The following pages contain the text, parts list, and schematics for the Type 51 Plug-In Module. This module is designed for use with Tektronix Type 560-Series Oscilloscopes.

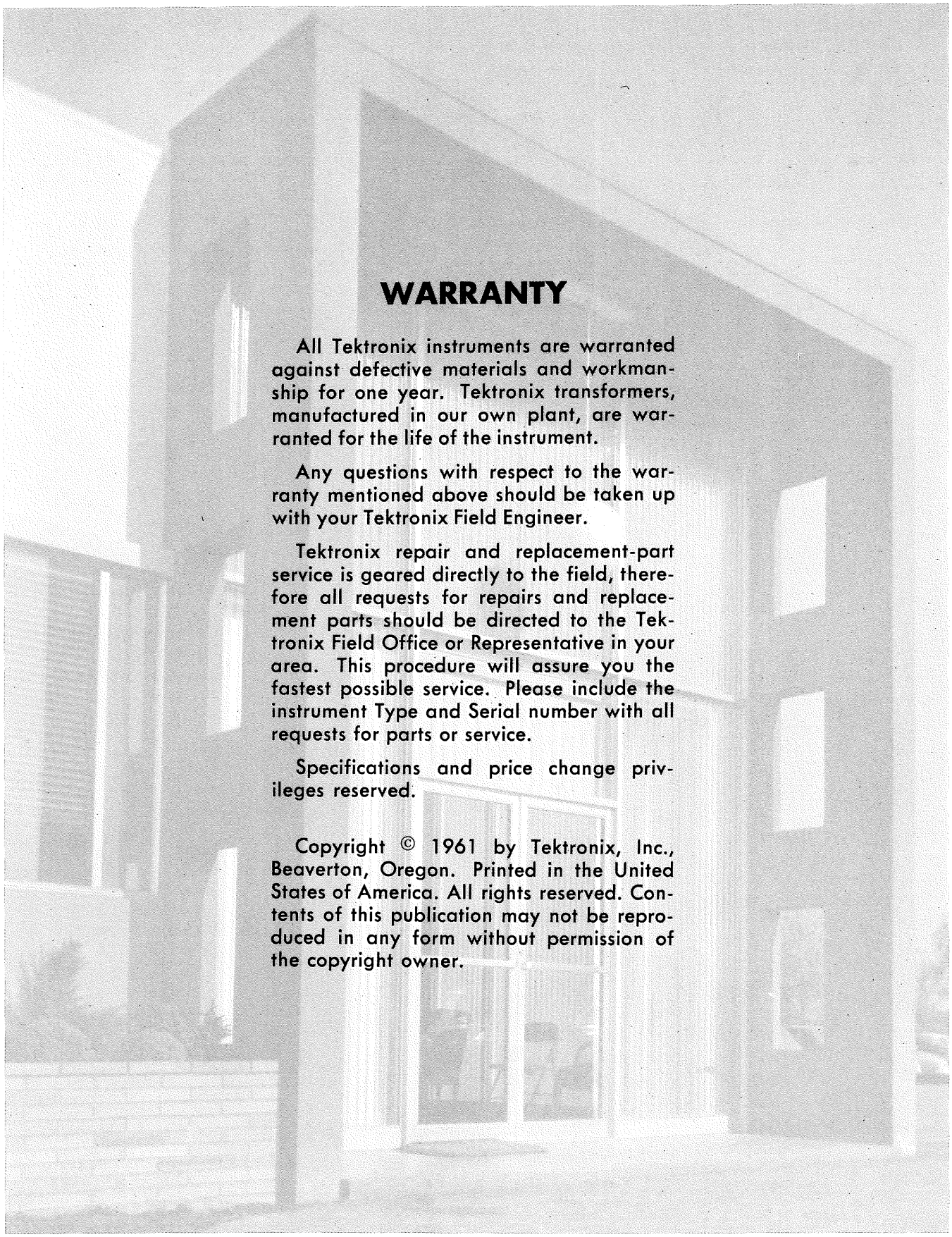
Insert these pages into the binder you received with the Indicator Unit manual so that you will have a complete instruction manual for your oscilloscope.

Instruction Manual

TYPE 51 SWEEP

Tektronix Inc. 070-265

P. O. Box 500 ● Beaverton, Oregon ● Phone: MI 4-0161 ● Cables: Tektronix



WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year. Tektronix transformers, manufactured in our own plant, are warranted for the life of the instrument.

Any questions with respect to the warranty mentioned above should be taken up with your Tektronix Field Engineer.

Tektronix repair and replacement-part service is geared directly to the field, therefore all requests for repairs and replacement parts should be directed to the Tektronix Field Office or Representative in your area. This procedure will assure you the fastest possible service. Please include the instrument Type and Serial number with all requests for parts or service.

Specifications and price change privileges reserved.

