070-6737-00
Product Group 46

CFG250 FUNCTION GENERATOR

SERVICE

Tektronix
COMMITTED TO EXCELLENCE

TEK SERVICE MANUAL

070-6737-00
Product Group 46

CFG250
FUNCTION GENERATOR
SERVICE

WARNING

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

Please Check for
CHANGE INFORMATION
at the Rear of This Manual

First Printing SEP 1988

Tektronix
COMMITTED TO EXCELLENCE

INSTRUMENT SERIAL NUMBERS

Each instrument has a serial number on a panel insert, tag, or stamped on the chassis. The first two digits designate the country of manufacture. The last five digits of the serial number are unique to each instrument. The country of manufacture is identified as follows:

B000000 Tektronix, Inc., Beaverton, Oregon, U.S.A.

E200000 Tektronix United Kingdom, Ltd., London

G100000 Tektronix Guernsey, Ltd., Channel Islands

HK00000 Hong Kong

H700000 Tektronix Holland, NV, Heerenveen, The Netherlands

J300000 Sony/Tektronix, Japan

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OPERATORS SAFETY SUMMARY

The general safety information in this part of the summary is for both operating and servicing personnel. Specific warnings and cautions will be found throughout the manual where they apply and do not appear in this summary.

Terms in This Manual

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

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

Terms as Marked on Equipment

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

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

Symbols in This Manual

⚠ This symbol indicates where applicable cautionary or other information is to be found. For maximum input voltage see Tables 1-1 and 1-2.

Symbols as Marked on Equipment

DANGER—High voltage.

Protective ground (earth) terminal.

ATTENTION—Refer to manual.

Replace fuse as specified—Refer to manual.

Power Source

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

Grounding the Product

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

Danger Arising From Loss of Ground

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

Use the Proper Power Cord

Use only the power cord and connector specified for your product.

Use only a power cord that is in good condition.

For detailed information on power cords and connectors, see Figure 2-2.

Use the Proper Fuse

To avoid fire hazard, use only a fuse of the correct type, voltage rating, and current rating as specified in the parts list for your product.

Do Not Operate in an Explosive Atmosphere

To avoid explosion, do not operate this instrument in an explosive atmosphere.

Do Not Remove Covers or Panels

To avoid personal injury, do not remove the product covers or panels. Do not operate the instrument without the covers and panels properly installed.

SERVICING SAFETY SUMMARY

FOR QUALIFIED SERVICE PERSONNEL ONLY

Refer also to the preceding Operators Safety Summary

Do Not Service Alone

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

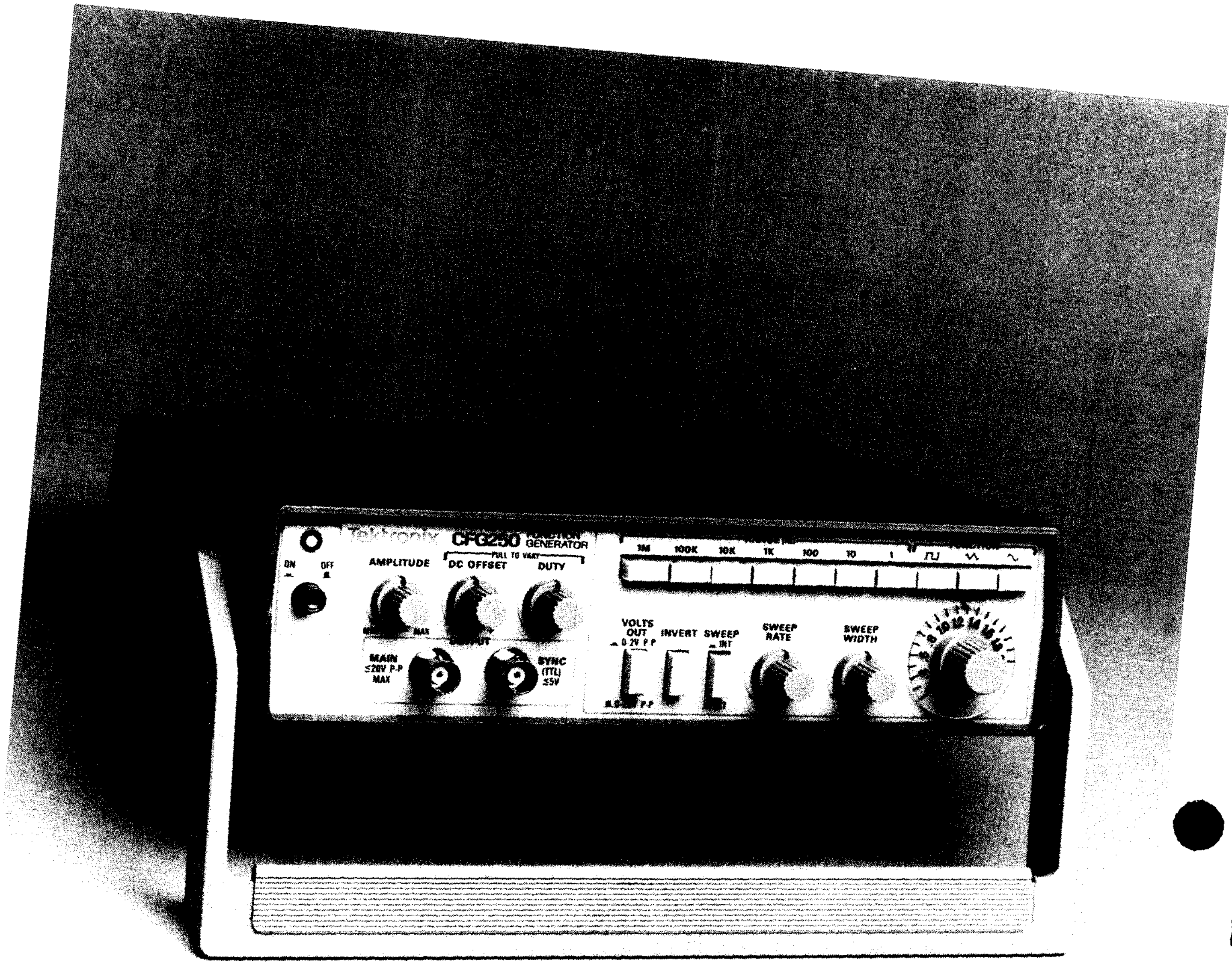
Use Care When Servicing With Power On

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

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

Power Source

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



6737-02

The CFG250 Frequency Generator.

GENERAL INFORMATION

INTRODUCTION

The TEKTRONIX CFG250 2 MHz FUNCTION GENERATOR produces square, triangle, and sine waves, and TTL compatible signals. The frequency range of the waveforms are from 0.2 Hz to 2 MHz. The maximum output amplitude of the waveform is 20 V p-p. The symmetry of the output waveform may also be varied. The output waveform can be frequency modulated by internal sweep or from an external voltage source.

The instrument can be used for such applications as testing audio amplifier, ultrasonic, and servo systems.

The CFG250 has a locking, multiposition handle that folds under the instrument to allow stacking with other instruments of the same series.

Standard accessories provided with the CFG250 include: a power cord and operators manual. For part numbers and further information about standard and optional accessories, refer to the Accessories page at the back of this manual. For additional information, contact your Tektronix Sales Office or Distributor and the Tektronix products catalog.

SPECIFICATION

The Operational characteristics given in Table 1-1 are valid when the instrument has been adjusted at an ambient temperature between +21°C and +25°C, has had a warm-up period of at least 30 minutes (with the cabinet in place), and is operating at an ambient temperature between 10°C and +40°C, with 75% maximum relative humidity.

Table 1-1

General Characteristics

Characteristics	Performance Requirements	
OPERATIONAL		
Frequency		
Range Selection	1 Hz to 1 MHz in seven steps (1, 10, 100, 1 K, 10 K, 100 K, and 1 M).	
Multiplier	Variable from 0.2 to 2.0 times the range selection.	
Accuracy	±5% of full scale.	
Internal Sweep	Linear.[a]	
Rate	0.5 Hz (2 second period) to 50 Hz (20 millisecond period), continuously variable.[a]	
Width	Variable from 1:1 to 100:1.[a]	
Sine-Wave Distortion	< 1% from 10 Hz to 100 kHz (maximum output into 50 Ω termination).	
Triangle Wave Linearity (Measured between 10% and 90% points)		
20 Hz to 100 kHz	≥ 99%.[a]	
200 kHz to 2 MHz	≥ 97%.[a]	
Square-Wave Response (Measured between 10% and 90% points)	≤ 100 ns.	
OUTPUT		
MAIN	VOLTS OUT	
	0.2 V p-p	0-20 V p-p
Open Circuit	≤ 10 mV p-p to ≥ 1.8 V	≤ 100 mV p-p to ≥ 20 V
50 Ω termination	≤ 5 mV p-p to ≥ 0.9 V	≤ 50 mV p-p to ≥ 9 V
Impedance	50 Ω ±10%.[a]	
SYNC (TTL)		
Open Circuit	> 3 V p-p.	
Rise Time and Fall Time	≤ 25 ns.	
DC OFFSET	±20 V minimum into an open circuit.	
Duty Cycle (Square Wave and Triangle Wave)	5 to 1 minimum duty cycle change (50% at maximum counter-clockwise position).	
VCF INPUT Impedance	10 kΩ ±10%.[a]	
External Voltage Controlled Sweep Range	100:1 minimum for 0 to +10 V dc input with FREQUENCY control set at 2.0.	

