TEKTRONIX®

DM 44

DIGITAL MULTIMETER

WITH OPTIONS

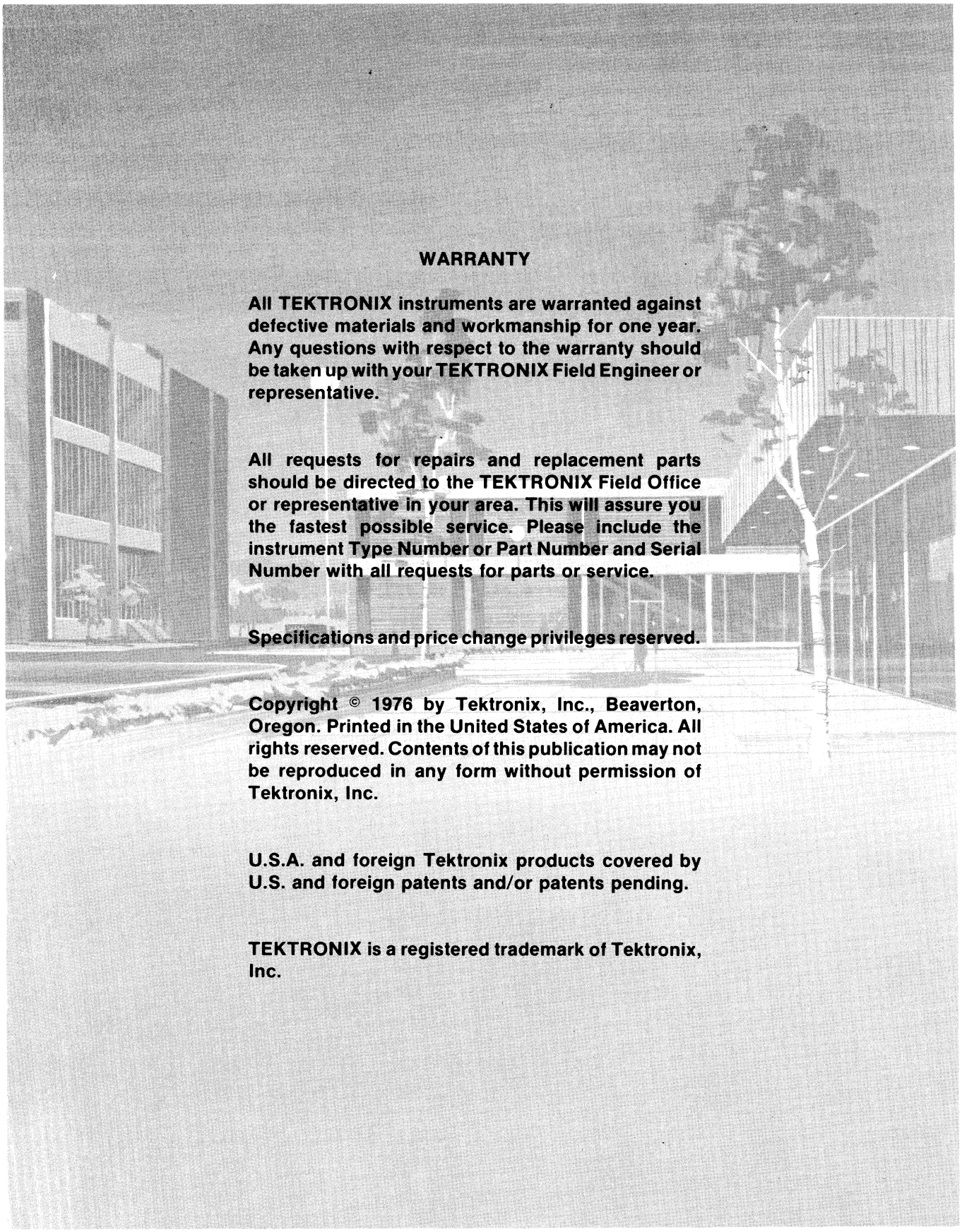
INSTRUCTION MANUAL

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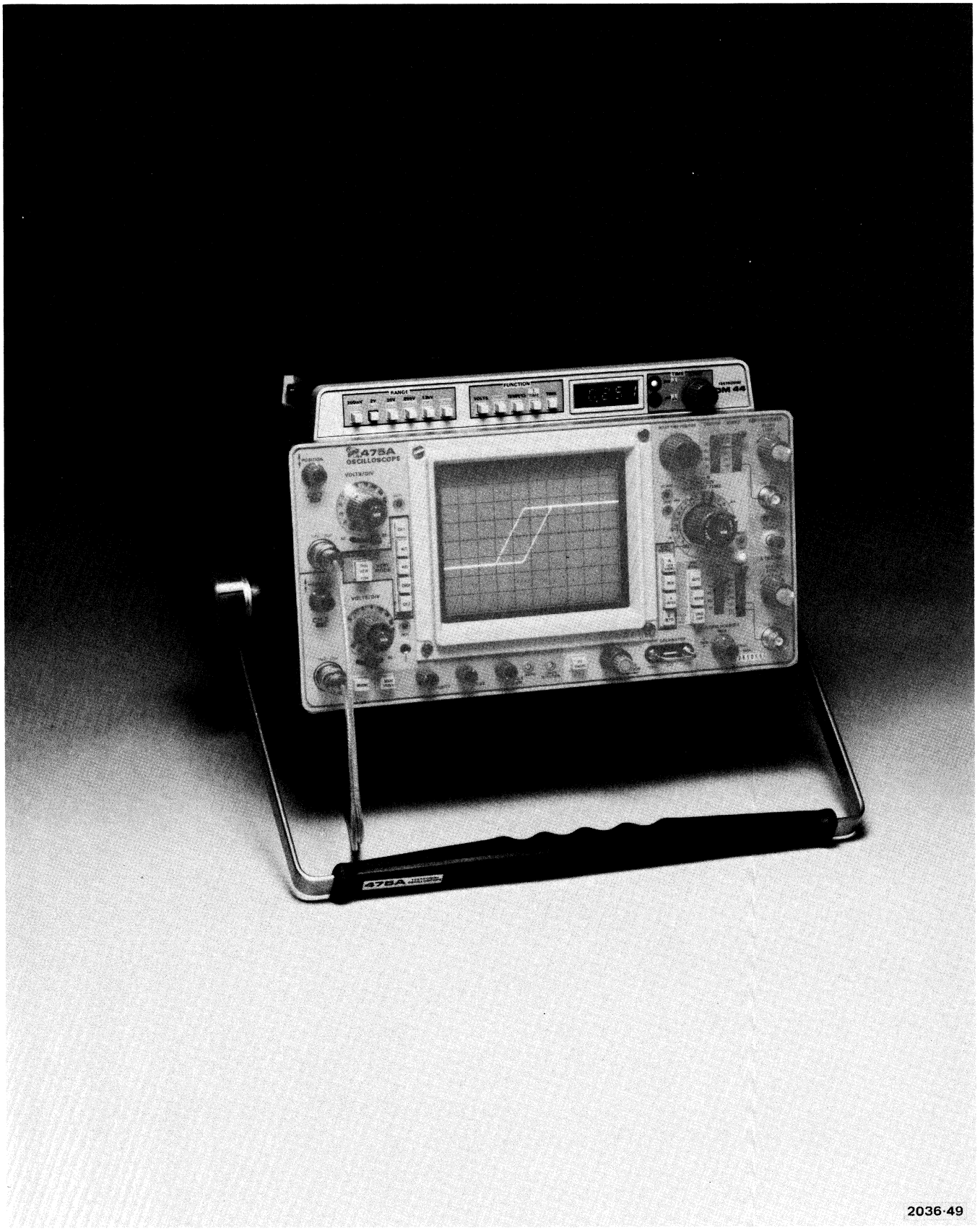
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475A with DM44 Digital Multimeter.

SPECIFICATIONS

The DM44 is a digital multimeter, added to the top of the 464, 465, 466, or 475 oscilloscope. This digital multimeter measures dc voltage, resistance, temperature, differential delay time (time between any 2 points on the oscilloscope trace), and reciprocal time (frequency if the period of one repetition is measured). The digital multimeter front panel contains the readout display, and function and range controls. Input terminals are located on the left side of the multimeter.

The readout is a 3-½ digit display using five 7-segment light-emitting diode displays. The decimal point is automatically positioned. Negative polarity indication is also automatic. A blinking display indicates an overrange condition.

The temperature probe is a standard accessory. Option 1 deletes the temperature probe.

TABLE 1-1
Electrical

Characteristics	Performance Requirement
DC VOLTAGE	
Ranges	0 to 1.2 kV in 5 steps (200 mV, 2 V, 20 V, 200 V, and 1.2 kV)
Resolution	100 μV
Accuracy	Within 0.1% of reading, ± 1 count
Input Resistance	10 MΩ, all ranges (user has option to remove an internal wire strap to increase input resistance to 1000 MΩ on the 200 mV and 2 V ranges)
Normal/Common-Mode Rejection Ratio	
Normal Mode	At least 60 dB at 50 and 60 Hz
Common Mode	At least 100 dB at dc; 80 dB at 50 to 60 Hz
Recycle Time	Approximately 3.3 measurements per second
Response Time	Within 0.5 second
Temperature Dependence	45 parts/million/°C
Maximum Safe Input Voltage, All Ranges	± 1200 V (dc + peak ac) between + and COMMON inputs or between + input and chassis
COMMON Floating Voltage	± 500 V (dc + peak ac) to chassis

TABLE 1-1 (cont.)
Electrical

Characteristics	Performance Requirement		
RESISTANCE			
Ranges	0 to 20 MΩ in six steps (200 Ω, 2 kΩ, 20 kΩ, 200 kΩ, 2 MΩ, and 20 MΩ)		
Resolution	0.1 Ω		
Accuracy			
200 Ω and 2 kΩ Ranges	Within 0.25%, ± 1 count, + probe resistance		
20 kΩ, 200 kΩ, and 2 MΩ Ranges	Within 0.25%, ± 1 count		
20 MΩ Range	Within 0.30%, ± 1 count		
Recycle Time	Approximately 3.3 measurements per second		
Response Time			
200 Ω through 200 kΩ Ranges	Within 1 second		
2 MΩ and 20 MΩ Ranges	Within 5 seconds		
Maximum Safe Input Voltage	120 V rms between + and COMMON inputs for an indefinitet time		
Current supplied to unknown resistance (approximate values, not guaranteed specification)	**OHMS RANGE**	**CURRENT**	
	200 Ω and 2 kΩ	1 mA	
	20 kΩ	100 μA	
	200 kΩ	10 μA	
	2 MΩ	1 μA	
	20 MΩ	100 nA	
TEMPERATURE (WITH P6430 PROBE)			
Range	−55°C to +150°C in one range		
Accuracy (with constant temperature and infinite heat source)	**DM44 Ambient Temperature**	**P6430 Tip Temperature**	**Accuracy**
Probe Calibrated to DM44	+15°C to +35°C	−55°C to +150°C	Within 2°C
	−15°C to +55°C	−55°C to +125°C	Within 3°C
	−15°C to +55°C	+125°C to +150°C	Within 4°C
Probe Not Calibrated to DM44	+15°C to +35°C	−55°C to +150°C	Within 6°C
	−15°C to +55°C	−55°C to +150°C	Within 8°C
TIME (DIFFERENTIAL DELAY)			
Accuracy			
+15°C to +35°C	Within 1% of reading, ± 1 count		
−15°C to +55°C	464, 465, and 466: Within 2.5%, ± 1 count 475: Within 1.5% ± 1 count		

TABLE 1-1 (cont.)
Electrical

Characteristics	Performance Requirement
1/TIME	
Accuracy	
+15°C to +35°C	Within 2% of reading, ± 1 count
−15°C to +55°C	464, 465, and 466: Within 3.5%, ± 1 count 475: Within 3%, ± 1 count

TABLE 1-2
Environmental

Characteristics	Performance Requirement
TEMPERATURE	
Storage	−55°C to +75°C
Operating	−15°C to +55°C
Calibration	+15°C to +35°C
ALTITUDE	
Storage	To 50,000 feet
Operating	To 15,000 feet, maximum operating temperature decreased 1°C/1000 feet above 5,000 feet
HUMIDITY	5 cycles (120 hours); reference is MIL-E-16400F. Instrument must be in operation at least 2 hours
VIBRATION	15 minutes along each of 3 major axes at a total displacement of 0.025 inch, peak-to-peak, (4 g's at 55 Hz) with frequency varied from 10 to 55 to 10 Hz in 1 minute sweeps. All major resonances must be above 55 Hz.
SHOCK (OPERATING AND NONOPERATING)	30 g's, ½ sine, 11 ms duration, 2 shocks per axis each direction for a total of 12 shocks

TABLE 1-3
Physical

Characteristics	Performance Requirement	
DM44 AND MAINFRAME WEIGHT	465-475 DM44	464-466 DM44
With Panel Cover, Accessories, and Pouch	29.5 lbs (13.4 kg)	31.0 lbs (14.0 kg)
Without Panel Cover, Accessories, and Pouch	26.5 lbs (12.0 kg)	28.0 lbs (12.7 kg)
DOMESTIC SHIPPING WEIGHT	36.0 lbs (16.7 kg)	38.9 lbs (17.6 kg)
DIMENSIONS	See Figure 1-1	

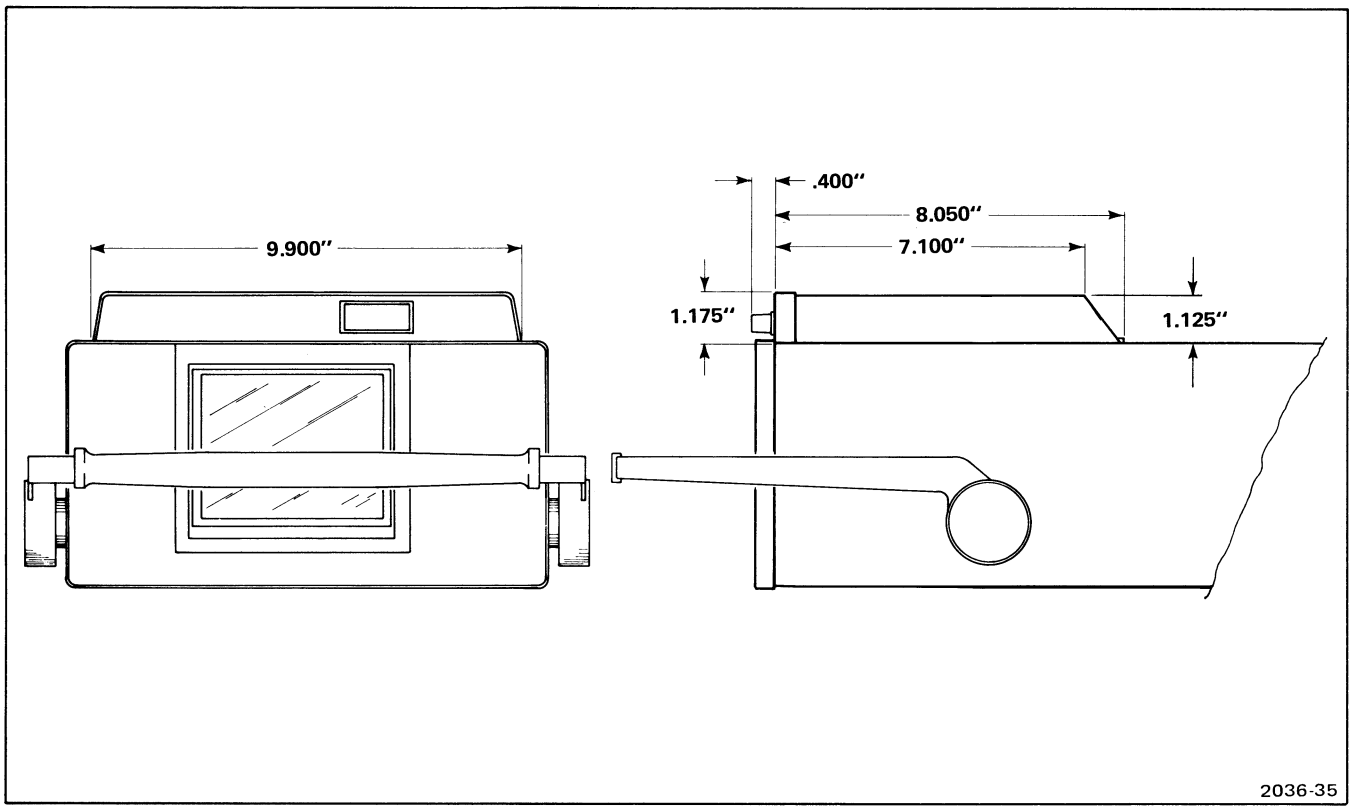


Figure 1-1. DM44 dimensional drawing.

STANDARD ACCESSORIES

(Refer to Mechanical Parts List)

RECOMMENDED ACCESSORIES

1 PAIR TEST LEADS

One test lead with probe on one end and banana plug on the other. One test lead with grounding clip on one end and banana plug on the other.

order Tektronix Part 012-0427-00

OPERATING INFORMATION

The following information will familiarize you with the location and basic operation of the DM44. If you need detailed operating instructions, see the Operator's manual.

OPERATING VOLTAGE

The DM44 gets its operating voltage from the instrument to which it is attached. See the oscilloscope Instruction manual or the Operator's manual for operating voltage information.

CONTROLS, CONNECTORS, AND INDICATORS

Figure 2-1 shows the location of the DM44 controls, connectors, and indicators. The numbers in Figure 2-1 correspond to the number preceding the discussion of that control.

(1) **Input Connectors**—Two banana jacks, + (red) and COM (black), provide inputs for voltage and resistance only.

(2) **Probe Connector**—Input connector for the temperature probe.

(3) **Readout**—A 3-½ digit display. Negative measurement indication is automatic for negative dc voltage and temperature. No polarity indication is shown for positive measurements. Decimal point location is automatic for all functions.

(4) **RANGE**—Selects from .2 V to 1.2 kV in five ranges and from 200 Ω to 20 MΩ in 6 ranges. Maximum safe input voltage in the VOLTS function is 1.2 kV.

(5) **FUNCTION**—Selects VOLTS, OHMS, TEMP (°C), 1/TIME, or TIME functions of the DM44.

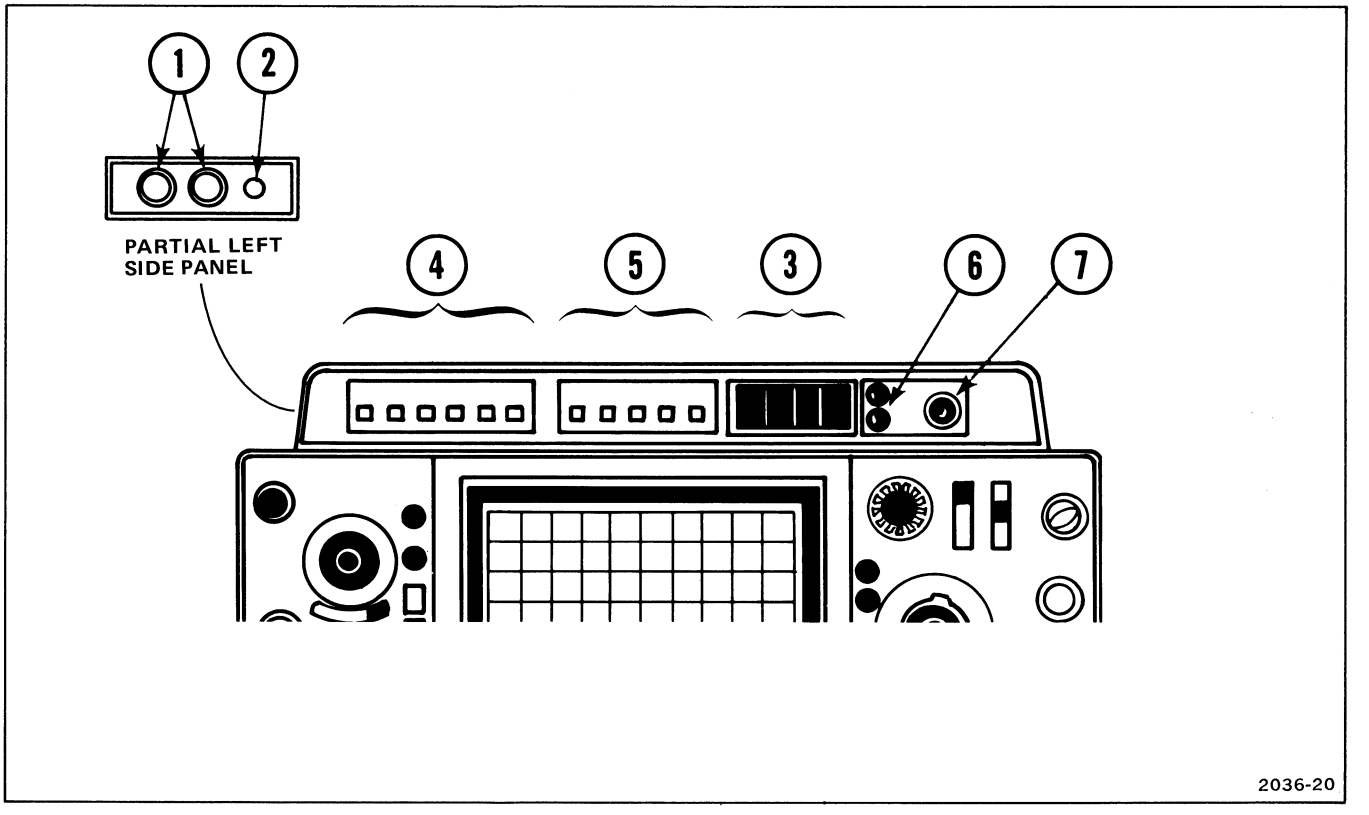


Figure 2-1. DM44 controls and connectors.

(6) **Scale Factor Lamps**—Used to indicate scale factor in the TIME and 1/TIME functions.

In the TIME function, the Readout and Scale Factor Lamps indicate the time difference between the two intensified zones on the crt display. One of the Scale Factor Lamps will light to indicate ms or μs. No lamp lit indicates seconds.

In the 1/TIME function, the Readout and Scale Factor Lamps indicate the number of measurement intervals per unit of time. One of the lamps will light to indicate intervals per ms (1/ms lamp) or intervals per μs (1/μs lamp). No lamp lit indicates intervals per second. If the duration of one repetition is measured, the Readout and Scale Factor Lamps indicate repetition rate. The 1/ms lamp indicates kHz, the 1/μs lamp indicates MHz, and no lamp lit indicates Hz.

(7) Δ **TIME**—Used in conjunction with the DELAY TIME POSITION control in the TIME and 1/TIME functions. The Δ TIME control moves only the time measurement point. The DELAY TIME POSITION control moves both the reference point and the time measurement point. With the time measurement point to the left of the reference point, the readout indicates a negative time difference.

NOTE

You can modify your instrument so the DELAY TIME POSITION control moves only the reference point. The procedure for making this modification is located in the Maintenance section of this manual.

PERFORMANCE CHECK

Since the TIME function of the DM44 affects the way you operate the oscilloscope's horizontal system, both the DM44 and the oscilloscope horizontal system are checked here. Perform these procedures in place of the Horizontal System portion of the Performance Check in the oscilloscope Service Manual.

There are three separate procedures given here. The first is for the DM44 only. The second is for the 464, 465, or 466 horizontal system. The third is for the 475 horizontal system. Perform the DM44 procedure then the appropriate horizontal system procedure.

TEST EQUIPMENT REQUIRED

The test equipment listed in Table 3-1 is required to perform a complete Performance Check. Table 3-2 lists the additional equipment required to perform the 475 Horizontal System Performance Check.

The specifications given for the test equipment are the minimum necessary for accurate results. Detailed operating instructions for the test equipment are not given here. See the appropriate instruction manual if more information is needed.

LIMITS AND TOLERANCE

The limits and tolerances given in these procedures are for the DM44 and oscilloscope under test. The possible inaccuracy of associated test equipment is not taken into consideration. Be sure to take this into account, especially if test equipment other than that recommended is used.

TABLE 3-1
Test Equipment Required

Description	Minimum Specifications	Use	Example
Test Oscilloscope	Bandwidth, 1 MHz; deflection factor, 1 volt/div; accuracy, within 3%.	A TRIG HOLDOFF check. 475 timing adjustment.	Tektronix 475 Portable Oscilloscope Tektronix 465 Portable Oscilloscope
Time-Mark Generator	Marker outputs, 2 ns to 0.5 s; marker accuracy, within 0.1%; trigger output, 1 ms to 0.1 μs, coincident with time markers.	Horizontal timing checks.	Tektronix TG501* Time-Mark Generator
Voltage Standard	Voltage range, 10 mV to 1.2 kV; accuracy, within 0.01%.	DM44 VOLTS Function checks	Fluke, Model 341A DC Voltage Calibrator.
Resistance Standard	Ohms range, 10 Ω to 18 MΩ; accuracy, within 0.03%.	DM44 OHMS Function	ESI. Dekabox, Model DB62.
Termination (1 required)	Impedance, 50 Ω; connectors, BNC.	Signal termination	Tektronix Part Number 011-0049-01
Cable (1 required)	Impedance, 50 Ω; connectors, BNC; length, any convenient.	Signal interconnection	Tektronix Part Number 012-0057-01

***Requires a TM500 power supply.**

TABLE 3-1 (continued)
Test Equipment Required

Description	Minimum Specifications	Use	Example
Light Shield	Folding viewing hood for oscilloscope.	To shield ambient light when measuring delay jitter.	For 464 and 466; Tektronix Part Number 016-0592-00. For 465 and 475; Tektronix Part Number 016-0180-00
Temperature Equalizing Block		Temp (°C) Function checks	See Figure 3-2.
Oil Testing Thermometer	Range 0°C to 125°C; accuracy, within 1/5°C.	TEMP (°C) Function checks	ASTM 67C, Nurnberg Catalog Number 5790.
Temperature Bath and Bath Cooler	Range 0°C to 125°C	TEMP (°C) Function checks (alternate method)	Neslab Instruments Model TE 9/100 Stirred Bath and Model PBC-4 Bath Cooler.
Shorting Strap	Banana to banana patch cord.	Zero check.	

TABLE 3-2
Additional Test Equipment Required For 475

Description	Minimum Specifications	Use	Example
Amplitude Calibrator	Amplitude accuracy, within 0.25%; signal amplitude, 2 mV to 20 V; output signal, 1 kHz square wave.	X Gain check	Tektronix PG506 Calibration Generator*
Sine-Wave Generator	Frequency, 350 kHz to above 200 MHz; output amplitude, variable from 15 mV to 4 V, p-p; output impedance, 50 ohms; reference frequency, 50 kHz to 350 kHz; amplitude accuracy, constant within 1% of amplitude at reference frequency as output frequency changes.	X-Y bandwidth	Tektronix SG503 Leveled Sine-Wave Generator.
500 MHz Filter	Impedance, 50 ohms, frequency adjustable; connectors, BNC.	Magnified timing	Tektronix 500 MHz Filter. 067-0684-00 Calibration Fixture.

***Requires a TM500 Power Supply.**

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DM44 PROCEDURE

1. CHECK ZERO AND POLARITY

a. Short the DM44 + and COM inputs.

b. Set DM44:

FUNCTION	VOLTS
RANGE	2

c. CHECK—DM44 reading is: .0001; .0000; or −.0001 (.0000 ±1 count).

d. Disconnect shorting strap.

e. Connect a voltage standard to the DM44 + and COM inputs.

f. Set the voltage standard to +1.800 volts.

g. CHECK—DM44 reading is 1.797 to 1.803 and no polarity sign is displayed.

h. Set the voltage standard polarity to − (minus).

i. CHECK—DM44 reading is 1.797 to 1.803 and the minus sign is displayed.

j. Set the voltage standard polarity to positive.

2. CHECK VOLTS FUNCTION

WARNING

Dangerous voltages are present from the voltage standard and the DM44 input connectors when checking the high-voltage ranges (200 V and 1.2 kV). Reduce the voltage standard output or place on standby when not actually measuring.

a. Set DM44 RANGE and voltage standard according to Table 3-3.

b. CHECK—The DM44 reading is within the limits given in Table 3-3.

c. Disconnect voltage standard.

TABLE 3-3
VOLTS Accuracy

DM44 RANGE	Voltage Standard	Readout Limits
1.2 kV	1.2 kV	1.198 to 1.202
1.2 kV	180.0 V	0.179 to 0.181
200 V	180.0 V	179.7 to 1.803
200 V	18.00 V	017.9 to 018.1
20 V	18.00 V	17.97 to 18.03
20 V	1.800 V	01.79 to 01.82
2 V	1.800 V	1.797 to 1.803
2 B	0.1800 V	0.179 to 0.181
200 mV	0.1800 V	179.7 to 180.3
200 mV	0.0100 V	009.9 to 010.1

3. CHECK OHMS FUNCTION

a. Set DM44 FUNCTION to OHMS.

b. Connect a resistance standard to the DM44 + and COM inputs.

c. Set DM44 RANGE and resistance standard according to Table 3-4.

d. CHECK—DM44 readings are within the limits given in Table 3-4.

e. Disconnect resistance standard.

TABLE 3-4
OHMS Accuracy

DM44 RANGE	Resistance Standard	Limits[2]
200 Ω	10 Ω	009.9 to 010.1[1]
200 Ω	180 Ω	199.5 to 180.5
2 kΩ	180 Ω	0.179 to 0.181
2 kΩ	1.8 kΩ	1.795 to 1.805
20 kΩ	1.8 kΩ	17.95 to 18.05
20 kΩ	18 kΩ	17.95 to 18.05
200 kΩ	18 kΩ	017.9 to 018.1
200 kΩ	180 kΩ	179.5 to 180.5
2 MΩ	180 kΩ	0.179 to 0.181
2 MΩ	1.8 MΩ	1.795 to 1.805
20 MΩ	1.8 MΩ	01.79 to 01.81
20 MΩ	11 MΩ	10.96 to 11.04

[1] **When measuring 10 Ω and 180 Ω, lead resistance may add up to 0.3 Ω to the reading. If in doubt, short the leads together and note the DM44 reading. Add this value to the 10 Ω reading.**

[2] **Accuracy: 200 Ω and 2 kΩ ranges; within 0.25% + probe resistance ± one count 20 kΩ, 200 kΩ, and 2 MΩ ranges; within 0.25% ± one count 20 MΩ range; 0.3% ± one count.**

4. CHECK TEMP (°C) FUNCTION

NOTE

The DM44 is calibrated to the temperature probe supplied with the DM44. If another probe is used, the DM44 Temperature circuit should be recalibrated.

a. Connect the temperature probe to the temperature input connector and set the FUNCTION switch to TEMP (°C).

b. When placing the temperature probe in a solution, keep the level of the solution below the bulge in the probe body (Figure 3-1).

c. Suspend the temperature probe and reference thermometer in a container (preferably insulated) of water and crushed or shaved ice. Let enough ice melt to stabilize the water temperature.

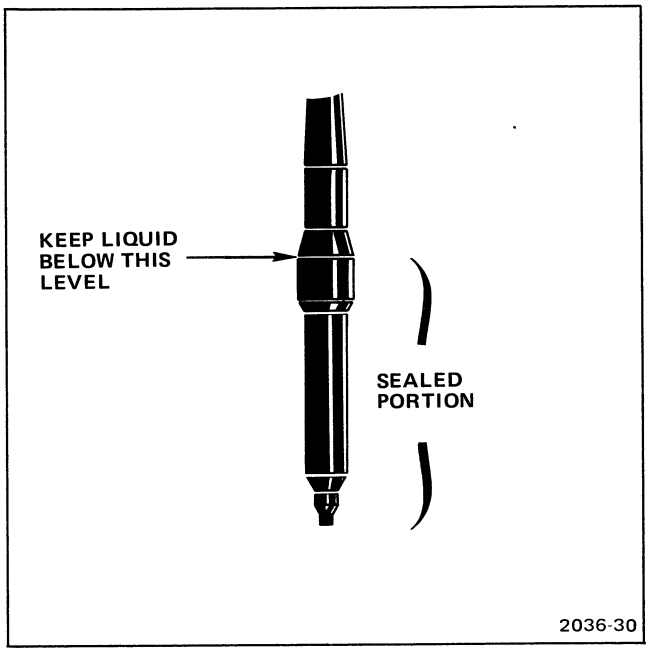


Fig. 3-1. Sealed portion of temperature probe.

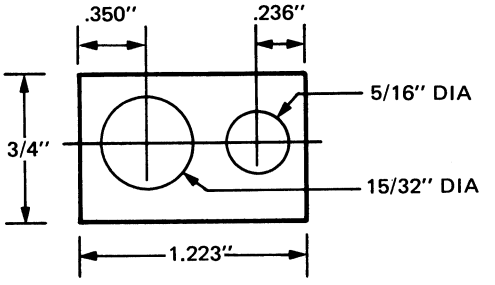
For an alternate method: Suspend the temperature probe and reference thermometer in a water and antifreeze solution in a circulating bath (see Table 3-1 for recommended test equipment). Set bath temperature to 0°C.

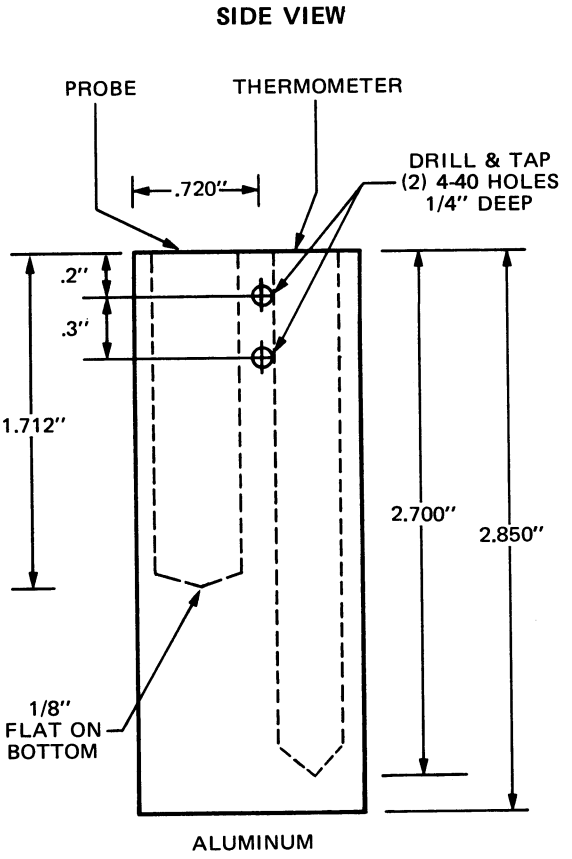
d. CHECK—That the DM44 reading is within 2°C of the reference thermometer reading.

e. Remove the temperature probe and reference thermometer from the solution and place in a temperature equalizing block (see Figure 3-2). Use a dielectric fluid (see note in Figure 3-2).

f. Let temperature probe and thermometer temperatures stabilize.

A small quantity of dielectric coolant should be placed in the equalizing block probe hole before installing the probe to ensure good thermal conduction. Use a dielectric coolant such as Type FC40 Fluorinert Brand Electronic Liquid.





1779-1

Fig. 3-2. Temperature probe equalizing block.

g. CHECK—That the DM44 reading is within 2°C of the reference thermometer reading.

NOTE

This is the end of the DM44 Performance Check. Now perform one of the following Horizontal System procedures.

5. TIME AND 1/TIME

Checked with oscilloscope horizontal system. See Applicable procedure following.

464, 465, OR 466 HORIZONTAL SYSTEM

This procedure replaces the horizontal system procedure in the 464, 465, and 466 Service manuals. If your DM44 is attached to a 475 or 475A, perform the procedure following this one.

PRELIMINARY CONTROL SETTINGS

POWER	ON

CRT

INTENSITY	As desired
FOCUS	Best focused display
SCALE ILLUM	As desired

VERTICAL (CH 1 and CH 2)

VERT MODE	CH 1
POSITION	Midrange
VOLTS/DIV	0.5 V
VAR VOLTS/DIV	Calibrated detent
AC-GND-DC	DC
INVERT	Normal (button out)
20 MHz BW (PULL)	Full bandwidth (No yellow showing)

TRIGGER (A and B)

COUPLING	AC
LEVEL	Midrange
SLOPE	+
A SOURCE	NORM
B SOURCE	STARTS AFTER DELAY
TRIG MODE	AUTO
A TRIG HOLDOFF	NORM

SWEEP (A and B)

HORIZ DISPLAY	A
TIME/DIV	1 ms
VAR TIME/DIV	Calibrated detent
DELAY TIME POSITION	Fully counterclockwsie
X10 MAG	Off (button out)
POSITION (horizontal)	Midrange
FINE	Midrange

STORAGE (464 and 466 ONLY)

REDUCED SCAN	Pushed in (466 only)
STORAGE LEVEL	NORM
SAVE INTEN	CCW
SAVE	Button out
NON STORE	Button in
VIEW TIME	NORM

1. CHECK MAGNIFIER REGISTRATION

a. Connect time-mark generator to CH 1 input through a 50-ohm BNC cable and 50-ohm termination.

b. Set X10 MAG button to the in position.

c. Set time-mark generator for 5 ms time markers.

d. Horizontally position the center time marker to the center vertical graticule line.

e. Set X10 MAG button to the out position.

f. CHECK—That the middle time mark is within 0.2 division of the center vertical graticule line.

2. CHECK A SWEEP LENGTH

a. Set time-mark generator for 0.1 ms time markers.

b. CHECK—That sweep length is between 10.5 and 11.5 divisions.

3. CHECK HORIZONTAL POSITION CONTROL RANGE

a. Set FINE control to midrange.

b. Set horizontal POSITION control fully clockwise.

c. CHECK—That the beginning of the sweep is to the right of the center vertical graticule line.

d. Set horizontal POSITION control fully counter-clockwise.

e. CHECK—That the end of the sweep is to the left of the center vertical graticule line.

4. CHECK A AND B TIME/DIV ACCURACY

a. Using the settings given in Table 3-5,

CHECK—A TIME/DIV accuracy is within 3% (see Figure 3-3).

TABLE 3-5
A and B TIME/DIV Accuracy

A and B Time/Div Settings	Time Mark Generator	Markers Displayed Per Div
0.5 μs	50 ns	1
.1 μs	.1 μs	1
.2 μs	.1 μs	2
.5 μs	.5 μs	1
1 μs	1 μs	1
2 μs	1 μs	2
5 μs	5 μs	1
10 μs	10 μs	1
20 μs	10 μs	2
50 μs	50 μs	1
.1 ms	.1 ms	1
.2 ms	.1 ms	2
.5 ms	.5 ms	1
1 ms	1 ms	1
2 ms	1 ms	2
5 ms	5 ms	1
*10 ms	10 ms	1
*20 ms	10 ms	2
*50 ms	50 ms	1
A Only		
*.1 s	.1 s	1
*.2 s	.1 s	2
*.5 s	.5 s	1

***Set TRIG MODE to NORM.**

b. Set HORIZ DISPLAY to B.

c. Using the settings given in Table 5-3,

CHECK—B TIME/DIV accuracy is within 2% (see Figure 3-3).

NOTE

If 11 time markers are not visible when checking B TIME/DIV accuracy, set the A TIME/DIV one step slower than the B TIME/DIV switch.

EXAMPLE:	*A TIME/DIV*	*1 ms*
	B TIME/DIV	*0.5 ms*

5. CHECK VAR TIME/DIV RANGE

a. Set

HORIZ DISPLAY	A
A TIME/DIV	2 ms
VAR TIME/DIV	Fully counter-clockwise

b. Set time-mark generator for 5 ms time markers.

c. CHECK—Distance between adjacent time markers is 1 division or less.

d. Set VAR TIME/DIV fully clockwise.

6. CHECK A AND B MAGNIFIED TIME/DIV ACCURACY

a. Set X10 MAG button to the in position.

b. Using the settings given in Table 3-6,

CHECK—A magnified TIME/DIV accuracy is within 3% (see Figure 3-3).

c. Set HORIZ DISPLAY to B.

464, 465, OR 466 HORIZONTAL SYSTEM

This procedure replaces the horizontal system procedure in the 464, 465, and 466 Service manuals. If your DM44 is attached to a 475 or 475A, perform the procedure following this one.

PRELIMINARY CONTROL SETTINGS

POWER	ON

CRT

INTENSITY	As desired
FOCUS	Best focused display
SCALE ILLUM	As desired

VERTICAL (CH 1 and CH 2)

VERT MODE	CH 1
POSITION	Midrange
VOLTS/DIV	0.5 V
VAR VOLTS/DIV	Calibrated detent
AC-GND-DC	DC
INVERT	Normal (button out)
20 MHz BW (PULL)	Full bandwidth (No yellow showing)

TRIGGER (A and B)

COUPLING	AC
LEVEL	Midrange
SLOPE	+
A SOURCE	NORM
B SOURCE	STARTS AFTER DELAY
TRIG MODE	AUTO
A TRIG HOLDOFF	NORM

SWEEP (A and B)

HORIZ DISPLAY	A
TIME/DIV	1 ms
VAR TIME/DIV	Calibrated detent
DELAY TIME POSITION	Fully counterclockwsie
X10 MAG	Off (button out)
POSITION (horizontal)	Midrange
FINE	Midrange

STORAGE (464 and 466 ONLY)

REDUCED SCAN	Pushed in (466 only)
STORAGE LEVEL	NORM
SAVE INTEN	CCW
SAVE	Button out
NON STORE	Button in
VIEW TIME	NORM

1. CHECK MAGNIFIER REGISTRATION

a. Connect time-mark generator to CH 1 input through a 50-ohm BNC cable and 50-ohm termination.

b. Set X10 MAG button to the in position.

c. Set time-mark generator for 5 ms time markers.

d. Horizontally position the center time marker to the center vertical graticule line.

e. Set X10 MAG button to the out position.

f. CHECK—That the middle time mark is within 0.2 division of the center vertical graticule line.

2. CHECK A SWEEP LENGTH

a. Set time-mark generator for 0.1 ms time markers.

b. CHECK—That sweep length is between 10.5 and 11.5 divisions.

3. CHECK HORIZONTAL POSITION CONTROL RANGE

a. Set FINE control to midrange.

b. Set horizontal POSITION control fully clockwise.

c. CHECK—That the beginning of the sweep is to the right of the center vertical graticule line.

d. Set horizontal POSITION control fully counter-clockwise.

e. CHECK—That the end of the sweep is to the left of the center vertical graticule line.

4. CHECK A AND B TIME/DIV ACCURACY

a. Using the settings given in Table 3-5,

CHECK—A TIME/DIV accuracy is within 3% (see Figure 3-3).

TABLE 3-5
A and B TIME/DIV Accuracy

A and B Time/Div Settings	Time Mark Generator	Markers Displayed Per Div
0.5 μs	50 ns	1
.1 μs	.1 μs	1
.2 μs	.1 μs	2
.5 μs	.5 μs	1
1 μs	1 μs	1
2 μs	1 μs	2
5 μs	5 μs	1
10 μs	10 μs	1
20 μs	10 μs	2
50 μs	50 μs	1
.1 ms	.1 ms	1
.2 ms	.1 ms	2
.5 ms	.5 ms	1
1 ms	1 ms	1
2 ms	1 ms	2
5 ms	5 ms	1
*10 ms	10 ms	1
*20 ms	10 ms	2
*50 ms	50 ms	1
A Only		
*.1 s	.1 s	1
*.2 s	.1 s	2
*.5 s	.5 s	1

***Set TRIG MODE to NORM.**

b. Set HORIZ DISPLAY to B.

c. Using the settings given in Table 5-3,

CHECK—B TIME/DIV accuracy is within 2% (see Figure 3-3).

NOTE

If 11 time markers are not visible when checking B TIME/DIV accuracy, set the A TIME/DIV one step slower than the B TIME/DIV switch.

EXAMPLE:	*A TIME/DIV*	*1 ms*
	B TIME/DIV	*0.5 ms*

5. CHECK VAR TIME/DIV RANGE

a. Set

HORIZ DISPLAY	A
A TIME/DIV	2 ms
VAR TIME/DIV	Fully counter-clockwise

b. Set time-mark generator for 5 ms time markers.

c. CHECK—Distance between adjacent time markers is 1 division or less.

d. Set VAR TIME/DIV fully clockwise.

6. CHECK A AND B MAGNIFIED TIME/DIV ACCURACY

a. Set X10 MAG button to the in position.

b. Using the settings given in Table 3-6,

CHECK—A magnified TIME/DIV accuracy is within 3% (see Figure 3-3).

c. Set HORIZ DISPLAY to B.

d. Using the settings given in Table 3-6,

CHECK—B magnified TIME/DIV accuracy is within 3% (see Figure 3-3).

TABLE 3-6
A And B Magnified TIME/DIV Accuracy

A and B Time/Div Settings	Time Mark Generator	Markers Displayed Per Div	Portions of[1] Total Length To Be Excluded
.05 μs	10 ms	1 per 2 div	1st and last 10 div
.1 μs	10 ns	1	1st and last 5 div
.2 μs	10 ns	2	1st and last 2.5 div
.5 μs	50 ns	1	
1 μs	.1 μs	1	
2 μs	.1 μs	2	
5 μs	.5 μs	1	
10 μs	1 μs	1	
20 μs	1 μs	2	
50 μs	10 μs	1	
.2 ms	10 μs	2	
.5 ms	50 μs	1	
1 ms	.1 ms	1	
2 ms	.1 ms	2	
5 ms	.5 ms	1	
10 ms	1 ms	1	
20 ms	1 ms	2	
50 ms	5 ms	1	
A Sweep Only			
.1 s	10 ms	1	
.2 s	10 ms	2	
.5 s	50 ms	1	

[1] To determine first portion to be excluded, release X10 MAG. Position sweep start to 1.5 divisions to left of graticule center line. Push X10 MAG—the first 10 divisions of sweep is magnified to the left and is off screen. To determine the last portion to be excluded on the .05 μs/div range, release X10 MAG. Position sweep stop 1.5 divisions to right of graticule center line. Push X10 MAG in—the last 50 ns of sweep is magnified to the right and is off screen.

7. CHECK DELAY JITTER

Delay jitter is checked at the worst case, but still usable, settings of the A TIME/DIV and B TIME/DIV switches. This results in a display that is hard to see. To make the display more visible, reduce ambient light as much as possible and use a viewing hood.

a. Set

A TRIG MODE	AUTO
A TIME/DIV	1 ms
B TIME/DIV	.2 μs
HORIZ DISPLAY	A INTEN
DM44 FUNCTION	VOLTS
X10 MAG	OUT (X1)

b. Set time-mark generator for 1 ms time markers.

c. Adjust the DTP control to intensify the ninth time marker.

d. Set HORIZ DISPLAY to B DLY'D and adjust the DTP control to center the displayed time marker.

e. CHECK—Horizontal jitter is one division or less (2.5 divisions or less if operating from a 50 Hz power source). Disregard the slow drift.

NOTE

Because the trace is difficult to see, skip parts f through i for 464 and 466.

f. Set

HORIZ DISPLAY	A INTEN
DM44 FUNCTION	TIME
DTP	Fully counterclockwise

g. Adjust the Δ TIME control to intensify the ninth time marker.

h. Set HORIZ DISPLAY to B DLY'D and adjust the Δ TIME control to center the displayed time marker.

i. CHECK—Horizontal jitter is one division or less (2.5 divisions or less if operating from a 50 Hz power source). Disregard the slow drift.

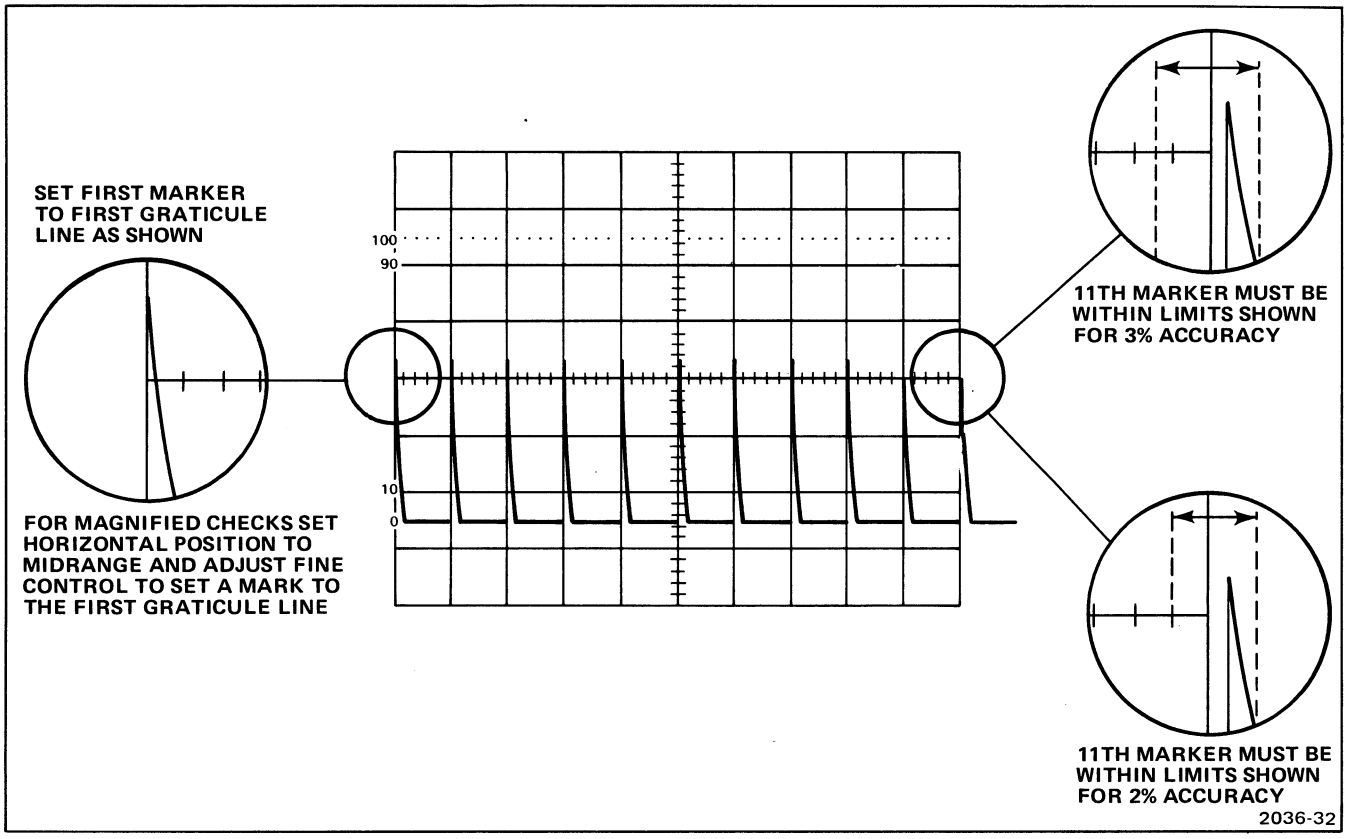


Fig. 3-3. Timing accuracies.

8. CHECK MIXED SWEEP ACCURACY

a. Set

DM44 FUNCTION	VOLTS
A TIME/DIV	1 ms
B TIME/DIV	.5 ms
DTP	Fully clockwise
HORIZ DISPLAY	B DLY'D
A TRIG HOLDOFF	Fully counterclockwise

b. Set time-mark generator for 1 ms time markers.

c. Measure the timing error between the second and tenth time markers. Record this value for use in part e.

d. Set HORIZ DISPLAY to MIX.

e. CHECK—Timing error between second and tenth time markers is within 0.18 division plus the error noted in part c (see Figure 3-4).

9. CHECK TIME AND 1/TIME LINEARITY

a. Set

DM44 FUNCTION	TIME
HORIZ DISPLAY	A INTEN
A TIME/DIV	1 ms
B TIME/DIV	5 μs
Δ TIME	Fully clockwise

b. Set time-mark generator for 1 ms time markers.

c. Adjust the DTP control so the reference point intensifies the second time marker.

d. Adjust the Δ TIME control so the measurement point intensifies the third time marker (one division separating points).

e. Set HORIZ DISPLAY to B DLY'D and adjust the Δ TIME control to superimpose the displayed time markers. Readjust the DTP control if necessary to center the display.

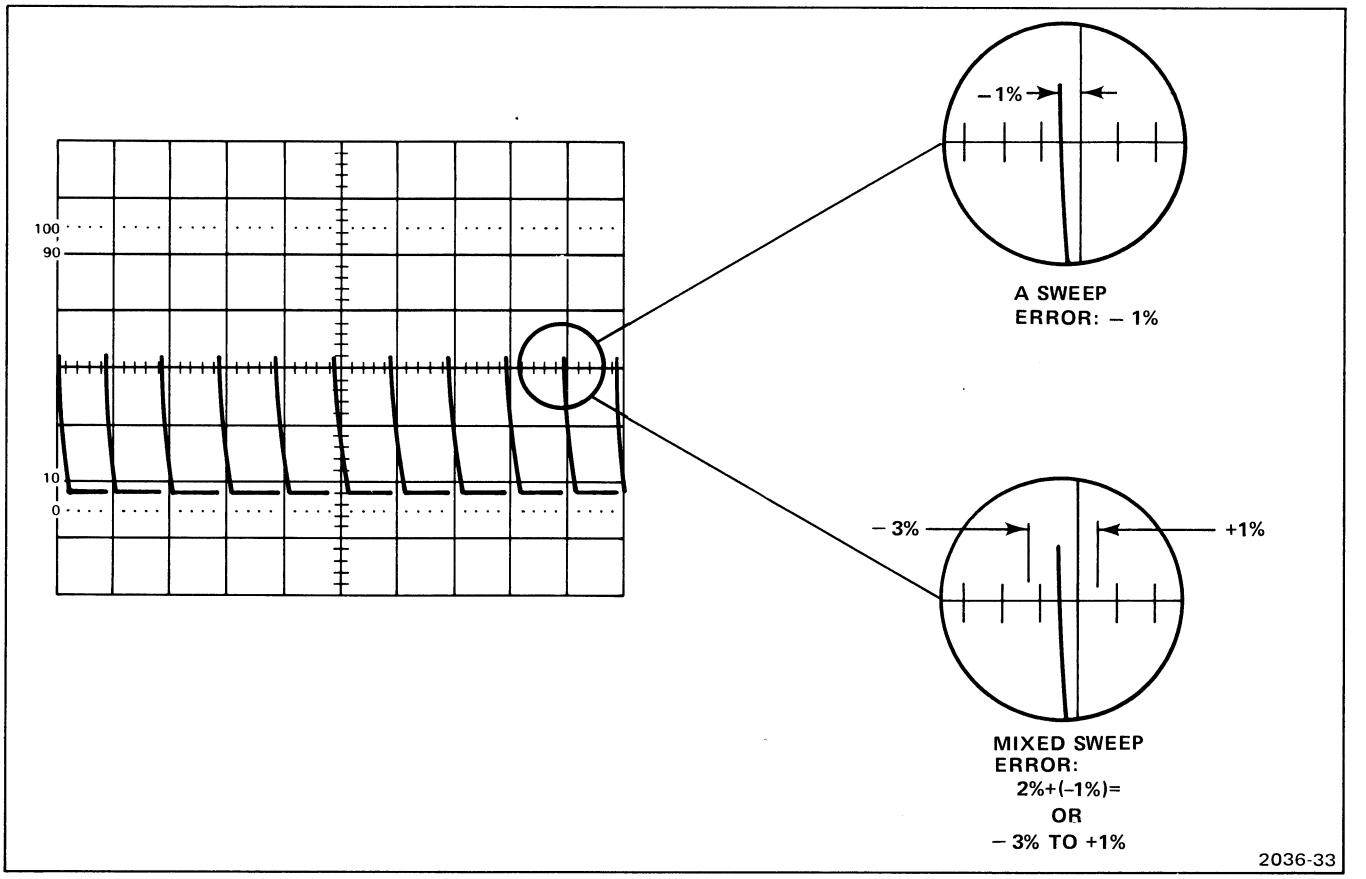


Fig. 3-4. Mixed sweep timing accuracy.

f. CHECK—DM44 reading is within the limits given in Table 3-7.

TABLE 3-7
TIME And 1/TIME Linearity

Distance Between Points (Divisions)	DM44 Reading[1] Limits For Time
1	0.989 to 1.011
2	1.979 to 02.03*
3	02.96 to 03.04
4	03.95 to 04.05
5	04.94 to 05.06
6	0.593 to 06.07
7	06.92 to 07.08
8	07.91 to 08.09

***Autoranging shifts decimal point.**
[1] TIME accuracy is within 1%, ± one count.

g. Adjust the Δ TIME control clockwise to move the next time marker into the display.

h. Repeat parts e through g until the accuracy at the tenth time marker has been checked (eight divisions separating points).

i. Set HORIZ DISPLAY to A INTEN.

j. Turn DTP clockwise so reference point intensifies the tenth time marker.

k. Turn Δ TIME counterclockwise so the measurement point intensifies the second time marker.

l. Set HORIZ DISPLAY to B DLY'D and adjust Δ TIME to superimpose the displayed time markers.

m. CHECK—DM44 reading is –07.91 to –08.09.

n. Set DM44 FUNCTION to 1/TIME.

o. Verify displayed time markers are still superimposed.

p. CHECK—DM44 reading is —.1224 to —.1274.

q. Set HORIZ DISPLAY to A INTEN.

r. Turn Δ TIME clockwise so measurement point intensifies the ninth time marker (one division separating intensified zones).

s. Set HORIZ DISPLAY to B DLY'D and adjust Δ TIME to superimpose the displayed time markers.

t. CHECK—DM44 reading is —0.979 to —1.021.

u. Set

HORIZ DISPLAY	A INTEN
TIME	Fully clockwise
DTP	To intensify the second time marker

v. Turn Δ TIME counterclockwise to intensify the tenth time marker.

w. Set HORIZ DISPLAY to B DLY'D and adjust Δ TIME to superimpose the displayed time markers.

x. CHECK—DM44 reading is .1224 to .1274.

10. CHECK TIME AND 1/TIME ACCURACY

a. Set

A TIME/DIV	.2 μs
B TIME/DIV	.05 μs
HORIZ DISPLAY	A INTEN
DM44 FUNCTION	TIME

b. Set time-mark generator for .1 microsecond time markers.

c. Adjust DTP so reference point intensifies the third time marker.

d. Adjust Δ TIME so the time-measurement point intensifies the 17th time marker.

e. Set HORIZ DISPLAY to B DLY'D and adjust Δ TIME to superimpose the displayed time markers.

f. CHECK—DM44 reading is 1.385 to 1.415 and the μs light is lit.

g. Set DM44 FUNCTION to 1/TIME.

h. CHECK—DM44 reading is 0.707 to 0.723 and the μs light is lit.

i. Set

A TIME/DIV	.5 μs
B TIME/DIV	.05 μs
HORIZ DISPLAY	A INTEN

j. Set time-mark generator for 15 microsecond time markers.

k. Adjust DTP to intensify second time marker.

l. Adjust Δ TIME to intensify the ninth time marker.

m. Set HORIZ DISPLAY to B DLY'D and adjust Δ TIME to superimpose displayed time markers.

n. CHECK—DM44 reading is 02.81 to 02.87 and the μs light is lit.

o. Set DM44 FUNCTION to TIME.

p. CHECK—DM44 reading is 03.45 to 03.55 and the μs light is lit.

q. Set

A TIME/DIV	1 μs
B TIME/DIV	.05 μs
HORIZ DISPLAY	A INTEN

r. Set time-mark generator for 1 microsecond time markers.

s. Adjust DTP to intensify second time marker.

t. Adjust Δ TIME to intensify the tenth time marker.

u. Set HORIZ DISPLAY to B DLY'D.

v. Adjust Δ TIME to superimpose time markers.

w. CHECK—DM44 reading is within the limits given in Table 3-8 in both the TIME and 1/TIME settings of the FUNCTION switch.

x. Repeat parts v through w for the remainder of the settings listed in Table 3-8.

11. CHECK AUTORANGING

a. Set

A TIME/DIV	1 ms
TIME/DIV	20 μs
DM44 FUNCTION	TIME

b. Adjust DTP so reference point intensifies the second time marker.

c. Adjust Δ TIME to superimpose both intensified zones.

d. Slowly turn Δ TIME clockwise and,

CHECK—That the DM44 upranges when the reading reaches 2.000 (the reading shifts from 2.000 to 02.00).

e. Slowly turn the Δ TIME control counterclockwise and

CHECK—That the DM44 downranges when the reading reaches 01.00 (the reading shifts to 1.000).

