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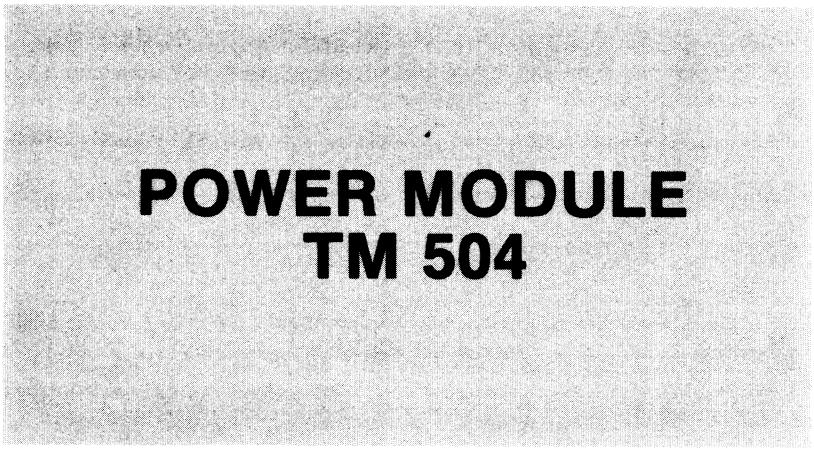
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POWER MODULE
TM 504

INSTRUCTION MANUAL

TEKTRONIX®



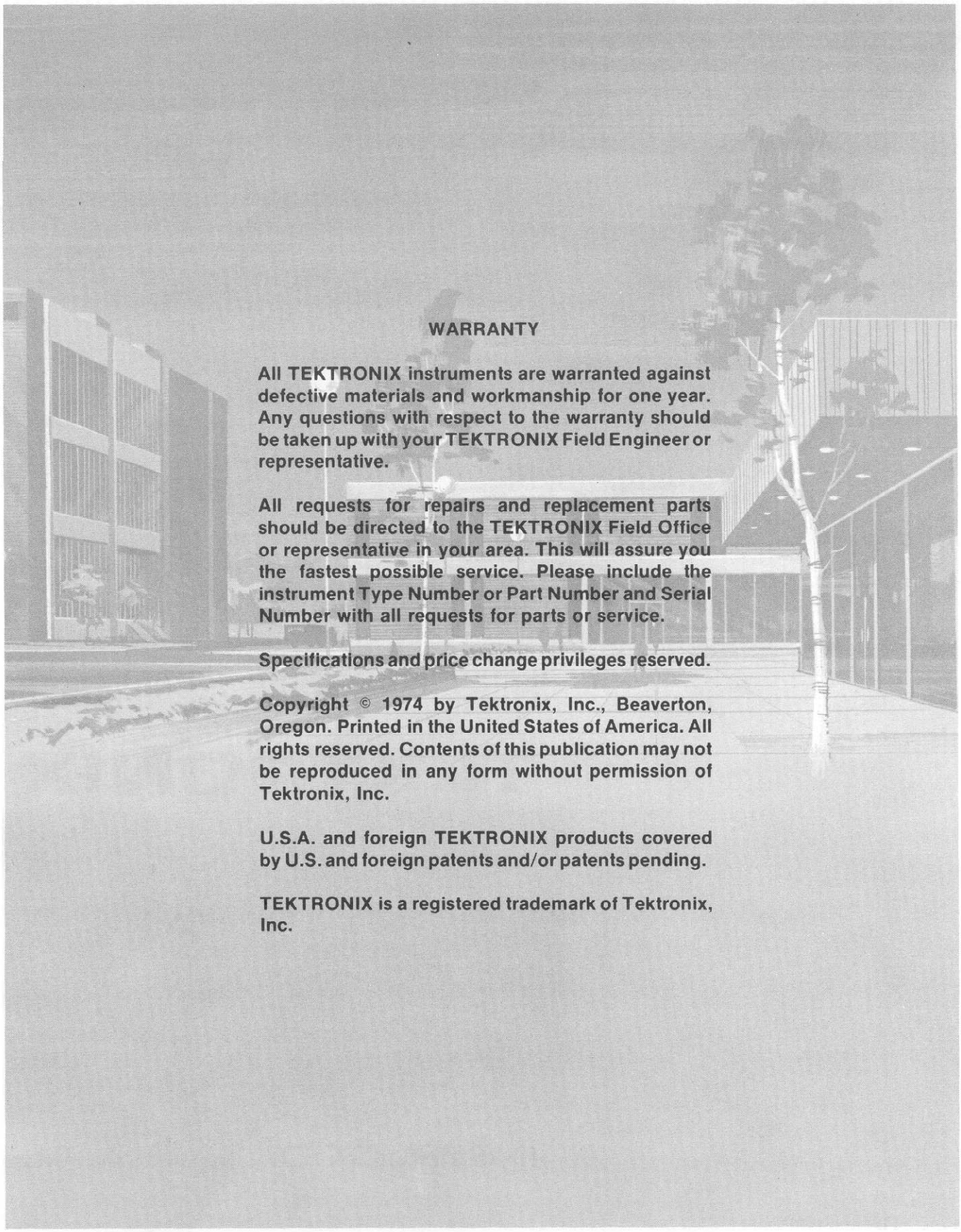
INSTRUCTION MANUAL

Tektronix, Inc.
P.O. Box 500
Beaverton, Oregon 97005

Serial Number _____

070-1716-00

First Printing JUNE 1974



WARRANTY

All TEKTRONIX instruments are warranted against defective materials and workmanship for one year. Any questions with respect to the warranty should be taken up with your TEKTRONIX Field Engineer or representative.

All requests for repairs and replacement parts should be directed to the TEKTRONIX Field Office or representative in your area. This will assure you the fastest possible service. Please include the instrument Type Number or Part Number and Serial Number with all requests for parts or service.

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INSTALLATION PROCEDURE

Before you start...

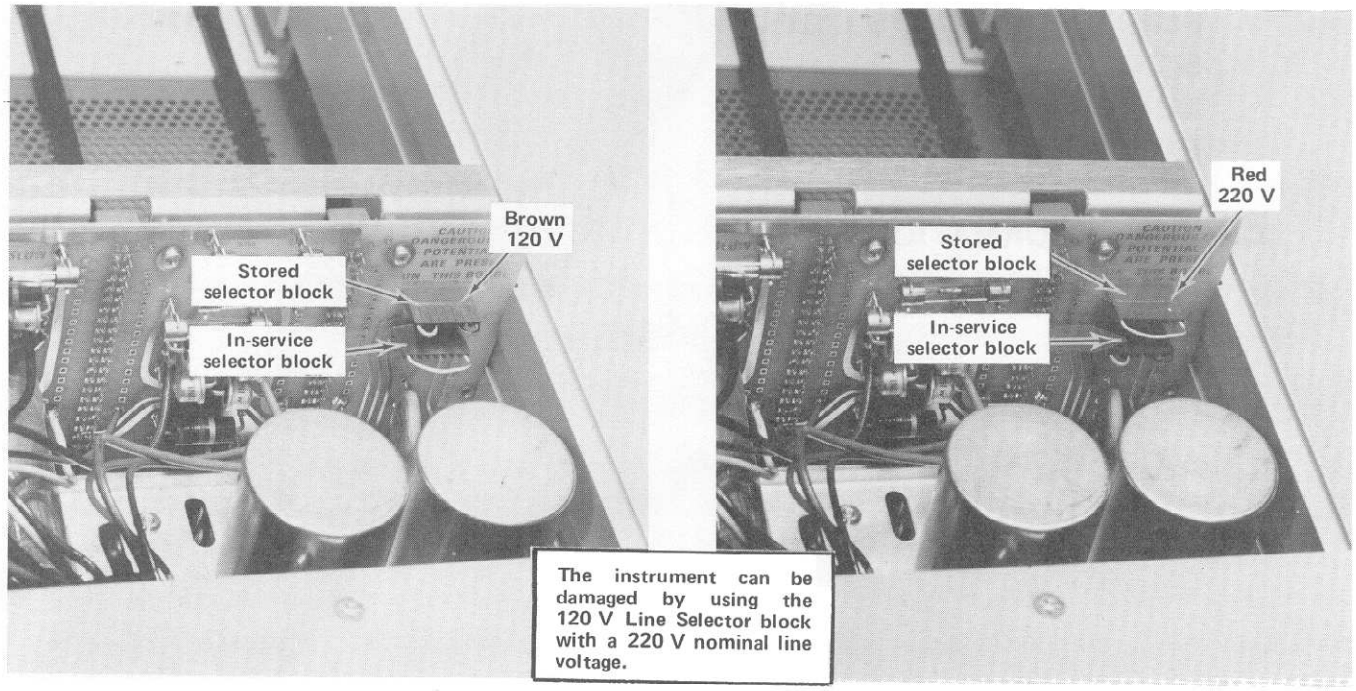
1. Check the rear panel markings. If the factory settings are compatible with the available line voltage and frequency, insert the desired plug-ins. Use the bail to raise the front of the instrument.

...go to Operating Instructions...

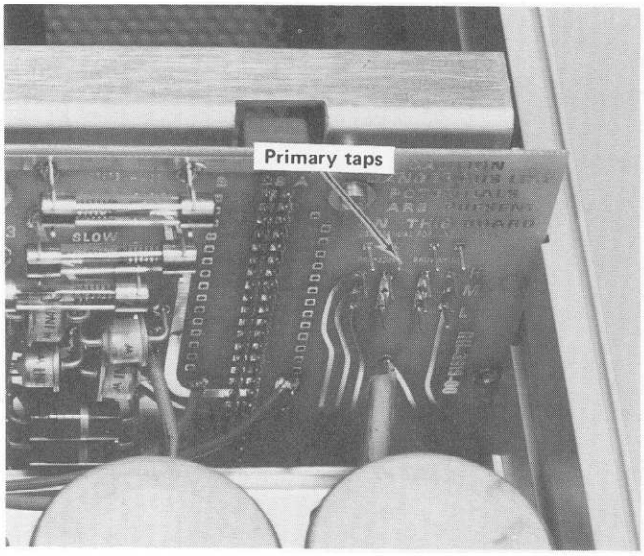
2. If a change is needed, follow these steps:

a. Line Selector Block(s)

Remove the four hold-down screws on the top of the dust cover cabinet and lift the cabinet off. This gives easy access to the Line Selector blocks located on the main circuit board.

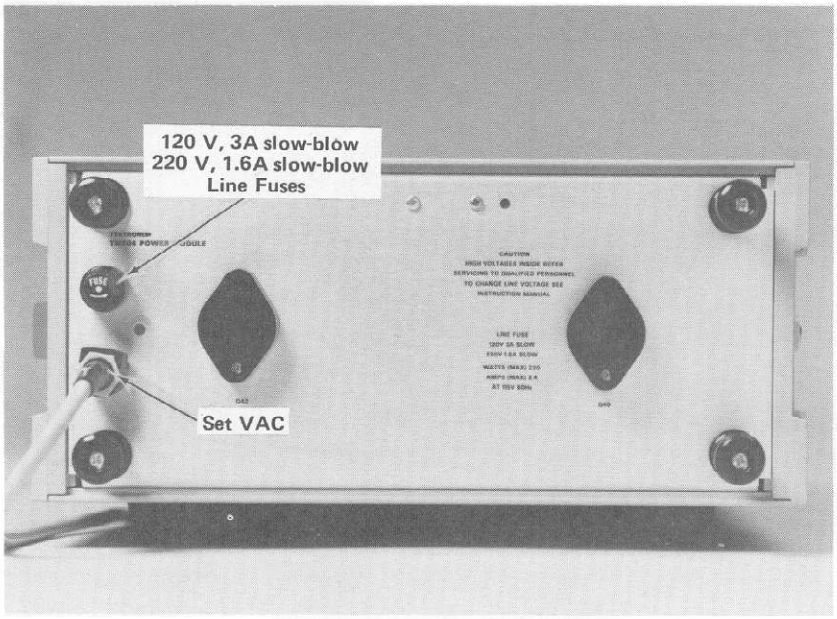


b. Line Range Taps



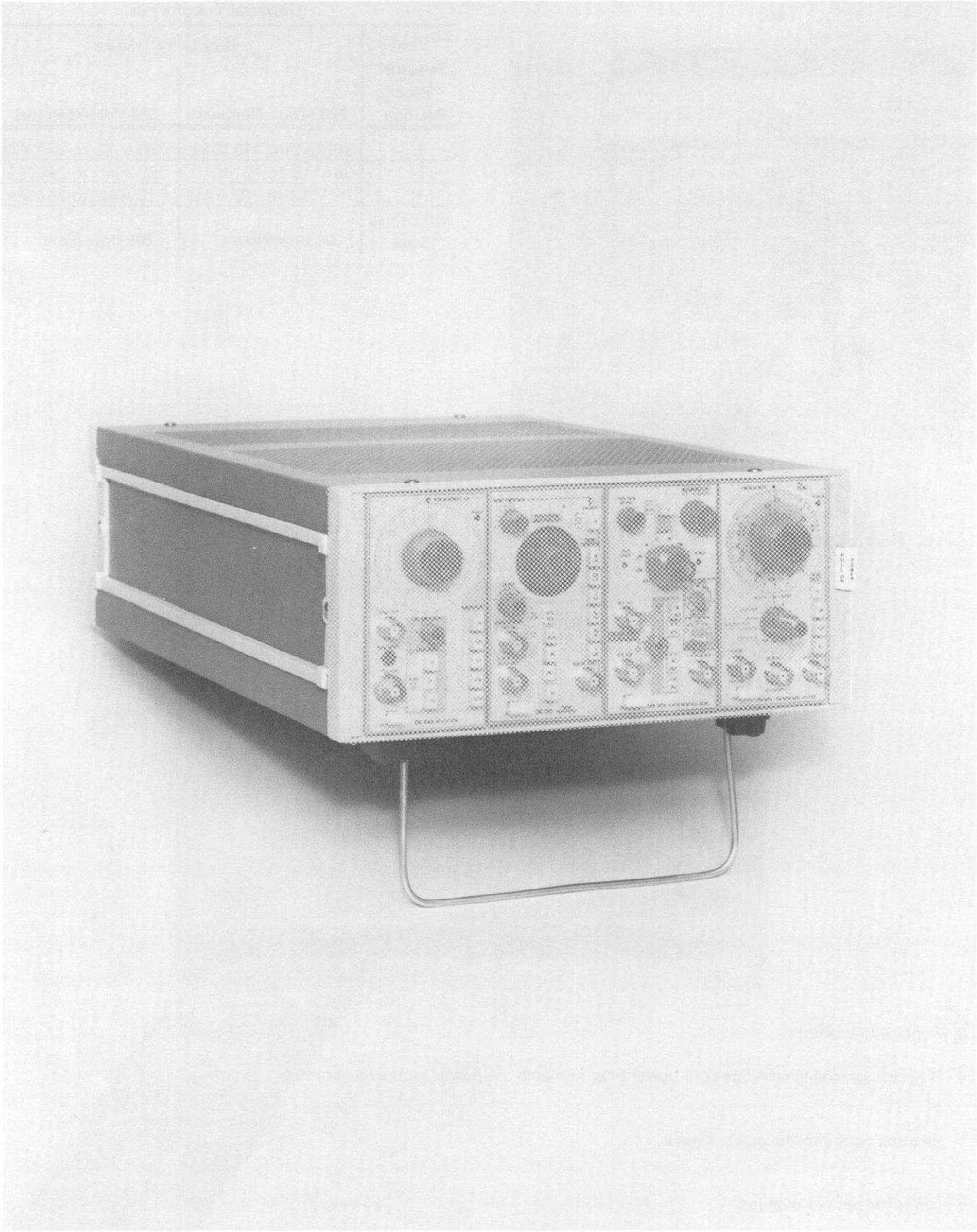
Universal Transformer		
Line Selector Block Position	Regulating Ranges	
	120 Volts Nominal	220-Volts Nominal
L	90 VAC to 110 VAC	180 VAC to 220 VAC
M	99 VAC to 121 VAC	198 VAC to 242 VAC
H	108 VAC to 132 VAC	216 VAC to 264 VAC
Line Fuse Data	3A slow-blow	1.6A slow-blow

c. Rear Panel



3. Replace the cabinet.
4. If necessary, change the line cord power plug to match the power source receptacle or use an adapter.
5. Plug the cord into the power source.
6. Insert the desired plug-ins.
7. Use the bail to raise the front of the instrument.

...go to Operating Instructions...



TM504 Power Module with plug-ins.

