

TEKTRONIX®

T921 - T922 - T922R OSCILLOSCOPES

SERVICE

INSTRUCTION MANUAL

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

Serial Number _____



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

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

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SPECIFICATIONS

This manual includes instructions for the T921, T922 and T922R portable oscilloscopes. The T922 is a 15 MHz, dual trace, oscilloscope and the T921 is a 15 MHz, single trace oscilloscope. The Vertical Amplifier, either single trace or dual trace, provides calibrated deflection factors from 2 mV to 10 V/div. The Time Base provides stable triggering over the full bandwidth of the Vertical Amplifier(s) and provides calibrated sweep rates from 0.5 s/div to 0.2 μ s/div. A variable X1 to X10 magnifier extends the maximum sweep rate to 20 ns/div.

The T992R is a rackmount version of the T922 oscilloscope which takes 5-1/4 inches of rack space.

Features added to the rackmount version include: single sweep; rear panel outputs for Sweep Gate, Sweep Ramp, and Vertical Signal; internally selectable Z Axis polarity; user selection of the CHOP or ALT dual trace modes; and switch-selectable front-panel or rear-panel inputs for CH 1, CH 2, and EXT TRIG signals.

The following instrument specifications apply over an ambient temperature range of 0°C to +45°C unless otherwise specified. The Adjustment Procedure in Section 4, when performed completely, allows the T921/T922/T922R to meet the electrical specifications listed in Table 1-1.

TABLE 1-1

Electrical

Characteristic	Performance Requirement
A. DISPLAY	
Probe Adjust Output	Approximately 0.5 V.
Voltage (0°C to +40°C)	
Repetition Rate	Approximately 1 kHz.
Z-Axis Input	5 volt signal causes a noticeable decrease in intensity.
Sensitivity	
Signal Polarity	
T921 and T922 T922R	Positive going from ground. Either polarity of signal can be applied, depending upon internal jumper connections.
Usable Frequency Range	Dc to 5 MHz.
Maximum Input Voltage	30 V (dc + peak ac) 30 V p-p at 1 kHz or less.
Input Impedance	Approximately 10 k Ω .
Power Source	(T922R 120 V/240 V and HI-LO adjustments are not externally accessible; 120 V/240 V setting is visible but not externally accessible on T921 and T922.)
Line Voltage Ranges (ac,rms)	
120 V Range	HI—108 to 132 V. LO—90 to 110 V.
240 V Range	HI—216 to 250 V. LO—198 to 242 V.

Characteristic	Performance Requirement
Line Frequency	50 to 60 Hz.
Maximum Power Consumption	50 watts; 60 Volt-Amps
CRT Display	
Display Area	8 x 10 cm.
Trace Rotation Range	Adequate to align trace with horizontal center line.
Standard Phosphor	P31.
Nominal Accelerating Potential	12,400 V.
B. VERTICAL AMPLIFIER	
Deflection Factor	
Range	2 mV/div to 10 V/div; 12 steps in a 1-2-5 sequence.
Accuracy	
+20°C to +30°C	Within 3%.
0°C to +45°C	Within 4%.
Uncalibrated (VAR) Range	Continuously variable between settings. Extends deflection factor to at least 25 V/div (at least 2.5:1).

OPERATING INSTRUCTIONS

WARNING

To prevent electric shock, do not remove instrument cover. Refer servicing to qualified personnel.

OPERATING VOLTAGE

Your instrument will operate from either a 120 V or 240 V ac 50 to 60 Hz nominal power input source. Check that the Power Input Voltage Selector (120 V/240 V) switch and the Regulating Range Selector (HI/LO) switch are set to positions that include the value of the applied power input voltage. In the United States, the 120 V/240 V switch is normally set for 120 V and the HI/LO switch is normally set for HI at the factory. In Europe, the 120 V/240 V switch is set for 240 V and the HI/LO switch is normally set for LO. The POWER indicator lamp will blink when the applied power input voltage varies more than about 10% (either high or low) from the value for which the switches are set.