TABLE 3-8
TIME And 1/TIME Accuracy

TIME MARK GEN	A TIME DIV	B TIME DIV	TIME			1/TIME		
			ACCURACY	ms	μs	ACCURACY	ms	μs
1 μ s	1 μs	.05 μs	07.91 to 08.09		X	0.123 to 0.127		X
2 μs	2 μs	.05 μs	15.83 to 16.17		X	.0618 to .0632		X
5 μs	5 μs	.1 μs	039.5 to 040.5		X	014.7 to 025.3	X	
10 μs	10 μs	.2 μs	079.1 to 080.9		X	012.3 to 012.7	X	
20 μs	20 μs	.5 μs	158.3 to 161.7		X	06.18 to 06.32	X	
50 μs	50 μs	1 μ s	0.395 to 0.405	X		02.47 to 02.53	X	
.1 ms	.1 ms	2 μs	0.791 to 0.809	X		01.23 to 01.27	X	
.2 ms	.2 ms	5 μs	1.583 to 1.617	X		0.618 to 0.632	X	
.5 ms	.5 ms	10 μs	03.95 to 04.05	X		0.247 to 0.253	X	
1 ms	1 ms	20 μs	07.91 to 08.09	X		0.123 to 0.127	X	
2 ms	2 ms	50 μs	15.83 to 16.17	X		.0618 to .0632	X	
5 ms	5 ms	.1 ms	039.5 to 040.5	X		024.7 to 025.3		
10 ms	10 ms	.2 ms	079.1 to 080.9	X		012.3 to 012.7		

If the above checks in this table are within tolerance, it is unlikely the following checks will be out of tolerance. The following checks are time consuming and may be skipped if you wish.

20 ms	20 ms	.5 ms	158.3 to 161.7	X		06.18 to 06.32	
50 ms	50 ms	1 ms	0.395 to 0.405			02.47 to 02.53	
.1 s	.1 s	2 ms	0.791 to 0.809			01.23 to 01.27	
.2 s	.2 s	5 ms	1.583 to 1.617			0.618 to 0.632	
.5 s	.5 s	10 ms	03.95 to 04.05			0.247 to 0.253	

12. CHECK B ENDS A

a. Set

DM44 FUNCTION	VOLTS
A TRIG HOLDOFF	B ENDS A
VERT MODE	ALT

b. Rotate the DTP and Δ TIME controls through their ranges and

CHECK—Sweep terminates at the end of the intensified zones.

13. CHECK A TRIGGER HOLDOFF

a. Set

HORIZ DISPLAY	A
A TIME/DIV	10 μs
A TRIGGER HOLDOFF	NORM
A TRIG LEVEL	Fully ccw
VERT MODE	CH 1

b. Set test oscilloscope

Vertical Mode	CH 1
Ch 1 Volts/Div	1 volt
Horiz Mode	A Sweep
A Trigger Slope	–
A Trigger Mode	Auto

c. Connect A +GATE output (on rear of oscilloscope on which the DM44 is mounted) to Ch 1 input of test oscilloscope via 50 Ω cable and 50 Ω termination.

d. Adjust test oscilloscope Time/Div and Var Volts/Div so that negative portion of +GATE (holdoff time) is 1 major division in length.

e. Rotate A TRIGGER HOLDOFF control clockwise, but not into B ENDS A detent.

f. CHECK—That holdoff time of A +GATE is increased at least 10 times.

g. Set A TRIGGER HOLDOFF to NORM.

475 HORIZONTAL SYSTEM

PRELIMARY CONTROL SETTING

Display

INTENSITY	midrange
FOCUS	midrange
Horizontal POSITION	midrange

Vertical

VOLTS/DIV	.5 V
VAR VOLTS/DIV	calibrated detent
AC-GND-DC	DC
INVERT	off (button out)
VERT MODE	CH 1
100 or 20 MHz BW	full bandwidth (push in, then release)

Trigger (A and B)

COUPLING	AC
LEVEL	0
A TRIGGER SOURCE	NORM
B TRIGGER SOURCE	STARTS AFTER DELAY
TRIG MODE	AUTO
A TRIG HOLDOFF	NORM

Sweep

A and B TIME/DIV	1 ms
VAR TIME/DIV	calibrated detent
DELAY TIME POSITION	fully counterclockwise (ccw)
HORIZ DISPLAY	A
X10 MAG button	off (button out)

1. CHECK VARIABLE TIME/DIVISION RANGE

a. Set time-mark generator for 5 millisecond time marks. Connect through a 42-inch, 20-ohm BNC cable and a 50-ohm BNC termination to CH 1 input.

b. Set A TRIGGER LEVEL for stable triggered display, then set VAR TIME/DIV fully counterclockwise.

c. CHECK—That VAR TIME/DIV UNCAL light is illuminated.

d. CHECK—For at least six time marks between first and last graticule lines.

e. Return VAR TIME/DIV control to calibrated detent.

2. CHECK SWEEP LENGTH AND HORIZONTAL POSITION RANGE

a. Set time-mark generator for 1 millisecond time marks.

b. CHECK—Sweep length for at least 10.1 divisions.

c. Turn POSITION and FINE (Horiz) fully clockwise. (Also check that each control will position trace.)

d. CHECK—That start of sweep is to right of graticule center.

e. Turn POSITION and FINE (Horiz) fully counterclockwise.

f. CHECK—That end of sweep is to left of graticule center.

g. Recenter POSITION and FINE (Horiz).

3. CHECK A TIMING ACCURACY

NOTE

Unless otherwise stated, set POSITION and FINE (HORIZ) controls so the first time marker coincides with the first graticule line and check the error at the last graticule line (see Figure 3-5).

When checking .01 μs and .02 μs settings of the TIME/DIV switch, turn INTENSITY fully on and exclude the first 25 nanoseconds of the display from the check.

Turn INTENSITY down after checking .01 μs and .02 μs settings.

As you change the TIME/DIV SETTINGS, change the setting of the time-mark generator to maintain one or two time markers per division.

a. Set

A TIME/DIV	.01 μs
TRIG MODE	NORM

b. CHECK—Timing accuracy is within 1% at TIME/DIV settings from .01 μs to 5 ms (see Figure 3-5).

c. CHECK—Timing accuracy is within 2% at TIME/DIV settings from 10 ms to .05 s.

4. CHECK A INTEN TIMING ACCURACY

a. Set

HORIZ DISPLAY	A INTEN
TIME/DIV	.05 μs
DTP	Fully counterclockwise

b. Set time-mark generator for 50 nanosecond time markers.

c. CHECK—Timing accuracy is within 2% at TIME/DIV settings from .05 μs to .5 s (see Figure 3-5).

5. CHECK A INTEN MAGNIFIED TIMING ACCURACY

a. Set

TIME/DIV	.05 μs
X10 MAG	X10 (button in)

b. Set time-mark generator for 5 nanosecond time markers.

NOTE

Exclude the following portions of the display from the check:
1. First 25 nanoseconds with INTENSITY fully on or first 2 divisions with INTENSITY set to normal
2. All beyond the 100th division.

c. CHECK—Timing accuracy is within 3% at TIME/DIV settings from .05 μs to .5 s (see Figure 3-5).

6. CHECK A MAGNIFIED TIMING ACCURACY

a. Set

TIME/DIV	.01 μs
A TRIGGER SOURCE	EXT
A TRIGGER COUPLING	LF REJ

b. Set time-mark generator for 2 nanosecond time markers.

c. Connect trigger output of time-mark generator through a 50 Ω BNC cable and 50 Ω BNC termination to the A TRIGGER EXT input. If a time-mark generator has selectable triggers, set trigger selector for .1 microsecond trigger.

d. Insert a 500 megahertz filter between the 50 Ω termination and CH 1 input. Adjust the filter for minimum amplitude modulatiion when 2 and 5 nanosecond time markers are used.

NOTE

Exclude the following portions of the display from the check:
1. First 25 nanoseconds with INTENSITY fully on or first 2 divisions with INTENSITY set to normal viewing level, whichever is greater.
2. All beyond the 100th division.

e. Set CH 1 VOLTS/DIV to maintain a convenient display amplitude and set A TRIGGER LEVEL for a stable display. It may be necessary to adjust A TRIG HOLDOFF for the most stable display.

f. CHECK—Timing accuracy is within 2% at TIME/DIV settings from .01 μs to .05 μs (see Figure 3-5).

g. CHECK—Timing accuracy is within 5% over any 2 division portion of the display except as previously noted.

h. Remove trigger cable setup from A TRIGGER EXT input.

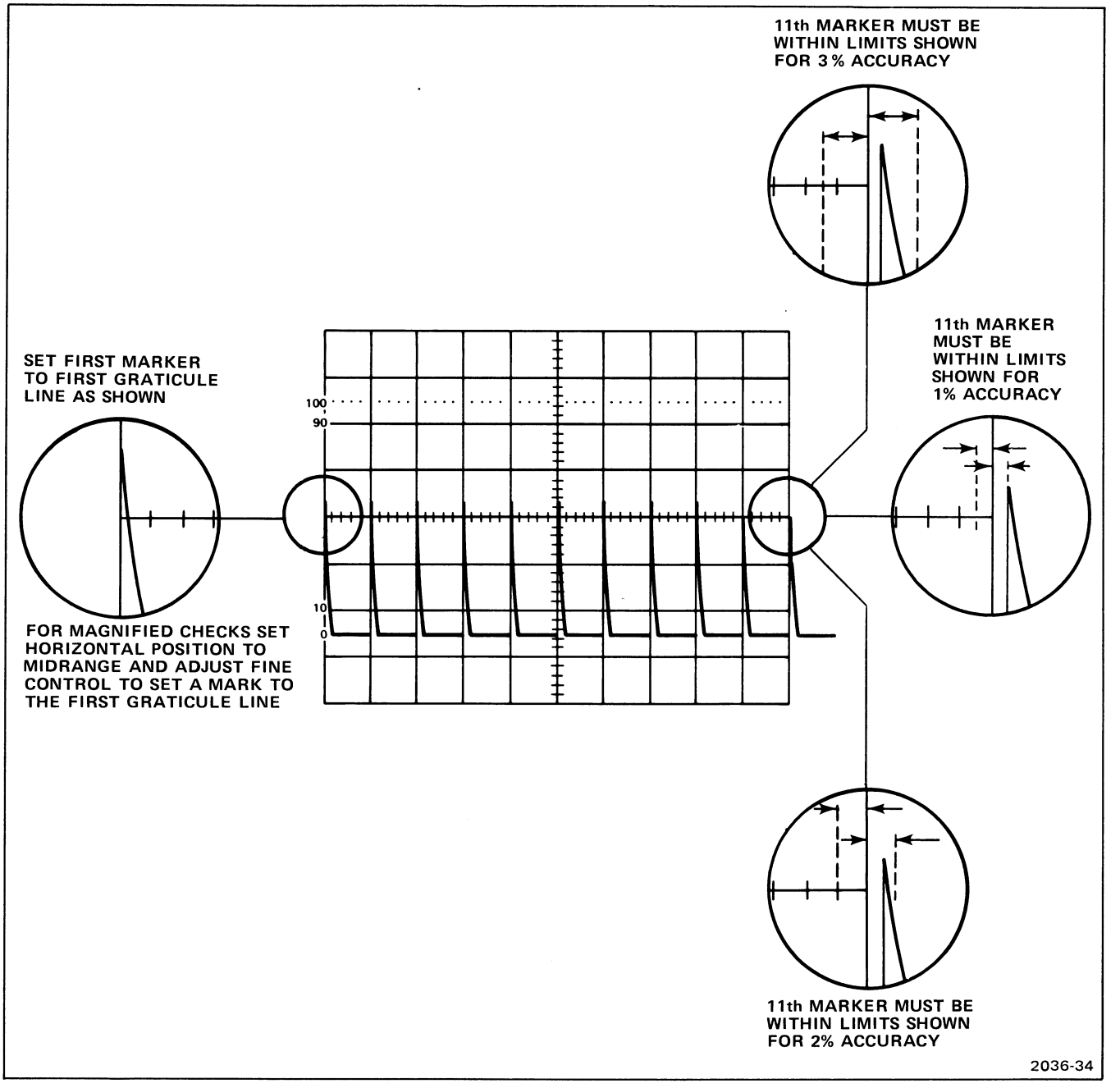


Fig. 3-5. Timing accuracies.

i. Set

A TRIGGER SOURCE NORM
A TRIGGER SOURCE AC

j. Remove 500 megahertz filter from CH 1 setup.

k. Set TIME/DIV to .1 μs and adjust CH 1 VOLTS/DIV for a convenient display amplitude.

l. Set time-mark generator for .1 microsecond time markers.

m. CHECK—Timing accuracy is within 2% at TIME/DIV settings from 0.1 μs to 5 ms.

n. CHECK—Timing accuracy is within 3% at TIME/DIV settings from 10 ms to .5 s.

7. CHECK DELAY JITTER

Delay jitter is checked at the worst case, but still usable, settings of the A TIME/DIV and B TIME/DIV switches. This results in a display that is hard to see. To make the display more visible, reduce ambient light as much as possible and use a viewing hood.

a. Set

A TRIG MODE	AUTO
A TIME/DIV	1 ms
B TIME/DIV	.2 μs
HORIZ DISPLAY	A INTEN
DM44 FUNCTION	VOLTS
X10 MAG	OUT (X1)

b. Set time-mark generator for 1 ms time markers.

c. Adjust the DTP control to intensify the ninth time marker.

d. Set HORIZ DISPLAY to B DLY'D and adjust the DTP control to center the displayed time marker.

e. CHECK—Horizontal jitter is one division or less (2.5 divisions or less if operating from a 50 Hz power source). Disregard the slow drift.

f. Set

HORIZ DISPLAY	A INTEN
DM44 FUNCTION	TIME
DTP	Fully counterclockwise

g. Adjust the Δ TIME control to intensify the ninth time marker.

h. Set HORIZ DISPLAY to B DLY'D and adjust the Δ TIME control to center the displayed time marker.

i. CHECK—Horizontal jitter is one division or less (2.5 divisions or less if operating from a 50 Hz power source). Disregard the slow drift.

8. CHECK TIME AND 1/TIME LINEARITY

a. Set

DM44 FUNCTION	TIME
HORIZ DISPLAY	A INTEN
A TIME/DIV	1 ms
B TIME/DIV	5 μs
Δ TIME	Fully clockwise

b. Set time-mark generator for 1 ms time markers.

c. Adjust the DTP control so the reference point intensifies the second time marker.

d. Adjust the Δ TIME control so the measurement point intensifies the third time marker (one division separating points).

e. Set HORIZ DISPLAY to B DLY'D and adjust the Δ TIME control to superimpose the displayed time markers. Readjust the DTP control if necessary to center the display.

f. CHECK—DM44 reading is within the limits given in Table 3-9.

g. Adjust the Δ TIME control clockwise to move the next time marker into the display.

h. Repeat parts e through g until the accuracy at the tenth time marker has been checked (eight divisions separating points).

TABLE 3-9
TIME And 1/TIME Linearity

Distance Between Points (Divisions)	DM44 Reading[1] Limits For Time
1	0.989 to 1.011
2	1.979 to 02.03*
3	02.96 to 03.04
4	03.95 to 04.05
5	04.94 to 05.06
6	0.593 to 06.07
7	06.92 to 07.08
8	07.91 to 08.09

***Autoranging shifts decimal point.**
[1] TIME accuracy is within 1%, ± one count.

i. Set HORIZ DISPLAY to A INTEN.

j. Turn DTP clockwise so reference point intensifies the tenth time marker.

k. Turn Δ TIME counterclockwise so the measurement point intensifies the second time marker.

l. Set HORIZ DISPLAY to B DLY'D and adjust Δ TIME to superimpose the displayed time markers.

m. CHECK—DM44 reading is −07.91 to −08.09.

n. Set DM44 FUNCTION to 1/TIME.

o. Verify displayed time markers are still superimposed.

p. CHECK—DM44 reading is −.1224 to −.1274.

q. Set HORIZ DISPLAY to A INTEN.

r. Turn Δ TIME clockwise so measurement point intensifies the ninth time marker (one division separating intensified zones).

s. Set HORIZ DISPLAY to B DLY'D and adjust Δ TIME to superimpose the displayed time markers.

t. CHECK—DM44 reading is −0.979 to −1.021.

u. Set

HORIZ DISPLAY	A INTEN
Δ TIME	Fully clockwise
DTP	To intensify the second time marker

v. Turn Δ TIME counterclockwise to intensify the tenth time marker.

w. Set HORIZ DISPLAY to B DLY'D and adjust Δ TIME to superimpose the displayed time markers.

x. CHECK—DM44 reading is .1224 to .1274.

9. CHECK TIME AND 1/TIME ACCURACY

a. Set

A TIME/DIV	.05 μs
B TIME/DIV	.01 μs
HORIZ DISPLAY	A INTEN
DM44 FUNCTION	TIME

b. Set time-mark generator for 50 nanosecond time markers.

c. Adjust DTP so reference point intensifies the second time marker.

d. Adjust Δ TIME so the time-measurement point intensifies the tenth time marker.

e. Set HORIZ DISPLAY to B DLY'D.

f. Adjust Δ TIME to superimpose the displayed time markers.

g. CHECK—DM44 reading is within the limits given in Table 3-10 in both TIME and 1/TIME settings of the FUNCTION switch.

h. CHECK—Correct scale-factor light is on as indicated in Table 3-10.

i. Repeat parts f through h for the remainder of the settings in Table 3-10.

10. CHECK AUTORANGING

a. Set

A TIME/DIV	1 ms
B TIME/DIV	20 μs
DM44 FUNCTION	TIME

b. Adjust DTP so reference point intensifies the second time marker.

c. Adjust Δ TIME to superimpose both intensifed zones.

d. Slowly turn the Δ TIME control clockwise and:

CHECK—That the DM44 upranges when the reading reaches 2.000 (the reading shifts from 2.000 to 02.00).

e. Slowly turn the Δ TIME control counterclockwise and:

CHECK—That the DM44 downranges when the reading reaches 01.00 (the reading shifts to 1.000).

TABLE 3-10
TIME And 1/TIME Accuracy

TIME MARK GEN	A TIME DIV	B TIME DIV	TIME			1/TIME		
			ACCURACY	ms	μs	ACCURACY	ms	μs
50 ns	.05 μs	.01 μs	0.395 to 0.405		X	02.47 to 02.53		X
.1 μs	.1 μs	.01 μs	0.791 to 0.809		X	01.23 to 01.27		X
.2 μs	.2 μs	.01 μs	1.583 to 1.617		X	0.618 to 0.632		X
.5 μs	.5 μs	.01 μs	03.95 to 04.05		X	0.247 to 0.253		X
1 μs	1 μs	.02 μs	07.91 to 08.09		X	0.123 to 0.127		X
2 μs	2 μs	.05 μs	15.83 to 16.17		X	.0618 to .0632		X
5 μs	5 μs	.1 μs	039.5 to 040.5		X	014.7 to 025.3	X	
10 μs	10 μs	.2 μs	079.1 to 080.9		X	012.3 to 012.7	X	
20 μs	20 μs	.5 μs	158.3 to 161.7		X	06.18 to 06.32	X	
50 μs	50 μs	1 μs	0.395 to 0.405	X		02.47 to 02.53	X	
.1 ms	.1 ms	2 μs	0.791 to 0.809	X		01.23 to 01.27	X	
.2 ms	.2 ms	5 μs	1.583 to 1.617	X		0.618 to 0.632	X	
.5 ms	.5 ms	10 μs	03.95 to 04.05	X		0.247 to 0.253	X	
1 ms	1 ms	20 μs	07.91 to 08.09	X		0.123 to 0.127	X	
2 ms	2 ms	50 μs	15,32 to 16.17	X		.0618 to .0632	X	
5 ms	5 ms	.1 ms	039.5 to 040.5	X		024.7 to 025.3		
10 ms	10 ms	.2 ms	079.1 to 080.9	X		012.3 to 012.7		
If the above checks in this table are within tolerance, it is unlikely the following checks will be out of tolerance. The following checks are time consuming and may be skipped if you wish.								
20 ms	20 ms	.5 ms	158.3 to 161.7	X		06.18 to 06.32		
50 ms	50 ms	1 ms	0.395 to 0.405			02.47 to 02.53		
.1 s	.1 s	2 ms	0.791 to 0.809			01.23 to 01.27		
.2 s	.2 s	5 ms	1.583 to 1.617			0.618 to 0.632		
.5 s	.5 s	10 ms	03.95 to 04.05			0.247 to 0.253		

11. CHECK MIXED SWEEP ACCURACY

a. Set

A TIME/DIV	.05 μs
B TIME/DIV	.02 μs
HORIZ DISPLAY	MIX
DTP	Fully clockwise
DM44 FUNCTION	VOLTS

b. Set time-mark generator for 50 nanosecond time markers.

NOTE

Delete the first 0.5 division of the sweep from the measurement in part d.

c. Set POSITION so the second time marker is at the second vertical graticule line.

d. CHECK—Accuracy at the tenth graticule line is within 3%.

e. Set DTP fully counterclockwise.

f. Set time-mark generator for 20 nanosecond time markers.

g. Adjust POSITION to move the peak of the fourth time marker to the second vertical graticule line. This eliminates the first 0.1 microsecond after the transition from A to B sweep.

h. CHECK—Accuracy at the tenth graticule is within 3%.

i. Disconnect test equipment.

12. CHECK X GAIN

a. Set

TRIG MODE	AUTO
A AND B TIME/DIV	X-Y
VERT MODE	CH 2
CH 1 VOLTS/DIV	5 mV

b. Connect amplitude calibrator to X (CH 1) input through a 42-inch, 50 ohm, BNC cable.

c. Set amplitude calibrator for 20 millivolt output.

d. CHECK—Display is two dots separated by 3.88 to 4.12 divisions (horizontally).

e. Disconnect test equipment.

13. CHECK X BANDWIDTH

a. Connect sine-wave generator to X (CH 1) input through 42-inch, 50 ohm, BNC cable and 50 ohm, BNC termination.

b. Set sine-wave generator for 4 horizontal division display of the reference fequency.

c. Increase frequency of sine-wave generator until display is reduced to 2.8 divisions (horizontally).

d. CHECK—Sine-wave generator output frequency is 3 megahertz or greater.

e. Disconnect all test equipment.

CIRCUIT DESCRIPTION

This section of the manual contains a description of the circuitry used in the DM44. The description begins with a general discussion of the instrument, using the basic block diagram shown in Figure 4-1. Then, each circuit is described in detail. The diamond-enclosed number following a heading indicates the schematic diagram on which the circuitry being discussed is located. The schematic diagrams are located on the pullout pages at the rear of this manual.

BLOCK DIAGRAM DISCUSSION ◇1

Figure 4-1 shows a simplified block diagram of the DM44 Digital Multimeter.

The input stages consist of four input converters (VOLTS, OHMS, TIME and 1/TIME, and TEMP). Each converter produces a dc voltage proportional to the magnitude of the input. This voltage is supplied to the A/D (Analog-to-Digital) Converter through the Function Selector. The A/D Converter produces a bcd output that is proportional to the dc input voltage. This bcd output is converted to a 3-½ digit, 7-segment display.

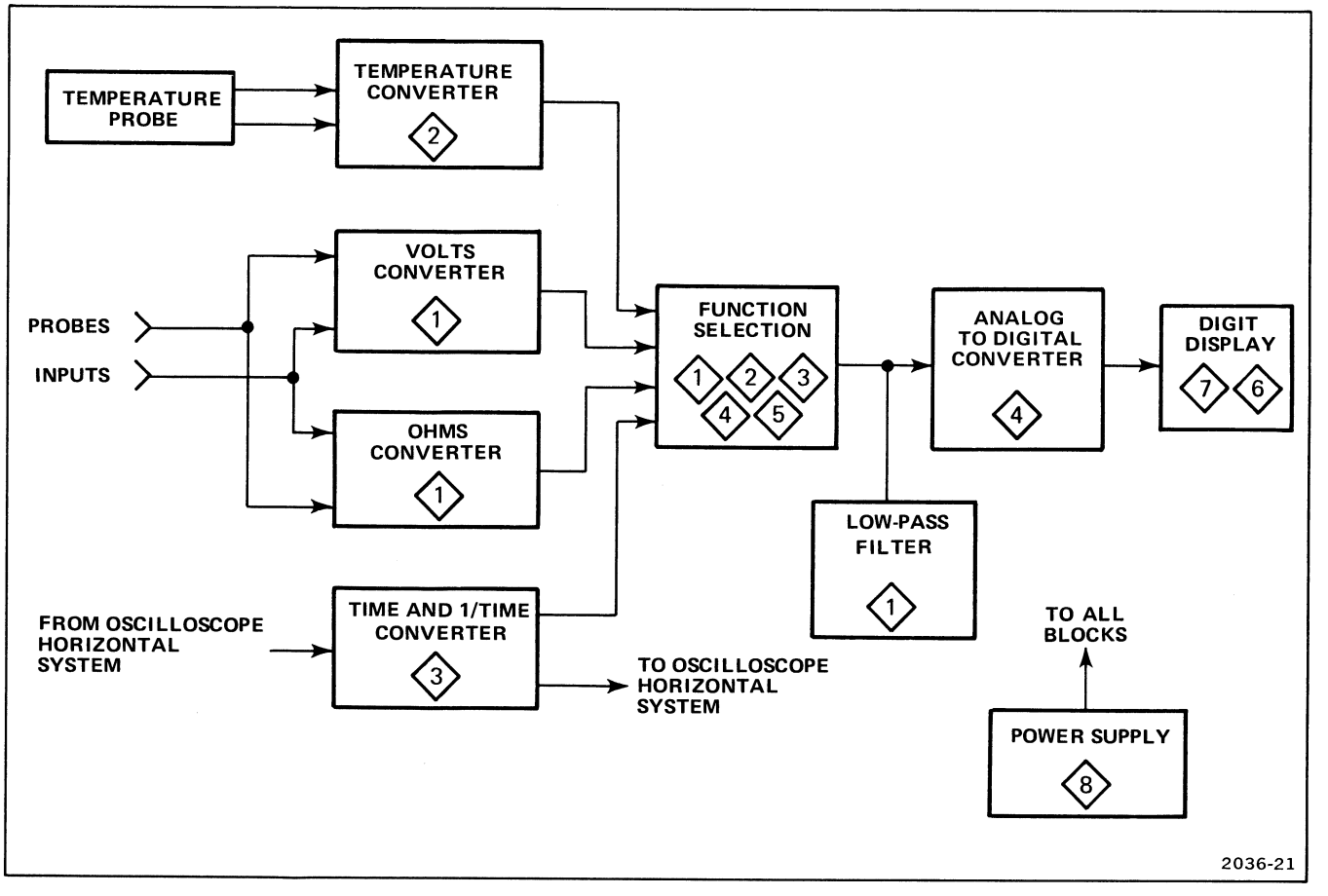


Figure 4-1. Simplified block diagram of the DM44.

TEMPERATURE CONVERTER ②

Figure 4-2 shows a simplified diagram of the Temperature Converter.

The temperature probe contains a sensing transistor. With a constant emitter current, the base-emitter voltage varies linearly as a function of temperature. This voltage is supplied to the A/D (Analog to Digital) Converter through U3091.

The constant current source consists of VR3077, R3078, U3091, and R3080. Zener VR3077 sets the negative reference voltage and R3078 determines the approximate emitter current in the sensing transistor. If the sensing transistor temperature increases, the base-to-emitter voltage decreases, (the emitter voltage goes more positive) causing an increase in the current through R3078. Positive feedback from U3091 increases the current through R3080 by an amount equal to the change in the current through R3078. Therefore, the emitter current remains constant as temperature increases. A similar condition holds for decreasing temperature.

The change in the base-to-emitter voltage with respect to temperature (about 2.2 mV per degree centigrade) is applied to the non-inverting input of U3091. R3095 (see diagram 2) adjusts the gain of U3091 to provide 10 mV per degree centigrade at the output of U3091. This voltage is supplied to the A/D Converter.

R3083 adjusts to provide an offset voltage (about 0.7 V) to the input of U3091 through R3086. This produces 0 volts at the output of U3091 at 0 degrees centigrade.

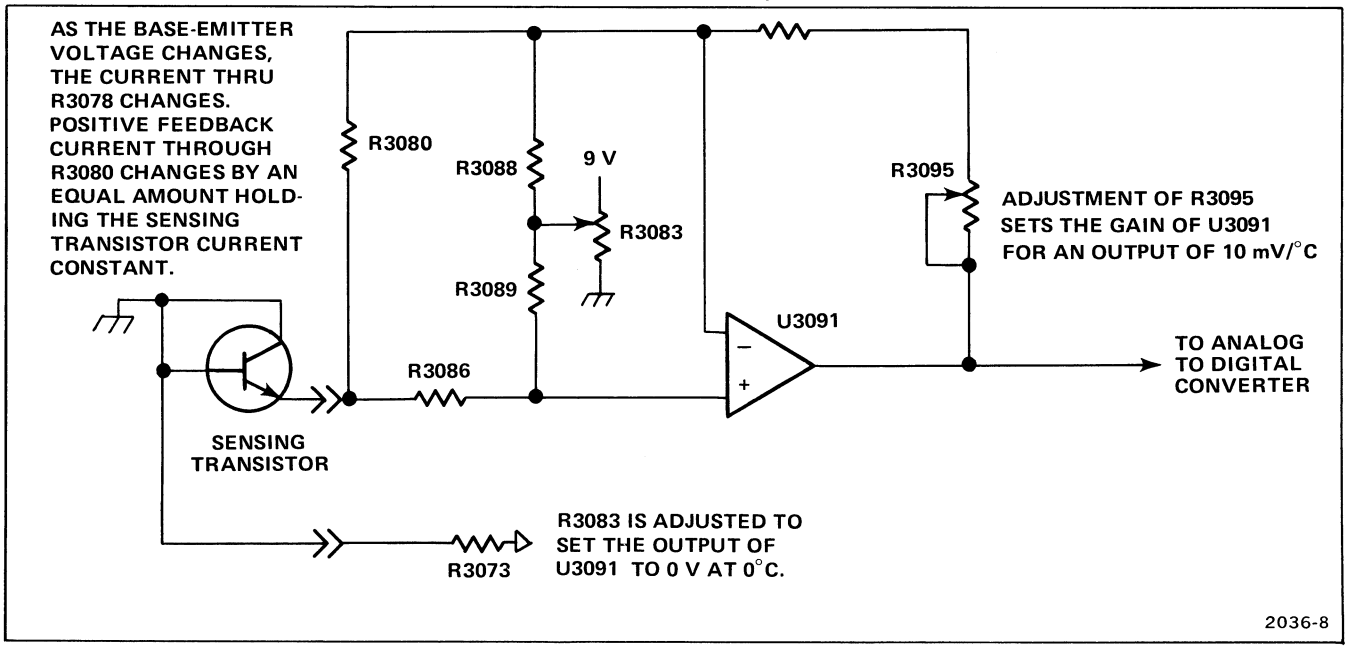


Figure 4-2. Simplified diagram of the Temperature Converter.

VOLTS CONVERTER ①

The Volts Converter is an attenuator (see Figure 4-3). The output of the attenuator is supplied to the A/D (Analog-to-Digital) Converter through FUNCTION switch, S3010.

R3002, R3003, R3004, and R3005 provide a constant input impedance of 10 megohms. A wire jumper may be disconnected (user option) to provide 1000 megohm input impedance in the 200 mV and 2 V ranges. See the Maintenance section for instructions.

In the 200 mV and 2 V ranges, the input voltage is not attenuated. In the other ranges, appropriate attenuation is provided by R3002, R3003, R3004, and R3005.

In the 200 millivolt range, the gain of the Integrator is increased by a factor of ten. See Integrator Gain Switching in the A/D Converter discussion.

Resistors R3010, R3011, R3012, and R3019 perform two functions. The first is providing current limiting to the A/D Converter (U3165). The second is providing a constant source impedance necessary for proper operation of the active low-pass filter U3023D.

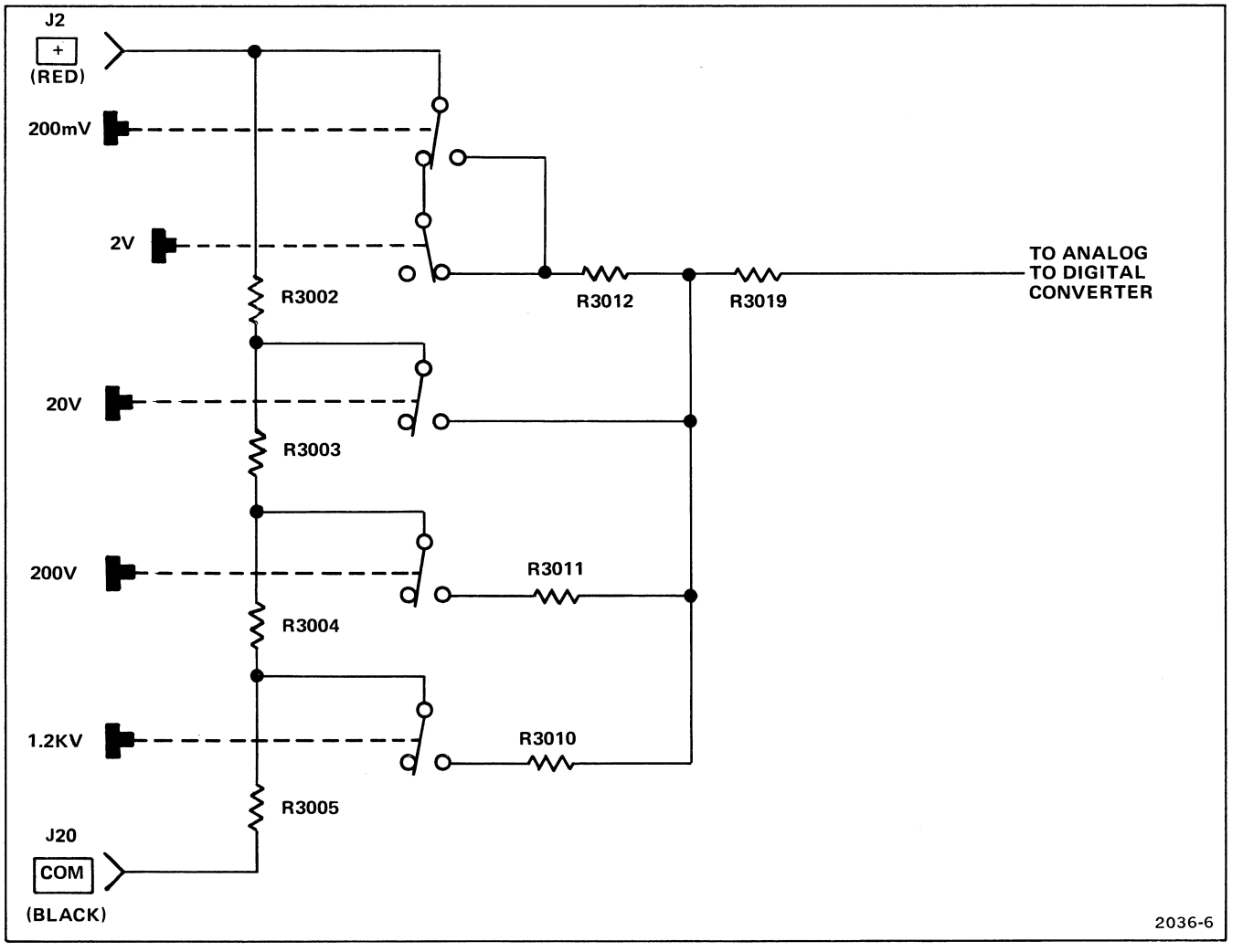


Figure 4-3. Simplified diagram of the VOLTS Converter.

OHMS CONVERTER ①

Figure 4-4 shows a simplified diagram of the Ohms Converter.

The OHMS Converter contains two constant-current sources (a reference current source and a floating current source).

The reference current source consists of U3023A, U3023B, VR3037 and Q3045 and provides a constant current (about 1.2 mA) through R3068. This current produces 1 volt between the minus (−) input and the output of U3061. The floating current source consists of operational amplifier U3061 and the appropriate feedback resistors. U3061 supplies a current through the range setting resistor(s) to set its positive (+) input to the same voltage as its minus input. The amplitude of the current through the range setting resistor(s) is determined by the resistance of the range setting resistor(s), and selected by the range switch S3020. This current also flows through CR3016, R3016, DS3016, and the unknown resistance. The voltage produced across the unknown resistance is supplied to the Analog-to-Digital Converter.

R3058 provides bias current compensation to U3061 in the 20-megohm range. This reduces errors when the bias current becomes an appreciable part of the measurement current.

DS3016 and CR3016 provide input protection to the Ohms Converter in case the probe leads are accidentally connected to a voltage source (up to 120 V ac).

Active filter U3023D is disconnected in the 20-megohm range to speed the measurement process.

In the 200-ohm range, the gain of the Integrator is increased by a factor of ten. See Integrator Gain Switching in the Analog-to-Digital Converter discussion.

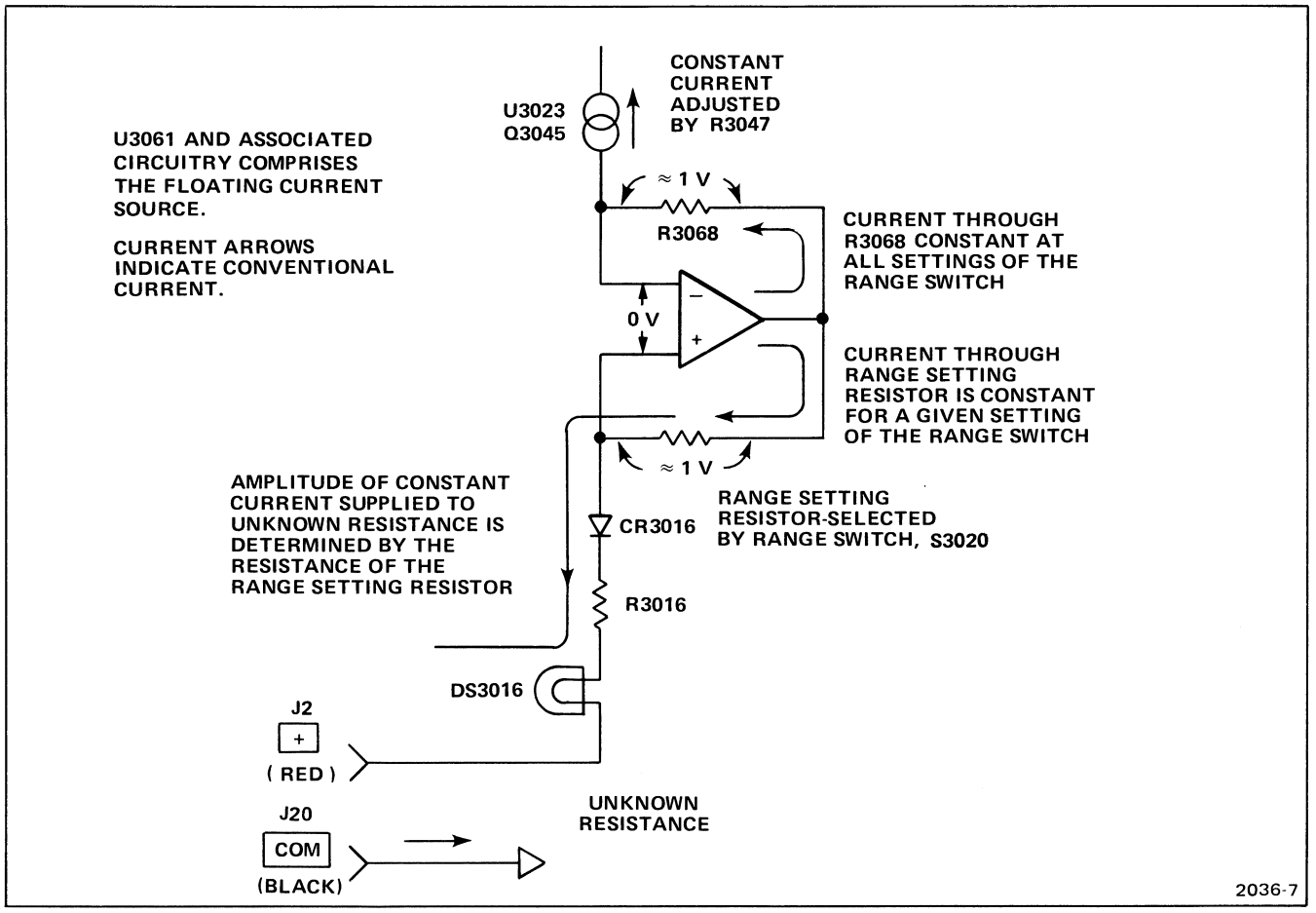


Figure 4-4. Simplified diagram of the OHMS Converter.

TIME AND 1/TIME CONVERTER ③

Each point on the crt display (horizontally) corresponds to a voltage level on the A sweep ramp (see Figure 4-5). Therefore, the distance between two points on the display is proportional to the voltage between corresponding points on the A sweep ramp. This is the basic method used to measure time difference with the DM44. A detailed discussion of circuit operation follows.

Obtaining a Voltage Proportional to the Time Difference

Figure 4-6 shows a simplified diagram of the TIME and 1/TIME Converter.

The DELAY TIME POSITION control (DTP control) adjusts the position of the reference point on the display. The voltage from the wiper of the DTP control is supplied to the junction of R2362 and R3263 through unity gain buffer amplifier U3256A. Current to resistors R3262, R3263, and R3272 is supplied by two constant current generators (U3256C-Q3251 and U3256D-Q3269). Therefore, the voltage is constant across R3272 and the combination of R3262 and R3263. With the Δ TIME control (R3272) centered, the voltage between TP3279 and TP3277 is 0 volts. As the Δ TIME control is adjusted off center, a voltage difference is produced between TP3279 and TP3277. This voltage is proportional to the physical

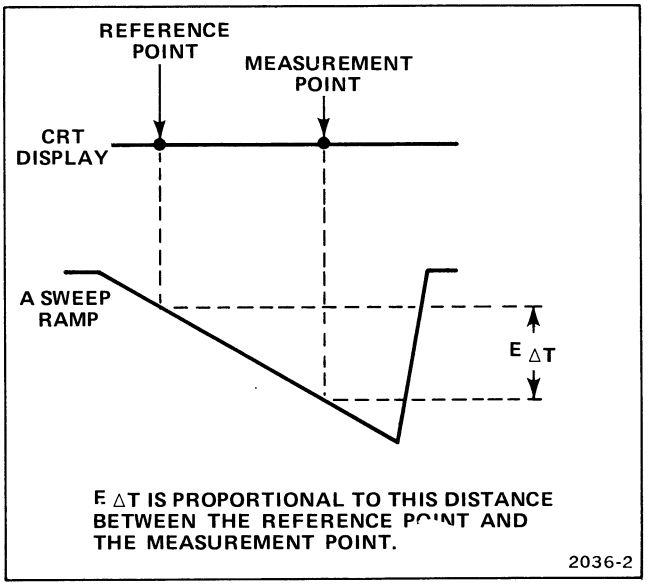


Figure 4-5. Basic function of the TIME and 1/TIME Cc

distance between the two points being measured on the crt. The voltage between TP3279 and TP3277 is attenuated in a 1-2-5 sequence by three resistors in the oscilloscope timing circuit providing a voltage proportional to the time between the two points being measured.

An alternate mode of operation (user selectable) allows the Δ TIME control to operate independently of the DTP control. To operate in this mode, disconnect the connector from P3272 and connect it to P3273. Also disconnect P3277.

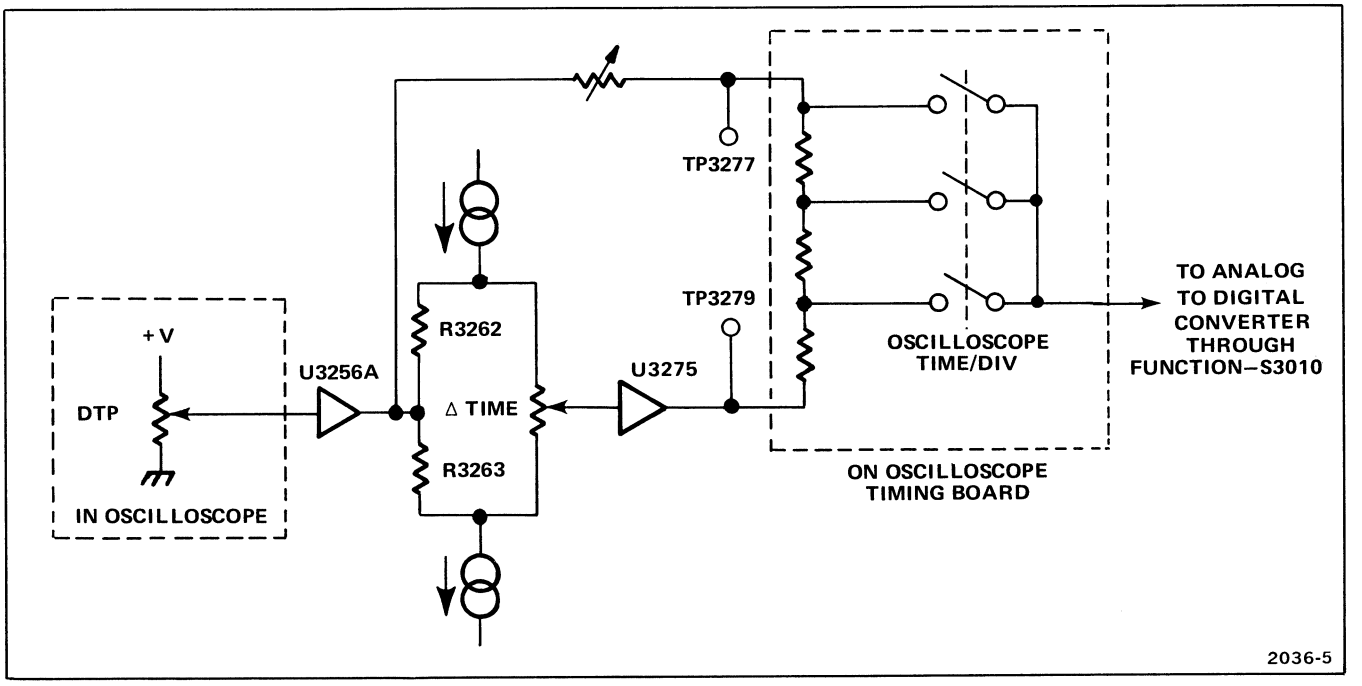


Figure 4-6. Obtaining a voltage proportional to the time interval being measured.

Delay Pickoff Selector Logic

Figure 4-7 shows a simplified diagram of the Delay Pickoff Selector Logic circuit.

In an oscilloscope not equipped with a DM44, the beginning of B sweep is controlled by the DELAY TIME POSITION (DTP) control. In an oscilloscope with a DM44, when operating the Time or 1/Time modes, the beginning of B sweep is controlled by the Δ TIME and DTP controls (see Figure 4-8). The Delay Pickoff Selector Logic selects which of these control determines the beginning of B sweep.

ALL VERTICAL MODES EXCEPT ALTERNATE. At the end of every A sweep, the oscilloscope supplies a negative-going alt trace sync pulse to pin 4 of U3211B. This pulse is level shifted by U3211B and applied to the clock input of D flip flop U3223. With the $\overline{Q}$ output connected to the D input, the Q output toggles at a rate determined by the alt trace sync pulse. The Q output controls FET switches U3282B and U3282C through U3211D and U3211C. Since U3211C inverts the Q output of U3223, one of the FET switches is on while the other is off. This condition reverses at the end of each A sweep when U3223 toggles.

ALT VERTICAL MODE. In the ALT mode, the ALT switch in the oscilloscope opens, allowing the input of U3256B to be pulled LO through R3215. Now a signal from the oscilloscope vertical channel switching circuit can control the states of the R and S inputs of U3223 through U3211A, U3213D, and U3213C (see Figure 4-7). In the ALT mode, U3282C is on while CH 1 is displayed, and U3282B is on while CH 2 is displayed. The visual effect is the reference point always appearing on the CH 1 display and the measurement point always appearing on the CH 2 display.

Figure 4-9 shows a timing diagram of the logic signals generated in the ALT mode.

When not in the TIME or 1/TIME functions, the + input of U3211C and the – input of U3211D are pulled HI through R3227. This holds the output of U3211C HI and the output of U3211D LO. U3282B is off and U3282C is on. Therefore, the Δ TIME control is disabled when not in the TIME or 1/TIME functions.

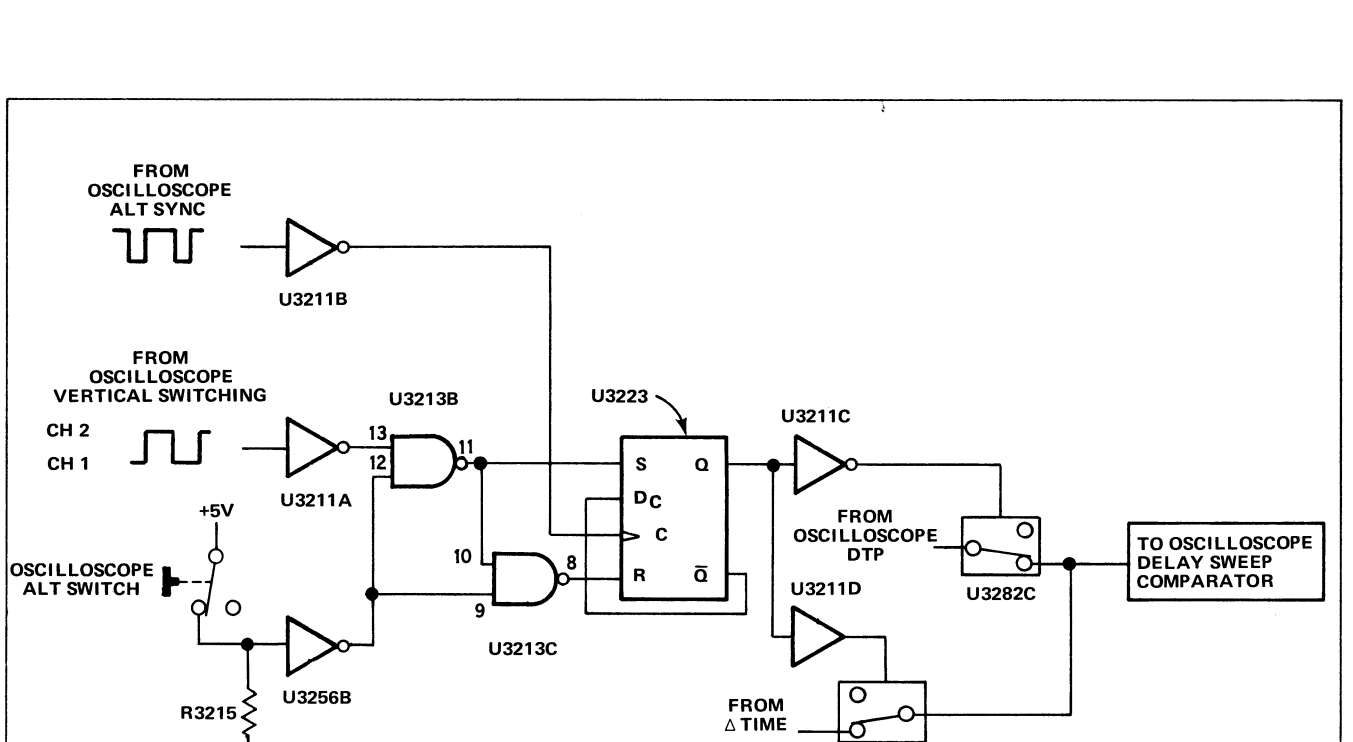


Figure 4-7. Simplified diagram of the Delay Pickoff Selector Logic.

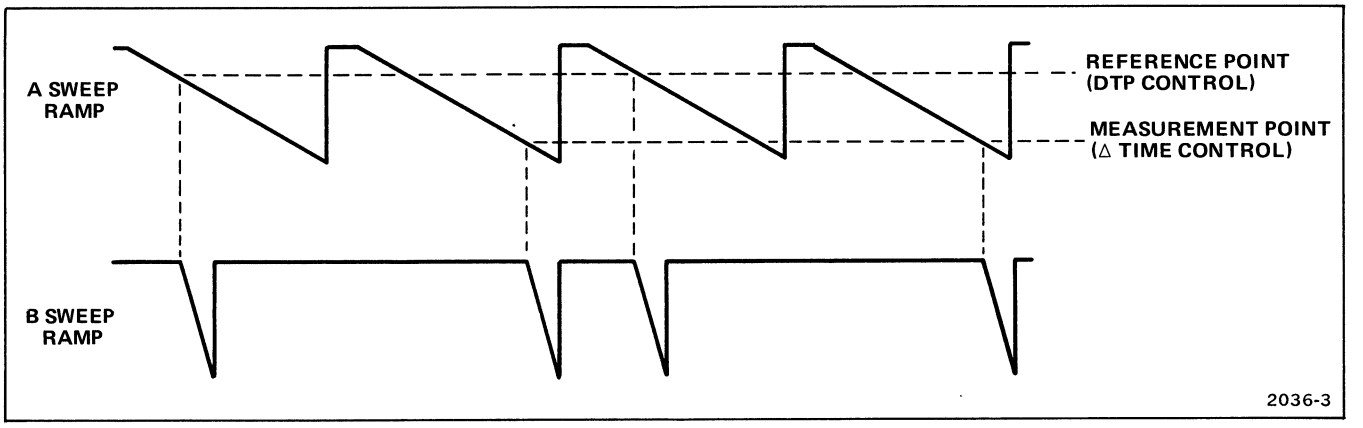


Figure 4-8. Delay Pickoff Selector Logic selects which control determines the beginning of B Sweep.

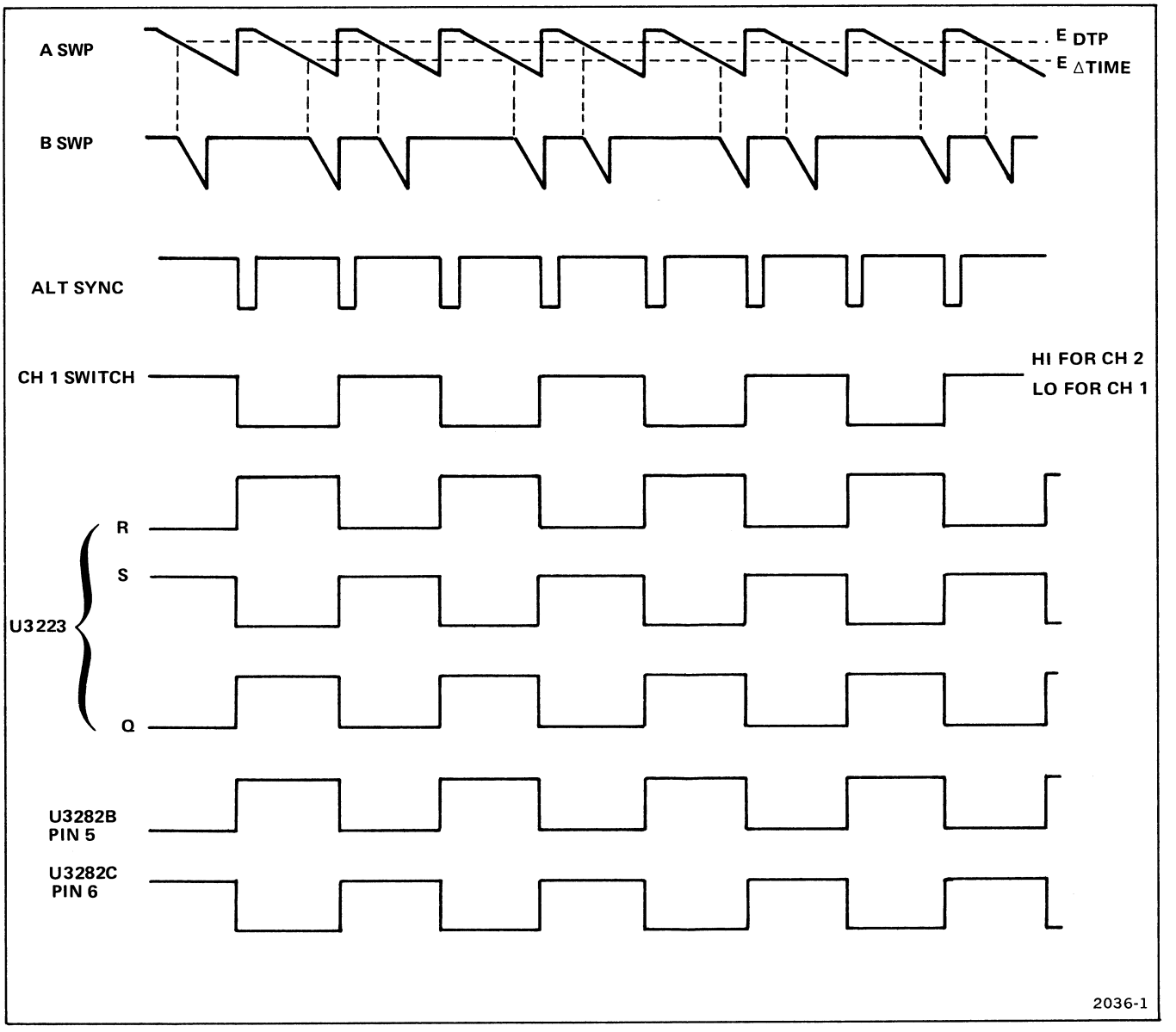


Figure 4-9. Timing diagram of Delay Pickoff Selector Logic signals generated in the ALT vertical mode.

FUNCTION SELECTION ◇1 ◇2 ◇3 ◇4 ◇5

All Functions Except 1/TIME

The function switch (S3010) selects the output of one of the Input Converters and connects it to pin 15 of U3165.

1/TIME Function

The 1/TIME function measures the reciprocal of the time difference between two points displayed on the crt. To accomplish this function, the output of the TIME and 1/TIME Converter is disconnected from pin 15 of U3165 and connected to pin 9 of U3165 (through U3113C and Q3153) in place of V_{ref} (see Figure 4-10). Also, approximately 30 mV is connected to pin 15 of U3165 in place of the output from the TIME and 1/TIME Converter. The resultant output of the A/D Converter is inversely proportional to the time between the two points being measured.

ANALOG-TO-DIGITAL CONVERTER ◇4 ◇6

The A/D (Analog-to-Digital) Converter produces a binary coded decimal (bcd) output that is proportional to the voltage supplied by one of the Input Converters.

The analog integrated circuit (U3165) contains the integrator, comparator, and input buffer. R3140, R3141, and R3145 are the integrator input and C3149 is the integrating capacitor. VR3037 provides the reference voltage (V_{ref}) for U3165 through U3113C and Q3153.

U3103C supplies the clock pulses to the A/D Converter. U3103 is a comparator connected as a square-wave oscillator. The repetition rate is set to 20.48 kilohertz, providing 50 and 60 hertz power line frequency rejection.

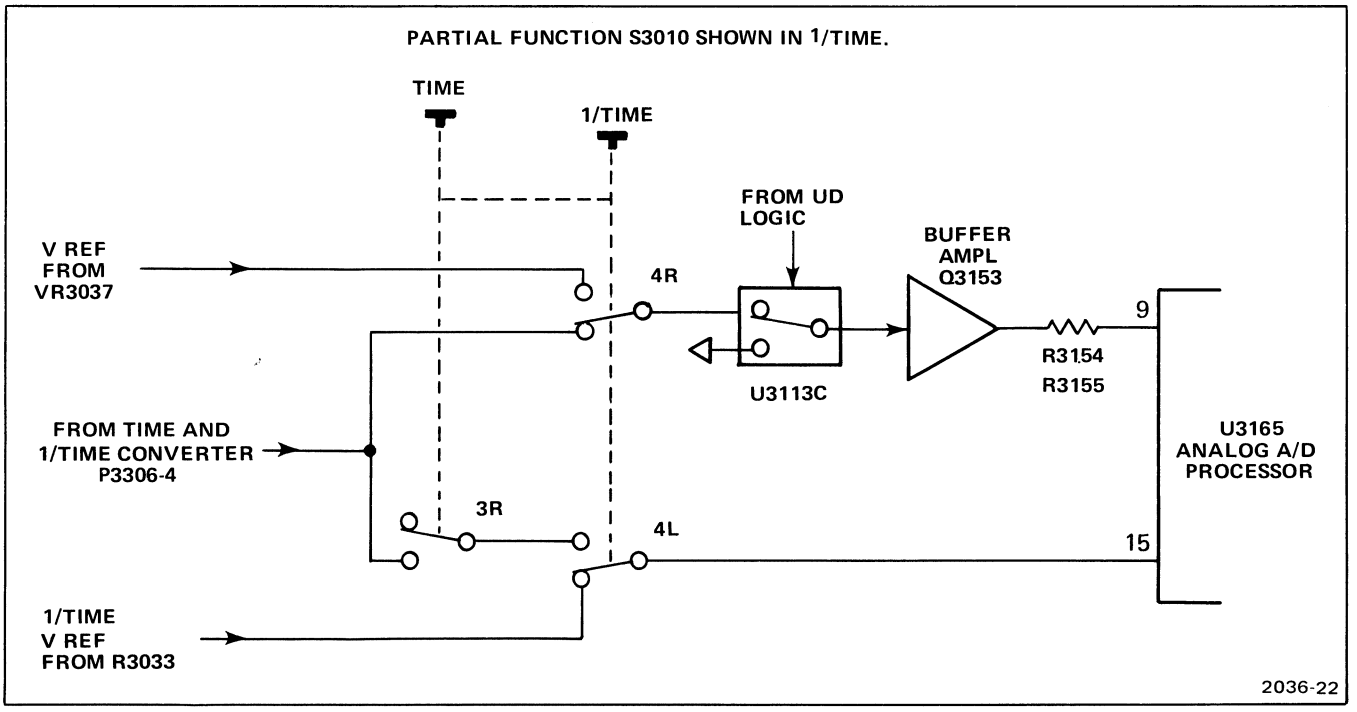


Figure 4-10. 1/TIME Function switching.

