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TEK

Service
Manual

11A71

Extended Service

Tektronix®
COMMITTED TO EXCELLENCE

11A71
Amplifier
Extended Service Manual

WARNING

The following servicing instructions are for use by qualified personnel only. To avoid personal injury, do not perform any servicing unless you are qualified to do so. Refer to the Safety Summary prior to performing any service.

Please check for CHANGE INFORMATION at the rear of this manual.

Serial Number______________________

First Printing OCT 1988

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INSTRUMENT SERIAL NUMBERS

Each instrument manufactured by Tektronix has a serial number on a panel insert, tag, or stamped on the chassis. The first letter in the serial number designates the country of manufacture. The last five digits of the serial number are assigned sequentially and are unique to each instrument. Those manufactured in the United States have six unique digits. The country of manufacture is identified as follows:

B010000	Tektronix, Inc. Beaverton, Oregon, USA
G100000	Tektronix Guernsey, Ltd., Channel Islands
E200000	Tektronix United Kingdom, Ltd., London
J300000	Sony/Tektronix, Japan
H700000	Tektronix Holland, NV, Heerenveen, The Netherlands

Instruments manufactured for Tektronix by external vendors outside the United States are assigned a two digit alpha code to identify the country of manufacture (e.g., JP for Japan, HK for Hong Kong, etc.).

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

Printed in U.S.A.

Contents

Section 3 — Maintenance

Related Documentation

The Replaceable Parts Section at the rear of this manual lists the Tektronix part numbers for all Standard and Optional Accessories provided with this product.

List of Illustrations

List of Tables

Safety Summary

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

Terms

In This Manual

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

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

As Marked on Equipment

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

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

Symbols

In This Manual

Static-Sensitive Devices.

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

As Marked on Equipment

⚡ DANGER—High Voltage.

⏚ Protective ground (earth) terminal.

⚠ ATTENTION—refer to manual.

Warnings

Power Source

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

Grounding the Product

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

Danger Arising from Loss of Ground

Upon loss of the protective–ground connection, all accessible conductive parts (including knobs and controls that may appear to be insulating), can render an electric shock.

Do Not Operate in Explosive Atmospheres

To avoid explosion, do not operate this product in an atmosphere of explosive gasses.

Do Not Service Alone

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

Use Care When Servicing with Power On

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

Disconnect power before removing protective panels, or replacing components.

Section 1
General Information

Section 1
General Information

This section gives all the information needed to apply power to the 11A71 Single-Channel Amplifier.

Information on installing and removing the amplifier, instrument options, packaging for shipment, and ambient temperature requirements are included here.

Introduction

The 11A71 is a single-channel, wide-bandwidth plug-in amplifier that plugs into any compatible 11000-series Tektronix oscillscope. All 11A71 functions are controlled by commands from the oscilloscope. The 11A71 front panel has a momentary pushbutton and a back-lighted "display on" indicator for the input channel. This front panel button is a functional extension of the host oscilloscope. The ID button of any probe so equipped becomes an 11A71 control when that probe is connected to an 11A71 input connector. The oscilloscope can distinguish between signals from the 11A71 buttons and probe ID buttons. All other controls and status indicators are located on the oscilloscope. See the Tektronix Products catalog for complete compatibility information.

The input impedance of CH 1 is 50 Ω. The 11A71 also provides display and trigger signals to the host oscilloscope. The display and trigger signals can be independently turned off.

The 11A71 has a TEKPROBE™ input connector, which accepts Level 1 and Level 2 TEKPROBEs™, any other probe with a BNC connector, or any BNC connector. The 11A71 will detect probe-encoding information and automatically account for it to achieve the desired settings.

Amplifier to Oscilloscope Compatibility

The 11A71 is designed for use in compatible 11000-series plug-in oscilloscopes. 11A71 bandwidth varies depending on host oscilloscope. Details about bandwidth are included in Part 4, Specification, of the User's Reference Supplement, and in the Tektronix Products catalog. See the Tektronix Products catalog for complete compatibility information.

Initial Inspection

This amplifier was inspected mechanically and electrically before shipment. Inspect the 11A71 for physical damage that may have occurred during transit. You can verify the instrument performance by performing the Checks and Adjustment procedures given in Section 2 of the 11A71 Reference Manual. If you find damage or deficiency, contact your local Tektronix field office or representative.

Installing and Removing the 11A71

CAUTION

To avoid oscilloscope damage ,set the oscilloscope ON/STANDBY switch to STANDBY before installing or removing the 11A71.

If the green indicator light remains ON, when the STANDBY position is selected, the switch has been internally disabled.

To remove or reinstall the amplifier, use the PRINCIPAL POWER SWITCH (rear panel) to shut OFF the power. This will prevent damage to either the amplifier or the oscilloscope.

To once again enable the ON/STANDBY switch, refer to the Maintenance section of the oscilloscope service manual.

The 11A71 amplifier provides the X (horizontal) part of an X-Y display or the trigger signal for the oscilloscope time base when the amplifier is installed in the right compartment of the 11301/11302.

To install the 11A71 in any 11000-series oscilloscope mainframe, set the oscilloscope ON/STANDBY switch to STANDBY (see CAUTION above). Align the grooves in the top and bottom of the 11A71 with the guides in the oscilloscope amplifier compartment, then insert the 11A71 into the oscilloscope until its front panel is flush with the front panel of the oscilloscope.

To remove the 11A71 from an oscilloscope, set the oscilloscope ON/STANDBY switch to STANDBY (see CAUTION above). Then pull the release latch (see Fig. 1-1) to disengage the unit from the oscilloscope, and pull the 11A71 straight out of the amplifier compartment.

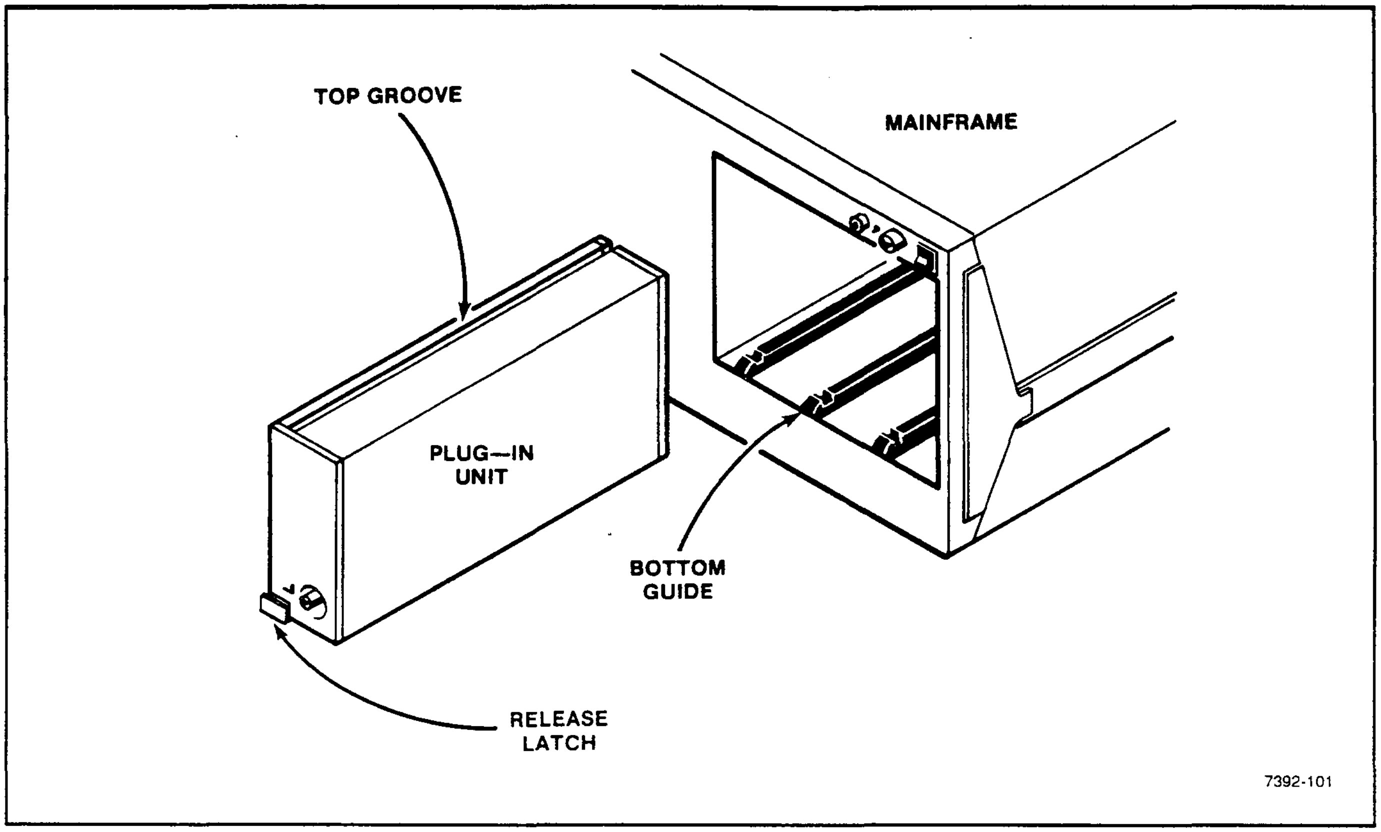

Figure 1-1. Installing an Amplifier in an Oscilloscope .

Oscilloscope Options

Option 26 includes one P6231 probe.

Packaging for Shipment

If this amplifier is to be shipped by commercial transportation, we recommend that it be packaged in the original manner. The original carton and packaging material can be saved and reused for this purpose.

NOTE

Package and ship the amplifiers and oscilloscopes separately.

If the 11A71 is to be shipped to a Tektronix Service Center for service or repair, attach a tag to the amplifier. On the tag, include the following information:

- Name and address of the instrument owner
- Name of a person at your firm who can be contacted about the instrument
- Complete instrument type and serial number
- A description of the service required.

If the original package is not available or is not fit for use, package the 11A71 as follows:

1. Obtain a corrugated cardboard carton with inside dimensions at least six inches greater than the amplifier dimensions. Use a carton with a test strength of at least 200 pounds.
2. Fully wrap the 11A71 with anti-static sheeting, or its equivalent, to protect the finish.
3. Cushion the 11A71 on all sides by tightly packing dunnage or urethane foam between the carton and the amplifier. Allow three inches of packing on each side.
4. Seal the carton with shipping tape or with industrial staples.
5. Mark the address of the Tektronix Service Center and your return address on the carton in one or more prominent places.

Operating Temperature

The 11A71 can be operated in ambient temperatures between 0° and +50°C It can be stored in ambient temperatures between –40° to +75°C. After storage at temperatures outside the operating limits, allow the amplifier to reach operating temperature limits before applying power.

Section 2

Theory

Section 2
Theory of Operation

This section describes the circuitry used in the 11A71 Amplifier. First we discuss the amplifier at the block diagram level, using the block diagram shown in Figure 2-1. The description then continues with details of relationships among major blocks and their subparts. Schematics of all major circuits are given in Section 6, Diagrams and Circuit Board Illustrations. Stages are outlined on the schematics with wide shaded lines. Refer to the schematics throughout the following descriptions.

Block Diagram

The following discussion is intended to aid in understanding the overall concept of the 11A71 before discussing individual circuits in detail. Figure 2-1 is a block diagram of the 11A71. Each block represents a major circuit in the amplifier. Only the basic interconnections between blocks are shown on the block diagram.

From the input BNC connector the input signal passes through the Delay Line and is applied to the Attenuator, which is controlled by five lines from the Kernel. Input coupling can be AC, DC or Off. In AC and DC coupling modes, the input signal is coupled to the Attenuator. In the Off mode, the signal path is open. During self-calibration the coupling is set to Off and a signal from the Calibration Buffer Amplifier is applied to the input.

The Attenuator has 2X, 5X, and 10X attenuation sections, which are connected in various ways to produce 2X, 5X, 10X, 20X, 50X or 100X attenuation.

If the amplitude of the input signal is sufficient to overload the oscilloscope, Input Protection circuitry will activate the Kernel, which will switch the 11A71 to the Off mode.

A Fast-Overload Protection circuit protects the input amplifier from large signals until the Input Protection circuit disconnects the input signal.

The Kernel provides DC balance, DC offset, and gain adjust signals to the Input Amplifier, which accepts the single-ended input and produces a push-pull output for the Output Amplifier. The display and trigger signals for the host oscilloscope come from the Output Amplifier

On/Off signals from the Kernel control both the Output and Trigger Amplifiers independently.

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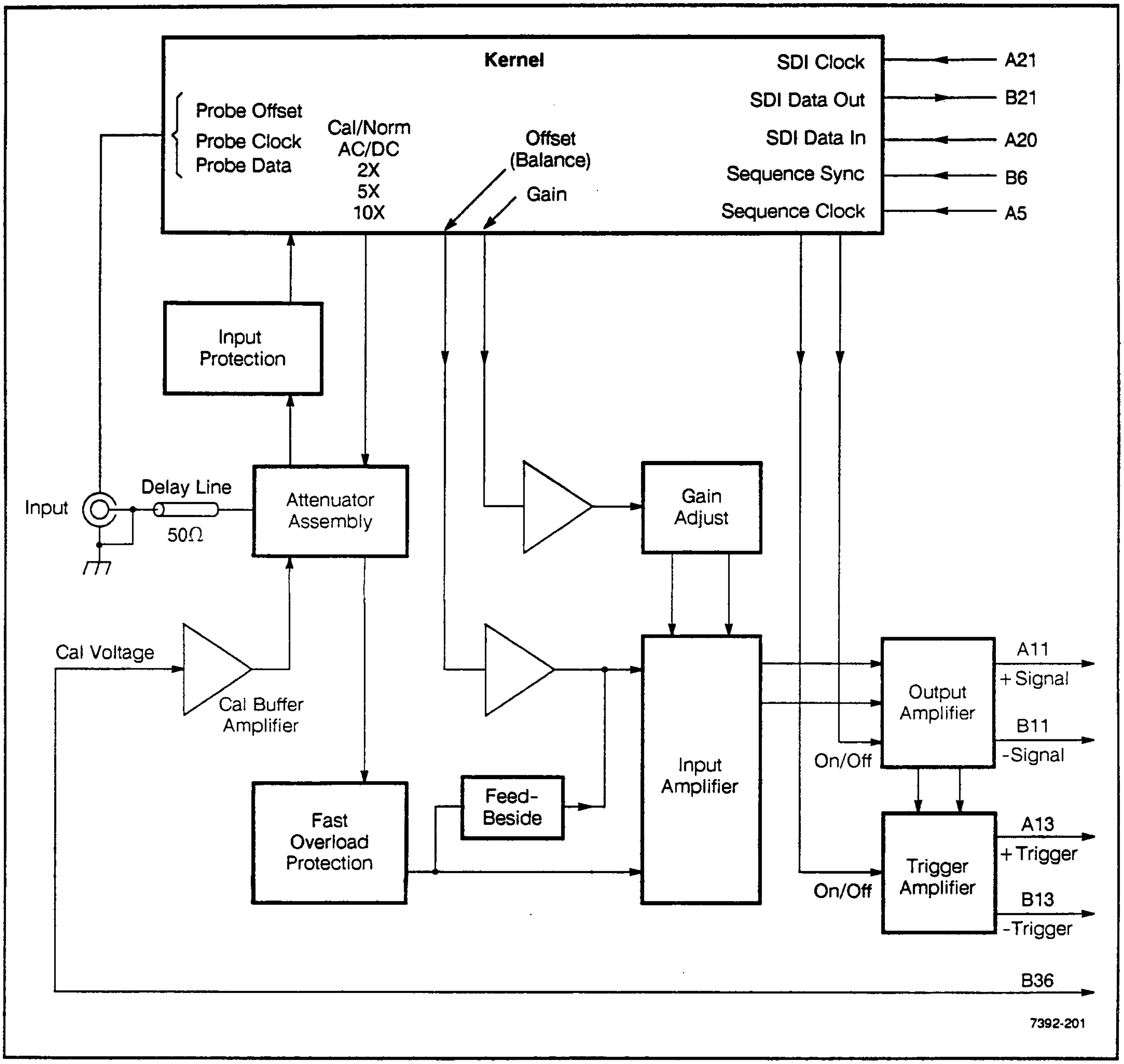


Figure 2-1. 11A71 Basic Block Diagram.

Input Attenuators <1>

This section describes the electrical operation and relationship of circuits in the input attenuator assemblies. See Schematic <1> in Section 6

Delay Line

The 11A71 uses a fixed delay line, which consists of a precision length of 50 Ω coaxial cable. This fixed delay line is in series with the signal path; it matches the nominal delay of the 11A71 to that of the other 11A-series plug-in units.

Attenuators

The 11A71 attenuators consist of thick-film resistor networks and hermetically sealed DPDT relays. The attenuator also contains a 2.2 µF ac coupling capacitor. The attenuator is protected against input signals that exceed 0.5 watt. A defective attenuator module is not repairable and should be replaced.

CAUTION

When removing or inserting the attenuator module, take care to unbolt the attenuator-mounting bracket from the main circuit board first. The attenuator-mounting bracket is designed as an integral part of the attenuator and supports the large ac coupling capacitor. To promote heat dissipation from the relay coils, the attenuators are not covered. Handle the attenuator module carefully.

The attenuator has five relays. In this discussion, we assume that the #1 relay (Cal/Norm) passes a signal to the #2 relay (AC/DC). From the #2 relay, the signal goes to the #3 relay (2X/1X), then to the #4 relay (5X/1X), and finally to the #5 relay (10X/1X). Each relay function is explained below:

Calibrate/Normal (#1 relay)

With the Cal/Norm relay in the Cal position (relay de-energized), the front panel input signal is disconnected and the attenuator input comes from pin 2 of the attenuator socket on the main circuit board. With the Cal/Norm relay in the Norm position (relay energized), the front panel input signal is connected to the input of the #2 relay on the attenuator. The signal voltage at pin 2 of the attenuator socket on the main ECB is disconnected from the input of the #2 relay on the attenuator. The Cal/Norm relay applies the accurate calibration voltage signal (VCAL) to the very front end of the 11A71 signal path during Enhanced Accuracy calibration. To optimize calibration accuracy, the calibration signal follows a signal path nearly identical to that of the signal applied at the input connector. The Cal/Norm relay is also used in the Off coupling mode.

AC/DC Coupling (#2 relay)

The AC/DC relay inserts a coupling capacitor into the input signal path between the input BNC and the remainder of the attenuator. When the AC/DC relay is set to AC position (energized), the #1 relay is AC coupled to the #3 relay. Alternately, with the AC/DC relay set to DC (de-energized), the #1 relay is DC coupled to the #3 relay. The network of resistors surrounding the AC/DC relay serves to charge the coupling capacitor while Coupling is set to Off, and to discharge the coupling capacitor when the input signal is removed from the input connector.

2X/1X (#3 relay)

With the #3 relay in the 2X position (de-energized), the signal from the #2 relay is attenuated by a factor of 2. With the #3 relay in the 1X position (energized), the signal from the #2 relay is not attenuated.

5X/1X (#4 relay)

With the #4 relay in the 5X position (de-energized), the signal from the #3 relay is attenuated by a factor of 5. When the #4 relay is set to the 1X position (energized), the signal from the #3 relay is not attenuated.

10X/1X (#5 relay)

With the #5 relay in the 10X position (de-energized), the signal from the #4 relay is attenuated by a factor of 10. With the #5 relay in 1X position (energized), the signal from the #4 relay is attenuated and proceeds to the output of the attenuator.

The attenuation factors of the attenuator networks are correct when the output of the attenuators drive a 50 Ω termination (the main amplifiers incorporate 50 Ω terminations at its input).

Attenuator States

DC

This is the most used attenuator state. Here the Cal/Norm relay is set to select the input signal. The AC/DC relay selects DC and the #3, #4, and #5 relays are set for the required attenuation factors. To obtain 10X attenuation when 100 mV/div is selected, relays #3 and #4 are set to 2X and 5X respectively.

Off

In the Off mode the #1 relay selects Cal (disconnects the input signal), the #2 relay selects DC (allows precharging of the AC coupling capacitor), and the #3, #4, and #5 relays are de-energized to select maximum attenuation (100X total attenuation). Without the precharging feature, the 11A71 and the circuit under test might both be subjected to a large voltage transient when switching from Off to AC.

AC

In the AC mode the #1 relay selects Norm (connects the input signal), the #2 relay selects AC, and #3, #4, and #5 relays are set for the required attenuation factors. To obtain 10X attenuation when 100 mV/division is selected, relays #3 and #4 are set to 2X and 5X, respectively.

Calibration

During calibration the #1 relay selects Cal (disconnects the input signal), the #2 relay selects DC, and the #3, #4, and #5 relays turn on and off until calibration is complete.

Calibration Buffer Amplifier

Calibration Buffer Amplifier U220 provides unity-gain voltage following of the VCAL signal (B36 at edge connector). To reduce gain errors, the voltage is sensed inside the attenuator. The internal sense line is available at pin 3 of the attenuator. IC U220B, Q221, and Q220 provide power amplification of the VCAL signal while U220A senses the CALSENSE feedback signal. Diodes CR330 and CR331 eliminate latchup that could occur because Q220 and Q221 are powered by ±5 V supplies. Q220 and Q221 are off during normal amplifier operation. During calibration K220 selects the calibration buffer amplifier, which requires Q220 and Q221 to produce up to ±4.0 V into 50 Ω. C331, C320, C230, R231, and R230 stabilize the amplifiers. The value of R232 was chosen to be high enough to prevent bleeding the AC coupling precharging signal voltage when the input coupling is changed from Off to AC.

Input Protection

The 11A71 uses two input protection circuits to prevent damage from most common overloads. First, U630 protects the Input Amplifier from high-frequency transients (see Fast Overload Protection under Input Amplifier in this section). Second, the Cal/Norm relay, which is activated by U130, disconnects the Input Attenuator and subsequent circuitry:

1. when input coupling is set to Off; and
2. when a signal capable of damaging the Input Attenuator or U630 is applied to the input connector.

At pin 9 of the attenuator module, the input signal is sampled and attenuated. Integrated circuit U330 performs an approximate RMS conversion on the input signal for frequencies up to about 100 MHz. Capacitor C420, at pin 1 of U330 integrates the RMS signal. When the voltage across C420 exceeds 2 V pin 16 of U330 goes high, causing the kernel to switch the Cal/Norm relay to the Cal position (input Coupling will be Off). This condition will occur when the 11A71 input signal exceeds 5 Vrms.

An attenuator or resistor network will safely dissipate more than its continuous rating for a short period of time because of its thermal mass. By integrating the RMS input voltage, U330 and C420 allow short term input of up to 12.5 W (25 V), an amount the 11A71 can handle safely. Above 25 V the risk of permanent damage to relay contacts becomes significant.

Radio frequencies (cw) above 100 MHz and greater than 0.5 W can cause damage because the sensitivity of U330 is reduced above 100 MHz. (For overload parameters, see Section 3, Specification, in the 11A71 Supplement to the Instrument User's Reference manual, under Input Characteristics).

The RMS TEST signal is used to self-test U330. With RMS TEST at +1.1 V, U330 "sees" a simulated +11 V overload, as if the 11A71 was overdriven by a +11 V_{DC} signal. Similarly, with RMS TEST at –1.1 V, the simulated overload would be –11 V.

Relay Driver IC

Relay driver IC U130 is a serial input to parallel output device. The Atten Shift Data and Atten Shift Clock lines set U130's internal latches, and the Relay Control line enables those latches. The Relay Disable line shuts off the output drivers. A high on the Atten Checkback Data line allows the system to self-test the relay driver. Output levels of U130 are +12.5 V when on, and 0 V when off. During power-up and power-down U130's outputs will be at 0 V. Diodes CR122, CR123, CR124, CR125, and CR126 protect U130's relay-driver outputs. These diodes can clamp a –75 V inductive spike during relay turnoff at U130's emitter-follower outputs to –0.7 V.

Relay Fast Power On (RFPO)

The RFPO circuit controls operating power to U130, the IC that drives the attenuator relays. At power-up, U130 receives operating power when the +15A supply reaches +13.6 V. At power-down, power to U130 is turned off when the output of the +15A supply falls below +12.9 V.

IC U330 detects that both the +15A and +5D power supplies have attained a large enough voltage to guarantee proper attenuator relay state changes. Also, at power-down U330 rapidly shuts off the relay supply current when the +15A supply begins to drop. VR430 sets the +15A "supply up" trip point. Resistors R232 and R330 divide the +15A voltage so it can be compared to the VR430 voltage. The relay power is turned on when +15A = +13.6 V (double the voltage across VR430). The relay power is turned off when +15A = +12.9 V (0.7 + 2 (VR430 – 0.7). The difference in the "relay power on" and "relay power off" voltage trip points (0.7 V) ensures that U330 does not oscillate during power-up or power-down.

Positive feedback through C330 to U330 causes U330 to make fast on/off transitions. Capacitor C331 filters digital noise. Diode VR330 lengthens the RESET(L) pulse at power-down. IC U330 drives Q230 through R231. Normally pin 1 of U330 is near zero V, which saturates Q230. When saturated, Q230 furnishes current to U130 through CR229 and L230. Diode CR229 drops 0.7 V to lower the power dissipated in the attenuator relays. Inductor L230 and C230 bypass the relay power to reduce digital noise at the attenuators.

Fuse Check Circuit

The Fuse Check Circuit produces +1.18 V for Analog-to-Digital converter (ADC) U310 when fuses F100, F110, F111, and F112 are intact. In normal operation, the +1.18 V indicates that the probe power supplies are all functioning properly. If any fuse fails, the FUSE CHECK output will change by at least ±1 V and the DAC, as directed by the processor, will acquire the new signal level. If during self-test or extended diagnostics the FUSE CHECK signal is not close to +1.18 V, the processor will send an error message to the oscilloscope. Diodes CR320 and VR320 limit the FUSE CHECK voltage to –0.3 V minimum and +5.1 V maximum.

Fast Overload Protection

The Fast Overload Protection stage protects the input amplifier from possible damage from fast-rise, high-amplitude input signals. Without this protection, such signals could damage U830 before the Input Protection circuitry, diagram 1, could respond and interrupt the input signal.

In normal operation, U630's four diodes are forward-biased. Signals applied to pin 8 pass through U630 to pin 18 with 15% attenuation. Bias resistors in U630 and the four diodes comprise a matched 50 Ω attenuator. The voltage at pin 3 of U630 is regulated by U610 and Q510. Potentiometer R521 (Input I) sets the current in Q630 to equal the current supplied to pin 3 of U630. This maintains 0 V at pins 8 and 18 of U630 when no input signal is present.

Potentiometer R511 (Z In) adjusts the voltage at pins 3 and 13 of U630, thus setting the current in U630. Because current flow determines the dynamic impedance of the four diodes in U630, and because these diodes are in series with the input signal, the impedance at U630 pin 8 also determines the 11A71 input impedance. The Input I control, R521, sets the sum of all currents flowing into U630 pin 8 to equal zero.

Because the dynamic resistance of U630's diodes depends on both temperature and current, current flow in pins 3 and 13 can be varied as a function of temperature to maintain constant diode dynamic impedance at all temperatures. Thermistor RT520 senses the ambient temperature and adjusts the voltage at U630 pin 3 to make U630's operation temperature-independent.

Signals over about 1.0 V reverse-bias one of the two left-hand diodes in U630. Positive signals turn off the top-left diode, and negative signals turn off the lower-left diode. When one diode is turned off, maximum current will flow from one of the power supplies through one of the resistors in U630. This current will apply only about 0.9 V to U830's input, which U830 can accept safely.

Feedbeside

"Feedbeside" is a method of compensating for low-frequency imperfections in the frequency response of U830 and U930. Self-heating of the base-emitter junction of some transistors in U830 and U930 causes the gain to increase slightly at low frequencies as compared to midband gain. To correct this, U430 inverts and amplifies a portion of the input signal, then applies its output to four resistor-capacitor (RC) networks.

Each of these RC networks has a different time constant. Potentiometers R510, R411, R410, R311, R312, and R310 are adjusted to provide a correction signal, which U400 inverts, amplifies, and applies through R732 and U830. The correction signal is subtracted from the signal entering pin 7 of U830. Proper adjustment of the five compensation controls results in flat frequency response and optimum transient response at the output (pins A11 and B11 on diagram 3). Diode network CR430, CR431, CR432, and CR433 limit the amplitude of the signal to the RC networks to improve overdrive recovery.

Input Amplifier

The Input Amplifier stage provides gain control and amplification of the signal. The single-ended input signal from the Fast Overload Protection stage enters U830 on pin 7, and the correction signal from the Feedbeside network enters U830 at pin 12.

Current flow through R831 and R731 dictates the proportion of signal current that flows in each pair of common-base transistors in U830. The gain of the input amplifier is controlled by the A3A1 Sample-Hold board through R311 and amplifier and level-shifter U120B.

The circuitry in U830 is a cascade amplifier using a Gilbert multiplier. For ease of explanation, assume that equal currents flow in R731 and R831, forward-biasing Q3, Q4, Q5, and Q6, which also conduct equal currents. Assume also that the base of Q2 (in U830) is held at a constant level (in reality, the feedbeside signal is injected here). Transistors Q1 and Q2 act as a phase splitter with the signal at the collector of Q2 in phase with the signal at the base of Q1. If a positive-going signal is applied to U830 pin 7 the emitters of Q3 and Q4 are pulled more negative, which increases their conduction. At the same time, the emitters of Q5 and Q6 go more positive because Q1's increased conduction reduces Q2's conduction. Current in Q5 and Q6 decreases by the amount that Q3's and Q4's conduction increases.

Because transistor pairs Q4-Q5 and Q3-Q6 are cross-coupled to pins 17 and 19, respectively, and one transistor in each pair increases its conduction by the same amount that its counterpart decreases conduction, current at pins 17 and 19 stays constant. This is the zero-gain condition for the circuit. (In actual operation the circuit operates near full gain, and zero-gain condition does not occur.)

When the base voltage of Q600A goes positive due to a change in the gain setting, Q600A, Q600B, and U700A increase current flow through R831 and decrease current flow through R731. IC U700A ensures that the total current through R831 and R731 does not vary.

Increased current in R831 causes Q3 and Q6 to conduct more, while Q4 and Q5 conduct less because less current flows in R731. The summation of currents at the collectors of Q3 and Q5 results in a current at U830 pin 19 that is out of phase with the input at U830 pin 17. This phenomenon occurs because Q3 conducts more out-of-phase signal than Q5 conducts in-phase-signal. Similarly, Q6 conducts more in-phase signal than Q4 conducts of the out-of-phase signal. Such increased conduction of Q3 and Q6, together with decreased conduction of Q4 and Q5, results in a gain increase for U830.

