Part No. 070-8330-00
Product Group 40

THE 222A DIGITAL STORAGE OSCILLOSCOPE

Service Manual

WARNING

The following servicing instructions are for use by qualified service 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.

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Instrument Serial Numbers

Each instrument manufactured by Tektronix has a serial number on a panel insert or 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
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, IL for Israel, etc.).

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Welcome

This section contains information needed to properly use this manual to service the 222A Digital Storage Oscilloscope, as well as general information critical to safe and effective servicing of this oscilloscope.

Before Servicing

This manual instructs qualified service persons on how to service the 222A Digital Storage Oscilloscope. To prevent injury to yourself or damage to the oscilloscope, read the following sections before you attempt service:

- *Safety Summary* found at the beginning of this manual
- *Strategy for Servicing* and *Supplying Operating Power* in this section

When using this manual for servicing, be sure to heed all warnings, cautions, and notes.

Strategy for Servicing

Throughout this manual, any field-replaceable component, assembly, or part of this oscilloscope is referred to generically as a module.

This manual contains all the information needed for periodic maintenance of the 222A Digital Storage Oscilloscope. (Examples of such information are procedures for checking performance and for readjustment.) Further, it also contains all information for corrective maintenance.

All modules are listed in Section 8, *Replaceable Electrical Parts* and Section 10, *Replaceable Mechanical Parts*. To isolate a failure, use the fault isolation procedures found in Section 6, *Maintenance*. To remove and replace any module, follow the instructions in *Removal and Installation Procedures*, also found in Section 6.

Manual Structure

This manual is divided into sections, such as *Specification* and *Theory of Operation*. The sections are divided into subsections, such as *Product Description* and *General Operating Instructions*.

Sections containing procedures also contain introductions to those procedures. Be sure to read these introductions because they provide information needed to do the service correctly and efficiently. The following is a brief description of each manual section.

- *Specification* – contains a product description of the 222A Digital Storage Oscilloscope and tables of the characteristics and descriptions that apply to it.

- *Operating Information* — provides general information and operating instructions at the level needed to safely power up and service this oscilloscope.
- *Theory of Operation* — contains circuit descriptions that support general service and fault isolation down to the module level.
- *Performance Verification* — contains a collection of procedures for confirming that this Digital Storage Oscilloscope functions properly and meets warranted limits.
- *Adjustment Procedures* — contains a collection of procedures for adjusting the 222A to meet warranted limits.
- *Maintenance* — contains information and procedures for doing preventive and corrective maintenance on the 222A. Instructions for cleaning, module removal and installation, and fault isolation to a module are found here.
- *Options* — lists options and accessories for the 222A and contains information on servicing any of the factory-installed options that may be present in your oscilloscope.
- *Electrical Replaceable Parts* — a table of all electrical replaceable parts.
- *Diagrams* — contains a collection of schematic diagrams, illustrations, and troubleshooting charts useful for troubleshooting the 222A.
- *Replaceable Mechanical Parts* — includes a table of all mechanical replaceable parts and exploded view illustrations that identify the parts.

Manual Conventions

This manual uses certain conventions that you should become familiar with before doing service.

Modules

Throughout this manual, any replaceable component, assembly, or part of this 222A is referred to generically as a module.

Safety

Symbols and terms related to safety appear in the *Safety Summary* found at the beginning of this manual.

Symbols

Besides the symbols related to safety, this manual uses the following symbols:

The "stop sign" icon labels information that must be read in order to correctly do service and to avoid incorrectly using or applying service procedures.

The clock icon labels procedure steps that require a pause to wait for the oscilloscope to complete some operation before you can continue.

Finding Other Information

The 222A Digital Storage Oscilloscope comes with the following manuals:

The *222A Digital Storage Oscilloscope Operator Manual* contains a tutorial to quickly show you how to operate the 222A Digital Storage Oscilloscope and an in depth discussion of how to more completely use its features. Applications and remote control via the RS-232 port are also discussed.

The *222A Digital Storage Oscilloscope Quick Reference Guide* provides a brief overview of how to use the major features and controls of the 222A.

Contents

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Safety Summary

Please take a moment to review these safety precautions. They are provided for your protection and to prevent damage to the 222A Digital Storage Oscilloscope. This safety information applies to all operators and service personnel.

WARNING

To avoid possible personal injury or damage to the 222A, do not apply more than 400 V peak between probe tip and earth ground, between probe tip and probe common, or between probe common and earth ground.

WARNING

To avoid possible injury, use caution when working with voltages above 42 V peak. Such voltages pose a shock hazard.

WARNING

To avoid possible injury or damage to the 222A or equipment connected to it, do not float the external trigger common connector, the RS-232 communications port, or the external power input above 42 V peak. These inputs are not electrically isolated from each other.

WARNING

To avoid possible injury or damage to the 222A, use only Tektronix P400 or P850 probes with this instrument. The use of other probes can pose a shock hazard to you.

Symbols and Terms

These two terms appear in manuals:

- 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.

These two terms appear on equipment:

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

This symbol appears in manuals:

Static-Sensitive Devices

These symbols appear on equipment:

DANGER
High Voltage

Protective
ground (earth)
terminal

ATTENTION
Refer to
manual

Specific Precautions

Observe all of the following precautions to ensure your personal safety and to prevent damage to either the 222A or equipment connected to it.

Do Not Perform Service While 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 or components while power is on. Disconnect power and remove the battery before removing protective panels, soldering, or replacing components.

Power Source

The 222A is intended to use its self-contained sealed lead acid battery as a power source. It also operates using power supplied to the external power input. Power supplied to this input must be less than 28 VDC or less than 18 VAC rms. Do not force either external power conductor negative by more than 0.5 V with respect to chassis ground. Both conductors of the external power input are fused internally.

You can operate the instrument on external power from a local 110 VAC through 240 VAC power supply using the supplied External Power AC Adapter. Use only external power AC adapters specified for this instrument.

Grounding the Digital Storage Oscilloscope

The channel 1 and channel 2 measurement inputs of the 222A are doubly insulated from each other and all other accessible portions of the instrument cabinet. It is not necessary to ground the instrument to avoid electric shock.

Use the Proper Power Cord

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

Use the Proper Fuse

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

Do Not Remove Covers or Panels

To avoid personal injury, do not operate the instrument without a properly assembled cabinet. The cabinet of the instrument should be disassembled only by qualified service personnel.

Do Not Operate in Explosive Atmospheres

The 222A provides no explosion protection from static discharges or arcing components. Do not operate the 222A in an atmosphere of explosive gasses.

Electric Overload

Never apply a voltage to a probe or connector on the 222A that is outside the range specified for that probe or connector.

Voltage Measurements

Do not measure power line voltages. Avoid connecting the 222A inputs to power systems unless you are certain that all possible surge voltages present in the system added to the normal line voltage waveform remain within the 400 V peak input voltage rating of the inputs.

Specification

Replace this page with the tab divider of the same name.

Product Description

This subsection begins with a general description of the traits of the 222A Digital Storage Oscilloscope. Three subsections follow, one for each of three classes of traits: *nominal traits, warranted characteristics,* and *typical characteristics*.

General

The Tektronix 222A Digital Storage Oscilloscope is a portable, two-channel instrument designed for use in a variety of test and measurement applications where external power is not available. Key features include:

- two fully isolated, independently floatable channels rated to 400 VDC plus peak AC
- light weight with a battery power source for field operations
- an automatic set-up button
- automatic triggering modes
- averaging and enveloping acquisition modes
- remote operation capabilities via the RS-232 communications port
- internal memory for saving up to four waveforms and four instrument setups
- DC to 10 MHz signal bandwidth
- 10 megasamples per second digitizing rate
- 1 MHz single pass storage bandwidth
- detachable probes

User Interface

This Digital Storage Oscilloscope uses a combination of front-panel buttons, knobs, and on-screen menus to control its many functions. The front-panel controls are grouped according to function: vertical, horizontal, and trigger. Within each group, any function likely to get adjusted often, such as vertical positioning, or time base setting, is set directly by its own front-panel knob.

Menus

Those functions for which control settings are usually changed less often, such as vertical coupling and horizontal mode, are set indirectly. That is, pressing one (sometimes two) front-panel button, such as **AUX FUNCT**, displays a menu of functions related to that button. Using the buttons beside

select a function, such as coupling, displays a *submenu* of settings for that function, such as AC, DC, or GND (ground). Use the buttons to the right of the menu to select a setting, such as DC.

Indicators

Several on-screen readouts help you keep track of the settings for various functions, such as vertical and horizontal scale and trigger level. There is also a readout to display the status of the battery.

Signal Acquisition System

The signal acquisition system provides two vertical channels with calibrated vertical scale factors from 5 mV to 50 V per division with the P400 1X probe and from 50 mV to 200 V per division with the P850 10X probe. Both channels can be acquired simultaneously.

Each of the two channels can be displayed, inverted and vertically positioned, and can have their vertical coupling specified.

Besides the two channels, up to four stored waveforms are available for display.

Horizontal System

There are four horizontal display modes: normal, average, envelope, and continuous envelope. In addition, you can position a waveform along the horizontal axis to perform measurements. The horizontal **POS** knob allows you to move a waveform to the left or right.

Normal acquisition mode presents a constantly updated waveform. Average mode combines four waveform acquisitions and then displays the resultant waveform. Envelope mode captures the maximum and minimum points during each sample period to create an envelope waveform. The continuous envelope mode continues adding newly acquired maximum and minimum data to the displayed envelope waveform until reset with the **INIT** button or a setup parameter (such as TIME/DIV) change.

Trigger System

The triggering system provides triggering from the either channel signal or from the External Trigger input. Types of trigger signals recognized include:

- **Internal**: This familiar type of triggering is fully configurable for source, slope, coupling, and mode. The selectable modes are auto-level, auto-baseline, normal, and single-sequence.
- **External**: This triggering source provides slope, level, and the same modes as the internal sources. The input signal may be up to 42 V p-p in amplitude. A fuse (not user accessible) protects the common input.

Trigger System

The triggering system provides triggering from the channel 1 or 2 signals or from the External Trigger input. Types of trigger signals recognized include:

- **Internal**: This familiar type of triggering is fully configurable for source, slope, coupling, and mode. The selectable modes are autolevel, auto-baseline, normal, and single-sequence.
- **External**: This triggering source provides slope, level, and the same modes as the internal sources. The input signal may be up to 42 V p-p in amplitude. Fuses (not user accessible) protect both the signal and common inputs.

You can choose where the trigger point is located within the acquired waveform record by selecting the amount of pretrigger data displayed. The available presets are pre-trigger, mid-trigger and post-trigger.

Acquisition Control

Depending on your measurement requirements, you can specify the mode and manner in which signals are acquired and processed:

- You select equivalent-time sampling on repetitive signals whenever you set the SEC/DIV setting to less than 5 µs/div. Equivalent-time sampling increases the apparent sample rate for a waveform when you exceed the maximum real-time rates.
- The mode available for acquiring signals are peak-detect, high-resolution, sample, envelope, and average.
- The acquisition can be set to stop after a single acquisition (or sequence of acquisitions if acquiring in average or envelope modes).

Auto Setup

Auto Setup automatically sets up the Digital Storage Oscilloscope for a good initial display of the input signal. The selected channel, with its vertical scale within a box, is vertically sized and the TIME/DIV is set to display one or more periods. The oscilloscope selects auto-level trigger mode to ensure stable triggering.

Storage and I/O

You can save four acquired waveforms and four front-panel setups in nonvolatile reference (REF) memory. Any or all of the REF waveforms can be displayed for comparison with the currently acquired waveforms.

To save a waveform or a front-panel setting, you choose its source and destination. For example, you could save the channel 1 signal as REF1, REF2, REF3, or REF4. You can also write reference waveforms into REF memory locations using the RS-232-C interface.

Display

The 222A Digital Storage Oscilloscope offers flexible display options. You can customize the following attributes of your display.

- Adjust intensity of the waveforms and readouts with a knob on the rear panel.
- Set the style of the waveform display to be normal, averaged, enveloped, or continuously enveloped, which provides infinite persistence capability.
- Select either XY or YT display format.
- Adjust focus with a screwdriver adjustment on the rear panel.

Magnification

The 222A provides an easy way to focus in on those waveform features you wish to examine up close. By pressing the **X10 MAG** control, you can magnify the acquired waveform horizontally. You then use the horizontal **POS** knob to move the waveform left or right to view the full extent of the magnified waveform.

Nominal Traits

This subsection contains a collection of tables that list the various *nominal traits* that describe the 222A Digital Storage Oscilloscope. Included are electrical and mechanical traits.

Nominal traits are described using simple statements of fact such as "Two full-featured" for the trait "Input Channels, Number of," rather than in terms of limits that are performance requirements.

Table 1-1: Nominal Traits – Vertical System

Name	Description
Digitizers, Number of	Two, both identical
Digitized Bits, Number of	8 bits, 25 levels per division, 10.24 divisions of dynamic range
Input Channels, Number of	Two full-featured (CH 1 and CH 2)
Input Coupling	DC, AC, GND or OFF
Maximum Input Voltage, Probe Tip to Common	400 V (DC + peak AC); derate with increased frequency according to Figure 1-1
Maximum Input Voltage, Probe Common to Chassis	400 V (DC + peak AC); derate with increased frequency according to Figure 1-2
Maximum Input Voltage, Between Channels	800 V (DC + peak AC)
Pulse Width, Minimum Detectable	Envelope and Continuous Envelope Modes: 100 ns.
Range, Sensitivity, CH 1 and CH 2	1X probe: 5 mV/div to 50 V/div in a 1-2-5 settings sequence 10X probe: 50 mV/div to 200 V/div in a 1-2-5 settings sequence
Single Shot Storage, Useful Bandwidth[1]	Normal Acquisition Mode: $\frac{5}{SEC/DIV\ \ Setting}$ Hz or 1 MHz, whichever is less Envelope and Continuous Envelope Modes: 1 MHz

[1]Useful Storage bandwidth is limited to the frequency where there are 10 Display Sample/Sine Wave Signal period. At Sec/Div Settings faster than 5 µs/Div, Storage Bandwidths limited to 1 MHz max sampling rate.

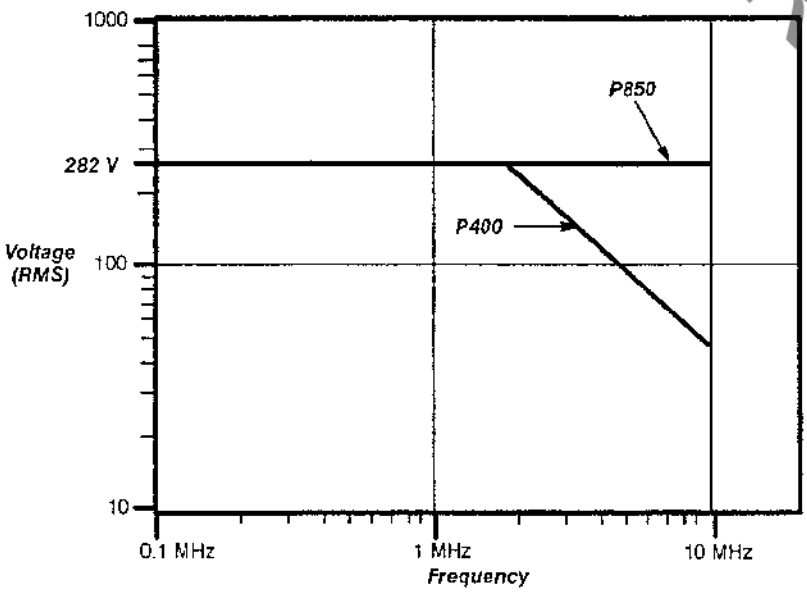

Figure 1-1: Maximum Normal-Mode Voltage Versus Frequency Derating Curve

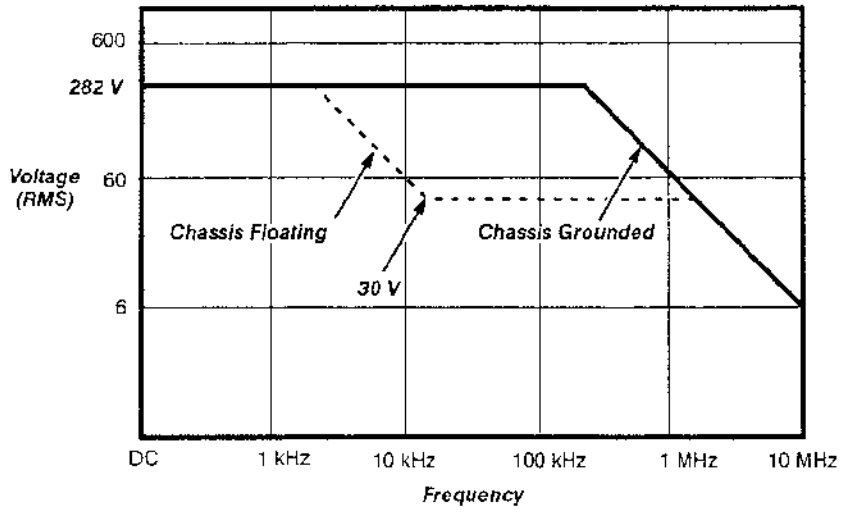

Figure 1-2: Maximum Common-Mode Voltage Versus Frequency Derating Curve

Table 1-2: Nominal Traits — Horizontal System

Name	Description		
Range, Sample-Rate	Time/Div	Acquisition Mode	Sample-Rate Range
	5 μs to 20 s/div	Normal	50/(sec/div) Samples/sec
	2 μs/div	Normal	5 MSamples/sec
	50 ns to 1 μs/div	Normal	10 MSample/sec
	20 μs to 20 s/div	Envelope	10 MSample/sec
Range, Seconds/Division	50 ns/div to 20 s/div; the X10 MAG control extends the maximum sweep speed to 5 ns/div		
Record Length	512 points; 50 points per division		

Table 1-3: Nominal Traits — Triggering System

Name	Description
External Trigger Maximum Input Voltage[1], Input to Common, Input to Earth Ground, Common to Earth Ground	42 V (DC + peak AC)

[1]**The external trigger input is not intended for floating measurements beyond 42 volts peak.**

Table 1-4: Nominal Traits — Display System

Name	Description
CRT Display Size	Display area of 6.4 cm (2.5 in) measured diagonally
Waveform Display Graticule	Single Graticule: 8 divisions high by 10 divisions wide, where divisions are 0.5 cm by 0.5 cm (0.2 in by 0.2 in)
CRT Reflectivity	CRT filter shield has an anti-reflectance surface to aid viewing in high ambient light conditions

Table 1-5: Nominal Traits – Power System

Name	Description
Internal Battery, Type	Sealed lead-acid
External Power, Input Voltage Range Pin to Pin	DC: 12 to 28 VDC AC: 16 to 20 V AC, 47 Hz to 400 Hz
External Power, Input Voltage Range Either Pin to EXT TRIG COM or RS-232-C SGND (signal ground)	−0.5 to 28 V (DC + peak AC)

Table 1-6: Nominal Traits – Communications Interface

Name	Description
COMM PORT Interface, Type	Complies with RS-232-C specification
COMM PORT Interface, Baud Rates	300, 1200, 2400, and 9600
COMM PORT Interface, Signals	RD, TD, and SGND normally used (configured as a DCE device). When the instrument is off, a rising edge on DTR will turn instrument power on.
Maximum Input Voltage, Any Pin	25 V (DC + peak AC)

Table 1-7: Nominal Traits – Mechanical

Name	Description
Cooling Method	Conduction through cabinet walls. There are no cooling vents.
Construction Material	Cabinet/chassis parts constructed of plastic with the internal surface coated with nickel base conductive paint for shielding; circuit boards constructed of glass-laminate with predominantly surface mount components.
Finish Type	Tektronix Blue cabinet with black synthetic rubber hand grips and black vinyl probe pouch.
Weight	Without accessories 2 kg (4.4 lbs) With accessories 2.72 kg (6.0 lbs)
Overall Dimensions	Height: 86.4 mm (3.4 in) Width: 159 mm (6.25 in), with handle. Length: 252 mm (9.9 in)
Probe Length, Detachable	2.0 m (78.7 in), P400

Warranted Characteristics

This subsection lists the various *warranted characteristics* that describe the 222A Digital Storage Oscilloscope. Included are electrical and environmental characteristics.

Warranted characteristics are described in terms of quantifiable performance limits which are warranted.

NOTE

In these tables, those warranted characteristics that are checked in the procedure Performance Verification, *found in Section 4, appear in* ***boldface type*** *under the column* **Name**.

As stated above, this subsection lists only warranted characteristics. A list of *typical characteristics* starts on page 1-13.

Performance Conditions

The electrical characteristics found in these tables of warranted characteristics apply when the scope has been adjusted at an ambient temperature between +15°C and +35°C and is operating at an ambient temperature within ±5°C of the temperature at which self-calibration was performed (unless otherwise noted).

Table 1-8: Warranted Characteristics – Vertical System

Name	Description
Accuracy, DC Gain (+15 to +35°C)	±4%, valid when self cal performed within ±5°C of ambient temperature
Accuracy, DC Gain (Ambient Temperature -15 to +15°C and +35 to +55°C)	±5%, valid when self cal performed within ±5°C of ambient temperature
Analog Bandwidth, Repetitive Signal[1]	$\frac{5}{SEC/DIV\ \ Setting}$ Hz or 10 MHz whichever is less
Balance, DC	±0.2 divisions maximum trace shift between VOLTS/DIV settings, valid when self cal performed within ±5°C of ambient temperature
Balance, Invert	±0.4 divisions maximum trace shift between inverted and non-inverted displays, valid when self cal performed within ±5°C of ambient temperature

[1]**Useful repetitive bandwidth is limited to the frequency at which 10 display samples are acquired for each sine wave period. For example at 10 µs per division the useful repetitive bandwidth is 500 kHz. At SEC/DIV settings faster than 0.5 µs/div, repetitive bandwidth is limited to 10 MHz by the input amplifier.**

Table 1-8: Warranted Characteristics — Vertical System (Cont.)

Name	Description
Input Current	2.5 nA maximum (0.5 divisions or less when switching between DC and GND input coupling with VOLTS/DIV set at 5 mV/div.
Pulse Response Aberrations, Low Frequency	±3% maximum (0.15 divisions with a 5 division signal displayed)
Rise Time, Useful for Repetitive Signals	$\frac{(SEC/DIV\ \ Setting) \times 1.6}{50}$ or 35 ns, whichever is greater

Table 1-9: Warranted Characteristics — Horizontal System

Name	Description
Accuracy, Displayed (X1)	±2% with X1 magnification
Accuracy, Displayed (X10)	±5% with X10 magnification

Table 1-10: Warranted Characteristics — Triggering System

Name	Description
Jitter, Trigger	2 µs/div to 50 ns/div: 1/50 division ±2 ns in X1 magnification 1/5 division ±2 ns in X10 magnification
Sensitivity, CH 1 and CH 2[1]	0.5 division p-p at 10 MHz
Sensitivity, External Trigger	250 mV p-p at 10 MHz

[1]**The minimum sensitivity for obtaining a stable trigger. A stable trigger results in a uniform, regular display triggered on the selected slope. The trigger point must not switch between opposite slopes on the waveform, and the display must not "roll" across the screen on successive acquisitions. The TRIG'D LED stays constantly lit when the SEC/DIV setting is 2 ms or faster but may flash when the SEC/DIV setting is 10 ms or slower.**

Table 1-11: Warranted Characteristics -- Environmental, Safety, and Reliability

Name	Description
Atmospherics	Temperature: -15°C to +55°C, operating; -30°C to +70°C, non-operating Relative humidity: 0 to 95% (-5%, +0%), operating to +55°C; non-operating to +60°C Altitude: Operating: to 15,000 ft. (4572 m); Nonoperating: to 50,000 ft. (15240 m); Maximum Operating Temperature decreases 1°C/1000 ft. above 5000 ft.
Dynamics	Vibration, Sinusoidal (Operating and Nonoperating): Meets or exceeds MIL-T-28800D, Class III Shock, 50 g, half-sine, 11 ms duration: Meets or exceeds MIL-T-28800D, Class III
Emissions, Electromagnetic	Meets or exceeds the requirements of the following standards: VDE 0871, Class B FCC Rules and Regulations, Part 15, Subpart J, Class A
User-Misuse Simulation	Resistance to Electrostatic Discharge: Meets or exceeds IEC 801-2 (15 kV maximum vulnerability test level) Resistance to Power line Misuse: Meets or exceeds MIL-T-28800D Resistance to Bench Handling (Operating and Nonoperating): Meets or exceeds MIL-T-28800D Resistance to Mishandling During Bench Use (Operating and Nonoperating): One 4-inch or balance point drop per corner

Typical Characteristics

This subsection contains tables that lists the various *typical characteristics* that describe the 222A Digital Storage Oscilloscope.

Typical characteristics are described in terms of typical or average performance. Typical characteristics are not warranted.

This subsection lists only typical characteristics. A list of warranted characteristics starts on page 1-9.

Table 1-12: Typical Characteristics — Vertical System

Name	Description
Common Mode Rejection Ratio DC–100 kHz	60 dB minimum (P850 probe), 1000:1 80 dB minimum (P400 probe), 10,000:1
Input Capacitance, Common to Chassis	150 pF
Input Capacitance Probe Tip to Common	X1 probe (P400): 30 pF X10 probe (P850): 4.5 pF
Input Resistance, Probe Tip to Common	X1 probe: 1 MΩ X10 probe: 10 MΩ
Isolation, Common Mode DC–100 kHz	80 dB minimum
Isolation, Normal Mode DC–100 kHZ	80 dB minimum, 10,000:1
Slew Rate, Maximum Common Mode	10,000 V/μs
Range, Position, CH 1 and CH 2	± 12 divisions minimum
Range, Variable VOLTS/DIV	Increases deflection factor by ≥250%
Pulse Response Aberrations, High Frequency	+ 6%, −6%, or 6% p-p maximum

Table 1-13: Typical Characteristics — Horizontal System

Name	Description
Accuracy, Sample Rate	±0.01%
Position Control Range	Either end of waveform can be positioned past the center vertical graticule line
Display Sweep Length	10.24 divisions
Delay Between Channels	5 ns maximum

Table 1-14: Typical Characteristics — Triggering System

Name	Description
Input Capacitance, External Input	18 pF
Input Resistance, External Input	1 MΩ
Trigger Level Range, External Input	±2.0 V
Trigger Level Range, Internal	±20 divisions

Table 1-15: Typical Characteristics — Power System

Name	Description
Battery, Charge Time	Three hours for full charge with instrument turned off
Battery, Excessive Discharge Protection	Instrument operation automatically interrupted when battery voltage drops to 7.32 VDC
Battery, Minimum Operating Time	3 hours at 25°C
Battery, Capacity Over Operating Temperature	−15°C: 80% 25°C: 100% 55°C: 110%
Current, Demand	1 amp Max (when charging battery)
Power Consumption, Maximum	15 watts or 16 VA (maximum power demand occurs when charging the battery)

Operating Information

Replace this page with the tab divider of the same name.

General Information

This section contains information about the 222A power requirements, how to connect and configure probes, the operating environment, and repackaging instructions.

Supplying Operating Power

You can supply power to the 222A from the internal battery or by connecting it to external power. This section explains how to do both. It also explains how to charge and change the battery when necessary. You will also find information on the power requirements of the 222A, the External Power AC Adapter, external supply voltages, general battery information, an alternate battery-charging method, and battery replacement.

Safety

Read the *Safety Summary* (preceding Section 1 of this manual) and this subsection before connecting the 222A to a power source.

Connecting the Battery

The battery is charged at the factory, but the 222A is shipped with the battery disconnected to prolong its shelf life. In order to use the battery for the first time, you must connect it as shown in Figure 2-1. To do so, follow these steps.

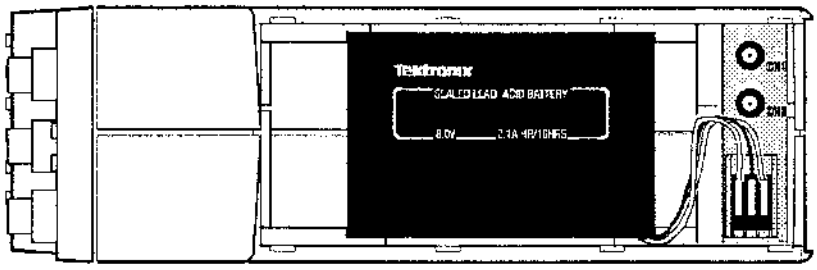

Figure 2-1: Side View Without Battery Cover

☐ **Step 1:** Place the oscilloscope on its left side as viewed from the front panel.

☐ **Step 2:** Disconnect the probes (if they are connected) and remove them from the probe pouch.

☐ **Step 3:** Slide the battery compartment cover and probe pouch toward the rear of the instrument to unlock the locking tabs.

☐ **Step 4:** Lift the battery compartment cover and remove it. The instrument now appears as shown in Figure 2-1.

☐ **Step 5:** Connect the three-wire battery connector to the pins at the rear of the instrument. The orientation of the connector does not matter.

☐ **Step 6:** Replace the battery compartment cover. Position the cover locking tabs into the matching slots in the battery compartment. Make sure the locking tabs are all the way in the slots on both the top and the bottom. If the tabs don't seat easily, first seat the top tabs, and then press on the bottom of the cover to seat the bottom tabs.

☐ **Step 7:** Push forward on the rear of the battery compartment cover to lock the tabs.

☐ **Step 8:** Charge the battery for three hours as soon as possible. Use the instructions below.

NOTE

The instrument is shipped from the factory with the battery charged. However, the state of the battery charge at the time you receive the instrument is unknown. Therefore, we recommend that you charge the battery for three hours before operating the 222A for the first time.

Battery Operation

The 222A comes supplied with a battery for use when portable operation is necessary. In order to operate the 222A from battery power, ensure that the battery is connected and then press the **ON** button.

Completely recharge the battery as soon as possible after each use of the instrument under battery power.

NOTE

Even when the instrument is turned off, current trickles slowly from the battery. If the current drawn off in this way depletes the battery below 7.32 V, the instrument cannot be started on battery power. If this occurs, recharge the battery immediately.

Charging the Battery

Under the worst circumstances, the battery will need to be recharged after three hours of operation. Under better circumstances, it may need recharging less often. The battery will last longer, however, if you recharge the instrument after each use.

When the battery charge is low, a low-battery indicator ⊟ appears in the upper right corner of the display. If the battery voltage drops below 7.32 V, the 222A automatically turns itself off.

In order to charge the battery, plug in the External Power AC Adapter as described on page 2-6 and leave the instrument turned off for three hours.

NOTE

The 222A battery recharges whenever it is plugged into external power. However, the battery recharges faster when the 222A is turned off.

If the battery charge is very low, the 222A may have an unstable display or it may shut off soon after power up. In either case, charge the battery for at least one hour before attempting to use the oscilloscope.

Charging the Battery Externally

You can charge the battery outside the instrument using the optional External Battery Charger accessory with the External Power AC Adapter. You can also use any other charger that supplies 9.8 VDC at 20°C with the supply current limited to 1 A. For best results in various temperatures, thermally compensate the charging voltage by −10 mV per degree C.

For example, at 50°C, the charging voltage should be

$$9.80\ V + [(50 - 20) \times -10\ mV] = 9.50\ V$$

Time-out Feature

An automatic time-out feature prevents the battery from being discharged when the instrument is unattended for a long period. When the time-out feature is enabled, the 222A turns itself off after two minutes of operating under battery power with no changes to the controls. You can turn the instrument on again by pressing the **ON** button. The time-out feature does not operate when external power is applied.

You can disable the time-out feature so that the instrument remains on indefinitely under battery power, regardless of whether you change any settings. You can also enable the time-out feature again when you wish. To do so, follow these steps.

☐ **Step 1:** Press the **AUX FUNCT** button on the top panel to display the auxiliary functions menu. The display appears as shown in Figure 2-2.

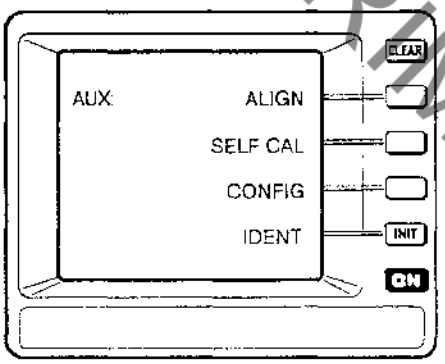

Figure 2-2: Selecting CONFIG from the AUX FUNCT Menu

☐ **Step 2:** Press the menu button aligned with the **CONFIG** menu item — the third menu button from the top — to access the configuration menu. The display now appears as shown in Figure 2-3.

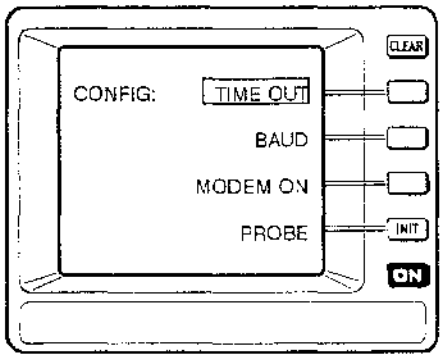

Figure 2-3: CONFIG Submenu with TIME OUT Selected

☐ **Step 3:** The **TIME OUT** menu item appears boxed when the time-out feature is enabled. To disable the time-out feature, press the top menu button, the one that is aligned with it. The **TIME OUT** item no longer appears boxed, and the feature is disabled.

This menu item is a toggle. Repeating this procedure re-enables the time-out feature and boxes the menu item again.

☐ **Step 4:** To clear the menu from the display, press the button labeled **CLEAR**.

Replacing the Battery

If you use the instrument on battery power often, you may wish to get and charge extra batteries to take with you. Then, when the battery charge inside the instrument gets low, you can switch to one of the fully charged spare batteries.

NOTE

Because saved data such as waveforms, front-panel settings, or configurations will be lost after 30 seconds (worst case) without power, have the spare battery handy before beginning this procedure.

To replace the battery, follow these steps.

- ☐ **Step 1:** Open the battery compartment as described in the procedure on page 2-1.
- ☐ **Step 2:** Disconnect the battery from the three-wire battery connector.
- ☐ **Step 3:** Lift the battery pack out of the battery compartment.
- ☐ **Step 4:** Place the charged replacement battery into the battery compartment with the battery leads on the bottom facing toward the three-wire battery connector.
- ☐ **Step 5:** Connect the battery to the three-wire battery connector.
- ☐ **Step 6:** Close the battery compartment as described in the procedure on page 2-1.
- ☐ **Step 7:** Recharge the low battery as soon as possible. See the procedure on page 2-3.

Storing the Instrument

When storing the instrument for a period shorter than two months, leave the battery inside it. When the instrument is turned off, the current drawn from the battery is less than 1 mA.

With the battery installed, waveform settings and front panel setups remain stored in memory; they are available when the oscilloscope is turned on again.

When storing the instrument for a period longer than two months, follow these steps to extend the life of your battery and instrument.

- ☐ **Step 1:** Charge the battery fully (follow the instructions on page 2-2).
- ☐ **Step 2:** Remove the battery from the instrument (follow the instructions on page 2-1).
- ☐ **Step 3:** Store the fully charged battery in a cool place.

Deep Discharge

Under certain circumstances, the battery can become deeply discharged. When the battery is in this state, it accepts a charge very slowly; in some cases, it may not accept a charge at all.

A deep discharge condition can be caused by three conditions:

- using the instrument until the battery charge is low and then storing it without recharging it
- storing the battery in a discharged state
- storing the instrument for over two months without removing the battery

If the battery becomes deeply discharged, you may be able to recover it with the following procedure.

☐ **Step 1:** Charge the battery for 24 hours as described on page 2-2.

☐ **Step 2:** If the battery does not retain the charge, remove it from the instrument and try again to charge it using a 20 V power supply that is current limited to 100 mA.

☐ **Step 3:** During this operation, check the power supply frequently for a current-limited state. If the battery recovers from its state of deep discharge, it will cause the power supply to current-limit. Do not leave the battery connected to the external power supply without checking it frequently.

☐ **Step 4:** If the power supply shows that it is current-limited, reinstall the battery in the instrument.

☐ **Step 5:** Continue to recharge the battery as described on page 2-2.

☐ **Step 6:** If the battery does not recover, dispose of it safely.

AC Line Operation

The 222A comes with an External Power AC Adapter. This adapter converts AC line voltage to the 16–20 VAC input voltage that the instrument requires. When used, it also recharges the 222A's battery.

You can operate the 222A on external power when the battery is not installed. For instructions on removing the battery, see page 2-5.

NOTE

In order to maintain the battery charge for times when portable operation is required, we recommend that you use the External Power AC Adapter whenever practical.

In order to operate the instrument from line power, follow these steps.

☐ **Step 1:** Plug the jack end of the External Power AC Adapter into the external power input on the rear panel of the instrument.

☐ **Step 2:** Plug the prong end of the External Power AC Adapter into an AC power source.

Figure 2-4 shows the External Power AC Adapter and the external power input.

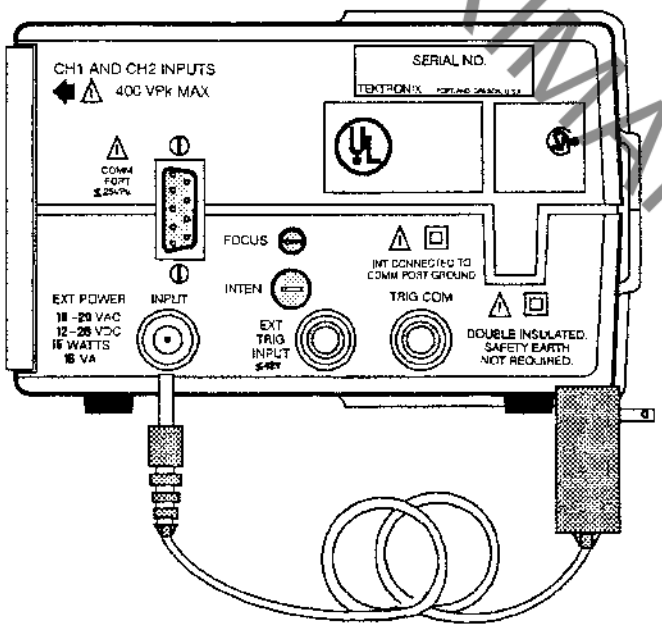

Figure 2-4: Rear Panel Connection of the External Power AC Adapter

☐ **Step 3:** Press the **ON** button to turn on the 222A. The instrument beeps when it is turned on.

When the oscilloscope is operating under external power, an external power indicator appears in the upper right corner of the display.

☐ **Step 4:** Press the same button again to turn off the 222A when you are finished.

Other Sources of External Power

You can operate the 222A from your own external power source. The power source must supply at least 15 W or 16 volt-amperes within the following limits:

- An AC power source must provide 16–20 VAC at 47–400 Hz.
- A DC power source must provide 12–28 VDC.

The external power input connector has two contacts. DC power of either polarity can be supplied between contacts.

WARNING

To avoid possible injury or damage to 222A or equipment connected to it, do not float the external trigger common connector, the RS-232-C communications port, or the external power input above 42 V peak. These inputs are not electrically isolated from each other.

NOTE

To prevent internal fuses being blown, do not force either pin lower than ½ volt more negative than the instrument chassis. The instrument chassis is connected to the ground pin of the RS-232 communications port and to the external trigger connector common.

Probes

CAUTION

To prevent improper operation and the risk of electric shock, use only Tektronix P400 or P850 probes with this instrument.

Actual probe attenuation factors are 3X for the P400 probe and 30X for the P850 probe. The instrument is calibrated to compensate for these attenuation factors. Other probes or input devices will therefore give incorrect amplitude displays.

WARNING

To avoid personal injury or damage to the 222A or the probes, do not apply more than 400 V peak between probe tip and earth ground, between probe tip and probe common, or between probe common and earth ground.

The P850 does not increase the 400 V (DC + pk AC) maximum input rating of the 222A.

Connecting the Probes

The input connectors for the probes are inside the pouch over the battery compartment, on the right side of the oscilloscope as you face the screen. You must unzip or remove the pouch to access the connectors.

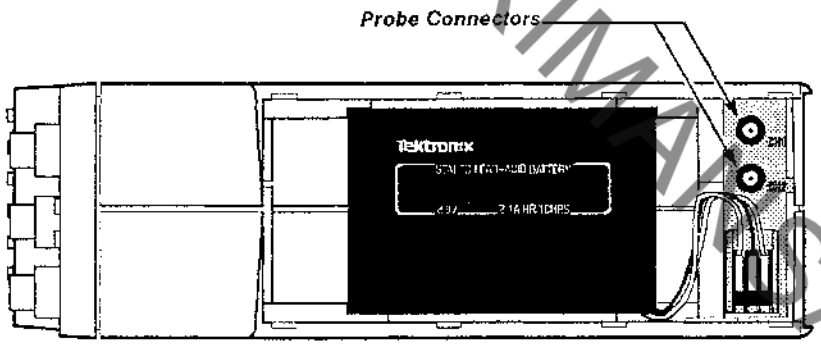

Figure 2-5: Side View Showing Probe Connectors (Pouch Removed)

To connect a probe, place its jack end into a channel input connector. Press until you feel the probe is firmly seated.

You do not need to disconnect the probes before storing them in the pouch.

CAUTION

The exposed probe tips are sharp for probing through solder-resin and oxide layers. When placing the probes in the side pouch, store them with the retractable hook tip attached to prevent unnecessary damage to the pouch.

Configuring the Probes

To ensure that the 222A is operating with the correct settings, configure the instrument to match the probes you are using.

To set the probe configuration, follow these steps.

☐ **Step 1:** Press the **AUX FUNCT** button on the top panel to display the auxiliary functions menu, as shown in Figure 2-6.

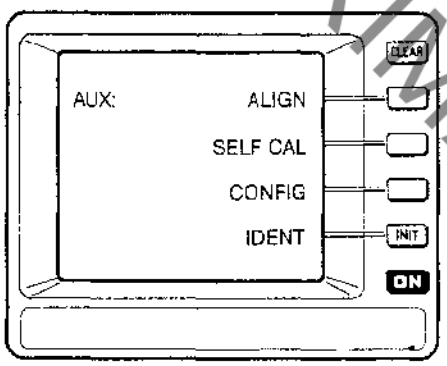

Figure 2-6: The Auxiliary Functions Menu

☐ **Step 2:** Press the menu button next to the **CONFIG** menu item to access the configuration menu. The display now appears as shown in Figure 2-7.

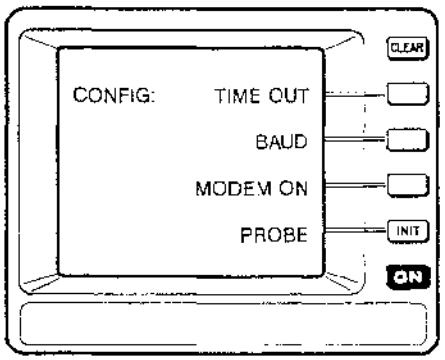

Figure 2-7: The Configuration Menu

☐ **Step 3:** Press the menu button next to the **PROBE** menu item to access the probe menu, as shown in Figure 2-8.

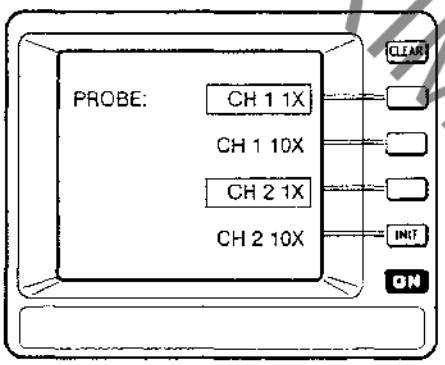

Figure 2-8: The Probe Menu

☐ **Step 4:** Boxes appear around the items that represent the current probe configuration. The default configuration for the 222A assumes 1X probes on both channels. Therefore, those menu items appear boxed unless you have already changed the probe configuration.

Press the menu button or buttons next to the menu items corresponding to the configuration you need. If the current probe settings are appropriate, you need not press any buttons.

☐ **Step 5:** After you have configured the 222A for the correct probes, press the **CLEAR** button to remove the menu from the display.

NOTE

The probe configurations are in the 222A memory. They remain there until you change them again or until the memory loses power. If the probe configuration is lost, it returns to the default value of 1Xprobes for both channels.

Repackaging for Shipment

We recommend that you save the original carton and packing material in the event it is necessary for the oscilloscope to be reshipped using a commercial transport carrier. If the original materials are unfit or not available, then repackage the instrument using the following procedure.

1. Use a corrugated cardboard shipping carton with a test strength of at least 275 pounds and an inside dimension at least six inches greater than the instrument dimensions.
2. Enclose the following information: owner's address, name and phone number of a contact person, serial number of the instrument, reason for returning, and a complete description of the service required.
3. Disconnect the battery cable before shipping the oscilloscope.

4. Completely wrap the instrument with polyethylene sheeting or equivalent to protect the outside finish and keep harmful substances out of the instrument.
5. Cushion the instrument on all sides with three inches of padding material or urethane foam, tightly packed between the carton and the instrument.
6. Seal the shipping carton with an industrial stapler or strapping tape.
7. Mark your return address on the shipping carton. Send the carton to the following address.

   Tektronix, Inc.
   4106 N. Vancouver Ave.
   Portland, OR 97217

   Attention: 200 Series Warranty Repair

NOTE

Most instruments will be returned within 24 hours of receipt at Tektronix, Inc.

Installed Options

Your instrument may be equipped with one or more instrument options. All options and optional accessories are listed and described in Section 7, *Options*.

General Operating Instructions

This chapter describes the controls, connectors, and display readouts of the 222A Digital Storage Oscilloscope. It is intended to help orient you and to provide basic information. For more detailed operating instructions, see your *222A Digital Storage Oscilloscope Operator Manual.*

Front Panel Controls

The front panel for the 222A Digital Storage Oscilloscope appears as shown in Figure 2-9.

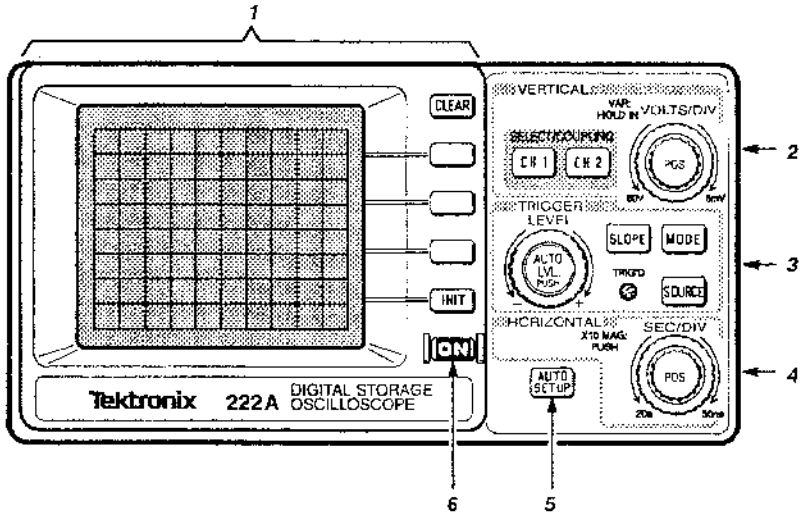

Figure 2-9: 222A Front Panel

1. The display area includes the screen and associated buttons. The screen shows signal traces, readouts, and menu items. Buttons along the side of the screen allow you to manipulate menus.
2. The vertical controls allow you to manipulate the vertical aspects of your signal.
3. The trigger controls allow you to manipulate the aspects of your signal having to do with triggering.
4. The horizontal controls allow you to manipulate the horizontal aspects of your signal.
5. **AUTO SETUP** allows you to set up the instrument with the push of a single button. Press this button for a quick, informative display of any signal between 20 Hz and 1 MHz.

AUTO SETUP sets vertical scaling, horizontal scaling, trigger mode to auto level and acquisition mode to **NONSTORE**. Coupling will change from **OFF** to **DC**, but AC coupling will not change.

6. The **ON** button toggles the instrument on or off. The instrument beeps when it is turned on.

Vertical Controls

Figure 2-10 shows the vertical controls that are located on the front panel.

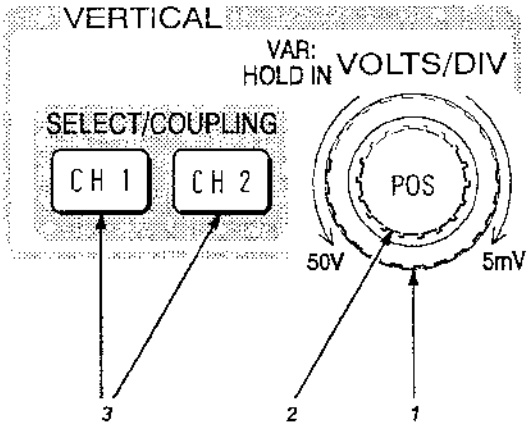

Figure 2-10: Vertical Controls

1. The outer knob sets the volts per division, which is the vertical scale of your display. Turn the knob clockwise to decrease the volts per division and counterclockwise to increase the volts per division.

2. The inner knob sets the vertical position of the signal. Turn the knob clockwise to move the signal towards the top of the screen and counter-clockwise to move the signal towards the bottom of the screen.

   Press on this knob while rotating counterclockwise to change the size of a signal to an arbitrary number of divisions. The waveform will be uncali-brated until you return the knob to its calibrated position. A beep will sound when you reach the calibrated position.

3. The 222A can display signals acquired through either or both of its two channels. The channel selector buttons allow you to select the channel that is affected by changes to the controls. With these buttons you can also select channel coupling or turn a channel off so that the signal it is measuring is not displayed.

Trigger Controls

The trigger controls are on the front panel of the 222A Digital Storage Oscilloscope. They appear as shown in Figure 2-11.

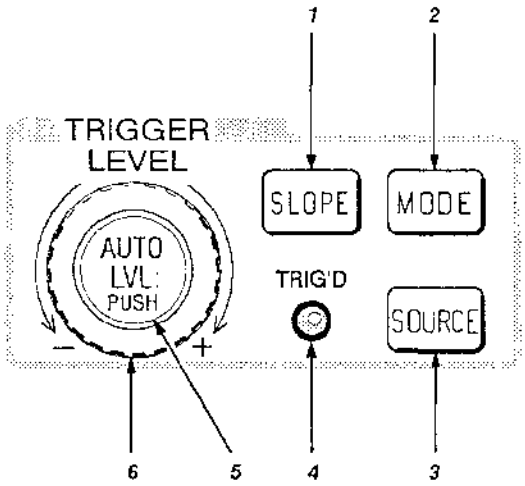

Figure 2-11: Trigger Controls

1. When you push the button labeled **SLOPE**, you toggle between a positive- and negative-trigger slope.
2. When you push the button labeled **MODE**, you invoke a menu that allows you to specify the trigger mode. The trigger mode choices are NORM, AUTOLVL (uses waveform midpoint), AUTOBL (free-running mode), or SSEQ (single-trigger mode, rearmed by pressing **INIT** button).
3. When you push the button labeled **SOURCE**, you invoke a menu that allows you to specify the trigger source. The source choices are **VERT** (lowest channel number displayed), **CH1, CH2,** or **EXT** (the rear panel external trigger input).
4. The light labeled **TRIG'D** turns on when the instrument is triggered.
5. The inner button, labeled **AUTOLVL: PUSH**, sets the trigger level automatically. When you push it, it determines the peak values and sets the trigger level to the midpoint of the signal.
6. The outer knob sets the trigger level – the threshold voltage the signal must cross in order to trigger the instrument. Turn it clockwise to raise the trigger level; turn it counterclockwise to lower the trigger level.

Horizontal Controls

The horizontal controls are on the front panel of the 222A Digital Storage Oscilloscope. They appear as shown in Figure 2-12.

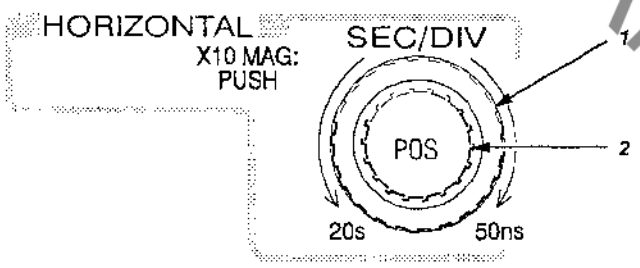

Figure 2-12: Horizontal Controls

1. The outer knob sets the seconds per division. This is the horizontal scale of your display. Turn the knob clockwise to decrease the seconds per division; turn it counterclockwise to increase the seconds per division.
2. The inner knob sets the horizontal position of the signal. Turn the knob clockwise to move the signal to the right. Turn it counterclockwise to move the signal to the left.

   Press this knob to magnify the signal by ten times. Press again to return to normal display.

The Display

The 222A display shows waveforms that represent electrical signals. However, it also shows two other kinds of information—readouts and menus.

Readouts

Readouts are numeric or symbolic information associated with a signal.

The 222A displays readouts at three places on the screen: along the top, along the bottom, and slightly above the bottom.

Readouts along the top show information associated with the vertical controls. Readouts along the bottom show information associated with the trigger and horizontal controls. The readouts just above them show information associated with saved waveforms.

Vertical Readouts — Figure 2-13 shows the vertical readouts along the top of the display. The readouts on the left refer to channel 1. The readouts on the right refer to channel 2.

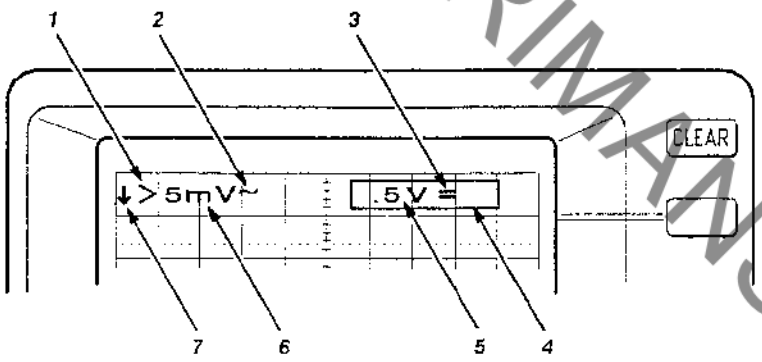

Figure 2-13: Vertical Readouts

1. The > indicates that the waveform is uncalibrated. Pressing and turning the vertical **POS** knob produces this indicator.
2. The ~ indicates AC coupling.

   A ⏚ indicates ground coupling.
3. This is the channel 2 coupling. The = indicates DC coupling.
4. The box around the channel information indicates that this channel is selected.
5. This number is the volts per division for channel 2—its vertical scaling.
6. This number is the volts per division for channel 1.

NOTE

If either channel is off, the volts-per-division number is replaced by an OFF.

7. The downward-pointing arrow indicates that the channel is inverted

Saved Waveform Readouts — Figure 2-14 shows the saved waveform readouts above the bottom of the display. The readouts refer to the last saved waveform displayed.

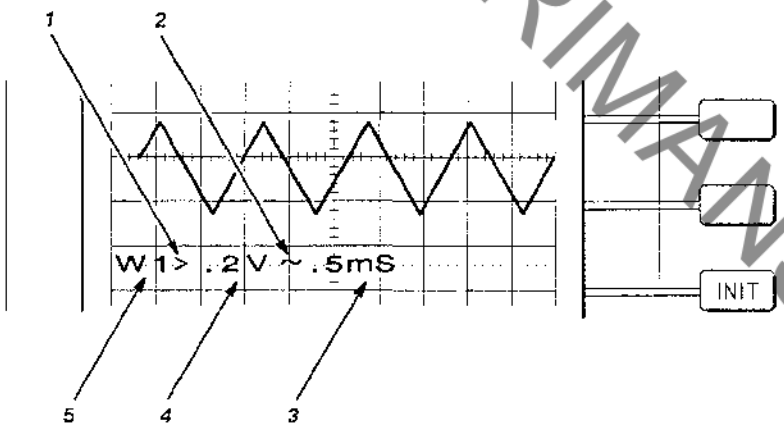

Figure 2-14: Saved Waveform Readouts

1. This indicates that the waveform is uncalibrated. This occurs when you use the variable volts-per-division control.
2. This is the channel coupling for the saved waveform.
3. This is the seconds per division setting for the saved waveform.
4. This is the volts per division setting for the saved waveform.
5. This is the memory location to which the waveform was saved. In this case, the waveform is saved in memory location 1.

Trigger and Horizontal Readouts – Figure 2-15 shows the horizontal and trigger readouts along the bottom of the display.

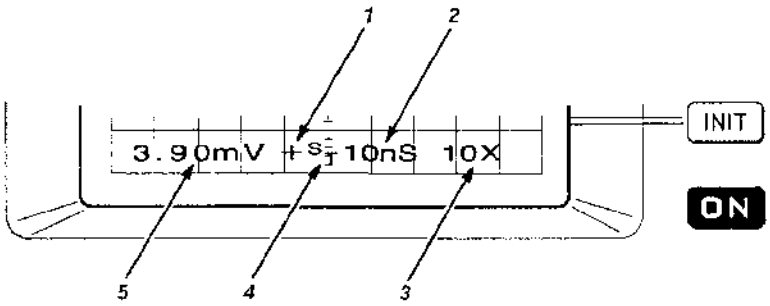

Figure 2-15: Trigger and Horizontal Readouts

1. The second from the left readout is the trigger slope. A + indicates that triggering occurs on a rising edge. A – indicates that triggering occurs on a falling edge.
2. The second from the right readout is the seconds per division – the horizontal scale factor.

3. At the right is the magnification indicator.
4. The middle readout indicates that the instrument is in store mode.
5. At the left is the trigger level in volts.

Menus and Menu Buttons

Menus are lists of choices that you can select in order to perform some action, such as placing the instrument in XY mode or turning off the time-out feature.

A number of buttons on the front and top panels of the 222A invoke menus when pressed. When a menu is on the display, you can select one of its items to perform an action. Figure 2-16 illustrates the parts of a menu.

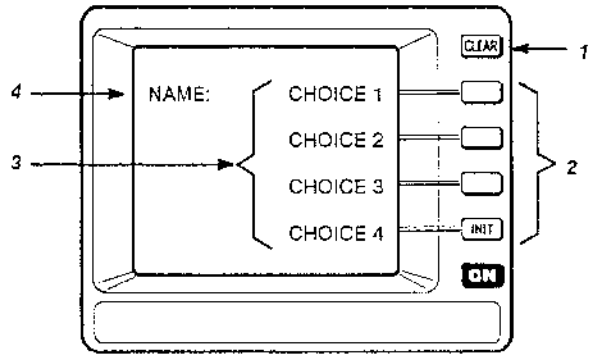

Figure 2-16: Parts of a Menu

1. The button labeled **CLEAR** erases the menu from the display.
2. The menu buttons are next to the screen, along its right edge. Pressing the button next to a menu item performs the action represented by that item.
3. The menu items appear along the right edge of the display. Up to four items can appear on a menu. Each represents a possible action you can perform.
4. The name of the menu appears at the top left of the display, followed by a colon.

Top Panel Controls

The top panel for the 222A Digital Storage Oscilloscope appears as shown in Figure 2-17.

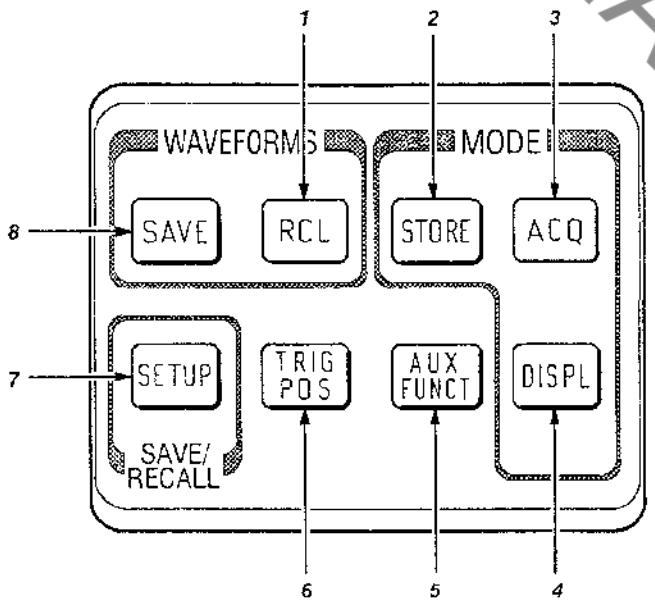

Figure 2-17: 222A Top Panel

1. Pressing the **RCL** button invokes a menu that allows you to recall saved waveforms.
2. Pressing the **STORE** button places the instrument in store mode, which displays traces between rare trigger events. In nonstore mode the screen is blanked after 30 ms without a trigger. Pressing the store button again takes the instrument out of store mode.
3. Pressing the **ACQ** button invokes a menu that allows you to specify the acquisition mode of the instrument. You can choose from four modes:
   - normal
   - averaging (reduces random noise by averaging the last four traces)
   - enveloping (displays the maximum and minimum variations of a signal)
   - continuous enveloping (displays an envelope waveform for all traces until you press the **INIT** button)
4. Pressing the **DISPL** button invokes a menu that allows you to specify whether to invert a channel, display signals in XY mode, or display signal readouts. Pressing a menu button toggles the function selection.
5. Pressing the **AUX FUNCT** button invokes a menu that allows you to execute a variety of special functions. In some cases, you may execute items from two or three layers of menus.

- ALIGN checks the display alignment.
- SELF CAL starts self-calibration routines for either channel or the external trigger input.
- You can enable or disable the time-out feature, set the baud rate, activate the modem, or select different probe types.
- You can view the instrument identification and firmware version number.

6. Pressing the **TRIG POS** button invokes a menu that allows you to specify the trigger position.
7. Pressing the **SETUP** button invokes a menu that allows you to save or recall front-panel setups.
8. Pressing the **SAVE** button invokes a menu that allows you to save waveforms.

Side Connectors

The right side of the 222A Digital Storage Oscilloscope appears as shown in Figure 2-18.

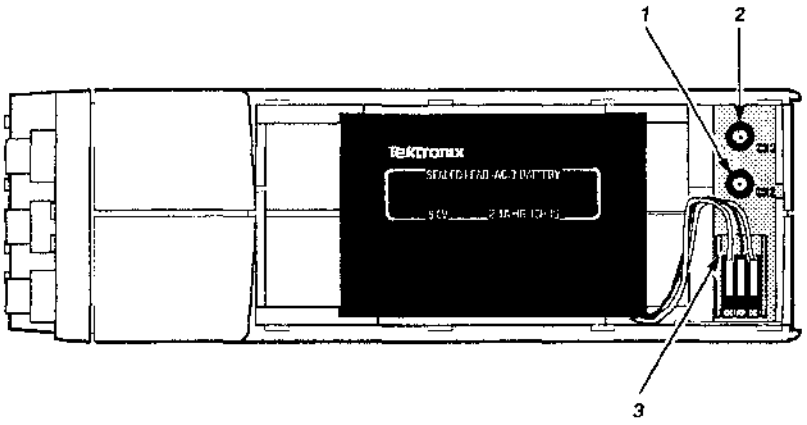

Figure 2-18: Side of 222A, Storage Pouch Removed

1. This is the probe connector for channel 2.
2. This is the probe connector for channel 1.
3. This is the battery connection.

The 222A comes with an attached storage pouch. Store the probes in the pouch when you are not using them. You do not need to disconnect the probes before you store them.

Rear Panel Controls and Connectors

The rear panel for the 222A Digital Storage Oscilloscope appears as shown in Figure 2-19.

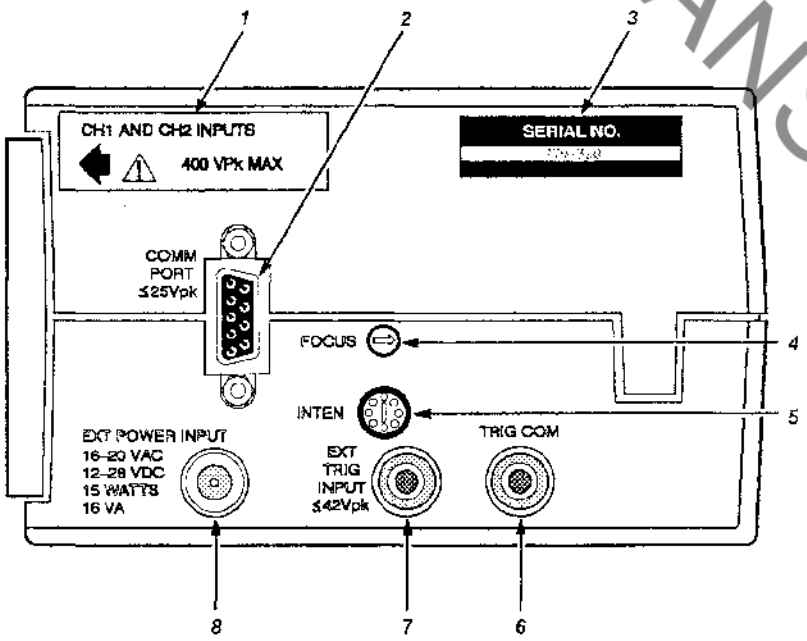

Figure 2-19: 222A Rear Panel

1. This panel points to the probe inputs on the instrument's side and indicates the 222A maximum input voltage rating.
2. This is the RS-232-C connection port for remote communications.
3. This is the instrument serial number. You will need it if you must ever arrange to ship the instrument back for maintenance.
4. This knob focuses the 222A screen. Insert a small screwdriver into the slot and turn it to adjust the focus.
5. This knob varies the brightness of the 222A screen.
6. This is the external trigger common reference connector. To use a grounded reference with your external trigger source, connect the reference signal here.

WARNING

To avoid possible injury, do not connect the trigger common reference input to voltages greater than 42 V peak. The trigger common reference input is not insulated.

7. This is the external trigger input connector. To use an external signal as a trigger source, connect the external trigger signal here.

WARNING

To avoid possible injury or damage to the 222A or equipment connected to it, do not float the external trigger common connector, the RS-232 communications port, or the external power input above 42 V peak. These inputs are not electrically isolated from each other.

8. This is the external power input. Connect the External Power AC Adapter to the input to run the instrument from line voltage.

The Tilt Stand

The 222A Digital Storage Oscilloscope comes with a tilt stand so that you can view the front-panel and screen more easily. The tilt stand folds under the instrument when not in use. To use it, lift the instrument and pull the tilt stand forward until the instrument rests on it.