[a] **Performance Requirement not check in manual.**

Table 1-1 (cont)

Characteristics	Performance Requirements
ELECTRICAL CHARACTERISTICS	
Line Voltage Range	90 Vac to 110 Vac, 108 Vac to 132 Vac, 198 Vac to 242 Vac, and 216 Vac to 250 Vac at 50–60 Hz.[a]
Power Consumption	20 VA, 17 W.[a]
ENVIRONMENTAL CHARACTERISTICS	
Temperature	
Operating	10°C to +40°C (+50°F to +104°F), 75% relative humidity.
Nonoperating	-10°C to +60°C (14°F to 140°F), 80% relative humidity.
PHYSICAL	
Width	240 mm (90.5 in).
Height	64 mm (2.5 in).
Depth	190 mm (7.5 in).
Weight	1.7 kg (3.7 lb).

[a] **Performance Requirement not check in manual.**

PREPARATION FOR USE

SAFETY

This section of the manual tells how to proceed with the initial start-up of the instrument.

Refer to the Safety Summaries at the front of this manual for power source, grounding, and other safety considerations pertaining to the use of the instrument. Before connecting the CFG250 to a power source, read both this section and the Safety Summaries.

LINE VOLTAGE

CAUTION

This instrument may be damaged if operated with the LINE VOLTAGE SELECT switches set for the wrong line voltage.

This product is intended to operate from a power source that does not supply more than 250 Vrms between the ac input conductors or between either ac input conductor and ground. Before connecting the power cord to a power-input source, verify that the LINE VOLTAGE SELECT switches on the Rear Panel are set to the correct line voltage setting. Figure 2-1 shows the location of the LINE VOLTAGE SELECT switches, power cord receptacle, and power fuse.

POWER CORD

A protective ground connection, the third wire in the power cord, is necessary for safe operation. To avoid electrical shock, plug the power cord into a properly wired receptacle before making any connections to the equipment input terminals. Do not remove the ground lug from the power cord for any reason. Use only the power cord and connector specified for this equipment.

Instruments are shipped with the required power cord as ordered by the customer (see Figure 2-2). Contact your Tektronix representative or Tektronix Field Office for additional power-cord information.

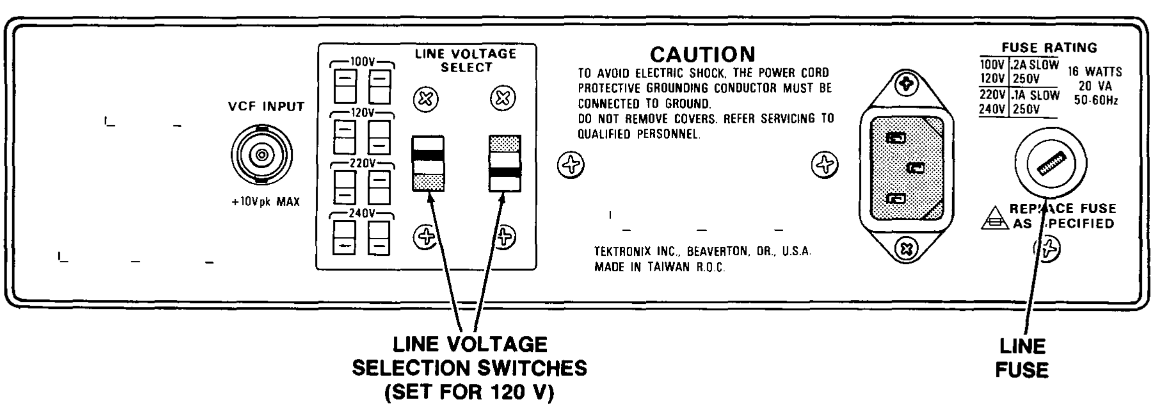
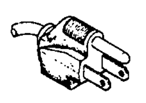
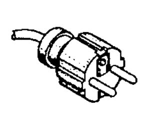
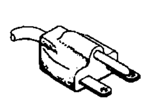
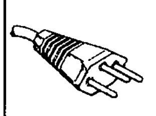


Figure 2-1. Rear Panel.

Plug Configuration	Option	Power Cord/ Plug Type	Line Voltage	Reference Standards [b]
	U.S. Std.	U.S. 120V	120V	ANSI C73.11 NEMA 5-15-P IEC 83 UL 198.6
	A1	EURO 220V	220V	CEE(7), II, IV, VII IEC 83 IEC 127
	A2	UK[a] 240V	240V	BS 1363 IEC 83 IEC 127
	A3	Australian 240V	240V	AS C112 IEC 127
	A4	North American 240V	240V	ANSI C73.20 NEMA 6-15-P IEC 83 UL 198.6
	A5	Switzerland 220V	220V	SEV IEC 127

[a] A 6A, type C fuse is also installed inside the plug of the Option A2 power cord.

[b] Reference Standards Abbreviations:

ANSI—American National Standards Institute
AS—Standards Association of Australia
BS—British Standards Institution
CEE—International Commission on Rules for the Approval of Electrical Equipment
IEC—International Electrotechnical Commission
NEMA—National Electrical Manufacturer's Association
SEV—Schweizervischer Elektrotechnischer Verein
UL—Underwriters Laboratories Inc.

Figure 2-2. Optional power cords.

FUSES

CAUTION

The instrument may be damaged if operated with the wrong type and rating line fuses installed.

WARNING

Unplug the power cord and disconnect the test leads from any voltage source before checking or changing the fuses.

Verify the proper value of the fuses with the following procedure. Figure 2-1, Rear Panel, shows the location of the fuse:

1. Disconnect the power cord from the power-input source.
2. Press in the fuse-holder cap and release it with a slight counterclockwise rotation.
3. Pull the cap (with the attached fuse inside) out of the fuse holder.
4. Verify proper fuse value.
5. Install the proper fuse and reinstall the fuse-holder cap.

DETAILED OPERATING INFORMATION

For detail operating information about the instrument, refer to the Operators Manual.

THEORY OF OPERATION

INTRODUCTION

This section contains a general description of the CFG250 Function Generator circuitry. General operation of the instrument is described in the Block Diagram Description. Each functional circuit is described in more detail in the Detailed Circuit Description.

The schematic diagram and the circuit board illustrations are located in the Diagrams section near the rear of this manual. To understand the circuit descriptions in this section, refer to both the Block Diagram, Figure 3-1 in this section, and to the schematic diagram.

BLOCK DIAGRAM DESCRIPTION

The VCF (Voltage Controlled Frequency) circuit generates positive and negative control signals that adjust the frequency within the selected range and the duty cycle of the output waveform. This is accomplished by varying the voltage level of the positive- and negative-control signal with the FREQUENCY and DUTY controls in the VCF circuit. The positive and negative control signals are fed to the Triangle-Wave Generator.

The positive and negative control signals regulates the charging rate of the Triangle-Wave Generator timing capacitors. The charging and discharging rate of the timing capacitor develops a positive and negative linear voltage ramp that is a triangle waveform. The amplitude of the triangle waveform is set by current control signal from the Square-Wave Generator. The output of the triangle waveform generator is applied to the Square-Wave Generator, the Sine-Wave Generator, and the FUNCTION switches.

In the Square-Wave Generator, two comparators circuits are used to develop a square waveform from the applied triangle waveform and to generate a current control signal for the Triangle-Wave Generator. The output of the Square-Wave Generator is applied to TTL Conversion circuit and to the FUNCTION switches.

The TTL Conversion circuit changes the square-wave signal to a TTL compatible signal. The TTL compatible signal is applied to the SYNC OUTPUT connector.

The triangle waveform to the Sine-Wave circuit is applied to the three symmetrical constant-current sources. The diode constant current sources change the triangle waveform to a sine waveform that is fed to an operational amplifier for buffering before being applied to the FUNCTION switch.

The FUNCTION switches select the waveform to be applied to the Output Amplifier. The Output Amplifier increases the amplitude of the waveform about 10 times. The output waveform amplitude is selectable between 0.2 V p-p and 20 V p-p. A front panel DC OFFSET control varies the dc voltage level of the output waveform.

The output waveforms can be frequency modulated by an internal sawtooth waveform from the Sweep circuit or by external signal. The internal sawtooth signal and external signal are applied to the SWEEP switch that routes the selected signal to the input of the VCF circuit. The sawtooth sweep signal rate and amplitude are adjustable by front panel controls. The external signal is applied to the VCF input connector located on the rear panel.

The power supply consists of a full-wave bridge rectifier that supplies two unregulated and three regulated voltages to the circuits of the Function Generator.

DETAILED CIRCUIT DESCRIPTION

Voltage Controlled Frequency

The VCF (Voltage Controlled Frequency) circuitry develops positive and negative control voltages for the Triangle-Wave and Square- Wave generators. The VCF circuit consists of operational amplifiers U1, U2, U3, and U4, transistors Q1 and Q2, and associated circuitry.

The positive control voltage is developed by Operational Amplifiers U1 and U3 and transistor Q1; negative control voltage is developed by Operational Amplifiers U2 and U4 and transistor Q2.

