Instruction Manual

TEKTRONIX ®

SWEPT FREQUENCY CONVERTER

070–0762–00

368

SECTION 1
CHARACTERISTICS

The Swept Frequency Converter is designed to be used with the Type 1L5 and Type 3L5 low-frequency Spectrum Analyzers. Frequency rolloff characteristics of filter circuits, amplifiers, etc. can be plotted within a bandwidth of 50 Hz to 1 MHz. The Swept Frequency Converter will also provide a fixed frequency output within the frequency range 50 Hz to 1 MHz by manually adjusting the Swept Oscillator in the Spectrum Analyzer.

The following electrical characteristics apply over an ambient temperature range of 0°C to $+50^\circ$C, provided an initial warmup period of 20 minutes, with power applied, is given to both the Swept Frequency Converter and its associated equipment (Spectrum Analyzer, test oscilloscope, etc.).

ELECTRICAL CHARACTERISTICS

Characteristics	Operating Requirement
Oscillator Input Frequency Range	3 MHz to 2 MHz
Output Frequency	50 Hz to 1 MHz
Output Voltage Level	Maximum output; 4 to 8 V peak to peak, behind 600 Ω
Output Resistance	600 Ω ±15%
Output Frequency Flatness	Within 0.5 dB (50 Hz to 1 MHz) into 600 Ω load
Harmonic Distortion (3rd order)	Within 3%; 50 Hz to 1 MHz (into 600 Ω load)
OUTPUT AMPLITUDE Control Range	≥ 25 dB
Output Amplitude Recovery (OUTPUT REGULATOR, FAST to SLOW)	≤ 10 s to recover to the same amplitude as FAST
FREQUENCY Range	Shifts the LO at least + and - ~~200~~ 150 Hz from 3 MHz
Oscillator Input Voltage	0.8 V to 2.0 V, peak to peak
Power Requirements	
Voltage Range	90 VAC to 272 VAC
Frequency Range	50 Hz to 400 Hz

MECHANICAL CHARACTERISTICS

Characteristic	Information
Construction	
Chassis	Aluminum
Front-panel	Aluminum with anodized finish
Circuit Boards	Glass-epoxy laminate

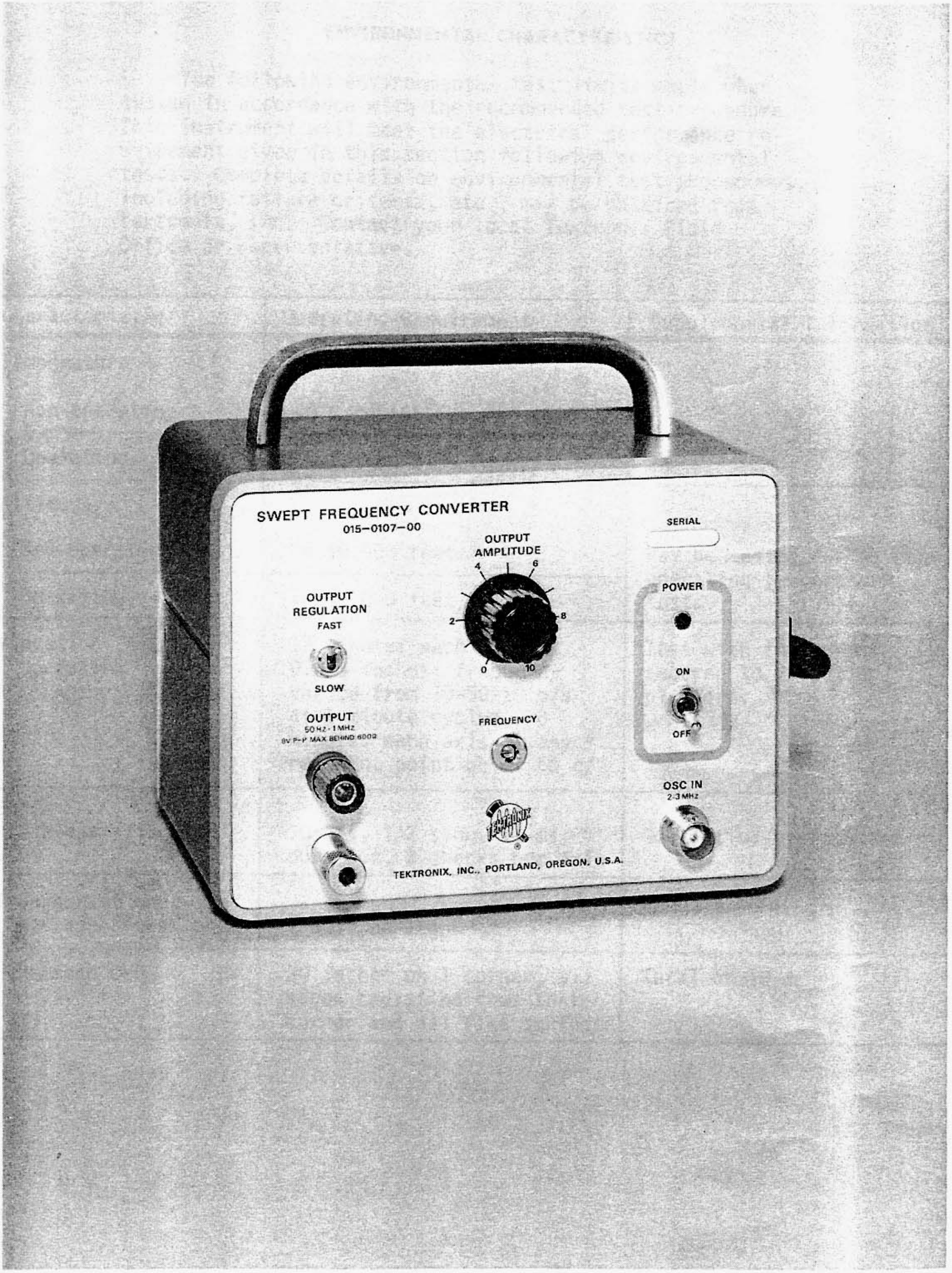


Fig. 1-1. Swept Frequency Converter.

ENVIRONMENTAL CHARACTERISTICS

The following environmental test limits apply when tested in accordance with the recommended test procedure. This instrument will meet the electrical performance requirement given in this section following environmental tests. Complete details on environmental test procedures, including failure criteria, etc., may be obtained from Tektronix, Inc. Contact your local Tektronix Field Office or representative.

Characteristic	Operating Requirement	Supplemental Information
Temperature		
Non-operating	-40°C to +65°C	
Operating	0°C to +50°C	
Altitude		
Non-operating	To 50,000 feet	May be tested during non-operating temperature tests.
Operating	To 15,000 feet	
Vibration Operating	15 minutes each axis at 0.015 inches; frequency varied from 10-50-10 c/s at 1 minute cycles. 3 minutes each axis at any resonant point or at 50 c/s	Test with instrument secured to vibration platform.
Shock Non-operating	30 g's, 1/2 sine, 11 ms duration, 2 shocks per axis	Guillotine-type shocks
Transportation Package Vibration	1 hour at 1 g	
Package Drop	30 inches on 1 corner, all edges radiating from that corner and all flat surfaces	Total of 10 drops

SECTION 2
OPERATION

The Swept Frequency Converter (Tektronix Part No. 015-0107-00) converts the Type 1L5 or 3L5 Spectrum Analyzer oscillator output to a frequency between 50 Hz and 1 MHz. The output signal level of the converter is adjustable and at maximum setting the output is between 4 and 8 volts.

The output frequency from the converter depends on its input frequency. When the input signal to the OSC IN connector is sweeping, the converter output signal to the analyzer is also a swept frequency. The swept frequency is centered at the selected Center Frequency of the Spectrum Analyzer, and sweeps above and below this center frequency by an amount equal to the Dispersion setting of the analyzer. The swept frequency is synchronized to the swept local oscillator of the analyzer; therefore, a tracked reference signal is provided to plot frequency response characteristics of filter or amplifier circuits within the bandwidth of 50 Hz to 1 MHz.

This section of the manual describes the operation and some basic applications for the Swept Frequency Converter.

Controls and Connections (Fig. 2-1)

OSC IN	Input connector to accept the 2 to 3 MHz swept frequency from the analyzer.
OUTPUT	Converter output signal. Frequency range ≤ 50 Hz to ≥ 1 MHz. Signal amplitude is dependent on the setting of the OUTPUT AMPLITUDE control.
OUTPUT AMPLITUDE	Controls the output signal level. Range equal to or greater than 25 dB. Maximum output between 4 and 8 V peak to peak, behind 600 Ω.
OUTPUT REGULATOR	Selects either FAST or SLOW response time, to regulate the output amplitude. Selection depends on the lowest output frequency within a given sweep speed. If the output frequency is below 10 kHz and meaningful displays are to be made at this frequency, the SLOW time constant should be used and the sweep rate must be decreased to 50 ms/cm or slower. The FAST position of the REGULATION is used for frequencies and sweep speeds above this.
FREQUENCY	Adjustment to calibrate the Swept Frequency Converter local oscillator to the Spectrum Analyzer 1st IF. Varies the oscillator frequency + and - ~~200~~ 150 Hz above and below 3 MHz. When calibrated, the converter output frequency will track with the Analyzer input frequency.