TM 504 OPERATING INSTRUCTIONS

INTRODUCTION

Description

The TEKTRONIX TM-504 Power Module is a mainframe for the TM 500 Series of Modular Instrumentation. It accepts up to four independently functional plug-in modules to form a compact versatile and low cost instrumentation system. The TM 504 is a basic power source and provides an interconnecting scheme for the other members of the TM 500 Series family. Factory options allow customer modification using signal access at the plug-in module/power module interface to provide rear panel inputs and outputs, and interconnections between compartments.

Power Source

This instrument is designed to operate from a power source with its neutral at or near earth (ground) potential with a separate safety-earth conductor. It is not intended for operation from two phases of a multi-phase system, or across the legs of a single phase, three-wire system.

Power Usage

With four plug-in modules installed, the TM 504 can require up to 220 W of power at the upper limits of the high line voltage ranges. Actual power consumption depends on the particular module combination and operating mode selected at any one time.

NOTE

The compartment closest to the PULL ON POWER switch is high power. Some of the TM 500 Series plug-in modules require high power to operate at their maximum capabilities.

Operating Temperatures

The TM 504 can be operated in an ambient air temperature of 0°C to 50°C. Thermal cutout devices protect the system by disconnecting the power to the TM 504 Power Module when internal temperatures rise above a safe operating level. These devices automatically return power to the unit when the internal temperatures return to a safe level.

Since the TM 504 can be stored in temperatures between −40°C and +75°C, allow the instruments's chassis to return to within the operating limits before applying power.

POWERING UP

Plug-In Modules

It is not necessary that all the plug-in compartments be utilized in order to operate the Power Module. The only modules needed are those necessary to accomplish the task.

CAUTION

Turn the Power Module off before inserting the plug-in; otherwise, damage may occur to the plug-in circuitry.

Module Installation

1. Check the location of the white plastic barriers on the TM 504 interconnecting jack to ensure that their locations match the slots in the edge of the plug-in module's circuit board.

2. Align the plug-module chassis with the upper and lower guides of the selected compartment. Push the module in and press firmly to seat the circuit board in the interconnecting jack. (Remove the plug-in module by pulling on the white release latch located in the lower left corner of each module.)

3. Pull the PULL ON POWER button on the right side of the TM 504. Some plug-in modules have independent power switches, usually labeled OUTPUT, controlling application of mainframe power to the module. Push this button to activate the plug-in module.

Loading Considerations

With four plug-in modules installed, the TM 504 can require up to 220 W of power from the line at high-line voltage range settings. Actual power consumed, of course, depends on the particular module combination selected at any one time.

This power capability can best be utilized by carefully planning the functional combinations of plug-ins, their external loads, and the resulting power distributions. Optimum conditions can be (1) equal loads in all three left hand compartments and full load in high power compartments, (2) as much power as possible dissipated in external loads, and (3) operating in an ambient temperature of about +25°C.

The TM 504 provides each plug-in module with access to a pair of heat-sinked, chassis-mounted transistors, one NPN and one PNP. These Series-Pass transistors allow the plug-in modules to operate in power ranges not possible if the power had to be dissipated within the modules.

BUILDING A SYSTEM

Family Compatibility

Mechanically, the plug-in modules are very similar to other Tektronix product families. However, they are not **electrically** compatible. Therefore, the TM 504 interface has barriers on the mating connectors between pins 6 and 7 to ensure that incompatible modules cannot be inserted. See Figure 1. A compatible module will have a matching slot between pins 6 and 7 of its main circuit board edge connector. This slot and barrier combination is the primary keying assignment.

TM 500-compatible plug-in modules are also identified by the white color of the release latch.

Customizing The Interface

The modularity of this instrumentation system provides for many different functions to be performed by the plug-in modules. Specific functions are grouped into families or classes, of which there may be several plug-in module members. For instance, some classes are Power Supplies, Signal Sources, Measurement, and so forth. Each modular member of a functional family will have a second slot peculiar to its family assignment located in its edge connector. The TM 504 user can "program" one or more compartments to accept only members of that family by installing a second barrier in the interface connector to match the module's slot location. An entire TM 504 can be "programmed" in this manner to set up instruction systems for specific work functions. For extra barriers, order Tektronix Part Number 214-1593-02.

Jumper wires can be used to further specialize the interface. Compartments can be made to "talk" to each other by connecting jumpers on the back side of the interface board, using pins 14 through 28, A-side and B-side both, of the interconnecting jacks. See the following description of Option 2. Refer to each plug-in module's Manual for the I/O assignments of each pin at the rear interface. Once having made interconnections of a specialized nature, it is recommended that barriers be installed on the interconnecting jacks to ensure module compatibility with the customized wiring.

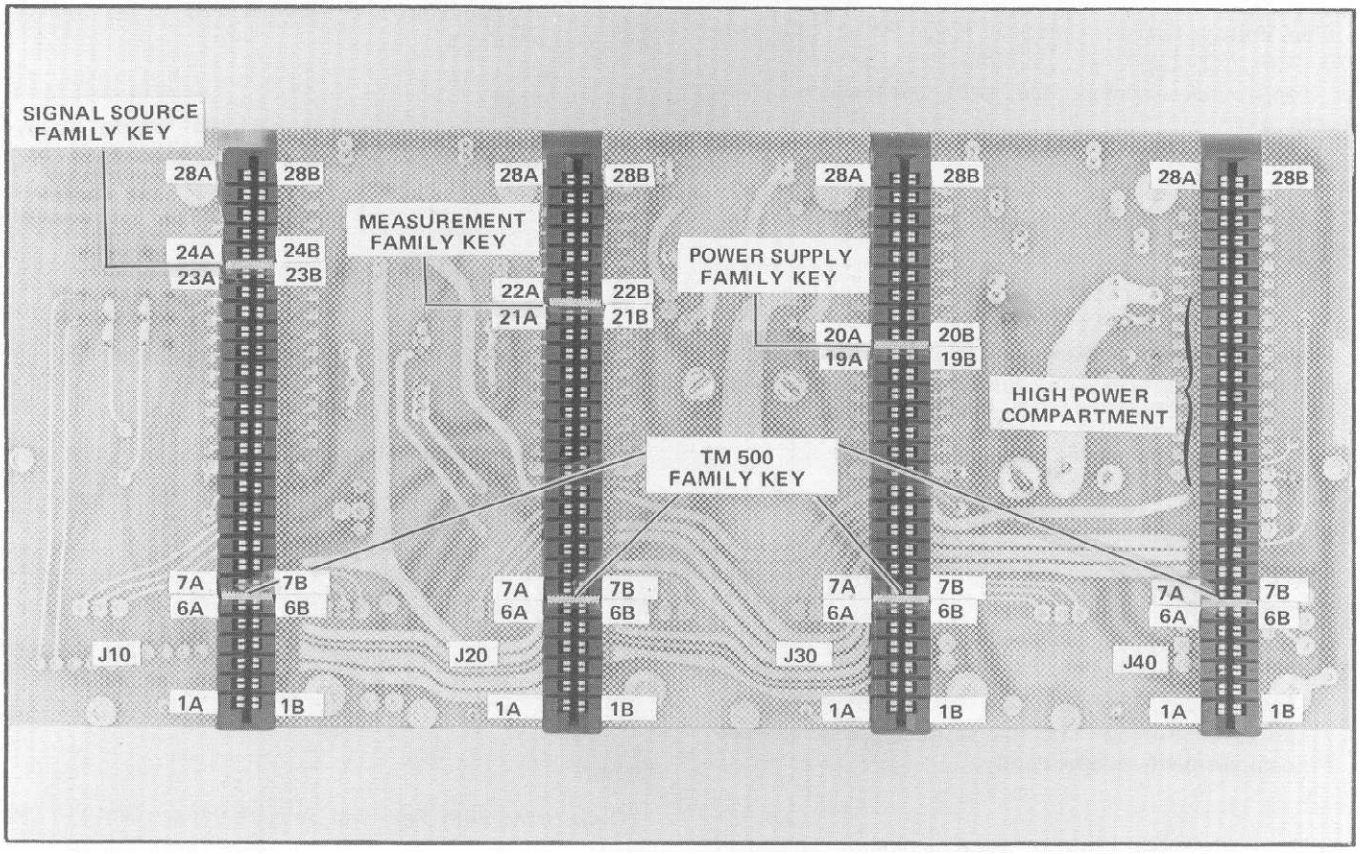


Fig. 1. Keying assignments for family functions. One of many possible sequence combination.

Rear Panel

The rear subpanel is punched for BNC and multi-pin connector mountings. Customer- or factory-installed connectors and wiring (see following description of Option 2) could provide external access to the interface for external I/O control. This feature makes the TM 500 Series Modular Instrumentation System very flexible in bench-top or rackmounted systems.

Option 2. This factory-installed option adds 25-mil square-pin connectors to the rear of the interconnecting jacks at all pin locations from pins 14A and B through pins 28A and B. This will keep the interface flexible by making it easy and fast to change customized wiring using prepared wires with square-pin receptacles and long-nose pliers or tweezers. It also protects the circuit board from damage by repeated soldering and unsoldering of jumper wires. This option also add three BNC connectors and one 50-pin connector to the rear panel. These connectors are not pre-wired, in order to give a system designer as much flexibility as possible. Instead, prepared jumpers, coaxial cables, and interconnection jack barriers are included in a kit.

SPECIFICATIONS

Power Requirements

Line Voltage Ranges. Universal Transformer: 100, 110, 120, 200, 220, 240 VAC, all within 10%. Range changing for transformer accomplished with quick-change line-selector block.

Line Frequency Ranges. Universal Transformer: 48 Hz to 440 Hz.

Power Consumption. Maximum primary power approximately 220 W at high line. Actual power consumption depends on plug-in selection and operating modes.

Supplies (Unregulated)

+33.5 VDC and −33.5 VDC, 1.4 A maximum, shared by all compartments.

Low Power (Left and Two Center Supplies). Two 25 VAC windings 500 mA each, supplied to each compartment, independently.

17.5 VAC and +11.5 V, 3.6 A maximum, shared in any combination between these two supplies and shared among all three compartments.

High Power (Compartment Nearest Switch). Two 25 VAC windings, 1 A supplied only to high power compartment.

17.5 VAC and +11.5, 4 A maximum, shared in any combination between these two supplies.

NOTE

Current and voltage ratings are for main frame maintenance only. In practice, not all available power may be used at once. More detailed information is supplied with kit 040-0652-02 (TM 500 plug-in).

Temperature Range

Operating: 0°C to +50°C. Nonoperating: −40°C to +75°C.

Altitude Range

Operating: To 15,000 feet. Nonoperating: To 50,000 feet.

Other

Dimensions with Feet and Bail: H 9.5 in., W 12 in., L 20 in.

Weight without plug-ins: Approximately 18.5 lbs.

TM 504 SYSTEM MAINTENANCE

GENERAL

Introduction

This section of the manual is meant to support the entire TM 500 Series family of modules with a general coverage of the most commonly-needed service information pertinent to preventive maintenance, troubleshooting, ordering parts, and replacing components and sub-assemblies.

Cabinet Removal

WARNING

Dangerous potentials exist at several points throughout the system. When the system must be operated with the cabinet removed, do not touch exposed connections or components. Some transistors have voltages present on their cases. Disconnect power before cleaning the system or replacing parts.

Four screws on the top secure the cabinet to the TM 504 frame. Remove them and lift the cabinet straight up. Do not operate the system with the cabinet removed any longer than necessary for troubleshooting and calibration. Re-install the cabinet to protect the interior from dust and to remove personnel shock hazards.

Cleaning

CAUTION

Avoid using chemical cleaning agents which might damage plastic parts. Avoid chemicals containing benzene, toluene, zylene, acetone, or similar solvents.

Exterior. Loose dust may be removed with a soft cloth or a dry brush. Water and a mild detergent may be used; however, abrasive cleaners should not be used.

Interior. Cleaning the interior of a unit should precede calibration since the cleaning processes could alter the settings of calibration adjustments. Use low-velocity compressed air to blow off accumulated dust. Hardened dirt can be removed with a soft, dry brush, cotton-tipped swab, or a cloth dampened in a solution of water and mild detergent.

Preventive Maintenance

Preventive maintenance steps performed on a regular basis will enhance the reliability of the instrumentation systems. However, periodic checks of the semiconductors in the absence of a malfunction are not recommended as preventive maintenance measures. See the semiconductor checking information under Troubleshooting Techniques, which follows. A convenient time to perform preventive maintenance is just before instrument calibration.

Calibration

To insure accurate signal generation and measurement, the performance of individual units composing the system should be checked periodically. Refer to the Instruction Manual for each unit for complete calibration and verification procedures.

TROUBLESHOOTING AIDS

Introduction

The following is provided to augment information contained elsewhere in this and other TM 500 Series family manuals when troubleshooting becomes necessary.

Circuit Descriptions

Each manual has a section devoted to explaining circuit operating theory. Used conjointly with the schematics, this can be a powerful analytic tool.

Diagrams

Block diagrams and detailed circuit schematics are located on foldout pages in the service section of most of the TM 500 Series family manuals. The schematic diagrams show the component values and assigned circuit reference numbers of each part necessary to the circuit design. Usually the first page of the service section defines the circuit symbols and reference designators used in that particular instrument. Major circuits are usually identifiable by a series of component numbers. Important waveforms and voltages may be shown within the diagrams or on adjoining aprons. Those portions of the circuits located on circuit boards are enclosed with a blue or grey tint outline.

Circuit Board Illustrations

Line illustrations showing component locations keyed with a grid scheme for each circuit board are usually placed on the back of a foldout page and sequenced as close as possible to an associated schematic. The GRID LOC columns located near the Parts Location Grid keys each component to easy location on the board.

Component and Wiring Color Codes

Colored stripes or dots on electrical components signify electrical values, tolerances, etc., according to EIA standards. Components not color-coded usually have information printed on the body. The wiring coding follows the same EIA standards.

Power Cord Conductor Identification

Conductor	Color	Alternate Color
Ungrounded (Line)	Brown	Black
Grounded (Neutral)	Blue	White
Grounding (Earthing)	Green-Yellow	Green-Yellow

Cam Switch Charts

Cam switches shown on the diagrams are coded on comprehensive charts to locate the cam number of the switch contract in the complete switch assembly, counting from the front, or knob end, toward the rear of the switch. The charts also indicate with a solid dot when each contact is closed.

Testing Equipment

Generally, a wide-band oscilloscope, a probe, and a multimeter are all that is needed to perform basic waveform and voltage checks for diagnostic purposes. The calibration procedures in the manual for each plug-in module list specific test equipment and the features necessary to adequately check out that particular module.

TROUBLESHOOTING TECHNIQUES

Introduction

This troubleshooting procedure is arranged in an order which checks the simple trouble possibilities before proceeding to extensive troubleshooting.

Control Settings

Incorrect control settings can indicate a trouble that does not exist. If there is any question about the correct function or operating of any control, see the Operating Instructions section of the manual for the instrument involved.

System and Associated Equipment

Before proceeding with troubleshooting the TM 500 Series system, check that the instruments in the system are operating correctly. Check for proper interconnection between the power module and the plug-in modules. Check the line voltage at the power source. Check that the signal is properly connected and that the interconnecting cables and signal source are not defective.

The associated plug-in modules can be checked for proper operation quickly by substituting other like units

known to be operating properly. If the trouble persists after substitution, then the power module is probably at fault. Moving a properly operating plug-in from compartment to compartment will help determine if one or more compartments has a problem.

Visual Check

Inspect the portion of the system in which the trouble is suspected. Many troubles can be located by visual clues such as unsoldered connections, broken wires, damaged circuit boards, damaged components, etc.

Instrument Calibration

Check the calibration of the suspected plug-in module or the affected circuit if the trouble is obviously in a certain circuit. The trouble may only be a result of misadjustment or may be corrected by re-calibration. Complete calibration instructions are given in the manual for each instrument in the system.

Circuit Isolation

Note the symptom. It often identifies the circuit in which the trouble is located. When trouble symptoms appear in more than one circuit, check the affected circuits by making waveform and voltage measurements.

Incorrect operating of all circuits often means trouble in the power supplies. Using a multimeter, check first for correct voltages of the individual regulated supplies according to the plug-in module schematics and calibration procedures. Then check the unregulated supplies of the power modules. Defective components elsewhere in the instruments can appear as power supply problems. In these instances, suspected circuits should be disconnected from apparently bad power supplies one at a time to narrow the search.

Voltages and Waveforms

Often defective components can be located by using waveform and voltage indications when they appear on the schematic or in the calibration procedures. Such waveforms and voltage labels are typical indications and will vary between instruments. To obtain operating conditions similar to those used to take these readings, refer to the first diagram in the service sections.