CAUTION

Your instrument may be damaged if it is operated from a 240 V power input voltage source with the 120 V/240 V switch set for 120 V. The 120 V/240 V switch and the HI/LO switch are both visible from the bottom of the instrument in all T900-series bench version oscilloscopes, but the 120 V/240 V switch is not adjustable from outside of the cabinet. Refer 120 V/240 V power input voltage selection to qualified service personnel.

SAFETY INFORMATION

The T921, T922, and T922R operate from a single-phase power source with one of the current-carrying conductors (the neutral conductor) at ground (earth) potential. Operation from power sources where both current-carrying conductors are live with respect to ground (such as phase-to-phase on a 3-wire system) is not recommended, since only the line conductor has over-current (fuse) protection within the instrument.

The T921, T922, and T922R have a 3-wire cord with a 3-terminal polarized plug for connection to the power source and safety-earth. The ground terminal of the plug is directly connected to the metal parts of the instrument. For electric-shock protection, insert this plug in a mating outlet with a safety-earth contact.

FUNCTIONS OF CONTROLS, CONNECTORS, AND INDICATORS T921 AND T922

NOTE

(See text preceding FIRST TIME OPERATION for features found only in T922R or those which differ from the T921/T922.)

Before you turn the instrument on, read this portion of the manual to familiarize yourself with the controls, connectors, and indicators.

A. DISPLAY

Front Panel (Fig. 2-1)

- 1 **INTENSITY**—Adjusts the brightness of the crt display. Set for the lowest visible display to prolong crt life.
- 2 **FOCUS**—Adjusts for optimum spot size and definition.
- 3 **BEAM FINDER**—Locates off-screen displays. Compresses the crt display to within the graticule area independently of the position control or applied signals.

To locate an off-screen display:

- a. Set the vertical POSITION and INTENSITY controls to midrange and rotate the horizontal POSITION control clockwise.
- b. If a display or dot still is not visible, press BEAM FINDER and hold in. A compressed display or dot should appear. If not, increase the INTENSITY until a display appears.

If a dot or vertical line appears, the sweep is not triggered. Set the trigger MODE switch to AUTO to obtain a display. Use the vertical and horizontal POSITION controls to move the display near the center of the graticule. Release the BEAM FINDER button and adjust the trigger level control for a stable display.

If a compressed display appears, adjust the VOLTS/DIV switch and the horizontal and vertical POSITION controls for a stable display.

PERFORMANCE CHECK

This procedure allows the basic performance specifications to be checked without removing the instrument covers. It is intended for use in incoming inspection to determine acceptability of newly purchased or recently calibrated instruments.

LIMITS AND TOLERANCES

Tolerances given are for the instrument under test and do not include test equipment error. Limits and tolerances in this check are instrument specifications only if they are called out as performance requirements in the specifications section.

TEST EQUIPMENT REQUIRED

You will need the test equipment listed in Table 3-1, or equivalent, to perform a complete Performance Check of the T921, T922, and T922R. The Specifications given for the equipment are the minimum necessary for accurate results.

TABLE 3-1
Test Equipment

Description	Minimum Specifications	Usage	Examples of Applicable Test Equipment
1. Amplitude Calibrator	Amplitude accuracy, within 0.5%; signal amplitude, 10 mV to 10 V; output signal, 1 kHz square wave.	Vertical Gain checks, X gain check.	a. Tektronix PG 506 Calibration Generator ¹ (with included 50 Ω precision cable). b. Tektronix 067-0502-01 Calibration Fixture.
2. Sine-Wave Generator	Frequency 50 kHz to above 15 MHz; output amplitude variable from 0.5 to 5 V p-p; output impedance, 50 Ω ; reference frequency, 50 kHz; amplitude accuracy, constant within 0.3% of reference frequency as output frequency changes.	Vertical Amplifier bandwidth checks, X bandwidth check. Triggering checks. Z axis input check.	a. Tektronix SG 503 Leveled Sine-Wave Generator. ¹ b. Tektronix Type 191 Constant Amplitude Signal Generator.
3. Time-Mark Generator	Marker outputs, 20 ns to 0.5 s; marker accuracy within 0.5%; trigger output 1 ms to 0.1 μ s, time coincident with markers.	Timing checks.	a. Tektronix TG 501 Time-Marker Generator. ¹ b. Tektronix 2901 Time-Mark Generator.
4. Termination	Impedance, 50 Ω ; BNC connectors.	Signal termination.	a. Tektronix Part 011-0049-01.
5. Cable (3)	Impedance 50 Ω ; BNC connectors.	Signal interconnection.	a. Tektronix Part 012-0057-01.

