lockwasher, #4 internal	210-0004-00
X	X	2	Screw, 4-40 X 0.25" panhead	211-0008-00
X	X	6	Screw, 4-40 X 0.5" panhead	211-0014-00
X	X	1	Shield, preformed fishpaper	337-2538-00
X	X	1	Spacer, plate	361-0911-00
X	X	1	Bar, Manifold bd mtg	381-0379-00
X	X	1	Circuit board, Manifold	670-4754-00
X	X	1	414 Operators Manual ¹	070-2041-00

¹The 414 Operators Manual is not part of the 016-0394-00 Adapter Kit, but is included with shipment of the 401 Option 1 or 2 Digital Readout Module.

INSTALLATION INSTRUCTIONS

NOTE

If your monitor has been adapted for use with a 400 Recorder, it is necessary to perform only the following steps:

414—A1 through A5, A7, A13, B8 (connect violet connector to Manifold board as shown in Figure 1-12), B10 through B17.

414 Option 21—A1 through A5, A7, A13, C6, C7, C12 through C14, C15 (connect violet connector to Manifold board as shown in Figure 1-14), C17, C18.

A. MONITOR PREPARATION

1. Disconnect monitor from ac-power source.
2. Remove top cover. Remove two screws on each side. Lift up left side of cover, make sure it has cleared the ECG LEAD CHECK terminals, and remove cover from monitor.
3. If present, remove 400 Recorder. Remove two screws on each side, which attach recorder adapter plates to monitor. Unplug red and black connectors from monitor battery pack. Unplug multi-conductor interconnecting cable from both recorder and monitor. Discard interconnecting cable.
4. If a 400 Recorder is not present, remove bottom cover. Remove two screws on each side and pull cover straight off.
5. Unplug P711 (battery cable) from monitor Main board. Dress battery cable between Main board and rear panel into monitor cavity; it will be connected in a later step.
6. Install white-violet wire (with violet connector) on Main board. See Figure 1-6.
7. Install white-brown wire (with brown connector). Solder free end of wire to junction of R712, R718, and C713. See Figure 1-6. Dress connector end of wire between Main board and rear panel into monitor cavity.
8. Bend down pins of P605, P692, P693, and P702 and install Manifold mounting bar as shown in Figure 1-7.

NOTE

Refer to Maintenance section of Monitor Service Manual for board removal and installation procedures.

9. Remove ECG board.

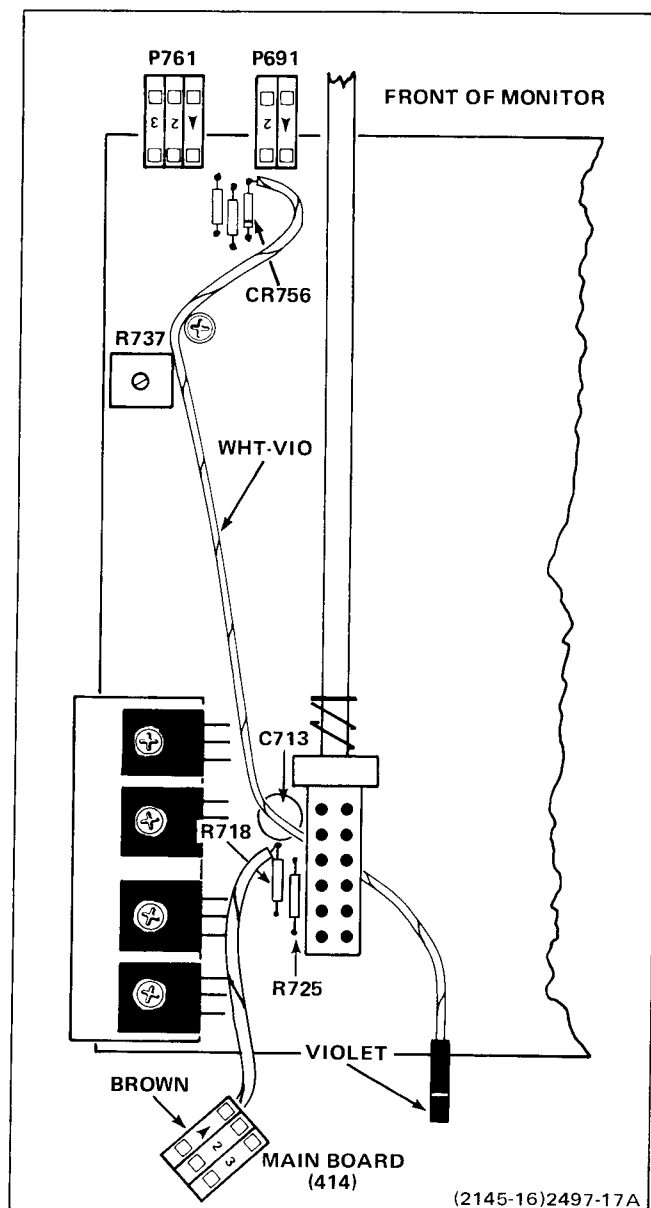


Figure 1-6. Adding wires to 414 Main board.

10. Install white-yellow wire (with yellow connector) on ECG board as shown in Figure 1-8.
11. Remove Readout Conditioner board.
12. Install 5-wire cable (with orange connector) to Readout Conditioner board as shown in Figure 1-9.
13. Some monitors have a press-mounted grounding stud and nut located on inside of rear panel directly behind upper rear corner of Readout Conditioner board.

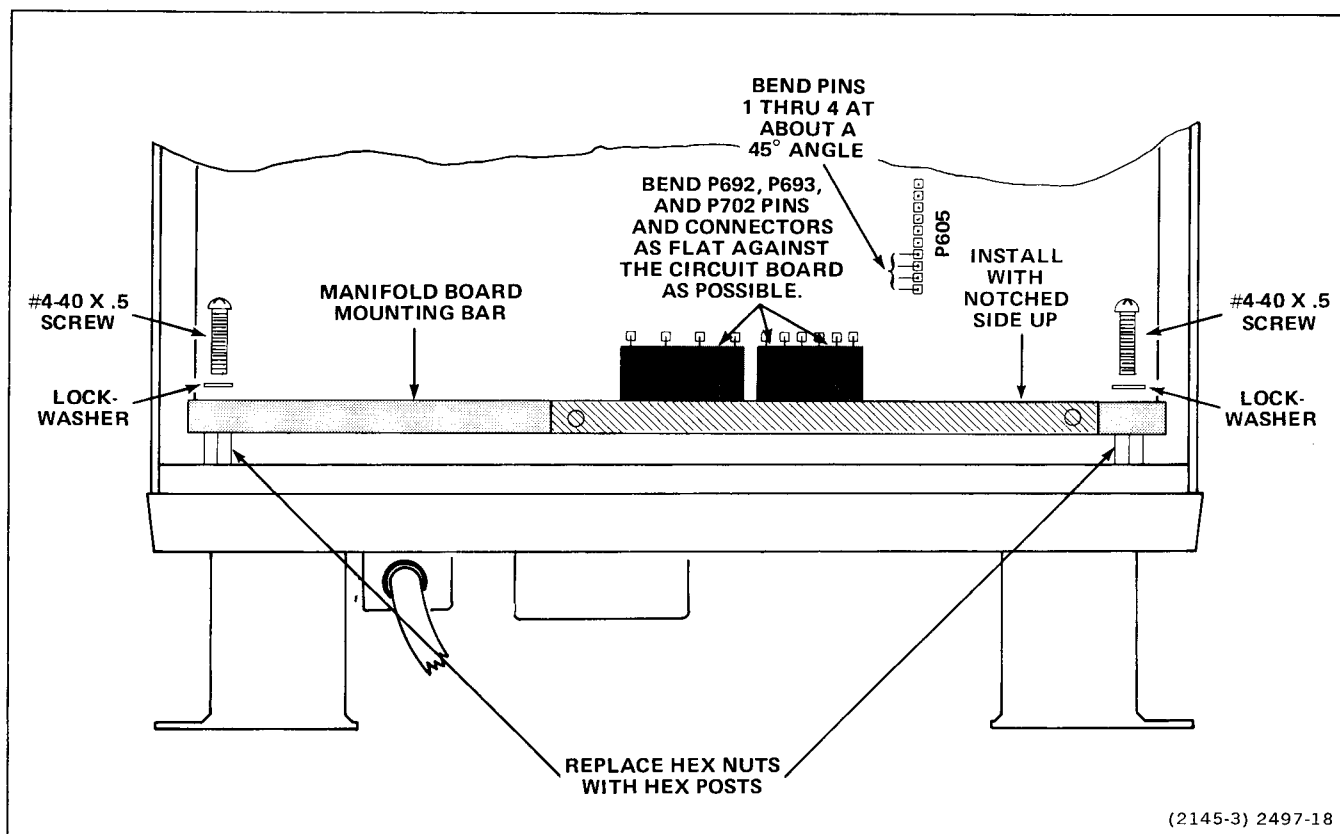


Figure 1-7. Installing Manifold board mounting bar.

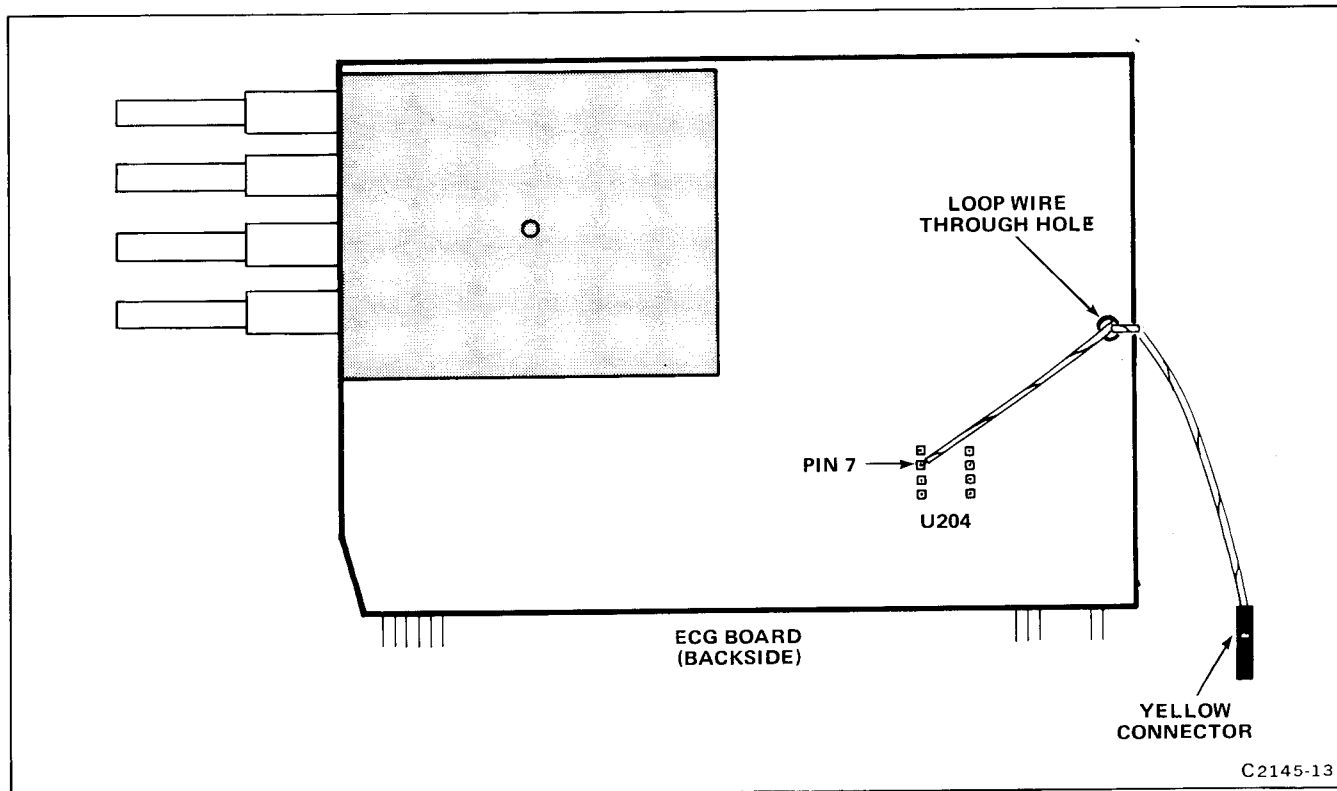


Figure 1-8. Adding wire to 414 ECG board.

If there is no such stud on your monitor, drill a 5/32 inch hole in upper left corner (viewing from rear) of rear panel as shown in Figure 1-10. Be careful not to drill into internal cables. Install 6-32 X 0.5 inch screw through hole from outside of rear panel. Secure screw with #6 nut.

NOTE

The following instructions are divided by monitor type. To complete the installation of the Adapter Kit, select one of the following sections; B-414; C-414 Option 21 (MOD FA) Monitor.

B. 414 MONITOR

1. Remove Pressure/Pulse board.
2. Install 2-wire cable (with brown connector) on Pressure/Pulse board as shown in Figure 1-11.
3. Install ECG board. Dress white-yellow wire down inside of rear panel and between rear frame casting and added Manifold mounting bar.
4. Install Readout Conditioner board. Dress added 5-wire cable down inside of rear panel between rear frame casting and added Manifold board mounting bar.

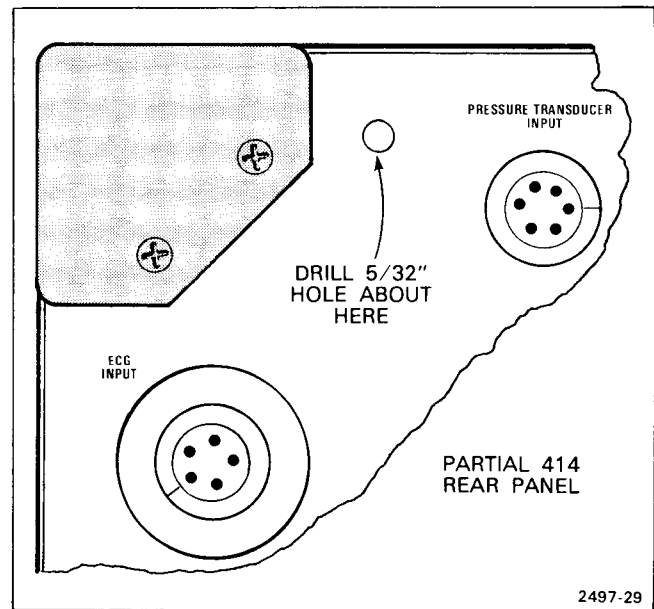


Figure 1-10. Drilling hole in rear panel for grounding screw.

5. Install Pressure/Pulse board. Dress added cable down inside rear panel between rear frame casting and added Manifold board mounting bar.

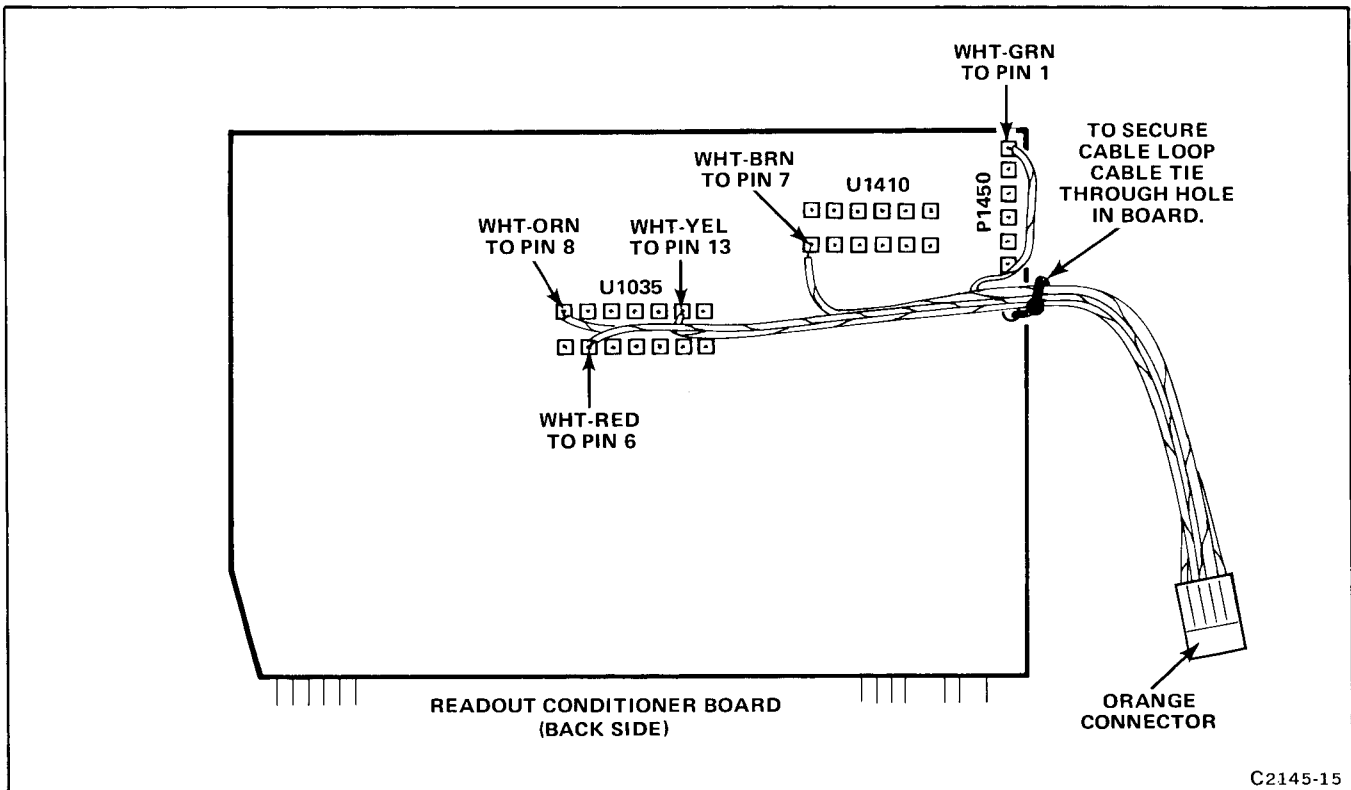


Figure 1-9. Adding 5-wire cable to 414 Readout Conditioner board.

General Information—401

6. Plug 7-wire cable (with blue connectors) onto Readout Conditioner board pins marked P1075. Dress this cable down inside of rear panel and between rear frame casting and Manifold board mounting bar.

7. Install white-red wire (with 8-conductor red connector) to anode of CR687 as shown in Figure 1-12.

8. Install white-violet wire (with violet connector on one end and gray connector on other end). Plug violet connector on pin 2 of P803 (+7 V point near SWEEP SPEED pushbutton on Main board).

9. Connect 4-wire cable (with green connector) to P605, install Manifold board and connect remaining cables. See Figure 1-13.

10. Connect 4-wire cable (with black connector on each end) to P711 (battery connector Main board). Dress free end of this cable between Main board and Manifold mounting bar into monitor cavity.

11. Remove four screws holding phone-jack mounting plate to monitor rear panel. Discard screws.

12. Pull phone-jack mounting plate away from rear panel.

13. Mark phone jacks to avoid confusion when replacing. Remove phone jacks from mounting plate. Retain hardware.

14. Insert phone jacks through spacer plate (from kit).

15. Place pre-formed fishpaper shield and spacer plate on mounting plate. Open side of fishpaper shield should be up.

16. With shield and spacer in place, install phone jacks on mounting plate using previously removed hardware. Be sure wired end of phone jacks is covered and phone jacks are in correct order. Mounting plate will be added to rear panel in a later step.

17. Wires and cables in vicinity of ECG input shield and cables should be tied together with a plastic cable tie and dressed away from ECG input shield and cable.

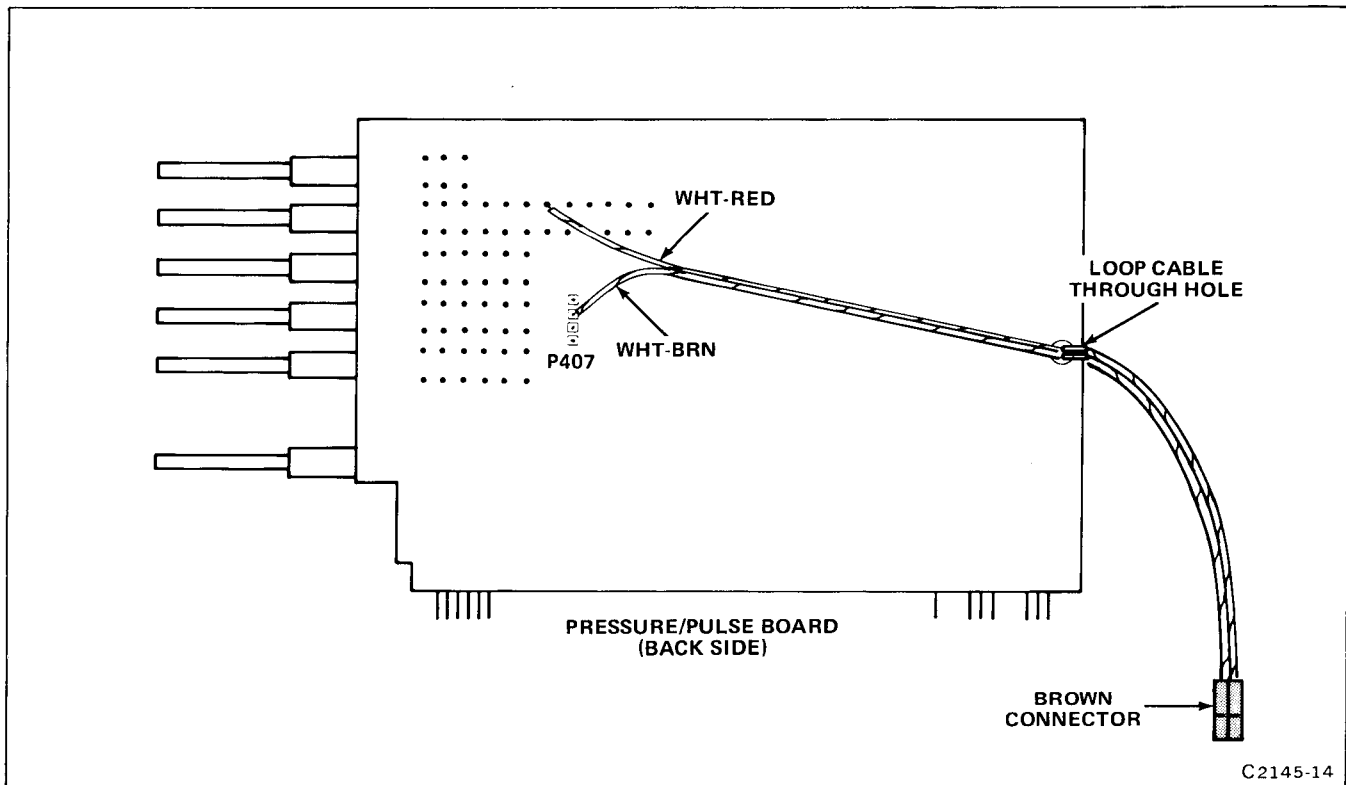


Figure 1-11. Adding 2-wire cable to 414 Pressure/Pulse board.

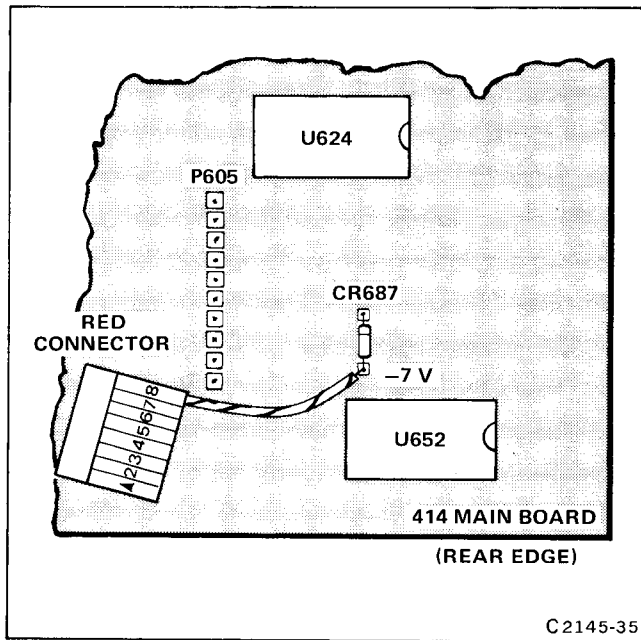


Figure 1-12. Adding wire to -7V on Standard 414 Main board.

NOTE

For remaining instructions, refer to Section D for 401/monitor combination or Section E for 401/monitor/recorder combination.

C. 414 OPTION 21 (MOD FA) MONITOR

1. For 414 Option 21 (Mod FA) Monitors Serial Numbers B010100-B041281: Add a short length of insulated wire (from kit) to back side of Dual-Pressure board between pin 1 of P3006 and pin 8 of U3090, see Figure 1-14. Note that wire can be added without removing Dual-Pressure board.

2. Plug 7-conductor cable (with blue connector) onto Readout Conditioner board pins marked P1075. Dress this cable down inside of rear panel and between rear frame casting and Manifold board mounting bar. Be sure to match triangle on plug with one on board.

3. Install Readout Conditioner board. Dress added 5-conductor cable down inside rear panel and between rear frame casting and added Manifold board mounting bar.

4. Install ECG board. Dress white-yellow wire down inside of rear panel and between rear frame casting and added Manifold board mounting bar.

5. Unplug P3006 (may be P3090 in some earlier monitors) from Dual-Pressure board.

6. Remove four screws holding mounting plate with three phone jacks to rear panel. Discard screws.

7. Pull phone-jack mounting plate out away from rear panel.

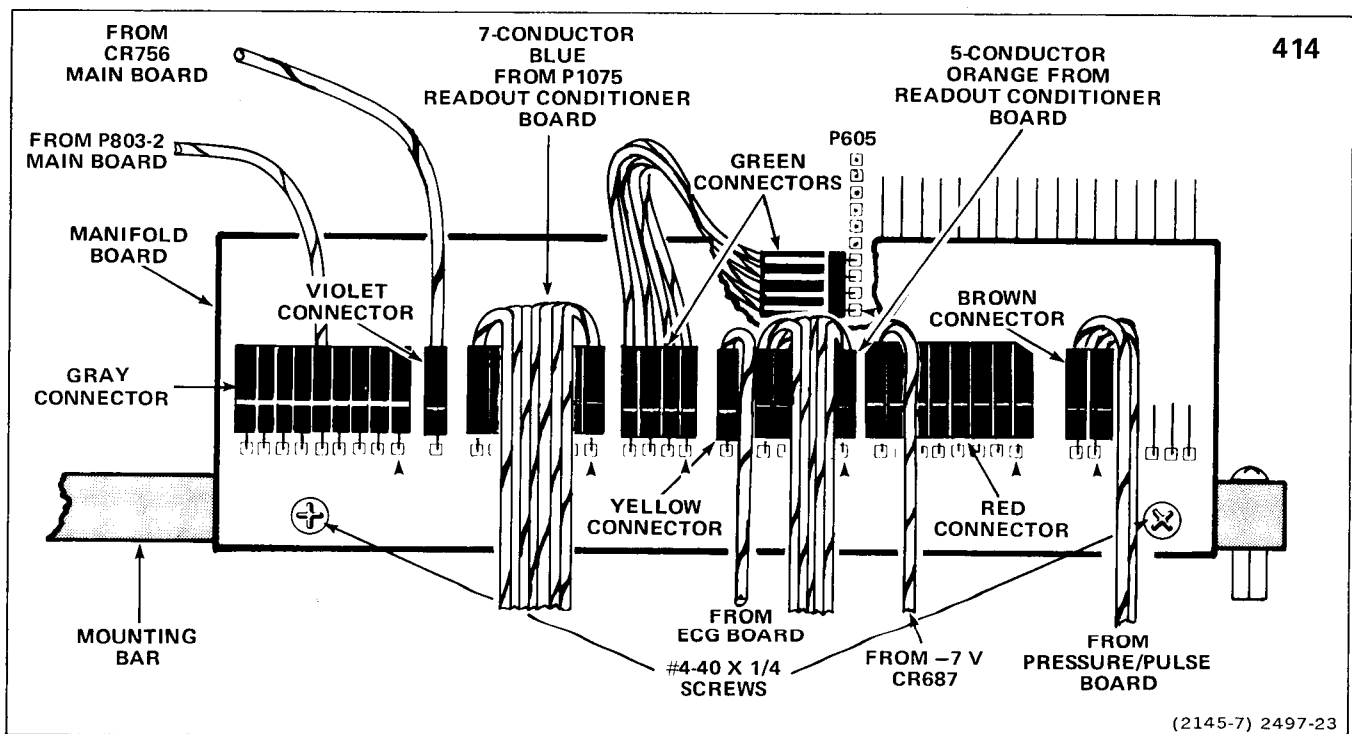


Figure 1-13. Installing Manifold board and connecting cables in Standard 414 Monitor.