The FREQUENCY control sets the current level to pin 2 of U1 and U2. An increase in current from the FREQUENCY control increases the frequency of the output waveform; a decrease in current from the FREQUENCY control decreases the frequency of the output waveform. The Hi Freq Adj potentiometer R6 sets the maximum frequency limit. The Sym Adj Potentiometers R10 and R18 adjust for zero volts difference between the respective inputs of U1 and U2.

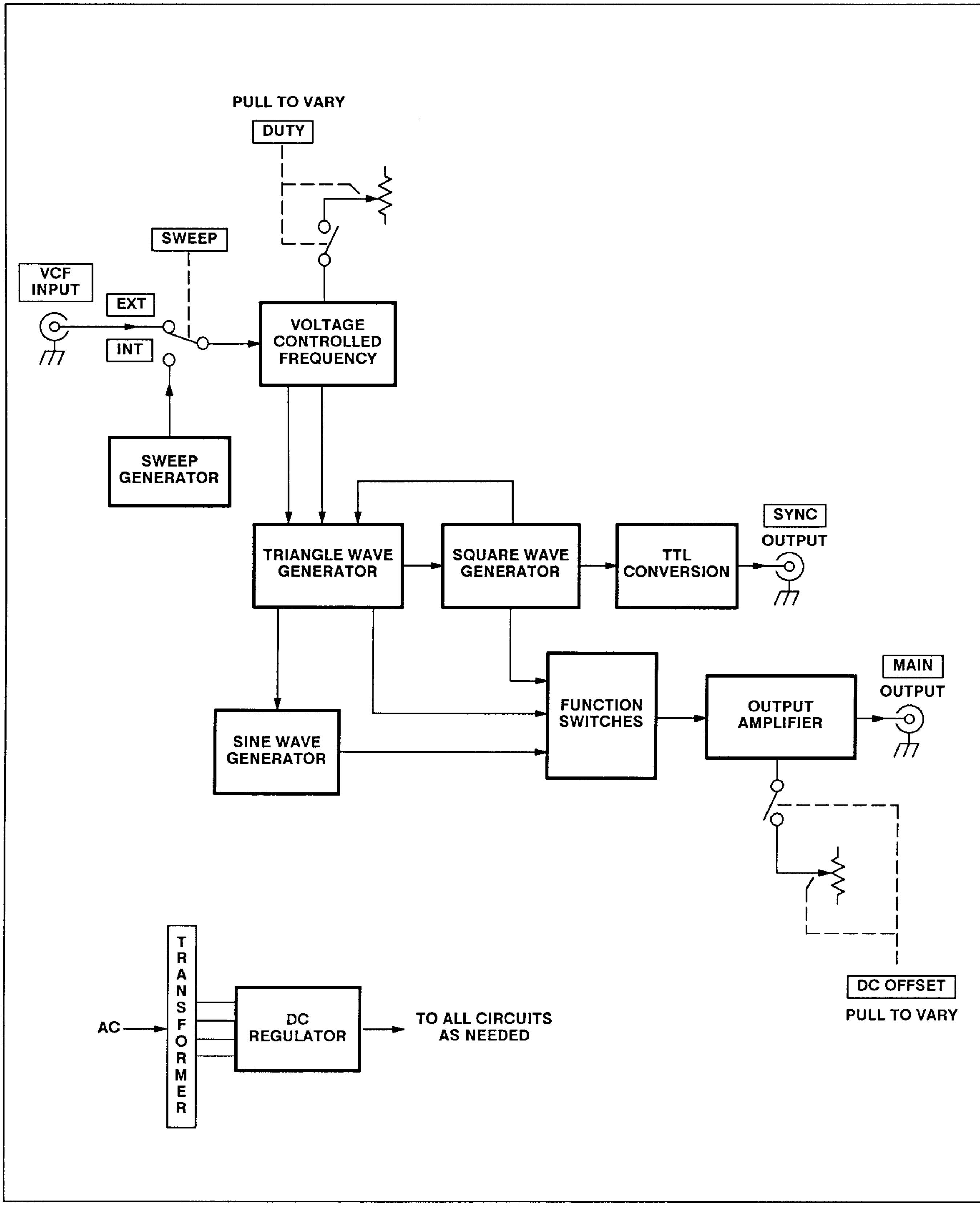


Figure 3-1. Block Diagram.

Potentiometers R10 and R18 adjust the dc offset for the positive and negative control voltages to set the waveform symmetry. The outputs of U1 and U2 are fed to Q1, Q2, U3 and U4.

The current rate for the positive or the negative control voltages can be adjusted by adding a potentiometer (DUTY control R20) to the emitters of Q1 or Q2. This is done by pulling out the DUTY control knob to add the potentiometer to the circuit. and rotating it. The emitter current to be adjusted is selected by the INVERT switch SW8. Adjusting the current rate for the positive or the negative control voltage varies the charging or discharging rate of the timing capacitor in the Triangle-Wave Generator and thereby varying the duty factor of the output waveforms.

Frequency modulation of the instrument output waveform is performed by applying either the internal sweep waveform or an external signal to the input of VCF circuit. The signal for frequency modulation is selected by the SWEEP switch.

Triangle-Wave Generator

The Triangle-Wave Generator provides a linear voltage ramp to the FUNCTION switches, the Square-Wave Generator, and the Sine-Wave Generator. The linear voltage ramp is produced by maintaining a constant current through selectable timing capacitors. The Triangle-Wave Generator consists of transistors Q3, Q4, Q5, U5C, and U5D, the disconnect diodes, and timing capacitors and resistors.

The selection of the timing capacitor(s) and resistor(s) by the RANGE (Hz) switch SW6 sets the frequency range of the output waveforms. Charging current through Q3 and Q4 for setting the frequency in a selected range is regulated by the VCF circuit which applies a positive control voltage to Q3 and negative control voltage to Q4.

The current control signal from the square wave circuit to the disconnect diodes (D1 through D8) determines which current source (Q3 or Q4) is connected to the selector timing capacitors. The current control signal switches between +1.8 V and -1.8 V.

Assume the current control signal is +1.8 V, diodes D1 and D3 are reverse biased and diodes D7 and D8 are forward biased. Current through the selected timing resistors, to transistor Q3, and diodes D2 and D4 charges the timing capacitor positive. When the ramp reaches about +1.2 V, the current control signal switches to -1.8 V. Diodes D1 and D3 are then forward biased and diodes D7 and D8 are reverse biased. Current flows through transistor Q4, diodes D5 and D6 and the timing resistor reversing the charge on the timing capacitor. When the timing capacitor charges to about -1.2 V level, and the current control signal switches to repeat the cycle.

The triangle waveform is buffered by Q5, U5C and U5D then applied to the FUNCTION switches, the Sine-Wave Generator and the Square-Wave Generator. The amplitude of the triangle waveform at pin 10 of U5D is about 1 V. The Zero Adj potentiometer, R33, sets the triangle waveform equally above and below the 0 V level.

Square-Wave Generator

The Square-Wave Generator changes the triangle waveform into a square wave signal. The square-wave signal is applied to the TTL Conversion circuit, and to the FUNCTION switches for application to the output amplifier. A second signal (current control) sets the voltage level of the triangle waveform positive and negative ramps.

The triangle-wave signal is fed to differential comparator U5A and U5B through a voltage divider, R35 and R36, that divides the signal by two. The triangle wave is converted to a square wave by U5A and U5B and applied to differential comparators Q6 and Q7. The square wave from Q6 is fed to the FUNCTION switches,and to TTL Conversion circuit. The square wave signal is conditioned by diodes D32 through D35 before being applied to the Output Amplifier.

The square wave from Q7 provides positive feedback to U5B and a control signal to triangle wave disconnect diodes D1 through D8. The control signal switches the triangle waveform between the positive- and negative-going ramps. Transistor U5B sets the voltage level for the triangle wave positive and negative going ramps. The Upper and Lower Sine Dis Adj potentiometers R43 and R45 adjust the triangle waveform positive and negative going ramps by changing the duty factor of the current-control signal. The CURRENT CONTROL signal is fed back to the disconnect diodes (D1 through D8) of the Triangle-Wave Generator.

Sine-Wave Generator

The signal from the Triangle-Wave Generator is applied to the three sine shapers in the Sine-Wave Generator. Each sine shaper consists of four disconnect diodes that convert different portions of the triangle wave into a partial sinewave. The partial sine waves are summed together at the junction R60, R63, R66, R68, and R69 to form a complete sine wave. The sine wave is fed into operational amplifier U7 where it is conditioned and amplified before being applied to the FUNCTION switches. Potentiometer R74 sets the gain for U7.

Output Amplifier

The output amplifier circuit is a non-inverting amplifier that has a gain of about 10 (20 dB).

The waveform signal from the FUNCTION switches is applied to differential amplifier Q9 and Q10 through the AMPLITUDE control. The collector of Q10 controls the constant current source of Q11 and Q12. The constant current source of Q11 and Q12 drives current amplifier Q13 and Q14. Both Q13 and Q14 draw minimum current when the signal level to Q9 and Q10 is about 0V.

As the waveform signal goes positive, the emitter of Q9 draws current away from the emitter of Q10. Current that was drawn by Q10 is now being drawn by Q11. Transistor Q11 draws more current than Q12, causing an unbalance in the two current sources. The collector of Q11 goes positive turning Q14 off and Q13 on. The positive waveform signal is passed through Q13 to the OUTPUT MAIN connector and to the base of Q10, the inverting input of the differential amplifier Q9 and Q10.

