

# Instruction Manual

**Tektronix**

**DC 504A  
Counter/Timer  
070-4291-00**

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Counter/Timer**

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**Warning**

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

**Please check for change information at the rear of this manual.**

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**WARNING**

*THE FOLLOWING SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID PERSONAL INJURY, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO. REFER TO OPERATORS SAFETY SUMMARY AND SERVICE SAFETY SUMMARY PRIOR TO PERFORMING ANY SERVICE.*

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## NOTE

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# OPERATORS SAFETY SUMMARY

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

## TERMS

### In This Manual

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

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

### As Marked on Equipment

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

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

## SYMBOLS

### In This Manual



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

### As Marked on Equipment



**DANGER** — High voltage.



Protective ground (earth) terminal.



**ATTENTION** — refer to manual.



Refer to manual

### Power Source

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

### Grounding The Product

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

### Danger Arising From Loss of Ground

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

### Use The Proper Fuse

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

Refer fuse replacement to qualified service personnel.

### Do Not Operate in Explosive Atmospheres

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

### Do Not Operate Plug-In Unit Without Covers

To avoid personal injury, do not operate this product without covers or panels installed. Do not apply power to the plug-in via a plug-in extender.

# SERVICING SAFETY SUMMARY

## FOR QUALIFIED SERVICE PERSONNEL ONLY

*Refer also to the preceding Operators Safety Summary*

### **Do Not Service Alone**

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

### **Use Care When Servicing With Power On**

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

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

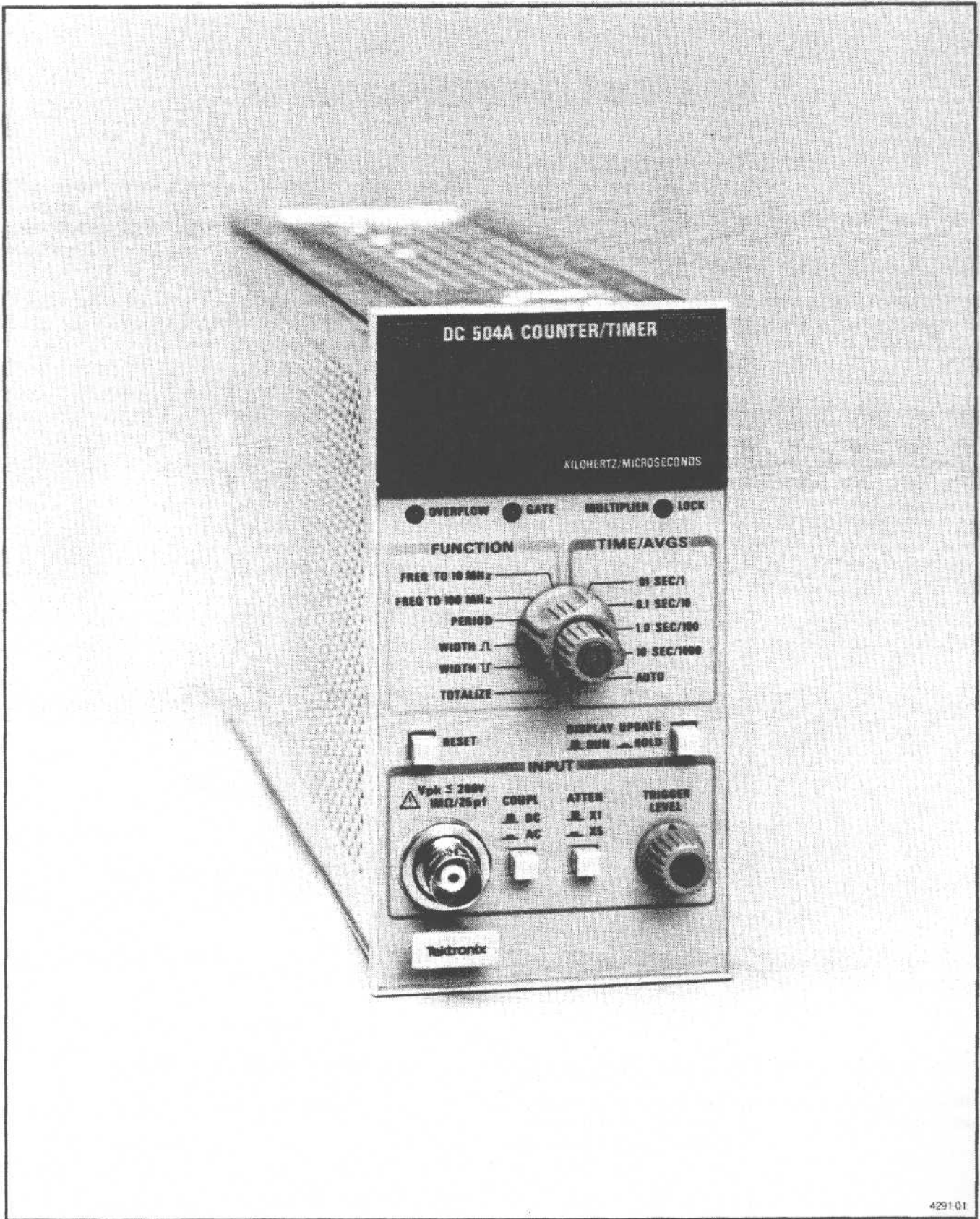
### **Do Not Wear Jewelry**

Remove jewelry before servicing this instrument. Rings, necklaces, and other metallic objects could come into contact with dangerous voltages and currents.

### **Power Source**

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





4291-01

DC 504A COUNTER/TIMER

# SPECIFICATION

## Instrument Description

The TEKTRONIX DC 504A is a multi-function counter/timer designed to operate in one compartment of any TM 500 or TM 5000-Series power module.

Frequency measurements to 100 MHz are within the capability of the DC 504A. Frequencies above 10 MHz are internally prescaled. Measurement of pulse widths and periods at rates up to 2.5 MHz is possible. Width and Period averaging of up to 1000 events is possible. An autorange feature allows the counter to automatically select the gate time (up to one second) or number of averages (up to 100). A  $\times 100$  phase-locked loop multiplier automatically increases display resolution by a factor of 100 in the 10 Hz to 25 kHz frequency range. The 10 MHz internal time base provides a single-shot resolution of 100 ns. Input signals can be ac or dc coupled and attenuated by a factor of five. All measurement results are displayed in a six digit LED readout.

No options to the standard DC 504A are available.

## Standard Accessories

1 Instruction Manual

## NOTE

*Refer to the tabbed Accessories page at the rear of this manual for more information.*

## Performance Conditions

The limits stated in the Performance Requirements column of the following tables are valid only if the DC 504A has been adjusted at an ambient temperature between  $+20^{\circ}\text{C}$  and  $+30^{\circ}\text{C}$  and is operating at an ambient temperature between  $0^{\circ}\text{C}$  and  $+50^{\circ}\text{C}$  unless otherwise stated.

Information given in the Supplemental Information and Description columns of the following tables is provided for user information only and should not be interpreted as performance check requirements.

The DC 504A must be operated or stored in an environment whose limits are described under Environmental Characteristics.

Allow at least 30 minutes warm up time for operation to specified accuracy; 60 minutes after storage in a high humidity environment.

Table 1-1  
ELECTRICAL CHARACTERISTICS

Characteristics	Performance Requirements	Supplemental Information
<b>INPUTS</b>		
Input Frequency Range Front Panel Rear Interface	Dc coupled, 0 to 100 MHz Ac coupled, 10 Hz to 100 MHz  Dc coupled, 0 to 50 MHz Ac coupled, 10 Hz to 50 MHz	
Input Sensitivity ×1 Attenuation  ×5 Attenuation Accuracy	30 mV rms sinewave (85 mV p-p) to 100 MHz 85 mV p-p pulse at a minimum width of 5 ns	Within 2% at dc
Input Dynamic Range X1 X5		2.0 V p-p signal within a $\pm 2.0$ Vdc window  10.0 V p-p signal within a $\pm 10.0$ Vdc window
Trigger Level Range		Typically greater than $\pm 2V$ X attenuator setting.
Maximum Safe Input Voltage Front Panel ×1 ×5 Rear Interface		200 V pk; 400 V p-p from dc to 50 kHz, derate to 15 V p-p from 1.33 MHz to 100 MHz  200 V pk; 400 V p-p from dc to 5 MHz, derate to 20 V p-p at 100 MHz  < 4 V pk
Input Impedance Front Panel ×1, ×5 Rear Interface ×1, ×5		1 M $\Omega$ , paralleled by approximately 25 pF  50 ohms $\pm 10\%$ at dc

Table 1-1 (cont.)

Characteristics	Performance Requirements	Supplemental Information
<b>FUNCTIONS</b>		
Frequency to 10 MHz		
Range	Dc coupled, 0 Hz to 10 MHz Ac coupled, 10 Hz to 10 MHz	
Accuracy		$\pm 1 \text{ count} \pm \text{time base error} \times \text{freq}$
Gate Time		10 ms to 10 sec, selectable in decade steps, or autoranging (10 ms to 1 sec only)
Resolution		
Non-phase-locked		100 Hz to 0.1 Hz, selectable in decade steps, or autoranging (100 Hz to 1 Hz only)
Phase Locked		1 Hz to 0.001 Hz, selectable in decade steps, or autoranging (1 Hz to 0.01 Hz only)
Lock Range	$10 \text{ Hz} \leq \text{Freq} \leq 25 \text{ kHz}$	
Multiplication	$\times 100$	
Lock Time	$\leq 5 \text{ seconds}$	Phase Lock Loop automatically increases resolution whenever loop locks. PLL defeat can be accomplished by an internal jumper.
Frequency to 100 MHz		
Range	Dc coupled, 0 Hz to 100 MHz Ac coupled, 10 Hz to 100 MHz	
Prescale Factor	$\div 10$	
Accuracy		$\pm 1 \text{ count} \pm \text{time base error} \times \text{freq}$
Gate Time (Resolution)		10 ms to 10 sec (1 kHz to 1 Hz). Selectable in decade steps, or autoranging (10 ms to 1 sec only).
Period AVG		
Freq Range	Dc coupled, 0 Hz to 2.5 MHz Ac coupled, 10 Hz to 2.5 MHz	Overflows above 99999.9 $\mu\text{s}$ (100 ms)
Number of Averages (N)		$10^0$ to $10^3$ , selectable in decade steps, or autoranging ( $10^0$ to $10^2$ only).
Resolution		100 ns to 100 ps, selectable in decade steps or autoranging (100 ns to 1 ns only).
Accuracy		$\pm \frac{100 \text{ ns}}{N} \pm \text{time base error} \times \text{period}$ $\pm 1.4 \times \left( \frac{\text{trigger jitter error}}{N} \right)$

Table 1-1 (cont.)



Characteristics	Performance Requirements	Supplemental Information
<p>Width  AVG</p> <p>Freq Range</p> <p>Slope</p> <p>Number of Avgs (N)</p> <p>Resolution</p> <p>Accuracy</p>	<p>Dc coupled, 0 Hz to 2.5 MHz Ac coupled, 10 Hz to 2.5 MHz</p> <p>Positive</p>	<p><math>10^0</math> to <math>10^3</math>, selectable in decades, or autoranging (<math>10^0</math> to <math>10^2</math> only)</p> <p><math>\frac{100 \text{ ns}}{\sqrt{N}}</math></p> <p><math>\pm \frac{100 \text{ ns}}{\sqrt{N}} \pm \text{time base error} \times \text{width}</math></p> <p><math>\pm \frac{\text{start trigger jitter error}}{\sqrt{N}}</math></p> <p><math>\pm \frac{\text{stop trigger jitter error}}{\sqrt{N}}</math></p> <p>+ (stop slew rate error – start slew rate error)</p> <p><math>\pm 10 \text{ ns}</math></p>
<p>Width  AVG</p> <p>Freq Range</p> <p>Slope</p> <p>Number of Avgs (N)</p> <p>Resolution</p> <p>Accuracy</p>	<p>Dc coupled, 0 Hz to 2.5 MHz Ac coupled, 10 Hz to 2.5 MHz</p> <p>Negative</p>	<p><math>10^0</math> to <math>10^3</math>, selectable in decades, or autoranging (<math>10^0</math> to <math>10^2</math> only)</p> <p><math>\frac{100 \text{ ns}}{\sqrt{N}}</math></p> <p><math>\pm \frac{100 \text{ ns}}{\sqrt{N}} \pm \text{time base error} \times \text{width}</math></p> <p><math>\pm \frac{\text{start trigger jitter error}}{\sqrt{N}}</math></p> <p><math>\pm \frac{\text{stop trigger jitter error}}{\sqrt{N}}</math></p> <p>+ (stop slew rate error – start slew rate error)</p> <p><math>\pm 10 \text{ ns}</math></p>

Table 1-1 (cont.)

Characteristics	Performance Requirements	Supplemental Information
Totalize Freq Range	Dc coupled, 0 Hz to 10 MHz Ac coupled, 10 Hz to 10 MHz	Overflows above 999999. Display update run/hold will hold display while counter continues to advance. Releasing run/hold will update display to new value.

NOTES:



$$\text{Trigger Jitter Error (in } \mu\text{s rms)} = \frac{\sqrt{(e_{n1})^2 + (e_{n2})^2} \text{ (V)}}{\text{Input slew rate at trigger point (V}/\mu\text{s)}}$$

where  $e_{n1}$  = 150  $\mu\text{V}$  rms typical internal noise

$e_{n2}$  = rms noise of the signal input at the trigger point for a 100 MHz bandwidth.

$$\text{Trigger slew rate error in } \mu\text{s} = \frac{\frac{\text{Input hysteresis (V)}}{2}}{|\text{Input slew rate}| \text{ at trigger point (V}/\mu\text{s)}}$$

where Input hysteresis = 30 mV p-p typical.

N = Number of periods averaged in PERIOD AVG, or the number of widths averaged in WIDTH AVG  or WIDTH AVG .

Time base error is the sum of all errors specified for the time base.

TIME BASE

Time Base Frequency (at calibration)	10 MHz $\pm 1 \times 10^{-7}$	
Adjustment Resolution	$\pm 5 \times 10^{-8}$	
Temperature Stability (0°C to +50°C)	$\pm 5 \times 10^{-6}$ ( $\pm 5$ ppm)	
Aging	$\leq 1 \times 10^{-6}$ /yr ( $\leq 1$ ppm/yr)	
External Timebase Input	10 MHz	Must Drive one HC Logic family load plus 100 K pull-down resistor $V_{IH} = 3.7 \text{ V}/40\mu\text{A}$ minimum $V_{IL} = 0.95 \text{ V}/10\mu\text{A}$ maximum

Table 1-2  
ENVIRONMENTAL<sup>a</sup>

Characteristics	Description	
Temperature	Meets MIL-T-28800B, class 5.	
Operating	0°C to +50°C	
Nonoperating	-55°C to +75°C	
Humidity	95% RH, 0°C to 30°C 75% RH, to 40°C 45% RH, to 50°C	Meets MIL-T-28800B, class 5.
Altitude	Meets MIL-T-28800B, class 5.	
Operating	4.6 km (15,000 ft)	
Nonoperating	15 km (50,000 ft)	
Vibration	0.38 mm (0.015") peak to peak, 5 Hz to 55 Hz, 75 minutes.	Meets MIL-T-28800B, class 5, when installed in qualified power modules. <sup>b</sup>
Shock	30 g's (1/2 sine), 11 ms duration, 3 shocks in each direction along 3 major axes, 18 total shocks.	Meets MIL-T-28800B, class 5, when installed in qualified power modules. <sup>b</sup>
Bench Handling	12 drops from 45°, 4" or equilibrium, whichever occurs first.	Meets MIL-T-28800B, class 5 when installed in qualified power modules. <sup>b</sup>
Packaged Product Vibration and Shock <sup>c</sup>	Qualified under National Safe Transit Association Preshipment Test Procedures 1A-B-1 and 1A-B-2.	
Electrostatic Immunity	20 kV maximum charge applied to instrument case.	
Electromagnetic Compatibility <sup>d</sup>	Within limits of F.C.C. Regulations, Part 15, Subpart J, Class A; VDE 0871; and MIL-461A tests RE01, CE01, CE03, RS01, RS03, CS01, and CS02. <sup>e</sup>	

ENVIRONMENTAL EXCEPTIONS

Temperature	During low temperature test 4.5.5.1.3 (b) for class 5, steps 4 and 5 shall be performed before step 2. Also, the instrument shall not be operating during step 6, paragraph 4.5.5.1.3 (e), class 5. While operating, condensed moisture shall not be present on class 5 instruments. Drying of the instrument for this class may be performed in a suitable chamber, if necessary.
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<sup>a</sup>With power module.

<sup>b</sup>Refer to TM 500/5000 power module specifications.

<sup>c</sup>Without power module.

<sup>d</sup>System performance subject to exceptions of power module or other individual plug-ins.

<sup>e</sup> Within 4 dB of RE02 spec at 140 MHz and 150 MHz.

Table 1-3  
PHYSICAL CHARACTERISTICS

Characteristics	Description
Finish	
Front Panel	Polycarbonate
Chassis	Chromate conversion coated aluminum
Net Weight (nominal)	794 g (1 3/4 lbs.)
Physical Dimensions (nominal)	
Height	126.0 mm (4.96 inches)
Width	65 mm (2.5 inches)
Length	278.8 mm (10.98 inches)



# OPERATING INSTRUCTIONS

## Introduction

This section of the manual provides operating information required to obtain the most effective performance from the DC 504A. Included is a functional description of the front panel controls and connectors, operating considerations, and basic measurement techniques. Also included are installation instructions and repackaging information.

## PREPARATION FOR USE

### First Time Inspection

Inspect the instrument for visible damage (dents, scratches, etc.). Keep the original shipping container and packing material for future use. If the instrument is damaged, notify the carrier and the nearest Tektronix Service Center or representative.

### Operating and Non-Operating Environments

The instrument can be operated, stored, or shipped within the environmental limits stated in the Specification section of this manual. However, the counter should be protected at all times from temperature extremes which can cause condensation within the instrument.

### Rear Interface Considerations

A slot between pins 21 and 22 on the rear connector identifies this instrument as a member of the TM 500 counter family. If the counter is used to build a system, insert a family barrier key (Tektronix Part No. 214-1593-02) in the corresponding position of the selected power module jack to prevent plug-ins belonging to a different family from being used in that compartment of the power module.

### WARNING

*To avoid electric shock, disconnect the power module power cord before inserting the family barrier key in the power module jack. Refer the barrier key insertion to qualified service personnel.*

### NOTE

*Rear interface information is found in the Maintenance section of this manual. Refer the interface connections to qualified service personnel.*

## INSTALLATION AND REMOVAL

### NOTE

*Refer to the Operator's Safety Summary in the front of this manual before installing this instrument in the power module.*

Refer to the power module instruction manual and make sure that the line selector block is positioned correctly for the line voltage in use. Check the counter and the power module for the proper fuses. Be certain that the power plug for the power module has the proper grounding conductor.

### CAUTION

*To prevent damage to the instrument, turn the power module off before installation or removal from the power module. Do not use excessive force to install or remove the instrument from the power module.*

Check to see that the plastic barrier keys on the interconnecting jack of the selected power module compartment match the cutouts in the rear interface connector for the counter. If they do not match, do not insert the counter until the reason is investigated.

If the cutouts and barrier keys match, align the chassis of the counter with the upper and lower guides of the selected compartment. See Fig. 2-1. Insert the counter into the compartment and press firmly to seat the rear interface connector. Apply power by operating the POWER switch on the power module.

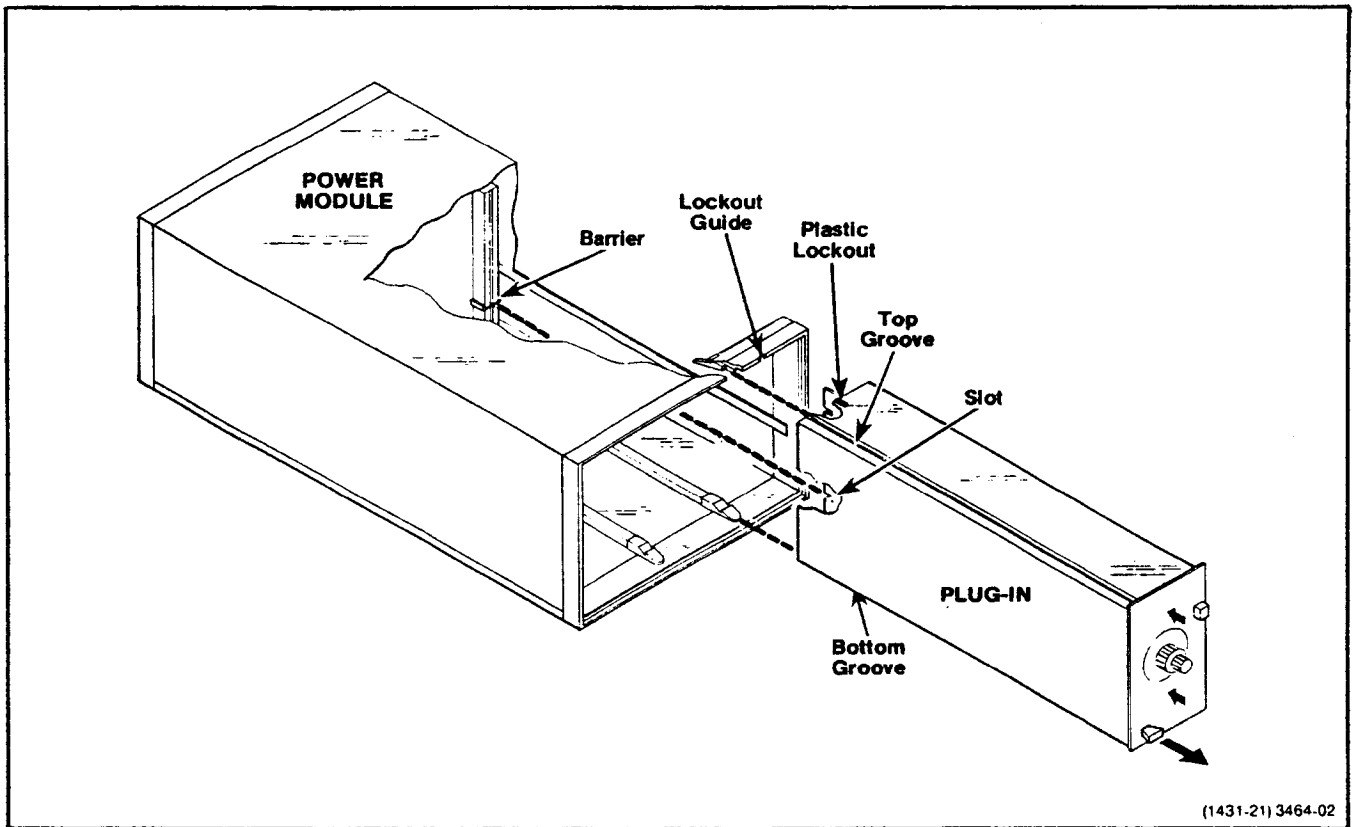


Fig. 2-1. Plug-in installation and removal.

To remove the counter from the power module, turn off the POWER switch, pull the release latch knob (located in the lower left front corner) until the interconnecting jack disengages. Pull the counter straight out of the power module compartment.

- ③ OVERFLOW—when illuminated, indicates register overflow.
- ④ MULTIPLIER LOCK—illuminated when the Multiplier (Phase Lock Loop) circuit is active. The Multiplier is automatically activated when measuring frequencies between 10 Hz and 25 kHz. This circuit multiplies the measured frequency by 100, providing two additional digits of display resolution.
- ⑤ FUNCTION—selects the following measurement or counting modes for the instrument.

## CONTROLS AND CONNECTORS

Although the DC 504A is fully calibrated and ready to use, the location and function of the controls and connectors should be reviewed before attempting to operate it. Following is a brief description of the front panel controls and connectors. Refer to Fig. 2-2.

- ① READOUT DISPLAY—six digit LED readout with automatically positioned decimal point and leading zero suppression. Display reads in KILOHERTZ or MICROSECONDS.
- ② GATE—indicates the status of the main gate. When illuminated, the gate is open; the instrument is in the process of making a measurement. When extinguished, the gate is closed.

FREQ TO 10 MHz—measures directly and displays the frequency of input signals up to 10 MHz.

FREQ TO 100 MHz—internally prescales and displays the frequency of input signals up to 100 MHz.

PERIOD—measures and displays the period of the input signal.

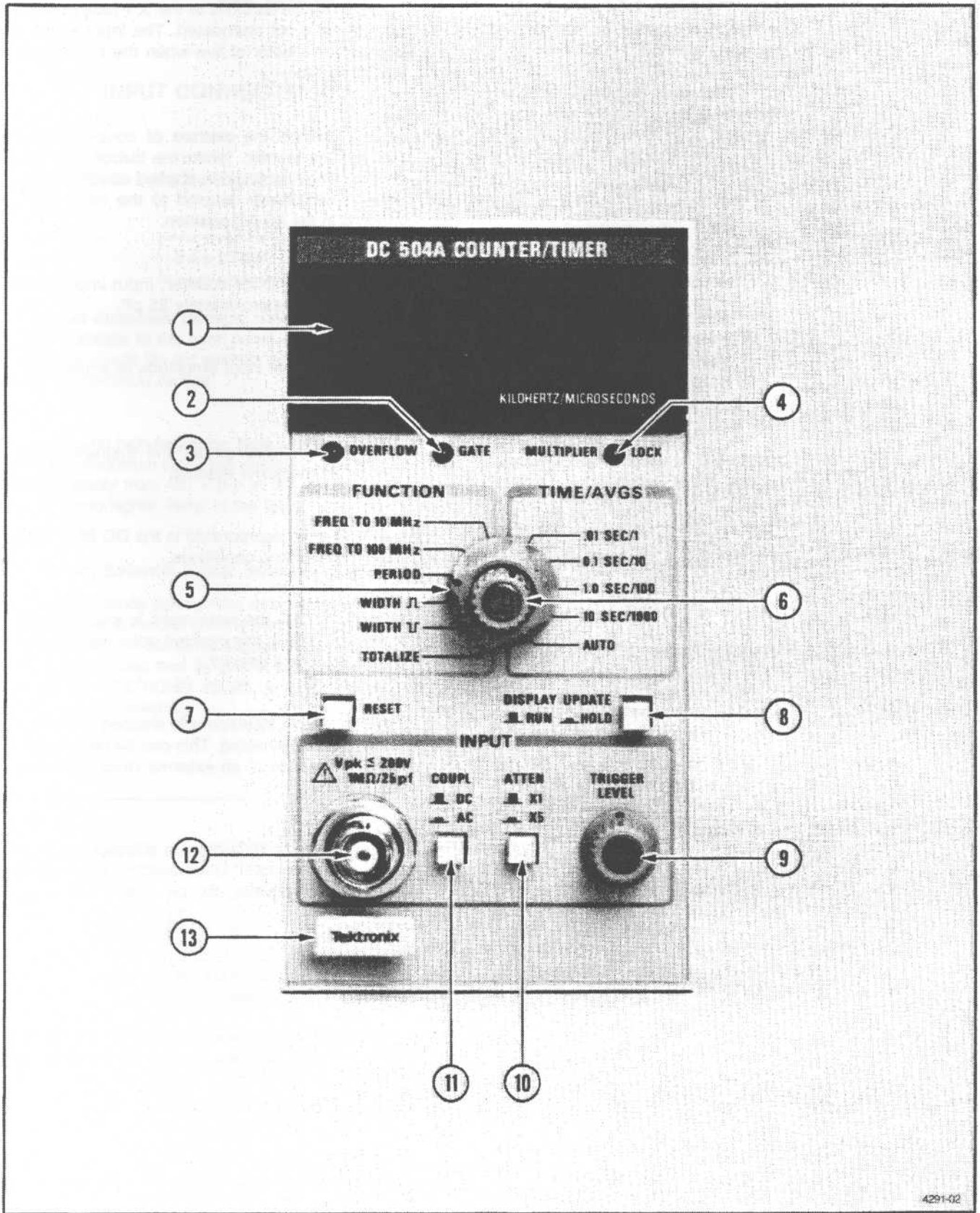




Fig. 2-2. Controls and Connectors.

WIDTH  —measures and displays the time interval between the triggering point on the positive leading edge to the corresponding point on the trailing edge of a pulse applied to the input.

WIDTH  —measures and displays the time interval between the triggering point on the negative leading edge to the corresponding point on the trailing edge of a pulse applied to the input.

TOTALIZE—pulses applied to the input will be displayed in a running total until the counter is manually reset or register overflow occurs.

⑥ TIME/AVGS—depending on the position of the FUNCTION switch, selects the gate time or the number of measurements to be averaged. In AUTO, a gate time that will display six digits is automatically selected.

⑦ RESET—resets the count to zero when operating in the TOTALIZE mode. Acts as a master reset ensuring that the readout has been cleared before the next measurement. Also provides a check of all display LED's; when pressed and held, a row of 8's is displayed.

⑧ DISPLAY UPDATE—when the button is in the RUN (out) position, the DC 504A counts or makes measurements continuously.

When the button is in the HOLD (in) position and the instrument is in a measurement mode, the last measurement is displayed and no more made until the button is released.

When the instrument is counting (TOTALIZE), moving the button to the HOLD position stops the display only; the count continues to accumulate in the registers. When the button is released, the display is automatically updated to the current count accumulation and continues to run.

⑨ TRIGGER LEVEL—selects the amplitude point on the positive or negative slope of the input signal at which the triggering window is placed.

⑩ ATTEN—selects the attenuation factor for the input signal. When the button is in the  $\times 1$  (out) position the input signal is not attenuated. The input signal is attenuated by a factor of five when the button is in the  $\times 5$  (in) position.

⑪ COUPL—selects the method of coupling the input signal to the counter. When the button is in the DC (out) position, the signal is applied directly. The input signal is capacitively coupled to the input when the button is in the AC (in) position.

⑫ Input Connector to the counter. Input impedance is  $1\text{ M}\Omega$  shunted by approximately  $25\text{ pF}$ .



Maximum input amplitude is limited to 200 V peak.

⑬ Release Latch—disengages the instrument for removal from the power module.

Provisions have been incorporated in the DC 504A to modify the following operating conditions.

Multiplier (PLL)—the instrument is shipped with the multiplier circuit in the enabled condition. This circuit can be disabled if desired.

Time Base—the instrument is shipped with the internal time base connected. This can be disconnected to permit application of an external clock signal via the rear interface.

Signal Input—the instrument is shipped with the front panel input connected. Disconnecting this input allows signal measurements to be made via the rear interface.

**WARNING**

*Refer qualified service personnel to the Maintenance Section to make changes to the above operating conditions.*

# OPERATING CONSIDERATIONS

## INPUT CONNECTIONS

### Maximum Safe Input Voltage Limits



#### CAUTION

To avoid instrument damage, make certain that the input voltages to the front panel connectors or rear interface inputs do not exceed their specified limits. See Specification section.

Be careful with high-frequency, high-amplitude signals. The front panel maximum safe input voltage ( $\times 1$  attenuation) is derated linearly from 400 V p-p at 50 kHz to 15 V p-p at 1.33 MHz and higher. Refer to the Specification section.

### Connecting External Signal Sources

If a high impedance signal probe is to be used between the front panel bnc connector and the measurement source, use a probe capable of compensating for the input capacitance of the counter (less than 30 pF). A high impedance probe such as the TEKTRONIX P6125, is recommended for all digital logic applications.

### Input Coupling, Noise, and Attenuation

You can use either the ac coupling (AC COUPL) or dc coupling (DC COUPL) mode to couple the input signal to the input amplifier. If the signal to be measured is riding on a dc level, its amplitude limits may not fall within the triggering level range. The AC COUPL mode should be used for repetitive signals having a fixed frequency and a constant duty cycle when they are riding on a large dc level.

If the signal duty cycle changes during a measurement, the triggering point will shift, possibly causing erroneous results. Use the DC COUPL mode for low frequency ac signals without large dc offset, signals with a low duty cycle, and during width measurements.

Noise may be coupled to the input amplifier along with the signal to be measured. Noise may originate from the operating environment, the signal source, or be caused by improper connections. If the noise is of sufficient amplitude, it can result in inaccurate measurements due to false triggering. Using an external attenuator may solve the problem. See Fig. 2-3.

The input dynamic range specification describes the largest amplitude signal with a risetime or falltime less than about 5 ns that will not cause ringing and distortion internal to the counter. Ringing may cause mistriggering near the positive or negative peaks of the signal.