Operation of a Basic Integrator

Figure 4-11 shows a simplified diagram of an integrator circuit. This integrating amplifier is an operational amplifier with its + input grounded. As V_{in} goes positive, current flows through R_{in} (V_{in}/R_{in}). Since the operational amplifier has a very high input impedance, this current flows into C_{int}, charging C_{int}. In order to maintain 0 V on the — input, the output of the integrating amplifier goes negative. The slope of the ramp thus produced is proportional to the amplitude of the current into C_{int} (V_{in}/R_{in}). Thus, the more positive V_{in} becomes, the steeper the slope becomes.

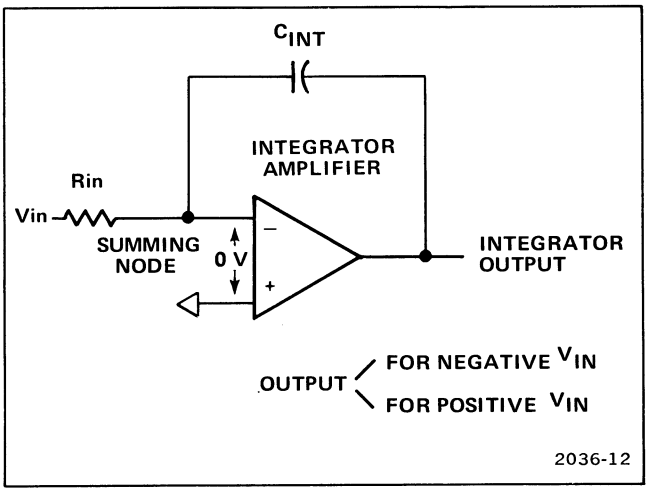


Figure 4-11. Simplified diagram of a basic integrator.

Auto Zero Interval Operation

During the Auto Zero Interval, an equilibrium is established in the closed loop system consisting of the auto zero amplifier, the integrator, the Cstrg (C3165, Fig. 4-13). Equilibrium is obtained when the sum of the average currents into the integrator summing node (pin 9 of U3165) is zero amps. This occurs when V_{strg}/R3147 (see Fig. 4-13) is about one-half V_{ref}/(R3154 + R3155). Figure 4-12 shows a timing diagram of the Auto Zero Interval. See the Measure Interval description for a discussion of the time between points A and B. After time B, the input buffer amplifier is grounded, the integrator output is connected to C_{strg} (C3165) through R3160 and R3165, and the up-down logic is pulsed at a 50-percent duty cycle, four clock pulses up and four clock pulses down. (See Figure 4-13.)

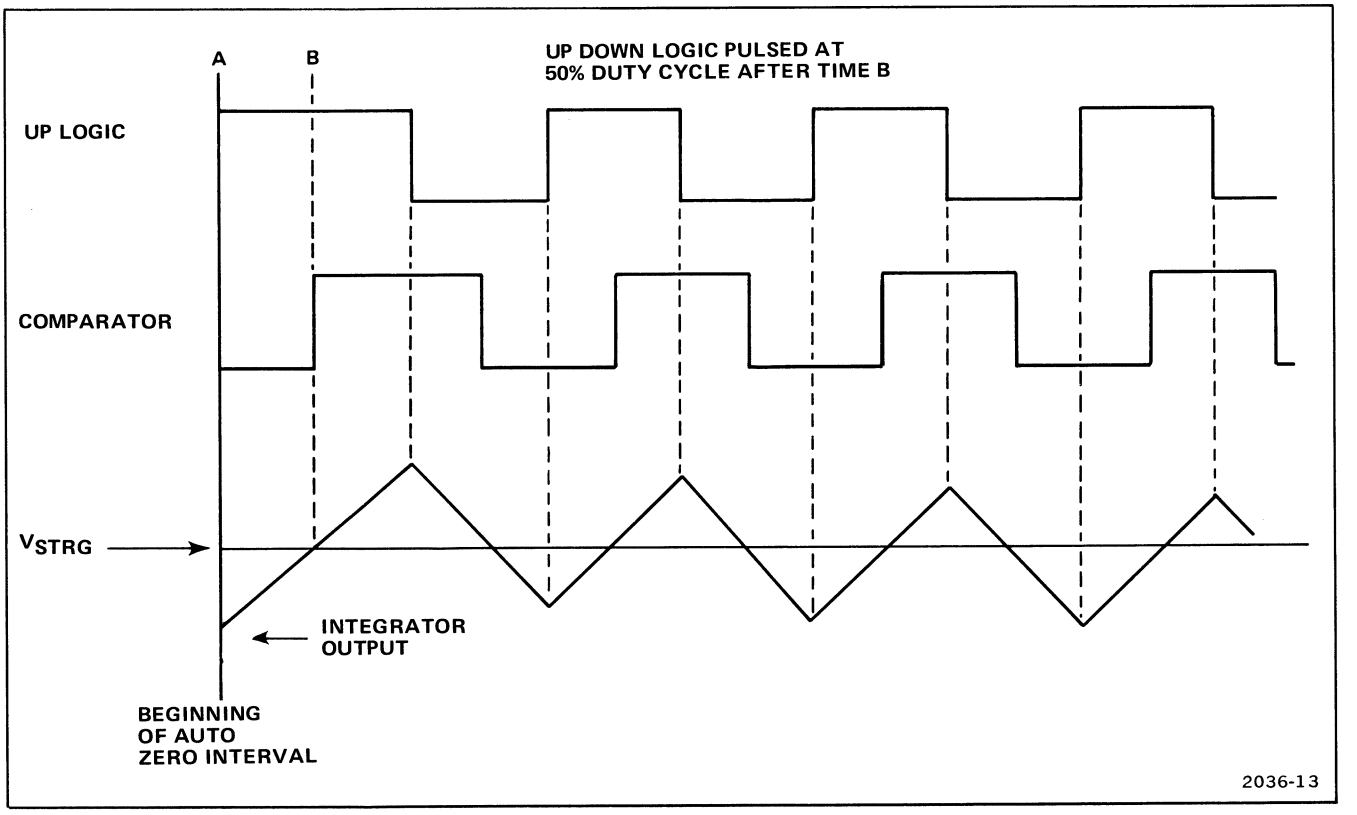


Figure 4-12. Auto Zero Interval timing.

The Up-Down logic controls U3113C. When the Up-Down logic is HI, U3113C connects the input of buffer amplifier Q3153 to ground. The voltage across R3154 and R3155 is about −1.2 V. Therefore, R3154 and R3155 supply the small current −1.2 V/(R3154 + R3155) to the integrator summing node. The remaining current flowing through R3147 is supplied by the Auto Zero amplifier. To hold the summing node at 0 V, the output of the integrator goes positive (see Figure 4-12).

When the Up-Down logic is LO, U3113C connects the input of buffer amplifier Q3153 to V_{ref}. Now V_{ref} supplies current to the integrator summing node, (V_{ref} −1.2 V)/(R3154 + R3155). This current is about twice that supplied through R3147. This will drive the integrator output negative.

Measure Interval Operation

At the beginning of the measure interval, the current path between the integrator output and C3165 (through R3160 and R3165) is opened. At the same time, the input buffer amplifier is connected to V_{in}. There are now three current sources for the integrator summing node.

The current through R3147 is constant at V_{strg}/R3147.

The current through R3145 is proportional to V_{in} (V_{in}/R3145).

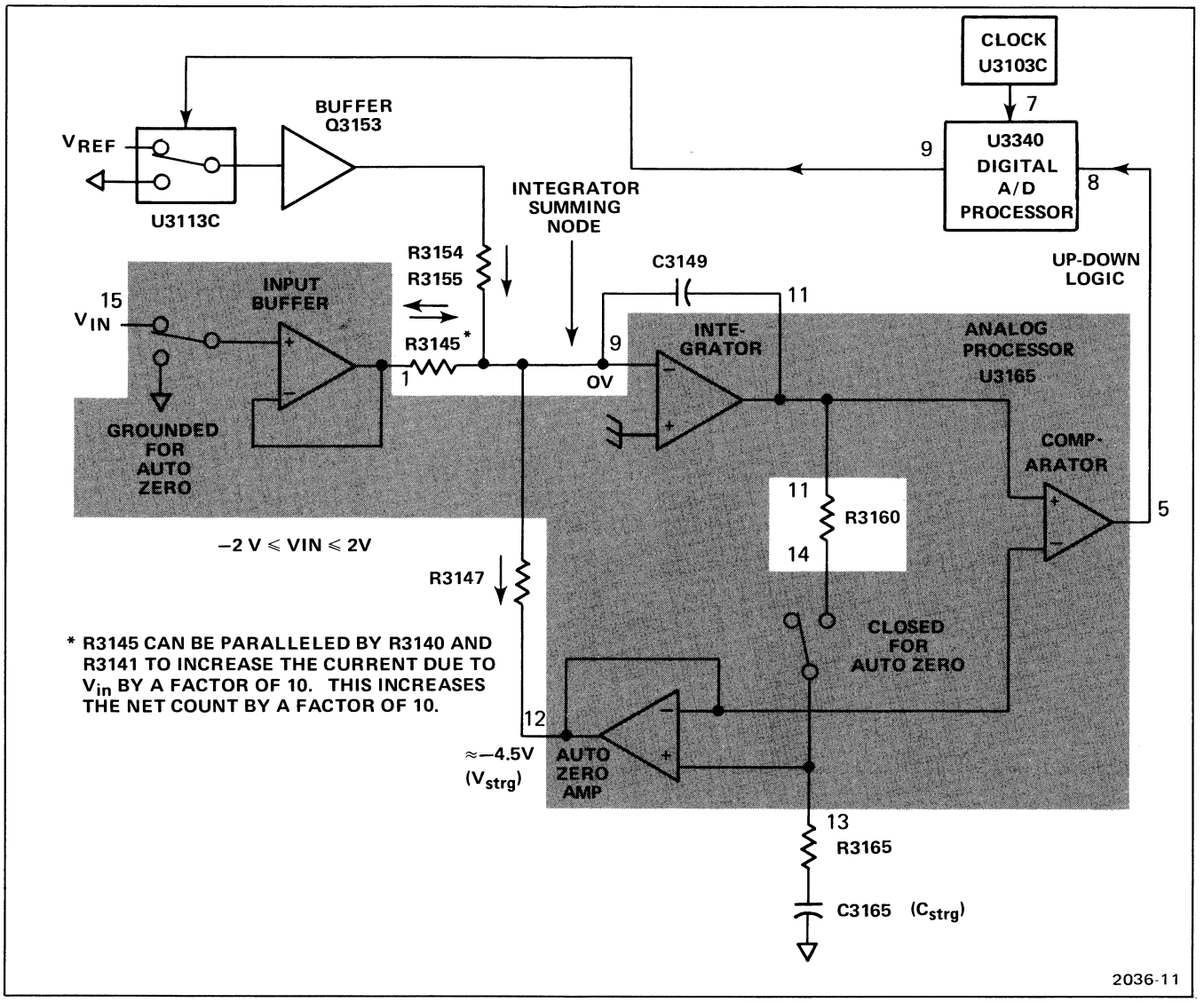


Figure 4-13. Simplified diagram of the Analog-to-Digital Converter.

The current through R3154 and R3155 is switched (by U3113C) between -1.2 V/(R3154 + R3155) and (V_{ref} -1.2 V)/(R3154 + R3155). U3110C is controlled by the Up-Down logic which is controlled by the comparator. During the measure interval, the Up-Down logic has two available duty cycles. When the comparator is HI, the Up-Down logic is HI for one clock pulse and LO for seven. When the output of the comparator is LO, the Up-Down logic is HI for seven clock pulses and LO for one. The comparator output is HI when the integrator output is more positive than V_{strg} and LO when the integrator output is more negative than V_{strg}.

The binary counter in U3340 is also controlled by the Up-Down logic. The counter counts up when the Up-Down logic is HI and down when the logic is LO.

Figure 4-14 shows a timing diagram of the signals generated with a negative V_{in}.

At the end of the measure interval, the integrator output is usually not equal to V_{strg}. To minimize this source of error, V_{in} remains connected and the counter continues to count after the beginning of the Auto Zero Interval until the integrator output reaches V_{strg}. The net count is then transferred to static latches, the counter is reset and locked out, and Auto Zero operation begins.

See the Readout Display and Readout Logic Discussions for how the net count is displayed.

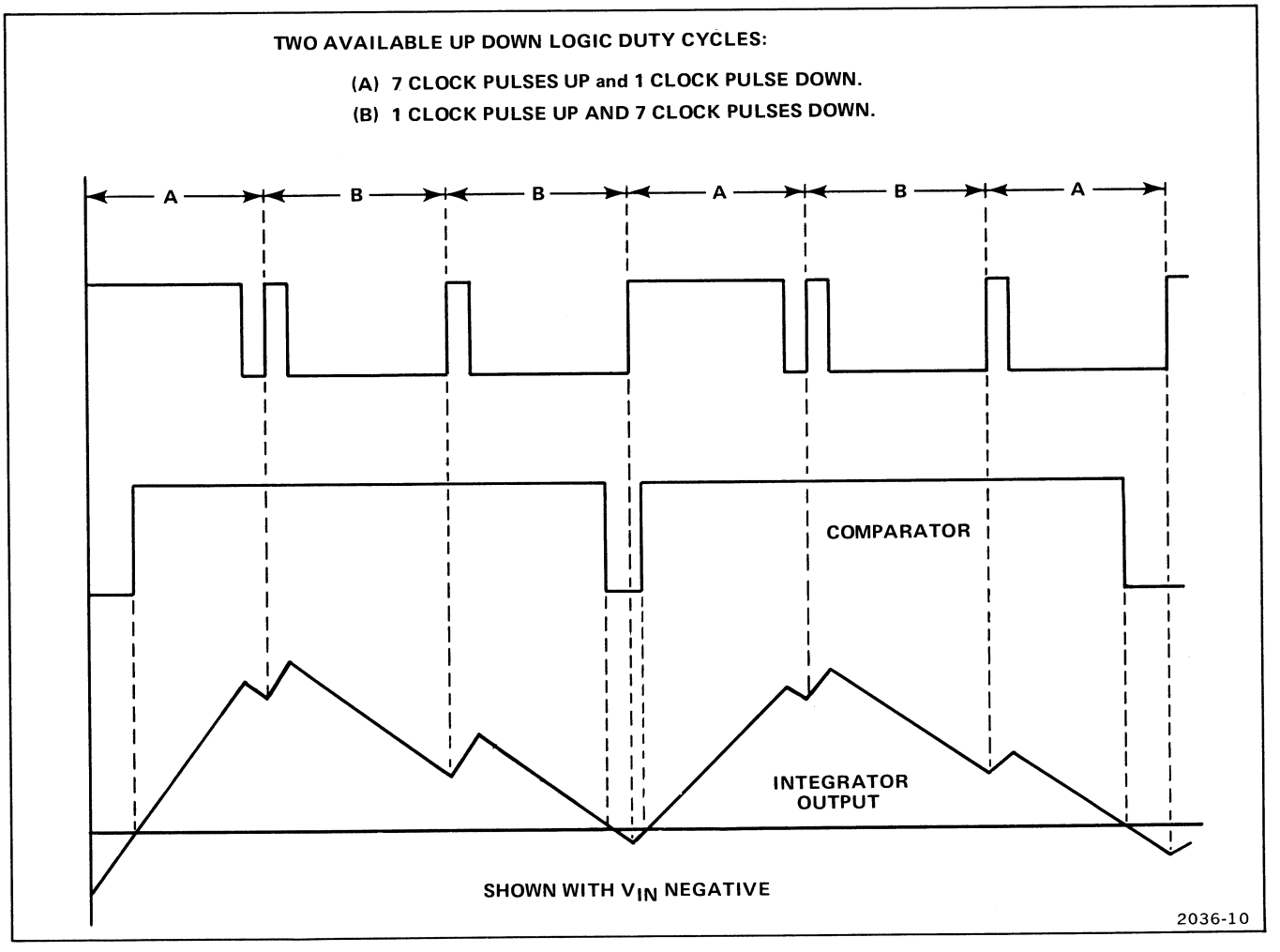


Figure 4-14. Measure interval timing with negative V_{in}.

Integrator Gain Switching

Figure 4-15 shows a simplified diagram of the Integrator Gain Switching circuit.

The integrator has two gain ranges, X1 and X10. Normally, the integrator is in the X1 range. The X10 range is manually selected by the RANGE switch (S3020) in the lowest range of the VOLTS and OHMS functions. The X10 range is automatically selected in the TIME and 1/TIME functions when an underrange condition occurs. (See TIME and 1/TIME Autorange Logic.)

X10 RANGE. In the 200-millivolt range, the 200-OHM range, or when the TIME and 1/TIME Autorange Logic senses an underrange condition, pin 9 of U3023C goes more negative than pin 10. This causes pin 8 of U3023C to go HI, turning on Q3143. Therefore, the current (due to V_{in}) supplied to the integrator summing node is about V_{in} divided by R3145 in parallel with R3140 and R3141. This current is ten times that supplied in the X1 range.

X1 RANGE. Normally pin 9 of U3023C is pulled more positive than pin 10, causing pin 8 of U3023C to go LO and turn off Q3143. Therefore, the current (due to V_{in}) supplied to the integrator summing node is about V_{in} divided by R3145.

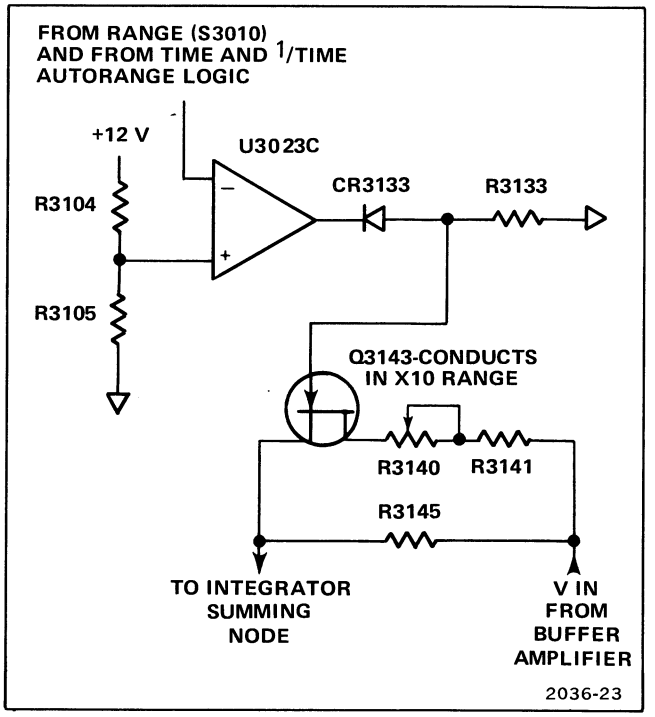


Figure 4-15. Simplified diagram of the Integrator Gain Switching circuit.

READOUT DISPLAY ⑦

The Readout Display consists of five 7-segment displays with decimal points and two light-emitting diodes. See the Readout Logic description for a discussion of how the readout is produced.

Figure 4-16 shows the relationships of the various circuits which drive the Readout Display.

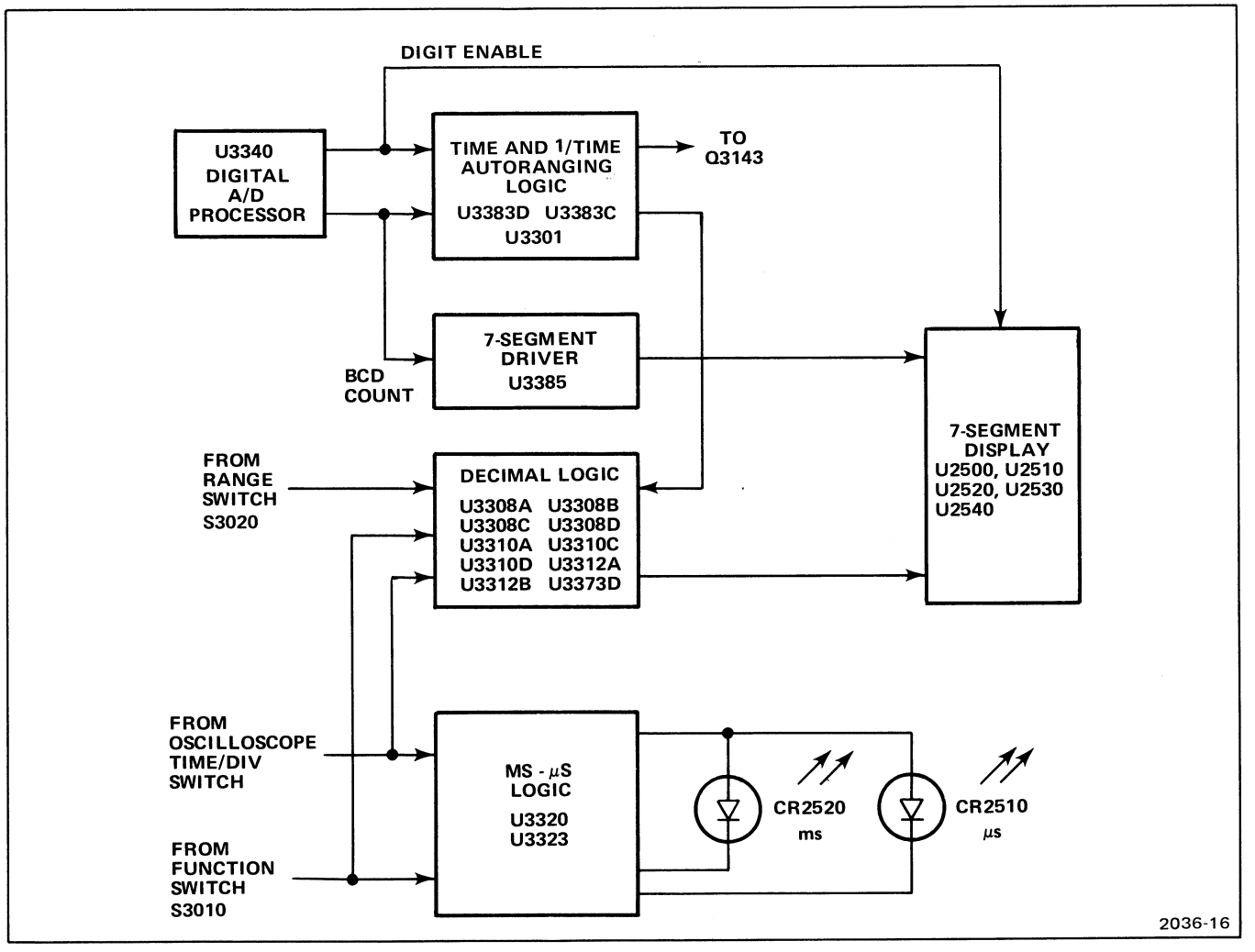


Figure 4-16. Block diagram of the Readout Display and associated circuitry.

READOUT LOGIC ◈6

Figure 4-17 shows a simplified diagram of the Readout Logic.

At the end of the measure interval, the net count is transferred to static latches within U3340. This bcd information is multiplexed in a 1-3-2-4 sequence and supplied to the decoder driver (U3385). Digit four is the most significant digit. The outputs of the 7-segment decoder are connected to the anodes of four 7-segment readouts with the corresponding anodes connected in parallel. The cathodes of the 7-segment readouts are connected to the digit enable outputs of U3340 through transistors and buffer amplifiers. Only one of the four transistors is turned on at a time to display one digit at a time.

To indicate an overrange condition, circuitry within U3340 causes the digit enable outputs of U3340 to blank all four digits during the Auto Zero Interval. This causes the display to blink off during the Auto Zero Interval.

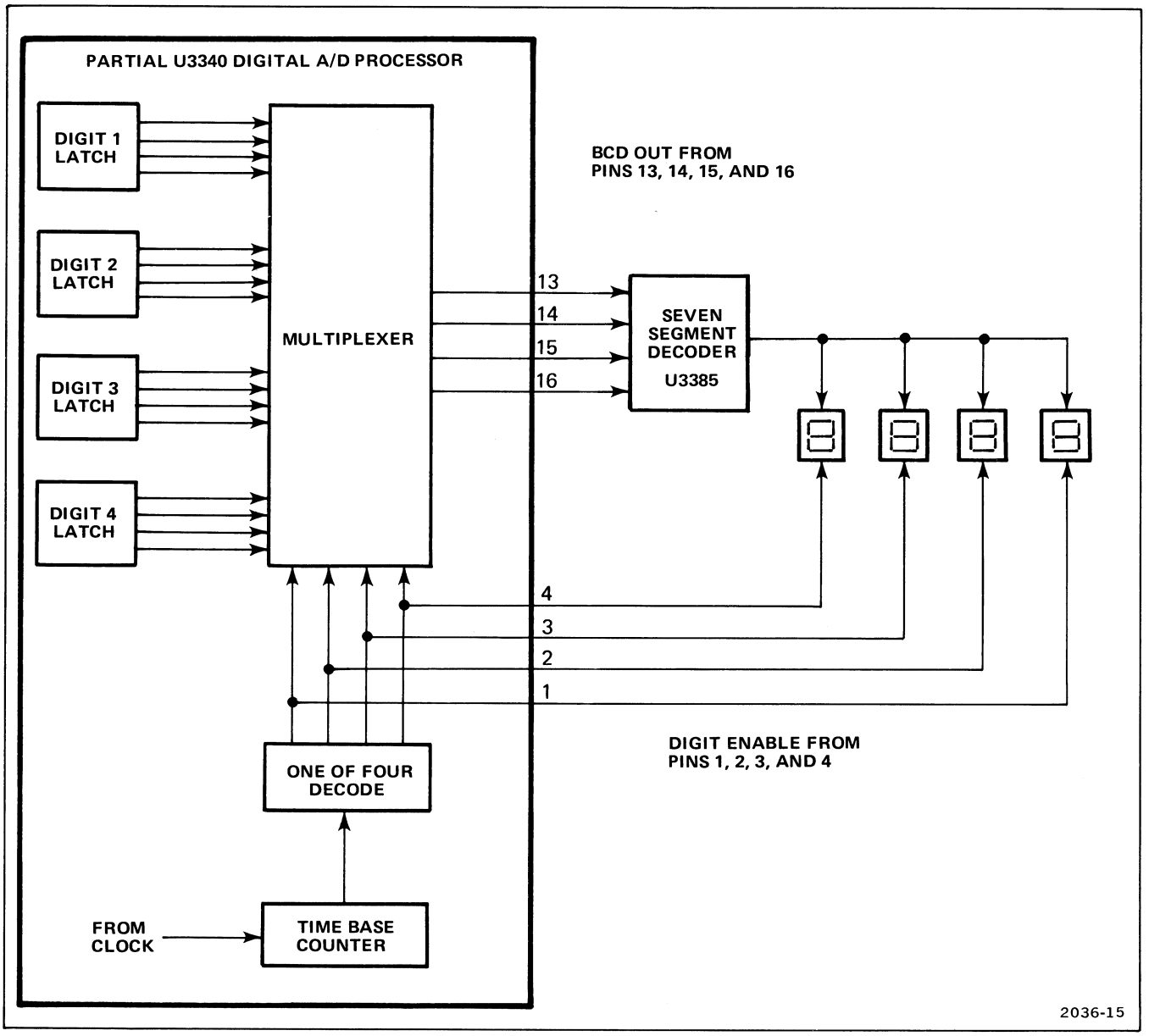


Figure 4-17. Simplified diagram of the Readout Logic.

TIME AND 1/TIME DECIMAL LOGIC ⑤

Figure 4-18 shows a simplified diagram of the TIME and 1/TIME decimal logic. The six nand gates shown are grouped into three pairs: U3308A and U3373D; U3310D and U3312B; U3310A and U3312A. Of the four inputs of each pair, two are controlled by a contact on the oscilloscope TIME/DIV switch and the other two are controlled by the TIME and 1/TIME Autorange Logic. The outputs of the Autorange Logic are the Q and $\overline{Q}$ outputs of the RS flip-flop (U3301C and U3301D).

Assume one of the TIME/DIV contacts closes. This puts a HI on one input of each nand gate in the corresponding pair. If the Autorange Logic is in the X1 mode (Q HI), the lower nand gate of the pair causes the appropriate decimal point to be displayed. If the Autorange Logic shifts to the X10 mode (Q LO), the upper nand gate of the pair causes the appropriate decimal to be displayed. As a result, the decimal shifts one position to the left when the Autorange Logic shifts from the X1 to the X10 mode.

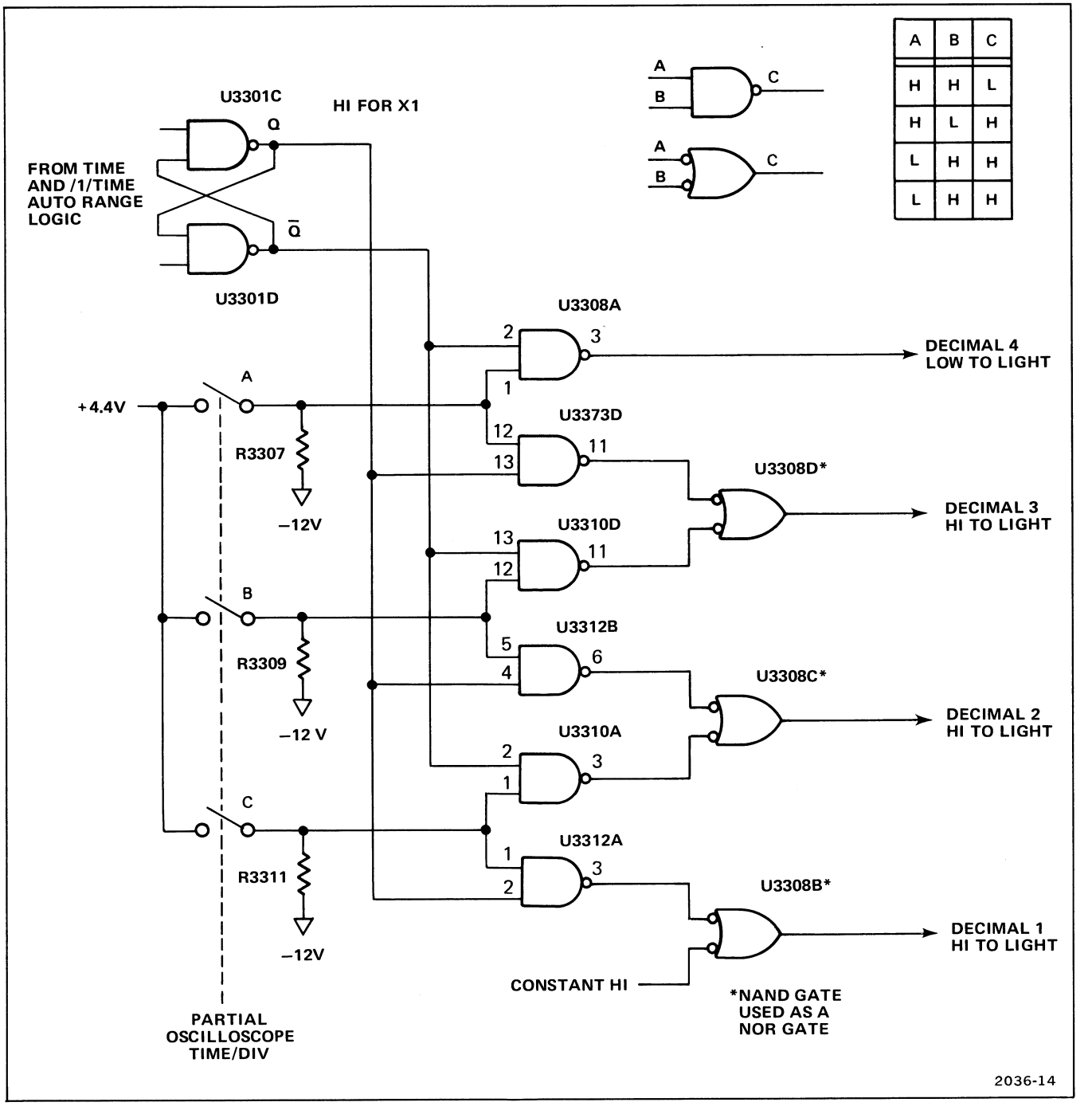
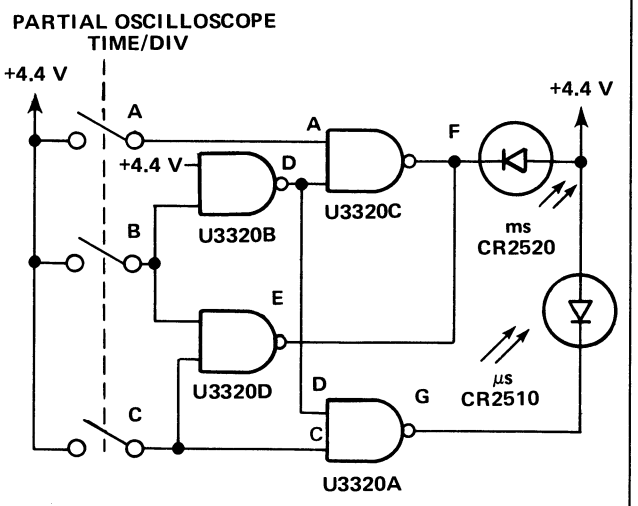


Figure 4-18. Simplified diagram of TIME and 1/TIME Decimal Logic.

MS AND μS LOGIC ⑤

The ms and μs indicators are controlled by U3323 in the TIME function and by U3320 in the 1/TIME function. To do this, the supply voltage to U3320 is disconnected in the TIME function and the supply voltage to U3323 is disconnected in the 1/TIME function.

Figure 4-19 shows a simplified diagram and truth table of the ms and μs Logic in the 1/TIME function. Notice that the last condition is invalid. The oscilloscope TIME/DIV settings which produce this condition are not usable. The supply voltage to U3323 is disconnected in the 1/TIME function. Therefore, U3323 can be ignored.



A	B	C	D	E	F	G
LO	HI	LO	LO	HI	HI	HI
LO	LO	LO	HI	HI	HI	HI
HI	HI	LO	LO	HI	HI	HI
HI	LO	LO	HI	FORCED LO	LO	HI
LO	HI	HI	LO	LO	FORCED LO	HI
LO	LO	HI	HI	HI	HI	LO
LO	HI	HI	LO	LO	FORCED LO	HI

2036-19

Figure 4-19. Simplified diagram of ms and μs Logic when in the 1/TIME function.

Figure 4-20 shows a simplified diagram of the ms and μs Logic in the TIME function. The supply voltage to U3320 is disconnected in the TIME function. Therefore, U3320 can be ignored.

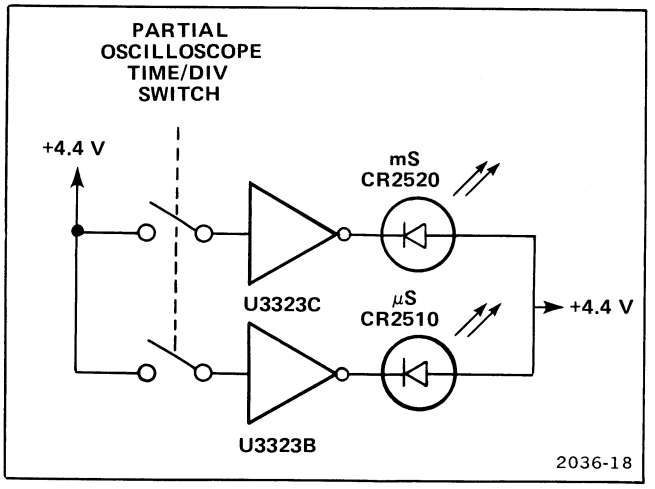
TIME AND 1/TIME AUTORANGE LOGIC ⑤

The Autorange Logic operates only in the TIME and 1/TIME functions. Figure 4-21 shows a simplified diagram of the TIME and 1/TIME Autorange Logic.

U3301C and U3301D are connected as an RS flip-flop. Normally the R and S inputs are both HI. With a HI on both inputs, the output state is not disturbed. A LO is needed on one of the inputs to set or reset the flip-flop.

Underrange Condition

The maximum net count from U3340 never allows bit four of digit four to go HI. When an underrange condition occurs, circuitry within U3340 causes pin 13 of U3340 (bit four) to go HI at the same time pin 4 of U3340 (digit four enable) goes HI. These two HI's reset the flip-flop through U3301A (the Q output goes LO). This LO is inverted by U3323C and allows Q3143 to conduct. This increases the gain of the integrator by a factor of ten (see Integrator Gain Switching in the Analog-to-Digital Converter discussion).



2036-18

Figure 4-20. Simplified diagram of ms and μs Logic when in the TIME function.

TIME AND 1/TIME DECIMAL LOGIC ⑤

Figure 4-18 shows a simplified diagram of the TIME and 1/TIME decimal logic. The six nand gates shown are grouped into three pairs: U3308A and U3373D; U3310D and U3312B; U3310A and U3312A. Of the four inputs of each pair, two are controlled by a contact on the oscilloscope TIME/DIV switch and the other two are controlled by the TIME and 1/TIME Autorange Logic. The outputs of the Autorange Logic are the Q and $\overline{Q}$ outputs of the RS flip-flop (U3301C and U3301D).

Assume one of the TIME/DIV contacts closes. This puts a HI on one input of each nand gate in the corresponding pair. If the Autorange Logic is in the X1 mode (Q HI), the lower nand gate of the pair causes the appropriate decimal point to be displayed. If the Autorange Logic shifts to the X10 mode (Q LO), the upper nand gate of the pair causes the appropriate decimal to be displayed. As a result, the decimal shifts one position to the left when the Autorange Logic shifts from the X1 to the X10 mode.

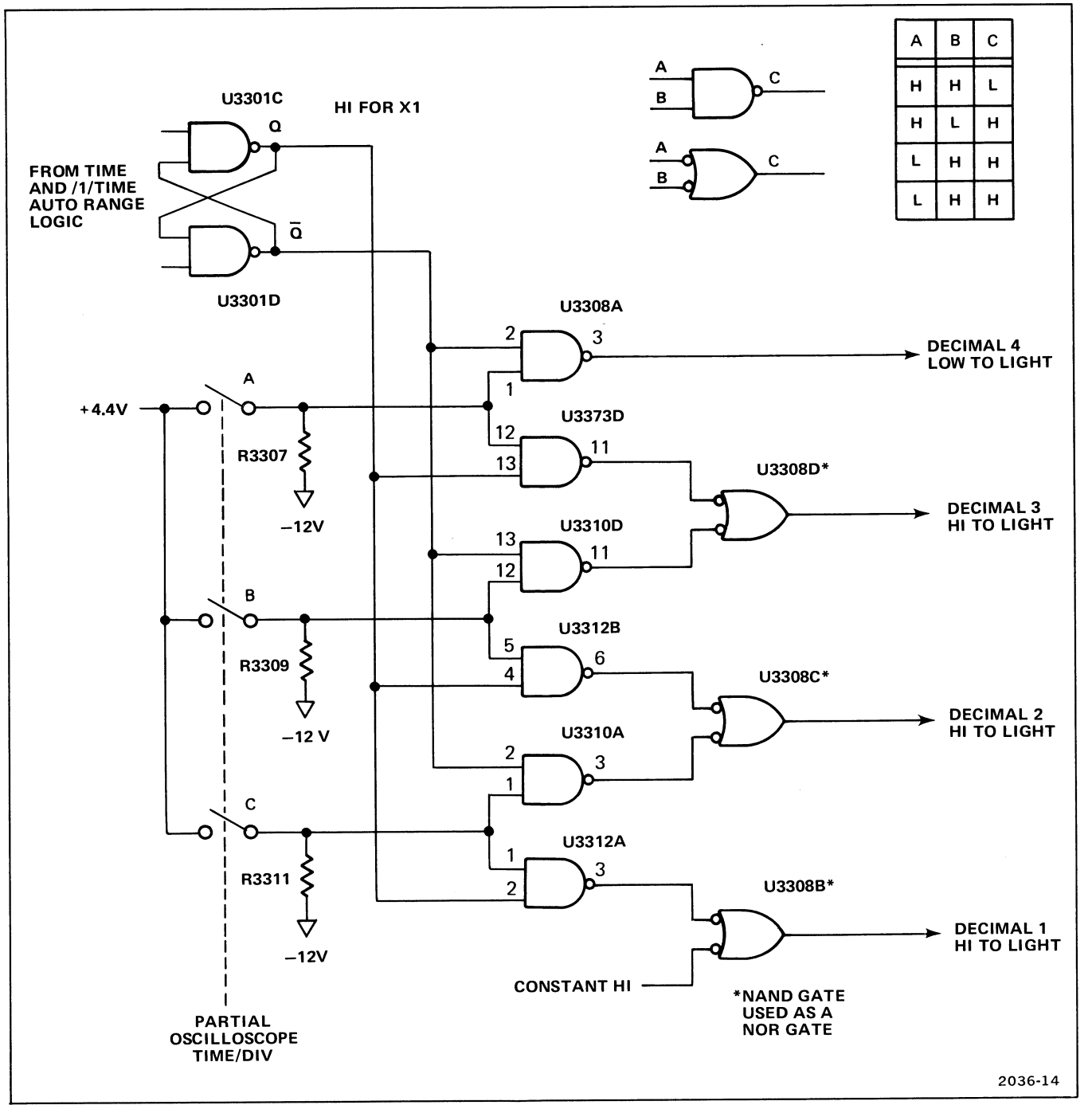
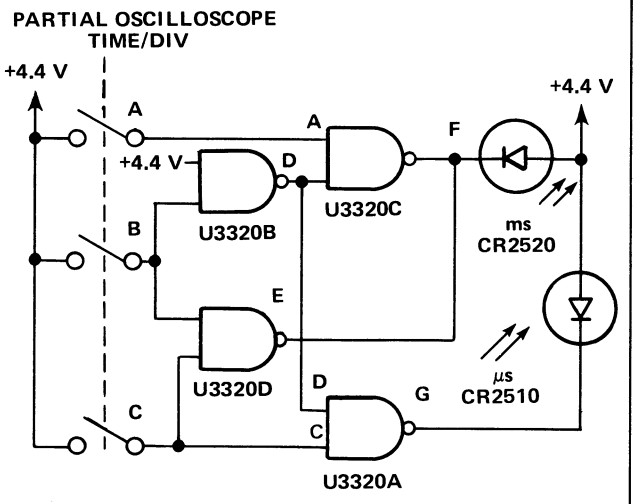


Figure 4-18. Simplified diagram of TIME and 1/TIME Decimal Logic.

MS AND μS LOGIC ⑤

The ms and μs indicators are controlled by U3323 in the TIME function and by U3320 in the 1/TIME function. To do this, the supply voltage to U3320 is disconnected in the TIME function and the supply voltage to U3323 is disconnected in the 1/TIME function.

Figure 4-19 shows a simplified diagram and truth table of the ms and μs Logic in the 1/TIME function. Notice that the last condition is invalid. The oscilloscope TIME/DIV settings which produce this condition are not usable. The supply voltage to U3323 is disconnected in the 1/TIME function. Therefore, U3323 can be ignored.



A	B	C	D	E	F	G
LO	HI	LO	LO	HI	HI	HI
LO	LO	LO	HI	HI	HI	HI
HI	HI	LO	LO	HI	HI	HI
HI	LO	LO	HI	FORCED LO	LO	HI
LO	HI	HI	LO	LO	FORCED LO	HI
LO	LO	HI	HI	HI	HI	LO
LO	HI	HI	LO	LO	FORCED LO	HI

2036-19

Figure 4-19. Simplified diagram of ms and μs Logic when in the 1/TIME function.

Figure 4-20 shows a simplified diagram of the ms and μs Logic in the TIME function. The supply voltage to U3320 is disconnected in the TIME function. Therefore, U3320 can be ignored.

TIME AND 1/TIME AUTORANGE LOGIC ⑤

The Autorange Logic operates only in the TIME and 1/TIME functions. Figure 4-21 shows a simplified diagram of the TIME and 1/TIME Autorange Logic.

U3301C and U3301D are connected as an RS flip-flop. Normally the R and S inputs are both HI. With a HI on both inputs, the output state is not disturbed. A LO is needed on one of the inputs to set or reset the flip-flop.

Underrange Condition

The maximum net count from U3340 never allows bit four of digit four to go HI. When an underrange condition occurs, circuitry within U3340 causes pin 13 of U3340 (bit four) to go HI at the same time pin 4 of U3340 (digit four enable) goes HI. These two HI's reset the flip-flop through U3301A (the Q output goes LO). This LO is inverted by U3323C and allows Q3143 to conduct. This increases the gain of the integrator by a factor of ten (see Integrator Gain Switching in the Analog-to-Digital Converter discussion).

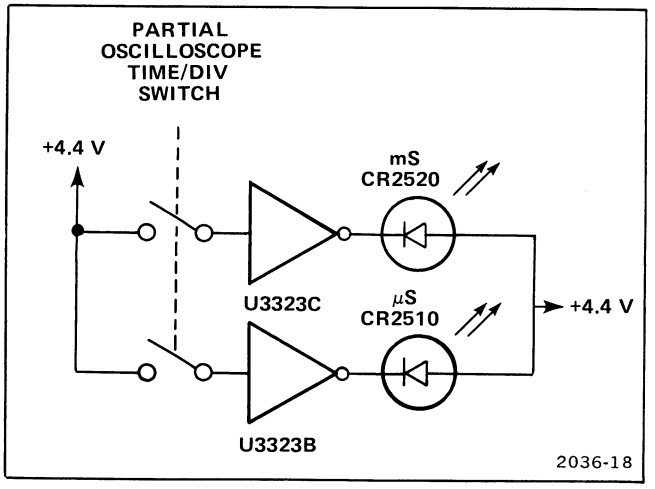


Figure 4-20. Simplified diagram of ms and μs Logic when in the TIME function.

Overrange Condition

When an overrange condition does not exist, one of the digit enable outputs is always HI (pin 1, 2, 3, or 4 of U3340). The digit enable outputs are connected to two nor gates (U3383D and U3383C). Therefore, one of the nor gate outputs is always LO (see Figure 4-21). The nor gate outputs are connected to a nand gate (U3301B). With one input of U3301B always LO, its output is always HI.

When an overrange condition exists, circuitry within U3340 causes all four digit enable outputs to step LO at the same time, resetting the RS flip-flop through U3383D, U3383C, and U3301B. The Q output goes HI, is inverted through U3023C and turns off Q3143. This decreases the gain of the integrator by a factor of ten. (See Integrator Gain Switching in the Analog-to-Digital Converter discussion.)

POWER SUPPLY ⑧

The DM44 Power Supply is a floating supply that uses the accessory windings of the oscilloscope power transformer to provide the regulated voltages; +12 volts, +5 volts, and −12 volts.

The +12 Volt Supply is regulated by integrated circuit regulator U2614, which contains a reference voltage, output driver, buffers, etc.

The +5 Volt Supply is regulated by integrated circuit regulator U2624, which also contains a reference voltage, dirvers, buffers, etc.

The −12 Volt Supply reference voltage is the +12 Volt Supply across R2635. Feedback from the junction of R2635 and R2634 is applied to the comparator composed of Q2638 and Q2634. Transistor Q2636 is the series regulator. Q2632 provides current limiting.

Ground 2 is the ground for the analog circuit and ground 1 is the digital ground return.

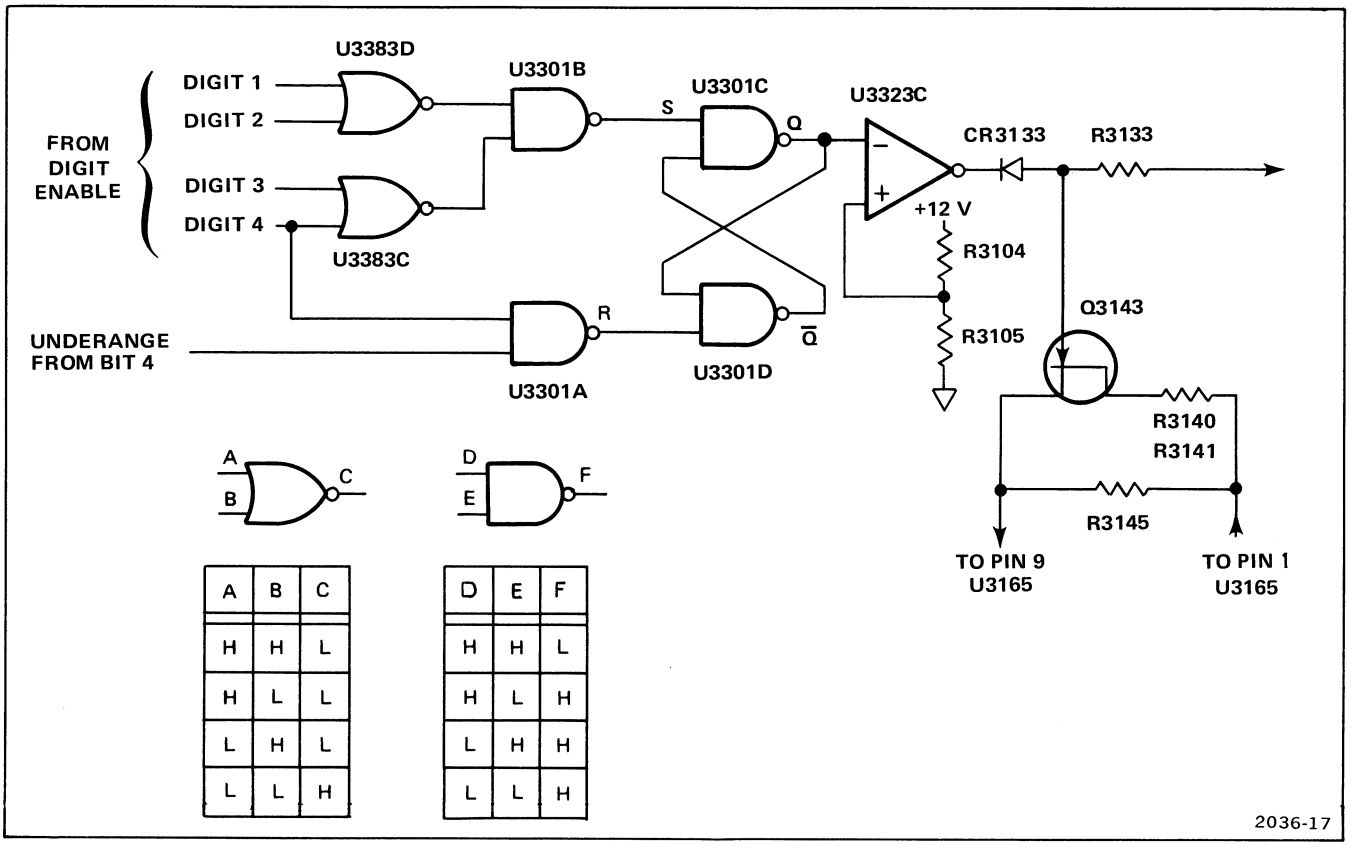


Figure 4-21. Simplified diagram of TIME and 1/TIME Autorange Logic.

MAINTENANCE

This section contains information for use in corrective maintenance and instructions for user modifications. The preventive maintenance information found in the oscilloscope service manual also applies to the DM44 and will not be repeated here.

MAINTENANCE PRECAUTIONS

To reduce the possibility of personal injury or instrument damage, observe the following precautions.

1. Disconnect instrument from power source before removing or installing components.

2. Handle semiconductors with care. Many of the semiconductors used in this instrument, especially MOS types, can be damaged by static discharge. Static discharge damage may not be immediately apparent.

3. Use care not to interconnect instrument grounds which may be at different potentials (cross grounding).

4. Do not use excessive heat when soldering. This can damage circuit boards and semiconductors.

CABINET REMOVAL

WARNING

To prevent electrical shock, disconnect power before removing the cabinet.

DM44 Cover

Use the following procedure to remove the DM44 cover.

1. Disconnect power cord.

2. Remove two screws from the DM44 cover (see Figure 5-1).

3. Slide the DM44 cover toward the rear of the instrument to remove.

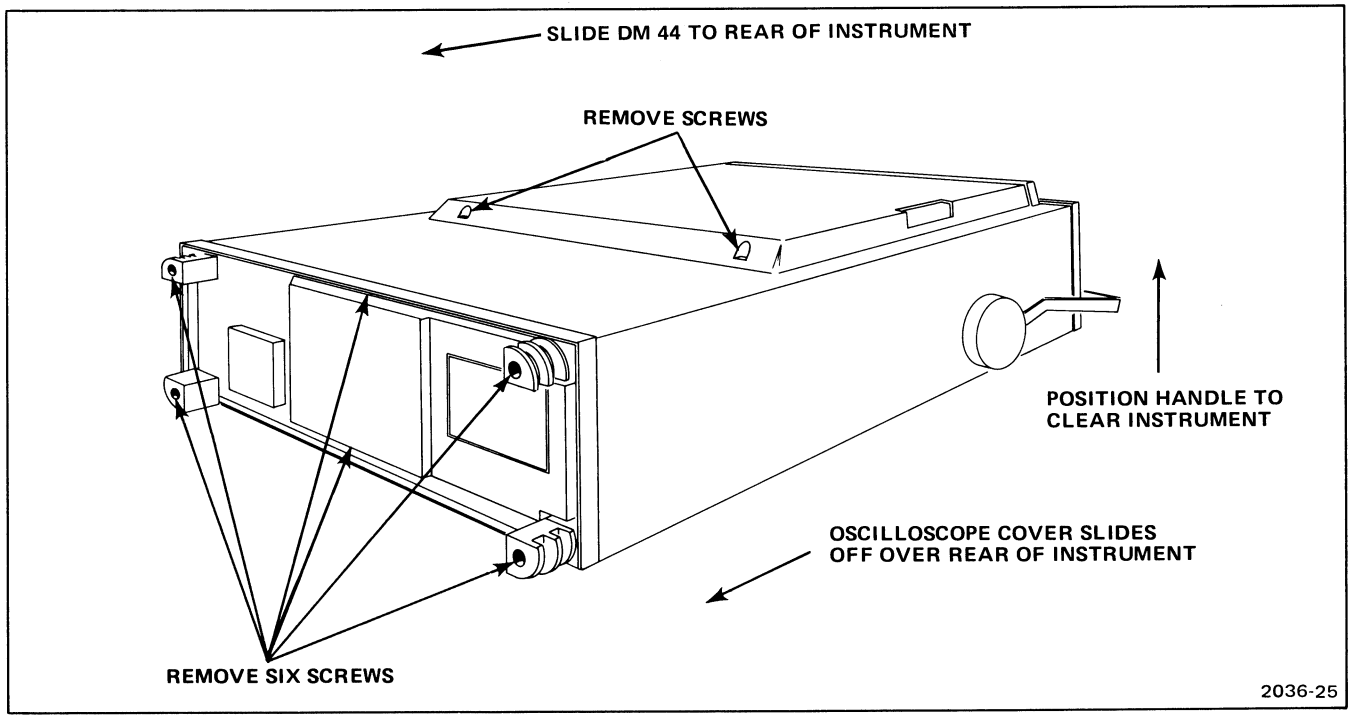


Figure 5-1. Cover removal.

Oscilloscope Cabinet

Use the following procedure to remove the oscilloscope cabinet.

1. Disconnect the power cord.
2. Unwrap the power cord from the cord-wrap feet.
3. Remove the six screws as shown in Figure 5-1.
4. Remove the rear ring.
5. Install the oscilloscope front cover. Stand the instrument on its front cover on a flat surface.
6. Lift the cabinet to remove.

USER MODIFICATIONS

The following information gives instructions for making user modifications.

INPUT IMPEDANCE MODIFICATION

Use the following procedure to increase the input impedance to 1000 megohms in the 200-millivolt and 2-volt ranges of the VOLTS function.

1. Remove the DM44 cover (see Cabinet Removal).
2. Unsolder and remove the wire strap as shown in Figure 5-2.
3. Replace the DM44 cover.

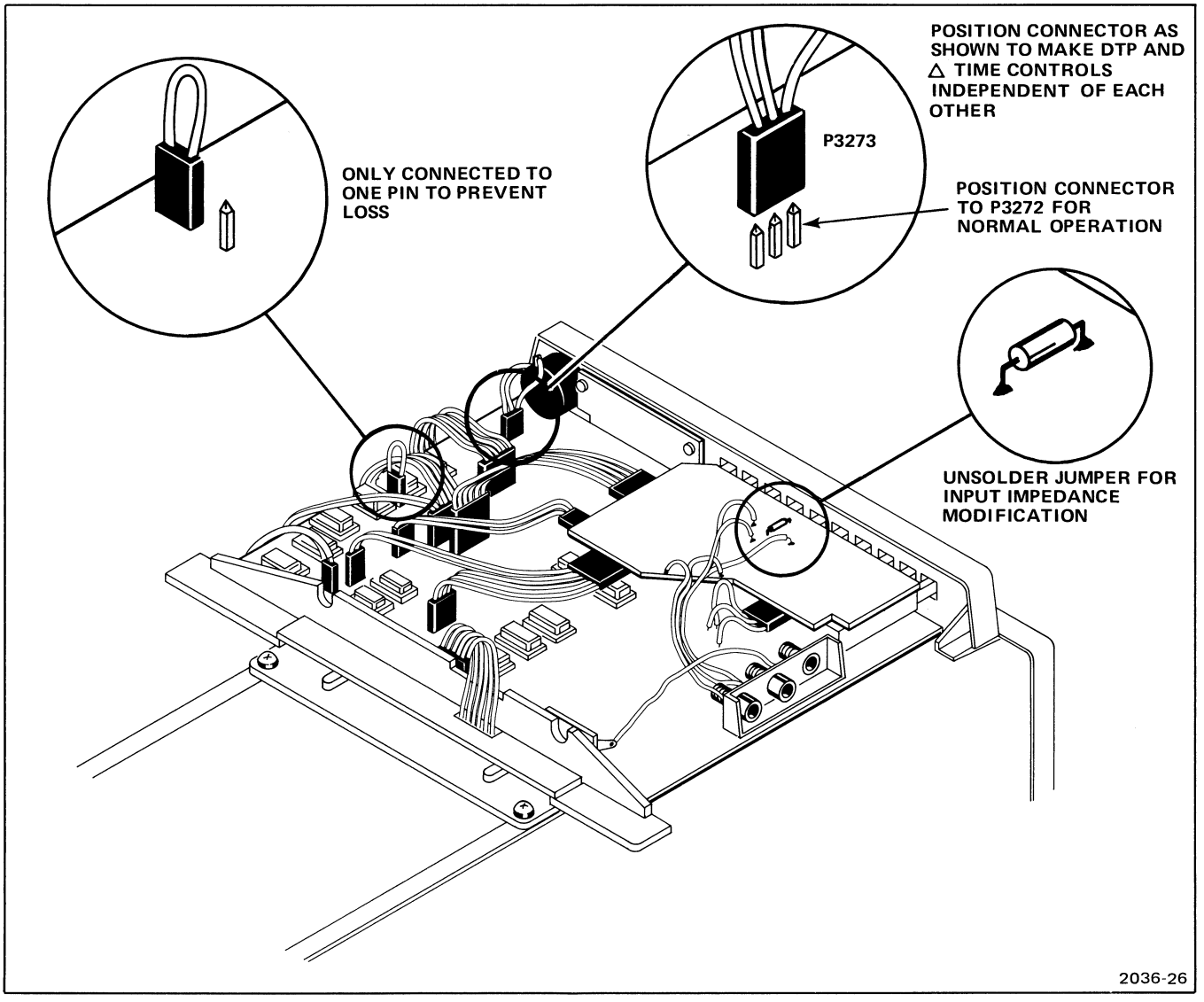


Figure 5-2. User modification.

DELAY TIME POSITION CONTROL MODIFICATION

Normally, the DELAY TIME POSITION (DTP) control moves both the reference point and the measurement point. However, using the following procedure, you can modify the DM44 so the DTP control moves only the reference point.