Kernel <2>

Analog Control Voltage System

The Analog Control Voltage System (ACVS) generates DC voltage levels used to set input offsets, balance and amplifier gains. The main ACVS components are the Housekeeper IC (U820), digital-to-analog converter (DAC) U620, and the Sample/Hold modules (A3A1).

Circuitry in U820 drives both the DAC and the sample/hold modules. Every 30 µs U620 is driven to one of eight voltage levels stored in U820's memory. Each A3A1 output is updated every 300 µs. The DAC is a two-byte, latched-data unit, which means that the high and low data bytes are loaded separately into the DAC. U820 produces LCLK and UCLK, which together control the latching of the individual high and low data bytes. The upper byte is latched in first by UCLK pulsing low. Then the signal LCLK pulses low, which transfers in the lower byte and tells the DAC that the 12-bit value is valid.

While the DAC is being driven, the Sample/Hold modules are given the address of a selected output using signals ARA0, ARA1, and ARA2; then strobed with the signals MAJSTB(L). The DAC is internally set to produce precisely +5.0 V maximum and –5.0 V minimum. Resistors R535 and R533 divide the DAC output to ±1.136 V to create the VDAC signal, which drives the sample/hold modules directly. Resistors R532 and R531 level-shift the DAC output and drive ADC U310 to self-test the DAC.

Analog-to-Digital Converter

The Analog-to-Digital converter (A/D) is contained in the TLC540 (U310). The TLC540 is a complete 8-bit, switched-capacitor, successive-approximation A/D converter. It has a serial interface to the microprocessor with a 12-channel analog multiplexer that can be used to sample any one of 11 inputs or an internal "self-test" voltage. The sample/hold operates under microprocessor control.

The ADC signal lines are described below:

TABLE 2-1
ADC Signal Lines

Name	pin #	Description
A0	1	(not used)
A1	2	(not used)
A2	3	Analog input for Fuse check.
A3	4	(not used)
A4	5	Analog input for CH 1 Probe data
A5	6	(not used)
A6	7	(not used)
A7	8	(not used)
A8	9	(not used)
A9	11	Analog input for DAC self-test
A10	12	Analog input for MAJTST (A3A1 self-test)
A11	——	(internal self-test of A/D = 1/2[(REF+) + (REF–] voltage)
Address in	17	Serial address input used to select A/D input A0-A11
Sys Clock	19	Runs the A/D conversion hardware
I/O Clock	18	Serial I/O clock input
CS(L)	15	Enables A/D converter I/O and conversion
Data out	16	Serial data output
REF+	14	Positive reference for the A0-A11 inputs
REF–	13	Negative reference for the A0-A11 inputs

The A0-A11 inputs are referenced to the input signal lines REF+ and REF–. The REF+ line is connected to +5A and the REF– line is connected to ground. Therefore, inputs near GND potential will convert to values near the digital value 00*hex* and inputs near +5A potential will convert to values near the digital value FF*hex*. A correctly operating A/D converter will give a self-test value of near 80*hex* for the A11 internal input shown above.

Random Access Memory

The Random Access Memory (RAM) is contained in the DS1220 battery backed up static RAM (U700). The DS1220 is a 16,384 bit, fully static, nonvolatile memory module organized as 2048 words by eight bits. The nonvolatile memory module has a self-contained lithium energy source and control circuitry that constantly monitors +5D (+5 V digital supply) for an out-of-tolerance condition. When such a condition occurs, the lithium energy source is automatically switched on and write protection is unconditionally enabled to prevent garbled data. An unlimited number of write cycles can be executed and no additional support circuitry is required for microprocessor interface. The pins labeled A0-A10 are the address lines, and the pins labeled D0-D7 are the data lines.

Read Mode

The static RAM executes a read cycle when WR(L) is high and CS(L) is low. The unique address specified by the 11 address inputs (A0-A10) defines which of the 2048 bytes of data is to be accessed. Valid data will be available to the eight data-output drivers within the access time after the last address input signal is stable.

Write Mode

The static RAM is in the Write mode when WR(L) and CS(L) are both low after the address inputs are stable. The later occurring falling edge of CS(L) or WR(L) will determine the start of the write cycle, which is terminated by the earlier rising edge of CS(L) or WR(L). All address inputs must be kept valid throughout the write cycle.

Data Retention Mode

The nonvolatile RAM module provides full functional capability as long as +5D is greater than 4.5 V, and write-protects at 4.25 V nominal. Data are maintained in the absence of +5D with no additional support circuitry. RAM U801 constantly monitors +5D. Should the supply voltage decay, the RAM will automatically write-protect itself; all RAM inputs become "don't care," and all outputs are high impedance. As +5D falls below approximately 3.0 V, the power-switching circuit connects the lithium energy source to the RAM. During power-up, when +5D rises above approximately 3.0 volts, the power switching circuit connects external +5D to the RAM, and disconnects the lithium energy source. Normal RAM operation can resume after +5D exceeds 4.5 V.

MPU

The CPU (U500) is an 8031 single-chip, 8-bit microcontroller. It contains an on-chip oscillator and clock circuitry, 32 I/O lines, 64 k address space for external data memory, 64 k address space for external program memory, two 16-bit timer/counters, a six-source interrupt structure, full-duplex serial port, and a Boolean processor.

In the following table, I = Input, O = Output, and Bi = Bi-directional.

TABLE 2-2
Port Bits

Bit #	Desc	Usage
P0.0	Bi	Output for the adrs latch & bi-directional data bus
P0.1	Bi	Output for the adrs latch & bi-directional data bus
P0.2	Bi	Output for the adrs latch & bi-directional data bus
P0.3	Bi	Output for the adrs latch & bi-directional data bus
P0.4	Bi	Output for the adrs latch & bi-directional data bus
P0.5	Bi	Output for the adrs latch & bi-directional data bus
P0.6	Bi	Output for the adrs latch & bi-directional data bus
P0.7	Bi	Output for the adrs latch & bi-directional data bus
P1.0	I	Attenuator checkback data (serially encoded)
P1.1	I	A-D converter data (serially encoded)
P1.2	O	(not used)
P1.3	Bi	Signature Analyzer Clock
P1.4	Bi	Signature Analyzer Start
P1.5	Bi	Signature Analyzer Stop
P1.6	I	A/D converter clock
P1.7	O	Relay disable
P2.0	O	Address bit 8 of the RAM and EPROM
P2.1	O	Address bit 9 of the RAM and EPROM
P2.2	O	Address bit 10 of the RAM and EPROM
P2.3	O	Address bit 11 of the RAM and EPROM
P2.4	O	Address bit used to enable the output latch (U410) and bit 12 of EPROM
P2.5	O	Address bit used to enable RAM U700 and U820 and bit 13 of EPROM
P2.6	O	Address bit used to enable U820
P2.7	O	Address bit used to enable EPROM and U430
P3.0	O	Attenuator shift data (serially encoded) and A/D converter Address In
P3.1	O	Attenuator shift clock
P3.2	I	(not used)
INT	I	(P3.3) Interrupt from Housekeeper(U820)
P3.4	O	A-D converter enable (U810)
P3.5	O	Sense for jumper J400
WR(L)	O	(P3.6) Write (L)
RD(L)	O	(P3.7) Read(L)

Table 2-3 lists miscellaneous pins on the 8031.

TABLE 2-3
Miscellaneous Pins

Reset	I	Resets the CPU, all port bits are set high on reset
XTL1	I	Input to the crystal oscillator
XTL2	O	Output from the crystal oscillator
PSEN	O	Program store enable
ALE	O	Address latch enable

Oscillator

Microprocessor U500 contains circuitry to drive a 12 MHz ceramic resonator (Y520). All oscillator circuitry is inside U500 except the two 6.8 pF capacitors, C520 and C530.

Housekeeper IC

The Housekeeper chip is a multi-function integrated circuit that provides a serial communication path to the oscilloscope, a channel switch sequencer, and control circuits for an ACVS system with up to 16 analog outputs for the amplifier channel. In table 2-4, I = Input, O = Output, and BI = Bi-directional.

TABLE 2-4
Signal Descriptions for the Housekeeper IC

Signal	Pin	Desc	Usage
WR(L)	23	I	When low, writes data into the Housekeeper IC if Chip Select (pin 21) is High
INT	22	O	Interrupt to processor (communication from oscilloscope)
CS	21	I	Allows writes or reads to the Housekeeper chip only when high.
PSEN(L)	20	I	The PSEN signal when low, allows CPU execution of instructions stored in RAM (U801)
ALE	18	I	Latches the address inputs on falling edge
RD(L)	24	I	If RD (read strobe) signal is asserted low , when Chip Select is high, it causes the Housekeeper IC to send the data specified by the last address it captured with ALE from its AD7-AD0 pins, onto those same AD7-AD0 pins.
AD0	17	Bi	Address input, data input, and data output
AD1	16	Bi	Address input, data input, and data output
AD2	15	Bi	Address input, data input, and data output
AD3	14	Bi	Address input, data input, and data output
AD4	13	Bi	Address input, data input, and data output
AD5	12	Bi	Address input, data input, and data output
AD6	11	Bi	Address input, data input, and data output
AD7	10	Bi	Address input, data input, and data output
FETCH(L)	19	O	The FETCH output is the "AND" of RD and PSEN. When FETCH is low, the RAM (U700) can send data to the data bus if the RAM chip select is enabled
SCLK	29	I	Sequence clock, positive edge increments the channel switch sequencer
SYNC	30	I	Sequence sync, high level applied during SCLK high clears the channel switch sequence counter.
Refresh CLK	25	I	Clock for operation of Sample/Hold refresh system

TABLE 2-4
Signal Descriptions for the Housekeeper IC (continued)

Signal	Pin	Desc	Usage
SDI	27	I	Serial communications clock input
M-P	26	I	Oscilloscope to plug-in serial data input
D0	61	O	DAC data bit 0
D1	60	O	DAC data bit 1
D2	59	O	DAC data bit 2
D3	58	O	DAC data bit 3
D4	57	O	DAC data bit 4
D5	56	O	DAC data bit 5
D6	55	O	DAC data bit 6
D7	54	O	DAC data bit 7
MAJSTB(L)	63	O	Sample/Hold module #1 sample strobe
ARA0	52	O	Sample/Hold module output select address bit 0
ARA1	53	O	Sample/Hold module output select address bit 1
ARA2	46	O	Sample/Hold module output select address bit 2
LCLK(L)	66	O	DAC data latch strobe low byte
UCLK(L)	65	O	DAC data latch strobe high byte
TRIGON1	31	O	Channel 1 trigger path on
DISPON1	28	O	Channel 1 display path on
P-M	7	O	Plug-in to oscilloscope serial data

Digital-to-Analog Converter

The Digital-to-Analog Converter (DAC) is contained in the AD667 (U620). The AD667 is a complete, voltage output, 12-bit DAC including a high-stability, buried-zener voltage reference and double-buffered input latch on a single chip. The converter uses 12 precision high-speed bipolar current-steering switches and a laser-trimmed thin-film resistor network to provide fast settling time and high accuracy.

Latching in Data

The DAC latch control lines are described below:

TABLE 2-5
DAC Latch Control Lines

Name	pin #	Description
CS(L)	11	Enables latching inside DAC
A3(L)	12	Enables final latching of 12 bit value to DAC
A2(L)	13	Enables initial latching of upper four MSBs of DAC value
A1(L)	14	Enables initial latching of middle four bits of DAC value
A0(L)	15	Enables initial latching of lowest four LSBs of DAC value

A low on any pin shown above will enable the described function. The latches are transparent when the control signals are low and latch when the control signals go high. In the 11A71 the CS(L) signal is tied low so the DAC is always receptive to having the latches loaded.

Once the 12-bit digital value is loaded, that value is converted to an analog current at the minus input of the on-chip operational amplifier. The op-amp adjusts its output such that the minus input of the op-amp is always at GND potential. In this manner the DAC current is converted to an output voltage that represents the digital input code minus an offset voltage. The offset is generated by the on-chip reference circuit, which is connected so that for a digital code of 0 the total output voltage will be –5 V (at pin 2 and 9) and for a code of 4095 the output will be +5 V. R534 drops a small amount of the reference voltage to help center the output between ±5 V.

Address Buffer Latch

Eight-bit transparent latch U600 captures the lower 8 address bits from the MPU's multiplexed address/data bus, and sends them to the battery RAM (U700) and EPROM (U800). When U600 pin 1 is high, the latch inputs drive the outputs. When the latch enable input goes low, U600 latches its outputs. The outputs are constantly on because the EN(L) input is wired low.

Output Latches

Eight-bit transparent latch U410 serves as an 8-bit output port from MPU U500. When pin 11 of U410 is high, the latch inputs drive the outputs. When the latch-enable input goes low, U820 latches its outputs. The outputs are constantly on because the EN(L) input is wired low. IC U430 is an 8-bit, edge-clocked latch with constantly on outputs. When low, the EN(L) input allows the data inputs to be latched in whenever the CP input goes high.

U520

The A and B sections of hex-inverter U520 are wired as a two-input NOR gate and used to address an 8-bit output port U410. U520C serves as an output driver for the probe data line (from the 11A71 to any attached probe). Because U520 is an open-collector part, the probe can also pull down on the probe data line to send messages to the 11A71. Diode VR220 protects the probe data line from static voltages.

Reset Circuit

Reset IC U411 disables the CPU while the oscilloscope is powering up or down. The reset circuit keeps the RESET input of microprocessor U500 low unless the output of the +5D supply falls below +4.55 V. At power-up, the pin 2 input of U411 (Rin) holds RESET high. When the +5D supply reaches +4.55 V, ±50 mV, U411 will produce a low on RESET after 13 ms. Capacitor C420 sets this delay time. When RESET goes low, the CPU can begin executing stored instructions.

At power-down, when the +5D supply decays to +4.55 V, U411 sets RESET high.

Analog Control/Signal Amplifier <3>

This section describes the electrical operation and relationship of circuits in the analog control circuitry and signal amplifiers. See Schematic <3> in Section 6

Output Amplifier

The Output Amplifier provides final amplification of the signal. Integrated amplifier U930 receives the output of the Input Amplifier and applies an amplified version of its input to pins A11 and B11, the output to the oscilloscope. Amplifier U1040A provides bias for U930 by comparing the average DC level at pins 7 and 9 of U930 with the DC voltage at the pin 3 input to U1040A (–6.0 V). By this means U1040A holds the pin 8 input of U930 at the voltage needed to keep U930's input at –6.0 V.

In order to maintain constant gain in U830 and U930 at all temperatures, RT820 varies the DC standing current in U930 over a temperature range of 0° and +50° C.

The voltage on U930 pin 18 must vary from 0.775 V at 0° C to 1.0 V at +50° C to maintain the average voltage at pins A11 and B11 within 0.15 V of ground. Thermistor RT1030 senses the ambient temperature and, with voltage-regulator U1040B-Q1030, sets the correct voltage at U930 pin 18.

On/Off Control Circuit

The DC voltage at U930 pin 13 is set by resistive divider R940 and R740. Resistors R841 and R741 set the voltage at U930 pin 14. Current sources Q840 and Q841 can change the voltage at pins 13 and 14, respectively. When the 11A71 display is turned on, the kernel will assert a high on the Display On line, which will saturate Q940. When saturated, Q940 causes the base of Q841 to be more negative than the base of Q840, which turns Q841 off and Q840 on. In this condition, Q840 lowers the voltage at U930 pin 13 to –3.5 V, which is more negative than pin 14. This combination of inputs turns Q5-Q8 on and Q6-Q7 off; the display is on. When the kernel turns the display off it also sets the Display On line low, which turns off Q940. The high level on Q940 turns Q841 on and Q840 off. Now Q5-Q8 are turned off and Q6-Q7 are turned on; Q5 and Q6 apply their drive to terminating resistors R1027 and R1029.

When the signal is off the DC common-mode voltage at connector pins A11 and B11 must be reduced to near ground potential. In the Off mode Q941 is saturated, which essentially grounds U930 pin 18.

Trigger Amplifier

A portion of the differential signal applied to U930 is sent to the Trigger Amplifier (from pins 2 and 4 of U930 to pins 9 and 7 of U910). This differential signal is amplified by U910 to become the + and – Trigger signal, and is applied to pins A13 and B13 of the rear-panel connector. The TRIGGER BAL adjustment balances the quiescent DC level between pins A13 and B13 when no signal is applied.

The Trigger On/Off circuit works the same as the Signal On/Off circuit.

Sample/Hold Assembly

The Sample/Hold (S/H) assembly supplies the following analog signals:

Fine offset	pin 16
Coarse offset	pin 15
DC balance	pin 19
Fine probe offset	pin 22
Coarse probe offset	pin 14
Gain adjust	pin 23
RMS test	pin 20
MAJTST	pin 21

This section discusses the Sample/Hold (S/H) assembly as a component in the amplifier. The S/H board contains only surface-mounted components which are coated with insulating material to minimize leakage current. A defective S/H assembly is not repairable and should be replaced.

One-of-eight analog multiplexer U100 periodically updates the voltages on C100 through C115. Inputs A1, B1, and C1 of U100 are the avenue through which U100 receives the address of the selected holding capacitor, while the S/H IN input receives the voltage to be applied to that capacitor. Amplifiers U102 and U103, which have very high impedance and unity gain, are used to buffer the voltages on holding capacitors C100 through C115 while U100 is updating those voltages. The holding capacitors can be charged only when the U100's EN1 input is low.

Analog multiplexer U101 provides a readback path for self-testing analog voltage outputs V1 through V8, which are normally in the range of ±1.15 V. The READBACK0, READBACK1, and READBACK2 lines contain the address of the voltage to be read; the analog readback is the FBOUT signal. Readback is possible only when the EN2 line is low.

Coarse and Fine Offsets

Coarse and Fine Offset voltages are available for the main amplifier (U830) and any external TEKPROBE™ accessory.

The S/H module furnishes coarse offset, fine offset, and amplifier DC balance voltages, respectively, at its pin 15, 16, and 19 outputs. These three signals are summed at the inverting input of U120A, which drives U830 at pin 12.

The probe-offset voltage is provided by R210 and R310. Diodes CR111 and CR110 clamp any static voltages introduced at the TEKPROBE™ connector.

In the 11A71 the amplifier offset and the probe offset are driven by separate outputs. When an active probe with a TEKPROBE™ connector is used, the probe offset output is driven and the main amplifier receives no offset voltage. When a nonactive probe is used, the offset voltage is applied only to the amplifier input; the probe offset output is not driven.

Gain Adjust

The analog voltage at pin 23 of the S/H assembly determines the exact gain of amplifier U830. Different 11A71 deflection factors may require slightly different voltage from the S/H assembly. Operational amplifier U120B inverts and level-shifts the voltage from the S/H assembly and applies it to Q600 A and B.

Section 3

Maintenance

Section 3
Maintenance

This section contains information for performing preventive maintenance, troubleshooting and corrective maintenance for the 11A71 Amplifier.

Preventive Maintenance

Preventive maintenance performed regularly can prevent or forestall instrument breakdown and may improve instrument reliability. The severity of the environment to which the instrument is subjected determines the frequency of maintenance. A convenient time to perform preventive maintenance is before electrical adjustment of the instrument.

Amplifier Panel Removal

The side panels, top-and-bottom frame rails, and front panel reduce radiation of electromagnetic interference from the oscilloscope. The side panels are held in place by grooves in the frame rails. To remove a panel, pry the panel out, beginning at the rear of the panel. To install a panel, position it over the frame rail grooves, then press down until the panel snaps into place. Exert pressure along the full length of the rails to secure the panel.

NOTE

The 11A71 will not slide into the oscilloscope if the side panels are not fully seated in the rails.

Cleaning

The 11A71 should be cleaned as often as operating conditions require. Dirt on components acts as an insulating blanket and prevents efficient heat dissipation, which can cause overheating and component breakdown. Dirt also provides an electrical conduction path and can result in oscilloscope failure.

NOTE

The cabinet panels of the oscilloscope in which the 11A71 is installed reduce the amount of dust reaching the interior of the oscilloscope. Operation without the panels in place necessitates more frequent cleaning.

CAUTION

Avoid the use of chemical cleaning agents which might damage the materials used in this oscilloscope. Use only Isopropyl alcohol or totally denatured ethyl alcohol. Before using any other type of cleaner, consult your Tektronix Service Center or representative.

Exterior

Loose dust accumulated on the outside of the amplifier can be removed with a soft cloth or small brush. The brush is particularly useful for dislodging dirt in and around the side-panel ventilation holes and front-panel switches.

NOTE

Remove the side panels before cleaning them.

Interior

Cleaning the interior of the amplifier should be necessary only occasionally. The best way to clean the interior is to blow off the accumulated dust with dry, low-velocity air (approximately 5 lb/in^2). Remove any dirt that remains with a soft brush or a cloth dampened with a mild solution of detergent and water. A cotton-tipped swab is useful for cleaning in narrow spaces, or for cleaning more delicate circuit components. However, do not use cotton-tipped swabs near Hypcon connectors.

CAUTION

Be sure that circuit boards and components are dry before applying power . Otherwise electrical damage may result.

Visual Inspection

The 11A71 should be inspected occasionally for loosely seated or heat-damaged components. The corrective procedure for most visible defects is obvious; however, particular care must be taken if heat-damaged parts are found. Overheating usually indicates other trouble in the oscilloscope; therefore, Therefore, be sure to correct the cause of the overheating to prevent further damage.

Semiconductor Checks

Periodic checks of semiconductors are not recommended. The best check of semiconductor performance is actual operation in the oscilloscope. More details on semiconductors are given under Troubleshooting, later in this section.

Periodic Electrical Adjustment

To ensure accurate measurements, check the electrical adjustment of this amplifier after each 2000 hours of operation, or every 24 months if used infrequently. In addition, replacement of components may necessitate adjustment of the affected circuits. Complete adjustment instructions are given in Section 2, Checks and Adjustment in the Service Reference Manual.

Corrective Maintenance

Corrective maintenance consists of component replacement and amplifier repair. Special techniques required to replace components in the 11A71 Amplifier are given here.

Ordering Parts

All electrical and mechanical part replacements for the 11A71 can be obtained through your Tektronix Field Office or representative. Before purchasing or ordering replacement parts, check the parts list for value, tolerance, rating, and description.

NOTE

When selecting replacement parts, remember that the physical size and shape of a component may affect its performance in the amplifier.. All replacement parts should be direct replacements unless you know that a different component will not adversely affect amplifier performance.

Some parts are manufactured or selected by Tektronix, Inc. to satisfy particular requirements, or are manufactured for Tektronix, Inc. to our specifications. Most of the mechanical parts used in this oscilloscope have been manufactured by Tektronix, Inc. To determine manufacturer of parts, refer to "Cross Index Mfr. Code Number to Manufacturer" located at beginning of Section 6 and section 8.

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

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

Static-Sensitive Device Classification

CAUTION

Static discharge can damage any semiconductor component in this amplifier.

This amplifier contains electrical components that are susceptible to damage from static discharge. Table 3-1 gives relative susceptibility of various classes of semiconductors. Static voltages of 1 kV to 30 kV are common in unprotected environments.

TABLE 3-1
Relative Susceptibility to Damage from Static Discharge

Semiconductor Classes	Relative Susceptibility Levels[1]
MOS or CMOS microcircuits and discrete or linear microcircuits with MOS inputs (most sensitive)	1
ECL	2
Schottky signal diodes	3
Schottky TTL	4
High-frequency bipolar transistors	5
JFETs	6
Linear Microcircuits	7
Low-power Schottky TTL	8
TTL (least sensitive)	9

[1] Voltage equivalent for levels
1 = 100 to 500 V
2 = 200 to 500 V
3 = 250 V
4 = 500 V
5 = 400 to 600 V
6 = 600 to 800 V
7 = 400 to 1000 V (est.)
8 = 900 V
9 = 1200 V

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

Observe the following precautions to avoid damage:

1. Minimize handling of static-sensitive components.
2. Transport and store static-sensitive components or assemblies in their original containers on a metal rail, or conductive foam. Label any package that contains static-sensitive assemblies or components.
3. Discharge the static voltage from your body by wearing a wrist strap while handling these components Servicing static-sensitive assemblies or components should be performed only at a static free work station by qualified service personnel. We recommend use of the Static Control Mat, Tektronix part 006-3414-00, and Wrist Strap, Tektronix part 006-3415-00.
4. Allow nothing capable of generating or holding a static charge on the work station surface.
5. Keep the component leads shorted together whenever possible.
6. Pick up components by the body, never by the leads.
7. Do not slide the components over any surface.
8. Avoid handling components in areas that have a floor or work-surface covering capable of generating a static charge.

9. Use a soldering iron that is connected to earth ground.

10. Use only special antistatic suction type desoldering tools.

Replacing Parts

CAUTION

To avoid component damage, disconnect the power plug and unplug the 11A71 from the oscilloscope before removing or replacing components.

The exploded-view drawing associated with the Replaceable Mechanical Parts list (located at the rear of this manual) may be helpful in the disassembly procedures that follow.

How to Replace Semiconductors

Semiconductors should be replaced only when defective. If removed from their sockets during routine maintenance, return them to their original sockets. Unnecessary replacement of semiconductors may affect the adjustment of the oscilloscope. When semiconductors are replaced, check the operation of circuits which may be affected.

Replacement semiconductors should be of the original type or a direct replacement. Lead configurations of the semiconductors used in this amplifier are shown in Figure 3-8, Semiconductor Lead Configurations.

CAUTION

Do not remove stickers affixed to the top of EPROMs. Removing this sticker will allow light into the chip, and may cause partial erasure of its data.

How to Remove the Housekeeper Integrated Circuit

When the Housekeeper IC is installed, the beveled corner of the IC is aligned with a spring at one corner of the socket. The other IC corners are notched and fit the edges of the socket.

1. Unfasten the retaining clip by moving it across the tabs. It may help to push down slightly on the cover.

2. Remove the cover slowly to prevent the IC from falling out. Notice the position of the IC before removing.

3. Remove the IC with tweezers.

CAUTION

Avoid touching the IC or the socket contacts with you fingers. Finger oils can lessen reliability.

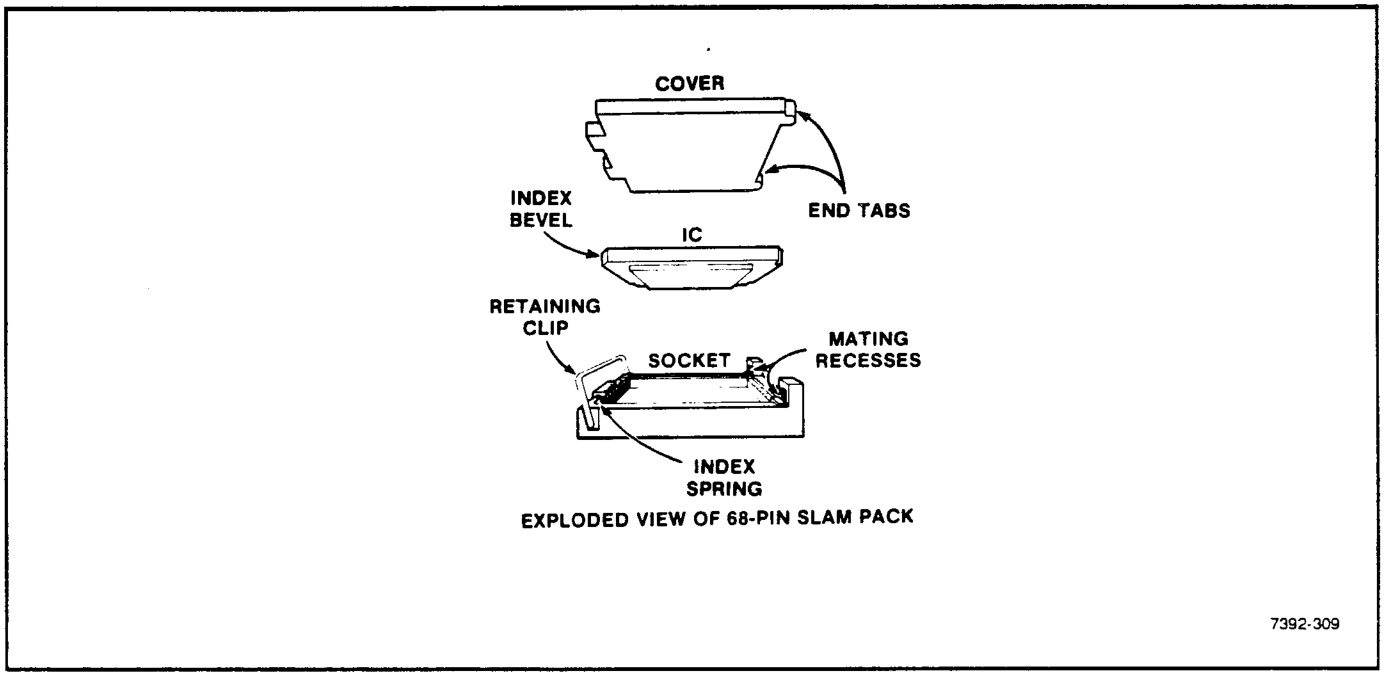


Figure 3-1. Exploded View of Housekeeper IC Holder.

How to Install the Housekeeper Integrated Circuit

1. Using Tweezers, place the beveled corner of the replacement IC against the index spring. See Figure 3-1.

CAUTION

Do not damage the spring with the beveled corner. Shorting of the two corner contacts could result.

2. Arrange the other IC corners, with the tweezers, to fit evenly at the edges of the socket.
3. Set the cover flat on the IC with its end tabs properly aligned with the mating recesses in the socket. (The cover is not symmetrical.)
4. Push the cover down, keeping it flat on the IC, and slide into place. Hold the cover in place while moving the retaining clip over the tabs on the other end.

How to Replace Amplifier Hybrid Circuits

The Hypcon (HYbrid-Printed CONNector) connector is designed to provide low-loss electrical and thermally efficient connection between the printed circuit board, the heat sink, and hybrid integrated circuit. Figure 3-2 shows an exploded view of the Hypcon connector and gives Disassembly and Replacement instructions. When replacing the hybrid ICs be careful not to touch the elastomer gold-plated contacts with your fingers, or to use a cleaner which will degrade contact reliability. The Hypcon connector and hybrid IC should be removed if it becomes necessary to use a cleaning solvent near the connector when replacing adjacent (within 1/2") circuit board components.

IMPORTANT: Remove all traces of solder flux or foreign material contamination from the circuit board contact area before replacing the connector. Contamination usually takes place during the soldering and cleaning process. Even when the soldering is done carefully, flux, oil, or other contaminants can be carried under the connector during the cleaning operation. When the solvent evaporates, nonconductive contaminants may remain on or near the contact interfaces.

Hand cleaning with solvent or machine cleaning in an automatic detergent wash is not recommended for boards containing Hypcon connectors.