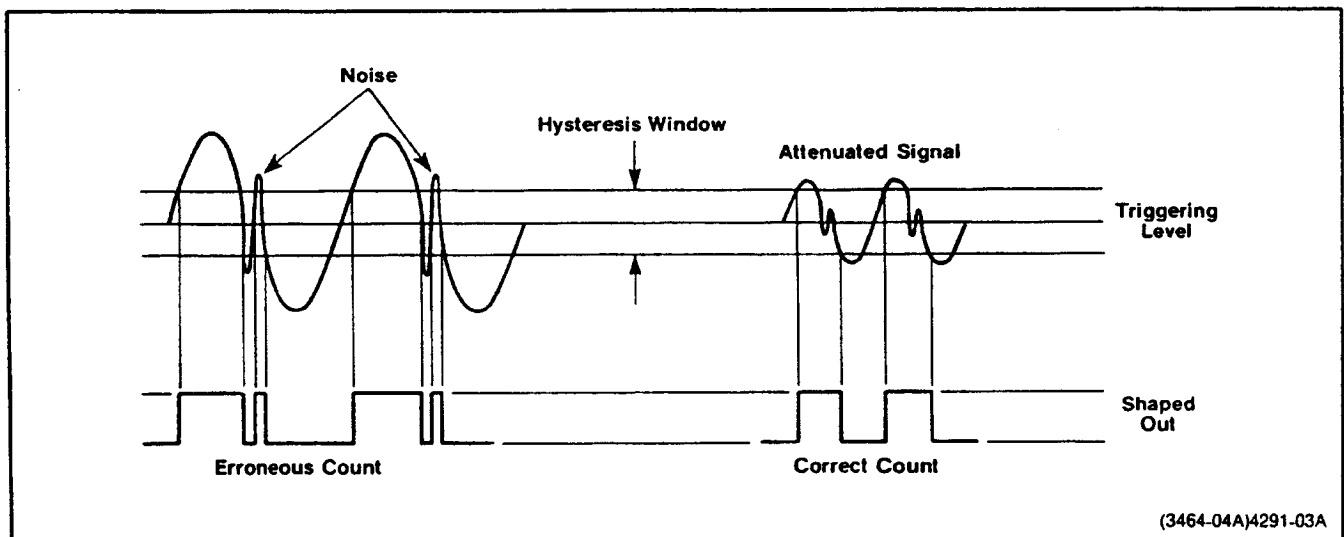


Fig. 2-3. Advantages in signal attenuation.

The minimum signal amplitudes are defined by the input sensitivity requirements for the AC COUPL and DC COUPL modes (see Specification section). Proper use of the ATTEN (attenuation) control will ensure operation within the maximum limits;  $\pm 2$  V for  $\times 1$  ATTEN,  $\pm 10$  V for  $\times 5$  ATTEN.

### Triggering

The TRIGGER LEVEL and COUPL controls affect the counter's ability to make a measurement. In general, the trigger controls are similar to oscilloscope controls, except that the end result is not a stable waveform graphic display, but a stable digital frequency display.

**Input Coupling Switch.** The Input Coupling switch selects ac (capacitive) or dc (direct) coupling for the input signal. Ac coupling is convenient for most frequency measurements to avoid readjusting the TRIGGER LEVEL control for changing dc levels. It does, however, reduce sensitivity to signals below 10 Hz. Thus, for period measurements longer than 0.1 sec, dc coupling should be used.

**Trigger Level.** The TRIGGER LEVEL control must be properly adjusted for a stable reading. It is not difficult to adjust unless the signal amplitude or frequency is close to (or beyond) the specified limits.

A signal that looks stable on an oscilloscope may still show jitter when measured with a digital counter. If the count varies from reading to reading, it is probably due to jitter in the signal source. If the count changes dramatically, the DC 504A is not being triggered properly, either because the controls are not set right or the signal is beyond the counter's capabilities (too small in amplitude or too high in frequency).

The TRIGGER LEVEL control allows the operator to move the hysteresis window of the trigger circuit to an optimum level on the input signal to ensure stable triggering. The TRIGGER LEVEL control adjusts over a nominal  $\pm 2.0$  V range of the input signal. If a wider range is desirable, use the  $\times 5$  input attenuator for  $\pm 10$  V range.

### Reducing Measurement Errors

As an aid in reducing measurement errors, keep in mind the following factors:

Use the proper ATTEN control and high impedance attenuator type probes when measuring signals from high impedance circuits.

- Consider trigger errors caused by input signals with slow rise or falltimes.
- Average the measurement over a larger number of cycles of the input signal (greater number of AVERAGES).
- Maintain the counter environment at a constant temperature.
- Apply a 10 MHz external time reference standard to the rear interface inputs.
- Perform internal adjustments, if necessary.

## FREQUENCY MEASUREMENTS

Use ac coupling for most frequency measurements to avoid readjusting the LEVEL control because of changing dc levels. Signals less than 4 volts peak-to-peak need not be attenuated; larger signals should be attenuated to within the range of 85 mV to 4 volts peak-to-peak.

Set the FUNCTION switch to FREQ TO 10 MHz and, with the TIME/AVGS switch, select one of the shorter gate times. Connect the signal to be measured to the input and adjust the TRIGGER LEVEL control for a stable display. The level control setting is not critical unless the signal amplitude and frequency are close to specified limits. Fig. 2-4 shows waveform timing during frequency measurement.

### Measurement Intervals

To adjust the trigger control, choose a short gate time such as 0.1 or .01 seconds. This gives rapid feedback via the display as to whether or not the counter is being triggered. Final selection of gate time depends upon the frequency being measured, desired resolution, and the time required to make a measurement. A 10 second gate time requires 10 seconds for a measurement to be made and displayed. This gives 0.1 Hz resolution. See Table 2-1.

### Overflow

Through intentional use of overflow displays, it is possible to increase the resolution of the counter. Select a gate time that displays the most significant digit as far to the left as possible without overflow. Note the numbers displayed to the right of the decimal. Move the decimal to the left, by selecting longer gate times, until the desired resolution is

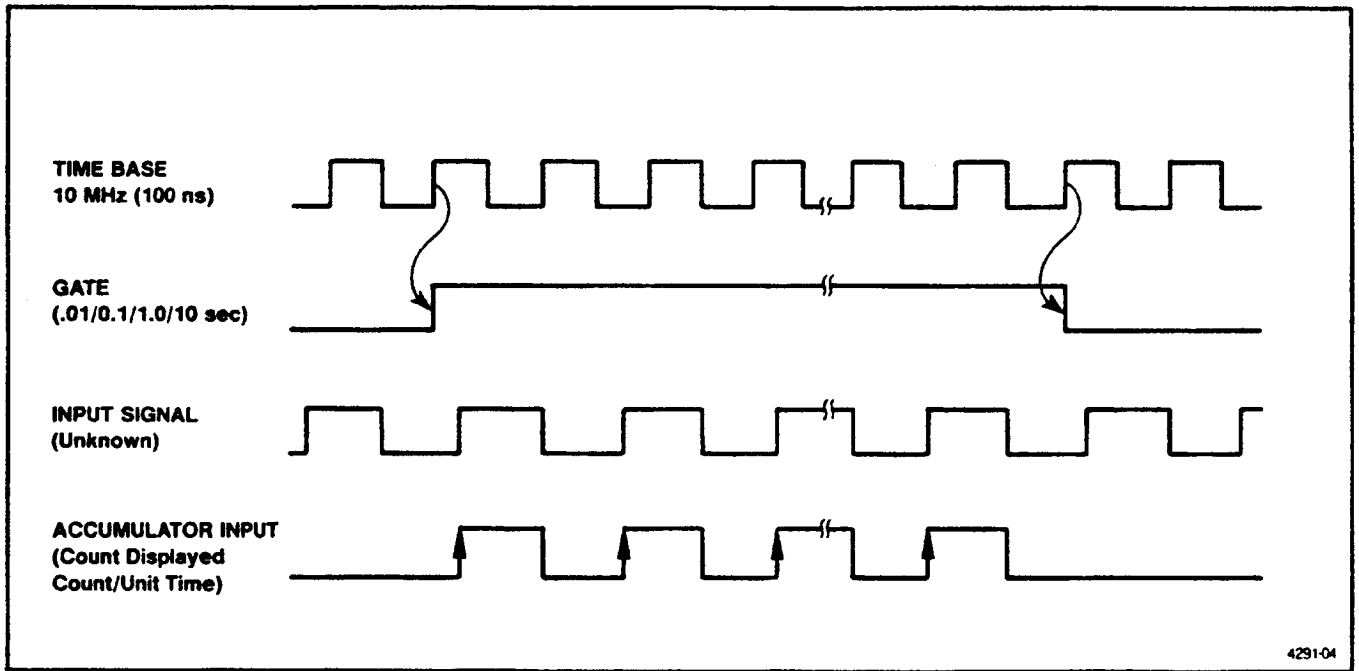


Fig. 2-4. Frequency Measurement.

achieved. The OVERFLOW indicator will light when the most significant digit has overflowed the last storage register. The relationship between gate time and resolution is shown in Table 2-1.

Table 2-1  
GATE TIME VS. MEASUREMENT RESOLUTION

Gate Time	FREQ TO 10 MHz	FREQ TO 10 MHz Multiplier Locked	FREQ TO 100 MHz
.01 sec	100 Hz	1 Hz	1 kHz
0.1 sec	10 Hz	0.1 Hz	100 Hz
1.0 sec	1 Hz	.01 Hz	10 Hz
10 sec	0.1 Hz	.001 Hz	1 Hz

**Frequencies Lower Than 10 MHz**

Frequencies 10 MHz and below are measured with the FUNCTION switch in the FREQ TO 10 MHz position. Frequencies within the range 10 Hz to 25 kHz are automatically multiplied internally by 100 to increase display resolution. This is accomplished by routing the incoming signal through a phase-locked loop multiplier circuit before it is counted. If, for example, a 5 kHz signal is to be measured with a conventional counter, the display would read 5.000 kHz with one second of gate time. The same signal measured with

the DC 504A, because it is multiplied by 100 (the counter is actually measuring 500 kHz), would display 5.00000 kHz with one second of gate time.

Since any frequency within the range of the multiplier will be multiplied, provision has been incorporated to lock out this feature if so desired. Refer qualified service personnel to the Maintenance Section. A front panel LED indicates when the multiplier is locked. The multiplier circuit is only active when the DC 504A is in this mode.

**NOTE**

When the multiplier is locked and a gate time of 10 Sec is selected, no decimal point appears. The decimal point is implied to the left of the sixth digit (MSD).

**Frequencies Higher Than 10 MHz**

Frequencies between 10 MHz and 100 MHz are measured with the FUNCTION switch in the FREQ TO 100 MHz position. Input frequencies in this range are internally prescaled (divided) by a factor of 10. If, for example, a frequency of 95 MHz is to be measured, the prescaler divides it down so the counter is actually measuring only 9.5 MHz. This, however, also reduces the display resolution by a factor of 10. Resolution can be increased, if desired, by selecting a longer gate time.

## PERIOD MEASUREMENTS

The PERIOD mode reverses the functions of signal and clock as compared to the frequency mode. In frequency mode, signal events are counted for some number of clock pulses, then displayed. In PERIOD, clock pulses are counted for some number of signal events then displayed. Refer to Fig. 2-5.

### Low Frequencies

Period measurements of signals below 10 Hz, and particularly in the lowest decade from 0.1 Hz to 1.0 Hz, are sensitive to wave shape and amplitude. Since it is desirable for the signal to pass through the trigger hysteresis abruptly, square-wave inputs are preferred. Sine and triangle waves can be measured accurately at the very low end if the input amplitude is kept somewhat above minimum specification so that the trigger input is driven hard.

### Period Averaging

The best single shot resolution attainable in a period measurement is a direct function of the speed (frequency) of the time base clock being counted. The DC 504A has a 10 MHz time base; a single period of this time base is 100 ns (period = 1/frequency). Therefore, the resolution of a single period measurement is 100 ns.

Resolution can be increased by utilizing the capability of the DC 504A to average period measurements. Period averaging

up to 1000 is attainable, which results in a directly proportional increase in resolution. If, for example, the resolution of a single period measurement is 100 ns, averaging 1000 events results in a 1000 times increase in resolution, or 100 ps.

To illustrate the display readout, assume an input signal with a 1.0032  $\mu$ s period. A single period measurement would display 1.0  $\mu$ s (100 ns LSD). Averaging 10 periods of this same signal would display 1.00  $\mu$ s (10 ns LSD) and 100 periods would display 1.003  $\mu$ s (1  $\mu$ s LSD). With a 1000 period average the display will read 1.0032  $\mu$ s (100 ps LSD).

In the AUTO mode, the counter always attempts to fill the display (6 digits) while averaging up to 100 events. Note that periods longer than 100 ms will overflow the display.

## WIDTH MEASUREMENTS

The width modes measure the time between two points on a waveform. These two points are selected with the TRIGGER LEVEL control such that the main gate turns on at the selected level and turns off at the same level but the opposite slope. Refer to Fig. 2-6.

### Width Averaging

Averaging can be used to increase the accuracy and resolution of repetitive signal measurements. The basic reason for

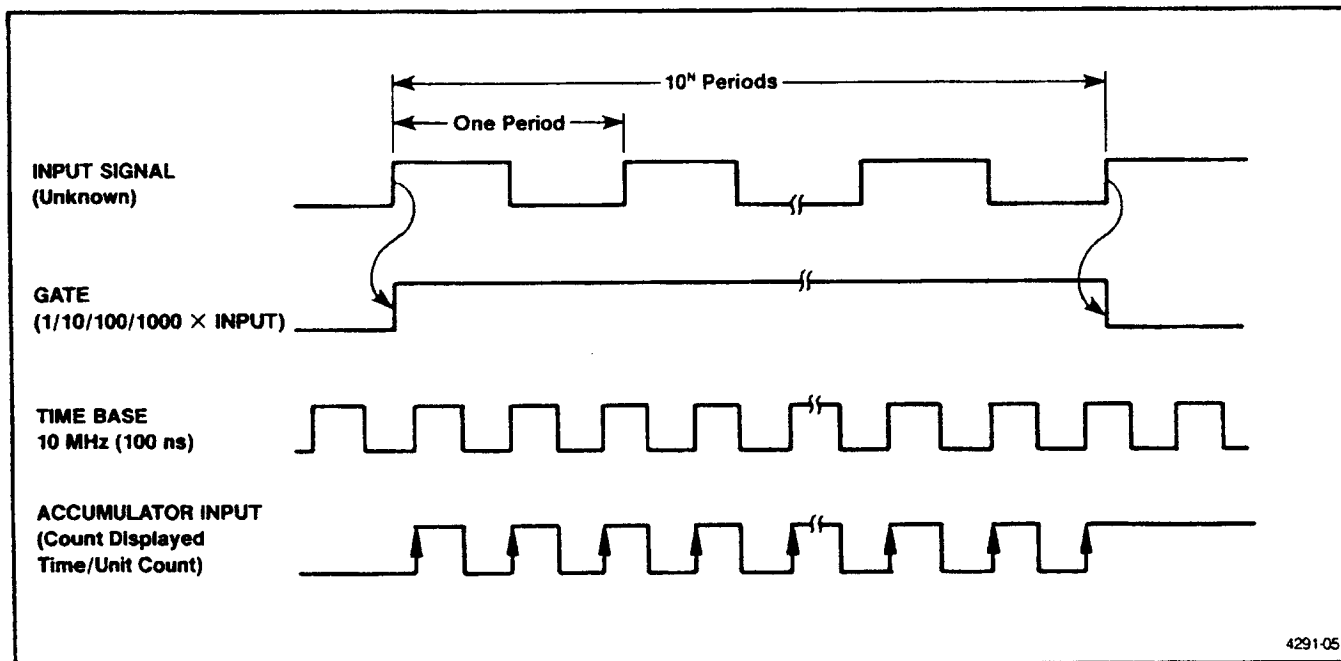


Fig. 2-5. Period Measurement.



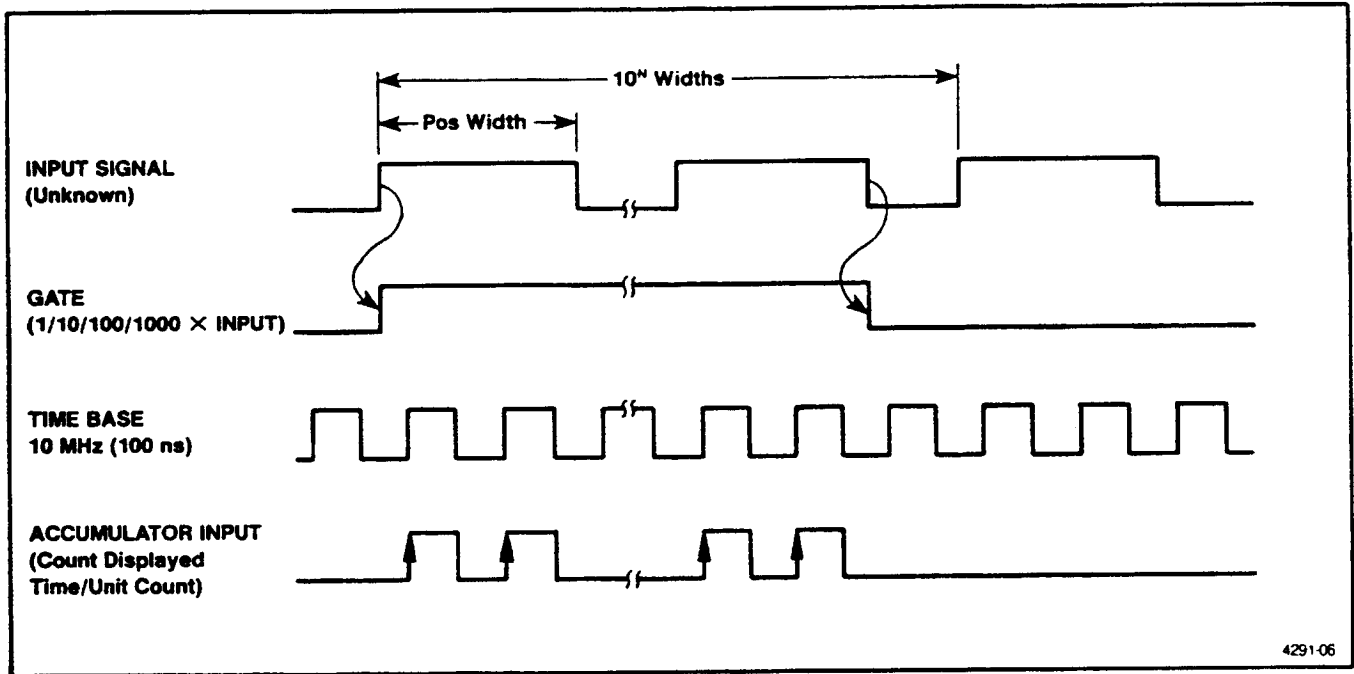


Fig. 2-6. Width Measurement.

averaging is the statistical reduction of the  $\pm 1$  count error. If the  $\pm 1$  count error is truly random, then as more intervals are averaged, the measurement will tend to approach the true value of the time interval. For time interval averaging to work, the time interval being measured must be repetitive and have a repetition frequency that is nonsynchronous to the counter clock rate.

The DC 504A has the capability of width averaging up to 1000 events. This single input measurement is much easier than typically associated with Universal Time Interval Counters.

#### NOTE

*Width  $\lrcorner$  and Width  $\llcorner$  require an arming pulse before a measurement begins. In the case where a stream of pulses is being measured, this presents no problem as the first pulse will arm the measurement, and the next "N" pulses will be measured. If a single pulse is to be measured, the counter can be put into the armed mode by rotating the trigger level completely clockwise, then counter-clockwise until the GATE indicator just turns on (it may require two rotations). The counter is then armed and will measure the next pulse it sees.*

## TOTALIZING

In the Totalize mode, signal events applied to the INPUT are counted and the accumulated total is displayed until the re-

set button is pushed or the FUNCTION switch is changed to another position. This mode is a manual analog of the frequency mode. Its main application is to accumulate a count of relatively slow and irregular events.

### Starting the Count

Apply the signal to the input connector and set the trigger controls the same as for frequency measurement. Adjust the TRIGGER LEVEL control until the displayed total begins to increment. The accumulated count is displayed in whole numbers. In the Totalize mode, only the TRIGGER LEVEL control, the RESET button and the DISPLAY UPDATE button affect the display.

#### NOTE

*In the TOTALIZE mode, moving the DISPLAY UPDATE button to the HOLD position stops the display only; the count continues to accumulate in the registers. Releasing the button to the RUN position updates the display to the current register accumulation and the count display continues from there.*

## REPACKAGING FOR SHIPMENT

Should it become necessary to return the instrument to a Tektronix Service Center for service or repair, attach a tag to the instrument showing the owner (with address) and the name of the individual to be contacted, complete instrument serial number, option number, and a description of the service required.

## Operating Instructions—DC 504A

If the original container and packaging material is unfit for use or not available, repackage the instrument as follows:

1. Obtain a carton of corrugated cardboard having inside dimensions no less than six inches more than the instrument dimensions; this will allow for cushioning. The shipping carton test strength for the DC 504A is 200 pounds.
2. Surround the instrument with polyethylene sheeting to protect the finish.
3. Cushion the instrument on all sides by tightly packing dunnage or urethane foam between carton and instrument, allowing three inches on all sides.
4. Seal the carton with shipping tape or industrial staples.
5. Mark the shipping carton "FRAGILE INSTRUMENT" to indicate special handling.

## Warning

*The following servicing instructions are for use only by qualified personnel. To avoid personnel injury, do not perform any servicing other than that contained in the operating instructions unless you are qualified to do so. Refer to General Safety Summary and Service Safety Summary prior to performing any service.*

# THEORY OF OPERATION

## Introduction

This section of the manual contains a description of the electrical circuits of the DC 504A. Refer to the block diagram and schematic diagrams on the foldout pages in the rear of the manual to aid in understanding this description. Diamond enclosed numbers appearing throughout this section refer to the schematic diagram on which the circuit being discussed is located. The schematic diagrams are divided with gray-tint blocks according to circuit function. The titles correspond to those shown on the block diagram.

## Block Diagram

The block diagram shows the stages and basic interconnections of each major circuit in the instrument. Each circuit is described in detail. Use the block diagram and detailed circuit diagrams for reference.

## Input Conditioning 1

Input signals are applied to front panel connector J4015, or through connections at the rear interface. The position of Input selector jumper P4014 selects either front panel or rear interface input. Input to the rear interface is terminated in  $50\ \Omega$  (R4015) to allow connections using standard  $50\ \Omega$  coaxial cable. Input signals pass through DC/AC coupling switch S4024 into a frequency compensated attenuator network. Attenuator switch S4025 is normally in the  $\times 1$  position, which allows the signal to pass directly through. Five times attenuation is provided by R4023 and R4024. C4021 and C4025 provide frequency compensation. R4028 is the  $1\ \text{M}\Omega$  input termination. R4032, R4036, and C4036 serve to limit current to and compensate for capacitance around the gate of Q4022. Overvoltage protection is provided by CR4032 and CR4037. These diodes clamp the signal at approximately  $\pm 5.5\ \text{V}$ .

A matched pair of FET's, Q4022 and Q4023, form a high impedance differential comparator. Constant current to this amplifier is supplied by Q4021 with associated circuitry. The voltage at the gate of Q4023 is set by the TRIGGER LEVEL control (R4037). This voltage is divided across R4033 and R4034 to approximately  $\pm 2.2\ \text{V}$ .

The output of the comparator drives a three stage line receiver, the inputs of which are pins 9 and 10 of U3022B. The

first stage matches the impedance of the comparator to the second stage amplifier. U3022A is a voltage amplifier with a gain of approximately three. The third stage, U3022C, is configured as a Schmitt trigger circuit. High frequency peaking is accomplished by C3021. This stage serves to shape the inputs into fast edge outputs which feed to the counter.

## Signal Routing 2

Output from the Schmitt trigger is routed through one of three paths to the counter circuit. Depending on the function or frequency range selected, signals pass directly, through a  $\div 10$  prescaler, or through a  $\times 100$  resolution multiplier (phase-locked loop) to the counter.

**DIRECT.** This routing to the counter is through a switching circuit composed of U1063A, Q1066, and Q1068. For all signals, except frequencies to be multiplied or divided, or negative pulse measurements, Q1068 turns off and the signal path is through Q1066. When the instrument is set to measure negative pulse width, Q1066 turns off and the signal path is through Q1068. When measuring frequencies higher than 10 MHz, Q1066 and Q1068 are both turned off and the path is through the  $\div 10$  Prescaler, U2067.

The output of the switching circuit is fed to pin 9 of U1063B. The differential outputs of U1063B drive an ECL to TTL converter, Q1062 and Q1064. The converter outputs are inverted through U1048A and U1048B and applied directly to the A and B inputs of the counter, U2047 (Diagram 3).

**PRESCALER.** Inputs at frequencies from 10 MHz to 100 MHz are routed through a  $\div 10$  prescaler. In this mode, both transistor switches (Q1066 and Q1068) are off and the signal is applied to the input (pin 7) of U2067. This integrated circuit is a  $\div 10$  counter; the output frequency is one-tenth the input frequency. The prescaler output (pin 15) connects to pin 10 of U1063B. The signal then routes through the ECL to TTL converter to the counter circuits. The prescaler is enabled when pin 9 is pulled low through S2061A in the FREQ TO 100 MHz position.

**$\times 100$  MULTIPLIER.** With the FUNCTION switch in the FREQUENCY TO 10 MHz position, inputs ranging between 10 Hz and 25 kHz route to a  $\times 100$  Resolution Multiplier

(phase-locked loop) circuit. This is an automatic function unless the loop is disabled by moving jumper P1040 (PLL Defeat) to the ground position.

Transistor Q1056 serves as an ECL to TTL converter. The input signal is buffered and inverted by U1052D and fed to pin 14 of U2054. (The output signal from U1052D is +5 V to -5 V). This integrated circuit consists of a phase comparator and voltage controlled oscillator. Only the phase comparator is utilized. The phase of the signal at pin 14 is compared to the phase of the signal at pin 3. The output at pin 13 determines the oscillator frequency. The voltage controlled oscillator (VCO) consists of U1044A, B, C, Q1053 and Q1054.

To understand the operation of the oscillator circuitry, assume that the emitter of Q1054 is at about +5 V. Current flows through U1044A and R1046 charging capacitor C1052. Pin 10 of U1044C is at about +5 V and pin 12 at about -5 V. Q1054 is turned off, with its base at about +5 V. The drain of U1044A goes negative at a rate determined by the current flow through it. When the voltage at the drain of U1044A drops to about 0 V, pin 12 of U1044C switches to about +5 V and pin 8 of U1044B goes low turning Q1054 on. As current flows through Q1054, the voltage drop across R1046 increases turning on Q1053. Current flow through Q1053 is much greater than through U1044A and pin 10 of U1044C rises rapidly until U1044C and U1044B change state. This turns off Q1054 and repeats the cycle. The output waveform at the collector of Q1054 is a fast spike from about -5 V to about 0 V. The frequency of the circuit varies from about 500 Hz to about 3.5 MHz. This is accomplished by varying the current through U1044A and consequently the charge time of C1052.

The positive going (-5 V to 0 V) spike, at varying frequencies, feeds to U1052A, is buffered, inverted and applied to the input of U1032 (pin 4). This integrated circuit (U1032A and B) divides the output frequency by 100. The output of U1032 (pin 13) feeds through Q1043, a TTL to MOS converter, to the second input of the phase comparator (U2054 pin 3).

If the frequency of the waveform at the collector of Q1054 goes higher than exactly 100 times the input (pin 14 U2054), the output voltage at pin 13 of U2054 goes more negative, reducing the oscillator frequency until both frequencies are in lock. The oscillator output at pin 3 U1052A feeds through U1052B and U1063C, is converted to ECL levels and applied to the third input, pin 11, of U1063B.

When the circuit is out of lock, pin 1 of U2054 goes low turning Q1057 on and Q1052 off. This results in a high at the output (pin 8) of U1052C. This high is applied to pin 9 of U1031B (Diagram 5) causing its output to go low. This low

at pin 13 of U1048E causes its output to go high extinguishing the MULTIPLIER LOCK indicator (Diagram 4). When the loop is locked, the output of U1052C goes low and the indicator is on.

### Counter

The counting circuitry for the DC 504A is contained almost entirely in one integrated circuit package U2047. With the exception of R2051, C2051, C2052, C2053, and a 10 MHz crystal (Y2054), the time base circuit is internal to the package. Range, function detection, switching circuitry, time slot, and display segment decoders and drivers are contained in the package.

The external oscillator input to the counter at pin 33 is connected to the buffered internal time base output, pin 38. Counter timing can also be from a clock signal external to the instrument by moving P2042 to the Ext position. This signal is taken from pin 14A on the rear interface and buffered by U2027C.

Variable capacitor C2051 serves to compensate for variations in the 10 MHz crystal and will vary the oscillator frequency several hundred Hertz.

The counter has two inputs for measured events; input A (pin 40) and input B (pin 2). All signals to these inputs come through the ECL to TTL converter circuit (Diagram 2). All events to be counted, except width, are applied to input A. In the width mode, the counter measures the time interval between an event on A input and an event on B input. For example: in the width positive mode, the rising edge of the pulse triggers input A starting the count, and the falling edge triggers input B stopping the count. There are four other inputs that set the counter to measure and display signals applied to inputs A and B. These inputs are: Range (pin 21), Function (pin 4), Control (pin 1), and Ext Decimal Point (pin 20). The counter digit drive (time slot) outputs, through the range and function select circuitry, provide the control signals. This is discussed in more detail under the heading Range and Function Selection.

The Run/Hold function is controlled by front panel pushbutton switch S3032. When the switch is in the RUN (out) position, pin 39 of U2047 is low through Q3031. When the switch is moved to the HOLD (in) position, pin 39 is at +5 V stopping the counter. The last complete measurement made is displayed. When operating in the TOTALIZE mode, activating HOLD stops only the display; the counter continues to accumulate information. Returning to RUN updates the display to the data in the accumulator and the count continues.

The Reset Input, pin 19, is high when the counter is running. Moving S3012A (RESET) to the reset position resets the counter to zero and clears the display. With S3012A in this position, pin 12 of U1031C (Diagram 5) is also pulled low enabling the gate and allowing TS8 to pass through the gate. TS8 is inverted through U1031A and applied to the counter Control Input, pin 1. During TS8, the counter Display Test function is activated and all segments and decimal points in the display are illuminated.

The BCD outputs, pins 6, 7, 17, and 18 are used to detect display zeros. The BCD information is applied to U1037A which triggers the autorange circuitry. Additional details are contained in the discussion on Autoranging.

The Measurement In Progress output at pin 3 is used to drive the front panel GATE indicator. The level at this pin is

low when the gate is open and the counter is making a measurement. This output is buffered and inverted through U1048D. The high output from U1048D turns the pulse stretcher circuit on, Q2023 and Q2027 (Diagram 4), which illuminates the GATE indicator. This circuit lengthens short gate pulses (to approximately 50 ms) so that the GATE indicator is on long enough to be visible.

The  $\overline{\text{STORE}}$  (pin 5) and  $\overline{\text{RESET}}$  (pin 32) outputs latch and reset the autorange circuit. See Autorange. Refer to Fig. 3-1 for the Gate, Store, and Reset relationship.

The digit select and segment drive outputs drive the display elements directly. However, because these outputs are neither TTL nor CMOS compatible, they are routed through level shift circuitry to drive the Range and Function Select components. The level shift circuit consists of a pair of

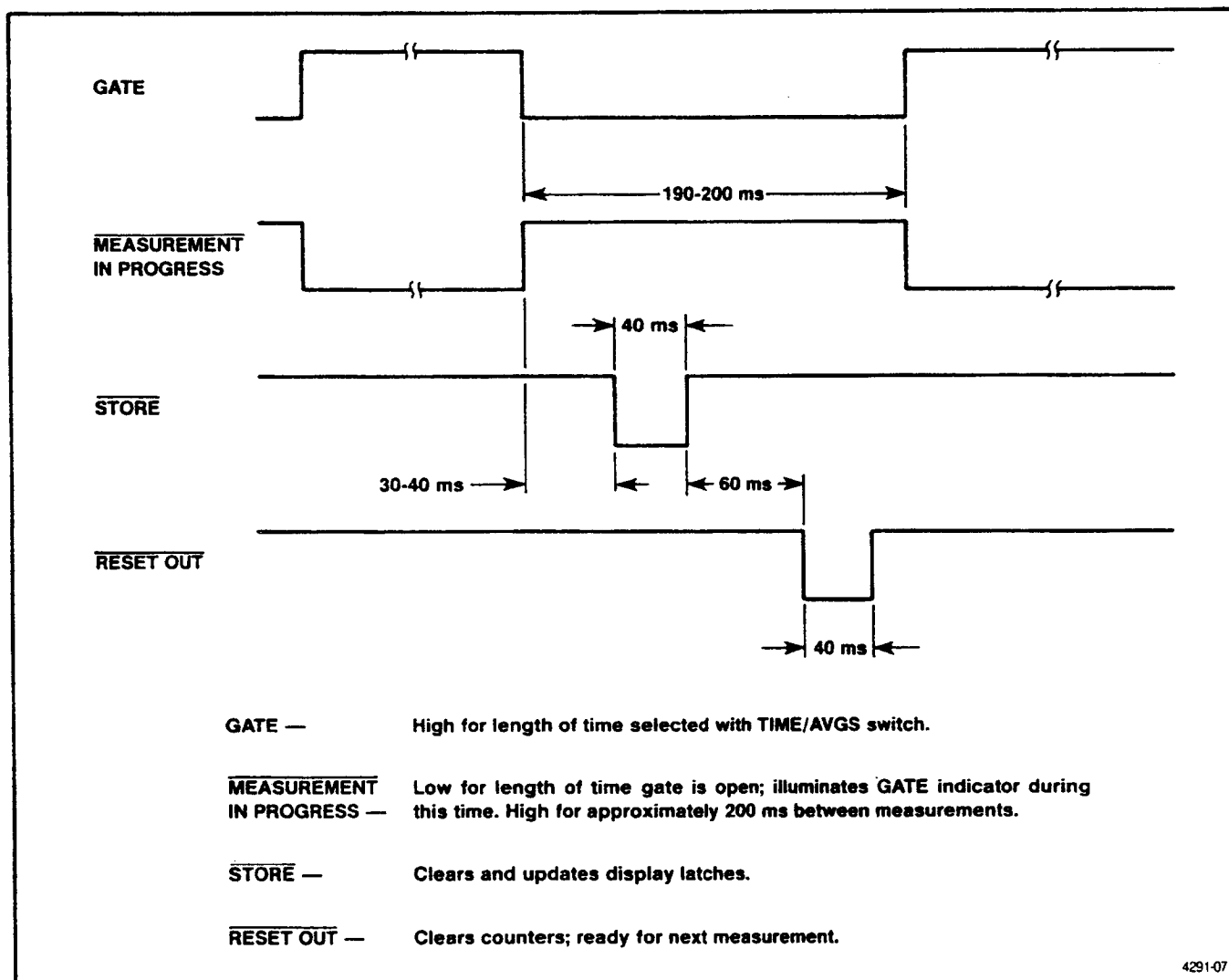


Fig. 3-1. Relationship of display update and counter reset signals.

quad-comparators U2043 and U2045. The reference voltage (minus input) of each unit is set at +2.5 V through divider R2034 and R2035. The open collector output of each device is pulled up to +5 V through 10 kΩ resistors, R1043B through I. The outputs of these comparators drive Multiplexer U1012 and the Function Select circuitry (Diagram 5).