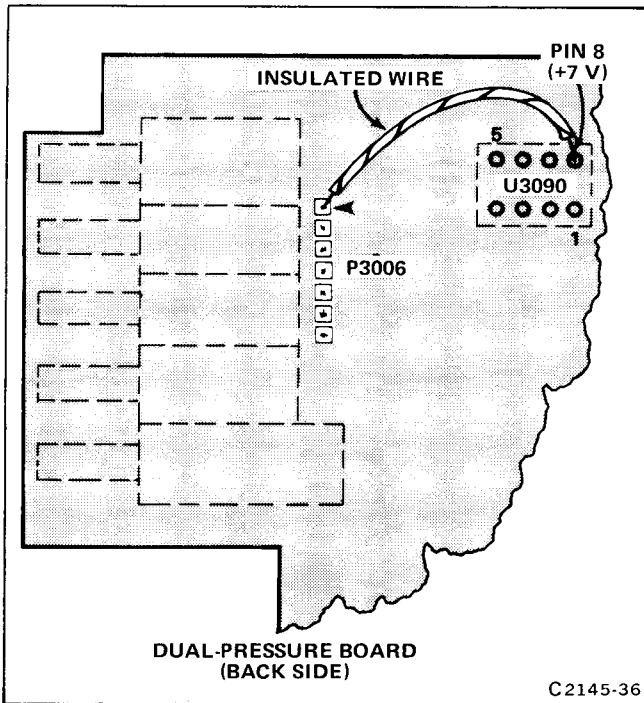


Figure 1-14. Adding wire to 414 Option 21 (MOD FA) Dual-Pressure Board.

8. Pull two P3005 cable wires through opening between phone jack mounting plate and rear panel. These two wires will be replaced in a later step.

9. Install 8-conductor cable (with red connector) from kit. Plug end of cable, which does not have extra wires attached, to P3006 on Dual-Pressure board. Be sure to match triangle on plug with one on board. Dress cable horizontally to rear panel, down inside of rear panel and between rear frame casting and added Manifold mounting bar.

10. Dress white-blue and white-yellow wires, connected to free end (P2414 end) of cable, to PRESSURE OUTPUT phone jack. (J3025).

11. Unsolder and replace respectively white-brown and white-red wires on PRESSURE OUTPUT jack with white-yellow and white-blue wires. (P2412-4 connects via white-yellow wire to tip contact and P2412-6 connects via white-blue wire to ring contact.) Discard 2-wire cable with white-brown and white-red wires.

12. Mark phone jacks to avoid confusion when replacing. Remove phone jacks from mounting plate. Retain hardware.

13. Place preformed fishpaper shield and spacer plate on mounting plate. Open side of fishpaper should be up.

14. With shield and spacer in place, install phone jacks on mounting plate using previously removed hardware. Be sure wired end of phone jacks is covered. Make sure phone jacks are in correct order. Mounting plate will be added to rear panel in a later step.

15. Install white-violet wire (with violet connector on one end and gray connector on the other end). Plug violet connector on pin 2 of P803 (+7 V point near SWEEP SPEED pushbutton on Main board).

16. Connect 2-wire cable (with green connector) to P605, install Manifold board and connect remaining cables. See Figure 1-15.

17. Connect 4-wire cable (with black connector on each end) to P711 (battery connector Main board). Dress free end of this cable between Main board and Manifold mounting bar into monitor cavity.

18. Wires and cables in vicinity of ECG input shield and cables should be tied together with a plastic cable tie and dressed away from ECG input shield and cable.

NOTE

For remaining instructions refer to Section D for 401/monitor combination or to Section E for 401/monitor/recorder combination.

D. 401/MONITOR COMBINATION

1. Locate the 19-inch interconnecting cable (with two connectors, from kit)

2. Fold cable as shown in drawing on bottom of 401 chassis. Be sure red stripe is in proper location.

3. Dress interconnecting cable between monitor Main board and Manifold board mounting bar. Dress cable horizontally to rear panel in area behind phone jacks and transformer.

4. While retaining folds nearest Manifold board, loosen screws holding Manifold board to mounting bar enough to slide interconnecting cable under Manifold board. Plug connector to Manifold board, P2400. Be sure red stripe is in proper location. Tighten screws holding Manifold board to mounting bar.

5. Carefully dress wires on phone jacks into monitor rear panel opening. Attach phone jack mounting plate to rear panel using four 4-40 X 0.5 inch screws and four #4 lockwashers.

6. Attach 401 to monitor as follows:

a. Place 401 Digital Readout Module near monitor and connect solder lug (at end of green-yellow wire, from 401) to rear-panel grounding stud or screw.

If monitor has press-mounted stud, use nut supplied on stud. If a screw and nut were added to the rear panel in a previous step, secure solder lug to screw with an additional #6 nut from kit. (This places solder lug between two #6 nuts.)

b. With interconnecting cable folded as shown in Figure 1-15, connect to P4010 on 401 Main board. Note correct location of red stripe.

c. Connect 3-wire cable (with brown connector) to P4060. See Figure 1-15. Be sure to match triangle on connector with one on board.

d. Connect 4-wire cable (with black connector, from P1982 on monitor) to P4050. See Figure 1-15. Be sure pin 1 on the connector (white-brown wire) mates with pin 1 of P4050 (indicated by triangle).

e. Connect 4-wire cable (with black connector from monitor battery pack) to P4040. See Figure 1-15. Be sure pin 1 on the connector (white-brown wire) mates with pin 1 of P4040 (indicated by triangle).

f. Gently slide bracket on bottom front edge of 401 onto edge of monitor front casting to engage front latch.

g. Lower back of 401 to align rear fastener with rear latch and turn slotted fastener, located at rear of 401 chassis, 90 degrees clockwise.

h. Install bottom cover on monitor. Secure with two screws on each side.

i. Install top cover supplied with 401. Place right side of top cover over ECG LEAD CHECK terminals then spring left side out and slip it over left side of 401 and monitor. Install two screws on each side of cover.

j. Turn on monitor and 401, and check for proper operation. Refer to Operating Information section.

k. Check monitor and 401 digital display calibration. Refer to Calibration section.

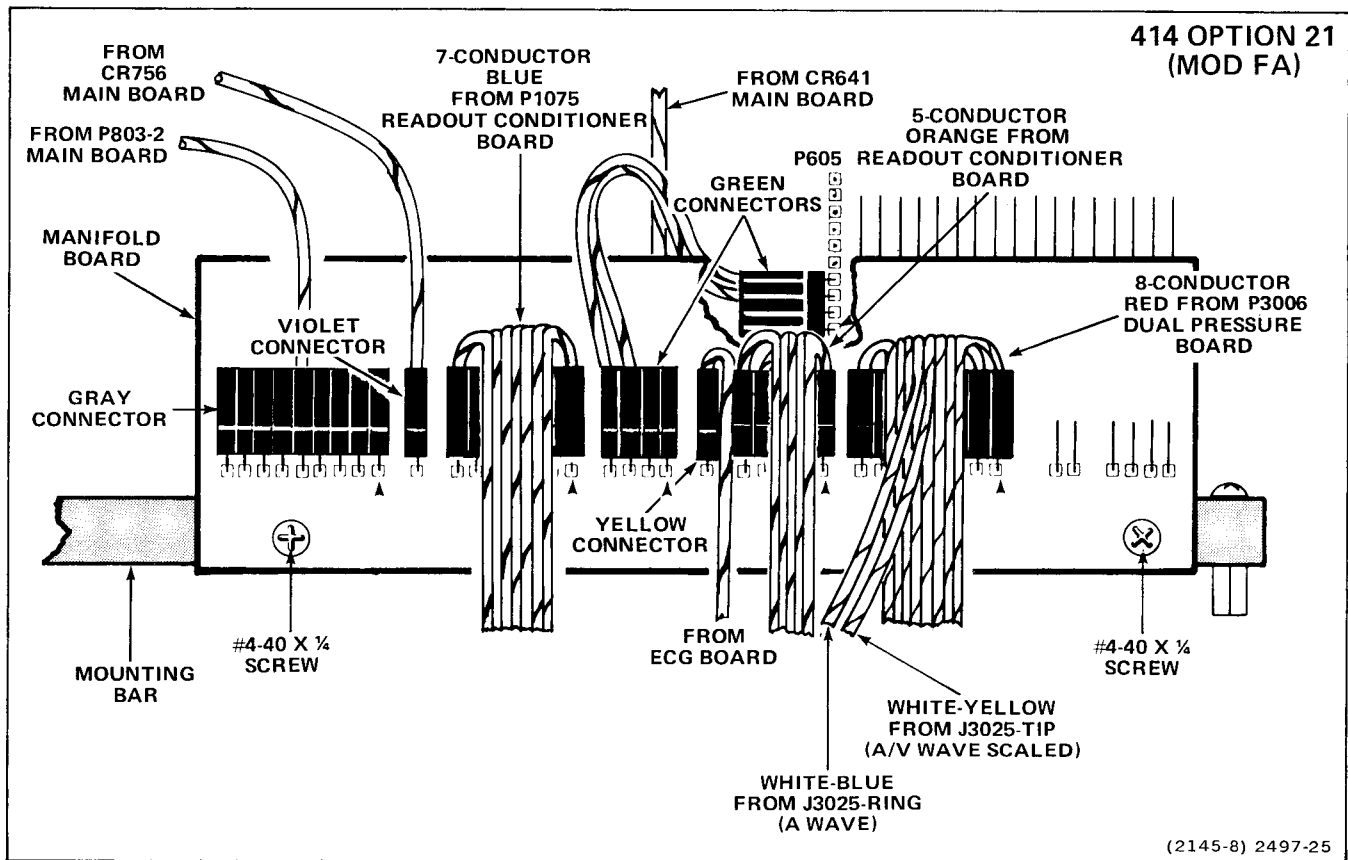


Figure 1-15. Installing Manifold board and connecting cables in 414 Option 21 (MOD FA) Monitor.

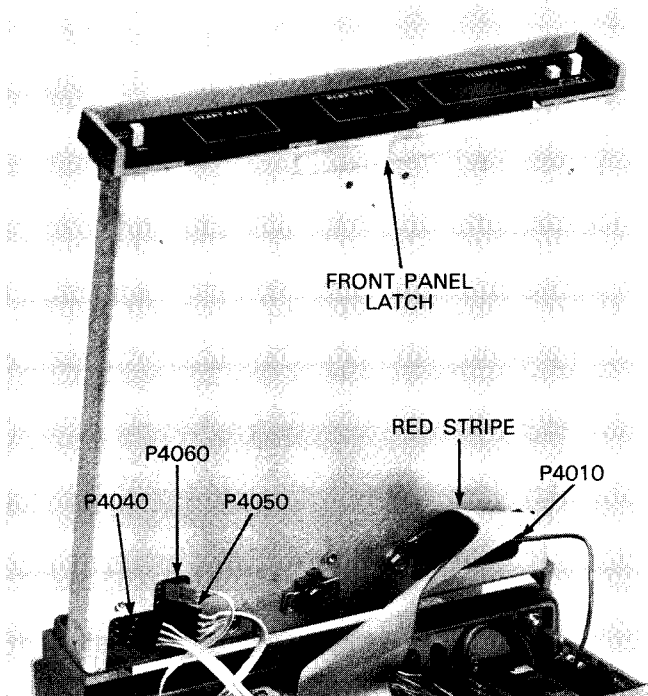


Figure 1-16. Attaching 401 to monitor.

E. 401/MONITOR/RECORDER COMBINATION

1. Locate 31 1/2 inch interconnecting cable (with 3 connectors, from kit).
2. Fold 12 1/2 inch section of interconnecting cable as shown in drawing on top of recorder chassis. Make sure connectors and red stripe are in proper position.
3. Fold 19 inch section of cable as shown in drawing on bottom of 401 chassis.
4. Dress interconnecting cable between monitor Main board and Manifold board mounting bar. Dress cable horizontally to rear panel in area behind phone jacks and transformer.
5. While retaining folds nearest Manifold board, loosen screws holding Manifold board to mounting bar enough to slide interconnecting cable under Manifold board. Plug connector to Manifold board P2400. Be sure red stripe is in proper location. Tighten screws holding Manifold board to mounting bar.
6. Carefully dress wires on phone jacks into monitor rear panel opening. Attach phone-jack mounting plate to rear panel using four 4-40 X 0.5 inch screws and four #4 lockwashers.

7. Reinstall recorder as follows:

- a. Route recorder power cable (red and black connectors) between monitor Main board and rear panel, in corner nearest power transistors, so that power cable plug can be pulled into vicinity of monitor battery pack.
- b. Plug recorder end of interconnecting cable onto P2200 of recorder.
- c. Carefully fit recorder to monitor. Dress interconnecting cable to lie flat on Main board and pull recorder power cable into monitor cavity.
- d. Connect recorder power cable to mating connector on side of battery pack.
- e. Replace four screws which attach recorder adapter plates to monitor.

9. Attach 401 to monitor/recorder unit as follows:

- a. Place 401 Digital Readout Module near monitor/recorder unit and connect solder lug (at end of green-yellow wire, from 401) to rear-panel grounding stud or screw.

If monitor has press-mounted stud, use nut supplied on stud. If a screw and nut were added to the rear panel in a previous step, secure solder lug to screw with an additional #6 nut from kit. (This places solder lug between two #6 nuts.)

- b. With interconnecting cable folded as shown in Figure 1-16. Connect to P4010 on 401 Main board. Note correct location of red stripe.
- c. Connect 3-wire cable (with brown connector) to P4060. See Figure 1-16. Be sure to match triangle on connector with one on board.
- d. Connect 4-wire cable (with black connector, from P1982 on monitor) to P4050. See Figure 1-16. Be sure pin 1 on the connector (white-brown wire) mates with pin 1 of P4050 (indicated by triangle).
- e. Connect 4-wire cable (with black connector from monitor battery pack) to P4040. See Figure 1-16. Be sure pin 1 on the connector (white-brown wire) mates with pin 1 of P4040 (indicated by triangle).
- f. Gently slide bracket on bottom front edge of 401 onto the edge of monitor front casting to engage front latch.
- g. Lower back of 401 to align rear fastener with rear latch and turn slotted fastener, at rear of 401 chassis, 90 degrees clockwise.

h. Install bottom cover on monitor. Secure with two screws on each side.

i. Install top cover supplied with 401. Place right side of cover over ECG LEAD CHECK terminals then spring left side out and slip it over left side of 401 and monitor. Install two screws on each side of cover.

j. Turn on monitor and 401, and check for proper operation. Refer to Operating Information section. Check recorder operation as deemed necessary.

k. Check monitor and 401 digital display calibration. Refer to Calibration section.

[illegible]

OPERATING INFORMATION

POWER CONSIDERATIONS

Power is supplied internally by the monitor batteries during both line and battery operation of the monitor. When the monitor is battery-powered, operating time of battery is two-thirds of normal. When the monitor is line-powered, it will take three time longer to recharge the battery. When the 401 is turned off (via front-panel ON pushbutton), battery operating times and charge rates return to normal.

READOUT CONSIDERATIONS

The monitor and 401 digital display readings may not agree when the same patient parameter is displayed on both. Normally the readings will be within 5 counts (5 beats/min., 5 breaths/min., 5 mmHg, or 0.5°C or F) of each other. However, during rapid changes in patient status, the difference might be greater than 5 counts. This is due to differences in internal-circuitry response time between the two units.

FUNCTIONS OF CONTROLS AND INDICATORS (See Fig. 2-1)

- ① **READOUT MODULE ON**—Turns Digital Readout Module on when pushed in and released. Monitor must be operating.
- ② **HEART RATE**—Displays heart rate in beats/min. Heart-rate information is supplied by monitor ECG channel (when on). When ECG channel is off, heart-rate information is supplied to each model as follows: Standard & Option 1, from pressure or pulse channel; Option 2 from pressure A channel (when on) otherwise from pressure A/V channel.
- ③ **RESP RATE (Standard 401 only)**—Displays respiration rate in breaths/min. Respiration-rate information is supplied by the monitor respiration channel. Respiration-rate readout is blanked when respiration channel is turned off.
- ④ **TEMPERATURE**—Displays temperature in°C or°F as selected by the monitor rear-panel switch. Temperature readout is blanked when temperature probes are not plugged in. Use only Yellow Springs Instrument Co. Series probes. Pushbuttons are provided on the Standard 401 that select separate readouts from either the A or B temperature probes. Readout of temperature A minus temperature B is provided when both pushbuttons are pushed in (temperature readout is blanked when both pushbuttons are out).
- ⑤ **PRESSURE (Option 1 only)**—Displays pressure in millimeters (mmHg). Pushbuttons select systolic or diastolic pressure readout. Arithmetic mean of pressure is displayed when both pushbuttons are pushed in. Pressure readout is blanked when both pushbuttons are out or when pulse function is selected.
- ⑥ **PRESSURE A/V (Option 2 only)**—Displays arterial/venous pressure in millimeters of mercury (mmHg). Pushbuttons select systolic or diastolic pressure readout. Arithmetic mean of pressure is displayed when both pushbuttons are pushed in. Pressure readout is blanked when both pushbuttons are out or when pressure transducer is not connected to A/V pressure channel input.

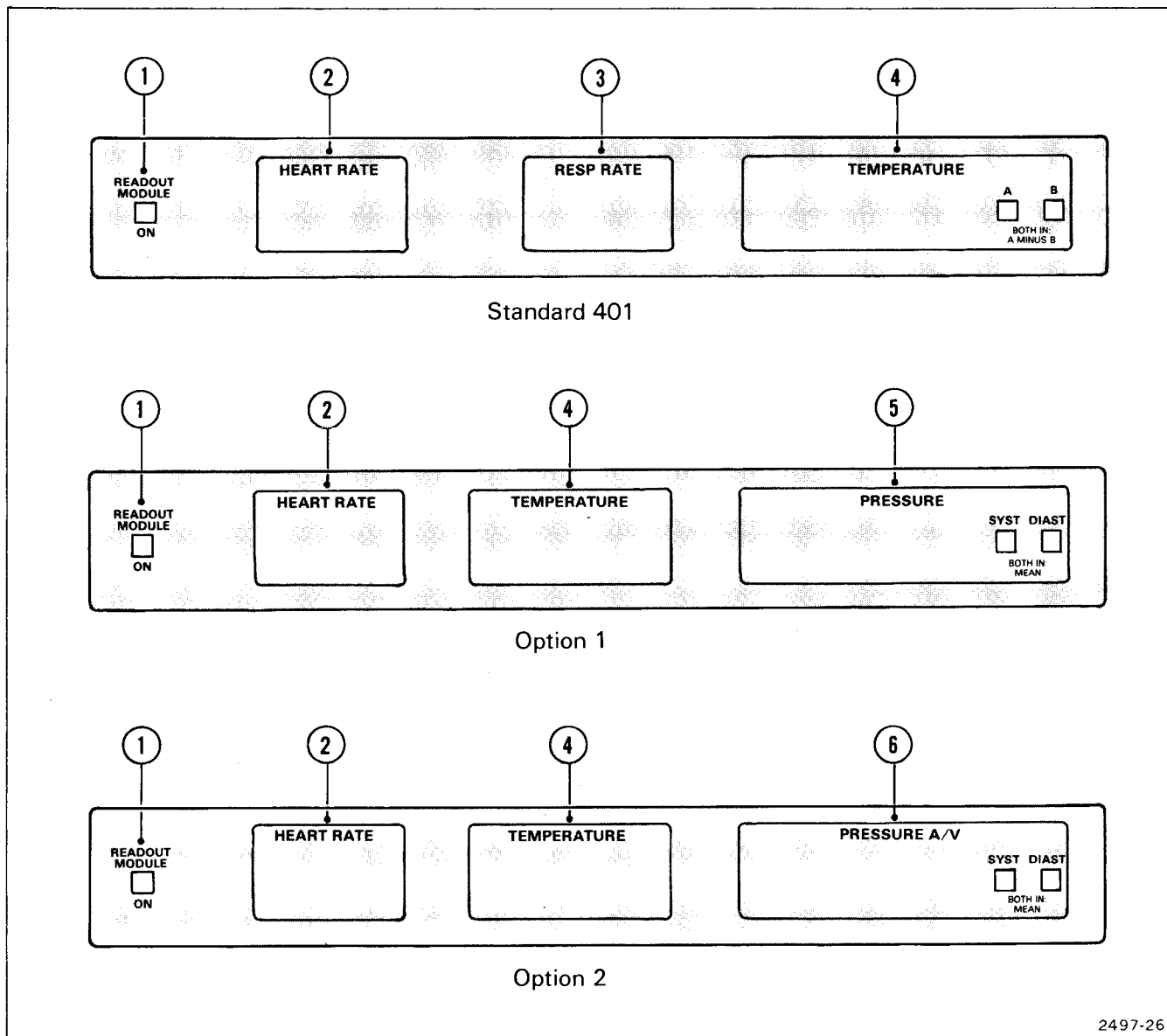


Figure 2-1. 401 front-panel controls and indicators.

THEORY OF OPERATION

This section describes the operation of the circuits in the 401 Digital Readout Module (Standard, Option 1, and 2). The circuitry is contained on eight circuit boards. The Main board is the largest and contains the power supplies, 10-hertz flash clock generator, and signal switching. The Program board and three identical Digital Voltmeter (DVM) boards are plugged onto the Main board. Three identical Display boards are plugged onto the DVM boards.

The Block Diagram in the Diagrams and Circuit Board Illustrations section at the back of this manual shows major circuits and signal flow to aid in understanding circuit relationships. Detailed schematics of each circuit are also located in the Diagrams and Circuit Board Illustrations section.

MAIN BOARD



The Main board provides the following functions:

1. Power to the DVM boards.
2. Signal switching and distribution from the Program board to the DVM boards.
3. A 10-hertz overrange flash clock signal to the DVM boards.
4. Battery charge control signals to the Monitor.

POWER SUPPLY OPERATION

The Power Supply circuit provides +165, +75, +5, -5, and -90 volts to the DVM boards, and battery charger thermal shutdown defeat signals to the Monitor. The +2.5-volt reference for the DVM circuit is also used as the Power Supply reference and starts the converter when the Digital Readout Module (DRM) and the Monitor are both turned on.

Battery power from the Monitor is always supplied to converter transistors Q4020 and Q4022 through pin 1 of P4040. However, the Monitor must be on and pushbutton S4050 must be pressed to apply +7 volts from pin 17 of P4010 to integrated circuit U4055 which provides the +2.5-volt reference that turns the DRM Power Supply on.

The converter, comprised of Q4020, Q4022, and T4020 is a non-saturating type circuit with feedback supplied to the bases of the converter transistors. The current supplied to the bases of Q4020 and Q4022 comes from Q4015 which is turned on by Q4075. Transistor Q4075 turns on when the +2.5-volt reference from pin 2 of U4055 is applied to its base.

Regulated Power Supply

The +5-volt regulated output is applied to the DVM boards through pin 13 of P4070, P4080, and P4090.

A sample of the +5-volt output is picked off at the divider network comprised of R4060, R4061 and R4062 and compared with the 2.5-volt reference from U4055. If the voltage at the wiper of variable resistor R4061 goes up, the current through Q4075 decreases and causes less current to flow in converter transistors Q4020 and Q4022 through Q4015. Thus, the converter output decreases to +5 volts. The reverse is true if the voltage at the wiper of variable resistor R4061 goes down.

The -5-volt regulated output is supplied by U4040 which is powered from the -5-volt winding of T4020 through a voltage doubler circuit comprised of C4041, C4044, CR4044 and CR4045.

Unregulated Power Supply

The -90-, +75-, and +165-volt outputs are not directly regulated but are controlled by the +5 volt regulation and the turns ratio of T4020. The +165-volt output is produced by voltage doubler circuit CR4028, CR4029, C4028, and C4029. The -90- and +75-volt outputs are produced by half-wave rectifiers CR4025 and CR4031 respectively. Resistor R4031 allows the +75-volt supply to "sink" as well as "source" current. Resistors R4025 and R4029 are bleeders to prevent shock to service personnel after instrument power is removed.

Battery Charger Thermal Shutdown Defeat (Standard 401 Only)

When the DRM is turned on, Q4055 saturates due to the +7 volts applied to the base of Q4055 through S4050 which brings the level at pin 2 of P4060 to near zero. This serves to defeat the thermal shutdown circuit in the 413 Monitor so there will always be enough charge current to charge the batteries and operate the DRM even if the Monitor or batteries are hot enough to actuate the thermal shutdown switch.

10-HERTZ FLASH-CLOCK OPERATION

The 10-Hertz Flash Clock is comprised of programmable unijunction transistor Q4071 (PUT) and associated circuitry.

The 10-Hertz Flash Clock circuit functions as a relaxation oscillator that operates at approximately 10 hertz. Gate biasing is provided at +5 volts by R4073 while R4070, R4071, and C4070 provide the proper time constants. With C4070 initially discharged and Q4071 gated off, the anode firing voltage slowly rises until the firing potential (approximately +5.6 volts) is reached. Then Q4071 turns on for a time determined by C4070 and R4071 and the gate voltage drops to near zero. A short duration, 5-volt negative-going pulse is generated at the gate of Q4071 and is fed to pin 6 of P4070, P4080 and P4090.

PROGRAM BOARD

The Program board processes and routes the input signals from the Monitor to the Main and DVM boards.

PROGRAM BOARD OPERATION

Standard Program Board

The Standard Program board for the 413 Monitor divides the respiration and heart rate signals (pin 16 and pin 19 of J4020) by 10 through the combination of R4130 and R4132 on the Program board and R4316 (pin 3 of P4080 and P4090) on the corresponding DVM board. Thus, a 1-volt respiration or heart rate signal from the Monitor corresponds -5 volts which are not used.

Option 1 Program Board

The Option 1 Program board for the 414 Monitor divides the systolic, diastolic, mean, and heart rate signals (pins 8, 9, 10, and 19 of J4020) by 10 through the combination of R4110, R4112, R4114, and R4125 on the Program board and R4316 (pin 3 of P4070 and P4090) on the corresponding DVM board.

Pressure readout blanking is also provided by the Option 1 Program board. When the Pulse mode is selected on the Monitor, a negative signal (PULSE) appears at pin 11 of J4020 which turns off Q4123. The collector of Q4123 then goes HI and blanks the PRESSURE readout on the DRM.

Option 2 Program Board

The Option 2 Program board for the 414 Option 21 Monitor contains a Systolic/Diastolic Converter followed by a two-pole filter. This sampling and filter system determines the peak and valley values of the pressure waveform and converts these pressure levels to a voltage that can be used by the DVM circuitry in the DRM to provide the A/V PRESSURE readout.

Integrated circuits U4170A and D are trigger circuits that determine when to take a sample. Switches U4161A and C are the sample and hold switches and C4066 and C4193 are the final storage capacitors that provide signal to the filter. When the incoming pressure signal (from pin 7 of U4145B) is rising, pin 10 of U4170C rises. The rise at pin 10 causes pin 8 to rise until CR4173 conducts and

charges C4177 to the value of the rising signal. During this period of rising input signal, since pin 5 of U4170B is HI, pin 7 goes HI and switch U4161C closes. Thus, the rising signal at pin 5 of voltage follower U4160B charges C4161 to the input level.

As long as the input pressure signal is rising, pin 1 of U4170A is LO, pin 14 of U4170D is LO and switches U4161A and B are open. At the peak of the rise (systolic), C4161 is now charged to that peak level (a sample is taken).

Now, when the pressure signal starts to fall, pin 8 of U4170C goes LO because pin 9 is held at the highest level by C4171 while pin 10 falls. Diode CR4173 turns off, pin 7 of U4170B goes LO which opens switches U4161C and D. The sample is now stored in C4161. Since there is no R associated with C4161 (except leakage current in U4160C), C4161 holds the highest value of the pressure signal.