If a component near a Hypcon connector must be replaced, the following steps are recommended:

1. Remove the hybrid IC and Hypcon connector (see Disassembly and Removal instructions) before any soldering or cleaning and store in a dirt-free covered container. When several hybrids and Hypcon connectors are to be removed, keep parts in sets and do not interchange parts between sets.

2. Hand soldering:

    a. Use small diameter solder (0.030"-0.040").

    b. Use low-wattage soldering irons (15-20 watts).

    c. Use care with solder amount and placement.

3. Remove solder flux and contact contamination with isopropyl alcohol or denatured ethyl alcohol.

4. Flush the hybrid and Hypcon connector mounting area with isopropyl alcohol. Do not scrub with a cotton-tipped swab, as cotton fibers will adhere to edges and surfaces of contact areas and cause open or intermittent connections. The elastomer should be examined under light for dust, hair, etc., before it is re-installed. If the etched circuit board surfaces require more cleaning, scrub with a soft rubber eraser and blow or vacuum clean while dusting surface with a small clean brush.

5. If the hybrid IC and elastomer contact holder are contaminated, clean the contact holder and hybrid by flushing or spraying with alcohol and oven dry at 50° C. Do not scrub with a cotton-tipped swab or similar device. If the contact holder is excessively contaminated, replace it with a new one.

Tighten the mounting screws with two-inch-pounds of torque to secure the Hypcon to the circuit board.

Make sure that the elastomer is properly seated in the contact holder before remounting the assembly to the circuit board. Exercise care when mounting the frame-elastomer connector holder-hybrid IC assembly to the circuit board to prevent misalignment between the connector and board.

CAUTION

Because of close tolerances involved, special care must be taken to ensure correct index alignment of each Hypcon part during reassembly. Failure to do so can result in a cracked hybrid substrate. See Figure 3-2 for index locations.

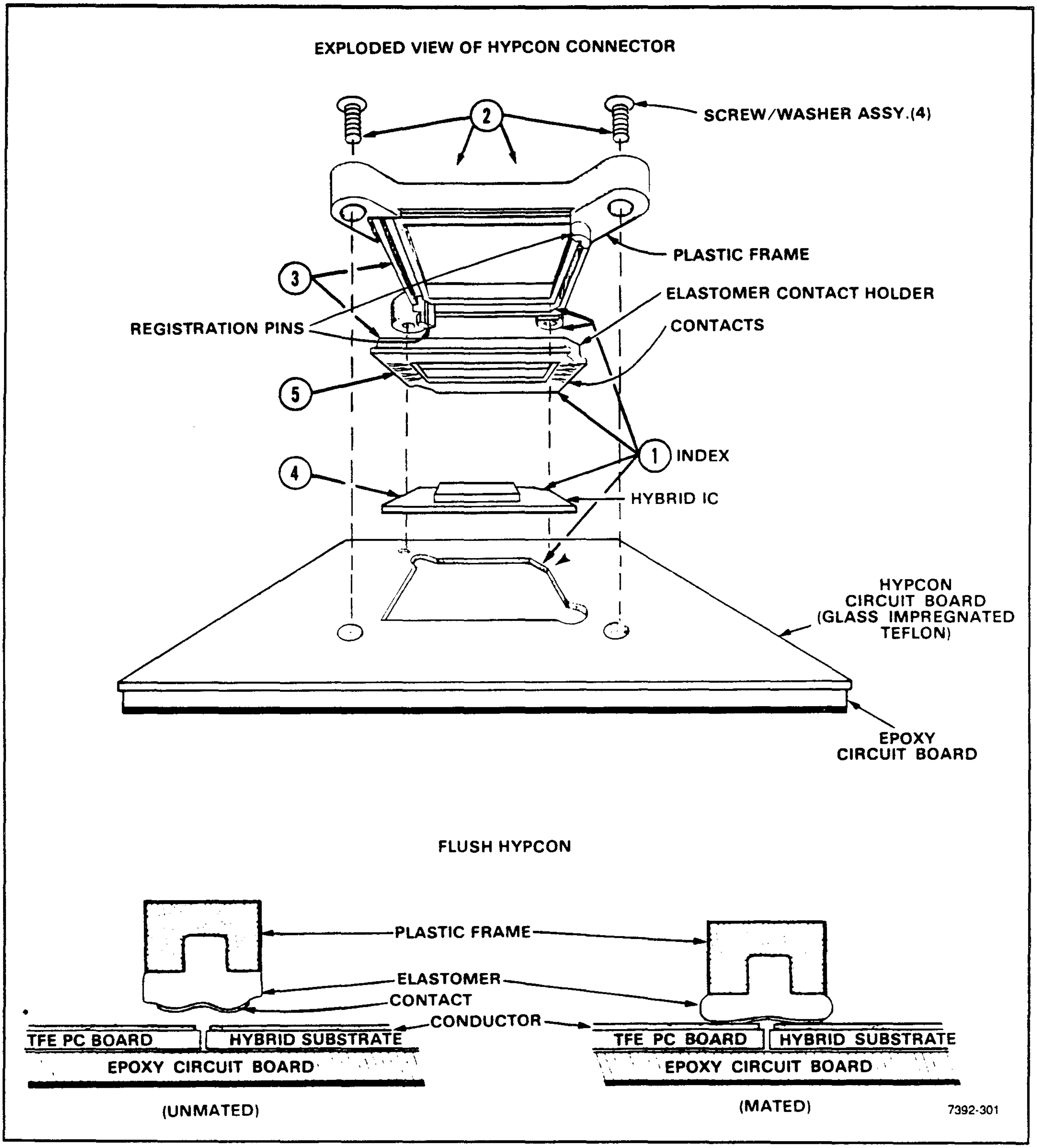


Figure 3-2a. Details of Hypcon Connectors.

Disassembly and Removal

① Notice index on circuit board (arrow) and plastic frame (pointed tab).

② Unscrew and remove the 4 screw/washer assemblies.

③ Lift plastic frame from board.

④ Notice index location of hybrid and remove from circuit board with tweezers.

NOTE

Step 5 describes the removal of the elastomer from plastic frame.
This step is not necessary when replacing only the hybrid.

⑤ Notice index location of elastomer contact holder and remove from plastic frame by grasping corner with tweezers and lifting up. Do not touch the gold-plated contacts with your fingers.

Reassembly and Replacement

a. Grasp a corner of the elastomer with tweezers and place it into plastic frame. Align keyed corner of elastomer with keyed corner of plastic frame. Tamp elastomer into plastic frame uniformly.

NOTE

Cleaniness is very important. Small hairs and elastomer flash under the contacts, which are almost invisible to the naked eye, will prevent good electrical contact. Most apparent failures of the hybrid are actually due to contamination of the Hypcon. Do not touch the the gold-plated contacts with fingers.

b. Place the hybrid into the square hole in circuit board. The hybrid is keyed so that it will fit into the circuit board in only one orientation. The hybrid is properly seated when the top of the hybrid is flush with the top of the circuit board.

c. Place the plastic frame with elastomer installed over hybrid such that key (pointed tab) aligns with the corner arrow on the circuit board.

d. Insert mounting hardware and apply two inch-pounds of torque (2.3 cm-kg) to secure connector assembly. Do not overtighten.

7392-301

Figure 3-2b. Details of Hypcon Connectors

How to Replace Peltola Coaxial-Cable Connectors

Replacement of the Peltola coaxial-cable connectors requires special tools and techniques; only experienced maintenance personnel should attempt to remove or replace these connectors. We recommend that the damaged cable be replaced as a unit. For cable part numbers, see Section 7, Replaceable Mechanical Parts. An alternative solution is to refer the replacement of the defective connector to your local Tektronix Field Office or representative. Figure 3-3 shows the parts of a Peltola coaxial-cable connector assembly.

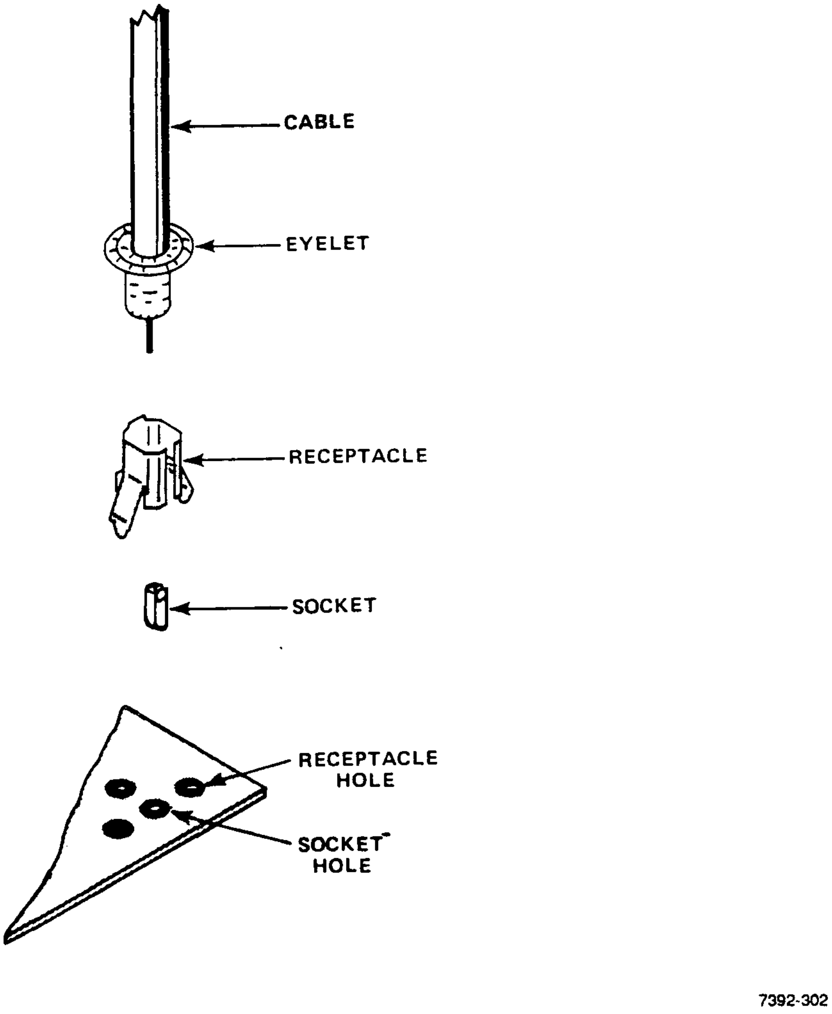


Figure 3-3 Peltola Coaxial-Cable Connector Assembly.

How to Remove the Front Panel

1. Unhook the return spring from the latch, and set it aside.
2. Use a Torx T-7 screwdriver to remove the four screws that fasten the front subpanel to the top and bottom frames.
3. Pull the latch as far out of the amplifier as it will come, and leave it in that position.
4. Insert a slender, sharp-pointed tool, such as a scribe, between the front panel and the subpanel at the notch around the latch. Gently separate the front panel from the subpanel. Use care to prevent bending the front panel.

How to Install the Front Panel

1. Check that the four screws that fasten the front subpanel to the top and bottom frames are removed.
2. Check that the latch return spring is removed.
3. Set the 11A71 on it side with the front panel facing you.
4. Pull the latch as far out of the amplifier as it will come, and leave it in that position.
5. Position the front panel so that the notch in the bottom fits over the latch rod, then carefully insert the four front-panel tabs into the slots in the front subpanel.

   You may need to pull the top and bottom frames away from the subpanel to allow the front-panel tabs to fit between the casting and the frames.
6. Gently snap the edges of the front panel into place around the input connectors and the outer edges of the panel.
7. Use a Torx T-7 screwdriver to install the four screws that fasten the front subpanel to the top and bottom frames.
8. Install the latch return spring. Orient the spring so that its loop fits over the frame hook correctly.

How to Replace a Front-Panel Board

1. Remove the front panel as outlined in "How to Remove the Front Panel."
2. Unplug the connector that provides electrical connection to the Main board.
3. Use a Torx T-6 screwdriver to remove the two screws that fasten the Front-Panel board to the front subpanel, and remove the Front-Panel board.
4. To replace a Front-Panel board, follow the preceding steps in reverse order.

How to Remove the Main Board

1. Unplug the cable from the input of the attenuator.
2. Carefully unplug the Kernel board assembly. Do not bend its pins.
3. Unplug the connector that connects the Main board to the Front-Panel board.
4. Use a Torx T-9 screwdriver to remove the six screws and nut blocks that secure the Main board to the top and bottom frames. Figure 3-4 shows the nut blocks.
5. Use a Torx T-7 screwdriver to remove the four screws that fasten the heat sink to the to and bottom frames. Figure 3-4 shows these screws.
6. Use a Torx T-15 screwdriver to remove the four screws that fasten the plastic rear panel to the top and bottom frames.
7. Carefully withdraw the Main board from between the frames.

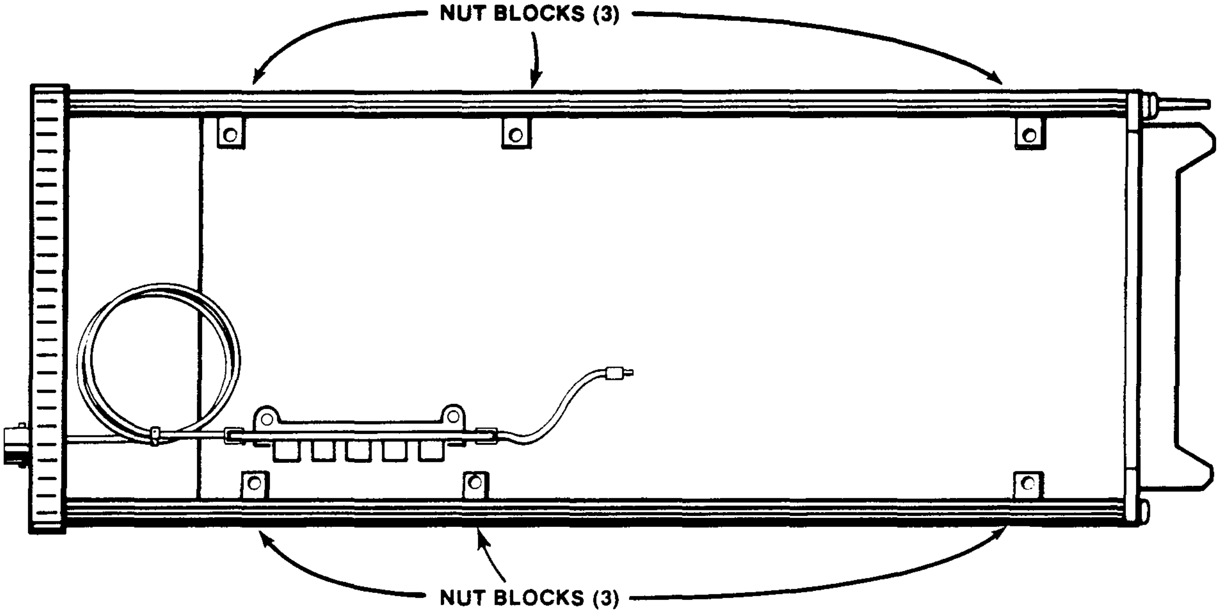


Figure 3-4. Location of Nut Blocks.

How to Install the Main Board

1. Set the 11A71 on its side with the pushbuttons up.
2. Carefully insert the Main board between the frames until the plastic rear panel contacts the top and bottom frames. The board fits on the top of the center ridges on the top and bottom frames. See Figure 3-5.
3. Use a Torx T-15 screwdriver to start the four screws that fasten the rear panel to the top and bottom frames.
4. Use a Torx T-7 screwdriver to install the four screws that fasten the heat sink to the top and bottom frames.
5. Use a Torx T-9 screwdriver to install the six screws and nut blocks that clamp the Main board to the top and bottom frames.
6. Plug the Kernel board assembly into its socket. Be carefully not to bend its pins.
7. Connect the cable from the Front Panel board to its connector on the Main board.
8. Tighten the four screws that you started in step 3.
9. If you installed a new board without the attenuator, install the attenuator as outlined in "How to Install an Attenuator Assembly."

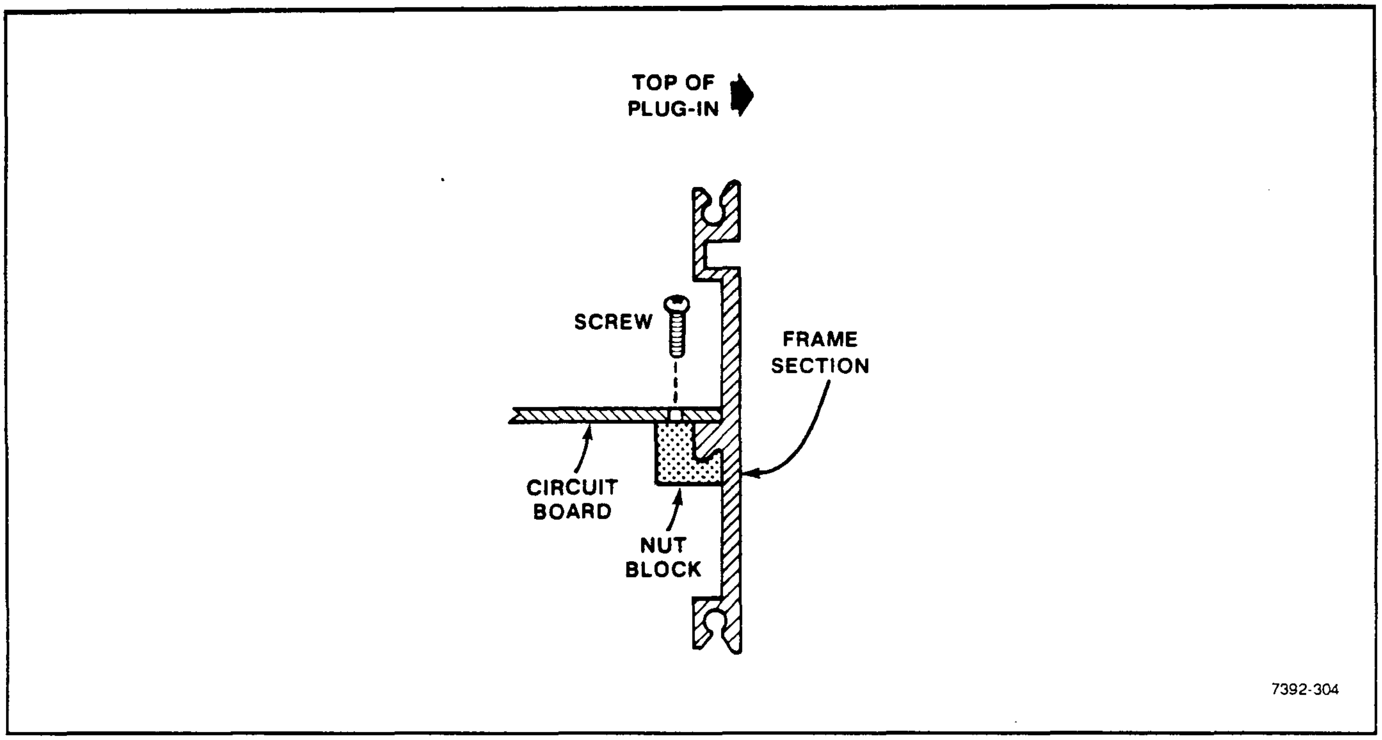


Figure 3-5. How the Main Board fits in the Frame.

How to Remove and Replace a BNC Connector Assembly (BCA)

1. Remove the front panel as outlined in "How to Remove the Front Panel."
2. Unplug the coaxial end-lead connector from the back of the BCA. A flat, flexible, seven-conductor cable connects probe information from the Main board to the BCA.
3. Unplug the probe information connector from the Main board.
4. Use a Torx screwdriver to remove the four screws that fasten the BCA to the front subpanel.
5. Remove the BCA from the oscilloscope.

To replace a BCA, proceed as follows:

6. Set the gray connector alignment ring on the BCA with its index on the inside of the BCA. The "inside" is the side where the flat cable enters the BCA.
7. Insert the BCA, and the connector alignment ring, into the hole in the front subpanel. Check that a) the flat cable faces the inside of the 11A71, and b) the index on the connector alignment ring fits into the notch in the front subpanel.
8. Use a Torx screwdriver to install the four screws that fasten the BCA to the front subpanel.
9. Plug the probe information connector into its socket on the Main board.

10. Plug the coaxial end-lead connector from the attenuator into the BCA. For best result, proceed as follows:
    a. Check that the center conductor is straight. Straighten if necessary.
    b. Plug the connector straight into the receptacle.
11. Install the front panel as outlined in "How to Install the Front Panel."

How to Remove an Attenuator Assembly (AA)

1. Unplug the coaxial end-lead connectors from the input and output of the Attenuator Assembly (AA).
2. Remove the Kernel board.
3. Use a Torx T-9 screwdriver to remove the two screws that fasten the subject AA to the Main board.
4. Using care to keep it straight, unplug the AA from the Main board. Avoid disengaging one end of the AA before disengaging the other end. Do not apply force to any subcomponents on the AA.

How to Install an Attenuator Assembly (AA)

1. Set the 11A71 on its side with the pushbutton down.
2. Align the AA pins with the connector on the Main board, and align the attenuator frame with the holes in the Main board.
3. Plug the AA into its connector on the Main board. Do not apply force to any subcomponents on the AA.
4. Use a Torx T-9 screwdriver to install the two screws that fasten the AA to the Main board.
5. Plug the coaxial end-lead connectors into the input and the output of the AA. Care is necessary when engaging these connectors. For best results, proceed as follows:
    a. Check that the center conductor is straight. Straighten if necessary.
    b. Plug the connector straight into the receptacle.
    c. Look through the slot in the outer receptacle, and watch the center conductor enter its receptacle as you insert the connector.
6. Install the Kernel board.

Soldering Techniques

WARNING

To avoid electric-shock hazard, and amplifier damage disconnect the amplifier from the power source before soldering.

The reliability and accuracy of this amplifier can be maintained only if proper soldering techniques are used when repairing or replacing parts.

The desoldering and removing of parts is especially critical and should be done only with a vacuum solder extractor; preferably, one approved by a Tektronix, Inc. Service Center.

To prevent damaging the pins, use an extracting tool to remove in-line integrated circuits. A tool is available from Tektronix, Inc; order Tektronix part 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 integrated circuit.. Try to avoid disengaging one end from the socket before the other end.

When removing multi-pin components, do not heat adjacent conductors consecutively (see Fig. 3-6). Allow a moment for the circuit board to cool before proceeding to the next pin.

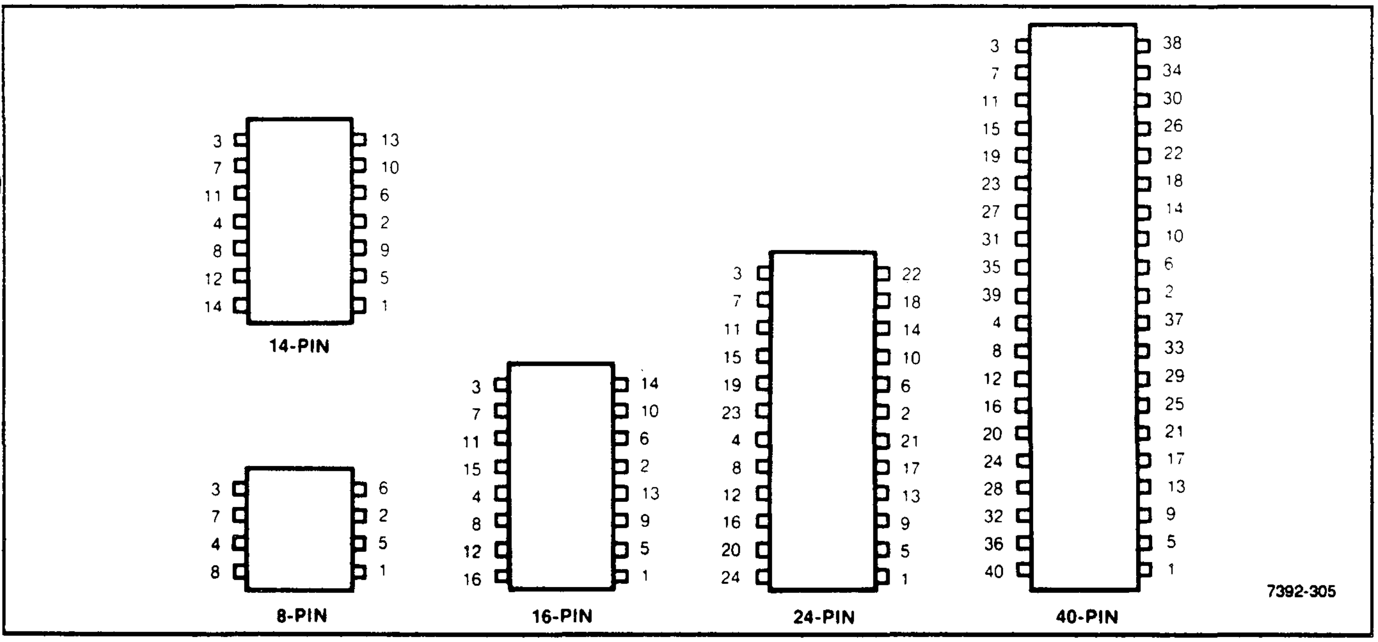


Figure 3-6. Recommended Desoldering Sequence

Use wire solder with rosin core, 63% tin, 37% lead. Contact your local Tektronix, Inc. representative or field office for approved solders.

The 11A71 Main board is a multi-layer board. Conductive paths between the top and bottom board layers may connect with one or more of inner layers. If this inner conductive path is broken (due to poor soldering practices), the board is unusable and must be replaced. Damage can void warranty.

CAUTION

Only an experienced maintenance person, proficient in the use of vacuum type desoldering equipment, should attempt repair of any board in this amplifier.

When soldering on circuit boards or small wiring, use only a 15-watt, pencil-type soldering iron. A higher wattage soldering iron can cause the etched circuit wiring to separate from the board base material, and melt the insulation from small wiring. Always keep the soldering-iron tip properly tinned to ensure the best heat transfer to the solder joint. Apply only enough heat to make a good solder joint. To protect heat-sensitive components, hold the component lead with a pair of long-nose pliers between the component body and the solder joint.

Touch the tip of the vacuum desoldering tool directly to the solder to be removed.

CAUTION

Excessive heat can cause the etched circuit wiring to separate from the board base material.

Troubleshooting

The following information is provided to facilitate troubleshooting the 11A71 Amplifier. Information contained in other sections of this manual should be used with the following data to aid in locating a defective component. An understanding of the circuit operation is helpful in locating troubles. See Section 2, Theory of Operation, for this information.

Troubleshooting Aids

Diagrams

Complete schematic diagrams are given on the pullout pages in Section 6, Schematic Diagrams and Circuit Board Illustrations. The circuit number and electrical value of each component in the 11A71 are shown on these diagrams. (See the first page of the Schematic Diagrams and Circuit Board Illustrations section for definitions of the reference designators and symbols used to identify components in the 11A71.)

Circuit Board Illustrations

An illustration of the amplifier showing circuit board placement is provided on the first page of Section 6—Schematic Diagrams and Circuit Board Illustrations.

A circuit board component illustration is shown adjacent to the first schematic diagram associated with a specific circuit board.

Each schematic diagram in section 6 has a grid matrix with an index to help locate components contained in that schematic diagram.

Component Color Coding

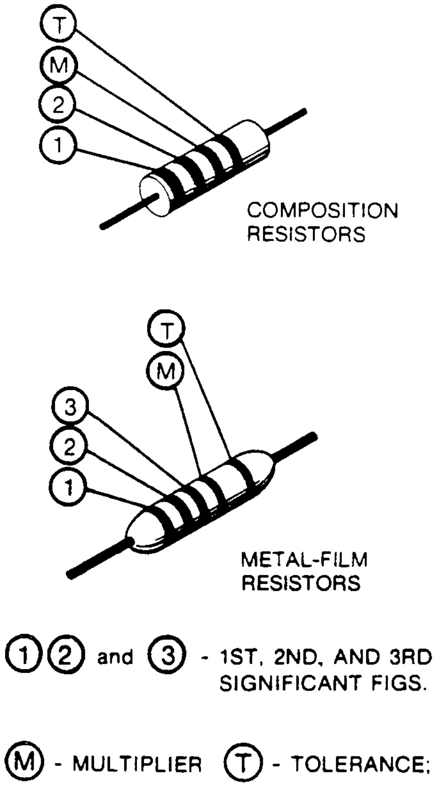
This amplifier contains composition resistors and metal-film resistors. The resistance values of composition resistors and metal-film resistors are color coded on the components, using the EIA color code (some metal-film resistors may have the value printed on the body). The color code is read starting with the stripe nearest the end of the resistor. Composition resistors have four stripes, which consist of two significant figures, a multiplier, and a tolerance value (see Fig. 3-7).

Metal-film resistors have five stripes consisting of three significant figures, a multiplier, and a tolerance value.

The values of common disc capacitors and small electrolytics are marked on the side of the component body.

The cathode end of glass-encased diodes is indicated by a stripe, a series of stripes, or a dot. The cathode and anode ends of metal-encased diodes can be identified by the diode symbol marked on the body.