**Function, Range, & Decimal Point Select** 5

Function and range selection in the DC 504A is accomplished through a combination of switch closures and counter time slot routing. Table 3-1 shows the relationship between function, range, time slot output, and counter input.

**Function Select.** Time slot switching logic for function selection is provided by U1036. One input of each of the gates is controlled by front panel FUNCTION switch S2061A. The other input of each gate is controlled by time slot output from the counter, U2047. FUNCTION switch closures are grounded through Q2031 and the time slot signals are active low.

To understand the switching action of the function select circuit, assume the FUNCTION switch is in the PERIOD position. In this position, pin 2 of U1036A is pulled low. This allows TS8 (Time Slot 8) to pass through the gate to pin 10 of U1037B. The output of U1037B drives pin 4 of the counter, U2047 (Diagram 3), setting it to the Period mode.

In like manner each of the other functions is selected and routed to the counter Function Input.

**Range Select.** Range selection is accomplished by routing the time slots through multiplexer U1012. Manual range selection is via the front panel TIME/AVGS switch, S2061B, which controls the A and B select line inputs to the multiplexer. All time slot switching is internal to U1012. The x output, pin 13, goes directly to the counter Range input, pin 21, U2047.

**Decimal Point Logic.** The display decimal point is placed automatically by the counter (U2047) for all measurement functions applied directly to the counter inputs. For those functions that are multiplied or divided prior to measurement, decimal point positioning is accomplished through selected time slot application to the counter Ext D.P. Input, pin 20. This input is enabled during TS3 at the counter Control Input, pin 1. TS3 is controlled and gated through U1034C and D. During TOTALIZE and measurement of PERIOD, WIDTH, and FREQ TO 10 MHz (with the multiplier off), pin 8 of U1034C is held low preventing TS3 from enabling the counter Control Input. During these measurements, circuitry internal to the counter sets the decimal point.

When measuring frequencies within the range of the Multiplier circuit, the display decimal point must be shifted left two digits. Pins 8 and 9 of U1031B are pulled low setting the output, pin 10, high. Pin 8 of U1025C is driven high, disabling the gate. The high output of U1031B is also inverted

**Table 3-1**  
**COUNTER INPUT, FUNCTION/RANGE SELECT, AND TIME SLOT RELATIONSHIPS**

COUNTER INPUT PIN #	FUNCTION/RANGE	TIME SLOT (DIGIT)
FUNCTION INPUT PIN 4	FREQUENCY PERIOD WIDTH TOTALIZE	TS1 (D0) TS8 (D7) TS5 (D4) TS4 (D3)
RANGE INPUT PIN 21	(TIME/AVGS) .01 SEC/1 0.1 SEC/10 1 SEC/100 10 SEC/1000	TS1 (D0) TS2 (D1) TS3 (D2) TS4 (D3)
CONTROL INPUT PIN 1	EXT OSC ENABLE EXT D.P. ENABLE DISPLAY TEST	TS1 (D0) TS3 (D2) TS8 (D7)
EXTERNAL DECIMAL POINT INPUT PIN 20	Decimal point is output for same time slot (digit) that is connected to this input.	

through U1048E driving pin 5 of U1025B low to enable the gate. The low output of U1048E also drives pin 4 of U1026A low switching its output high. The high now at pin 8 of U1034C enables the gate and TS3 passes to pin 1 of the counter. This enables the Ext D.P. Input. Depending on the range (gate time) selected, TS4, 5, 6, or 7 gates through U1025B to U1025D. The time slot now at U1025D (pin 11) is applied to the Ext D.P. Input (pin 20) of the counter.

Since frequencies above 10 MHz are divided by ten prior to counting, the display decimal point must be shifted one digit to the right. During this condition, pin 5 of U2026A is pulled low through S2061A forcing the output high. This sets pin 8 of U1034C high to gate TS3 through to the counter Control Input, pin 1. This enables the Ext D.P. Input. Pin 8 of U1031B is high during these measurements, and the output remains low. The low output from U1031B sets pin 8 of U1025C low enabling this gate. The low output from U1031B is inverted through U1048E and applied to pin 5 of U1025B disabling this gate. The low output from U1025B enables U1025D and, depending on the range (gate time) selected, gates TS1, 2, 3, or 4 through to the Ext D.P. Input (pin 20) of the counter. Refer to Table 3-2 for Time Slot (TS) to decimal point relationships.

### Autorange 5

In the Auto mode, the front panel TIME/AVGS switch (S2061B) is disconnected from the multiplexer (U1012) control inputs. In this mode, the output of the autorange circuit controls the inputs to the multiplexer. Setting S2061B to the AUTO position pulls pin 2 of U2027A low through Q2032. This switches the output high enabling the autorange circuit.

Output from pin 1 of U2027A drives pin 2 of U1034A high switching the output low, removing the resets on U1011A and U1011B. The reset caused the  $\bar{Q}$  outputs, pin 2 and pin 14, to be high. With pin 10 of U2026B and pin 12 of U2026C high (enabled) by U2027A, the high levels at pins 9 and 13 switch the output of these gates low. The low outputs from U2026B and U2026C drive the control inputs of U1012 low. This causes time slot one (TS1) to appear at the x output, pin 13. With TS1 applied to the Range Input, pin 21 of U2047, the counter selects the shortest range, .01 sec. A measurement is made and the result displayed. If the displayed result does not fill digit six (MSD), U1037A (Diagram 3) detects all lows on its inputs, during TS6, causing the output to go high (display zero). The high at pin 1 of U1037A is applied to the Data input, pin 9, of U1024B. The leading edge of TS6 triggers the input of a one shot multivibrator, pin 5 of U1023A. About halfway through TS6 (approximately 125  $\mu$ s) the  $\bar{Q}$  output, pin 7, of U1023A goes high. This high is applied to the Clock input, pin 11 of U1024B, which latches the high present on the Data input. Since U1024B is in a set state, latching a high on the Data causes no change in state and the  $\bar{Q}$  output, pin 12, remains low. This low is inverted through U2027B driving the J and K inputs of U1011A high and putting the flip-flop in the toggle state. The Store pulse from pin 5 of the counter, U2047, is applied to the CLOCK input, pin 3, causing U1011A to change state. U1011A  $\bar{Q}$ , pin 2, switches from high to low driving pin 13 of U2026C low. The output of U2026C switches from low to high driving the A input, pin 10, of the multiplexer high. This change in the control input causes TS2 to appear at the output, pin 13, which is applied to the Range input of the counter. The counter selects the next longer gate time, 0.1 sec, and another measurement is made and displayed. If the second gate time selected is still too short to fill the sixth digit (MSD), the events are repeated and TS3 selects the next longer gate time, 1 sec.

Table 3-2  
TIME SLOT TO DECIMAL POINT RELATIONSHIP

TIME/AVGS	FUNCTION							
	FREQ TO 10 MHz PERIOD WIDTH		FREQ TO 10 MHz ( $\times 100$ MULTIPLIER)		FREQ TO 100 MHz ( $\div 10$ PRESCALE)		TOTALIZE	
	TIME SLOT	DISPLAY DECIMAL	TIME SLOT	DISPLAY DECIMAL	TIME SLOT	DISPLAY DECIMAL	TIME SLOT	DISPLAY DECIMAL
.01 SEC/1	TS2	0.0	TS4	0.000	TS1	0.	TS1	0.
0.1 SEC/10	TS3	0.00	TS5	0.0000	TS2	0.0	TS1	0.
1.0 SEC/100	TS4	0.000	TS6	0.00000	TS3	0.00	TS1	0.
10 SEC/1000	TS5	0.0000	TS7	*000000	TS4	0.000	TS1	0.
EXT D.P. ACTIVE	NO		YES		YES		NO	

\*Decimal point implied to left of digit six.



When the counter selects a gate time that results in the display of digit six at least one of the BCD lines driving U1037A (Diagram 3) will be high and the output, pin 1, is low driving the Data input, pin 9, of U1024B low. TS6 triggers the input of U1023A causing the  $\bar{Q}$  output to go high. This high is applied to the Clock input of U1024B. The high Clock input latches the low on the Data input causing a change in state. The  $\bar{Q}$  output switches from low to high. This high at pin 5 of U2027B causes the output to go low driving the J and K inputs of U1011A low. With the J and K inputs held low, the  $\bar{Store}$  pulse from the counter cannot toggle the device. No change at the input of U1012 results in no change in time slot output. Measurements will continue using the last gate time selected.

The Autorange circuit prevents the counter advancing to the 10 sec gate time. If the 1 sec gate time is too short to fill digit six, measurements continue in this gate time, displaying as many digits as time allows. Conditions at the output of U1011B when the 1 sec gate time was selected, prevent advancement to the 10 sec time. When the 1 sec gate time is selected, the Q output, pin 15, of U1011B switches high. This high is inverted through U2027B, driving the J and K inputs of U1011A low, disabling the device. With the J and K inputs low, the  $\bar{Store}$  pulse from the counter does not cause a change in state. The  $\bar{Q}$  output remains high, U2026C output remains low, no new time slot information is sent from U1012, and the counter continues measuring in the 1 sec range.

Overflow conditions (when the counter tries to display digit seven) are detected during TS7. When an overflow condition occurs, the Data input, pin 5, of U1024A goes low through Q1025 (Diagram 3). TS7 triggers the input to U1023B causing the  $\bar{Q}$  output to go low for approximately 125  $\mu$ s, then returns to the high state. This high at the Clock input, pin 3 of U1024A, latches the low on the Data line and toggles the device causing the Q1 output to go low. This low at pin 1 of U1034A causes the output to go high. This high resets U1011A and U1011B, causing their  $\bar{Q}$  outputs to go high. These highs are inverted through U2026B and U2026C. The output from these gates drives the multiplexers (U1012) control inputs low causing TS1 to appear at the output, pin 13. TS1 at the Range input, pin 21, sets the counter to the shortest (.01 sec) gate time. The counter progresses through the succeeding longer ranges as previously described.

#### Display 4

The display consists of six common cathode seven segment LED's. Digit select time slot pulses (TS1 through TS8) are

generated within counter U2047 (Diagram 3). Individual segment drive (a through f and dp) is also generated within the counter. The OVERFLOW indicator, DS2011, connects to the seventh digit position. Whenever time slot 7 (TS7) and either segment line b or f are active this LED illuminates indicating a display overflow condition. Capacitor C2031, one section of which is connected to each time slot line, serves to suppress any noise spikes that might result in erroneous displays.

#### Power Supplies 3

The DC 504A receives power from the power module via interface connections on the rear edge of the main circuit board. The voltages supplied depend on the power module being used. Typical nominal voltages are: +26 Vdc TM 5000 Series (+33.5 Vdc TM 500 Series), -26 Vdc TM 5000 Series (-33.5 Vdc TM 500 Series) and +8 Vdc TM 5000 Series (+11.5 Vdc TM 500 Series). The regulated +5 V and -5 V supplies for the DC 504A are developed from these voltages.

The +5 V supply, except for a series pass transistor located in the power module, is contained almost entirely within regulator package U2013. This regulator package contains a reference, operational amplifier, and current limiting elements. The regulator is powered by the fused +26 V/+33.5 V supply from the power module. The regulated +5 V is developed from fused +8 V/+11.5 V furnished by the power module.

The output of U2013 drives the series pass transistor. The regulator reference voltage, +7.15 V (nominal), is divided to +5.00 V by R3012 and R3015 and connected to pin 5 ( $V_{ref}$  In). Frequency compensation for the regulator is provided by R3014 and C3013. The 0.3  $\Omega$  resistor, R2016 in the emitter circuit of the series pass transistor, is the external current sensing element. Should the current flow through R2016 reach approximately 2 A, the sensing and drive circuitry within the regulator reduce base drive to the series pass transistor. This results in reduced supply output and shut-down if current demand rises sufficiently.

The entire -5 V supply, except filter capacitors C2014 and C3014, is contained within regulator package U2014. This regulator receives supply voltage from the fused power module -26 V/-33.5 V supply and is completely self contained.

# PERFORMANCE CHECK PROCEDURE

## Introduction

This procedure checks the electrical performance requirements as listed in the Specification section in this manual. Perform the Adjustment procedure if the instrument fails to meet these checks. In some cases, readjustment may not correct the discrepancy; circuit troubleshooting is then indicated. Also, use this procedure to determine acceptability of performance in an incoming inspection facility.

## Adjustment Interval

To ensure instrument accuracy, check the performance every 2000 hours of operation or at a minimum of every 12 months if used infrequently. Allow 30 minutes warm up time prior to performing any checks.

## Services Available

Tektronix, Inc. provides complete instrument repair, adjustment, and performance verification at local field service centers and at the factory service center. Contact your local Tektronix field office or representative for further information.

## Test Equipment Required

The test equipment (or equivalent) listed in Table 4-1 is suggested to perform the Performance Check and Adjustment Procedures.

Table 4-1  
LIST OF TEST EQUIPMENT REQUIREMENTS

Description	Performance Requirements	Perf. Check	Adj. Proc.	Example
Power Module		X	X	TEKTRONIX TM 506 or TM 5006
Oscilloscope Mainframe	Dc to 250 MHz bandwidth	X		TEKTRONIX 7704A
Vertical Plug-In	Bandwidth, dc to 200 MHz	X		TEKTRONIX 7A16A
Horizontal Plug-In	Fastest sweep rate 10 ns	X		TEKTRONIX 7B80
Leveled Sinewave Generator	Calibrated amplitude > 135 MHz	X		TEKTRONIX SG 503
Pulse Generator	Risetime < 1 ns	X		TEKTRONIX PG 502
Function Generator	Range, Sinewave 10 Hz to 1 MHz; Offset +7.5 V level	X		TEKTRONIX FG 501A
Digital Multimeter	4½ digits, 0.5%	X		TEKTRONIX DM 501A
WWVB (60 kHz) Receiver/Frequency Standard	1 MHz ±1×10 <sup>-9</sup> output	X	X	SPECTRACOM CORP Type 8161
50 Ω Feedthrough Termination	Bnc connectors	X	X	Tektronix Part No. 011-0049-01
Coaxial cable, 50 Ω Precision 36 inch	Bnc connectors	X	X	Tektronix Part No. 012-0482-00
Adapter, Bnc Female to Dual Banana		X		Tektronix Part No. 103-0090-00
50 Ω, 10× Attenuator	Bnc connectors	X		Tektronix Part No. 011-0059-02
50 Ω, 5× Attenuator	Bnc connectors	X		Tektronix Part No. 011-0060-02
Flexible Extender			X	Tektronix Part No. 067-0645-01

**1. Check Display**

Test Equipment Required:

- Function Generator
- 50 Ω Termination
- ×10 Attenuator

a. Set the DC 504A controls as follows:

FUNCTION	TOTALIZE
TIME/AVGS	AUTO
COUPL	DC
ATTEN	×1

b. Set the function generator to produce a 2 Hz sine wave with an amplitude of approximately 5 volts and zero offset (into 50 Ω).

c. Connect the function generator output, through a ×10 attenuator and 50 Ω termination, to the DC 504A input.

d. Reset the DC 504A by pushing the RESET button.

e. CHECK—that the least significant digit (far right) in the DC 504A display counts from 0 to 9 and carries to the next digit.

f. Set the function generator to 20 Hz.

g. CHECK—that the second digit in the DC 504A display counts from 0 to 9 and carries to the third digit.

h. Increase the function generator frequency in decade steps until all six digits in the display have been checked.

i. CHECK—that the OVERFLOW light on the DC 504A comes on after the most significant digit (far left) has counted to 9.

j. Set the DC 504A DISPLAY UPDATE switch to the HOLD position.

k. CHECK—that the DC 504A display remains stable.

l. Set the DC 504A DISPLAY UPDATE switch to the RUN position.

m. CHECK—that the DC 504A display indicates a new number and continues counting from there.

n. Set the function generator frequency to 200 kHz.

o. Set the DC 504A FUNCTION switch to FREQ TO 10 MHz and the TIME/AVGS switch to the .01 SEC/1 position.

p. CHECK—that the DC 504A display reads approximately 200.0 kHz.

q. Rotate the DC 504A TIME/AVGS switch clockwise through each position.

r. CHECK—that the DC 504A display indicates one additional digit of resolution for each succeeding switch position. In the 10 SEC/1000 position the OVERFLOW light will be on.

s. CHECK—that the DC 504A display reads approximately 200.000 kHz with the TIME/AVGS switch in the AUTO position.

#### NOTE

*Stability of the display will depend on stability of the signal source used.*

t. Push the RESET button and check that the display shows all 8's with all decimal points illuminated.

u. Remove all connections for the next step.

## 2. Check Time Base Oscillator Frequency

Test Equipment Required:

1 MHz Frequency Standard  
50  $\Omega$  Termination

a. Set the DC 504A controls as follows:

FUNCTION	FREQ TO 10 MHz
TIME/AVGS	1.0 SEC/100
COUPL	DC
ATTEN	$\times 1$
TRIGGER LEVEL	midrange

b. Connect a coaxial cable and 50  $\Omega$  termination from the 1 MHz frequency standard to the DC 504A input connector.

c. Adjust the DC 504A TRIGGER LEVEL control for a stable display.

d. CHECK—that the DC 504A display reads between 999.994 and 000.006 ( $\pm 5$  ppm  $\pm 1$  count). The OVERFLOW light will be on if the count is greater than 999.999.

e. Remove this connection for the next step.

## 3. Check Input Impedance

Test Equipment Required:

Digital Multimeter  
50  $\Omega$  Termination

a. Set the DC 504A controls as follows:

FUNCTION	FREQ TO 10 MHz
TIME/AVGS	0.1 SEC/10
COUPL	DC
ATTEN	$\times 1$

b. Connect the BNC Female to Dual Banana adaptor to the Digital Multimeter with the adaptors GND connected to the HI input of the meter. Connect the DC 504A to the meter. Set the Digital Multimeter to read 1 M $\Omega$ .

c. CHECK—that the digital multimeter display reads between .990 M $\Omega$  and 1.010 M $\Omega$ .

d. Set the DC 504A ATTEN switch to the  $\times 5$  position.

e. CHECK—that the digital multimeter display reads between .990 M $\Omega$  and 1.010 M $\Omega$ .

f. Return the DC 504A ATTEN switch to the  $\times 1$  position.

g. Remove all connections for the next step.

**4. Check Attenuator**

Test Equipment Required:

- Pulse Generator
- Digital Multimeter
- ×5 Attenuator
- 50 Ω Termination

a. Set the DC 504A controls as follows:

FUNCTION	PERIOD
TIME/AVGS	AUTO
COUPL	DC
ATTEN	×1
TRIGGER LEVEL	fully clockwise

b. Set the pulse generator for manually triggered output.

c. Connect the pulse generator, through a 50 Ω termination and 5× attenuator, to the digital multimeter.

d. Adjust the pulse generator output for approximately 1 volt reading on the multimeter. Note the reading. (The Pulse Generator is used as a voltage source in this case.)

e. Move the connection from the multimeter to the DC 504A input.

f. Press the DC 504A RESET button.

g. Adjust the DC 504A TRIGGER LEVEL control counter-clockwise until the GATE light just comes on.

h. Repeat steps 4f and 4g several times to arrive as close as possible to the point where the GATE light just turns on.

i. Set the DC 504A ATTEN switch to the ×5 position.

j. Remove the ×5 attenuator from the test set up and re-connect the cable.

k. Press the DC 504A RESET button.

l. Adjust the pulse generator output control clockwise until the DC 504A GATE light just comes on.

m. Repeat steps 4k and 4l several times to arrive as close as possible to the point where the GATE light just comes on.

n. Move the connection from the DC 504A to the multimeter.

o. Note the multimeter reading.

p. Divide the reading obtained in step 4o by the reading obtained in step 4d.

q. CHECK—that the result obtained in step 4p is between 4.90 and 5.10.

r. Remove these connections for the next step.

**5. Check Low Frequency Stability**

Test Equipment Required:

- Function Generator
- 50 Ω Termination

a. Set the DC 504A controls as follows:

FUNCTION	FREQ TO 10 MHz
TIME/AVGS	AUTO
COUPL	DC
ATTEN	×1
TRIGGER LEVEL	midrange

b. Set the function generator controls to produce a 25 kHz sine wave with an amplitude of 60 mV centered around 0 volts. Attenuate the output if necessary.

c. Connect the function generator output, through a 50 Ω coaxial cable and 50 Ω termination, to the DC 504A INPUT connector.

d. Adjust the DC 504A TRIGGER LEVEL control for a stable display.

e. CHECK—that the DC 504A display reads approximately 25.0000 kHz and the MULTIPLIER LOCK light is on. The display must be stable within 100 counts.

f. Readjust the function generator controls to produce a 10 Hz sine wave.

g. Adjust the DC 504A TRIGGER LEVEL control for a stable display.

h. CHECK—that the DC 504A display reads approximately .01000 kHz and the MULTIPLIER LOCK light is on. The display must be stable within 10 counts.

i. Set the function generator dc offset to a level at least 0.5 volts negative.

j. CHECK—that the DC 504A display reads .000 kHz and the MULTIPLIER LOCK light is off.

k. Set the DC 504A COUPL switch to AC.

l. CHECK—that the DC 504A display is stable at approximately .01000 kHz and the MULTIPLIER LOCK light is on.

m. Remove these connections for the next step.

## 6. Check High Frequency Stability

### Test Equipment Required:

Sine Wave Generator  
50  $\Omega$  Termination

a. Set the DC 504A controls as follows:

FUNCTION	FREQ TO 100 MHz
TIME/AVGS	AUTO
COUPL	DC
ATTEN	$\times 1$

b. Set the sine wave generator to produce a 100 MHz signal with a peak-to-peak amplitude of 70 mV centered around 0 Volts.

c. Adjust the DC 504A TRIGGER LEVEL for a stable display.

d. CHECK—that the DC 504A display reads approximately 100000. kHz and is stable within one count.

e. Set the sine wave generator amplitude to 4.0 V.

f. CHECK—that the DC 504A display reads approximately 100000. kHz and is stable within one count.

g. Set the sine wave generator frequency to 10 MHz and the DC 504A FUNCTION switch to FREQUENCY TO 10 MHz.

h. CHECK—that the DC 504A display reads approximately 10000.0 kHz and is stable within one count.

i. Set the sine wave generator amplitude to 70 mV.

j. CHECK—that the DC 504A display reads approximately 10000.0 kHz and is stable within one count.

k. Set the DC 504A FUNCTION switch to TOTALIZE.

l. CHECK—that the DC 504A display is advancing (digits will appear blurred and dim).

m. Leave these connections for the next step.

## 7. Check Period and Width

### Test Equipment Required:

Pulse Generator  
50  $\Omega$  Termination  
X10 Attenuator

a. Set the DC 504A controls as follows:

FUNCTION	PERIOD
TIME/AVGS	AUTO
COUPL	DC
ATTEN	$\times 1$

b. Set the pulse generator to produce a 2.55 MHz square wave with an amplitude of 60 mV p-p.

c. CHECK—that the DC 504A display reads approximately .392  $\mu$ s and is stable within one count. Note the reading.

**Checks and Adjustments—DC 504A**

d. Set the DC 504A FUNCTION switch to WIDTH  .

e. CHECK—that the DC 504A display reads approximately .200  $\mu$ s and is stable within  $\pm 15$  counts. Note the reading.

f. Set the DC 504A FUNCTION switch to WIDTH  .

g. CHECK—that the DC 504A display reads approximately .200  $\mu$ s and is stable within  $\pm 15$  counts. Note the reading.

h. The sum of the readings obtained in steps 8e and 8g should be equal to the reading obtained in step 8c  $\pm .040 \mu$ s.

This completes the performance check procedure for the DC 504A; remove all connections.

# ADJUSTMENT PROCEDURE

## Introduction

Use this Adjustment Procedure to restore the DC 504A to original performance requirements. This Adjustment Procedure need not be performed unless the instrument fails to meet the Performance Requirements of the electrical characteristics listed in the Specification section, or if the Performance Check procedure cannot be completed satisfactorily. If the instrument has undergone repairs, the Adjustment Procedure is recommended. Allow thirty minutes warmup time for operation to specified accuracy (sixty minutes after storage in a high humidity environment).

Satisfactory completion of all adjustment steps in this procedure assures that instrument performance will meet the Performance Requirements.

## Test Equipment Required

The test equipment (or equivalent) listed in Table 4-1 is required for adjustment of the DC 504A. Specifications given for the test equipment are the minimum necessary for accurate adjustment. All test equipment is assumed to be correctly calibrated and operating within specifications.

If other test equipment is substituted, the adjustment setup may need to be altered to meet the requirements of the equipment used.

## Preparation

Access to the internal adjustments is achieved most easily when the DC 504A is connected to the power module with a flexible plug-in extender. Remove the left side cover of the DC 504A to reach the adjustments on the main board. Refer to the Adjustment Locations in the pullout pages at the rear of this manual.

## NOTE

*Make adjustments at an ambient temperature between +20° C and +30° C.*

## 1. Adjust Time Base Frequency—C2051

Test Equipment Required:

1 MHz Frequency Standard  
50  $\Omega$  Termination

a. Set the DC 504A controls as follows:

FUNCTION	FREQ TO 10 MHz
TIME/AVGS	10 SEC/1000
COUPL	DC
ATTEN	×1
TRIGGER LEVEL	midrange

b. Connect a coaxial cable and 50  $\Omega$  termination from the 1 MHz frequency standard to the DC 504A input connector.

c. Adjust the DC 504A TRIGGER LEVEL control for a stable display.

d. ADJUST—C2051 (located on the main board) until the DC 504A display reads between 99.9998 and 00.0002 ( $\pm 0.1$  ppm  $\pm 1$  count). The OVERFLOW light will be on.

This completes the adjustment procedure; remove all connections.



# MAINTENANCE

## Static-Sensitive Components

**CAUTION**

*Static discharge may damage semiconductor components in this instrument.*

This instrument contains electrical components that are susceptible to damage from static discharge. See Table 5-1 for relative susceptibility of various classes of semiconductors. Static voltages of 1 kV to 30 kV are common in unprotected environments.

Observe the following precautions to avoid damage:

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

## Test Equipment

Before using any test equipment to make measurements on static-sensitive components or assemblies, be certain that any voltage or current supplied by the test equipment does not exceed the limits of the component to be tested.

**Table 5-1**  
**RELATIVE SUSCEPTIBILITY**  
**TO STATIC DISCHARGE DAMAGE**

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

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

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

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

## Cleaning Instructions

This instrument should be cleaned as often as operating conditions require. Accumulation of dirt on components acts as an insulating blanket and prevents efficient heat dissipation that can cause overheating and component breakdown.

### CAUTION

*Avoid the use of chemical cleaning agents that might leave a film or damage the plastic material used in this instrument. Use a nonresidue type of cleaner, preferably, isopropyl alcohol or totally denatured ethyl alcohol. Before using any other type of cleaner, consult your Tektronix Service Center or representative.*

**Exterior.** Loose dust accumulated on the front panel can be removed with a soft cloth or a small brush. Dirt that remains can be removed with a soft cloth dampened with a mild detergent and water solution. Abrasive cleaners should not be used.

**Interior.** Dust in the interior of the instrument should be removed occasionally, due to its electrical conductivity under high humidity conditions. The best way to clean the interior is to blow off the accumulated dust with dry, low pressure air, then use a soft brush. If further cleaning is required, use a mild detergent and water solution, flushing well with clean water.

### CAUTION

*Do not clean the circuit board with any solvent, unless the pushbutton switches and FUNCTION and TIME/AVGS switch are removed first. Any solvent forced or carried under the switches can remove the lubricants and cause intermittent operation. Circuit boards and components must be dry before applying power to prevent damage from electrical arcing.*

Drying can be accomplished with dry, low-pressure air or by placing in an oven at 40°C to 60°C for approximately four hours.

After making minor board repairs, cleaning is best accomplished by carefully flaking or chipping the solder flux from the repaired area.

Isopropyl alcohol can be used to clean major repairs to the circuit board; however, flush the board well with clean, isopropyl alcohol. Make certain that resin or dirt is carefully

removed from the board. Avoid contact with switches (see CAUTION above).

## Obtaining Replacement Parts

Electrical and mechanical parts can be obtained through your local Tektronix Field Office or representative. However, many of the standard electronic components can be obtained from a local commercial source. Before purchasing or ordering parts from a source other than Tektronix, Inc., check the Replaceable Electrical Parts list for the proper value, rating, tolerance, and description.

## Ordering Parts

When ordering replacement parts from Tektronix, Inc., it is important to include all of the following information.

1. Instrument type (include modification or option numbers).
2. Instrument serial number.
3. A description of the part (if electrical, include the component number).
4. Tektronix part number.

## Soldering Techniques

### WARNING

*To avoid electric shock hazard, disconnect the instrument from the power source before soldering.*

The reliability and accuracy of this instrument can be maintained only if proper soldering techniques are used when repairing or replacing parts. General soldering techniques which apply to maintenance of any precision electronic equipment should be used when working on this instrument. Use only 60/40 rosin-core, electronic grade solder. The choice of soldering iron is determined by the repair to be made.

When soldering on circuit boards or small wiring, use only a 15 watt, pencil type soldering iron. A higher wattage soldering iron can cause the etched circuit wiring to separate from the board base material and melt the insulation from small wiring. Always keep the soldering iron tip properly tinned to

ensure the best heat transfer to the solder joint. Apply only enough heat to remove the component or to make a good solder joint. To protect heat sensitive components, hold the component lead with a pair of long-nose pliers between the component body and the solder joint. Use a solder removing wick to remove excess solder from connections or to clean circuit board pads.

### Interconnecting Pins

Several methods of interconnection are used to electrically connect the circuit boards with the other boards and components.

Several types of mating connectors are used for these interconnecting pins. If the mating connector is mounted on a plug-on circuit board, special sockets are soldered into the board. If the mating connector is on the end of a lead, an end-lead pin connector is used. This connector mates with the interconnecting pin. The following information provides the removal and replacement procedure for the various interconnecting methods.

### Square Pin Assemblies

See Fig. 5-1. These pins are of various lengths. They are attached to each other with a plastic strip. To remove them simply unsolder from the circuit board.

### Multipin Connectors

The pin connectors used to connect the wires to the interconnecting pins are clamped to the ends of the wires. To replace damaged multipin connectors, remove the old pin connector from the holder. Do this by inserting a scribe between the connector and the holder and prying the connector from the holder. Clamp the replacement connector to the wire. Reinstall the connector in the holder.

If the individual end lead pin connectors are removed from the plastic holder, note the order of the individual wires for correct replacement in the holder. For proper replacement see Fig. 5-2.

### Semiconductors

To remove the in-line integrated circuits installed in sockets, use an extracting tool. This tool is available from Tektronix, Inc.; order Tektronix Part Number 003-0619-00. If an extracting tool is not available, use care to avoid damaging the pins. Pull slowly and evenly on both ends of the integrated

circuit. Try to avoid disengaging one end before the other. IC's that are soldered in should be carefully unsoldered, using commercially available de-soldering tools, and gently removed. Care should be taken not to lift runs or pads from the etched circuit board. If de-soldering tools are not available, the pins of the IC may be clipped with diagonal cutters, and the pins then individually removed from the board.

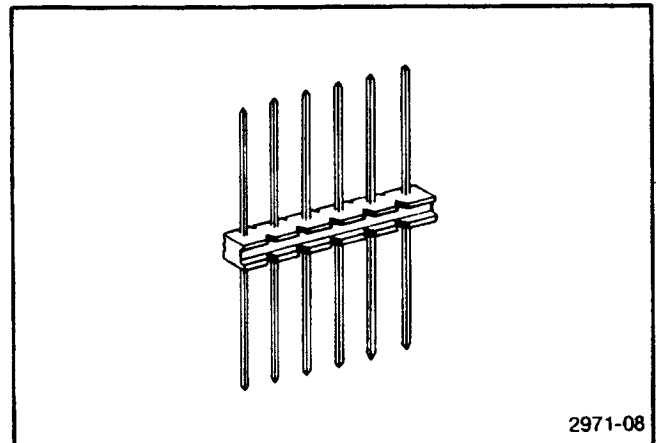


Fig. 5-1. Typical square pin assembly.