As the pressure falls, pin 3 of U4170A falls, pin 1 of U4170A falls, CR4183 turns on, and C4181 charges toward the pressure signal level. As pin 1 of U4170A falls, pin 14 of U4170D goes HI which closes switches U4161A and B. Capacitor C4191 now charges toward the pressure input signal level via U4160A. At the same time, since U4161B is now closed, the voltage on C4161 is transferred to C4163 and the systolic sample is fed to the two-pole filter U4180A and associated circuitry. Since U4161D is open, the diastolic sample is not connected to the two-pole filter, U4180B, and associated circuitry. When the input pressure signal reaches the lowest value, C4191 is charged to that value.

As the input pressure now starts to rise, pin 1 of U4170A goes HI because pin 2 is held at the lower level by C4181 while pin 3 rises. Diode CR4183 turns off, pin 8 of U4170D goes LO, switch U4161A and B open, and the diastolic sample is now the voltage on C4191.

At the start of the input pressure rise, pin 8 of U4170C again goes HI, pin 7 of U4170B goes HI, switch U4161D closes, the voltage on C4191 is transferred to C4193, and the diastolic sample is fed to the two-pole filter U4180B and associated circuitry. Switch U4161C again closes and a new cycle starts. The systolic and diastolic signals are fed to the DVM board input when selected by pressure selector switches S4082 and S4080. The circuit responds to each peak and valley value (systolic and diastolic), regardless of the direction of the change, while rejecting normal dicrotic notch level changes. The discharge rates of C4171 (systolic) and C4181 (diastolic) are such that the systolic and diastolic switching points are as shown in Figure 3-1.

Resistors R4171 and R4181 ensure that whenever there is no pulsatile pressure (systolic minus diastolic = 0), all output levels decay to the static incoming pressure.

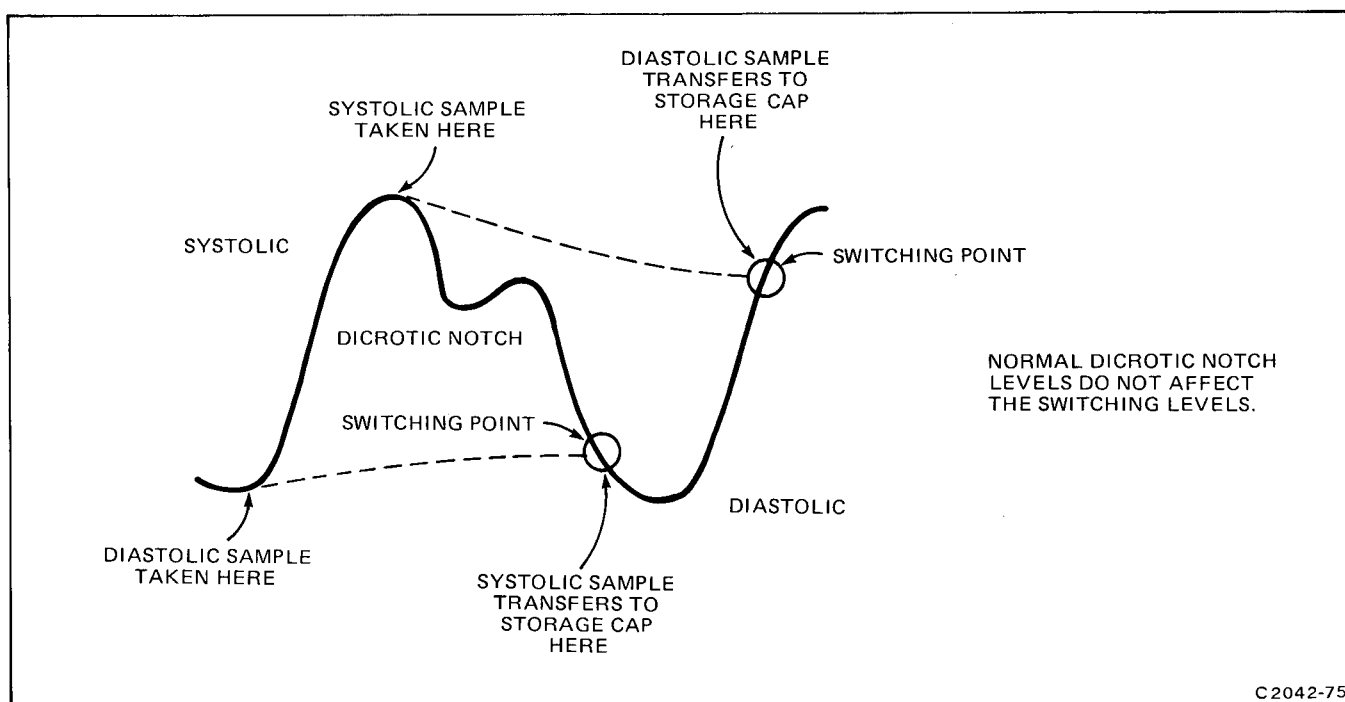


Figure 3-1. Systolic/diastolic switching points.

Integrated circuits U4145B, U4145D and U4145A and associated circuitry compose a Mean Pressure Filter and Negative Pressure Limiter.

The four-pole filter is designed to provide an accurate mean value of the pressure signal while holding ripple to about 1 mmHg. The operational amplifiers provide impedance matching: U4145B presents a high-impedance load to the pressure signal limiter circuit, and low impedance out to the first pole of the filter. Since the impedance of the second pole is too high to drive the third pole, U4145D provides the impedance interface. Integrated circuit U4145A provides the low impedance to drive the readout selector input, pin 3 of U4311.

All of the filters in the pressure converter circuits use polarized tantalum capacitors (ground reference). The Negative Pressure Limiter circuit comprised of CR4140, CR4143, R4140 and R4143 prevents excessive reverse voltage on these capacitors.

The Pressure Overrange Detector consists of U4200A and B, U4145C and associated circuitry. The detector is a pair of comparators that compare the incoming pressure signal to fixed voltages set by divider network R4206, R4207 and R4208. The arterial/venous pressure signal from pin 14 of J4020 is direct pressure and is not attenuated. The comparison level is such that an overrange signal is produced for 2 to 3 seconds if the display (even a spike) goes off the monitor screen. Integrated circuit U4145C serves as a comparator for timing circuit R4210 and C4210.

Since the filtered pressure signals are average signals, even an off-screen spike might change the average significantly. If the Overrange Detector produces an overrange signal (HI) to pin 8 of U4145C, and, if pressure A/V has been selected on the DRM, a HI appears at pin 5 of P4070 which enables the overrange blanking function on the DVM board. The systolic, diastolic and mean pressure outputs from the filters, along with the skip and overrange signals, are fed to pressure selector switches S4082 and S4080. The selected switch outputs are fed to the appropriate DVM board.

DIGITAL VOLTMETER (DVM) AND DISPLAY BOARDS ②

The DVM and Display boards provide the following functions:

NOTE

Each DVM and Display board is identical for each readout function.

1. Analog input levels from the Main board converted to digital signals for display on the gas-discharge readout.
2. Digital display blanking to prevent displays during certain intervals.
3. Sign and decimal point drive.
4. Leading zero suppression.

DVM AND DISPLAY CIRCUIT OPERATION

The basic DVM (digital voltmeter) circuit is comprised of U4400, U4311 and associated circuitry. Integrated circuit U4311 is a dual-ramp A/D Converter that contains digital logic circuitry that integrates, counts, and multiplexes and also analog circuitry that provides operational amplifiers and comparators. Integrated circuit U4400 is a Decoder-Driver that converts the binary-coded-decimal (BCD) information from A/D Converter U4311, to the form necessary to drive the cathode segments of the gas-discharge display. The remaining circuits provide overrange-flash blanking inter-digit blanking, leading-zero suppression, and display drive operation.

A/D Converter

Integrated circuit U4311 is basically an A/D ratiometric converter that measures an unknown input voltage (V_x) at pin 3 as a ratio of the reference voltage (V_{ref}) at pin 2. The full scale voltage is equal to the reference voltage (V_{ref}) applied to pin 2. Thus, a full scale voltage of 1.999 volts requires a reference voltage of 2.000 volts.

During each conversion cycle, the offset voltages of the internal amplifiers and comparators are compensated for by the system's autozero operation. The conversion cycle requires slightly more than 16000 clock periods that can be divided into six segments. The conversion cycle waveform at pin 6 is shown in Fig. 3-2. The six segments of this waveform are described as follows:

Segment 1. The offset capacitor C4324 (C_o), which compensates for the input offset voltages of the buffer and integrator amplifiers, is charged during this period. Also, the integrator capacitor is shorted. This segment requires 4000 clock periods.

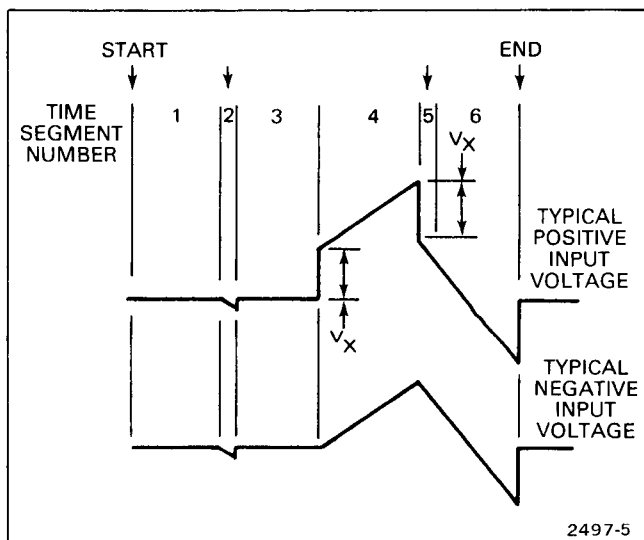


Figure 3-2. Integrator waveform at pin 6 of U4311.

Segment 2. The integrator output decreases to the comparator threshold voltage. At this time a number of counts equivalent to the input offset voltage of the comparator is stored in the offset latches for later use in the autozero process. The time for this segment is variable, and less than 800 clock periods.

Segment 3. This segment of the conversion cycle is the same as Segment 1.

Segment 4. Segment 4 is an up-going ramp cycle with the unknown input voltage (V_x) at pin 3 as the input to the integrator. Figure 3-3 shows the equivalent configuration of the analog section of U4311. The actual configuration of the analog section is dependent upon the polarity of the input voltage during the previous conversion cycle.

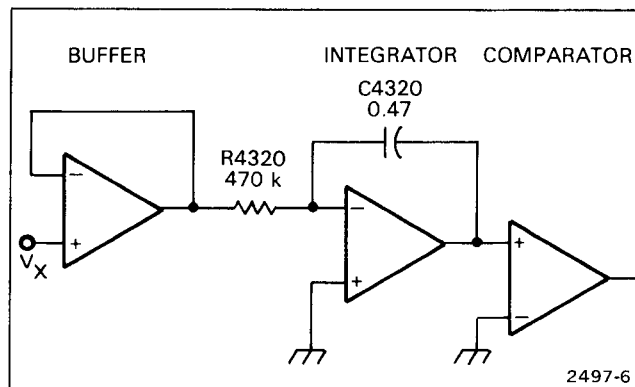


Figure 3-3. Equivalent circuit diagram of the analog section of U4311 during Segment 4.

Segment 5. This segment is a down-going ramp period with the reference voltage as the input to the integrator. Segment 5 of the conversion cycle has a time equal to the number of counts stored in the offset storage latches during Segment 2. As a result, the system zeros automatically.

Segment 6. This is an extension of Segment 5. The time period for this portion is 4000 clock periods. The results of the A/D conversion cycle are determined in this portion of the conversion cycle.

An end-of-conversion (EOC) pulse is available at pin 14 of U4311 after each conversion cycle. The EOC pulse width is equivalent to one-half the period of the system clock at pin 11 (CLK_o).

The results of each conversion cycle are stored in the output latches and are multiplexed out through the digit select outputs at pins I9, I8, I7 and I6 (i.e., DS1, DS2, DS3 and DS4 respectively). The digit select output is high when the respective digit is selected. The most

significant digit DS1 turns on immediately after an EOC pulse followed by the remaining digits, sequencing from most-significant digit (MSD) to least-significant digit (LSD). An interdigit blanking time of two clock periods is included to ensure that the binary-coded decimal (BCD) data from the Q output (pins 20, 21, 22 and 23 of U4311) has settled. The multiplex cycle rate is about 200 hertz. Relative timing between the digit select (DS) output and the EOC signals is shown in Figure 3-4.

The BCD data outputs at pins 20, 21, 22 and 23 (Q₀ through Q₃) are multiplexed on immediately after an EOC pulse occurs. Three full digits of information are available during DS2, 3 and 4, while during DS1, the 1/2 digit and polarity are available.

When pin 19 (DS1) goes HI, the code on the BCD data outputs (Q₀) through (Q₃) determines polarity and whether a 1 or nothing is displayed in the MSD location (A1) on gas-discharge readout element U4510. Refer to the following Truth Table for the formats of the information during DS1.

When pin 18 (DS2) goes HI, digit A2 is selected through Anode Drivers Q4371 and Q4374. At the same time, the BCD data outputs at pins 20 through 23 (Q₀ through Q₃) of U4311 would represent the binary-coded decimal value of the number selected to appear at digit A2. Decoder-Driver U4400 decodes the binary-coded decimal value and provides the necessary outputs to light the appropriate cathode segments of digit A2.

Anode Drivers

The display anodes AD1 through AD4 are driven from Anode Driver circuits Q4361-Q4364, Q4371-Q4374, Q4381-Q4384 and Q4391-Q4394.

TRUTH TABLE

Coded Condition of MSD	Q3 ¹	Q2 ¹	Q1	Q0
+0	1	1	1	0
-0	1	0	1	0
+1	0	1	0	0
-1	0	0	0	0

¹Q2 is the sign bit: 1 = (+), 0 = (-).

²Q3 is the (1) digit bit: 1 = (1) displayed, 0 = (1) displayed.

The Anode Drivers are driven by the DS outputs from A/D Converter U4311. The Anode Driver circuits are identical so only one is described here.

When DS1 (pin 19 of U4311) goes HI, Q4361 turns on which pulls its collector down far enough to cause Q4364 to saturate. When Q4364 saturates, the gas-discharge display anode at location A1 is at about +165 volts.

Inter-Digit Blanking

When switching from one digit to the next in the same envelope, the display is blanked briefly to allow time for deionization of the gas in the readout to prevent partially lit segments or streamers (blue glow) between digits.

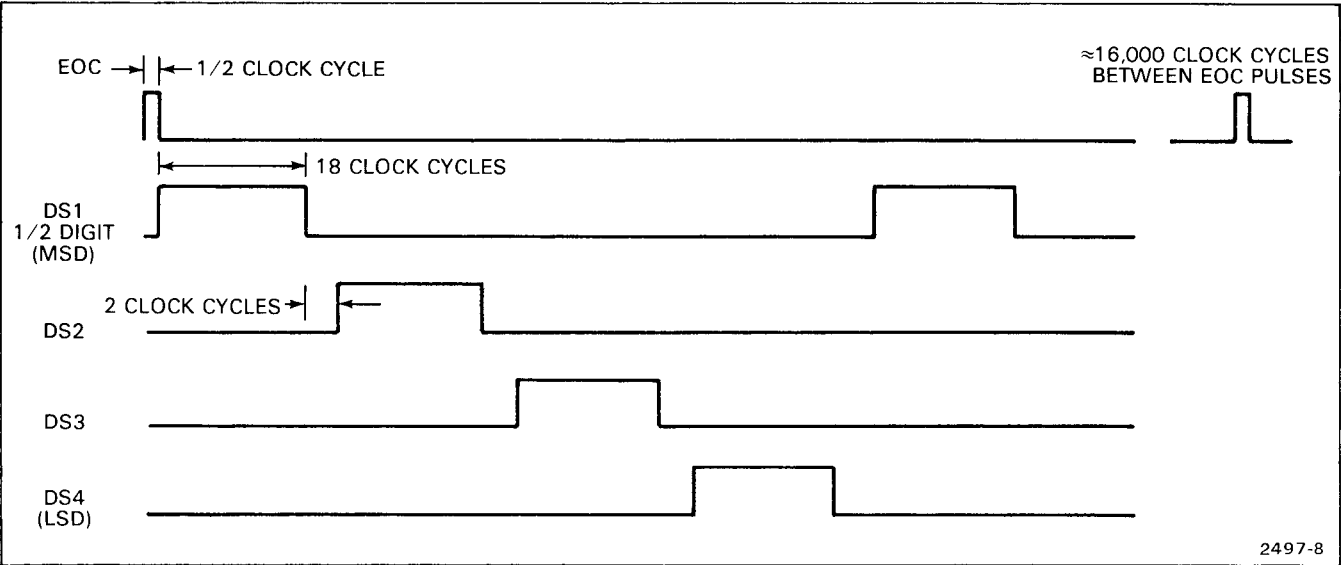


Figure 3-4. Digital select timing diagram.

Quiescently, with all the digit select lines low, U4352A and B are set by U4350B. Pin 2 and 3 of U4350A and pin 4 of U4334A are HI which holds the Anode Drivers off and blanks the display. When any of the digit select lines (DS1 through 4) goes HI, U4352A and B start counting. After 3-1/2 clock cycles, U4352A and B reset and both Q outputs (pin 1 and 15) go LO which turns on the Anode Drivers through pin 4 of U4334A. The display remains unblanked for the rest of the digit select conversion cycle. Then the digit select lines go LO and U4352A and B are again set to the quiescent condition.

Transistor Q4410 applies the inter-digit blanking signal (as well as all the other blanking signals) to the digit display cathodes through pin 4 of U4400 which aids in the suppression of streamers and undesirable segment glowing. See Decoder Driver discussion.

Overrange-Flash Blanking

The Overrange-Flash Blanking circuit is comprised of U4334C, U4338A and associated circuitry. Integrated circuit U4338A is a flip-flop that blanks the display for 100 milliseconds every 200 milliseconds when the overrange line from the monitor analog circuits (pin 5 of J4300) goes HI.

A 10-hertz negative-going pulse from 10-Hertz Flash Clock U4071 on the Main board is always present at pin 3 of U4338A. When no overrange signal is present at pin 4 (i.e. a LO at pin 5 of J4300) U4338A is held in the reset condition by U4334C. When an overrange condition occurs in the monitor, pin 5 of J4300 goes HI and the reset is removed from U4338A. Consequently, U4338A is triggered by the trailing (rising) edge of each Flash Clock pulse, and thus, switches at the 10-hertz rate. The resulting output from pin 1 of U4338A blanks and unblanks (flashes) the display (i.e. 100 milliseconds on, 100 milliseconds off) through U4350A and U4334A.

Skip Blanking

If the proper input signals are not present to the monitor or the appropriate function has not been selected on the monitor, a HI is present at pin 4 of J4300. Consequently, pin 4 of both U4350A and U4334A goes HI which blanks the display through the Anode Driver emitters.

Decoder-Driver

Decoder-Driver U4400 converts the binary-coded decimal (BCD) information from the A/D Converter to the form required to drive the cathode segments of the 7-segment gas-discharge display.

The BCD outputs (Q0 through Q3) from the A/D Converter are fed to the A, B, C and D inputs of the Decoder-Driver. When turned on by a binary-coded number at the A, B, C, and D inputs, the segment drivers pull toward ground and current is controlled to each display segment. The current outputs are set for the appropriate ratio to light the display segments evenly since some segments are larger than the others.

When the display segments are not on, the cathode segments are set at about +75 volts by resistor pack R4364A through P. Resistor R4400 at the programming input (pin 3) sets the average current for all the outputs to control the display brightness. The ripple blanking output (RBO) of U4400 is also an input for blanking signals since it is an open collector output with resistor pull-up to +5 volts. Thus, pin 4 of U4400 can be pulled LO by either internal or external logic signals to blank the display-element cathodes. Ripple blanking input and output operates in conjunction with leading zero suppression which is described in the following discussion.

Leading-Zero Suppression

Integrated circuits U4334B, U4420A, U4420B, U4338B and U4334F provide leading zero suppression. Which zeros are suppressed or blanked depends on whether there is a 1 displayed in digit location A1 (i.e. 1/2-digit position).

If a 1 is displayed in digit location A1, pin 23 (Q3) of the A/D Converter, U4311, is LO. This condition puts a LO on the data input, pin 9, and when DS1 at the clock input, pin 11, goes HI, pin 13 of U4338B is LO which puts a HI on the ripple blanking input, pin 5, of Decoder Driver, U4400 and no zero suppression (blanking) occurs.

If a 1 is not displayed in digit location A1, pin 9 is HI and the rising edge of DS1 at pin 11 sets pin 13 of U4338B HI, which puts a LO on the ripple blanking input, pin 5, of Decoder Driver U4400. Consequently, any zero that is decoded from the A, B, C, and D inputs to U4400 is blanked.

Certain other situations occur that require cancelling the zero suppression condition when a 1 is not displayed in digit location A1. For example, when temperature is displayed, a LO is present at pin 8 of J4300 which puts a HI at pin 13 of AND-OR-INVERT gate U4420A.

Pin 12 of U4420A also goes HI to satisfy the AND condition when pin 17 (DS3) of U4311 goes HI. Flip-flop U4338B is then reset by the HI at pin 10. Thus, pin 13 goes LO which puts a HI at pin 5 of U4400 and no zero suppression occurs. This condition insures that, in the temperature mode, the digit at location A3 just prior to the decimal will always be displayed even if it is a zero. Another zero-suppression cancel command occurs when pin 16 of U4311 goes HI and resets U4338B. Thus, pin 5 of U4338B goes HI as described previously, and the last digit is never blanked even if it is a zero.

The last zero-suppression cancel command occurs when a 1 is not being displayed in digit location A1 while the digit displayed in location A2 is other than a zero. For example, if a 1 is not being displayed in location A1, U4338A is set as described previously and all succeeding zeros would be blanked. However, if the digit displayed in location A2 is other than a zero, the zero suppression

condition is cancelled. This is accomplished when pin 18 (DS2) of U4311 goes HI and the ripple blanking output from pin 4 of U4400 also goes HI which resets flip-flop U4338B. The ripple-blanking output from pin 4 of U4400 is HI when the digit at location A2 is other than a zero. With U4338B reset, pin 5 of U4400 is HI and the zero-suppression condition is cancelled.

Transistor Q4355 sets U4338B at the end of each digit select cycle following DS4 and prior to DS1. Thus, even if DS1 is skipped at the beginning of any multiplex cycle (which can occur with U4311 under certain conditions) and U4338B fails to set, Q4355 prevents the suppressed zeroes from flashing.

Sign, Decimal, and 1/2-Digit Drivers

Transistors Q4430, Q4440, Q4450, Q4460 and Q4470 are cathode-current drivers for the plus (+) and minus (-) signs, the decimal point, and the 1 displayed at digit location A1. When the base of the driver transistors is pulled HI (to +5 volts) the driver emitter resistor sets the collector current and turns on the appropriate display cathode segments.

For example, if the display is supposed to be +1000, the binary code from the Q outputs of U4311 for a +1 display at digit location A1 is 0100 (refer to the Truth Table in the A/D Converter discussion). The LO at Q3 (pin 23) of U4311 turns on Q4460 and lights the 1 at digit location

A1. The level at Q2 (pin 22) of U4311 determines the displayed polarity at digit location A1. In this case, binary code 0100 at the Q outputs of U4311 means the level at Q2 is HI which turns on Q4440 and lights the plus (+) sign. A LO at Q2 turns on Q4450 through inverter U4334E and lights the minus (-) sign at location A1.

Transistor Q4430 disables the digit display cathodes at location A1 between digit select cycles to help prevent inter-digit glowing and also disables digit location A1 for the heart and respiration rate (Option 6 only) readouts. (The heart and respiration rate readouts use only the right three digits.) All the cathode drivers for digit location A1 have their emitter current control resistors returned to the collector of Q4430 instead of to ground. Transistor Q4430 is turned on only by a HI at pin 19 (DS1) of U4311 unless Q4430 is held off by a HI at pin 7 of J4300 which occurs for the heart and respiration rate readouts. Quiescently, the Cathode Drivers for digit location A1 are disabled until Q4430 conducts and pulls the Cathode Driver emitter resistors to ground.

Transistor Q4470 and associated circuitry compose a decimal point driver that is enabled when pin 17 (DS3) of U4311 goes HI (i.e. a digit is selected for location A3) and pin 8 (DP3) of J4300 goes LO. The decimal point is used only for the 3 1/2-digit temperature readout.

100

MAINTENANCE

INTRODUCTION

This section includes component removal and replacement procedures specifically for the 401 Digital Readout Module. For general preventive and corrective maintenance information, refer to the monitor service manual.

COMPONENT REMOVAL AND REPLACEMENT

WARNING

Potentially dangerous voltages exist in the monitor and 401 Digital Readout Module. Disconnect ac power from monitor before removing 401 from monitor.

CABINET TOP COVER REMOVAL

1. Remove two screws on each side of cabinet top cover.
2. Lift left side of cover and gently pull cover away from chassis. Pull cover out just far enough to allow back of plastic bumpers to clear chassis.
3. Gently lift cover toward right side of monitor chassis to clear monitor ECG LEAD CHECK terminals and remove cover.

CAUTION

Some components can be damaged by static discharge. See caution note on page 4-2.

DIGITAL READOUT MODULE REMOVAL

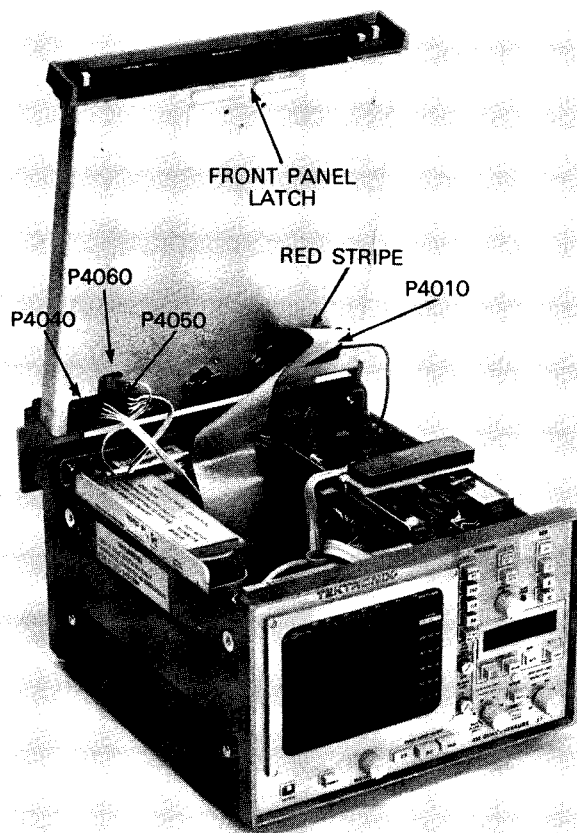
1. Remove cabinet top cover as described in previous Cabinet Top Cover Removal procedure.
2. Rotate slotted fastener, at rear of 401 chassis, 90 degrees counterclockwise to release rear of 401 from monitor.

3. Lift rear of 401 away from monitor; then slide backwards to free it from monitor.

4. Tip up front of 401 and remove battery plugs P4040 and P4050. See Figure 4-1.

5. Remove remaining interconnecting cable plugs (P4060 and P4010).

6. Disconnect green-yellow protective-ground wire from 401 chassis. Remove nut holding solder lug to chassis. Do not unsolder green-yellow wire from solder lug.



2497-9

Figure 4-1. Digital Readout Module removal and replacement.



YOU ARE DESTRUCTIVE **STATIC DISCHARGE** CAN DAMAGE COMPONENTS



FACT: BOTH **MOS** AND **BIPOLAR** INTEGRATED CIRCUITS CAN BE DAMAGED BY DISCHARGE OF STATIC ELECTRICITY.

FACT: BOTH **DIGITAL** AND **LINEAR** I.C.'S CAN BE DAMAGED.

FACT: I.C.'S CAN BE DAMAGED WHEN THEY ARE **IN THE CIRCUIT** AS WELL AS WHEN THEY ARE NOT.

FACT: DAMAGE MAY **NOT** BE **APPARENT FOR SEVERAL MONTHS**.