COLOR CODE



COLOR	SIGNIFICANT FIGURES	RESISTORS	
		MULTIPLIER (OHMS)	TOLERANCE
BLACK	0	1	———
BROWN	1	10	±1%
RED	2	10^2 or 100	±2%
ORANGE	3	10^3 or 1 K	±3%
YELLOW	4	10^4 or 10 K	±4%
GREEN	5	10^5 or 100 K	±1/2%
BLUE	6	10^6 or 1 M	±1/4%
VIOLET	7	———	±1/10%
GRAY	8	———	———
WHITE	9	———	———
GOLD	———	10^{-1} or 0.1	±5%
SILVER	———	10^{-2} or 0.01	±10%
NONE	———	———	±20%

7392-306

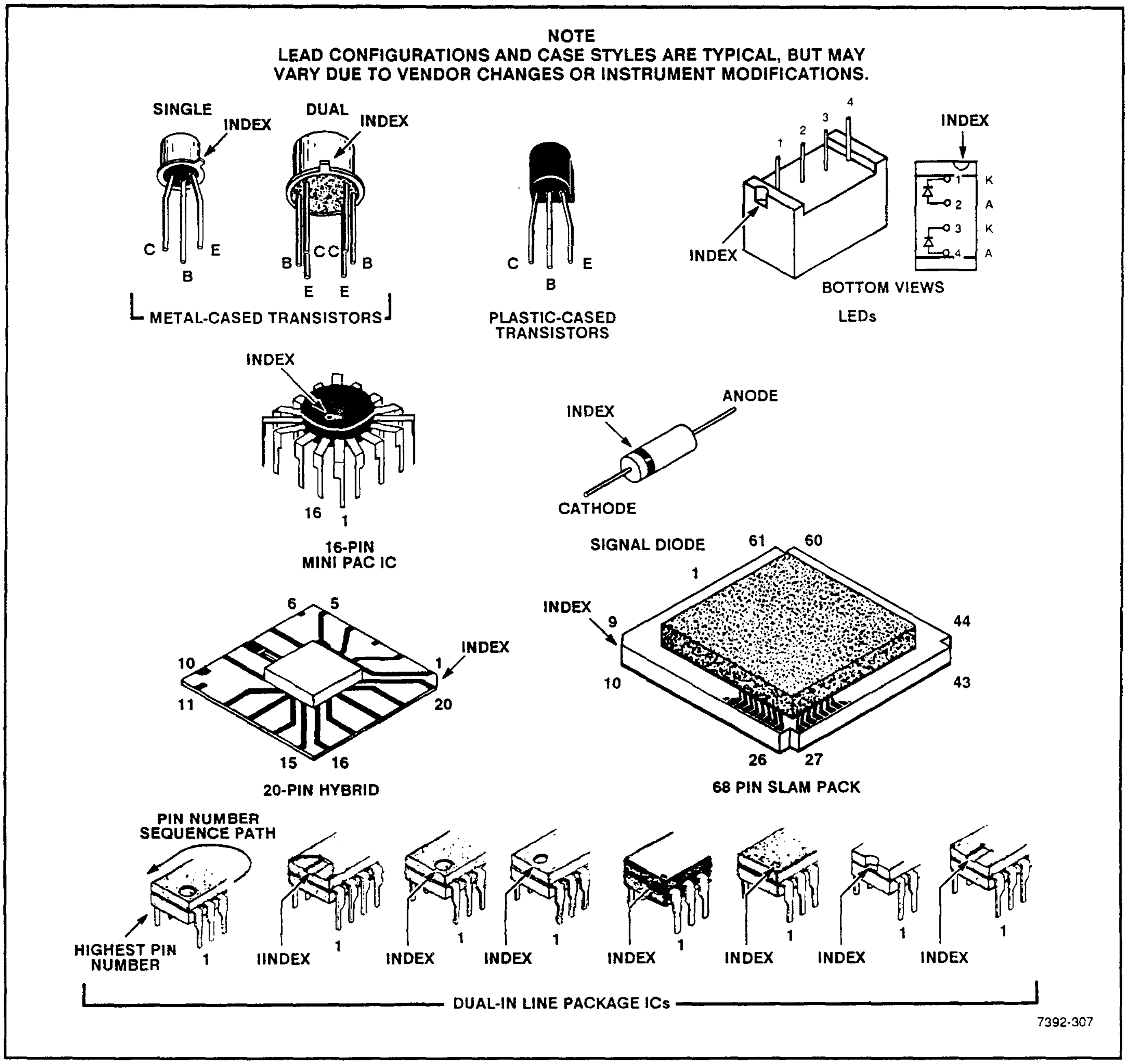
Figure 3-7. Resistor Color Codes.

Wiring Color Code

Some wiring is done with multi-conductor ribbon cables with differently colored conductors. The colors of these cables follow the EIA color code, and the brown conductor should connect to pin 1 of the associated connector.

Semiconductor Lead Configurations

Lead configurations and index locators for semiconductor devices used in the 11A71 are shown in Figure 3-8.



NOTE
LEAD CONFIGURATIONS AND CASE STYLES ARE TYPICAL, BUT MAY VARY DUE TO VENDOR CHANGES OR INSTRUMENT MODIFICATIONS.

Figure 3-8. Semiconductor Lead Configurations.

Multi-Pin Connector Identification

A triangle on the holder identifies pin 1 of multi-pin connector holders. When connecting the holder to its row of pins on the circuit board, orient the holder to align its triangle with the triangle on the circuit board (see Fig. 3-9).

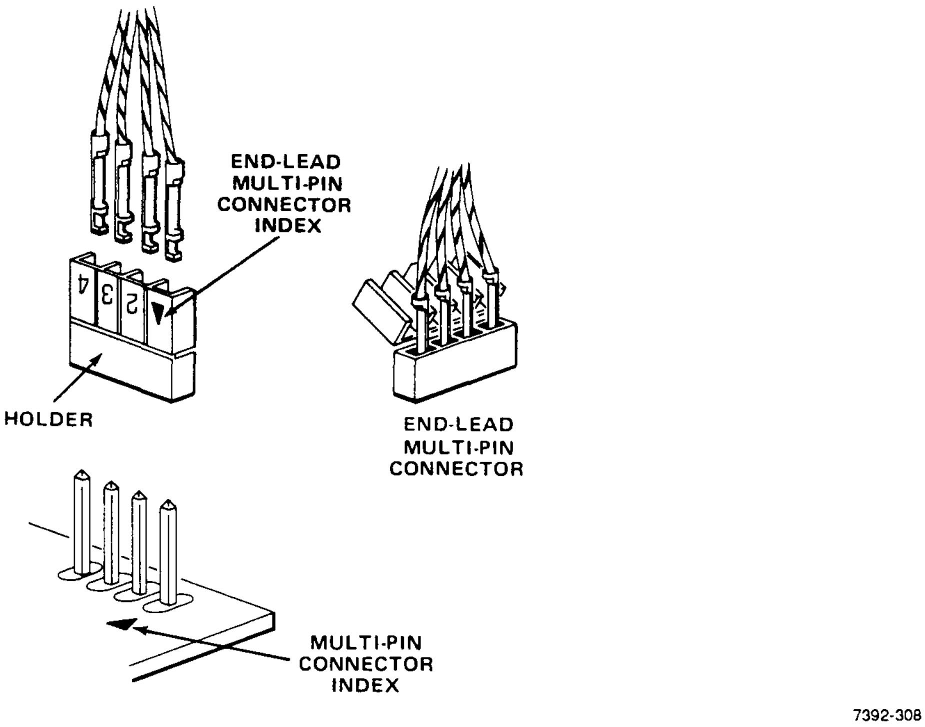


Figure 3-9. Orientation of Multi-Pin Connectors

Troubleshooting Equipment

The following equipment is useful for troubleshooting the 11A71 Amplifier.

1. Test Oscilloscope

   Description: Frequency response, DC to 200 megahertz minimum, deflection factor, 5 mV to 5 V/div. A 10X, 10 MΩ voltage probe should be used to reduce circuit loading for voltage measurements.

   Purpose: Check operating waveforms.

   Recommended type: TEKTRONIX 7904A Oscilloscope with 7A26 Dual-Trace Amplifier, 7S14 Dual Trace Delayed Sweep Sampler, and 7B10 and 7B15 Time Bases, or equivalent.

2. Calibration Fixtures

   (A) Flexible Extender Set (amplifier)

   Purpose: Troubleshooting with 11A71 extended

   Recommended type: Tektronix part 067-1261-00 Flexible Extender.

   (B) Signal Pickoff

   Purpose: Troubleshooting the circuit boards.

   Recommended type: Tektronix part 067-1262-00 Signal Pickoff Connector.

   (C) Signal Standardizer

   Purpose: Troubleshooting the circuit boards.

   Recommended type: Tektronix part 067-0587-02 Signal Standardizer.

   (D) Normalizer

   Purpose: Troubleshooting the circuit boards.

   Recommended type: Tektronix part 067-0537-00 15 pF Terminator

3. Digital Multimeter

   Description: 10 megohm input impedance and 0 to 1 kilovolt range, ac and DC; ohmmeter, accuracy, within 0.1%. Test probes must be insulated to prevent accidental shorting.

   Purpose: Check voltages and resistances.

   Recommended type: TEKTRONIX DM501A Digital Multimeter, with TM 506 Power Module Mainframe.

4. Frequency Counter

   Purpose: Troubleshooting the circuit boards.

Recommended type: TEKTRONIX DC 510 350 MHz Universal Counter/Timer with TM 506 Power Module Mainframe.

5. Logic Analyzer

Purpose: Troubleshooting the circuit boards.

Recommended type: TEKTRONIX 1240 Logic Analyzer with D1 and D2 Acquisition Cards.

Troubleshooting Techniques

This troubleshooting procedure is arranged to check the simple trouble possibilities before proceeding with extensive troubleshooting. The first few checks ensure proper connection and operation of associated equipment. If the trouble is not located by these checks, the remaining steps aid in locating the defective component. When the defective component is located, replace it using the replacement procedures given under Corrective Maintenance.

1. Check Control Settings

Incorrect control settings can indicate a nonexistent trouble. If there is any question about the correct function or operation of any control on the 11A71 refer to the Oscilloscope User's Reference Manual or Amplifier supplement.

2. Check Associated Equipment

Before proceeding with troubleshooting, check that the equipment used with this amplifier is operating correctly. Also, check that the input signals are properly connected and that the interconnecting cables are not defective. Check the line-voltage source.

3. Visual Check

Visually check any part of the amplifier where the trouble may be located. Many troubles can be found by visible indications such as unsoldered connections, broken wires, damaged circuits, and damaged components. Especially check that all cables are properly installed.

4. Isolate Trouble to a Circuit

To isolate the trouble to a circuit, refer to Section 4, Diagnostics.

5. Check Oscilloscope Adjustment

Check the electrical adjustment of the 11A71, or of the affected circuit if the trouble appears in one circuit. If the apparent trouble cannot be isolated to a defective component, the trouble may only be a result of maladjustment. Complete adjustment instructions are given in Section 2, Checks and Adjustment in the Service Reference Manual.

6. Check Individual Components

The following procedures describe methods of checking individual components in the 11A71. Components that are soldered in place (excluding integrated circuits) are best checked by first disconnecting one end. This isolated the measurement from the effects of surrounding circuitry.

CAUTION

To avoid electric-shock hazard, always set the oscilloscope ON/STANDBY switch to STANDBY before removing or replacing components.

If the green light indicator remains lit after the ON/STANDBY switch is moved to STANDBY, the power has been internally locked ON. To remove or replace components, use the PRINCIPAL POWER SWITCH (rear panel) to shut OFF the power.

Transistors

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 previously checked). 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, because they do not check operation under simulated operating conditions.

Integrated Circuits

Integrated circuits can be checked with a test oscilloscope, digital tester or by direct substitution.

CAUTION

Direct substitution must not be attempted with soldered-in integrated circuits. The IC, circuit board, or both, could be damaged due to the heat required to melt the solder from the connections. Refer to Soldering Techniques earlier in this section. Use care when checking voltages and waveforms around the integrated circuits so that adjacent leads are not shorted together. The integrated circuit test clip provides a convenient means of clipping a test probe to the in-line, multi-pin integrated circuits.

A good understanding of the circuit operation is essential to troubleshooting circuits using integrated circuits. Operating conditions and other information for the integrated circuits are given in Section 2, Theory of Operation and Section 6, Schematic Diagrams and Circuit Board Illustrations.

Diodes

A diode can be checked for an open or shorted condition by measuring the resistance between terminals with an ohmmeter on a scale having a low internal source current, such as the R x 1 k scale. The resistance should be very high in one direction and very low in the other direction.

Resistors

Check resistors with an ohmmeter. Resistor tolerances are given in Section 5, Replaceable Electrical Parts. Normally, resistors need be replaced only if the measured value varies widely from the specified value.

Capacitors

A leaky or shorted capacitor can best be detected by checking resistance with an ohmmeter on the highest scale. Do 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 capacitance meter or by checking that the capacitor passes ac signals.

7. Repair and Adjust the Circuit

If any defective parts are located, follow the replacement procedures given under Component Replacement in this section. Check the performance of any circuit that has been repaired or that has had any electrical components replaced. Adjustment of the circuit may be necessary.

Section 4

Diagnostics

Section 4
Diagnostics

This section explains the self-test and diagnostic systems used in the 11A71 Single Channel Amplifier. The reader needs a familiarity with the general operating principle of the amplifier, knowledge of its circuitry, and a working knowledge of the amplifier/oscilloscope interface to best use this section.

Diagnostic Overview

This firmware contains comprehensive test and diagnostic routines that detect and help locate hardware faults. These test and diagnostic routines are grouped into three categories:

a) Power-up Kernel testing

b) Self-tests (Invoked by oscilloscope)

c) Diagnostics (Invoked by oscilloscope)

Each part of the test/diagnostic system is described in detail in the following sections.

Kernel Testing

When the amplifier is powered-up and the CPU has reset, the amplifier begins a sequence of test routines to determine if its crucial systems are operating properly. If any of these tests fail, it is unlikely that the amplifier will operate correctly in a system. The amplifier indicates a failure by flashing a specific fault code on the front panel CH 1 LED. This fault code indicates which kernel test is failing. Use the following procedure to interpret the fault code.

If the amplifier kernel tests detect any fault, a fault code will be displayed by flashing the CH 1 LED eight times. Each time the CH 1 LED turns on, count the occurrences. If the CH 1 LED is lit twice as long, the test corresponding to the count accumulated so far is the one which failed. Refer to the timing diagram in Figure 4-1 for a sample LED fault code. The timing diagram shows that test number 2 has failed.

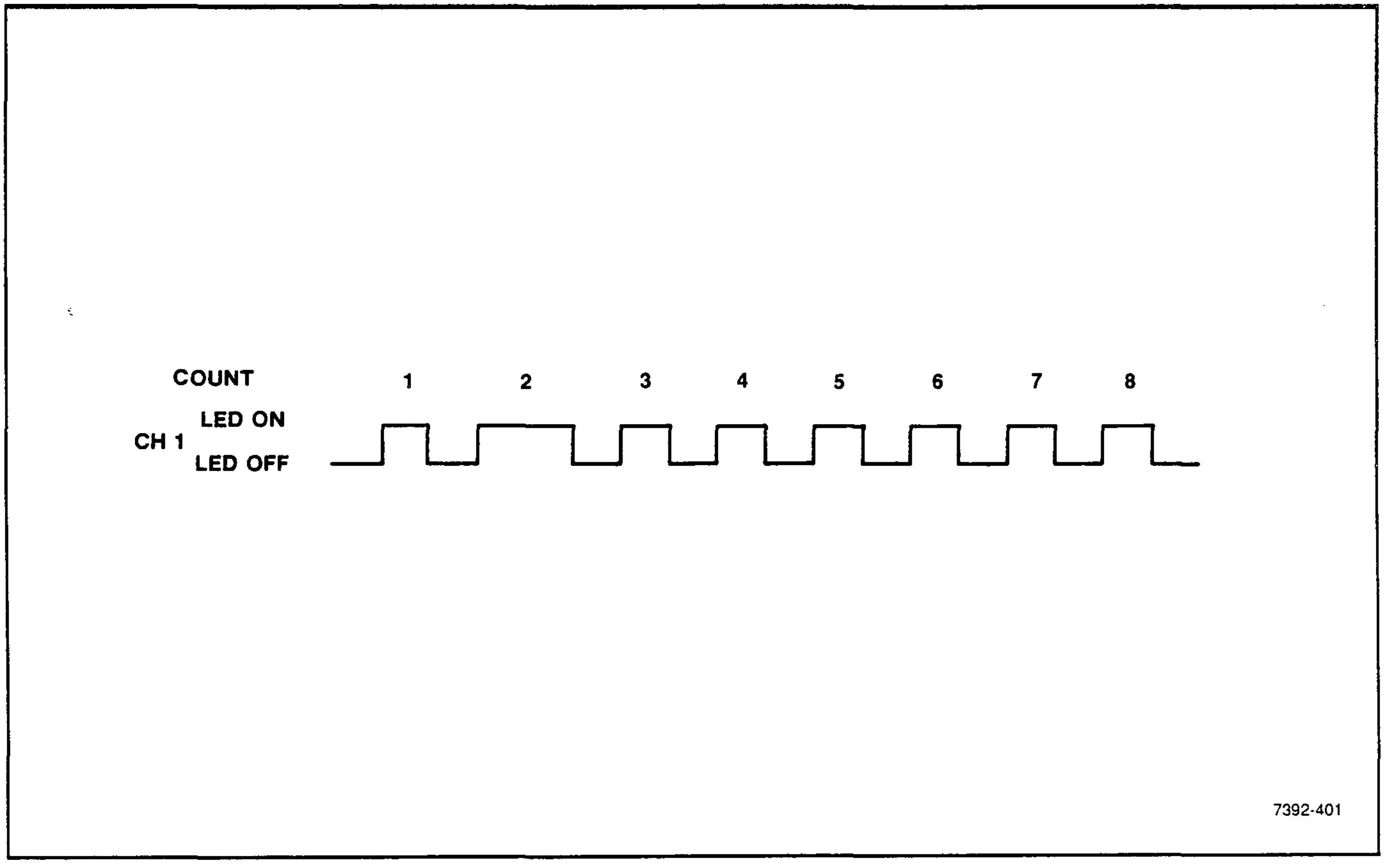


Figure 4-1. Sample LED Fault Code Timing Diagram.

The following kernel tests are executed in the order given at power-up time :

1. Non-volatile RAM Test
2. U820 (M382) function Test

The nonvolatile RAM (NVRAM) test verifies that the NVRAM, U801, functions properly as a RAM while power is applied. The test takes advantage of the fact that the information that must be preserved nonvolatile in U801 does not fill the entirety of the RAM. This critical information is distributed in such a way that the first byte of the RAM's first seven 256-byte pages as well as the entirety of its eighth page, can be written into during the course of the NVRAM self-test; the remainder of the NVRAM is left undisturbed.

Prior to 11A71 firmware version 3.3, the entirety of the NVRAM was written to during its self-test, using its top spare page to save temporary copies of the critical information while the information's primary storage areas are tested. This approach was vulnerable to calconstant loss if power failed during the test, however, so the ram test was amended as described above.

If the test detects a failure, the amplifier reports a fault code of 1, and repeatedly loops the RAM test, while generating signature analysis signals on the appropriate test points. (Each repetition of the test is framed by pulses on the SA Start and SA Stop test points.) The signal on SA Start(L) goes from high to low at the start of each repetition, and stays low throughout the test. The signal on SA Stop goes from high to low at the end of the test.)

These signature analysis signals may be used to help pinpoint the cause of the test failure. The oscilloscope will continue looping the RAM test until the power is removed. Until the condition causing the RAM test to fail is corrected, the amplifier will not be recognized by any oscilloscope in which it is installed.

The M382 Test verifies the functionality of the M382 IC. The M382 performs many housekeeping chores of the Amplifier, including channel sequencing, refreshing the Analog Control Voltage System, and SDI communications with the oscilloscope. This test exercises the M382 by applying controlled stimulus to the chip, and records the chip's reactions using an algorithm similar to that used for signature analysis. If the resulting signature of the M382 IC does not match a known good signature, the test is considered to have failed, and a fault code of 3 is reported. If the test fails, it is executed repeatedly, while generating signature analysis signals on the appropriate test points. The signal on SA START(L) goes from High to Low at the start of each repetition, and remains Low throughout the test. The signal on SA STOP(L) goes from High to Low at the end of the test.

The signature analysis signals may be used to help locate the cause of the test failure. The oscilloscope will continue looping the M382 test until power is removed. Until the condition causing the M382 test to fail is corrected, the amplifier will not be recognized by any oscilloscope in which it is installed.

After all power-on kernel tests have completed and successfully passed, the amplifier commences initializing its settings and starts dialog with the oscilloscope.

Self-Tests

After the amplifier has successfully powered up, initialized its settings, and established communication with the oscilloscope, the oscilloscope requests that the amplifier executes its self-test routines (unless the oscilloscope's self-tests have been disabled, in which case all self-tests will be skipped). The amplifier starts executing self-test routines that require no oscilloscope resources (Calibrated Voltage Reference or Measurement System). The following self-test routines are executed:

- RELAY DRVR—Attenuator Driver Test
- PROBECODES—Check for Stable Probecode
- SERIALSUM-Check the Non-Volatility of the CMOS RAM
- ADC TEST—Test Analog to Digital Converter
- FUSE TEST—Check Probe Power Fuses
- Input PROTECTION TEST—Checks input protection circuit
- ACVS TEST—Test Analog Control Voltage System
- Check Calconstants for Channel 1

For descriptions of each of the tests, see Diagnostics in this section.

Each test is run in turn, starting with the Attenuator Driver Test. If any of the test routines fail, the area and routine number of the failing routine are saved (First Failed Area/Routine), and a block of descriptive information relating to the failure is stored in the amplifier for later retrieval by the oscilloscope (via the DIAG CONFIG command). All of the tests are executed, regardless of their exit status.

When all tests are complete, a TEST STATUS message is sent to the oscilloscope indicating

a) all tests passed, or

b) the Area and Routine number of the first routine that failed.

If large numbers of tests failed, the amplifier, which has limited storage resources, saves as much failure information as possible. (The number of failure information blocks that may be stored in the amplifier varies, depending on the types of failures involved; any overflow failure information is discarded.)

After running the tests that require no oscilloscope resources, the oscilloscope requests that the amplifier execute the remaining self-test routines which require oscilloscope resources. Upon receipt of this request, the amplifier performs a series of tests that use the oscilloscope's Calibrated Voltage Reference (CVR), and the oscilloscope's measurement system. The following tests are executed:

- CALMEASURE—Test Oscilloscope Measurement System

- CALSIGPATH—Test System Calibration/Signal Path

These tests are executed in the same manner as the preceding tests which do not require oscilloscope resources, with each test executing in turn. If a failure is found, failure information blocks are stored in the amplifier for later retrieval by the oscilloscope. For more information on the specific functioning of these tests, see the Diagnostics later in this section. When the tests are complete, the amplifier will report their success or failure with a TEST STATUS message.

When the oscilloscope receives the TEST STATUS message, it sends a TEST EXIT message to the amplifier, which will cause the amplifier to exit self-test mode and enter diagnostic mode.

Extended Diagnostics

The amplifier diagnostics code lets the user to individually execute and receive the results of test/diagnostic routines via the oscilloscope's front panel. Diagnostic routines are grouped into Areas and Routines. Each area contains one or more diagnostic routines. The various routines in an area share a common trait: they report their results in the same format.

Tests may be executed in one of three modes, known as Single, Cycle, and Cycle_Halt. Single mode causes the specified diagnostic routine to be executed once, and the results of the test to be reported upon completion. Cycle tests are repeated indefinitely, and are terminated by pressing the amplifier's CH 1 front-panel button. Upon detecting the termination signal, the amplifier reports the number of times the test was executed, the number of times the test failed, and specific failure information. Cycle_Halt mode is identical to Cycle mode, except that the test cycles until the user either terminates it by pressing the amplifier CH 1 button, or until the selected test fails.

The oscilloscope's human interface determines how the diagnostic system is presented to the user, so from here on all explanations are specific to the oscilloscope/amplifier interface.

Table 4-1 lists all the available diagnostic routines for the 11A71:

TABLE 4-1
11A71 Diagnostic Routines

Area	Routine	Test/Diagnostic Routine
1	1	Test Attenuator Driver (RELAY DRVR)
1	2	Check Probe Code Stability (PROBECODES)
1	3	Check Signal Path Calconstant Checksum (CKSM PLUG)
1	4	Check Probe Calconstant Checksum (CKSM PROBE)
1	5	Check the Non-Volatility of the CMOS RAM (SERIAL SUM)
1	6	Generate Walking-1's on Output Latches (WALK ONES)
2	1	Test Analog to Digital Converter (ADC TEST)
2	2	Test Probe Power Fuses (FUSE TEST)
2	3	Test Input Protection (PROTECTION TEST)
3	1	Test Analog Control Voltage System (ACVS TEST)
3	2	Give Detailed Information on Calconstant Test Failures (EXPLAINCAL)
4	1	Test PROBE GAIN Calconstants (PROBE GAIN)
4	2	Test ATTENUATOR GAIN Calconstants (ATTEN GAIN)
4	3	Test GAIN HI Calconstant (GAIN HI)
4	4	Test GAIN LO Calconstant (GAIN LO)
4	5	Test BALANCE Calconstants (BALANCE)
4	6	Test COARSE OFFSET Calconstants (COARSE DAC)
4	7	Test OFFSET Calconstants (LAST OFFSET) (version 2.8 and later)
4	8	Calconstant Viewer (CC DUMPER)
5	1	Test Oscilloscope Measurement System (CALMEASURE)
5	2	Test System Signal/Calibration Path (CALSIGPATH)

Test Descriptions

Attenuator-Driver Test (RELAY DRVR)

The Attenuator-Driver test exercises the attenuator shift register (U130). The test verifies that the shift register can clock data through its entire length. This test cannot determine if the drivers actually drive the relays; its sole purpose is to verify the integrity of the shift register. The relay driver outputs must be tested using manual methods. The attenuator shift register test first clears the attenuator shift register by clocking in an appropriate number of 0's. The test then begins clocking in 1's, and looks for the 1 to appear on the serial output within a certain number of clocks. If the 1 does not come out of the end of the register within a predetermined number of clock cycles, the test is flagged as failed.

The Address field is not used in this test, and will return zero. If the Actual value returned by the test does not equal the Expected value from the table above, the test has failed.

Test Failure

The expected value for this test is 00*hex*. Failure indicates problems with the attenuator shift register ICs, or with connections between the shift register ICs and the CPU.

Check Probecode Stability (PROBECODES)

The Probecode Stability test checks the probe code voltages to see if they have settled to a stable level within a given period of time. This routine is actually used as a delay during the self-test period to ensure that the probecode voltages levels have stabilized before continuing with other self-tests. The Probecode Stability test normally returns zero in the Actual field; any other value indicates a failure. Bit 0 of the Actual field represents failure of channel 1. The Address field of the test is not used and will return zero.

Test Failure

The Expected field is 00*hex*. Failure indicates problems with the analog to digital converter or with the probecode voltages.

Check the Non-Volatility of the CMOS RAM (SERIAL SUM)

The Serial Sum diagnostic is intended to test the non-volatility of the amplifier's battery-backed CMOS RAM. An eight-bit checksum is computed of the amplifier's stored (in NVRAM) Unit Identification string (which usually contains the amplifier's serial number), and this checksum is compared to the correct answer, which was also stored in the NVRAM along with the Unit ID.

Test Failure

If the test fails, re-enter the amplifier's serial number. Chronic failure of this test may indicate that the battery has gone bad.

Check Signal Path Calconstant Checksum (CKSM PLUG)

The calconstants in the amplifier are protected by a checksum generated after a calibration cycle, or after the amplifier calconstants are modified using the CAL CONST_SET command. The calconstant checksum helps the amplifier detect the corruption of calconstants caused by external problems such as alpha-particle hits, bad NVRAM battery, power failure during the NVRAM kernel test, or other failures.

The signal path calconstant checksum test runs a checksum algorithm on calconstants related to the signal path of the amplifier (not including probes) and compares the calculated checksum with the checksum stored (with calconstants) in NVRAM. If the calculated checksum does not match the stored checksum, it indicates that the calconstants (or the checksum) have changed due to some outside influence.

Note that setting the calconstants to factory defaults will not cause a new calconstant checksum to be generated for the factory default calconstants. The signal path calconstant checksum test will continue to fail until the amplifier is either run through a calibration cycle, or the CAL CONST_SET command is used to force a new calconstant checksum to be generated. The Address field is not used in this test, and is zero. The Expected field is zero, indicating that the test should return zero if the checksum was correct. The Actual field will be zero if the checksum was correct, and nonzero (with no significance to the value) if the checksum was incorrect.

Test Failure

The Expected field is zero. Failure of this routine should flag the user that the calconstants currently residing in the amplifier's NVRAM are corrupted, and that the amplifier should be recalibrated before expecting normal operation.

Check Probe Calconstant Checksum (CKSM PROBE)

Amplifier calconstants are protected by a checksum generated after a calibration cycle, or after the amplifier calconstants are modified using the CAL CONST_SET command. This calconstant checksum helps the amplifier detect corruption of calconstants caused by external problems, such as alpha-particle hits, bad NVRAM battery, or other unknown phenomena.

The probe calconstant checksum test runs a checksum algorithm on calconstants related to probes currently installed, and compares the calculated checksum with the checksum stored (with calconstants) in NVRAM. If the calculated checksum does not match the stored checksum, it indicates that the calconstants (or the checksum) have changed due to some outside influence.

Note that setting the calconstants to factory defaults will not cause a new calconstant checksum to be generated for the factory default calconstants. The probe calconstant checksum test will continue to fail until the amplifier is either run through a calibration cycle, or the CAL CONST_SET command is used to force a new calconstant checksum to be generated, or one or more changes in probe attachment status have occurred. The

Address field is not used in this test, and is zero. The Actual field will be zero if the checksum was correct, and nonzero (with no significance to the value) if the checksum was incorrect.

Test Failure

The Expected field is zero, indicating that the test should return zero if the checksum was correct. Failure of this routine should warn the user that the calconstants currently residing in the amplifier's NVRAM are corrupted, and that the probe should be recalibrated, before expecting normal operation.

Walking Ones Test (WALK ONES)

This test sequences a "walking-one" through all the external latches used to interface the processor to the rest of the amplifier hardware. The test always passes because the processor cannot determine if the outputs are actually working. The test is intended to be run with the user manually observing the latch outputs with an oscilloscope or logic analyzer. The test works by setting all output latches to zero, then individually setting each output bit in turn to a one, while leaving all other outputs zero.

Test Failure

If the user finds inactive output latch bits (stuck high/low), the fault is either in the latch chips, on the circuitry connected to the latch output pin, or in the circuitry interfacing the latch to the processor.

Analog to Digital Converter Test (ADC Test)

The amplifier contains an analog to digital converter (A/D, U620) that digitally encodes probe code voltages, measures termination resistor temperatures, and reads data from serial (Level II) probes. The ADC test works by selecting an internal self-test mode in the A/D chip, which causes it to convert a known reference voltage. The result of this conversion is read back by the processor; if it does not match an expected value within a given tolerance, the test is flagged as failed.

Test Failure

Failure of this test indicates problems with the analog to digital converter chip.

Fuse Test (FUSE TEST)

Each amplifier contains four fuses (F100, F110, F111, F112) to protect the power supplies for external probes. These fuses are checked by the Fuse Test self-test/diagnostic routine. The protected sides of the fuses are connected to a resistor array that forms a simple digital to analog converter. The output of this array is connected to the analog to digital converter in the amplifier. The ADC changes the voltage from this resistor array to a numeric value, which is checked by the diagnostic routine to ensure that it is within an allowable range.

Test Failure

If the returned value is outside the allowable range, it indicates that one or more of the fuses is open. If the fuse test fails, it is likely that any Level 2 probes connected to the amplifier will not work correctly.