Component Checking

If a component cannot be disconnected from its circuit, then the effects of the associated circuitry must be considered when evaluating the measurement. Except for soldered in transistors and integrated circuits, most components can be lifted at one end from the circuit board.

Transistors and IC's. Turn the power switch off before removing or replacing any semiconductor.

A good check of transistor operation is actual performance under operating conditions. A transistor can most effectively be checked by substituting a new component for it (or one which has been checked previously). However, be sure that circuit conditions are not such that a replacement transistor might also be damaged. If substitute transistors are not available, use a dynamic tester. Static-type testers are not recommended, since they do not check operation under simulated operating conditions. A suction-type desoldering tool must be used to remove soldered-in transistors; see component replacement procedure for details.

Integrated circuits can be checked with a voltmeter, test oscilloscope, or by direct substitution. A good understanding of the circuit description is essential to troubleshooting circuits using IC's. Operating waveforms, logic levels, and other operating information for the IC's are given in the circuit description information of the appropriate manual. Use care when checking voltages and waveforms around the IC's so that adjacent leads are not shorted together. A convenient means of clipping a test probe to the 14- and 16-pin in-line IC's is with an integrated circuit test clip. This device also doubles as an extraction tool.

Diodes. Do not use an ohmmeter that has a high internal current. High currents may damage the diode.

A diode may be checked for an open or shorted condition by measuring the resistance between terminals. With an ohmmeter scale having an internal source of between 800 mV and 3 V, the resistance should be very high in one direction and very low when the leads are reversed.

Resistors. Check the resistors with an ohmmeter. Resistor tolerances are given in the Electrical Parts List. Resistors do not normally need to be replaced unless the measured value varies widely from the specified value.

Capacitors. A leaky or shorted capacitor can be detected by checking resistance with an ohmmeter on the highest scale. Use an ohmmeter which will not exceed the voltage rating of the capacitor. The resistance reading should be high after initial charge of the capacitor. An open capacitor can best be detected with a capacity meter, or by checking whether it passes ac signals.

PARTS ORDERING AND REPLACING

Ordering

Standard Parts. All electrical and mechanical replacement parts can be obtained through the local Tektronix Field Office or representative. However, many of the standard electronic components can be obtained locally in less time than is required to order them from Tektronix, Inc. Before purchasing or ordering replacement parts, check the Parts Lists for value, tolerance, rating, and description. When selecting replacement parts, it is important to remember that the physical size and shape of the component may affect its performance in an instrument. All replacement parts should be direct replacements unless it is known that a different component will not adversely affect the instrument performance.

Special Parts. Some parts are manufactured or selected by Tektronix, Inc., to satisfy particular requirements, or are manufactured for Tektronix, Inc., to our specifications. Most of the mechanical parts used in this system have been manufactured by Tektronix, Inc. Order all special parts directly from the local Tektronix Field Office or representive.

Ordering Procedure. When ordering replacement parts from Tektronix, Inc., please include the following minimum information:

1. Instrument Type (PS 501, SG 502, DC 501, etc.)

2. Instrument Serial Number (For example, B010251)

3. A description of the part (if electrical, include the circuit number)

4. Tektronix part number

Please do not return any instruments or parts before receiving directions from Tektronix, Inc.

A listing of Tektronix Field Offices, Service Centers, and Representatives can be found in the Tektronix Product Catalog and Supplements.

Replacing

The exploded view drawings associated with the Mechanical Parts List, located to the rear of most manuals, may be especially helpful when disassembling or reassembling individual components or sub-assemblies.

Circuit Boards. If a circuit board is damaged beyond repair, the entire assembly, including all soldered-on components, can be replaced.

To remove or replace a board, proceed as follows:

1. Disconnect all leads connected to the board (both soldered lead connections and solderless pin connections).

2. Remove all screws holding the board to the chassis or other mounting surface. Some boards may be held fast by plastic mounting clips around the board edges. For these push the mounting clips away from the circuit board edges to free the board. Also, remove any knobs, etc., that would prevent the board from being lifted out of the instrument.

3. Lift the circuit board out of the unit. Do not force or bend the board.

4. To replace the board, reverse the order of removal. Use care when replacing pin connectors; if forced into place incorrectly positioned, the pin connectors may be damaged.

Transistors and IC's. Transistors and IC's should not be replaced unless they are actually defective. If removed from their sockets during routine maintenance, return them to their original sockets. Unnecessary replacement or switching of semiconductor devices may affect the calibration of the instruments. When a transistor is replaced, check the operation of the part of the instrument that may be affected.

Replacement semiconductors should be of the original type or a direct replacement. Figure 2 shows the lead configuration of the semiconductors used in this instrument system. When removing soldered-in transistors, use a suction-type de-soldering tool to remove the solder from the holes in the circuit board.

An extracting tool should be used to remove the 14- and 16-pin integrated circuits to prevent damage to the pins. This tool is available from Tektronix, Inc. Order Tektronix Part No. 003-0619-00. If an extracting tool is not available, use care to avoid damaging the pins. Pull slowly and evenly on both ends of the IC. Try to avoid having one end of the IC disengage from the socket before the other end.

To replace one of the power transistors mounted on the Power Module chassis adjacent to the interface circuit board, first unsolder the leads. Then, loosen the nuts which clamp the transistor to the chassis. Remove the defective transistor. When replacing the transistor, use a mica washer on the metal tab to increase heat transfer from the transistor to the chassis.

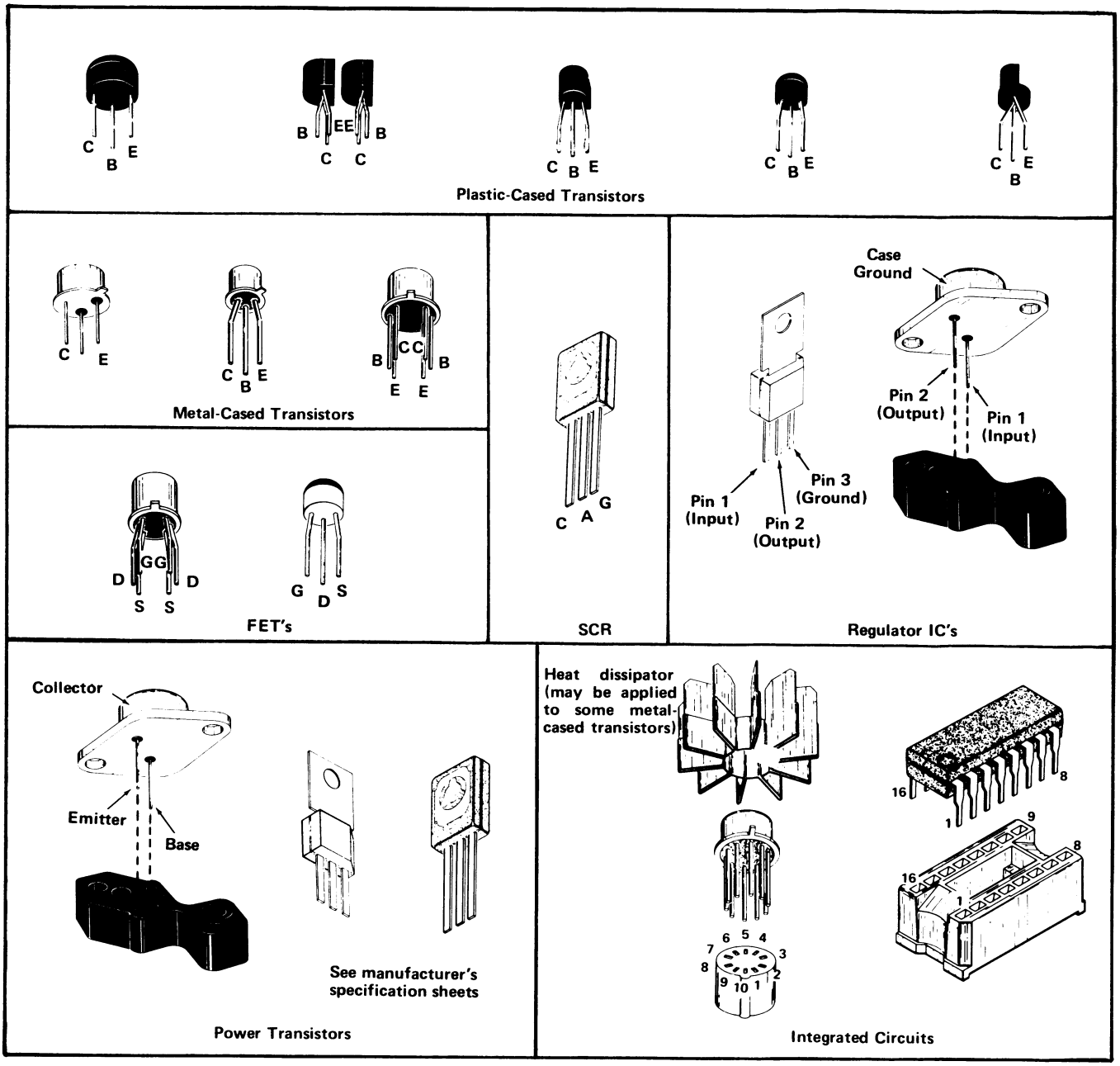


Fig. 2. Semiconductor device lead configurations found in the TM 500 family.

Interconnecting Pins. To replace a pin which is mounted on a circuit board, first disconnect any pin connectors. Then, unsolder the damaged pin and pull it out of the board with a pair of pliers. Be careful not to damage the wiring on the board with too much heat. Ream out the hole in the circuit board with a 0.031-inch drill. Remove the ferrule from the new interconnecting pin and press the new pin into the hole in the circuit board. Position the pin in the same manner as the old pin. If the old pin was bent at an angle to mate with a connector, bend the new pin to match the associated pins.

NOTE

A pin replacement kit including necessary tools, instructions, and replacement pins is available from Tektronix, Inc. Order Tektronix Part No. 040-0542-00.

Cam Switches. Repair of cam-type switches should be undertaken only by experienced maintenance personnel. Switch alignment and spring tension of the contacts must be carefully maintained for proper operation of the switch. For assistance, contact your local Tektronix Field Office or representative.

NOTE

A cam-type switch repair kit including necessary tools, instructions, and replacement contacts is available from Tektronix, Inc. Order Tektronix Part No. 040-0541-00.

The cam-type switches consist of rotating cam drums which are turned by front-panel knobs, and sets of spring-leaf contacts mounted on adjacent circuit boards. The contacts are actuated by lobes on the cams. These switches can be disassembled for inspection, cleaning, repair, or replacement as follows:

1. Remove the screws which hold the metal cover on the switch, and lift the cover off the switch. The switch is now open for inspection or cleaning.

2. To completely remove a switch from the circuit board, first remove any knobs or shaft extensions. Loosen the coupling at the potentiometer at the rear of the switch, and pull the long shaft out of the switch assembly.

3. Remove the screws (from the opposite side of the circuit board) which hold the cam drum to the board.

4. To remove the cam drum from the front support block, remove the retaining ring from the shaft on the front of the switch and slide the cam drum out of the support block. Be careful not to lose the small detent roller.

5. To replace defective switch contacts, follow the instructions given in the switch repair kit.

6. To re-install the switch assembly, reverse the above procedure.

Pushbutton Switches. The pushbutton switches are not repairable and should be replaced as a unit if defective. Use a suction-type de-soldering tool to remove solder from the circuit board when removing these switches.

Incandescent Bulbs. Most of these light bulbs are mounted on the sub-panel using plastic sleeve stand-offs. Unsolder the lead wires and pull the bulb out of the sleeve from the rear of the sub-panel.

Light-Emitting Diodes. LED's used as indicators are mounted on the sub-panels with plastic sleeve sockets similar to the incadenscent bulb mountings or they are soldered directly to a sub-assembly and so mounted that they protrude through holes in the panel. In these cases, the sub-assembly must be exposed and the anode and cathode lead orientations carefully noted before unsoldering the defective LED. See Figure 3 for LED lead identifying information.

Power Transformer. Replace the transformer only with a Tektronix direct replacement transformer. Refer to the exploded view drawing at the rear of the Power Module manuals for disassembly of the rear panel to expose the power transformer. Refer to the schematic diagrams color-coding information for correct wiring. After replacement check out the power supply voltages before installing a plug-in module.

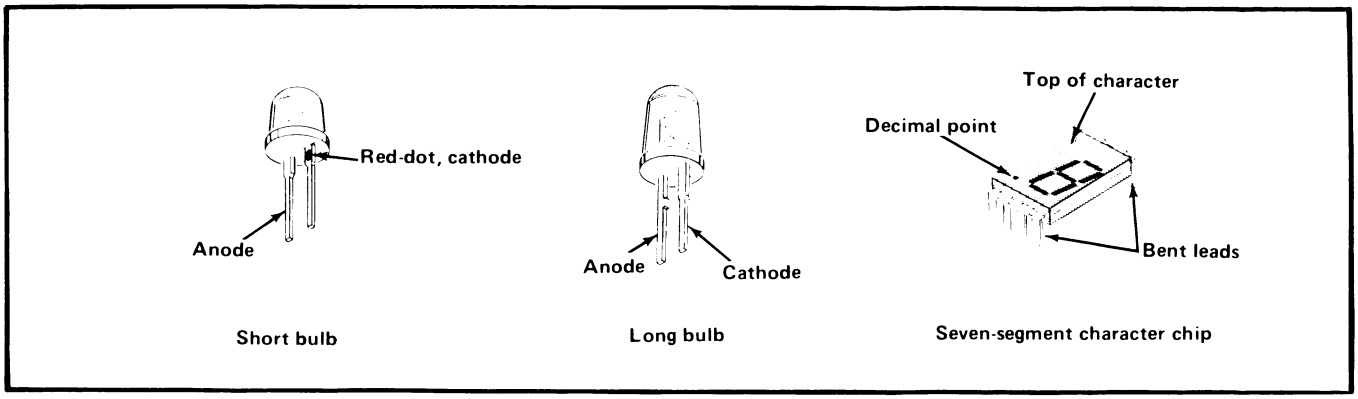


Fig. 3. Light-emitting diode (LED) lead orientation illustration.

Fuse Replacement. Table 1 gives the rating and function of the fuses used in this power supply.

TABLE 1

Circuit Number	Rating	Function
F2	120 VAC – 3A Slow 220 VAC – 1.6A Slow	Line Voltage Input
F50	11.5 VAC – 5A Slow	High Power Hole
F35	11.5 VAC – 5A Slow	Low Power Holes
F20, R22	+33.5 VAC – 1.6A Slow +33.5 VAC – 1.6A Slow	Low Power Holes Low Power Holes

Repackaging for Shipment

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

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

1. Obtain a carton of corrugated cardboard having inside dimensions of no less than six inches more than the instrument dimensions; this will allow for cushioning. Refer to the following table for carton test strength requirements.
2. Surround the instrument with polyethylene sheeting to protect the finish of the instrument.
3. Cushion the instrument on all sides by tightly packing dunnage or urethane foam between carton and instrument, allowing three inches on all sides.
4. Seal carton with shipping tape or industrial stapler.

SHIPPING CARTON TEST STRENGTH

Gross Weight (lb)	Carton Test Strength (lb)
0-10	200
10-30	275
30-120	375
120-140	500
140-160	600

SERVICE INFORMATION

SYMBOLS AND REFERENCE DESIGNATORS

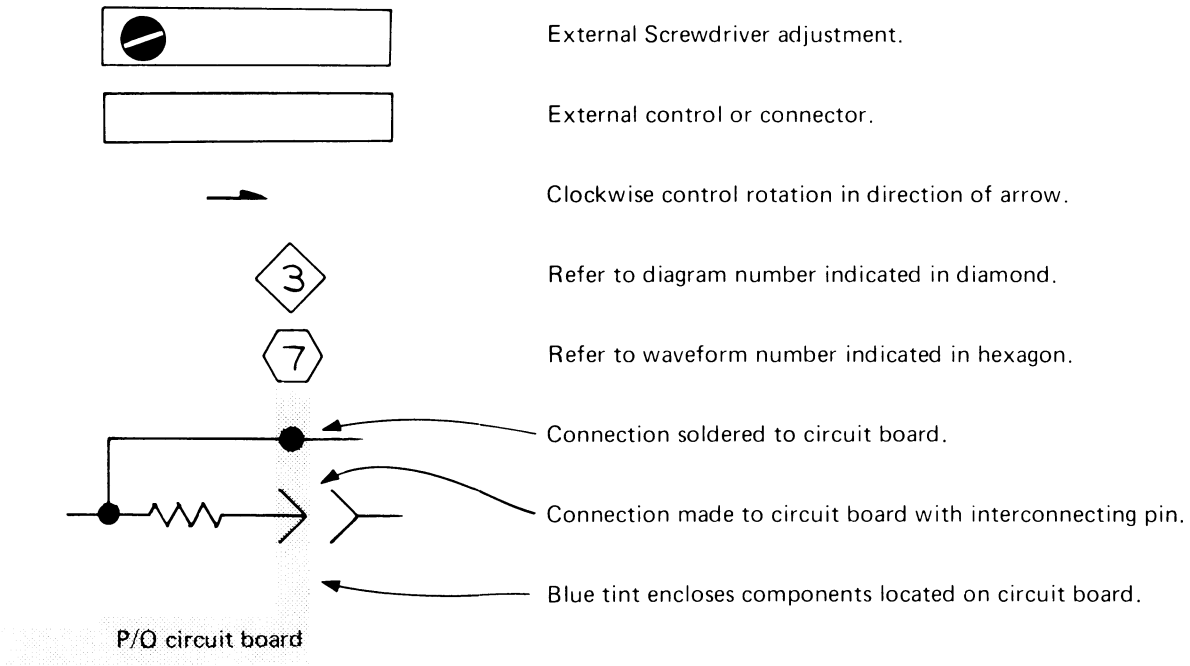
Electrical components shown on the diagrams are in the following units unless noted otherwise:

Capacitors =	Values one or greater are in picofarads (pF).
	Values less than one are in microfarads (μF).
Resistors =	Ohms (Ω)

Symbols used on the diagrams are based on ANSI Y32.2 – 1970.