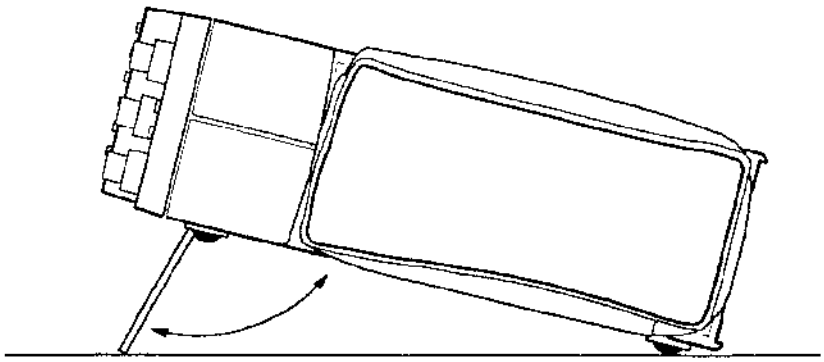

Figure 2-20: The 222A With Tilt Stand

Theory of Operation

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Circuit Description

This section describes the electrical operation of the 222A Digital Storage Oscilloscope. First, an overview discussion, based on the block diagram, gives an overall view of the module design. It is followed by a detailed circuit description based on the schematic diagrams in Section 9. These descriptions, together with the troubleshooting information in Sections 6 and 9, enable a qualified technician with the appropriate test equipment to isolate a problem to the faulty component.

This section has three main parts:

- **Logic Conventions** describes how logic functions are discussed and represented in this manual.
- **Module Overview** describes circuit operation from a functional-circuit block perspective.
- **Detailed Circuit Description** provides detailed information about the 222A Digital Storage Oscilloscope hardware with reference to the numbered schematics in Section 9.

Logic Conventions

The 222A Digital Storage Oscilloscope contains many digital logic circuits. This manual refers to these circuits with standard logic symbols and terms. Unless otherwise stated all logic functions are described using the positive-logic convention: the more positive of the two logic levels is the high (1) state, and the more negative level is the low (0) state. Signal states may also be described as "true" meaning their active state or "false" meaning their non-active state. The specific voltages that constitute a high or low state vary among the electronic devices.

Active-low signals are indicated by a tilde prefixed to the signal name (~RESET). Signal names are considered to be either active-high, active-low, or to have both active-high and active-low states.

Module Overview

This module overview describes the basic operation of each functional circuit block as shown in Figure 3-1.

General

The 222A Digital Storage Oscilloscope is a portable, two-channel instrument suitable for use in a variety of bench and field test applications. It has an internal, rechargeable battery for portable operation.

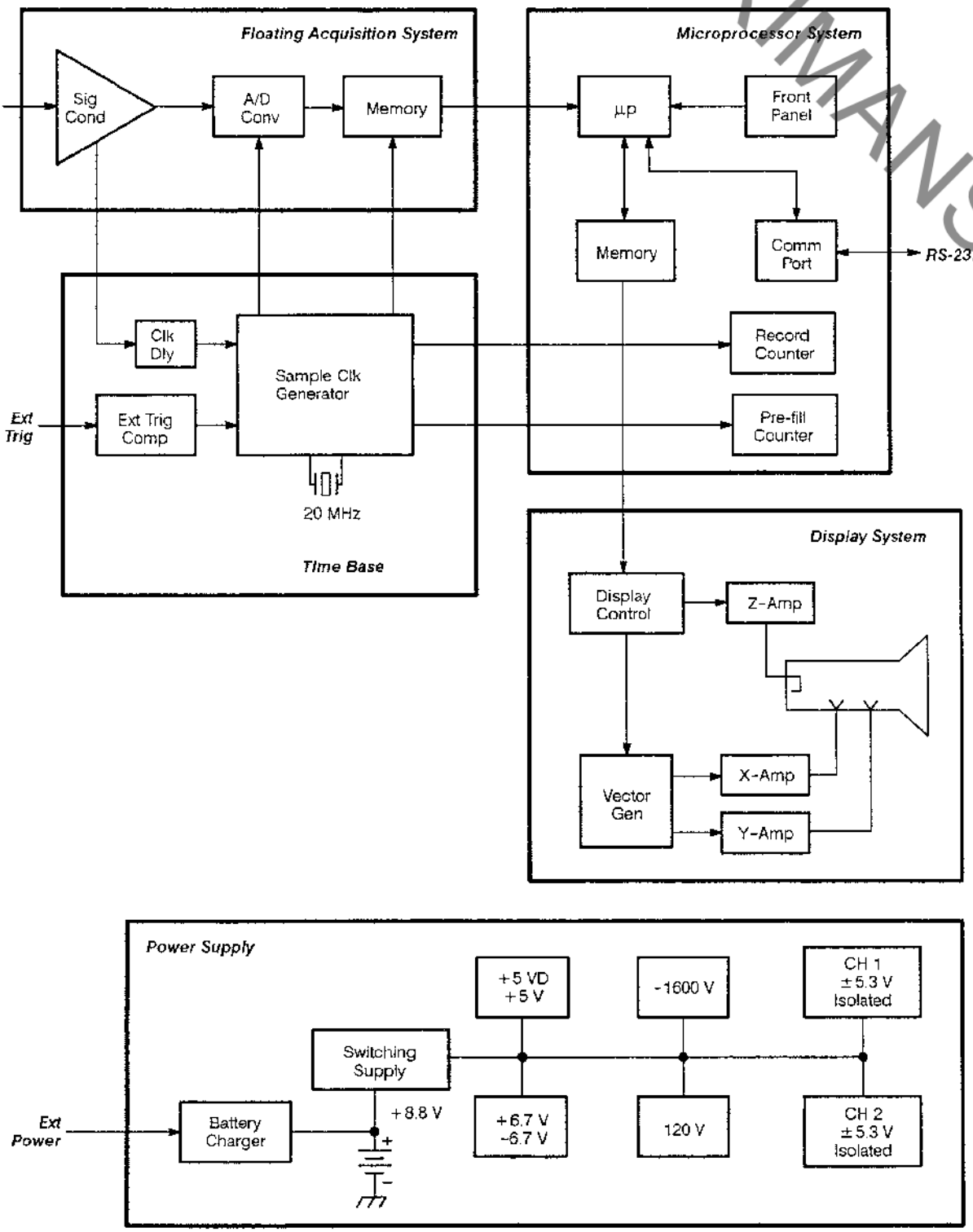

Figure 3-1: Simplified Block Diagram of the Instrument

Floating Acquisition System

An input signal is applied to the floating acquisition system which is electrically isolated from the other functional blocks. There it is amplified, offset for position and calibration, and limited to the dynamic range of the A/D converter. The signal is then digitized and stored in acquisition memory.

An internal trigger signal is derived from the input signal. The trigger signal starts events in the time base that cause the acquisition of the input signal to be completed. Acquisition is the conversion of the input signal to a series of digital values and the storing of those values in memory.

Time Base

The time base produces all acquisition clock signals needed to drive the acquisition system. Prefill and postfill sample point counters and a time interpolator determine the correct location of the trigger point in the waveform record. And the External Trigger signal, when selected, is monitored for correct slope and level.

Microprocessor System

The microprocessor system controls all instrument functions. It transfers the digital waveform data from acquisition memory to the display memory. That data can then be displayed or stored in memory for later recall and viewing. The microprocessor system scans the front-panel and top-panel switches to determine when the user presses a button. It also controls the time base, the acquisition system, and the power supplies. An RS-232-C compatible serial port provides the processor system with an interface to external communication devices. Waveform data may be sent or received over the interface, and the control settings of the instrument may be changed or queried.

Display System

In the display system the digital waveform data are converted back to analog signals. These analog points are connected by the vector generator to provide a continuous waveform display. The waveform is amplified and applied to the CRT deflection plate. Settings, status, and menu information is added to the waveform data for display.

Power Supply

Either the internal battery or the external wall transformer can supply the voltage for the power supplies. A battery charger circuit supplies charging current to the battery whenever external power is applied to the instrument. The external power can run the instrument with or without the battery installed. Separate supply circuits provide power for the CRT, the floating acquisition systems, and the remaining digital circuitry of the instrument.

Acquisition System A1

The acquisition system contains two complete, isolated vertical channels (see Figure 3-2). Each channel has its own attenuator, amplifier, trigger circuit, A/D converter, peak detector, acquisition memory, and isolated power supply. The channel grounds are isolated from each other and from instrument ground. Since the CH 1 and CH 2 circuits are similar only CH 1 is described.

Power and data and clock signals pass through pulse transformers to ensure complete isolation of each channel from the rest of the 222A system. COM1 is the common ground for the CH 1 acquisition system as COM2 is for CH 2.

Acquisition Hybrids ◇1◇4◇

The hybrid circuit AT110 contains the sample-and-hold attenuator, amplifier, and trigger circuit. The input signal from the probe connects with a Peltola connector directly onto the hybrid.

Control signals from U130 ◇2◇ switch latching relays that select X10 and X100 passive attenuators on the hybrid. The attenuators are matched to the available probes so no probe compensation is needed. The relays also select AC, DC, or OFF coupling. In OFF mode, the signal input is opened and the amplifier input is grounded.

The preamplifier has a FET input for high impedance. DC differential signals GAIN1 + and GAIN1 − set the gain. Signal GAINSW1, when high (≥2.4 V) boosts the gain for 5 mV and 10 mV/division sensitivity. The inverting input sees a DC level that is the passive sum of the selected offset level and VREF. VREF is a precision 2.5 volt reference from U101. A different DC level drives this input during self calibration. The DC signal POS1 (0 to −2.44 V) sets the signal position on screen. The amplifier has a low output impedance matched to the D/A converter U111. A limiting stage keeps the output swing to 2.5 volts. The −VREF1/2 signal centers the output for the D/A converter.

The preamplifier drives a trigger circuit on the hybrid. The trigger circuit outputs a differential trigger pulse (TRIG−1, TRIG + 1). The TRIGLVL1 (0 to −2.44 V) signal sets the trigger level. The SLOPE1 signal (CMOS) sets the trigger slope to positive when ≤0.5 V and negative when ≥2.4 V.

Control IC U120 ◇2◇ produces control signals for the AT110 hybrid and A/D converter directly and by setting the digital-to-analog converters (DAC) U131 – U133 to produce specific DC voltages. A DAC input of hexadecimal FFF (FFF_{16}) produces −2.5 V while an input of 000_{16} produces 0 V. U101 provides a reset signal (~RST1) that delays the start up of U120 by 1 ms. U134 drives the hybrid gain stages directly with a differential signal. The 0 point is the offset value 800_{16}.

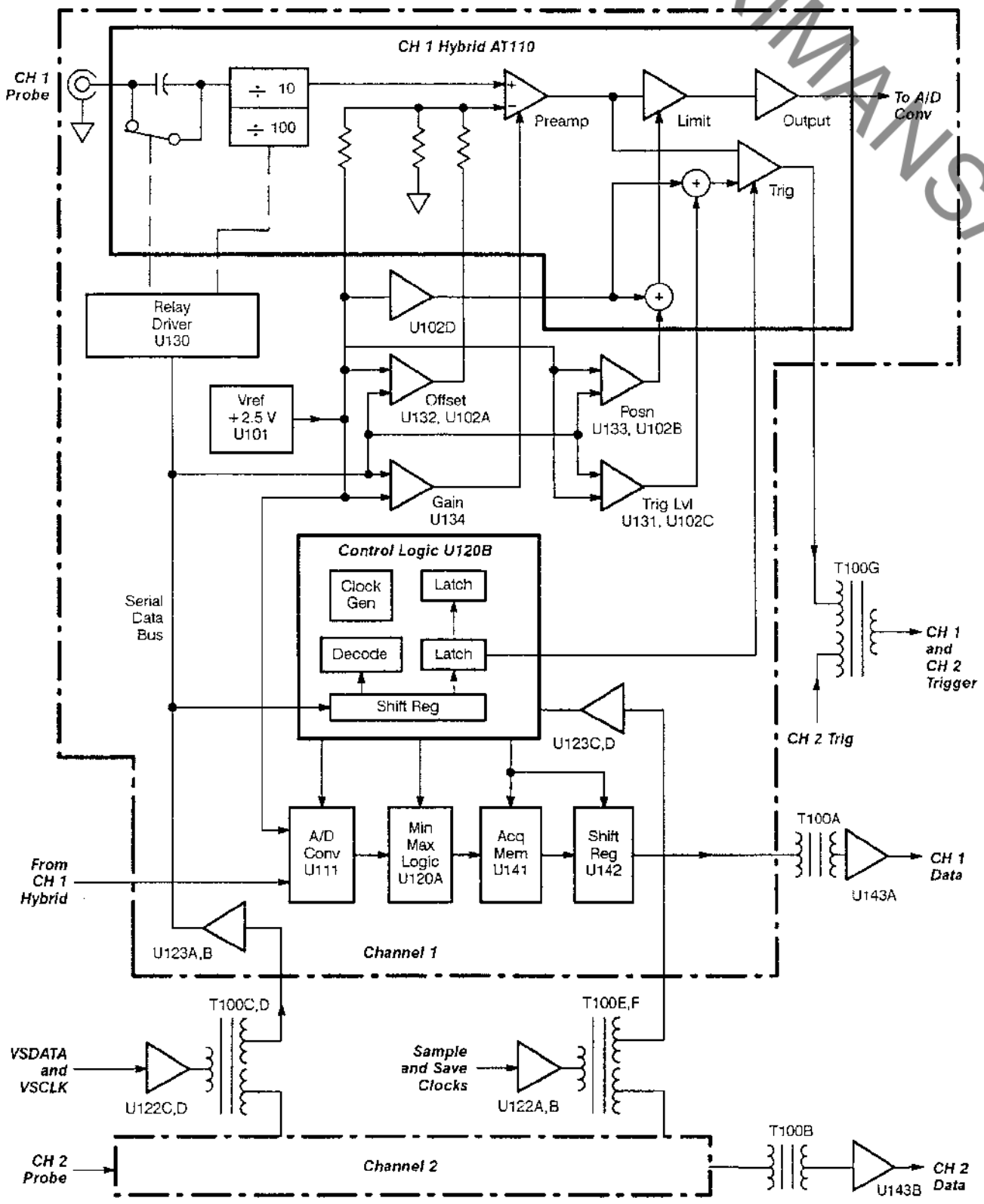

Figure 3-2: Floating Acquisition System

A/D Converter ◇1◇4

A/D converter U111 converts signal output from the AT110 amplifier into 8-bit data words. The 10 MHz sample clock SMPLCLK1 sets the conversion rate which is not changed with changes to the time/division setting. To provide lower sampling rates, data words are stored in the acquisition memory at the SAVE clock rate which varies with the time/division setting. The CH 1 digital samples are sent on data lines CH1D0–CH1D7 to the acquisition control IC U120.

Acquisition Control and Memory ◇2◇5

U120 controls the acquisition cycle, sets control voltages for the acquisition hybrid and puts sample data into memory. U120 is programmed with serial data on VSDATA1 clocked by the CPU generated SCLK1 (serial data clock). Acquisition memory is a first-in-first-out (FIFO) system. The length of the FIFO memory is 512 bytes. In the normal sample mode, data bytes are stored in acquisition memory at the 10 MHz sample clock rate. In peak and envelope modes, samples are saved internally in either a MIN or MAX register. At the next SAVE clock (which changes with the time/division setting) both the MIN and MAX data bytes are sent to memory on consecutive sample clocks. When SAVE is high, FIFOWR (FIFO memory write) follows SMPLCLK1 to save sample data in memory. At time base settings above 5 µs/div, FIFOWR follows the SAVE clock rate. When memory is full, the read signal FIFORD (FIFO memory read) will follow FIFOWR to provide room for new samples. When all samples are acquired for a waveform, data will be sent to display memory through U142.

Shift register U142 converts acquisition memory data to a serial bit stream for transfer to display memory. When acquisition is complete, SAVE will go low and FIFORD will begin going low after every eight SCLK transitions. Inverted SCLK, ~SCLK shifts the bits out U142 and through isolation transformer T100A. The serial data signal CH1DATA, out of U143B, is sent to display memory on the A2 CPU/Display board.

Isolation Interface ◇3◇6

Pulse transformers and optical isolators isolate the control signals SAVE, SAMPLE, SLOAD, VSDATA, and VSCLK from the A3 Main board. Pulse transformers provide isolation and common mode rejection for each acquisition channel from the rest of the system. The pulse transformers have windings built into the A1 Acquisition board. Core pieces fit through the board and are completed with cap pieces. The core and cap, which are held together with metal clips, must have a tight fit to work properly. Digital signal pulses appear as 10 ms pulses (≥100 mV) on the transformer secondary. The schmidt-trigger amplifiers reconstruct the digital signal. SLOAD is optically coupled on the A3 Main board.

Motor Trigger ◇3◇

The motor trigger circuit provides a stable trigger from motor power systems. Positive trigger pulses decoded by U143 cause C145 to charge. During the negative power pulses seen in a motor circuit, the charge drains through R147 in 2.25 ms, while high MOTTRIG keeps the time base from accepting triggers. Hence, all but the first positive pulse is ignored.

CPU/Display System A2

The A2 CPU/Display board contains the microprocessor system and the display system as shown in Figure 3-1. The microprocessor system controls all instrument functions. It receives instructions from the front panel and RS-232-C interface and sets the instrument for the requested function. The display system combines waveform data with status text and graphics to generate the X and Y vector signals that drive the raster display.

Microprocessor A2 ◇2◇

The microprocessor system consists of a microcontroller (CPU), program memory (EEPROM), programmable timers, address and data buffers, and an RS-232-C interface (see Figure 3-3).

U201 is an 8-bit CPU with built-in RAM, ROM, EEPROM, timers, A/D converter, and serial and parallel ports. The dedicated address bus A0–A15 outputs addresses for the ROM, display RAM, the address decoders, and external timers. The B port (PB0–PB7) provides the A8–A15 address bits. The C port is an address/data bus that provides addresses A0–A7 and data D0–D7. The internal A/D converter encodes the front panel potentiometer settings and monitors the battery voltage level.

The 8 MHz, crystal-controlled oscillator Y201 and a coupled oscillator within U201, time all processor and display functions. They are not synchronized to the 20 MHz time-base oscillator.

External EEPROM U221 and U213 provide 64 kilobytes of program memory. The internal ROM of the microprocessor contains diagnostic routines used to check out the external devices on the bus when the EEPROMs cannot be accessed. To program the EEPROMs use the Firmware Kit listed in *Optional Accessories* under *Options*, Section 7.

The CPU sends control data that sets gain, attenuation, and time base multiplexing to the display system, the acquisition system, the front panel, and the acquisition control latch. The display system only accepts serial data when its select line DSPEND is high. The front panel, acquisition control latch, and the acquisition system contain latches that are strobed so that only the desired latch is loaded and only the serial data needed for a chosen latch is sent. U222 selects a serial data source for the CPU MOSO input. Sources are channel data, front panel data and the display system (XYDATA from U251).

Shorting pins 5 and 6 of TP200 will reset the microprocessor.

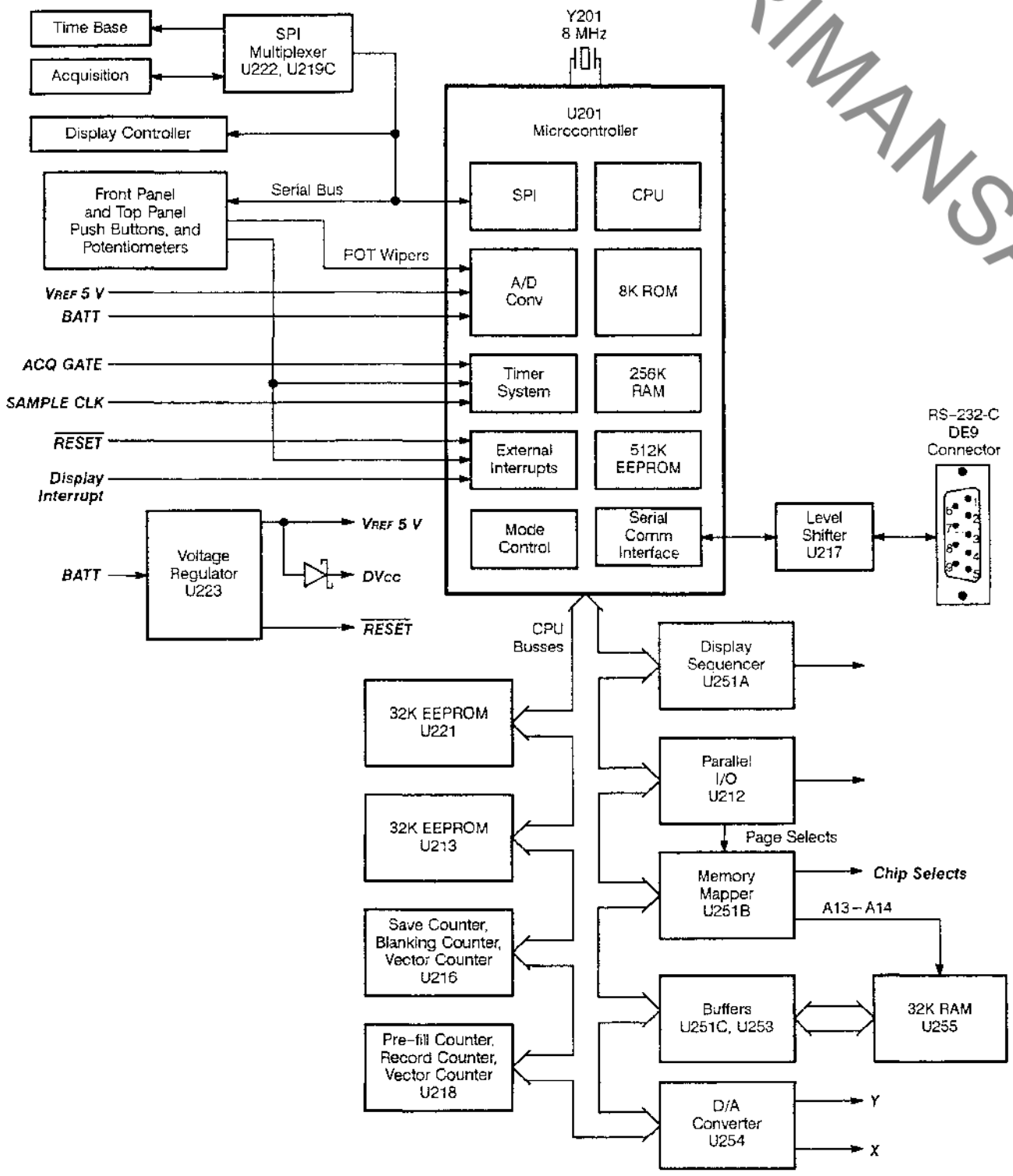

Figure 3-3: Microprocessor System Block Diagram

COMM PORT – The CPU has an asynchronous communications port that supports an RS-232-C interface. The available baud rates are 300, 1200, 2400, and 9600 (9600 is the default). Pins 20 and 21 on U201 act as data read and write lines buffered through level shifter U217. U217 converts the CMOS levels output by the CPU to level shifted ±6 V signals to conform with the RS-232-C standard. The RS-232 COMM PORT pin assignment conforms to that of the IBM® AT PC. (See the *Performance Check* for information on the pin assignments.) The COMM PORT is configured as a DTE (modem) device with a female connector. This allows direct connection to an IBM AT (or compatible) when using the adapter cable described in *Optional Accessories* under *Options,* Section 7. If the display system fails, the diagnostic software will send error messages to a connected terminal or host computer.

Display Memory – The CPU uses the lower 4 kbytes of display memory, which is implemented as an external 32K by 8 bit static CMOS RAM (U255), for system variables. The CPU also writes current waveform data, reference waveforms and front panel settings to display memory. The CPU reads data from the RAM for settings or waveform data for transmission over the RS-232-C interface. The CPU access to this RAM is interleaved with the Display Controller U251 on opposite phases of the E clock. When E is high, the CPU controls the RAM output enable. Display memory is discussed further under the Display discussion on page 3-10.

External Timers – In addition to the timers internal to the CPU, there are six external ones contained within U216 and U218. These timers, when selected by U251, are loaded by a CPU write cycle. The three counters in each IC are labeled OUT0, OUT1, and OUT2. Their purposes are as follows:

- Save Clock (U216–OUT0). Generates the clock signal <10 MHz, which is used to generate the SAVE clock for sample rates <10 MHz.
- Blanking Counter (U216–OUT1). Counts the number of starting vectors to be blanked. This provides a part of the horizontal positioning system.
- Vector Counter (U216–OUT2). Counts the total number of vectors to be displayed.
- Prefill Counter (U218–OUT0). Counts the number of data points prior to the trigger.
- Record Counter (U218–OUT1). Counts the number of data points after the trigger.
- Clock Delay Counter (U218–OUT2). Counts the time for C305 to discharge to 0.

Front Panel – The front panel consists of a switch matrix, three potentiometers, two shaft encoders, and an LED. All controls on the front panel are routed through the processor. With the exception of the three potentiometers, the front panel is interrupt driven and is only serviced when a control is moved or a button is pressed. Data is sent and received serially to keep the number of interconnections between the processor and the front panel to a minimum.

The front-panel and top-panel keypads are encoded using the same switch matrix. When one of the buttons is pressed, an interrupt is sent to the processor. The processor then latches the row data from the switch matrix and processes it to determine if a switch in that row was pressed. Each row is processed in turn to determine which switch was pressed.

Shaft Encoders – The volts-per-division and seconds-per-division shaft encoders are 16-position devices that produce a quadrature (gray code), 2-bit output. Each position change causes only one of the two bits to change states. This change is sensed and an interrupt is sent to the processor. On an interrupt, the processor latches the encoder's outputs, and then processes that information against the previous settings to determine the direction and amount of shaft rotation.

Display System A2 ◇1◇3

The display system consists of the display memory, the display controller, X and Y vector generators, and the CRT drivers (see Figure 3-4). The display memory holds the current acquired waveform as 512 16 bit words. The upper 8 bits are waveform data while the lower 8 bits are either character information or X data when an XY waveform is displayed. The least significant bit of the X data is used as a blanking bit in character mode.

Information to be displayed is stored in display memory by the CPU during one phase of the E (enabling) clock. During a display cycle (the alternate phase of the E clock), the Display Controller U251 reads data from memory and transfers it to U263, a dual 8-bit digital-to-analog converter (DAC). The analog output from the DAC drives the X- and Y-axis circuits. When displaying waveform data, the X-axis is driven by a simple single-speed sweep generator.

During a memory write cycle, the processor stores newly acquired waveform data in preparation for the next display cycle.

Display Controller – The display controller U251 consists of a state machine, display address counter, vector counter, and a blanking counter. It also latches the lower address lines on the falling edge of the address strobe AS. The state machine produces read and write signals for display memory U255. An internal counter generates memory addresses by incrementing from a CPU supplied starting address. It also controls the sweep generators, vector generators, and CRT blanking in the U218 timer.

The CPU loads control data serially to the display controller on line SO when DSPEND is high. The CPU can read the status of the display controller on the XY data line.

The vector counter (U216, Pin 20) keeps track of the number of vectors displayed. When the pre-loaded count for a display is reached, it resets the display state machine and drives DSPEND high. The blanking counter can extend the initial blanking period by a number of vector periods. The effects of the blanking counter combined with moving the starting address of the display address counter provides horizontal positioning of the waveform on the CRT.

The Display Memory is a static 32K by 8-bit RAM which is organized as 512 16-bit words. When displaying a waveform, the 16-bit word contains waveform data only and just the upper (even) byte is displayed. In XY mode and when displaying characters, the 16-bit word contains Y data in the upper byte and X or character data in the lower byte. The least significant bit of the X data is used as a blanking bit in character mode.

Vector Generator ◇3◇ — The X- and Y-vector generators are identical. They both produce a range of output voltages from 0 to 3.2 V. These voltages correspond to 10.24 divisions of calibrated deflection (X and Y). A description of the Y vector generator through a typical operation cycle follows.

Potentiometers — The three potentiometers are scanned by the processor's internal 8-bit A/D converter. Their voltage outputs are compared with previously digitized values to determine if a new level setting has been made.

Latch U257 latches the Y data (even byte) when ~DACWR is low (true) and the E line goes low. The latched data is converted by DAC U263 to an analog value. The first data point is loaded twice to give the vector generator time to reach the waveform starting point. In the XY mode, two ~DACWR pulses are sent to load the Y and X DACs. Output current from the DAC is converted to a voltage signal by U264B and applied to differential amplifier U265. The signal ~VUPDATE enables the Y and X sample and hold circuits by closing switches U270A and U270D.

For typical sweep displays the signal SWPRUN goes high on the second vector, which allows C260 to charge from -VREF. This produces the horizontal sweep ramp. U266A selects the sweep ramp when line XY is low.

The differential amplifier U266A produces an output signal that is the difference between the present DAC output (next display position) and the previous analog value (present display position). This difference signal is integrated to produce a vector that will cause a straight line to be drawn between the two points. The vector generator is bypassed in dot display mode and the CRT is blanked between dot displays.

Sweep Generator — Only a single sweep speed is needed when the display is being updated. The sweep generator produces a 500 volts-per-second ramp during sweep periods.

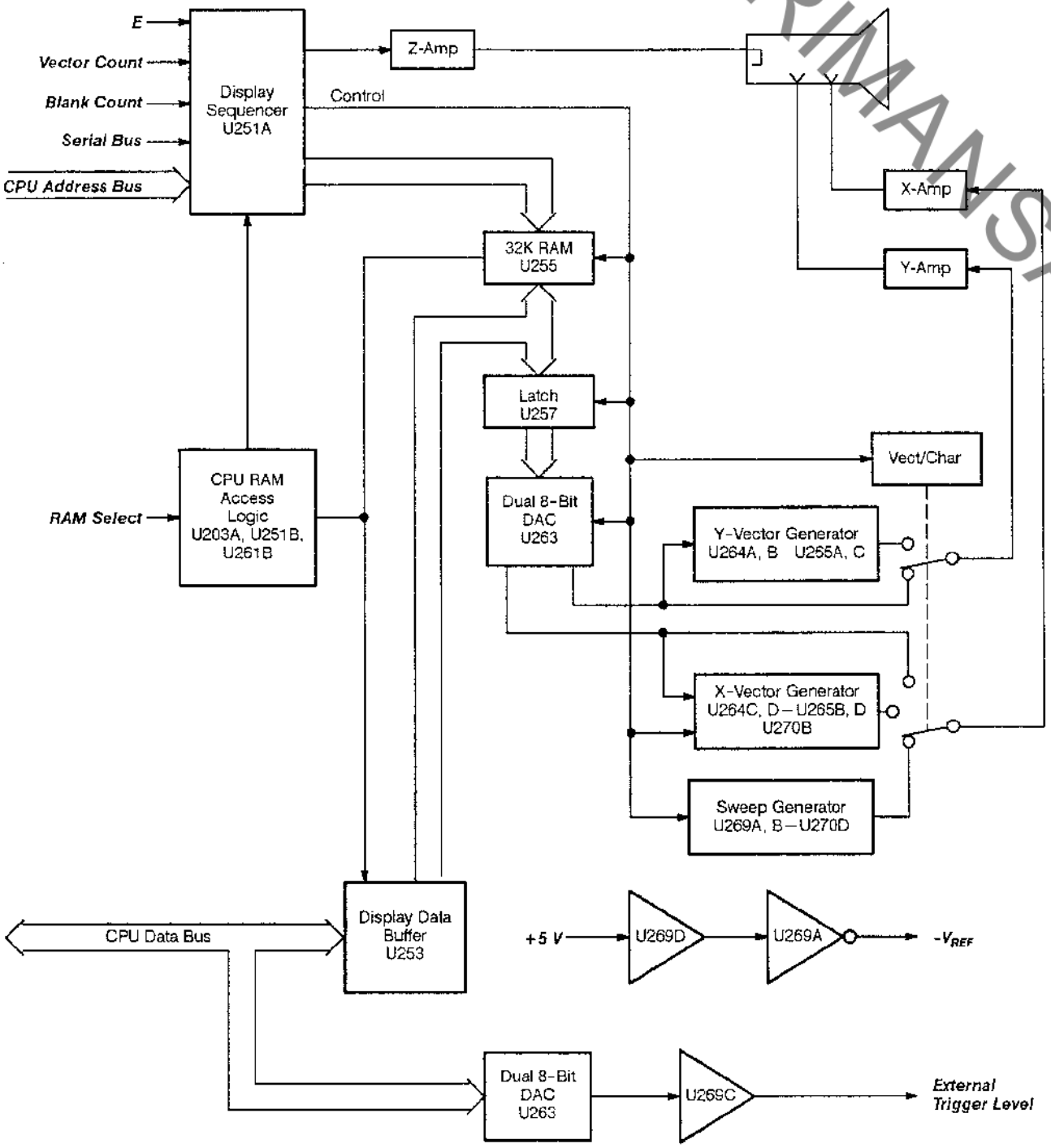

Figure 3-4: Display System

Main Board A3

The A3 Main board contains the floating acquisition power supplies, the battery charger circuit, and the time base.

Acquisition Power Supply ◇1

The acquisition power supplies are decoupled from the other system supplies by transformer T301. Each channel is rectified and filtered separately to produce a 5.3 V supply. PRIDRIVE+ and PRIDRIVE– are taken from the secondary of the main transformer on the Power Supply board. The CPU signal VERT is optically decoupled for each input channel. This becomes the acquisition memory control signal SLOAD.

Battery Charger Regulator ◇2

The battery charger circuit (see Figure 3-5) is a switching power supply that accepts 11 to 28 V external power (AC or DC). It produces a battery charging voltage of 9.8 V. When external power is not applied, the battery supplies the operating power.

The standard 222A external transformer converts AC power from the main supply to approximately 18 VAC. The external power is applied to an input bridge rectifier via line filters and two 2.5 A line fuses (F301 and F302). The rectified input is filtered by a large capacitor and applied to the battery charger switching transformer and a pulse-width-modulator regulator device U318.

The regulator controls the switching FET Q307. Feedback from the output of the battery charger rectifier controls the width of the switching pulses to the FET to maintain a constant output voltage to charge the battery and to drive the Power Supply board. Switching current is monitored by the over-current sensing resistor R339. The sensing circuit shuts down the switching supply if current exceeds the design limit.

Secondary voltage from the switching transformer is rectified and filtered to produce the charging and operating power for the instrument.

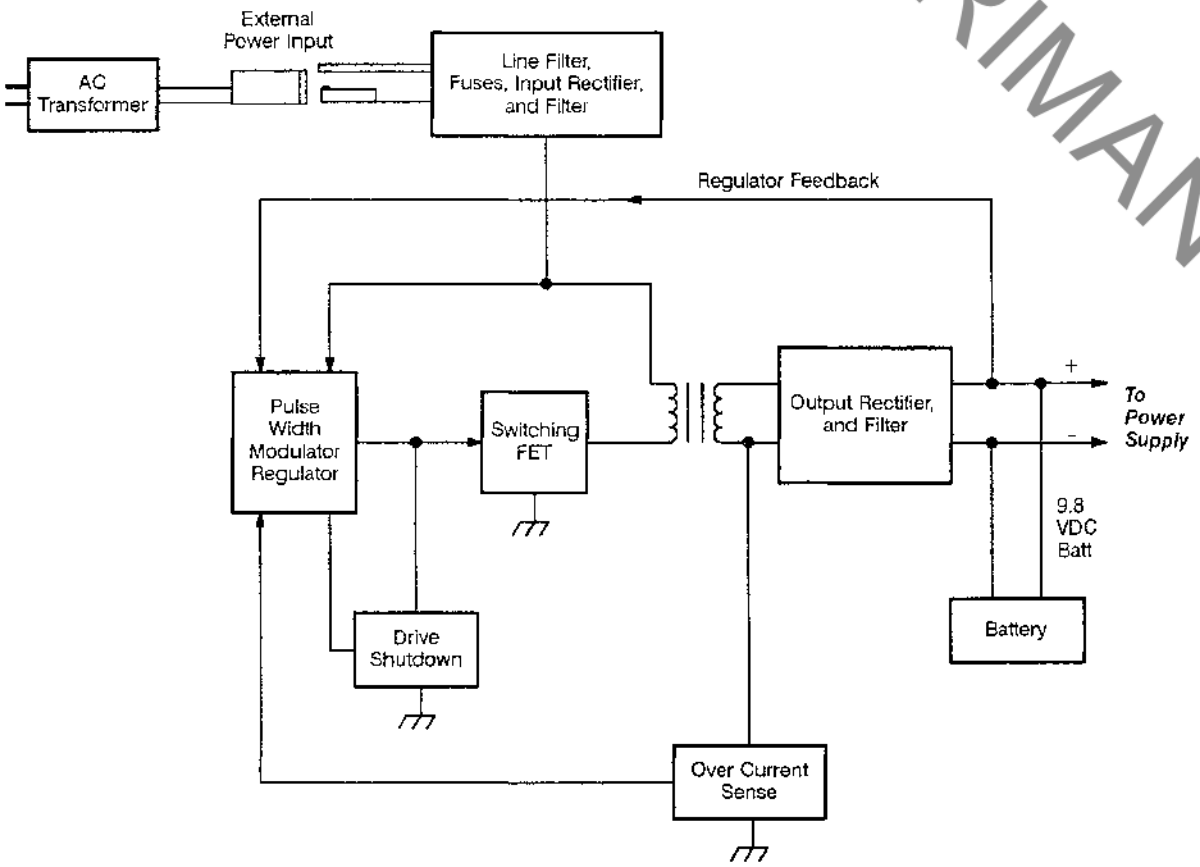

Figure 3-5: Battery Charger Block Diagram

Time Base ◇3◇4

All acquisition clock signals are derived from the free-running 20 MHz master oscillator U300. See Figure 3-6. U301 and U302 form an acquisition control register which is loaded over the serial bus by the CPU. It selects the trigger source, the SAVE clock source, and controls the output of U300. CLK0–CLK2 should all be low for a 20 MHz clock output. U304 halves the oscillator frequency to produce the 10 MHz clock SAMPLE, which clocks the acquisition system A/D converters.

U310 has three clock sources, which can be selected for the SAVE clock and the DLYCLK. One source, developed by U305A, U315A and U305B, reduces the pulse width of the <10MHZ signal to that of the SAMPLE clock. The other active input is a 5 MHz clock out of U304B. The third source is +5 V for SAVE and GND for DLYCLK. The DLYCLK clocks the prefill and postfill counters in U218 on the CPU/DISPLAY board.

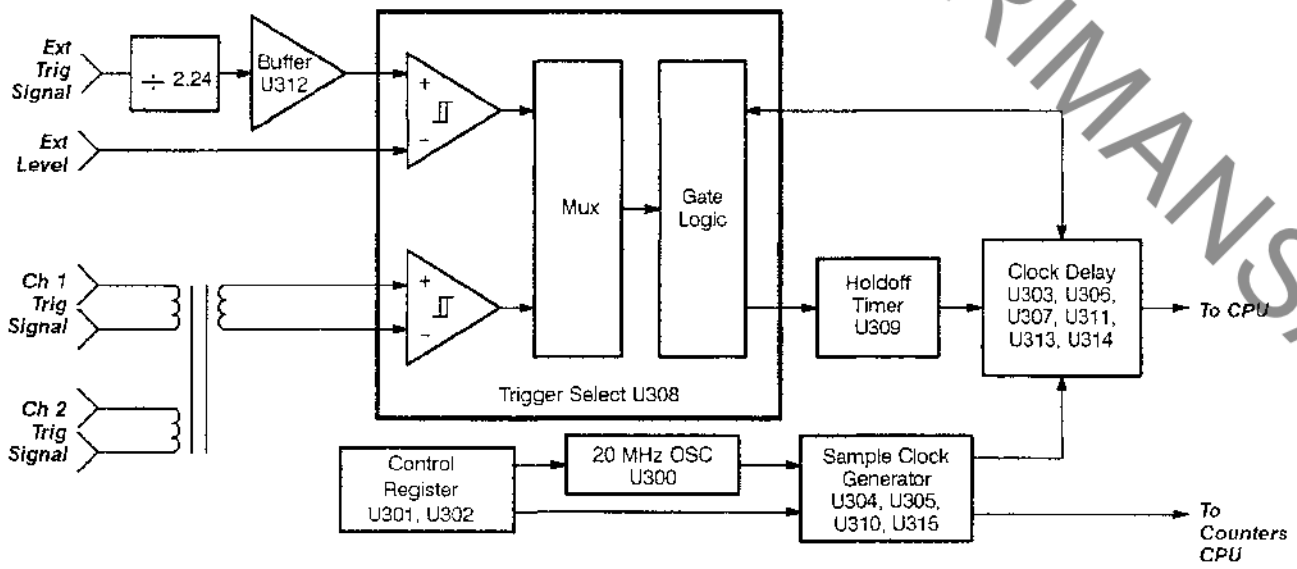

Figure 3-6: Time Base Block Diagram

The pre-fill counter (A2, U218, Pin 12) determines when enough pretrigger waveform data has been acquired and sets the ARM signal. Then the trigger circuit U308 is enabled to accept a trigger event. When the trigger occurs, the remaining data points needed to fill the waveform record are acquired. The record or post-fill counter determines when those data points have been acquired and then halts the acquisition system with the ACQHLT signal. An interrupt to the CPU indicates that a complete waveform record is ready in the acquisition memory.

The clock delay circuit (U303, U306, U307, U308, U311, U313, and U314) is used during repetitive store mode. The time difference between the trigger event and the rising edge of the sample clock is measured so that repetitive samples taken on different triggers may be correctly placed in the waveform record. The resolution of the clock delay timer is 0.5 ns. C302 charges during the time between a trigger and the next SAMPLE clock. Then the time required to discharge C302 at a calibrated rate is measured and used to calculate the correct placement of the trigger.

TRGSRC0 and TRGSRC1 select the trigger source. When TRGSRC1 is low, the external trigger is selected. A high on TRGSRC0 selects negative slope and a low selects positive slope. When TRGSRC1 is high, TRGSRC0 low selects AUTO triggering and TRGSRC0 high selects the enabled input channel trigger. The trigger comparator U308 is used to produce the actual trigger event from the applied signals. For operation on internal trigger signals, the Schmitt trigger circuit is used to allow the signal to return to zero without producing a false trigger signal.

Power Supply Board A4

The A4 Power Supply board produces the main digital and analog circuit voltage supplies. The supplies are regulated and temperature compensated for reliable operation over the full operating range of the 222A. The A4 board also contains the horizontal and vertical deflection amplifiers and the high-voltage control circuits for the CRT. Voltages up to −1600 V are developed from the nominal 8 V battery or battery charger circuit.

Low Voltage Supply ◇1

DC power from either the 8 V battery or the 7.3 to 9.8 V from the battery charger circuit powers the center-tapped switching transformer T402. See Figure 3-7. When the applied voltage is high enough, the CPU sets the DISPLYE signal high to enable the power line BATT through Q403 and Q404. While operating on battery power, the automatic time out will shut down the power supply after two minutes of no front panel activity. Pressing a front-panel button will reactivate the low voltage supply. Also, the power supply will shut down if the battery discharges to the point where its voltage drops below 7.32 volts.

U401 is a pulse-width modulator device that drives the switching FETs. The FETs are turned on for shorter or longer durations depending on the feed back signal applied to Pin 13. ADC 800 V feedback line from the T401 secondary, through CR410, is reduced by series resistors and summed with VREF (5 V) to produce 0 V at Pin 2.

CAUTION

DO NOT disconnect the feedback loop to U401 Pin 13 as this could damage the instrument.

The switching FETs drive T402 through series transformer T401. R438 will detect excess current flow and limit the pulses to the switching FETs. T402 has two secondary windings. One winding supplies low AC voltage to the CRT heater filament. The other multi-tapped winding supplies voltages that are rectified and filtered to produce two rectified 5 V supplies (VCC and DVCC), +6.7 (AVCC), −6.7 (VEE), 120 V, 800 V ◇2 and −1600 V ◇2.

High Voltage Power Supply ◇2

The 800 V and −1600 V voltage for the CRT is developed by a voltage multiplier circuit consisting of CR418, CR419, CR420, CR422, and associated capacitors and resistors. The negative 1600 V is applied to the GRID through Intensity adjustment R413. Focus voltage is tapped off of Focus adjustment R415, which is tied to the 800 V supply and a resistive divider network. The Astigmatism adjustment R424 controls Q406 to control X and Y axes convergence.

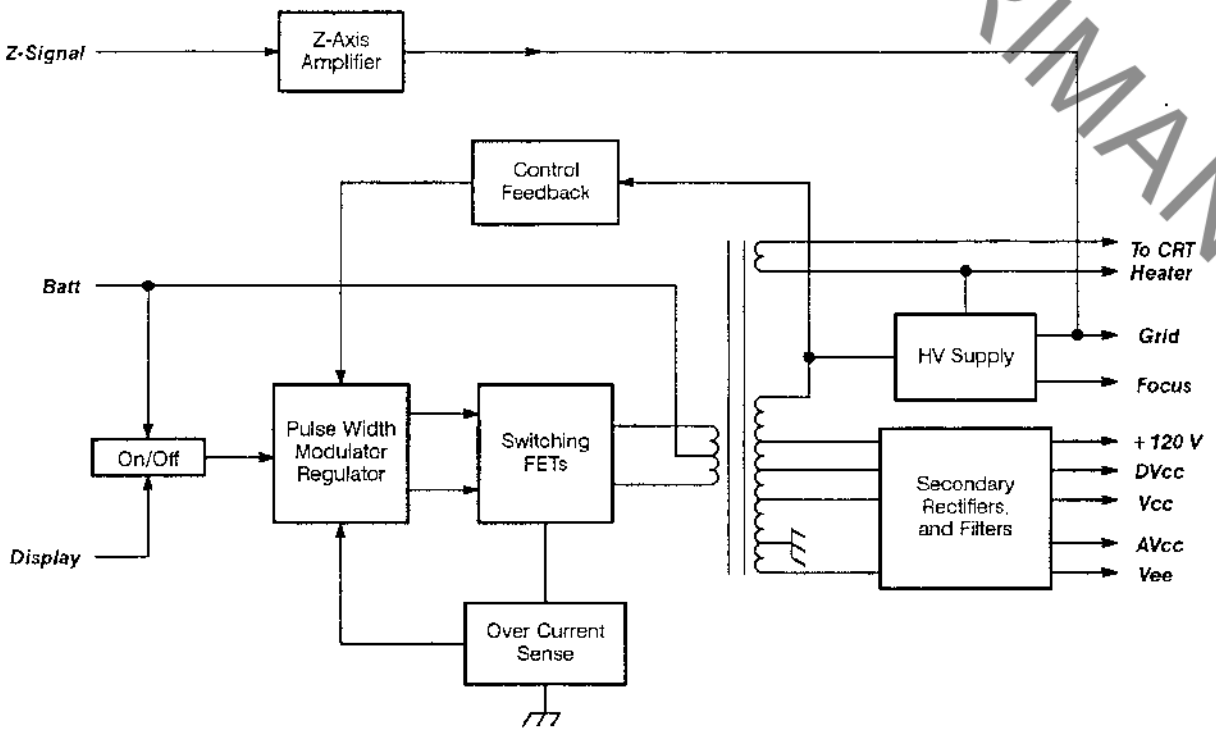

Figure 3-7: Power Supply Block Diagram

Z-Amplifier – The Z-amplifier is a class B stage that is nonlinear, since it only needs two output states: blanked and unblanked. When on, the output of the amplifier is about 0.2 V; when off, its output goes to 119.3 V. This pulse is coupled through a restorer to the grid of the CRT to turn the electron beam on and off for blanking. The grid voltage of the CRT is about –1550 V and the DC restorer circuit allows the Z-amplifier to take the grid 119 V below that level to blank it. Blanking times are under control of the processor and are held to less than 10 ms. Z-axis information is amplified to 120 V and added to the high DC voltage grid through C414.

Deflection Amplifiers ◈3

The horizontal and vertical deflection amplifiers amplify the X and Y data and allow rotational adjustment. The differential amplifiers based on U450 are identical with the exception of the Vert Pos adjustment R456 on the vertical amplifier. The grounded base transistors Q440, Q441, Q450 and Q451 isolate U450 from the 120 V potential. R447 sets horizontal gain and R455 sets the vertical gain. A 0 to 3.2 V change from the Y vector generator will produce a 70 V swing at the collectors of the common base amplifiers. Trace rotation is controlled by mixing a small portion of the Y signal into the X signal and vice versa. R426 adds the Y signal to the X amplifier and R431 adds the X signal to the Y amplifier. Up to 10% of the signal can be mixed in to achieve ±5.4 degrees of rotation.

Pot Board A5

The A5 Pot board contains front panel potentiometers (pots) and shaft switches and the hardware that allows the CPU to read changes. Changes in the 16 position rotary switches are detected by U502 and U503 which generate an interrupt (PULSEN) to the CPU. When interrupted, the CPU latches the switch state into U501 with the KEYBOARD signal. The latch data is serially read with the SCLK.

The CPUs internal A/D converter scans the pots R502, R503, and R504. R503 and R504 contain two pots which are 180° out of phase.

Front Panel Board A6 Keypad Board A7

The A6 Front Panel board contains the switch matrix and the hardware that allows the CPU to read changes. The Keypad board A7 contains the top keypad switches. Presses on any Front Panel and Keypad buttons create an interrupt signal (KEYPRESS) out of U601 Pin 8. Normally the column outputs of U602 are low and all rows are pulled high by R601. When a button is pressed, a row is pulled low interrupting the CPU. The CPU toggles KEYBOARD on Pin 9 on U603 which latches the row status. The CPU reads the latch with the SCLK on the SDATAI line. The CPU proceeds to set each of the column outputs of U602 low and then reads the row status through U603 until the pressed button is found.

The A7 Keypad board is scanned with the A6 Front Panel board hardware.

Performance Verification

Replace this page with the tab divider of the same name.

Brief Procedures

This subsection contains a quick-to-perform procedure that you can use to verify that the 222A functions properly. The *Self Cal Tests* procedure uses internal routines to confirm that both input channels can be calibrated and that the display is working properly. The only test equipment required is a patch cord.

The *Autoset Tests* procedure uses the automatic setup feature of the 222A to verify the acquisition system, trigger circuits and waveform display capability. The standard-accessory probes, included with this oscilloscope, are the only equipment needed.

General Instructions

The *Self Cal Tests* and *Autoset Tests* procedures combine with the *Performance Tests* found later in this section to extensively test the 222A.

You may not need to perform both the *Brief Procedures* and the *Performance Tests*, depending on what you want to accomplish:

- To rapidly confirm that this oscilloscope functions and was adjusted properly, just do the procedure under *Self Cal Tests*, which begins on page 4-3.
- To further check functionality, first do the *Self Cal Tests* just mentioned, and then do the procedure under *Autoset Tests* that begins on page 4-4.
- If more extensive confirmation of performance is desired, do the *Performance Tests*, beginning on page 4-5, after doing the *Self Cal Tests* and *Autoset Tests*. The *Performance Tests* directly check warranted specifications, but they require more time and specific test equipment.

If you are not familiar with operating this oscilloscope, read *General Operating Instructions* in Section 2 of this manual. These instructions will acquaint you with the use of the front- and top-panel controls, and the menu system.

Conventions

Throughout these procedures the following conventions apply:

- Each test procedure uses the following general format:

  Title of Test

  Equipment Required

  Prerequisites

  Procedure

- Each procedure consists of as many steps, substeps, and subparts as required to do the test. Steps, substeps, and subparts are sequenced as follows:

1. First Step
   a. First Substep
      - First Subpart
      - Second Subpart
   b. Second Substep
2. Second Step

- Where instructed to use a front-panel button or knob or verify a readout or status message, the name of the button or knob appears in boldface type: "Rotate the **VERT POS** knob to position the waveform at center screen."

The symbol at the left is accompanied by information you must read to do the procedure properly.

Initial Setup Procedure

This procedure connects the oscilloscope to external power and installs probes for the tests that follow.

Equipment Required (See Table 4-1)

P400 probe (standard accessory, Item 11)
External Power AC Adapter (standard accessory, Item 3)

Prerequisites

None

Procedure

1. Plug the External Power AC Adapter into the AC power source.
2. Plug in the cord from the adapter to the **EXT POWER INPUT** connector on the rear panel of the oscilloscope.
3. Open the zipper on the probe pouch and remove the probes. If disconnected, connect the probes through the oval opening at the rear of the pouch to the connectors on the oscilloscope.
4. Press the **ON** button of the oscilloscope to toggle it into the operating mode.

Self Cal Tests

This procedure uses internal routines to verify that this 222A functions and can properly perform self-calibration of both input channels. This procedure also guarantees the highest accuracy state for the *Performance Tests* that follow.

Equipment Required (See Table 4-1)

Patch cord; banana connectors (Item 7)
External Power AC Adapter (standard accessory, Item 3)

Prerequisites

Initial Setup Procedure

Procedure

1. Press the **AUX FUNCT** button to bring up the AUX menu.
2. Select SELF CAL from the menu.

NOTE

Disconnect both the Channel 1 and Channel 2 probes from any signal source before performing the self-calibration routines.

3. Select CH1 from the SELF CAL submenu to start the Channel 1 self-calibration routine. When the oscilloscope displays a PASS/FAIL message, the first routine is done.
4. Select CH2 from the SELF CAL submenu to start the Channel 2 self-calibration routine. When the oscilloscope displays a PASS/FAIL message, the second routine is done.
5. Select EXT TRIG to display the external trigger self-calibration menu.

NOTE

*For this self-calibration routine, the **EXT TRIG COMM** and **EXT TRIG INPUT** connectors must be connected together. Use a short jumper with banana plug connectors to make the connection.*

6. Select CAL to start the external trigger self-calibration routine after the **EXT TRIG COMM** and **EXT TRIG INPUT** connectors are joined. A PASS/FAIL message is displayed when the routine is done. Remove the jumper.
7. Press the **CLEAR** button at the completion of the self-calibration routines to return to normal oscilloscope operation. You are now ready to make the performance checks.

If a self-calibration step fails, the currently stored calibration constants are not changed. Run the failed routine again.

If the failure persists, further information about the nature of the failure may be found by connecting the RS-232 interface port to a terminal or host computer and rerunning the failed self-calibration routine. A coded error message is output when the error occurs.

Refer to *Troubleshooting* in the *Maintenance* section of this manual for explanations of the error codes.

Autoset Tests

The Autoset test procedure, while simple and easy to perform, will check 90% of the functionality of your 222A Digital Storage Oscilloscope.

Equipment Required (See Table 4-1)

P400 probe (standard accessory, Item 11)
External Power AC Adapter (standard accessory, Item 3)

Prerequisites

Initial Setup Procedure

Procedure

1. Remove the retractable hook tip from the channel 1 probe.
2. Display the channel 1 signal.
3. Hold the probe tip to the end of your finger. Make good contact, but do not puncture yourself.
4. With one of your *other* fingers, press the **AUTO SETUP** button.
5. When the auto-setup sequence is complete, channel 1 should show a 60 Hz noisy sine waveform.
6. Repeat this procedure for channel 2.

If the auto-setup routine displays a signal for both channels, it indicates that most of the instrument's major systems are operational and will perform correctly.

Performance Tests

This section contains a collection of procedures for checking that the 222A Digital Storage Oscilloscope performs as warranted.

There are three primary performance verification sequences:

- Vertical Checks
- Horizontal Checks
- Trigger Checks

These performance check procedures verify the performance requirements of the instrument as listed in the specification section. These checks may be used as an acceptance test or as a preliminary troubleshooting aid to help determine the need for repair or readjustment.

These procedures *extend* the confidence level provided by the basic procedures described in the previous section. Perform the basic procedures first, then continue to these if needed.

Prerequisites

To ensure the validity of these performance check procedures, the testing environment must meet these qualifications:

- The cabinet must be in place.
- You must perform and pass the self-calibration routines and functional tests found on page 4-3.

Related Information

Read *General Instructions* and *Conventions* that start on page 4-1. Also, if you are not familiar with operating the 222A, read *General Operating Instructions* in Section 2 before doing any of these procedures.

Equipment Required

Table 4-1 lists all the test equipment required to do the performance check procedure. Test equipment specifications described are the minimum necessary to provide accurate results. For test equipment operation information, refer to the appropriate test equipment instruction manual.

When you use equipment other than that recommended, you may have to make some changes to the test setups. If the exact example equipment in Table 4-1 is not available, use the Minimum Requirements column to determine if any other available test equipment might be adequate to do the check.

Table 4-1: Test Equipment

Item Number and Description		Minimum Requirements	Example	Purpose
1	Adapter	Connectors: BNC-to-miniature-probe tip	Tektronix part number 013-0084-03[1]	Signal connection
2	Calibration Generator	Standard-amplitude signal levels (DC and square wave): 5 mV to 50 V. Accuracy: 5 mV to 50 V ±0.25%. High-amplitude signal levels: 1 V to 60 V. Repetition rate: 1 kHz. Fast-rise signal level: 1 V. Repetition rate: 1 MHz. Rise time: 1 ns or less. Flatness: ±0.5%	TEKTRONIX PG 506A Calibration Generator	Gain and transient response checks.
3	AC Power Source	External Power AC Adapter	Standard (U.S.) External Power AC Adapter, Tektronix part number 120-1807-00	Reliable Power for oscilloscope and defeats auto-shutdown
4	Adjustment Tool	Small flat blade, narrow tip	General Tool 120-250	Adjust Focus before measurements
5	Termination, 50 Ω	Impedance 50 Ω; connectors: female BNC input, male BNC output	Tektronix part number 011-0049-01	Impedance matching between generators and probes
6	Cable, 50 Ω Coaxial	50 Ω, 36 in, male-to-male BNC connectors	Tektronix part number 012-0482-00	Signal connection
7	Connector, Dual Banana	Female BNC to dual banana	Tektronix part number 103-0090-00	Signal coupling to External Trigger and Common inputs
8	Connector, BNC T	Male, BNC-to-dual-female BNC	Tektronix part number 103-0030-00	Checking Trigger Sensitivity

[1] If you do not use this connector you must connect the probe ground lead to a ground source.

Table 4-1: Test Equipment (Cont.)

Item Number and Description	Minimum Requirements	Example	Purpose
9 Generator, Leveled Sine Wave	50 kHz to 20 MHz; Variable amplitude from 5 mV to 5 V p-p into 50 Ω. Amplitude accuracy: constant within 1.5% of reference frequency to 2020 MHz.	TEKTRONIX SG 503 Leveled Sine Wave Generator	Checking Vertical Triggering and Bandwidth
10 Generator, Time Mark	Variable marker frequency from 0.55 ms to 5 ns; accuracy within 2 ppm	TEKTRONIX TG 501A Time Mark Generator	Checking Sample-Rate and Delay-time Accuracy
11 Probe (2 required)	P400, 1X	TEKTRONIX P400	Connect oscilloscope to signal source

Preparation

The performance verification procedure is divided into subsections to let you check individual sections of the instrument when it is not necessary to do the complete performance check. An Equipment Required block at the beginning of each subsection lists the equipment from Table 4-1 that is needed to do the checks in that subsection.

The initial control settings at the beginning of each subsection prepare the instrument for the first step of the subsection. Do each of the steps in a subsection completely and in order to ensure the correct control settings for the steps that follow. Let the test equipment warm-up for 20 minutes to obtain a valid performance check to the accuracies stated in *Specifications*, Section 1.

Preliminaries

This preliminary procedure adjusts the display for greatest clarity prior to making measurements in the Performance Verification checks. You will make only externally available adjustments.

Equipment Required (See Table 4-1)

External Power AC Adapter (wall transformer, Item 3)
Adjustment Tool (Item 4)

Prerequisites

Self Tests and Autoset Tests starting on page 4-3

Initial Control Settings

Power and Display

External Power . . . . . External Power AC Adapter connected
Power . . . . . **ON**

Front-Panel Controls

AUTO SETUP . . . . . Press for initial signal display

Procedure

1. **Check/Adjust Intensity Control**
   a. Adjust the **INTEN** control for a sharp display.
2. **Adjust FOCUS Control**
   a. Press the **AUX FUNCT** button on the top panel.
   b. Select the ALIGN menu choice, then the XY menu choice. This displays a test pattern on the CRT.
   c. Adjust the **FOCUS** control for the best definition of the pattern.
   d. Press the **CLEAR** button to remove the display pattern and return to normal operation.

Index to Performance Tests

The following is a list of the three groups of performance test procedures in the section and their page numbers. Perform all checks in a group in sequence.

Vertical Checks

Horizontal Checks

Trigger Checks

Vertical Checks

These procedures check those characteristics for the signal acquisition and display systems that are listed as checked under *Warranted Characteristics* in Section 1, *Specification*. Set up the test equipment as shown in Figure 4-1. Both generators will not be used at the same time but they should both remain powered up during the procedure to ensure stable operation.

Equipment Required (See Table 4-1)

Leveled Sine Wave Generator (Item 9)
Calibration Generator (Item 2)
50 Ω BNC Termination (Item 5)
BNC-to-miniature-probe-tip Adapter (Item 1)
External Power AC Adapter (wall transformer, Item 3)
2 Probes (Item 11)

Prerequisites

Self Tests and Autoset Tests starting on page 4-3

Preliminaries on page 4-8

NOTE

If you are not using the recommended probe-tip adapter (Tektronix part number 013-0084-03), then you will need to connect the probe ground lead to the probe signal source.

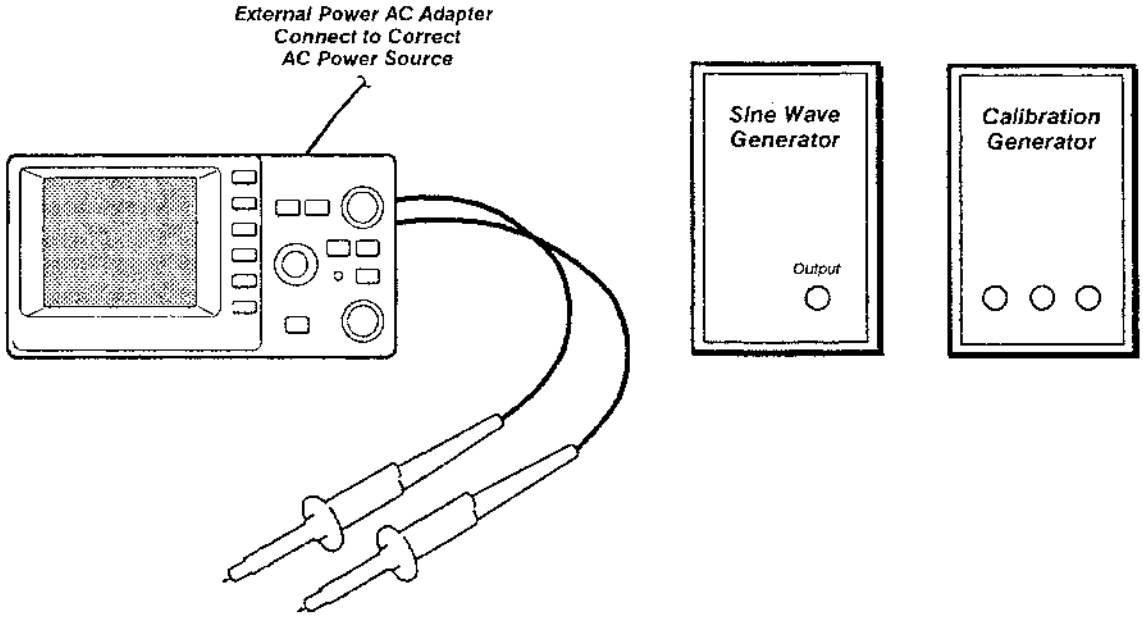

Figure 4-1: Initial Setup for Vertical Checks

Initial Control Settings

Power and Display

External Power ..... External Power AC Adapter connected
Power ..... **ON**

Vertical Area

CH 2 Coupling ..... OFF
CH 2 **VOLTS/DIV** ..... 5 mV
CH 2 Variable ..... CAL
CH 1 Coupling ..... GND
CH 1 **VOLTS/DIV** ..... 5 mV
CH 1 Variable ..... CAL

Horizontal Area

SEC/DIV ..... 1 ms
X10 MAG ..... OFF
POS ..... center the waveform

Trigger Area

Trigger **MODE** ..... AUTOBL
Trigger **SOURCE** ..... VERT
Trigger **SLOPE** ..... +

Top Panel Controls

TRIG POS ..... POST
STORE ..... STORE

DISPL
INV1 ..... OFF
INV2 ..... OFF
XY ..... OFF
RO OFF ..... OFF (not selected)
ACQ ..... NORM

Procedure

1. **Check Input Current, DC Balance, and Invert Balance**

   a. Connect the channel 1 ground lead to the probe tip.

   b. Press the **CLEAR** button to clear the display.

   c. Vertically position the channel 1 trace to the center horizontal graticule line.

   d. Set the channel 1 coupling to DC.

   e. CHECK for 0.5 division or less shift from the center horizontal graticule line.

   f. Set channel 1 coupling to GND.

g. Rotate the **VOLTS/DIV** control from 5 mV to 50 V.

h. CHECK for 0.2 division or less shift from the center horizontal graticule line.

i. Set the **VOLTS/DIV** control to 5 mV/div.

j. Select channel invert by pressing the **DISPL** button and selecting INV1.

k. CHECK for 0.4 division or less shift from the center horizontal graticule line.

l. Set channel 1 coupling to CH1 OFF.

m. Set channel 2 coupling to GND.

n. Repeat steps a through k for channel 2.