Analog Control Voltage System Test (ACVS TEST)

The amplifier relies upon a refreshed sample and hold system to generate all internal variable control voltages. This system is called the Analog Control Voltage System; ACVS for short. The ACVS consists of a section of U820, the IC that contains the sequencing logic and refresh RAM, a precision digital to analog converter, along with one sample-and-hold farm. The ACVS test exercises this system by first setting all the analog control voltages to their minimum values, then selecting and measuring each ACVS channel using the amplifier's ADC to verify that each channel is at the proper value. Each ACVS channel is then set to maximum, one at a time, and the ADC is used to measure that channel, verifying that it went to the proper maximum voltage. All the other channels are then checked to confirm that they stayed at their minimum values. Because the ADC range is limited, this test does not give 100% coverage of ACVS functionality. However, if ACVS channels are flawed, the calibration system and diagnostics should catch any flaws that the ACVS diagnostic misses. The ACVS diagnostic is also set so that when the test is executed in looping mode a technician using an oscilloscope triggered on the SA_Start signal may verify that the outputs of the individual ACVS channels are properly moving between their minimum (approx. –1 V) and maximum (approx. +1 V) values when the test is executed in looping mode. As a byproduct of the way the hardware operates, the front-panel LED will flicker during test execution. This behavior is normal, and does not indicate any fault.

The test generates a bitmap that indicates which ACVS channels are suspected of not operating properly. This bitmap is returned in the Actual field displayed on the oscilloscope's user interface as an 8-bit hexadecimal number. When the hex number is converted to binary, each bit corresponds to a specific pin number on a Sample & Hold Farm. Table 4-2 relates bits to Sample & Hold farm pin numbers:

TABLE 4-2
Bits to Sample and Hold Farm Pin Numbers

	Bit	11A71	
(MSB)	15	20	
	14	22	
	13	NU	Not Used
	12	NU	Not Used
	11	19	
	10	23	
	9	NU	Not Used
	8	NU	Not Used
	7	17	
	6	14	
	5	NU	Not Used
	4	NU	Not Used
	3	15	
	2	16	
	1	NU	Not Used
(LSB)	0	NU	Not Used

For example, suppose the ACVS test failed and returned an Actual field of 00C4. Converting 00C4 to binary yields 0000 0000 1100 0100 on bits 15 through 0. The ones on bits 2, 6, and 7 indicate that the ACVS channels on Sample & Hold Farm pins 17, 16, and 14; were not operating properly.

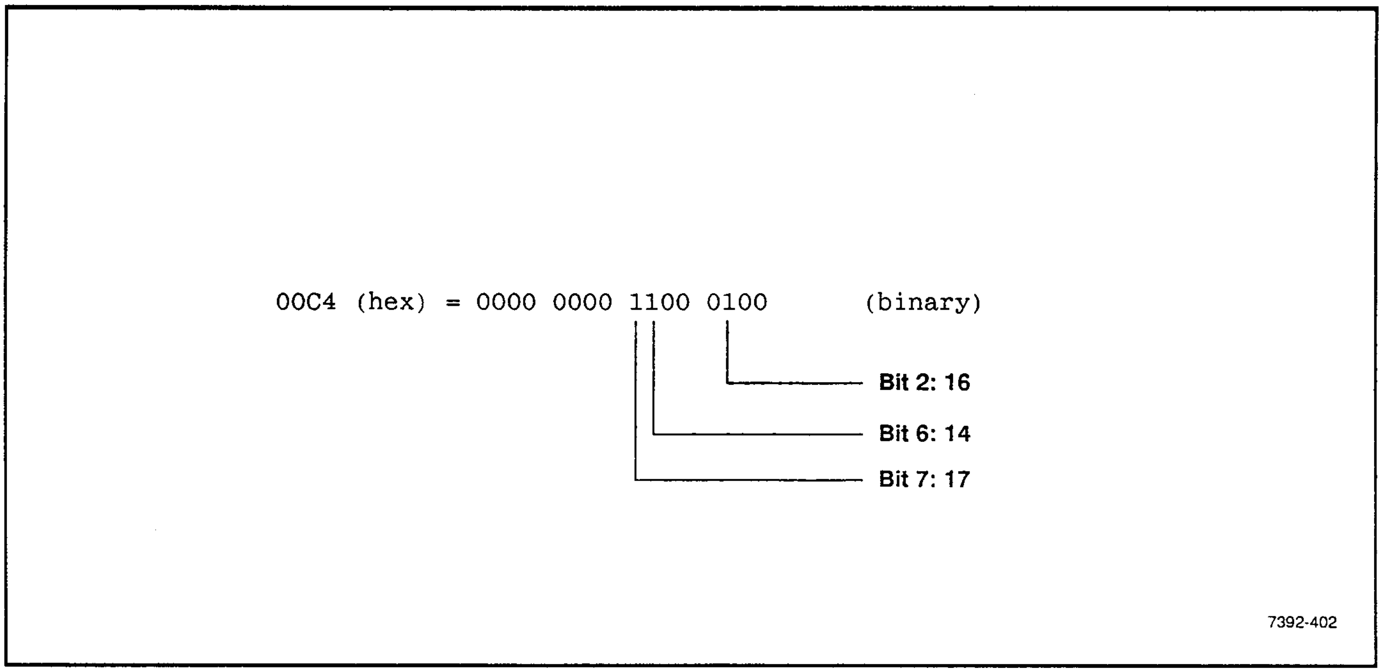


Figure 4-2 Diagnostics Test Results

Test Failure

If the test fails, a fault is likely in one or more of the following areas:

- Digital to Analog Converter (U620)
- Sample-and-hold Farm(s) (U102)
- Self-test ACVS readback circuitry
- CPU to M382 Interconnection
- M382 to D/A / Sample-and-hold Farm Interconnection
- Shorted ACVS output

Calconstant Diagnostics

Each amplifier contains a large number of calconstant diagnostic routines that verify the accuracy of the last amplifier calibration cycle. These tests do not test specific hardware. Instead, they examine the calibration constants generated by the last calibration cycle, and apply mathematical models of an ideal amplifier signal path to these calconstants to determine theoretically if the various operating parameters of the amplifier signal path are such that the oscilloscope can accurately attain all its settings. These tests are strictly numeric in nature, meaning that repeated (looping) execution of these tests is impractical.

A failure in any of these diagnostics indicates that the amplifier will not be able to accurately attain some or all of its possible settings. Failures in these diagnostics do not indicate specific parts of the amplifier hardware, however, they can give clues to the technician about where amplifier signal path problems may be. Failures in any calconstant routine may be caused by ACVS problems (M382, Sample & Hold Farm), faulty output amplifier IC, interconnect problems (coaxial cables, or Hypcon connectors), and improper component installation.

The following diagnostics are included in this section because their success or failure depends strictly upon observations of calconstants generated by the last amplifier calibration cycle. The name of the diagnostic as displayed by the oscilloscope diagnostic interface is shown in the following table, first in upper case letters, then followed by an expanded description of the diagnostic.

- PROBE GAIN—Probe Gain
- ATTEN GAIN—Attenuator Gain
- GAIN HI—High Gain Limit
- GAIN LO—Low Gain Limit
- BALANCE—Balance
- COARSE DAC—Coarse Offset
- ATT OFFSET—Offset Gain (version 2.8 and later)

The individual calconstant diagnostic routines are described here.

PROBE GAIN

This test checks the gain error of the currently installed probe. In order for the test to report results that accurately reflect the probe gain error, a probe calibration cycle must have first been initiated on the probe being tested. If a probe is installed and a probe calibration cycle has not been run on the probe, the test will always give a very small error (the error occurs as a result of the input BNC-to-attenuator connection resistance which is outside the calibration systems feedback loop). This is because the nominal gain of the probe (read from the probe-coding resistor or from the EEPROM in a Level 2 probe) is used as the probe gain calconstant until a probe calibration cycle is run. After a probe calibration cycle, the probe gain calconstant is replaced with the value generated by the probe calibration.

Test Failure

If the test fails, the probe's gain error is not within specifications. The test reports its results as a percentage gain error, with an allowable probe gain error of ±2%. If this test fails with no probe installed, it indicates that the probe code signal for the channel may be shorted to ground. If so, the amplifier will never recognize a probe on this channel because it is seeing a continuous PROBE ID signal. As a result, the amplifier will never install a default nominal probe gain calconstant. Because the default probe gain is never initialized when the amplifier receives a continuous Probe ID signal, an indeterminate value will be sent to the diagnostic, with unexpected results.

ATTEN GAIN

This routine checks the gain error of the worst-performing attenuator setting. The error is displayed as a percentage error, with an allowable range of ±2%. If the Atten Gain test fails, it indicates that one or more of the attenuator ranges does not exhibit the proper attenuation.

Test Failure

Possible causes of test failure can be faulty attenuator relays, dirty/corroded relay contacts, failing relay driver stages, bad interconnections between the main circuit board and the attenuator, or bad connection from the attenuator to the rest of the signal path (coaxial cable). If this test fails, the attenuator settings with the most negative and most positive attenuation error are stored for later retrieval by the Explain Cal diagnostic.

GAIN HI

This routine checks the upper end point of the gain characterization segment. The upper limit is intended to be set at approximately 3.5% excess gain. Due to variations in the gain circuit, this value will typically exceed 3.5%. The upper limit on this constant is the maximum gain the amplifier can achieve minus 0.5%. The 0.5% margin makes sure that the upper gain point is not on the knee of the gain curve.

Failures in this test will cause the amplifier to emit DAC Overflow errors when the amplifier is commanded to go to settings that cause the amplifier to request gain settings beyond the characterized range of the gain control.

Test Failure

Failures of this test may indicate problems anywhere in the signal path or the gain control circuitry. It may also mean that the amplifier does not have sufficient excess gain.

GAIN LO

This routine checks the lower end point of the gain characterization segment. The lower limit is intended to be set at approximately 3.5% below unity gain. Due to variations in the gain circuit, the value will typically be less than 3.5%. The lower limit is 10% below unity gain.

Failures in this test will cause the amplifier to emit DAC Overflow errors when the amplifier is commanded to go to settings that cause the amplifier to request gain settings beyond the characterized range of the gain control.

Test Failure

Failures of this test may indicate problems anywhere in the signal path or the gain control circuitry.

BALANCE

This routine checks the calconstant used in balancing the amplifier. If insufficient range is available, the test is flagged as failed. The values returned by the test are the limits of the balance adjustment (–0.999 to +0.999), representing the full-scale range of the balance adjustment) and the actual setting necessary to correct for the worst-case imbalance.

Test Failure

Failure of this test may indicate the amplifier is unable to balance. It may also indicate problems with the generation of the balance voltage.

COARSE DAC

This routine checks the offset scaling error of the coarse offset calconstants. It generates a percentage error of the characterized coarse offset scaling versus the expected nominal coarse offset scaling. If the calculated error exceeds ±2%, the test is flagged as failed.

Test Failure

Failure of this test may indicate problems in the circuitry used to generate and combine the voltages.

GAIN HI (version 2.8 and later)

This routine checks the upper end point of the gain characterization segment. The upper limit is intended to be set at approximately 2.5% above the worst case attenuator low gain. This value must be at least 2.0% above the worst case attenuator gain. The upper limit on this constant is the maximum gain the amplifier can achieve minus 0.5%. The 0.5% margin makes sure that the upper gain point is not on the knee of the gain curve.

Failures in this test will cause the amplifier to emit DAC Overflow errors when the amplifier is commanded to go to settings that cause the amplifier to request gain settings beyond the characterized range of the gain control.

Test Failure

Failures of this test may indicate problems anywhere in the signal path or the gain control circuitry. It may also mean that the amplifier does not have sufficient excess gain.

ATT OFFSET (version 2.8 and later)

This routine checks the error of the attenuators as seen by the offset function. The error of the worst performing attenuator setting is displayed as a percentage error, with an allowable range of ±2%. If the Atten Offset test fails, it indicates that one or more of the attenuator ranges does not exhibit the proper attenuation as seen by the offset function.

If this test fails, the attenuator with the most negative and most positive errors are stored for later retrieval by the Explain Cal Diagnostic.

Test Failure

Possible causes can be faulty attenuator relays, dirty/corroded relay contacts, failing relay driver stages, bad interconnects between the CPU board and the Main board or bad connection from the attenuator to the rest of the signal path (coaxial cable).

Explain Cal (EXPLAINCAL)

The Explain Cal diagnostic is a follow-up to selected calconstant check diagnostics that can provide more specific information about failures in those diagnostic routines. Whenever one of the selected set of calconstant check diagnostic routines fails, information relating to oscilloscope settings in which the failure conditions will occur are stored in a dedicated area. That storage area which can be queried with the Explain Cal diagnostic, contains only enough room to store the failing setting information for the last calconstant check diagnostic executed.

Only the Atten Gain calconstant check diagnostic generates information which may be queried with the Explain Cal diagnostic. The test returns two 16-bit numbers in hexadecimal notation: an Address field and an Expected field. Each digit of the fields has a particular meaning depending on which diagnostic test is being explained. Each letter (hijk, WXYZ) corresponds to a digit in the result returned by the Explain Cal diagnostic. Unused digits in the fields are always zero. The Actual field is not used, and is always zero. This diagnostic will always pass, as it is simply used to retrieve information generated by other diagnostic routines.

The following information shows how to interpret the results of the Explain Cal diagnostic when the specified calconstant check diagnostic information is retrieved:

Atten Gain :

ADDRESS				EXPECTED			
h	i	j	k	W	X	Y	Z

k: encodes the index of the attenuator with the most negative (i.e., lowest) gain error.

Z: encodes the index of the attenuator with the most positive (i.e., highest) gain error.

k or Z	Attenuator Range
0	X1
1	X2
2	X5
3	X10
4	X20
5	X50
6	X100

Calconstant Dumper (CC DUMPER)

The CC Dumper diagnostic provides a method of viewing any of the amplifier's internal calconstants through the diagnostic interface without having to use the GPIB or RS232 oscilloscope interfaces. The amplifier contains up to 64 floating point calconstants, which are stored in the amplifier's non-volatile RAM. The CC Dumper diagnostic never returns a Fail indication as it does not attempt to validate any calconstants; its only purpose is to provide a method of querying the calconstants through the diagnostic user interface. The diagnostic should be executed in Loop mode. When so executed, the calconstant number and the value stored in that particular calconstant location will be displayed.

The CH 1 button on the amplifier front panel may be used to step through the calconstant storage area for the channel currently selected. Pressing the CH 1 button will increment the calconstant number on each cycle of the diagnostic.

Due to display field-width limitations on the oscilloscope display, the calconstant values must be rounded to fit the allotted display area. To get exact values for the calibration constants in the amplifier, the GPIB or RS232 calconstant query commands must be used.

Oscilloscope Measurement System Test (CALMEASURE)

This diagnostic is a simple test of the oscilloscope's measurement system, to ensure positive interconnection between the amplifier output and the oscilloscope measurement system. The test operates by using the amplifier's internal control voltages to set the amplifier outputs (channel at a time) to plus full-scale, then minus full-scale. As each voltage is generated, the amplifier requests the oscilloscope to measure the amplifier output and return the resultant measurement to the amplifier. The amplifier examines the measurements to see if each measurement produces a minimum of 3.5 divisions of deflection. If the measurements indicate that the output is not attaining the expected levels, the test is flagged as failed.

Test Failure

If the test fails, it indicates either a connection problem between the amplifier and the oscilloscope, or a general signal path problem in the amplifier. Failure could also be caused by troubles with the oscilloscope's measurement system. If this fails along with other amplifier diagnostic tests, the failure is more likely to exist in the amplifier than in the oscilloscope. If the test fails by itself, or in conjunction with the oscilloscope calibration voltage reference (CVR) test, the trouble is more likely to reside in the oscilloscope (however, the amplifier could cause such failures). The test returns the difference of two measurements at approximately + and –3 divisions..

Test System Signal Path (CALSIGPATH)

The Calsigpath diagnostic runs a cursory test of the entire system signal path, from the oscilloscope's calibrated voltage reference, through the amplifier signal path, back into the oscilloscope's digitizer. The amplifier is set to a standard signal path gain (the amplifier should have had a calibration cycle before running this test).

The amplifier requests ±3 divisions of deflection from the oscilloscope's calibrated voltage reference (CVR), then makes two sets of requests the oscilloscope to measure the amplifier's output. For the first set, the amplifiers' output is turned off. Measurements are made with the cal voltage set to +3V then -3V. These two values are subtracted. The difference value should be between +0.5V and -0.5V; if it is not, the difference value appears in the actual field and the rest of the test is not run. If the first measurement is correct, the amplifiers' output is turned on and the measurements are repeated at +3V and -3V. The difference should be > 5.5V. This value will be displayed whether or not the test passes.

Test Failure

Failures of this test usually indicate problems in the amplifier attenuators, amplifier channel switching, insufficient amplifier gain, or trouble in the particular oscilloscope CVR or measurement system.

Section 5

Electrical Parts

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.

LIST OF ASSEMBLIES

A list of assemblies can be found at the beginning of the Electrical Parts List. The assemblies are listed in numerical order. When the complete component number of a part is known, this list will identify the assembly in which the part is located.

CROSS INDEX-MFR. CODE NUMBER TO MANUFACTURER

The Mfr. Code Number to Manufacturer index for the Electrical Parts List is located immediately after this page. The Cross Index provides codes, names and addresses of manufacturers of components listed in the Electrical Parts List.

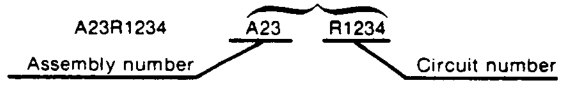
ABBREVIATIONS

Abbreviations conform to American National Standard Y1.1.

COMPONENT NUMBER (column one of the Electrical Parts List)

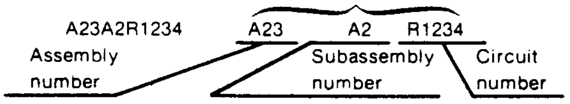
A numbering method has been used to identify assemblies, subassemblies and parts. Examples of this numbering method and typical expansions are illustrated by the following:

Example a.



Read: Resistor 1234 of Assembly 23

Example b.



Read: Resistor 1234 of Subassembly 2 of Assembly 23

Only the circuit number will appear on the diagrams and circuit board illustrations. Each diagram and circuit board illustration is clearly marked with the assembly number. Assembly numbers are also marked on the mechanical exploded views located in the Mechanical Parts List. The component number is obtained by adding the assembly number prefix to the circuit number.

The Electrical Parts List is divided and arranged by assemblies in numerical sequence (e.g., assembly A1 with its subassemblies and parts, precedes assembly A2 with its subassemblies and parts).

Chassis-mounted parts have no assembly number prefix and are located at the end of the Electrical Parts List.

TEKTRONIX PART NO. (column two of the Electrical Parts List)

Indicates part number to be used when ordering replacement part from Tektronix.

SERIAL/MODEL NO. (columns three and four of the Electrical Parts List)

Column three (3) indicates the serial number at which the part was first used. Column four (4) indicates the serial number at which the part was removed. No serial number entered indicates part is good for all serial numbers.

NAME & DESCRIPTION (column five of the Electrical Parts List)

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.

MFR. CODE (column six of the Electrical Parts List)

Indicates the code number of the actual manufacturer of the part. (Code to name and address cross reference can be found immediately after this page.)

MFR. PART NUMBER (column seven of the Electrical Parts List)

Indicates actual manufacturers part number.

CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
00213	NYTRONICS COMPONENTS GROUP INC SUBSIDIARY OF NYTRONICS INC	ORANGE ST	DARLINGTON SC 29532
00779	AMP INC	2800 FULLING MILL PO BOX 3608	HARRISBURG PA 17105
00853	SANGAMO WESTON INC COMPONENTS DIV	SANGAMO RD PO BOX 128	PICKENS SC 29671-9716
01121	ALLEN-BRADLEY CO	1201 S 2ND ST	MILWAUKEE WI 53204-2410
01295	TEXAS INSTRUMENTS INC SEMICONDUCTOR GROUP	13500 N CENTRAL EXPY PO BOX 655012	DALLAS TX 75265
02735	RCA CORP SOLID STATE DIVISION	ROUTE 202	SOMERVILLE NJ 08876
03508	GENERAL ELECTRIC CO SEMI-CONDUCTOR PRODUCTS DEPT	W GENESEE ST	AUBURN NY 13021
04222	AVX CERAMICS DIV OF AVX CORP	19TH AVE SOUTH P O BOX 867	MYRTLE BEACH SC 29577
04713	MOTOROLA INC SEMICONDUCTOR PRODUCTS SECTOR	5005 E MCDOWELL RD	PHOENIX AZ 85008-4229
05828	GENERAL INSTRUMENT CORP GOVERNMENT SYSTEMS DIV	600 W JOHN ST	HICKSVILLE NY 11802
07263	FAIRCHILD SEMICONDUCTOR CORP NORTH AMERICAN SALES SUB OF SCHLUMBERGER LTD MS 118	10400 RIDGEVIEW CT	CUPERTINO CA 95014
07716	TRW INC TRW IRC FIXED RESISTORS/BURLINGTON	2850 MT PLEASANT AVE	BURLINGTON IA 52601
09922	BURNDY CORP	RICHARDS AVE	NORWALK CT 06852
14193	CAL-R INC	1601 OLYMPIC BLVD PO BOX 1397	SANTA MONICA CA 90406
14552	MICROSEMI CORP	2830 S FAIRVIEW ST	SANTA ANA CA 92704-5948
15238	ITT SEMICONDUCTORS A DIVISION OF INTERNATIONAL TELEPHONE AND TELEGRAPH CORP	500 BROADWAY PO BOX 168	LAWRENCE MA 01841-3002
15636	ELEC-TROL INC	26477 N GOLDEN VALLEY RD	SAUGUS CA 91350-2621
19613	MINNESOTA MINING AND MFG CO TEXTOOL PRODUCTS DEPT ELECTRONIC PRODUCT DIV	1410 E PIONEER DR	IRVING TX 75061-7847
19701	MEPCO/CENTRALAB A NORTH AMERICAN PHILIPS CO MINERAL WELLS AIRPORT	PO BOX 760	MINERAL WELLS TX 76067-0760
20932	KYOCERA INTERNATIONAL INC	11620 SORRENTO VALLEY RD PO BOX 81543 PLANT NO 1	SAN DIEGO CA 92121
22526	DU PONT E I DE NEMOURS AND CO INC DU PONT CONNECTOR SYSTEMS DIV MILITARY PRODUCTS GROUP	515 FISHING CREEK RD	NEW CUMBERLAND PA 17070-3007
24355	ANALOG DEVICES INC	RT 1 INDUSTRIAL PK PO BOX 9106	NORWOOD MA 02062
24546	CORNING GLASS WORKS	550 HIGH ST	BRADFORD PA 16701-3737
32997	BOURNS INC TRIMPOT DIV	1200 COLUMBIA AVE	RIVERSIDE CA 92507-2114
34649	INTEL CORP SALES OFFICE /ST4-2/	3065 BOWERS AVE	SANTA CLARA CA 95051
50434	HEWLETT-PACKARD CO OPTOELECTRONICS DIV	370 W TRIMBLE RD	SAN JOSE CA 95131
51406	MURATA ERIE NORTH AMERICA INC HEADQUARTERS AND GEORGIA OPERATIONS	2200 LAKE PARK DR	SMYRNA GA 30080
53387	MINNESOTA MINING AND MFG CO ELECTRONIC PRODUCTS DIV	3M CENTER	ST PAUL MN 55101-1428
54473	MATSUSHITA ELECTRIC CORP OF AMERICA	ONE PANASONIC WAY PO BOX 1501	SECAUCUS NJ 07094-2917
55680	NICHICON /AMERICA/ CORP	927 E STATE PKY	SCHAUMBURG IL 60195-4526
57668	ROHM CORP	8 WHATNEY PO BOX 19515	IRVINE CA 92713
75042	IRC ELECTRONIC COMPONENTS PHILADELPHIA DIV TRW FIXED RESISTORS	401 N BROAD ST	PHILADELPHIA PA 19108-1001
75915	LITTELFUSE INC SUB TRACOR INC	800 E NORTHWEST HWY	DES PLAINES IL 60016-3049

CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
76493	BELL INDUSTRIES INC JW MILLER DIV	19070 REYES AVE PO BOX 5825	COMPTON CA 90224-5825
80009	TEKTRONIX INC	14150 SW KARL BRAUN DR PO BOX 500	BEAVERTON OR 97707-0001
91293	JOHANSON MFG CO	400 ROCKWAY VALLEY RD	BOONTON NJ 07005
91637	DALE ELECTRONICS INC	2064 12TH AVE PO BOX 609	COLUMBUS NE 68601-3632
TK1345	ZMAN AND ASSOCIATES	7633 S 180TH	KENT WA 98032
TK1356	MURATA/ERIE N AMERICA CORP	645 W 11TH AVE	ERIE PA 16512
TK1424	MARCON AMERICA CORP	3 PEARL CT	ALLENDALE NJ 07401
TK1450	TOKYO COSMOS ELECTRIC CO LTD	2-268 SOBUDAI ZAWA	KANAGAWA 228 JAPAN

	Tektronix	Serial/Assembly No.			Mfr.	
Component No.	Part No.	Effective	Dscont	Name & Description	Code	Mfr. Part No.
A1	670-9735-00	B010100	B010508	CIRCUIT BD ASSY:MAIN	80009	670-9735-00
A1	670-9735-01	B010509		CIRCUIT BD ASSY:MAIN	80009	670-9735-01
A2	670-9336-00			CIRCUIT BD ASSY:FRONT PANEL (NO REPLACEABLE SUBPARTS)	80009	670-9336-00
A3	670-9747-00			CIRCUIT BD ASSY:KERNEL	80009	670-9747-00
A3A1	670-8986-00			CIRCUIT BD ASSY:SAMPLE/HOLD (NO REPLACEABLE SUBPARTS)	80009	670-8986-00
A1	670-9735-00	B010100	B010508	CIRCUIT BD ASSY:MAIN	80009	670-9735-00
A1	670-9735-01	B010509		CIRCUIT BD ASSY:MAIN	80009	670-9735-01
A1A1	----- -----			CIRCUIT BOARD:HIGH FREQUENCY (NOT REPLACEABLE)		
A1C220	281-0791-00			CAP,FXD,CER DI:270PF,10%,100V	04222	MA101C271KAA
A1C230	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A1C231	281-0775-00	B010100	B010508	CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A1C240	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A1C241	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A1C310	283-0100-00			CAP,FXD,CER DI:0.0047UF,10%,200V	04222	SR306A472KAA
A1C320	281-0812-00			CAP,FXD,CER DI:1000PF,10%,100V	04222	MA101C102KAA
A1C330	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A1C331	281-0791-00			CAP,FXD,CER DI:270PF,10%,100V	04222	MA101C271KAA
A1C400	281-0773-00			CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
A1C410	283-0249-00			CAP,FXD,CER DI:0.068PF,10%,50V	04222	SR305C683KAA
A1C411	283-0268-00			CAP,FXD,CER DI:0.015UF,20%,50V	04222	3439-050C-153K
A1C412	281-0265-00			CAP,VAR,CER DI:5.2-30PF,100V	TK1356	TZ03R300FR169
A1C420	290-0943-01	B010100	B010508	CAP,FXD,ELCTLT:47UF,20%,25V	55680	ULB1E470MPAANA1T
A1C420	290-0776-01	B010509		CAP,FXD,ELCTLT:22UF,20%,10WVDC	55680	ULB1A220MAA1TD
A1C421	290-0943-01			CAP,FXD,ELCTLT:47UF,20%,25V	55680	ULB1E470MPAANA1T
A1C440	281-0773-00			CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
A1C500	281-0783-00			CAP,FXD,CER DI:0.1 UF 20%,100V	04222	MA401C104MAA
A1C510	283-0666-00			CAP,FXD,MICA DI:890PF,2%,100V	00853	D151F891G0
A1C511	290-0943-01			CAP,FXD,ELCTLT:47UF,20%,25V	55680	ULB1E470MPAANA1T
A1C530	283-0177-05			CAP,FXD,CER DI:1UF,+80-20%,25V	04222	SR305E105ZAATR
A1C630	290-0745-00			CAP,FXD,ELCTLT:22UF,+50-20%,25WVDC	54473	ECE-A25V22L
A1C640	290-0745-00			CAP,FXD,ELCTLT:22UF,+50-20%,25WVDC	54473	ECE-A25V22L
A1C710	290-0943-01			CAP,FXD,ELCTLT:47UF,20%,25V	55680	ULB1E470MPAANA1T
A1C711	283-0177-05			CAP,FXD,CER DI:1UF,+80-20%,25V	04222	SR305E105ZAATR
A1C810	281-0783-00			CAP,FXD,CER DI:0.1 UF 20%,100V	04222	MA401C104MAA
A1C811	283-0326-00			CAP,FXD,CER DI:0.082UF,10%,50V	51406	RPE111X7R823K50V
A1C821	283-0408-00			CAP,FXD,CER DI:0.68UF,+100-0%,12V	91293	120S41Y684PP2S
A1C823	283-0249-00			CAP,FXD,CER DI:0.068PF,10%,50V	04222	SR305C683KAA
A1C835	283-0249-00			CAP,FXD,CER DI:0.068PF,10%,50V	04222	SR305C683KAA
A1C928	283-0408-00			CAP,FXD,CER DI:0.68UF,+100-0%,12V	91293	120S41Y684PP2S
A1C930	281-0812-00			CAP,FXD,CER DI:1000PF,10%,100V	04222	MA101C102KAA
A1C940	281-0812-00			CAP,FXD,CER DI:1000PF,10%,100V	04222	MA101C102KAA
A1C1000	290-0943-01			CAP,FXD,ELCTLT:47UF,20%,25V	55680	ULB1E470MPAANA1T
A1C1001	290-0943-01			CAP,FXD,ELCTLT:47UF,20%,25V	55680	ULB1E470MPAANA1T
A1C1010	281-0812-00			CAP,FXD,CER DI:1000PF,10%,100V	04222	MA101C102KAA
A1C1020	281-0812-00			CAP,FXD,CER DI:1000PF,10%,100V	04222	MA101C102KAA
A1CR120	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR121	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR122	152-0141-02	B010509		SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR123	152-0141-02	B010509		SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR124	152-0141-02	B010509		SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A1CR125	152-0141-02	B010509		SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR126	152-0141-02	B010509		SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR130	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR330	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR331	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR430	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR431	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR432	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR433	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR500	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR610	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR640	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR700	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR800	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1F100	159-0253-00			FUSE,CARTRIDGE:0.250A,125V,FAST,SUBMIN	75915	251.250 T & R T1
A1F110	159-0235-00			FUSE,WIRE LEAD:0.75A,125V,FAST	80009	159-0235-00
A1F111	159-0235-00			FUSE,WIRE LEAD:0.75A,125V,FAST	80009	159-0235-00
A1F112	159-0253-00			FUSE,CARTRIDGE:0.250A,125V,FAST,SUBMIN	75915	251.250 T & R T1
A1J120	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL (QUANTITY OF 20)	22526	48283-036
A1K220	148-0086-00			RELAY,REED:FORM C,100MA,100VDC,COIL 5VDC 150 OHM	15636	R8149-1
A1L230	108-1315-00	B010100	B010508	COIL,RF:FXD,440NH,+/-10%	76493	ORDER BY DESCR
A1L240	108-1354-00			COIL,RF:FXD,3.3UH,10%	80009	108-1354-00
A1L720	108-0538-00			COIL,RF:FIXED,2.7UH	76493	JWM#B7059
A1L810	108-1315-00			COIL,RF:FXD,440NH,+/-10%	76493	ORDER BY DESCR
A1L900	108-1315-00			COIL,RF:FXD,440NH,+/-10%	76493	ORDER BY DESCR
A1L922	108-0413-00			COIL,RF:FIXED,0.4UH	80009	108-0413-00
A1L927	108-0413-00			COIL,RF:FIXED,0.4UH	80009	108-0413-00
A1L1009	108-0436-00			COIL,RF:FIXED,235NH	80009	108-0436-00
A1L1010	108-1315-00			COIL,RF:FXD,440NH,+/-10%	76493	ORDER BY DESCR
A1L1019	108-0436-00			COIL,RF:FIXED,235NH	80009	108-0436-00
A1L1030	108-1315-00			COIL,RF:FXD,440NH,+/-10%	76493	ORDER BY DESCR
A1L1110	108-1315-00			COIL,RF:FXD,440NH,+/-10%	76493	ORDER BY DESCR
A1LR823	108-0924-01			COIL,RF:FIXED,1.7UH (NOMINAL VALUE)	TK1345	108-0924-01
A1LR823	108-0924-00			COIL,RF:FIXED,1.7UH	TK1345	108-0924-00
A1LR823	108-0924-02			COIL,RF:FIXED,1.7UH (LR823 IS SELECTABLE)	TK1345	108-0924-02
A1LR825	108-0271-00			COIL,RF:FIXED,245NH	80009	108-0271-00
A1LR833	108-0271-00			COIL,RF:FIXED,245NH	80009	108-0271-00
A1LR835	108-0924-01			COIL,RF:FIXED,1.7UH (NOMINAL VALUE)	TK1345	108-0924-01
A1LR835	108-0924-00			COIL,RF:FIXED,1.7UH	TK1345	108-0924-00
A1LR835	108-0924-02			COIL,RF:FIXED,1.7UH (LR835 IS SELECTABLE)	TK1345	108-0924-02
A1P130	131-3798-00			CONN,RCPT,ELEC:7 POSITION,0.1 SPACING	00779	643107-1
A1P1010	131-3908-00			TERM SET,PIN:2 X 8,0.025 SQ,0.1 CENTERS	53387	DHY2016001A1057E
A1Q220	151-0622-00			TRANSISTOR:PNP,SI,40V,1A,TO-226AE/237	04713	SPS8956(MPSW51A)
A1Q221	151-0710-00			TRANSISTOR:NPN,SI,TO-92 PLUS	04713	MPSW01A
A1Q510	151-0301-00			TRANSISTOR:PNP,SI,TO-18	04713	ST898
A1Q600	151-0261-00			TRANSISTOR:PNP,SI,TO-77	80009	151-0261-00
A1Q630	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899
A1Q710	151-0301-00			TRANSISTOR:PNP,SI,TO-18	04713	ST898
A1Q740	151-0301-00			TRANSISTOR:PNP,SI,TO-18	04713	ST898
A1Q800	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899
A1Q810	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899
A1Q840	151-0192-05			TRANSISTOR:NPN,SI,TO=92	04713	ORDER BY DESCR
A1Q841	151-0192-05			TRANSISTOR:NPN,SI,TO=92	04713	ORDER BY DESCR