Logic symbology is based on MIL-STD-806B in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

The following special symbols are used on the diagrams:



External Screwdriver adjustment.

External control or connector.

Clockwise control rotation in direction of arrow.

Refer to diagram number indicated in diamond.

Refer to waveform number indicated in hexagon.

Connection soldered to circuit board.

Connection made to circuit board with interconnecting pin.

Blue tint encloses components located on circuit board.

OPTION INFORMATION

Your instrument may be equipped with one or more options. This section describes those options, or directs the reader to where the option is documented.

Option 1 — Not applicable

Option 2	Wire Kit	Described in this section	3 Pages

OPTION 2

INTRODUCTION

This factory-installed option adds 25-mil square-pin connectors to the rear of the interconnecting jacks at all pin locations from pins 14A and B through pins 28A and B. This keeps the interface flexible by making it easy to quickly change customized wiring by using the prepared wires with square-pin receptacles. It also protects the circuit board from damage by repeated soldering and unsoldering of jumper wires. This option also adds BNC connectors and one 50-pin connector to the rear panel. These connectors are not prewired, in order to give a system designer as much flexibility as possible. Prepared jumpers, coax cables and interconnection jack barriers are included in the TM504.

SYSTEM DESIGN DIRECTIONS

1. Plan the plug-in location based on front-panel controls and operator convenience as well as interface connections.

2. Plan the wiring between interconnecting jacks and to the rear panel connectors carefully before starting assembly. A mating rear panel 50-pin connector and cover are provided for external cabling.

NOTE

There are no pin assignments for the rear panel connectors, due to the great variety of possible connections. When high frequency or fast digital signals are involved, plan the wires so as to minimize crosstalk. Make allowance for the possible need to make auxiliary ground connections.

The 50-pin rear panel connector will be easier to connect if it is removed from the rear panel and remounted after connections are made. Remove the top-rear cabinet piece for ease of access (nine screws into tapped holes or captive nuts). If more than 50 pins are needed, order Tektronix Part No. 015-0243-00 to receive a kit with a 104-pin connector shell, crimp-on pins, insertion tool, and associated parts. This connector will fit the existing cut-out. The crimping tool is not included.

3. Pin assignments for individual plug-ins will be found in the appropriate instruction manual.

4. Install an interconnection jack barrier at the appropriate location on the interconnection jack (refer to the TM504 instruction manual for keying assignments for family functions).

5. Select and install the wires (hook-up or coax) following the guidelines in the Wire Use part of these instructions.

6. Wires or cables that may be at large potential differences should be dressed or bundled so as to avoid contact. Keep all interface wiring away from the TM504 primary line wiring.

7. There is an empty cut-out that will mount the standard IEC digital interface connector. The connector is not supplied with this option.

WIRE USE

1. Hook up wire with square-pin receptacle on both ends. These may be used for low-frequency or dc circuits where impedance levels and crosstalk are not a problem. The wire is supplied in four lengths for connection between compartments (adjacent or nonadjacent) or between a compartment and the rear panel. Cut to length, then tin and solder the end going to the rear panel. Quantities and lengths are:

15 each 5″

15 each 8″

15 each 10″

15 each 15″

2. Coaxial wire with square-pin receptacles on both ends. These are used for connections that require shielding, or that must maintain a 50 ohm characteristic impedance. The outer conductor should be connected to either chassis ground or circuit ground. Plug-in lines that require coax leads usually have a specified ground pin assignment. If necessary, establish auxiliary ground connections at the appropriate wire ends. The coaxial wire is supplied in four lengths for connection between compartments (adjacent or nonadjacent) or between a compartment and the rear panel. For connection to the rear panel, cut to length, then tin and solder the end going to the rear panel. Quantities and lengths are:

15 each 5″

15 each 8″

15 each 10″

15 each 15″

@

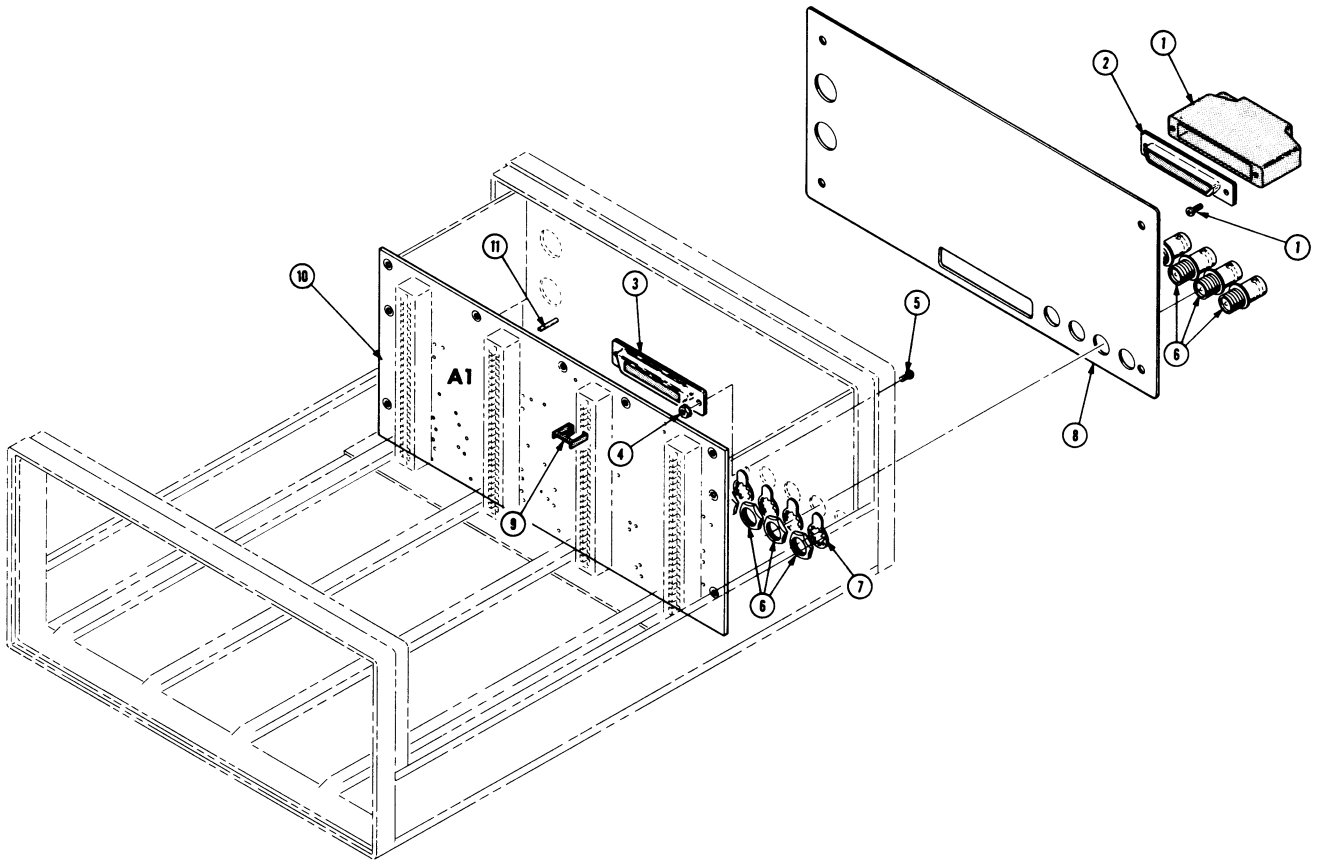
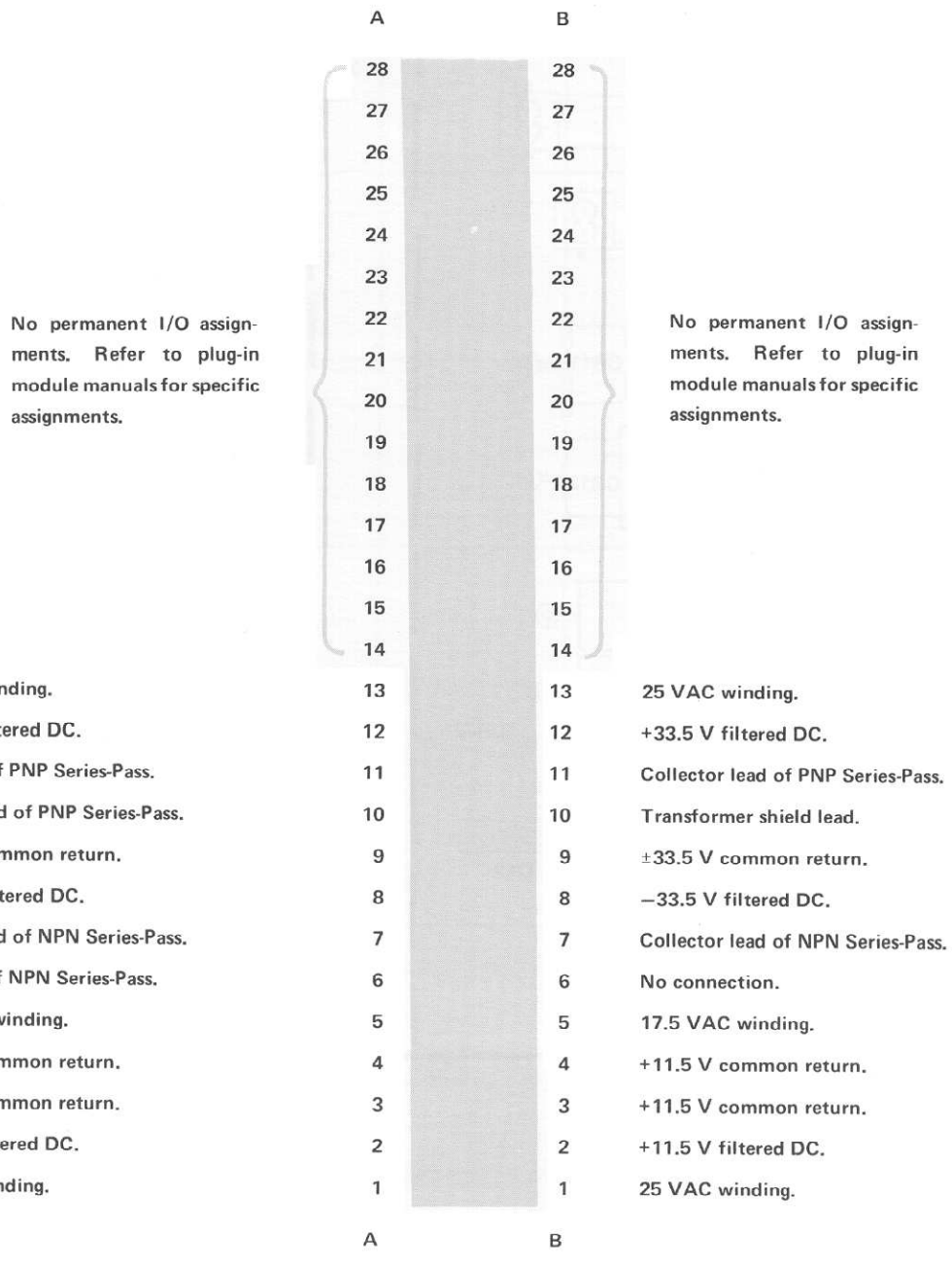
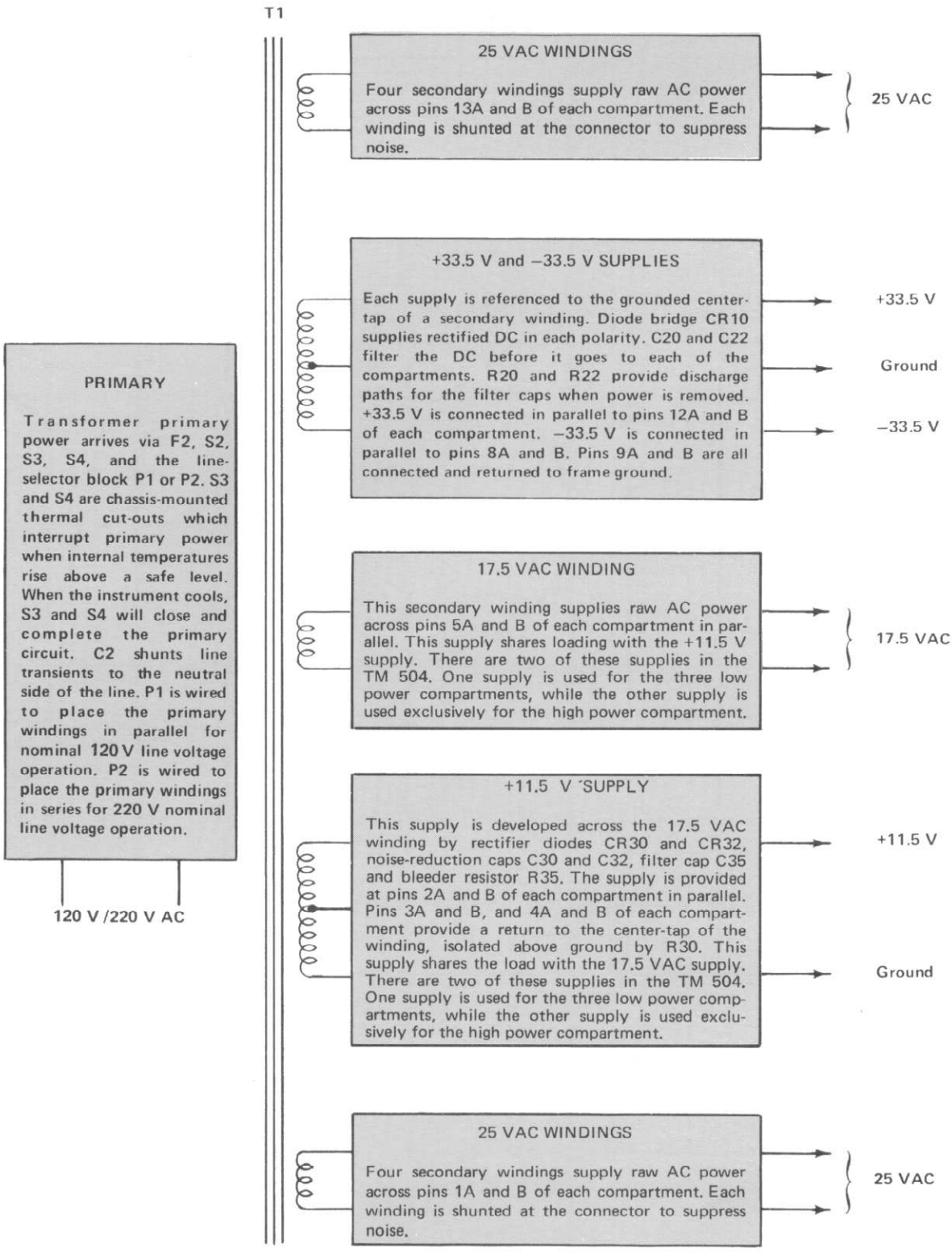


Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
-1	131-1319-00			1		COVER,,CONN:MOLD PLASTIC W/HARDWARE	08051	DD51216-1
-2	131-1345-00			1		CONNECTOR,RCPT,:50 FEMALE CONTACT	71468	DD-50S
-3	131-1344-00			1		CONNECTOR,PLUG,:50 CONT,MALE D	71468	DD-50P
						(ATTACHING PARTS)		
-4	210-0586-00			2		NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL	78189	OBD
-5	211-0008-00			2		SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
						- - - * - - -		
-6	131-0955-00			4		CONNECTOR,RCPT,:BNC,FEMALE,W/HARDWARE	05091	31-279
						(ATTACHING PARTS)		
-7	210-0255-00			4		TERMINAL,LUG:0.391" ID INT TOOTH	80009	210-0255-00
						- - - * - - -		
	200-1814-00	XB124999		1		COVER,CONN:HOLE	80009	200-1814-00
	334-2553-00	XB020950		1		MARKER,IDENT:MARKED CAUTION	22670	OBD
	334-2859-00	XB020950		1		MARKER,IDENT:MARKED CAUTION	22670	OBD
-8	333-1839-00	B010100	B012499	1		PANEL,REAR:OPTION 2	80009	333-1839-00
	333-1839-01	B012500		1		PANEL,REAR:OPTION 2	80009	333-1839-01
-9	214-1593-02			15		KEY,CONN PLZN:	80009	214-1593-02
-10	----- -----			1		. CKT BOARD ASSY:INTERFACE(SEE A1 EPL)		
	----- -----			-		. CKT BOARD ASSY INCLUDES:		
-11	131-0608-00			120		. CONTACT,ELEC:0.365 L X 0.25 PH BRZ GOLD PL	22526	47357
						(OTHER SUBPARTS SAME AS STANDARD INTER-FACE CIRCUIT BOARD)		
	020-0131-00			1		COMPONENT KIT:WIRES AND CONNECTORS	80009	020-0131-00

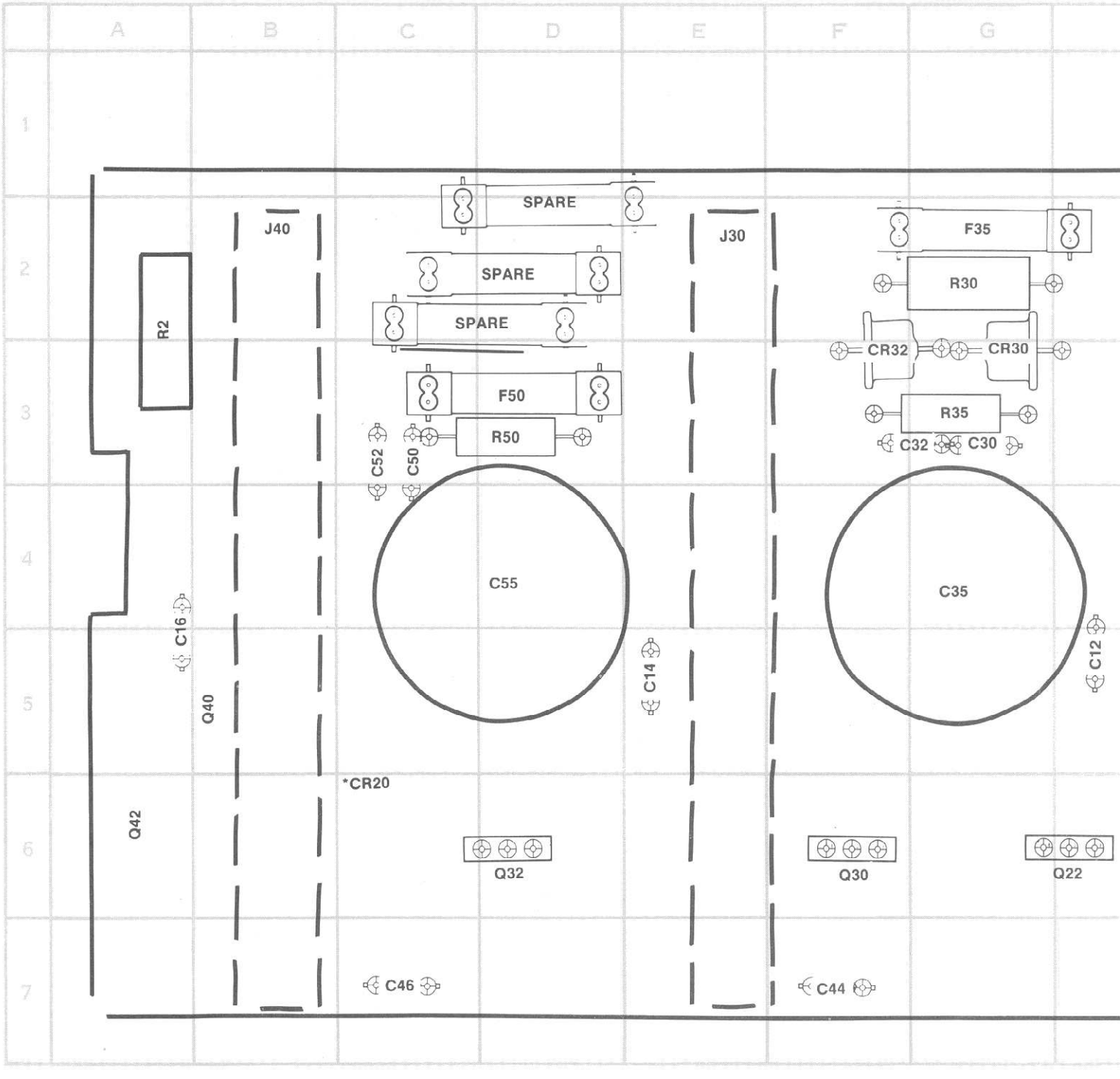
POWER MODULE INTERFACE PIN ASSIGNMENTS



DETAILED BLOCK DIAGRAM



PARTS LOCATIO

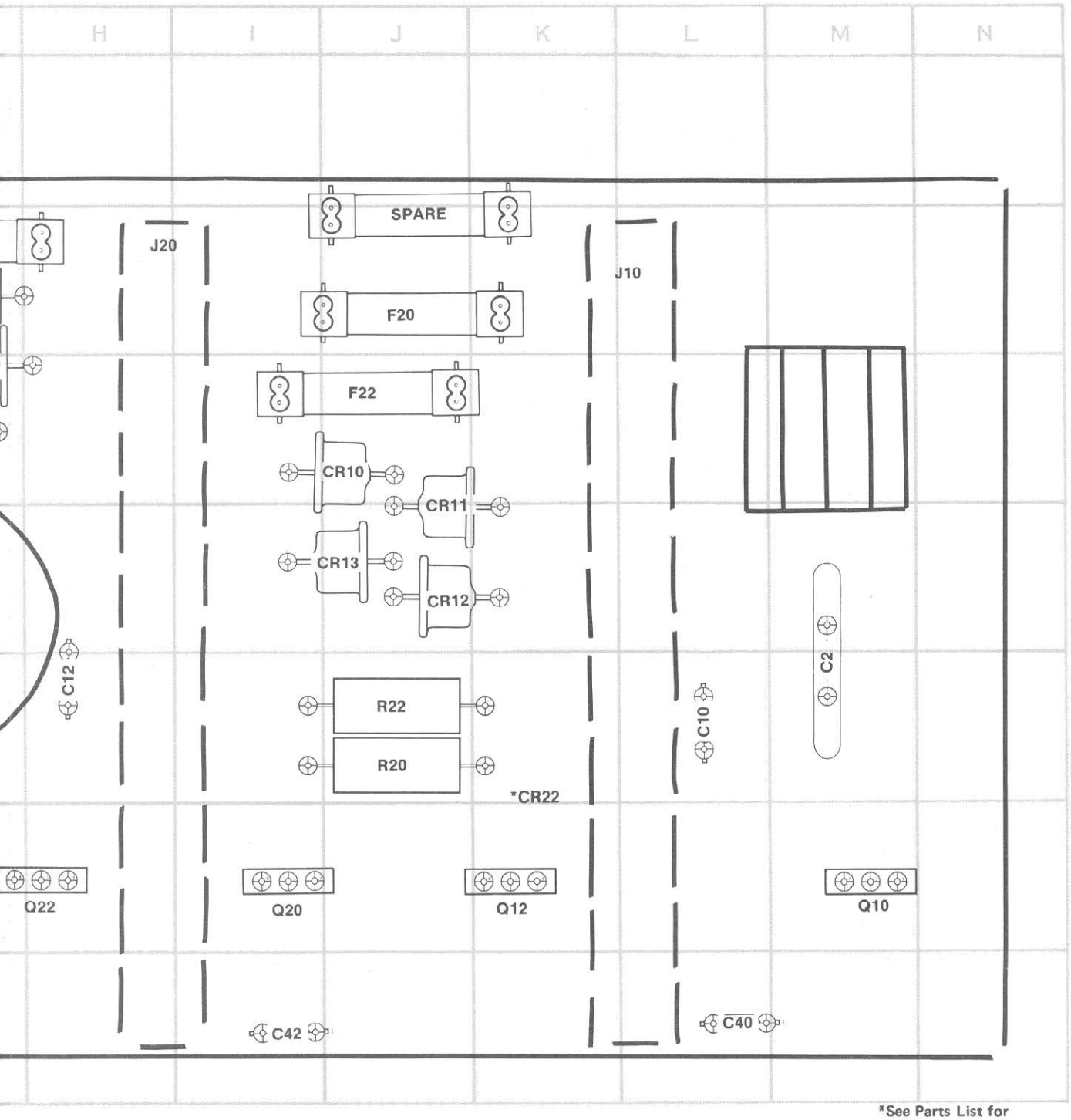


PARTS LOCATION GRID

located on back of board

J10	J30
J20	J40

CATION GRID



*See Parts List for serial number ranges.

CKT NO	GRID LOC
C2	M5
C10	L5
C12	H5
C14	E5
C16	A5
C30	G3
C32	G3
C35	G4
C40	L7
C42	I7
C44	F7
C46	C7
C50	C3
C52	C3
C55	D4
CR10	J4
CR11	J3
CR12	J4
CR13	J4
CR20	C6
CR22	K5
CR30	F4
CR32	G4
F20	J2
F22	H2
F35	G2
F50	D3
J10	L2
J20	H2
J30	E2
J40	B2
Q10	M6
Q12	K6
Q20	I6
Q22	H6
Q30	F6
Q32	D6
Q40	B5
Q42	A6
R2	A2
R20	J5
R22	J5
R30	G2
R35	G3
R50	D3

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

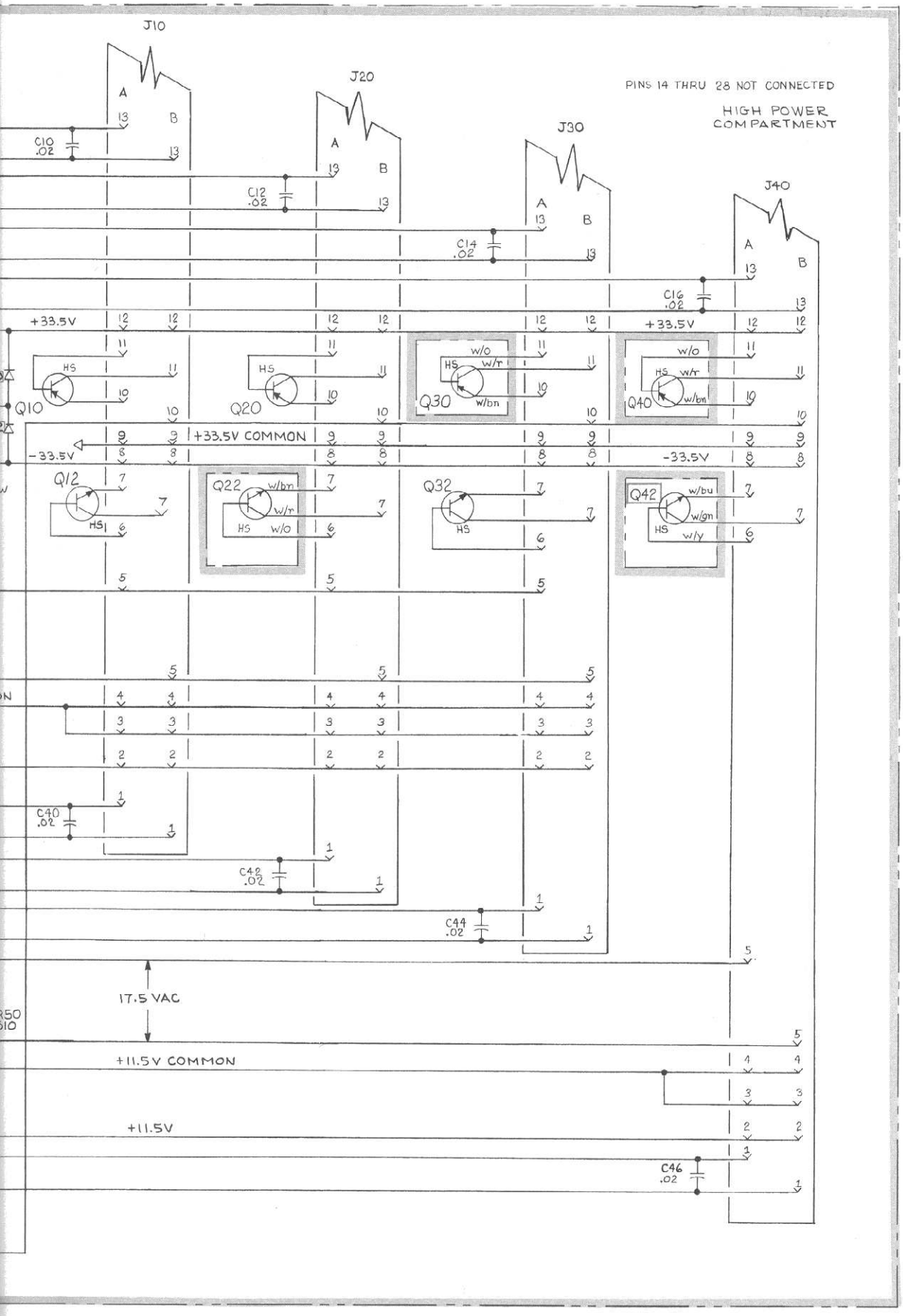
Mfr. Code	Manufacturer	Address	City, State, Zip
01121	ALLEN-BRADLEY COMPANY	1201 2ND STREET SOUTH	MILWAUKEE, WI 53204
02735	RCA CORPORATION, SOLID STATE DIVISION	ROUTE 202	SOMERVILLE, NY 08876
04713	MOTOROLA, INC., SEMICONDUCTOR PROD. DIV.	5005 E MCDOWELL RD,PO BOX 20923	PHOENIX, AZ 85036
56289	SPRAGUE ELECTRIC CO.		NORTH ADAMS, MA 01247
71400	BUSSMAN MFG., DIVISION OF MCGRAW-EDISON CO.	2536 W. UNIVERSITY ST.	ST. LOUIS, MO 63107
72982	ERIE TECHNOLOGICAL PRODUCTS, INC.	644 W. 12TH ST.	ERIE, PA 16512
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
81439	THERM-O-DISC, INC.	1320 S MAIN, P O BOX 1538	MANSFIELD, OH 44907
91637	DALE ELECTRONICS, INC.	P. O. BOX 609	COLUMBUS, NE 68601
91929	HONEYWELL, INC., MICRO SWITCH DIV.	CHICAGO & SPRING STS.	FREEPORT, IL 61032
93410	ESSEX INTERNATIONAL, INC., CONTROLS DIV. LEXINGTON PLANT	P. O. BOX 1007	MANSFIELD, OH 44903
95238	CONTINENTAL CONNECTOR CORP.	34-63 56TH ST.	WOODSIDE, NY 11377