1. Remove the DM44 cover (see Cabinet Removal).

2. Disconnect the connector from P3272 and connect it to P3273 (see Figure 5-2).

3. Disconnect P3277. To prevent loss of the two-pin connector, connect it to only one of the pins of P3277.

PREVENTIVE MAINTENANCE

The preventive maintenance information in the oscilloscope Service Manual also applies to the DM44 and will not be repeated here.

TROUBLESHOOTING

Troubleshooting consists of locating the source of a malfunction. When you locate the problem, see Corrective Maintenance for component replacement and disassembly information.

RECOMMENDED TEST EQUIPMENT

The following test equipment is useful in troubleshooting the DM44.

1. Digital multimeter such as another DM44, a Tektronix DM501, or a Tektronix DM502.

2. Test oscilloscope such as a Tektroinx 465 portable oscilloscope or a Tektronix 464 portable storage oscilloscope.

TROUBLESHOOTING AIDS

Circuit Description

An understanding of circuit operation is necessary when troubleshooting. See the Circuit Description in Section 4 of this manual. To locate the discussion of the circuit you suspect, see the Table of Contents at the front of this manual.

Diagrams

Schematic diagrams of the DM44 circuitry are located in the pullout pages at the end of this manual.

Voltages and Waveforms

Typical voltages are given on each diagram. These are typical values and may vary between instruments. Typical waveforms are shown on the page opposite the diagram. These are typical waveforms and may vary slightly from instrument to instrument. Each waveform is numbered. The source of the waveform is indicated on the diagram and on the circuit-board illustration by this number.

Circuit Board Illustrations

Opposite each diagram is a circuit-board illustration. This illustration shows the physical location of each component on the corresponding diagram that is located on a circuit board.

Troubleshooting Chart

The troubleshooting chart is an aid in localizing a circuit problem. The troubleshooting chart is located in the Diagrams section at the rear of this manual.

CORRECTIVE MAINTENANCE

Corrective maintenance consists of obtaining and installing replacement parts.

OBTAINING REPLACEMENT PARTS

Standard Parts

All electrical and mechanical part replacements for this instrument can be obtained through your local Tektronix Field Office or representative. However, many of the standard electronic components may be available locally in less time. Before purchasing or ordering replacement parts, check the parts list for value, tolerance, rating and description.

NOTE

Physical size and shape of a component may affect instrument performance. Always use direct replacement components, unless you know that a substitute will not degrade instrument performance.

Special Parts

In addition to the standard electronic components, some special components are used in this instrument. Some are manufactured or selected by Tektronix, Inc. to meet specific performance requirements. Others are manufactured for Tektronix, Inc. according to our specifications (see Cross Index Manufacturers Code Number to Manufacturer in the Electrical Parts List for code numbers). Most of the mechanical parts used in this instrument have been manufactured by Tektronix, Inc. Order all special parts directly from your local Tektronix Field Office or representative.

Ordering Parts

When ordering replacement parts from Tektronix, Inc., include all of the following information to ensure receiving the proper parts.

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

DISASSEMBLY PROCEDURES

DM44—Oscilloscope Separation

Use the following procedure to disconnect the DM44 from the oscilloscope.

1. Disconnect the instrument from the power source.
2. Remove the instrument covers (see Cabinet Removal).
3. After making note of their location to aid reassembly, disconnect:

   P3201
   P3276
   P3306
   P3255
   P3215

4. Remove two screws from the rear of the DM44 (see Figure 5-3).
5. Slide the DM44 toward the rear of the oscilloscope. While guiding the ribbon cable through the hole at the rear of the DM44, lift the DM44 away from the oscilloscope (see Figure 5-3).

Front Panel Removal

Use the following procedure to remove the DM44 front panel.

1. Disconnect the instrument from the power source.
2. Separate the DM44 from the oscilloscope (see previous procedure).

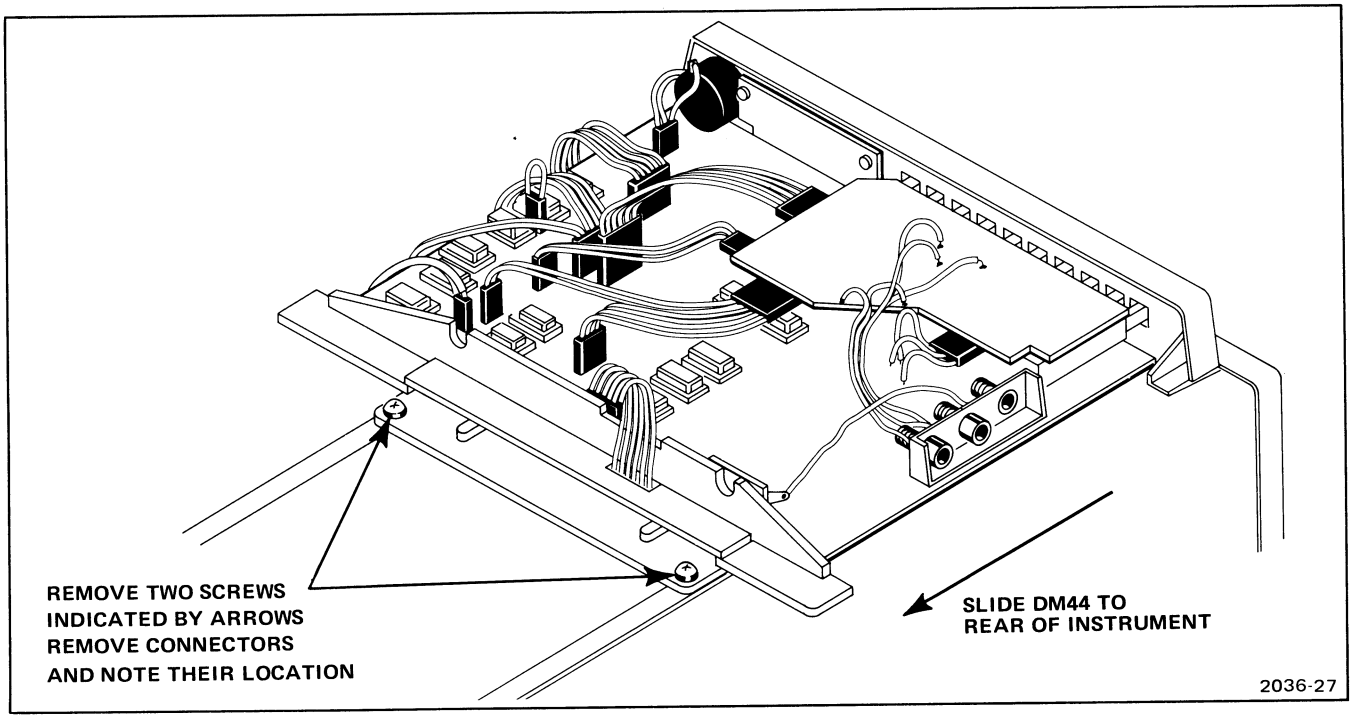


Fig. 5-3. DM44-Oscilloscope separation.

3. Remove the three screws from the bottom of the main board (near the front of the DM44).

4. Making note of its location to aid reassembly remove the connector from P3272 or P3273. It may be connected in either position depending on the DELAY TIME POSITION control mode of operation (see User Modification).

5. Carefully pull the front panel and main board apart. When reinstalling the front panel, carefully align the pins on the readout board with the connector on the main board.

Readout Board Removal

Use the following procedure to remove the readout board.

1. Disconnect the instrument from the power source.

2. Remove the DM44 front panel (see previous procedure).

3. Remove the two screws from the readout board.

4. Pull the readout board away from the front panel.

DM44 Power Supply Assembly Removal

Use the following procedure to remove the DM44 power supply assembly from the oscilloscope.

1. Disconnect the instrument from the power source.

2. Remove the instrument covers (see Cabinet Removal).

3. Unsolder five wires from the power transformer (see Figure 5-4).

4. Remove one screw from near the power transformer (see Figure 5-4).

5. Disconnect P3476 (near the back of the main board). Guide the ribbon cable through the hole in the mounting bracket.

6. Remove two screws from the power supply chassis.

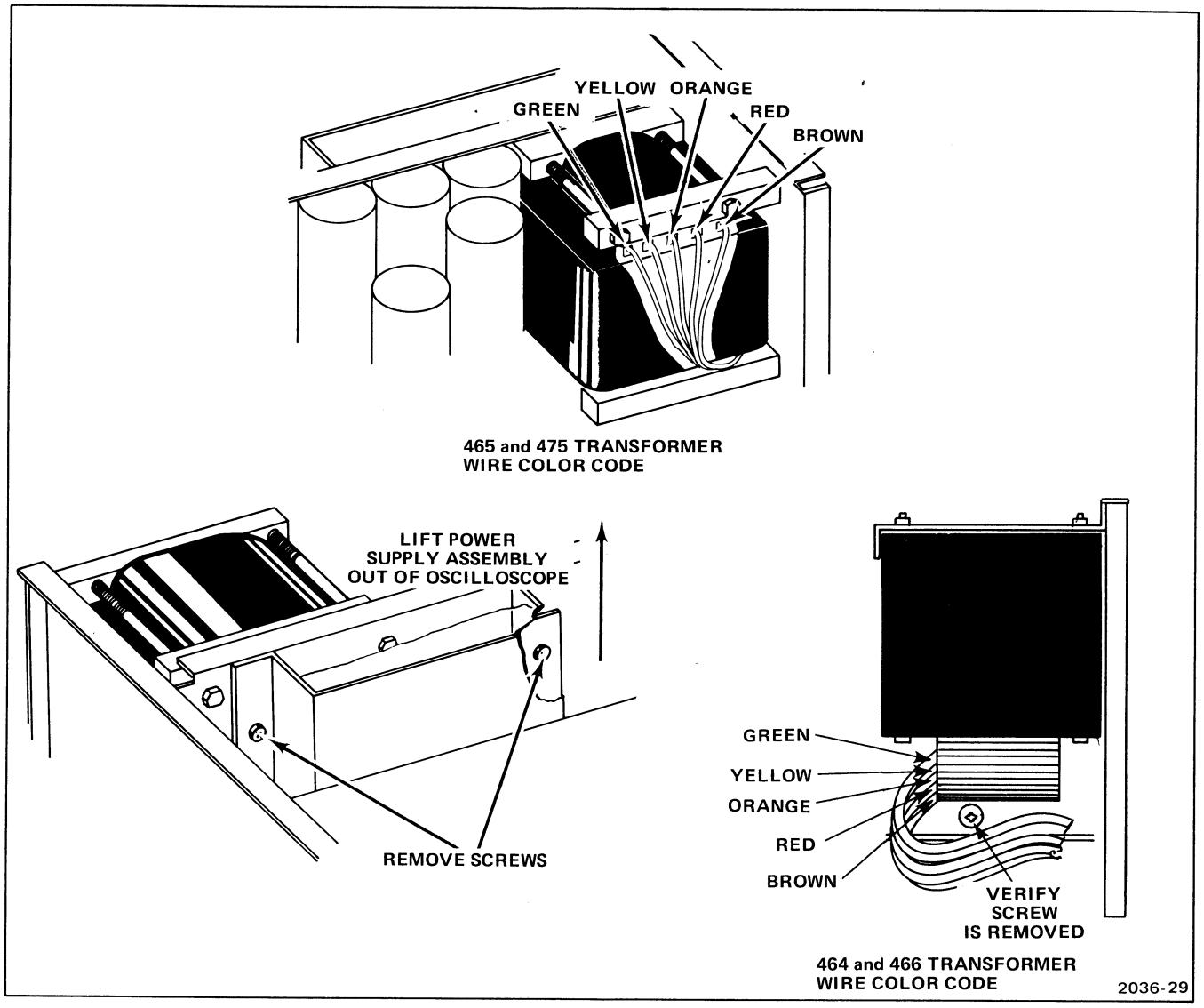


Fig. 5-4. DM44 Power Supply assembly removal.

7. While guiding the five-wire ribbon cable through the chassis, lift the DM44 power supply assembly away from the oscilloscope.

CALIBRATION

Since the TIME and 1/TIME functions of the DM44 affect the way you calibrate the oscilloscope horizontal system, therefore both the DM44 and the oscilloscope horizontal system are calibrated here. Perform these procedures in place of the horizontal system procedure in the oscillsocope Service manual.

There are three separate procedures given here. The first is for the DM44 only. The second is for the 464, 465, or 466 horizontal system. Perform the DM44 procedure first then the appropriate horizontal system procedure.

These procedures can be made shorter by performing only the ADJUST steps (skip the CHECK steps). You should do this only if you are performing a periodic routine maintenance procedure and are certain there are no malfunctions.

TEST EQUIPMENT REQUIRED

The test equipment listed in Table 6-1 is required to perform a complete calibration procedure. Table 6-2 lists the additional test equipment required to perform the 475 horizontal system procedure.

The specifications given for the test equipment are the minimum necessary for accurate results. Detailed operating instructions for the test equipment are not given here. See the appropriate instruction manual if more information is needed.

LIMITS AND TOLERANCES

The limits and tolerances given in these procedures are for the DM44 and oscilloscope under test. The possible inaccuracy of associated test equipment is not taken into consideration. Be sure to take this into account, especially if test equipment other than that recommended is used.

TABLE 6-1
Test Equipment Required

Description	Minimum Specifications	Use	Example
Digital Voltmeter	Range, 0 to 150 V; voltage accuracy, within 0.15%; display, 4½ digits.	DM44 Reference current adjustment. 475 horizontal centering adjustment.	Tektronix DM501 Digital Multimeter.
Test Oscilloscope	Bandwidth, 1 MHz; deflection factor, 1 volt/div; accuracy, within 3%.	A TRIG HOLDOFF check. 475 timing adjustment.	Tektronix 475 Portable Oscilloscope Tektronix 465 Portable Oscilloscope
Time-Mark Generator	Marker outputs, 2 ns to 0.5 s; marker accuracy, within 0.1%; trigger output, 1 ms to 0.1 μs coincident with time markers.	Horizontal timing checks and adjustments.	Tektronix TG501* Time-Mark Generator
Voltage Standard	Voltage range, 10 mV to 1.2 kV; accuracy, within 0.01%.	DM44 VOLTS Function checks and adjustments	Fluke, Model 341A DC Voltage Calibrator.
Resistance Standard	Ohms range, 10 Ω to 18 MΩ accuracy, within 0.03%.	DM44 OHMS Function	ESI. Dekabox, Model DB62.

***Requires TM-Series power module.**

TABLE 6-1 (continued)
Test Equipment Required

Description	Minimum Specifications	Use	Example
Termination (1 required)	Impedance, 50 Ω; connectors, BNC.	Signal termination	Tektronix Part Number 011-0049-01
Cable (1 required)	Impedance, 50 Ω; connectors, BNC; length, any convenient.	Signal interconnection	Tektronix Part Number 012-0057-01
Light Shield	Folding viewing hood for oscilloscope.	To shield ambient light when measuring delay jitter.	For 464 and 466; Tektronix Part Number 016-0592-00. For 465 and 475; Tektronix Part Number 016-0180-00.
Temperature Equalizing Block		Temp (°C) Function adjustment.	See Figure 6-2.
Oil Testing Thermometer	Range 0°C to 125°C; accuracy, within 1/5°C	TMEP (°C) Function	ASTM 67C, Nurnberg Catalog Number 5790.
Temperature Bath and Bath Cooler	Range 0°C to 125°C	TEMP (°C) Function adjustment (alternate method)	Neslab Instruments Model TE 9/100 Stired Bath and Model PBC-4 Bath Cooler.
Shorting Strap	Banana to banana patch cord.	Zero check.	

TABLE 6-2
Additional Test Equipment Required For 475

Description	Minimum Specifications	Use	Example
Current Probe	Sensitivity, 1 mA/m V; bandwidth, at least 8.5 kHz to 100 MHz	Major recalibration of high-speed timing	P6022 ac current probe.
Amplitude Calibrator	Amplitude accuracy, within 0.25%; signal amplitude 2 mV to 20 V; output signal, 1 kHz square wave.	X Gain adjustment	Tektronix PG506 Calibration Generator*
Sine-Wave Generator	Frequency, 350 kHz to above 200 MHz; output amplitude, variable from 15 mV to 4 V, p-p; output impedance, 50 ohms; reference freqeuncy, 50 kHz to 350 kHz; amplitude accuracy, constant within 1% of amplitude at reference frequency as output frequency changes.	X-Y bandwidth check	Tektronix SG503 Leveled Sine-Wave Generator.
500 MHz Filter	Impedance, 50 ohms, frequency adjustable; connectors, BNC.	Magnified timing checks and adjustment	Tektronix 500 MHz Filter. 067-0684-00 Calibration Fixture.

***Requires TM-Series power module.**

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DM44 PROCEDURE

See ADJUSTMENT LOCATIONS pull-out page for adjustments and test points (TP).

1. ADJUST REFERENCE CURRENT (R3031)

a. Set

DM44 FUNCTION	VOLTS
DM44 RANGE	20 V
A and B TIME/DIV	1 ms
INTENSITY	Fully ccw (off)

b. Turn oscilloscope power on.

c. Connect test DMM (Digital Multimeter) between TP3030 and TP3031.

d. **ADJUST**—R3031 for a test DMM reading of 4.71 volts.

e. Disconnect test DMM.

2. ADJUST 2 V (R3155) AND ZERO (C3164)

WARNING

Dangerous voltages are present from the voltage standard and the DM44 input connectors when checking the high-voltage ranges (200 V and 1.2 kV). Reduce the voltage standard output or place on standby when not actually measuring.

a. Connect voltage standard positive (+) output to the red DM44 input and the common (—) output to the black input.

b. Set DM44 RANGE to 2 V.

c. Set voltage standard

Range	10 V
output	1.80000 volts
Current Limit	to about 10 o'clock
Function	METER VOLTAGE
Polarity	+

d. **ADJUST**—R3155 for a DM44 reading of 1.800.

e. Set voltage standard POLARITY to —.

f. If DM44 reading is —1.800, move on to step 3. If not continue with part g of this step.

g. While switching voltage standard polarity between + and —,

ADJUST—R3164 (SN B030601-UP) or C3164 (SN B010100-B030600) for the same DM44 reading in both + and — settings of voltage standard POLARITY. Ignore the DM44 minus indication.

h. Set voltage standard POLARITY to +.

i. **READJUST**—R3155 for a DM44 reading of 1.800.

j. Repeat parts e through i until a DM44 reading of 1.800 is obtained in both + and — settings of voltage standard POLARITY. Neglect DM44 minus indication.

k. Set voltage standard to standby and disconnect from DM44 inputs.

3. CHECK ZERO

a. Connect a shorting strap between the red and black inputs of the DM44.

b. **CHECK**—DM44 reading is 0.000 ± one count.

c. Disconnect shorting strap.

4. ADJUST 200 mV (R3140)

a. Reconnect voltage standard to DM44 inputs.

b. Set DM44 RANGE to 200 mV.

c. Set voltage standard output to 0.18000 and POLARITY to +.

d. **ADJUST**—R3140 for a DM44 reading of 180.0.

5. CHECK VOLTS ACCURACY

a. Set DM44 RANGE and voltage standard output according to Table 6-3.

b. **CHECK**—DM44 reading is within the limits given in Table 6-3.

c. Disconnect voltage standard from DM44.

TABLE 6-3
VOLTS Accuracy

DM44 RANGE	Voltage Standard	Readout Limits
1.2 kV	1.2 kV	1.198 to 1.202
1.2 kV	180.0 V	0.179 to 0.181
200 V	180.0 V	179.7 to 180.3
200 V	18.00 V	017.9 to 018.1
20 V	18.00 V	17.97 to 18.03
20 V	1.800 V	01.79 to 01.82
2 V	1.800 V	1.797 to 1.803
2 V	0.1800 V	0.179 to 0.181
200 mV	0.1800 V	179.7 to 180.3
200 mV	0.0100 V	009.9 to 010.1

6. ADJUST OHMS (R3047 and R3007)

a. Connect resistance standard to DM44 inputs.

b. Set

DM44 FUNCTION	OHMS
DM44 RANGE	20 kΩ

c. Set resistance standard to 18.00 kΩ.

d. **ADJUST**—R3047 for a DM44 reading of 18.00.

e. Set DM44 RANGE to 2 kΩ.

f. Set resistance standard to 1.80 kΩ.

g. **ADJUST**—R3007 for a DM44 reading of 1.800.

h. Set DM44 RANGE to 200 Ω.

i. Set resistance standard to 180 Ω.

j. **CHECK**—DM44 reading is 180.0.

k. If reading noted in part j is not 180.0, repeat parts e through k for the best compromise between the 2 kΩ and 200 Ω settings of the RANGE switch.

7. CHECK OHMS ACCURACY

a. Set resistance standard and DM44 range according to Table 6-4.

b. **CHECK**—DM44 reading is within the limits given in Table 6-4.

TABLE 6-4
OHMS Accuracy

DM44 RANGE	Resistance Standard	Readout Limits[2]
200 Ω	10 Ω	009.9 to 010.1[1]
200 Ω	180 Ω	179.5 to 180.5
2 kΩ	180 Ω	0.179 to 0.181
2 kΩ	1.8 kΩ	1.795 to 1.805
20 kΩ	1.8 kΩ	01.79 to 01.81
20 kΩ	18 kΩ	17.95 to 18.05
200 kΩ	18 kΩ	017.9 to 018.1
200 kΩ	180 kΩ	179.5 to 180.5
2 MΩ	180 kΩ	0.179 to 0.181
2 MΩ	1.8 MΩ	1.795 to 1.805
20 MΩ	1.8 MΩ	01.79 to 01.81
20 MΩ	11 MΩ	10.96 to 11.04

[1] When measuring 10 Ω and 180 Ω, lead resistance may add up to 0.3 Ω to the reading. If in doubt, short the leads together and note the DM44 reading. Add this value to the 10 Ω reading.

[2] Accuracy: 200 Ω and 2 kΩ ranges; within 0.25% + probe resistance ± one count 20 kΩ, 200 kΩ, and 2 MΩ ranges; within 0.25% ± one count 20 MΩ range; 0.3% ± one count.

c. Disconnect resistance standard from DM44 inputs.

NOTE

If you have a DM44 Option 1, skip step 8. Move on to the Horizontal System procedure which matches your oscilloscope.

8. ADJUST TEMPERATURE (R3083 and R3095)

a. Connect Temperature Probe to DM44 TEMP input.

b. Set DM44 FUNCTION to TEMP °C.

CAUTION

When submerging the Temperature Probe, keep the level of the liquid below the bulge in the probe body (see Figure 6-1).

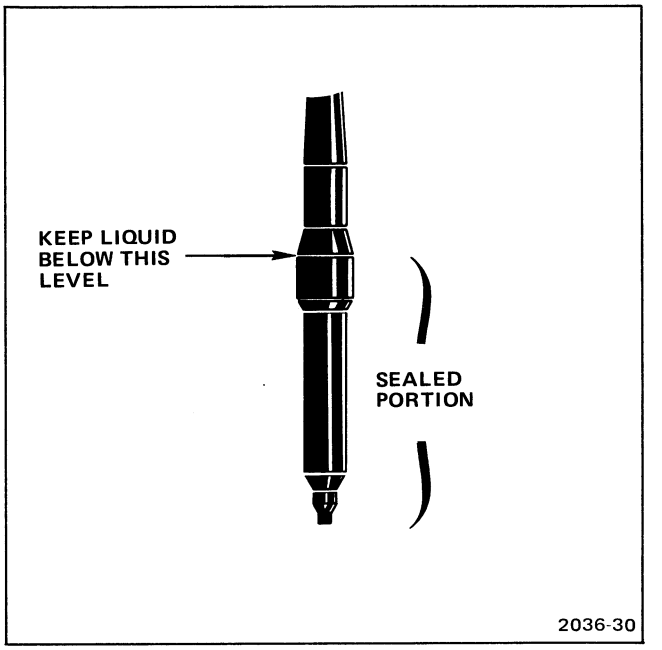


Fig. 6-1. Sealed portion of temperature probe.

c. Suspend Temperature Probe and reference thermometer in a container (preferrably insulated) of water and crushed ice. Let enough ice melt to stabilize water temperature.

ALTERNATE METHOD

Suspend Temperature Probe and reference thermometer in a water and antifreeze solution in a circulating bath (see Table 6-1 for recommended type).

d. **ADJUST**—R3083 so DM44 reading matches reference thermometer reading.

e. Remove Temperature Probe and reference thermometer from solution and place in temperature-equalizing block (see Figure 6-2) at room temperature. Use dielectric fluid (see note in Figure 6-2).

f. Let Temperature Probe and reference thermometer temperature stabilize.

g. **ADJUST**—R3095 so DM44 reading matches reference thermometer reading.

h. There may be some interaction between the adjustments made by R3083 and R3095. Repeat parts c through g as necessary.

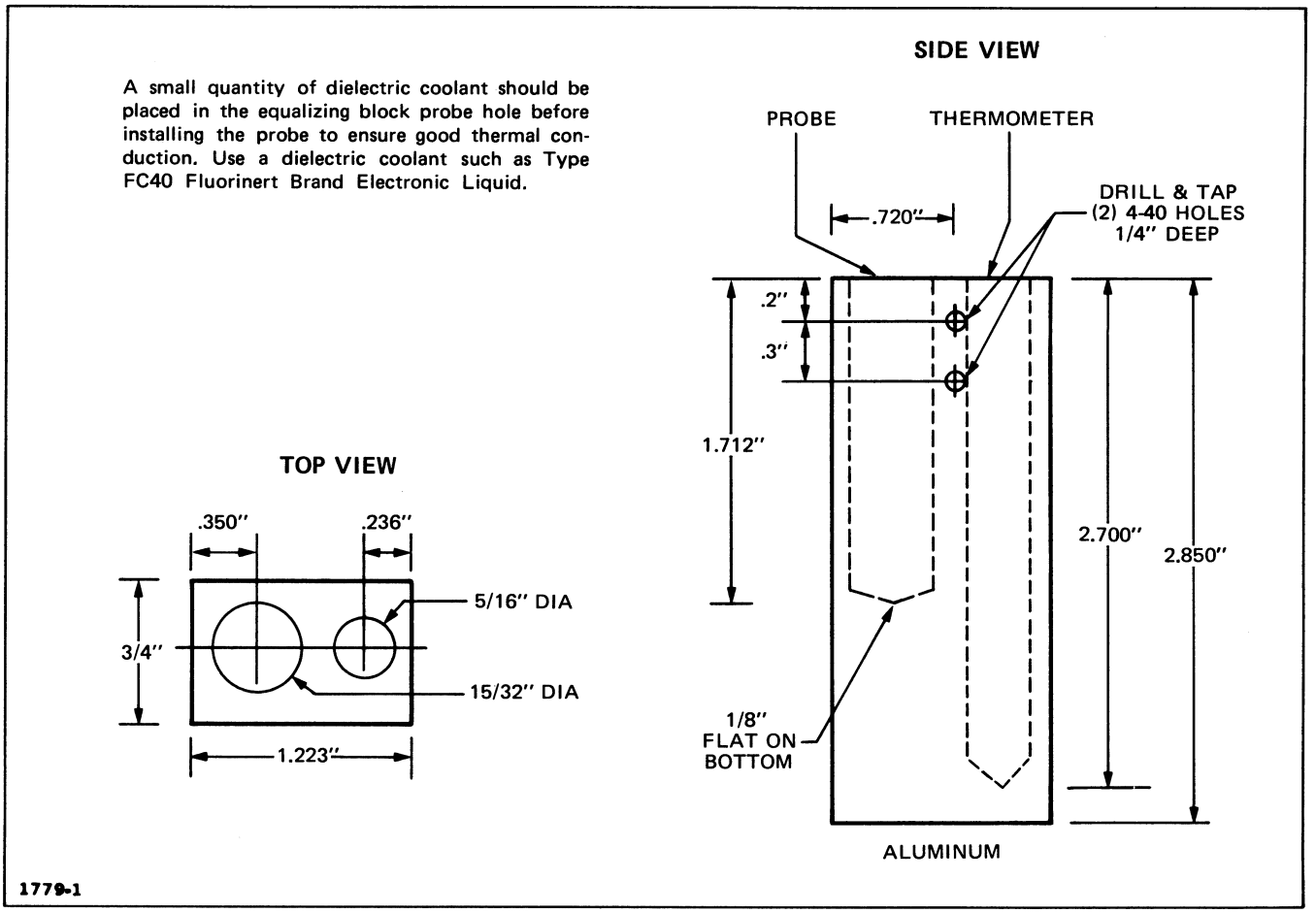


Fig. 6-2. Temperature probe equalizing block.

464, 465, 466 HORIZONTAL SYSTEM

See ADJUSTMENT LOCATIONS pull-out page for adjustments and test points (TP).

This procedure replaces the 464, 465, or 466 Horizontal System Calibration procedures in the oscilloscope service manual. If your DM44 is attached to a 475 or 475A oscilloscope, perform the procedure following this one.

PRELIMINARY CONTROL SETTINGS

Display

REDUCED SCAN (466 only)	Off (push INTEN in)
INTEN	As desired
FOCUS	As desired
SCALE ILLUM	As desired

Vertical (CH 1 and CH 2)

VERT MODE	CH 1
POSITION	Midrange
VOLTS/DIV	.5 V
VAR VOLTS/DIV	Calibrated detent
AC-GND-DC	DC
INVERT	Normal (button out)
20 MHz BW (PULL)	Full bandwidth (push in, then release; shows no yellow)

Storage

NON STORE	On (button in)
STORAGE LEVEL	NORM
SAVE INTEN	Midrange
SAVE	Off (button out)
VIEW TIME	NORM

Trigger (A and B)

COUPLING	AC
LEVEL	As needed for triggered display
SLOPE	+
A TRIGGER SOURCE	NORM
B (DLY'D) TRIGGER SOURCE	STARTS AFTER DELAY
TRIG MODE	AUTO
A TRIG HOLDOFF	NORM

Sweep (A and B)

HORIZ DISPLAY	A INTEN
A TIME/DIV	1 ms
B TIME/DIV	.5 μs
VAR TIME/DIV	Calibrated detent
DELAY TIME POSITION	CCW
X10 MAG	Off (button out)
POSITION (horizontal)	As needed
FINE	As needed

DM44

FUNCTION	VOLTS
RANGE	2 V

1. ADJUST SWEEP START AND STOP (R1115 and R1145)

a. Connect time mark generator to CH 1 input through a 42-inch, 50-ohm BNC cable.

b. Set time mark generator for 1 ms time markers.

c. Verify exactly one time marker per division. If not, adjust R1237 (465) or R1257 (464 and 466) for exactly one time marker per division.

d. Set time mark generator for 0.1 ms time markers (10 markers per division).

e. Set DELAY TIME POSITION (DTP) fully counter-clockwise.

f. **ADJUST**—R1115 to intensify the second time marker (see Figure 6-3).

g. Horizontally position intensified time marker to first horizontal graticule line (see Figure 6-3).

h. Set DTP fully clockwise.

i. **ADJUST**—R1145 to intensify 102nd time marker at far right graticule line (see Figure 6-3).

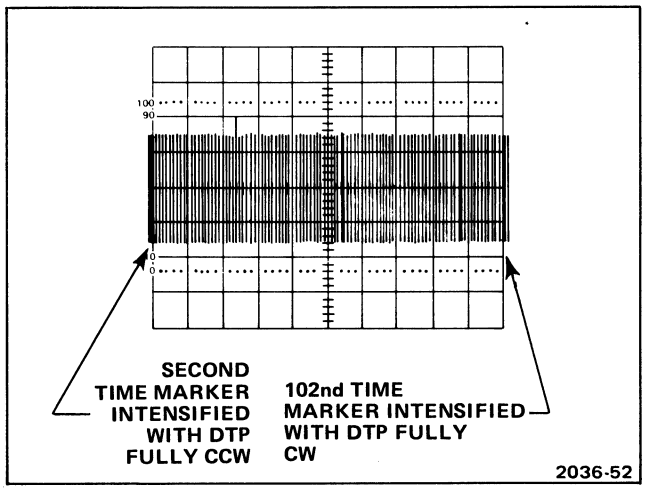


Fig. 6-3. Sweep start and stop adjustment (464, 465, or 466).

j. Due to interaction, repeat parts e through i until no further adjustment is needed.

2. ADJUST X1 HORIZONTAL GAIN R1237 R1257 (464 or 466)

a. Set

HORIZ DISPLAY	A
A and B TIME/DIV	1 ms

b. Set time mark generator for 1 ms time markers.

c. **ADJUST**—R1237 (465) or R1257 (464 or 466) for one time mark per division over entire ten divisions.

3. ADJUST X10 HORIZONTAL GAIN R1238 (465) R1253 (464 or 466)

a. Set X10 MAG to X10 (in).

b. Set time mark generator for 0.1 ms time markers.

c. **ADJUST**—R1238 (465) or R1253 (464 or 466) for one time mark per division over entire ten divisions displayed.

4. ADJUST MAGNIFIER REGISTRATION R1225 (465) R1255 (464 or 466)

a. Set time mark generator for 5 ms time markers.

b. Set X10 MAG to X10 (in).

c. Horizontally position center time marker to center vertical graticule line.

d. Set X10 MAG to X1 (out).

e. **ADJUST**—R1225 (465) or R1255 (464 or 466) to move the center time marker back to the center vertical graticule line.

f. Repeat parts b through e until no more adjustment is needed.

5. ADJUST B SWEEP CAL (R1175)

a. Set

DTP	Fully counterclockwise
B Trigger COUPLING	AC
B Trigger SOURCE	NORM
A TIME/DIV	2 ms
B TIME/DIV	1 ms
HORIZ DISPLAY	B DLY'D

b. Set time mark generator for 1 ms time markers.

c. **ADJUST**—R1175 for one time marker per division over entire ten divisions.

6. CHECK A SWEEP LENGTH

a. Set

A and B TIME/DIV	1 ms
HORIZ DISPLAY	A

b. **CHECK**—A sweep length is 10.5 to 11.5 divisions.

7. CHECK A VAR RANGE

a. Set

A and B TIME/DIV	2 ms
A VAR	Fully counterclockwise

b. Set time mark generator for 5 ms time markers.

c. **CHECK**—Distance between adjacent time markers is one division or less.

8. CHECK HORIZONTAL POSITION RANGE

a. Set Horizontal POSITION fully clockwise.

b. **CHECK**—Left end of display is to the right of the center vertical graticule line.

c. Set Horizontal POSITION fully counterclockwise.

d. **CHECK**—Right end of display is to the left of the center vertical graticule line.

9. ADJUST TIME (R3287), 1/TIME (R3033), AND 1/TIME LINEARITY (C3162)

a. Set

HORIZ DISPLAY	A INTEN
A TIME/DIV	.2 ms
B TIME/DIV	2 μs
B Trigger COUPLING	DC
B Trigger SOURCE	STARTS AFTER DLY

b. Set time mark generator for 0.1 ms time markers.

c. Set DTP to intensify the third time marker.

d. Set DM44 FUNCTION to TIME.

e. Set Δ TIME so measurement point intensifies the nineteenth time marker.

f. Set HORIZ DISPLAY to B DLY'D.

g. Set Δ TIME to superimpose displayed time markers.

h. **ADJUST**—R3287 for a DM44 reading of 1.600.

i. Set DM44 FUNCTION to 1/TIME.

j. Verify the displayed time markers are still superimposed.

k. **ADJUST**—R3033 for a DM44 reading of 0.625.

l. Set

DM44 FUNCTION	TIME
HORIZ DISPLAY	A INTEN

m. Set Δ TIME to intensify the fourth time marker (two adjacent time markers separated by one half division should now be intensified).

n. Set HORIZ DISPLAY to B DLY'D.

o. Set Δ TIME to superimpose displayed time markers. Neglecting tolerances, the DM44 reading should be .1000.

p. Set DM44 FUNCTION to 1/ TIME.

NOTE

C3162 is a selectable part. It may have been removed. See the Electrical Parts List in Section 8 of this manual.

q. **ADJUST**—R3162 (SN B030601-UP) or C3162 (SN B010100-B030600) for a DM44 reading of 10.00.

10. CHECK Δ TIME RANGE

NOTE

This check requires the Δ TIME and DTP controls operate in the normal (tracking) mode. To ensure this, verify the following:
1. Jumper plug is connected to P3277.
2. Connect the end of the wires from the Δ TIME control is connected to P3272.

a. Set

HORIZ DISPLAY	A INTEN
A TIME/DIV	.2 ms
B TIME/DIV	1 μs
DM44 FUNCTION	TIME
Δ TIME	Fully ccw
DTP	Fully ccw

b. **CHECK**—By adjusting the Δ TIME control clockwise, the two intensified zones can be positioned at least 10 divisions apart.

c. Set DTP fully counterclockwise.

d. **CHECK**—By adjusting the Δ TIME control clockwise, the two intensified zones can be positioned at least 10 divisions apart.

e. Set DTP and Δ TIME controls so both intensified zones are near the center of the crt.

f. **CHECK**— DTP control moves both intensified zones.

g. **CHECK**—Δ TIME control moves only one intensified zone.

11. CHECK INDEPENDENT Δ TIME AND DTP CONTROL OPERATION

a. Remove the jumper connector from P3277.

b. Move the connector from P3272 to P3273.

c. **CHECK**—Adjusting the DTP control moves only one intensified zone and adjusting the Δ TIME control moves the other intensified zone.

d. Set DTP fully counterclockwise.

e. **CHECK**—By adjusting the Δ TIME control, the two intensified zones can be positioned at least 10 divisions apart.

f. Set connectors for desired mode of operation. As they are now connected for independent mode or as in the note at the beginning of step 9 for tracking mode.

12. CHECK AUTORANGING

a. Set

A TIME/DIV	1 ms
B TIME/DIV	20 μs

b. **ADJUST**—DTP so reference point intensifies the second time marker.

c. **ADJUST**—Δ TIME to superimpose both intensified zones.

d. Slowly turn the Δ TIME control clockwise and

CHECK—That the DM44 upranges when the reading reaches 2.000 (the reading shifts from 2.000 to 02.00).

e. Slowly turn the Δ TIME control counterclockwise and

CHECK—That the DM44 downranges when the reading reaches 01.00 (the reading shifts to 1.000).

13. CHECK TIME AND 1/TIME LINEARITY

a. Set

DM44 FUNCTION	TIME
HORIZ DISPLAY	A INTEN
A TIME/DIV	1 ms
B TIME/DIV	5 μs
Δ TIME	Fully clockwise

b. Set time-mark generator for 1 ms time markers.

c. Adjust the DTP control so the reference point intensifies the second time marker.

d. Adjust the Δ TIME control so the measurement point intensifies the third time marker (one division separating points).

e. Set HORIZ DISPLAY to B DLY'D and adjust the Δ TIME control to superimpose the displayed time markers. Readjust the DTP control if necessary to center the display.

f. **CHECK**—DM44 reading is within the limits given in Table 6-5.

g. Adjust the Δ TIME control clockwise to move the next time marker into the display.

h. Repeat parts e through g until the accuracy at the tenth time marker has been checked (eight divisions separating points).

TABLE 6-5
TIME Linearity

Distance Between Point (Divisions)	DM44 Reading[1] Limits For Time
1	0.989 to 1.011
2	1.979 to 02.03*
3	02.96 to 03.04
4	03.95 to 04.05
5	04.94 to 05.06
6	0.593 to 06.07
7	06.92 to 07.08
8	07.91 to 08.09

***Autoranging shifts decimal point.**
[1] TIME accuracy is within 1%, ± one count.

i. Set HORIZ DISPLAY to A INTEN.

j. Turn DTP clockwise so reference point intensifies the tenth time marker.

k. Turn Δ TIME counterclockwise so the measurement point intensifies the second time marker.

l. Set HORIZ DISPLAY to B DLY'D and adjust Δ TIME to superimpose the displayed time markers.

m. **CHECK**—DM44 reading is –07.91 to –08.09.

n. Set DM44 FUNCTION to 1/TIME.

o. Verify displayed time markers are still superimposed.

p. **CHECK**—DM44 reading is –.1224 to –.1274.

q. Set HORIZ DISPLAY to A INTEN.

r. Turn Δ TIME clockwise so measurement point intensifies the ninth time marker (one division separating intensified zones).

s. Set HORIZ DISPLAY to B DLY'D and adjust Δ TIME to superimpose the displayed time markers.

t. **CHECK**—DM44 reading is –0.979 to –1.021.

u. Set

HORIZ DISPLAY	A INTEN
Δ TIME	Fully clockwise
DTP	To intensify the second time marker

v. Turn Δ TIME counterclockwise to intensify the tenth time marker.

w. Set HORIZ DISPLAY to B DLY'D and adjust Δ TIME to superimpose the displayed time markers.

x. **CHECK**—DM44 reading is .1224 to .1274.

14. CHECK DELAY JITTER

Delay jitter is checked at the worst case, but still usable, settings of the A TIME/DIV and B TIME/DIV switches. This results in a display that is hard to see. To make the display more visible, reduce ambient light as much as possible and use a viewing hood.

a. Set

A TRIG MODE	AUTO
A TIME/DIV	1 ms
B TIME/DIV	.2 μs
HORIZ DISPLAY	A INTEN
DM44 FUNCTION	VOLTS
X10 MAG	OUT (X1)

b. Set time mark generator for 1 ms time markers.

c. Adjust the DTP control to intensify the ninth time marker.

d. Set HORIZ DISPLAY to B DLY'D and adjust the DTP control to center the displayed time marker.

e. **CHECK**—Horizontal jitter is one division or less (2.5 divisions or less if operating from a 50 Hz power source). Disregard the slow drift.

NOTE

For 464 and 466, skip parts f through i. Setting the DM44 to TIME reduces repetition rate of the pulse display making the pulse nearly impossible to see on the storage crt.

f. Set

HORIZ DISPLAY	A INTEN
DM44 FUNCTION	TIME
DTP	Fully counterclockwise

g. Adjust the Δ TIME control to intensify the ninth time marker.

h. Set HORIZ DISPLAY to B DLY'D and adjust the Δ TIME control to center the displayed time marker.

i. **CHECK**—Horizontal jitter is one division or less (2.5 divisions or less if operating from a 50 Hz power source). Disregard the slow drift.

15. ADJUST 20 μs TIMING (C1136)

a. Set

A TIME/DIV	20 μs
B TIME/DIV	.2 μs
HORIZ DISPLAY	A INTEN
DTP	Fully counterclockwise
DM44 FUNCTION	TIME

b. Set time mark generator for 10 μs time markers.

c. **ADJUST**—C1136 for two time markers per division over entire ten divisions.

d. Set DTP so reference point intensifies the third time marker.

e. Set Δ TIME so measurement point intensifies the nineteenth time marker.

f. Set HORIZ DISPLAY to B DLY'D.

g. Set Δ TIME for a DM44 reading of 160.0.

h. **ADJUST**—C1136 to superimpose displayed time markers.

16. ADJUST .2 μs TIMING (C1137)

a. Set

A TIME/DIV	.2 μs
B TIME/DIV	.05 μs
HORIZ DISPLAY	A

b. Set time mark generator for .1 ms time markers.

c. **ADJUST**—C1137 for two time markers per division over entire ten divisions.

d. Set HORIZ DISPLAY to A INTEN.

e. Set DTP so reference point intensifies the third time marker.

f. Set Δ TIME so measurement intensifies the seventeenth time marker.

g. Set

HORIZ DISPLAY	B DLY'D
X10 MAG	X10 (in)

h. Set Horizontal POSITION so time markers are in the display area.

i. Set A LEVEL and A TRIG HOLDOFF as needed for a stable display.

j. Set Δ TIME for a DM44 reading of 1.400.

k. **ADJUST**—C1137 to superimpose displayed time markers.

17. ADJUST B SWEEP .1 μs TIMING (C1176)

a. Set

A and B TIME/DIV	.1 μs
DM44 FUNCTION	VOLTS
X10 MAG	X1 (out)
HORIZ DISPLAY	B DLY'D
DTP	Fully counterclockwise

b. Set time mark generator for .1 μs time markers.

c. **ADJUST**—C1167 for 1 time marker per division.

18. ADJUST HIGH-SPEED MAGNIFIED TIMING C1261 and C1281 (465) C1262 and C1265 (464 or 466)

a. Set

HORIZ DISPLAY	A
X10 MAG	X10 (in)
Horizontal POSITION	midrange
A and B TIME/DIV	.05 μs

b. Set time mark generator for 10 ns time markers.

c. Slightly readjust Horizontal POSITION to move the peak of the first displayed time mark to the center vertical graticule line.

d. **CHECK**—Peak of sixth displayed time marker is within 0.3 division (3%) of the tenth vertical graticule line.

e. **ADJUST**—If necessary, C1261 and C1281 (465) or C1262 and C1265 (464 or 466). Repeat parts c through e as necessary.

f. Set X10 MAG to X1 (out).

19. CHECK A AND B TIME/DIV ACCURACY

a. Using the settings given in Table 6-6,

CHECK—A TIME/DIV accuracy is within 3% (see Figure 6-4).

b. Set HORIZ DISPLAY to B.

c. Using the settings given in Table 6-6,

CHECK—B TIME/DIV accuracy is within 2% (see Figure 6-4.

NOTE

If 11 time markers are not visible when checking B TIME/DIV accuracy, set the A TIME/DIV one step slower than the B TIME/DIV switch.

EXAMPLE: *A TIME/DIV* *1 ms*
B TIME/DIV *0.5 ms*

TABLE 6-6
A and B TIME/DIV Accuracy

A and B Time/Div Settings	Time Mark Generator	Markers Displayed Per Div
.05 μs	50 ns	1
.1 μs	.1 μs	1
.2 μs	.1 μs	2
.5 μs	.5 μs	1
1 μs	1 μs	1
2 μs	1 μs	2
5 μs	5 μs	1
10 μs	10 μs	1
20 μs	10 μs	2
50 μs	50 μs	1
.1 ms	.1 ms	1
.2 ms	.1 ms	2
.5 ms	.5 ms	1
1 ms	1 ms	1
2 ms	1 ms	2
5 ms	5 ms	1
*10 ms	10 ms	1
*20 ms	10 ms	2
*50 ms	50 ms	1
	A Only	*
*.1 s	.1 s	1
*.2 s	.1 s	2
*.5 s	.5 s	1

***Set TRIG MODE to NORM.**

20. CHECK A AND B MAGNIFIED TIME/DIV ACCURACY

a. Set X10 MAG button to the in position.

b. Using the settings given in Table 6-7,

CHECK—A magnified TIME/DIV accuracy is within 3% (see Figure 6-4).

c. Set HORIZ DISPLAY to B DLY'D.

d. Using the settings given in Table 6-7,

CHECK—B magnified TIME/DIV accuracy is within 3% (see Figure 6-4).

TABLE 6-7
A And B Magnified TIME/DIV Accuracy

A and B Time/Div Settings	Time Mark Generator	Markers Displayed Per Div	Portions of[1] Total Length To Be Excluded
.05 μs	10 ns	1 2	1st and last 10 div
.1 μs	10 ns	1	1st and last 5 div
.2 μs	10 ns	2	1st and last 2.5 div
.5 μs	50 ns	1	
1 μs	.1 μs	1	
2 μs	.1 μs	2	
5 μs	.5 μs	1	
10 μs	1 μs	1	
20 μs	1 μs	2	
50 μs	10 μs	1	
.2 ms	10 μs	2	
.5 ms	50 μs	1	
1 ms	.1 ms	1	
2 ms	.1 ms	2	
5 ms	.5 ms	1	
10 ms	1 ms	1	
20 ms	1 ms	2	
50 ms	5 ms	1	
A Sweep Only			
.1 s	10 ms	1	
.2 s	10 ms	2	
.5 s	50 ms	1	

[1] To determine first portion to be excluded, release X10 MAG. Position sweep start to 1.5 divisions to left of graticule center line. Push X10 MAG—the first 10 divisions of sweep is magnified to the left and is off screen. To determine the last portion to be excluded on the 0.5 μs/div range, release X10 MAG. Position sweep stop 1.5 divisions to right of graticule center line. Push X10 MAG in—the last 50 ns of sweep is magnified to the right and is off screen.

21. CHECK TIME AND 1/TIME ACCURACY

a. Set

A TIME/DIV	.2 μs
B TIME/DIV	.05 μs
HORIZ DISPLAY	A INTEN
DM44 FUNCTION	TIME

b. Set time-mark generator for .1 microsecond time markers.

c. Adjust DTP so reference point intensifies the third time marker.

d. Adjust Δ TIME so the time-measurement point intensifies the 17th time marker.

e. Set HORIZ DISPLAY to B DLY'D and adjust Δ TIME to superimpose the displayed time markers.

f. **CHECK**—DM44 reading is 1.385 to 1.415 and the μs light is lit.

g. Set DM44 FUNCTION to 1/TIME.

h. **CHECK**—DM44 reading is 0.707 to 0.723 and the μs light is lit.

i. Set

A TIME/DIV	.5 μs
B TIME/DIV	.05 μs
HORIZ DISPLAY	A INTEN

j. Set time-mark generator for 15 microsecond time markers.

k. Adjust DTP to intensify second time marker.

l. Adjust Δ TIME to intensify the ninth time marker.

m. Set HORIZ DISPLAY to B DLY'D and adjust Δ TIME to superimpose displayed time markers.

n. **CHECK**—DM44 reading is 02.81 to 02.87 and the μs light is lit.

o. Set DM44 FUNCTION to TIME.

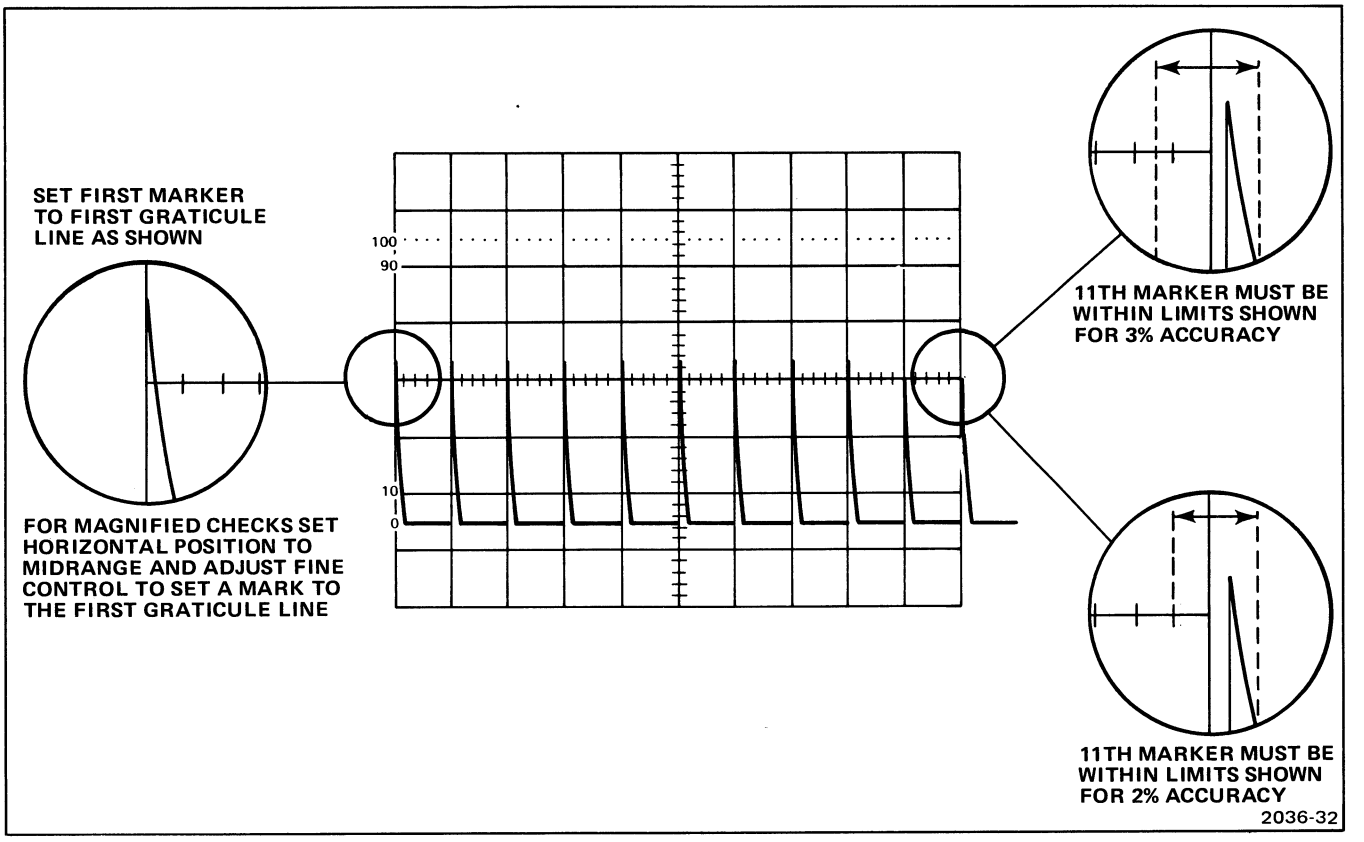


Fig. 6-4. Timing accuracies.

p. **CHECK**—DM44 reading is 03.45 to 03.55 and the μs light is lit.

q. Set

A TIME/DIV	1 μs
B TIME/DIV	.05 μs
HORIZ DISPLAY	A INTEN

r. Set time-mark generator for 1 microsecond time markers.

s. Adjust DTP to intensify second time marker.

t. Adjust Δ TIME to intensify the tenth time marker.

u. Set HORIZ DISPLAY to B DLY'D.

v. Adjust Δ TIME to superimpose time markers.

w. **CHECK**—DM44 reading is within the limits given in Table 6-8 in both the TIME and 1/TIME settings of the FUNCTION switch.

x. Repeat parts v through w for the remainder of the settings listed in Table 6-8.

TABLE 6-8
TIME And 1/TIME Accuracy

TIME MARK GEN	A TIME DIV	B TIME DIV	TIME			1/TIME		
			ACCURACY	ms	μs	ACCURACY	ms	μs
1 μs	1 μs	.05 μs	07.91 to 08.09		X	0.123 to 0.127		X
2 μs	2 μs	.05 μs	15.83 to 16.17		X	.0618 to .0632		X
5 μs	5 μs	.1 μs	039.5 to 040.5		X	014.7 to 025.3	X	
10 μs	10 μs	.2 μs	079.1 to 080.9		X	012.3 to 012.7	X	
20 μs	20 μs	.5 μs	158.3 to 161.7		X	06.18 to 06.32	X	
50 μs	50 μs	1 μs	0.395 to 0.405	X		02.47 to 02.53	X	
.1 ms	.1 ms	2 μs	0.791 to 0.809	X		01.23 to 01.27	X	
.2 ms	.2 ms	5 μs	1.583 to 1.617	X		0.618 to 0.632	X	
.5 ms	.5 ms	10 μs	03.95 to 04.05	X		0.247 to 0.253	X	
1 ms	1 ms	20 μs	07.91 to 08.09	X		0.123 to 0.127	X	
2 ms	2 ms	50 μs	15.83 to 16.17	X		.0618 to .0632	X	
5 ms	5 ms	.1 ms	039.5 to 040.5	X		024.7 to 025.3		
10 ms	10 ms	.2 ms	079.1 to 080.9	X		012.3 to 012.7		
If the above checks in this table are within tolerance, it is unlikely the following checks will be out of tolerance. The following checks are time consuming and may be skipped if you wish.								
20 ms	20 ms	.5 ms	158.3 to 161.7	X		06.18 to 06.32		
50 ms	50 ms	1 ms	0.395 to 0.405			02.47 to 02.53		
.1 s	.1 s	2 ms	0.791 to 0.809			01.23 to 01.27		
.2 s	.2 s	5 ms	1.583 to 1.617			0.618 to 0.632		
.5 s	.5 s	10 ms	03.95 to 04.05			0.247 to 0.253		

22. CHECK MIXED SWEEP ACCURACY

a. Set

DM44 FUNCTION	VOLTS
A TIME/DIV	1 ms
B TIME/DIV	.5 ms
DTP	Fully clockwise
HORIZ DISPLAY	B DLY'D
A TRIG HOLDOFF	Fully counterclockwise

b. Set time-mark generator for 1 ms time markers.

c. Measure the timing error between the second and tenth time markers. Record this value for use in part e.

d. Set HORIZ DISPLAY to MIX.

e. **CHECK**—Timing error between second and tenth time markers is within 0.18 division plus the error noted in part c (see Figure 6-5).

23. CHECK B ENDS A

a. Set

DM44 FUNCTION	VOLTS
A TRIG HOLDOFF	B ENDS A

b. Rotate the DTP and Δ TIME controls through their ranges and

CHECK—Sweep terminates at the end of the intensified zones.

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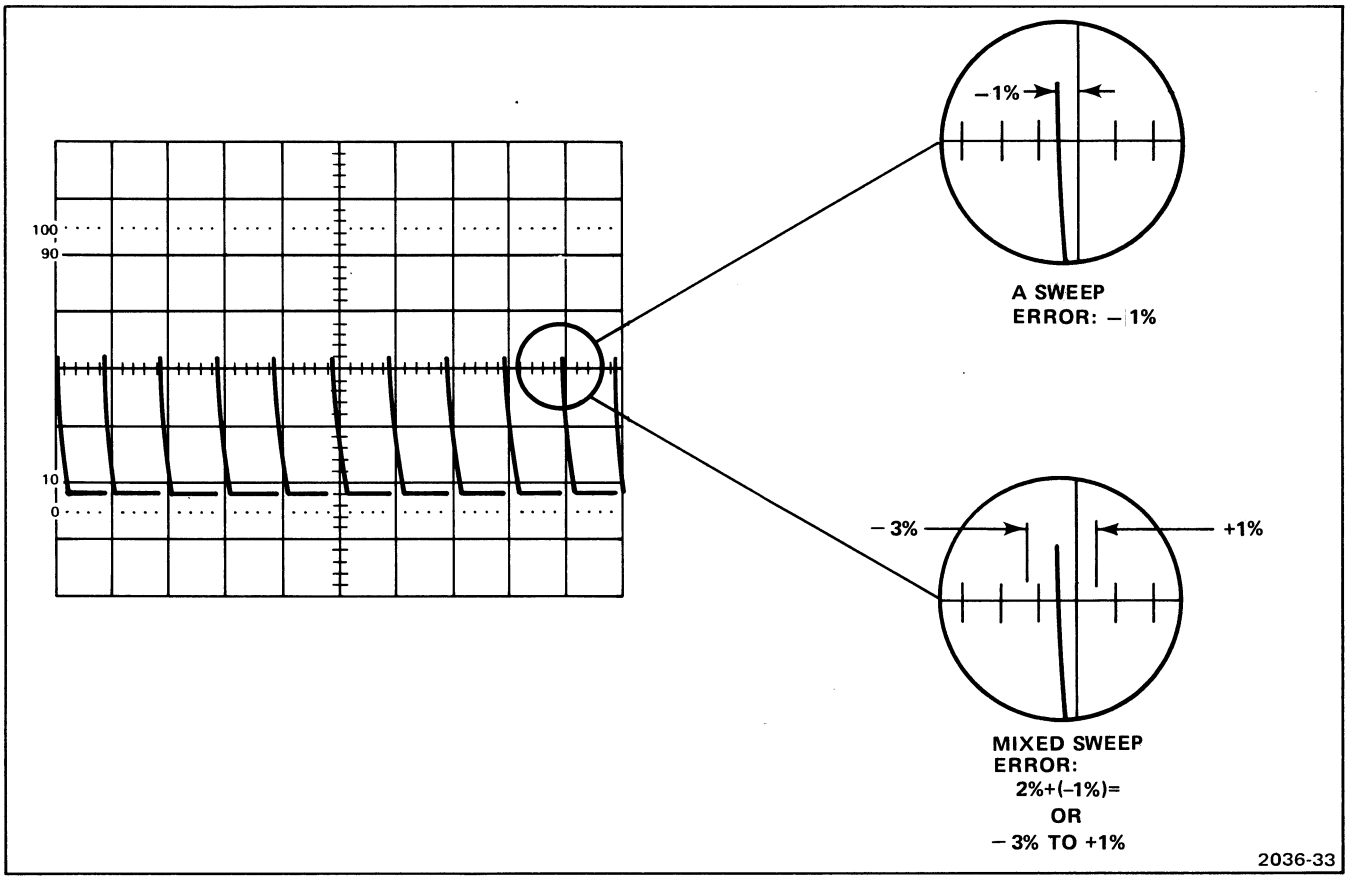


Fig. 6-5. Mixed sweep accuracy.

24. CHECK A TRIGGER HOLDOFF

a. Set

HORIZ DISPLAY	A
A TIME/DIV	10 μs
A TRIGGER HOLDOFF	NORM
A TRIG LEVEL	Fully ccw

b. Set test oscilloscope

Vertical Mode	CH 1
CH 1 Volts/Div	1 volt
Horiz Mode	A Sweep
A Trigger Slope	−
A Trigger Mode	Auto

c. Connect A +GATE output (on rear of oscilloscope on which the DM44 is mounted) to CH 1 input of test oscilloscope via 50 Ω cable and 50 Ω termination.

d. Adjust test oscilloscope Time/Div and Var Volts/Div so that negative portion of +GATE (holdoff time) is 1 major division in length.

e. Rotate A TRIGGER HOLDOFF control clockwise, but not into B ENDS A detent.

f. **CHECK**—That holdoff time of A +GATE is increased at least 10 times.

g. Set A TRIGGER HOLDOFF to NORM.