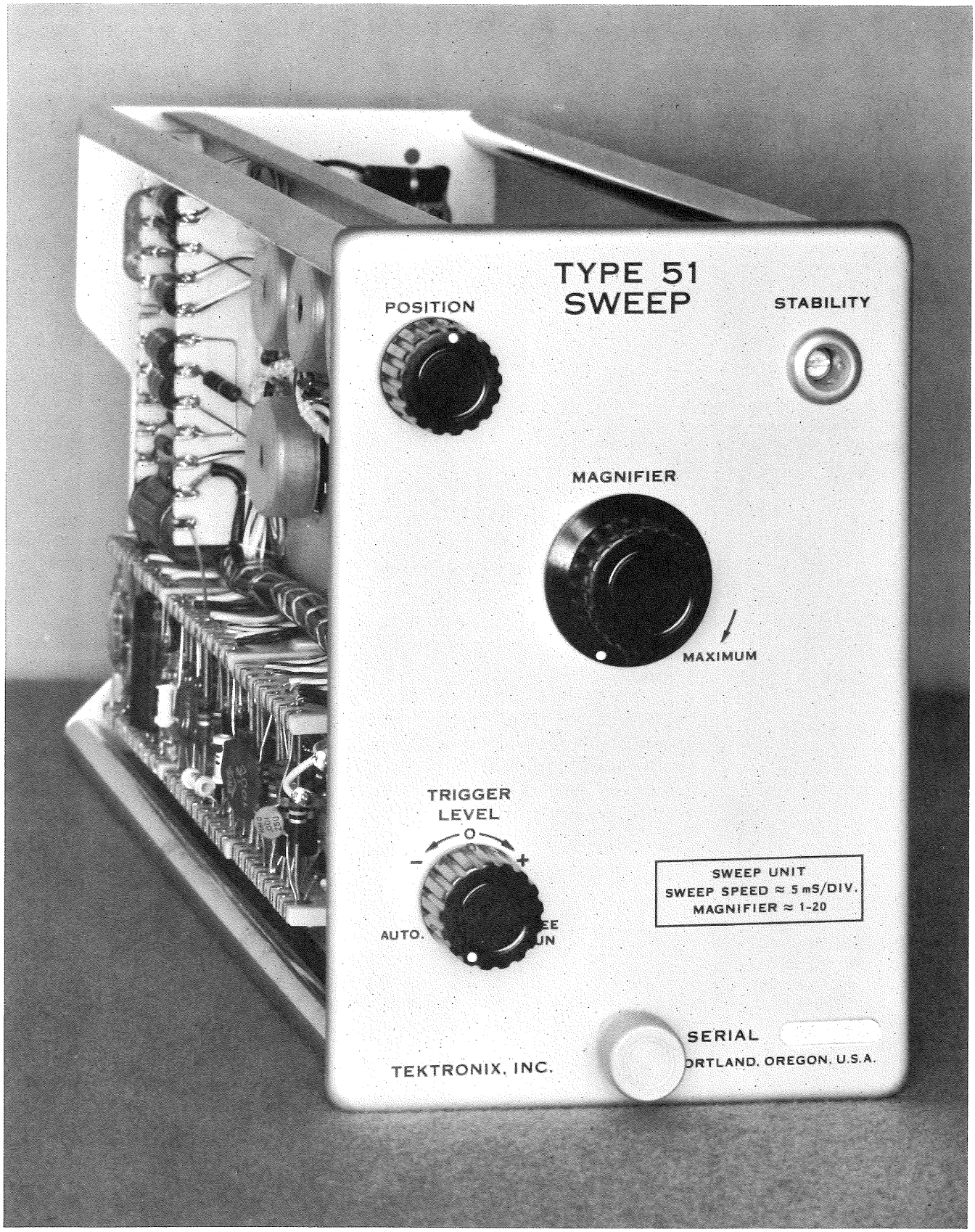


Fig. 1. Type 51 Sweep module.

TYPE 51 SWEEP

INTRODUCTION

The Tektronix Type 51 Sweep module, Fig. 1, is designed for use with Tektronix Type 560 and Type 561 Oscilloscopes. When used with either of these instruments, it produces a triggered or free-running sweep with a nominal sweep rate of 5 milliseconds per division — that is, the trace on the oscilloscope screen moves one graticule division in 5 milliseconds. By means of a sweep-magnifying circuit, this rate can be increased to about 0.25 millisecond per division. The sweep may be triggered by the signal in the amplifier module or, in the absence of such signal, automatically at about 5 sweeps per second. Or it can be allowed to free-run, in which case it will generate about 13 sweeps per second. Regardless of the number of sweeps per second, the speed with which the trace moves across the screen is fixed by internal adjustments and the setting of the MAGNIFIER control.

The Type 51 Sweep module is intended primarily to be used with the Type 50 Amplifier module in the Type 560 or Type 561 Oscilloscope for displaying signals produced by magnetic-ink characters as they are scanned by a magnetic-ink tester, such as the Kidder Whirly-Sig. A special manual has been prepared containing instructions for the operation of these oscilloscopes (with the Type 50 and Type 51 modules) specifically in this application. If you are using your Type 51 module for this purpose and do not have the special manual, contact your Tektronix Field Engineer.

This manual describes operating instructions for general use of the Type 51 module. It also contains a detailed circuit description of the module and troubleshooting and calibration instructions. A parts list and schematic diagram are contained at the rear.

Operating Instructions

Throughout the instructions that follow, it is assumed, unless otherwise stated, that the Type 51 module is inserted in the right-hand opening of the oscilloscope, thereby providing horizontal deflection of the trace. If the module is inserted in the left-hand opening, it will provide vertical deflection and the instructions must be interpreted accordingly. It is further assumed throughout the discussion that there is an amplifier module in the left-hand opening, although the Type 51 will produce a sweep on the screen when there is no module in the left-hand opening.

TRIGGER LEVEL Control

For most operations, the TRIGGER LEVEL control may be placed in the AUTO. position (fully counterclockwise) and left there. When the control is in this position, the sweep will usually be triggered properly by the triggering signal from the amplifier module in the other opening. In the absence of a triggering signal from the other module, the sweep will continue to be triggered automatically at a rate of about 5 sweeps per second. This provides a reference trace which indicates that the oscilloscope is adjusted to display any signal which might be applied to the amplifier module. This trace can also be used as a reference from which to measure dc voltages if you are using a dc-coupled amplifier module.

When the TRIGGER LEVEL control is moved off the AUTO. position and into the center of its range, it allows you to select, within certain limits, the point on the triggering signal at which the sweep will be triggered. If stable triggering of the sweep cannot be obtained with the TRIGGER LEVEL control in the AUTO. position, this portion of the control range should be used.

The sweep is always triggered by a positive-going portion of the triggering signal. Turning the TRIGGER LEVEL control clockwise (toward +) causes the sweep to be triggered at a more positive point on the signal; turning the TRIGGER LEVEL control counterclockwise (toward —) causes the sweep to be triggered at a less positive (more negative) point on the signal. When the Type 51 module is used with an amplifier module which supplies a dc-coupled triggering signal, the vertical position of the signal on the screen will make a difference in the TRIGGER LEVEL control setting at which stable triggering is obtained.

When the TRIGGER LEVEL control is set fully clockwise to the FREE RUN position, the Type 51 module produces a free-running sweep, independent of any triggering signal. This free-running sweep can be used as a dc reference level with those amplifier modules which provide dc coupling of the signal, and is also used in trouble isolation (see Troubleshooting).

MAGNIFIER Control

The MAGNIFIER control provides a means of expanding the center portion of the sweep by a factor of about 20. To expand a given portion of a displayed signal, set that portion to the center of the graticule with the POSITION control, and rotate the MAGNIFIER control clockwise until the desired degree of expansion is obtained.

POSITION Control

The POSITION control contains a step-down turning-ratio feature which allows smooth positioning of the trace.