	Tektronix	Serial/Assembly No.			Mfr.	
Component No.	Part No.	Effective	Dscont	Name & Description	Code	Mfr. Part No.
A1Q900	151-0192-05			TRANSISTOR:NPN,SI,TO=92	04713	ORDER BY DESCR
A1Q901	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899
A1Q940	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899
A1Q941	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899
A1Q1000	151-0192-05			TRANSISTOR:NPN,SI,TO=92	04713	ORDER BY DESCR
A1Q1030	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899
A1R100	322-3430-00			RES,FXD,FILM:294K OHM,1%,0.2W,TC=T0	80009	322-3430-00
A1R110	322-3385-00			RES,FXD,FILM:100K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 100K
A1R111	322-3385-00			RES,FXD,FILM:100K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 100K
A1R210	322-3385-00			RES,FXD,FILM:100K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 100K
A1R211	322-3385-00			RES,FXD,FILM:100K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 100K
A1R220	322-3193-00			RES,FXD,FILM:1K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 1K00
A1R230	322-3193-00			RES,FXD,FILM:1K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 1K00
A1R231	322-3072-00			RES,FXD,FILM:54.9 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 54E9
A1R232	322-3385-00			RES,FXD,FILM:100K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 100K
A1R240	322-3072-00	B010100	B011905	RES,FXD,FILM:54.9 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 54E9
A1R240	322-3073-00	B011906		RES,FXD,FILM:56.2 OHM,1%,0.2W,TC=T0	80009	322-3073-00
A1R241	322-3164-00			RES,FXD,FILM:499 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 499E
A1R310	311-2235-00			RES,VAR,NONWW:TRMR,10K OHM,20%,0.5W LINEAR	32997	3362M-1-103R
A1R311	311-2233-00			RES,VAR,NONWW:TRMR,3.0K OHM,20%,0.5W LINEAR	TK1450	GF06UT3K
A1R312	311-2236-00			RES,VAR,NONWW:TRMR,20K OHM,20%,0.5W LINEAR	TK1450	GF06UT 20K
A1R320	322-3289-00			RES,FXD,FILM:10K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 10K0
A1R321	322-3314-00			RES,FXD,FILM:18.2K OHM,1%,0.2W,TC=T0	80009	322-3314-00
A1R322	313-1473-00			RES,FXD,FILM:47K OHM,5%,0.2W	57668	TR20JE 47K
A1R323	322-3222-00			RES,FXD,FILM:2K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 2K00
A1R324	322-3289-00			RES,FXD,FILM:10K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 10K0
A1R325	322-3289-00			RES,FXD,FILM:10K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 10K0
A1R400	322-3320-00			RES,FXD,FILM:21K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 21K0
A1R401	322-3222-00			RES,FXD,FILM:2K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 2K00
A1R402	322-3400-00			RES,FXD,FILM:143K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 143K
A1R410	311-2238-00			RES,VAR,NONWW:TRMR,50K OHM,20%,0.5W LINEAR	TK1450	GF06UT 50 K
A1R411	311-2239-00			RES,VAR,NONWW:TRMR,100K OHM,20%,0.5W LINEAR	TK1450	GF06UT 100K
A1R420	313-1822-00			RES,FXD,FILM:8.2K,OHM,5%,0.2W	57668	TR20JE 08K2
A1R421	313-1823-00			RES,FXD,FILM:82K OHM,5%,0.2W	57668	TR20JE 82K
A1R422	313-1303-00			RES,FXD,FILM:30K OHM,5%,0.2W	57668	TR20JE 30K
A1R423	313-1204-00			RES,FXD,FILM:200K,5%,0.2W	57668	TR20JE 200K
A1R424	313-1392-00			RES,FXD,FILM:3.9K OHM,5%,0.2W	57668	TR20JE 03K9
A1R425	313-1473-00			RES,FXD,FILM:47K OHM,5%,0.2W	57668	TR20JE 47K
A1R426	322-3260-00			RES,FXD,FILM:4.99K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 4K99
A1R430	321-0190-00			RES,FXD,FILM:931 OHM,1%,0.125W,TC=T0	19701	5043ED931R0F
A1R500	323-0310-00			RES,FXD,FILM:16.5K OHM,1%,0.5W,TC=T0	75042	CECT0-1652F
A1R510	311-2235-00			RES,VAR,NONWW:TRMR,10K OHM,20%,0.5W LINEAR	32997	3362M-1-103R
A1R511	311-2234-00			RES,VAR,NONWW:TRMR,5K OHM,20%,0.5W LINEAR	TK1450	GF06UT 5K
A1R520	313-1202-00			RES,FXD,FILM:2K OHM,5%,0.2W	57668	TR20JE02K0
A1R521	311-2229-00			RES,VAR,NONWW:TRMR,250 OHM,20%,0.5W LINEAR	TK1450	GF06UT 250
A1R522	321-1289-07			RES,FXD,FILM:10.1K OHM,0.1%,0.125W,TC=T9	19701	5033RE10K10B
A1R530	322-3260-00			RES,FXD,FILM:4.99K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 4K99
A1R531	313-1512-00			RES,FXD,FILM:5.1K OHM,5%,0.2W	57668	TR20JE 5K1
A1R532	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A1R540	313-1151-00			RES,FXD,FILM:150 OHM,5%,0.2W	57668	TR20JE150E
A1R541	313-1303-00			RES,FXD,FILM:30K OHM,5%,0.2W	57668	TR20JE 30K
A1R542	321-0289-06			RES,FXD,FILM:10.0K OHM,0.25%,0.125W,TC=T9	19701	5033RE10K00C
A1R600	321-0612-03			RES,FXD,FILM:500 OHM,0.25%,0.125W,TC=T2	19701	5033RC500R0C
A1R601	321-0289-03			RES,FXD,FILM:10.0K OHM,0.25%,0.125W,TC=T2	07716	CEAC10001C
A1R602	321-0289-03			RES,FXD,FILM:10.0K OHM,0.25%,0.125W,TC=T2	07716	CEAC10001C
A1R610	322-3428-00			RES,FXD,FILM:280K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 280K
A1R611	322-3223-00			RES,FXD,FILM:2.05K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 2K05
A1R612	322-3162-00			RES,FXD,FILM:475 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 475E

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A1R613	322-3223-00			RES,FXD,FILM:2.05K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 2K05
A1R614	313-1151-00			RES,FXD,FILM:150 OHM,5%,0.2W	57668	TR20JE150E
A1R615	313-1682-00			RES,FXD,FILM:6.8K OHM,5%,0.2W	57668	TR20JE 06K8
A1R616	313-1102-00			RES,FXD,FILM:1K OHM,5%,0.2W	57668	TR20JE01K0
A1R617	322-3206-00			RES,FXD,FILM:1.37K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 1K37
A1R620	322-3315-00			RES,FXD,FILM:18.7K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 18K7
A1R621	313-1200-00			RES,FXD,FILM:20 OHM,5%,0.2W	57668	TR20JE20E
A1R622	308-0541-00			RES,FXD,WW:1K OHM,0.1%,3W,TC=20PPM	00213	1240S-10000B
A1R630	313-1101-00			RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A1R700	313-1120-00			RES,FXD,FILM:12 OHM,5%,0.2W	57668	TR20JE12E0
A1R710	313-1101-00			RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A1R711	322-3108-00			RES,FXD,FILM:130 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 130E
A1R712	322-0139-00			RES,FXD,FILM:274 OHM,1%,0.25W,TC=T0	91637	MFF1421G274R0F
A1R720	323-0133-00			RES,FXD,FILM:237 OHM,1%,0.5W,TC=T0	75042	CECT0-2370F
A1R723	313-1682-00			RES,FXD,FILM:6.8K OHM,5%,0.2W	57668	TR20JE 06K8
A1R725	313-1821-00			RES,FXD,FILM:820 OHM,5%,0.2W	57668	TR20JE 820E
A1R730	301-0201-00			RES,FXD,FILM:200 OHM,5%,0.5W	19701	5053CX200R0J
A1R731	313-1510-00			RES,FXD,FILM:51 OHM,5%,0.2W	80009	313-1510-00
A1R732	313-1151-00			RES,FXD,FILM:150 OHM,5%,0.2W	57668	TR20JE150E
A1R733	322-3179-00			RES,FXD,FILM:715 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 715E
A1R740	322-3202-00			RES,FXD,FILM:1.24K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 1K24
A1R741	322-3202-00			RES,FXD,FILM:1.24K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 1K24
A1R742	308-0541-00			RES,FXD,WW:1K OHM,0.1%,3W,TC=20PPM	00213	1240S-10000B
A1R800	322-3296-00			RES,FXD,FILM:11.8K OHM,1%,0.2W,TC=T0	80009	322-3296-00
A1R801	322-3204-00			RES,FXD,FILM:1.3K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 1K30
A1R802	322-3289-00			RES,FXD,FILM:10K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 10K0
A1R803	322-3363-00			RES,FXD,FILM:59K OHM,1%,0.2W,TC=T0	80009	322-3363-00
A1R804	322-3281-00			RES,FXD,FILM:8.25K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 8K25
A1R805	322-3295-00			RES,FXD,FILM:11.5K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 11K5
A1R810	313-1131-00			RES,FXD,FILM:130 OHM,5%,0.26	57668	TR20JT68 130E
A1R811	322-3164-00			RES,FXD,FILM:499 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 499E
A1R812	311-2230-00			RES,VAR,NONWW:TRMR,500 OHM,20%,0.50 LINEAR	TK1450	GF06UT 500
A1R813	311-2226-00			RES,VAR,NONWW:TRMR,50 OHM,20%,0.5W	TK1450	GF06UT 50 OHM
A1R814	301-0302-00			RES,FXD,FILM:3K OHM,5%,0.5W	19701	5053CX3K000J
A1R820	323-0116-00			RES,FXD,FILM:158 OHM,1%,0.5W,TC=T0	19701	5053RD158R0F
A1R830	313-1510-00			RES,FXD,FILM:51 OHM,5%,0.2W	80009	313-1510-00
A1R831	313-1510-00			RES,FXD,FILM:51 OHM,5%,0.2W	80009	313-1510-00
A1R840	322-3135-00			RES,FXD,FILM:249 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 249E
A1R841	322-3135-00			RES,FXD,FILM:249 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 249E
A1R842	322-3219-00			RES,FXD,FILM:1.87K,OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 1K87
A1R843	322-3262-00			RES,FXD,FILM:5.23K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 5K23
A1R900	322-3135-00			RES,FXD,FILM:249 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 249E
A1R901	322-3202-00			RES,FXD,FILM:1.24K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 1K24
A1R902	322-3262-00			RES,FXD,FILM:5.23K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 5K23
A1R903	322-3219-00			RES,FXD,FILM:1.87K,OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 1K87
A1R904	322-3239-00			RES,FXD,FILM:3.01K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 3K01
A1R905	322-3203-00			RES,FXD,FILM:1.27K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 1K27
A1R906	322-3171-00			RES,FXD,FILM:590 OHM,1%,0.2W,TC=T0	80009	322-3171-00
A1R907	313-1332-00			RES,FXD,FILM:3.3K OHM,5%,0.2W	57668	TR20JE 03K3
A1R910	313-1510-00			RES,FXD,FILM:51 OHM,5%,0.2W	80009	313-1510-00
A1R911	313-1510-00			RES,FXD,FILM:51 OHM,5%,0.2W	80009	313-1510-00
A1R912	317-0121-00			RES,FXD,CMPSN:120 OHM,5%,0.125W	01121	BB1215
A1R913	317-0121-00			RES,FXD,CMPSN:120 OHM,5%,0.125W	01121	BB1215
A1R914	313-1510-00			RES,FXD,FILM:51 OHM,5%,0.2W	80009	313-1510-00
A1R915	313-1510-00			RES,FXD,FILM:51 OHM,5%,0.2W	80009	313-1510-00
A1R925	321-0183-00			RES,FXD,FILM:787 OHM,1%,0.125W,TC=T0	07716	CEAD787R0F
A1R930	322-3203-00			RES,FXD,FILM:1.27K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 1K27
A1R931	313-1510-00			RES,FXD,FILM:51 OHM,5%,0.2W	80009	313-1510-00

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A1R932	313-1101-00			RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A1R933	313-1101-00			RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A1R940	313-1332-00			RES,FXD,FILM:3.3K OHM,5%,0.2W	57668	TR20JE 03K3
A1R941	322-3239-00			RES,FXD,FILM:3.01K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 3K01
A1R942	322-3171-00			RES,FXD,FILM:590 OHM,1%,0.2W,TC=T0	80009	322-3171-00
A1R1000	322-3202-00			RES,FXD,FILM:1.24K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 1K24
A1R1001	322-3135-00			RES,FXD,FILM:249 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 249E
A1R1009	323-0184-00			RES,FXD,FILM:806 OHM,1%,0.5W,TC=T0	24546	NA65D806F
A1R1010	313-1510-00			RES,FXD,FILM:51 OHM,5%,0.2W	80009	313-1510-00
A1R1011	313-1510-00			RES,FXD,FILM:51 OHM,5%,0.2W	80009	313-1510-00
A1R1019	323-0184-00			RES,FXD,FILM:806 OHM,1%,0.5W,TC=T0	24546	NA65D806F
A1R1027	313-1510-00			RES,FXD,FILM:51 OHM,5%,0.2W	80009	313-1510-00
A1R1029	313-1510-00			RES,FXD,FILM:51 OHM,5%,0.2W	80009	313-1510-00
A1R1030	313-1510-00			RES,FXD,FILM:51 OHM,5%,0.2W	80009	313-1510-00
A1R1031	321-1296-03			RES,FXD,FILM:12.0K OHM,0.25%,0.125W,TC=T2	07716	CEAC12001C
A1R1032	313-1510-00			RES,FXD,FILM:51 OHM,5%,0.2W	80009	313-1510-00
A1R1040	322-3286-00			RES,FXD,FILM:9.31K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 9K31
A1R1041	322-3126-00			RES,FXD,FILM:200 OHM,1%,0.2W,TC=T0	91637	CCF501G200R0F
A1R1042	322-3280-00			RES,FXD,FILM:8.06K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 8K06
A1R1130	313-1103-00			RES,FXD,FILM:10K OHM,5%,0.2W	57668	TR20JE10K0
A1RT520	307-0642-00			RES,THERMAL:10K OHM,5%,25 DEG C	01295	TG1/8 103J
A1RT725	307-0477-00			RES,THERMAL:1K OHM,10%,6MW/DEG C	14193	2J21
A1RT820	307-0126-00			RES,THERMAL:100 OHM,10%,NTC	14193	2D21-101-D
A1RT1030	307-0250-00			RES,THERMAL:390 OHM,10%,0.125W	01295	TG1/8 391K
A1TP100	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
A1TP110	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
A1TP111	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
A1TP112	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
A1U220	156-1191-00			MICROCKT,LINEAR:DUAL BI-FET OPNL AMPL	01295	TL072CP
A1U330	155-0076-00			MICROCKT,LINEAR:INPUT PROTECTION	80009	155-0076-00
A1U400	156-1156-00			MICROCKT,LINEAR:OPERATIONAL AMPLIFIER	80009	156-1156-00
A1U430	156-1156-00			MICROCKT,LINEAR:OPERATIONAL AMPLIFIER	80009	156-1156-00
A1U530	156-0067-00			MICROCKT,LINEAR:OPNL AMPL,SEL	04713	MC1741CP1
A1U610	156-0067-00			MICROCKT,LINEAR:OPNL AMPL,SEL	04713	MC1741CP1
A1U630	155-0180-00			MICROCKT,LINEAR:FAST INPUT PROTECTION	80009	155-0180-00
A1U700	156-0158-04			MICROCKT,LINEAR:DUAL OPNL AMPL	01295	MC1458JG
A1U800	156-0067-00			MICROCKT,LINEAR:OPNL AMPL,SEL	04713	MC1741CP1
A1U830	155-0181-00			MICROCKT,LINEAR:INPUT AMPLIFIER	80009	155-0181-00
A1U910	155-0175-00			MICROCKT,LINEAR:TRIGGER AMPLIFIER	80009	155-0175-00
A1U930	155-0175-00			MICROCKT,LINEAR:TRIGGER AMPLIFIER	80009	155-0175-00
A1U1040	156-0158-04			MICROCKT,LINEAR:DUAL OPNL AMPL	01295	MC1458JG
A1VR810	152-0304-00			SEMICOND DVC,DI:ZEN,SI,20V,5%,0.4W,DO-7	15238	Z5411
A1VR921	153-0069-00			SEMICOND DVC SE:1N4742A FAMILY,MATCHED PAIR	80009	153-0069-00
A1VR928	153-0069-00			SEMICOND DVC SE:1N4742A FAMILY,MATCHED PAIR	80009	153-0069-00
A2	670-9336-00			CIRCUIT BD ASSY:FRONT PANEL (NO REPLACEABLE SUBPARTS)	80009	670-9336-00
A3	670-9747-00			CIRCUIT BD ASSY:KERNEL	80009	670-9747-00
A3C120	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A3C210	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A3C211	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A3C230	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A3C310	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A3C330	281-0791-00			CAP,FXD,CER DI:270PF,10%,100V	04222	MA101C271KAA
A3C331	281-0791-00			CAP,FXD,CER DI:270PF,10%,100V	04222	MA101C271KAA
A3C411	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A3C420	290-0778-00			CAP,FXD,ELCTLT:1UF,20%,50V,NPLZD	54473	ECE-A50N1
A3C520	281-0895-00			CAP,FXD,CER DI:6.8PF,100WVDC	04222	MA101A6R8DAA
A3C530	281-0895-00			CAP,FXD,CER DI:6.8PF,100WVDC	04222	MA101A6R8DAA
A3C600	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A3C621	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A3C630	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A3C700	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A3C701	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A3C730	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A3C900	283-0203-00			CAP,FXD,CER DI:0.47UF,20%,50V	04222	SR305SC474MAA
A3C930	290-1157-00			CAP,FXD,ELCTLT:220UF,20%,25DVC	TK1424	CEAFM1E221M-T4
A3CR110	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A3CR111	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A3CR229	152-0066-00			SEMICOND DVC,DI:RECT,SI,400V,1A,DO-41	05828	GP10G-020
A3CR230	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A3CR320	152-0322-00			SEMICOND DVC,DI:SCHOTTKY,SI,15V,1.2PF,DO-35	50434	5082-2672
A3CR710	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A3CR720	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A3CR900	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A3CR901	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A3CR910	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A3CR911	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A3CR912	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A3CR913	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A3CR920	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A3CR921	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A3J100	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL (QUANTITY OF 6)	22526	48283-036
A3J110	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL (QUANTITY OF 20)	22526	48283-036
A3J400	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL (QUANTITY OF 3)	22526	48283-036
A3J410	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL (QUANTITY OF 3)	22526	48283-036
A3J930	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL (QUANTITY OF 6)	22526	48283-036
A3L230	108-1354-00			COIL,RF:FXD,3.3UH,10%	80009	108-1354-00
A3L920	108-1315-00			COIL,RF:FXD,440NH,+/-10%	76493	ORDER BY DESCR
A3Q230	151-0622-00			TRANSISTOR:PNP,SI,40V,1A,TO-226AE/237	04713	SPS8956(MPSW51A)
A3R100	322-3193-00			RES,FXD,FILM:1K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 1K00
A3R110	322-3289-00			RES,FXD,FILM:10K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 10K0
A3R210	322-3164-00			RES,FXD,FILM:499 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 499E
A3R211	322-3193-00			RES,FXD,FILM:1K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 1K00
A3R212	322-3289-00			RES,FXD,FILM:10K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 10K0
A3R213	322-3260-00			RES,FXD,FILM:4.99K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 4K99
A3R214	322-3318-00			RES,FXD,FILM:20K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 20K0
A3R215	322-3318-00			RES,FXD,FILM:20K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 20K0
A3R220	322-3218-00			RES,FXD,FILM:1.82K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 1K82
A3R221	322-3255-00			RES,FXD,FILM:4.42K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 4K42
A3R222	313-1561-00			RES,FXD,FILM:560 OHM,5%,0.2W	57668	TR20JE 560E
A3R223	322-3193-00			RES,FXD,FILM:1K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 1K00
A3R230	322-3220-00			RES,FXD,FILM:1.91K OHM,1%,0.2W,TC=T0	80009	322-3220-00
A3R231	322-3220-00			RES,FXD,FILM:1.91K OHM,1%,0.2W,TC=T0	80009	322-3220-00
A3R232	322-3385-00			RES,FXD,FILM:100K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 100K
A3R310	322-3289-00			RES,FXD,FILM:10K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 10K0
A3R311	322-3193-00			RES,FXD,FILM:1K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 1K00
A3R330	322-3385-00			RES,FXD,FILM:100K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 100K
A3R331	322-3289-00			RES,FXD,FILM:10K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 10K0
A3R332	322-3289-00			RES,FXD,FILM:10K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 10K0

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A3R334	322-3135-00			RES,FXD,FILM:249 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 249E
A3R410	322-3193-00			RES,FXD,FILM:1K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 1K00
A3R411	322-3289-00			RES,FXD,FILM:10K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 10K0
A3R530	322-3193-00			RES,FXD,FILM:1K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 1K00
A3R531	322-3318-00			RES,FXD,FILM:20K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 20K0
A3R532	322-3318-00			RES,FXD,FILM:20K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 20K0
A3R533	322-3193-00			RES,FXD,FILM:1K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 1K00
A3R534	322-3039-00			RES,FXD,FILM:24.9 OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 24E9
A3R535	322-3244-00			RES,FXD,FILM:3.4K OHM,1%,0.2W,TC=T0	57668	CRB20 FXE 3K40
A3R720	313-1101-00			RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A3R900	313-1101-00			RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A3R910	313-1101-00			RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A3R911	313-1101-00			RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A3R920	313-1101-00			RES,FXD,FILM:100 OHM,5%,0.2W	57668	TR20JE100E
A3TP130	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
A3TP500	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
A3TP501	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
A3TP502	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
A3TP510	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
A3TP511	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
A3TP610	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
A3TP720	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
A3TP900	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
A3TP910	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
A3TP911	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
A3TP912	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
A3TP920	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
A3U120	156-0158-04			MICROCKT,LINEAR:DUAL OPNL AMPL	01295	MC1458JG
A3U130	156-2669-00			MICROCKT,INTFC:RELAY DRVR,8 OUTPUT SERIAL INPUT W/LATCHES	80009	156-2669-00
A3U310	156-2455-00			MICROCKT,LINEAR:8 BIT A/D PERIPHERALS W/ SERIAL CONTROL & 11 INPUTS,SCRN	01295	TLC541IN3
A3U330	156-1225-00			MICROCKT,LINEAR:DUAL COMPARATOR	01295	LM393P
A3U410	156-1065-01			MICROCKT,DGTL:LSTTL,OCTAL D-TYPE TRANS	04713	SN74LS373 ND/JD
A3U411	156-2396-00			MICROCKT,DGTL:RESET GENERATOR,5V SUPPLY	01295	TL7705 ACP
A3U430	156-2370-00			MICROCKT,DGTL:CMOS,QUAD 2 TO 1 SELECTOR/ MULTIPLEXER	02735	QHCT257EX98
A3U500	156-1684-01			MICROCKT,DGTL:MICROCOMPUTER,8 BIT	34649	P8031AH
A3U520	156-0724-02			MICROCKT,DGTL:HEX INV W/OC OUT,SCRN,	01295	SN74LS05NP3
A3U600	156-1065-01			MICROCKT,DGTL:LSTTL,OCTAL D-TYPE TRANS	04713	SN74LS373 ND/JD
A3U610	156-0386-02			MICROCKT,DGTL:TRIPLE 3-INP NAND GATE,SCRN	07263	74LS10PCQR
A3U620	156-2459-00			MICROCKT,LINEAR:12 BIT D TO A CONVERTER	24355	AD667JN/+
A3U700	156-2671-00			MICROCKT,DGTL:CMOS,2048 X 8 SRAM MDL W/ INTEGRAL BATTERY DS1220,24	80009	156-2671-00
A3U800	160-4065-02	B010100	B010196	MICROCKT,DGTL:HMOS,16385 X 8 EPROM,PRGM	80009	160-4065-02
A3U800	160-4065-03	B010197	B011287	MICROCKT,DGTL:HMOS,16385 X 8 EPROM,PRGM	80009	160-4065-03
A3U800	160-4065-04	B011288	B011318	MICROCKT,DGTL:HMOS,16385 X 8 EPROM,PRGM	80009	160-4065-04
A3U800	160-4065-05	B011319	B011563	MICROCKT,DGTL:HMOS,16385 X 8 EPROM,PRGM	80009	160-4065-05
A3U800	160-4065-06	B011564		MICROCKT,DGTL:HMOS,16385 X 8 EPROM,PRGM	80009	160-4065-06
A3U820	156-2625-00			MICROCKT,DGTL:NMOS,CUSTOM,SENESCHAL	80009	156-2625-00
A3VR220	152-0175-00			SEMICOND DVC,DI:ZEN,SI,5.6V,5%,0.5W,DO-7	14552	TD3810976
A3VR320	152-0195-00			SEMICOND DVC,DI:ZEN,SI,5.1V,5%,0.4W,DO-7	04713	SZ11755RL
A3VR330	152-0175-00			SEMICOND DVC,DI:ZEN,SI,5.6V,5%,0.5W,DO-7	14552	TD3810976
A3VR430	152-0647-00			SEMICOND DVC,DI:ZENER,SI,6.8V,5%,400MW,DO-7	04713	1N957B
A3VR431	152-0175-00			SEMICOND DVC,DI:ZEN,SI,5.6V,5%,0.5W,DO-7	14552	TD3810976
A3X500	136-0757-00			SKT,PL-IN ELEK:MICROCIRCUIT,40 DIP	09922	DILB40P-108
A3X800	136-0755-00			SKT,PL-IN ELEK:MICROCIRCUIT,28 DIP	09922	DILB28P-108
A3X820	136-0813-00			SKT,PL-IN ELEK:CHIP CARRIER,68 CONTACTS	19613	268-5400-00-1102

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A3Y520	119-2395-00			RESONATOR,CER:12MHZ,CMOS,5%	20932	KBR-12.0M
A3A1	670-8986-00			CIRCUIT BD ASSY:SAMPLE/HOLD (NO REPLACEABLE SUBPARTS)	80009	670-8986-00

Section 6

Schematic Diagrams and Circuit Board Illustrations

Schematic Diagrams and Circuit Board Illustrations

Symbols

Graphic symbols and class designation letters are based on ANSI Standard Y32.2-1975.

Logic symbology is based on ANSI/IEEE Std 91-1984 in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

The overline on a signal name indicates that the signal performs its intended function when it is in the low state.

Abbreviations are based on ANSI Y1.1-1972.

Other ANSI standards that are used in the preparation of diagrams by Tektronix, Inc. are:

Y14.15, 1966	Drafting Practices.
Y14.2, 1973	Line Conventions and Lettering.
Y10.5, 1968	Letter Symbols for Quantities Used in Electrical Science and Electrical Engineering.