When the waveform signal goes negative, Q10 draws more current than Q9. Transistor Q12 draws current away from Q11, placing a more negative voltage on the collector of Q11, turning Q13 off and Q14 on. The negative waveform signal is passed through Q14 to the OUTPUT MAIN connector and to the inverting input of the differential amplifier Q9 and Q10.

The feedback network to Q9 and Q10 consist of R87, C30, and C31. Potentiometer R82 presets the dc offset of the output amplifier to 0 V. When DC OFFSET is in PULL TO VARY position, a positive or negative dc offset can be added to the output level of the amplifier.

The waveform signal is applied directly to the OUTPUT connector or through the divide by 10 voltage divider of R98 and R99. The VOLTS OUT switch is a push-push type that selects 0-20 V p-p in Out position or 0-2 V p-p in In position.

TTL Conversion

The TTL Conversion circuit changes the square-wave signal to a TTL compatible signal. The circuit consists of U6, a dual positive-NAND gate.

The square wave from Q6 is applied to pins 1 and 9 of U6 through diodes D28, D29, and D30. The diodes D28 through D30 shift the dc level of the square wave from 1.8 V to 3.6 V. The NAND gates of U6 invert the square-wave signal being applied to the OUTPUT SYNC connector. The output voltage is 0 V to 4 V open circuit.

Sweep Generator

The Sweep Generator circuit provides a sawtooth waveform that is applied to the VCF circuit for frequency modulating (FM) the output waveforms.The Sweep circuit consists of integrator U9, transistor Q17, inverting buffer U10, and associated components.

At initial instrument turn on, the sweep circuit starts with U9A pin 2 being more negative than pin 3. The output voltage of U9A ramps up linearly due to the charging of C45. The charge rate of C45 is set by the SWEEP RATE control R106. The charging of C45 develops a linear positive voltage ramp at pin6 of U9B. When pin 6 becomes more positive (about 10 V) than pin 5 of U9B, the output of U9B goes LO. This LO turns on Q17 clamping pin 2 of U9A and pin 5 of U9B at about 0V, causing the output voltage of U9A to fall rapidly toward the negative supply level. This will lower the input voltage to pin 6 of U9B. When pin 6 becomes more negative then pin 5, the output of U9B goes HI turning off Q17. With Q17 turned off, pin 2 becomes more negative then pin 3 of U9A allowing the cycle to repeat again.

The sweep signal from the output of U9A is applied to unity gain Inverting Buffer U10. The output of U10 is applied to the SWEEP switch through SWEEP WIDTH control. The SWEEP WIDTH control selects the amplitude of the sawtooth signal to be applied to the input of VCF circuit through the SWEEP switch.

Power Supply

The power supply provides two unregulated supplies and three regulated supplies to operate the instrument.

POWER INPUT. The POWER switch applies line voltage through the LINE VOLTAGE SELECT switch to the primary side of the power transformer. POWER indicator connected between -15 V and ground indicates if the instrument is On or Off.

+30 V and -30 V. The dc outputs of the bridge rectifier D52 through D55 supplies the unregulated +30 V and -30 V. These two voltages are filtered by C41 and C43 and fed to the output amplifier and regulated supplies of +15 V, +5 V, and -15 V,

+15 V. The +15 V regulated output is provided from the +30 V supply input to a three-terminal voltage regulator. Transistors Q18 and Q19 monitors the the voltage drop across R118 and applies overload shutdown signal to pin 2 of Q15.

+5 V. The +5 V regulated supply is provided by the series-pass transistor Q8. Zener diode D31 sets the base voltage level for Q8.

-15 V. The -15 V regulated supply is provided by series-pass transistor Q16 and operational amplifier U8. The control voltage for Q16 is provided by U8 that monitors the voltage across the voltage divider of R102 and R103.

PERFORMANCE CHECK PROCEDURE

INTRODUCTION

This procedure checks the electrical characteristics listed in the Specification part of Section 1 of this manual. If the instrument fails to meet the requirements given in this performance check, the Calibration Procedure in Section 5 should be done. This performance check may also be used as an acceptance test or as a troubleshooting aid.

You do not have to remove the instrument case to do this procedure. All checks can be made with controls and connectors accessible from the outside.

To ensure instrument accuracy, check its performance after every 2000 hours of operation, or once each year if used infrequently. If these checks indicate a need for readjustment or repair, refer the instrument to a qualified service person.

TEST EQUIPMENT NEEDED

The test equipment listed in Table 4-1 is a complete list of the equipment needed for this performance check and the adjustment procedure in Section 5. All test equipment is assumed to be operating within tolerance. Detailed operating instructions for test equipment are not given in this procedure. If operating information is needed, refer to the appropriate test equipment instruction manual.

Table 4-1
Test Equipment Required

Item and Description	Minimum Specification	Purpose	Example of Applicable Test Equipment
1. Frequency Counter	Frequency: Dc to above 2 MHz. Accuracy: Within one part of 10^5 ± count.	Output waveform checks and adjustments, and VCF input check.	TEKTRONIX DC 504A
2. Variable dc Power Supply	Output: 0 V to 10 V.	Check VCF INPUT	TEKTRONIX CPS250
3. Distortion Analyzer	Frequency: 10 Hz to 100 Hz. Distortion resolution: < 1%.	Check sine wave distortion	TEKTRONIX AA 501A DISTORTION ANALYZER
4. Test Oscilloscope with 10X probe	Bandwidth: dc to 50 MHz. Minimum deflection factor: 5 mV/div Accuracy: ±3%.	Gain and transient response checks.	Tektronix 2225 Oscilloscope
5. Adapter	BNC female to dual banana plug.	Single interconnections.	Tektronix Part Number 103-0090-00
6. Coaxial Cable (2 required)	Impedance: 50 Ω. Length: 36 in. Connectors: BNC	Signal interconnections.	Tektronix Part Number 012-0057-01
7. Termination	Impedance: 50 Ω. Connectors: BNC	Signal Termination.	Tektronix Part Number 011-0049-01
8. Alignment Tool	Length: 1-in shaft. Bit size: 3/32 in. Low Capacitance: insulated.	Adjust variable capacitors and resistors.	Tektronix Part Number 003-0675-00

PREPARATION

Connect the test equipment to an appropriate ac-power-input source and connect the CFG250 to a variable autotransformer that is set to 120 Vac. Apply power and allow 20 minutes for the instrument to warm up and stabilize.

Set the following controls for the instrument under test during warm-up time:

AMPLITUDE	MIN
DC OFFSET	Push in and midrange
DUTY	Push in and midrange
RANGE (Hz)	1K
FUNCTION	All buttons out
VOLTS OUT	0-20V P-P
INVERT	Button out
SWEEP	EXT
SWEEP RATE	Midrange
SWEEP WIDTH	Midrange
FREQUENCY	2.0

PROCEDURE

1. Check Dc Offset Range

a. Connect CFG250 MAIN OUTPUT connector to the test oscilloscope vertical input connector via a 50 Ω cable.

b. Set the test oscilloscope vertical deflection to 2 V per division and input coupling switch to GND position.

c. Vertically position the baseline trace to the bottom horizontal graticule line. Set the the input coupling switch to DC input.

d. Pull the DC OFFSET knob out and rotate the control clockwise to the + position.

e. CHECK—Baseline trace is positioned more than 5 divisions above the bottom horizontal graticule line.

f. Set the vertical input coupling switch to GND (0 V) and vertically position the baseline trace to the top horizontal graticule line. Set the the input coupling switch to DC input.

g. Rotate the DC OFFSET control counter-clockwise to the - position.

h. CHECK—Baseline trace is positioned more than 5 divisions below the top horizontal graticule line.

2. Check MAIN OUTPUT Amplitude

a. Set the test oscilloscope front-panel controls for free running sweep at 0.1 ms and calibrated vertical deflection of 20 mV per division.

b. Set:

DC OFFSET	Push in and midrange
FUNCTION	∿ button in

c. CHECK—Sine-wave amplitude into an open circuit for limits given in Table 4-2.

Table 4-2
Output Amplitude
Into an Open Circuit

VOLTS OUT	AMPLITUDE Position	Test Oscilloscope Volts/Div Settings	Test Oscilloscope Display Amplitude
0-20V P-P	MIN	20 mV	≤5 divisions
	MAX	5 V	≥4 divisions
0-2V P-P	MIN	5 mV	≤2 divisions
	MAX	0.5 V	≥3.6 divisions

d. Disconnect the 50 Ω cable from the test oscilloscope and connect the 50 Ω termination to the end of the cable. Reconnect the 50 Ω cable to the test oscilloscope.

e. CHECK—Sine-wave amplitude for limits given in Table 4-3 using the 50 Ω termination.

f. Push the FUNCTION ⊓⊔ button in.

g. Repeat part e for square-wave amplitude.