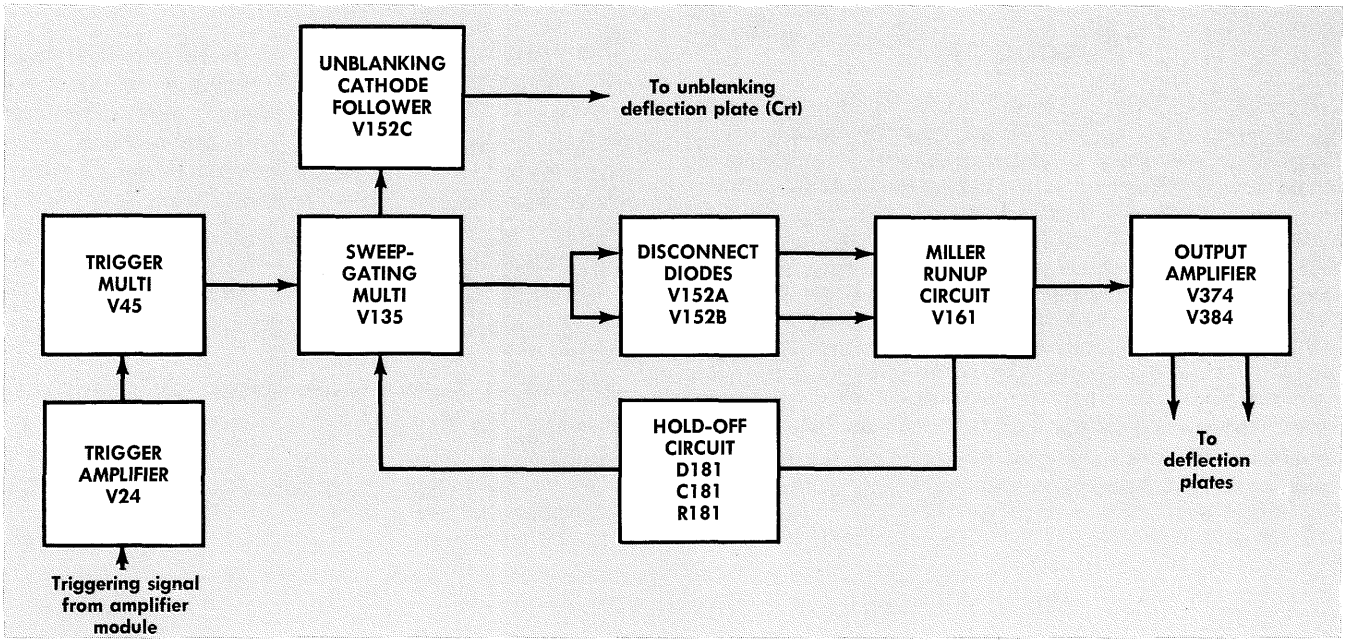


Fig. 2. Block diagram of Type 51 Sweep module.

Circuit Description

A block diagram of the Type 51 Sweep module is shown in Fig. 2. Basically, the overall operation of the module is as follows.

The Trigger Amplifier inverts and amplifies the triggering signal from the amplifier module and applies it to the Trigger Multivibrator. The Trigger Multivibrator develops a negative trigger pulse coincident with a selected point on each cycle of the triggering signal. This negative pulse causes the Sweep-Gating Multivibrator to change states and apply a negative gate to the Disconnect Diodes. The Disconnect Diodes "unclamp" the two sides of the Timing Capacitor in the Miller Runup Circuit, and the Miller Runup Circuit develops a sawtooth waveform which is applied to the Output Amplifier. The Output Amplifier "splits" the sawtooth waveform and applies it push-pull to the deflection plates of the crt. This causes the trace to move across the screen. A portion of the sawtooth waveform is coupled back to the Sweep-Gating Multivibrator via the Hold-Off Circuit to turn the sweep off after the trace reaches the other side of the screen.

Following is a more detailed description of the operation of each of the circuits of the Type 51 module. (Refer to the schematic diagram at the rear of this manual.)

Triggering Circuits

The triggering signal from the amplifier module is applied through pin 12 of the interconnecting plug to the input grid of the Trigger Amplifier (grid of V24A). The Trigger Amplifier inverts this signal and amplifies it by a factor of about 10. The setting of the TRIGGER LEVEL control sets the grid level of V24B, and thereby controls the average dc level about which the amplified triggering signal swings at the plate of V24A.

The Trigger Multivibrator is a two-state Schmitt circuit. When the voltage at its input grid (grid of V45A) is above a certain critical level (neglecting hysteresis), the Trigger Multivibrator is in one state, with V45A conducting and V45B cut off. When the Trigger Multivibrator is in this state, the voltage at its output (plate of V45B) is at +300 volts. When the voltage at the input grid is below the critical level (still neglecting hysteresis), the Trigger Multivibrator is in the other state, with V45A cut off and V45B conducting. When the Trigger Multivibrator is in this second state, the voltage at its output is about +280 volts. The transition from one state to the other occurs very rapidly, regardless of how slowly the voltage at the input grid passes the critical level. Thus, the output of the Trigger Multivibrator is a 20-volt square wave. The negative-going transition occurs when the voltage at the grid of V45A passes the critical level while moving in the negative direction, and the positive-going transition occurs when the voltage at the grid of V45A passes the critical level while moving in the positive direction.

This square wave is differentiated by C130 and R130 to form negative and positive pulses at the input to the Sweep-Gating Multivibrator. The negative pulses trigger the Sweep-Gating Multivibrator to start the sweep; the positive pulses are clamped by D130. By means of the TRIGGER LEVEL control, the negative triggering pulses can be made to coincide with virtually any point on the positive-going portion of the incoming triggering signal.

Actually, the input voltage level at which the Trigger Multivibrator changes states on a negative-going signal is slightly lower than the input voltage level at which it changes states on a positive-going signal. The difference between the two voltage levels at which the changes in state occur is the hysteresis of the circuit. The signal at the grid of V24A must have an amplitude of about 0.4 volt or more to overcome this hysteresis and produce reliable triggering.

As will be seen in the discussion of Sweep Generation, not every negative trigger pulse from the Trigger Multivibrator initiates a sweep. Trigger pulses which arrive at the Sweep-Gating Multivibrator during the time that a sweep is in progress will have no effect on the circuit. It is only after a sweep has been completed and all circuits have returned to their quiescent state that the Sweep-Gating Multivibrator will be retriggered by a pulse from the Trigger Multivibrator.