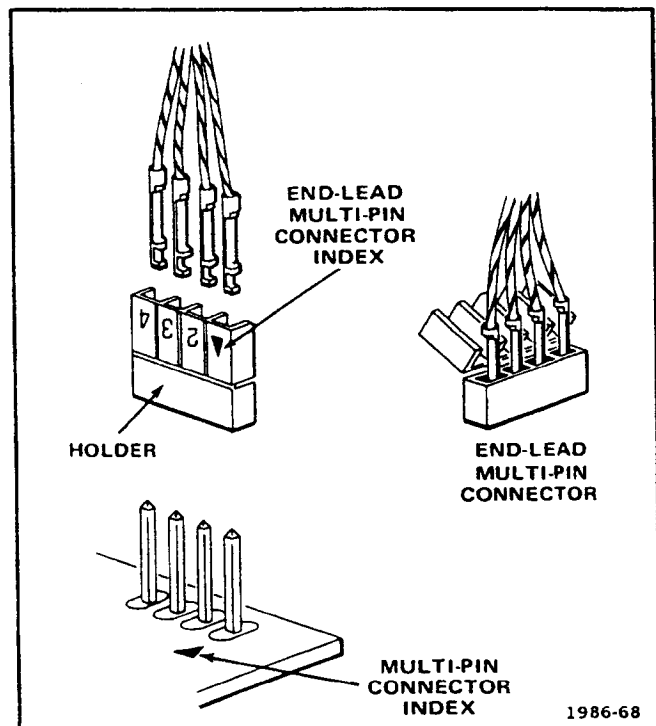


Fig. 5-2. Orientation and disassembly of multipin connectors.

### Release Latch Removal

All plastic parts of the latch assembly and the return spring are individually replaceable. However, should the latch tension spring become damaged, the entire bottom frame rail assembly must be replaced.

1. Pull the latch pull bar out approximately 1/8 inch and hold the latch out.
2. Push the pull bar inward and downward until the retaining pins clear the slot in the latch.
3. Release the latch and remove the pull bar.
4. Remove the screw securing the lower edge of the main circuit board to the bottom frame rail.
5. Remove the two screws from the bottom of the front frame assembly and the two guide pins at the lower edge of the rear frame.
6. The bottom frame rail can now be removed and the latch disassembled.
7. Re-assemble in the reverse order.
8. Push the pull bar through the front panel as far as it will go and hold it. Push the latch forward until the pull bar retaining pins engage the slot in the latch.

### Main Circuit Board (A12) Removal

1. Remove the side covers. A tab on the front frame assembly and a quarter-turn fastener at the rear secure the covers.
2. Remove the TIME/AVGS and FUNCTION switch knobs.
3. Disconnect the input cable at J4012.
4. Remove the screw securing U2014 (heat sink) to the rear frame.
5. Remove the two screws and two guide pins that secure the rear frame to the top and bottom frame rails and remove the rear frame.

6. Remove the three screws that secure the circuit board to the top (2) and bottom (1) frame rails.
7. Pull the circuit board straight toward the rear of the instrument to disengage the connection to the display circuit board.
8. Re-assemble in the reverse order. Take care that the pins on the display board are properly aligned with the mating connector on the main board.

### Display Circuit Board (A10) Removal

1. Remove the side covers. A tab on the front frame assembly and a quarter-turn fastener at the rear secure the covers.
2. Remove the release latch pull bar as previously outlined under Release Latch Removal.
3. Remove the TIME/AVGS and FUNCTION switch and TRIGGER LEVEL knobs.
4. Remove the nut from the INPUT connector. A special wrench to remove this nut is available from Tektronix, Inc.; order Tektronix Part Number 003-0306-00. If this tool is not available, exercise care to prevent damage to the front panel.
5. Disconnect the input cable from the display circuit board at J4012.
6. Remove four screws that secure the top (2) and bottom (2) frame rails to the front frame assembly.
7. Pull the front frame assembly carefully straight out to avoid damaging the interconnecting pins to the main circuit board.
8. Remove the two screws on the back of the circuit board and separate the assembly.
9. Re-assemble in the reverse order taking care that interconnecting pins, LEDs, etc. are properly aligned.

#### NOTE

*Display and indicator LED lead length is critical. If the leads of the replacement part are cut shorter than the original, that digit or indicator may not be clearly visible when viewed from an angle.*

### Internal Jumpers

Refer to the Adjustments and Test Points illustrations in the pull out pages for the locations of the following internal jumpers.

PLL DISABLE (P1040) located on the main board (A12)—disables the Phase Lock Loop circuitry.

INT/EXT CLOCK (P2042) located on the main board (A12)—selects the internal (10 MHz) time base, or permits application of an external time base via the rear interface.

INT/EXT INPUT (P4014) located on the display board (A10)—permits signal measurements via the front panel INPUT connector (EXT) or the rear interface (INT). P4012 at the rear edge of the Main board (A12) must also be moved to pins 1 and 2 of J4012 for INT.

### Test Fixture Connectors

The two connectors identified on the schematic diagrams as J1032 and J2032 are test points used during the manufacturing process.

## REAR INTERFACE CONNECTOR

Refer to Fig. 5-3 for the following.

A slot between pins 21 and 22 on the rear connector identifies this instrument as a member of the TM 500 counter family. Insert a barrier in the corresponding position of the power module jack to prevent noncompatible plug-ins being used in that compartment. Consult the power module manual for further information.

### Functions Available

Pin 14A External Clock Input—This connection allows an external 10 MHz frequency standard to be used in

place of the internal time base. The input is one LSTTL load.

Pin 15A External Clock Ground—This is the common connection for the clock input and output signals.

Pin 16A Input—This is the signal input when the INT/EXT jumper is in the INT position. This connection is terminated into 50  $\Omega$  with a maximum input of 4 volts peak.

Pin 17A Input Ground—This is the common connection for the rear interface signal input.

INPUT OR OUTPUT	PIN B		PIN A	INPUT OR OUTPUT
	28	FAMILY BARRIER SLOT	28	
	22		22	
	21	TMS00 BARRIER SLOT	21	
			17	INPUT GND
			16	INPUT
			15	EXT CLOCK GND
			14	EXT CLOCK IN
* +26 Vdc	12		12	* +26 Vdc
GROUND	9		9	GROUND
* -26 Vdc	8		8	* -26 Vdc
NPN SERIES PASS COLLECTOR	7		7	NPN SERIES PASS EMITTER
	6		6	NPN SERIES PASS BASE
GROUND	4	REAR VIEW OF PLUG-IN	4	GROUND
GROUND	3		3	GROUND
* +8 Vdc	2		2	* +8 Vdc
	1		1	

\* Nominal Voltage - May be higher depending on power module type.

4291-09

Fig. 5-3. Rear interface connector assignments.

# OPTIONS

There are no options for the DC 504A.

# REPLACEABLE ELECTRICAL PARTS

## PARTS ORDERING INFORMATION

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

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

### LIST OF ASSEMBLIES

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

### CROSS INDEX-MFR. CODE NUMBER TO MANUFACTURER

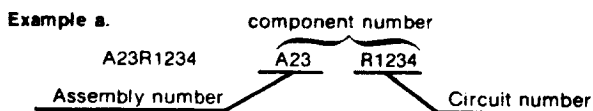
The Mfr. Code Number to Manufacturer index for the Electrical Parts List is located immediately after this page. The Cross Index provides codes, names and addresses of manufacturers of components listed in the Electrical Parts List.

### ABBREVIATIONS

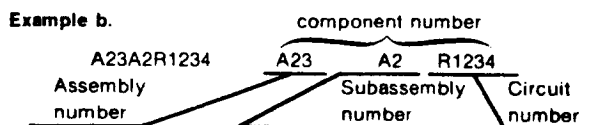
Abbreviations conform to American National Standard Y1.1.

### COMPONENT NUMBER (column one of the Electrical Parts List)

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



Read: Resistor 1234 of Assembly 23



Read: Resistor 1234 of Subassembly 2 of Assembly 23

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

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

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

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

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

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

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

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

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

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

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

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

Indicates actual manufacturers part number.



CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
00136	MCCOY ELECTRONICS CO	100 WATTS ST PO BOX B	MT HOLLY SPRINGS PA 17065-1821
00213	NYTRONICS COMPONENTS GROUP INC SUBSIDIARY OF NYTRONICS INC	ORANGE ST	DARLINGTON SC 29532
00853	SANGAMO WESTON INC COMPONENTS DIV	SANGAMO RD PO BOX 128	PICKENS SC 29671-9716
01121	ALLEN-BRADLEY CO	1201 SOUTH 2ND ST	MILWAUKEE WI 53204-2410
01295	TEXAS INSTRUMENTS INC SEMICONDUCTOR GROUP	13500 N CENTRAL EXP PO BOX 655012	DALLAS TX 75265
02735	RCA CORP SOLID STATE DIVISION	ROUTE 202	SOMERVILLE NJ 08876
03508	GENERAL ELECTRIC CO SEMI-CONDUCTOR PRODUCTS DEPT	W GENESEE ST	AUBURN NY 13021
04222	AVX CERAMICS DIV OF AVX CORP	19TH AVE SOUTH P O BOX 867	MYRTLE BEACH SC 29577
04713	MOTOROLA INC SEMICONDUCTOR PRODUCTS SECTOR	5005 E MCDOWELL RD	PHOENIX AZ 85008-4229
05828	GENERAL INSTRUMENT CORP GOVERNMENT SYSTEMS DIV	600 W JOHN ST	HICKSVILLE NY 11802
07263	FAIRCHILD SEMICONDUCTOR CORP NORTH AMERICAN SALES SUB OF SCHLUMBERGER LTD MS 118	10400 RIDGEVIEW CT	CUPERTINO CAW CA 95014
07716	TRW INC TRW IRC FIXED RESISTORS/BURLINGTON	2850 MT PLEASANT AVE	BURLINGTON IA 52601
11236	CTS CORP BERNE DIV THICK FILM PRODUCTS GROUP	406 PARR ROAD	BERNE IN 46711-9506
18324	SIGNETICS CORP MILITARY PRODUCTS DIV	4130 S MARKET COURT	SACRAMENTO CA 95834-1222
19701	MEPCO/CENTRALAB A NORTH AMERICAN PHILIPS CO	P O BOX 760	MINERAL WELLS TX 76067-0760
22526	DU PONT E I DE NEMOURS AND CO INC DU PONT CONNECTOR SYSTEMS DIV MILITARY PRODUCTS GROUP	515 FISHING CREEK RD	NEW CUMBERLAND PA 17070-3007
24931	SPECIALTY CONNECTOR CO INC	2100 EARLYWOOD DR PO BOX 547	FRANKLIN IN 46131
27014	NATIONAL SEMICONDUCTOR CORP	2900 SEMICONDUCTOR DR	SANTA CLARA CA 95051-0606
29604	STACKPOLE COMPONENTS CO SUB OF THE STACKPOLE CORP	PO BOX 14466	RALEIGH NC 27610
32293	INTERSIL INC SUB OF GENERAL ELECTRIC CO	10600 RIDGEVIEW COURT	CUPERTINO CA 95014-0704
32997	BOURNS INC TRIMPOT DIV	1200 COLUMBIA AVE	RIVERSIDE CA 92507-2114
54473	MATSUSHITA ELECTRIC CORP OF AMERICA	ONE PANASONIC WAY PO BOX 1501	SECAUCUS NJ 07094-2917
55680	NICHICON /AMERICA/ CORP	927 E STATE PKY	SCHAUMBURG IL 60195-4526
56289	SPRAGUE ELECTRIC CO WORLD HEADQUARTERS	92 HAYDEN AVE	LEXINGTON MA 02173-7929
57668	R-OHM CORP	16931 MILLIKEN AVE	IRVINE CA 92713
58361	GENERAL INSTRUMENT CORP OPTOELECTRONICS DIV	3400 HILLVIEW AVE	PALO ALTO CA 94304-1319
59660	TUSONIX INC	7741 N BUSINESS PARK DR PO BOX 37144	TUCSON AZ 85740-7144
71400	BUSSMANN DIV OF COOPER INDUSTRIES INC	114 OLD STATE RD PO BOX 14460	ST LOUIS MO 63178
71590	MEPCO/CENTRALAB INC A NORTH AMERICAN PHILIPS CO	HWY 20 W P O BOX 858	FORT DODGE IA 50501
76493	BELL INDUSTRIES INC JW MILLER DIV	19070 REYES AVE PO BOX 5825	COMPTON CA 90224-5825
80009	TEKTRONIX INC	14150 SW KARL BRAUM DR PO BOX 500 MS 53-111	BEAVERTON OR 97077
80031	MEPCO/ELECTRA INC	22 COLUMBIA RD	MORRISTOWN NJ 07960
96733	SFE TECHNOLOGIES	1501 FIRST ST	SAN FERNANDO CA 91340-2707
TK1483	TEKA PRODUCTS INC	45 SALEM ST	PROVIDENCE RI 02907

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A10	670-7597-00	B010100	B011129	CIRCUIT BD ASSY:DISPLAY	80009	670-7597-00
A10	670-7597-01	B011130		CIRCUIT BD ASSY:DISPLAY	80009	670-7597-01
A12	670-7598-00	B010100	B011129	CIRCUIT BD ASSY:MAIN	80009	670-7598-00
A12	670-7598-01	B011130	B011469	CIRCUIT BD ASSY:MAIN	80009	670-7598-01
A12	670-7598-02	B011470	B012375	CIRCUIT BD ASSY:MAIN	80009	670-7598-02
A12	670-7598-03	B012376		CIRCUIT BD ASSY:MAIN	80009	670-7598-03
A10	670-7597-00	B010100	B011129	CIRCUIT BD ASSY:DISPLAY	80009	670-7597-00
A10	670-7597-01	B011130		CIRCUIT BD ASSY:DISPLAY	80009	670-7597-01
A10C2011	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A10C2012	290-0920-00			CAP,FXD,ELCTLT:33UF,+50-20%,35WVDC	55680	UVX1H330MPA
A10C2014	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A10C2031	283-0487-00			CAP NTWK,CER,DI:(7)330PF,20%,50V	56289	470C7C0G331M5DG
A10C2033	290-0920-00			CAP,FXD,ELCTLT:33UF,+50-20%,35WVDC	55680	UVX1H330MPA
A10C3021	281-0785-00			CAP,FXD,CER DI:68PF,10%,100V	04222	MA101A680KAA
A10C3034	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A10C4013	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A10C4014	283-0057-00	B010100	B011129	CAP,FXD,CER DI:0.1UF,+80-20%,200V	04222	SR306E104ZAA
A10C4014	281-0907-00	B011130		CAP,FXD,CER DI:0.068UF,10%,200V	96733	RH06BX683K
A10C4021	281-0797-00			CAP,FXD,CER DI:15PF,10%,100V	04222	MA106A150KAA
A10C4025	281-0798-00			CAP,FXD,CER DI:51PF,1%,100V	04222	MA101A510GAA
A10C4035	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A10C4036	283-0067-00			CAP,FXD,CER DI:0.001UF,10%,200V	59660	835-515-YSE0102K
A10C4038	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A10CR2012	152-0141-02			SEMICON DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A10CR2013	152-0141-02			SEMICON DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A10CR2023	152-0141-02			SEMICON DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A10CR3034	152-0141-02			SEMICON DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A10CR4032	152-0141-02			SEMICON DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A10CR4037	152-0141-02			SEMICON DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A10DS1011	150-1048-00			LAMP,LED RDOU:ORANGE,7 SEG,1 DIGIT	58361	Q3383/MAN4640A
A10DS1012	150-1048-00			LAMP,LED RDOU:ORANGE,7 SEG,1 DIGIT	58361	Q3383/MAN4640A
A10DS1023	150-1048-00			LAMP,LED RDOU:ORANGE,7 SEG,1 DIGIT	58361	Q3383/MAN4640A
A10DS1024	150-1048-00			LAMP,LED RDOU:ORANGE,7 SEG,1 DIGIT	58361	Q3383/MAN4640A
A10DS1035	150-1048-00			LAMP,LED RDOU:ORANGE,7 SEG,1 DIGIT	58361	Q3383/MAN4640A
A10DS1036	150-1048-00			LAMP,LED RDOU:ORANGE,7 SEG,1 DIGIT	58361	Q3383/MAN4640A
A10DS2011	150-1036-00			LT EMITTING DIO:RED,650NM,40MA MAX	58361	Q6878/MV5074C
A10DS2022	150-1036-00			LT EMITTING DIO:RED,650NM,40MA MAX	58361	Q6878/MV5074C
A10DS2034	150-1036-00			LT EMITTING DIO:RED,650NM,40MA MAX	58361	Q6878/MV5074C
A10J2062	131-2651-01			CONN,RCPT,ELEC:HEADER,1 X 36,0.1 CTR,0.025 PIN	TK1483	082-3643-SS06
A10J4012	131-1857-00			TERM SET,PIN:36/0.025 SQ PIN,ON 0.1 CTRS	TK1483	082-3643-SS10
A10J4014	131-1857-00			TERM SET,PIN:36/0.025 SQ PIN,ON 0.1 CTRS	TK1483	082-3643-SS10
A10J4015	131-2833-00			CONN,RCPT,ELEC:BNC,FEMALE	24931	28JR175-4
A10L2013	108-0245-00			CHOKE,RF:FIXED,3.9UH	76493	B6310-1
A10Q2023	151-0341-00			TRANSISTOR:NPN,SI,TO-106	04713	SPS6919
A10Q2027	151-0342-00			TRANSISTOR:PNP,SI,TO-92	07263	S035928
A10Q3011	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
A10Q3031	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
A10Q4021	151-0427-00			TRANSISTOR:NPN,SI,TO-92	07263	S39287
A10Q4022	151-1042-00			SEMICON DVC SE:FET,SI,TO-92	04713	SPF627M2
A10Q4023	151-1042-00			SEMICON DVC SE:FET,SI,TO-92	04713	SPF627M2
A10R2011	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
A10R2012	315-0512-00			RES,FXD,FILM:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
A10R2022	315-0561-00			RES,FXD,FILM:560 OHM,5%,0.25W	19701	5043CX560R0J
A10R2023	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
A10R2025	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A10R2026	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7

Replaceable Electrical Parts - DC 504A

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Discont	Name & Description	Mfr. Code	Mfr. Part No.
A10R2027	315-0104-00			RES, FXD, FILM: 100K OHM, 5%, 0.25W	57668	NTR25J-E100K
A10R2031	315-0561-00			RES, FXD, FILM: 560 OHM, 5%, 0.25W	19701	5043CX560R0J
A10R2034	315-0152-00			RES, FXD, FILM: 1.5K OHM, 5%, 0.25W	57668	NTR25J-E01K5
A10R2035	315-0103-00			RES, FXD, FILM: 10K OHM, 5%, 0.25W	19701	5043CX10K00J
A10R2036	315-0512-00			RES, FXD, FILM: 5.1K OHM, 5%, 0.25W	57668	NTR25J-E05K1
A10R3012	315-0122-00			RES, FXD, FILM: 1.2K OHM, 5%, 0.25W	57668	NTR25J-E01K2
A10R3014	315-0221-00			RES, FXD, FILM: 220 OHM, 5%, 0.25W	57668	NTR25J-E220E
A10R3018	315-0181-00			RES, FXD, FILM: 180 OHM, 5%, 0.25W	57668	NTR25J-E180E
A10R3022	307-0539-00			RES NTWK, FXD, FI: (7) 510 OHM, 10%, 1W	11236	750-81-R510 OHM
A10R3024	315-0101-00			RES, FXD, FILM: 100 OHM, 5%, 0.25W	57668	NTR25J-E 100E
A10R3025	315-0122-00			RES, FXD, FILM: 1.2K OHM, 5%, 0.25W	57668	NTR25J-E01K2
A10R3026	315-0221-00			RES, FXD, FILM: 220 OHM, 5%, 0.25W	57668	NTR25J-E220E
A10R3027	315-0221-00			RES, FXD, FILM: 220 OHM, 5%, 0.25W	57668	NTR25J-E220E
A10R3032	315-0121-00			RES, FXD, FILM: 120 OHM, 5%, 0.25W	19701	5043CX120R0J
A10R3035	315-0122-00			RES, FXD, FILM: 1.2K OHM, 5%, 0.25W	57668	NTR25J-E01K2
A10R3036	315-0221-00			RES, FXD, FILM: 220 OHM, 5%, 0.25W	57668	NTR25J-E220E
A10R3037	315-0122-00			RES, FXD, FILM: 1.2K OHM, 5%, 0.25W	57668	NTR25J-E01K2
A10R4012	315-0242-00			RES, FXD, FILM: 2.4K OHM, 5%, 0.25W	57668	NTR25J-E02K4
A10R4014	315-0242-00			RES, FXD, FILM: 2.4K OHM, 5%, 0.25W	57668	NTR25J-E02K4
A10R4015	315-0510-00			RES, FXD, FILM: 51 OHM, 5%, 0.25W	19701	5043CX51R00J
A10R4023	321-0618-00			RES, FXD, FILM: 250K OHM, 1%, 0.125W, TC=TO	19701	5043ED250K0F
A10R4024	321-0891-00			RES, FXD, FILM: 800K OHM, 1%, 0.125W, TC=TO	19701	5043ED800K0F
A10R4027	315-0102-00			RES, FXD, FILM: 1K OHM, 5%, 0.25W	57668	NTR25JE01K0
A10R4028	321-0481-00			RES, FXD, FILM: 1M OHM, 1%, 0.125W, TC=TO	19701	5043ED1M000F
A10R4032	315-0680-00			RES, FXD, FILM: 68 OHM, 5%, 0.25W	57668	NTR25J-E68E0
A10R4033	315-0272-00			RES, FXD, FILM: 2.7K OHM, 5%, 0.25W	57668	NTR25J-E02K7
A10R4034	315-0332-00			RES, FXD, FILM: 3.3K OHM, 5%, 0.25W	57668	NTR25J-E03K3
A10R4036	315-0154-00			RES, FXD, FILM: 150K OHM, 5%, 0.25W	57668	NTR25J-E150K
A10R4037	311-2188-00			RES, VAR, NONNW: PNL, 1K OHM, 20%, 0.5W	01121	WP4G056S102M2
A10S3012	260-1976-00			SWITCH, PUSH: DPDT, NONSHORTING, MOMENTARY	71590	K40152AB
A10S3032	260-1995-00			SWITCH, PUSH: 1 BUTTON, 2 POLE, SLOPE	71590	K40352AB
A10S4024	260-1995-00			SWITCH, PUSH: 1 BUTTON, 2 POLE, SLOPE	71590	K40352AB
A10S4025	260-1995-00			SWITCH, PUSH: 1 BUTTON, 2 POLE, SLOPE	71590	K40352AB
A10U3022	156-0369-00			MICROCKT, DGLT: ECL, TRIPLE LINE RECEIVER	04713	MC10216 P OR L
A12	670-7598-00	B010100	B011129	CIRCUIT BD ASSY: MAIN	80009	670-7598-00
A12	670-7598-01	B011130	B011469	CIRCUIT BD ASSY: MAIN	80009	670-7598-01
A12	670-7598-02	B011470	B012375	CIRCUIT BD ASSY: MAIN	80009	670-7598-02
A12	670-7598-03	B012376		CIRCUIT BD ASSY: MAIN	80009	670-7598-03
A12C1011	281-0775-00			CAP, FXD, CER DI: 0.1UF, 20%, 50V	04222	MA205E104MAA
A12C1012	281-0775-00			CAP, FXD, CER DI: 0.1UF, 20%, 50V	04222	MA205E104MAA
A12C1021	281-0815-00			CAP, FXD, CER DI: 0.027UF, 20%, 50V	04222	MA205C273MAA
A12C1023	281-0815-00			CAP, FXD, CER DI: 0.027UF, 20%, 50V	04222	MA205C273MAA
A12C1051	281-0775-00			CAP, FXD, CER DI: 0.1UF, 20%, 50V	04222	MA205E104MAA
A12C1052	281-0791-00			CAP, FXD, CER DI: 270PF, 10%, 100V	04222	MA101C271KAA
A12C1057	281-0775-00			CAP, FXD, CER DI: 0.1UF, 20%, 50V	04222	MA205E104MAA
A12C2012	290-0746-00			CAP, FXD, ELCTLT: 47UF, +50-10%, 16V	54473	ECE-A6V47L
A12C2014	290-0746-00			CAP, FXD, ELCTLT: 47UF, +50-10%, 16V	54473	ECE-A6V47L
A12C2027	281-0775-00			CAP, FXD, CER DI: 0.1UF, 20%, 50V	04222	MA205E104MAA
A12C2038	281-0775-00			CAP, FXD, CER DI: 0.1UF, 20%, 50V	04222	MA205E104MAA
A12C2045	281-0775-00			CAP, FXD, CER DI: 0.1UF, 20%, 50V	04222	MA205E104MAA
A12C2051	281-0204-00			CAP, VAR, PLASTIC: 2-22PF, 100V	80031	2807C00222MJ02
A12C2052	283-0602-00	B010100	B012375	CAP, FXD, MICA DI: 53PF, 5%, 300V	00853	D155E530J0
A12C2052	283-0600-00	B012376		CAP, FXD, MICA DI: 43PF, 5%, 500V	00853	D105E430J0
A12C2053	283-0600-00			CAP, FXD, MICA DI: 43PF, 5%, 500V	00853	D105E430J0
A12C2055	290-0782-00			CAP, FXD, ELCTLT: 4.7UF, +75-10%, 35VDC	55680	ULB1V4R7TAAANA
A12C2067	281-0814-00			CAP, FXD, CER DI: 100 PF, 10%, 100V	04222	MA101A101KAA
A12C2068	281-0775-00			CAP, FXD, CER DI: 0.1UF, 20%, 50V	04222	MA205E104MAA
A12C3013	281-0770-00			CAP, FXD, CER DI: 1000PF, 20%, 100V	04222	MA101C102MAA

Component No.	Tektronix		Serial/Assembly No. Effective    Discort	Name & Description	Mfr.	Mfr. Part No.
	Part No.	Part No.			Code	
A12C3014	290-0952-00			CAP, FXD, ELCTLT: 4.7UF +/- 20%, 63V	55680	ULB1J4R7MAA
A12CR1020	152-0141-02			SEMI:COND DVC, DI: SW, SI, 30V, 150MA, 30V, DO-35	03508	DA2527 (1N4152)
A12CR1021	152-0141-02			SEMI:COND DVC, DI: SW, SI, 30V, 150MA, 30V, DO-35	03508	DA2527 (1N4152)
A12CR1025	152-0141-02			SEMI:COND DVC, DI: SW, SI, 30V, 150MA, 30V, DO-35	03508	DA2527 (1N4152)
A12CR1026	152-0141-02			SEMI:COND DVC, DI: SW, SI, 30V, 150MA, 30V, DO-35	03508	DA2527 (1N4152)
A12CR1062	152-0141-02			SEMI:COND DVC, DI: SW, SI, 30V, 150MA, 30V, DO-35	03508	DA2527 (1N4152)
A12CR1063	152-0141-02			SEMI:COND DVC, DI: SW, SI, 30V, 150MA, 30V, DO-35	03508	DA2527 (1N4152)
A12CR2014	152-0066-00			SEMI:COND DVC, DI: RECT, SI, 400V, 1A, DO-41	05828	GP10G-021
A12CR2018	152-0066-00			SEMI:COND DVC, DI: RECT, SI, 400V, 1A, DO-41	05828	GP10G-021
A12CR2022	152-0141-02			SEMI:COND DVC, DI: SW, SI, 30V, 150MA, 30V, DO-35	03508	DA2527 (1N4152)
A12CR2023	152-0141-02			SEMI:COND DVC, DI: SW, SI, 30V, 150MA, 30V, DO-35	03508	DA2527 (1N4152)
A12CR2034	152-0141-02			SEMI:COND DVC, DI: SW, SI, 30V, 150MA, 30V, DO-35	03508	DA2527 (1N4152)
A12CR2035	152-0141-02			SEMI:COND DVC, DI: SW, SI, 30V, 150MA, 30V, DO-35	03508	DA2527 (1N4152)
A12CR2036	152-0141-02			SEMI:COND DVC, DI: SW, SI, 30V, 150MA, 30V, DO-35	03508	DA2527 (1N4152)
A12CR2037	152-0141-02			SEMI:COND DVC, DI: SW, SI, 30V, 150MA, 30V, DO-35	03508	DA2527 (1N4152)
A12CR2038	152-0141-02			SEMI:COND DVC, DI: SW, SI, 30V, 150MA, 30V, DO-35	03508	DA2527 (1N4152)
A12F2010	159-0222-00			FUSE, WIRE LEAD: 0.250A, 125V, FAST	71400	TR/A 1/4
A12F3012	159-0220-00			FUSE, WIRE LEAD: 3A, 125V, FAST	71400	TRA3
A12F3013	159-0114-00			FUSE, CARTRIDGE: 1A, 125A, AXIAL LEADS	71400	GFA 1
A12J1032	131-2132-01			CONN, RCPT, ELEC: HEADER, 1X36, 0.1CTR	TK1483	082-3640-550E
A12J1040	131-1857-00			TERM SET, PIN: 36/0.025 SQ PIN, ON 0.1 CTRS	TK1483	082-3643-5510
A12J2032	131-2132-01			CONN, RCPT, ELEC: HEADER, 1X36, 0.1CTR	TK1483	082-3640-550E
A12J2042	131-1857-00			TERM SET, PIN: 36/0.025 SQ PIN, ON 0.1 CTRS	TK1483	082-3643-5510
A12J4012	131-1857-00			TERM SET, PIN: 36/0.025 SQ PIN, ON 0.1 CTRS	TK1483	082-3643-5510
A12P2062	131-2858-00			CONN, RCPT, ELEC: CKT BD, 2 X 13, HORIZONTAL	22525	65000-012
A12Q1025	151-0190-00			TRANSISTOR: NPN, SI, TO-92	80009	151-0190-00
A12Q1042	151-0190-00			TRANSISTOR: NPN, SI, TO-92	80009	151-0190-00
A12Q1043	151-0190-00			TRANSISTOR: NPN, SI, TO-92	80009	151-0190-00
A12Q1052	151-0188-00			TRANSISTOR: PNP, SI, TO-92	80009	151-0188-00
A12Q1053	151-0164-00			TRANSISTOR: PNP, SI, TO-92	04713	2N2907A
A12Q1054	151-0164-00			TRANSISTOR: PNP, SI, TO-92	04713	2N2907A
A12Q1056	151-0188-00			TRANSISTOR: PNP, SI, TO-92	80009	151-0188-00
A12Q1057	151-0216-00			TRANSISTOR: PNP, SI, TO-92	04713	SPS8803
A12Q1062	151-0220-00			TRANSISTOR: PNP, SI, TO-92	80009	151-0220-00
A12Q1064	151-0220-00			TRANSISTOR: PNP, SI, TO-92	80009	151-0220-00
A12Q1066	151-0188-00			TRANSISTOR: PNP, SI, TO-92	80009	151-0188-00
A12Q1068	151-0188-00			TRANSISTOR: PNP, SI, TO-92	80009	151-0188-00
A12Q2031	151-0190-00			TRANSISTOR: NPN, SI, TO-92	80009	151-0190-00
A12Q2032	151-0190-00			TRANSISTOR: NPN, SI, TO-92	80009	151-0190-00
A12R201	315-0104-00	B011470		RES, FXD, FILM: 100K OHM, 5%, 0.25W	57668	NTR25J-E100K
A12R1013	307-0445-00			RES, NETWK, FXD, FI: 4.7K OHM, 20%, (9)RES	32997	4310R-101-472
A12R1022	315-0101-00			RES, FXD, FILM: 100 OHM, 5%, 0.25W	57668	NTR25J-E 100E
A12R1024	315-0222-00			RES, FXD, FILM: 2.2K OHM, 5%, 0.25W	57668	NTR25J-E02K2
A12R1025	315-0103-00			RES, FXD, FILM: 10K OHM, 5%, 0.25W	19701	5043CX10K00J
A12R1026	315-0223-00			RES, FXD, FILM: 22K OHM, 5%, 0.25W	19701	5043CX22K00J32U
A12R1031	315-0272-00			RES, FXD, FILM: 2.7K OHM, 5%, 0.25W	57668	NTR25J-E02K7
A12R1032	315-0103-00			RES, FXD, FILM: 10K OHM, 5%, 0.25W	19701	5043CX10K00J
A12R1039	315-0472-00			RES, FXD, FILM: 4.7K OHM, 5%, 0.25W	57668	NTR25J-E04K7
A12R1040	315-0151-00			RES, FXD, FILM: 150 OHM, 5%, 0.25W	57668	NTR25J-E150E
A12R1041	315-0102-00			RES, FXD, FILM: 1K OHM, 5%, 0.25W	57668	NTR25J-E01K0
A12R1042	315-0103-00			RES, FXD, FILM: 10K OHM, 5%, 0.25W	19701	5043CX10K00J
A12R1043	307-0446-00			RES, NETWK, FXD, FI: 10K OHM, 20%, (9)RES	11236	750-101-R10K
A12R1044	315-0152-00			RES, FXD, FILM: 1.5K OHM, 5%, 0.25W	57668	NTR25J-E01K5
A12R1045	315-0561-00			RES, FXD, FILM: 560 OHM, 5%, 0.25W	19701	5043CX560R0J
A12R1046	315-0101-00			RES, FXD, FILM: 100 OHM, 5%, 0.25W	57668	NTR25J-E 100E
A12R1047	315-0107-00			RES, FXD, FILM: 100M OHM, 5%, 0.25W	01121	CB1075
A12R1050	315-0102-00			RES, FXD, FILM: 1K OHM, 5%, 0.25W	57668	NTR25J-E01K0
A12R1052	315-0331-00			RES, FXD, FILM: 330 OHM, 5%, 0.25W	57668	NTR25J-E330E