American National Standard Institute
1430 Broadway
New York, New York 10018

Component Values

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

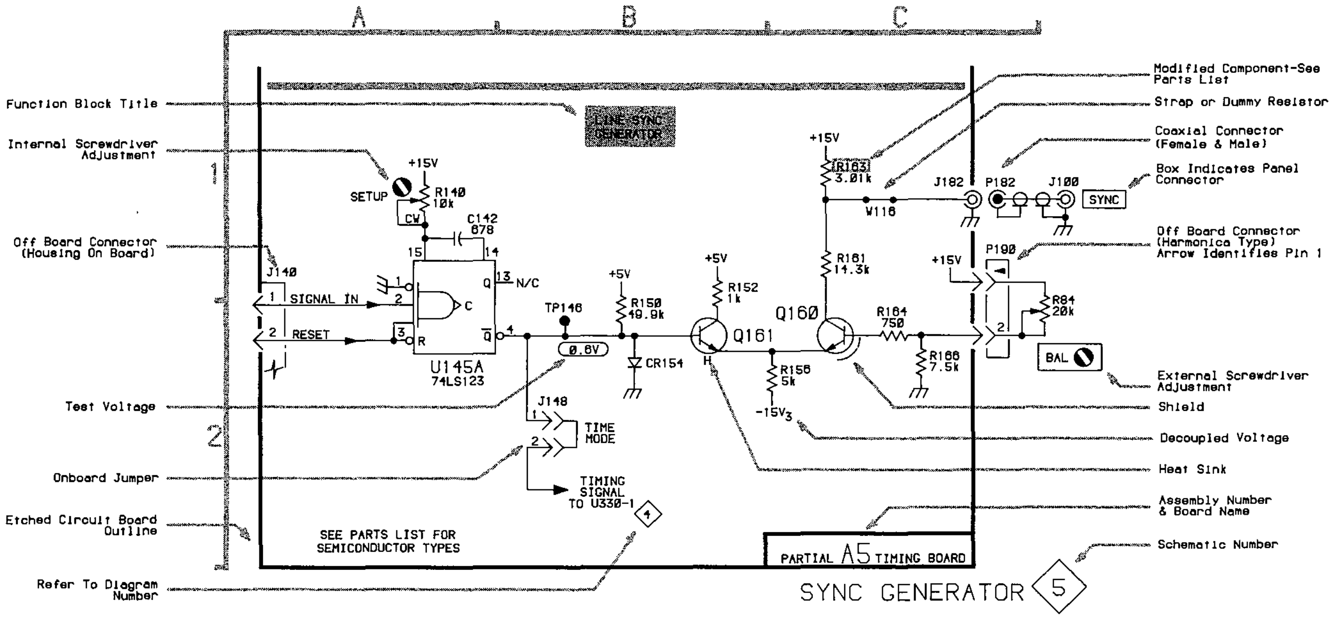
Capacitors =	Values one or greater are in picofarads (pF). Values less than one are in microfarads (μF).
Resistors =	Ohms (Ω).

The information and special symbols below may appear in this manual.

Assembly Numbers and Grid Coordinates

Each assembly in the instrument is assigned an assembly number (e.g., A20). The assembly number appears on the circuit board outline on the diagram, in the title for the circuit board component location illustration, and in the lookup table for the schematic diagram and corresponding component locator illustration. The Replaceable Electrical Parts list is arranged by assemblies in numerical sequence; the components are listed by component number.

The schematic diagram and circuit board component location illustration have grids. A lookup table with the grid coordinates is provided for ease of locating the component. Only the components illustrated on the facing diagram are listed in the lookup table. When more than one schematic diagram is used to illustrate the circuitry on a circuit board, the circuit board illustration may only appear opposite the first diagram on which it was illustrated; the lookup table will list the diagram number of other diagrams that the circuitry of the circuit board appears on.



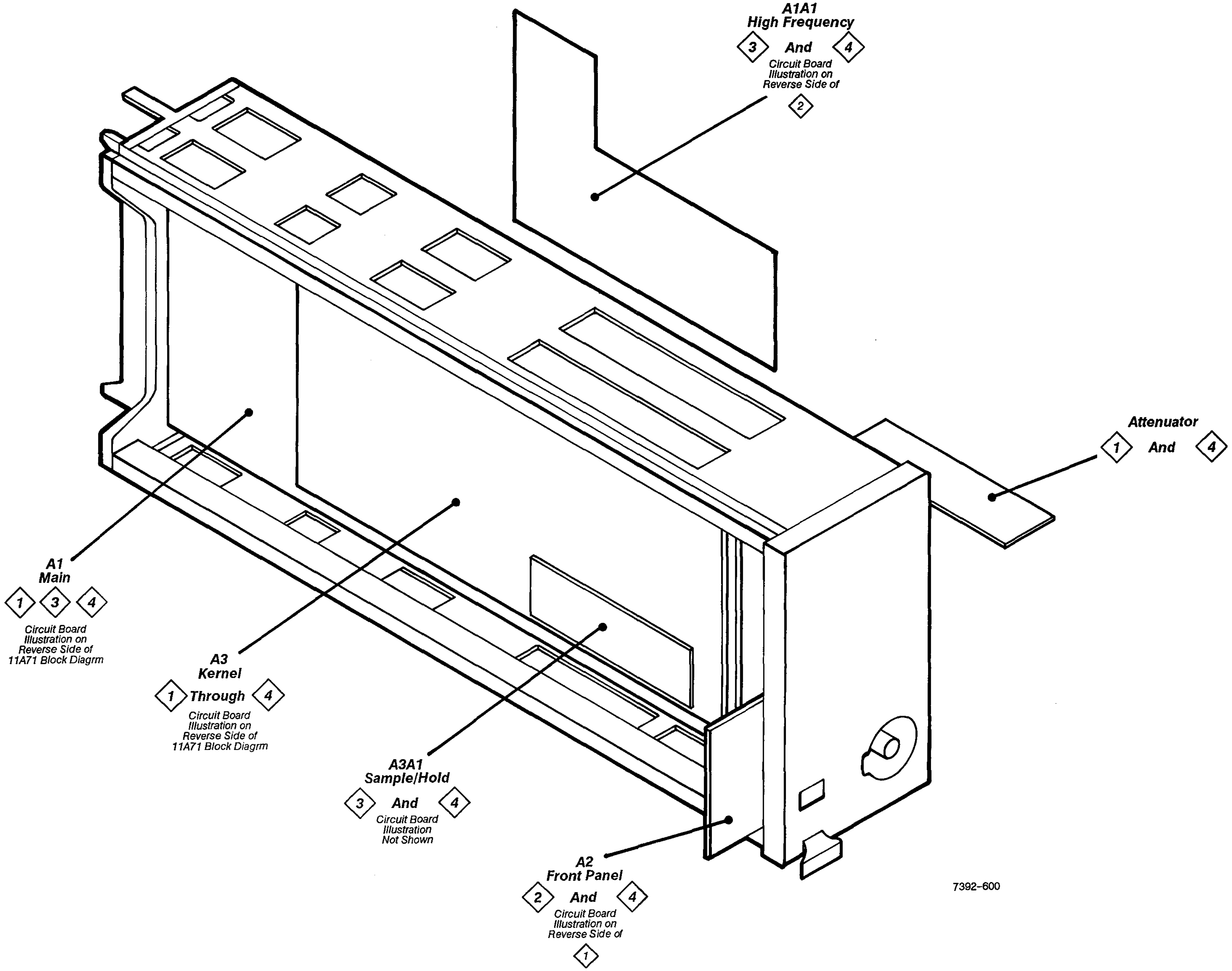
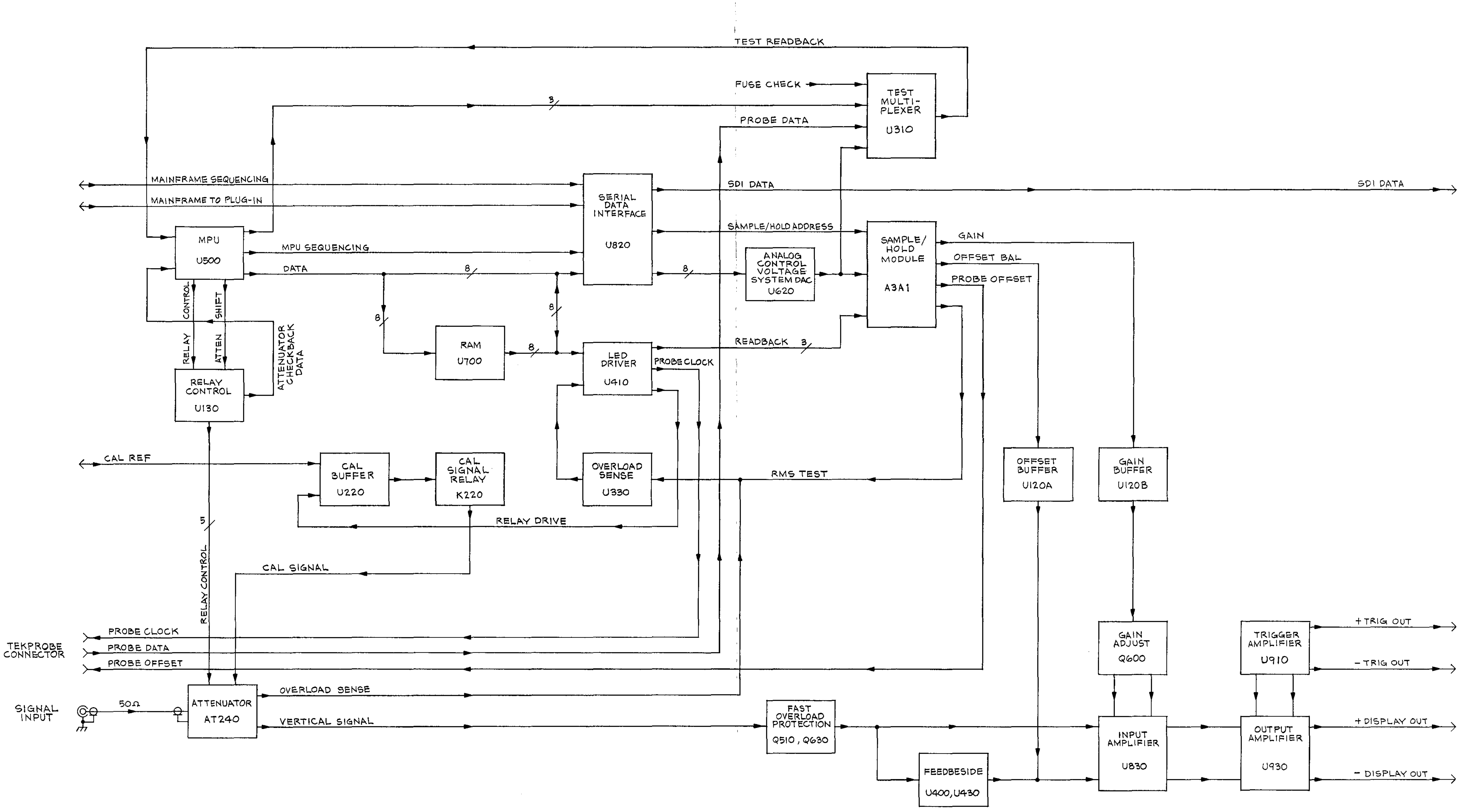


Figure 6-1. *11A71 Circuit Board Locator*

Scan by Zenith



11A71

BLOCK DIAGRAM

11A71 Block Diagram

Reverse Side A1, A3

Figure 6-2. *11A71 Block Diagram*

7392-601

Assemblies A1, A3

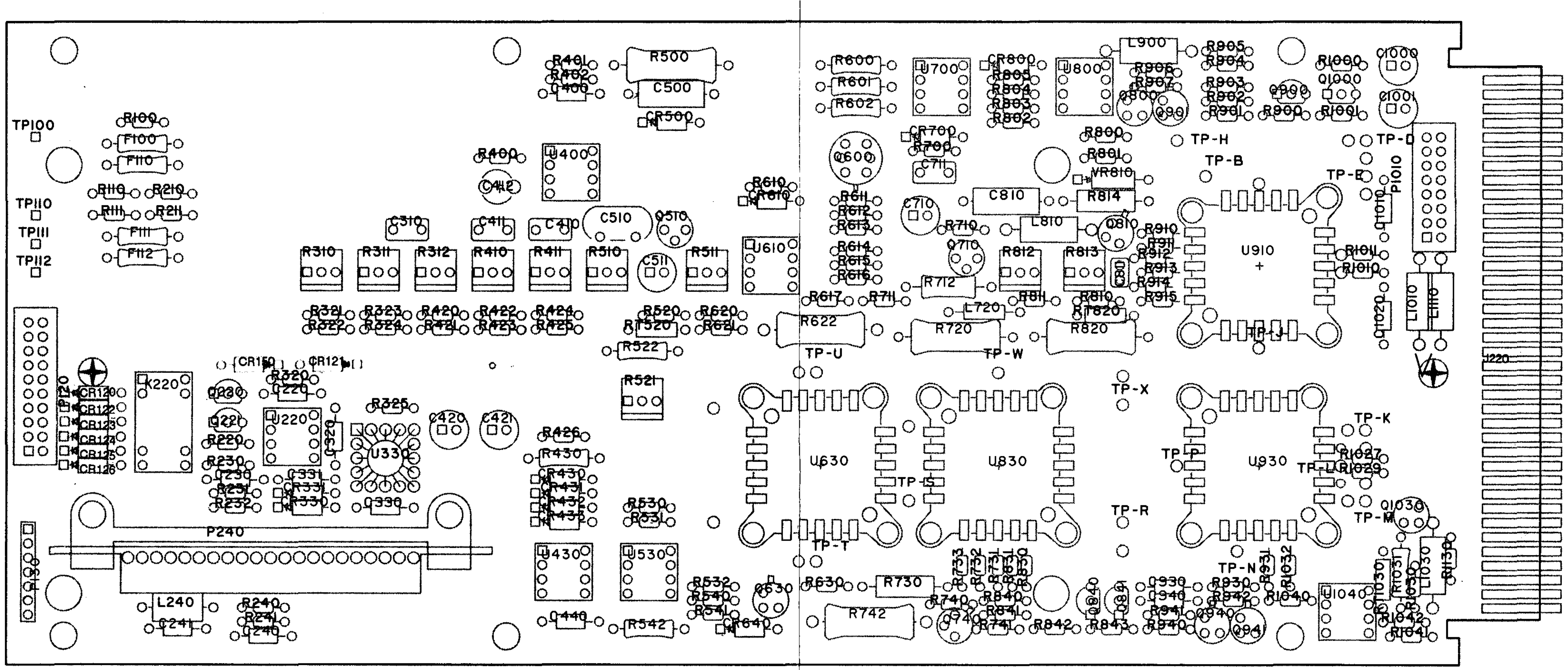


Figure 6-3. *A1–Main Circuit Board Assembly*

7392-602

A1–Main circuit board illustration to be used with diagrams ⟨1⟩ ⟨3⟩ and ⟨4⟩

Static Sensitive Devices
See Maintenance Section

COMPONENT NUMBER EXAMPLE

Component Number
A23 A2 R1234
Assembly Number
Subassembly Number (if used)
Schematic Circuit Number

Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

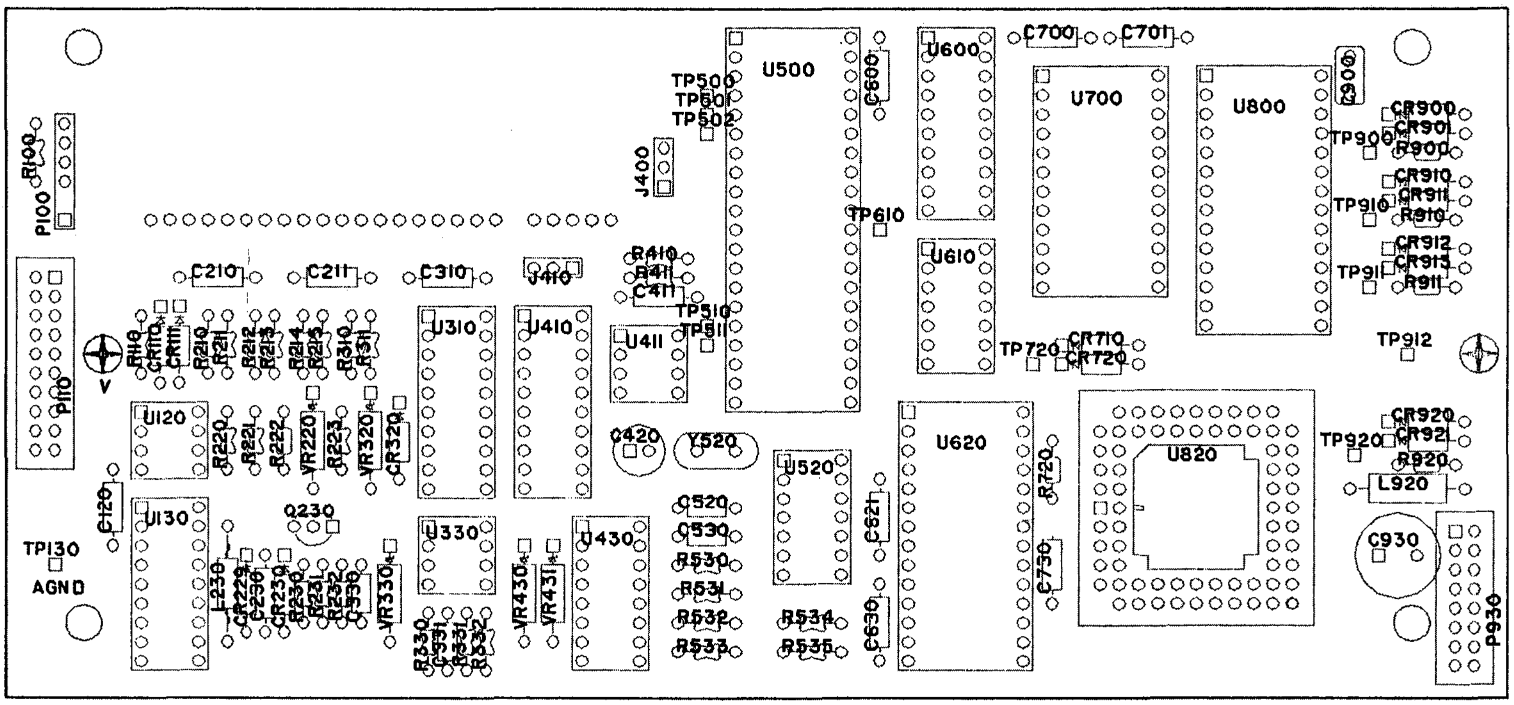


Figure 6-4. *A3-Kernel Circuit Board Assembly*

7392-603

A3-Kernel circuit board illustration to be used with diagrams ⟨1⟩ through ⟨4⟩

ATTENUATOR DIAGRAM ⟨1⟩

ASSEMBLY A1

CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION
AT240	1D	F100	1G	Q220	1B
		F110	1G	Q221	1B
C220	1A	F111	2G		
C230	2B	F112	2G	R100	1G
C240	3F			R110	1F
C241	3C	J230	2C	R111	1F
C320	1B	J400	2E	R210	1G
C330	2F	J530	2F	R211	1F
C331	1B			R220	1B
C420	2G	K220	1C	R230	2B
				R231	1B
CR120	1B	L240	3C	R232	2C
CR121	2C			R240	3F
CR122	3E	P110	3C	R241	3F
CR123	3E	P110	3G	R320	1A
CR124	3D	P120	1A	R325	2G
CR125	3D	P120	1G		
CR126	3C	P120	3C	U220A	1B
CR130	2C	P130	2A	U220B	1B
CR330	1B	P240	1C	U330	2G
CR331	2B	P240	2E		

Partial A1 also shown on diagrams 2, 3 and 4.

ASSEMBLY A3

CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION
C230	5C	Q230	4C	U130	3B
C330	4C			U130	5C
C331	5B	R230	4C	U330	4C
		R231	4C		
CR229	5C	R232	4C	VR330	5B
CR230	5C	R330	4B	VR430	4B
		R331	4B		
L230	5C	R332	4B		

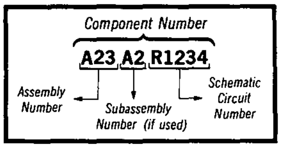
Partial A3 also shown on diagrams 2, 3 and 4.

CHASSIS MOUNTED PARTS

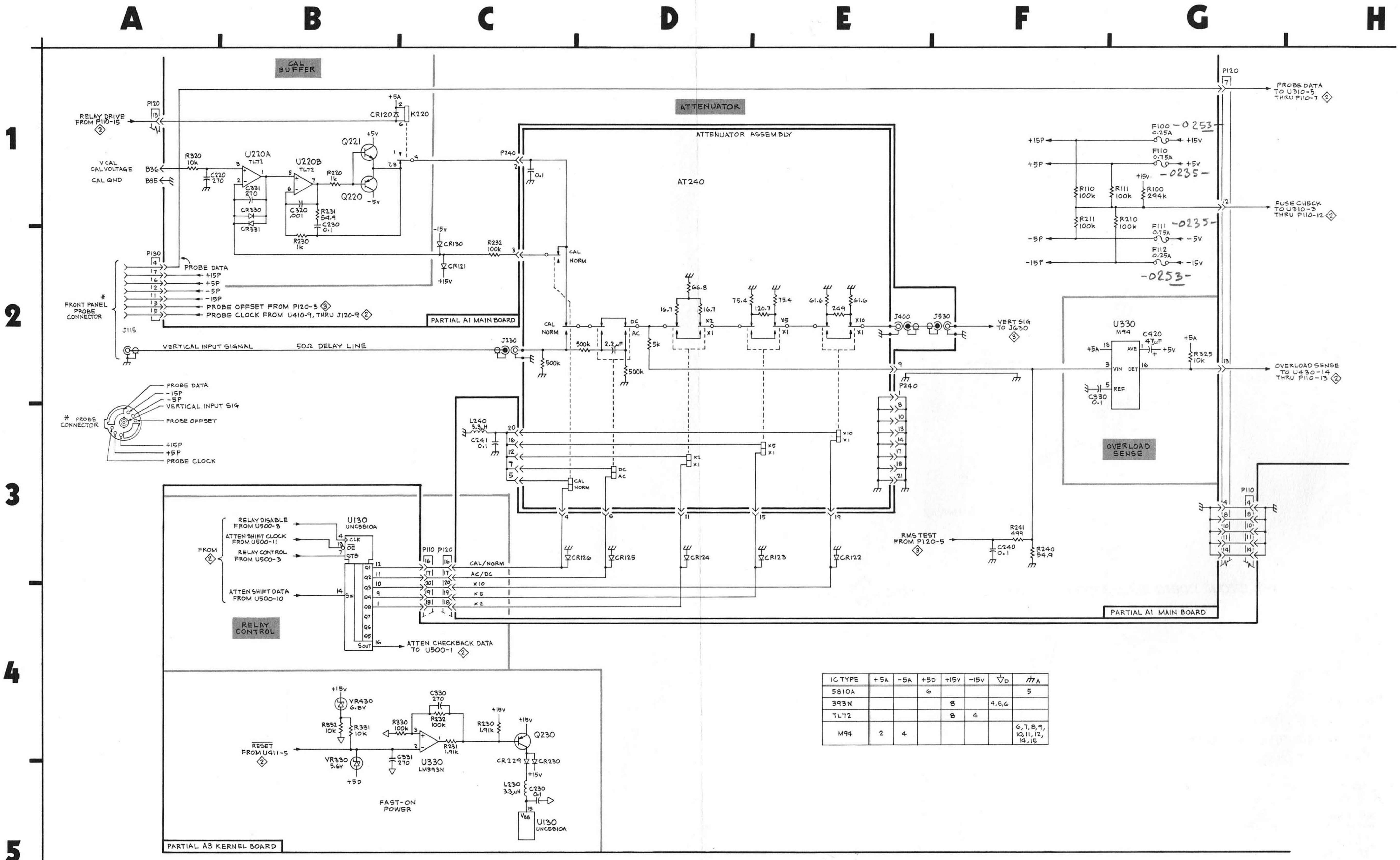
CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION
J115	2A				

Static Sensitive Devices
See Maintenance Section

COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.



IC TYPE	+5A	-5A	+5D	+15V	-15V	▽D	⏚A
5810A			6				5
393N				8		4,5,6	
TL72				8	4		
M94	2	4					6,7,8,9, 10,11,12, 14,15

11A71

ATTENUATOR ①

① Attenuator

Reverse Side A2

KERNEL DIAGRAM ◇2

ASSEMBLY A3

CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION
C120	3G	L920	3G	TP511	3B
C210	3G			TP610	2B
C310	2F	P100	1G	TP720	5D
C411	3A	P110	1F	TP900	5D
C420	3A	P110	2F	TP910	5D
C520	2A	P110	2G	TP911	5D
C530	2A	P930	3G	TP912	3A
C600	2B	P930	4G	TP920	5D
C621	3F	P930	5C		
C630	4E			U310	2G
C700	4C	R100	1G	U410	1G
C701	2C	R223	2F	U411	2A
C730	3D	R410	2A	U430	1F
C900	3C	R411	2A	U500	3A
C930	3G	R530	1B	U520A	1B
		R531	3F	U520B	1B
CR320	2F	R532	2F	U520C	2C
CR710	5E	R533	4F	U600	4C
CR720	5E	R534	4F	U610A	3B
CR900	5C	R535	4F	U610B	3B
CR901	5C	R720	5E	U610C	3B
CR910	5D	R900	5C	U620	3E
CR911	5D	R910	5C	U700	2C
CR912	5C	R911	5C	U800	3C
CR913	5C	R920	5C	U820	3D
CR920	5D				
CR921	5D	TP130	4A	VR220	2F
		TP500	4B	VR320	2F
J400	4A	TP501	4A	VR431	2G
J410	2A	TP502	4A		
		TP510	3B	Y520	2A

Partial A3 also shown on diagrams 1, 3 and 4.

ASSEMBLY A1

CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION
P120	2H	P1010	4H		
P1010	3H	P1010	5C		

Partial A1 also shown on diagrams 1, 3 and 4.

ASSEMBLY A2

CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION
DS100	1H	R100	1G	S100	1G
DS101	1H	R101	1H	S101	1H
		R102	1H		
P100	1G	R103	1H		

Partial A2 also shown on diagram 4.