Automatic Triggering

Placing the TRIGGER LEVEL control in the AUTO. position converts the Trigger Multivibrator from a bistable to an astable (free-running) configuration. This is accomplished by coupling the grid circuit of V45B to the grid circuit of V45A via R40. The time constant thus formed by R40 and C30 is such that the Trigger Multivibrator free runs at about 5 cps. However, since the output of the Trigger Amplifier is still coupled to the Trigger Multivibrator through C30, any triggering signal of sufficient amplitude will synchronize the operation of the Trigger Multivibrator at the triggering signal frequency. In the absence of any triggering signal, the sweep continues to be triggered at about 5 sweeps per second by the free-running action of the Trigger Multivibrator.

Placing the TRIGGER LEVEL control in the AUTO. position also grounds the grid of V24B. This places V24A in about the middle of its dynamic range. Thus, the switching of the Trigger Multivibrator will take place at approximately the average dc level of the triggering signal rather than at a selected point on the signal. Insertion of R13 into the circuit decreases the sensitivity of the Trigger Amplifier to prevent triggering on random noise in the triggering signal.

Sweep Generation

In the quiescent state — that is, when no sweep is being generated — V135A is conducting and V135B is cut off. (The STABILITY adjustment is set so that the grid of V135A is just above cutoff.) The plate of V135B is at about —2.5 volts with respect to ground. The Disconnect Diodes are conducting and hold both sides of the Timing Capacitor, C160, at about —2.5 volts. With its cathode grounded and its grid at —2.5 volts, the Miller Runup tube, V161A, is conducting heavily and its plate is at about +30 volts.

A negative trigger pulse, arriving at the grid of V135A from the Trigger Multivibrator, causes the Sweep-Gating Multivibrator to switch rapidly to its other state. That is, V135A cuts off and V135B conducts. V135A is held in cutoff after the trigger pulse passes by a rise in voltage at the common cathode connection. This prevents the Sweep-Gating Multivibrator from being affected by further trigger pulses during the time that a sweep is in progress. As V135B conducts, its plate voltage goes down, cutting off the Disconnect Diodes. When the Disconnect Diodes cut off, the plates of the Timing Capacitor are no longer held at —2.5 volts, and the Timing Capacitor starts to charge toward the instantaneous potential difference between the —150-volt supply and the potential at the cathode of V161B. However, as the lower side of the Timing Capacitor starts to move in a negative direction, it takes the grid of V161A with it. This produces a positive swing at the plate of V161A which is coupled, through B167 and V161B, to the upper side of the Timing Capacitor. This increases the voltage to which the Timing Capacitor is trying to charge. The effect is to "straighten out" the charging curve by increasing the charging voltage with each increment of charge already on the capacitor. The positive swing at the top of the Timing Capacitor also tends to prevent the lower side from swinging negatively. Since the gain of V161A is about 200, the potential at the top of the Timing Capacitor moves about 100 volts with respect to ground while the potential on the lower side moves about one-half volt. The result is an extremely linear sawtooth at the cathode of V161B, which is applied through the Output Amplifier to the deflection plates of the cathode-ray tube.

B152 and B161 protect V152C and V161B, respectively, against cathode-to-grid breakdown when the instrument is first turned on, by holding the cathodes within a safe operating level of the grids until the heaters have warmed up enough to allow the tubes to conduct.

Sweep Length

The total time duration of the sweep is adjustable by means of the SWP. LENGTH adjustment, R176. As the sweep voltage rises at the cathode of V161B, there is a proportionate rise in the voltage at the arm of the adjustment. This rise is coupled through D181, R130, and R131 to the grid of V135A. When the voltage rises to the point where V135A comes out of cutoff, the Sweep-Gating Multivibrator rapidly reverts to its original state, with V135A conducting and V135B cut off. The voltage at the plate of V135B rises, carrying with it the voltage at the plates of the Disconnect Diodes.

V152B starts conducting and forms a discharge path for the Timing Capacitor. This brings the grid of V161A quickly back to its quiescent level. The rise in voltage at the grid causes the tube to conduct more, so the plate voltage drops, carrying with it the grid and cathode of V161B. When the voltage at the cathode of V161B returns to about —2.5 volts, V152A conducts, clamping the voltage at this point. The circuit has now returned to its quiescent state and is ready for the next negative trigger pulse.

Hold-Off

During sweep time, the rise in voltage at the SWP. LENGTH adjustment charges C181 through D181. At the end of the sweep, C181 must then discharge through R181 before the grid of V135A can drop low enough to allow the tube to be cut off again by a negative trigger pulse from the Trigger Multivibrator. The time constant of C181

and R181 is long enough that this does not occur until after the Miller Runup Circuit has had time to recover and stabilize in its quiescent condition.

Stability

When the TRIGGER LEVEL control is not in the FREE RUN position, the quiescent dc level of the grid of V135A is set by the STABILITY adjustment, R111 (the switch across R111 is open). This adjustment is set so that the grid of V135A is high enough to hold V135A in conduction but low enough that a negative trigger pulse from the Trigger Multivibrator will cause the Sweep-Gating Multivibrator to change states. This is normally between about —58 and —62 volts.

Placing the TRIGGER LEVEL control in the FREE RUN position closes the switch across R111. This places a sufficiently negative voltage at the grid of V135A that V135A cuts off immediately upon decay of the charge on C181 and initiates the next sweep without a trigger pulse. The result is a free-running sweep whose period is the total of the sweep time plus the discharge time of C181.

Trace Blanking and Unblanking

Pins 13 and 14 of the right-hand interconnecting plug in the Type 560 and Type 561 Oscilloscopes are tied directly to the unblanking deflection plates in the oscilloscope cathode-ray tube. (See the discussion of the Crt Circuit in the oscilloscope manual.) When the Type 51 module is in the right-hand opening of the oscilloscope, +125 volts is applied to one unblanking deflection plate and the signal at the cathode of V152C is applied to the other. During sweep time, the cathode of V152C is at about +125 volts. Thus, there are equal voltages applied to both unblanking deflection plates and the crt is unblanked. Between sweeps, the cathode of V152C is between about 0 and +40 volts, and the crt is blanked.