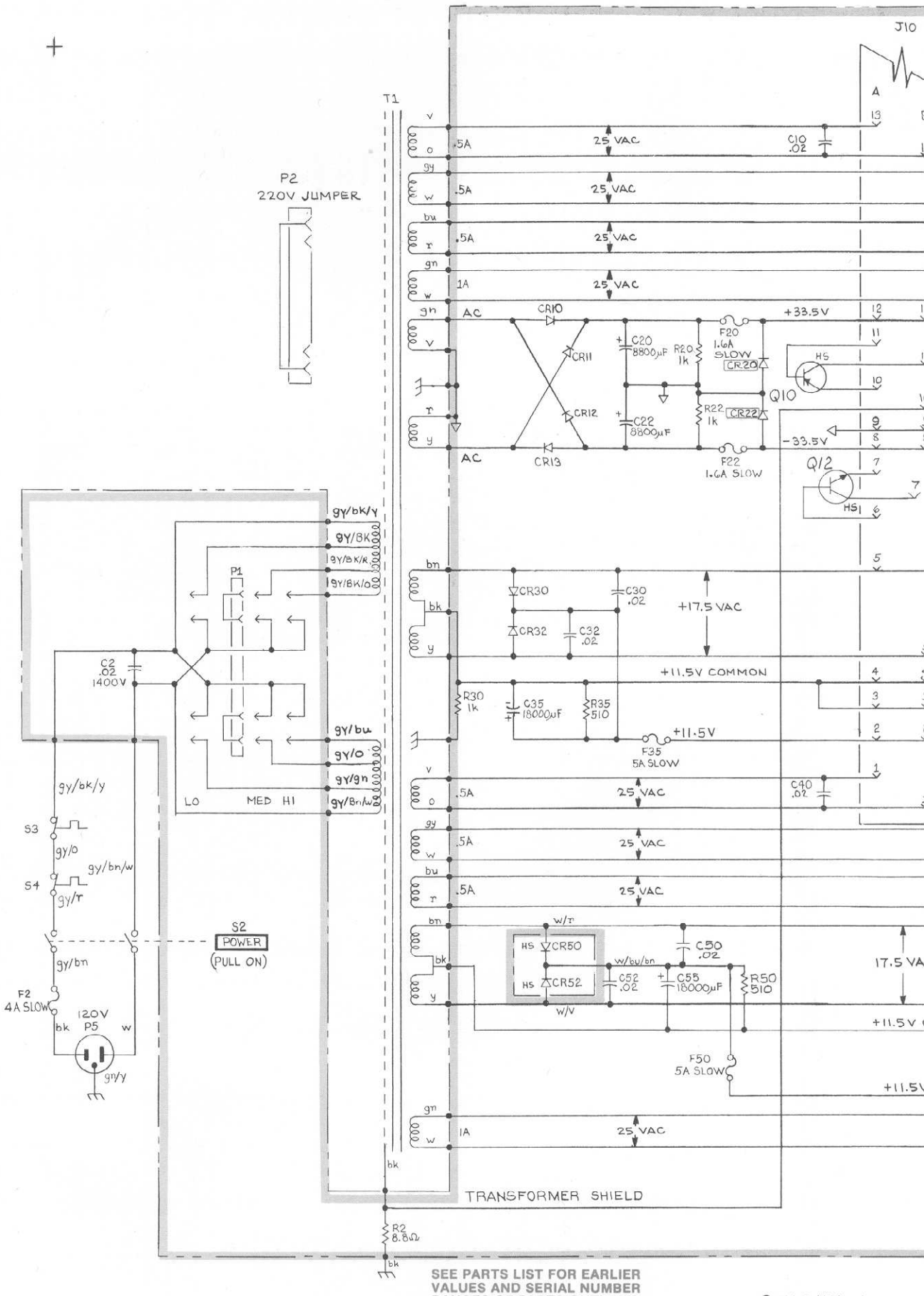
Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A1	670-3394-00	B010100	B014049	CKT BOARD ASSY:INTERFACE	80009	670-3394-00
A1	670-3394-01	B014050		CKT BOARD ASSY:INTERFACE	80009	670-3394-01
A1[1]	670-3986-00	B010100	B013609	CKT BOARD ASSY:INTERFACE	80009	670-3986-00
A1[1]	670-3986-01	B013610		CKT BOARD ASSY:INTERFACE	80009	670-3986-01
C2	283-0022-00			CAP.,FXD,CER DI:0.02UF,1400VDCAC	80009	283-0022-00
C10	283-0004-00			CAP.,FXD,CER DI:0.02UF,+80-20%,150V	72982	855-558-Z5V0203Z
C12	283-0004-00			CAP.,FXD,CER DI:0.02UF,+80-20%,150V	72982	855-558-Z5V0203Z
C14	283-0004-00			CAP.,FXD,CER DI:0.02UF,+80-20%,150V	72982	855-558-Z5V0203Z
C16	283-0004-00			CAP.,FXD,CER DI:0.02UF,+80-20%,150V	72982	855-558-Z5V0203Z
C20	290-0655-00			CAP.,FXD,ELCTLT:8,800UF,+75-10%,40V	56289	36D7708
C22	290-0655-00			CAP.,FXD,ELCTLT:8,800UF,+75-10%,40V	56289	36D7708
C30	283-0004-00			CAP.,FXD,CER DI:0.02UF,+80-20%,150V	72982	855-558-Z5V0203Z
C32	283-0004-00			CAP.,FXD,CER DI:0.02UF,+80-20%,150V	72982	855-558-Z5V0203Z
C35	290-0508-00			CAP.,FXD,ELCTLT:18,000UF,+100-10%,15V	56289	68D10444
C40	283-0004-00			CAP.,FXD,CER DI:0.02UF,+80-20%,150V	72982	855-558-Z5V0203Z
C42	283-0004-00			CAP.,FXD,CER DI:0.02UF,+80-20%,150V	72982	855-558-Z5V0203Z
C44	283-0004-00			CAP.,FXD,CER DI:0.02UF,+80-20%,150V	72982	855-558-Z5V0203Z
C46	283-0004-00			CAP.,FXD,CER DI:0.02UF,+80-20%,150V	72982	855-558-Z5V0203Z
C50	283-0004-00			CAP.,FXD,CER DI:0.02UF,+80-20%,150V	72982	855-558-Z5V0203Z
C52	283-0004-00			CAP.,FXD,CER DI:0.02UF,+80-20%,150V	72982	855-558-Z5V0203Z
C55	290-0508-00			CAP.,FXD,ELCTLT:18,000UF,+100-10%,15V	56289	68D10444
CR10	152-0198-01			SEMICOND DEVICE:SILICON,200V,3A	04713	SR1557
CR11	152-0198-01			SEMICOND DEVICE:SILICON,200V,3A	04713	SR1557
CR12	152-0198-01			SEMICOND DEVICE:SILICON,200V,3A	04713	SR1557
CR13	152-0198-01			SEMICOND DEVICE:SILICON,200V,3A	04713	SR1557
CR20[2]	152-0040-00	XB014050		SEMICOND DEVICE:SILICON,600V,1A	80009	152-0040-00
CR20[1]	152-0040-00	XB013610		SEMICOND DEVICE:SILICON,600V,1A	80009	152-0040-00
CR22[2]	152-0040-00	XB014050		SEMICOND DEVICE:SILICON,600V,1A	80009	152-0040-00
CR22[1]	152-0040-00	XB013610		SEMICOND DEVICE:SILICON,600V,1A	80009	152-0040-00
CR30	152-0198-01			SEMICOND DEVICE:SILICON,200V,3A	04713	SR1557
CR32	152-0198-01			SEMICOND DEVICE:SILICON,200V,3A	04713	SR1557
CR50	152-0274-00			SEMICOND DEVICE:SILICON,100V,10A	80009	152-0274-00
CR52	152-0274-00			SEMICOND DEVICE:SILICON,100V,10A	80009	152-0274-00
F2	159-0005-00			FUSE,CARTRIDGE:3AG,3A,125V,30 SEC,CER	71400	MDA3
F20	159-0003-00			FUSE,CARTRIDGE:3AG,1.6A,250V,SLOW-BLOW	71400	MDX16-10
F22	159-0003-00			FUSE,CARTRIDGE:3AG,1.6A,250V,SLOW-BLOW	71400	MDX16-10
F35	159-0006-00			FUSE,CARTRIDGE:5A,3AG,125V,SLOW-BLOW	71400	MDX5
F50	159-0006-00			FUSE,CARTRIDGE:5A,3AG,125V,SLOW-BLOW	71400	MDX5
J10	131-1078-00			CONNECTOR,RCPT,:28/56 CONTACT	95238	600-1156Y256DF30
J20	131-1078-00			CONNECTOR,RCPT,:28/56 CONTACT	95238	600-1156Y256DF30
J30	131-1078-00			CONNECTOR,RCPT,:28/56 CONTACT	95238	600-1156Y256DF30
J40	131-1078-00			CONNECTOR,RCPT,:28/56 CONTACT	95238	600-1156Y256DF30
Q10	151-0373-00			TRANSISTOR:SILICON,PNP	80009	151-0373-00
Q12	151-0436-00			TRANSISTOR:SILICON,NPN	80009	151-0436-00
Q20	151-0373-00			TRANSISTOR:SILICON,PNP	80009	151-0373-00
Q22	151-0436-00			TRANSISTOR:SILICON,NPN	80009	151-0436-00
Q30	151-0373-00			TRANSISTOR:SILICON,PNP	80009	151-0373-00
Q32	151-0436-00			TRANSISTOR:SILICON,NPN	80009	151-0436-00
Q40	151-0258-00			TRANSISTOR:SILICON,PNP	04713	MJ2955
Q42[2]	151-0413-00	B010100	B011749	TRANSISTOR:SILICON,NPN	02735	2N6258
Q42[2]	151-0140-00	B011750		TRANSISTOR:SILICON,NPN	80009	151-0140-00
Q42[1]	151-0413-00	B010100	B011389	TRANSISTOR:SILICO,NPN	02735	2N6258

[1]Option 2 only.
[2]Standard only.

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
Q42[1]	151-0140-00	B011390		TRANSISTOR:SILICON,NPN	80009	151-0140-00
R2	308-0704-00			RES.,FXD,WW:8.8 OHM,5%,5W	91637	CW5-SR800J
R20	306-0102-00			RES.,FXD,CMPSN:1K OHM,10%,2W	01121	HB1021
R22	306-0102-00			RES.,FXD,CMPSN:1K OHM,10%,2W	01121	HB1021
R30	306-0102-00			RES.,FXD,CMPSN:1K OHM,10%,2W	01121	HB1021
R35	303-0511-00			RES.,FXD,CMPSN:510 OHM,5%,1W	01121	GB5115
R50	303-0511-00			RES.,FXD,CMPSN:510 OHM,5%,1W	01121	GB5115
T1	120-0942-00			TRANSFORMER:PWR	80009	120-0942-00
S2	260-1222-00			SWITCH,PUSH-PUL:10A,250VAC	91929	2DM301
S3	260-0907-00			SW,THERMOSTATIC:OPEN 97.8,CL 75.6,10A,240V	93410	110228
S4	260-0551-00			SW,THERMOSTATIC:NC,10A,240VAC	81439	S636336T21

[1]Option 2 only.


J10
J20
J30
J40
PINS 14 THRU 28 NOT CONNECTED
HIGH POWER COMPARTMENT
C10 .02
C12 .02
C14 .02
C16 .02
+33.5V
-33.5V
+33.5V COMMON
Q10
Q20
Q30
Q40
Q12
Q22
Q32
Q42
HS
w/o
w/r
w/bn
w/bu
w/gn
w/y
C40 .02
C42 .02
C44 .02
C46 .02
17.5 VAC
+11.5V COMMON
+11.5V



SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN BLUE.

REV. F JAN, 1977

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
#	NUMBER SIZE
ACTR	ACTUATOR
ADPTR	ADAPTER
ALIGN	ALIGNMENT
AL	ALUMINUM
ASSEM	ASSEMBLED
ASSY	ASSEMBLY
ATTEN	ATTENUATOR
AWG	AMERICAN WIRE GAGE
BD	BOARD
BRKT	BRACKET
BRS	BRASS
BRZ	BRONZE
BSHG	BUSHING
CAB	CABINET
CAP	CAPACITOR
CER	CERAMIC
CHAS	CHASSIS
CKT	CIRCUIT
COMP	COMPOSITION
CONN	CONNECTOR
COV	COVER
CPLG	COUPLING
CRT	CATHODE RAY TUBE
DEG	DEGREE
DWR	DRAWER
ELCTRN	ELECTRON
ELEC	ELECTRICAL
ELCTLT	ELECTROLYTIC
ELEM	ELEMENT
EPL	ELECTRICAL PARTS LIST
EQPT	EQUIPMENT
EXT	EXTERNAL
FIL	FILLISTER HEAD
FLEX	FLEXIBLE
FLH	FLAT HEAD
FLTR	FILTER
FR	FRAME or FRONT
FSTNR	FASTENER
FT	FOOT
FXD	FIXED
GSKT	GASKET
HDL	HANDLE
HEX	HEXAGON
HEX HD	HEXAGONAL HEAD
HEX SOC	HEXAGONAL SOCKET
HLCPS	HELICAL COMPRESSION
HLEXT	HELICAL EXTENSION
HV	HIGH VOLTAGE
IC	INTEGRATED CIRCUIT
ID	INSIDE DIAMETER
IDENT	IDENTIFICATION
IMPLR	IMPELLER
IN	INCH
INCAND	INCANDESCENT
INSUL	INSULATOR
INTL	INTERNAL
LPHLDR	LAMPHOLDER
MACH	MACHINE
MECH	MECHANICAL
MTG	MOUNTING
NIP	NIPPLE
NON WIRE	NOT WIRE WOUND
OBD	ORDER BY DESCRIPTION
OD	OUTSIDE DIAMETER
OVH	OVAL HEAD
PH BRZ	PHOSPHOR BRONZE
PL	PLAIN or PLATE
PLSTC	PLASTIC
PN	PART NUMBER
PNH	PAN HEAD
PWR	POWER
RCPT	RECEPTACLE
RES	RESISTOR
RGD	RIGID
RLF	RELIEF
RTNR	RETAINER
SCH	SOCKET HEAD
SCOPE	OSCILLOSCOPE
SCR	SCREW
SE	SINGLE END
SECT	SECTION
SEMICOND	SEMICONDUCTOR
SHLD	SHIELD
SHLDR	SHOULDERED
SKT	SOCKET
SL	SLIDE
SLFLKG	SELF-LOCKING
SLVG	SLEEVING
SPR	SPRING
SQ	SQUARE
SST	STAINLESS STEEL
STL	STEEL
SW	SWITCH
T	TUBE
TERM	TERMINAL
THD	THREAD
THK	THICK
TNSN	TENSION
TPG	TAPPING
TRH	TRUSS HEAD
V	VOLTAGE
VAR	VARIABLE
W/	WITH
WSHR	WASHER
XFMR	TRANSFORMER
XSTR	TRANSISTOR

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
04713	MOTOROLA, INC., SEMICONDUCTOR PROD. DIV.	5005 E MCDOWELL RD,PO BOX 20923	PHOENIX, AZ 85036
05091	TRI-ORDINATE CORPORATION	343 SNYDER AVENUE	BERKELEY HEIGHTS, NJ 07922
08051	ITT CANNON ELEC., SANTA ANA DIVISION, DELETED, REPLACED BY 71468		
08261	SPECTRA-STRIP CORP.	7100 LAMPSON AVE.	GARDEN GROVE, CA 92642
12327	FREEWAY CORPORATION	9301 ALLEN DRIVE	CLEVELAND, OH 44125
16428	BELDEN CORP.	P. O. BOX 1331	RICHMOND, IN 47374
22526	BERG ELECTRONICS, INC.	YOUK EXPRESSWAY	NEW CUMBERLAND, PA 17070
22670	G.M. NAMEPLATE, INC.	2040 15TH AVENUE WEST	SEATTLE, WA 98119
26365	GRIES REPRODUCER CO., DIV. OF COATS AND CLARK, INC.	125 BEECHWOOD AVE.	NEW ROCHELLE, NY 10802
70485	ATLANTIC INDIA RUBBER WORKS, INC.	571 W. POLK ST.	CHICAGO, IL 60607
71468	ITT CANNON ELECTRIC	666 E. DYER RD.	SANTA ANA, CA 92702
73743	FISCHER SPECIAL MFG. CO.	446 MORGAN ST.	CINCINNATI, OH 45206
74921	ITEN FIBRE CO., THE	4001 BENEFIT AVE., P O BOX 9	ASHTABULA, OH 44004
75915	LITTELFUSE, INC.	800 E. NORTHWEST HWY	DES PLAINES, IL 60016
77250	PHEOLL MANUFACTURING CO., DIVISION OF ALLIED PRODUCTS CORP.	5700 W. ROOSEVELT RD.	CHICAGO, IL 60650
78189	ILLINOIS TOOL WORKS, INC. SHAKEPROOF DIVISION	ST. CHARLES ROAD	ELGIN, IL 60120
78471	TILLEY MFG. CO.	900 INDUSTRIAL RD.	SAN CARLOS, CA 94070
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
83385	CENTRAL SCREW CO.	2530 CRESCENT DR.	BROADVIEW, IL 60153
86928	SEASTROM MFG. COMPANY, INC.	701 SONORA AVENUE	GLENDALE, CA 91201
91929	HONEYWELL, INC., MICRO SWITCH DIV.	CHICAGO & SPRING STS.	FREEPORT, IL 61032
95238	CONTINENTAL CONNECTOR CORP.	34-63 56TH ST.	WOODSIDE, NY 11377