RECOMMENDED HANDLING RULES

STORING AND TRANSPORTING

Don't remove semiconductors or boards containing semiconductors from original antistatic container until needed.

Don't place semiconductors or boards containing semiconductors on or in plastic containers, styrofoam or other nonconductive material. Use material specifically treated for antistatic qualities.

Do use grounded soldering iron and test equipment.

Do turn the instrument power off before removing or inserting semiconductors.

Do use a grounded conductive bench top when working on boards or instruments containing semiconductors. If not available, use uncoated cardboard as a substitute.

INSTALLING

Do discharge static charge from your body. Connect yourself to ground through 100 k Ω while handling circuits or semiconductors.

Don't slide semiconductors or boards containing semiconductors across any surface.

Don't touch semiconductor leads unless necessary.

DIGITAL READOUT MODULE INSTALLATION

NOTE

Refer to Figure 4-1 when performing this procedure.

1. Position 401 over monitor.
2. Fold main interconnecting cable, as shown, and connect plug P4010 to 401.
3. Connect remaining interconnecting cable plugs (connect P4040 and P4050 last).
4. Gently slide bottom front edge of 401 up to monitor front frame casting to engage the front latch.
5. Keeping interconnecting cables clear, lower back of 401 so that it meets monitor rear frame casting.
6. Rotate slotted fastener, at rear of 401 chassis, 90 degrees clockwise to secure 401 to monitor.
7. Replace cabinet top cover in reverse order of previous Cabinet Top Cover Removal procedure.

CIRCUIT BOARDS

Occasionally, a circuit board may be damaged beyond repair. If this is the case, replace entire board assembly. Part numbers are given in Replaceable Electrical Parts list for completely wired boards.

DVM and Display Boards

Remove and replace DVM and Display boards as follows:

1. Remove two mounting screws holding DVM board to front of Main board.
2. Remove mounting screw from center rear of DVM board.
3. Gently lift rear of DVM board to disconnect interconnecting plug and remove board.
4. Remove two Display board mounting screws (one on each side of gas-discharge display elements). Remove only screws on front of Display board. Do not remove screws mounted in slotted holes in DVM board. (These holes provide adjustment to set display elements with respect to front panel.)

5. Gently pull Display board forward to disconnect interconnecting plug and remove Display board from DVM board.

6. Replace DVM and Display boards in reverse order of removal.

Gas-discharge display elements can be removed from Display board as follows:

Using a screwdriver (preferably with plastic shaft), carefully pry display element out of its socket. Pry a little at each side until display element is released from socket.

NOTE

Make sure pins are straight before attempting to install display element.

Main Board

Remove and replace Main board as follows:

1. Remove 401 from monitor as described in previous Digital Readout Module Removal procedure.
2. Remove DVM and Display boards as described in preceding DVM and Display Board removal procedure. It is not necessary to separate the Display board from the DVM board.
3. Remove two transistor (Q4020 and Q4023) heat-sink mounting screws from 401 rear panel.
4. Remove two screws holding 401 rear casting to chassis. Remove rear frame casting.
5. Remove six mounting screws, (three at front and three at back of board).
6. Slide Main board backwards to clear 401 front panel. Remove Main board.

NOTE

To remove and replace pushbutton switch extension shafts, refer to Pushbutton Extension Shaft procedure below.

7. Replace Main board in reverse order of removal procedure.

PUSHBUTTON EXTENSION SHAFT

Pushbutton extension shafts can be removed from switch shafts as follows:

1. Insert a sharp pointed tool (such as a scriber) between end of switch shaft and extension shaft as shown in Figure 4-2.
2. Move sharp pointed tool back and forth to release extension shaft from switch shaft.
3. Replace extension shaft by pressing it straight onto switch shaft until it snaps in place.

ADJUSTMENT AFTER REPAIR

After any electrical component has been replaced, check adjustment of that particular circuit, as well as the adjustment of any closely related circuits. Since the power supply affects all circuits, check adjustment of entire instrument after replacing the power transformer or components in the power supply. See Section 5, Calibration, for a complete adjustment procedure.

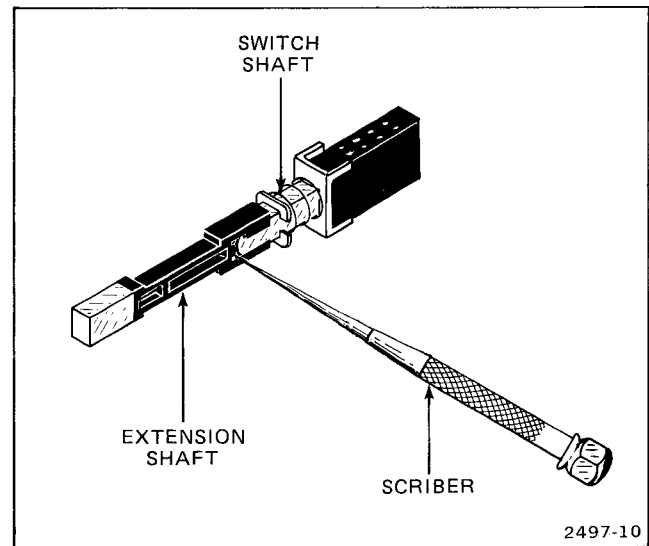


Figure 4-2. Pushbutton extension shaft removal.

CALIBRATION

INTRODUCTION

PURPOSE

This section provides procedures to check performance and make necessary adjustments to the 401 Digital Readout Module.

CALIBRATION INTERVAL

Performance should be checked and adjustments made every 1000 hours or 6 months. Partial or complete recalibration should be performed following specific repairs; see Maintenance section.

PARTIAL ADJUSTMENT

It is often desirable to make partial adjustments after replacing components or just to touch up the adjustment of a portion of the 401 between major performance checks.

The three DVM Cal adjustments can be made independently without interaction. However, if you change the +5 volt adjustment, you should check calibration of the entire 401.

TEST EQUIPMENT REQUIRED

Test equipment and other items listed in Table 5-1 are required for complete recalibration of the 401. The

specifications given for the test equipment are the minimum necessary for accurate calibration. All test equipment should be correctly calibrated and operating within the manufacturer's specifications.

PRELIMINARY CHECK

Operation of all monitor and 401 digital display modes should be checked and any defects corrected before attempting to adjust the 401.

The minimum possible deviation between the 401 and monitor digital display readings depends on accurate monitor calibration. Make sure that the monitor is properly calibrated before starting the following procedure. Refer to the appropriate monitor service manual for the monitor adjustment procedure.

PRELIMINARY SETUP

NOTE

The performance of the 401 can be checked at any ambient temperature from 0° to 50°C. However, only make adjustments at +20° to 30°C.

TABLE 5-1
Test Equipment

Description	Minimum Specifications	Usage	Examples of Applicable Test Equipment
1. Digital Voltmeter (test DVM)	Accuracy, within 1%.	+5 volt adjustment.	TEKTRONIX DM501 Digital Multimeter.
2. Function Generator	Output amplitude, 1 V square wave; Risetime, 10 μ s or faster; Frequency Range, 1 Hz to 4 Hz.	Heart Rate and Respiration Rate DVM checks and adjustments.	TEKTRONIX FG501 Function Generator.
3. Universal Counter	Frequency Range, 1 Hz to 4 Hz.	Function Generator frequency verification.	TEKTRONIX DC 504 Counter/Timer.
4. Manometer	Range, 0 to 250 mmHg; Accuracy, within 1%.	Pressure DVM checks and adjustments.	
5. Pressure Transducer	Standardized to 50 μ V/V/cmHg.	Pressure DVM checks and adjustment.	
6. Temperature Sensor Substitution Plugs	Figure 5-2.	Temperature DVM checks and adjustment.	
7. Low-Pass Filter	Figure 5-3.	Heart Rate and Respiration Rate DVM adjustments.	
8. 10 Megohm Resistor		Respiration Rate DVM check and adjustment.	

1. REMOVE CABINET AS FOLLOWS:

- Remove two screws on each side of cabinet top cover.
- Lift left side of cover and gently pull cover away from chassis. Pull cover out just far enough to allow back of plastic bumpers to clear chassis. Gently lift cover toward right side of monitor chassis to clear monitor ECG LEAD CHECK terminals and remove cover.

2. SET MONITOR CONTROLS AS FOLLOWS:

DISPLAY OFF
(Resp., 413 only).....in (off)
DISPLAY OFF
(Press/Pulse).....in (off)
OFF (ECG).....in (off)
LOW RATE LIMIT.....RATE ALARM OFF (ccw)
PULSE ALARM.....out (off)
POWER.....in (on)

- Set remaining monitor controls as desired. Connect monitor to correct ac-line source.

- Set 401 POWER pushbutton in (on) and allow about 20 minutes for monitor and 401 to warm up before making adjustments.

ADJUSTMENT PROCEDURE**1. +5 VOLT ADJUSTMENT**

- Connect test-DVM ground (-) lead to TP4065 (GND) and positive (+) lead to TP4040 (+5). See Figure 5-1 for test-point locations.

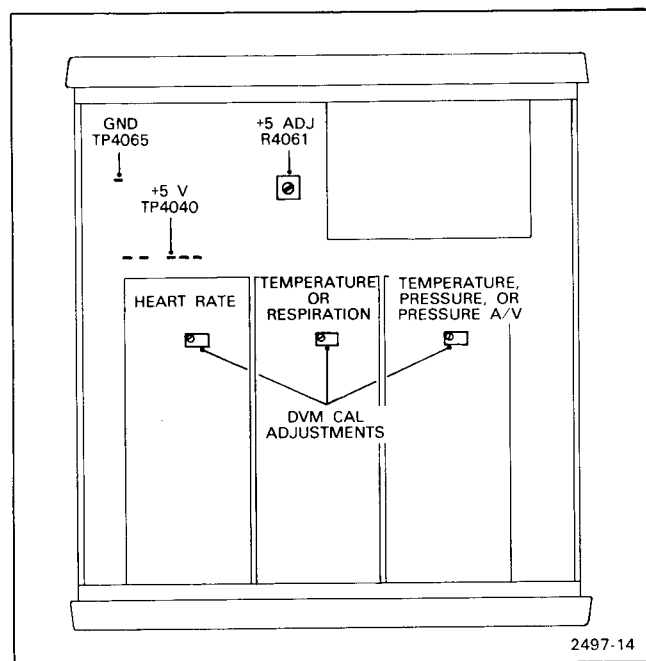


Figure 5-1. Test-point and adjustment locations.

- CHECK**—Test DVM reads +5 volts within 50 mV.

- ADJUST**—R4061 (+5 V Adj Fig. 5-1) so that test DVM reads +5 volts within 10 mV.

- Remove test-DVM leads from test points.

2. TEMPERATURE DVM CAL

- Set monitor controls as follows:

TEMPERATURE
A (413).....in
TEMPERATURE
(414 or 414 Opt 21).....in
°C/°F (monitor).....°F

- Set 401 TEMPERATURE A pushbutton in.

- Insert 113°F/45°C temperature sensor substitution plug (Fig. 5-2) into TEMPERATURE SENSOR INPUT (A, 413) jack on monitor rear panel.

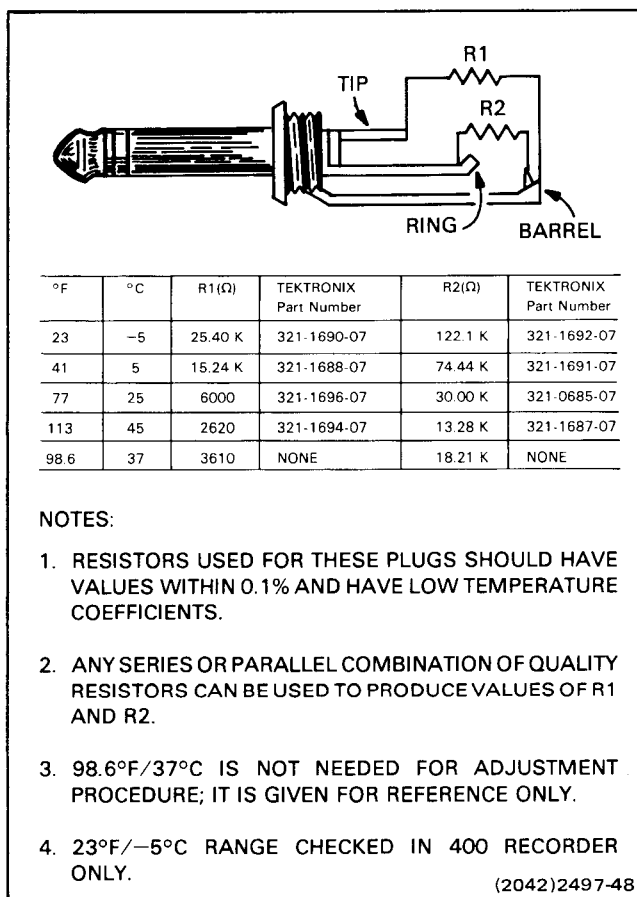


Figure 5-2. Temperature-sensor substitution plugs.

TABLE 5-2
Temperature Readout Checks

Temperature Input & Display Selection ¹	Temperature Sensor Simulation Plug	°C/°F Switch Setting	401 Temperature Display Reading	Maximum Allowable Deviation Between Monitor and 401 Readings
A	113°F/45°C	°C	45.0 ± 0.3	0.5
B	113°F/45°C	°C	45.0 ± 0.3	0.5
B	113°F/45°C	°F	113.0 ± 0.5	0.5
A	77°F/25°C	°F	77.0 ± 0.5	0.5
A	77°F/25°C	°C	25.0 ± 0.3	0.5
B	77°F/25°C	°C	25.0 ± 0.3	0.5
B	77°F/25°C	°F	77.7 ± 0.5	0.5
A	41°F/5°C	°F	41.0 ± 0.5	0.5
A	41°F/5°C	°C	5.0 ± 0.3	0.5
B	41°F/5°C	°C	5.0 ± 0.3	0.5
B	41°F/5°C	°F	41.0 ± 0.5	0.5

¹Insert temperature sensor substitution plug in the **TEMPERATURE SENSOR INPUT** jack as indicated. Set **TEMPERATURE A, B** pushbuttons (on monitor and 401) to corresponding positions.

When calibrating 401 with 414 or 414 Option 21 monitor, ignore **TEMPERATURE INPUT B** checks since there is only one temperature input.

d. **ADJUST**—Temperature DVM Cal (Fig. 5-1) so that 401 digital display reads 113.0 +/-0.1.

e. **CHECK**—Monitor digital display reads same as 401 **TEMPERATURE** display within 0.5.

f. Using Table 5-2, check 401 **TEMPERATURE** display accuracy and deviation from monitor. Skip **TEMPERATURE B** when calibrating a 401 with a 414 or 414 Option 21.

g. Insert 113°F/45°C temperature sensor substitution plug into **TEMPERATURE SENSOR INPUT A** and a 77°F/25°C plug into **TEMPERATURE SENSOR INPUT B**.

h. Press in 401 **TEMPERATURE A** pushbutton and record digital readout. Press in **B** pushbutton and record digital readout. Calculate A-B.

i. Set both 401 **TEMPERATURE A** and **B** pushbuttons in at the same time (A MINUS B).

j. **CHECK**—401 digital display of A minus B is same as the calculated value within 1.0°F or 0.6°C.

k. Set both monitor **TEMPERATURE A** and **B** pushbuttons in at the same time (A MINUS B).

l. **CHECK**—Monitor digital display reads same as 401 **TEMPERATURE A MINUS B** display within 0.5°F or 0.5°C.

m. Remove temperature sensor substitution plugs.

3. HEART RATE DVM CAL

a. Set monitor **ECG I** and **HEART RATE/MIN** pushbuttons in.

b. Connect function generator square wave through low-pass filter (Fig. 5-3) to monitor **ECG INPUT** connector. Display about 4 cm at 4 Hz (verify frequency with universal counter).

c. **ADJUST**—Heart Rate DVM Cal (Fig. 5-1) so that 401 **HEART RATE** display reads 240 +/-1.

d. **CHECK**—Monitor digital display reads the same as 401 **HEART RATE** display within 5.

e. Set function-generator frequency to 2 Hz (verify with counter).

f. **CHECK**—401 **HEART RATE** display reads 120 ± 3.

g. **CHECK**—Monitor digital display reads same as 401 **HEART RATE** display within 5.

h. Set function generator frequency to 1 Hz (verify with counter).

i. **CHECK**—401 **HEART RATE** display reads 60 ± 3.

Calibration—401

j. **CHECK**—Monitor digital display reads the same as 401 HEART RATE display within 5.

IF YOU ARE CALIBRATING A 401 WITH A 414 OR 414 OPTION 21 SKIP TO STEP 5.

4. RESPIRATION RATE DVM CAL (STANDARD 401 ONLY)

a. Remove 401 Digital Readout Module from 413 Monitor as follows:

1. Place 413/401 on its side.
2. Rotate slotted fastener at rear of 401 chassis with screwdriver 90 degrees counter-clockwise to release rear of 401 from monitor.
3. Lift rear of 401 away from monitor; then slide 401 backwards to free it from the monitor.
4. Leave monitor and 401 on their sides while calibrating.

b. Connect a 10 M Ω resistor between TP 371 on the monitor ECG board and TP441 on the monitor Respiration board. See Figure 5-4.

c. Set function generator frequency so that 401 HEART RATE display reads 115 to 120.

d. Set monitor control as follows:

RESPIRATION SIZEMidpoint (dot on panel)
RESP RATE/MINin

e. **ADJUST**—Respiration DVM Cal (Fig. 5-1) so that 401 RESPIRATION display reads same as 401 HEART RATE display within 1.

f. **CHECK**—Monitor digital display reads same as 401 RESPIRATION RATE display within 5.

g. Set function generator so that 401 HEART RATE display reads 55 to 60. Allow at least 30 seconds for RESPIRATION display reading to settle.

h. **CHECK**—401 RESPIRATION RATE display reads same as HEART RATE display within 3.

i. **CHECK**—Monitor digital display reads same as 401 RESPIRATION display within 5.

j. Reinstall 401 on monitor as follows:

1. Gently slide bottom front edge of 401 up to monitor front frame casting to engage front latch.

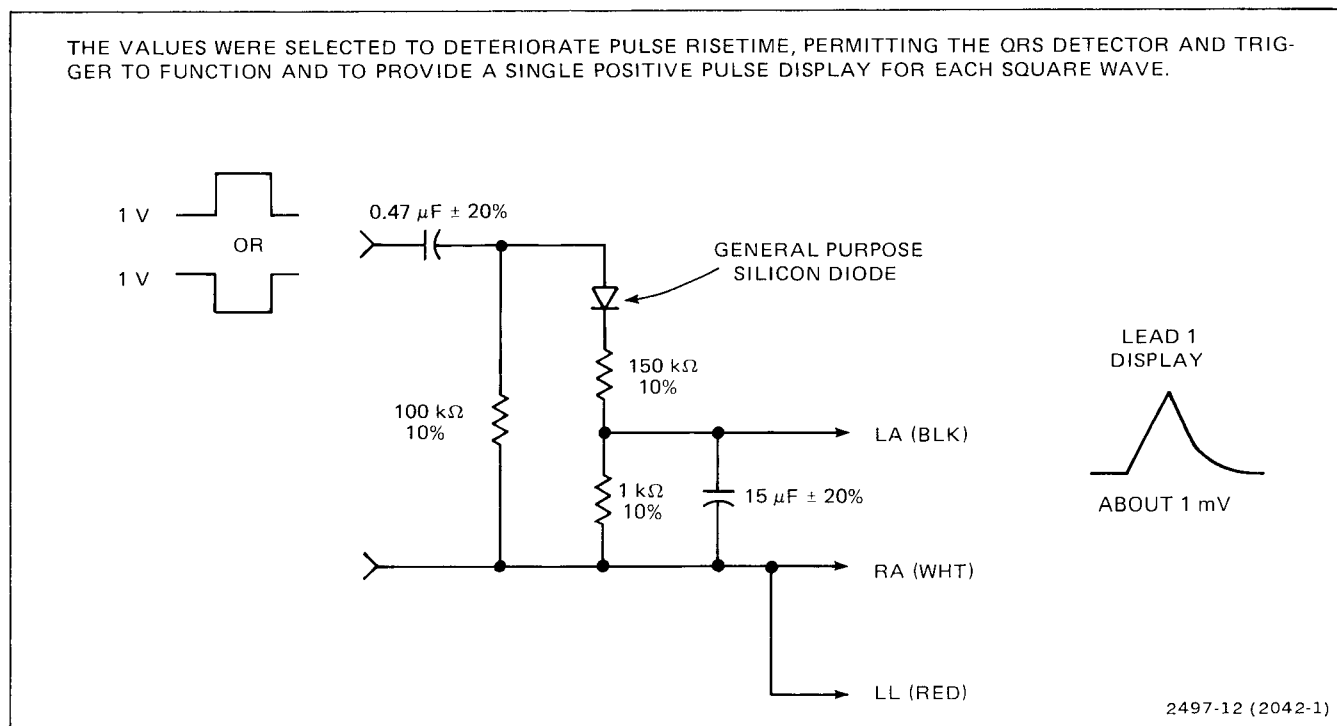


Figure 5-3. Low-pass filter.

2. Keeping interconnecting cables clear, lower back of 401 so that it meets monitor rear frame casting. Rotate slotted fastener, at rear of 401, with screwdriver 90 degrees clockwise to secure 401 to monitor.

IF YOU ARE CALIBRATING A 401 WITH A 413 MONITOR, THE PROCEDURE IS COMPLETE AT THIS POINT. REPLACE TOP COVER.

5. PRESSURE (A/V) DVM CAL

a. Set Monitor controls as follows:

PRESSURE RANGE
(413 Opt 22).....0-250
(414 or 414 Opt 21).....250
MEAN.....in
DISPLAY OFF
(Pressure, A/V)in (off)
READOUT AND PULSE
ALARM (Opt 21).....in (A/V)

b. Set 401 SYST and DIAST pushbuttons in to select MEAN PRESSURE display.

c. Connect manometer to pressure transducer and pressure transducer to PRESSURE TRANSDUCER INPUT connector on monitor rear panel. Use ARTERIAL/ VENOUS TRANSDUCER INPUT with 414 Option 21 monitor.

d. Press in monitor ZERO (A/V, 414 Opt 21) control and adjust for monitor digital display reading of +or—0.

NOTE

Make sure pressure, applied in following steps, remains at the indicated value and does not slowly diminish.

e. Apply 250 mmHg pressure as indicated by manometer.

f. **ADJUST**—Pressure DVM Cal (Fig. 5-1) so that 401 PRESSURE display reads 250 \pm 1.

g. **CHECK**—Monitor reads same as 401 PRESSURE display within 5.

h. Apply 125 mmHg pressure as indicated by manometer.

i. **CHECK**—401 PRESSURE display reads 125 \pm 3.

j. **CHECK**—Monitor digital display reads same as 401 PRESSURE display within 5.

k. Apply 75 mmHg pressure as indicated by manometer.

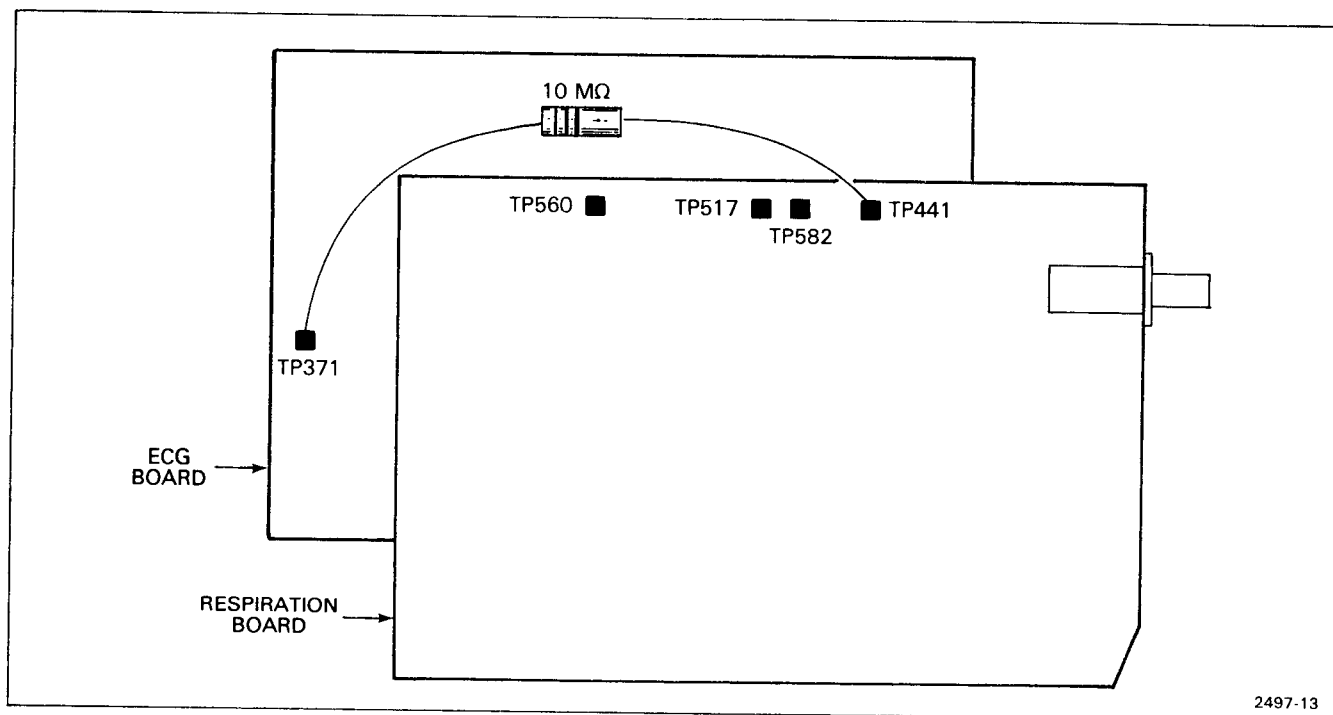


Figure 5-4. Respiration-rate test-signal connection.

Calibration—401

l. **CHECK**—401 PRESSURE display reads 75 ± 3 .

m. **CHECK**—Monitor digital display reads same as 401 PRESSURE display within 5.

n. Apply 25 mmHg pressure as indicated by manometer.

o. **CHECK**—401 PRESSURE display reads 25 ± 3 .

p. **CHECK**—Monitor digital display reads same as 401 PRESSURE display within 5.

q. Disconnect pressure transducer and manometer.

r. Replace top cover.