Front Panel Adjustment

Apply the Oscillator Output signal from the 1L5 or 3L5 to the OSC IN connector through the 93 Ω coaxial cable supplied with the accessories. Apply the OUTPUT signal from the Swept Frequency Converter to the Input connector of the Spectrum Analyzer. Use the banana plug to BNC adapter (Tektronix Part No. 013-0094-00), the 93 Ω coaxial cable and the 600 Ω termination. Apply power to both the Swept Frequency Converter and Spectrum Analyzer. Allow approximately a 20

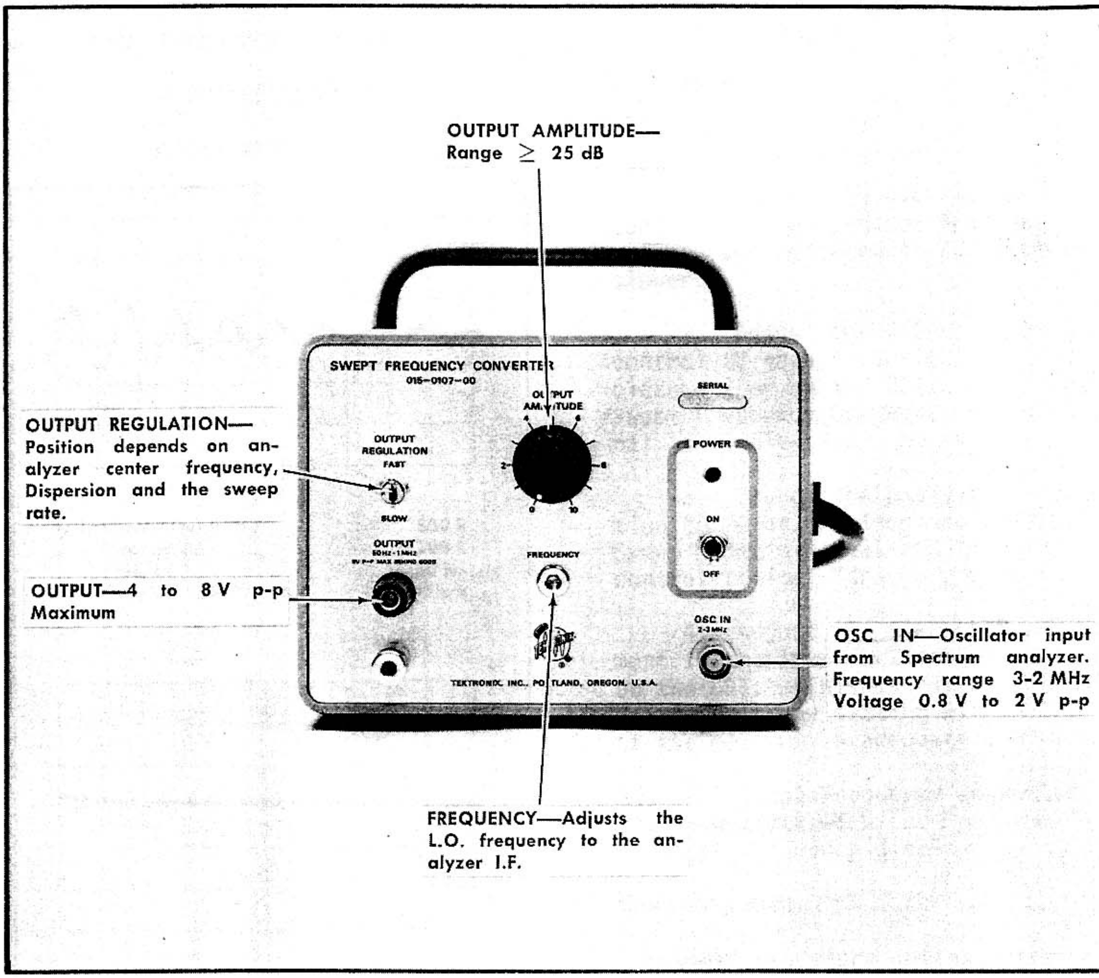


Fig. 2–1. Front panel controls on the Swept Frequency Converter.

minute warm-up period for the Analyzer and the Swept Frequency Converter to stabilize. Set the front panel controls as follows:

Spectrum Analyzer (Type 1L5)

Center Frequency	500k
Volts/cm	.05
V/cm ÷ 100	Pushed in
Dispersion Hz/cm	100k
Resolution	Coupled to Dispersion
Sweep Mode	Ext or Int (dependent on plug-in oscilloscope)
Vertical Display	Lin

Swept Frequency Converter	
OUTPUT REGULATION	FAST
OUTPUT AMPLITUDE	CCW

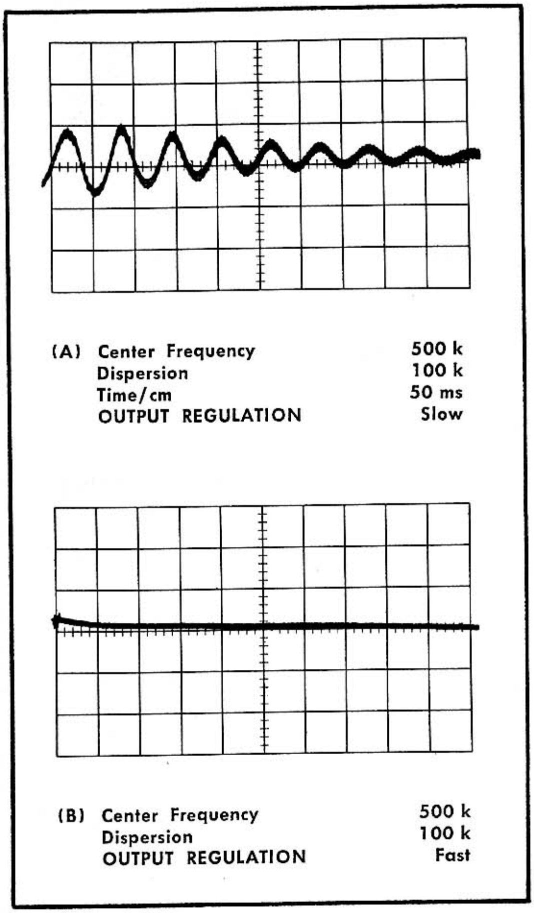


Fig. 2-2. Output regulator operation, high frequency, wide dispersion and fast sweep rate.

1. Adjust the oscilloscope containing the Spectrum Analyzer for a free running sweep of 20 ms/cm or slower.

2. Adjust the OUTPUT AMPLITUDE control to obtain vertical trace displacement or an indication that the Swept Frequency Converter output signal is displayed on the CRT.

3. Change the analyzer resolution to 10 Hz. Switch the Analyzer Sweep Mode to Manual and turn the control to its midrange position.

4. Adjust the FREQUENCY adjustment for maximum vertical deflection on the CRT. (This is not a critical adjustment; any setting within 50% of the maximum is adequate).

The Swept Frequency Converter will now track with the Spectrum Analyzer frequency display.

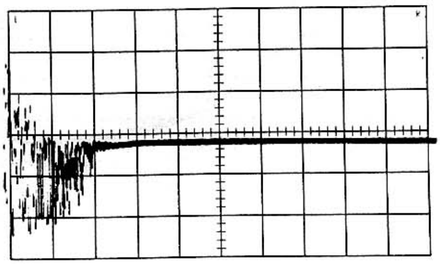
Basic Operation

This procedure demonstrates some operational techniques and should prove helpful in becoming familiar with the controls.

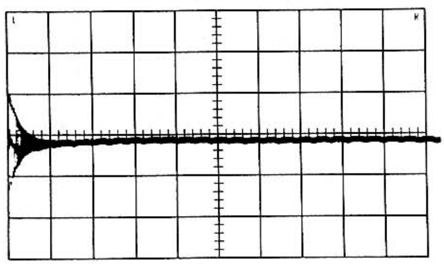
1. Connect the Spectrum Analyzer and the Swept Frequency Converter as previously described. Set the front panel controls of both instruments as directed for the front panel adjustments. Adjust the OUTPUT AMPLITUDE for a vertical display deflection of approximately 4 divisions on the CRT.