475 HORIZONTAL SYSTEM

See **ADJUSTMENT LOCATIONS** pull-out page for adjustments and test points (TP).

This portion of the calibration procedure replaces the Horizontal portion of the calibration procedure in the 475 and 475A Service Manuals. All references to 475 also apply to 475A, except as noted.

PRELIMINARY CONTROL SETTINGS

Display

INTENSITY	midrange
FOCUS	midrange
Horizontal POSITION	midrange

Vertical

VOLTS/DIV	.5 V
VAR VOLTS/DIV	calibrated detent
AC-GND-DC	DC
INVERT	off (button out)
VERT MODE	CH 1
100 or 20 MHz BW	full bandwidth (push in, then release)

Trigger (A and B)

COUPLING	AC
LEVEL	0
SLOPE	+
A TRIGGER SOURCE	NORM
B TRIGGER SOURCE	STARTS AFTER DELAY
TRIG MODE	AUTO
A TRIG HOLDOFF	NORM

Sweep

A and B TIME/DIV	1 ms
VAR TIME/DIV	calibrated detent
DELAY TIME POSITION	Fully counterclockwise
HORIZ DISPLAY	A
X10 MAG button	off (button out)

DM44

FUNCTION	VOLTS
RANGE	2 V

1. ADJUST SWEEP START (R938) AND SWEEP STOP (R936)

a. Set

A TIME/DIV	.1 ms
B TIME/DIV	.05 μs
HORIZ DISPLAY	A INTEN
DTP	Fully ccw
INTENSITY	So intensified zone is visible

b. Connect time mark generator to oscilloscope CH 1 input through a 42-inch 50-ohm BNC cable and 50-ohm BNC termination.

c. Set time mark generator for 0.1 ms time markers.

d. Set DTP fully ccw.

e. **ADJUST**–Sweep start (R938) to position the intensified zone to the vertical center of the trailing edge of the first time marker (see Figure 6-6).

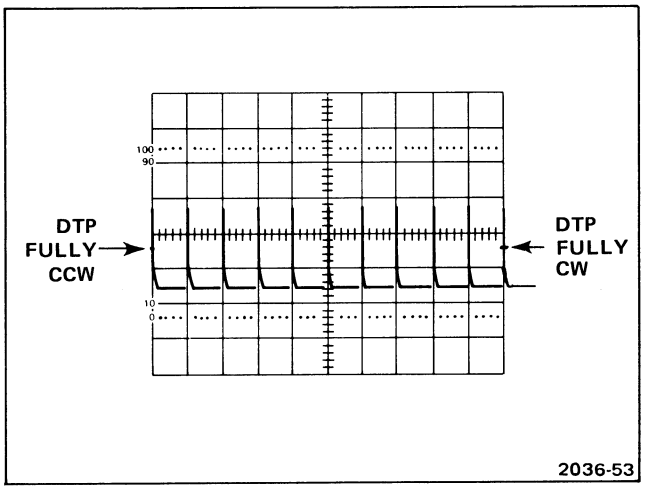


Fig. 6-6. Sweep start and stop adjustment (475).

f. Set DTP fully cw.

g. **ADJUST**—Sweep stop (R936) to position the intensified zone to the vertical center of the trailing edge of the eleventh time marker (see Figure 6-6).

h. Due to interaction, repeat parts d through g until no further adjustment is required.

2. CHECK B ENDS A

a. Set

HORIZ DISPLAY	A INTEN
A TIME/DIV	1 ms
B TIME/DIV	.2 ms
A TRIG HOLDOFF	B ENDS A
DTP	About midrange
CH 1 AC-GND-DC	GND

b. **CHECK**—Sweep ends at the end of the intensified zone.

3. ADJUST HORIZONTAL GAIN (R1155)

a. Set

CH 1 AC-GND-DC	DC
HORIZ DISPLAY	A
A and B TIME/DIV	1 ms

b. Set time mark generator for 1 ms time markers.

c. **ADJUST**—R1155 for one time marker per division over entire ten divisions.

NOTE

If you have replaced a crt and R1155 does not have enough adjustment range, change the value of R1154. See the Electrical Parts List in Section 8 of this manual for values.

4. ADJUST INTENSIFIED GAIN (R950)

a. Set

HORIZ DISPLAY	A INTEN
A and B TIME/DIV	1 ms
B Trigger SOURCE	STARTS AFTER DLY
DTP	Fully ccw

b. **ADJUST**—R950 for one time marker per division over entire ten divisions.

5. CHECK SWEEP LENGTH

a. **CHECK**—Length of trace is 10.5 to 12.5 divisions.

6. ADJUST MAGNIFIER REGISTRATION (R1130).

a. Set time mark generator for 5 ms time markers.

b. Set X10 MAG to X10 (in).

c. Horizontally position the peak of the second (center) time marker to the center vertical graticule line.

d. Set X10 MAG to X1 (out).

e. ADJUST—R1130 to move the second time marker back to the center vertical graticule line.

f. Due to interaction, repeat parts b through e until no further adjustment is needed.

7. CHECK VAR TIME/DIV RANGE

a. Set

A VAR	Fully ccw
X10 MAG	X1 (out)

b. Set time mark generator for 10 ms time markers.

c. **CHECK**—Distance between adjacent time markers is 4 divisions or less.

d. **CHECK**—UNCAL light is on when the A VAR control is out of the detent position.

8. ADJUST TIME (R3287), 1/TIME (R3033), AND 1/TIME LINEARITY (C3162)

a. Set

HORIZ DISPLAY	A INTEN
A TIME/DIV	.2 ms
B TIME/DIV	1 μs
B Trigger SOURCE	STARTS AFTER DLY

b. Set time mark generator for 0.1 ms time markers.

c. Set DTP to intensify the third time marker.

d. Set DM44 FUNCTION to TIME.

e. Set Δ TIME so measurement point intensifies the nineteenth time marker.

f. Set HORIZ DISPLAY to B DLY'D.

g. Set Δ TIME to superimpose displayed time markers.

h. **ADJUST**—R3287 for a DM44 reading of 1.600.

i. Set DM44 FUNCTION to 1/TIME.

j. Verify the displayed time markers are still superimposed.

k. **ADJUST**—R3033 for a DM44 reading of 0.625.

l. Set

DM44 FUNCTION	TIME
HORIZ DISPLAY	A INTEN

m. Set Δ TIME to intensify the fourth time marker (two adjacent time markers separated by one half division should now be intensified).

n. Set HORIZ DISPLAY to B DLY'D.

o. Set Δ TIME to superimpose displayed time markers. Neglecting tolerances, the DM44 reading should be .1000.

p. Set DM44 FUNCTION to 1/TIME.

NOTE

C3162 is a selectable part. It may have been removed. See the Electrical Parts List in Section 8 of this manual.

q. **ADJUST**—R3162 (SN B030601-UP) or C3162 (SN B010100-B030600) for a DM44 reading of 10.00.

9. CHECK Δ TIME RANGE

NOTE

This check requires the Δ TIME and DTP controls operate in the normal (tracking) mode. To ensure this, verify the following:
1. Jumper plug is connected to P3277.
2. Connector on the end of the wires from the Δ TIME control is connected to P3272.

a. Set

HORIZ DISPLAY	A INTEN
A TIME/DIV	.2 ms
B TIME/DIV	1 μs
DM44 FUNCTION	TIME
Δ TIME	Fully ccw
DTP	Fully ccw

b. **CHECK**—By adjusting the Δ TIME control clockwise, the two intensified zones can be positioned at least 10 divisions apart.

c. Set DTP fully counterclockwise.

d. **CHECK**—By adjusting the Δ TIME control clockwise, the two intensified zones can be positioned at least 10 divisions apart.

e. Set DTP and Δ TIME controls so both intensified zones are near the center of the crt.

f. **CHECK**—DTP control moves both intensified zones.

g. **CHECK**—Δ TIME control moves only one intensified zone.

10. CHECK INDEPENDENT Δ TIME AND DTP CONTROL OPERATION

a. Remove the jumper connector from P3277.

b. Move the connector from P3272 to P3273.

c. **CHECK**—Adjusting the DTP control moves only one intensified zone and adjusting the Δ TIME control moves the other intensified zone.

d. Set DTP fully counterclockwise.

e. **CHECK**—By adjusting the Δ TIME control, the two intensified zones can be positioned at least 10 divisions apart.

f. Set connectors for desired mode of operation. As now connected for independent mode or as in the note at the beginning of step 9 for tracking mode.

11. CHECK AUTORANGING

a. Set

A TIME/DIV	1 ms
B TIME/DIV	20 μs

b. Adjust DTP so reference point intensifies the second time marker.

c. Adjust Δ TIME to superimpose both intensified zones.

d. Slowly turn the Δ TIME control clockwise and

CHECK—That the DM44 upranges when the reading reaches 2.000 (the reading shifts from 2.000 to 02.00).

e. Slowly turn the Δ TIME control counterclockwise and

CHECK—That the DM44 downranges when the reading reaches 01.00 (the reading shifts to 1.000).

12. CHECK TIME AND 1/TIME LINEARITY

a. Set

DM44 FUNCTION	TIME
HORIZ DISPLAY	A INTEN
A TIME/DIV	1 ms
B TIME/DIV	5 μs
Δ TIME	Fully clockwise

b. Set time-mark generator for 1 ms time markers.

c. Adjust the DTP control so the reference point intensifies the second time marker.

d. Adjust the Δ TIME control so the measurement point intensifies the third time marker (one division separating points).

e. Set HORIZ DISPLAY to B DLY'D and adjust the Δ TIME control to superimpose the displayed time markers. Readjust the DTP control if necessary to center the display.

f. **CHECK**—DM44 reading is within the limits given in Table 6-9.

g. Adjust the Δ TIME control clockwise to move the next time marker into the display.

h. Repeat parts e through g until the accuracy at the tenth time markers has been checked (eight divisions separating points).

TABLE 6-9
TIME LINEARITY

Distance Between Point (Divisions)	DM44 Reading[1] Limits For Time
1	0.989 to 1.011
2	1.979 to 02.03*
3	02.96 to 03.04
4	03.95 to 04.05
5	04.94 to 05.06
6	0.593 to 06.07
7	06.92 to 07.08
8	07.91 to 08.09

***Autoranging shifts decimal point.**
[1] TIME accuracy is within 1% one count.

i. Set HORIZ DISPLAY to A INTEN.

j. Turn DTP clockwise so reference point intensifies the tenth time marker.

k. Turn Δ TIME counterclockwise so the measurement point intensifies the second time marker.

l. Set HORIZ DISPLAY to B DLY'D and adjust Δ TIME to superimpose the displayed time markers.

m. **CHECK**—DM44 reading is –07.91 to –08.09.

n. Set DM44 FUNCTION to 1/TIME.

o. Verify displayed time markers are still superimposed.

p. **CHECK**—DM44 reading is –.1224 to –.1274.

q. Set HORIZ DISPLAY to A INTEN.

r. Turn Δ TIME clockwise so measurement point intensifies the ninth time marker (one division separating intensified zones).

s. Set HORIZ DISPLAY to B DLY'D and adjust Δ TIME to superimpose the displayed time markers.

t. **CHECK**—DM44 reading is –0.979 to –1.021.

u. Set

HORIZ DISPLAY	A INTEN
Δ TIME	Fully clockwise
DTP	To intensify the second time marker

v. Turn Δ TIME counterclockwise to intensify the tenth time marker.

w. Set HORIZ DISPLAY to B DLY'D and adjust Δ TIME to superimpose the displayed time markers.

x. **CHECK**—DM44 reading is .1224 to .1274.

13. CHECK DELAY JITTER

Delay jitter is checked at the worst case, but still usable, settings of the A TIME/DIV and B TIME/DIV switches. This results in a display that is hard to see. To make the display more visible, reduce ambient light as much as possible and use a viewing hood.

a. Set

A TRIG MODE	AUTO
A TIME/DIV	1 ms
B TIME/DIV	.2 μs
HORIZ DISPLAY	A INTEN
DM44 FUNCTION	VOLTS
X10 MAG	OUT (X1)

b. Set time-mark generator for 1 ms time markers.

c. Adjust the DTP control to intensify the ninth time marker.

d. Set HORIZ DISPLAY to B DLY'D and adjust the DTP control to center the displayed time marker.

e. **CHECK**—Horizontal jitter is one division or less (2.5 divisions or less if operating from a 50 Hz power source). Disregard the slow drift.

f. Set

HORIZ DISPLAY	A INTEN
DM44 FUNCTION	TIME
DTP	Fully counterclockwise

g. Adjust the Δ TIME control to intensify the ninth time marker.

h. Set HORIZ DISPLAY to B DLY'D and adjust the Δ TIME control to center the displayed time marker.

i. **CHECK**—Horizontal jitter is one division or less (2.5 divisions or less if operating from a 50 Hz power source). Disregard the slow drift.

14. ADJUST 20 μs TIMING (C1064, C1023)

a. Set

A and B TIME/DIV	20 μs
HORIZ DISPLAY	A

b. Set time mark generator for 10 μs time markers.

c. **ADJUST**—C1064 for 2 time markers per divisions.

b. Move the connector from P3272 to P3273.

c. **CHECK**—Adjusting the DTP control moves only one intensified zone and adjusting the Δ TIME control moves the other intensified zone.

d. Set DTP fully counterclockwise.

e. **CHECK**—By adjusting the Δ TIME control, the two intensified zones can be positioned at least 10 divisions apart.

f. Set connectors for desired mode of operation. As now connected for independent mode or as in the note at the beginning of step 9 for tracking mode.

11. CHECK AUTORANGING

a. Set

A TIME/DIV	1 ms
B TIME/DIV	20 μs

b. Adjust DTP so reference point intensifies the second time marker.

c. Adjust Δ TIME to superimpose both intensified zones.

d. Slowly turn the Δ TIME control clockwise and

CHECK—That the DM44 upranges when the reading reaches 2.000 (the reading shifts from 2.000 to 02.00).

e. Slowly turn the Δ TIME control counterclockwise and

CHECK—That the DM44 downranges when the reading reaches 01.00 (the reading shifts to 1.000).

12. CHECK TIME AND 1/TIME LINEARITY

a. Set

DM44 FUNCTION	TIME
HORIZ DISPLAY	A INTEN
A TIME/DIV	1 ms
B TIME/DIV	5 μs
Δ TIME	Fully clockwise

b. Set time-mark generator for 1 ms time markers.

c. Adjust the DTP control so the reference point intensifies the second time marker.

d. Adjust the Δ TIME control so the measurement point intensifies the third time marker (one division separating points).

e. Set HORIZ DISPLAY to B DLY'D and adjust the Δ TIME control to superimpose the displayed time markers. Readjust the DTP control if necessary to center the display.

f. **CHECK**—DM44 reading is within the limits given in Table 6-9.

g. Adjust the Δ TIME control clockwise to move the next time marker into the display.

h. Repeat parts e through g until the accuracy at the tenth time markers has been checked (eight divisions separating points).

TABLE 6-9
TIME LINEARITY

Distance Between Point (Divisions)	DM44 Reading[1] Limits For Time
1	0.989 to 1.011
2	1.979 to 02.03*
3	02.96 to 03.04
4	03.95 to 04.05
5	04.94 to 05.06
6	0.593 to 06.07
7	06.92 to 07.08
8	07.91 to 08.09

***Autoranging shifts decimal point.**
[1] TIME accuracy is within 1% one count.

i. Set HORIZ DISPLAY to A INTEN.

j. Turn DTP clockwise so reference point intensifies the tenth time marker.

k. Turn Δ TIME counterclockwise so the measurement point intensifies the second time marker.

l. Set HORIZ DISPLAY to B DLY'D and adjust Δ TIME to superimpose the displayed time markers.

m. **CHECK**–DM44 reading is –07.91 to –08.09.

n. Set DM44 FUNCTION to 1/TIME.

o. Verify displayed time markers are still superimposed.

p. **CHECK**–DM44 reading is –.1224 to –.1274.

q. Set HORIZ DISPLAY to A INTEN.

r. Turn Δ TIME clockwise so measurement point intensifies the ninth time marker (one division separating intensified zones).

s. Set HORIZ DISPLAY to B DLY'D and adjust Δ TIME to superimpose the displayed time markers.

t. **CHECK**–DM44 reading is –0.979 to –1.021.

u. Set

HORIZ DISPLAY	A INTEN
Δ TIME	Fully clockwise
DTP	To intensify the second time marker

v. Turn Δ TIME counterclockwise to intensify the tenth time marker.

w. Set HORIZ DISPLAY to B DLY'D and adjust Δ TIME to superimpose the displayed time markers.

x. **CHECK**–DM44 reading is .1224 to .1274.

13. CHECK DELAY JITTER

Delay jitter is checked at the worst case, but still usable, settings of the A TIME/DIV and B TIME/DIV switches. This results in a display that is hard to see. To make the display more visible, reduce ambient light as much as possible and use a viewing hood.

a. Set

A TRIG MODE	AUTO
A TIME/DIV	1 ms
B TIME/DIV	.2 μs
HORIZ DISPLAY	A INTEN
DM44 FUNCTION	VOLTS
X10 MAG	OUT (X1)

b. Set time-mark generator for 1 ms time markers.

c. Adjust the DTP control to intensify the ninth time marker.

d. Set HORIZ DISPLAY to B DLY'D and adjust the DTP control to center the displayed time marker.

e. **CHECK**–Horizontal jitter is one division or less (2.5 divisions or less if operating from a 50 Hz power source). Disregard the slow drift.

f. Set

HORIZ DISPLAY	A INTEN
DM44 FUNCTION	TIME
DTP	Fully counterclockwise

g. Adjust the Δ TIME control to intensify the ninth time marker.

h. Set HORIZ DISPLAY to B DLY'D and adjust the Δ TIME control to center the displayed time marker.

i. **CHECK**–Horizontal jitter is one division or less (2.5 divisions or less if operating from a 50 Hz power source). Disregard the slow drift.

14. ADJUST 20 μs TIMING (C1064, C1023)

a. Set

A and B TIME/DIV	20 μs
HORIZ DISPLAY	A

b. Set time mark generator for 10 μs time markers.

c. **ADJUST**–C1064 for 2 time markers per divisions.

d. Set

A TIME/DIV	20 μs
B TIME/DIV	.2 μs
HORIZ DISPLAY	A INTEN
DM44 FUNCTION	TIME

e. **ADJUST**—C1023 for 2 time markers per division.

f. Set DTP so reference point intensifies the third time marker.

g. Set Δ TIME so the measurement point intensifies the nineteenth time marker.

h. Set HORIZ DISPLAY to B DLY'D.

i. Set Δ TIME control for a DM44 reading of 160.0.

j. **ADJUST**—C1023 to superimpose the displayed time markers.

15. ADJUST .2 μs TIMING (C1009 C1025)

a. Set

A and B TIME/DIV	.2 μs
HORIZ DISPLAY	A

b. Set time mark generator for 0.1 μs time markers.

c. **ADJUST**—C1009 for two time markers per division over the entire ten divisions.

d. Set

A TIME/DIV	.2 μs
B TIME/DIV	.01 μs
HORIZ DISPLAY	A INTEN

e. **ADJUST**—C1025 for two time markers per division over the entire ten divisions.

f. Set DTP control so the reference point intensifies the third time marker.

g. Set Δ TIME control so the measurement point intensifies the ninteenth time marker.

h. Set HORIZ DISPLAY to B DLY'D.

i. Adjust Trigger LEVEL and A TRIG HOLDOFF for the most stable display.

j. Slightly readjust Δ TIME for a DM44 reading of 1.600.

k. **ADJUST**—C1025 to superimpose the displayed time markers.

16. ADJUST HORIZONTAL OUTPUT CENTERING (R1256). CHECK BEAMFINDER AND CHECK HORIZONTAL POSITION RANGE.

a. Set

DM44 FUNCTION	VOLTS
HORIZ DISPLAY	A
A and B TIME/DIV	XY (fully ccw)
VERT MODE	CH 2
CH 1 AC-DC-GND	GND

b. Set dot display to the vertical and horizontal center of the graticule area with CH 1 and CH 2 POSITION controls.

c. Connect test digital voltmeter (set to read at least 50 volts) negative lead to GND test point on main interface circuit board and compare readings between collectors (transistor cases) of Q1204 and Q1214.

d. Set POSITION (Horiz) for equal readings between transistor collectors of Q1204 and Q1214 and note final reading.

e. **CHECK**—For reading of +50 volts within 2 volts.

f. **ADJUST**—Horizontal DC Centering R1256 for a reading of +50 volts.

g. Disconnect test digital voltmeter.

h. Set A and B TIME/DIV to 1 ms.

i. **CHECK**—Left end of sweep can be positioned to the right of graticule center and the right end of the sweep can be positioned to the left of graticule center.

j. Push BEAMFINDER in and hold.

k. **CHECK**—Trace remains on screen at all settings of the horizontal, CH 1, and CH 2 POSITION controls.

17. ADJUST HIGH-SPEED TIMING, VISUAL METHOD (C1253, C1233, C1179, and R1105)

NOTE

This step is intended to check high-speed timing and, if necessary, perform minor adjustment. If timing cannot be adjusted to within specified limits, perform the procedure given in step 18.

a. Set

VERT MODE	CH 1
CH 1 AC-GND-DC	DC
A and B TIME/DIV	.05 μs
X10 MAG	X10 (IN)
A Trigger SOURCE	EXT
A Trigger COUPLING	LF REJ

b. Set time mark generator for 5 ns time markers.

c. Connect time mark generator trigger output through a 42-inch, 50-ohm, BNC cable and 50-ohm, BNC termination to A EXT Trigger input.

d. If time mark generator has selectable trigger output, select 0.1 μs triggers.

NOTE

If there is significant amplitude modulation of the display, connect a 500 MHz filter in series between the 50-ohm termination and the CH 1 vertical input. Adjust the filter as needed for minimum modulation.

e. Set CH 1 VOLTS/DIV for a convenient display amplitude. Adjust A Trigger LEVEL and A TRIG HOLDOFF as needed for a stable display.

NOTE

When making high-speed checks and adjustments (steps 17 and 18), set horizontal POSITION to about mid-range. This prevents checking timing accuracy in the portions of the sweep not included in the accuracy specification (see Section 1 of this manual). Portions of the sweep not included can be located as follows:
1. Set INTENSITY fully on.
2. Exclude the first 25 nanoseconds of the display with INTENSITY fully on or, with the INTENSITY set to a normal viewing level, the first two unblanked divisions; whichever is greater.
3. Also exclude all beyond the 100th division (tenth division of unmagnified display).

f. Set first displayed time marker to the first vertical graticule line.

g. **CHECK**—The eleventh time marker is within 0.2 divisions (2%) of the eleventh vertical graticule line (see Figure 6-7).

NOTE

If display is amplitude modulated, check two-division accuracy between two time markers of equal amplitude.

h. **CHECK**—Accuracy over any two-division interval is within 0.1 division.

i. **ADJUST**—C1253 and C1233, in equal amounts, for one cycle per division over entire ten divisions displayed.

j. Set A and B TIME/DIV to .02 μs.

k. Set time mark generator for 2 ns time markers.

l. Set first displayed time marker to first vertical graticule line.

m. **CHECK**—Eleventh time marker is within 0.2 division of the eleventh vertical graticule line (see Figure 6-7).

n. **CHECK**—Accuracy over any two-division interval is within 0.1 division.

o. **ADJUST**—C1179 for one cycle per division over the entire ten divisions displayed.

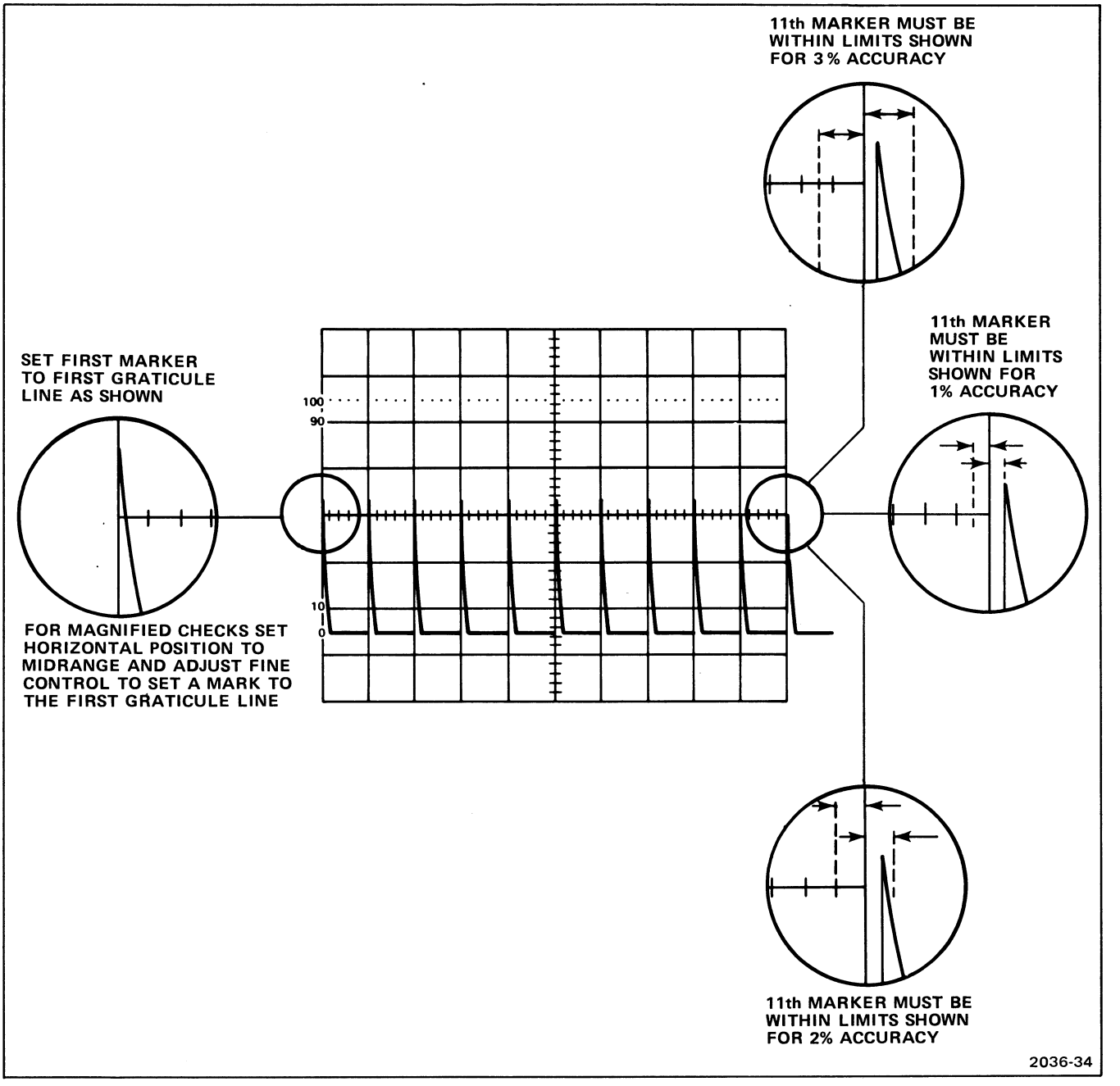


Fig. 6-7. Timing accuracies.

p. Interaction between adjustments made at .05 μs and .02 μs per division. Set A and B TIME/DIV to .05 μs, time mark generator for 5 ns time markers and repeat parts f through o for the best compromise.

q. Set A and B TIME/DIV to .01 μs.

r. Set time mark generator for 2 ns time markers.

s. Set first displayed time marker to first vertical graticule line.

t. **CHECK**—Sixth displayed time marker is within 0.2 division of the eleventh vertical graticule line.

u. **ADJUST**—R1075 for one cycle per two divisions.

NOTE

If you could not adjust high-speed timing to within the given limits, proceed with step 18. If timing is within given limits, skip step 18 and proceed to step 19.

18. ADJUST HIGH-SPEED TIMING, CURRENT PROBE METHOD (C1253, C1233, C1179, R1185, and R1175)

NOTE

This step is intended only for major recalibration of high-speed timing. Any reference to 475 through step 18 refers to the 475 (or 475A) under calibration.

a. Set A and B TIME/DIV to .02 μs and X10 MAG to X10 (in).

b. Set Horizontal POSITION control to midrange. This prevents checking or adjusting timing in the portions of the sweep not included in the accuracy specification. See the note in step 17.

c. Set time mark generator for 2 ns time markers.

d. Connect the current probe with passive termination to channel one of the test oscilloscope. Set passive termination to 1 mA/mV.

e. Connect the probe head around the crossed horizontal deflection plate leads. See Figure 6-8 for proper probe connection.

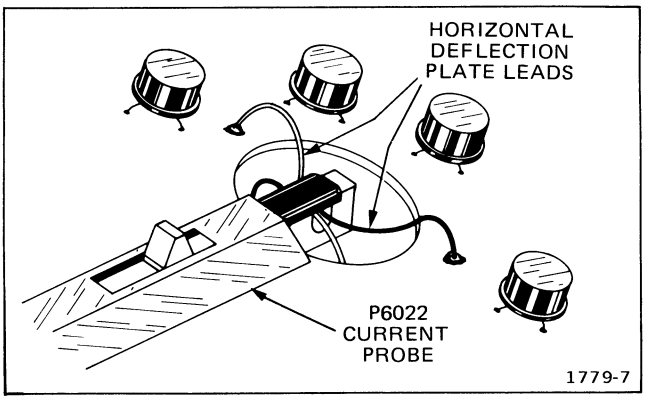


Fig. 6-8. Proper connection of current probe to horizontal deflection plate leads.

f. Set test oscilloscope

vertical mode	channel one
time/division	0.2 microseconds
X10 magnifier	on (X10)
channel one volts/division	20 millivolts
horizontal position	so current pulse is near center of crt

g. **ADJUST**—C1253, C1233, R1179, R1185, and R1175 for a symetrical, flat-top waveform similiar to that in Figure 6-9.

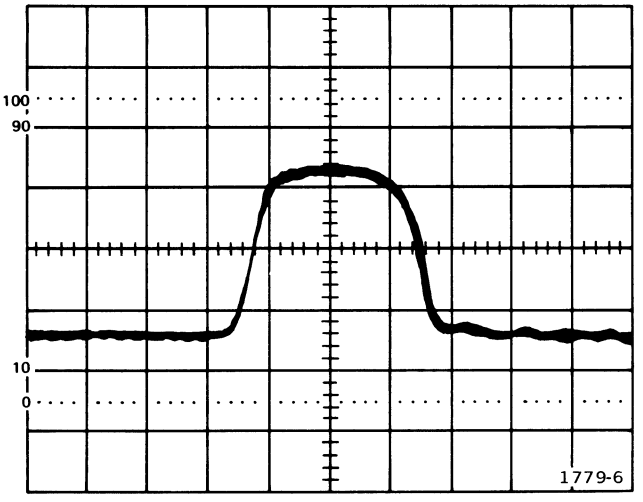


Fig. 6-9. Current waveform when high-speed timing is correctly adjusted.

CALIBRATION AID

Preset C1253 and C1233 for approximately 1/4 turn from counterclockwise stop. Preset C1179 and R1185 near clockwise stop.

Adjust R1175 for a flat top and fast leading edge of the current waveform at 475 TIME/DIV settings of .02 μs and .01 μs. Adjust R1185 for best overall flat top on current waveform at 475 TIME/DIV setting of .02 μs. Adjust C1253 and C1233 individually for a symetrical current waveform with a fast trailing edge.

h. Interraction between adjustments. Repeat part g as needed to obtain the best flat-top current waveform.

i. Set 475 TIME/DIV to .05 μs and set time mark generator for 5 ns time markers.

j. Set first displayed time marker to first vertical graticule line (see Figure 6-7).

k. **CHECK**—Eleventh time marker is within 0.2 division (2%) of the eleventh vertical graticule line (see Figure 6-7).

NOTE

If display is amplitude modulated, check two-division accuracy between two time markers of equal amplitude. Adjust filter for minimum modulation.

l. **CHECK**—Accuracy over any two-division interval is within 0.1 division.

m. **ADJUST**—C1253 and C1233, in equal amounts, for one cycle per division over entire ten divisions displayed.

n. Set 475 TIME/DIV to .02 μs and set time mark generator for 2 ns time markers.

NOTE

In the following parts, you may need to adjust R1185 and R1175 to maintain a symetrical, flat-top waveform.

o. Set first displayed waveform to first vertical graticule line (remember to keep the horizontal POSITION control near midrange).

p. **CHECK**—The eleventh time marker is within 0.2 division (2%) of the eleventh vertical line.

q. **CHECK**—Accuracy over any two-division interval is within 0.1 division.

r. **ADJUST**—C1179 for one cycle per division over the entire ten divisions displayed.

s. Interaction between adjustments made at .05 μs and .02 μs per division. Repeat parts i through r for best compromise.

t. Set A and B TIME/DIV to .01μs and set time mark generator for 2 ns time markers.

u. Set first displayed time marker to the first vertical graticule line.

v. **CHECK**—Sixth displayed time marker is within 0.2 division (2%) of the eleventh vertical line.

w. **CHECK**—Accuracy over any two division interval is within 0.1 division.

x. **ADJUST**—R1075 for 1 cycle per division over entire ten divisions displayed.

NOTE

When disconnecting current, do not disturb the placement of the deflection plate leads. The position of the leads affects timing.

y. Disconnect current probe from deflection plate leads.

z. Interaction between timing with current probe connected and disconnected. Repeat parts i through w and readjust slightly if necessary. Disregard the note between parts n and o.

aa. Set

X10 MAG	X1 (out)
A and B TIME/DIV	.1 μs

ab. Set time mark generator for 0.1 μs time markers.

ac. Set first time marker to first vertical graticule line.

ad. **CHECK**–The eleventh time marker is within 0.2 division of the eleventh vertical graticule line.

NOTE

If you make the adjustment in part ac, repeat parts i through w and readjust slightly if necessary.

ae. **ADJUST**–C1009 for one cycle per division over the entire ten divisions displayed.

af. Remove the trigger cable setup from the A Trigger EXT input.

ag. Set

A Trigger SOURCE	NORM
A Trigger COUPLING	AC

19. CHECK A TIMING ACCURACY

NOTE

Unless otherwise stated, set POSITION and FINE (HORIZ) controls so the first time marker coincides with the first graticule line and check the error at the last graticule line (see Figure 6-7).

When checking .01μs and .02 μs settings of the TIME/DIV switch, turn INTENSITY full on and exclude the first 25 nanoseconds of the display from the check. Turn INTENSITY down after checking .01 μs and .02 μs settings.

As you change the TIME/DIV SETTINGS, change the setting of the time-mark generator to maintain one or two time markers per division.

a. Set

A TIME/DIV	.01 μs
TRIG MODE	NORM

b. **CHECK**–Timing accuracy is within 1% at TIME/DIV settings from .01 μs to 5 ms (see Figure 6-7).

c. **CHECK**–Timing accuracy is within 2% at TIME/DIV settings from 10 ms to 0.5 s.

20. CHECK A INTEN TIMING ACCURACY

a. Set

HORIZ DISPLAY	A INTEN
TIME/DIV	.05 μs
DTP	Fully counterclockwise

b. Set time-mark generator for 50 nanosecond time markers.

c. **CHECK**–Timing accuracy is within 2% at TIME/DIV settings from .05 μs to .5 s (see Figure 6-7).

21. CHECK A INTEN MAGNIFIED TIMING ACCURACY

a. Set

TIME/DIV	.05 μs
X10 MAG	X10 (button in)

b. Set time-mark generator for 5 nanosecond time markers.

NOTE

Exclude the following portions of the display from the check:
1. First 25 nanoseconds with INTENSITY fully on or first 2 divisions with INTENSITY set to normal viewing level, whichever is greater.
2. All beyond the 100th division.

c. **CHECK**–Timing accuracy is within 3% at TIME/DIV settings from .05 μs to .5 s (see Figure 6-7).

22. CHECK A MANGIFIED TIMING ACCURACY

a. Set

TIME/DIV	.01 μs
A TRIGGER SOURCE	EXT
A TRIGGER COUPLING	LF REJ

b. Set time-mark generator for 2 nanosecond time markers.

c. Connect trigger output of time-mark generator through a 50 Ω BNC cable and 50 Ω BNC termination to the A TRIGGER EXT input. If you use time-mark generator with selectable trigger, set trigger selector for .1 microsecond trigger.

d. Insert a 500 megahertz filter between the 50 Ω termination and CH 1 input. Adjust the filter for minimum amplitude modulation when 2 and 5 nanosecond time markers are used.

NOTE

Exclude the following portions of the display from the check:
1. First 25 nanoseconds with INTENSITY fully on or first 2 divisions with INTENSITY set to normal viewing level, whichever is greater.
2. All beyond the 100th division.

e. Set CH 1 VOLTS/DIV to maintain a convenient display amplitude and set A TRIGGER LEVEL for a stable display. It may be necessary to adjust A TRIG HOLDOFF for the most stable display.

f. **CHECK**—Timing accuracy is within 2% at TIME/DIV settings from .01 μs to .05 μs (see Figure 6-7).

g. **CHECK**—Timing accuracy is within 5% over any 2 division portion of the display except as previously noted.

h. Remove trigger cable setup from A TRIGGER EXT input.

i. Set

A TRIGGER SOURCE	NORM
A TRIGGER SOURCE	AC

j. Remove 500 megahertz filter from CH 1 setup.

k. Set TIME/DIV to .1 μs and adjust CH 1 VOLTS/DIV for a convenient display amplitude.

l. Set time-mark generator for .1 microsecond time markers.

m. **CHECK**—Timing accuracy is within 2% at TIME/DIV settings from 0.1 μs to 5 ms.

n. **CHECK**—Timing accuracy is within 3% at TIME/DIV settings from 10 ms to .5 s.

23. CHECK MIXED SWEEP ACCURACY

a. Set

A TIME/DIV	.05 μs
B TIME/DIV	.02 μs
HORIZ DISPLAY	MIX
DTP	Fully clockwise

b. Set time-mark generator for 50 nanosecond time markers.

NOTE

Delete the first 0.5 division of the sweep from the measurement in part d.

c. Set POSITION so the second time marker is at the second vertical graticule line.

d. **CHECK**—Accuracy at the tenth graticule line is within 3%.

e. Set DTP fully counterclockwise.

f. Set time-mark generator for 20 nanosecond time markers.

g. Adjust POSITION to move the peak of the fourth time marker to the second vertical graticule line. This eliminates the first 0.1 microsecond after the transition from A to B sweep.

h. **CHECK**—Accuracy at the tenth graticule is within 3%.

i. Disconnect test equipment.

24. CHECK TIME AND 1/TIME ACCURACY

a. Set

A TIME/DIV	.05 μs
B TIME/DIV	.01 μs
HORIZ DISPLAY	A INTEN
DM44 FUNCTION	TIME

b. Set time-mark generator for 50 nanosecond time markers.

c. Adjust DTP so reference point intensifies the second time marker.

d. Adjust Δ TIME so the time-measurement point intensifies the tenth time marker.

e. Set HORIZ DISPLAY to B DLY'D.

f. Adjust Δ TIME to superimpose the displayed time markers.

g. **CHECK**—DM44 reading is within the limits given in Table 6-10 in both TIME and 1/TIME settings of the FUNCTION switch.

h. **CHECK**—Correct scale-factor light is on as indicated in Table 6-10.

TABLE 6-10
TIME And 1/TIME Accuracy

TIME MARK GEN	A TIME DIV	B TIME DIV	TIME			1/TIME		
			ACCURACY	ms	μs	ACCURACY	ms	μs
50 ns	.05 μs	.01 μs	0.395 to 0.405		X	02.47 to 02.53		X
.1 μs	.1 μs	.01 μs	0.791 to 0.809		X	01.23 to 01.27		X
.2 μs	.2 μs	.01 μs	1.583 to 1.617		X	0.618 to 0.632		X
.5 μs	.5 μs	.01 μs	03.95 to 04.05		X	0.247 to 0.253		X
1 μs	1 μs	.02 μs	07.91 to 08.09		X	0.123 to 0.127		X
2 μs	2 μs	.05 μs	15.83 to 16.17		X	.0618 to .0632		X
5 μs	5 μs	.1 μs	039.5 to 040.5		X	014.7 to 025.3	X	
10 μs	10 μs	.2 μs	079.1 to 080.9		X	012.3 to 012.7	X	
20 μs	20 μs	.5 μs	158.3 to 161.7		X	06.18 to 06.32	X	
50 μs	50 μs	1 μs	0.395 to 0.405	X		02.47 to 02.53	X	
.1 ms	.1 ms	2 μs	0.791 to 0.809	X		01.23 to 01.27	X	
.2 ms	.2 ms	5 μs	1.583 to 1.617	X		0.618 to 0.632	X	
.5 ms	.5 ms	10 μs	03.95 to 04.05	X		0.247 to 0.253	X	
1 ms	1 ms	20 μs	07.91 to 08.09	X		0.123 to 0.127	X	
2 ms	2 ms	50 μs	15.83 to 16.17	X		.0618 to .0632	X	
5 ms	5 ms	.1 ms	039.5 to 040.5	X		024.7 to 025.3		
10 ms	10 ms	.2 ms	079.1 to 080.9	X		012.3 to 012.7		
If the above checks in this table are within tolerance, it is unlikely the following checks will be out of tolerance. The following checks are time consuming and may be skipped if you wish.								
20 ms	20 ms	.5 ms	158.3 to 161.7	X		06.18 to 06.32		
50 ms	50 ms	1 ms	0.395 to 0.405			02.47 to 02.53		
.1 s	.1 s	2 ms	0.791 to 0.809			01.23 to 01.27		
.2 s	.2 s	5 ms	1.583 to 1.617			0.618 to 0.632		
.5 s	.5 s	10 ms	03.95 to 04.05			0.247 to 0.253		

i. Repeat parts f through h for the remainder of the settings in Table 6-10.

25. ADJUST X GAIN (R1102)

a. Set

HORIZ DISPLAY	A
TRIG MODE	AUTO
A and B TIME/DIV	X-Y
VERT MODE	CH 2
X (CH 1) VOLTS/DIV	5 mV
X (CH 1) AC-GND-DC	DC
4 (CH 2) AC-GND-DC	GND

b. Connect amplitude calibrator to CH 1 input through a 50-ohm, BNC cable (no 50-ohm termination).

c. Set amplitude calibrator for 20 millivolt standard amplitude output.

d. Set CH 1 and CH 2 POSITION controls to center the two-dot display.

e. **ADJUST**—X gain (R1102) for four divisions (horizontally) between two dots.

f. Set CH 1 VAR and CH 1 POSITION for exactly two divisions between dots with display centered (one division on either side of the center vertical graticule line).

g. Set CH 1 POSITION so right dot is at extreme right graticule line.

h. **CHECK**—Distance between dots is 1.8 to 2.2

i. Disconnect test equipment.

26. ADJUST X-Y PHASE DIFFERENCE

a. Set

CH 1 VAR	calibrated detent
CH 1 AC-GND-DC	GND
CH 2 AC-GND-DC	DC
CH 2 VOLTS/DIV	5 mV

b. Connect test equipment as shown in Figure 6-10.

c. Set sine-wave generator for an eight division display or reference frequency (vertical line eight divisions in amplitude).

d. Set CH 1 AC-GND-DC to DC.

e. Vertically and horizontally center the display with the CH 1 and CH 2 POSITION controls (see Figure 6-10).

f. **ADJUST**—L1103 for minimum horizontal opening at the center horizontal graticule line (see Figure 6-10).

g. Increase generator frequency to two megahertz.

h. **CHECK**—Opening at center of display is 0.42 division (horizontally) or less (see Figure 6-10).

i. Disconnect test equipment.

27. CHECK — X BANDWIDTH

a. Connect high-frequency sine-wave generator output through a 50-ohm, BNC cable and 50-ohm, BNC termination to CH 1 input.

b. Set CH 2 AC-GND-DC to GND.

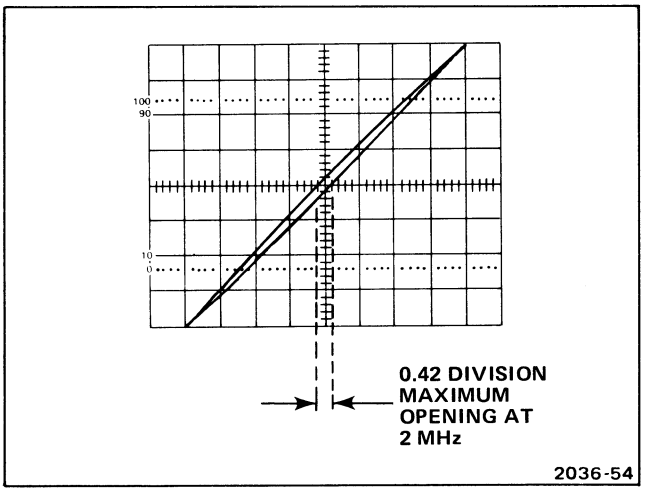


Fig. 6-10. X-Y phase difference.

c. Set sine-wave generator for a four-division display (horizontally) of the reference frequency.

d. Increase generator frequency until display length is reduced to 2.8 divisions.

e. **CHECK**—Sine-wave generator frequency is 3 megahertz or greater.

f. Disconnect test equipment.

28. CHECK A TRIG HOLDOFF RANGE

a. Set

A TRIG HOLDOFF	NORM
A and B TIME/DIV	1 ms

b. Connect A +GATE (output connector on rear panel) to channel one input of test oscilloscope through a 42-inch, BNC cable.

c. Set test oscilloscope

time/div	1 millisecond
X10 magnifier	X1 (off)
channel one volts/div	2 volts
trigger slope	positive (+)

d. Set A TRIG HOLDOFF for maximum time of negative portion of waveform on test oscilloscope.

e. **CHECK**—Length of negative portion of waveform on test oscilloscope is nine divisions or greater.

f. Disconnect test equipment.

NOTE

This completes the 475 Horizontal System Calibration Procedure. Return to the procedure in the 475 Service Manual.

REPLACEABLE ELECTRICAL PARTS

PARTS ORDERING INFORMATION

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

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

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

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

SPECIAL NOTES AND SYMBOLS

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

ITEM NAME

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

ABBREVIATIONS

ACTR	ACTUATOR	PLSTC	PLASTIC
ASSY	ASSEMBLY	QTZ	QUARTZ
CAP	CAPACITOR	RECP	RECEPTACLE
CER	CERAMIC	RES	RESISTOR
CKT	CIRCUIT	RF	RADIO FREQUENCY
COMP	COMPOSITION	SEL	SELECTED
CONN	CONNECTOR	SEMICOND	SEMICONDUCTOR
ELCTLT	ELECTROLYTIC	SENS	SENSITIVE
ELEC	ELECTRICAL	VAR	VARIABLE
INCAND	INCANDESCENT	WW	WIREWOUND
LED	LIGHT EMITTING DIODE	XFMR	TRANSFORMER
NONWIR	NON WIREWOUND	XTAL	CRYSTAL

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
00779	AMP, INC.	P O BOX 3608	HARRISBURG, PA 17105
00853	SANGAMO ELECTRIC CO., S. CAROLINA DIV.	P O BOX 128	PICKENS, SC 29671
01121	ALLEN-BRADLEY COMPANY	1201 2ND STREET SOUTH	MILWAUKEE, WI 53204
01295	TEXAS INSTRUMENTS, INC., SEMICONDUCTOR GROUP	P O BOX 5012, 13500 N CENTRAL EXPRESSWAY	DALLAS, TX 75222
03888	KDI PYROFILM CORPORATION	60 S JEFFERSON ROAD	WHIPPANY, NJ 07981
04222	AVX CERAMICS, DIVISION OF AVX CORP.	P O BOX 867, 19TH AVE. SOUTH	MURTLE BEACH, SC 29577
04713	MOTOROLA, INC., SEMICONDUCTOR PROD. DIV.	5005 E MCDOWELL RD,PO BOX 20923	PHOENIX, AZ 85036
07263	FAIRCHILD SEMICONDUCTOR, A DIV. OF FAIRCHILD CAMERA AND INSTRUMENT CORP.	464 ELLIS STREET	MOUNTAIN VIEW, CA 94042
07910	TELEDYNE SEMICONDUCTOR	12515 CHADRON AVE.	HAWTHORNE, CA 90250
19396	IILINOIS TOOL WORKS, INC. PAKTRON DIV.	900 FOLLIN LANE, SE	VIENNA, VA 22180
22526	BERG ELECTRONICS, INC.	YOUK EXPRESSWAY	NEW CUMBERLAND, PA 17070
27014	NATIONAL SEMICONDUCTOR CORP.	2900 SEMICONDUCTOR DR.	SANTA CLARA, CA 95051
32997	BOURNS, INC., TRIMPOT PRODUCTS DIV.	1200 COLUMBIA AVE.	RIVERSIDE, CA 92507
56289	SPRAGUE ELECTRIC CO.		NORTH ADAMS, MA 01247
71590	CENTRALAB ELECTRONICS, DIV. OF GLOBE-UNION, INC.	P O BOX 858	FORT DODGE, IA 50501
71744	CHICAGO MINIATURE LAMP WORKS	4433 RAVENSWOOD AVE.	CHICAGO, IL 60640
72982	ERIE TECHNOLOGICAL PRODUCTS, INC.	644 W. 12TH ST.	ERIE, PA 16512
73138	BECKMAN INSTRUMENTS, INC., HELIPOT DIV.	2500 HARBOR BLVD.	FULLERTON, CA 92634
75042	TRW ELECTRONIC COMPONENTS, IRC FIXED RESISTORS, PHILADELPHIA DIVISION	401 N. BROAD ST.	PHILADELPHIA, PA 19108
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
81483	INTERNATIONAL RECTIFIER CORP.	9220 SUNSET BLVD.	LOS ANGELES, CA 90069
90201	MALLORY CAPACITOR CO., DIV. OF P. R. MALLORY AND CO., INC.	3029 E WASHINGTON STREET P O BOX 372	INDIANAPOLIS, IN 46206
91637	DALE ELECTRONICS, INC.	P. O. BOX 609	COLUMBUS, NE 68601

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A1[1]	672-0591-10			CKT BOARD ASSY:MAIN	80009	672-0591-10
A1[2]	672-0591-20			CKT BOARD ASSY:MAIN	80009	672-0591-20
A1[3]	672-0591-30			CKT BOARD ASSY:MAIN	80009	672-0591-30
A2	670-3469-01			CKT BOARD ASSY:READOUT	80009	670-3469-01
A3	670-3470-00			CKT BOARD ASSY:REGULATOR	80009	670-3470-00
A4	670-4585-00			CKT BOARD ASSY:SWITCH	80009	670-4585-00
C2612	290-0327-00			CAP.,FXD,ELCTLT:0.56UF,20%,100V	56289	150D564X0100A2
C2613	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	72982	8131N075 E224M
C2615	290-0527-00			CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020FL
C2622	290-0369-00			CAP.,FXD,ELCTLT:800UF,+75-10%,15V	56289	39D807G15FJ4
C2623	290-0369-00			CAP.,FXD,ELCTLT:800UF,+75-10%,15V	56289	39D807G15FJ4
C2624	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	72982	8131N075 E224M
C2626	290-0527-00			CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020FL
C2632	290-0325-00			CAP.,FXD,ELCTLT:330UF,+75-10%,50V	56289	601D337G050FL4
C2634	290-0534-00			CAP.,FXD,ELCTLT:1UF,20%,35V	56289	196D105X0035HA1
C2636	290-0527-00			CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020FL
C3023	285-1100-00			CAP.,FXD,PLSTC:0.022UF,5%,200V	19396	223J02PT485
C3024	285-1104-00			CAP.,FXD,PLSTC:0.033UF,5%,200V	19396	333J02PP580
C3037	290-0524-00			CAP.,FXD,ELCTLT:4.7UF,20%,10V	90201	TDC475M010EL
C3062	283-0204-00			CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075Z5U0103M
C3071	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C3091	283-0103-00			CAP.,FXD,CER DI:180PF,5%,500V	56289	40C638
C3094	283-0204-00			CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075Z5U0103M
C3106	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	72982	8131N075 E224M
C3107	290-0535-00			CAP.,FXD,ELCTLT:33UF,20%,10V	56289	196D336X0010KA1
C3109	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	72982	8131N075 E224M
C3113	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	72982	8131N075 E224M
C3137	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	72982	8131N075 E224M
C3149	283-0204-00			CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075Z5U0103M
C3162	281-0221-00			CAP.,VAR,CER DI:2-10PF,100V	72982	0513013A 2.0-10
C3163	281-0580-00			CAP.,FXD,CER DI:470PF,10%,500V	04222	7001-1374
C3164	281-0123-00			CAP.,VAR,CER DI:5-25PF,100V	72982	518-000A5-25
C3165	285-0703-00			CAP.,FXD,PLSTC:0.1UF,5%,100V	56289	410P10451
C3167	281-0523-00			CAP.,FXD,CER DI:100PF,+/-20PF,500V	72982	301-000U2M0101M
C3213	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	72982	8131N075 E224M
C3223	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	72982	8131N075 E224M
C3255	283-0198-00	B010100	B010179	CAP.,FXD,CER DI:0.22UF,20%,50V	72982	8131N075 E224M
C3255	290-0522-00	B010180		CAP.,FXD,ELCTLT:1UF,20%,50V	56289	196D105X0050HA1
C3256	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	72982	8131N075 E224M
C3257	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	72982	8131N075 E224M
C3259	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	72982	8131N075 E224M
C3260	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	72982	8131N075 E224M
C3269	283-0177-00	XB010180		CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8131N039 E 105Z
C3274	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	72982	8131N075 E224M
C3277	283-0212-00	XB010180		CAP.,FXD,CER DI:2UF,20%,50V	72982	8141N064Z5U205M
C3278	283-0198-00	B010100	B010179	CAP.,FXD,CER DI:0.22UF,20%,50V	72982	8131N075 E224M
C3278	283-0204-00	B010180		CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075Z5U0103M
C3279	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	72982	8131N075 E224M
C3281	283-0177-00	XB025590		CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8131N039 E 105Z
C3282	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	72982	8131N075 E224M
C3302	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	72982	8131N075 E224M
C3303	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	72982	8131N075 E224M

[1]465 only.
[2]464 and 466 only.
[3]475 and 475A only.

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C3321	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	72982	8131N075 E224M
C3322	283-0013-00			CAP.,FXD,CER DI:0.01UF,+100-0%,1000V	56289	33C29A7
C3324	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	72982	8131N075 E224M
C3333	283-0696-00			CAP.,FXD,MICA D:2300PF,1%,500V	00853	D19-5E232F0
C3341	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	72982	8131N075 E224M
C3661	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	72982	8131N075 E224M
C3675	290-0535-00			CAP.,FXD,ELCTLT:33UF,20%,10V	56289	196D336X0010KA1
C3676	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	72982	8131N075 E224M
C3681	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	72982	8131N075 E224M
CR2510	150-1001-01			LAMP,LED:RED,2V,100MA	80009	150-1001-01
CR2520	150-1001-01			LAMP,LED:RED,2V,100MA	80009	150-1001-01
CR2610	152-0488-00			SEMICOND DEVICE:SILICON,200V,1500MA	80009	152-0488-00
CR2622	152-0423-00			SEMICOND DEVICE:SILICON,400V,3A	04713	1N5000
CR2623	152-0423-00			SEMICOND DEVICE:SILICON,400V,3A	04713	1N5000
CR2636	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	80009	152-0066-00
CR3016	152-0040-00			SEMICOND DEVICE:SILICON,600V,1A	80009	152-0040-00
CR3062	152-0323-00			SEMICOND DEVICE:SILICON,35V,0.1A	80009	152-0323-00
CR3065	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR3066	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR3074	152-0040-00			SEMICOND DEVICE:SILICON,600V,1A	80009	152-0040-00
CR3075	152-0040-00			SEMICOND DEVICE:SILICON,600V,1A	80009	152-0040-00
CR3120	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR3133	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR3221	152-0075-00			SEMICOND DEVICE:GE,25V,40MA	80009	152-0075-00
CR3232	152-0141-02	B010100	B010179	SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR3232	152-0075-00	B010180		SEMICOND DEVICE:GE,25V,40MA	80009	152-0075-00
CR3234	152-0141-02	B010100	B010179	SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR3234	152-0075-00	B010180		SEMICOND DEVICE:GE,25V,40MA	80009	152-0075-00
CR3274	152-0141-02	B010100	B010179X	SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR3275	152-0141-02	B010100	B010179X	SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR3278	152-0075-00	XB010180		SEMICOND DEVICE:GE,25V,40MA	80009	152-0075-00
CR3279	152-0075-00	XB010180		SEMICOND DEVICE:GE,25V,40MA	80009	152-0075-00
CR3292	152-0141-02	B010100	B010179X	SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR3320	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR3321	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR3324	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
DS3016	150-0131-00			LAMP,INCAND:120V,0.025A	71744	120PS
J3350	136-0328-03			SOCKET,PIN TERM:HORIZ,SQ PIN RCPT	22526	47710
L3675	120-0407-00			XFMR,TOROID:5 TURNS SINGLE	80009	120-0407-00
P3277	131-0993-00			LINK,TERM.CONNE:2 WIRE BLACK	00779	530153-2
Q2632	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q2634	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q2636	151-0464-00			TRANSISTOR:SILICON,PNP	80009	151-0464-00
Q2638	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q3045	151-0254-00			TRANSISTOR:SILICON,NPN	80009	151-0254-00
Q3143	151-1022-00			TRANSISTOR:SILICON,JFE,SEL FROM 2N4392	80009	151-1022-00
Q3153	151-0254-00			TRANSISTOR:SILICON,NPN	80009	151-0254-00
Q3251	151-0435-00			TRANSISTOR:SILICON,PNP	80009	151-0435-00
Q3269	151-0254-00			TRANSISTOR:SILICON,NPN	80009	151-0254-00
Q3350	151-0301-00			TRANSISTOR:SILICON,PNP	04713	2N2907A

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Q3355	151-0207-00			TRANSISTOR:SILICON,NPN	80009	151-0207-00
Q3360	151-0207-00			TRANSISTOR:SILICON,NPN	80009	151-0207-00
Q3365	151-0207-00			TRANSISTOR:SILICON,NPN	80009	151-0207-00
Q3370	151-0207-00			TRANSISTOR:SILICON,NPN	80009	151-0207-00
Q3380	151-0301-00			TRANSISTOR:SILICON,PNP	04713	2N2907A
Q3390	151-0301-00			TRANSISTOR:SILICON,PNP	04713	2N2907A
R2633	307-0114-00			RES.,FXD,CMPSN:6.2 OHM,5%,0.25W	01121	CB62G5
R2634	321-0274-00			RES.,FXD,FILM:6.98K OHM,1%,0.125W	91637	MFF1816G69800F
R2635	321-0274-00			RES.,FXD,FILM:6.98K OHM,1%,0.125W	91637	MFF1816G69800F
R2636	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
R3002 R3003 R3004 R3005	325-0185-00			RES. SET,MTCHD:9M,900K,90K,10K OHM	03888	OBD
R3006	323-0192-09			RES.,FXD,FILM:976 OHM,1%,0.50W	91637	MFF1226C976R0F
R3007	311-1276-00			RES.,VAR,NONWIR:50 OHM,+/-10%,0.5W	32997	3329W-L58-500
R3010	301-0824-00			RES.,FXD,CMPSN:820K OHM,5%,0.50W	01121	EB8245
R3011	301-0754-00			RES.,FXD,CMPSN:750K OHM,5%,0.50W	01121	EB7545
R3012	304-0824-00			RES.,FXD,CMPSN:820K OHM,10%,1W	01121	GB8241
R3016	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R3019	304-0824-00			RES.,FXD,CMPSN:820K OHM,10%,1W	01121	GB8241
R3023	315-0225-00			RES.,FXD,CMPSN:2.2M OHM,5%,0.25W	01121	CB2255
R3030	321-0168-00			RES.,FXD,FILM:549 OHM,1%,0.125W	91637	MFF1816G549R0F
R3031	311-1260-00			RES.,VAR,NONWIR:250 OHM,10%,0.50W	32997	3329P-L58-251
R3032	321-1627-06			RES.,FXD,FILM:731.3K OHM,0.25%,0.125W	91637	MFF1816C73132C
R3033	311-1895-00			RES.,VAR,NONWIR:2K OHM,10%,0.50W	32997	3299W-1-202
R3034	321-0228-09			RES.,FXD,FILM:2.32K OHM,1%,0.125W	91637	MFF1816C23200F
R3041	321-0291-09			RES.,FXD,FILM:10.5K OHM,1%,0.125W	91637	MFF1816C10501F
R3043	321-1299-09			RES.,FXD,FILM:12.9K OHM,1%,0.125W	91637	MFF1816C12901F
R3044	321-1299-09			RES.,FXD,FILM:12.9K OHM,1%,0.125W	91637	MFF1816C12901F
R3045	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R3047	311-1680-00			RES.,VAR,NONWIR:250 OHM,10%,0.75W	73138	89P-161-0-251K
R3048	321-0228-09			RES.,FXD,FILM:2.32K OHM,1%,0.125W	91637	MFF1816C23200F
R3051	321-0313-09			RES.,FXD,FILM:17.8K OHM,1%,0.125W	91637	MFF1816C17801F
R3058	315-0106-00			RES.,FXD,CMPSN:10M OHM,5%,0.25W	01121	CB1065
R3062	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R3065	315-0622-00			RES.,FXD,CMPSN:6.2K OHM,5%,0.25W	01121	CB6225
R3068	321-0729-06			RES.,FXD,FILM:786 OHM,0.25%,0.125W	91637	MFF1816C786R0C
R3073	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R3077	321-0133-00			RES.,FXD,FILM:237 OHM,1%,0.125W	91637	MFF1816G237R0F
R3078	321-0347-09			RES.,FXD,FILM:40.2K OHM,1%,0.125W	91637	MFF1816C40201F
R3080	321-1642-06			RES.,FXD,FILM:72.3K OHM,0.25%,0.125W	91637	MFF1816C72301C
R3082	321-0183-00			RES.,FXD,FILM:787 OHM,1%,0.125W	91637	MFF1816G787R0F
R3083	311-1897-00			RES.,VAR,NONWIR:25K OHM,10%,0.50W	32997	3299W-1-253
R3084	321-0365-09			RES.,FXD,FILM:61.9K OHM,1%,0.125W	75042	CEAT9-6192F
R3086	321-0318-06			RES.,FXD,FILM:20K OHM,0.25%,0.125W	91637	MFF1816C20001C
R3088	321-0807-00			RES.,FXD,FILM:900K OHM,1%,0.125W	91637	HFF1104F90002F
R3089	321-0423-09			RES.,FXD,FILM:249K OHM,1%,0.125W	91637	MFF1816C24902F
R3090	321-0321-07			RES.,FXD,FILM:21.5K OHM,0.1%,0.125W	91637	MFF1816C21501B
R3093	321-0276-09			RES.,FXD,FILM:7.32K OHM,1%,0.125W	91637	MFF1816C73200F
R3094	321-0964-07			RES.,FXD,FILM:49.31K OHM,0.1%,0.125W	91637	MFF1816C49311B
R3095	311-1897-00			RES.,VAR,NONWIR:25K OHM,10%,0.50W	32997	3299W-1-253

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R3098	304-0824-00			RES.,FXD,CMPSN:820K OHM,10%,1W	01121	GB8241
R3104	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R3105	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R3106	307-0106-00			RES.,FXD,CMPSN:4.7 OHM,5%,0.25W	01121	CB47G5
R3113	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R3115	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R3116	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R3117	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R3120	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R3132	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R3133	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R3137	315-0913-00			RES.,FXD,CMPSN:91K OHM,5%,0.25W	01121	CB9135
R3138	315-0913-00			RES.,FXD,CMPSN:91K OHM,5%,0.25W	01121	CB9135
R3140	311-1244-00			RES.,VAR,NONWIR:100 OHM,10%,0.50W	32997	3386X-T07-101
R3141	321-1643-07			RES.,FXD,FILM:11.03K OHM,0.1%,0.125W	91637	MFF1816C11031B
R3145	321-0385-07			RES.,FXD,FILM:100K OHM,0.1%,0.125W	91637	MFF1816C10002B
R3147	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R3153	315-0622-00			RES.,FXD,CMPSN:6.2K OHM,5%,0.25W	01121	CB6225
R3154	321-1642-06			RES.,FXD,FILM:72.3K OHM,0.25%,0.125W	91637	MFF1816C72301C
R3155	311-1896-00			RES.,VAR,NONWIR:5K OHM,10%,0.50W	32997	3299W-1-502
R3157	315-0474-00			RES.,FXD,CMPSN:470K OHM,5%,0.25W	01121	CB4745
R3158	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R3160	315-0154-00			RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R3161	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R3165	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R3201	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R3202	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R3204	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R3205	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R3208	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R3209	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R3210	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R3212	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
R3213	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R3215	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R3216	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R3217	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R3220	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R3227	315-0333-00			RES.,FXD,CMPSN:33K OHM,5%,0.25W	01121	CB3335
R3228	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R3231	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R3232	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R3233	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R3234	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R3235	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R3240	321-0376-00			RES.,FXD,FILM:80.6K OHM,1%,0.125W	91637	MFF1816G80601F
R3241	321-0435-00			RES.,FXD,FILM:332K OHM,1%,0.125W	91637	MFF1816G33202F
R3242	321-0393-00			RES.,FXD,FILM:121K OHM,1%,0.125W	91637	MFF1816G12102F
R3245	321-0402-00			RES.,FXD,FILM:150K OHM,1%,0.125W	91637	MFF1816G15002F
R3247	321-0338-00			RES.,FXD,FILM:32.4K OHM,1%,0.125W	91637	MFF1816G32401F
R3248	321-0365-00			RES.,FXD,FILM:61.9K OHM,1%,0.125W	91637	MFF1816G61901F
R3250[1]	321-0335-00			RES.,FXD,FILM:30.1K OHM,1%,0.125W	91637	MFF1816G30101F
R3251[2]	321-0322-00			RES.,FXD,FILM:22.1K OHM,1%,0.125W	91637	MFF1816G22101F

[1] 464 and 466 only.
[2] 475, 475A and 465 only.