Replaceable Electrical Parts - DC 504A

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Discont	Name & Description	Mfr. Code	Mfr. Part No.
A12R1052	315-0331-00			RES, FXD, FILM: 330 OHM, 5%, 0.25W	57668	NTR25J-E330E
A12R1053	315-0162-00			RES, FXD, FILM: 1.6K OHM, 5%, 0.25W	19701	5043CX1K600J
A12R1054	315-0561-00			RES, FXD, FILM: 560 OHM, 5%, 0.25W	19701	5043CX560R0J
A12R1055	315-0102-00			RES, FXD, FILM: 1K OHM, 5%, 0.25W	57668	NTR25JE01K0
A12R1056	315-0201-00			RES, FXD, FILM: 200 OHM, 5%, 0.25W	57668	NTR25J-E200E
A12R1057	315-0270-00			RES, FXD, FILM: 27 OHM, 5%, 0.25W	19701	5043CX27R00J
A12R1058	315-0473-00			RES, FXD, FILM: 47K OHM, 5%, 0.25W	57668	NTR25J-E47K0
A12R1059	315-0103-00			RES, FXD, FILM: 10K OHM, 5%, 0.25W	19701	5043CX10K00J
A12R1060	315-0103-00			RES, FXD, FILM: 10K OHM, 5%, 0.25W	19701	5043CX10K00J
A12R1062	315-0511-00			RES, FXD, FILM: 510 OHM, 5%, 0.25W	19701	5043CX510R0J
A12R1063	315-0270-00			RES, FXD, FILM: 27 OHM, 5%, 0.25W	19701	5043CX27R00J
A12R1064	315-0101-00			RES, FXD, FILM: 100 OHM, 5%, 0.25W	57668	NTR25J-E 100E
A12R1065	315-0101-00			RES, FXD, FILM: 100 OHM, 5%, 0.25W	57668	NTR25J-E 100E
A12R1066	315-0182-00			RES, FXD, FILM: 1.8K OHM, 5%, 0.25W	57668	NTR25J-E1K8
A12R1067	315-0182-00			RES, FXD, FILM: 1.8K OHM, 5%, 0.25W	57668	NTR25J-E1K8
A12R1068	315-0181-00			RES, FXD, FILM: 180 OHM, 5%, 0.25W	57668	NTR25J-E180E
A12R1069	315-0751-00			RES, FXD, FILM: 750 OHM, 5%, 0.25W	57668	NTR25J-E750E
A12R2014	315-0104-00	B011470		RES, FXD, FILM: 100K OHM, 5%, 0.25W	57668	NTR25J-E100K
A12R2015	315-0102-00			RES, FXD, FILM: 1K OHM, 5%, 0.25W	57668	NTR25JE01K0
A12R2016	308-0244-00			RES, FXD, WW: 0.3 OHM, 10%, 2W	00213	310S 0.3-10
A12R2031	307-0445-00			RES NTWK, FXD, FI: 4.7K OHM, 20%, (9)RES	32997	4310R-101-472
A12R2032	307-0445-00			RES NTWK, FXD, FI: 4.7K OHM, 20%, (9)RES	32997	4310R-101-472
A12R2034	315-0472-00			RES, FXD, FILM: 4.7K OHM, 5%, 0.25W	57668	NTR25J-E04K7
A12R2035	315-0472-00			RES, FXD, FILM: 4.7K OHM, 5%, 0.25W	57668	NTR25J-E04K7
A12R2038	315-0103-00			RES, FXD, FILM: 10K OHM, 5%, 0.25W	19701	5043CX10K00J
A12R2039	315-0103-00			RES, FXD, FILM: 10K OHM, 5%, 0.25W	19701	5043CX10K00J
A12R2046	315-0472-00			RES, FXD, FILM: 4.7K OHM, 5%, 0.25W	57668	NTR25J-E04K7
A12R2047	315-0561-00	B010100	B011129	RES, FXD, FILM: 560 OHM, 5%, 0.25W	19701	5043CX560R0J
A12R2048	315-0561-00	B010100	B011129	RES, FXD, FILM: 560 OHM, 5%, 0.25W	19701	5043CX560R0J
A12R2051	315-0106-00			RES, FXD, FILM: 10M OHM, 5%, 0.25W	01121	CB1065
A12R2052	315-0682-00			RES, FXD, FILM: 6.8K OHM, 5%, 0.25W	57668	NTR25J-E06K8
A12R2053	315-0154-00			RES, FXD, FILM: 150K OHM, 5%, 0.25W	57668	NTR25J-E150K
A12R2063	307-0598-00			RES NTWK, FXD, FI: 7, 330 OHM, 2%, 1.0W	11236	750-81-R330
A12R3012	321-0260-00			RES, FXD, FILM: 4.99K OHM, 1%, 0.125W, TC=TO	19701	5033ED4K990F
A12R3014	315-0162-00			RES, FXD, FILM: 1.6K OHM, 5%, 0.25W	19701	5043CX1K600J
A12R3015	321-0225-00			RES, FXD, FILM: 2.15K OHM, 1%, 0.125W, TC=TO	19701	5033ED2K15F
A12R3016	321-0105-00			RES, FXD, FILM: 121 OHM 1%, 0.125W, TC=\0	07716	CEAD121R0F
A12R3017	321-0151-00			RES, FXD, FILM: 365 OHM, 1%, 0.125W, TC=TO	07716	CEAD365R0F
A12S2061	260-2123-00			SWITCH, ROTARY: DUAL CONCENTRIC	29604	73-8501
A12TP1063	214-0579-00			TERM, TEST POINT: BRS CD PL	80009	214-0579-00
A12TP2012	214-0579-00			TERM, TEST POINT: BRS CD PL	80009	214-0579-00
A12TP2014	214-0579-00			TERM, TEST POINT: BRS CD PL	80009	214-0579-00
A12TP3012	214-0579-00			TERM, TEST POINT: BRS CD PL	80009	214-0579-00
A12U1011	156-0525-03			MICROCKT, DGTL: DUAL J-K MASTER SLAVE FF, SEL	04713	MC14027BCLD
A12U1012	156-0514-01			MICROCKT, DGTL: DIFF 4-CHANNEL MUX, SEL	80009	156-0514-01
A12U1023	156-1152-01			MICROCKT, DGTL: PRCN RETRIGGERABLE, SCRN	04713	MC14538BCLDS
A12U1024	156-0366-02			MICROCKT, DGTL: DUAL D FLIP-FLOP, SCREENED	02735	CD4013BFX
A12U1025	156-0349-06			MICROCKT, DGTL: QUAD 2 INP NOR GATE	02735	CD4001BFX
A12U1031	156-0383-02			MICROCKT, DGTL: QUAD 2-INP NOR GATE, SCRN,	18324	N74LS02NB
A12U1032	156-0910-02			MICROCKT, DGTL: DUAL DECADE COUNTER, SCRN	01295	SN74LS390N3
A12U1034	156-0350-05			MICROCKT, DGTL: QUAD 2 INPUT NAND GATE	02735	CD4011BFX
A12U1036	156-0349-06			MICROCKT, DGTL: QUAD 2 INP NOR GATE	02735	CD4001BFX
A12U1037	156-0754-02			MICROCKT, DGTL: DUAL 4-INPUT NOR GATE, SCRN	02735	CD4002BFX-98
A12U1044	156-0352-00			MICROCKT, DGTL: CMOS, DUAL CMLM PAIR + INVT	02735	CD4007A(E OR F)
A12U1048	156-0385-02	B010100	B011129	MICROCKT, DGTL: HEX INVERTER, SCRN	07263	74LS04PCQR
A12U1048	156-2027-00	B011130		MICROCKT, DGTL: CMOS, HEX INVERTER	27014	MM74HC04N
A12U1052	156-0970-03			MICROCKT, DGTL: QUAD HV NAND GATE W/OC OUT	01295	SN74LS26NP3
A12U1063	156-0182-02			MICROCKT, DGTL: TRIPLE 2-3-2 INP GATE, SCRN	04713	MC10105PD/LD

Component No.	Tektronix Part No.	Serial/Assembly No.		Name & Description	Mfr. Code	Mfr. Part No.
		Effective	Dscont			
A12U2013	156-0071-02			MICROCKT, LINEAR: VOLTAGE REGULATOR, CHECKED	04713	MC1723CLDS
A12U2014	156-1451-00			MICROCKT, LINEAR: 3-TERM NEG VOLTAGE RGLTR	27014	LM337T
A12U2026	156-0384-02			MICROCKT, DGTL: QUAD 2-INP NAND GATE, SCRN	07263	74LS03PCOR
A12U2027	156-0383-02	B010100	B011129	MICROCKT, DGTL: QUAD 2-INP NOR GATE, SCRN,	18324	N74LS02NB
A12U2027	156-2026-00	B011130		MICROCKT, DGTL: CMOS, QUAD 2 INPUT NOR GATE	04713	MC74HC02(N OR J)
A12U2043	156-0411-02			MICROCKT, LINEAR: QUAD COMPARATOR, SCREENED	04713	LM339JDS
A12U2045	156-0411-02			MICROCKT, LINEAR: QUAD COMPARATOR, SCREENED	04713	LM339JDS
A12U2047	156-1655-00			MICROCKT, DGTL: IDL, 10MHZ UNIVERSAL COUNTER	32293	ICM72268IPL
A12U2054	156-0704-00			MICROCKT, LINEAR: CMOS, PHASE LOCK LOOP	04713	MC14046CP
A12U2067	156-0642-01			MICROCKT, DGTL: BI QUINARY CNTR, SCREENED	04713	MC10138PD/LD
A12Y2054	158-0129-00			XTAL UNIT, QTZ: 10MHZ 0.001%, PARALLEL	00136	20-9-1

# DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

## Symbols

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

Logic symbology is based on ANSI Y32.14-1973 in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

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

Abbreviations are based on ANSI Y1.1-1972.

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

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

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

## Component Values

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

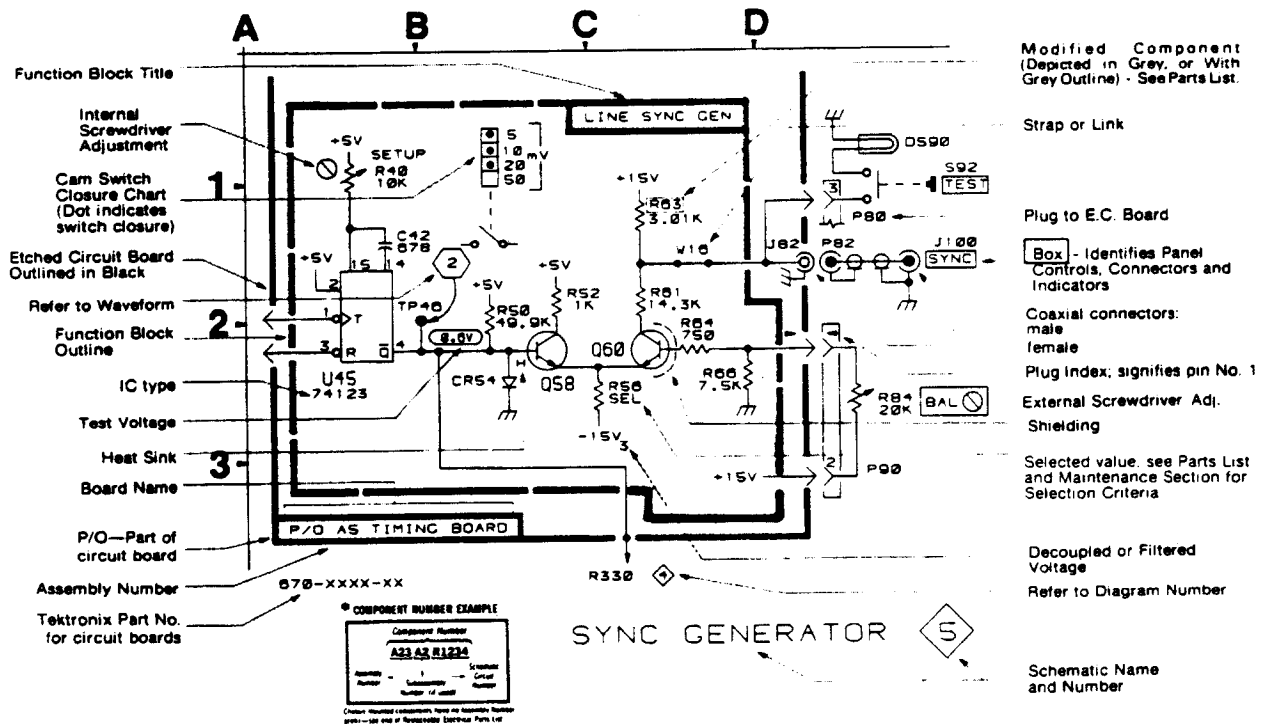
- Capacitors = Values one or greater are in picofarads (pF).  
Values less than one are in microfarads ( $\mu$ F).
- Resistors = Ohms ( $\Omega$ ).

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

## Assembly Numbers and Grid Coordinates

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

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



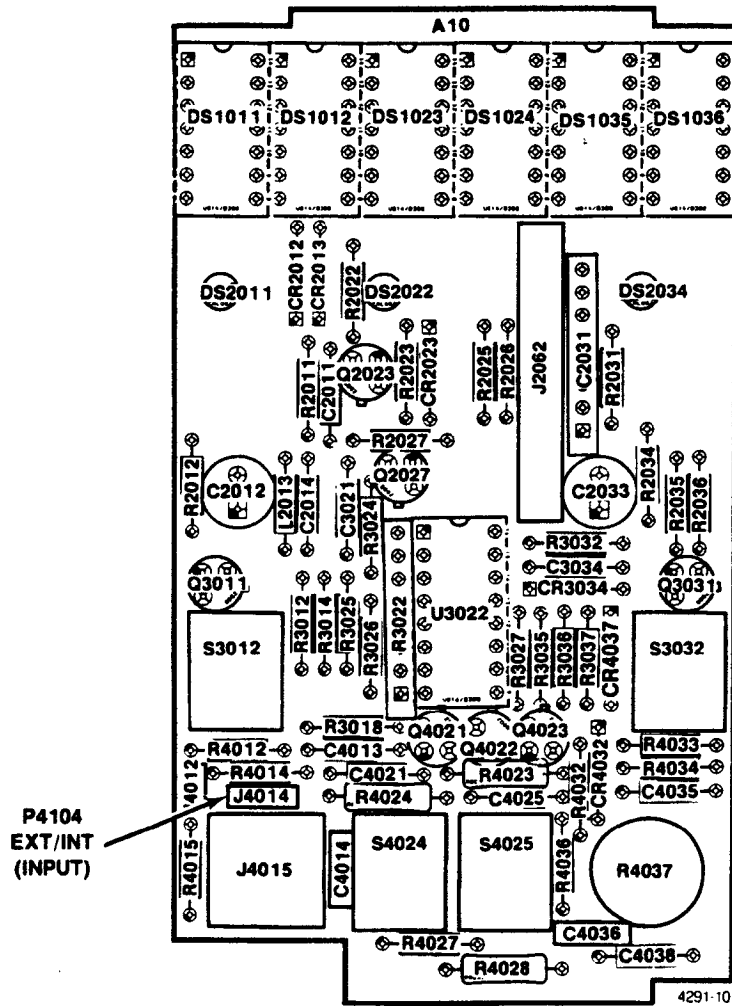
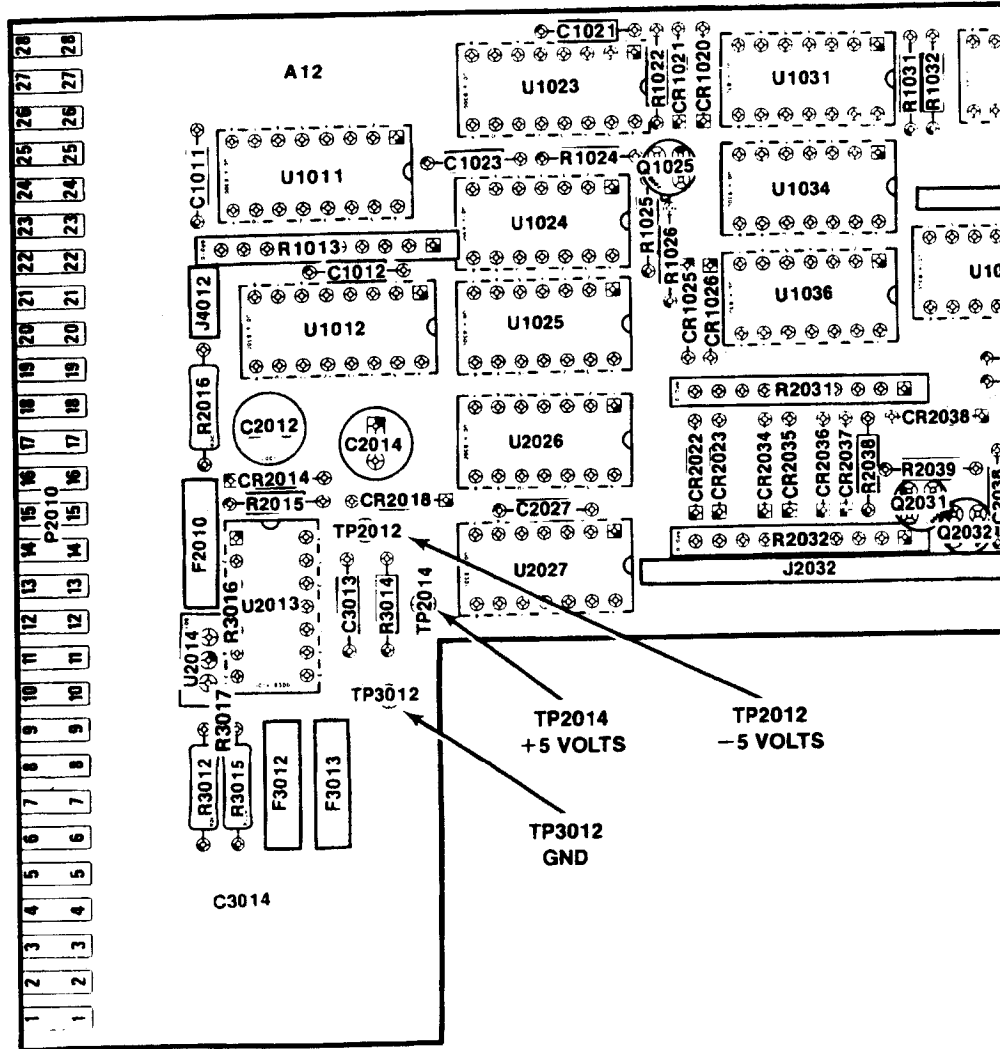


Fig. 8-1. Display Board.



# ADJUSTMENTS AND TEST POINTS



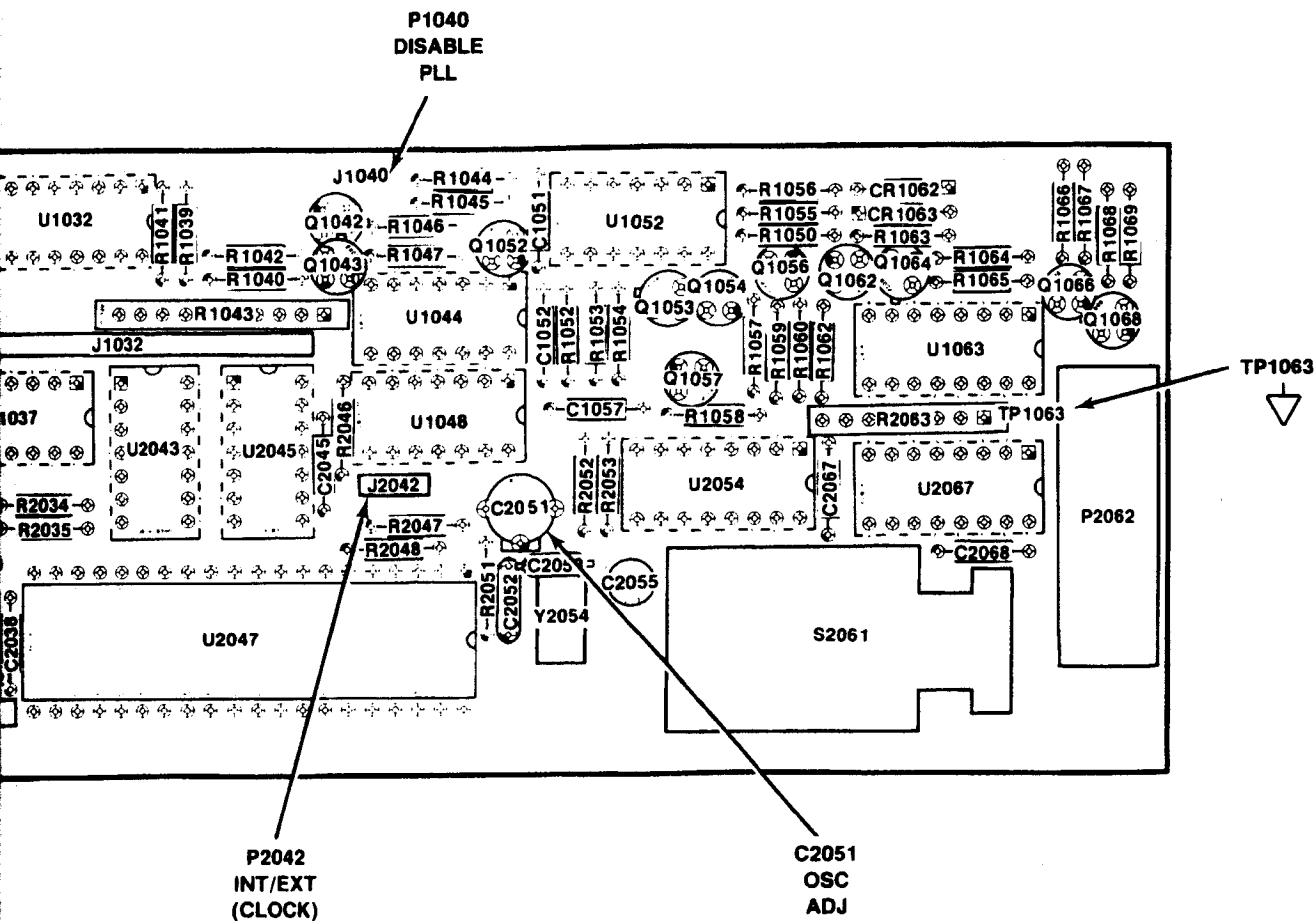
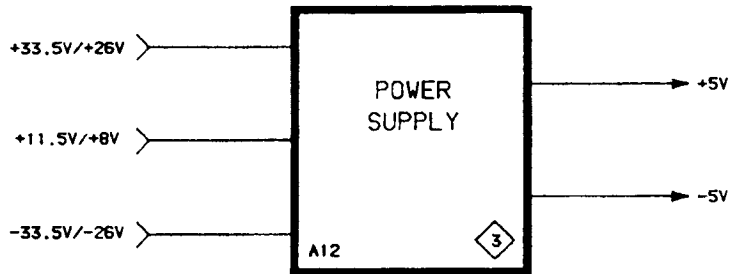
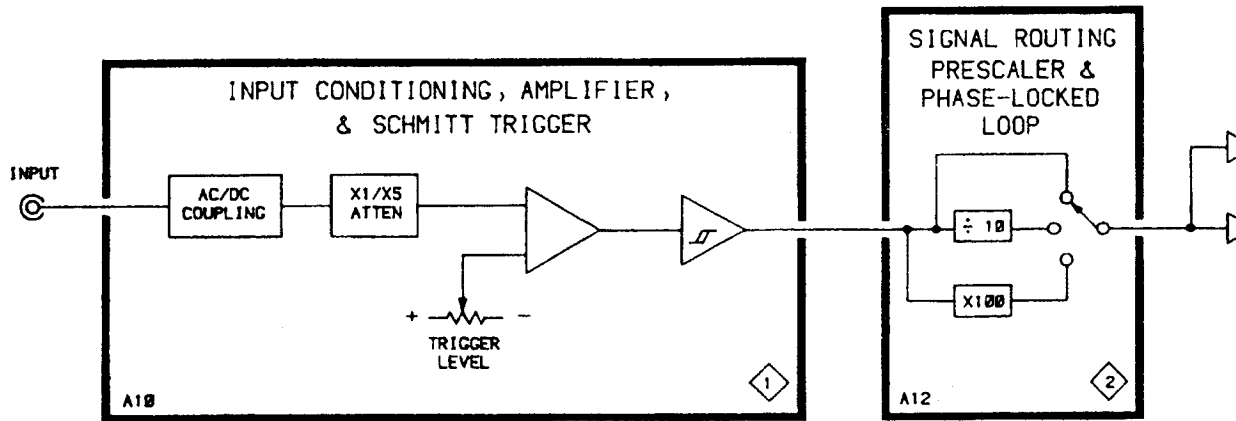
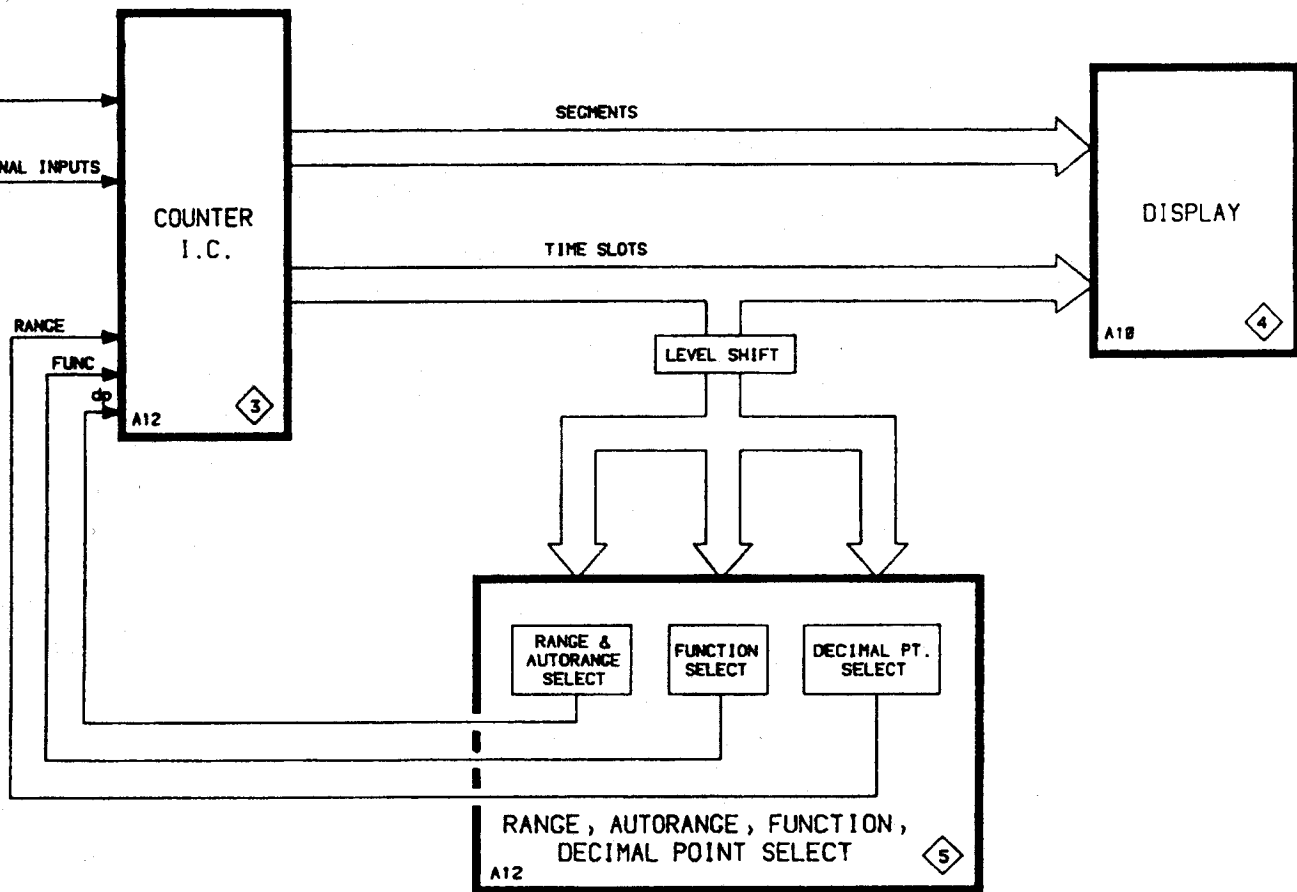


Fig. 8-2. Main Board.



DC 504A



4291-55

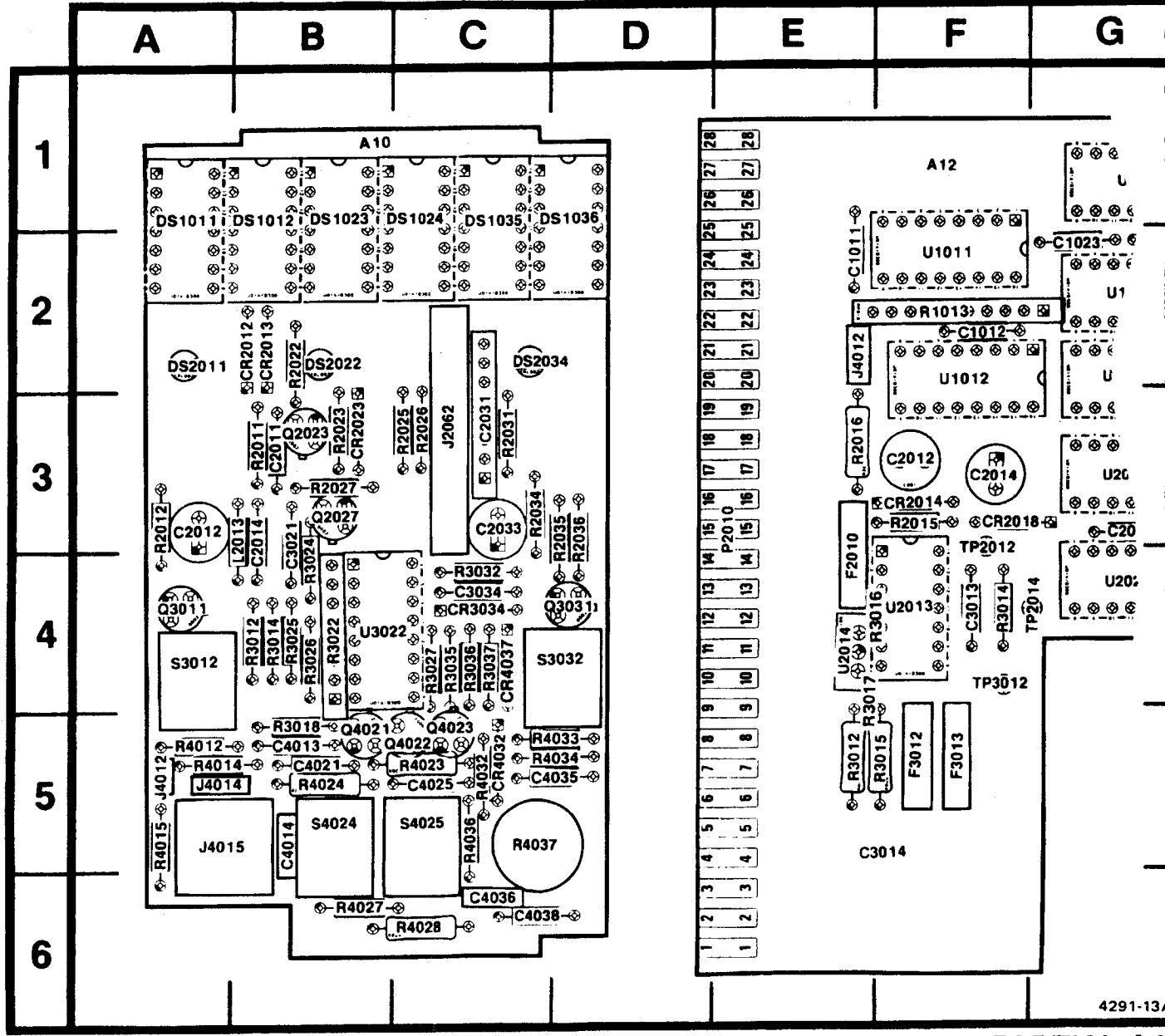
BLOCK DIAGRAM

Fig. 6-3. Block Diagram.