Table 4-3
Output Amplitude
Into a 50 Ω Termination

VOLTS OUT	AMPLITUDE Position	Test Oscilloscope Volts/Div Settings	Test Oscilloscope Display Amplitude
0-20V P-P	MIN	10 mV	≤5 divisions
	MAX	2 V	≥4.5 divisions
0-2V P-P	MIN	5 mV	≤1 divisions
	MAX	0.2 V	≥4.5 divisions

3. Check Square Wave Rise Time and Fall Time

a. Set:

AMPLITUDE	MAX (fully clockwise)
DC OFFSET	Off (knob in and midrange)
VOLTS OUT	0-20V P-P
RANGE (Hz)	1M
FREQUENCY	1.0

b. Set the test oscilloscope vertical deflection to 1 V per division. Adjust the oscilloscope vertical variable control for a 5-division display. Set the sweep speed to 20-ns per division, and trigger to positive slope for a rise-time display. Ensure that the 50 Ω cable is terminated with the 50 Ω termination.

c. Vertically position the trace so that the zero reference of the waveform touches the 0% graticule line and the top of the waveform touches the 100% graticule line.

d. CHECK—The rise time is 100 ns or less between the 10% and 90% points of the square wave.

e. Set the test oscilloscope trigger to negative slope for a fall-time display. Reposition the waveform on the screen if necessary.

f. CHECK—The fall time is 100 ns or less between the 10% and 90% points of the square wave.

g. Disconnect the test equipment from the instrument. Return the test oscilloscope vertical variable control back to the calibrated detent.

4. Check SYNC OUTPUT Amplitude

a. Connect the instrument SYNC OUTPUT connector to the test oscilloscope vertical input connector via a 50 Ω cable and a 50 Ω termination.

b. Set the test oscilloscope vertical deflection to 0.2 V per division.

c. CHECK—Display amplitude is 5-divisions (1 V) or greater.

5. Check SYNC OUTPUT Rise Time

a. Set the test oscilloscope vertical deflection and variable control for an exact 5-division display. Set the sweep speed to 10-ns per division.

b. Set the test oscilloscope trigger to positive slope for a rise-time display.

c. Vertically position the trace so that the zero reference of the waveform touches the 0% graticule line and the top of the waveform touches the 100% graticule line.

d. CHECK—The rise time is 25 ns or less between the 10% and 90% points of the TTL sync pulse.

e. Disconnect the test equipment from the instrument.

6. Check Output Frequency Accuracy

a. Set:

AMPLITUDE	MAX (fully clockwise)
DC OFFSET	Off (knob in and midrange)
VOLTS OUT	0-20V P-P

b. Connect CFG250 OUTPUT connector to the frequency counter via a 50 Ω cable and a 50 Ω termination.

c. CHECK—Output frequencies at 0.2 and 2.0 on the FREQUENCY control for all RANGE (Hz) settings as given in Table 4-4.

Table 4-4
Accuracy of Output Frequency

RANGE (Hz)	Test Oscilloscope 0.2	2.0
1 M	100 KHz to 300 kHz	1.9 MHz to 2.1 MHz
100 K	10 kHz to 30 kHz	190 kHz to 210 kHz
10 K	1.0 kHz to 3.0 kHz	19 kHz to 21 kHz
1 K	100 Hz to 300 Hz	1.9 kHz to 2.1 kHz
100	10 Hz to 30 Hz	190 Hz to 210 Hz
10	1.0 Hz to 3.0 Hz	19 Hz to 21 Hz
1	0.10 Hz to 0.30 Hz	1.9 Hz to 2.1 Hz

7. Check External Voltage Controlled Sweep Range

a. Set:

RANGE (Hz)	1K
FUNCTION	∿ button in
SWEEP	EXT
FREQUENCY	2.0

b. Adjust the 0–20 V power supply to be connected to the instrument VCF connector for 0 volts out.

c. Connect the instrument SYNC OUTPUT connector to the test oscilloscope vertical input connector via a 50 Ω cable and a 50 Ω termination.

d. Connect the 0–20 V power supply to the instrument VCF INPUT connector via BNC female to dual banana adapter and a 50 W cable. Ensure the ground side of the BNC female to dual banana connector adapter goes to the - binding post of the power supply.

e. Increase the output voltage of the the 0–20 V power supply until the output frequency of the instrument decreases to 20 Hz as read on the frequency counter.

f. CHECK—The output voltage of the 0–20 V power supply is less than +10 V.

g. Disconnect the test equipment from the instrument.

8. Check Sine-Wave Distortion

a. Connect CFG250 OUTPUT connector to the distortion analyzer via a 50 Ω cable and a 50 Ω termination.

b. CHECK—For less than 1% distortion for frequencies given in Table 4-5.

Table 4-5
Sine-Wave Distortion

RANGE (Hz)	FREQUENCY Control Setting	Distortion Analyzer Frequency	Percent Distortion
100 K	1.0	100 kHz	< 1%
10 K	2.0	20 kHz	< 1%
1 K	2.0	2 kHz	< 1%
100	2.0	200 Hz	< 1%
10	2.0	20 Hz	< 1%

c. Disconnect the test equipment from the instrument.

ADJUSTMENT PROCEDURE

To ensure instrument accuracy, this Adjustment Procedure should be done every 2000 hours of operation or at least once each year if used infrequently.

PREPARATION FOR ADJUSTMENT

Make the adjustments in this procedure at an ambient temperature of +21 °C to +25 °C (+69.8 °F to +77 °F) and a relative humidity of 75% or less.

It is necessary to remove the top cover from the instrument to gain access to the adjustments located on the component side of the Main circuit board. Disconnect the power cord from the CFG250 and follow the top case and side panels removal instructions in the Maintenance section of this manual.

Test equipment needed for these adjustments is described in Table 4-1 at the beginning of the Performance Check Procedure. Refer to the appropriate test equipment instruction manuals for test equipment operating information.

Connect the test equipment to an appropriate ac-power-input source and connect the CFG250 to a variable autotransformer that is set to 120 Vac. Apply power and allow 20 minutes for the instrument to warm up and stabilize.

Set the following controls for the instrument under test during warm-up time:

AMPLITUDE	MIN (fully counterclockwise)
DC OFFSET	Push in and midrange
DUTY	Push in and midrange
RANGE (Hz)	1K
FUNCTION	All buttons out
VOLTS OUT	0-20V P-P
INVERT	Button out
SWEEP	EXT
SWEEP RATE	Midrange
SWEEP WIDTH	Midrange
FREQUENCY	2.0

PROCEDURE

1. Adjust Triangle DC Level (R46)

a. Connect the test oscilloscope and its 10X probe tip to the gate of Q5 and the probe common lead to the instrument chassis ground.

b. Set the test oscilloscope vertical deflection to 50 mV per division and horizontal deflection to 0.5 ms per division.

c. Set the test oscilloscope vertical input coupling switch to GND (0 V) and vertically center the baseline trace on the center horizontal graticule line.

d. Set the test oscilloscope vertical input coupling switch to DC.

e. ADJUST—Zero Adj (R33) to center the display equally above and below the center horizontal graticule line.

f. Disconnect the test equipment from the instrument.

2. Adjust Internal Dc Offset (R82)

a. Connect CFG250 OUTPUT connector via a 50 Ω cable to vertical input of the test oscilloscope.

b. Set the test oscilloscope vertical deflection factor to 10 mV per division and input coupling switch to GND (0 V). Vertically center the baseline trace on the center horizontal graticule line.

c. Set the test oscilloscope vertical input coupling switch to DC.

d. ADJUST—The Int Offset Adj (R82) to vertically center the baseline trace exactly on the center horizontal graticule line.

3. Check Dc Offset Range

a. Set the test oscilloscope vertical deflection to 2 V per division and input coupling switch to GND position.

b. Vertically position the baseline trace to the bottom horizontal graticule line. Set the the input coupling switch to DC input.

c. Pull the DC OFFSET knob out and rotate the control clockwise to the + position.

d. CHECK—Baseline trace is positioned more than 5 divisions above the bottom horizontal graticule line.

e. Set the vertical input coupling switch to GND (0 V) and vertically position the baseline trace to the top horizontal graticule line. Set the the input coupling switch to DC input.

f. Rotate the DC OFFSET control counterclockwise to the - position.

g. CHECK—Baseline trace is positioned more than 5 divisions below the top horizontal graticule line.

4. Adjust Square Wave Amplitude (R56)

a. Set the test oscilloscope front-panel controls for free running sweep at 0.1 ms and calibrated vertical deflection of 5 V per division.

b. Set:

AMPLITUDE	MAX (fully clockwise)
DC OFFSET	Push in and midrange
FUNCTION	⊓⊔ button in

c. ADJUST—Sq Amp Adj (R56) for a amplitude of 4-division display (20 V).

5. Adjust Sine Wave Amplitude (R74)

a. Push the FUNCTION ∿ button in.

b. ADJUST—Sine Amp Adj (R74) for a amplitude of 4-division display (20 V).

6. Check MAIN OUTPUT Amplitude

a. CHECK—Sine wave display amplitude into an open circuit for limits given in Table 5-1.

Table 5-1
Output Amplitude
Into an Open Circuit

VOLTS OUT	AMPLITUDE Position	Test Oscilloscope Volts/Div Settings	Test Oscilloscope Display Amplitude
0-20V P-P	MIN	20 mV	≤5 divisions
	MAX	5 V	≥4 divisions
0-2V P-P	MIN	5 mV	≤2 divisions
	MAX	0.5 V	≥3.6 divisions

b. Disconnect the 50 Ω cable from the test oscilloscope and connect the 50 Ω termination to the end of the cable. Reconnect the 50 Ω cable to the test oscilloscope.

c. CHECK—Sine-wave amplitude for limits given in Table 5-2 using the 50 Ω termination.