2. Switch the OUTPUT REGULATION from FAST to SLOW position. Note the time delay before the slow time constant of the regulator recovers. Note also the damped oscillation of the regulator circuit as it attempts to recover output regulation after the swept frequency has gone through 0 Hz. See Fig. 2-2.

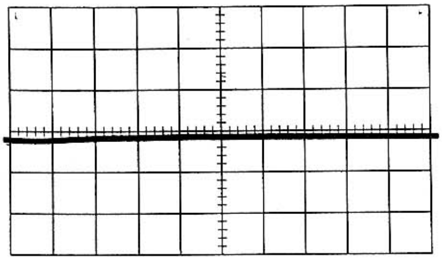
3. With the OUTPUT REGULATION selector in the SLOW position, decrease the sweep rate to 1 s/cm. Note that the regulator recovery, after the analyzer goes through 0 Hz, is now within a narrow dispersion width. The slow sweep rate provides the additional time required for the long time constant of the regulator to stabilize within a relatively narrow frequency excursion.



(A)	Center Frequency	5000
	Dispersion	1 k
	Time/cm	50 ms
	OUTPUT REGULATION	Fast

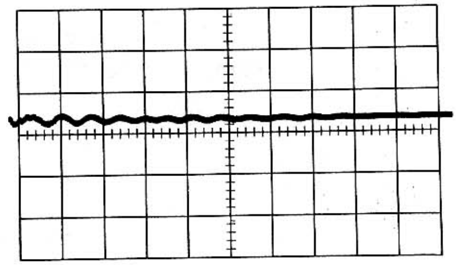


(B)	Center Frequency	5000
	Dispersion	1 k
	OUTPUT REGULATION	Slow

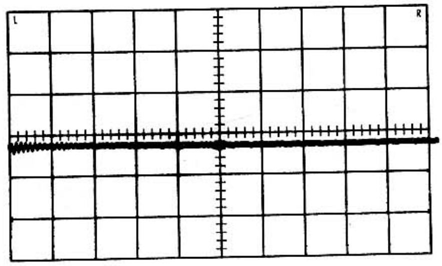


(C)	Center Frequency	5000
	Dispersion	1 k
	Resolution	10 Hz
	OUTPUT REGULATION	Slow

Fig. 2-3. Output regulator operation, low frequencies, medium dispersion and fast sweep rates.



(A)	Center Frequency	500
	Dispersion	100
	Resolution	10
	Time/cm	50 ms
	OUTPUT REGULATION	Slow



(B) Settings of display (A) with sweep rate reduced to 1 s/cm.

Fig. 2-4. Effects of sweep rate on output regulation.

4. Change the front panel controls to the following :

Spectrum Analyzer and Plug-In Oscilloscope

Center Frequency	5000
Dispersion	1 kHz
Resolution	Coupled
Time/cm	20 ms

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Notice that this control setup produces erratic output regulation at the low frequency end of the display, as shown in Fig. 2-3A.

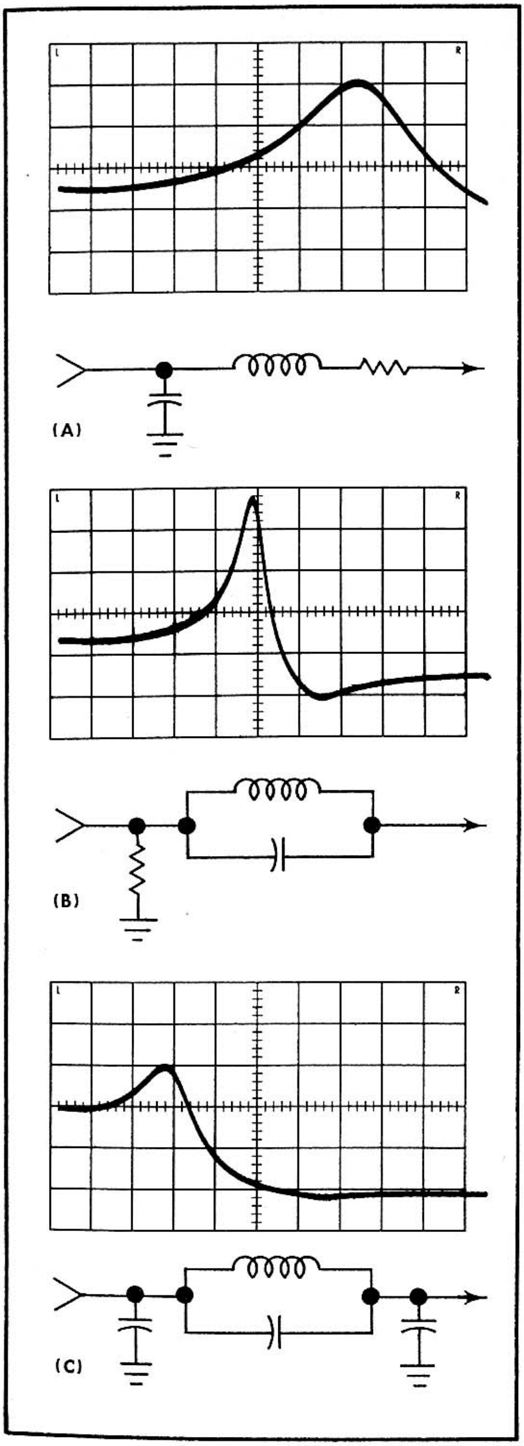


Fig. 2–5. Response characteristics of three basic filters as displayed on the Spectrum Analyzer.

5. Switch the OUTPUT REGULATION to the SLOW position. Note the effect on the display. See Fig. 2-3B.

6. Increase the Spectrum Analyzer resolution by switching the Resolution selector to the 20 Hz or 10 Hz position. Note the improved output flatness. See Fig. 2-3C.

7. Change the front panel controls to the following positions:

Center Frequency	500 Hz
Dispersion-Hz/cm	100
Resolution	10
Time/cm	50 ms
OUTPUT REGULATION	SLOW

Note the output regulation of the Swept Frequency Converter, as evidenced in Fig. 2-4A.

8. Change the sweep rate to 1 s/cm. This should produce an improvement in output flatness. See Fig. 2-4B. The slower sweep rate permits the regulator to stabilize within a narrow swept frequency range.

These demonstrations illustrate the effect produced on the converter output signal by the selected OUTPUT REGULATION, the sweep rate, and the Spectrum Analyzer Resolution with various Center Frequencies and Dispersion settings.

Applications

Applications for the Swept Frequency Converter are primarily in the field of filter analysis, amplifier response characteristics and transmission line frequency characteristics. Frequency characteristics of three basic filter types are illustrated in Fig. 2-5.

The frequency characteristics or frequency response of a device may be displayed and measured as follows:

1. Apply the OUTPUT of the Swept Frequency Converter through the filter, amplifier, or the device to be measured, to the Input of the Type 1L5 or 3L5 Spectrum Analyzer.

2. Begin the analyses with a wide dispersion display and a Center Frequency within the desired spectrum, to locate the desired portion of the frequency response. Adjust the OUTPUT AMPLITUDE control to obtain the desired display amplitude.

3. Adjust the analyzer Center Frequency and Dispersion to open the display in the desired portion of the spectrum. Analysis may now be performed, such as measuring the frequency characteristics, attenuation per octave, etc.

SECTION 3

CIRCUIT DESCRIPTION

This instrument converts the oscillator output signal from the Type 1L5 or 3L5 Spectrum Analyzer to a frequency within the 50 Hz to 1 MHz band. The center of the converter output frequency is the selected center frequency of the analyzer. The swept frequency dispersion of the output frequency depends on the dispersion selection of the analyzer. When this swept frequency output is applied through some external device and fed back to the input of the analyzer, a frequency response characteristic of the device will be displayed by the analyzer on the plug-in oscilloscope CRT.

The output signal level from the converter is adjustable, and has a maximum voltage output between 4 and 8 volts peak to peak behind 600 Ω. The output will be reduced to approximately one half of this figure if the OUTPUT is terminated into 600 Ω. The output amplitude, through the frequency range of the converter, is constant for a given setting of the OUTPUT AMPLITUDE control.

A block diagram of the Swept Frequency Converter is illustrated in Fig. 3-1. The 3 MHz to 2 MHz oscillator signal from the Type 1L5 or 3L5 applied to the OSC IN connector of the Swept Frequency Converter is AC coupled to the base of an emitter follower Q10. The output of Q10 is transformer-coupled to the input of a balanced mixer circuit. A second frequency, from a crystal controlled oscillator, is applied to a second input (junction of R10 and R20) of the balanced mixer. The instantaneous difference frequency at the output of the mixer will be within the frequency range of the Type 1L5 or 3L5 Spectrum Analyzers.