Output Amplifier

The Output Amplifier converts the single-ended sawtooth output of the Miller Runup Circuit to a push-pull sawtooth which is applied through the interconnecting plug to the deflection plates of the crt.

V374 and V384 form a cathode-coupled paraphase amplifier. When the MAGNIFIER control is set fully counterclockwise (wiper arm at the lower end of R351), the sawtooth at the grid of V374 is about 1.5 volts in amplitude. This is amplified in the paraphase amplifier to produce opposing sawtooth waveforms of about 120 volts amplitude at the plates of V374 and V384. The POSITION control, R323, varies the dc level of the sawtooth at the grid of V374, thereby varying the dc level of the waveforms at the plates inversely to one another. The HORIZ. GAIN adjustment, R379, controls the gain of the amplifier by varying the amount of degeneration in the cathode circuit.

Turning the MAGNIFIER control clockwise increases the amplitude of the sawtooth applied to the grid of V374. At the fully clockwise position of the control, the sawtooth is about 37.5 volts in amplitude. This causes that portion of the sawtooth which passes through the dynamic range of the amplifier (from about —2 volts to +2 volts at the grid of V374) to be magnified by a factor of about 20 as seen at the plates of the tubes. This has the effect of magnifying that portion of the sweep which lies at the center of the oscilloscope screen. The POSITION control raises or lowers the level of the entire signal at the grid of V374 so that any selected portion of the sawtooth can be magnified.

The SWP./MAG. REGIS. adjustment sets the dc balance of the paraphase amplifier so that the average dc level of the signals at the plates of the tubes will not vary as the MAGNIFIER control is rotated. Thus the center of the trace will stay in the center of the screen as the MAGNIFIER control is rotated.

Troubleshooting

General maintenance and troubleshooting information is contained in the Oscilloscope manuals. In the following discussion, it is assumed that you have already read that information and have definitely isolated a trouble to the Type 51 module by the procedures described there.

First, remove the right-hand side panel of the oscilloscope and check to see if there is heater glow in all of the tubes of the module. Replace any in which there is no heater glow. If there is still no heater glow in any tube, trace out its heater circuit to find the trouble.

If there is heater glow in all tubes, remove the module and inspect it closely for damaged or burned components, loose wires, broken switches, etc., which could cause trouble. If the visual inspection does not reveal the source of trouble, insert the module in the left-hand opening of the oscilloscope and remove the left-hand side panel. This will allow access to the wiring and components of the module.

The Type 51 module will produce a vertical sweep when it is inserted in the left-hand opening of the oscilloscope. For troubleshooting purposes, you do not need a module in the right-hand opening (except to check triggering and blanking circuits). If, for some reason, you do not wish to exchange positions of modules for troubleshooting work, you may use a plug-in extension, Tektronix part no. 013-034, which allows the module to be operated while extended partially out of the front of the oscilloscope.

The following troubleshooting information is divided according to the symptoms presented to the operator. It should enable you to isolate virtually any trouble in the Type 51 module to a given circuit or part of a circuit. When the trouble has been so isolated, you should first change the tube or tubes in the circuit. If this does not eliminate the trouble, it will be necessary to make voltage, resistance, and/or waveform checks through the circuit to determine the faulty component. Waveforms and voltages to be encountered at various points throughout the module

are shown on the schematic diagram at the rear of this manual. Resistance measurements will usually be point-to-point checks, for which the proper values can be approximated from the schematic diagram.

No Sweep

If you are unable to obtain a sweep regardless of the setting of the TRIGGER LEVEL control, set the control to FREE RUN and observe B167. There should be a perceptibly pulsating glow around one of the elements of the tube. If the glow is pulsating, the sweep circuits (Sweep-Gating Multivibrator, Disconnect Diodes, Miller Runup Circuit, and Hold-Off Circuit) are operating properly and the trouble is in the Output Amplifier. If the glow is steady, the trouble is in the sweep circuits. If there is no glow at all, the trouble is in one of the components connected to B167.

If the trouble is found to be in the Output Amplifier (pulsating glow in B167), connect a shorting strap between the grids of the amplifier (pin 1 of V374 and pin 1 of V384). If a spot now appears on the screen, the trouble is in the resistive network between the cathode of V161B and the grid of V374, or in the grid circuit of V384. If a spot does not appear on the screen when the two grids of the Output Amplifier are shorted together, connect the shorting strap between the two plates. If a spot now appears on the screen, the trouble is in V374 or V384 or in the plate or cathode circuits of the tubes. If the spot does not appear when the two plates are shorted together, the trouble is in the wiring between these points and the crt deflection plate pins (assuming that you have already checked the crt as described in the oscilloscope manual).

If the trouble is in the sweep circuits (steady glow in B167), measure the voltage at the plate (pin 6) of V161A. It will probably be either +100 volts or more with respect to ground (possibly as high as +250 volts), or less than +30 volts with respect to ground. These two conditions will be treated separately in the discussion that follows as "High Plate Voltage at V161A" and "Low Plate Voltage at V161A," respectively.

High Plate Voltage at V161A. If the voltage at the plate of V161A is +100 volts or more, momentarily ground the grid (pin 2) of the tube. The plate voltage should drop to less than +10 volts. If it does not, the tube is probably bad and should be replaced. If the plate voltage of V161A does drop when the grid is grounded, momentarily ground the plate (pin 6) of V152B. Again, the plate of V161A should drop to within about 10 volts of ground. If it does not, V152 is bad.

If the plate of V161A does drop when the plate of V152B is grounded, remove the ground and measure the voltage at the cathode (pin 8) of V161B. It should be about 30 volts less positive than that measured at the plate of V161A. If it is not, the trouble is in V161B or associated components. If the cathode of V161B is about 30 volts less positive than the plate of V161A, measure the voltage at the grid (pin 2) of V135A. If it is —60 volts or more with respect to ground, the trouble is in the Hold-Off circuit or in the stability circuit. If the voltage at the grid of V135A is less than —60 volts with respect to ground, the trouble is in the Sweep-Gating Multivibrator.