## Table 8-1 COMPONENT REFERENCE CHART

P/O A10 ASSY			FRONT PANEL BOARD <span style="float: right;">◇ 1</span>		
CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION
C2012	E2	A3	R3012	K2	B4
C2014	D2	B4	R3014	K3	B4
C2033	D3	C3	R3018	I6	B5
C3021	L4	B4	R3024	L3	B4
C3034	I2	C4	R3025	K4	B4
C4013	H6	B5	R3026	K3	B4
C4014	E5	B5	R3027	H2	C4
C4021	F5	B5	R3032	M3	C4
C4025	F6	C5	R3035	J4	C4
C4035	I5	D5	R3036	I2	C4
C4036	G4	C6	R3037	J2	C4
C4038	K4	C6	R4012	H6	A5
CR3034	I2	C4	R4014	H6	A5
CR4032	H4	C5	R4015	D7	A5
CR4037	H5	C4	R4023	E6	C5
J4012	C6	A5	R4024	E5	B5
J4014	D5	A5	R4027	E5	B6
J4015	C5	A5	R4028	G5	C6
L2013	D2	B4	R4032	H4	C5
P4012	B6	A5	R4033	J5	D5
P4014	D4	A5	R4034	J4	D5
Q4021	I6	B5	R4036	G5	C5
Q4022	H5	C5	R4037	K5	C5
Q4023	I4	C5	S4024	J6	B5
			S4025	J6	C5
			U3022	K3	B4
			W500	B6	Chassis
P/O A10 ASSY also shown on <span style="margin-left: 20px;">◇ 3</span> <span style="margin-left: 20px;">◇ 4</span>					
P/O A12 ASSY			MAIN BOARD		
J4012	B6	E2	P2010	B6	E3
			P4012	B6	E2
P/O A12 ASSY also shown on <span style="margin-left: 20px;">◇ 2</span> <span style="margin-left: 20px;">◇ 3</span> <span style="margin-left: 20px;">◇ 5</span>					

# PARTS LOCATION GRID



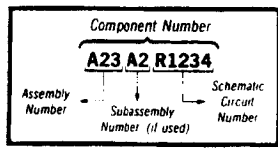
4291-13/

## A10, PARTIAL A1-

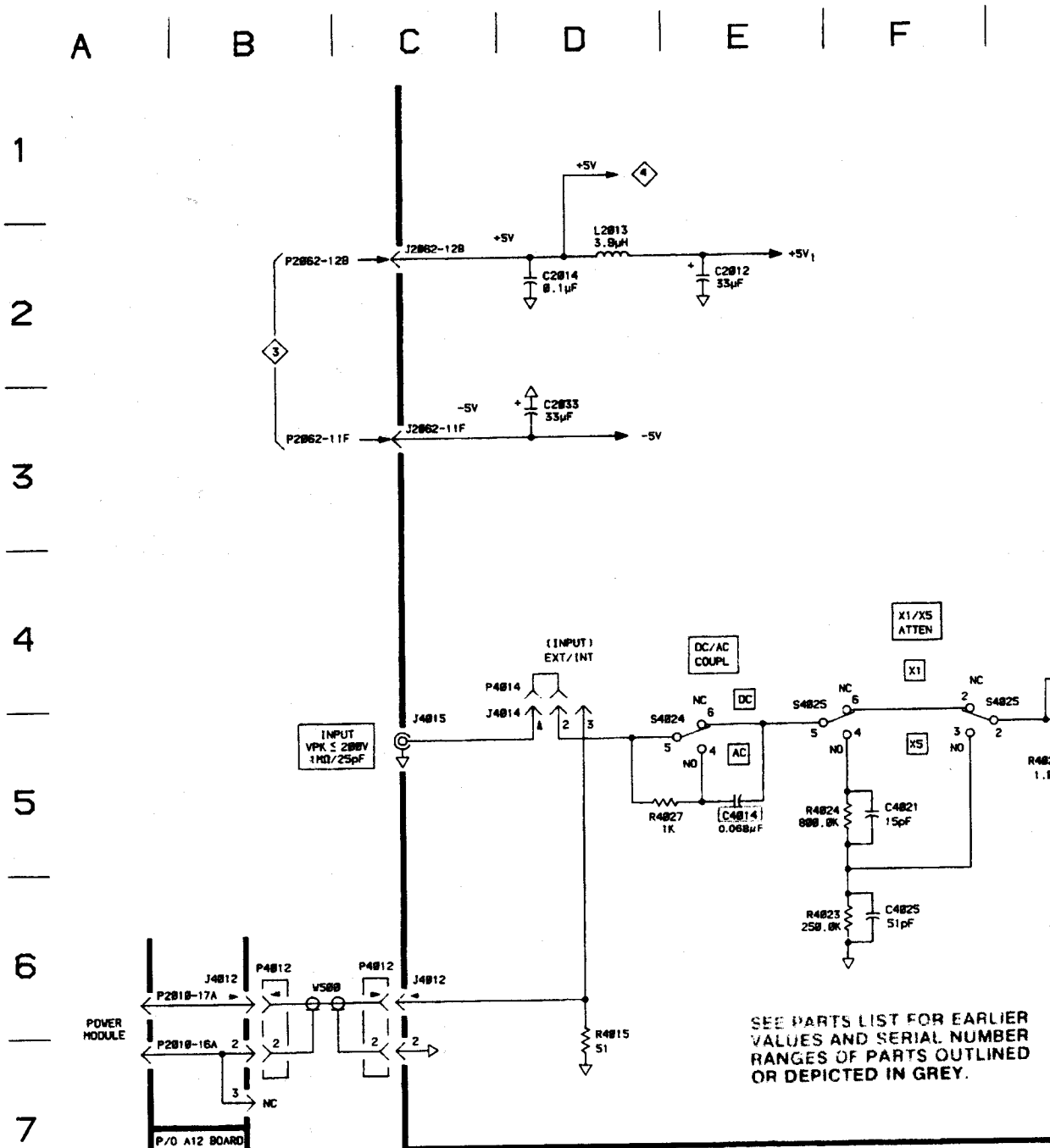
 Static Sensitive Devices  
See Maintenance Section

Fig. 8-4. Display Board (A10 Assy), and partial of Main Board (A12 Assy).

**COMPONENT NUMBER EXAMPLE**



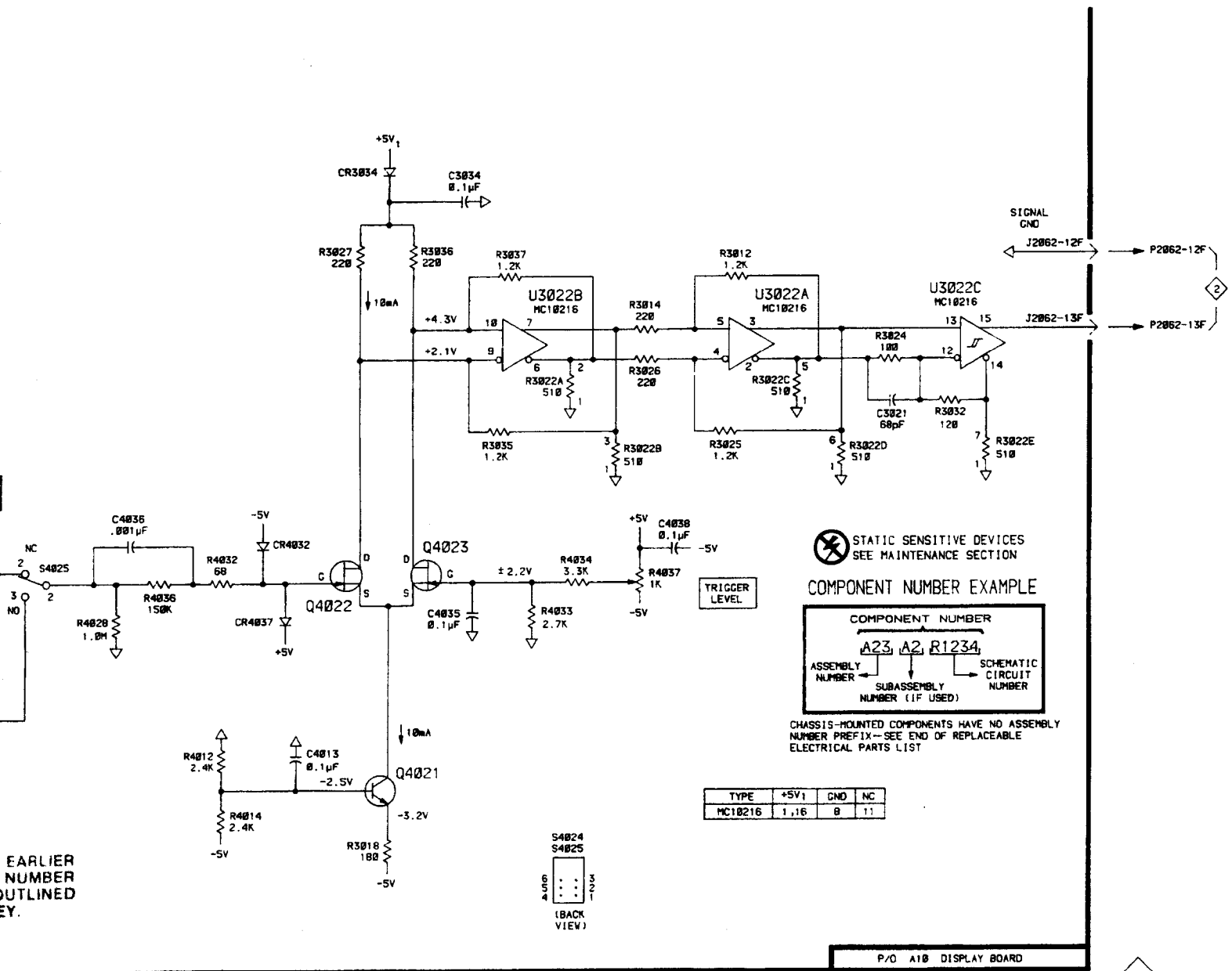
Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List



DC 504A

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

G | H | I | J | K | L | M



⊗ STATIC SENSITIVE DEVICES  
SEE MAINTENANCE SECTION

COMPONENT NUMBER EXAMPLE

COMPONENT NUMBER		
A23	A2	R1234
ASSEMBLY NUMBER	SUBASSEMBLY NUMBER (IF USED)	SCHEMATIC CIRCUIT NUMBER

CHASSIS-MOUNTED COMPONENTS HAVE NO ASSEMBLY NUMBER PREFIX--SEE END OF REPLACEABLE ELECTRICAL PARTS LIST

TYPE	+5V1	GND	NC
MC10216	1,16	8	11

S4024  
S4025

4	5	6	7	8	9	10	11	12
---	---	---	---	---	---	----	----	----

(BACK VIEW)

EARLIER NUMBER OUTLINED KEY.

4291-58  
REV SEP 1984

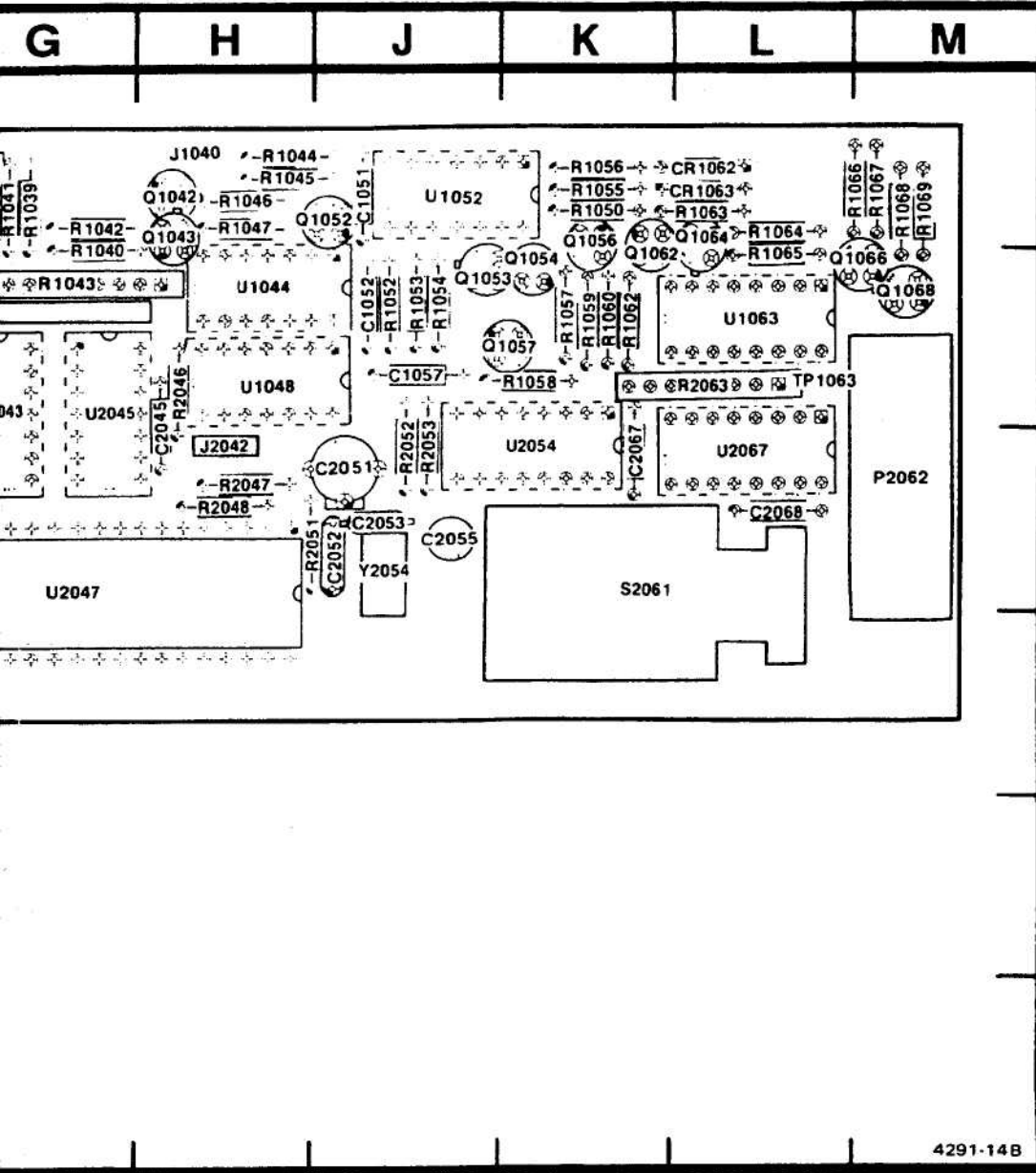
INPUT CONDITIONING, AMPLIFIER, & SCHMITT TRIGGER

P/O A10 DISPLAY BOARD

1 JCS



ION GRID



4291-14B

A12

nd (A12 Assy).

# PARTS LOCATION

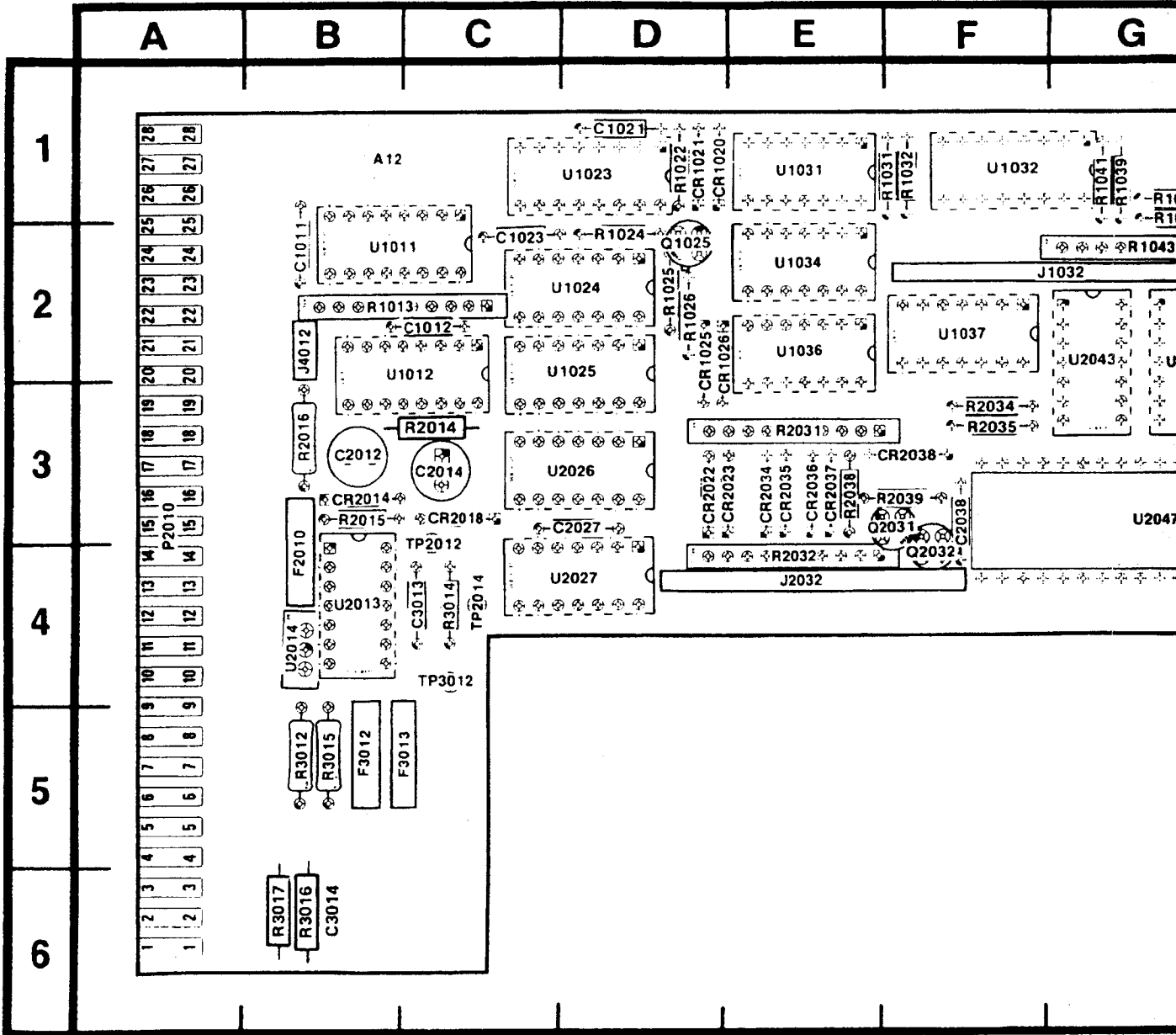


Fig. 8-5. Main Board (A12 As

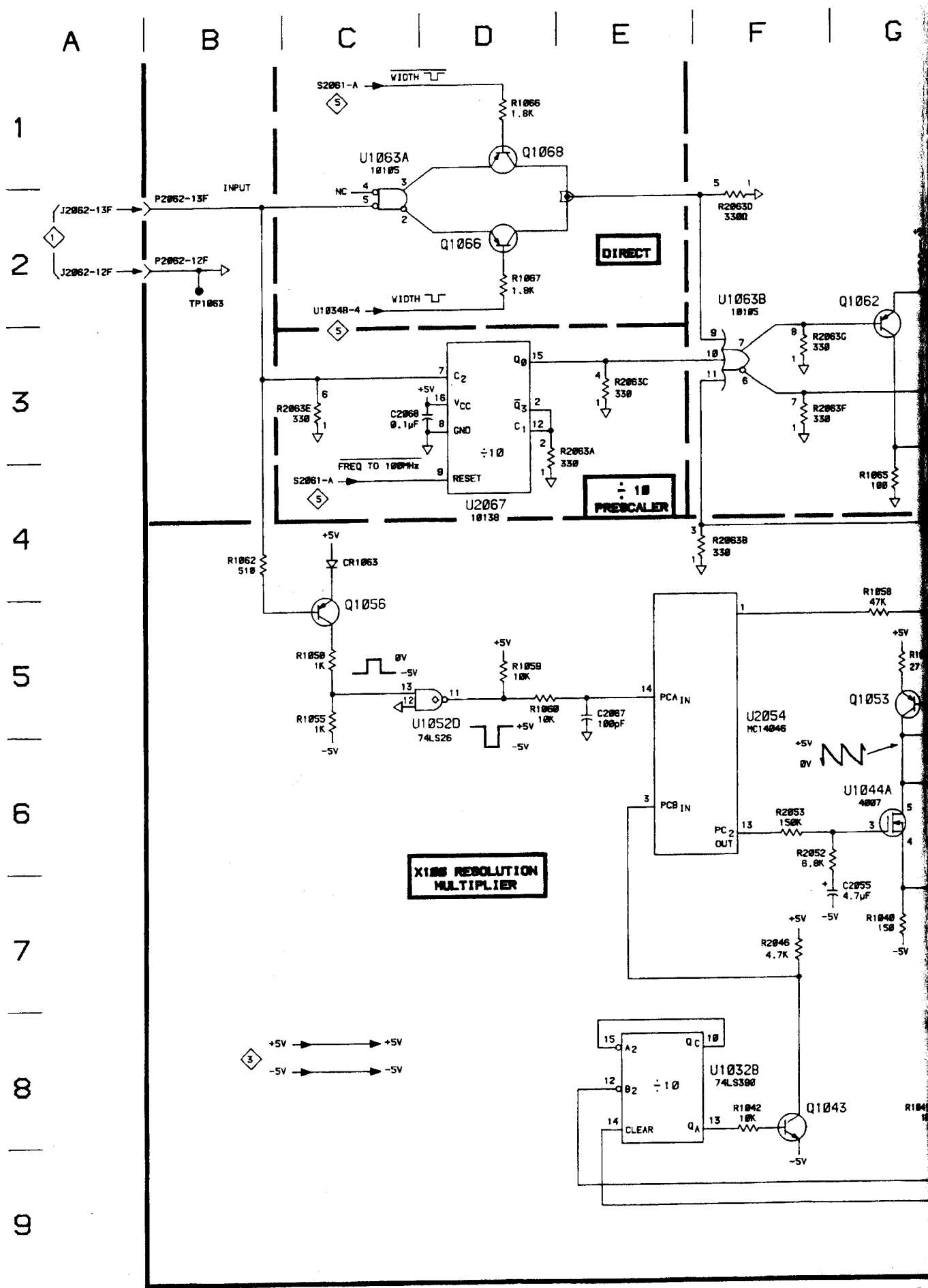
## Table 8-2 COMPONENT REFERENCE CHART

P/O A12 ASSY			MAIN BOARD <span style="border: 1px solid black; padding: 2px;">2</span>		
CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION
C1051	L7	J1	R1046	J5	H1
C1052	G6	J2	R1047	G6	H1
C1057	H5	J2	R1050	C5	K1
C2055	G7	J3	R1052	J4	J2
C2067	E5	K3	R1053	I6	J2
C2068	C3	L3	R1054	I6	J2
CR1020	L5	D1	R1055	C5	K1
CR1021	L5	D1	R1056	I6	K1
CR1062	J6	L1	R1057	G5	K2
CR1063	C4	L1	R1058	G4	K2
J1040	I9	H1	R1059	D5	K2
P1040	J9	H1	R1060	D5	K2
Q1042	H7	H1	R1062	B4	K2
Q1043	F8	H1	R1063	G2	L1
Q1052	J4	J1	R1064	H4	L1
Q1053	G5	J2	R1065	G4	L2
Q1054	J6	K2	R1066	D1	M1
Q1056	C5	K1	R1067	D2	M1
Q1057	J4	K2	R1068	L6	M1
Q1062	G2	K1	R1069	L6	M1
Q1064	H2	L1	R2046	F7	H2
Q1066	D2	M1	R2047*	I3	H3
Q1066	D2	M2	R2048*	J3	H3
Q1068	D1	M2	R2052	F6	J3
R1031	K5	F1	R2053	F6	J3
R1032	L5	F1	R2063	E3	L2
R1039	H7	G1	TP1063	B2	L2
R1040	G7	G1	U1032	I8	F1
R1041	G8	G1	U1044	G6	H2
R1042	F8	G2	U1048	H3	H2
R1044	K6	H1	U1052	J6	J1
R1045	J5	H1	U1063	C1	L2
			U2054	F5	K3
			U2067	D4	L3

P/O A12 ASSY also shown on



\*See Parts List for  
serial number ranges.



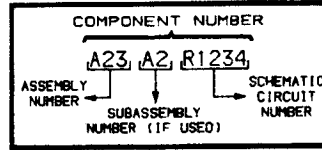
G | H | I | J | K | L | M | N

PRESCALER & PHASE LOCKED LOOP

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

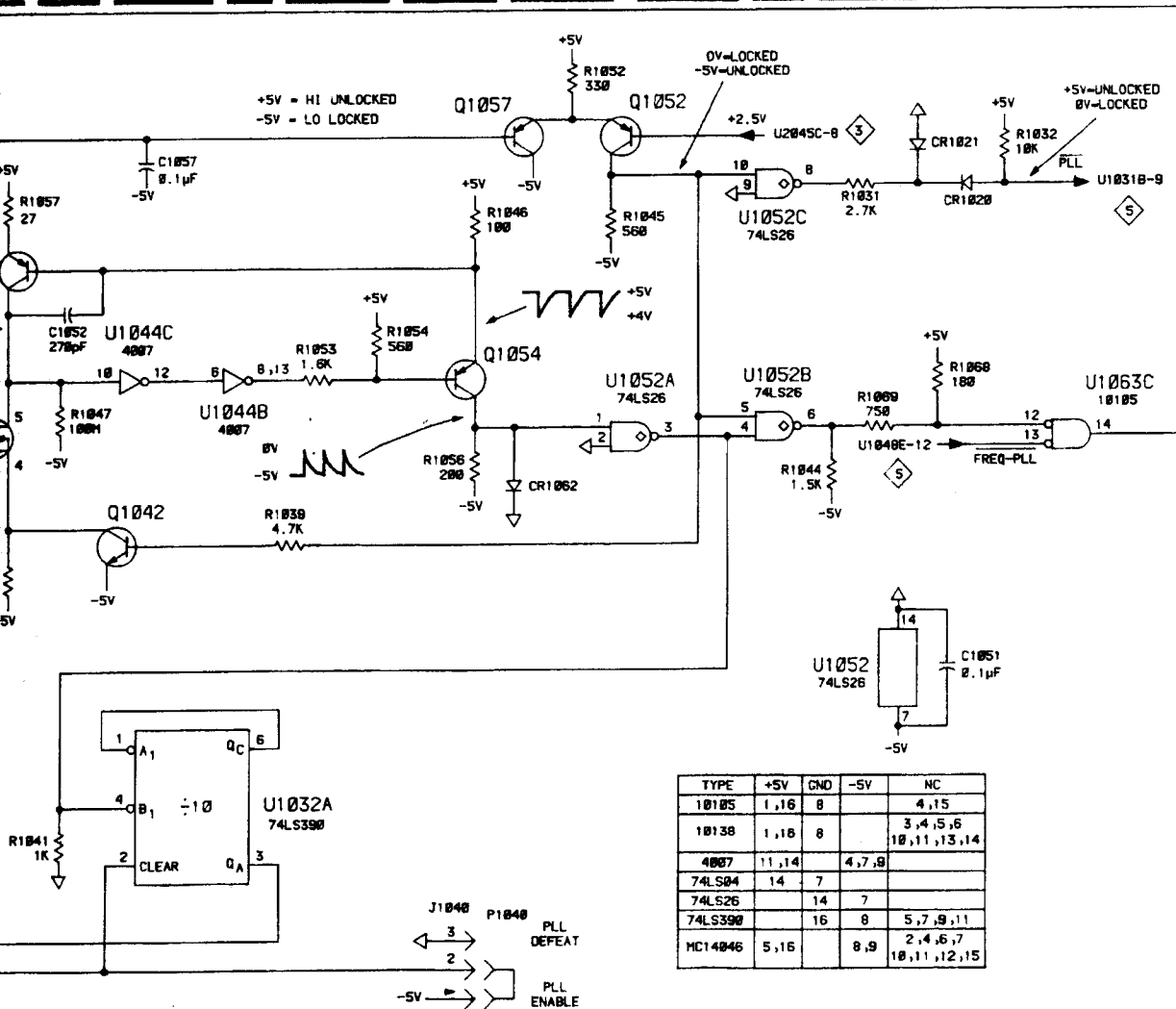
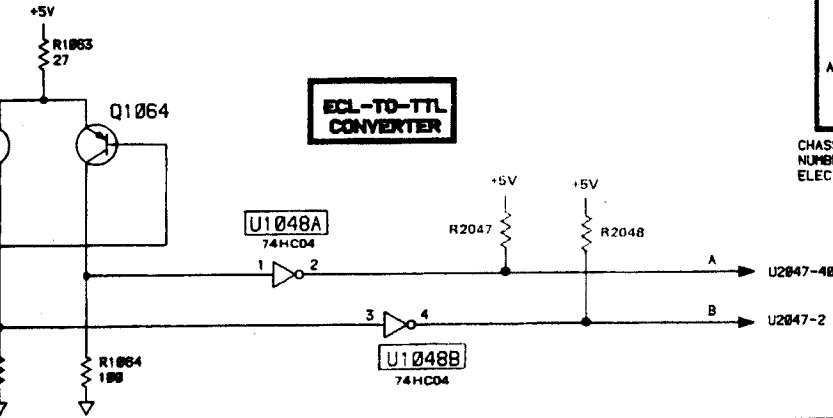
 STATIC SENSITIVE DEVICES  
SEE MAINTENANCE SECTION

COMPONENT NUMBER EXAMPLE



CHASSIS-MOUNTED COMPONENTS HAVE NO ASSEMBLY NUMBER PREFIX—SEE END OF REPLACEABLE ELECTRICAL PARTS LIST

**ECL-TO-TTL CONVERTER**



TYPE	+5V	GND	-5V	NC
10105	1,16	8		4,15
10138	1,16	8		3,4,5,6,10,11,13,14
4007	11,14		4,7,9	
74LS04	14	7		
74LS26		14	7	
74LS390		16	8	5,7,9,11
MC14946	5,16		8,9	2,4,6,7,10,11,12,15

P/O A12 MAIN BOARD

SIGNAL ROUTING, PRESCALER, & PHASE-LOCKED LOOP

# LOCATION GRIDS

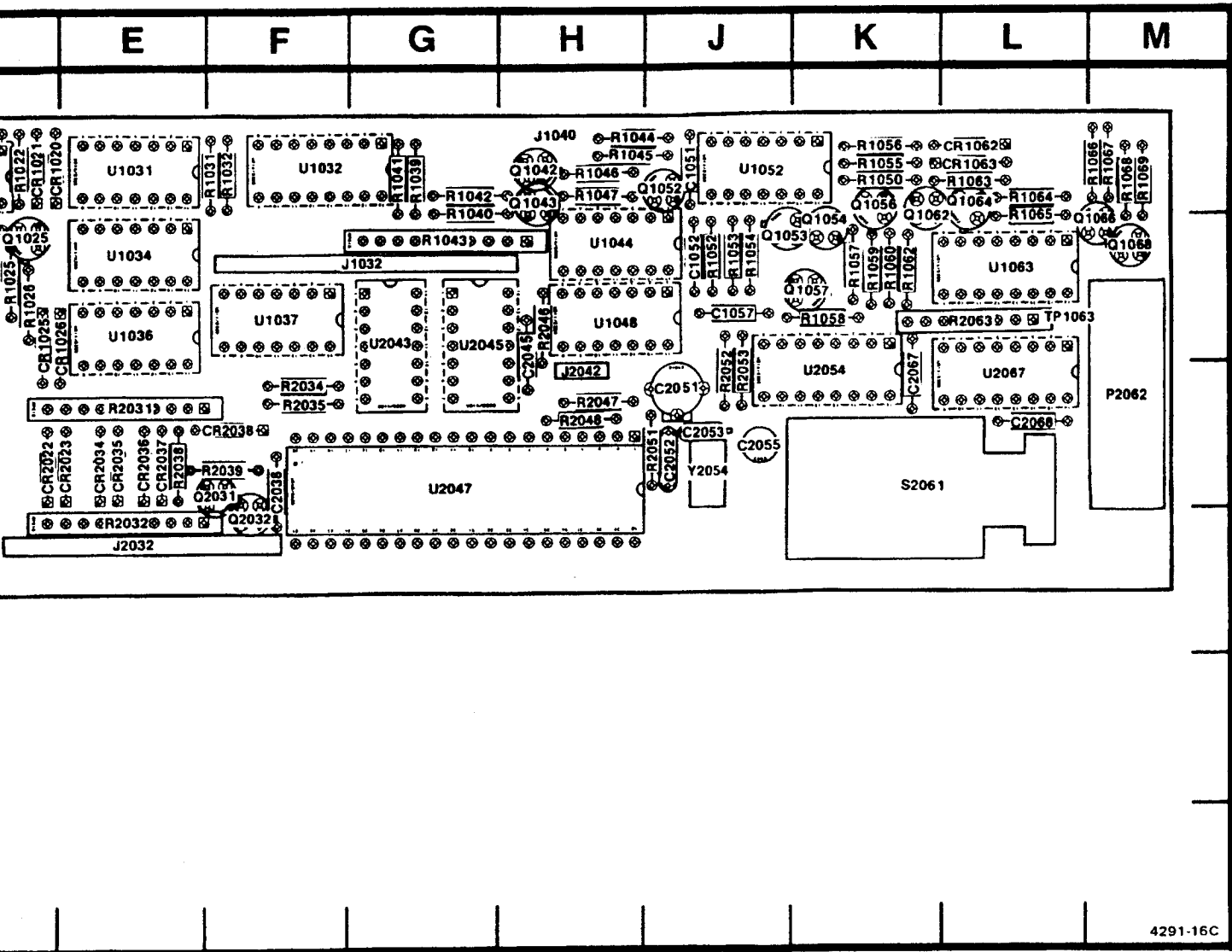
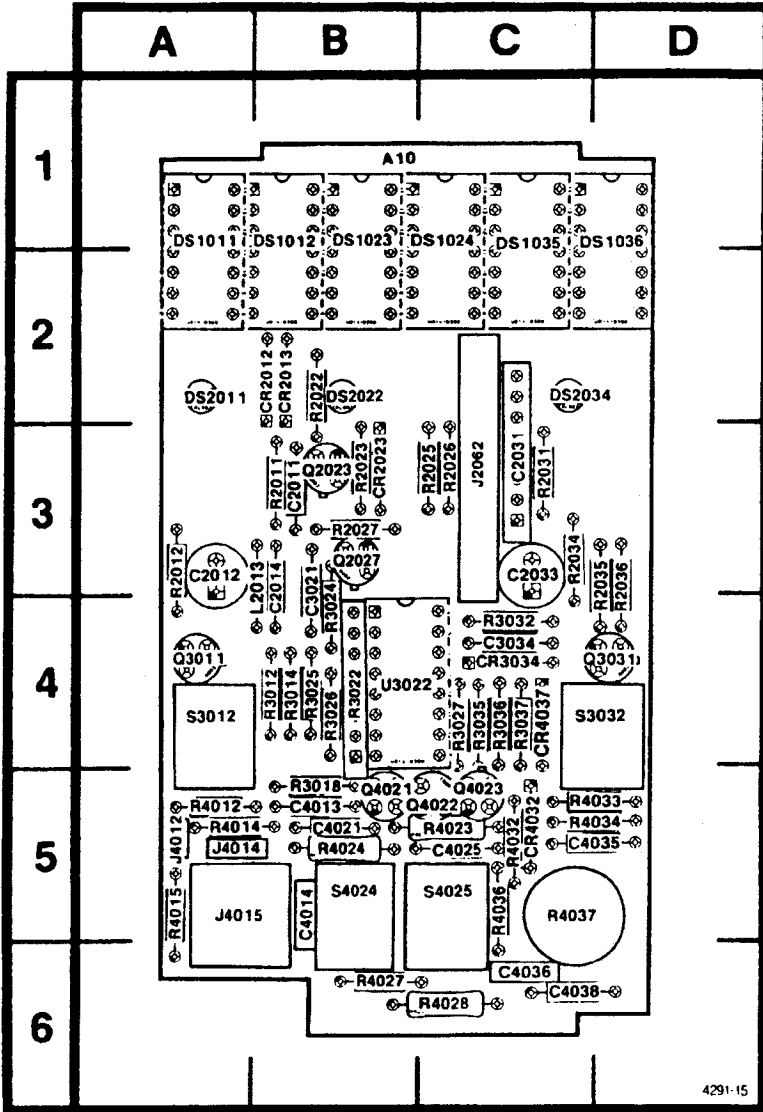


Fig. 8-7. Main Board (A12 Assy).