If the input frequency to the OSC IN connector is sweeping, the output frequency from the balanced mixer will be a swept frequency that is centered near the center frequency of the analyzer. For example; with the analyzer tuned to a center frequency of 5000 Hz and the Dispersion-Hz/cm selector set to 1K, the frequency into the Swept Frequency Converter will be sweeping from 2.990 MHz to 3.0 MHz with a center frequency of 2.995 MHz. This will generate a converter output frequency (difference between the 3.0 MHz crystal controlled oscillator and the input frequency) that is between 10 kHz and 0 Hz (3.0 MHz - 2.990 MHz, and 3.0 MHz - 3.0 MHz) with a center frequency of 5000 Hz (3.0 MHz - 2.995 MHz). Due to the regulator circuit characteristics the output amplitude is not constant below 50 Hz; therefore, the useful output frequency for this example is sweeping between 10 kHz and 50 Hz.

The output signal from the balanced mixer is applied through a low-pass filter to an IC (integrated circuit) operational amplifier U30. The low-pass filter attenuates frequencies above 2 MHz, so that undesirable residual frequencies that might be introduced into the mixer (such as the upper conversion frequencies produced by the local oscillator and input frequencies) are not fed through to the output. Terminal 2 of U30 is the inverting input terminal and terminal 3 is the non-inverting input. Closed loop gain of the operational amplifier is approximately 40 dB.

The output signal, from the operational amplifier, is connected to the OUTPUT connector through a constant impedance T attenuator. The range of this attenuator equals or exceeds 25 dB. Output signal level through the frequency range of the converter is regulated by a high-gain feedback loop to the input amplifier.

The amplitude regulator circuit samples the peak-to-peak signal amplitude at the output of the operational amplifier and compares this to a reference

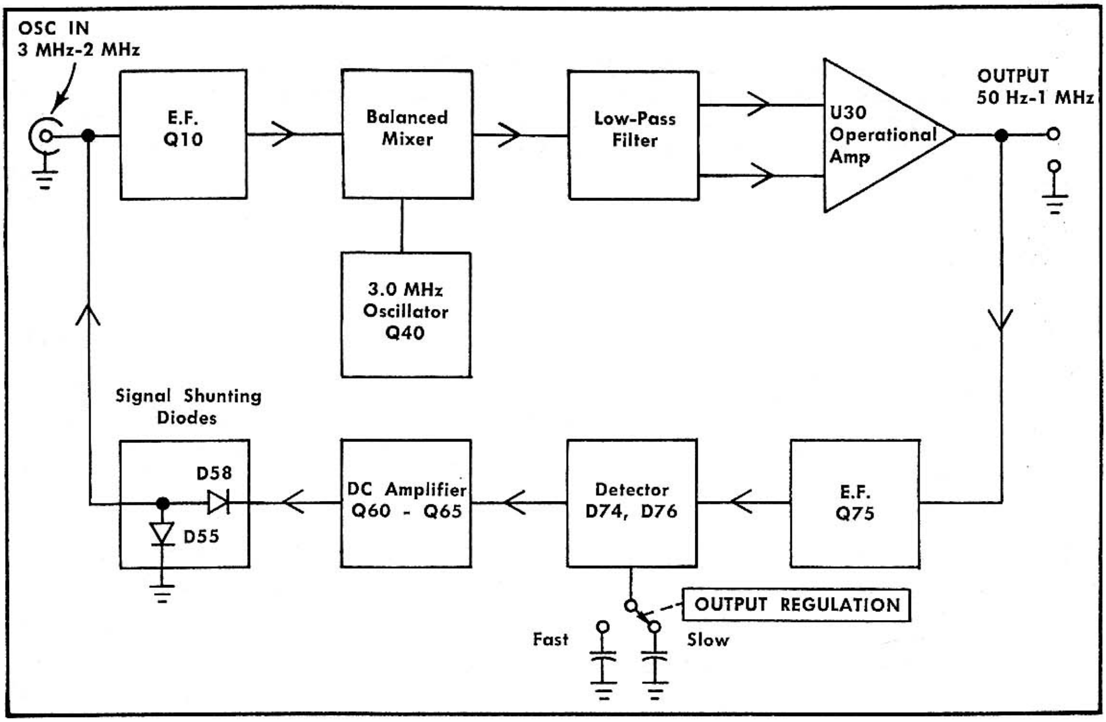


Fig. 3-1. Functional block diagram of the Swept Frequency Converter.

voltage set by Zener diode D65. The difference voltage is amplified and applied as a control bias to two diodes, D55 and D58. These diodes are part of a shunt load circuit across the input to the emitter follower Q10. Changing the forward bias of the diodes changes the dynamic impedance of the diodes to vary the input of the emitter follower and regulate the signal level to the balanced mixer.

The local oscillator provides a stable output frequency near 3 MHz which can be adjusted to equal the nominal IF of the Spectrum Analyzer. This circuit adjusts the oscillator frequency approximately ~~200~~ 150 Hz above and below this nominal IF to accommodate variations in the spectrum analyzer intermediate frequency.

The collector load for Q40 is the tuned circuit for the oscillator, consisting of the center tapped coil L41 and capacitor C42. The feedback circuit to the base of Q40 contains the crystal Y48, the variable capacitance diode D48 and the capacitor C46. The oscillator frequency is a function of the crystal frequency and the series capacitance of D48. The FREQUENCY control R50 adjusts the bias potential to the variable capacitance diode, to change the capacity of the diode and shift the oscillator frequency.

Feedback Voltage Regulator Circuit

The output from the emitter follower Q75 is connected to a peak to peak detector containing diodes D74 and D76. Either of two time constants (SLOW or FAST) can be selected with the OUTPUT REGULATION switch SW75. The slow time constant is approximately 80 seconds and operates over the lower frequency and narrow dispersion range of the analyzer, for sweep rates 50 ms/cm or slower. With the faster sweep rates, higher center frequencies and wide dispersions, the fast time constant is required for good regulation.

A higher output signal level from the IC operational amplifier produces an increased negative voltage across capacitor C72 and C73. This negative voltage is amplified by Q65 and Q60, producing a reduction in the collector voltage of Q65. This increases the current through diodes D55 and D58, which lowers the dynamic impedance of the diodes and decreases the output signal level from emitter follower Q10, maintaining a constant output signal level from the operational amplifier. The maximum output voltage depends on the reference voltage set by the Zener diode D65 and should not exceed 8 V peak to peak behind 600 Ω.

Power Supply

The power supply provides regulated + and - 10 volts DC. The rectifier for the supplies consists of two separate full wave rectifiers, one for each supply. Q95 is the pass transistor for the + 10 volt supply and Q90 is the error amplifier. Q105 is the pass transistor for the - 10 volt supply with Q100 as the error amplifier.

The bias of Q95 is set by the collector voltage of Q90. A sample of the output + 10 volts supply is applied from the junction of the voltage divider R97, R98 to the base of Q90 and compared to the emitter voltage, which is set by Zener diode D92. An increase in the output at the + 10 volt supply causes the collector current of Q90 to increase, thus reducing the forward bias of Q95 and counteracting the initial change.

The forward bias of Q105 is set by the collector output of Q100. The - 10 volt supply is referenced to the + 10 volt supply through the divider R103 and R102. The difference voltage at the junction of the divider is applied as an error signal to the base of Q100. An increase in the output of the - 10 volt supply would increase the current to Q100, thus decreasing the forward bias of Q105 and counteracting the initial change.

SECTION 4
MAINTENANCE

This section consists of preventive maintenance procedures to help minimize major problems, maintenance techniques such as soldering components to the boards, instructions on circuit board or component replacement and some troubleshooting procedures.

PREVENTIVE MAINTENANCE

Preventive maintenance consists of cleaning, visual inspection and recalibration. The preventive maintenance schedule established for this instrument should be based on the usage and the environment in which the instrument is used. We recommend servicing and recalibration after approximately 1000 hours of operation or more frequently if the instrument is operated under adverse conditions, (such as high temperature or a dusty or corrosive atmosphere). Even if the instrument is used occasionally it should be serviced and recalibrated once every six months.

Cleaning

Loose dust accumulated on the outside of the instrument can be removed with a soft cloth or small paint brush. The paint brush is particularly useful for dislodging dirt on and around the front-panel controls. Dirt which remains can be removed with a soft cloth dampened in a mild solution of water and detergent. Abrasive cleaners should not be used.

CAUTION

Avoid the use of chemical cleaning agents which might damage the plastic and paint used in this instrument. Some chemicals to avoid are benzene, toluene, xylene, acetone or similar solvents.

The interior of the instrument should be cleaned occasionally due to the electrical conductivity of dust under high-humidity conditions. The best way to clean the interior is to blow off the accumulated dust with dry, low-velocity air. Remove any dirt which remains with a soft paint brush or a cloth dampened with a mild detergent and water solution. A cotton-tipped applicator is useful for cleaning in and around narrow spaces such as ceramic terminal strips and circuit boards.