Low Plate Voltage at V161A. If the voltage at the plate of V161A is +30 volts or less, the tube is conducting heavily. In this case, measure the voltage at the cathode (pin 8) of V161B. It should be about 30 volts less positive than that at the plate of V161A. If it is not, the trouble is in V161B or associated components. If the cathode of V161B is about 30 volts less positive than the plate of V161A, measure the voltage at the grid (pin 2) of V135A. It should be —60 volts or more with respect to ground. If it is not, then the trouble is in the Hold-Off Circuit or the stability circuit. If the voltage at the grid of V135A is —60 volts or more with respect to ground, measure the voltage at the plate (pin 6) of V135B. It should be —4 volts or more with respect to ground. If it is not, the trouble is in the Sweep-Gating Multivibrator. If the voltage at the plate of V135B is —4 volts or more with respect to ground, the trouble is in the grid circuit of V161A (the grid is probably shorted to ground).

Triggering Difficulties

If you obtain a sweep when the TRIGGER LEVEL control is in the FREE RUN position, but not when the control is at any other position (either AUTO. or in the center part of its range), the trouble is in the Trigger Multivibrator.

If you obtain a sweep with the TRIGGER LEVEL control in FREE RUN and AUTO. but not in the center part of its range (with a triggering signal applied), the trouble is either in the Trigger Amplifier or in the trigger signal lead from the interconnecting plug. In this case, set the TRIGGER LEVEL control fully clockwise and then rotate it slowly counterclockwise. Near the center of the range of the control, you should obtain one sweep across the oscilloscope screen. If you do not, the Trigger Amplifier is bad. If you do obtain a single sweep as the TRIGGER LEVEL control is rotated counterclockwise, the trouble is between pin 12 of the interconnecting plug and the grid of V24A.

If the triggered sweep seems normal but becomes abnormally short at certain settings of the TRIGGER LEVEL control, D130 is probably open. (This would allow the positive pulses from the Trigger Multivibrator to reset the Sweep-Gating Multivibrator before the sweep is completed.) If the sweep free runs in all positions of the TRIGGER LEVEL control, D113 is probably open.

Nonlinear Sweep

A nonlinear sweep will probably be due to a bad V161A or to a leaky C160. It might also be due to a bad tube in the Output Amplifier.

Incorrect Sweep Timing

Incorrect sweep timing which cannot be corrected by calibration will probably be due to an off-value C160, R160, or R161, a weak V161A, or loss of gain in the Output Amplifier.

Calibration

To perform the following calibration, insert the Type 51 module in the right-hand opening of the oscilloscope, an amplifier module in the left-hand opening, and remove the right-hand side panel. This allows access to all of the internal calibration adjustments.

1. Set the MAGNIFIER control fully counterclockwise and the TRIGGER LEVEL control to FREE RUN.

2. Adjust the INTENSITY, FOCUS, and POSITION controls so that a sharply defined trace is visible on the screen.

3. Set the TRIGGER LEVEL control to AUTO. and the STABILITY adjustment fully counterclockwise. The trace will disappear.

4. Turn the STABILITY adjustment slowly clockwise until a flickering trace appears on the screen. Note the position of the STABILITY adjustment when the flickering trace first appears.

5. Turn the STABILITY adjustment farther clockwise until the trace takes on a noticeably faster flicker rate. Note the position of the STABILITY adjustment at this point.

6. Turn the STABILITY adjustment counterclockwise to a position approximately midway between the positions noted in steps 4 and 5.

7. Set the POSITION control fully clockwise.

8. Set the SWP./MAG. REGIS. adjustment so that the left end of the trace is at the vertical centerline of the graticule.

9. Set the POSITION control fully counterclockwise.

10. Set the SWP. LENGTH adjustment so that the right end of the trace is at the vertical centerline of the graticule.

11. Set the POSITION control to midrange.

12. Apply a signal from the CAL. OUT connector to the INPUT connector of the amplifier module in the left-hand opening.

13. Set the CALIBRATOR switch and the amplifier module VOLTS/DIV. switch to produce one or two divisions of deflection on the screen. (If you are using the Type 50 amplifier module, one millivolt of Calibrator signal will produce one division of deflection.)

14. Set the HORIZ. GAIN adjustment fully counterclockwise.

15. Set the SWP. CAL. adjustment so that about three and a half cycles of the Calibrator waveform (at 60 cps) are displayed on the shortened trace. (If you are using other than a 60-cps line frequency, refer to the note at the end of this procedure.)

16. Set the HORIZ. GAIN adjustment so that three cycles of the Calibrator waveform (at 60 cps) occupy exactly 10 graticule divisions. Adjust the POSITION control as necessary in this step.

17. Set the MAGNIFIER control fully clockwise.

18. Adjust the POSITION control to set one of the vertical portions of the waveform to the vertical centerline of the graticule.