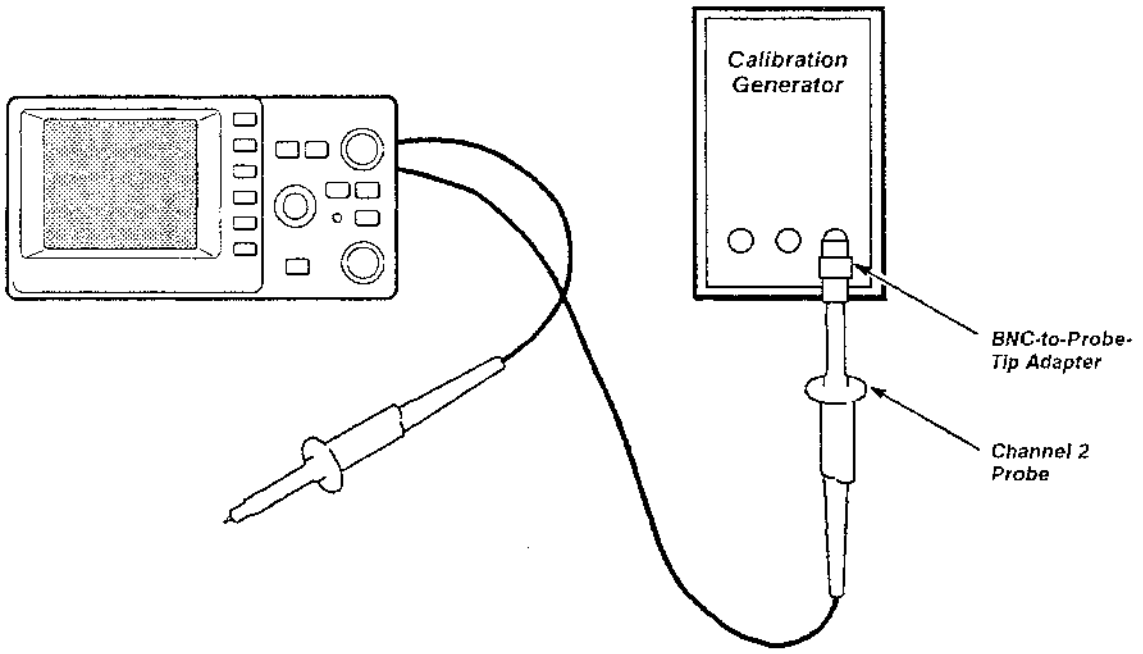

Figure 4-2: Setup for Input Coupling Check

2. **Check Input Coupling (Set up the test equipment as shown in Figure 4-2.)**

   a. SET:

SEC/DIV	0.5 ms
Trigger **MODE**	AUTOLVL
VOLTS/DIV	.5 V

   b. Set the Calibration Generator to a standard-amplitude mode output signal of 2.0 V.

   c. Vertically position the bottom of the signal to the center horizontal graticule line.

d. Set the channel 2 coupling to AC.

e. CHECK that the display moves to approximately vertical center screen.

f. SET: CH 2 Coupling — CH2 OFF
CH 1 Coupling — DC

g. Disconnect the channel 2 probe tip from the test equipment and connect the channel 1 probe tip.

h. Repeat parts c, d, and e for channel 1.

3. **Check VOLTS/DIV Accuracy**

a. Set Calibration Generator for a standard-amplitude output signal of 20 mV.

b. Set the channel 2 **VOLTS/DIV** control to 5 mV.

c. Vertically center the display.

d. CHECK all positions of the volts per division settings for correct signal-to-graticule accuracy using the **VOLTS/DIV** control and Calibration Generator settings and amplitude limits given in Table 4-2.

e. Return the Calibration Generator output to 20 mV.

f. SET: CH 2 Coupling — CH2 OFF
CH 1 Coupling — DC
CH 1 **VOLTS/DIV** — 55 mV

g. Disconnect the channel 2 probe tip from the test equipment and connect the channel 1 probe tip.

h. Repeat part d for channel 1.

i. Disconnect the test equipment from the oscilloscope.

Table 4-2: VOLTS/DIV Accuracy Settings

Volts/Div	Calibration Generator	Amplitude Limits
5 mV[1]	20 mV	3.84 div – 4.16 div
10 mV[1]	50 mV	4.80 div – 5.20 div
20 mV[1]	0.1 V	4.80 div – 5.20 div
50 mV	0.2 V	3.84 div – 4.16 div
0.1 V	0.5 V	4.80 div – 5.20 div
0.2 V	1 V	4.80 div – 5.20 div
0.5 V	2 V	3.84 div – 4.16 div
1 V	5 V	4.80 div – 5.20 div
2 V	10 V	4.80 div – 5.20 div
5 V	20 V	3.84 div – 4.16 div

[1] **These ranges are available only with a P400 X1 probe.**

Table 4-2: VOLTS/DIV Accuracy Settings (Cont.)

Volts/Div	Calibration Generator	Amplitude Limits
10 V	50 V	4.80 div – 5.20 div
20 V	100 V	4.80 div – 5.20 div
50 V	100 V	1.92 div – 2.08 div
100 V	– –	– –[2]
200 V	– –	– –[2]

[2] For P850 probe only; not practical to check due to calibration generator limitation. To check attenuator accuracy in these positions, check the 10 and 20 V per division settings.

4. **Check Probe Compensation (Low Frequency Pulse Response)**

   a. Set up the equipment as shown in Figure 4-3.

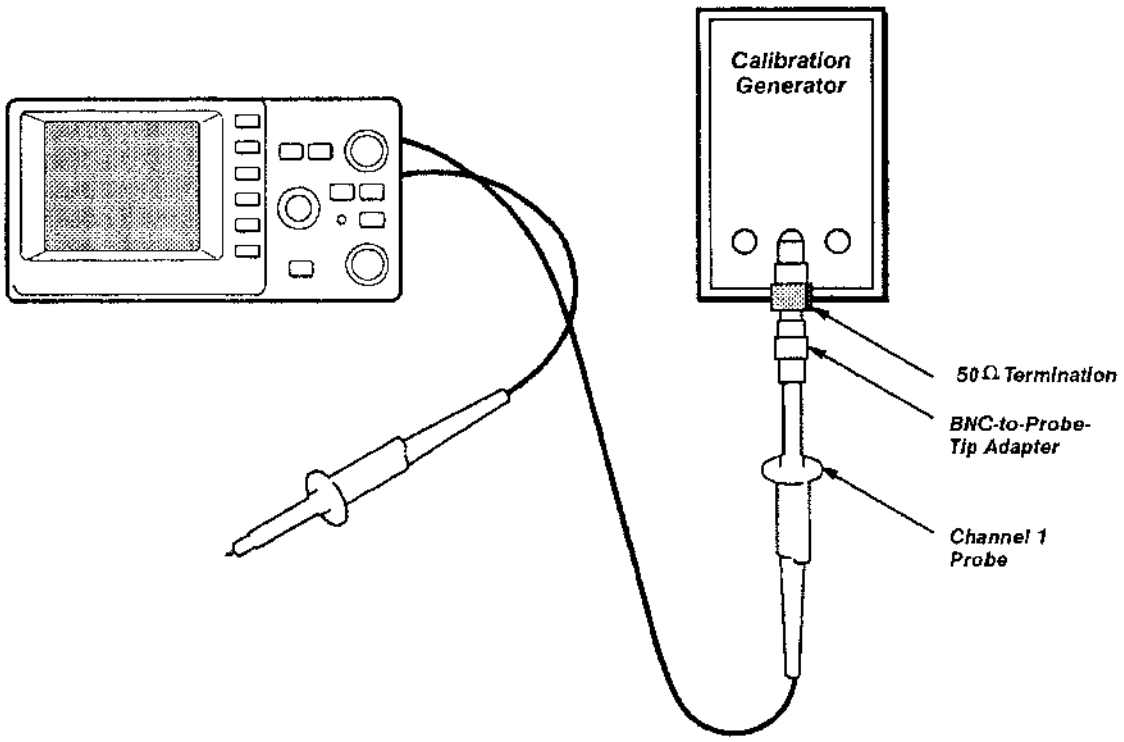

Figure 4-3: Setup for Probe Compensation Check

   b. Set: CH 1 **VOLTS/DIV** 50 mV
   SEC/DIV 0.2 ms
   TRIG POS MID

   c. Set the Calibration Generator output for a fast-rise signal with a 1 ms period.

d. Adjust the Calibration Generator pulse amplitude for a 5 division display.

e. Vertically position the top of the square wave on the second horizontal graticule line above the center.

f. Position the rising edge at the trigger position to the center vertical graticule line.

g. CHECK for 0.15 division or less of rolloff or overshoot at the front corner.

h. Set:

CH 1 Coupling	CH1 OFF
CH 2 Coupling	DC
CH 2 **VOLTS/DIV**	50 mV

i. Disconnect the channel 1 probe tip from the BNC-to-probe-tip adapter and connect the channel 2 probe tip.

j. Vertically center the display.

k. Repeat part g for channel 2.

l. Disconnect the channel 2 probe tip from the test equipment.

5. **Check Analog Bandwidth (Set up the test equipment as shown in Figure 4-4.)**

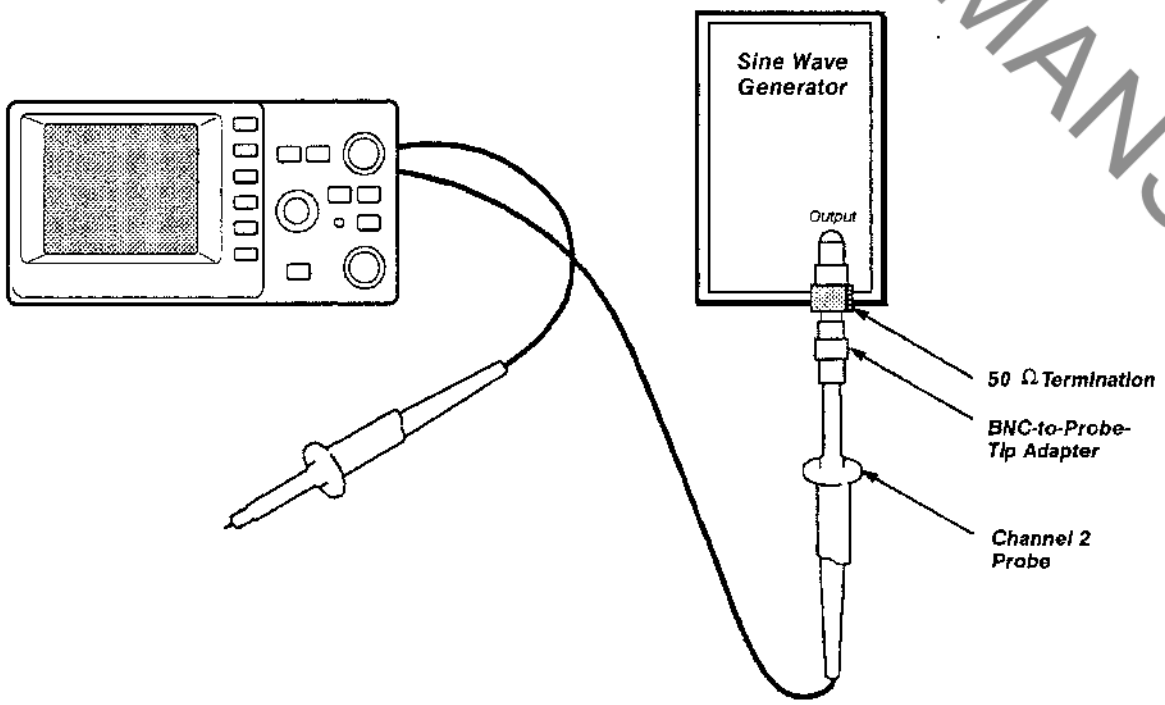

Figure 4-4: Setup for Analog Bandwidth Check

a. Set: CH 2 **VOLTS/DIV** 0.5 V
SEC/DIV 5 µs

b. Set the Leveled Sine Wave Generator for a display amplitude of 6 divisions at 50 kHz.

c. Set the **SEC/DIV** control to 50 ns.

d. Set the Leveled Sine Wave Generator output frequency to 10 MHz.

e. CHECK that the display amplitude is at least 4.2 divisions.

f. Return the Leveled Sine Wave Generator output frequency to 50 kHz.

g. Set: CH 2 Coupling CH2 OFF
CH 1 Coupling DC
CH 1 **VOLTS/DIV** 0.5 V
SEC/DIV 5 µs

h. Disconnect the channel 2 probe tip from the test equipment and connect the channel 1 probe tip.

i. Vertically center the display.

j. Repeat parts b, c, d, and e for channel 1.

Horizontal Check

The horizontal checks procedures verify those characteristics that relate to the time-base system and that are listed as checked under *Warranted Characteristics* in Section 1, *Specification*. Set up the test equipment as shown in Figure 4-5.

Equipment Required (See Table 4-1)

Time-Mark Generator (Item 10)
50 Ω BNC Termination (Item 5)
BNC-to-miniature-probe-tip Adapter (Item 1)
External Power AC Adapter (wall transformer, Item 3)
2 Probes (Item 11)

Prerequisites

Self Tests and Autoset Tests starting on page 4-3

Preliminaries on page 4-8

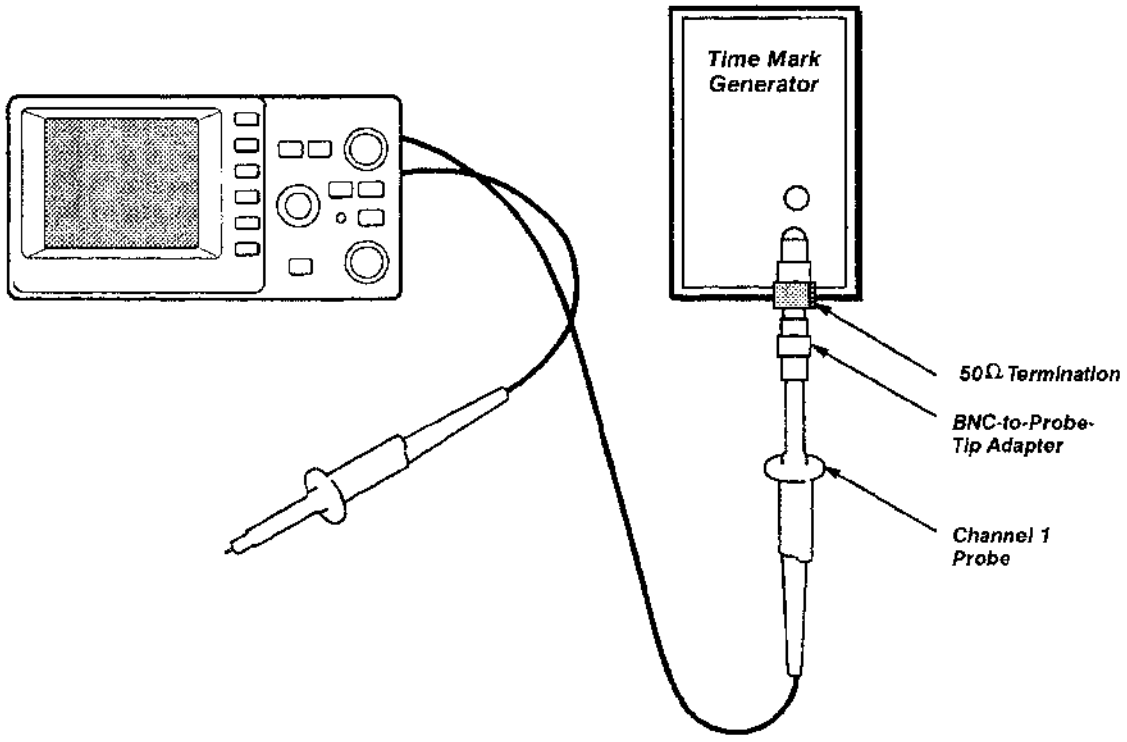

Figure 4-5: Setup for Horizontal Test

Initial Control Settings

Power and Display

External Power ..... External Power AC Adapter connected
Power ..... **ON**

Vertical Area

CH 2 Coupling ..... CH2 OFF
CH 1 Coupling ..... DC
CH 1 **VOLTS/DIV** ..... 0.1 V
CH 1 **VAR** ..... CAL

Horizontal Area

SEC/DIV ..... 1 ms
X10 MAG ..... OFF

Trigger Area

Trigger **MODE** ..... AUTOLVL
Trigger **SOURCE** ..... VERT
Trigger **SLOPE** ..... +

Top Panel Controls

TRIG POS ..... POST
STORE ..... STORE

DISPL
INV1 ..... OFF
INV2 ..... OFF
XY ..... OFF
RO OFF ..... OFF (not selected)

ACQ ..... NORM

Procedure

1. **Check X1 SEC/DIV Accuracy**

   a. Press the **CLEAR** button to clear the display.

   b. Set the Time Mark Generator to output 1 ms time markers.

   c. Vertically position the baseline of the time-mark signal to the center horizontal graticule line.

   d. Horizontally position the left time marker with the first vertical graticule line.

   e. CHECK that the leading edge of each time marker is aligned to a vertical graticule line within 2% (±0.1 division).

   f. Disconnect the test equipment from the oscilloscope.

Trigger Checks

The Trigger Checks procedures verify those characteristics that relate to the trigger system and that are listed as checked under *Warranted Characteristics* in Section 1, *Specification*. Set up the test equipment as shown in Figure 4-6.

Equipment Required (See Table 4-1)

Leveled Sine Wave Generator (Item 9)
BNC-to-dual-banana Adapter (Item 7)
BNC-T connector (Item 8)
BNC-to-miniature-probe-tip Adapter (Item 1)
50 Ω BNC Termination (Item 5)
External Power AC Adapter (wall transformer, Item 3)
BNC Coaxial Cable (Item 6)
2 Probes (Item 11)

Prerequisites

Self Tests and Autoset Tests starting on page 4-3

Preliminaries on page 4-8

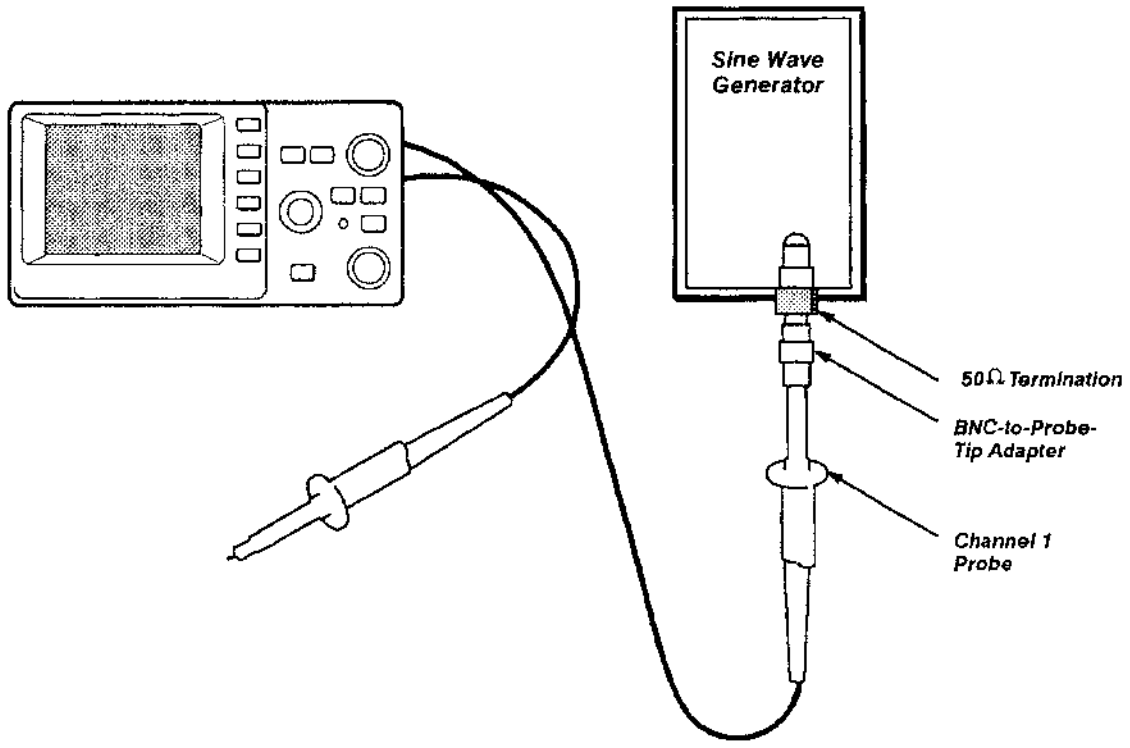

Figure 4-6: Setup for Trigger Checks

Initial Control Settings

Power and Display

External Power ..... External Power AC Adapter connected
Power ..... **ON**

Vertical Area

CH 2 Coupling ..... CH2 OFF
CH 2 **VAR** ..... CAL

CH 1 Coupling ..... DC
CH 1 **VOLTS/DIV** ..... 50 mV
CH 1 **VAR** ..... CAL

Horizontal Area

X10 MAG ..... OFF
SEC/DIV ..... 50 ns

Trigger Area

Trigger **MODE** ..... AUTOLVL
Trigger **SLOPE** ..... +
Trigger **SOURCE** ..... VERT

Top Panel Controls

TRIG POS ..... POST
STORE ..... STORE

DISPL

INV1 ..... OFF
INV2 ..... OFF
XY ..... OFF
RO OFF ..... OFF (not selected)

ACQ ..... NORM

Procedure

1. **Check Trigger Sensitivity**

   a. Set the Leveled Sine Wave Generator for a 5 division display amplitude at 10 MHz.

   b. Set the channel 1 **VOLTS/DIV** control to 0.5 V.

   c. Push **AUTOLVL** knob.

   d. CHECK for a stable display with the **TRIG'D** indicator on.

2. **Check Fill Time**

a. Set: CH 1 **SEC/DIV** 5 µs
CH 1 **VOLTS/DIV** 5 mv

b. Return the Leveled Sine Wave Generator to 50 kHz and adjust for a five-division amplitude.

c. Press **INIT** to restart the acquisition.

d. CHECK that the display fills completely in less than 10 s.

3. **Check External Trigger Sensitivity (Set up the test equipment as shown in Figure 4-7.)**

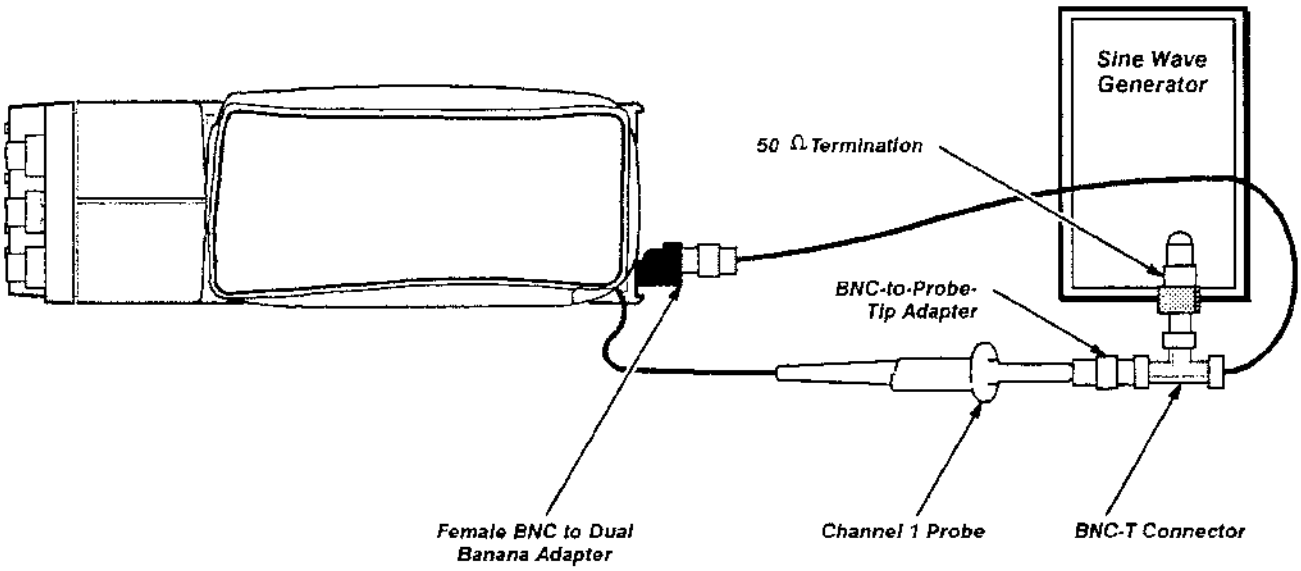

Figure 4-7: Setup for External Trigger Sensitivity

a. Set: CH 2 Coupling GND
CH 1 Coupling DC
CH 1 **VOLTS/DIV** 50 mV
Trigger **SOURCE** EXT
STORE OFF (not selected)

b. Connect the Leveled Sine Wave Generator output via a 50 Ω termination, a BNC-T connector, and a BNC-to-probe-tip adapter to the channel 1 probe tip.

c. Connect the other side of the BNC-T connector via a 50 Ω coaxial cable and female BNC-to-dual-banana connector to the **EXT TRIG INPUT** and **EXT TRIG COMM** input jacks on the rear panel.

d. Vertically center the display.

e. Set the **SEC/DIV** control to 50 ns.

f. Set the Leveled Sine Wave Generator to display five divisions of amplitude at 50 kHz.

g. CHECK for a triggered display (**TRIG'D** indicator light on).

h. Set CH1 **VOLTS/DIV** to 0.2 V.

i. Set the Leveld Sine Wave Generator to display five divisions of amplitude at 60 MHz.

j. CHECK for a triggered display (**TRIG'D** indicator light on).

k. Disconnect the probe from the test equipment.

Adjustment Procedures

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Adjustment Procedures

This section contains information you need to adjust your 222A Digital Storage Oscilloscope.

Description — The *Adjustment Procedures* are divided into two parts:

- General information about adjusting this oscilloscope, the equipment needed, and the adjustments required after repairing some modules.
- Six written procedures that allow you to manually adjust the vertical, horizontal, and trigger systems.

Purpose -- Use this procedure to return the oscilloscope to conformance with its *Warranted Characteristics* as listed in Section 1, *Specification*. It can also be used to optimize the performance of the oscilloscope.

Adjustment Interval -- As a general rule, these adjustments should be done after every 2000 hours of operation or once a year if used infrequently.

Requirements for Performance

Before you do this procedure, you need to address the following requirements.

Personnel

This procedure is to be performed only by trained service technicians.

Warm-up Period

The test equipment requires a 20 minute warm-up time in a 15°C to 35°C environment before use.

Access to Adjustments

To access the adjustments you must remove the front panel and top case. The procedure *Preparation* on page 5-4 shows you how to prepare the 222A for adjustment.

Test Equipment

The equipment list on page 5-3 in this section lists all test equipment required to adjust this oscilloscope.

You do not need to set any adjustment to a default setting before performing this procedure. Only change an internal adjustment setting if a performance characteristic cannot be met with the original setting.

Adjustment After Repair

Depending on the module replaced, you may need to perform a partial or complete adjustment. Table 5-1 lists the circuit board modules and the adjustment required for each. Perform the listed adjustment for a circuit board when you repair any module on that circuit board.

Table 5-1: Adjustments Required for Module Replaced

Module Replaced	Adjustment Required
Acquisition Board	Complete Adjustment
Front Panel Board	None Required
Pot Board	None required
Power Supply Board	Complete Adjustment
CPU/Display Board	Complete Adjustment[1]
Main Board	Complete Adjustment
CRT Assembly	Display Adjustment Only

[1]**If a software upgrade is done or the EEPROMs are replaced, a complete adjustment is required.**

Adjustment Dependencies

Some adjustments depend on the successful completion of other adjustments. For example, the Reference Self Calibration Adjustment must be performed before the Channel Gain Self Calibration is performed. Table 5-2 lists the adjustments and their dependencies.

Table 5-2: Adjustments and Dependencies

Adjustment	Prior Completion Requirements
Display Adjustment	None
Sweep Length and Vector Generator Adjustment	Display Adjustment
Reference Self Calibration	None
Gain Self Calibration	Reference Self Calibration
Clock Delay Adjustment	None
External Trigger Offset Calibration	None

Equipment Required

Table 5-3 lists the test equipment required to adjust the 222A Digital Storage Oscilloscope.

Table 5-3: Test Equipment, Fixtures, and Supplies

Item Number and Description		Minimum Requirements	Example	Purpose
1	External Power AC Adapter (for 222A)	DC: 12 to 20 VDC; or AC: 16 to 20 VAC, at 47 Hz to 400 Hz	Tektronix part number 120-1807-00	Instrument Power
2	DMM Calibrator	Variable amplitude to ±1 V; accuracy to 0.05%	Data Precision 8200	Reference Self Calibration
3	Screwdriver, Handle	Accepts Torx® tip	Tektronix part number 003-0301-00	Case Disassembly
4	Torx® Tip	T-15	Tektronix part number 003 0966 00	Case Disassembly
5	Wrench, Hex	0.050 inch hex wrench		Case Disassembly
6	Adjustment Tool	Small flat blade, narrow tip	General Tool 120-250	Adjust Focus Before Measurements
7	Probe (2 required)	P400, 1X	TEKTRONIX P400	Connect Oscilloscope to Signal Source
8	Connector, Dual-banana	Female BNC to dual banana	Tektronix part number 103-0090-00	Reference Self Calibration
9	Adapter, Probe Tip to BNC (two required)	Connectors: BNC, male-to-miniature-probe tip.	Tektronix Part Number 013-0084-03	Reference Self Calibration
10	Connector, BNC-T	Male, BNC-to-dual-female BNC	Tektronix part number 103-0030-00	Reference Self Calibration
11	Cable, Precision Coaxial	50 Ω, 36 in, male-to-male BNC connectors	Tektronix part number 012-0482-00	Reference Self Calibration
12	Patch Cord	Connectors: banana; 3 in (8 cm) or longer	Tektronix part number 012-0031-00	External Trigger Offset Calibration

[1]Requires a TM 500 Series Power Module Mainframe.

Preparation

Perform the initial setup in preparation for the following adjustment procedures. Set up equipment as shown in Figure 5-1. Power up the DMM Calibrator so that it will warm up for later use. Refer to the following procedure for additional connection instructions.

Equipment Required (See Table 5-3)

External Power AC Adapter (wall transformer, Item 1)
Torx Driver, T-15 Tip (Items 3 and 4)
Hex Wrench, 0.050 inch (Item 5)

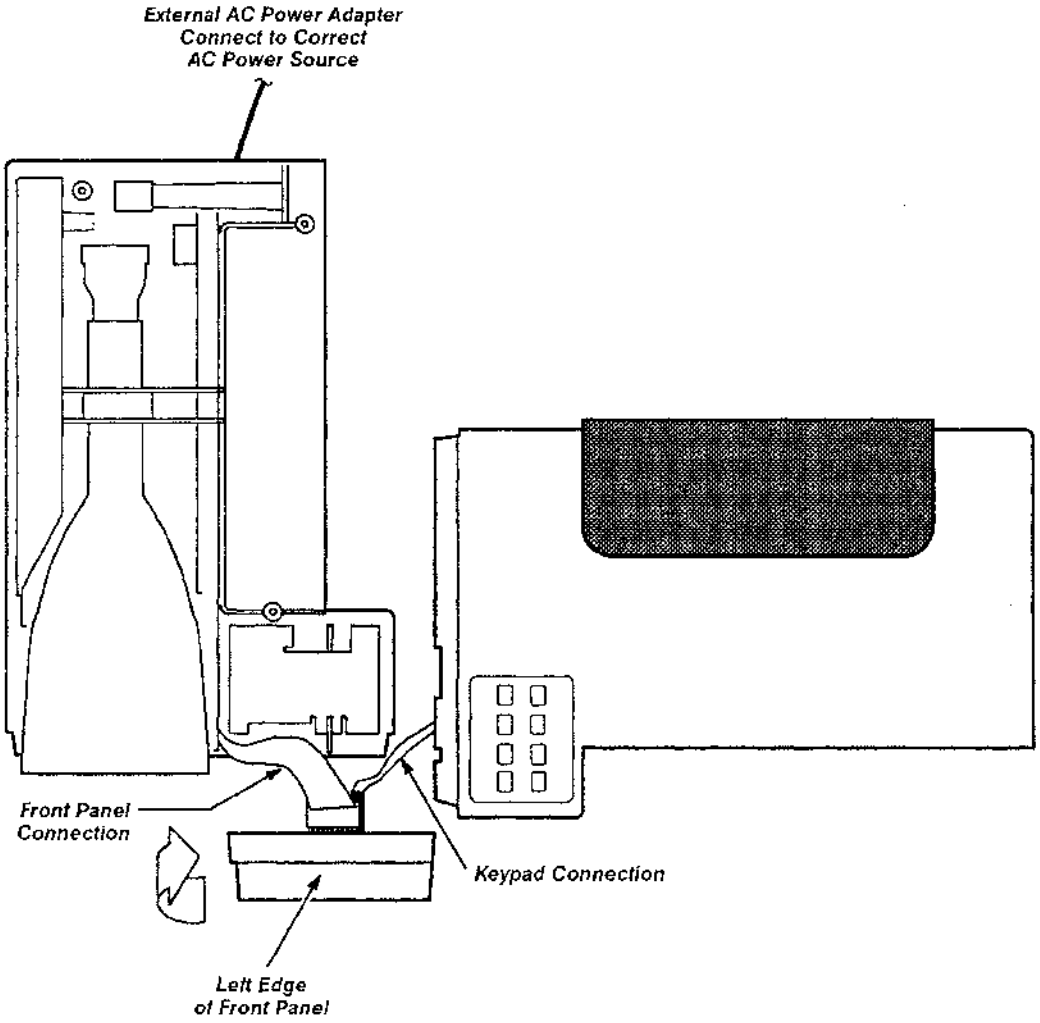


Figure 5-1: Initial Equipment Setup for Adjustment Procedures

Procedure

1. Power up the test equipment: Connect the test equipment to AC power and allow a 20 minute warm-up period before beginning the procedures.
2. Configure the 222A for adjustment (see Figure 5-1):
   a. Remove the front panel and the top case half from the instrument. See the *Front and Top Case* removal procedure in *Maintenance*, Section 6. When removing the top case, make sure the channel input connector assembly remains in the lower case. If it sticks to the top case, remove it and replace it in its slot in the lower case.
   b. Swing the front panel up from the left side to allow the CRT to be viewed directly when the display adjustments are made.
   c. Lay the top case half down on the right side of the instrument with the front of the case facing the instrument. Reconnect the top keypad cable to its front panel connector.
3. Connect the 222A to external power: Connect the wall transformer part of the External Power AC Adapter to AC power and connect the power supply cable to the **EXT POWER INPUT** connector on the rear panel.
4. Press the front panel **ON** button to power up the oscilloscope.
5. Allow a 20 minute warm-up period for the oscilloscope before beginning the adjustment procedures.

Display Adjustments

Perform display adjustment procedure to adjust the display. Set up equipment as shown in Figure 5-1. Before starting this procedure, first perform the procedure *Preparation* on page 5-4 to configure the oscilloscope for adjustment.

Equipment Required (See Table 5-3)

External Power AC Adapter (wall transformer, Item 1)
Adjustment Tool (Item 6)

Procedure

1. Select the XY alignment pattern.
   a. Press the **AUX FUNCT** button on the top panel.
   b. Select the ALIGN menu item to display the ALIGN menu.
   c. Press the same button (now labeled XY) again to display the test pattern as shown in Figure 5-2.
2. Adjust display intensity: Adjust the **INTEN** control located on the rear panel of the instrument (see Figure 5-3) for a sharp display with no blooming of lines.

3. Adjust display focus and astigmatism: Adjust the **FOCUS** control located on the rear panel of the instrument (see Figure 5-3) and the ASTIG adjustment (see Figure 5-4 for the location) for the best focused display over the entire graticule area.

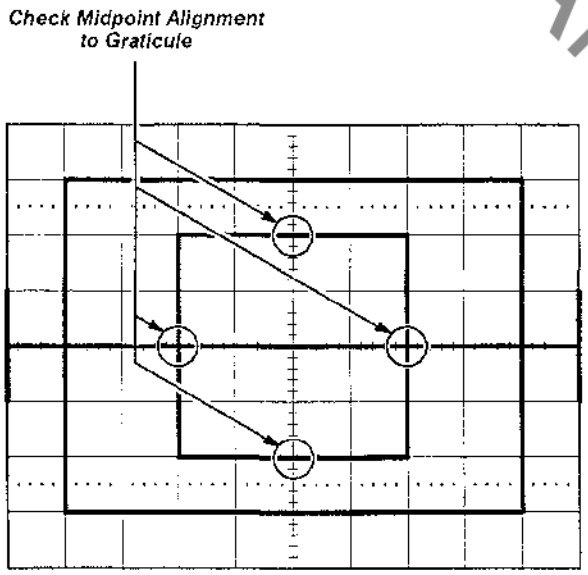


Figure 5-2: Test Pattern Showing Alignment Points for Horizontal and Vertical Gain Adjustments

4. Center the XY calibration pattern with the graticule: Adjust VPOS (R456) and HPOS (R448) to center the ALIGN XY calibration pattern with the graticule. See Figure 5-4 for the adjustment locations.
5. Align the XY calibration pattern with the graticule: Adjust HORIZ ALIGN (R426) and VERT ALIGN (R431) for best horizontal and vertical alignment of the box pattern to the graticule lines. See Figure 5-4 for the adjustment locations.
6. Adjust vertical and horizontal gain: Adjust VGAIN (R455) for a display four vertical divisions high and HGAIN (R447) for a display four horizontal divisions wide on the inner box pattern. See Figure 5-4 for the adjustment locations.

NOTE

Make sure the midpoint of each outside trace of the calibration pattern is exactly centered over its respective graticule line. See Figure 5-2.

7. Check that all display adjustments are optimized for the best display.

8. Remove the XY alignment pattern: Press the **CLEAR** button to remove the pattern.

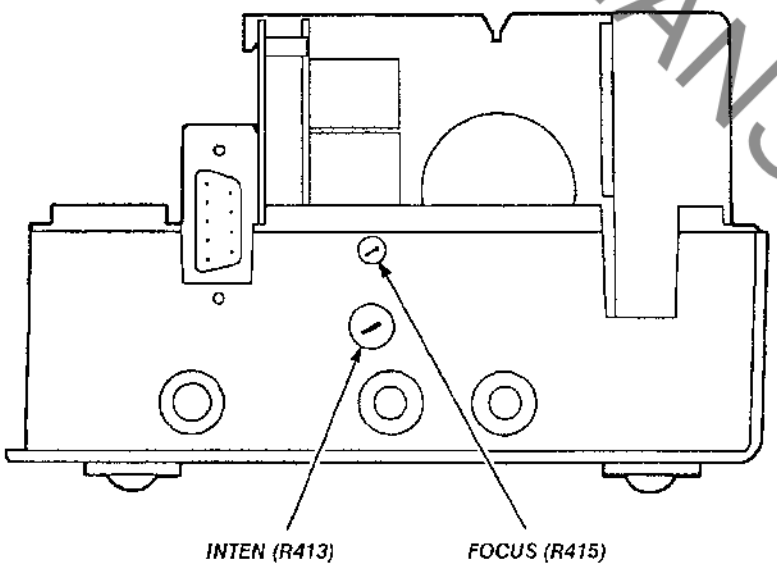


Figure 5-3: Rear Panel Adjustments

Sweep Length and Vector Adjustments

Perform sweep length and vector adjustments procedure to adjust the horizontal sweep length and the vector alignment. Set up equipment as shown in Figure 5-1.

Equipment Required (See Table 5-3)

External Power AC Adapter (wall transformer, Item 1)
Adjustment Tool (Item 6)

Procedure

1. Select the XY alignment pattern.
   a. Press the **AUX FUNCT** button on the top panel.
   b. Select the ALIGN to display the ALIGN menu.
   c. Select XY to display the test pattern shown in Figure 5-2.
2. Adjust the sweep length: Adjust SWP (R255) to set the end of the sweep just to the right most vertical line of the display pattern (see Figure 5-2).
3. Adjust the sweep length: Adjust XVECT (R259) and YVECT (R260) for the best square corner at the lower left of the display pattern.

4. Remove the XY alignment pattern: Press the **CLEAR** button to remove the pattern.

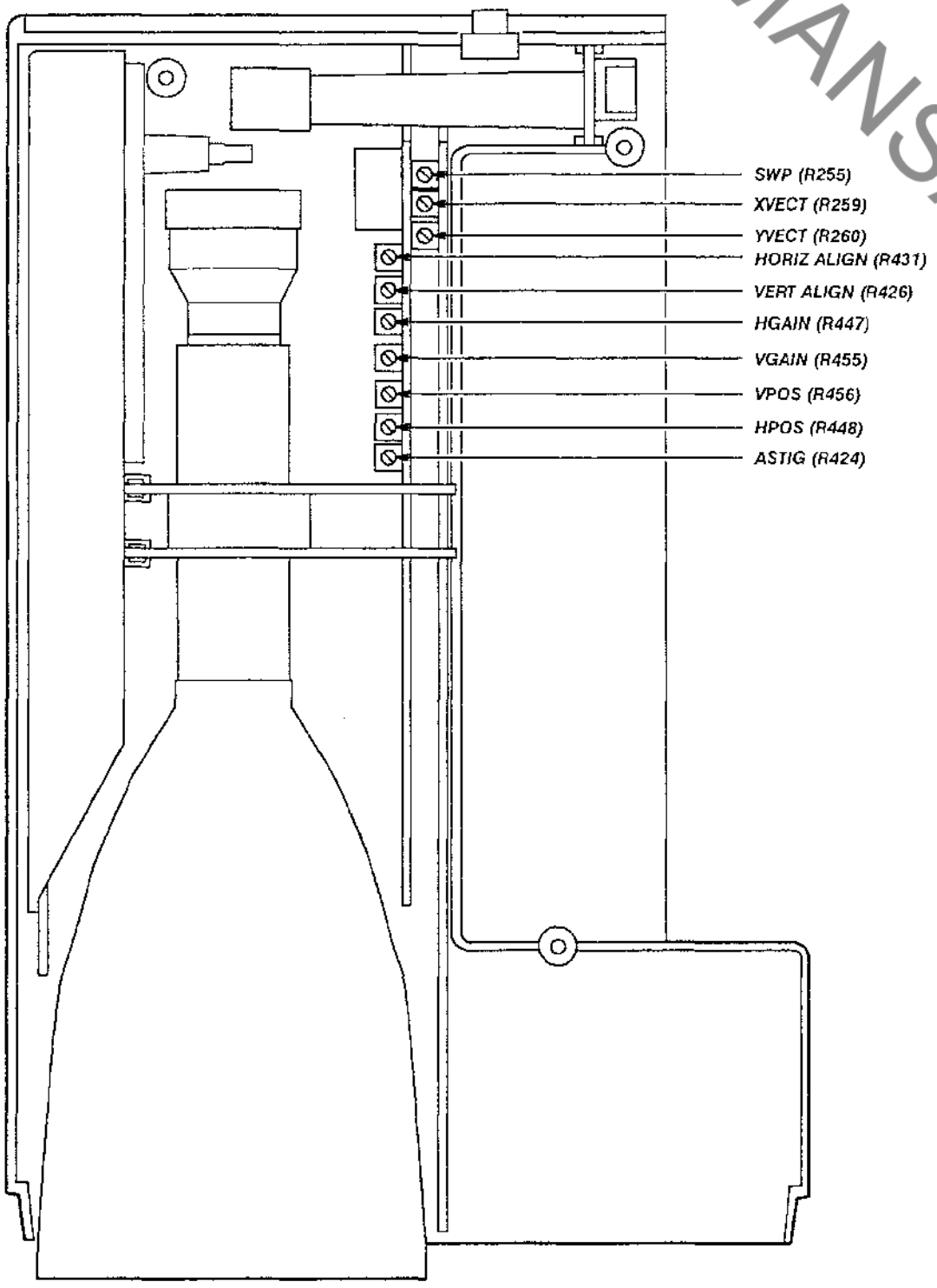


Figure 5-4: Top Accessible Adjustments

Reference Self Calibration

Perform the reference self calibration procedure to set the internal references for the acquisition channels. Set up equipment as shown in Figure 5-5.

Equipment Required (See Table 5-3)

External Power AC Adapter (wall transformer, Item 1)
DMM Calibrator (Item 2)
Dual Banana to Female BNC Adapter (Item 8)
BNC-T connector (Item 10)
50 Ω BNC Coaxial Cable (Item 11)
Probes (two required, Item 7)
BNC to Miniature Probe Tip Adapter (2 required, Item 9)

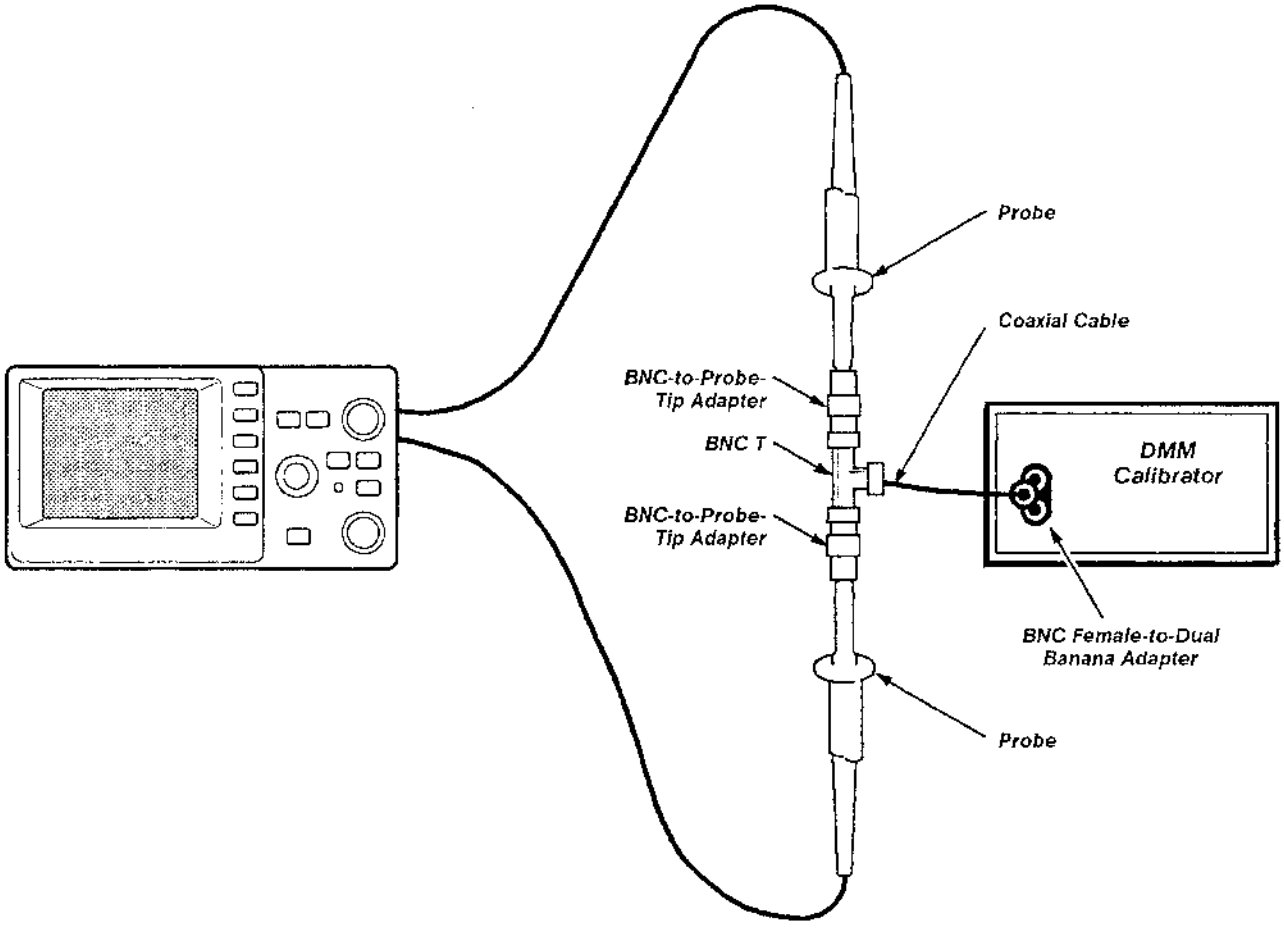


Figure 5-5: Equipment Setup for Reference Self Calibration

Procedure

1. Set the DMM Calibrator output: Set the DMM Calibrator to provide a 0.3 V reference voltage within ± 0.05%.
2. Connect the Probes to the DMM Calibrator: Connect the equipment as shown in Figure 5-5.
3. Select the reference calibration function.
   a. Press the **AUX FUNCT** button on the top panel.
   b. Select SELF CAL to call up the calibration menu.
   c. Select PROBE to display the APPLY REF menu.
4. Run the channel 1 reference calibration: Select CH 1 to run the CH 1 reference Self Cal.
5. Run the channel 2 reference calibration: Select CH 2 to run the CH 2 reference Self Cal.
6. Remove the APPLY REF menu: Press the **CLEAR** button to remove the menu.
7. Disconnect the equipment: When the calibration routine has finished, disconnect the BNC-T connector and the two probes from their adapters.

Gain Self Calibration

Perform the gain self calibration procedure to calibrate the gain through both input channels. Set up equipment as shown in Figure 5-1.

Equipment Required (See Table 5-3)

External Power AC Adapter (wall transformer, Item 1)

Procedure

1. Select the reference calibration function:
   a. Press the **AUX FUNCT** button on the top panel.
   b. Select SELF CAL to call up the calibration menu.
2. Run the channel 1 self calibration: Select CH 1 to run the CH 1 Self Cal. Watch for a PASS message indicating that calibration was completed successfully. A FAIL message indicates a need for repair.
3. Run the channel 2 self calibration: Select CH 2 to run the CH 2 Self Cal. Watch for a PASS message indicating that calibration was completed successfully. A FAIL message indicates a need for repair.
4. Remove the SELF CAL menu: Press the **CLEAR** button to remove the menu.

NOTE

The PASS/FAIL message is not self-clearing and will remain on the display until cleared. You can remove the message by pressing the ***CLEAR*** *button.*

Clock Delay Adjustment

Perform clock delay adjustment procedure to calibrate the clock delay. Set up equipment as shown in Figure 5-1.

Equipment Required (See Table 5-3)

External Power AC Adapter (wall transformer, Item 1)
Adjustment Tool (Item 6)

Procedure

1. Select the clock calibration function.
   a. Press the **AUX FUNCT** button on the top panel.
   b. Select ALIGN to display the ALIGN menu.
   c. Press the third button (the one below the XY menu choice; it is not labeled) to start the clock calibration procedure.
2. Adjust the clock delay: Adjust the clock delay adjustment (R308), located below the front of the CRT (see Figure 5-6), until the trigger position indicator (+) remains within the center two horizontal divisions. An occasional jump outside the center division may occur. See Figure 5-7 for the limits.
3. Exit the clock calibration function: Press the **CLEAR** button to return to normal operation.

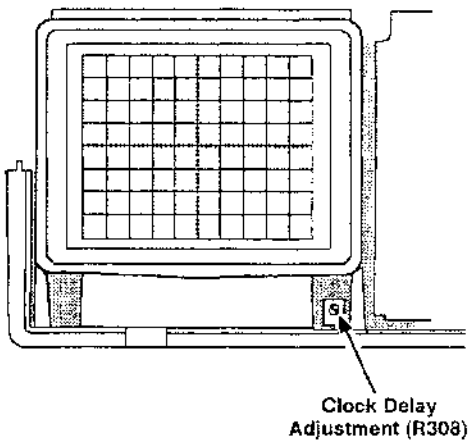


Figure 5-6: Clock Delay Adjustment

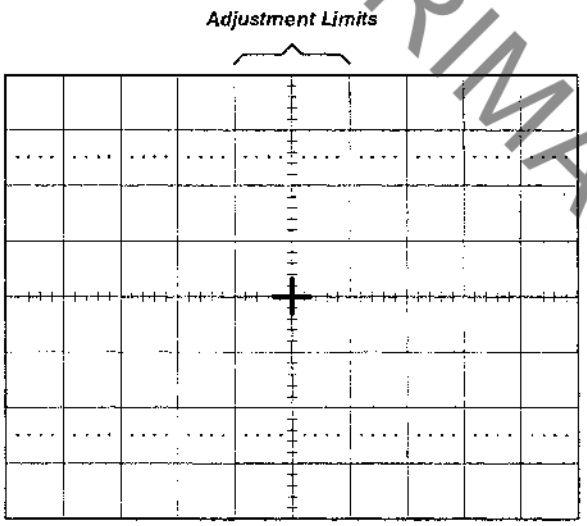


Figure 5-7: Clock Delay Adjustment Limits

External Trigger Offset Calibration

Perform this procedure to calibrate the external trigger offset. Set up equipment as shown in Figure 5-8.

Equipment Required (See Table 5-3)

External Power AC Adapter (wall transformer, Item 1)
Patch Cord (with banana connectors, Item 12)

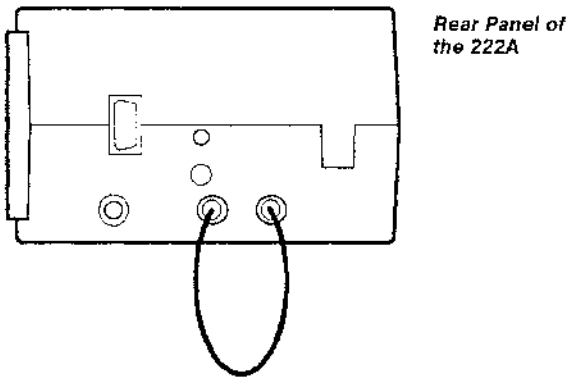


Figure 5-8: Equipment Setup for External Trigger Offset Calibration

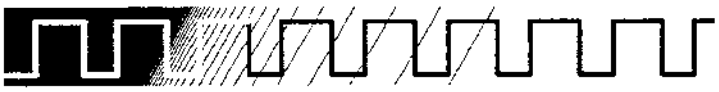
Procedure

1. Short the **EXT TRIG INPUT** and **TRIG COM** connectors: Use the banana plug patch cord to connect the **TRIG COM** and **EXT TRIG INPUT** connectors together.

NOTE

*The **TRIG COM** and **EXT TRIG INPUT** connectors on the rear panel must be connected together before running the external trigger offset self calibration.*

2. Select the external trigger calibration function.
   a. Press the **AUX FUNCT** button on the top panel.
   b. Select SELF CAL to call up the calibration menu.
   c. Select EXT TRIG to display the next menu.
   d. Press the CAL button to run the external trigger self calibration routine. Watch for a PASS message indicating that calibration was competed successfully. A FAIL message indicates a need for repair.
3. Disconnect equipment: When the trigger calibration is finished, disconnect the patch cord from the **TRIG COM** and **EXT TRIG INPUT** connectors.



Maintenance

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Maintenance Information

This section contains the information needed to do periodic and corrective maintenance on the 222A Digital Storage Oscilloscope. Specifically, four subsections are included:

- **Maintenance Information** – This subsection. It includes this introduction plus general information on preventing damage to internal modules when doing maintenance.
- **Inspection and Cleaning** – Information anc procedures for inspecting the oscilloscope and cleaning its external and internal modules.
- **Removal and Installation Procedures** – Procedures for the removal of defective modules and replacement of new or repaired modules. Also included is a procedure for disassembly of the oscilloscope for cleaning.
- **Troubleshooting** – Information for isolating and troubleshooting failed modules. Included are instructions for using the oscilloscope internal diagnostic routines the troubleshooting trees located in Section 9, *Diagrams*.

Information and Procedures Not In This Section

The following sections contain information or procedures related to doing maintenance.

- Section 2, *Operating Information*, covers instructions useful when operating the oscilloscope in order to troubleshoot it. It also details the service strategy and lists options for obtaining maintenance service and for replacing failed modules.
- Section 3, *Theory of Operation*, contains a detailed circuit description of the oscilloscope.
- Section 4, *Performance Verification*, contains procedures that may be useful in isolating problems to modules by testing oscilloscope performance.
- Section 5, *Adjustment Procedures*, addresses after repair adjustment and the interval between periodic adjustments. It contains a procedure for adjusting the internal circuits of the oscilloscope.
- Section 8, *Replaceable Electrical Parts,* lists all replaceable electrical parts by part number.
- Section 9, *Diagrams*, contains troubleshooting trees, component location diagrams and tables, circuit waveforms, block diagrams, and schematics.
- Section 10, *Replaceable Mechanical Parts,* lists all replaceable mechanical parts by part number.

Preventing ESD

CAUTION

Static discharge can damage any semiconductor component in this oscilloscope.

Precautions

When performing any service that requires internal access to the oscilloscope, follow these precautions to avoid damaging internal modules and their components due to electrostatic discharge (ESD).

1. Minimize handling of static-sensitive modules.
2. Transport and store static-sensitive modules in their static protected containers or on a metal rail. Label any package that contains static-sensitive modules.
3. Discharge the static voltage from your body by wearing a grounded antistatic wrist strap while handling these modules. Perform service of static-sensitive modules only at a static-free work station.
4. Nothing capable of generating or holding a static charge should be allowed on the work station surface.
5. Handle circuit boards by the edges when possible.
6. Do not slide the modules over any surface.
7. Avoid handling modules in areas that have a floor or work-surface covering capable of generating a static charge.

Susceptibility to ESD

Table 6-1 lists the relative susceptibility of various classes of semiconductors. Static voltages of 1 kV to 30 kV are common in unprotected environments.

Table 6-1: Relative Susceptibility to Electrostatic Discharge (ESD)

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

[1]Voltage equivalent for levels (voltage discharged from a 100 pF capacitor through resistance of 100 ohms):

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

Inspection and Cleaning

Inspection and Cleaning describes how to inspect for dirt and damage on and how to clean the exterior and interior of the 222A Digital Storage Oscilloscope. Inspection and cleaning are done as preventive maintenance. Preventive maintenance, when done regularly, may prevent oscilloscope malfunction and enhance its reliability.

Preventive maintenance consists of visually inspecting and cleaning the oscilloscope and using general care when operating it.

How often to do maintenance depends on the severity of the environment in which the oscilloscope is used. A proper time to perform preventive maintenance is just before oscilloscope adjustment.

General Care

The cabinet helps keep dust out of the oscilloscope and should normally be in place when operating the oscilloscope. The oscilloscope's front cover protects the front panel and display from dust and damage. Install it when storing or transporting the oscilloscope.

Inspection and Cleaning Procedures

Inspect and clean the oscilloscope as often as operating conditions require. The collection of dirt on components inside can cause them to overheat and breakdown. (Dirt acts as an insulating blanket, preventing efficient heat dissipation.) Dirt also provides an electrical conduction path that could cause an oscilloscope failure, especially under high-humidity conditions.

CAUTION

Avoid the use of chemical cleaning agents which might damage the plastics used in this oscilloscope. Use only deionized water when cleaning the menu buttons or front-panel buttons. Use a 75% isopropyl alcohol solution as a cleaner and rinse with deionized water. Before using any other type of cleaner, consult your Tektronix Service Center or representative.

Inspection — Exterior

Using Table 6-2 as a guide, inspect the outside of the oscilloscope for damage, wear, and missing parts. Oscilloscopes that appear to have been dropped or otherwise abused should be checked thoroughly to verify correct operation and performance. Repair defects that could cause personal injury or lead to further damage to the oscilloscope immediately.

Table 6-2: External Inspection Check List

Item	Inspect For	Repair Action
Cabinet, front panel, and cover	Cracks, scratches, deformations, damaged hardware or gaskets.	Repair or replace defective module.
Front-panel knobs	Missing, damaged, or loose knobs.	Repair or replace missing or defective knobs.
Connectors	Broken shells, cracked insulation, and deformed contacts. Dirt in connectors.	Repair or replace defective modules. Clear or wash out dirt.
Carrying handle, bail, cabinet feet.	Correct operation.	Repair or replace defective module.
Accessories	Missing items or parts of items, bent pins, broken or frayed cables, and damaged connectors.	Repair or replace damaged or missing items, frayed cables, and defective modules.

Cleaning Procedure — Exterior

CAUTION

To prevent getting moisture inside the oscilloscope during external cleaning, use only enough liquid to dampen the cloth or applicator.

1. Remove loose dust on the outside of the oscilloscope with a lint free cloth.
2. Remove remaining dirt with a lint free cloth dampened in a general purpose detergent-and-water solution. Do not use abrasive cleaners.
3. Clean the light filters and the CRT face with a lint-free cloth dampened with either isopropyl alcohol or a mild, general purpose detergent-and-water solution.

Inspection — Interior

To access the inside of the oscilloscope for inspection and cleaning, refer to the *Removal and Installation Procedures* in this section.

Using Table 6-3 as a guide, inspect the internal portions of the oscilloscope for damage and wear. Defects found should be repaired immediately.

If any electrical module is repaired or replaced, check Table 5-1 in Section 5 to see if it is necessary to adjust the oscilloscope.

CAUTION

To prevent damage from electrical arcing, ensure that circuit boards and components are dry before applying power to the oscilloscope.

Table 6-3: Internal Inspection Check List

Item	Inspect For	Repair Action
Circuit boards	Loose, broken, or corroded solder connections. Burned circuit boards. Burned, broken, or cracked circuit-run plating.	Repair or replace the module.
Resistors	Burned, cracked, broken, blistered condition.	Repair or replace the module.
Solder connections	Cold solder or rosin joints.	Resolder joint and clean with isopropyl alcohol.
Capacitors	Damaged or leaking cases. Corroded solder on leads or terminals.	Repair or replace the module.
Semiconductors	Loosely inserted in sockets. Distorted pins.	Firmly seat loose semiconductors. Remove devices that have distorted pins. Using long-nose pliers, carefully straighten pins (as required to fit the socket), and insert semiconductor firmly. Ensure that straightening action does not crack pins, which can cause them to break off.
Wiring and cables	Loose plugs or connectors. Burned, broken, or frayed wiring.	Firmly seat connectors. Repair or replace modules with defective wires or cables.
Chassis	Dents, deformations, and damaged hardware.	Straighten, repair, or replace defective hardware.

Cleaning Procedure — Interior

If, after doing steps 1 and 2, a module is clean upon inspection, skip the remaining steps.

1. Blow off dust with dry, low-pressure, deionized air (approximately 9 psi).
2. Remove any remaining dust with a lint free cloth dampened in isopropyl alcohol (75% solution) and rinse with a warm deionized water. (A cotton-tipped applicator is useful for cleaning in narrow spaces and on circuit boards.)
3. If steps 1 and 2 do not remove all the dust or dirt, the oscilloscope may be spray washed using a solution of 75% isopropyl alcohol by doing steps 4 through 8.
4. Gain access to the parts to be cleaned by removing easily accessible shields and panels (see *Removal and Installation Procedures*).
5. Spray wash dirty parts with the isopropyl alcohol and wait 60 seconds for the majority of the alcohol to evaporate.
6. Use hot (49°C to 60°C) deionized water to thoroughly rinse them.
7. Dry all parts with low-pressure, deionized air.
8. Dry all components and assemblies in an oven or drying compartment using low-temperature (52°C to 66°C) circulating air.

Lubrication

There is no periodic lubrication required for this oscilloscope.

Removal and Installation Procedures

This subsection contains procedures for removal and installation of all mechanical and electrical modules. Any mechanical module, assembly, or part listed in Section 10 of this manual is a module.

WARNING

Before performing this or any other procedure in this manual, read the Safety Summary *at the beginning of this manual. Also, to prevent possible injury to service personnel or damage to components of this oscilloscope, read* Before Servicing and Supplying Operating Power *in Section 2 and* Preventing ESD *in this section.*

This subsection contains the following:

- This preparatory information that you need to properly do the procedures that follow.
- List of Equipment required to remove and disassemble all modules.
- Procedures for removal and reinstallation of the electrical and mechanical modules.
- A circuit board module locator diagram (see Figure 6-1) for identifying the circuit boards in this oscilloscope.
- Module disassembly procedures.

WARNING

To prevent serious injury or death, disconnect the external power connection and the battery from the oscilloscope before doing any procedure in this subsection.

List of Modules

Section 8 lists all electrical modules and Section 10 lists all mechanical modules.

General Instructions

READ THESE GENERAL INSTRUCTIONS BEFORE REMOVING A MODULE.

First read over the *Summary of Procedures* that follows to understand how the procedures are grouped. Then read *Equipment Required* for a list of the tools needed to remove and install modules in this oscilloscope.

If you are disassembling this oscilloscope for cleaning or service, do the procedure *Front and Top Case* on page 6-13 and then the appropriate procedures for circuit board/assembly removal.

NOTE

Read the procedures in Inspection and Cleaning *on page 6-5 before disassembling the oscilloscope for cleaning.*

Summary of Procedures

The procedures are described in the order in which they appear in this section. In addition, you can look up any procedure for removal and reinstallation of any module in the *Table of Contents* of this manual.

- *Front and Top Case* procedure on page 6-13 removes the top and front case pieces to provide access to all internal modules.
- *CRT and Power Supply Board* procedure on page 6-16 removes the CRT and Power Supply board as an assembly from the bottom case.
- *CPU/Display Board* procedure on page 6-18 removes the CPU/Display board from the bottom case.
- *Acquisition board and Main board* procedure on page 6-19, removes the Acquisition and Main boards as an assembly from the bottom case.
- *Front Panel Board* procedure on page 6-22 separates the Front Panel board from the Front case.
- *Keypad board* removal procedure on page 6-23 separates the Keypad board from the Top case.
- *Pot board* procedure on page 6-24 removes the Pot board from the potentiometer bracket.

Equipment Required

Most modules in this oscilloscope can be removed with a screwdriver handle mounted with a size T-15, Torx® screwdriver tip. Table 6-4 lists the tools needed to remove and replace the modules in the oscilloscope. All equipment required to remove and reinstall each module is listed at the beginning of its procedure.

Table 6-4: Tools Required for Module Removal and Installation

Item No.	Name	Description	Tektronix Part Number
1	0.050 inch Hex wrench	L-shaped for best access to knob set screws	
2	Screwdriver handle	Accepts Torx® driver tips	003-0301-00
3	Torx head tip	T-15 tip (recommended 2 inch length)	003-0966-00
4	Angle-tipped Tweezers	Standard tool	
5	Adhesive	PRISM 454 gel, Loctite #45440	
6	Accelerator	Tak Pak spray, Loctite #14647	

Circuit Board Identification

Figure 6-1 identifies and shows the location of the oscilloscope circuit boards. The procedure *Front and Top Case* on page 6-13 provides access to the circuit boards.

CAUTION

All assembly and disassembly of the instrument must be done at an approved anti-static work station. The semiconductor devices in the instrument are highly susceptible to static discharge damage.