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
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
02735	RCA CORPORATION, SOLID STATE DIVISION	ROUTE 202	SOMERVILLE, NY 08876
03508	GENERAL ELECTRIC COMPANY, SEMI-CONDUCTOR PRODUCTS DEPARTMENT	ELECTRONICS PARK	SYRACUSE, NY 13201
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
14752	ELECTRO CUBE INC.	1710 S. DEL MAR AVE.	SAN GABRIEL, CA 91776
24355	ANALOG DEVICES INC.	RT 1 INDUSTRIAL PK, P O BOX 280	NORWOOD, MA 02062
27014	NATIONAL SEMICONDUCTOR CORP.	2900 SEMICONDUCTOR DR.	SANTA CLARA, CA 95051
32997	BOURNS, INC., TRIMPOT PRODUCTS DIV.	1200 COLUMBIA AVE.	RIVERSIDE, CA 92507
52536	BECKMAN INSTRUMENTS, INC., INFORMATION DISPLAYS OPERATION	350 N. HAYDEN ROAD	SCOTTSDALE, AZ 85257
55680	NICHICON/AMERICA/CORP.	6435 N PROESEL AVENUE	CHICAGO, IL 60645
56289	SPRAGUE ELECTRIC CO.		NORTH ADAMS, MA 01247
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
90201	MALLORY CAPACITOR CO., DIV. OF P. R. MALLORY AND CO., INC.	3029 E. WASHINGTON STREET	INDIANAPOLIS, IN 46206
91637	DALE ELECTRONICS, INC.	P. O. BOX 372 P. O. BOX 609	COLUMBUS, NE 68601

Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
A1	670-5451-01	B010100 B010759	CKT BOARD ASSY:MOTHER	80009	670-5451-01
A1	670-5451-02	B010760	CKT BOARD ASSY:MAIN	80009	670-5451-02
A2	670-5452-00		CKT BOARD ASSY:PROGRAMMED	80009	670-5452-00
A3	670-5453-00		CKT BOARD ASSY:PROGRAMMED (OPTION 1 ONLY)	80009	670-5453-00
A4	670-5458-00		CKT BOARD ASSY:PROGRAMMED (OPTION 2 ONLY)	80009	670-5458-00
A5	670-5450-00		CKT BOARD ASSY:DVM	80009	670-5450-00
A6	670-5454-00		CKT BOARD ASSY:DISPLAY	80009	670-5454-00
C4015	283-0111-00	B010100 B010119	CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C4015	283-0203-00	B010120	CAP.,FXD,CER DI:0.47UF,20%,50V	72982	8131N075 E474M
C4017	283-0164-00		CAP.,FXD,CER DI:2.2UF,20%,25V	72982	8141N037Z5U0225M
C4025	290-0758-00		CAP.,FXD,ELCTLT:2.2UF,+50-10%,160V	56289	502D227
C4028	290-0758-00		CAP.,FXD,ELCTLT:2.2UF,+50-10%,160V	56289	502D227
C4029	290-0758-00		CAP.,FXD,ELCTLT:2.2UF,+50-10%,160V	56289	502D227
C4031	283-0057-00		CAP.,FXD,CER DI:0.1UF,+80-20%,200V	56289	274C10
C4040	290-0755-00		CAP.,FXD,ELCTLT:100UF,+50-10%,10V	56289	502D223
C4041	290-0804-00		CAP.,FXD,ELCTLT:10UF,+50-10%,25V	55680	25ULA10V-T
C4044	290-0804-00		CAP.,FXD,ELCTLT:10UF,+50-10%,25V	55680	25ULA10V-T
C4046	290-0804-00		CAP.,FXD,ELCTLT:10UF,+50-10%,25V	55680	25ULA10V-T
C4052	290-0804-00		CAP.,FXD,ELCTLT:10UF,+50-10%,25V	55680	25ULA10V-T
C4070	285-0898-00		CAP.,FXD,PLSTC:0.47UF,10%,100V	56289	LP66A1B474K
C4150	290-0722-00		CAP.,FXD,ELCTLT:100UF,20%,10V (C4150, OPTION 2 ONLY)	56289	196D107X0010PE3
C4151	290-0536-00		CAP.,FXD,ELCTLT:10UF,20%,25V (C4151, OPTION 2 ONLY)	90201	TDC106M025FL
C4155	290-0722-00		CAP.,FXD,ELCTLT:100UF,20%,10V (C4155, OPTION 2 ONLY)	56289	196D107X0010PE3
C4156	290-0536-00		CAP.,FXD,ELCTLT:10UF,20%,25V (C4156, OPTION 2 ONLY)	90201	TDC106M025FL
C4161	290-0722-00		CAP.,FXD,ELCTLT:100UF,20%,10V (C4156, OPTION 2 ONLY)	56289	196D107X0010PE3
C4163	290-0722-00		CAP.,FXD,ELCTLT:100UF,20%,10V (C4163, OPTION 2 ONLY)	56289	196D107X0010PE3
C4165	290-0722-00		CAP.,FXD,ELCTLT:100UF,20%,10V (C4165, OPTION 2 ONLY)	56289	196D107X0010PE3
C4166	290-0536-00		CAP.,FXD,ELCTLT:10UF,20%,25V (C4166, OPTION 2 ONLY)	90201	TDC106M025FL
C4171	290-0722-00		CAP.,FXD,ELCTLT:100UF,20%,10V (C4171, OPTION 2 ONLY)	56289	196D107X0010PE3
C4181	290-0722-00		CAP.,FXD,ELCTLT:100UF,20%,10V (C4181, OPTION 2 ONLY)	56289	196D107X0010PE3
C4191	290-0722-00		CAP.,FXD,ELCTLT:100UF,20%,10V (C4191, OPTION 2 ONLY)	56289	196D107X0010PE3
C4193	290-0722-00		CAP.,FXD,ELCTLT:100UF,20%,10V (C4193, OPTION 2 ONLY)	56289	196D107X0010PE3
C4195	290-0722-00		CAP.,FXD,ELCTLT:100UF,20%,10V (C4195, OPTION 2 ONLY)	56289	196D107X0010PE3
C4196	290-0536-00		CAP.,FXD,ELCTLT:10UF,20%,25V (C4196, OPTION 2 ONLY)	90201	TDC106M025FL
C4210	290-0536-00		CAP.,FXD,ELCTLT:10UF,20%,25V (C4210, OPTION 2 ONLY)	90201	TDC106M025FL
C4311	283-0111-00		CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C4317	283-0204-00		CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N061Z5U0103M
C4320	285-1097-00		CAP.,FXD,PLSTC:0.47UF,10%,100V	14752	230B1B474K
C4322	283-0111-00		CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C4324	285-0808-00		CAP.,FXD,PLSTC:0.1UF,10%,50V	56289	LP66A1A104K004

Replaceable Electrical Parts—401

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
C4357	283-0054-00			CAP., FXD, CER DI:150PF, 5%, 200V	72982	855-535U2J151J
C4364	281-0549-00			CAP., FXD, CER DI:68PF, 10%, 500V	72982	301-000U2J0680K
C4374	281-0549-00			CAP., FXD, CER DI:68PF, 10%, 500V	72982	301-000U2J0680K
C4384	281-0549-00			CAP., FXD, CER DI:68PF, 10%, 500V	72982	301-000U2J0680K
C4394	281-0549-00			CAP., FXD, CER DI:68PF, 10%, 500V	72982	301-000U2J0680K
CR4025	152-0107-00	B010100	B010119	SEMICON D DEVICE:SILICON, 400V, 400MA	01295	G727
CR4025	152-0107-03	B010120		SEMICON D DEVICE:SILICON, 375V, 400MA, SEL	80009	152-0107-03
CR4028	152-0107-00	B010100	B010119	SEMICON D DEVICE:SILICON, 400V, 400MA	01295	G727
CR4028	152-0107-03	B010120		SEMICON D DEVICE:SILICON, 375V, 400MA, SEL	80009	152-0107-03
CR4029	152-0107-00	B010100	B010119	SEMICON D DEVICE:SILICON, 400V, 400MA	01295	G727
CR4029	152-0107-03	B010120		SEMICON D DEVICE:SILICON, 375V, 400MA, SEL	80009	152-0107-03
CR4031	152-0107-00	B010100	B010119	SEMICON D DEVICE:SILICON, 400V, 400MA	01295	G727
CR4031	152-0107-03	B010120		SEMICON D DEVICE:SILICON, 375V, 400MA, SEL	80009	152-0107-03
CR4040	152-0107-00	B010100	B010119	SEMICON D DEVICE:SILICON, 400V, 400MA	01295	G727
CR4040	152-0107-03	B010120		SEMICON D DEVICE:SILICON, 375V, 400MA, SEL	80009	152-0107-03
CR4041	152-0107-00	B010100	B010119	SEMICON D DEVICE:SILICON, 400V, 400MA	01295	G727
CR4041	152-0107-03	B010120		SEMICON D DEVICE:SILICON, 375V, 400MA, SEL	80009	152-0107-03
CR4044	152-0107-00	B010100	B010119	SEMICON D DEVICE:SILICON, 400V, 400MA	01295	G727
CR4044	152-0107-03	B010120		SEMICON D DEVICE:SILICON, 375V, 400MA, SEL	80009	152-0107-03
CR4045	152-0107-00	B010100	B010119	SEMICON D DEVICE:SILICON, 400V, 400MA	01295	G727
CR4045	152-0107-03	B010120		SEMICON D DEVICE:SILICON, 375V, 400MA, SEL	80009	152-0107-03
CR4080	152-0141-02			SEMICON D DEVICE:SILICON, 30V, 50NA	01295	1N4152R
CR4082	152-0141-02			SEMICON D DEVICE:SILICON, 30V, 50NA	01295	1N4152R
CR4084	152-0141-02			SEMICON D DEVICE:SILICON, 30V, 50NA	01295	1N4152R
CR4086	152-0141-02			SEMICON D DEVICE:SILICON, 30V, 50NA	01295	1N4152R
CR4120	152-0141-02			SEMICON D DEVICE:SILICON, 30V, 50NA	01295	1N4152R
	-----			(CR4120, OPTION 1 ONLY)		
CR4140	152-0141-02			SEMICON D DEVICE:SILICON, 30V, 50NA	01295	1N4152R
	-----			(CR4140, OPTION 2 ONLY)		
CR4143	152-0141-02			SEMICON D DEVICE:SILICON, 30V, 50NA	01295	1N4152R
	-----			(CR4143, OPTION 2 ONLY)		
CR4173	152-0141-02			SEMICON D DEVICE:SILICON, 30V, 50NA	01295	1N4152R
	-----			(CR4173, OPTION 2 ONLY)		
CR4183	152-0141-02			SEMICON D DEVICE:SILICON, 30V, 50NA	01295	1N4152R
	-----			(CR4183, OPTION 2 ONLY)		
CR4210	152-0141-02			SEMICON D DEVICE:SILICON, 30V, 50NA	01295	1N4152R
	-----			(CR4210, OPTION 2 ONLY)		
CR4212	152-0141-02			SEMICON D DEVICE:SILICON, 30V, 50NA	01295	1N4152R
	-----			(CR4212, OPTION 2 ONLY)		
CR4326	152-0141-02			SEMICON D DEVICE:SILICON, 30V, 50NA	01295	1N4152R
CR4440	152-0061-00			SEMICON D DEVICE:SILICON, 175V, 100MA	07263	FDH2161
CR4450	152-0061-00			SEMICON D DEVICE:SILICON, 175V, 100MA	07263	FDH2161
CR4460	152-0061-00			SEMICON D DEVICE:SILICON, 175V, 100MA	07263	FDH2161
CR4470	152-0061-00			SEMICON D DEVICE:SILICON, 175V, 100MA	07263	FDH2161
F4012	159-0152-00			FUSE, WIRE LEAD: 5A, 125V, FAST BLOW	75915	275-005
Q4015	151-0188-00			TRANSISTOR: SILICON, PNP	04713	SPS6868K
Q4020	151-0323-00			TRANSISTOR: SILICON, NPN, SEL FROM MJE521	80009	151-0323-00
Q4022	151-0323-00			TRANSISTOR: SILICON, NPN, SEL FROM MJE521	80009	151-0323-00
Q4055	151-0190-00			TRANSISTOR: SILICON, NPN	07263	S032677
Q4059	151-0190-00			TRANSISTOR: SILICON, NPN	07263	S032677
Q4071	151-0508-00			TRANSISTOR: SILICON, NPN, PROGRAMMABLE	03508	2N6027
Q4075	151-0190-00			TRANSISTOR: SILICON, NPN	07263	S032677
Q4123	151-0190-00			TRANSISTOR: SILICON, NPN	07263	S032677
	-----			(Q4123, OPTION 1 ONLY)		
Q4355	151-0190-00			TRANSISTOR: SILICON, NPN	07263	S032677
Q4361	151-0444-00			TRANSISTOR: SILICON, NPN	80009	151-0444-00

Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
Q4364	151-0443-00		TRANSISTOR:SILICON,PNP	80009	151-0443-00
Q4371	151-0444-00		TRANSISTOR:SILICON,NPN	80009	151-0444-00
Q4374	151-0443-00		TRANSISTOR:SILICON,PNP	80009	151-0443-00
Q4381	151-0444-00		TRANSISTOR:SILICON,NPN	80009	151-0444-00
Q4384	151-0443-00		TRANSISTOR:SILICON,PNP	80009	151-0443-00
Q4391	151-0444-00		TRANSISTOR:SILICON,NPN	80009	151-0444-00
Q4394	151-0443-00		TRANSISTOR:SILICON,PNP	80009	151-0443-00
Q4410	151-0190-00		TRANSISTOR:SILICON,NPN	07263	S032677
Q4430	151-0190-00		TRANSISTOR:SILICON,NPN	07263	S032677
Q4440	151-0347-00		TRANSISTOR:SILICON,NPN	04713	SPS7951
Q4450	151-0347-00		TRANSISTOR:SILICON,NPN	04713	SPS7951
Q4460	151-0347-00		TRANSISTOR:SILICON,NPN	04713	SPS7951
Q4470	151-0347-00		TRANSISTOR:SILICON,NPN	04713	SPS7951
R4012	315-0821-00		RES.,FXD,CMPSN:820 OHM,5%,0.25W	01121	CB8215
R4014	315-0101-00		RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R4015	315-0101-00		RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R4025	315-0105-00		RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R4029	315-0105-00		RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R4031	315-0104-00		RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R4050	315-0125-00	XB010760	RES.,FXD,CMPSN:1.2M OHM,5%,0.25W (INSTALLED ONLY WHEN MONITOR HAS REDUCED CHARGE CURRENT)	01121	CB1255
R4052	315-0101-00		RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R4055	315-0103-00		RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4057	315-0102-00		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R4060	321-0227-00		RES.,FXD,FILM:2.26K OHM,1%,0.125W	91637	MFF1816G22600F
R4061	311-1224-00		RES.,VAR,NONWIR:500 OHM,20%,0.50W	32997	3386F-T04-501
R4062	321-0227-00		RES.,FXD,FILM:2.26K OHM,1%,0.125W	91637	MFF1816G22600F
R4065	315-0101-00		RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R4070	315-0275-00		RES.,FXD,CMPSN:2.7M OHM,5%,0.25W	01121	CB2755
R4071	315-0102-00		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R4073	315-0472-00		RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R4110	321-0993-07		RES.,FXD,FILM:90K OHM,0.1%,0.125W (R4110, OPTION 1 ONLY)	91637	MFF1816C90001B
R4112	321-0993-07		RES.,FXD,FILM:90K OHM,0.1%,0.125W (R4112, OPTION 1 ONLY)	91637	MFF1816C90001B
R4114	321-0993-07		RES.,FXD,FILM:90K OHM,0.1%,0.125W (R4114, OPTION 1 ONLY)	91637	MFF1816C90001B
R4120	315-0104-00		RES.,FXD,CMPSN:100K OHM,5%,0.25W (R4120, OPTION 1 ONLY)	01121	CB1045
R4121	315-0104-00		RES.,FXD,CMPSN:100K OHM,5%,0.25W (R4121, OPTION 1 ONLY)	01121	CB1045
R4123	315-0103-00		RES.,FXD,CMPSN:10K OHM,5%,0.25W (R4123, OPTION 1 ONLY)	01121	CB1035
R4125	321-0993-07		RES.,FXD,FILM:90K OHM,0.1%,0.125W (R4125, OPTION 1 ONLY)	91637	MFF1816C90001B
R4130	321-0993-07		RES.,FXD,FILM:90K OHM,0.1%,0.125W	91637	MFF1816C90001B
R4132	321-0993-07		RES.,FXD,FILM:90K OHM,0.1%,0.125W	91637	MFF1816C90001B
R4140	315-0104-00		RES.,FXD,CMPSN:100K OHM,5%,0.25W (R4140, OPTION 2 ONLY)	01121	CB1045
R4142	315-0103-00		RES.,FXD,CMPSN:10K OHM,5%,0.25W (R4142, OPTION 2 ONLY)	01121	CB1035
R4143	315-0103-00		RES.,FXD,CMPSN:10K OHM,5%,0.25W (R4143, OPTION 2 ONLY)	01121	CB1035
R4145	315-0103-00		RES.,FXD,CMPSN:10K OHM,5%,0.25W (R4145, OPTION 2 ONLY)	01121	CB1035

Replaceable Electrical Parts—401

Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
R4150	315-0103-00 -----		RES.,FXD,CMPSN:10K OHM,5%,0.25W (R4150, OPTION 2 ONLY)	01121	CB1035
R4151	315-0104-00 -----		RES.,FXD,CMPSN:100K OHM,5%,0.25W (R4151, OPTION 2 ONLY)	01121	CB1045
R4153	315-0114-00 -----		RES.,FXD,CMPSN:110K OHM,5%,0.25W (R4153, OPTION 2 ONLY)	01121	CB1145
R4155	315-0103-00 -----		RES.,FXD,CMPSN:10K OHM,5%,0.25W (R4155, OPTION 2 ONLY)	01121	CB1035
R4156	315-0104-00 -----		RES.,FXD,CMPSN:100K OHM,5%,0.25W (R4156, OPTION 2 ONLY)	01121	CB1045
R4158	315-0114-00 -----		RES.,FXD,CMPSN:110K OHM,5%,0.25W (R4158, OPTION 2 ONLY)	01121	CB1145
R4159	321-0993-07 -----		RES.,FXD,FILM:90K OHM,0.1%,0.125W (R4159, OPTION 2 ONLY)	91637	MFF1816C90001B
R4165	315-0103-00 -----		RES.,FXD,CMPSN:10K OHM,5%,0.25W (R4165, OPTION 2 ONLY)	01121	CB1035
R4166	315-0104-00 -----		RES.,FXD,CMPSN:100K OHM,5%,0.25W (R4166, OPTION 2 ONLY)	01121	CB1045
R4167	315-0114-00 -----		RES.,FXD,CMPSN:110K OHM,5%,0.25W (R4167, OPTION 2 ONLY)	01121	CB1145
R4169	321-0993-07 -----		RES.,FXD,FILM:90K OHM,0.1%,0.125W (R4169, OPTION 2 ONLY)	91637	MFF1816C90001B
R4170	315-0103-00 -----		RES.,FXD,CMPSN:10K OHM,5%,0.25W (R4170, OPTION 2 ONLY)	01121	CB1035
R4171	315-0105-00 -----		RES.,FXD,CMPSN:1M OHM,5%,0.25W (R4171, OPTION 2 ONLY)	01121	CB1055
R4180	315-0103-00 -----		RES.,FXD,CMPSN:10K OHM,5%,0.25W (R4180, OPTION 2 ONLY)	01121	CB1035
R4181	315-0105-00 -----		RES.,FXD,CMPSN:1M OHM,5%,0.25W (R4181, OPTION 2 ONLY)	01121	CB1055
R4195	315-0103-00 -----		RES.,FXD,CMPSN:10K OHM,5%,0.25W (R4195, OPTION 2 ONLY)	01121	CB1035
R4196	315-0104-00 -----		RES.,FXD,CMPSN:100K OHM,5%,0.25W (R4196, OPTION 2 ONLY)	01121	CB1045
R4197	315-0114-00 -----		RES.,FXD,CMPSN:110K OHM,5%,0.25W (R4197, OPTION 2 ONLY)	01121	CB1145
R4199	321-0993-07 -----		RES.,FXD,FILM:90K OHM,0.1%,0.125W (R4199, OPTION 2 ONLY)	91637	MFF1816C90001B
R4200	315-0104-00 -----		RES.,FXD,CMPSN:100K OHM,5%,0.25W (R4200, OPTION 2 ONLY)	01121	CB1045
R4201	315-0103-00 -----		RES.,FXD,CMPSN:10K OHM,5%,0.25W (R4201, OPTION 2 ONLY)	01121	CB1035
R4206	321-0204-00 -----		RES.,FXD,FILM:1.3K OHM,1%,0.125W (R4206, OPTION 2 ONLY)	91637	MFF1816G13000F
R4207	321-0255-00 -----		RES.,FXD,FILM:4.42K OHM,1%,0.125W (R4207, OPTION 2 ONLY)	91637	MFF1816G44200F
R4208	321-0254-00 -----		RES.,FXD,FILM:4.32K OHM,1%,0.125W (R4208, OPTION 2 ONLY)	91637	MFF1816G43200F
R4210	315-0334-00 -----		RES.,FXD,CMPSN:330K OHM,5%,0.25W (R4210, OPTION 2 ONLY)	01121	CB3345
R4212	315-0104-00 -----		RES.,FXD,CMPSN:100K OHM,5%,0.25W (R4212, OPTION 2 ONLY)	01121	CB1045
R4219	321-0993-07 -----		RES.,FXD,FILM:90K OHM,0.1%,0.125W (R4219, OPTION 2 ONLY)	91637	MFF1816C90001B
R4310	321-0260-00		RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
R4311	311-1943-00		RES.,VAR, NONWIR:10K OHM,10%,0.50W	73138	68-10-0
R4312	321-0341-00		RES.,FXD,FILM:34.8K OHM,1%,0.125W	91637	MFF1816G34801F

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R4315	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R4316	321-0289-07			RES.,FXD,FILM:10K OHM,0.1%,0.125W	91637	MFF1816C10001B
R4317	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R4320	315-0474-00			RES.,FXD,CMPSN:470K OHM,5%,0.25W	01121	CB4745
R4326	315-0155-00			RES.,FXD,CMPSN:1.5M OHM,5%,0.25W	01121	CB1555
R4327	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4330	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R4333	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R4334	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R4340	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R4341	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R4343	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R4345	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R4355	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4356	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R4357	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4360	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4361	315-0514-00			RES.,FXD,CMPSN:510K OHM,5%,0.25W	01121	CB5145
R4362	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R4364	307-0508-00			RES NTWK,FXD FI:15,1M OHM,5%,1.125W	01121	316A105
R4370	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4371	315-0514-00			RES.,FXD,CMPSN:510K OHM,5%,0.25W	01121	CB5145
R4372	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R4380	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4381	315-0514-00			RES.,FXD,CMPSN:510K OHM,5%,0.25W	01121	CB5145
R4382	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R4390	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4391	315-0514-00			RES.,FXD,CMPSN:510K OHM,5%,0.25W	01121	CB5145
R4392	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R4400	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R4410	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R4430	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R4431	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4441	315-0362-00			RES.,FXD,CMPSN:3.6K OHM,5%,0.25W	01121	CB3625
R4451	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	01121	CB6825
R4461	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R4471	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
R4480	315-0275-00			RES.,FXD,CMPSN:2.7M OHM,5%,0.25W	01121	CB2755
R4482	315-0275-00			RES.,FXD,CMPSN:2.7M OHM,5%,0.25W	01121	CB2755
S4050	260-1453-00			SWITCH,PUSH:1 BUTTON	80009	260-1453-00
S4082	260-1908-00			SWITCH,PUSH:2 BTN,4 POLE,1A,28VDC	80009	260-1908-00
T4020	120-1171-00	B010100	B010119	TRANSFORMER,RF:INVERTER,POT CORE	80009	120-1171-00
T4020	120-1171-01	B010120		TRANSFORMER,RF:INVERTER,POT CORE	80009	120-1171-01
U4040	156-1150-00			MICROCIRCUIT,LI:VOLTAGE REGULATOR,NEGATIVE	04713	MC79L05ACP
U4055	156-0937-00			MICROCIRCUIT,LI:VOLTAGE REFERENCE	24355	AD580LH
U4145	156-0495-00			MICROCIRCUIT,LI:OPNL AMPL (U4145, OPTION 2 ONLY)	27014	LM324N
U4160	156-0495-00			MICROCIRCUIT,LI:OPNL AMPL (U4160, OPTION 2 ONLY)	27014	LM324N
U4161	156-0644-00			MICROCIRCUIT,DI:QUAD BILATERAL SWITCH (U4161, OPTION 2 ONLY)	80009	156-0644-00
U4170	156-0495-00			MICROCIRCUIT,LI:OPNL AMPL (U4170, OPTION 2 ONLY)	27014	LM324N
U4180	156-0495-00			MICROCIRCUIT,LI:OPNL AMPL (U4180, OPTION 2 ONLY)	27014	LM324N

Replaceable Electrical Parts—401

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Discont	Name & Description	Mfr Code	Mfr Part Number
U4200	156-0853-00			MICROCIRCUIT, LI: OPERATIONAL AMPLIFIER, DUAL (U4200, OPTION 2 ONLY)	27014	LM358N
U4311	156-1118-00			MICROCIRCUIT, LI: ANALOG/DIGITAL CONVERTER	04713	MC14433PD
U4334	156-0494-00			MICROCIRCUIT, DI: HEX INVERTER/BUFFER	80009	156-0494-00
U4338	156-0366-00			MICROCIRCUIT, DI: DUAL D-TYPE F-F	80009	156-0366-00
U4350	156-0754-00			MICROCIRCUIT, DI: DUAL 4-INPUT NOR GATES	80009	156-0754-00
U4352	156-0525-00			MICROCIRCUIT, DI: DUAL J-K MASTER SLAVE F-F	80009	156-0525-00
U4400	156-0284-00			MICROCIRCUIT, DI: BCD-7 SEG DECODER/DRIVER	80009	156-0284-00
U4420	156-0925-00			MICROCIRCUIT, DI: DUAL 2 WIDE 2INP	02735	CD4085BF
U4510	150-1039-00	B010100	B010581	LAMP, GLOW, RDOUT: NEON, 7 SEGMENT, 1.5 DIGIT	52536	SP331
U4510	150-1039-01	B010582		LAMP, GLOW, RDOUT: NEON, 7 SEGMENT, 1.5 DIGIT	73138	SP331-02
U4520	150-1015-00	B010100	B010581	LAMP, GLOW, RDOUT: ORANGE, 2.0 DIGIT	73138	SP332
U4520	150-1015-01	B010582		LAMP, GLOW, RDOUT: ORANGE, 2.0 DIGIT	73138	SP332-01

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 (μ F).

Resistors = Ohms (Ω).

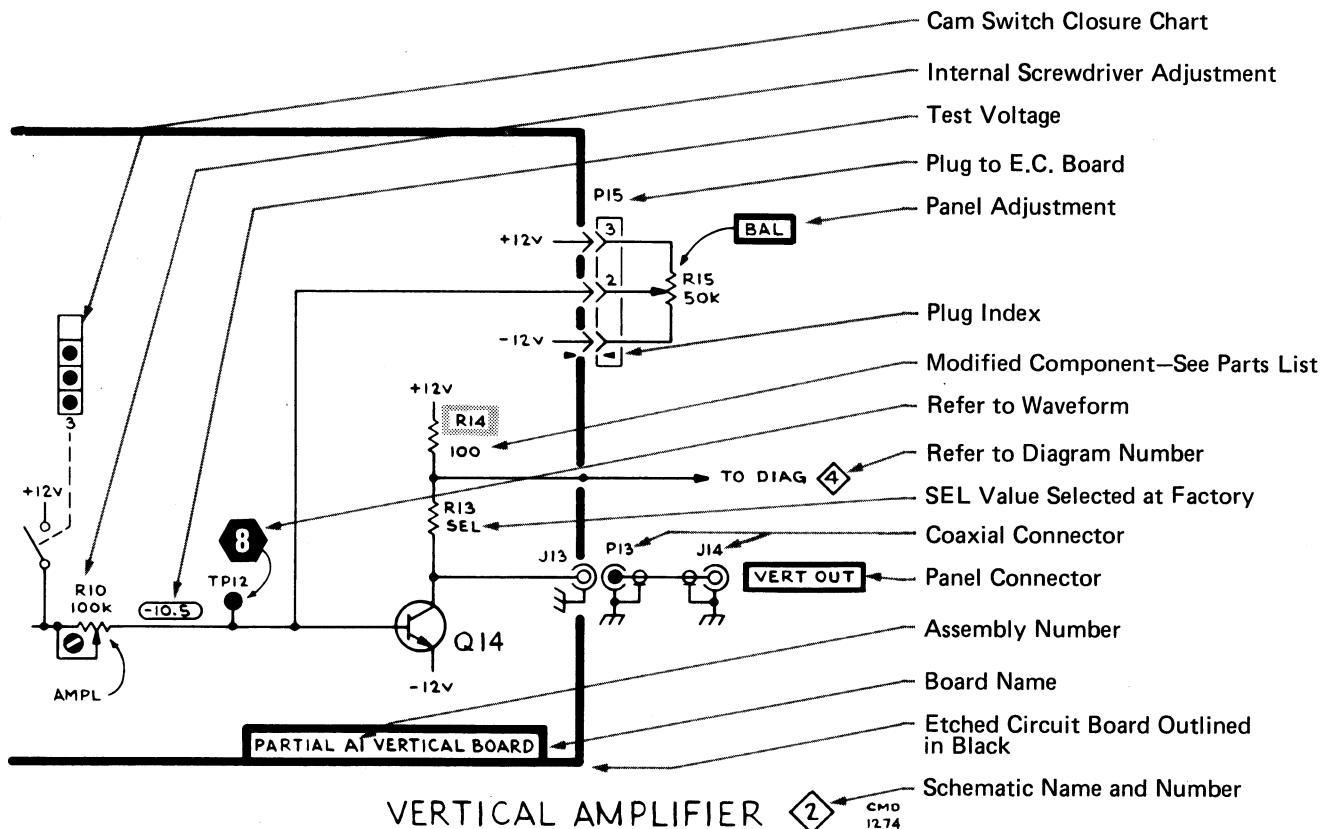
Symbols used on the diagrams are based on ANSI Standard Y32.2-1975.