4291-16C

A12



4291-15

A10

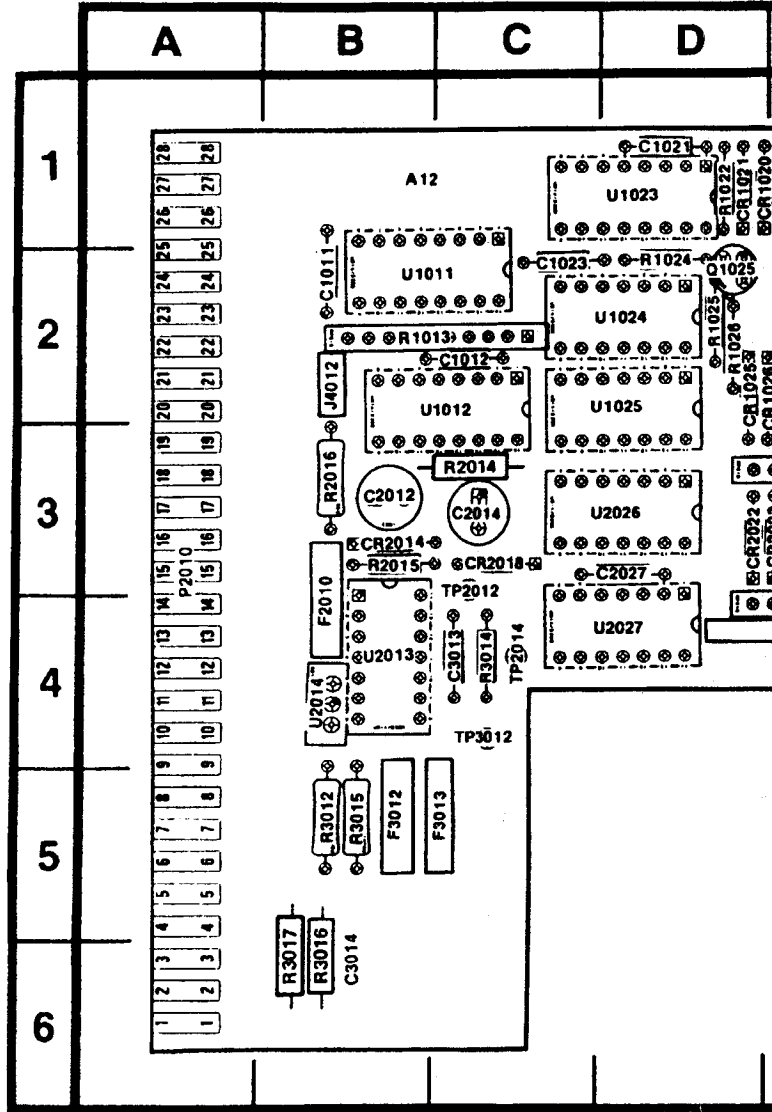


Fig. 8-6. Display Board (A10 Assy).

## Table 8-3 COMPONENT REFERENCE CHART

P/O A12 ASSY			MAIN BOARD <span style="border: 1px solid black; padding: 2px;">3</span>		
CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION
C2012	K8	B3	R1013	F4	B2
C2014	G10	C3	R1024	C2	D2
C2038	L8	F3	R1025	C2	D2
C2045	L9	A2	R1026	C2	D2
C2051	C4	J3	R1043	K1	G2
C2052 *	D4	J3	R2014*	B3	C3
C2053	C4	J3	R2015	I8	B3
C3013	I9	C4	R2016	I8	B3
C3014	F10	B5	R2034	A6	F3
CR2014	K8	B3	R2035	H1	F3
CR2018	H10	C3	R2051	D4	J3
F2010	E8	B4	R3012	H9	B5
F3012	E8	B5	R3014	I9	C4
F3013	E10	C5	R3015	H9	B5
J1032	B3	G2	R3016†	G10	B6
J2032	D7	E4	R3017†	F10	B6
J2042	D3	H3	TP2012	H10	C3
P2010	D10	A3	TP2014	L8	C4
P2042	D3	H3	TP3012	D9	C4
P2062	I5	M3	U1037	G3	F2
Q1025	C2	D2	U1048	C4	H2
			U2013	K8	B4
			U2014	F10	B4
			U2027	C3	D4
			U2043	J4	G2
			U2045	J2	U2
			U2047	F4	G3
			Y2054	D4	J3

P/O A12 ASSY also shown on 1 2 5

P/O A10 ASSY			DISPLAY BOARD		
CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION
Q3011	B6	A4	R2035	B6	D3
Q3031	B6	D4	R2036	C6	D3
R2011	B7	B3	S3012	B6	A4
R2012	C6	A3	S3032	B6	D4

P/O A10 ASSY also shown on 1 4

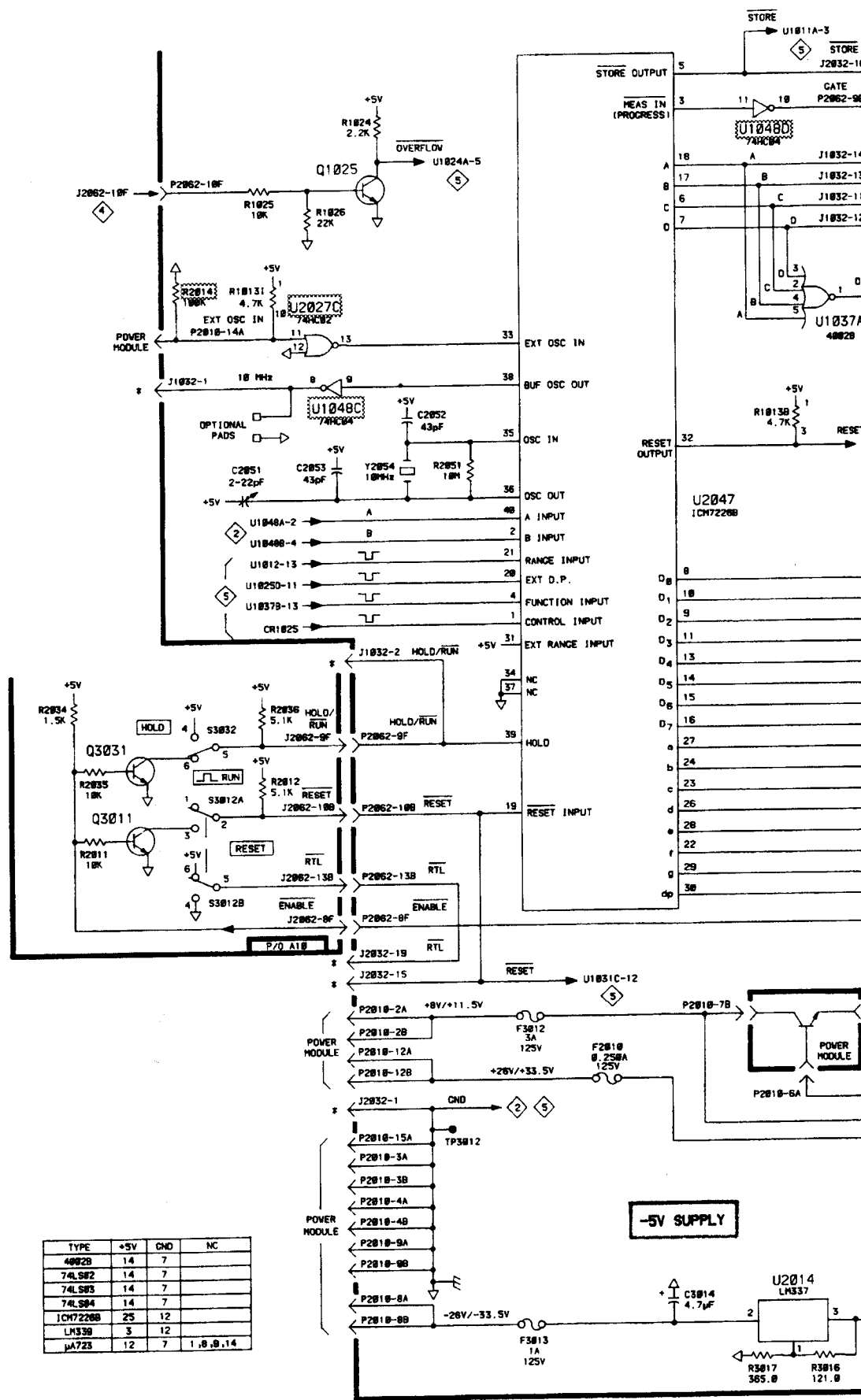
†May be located on back of board.

\*See Parts List for serial number ranges.



A | B | C | D | E | F | G

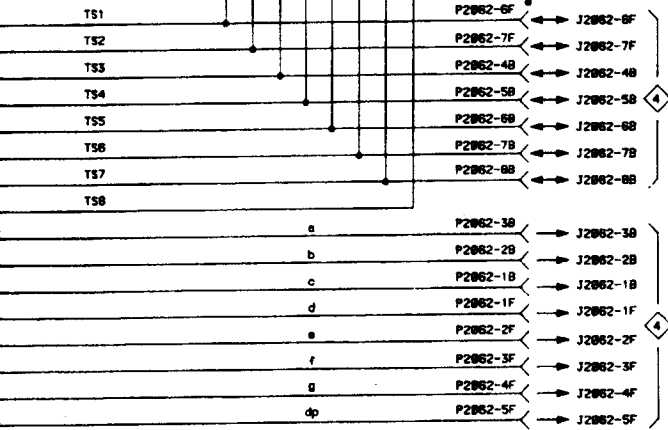
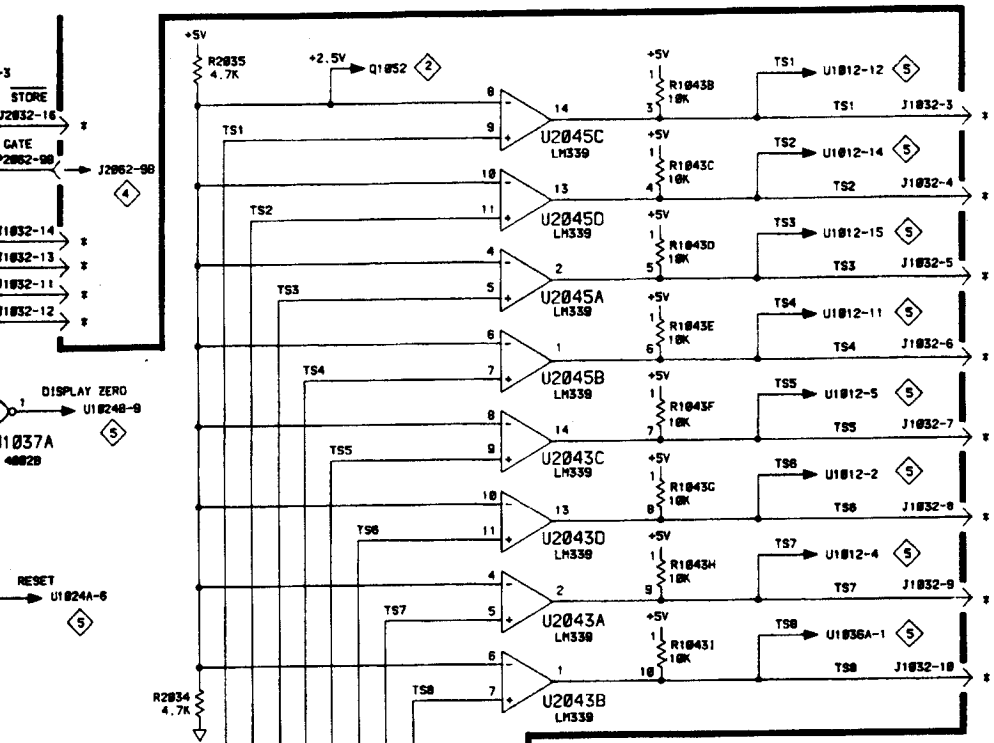
1  
2  
3  
4  
5  
6  
7  
8  
9  
10



TYPE	+5V	GND	NC
4002B	14	7	
74LS02	14	7	
74LS05	14	7	
74LS04	14	7	
1CH7220B	25	12	
LMS30	3	12	
μA723	12	7	1, 8, 14

G | H | I | J | K | L | M | N

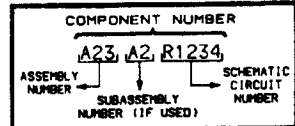
COUNTER & POWER SUPPLIES



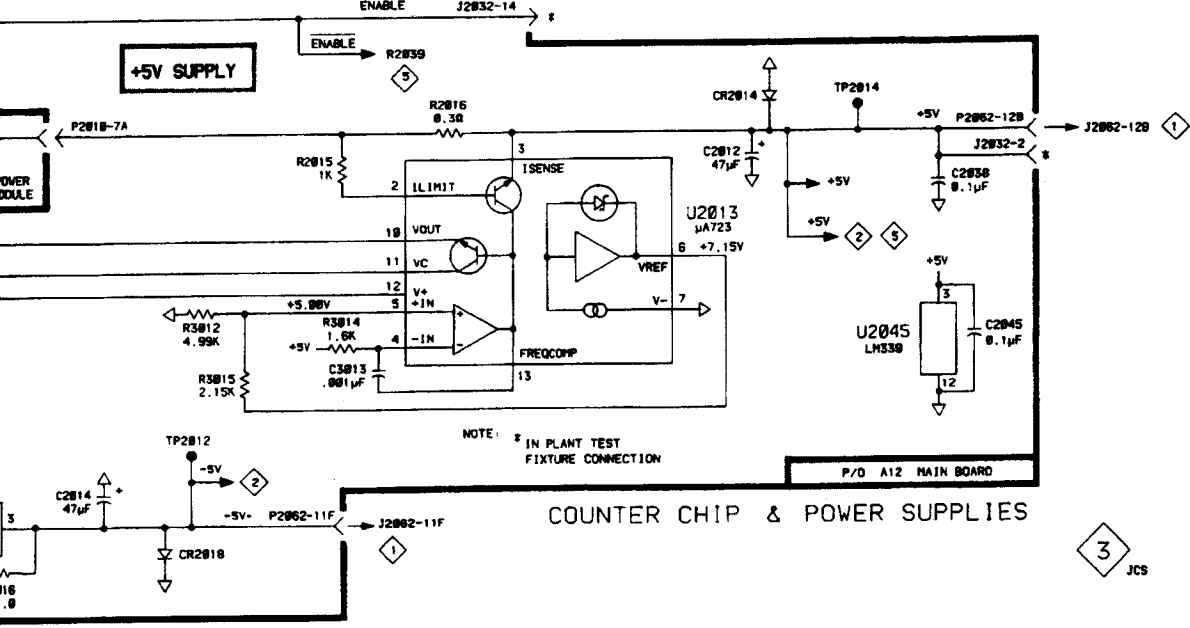
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN GREY

⊗ STATIC SENSITIVE DEVICES  
SEE MAINTENANCE SECTION

COMPONENT NUMBER EXAMPLE



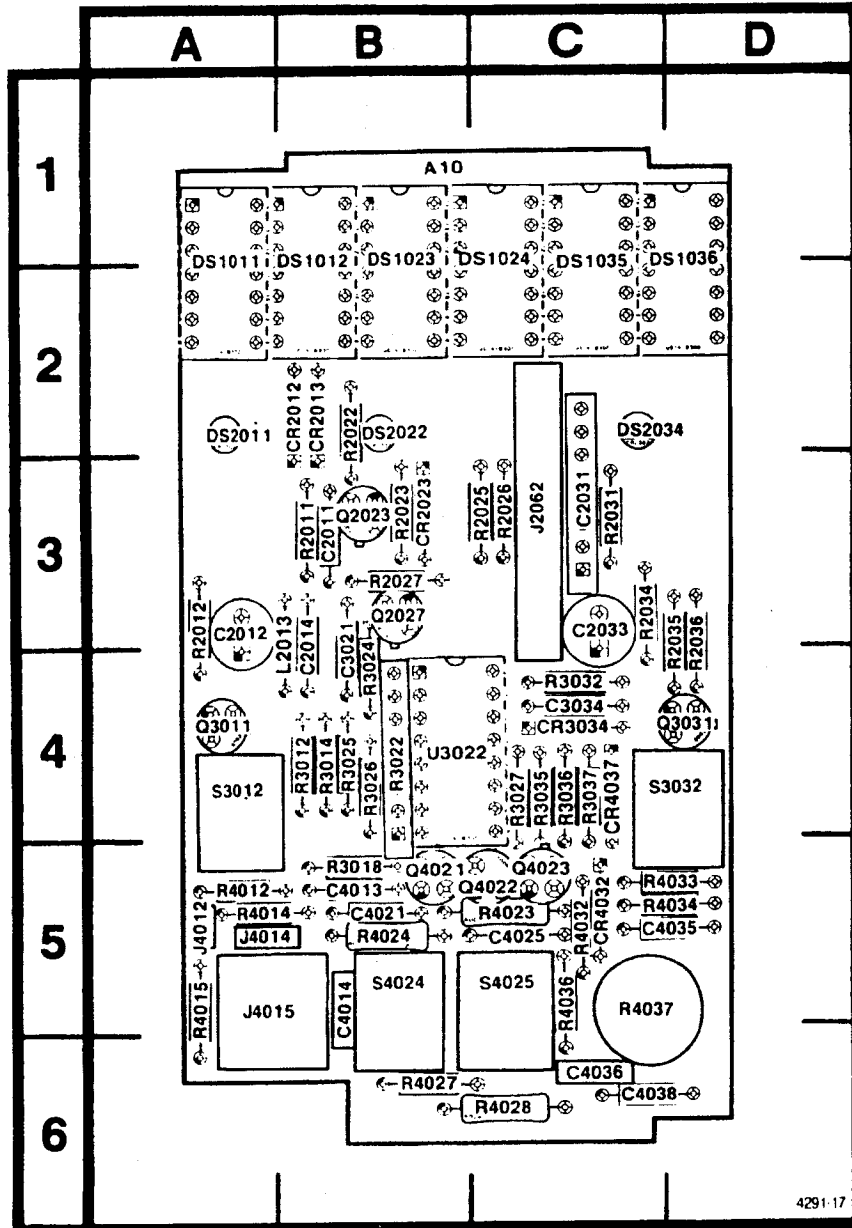
CHASSIS-MOUNTED COMPONENTS HAVE NO ASSEMBLY NUMBER PREFIX - SEE END OF REPLACEABLE ELECTRICAL PARTS LIST



COUNTER CHIP & POWER SUPPLIES

3 JCS

# PARTS LOCATION GRID



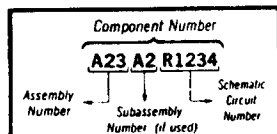
4291-17

**A10**

Fig. 8-8. Display Board (A10 Assy).

 **Static Sensitive Devices**  
See Maintenance Section

**COMPONENT NUMBER EXAMPLE**



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

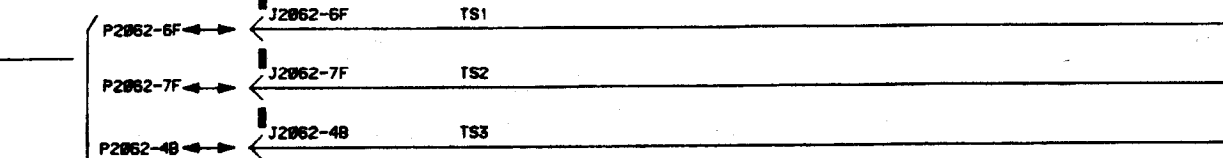
## Table 8-4 COMPONENT REFERENCE CHART

P/O A10 ASSY			DISPLAY BOARD <span style="float: right;">◇ 4</span>		
CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION
C2011	D6	B3	J2062	B2	C3
C2031	C3	C3	P2062	A1	C3
CR2012	C4	B2	Q2023	D7	B3
CR2013	B4	B2	Q2027	C6	B3
CR2023	C6	B3	R2022	D6	B2
DS1011	D3	A1	R2023	C7	B3
DS1012	E3	B1	R2025	D7	C3
DS1023	F3	B1	R2026	C7	C3
DS1024	G3	C1	R2027	D6	B3
DS1035	I3	C1	R2031	F6	C3
DS1036	J3	D1			
DS2011	C3	A2			
DS2022	D6	B2			
DS2034	F6	C2			

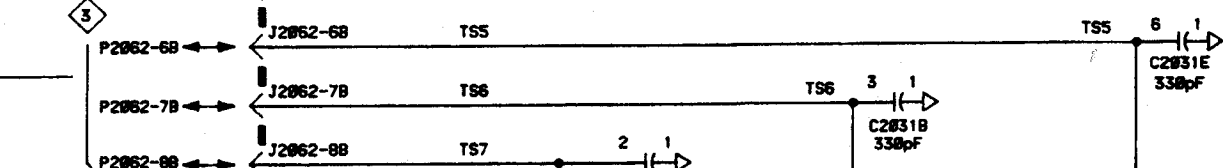
P/O A10 ASSY also shown on ◇ 1 ◇ 3

A | B | C | D | E

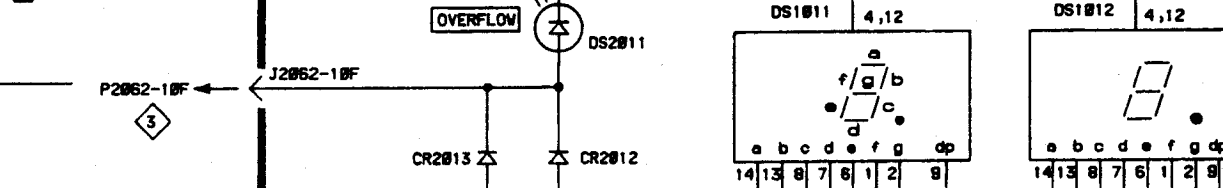
1



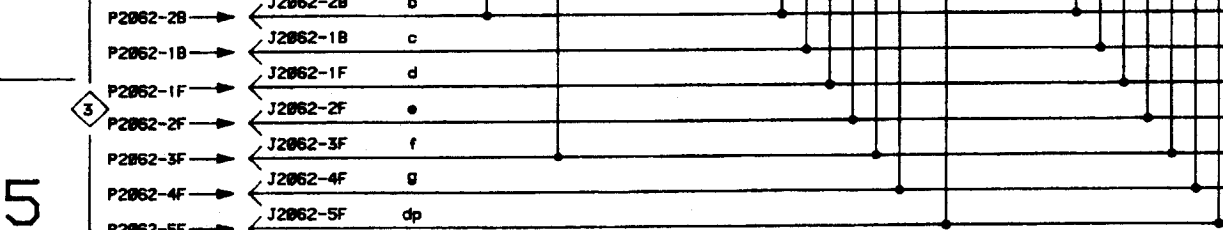
2



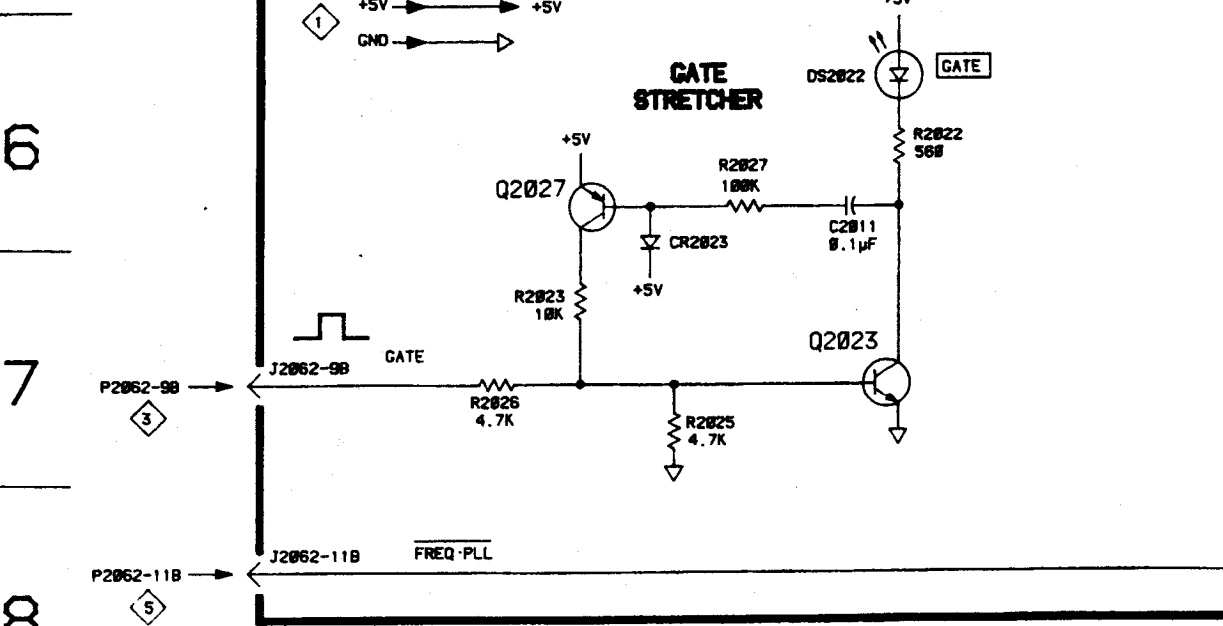
3



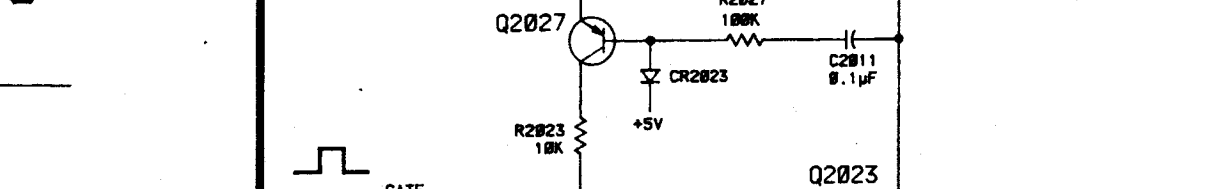
4



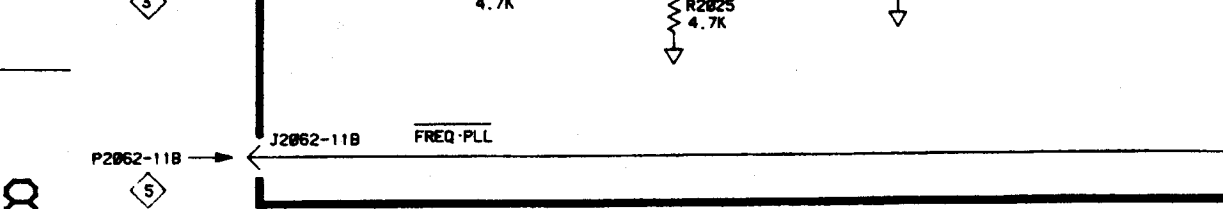
5



6

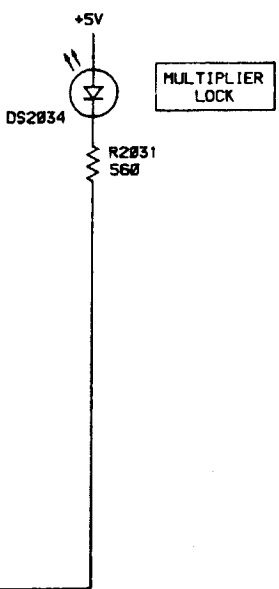
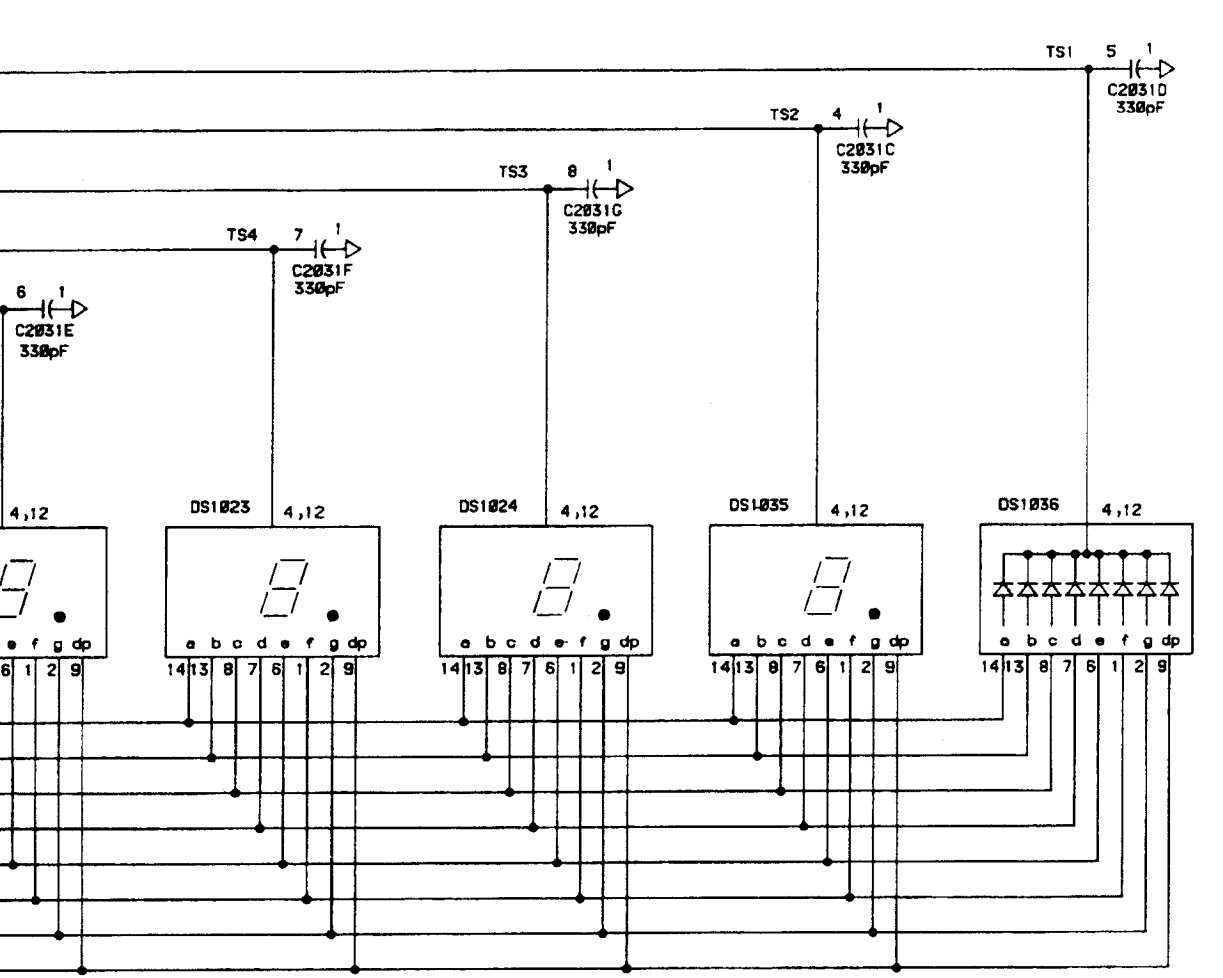


7



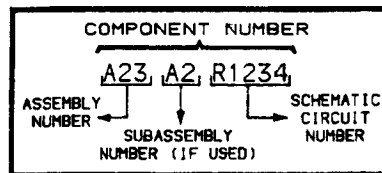
8

F | G | H | I | J | K



 STATIC SENSITIVE DEVICES  
SEE MAINTENANCE SECTION

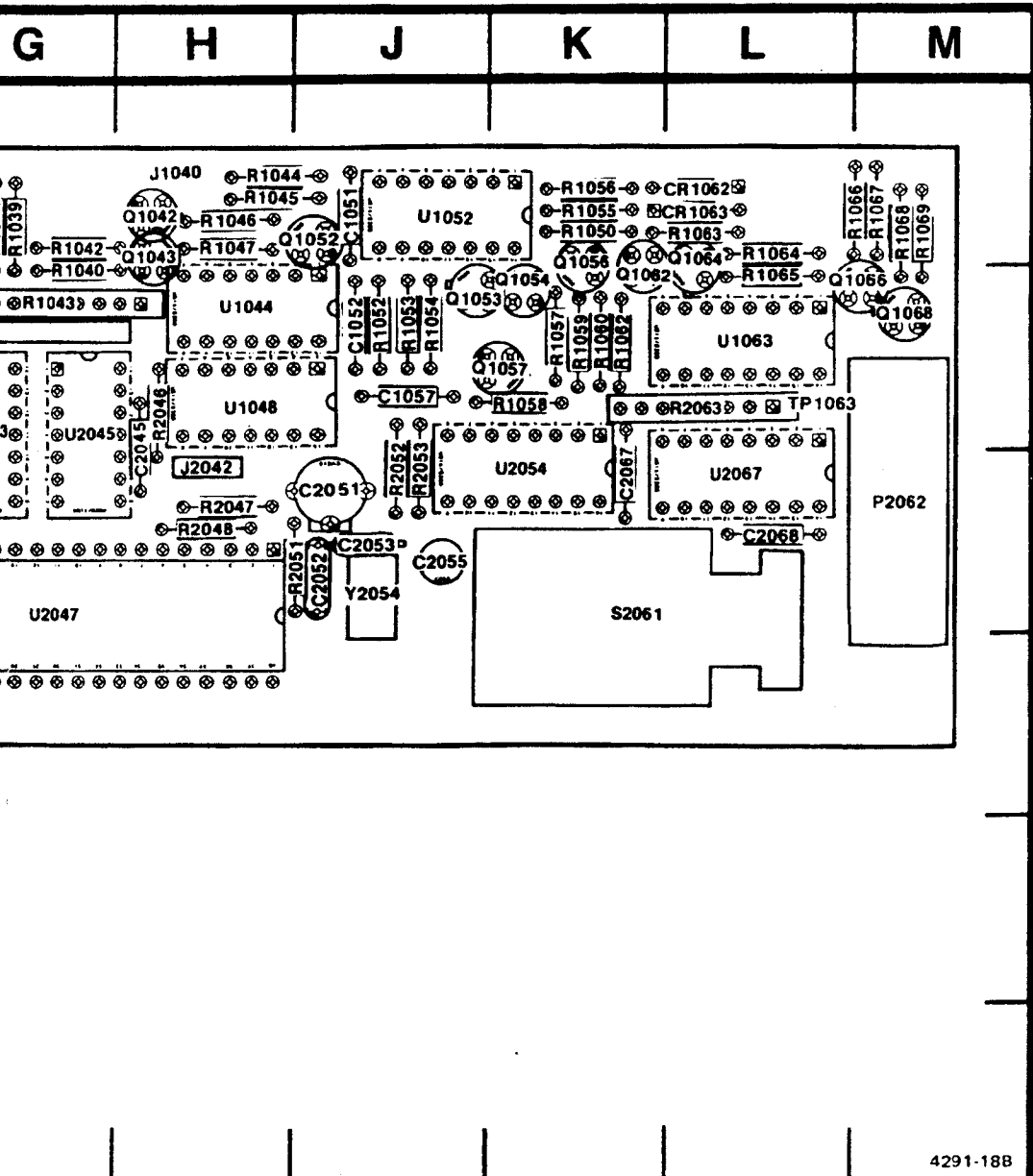
COMPONENT NUMBER EXAMPLE



CHASSIS-MOUNTED COMPONENTS HAVE NO ASSEMBLY NUMBER PREFIX—SEE END OF REPLACEABLE ELECTRICAL PARTS LIST

P/O A10 DISPLAY BOARD

N GRID



4291-18B

A12

sy).