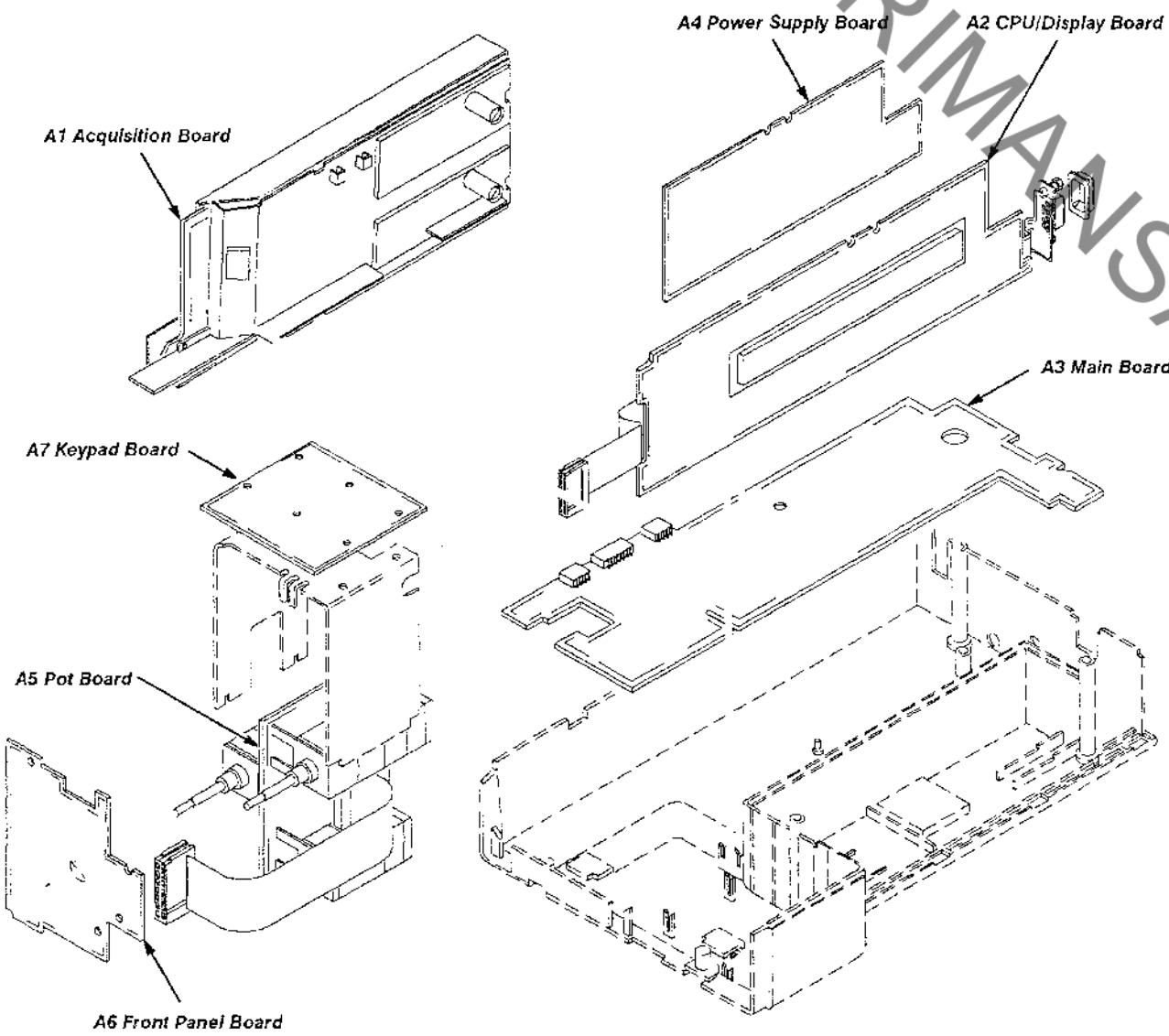


Figure 6-1: Circuit Board Identification

Front and Top Case

The Front and Top Case procedure prepares the oscilloscope for access to internal modules or to internal calibration adjustments. Refer to Figures 6-2 and 6-3 during the following procedure.

Equipment Required (See Table 6-4)

0.050 inch Hex wrench (Item 1)
Screwdriver handle with T-15 tip (Items 2 and 3)
Angle-tipped Tweezers (Item 4)

1. Remove probes, probe pouch and battery cover.
   a. Unzip the probe pouch; unplug the probes (if connected) and remove the probes from the pouch.
   b. Place the instrument on its side and slide the probe pouch and battery compartment cover toward the rear of the instrument to disengage the locking tabs.
   c. Lift the probe pouch and battery compartment cover up and off the instrument.
2. Remove the battery: Disconnect the three wire battery connector and remove the battery pack from the compartment.
3. Remove the front-panel knob assemblies.
   a. Remove the three smaller rubber knob shells labeled **POS** (two shells) and **AUTO LVL:PUSH**. This can easily be done by placing a small angle-tipped object (such as a tweezers) behind the knob shell and gently prying the knob shell off the knob insert. Figure 6-2 shows how to take the knobs off.
   b. Using a 0.050 inch hexagonal wrench, loosen the setscrews in the exposed knob inserts and remove them.
   c. Remove the three larger, knob shells and inserts in the same manner as the smaller ones.
4. Remove screws from the bottom case.
   a. Place the instrument on its top case as shown in Figure 6-3. Lift the flip stand up.
   b. Use a T-15 Torx-head tip screwdriver to remove the two short screws at the front, the two long screws at the rear, and the long screw located under the flip stand. Fold the flip stand back against the case.

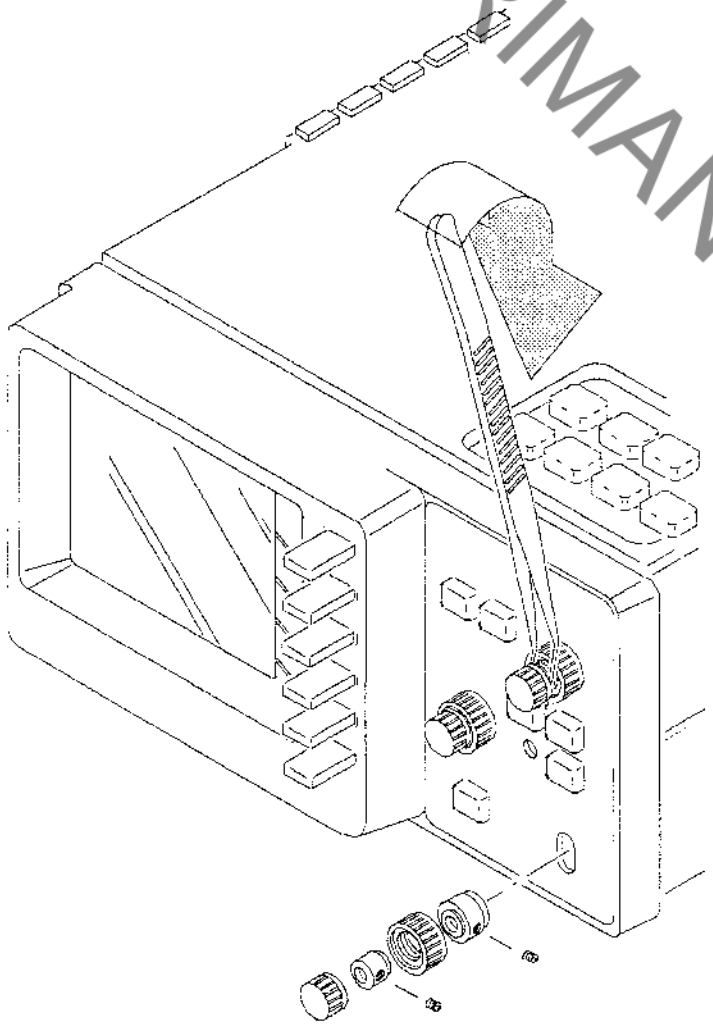


Figure 6-2: Removing Knobs From the Front Panel

5. Remove the front case.

   a. Turn the instrument over and set it down with the front panel facing you.

   b. Pull the bottom of the front case piece out until it clears the bottom case. Disengage the front case from the top case and carefully pull it away from the instrument, extending the connecting cables only about an inch.

   c. Note the orientation of the six-wire cable that comes from the Keypad board (attached to the top case), to the Front Panel board for correct installation later. Disconnect the cable at the Front Panel board.

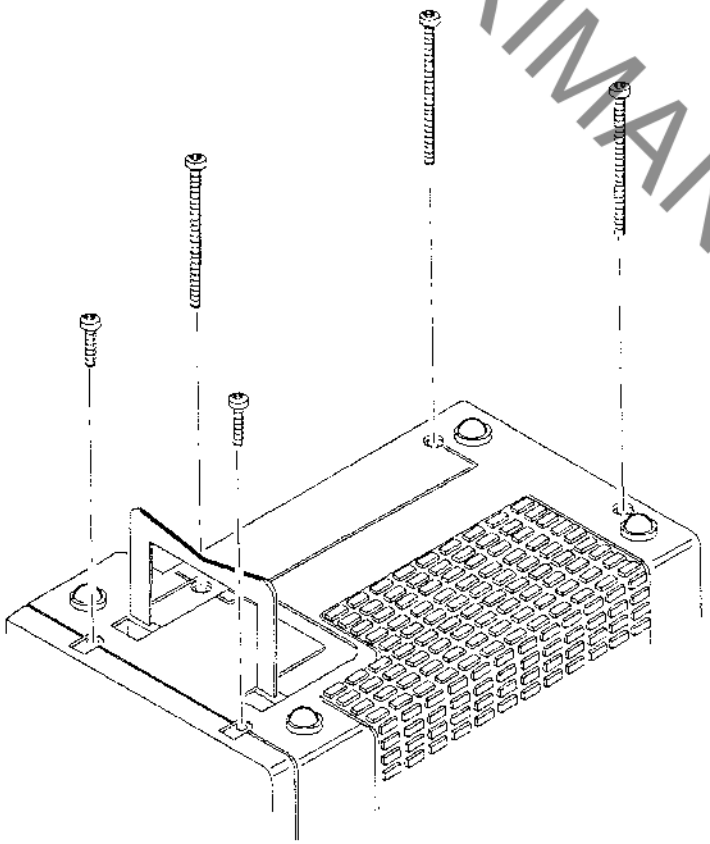


Figure 6-3: Removing Screws from the Bottom Case

6. Lift the top case off the instrument.

NOTE

If you are removing the top case for calibration only, do not disassemble the instrument further. Do not separate the Front Panel or Keypad board from their case attachments unless you intend to change the boards or their rubber push-button actuators.

7. Reinstallation: If any circuit boards were removed, ensure that they are now positioned correctly for reassembly. To install the top case, carefully align the two halves while making sure the following items are all in place:

   a. The probe receptacle is in its grooves and the COMM Port is in the case slot.

   b. The Keypad board guide posts fit in the holes of the Pot board bracket.

   c. The handle strap is properly captured between the top and bottom clips in the case halves.

Perform Steps 1–6 in reverse order. When installing the bottom case screws apply 4 in/lbs of torque. When replacing both sizes of knob inserts, position the smaller diameter surface towards the instrument. Space the large inserts 0.2" from the front case and the small knob inserts 0.2" from the large inserts to ensure travel for the center push button of each potentiometer.

CAUTION

Do not overtighten the setscrews in the knob inserts. Excessive pressure can burr the potentiometer shafts and make the knobs difficult to remove. The recommended torque is 2 in/lbs.

CRT and Power Supply Board

The CRT and Power Supply board removal procedure removes the CRT and Power Supply board as an assembly from the bottom case. Refer to Figure 6-4 during this procedure.

Equipment Required (See Table 6-4)

0.050 inch Hex wrench (Item 1)
Screwdriver handle with T-15 tip (Items 2 and 3)
Angle-tipped Tweezers (Item 4)

1. To gain access to the circuit board, remove the front case and top case: Perform the procedure *Front and Top Case* on page 6-13.

WARNING

The CRT is a high-vacuum component. Wear the proper eye protection when handling the CRT. Use care not to place excessive strain on the neck or connector pins. Place the CRT in a protected location while it is out of the instrument.

2. Remove the probe receptacle: Pull the probe receptacle up and out of the bottom case. You can leave the input signal cables connected to the Acquisition board.
3. Remove the CRT and the Power Supply board.
   a. Pull up on the front of the CRT until you can grasp the Power Supply board. Leave the support bracket on the neck of the CRT.
   b. Hold the CRT up a little while you pull the Power Supply board up from the front and out of its connectors on the Main board.

c. Bring the CRT and Power Supply board forward and out of the instrument. The INTENSITY adjustment knob extends through the rear panel and must be moved forward for removal.

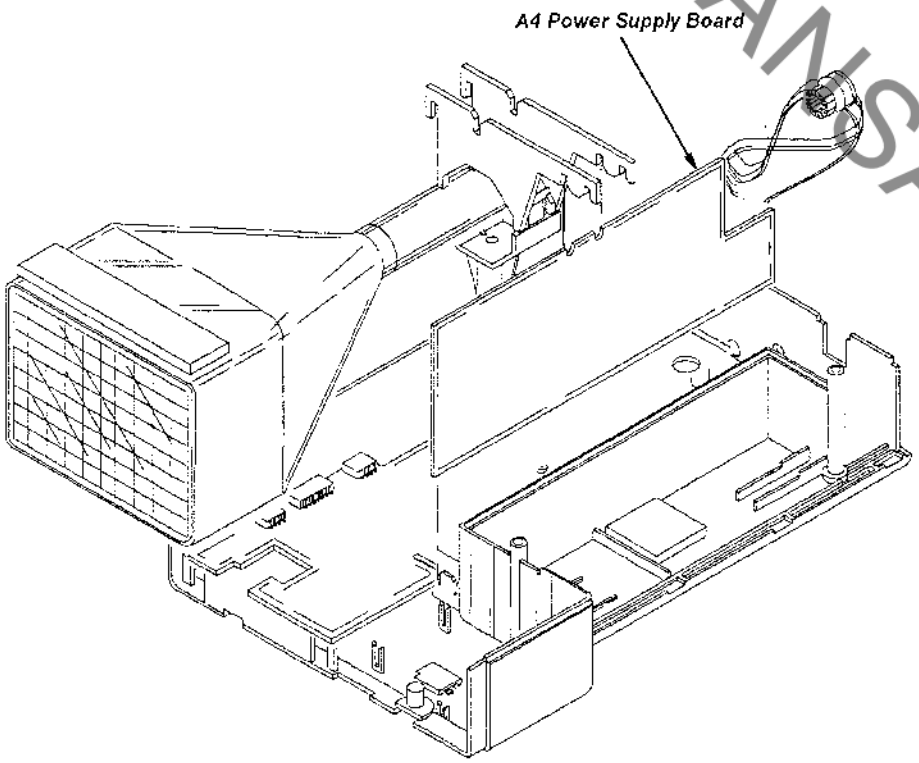


Figure 6-4: Removing the CRT Assembly

4. Disconnect the CRT: Grasp the CRT socket harness at its front while holding the CRT about its neck. Wiggle the socket back and forth as you pull it off the CRT. Take care not to pull the back cover off the socket as this will free the connecting wires from W1 on the Power Supply board and require their reinstallation in the socket.

   To insert the connecting wires from W1 into the CRT socket, place the shielded lead at pin 1 (the isolated socket pin) and then insert pins 2 through 9 clockwise from pin 1. You might find it helpful to place the socket, minus the cap, on the CRT and then insert wires through the socket onto the CRT pins. The wires are color coded to match the pin numbering of the CRT pins and the W1 connections on the circuit board.

5. Replace the CRT: Place the CRT in a safe place if it is to be reinstalled or dispose of it safely if it is defective. If replacing the CRT, unsnap the bottom half of the support bracket from the top half and remove the brackets from the CRT.

6. Reinstallation: If you are replacing the Power Supply board, move the extension knob from the **INTEN** (intensity) control to the new board.

Perform Steps 1–5 in reverse order. Ensure that the CRT neck support bracket rests on the alignment pin in the bottom case. As you lower the CRT into place, align the support bracket guides with the slots on the Power Supply and CPU/Display boards and the square holes on the Acquisition board assembly.

CPU/Display Board

The CPU/Display board removal procedure removes the CPU/Display board from the bottom case. Refer to Figure 6-5 during this procedure.

Equipment Required (See Table 6-4)

0.050 inch Hex wrench (Item 1)
Screwdriver handle with T-15 tip (Items 2 and 3)
Angle-tipped Tweezers (Item 4)

1. To gain access to the circuit board, remove the front case and top case. Perform the procedure *Front and Top Case* on page 6-13.
2. Remove the probe receptacle: Pull the probe receptacle up and out of the bottom case. You can leave the input signal cables connected to the Acquisition board.
3. Remove the CRT and the Power Supply board.
   a. Pull up on the front of the CRT until you can grasp the Power Supply board. Leave the support bracket on the neck of the CRT.
   b. Hold the CRT up a little while you pull the Power Supply board up from the front and out of its connectors on the Main board.
   c. Bring the CRT and Power Supply board forward and out of the instrument. The INTENSITY adjustment knob extends through the rear panel and must be moved forward for removal.
4. Remove the CPU/Display board: Hold the Main board down while you pull the CPU/Display board up at the center to disconnect it from the Main board. Lift the CPU/Display board out of the bottom case.
5. Reinstallation: Align the connectors at the front end of the CPU/Display board with the pins on the Main board. Ensure that the COMM PORT connector is properly seated in the case slot. You may have to guide the foam gasket strip on the back side of the board past the edge of the bottom case. Perform Steps 1–3 in reverse order.

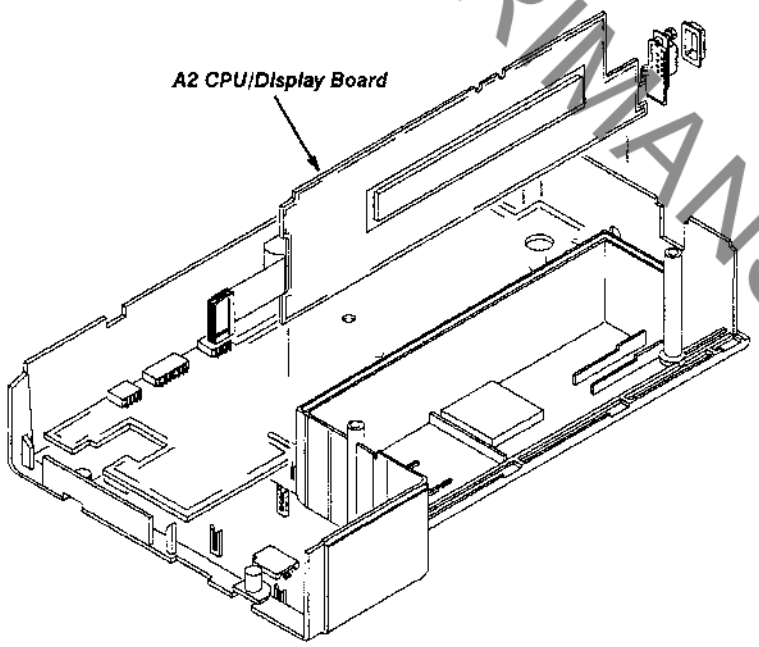


Figure 6-5: Removing the CPU/Display Board

Acquisition Board and Main Board

The Acquisition board and Main board procedure, removes the Acquisition and Main boards as an assembly from the bottom case. Once the assembly is out of the case, the two boards can be easily separated. Refer to Figure 6-6 during this procedure.

Equipment Required (See Table 6-4)

0.050 inch Hex wrench (Item 1)
Screwdriver handle with T-15 tip (Items 2 and 3)
Angle-tipped Tweezers (Item 4)

1. To gain access to the circuit board, remove the front case and top case: Perform the procedure *Front and Top Case* on page 6-13.
2. Remove the probe receptacle: Pull the probe receptacle up and out of the bottom case. Disconnect the input signal cables from the Acquisition board. Note that the CH 1 coax cable has a mark or white heat shrink at the metal end.
3. Remove the CRT and the Power Supply board.
   a. Pull up on the front of the CRT until you can grasp the Power Supply board. Leave the support bracket on the neck of the CRT.
   b. Hold the CRT up a little while you pull the Power Supply board up from the front and out of its connectors on the Main board.

c. Bring the CRT and Power Supply board forward and out of the instrument. The INTENSITY adjustment knob extends through the rear panel and must be moved forward for removal.

4. Remove the securing screw from the Main board: Remove the T-15 Torx head screw (see Figure 6-6 for the location) that holds the Main board to the bottom case.

5. Remove the Acquisition and Main board assembly from the case: Grasp the square black component on the Main board and carefully pull straight up until the Main board is clear of the bottom case.

6. Separate the Acquisition board assembly from the Main board: Pull firmly and evenly on the front and lower edges of the Acquisition board assembly to separate it from the Main board.

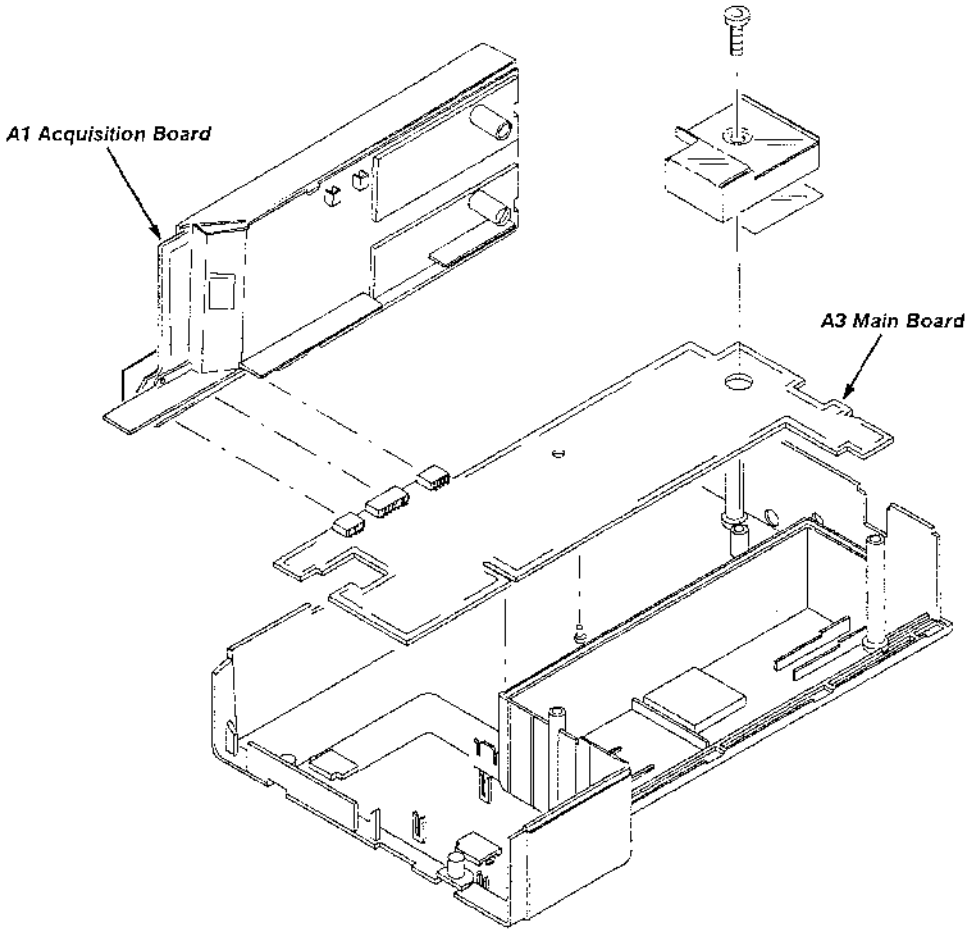


Figure 6-6: Removing the Main and Acquisition Boards as an Assembly

7. Remove the shielding from the Acquisition board.
   a. Place the Acquisition board assembly on a static free work surface with the signal inputs up.
   b. Unsnap the case halves using angle-tipped tweezers. This is best done by starting with the two snaps in the middle of the assembly and then the two at the rear.
   c. Turn the assembly over and remove the shield piece.
   d. Remove the Acquisition board from the other half.

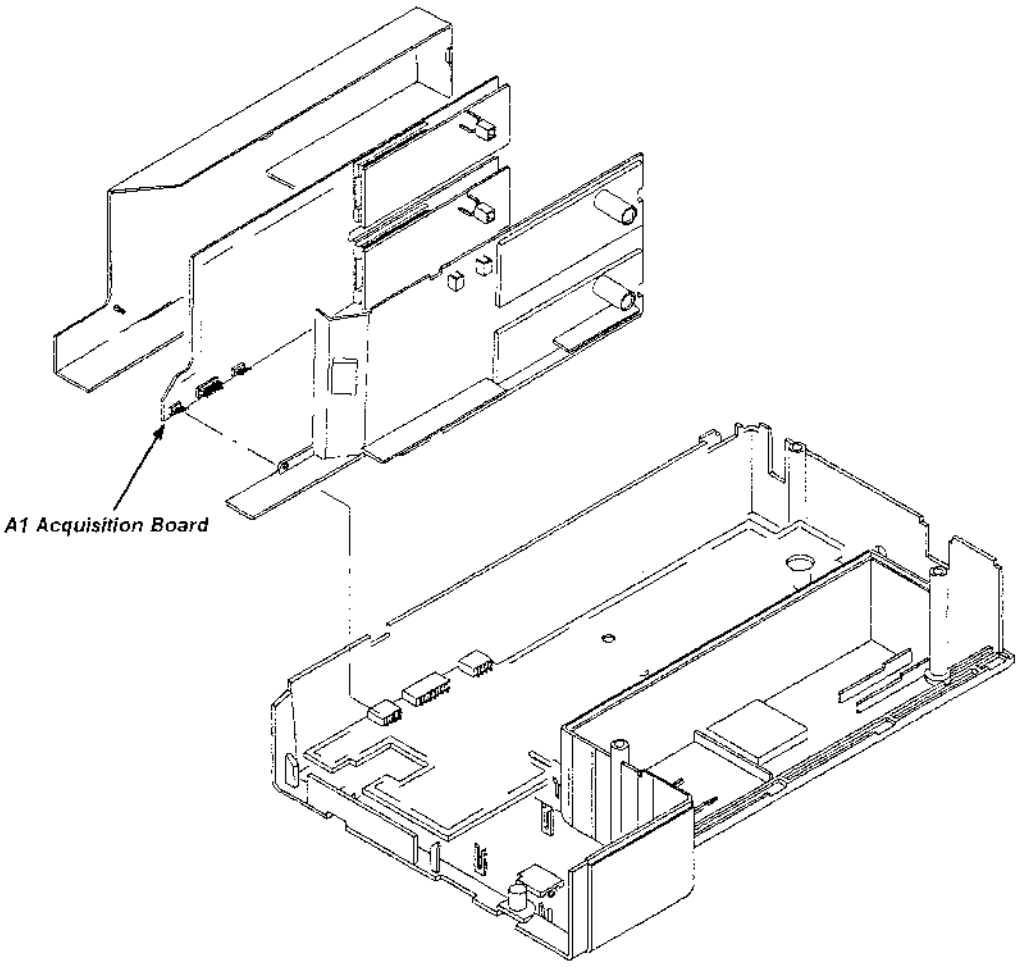


Figure 6-7: Removing the Acquisition Board Shield

8. Reinstallation: Perform Steps 1–7 in reverse order. When placing the Acquisition and Main board assembly in the bottom case, guide the foam gasket on the Acquisition board assembly past the edge of the bottom case.

Front Panel Board

The Front Panel board removal procedure separates the Front Panel board from the Front case. Refer to Figure 6-1 during the following procedure.

Equipment Required (See Table 6-4)

0.050 inch Hex wrench (Item 1)
Screwdriver handle with T-15 tip (Items 2 and 3)
Angle-tipped Tweezers (Item 4)
Adhesive and Accelerator (Items 5 and 6)

1. To gain access to the circuit board, remove the front case and top case: Perform the procedure *Front and Top Case* on page 6-13.
2. Disconnect cables to the Front Panel board: Disconnect the two 14-pin cables from the Front Panel board; lay the front case piece down on a static-free work surface.
3. Remove the Front Panel board: Remove the Front Panel board from the front case piece by carefully breaking the glue off the guide posts that protrude through the board.

CAUTION

Do not attempt to remove the glue by melting it with a heat gun. Excessive heat can damage the plastic front panel assembly.

4. If replacement is necessary, remove the the rubber pushbutton actuator mat.

CAUTION

Do not touch either the switch contact area on the Front Panel board or the carbon contact area on the pushbutton actuator mat with bare fingers. Body oils can corrode the contact surfaces.

5. Reinstallation: Perform Steps 1–3 in reverse order. Ensure that you orient the button text correctly. Secure the Front Panel board to the front case using a small amount of adhesive and accelerator on each guide post. Refer to the adhesive manufactures instructions for proper use and safety precautions.

Keypad Board

The Keypad board removal procedure separates the Keypad board from the Top case. Refer to Figure 6-1 during the following procedure.

Equipment Required (See Table 6-4)

0.050 inch Hex wrench (Item 1)
Screwdriver handle with T-15 tip (Items 2 and 3)
Angle-tipped Tweezers (Item 4)
Adhesive and Accelerator (Items 5 and 6)

1. To gain access to the circuit board, remove the front case and top case: Perform the procedure *Front and Top Case* on page 6-13.
2. Position the Top case: Lay the Top case down with the Keypad board visible.
3. Remove the Keypad board: Remove the Keypad board from the Top case by carefully breaking the glue off the guide posts protruding through the board. Remove the Keypad board.
4. Remove the rubber pushbutton actuator mat if replacement is necessary.

NOTE

Do not touch either the switch contact area on the Keypad board or the carbon contact area on the pushbutton actuators with bare fingers. Body oils can corrode the contact surfaces.

NOTE

Do not glue the two guide posts nearest the side of the case.

5. Reinstallation: Perform Steps 1–4 in reverse order. Ensure that the text is oriented correctly. Secure the Front Panel board to the Front case by applying a small amount of adhesive and accelerator on each guide post while applying slight pressure to the board. Refer to the adhesive manufactures instructions for proper use and safety precautions.

Pot Board

The Pot board removal procedure removes the Pot board from the potentiometer bracket. Refer to Figure 6-1 during the following procedure.

Equipment Required (See Table 6-4)

0.050 inch Hex wrench (Item 1)
Screwdriver handle with T-15 tip (Items 2 and 3)
Angle-tipped Tweezers (Item 4)
Adhesive and Accelerator (Items 5 and 6)

1. To gain access to the circuit board, remove the front case and top case: Perform the procedure *Front and Top Case* on page 6-13.
2. Remove the Pot board assembly: Lift the Pot board assembly out of the bottom case. Note the slots in the bottom case that align with slots in the metal bracket holding the Pot board.
3. Remove the Pot board: Remove the T-15 Torx head screw from the Pot board. Slide the Pot board from the metal bracket.
4. Reinstallation: Perform Steps 1–3 in reverse order.

Troubleshooting

This subsection contains information and procedures designed to help you isolate and repair faulty circuitry in the oscilloscope.

The troubleshooting information presented here is of two types:

- *Troubleshooting procedures* guide you by symptoms and checks to the faulty module. The Troubleshooting Procedures are located in *Diagrams*, Section 9, of this manual. A description of their use follows.
- *Internal diagnostic software* displays error codes to a connected terminal. A diagnostic failure is indicated on the oscilloscope display by the message FAIL. The description of the internal diagnostics begins on page 6-26.

Troubleshooting Procedures

The troubleshooting procedures help you locate and repair faulty components in the 222A. They are designed to be used with the *Theory of Operation* in Section 3 and the *Schematic Diagrams* in Section 9.

The troubleshooting procedures cover all the circuitry in the oscilloscope including the CRT and power supplies. Since much of the circuitry is surface mounted, you need to know how to probe and solder these components.

CAUTION

Do not short together adjacent pins of an IC. Many of the ICs have their power and ground leads next to each other. The short circuit current supplied by the power supply can destroy the IC leads, the circuit board runs, and the circuit board.

How to Use the Troubleshooting Procedures

The troubleshooting procedures begin with a three-page basic procedure on page 9-5. This basic procedure helps you isolate the problem to a suspect circuit board. You then have the option of either replacing the suspect circuit board or of performing an indicated troubleshooting procedure. For example, if the Basic procedure indicates that the A1 Acquisition board is suspect, you could replace it with a fresh board or you could perform the Acquisition Troubleshooting Procedure as indicated in the basic procedure.

The troubleshooting procedures include illustrations of critical signals where appropriate. These signal illustrations are placed on the troubleshooting procedure or on the following page.

After repairing or replacing a module, you should perform the complete *Adjustment Procedures* in Section 5. Then perform the *Basic Procedures* and *Performance Checks* in Section 4 to ensure correct operation of the oscilloscope.

Organization of Troubleshooting Procedures

The troubleshooting procedures begin with the basic procedure on page 9-5. This procedure occupies three pages. Thereafter, the circuit specific troubleshooting procedures follow the circuit board order. That is, the A1 Acquisition board troubleshooting procedures precede the A2 CPU/Display procedures. The troubleshooting procedure(s) for each circuit board are grouped with their circuit board illustrations and component locator tables.

222A Diagnostics

This 222A contains internal diagnostic routines that can help you localize module failures. If the diagnostics detect a failure during power up or self-calibration routines, the instrument will send an error message over the RS-232-C interface (the COMM PORT connection on the rear panel) to a connected terminal or host computer. Only PASS/FAIL self calibration messages are displayed on the CRT. Refer to *RS-232-C Connection* in this section for complete information on RS-232-C parameters and connection requirements.

The 222A oscilloscope can produce diagnostic information in two ways:

- *Power up diagnostics* run when you press the ON button. These diagnostics check basic functionality and communication between the primary circuit boards. Any problems are reported as error codes when the 222A is connected to a terminal. Only a PASS/FAIL message is displayed on the oscilloscope CRT.
- *Self calibration* produces error codes when the oscilloscope has a problem completing self calibration for an input channel or the external trigger. Any problems are reported as error codes when the 222A is connected to a terminal. Only a PASS/FAIL message is displayed on the oscilloscope CRT.

RS-232-C Connection

The rear panel COMM PORT is an RS-232-C type serial communication port. To connect a terminal you will need a compatible cable. Table 6-5 shows pin-to-pin wiring for several possible communications devices. You can purchase a cable compatible with a PC XT® from Tektronix. Refer to the *Options* section in this manual for more information on this optional accessory.

The default RS-232-C configuration of the 222A is as follows:

- Start bits: 1
- Stop bits: 1
- Data bits: 8
- Parity: None

- Flow Control: XON/XOFF
- Signals: RX, TX, and SGND are functional. SGND is connected internally to EXT TRIG COMM. DSR and CTS are always high. DTR going active turns the scope on and RTS is ignored.

Table 6-5: RS-232-C Interconnect Wiring for the 222A

DCE Male at 222A	To DCE Modem	To DTE PC XT	To DTE PC AT
CD 1[1]	8 CD	8 CD	1 CD
RX 2	2 TX	3 RX	2 RX
TX 3	3 RX	2 TX	3 TX
DTR 4	6 DSR	20 DTR	4 DTR
SGND 5[1]	7 GND	7 GND	5 SGND
DSR 6	20 DTR	6 DSR	6 DSR
RTS 7[1]	5 CTS	4 RTS	7 RTS
CTS 8	4 RTS	5 CTS	8 CTS
RI 9[1]	22 RI	22 RI	9 RI

[1]This connection is optional.

Diagnostic Firmware

The Diagnostic software resides in two internal EEPROMs located on the A2 CPU/Display board. If either of these devices are replaced, the oscilloscope firmware will need to be loaded before the instrument or its diagnostics can operate. Refer to Firmware Installation on page 6-31 in this section.

Power-up Error Codes

When the instrument powers up, the contents of the microprocessor EEPROMs are checked for incorrect data that would indicate corrupted calibration constants. If the instrument fails the power-up tests, the oscilloscope can send error codes via the RS-232-C interface to a terminal or host computer. Refer to Table 6-6 for error codes, descriptions, and recommended corrective actions.

Any combination of power-up error codes may occur. The last two digits of the error code are a hexadecimal number that can be converted to an eight bit binary number. After converting to binary and determining which bits are high (set to 1), use Table 6-6 to determine which self calibration procedures to perform.

For example, suppose the terminal shows the following error code:

4002 0021

Convert the hexadecimal value of 21 to binary format as follows:

Bit Field							
7	6	5	4	3	2	1	0
0	0	1	0	0	0	0	1

Note that the 0 bit and the 5th bit are high. Find the corresponding row in the Bit Field column in Table 6-6. The table indicates that CH 1 gain constant and CH 2 trigger constant errors occurred. As the Corrective Action column indicates, you should perform the CH 1 gain and the CH 2 trigger gain self-calibration procedures to correct the problems. Self calibration procedures are described in *Brief Procedures* in the *Performance Verification* section.

Table 6-6: Power-up Error Codes

Code	Bit Field	Description	Corrective Action
4001		EEPROM checksum bad	Perform all self calibrations
4002 FFFF		Initial self cal needed	Perform all self calibrations
4002 0001	0	CH 1 gain constant error	Perform CH 1 gain self calibration
4002 0002	1	CH 2 gain constant error	Perform CH 2 gain self calibration
4002 0004	2	CH 1 reference constant error	Perform CH 1 reference self calibration
4002 0008	3	CH 2 reference constant error	Perform CH 2 reference self calibration
4002 0010	4	CH 1 trigger constant error	Perform CH 1 trigger gain self calibration
4002 0020	5	CH 2 trigger constant error	Perform CH 2 trigger gain self calibration
4002 0040	6	External trigger constant error	Perform external trigger self calibration
4002 0080	7	Clock delay constant error	Perform clock delay self calibration

Self Calibration Error Codes

When you run a self calibration process, the oscilloscope will display a PASS or FAIL message when calibration finishes. If a calibration process fails, the oscilloscope can send error codes via the RS-232-C interface to a terminal or host computer. When calibration fails, the associated calibration constants are *not* updated. As the instrument is turned off and back on, it will continue to output calibration constant error codes. A successful self-calibration routine will correct the calibration constants and eliminate the error messages.

When a self calibration process fails, several error messages may be sent before the calibration process stops. Table 6-7 descriptions the possible error codes and the recommended corrective actions.

Table 6-7: Self Calibration Error Codes

Code	Description
8009 XXXX[1]	Trigger search error
8013 XXXX	External trigger offset range error
8014 XXXX	External trigger hysteresis error
8015 XXXX	Clock delay error
8101 XXXX[2]	CH 1 acquisition timeout error
8102 XXXX	CH 1 mid position search error
8103 XXXX	CH 1 mid position range error
8104 XXXX	CH 1 offset search error
8105 XXXX	CH 1 offset range error
8106 XXXX	CH 1 offset gain error
8107 XXXX	CH 1 gain range error
8108 XXXX	CH 1 gain search error
8109 XXXX	CH 1 trigger search error
8110 XXXX	CH 1 trigger offset range error
8111 XXXX	CH 1 trigger gain error
8112 XXXX	CH 1 trigger hysteresis error
8116 XXXX	CH 1 acquisition delay error
8201 XXXX[2]	CH 2 acquisition timeout error
8202 XXXX	CH 2 mid position search error
8203 XXXX	CH 2 mid position range error
8204 XXXX	CH 2 offset search error
8205 XXXX	CH 2 offset range error
8207 XXXX	CH 2 gain range error
8208 XXXX	CH 2 gain search error
8209 XXXX	CH 2 trigger search error
8210 XXXX	CH 2 trigger offset range error
8211 XXXX	CH 2 trigger gain error
8212 XXXX	CH 2 trigger hysteresis error
8216 XXXX	CH 2 acquisition delay error

[1] To repair 80XX failures, check and repair the A3 Main board. If the problem still exists, then check and repair the A2 CPU/Display board.

[2] To repair 81XX and 82XX failures, replace the A1 Acquisition board.

Table 6-8 provides a quick index to the self calibration procedures.

Table 6-8: Index To Self Calibration Procedures

Procedure	Page Number
CH 1 and CH 2 GAIN	5-10
CH 1 and CH 2 REFERENCE	5-9
CLOCK DELAY	5-11
EXT TRIG	5-12

Under unusual circumstances, functional processes may be disrupted during normal operation, resulting in the transmission of error messages out the RS-232-C port. See Table 6-9 for error codes, descriptions, and corrective actions.

Table 6-9: Error Codes Occurring During Normal Operation

Code	Description
8009[1]	Auto level trigger search error
F000[2]	COP timeout error
F001	Illegal opcode execution
F002	Interrupt exception
F003	Task exception

[1] Indicates a failure to locate and trigger on the signal. In Auto Level trigger mode, the error code will be output continuously until the signal can be located. If this condition occurs for all signals, perform the CH 1 and CH 2 self calibration procedures. Most likely, one of them will indicate a trigger system failure which should be corrected by replacing the Acquisition circuit board. If the problem still occurs, replace the Main circuit board.

[2] The FXXX codes result in a system reset. If the front panel settings appear to be corrupted, they are returned to the default values. If these error codes occur frequently, it is likely that a failure has occurred on the CPU circuit board; replace it to correct the problem.

Incorrect control settings can give a false indication of instrument malfunction. If there is any question about the correct function or operation of any control, refer to the operating information in the *Operator Manual*.

Firmware Installation

You should install new 222A firmware after replacing the EEPROMs on the A2 CPU/Display board or when you choose to upgrade your instrument's firmware.

To install the 222A firmware you will need the firmware installation kit available from Tektronix, a PC XT® compatible computer, and the RS-232-C interconnection cable accessory listed in the *Optional Accessories* section. The firmware installation kit contains software on floppy disk, a special interface cable, and complete instructions. The instruction sheet describes now to connect the special interface cable and how to install and run the installation software on your PCXT®. Your PC XT® computer must have an RS-232-C interface port, a parallel printer interface, and the CrossTalk software package installed.

NOTE

You must supply a PCXT® or compatible computer to run the firmware installation software. A computer is not included in the firmware installation kit.

To order the firmware installation kit, see *Optional Accessories*, in Section 7 for the kit part number.

Troubleshooting Equipment

The equipment listed in Table 4-1 of this manual, or equivalent equipment, may be useful while troubleshooting this oscilloscope.

Options and Accessories

Replace this page with the tab divider of the same name.

Options and Accessories

This section describes options as well as the standard and optional accessories available for the 222A Digital Storage Oscilloscope. To order an accessory, determine its part number and contact your local Tektronix field office or representative. In the United States, you can also call the Tektronix National Marketing Center toll-free at 1-800-426-2200.

For more information about Tektronix products and accessories, see the current *Tektronix Product Catalog*.

Options

You can order the 222A with the following options.

Table 7-1: Instrument Options

Option	Description	Part Number
Option 05	Instrument supplied with CAT200 Virtual Instrument Software	CAT200
Option 04	Instrument supplied with WP200 Intelligent Printer Interface	WP200
Option 03	Istrument supplied with P850 probes instead of P400	P850

External Power AC Adapter Options

The 222A includes an External Power AC Adapter as a standard accessory. The following options for the External Power AC Adapter are available:

Table 7-2: External Power AC Adapter Options

Option	Description	Part Number
Option 02	Instrument supplied without external power AC adapter	None
Option A1	Universal European 220 V, 50 Hz	120-1826-00
Option A2	UK 240 V, 50 Hz	120-1827-00

Standard Accessories

The following accessories are included with the 222A.

Table 7-3: Standard Accessories

Accessory	Part Number
222A Digital Storage Oscilloscope Operator Manual	070–8328–00
222A Digital Storage Oscilloscope Quick Reference	070–8329–00
Standard (U.S.) External Power AC Adapter	120–1807–00
Carry Case	016–1024–00
Cabinet feet accessory kit	020–1752–00
1X probe with accessories (two included)	P400

Optional Accessories

You can also order the following accessories.

Table 7-4: Optional Accessories

Accessory	Part Number
222A Service Manual	070–8330–00
Spare Battery	146–0075–00
Accessory pouch (for spare battery or External Power AC Adapter)	016–0993–00
RS-232-C cable	174–1453–00
BNC-female-to-dual-banana adapter	103–0090–00
Miniature-probe-tip-to-BNC adapter	013–0084–03
10X probe with accessories	P850
Set of two test leads (red and black) with miniature probe tips	ALM02
External trigger probe with accessories (requires BNC-female-to-dual-banana adapter)	P6122
Virtual instrument software package	CAT200
External battery charger with other field accessories: External battery charger unit External battery charger data sheet Two accessory pouches Viewing hood Spare battery Cigarette lighter adapter power cable Accessory kit data sheet	BAT200
Firmware Installation Kit	067–0210–01

Replaceable Electrical Parts

Replace this page with the tab divider of the same name.

Replaceable Electrical Parts

Parts Ordering Information

Replacement parts are available from or through your local Tektronix, Inc., Field Office or representative.

When ordering parts, 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

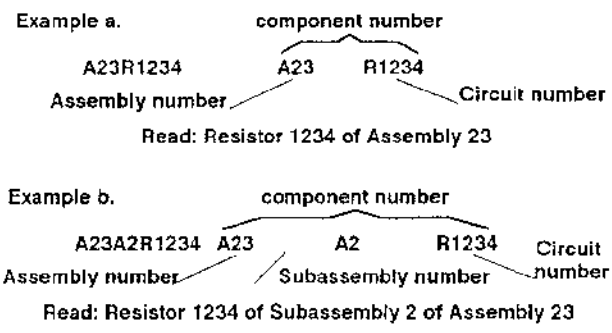
The Mfg. Code Number to Manufacturer Cross Index for the electrical parts list is located immediately after this page. The cross index provides codes, names, and addresses of manufacturers of components listed in the electrical parts list.

Abbreviations

Abbreviations conform to American National Standard Y1.1.

Component Number

(column 1 of the parts list)



The circuit component's number appears 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 (for example, 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 2 of the parts list)

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

Serial No.

(columns 3 & 4 of the 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 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 Catalog handbook H6-1 can be used where possible.

Mfr. Code

(column 6 of the 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 No.

(column 7 of the parts list)

Indicates the actual manufacturer's part number.

CROSS INDEX – MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
S0482	SONY CONSUMER ELECTRONICS		TOKYO JAPAN
TK0875	MATSUO ELECTRONICS INC	831 S DOUBLAS ST	EL SEGUNDO CA 92641
TK1146	MITSUBISHI ELECTRIC CORP	1230 OAKMEAD PARKWAY	SUNNYVALE CA 94086
TK1919	AMERICAN KSS INC	2620 AUGUSTINE DR SUITE 100	SANTA CLARA CA 95054
TK2073	TOCOS AMERICA INC	565 W GULF ROAD	ARLINGTON HEIGHTS IL 60005
TK2236	INTERNATIONAL IMPORTERS INC	5221 S MILLARD AVE	CHICAGO IL 60632
TK2465	PRECISION INTERCONNECTIONS INC	470 WINDSOR PARK DR	CENTERVILLE OH 45459
TK2466	ELECTRICAL ASSEMBLERS INC	PO BOX 664	HOOD RIVER OR 97031
TK2469	UNITREK CORP	3000 LEWIS & CLARK WAY SUITE #2	VANCOUVER WA 98601
TK6054	VTC INC	2401 E 86TH ST	BLOOMINGTON MN 55420
0CVK3	ALLEGRO MICROSYSTEM	115 NE CUTOFF	WORCHESTER MA 01606
0J260	COMTEK MANUFACTURING OF OREGON (METALS)	PO BOX 4200	BEAVERTON OR 97076-4200
00779	AMP INC	2800 FULLING MILL PO BOX 3608	HARRISBURG PA 17105
01295	TEXAS INSTRUMENTS INC SEMICONDUCTOR GROUP	13500 N CENTRAL EXPY PO BOX 655012	DALLAS TX 75265
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
1W344	UNITED CHEMI-CON INC	9801 W HIGGINS SUITE 430	ROSEMONT IL 60018-4704
11236	CTS CORP BERNE DIV THICK FILM PRODUCTS GROUP	406 PARR ROAD	BERNE IN 46711-9506
12697	CLAROSTAT MFG CO INC	LOWER WASHINGTON ST	DOVER NH 03820
13606	SPRAGUE ELECTRIC CO	70 PEMBROKE RD	CONCORD NH 03301-5755
17856	SILICONIX INC	2201 LAURELWOOD RD	SANTA CLARA CA 95054-1516
18324	SIGNETICS CORP MILITARY PRODUCTS DIV	4130 S MARKET COURT	SACRAMENTO CA 95834-1222
22526	DU PONT E I DE NEMOURS AND CO INC DU PONT ELECTRONICS DEPT	515 FISHING CREEK RD	NEW CUMBERLAND PA 17070-3007
24165	SPRAGUE ELECTRIC CO	267 LOWELL ROAD	HUDSON NH 03051
24355	ANALOG DEVICES INC	RT 1 INDUSTRIAL PK PO BOX 9106	NORWOOD MA 02062
25403	PHILIPS COMPONENTS DISCRETE PRODUCTS DIV DISCRETE SEMICONDUCTOR GROUP	GEORGE WASHINGTON HWY	SMITHFIELD RI 02917
27014	NATIONAL SEMICONDUCTOR CORP	2900 SEMICONDUCTOR DR	SANTA CLARA CA 95051-0606
29454	JOHANSON DIELECTRICS INC	2210 SCREENLAND DR PO BOX 6465	BURBANK CA 91505-1137
32997	BOURNS INC TRIMPOT DIV	1200 COLUMBIA AVE	RIVERSIDE CA 92507-2114

CROSS INDEX – MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
34649	INTEL CORP SALES OFFICE /ST4-2/	3065 BOWERS AVE	SANTA CLARA CA 95051
34899	FAIR-RITE PRODUCTS CORP	1 COMMERCIAL ROW	WALLKILL NY 12589
4T165	NEC ELECTRONICS USA INC ELECTRON DIV	401 ELLIS ST PO BOX 7241	MOUNTAIN VIEW CA 94039
50434	HEWLETT-PACKARD CO OPTOELECTRONICS DIV	370 W TRIMBLE RD	SAN JOSE CA 95131
53387	MINNESOTA MINING MFG CO	PO BOX 2963	AUSTIN TX 78769-2963
54583	TDK ELECTRONICS CORP	12 HARBOR PARK DR	PORT WASHINGTON NY 11550
58050	TEKA PRODUCTS INC	45 SALEM ST	PROVIDENCE RI 02907
61058	MATSUSHITA ELECTRIC CORP OF AMERICA PANASONIC INDUSTRIAL CO DIV	ONE PANASONIC WAY PO BOX 1502	SECAUCUS NJ 07094-2917
61441	SARONIX	4010 TRANSPORT ST	PALO ALTO CA 94303-4913
61772	INTEGRATED DEVICE TECHNOLOGY	3236 SCOTT BLVD	SANTA CLARA CA 95051
63791	STAR MICRONICS INC	200 PARK AVE SUITE 2308	NEW YORK NY 10166-0001
75498	MULTICOMP INC	3005 SW 154TH TERRACE #3	BEAVERTON OR 97006
75915	LITTELFUSE INC SUB TRACOR INC	800 E NORTHWEST HWY	DES PLAINES IL 60016-3049
80009	TEKTRONIX INC	14150 SW KARL BRAUN DR PO BOX 500	BEAVERTON OR 97077-0001
91637	DALE ELECTRONICS INC	2064 12TH AVE PO BOX 609	COLUMBUS NE 68601-3632

Component Number	Tektronix Part No.	Serial No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A1	671-1987-00			CIRCUIT BD ASSY:ACQUISITION	80009	671-1987-00
A2	671-2199-00			CIRCUIT BD ASSY:CPU/DISPLAY	80009	671-2199-00
A3	671-1989-00			CIRCUIT BD ASSY:MAIN	80009	671-1989-00
A4	671-1990-01			CIRCUIT BD ASSY:POWER SUPPLY	80009	671-1990-01
A5	671-1991-00			CIRCUIT BD ASSY:POTENTIOMETER	80009	671-1991-00
A6	671-0063-01			CIRCUIT BD ASSY:FRONT PANEL	80009	671-0063-01
A7	671-0269-01			CIRCUIT BD ASSY:KEYPAD	80009	671-0269-01
A1	671-1987-00			CIRCUIT BD ASSY:ACQUISITION	80009	671-1987-00
A1AT110	165-2404-00			MICROCKT,LINEAR:ATTENUATOR	80009	165-2404-00
A1AT160	165-2404-00			MICROCKT,LINEAR:ATTENUATOR	80009	165-2404-00
A1C101	290-5019-00			CAP,FXD,ELCTLT:4.7UF,20%,10V	13606	293D475X0010B2T
A1C102	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A1C103	290-5019-00			CAP,FXD,ELCTLT:4.7UF,20%,10V	13606	293D475X0010B2T
A1C104	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A1C105	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A1C106	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A1C107	290-5019-00			CAP,FXD,ELCTLT:4.7UF,20%,10V	13606	293D475X0010B2T
A1C108	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A1C110	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A1C114	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A1C115	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A1C116	290-5019-00			CAP,FXD,ELCTLT:4.7UF,20%,10V	13606	293D475X0010B2T
A1C120	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A1C121	283-5188-00			CAP,FXD,CER DI:100PF,5%,100V	04222	W1206C101J3B04
A1C122	283-5188-00			CAP,FXD,CER DI:100PF,5%,100V	04222	W1206C101J3B04
A1C123	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A1C124	283-5188-00			CAP,FXD,CER DI:100PF,5%,100V	04222	W1206C101J3B04
A1C125	283-5188-00			CAP,FXD,CER DI:100PF,5%,100V	04222	W1206C101J3B04
A1C128	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A1C134	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A1C135	283-5185-00			CAP,FXD,CER DI:1000PF,5%,50V	04222	W1206C102J2B04
A1C136	283-5188-00			CAP,FXD,CER DI:100PF,5%,100V	04222	W1206C101J3B04
A1C137	283-5188-00			CAP,FXD,CER DI:100PF,5%,100V	04222	W1206C101J3B04
A1C140	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A1C141	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A1C142	283-5188-00			CAP,FXD,CER DI:100PF,5%,100V	04222	W1206C101J3B04
A1C143	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A1C144	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A1C145	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A1C146	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01

Component Number	Tektronix Part No.	Serial No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A1C150	290-5019-00			CAP,FXD,ELCTLT:4.7UF,20%,10V	13606	293D475X0010B2T
A1C151	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A1C152	290-5019-00			CAP,FXD,ELCTLT:4.7UF,20%,10V	13606	293D475X0010B2T
A1C155	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A1C156	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A1C157	290-5019-00			CAP,FXD,ELCTLT:4.7UF,20%,10V	13606	293D475X0010B2T
A1C160	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A1C164	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A1C165	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A1C166	290-5019-00			CAP,FXD,ELCTLT:4.7UF,20%,10V	13606	293D475X0010B2T
A1C173	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A1C174	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A1C178	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A1C184	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A1C185	283-5185-00			CAP,FXD,CER DI:1000PF,5%,50V	04222	W1206C102J2B04
A1C186	283-5188-00			CAP,FXD,CER DI:100PF,5%,100V	04222	W1206C101J3B04
A1C187	283-5188-00			CAP,FXD,CER DI:100PF,5%,100V	04222	W1206C101J3B04
A1C190	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A1C191	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A1C192	283-5188-00			CAP,FXD,CER DI:100PF,5%,100V	04222	W1206C101J3B04
A1C195	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A1J100	131-3625-00			CONN,BOX::PCB,SIP;FEMALE,STR,1 X 15	00779	643647-1
A1J101	131-3625-00			CONN,BOX::PCB,SIP;FEMALE,STR,1 X 15	00779	643647-1
A1J102	131-3625-00			CONN,BOX::PCB,SIP;FEMALE,STR,1 X 15	00779	643647-1
A1J160	131-3625-00			CONN,BOX::PCB,SIP;FEMALE,STR,1 X 15	00779	643647-1
A1J161	131-3625-00			CONN,BOX::PCB,SIP;FEMALE,STR,1 X 15	00779	643647-1
A1J162	131-3625-00			CONN,BOX::PCB,SIP;FEMALE,STR,1 X 15	00779	643647-1
A1L101	108-5002-00			COIL,RF:FXD,15UH	54583	NL453232T-150K
A1L110	108-5002-00			COIL,RF:FXD,15UH	54583	NL453232T-150K
A1L150	108-5002-00			COIL,RF:FXD,15UH	54583	NL453232T-150K
A1L160	108-5002-00			COIL,RF:FXD,15UH	54583	NL453232T-150K
A1P14	131-4414-00			CONN,HDR:PCB,:MALE,STR,1 X 4	58050	182-0444-SS11
A1P15	131-4414-00			CONN,HDR:PCB,:MALE,STR,1 X 4	58050	182-0444-SS11
A1P16	131-4415-00			CONN,HDR:PCB,:MALE,STR,2 X 7	58050	182-0744-SD11
A1Q101	151-5001-00			TRANSISTOR,SIG:BIPOLAR,NPN;40V,200MA	04713	MMBT3904T1/T2
A1R101	307-5072-01			RES,NTWK,FXD,FI:8,10K,2%,0.25W	11236	766-163-R10KT
A1R121	321-5016-00			RES,FXD,FILM:562 OHM,1%,0.125W	91637	CRCW12065620FT
A1R122	321-5050-00			RES,FXD,FILM:33.2 OHM,1%,0.125W	91637	CRCW120633R2FT
A1R123	321-5000-00			RES,FXD,FILM:10 OHM,1%,0.125W	91637	CRCW120610R0FT
A1R124	321-5016-00			RES,FXD,FILM:562 OHM,1%,0.125W	91637	CRCW12065620FT

Component Number	Tektronix Part No.	Serial No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A1R125	321-5050-00			RES,FXD,FILM:33.2 OHM,1%,0.125W	91637	CRCW120633R2FT
A1R126	321-5000-00			RES,FXD,FILM:10 OHM,1%,0.125W	91637	CRCW120610R0FT
A1R127	321-5015-00			RES,FXD,FILM:562 OHM,1%,0.125W	91637	CRCW12065620FT
A1R128	321-5050-00			RES,FXD,FILM:33.2 OHM,1%,0.125W	91637	CRCW120633R2FT
A1R129	321-5000-00			RES,FXD,FILM:10 OHM,1%,0.125W	91637	CRCW120610R0FT
A1R130	321-5015-00			RES,FXD,FILM:562 OHM,1%,0.125W	91637	CRCW12065620FT
A1R131	321-5050-00			RES,FXD,FILM:33.2 OHM,1%,0.125W	91637	CRCW120633R2FT
A1R132	321-5000-00			RES,FXD,FILM:10 OHM,1%,0.125W	91637	CRCW120610R0FT
A1R134	321-5047-00			RES,FXD,FILM:100K,1%,0.125W	91637	CRCW12061003FT
A1R136	321-5018-00			RES,FXD,FILM:1.00K,1%,0.125W	91637	CRCW12061001FT
A1R137	321-5018-00			RES,FXD,FILM:1.00K,1%,0.125W	91637	CRCW12061001FT
A1R140	321-5015-00			RES,FXD,FILM:562 OHM,1%,0.125W	91637	CRCW12065620FT
A1R141	321-5000-00			RES,FXD,FILM:10 OHM,1%,0.125W	91637	CRCW120610R0FT
A1R142	321-5050-00			RES,FXD,FILM:33.2 OHM,1%,0.125W	91637	CRCW120633R2FT
A1R143	321-5018-00			RES,FXD,FILM:1.00K,1%,0.125W	91637	CRCW12061001FT
A1R144	321-5030-00			RES,FXD,FILM:10.0K,1%,0.125W	91637	CRCW12061002FT
A1R145	321-5030-00			RES,FXD,FILM:10.0K,1%,0.125W	91637	CRCW12061002FT
A1R146	321-5006-00			RES,FXD,FILM:100 OHM,1%,0.125W	91637	CRCW12061000FT
A1R147	321-5047-00			RES,FXD,FILM:100K,1%,0.125W	91637	CRCW12061003FT
A1R151	307-5072-01			RES,NTWK,FXD,FI:8,10K,2%,0.25W	11236	766-163-R10KT
A1R184	321-5047-00			RES,FXD,FILM:100K,1%,0.125W	91637	CRCW12061003FT
A1R186	321-5018-00			RES,FXD,FILM:1.00K,1%,0.125W	91637	CRCW12061001FT
A1R187	321-5018-00			RES,FXD,FILM:1.00K,1%,0.125W	91637	CRCW12061001FT
A1R190	321-5000-00			RES,FXD,FILM:10 OHM,1%,0.125W	91637	CRCW120610R0FT
A1R191	321-5050-00			RES,FXD,FILM:33.2 OHM,1%,0.125W	91637	CRCW120633R2FT
A1R192	321-5015-00			RES,FXD,FILM:562 OHM,1%,0.125W	91637	CRCW12065620FT
A1R193	321-5018-00			RES,FXD,FILM:1.00K,1%,0.125W	91637	CRCW12061001FT
A1U101	156 5441-01			IC,LINEAR:BIPOLAR,VOLTAGE REGULATOR	27014	LP2951CM/63
A1U102	156-5433-01			IC,LINEAR:CMOS,OP-AMP	01295	TLC27M9CDR
A1U111	156-5909-01			IC,CONVERTER:CMOS,A/D;8-BIT,20MSPS,FLASH	S0482	CXD1175AM-T5
A1U120	156-5651-01			IC,ASIC:CMOS,GATE ARRAY	04713	S38DC011PM01TR1
A1U122	156-5357-01			IC,DIGITAL:HCMOS,GATE;QUAD 2-INPUT NOR	18324	74HC02DT
A1U123	156-5719-01			IC,LINEAR:BIPOLAR COMPARATOR	TK6054	V10331BQDLZ-R
A1U124	156-5357-01			IC,DIGITAL:HCMOS,GATE;QUAD 2-INPUT NOR	18324	74HC02DT
A1U130	156-5436-01			IC,LINEAR:BIMOS,POWER DRIVER	0CVK3	UCN5895EP/TR
A1U131	156-6011-01			IC,CONVERTER:CMOS,D/A;12-BIT,2.0US	24355	AD7543KR-REEL
A1U132	156-6011-01			IC,CONVERTER:CMOS,D/A;12-BIT,2.0US	24355	AD7543KR-REEL
A1U133	156-6011-01			IC,CONVERTER:CMOS,D/A;12-BIT,2.0US	24355	AD7543KR-REEL
A1U134	156-6011-01			IC,CONVERTER:CMOS,D/A;12-BIT,2.0US	24355	AD7543KR-REEL
A1U141	156-5446-01			IC,MEMORY:CMOS,FIFO;512 X 9,65 NS	61772	IDT7201S65J

Component Number	Tektronix Part No.	Serial No. Effective	Serial No. Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A1U142	156-6228-01			IC,DIGITAL:HCMOS,REGISTER	01295	SN74HC166DR
A1U143	156-5719-01			IC,LINEAR:BIPOLAR COMPARATOR	TK6054	V10331BQDLZ-R
A1U151	156-5441-01			IC,LINEAR:BIPOLAR,VOLTAGE REGULATOR	27014	LP2951CM/63
A1U152	156-5433-01			IC,LINEAR:CMOS,OP-AMP	01295	TLC27M9CDR
A1U161	156-5909-01			IC,CONVERTER:CMOS,A/D;8-BIT,20MSPS,FLASH	S0482	CXD1175AM-T5
A1U170	156-5651-01			IC,ASIC:CMOS,GATE ARRAY	04713	S38DC011PM01TR1
A1U173	156-5719-01			IC,LINEAR:BIPOLAR COMPARATOR	TK6054	V10331BQDLZ-R
A1U174	156-5357-01			IC,DIGITAL:HCMOS,GATE;QUAD 2-INPUT NOR	18324	74HC02DT
A1U180	156-5436-01			IC,LINEAR:BIMOS,POWER DRIVER	0CVK3	UCN5895E9/TR
A1U181	156-6011-01			IC,CONVERTER:CMOS,D/A;12-BIT,2.0US	24355	AD7543KR-REEL
A1U182	156-6011-01			IC,CONVERTER:CMOS,D/A;12-BIT,2.0US	24355	AD7543KR-REEL
A1U183	156-6011-01			IC,CONVERTER:CMOS,D/A;12-BIT,2.0US	24355	AD7543KR-REEL
A1U184	156-6011-01			IC,CONVERTER:CMOS,D/A;12-BIT,2.0US	24355	AD7543KR-REEL
A1U191	156-5446-01			IC,MEMORY:CMOS,FIFO;512 X 9,65 NS	61772	IDT7201S65J
A1U192	156-6228-01			IC,DIGITAL:HCMOS,REGISTER	01295	SN74HC166DR
A2	671-2199-00			CIRCUIT BD ASSY:CPU/DISPLAY	80009	671-2199-00
A2C201	283-5187-00			CAP,FXD,CER DI:15PF,5%,100V	04222	W1206C150J3B04
A2C202	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A2C203	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A2C204	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A2C205	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A2C206	283-5003-00			CAP,FXD,CER DI:0.01UF,10%,50V	04222	W1206X103K2B04
A2C207	290-5005-00			CAP,FXD,ELCTLT:47MF,10%,10V,TANTLUM	TK0875	267M--1002 476-K
A2C208	290-5019-00			CAP,FXD,ELCTLT:4.7UF,20%,10V	13606	293D475X0010B2T
A2C209	283-5003-00			CAP,FXD,CER DI:0.01UF,10%,50V	04222	W1206X103K2B04
A2C210	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A2C211	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A2C212	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A2C213	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A2C214	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A2C215	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A2C216	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A2C217	290-5019-00			CAP,FXD,ELCTLT:4.7UF,20%,10V	13606	293D475X0010B2T
A2C218	290-5019-00			CAP,FXD,ELCTLT:4.7UF,20%,10V	13606	293D475X0010B2T
A2C219	290-5019-00			CAP,FXD,ELCTLT:4.7UF,20%,10V	13606	293D475X0010B2T
A2C220	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A2C248	283-5189-00			CAP,FXD,CER DI:220PF,5%,100V	04222	W1206C221J3B04
A2C249	283-5189-00			CAP,FXD,CER DI:220PF,5%,100V	04222	W1206C221J3B04
A2C250	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A2C251	283-5187-00			CAP,FXD,CER DI:15PF,5%,100V	04222	W1206C150J3B04