Table 5-2
Output Amplitude
Into a 50 Ω Termination

VOLTS OUT	AMPLITUDE Position	Test Oscilloscope Volts/Div Settings	Test Oscilloscope Display Amplitude
0-20V P-P	MIN	10 mV	≤5 divisions
	MAX	2 V	≥5 divisions
0-2V P-P	MIN	5 mV	≤1 divisions
	MAX	0.2 V	≥4.5 divisions

d. Push the FUNCTION ⊓⊔ button in.

e. Repeat part c for square wave amplitude.

7. Adjust Sine-Wave Distortion (R43 and R46)

a. Set:

AMPLITUDE	MAX (fully clockwise)
RANGE (Hz)	10
VOLTS OUT	0-20V P-P
FUNCTION	∿ button in

b. Connect CFG250 OUTPUT connector to the distortion analyzer via a 50 Ω cable and a 50 Ω termination.

c. Connect CFG250 OUTPUT connector via a 50 Ω cable and a 50 Ω termination to the distortion analyzer input connectors.

d. ADJUST—Upper Sine Dis Adj (R43) and Lower Sine Dis Adj (R46) for less than 0.5% of distortion as read by the distortion analyzer.

e. CHECK—For less than 1% distortion for frequencies given in Table 5-3.

Table 5-3
2.0 Sine-Wave Distortion

RANGE (Hz)	FREQUENCY Control Setting	Distortion Analyzer Frequency	Percent Distortion
100K	2.0	200 kHz	< 1%
10K	2.0	20 kHz	< 1%
1K	2.0	2 kHz	< 1%
100	2.0	200 Hz	< 1%
10	2.0	20 Hz	< 1%

8. Adjust VCF Input (R10 and R18)

a. Set:

AMPLITUDE	MAX (fully clockwise)
RANGE (Hz)	100
FREQUENCY	0.2

b. Connect the digital multimeter common lead to the chassis and the positive lead to pin 3 of U1. Note the multimeter reading for use in part d.

c. Move the positive lead from pin 3 to pin 2 of U1.

d. ADJUST—Sym Adj (R10) so that the multimeter reading is the same as in part b.

e. Disconnect the multimeter from the instrument.

f. ADJUST—Sym Adj (R18) for less than 0.5% of distortion as read by the distortion analyzer.

g. CHECK—For less than 1% distortion for frequencies given in Table 5-4.

Table 5-4
0.2 Sine-Wave Distortion

RANGE (Hz)	FREQUENCY Control Setting	Distortion Analyzer Frequency	Percent Distortion
100K	0.2	20 kHz	< 1%
10K	0.2	2 kHz	< 1%
1K	0.2	200 kHz	< 1%
100	0.2	20 Hz	< 1%

9. Adjust Frequency Accuracy (R6)

a. Set:

RANGE (Hz)	100K
FUNCTION	⩘ button in
FREQUENCY	2.0

b. Connect CFG250 OUTPUT connector to the frequency counter via a 50 Ω cable and a 50 Ω termination.

c. ADJUST—Hi Freq Adj (R6) for a frequency counter reading between 190 kHz and 210 kHz.

d. CHECK—Output frequencies at 0.2 and 2.0 on the FREQUENCY control for RANGE (Hz) settings between 100K and 1 as given in Table 5-5.

Table 5-5
Accuracy of Frequency Ranges from 100K to 1

RANGE (Hz)	FREQUENCY Control	
	0.2	2.0
100K	10 kHz to 30 kHz	190 kHz to 210 kHz
10K	1.0 kHz to 3.0 kHz	19 kHz to 21 kHz
1K	100 Hz to 300 Hz	1.9 kHz to 2.1 kHz
100	10 Hz to 30 Hz	190 Hz to 210 Hz
10	1.0 Hz to 3.0 Hz	19 Hz to 21 Hz
1	0.10 Hz to 0.30 Hz	1.9 Hz to 2.1 Hz

e. Repeat parts c and d for all 2.0 FREQUENCY control settings as necessary.

10. Adjust 1 MHz Range Frequency (C8)

a. Set:

AMPLITUDE	MAX (fully clockwise)
RANGE (Hz)	1M
FREQUENCY	2.0

b. ADJUST—1 MHz Range Freq Adj (C8) for a frequency counter reading of between 1.9 MHz and 2.1 MHz.

c. Rotate the FREQUENCY control to 0.2 position.

d. CHECK—The frequency counter reads between 100 kHz and 300 kHz.

e. Repeat parts a to d as necessary.

f. Disconnect the test equipment from the instrument.

11. Adjust Square Wave Rise Time and Fall Time (C31)

a. Set:

AMPLITUDE	MAX (fully clockwise)
RANGE (Hz)	1M
FUNCTION	⊓⊔ button in
FREQUENCY	1.0

b. Connect CFG250 OUTPUT connector via a 50 Ω cable and a 50 Ω termination to vertical input of the test oscilloscope.

c. Set the test oscilloscope vertical deflection to 1 V per division. Adjust the vertical variable control for a 5-division display and set the sweep speed to 20-ns per division.

d. Set the test oscilloscope trigger to positive slope for a rise-time display.

e. Vertically position the trace so that the zero reference of the waveform touches the 0% graticule line and the top of the waveform touches the 100% graticule line.

f. ADJUST—2MHz Sq TRTF Adj (C31) for a square wave rise time of less than 100 ns.

g. Set the test oscilloscope trigger to negative slope for a fall-time display. Reposition the waveform on the screen if necessary.

h. CHECK—Square wave fall time is less than 100 ns.

i. Repeat parts d through i until square wave rise time and fall time is less than 100 ns.

j. Disconnect the test equipment from the instrument.

12. Check SYNC OUTPUT Amplitude

a. Connect the instrument SYNC OUTPUT connector to the test oscilloscope vertical input connector via a 50 Ω cable and a 50 Ω termination.

b. Set the test oscilloscope vertical deflection to 0.2 V per division.

c. CHECK—Display amplitude is 5-divisions or greater.

13. Check SYNC OUTPUT Rise Time

a. Set the test oscilloscope vertical deflection and variable control for an exact 5-division display. Set the sweep speed to 10-ns per division.

b. Set the test oscilloscope trigger to positive slope for a rise-time display.

c. Vertically position the trace so that the zero reference of the waveform touches the 0%

graticule line and the top of the waveform touches the 100% graticule line.

d. CHECK—The rise time is 25 ns or less between the 10% and 90% points of the TTL sync pulse.

e. Disconnect the test equipment from the instrument.

14. Check External Voltage Controlled Sweep Range

a. Set:

RANGE (Hz)	1K
FUNCTION	∿ button in
SWEEP	EXT
FREQUENCY	2.0

b. Connect CFG250 OUTPUT connector to the frequency counter via a 50 Ω cable and a 50 Ω termination.

c. Adjust the 0–20 V power supply to be connected to the instrument VCF connector for 0 volts out.

d. Connect the 0–20 V power supply to the instrument VCF INPUT connector via BNC female to dual banana adapter and a 50 Ω cable. Ensure the ground side of the BNC female to dual banana connector adapter goes to the – binding post of the power supply.

e. Increase the output voltage of the the 0–20 V power supply until the output frequency of the instrument decreases to 20 Hz as read on the frequency counter.

f. CHECK—The output voltage of the 0–20 V power supply is less than +10 V.

g. Disconnect the test equipment from the instrument.

MAINTENANCE

This section of the manual contains information on static-sensitive components, preventive maintenance, trouble-shooting, and corrective maintenance.

STATIC-SENSITIVE COMPONENTS

The following precautions apply when performing any maintenance involving internal access to the instrument.

CAUTION

Static discharge can damage any semiconductor component in this instrument.

This instrument contains electrical components that are susceptible to damage from static discharge. Table 6-1 lists the relative susceptibility of various classes of semiconductors. Static voltages of 1 kV to 30 kV are common in unprotected environments.

When performing maintenance, observe the following precautions to avoid component damage:

1. Minimize handing of static-sensitive components.
2. Transport and store static-sensitive components or assemblies in their original containers or on a metal rail. Label any package that contains static-sensitive components or assemblies.
3. Discharge the static voltage from your body by wearing a grounded antistatic wrist strap while handling these components. Servicing static-sensitive components or assemblies should be performed only at a static-free work station by qualified service personnel.
4. Keep anything capable of generating or holding a static charge off the work station surface.
5. Keep the component leads shorted together whenever possible.
6. Pick up components by their bodies, never by their leads.
7. Do not slide the components over any surface.
8. Avoid handling components in areas that have a floor or work-surface covering capable of generating a static charge.
9. Use a soldering iron that is connected to earth ground.
10. Use only approved antistatic, vacuum-type desoldering tools for component removal.

Table 6-1

Relative Susceptibility to Static-Discharge Damage

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

[a] Voltage equivalent for levels (voltage discharged from a 100-pF capacitor through a resistance of 100 Ω):

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

PREVENTIVE MAINTENANCE

Preventive maintenance consists of cleaning, inspection, and checking instrument performance. Preventive maintenance done on a regular basis may prevent some instrument problems and improve reliability. The required frequency of regular maintenance depends on the environment in which the instrument is used. A good time to do preventive maintenance is just before instrument adjustment.

INSPECTION AND CLEANING

Inspect and clean the CFG250 as often as operating conditions require. Dirt inside the instrument can cause overheating and component breakdown because dirt insulates and prevents heat dissipation. It also provides an electrical conduction path that could result in instrument failure, especially under high-humidity conditions.