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
Q3355	151-0207-00			TRANSISTOR:SILICON,NPN	80009	151-0207-00
Q3360	151-0207-00			TRANSISTOR:SILICON,NPN	80009	151-0207-00
Q3365	151-0207-00			TRANSISTOR:SILICON,NPN	80009	151-0207-00
Q3370	151-0207-00			TRANSISTOR:SILICON,NPN	80009	151-0207-00
Q3380	151-0301-00			TRANSISTOR:SILICON,PNP	04713	2N2907A
Q3390	151-0301-00			TRANSISTOR:SILICON,PNP	04713	2N2907A
R2633	307-0114-00			RES.,FXD,CMPSN:6.2 OHM,5%,0.25W	01121	CB62G5
R2634	321-0274-00			RES.,FXD,FILM:6.98K OHM,1%,0.125W	91637	MFF1816G69800F
R2635	321-0274-00			RES.,FXD,FILM:6.98K OHM,1%,0.125W	91637	MFF1816G69800F
R2636	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
R3002 R3003 R3004 R3005	325-0185-00			RES. SET,MTCHD:9M,900K,90K,10K OHM	03888	OBD
R3006	323-0192-09			RES.,FXD,FILM:976 OHM,1%,0.50W	91637	MFF1226C976R0F
R3007	311-1276-00			RES.,VAR,NONWIR:50 OHM,+/-10%,0.5W	32997	3329W-L58-500
R3010	301-0824-00			RES.,FXD,CMPSN:820K OHM,5%,0.50W	01121	EB8245
R3011	301-0754-00			RES.,FXD,CMPSN:750K OHM,5%,0.50W	01121	EB7545
R3012	304-0824-00			RES.,FXD,CMPSN:820K OHM,10%,1W	01121	GB8241
R3016	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R3019	304-0824-00			RES.,FXD,CMPSN:820K OHM,10%,1W	01121	GB8241
R3023	315-0225-00			RES.,FXD,CMPSN:2.2M OHM,5%,0.25W	01121	CB2255
R3030	321-0168-00			RES.,FXD,FILM:549 OHM,1%,0.125W	91637	MFF1816G549R0F
R3031	311-1260-00			RES.,VAR,NONWIR:250 OHM,10%,0.50W	32997	3329P-L58-251
R3032	321-1627-06			RES.,FXD,FILM:731.3K OHM,0.25%,0.125W	91637	MFF1816C73132C
R3033	311-1895-00			RES.,VAR,NONWIR:2K OHM,10%,0.50W	32997	3299W-1-202
R3034	321-0228-09			RES.,FXD,FILM:2.32K OHM,1%,0.125W	91637	MFF1816C23200F
R3041	321-0291-09			RES.,FXD,FILM:10.5K OHM,1%,0.125W	91637	MFF1816C10501F
R3043	321-1299-09			RES.,FXD,FILM:12.9K OHM,1%,0.125W	91637	MFF1816C12901F
R3044	321-1299-09			RES.,FXD,FILM:12.9K OHM,1%,0.125W	91637	MFF1816C12901F
R3045	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R3047	311-1680-00			RES.,VAR,NONWIR:250 OHM,10%,0.75W	73138	89P-161-0-251K
R3048	321-0228-09			RES.,FXD,FILM:2.32K OHM,1%,0.125W	91637	MFF1816C23200F
R3051	321-0313-09			RES.,FXD,FILM:17.8K OHM,1%,0.125W	91637	MFF1816C17801F
R3058	315-0106-00			RES.,FXD,CMPSN:10M OHM,5%,0.25W	01121	CB1065
R3062	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R3065	315-0622-00			RES.,FXD,CMPSN:6.2K OHM,5%,0.25W	01121	CB6225
R3068	321-0729-06			RES.,FXD,FILM:786 OHM,0.25%,0.125W	91637	MFF1816C786R0C
R3073	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R3077	321-0133-00			RES.,FXD,FILM:237 OHM,1%,0.125W	91637	MFF1816G237R0F
R3078	321-0347-09			RES.,FXD,FILM:40.2K OHM,1%,0.125W	91637	MFF1816C40201F
R3080	321-1642-06			RES.,FXD,FILM:72.3K OHM,0.25%,0.125W	91637	MFF1816C72301C
R3082	321-0183-00			RES.,FXD,FILM:787 OHM,1%,0.125W	91637	MFF1816G787R0F
R3083	311-1897-00			RES.,VAR,NONWIR:25K OHM,10%,0.50W	32997	3299W-1-253
R3084	321-0365-09			RES.,FXD,FILM:61.9K OHM,1%,0.125W	75042	CEAT9-6192F
R3086	321-0318-06			RES.,FXD,FILM:20K OHM,0.25%,0.125W	91637	MFF1816C20001C
R3088	321-0807-00			RES.,FXD,FILM:900K OHM,1%,0.125W	91637	HFF1104F90002F
R3089	321-0423-09			RES.,FXD,FILM:249K OHM,1%,0.125W	91637	MFF1816C24902F
R3090	321-0321-07			RES.,FXD,FILM:21.5K OHM,0.1%,0.125W	91637	MFF1816C21501B
R3093	321-0276-09			RES.,FXD,FILM:7.32K OHM,1%,0.125W	91637	MFF1816C73200F
R3094	321-0964-07			RES.,FXD,FILM:49.31K OHM,0.1%,0.125W	91637	MFF1816C49311B
R3095	311-1897-00			RES.,VAR,NONWIR:25K OHM,10%,0.50W	32997	3299W-1-253

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R3098	304-0824-00			RES.,FXD,CMPSN:820K OHM,10%,1W	01121	GB8241
R3104	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R3105	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R3106	307-0106-00			RES.,FXD,CMPSN:4.7 OHM,5%,0.25W	01121	CB47G5
R3113	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R3115	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R3116	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R3117	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R3120	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R3132	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R3133	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R3137	315-0913-00			RES.,FXD,CMPSN:91K OHM,5%,0.25W	01121	CB9135
R3138	315-0913-00			RES.,FXD,CMPSN:91K OHM,5%,0.25W	01121	CB9135
R3140	311-1244-00			RES.,VAR,NONWIR:100 OHM,10%,0.50W	32997	3386X-T07-101
R3141	321-1643-07			RES.,FXD,FILM:11.03K OHM,0.1%,0.125W	91637	MFF1816C11031B
R3145	321-0385-07			RES.,FXD,FILM:100K OHM,0.1%,0.125W	91637	MFF1816C10002B
R3147	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R3153	315-0622-00			RES.,FXD,CMPSN:6.2K OHM,5%,0.25W	01121	CB6225
R3154	321-1642-06			RES.,FXD,FILM:72.3K OHM,0.25%,0.125W	91637	MFF1816C72301C
R3155	311-1896-00			RES.,VAR,NONWIR:5K OHM,10%,0.50W	32997	3299W-1-502
R3157	315-0474-00			RES.,FXD,CMPSN:470K OHM,5%,0.25W	01121	CB4745
R3158	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R3160	315-0154-00			RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R3161	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R3165	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R3201	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R3202	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R3204	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R3205	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R3208	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R3209	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R3210	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R3212	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
R3213	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R3215	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R3216	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R3217	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R3220	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R3227	315-0333-00			RES.,FXD,CMPSN:33K OHM,5%,0.25W	01121	CB3335
R3228	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R3231	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R3232	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R3233	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R3234	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R3235	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R3240	321-0376-00			RES.,FXD,FILM:80.6K OHM,1%,0.125W	91637	MFF1816G80601F
R3241	321-0435-00			RES.,FXD,FILM:332K OHM,1%,0.125W	91637	MFF1816G33202F
R3242	321-0393-00			RES.,FXD,FILM:121K OHM,1%,0.125W	91637	MFF1816G12102F
R3245	321-0402-00			RES.,FXD,FILM:150K OHM,1%,0.125W	91637	MFF1816G15002F
R3247	321-0338-00			RES.,FXD,FILM:32.4K OHM,1%,0.125W	91637	MFF1816G32401F
R3248	321-0365-00			RES.,FXD,FILM:61.9K OHM,1%,0.125W	91637	MFF1816G61901F
R3250[1]	321-0335-00			RES.,FXD,FILM:30.1K OHM,1%,0.125W	91637	MFF1816G30101F
R3251[2]	321-0322-00			RES.,FXD,FILM:22.1K OHM,1%,0.125W	91637	MFF1816G22101F

[1] 464 and 466 only.
[2] 475, 475A and 465 only.

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R3259	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R3260	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R3262	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R3263	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R3266	321-0376-00			RES.,FXD,FILM:80.6K OHM,1%,0.125W	91637	MFF1816G80601F
R3267[1]	321-0340-00			RES.,FXD,FILM:34K OHM,1%,0.125W	91637	MFF1816G34001F
R3268[1]	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R3269[2]	321-0232-00			RES.,FXD,FILM:2.55K OHM,1%,0.125W	91637	MFF1816G25500F
R3272	311-1709-00			RES.,VAR,WW:20K OHM,10%,2W	73138	8136-22-0
R3273	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R3277	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R3278	315-0100-00	B010100	B010179	RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R3278	315-0102-00	B010180		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R3279	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R3286	321-1211-09			RES.,FXD,FILM:1560 OHM,1%,0.125W	91637	MFF1816C15600F
R3287[1]	311-1307-00			RES.,VAR,NONWIR:500 OHM,0.50W	32997	3299W-R27-501
R3288[1]	321-0239-07			RES.,FXD,FILM:3.01K OHM,0.1%,0.125W	91637	MFF1816C30100B
R3289[2]	321-0249-09			RES.,FXD,FILM:3.83K OHM,1%,0.125W	91637	MFF1816C38300F
R3292	305-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,2W	01121	HB1525
R3302	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R3303	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R3307	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R3309	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R3311	315-0182-00			RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	01121	CB1825
R3313	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
R3314	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
R3315	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
R3316	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
R3317	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
R3321	315-0301-00			RES.,FXD,CMPSN:300 OHM,5%,0.25W	01121	CB3015
R3322	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R3324	315-0301-00			RES.,FXD,CMPSN:300 OHM,5%,0.25W	01121	CB3015
R3325	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R3326	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R3327	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R3328	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R3332	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
R3333	321-0305-00			RES.,FXD,FILM:14.7K OHM,1%,0.125W	91637	MFF1816G14701F
R3334	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R3335	321-0290-00			RES.,FXD,FILM:10.2K OHM,1%,0.125W	91637	MFF1816G10201F
R3341	307-0106-00			RES.,FXD,CMPSN:4.7 OHM,5%,0.25W	01121	CB47G5
R3347	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R3348	315-0751-00			RES.,FXD,CMPSN:750 OHM,5%,0.25W	01121	CB7515
R3351	315-0181-00			RES.,FXD,CMPSN:180 OHM,5%,0.25W	01121	CB1815
R3353	315-0361-00			RES.,FXD,CMPSN:360 OHM,5%,0.25W	01121	CB3615
R3355	315-0561-00			RES.,FXD,CMPSN:560 OHM,5%,0.25W	01121	CB5615
R3358	315-0361-00			RES.,FXD,CMPSN:360 OHM,5%,0.25W	01121	CB3615
R3360	315-0561-00			RES.,FXD,CMPSN:560 OHM,5%,0.25W	01121	CB5615
R3363	315-0361-00			RES.,FXD,CMPSN:360 OHM,5%,0.25W	01121	CB3615
R3365	315-0561-00			RES.,FXD,CMPSN:560 OHM,5%,0.25W	01121	CB5615
R3368	315-0361-00			RES.,FXD,CMPSN:360 OHM,5%,0.25W	01121	CB3615
R3370	315-0561-00			RES.,FXD,CMPSN:560 OHM,5%,0.25W	01121	CB5615
R3375	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025

[1] 465, 464 and 466 only.
[2] 475 and 475A only.

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R3378	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R3379	315-0181-00			RES.,FXD,CMPSN:180 OHM,5%,0.25W	01121	CB1815
R3380	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
R3388	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R3389	315-0751-00			RES.,FXD,CMPSN:750 OHM,5%,0.25W	01121	CB7515
R3390	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
R3675	307-0106-00			RES.,FXD,CMPSN:4.7 OHM,5%,0.25W	01121	CB47G5
S3010	260-1848-00			SWITCH,PUSH:5 BUTTON	71590	OBD
S3020	260-1688-00			SWITCH,PUSH:6 STA,4 POLE,W/O MTG EARS	71590	2KBC006000-83
U2500	150-1011-01			LAMP,LED,RDOUT:RED SINGLE DIGIT	07263	FND 357
U2510	150-1011-01			LAMP,LED,RDOUT:RED SINGLE DIGIT	07263	FND 357
U2520	150-1011-01			LAMP,LED,RDOUT:RED SINGLE DIGIT	07263	FND 357
U2530	150-1011-01			LAMP,LED,RDOUT:RED SINGLE DIGIT	07263	FND 357
U2540	150-1011-01			LAMP,LED,RDOUT:RED SINGLE DIGIT	07263	FND 357
U2614	156-0285-00			MICROCIRCUIT,LI:VOLTAGE REGULATOR,12V,1A	80009	156-0285-00
U2624	156-0277-00			MICROCIRCUIT,LI:VOLTAGE REGULATOR	80009	156-0277-00
U3023	156-0495-00			MICROCIRCUIT,LI:QUAD OP AMPL,SGL SUPPLY	27014	LM324N
U3061	156-0335-00			MICROCIRCUIT,DI:OP AMPL,FET INPUT	27014	LH0042CH
U3091	156-0512-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	27014	LM308N
U3103	156-0411-00			MICROCIRCUIT,DI:QUAD-COMP,SGL SUPPLY	80009	156-0411-00
U3113	156-0515-00			MICROCIRCUIT,DI:TRIPLE 3-CHAN MUX	80009	156-0515-00
U3165	156-0477-00			MICROCIRCUIT,DI:ANALOG SECT OF A/D SYSTEM	80009	156-0477-00
U3211	156-0411-00			MICROCIRCUIT,DI:QUAD-COMP,SGL SUPPLY	80009	156-0411-00
U3213	156-0113-00			MICROCIRCUIT,DI:QUAD 2-INP NAND GATE	80009	156-0113-00
U3223	156-0041-00			MICROCIRCUIT,DI:DUAL D-TYPE FLIP-FLOP	27014	DM7474N
U3256	156-0495-00			MICROCIRCUIT,LI:QUAD OP AMPL,SGL SUPPLY	27014	LM324N
U3275	156-0067-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U3282	156-0289-00	B010100	B011729	MICROCIRCUIT,DI:QUAD BILATERAL SWITCH	80009	156-0289-00
U3282	156-0644-00	B011730		MICROCIRCUIT,DI:QUAD BILATERAL SWITCH	80009	156-0644-00
U3301	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U3308	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U3310	156-0186-00			MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE	01295	SN7403N
U3312	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U3320	156-0186-00			MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE	01295	SN7403N
U3323	156-0144-00			MICROCIRCUIT,DI:3-INPUT POS NAND GATE	01295	SN7412N
U3340	156-0476-00			MICROCIRCUIT,DI:DIG SECT OF A/D SYSTEM	80009	156-0476-00
U3343	156-0140-00			MICROCIRCUIT,DI:HEX BFR,15V,TTL	01295	SN7417N
U3373	156-0186-00			MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE	01295	SN7403N
U3383	156-0043-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NOR GATE	80009	156-0043-00
U3385	156-0493-00			MICROCIRCUIT,DI:BCD TO 7 SEG DEC/DRIVER	07263	9368DC
VR3037	152-0486-00			SEMICOND DEVICE:ZENER,0.25W,6.2V,5%	80009	152-0486-00
VR3077	152-0317-00			SEMICOND DEVICE:ZENER,0.25W,6.2V,5%	81483	1N3497
VR3082	152-0359-00			SEMICOND DEVICE:ZENER,0.25W,5%,9V	04713	SZ50850
VR3149	152-0306-01			SEMICOND DEVICE:ZENER,0.4W,9.1V,54	04713	SCG44
VR3291[1]	152-0149-00			SEMICOND DEVICE:ZENER,0.4W,10V,5%	04713	1N961B
VR3292	152-0195-00			SEMICOND DEVICE:ZENER,0.4W,5.1V,5%	80009	152-0195-00
VR3293	152-0195-00	XB010180		SEMICOND DEVICE:ZENER,0.4W,5.1V,5%	80009	152-0195-00
W3291[2]						

[1]464 and 466 only.
[2]Strap.

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
				DIFFERENCES BETWEEN MAIN PORTION OF STANDARD INSTRUMENT AND INSTURMENT EQUIPPED WITH DM44		
				465		
				CHASSIS		
CHANGE TO:						
R1110	311-1709-00			RES.,VAR,WW:20K OHM,10%,2W	73138	8136-22-0
A7	670-3467-02			CKT BOARD ASSY:TIMING(DM44)	80009	670-3467-02
ADD:						
R1142	321-0612-07			RES.,FXD,FILM:500 OHM,0.1%,0.125W	91637	MFF1816C500R0B
R1143	321-0928-07			RES.,FXD,FILM:250 OHM,0.1%,0.125W	91637	MFF1816C250R0B
R1144	321-0928-07			RES.,FXD,FILM:250 OHM,0.1%,0.125W	91637	MFF1816C250R0B
CHANGE TO:						
R1111	321-0265-00			RES.,FXD,FILM:5.62K OHM,1%,0.125W	91637	MFF1816G56200F
R1112	321-0252-00			RES.,FXD,FILM:4.12K OHM,1%,0.125W	91637	MFF1816G41200F
R1113	321-0154-00			RES.,FXD,FILM:392 OHM,1%,0.125W	91637	MFF1816G392R0F
A3	----- -----			CKT BOARD ASSY:VERT PREAMPL(DM44)		
ADD:						
R360	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R363	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
A8	----- -----			CKT BOARD ASSY:TRIG GEN/SW LOGIC(DM44)		
REMOVE:						
C1044	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0020HA1
ADD:						
R1318	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
				464/466		
				CHASSIS		
CHANGE TO:						
R1116	311-1709-00			RES.,VAR,WW:20K OHM,10%,2W	73138	8136-22-0
A7	670-3466-04			CKT BOARD ASSY:TIMING(DM44)	80009	670-3466-04
ADD:						
R1142	321-0612-07			RES.,FXD,FILM:500 OHM,0.1%,0.125W	91637	MFF1816C500R0B
R1143	321-0928-07			RES.,FXD,FILM:250 OHM,0.1%,0.125W	91637	MFF1816C250R0B
R1147	321-0928-07			RES.,FXD,FILM:250 OHM,0.1%,0.125W	91637	MFF1816C250R0B
CHANGE TO:						
R1112	321-0154-00			RES.,FXD,FILM:392 OHM,1%,0.125W	91637	MFF1816G392R0F
R1113	321-0252-00			RES.,FXD,FILM:4.12K OHM,1%,0.125W	91637	MFF1816G41200F
R1117	321-0265-00			RES.,FXD,FILM:5.62K OHM,1%,0.125W	91637	MFF1816G56200F

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A5	----- -----			CKT BOARD ASSY:TRIG GEN/SWP LOGIC(DM44)		
REMOVE:						
C822	290-0534-00			CAP.,FXD,ELCTLT:1UF,20%,35V	56289	196D105X0035HA1
ADD:						
R918	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
				475/475A		
				CHASSIS		
CHANGE TO:						
R930	311-1709-00			RES.,VAR,WW:20K OHM,10%,2W	73138	8136-22-0
A7	670-3468-02			CKT BOARD ASSY:TIMING(DM44)	80009	670-3468-02
A8	----- -----			CKT BOARD ASSY:TRIGGER GEN AND Z AXIS(DM44)		
ADD:						
C605	281-0763-00			CAP.,FXD,CER DI:47PF,10%,100V	72982	390049X5P0470K
R605	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
A3	----- -----			CKT BOARD ASSY:VERTICAL PREAMPL(DM44)		
ADD:						
R370	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A9	----- -----			CKT BOARD ASSY INTERFACE(DM44)		
REMOVE:						
C923	283-0059-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8141N037Z5U0105Z

OPTIONS

At the time of this printing the following options are available for the DM44.

OPTION 1

Deletes the P6430 Temperature probe if temperature measurement capability is not required. Price is reduced from standard DM44. Temperature capability may be added at a later date by ordering a P6430 Temperature Probe. Temperature circuit must then be calibrated to probe for specified accuracy.

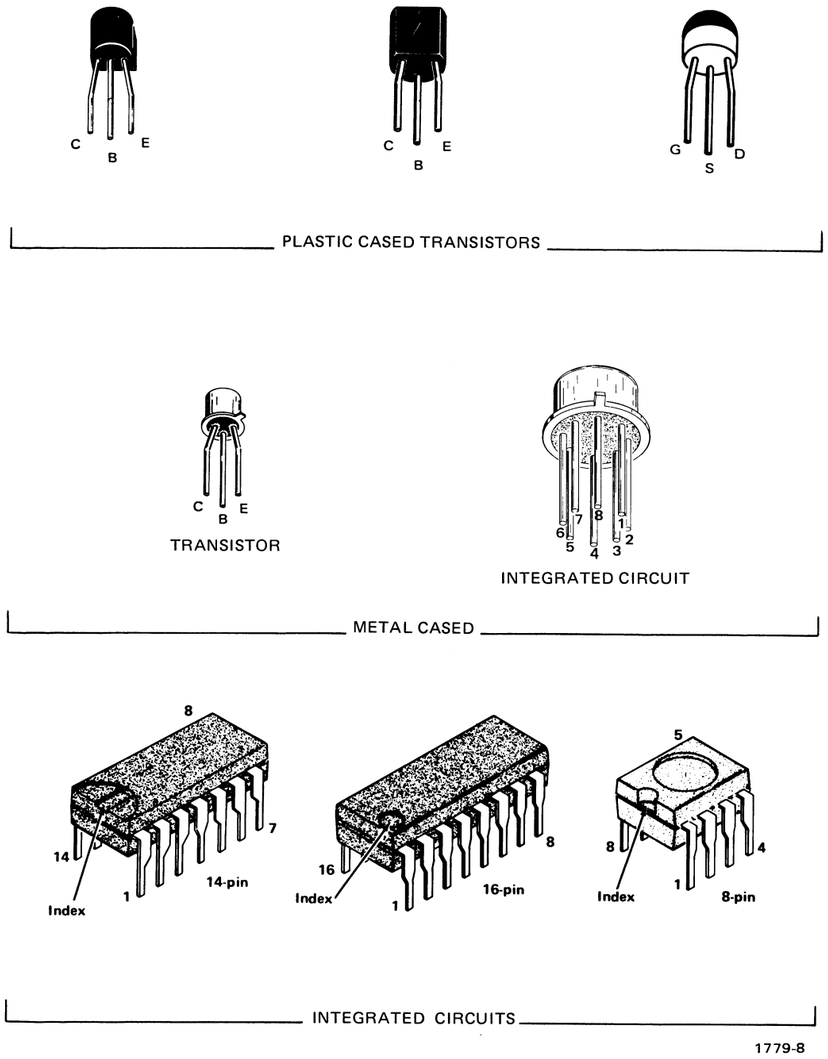


Fig. 9-1. Semiconductor lead configurations.

DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

Symbols and Reference Designators

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

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

Resistors = Ohms (Ω).

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.

Abbreviations are based on ANSI Y1.1-1972.

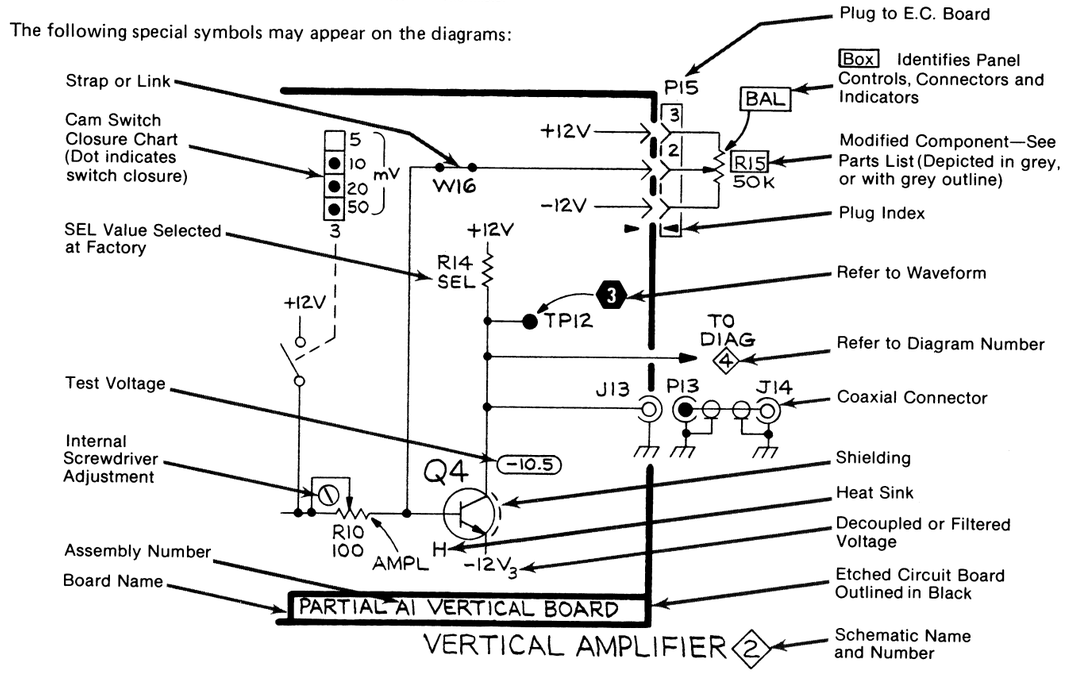
Other ANSI standards that are used in the preparation of diagrams by Tektronix, Inc. are:

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.

The following prefix letters are used as reference designators to identify components or assemblies on the diagrams.

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

The following special symbols may appear on the diagrams:



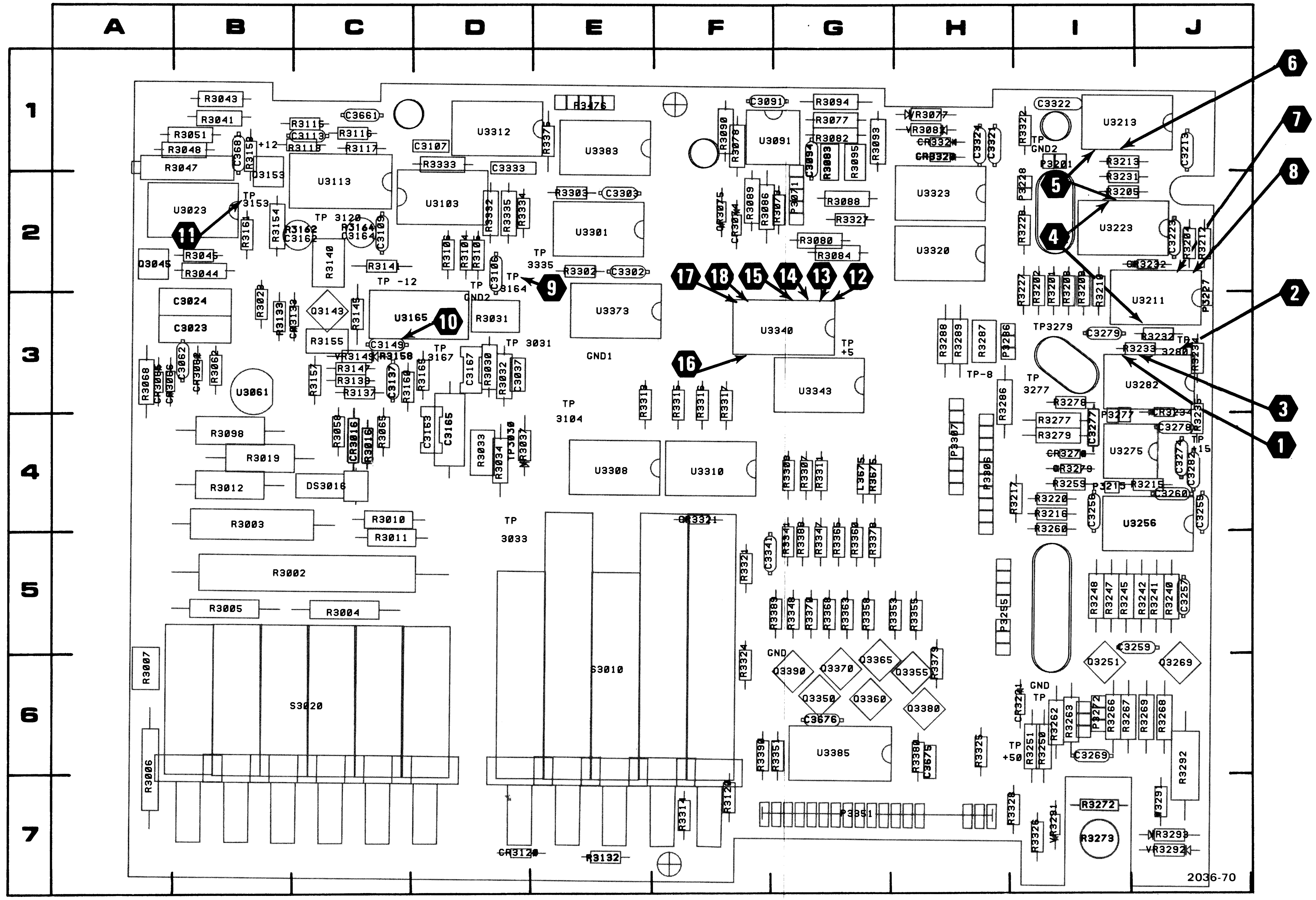
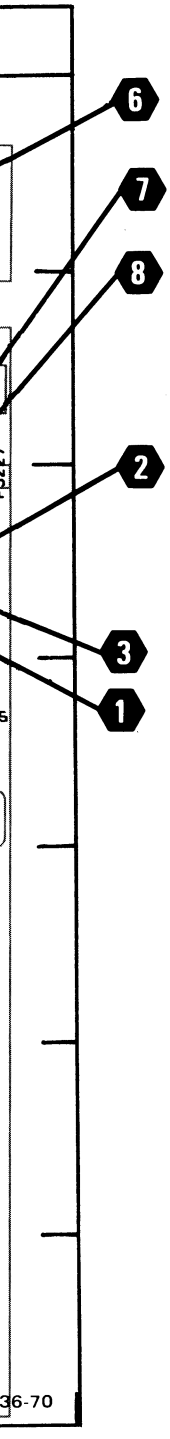


Fig. 9-2. A1 Main board component locations (SN B020000—UP).

*See Parts List for serial number ranges.

†Located on back side of board



CKT NO	GRID LOC
C3023	3B
C3024	3B
C3037	3D
C3062	3B
C3091	1F
C3094	1G
C3106	2D
C3107	1D
C3109	2C
C3113	1C
C3137	3C
C3149	3C
C3162*	2B
C3163	4D
C3164*	2C
C3165	4D
C3167	3D
C3213	1J
C3223	2J
C3255	4J
C3256	4I
C3257	5J
C3259	5I
C3260	4J
C3269	6I
C3274	4J
C3277	4I
C3278	4J
C3279	3I
C3281*	†
C3282	4J
C3302	2E
C3303	2E
C3321	1H
C3322	1I
C3324	1H
C3333	1D
C3341	5F
C3661	1C
C3675	6H
C3676	6G
C3681	1B
CR3016	4C
CR3062	3B
CR3065	3A
CR3066	3A
CR3074	2F
CR3075	2F
CR3120	7D
CR3133	3B
CR3221	6I
CR3232	2J
CR3234	3J
CR3278	4I
CR3279	4I
CR3320	1H
CR3321	4F
CR3324	1H

CKT NO	GRID LOC
DS3016	4C
L3675	4G
P3071	2G
P3201	1I
P3215	4I
P3227	3J
P3228	2I
P3255	5H
P3272	6I
P3277	4I
P3286	3H
P3306	4H
P3307	4H
P3351	7G
P3476	1E
Q2632	1C
Q2634	2D
Q2636	1D
Q2638	2D
Q3045	2A
Q3143	3C
Q3153	1B
Q3251	6I
Q3269	6J
Q3350	6G
Q3355	6H
Q3360	6G
Q3365	6G
Q3370	6G
Q3380	6H
Q3390	6G
R3002	5B
R3003	4B
R3004	5C
R3005	5B
R3006	6A
R3007	6A
R3010	4C
R3011	5C
R3012	4B
R3016	4C
R3019	4B
R3023	3B
R3030	3D
R3031	3D
R3032	3D
R3033	4D
R3034	4D
R3041	1B
R3043	1B
R3044	2B
R3045	2B
R3047	1B
R3048	1B
R3051	1B
R3058	4C

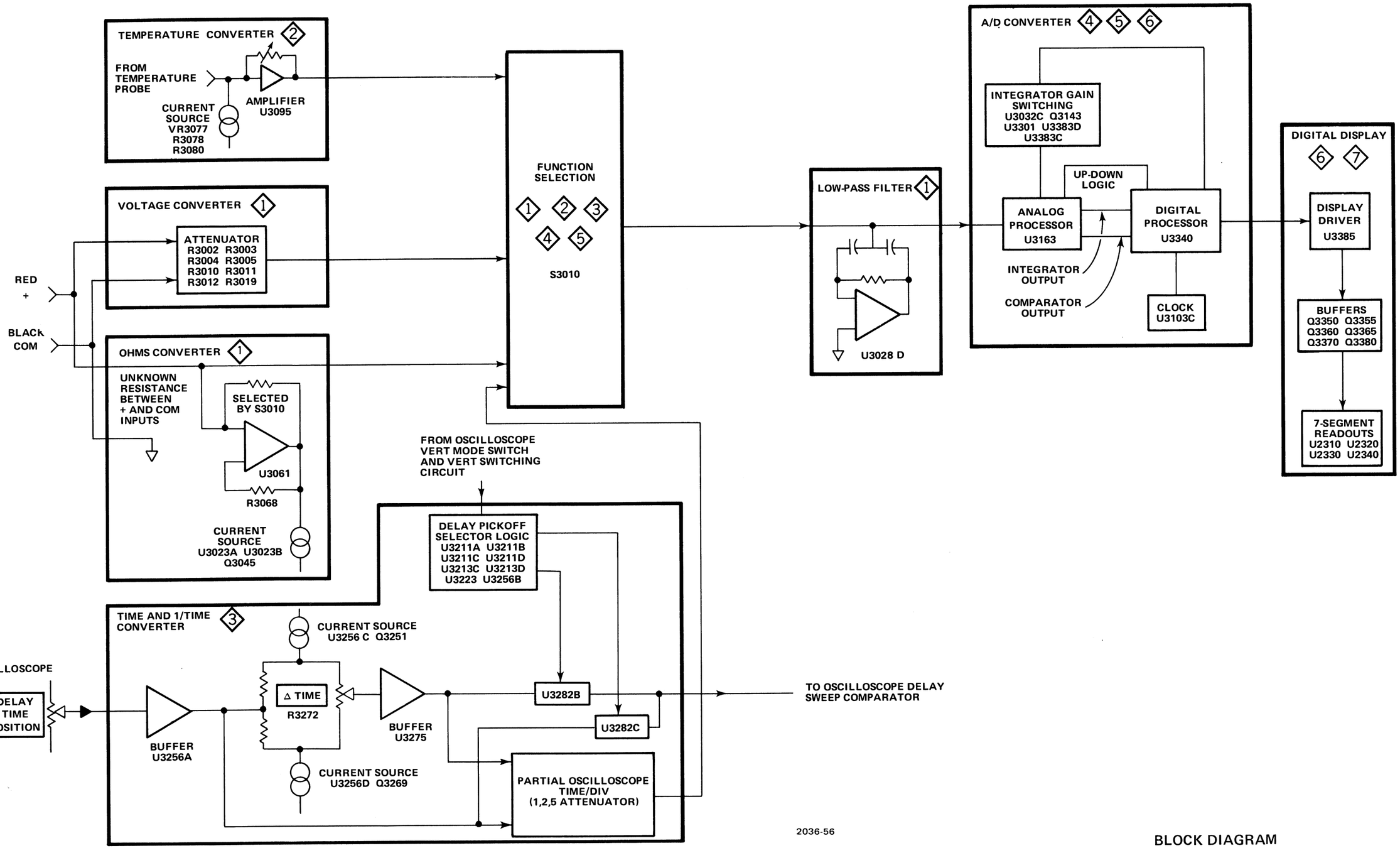
CKT NO	GRID LOC
R3062	3B
R3065	4C
R3068	3A
R3073	2G
R3077	1G
R3078	1F
R3080	2G
R3082	1G
R3083	1G
R3084	2G
R3086	2F
R3088	2G
R3089	2F
R3090	1F
R3093	1G
R3094	1G
R3095	1G
R3098	4B
R3104	2D
R3105	2D
R3106	2D
R3113	1C
R3115	1C
R3116	1C
R3117	1C
R3120	7F
R3132	7E
R3133	3B
R3137	3C
R3138	3C
R3140	2C
R3141	2C
R3145	3C
R3147	3C
R3153	1B
R3154	2B
R3155	3C
R3157	3C
R3158	3C
R3160	3C
R3161	2B
R3162*	2B
R3164*	2C
R3165	3D
R3201	2I
R3202	2I
R3204	2J
R3205	2I
R3208	2I
R3209	2I
R3210	2I
R3212	2J
R3213	1I
R3215	4J
R3216	4I
R3217	4H
R3220	4I
R3227	2I
R3228	2I
R3231	2I
R3232	3J

CKT NO	GRID LOC
R3233	3J
R3234	3J
R3235	4J
R3240	5J
R3241	5J
R3242	5J
R3245	5I
R3247	5I
R3248	5I
R3250	6I
R3251	6I
R3259	4I
R3260	4I
R3262	6I
R3263	6I
R3266	6I
R3267	6I
R3268	6J
R3269	6J
R3272	7I
R3273	7I
R3277	4I
R3278	3I
R3279	4I
R3286	3H
R3287	3H
R3288	3H
R3289	3H
R3292	6J
R3302	2E
R3303	2E
R3307	4G
R3309	4G
R3311	4G
R3313	3E
R3314	7F
R3315	3F
R3316	3F
R3317	3F
R3321	5F
R3322	1I
R3324	6F
R3325	6H
R3326	7I
R3327	2G
R3328	7I
R3332	2D
R3333	1D
R3334	2D
R3335	2D
R3341	5G
R3347	5G
R3348	5G
R3351	6G
R3353	5G
R3355	5H
R3358	5G
R3360	5G
R3363	5G

CKT NO	GRID LOC
R3365	5G
R3368	5G
R3370	5G
R3375	1E
R3378	5G
R3379	6H
R3380	6H
R3388	5G
R3389	5F
R3390	6F
R3675	4G
S3010	6E
S3020	6C
TP3030	4D
TP3031	3D
TP3033	4D
TP3104	3E
TP3120	2C
TP3153	2B
TP3164	2D
TP3167	3D
TP3277	3I
TP3279	3I
TP3280	3J
TP3292	6H
TP3335	2E
U3023	2B
U3061	3B
U3091	1F
U3103	2D
U3113	2C
U3165	3C
U3211	3J
U3213	1I
U3223	2I
U3256	4J
U3275	4I
U3282	3J
U3301	2E
U3308	4E
U3310	4F
U3312	1D
U3320	2H
U3323	2H
U3340	3G
U3343	3G
U3373	3E
U3383	1E
U3385	6G
VR3037	4D
VR3077	1H
VR3082	1H
VR3149	3C
VR3291	7I
VR3292	7J
VR3293	7J
W3291	7J

*See Parts List for serial number ranges.

†Located on back side of board



2036-56

BLOCK DIAGRAM

A1 MAIN BD COMP LOC
(SN B010100—B019999)

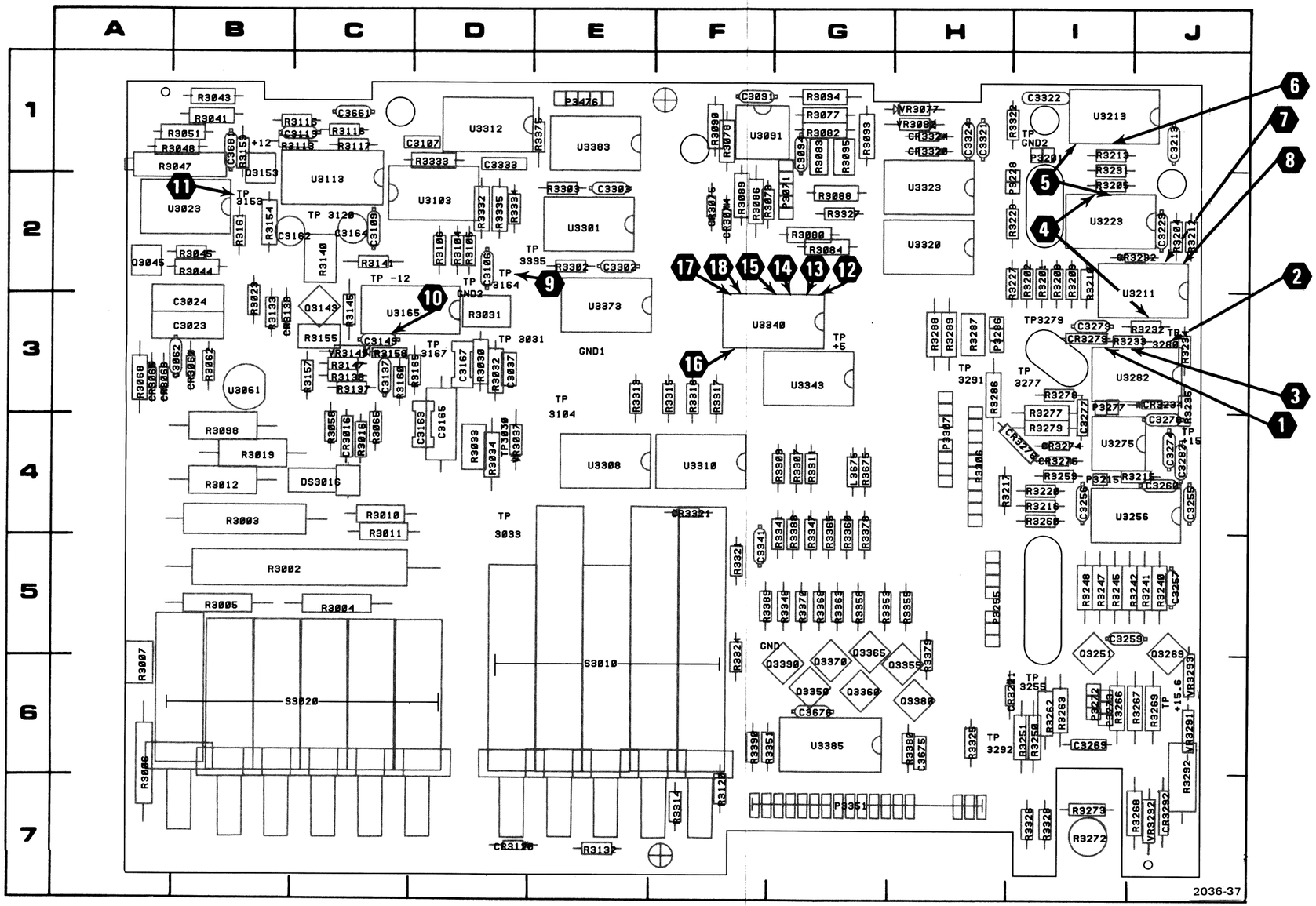
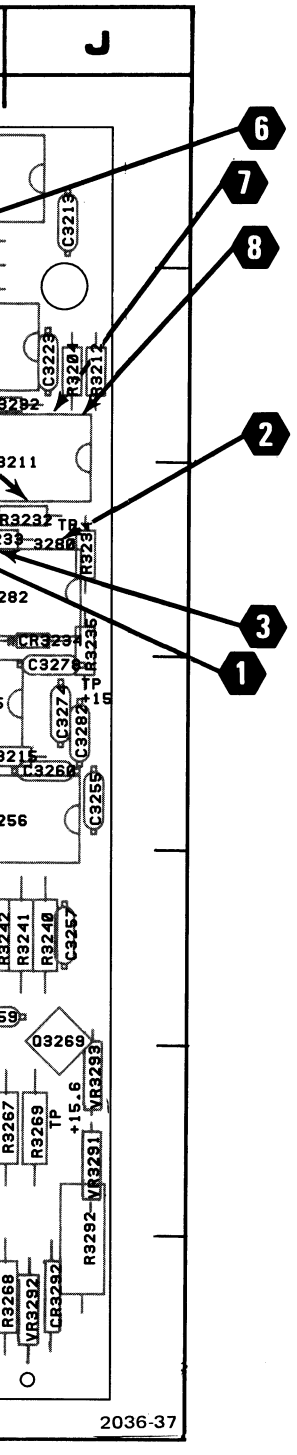


Fig. 9-3. A1 Main board component locations (SN B010100—B019999).

CKT NO	GRID LOC	CKT NO	GRID LOC
C3023	3B	CR3320	1H
C3024	3B	CR3321	4F
C3037	3D	CR3324	1H
C3062	3B		
C3091	1F	DS3016	4C
C3094	1G		
C3106	2D	L3675	4G
C3107	1D		
C3109	2C	P3071	2G
C3113	1C	P3201	1I
C3137	3C	P3215	4I
C3149	3C	P3228	2I
C3162	2B	P3255	5H
C3163	4D	P3272	6I
C3164	2C	P3277	4I
C3165	4D	P3286	3H
C3167	3D	P3306	4H
C3213	1J	P3307	4H
C3223	2J	P3351	7G
C3255	4J	P3476	1E
C3256	4I		
C3257	5J	Q3045	2A
C3259	5I	Q3143	3C
C3260	4J	Q3153	2B
C3269*	6I	Q3251	5I
C3274	4J	Q3269	5J
C3277*	4I	Q3350	6G
C3278	4J	Q3355	6H
C3279	3I	Q3360	6G
C3282	4J	Q3365	5G
C3302	2E	Q3370	6G
C3303	2E	Q3380	6H
C3321	1H	Q3390	6G
C3322	1I		
C3324	1H	R3002	5B
C3333	1D	R3003	4B
C3341	5F	R3004	5C
C3661	1C	R3005	5B
C3675	6H	R3006	6A
C3676	6G	R3007	6A
C3681	1B	R3010	4C
		R3011	5C
CR3016	4C	R3012	4B
CR3062	3B	R3016	4C
CR3065	3A	R3019	4B
CR3066	3A	R3023	3B
CR3074	2F	R3030	3D
CR3075	2F	R3031	3D
CR3120	7D	R3032	3D
CR3133	3B	R3033	4D
CR3221	6I	R3034	4D
CR3232	2J	R3041	1B
CR3234	3J	R3043	1B
CR3274*	4I	R3044	2B
CR3275*	4I	R3045	2B
CR3278*	4I	R3047	1B
CR3279*	3I	R3048	1B
CR3292*	7J	R3051	1B

*See Parts List for serial number ranges.



*See Parts List for serial number ranges.

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C3023	3B	CR3320	1H	R3058	4C	R3231	1I	R3358	5G	VR3149	3C
C3024	3B	CR3321	4F	R3062	3B	R3232	3J	R3360	4G	VR3291*	6J
C3037	3D	CR3324	1H	R3065	4C	R3233	3J	R3363	5G	VR3292	7J
C3062	3B			R3068	3A	R3234	3J	R3365	4G	VR3293*	6J
C3091	1F	DS3016	4C	R3073	2F	R3235	3J	R3368	5G		
C3094	1G			R3077	1G	R3240	5J	R3370	5G		
C3106	2D	L3675	4G	R3078	1F	R3241	5J	R3375	1E		
C3107	1D			R3080	2G	R3242	5J	R3378	4G		
C3109	2C	P3071	2G	R3082	1G	R3245	5I	R3379	5H		
C3113	1C	P3201	1I	R3083	1G	R3247	5I	R3380	6H		
C3137	3C	P3215	4I	R3084	2G	R3248	5I	R3388	4G		
C3149	3C	P3228	2I	R3086	2F	R3250	6I	R3389	5F		
C3162	2B	P3255	5H	R3088	2G	R3251	6I	R3390	6F		
C3163	4D	P3272	6I	R3089	2F	R3259	4I	R3675	4G		
C3164	2C	P3277	4I	R3090	1F	R3260	4I				
C3165	4D	P3286	3H	R3093	1G	R3262	6I	S3010	6E		
C3167	3D	P3306	4H	R3094	1G	R3263	6I	S3020	6C		
C3213	1J	P3307	4H	R3095	1G	R3266	6I				
C3223	2J	P3351	7G	R3098	4B	R3267	6J	TP3030	4D		
C3255	4J	P3476	1E	R3104	2D	R3268	7J	TP3031	3D		
C3256	4I			R3105	2D	R3269	6J	TP3033	4D		
C3257	5J	Q3045	2A	R3106	2D	R3272	7I	TP3104	3E		
C3259	5I	Q3143	3C	R3113	1C	R3273	7I	TP3120	2C		
C3260	4J	Q3153	2B	R3115	1C	R3277	4I	TP3153	2B		
C3269*	6I	Q3251	5I	R3116	1C	R3278	3I	TP3164	2D		
C3274	4J	Q3269	5J	R3117	1C	R3279	4I	TP3167	3D		
C3277*	4I	Q3350	6G	R3120	7F	R3286	3H	TP3277	3I		
C3278	4J	Q3355	6H	R3132	7E	R3287	3H	TP3279	3I		
C3279	3I	Q3360	6G	R3133	3B	R3288	3H	TP3280	3J		
C3282	4J	Q3365	5G	R3137	3C	R3289	3H	TP3335	2D		
C3302	2E	Q3370	6G	R3138	3C	R3292	6J				
C3303	2E	Q3380	6H	R3140	2C	R3302	2E	U3023	2B		
C3321	1H	Q3390	6G	R3141	2C	R3303	2E	U3061	3B		
C3322	1I			R3145	3C	R3307	4G	U3091	1F		
C3324	1H	R3002	5B	R3147	3C	R3309	4G	U3103	2D		
C3333	1D	R3003	4B	R3153	1B	R3311	4G	U3113	2C		
C3341	5F	R3004	5C	R3154	2B	R3313	3E	U3165	3C		
C3661	1C	R3005	5B	R3155	3C	R3314	7F	U3211	2J		
C3675	6H	R3006	6A	R3157	3C	R3315	3F	U3213	1I		
C3676	6G	R3007	6A	R3158	3C	R3316	3F	U3223	2I		
C3681	1B	R3010	4C	R3160	3C	R3317	3F	U3256	4J		
		R3011	5C	R3161	2B	R3321	5F	U3275	4I		
CR3016	4C	R3012	4B	R3165	3D	R3322	1I	U3282	3J		
CR3062	3B	R3016	4C	R3201	2I	R3324	5F	U3301	2E		
CR3065	3A	R3019	4B	R3202	2I	R3325	6H	U3308	4E		
CR3066	3A	R3023	3B	R3204	2J	R3326	7I	U3310	4F		
CR3074	2F	R3030	3D	R3205	2I	R3327	2G	U3312	1D		
CR3075	2F	R3031	3D	R3208	2I	R3328	7I	U3320	2H		
CR3120	7D	R3032	3D	R3209	2I	R3332	2D	U3323	2H		
CR3133	3B	R3033	4D	R3210	2I	R3333	1D	U3340	3G		
CR3221	6I	R3034	4D	R3212	2J	R3334	2D	U3343	3G		
CR3232	2J	R3041	1B	R3213	1I	R3335	2D	U3373	3E		
CR3234	3J	R3043	1B	R3215	4J	R3341	4G	U3383	1E		
CR3274*	4I	R3044	2B	R3216	4I	R3347	4G	U3385	6G		
CR3275*	4I	R3045	2B	R3217	4H	R3348	5G				
CR3278*	4I	R3047	1B	R3220	4I	R3351	6G	VR3037	4D		
CR3279*	3I	R3048	1B	R3227	2I	R3353	5G	VR3077	1H		
CR3292*	7J	R3051	1B	R3228	2I	R3355	5H	VR3082	1H		

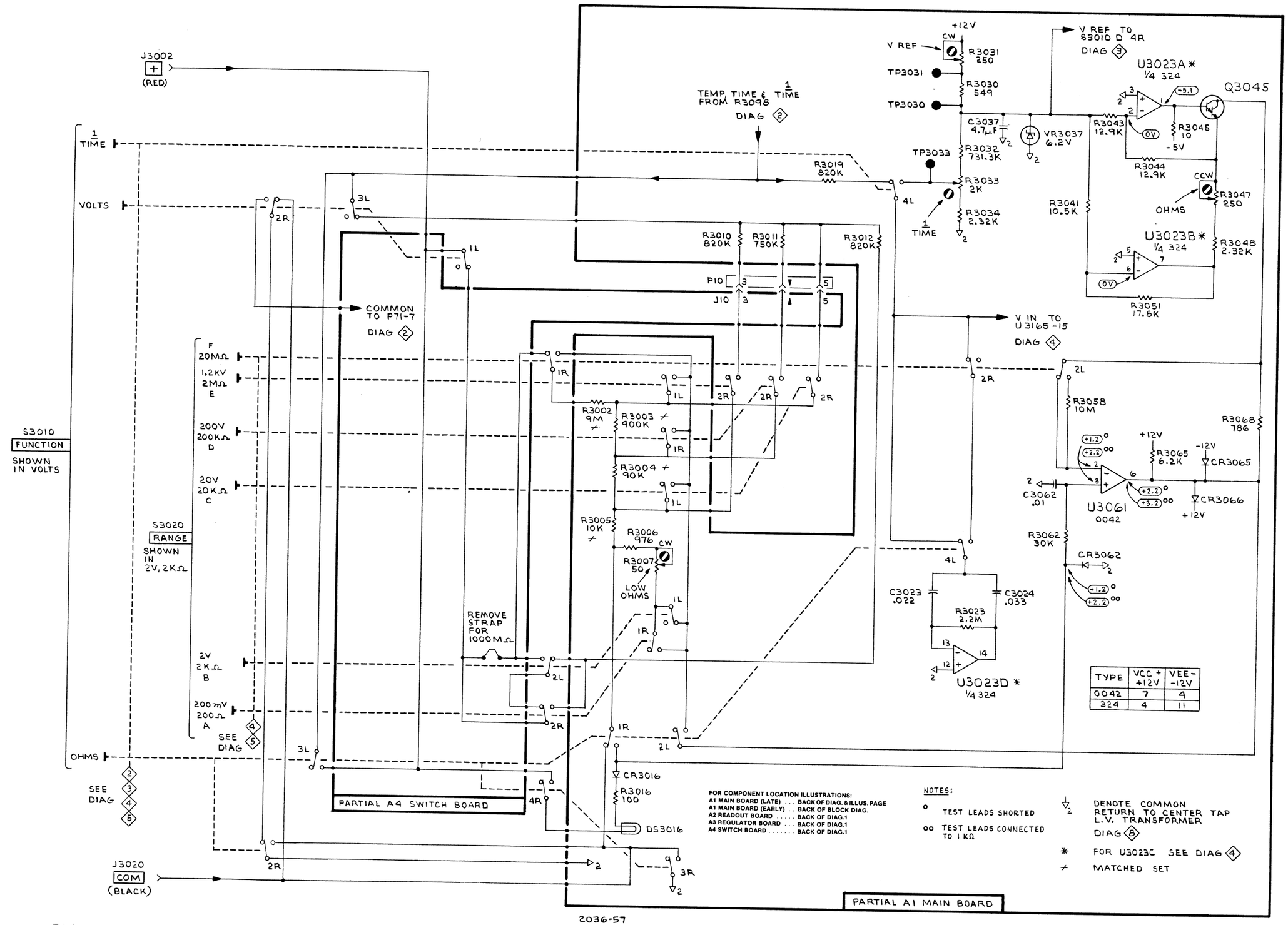
VOLTAGE CONDITIONS

DM44 FUNCTION	OHMS
DM44 RANGE	2 kΩ

Voltages measured with respect to ground 2 except as noted on the diagram.