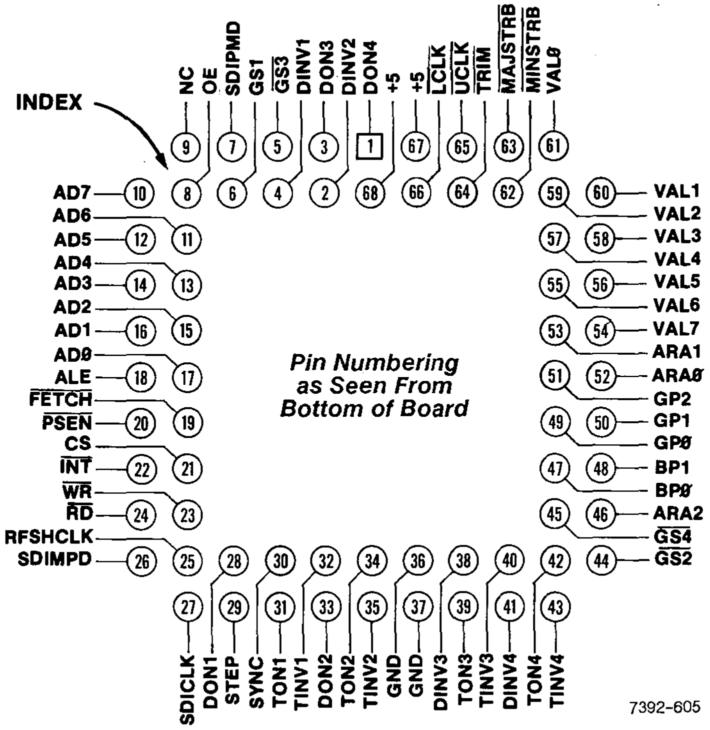
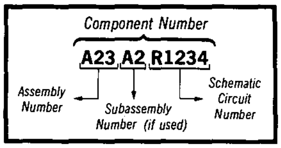


Figure 6-6. *M382 Socket Basing Diagram*

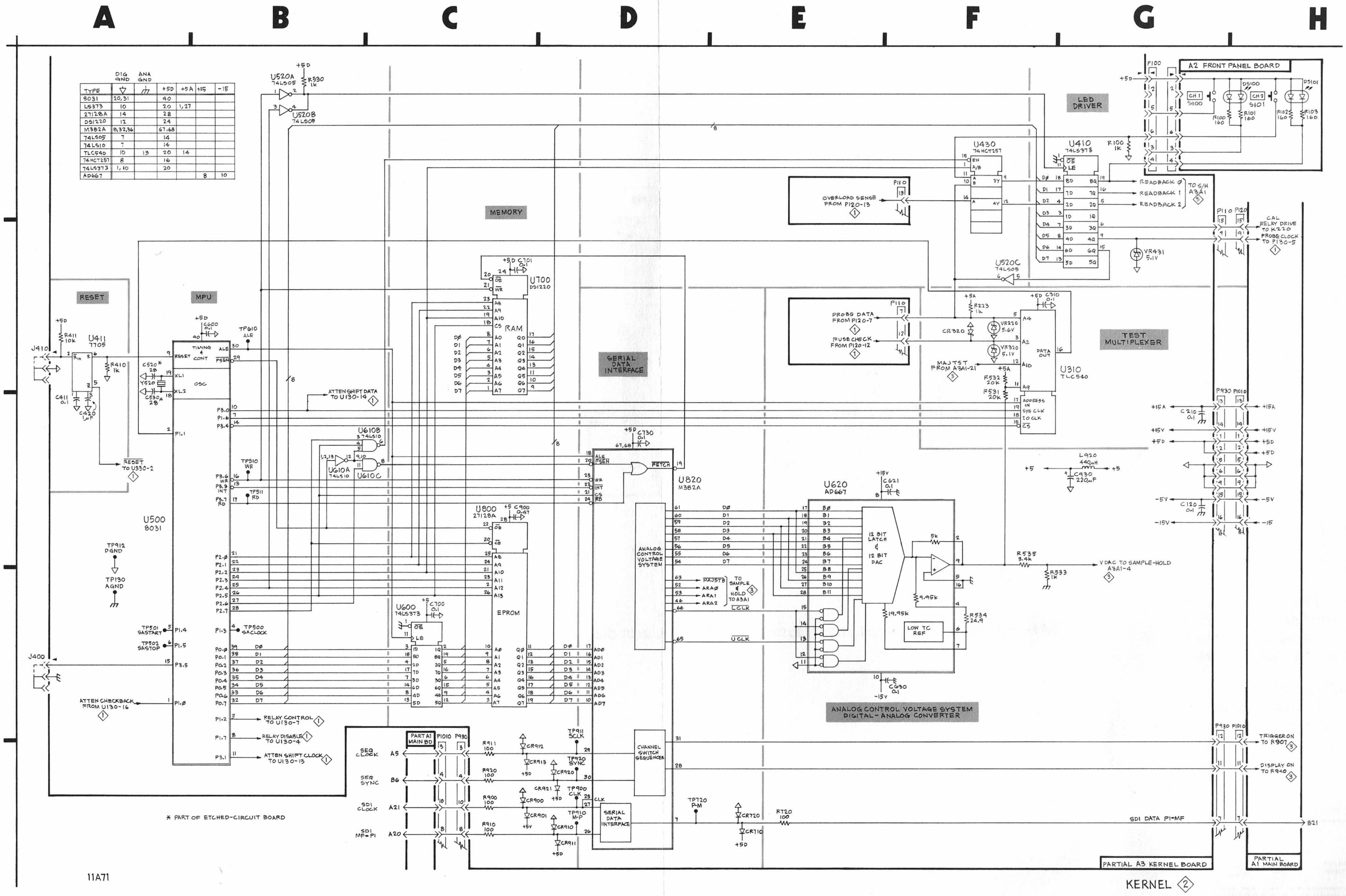
Static Sensitive Devices
See Maintenance Section

COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

Scan by Zenith



TYPE	DIG GND ▽	ANA GND	+5D	+5A	+15	-15
8031	20,31		40			
LS373	10		20	1,27		
27128A	14		28			
DS1220	12		24			
M382A	8,32,36		67,68			
74LS05	7		14			
74LS10	7		14			
TLC540	10	13	20	14		
74HCT257	8		16			
74LS373	1,10		20			
AD667					8	10

KERNEL ②

② Kernel

Reverse Side A1A1

7392-606

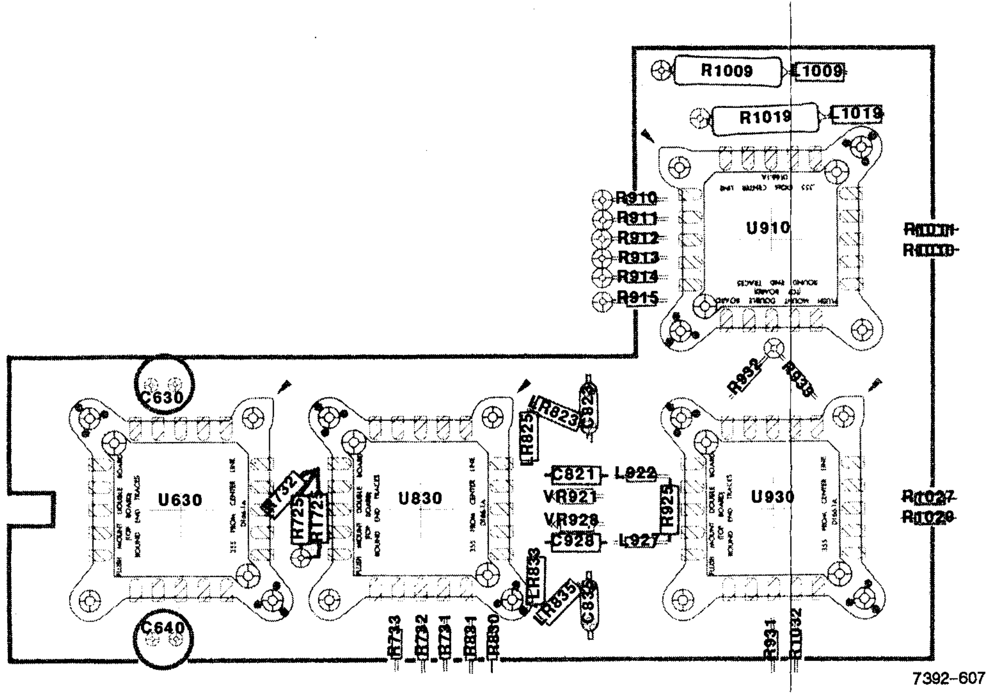


Figure 6-7. A1A1-High Frequency Circuit Board Assembly

A1A1-High Frequency circuit board illustration to be used with diagrams 3 and 4

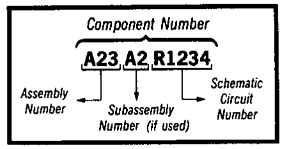
A1-Main
circuit board illustration
is located on reverse side of
11A71 Block Diagram

A3-Kernel
circuit board illustration
is located on reverse side of
11A71 Block Diagram

Assembly A1A1

Static Sensitive Devices
See Maintenance Section

COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

AMPLIFIER DIAGRAM 3

ASSEMBLY A1

CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION
C310	4C			R420	4C	R616	3B	R820	5F	R1011	2G
C400	2D	Q510	3B	R421	4C	R617	3E	R830	3E	R1027	3G
C410	4C	Q530	4B	R422	4D	R620	3B	R831	3E	R1029	4G
C411	4C	Q600A	2E	R423	4D	R621	3B	R841	5G	R1030	4G
C412	5D	Q600B	2E	R424	4D	R622	2E	R842	5G	R1031	4F
C440	3D	Q710	3E	R425	4D	R630	5E	R843	5G	R1041	4G
C500	2E	Q740	5E	R426	4C	R700	2E	R900	2G	R1042	4F
C510	4D	Q800	3G	R430	4C	R710	3E	R901	2G	R1044	4H
C511	3B	Q810	1G	R500	2E	R711	3E	R902	3G		
C711	2E	Q840	5G	R510	4D	R712	2F	R903	3G	RT520	3B
C811	1F	Q841	5G	R511	3B	R720	4D	R904	3G	RT820	5F
C930	5F	Q900	2G	R520	3B	R730	4F	R905	2G	RT1030	4G
C940	5G	Q901	3H	R521	4A	R731	3E	R906	3G		
C1010	2F	Q940	5G	R522	4A	R732	4D	R907	3G	U400	4D
C1020	2G	Q941	5H	R530	4C	R733	3E	R910	1F	U430	4B
		Q1000	2G	R531	4B	R740	5F	R911	1F	U530	4B
CR430	4C	Q1030	4G	R532	4B	R741	5G	R912	1F	U610	3B
CR431	4B			R540	4B	R742	5E	R913	1F	U700A	2E
CR432	4B	R310	4C	R541	4B	R800	1H	R914	2F	U700B	2E
CR433	4C	R311	4C	R542	4A	R801	1H	R915	2F	U800	1H
CR500	2E	R312	4C	R600	1E	R802	2D	R930	5G	U1040A	4F
CR610	3A	R321	4C	R601	1E	R803	2D	R931	5G	U1040B	4G
CR640	4A	R323	4C	R602	1F	R804	2F	R940	5F		
CR700	2E	R324	4C	R610	2E	R805	2F	R940	5G	VR810	1G
CR800	2F	R400	5D	R611	1E	R810	5F	R941	5G		
		R402	2D	R612	1E	R811	2F	R942	5G		
L720	4D	R410	2D	R613	1E	R812	2F	R1000	2F		
		R410	4C	R614	3B	R813	1G	R1001	2F		
P120	1D	R411	4D	R615	3B	R814	1G	R1010	2G		

Partial A1 also shown on diagrams 1, 2 and 4.

ASSEMBLY A1A1

CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION
C630	3B	J630	3A	LR823	3E	R925	4E	RT725	4B	VR921	3E
C640	4B			LR825	3E	R932	3F			VR928	4E
C823	3E	L922	4E	LR833	4E	R933	4F	U630	3B		
C835	5E	L927	4E	LR835	5E	R1019	2G	U830	4E		
C921	3E	L1019	2G			R1032	5G	U910	1F		
C928	4E	L1099	1G	R723	3B	R1099	1G	U930	3F		
				R725	4B						

Partial A1A1 also shown on diagram 4.

ASSEMBLY A3A1

CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION
C100	1B	C106	1B	C112	2B	R100	1B	R106	2B	U102	1B
C101	1B	C107	1B	C113	2B	R101	1B	R107	2B	U103	1B
C102	1B	C108	2B	C114	2B	R102	1B	R108	1A		
C103	1B	C109	2B	C115	2B	R103	1B				
C104	1B	C110	2B	C116	1A	R104	2B	U100	1B		
C105	1B	C111	2B	C117	2A	R105	2B	U101	2A		

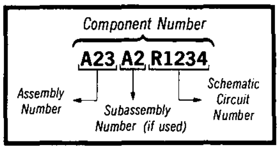
ASSEMBLY A3

CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION
C211	1A	P110	1D	R211	1C	R215	2C	R310	2C	U120B	2C
				R212	1C	R220	1C	R311	2C		
CR110	1C	R110	3C	R213	2C	R221	2C				
CR111	1C	R210	1C	R214	2C	R222	2C	U120A	3C		

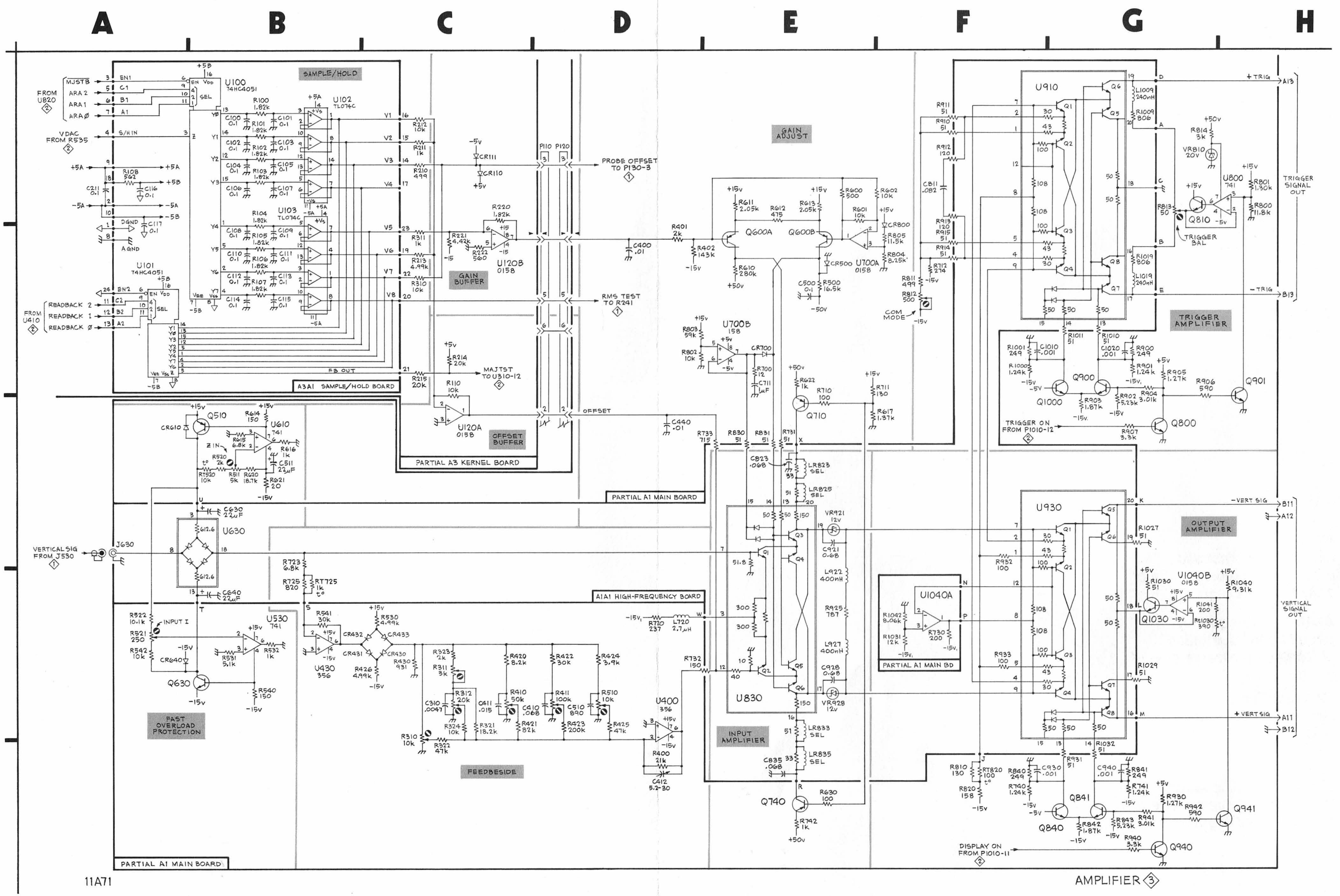
Partial A3 also shown on diagrams 1, 2 and 4.

Static Sensitive Devices
See Maintenance Section

COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.



11A71

AMPLIFIER ③

WIRING DIAGRAM/MAIN INTERFACE DIAGRAM 4

ASSEMBLY A1A1

CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION
J530	5D				

Partial A1A1 also shown on diagram 3.

ASSEMBLY A1

CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION
C421	5F	J230	5D	L1110	3G
C530	3G	J400	5D		
C710	3F			P120	1D
C810	3F	L810	3F	P130	5D
C1000	2F	L900	2F	P1010	3D
C1001	3G	L1010	3F		
		L1030	5F	R1130	3G

Partial A1 also shown on diagrams 1, 2 and 3.

ASSEMBLY A2

CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION
P101	2A				

Partial A2 also shown on diagram 2.

ASSEMBLY A3

CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION
P100	2B	P110	1C	P930	3C

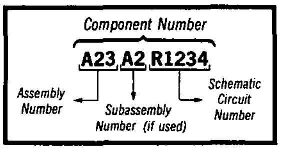
Partial A3 also shown on diagrams 1, 2 and 3.

CHASSIS MOUNTED PARTS

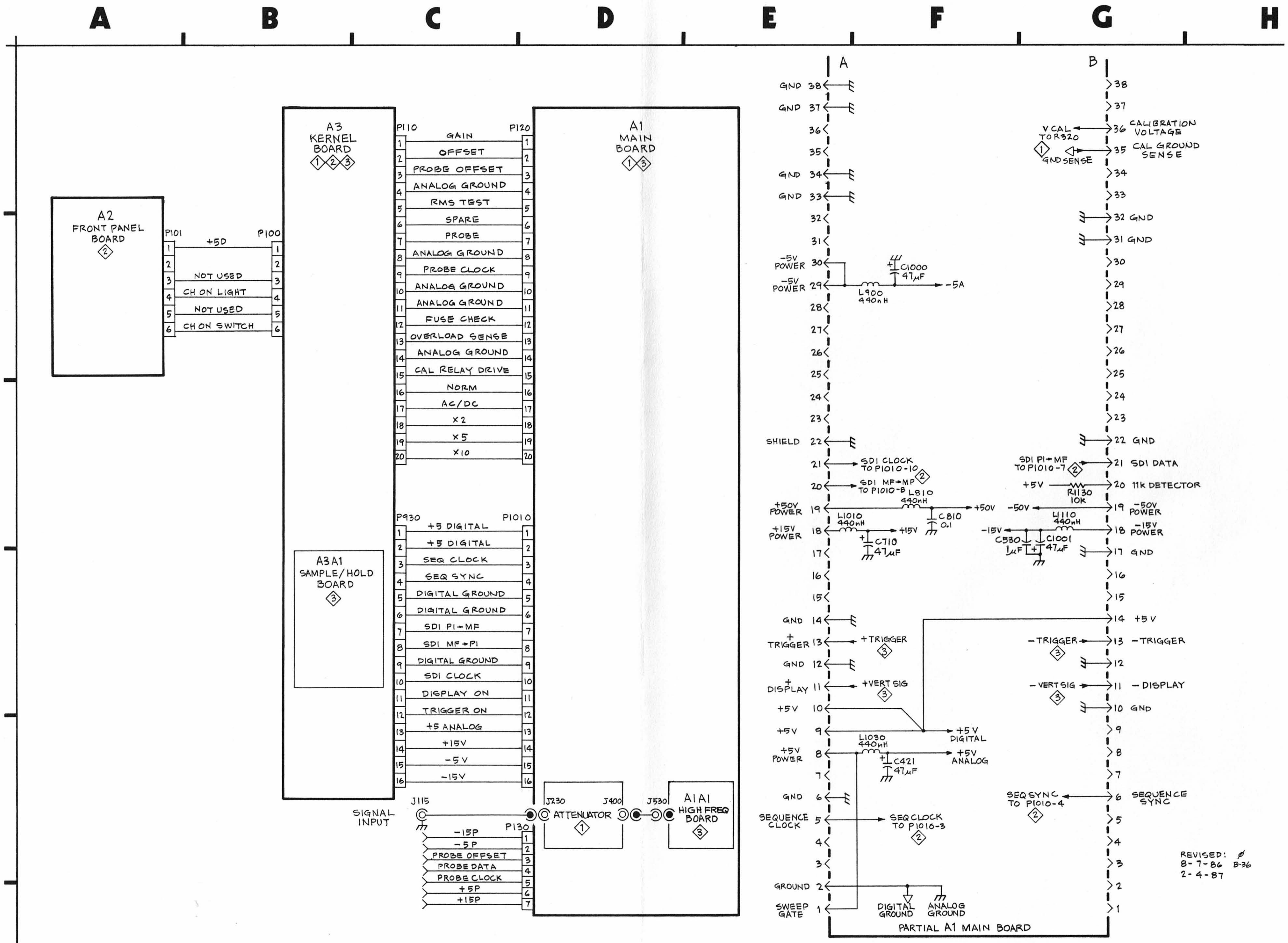
CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM LOCATION
J115	5C				

Static Sensitive Devices
See Maintenance Section.

COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.



WIRING DIAGRAM / MAIN INTERFACE ④

Section 7
Mechanical Parts

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.

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.

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
END ATTACHING PARTS

Detail Part of Assembly and/or Component
Attaching parts for Detail Part
END ATTACHING PARTS

Parts of Detail Part
Attaching parts for Parts of Detail Part
END ATTACHING PARTS

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.

Attaching parts must be purchased separately, unless otherwise specified.

ABBREVIATIONS

Abbreviations conform to American National Standards Institute YI.I

CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
00779	AMP INC	2800 FULLING MILL PO BOX 3608	HARRISBURG PA 17105
06383	PANDUIT CORP	17301 RIDGELAND	TINLEY PARK IL 07094-2917
07707	USM CORP SUB OF EMHART INDUSTRIES INC USM FASTENER DIV	510 RIVER RD	SHELTON CT 06848-4517
22526	DU PONT E I DE NEMOURS AND CO INC DU PONT CONNECTOR SYSTEMS DIV MILITARY PRODUCTS GROUP	515 FISHING CREEK RD	NEW CUMBERLAND PA 17070-3007
22599	AMERACE CORP ESNA DIV	15201 BURBANK BLVD SUITE C	VAN NUYS CA 91411-3532
80009	TEKTRONIX INC	14150 SW KARL BRAUN DR PO BOX 500	BEAVERTON OR 97707-0001
83385	MICRODOT MFG INC GREER-CENTRAL DIV	3221 W BIG BEAVER RD	TROY MI 48098
91260	CONNOR SPRING AND MFG CO A SLOSS AND BRITTAN INC CO	1729 JUNCTION AVE	SAN JOSE CA 95112
92194	ALPHA WIRE CORP	711 LIDGERWOOD AVE	ELIZABETH NJ 07207
93907	TEXTRON INC CAMCAR DIV	600 18TH AVE	ROCKFORD IL 61108-5181
TK1326	NORTHWEST FOURSLIDE INC	18224 SW 100TH CT	TUALATIN OR 97062
TK1831	PACIFIC HYBRID MICROELECTRONICS INC	7790 SW NIMBUS AVE BLDG 10	BEAVERTON OR 97005

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
1-1	366-0600-00			1	PUSH BUTTON:0.269 X 0.409,ABS	80009	366-0600-00
-2	366-1058-00			1	KNOB:GRAY,0.625 X 0.255 X 0.485	80009	366-1058-00
					(ATTACHING PARTS)		
-3	214-1095-00			1	PIN,SPRING:0.187 L X 0.094 OD,STL,CD PL	22599	52-022-094-0187
					(END ATTACHING PARTS)		
-4	105-0076-04			1	RELEASE BAR,LCH:PLUG-IN UNIT	80009	105-0076-04
-5	214-1280-00			1	SPRING,HLCPS:0.14 OD X 1.126 L,TWIST LOOP	91260	ORDER BY DESCR
-6	214-1054-00			1	SPRING,FLAT:0.825 X 0.322,SST	TK1326	ORDER BY DESCR
-7	105-0075-00			1	BOLT,LATCH:	80009	105-0075-00
-8	333-3409-00			1	PANEL,FRONT:	80009	333-3409-00
					(ATTACHING PARTS)		
-9	211-0392-00			4	SCREW,MACHINE:4-40 X 0.25,FLH,82 DEG,STL	80009	211-0392-00
					(END ATTACHING PARTS)		
-10	348-0235-00			2	SHLD GSKT,ELEK:FINGER TYPE,4.734 L	80009	348-0235-00
-11	386-5219-00			1	SUBPANEL,FRONT:	80009	386-5219-00
-12	----- -----			1	CIRCUIT BD ASSY:FRONT PANEL		
					(SEE A2 REPL)		
					(ATTACHING PARTS)		
-13	211-0398-00	B010100	B010508	2	SCREW,MACHINE:2-56 X 0.312,FLH,82 DEG,STL	80009	211-0398-00
	211-0413-00	B010509		2	SCREW,MACHINE:2-56 X 0.375,FLH,82 DEG,STL	93907	ORDER BY DESCR
					(END ATTACHING PARTS)		
-14	174-0159-00			1	CA ASSY,SP,ELEC:6,26 AWG,3.0 L,RIBBON	80009	174-0159-00
-15	426-2061-00			1	FR SECT,PLUG-IN:LOWER,ALUMINUM	80009	426-2061-00
-16	334-3540-00			1	MARKER,IDENT:MARKED WARNING	80009	334-3540-00
-17	131-3589-00			1	CONN ASSY,ELEC:FRONT PNL	80009	131-3589-00
					(ATTACHING PARTS)		
-18	211-0398-00	B010100	B010508	4	SCREW,MACHINE:2-56 X 0.312,FLH,82 DEG,STL	80009	211-0398-00
	211-0413-00	B010509		4	SCREW,MACHINE:2-56 X 0.375,FLH,82 DEG,STL	93907	ORDER BY DESCR
					(END ATTACHING PARTS)		
-19	354-0654-00			1	RING,CONN ALIGN:BNC	80009	354-0654-00
-20	174-0205-00			1	CABLE ASSY,RF:50 OHM COAX,2.6 L	80009	174-0205-00
	174-0665-00			1	CABLE ASSY,RF:50 OHM COAX,13.3 L	80009	174-0665-00
	343-0549-00			1	STRAP,TIEDOWN,E:0.091 W X 4.0 L,ZYTEL	06383	PLT1M
-21	119-2397-00			1	ATTENUATOR:5 STAGE PROGRAMMABLE	TK1831	119-2397-00
					(ATTACHING PARTS)		
-22	211-0409-00			2	SCR,ASSEM WSHR:4-40 X 0.312,PNH,STL	93907	ORDER BY DESCR
					(END ATTACHING PARTS)		
-23	174-0559-00			1	CA ASSY,SP,ELEC:20,28 AWG,2.25 L,RIBBON	80009	174-0559-00
-24	426-2060-00			1	FR SECT,PLUG-IN:UPPER,ALUMINUMN	80009	426-2060-00
-25	334-3438-00			1	MARKER,IDENT:MARKED TURN OFF POWER	80009	334-3438-00
-26	214-1061-00			1	CONTACT,ELEC:GROUNDING,CU BE	80009	214-1061-00
-27	337-1064-12			2	SHIELD,ELEC:SIDE FOR PLUG-IN UNIT	80009	337-1064-12
-28	220-0022-00			6	NUT BLK:0.4 X 0.25 X 0.33,4-40 THRU,NI SIL	80009	220-0022-00
					(ATTACHING PARTS)		
-29	211-0409-00			6	SCR,ASSEM WSHR:4-40 X 0.312,PNH,STL	93907	ORDER BY DESCR
					(END ATTACHING PARTS)		
-30	174-0560-00			1	CA ASSY,SP,ELEC:16,28 AWG,2.75 L,RIBBON	80009	174-0560-00
-31	----- -----			1	CIRCUIT BD ASSY:KERNEL		
					(SEE A3 REPL)		
					(ATTACHING PARTS)		
-32	211-0409-00			4	SCR,ASSEM WSHR:4-40 X 0.312,PNH,STL	93907	ORDER BY DESCR
					(END ATTACHING PARTS)		
					KERNAL BOARD ASSEMBLY INCLUDES:		
-33	----- -----			1	.CIRCUIT BD ASSY:SAMPLE/HOLD		
					.(SEE A3A1 REPL)		
-34	----- -----			1	CIRCUIT BD ASSY:MAIN		
					(SEE A1 REPL)		
-35	426-1351-00			4	.FRAME,MICROCKT:1.75 CM	80009	426-1351-00
					(ATTACHING PARTS)		
-36	211-0391-00			16	.SCREW,MACHINE:2-56 X 0.437,P4,STL CD PL	80009	211-0391-00
					(END ATTACHING PARTS)		
-37	131-1967-00			4	.CONT SET,ELEC:MICROCKT,1.75 CM,RUBBER	80009	131-1967-00
-38	136-0252-07			21	.SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
-39	131-2032-00			1	.CONTACT,ELEC:SINGLE,TOP,CU BE	80009	131-2032-00
-40	131-2033-00			1	.CONTACT,ELEC:SINGLE,BOTTOM,CU BE	80009	131-2033-00
					(ATTACHING PARTS)		
-41	210-0702-00			2	.EYELET,METALLIC:0.047 OD X 0.125 L	07707	S-6127
					(END ATTACHING PARTS)		

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
1-42	136-0252-00			1	.SOCKET,PIN TERM:U/W 0.019 DIA PINS	00779	2-330808-7
-43	386-1557-00			1	.SPACER,CKT BD:0.29 H,ACETAL	80009	386-1557-00
	175-2054-00			AR	.WIRE,ELECTRICAL:SOLID,30 AWG,BLACK,KYNAR	92194	5951
-44	386-5296-00			1	PANEL,REAR:	80009	386-5296-00
					(ATTACHING PARTS)		
-45	213-0904-00			4	SCREW,TPG,TR:6-32 X 0.5,PNH,STL	83385	ORDER BY DESCR
					(END ATTACHING PARTS)		
					STANDARD ACCESSORIES		
	070-6288-01			1	MANUAL,TECH:USERS REFERENCE,11A71	80009	070-6288-01
	070-6699-01			1	PROCEDURE:INCOMING INSPECTION,11A71	80009	070-6699-01
					OPTIONAL ACCESSORIES		
	070-6787-00			1	MANUAL,TECH:SERVICE REF,11A71	80009	070-6787-00

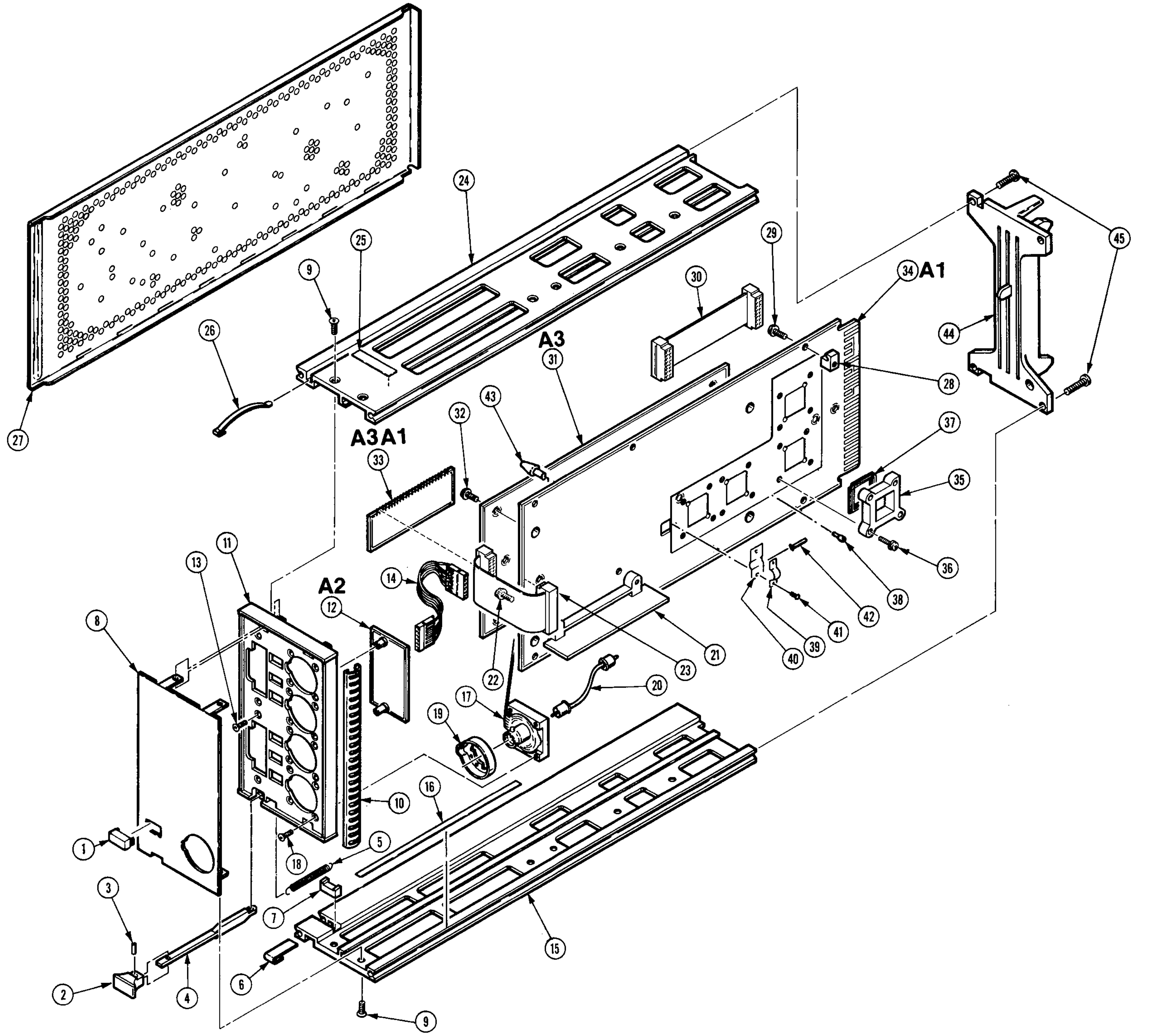


FIG. 1 EXPLODED VIEW