¹Requires a TM500 Series Power Module.

ADJUSTMENTS

WARNING

SERVICING INFORMATION IN THE FOLLOWING SECTIONS IS INTENDED FOR USE BY QUALIFIED SERVICE PERSONNEL ONLY. TO AVOID ELECTRIC SHOCK, DO NOT REMOVE INSTRUMENT COVERS OR PERFORM ANY SERVICING UNLESS QUALIFIED TO DO SO.

IMPORTANT—PLEASE READ BEFORE USING THIS PROCEDURE

When done properly, this procedure allows you to adjust the instrument to its original performance specifications. The Adjustment Procedure is not intended as a troubleshooting guide. Any trouble you find during the procedure should be corrected before continuing. Refer to the Service Information section for further information.

LIMITS AND TOLERANCES

Limits and tolerances are instrument specifications only if they are called out as performance requirements in the Specification section. Tolerances given are for the oscilloscope under test and do not include test equipment error.

ADJUSTMENT INTERACTION

Some adjustments interact with others. These are identified with an INTERACTION step.

PARTIAL PROCEDURES

You can perform part of the adjustment procedure after replacing components or just to touch up the performance between major re-adjustments. Do not change the setting

of the -8 V supply unless you intend to re-adjust the entire instrument.

To adjust only part of the instrument, set the controls according to the nearest preceding Control Settings and use the test setup given in the step you intend to perform or the setup in a preceding step. To prevent unnecessary re-adjustment of other parts of the instrument, reset an adjustment only if the tolerance given for that step is not met. If it is necessary to reset an adjustment, also check any steps listed in the INTERACTION— part of the step.

TEST EQUIPMENT REQUIRED

The test equipment listed in Table 4-1, or equivalent is required for complete calibration of the oscilloscope. Specifications given for the equipment are the minimum necessary for accurate calibration.

TABLE 4-1
Test Equipment

Description	Minimum Specifications	Usage	Examples of Applicable Test Equipment
1. Digital Voltmeter	Range, 0 to 9 V dc; accuracy within 0.3%.	Power supply adjustment.	a. Tektronix DM 501 Digital Multimeter. ¹
2. Time-Mark Generator	Markers, 0.5 μs to 0.5 s; accuracy, within 0.3%.	Y-axis alignment, geometry adjustment, sweep and timing adjustments.	a. Tektronix TG 501 Time-Mark Generator. ¹ b. Tektronix 2901 Time-Mark Generator.
3. Amplitude Calibrator	Signal amplitude, 10 mV to 50 V square wave; frequency, 1 kHz; amplitude accuracy, within 0.3%.	Vertical gain adjustment.	a. Tektronix PG 506 Calibration Generator. ¹

¹Requires TM500 Series Power Module.

SERVICE INFORMATION

The following information is provided to help you keep your T921/T922/T922R in good operating condition. We recommend that servicing be done by qualified service personnel only. You can, if you like, send your instrument to a Tektronix Service Center for re-adjustment and repair. Contact your local Tektronix representative for information about the Service Centers in your area.

CABINET REMOVAL

WARNING

Dangerous potentials exist at several points throughout the T921, T922, and T922R. When operating the instrument with the covers off, avoid touching connections and components. Some transistors have elevated cases. Disconnect the power before cleaning the instrument or replacing parts.

T921 AND T922

To remove the cover, take out the six screws (top and bottom) holding the two halves together. Pull the two halves apart.

To replace the cover, line up the slots on the cover with the front panel and the rear subpanel and slide together. Replace screws.

T922R

The T922R cabinet is made of two pieces which can be removed independently. Each half is held on by six captive screws. To remove a cabinet half, turn the six captive screws 90 degrees counterclockwise and lift that half of the cabinet away from the instrument. Use a large coin to loosen the captive screws.