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 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.)	RT	Thermistor
AT	Attenuator, fixed or variable	HR	Heater	S	Switch
B	Motor	HY	Hybrid circuit	T	Transformer
BT	Battery	J	Connector, stationary portion	TC	Thermocouple
C	Capacitor, fixed or variable	K	Relay	TP	Test point
CB	Circuit breaker	L	Inductor, fixed or variable	U	Assembly, inseparable or non-repairable (integrated circuit, etc.)
CR	Diode, signal or rectifier	LR	Inductor/resistor combination	V	Electron tube
DL	Delay line	M	Meter	VR	Voltage regulator (zener diode, etc.)
DS	Indicating device (lamp)	P	Connector, movable portion	Y	Crystal
E	Spark Gap	Q	Transistor or silicon-controlled rectifier	Z	Phase shifter
F	Fuse	R	Resistor, fixed or variable		
FL	Filter				

The following special symbols are used on the diagrams:



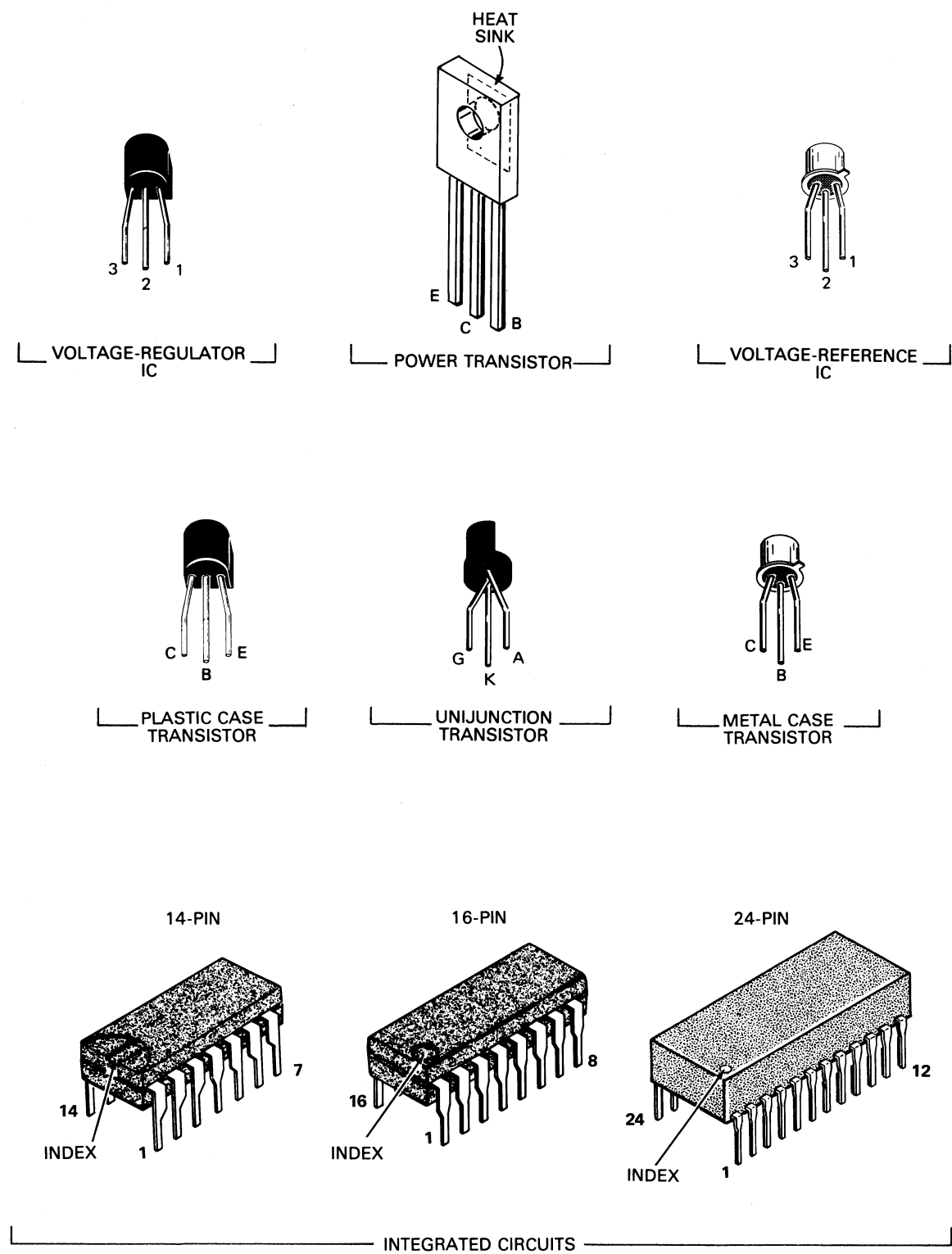


Figure 7-1. Semiconductor lead configurations.

2497-30

I.C. TRUTH TABLES

Symbol Definitions

1 High Level

X Don't Care

Negative Transition

0 Low Level

Positive Transition

CL Clock Level Change

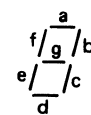
4027 (156-0525-00) DUAL J-K MASTER SLAVE FLIP-FLOP (U4352)

PRESENT STATE					CL ^Δ	NEXT STATE	
J	K	S	R	Q		Q	Q̄
1	X	0	0	0	Positive Transition	1	0
X	0	0	0	1	Positive Transition	1	0
0	X	0	0	0	Positive Transition	0	1
X	1	0	0	1	Positive Transition	0	1
X	X	0	0	X	Negative Transition		←NO CHANGE
X	X	1	0	X	X	1	0
X	X	0	1	X	X	0	1
X	X	1	1	X	X	1	1

4066 (156-0644-00) QUAD BILATERAL SWITCH (U4161)

CONTROL	SWITCH
1	closed
0	open

DM8880 (156-0284-00) DECODER/DRIVER (U4400)



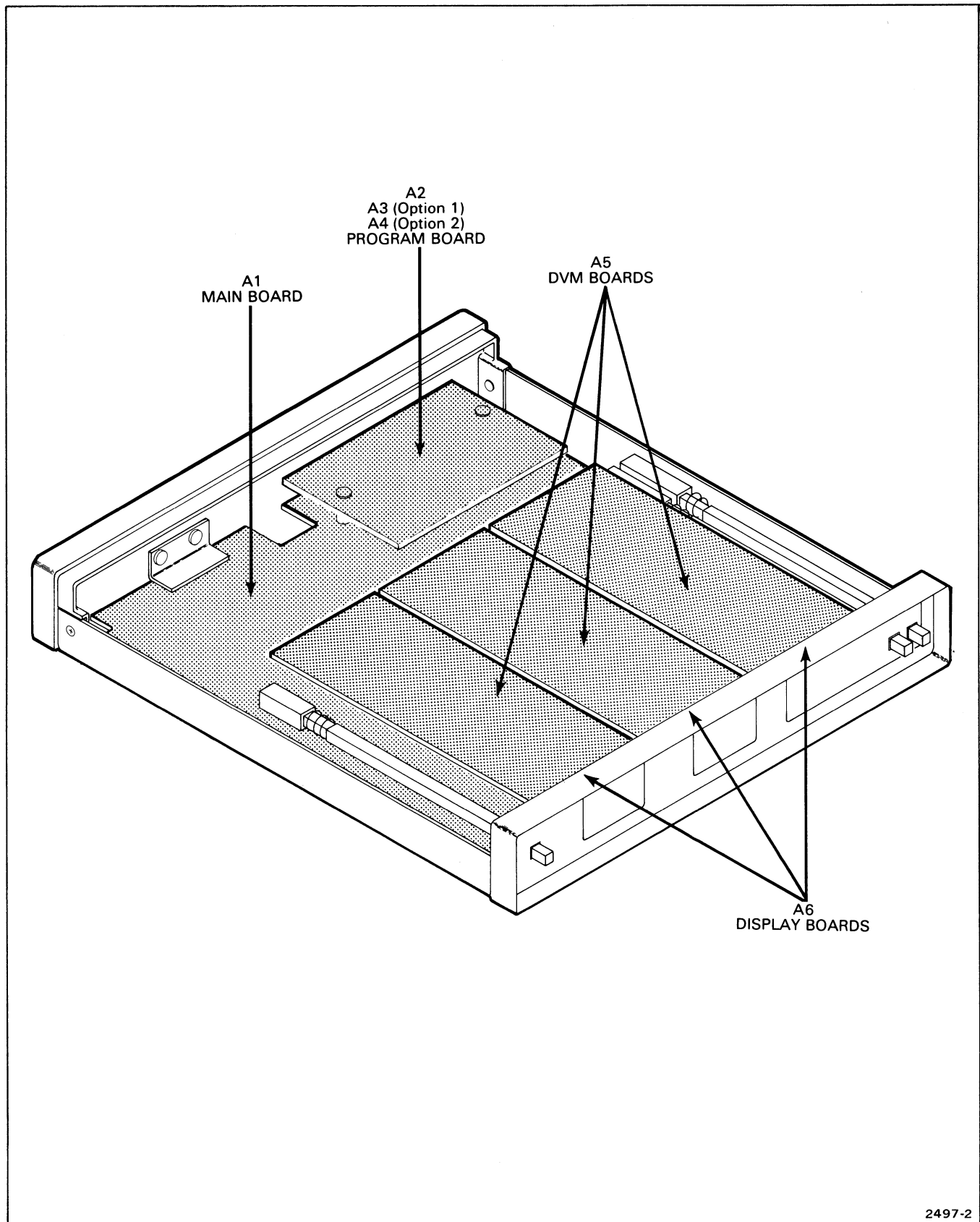
(SYMBOL IDENTIFICATION)

DECIMAL OR FUNCTION	RB1	D	C	B	A	B1/RB0	a	b	c	d	e	f	g	DISPLAY
0	1	0	0	0	0	1	0	0	0	0	0	0	1	0
1	X	0	0	0	1	1	1	0	0	1	1	1	1	1
2	X	0	0	1	0	1	0	0	1	0	0	1	0	2
3	X	0	0	1	1	1	0	0	0	0	1	1	0	3
4	X	0	1	0	0	1	1	0	0	1	1	0	0	4
5	X	0	1	0	1	1	0	1	0	0	1	0	0	5
6	X	0	1	1	0	1	0	1	0	0	0	0	0	6
7	X	0	1	1	1	1	0	0	0	1	1	1	1	7
8	X	1	0	0	0	1	0	0	0	0	0	0	0	8
9	X	1	0	0	1	1	0	0	0	0	1	0	0	9
10	X	1	0	1	0	1	0	0	0	1	0	0	0	A
11	X	1	0	1	1	1	1	1	0	0	0	0	0	b
12	X	1	1	0	0	1	0	1	1	0	0	0	1	C
13	X	1	1	0	1	1	1	0	0	0	0	1	0	d
14	X	1	1	1	0	1	0	1	1	0	0	0	0	E
15	X	1	1	1	1	1	0	1	1	1	0	0	0	F
B1	X	X	X	X	X	0	1	1	1	1	1	1	1	
RB1	0	0	0	0	0	0	1	1	1	1	1	1	1	

Figure 7-2. IC truth tables.

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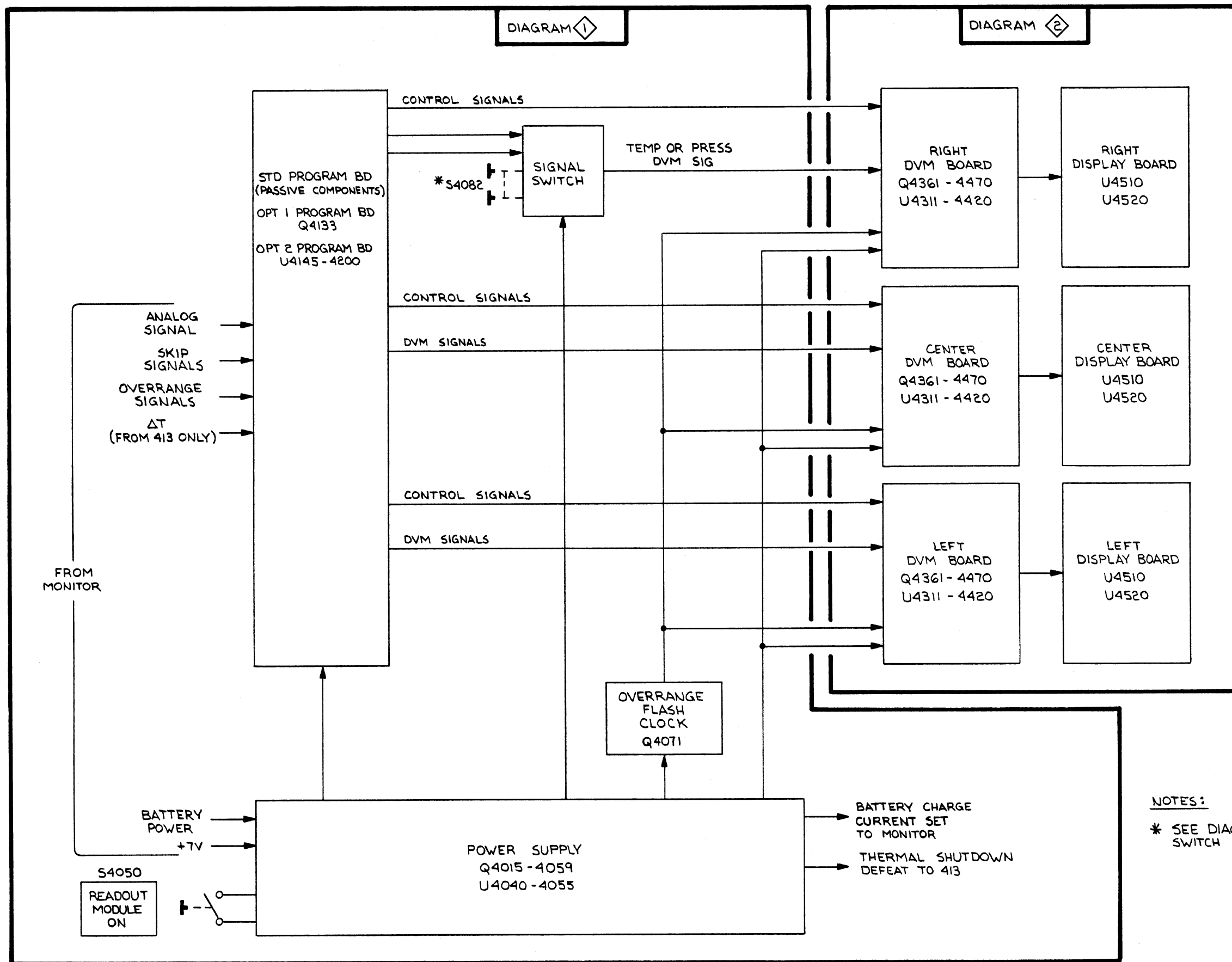
2497-31



2497-2

Figure 7-3. Circuit board locations.

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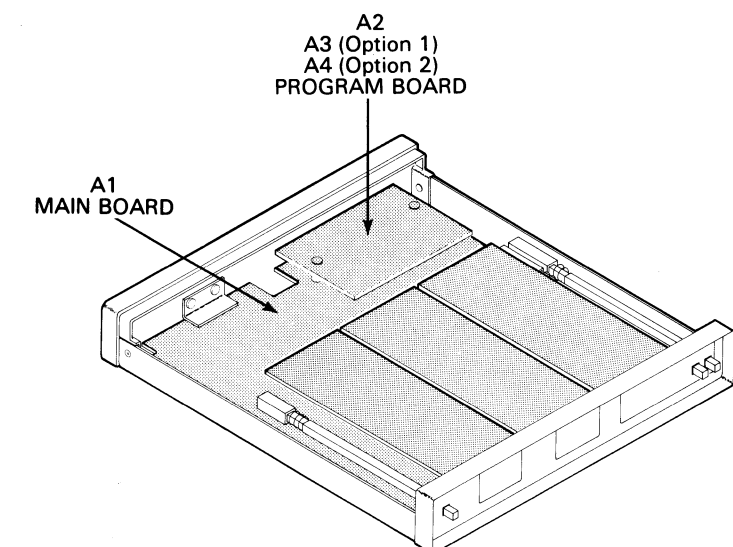


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CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
C4015	4F	CR4040	4H	P4070	2C	R4031	3H	TP4012	5F
C4017	5H	CR4041	4H	P4080	2E	R4050	5H	TP4014	5F
C4025	3F	CR4044	4H	P4090	2G	R4052	3I	TP4025	3H
C4028	3G	CR4045	4H			R4055	5H	TP4029	3G
C4029	3H	CR4080	3B	Q4015	4F	R4057	4F	TP4031	3H
C4031	3H	CR4082	3A	Q4020	6G	R4060	4E	TP4040	3H
C4040	4H	CR4084	3B	Q4022	6G	R4061	4E	TP4046	3H
C4041	4I	CR4086	3A	Q4055	4I	R4062	4E	TP4055	5F
C4044	4H			Q4059	5F	R4065	5I	TP4065	4I
C4046	3H	F4012	5H	Q4071	4E	R4070	3E	TP4071	3E
C4052	5F			Q4075	4F	R4071	3F	TP4075	3F
C4070	3F	P4010	5B			R4073	3F		
		P4020	6C	R4012	4F			U4040	4H
CR4025	3G	P4030	4C	R4014	5H	S4050	2I	U4055	5F
CR4028	3G	P4040	5I	R4015	4G	S4082	2A		
CR4029	3G	P4050	5H	R4025	3G				
CR4031	3H	P4060	5H	R4029	3G	T4020	4G		



CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
C4150	3A	CR4173	2D	R4159	1A	R4210	2B
C4151	1A	CR4183	2D	R4165	2C	R4212	3A
C4155	2A	CR4210	3B	R4166	1C	R4219	3D
C4156	2B	CR4212	2B	R4167	2B		
C4161	3C			R4169	1B	TP4159	1A
C4163	1C	P4020	3B	R4170	3D	TP4169	2B
C4165	1C	P4030	1B	R4171	3D	TP4199	1B
C4166	1B			R4180	1D		
C4171	3D	R4140	3A	R4181	1D	U4145	2A
C4181	2D	R4142	3B	R4195	1C	U4160	2C
C4191	1C	R4143	3A	R4196	1B	U4161	2C
C4193	3C	R4145	2A	R4197	1B	U4170	2D
C4195	1B	R4150	3A	R4199	1B	U4180	2B
C4196	2B	R4151	1A	R4200	3B	U4200	3C
C4210	2B	R4153	1A	R4201	3B		
		R4155	1A	R4206	3B		
CR4140	3A	R4156	2A	R4207	2C		
CR4143	3A	R4158	2A	R4208	3C		



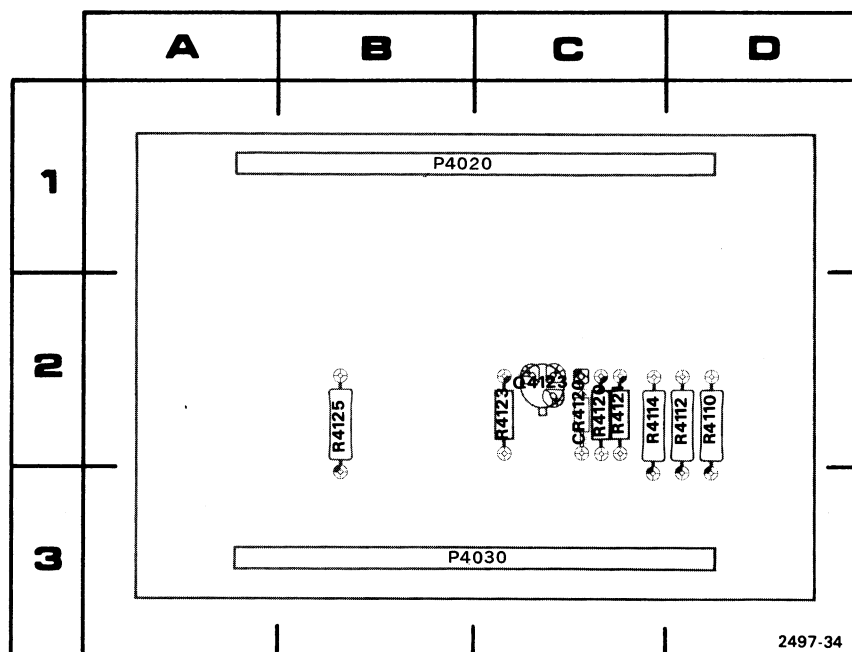


Figure 7-6. A3-401 Option 1 Program board component locations.

CKT NO	GRID COORD	CKT NO	GRID COORD
CR4120	2C	R4110	2D
P4020	1B	R4112	2D
P4030	3B	R4114	2C
		R4120	2C
		R4121	2C
Q4123	2C	R4123	2C
		R4125	2B

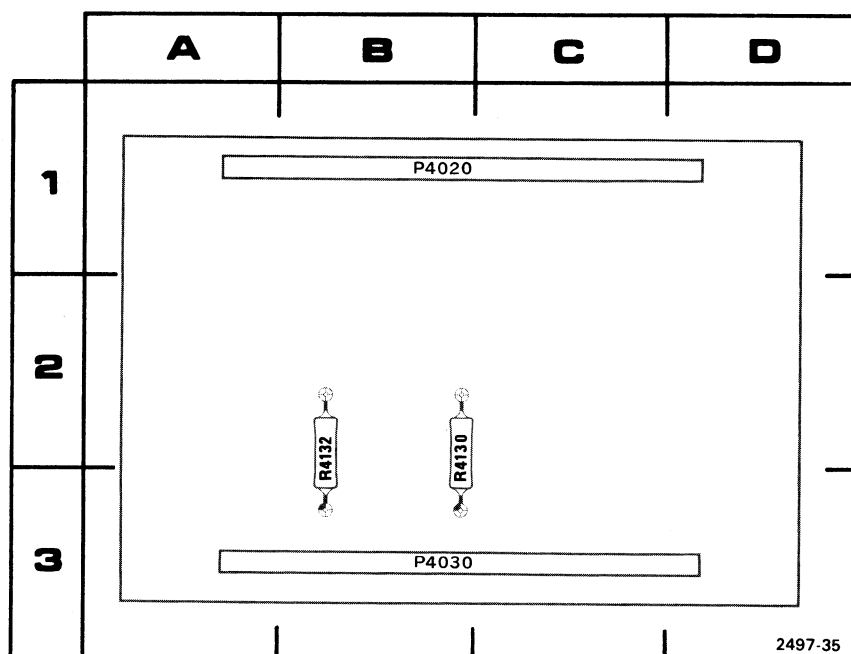


Figure 7-7. A2-401 Program board component locations.

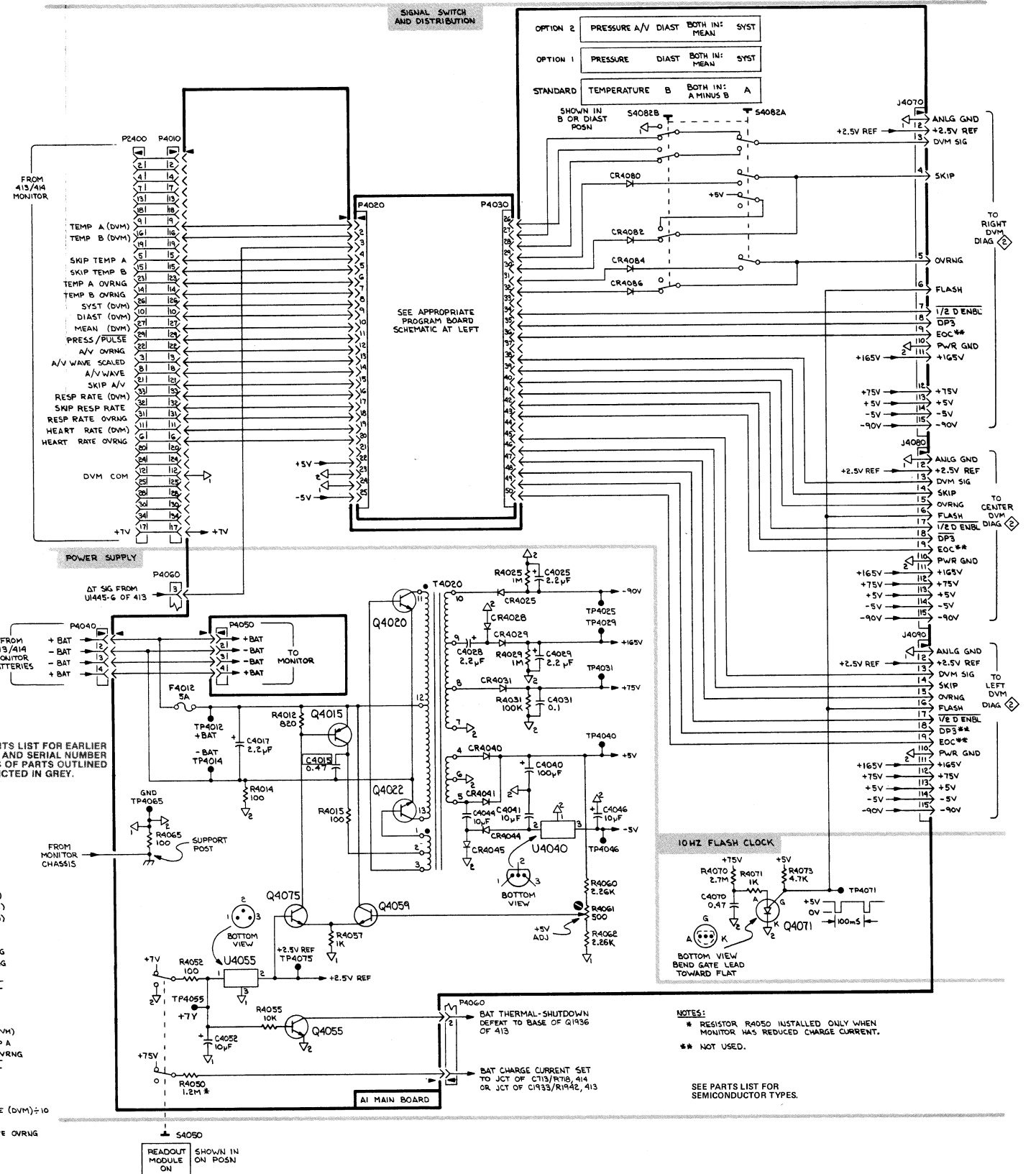
CKT NO	GRID COORD
P4020	1B
P4030	3B
R4130	3B
R4132	2B

MONITOR/401 INTERCONNECTING SIGNALS

P4010	SIGNAL NAME	NOT USED	STD	OPT 1	OPT 2	DIGITAL VOLTAGE LIMITS		ANALOG VOLTAGE EQUIV
						LO	HI	
1	ALARM EXT OUT	X				0V	+7V	
2	ALARM RESET	X				0V	+7V	
3	A/V WAVE SCALED				X			10 mV/mmHg
4	SKIP A	X				-7V	+7V	
5	SKIP TEMP A		X	X	X	-7V	+7V	
6	HEART RATE OVERRANGE		X	X	X	-7V	+7V	
7	°F/°C	X				0V	+1V	
8	A/V WAVE (PULSE WAVE)				X			0.5 V/cm
9	TEMP A (DVM)		X	X	X			10 mV/°C or °F
10	DIAST (DVM)			X				10 mV/mmHg
11	HEART RATE (DVM)		X	X	X			10 mV/bpm
12	DVM COMMON		X	X	X			
13	LOW BATT/MONITOR ON	X				-7V	+7V	
14	TEMP B OVERRANGE		X			-7V	+7V	
15	SKIP TEMP B		X			-7V	+7V	
16	TEMP B (DVM)		X					10 mV/°C or °F
17	+7 V		X	X	X			
18	A WAVE SCALED	X						10 mV/°C or °F
19	RESP WAVE							0.5 V/cm
20	A WAVE	X						0.5 V/cm
21	SKIP A/V				X	-7V	+7V	
22	A/V OVERRANGE			X		-7V	+7V	
23	TEMP A OVERRANGE		X	X	X	-7V	+7V	
24	-ECG WAVE	X						0.5 V/cm
25	WAVE COMMON	X						
26	SYST (DVM)			X				10 mV/mmHg
27	MEAN (DVM)			X				10 mV/mmHg
28	PRESS/PULSE TRIG	X				-7V	+7V	
29	PRESS/PULSE			X		-3.6V	+7V	
30	ALARM	X				-7V	+7V	
31	RESP RATE OVERRANGE		X			-7V	+7V	
32	SKIP RESP RATE		X			-7V	+7V	
33	RESP RATE (DVM)		X					10 mV/brth/min
34	RESP TRIG	X				-7V	+7V	

P4040/4050	
1 & 4	+BATTERY
2 & 3	-BATTERY

P4060	
1	BATTERY CHARGE CURRENT SET
2	BATTERY THERMAL SHUTDOWN DEFEAT
3	Δ T



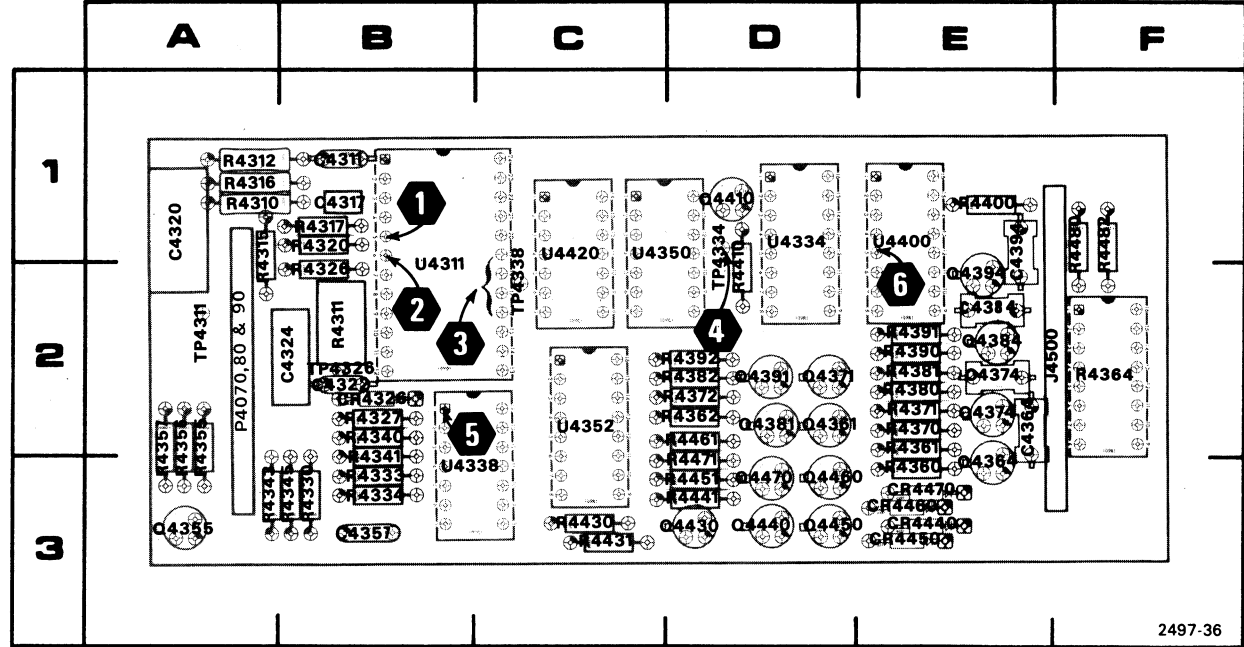


Figure 7-8. A5—DVM board component locations.

CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
C4311	1B	Q4371	2D	R4330	3B	R4431	3C
C4317	1B	Q4374	2E	R4333	3B	R4441	3D
C4320	3A	Q4381	2D	R4334	3B	R4451	3D
C4322	2B	Q4384	2E	R4340	2B	R4461	2C
C4324	2A	Q4391	2D	R4341	2B	R4471	2D
C4364	2E	Q4394	2E	R4343	3B	R4480	1F
C4374	2E	Q4410	1D	R4345	3B	R4482	1F
C4384	2E	Q4430	3D	R4360	3E		
C4394	1E	Q4440	3D	R4361	2E	TP4311	3A
		Q4450	3D	R4362	2C	TP4326	2B
CR4326	2B	Q4460	3D	R4364	2F	TP4334	1D
CR4440	3E	Q4470	3D	R4370	2E	TP4338	2C
CR4450	3E			R4371	2E		
CR4460	3E	R3281	2E	R4372	2C	U4311	1B
CR4470	3E	R4310	1A	R4380	2E	U4334	1D
		R4311	2B	R4381	2E	U4338	3B
		R4312	1A	R4382	2C	U4350	1C
P4070	2A	R4315	1A	R4390	2E	U4352	2C
P4080	2A	R4316	1A	R4391	2E	U4400	1E
P4090	2A	R4317	1B	R4392	2C	U4420	1C
P4500	2E	R4320	1B	R4400	1E		
Q4361	2D	R4326	2B	R4410	1D		
Q4364	3E	R4327	2B	R4430	3C		

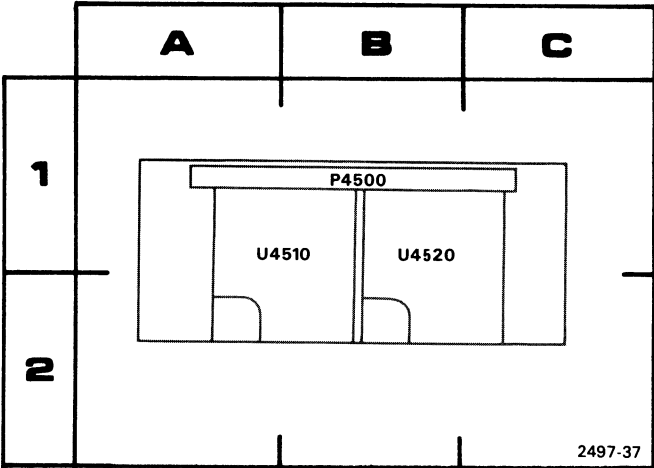
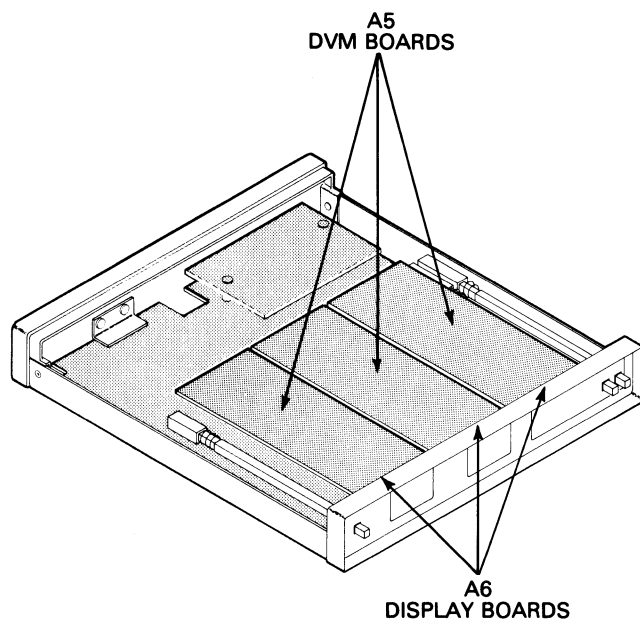


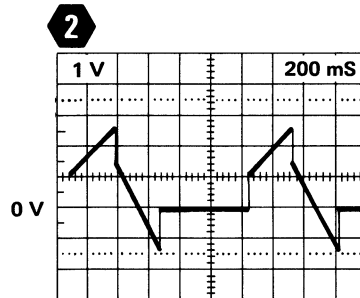
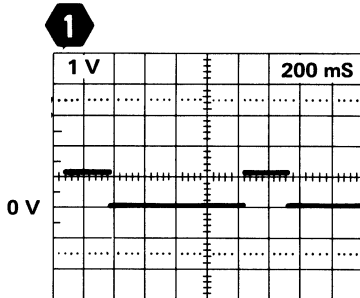
Figure 7-9. A6—Display component locations.

CKT NO	GRID COORD
P4500	1B
U4510	1B
U4520	1B

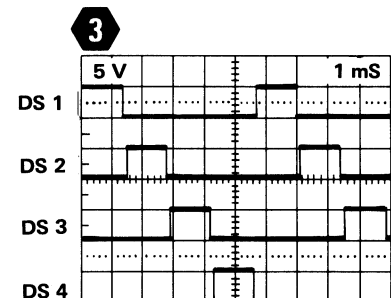


WAVEFORM CONDITIONS

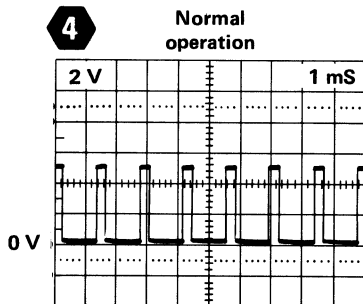
Waveforms shown below were taken on the temperature DVM board. A simulated temperature-sensor input of 113°F (DVM SIG = 1.13 V) was used, except for overrange condition. Overage condition is created by using a 122°F temperature-sensor input or by connecting +5 V to pin 7 of U4334C through a 10 k resistor.



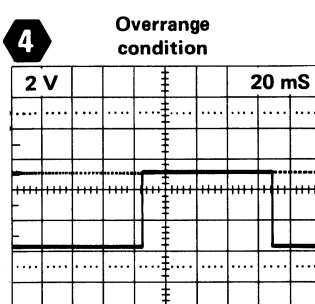
Test-oscilloscope sweep triggered on + slope of waveform 1. See note 1.



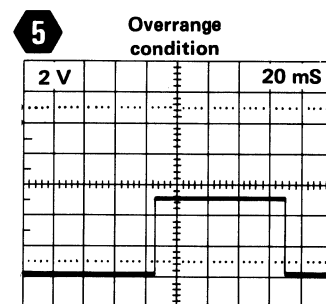
Test-oscilloscope sweep triggered on + slope of waveform 5. See note 2.



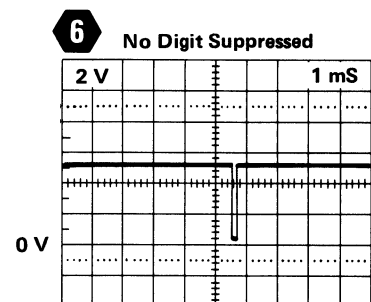
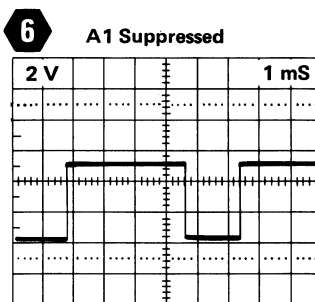
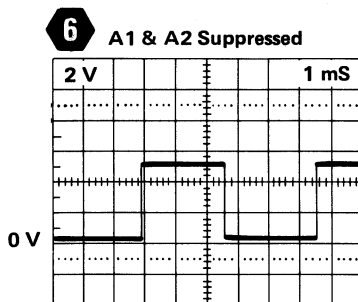
Test-oscilloscope sweep triggered on + slope of waveform 3 (DS1). See note 3.



Test-oscilloscope sweep triggered on - slope of waveform 3 (DS1)



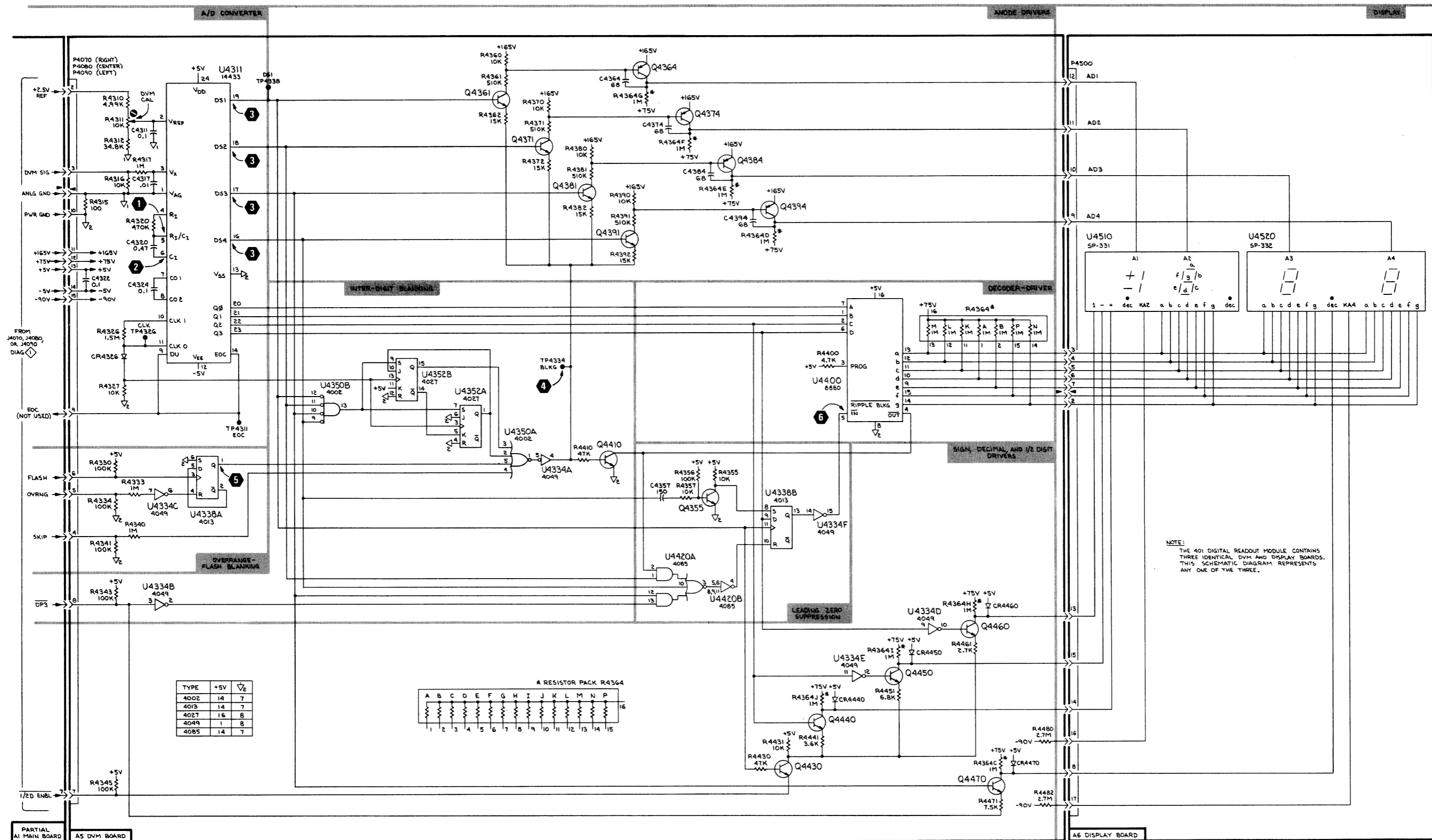
Test-oscilloscope sweep triggered on - slope of waveform 3 (DS1).



Test-oscilloscope sweep triggered on + slope of waveform 3 (DS1).

NOTES:

1. Slope and duration of ramp increases as amplitude of DVM SIG increases. Slope of falling ramp is constant at about 10 V/sec. Duration of falling ramp constant at 4000 clock pulses (TP4326).
2. There is a slight delay between digit select pulses. Time between pulses on given test point may appear unstable due to the operation of the autozero circuitry. This is normal.
3. This signal provides additional delay between digit-select pulses supplied to digit anodes.



SEE PARTS LIST FOR SEMICONDUCTOR TYPES.

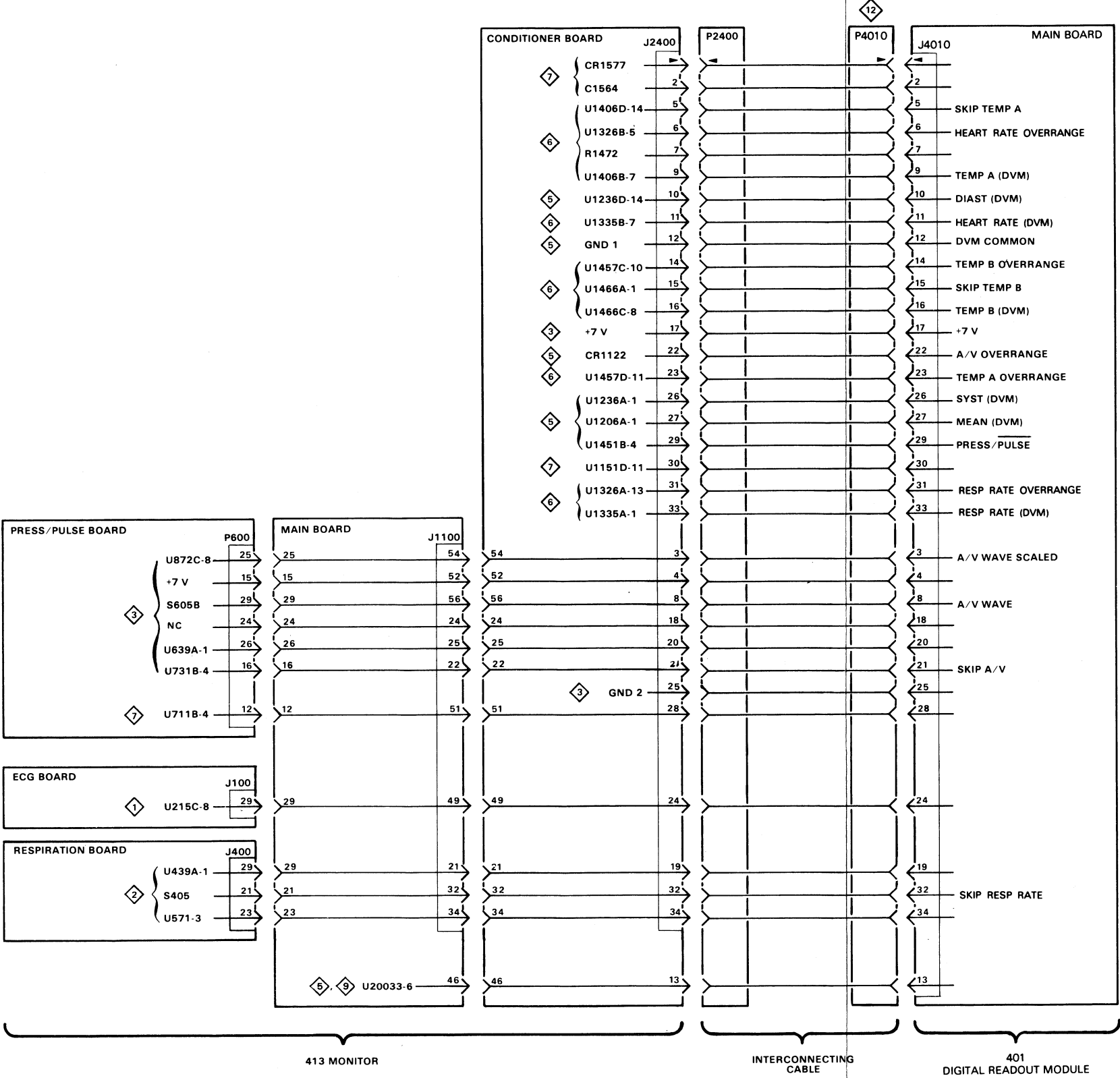
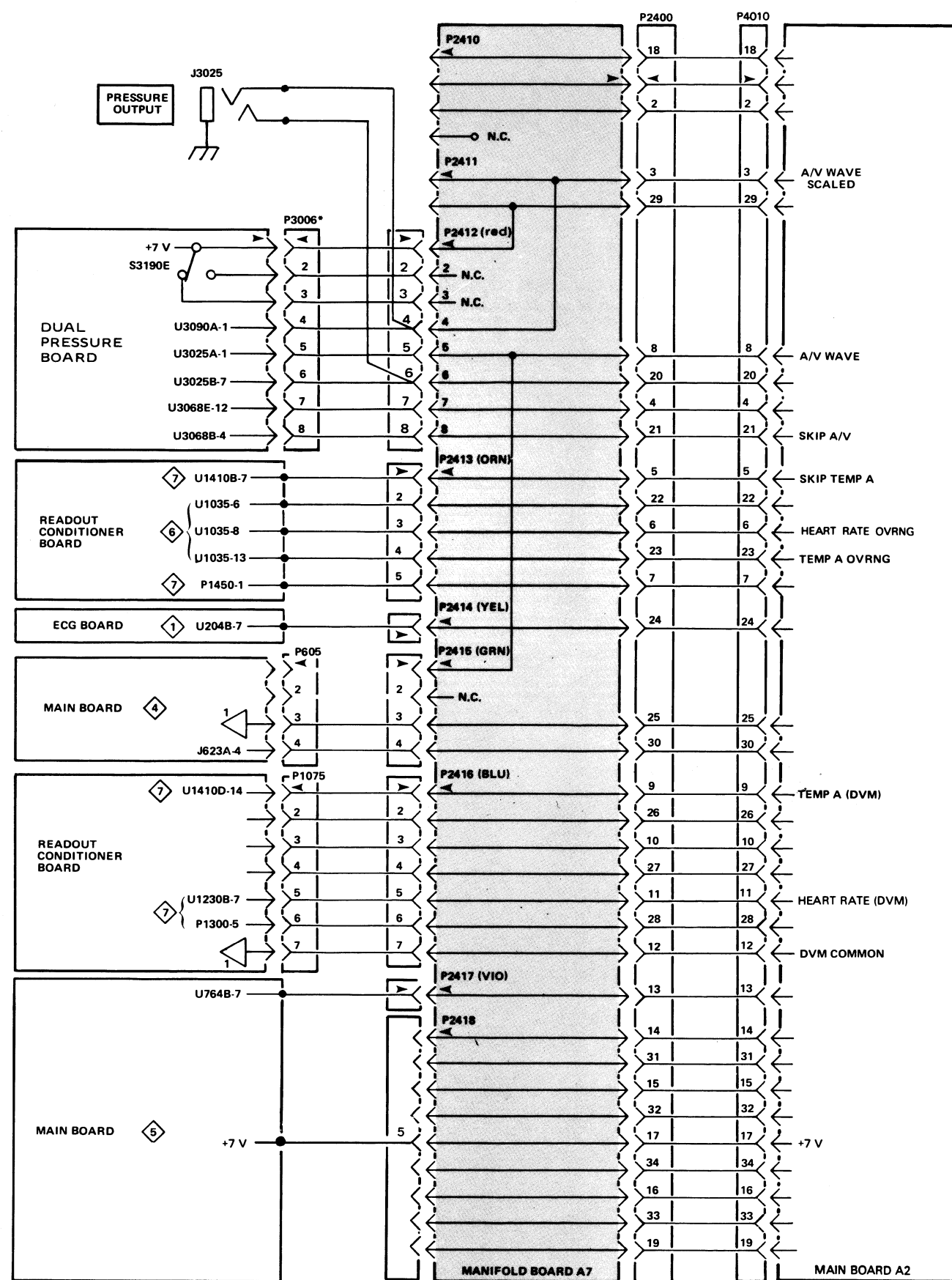


Figure 7-10. 413/401 Signal Interconnections.

(2429-28) 2497-40

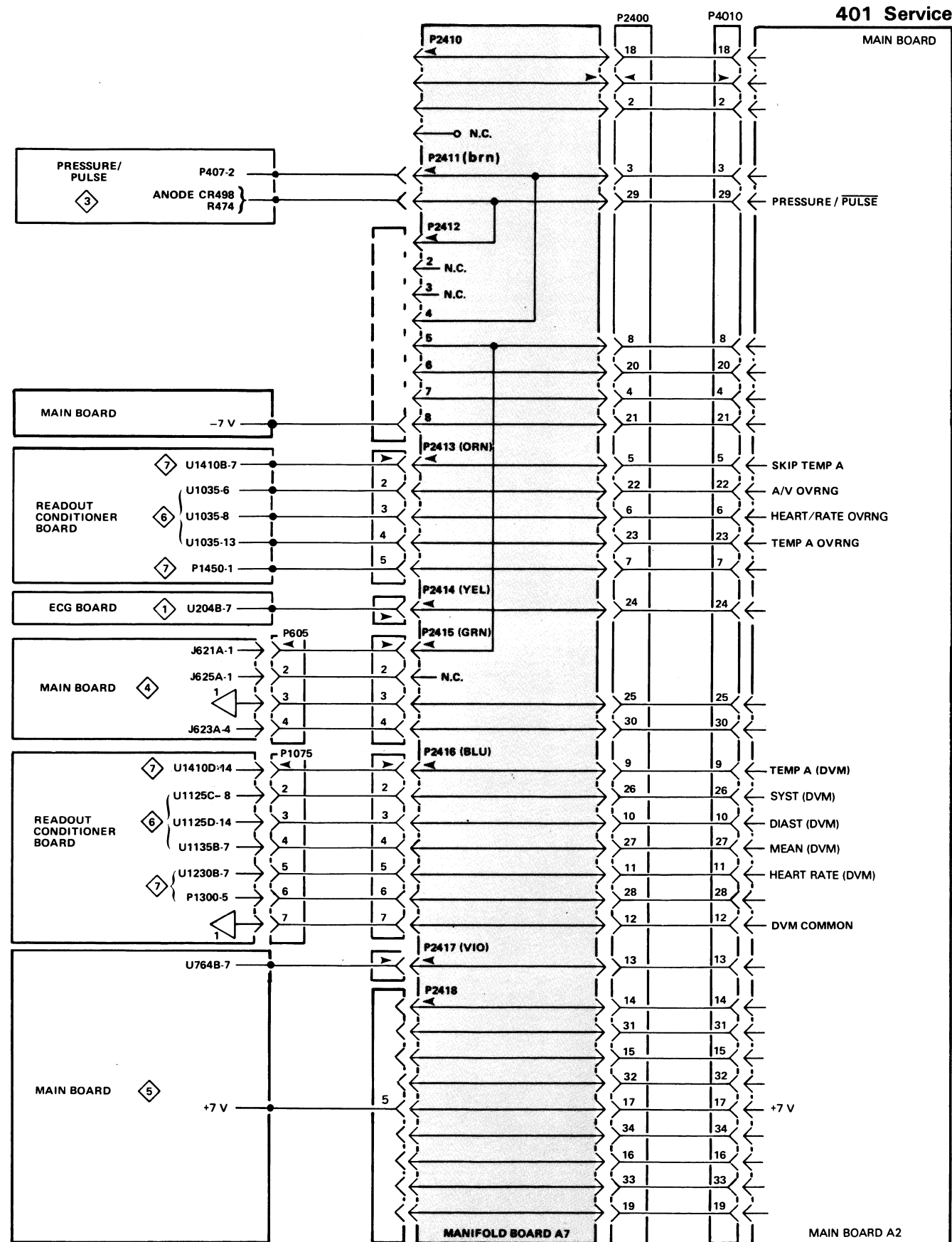


414 OPT 21 (MOD FA)

*ON SOME EARLY DUAL PRESSURE SCHEMATICS, P3006 MAY BE SHOWN AS P3090, ALSO PINS 7 & 8 ARE SHOWN INTERCHANGED.

INTERCONNECTING
CABLE

**401 DIGITAL
READOUT MODULE**
(2145-90) 2497-41



414

INTERCONNECTING
CABLE

401 DIGITAL
READOUT MODULE

(2145-89) 2497-42

Figure 8-11. 414/401 Signal Interconnections.