19. Set the MAGNIFIER control fully counterclockwise.

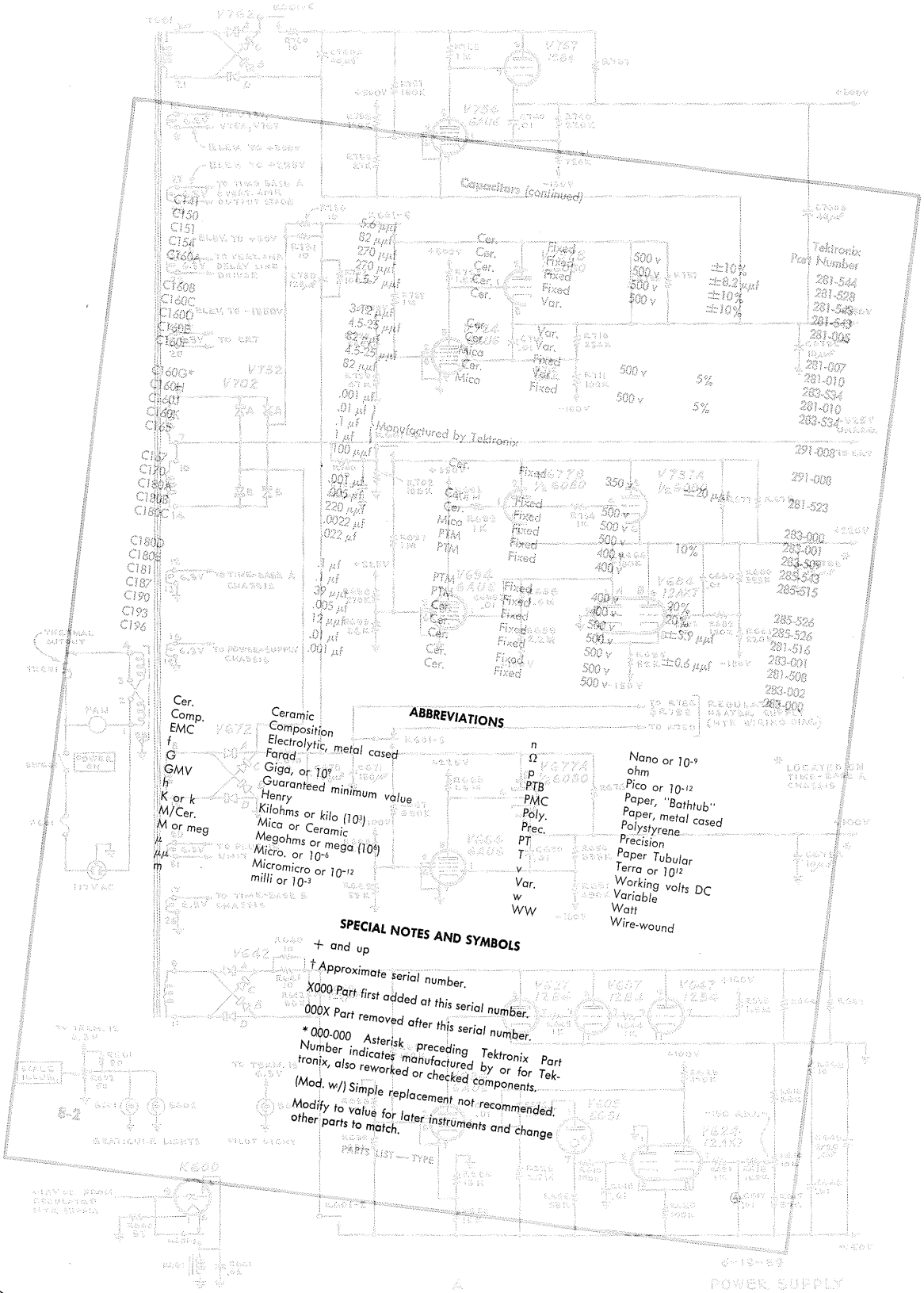
20. Adjust the SWP./MAG. REGIS. adjustment to set the same vertical portion of the waveform to the vertical centerline of the graticule.

NOTE

(See steps 15 and 16 of the foregoing procedure.) The oscilloscope Calibrator operates at line frequency. If you are using a line frequency other than 60 cps, compute the total number of cycles to be displayed in step 16 by the following formula:

Cycles displayed = line frequency x 50 milliseconds. In step 15, set the SWP. CAL. adjustment so that the shortened trace contains about 10% more than this number of cycles.

PARTS LIST *and* DIAGRAMS



MANUFACTURERS OF CATHODE-RAY OSCILLOSCOPES

TYPE 51
Mod. 3823
S/N 239

R148	Change to	2k	1/2w	Comp.	5%	301-202

HOW TO ORDER PARTS

Replacement parts may be purchased at current net prices from your local Tektronix Field Office or from the factory. Most of the parts can be obtained locally. All of the structural parts, and those parts noted in the parts list "Manufactured by Tektronix", should be ordered from Tektronix.

When ordering from Tektronix include a complete description of the part, and its 6-digit part number. Give the type, serial number, and modification number (if any) of the instrument for which it is ordered.

If the part which you have ordered has been replaced by a new or improved part, the new part will be shipped instead. Tektronix Field Engineers are informed of such changes. Where necessary replacement information comes with new parts.

PARTS LIST
Type 51

Values are fixed unless marked Variable.

Bulbs

		Tektronix Part Number
B152	NE-2	150-002
B161	NE-2	150-002
B167	NE-2	150-002

Capacitors

Tolerance ±20% unless otherwise indicated.

C15	.001 μf	Discap	500 v		283-000
C19	.001 μf	Discap	500 v		283-000
C30	.1 μf	Discap	100 v		283-012
C37	15 μμf	Cer.	500 v	10%	281-509
C130	27 μμf	Cer.	500 v		281-513
C141	4.7 μμf	Cer.	500 v	±1 μμf	281-501
C160	.047 μf	PTM	400 v		285-519
C167	.001 μf	Discap	500 v		283-000
C181	.5 μf	PTM	400 v		285-537
C323	.02 μf	Discap	150 v		283-004

Diodes

D113	T12G	Germanium			152-008
D130	T12G	Germanium			152-008
D181	T12G	Germanium			152-008

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

R13	5.6 meg	½ w				302-565
R14	1 meg	½ w				302-105
R15	470 k	½ w				302-474
R16	12 k	½ w				302-123
R17	100 k		Var.		TRIGGER LEVEL	311-026
R18	560 k	½ w				302-564
R19	150 k	½ w				302-154
R20	47 Ω	½ w				302-470
R21	47 Ω	½ w				302-470
R23	18 k	2 w				306-183
R25	12 k	½ w				302-123
R30	10 k	½ w				302-103
R31	100 Ω	½ w				302-101
R35	3.3 k	½ w			5%	301-332
R37	390 k	½ w		Prec.	1%	309-056

Resistors *(continued)*

						Tektronix Part Number
R38	500 k	½ w		Prec.	1%	309-003
R40	3.3 meg	½ w				302-335
R41	100 Ω	½ w				302-101
R43	4.7 k	½ w			5%	301-472
R46	27 k	1 w			5%	303-273
R111	15 k		Var.		STABILITY	311-112
R112	20 k	½ w			5%	301-203
R113	30 k	½ w			5%	301-303
R130	10 k	½ w				302-103
R131	100 Ω	½ w				302-101
R134	50 k	½ w		Prec.	1%	309-090
R137	100 Ω	½ w				302-101
R141	54 k	½ w		Prec.	1%	309-322
R143	20 k	½ w		Prec.	1%	309-153
R144	20 k	½ w		Prec.	1%	309-153
R146	100 Ω	½ w				302-101
R148	1.5 k	½ w				302-152
R160	1 meg	½ w		Prec.	1%	309-014
R161	1 meg		Var.		Swp. Cal.	311-211
R162	100 Ω	½ w				302-101
R164	150 k	½ w				302-154
R167	1 meg	½ w				302-105
R168	220 k	½ w				302-224
R174	24 k	½ w			5%	301-243
R176	5 k		Var.		Swp. Length	311-195
R178	12 k	½ w			5%	301-123
R181	100 k	½ w				302-104
R320	200 k	½ w		Prec.	1%	309-051
R321	200 k	½ w		Prec.	1%	309-051
R323	50 k		Var.		POSITION	311-243
R350	10 meg	½ w				302-106
R351	500 k		Var.		MAGNIFIER	311-244
R352	22.6 k	¼ w		Prec.	1%	319-013
R361	100 k		Var.		Swp/Mag. Regis.	311-207
R363	1 meg	½ w				302-105
R364	10 k	½ w				302-103
R371	100 Ω	½ w				302-101
R373	39 k	2 w			5%	305-393
R376	22 k	2 w			5%	305-223
R379	250 Ω		Var.		Horiz. Gain	311-194
R381	100 Ω	½ w				302-101
R383	39 k	2 w			5%	305-393
R386	22 k	2 w			5%	305-223
R389	100 Ω	½ w				302-101
R395	1.5 k	2 w				306-152