CAUTION

Do not use chemical cleaning agents which might damage the plastics used in this instrument. Use a nonresidue-type cleaner, preferably isopropyl alcohol or a solution of 1% mild detergent and 99% water. Before using any other type of cleaner, consult your Tektronix Service Center or representative.

Exterior

INSPECTION. Inspect the external parts of the instrument for damage, wear, and missing parts; use Table 6-2 as a guide. Instruments that appear to have been dropped or abused should be checked for correct operation. Defects that could cause personal injury or could further damage the instrument should be repaired at once.

CAUTION

Do not allow moisture to get inside the instrument during external cleaning. Use only enough liquid to dampen the cloth or applicator.

CLEANING. Dust on the outside of the instrument can be removed with a soft cloth or small soft-bristle brush. The brush is useful on and around controls and connectors. Remove remaining dirt with a soft cloth dampened in a mild detergent-and-water solution. Do not use abrasive cleaners.

Interior

WARNING

To avoid electrical shock, disconnect the instrument from the ac power source before inspecting or cleaning the internal circuitry.

To clean or inspect the inside of the instrument, first refer to the removal and replacement instructions in the Corrective Maintenance part of this section.

INSPECTION. Inspect the internal parts of the CFG250 for damage and wear, using Table 6-3 as a guide. Repair any problems immediately. The repair method for most visible defects is obvious, but take particular care if heat-damaged components are found. Since overheating usually indicates other trouble in the instrument, the cause of overheating must be found and corrected to prevent further damage.

CAUTION

To prevent damage from electrical arcing, ensure that circuit boards and components are dry before applying power to the instrument.

CLEANING. To clean the interior, blow off dust with dry, low-pressure air (approximately 9 psi). Remove any remaining dust with a soft brush or a cloth dampened with a solution of mild detergent and water. A cotton-tipped applicator is useful for cleaning in narrow spaces and on circuit boards.

Semiconductor Checks

Periodic checks of the transistors and other semiconductors in this instrument are not recommended. The best check of semiconductor performance is actual operation in the instrument.

Table 6-2
External Inspection Checklist

Item	Inspect For	Repair Action
Front-panel buttons	Missing, damaged, or loose buttons.	Repair or replace missing or defective items.
Front-panel connectors	Broken shells, cracked insulation, and deformed contacts. Dirt in connectors.	Replace Front-Panel assembly or replace defective parts. Clean or wash out dirt.
Accessories	Missing items or parts of items, bent pins, broken or frayed cables, and damaged connectors.	Replace damaged or missing items, frayed cables, and defective parts.

Table 6-3
Internal Inspection Checklist

Item	Inspect For	Repair Action
Circuit Boards	Loose, broken, or corroded solder connections. Burned circuit boards. Burned, broken, or cracked circuit-run plating.	Replace circuit board assembly or repair as follows: Clean solder corrosion with an eraser and flush with isopropyl alcohol. Resolder defective connections. Determine cause of burned items and repair. Repair defective circuit runs.
Resistors	Burned, cracked, broken, or blistered.	Replace circuit board assembly or repair as follows: Replace defective resistors. Check for cause of burned component and repair as necessary.
Solder Connections	Cold solder or rosin joints.	Resolder joint and clean with isopropyl alcohol.
Capacitors	Damaged or leaking cases. Corroded solder on leads or terminals.	Replace circuit board assembly or repair as follows: Replace defective capacitors. Clean solder connections and flush with isopropyl alcohol.
Semiconductors	Loosely inserted in sockets. Distorted pins.	Firmly seat loose semiconductors. Remove devices having distorted pins. Carefully straighten pins (as required to fit the socket), using long-nose pliers, and reinsert firmly. Ensure that straightening action does not crack the pins, causing them to break.
Wiring and Cables	Loose plugs or connectors. Burned, broken, or frayed wiring.	Firmly seat connectors. Repair or replace defective wires or cables, or replace the assembly.
Chassis	Dents, deformations, and damaged hardware.	Replace defective assembly or straighten, repair, or replace defective hardware.

TROUBLESHOOTING

Preventive maintenance done on a regular basis should reveal most potential problems before an instrument fails. However, should troubleshooting be needed, the following information will help to locate the problem. Also, the Theory of Operation and the Diagrams sections of this manual may help with troubleshooting.

TROUBLESHOOTING AIDS

Schematic Diagram

A schematic diagram is located on a tabbed foldout page in the Diagrams section. Portions of circuitry mounted on each circuit board are enclosed by heavy black lines. The assembly number and name(s) of the circuit(s) are shown near the top or the bottom edge of the diagram.

Functional blocks on the schematic diagram are outlined with a wide gray line. Components within the outlined area perform the function named by the block label. The Theory of Operation uses these functional block names when describing circuit operation.

Component numbers and electrical values of components in this instrument are shown on the schematic diagram. Refer to the first page of the Diagrams section for the reference designators and symbols used to identify components. Important voltages are also shown on the diagram.

Circuit Board Illustrations

Circuit board illustrations in the Diagrams section show the physical location of each component.

Grid Coordinate System

The schematic diagram and circuit board illustrations have grid borders along their left and top edges. The grid coordinates for the components are given in an accompanying table.

Component Color Coding

An illustration at the beginning of the Diagrams section gives information about color codes and markings on resistors and capacitors.

RESISTORS. Resistors used in this instrument are carbon-film, composition, or precision metal-film types. They are usually color coded with the EIA color code; however, some metal-film type resistors may have the value printed on the body. The color code is interpreted starting with the stripe nearest to one end of the resistor. Composition resistors have four stripes; these represent two significant digits, a multiplier, and a tolerance value. Metal-film resistors have five stripes representing three significant digits, a multiplier, and a tolerance value.

CAPACITORS. Common disc capacitors and small electrolytics have capacitance values marked on the side of the capacitor body. White ceramic capacitors are color coded in picofarads, using a modified EIA code. Dipped tantalum capacitors are color coded in microfarads. The color dot indicates both the positive lead and the voltage rating. Since these capacitors are easily destroyed by reversed or excessive voltage, be careful to observe the polarity and voltage rating when replacing them.

DIODES. The cathode end of each glass-encased diode is indicated by either a stripe, a series of stripes, or a dot. The cathode and anode ends of a metal-encased diode may be identified by the diode symbol marked on its body.

Semiconductor Lead Configurations

The second figure in the Diagrams section shows some typical lead configurations for semiconductor devices that may be used in this instrument. If a semiconductor does not seem to match the configurations shown, consult a manufacturer's data sheet.

TROUBLESHOOTING TECHNIQUES

When troubleshooting the CFG250, be sure to read the troubleshooting techniques given here before going on to CFG250 Troubleshooting Tips. The troubleshooting methods described in this procedure are general techniques that should be used together with the more specific CFG250 Troubleshooting Tips.

This procedure is arranged to check simple trouble possibilities before doing more extensive troubleshooting.

When the defective component is located, either replace the assembly containing the defective part or replace the component by using the appropriate replacement procedure given under Corrective Maintenance. Replacement assemblies are available through Tektronix and are shown in an exploded-view drawing in Replaceable Parts (section 8) and are described in the parts list in that section.

CAUTION

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

1. Check Control Settings

Incorrect control settings can give a false indication of instrument malfunction. If there is any question about the correct function or operation of any control, refer to the CFG250 Operators Manual.

2. Check Associated Equipment

Before proceeding, ensure that any equipment used with the CFG250 is operating correctly. Verify that input signals are properly connected and that the interconnecting cables are not defective. Check that the ac-power-source voltage to all equipment is correct.

3. Visual Check

WARNING

To avoid electrical shock, disconnect the instrument from the ac power source before making a visual inspection of the internal circuitry.

Look for broken connections or wires, damaged components, semiconductors not firmly mounted, damaged circuit boards, or other clues to the cause of a malfunction.

4. Check Instrument Performance and Adjustment

Check the performance of either those circuits where you suspect trouble or the entire instrument. An apparent trouble may be the result of misadjustment. The Performance Check is in section 4 of this manual, and the Adjustment Procedure in section 5.

5. Isolate Trouble to a Circuit

To isolate problems, use any symptoms noticed when checking the instrument's operation to help localize the trouble to a particular circuit. The CFG250 Troubleshooting Tips, following this procedure, may help in locating a problem.

6. Check Individual Components

WARNING

To avoid electrical shock, always disconnect the instrument from the ac power source before removing or replacing components.

The following procedures describe methods of checking individual components. Two-lead components that are soldered in place are most accurately checked by first disconnecting one end from the circuit board. This isolates the measurement from the effects of the surrounding circuitry. See Figure 9-1 for component value identification and Figure 9-2 for semiconductor lead configurations.

CAUTION

When checking semiconductors, observe the static-sensitivity precautions given at the beginning of this section.

TRANSISTORS. A good check of a transistor is actual performance under operating conditions. A transistor can most effectively be checked by substituting a known-good component. However, be sure that circuit conditions are not such that a replacement transistor will also be damaged. If substitute transistors are not available, use a dynamic-type transistor checker for testing. Static-type transistor checks are not recommended, since they do not check operation under simulated operating conditions.

When troubleshooting transistors in the circuit with a voltmeter, measure both the emitter-to-base and emitter-to-collector voltages to find out if they are consistent with normal circuit voltages. Voltages across a transistor may vary with the type of device and its circuit function.