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A2C252	283-5187-00			CAP,FXD,CER DI:15PF,5%,100V	04222	W1206C150J3B04
A2C253	283-5185-00			CAP,FXD,CER DI:1000PF,5%,50V	04222	W1206C102J2B04
A2C254	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A2C255	283-5188-00			CAP,FXD,CER DI:100PF,5%,100V	04222	W1206C101J3B04
A2C256	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A2C257	283-5185-00			CAP,FXD,CER DI:1000PF,5%,50V	04222	W1206C102J2B04
A2C258	283-5188-00			CAP,FXD,CER DI:100PF,5%,100V	04222	W1206C101J3B04
A2C259	283-5188-00			CAP,FXD,CER DI:100PF,5%,100V	04222	W1206C101J3B04
A2C260	283-5183-00			CAP,FXD,CER DI:0.01UF,1%,100V	04222	W1825C103F3B04
A2C261	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A2C262	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A2C263	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A2C264	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A2C265	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A2C266	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A2C267	290-1264-00			CAP,FXD,ELCTLT:0.047F,-20%/+80%,5.5V,0.53OD	61058	EECF5R54473
A2C269	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A2CR201	152-5027-00			DIODE,RECT:SCHTKY,;40V,1A	04713	MBRS140T3
A2CR202	152-5027-00			DIODE,RECT:SCHTKY,;40V,1A	04713	MBRS140T3
A2CR207	152-5027-00			DIODE,RECT:SCHTKY,;40V,1A	04713	MBRS140T3
A2CR208	152-5027-00			DIODE,RECT:SCHTKY,;40V,1A	04713	MBRS140T3
A2CR251	152-5027-00			DIODE,RECT:SCHTKY,;40V,1A	04713	MBRS140T3
A2CR252	152-5027-00			DIODE,RECT:SCHTKY,;40V,1A	04713	MBRS140T3
A2J1	136-5004-00			SKT,PL-IN ELEK:MICROCKT,2 X 7	58050	TKO-07254-204
A2J2	136-5004-00			SKT,PL-IN ELEK:MICROCKT,2 X 7	58050	TKO-07254-204
A2L201	108-5057-00			COIL RF:68UH	54583	NL453232T-680K
A2Q201	151-5001-00			TRANSISTOR,SIG:BIPOLAR,NPN	04713	MMBT3904T1/T2
A2R201	321-5047-00			RES,FXD,FILM:100K,1%,0.125W	91637	CRCW12061003FT
A2R202	321-5047-00			RES,FXD,FILM:100K,1%,0.125W	91637	CRCW12061003FT
A2R203	313-5001-00			RES,FXD,FILM:10M,5%,0.125W	91637	CRCW12061005JT
A2R204	321-5171-00			RES,FXD,FILM:562K OHM,1%,0.125W	91637	CRCW1206-5623FT
A2R205	321-5171-00			RES,FXD,FILM:562K OHM,1%,0.125W	91637	CRCW1206-5623FT
A2R206	321-5171-00			RES,FXD,FILM:562K OHM,1%,0.125W	91637	CRCW1206-5623FT
A2R207	321-5171-00			RES,FXD,FILM:562K OHM,1%,0.125W	91637	CRCW1206-5623FT
A2R208	321-5006-00			RES,FXD,FILM:100 OHM,1%,0.125W	91637	CRCW12061000FT
A2R209	307-5072-01			RES,NTWK,FXD,FI:8,10K,2%,0.25W,SO16,SMD	11236	766-163-R10KT
A2R210	321-5018-00			RES,FXD,FILM:1.00K,1%,0.125W	91637	CRCW12061001FT
A2R211	321-5038-00			RES,FXD,FILM:47.5K,1%,0.125W	91637	CRCW12064752FT
A2R213	321-5176-00			RES,FXD,FILM:3.01K,1%,0.125W	91637	CRCW12063011FT
A2R220	321-5047-00			RES,FXD,FILM:100K,1%,0.125W	91637	CRCW12061003FT

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A2R251	307-5072-01			RES,NTWK,FXD,FI:8,10K,2%,0.25W,SO16,SMD	11236	766-163-R10KT
A2R252	307-5072-01			RES,NTWK,FXD,FI:8,10K,2%,0.25W,SO16,SMD	11236	766-163-R10KT
A2R253	321-5000-00			RES,FXD,FILM:10 OHM,1%,0.125W	91637	CRCW120610R0FT
A2R254	321-5006-00			RES,FXD,FILM:100 OHM,1%,0.125W	91637	CRCW12061000FT
A2R255	311-5010-00			RES,VAR,NONWW:50K OHM,20%,0.25W	32997	3314S-1-503E
A2R256	321-5171-00			RES,FXD,FILM:562K OHM,1%,0.125W	91637	CRCW1206-5623FT
A2R257	321-5006-00			RES,FXD,FILM:100 OHM,1%,0.125W	91637	CRCW12061000FT
A2R258	321-5006-00			RES,FXD,FILM:100 OHM,1%,0.125W	91637	CRCW12061000FT
A2R259	311-5042-00			RES,VAR,NONWW:2K OHM,20%,0.25W	32997	3314S-1-202E
A2R260	311-5042-00			RES,VAR,NONWW:2K OHM,20%,0.25W	32997	3314S-1-202E
A2R261	321-5178-00			RES,FXD,FILM:249K,1%,0.125W	91637	CRCW12062493FT
A2R262	321-5151-00			RES,FXD,FILM:453K,1%,0.125W	91637	CRCW12064533FT
A2R263	321-5006-00			RES,FXD,FILM:100 OHM,1%,0.125W	91637	CRCW12061000FT
A2R264	321-5006-00			RES,FXD,FILM:100 OHM,1%,0.125W	91637	CRCW12061000FT
A2R267	321-5018-00			RES,FXD,FILM:1.00K,1%,0.125W	91637	CRCW12061001FT
A2R269	321-5171-00			RES,FXD,FILM:562K OHM,1%,0.125W	91637	CRCW1206-5623FT
A2R270	321-5261-00			RES,FXD,FILM:2.00M,1%,0.125W	91637	CRCW12062004FT2
A2U201	156-5472-01			IC,PROCESSOR:CMOS,MICROCOMPUTER	04713	MC68HC11A8FN1
A2U203	156-5357-01			IC,DIGITAL:HCMOS,GATE:QUAD 2-INPUT NOR	18324	74HC02DT
A2U205	156-5075-03			IC,DIGITAL:HCMOS,GATE:QUAD 2-INPUT NAND	04713	MC74HC00ADTR7
A2U206	156-5075-03			IC,DIGITAL:HCMOS,GATE:QUAD 2-INPUT NAND	04713	MC74HC00ADTR7
A2U207	156-6101-01			IC,MISC:BIPOLAR,PWR SUPPLY SUPERVISOR	04713	MC34164D-5R2
A2U208	156-5710-01			IC,DIGITAL:HCMOS,FLIP-FLOP	04713	MC74HC109DTR13
A2U209	156-5075-03			IC,DIGITAL:HCMOS,GATE:QUAD 2-INPUT NAND	04713	MC74HC00ADTR7
A2U212	156-5458 01			IC,DIGITAL:HCMOS,LATCH;8-BIT ADDRESSABLE	04713	MC74HC259D
A2U213	156-5702-01			IC,DIGITAL:CMOS,EPROM:32K X 8,FLASH,200NS	34649	N28F256A-200
A2U216	156-5473-01			IC,PROCESSOR:CMOS,PERIPHERAL	34649	N82C54-2
A2U217	156-5437-01			IC,DIGITAL:CMOS,TRIPLE RS-232 LINE DR/RCVR	04713	MC145406DWR2
A2U218	156-5473-01			IC,PROCESSOR:CMOS,PERIPHERAL	34649	N82C54-2
A2U219	156-5073-01			IC,MISC:HCMOS,ANALOG MUX;TRIPLE SPDT	18324	74HC4053DT
A2U221	156-5702-01			IC,DIGITAL:CMOS,EPROM:32K X 8,FLASH,200NS	34649	N28F256A-200
A2U222	156-5711-01			IC,DIGITAL:HCMOS,MUX/ENCODER	04713	MC74HC153DR2
A2U223	156-5441-01			IC,LINEAR:BIPOLAR,VOLTAGE REGULATOR	27014	LP2951CM/63
A2U251	156-6154-01			IC,ASIC:CMOS,GATE ARRAY	4T165	UPD65012L-583
A2U253	156-5459-01			IC,DIGITAL:HCMOS,TRANSCEIVER	01295	SN74HC245DR
A2U254	156-5435-01			IC,CONVERTERMI:CMOS,D/A	24355	AD7528JP(REEL)
A2U255	156-5286-01			IC,MEMORY:CMOS,SRAM:32K X 8,120NS,OE	4T165	UPD43256AGU-12L
A2U257	156-5478-01			IC,DIGITAL:HCMOS,LATCH;OCTAL D-TYPE	01295	SN74HC573DR
A2U261	156-5710-01			IC,DIGITAL:HCMOS,FLIP-FLOP	04713	MC74HC109DTR13
A2U263	156-5435-01			IC,CONVERTERMI:CMOS,D/A	24355	AD7528JP(REEL)

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A2U264	156-5442-01			IC,LINEAR:BIFET,OP-AMP;QUAD,LOW POWER	04713	MC34184DR2
A2U265	156-5442-01			IC,LINEAR:BIFET,OP-AMP;QUAD,LOW POWER	04713	MC34184DR2
A2U266	156-5073-01			IC,MISC:HCMOS,ANALOG MUX;TRIPLE SPDT	18324	74HC4053DT
A2U269	156-5442-01			IC,LINEAR:BIFET,OP-AMP;QUAD,LOW POWER	04713	MC34184DR2
A2U270	156-6059-01			IC,MISC:CMOS,ANALOG SWITCH;QUAD	17856	SDG44405/DG444D
A2W5	259-0087-01			FLEX CIRCUIT:6 PIN FLEX W/9 PIN D-SUB	TK2465	1003-9S-01-FCM
A2W8	174-1452-00			CA ASSY,SP,ELEC:14,0.05,4.5 L	53387	5-000-500
A2Y201	158-5007-00			XTAL UNIT,RES:8MHZ	61441	NMS-080T
A3	671-1989-00			CIRCUIT BD ASSY:MAIN;	80009	671-1989-00
A3C301	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A3C302	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A3C303	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A3C304	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A3C305	283-5188-00			CAP,FXD,CER DI:100PF,5%,100V	04222	W1206C101J3B04
A3C306	283-5003-00			CAP,FXD,CER DI:0.01UF,10%,50V	04222	W1206X103K2B04
A3C307	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A3C308	283-5188-00			CAP,FXD,CER DI:100PF,5%,100V	04222	W1206C101J3B04
A3C309	283-5003-00			CAP,FXD,CER DI:0.01UF,10%,50V	04222	W1206X103K2B04
A3C310	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A3C311	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A3C312	290-5005-00			CAP,FXD,ELCTLT:47MF,10%,10V,TANTLUM	TK0875	267M-1002-476-K
A3C313	290-5005-00			CAP,FXD,ELCTLT:47MF,10%,10V,TANTLUM	TK0875	267M-1002-476-K
A3C314	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A3C315	283-5003-00			CAP,FXD,CER DI:0.01UF,10%,50V	04222	W1206X103K2B04
A3C316	290-5005-00			CAP,FXD,ELCTLT:47MF,10%,10V,TANTLUM	TK0875	267M-1002-476-K
A3C317	290-5005-00			CAP,FXD,ELCTLT:47MF,10%,10V,TANTLUM	TK0875	267M-1002-476-K
A3C318	290-5005-00			CAP,FXD,ELCTLT:47MF,10%,10V,TANTLUM	TK0875	267M-1002-476-K
A3C319	283-5003-00			CAP,FXD,CER DI:0.01UF,10%,50V	04222	W1206X103K2B04
A3C320	290-1235-00			CAP,FXD,ALUM:1000UF,20%,35V	1W344	SME35VB102M12X2
A3C321	290-5005-00			CAP,FXD,ELCTLT:47MF,10%,10V,TANTLUM	TK0875	267M-1002-476-K
A3C322	290-5005-00			CAP,FXD,ELCTLT:47MF,10%,10V,TANTLUM	TK0875	267M-1002-476-K
A3C323	283-5003-00			CAP,FXD,CER DI:0.01UF,10%,50V	04222	W1206X103K2B04
A3C324	290-5005-00			CAP,FXD,ELCTLT:47MF,10%,10V,TANTLUM	TK0875	267M-1002-476-K
A3C325	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A3C326	290-5004-00			CAP,FXD,ELCTLT:22UF,20V,TANTALUM	04222	TAJD226K020R
A3C327	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A3C328	283-5005-00			CAP,FXD,CER DI:4PF,+/- 0.25PF,50V	54583	C3216COG1H040C-
A3C329	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A3C330	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01

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A3C331	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A3C332	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A3C333	283-5105-00			CAP,FXD,CER DI:1UF,+80/-20%,50V	04222	W1825Z105Z2B04
A3C334	290-5004-00			CAP,FXD,ELCTLT:22UF,20V,TANTALUM	04222	TAJD226K020R
A3C335	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A3C336	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A3C337	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A3C338	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A3C339	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A3C340	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A3C341	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A3C342	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A3C343	283-5188-00			CAP,FXD,CER DI:100PF,5%,100V	04222	W1206C101J3B04
A3C348	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A3C349	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A3C350	283-5188-00			CAP,FXD,CER DI:100PF,5%,100V	04222	W1206C101J3B04
A3CR301	152-5027-00			DIODE,RECT:SCHTKY,;40V,1A	04713	MBRS140T3
A3CR302	152-5027-00			DIODE,RECT:SCHTKY,;40V,1A	04713	MBRS140T3
A3CR303	152-5027-00			DIODE,RECT:SCHTKY,;40V,1A	04713	MBRS140T3
A3CR304	152-5027-00			DIODE,RECT:SCHTKY,;40V,1A	04713	MBRS140T3
A3CR305	152-5027-00			DIODE,RECT:SCHTKY,;40V,1A	04713	MBRS140T3
A3CR306	152-5027-00			DIODE,RECT:SCHTKY,;40V,1A	04713	MBRS140T3
A3CR307	152-5027-00			DIODE,RECT:SCHTKY,;40V,1A	04713	MBRS140T3
A3CR308	152-5027-00			DIODE,RECT:SCHTKY,;40V,1A	04713	MBRS140T3
A3CR310	152-5027-00			DIODE,RECT:SCHTKY,;40V,1A	04713	MBRS140T3
A3CR311	152-5027-00			DIODE,RECT:SCHTKY,;40V,1A	04713	MBRS140T3
A3CR312	152-5027-00			DIODE,RECT:SCHTKY,;40V,1A	04713	MBRS140T3
A3CR313	152-5027-00			DIODE,RECT:SCHTKY,;40V,1A	04713	MBRS140T3
A3CR314	152-5027-00			DIODE,RECT:SCHTKY,;40V,1A	04713	MBRS140T3
A3CR315	152-5027-00			DIODE,RECT:SCHTKY,;40V,1A	04713	MBRS140T3
A3CR316	152-5027-00			DIODE,RECT:SCHTKY,;40V,1A	04713	MBRS140T3
A3F301	159-5000-00			FUSE,THERMAL:2.5A,125V,FAST,2816,SMD	75915	45902.5
A3F302	159-5000-00			FUSE,THERMAL:2.5A,125V,FAST,2816,SMD	75915	45902.5
A3F303	159-5000-00			FUSE,THERMAL:2.5A,125V,FAST,2816,SMD	75915	45902.5
A3J14	136-5002-00			SKT,PL-IN ELEK:HORIZ,1 X 4	58050	TKO-04254-104
A3J15	136-5002-00			SKT,PL-IN ELEK:HORIZ,1 X 4	58050	TKO-04254-104
A3J16	136-5004-00			SKT,PL-IN ELEK:MICROCKT,2 X 7	58050	TKO-07254-204
A3J17	131-4368-00			JACK,POWER DC:PCB,;MALE,RTANG	TK2236	DC12-2.0
A3J18	136-0997-00			SOCKET,ELEC:BANANA JACK	0J260	ORDER BY DESC
A3J19	136-0997-00			SOCKET,ELEC:BANANA JACK	0J260	ORDER BY DESC

Component Number	Tektronix Part No.	Serial No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A3L301	108-1449-00			INDUCTOR:BOBBIN CORE,33UH,10%,1.2A	54583	TSL0807-330K1R2
A3L302	108-5100-00			BEAD,FERRITE:50 OHMS	34899	2743021447
A3L303	108-5057-00			COIL RF:68UH	54583	NL453232T-680K
A3L304	108-5057-00			COIL RF:68UH	54583	NL453232T-680K
A3L305	108-5100-00			BEAD,FERRITE:50 OHMS	34899	2743021447
A3L306	108-1449-00			INDUCTOR:BOBBIN CORE,33UH,10%,1.2A	54583	TSL0807-330K1R2
A3L307	108-5100-00			BEAD,FERRITE:50 OHMS	34899	2743021447
A3L308	108-5100-00			BEAD,FERRITE:50 OHMS	34899	2743021447
A3L309	108-5100-00			BEAD,FERRITE:50 OHMS	34899	2743021447
A3L310	108-5100-00			BEAD,FERRITE:50 OHMS	34899	2743021447
A3L311	108-5100-00			BEAD,FERRITE:50 OHMS	34899	2743021447
A3L312	108-5100-00			BEAD,FERRITE:50 OHMS	34899	2743021447
A3P1	131-4415-00			CONN,HDR:PCB,:MALE,STR,2 X 7	58050	182-0744-SD11
A3P2	131-4415-00			CONN,HDR:PCB,:MALE,STR,2 X 7	58050	182-0744-SD11
A3P3	131-4415-00			CONN,HDR:PCB,:MALE,STR,2 X 7	58050	182-0744-SD11
A3P6	131-4415-00			CONN,HDR:PCB,:MALE,STR,2 X 7	58050	182-0744-SD11
A3P20	131-1939-00			CONN,HDR:PCB/WIREWRAP:MALE,STR,1 X 14	22526	65561-114
A3Q301	151-5001-00			TRANSISTOR,SIG:BIPOLAR,NPN	04713	MMBT3904T1/T2
A3Q302	151-5001-00			TRANSISTOR,SIG:BIPOLAR,NPN	04713	MMBT3904T1/T2
A3Q303	151-5001-00			TRANSISTOR,SIG:BIPOLAR,NPN	04713	MMBT3904T1/T2
A3Q304	151-5001-00			TRANSISTOR,SIG:BIPOLAR,NPN	04713	MMBT3904T1/T2
A3Q305	151-5001-00			TRANSISTOR,SIG:BIPOLAR,NPN	04713	MMBT3904T1/T2
A3Q306	151-5001-00			TRANSISTOR,SIG:BIPOLAR,NPN	04713	MMBT3904T1/T2
A3Q307	151-5038-01			TRANSISTOR,PWR:MOS,N-CH	04713	MTD10N05ET1
A3Q308	151-5000-00			TRANSISTOR,SIG:BIPOLAR,PNP	04713	MMBT3906LT1
A3Q309	151-5001-00			TRANSISTOR,SIG:BIPOLAR,NPN	04713	MMBT3904T1/T2
A3R300	321-5030-00			RES,FXD,FILM:10.0K,1%,0.125W	91637	CRCW12061002FT
A3R301	321-5022-00			RES,FXD,FILM:2.21K,1%,0.125W	91637	CRCW12062211FT
A3R302	321-5047-00			RES,FXD,FILM:100K,1%,0.125W	91637	CRCW12061003FT
A3R303	321-5030-00			RES,FXD,FILM:10.0K,1%,0.125W	91637	CRCW12061002FT
A3R304	321-5034-00			RES,FXD,FILM:22.1K,1%,0.125W	91637	CRCW12062212FT
A3R305	321-5018-00			RES,FXD,FILM:1.00K,1%,0.125W	91637	CRCW12061001FT
A3R306	321-5034-00			RES,FXD,FILM:22.1K,1%,0.125W	91637	CRCW12062212FT
A3R307	321-5151-00			RES,FXD,FILM:453K,1%,0.125W	91637	CRCW12064533FT
A3R308	311-5010-00			RES,VAR,NONWW:50K OHM,20%,0.25W	32997	3314S-1-503E
A3R309	321-5000-00			RES,FXD,FILM:10 OHM,1%,0.125W	91637	CRCW120610R0FT
A3R310	321-5030-00			RES,FXD,FILM:10.0K,1%,0.125W	91637	CRCW12061002FT
A3R311	321-5000-00			RES,FXD,FILM:10 OHM,1%,0.125W	91637	CRCW120610R0FT
A3R312	321-5006-00			RES,FXD,FILM:100 OHM,1%,0.125W	91637	CRCW12061000FT
A3R313	321-5026-00			RES,FXD,FILM:4.75K,1%,0.125W	91637	CRCW12064751FT

Component Number	Tektronix Part No.	Serial No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A3R314	321-5026-00			RES,FXD,FILM:4.75K,1%,0.125W	91637	CRCW12064751FT
A3R315	321-5018-00			RES,FXD,FILM:1.00K,1%,0.125W	91637	CRCW12061001FT
A3R316	321-5000-00			RES,FXD,FILM:10 OHM,1%,0.125W	91637	CRCW120610R0FT
A3R317	321-5030-00			RES,FXD,FILM:10.0K,1%,0.125W	91637	CRCW12061002FT
A3R318	321-5020-00			RES,FXD,FILM:1.50K,1%,0.125W	91637	CRCW12061501FT
A3R319	321-5006-00			RES,FXD,FILM:100 OHM,1%,0.125W	91637	CRCW12061000FT
A3R320	321-5176-00			RES,FXD,FILM:3.01K,1%,0.125W	91637	CRCW12063011FT
A3R321	321-5006-00			RES,FXD,FILM:100 OHM,1%,0.125W	91637	CRCW12061000FT
A3R322	321-5022-00			RES,FXD,FILM:2.21K,1%,0.125W	91637	CRCW12062211FT
A3R323	321-5015-00			RES,FXD,FILM:562 OHM,1%,0.125W	91637	CRCW12065620FT
A3R324	321-5160-00			RES,FXD,FILM:90.9K,1%,0.125W	91637	CRCW12069092FT
A3R325	321-5006-00			RES,FXD,FILM:100 OHM,1%,0.125W	91637	CRCW12061000FT
A3R326	321-5178-00			RES,FXD,FILM:249K,1%,0.125W	91637	CRCW12062493FT
A3R327	321-5178-00			RES,FXD,FILM:249K,1%,0.125W	91637	CRCW12062493FT
A3R328	321-5047-00			RES,FXD,FILM:100K,1%,0.125W	91637	CRCW12061003FT
A3R329	321-5015-00			RES,FXD,FILM:562 OHM,1%,0.125W	91637	CRCW12065620FT
A3R330	321-5006-00			RES,FXD,FILM:100 OHM,1%,0.125W	91637	CRCW12061000FT
A3R331	321-5006-00			RES,FXD,FILM:100 OHM,1%,0.125W	91637	CRCW12061000FT
A3R332	321-5050-00			RES,FXD FILM:33.2 OHM,1%,0.125W	91637	CRCW120633R2FT
A3R333	321-5261-00			RES,FXD,FILM:2.00M,1%,0.125W	91637	CRCW12062004FT2
A3R334	321-5171-00			RES,FXD,FILM:562K OHM,1%,0.125W	91637	CRCW1206-5623FT
A3R335	321-5261-00			RES,FXD,FILM:2.00M,1%,0.125W	91637	CRCW12062004FT2
A3R336	321-5018-00			RES,FXD,FILM:1.00K,1%,0.125W	91637	CRCW12061001FT
A3R337	321-5020-00			RES,FXD,FILM:1.50K,1%,0.125W	91637	CRCW12061501FT
A3R338	321-5018-00			RES,FXD,FILM:1.00K,1%,0.125W	91637	CRCW12061001FT
A3R339	306-5004-00			RES,FXD,WW:0.1 OHM,1%,1W SMD	91637	WSC-1 .10HW/W1%
A3R340	321-5006-00			RES,FXD,FILM:100 OHM,1%,0.125W	91637	CRCW12061000FT
A3R341	321-5018-00			RES,FXD,FILM:1.00K,1%,0.125W	91637	CRCW12061001FT
A3R342	321-5047-00			RES,FXD,FILM:100K,1%,0.125W	91637	CRCW12061003FT
A3R343	321-5006-00			RES,FXD,FILM:100 OHM,1%,0.125W	91637	CRCW12061000FT
A3R344	321-5151-00			RES,FXD,FILM:453K,1%,0.125W	91637	CRCW12064533FT
A3R345	321-5030-00			RES,FXD,FILM:10.0K,1%,0.125W	91637	CRCW12061002FT
A3R346	321-5050-00			RES,FXD,FILM:33.2 OHM,1%,0.125W	91637	CRCW120633R2FT
A3R347	321-5006-00			RES,FXD,FILM:100 OHM,1%,0.125W	91637	CRCW12061000FT
A3R348	321-5030-00			RES,FXD,FILM:10.0K,1%,0.125W	91637	CRCW12061002FT
A3R349	321-5030-00			RES,FXD,FILM:10.0K,1%,0.125W	91637	CRCW12061002FT
A3T301	120-1881-00			TRANSFORMER:ISOLATION,20KHZ	75498	128-9123-EC
A3T302	120-1781-00			TRANSFORMER,RF:POT CORE,LOW VOLTAGE	75498	120-1781-00
A3U300	119-2245-00			OSCILLATOR:CMOS,CRYSTAL CLOCK,20MHZ	TK1919	EXO3C20
A3U301	156-5021-01			IC,DIGITAL:CMOS,SHIFT REGISTER	18324	HEF4094BTDT

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A3U302	156-5021-01			IC,DIGITAL:CMOS,SHIFT REGISTER	18324	HEF4094BTDT
A3U303	156-5710-01			IC,DIGITAL:HCMOS,FLIP-FLOP	04713	MC74HC109DTR13
A3U304	156-5710-01			IC,DIGITAL:HCMOS,FLIP-FLOP	04713	MC74HC109DTR13
A3U305	156-5710-01			IC,DIGITAL:HCMOS,FLIP-FLOP;	04713	MC74HC109DTR13
A3U306	156-5710-01			IC,DIGITAL:HCMOS,FLIP-FLOP	04713	MC74HC109DTR13
A3U307	156-5357-01			IC,DIGITAL:HCMOS,GATE;QUAD 2-INPUT NOR	18324	74HC02DT
A3U308	234-0743-20			IC,ASIC:BIPOLAR,TRIGGER/TIME INTERPOLATOR	80009	234-0743-20
A3U309	156-5479-01			IC,DIGITAL:HCMOS,MULTIVIBRATOR	27014	MM74HC4538M/63
A3U310	156-5711-01			IC,DIGITAL:HCMOS,MUX/ENCODER	04713	MC74HC153DR2
A3U311	156-5434-01			IC,LINEAR:CMOS,COMPARATOR	01295	TLC372CDR
A3U312	151-5018-00			TRANSISTOR,SIG:JFET,N-CH	17856	SST441
A3U313	156-5357-01			IC,DIGITAL:HCMOS,GATE;QUAD 2-INPUT NOR	18324	74HC02DT
A3U314	156-5439-01			IC,LINEAR:BIPOLAR,TRANSISTOR ARRAY	04713	MMPQ2907AR2
A3U315	156-5710-01			IC,DIGITAL:HCMOS,FLIP-FLOP	04713	MC74HC109DTR13
A3U316	156-4076-00			IC,OPTO:,ISOLATOR	TK2466	156-4076-00
A3U317	156-4076-00			IC,OPTO:,ISOLATOR	TK2466	156-4076-00
A3U318	156-6084-01			MICROCKT,LINEAR:BIPOLAR,SW REG/CONT	01295	TL594CDR
A3VR301	152-5033-00			SEMICOND DVC,DI:ZENER	04713	MLL5235BT1
A3VR302	152-5033-00			SEMICOND DVC,DI:ZENER	04713	MLL5235BT1
A3VR303	152-5033-00			SEMICOND DVC,DI:ZENER	04713	MLL5235BT1
A4	671-1990-01			CIRCUIT BD ASSY:POWER SUPPLY	80009	671-1990-01
A4C401	290-0164-00			CAP,FXD,ELCTLT:1UF,+50-10%,150V	24165	516D105M160LL7B
A4C402	283-5235-00			CAP,FXD,CERAMIC:0.56UF,100V	04222	W1825Z564M3B04
A4C403	283-5189-00			CAP,FXD,CER DI:220PF,5%,100V	04222	W1206C221J3B04
A4C404	283-5003-00			CAP,FXD,CER DI:0.01UF,10%,50V	04222	W1206X103K2B04
A4C405	283-5189-00			CAP,FXD,CER DI:220PF,5%,100V	04222	W1206C221J3B04
A4C406	290-0973-00			CAP,FXD,ELCTLT:100UF,20%,25VDC	1W344	SM25VB10RM8X11L
A4C407	290-5004-00			CAP,FXD,ELCTLT:22UF,20V,TANTALUM	04222	TAJD226K020R
A4C408	290-5004-00			CAP,FXD,ELCTLT:22UF,20V,TANTALUM	04222	TAJD226K020R
A4C409	290-5005-00			CAP,FXD,ELCTLT:47MF,10%,10V,TANTLUM	TK0875	267M-1002-476-K
A4C410	283-5251-00			CAP,FXD,CER DI:0.01UF,2000V,+100/-0%,SMD	29454	202H50W103KY4E
A4C411	283-5251-00			CAP,FXD,CER DI:0.01UF,2000V,+100/-0%,SMD	29454	202H50W103KY4E
A4C412	283-5251-00			CAP,FXD,CER DI:0.01UF,2000V,+100/-0%,SMD	29454	202H50W103KY4E
A4C413	283-5251-00			CAP,FXD,CER DI:0.01UF,2000V,+100/-0%,SMD	29454	202H50W103KY4E
A4C414	283-5251-00			CAP,FXD,CER DI:0.01UF,2000V,+100/-0%,SMD	29454	202H50W103KY4E
A4C415	283-5251-00			CAP,FXD,CER DI:0.01UF,2000V,+100/-0%,SMD	29454	202H50W103KY4E
A4C416	290-5005-00			CAP,FXD,ELCTLT:47MF,10%,10V,TANTLUM	TK0875	267M-1002-476-K
A4C417	290-5005-00			CAP,FXD,ELCTLT:47MF,10%,10V,TANTLUM	TK0875	267M-1002-476-K

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A4C418	290-5005-00			CAP,FXD,ELCTLT:47MF,10%,10V,TANTLUM	TK0875	267M-1002-476-K
A4C419	283-5235-00			CAP,FXD,CERAMIC:0.56UF,100V	04222	W1825Z564M3B04
A4C420	290-5004-00			CAP,FXD,ELCTLT:22UF,20V,TANTALUM	04222	TAJD226K020R
A4C421	290-5004-00			CAP,FXD,ELCTLT:22UF,20V,TANTALUM	04222	TAJD226K020R
A4C422	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A4C423	290-5004-00			CAP,FXD,ELCTLT:22UF,20V,TANTALUM	04222	TAJD226K020R
A4C424	283-5210-01			CAP,FXD,CER DI:1000PF,10%,1000V	04222	1812AA102KAT060
A4C425	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A4C426	283-5210 01			CAP,FXD,CER DI:1000PF,10%,1000V	04222	1812AA102KAT060
A4C427	283-5235-00			CAP,FXD,CERAMIC:0.56UF,100V	04222	W1825Z564M3B04
A4C428	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A4CR401	152-5022-00			DIODE,RECT:,,1000V,1.5A,1.05VF,BYD17M	25403	BYD17M
A4CR402	152-5027-00			DIODE,RECT:SCHTKY,:40V,1A	04713	MBRS140T3
A4CR403	152-5027-00			DIODE,RECT:SCHTKY,:40V,1A	04713	MBRS140T3
A4CR404	152-5027-00			DIODE,RECT:SCHTKY,:40V,1A	04713	MBRS140T3
A4CR405	152-5027-00			DIODE,RECT:SCHTKY,:40V,1A	04713	MBRS140T3
A4CR406	152-5027-00			DIODE,RECT:SCHTKY,:40V,1A	04713	MBRS140T3
A4CR407	152-5027-00			DIODE,RECT:SCHTKY,:40V,1A	04713	MBRS140T3
A4CR408	152-5027-00			DIODE,RECT:SCHTKY,:40V,1A	04713	MBRS140T3
A4CR409	152-5022-00			DIODE,RECT:,,1000V,1.5A,1.05VF,BYD17M	25403	BYD17M
A4CR410	152-5022-00			DIODE,RECT:,,1000V,1.5A,1.05VF,BYD17M	25403	BYD17M
A4CR411	152-5022-00			DIODE,RECT:,,1000V,1.5A,1.05VF,BYD17M	25403	BYD17M
A4CR415	152-5022-00			DIODE,RECT:,,1000V,1.5A,1.05VF,BYD17M	25403	BYD17M
A4CR416	152-5022-00			DIODE,RECT:,,1000V,1.5A,1.05VF,BYD17M	25403	BYD17M
A4CR418	152-5022-00			DIODE,RECT:,,1000V,1.5A,1.05VF,BYD17M	25403	BYD17M
A4CR419	152-5022-00			DIODE,RECT:,,1000V,1.5A,1.05VF,BYD17M	25403	BYD17M
A4CR420	152-5022-00			DIODE,RECT:,,1000V,1.5A,1.05VF,BYD17M	25403	BYD17M
A4CR422	152-5022-00			DIODE,RECT:,,1000V,1.5A,1.05VF,BYD17M	25403	BYD17M
A4J3	136-5004-00			SKT,PL-IN ELEK:MICROCKT,2 X 7	58050	TKO-07254-204
A4J6	136-5004-00			SKT,PL-IN ELEK:MICROCKT,2 X 7	58050	TKO-07254-204
A4L401	108-1449-00			INDUCTOR:BOBBIN CORE,33UH,10%,1.2A	54583	TSL0807-330K1R2
A4L402	108-5002-00			COIL,RF:FXD,15UH	54583	NL453232T-150K
A4L403	108-5057-00			COIL,RF:FXD,68UH	54583	NL453232T-680K
A4L404	108-5002-00			COIL,RF:FXD,15UH	54583	NL453232T-150K
A4L405	108-1449-00			INDUCTOR:BOBBIN CORE,33UH,10%,1.2A	54583	TSL0807-330K1R2
A4LS401	119-2101-00			XDCR,AUDIO:6V NOM,40 MA,IMP 90 OHM	63791	SMX-06
A4Q401	151-5038-01			TRANSISTOR,PWR:MOS,N-CH	04713	MTD10N05ET1
A4Q402	151-5038-01			TRANSISTOR,PWR:MOS,N-CH	04713	MTD10N05ET1
A4Q403	151-5000-00			TRANSISTOR,SIG:BIPOLAR,PNP	04713	MMBT3906LT1
A4Q404	151-5001-00			TRANSISTOR,SIG:BIPOLAR,NPN	04713	MMBT3904T1/T2

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A4Q405	151-5027-00			TRANSISTOR,SIG:BIPOLAR,NPN	04713	MMBT5551LT1
A4Q406	151-5027-00			TRANSISTOR,SIG:BIPOLAR,NPN	04713	MMBT5551LT1
A4Q407	151-5027-00			TRANSISTOR,SIG:BIPOLAR,NPN	04713	MMBT5551LT1
A4Q440	151-5027-00			TRANSISTOR,SIG:BIPOLAR,NPN	04713	MMBT5551LT1
A4Q441	151-5027-00			TRANSISTOR,SIG:BIPOLAR,NPN	04713	MMBT5551LT1
A4Q450	151-5027-00			TRANSISTOR,SIG:BIPOLAR,NPN	04713	MMBT5551LT1
A4Q451	151-5027-00			TRANSISTOR,SIG:BIPOLAR,NPN	04713	MMBT5551LT1
A4R401	321-5261-00			RES,FXD,FILM:2.00M,1%,0.125W	91637	CRCW12062004FT2
A4R402	321-5047-00			RES,FXD,FILM:100K,1%,0.125W	91637	CRCW12061003FT
A4R403	321-5261-00			RES,FXD,FILM:2.00M,1%,0.125W	91637	CRCW12062004FT2
A4R404	321-5038-00			RES,FXD,FILM:47.5K,1%,0.125W	91637	CRCW12064752FT
A4R405	321-5176-00			RES,FXD,FILM:3.01K,1%,0.125W	91637	CRCW12063011FT
A4R406	321-5261-00			RES,FXD,FILM:2.00M,1%,0.125W	91637	CRCW12062004FT2
A4R407	321-5261-00			RES,FXD,FILM:2.00M,1%,0.125W	91637	CRCW12062004FT2
A4R408	321-5047-00			RES,FXD,FILM:100K,1%,0.125W	91637	CRCW12061003FT
A4R409	321-5038-00			RES,FXD,FILM:47.5K,1%,0.125W	91637	CRCW12064752FT
A4R410	321-5030-00			RES,FXD,FILM:10.0K,1%,0.125W	91637	CRCW12061002FT
A4R411	321-5261-00			RES,FXD,FILM:2.00M,1%,0.125W	91637	CRCW12062004FT2
A4R412	321-5047-00			RES,FXD,FILM:100K,1%,0.125W	91637	CRCW12061003FT
A4R413	311-2430-00			RES,VAR,NONWW:2M OHM,20%,0.75W	TK2073	GF12S 8.2SK 205
A4R414	321-5018-00			RES,FXD,FILM:1.00K,1%,0.125W	91637	CRCW12061001FT
A4R415	311-2430-00			RES,VAR,NONWW:2M OHM,20%,0.75W	TK2073	GF12S 8.2SK 205
A4R416	321-5018-00			RES,FXD,FILM:1.00K,1%,0.125W	91637	CRCW12061001FT
A4R417	321-5018-00			RES,FXD,FILM:1.00K,1%,0.125W	91637	CRCW12061001FT
A4R418	321-5047-00			RES,FXD,FILM:100K,1%,0.125W	91637	CRCW12061003FT
A4R419	321-5020-00			RES,FXD,FILM:1.50K,1%,0.125W	91637	CRCW12061501FT
A4R420	313-5001-00			RES,FXD,FILM:10M,5%,0.125W	91637	CRCW12061005JT
A4R421	321-5047-00			RES,FXD,FILM:100K,1%,0.125W	91637	CRCW12061003FT
A4R422	321-5018-00			RES,FXD,FILM:1.00K,1%,0.125W	91637	CRCW12061001FT
A4R423	321-5018-00			RES,FXD,FILM:1.00K,1%,0.125W	91637	CRCW12061001FT
A4R424	311-5043-00			RES,VAR,NONWW:2M OHM,20%,0.25W	32997	3314S-1-205E
A4R425	321-5030-00			RES,FXD,FILM:10.0K,1%,0.125W	91637	CRCW12061002FT
A4R426	311-5010-00			RES,VAR,NONWW:50K OHM,20%,0.25W	32997	3314S-1-503E
A4R427	321-5029-00			RES,FXD,FILM:8.25K,1%,0.125W	91637	CRCW12068251FT
A4R428	321-5150-00			RES,FXD,FILM:90.9K,1%,0.125W	91637	CRCW12069092FT
A4R429	321-5030-00			RES,FXD,FILM:10.0K,1%,0.125W	91637	CRCW12061002FT
A4R430	321-5150-00			RES,FXD,FILM:90.9K,1%,0.125W	91637	CRCW12069092FT
A4R431	311-5010-00			RES,VAR,NONWW:50K OHM,20%,0.25W	32997	3314S-1-503E
A4R432	321-5020-00			RES,FXD,FILM:1.50K,1%,0.125W	91637	CRCW12061501FT
A4R433	321-5020-00			RES,FXD,FILM:1.50K,1%,0.125W	91637	CRCW12061501FT

Component Number	Tektronix Part No.	Serial No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A4R434	321-5029-00			RES,FXD,FILM:8.25K,1%,0.125W	91637	CRCW12068251FT
A4R435	321-5176-00			RES,FXD,FILM:3.01K,1%,0.125W	91637	CRCW12063011FT
A4R436	321-5020-00			RES,FXD,FILM:1.50K,1%,0.125W	91637	CRCW12061501FT
A4R437	321-5020-00			RES,FXD,FILM:1.50K,1%,0.125W	91637	CRCW12061501FT
A4R438	308-5004-00			RES,FXD,WW:0.1 OHM,1%,1W	91637	WSC1-R100FT
A4R439	321-5261-00			RES,FXD,FILM:2.00M,1%,0.125W	91637	CRCW12062004FT2
A4R440	321-5030-00			RES,FXD,FILM:10.0K,1%,0.125W	91637	CRCW12061002FT
A4R441	321-5022-00			RES,FXD,FILM:2.21K,1%,0.125W	91637	CRCW12062211FT
A4R442	321-5018-00			RES,FXD,FILM:1.00K,1%,0.125W	91637	CRCW12061001FT
A4R443	321-5018-00			RES,FXD,FILM:1.00K,1%,0.125W	91637	CRCW12061001FT
A4R444	321-5026-00			RES,FXD,FILM:4.75K,1%,0.125W	91637	CRCW12064751FT
A4R445	321-5026-00			RES,FXD,FILM:4.75K,1%,0.125W	91637	CRCW12064751FT
A4R446	321-5022-00			RES,FXD,FILM:2.21K,1%,0.125W	91637	CRCW12062211FT
A4R447	311-5042-00			RES,VAR,NONWW:2K OHM,20%,0.25W	32997	3314S-1-202E
A4R448	311-5042-00			RES,VAR,NONWW:2K OHM,20%,0.25W	32997	3314S-1-202E
A4R449	321-5261-00			RES,FXD,FILM:2.00M,1%,0.125W	91637	CRCW12062004FT2
A4R450	321-5047-00			RES,FXD,FILM:100K,1%,0.125W	91637	CRCW12061003FT
A4R451	321-5047-00			RES,FXD,FILM:100K,1%,0.125W	91637	CRCW12061003FT
A4R452	321-5026-00			RES,FXD,FILM:4.75K,1%,0.125W	91637	CRCW12064751FT
A4R453	321-5026-00			RES,FXD,FILM:4.75K,1%,0.125W	91637	CRCW12064751FT
A4R454	321-5026-00			RES,FXD,FILM:4.75K,1%,0.125W	91637	CRCW12064751FT
A4R455	311-5042-00			RES,VAR,NONWW:2K OHM,20%,0.25W	32997	3314S-1-202E
A4R456	311-5042-00			RES,VAR,NONWW:2K OHM,20%,0.25W	32997	3314S-1-202E
A4R457	321-5030-00			RES,FXD,FILM:10.0K,1%,0.125W	91637	CRCW12061002FT
A4R458	321-5047-00			RES,FXD,FILM:100K,1%,0.125W	91637	CRCW12061003FT
A4R459	321-5047-00			RES,FXD,FILM:100K,1%,0.125W	91637	CRCW12061003FT
A4R460	321-5030-00			RES,FXD,FILM:10.0K,1%,0.125W	91637	CRCW12061002FT
A4R461	321-5030-00			RES,FXD,FILM:10.0K,1%,0.125W	91637	CRCW12061002FT
A4R462	321-5261-00			RES,FXD,FILM:2.00M,1%,0.125W	91637	CRCW12062004FT2
A4R463	321-5020-00			RES,FXD,FILM:1.50K,1%,0.125W	91637	CRCW12061501FT
A4R464	313-5001-00			RES,FXD,FILM:10M,5%,0.125W	91637	CRCW12061005JT
A4R465	313-5001-00			RES,FXD,FILM:10M,5%,0.125W	91637	CRCW12061005JT
A4R466	321-5018-00			RES,FXD,FILM:1.00K,1%,0.125W	91637	CRCW12061001FT
A4R467	321-5047-00			RES,FXD,FILM:100K,1%,0.125W	91637	CRCW12061003FT
A4R468	313-5001-00			RES,FXD,FILM:10M,5%,0.125W	91637	CRCW12061005JT
A4R469	321-5261-00			RES,FXD,FILM:2.00M,1%,0.125W	91637	CRCW12062004FT2
A4R470	321-5261-00			RES,FXD,FILM:2.00M,1%,0.125W	91637	CRCW12062004FT2
A4R472	321-5261-00			RES,FXD,FILM:2.00M,1%,0.125W	91637	CRCW12062004FT2
A4R473	321-5171-00			RES,FXD,FILM:562K OHM,1%,0.125 W	91637	CRCW1206-5623FT
A4R474	321-5151-00			RES,FXD,FILM:453K,1%,0.125W	91637	CRCW12064533FT

Component Number	Tektronix Part No.	Serial No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A4R475	321-5000-00			RES,FXD,FILM:10 OHM,1%,0.125W	91637	CRCW120610R0FT
A4R476	321-5000-00			RES,FXD,FILM:10 OHM,1%,0.125W	91637	CRCW120610R0FT
A4R477	321-5000-00			RES,FXD,FILM:10 OHM,1%,0.125W	91637	CRCW120610R0FT
A4R478	321-5038-00			RES,FXD,FILM:47.5K,1%,0.125W	91637	CRCW12064752FT
A4R479	321-5022-00			RES,FXD,FILM:2.21K,1%,0.125W	91637	CRCW12062211FT
A4R480	321-5047-00			RES,FXD,FILM:100K,1%,0.125W	91637	CRCW12061003FT
A4T401	120-1780-00			TRANSFORMER,RF:POT CORE,LOW VOLTAGE	75498	120-1780-00
A4T402	120-1744-01			TRANSFORMER,PWR:POT CORE,HIGH VOLTAGE	75498	128-7077-01
A4U401	156-6084-01			MICROCKT,LINEAR:BIPOLAR,SW REG/CONT	01295	TL594CDR
A4U440	156-5438-01			IC,LINEAR:BIPOLAR,TRANSISTOR ARRAY	04713	MMPQ2222AR2
A4U450	156-5438-01			IC,LINEAR:BIPOLAR,TRANSISTOR ARRAY	04713	MMPQ2222AR2
A4VR420	152-5029-00			SEMICOND DVC,DI:ZENER	04713	MLL5268AT1
A4W1	136-1001-00			SKT,PL-IN ELEK:CRT,9 PIN,	TK2469	136-1001-00

Component Number	Tektronix Part No.	Serial No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A5	671-1991-00			CIRCUIT BD ASSY:POTENTIOMETER	80009	671-1991-00
A5C501	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A5R501	307-5043-01			RES,FXD,FILM:100K X 8.2%,0.250 W	91637	SOMC-1603-104G-
A5R502	311-2392-01			RES,VAR,NONWW:CKT BD,50K,10%	12697	CM45253
A5R503	311-2393-01			RES,VAR,NONWW:CKT BD,DUAL 50K,10%,	12697	CM45254
A5R504	311-2431-01			RES,VAR,NONWW:CKT BD,DUAL 50K,10%,	12697	CM45255
A5R505	321-5006-00			RES,FXD,FILM:100 OHM,1%,0.125W	91637	CRCW12061000FT
A5U501	156-5080-01			IC,DIGITAL:CMOS,REGISTER	18324	HEF4021BTD
A5U502	156-5455-01			IC,DIGITAL:HCMOS,GATE;QUAD 2-INPUT XOR	04713	MC74HC86DTR13
A5U503	156-5455-01			IC,DIGITAL:HCMOS,GATE;QUAD 2-INPUT XOR	04713	MC74HC86DTR13
A5W9	174-1451-00			CA ASSY,SP,ELEC:14,0.05,3.5 L	53387	6-000503

Component Number	Tektronix Part No.	Serial No. Effective	Serial No. Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A6	671-0063-01			CIRCUIT BD ASSY:FRONT PANEL	80009	671-0063-01
A6C601	283-5004-00			CAP,FXD,CER DI:0.1UF,10%,25V	04222	W1206X104K1B01
A6DS601	150-1078-00			LT EMITTING DIO:GREEN,565NM,20MA	50434	HLMP-1503
A6P8	131-5017-00			CONN,HDR:SMD/PCB,:MALE,STR,2 X 7	58050	182-0744-SD92
A6P9	131-5017-00			CONN,HDR:SMD/PCB,:MALE,STR,2 X 7	58050	182-0744-SD92
A6P10	131-5016-00			CONN,HDR:SMD/PCB,:MALE,STR,2 X 3	58050	182-0344-SD92
A6R601	307-5043-01			RES,FXD,FILM:100K X 8,2%,0.250 W	91637	SOMC-1603-104G-
A6R602	321-5022-00			RES,FXD,FILM:2.21K,1%,0.125W	91637	CRCW12062211FT
A6U601	156-5457-01			IC,DIGITAL:HCMOS,GATE;8-INPUT NAND	01295	SN74HC30D
A6U602	156-5021-01			IC,DIGITAL:CMOS,SHIFT REGISTER	18324	HEF4094BTDT
A6U603	156-5080-01			IC,DIGITAL:CMOS,REGISTER	18324	HEF4021BTD

Component Number	Tektronix Part No.	Serial No. Effective	Serial No. Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A7	671-0269-01			CIRCUIT BD ASSY;KEYPAD	80009	671-0269-01
A7W10	174-1532-00			CA ASSY,SP,ELEC;6,26 AWG,3.0 L,RIBBON	TK2469	174-1532-00

Diagrams

Replace this page with the tab divider of the same name.

Diagrams and Circuit Board Illustrations

This section contains the troubleshooting procedures, block diagrams, circuit board illustrations, component locator tables, waveform illustrations, and schematic diagrams for the 222A.

Symbols

Graphic symbols and class designation letters are based on ANSI Standard Y32.2-1975. Abbreviations are based on ANSI Y1.1-1972.

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

The tilde (~) preceding a signal name indicates that the signal performs its intended function when in the low state.

Other standards used in the preparation of diagrams by Tektronix, Inc., include the following:

- Tektronix Standard 062-2476 Symbols and Practices for Schematic Drafting
- ANSI Y14.159-1971 Interconnection Diagrams
- ANSI Y32.16-1975 Reference Designations for Electronic Equipment
- MIL-HDBK-63038-1A Military Standard Technical Manual Writing Handbook

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: Values are in Ohms (Ω).

Graphic Items and Special Symbols Used in This Manual

Each assembly in the instrument is assigned an assembly identifier (for example, MAIN or A3). The assembly identifier appears on the circuit board outline on the diagram (see Figure 9-1), 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 assembly in numerical sequence; the components are listed by component number.

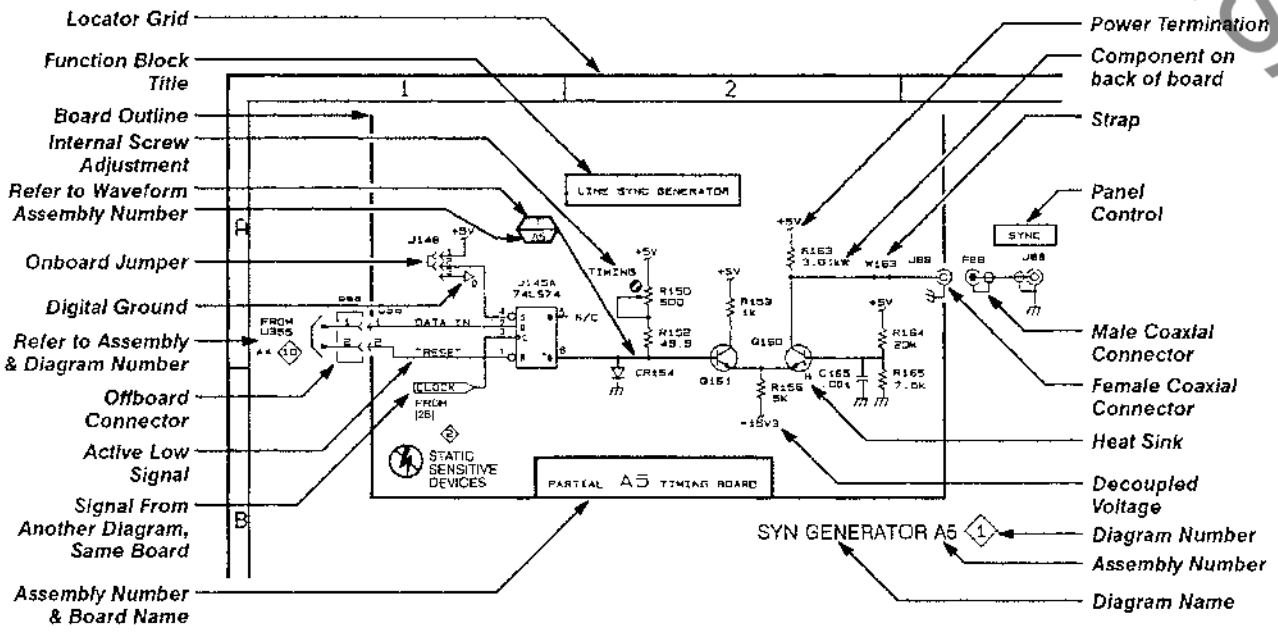


Figure 9-1: Graphic Items and Special Symbols Used in This Manual

Component Locator Diagrams

The schematic diagram and circuit board component location illustrations have grids marked on them. The component lookup tables refer to these grids to help you locate a component. The circuit board illustration appears only once; its lookup table lists the diagram number of all diagrams on which the circuitry appears.

Some of the circuit board component location illustrations are expanded and divided into several parts to make it easier for you to locate small components. To determine which part of the whole locator diagram you are looking at, refer to the small locator key positioned at the upper left of each circuit board component locator diagram, as shown in Figure 9-2. The gray block, within the larger circuit board outline, shows where that part fits in the whole locator diagram. Each part in the key is labeled with an identifying letter that appears in the figure titles under component locator diagrams.

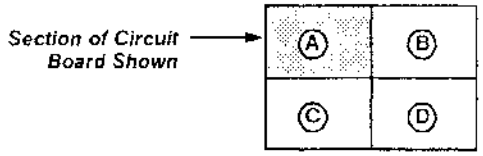
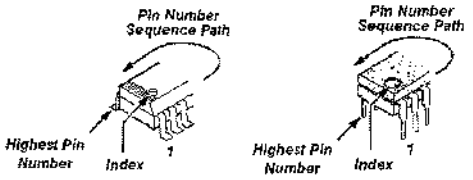
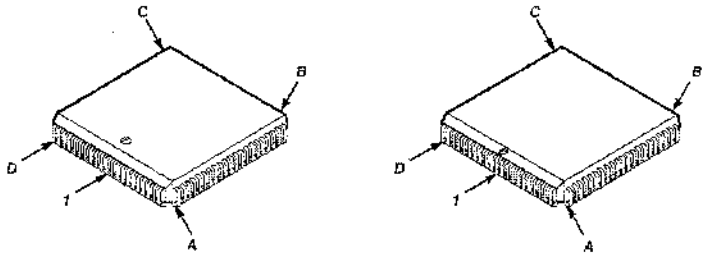


Figure 9-2: Circuit Board Component Locator Diagram Key

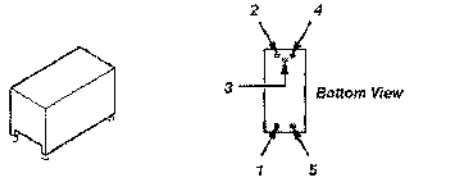




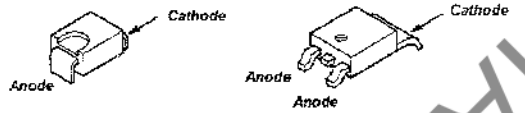
Reference Table for Integrated Circuit Pin Numbers

Total Pins	Pins Per Side	A	B	C	D
20	5	4	9	14	19
28	7	5	12	19	26
32	7 and 9	5	14	21	30
52	13	8	21	34	47
68	17	11	28	45	62

Integrated Circuits



Opto-Isolator



Diodes

LEDs

Plastic Case Transistors

Lead configurations and case styles are typical, but may vary due to vendor changes or instrument modifications.

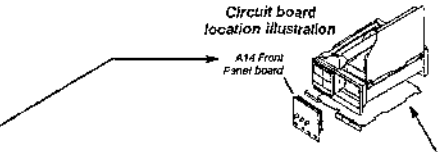
Figure 9-3: Semiconductor Lead Configurations

LOCATING COMPONENTS ON THE CIRCUIT BOARD OR SCHEMATIC DIAGRAM

CIRCUIT BOARD TO SCHEMATIC DIAGRAM

1. **Locate the circuit board illustration.**
   - Identify the circuit board and its assembly number that the part is located on by using the **circuit board location illustration.** Example: **A14**.
   - In the manual, locate the page whose title corresponds with the assembly number of the circuit board.
2. **Determine the circuit number.**
   - Compare the circuit board with its illustration and locate the part by area and shape on the illustration. Example: **R930**.
   - Scan the **component location table** for the circuit board illustration, and find the circuit number of the part.
   - Determine the schematic diagram number in which the part is located. Example: **A14 diagram 4.**
3. **Locate the component on the schematic diagram.**
   - Locate the page whose number corresponds with the schematic diagram number just found in the **component location table.**
   - Scan the **component location table** for that circuit board and assembly, and find the circuit number of the part.
   - Under the **SCHEM LOCATION** column, read the grid coordinates for the part.
   - Using the circuit number and grid coordinates, locate the part on the schematic diagram.

Circuit board location illustration



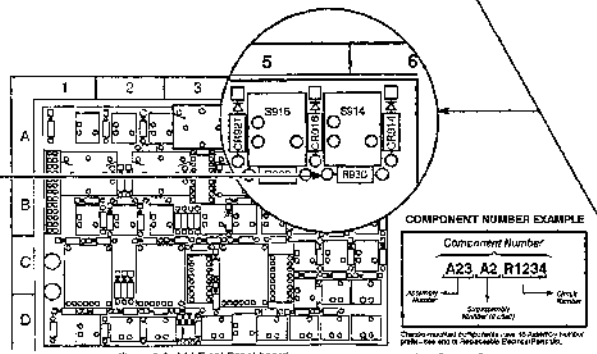


Figure 9-5: A14 Front Panel board

Assembly number and circuit board name

COMPONENT NUMBER EXAMPLE

STATIC SENSITIVE DEVICES

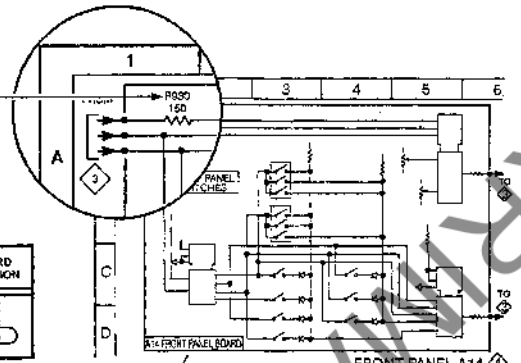
SCHEMATIC DIAGRAM TO CIRCUIT BOARD

1. **Determine the circuit board illustration and component location.**
   - From the schematic diagram, determine the assembly number of the circuit board on which the part is mounted. Example: **A14 FRONT PANEL BOARD.**
   - Scan the **component location table** for that schematic and assembly number, and find the number of the part.
   - Under the **BOARD LOCATION column**, read the grid coordinates for the part.
2. **Locate the component on the circuit board.**
   - Using the circuit number and grid coordinates, find the part on the **circuit board illustration.**
   - In the **circuit board location illustration**, determine the location of the circuit board in the instrument.
   - Find the circuit board in the instrument and use the circuit board illustration in the manual to help find the part on the board.

Component location table

A14 FRONT PANEL BOARD

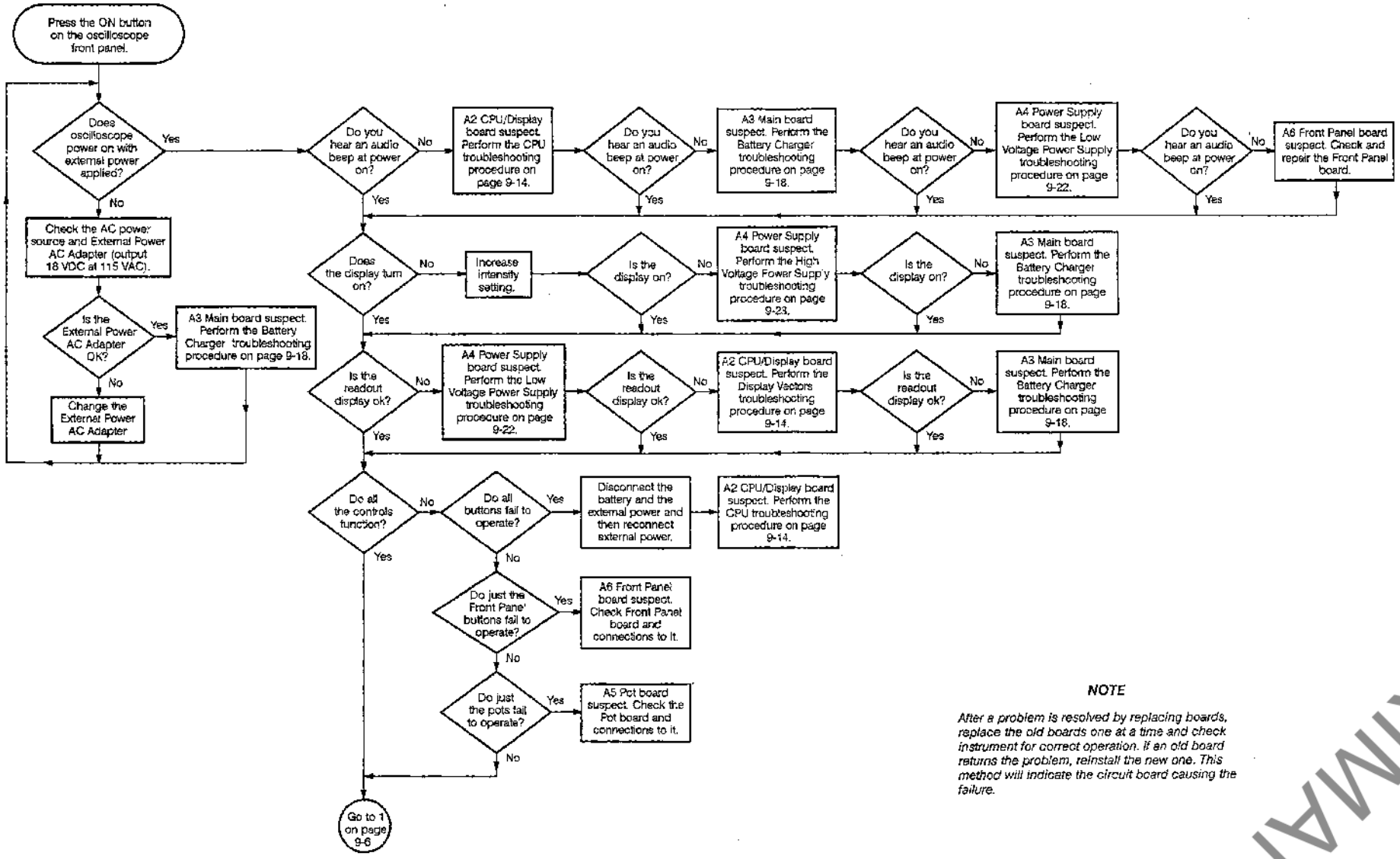
CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	CIRCUIT BOARD	BOARD LOCATION	CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	CIRCUIT BOARD	BOARD LOCATION
DS902	A14-4	6L	A14	2A	R901A	A14-4	3L	A14	1E
DS903	A14-4	6L	A14	2E	R901B	A14-4	3L	A14	1E
DS904	A14-4	6L	A14	2E	R930	A14-4	1A	A14	6A



Circuit board assembly number and name

Schematic diagram name and number

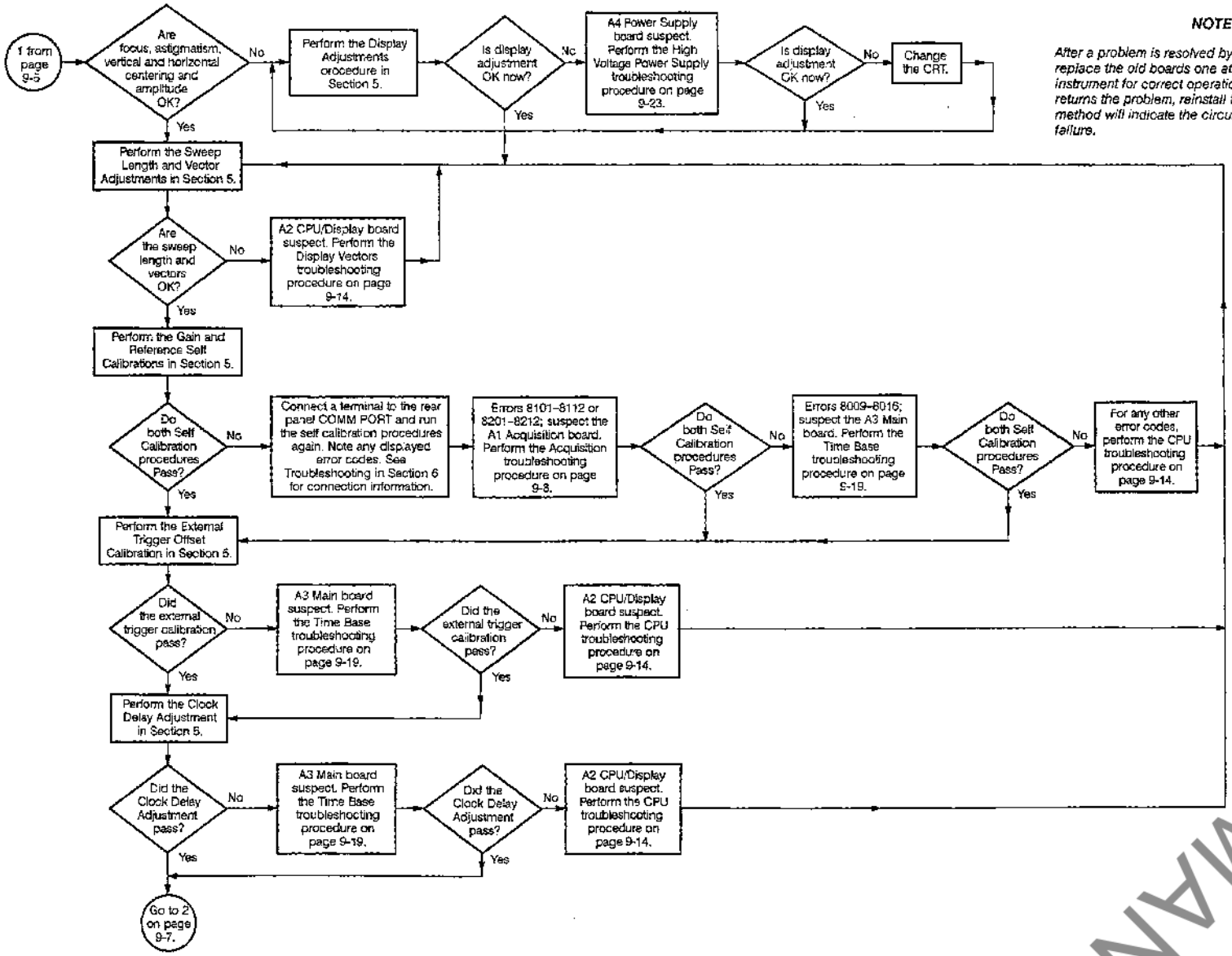
Figure 9-4: Locating Components on Circuit Board or Schematic Diagram



NOTE

After a problem is resolved by replacing boards, replace the old boards one at a time and check instrument for correct operation. If an old board returns the problem, reinstall the new one. This method will indicate the circuit board causing the failure.