OPERATING VOLTAGE SELECTION

Your instrument will operate from either a 120 V or 240 V ac 50 to 60 Hz nominal power input source. Check that the Power Input Voltage Selector (120 V/240 V) switch and the Regulating Range Selector (HI/LO) switch are set to positions that include the value of the applied power input voltage. In the United States, the 120 V/240 V switch is normally set for 120 V and the HI/LO switch is normally set for HI at the factory. In Europe, the 120 V/240 V switch is set for 240 V and the HI/LO switch is normally set for LO. The POWER indicator lamp will blink when the applied power input voltage varies more than about 10% (either high or low) from the value for which the switches are set.

CAUTION

Your instrument may be damaged if it is operated from a 240 V power input voltage source with the 120 V/240 V switch set for 120 V. The 120 V/240 V switch and the HI/LO switch are both visible from the bottom of the instrument in all T900-series bench version oscilloscopes, but the 120 V/240 V switch is

not adjustable from outside of the cabinet. Refer 120 V/240 V power input voltage selection to qualified service personnel.

The 120 V/240 V switch S701 is accessible in all T900-series instruments when the cabinet is removed. If S701 setting needs to be changed, the value of the line fuse F700 must also be changed. See Fuse Replacement in Corrective Maintenance portion of Service Information section of this manual.

PREVENTIVE MAINTENANCE

Preventive maintenance consists of cleaning the instrument regularly and inspecting it occasionally for broken or damaged parts. Regular maintenance will improve the reliability of your instrument and prevent breakdowns.

Cleaning

Accumulations of dirt and dust on components act as an insulating blanket preventing efficient heat dissipation. Dust on circuit boards and wires can cause arcing and short circuits, resulting in damage to components or even instrument failure. Clean your instrument before this happens!

The cabinet provides protection from dust and dirt and should be in place during normal operation of the instrument.

CAUTION

Avoid the use of chemical cleaning agents containing benzene, toluene, xylene, acetone or similar solvents. These chemicals may damage the plastics used in this instrument. Recommended cleaning agents are isopropyl alcohol or Kelite (1 part Kelite, 20 parts water).

Exterior. Dust the cabinet with a soft cloth. Dust the front panel controls with a small soft paint brush. Dirt clinging to the surface of the cabinet may be removed with a soft cloth dampened with a mild detergent and water solution. Avoid using abrasive cleaners. They will scratch the cabinet and front panel.

Interior. Dust in the interior of the instruments should be removed before it builds up enough to cause arcing and short circuits during periods of high humidity. Dust is best removed from the interior by dry, (approximately 9 lb/in.²) low-pressure air. Dirt clinging to surfaces may be removed

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

OPTIONS

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

Option 1	Differential Mode	Described in this Section
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(Schematic diagrams for Option 1 are included at the end of the Diagrams section in this manual.)

DIAGRAMS AND CIRCUIT DESCRIPTION

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.

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

Abbreviations are based on ANSI Y1.1-1972.