REV A MAY 1980

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	SLEEVING
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	ID	INTEGRATED CIRCUIT	RTNR	RETAINER	W/	WITH
CRT	CATHODE RAY TUBE	IC	INSIDE DIAMETER	SCH	SOCKET HEAD	WSHR	WASHER
DEG	DEGREE	IDNT	IDENTIFICATION	SCOPE	OSCILLOSCOPE	XFMR	TRANSFORMER
DWR	DRAWER	IMPLR	IMPELLER	SCR	SCREW	XSTR	TRANSISTOR

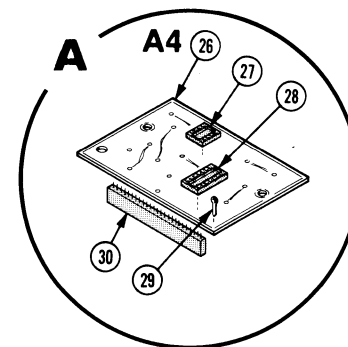
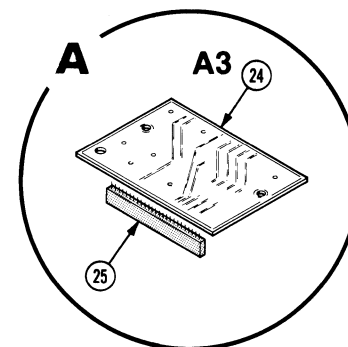
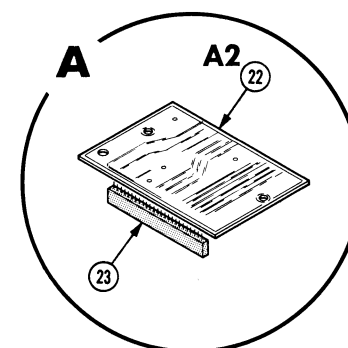
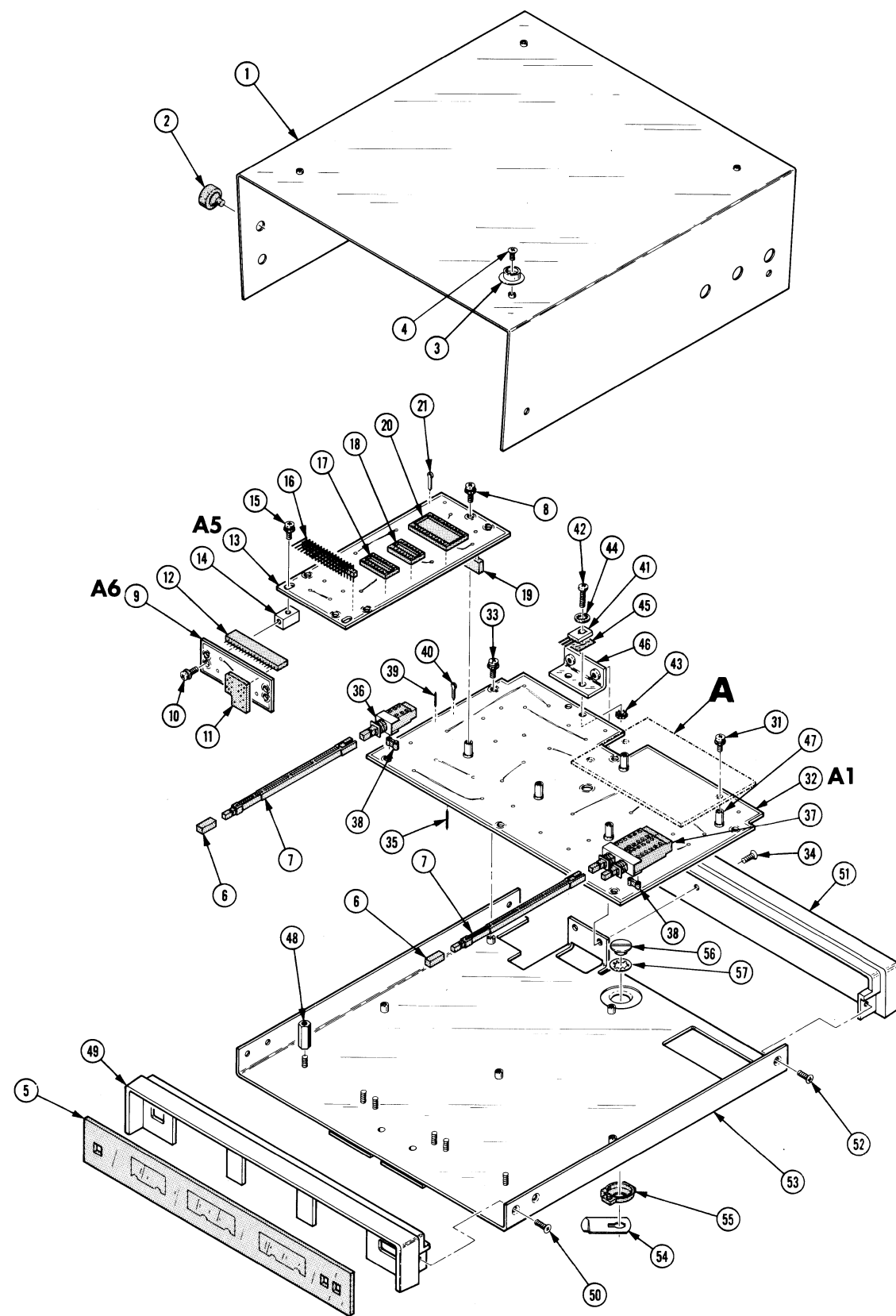
CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
22526	BERG ELECTRONICS, INC.	YOUK EXPRESSWAY	NEW CUMBERLAND, PA 17070
22670	G.M. NAMEPLATE, INC.	2040 15TH AVENUE WEST	SEATTLE, WA 98119
52536	BECKMAN INSTRUMENTS, INC., INFORMATION DISPLAYS OPERATION	350 N. HAYDEN ROAD	SCOTTSDALE, AZ 85257
71785	TRW, CINCH CONNECTORS	1501 MORSE AVENUE	ELK GROVE VILLAGE, IL 60007
73803	TEXAS INSTRUMENTS, INC., METALLURGICAL MATERIALS DIV.	34 FOREST STREET	ATTLEBORO, MA 02703
77132	DOT FASTENER CO., A UNITED-CARR DIV. OF TRW INC.	ROUND HOUSE INDL PK, PO BOX 710	WATERBURY, CT 06720
78189	ILLINOIS TOOL WORKS, INC. SHAKEPROOF DIVISION	ST. CHARLES ROAD	ELGIN, IL 60120
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
83385	CENTRAL SCREW CO.	2530 CRESCENT DR.	BROADVIEW, IL 60153

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-1	390-0622-00		1		CAB., WRAPAROUND:	80009	390-0622-00
	390-0623-00		1		CAB., WRAPAROUND:	80009	390-0623-00
	-----		-		(OPTION 1 AND 2)		
-2	348-0414-00		2		BUMPER, PLASTIC: 0.500 DIA, TEKBLUE	80009	348-0414-00
-3	355-0184-00		4		STUD, SNAP FSTNR:	77132	BS-10370
					(ATTACHING ARTS)		
-4	211-0105-00		4		SCREW, MACHINE: 4-40 X 0.188" 100 DEG, FLH STL	83385	OBD
					- - - * - - -		
-5	333-2424-00		1		PANEL, FRONT: 413 OPT 06	80009	333-2424-00
	333-2425-00		1		PANEL, FRONT: 414 OPT 07	80009	333-2425-00
	333-2426-00		1		PANEL, FRONT: 414 OPT 08	80009	333-2426-00
-6	366-1559-00		3		PUSH BUTTON: SIL GY, 0.18 SQ X 0.43	80009	366-1559-00
-7	384-1101-00		3		EXTENSION SHAFT: 4.14 INCH LONG	80009	384-1101-00
	334-3371-00		3		MARKER, IDENT: MARKED CAUTION	80009	334-3371-00
	381-0379-00		1		BAR, MOUNTING: CIRCUIT BOARD	80009	381-0379-00
	672-0731-00		3		CKT BOARD ASSY: DVM/DISPLAY	80009	672-0731-00
					(ATTACHING PARTS FOR EACH)		
-8	211-0116-00		3		SCR, ASSEM WSHR: 4-40 X 0.312 INCH, PNH BRS	83385	OBD
	-----		-		- - - * - - -		
-9	-----		-		. EACH CKT BOARD ASSY INCLUDES:		
			1		. CKT BOARD ASSY: DISPLAY (SEE A6 EPL)		
					(ATTACHING PARTS)		
-10	211-0116-00		2		. . SCR, ASSEM WSHR: 4-40 X 0.312 INCH, PNH BRS	83385	OBD
					- - - * - - -		
-11	136-0565-01		2		. . SKT, PL-IN ELEK: READOUT TUBE	52536	CS-332
-12	131-2184-00		1		. . CONN, RCPT, ELEC: CKT BD, 1 X 17FEM, TOP ENTRY	22526	65780-017
-13	-----		1		. CKT BOARD ASSY: DVM (SEE A5 EPL)		
-14	220-0729-00		2		. . NUT BLOCK: 0.25 X 0.471 INCH LONG	80009	220-0729-00
					(ATTACHING PARTS FOR EACH)		
-15	211-0116-00		1		. . SCR, ASSEM WSHR: 4-40 X 0.312 INCH, PNH BRS	83385	OBD
					- - - * - - -		
-16	131-2073-00		1		. . TERM. SET, PIN: 17 MALE CONT, RIGHT ANGLE	22526	65525-117
-17	136-0260-02		4		. . SKT, PL-IN ELEK: MICROCIRCUIT, 16 DIP, LOW CLE	71785	133-51-92-008
-18	136-0269-02		3		. . SKT, PL-IN ELEK: MICROCIRCUIT, 14 DIP, LOW CLE	73803	CS9002-14
-19	131-2173-00		1		. . CONN, RCPT, ELEC: CIRCUIT BD, 15 CONTACT	22526	65780-015
-20	136-0578-00		1		. . SKT, PL-IN ELEK: MICROCKT, 24 PIN, LOW PROFILE	73803	C S9002-24
-21	214-0579-00		4		. . TERM, TEST POINT: BRS CD PL	80009	214-0579-00
-22	-----		1		CKT BOARD ASSY: PROGRAMMED (SEE A2 EPL)		
-23	131-2174-00		2		. . CONN, RCPT, ELEC: CIRCUIT BD, 125 CONTACTS	22526	65780-025
-24	-----		1		CKT BOARD ASSY: PROGRAMMED (SEE A3 EPL)		
			-		(OPTION 1)		
-25	131-2174-00		2		. . CONN, RCPT, ELEC: CIRCUIT BD, 125 CONTACTS	22526	65780-025
-26	-----		1		CKT BOARD ASSY: PROGRAMMED (SEE A4 EPL)		
			-		(OPTION 2)		
-27	136-0514-00		1		. . SKT, PL-IN ELEK: MICROCIRCUIT, 8 DIP	73803	CS9002-8
-28	136-0269-02		5		. . SKT, PL-IN ELEK: MICROCIRCUIT, 14 DIP, LOW CLE	73803	CS9002-14
-29	214-0579-00		2		. . TERM, TEST POINT: BRS CD PL	80009	214-0579-00
-30	131-2174-00		2		. . CONN, RCPT, ELEC: CIRCUIT BD, 125 CONTACTS	22526	65780-025
					(ATTACHING PARTS FOR EACH OPT. BD)		
-31	211-0116-00		2		SCR, ASSEM WSHR: 4-40 X 0.312 INCH, PNH BRS	83385	OBD
					- - - * - - -		
-32	-----		1		CKT BOARD ASSY: MAIN (SEE A1 EPL)		
					(ATTACHING PARTS)		
-33	211-0116-00		6		SCR, ASSEM WSHR: 4-40 X 0.312 INCH, PNH BRS	83385	OBD
-34	211-0038-00		2		SCREW, MACHINE: 4-40 X 0.312, FLH, 100 DEG	83385	OBD
					- - - * - - -		
			-		. CKT BOARD ASSY INCLUDES:		
-35	131-0589-00		11		. TERM, PIN: 0.46 L X 0.025 SQ. PH BRZ GL	22526	47350
-36	-----		1		. SWITCH, PUSH: (SEE S4050 EPL)		
-37	-----		1		. SWITCH, PUSH: (SEE S4082 EPL)		
-38	361-0385-00		6		. SPACER, PB SW: 0.164 INCH LONG	80009	361-0385-00
-39	131-0608-00		129		. TERMINAL, PIN: 0.365 L X 0.25 PH, BRZ, GOLD PL	22526	47357
-40	214-0579-00		11		. TERM, TEST POINT: BRS CD PL	80009	214-0579-00

Replaceable Mechanical Parts—401

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-41	-----	-----	2	.	TRANSISTOR:(SEE Q4020 & Q4022 EPL) (ATTACHING PARTS FOR EACH)		
-42	211-0012-00		1	.	SCREW,MACHINE:4-40 X 0.375,PNH STL CD PL	83385	OBD
-43	210-0586-00		1	.	NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL	83385	211-041800-00
-44	210-0071-00		1	.	WASHER,SPR TNSN:0.146 ID X 0.323" OD,STL	78189	4706-05-01-0531
-45	342-0224-00		1	.	INSULATOR,PLATE:TRANSISTOR	80009	342-0224-00
					- - - * - - -		
-46	214-2712-00		1	.	HEAT SINK,ELEC:CKT BD MOTHER,AL	80009	214-2712-00
-47	129-0232-00		5	.	SPACER,POST:0.344L,W/4-40THD THRU,BRASS	80009	129-0232-00
-48	129-0420-00		6	.	POST,ELEC-MECH:0.575 LONG X 0.188 I HEX	80009	129-0420-00
	210-0202-00		2	.	TERMINAL,LUG:0.146 ID,LOCKING,BRZ TINNED	78189	2104-06-00-2520N
	210-0457-00		1	.	NUT,PL,ASSEM WA:6-32 X 0.312 INCH,STL	83385	OBD
-49	426-1511-00		1	.	FRAME,CABINET:FRONT	80009	426-1511-00
					(ATTACHING PARTS)		
-50	211-0038-00		2	.	SCREW,MACHINE:4-40 X 0.312,FLH,100 DEG	83385	OBD
					- - - * - - -		
-51	426-1512-00		1	.	FRAME,CABINET:REAR	80009	426-1512-00
					(ATTACHING PARTS)		
-52	211-0038-00		2	.	SCREW,MACHINE:4-40 X 0.312,FLH,100 DEG	83385	OBD
					- - - * - - -		
-53	441-1417-00		1	.	CHASSIS,CAB.FR:	80009	441-1417-00
-54	386-1151-00		1	.	CLAMP,RIM CLENC:SPG STL CD PL	80009	386-1151-00
-55	386-0227-00		1	.	STOP,CLP,RIM CL:ACETAL	80009	386-0227-00
					(ATTACHING PARTS)		
-56	214-0603-01		1	.	PIN,SECURING:0.27 INCH LONG	80009	214-0603-01
-57	214-0604-00		1	.	WASH.,SPG TNSN:0.26 ID X 0.47 INCH OD	80009	214-0604-00
					- - - * - - -		
	334-3380-00	B010100 B010319	1	.	MARKER,IDENT:MKD STATIC ELEC CAN DAMAGE	22670	OBD
	334-3380-00	B010320	3	.	MARKER,IDENT:MKD STATIC ELEC CAN DAMAGE	22670	OBD
	334-3469-00	XB010120	1	.	MARKER,IDENT:MKD INTCON CAARRANGEMENT	80009	334-3469-00
	334-3471-00	XB010120	1	.	MARKER,IDENT:MKD INTCON CAARRANGEMENT	80009	334-3471-00
	334-3472-00	XB010120	1	.	MARKER,IDENT:MKD INTCON CAARRANGEMENT	80009	334-3472-00
	-----		-	.	(OPTION 1 AND 2)		
	334-3473-00	XB010120	1	.	MARKER,IDENT:MKD INTCON CAARRANGEMENT	80009	334-3473-00
	-----		-	.	(OPTION 1 AND 2)		
	195-0237-00		1	.	LEAD,ELECTRICAL:26 AWG,13.5 L,STRANDED	80009	195-0237-00
	195-0187-00		1	.	LEAD,ELECTRICAL:1,26 AWG,4.0 L	80009	195-0187-00
					ACCESSORIES		
	070-2497-00		1	.	MANUAL,TECH:INSTRUCTION	80009	070-2497-00
	070-2565-00		1	.	MANUAL,TECH:OPERATORS	80009	070-2565-00



ACCESSORIES

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1	2	3	4	5	Name & Description	Mfr Code	Mfr Part Number
	070-2497-00			1						MANUAL, TECH: INSTRUCTION	80009	070-2497-00
	070-2565-00			1						MANUAL, TECH: OPERATORS	80009	070-2565-00

ACCESSORIES



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 Ω .	107 - Risetime less than 3.0 ns into 50 Ω .
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 market 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 μ 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 μ 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.

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**TEKTRONIX®**committed to
technical excellence**MANUAL CHANGE INFORMATION**PRODUCT 400, 401, 408, 412
413 & 414 SERVICE MANUALSCHANGE REFERENCE C8/378DATE 3-15-78

CHANGE:

DESCRIPTION

BATTERY USE AND CARE

THIS INFORMATION SUPERSEDES ALL SIMILAR INFORMATION
CONTAINED ELSEWHERE IN THIS MANUAL

CONTENTS OF THIS SECTION:

1. BATTERY CHARGING INSTRUCTIONS AND RELATED INFORMATION,
2. INSTRUCTIONS FOR A PERIODIC BATTERY-OPERATING-TIME TEST WHICH THE USER SHOULD PERFORM,
3. A CHART WHICH SHOWS THE BATTERY CHARGING AND OPERATING TIMES APPROPRIATE FOR VARIOUS MONITORS, AND
4. A MAINTENANCE PLAN FOR QUALIFIED SERVICE PERSONNEL.

1. BATTERY CHARGING INSTRUCTIONS

- A. 16 HOURS MINIMUM ARE REQUIRED TO RECHARGE A DEPLETED BATTERY. CONNECT THE LINE CORD PLUG TO A "HOSPITAL GRADE" AC OUTLET.

LONGER CHARGING TIME IS REQUIRED UNDER CERTAIN CIRCUMSTANCES. SEE THE TIME CHART ON A LATER PAGE OF THIS SECTION.

- B. CHARGE IN A COOL PLACE; PREFERABLY NO WARMER THAN $+22^{\circ}\text{C}$ ($\approx +72^{\circ}\text{F}$).

HIGHER TEMPERATURES PREVENT THE BATTERY FROM ACCEPTING MAXIMUM CHARGE. LONGER CHARGING TIME WILL ONLY PARTIALLY COMPENSATE FOR A HIGH TEMPERATURE. NO CHARGING WILL OCCUR WHEN THE TEMPERATURE EXCEEDS $+40^{\circ}\text{C}$ ($+104^{\circ}\text{F}$).

MAXIMUM BATTERY OPERATING TIME IS OBTAINED WHEN CHARGING IS DONE WITH THE MONITOR TURNED

CHANGE:	DESCRIPTION
	<p>OFF AND IN A COOL PLACE. WITH THE MONITOR OFF, THE INTERNAL TEMPERATURE WILL BE LOWER.</p> <p>C. AVOID EXCESSIVE CHARGING.</p> <p>IF THE MONITOR IS NOT BEING USED, TURN IT OFF. UNPLUG IT FROM THE AC OUTLET WHEN THE BATTERY IS FULLY CHARGED.</p> <p>THE BATTERY WILL GRADUALLY DISCHARGE ITSELF OVER A TWO TO SIX MONTH PERIOD AND WILL, THEREFORE, REQUIRE RECHARGING WHEN IT IS AGAIN PLACED INTO USE.</p> <p>APPLICATIONS, SUCH AS USE IN INTENSIVE CARE, MAY REQUIRE CONTINUOUS USE AND, THEREFORE, WILL REQUIRE THE MONITOR TO BE CONTINUOUSLY CONNECTED TO AN AC OUTLET. WEEKS OR MONTHS OF EXCESSIVE CHARGING RESULT. WHEN NEXT USED ON BATTERY, THE OPERATING TIME MAY BE SIGNIFICANTLY LESS THAN THE LISTED, TYPICAL AMOUNT.</p> <p>2. BATTERY OPERATING TIME TEST</p> <p>OCCASIONALLY CHECK OPERATING TIME AS FOLLOWS:</p> <p>A. CHARGE FULLY. SEE THE TIME CHART ON A LATER PAGE OF THIS SECTION.</p> <p>B. OPERATE MONITOR ON BATTERY UNTIL AUTOMATIC SHUTDOWN OCCURS.</p> <p>C. NOTE THE OPERATING TIME.</p> <p>IF THE OPERATING TIME IS SIGNIFICANTLY LESS THAN LISTED ON THE CHART AND BECOMES, THEREFORE, UNSUITABLE FOR YOUR APPLICATION, REFER THE MONITOR FOR SERVICE.</p>
PAGE 2 OF 6	

TEKTRONIX MEDICAL MONITORS

BATTERY CHARGING AND OPERATING TIMES

MONITOR TYPE	CHARGING HOURS @ 20-25°C AMBIENT			OPERATING HOURS ^{①②}	
	D-CELL BATTERY	F-CELL BATTERY		D-CELL BATTERY	F-CELL BATTERY
	EITHER OPERATING OR NOT	NOT OPERATING	FULLY OPERATING	TYPICAL	TYPICAL
408 MONITOR	16	16	18	3.5	5.6
w/400 RECORDER	③	16	20④		5.3④
w/400 RECORDER	③	16	26⑤		4.6⑤
412 MONITOR	16	16	18	2.5	4.0
w/400 RECORDER	③	16	20④		3.8④
w/400 RECORDER	③	16	26⑤		3.3⑤
413 MONITOR	16	16	18	1.6	2.6
w/400 RECORDER	③	16	20④		2.5④
w/400 RECORDER	③	16	26⑤		2.3⑤
w/401 DRM	③	16	50		1.9
w/BOTH 400 & 401	③	16	⑦		1.8④
414 MONITOR	16	16	18	1.7	2.7
w/400 RECORDER	③	16	20④		2.6④
w/400 RECORDER	③	16	26⑤		2.4⑤
w/400 RECORDER	③	16	22⑥		2.5⑥
w/401 DRM	③	16	50		2.1
w/BOTH 400 & 401	③	16	⑦		2.0④

Footnotes:

- Operating times listed are for new battery packs which have been charged while the monitor is turned off. For battery packs charged while the monitor was operating, reduce the listed time by about one-third.
- Operating times listed assume that all monitor capabilities are being used and with typical trace positions and sizes.
- Combination not recommended.
- With Recorder producing four 14-second strips per hour.
- With Recorder producing twenty 14-second strips per hour.
- With Option 3 Recorder producing four 28-second strips per hour.
- Monitor can be operating, but either or both the Recorder or DRM must be turned off for charging to take place.

CHANGE:

DESCRIPTION

4. MAINTENANCE

THE FOLLOWING PROCEDURES ARE TO BE PERFORMED BY QUALIFIED SERVICE PERSONNEL ONLY.

WHEN A BATTERY PROVIDES SIGNIFICANTLY LESS THAN THE RATED OPERATING TIME, THERE ARE THREE ALTERNATIVES:

- A. REPLACE IT WITH A NEW BATTERY, OR
- B. ATTEMPT TO REJUVENATE THE BATTERY, OR
- C. CONTINUE TO USE THE BATTERY, AS IS.

ATTEMPTED REJUVENATION CARRIES THE RISK THAT ONE OR MORE CELLS MAY BECOME SHORT CIRCUITED INTERNALLY AND MUST THEN BE REPLACED. THIS RISK IS OF LITTLE CONSEQUENCE IF IT HAS ALREADY BEEN DECIDED THAT THE BATTERY CAN NO LONGER BE USED.

REJUVENATION CONSISTS OF:

- A. DEEP DISCHARGE
- B. RECHARGE
- C. DEEP DISCHARGE
- D. RECHARGE

THIS PROCEDURE SHOULD CORRECT ANY ACCUMULATED CHARGE IMBALANCE AND REFORM THE CRYSTALLINE STRUCTURE OF THE CELL PLATES. IF ADEQUATE OPERATING TIME IS NOT RESTORED, THE BATTERY SHOULD BE REPLACED.

DEEP DISCHARGE IS ACCOMPLISHED BY CONNECTING A RESISTOR ACROSS THE BATTERY. RESISTOR VALUE SHOULD BE ABOUT TEN OHMS AND THE POWER RATING SHOULD BE AT LEAST FIVE WATTS (TEK PART No. 308-0399-00). THE RESISTOR WILL GET HOT, SO TAKE APPROPRIATE PRECAUTIONS. THE RESISTOR SHOULD REMAIN CONNECTED UNTIL THE BATTERY VOLTAGE DROPS BELOW ONE VOLT.

CHANGE:	DESCRIPTION
	<p>BATTERY RECHARGING CAN, OF COURSE, BE ACCOMPLISHED THROUGH IT'S MONITOR, BUT YOUR MONITORS NEED NOT BE KEPT IN THE MAINTENANCE AREA WHILE THIS REJUVENATION IS PERFORMED. THE MONITOR CAN BE USED ON AC LINE WITHOUT A BATTERY INSTALLED (UNLESS THE MONITOR IS EQUIPPED WITH A 400 RECORDER AND/OR A 401 DIGITAL READOUT MODULE). HOWEVER, THIS MAY BE INCOMPATIBLE WITH THE USER'S NEEDS.</p> <p>RECHARGING SHOULD BE DONE WITH A RELATIVELY CONSTANT CURRENT SOURCE, NOT A VOLTAGE SOURCE AS WITH LEAD-ACID BATTERIES. THIS CAN BE ACCOMPLISHED BY PUTTING A SUITABLE RESISTOR IN SERIES WITH A POWER SUPPLY. THE PACK VOLTAGE WILL RANGE FROM AS LOW AS 4.6 VOLTS DURING THE LATTER PHASE OF DISCHARGING TO AS HIGH AS 6 VOLTS DURING THE LATTER PHASE OF CHARGING.</p> <p>THE RECOMMENDED CHARGING CURRENTS FOR THIS PURPOSE ARE:</p> <p>D - CELLS 250 TO 350 mA (BATTERY PACK - TEK PART No.: 119-0441-01)</p> <p>F - CELLS 400 TO 600 mA (BATTERY PACK - TEK PART No.: 119-0443-01)</p> <p>THE FOLLOWING IS RECOMMENDED. BUY EXTRA BATTERY PACKS, PERHAPS ONE EXTRA FOR EACH FIVE MONITORS IN USE. IF YOU USE BOTH "D" AND "F" CELL BATTERIES, THEY MUST BE CONSIDERED SEPARATELY. PUT A NEW BATTERY IN THE MONITOR AND RETURN IT FOR USE WHILE THE REJUVENATION PROCEDURE IS PERFORMED. (NOTE: MONITORS EQUIPPED WITH D-CELL PACKS CAN BE CONVERTED TO F-CELL PACKS BY INSTALLING AN F-CELL MOD KIT - TEK PART No.: 040-0710-00).</p> <p>IT IS SUGGESTED THAT EACH BATTERY PACK BE MARKED WITH AN IDENTIFYING NUMBER AND THAT BATTERY SERVICE RECORDS BE KEPT.</p>

CHANGE:	DESCRIPTION
	<p>BATTERY PACKS WHICH FAIL TO REJUVENATE MAY BE REPAIRABLE BY REPLACING THE DEFECTIVE CELL(S). THERE ARE SEVERAL THINGS TO KEEP IN MIND WHEN REPLACING CELLS:</p> <ol style="list-style-type: none">1. REPLACE CELLS WHICH FAIL TO DELIVER AT LEAST 75% OF THEIR LISTED, TYPICAL OPERATING TIME.2. WHEN A BATTERY PACK HAS BEEN IN SERVICE MORE THAN ONE YEAR, IT IS PROBABLY WISE TO REPLACE ALL OF THE CELLS WHEN THE FIRST BAD CELL IS DETECTED.3. REPLACEMENT CELLS SHOULD BE OBTAINED FROM TEKTRONIX BECAUSE THESE SPECIAL CELLS ARE DIFFICULT TO OBTAIN OTHERWISE. LOCALLY AVAILABLE CELLS TYPICALLY HAVE LOWER CAPACITY, NARROWER TEMPERATURE RANGE AND CANNOT TOLERATE THE MAGNITUDE OF CHARGING CURRENT PROVIDED BY THE MONITOR.4. MINIMIZE THE AMOUNT OF HEAT TRANSFERRED FROM SOLDERING IRON TO CELL BODY. BEND THE SOLDER TAB OUTWARD, AWAY FROM THE CELL BODY AND PLACE A HEAT-SINK CLIP BETWEEN THE CELL BODY AND THE SOLDER AREA. NEVER SOLDER DIRECTLY TO THE CELL BODY.