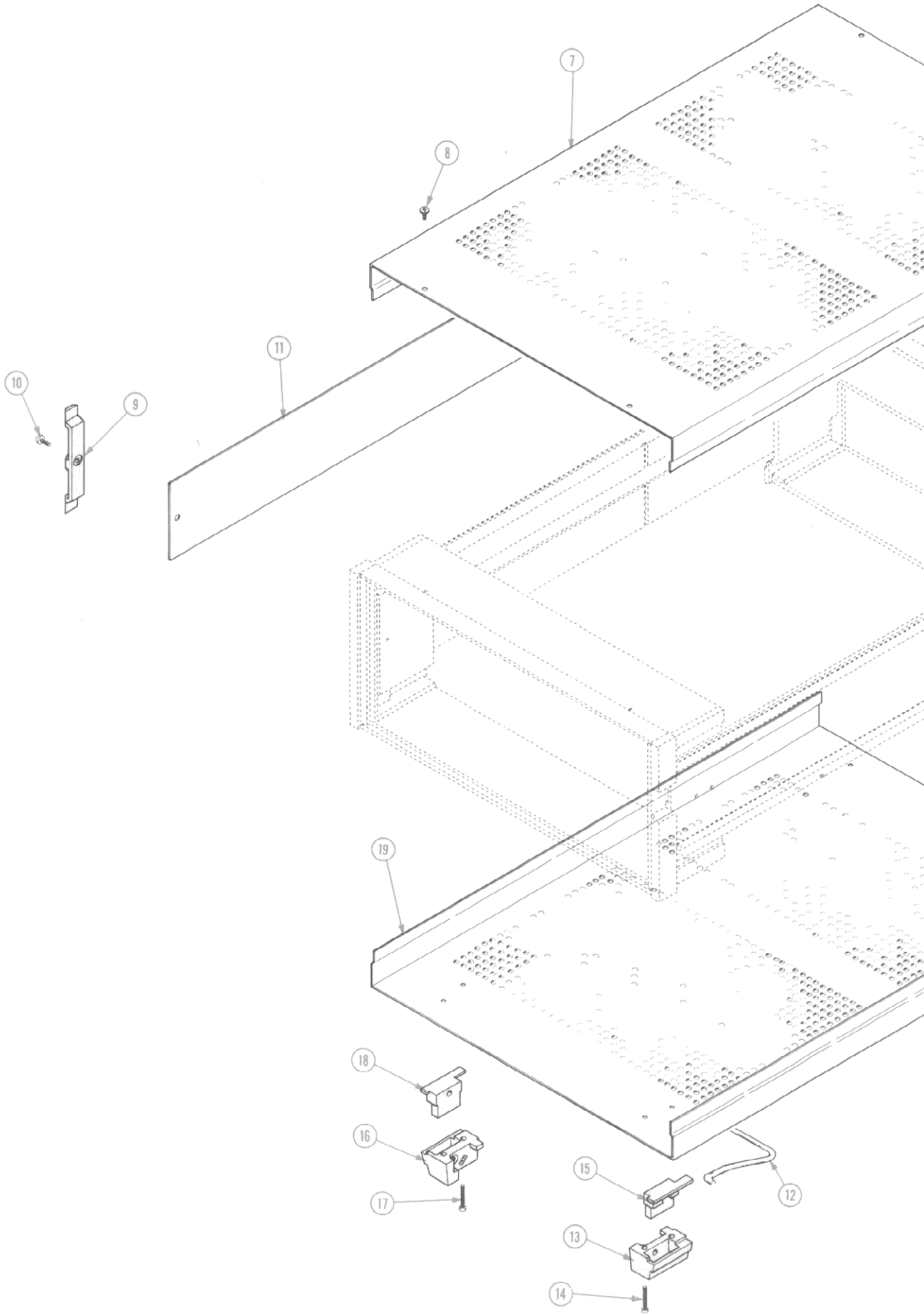
Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-1	200-0728-00			2		COV,HANDLE END:	80009	200-0728-00
-2	367-0116-00			1		HANDLE,CARRYING:	80009	367-0116-00
						(ATTACHING PARTS)		
-3	212-0616-00			4		SCREW,SHOULDER:10-32 X 0.531 L,HEX STL CD,PL	80009	212-0616-00
-4	386-1624-00			2		PL,RET.,HANDLE:	80009	386-1624-00
-5	386-1283-00			2		PLATE,HDL MTG:PLASTIC	80009	386-1283-00
						- - - * - - -		
-6	124-0293-00			1		STRIP,TRIM:RIGHT	80009	124-0293-00
-7	390-0431-00			1		CAB.,WRAPAROUND:UPPER	80009	390-0431-00
						(ATTACHING PARTS)		
-8	211-0622-00			4		SCREW,MACHINE:6-32 X 0.188 INCH,TH SST	77250	OBD
						- - - * - - -		
-9	348-0385-00			2		FOOT,CABINET:	80009	348-0385-00
						(ATTACHING PARTS)		
-10	211-0537-00			1		SCREW,MACHINE:6-32 X 0.375 INCH,TRH STL	83385	OBD
						- - - * - - -		
-11	124-0294-00			1		STRIP,TRIM:LEFT	80009	124-0294-00
-12	348-0404-00			1		FLIPSTAND,CAB:	80009	348-0404-00
-13	348-0074-00			2		SPT PIVOT,FLIP:RIGHT FRONT AND LEFT REAR	80009	348-0074-00
						(ATTACHING PARTS)		
-14	211-0532-00			2		SCREW,MACHINE:6-32 X 0.75 INCH,FILH STL	83385	OBD
-15	348-0207-00			1		FOOT,CABINET:RIGHT FRONT AND LEFT REAR	80009	348-0207-00
						- - - * - - -		
-16	348-0073-00			2		SPT PIVOT,FLIP:LEFT FRONT AND RIGHT REAR	80009	348-0073-00
						(ATTACHING PARTS FOR EACH)		
-17	211-0532-00			2		SCREW,MACHINE:6-32 X 0.75 INCH,FILH STL	83385	OBD
-18	348-0208-00			1		FOOT,CABINET:LEFT FRONT AND RIGHT REAR	80009	348-0208-00
-19	390-0430-00			1		CAB.,WRAPAROUND:	80009	390-0430-00
						(ATTACHING PARTS)		
	211-0622-00			4		SCREW,MACHINE:6-32 X 0.188 INCH,TH SST	77250	OBD
						- - - * - - -		

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
2-1	384-1243-00			1		SHAFT,EXT:PWR SW FOR TM504	80009	384-1243-00
						(ATTACHING PARTS)		
-2	211-0105-00			2		SCREW,MACHINE:4-40 X 0.188"100 DEG,FLH STL	83385	OBD
						- - - * - - -		
-3	214-2010-00			1		ACTUATOR,SW:FOR TM504	80009	214-2010-00
-4	260-1222-00			1		SWITCH,PUSH-PUL:10A,250VAC	91929	2DM301
-5	407-0895-00			1		BRACKET,SW, MTG:POWER	80009	407-0895-00
						(ATTACHING PARTS)		
-6	211-0038-00			2		SCREW,MACHINE:4-40 X 0.312"100 DEG,FLH STL	83385	OBD
-7	210-0586-00			2		NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL	78189	OBD
						- - - * - - -		
-8	426-1148-00			1		FRAME SECT.,CAB:UPPER REAR	80009	426-1148-00
						(ATTACHING PARTS)		
-9	211-0040-00			9		SCREW,MACHINE:4-40 X 0.25",BDGH PLSTC	26365	OBD
						- - - * - - -		
-10	348-0191-00			4		LEG,ELEC EQUIP.:PLASTIC	80009	348-0191-00
						(ATTACHING PARTS FOR EACH)		
-11	212-0082-00			1		SCREW,MACHINE:8-32 X 1.250 INCH,PNH STL	83385	OBD
-12	210-0458-00			1		NUT,PLAIN,EXT W:8-32 X 0.344 INCH,STL	83385	OBD
						- - - * - - -		
-13	352-0362-00			1		FUSEHOLDER: W/MOUNTING HARDWARE	75915	345001
-14	210-0873-00			1		WASHER,NONMETAL:0.5 ID X 0.688 INCH OD,NPRN	70485	OBD
-15	210-0201-00			1		TERMINAL,LUG:SE #4	78189	2104-04-00-2520N
						(ATTACHING PARTS)		
-16	210-0586-00			1		NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL	78189	OBD
						- - - * - - -		
-17	200-0692-00			2		COV,TRANSISTOR:BLACK PLASTIC	80009	200-0692-00
						(ATTACHING PARTS FOR EACH)		
-18	211-0016-00	B010100	B013899	1		SCREW,MACHINE:4-40 X 0.625 INCH,PNH STL	83385	OBD
	210-0513-00	B013900		1		NUT,PLAIN,SQ:	80009	210-0513-00
-19	210-0586-00	B010100	B013899	1		NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL	78189	OBD
	210-0457-00	B013900		1		NUT,PLAIN,EXT W:6-32 X 0.312 INCH,STL	83385	OBD
-20	210-0593-00	B010100	B013899	1		NUT,FINISHING:0.25 HEX X 0.312" LONG,BRS	80009	210-0593-00
	210-0935-00	B013900		1		WASHER,NONMETAL:FIBER,0.14 IDX 0.375"OD	74921	OBD
	210-0804-00	XB013900		1		WASHER,FLAT:0.17 ID X 0.375 INCH OD,STL	12327	OBD
						- - - * - - -		
-21	----- -----			2		TRANSISTOR:(SEE Q40 AND Q42 EPL)		
						(ATTACHING PARTS FOR EACH)		
	386-0978-00			1		INSULATOR,PLATE:0.002 INCH MICA,FOR TO-3	80009	386-0978-00
-22	211-0012-00	B010100	B013899	1		SCREW,MACHINE:4-40 X 0.375 INCH,PNH STL	83385	OBD
	211-0511-00	B013900		1		SCREW,MACHINE:6-32 X 0.50 INCH,PNH STL	83385	OBD
-23	210-0586-00	B010100	B013899	1		NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL	78189	OBD
	210-0457-00	B013900		1		NUT,PLAIN,EXT W:6-32 X 0.312 INCH,STL	83385	OBD
-24	210-0201-00	B010100	B013899	1		TERMINAL,LUG:SE #4	78189	2104-04-00-2520N
	210-0202-00	B013900		1		TERMINAL,LUG:SE #6	78189	2104-06-00-2520N
	210-0804-00	XB013900		1		WASHER,FLAT:0.17 ID X 0.375 INCH OD,STL	12327	OBD
-25	210-0935-00			1		WASHER,NONMETAL:FIBER,0.14 IDX 0.375"OD	74921	OBD
						- - - * - - -		
-26	----- -----			1		SW.THERMOSTATIC:(SEE S3 EPL)		
						(ATTACHING PARTS)		
-27	211-0012-00	B010100	B013899	2		SCREW,MACHINE:4-40 X 0.375 INCH,PNH STL	83385	OBD
	211-0507-00	B013900		2		SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	OBD
-28	210-0586-00	B010100	B013899	2		NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL	78189	OBD
	210-0407-00	B013900		2		NUT,PLAIN,HEX.:6-32 X 0.25 INCH,BRS	73743	3038-0228-402
	210-0055-00	XB013900		2		WASHER,LOCK:SPLIT,0.145 ID X 0.253 OD,STL	83385	OBD
						- - - * - - -		
-29	161-0033-04			1		CABLE ASSY,PWR:	16428	KH854-2
-30	358-0515-00			1		BSHG,STRAIN RLF:TOP	80009	358-0515-00
-31	358-0516-00			1		BSHG,STRAIN RLF:BOTTOM	80009	358-0516-00
-32	200-1646-00			1		CABLE NIP,PWR:1.500 X 0.625 ID W/FLANGE	80009	200-1646-00
-33	214-2038-00			1		IND,LINE V:	80009	214-2038-00

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
2-34	----- -----			2		TRANSISTOR:(SEE Q22 & Q30 EPL)		
						(ATTACHING PARTS FOR EACH)		
-35	211-C102-00			1		SCREW,MACHINE:4-40 X 0.500",FLH,STL	83385	OBD
-36	210-0586-00			1		NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL	78189	OBD
	210-1122-00			1		WASHER,LOCK:0.228 ID X 0.375 INCH OD,STL	04713	B52200F006
-37	342-0136-00			1		INSULATOR,WSHR:0.812 OD X 0.0025 INCH THK	04713	OBD
						- - - * - - -		
-38	426-1151-00			1		FRAME SECT.,CAB:LOWER REAR	80009	426-1151-00
						(ATTACHING PARTS)		
-39	212-0040-00			9		SCREW,MACHINE:8-32 X 0.375 100 DEG,FLH STL	83385	OBD
						- - - * - - -		
	334-2859-00	XB020890		1		MARKER,IDENT:MARKED CAUTION	22670	OBD
	334-2553-00	XB020890		1		MARKER,IDENT:MARKED CAUTION	22670	OBD
-40	333-1840-00			1		PANEL:REAR	80009	333-1840-00
-41	----- -----			1		TRANSFORMER,PWR:(SEE T1 EPL)		
						(ATTACHING PARTS)		
-42	212-0522-00			4		SCREW,MACHINE:10-32 X 2.50",HEX HD STL	83385	OBD
	210-0010-00	B010100	B014049X	4		WASHER,LOCK:INT,0.20 ID X0.376" OD,STL	78189	1210-00-00-0541C
	210-0805-00	B014050	B013899	4		WASHER,FLAT:0.204 ID X 0.438 INCH OD,STL	12327	OBD
	210-0834-00	B014050		4		WASHER,FLAT:0.203 ID X 0.438 INCH OD,NPRE	78471	OBD
-43	220-0410-00			4		NUT,EXTENDED WA:10-32 X 0.375 INCH,STL	83385	OBD
-44	166-0457-00	B010100	B014049	4		INSUL SLVG,ELEC:0.19 ID X 1.875"LONG MYLAR	80009	166-0457-00
	166-0434-00	B014050		4		SPACER,SLEEVE:MYLAR	80009	166-0434-00
						- - - * - - -		
-45	407-1551-00	B010100	B013899	2		BRACKET,XFMR:	80009	407-1551-00
	407-1551-01	B013900		2		BRACKET,XFMR:	80009	407-1551-01
-46	351-0286-04			4		GUIDE,SLIDE:BLACK	80009	351-0286-04
						(ATTACHING PARTS FOR EACH)		
-47	211-0101-00			1		SCREW,MACHINE:4-40 X 0.25" 100 DEG,FLH STL	83385	OBD
						- - - * - - -		
-48	426-1150-00			1		FRAME SECT.,CAB:LOWER FRONT	80009	426-1150-00
						(ATTACHING PARTS)		
-49	212-0040-00			4		SCREW,MACHINE:8-32 X 0.375 100 DEG,FLH STL	83385	OBD
						- - - * - - -		
-50	334-2380-00			1		MARKER,IDENT:	80009	334-2380-00
-51	351-0379-01			4		GUIDE,PL-IN:UPPER	80009	351-0379-01
						(ATTACHING PARTS FOR EACH)		
-52	211-0030-00			1		SCREW,MACHINE:2-56 X 0.25"82 DEG,FLH STL	83385	OBD
						- - - * - - -		
-53	426-1149-00			1		FRAME SECT.,CAB:UPPER FRONT	80009	426-1149-00
						(ATTACHING PARTS)		
-54	212-0040-00			4		SCREW,MACHINE:8-32 X 0.375 100 DEG,FLH STL	83385	OBD
						- - - * - - -		
-55	----- -----			1		CKT BOARD ASSY:INTERFACE(SEE A1 EPL)		
						(ATTACHING PARTS)		
-56	211-0008-00	B010100	B013899	8		SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
	211-0033-00	B013900		8		SCR,ASSEM WSHR:4-40 X 0.312 1NCH,PNH STL	83385	OBD
-57	211-0012-00			4		SCREW,MACHINE:4-40 X 0.375 INCH,PNH STL	83385	OBD
-58	210-1122-00			4		WASHER,LOCK:0.228 ID X 0.375 INCH OD,STL	04713	B52200F006
-59	342-0136-00			4		INSULATOR,WSHR:0.812 OD X 0.0025 INCH THK	04713	OBD
						- - - * - - -		
	----- -----			-		. CKT BOARD ASSY INCLUDES:		
-60	131-0608-00			16		. CONTACT,ELEC:0.365 L X 0.25 PH BRZ GOLD PL	22526	47357
-61	131-1078-00			4		. CONNECTOR,RCPT,:28/56 CONTACT	95238	600-1156Y256DF30
-62	214-1593-02			4		. KEY,CONN PLZN:	80009	214-1593-02
-63	344-0154-00			16		. CLIP,ELECTRICAL:FOR 0.25 INCH DIA FUSE	80009	344-0154-00
-64	131-1895-00			1		. LINK,TERM. CONN:8,22 AWG,1.5 L	80009	131-1895-00
-65	131-1896-00			1		. LINK,TERM. CONN:8,22 AWG,1.5 L	80009	131-1896-00
-66	334-2359-00			1		. MARKER,IDENT:WARNING	80009	334-2359-00
-67	----- -----			4		TRANSISTOR:(SEE Q10,Q12,Q20 & Q32 EPL)		
-68	441-1247-00			1		CHAS,PWR SUPPLY:	80009	441-1247-00
						(ATTACHING PARTS)		
-69	212-0040-00			4		SCREW,MACHINE:8-32 X 0.375 100 DEG,FLH STL	83385	OBD
-70	210-0458-00			4		NUT,PLAIN,EXT W:8-32 X 0.344 INCH,STL	83385	OBD
						- - - * - - -		