# PARTS LOCATION GRID

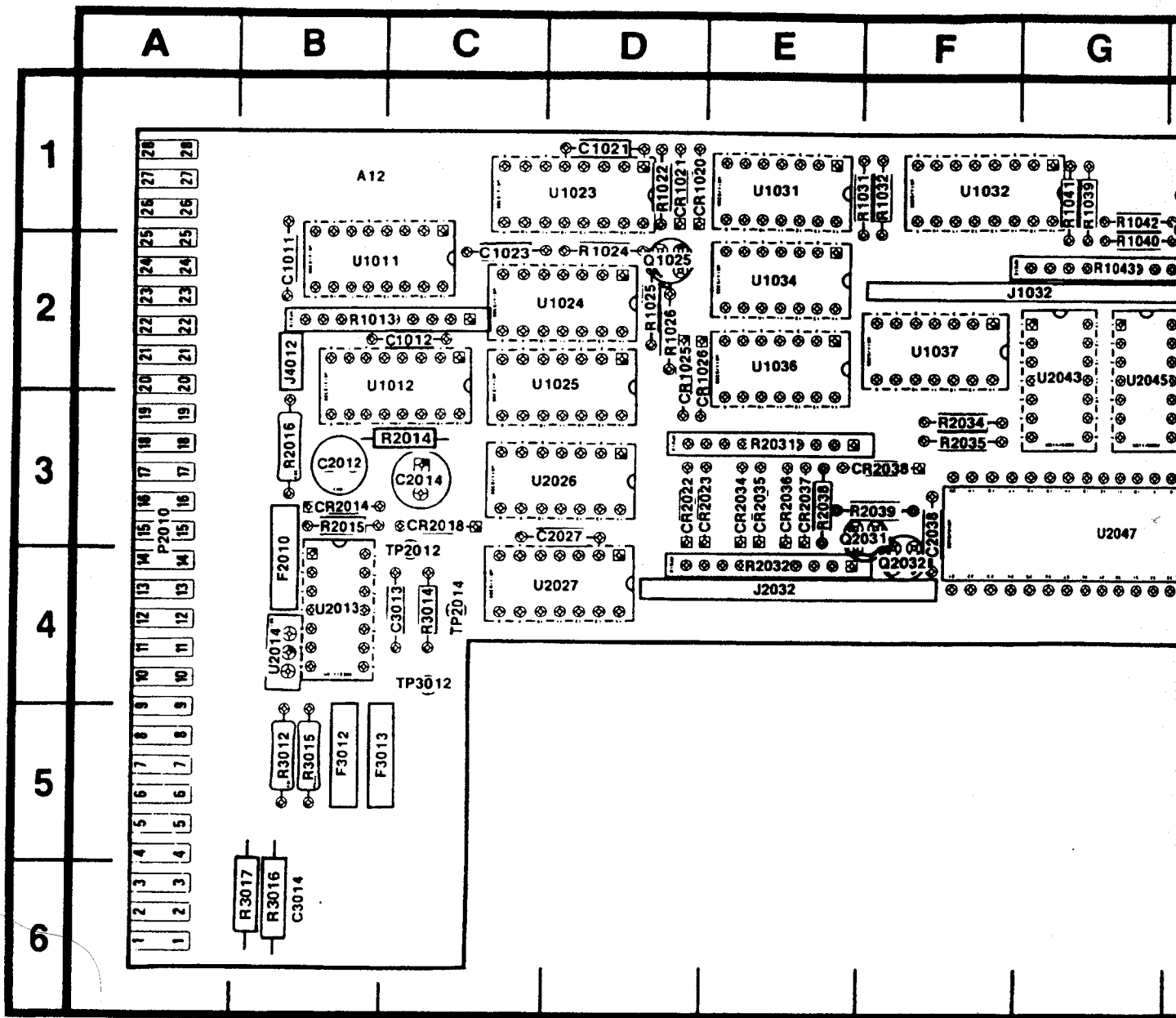


Fig. 8-9. Main Board (A12 Assy).



**Table 8-5  
COMPONENT REFERENCE CHART**

P/O A12 ASSY			MAIN BOARD <span style="border: 1px solid black; padding: 2px;">5</span>		
CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION
C1011	J7	B2	R1013	E10	B2
C1012	K7	C2	R1022	I8	D1
C1021	G10	D1	R1043A*	J6	G2
C1023	D9	C2	R2031	C7	E3
C2027	K8	D3	R2032	D1	E4
			R2038	B4	E3
			R2039	B4	F3
CR1025	I5	D2			
CR1026	I6	D2	S2061	C3	K3
CR2022	B7	D3			
CR2023	B7	E3	U1011	I7	B2
CR2034	E3	E3	U1012	E7	C2
CR2035	E3	E3	U1023	H10	D1
CR2036	E3	E3	U1024	F9	D2
CR2037	E2	E3	U1025	I5	D2
CR2038	G5	F3	U1031	G5	E1
			U1034	H11	E2
J2032	A1	E4	U1036	G3	E2
			U1037	H4	F2
Q2031	C3	F3	U1048	G6	H2
Q2032	B4	F4	U2026	H5	D3
			U2027	D8	D4

P/O A12 ASSY also shown on

1

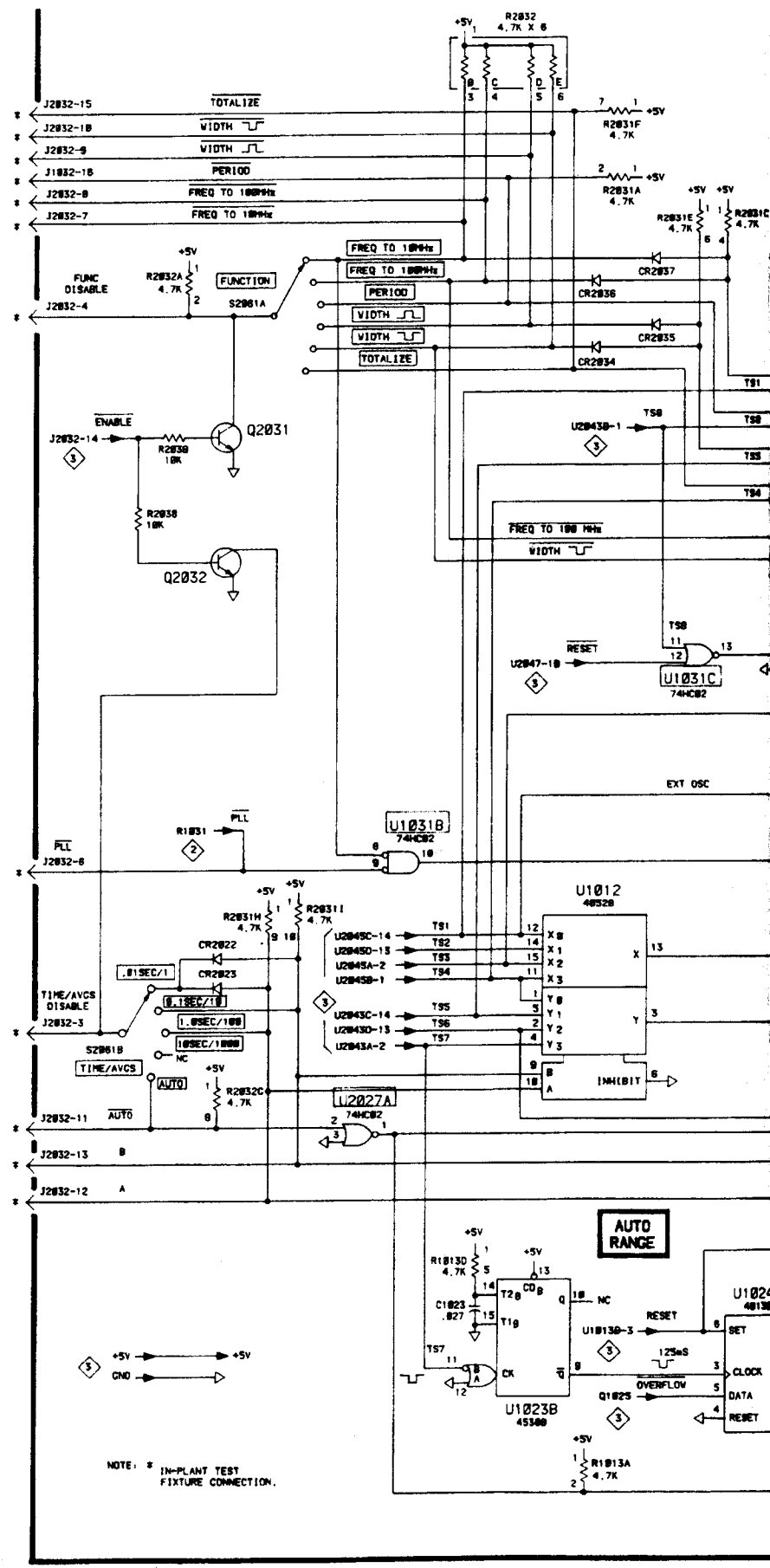
2

3

\*See Parts List for serial number ranges.

A | B | C | D | E | F

1  
2  
3  
4  
5  
6  
7  
8  
9  
10



DC 504A

REV. J

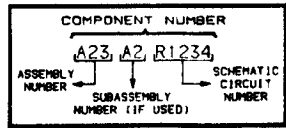
F | G | H | I | J | K | L

FUNCTION INPUT	TIME SLOT
FREQUENCY	TS1
PERIOD	TS8
WIDTH	TS5
TOTALIZE	TS4

**FUNCTION SELECT**

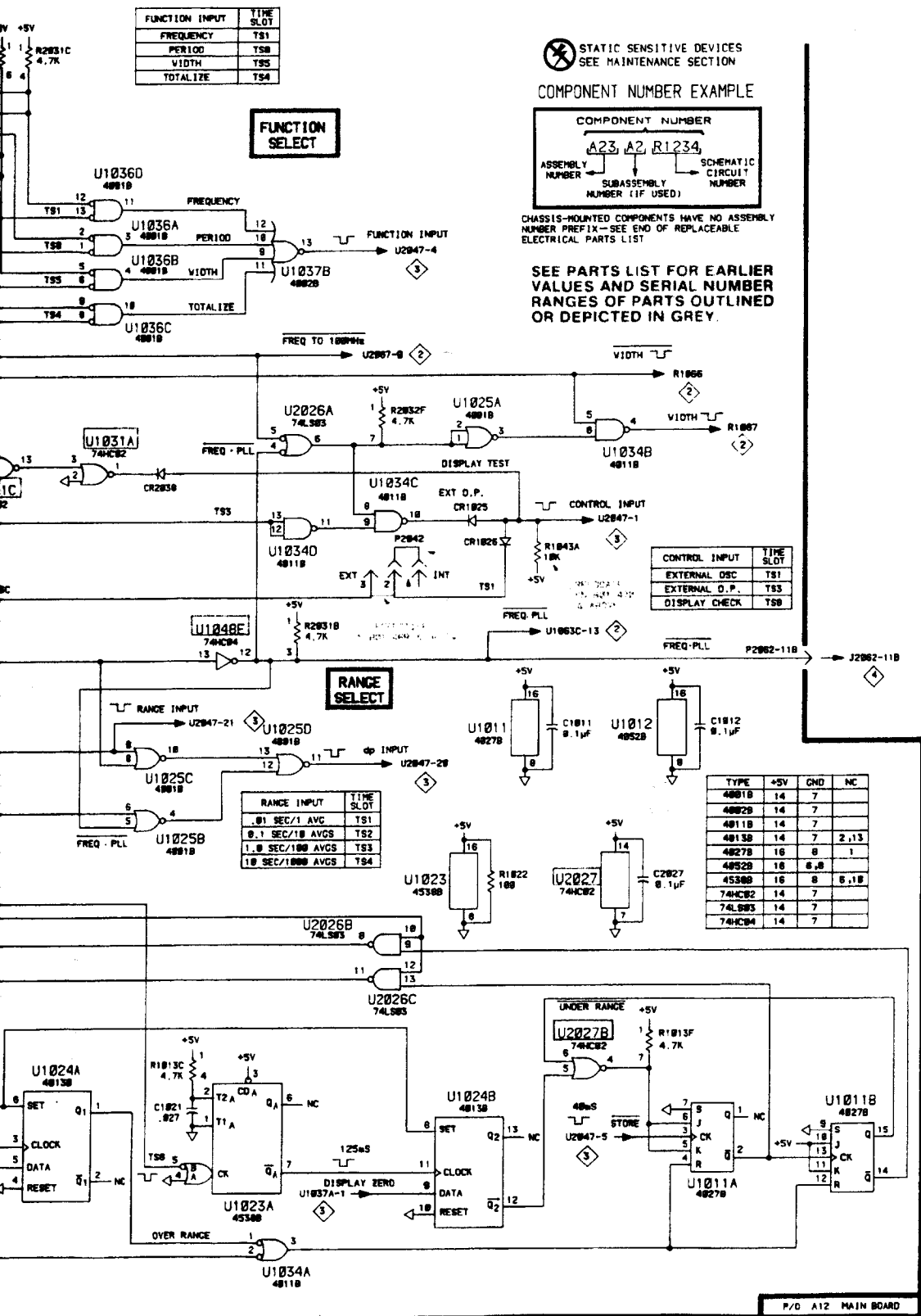
⊗ STATIC SENSITIVE DEVICES  
SEE MAINTENANCE SECTION

COMPONENT NUMBER EXAMPLE



CHASSIS-MOUNTED COMPONENTS HAVE NO ASSEMBLY NUMBER PREFIX—SEE END OF REPLACEABLE ELECTRICAL PARTS LIST

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



CONTROL INPUT	TIME SLOT
EXTERNAL OSC	TS1
EXTERNAL O.P.	TS3
DISPLAY CHECK	TS8

RANGE INPUT	TIME SLOT
0.1 SEC/1 AVCS	TS1
0.1 SEC/10 AVCS	TS2
1.0 SEC/100 AVCS	TS3
10 SEC/1000 AVCS	TS4

TYPE	+5V	GND	NC
4001B	14	7	
4002B	14	7	
4011B	14	7	
4013B	14	7	2,13
4027B	16	8	1
4052B	16	8,8	
4530B	16	8	6,10
74HC02	14	7	
74LS03	14	7	
74HC04	14	7	

RANGE, AUTORANGE, FUNCTION & DECIMAL POINT SELECTION

5 Jcs

# REPLACEABLE MECHANICAL PARTS

## PARTS ORDERING INFORMATION

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

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

## SPECIAL NOTES AND SYMBOLS

X000 Part first added at this serial number  
00X Part removed after this serial number

## FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations.

## INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the description column.

1 2 3 4 5 *Name & Description*

*Assembly and/or Component*

*Attaching parts for Assembly and/or Component*

---\*---

*Detail Part of Assembly and/or Component*

*Attaching parts for Detail Part*

---\*---

*Parts of Detail Part*

*Attaching parts for Parts of Detail Part*

---\*---

Attaching Parts always appear in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation. The separation symbol ---\*--- indicates the end of attaching parts.

**Attaching parts must be purchased separately, unless otherwise specified.**

## ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

## ABBREVIATIONS

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

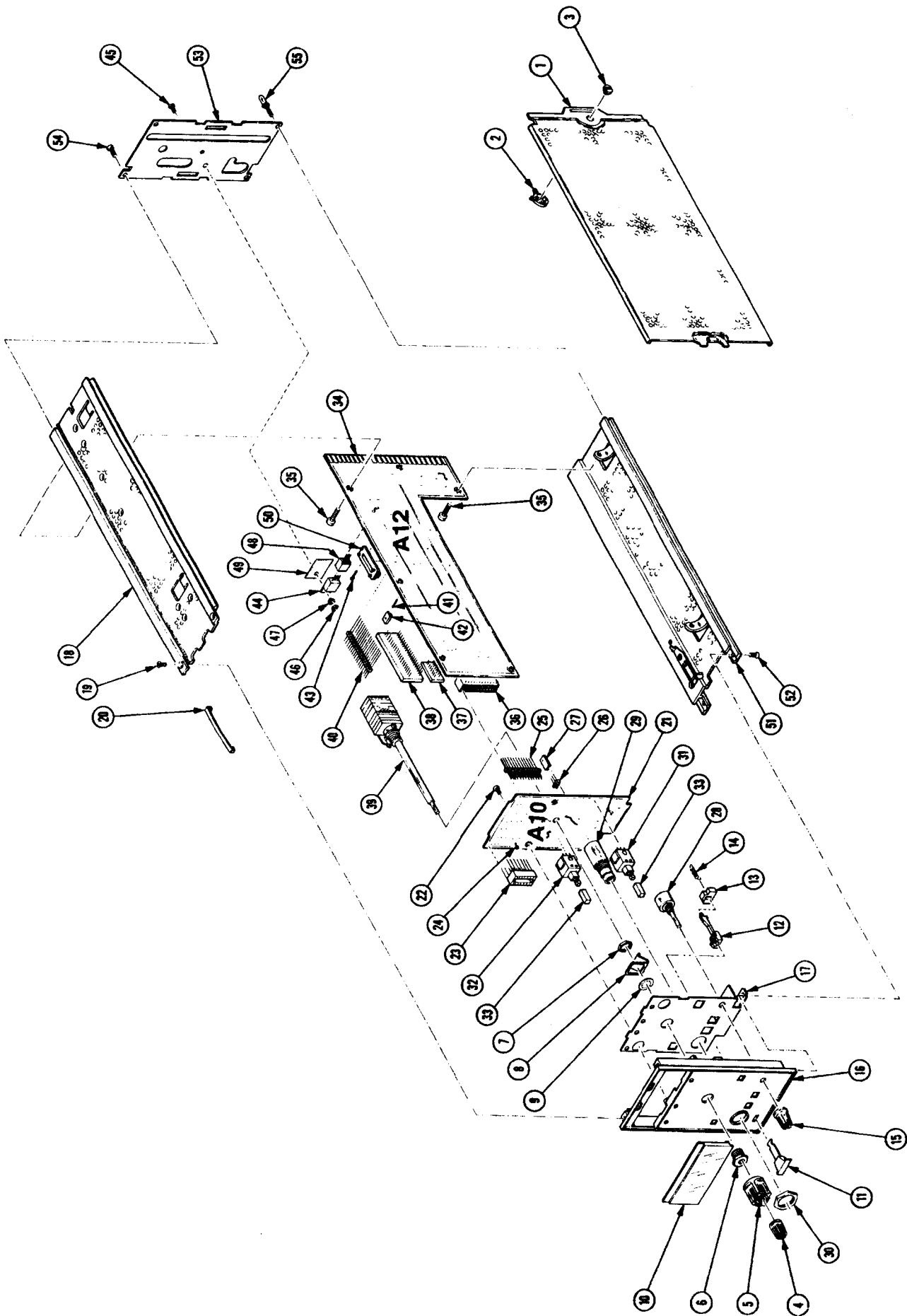
CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
00261	GENERAL ELECTRIC CO	14TH AND ARNOLD STS	CHICAGO HEIGHTS IL 60411
09772	FOOD SERVICE EQUIPMENT BUSINESS DEPT WEST COAST LOCKWASHER CO INC	16730 E JOHNSON DRIVE P O BOX 3588 RICHARDS AVE	CITY OF INDUSTRY CA 91744
09922	BURNDY CORP	RICHARDS AVE	NORWALK CT 06852
22526	DU PONT E I DE NEMOURS AND CO INC DU PONT CONNECTOR SYSTEMS DIV MILITARY PRODUCTS GROUP	515 FISHING CREEK RD	NEW CUMBERLAND PA 17070-3007
55285	BERGQUIST CO INC THE	5300 EDINA INDUSTRIAL BLVD	MINNEAPOLIS MN 55435-3707
71159	BRISTOL SOCKET SCREW CO		WATERBURY CT
73743	FISCHER SPECIAL MFG CO	111 INDUSTRIAL RD	COLD SPRING KY 41076-9749
78189	ILLINOIS TOOL WORKS INC SHAKEPROOF DIV	ST CHARLES ROAD	ELGIN IL 60120
80009	TEKTRONIX INC	14150 SW KARL BRAUM DR PO BOX 500 MS 53-111	BEAVERTON OR 97077
83385	MICRODOT MFG INC GREER-CENTRAL DIV	3221 W BIG BEAVER RD	TROY MI 48098
93907	TEXTRON INC CAMCAR DIV	600 18TH AVE	ROCKFORD IL 61101
TK0392	NORTHWEST FASTENER SALES INC	7923 SW CIRRRUS DRIVE	BEAVERTON OR 97005-6448
TK0435	LEWIS SCREW CO	4300 S RACINE AVE	CHICAGO IL 60609-3320
TK0772	RADAR ELECTRIC	168 WESTERN AVE W	SEATTLE WA 98119-4212
TK0858	STAUFFER SUPPLY CO	105 SE TAYLOR	PORTLAND OR 97214
TK1326	NORTHWEST FOURSIDE INC	18224 SW 100TH CT	TUALATIN OR 97062

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No.		Qty	12345 Name & Description	Mfr.	
		Effective	Discont			Code	Mfr. Part No.
1-1	337-3039-00			2	SHIELD,ELEC:SIDE	80009	337-3039-00
-2	105-0932-00			2	LATCH,PANEL:SIDE	80009	105-0932-00
-3	214-3364-00			2	FASTENER,LATCH:ACETAL,SIL GRAY	80009	214-3364-00
-4	366-1023-13			1	KNOB:GY,0.127 ID X 0.392 OD X 0.531 H	80009	366-1023-13
	213-0246-00			1	.SETSCREW:5-40 X 0.094,STL	71159	ORDER BY DESCR
-5	366-2156-00			1	KNOB:DOVE GRAY,0.421 ID X 0.706 OD X 0.6 H	80009	366-2156-00
	213-0153-00			2	.SETSCREW:5-40 X 0.125,STL	TK0392	ORDER BY DESCR
-6	358-0686-00			1	BUSHING,SLEEVE:0.197 ID X 0.438 OD X 0.375 (ATTACHING PARTS)	80009	358-0686-00
-7	220-0495-00			1	NUT,PLAIN,HEX:0.375-32 X 0.438 HEX,BRS	73743	ORDER BY DESCR
-8	344-0195-01			1	CLIP,ELECTRICAL:GROUNDING,PH BRZ ALBALOY PL	80009	344-0195-01
-9	210-0012-00			1	WASHER,LOCK:0.384 ID,INTL,0.022 THK,STL (END ATTACHING PARTS)	09772	ORDER BY DESCR
-10	378-2030-05			1	LENS,LED DSPL:RED W/MARKINGS	80009	378-2030-05
	334-4827-00			1	MARKER,IDENT:MKD DC504A	80009	334-4827-00
-11	366-1851-01			1	KNOB,LATCH:IVORY GY,0.625 X 0.25 X 1.09	80009	366-1851-01
-12	105-0865-00			1	BAR,LATCH RLSE:	80009	105-0865-00
-13	105-0866-00			1	LATCH,RETAINING:SAFETY	80009	105-0866-00
-14	214-3143-00			1	SPRING,HLEXT:0.125 OD X 0.545 L,XLOOP	80009	214-3143-00
-15	366-0494-08			1	KNOB:GY,NEW GEN,0.127ID X 0.530D X 0.5H	80009	366-0494-08
	213-0246-00			1	.SETSCREW:5-40 X 0.094,STL	71159	ORDER BY DESCR
-16	333-3009-00			1	FRONT PNL ASSY:	80009	333-3009-00
-17	337-3044-00			1	SHIELD,ELEC:FRONT SUBPANEL	80009	337-3044-00
-18	426-0725-24			1	FR SECT,PLUG-IN:TOP (ATTACHING PARTS)	80009	426-0725-24
-19	211-0101-00			2	SCREW,MACHINE:4-40 X 0.25,FLH,100 DEG,STL (END ATTACHING PARTS)	TK0435	ORDER BY DESCR
-20	214-3406-00			1	SPRING,FLAT:1.48 L X 0.125 W,CU BE	TK1326	ORDER BY DESCR
-21	-----			1	CKT BOARD ASSY:DISPLAY(SEE A10 REPL) (ATTACHING PARTS)		
-22	211-0244-00			2	SCR,ASSEM WSHR:4-40 X 0.312,PNH STL (END ATTACHING PARTS) CKT BOARD ASSY INCLUDES:	TK0858	211-0244-00
-23	136-0494-00			6	.SKT,PL-IN ELEK:MICROCIRCUIT,14 DIP	80009	136-0494-00
-24	136-0252-07			6	.SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
-25	-----			1	.CONN,RCPT,ELEC:(SEE A10J2062 REPL)		
-26	-----			1	.TERM SET,PIN:(SEE A10J4012,4014 REPL)		
-27	131-0993-00			1	.BUS,CONDUCTOR:SHUNT ASSEMBLY,BLACK	22526	65474-005
-28	-----			1	.RES.,VAR,NONWIR:(SEE A10R4037 REPL)		
-29	-----			1	.CONN,RCPT,ELEC:(SEE A10J4015 REPL) (ATTACHING PARTS)		
-30	210-0473-00			1	.NUT,PLAIN,DODEC:0.469-32 X 0.638,BRS NP (END ATTACHING PARTS)	73743	ORDER BY DESCR
-31	-----			3	.SWITCH,PUSH:(SEE A10S3032,4024,425 REPL)		
-32	-----			1	.SWITCH,PUSH:(SEE A10S3012 REPL)		
-33	366-1559-09			4	PUSH BUTTON:IVORY GRAY,0.18 SQ X 0.43 H	80009	366-1559-09
-34	-----			1	CKT BOARD ASSY:MAIN(SEE A12 REPL) (ATTACHING PARTS)		
-35	213-0146-00			4	SCREW,TPG,TF:6-20 X 0.312,TYPE B,PNH,STL (END ATTACHING PARTS) CKT BOARD ASSY INCLUDES:	83385	ORDER BY DESCR
-36	-----			1	.CONN,RCPT,ELEC:(SEE A12P2062 REPL)		
-37	136-0729-00			1	.SKT,PL-IN ELEK:MICROCKT,16 CONTACT	09922	DILB16P-108T
-38	136-0757-00			1	.SKT,PL-IN ELEK:MICROCIRCUIT,40 DIP	09922	DILB40P-108
-39	-----			1	.SWITCH,ROTARY:(SEE A12S2061 REPL)		
-40	-----			1	.CONN,RCPT,ELEC:(SEE A12J1032,2032 REPL)		
-41	-----			9	.TERMINAL PIN:(SEE A12J1040,2042,4012 REPL)		
-42	131-0993-00			2	.BUS,CONDUCTOR:SHUNT ASSEMBLY,BLACK	22526	65474-005
-43	-----			4	.TERM,TEST POINT:(SEE A12TP1063,TP2012, .TP2014,TP3012 REPL)		
-44	-----			1	.MICROCIRCUIT,LI:(SEE A12U2014 REPL) (ATTACHING PARTS)		
-45	211-0292-00			1	.SCR,ASSEM WSHR:4-40 X 0.29,PNH,BRS NI PL	78189	51-040445-01
-46	210-0406-00			1	.NUT,PLAIN,HEX:4-40 X 0.188,BRS CD PL	73743	12161-50
-47	210-1171-00			1	.WASHER,SHLDR:0.12 ID X 0.143 OD X 0.07 D (END ATTACHING PARTS)	00261	A7148516P2
-48	136-0760-00			1	.SKT,PL-IN ELEK:TRANSISTOR,3 CONTACT	TK0772	10-18-2033
-49	342-0354-00			1	INSULATOR,PLATE:TRANSISTOR	55285	7403-09FR-52

Replaceable Mechanical Parts - DC 504A

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective    Dscnt	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
1-50	351-0612-00		1	GUIDE,CKT BOARD:NYLON,1.0 L	80009	351-0612-00
-51	426-0724-25		1	FR SECT,PLUG-IN:BOTTOM (ATTACHING PARTS)	80009	426-0724-25
-52	211-0101-00		2	SCREW,MACHINE:4-40 X 0.25,FLH,100 DEG,STL (END ATTACHING PARTS)	TK0435	ORDER BY DESCR
-53	386-4910-00		1	SUPPORT,FRAME:REAR (ATTACHING PARTS)	80009	386-4910-00
-54	213-0868-00		2	SCREW,TPG,TF:6-32 X 0.375 L,FILH,STL	93907	ORDER BY DESCR
-55	386-3657-01		2	SUPPORT,PLUG-IN: (END ATTACHING PARTS)	93907	ORDER BY DESCR
	175-2985-00		1	WIRE ASSEMBLIES CABLE ASSY,RF:50 OHM COAX,10.0 L,9-3	80009	175-2985-00
	070-4291-00		1	STANDARD ACCESSORIES MANUAL,TECH:INSTRUCTION,DC504A	80009	070-4291-00







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