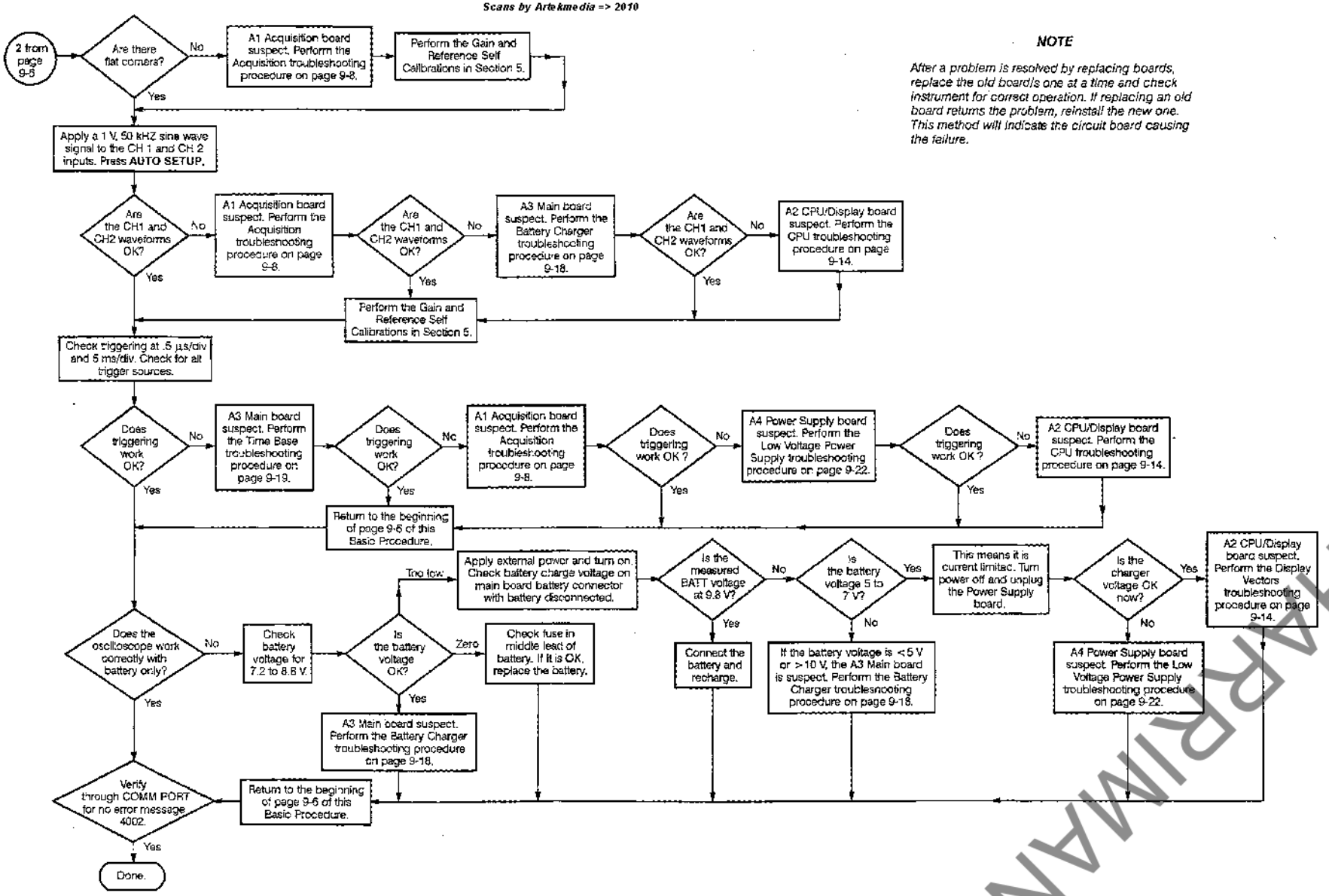
Figure 9-5: Basic Troubleshooting Procedure



NOTE

After a problem is resolved by replacing boards, replace the old boards one at a time and check instrument for correct operation. If an old board returns the problem, reinstall the new one. This method will indicate the circuit board causing the failure.

Figure 9-5: Basic Troubleshooting Procedure (Cont.)



NOTE

After a problem is resolved by replacing boards, replace the old boards one at a time and check instrument for correct operation. If replacing an old board returns the problem, reinstall the new one. This method will indicate the circuit board causing the failure.

Figure 9-5: Basic Troubleshooting Procedure (Cont.)

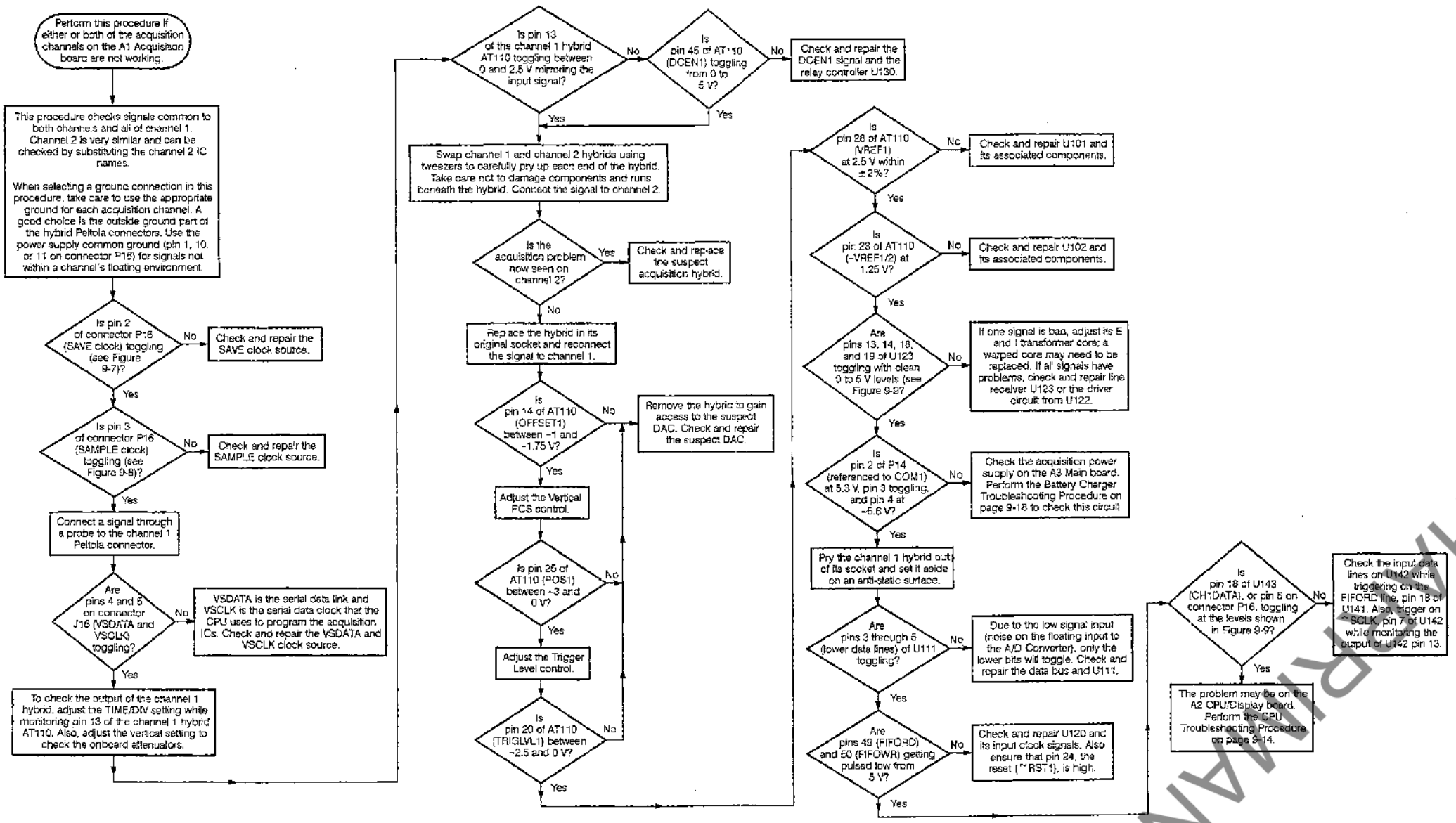


Figure 9-6: Acquisition Troubleshooting Procedure

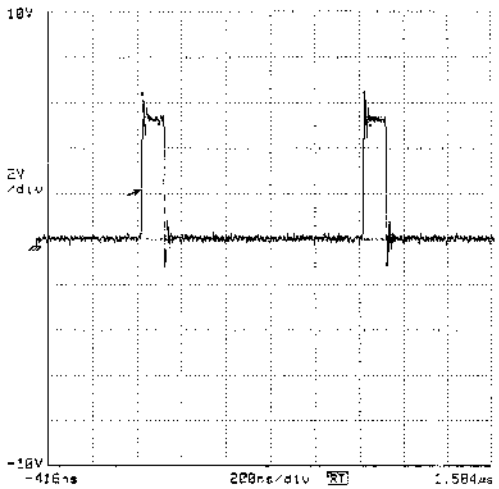


Figure 9-7: SAVE Clock Signal at Pin 2 of P16

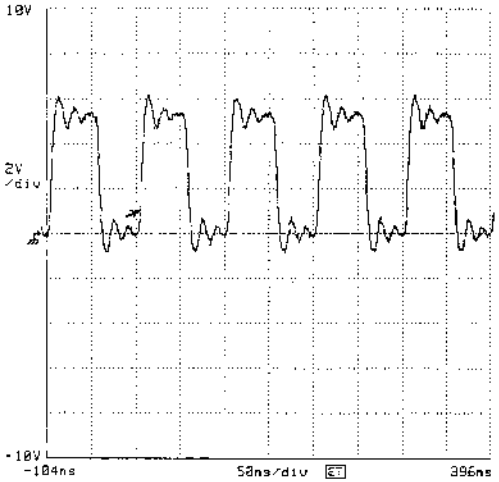


Figure 9-8: SAMPLE Clock Signal at Pin 3 of P16

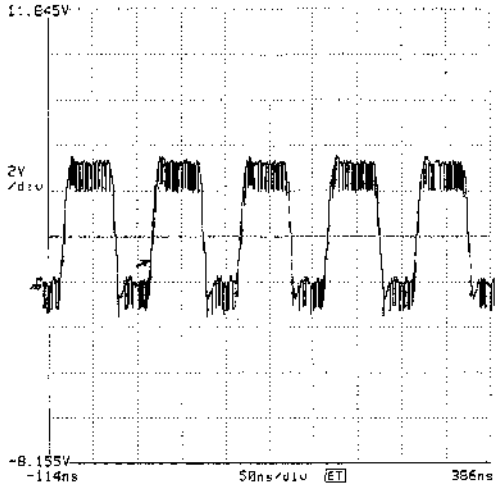


Figure 9-9: ~SMPLCLK1 Waveform Showing Typical Logic Levels for Line Receivers

Figure 9-6: Acquisition Troubleshooting Procedure (Cont.)

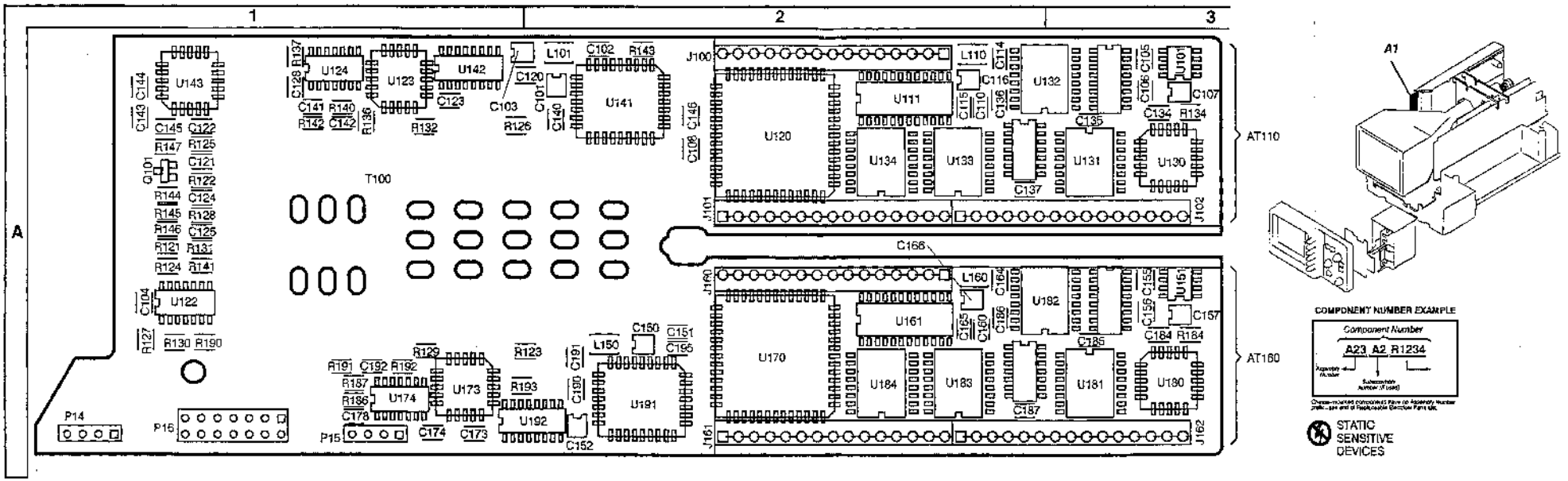


Figure 9-10: A1 Acquisition Board

A1 Acquisition Component Locator

CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	BOARD NUMBER	BOARD LOCATION	CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	BOARD NUMBER	BOARD LOCATION	CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	BOARD NUMBER	BOARD LOCATION	CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	BOARD NUMBER	BOARD LOCATION	CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	BOARD NUMBER	BOARD LOCATION
AT110	A1-1	4B	A1	2A	C156	A1-4	3A	A1	3A						R151F	A1-4	4A	A1	3A	U124B	A1-3	4B	A1	1A
AT160	A1-4	4B	A1	2A	C157	A1-4	4A	A1	3A	R101A	A1-1	5D	A1	3A	R151G	A1-4	4A	A1	3A	U124C	A1-3	4C	A1	1A
					C160	A1-4	4A	A1	2A	R101C	A1-1	3A	A1	3A	R151H	A1-4	5A	A1	3A	U124D	A1-3	4C	A1	1A
C101	A1-3	2D	A1	2A	C164	A1-4	5B	A1	2A	R101D	A1-1	3A	A1	3A	R1513	A1-5	6C	A1	3A	U130	A1-2	3D	A1	3A
C102	A1-3	2D	A1	2A	C165	A1-4	6B	A1	2A	R101E	A1-1	3A	A1	3A	R184	A1-5	3C	A1	3A	U131	A1-1	1A	A1	3A
C103	A1-3	1D	A1	1A	C166	A1-4	5B	A1	2A	R101F	A1-1	4A	A1	3A	R186	A1-6	4B	A1	1A	U132	A1-1	1D	A1	2A
C104	A1-3	2D	A1	1A	C173	A1-6	3B	A1	1A	R101G	A1-1	4A	A1	3A	R187	A1-5	4C	A1	1A	U133	A1-1	1B	A1	2A
C105	A1-1	3B	A1	3A	C174	A1-6	3B	A1	1A	R101H	A1-1	5A	A1	3A	R190	A1-5	6B	A1	1A	U134	A1-1	1C	A1	2A
C106	A1-1	3A	A1	3A	C178	A1-6	2C	A1	1A	R101S	A1-2	5C	A1	3A	R191	A1-5	5B	A1	1A	U141	A1-2	3B	A1	2A
C107	A1-1	4A	A1	3A	C184	A1-5	3C	A1	3A	R121	A1-3	2A	A1	1A	R192	A1-5	5B	A1	1A	U142	A1-2	4B	A1	1A
C108	A1-3	3C	A1	2A	C185	A1-4	2A	A1	3A	R122	A1-3	2A	A1	1A	R193	A1-5	4B	A1	1A	U143B	A1-2	5B	A1	1A
C110	A1-1	4A	A1	2A	C186	A1-4	2C	A1	2A	R123	A1-3	3A	A1	1A						U143A	A1-3	5D	A1	1A
C114	A1-1	5B	A1	2A	C187	A1-4	2B	A1	2A	R124	A1-3	2B	A1	1A	T100A	A1-2	5B	A1	1A	U143D	A1-3	4D	A1	1A
C115	A1-1	5B	A1	2A	C190	A1-5	2B	A1	2A	R125	A1-3	2B	A1	1A	T100C	A1-3	2B	A1	1A	U143C	A1-5	5B	A1	1A
C116	A1-1	5B	A1	2A	C191	A1-5	5B	A1	2A	R126	A1-3	3A	A1	1A	T100D	A1-3	2C	A1	1A	U151	A1-4	3A	A1	3A
C120	A1-3	3C	A1	1A	C192	A1-5	5B	A1	1A	R127	A1-3	2B	A1	1A	T100E	A1-3	2A	A1	1A	U152A	A1-4	2D	A1	2A
C121	A1-3	2A	A1	1A	C195	A1-5	3B	A1	2A	R128	A1-3	2B	A1	1A	T100F	A1-3	2A	A1	1A	U152B	A1-4	2B	A1	2A
C122	A1-3	2B	A1	1A						R129	A1-3	3B	A1	1A	T100G	A1-3	4C	A1	1A	U152C	A1-4	2A	A1	2A
C123	A1-3	4B	A1	1A	J100	A1-1	4B	A1	2A	R130	A1-3	2C	A1	1A	T100B	A1-5	5B	A1	1A	U152D	A1-4	5B	A1	2A
C124	A1-3	2B	A1	1A	J101	A1-1	3B	A1	2A	R131	A1-3	2C	A1	1A						U151	A1-4	5B	A1	2A
C125	A1-3	2C	A1	1A	J102	A1-1	3C	A1	2A	R132	A1-3	3B	A1	1A	U101	A1-1	3A	A1	3A	U170	A1-5	2B	A1	2A
C128	A1-3	2D	A1	1A	J160	A1-4	4B	A1	2A	R134	A1-2	3C	A1	3A	U102A	A1-1	2D	A1	2A	U173A	A1-6	3B	A1	1A
C134	A1-2	3C	A1	3A	J161	A1-4	3B	A1	2A	R135	A1-3	4B	A1	1A	U102B	A1-1	2B	A1	2A	U173B	A1-6	3A	A1	1A
C135	A1-1	2A	A1	3A	J162	A1-4	3C	A1	2A	R137	A1-3	4C	A1	1A	U102C	A1-1	2A	A1	2A	U173C	A1-6	3B	A1	1A
C136	A1-1	2C	A1	2A						R140	A1-2	5B	A1	1A	U102D	A1-1	5B	A1	2A	U173D	A1-6	3C	A1	1A
C137	A1-1	2B	A1	2A	L101	A1-3	2C	A1	1A	R141	A1-2	6B	A1	1A	U111	A1-1	5B	A1	2A	U174A	A1-6	3A	A1	1A
C140	A1-2	3B	A1	2A	L110	A1-1	5B	A1	2A	R142	A1-2	5B	A1	1A	U120	A1-2	2B	A1	2A	U174B	A1-6	4B	A1	1A
C141	A1-2	5B	A1	1A	L150	A1-6	2C	A1	2A	R143	A1-2	4B	A1	2A	U122A	A1-3	1B	A1	1A	U174C	A1-6	3C	A1	1A
C142	A1-2	5B	A1	1A	L160	A1-4	5B	A1	2A	R144	A1-3	4D	A1	1A	U122B	A1-3	1C	A1	1A	U174D	A1-6	4C	A1	1A
C143	A1-3	4D	A1	1A						R145	A1-3	5D	A1	1A	U122C	A1-3	1A	A1	1A	U180	A1-5	3D	A1	3A
C144	A1-3	5D	A1	1A	P14	A1-3	1C	A1	1A	R146	A1-3	5D	A1	1A	U122D	A1-3	1A	A1	1A	U181	A1-4	1A	A1	3A
C145	A1-3	5D	A1	1A	P15	A1-6	1C	A1	1A	R147	A1-3	5D	A1	1A	U123A	A1-3	3C	A1	1A	U182	A1-4	1D	A1	2A
C146	A1-2	3B	A1	2A	P16B	A1-2	6B	A1	1A	R151A	A1-4	6D	A1	3A	U123B	A1-3	3B	A1	1A	U183	A1-4	1B	A1	2A
C150	A1-6	2D	A1	2A	P16A	A1-3	1B	A1	1A	R151C	A1-4	3A	A1	3A	U123C	A1-3	3A	A1	1A	U184	A1-4	1C	A1	2A
C151	A1-6	2D	A1	2A	P16C	A1-2	6C	A1	1A	R151D	A1-4	3B	A1	3A	U123D	A1-3	3B	A1	1A	U191	A1-5	3B	A1	2A
C152	A1-6	1D	A1	2A						R151E	A1-4	3A	A1	3A	U124A	A1-3	4A	A1	1A	U192	A1-5	4B	A1	1A
C155	A1-4	3B	A1	3A	Q101	A1-3	6D	A1	1A															

*Asterisks indicate components located on the back of the board.

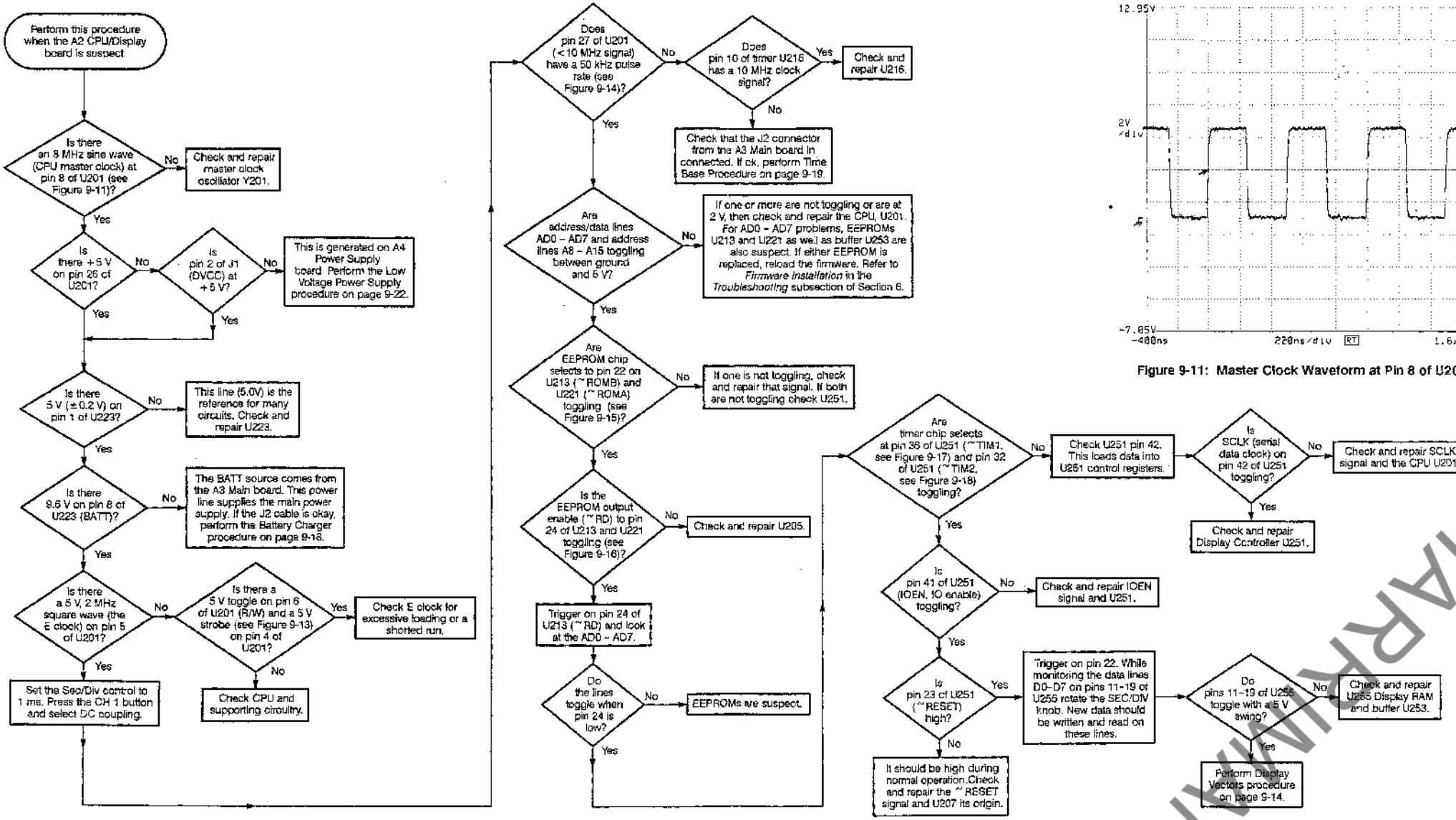


Figure 9-11: Master Clock Waveform at Pin 8 of U201

Figure 9-12: CPU Troubleshooting Procedure

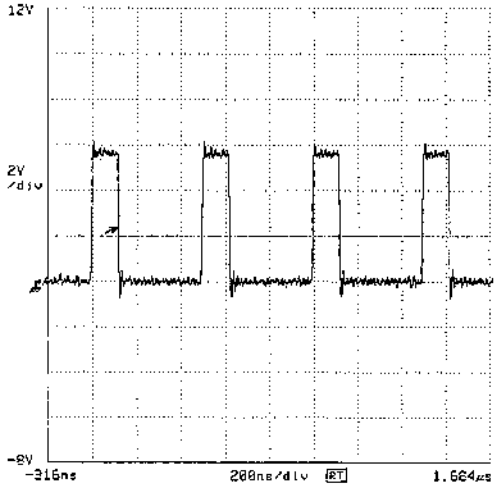


Figure 9-13: CPU Address Strobe at Pin 4 of U201

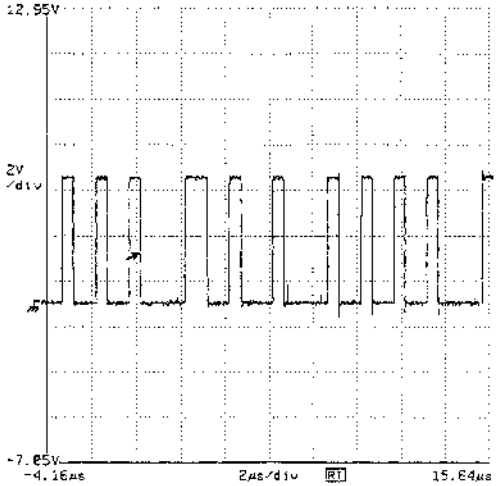


Figure 9-15: EEPROM Chip Select Waveform

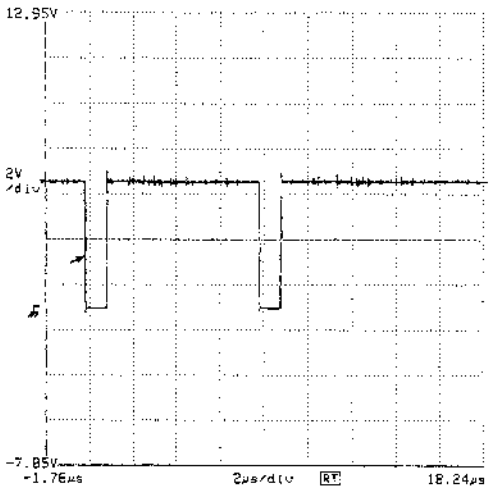


Figure 9-17: Timer U216 Chip Select ~TIM1 Waveform

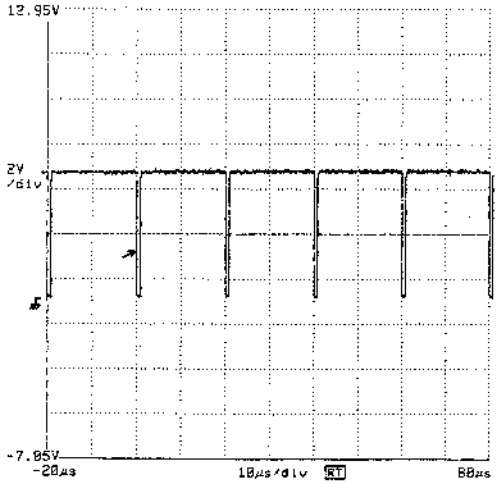


Figure 9-14: Clock Signal < 10 MHz at Pin 27 of U201

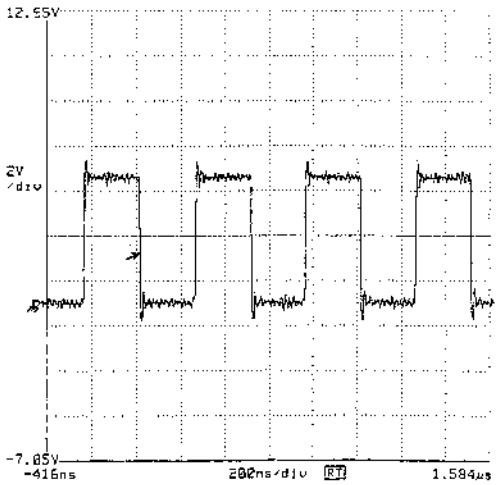


Figure 9-16: EEPROM Output Enable Waveform

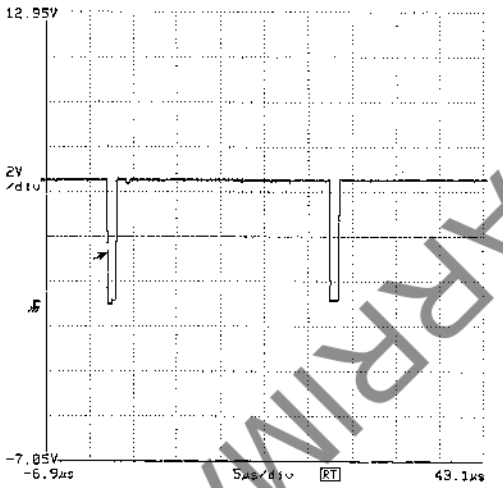


Figure 9-18: Timer U218 Chip Select ~TIM2 Waveform

Figure 9-12: CPU Troubleshooting Procedure (Cont.)

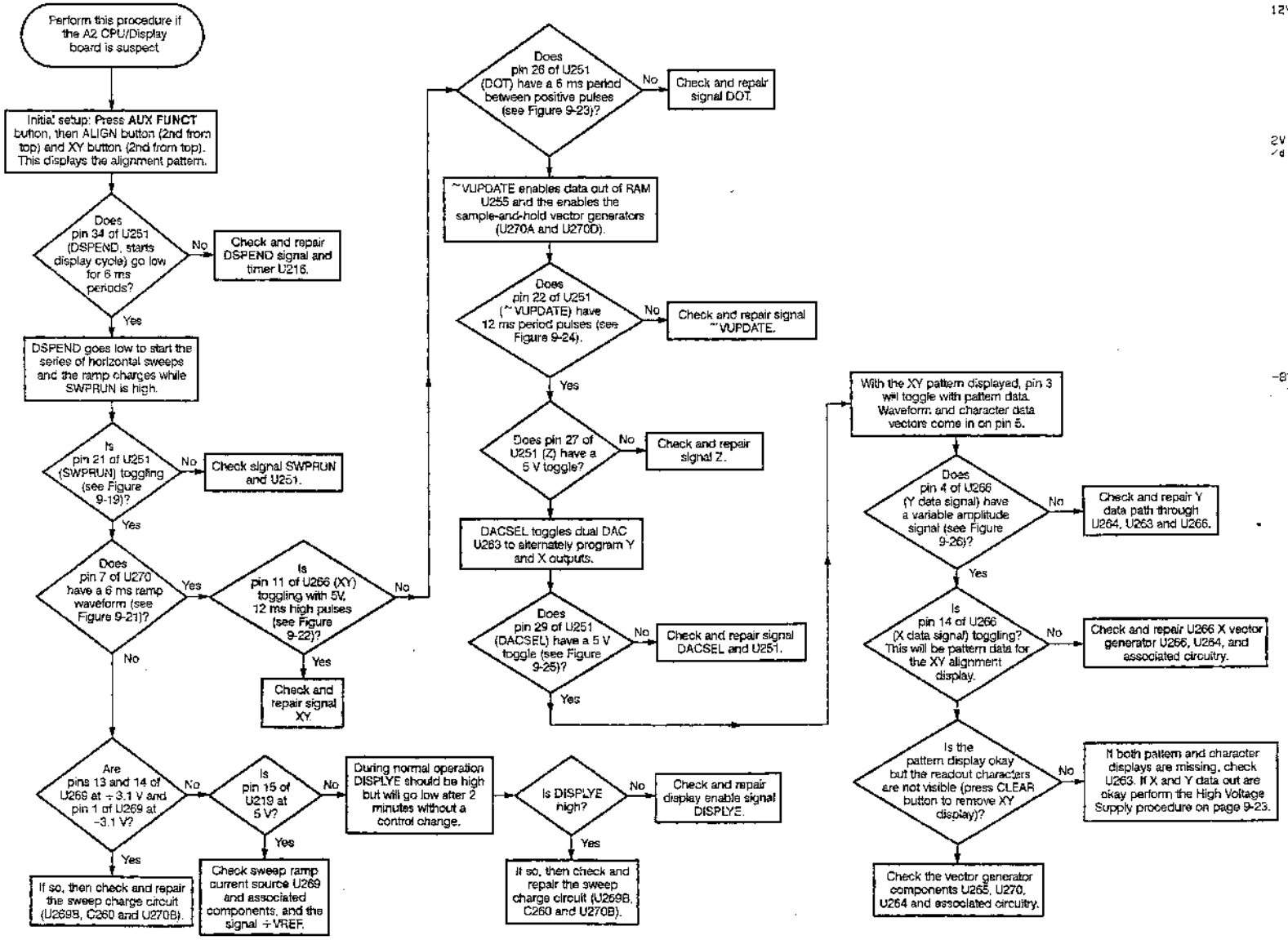


Figure 9-20: Display Vectors Troubleshooting Procedure

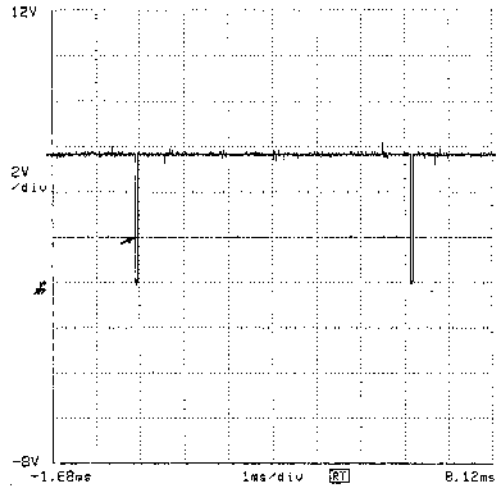


Figure 9-19: Typical Waveform of Signal SWPRUN

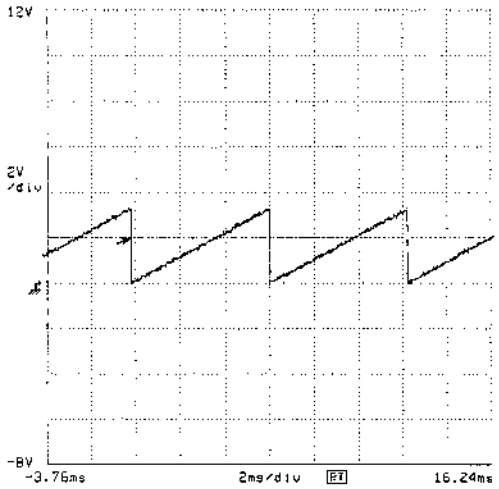


Figure 9-21: Unamplified Sweep Ramp Waveform

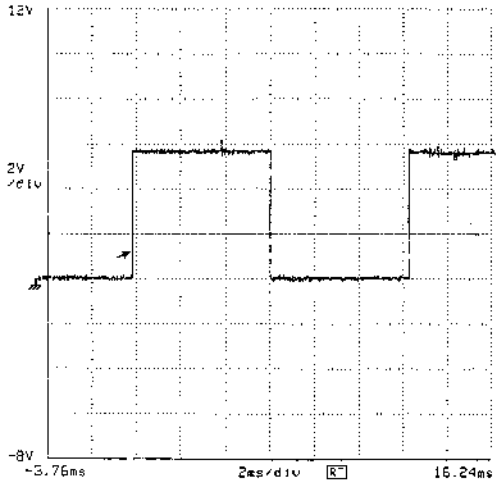


Figure 9-22: Signal XY Ramp Select Waveform

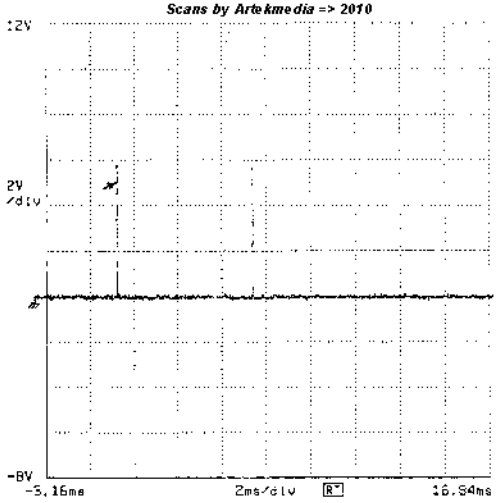


Figure 9-23: Signal DOT Waveform

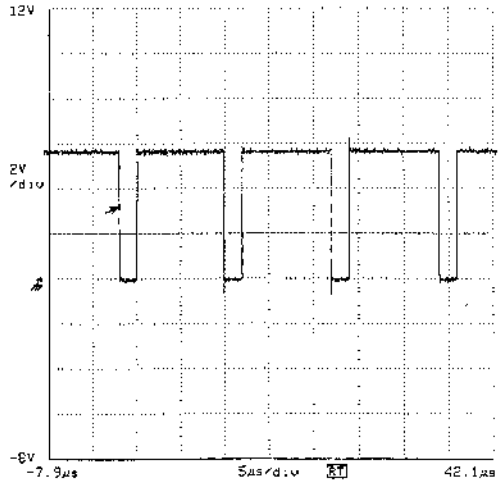


Figure 9-24: Signal ~VUPDATE Waveform

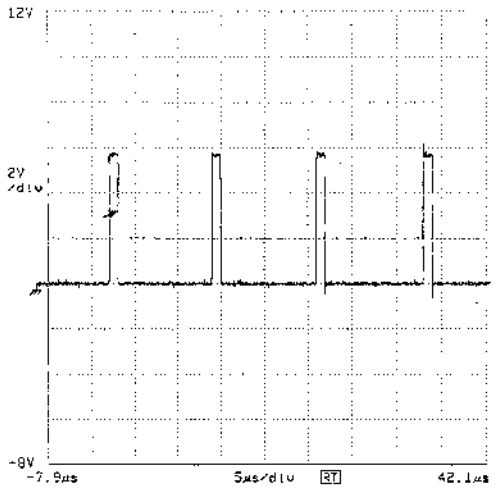


Figure 9-25: Signal DACSEL Waveform

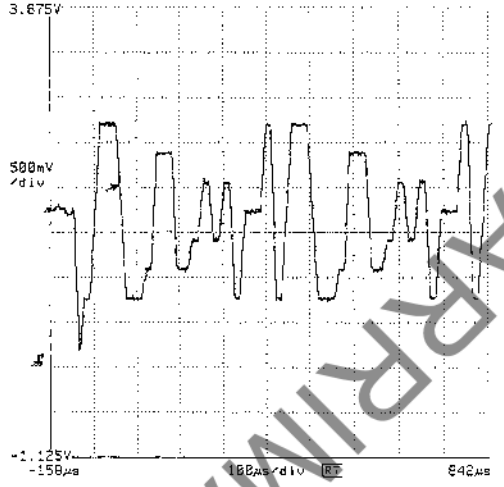


Figure 9-26: Data Signal Y When XY Pattern Displayed

Figure 9-20 : Display Vectors Troubleshooting Procedure (Cont.)

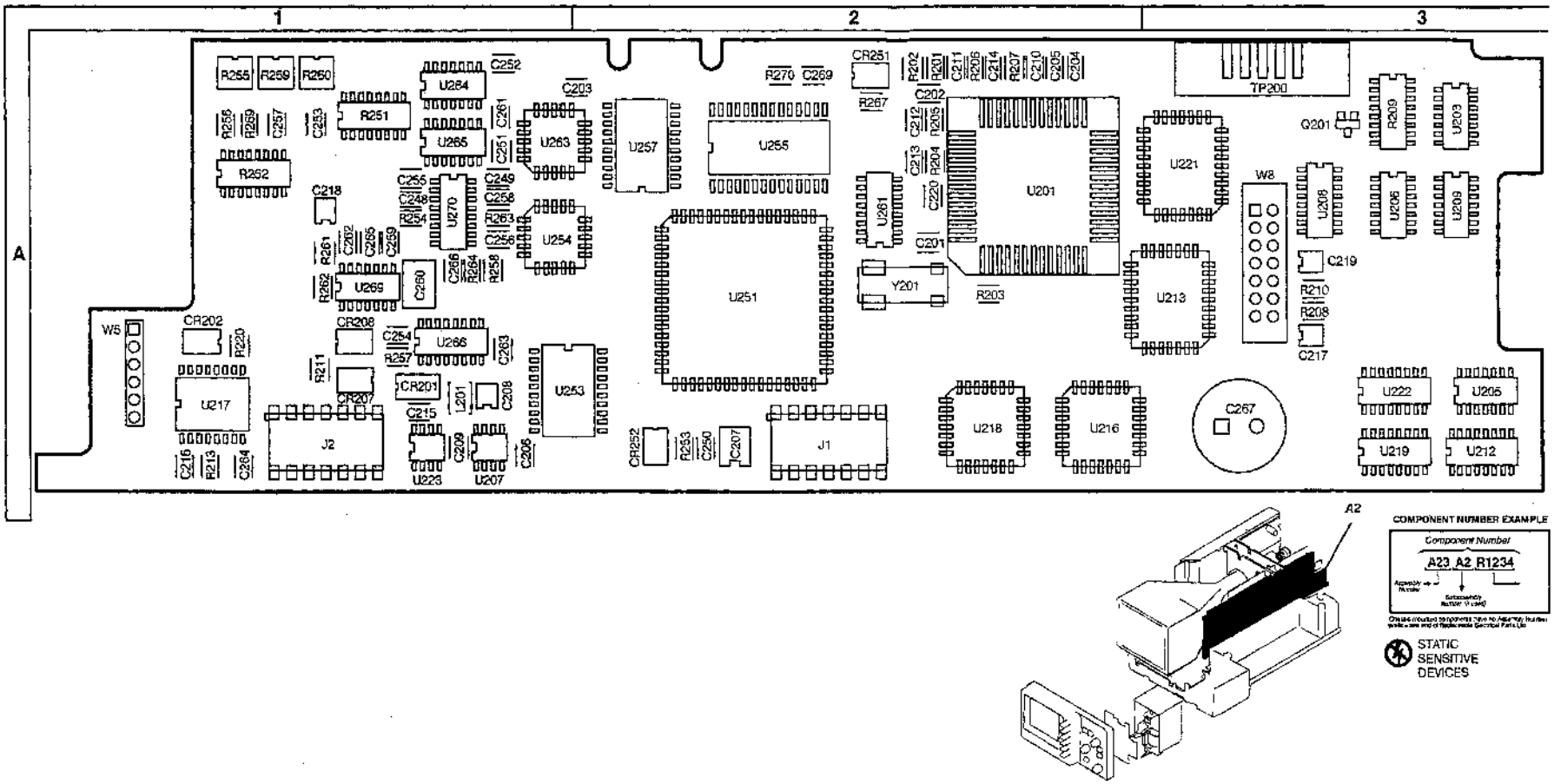


Figure 9-27: A2 CPU/Display Board

A2 CPU/Display Component Locator

CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	BOARD NUMBER	BOARD LOCATION	CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	BOARD NUMBER	BOARD LOCATION	CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	BOARD NUMBER	BOARD LOCATION	CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	BOARD NUMBER	BOARD LOCATION	CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	BOARD NUMBER	BOARD LOCATION
C201	A2-2	2C	A2	2A	C263	A2-3	2D	A2	1A	R209G	A2-3	2D	A2	3A	R270	A2-1	6A	A2	2A	J222	A2-2	4A	A2	3A
C202	A2-2	2C	A2	2A	C264	A2-3	2D	A2	1A	R210	A2-3	2D	A2	3A						J223	A2-2	1D	A2	1A
C203	A2-1	5D	A2	1A	C265	A2-3	2C	A2	1A	R211	A2-3	1C	A2	1A	TP200	A2-2	1A	A2	5A	J251	A2-1	2A	A2	2A
C204	A2-1	6D	A2	2A	C266	A2-1	5A	A2	1A	R213	A2-2	2C	A2	1A						J263	A2-2	4D	A2	1A
C205	A2-1	6D	A2	2A	C267	A2-1	6A	A2	3A	R220	A2-2	2C	A2	1A	U2	A2-1	6B	A2	3A	U254	A2-1	5C	A2	1A
C206	A2-2	2A	A2	1A	C269	A2-1	6B	A2	2A	R251A	A2-3	3B	A2	1A	U201	A2-2	2B	A2	2A	U255	A2-1	6B	A2	2A
C207	A2-1	6D	A2	2A						R251B	A2-3	3B	A2	1A	U203A	A2-1	4A	A2	3A	U257	A2-3	2B	A2	1A
C208	A2-2	2D	A2	1A	CR201	A2-2	2D	A2	1A	R261C	A2-3	4C	A2	1A	U203D	A2-1	4D	A2	3A	U261B	A2-1	6B	A2	2A
C209	A2-2	2C	A2	1A	CR202	A2-2	2C	A2	1A	R251D	A2-3	3C	A2	1A	U203B	A2-3	1B	A2	3A	U261A	A2-3	2A	A2	2A
C210	A2-2	2B	A2	2A	CR207	A2-3	1C	A2	1A	R251E	A2-3	4B	A2	1A	U203C	A2-3	2C	A2	3A	U263	A2-3	2A	A2	1A
C211	A2-2	2B	A2	2A	CR208	A2-3	1C	A2	1A	R251F	A2-3	3B	A2	1A	U205A	A2-2	3B	A2	3A	U264A	A2-3	5A	A2	1A
C212	A2-2	2B	A2	2A	CR251	A2-1	6A	A2	2A	R251G	A2-3	3A	A2	1A	U205B	A2-2	4B	A2	3A	U264B	A2-3	3B	A2	1A
C213	A2-2	1B	A2	2A	CR262	A2-1	3A	A2	2A	R251H	A2-3	4A	A2	1A	U205C	A2-2	5D	A2	3A	U264C	A2-3	3B	A2	1A
C214	A2-2	1B	A2	2A						R252C	A2-1	6C	A2	1A	U205D	A2-2	4B	A2	3A	U264D	A2-3	5B	A2	1A
C215	A2-2	1C	A2	1A	J1	A2-1	1C	A2	2B	R252D	A2-1	6C	A2	1A	U205C	A2-1	4D	A2	3A	U265A	A2-3	4A	A2	1A
C216	A2-2	1C	A2	1A	J2A	A2-2	6B	A2	1A	R252E	A2-1	6C	A2	1A	U206D	A2-1	5D	A2	3A	U265B	A2-3	4B	A2	1A
C217	A2-3	1C	A2	3A	J2B	A2-3	6B	A2	1A	R252F	A2-1	6D	A2	1A	U206A	A2-2	2A	A2	3A	U265C	A2-3	4A	A2	1A
C218	A2-3	3C	A2	1A						R252A	A2-3	4D	A2	1A	U206B	A2-3	2D	A2	3A	U265C	A2-3	3B	A2	1A
C219	A2-2	2D	A2	3A	L201	A2-2	2D	A2	1A	R252B	A2-3	4D	A2	1A	U207	A2-2	2A	A2	1A	U266A	A2-3	5D	A2	1A
C220	A2-2	3C	A2	2A						R252G	A2-3	5A	A2	1A	U206A	A2-3	1C	A2	3A	U266B	A2-3	6B	A2	1A
C248	A2-3	4A	A2	1A						R252H	A2-3	5B	A2	1A	U208B	A2-3	2C	A2	3A	U266C	A2-3	6B	A2	1A
C249	A2-2	4B	A2	1A	R202	A2-2	2C	A2	2A	R253	A2-1	1A	A2	2A	U209A	A2-3	3C	A2	3A	U266C	A2-1	6C	A2	1A
C250	A2-1	1A	A2	2A	R203	A2-2	2C	A2	2A	R254	A2-3	4A	A2	1A	U209B	A2-3	3D	A2	3A	U269A	A2-3	4C	A2	1A
C251	A2-3	3B	A2	1A	R204	A2-2	1B	A2	2A	R255	A2-3	4D	A2	1A	U209C	A2-3	3C	A2	3A	U269B	A2-3	5D	A2	1A
C252	A2-3	3B	A2	1A	R205	A2-2	2B	A2	2A	R256	A2-3	4D	A2	1A	U209D	A2-3	2D	A2	3A	U269D	A2-3	4D	A2	1A
C253	A2-3	5A	A2	1A	R206	A2-2	2B	A2	2A	R257	A2-3	6D	A2	1A	L212	A2-2	5C	A2	3A	U270C	A2-1	5A	A2	1A
C254	A2-3	5D	A2	1A	R207	A2-2	2B	A2	2A	R258	A2-1	5A	A2	1A	L213	A2-2	5C	A2	2A	U270A	A2-3	4A	A2	1A
C255	A2-3	4A	A2	1A	R208	A2-3	2C	A2	3A	R259	A2-3	5B	A2	1A	L216	A2-1	4C	A2	2A	U270B	A2-3	5C	A2	1A
C256	A2-1	5A	A2	1A	R208A	A2-2	2A	A2	3A	R260	A2-3	5A	A2	1A	U217	A2-2	1C	A2	1A	U270D	A2-3	4B	A2	1A
C257	A2-3	5B	A2	1A	R208B	A2-2	5D	A2	3A	R261	A2-3	3D	A2	1A	L218	A2-1	5D	A2	2A					
C258	A2-3	4B	A2	1A	R208C	A2-2	2B	A2	3A	R262	A2-3	3D	A2	1A	L219A	A2-1	2C	A2	3A	W5	A2-2	1C	A2	1A
C259	A2-1	6C	A2	1A	R208D	A2-2	2B	A2	3A	R263	A2-3	4B	A2	1A	L219C	A2-2	5A	A2	3A	W8	A2-2	6A	A2	3A
C260	A2-3	6D	A2	1A	R208E	A2-2	4B	A2	3A	R264	A2-1	5B	A2	1A	L219B	A2-3	3D	A2	3A					
C261	A2-3	1D	A2	1A	R208F	A2-2	4B	A2	3A	R267	A2-1	6A	A2	2A	L221	A2-2	4C	A2	2A	Y201	A2-2	2C	A2	2A
C262	A2-3	3D	A2	1A	R208H	A2-2	4C	A2	3A	R269	A2-3	4C	A2	1A										

*Asterisks indicate components located on the back of the board.

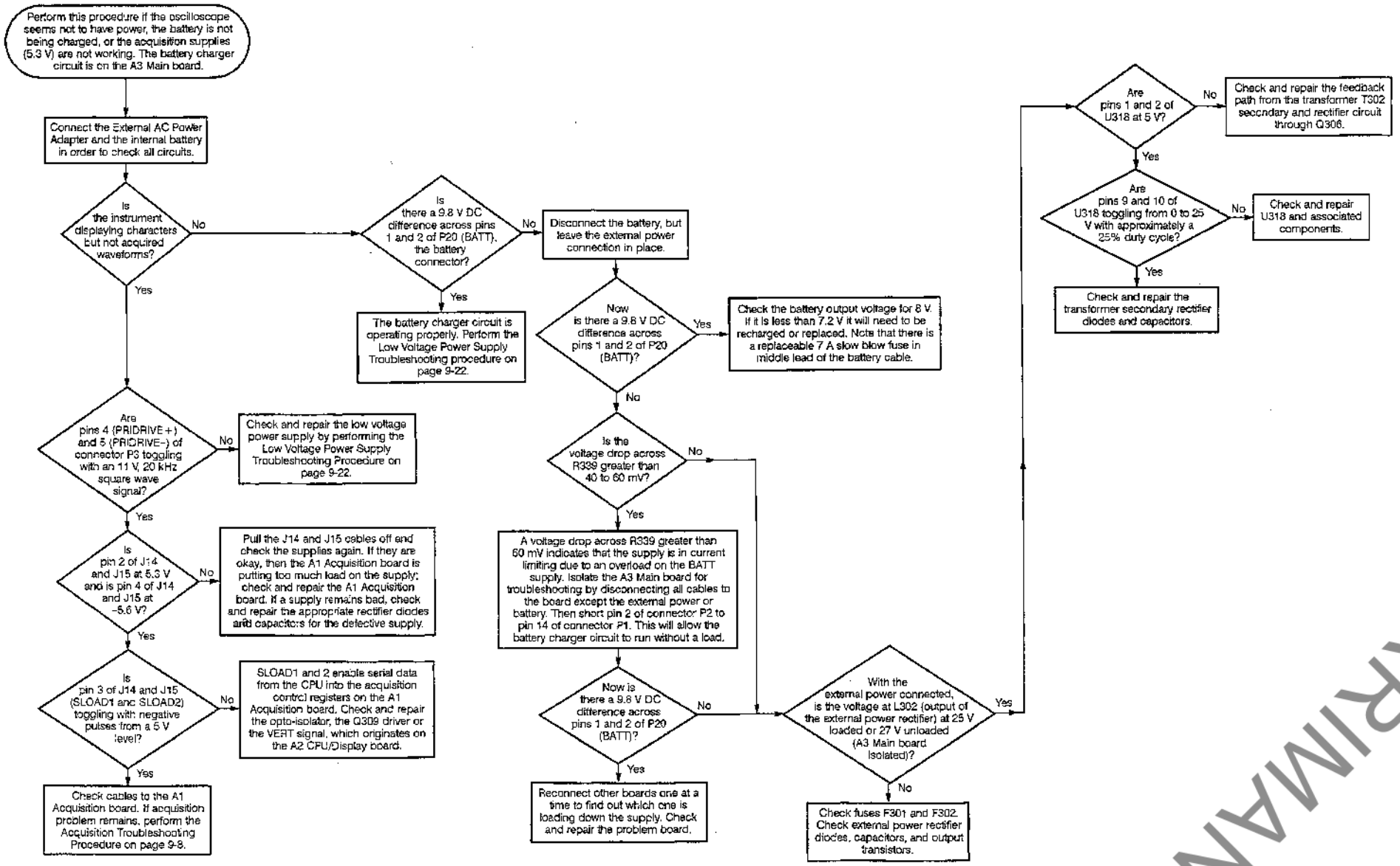


Figure 9-28: Battery Charger Troubleshooting Procedure

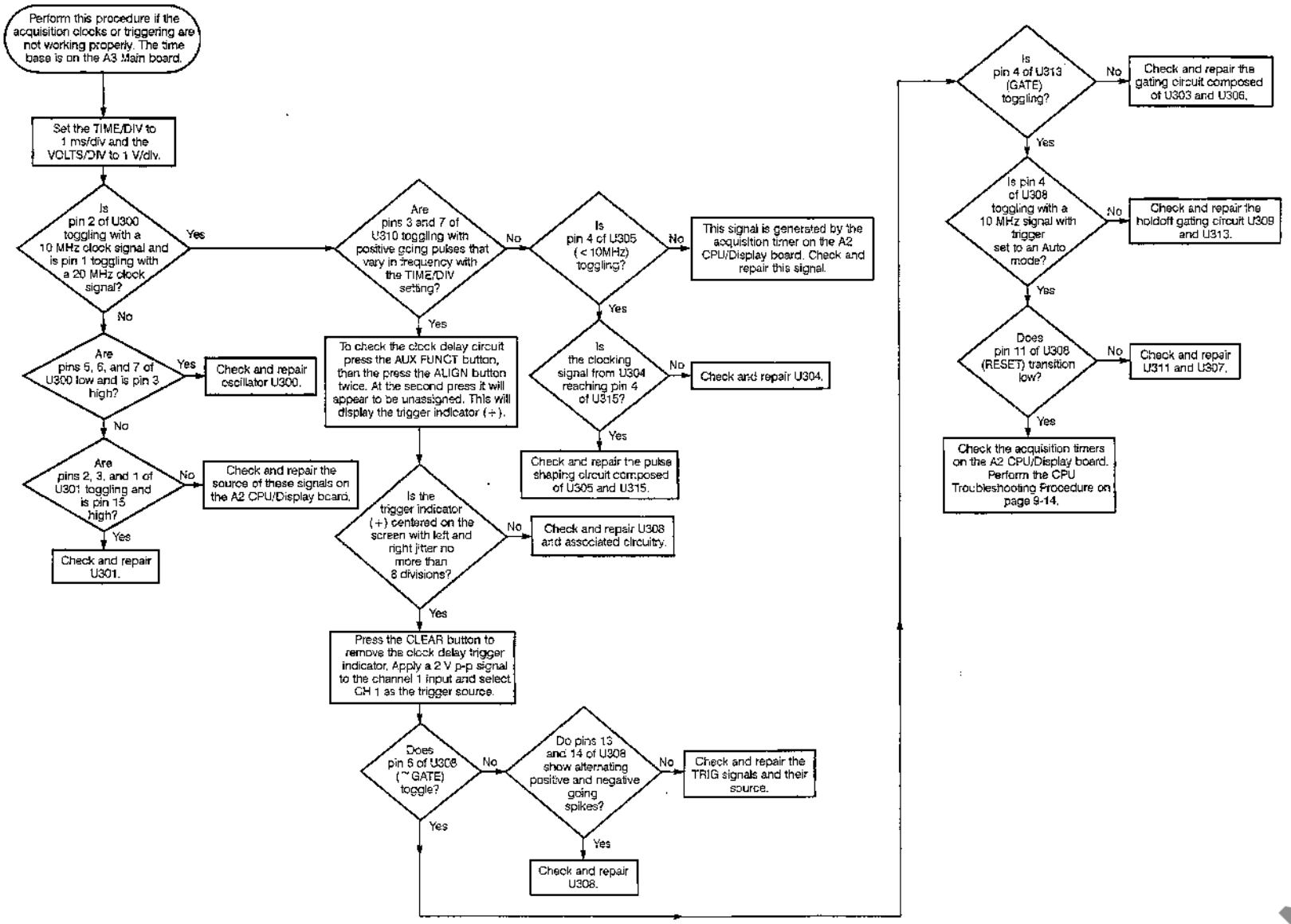


Figure 9-29: Time Base Troubleshooting Procedure

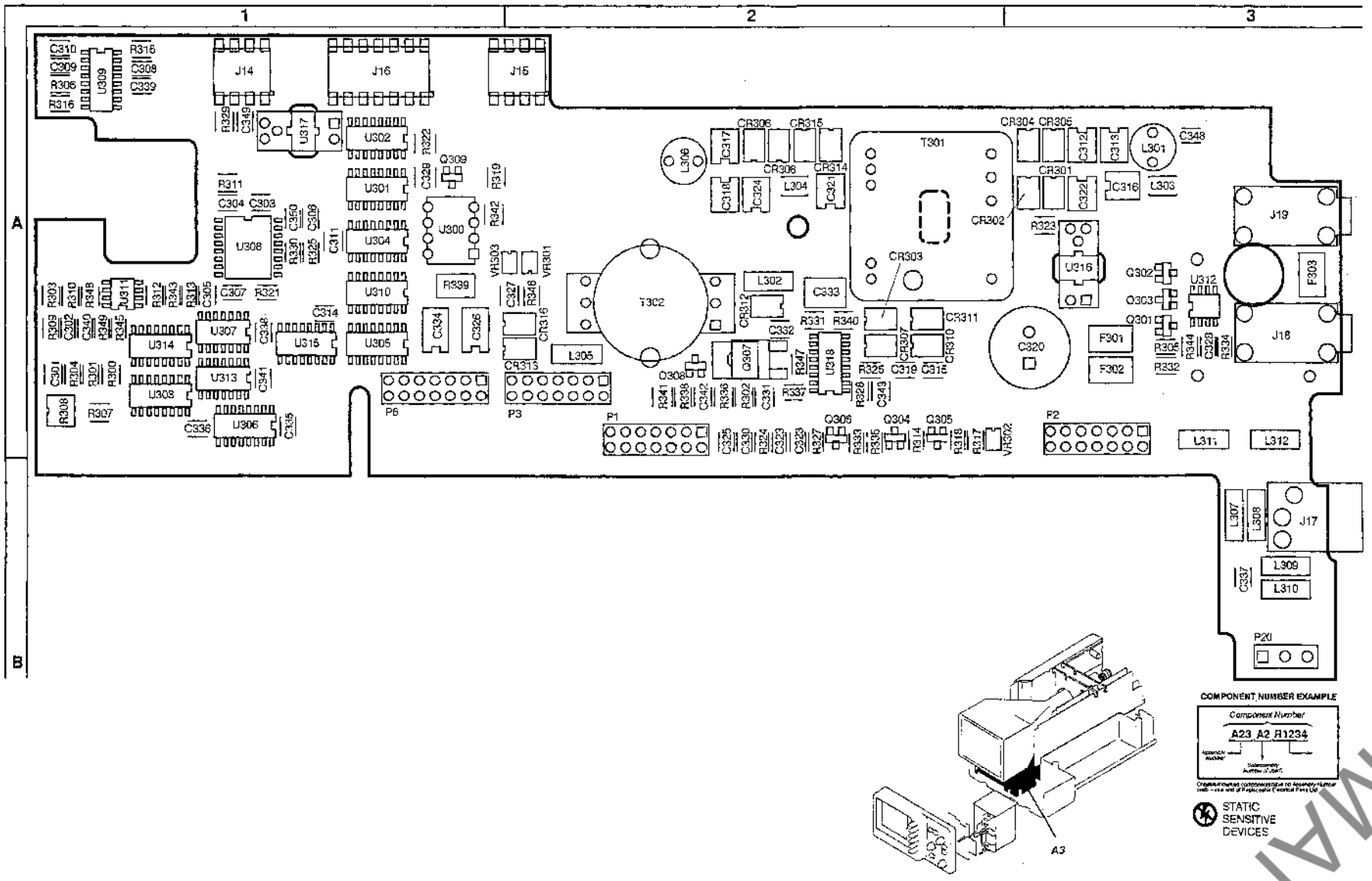


Figure 9-30: A3 Main Board

A3 Main Component Locator

CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	BOARD NUMBER	BOARD LOCATION	CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	BOARD NUMBER	BOARD LOCATION	CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	BOARD NUMBER	BOARD LOCATION	CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	BOARD NUMBER	BOARD LOCATION	CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	BOARD NUMBER	BOARD LOCATION
					C342	A3-2	6D	A3	2A	L303	A3-3	3B	A3	3A	R316	A3-4	2B	A3	1A	R362	A3-4	2D	A3	1A
C301	A3-4	4C	A3	1A	C343	A3-2	2C	A3	2A	L304	A3-3	3C	A3	2A	R317	A3-2	3B	A3	2A	R363	A3-4	2D	A3	1A
C302	A3-4	5C	A3	1A	C346	A3-3	5B	A3	3A	L305	A3-2	3B	A3	2A	R318	A3-2	3A	A3	2A					
C303	A3-4	4B	A3	1A	C349	A3-3	5C	A3	1A	L306	A3-3	3B	A3	2A	R319	A3-3	5C	A3	1A	T301	A3-3	2A	A3	2A
C304	A3-4	4B	A3	1A	C350	A3-4	3D	A3	1A	L307	A3-2	2A	A3	2B	R320	A3-2	4C	A3	2A	T302	A3-2	5B	A3	2A
C305	A3-4	4C	A3	1A	C351	A3-4	2D	A3	1A	L308	A3-2	2A	A3	3B	R321	A3-4	5D	A3	1A	U300	A3-3	3A	A3	1A
C306	A3-4	3D	A3	1A	C352	A3-4	2D	A3	1A	L309	A3-2	1B	A3	3B	R322	A3-3	4C	A3	1A	U301	A3-3	2A	A3	1A
C307	A3-4	5C	A3	1A	C353	A3-4	1D	A3	1A	L310	A3-2	1B	A3	3B	R323	A3-3	5B	A3	3A	U302	A3-3	3C	A3	1A
C308	A3-4	1B	A3	1A	C354	A3-4	2D	A3	1A	L311	A3-2	2A	A3	3A	R324	A3-2	3C	A3	2A	U303A	A3-4	3A	A3	1A
C309	A3-4	2B	A3	1A	C355	A3-4	2D	A3	1A	L312	A3-2	2A	A3	3A	R325	A3-3	5C	A3	1A	U303B	A3-4	3A	A3	1A
C310	A3-4	2B	A3	1A											R326	A3-2	3C	A3	2A	U304A	A3-3	3A	A3	1A
C311	A3-3	2D	A3	1A	CR301	A3-3	2B	A3	3A	P1	A3-4	6A	A3	2B	R327	A3-2	3B	A3	2A	U304B	A3-3	4A	A3	1A
C312	A3-3	3B	A3	3A	CR302	A3-3	2B	A3	3A	P2	A3-4	6B	A3	3B	R328	A3-2	3C	A3	2A	U305A	A3-3	3B	A3	1A
C313	A3-3	3B	A3	3A	CR303	A3-2	3A	A3	2A	P3	A3-3	1A	A3	2A	R329	A3-3	5C	A3	1A	U305B	A3-3	4B	A3	1A
C314	A3-3	2D	A3	1A	CR304	A3-3	3A	A3	3A	P6	A3-2	1C	A3	1A	R330	A3-3	6C	A3	1A	U306A	A3-4	3A	A3	1A
C315	A3-2	2A	A3	2A	CR305	A3-3	3B	A3	3A	P20	A3-2	1B	A3	3B	R331	A3-2	5E	A3	2A	U306B	A3-4	2A	A3	1A
C316	A3-3	3B	A3	3A	CR306	A3-3	3C	A3	2A						R332	A3-4	2C	A3	3A	U307A	A3-4	3B	A3	1A
C317	A3-3	3B	A3	2A	CR307	A3-2	3A	A3	2A	Q301	A3-4	1C	A3	3A	R333	A3-2	2B	A3	2A	U307B	A3-4	3B	A3	1A
C318	A3-3	3B	A3	2A	CR308	A3-3	3B	A3	2A	Q302	A3-4	2C	A3	3A	R334	A3-4	1C	A3	3A	U307C	A3-4	3B	A3	1A
C319	A3-2	2A	A3	2A	CR310	A3-2	2A	A3	2A	Q303	A3-4	2C	A3	3A	R335	A3-2	3B	A3	2A	U307D	A3-4	3C	A3	1A
C320	A3-2	3A	A3	2A	CR311	A3-2	2A	A3	2A	Q304	A3-2	3A	A3	2A	R336	A3-2	6D	A3	2A	U308	A3-4	4B	A3	1A
C321	A3-3	3C	A3	2A	CR312	A3-2	5C	A3	2A	Q305	A3-2	3A	A3	2A	R337	A3-2	4C	A3	2A	U309A	A3-4	2B	A3	1A
C322	A3-3	3B	A3	3A	CR313	A3-2	5B	A3	1A	Q306	A3-2	3B	A3	2A	R338	A3-2	6D	A3	2A	U309B	A3-4	1B	A3	1A
C323	A3-2	4C	A3	2A	CR314	A3-3	2C	A3	2A	Q307	A3-2	5C	A3	2A	R339	A3-2	6D	A3	1A	U310	A3-3	5B	A3	1A
C324	A3-3	3C	A3	2A	CR315	A3-3	2B	A3	2A	Q308	A3-2	5C	A3	2A	R340	A3-2	5B	A3	2A	U312A	A3-4	1C	A3	3A
C325	A3-2	3C	A3	2A	CR316	A3-2	5B	A3	1A	Q309	A3-3	5C	A3	1A	R341	A3-2	4C	A3	2A	U312B	A3-4	1C	A3	3A
C326	A3-2	6B	A3	1A						Q350	A3-4	1C	A3	1A	R343	A3-4	4C	A3	1A	U313A	A3-4	2A	A3	1A
C327	A3-2	6B	A3	1A	F301	A3-2	2A	A3	3A	Q351	A3-4	2C	A3	1A	R344	A3-4	1C	A3	3A	U313B	A3-4	3A	A3	1A
C328	A3-4	1C	A3	3A	F302	A3-2	2A	A3	3A						R346	A3-2	6B	A3	2A	U315C	A3-4	4B	A3	1A
C329	A3-3	2D	A3	1A	F303	A3-4	1D	A3	3A	R300	A3-4	5C	A3	1A	R347	A3-2	5C	A3	2A	U315D	A3-4	2C	A3	1A
C330	A3-2	4C	A3	2A						R301	A3-4	5C	A3	1A	R348	A3-4	4B	A3	1A	U315A	A3-3	4B	A3	1A
C331	A3-2	3C	A3	2A	J13	A3-4	5C	A3	1A	R302	A3-2	3C	A3	2A	R349	A3-3	2A	A3	1A	U315B	A3-4	3D	A3	1A
C332	A3-2	5B	A3	2A	J14	A3-3	5C	A3	1A	R305	A3-4	2D	A3	3A	R354	A3-4	2D	A3	1A	U316	A3-3	5B	A3	3A
C333	A3-2	4B	A3	2A	J15	A3-3	5B	A3	1A	R306	A3-4	2B	A3	1A	R355	A3-4	2D	A3	1A	U317	A3-3	5C	A3	1A
C334	A3-2	5B	A3	1A	J16	A3-3	5B	A3	1A	R308	A3-4	5D	A3	1A	R356	A3-4	2D	A3	1A	U318	A3-2	4C	A3	2A
C335	A3-4	4D	A3	1A	J17	A3-2	1A	A3	3B	R309	A3-4	5C	A3	1A	R357	A3-4	2D	A3	1A	U350	A3-4	2D	A3	1A
C336	A3-4	3D	A3	1A	J18	A3-4	1C	A3	3A	R311	A3-4	4B	A3	1A	R358	A3-4	1D	A3	1A					
C337	A3-2	2B	A3	3B	J19	A3-4	1C	A3	3A	R313	A3-4	5B	A3	1A	R359	A3-4	2D	A3	1A	VR301	A3-2	6B	A3	2A
C338	A3-4	4D	A3	1A						R314	A3-2	3A	A3	2A	R360	A3-4	1D	A3	1A	VR302	A3-2	5A	A3	2A
C339	A3-4	4D	A3	1A	L301	A3-3	3A	A3	3A	R315	A3-4	1B	A3	1A	R361	A3-4	1D	A3	1A	VR303	A3-2	6C	A3	1A
C341	A3-4	4D	A3	1A	L302	A3-2	5B	A3	2A															

*Asterisks indicate components located on the back of the board.