After a thorough cleaning, the instrument should be carefully inspected for such defects as poor connections, damaged parts and improperly seated transistors. The remedy for most visible defects is obvious; however, if heat-damaged parts are discovered, determine the cause of overheating before the damaged parts are replaced; otherwise, the damage may be repeated.

Periodic preventive maintenance checks, consisting only of removing transistors from the instrument and testing them in a tester, are not recommended. The circuits within the instrument provide the only satisfactory check on transistor performance. Defective transistors are usually detected during recalibration of the instrument.

CORRECTIVE MAINTENANCE

Corrective maintenance consists of component replacement and instrument repair. Special techniques or procedures required to replace components in this instrument are described in this section.

Obtaining Replacement Parts

Local Purchase. All electrical and mechanical parts replacements for the Swept Frequency Converter can be obtained through your local Tektronix Field Office or representative. Many of the standard electronic components, however, can be obtained locally in less time than that required to order from Tektronix, Inc. Before purchasing or ordering replacement parts, consult the Parts List for the value, tolerance and rating of the component. The Parts Lists contain instructions on how to order replacement parts.

NOTE

When selecting replacement parts, it is important to remember that the physical size and shape of the component may affect its performance in the circuit. See Replacing Components in this section.

In addition to the standard electronic components, some special parts are used in this instrument. These parts are manufactured or selected by Tektronix, Inc. to meet specific performance requirements, or are manufactured in accordance with our specifications. These special parts are indicated in the Parts List by an asterisk preceding the part number. Most of the mechanical parts used in this instrument have been manufactured by Tektronix, Inc. Order all special parts directly from your Tektronix Field Office or representative.

Soldering Techniques

The circuit boards in this instrument are easily removed, (see board and component replacement); therefore, component soldering is best performed with the board removed so the soldering iron can be applied to the underside of the board.

Circuit Boards

Use ordinary 60/40 solder and a 35 to 40-watt pencil type soldering iron on the circuit boards. The tip of the iron should be clean and properly tinned for best heat transfer to the solder joint. A higher wattage soldering iron may separate the etched wiring from the base material.

The following technique should be used to replace a component on a circuit board.

1. Grip the component lead with needle-nose pliers or a hemostat. Touch the soldering iron to the lead at the solder connection.

2. When the solder begins to melt, gently pull the lead out. This should leave a clean hole in the board. If not, clean by reheating the solder and placing a sharp object such as a toothpick or enameled wire into the hole.

3. Bend the leads of the new component to fit the holes in the board. Insert the leads into the plated holes through the board until the component is firmly seated.

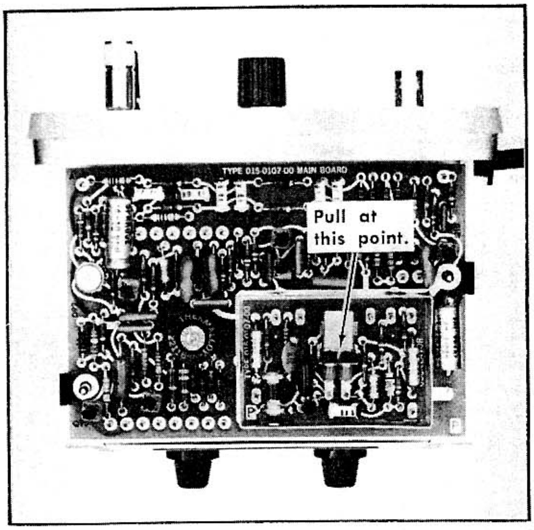


Fig. 4–1. Pull tab to remove oscillator circuit board.

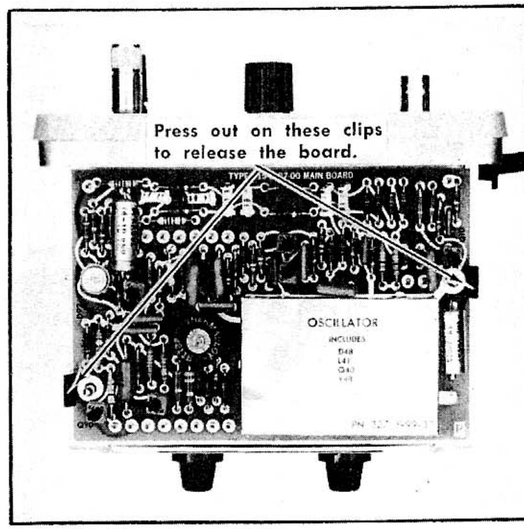


Fig. 4–2. Removing the main circuit board.

4. Apply the iron and a small amount of solder to the connection to make a firm solder joint. Too much solder may wick through the eyelet and short to another circuit. To protect heat-sensitive components, hold the lead between the component body and the solder joint with a pair of long-nose pliers or other heat sink.

5. Clip the excess leads that protrude through the board.

6. Clean the area around the soldered connection with a flux-remover solvent to maintain good environmental characteristics. Be careful not to remove the information printed on the board.

CIRCUIT BOARD AND COMPONENT REPLACEMENT

Transistors and IC Substitution or Replacement

Transistors should not be replaced unless they are actually defective; however, temporary substitution is often a convenient way to detect defective transistors. Before a substitution is made, check circuit conditions to be certain that a replacement will not be damaded. Fig. 4-5 illustrates the transistor lead configuration and the socket connection for transistors used in this instrument, plus the lead configuration of the integrated circuit. The pictorial circuit board component layout at the end of this section may also serve as a guide in locating the position of each transistor.

The heat sink over transistor Q105 is removed by unscrewing the top cap and sliding the sink off the transistor.

The integrated circuit is removed by pulling the IC from its socket. Align the metal tab on the IC with the arrow on the socket to replace the IC.

In–Circuit Diode Checks

In-circuit diode checks may be performed with a voltmeter. A comparison check of the voltages on each side of the diode with the typical voltages listed on the diagram will help isolate faulty diodes. Forward-to-back resistance ratios can be checked by referring to the schematic and pulling appropriate transistors and square pin connectors to remove low resistance loops around the diode.

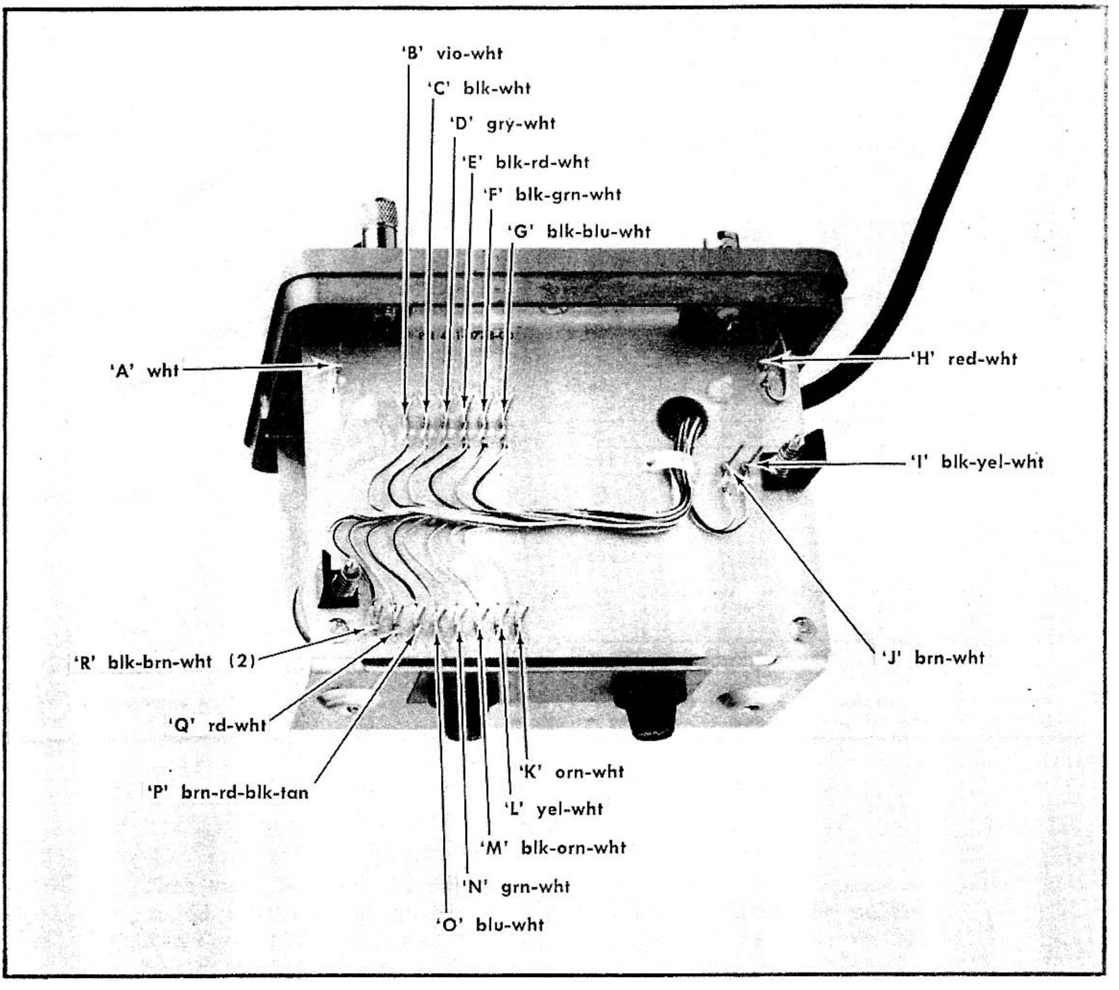


Fig. 4–3. Wire color code to square pin connectors.