Either short the DM44 leads together or connect them to a 1 kΩ resistor as noted on the diagram.

Voltages measured with a Tektronix DM501 Digital Multimeter.



TYPE	VCC + +12V	VEE - -12V
0042	7	4
324	4	11

FOR COMPONENT LOCATION ILLUSTRATIONS:
A1 MAIN BOARD (LATE) . . . BACK OF DIAG. & ILLUS. PAGE
A1 MAIN BOARD (EARLY) . . BACK OF BLOCK DIAG.
A2 READOUT BOARD . . . . . BACK OF DIAG.1
A3 REGULATOR BOARD . . . BACK OF DIAG.1
A4 SWITCH BOARD . . . . . BACK OF DIAG.1

NOTES:

o TEST LEADS SHORTED

oo TEST LEADS CONNECTED TO 1 KΩ

▽2 DENOTE COMMON RETURN TO CENTER TAP L.V. TRANSFORMER DIAG 8

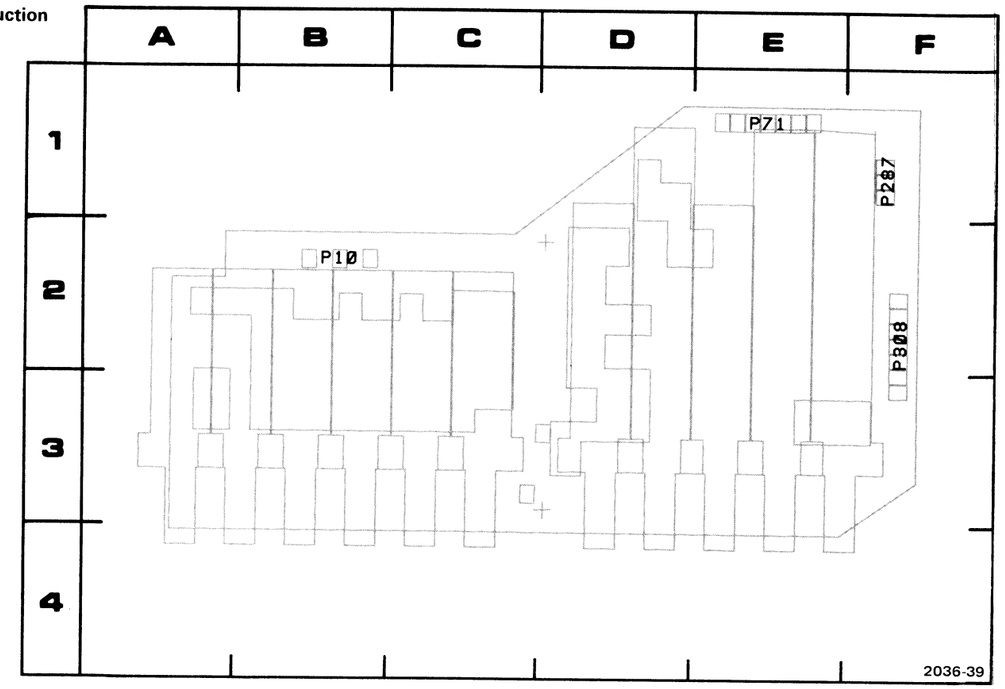
* FOR U3023C SEE DIAG 4

≠ MATCHED SET

DM44

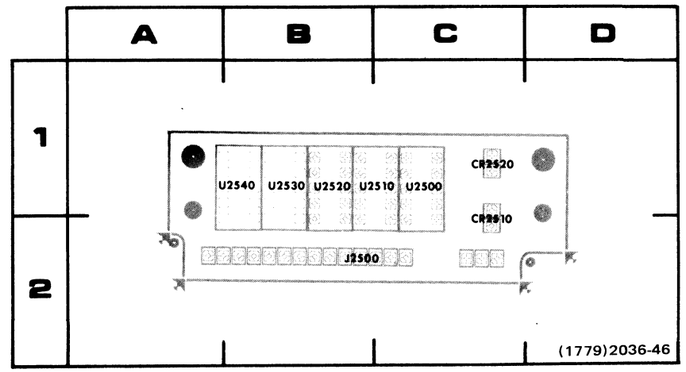
2036-57
REV.B, JAN. , 1978

INPUT ATTENUATOR & OHMS CONVERTER 1



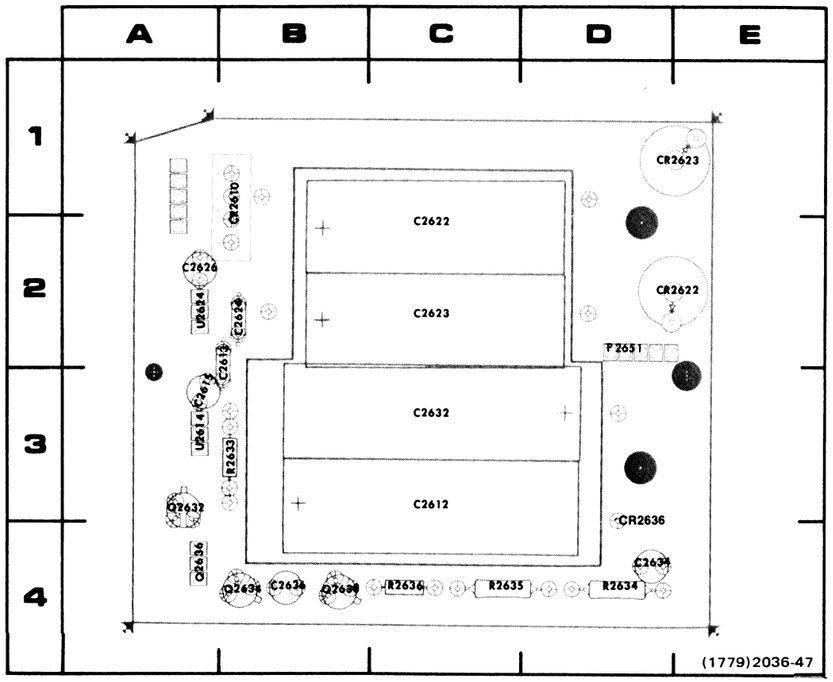
CKT NO	GRID LOC
P10	2B
P71	1E
P287	1F
P308	2F

Fig. 9-4. A4 Switch board component locations.



CKT NO	GRID LOC
CR2510	2C
CR2520	1C
J2500	2B
U2500	1C
U2510	1B
U2520	1B
U2530	1B
U2540	1B

Fig. 9-5. A2 Readout board component locations.



CKT NO	GRID LOC	CKT NO	GRID LOC
C2612	3C	P2651	2D
C2613	2B		
C2615	3A	Q2632	3A
C2622	2C	Q2634	4B
C2623	2C	Q2636	4A
C2624	2B	Q2638	4B
C2626	2A		
C2632	3C	R2633	3B
C2634	4D	R2634	4D
C2636*	4B	R2635	4C
		R2636	4C
CR2610	1B		
CR2622	2E	U2614	3A
CR2623	1E	U2624	2A
CR2636	3D		

*See Parts List for serial number ranges.

Fig. 9-6. A3 Regulator board component locations.

VOLTAGE CONDITIONS

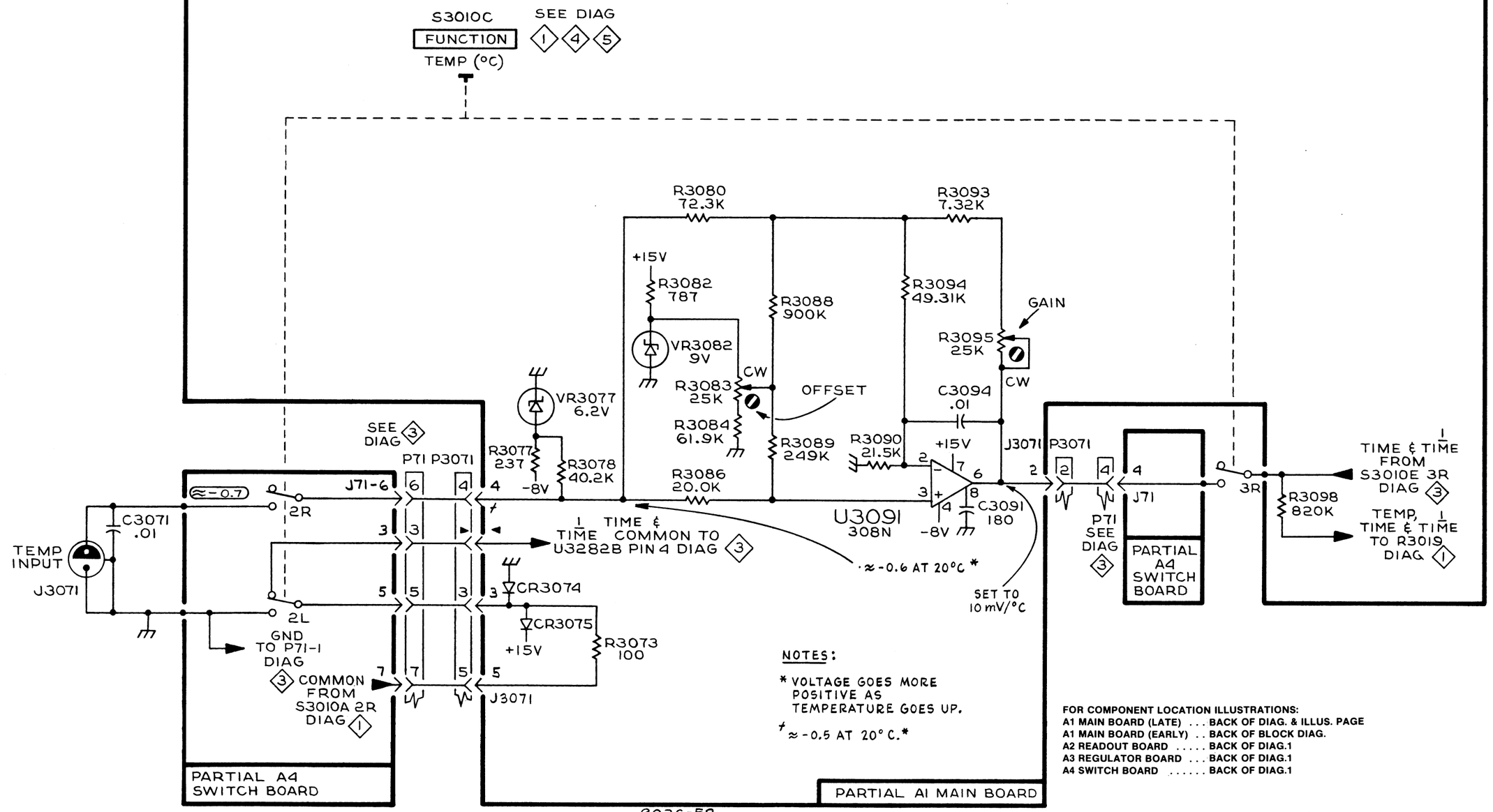
DM44 FUNCTION TEMP (°C)

Temperature probe connected to DM44.

Ambient temperature about 20 °C.

Voltages measured with respect to chassis ground.

Voltages measured with a Tektronix DM501 Digital Multimeter.



DM44

2036-58
REV. A, MARCH 1977

TEMPERATURE 2

WAVEFORM CONDITIONS

DM44

FUNCTION	TIME

OSCILLOSCOPE (TO WHICH DM44 IS ATTACHED

A TIME/DIV	1 ms
B TIME/DIV	5 μs
HORIZ DISPLAY	A INTEN
VERT MODE	ALT*
DELAY TIME POSITION	To set reference point to the third vertical graticule line
TIME	For a DM44 reading of about 06.00

*Must be set to ALT for stable triggering of test oscilloscope.

TEST OSCILLOSCOPE

TRIGGER MODE	NORM
TRIGGER SOURCE	CH 2
VERT MODE	CH 1 (After trigger setup)
CH 2 VOLTS/DIV	1 V

TRIGGER SETUP

1. Connect CH 2 probe to pin 1 of U3211 (or one lead of R3212).
2. Set VERT MODE to CH 2.
3. Set TRIGGER SLOPE as indicated with desired waveform.
4. Adjust TRIGGER LEVEL for a stable display triggered on the slope selected in step 3.
5. Set VERT MODE to CH 1 (do not readjust TRIGGER controls).
6. Make mesaurement with CH 1 probe.

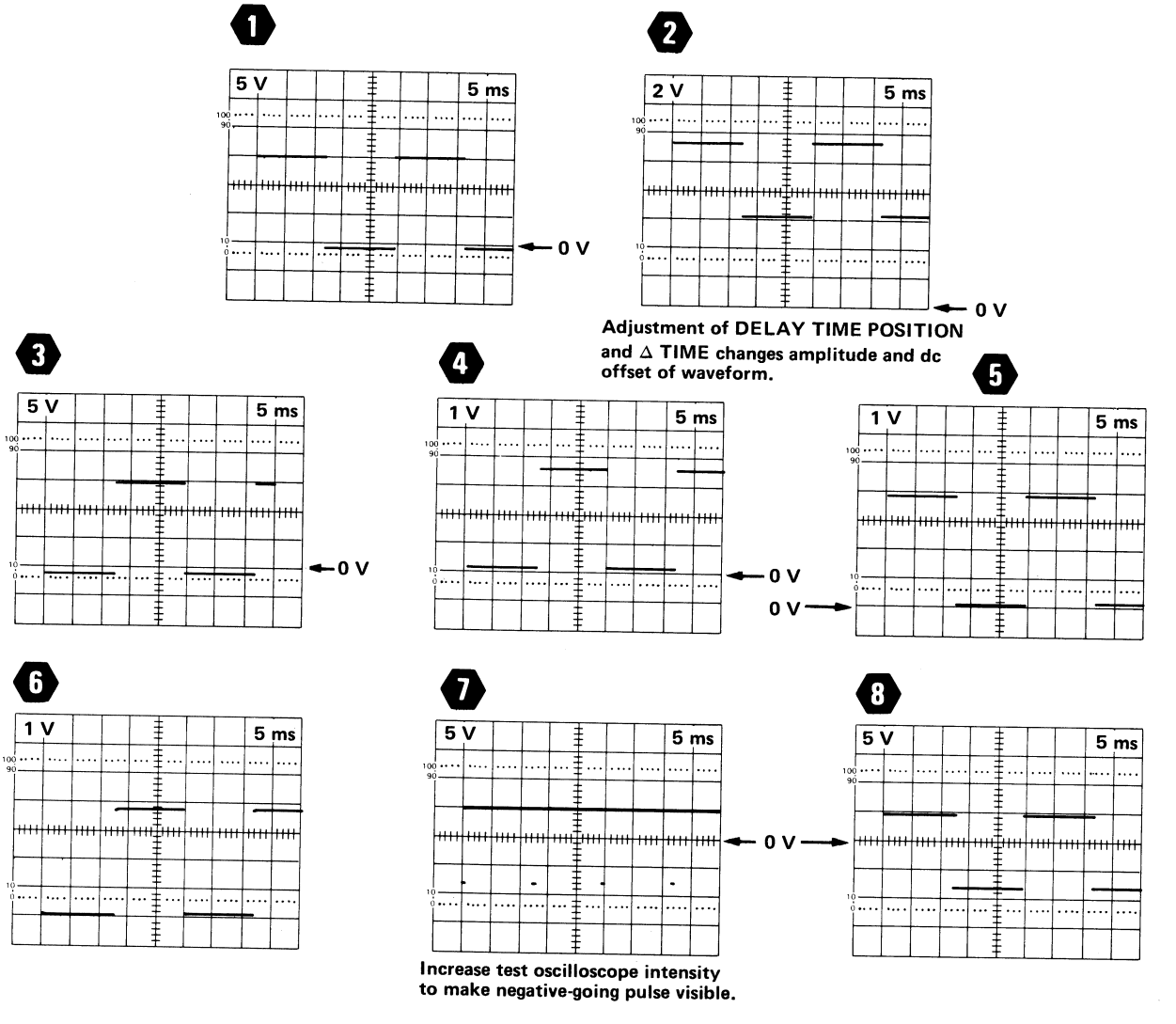
VOLTAGE CONDITIONS

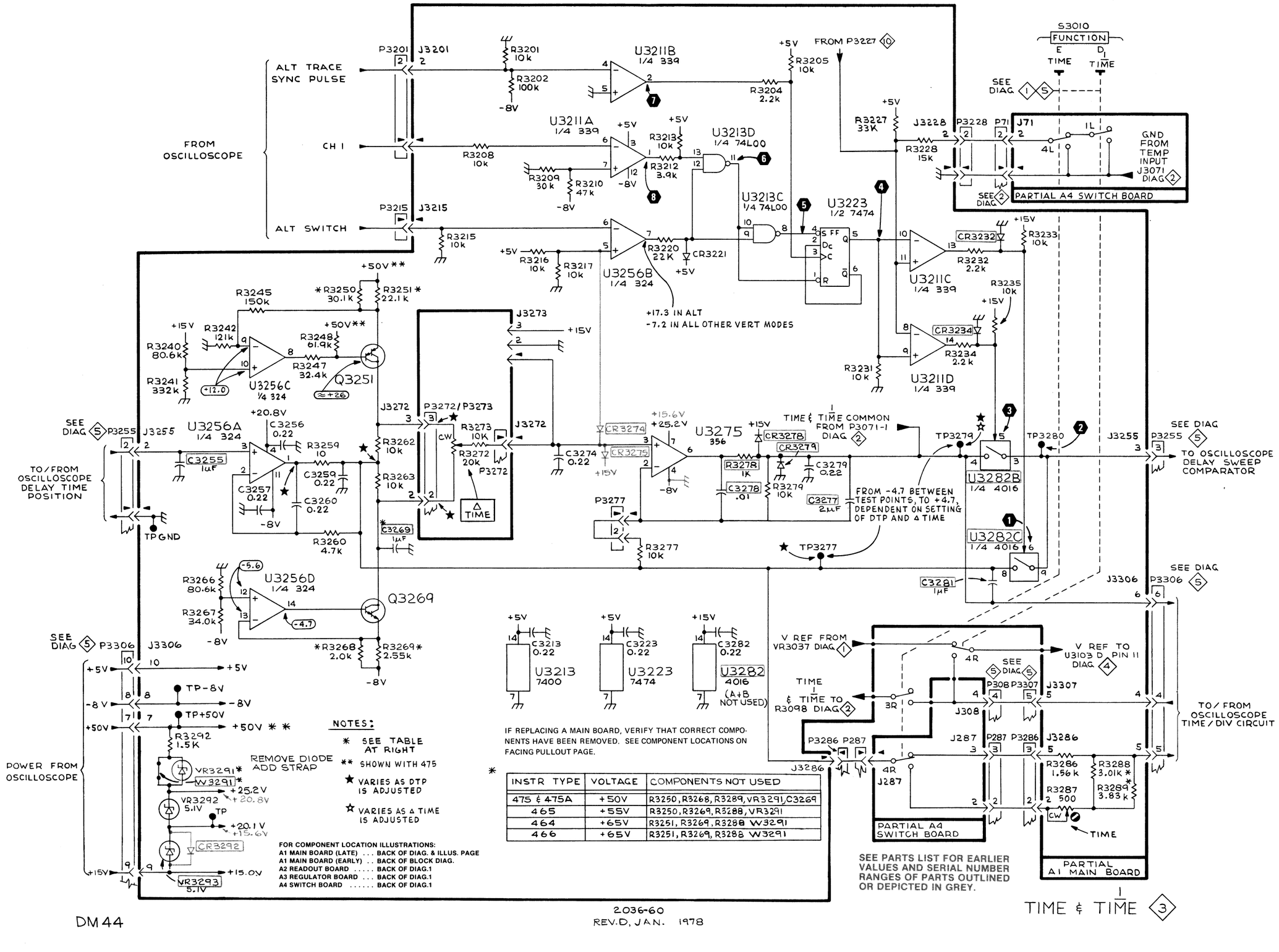
DM44 FUNCTION	TIME

RECOMMENDED TEST EQUIPMENT

Tektronix 465 Oscillsocope with two 10X probes for waveforms.

Tektronix DM501 or DM502 Digital Multimeter for voltages.





INSTR TYPE	VOLTAGE	COMPONENTS NOT USED
475 & 475A	+50V	R3250, R3268, R3289, VR3291, C3269
465	+55V	R3250, R3269, R3288, VR3291
464	+65V	R3251, R3269, R3288 W3291
466	+65V	R3251, R3269, R3288 W3291

WAVEFORM CONDITIONS

DM44

FUNCTION	OHMS
RANGE	2 k

OSCILLOSCOPE (TO WHICH DM44 IS ATTACHED

Has no effect on display.;

TEST OSCILLOSCOPE

TRIGGER MODE	NORM
TRIGGER SOURCE	CH 2
VERT MODE	CH 1 (After trigger setup)
CH 2 VOLTS/DIV	1 V

TRIGGER SETUP

1. Connect CH 2 probe to TP3164.
2. Set VERT MODE to CH 2.
3. Set TRIGGER SLOPE as indicated with desired waveform).
4. Adjust TRIGGER LEVEL for a stable display triggered on the slope selected in step 3.
5. Set VERT MODE to CH 1 (do not readjust TRIGGER controls).
6. Make measurement with CH 1 probe.

VOLTAGE CONDITIONS

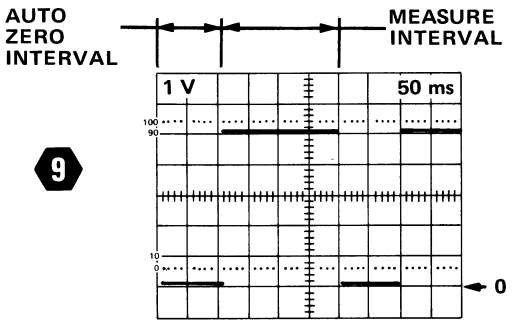
DM44 FUNCTION	TIME
A TIME/DIV	1 ms
B TIME/DIV	5 μs
HORIZ DISPLAY	A INTEN
DELAY TIME POSITION	To position reference point to the third vertical graticule line
TIME	For a DM44 reading of about 06.00

RECOMMENDED TEST EQUIPMENT

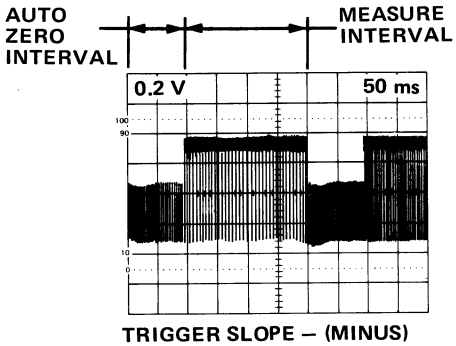
Tektronix 465 Oscilloscope with two 10X probes for waveforms.

Tektronix DM501 or DM502 Digital Multimeter for voltages.

10A

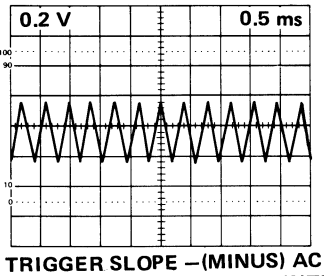


TRIGGER SLOPE –(MINUS)



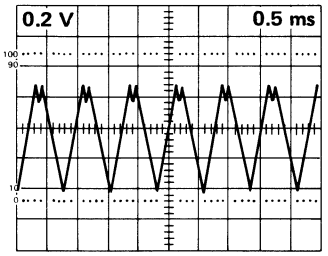
TRIGGER SLOPE – (MINUS) AC COUPLED

10B



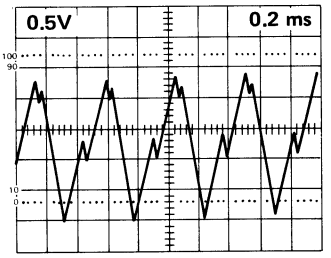
TRIGGER SLOPE –(MINUS) AC COUPLED PORTION OF AUTO ZERO INTERVAL EXPANDED

10C



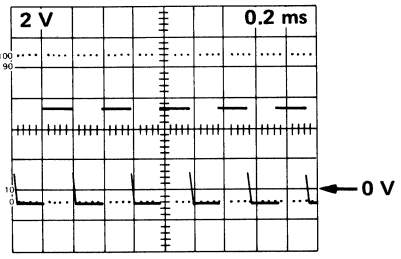
TRIGGER SLOPE + AC COUPLED PORTION OF MEASURE INTERVAL EXPANDED (INPUTS SHORTED)

10D



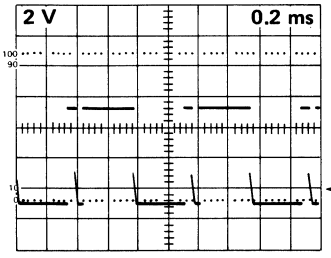
TRIGGER SLOPE + AC COUPLED PORTION OF MEASURE INTERVAL EXPANDED (MEASURING 1 kΩ)

11A



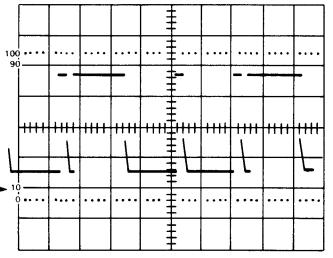
TRIGGER SLOPE –(MINUS) DURING AUTO ZERO INTERVAL

11B

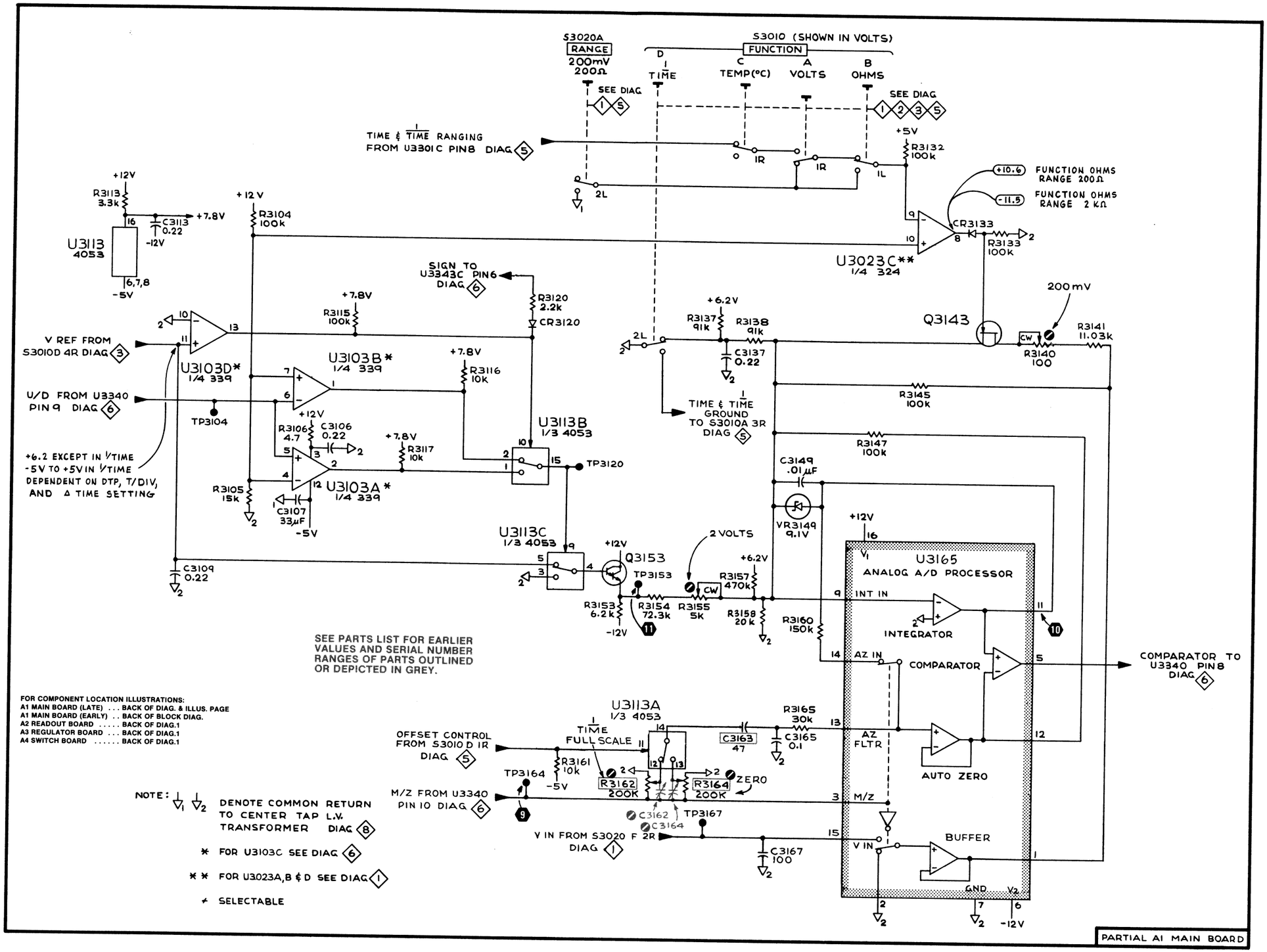


TRIGGER SLOPE + DURING MEASURE INTERVAL (INPUTS SHORTED TOGETHER)

11C



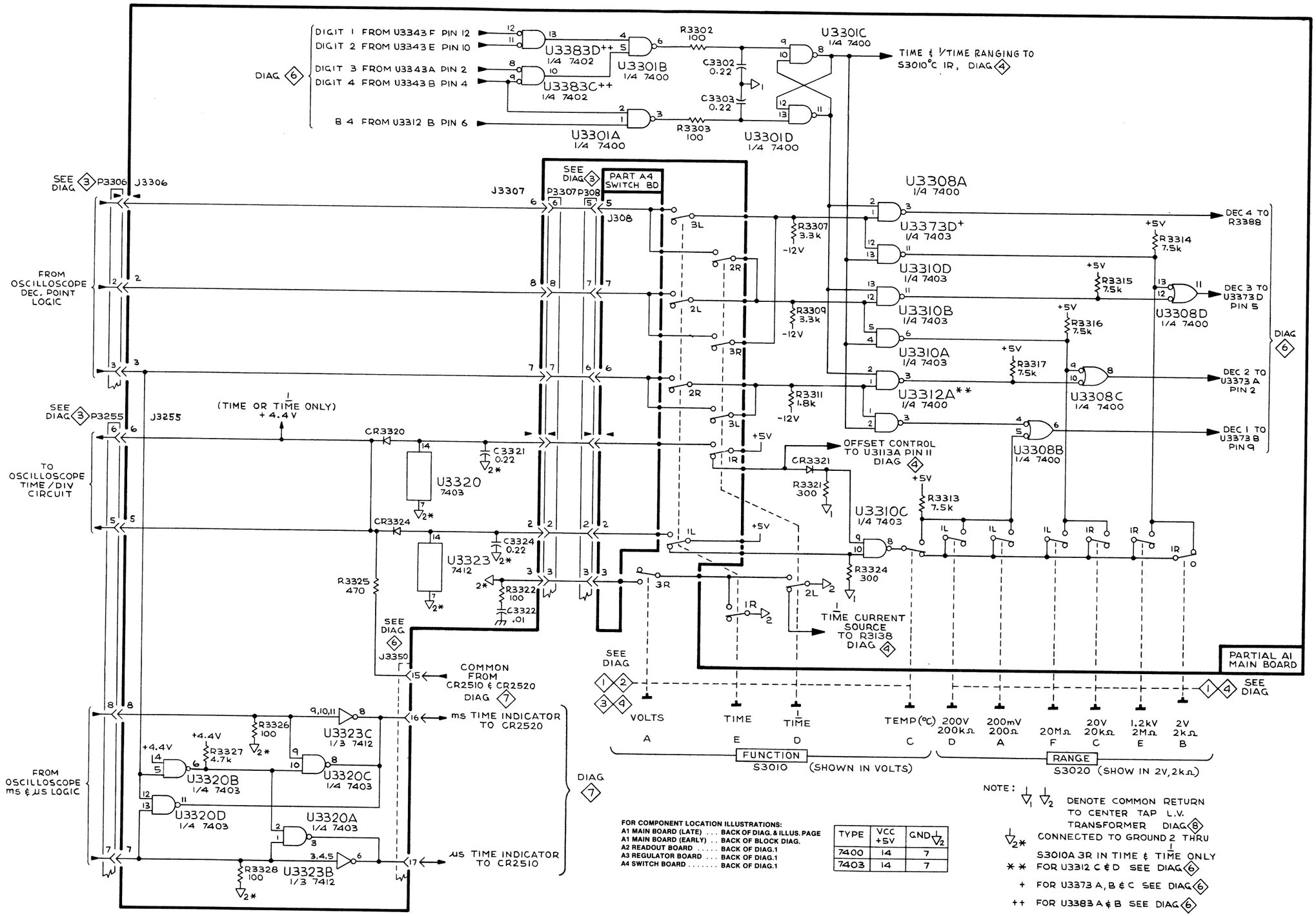
TRIGGER SLOPE + DURING MEASURE INTERVAL (MEASURING 1 kΩ


S3020A
RANGE
200mV
200Ω
S3010 (SHOWN IN VOLTS)
FUNCTION
D TIME
C TEMP(°C)
A VOLTS
B OHMS
SEE DIAG 1 5
SEE DIAG 1 2 3 5
TIME & 1/TIME RANGING FROM U3301C PIN8 DIAG 5
+5V
R3132 100k
1R
1R
1L
2L
+10.6 FUNCTION OHMS RANGE 200Ω
-11.5 FUNCTION OHMS RANGE 2 kΩ
+12V
R3113 3.3k
C3113 0.22
+7.8V
-12V
U3113 4053
6,7,8
-5V
+12 V
R3104 100k
U3023C**
1/4 324
CR3133
R3133 100k
SIGN TO U3343C PIN6 DIAG 6
R3120 2.2k
CR3120
+7.8V
R3115 100k
+6.2V
R3137 91k
R3138 91k
C3137 0.22
Q3143
200mV
R3141 11.03k
CW
R3140 100
V REF FROM S3010D 4R DIAG 3
U3103D*
1/4 339
U3103B*
1/4 339
+7.8V
R3116 10k
U/D FROM U3340 PIN 9 DIAG 6
TP3104
+12V
R3106 4.7
C3106 0.22
+7.8V
R3117 10k
U3113B
1/3 4053
TP3120
R3145 100k
TIME & 1/TIME GROUND TO S3010A 3R DIAG 5
R3147 100k
C3149 .01μF
VR3149 9.1V
+6.2 EXCEPT IN 1/TIME
-5V TO +5V IN 1/TIME
DEPENDENT ON DTP, T/DIV, AND Δ TIME SETTING
R3105 15k
C3107 33μF
-5V
U3103A*
1/4 339
U3113C
1/3 4053
+12V
Q3153
TP3153
2 VOLTS
+6.2V
R3157 470k
CW
R3153 6.2k
R3154 72.3k
R3155 5k
R3158 20k
-12V
C3109 0.22
R3160 150k
+12V
U3165
ANALOG A/D PROCESSOR
INT IN
INTEGRATOR
AZ IN
COMPARATOR
COMPARATOR TO U3340 PIN8 DIAG 6
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN GREY.
U3113A
1/3 4053
TIME FULL SCALE
R3165 30k
C3163 47
C3165 0.1
AZ FLTR
AUTO ZERO
OFFSET CONTROL FROM S3010 D 1R DIAG 5
R3161 10k
-5V
TP3164
R3162 200K
R3164 200K
ZERO
M/Z FROM U3340 PIN 10 DIAG 6
M/Z
C3162
C3164
TP3167
V IN FROM S3020 F 2R DIAG 1
C3167 100
V IN
BUFFER
GND
-12V
FOR COMPONENT LOCATION ILLUSTRATIONS:
A1 MAIN BOARD (LATE) . . . BACK OF DIAG. & ILLUS. PAGE
A1 MAIN BOARD (EARLY) . . BACK OF BLOCK DIAG.
A2 READOUT BOARD . . . . . BACK OF DIAG.1
A3 REGULATOR BOARD . . . BACK OF DIAG.1
A4 SWITCH BOARD . . . . . BACK OF DIAG.1
NOTE: 1/V1 2/V2 DENOTE COMMON RETURN TO CENTER TAP L.V. TRANSFORMER DIAG 8
* FOR U3103C SEE DIAG 6
** FOR U3023A,B & D SEE DIAG 1
SELECTABLE
PARTIAL A1 MAIN BOARD

VOLTAGE CONDITIONS

DM44 FUNCTION	VOLTS
DM44 RANGE	As noted on diagram 5

Voltages measured with a Tektronix DM501 Digital Multimeter.



1/TIME & TIME DECIMAL POINT LOGIC 5

WAVEFORM CONDITIONS

DM44

FUNCTION	TIME

OSCILLOSCOPE (TO WHICH DM44 IS ATTACHED)

A TIME/DIV	1 ms
B TIME/DIV	5 μs
HORIZ DISPLAY	A INTEN
VERT MODE	ALT*
DELAY TIME POSITION	To set reference point to the third vertical graticule line
TIME	For a DM44 reading of about 06.00

*Must be set to ALT for stable triggering of test oscilloscope.

TEST OSCILLOSCOPE

TRIGGER MODE	NORM
TRIGGER SOURCE	CH 2
VERT MODE	CH 1 (After trigger setup)
CH 2 VOLTS/DIV	1 V

TRIGGER SETUP

1. Connect CH 2 probe to TP3164.
2. Set VERT MODE to CH 2.
3. Set TRIGGER SLOPE as indicated with desired waveform.
4. Adjust TRIGGER LEVEL for a stable display triggered on the slope selected in step 3..
5. Set VERT MODE to CH 1 (do not readjust TRIGGER controls).
6. Make measurement with probe connected to CH 1.

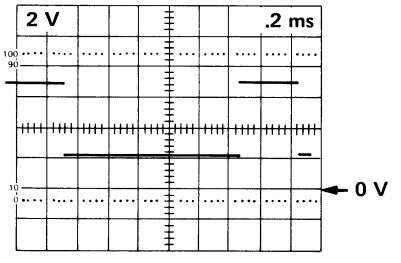
VOLTAGE CONDITIONS

DM44 FUNCTION	TIME

RECOMMENDED TEST EQUIPMENT

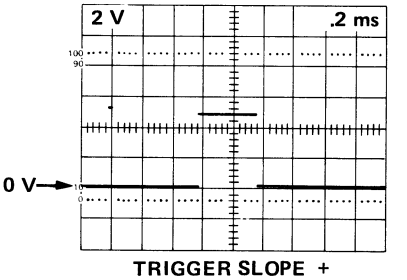
Tektronix 465 Oscilloscope for waveforms. Tektronix DM501 or DM502 Digital Multimeter for voltages.

12



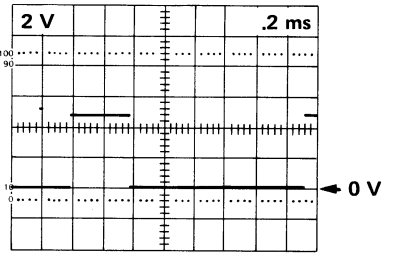
TRIGGER SLOPE +

13



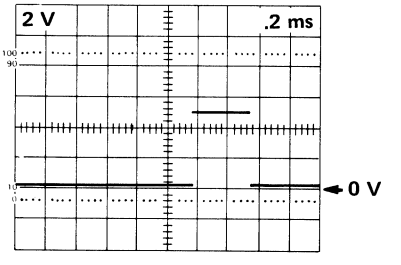
TRIGGER SLOPE +

14



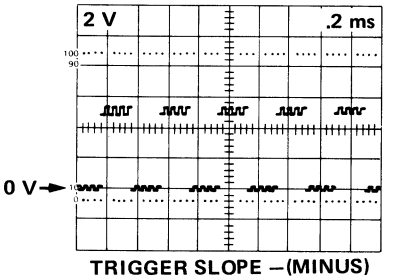
TRIGGER SLOPE +

15



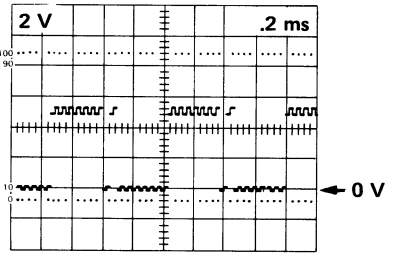
TRIGGER SLOPE +

16 A



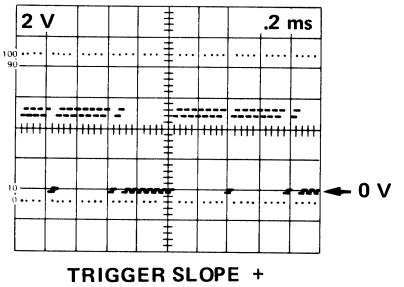
TRIGGER SLOPE – (MINUS)
DURING AUTO ZERO INTERVAL

16 B



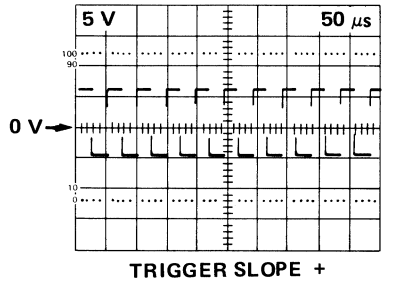
TRIGGER SLOPE +
DURING MEASURE INTERVAL
(INPUTS SHORTED TOGETHER)

16 C



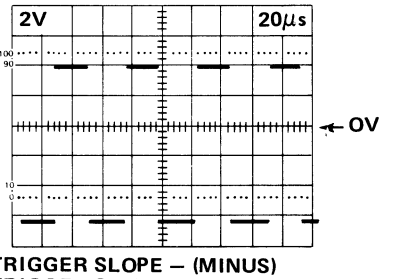
TRIGGER SLOPE +
DURING MEASURE INTERVAL
(MEASURING 1 kΩ)

17



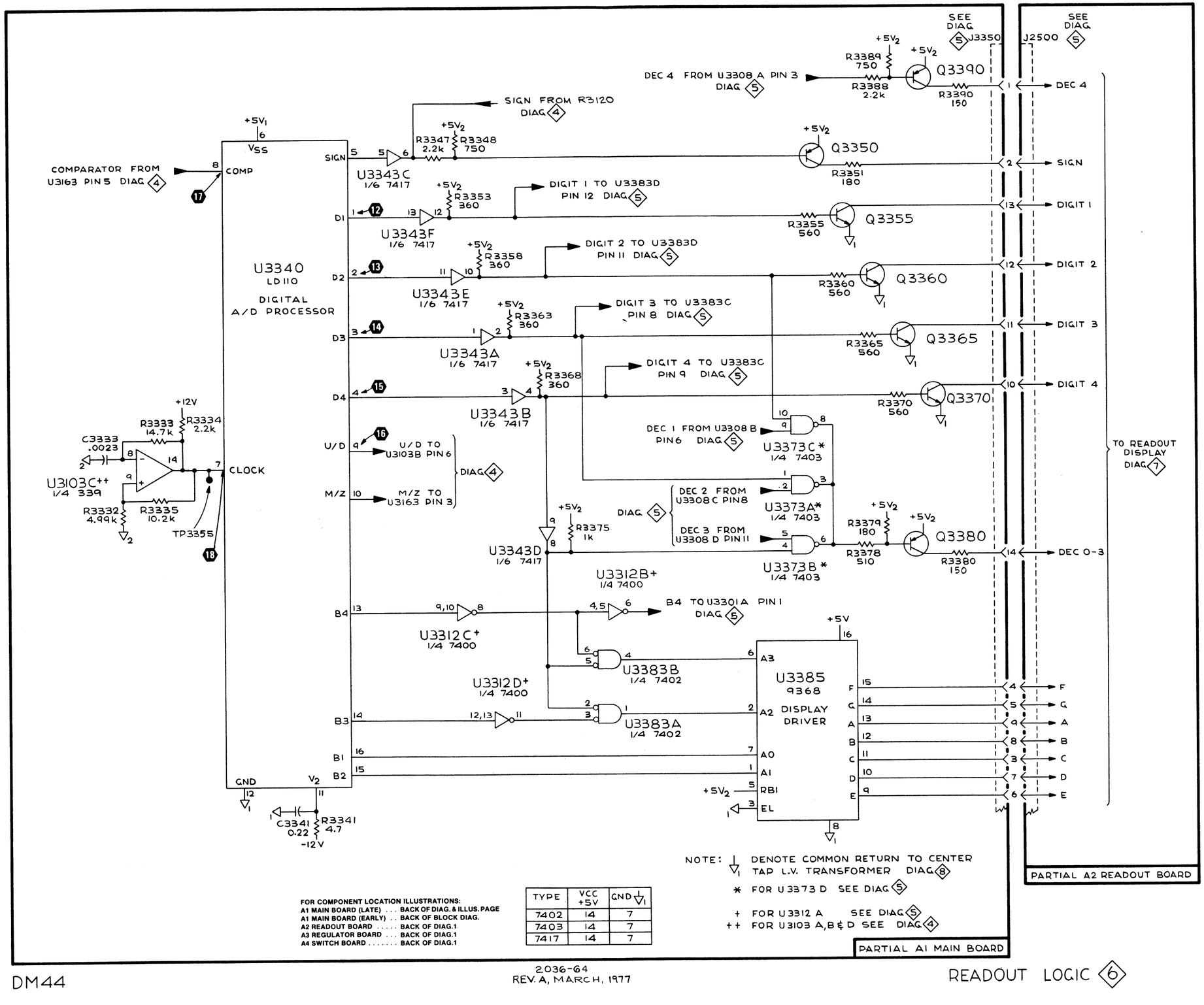
TRIGGER SLOPE +
TRIGGER SOURCE SET TO INTERNAL

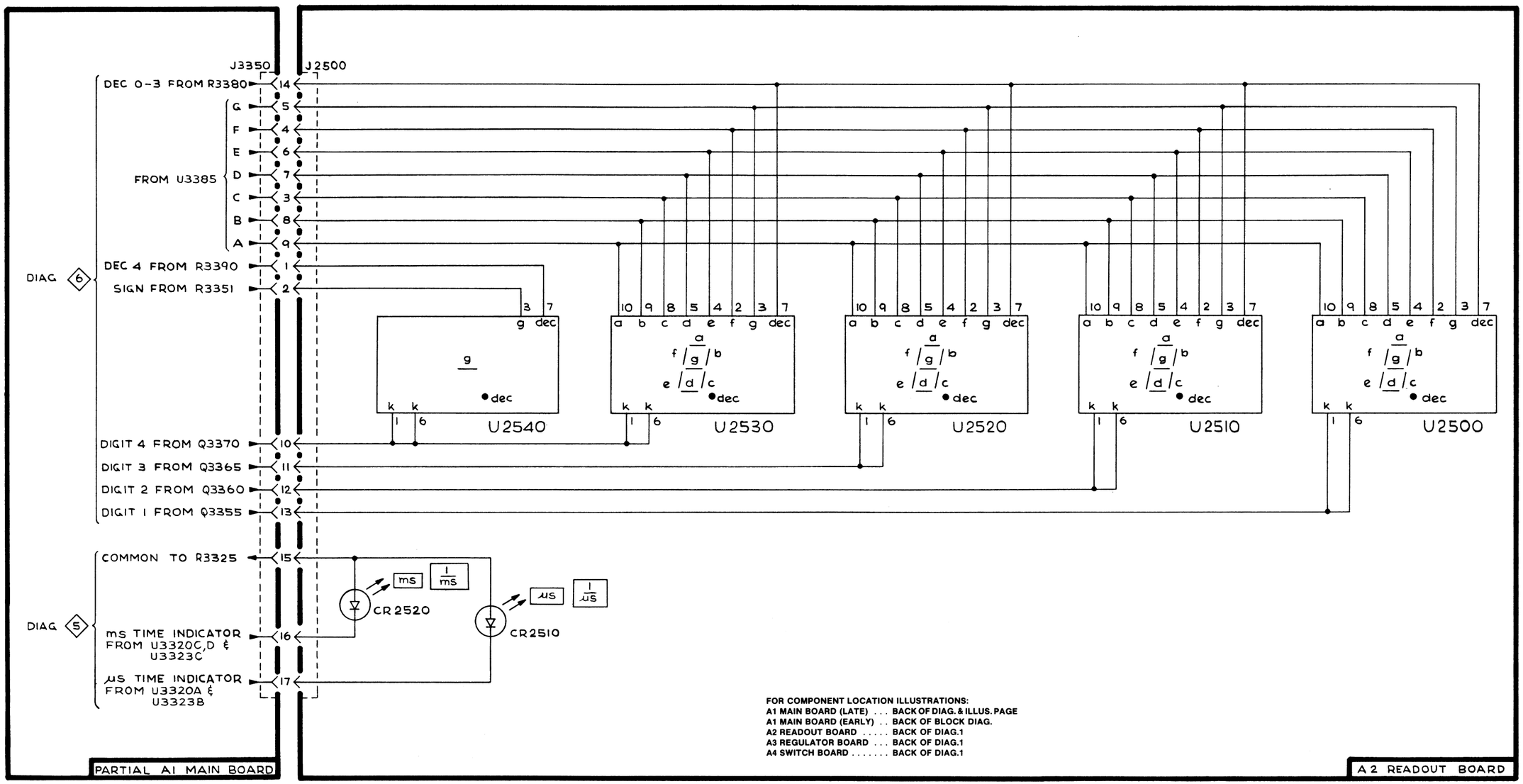
18



TRIGGER SLOPE – (MINUS)
TRIGGER SOURCE SET TO INTERNAL

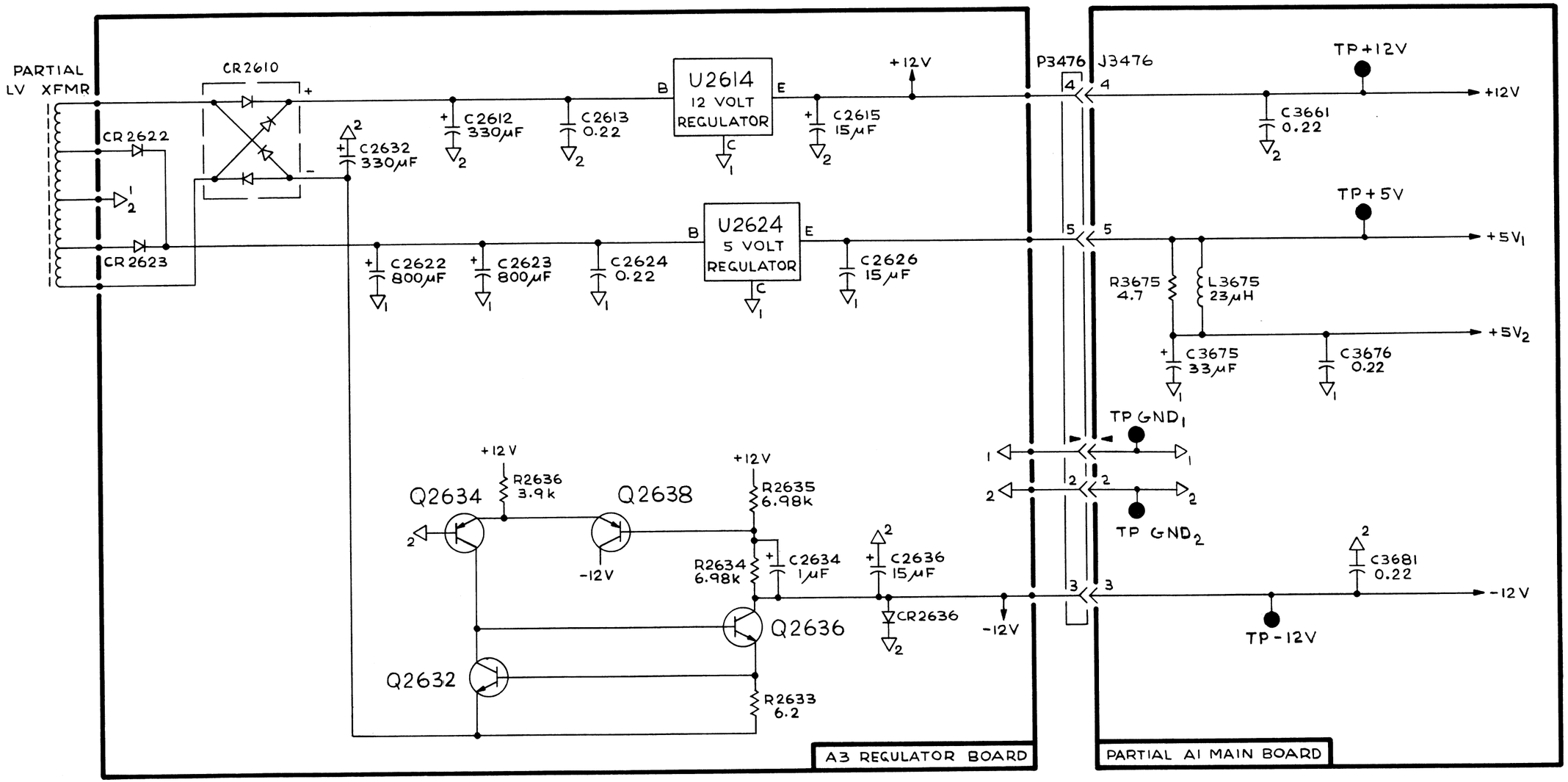
2036-64


SEE DIAG 5 J3350
SEE DIAG 5 J2500
DEC 4 FROM U3308 A PIN 3 DIAG 5
R3389 750
R3388 2.2k
Q3390
R3390 150
DEC 4
SIGN FROM R3120 DIAG 4
+5V1
VSS
COMPARATOR FROM U3163 PIN 5 DIAG 4
COMP
SIGN
U3343C 1/6 7417
R3347 2.2k
R3348 750
Q3350
R3351 180
SIGN
DIGIT 1 TO U3383D PIN 12 DIAG 5
D1
U3343F 1/6 7417
R3353 360
R3355 560
Q3355
DIGIT 1
DIGIT 2 TO U3383D PIN 11 DIAG 5
D2
U3343E 1/6 7417
R3358 360
R3360 560
Q3360
DIGIT 2
U3340 LD110 DIGITAL A/D PROCESSOR
DIGIT 3 TO U3383C PIN 8 DIAG 5
D3
U3343A 1/6 7417
R3363 360
R3365 560
Q3365
DIGIT 3
DIGIT 4 TO U3383C PIN 9 DIAG 5
D4
U3343B 1/6 7417
R3368 360
R3370 560
Q3370
DIGIT 4
+12V
R3333 14.7k
R3334 2.2k
C3333 .0023
U3103C++ 1/4 339
R3332 4.99k
R3335 10.2k
TP3355
CLOCK
U/D
U/D TO U3103B PIN 6
M/Z
M/Z TO U3163 PIN 3
DIAG 4
DEC 1 FROM U3308 B PIN 6 DIAG 5
U3373C* 1/4 7403
DEC 2 FROM U3308 C PIN 8
DEC 3 FROM U3308 D PIN 11
DIAG 5
U3373A* 1/4 7403
U3373B* 1/4 7403
R3375 1k
U3343D 1/6 7417
U3312B+ 1/4 7400
R3379 180
Q3380
R3378 510
R3380 150
DEC 0-3
TO READOUT DISPLAY DIAG 7
B4
U3312C+ 1/4 7400
B4 TO U3301A PIN 1 DIAG 5
U3312D+ 1/4 7400
U3383B 1/4 7402
B3
U3383A 1/4 7402
B1
B2
U3385 9368 DISPLAY DRIVER
A3
A2
A0
A1
RBI
EL
F
G
A
B
C
D
E
GND
V2
C3341 0.22
R3341 4.7
-12V
NOTE: DENOTE COMMON RETURN TO CENTER TAP L.V. TRANSFORMER DIAG 8
* FOR U3373 D SEE DIAG 5
+ FOR U3312 A SEE DIAG 5
++ FOR U3103 A,B & D SEE DIAG 4
PARTIAL A2 READOUT BOARD
PARTIAL A1 MAIN BOARD
FOR COMPONENT LOCATION ILLUSTRATIONS:
A1 MAIN BOARD (LATE) . . . BACK OF DIAG. & ILLUS. PAGE
A1 MAIN BOARD (EARLY) . . BACK OF BLOCK DIAG.
A2 READOUT BOARD . . . . . BACK OF DIAG.1
A3 REGULATOR BOARD . . . BACK OF DIAG.1
A4 SWITCH BOARD . . . . . BACK OF DIAG.1
TYPE | VCC +5V | GND
7402 | 14 | 7
7403 | 14 | 7
7417 | 14 | 7



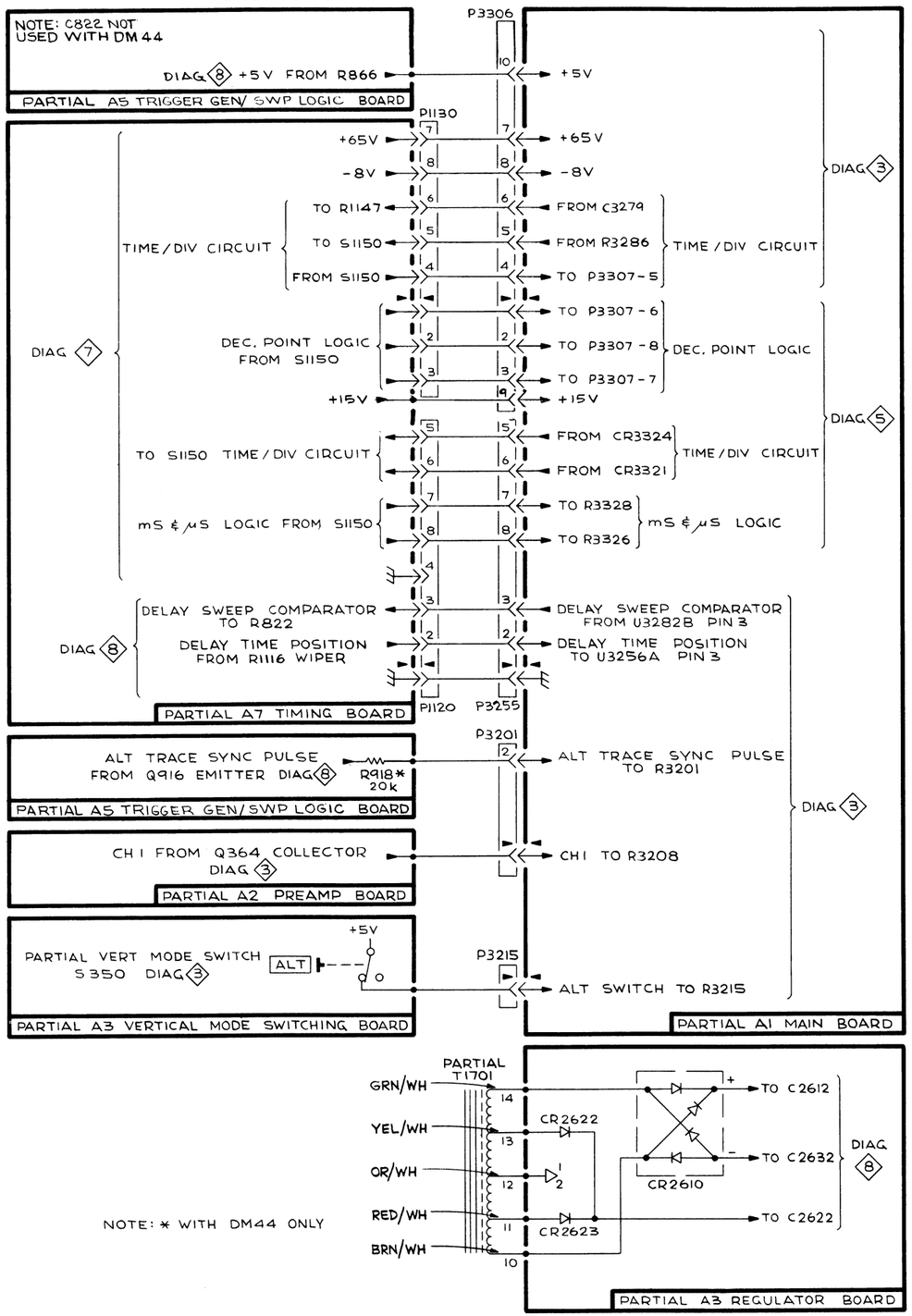
FOR COMPONENT LOCATION ILLUSTRATIONS:
A1 MAIN BOARD (LATE) . . . BACK OF DIAG. & ILLUS. PAGE
A1 MAIN BOARD (EARLY) . . BACK OF BLOCK DIAG.
A2 READOUT BOARD . . . . . BACK OF DIAG.1
A3 REGULATOR BOARD . . . BACK OF DIAG.1
A4 SWITCH BOARD . . . . . BACK OF DIAG.1