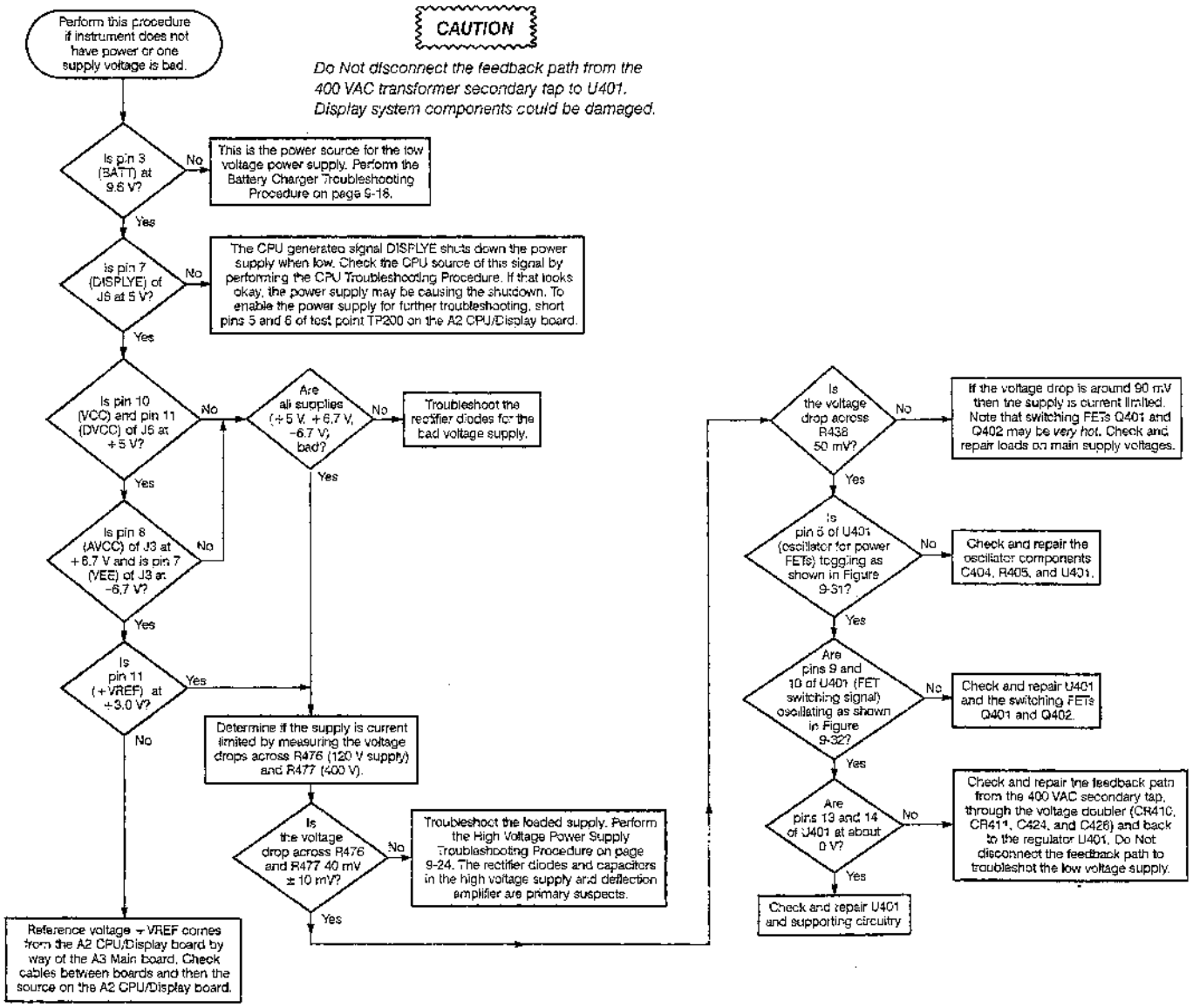


Figure 9-33: Low Voltage Power Supply Troubleshooting Procedure

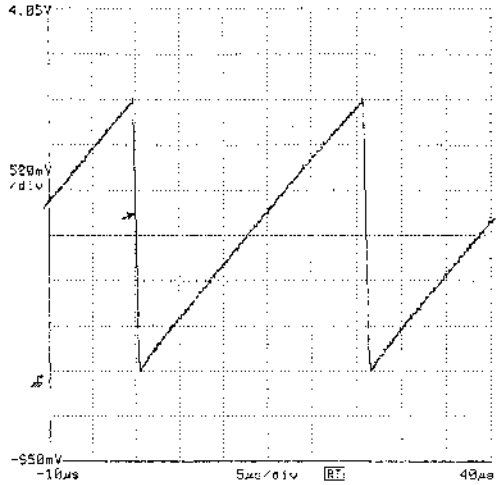


Figure 9-31: Oscillator Signal to the FET Power Supply Controller

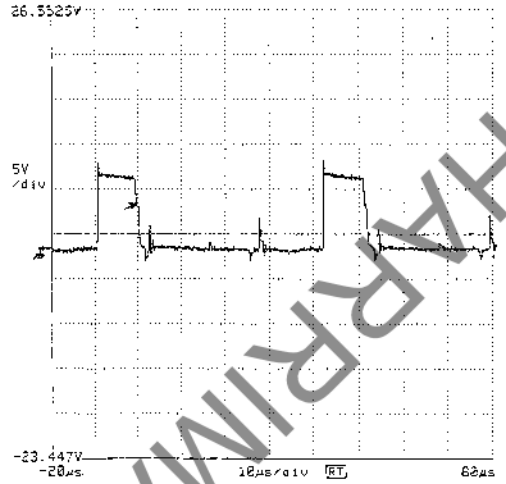


Figure 9-32: Switching Signal for Power Supply FETs

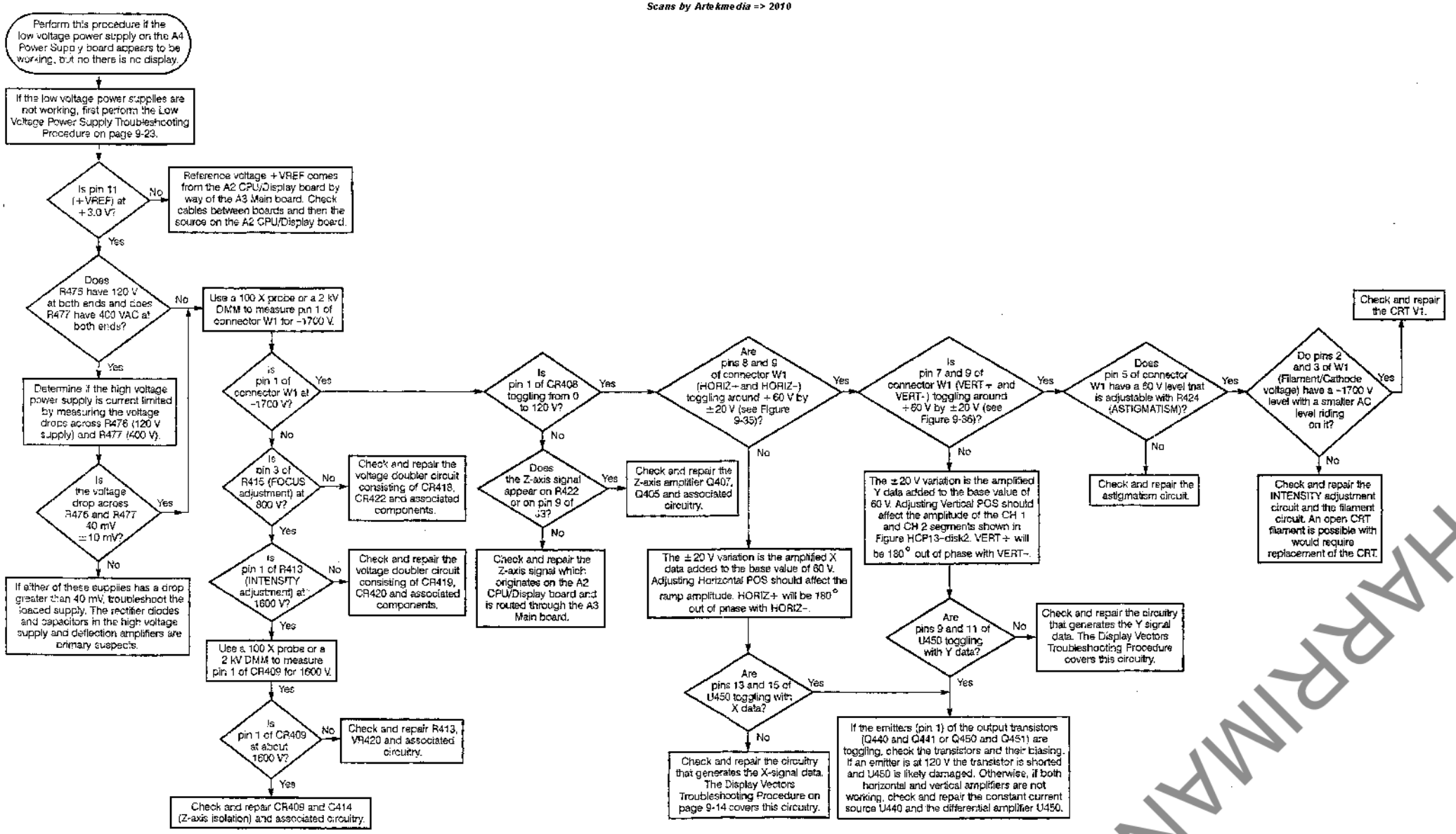


Figure 9-34: High Voltage Power Supply Troubleshooting Procedure

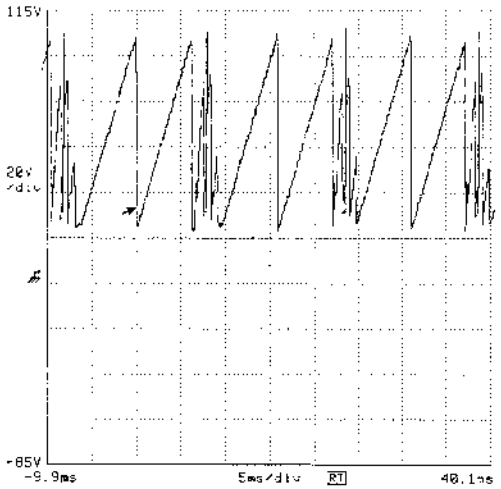


Figure 9-35: Typical Sweep Signal Out of the Horizontal Amplifier

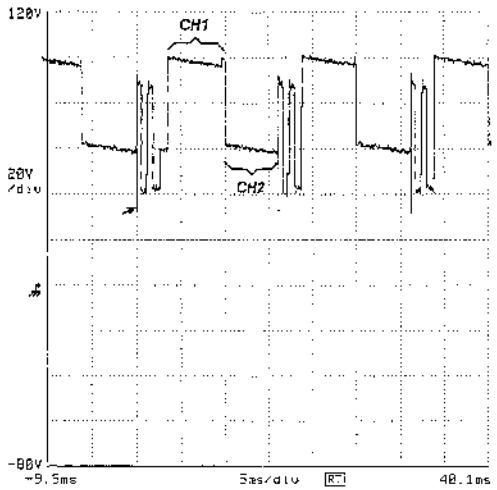


Figure 9-36: Typical Signal Out of the Vertical Amplifier

Figure 9-34: High Voltage Power Supply Troubleshooting Procedure (Cont.)

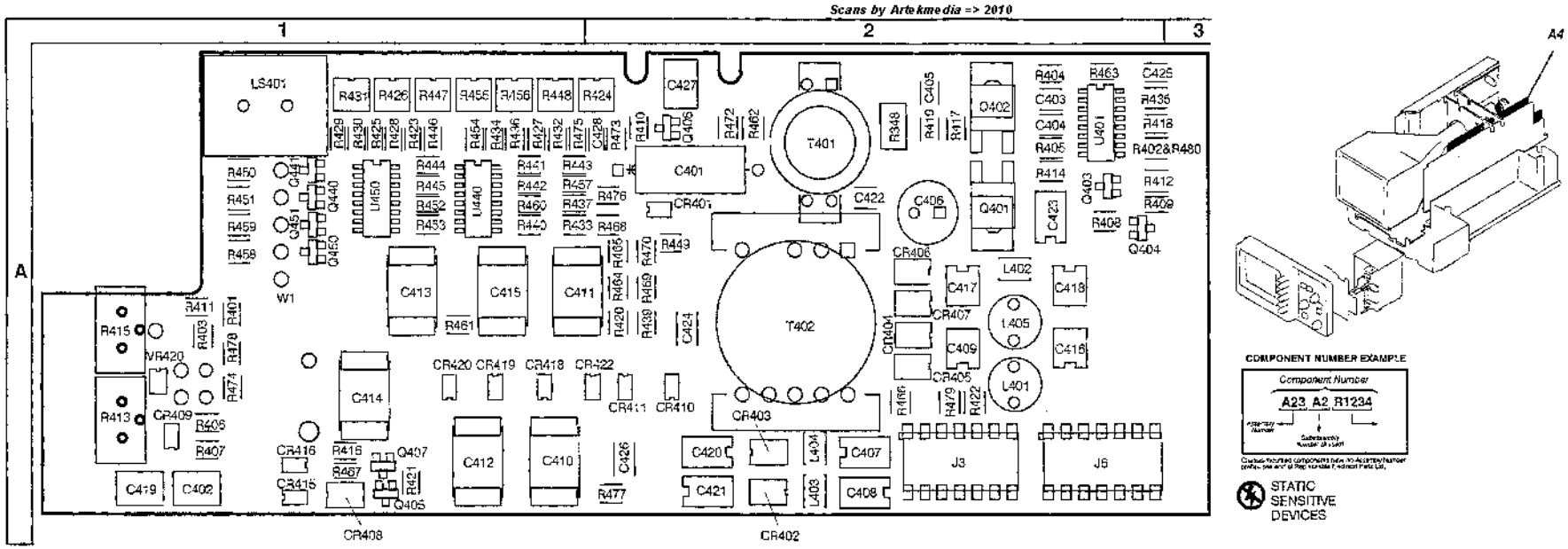
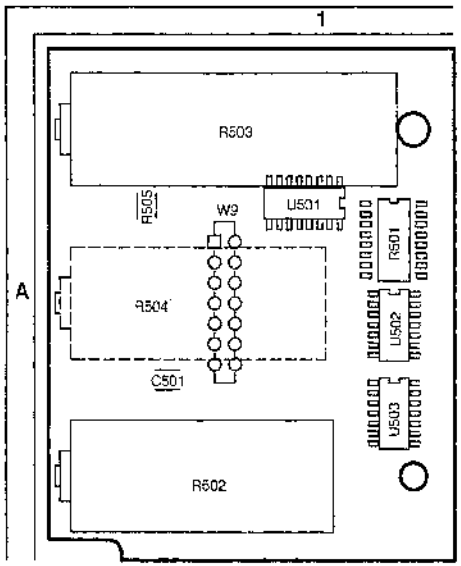


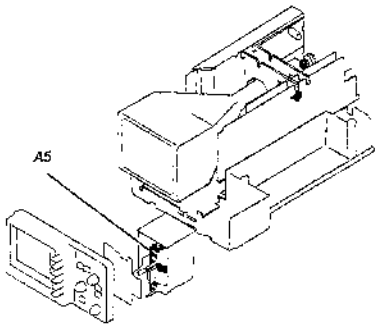
Figure 9-37: A4 Power Supply Board

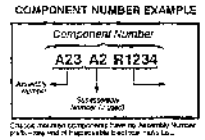
A4 Power Supply Component Locator

CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	BOARD NUMBER	BOARD LOCATION	CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	BOARD NUMBER	BOARD LOCATION	CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	BOARD NUMBER	BOARD LOCATION	CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	BOARD NUMBER	BOARD LOCATION	CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	BOARD NUMBER	BOARD LOCATION
C401	A4-1	5B	A4	2A	CR407	A4-1	5C	A4	2A	R402	A4-1	2B	A4	2A	R436	A4-3	6B	A4	1A	R470	A4-1	2B	A4	2A
C402	A4-2	3B	A4	1A	CR408	A4-2	3A	A4	1A	R403	A4-2	3B	A4	1A	R437	A4-3	6C	A4	1A	R472	A4-2	4C	A4	2A
C403	A4-1	5B	A4	2A	CR409	A4-2	3B	A4	1A	R404	A4-1	2B	A4	2A	R438	A4-1	3C	A4	2A	R473	A4-2	4B	A4	1A
C404	A4-1	2C	A4	2A	CR410	A4-1	4A	A4	2A	R405	A4-1	2C	A4	2A	R439	A4-1	2B	A4	2A	R474	A4-2	2B	A4	1A
C405	A4-1	4B	A4	2A	CR411	A4-1	4B	A4	1A	R406	A4-2	3B	A4	1A	R440	A4-3	2C	A4	1A	R475	A4-1	2D	A4	1A
C406	A4-1	1A	A4	2A	CR415	A4-2	3A	A4	1A	R407	A4-2	3B	A4	1A	R441	A4-3	2D	A4	1A	R476	A4-1	5B	A4	1A
C407	A4-1	6B	A4	2A	CR416	A4-2	3A	A4	1A	R408	A4-1	2A	A4	2A	R442	A4-3	5D	A4	1A	R477	A4-2	2D	A4	1A
C408	A4-1	6B	A4	2A	CR418	A4-2	2C	A4	1A	R409	A4-1	2A	A4	2A	R443	A4-3	5D	A4	1A	R478	A4-2	2B	A4	1A
C409	A4-1	6C	A4	2A	CR419	A4-2	2C	A4	1A	R410	A4-2	4B	A4	1A	R444	A4-3	5C	A4	1A	R479	A4-2	2A	A4	2A
C410	A4-2	2C	A4	1A	CR420	A4-2	2C	A4	1A	R411	A4-2	3C	A4	1A	R445	A4-3	3C	A4	1A	R480	A4-1	2b	A4	2A
C411	A4-2	2C	A4	1A	CR422	A4-2	2C	A4	1A	R412	A4-1	2A	A4	2A	R446	A4-3	3D	A4	1A					
C412	A4-2	3C	A4	1A						R413	A4-2	2B	A4	1A	R447	A4-3	3B	A4	1A	T401	A4-1	4B	A4	2A
C413	A4-2	2B	A4	1A	J5	A4-1	1C	A4	2A	R414	A4-1	3B	A4	2A	R448	A4-3	3B	A4	1A	T402	A4-1	5B	A4	2A
C414	A4-2	4A	A4	1A	J6	A4-1	1A	A4	2A	R415	A4-2	3C	A4	1A	R449	A4-1	2B	A4	2A					
C415	A4-2	2C	A4	1A						R416	A4-2	2A	A4	1A	R450	A4-3	2A	A4	1A	U401	A4-1	3B	A4	2A
C416	A4-1	6C	A4	2A	L401	A4-1	5B	A4	2A	R417	A4-1	3C	A4	2A	R451	A4-3	3B	A4	1A	U440A	A4-3	2D	A4	1A
C417	A4-1	6C	A4	2A	L402	A4-1	6D	A4	2A	R418	A4-1	2C	A4	2A	R452	A4-3	5D	A4	1A	U440B	A4-3	3D	A4	1A
C418	A4-1	6C	A4	2A	L403	A4-1	6B	A4	2A	R419	A4-1	4B	A4	2A	R453	A4-3	5C	A4	1A	U440C	A4-3	5C	A4	1A
C419	A4-2	2B	A4	1A	L404	A4-1	6B	A4	2A	R420	A4-2	3C	A4	1A	R454	A4-3	5C	A4	1A	U440D	A4-3	6D	A4	1A
C420	A4-1	6B	A4	2A	L405	A4-1	1A	A4	2A	R421	A4-2	3A	A4	1A	R455	A4-3	5B	A4	1A	U450A	A4-3	2B	A4	1A
C421	A4-1	6B	A4	2A						R422	A4-2	2A	A4	2A	R456	A4-3	6B	A4	1A	U450B	A4-3	3B	A4	1A
C422	A4-1	1A	A4	2A	S401	A4-1	2A	A4	1A	R423	A4-3	2B	A4	1A	R457	A4-3	5D	A4	1A	U450C	A4-3	5B	A4	1A
C423	A4-1	2B	A4	2A						R424	A4-2	4C	A4	1A	R458	A4-3	5A	A4	1A	U450D	A4-3	5B	A4	1A
C424	A4-1	4B	A4	2A	Q402	A4-1	4C	A4	2A	R425	A4-3	2B	A4	1A	R459	A4-3	5B	A4	1A					
C425	A4-1	4C	A4	2A	Q403	A4-1	3A	A4	2A	R426	A4-3	2C	A4	1A	R460	A4-3	3D	A4	1A	VR420	A4-2	2B	A4	1A
C426	A4-1	5B	A4	1A	Q404	A4-1	2A	A4	2A	R427	A4-3	3B	A4	1A	R461	A4-2	2D	A4	1A					
C427	A4-2	5C	A4	2A	Q405	A4-2	3A	A4	1A	R428	A4-3	2D	A4	1A	R462	A4-2	4C	A4	2A	W1A	A4-2	5D	A4	1A
C428	A4-1	2D	A4	1A	Q406	A4-2	4C	A4	2A	R429	A4-3	4B	A4	1A	R463	A4-1	4C	A4	2A	W1B	A4-2	6D	A4	1A
					Q407	A4-2	3A	A4	1A	R430	A4-3	4C	A4	1A	R464	A4-2	3C	A4	1A	W1C	A4-2	6D	A4	1A
CR401	A4-1	6B	A4	2A	Q440	A4-3	3B	A4	1A	R431	A4-3	5C	A4	1A	R465	A4-2	3D	A4	1A	W1D	A4-2	5C	A4	1A
CR402	A4-1	6B	A4	2A	Q441	A4-3	2B	A4	1A	R432	A4-3	3B	A4	1A	R466	A4-2	3A	A4	2A	W1E	A4-2	5C	A4	1A
CR403	A4-1	5B	A4	2A	Q450	A4-3	5B	A4	1A	R433	A4-3	3C	A4	1A	R467	A4-2	3A	A4	1A	W1F	A4-2	5E	A4	1A
CR404	A4-1	5B	A4	2A	Q451	A4-3	5B	A4	1A	R434	A4-3	6B	A4	1A	R468	A4-2	3D	A4	1A	W1G	A4-2	5E	A4	1A
CR405	A4-1	5C	A4	2A						R435	A4-1	2B	A4	2A	R469	A4-1	2B	A4	2A	W1H	A4-2	5B	A4	1A
CR406	A4-1	5C	A4	2A	R451	A4-3	5C	A4	1A															

*Asterisks indicate components located on the back of the board.







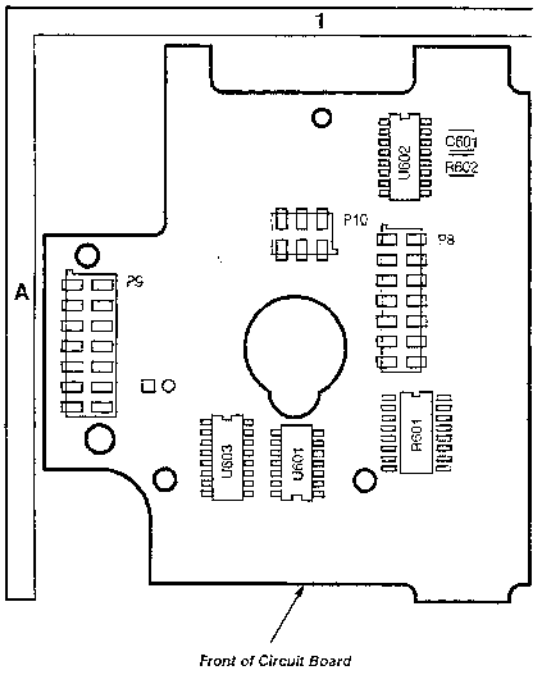
STATIC SENSITIVE DEVICES

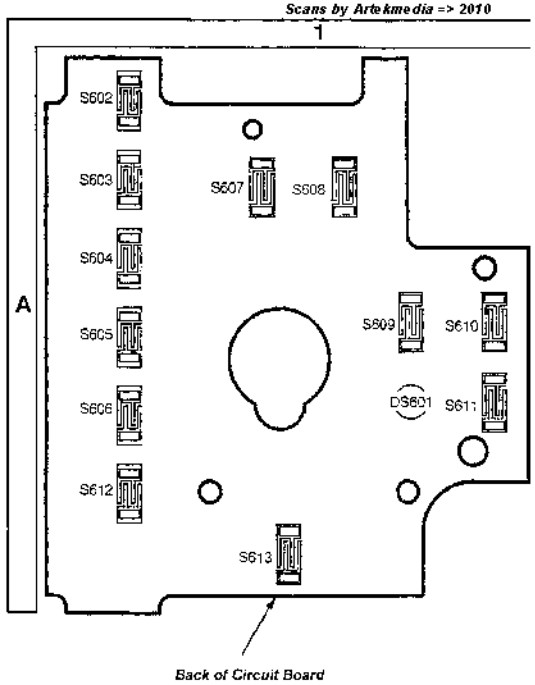
Figure 9-38: A5 Pot Board

A5 Pot Component Locator

CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	BOARD NUMBER	BOARD LOCATION	CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	BOARD NUMBER	BOARD LOCATION	CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	BOARD NUMBER	BOARD LOCATION	CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	BOARD NUMBER	BOARD LOCATION	CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	BOARD NUMBER	BOARD LOCATION
C5C1	A5–1	2B	A5	1A	R5C1F	A5–1	4A	A5	1A	R503	A5–1	2C	A5	1A	R504B	A5–1	3E	A5	1A	U502B	A5–1	4B	A5	1A
					R5C1G	A5–1	3B	A5	1A	R503A	A5–1	3E	A5	1A	R504C	A5–1	3E	A5	1A	U502C	A5–1	5A	A5	1A
R501A	A5–1	3B	A5	1A	R502	A5–1	2D	A5	1A	R503B	A5–1	5E	A5	1A	R504D	A5–1	3E	A5	1A	U502D	A5–1	5A	A5	1A
R501B	A5–1	3B	A5	1A	R502A	A5–1	4E	A5	1A	R503C	A5–1	4E	A5	1A	R505	A5–1	2B	A5	1A	U503A	A5–1	6A	A5	1A
R501C	A5–1	5A	A5	1A	R502B	A5–1	4E	A5	1A	R503D	A5–1	4E	A5	1A						U503B	A5–1	6A	A5	1A
R501D	A5–1	4A	A5	1A	R502C	A5–1	4E	A5	1A	R504	A5–1	2B	A5	1A	U501	A5–1	4C	A5	1A	U503C	A5–1	4B	A5	1A
R501E	A5–1	4A	A5	1A	R502D	A5–1	4E	A5	1A	R504A	A5–1	3E	A5	1A	U502A	A5–1	4B	A5	1A	U503D	A5–1	5A	A5	1A

*Asterisks indicate components located on the back of the board.





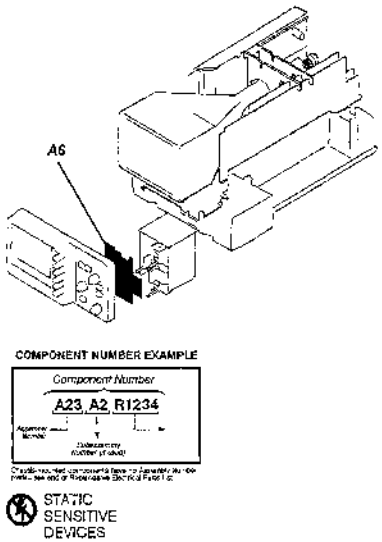
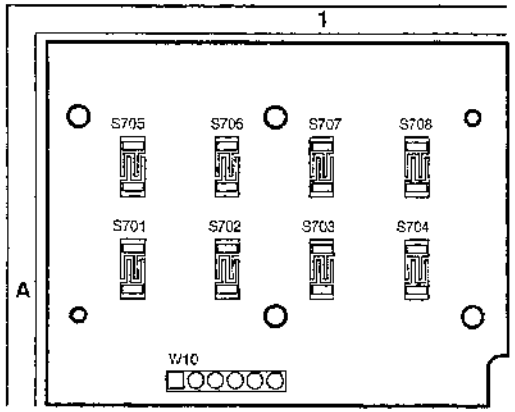


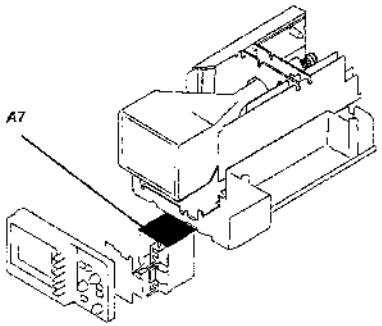
Figure 9-39: A6 Front Panel Board

A6 Front Panel Component Locator

CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	BOARD NUMBER	BOARD LOCATION	CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	BOARD NUMBER	BOARD LOCATION	CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	BOARD NUMBER	BOARD LOCATION	CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	BOARD NUMBER	BOARD LOCATION	CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	BOARD NUMBER	BOARD LOCATION
CB01	A6-1	2C	A6	1A						R3C1G	A6-1	4A	A6	1A	S605*	A6-1	5C	A6	1A	S612*	A6-1	5C	A6	1A
					R601A	A6-1	3A	A6	1A	R3C1H	A6-1	5A	A6	1A	S607*	A6-1	5C	A6	1A	S613*	A6-1	5C	A6	1A
DS601*	A6-1	4D	A6	1A	R601B	A6-1	3A	A6	1A	R602	A6-1	4D	A6	1A	S608*	A6-1	5C	A6	1A					
					R601C	A6-1	3A	A6	1A						S609*	A6-1	5C	A6	1A	U601*	A6-1	2A	A6	1A
P8	A6-1	1E	A6	1A	R601D	A6-1	3A	A6	1A	S603*	A6-1	5B	A6	1A	S610*	A6-1	5B	A6	1A	U602	A6-1	4C	A6	1A
P9	A6-1	1C	A6	1A	R601E	A6-1	4A	A6	1A	S604*	A6-1	5C	A6	1A	S611*	A6-1	5B	A6	1A	U603	A6-1	4B	A6	1A
P10	A6-1	6B	A6	1A	R601F	A6-1	4A	A6	1A	S605*	A6-1	5C	A6	1A										

*Asterisks indicate components located on the back of the board.





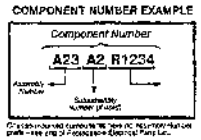
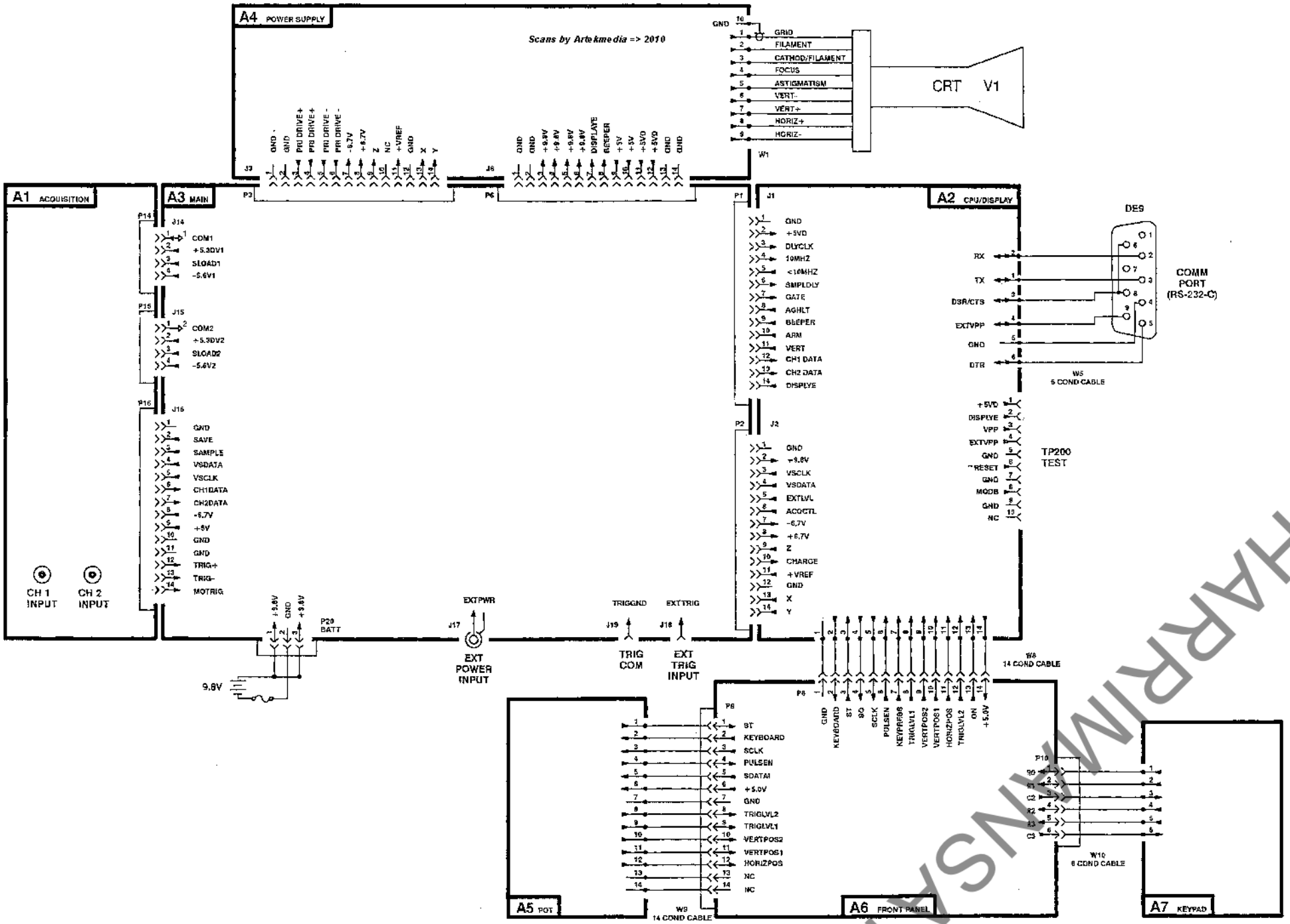


Figure 9-40: A7 Keypad Board

A7 Keypad Component Locator

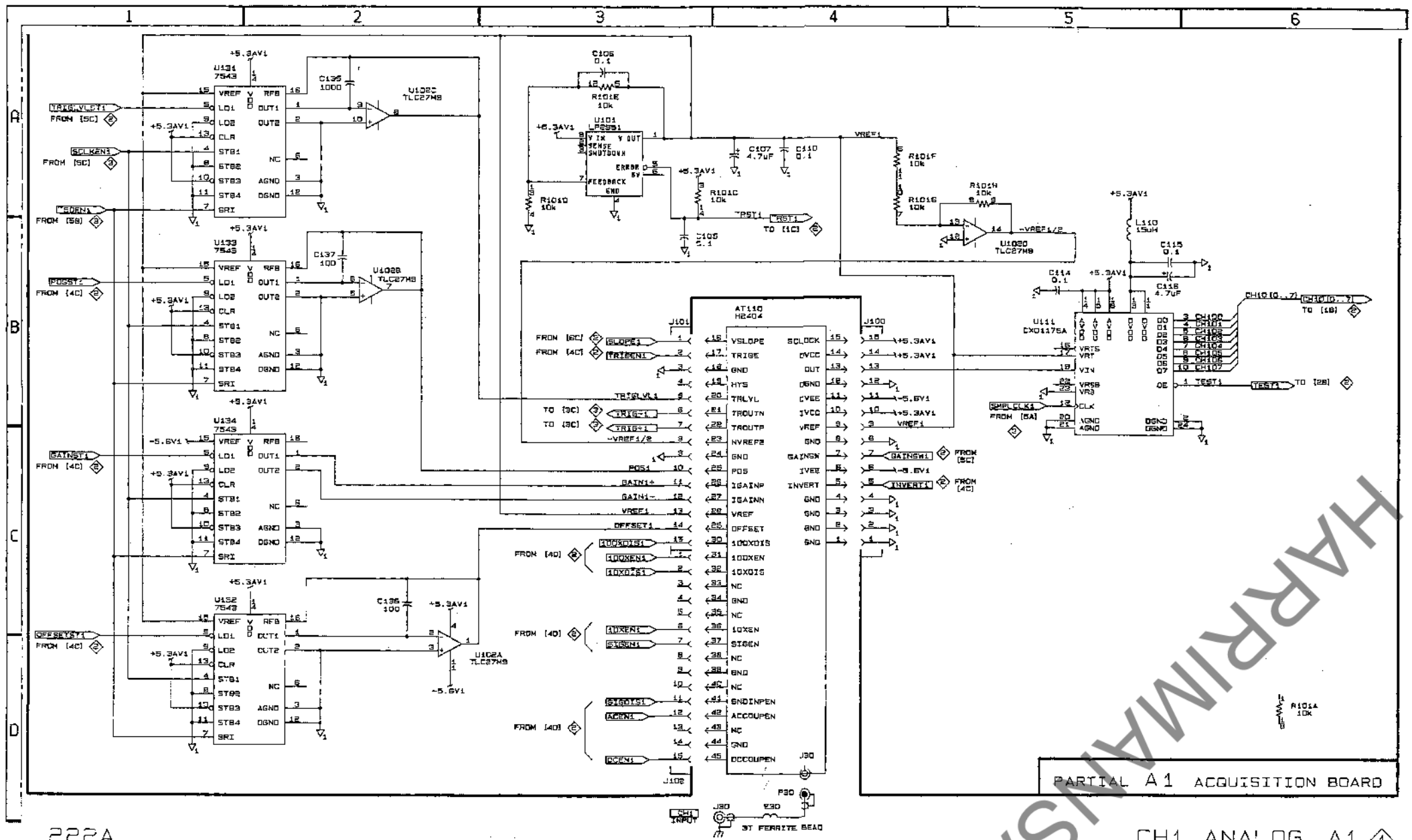
CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	BOARD NUMBER	BOARD LOCATION	CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	BOARD NUMBER	BOARD LOCATION	CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	BOARD NUMBER	BOARD LOCATION	CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	BOARD NUMBER	BOARD LOCATION	CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	BOARD NUMBER	BOARD LOCATION
S701 S702	A7-1 A7-1	4B 4C	A7 A7	1A 1A	S703 S704	A7-1 A7-1	4C 4C	A7 A7	1A 1A	S705 S706	A7-1 A7-1	4B 4C	A7 A7	1A 1A	S707 S708	A7-1 A7-1	4C 4C	A7 A7	1A 1A	W10	A7-1	2B	A7	1A

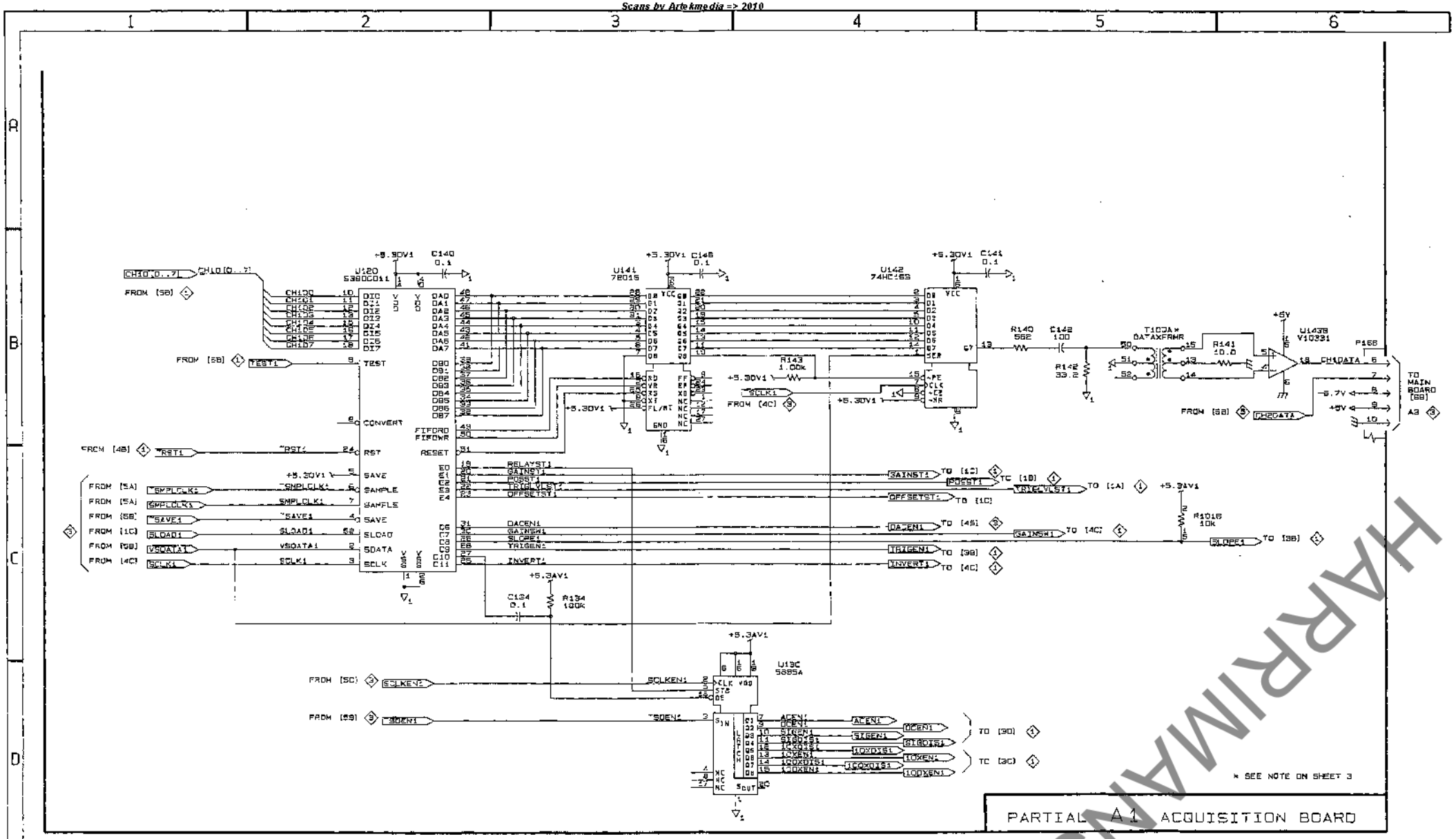
*Asterisks indicate components located on the back of the board.

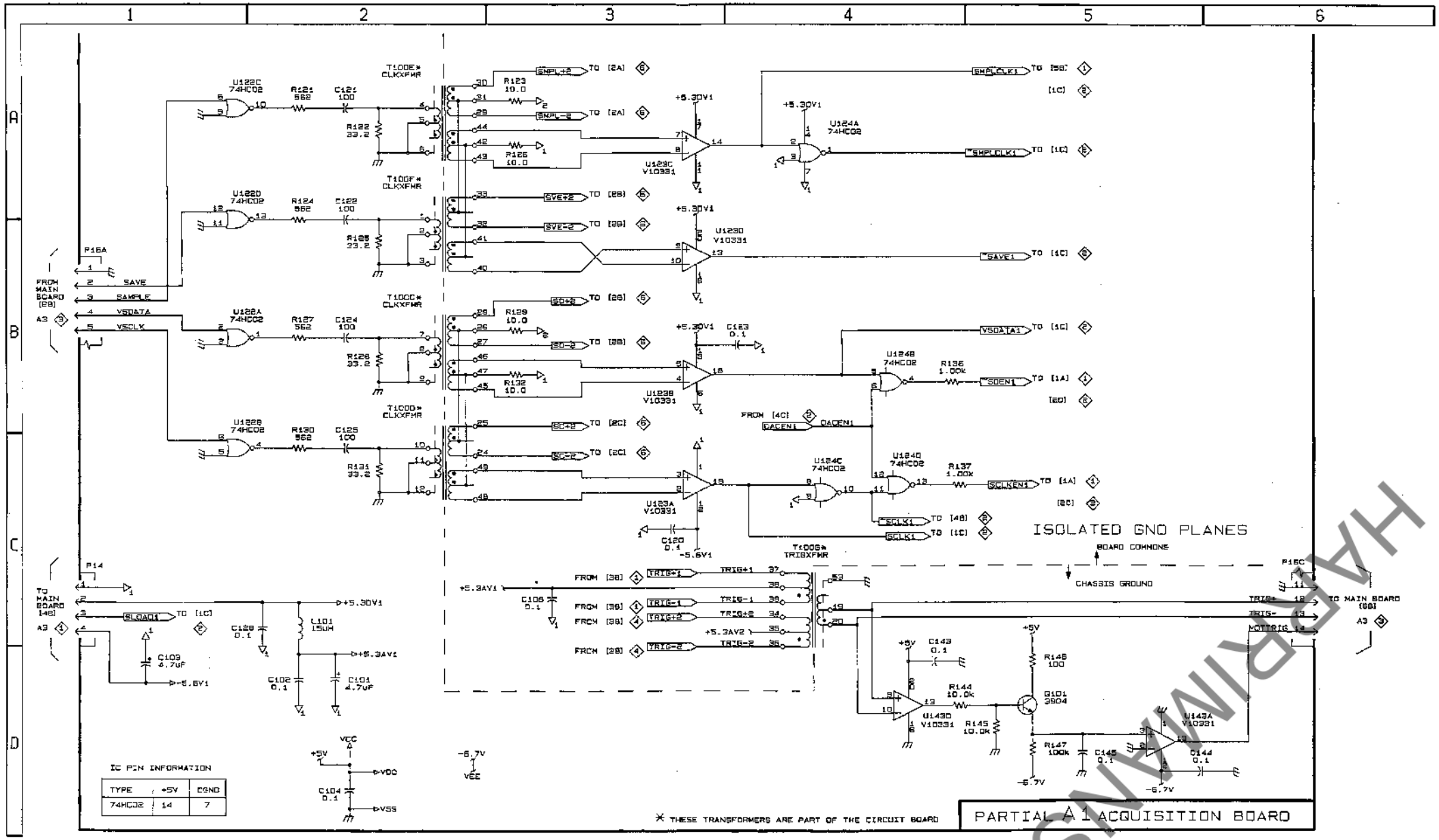


222A

INTERCONNECT DIAGRAM

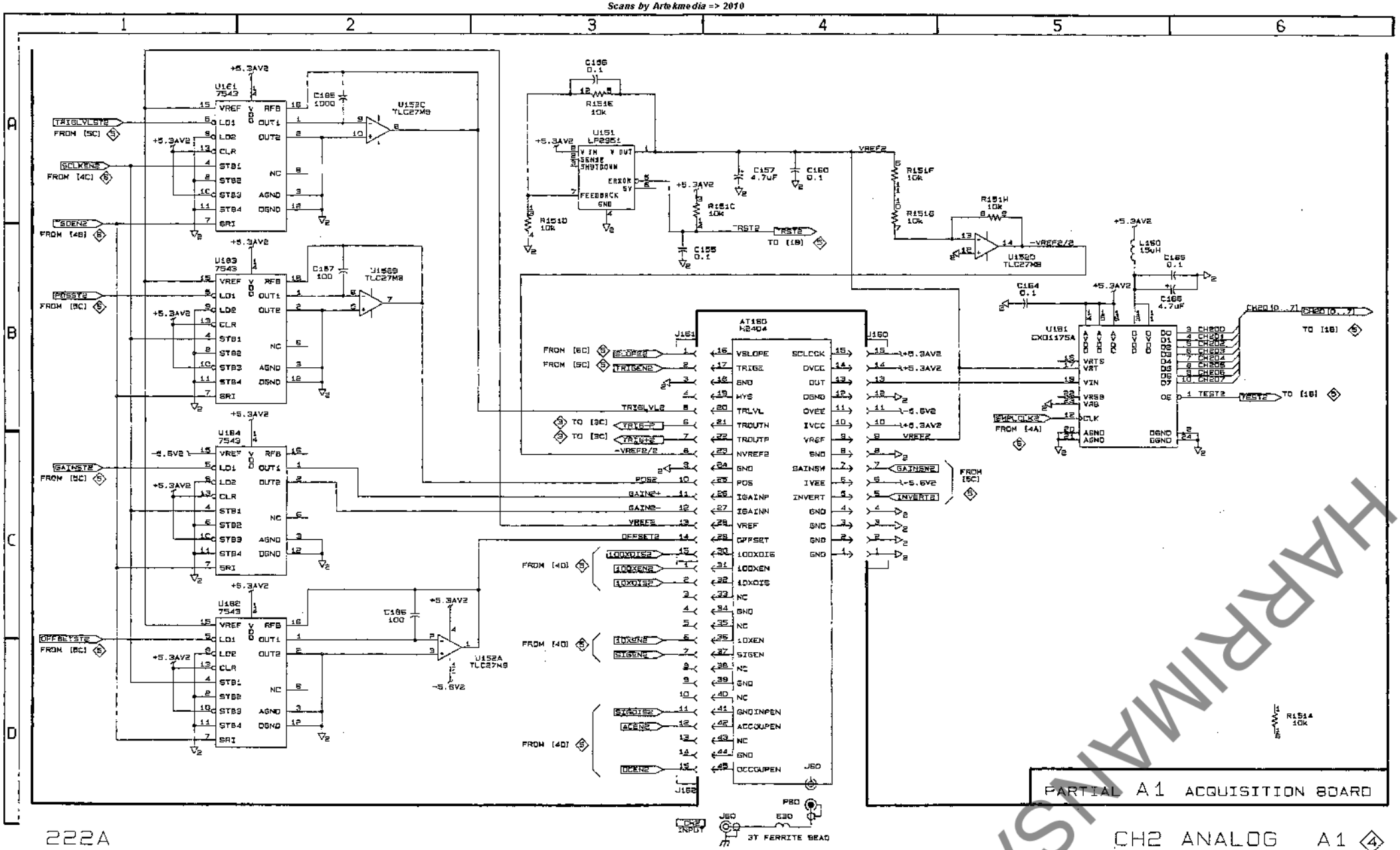


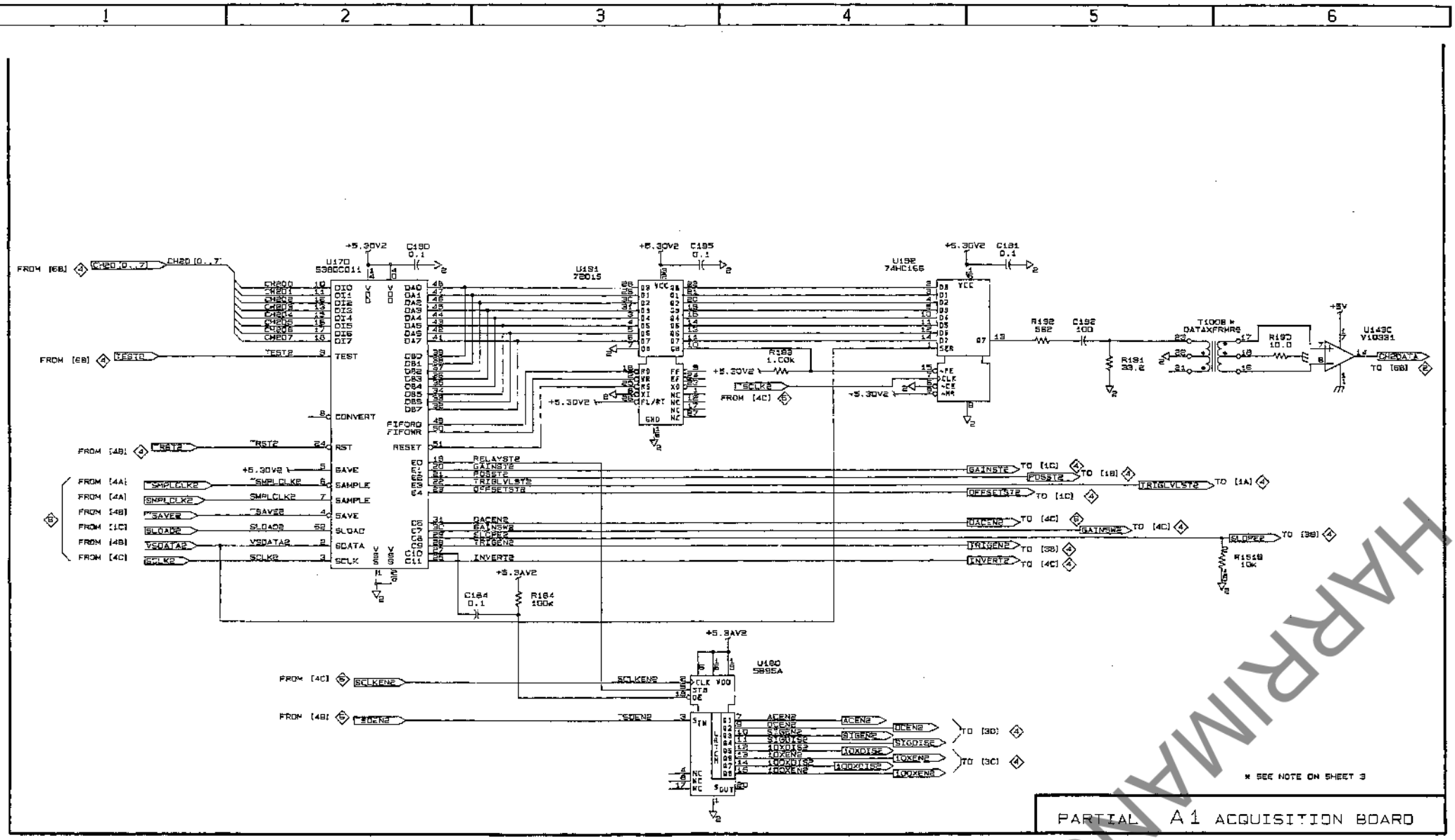


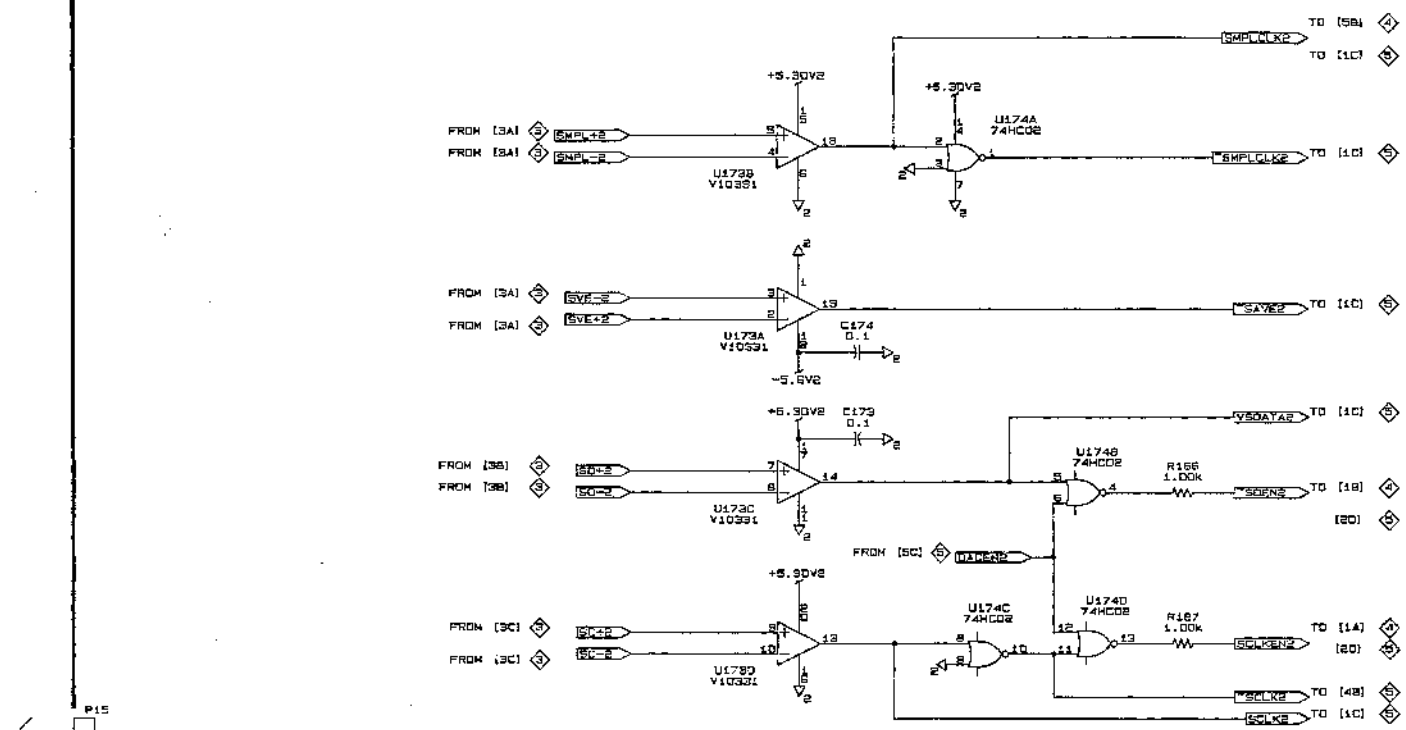


222A

CH1 ISOLATED INTERFACE A1 3



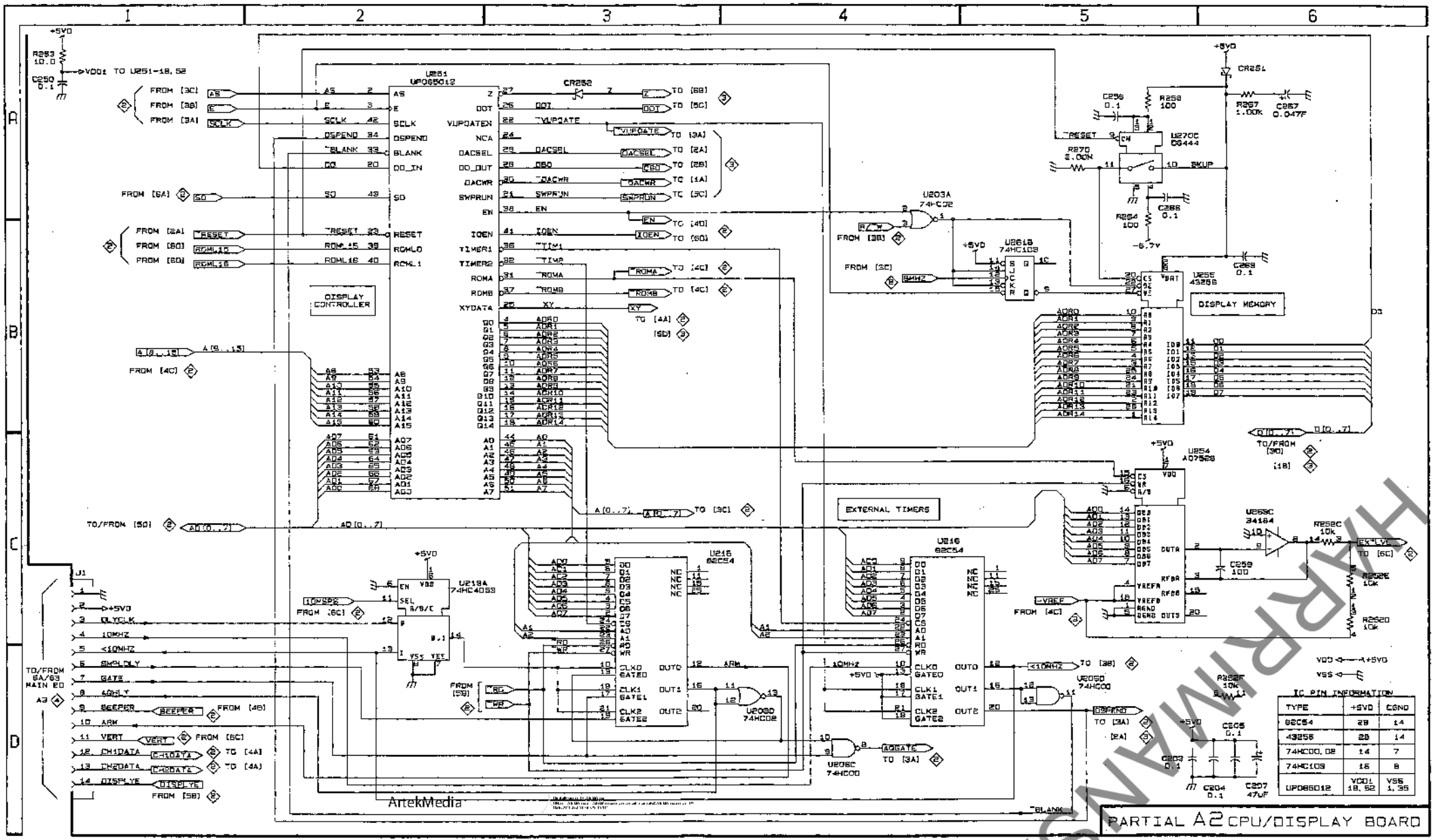

1
2
3
4
5
6
A
B
C
D
U170
5380C011
U191
78015
U192
74HC165
U160
5895A
U143C
V10331
TO [6B]
TO [1C]
TO [1B]
TO [1A]
TO [3B]
TO [4C]
TO [3D]
TO [3C]
FROM [6B]
FROM [4B]
FROM [4A]
FROM [1C]
FROM [4C]
* SEE NOTE ON SHEET 3
PARTIAL A1 ACQUISITION BOARD
222A
CH2 DIGITAL A1
5
Scans by ArtekMedia => 2010
HARRIMAN SAT