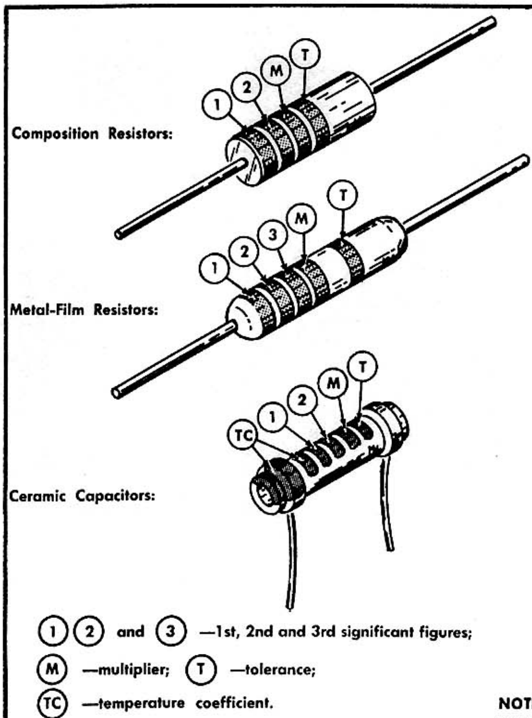
CAUTION

Do not use an ohmmeter scale that has a high internal current. Do not check the forward-to-back resistance ratios of Zener diodes or the mixer diodes.

Circuit Board Replacement. If a circuit board is damaged and cannot be repaired, a new board with or without components may be ordered from Tektronix. See Parts List section for ordering information.

The oscillator board plugs into the shielded compartment on the main board and makes electrical contact to the exterior circuits through square pin connectors. The board is removed by pulling on the plastic tab in the center of the board. (See Fig. 4-1.)

The main circuit board also plugs into square pin connectors that are mounted on the chassis. The board is held in place by spring clips. See Fig. 4-2. To remove the board, press out on the plastic clips until the board is free, then lift out.



Resistor and Capacitor Color Code

Color	Significant Figures	Multiplier: Resistors	Multiplier: Capacitors	Tolerance: Resistors	Tolerance: Capacitors
Silver	---	10^{-2}	---	±10%	---
Gold	---	10^{-1}	---	±5%	---
Black	0	1	1	---	±20% or 2 pF*
Brown	1	10	10	±1%	±1% or 0.1 pF*
Red	2	10^2	10^2	±2%	±2%
Orange	3	10^3	10^3	±3%	±3%
Yellow	4	10^4	10^4	±4%	+100% −0%
Green	5	10^5	10^5	±0.5%	±5% or 0.5 pF*
Blue	6	10^6	10^6	---	---
Violet	7	---	---	---	---
Gray	8	---	10^{-2}	---	+80% −20% or 0.25 pF*
White	9	---	10^{-1}	---	±10% or 1 pF*
(none)	---	---	---	±20%	±10% or 1 pF*

*For capacitance of 10 pF or less.

NOTE: (T) and/or (TC) color code for capacitors depends upon manufacturer and capacitor type. May not be present in some cases.

Fig. 4–4. Color code for resistors and ceramic capacitors.

CAUTION

Care must be used in removing and replacing the board to avoid bending any of the pins. The board should be pulled straight out. One end of the board should not be lifted ahead of the other. When the board is to be replaced, check the pins, then gently lay the board on the pins and press lightly, checking to see that all pins have centered in their holes. Do not force. If the board does not plug in easily, look for a pin that has missed its hole.

Component Numbering and Identification

The circuit number of each electrical component is shown on the circuit diagram and the physical location of each is shown in Fig. 4-6.

Wiring Color Code

All insulated wire used in this instrument is color-coded according to the EIA standard color code (as used for resistors) to facilitate circuit tracing. The widest color stripe identifies the first color of the code.

Fig. 4-3 shows the wiring color for the circuit board-to-chassis wiring through the square pin connectors.

Resistor Color Code

In addition to the brown composition resistors, some metal-film resistors

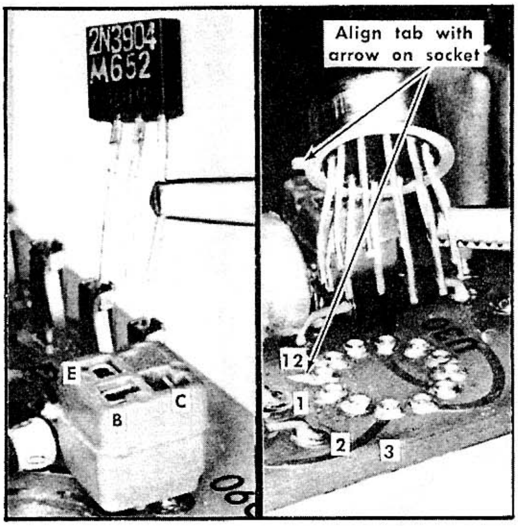


Fig. 4-5. Transistor and integrated circuit lead configuration.

are used in this instrument. The resistance values of composition resistors and metal-film resistors are indicated on the components with EIA color code (some metal-film resistors may have the value printed on the body). Composition resistors have four stripes, describing two significant figures, a multiplier and a tolerance value (see Fig. 4-4). Metal-film resistors have five stripes consisting of three significant figures, a multiplier and a tolerance value.

Capacitor Marking

The capacitance values of common disc capacitors and small electrolytics are marked in microfarads on the side of the component body. The white ceramic capacitors are coded in picofarads using a modified EIA code (see Fig. 4-4).

Diode Color Code

The cathode end of each glass-encased diode is indicated by a series of stripes or a dot. For most silicon or germanium diodes with a series of stripes, the color code indicates the type of diode and identifies the Tektronix Part Number using the resistor color code system (e.g., a diode color-coded blue-brown-gray-green indicates diode type 6185 with Tektronix Part Number 152-0185-00.) The cathode and anode ends of metal-encased diodes can be identified by the diode symbol marked on the body.

Transistor Lead Configuration

Fig. 4-5 shows the lead configuration of the transistor and IC used in this instrument.

Trouble Shooting

Procedure for trouble shooting consists of a systematic step analysis.

1. Verify that the apparent trouble is not improper control settings or malfunction of the associated equipment.

2. Check the instrument calibration.

3. Check circuit voltages and waveforms against those shown on the schematic diagram. Fig. 4-6 is a pictorial diagram showing the location of the electrical components.

CAUTION

Use care when measuring voltages and waveforms on live circuits. The small size and high density of components in this instrument increases the probability that an inadvertent movement of the test probe may short circuit between components.