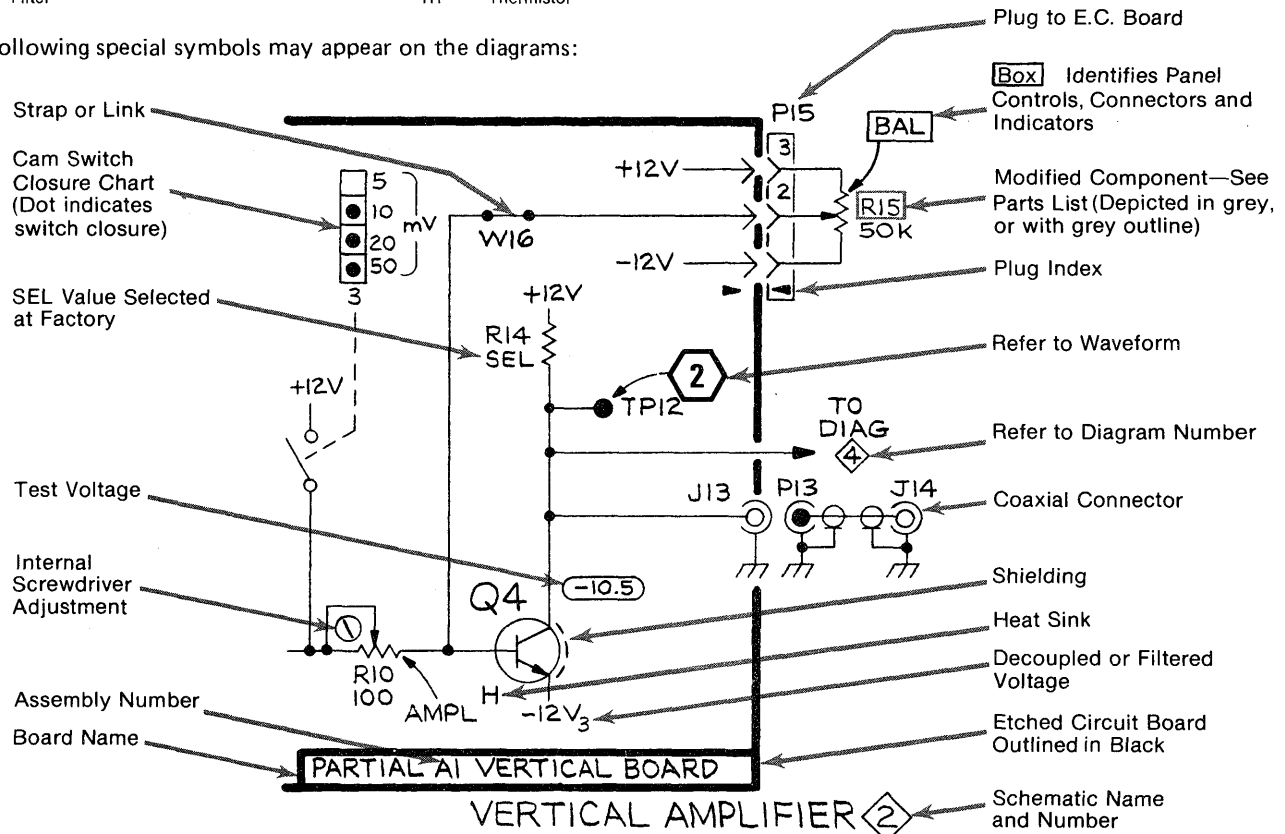
Other ANSI standards that are used in the preparation of diagrams by Tektronix, Inc. are:

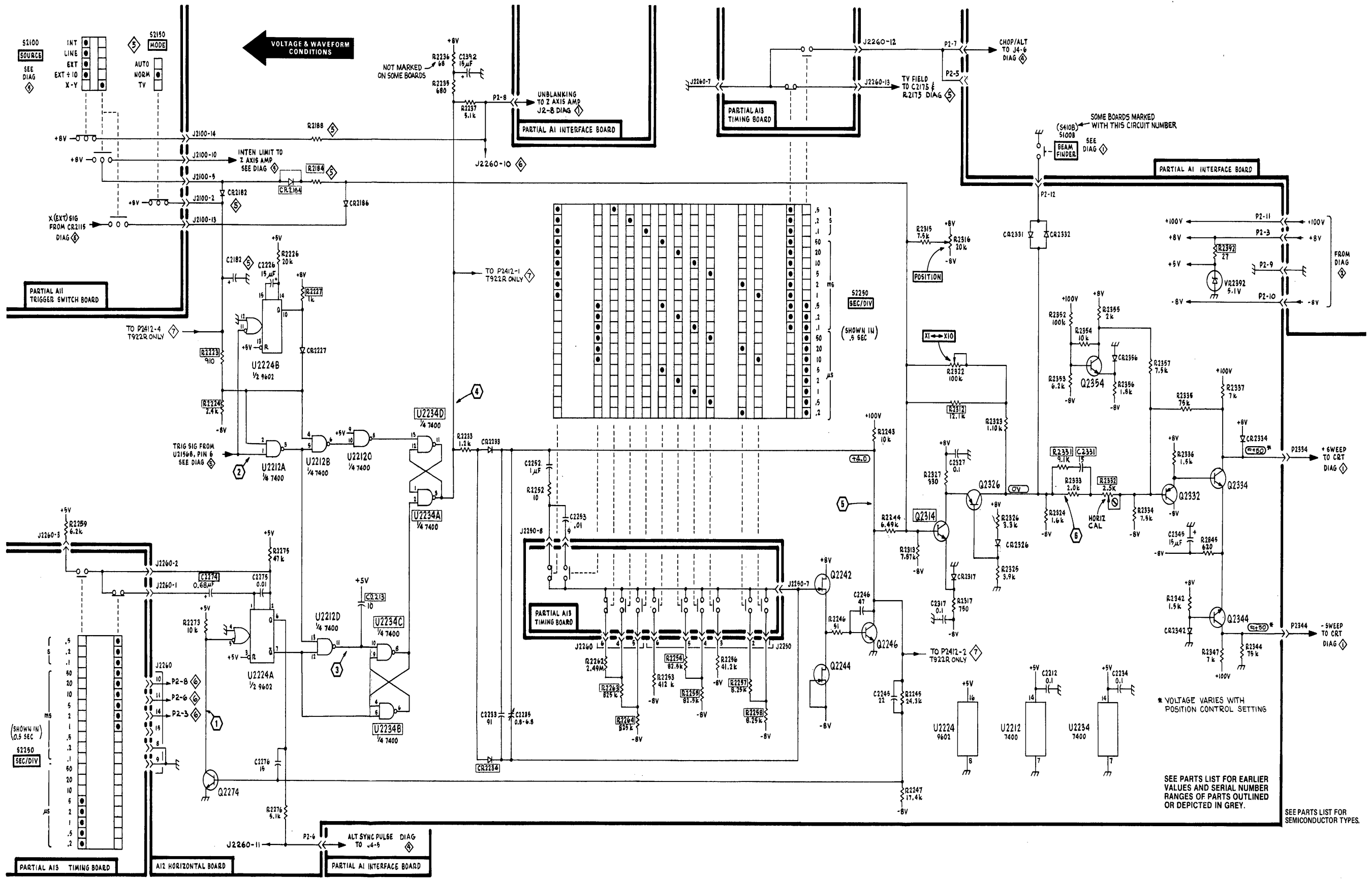
- Y14.15, 1966 Drafting Practices.
- Y14.2, 1973 Line Conventions and Lettering.
- Y10.5, 1968 Letter Symbols for Quantities Used in Electrical Science and Electrical Engineering.

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)	H	Heat dissipating device (heat sink, heat radiator, etc)	S	Switch or contactor
AT	Attenuator, fixed or variable	HR	Heater	T	Transformer
B	Motor	HY	Hybrid circuit	TC	Thermocouple
BT	Battery	J	Connector, stationary portion	TP	Test point
C	Capacitor, fixed or variable	K	Relay	U	Assembly, inseparable or non-repairable (integrated circuit, etc.)
CB	Circuit breaker	L	Inductor, fixed or variable	V	Electron tube
CR	Diode, signal or rectifier	M	Meter	VR	Voltage regulator (zener diode, etc.)
DL	Delay line	P	Connector, movable portion	W	Wirestrap or cable
DS	Indicating device (lamp)	Q	Transistor or silicon-controlled rectifier	Y	Crystal
E	Spark Gap, Ferrite bead	R	Resistor, fixed or variable	Z	Phase shifter
F	Fuse	RT	Thermistor		
FL	Filter				

The following special symbols may appear on the diagrams:





T921/T922/T922R

1982-30
REV. E, FEB 1979

SWEEP & HORIZONTAL AMPLIFIER

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
<i>Assembly and/or Component</i>					
<i>Attaching parts for Assembly and/or Component</i>					
--- * ---					
<i>Detail Part of Assembly and/or Component</i>					
<i>Attaching parts for Detail Part</i>					
--- * ---					
<i>Parts of Detail Part</i>					
<i>Attaching parts for Parts of Detail Part</i>					
--- * ---					

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