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
2-71	----- -----			2		CAPACITOR:W/HARDWARE(SEE C20,C22 EPL)		
-72	210-0224-00			5		TERMINAL,LUG:0.20 ID X 0.344 OD,SE,BRS	86928	A373-148-1
-73	----- -----			1		SW,THERMOSTATIC:(SEE S4 EPL)		
						(ATTACHING PARTS)		
-74	211-0008-00	B010100	B013899	2		SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
	211-0507-00	B013900		2		SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	OBD
-75	210-0586-00	B010100	B013899	2		NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL	78189	OBD
	220-0456-00	B013900		2		NUT,PLAIN,HEX.:6-32 X 0.25 INCH,STL	73743	9038
	210-0055-00	XB013900		2		WASHER,LOCK:SPLIT,0.145 ID X 0.253 OD,STL	83385	OBD
						- - - * - - -		
-76	----- -----			2		DIODE:W/HARDWARE(SEE CR50 CR52 EPL)		
-77	342-0136-00			2		INSULATOR,WSHR:0.812 OD X 0.0025 INCH THK	04713	OBD
-78	214-1999-00			1		HEAT SINK,XSTR:	80009	214-1999-00
						(ATTACHING PARTS)		
-79	212-0040-00			4		SCREW,MACHINE:8-32 X 0.375 100 DEG,FLH STL	83385	OBD
-80	210-0458-00			4		NUT,PLAIN,EXT W:8-32 X 0.344 INCH,STL	83385	OBD
						- - - * - - -		
-81	426-1174-01			1		FRAME SECT,CAB:LEFT	80009	426-1174-01
-82	426-1175-01			L		FRAME SECT,CAB:RIGHT	80009	426-1175-01
-83	175-0826-00			FT		WIRE,ELECTRICAL:3 WIRE RIBBON	08261	OBD
-84	179-2179-00	B010100	B011549	1		WIRING HARNESS:CHASSIS	80009	179-2179-00
	179-2179-01	B011550		1		WIRING HARNESS:CHASSIS	80009	179-2179-01

Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
	070-1716-00			1		MANUAL,TECH:INSTRUMENT(NOT SHOWN)	80009	070-1716-00
	016-0609-00			1		COVER,FRONT(OPTIONAL)	80009	016-0609-00


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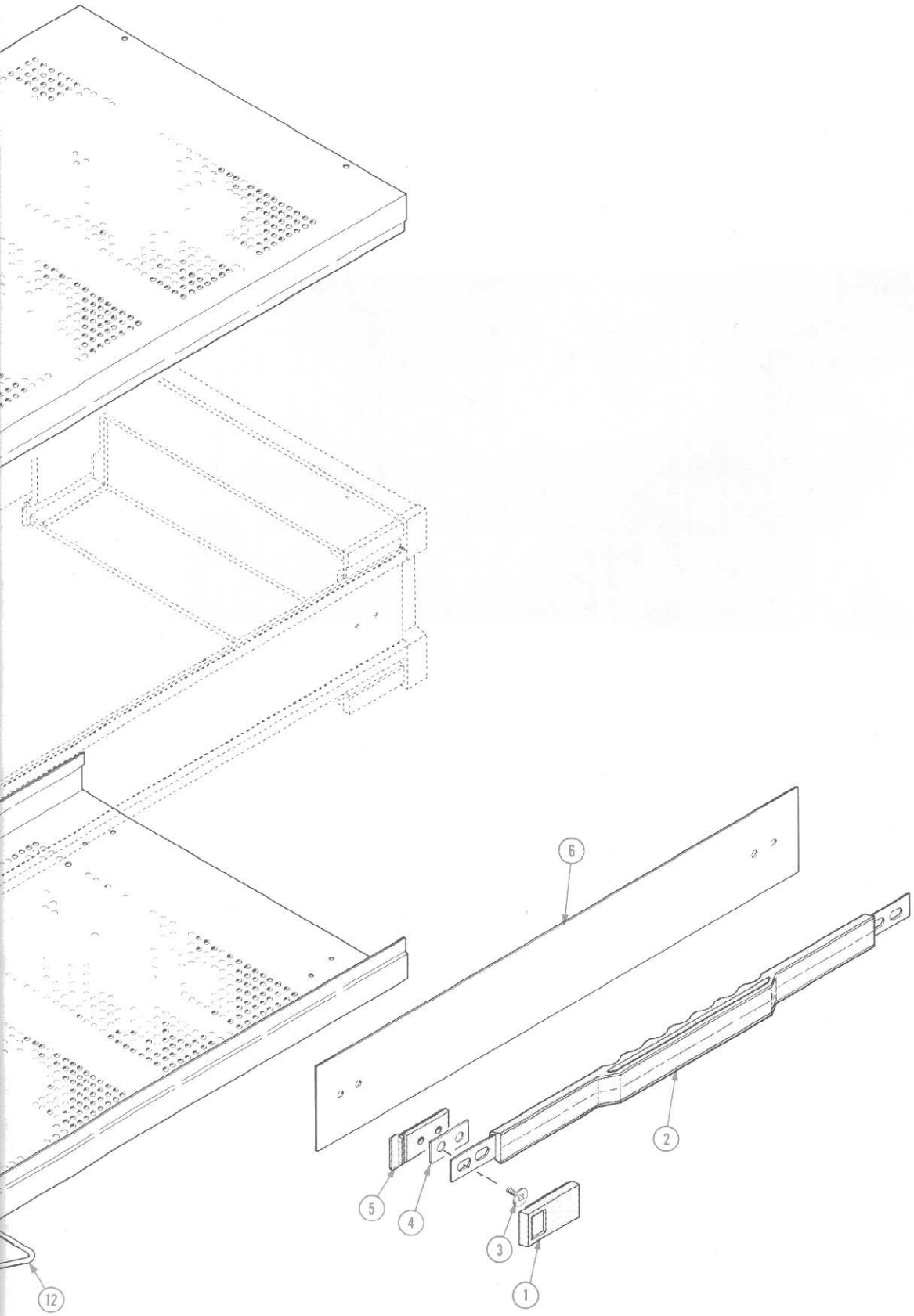
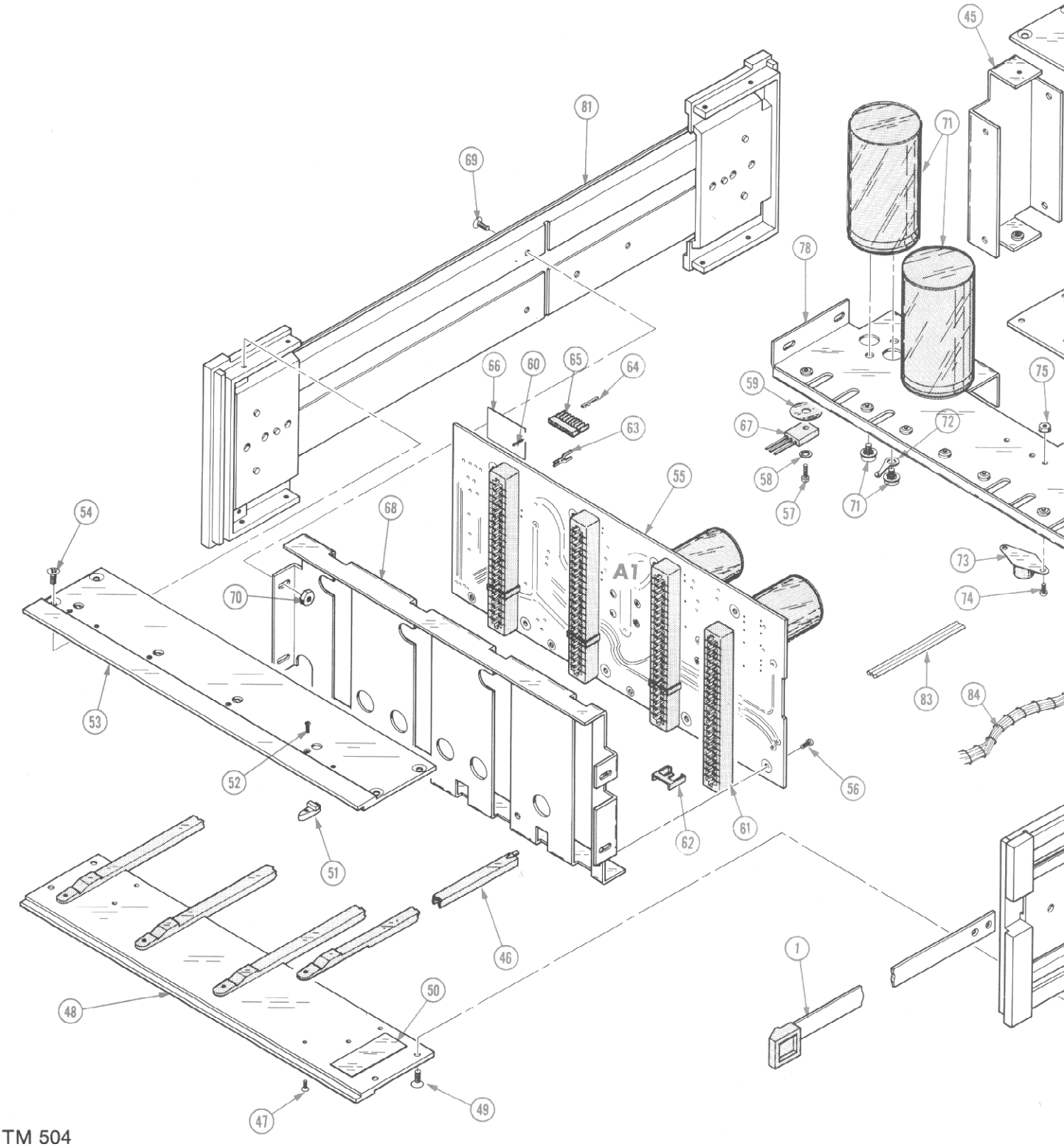
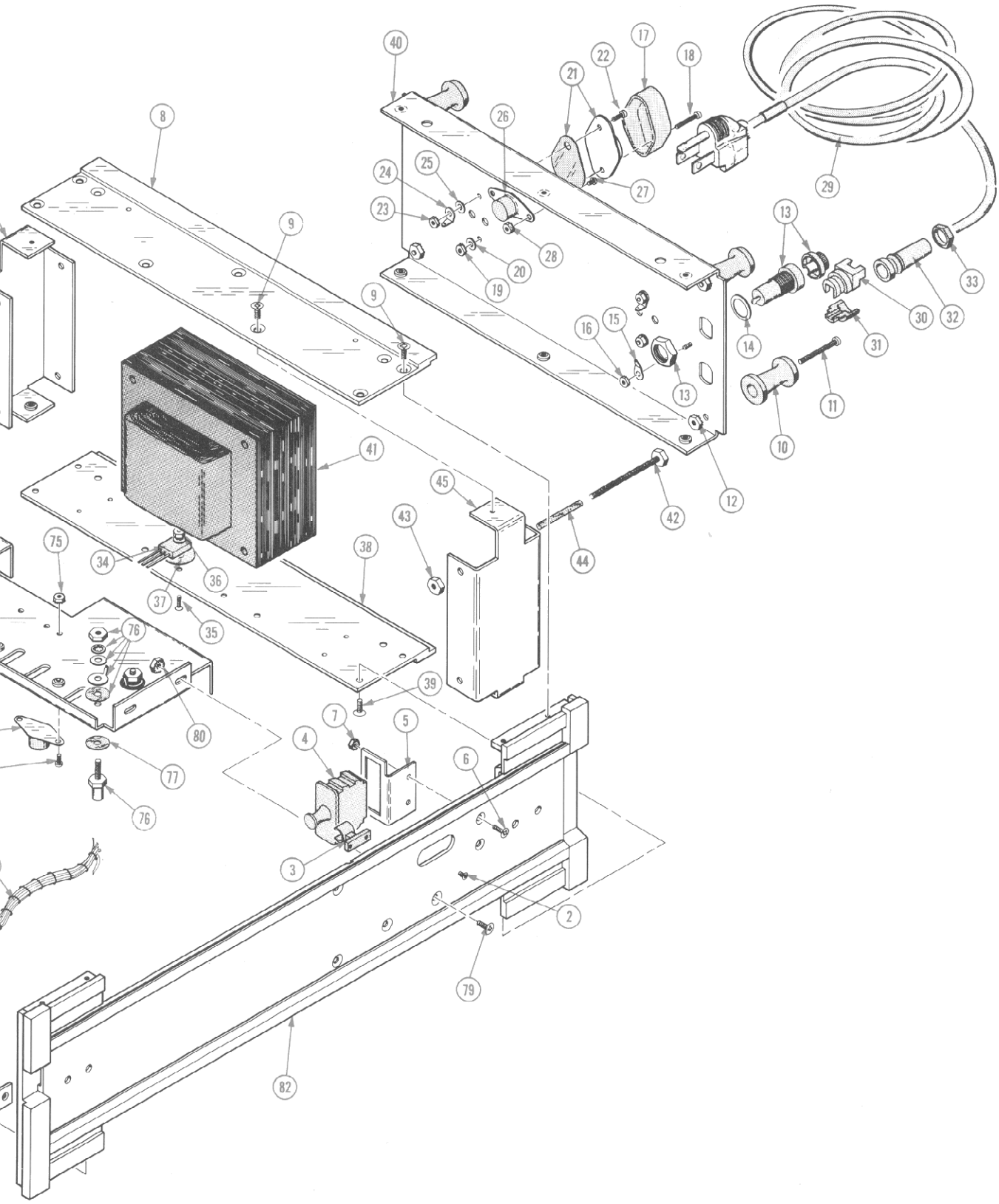


FIG. 1 CABINET

FIG. 2 EXPLODED



TM 504


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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		
067-0532-01	SG 503 - Frequency range 250 kHz to 250 MHz.	0532-01 - Frequency range 65 MHz to 500 MHz.
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		181 - Multiple time-marks
184	TG 501 - Trigger output-slaved to market output from 5 sec through 100 ns. One time-mark can be generated at a time.	184 - Separate trigger pulses of 1 and 0.1 sec; 10, 1, and 0.1 ms; 10 and 1 μs.
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 μs. 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.

REV B, JUN 1978

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MANUAL CHANGE INFORMATION

PRODUCT TM 503, TM 504, TM 506, & TM 515

CHANGE REFERENCE OPTION 7

DATE 4-20-76 REV. 10-25-76

CHANGE:	DESCRIPTION

OPTION 7

TM 503, TM 504, TM 506, and TM 515

The following described bus wires and keys are added to the connector boards of the above named TM 500-Series Power Modules to provide rear interface connections between the DC 502 Option 7, the TR 502, and the SW 503.

Bus Wires. Six-conductor ribbon cable (Tektronix Part No. 175-0829-00) is used to make bus runs between the following points:

TM 503, TM 504,TM506 and TM515

B14 on J10, J20, and J30
B15 on J10, J20, and J30
B16 on J10, J20, and J30
B17 on J10, J20, and J30
B18 on J10, J20, and J30
A18 on J10, J20, and J30

Barrier Keys. Plastic barrier keys (Tektronix Part No. 214-1593-02) are inserted between pins 21 and 22 on J10 between pins 23 and 24 on J20 and between pins 17 and 18 on J30.

Once the above bus connections are made and barrier keys inserted, the three connectors so changed are system dedicated and the three slots should only be used for system-dedicated plug-ins.

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