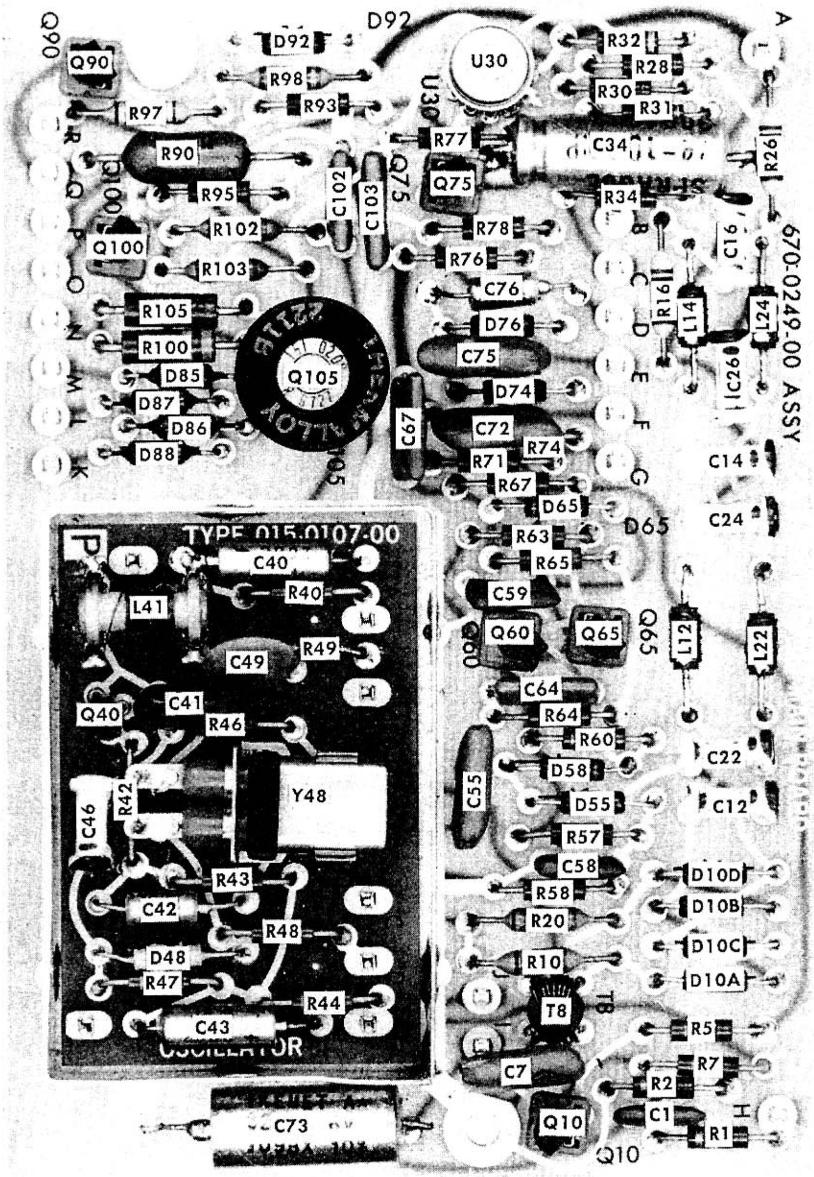


Fig. 4–6. Component location on the circuit boards.

The pin connectors to the circuit boards provide a means to isolate circuit voltages and resistances. Check circuit conditions before disconnecting voltages to make certain that the removal of bias voltages will not cause excessive overloads.

4. When the trouble has been isolated to a circuit, check the circuit description for a discussion of the circuit operation. This may help isolate the trouble to the faulty component.

SECTION 6
ELECTRICAL PARTS LIST

Values are fixed unless marked Variable

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
				BULB			
B95	150-0046-00			Incandescent #21070			
				CAPACITORS			
Tolerance ±20% unless otherwise indicated.							
C1	283-0005-00			0.01 μF	Cer	250 V	
C7	283-0024-00			0.1 μF	Cer	30 V	
C12	281-0638-00			240 pF	Cer	500 V	5%
C14	281-0580-00			470 pF	Cer	500 V	
C16	281-0638-00			240 pF	Cer	500 V	5%
C22	281-0638-00			240 pF	Cer	500 V	5%
C24	281-0580-00			470 pF	Cer	500 V	
C26	281-0638-00			240 pF	Cer	500 V	5%
C34	290-0367-00			70 μF	Elect.	6 V	
C40	290-0135-00			15 μF	Elect.	20 V	
C41	283-0594-00			0.001 μF	Mica	100 V	1%
C42	290-0183-00			1 μF	Elect.	35 V	10%
C43	290-0135-00			15 μF	Elect.	20 V	
C46	281-0504-00			10 pF	Cer	500 V	10%
C49	283-0003-00			0.01 μF	Cer	150 V	
C55	283-0024-00			0.1 μF	Cer	30 V	
C58	283-0005-00			0.01 μF	Cer	250 V	
C59	283-0005-00			0.01 μF	Cer	250 V	
C64	283-0059-00			1 μF	Cer	25 V	+80%-20%
C67	283-0059-00			1 μF	Cer	25 V	+80%-20%
C72	283-0024-00			0.1 μF	Cer	30 V	
C73	290-0326-00			820 μF	Elect.	6 V	10%
C75	283-0024-00			0.1 μF	Cer	30 V	
C76	290-0247-00			5.6 μF	Elect.	6 V	10%

CAPACITORS *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
C87	290-0278-00			550 μF	Elect.	50 V	
C88	290-0278-00			550 μF	Elect.	50 V	
C102	283-0059-00			1 μF	Cer	25 V	+80%-20%
C103	283-0059-00			1 μF	Cer	25 V	+80%-20%

SEMICONDUCTOR DEVICE, DIODES

Ckt. No.	Tektronix Part No.	Eff	Disc	Description	
D10A B,C,D(4)	*152-0185-00			Silicon	Replaceable by 1N4152
D48	152-0271-00			Silicon	VVC, 10 pF at 4 V ±20%; V10E
D55	*152-0185-00			Silicon	Replaceable by 1N4152
D58	*152-0185-00			Silicon	Replaceable by 1N4152
D65	152-0280-00			Zener	1N753A, 400 mW, 6.2 V, 5%
D74	*152-0185-00			Silicon	Replaceable by 1N4152
D76	*152-0185-00			Silicon	Replaceable by 1N4152
D85	*152-0107-00			Silicon	Replaceable by 1N647
D86	*152-0107-00			Silicon	Replaceable by 1N647
D87	*152-0107-00			Silicon	Replaceable by 1N647
D88	*152-0107-00			Silicon	Replaceable by 1N647
D92	152-0280-00			Zener	1N753A, 400 mW, 6.2 V, 5%

FUSES

Ckt. No.	Tektronix Part No.	Eff	Disc	Description	
F80	159-0051-00			1/16 A	Slo-Blo
F82	159-0051-00			1/16 A	Slo-Blo

CONNECTORS

Ckt. No.	Tektronix Part No.	Eff	Disc	Description
J1	131-0106-01			1 contact, female, receptacle
J35	129-0064-00			Post, binding

INDUCTORS

Ckt. No.	Tektronix Part No.	Eff	Disc	Description	
L12	108-0226-00			100 μH	
L14	108-0226-00			100 μH	
L22	108-0226-00			100 μH	
L24	108-0226-00			100 μH	
L41	*114-0273-00			2 μH-4 μH	Core 276-0582-00

TRANSISTORS

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description	
Q10	151-0190-00			Silicon	2N3904
Q40	151-0190-00			Silicon	2N3904
Q60	151-0190-00			Silicon	2N3904
Q65	151-0190-00			Silicon	2N3904
Q75	151-0190-00			Silicon	2N3904
Q90	151-0190-00			Silicon	2N3904
Q95	*151-0149-00			Silicon	Selected from 23441
Q100	151-0188-00			Silicon	2N3906
Q105	151-0208-00			Silicon	2N4036

RESISTORS

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

R1	315-0103-00	10 kΩ	1/4 W		5%
R2	315-0103-00	10 kΩ	1/4 W		5%
R5	315-0101-00	100 Ω	1/4 W		5%
R7	315-0222-00	2.2 kΩ	1/4 W		5%
R10	321-0133-00	237 Ω	1/8 W	Prec	1%
R16	321-0193-00	1 kΩ	1/8 W	Prec	1%
R20	321-0133-00	237Ω	1/8 W	Prec	1%
R26	321-0193-00	1 kΩ	1/8 W	Prec	1%
R28	315-0102-00	1 kΩ	1/4 W		5%
R30	315-0103-00	10 kΩ	1/4 W		5%
R31	315-0472-00	4.7 kΩ	1/4 W		5%
R32	315-0471-00	470 Ω	1/4 W		5%
R34	315-0621-00	620 Ω	1/4 W		5%
R35	311-0841-00	2 X 600 Ω, Var			
R36	315-0240-00	24 Ω	1/4 W		5%
R37	315-0621-00	620 Ω	1/4 W		5%
R38	315-0621-00	620 Ω	1/4 W		5%
R40	315-0102-00	1 kΩ	1/4 W		5%
R42	315-0220-00	22 Ω	1/4 W		5%
R43	315-0222-00	2.2 kΩ	1/4 W		5%