PARTIAL A1 ACQUISITION BOARD

222A

CH2 ISOLATED INTERFACE A1 6



222A

DISPLAY RAM CONTROL A2 1

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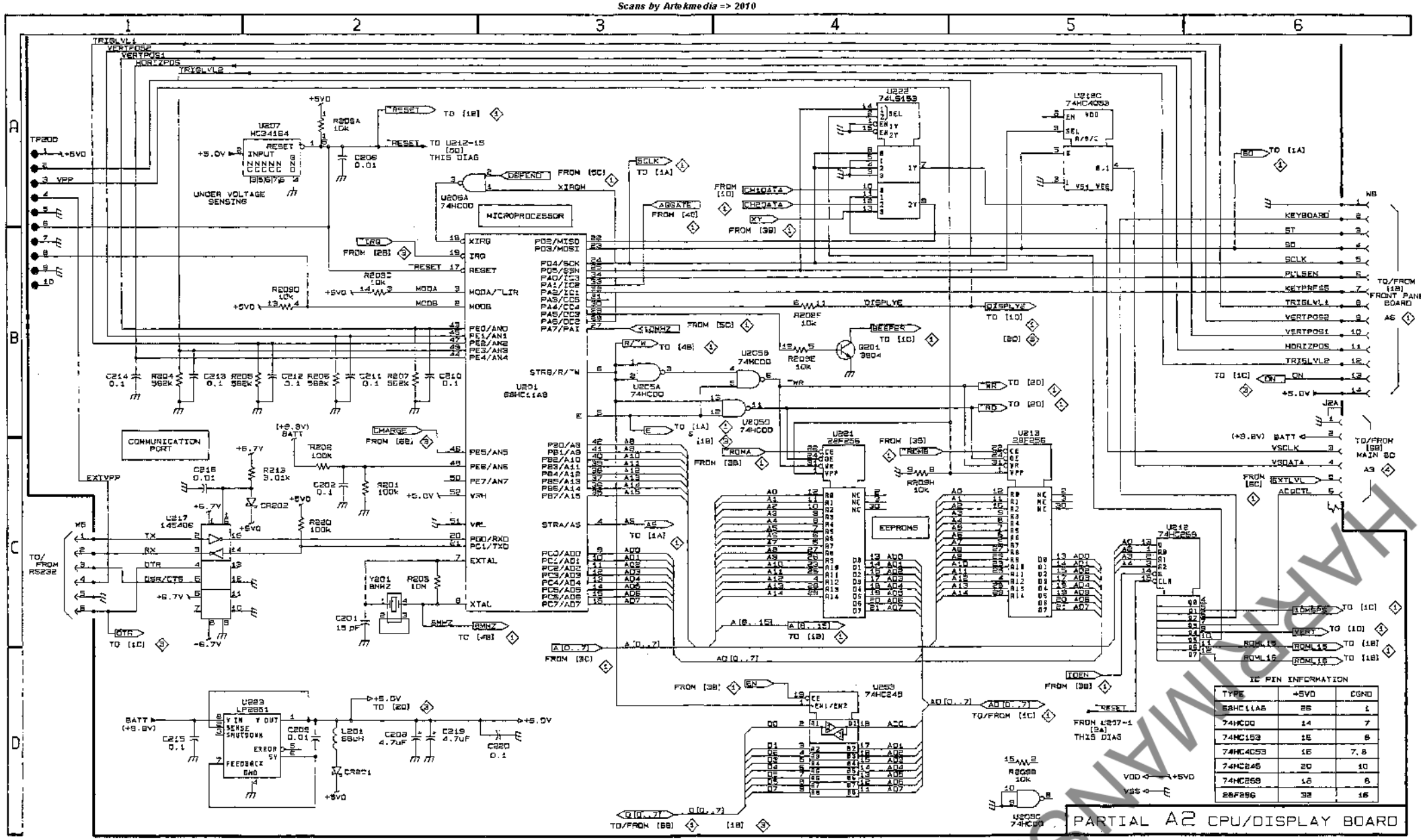
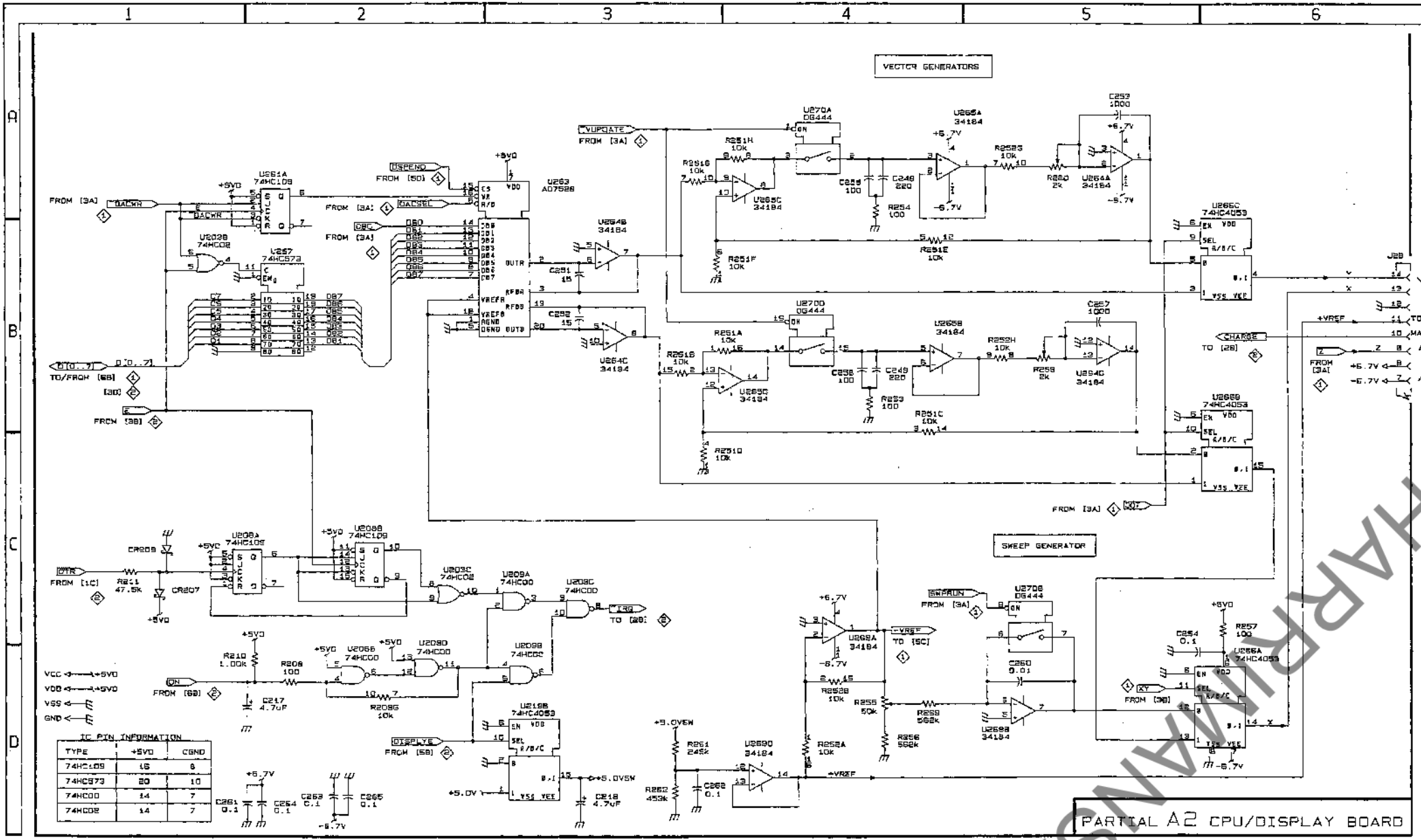


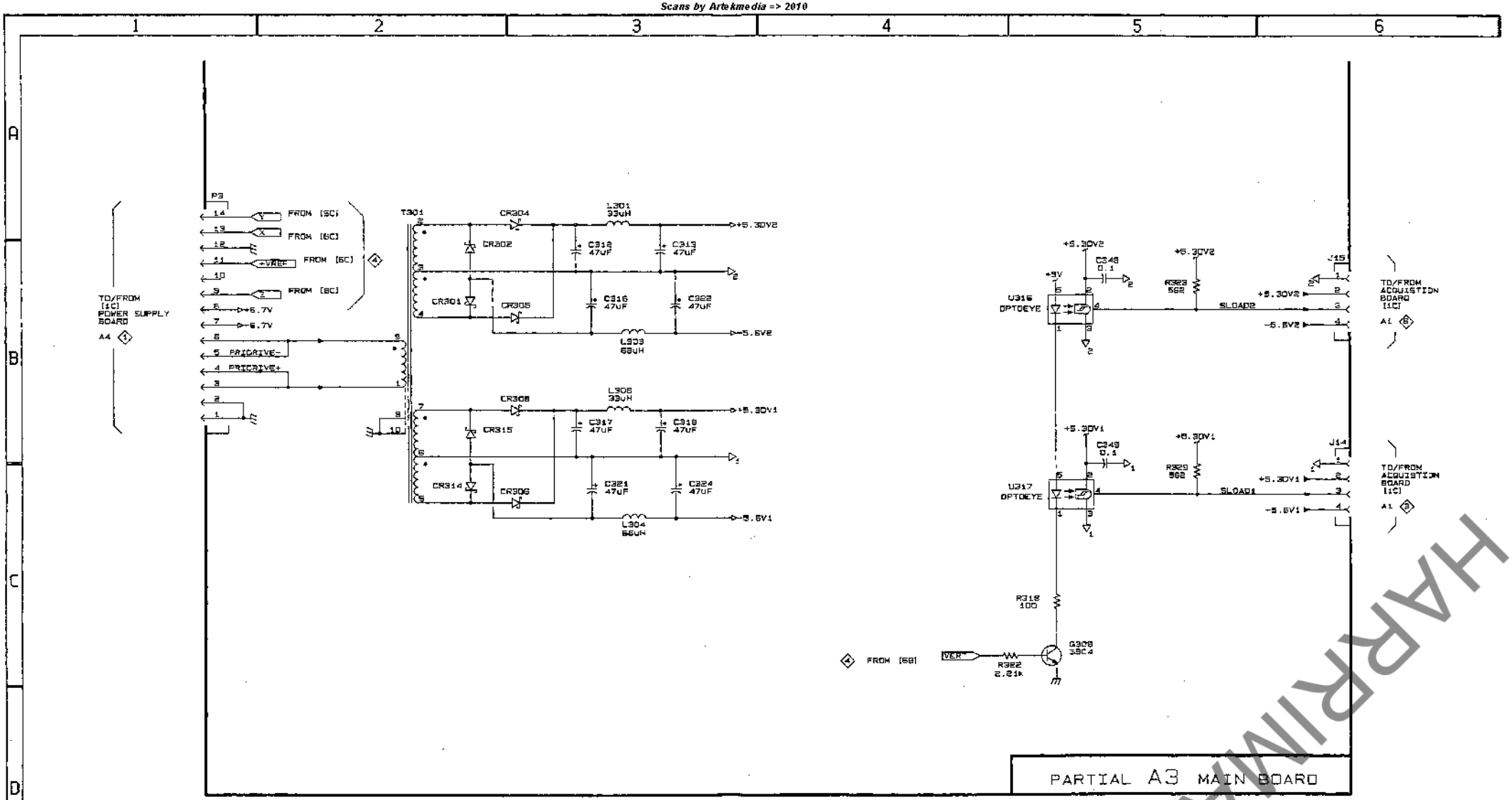
222A

MICROPROCESSOR A2 (2)



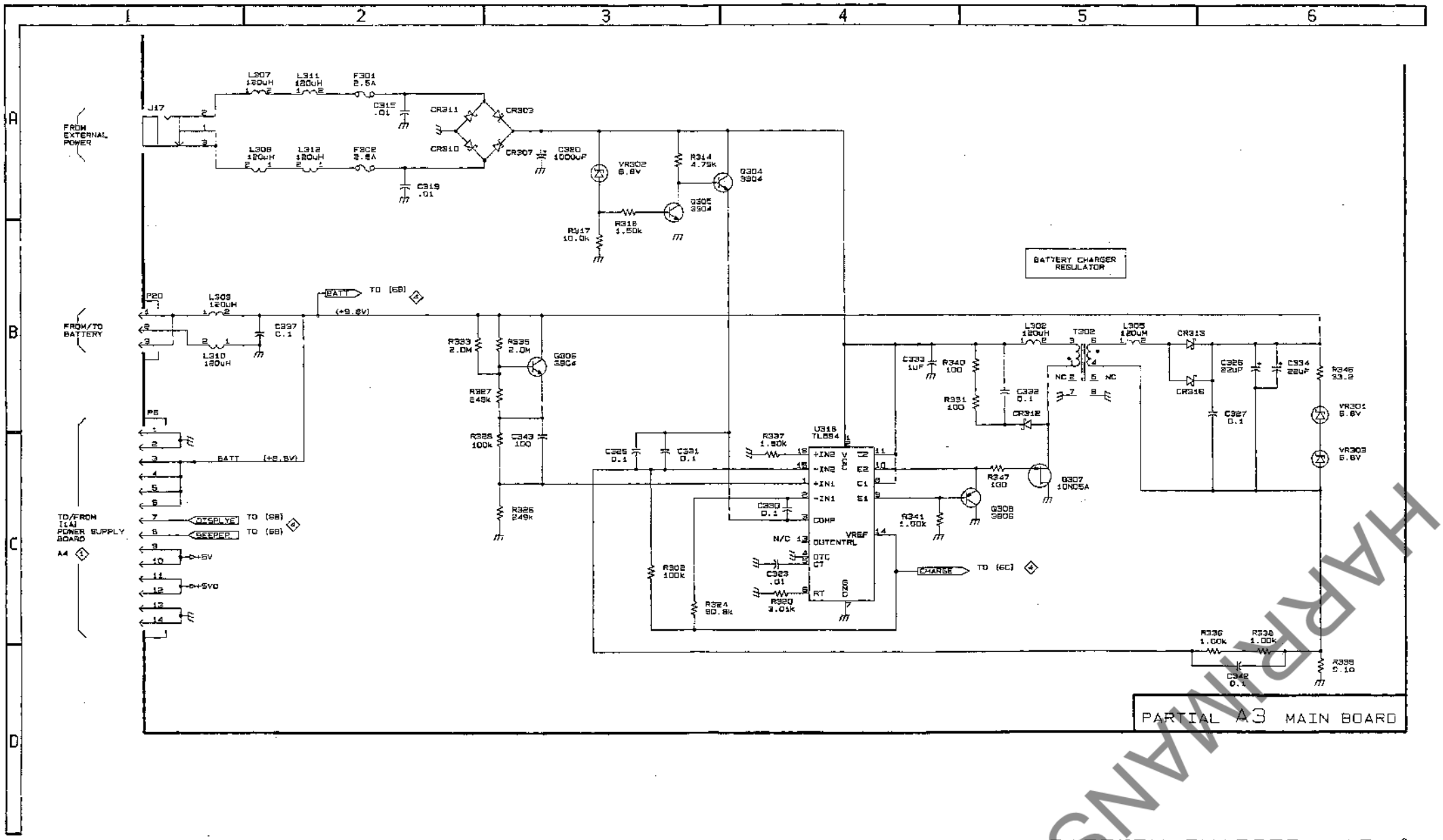
222A

VECTORS A2 3



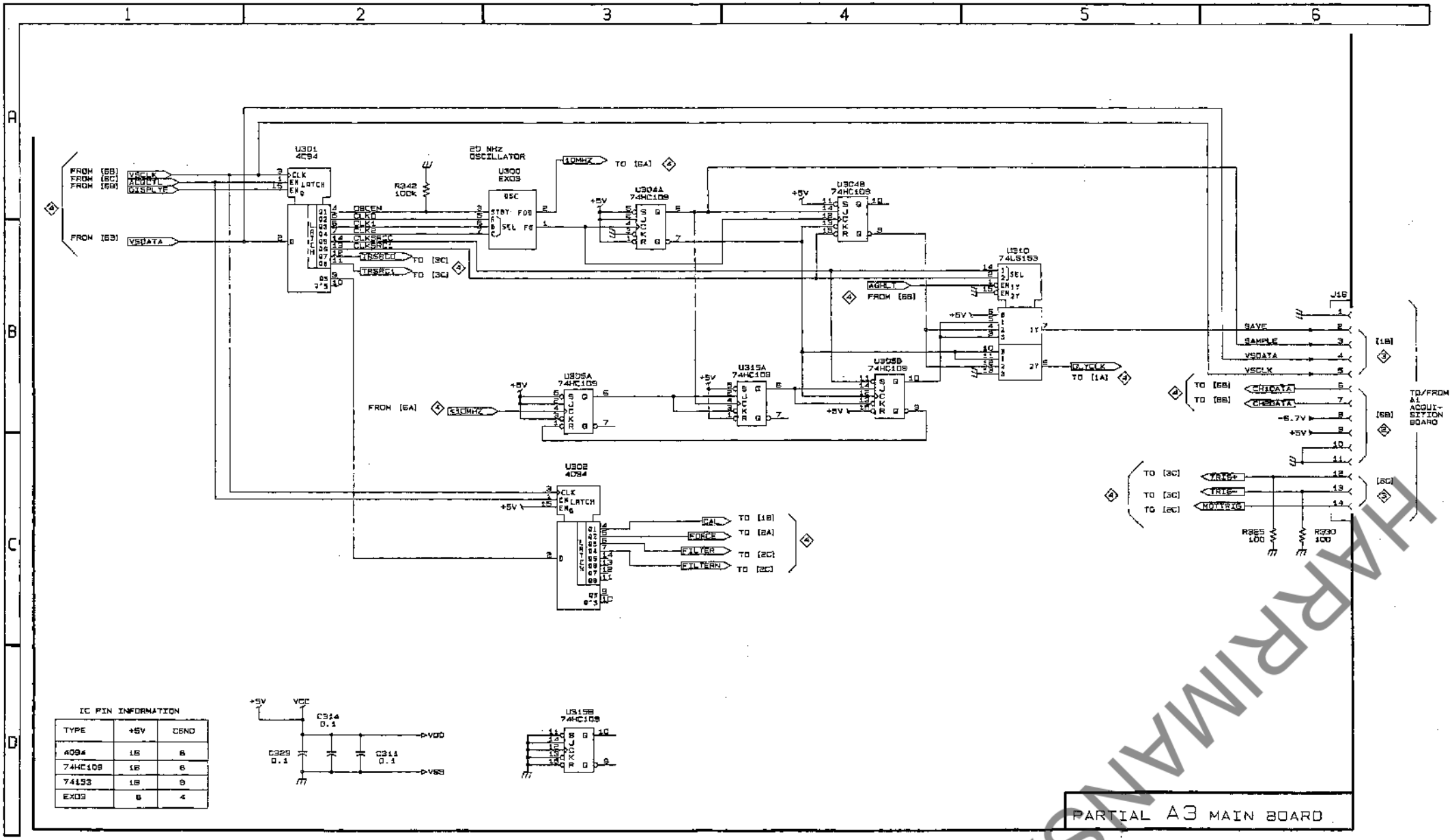
222A

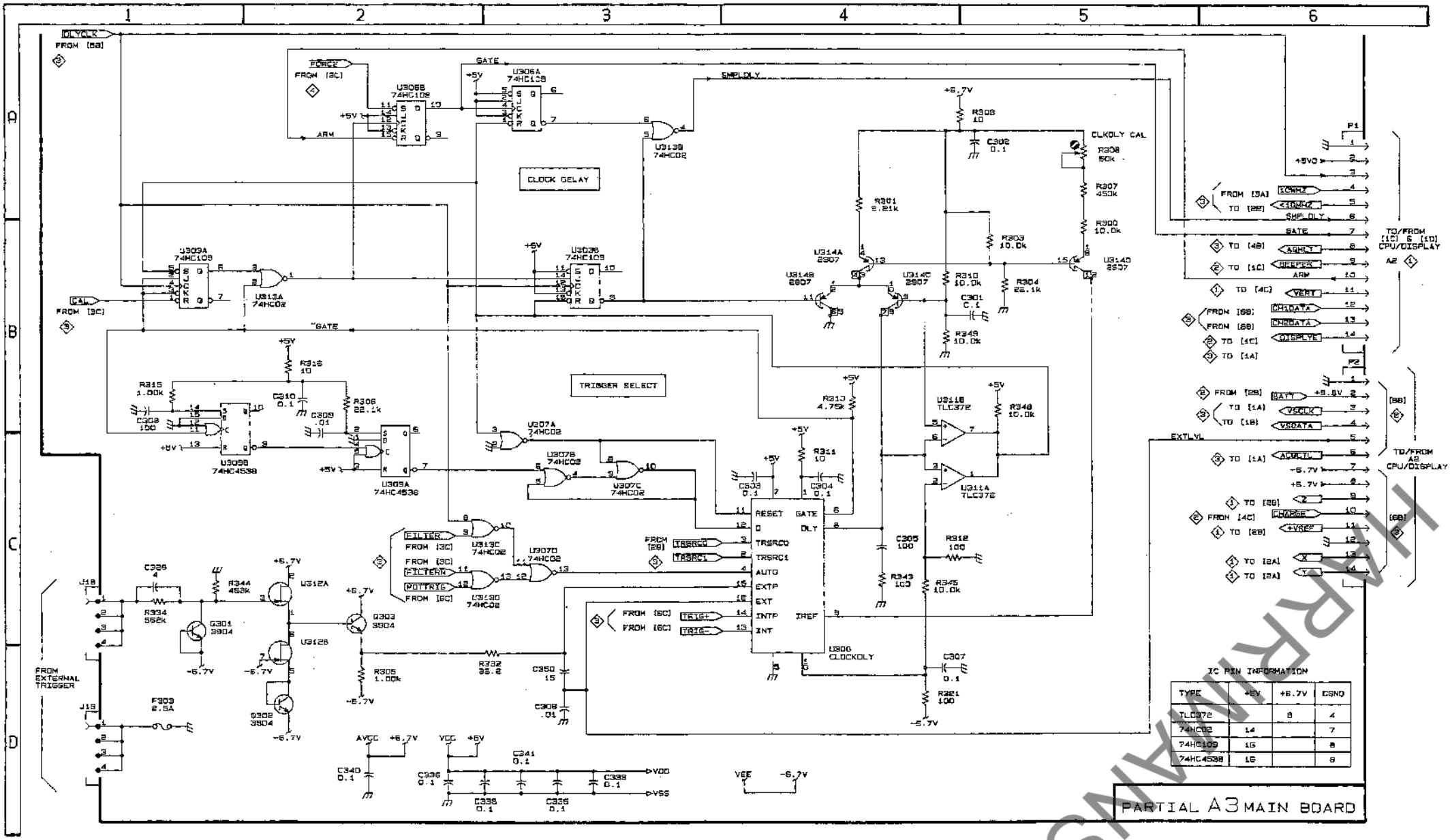
ACQUISITION POWER SUPPLY A3 ◇1



222A

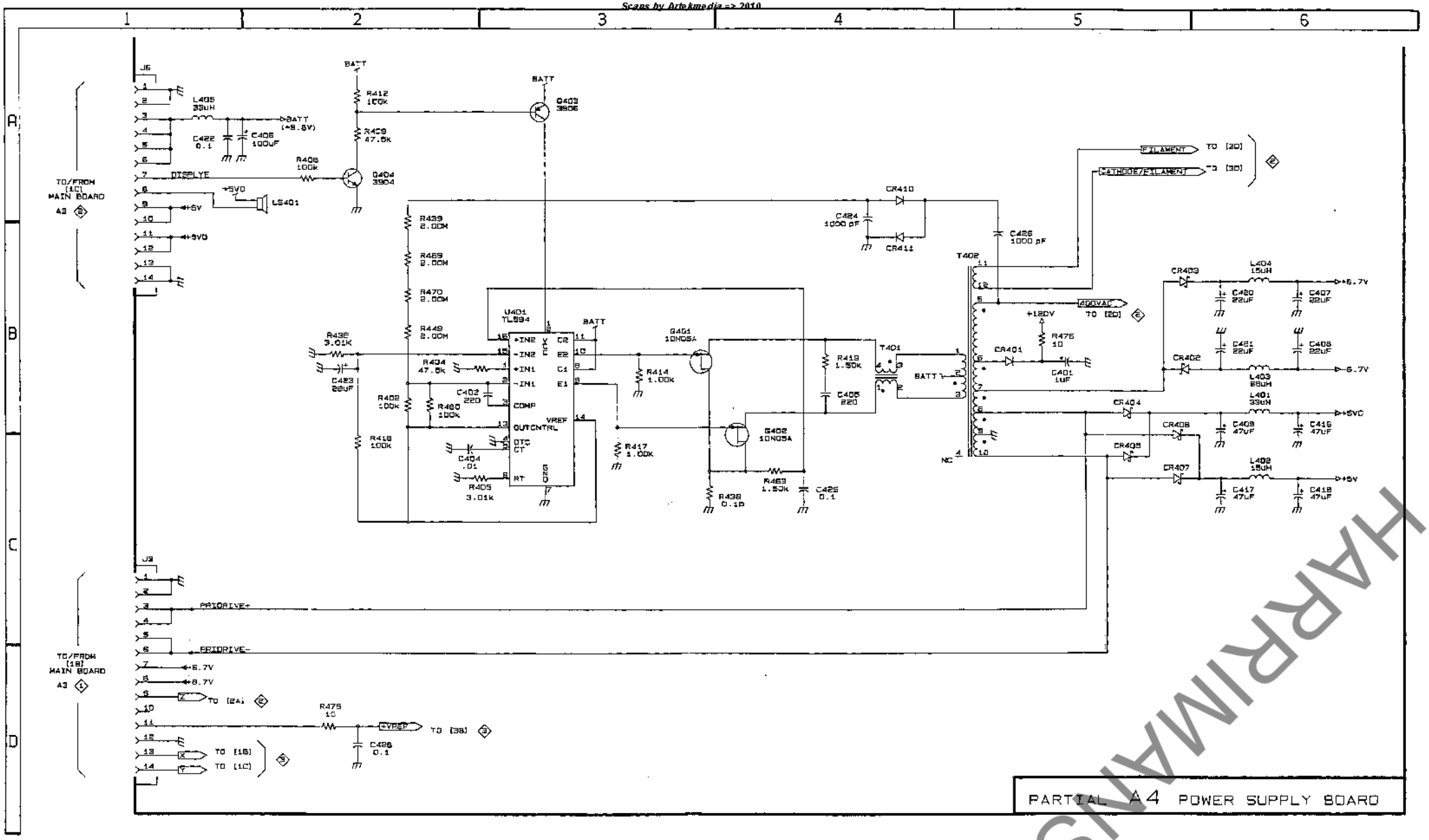
BATTERY CHARGER A3 (2)

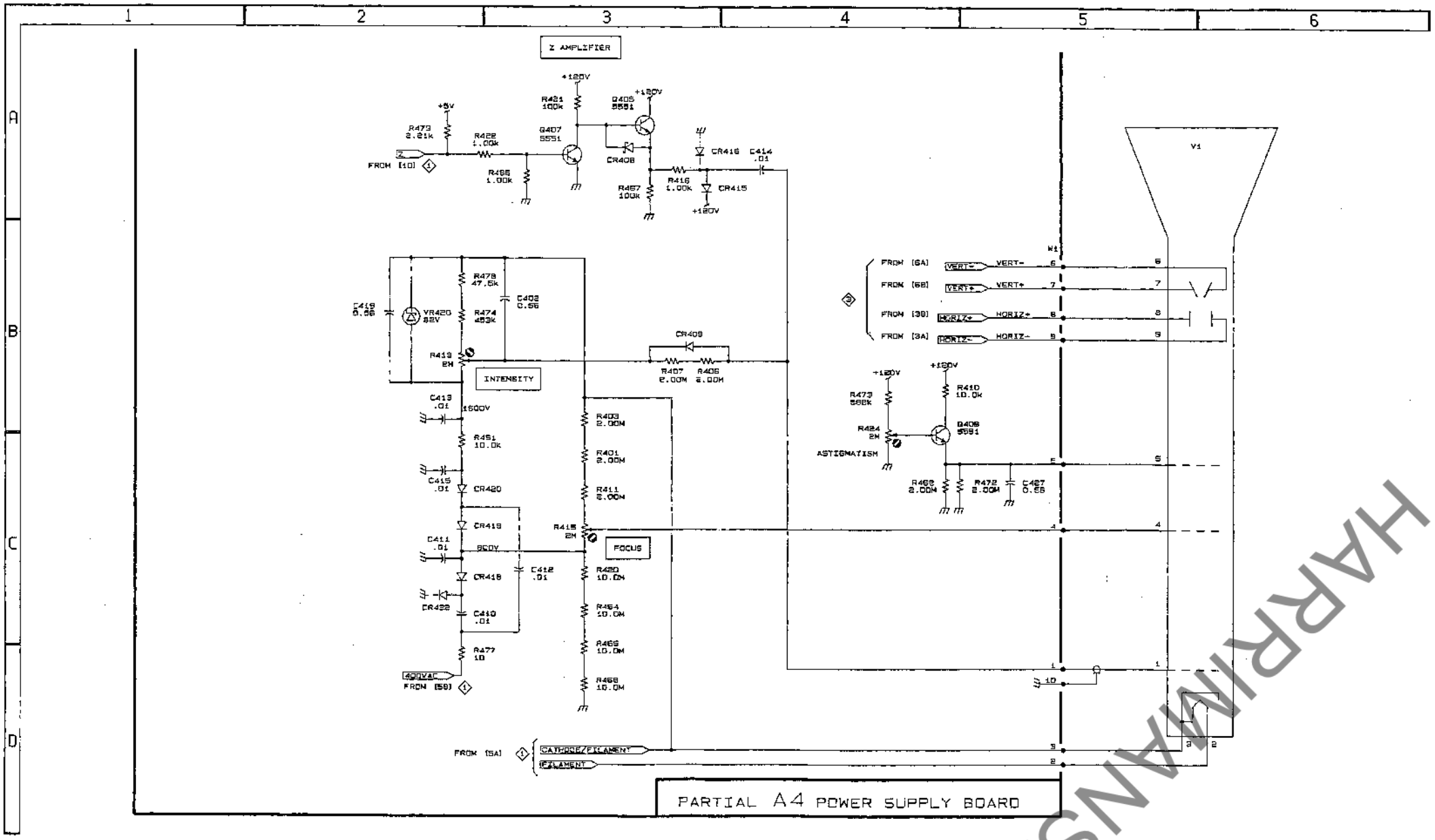




222A

TRIGGER A3 4

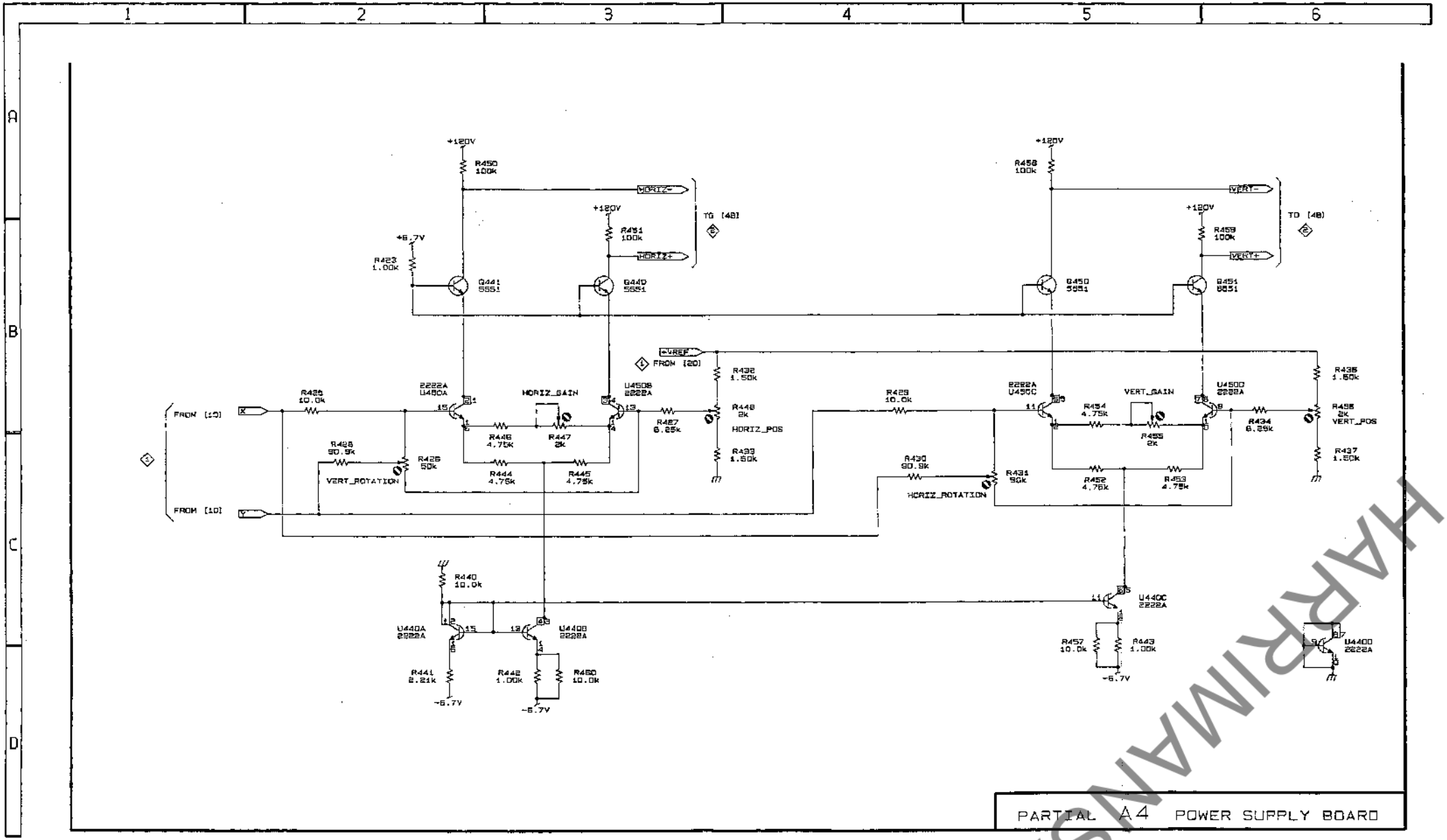




PARTIAL A4 POWER SUPPLY BOARD

222A

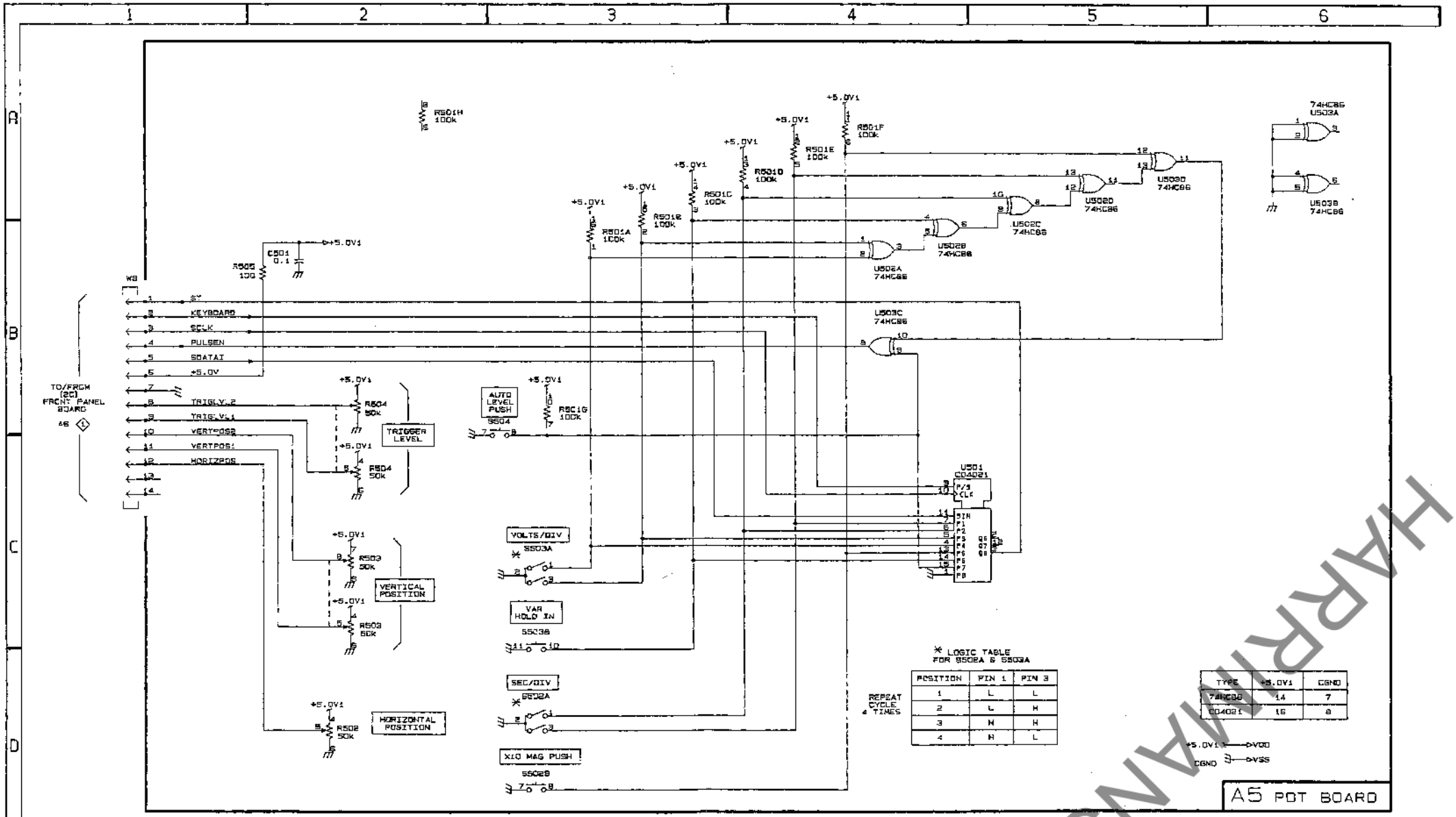
HIGH VOLTAGE POWER SUPPLY A4 (2)



PARTIAL A4 POWER SUPPLY BOARD

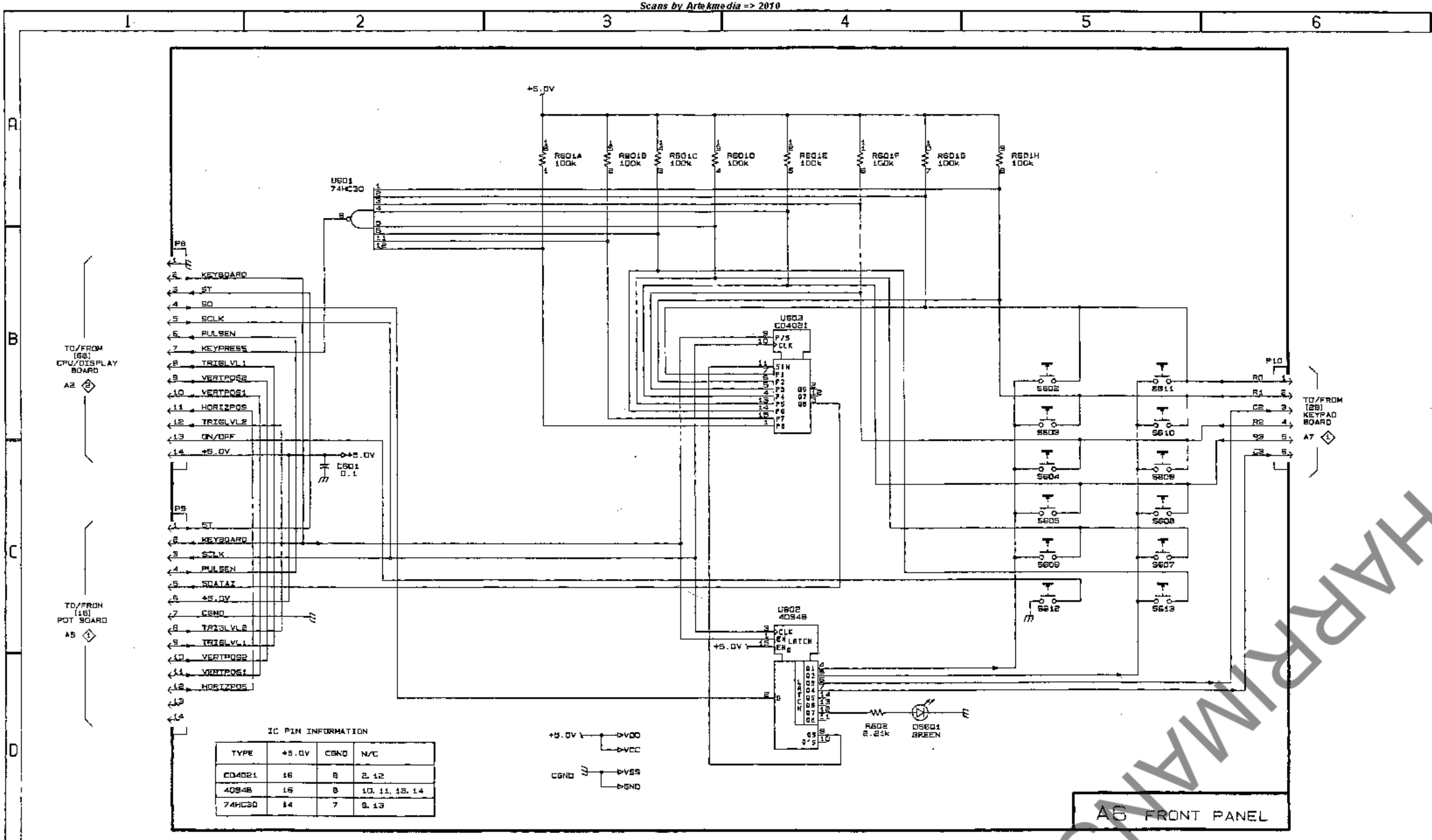
222A

DEFLECTION AMP A4 ③



222A

POT BOARD A5 1



IC PIN INFORMATION

TYPE	+5.0V	CGND	N/C
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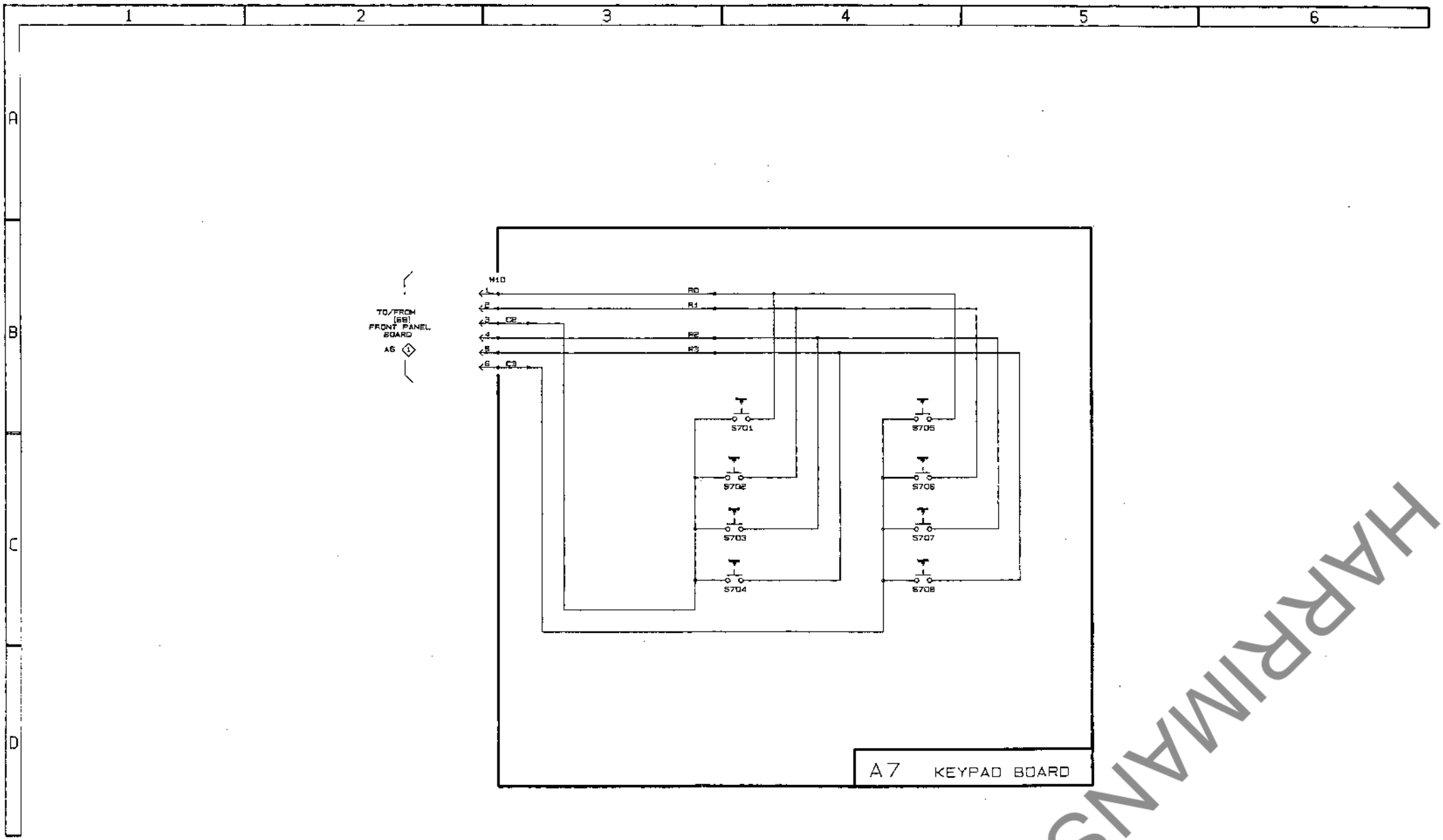
4094B	16	8	10, 11, 13, 14
74HC30	14	7	9, 13

222A

FRONT PANEL BOARD A6



KEYPAD BOARD A7 ①

Parts List

Replace this page with the tab divider of the same name.

Replaceable Mechanical Parts

This section contains a list of the components that are replaceable for the 222A Digital Storage Oscilloscope. As described below, use this list to identify and order replacement parts. There is a separate Replaceable Parts List for each instrument.

Parts Ordering Information

Replacement parts are available from or through your local Tektronix, Inc., service center 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. Therefore, when ordering parts, it is important to include the following information in your order:

- Part number
- Instrument type or model number
- Instrument serial number
- Instrument modification number, if applicable

If a part you order has been replaced with a different or improved part, your local Tektronix service center or representative will contact you concerning any change in the part number.

Using the Replaceable Parts List

The tabular information in the Replaceable Parts List is arranged for quick retrieval. Understanding the structure and features of the list will help you find the all the information you need for ordering replacement parts.

Item Names

In the Replaceable 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, U.S. Federal Cataloging Handbook H6-1 can be used where possible.

Indentation System

This parts list is indented to show the relationship between items. The following example is 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 at 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 (ANSI) standard Y1.1.

CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
TK0IK	MODERN METALS	UNIT A/K, 5/F GOLD KING IND. BLDG NO. 35-41 TAI LIN ROAD	KWAI-CHUNG N.T. HONG KONG
TK0435	LEWIS SCREW CO	4300 S RACINE AVE	CHICAGO IL 60609-3320
TK1163	POLYCAST INC	9898 SW TIGARD ST	TIGARD OR 97223
TK1326	NORTHWEST FOURSLIDE INC	18224 SW 100TH CT	TUALATIN OR 97062
TK1506	HUGHES R S CO INC	2238 NE COLUMBIA BLVD	PORTLAND OR 97211-0068
TK2415	FRIWO FRIEMANN & WOLF	GERATEAU GMBH POSTFOCH 1209 B-4412	OSTBEVEN GERMANY
0DWW6	MICRO POWER ELECTRONICS	7973 SW CIRRUS DRIVE BLDG. #22	BEAVERTON OR 97005
0JRZ2	BADGLEY MFG CO	1620 NE ARGYLE	PORTLAND OR 97211
0J260	COMTEK MANUFACTURING OF OREGON (METALS)	PO BOX 4200	BEAVERTON OR 97076-4200
0KBZ5	MORELLIS Q & D PLASTICS	1812 16TH AVE	FOREST GROVE OR 97116
0KB01	STAUFFER SUPPLY	810 SE SHERMAN	PORTLAND OR 97214
14310	AULT INC	1600-H FREEWAY BLVD	MINNEAPOLIS MN 55430-1706
2K262	BOYD CORP	6136 NE 87th AVE PO BOX 20038	PORTLAND OR 97220
28733	CERAMIC MAGNETICS INC	87 FAIRFIELD RD	FAIRFIELD NJ 07006-4732
77824	SCHLEGEL CORP	1555 JEFFERSON RD PO BOX 23197	ROCHESTER NY 14692-3113
80009	TEKTRONIX INC	14150 SW KARL BRAUN DR PO BOX 500	BEAVERTON OR 97077-0001
95760	PROTECTIVE CLOSURES CO INC	2150 ELMWOOD AVE	BUFFALO NY 14207-1910

Fig. & Index No.	Tektronix Part No.	Serial No. Effective	Serial No. Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
1-1	346-0251-00			1	STRAP,HANDLE:HAND/CARRY GRIP ASSY	0JR22	ORDER BY DESC
-2	437-0432-00			1	CABINET ASSY:TOP W/PAD	80009	437-0432-00
-3	260-2422-00			1	SWITCH,PUSH:8 BUTTON,2 POLE	TK0IK	ORDER BY DESC
-4	342-0889-01			1	INSUL,CKT BD:POLYESTER,0.010 THK	2K262	ORDER BY DESC
-5	200-3967-00			1	DOOR ASSEMBLY:BAT COVER/PORCH W/LABEL	80009	200-3967-00
-6	146-0075-00			1	BATTERY PACK AS:RECHARGABLE,2 X 4V	0DWW6	ORDER BY DESC
-7	211-0744-00			3	SCREW,MACHINE:6-32 X 2.0,PNH,TORX,STL,CD	TK0435	ORDER BY DESC
-8	437-0433-00			1	CABINET ASSY:BOTTOM W/PAD	80009	437-0433-00
-9	348-1059-00			1	STAND,TILT:LEXAN,TEK BLUE	TK1163	ORDER BY DESC
-10	211-0721-00			2	SCREW,MACHINE:6-32 X 0.375,PNH,STL	0KB01	ORDER BY DESC
-11	260-2423-00			1	SWITCH,PUSH:12 BUTTON,2 POLE	TK0IK	ORDER BY DESC
-12	390-1047-03			1	CABINET ASSY:FRONT,SMOKE TAN, W/ELECTRODAG AND LABELS	80009	390-1047-03
-13	377-0612-00			3	INSERT,KNOB:0.128 ID X 0.518 OD X 0.270 H, W/4-40 SETSCREW,AL	0J260	ORDER BY DESC
-14	366-2137-00			3	KNOB,SHELL:IVORY GRAY	TK1163	ORDER BY DESC
-15	377-0613-00			3	INSERT,KNOB:0.080 ID X 0.310 OD X 0.255 H, W/4-40 SETSCREW,AL	0J260	ORDER BY DESC
-16	366-2138-00			2	KNOB,SHELL:IVORY GRAY, W/BLACK POS	TK1163	ORDER BY DESC
-17	366-2139-00			1	KNOB,SHELL:IVORY GRAY W/BLACK AUTO LVL PUSH	TK1163	ORDER BY DESC
-18	378-0388-00			1	FILTER ASSY:CRT FILTER,BLUE W/FOAM STRIPS	80009	378-0388-00

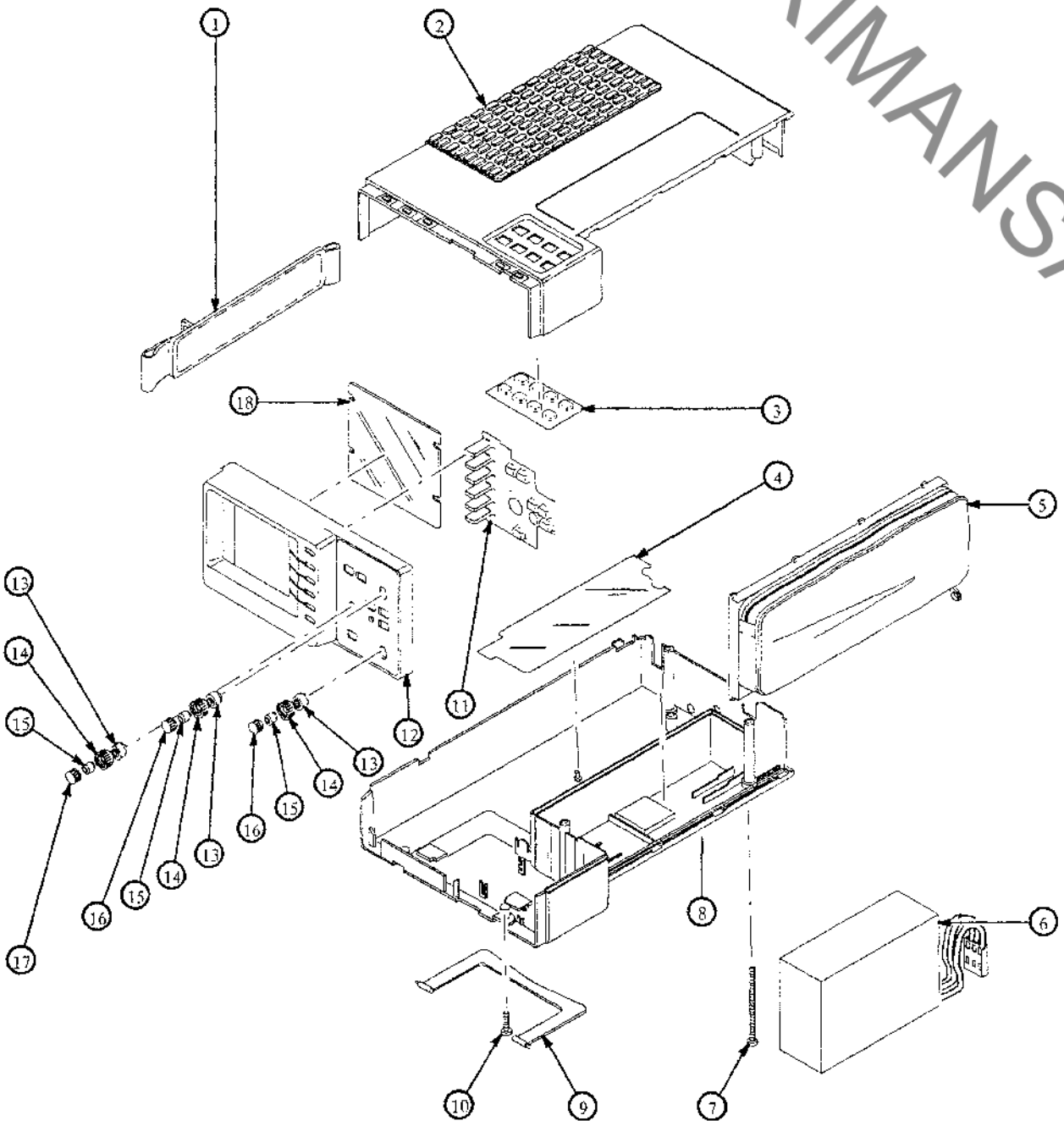


Figure 10-1: Front Panel and Cabinet

Fig. & Index No.	Tektronix Part No.	Serial No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
2-1	380-1004-00			1	HOUSING ASSY: W/EMI GASKET STRIP AND WARNING LABEL	80009	380-1004-00
-2	----------			1	CIRCUIT BD ASSY:(SEE A1 REPL)		
-3	344-0439-00			7	CLIP,FERRITE CO:0.006,BE CU 25	TK1326	ORDER BY DESC
-4	276-0820-00			7	CORE,FERRITE:E 0.093 X 0.390 L	28733	005058-0
-5	276-0821-00			7	CORE,FERRITE:I BAR,0.059 X 0.093 X 0.390 L	28733	002124-0
-6	348-1100-00			2	SHLD GSKT,ELEK:EMI,0.125 X 0.5 X 0.375 L W/ADHESIVE	77824	5728-191V-6
-7	200-3931-00			1	COVER ASSEMBLY: W/EMI GASKET PAD	80009	200-3931-00
-8	386-5781-00			1	SUPPORT,TOP:POLYCARBONATE	TK1163	ORDER BY DESC
-9	131-4656-00			1	CONN,RCPT,ELEC:PROBE TO INSTR ASSY,X2 W/PAD	80009	131-4656-00
-10	386-5782-01			1	SUPPORT,BOTTOM:CRT SHIELD,LEXAN	TK1163	ORDER BY DESC
-11	----------			1	CIRCUIT BD ASSY:(SEE A4 REPL)		
-12	----------			1	SKT,PL-IN ELEK:(SEE A4W1 REPL)		
-13	366-2110-00			1	KNOB,EXTENSION:INTENSITY,TEK BLUE	0KBZ5	ORDER BY DESC
-14	----------			1	CIRCUIT BD ASSY:(SEE A2 REPL)		
-15	----------			1	FLEX CIRCUIT:(SEE A2W5 REPL)		
-16	200-3750-00			1	CAP,PROTECTIVE:POLYETHYLENE,BLACK, CONDUCTIVE,D SUB,9 PIN	95760	ORDER BY DESC
-17	348-1101-00			1	SHLD GSKT,ELEK:EMI,0.125 X 0.5 X 5.1 L W/ADHESIVE	77824	5728-191V-6
-18	253-0405-00			1	TAPE,PRESS SENS:0.062 X 0.75 X 5.3 L VINYLFOAM DOUBLE SIDED	TK1506	ORDER BY DESC
-19	----------			1	CA ASSY,SP,ELEC:(SEE A2W8 REPL)		
-20	211-0721-00			1	SCREW,MACHINE:6-32 X 0.375,PNH,STL	0KB01	ORDER BY DESC
-21	----------			1	CIRCUIT BD ASSY:(SEE A5 REPL)		
-22	----------			1	CA ASSY,SP,ELEC:(SEE A5W9 REPL)		
-23	----------			1	CIRCUIT BD ASSY:(SEE A3 REPL)		
-24	211-0721-00			1	SCREW,MACHINE:6-32 X 0.375,PNH,STL	0KB01	ORDER BY DESC
-25	337-3558-00			1	SHIELD,ELEC:STEEL ALLOY	0J260	ORDER BY DESC
-26	342-0890-00			1	INSULATOR,FILM:POLYMIDE W/ACRYLIC ADHESIVE	2K262	ORDER BY DESC
-27	348-1102-00			1	SHLD GSKT,ELEK:EMI,0.250 X 0.5 X 0.375 L W/ADHESIVE	77824	5725-191V-3 C
-28	407-3734-00			1	BRACKET,KEYPAD:ALUMINUM	0J260	ORDER BY DESC
-29	----------			1	CIRCUIT BD ASSY:(SEE A7 REPL)		
-30	----------			1	CA ASSY,SP,ELEC(SEE A7W10 REPL)		

Fig. & Index No.	Tektronix Part No.	Serial No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
-31	----------			1	CIRCUIT BD ASSY:(SEE A6 REPL)		
-32	119-3547-00			1	CRT ASSEMBLY:222 CRT W/SHIELD & EMI GASKET	80009	119-3547-00

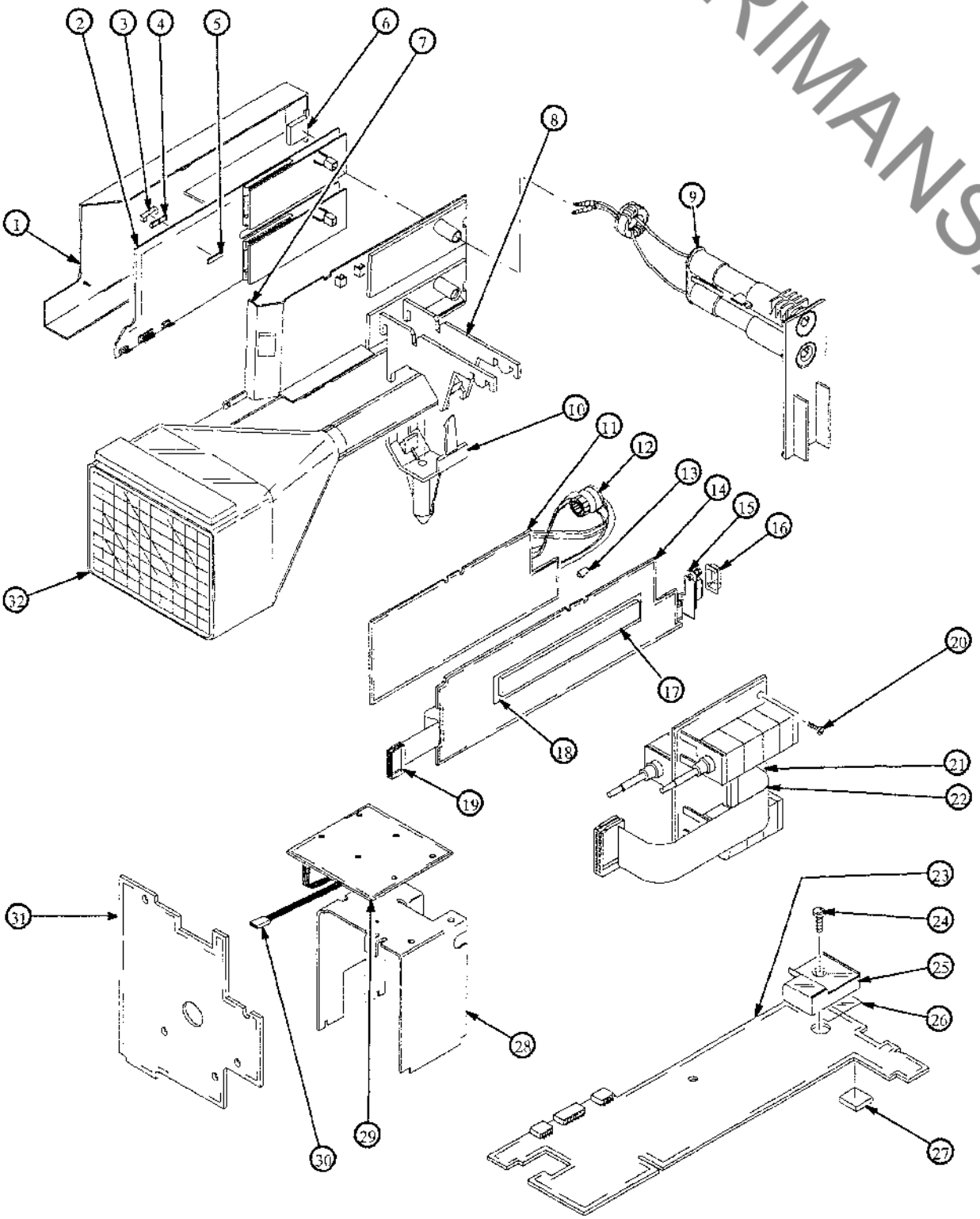


Figure 10-2: Chassis and Circuit Boards

Fig. & Index No.	Tektronix Part No.	Serial No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
					ACCESSORIES		
3-1	120-1827-00			1	TRANSFORMER:240VAC/50HZ INPUT 18VAC/16V OUTPUT,WALL MOUNT	TK2415	ORDER BY DESC
-2	120-1826-00			1	TRANSFORMER:220VAC/50HZ INPUT 18VAC/16V OUTPUT,WALL MOUNT	TK2415	ORDER BY DESC
-3	120-1807-00			1	TRANSFORMER,PWR:POWER SUPPLY, WALL MOUNT,PLUG IN, IN 120VAC,OUT 18 VAC	14310	3281059001
-4	016-1024-00			1	CASE,CARRYING:BLACK CLOTH	0JRZ2	ORDER BY DESC
-5	020-1752-00			1	ACCESSORY KIT:FOUR RUBBER FEET IN BAG W/INSTRUCTION	2K262	ORDER BY DESC
-6	P400			2	PROBE PASSIVE:60MHZ W/ACCESSORIES	80009	P400
-7	020-1908-00			1	ACCESSORY,PKG:P400	80009	020-1908-00
-8	175-3766-04			1	CABLE ASSY,RF:70 OHM,71.5 L,SLATE GRAY	80009	175-3766-04
-9	206-0426-00			1	PROBE HEAD:P400,X3	80009	206-0426-00
-10	013-0107-07			1	TIP,PROBE:RETRACTABLE HOOK	80009	013-0107-07
	070-8328-00			1	MANUAL,TECH:OPERATORS	80009	070-8328-00
	070-8329-00			1	CARD,INFO:USERS QUICK REFERENCE	80009	070-8329-00

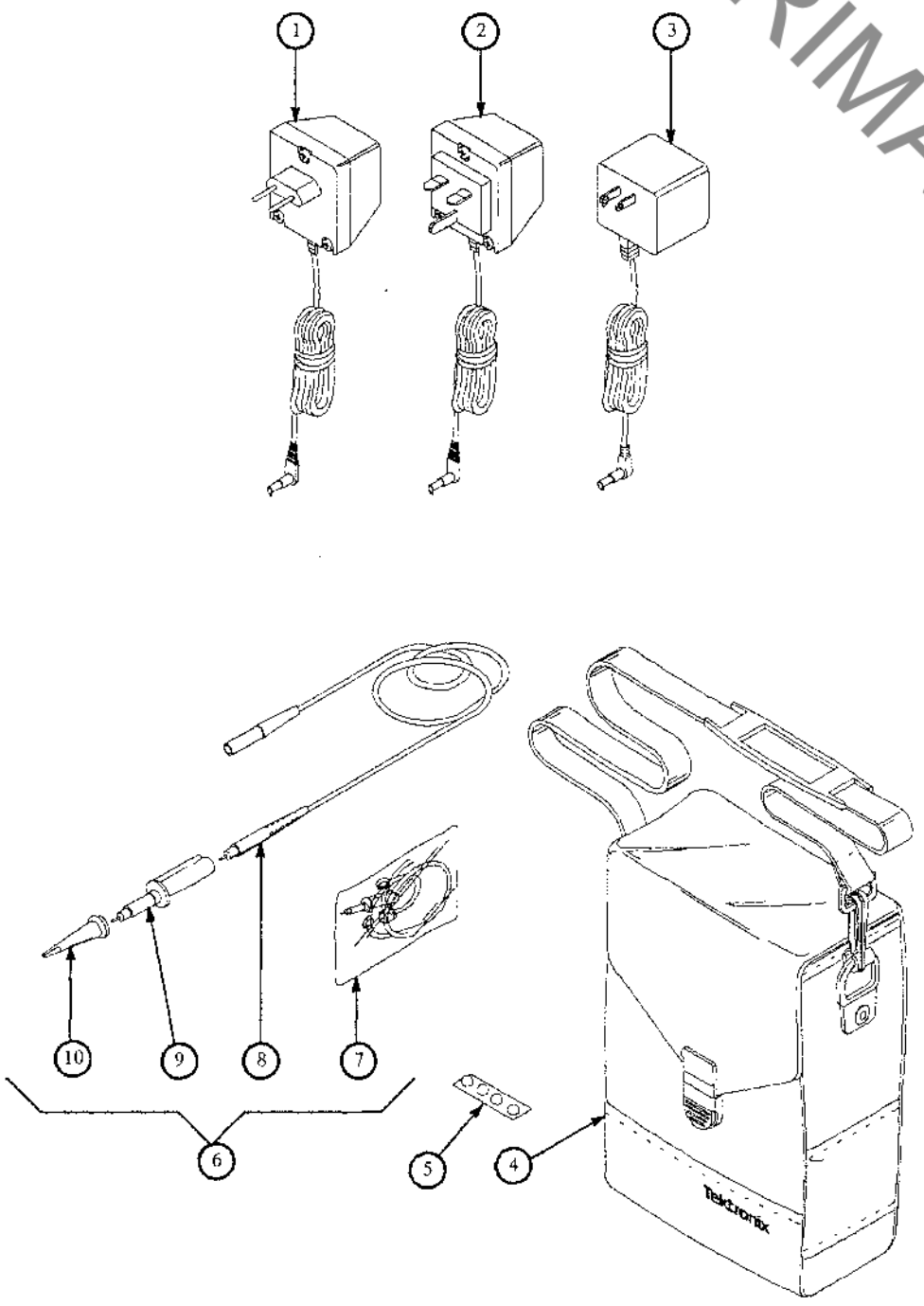


Figure 10-3: Accessories

Index

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Symbols

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