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REV. A, MARCH 1977



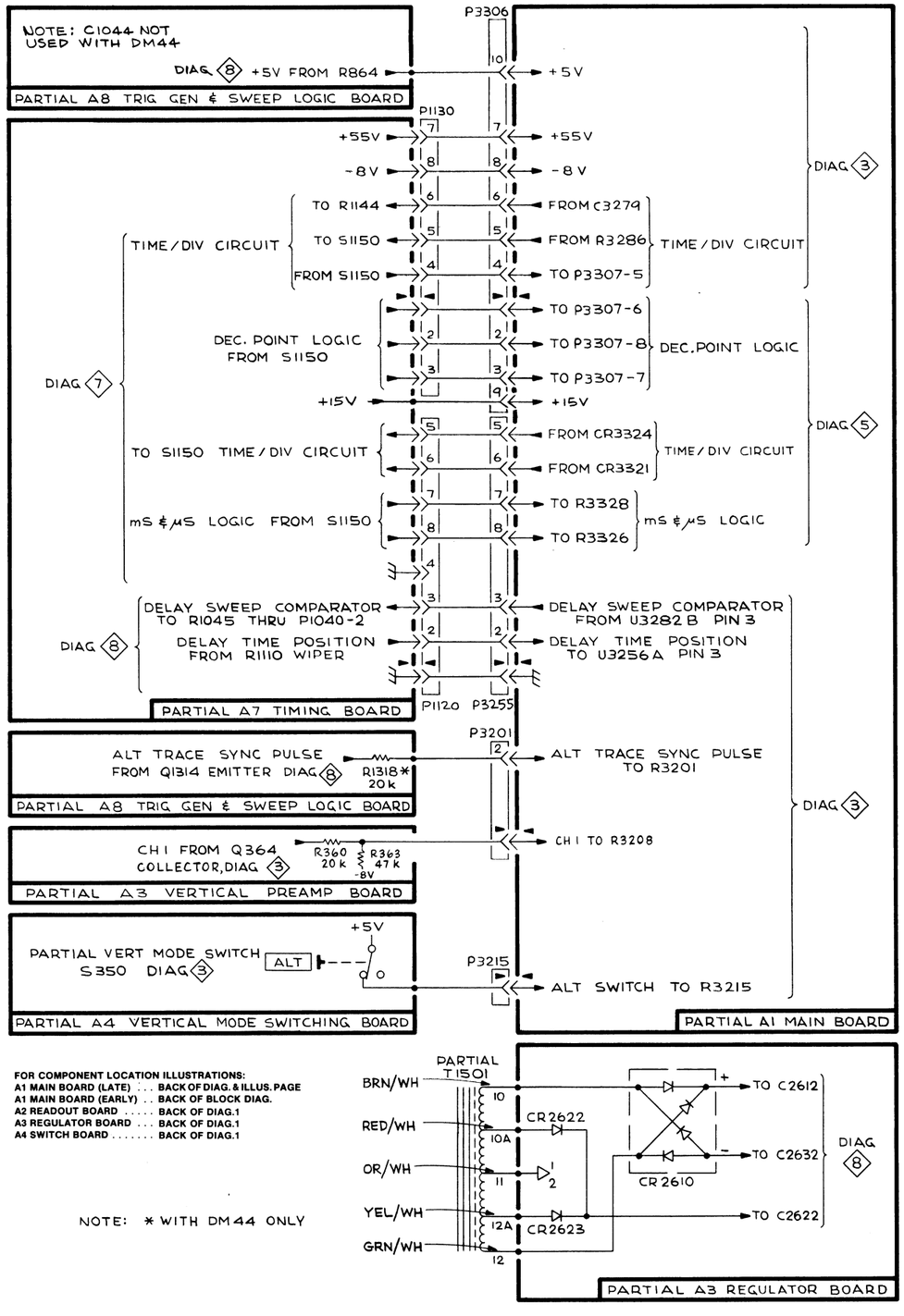
FOR COMPONENT LOCATION ILLUSTRATIONS:
A1 MAIN BOARD (LATE) . . . BACK OF DIAG. & ILLUS. PAGE
A1 MAIN BOARD (EARLY) . . BACK OF BLOCK DIAG.
A2 READOUT BOARD . . . . . BACK OF DIAG.1
A3 REGULATOR BOARD . . . BACK OF DIAG.1
A4 SWITCH BOARD . . . . . BACK OF DIAG.1

464 OR 466 OSCILLOSCOPE — DM 44



NOTE: * WITH DM44 ONLY

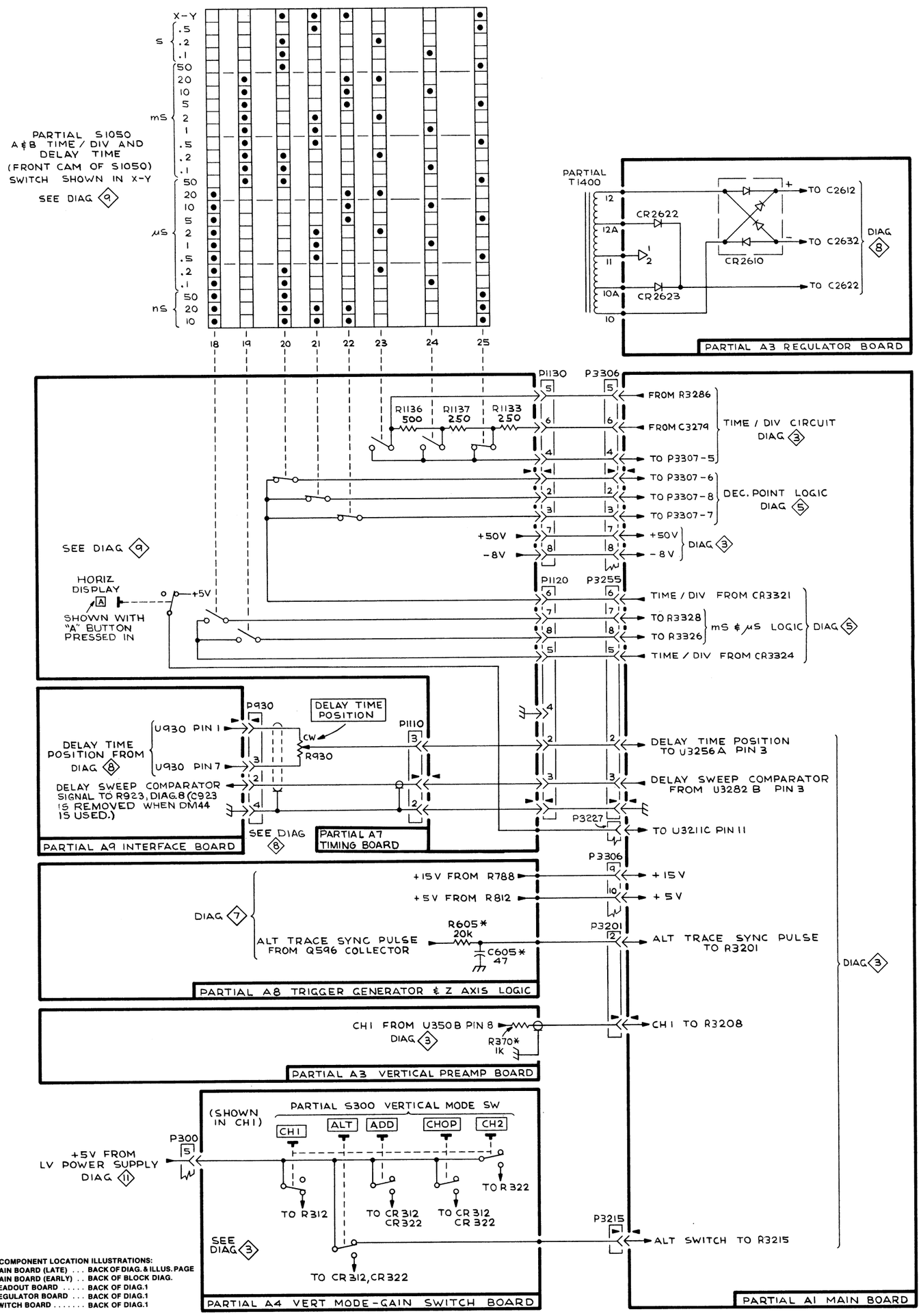
465 OSCILLOSCOPE — DM 44



FOR COMPONENT LOCATION ILLUSTRATIONS:
A1 MAIN BOARD (LATE) . . . BACK OF DIAG. & ILLUS. PAGE
A1 MAIN BOARD (EARLY) . . BACK OF BLOCK DIAG.
A2 READOUT BOARD . . . . . BACK OF DIAG.1
A3 REGULATOR BOARD . . . BACK OF DIAG.1
A4 SWITCH BOARD . . . . . BACK OF DIAG.1

NOTE: * WITH DM44 ONLY

475 OR 475A OSCILLOSCOPE DM 44



FOR COMPONENT LOCATION ILLUSTRATIONS:
A1 MAIN BOARD (LATE) . . . BACK OF DIAG. & ILLUS. PAGE
A1 MAIN BOARD (EARLY) . . BACK OF BLOCK DIAG.
A2 READOUT BOARD . . . . . BACK OF DIAG.1
A3 REGULATOR BOARD . . . BACK OF DIAG.1
A4 SWITCH BOARD . . . . . BACK OF DIAG.1

NOTE: * WITH DM44 ONLY

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REV. B, AUG 1977

DM 44
475 INTERFACE 10

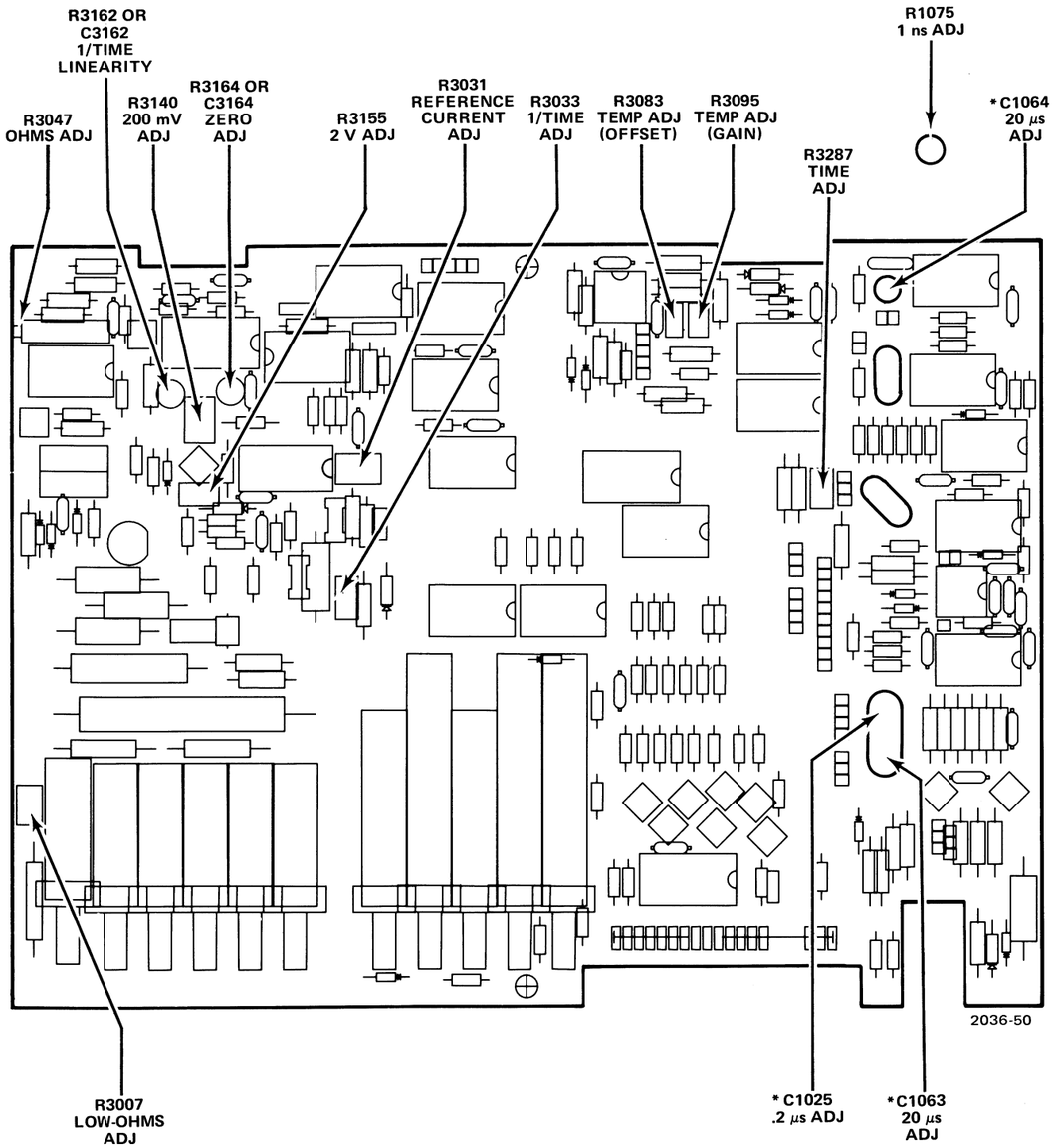


Fig. 9-7A. Adjustment loc. 475 DM44 & 475A DM44.

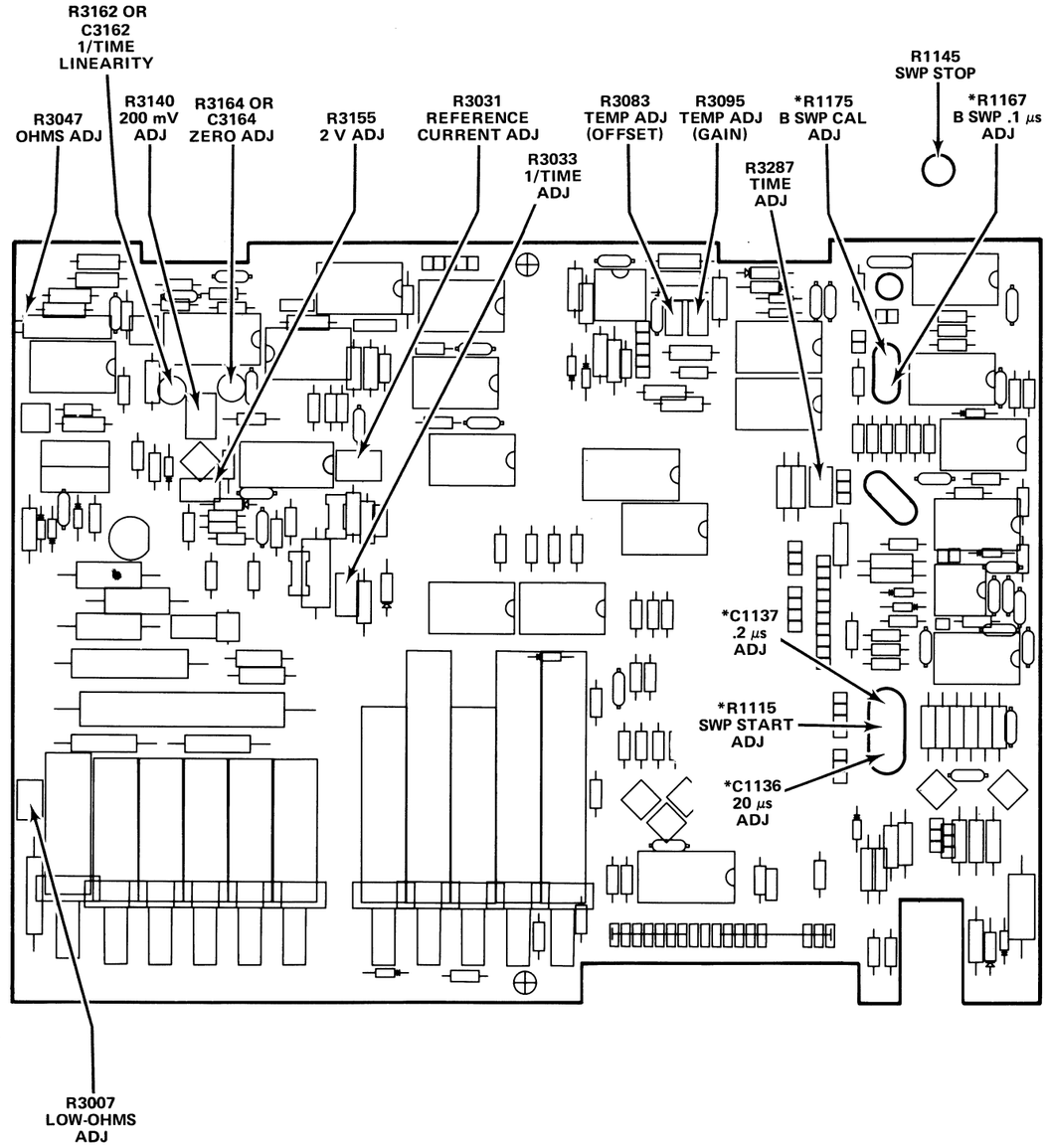


Fig. 9-7B. Adjustment loc. 464 DM44, 465 DM44, & 466 DM44.

NOTE

FIG. 9-15A AND FIG. 9-15B SHOW DM44 ADJUSTMENTS AND OSCILLOSCOPE ADJUSTMENTS LOCATED UNDER THE DM44 MAIN BOARD. FOR OTHER ADJUSTMENTS, SEE THE OSCILLOSCOPE SERVICE OR INSTRUCTION MANUAL.

*PARTS MOUNTED ON OSCILLOSCOPE TIMING BOARD, ACCESSIBLE THROUGH HOLE IN DM44 MAIN BOARD.

NO

SUSPECT U3340 ALSO VERIFY PROPER INSTALLATION OF U3163 AND U3340

IS DISPLAY READING UNSTABLE

NO

YES

MEASURE THE VOLTAGE ON TP3167 WITH RESPECT TO GROUND 2

IS DISPLAY BLINKING

NO

YES

VERIFY MEASUREMENT IS WITHIN THE LIMITS OF THE FUNCTION AND RANGE SELECTED

IS THE PROBLEM AN IMPROPERLY PLACED OR MISSING DECIMAL

YES

SEE DECIMAL LOGIC DIAGRAM

NO

MEASURE THE VOLTAGE BETWEEN TP3167 AND GROUND 2 IS THE VOLTAGE BETWEEN 0 AND 2 VOLTS

NO

SUSPECT THE INPUT CONVERTER

YES

IS FUNCTION SET TO 1/TIME

YES

USE Δ TIME CONTROL TO POSITION INTENSIFIED ZONES 2 DIVISIONS APART IS DISPLAY STILL BLINKING

YES

SUSPECT
U3163 U3340
U3113 U3103
Q3153

NO

SUSPECT
U3163 U3113
U3103 U3340
Q3153

NO

IS PIN 8 of U3023 HI OR LO

HI

SUSPECT AUTORANGE LOGIC
U3383C U3383D
U3301A U3301C
U3023 U3301D

LO

SUSPECT
CR3133 OR Q3143

NO

IS THE VOLTAGE JUST MEASURED UNSTABLE

YES

SUSPECT ACTIVE FILTER U3023 THE ACTIVE FILTER IS DISCONNECTED IN THE 20 MΩ RANGE OF THE OHMS FUNCTION

NO

SUSPECT
U3163 U3340
VR3049 U3113
Q3153 Q3103

SUSPECT CIRCUITRY BETWEEN INPUT LEADS AND PIN 15 OF U3163 IF INACCURACY IS ONLY ON HIGHER RANGES, SUSPECT THE VOLTAGE DIVIDER STRING (R3002, R3003, R3004, AND R3005)

IS PROBLEM IN VOLTS FUNCTION

NO

YES

1. SET RANGE TO 2 V
2. CONNECT INPUT LEADS TO 1.8 VOLTS SOURCE
3. MEASURE VOLTAGE ON TP3167 WITH THE DVM

IS THE MEASURED VOLTAGE ABOUT 1.6 VOLTS (1.8 VOLTS IF STRAP REMOVED FOR 1000 M INPUT)

NO

SUSPECT INPUT ATTENUATOR STRING OR U3163 LOADING CIRCUIT

YES

IS THE VOLTAGE ON TP3030 6.2 VOLTS

NO

SUSPECT
VR3037 R3031
R3030 C3037

YES

IS THE VOLTAGE ON PIN 9 OF U3163 ZERO VOLTS

NO

SUSPECT
U3163 C3149
VR3049 U3349
U3113 Q3153
U3103

YES

SUSPECT
Q3158 U3113
U3163 U3340
U3103

IS PROBLEM IN OHMS FUNCTION

NO

1

YES

CHECK REFERENCE CURRENT SOURCE VOLTAGES
1. TP3030 6.2 V
2. U3023A PIN 1 ABOUT -5 V
3. U3023B PIN 7 ABOUT -10.5 V
4. EMITTER

ONE OR MORE VOLTAGES WRONG

SUSPECT
VR3037 U3023A
U3023B Q3045

OK

IS VOLTAGE BETWEEN PIN 6 AND PIN 2 OF U3061 ABOUT 1 V

NO

SUSPECT U3061 AND ASSOCIATED CIRCUITRY

YES

IS VOLTAGE BETWEEN PIN 3 AND PIN 6 OF U3061 ABOUT 1 V

NO

SUSPECT U3061 AND ASSOCIATED CIRCUITY OR STRING DIVIDER
CR3003, R3003, R3004, R3005, R3006, AND R3007

YES

SHORT LEAD INPUT—IS VOLTAGE BETWEEN PIN 3 OF U3061 AND GND 2 ABOUT 0.7 V

NO

SUSPECT
DS3016 R3016
CR3016

YES

2

YES

YES

ME

NO

IS PROBLEM IN 1/TIME FUNCTION

YES

DOES TIME FUNCTION OPERATE PROPERLY

YES

CHECK TP3033 FOR ABOUT 30 mV THE RANGE OF ADJUSTMENT OF R3033 IS ABOUT 20 TO 40 mV AT TP3033 IN THE 1/TIME FUNCTION THE VOLTAGE ON PIN 15 OF U3163 SHOULD BE SAME AS ON TP3033

NO

NO

AND

OF

ABLE TO GET 8 V

CONNECT DVM BETWEEN TP3279 AND CHASSIS GND ADJUST Δ TIME FOR A DVM READING OF 6 VOLTS

SUSPECT
U3256D U3256C
Q3269 Q3251
U3275 CR3274
CR3275

ABLE TO GET 6 VOLTS

ARE THERE TWO INTENSIFIED ZONES DISPLAYED

YES

NO

VERIFY CORRECT SWITCHING FROM OSCILLOSCOPE AT P3201 AND P3215

OK

SUSPECT DELAY PICK-OFF SELECTOR LOGIC
U3211B U3213D
U3211A U3223
U3256B U3211C
U3213C U3211D
U3282B U3282C

BY ADJUSTMENT BOTH Δ TIME AND DTP CONTROLS CAN MEASUREMENT POINT BE POSITION 10 DIVISIONS TO THE RIGHT OF THE REFERENCE POINT THEN 10 DIVISIONS TO THE LEFT

YES

NO

VERIFY CORRECT RESISTANCE OF
R3250 R3251
R3268 R3269

SUSPECT
U3256 U3275
Q3251 U3282B
Q3269 U3282C

IS THE PROBLEM IN THE ALT MODE ONLY

YES

NO

SOME CAUSES OF INACCURATE READINGS ARE:
1. MISCALIBRATION OF TIME CIRCUIT
2. INACCURACY IN OSCILLOSCOPE HORIZONTAL SYSTEM
3. RESISTORS FROM P3306-5 TO P3286-2 AND P3286-3 MAY BE WRONG VALUE FOR THE OSCILLOSCOPE TO WHICH THE DM44 IS ATTACHED

CHECK FOR SQUARE-WAVE ON PIN 1 OF U3211A (REPETITION RATE SAME AS A SWEEP RATE)

NOT THERE

SUSPECT U3211A OR SWITCHING SIGNAL FROM OSCILLOSCOPE

OK

VERIFY ZERO VOLTS ON PIN 6 OF U3256B (FROM ALT SWITCH IN OSCILLOSCOPE)

OK

SUSPECT
U3256B U3213C
U3223

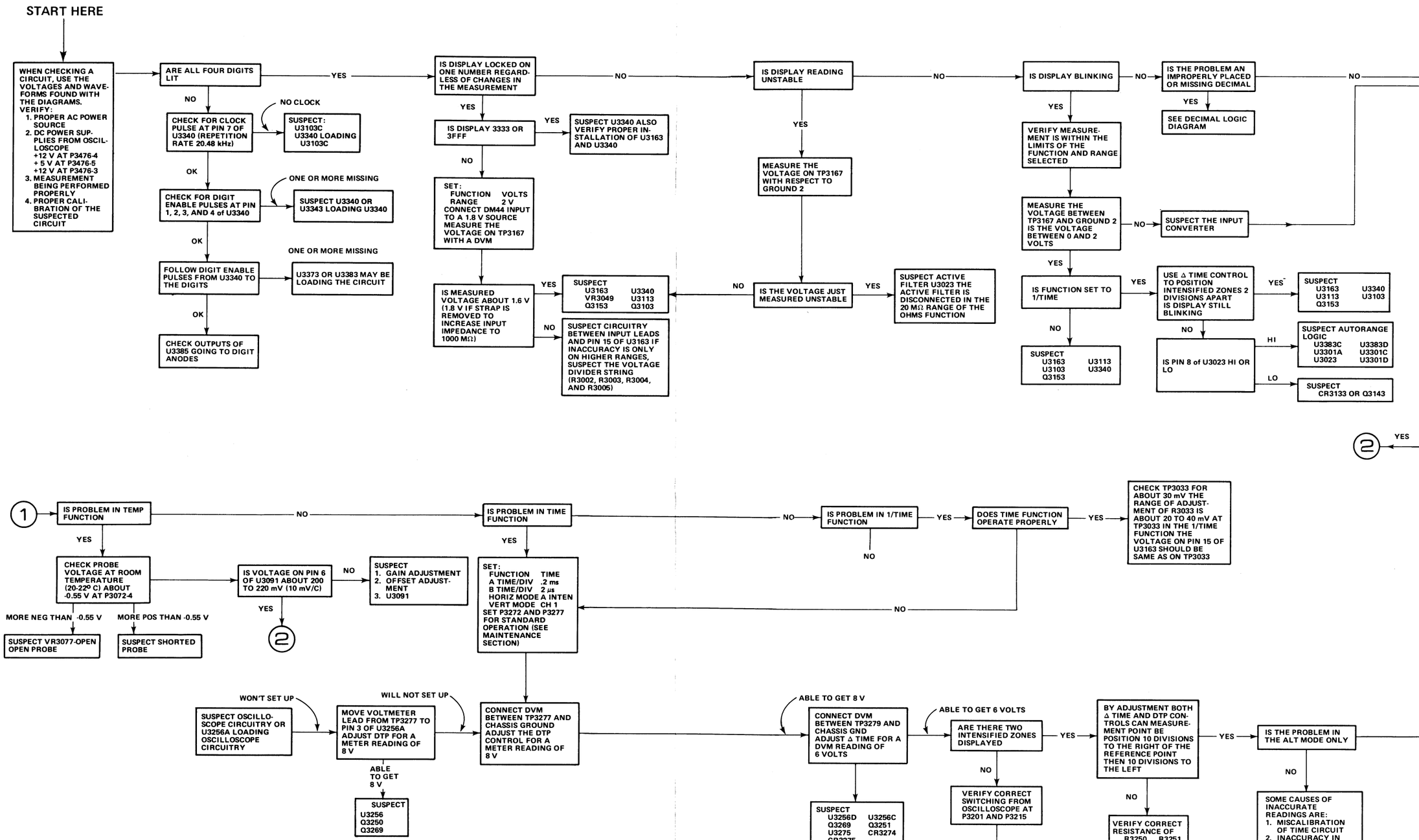


Fig. 9-8. Troubleshooting chart.

REPLACEABLE MECHANICAL PARTS

PARTS ORDERING INFORMATION

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

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

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

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

SPECIAL NOTES AND SYMBOLS

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

FIGURE AND INDEX NUMBERS

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

INDENTATION SYSTEM

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

1 2 3 4 5 Name & Description

Assembly and/or Component
Attaching parts for Assembly and/or Component
- - - * - - -
Detail Part of Assembly and/or Component
Attaching parts for Detail Part
- - - * - - -
Parts of Detail Part
Attaching parts for Parts of Detail Part
- - - * - - -

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

Attaching parts must be purchased separately, unless otherwise specified.

ITEM NAME

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

ABBREVIATIONS

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

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
0000A	LEMO USA	2015 2ND STREET	BERKLEY, CA 94710
00779	AMP, INC.	P O BOX 3608	HARRISBURG, PA 17105
01295	TEXAS INSTRUMENTS, INC., SEMICONDUCTOR GROUP	P O BOX 5012, 13500 N CENTRAL EXPRESSWAY	DALLAS, TX 75222
08261	SPECTRA-STRIP CORP.	7100 LAMPSON AVE.	GARDEN GROVE, CA 92642
08530	RELIANCE MICA CORP.	342-39TH ST.	BROOKLYN, NY 11232
12327	FREEWAY CORPORATION	9301 ALLEN DRIVE	CLEVELAND, OH 44125
18359	PYLON CO., INC.	51 NEWCOMB ST.	ATTLEBORO, MA 02703
22526	BERG ELECTRONICS, INC.	YOUK EXPRESSWAY	NEW CUMBERLAND, PA 17070
29372	TRIDAIR INDUSTRIES, FASTENER DIVISION	3000 W LOMITA BLVD.	TORRANCE, CA 90505
55210	GETTIG ENG. AND MFG. COMPANY	PO BOX 85, OFF ROUTE 45	SPRING MILLS, PA 16875
73743	FISCHER SPECIAL MFG. CO.	446 MORGAN ST.	CINCINNATI, OH 45206
74445	HOLO-KROME CO.	31 BROOK ST. WEST	HARTFORD, CT 06110
75497	LAMSON AND SESSIONS CO., THE	5000 TIEDEMAN ROAD	CLEVELAND, OH 44144
78189	ILLINOIS TOOL WORKS, INC. SHAKEPROOF DIVISION	ST. CHARLES ROAD	ELGIN, IL 60120
78471	TILLEY MFG. CO.	900 INDUSTRIAL RD.	SAN CARLOS, CA 94070
79807	WROUGHT WASHER MFG. CO.	2100 S. O BAY ST.	MILWAUKEE, WI 53207
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
82647	TEXAS INSTRUMENTS, INC., CONTROL PRODUCTS DIV.	34 FOREST ST.	ATTLEBORO, MA 02703
83385	CENTRAL SCREW CO.	2530 CRESCENT DR.	BROADVIEW, IL 60153
86928	SEASTROM MFG. COMPANY, INC.	701 SONORA AVENUE	GLENDALE, CA 91201
97464	INDUSTRIAL RETAINING RING CO.	57 CORDIER ST.	IRVINGTON, NJ 07111

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-1	----- -----			1		CKT BOARD ASSY:MAIN(SEE A1 EPL)		
-2	366-1024-02			1		. KNOB:GRAY	80009	366-1024-02
	213-0153-00			2		. . SETSCREW:5-40 X 0.125 INCH,HEX SOC STL	74445	OBD
-3	----- -----			1		. RESISTOR,VAR:(SEE R3272 EPL)		
						(ATTACHING PARTS)		
-4	210-0590-00			1		. NUT,PLAIN,HEX.:0.375 X 0.438 INCH,STL	73743	2X28269-402
-5	210-0978-00			1		. WASHER,FLAT:0.375 ID X 0.50 INCH OD,STL	78471	OBD
-6	358-0575-00			1		. BUSHING,SLEEVE:	80009	358-0575-00
						- - - * - - -		
-7	366-1512-00			11		. PUSH BUTTON:GRAY,0.18 SQ X 0.83 INCH LG	80009	366-1512-00
-8	333-2213-00			1		. PANEL,FRONT:	80009	333-2213-00
						(ATTACHING PARTS)		
-9	354-0195-00			3		. RING,RETAINING:	97464	6100-12-ST-PA
						- - - * - - -		
-10	426-1072-00			11		. FRAME,PUSH BTN:PLASTIC	80009	426-1072-00
-11	426-1176-00			1		. FRAME SECT,CAB:FRONT	80009	426-1176-00
						(ATTACHING PARTS)		
-12	211-0207-00			3		. SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL	83385	OBD
						- - - * - - -		
-13	----- -----			1		. CKT BOARD ASSY:READOUT(SEE A2 EPL)		
						(ATTACHING PARTS)		
-14	211-0180-00			2		. SCR,ASSEM WSHR:2-56 X 0.25 INCH,PNH BRS	83385	OBD
	----- -----			-		. . CKT BOARD ASSY INCLUDES:		
-15	131-0787-00			17		. . CONTACT,ELEC:0.64 INCH LONG	22526	47359
-16	----- -----			2		. . LED:(SEE CR2510,CR2520 EPL)		
-17	331-0397-00			1		. WINDOW,READOUT:0.55 X 1.495,PLASTIC	80009	331-0397-00
-18	334-2354-00			2		. MARKER,IDENT:DANGER	80009	334-2354-00
-19	136-0139-00			1		. JACK,TIP:BANANA STYLE,W/RED CAP	80009	136-0139-00
						(ATTACHING PARTS)		
-20	210-0465-00			1		. NUT,PLAIN,HEX.:0.25-32 X 0.375 INCH BRS	73743	3095-402
-21	210-0940-00			1		. WASHER,FLAT:0.25 ID X 0.375 INCH OD,STL	79807	OBD
-22	210-0223-01			1		. TERMINAL,LUG:0.25 INCH DIA,SE,60 DEG BEND	86928	OBD
						- - - * - - -		
-23	136-0138-00			1		. JACK,TIP:BANANA STYLE,W/BLACK CAP	80009	136-0138-00
						(ATTACHING PARTS)		
-24	210-0465-00			1		. NUT,PLAIN,HEX.:0.25-32 X 0.375 INCH BRS	73743	3095-402
-25	210-0940-00			1		. WASHER,FLAT:0.25 ID X 0.375 INCH OD,STL	79807	OBD
-26	210-0223-01			1		. TERMINAL,LUG:0.25 INCH DIA,SE,60 DEG BEND	86928	OBD
						- - - * - - -		
-27	131-1652-00			1		. CONN,RCPT,ELEC:1 FEMALE,1 MALE CONTACT	18359	P3657REV1
						(ATTACHING PARTS)		
-28	210-0302-00			1		. TERMINAL,LUG:0.365 INCH DIA,SE,0.025 STL	0000A	RAO-251
						- - - * - - -		
-29	----- -----			1		. CKT BOARD ASSY:SWITCH(SEE A4 EPL)		
-30	131-0566-00			1		. . LINK,TERM.CONNE:0.086 DIA X 2.375 INCH L	55210	L-2007-1
-31	131-0589-00			20		. . CONTACT,ELEC:0.46 INCH LONG	22526	47350
-32	407-1569-00			1		. BRACKET,ANGLE:	80009	407-1569-00
						(ATTACHING PARTS)		
-33	211-0207-00			2		. SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL	83385	OBD
						- - - * - - -		
-34	386-3108-00			1		. SUPPORT,CKT BOARD:	80009	386-3108-00
						(ATTACHING PARTS)		
-35	211-0507-00			2		. SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	OBD
-36	211-0207-00			3		. SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL	83385	OBD
						- - - * - - -		
-37	210-0202-00			1		. TERMINAL,LUG:SE #6	78189	2104-06-00-2520N
						(ATTACHING PARTS)		
-38	210-0586-00			1		. NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL	78189	211-041800-00
						- - - * - - -		
-39	342-0239-00			1		. INSULATOR,PLATE:	80009	342-0239-00
-40	407-1568-00			1		. BRACKET,ANGLE:	80009	407-1568-00
-41	348-0417-00			1		. GROMMET,PLASTIC:0.75 INCH DIA	80009	348-0417-00
-42	198-3163-00			1		. WIRE SET,ELEC:	80009	198-3163-00

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-43	179-2504-00			1		. WIRING HARNESS,:MAIN	80009	179-2504-00
-44	131-0608-00			50		. TERMINAL,PIN:0.365 L X 0.25 PH,BRZ,GOLD PL	22526	47357
-45	131-0993-00			1		. LINK,TERM.CONNE:2 WIRE BLACK	00779	530153-2
-46	136-0252-04			79		. SOCKET,PIN TERM:0.188 INCH LONG	22526	75060
-47	136-0260-02			2		. SOCKET,PLUG-IN:16 CONTACT,LOW CLEARANCE	82647	C9316-18
-48	136-0269-02			15		. SOCKET,PLUG-IN:14 CONTACT,LOW CLEARANCE	01295	C95140
-49	136-0328-03			17		. SOCKET,PIN TERM:HORIZ,SQ PIN RCPT	22526	47710
-50	136-0514-00			1		. SOCKET,PLUG IN:MICROCIRCUIT,8 CONTACT	82647	C93-08-18
-51	214-0579-00			24		. TERM.,TEST PT:0.40 INCH LONG	80009	214-0579-00
-52	----- -----			1		. SWITCH,PB:(SEE S3020 EPL)		
-53	----- -----			1		. SWITCH,PB:(SEE S3010 EPL)		
-54	361-0608-00			15		. SPACER,PUSH SW:PLASTIC	80009	361-0608-00
-55	344-0154-00			2		. CLIP,ELECTRICAL:FOR 0.25 INCH DIA FUSE	80009	344-0154-00
	672-0482-00[1]			1		CKT BOARD ASSY:POWER SUPPLY	80009	672-0482-00
	672-0453-00[2]			1		CKT BOARD ASSY:POWER SUPPLY	80009	672-0453-00
-56	342-0238-00			1		. INSULATOR,PLATE:	80009	342-0238-00
-57	----- -----			1		. CKT BOARD ASSY:POWER SUPPLY(SEE A3 EPL)		
						(ATTACHING PARTS)		
-58	211-0207-00			2		. SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL	83385	OBD
						- - - * - - -		
	----- -----			-		. . CKT BOARD ASSEMBLY INCLUDES:		
-59	136-0252-04			9		. . SOCKET,PIN TERM:0.188 INCH LONG	22526	75060
-60	348-0055-00			1		. GROMMET,PLASTIC:0.25 INCH DIA	80009	348-0055-00
-61	348-0141-00			1		. GROMMET,PLASTIC:U-SHP,0.625 X0.658 INCH	80009	348-0141-00
-62	343-0507-00			1		. RETAINER,XSTR:	80009	343-0507-00
						(ATTACHING PARTS)		
-63	210-0586-00			3		. NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL	78189	211-041800-00
						- - - * - - -		
-64	342-0195-00			1		. INSULATOR,PLATE:0.70 X 3 INCHES LONG	08530	OBD
-65	441-1171-00			1		. CHASSIS,SCOPE:INVERTER	80009	441-1171-00
-66	198-3066-00[1]			1		WIRE SET,ELEC:	80009	198-3066-00
	198-3058-00[2]			1		WIRE SET,ELEC:	80009	198-3058-00

[1]464 and 466 only.
[2]465, 475 and 475A only.

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
2-1	200-1723-00			1		COVER,SCOPE:FRONT,W/DM43/DM40	80009	200-1723-00
-2	200-1722-00			1		COVER,SCOPE:	80009	200-1722-00
						(ATTACHING PARTS)		
-3	212-0130-00			2		SCREW,MACHINE:8-32 X 0.50 INCH,PNH STL	29372	CA 13036-8-3-8
						- - - * - - -		
-4	----- -----			1		DM44:		
						(ATTACHING PARTS)		
-5	213-0146-00			2		SCR,TPG,THD FOR:6-20 X 0.313 INCH,PNH STL	83385	OBD
-6	210-0803-00			2		WASHER,FLAT:0.15 ID X 0.375 INCH OD,STL	12327	OBD
-7	211-0008-00			3		SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
-8	210-0938-00			3		WASHER,FLAT:0.109 ID X 0.25 INCH OD,STL	75497	AN960-3
						- - - * - - -		
-9	437-0174-00			1		CABINET,SCOPE:	80009	437-0174-00
-10	348-0063-00			1		GROMMET,PLASTIC:0.50 INCH DIA	80009	348-0063-00
-11	----- -----[1]			1		RESISTOR,VAR:(SEE R1110,R930,R816 EPL)		
						(ATTACHING PARTS)		
-12	210-0590-00			1		NUT,PLAIN,HEX.:0.375 X 0.438 INCH,STL	73743	2X28269-402
-13	210-0978-00			1		WASHER,FLAT:0.375 ID X 0.50 INCH OD,STL	78471	OBD
-14	210-0012-00			1		WASHER,LOCK:INTL,0.375 ID X 0.50" OD STL	78189	1220-02-00-0541C
						- - - * - - -		
-15	366-1563-00			1		KNOB:GRAY	80009	366-1563-00
	213-0153-00			2		. SETSCREW:5-40 X 0.125 INCH,HEX SOC STL	74445	OBD
	198-3160-00[2]	XB022570		1		WIRE SET,ELEC:	80009	198-3160-00
	131-0707-00			36		. CONNECTOR,TERM.:0.48" L,22-26AWG WIRE	22526	75691-005
	131-0708-00			1		. CONTACT,ELEC:0.48"L,28-32 AWG WIRE	22526	47437
	175-0825-00			FT		. WIRE,ELECTRICAL:2 WIRE RIBBON,0.614 FT L	08261	OBD
	175-0830-00			FT		. WIRE,ELECTRICAL:7 WIRE RIBBON,0.396 FT L	08261	SS-0726-710610C
	175-0831-00			FT		. WIRE,ELECTRICAL:8 WIRE RIBBON,0.396 FT L	08261	OBD
	352-0166-00			4		. CONN BODY,PL,EL:8 WIRE BLACK	80009	352-0166-00
	352-0169-00			2		. CONN BODY,PL,EL:2 WIRE BLACK	80009	352-0169-00
	352-0171-00			2		. CONN BODY,PL,EL:1 WIRE BLACK	80009	352-0171-00

[1] R1110 and 465, R930 on 475, 475A, R816 on 464, 466.
[2] 475/475A only.

FIG. 1 DM44 EXPLODED

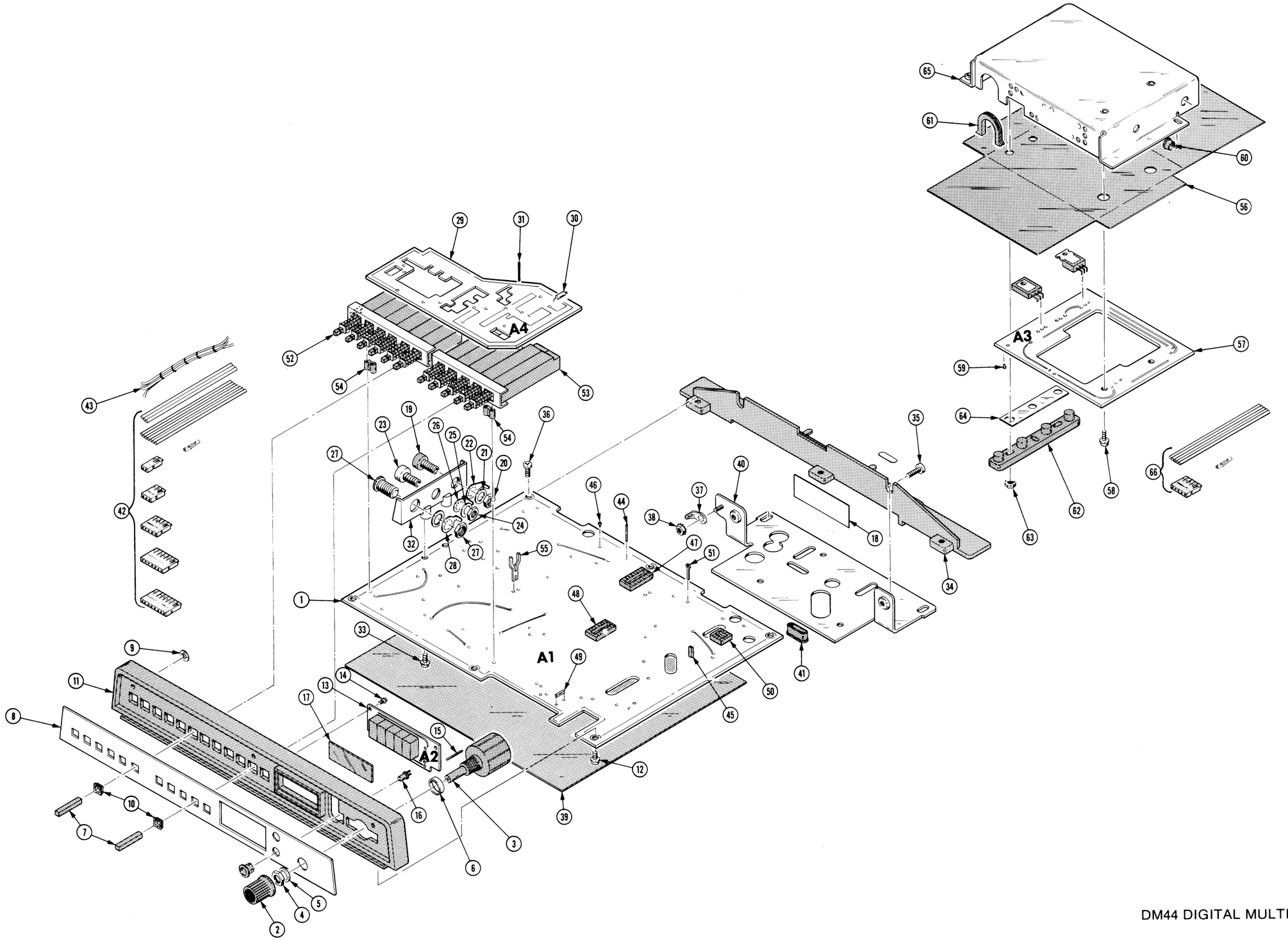
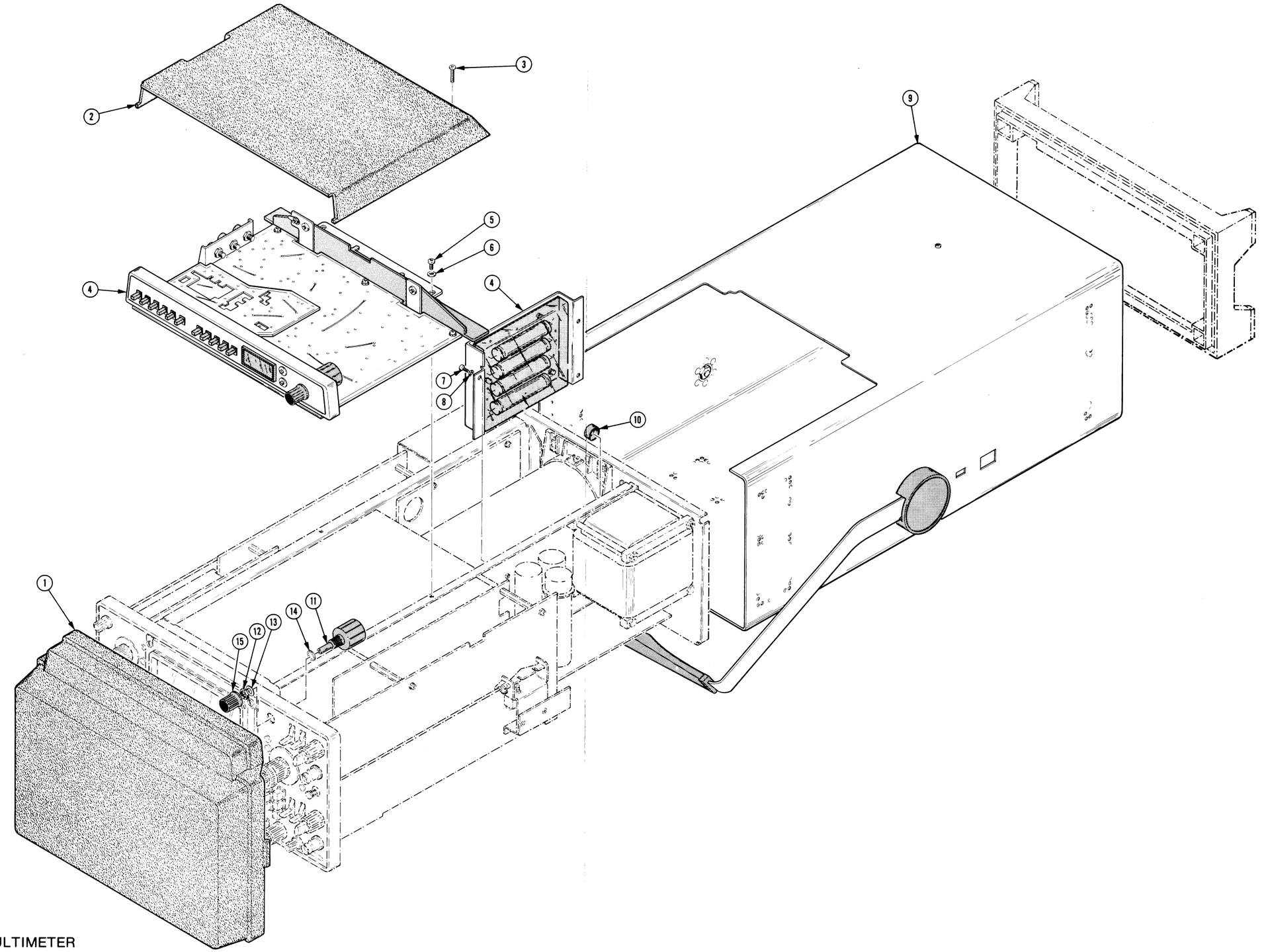


FIG. 2 MOUNTING DM44



DM44 DIGITAL MULTIMETER

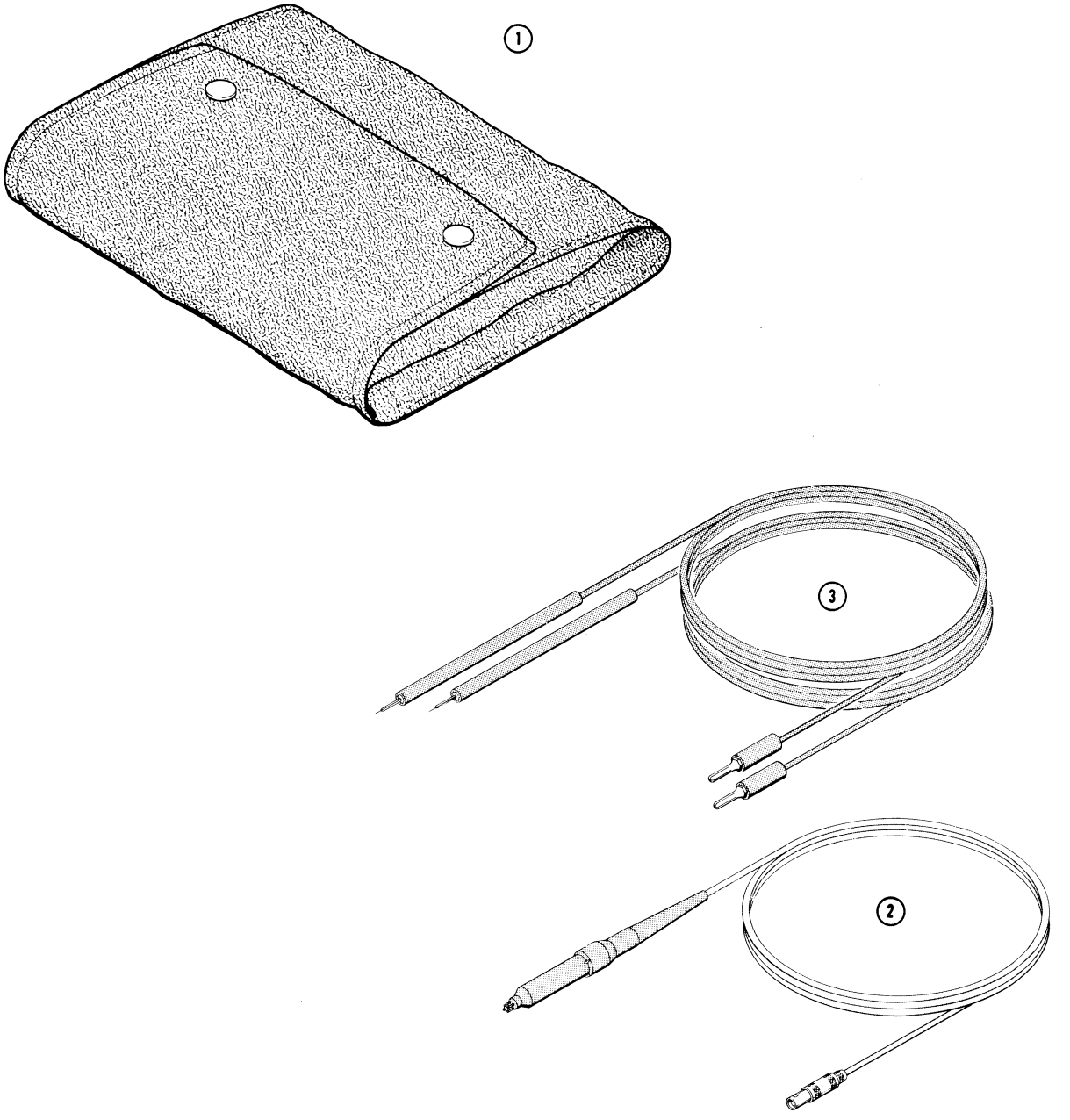


Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
3-1	016-0594-00			1		POUCH,ACCESSORY:W/HARDWARE	80009	016-0594-00
-2	010-6430-00			1		LEAD,TEST:1.5 METERS LONG	80009	010-6430-00
-3	003-0120-00			1		LEAD,TEST:PAIR	80009	003-0120-00
	070-2036-00			1		MANUAL,TECH:SERVICE	80009	070-2036-00
	070-2037-00			1		MANUAL,TECH:OPERATORS,464,466	80009	070-2037-00
	070-2038-00			1		MANUAL,TECH:OPERATORS,465	80009	070-2038-00
	070-2039-00			1		MANUAL,TECH:OPERATORS,475	80009	070-2039-00
	070-2163-00			1		MANUAL,TECH:OPERATORS,475A	80009	070-2163-00

MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages.

A single change may affect several sections. Since the change information sheets are carried in the manual until all changes are permanently entered, some duplication may occur. If no such change pages appear following this page, your manual is correct as printed.

SERVICE NOTE

Because of the universal parts procurement problem, some electrical parts in your instrument may be different from those described in the Replaceable Electrical Parts List. The parts used will in no way alter or compromise the performance or reliability of this instrument. They are installed when necessary to ensure prompt delivery to the customer. Order replacement parts from the Replaceable Electrical Parts List.

CALIBRATION TEST EQUIPMENT REPLACEMENT

Calibration Test Equipment Chart

This chart compares TM 500 product performance to that of older Tektronix equipment. Only those characteristics where significant specification differences occur, are listed. In some cases the new instrument may not be a total functional replacement. Additional support instrumentation may be needed or a change in calibration procedure may be necessary.

Comparison of Main Characteristics

DM 501 replaces 7D13		
PG 501 replaces 107	PG 501 - Risetime less than 3.5 ns into 50 Ω.	107 - Risetime less than 3.0 ns into 50 Ω.
108	PG 501 - 5 V output pulse; 3.5 ns Risetime	108 - 10 V output pulse 1 ns Risetime
PG 502 replaces 107		
108	PG 502 - 5 V output	108 - 10 V output
111	PG 502 - Risetime less than 1 ns; 10 ns Pretrigger pulse delay	111 - Risetime 0.5 ns; 30 to 250 ns Pretrigger pulse delay
PG 508 replaces 114	Performance of replacement equipment is the same or better than equipment being replaced.	
115		
2101		
PG 506 replaces 106	PG 506 - Positive-going trigger output signal at least 1 V; High Amplitude output, 60 V.	106 - Positive and Negative-going trigger output signal, 50 ns and 1 V; High Amplitude output, 100 V.
067-0502-01	PG 506 - Does not have chopped feature.	0502-01 - Comparator output can be alternately chopped to a reference voltage.
SG 503 replaces 190, 190A, 190B	SG 503 - Amplitude range 5 mV to 5.5 V p-p.	190B - Amplitude range 40 mV to 10 V p-p.
191		
067-0532-01	SG 503 - Frequency range 250 kHz to 250 MHz.	0532-01 - Frequency range 65 MHz to 500 MHz.
SG 504 replaces 067-0532-01	SG 504 - Frequency range 245 MHz to 1050 MHz.	0532-01 - Frequency range 65 MHz to 500 MHz.
067-0650-00		
TG 501 replaces 180, 180A	TG 501 - Trigger output-slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time.	180A - Trigger pulses 1, 10, 100 Hz; 1, 10, and 100 kHz. Multiple time-marks can be generated simultaneously.
181		181 - Multiple time-marks
184	TG 501 - Trigger output-slaved to market output from 5 sec through 100 ns. One time-mark can be generated at a time.	184 - Separate trigger pulses of 1 and 0.1 sec; 10, 1, and 0.1 ms; 10 and 1 μs.
2901	TG 501 - Trigger output-slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time.	2901 - Separate trigger pulses, from 5 sec to 0.1 μs. Multiple time-marks can be generated simultaneously.

NOTE: All TM 500 generator outputs are short-proof. All TM 500 plug-in instruments require TM 500-Series Power Module.

TEKTRONIX®
committed to technical excellence

MANUAL CHANGE INFORMATION

PRODUCT DM44
070-2036-00

CHANGE REFERENCE C2/377
DATE 3-30-77

CHANGE:	DESCRIPTION

EFFECTIVE ALL SN

NOTE

All references to the 475 in this manual also apply to the 475A.

TEKTRONIX®
committed to technical excellence

MANUAL CHANGE INFORMATION

PRODUCT DM44
070-2036-00

CHANGE REFERENCE M34686
DATE 8-21-78

CHANGE:	DESCRIPTION

EFF SN B030601-up

TEXT, ELECTRICAL PARTS LIST AND SCHEMATIC CHANGES

TEXT CHANGES

Page 6-3 DM44 PROCEDURE, Step 2:

CHANGE TO:

2. Adjust 2V, R3155; and Zero, R3164 (SN B030601-up) or C3164 (SN B010100-B030600)..... 6-5

Page 6-3 464, 465, or 466 HORIZONTAL SYSTEM, Step 9:

CHANGE TO:

9. Adjust TIME, R3287; 1/TIME, R3033; and 1/TIME Linearity, R3162 (SN B030601-up) or C3162 (SN B010100-B030600)..... 6-11

Page 6-3 475 HORIZONTAL SYSTEM, Step 8:

CHANGE TO:

8. Adjust TIME, R3287; 1/TIME, R3033; and 1/TIME Linearity, R3162 (SN B030601-up) or C3162 (SN B010100-B030600)..... 6-22

Page 6-5 Step 2, part g, ADJUST:

CHANGE TO: ADJUST - R3164 (SN B030601-up) or C3164 (SN B010100-B030600) for the same DM44 reading in both.....

Page 6-11 Step 9, part q:

CHANGE TO:

q. ADJUST - R3162 (SN B030601-up) or C3162 (SN B010100-SN B030600) for a DM44 reading of 10.00.

Page 6-22 Step 8, part q:

CHANGE TO:

q. ADJUST - R3162 (SN B030601-up) or C3162 (SN B010100-B030600) for a DM44 reading of 10.00.

ELECTRICAL PARTS LIST AND SCHEMATIC CHANGES

REMOVE:

C3162	281-0221-00	CAP.,VAR,CER DI:2-10PF,100V
C3164	281-0123-00	CAP.,VAR,CER DI:5-25PF,100V

CHANGE:	DESCRIPTION

(C3162 and C3164 are replaced with R3162 and R3164 located on A1 MAIN board, see A/D CONVERTER diagram 4).

CHANGE TO:

C3163	281-0518-00	CAP.,FXD,CER DI:47PF,+/-9.4PF,500V

ADD:

R3162	311-0660-00	RES.,VAR,NONWIR:200K OHM,10%,0.50W
R3164	311-0660-00	RES.,VAR,NONWIR:200K OHM,10%,0.50W

(R3162 and R3164 replace C3162 and C3164, change affects A1 MAIN board and A/D CONVERTER diagram 4 - see partial diagram below.

PARTIAL A/D CONVERTER 4