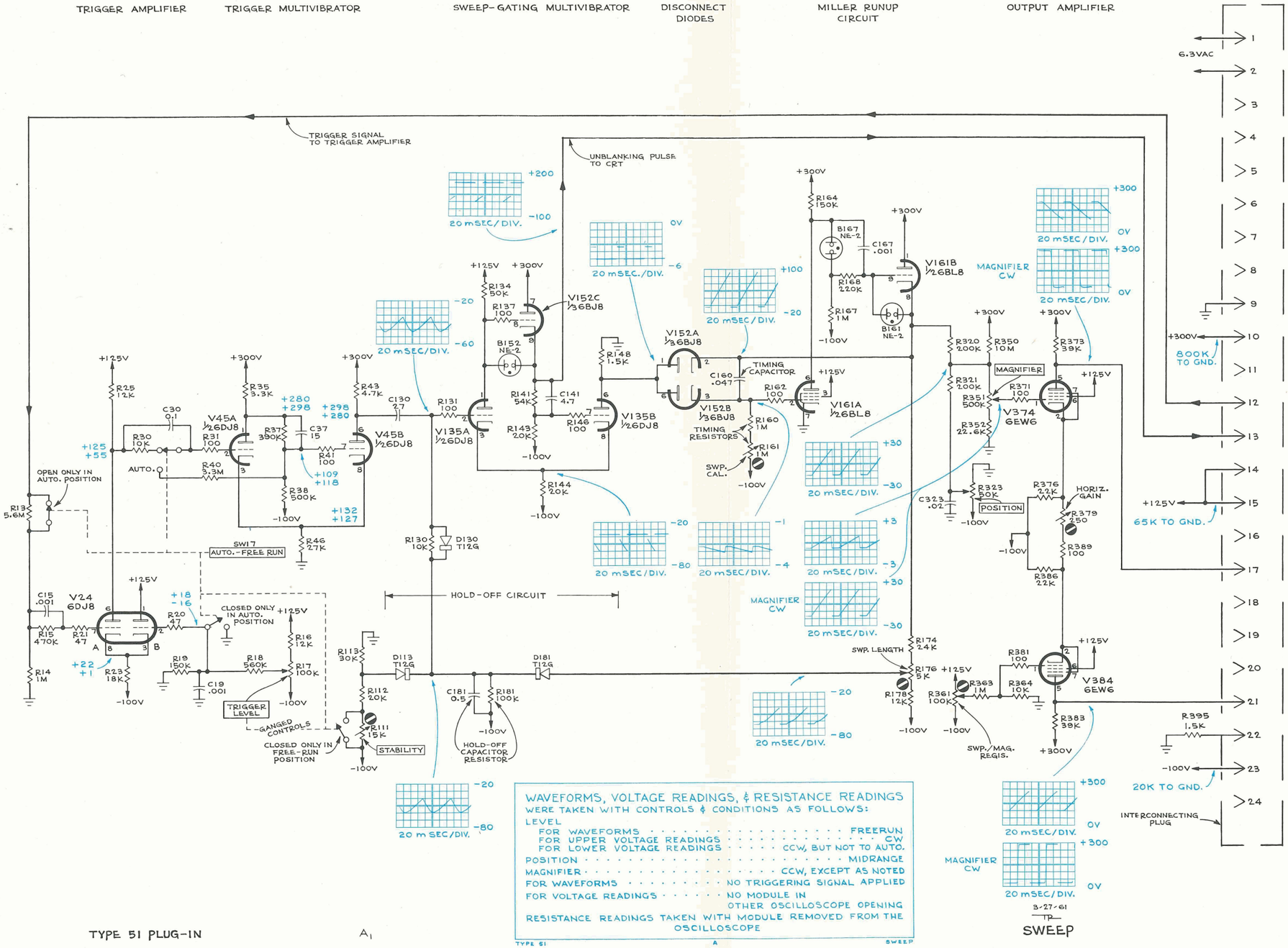
Switches

		Wired	Unwired
SW17	Auto-Free Run	*262-387	*260-235

Electron Tubes

		Tektronix Part Number
V24	6DJ8	154-187
V45	6DJ8	154-187
V135	6DJ8	154-187
V152	6BJ8	154-305
V161	6BL8	154-278
V374	6EW6	154-212
V384	6EW6	154-212

TRIGGER AMPLIFIER | TRIGGER MULTIVIBRATOR | SWEEP-GATING MULTIVIBRATOR | DISCONNECT DIODES | MILLER RUNUP CIRCUIT | OUTPUT AMPLIFIER



WAVEFORMS, VOLTAGE READINGS, & RESISTANCE READINGS WERE TAKEN WITH CONTROLS & CONDITIONS AS FOLLOWS:

LEVEL
- FOR WAVEFORMS . . . . . FREERUN
- FOR UPPER VOLTAGE READINGS . . . . . CW
- FOR LOWER VOLTAGE READINGS . . . . . CCW, BUT NOT TO AUTO.

POSITION . . . . . MIDRANGE

MAGNIFIER . . . . . CCW, EXCEPT AS NOTED

FOR WAVEFORMS . . . . . NO TRIGGERING SIGNAL APPLIED

FOR VOLTAGE READINGS . . . . . NO MODULE IN OTHER OSCILLOSCOPE OPENING

RESISTANCE READINGS TAKEN WITH MODULE REMOVED FROM THE OSCILLOSCOPE

TYPE 51 A SWEEP

TYPE 51 PLUG-IN

A1

3-27-61 TP

SWEEP