RESISTORS *(cont)*

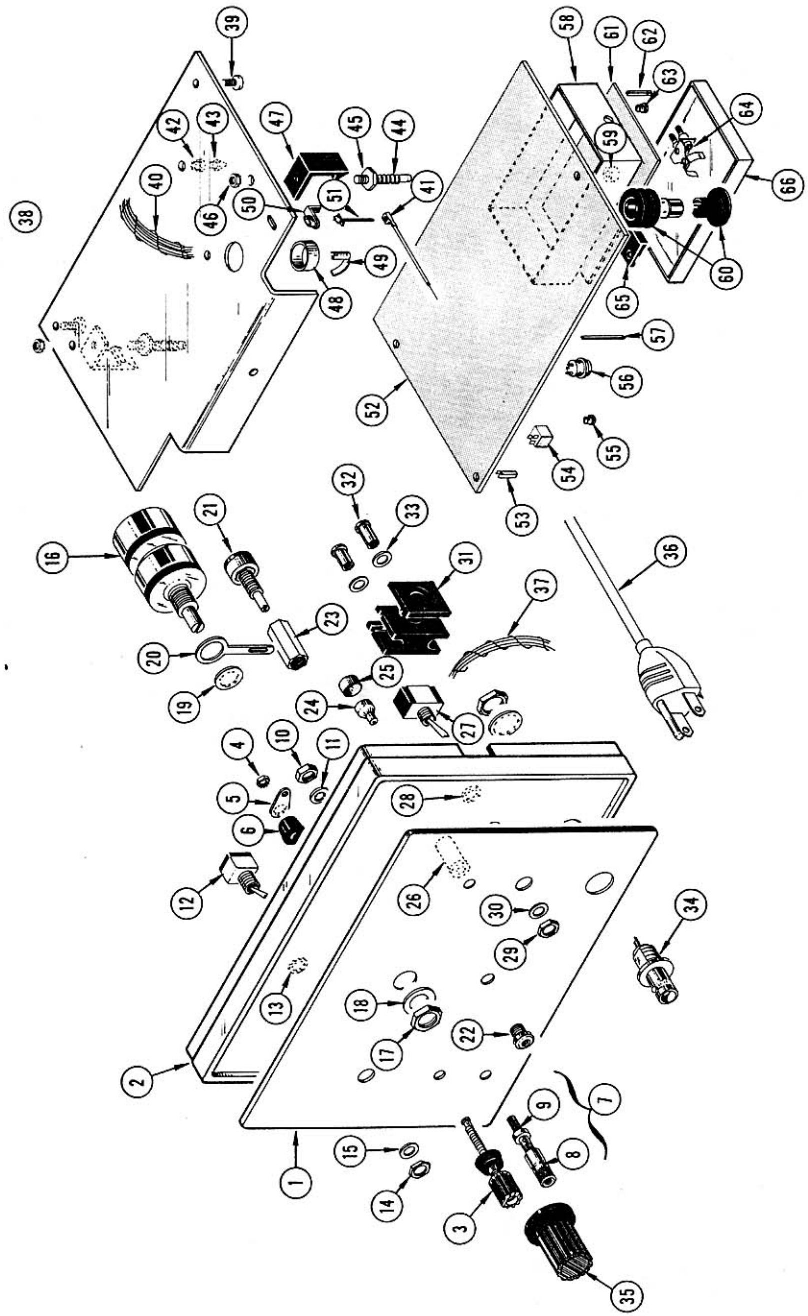
Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
R44	315-0102-00			1 kΩ	1/4 W		5%
R46	315-0222-00			2.2 kΩ	1/4 W		5%
R47	315-0273-00			27 kΩ	1/4 W		5%
R48	315-0104-00			100 kΩ	1/4 W		5%
R49	315-0681-00			680 Ω	1/4 W		5%
R50	311-0467-00			100 kΩ, Var			
R57	315-0102-00			1 kΩ	1/4 W		5%
R58	315-0102-00			1 kΩ	1/4 W		5%
R60	315-0103-00			10 kΩ	1/4 W		5%
R63	315-0104-00			100 kΩ	1/4 W		5%
R64	315-0561-00			560 Ω	1/4 W		5%
R65	315-0104-00			100 kΩ	1/4 W		5%
R67	315-0162-00			1.6 kΩ	1/4 W		5%
R71	315-0104-00			100 kΩ	1/4 W		5%
R74	315-0102-00			1 kΩ	1/4 W		5%
R76	315-0102-00			1 kΩ	1/4 W		5%
R77	315-0222-00			2.2 kΩ	1/4 W		5%
R78	315-0100-00			10 Ω	1/4 W		5%
R90	308-0077-00			1 kΩ	3 W	WW	
R92	315-0152-00			1.5 kΩ	1/4 W		5%
R95	315-0100-00			10Ω	1/4 W		5%
R97	321-0230-00			2.43 kΩ	1/8 W	Prec	1%
R98	321-0269-00			6.19 kΩ	1/8 W	Prec	1%
R100	301-0332-00			3.3 kΩ	1/2 W		5%
R102	321-0229-00			2.37 kΩ	1/8 W	Prec	1%
R103	321-0224-00			2.1 kΩ	1/8 W	Prec	1%
R105	301-0820-00			82 Ω	1/2 W		5%

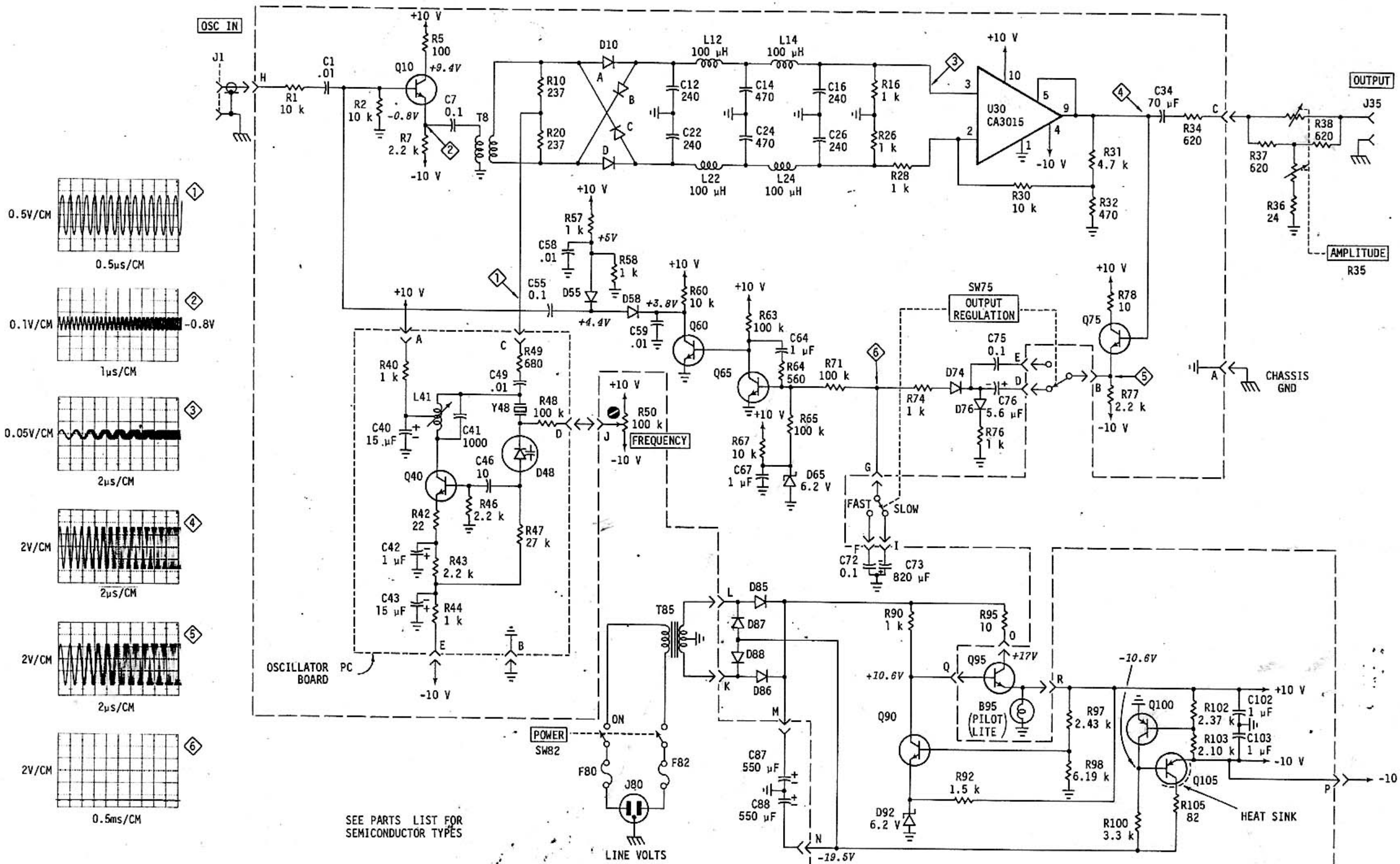
SWITCHES

	Unwired or Wired		
SW75	260-0642-00	Toggle	OUTPUT REGULATION
SW82	260-0834-00	Toggle	POWER

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
				TRANSFORMERS
T8	*120-0550-00			Toroid, 2 windings
T85	*120-0549-00			Power
				INTEGRATED CIRCUIT
U30	156-0017-00			CA3015
				CRYSTAL
Y48	158-0040-00			3000.05 KHz

SECTION 7
MECHANICAL PARTS LIST





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