Some of these voltages are predictable. The emitter-to-base voltage for a conducting silicon transistor will normally range from 0.6 V to 0.8 V. The emitter-to-collector voltage for a saturated transistor is about 0.2 V. Because these values are small, the best way to check them is by connecting a sensitive voltmeter across the junction rather than comparing two voltages taken with respect to ground. If the former method is used, both leads of the voltmeter must be isolated from ground.

If voltage values measured are less than those just given, either the device is shorted or no current is flowing in the external circuit. If values exceed the emitter-to-base values given, either the junction is reverse biased or the device is defective. Voltages exceeding those given for typical emitter-to-collector values could indicate either a nonsaturated device operating normally or a defective (open-circuited) transistor. If the device is conducting, voltage will be developed across the resistors in series with it; if open, no voltage will be developed across the resistors unless current is being supplied by a parallel path.

CAUTION

When checking emitter-to-base junctions, do not use an ohmmeter range that has a high internal current. High current may damage the transistor. Reverse biasing the emitter-to-base junction with a high current may degrade the current-transfer ratio (Beta) of the transistor.

A transistor emitter-to-base junction also can be checked for an open or shorted condition by measuring the resistance between terminals with an ohmmeter set to a range having a low internal source current, such as the R X 1 kΩ range. The junction resistance should be very high in one direction and much lower when the meter leads are reversed.

When troubleshooting a field-effect transistor (FET), the voltage across its elements can be checked in the same manner as previously described for other transistors. However, remember that in the normal depletion mode of operation, the gate-to-source junction is reverse biased; in the enhanced mode, the junction is forward biased.

INTEGRATED CIRCUITS. An integrated circuit (IC) can be checked with a voltmeter, test oscilloscope, or by direct substitution. A good understanding of circuit operation is essential when troubleshooting a circuit having IC components. Use care when checking voltages and waveforms around the IC so that adjacent leads are not shorted together. An IC test clip provides a convenient means of clipping a test probe to an IC.

CAUTION

When checking a diode, do not use an ohmmeter scale that has a high internal current. High current may damage a diode. Checks on diodes can be performed in much the same manner as those on transistor emitter-to-base junctions.

DIODES. A diode can be checked for either an open or a shorted condition by measuring the resistance between terminals with an ohmmeter set to a range having a low internal source current, such as the R X 1 kΩ range. The diode resistance should be very high in one direction and much lower when the meter leads are reversed.

Silicon diodes should have 0.6 V to 0.8 V across their junctions when conducting; Schottky diodes about 0.2 V to 0.4 V. Higher readings indicate that they are either reverse biased or defective, depending on polarity.

RESISTORS. Check resistors with an ohmmeter. Refer to the Replaceable Parts list for the tolerances of resistors used in this instrument. A resistor normally does not require replacement unless its measured value varies widely from its specified value and tolerance.

INDUCTORS. Check for open inductors by checking continuity with an ohmmeter. Shorted or partially shorted inductors can usually be found by checking the waveform response when high-frequency signals are passed through the circuit.

CAPACITORS. A leaky or shorted capacitor can be detected by checking resistance with an ohmmeter set to one of the highest ranges. Do not exceed the voltage rating of the capacitor. The resistance reading should be high after the capacitor is charged to the output voltage of the ohmmeter. An open capacitor can be detected with a capacitance meter or by checking whether the capacitor passes ac signals.

7. Repair and Adjust the Circuit

If any defective parts are located, follow the replacement procedures given under Corrective Maintenance in this section. After any electrical component has been replaced, the performance of that circuit and any other closely related circuit should be checked. Since the power supplies affect all circuits, performance of the entire instrument should be checked if work has been done on the power supplies. Refer to the Performance Check Procedure and the Adjustment Procedure, sections 4 and 5 in this manual.

CFG250 TROUBLESHOOTING TIPS

NOTE

Check resistors with an ohmmeter. Refer to the Replaceable Parts list for the tolerances of resistors used in this instrument. Refer to the parts list or schematic for component values. Also refer to Troubleshooting Techniques in this section for more detailed troubleshooting methods. Voltages given in troubleshooting Tips procedure are not absolute and may vary between instruments.

No Output Waveforms

1. Check that the power cord is connected to a suitable ac-power source.
2. Check LINE VOLTAGE SELECT switches are set to correct line voltage.
3. Check line fuse FS3 for open.
4. Check for correct initial front panel control settings.
5. Check the power supply for the following voltages:
   a. Check for unregulated +30 V at the cathodes of D53 and D55.
   b. Check for +15 V at the mounting screw of Q15.
   c. Check for +5 V at pin 14 of U6.
   d. Check for −15 V at pin 4 of U2.
   e. Check for unregulated −30 V at the mounting screw of Q16.
6. Check for waveforms at the junction R95, R96, and R98.
7. Check dc offset is set at 0 V.
8. Check at the base of Q9 for waveforms.
9. Check AMPLITUDE control and FUNCTION switches for continuity.

No Triangle Wave Output

1. Check pin 10 of U5 for a 1 V p-p triangle wave.
2. Check Q5 gate for about 2.4 V p-p triangle wave.
3. Check RANGE (Hz) switches for proper operation.
4. Rotate the FREQUENCY control from 2.0 to 0.2 and check for the following voltage changes.
   a. Dc voltage level at pins 3 and 6 of U3 varies from +7.4 V to +14 V.
   b. Dc voltage level at pins 3 and 6 of U4 varies from -7.4 V to -14 V.
   c. Dc voltage level at pin 6 of U1 varies from +1.8 V to +0.67 V.
   d. Dc voltage level at pin 6 of U2 varies from -1.8 V to -0.67 V.
5. Set the FREQUENCY control to 0.2. Check that the voltage levels at pins 2 of U1 and U2 are the same.
6. Check the center tap of the FREQUENCY control for a voltage change from -1.8 V to 0 V.

No Sine Wave Output

1. Check pin 12 of U7 for a 2 V p-p sine wave.
2. Check for sine wave at the junction of R68 and R69.
3. Check for defective diodes D36 through D47.
4. Check Sine-Wave Generator side of R57 for triangle wave.

No Square Wave Output

1. Check for 2 V p-p square wave at the FUNCTION switches side of R56.
2. Check collectors of Q6 and Q7 for 2 V p-p square wave.
3. Check pin 4 of U5 for 0.5 V p-p square wave.
4. Check pins 1 and 5 of U5 for 0.3 V p-p square wave.
5. Check pin 10 of U5 for 1 V p-p triangle wave.

No Sweep Function Output

1. Check for sawtooth signal at R1.
2. Check pin 6 of U10 for sawtooth signal from +1.2 V to -10 V.
3. Check pin 1 of U9 for a sawtooth signal from +10 V to -1.2 V.
4. Check pin 5 of U9 for +10 V square pulse.
5. Check resistors R105 through R108 for correct values.

CORRECTIVE MAINTENANCE

The Corrective maintenance part of the manual describes methods and procedures for disassembly, parts replacement, and repair. If it is necessary to ship your instrument to a Tektronix Service Center for repair or service, refer to the repackaging information in this section.

MAINTENANCE PRECAUTIONS

To avoid personal injury or damage to equipment, observe the following precautions:

- Disconnect the instrument from the ac-power source before removing or installing components.
- Verify that any line-rectifier filter capacitors are discharged before doing any servicing.
- Use care not to interconnect instrument grounds which may be at different potentials (cross grounding).
- When soldering on circuit boards or small insulated wires, use only a 15-watt, pencil-type soldering iron.

OBTAINING REPLACEMENT PARTS

Replacement assemblies for this instrument (Cabinet, Front Panel, Rear Panel, Main board, and Switch board) can be obtained from through your local Tektronix Field Office or representative. The CFG250 assemblies and their Tektronix part numbers are shown in the exploded-view drawing in section 8 of this manual.

The Replaceable Parts list in section 8 gives Tektronix part number, name and description of the instrument assemblies and lists mechanical and electrical parts in each assembly. The Replaceable Part list gives a generic description (value, rating, and tolerance) of the individual parts for each assembly. The Replaceable parts list is useful if a component is obtained from a local commercial source.

NOTE

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

Ordering Parts

When ordering parts from Tektronix, Inc., be sure to include the following information:

- Instrument type (include all modification and option numbers).
- Instrument serial number.
- A description of the part.
- Tektronix part number.

REPACKAGING FOR SHIPMENT

Save the original carton and packing material for reuse if the instrument should have to be reshipped on a commercial transport carrier. If the original materials are unfit or not available, repackage the instrument as follows:

1. Use a corrugated cardboard shipping carton with a test strength of at least 200 pounds and with an inside dimension at least six inches greater than the instrument dimensions.
2. If the instrument is being shipped to a Tektronix Service Center, enclose the following: the owner's address, name and phone number of a contact person, type and serial number of the instrument, reason for returning, and a complete description of the service needed.
3. Completely wrap the instrument with polyethylene sheeting or equivalent to protect the outside finish and prevent entry of foreign material into the instrument.
4. Cushion the instrument on all sides, using three inches of padding material or urethane foam tightly packed between the carton and the instrument.
5. Seal the shipping carton with an industrial stapler or strapping tape.
6. Mark the address of the Tektronix Service Center and also your own return address on the shipping carton.

MAINTENANCE AIDS

The maintenance aids recommended in Table 6-4 include items that may be needed for instrument maintenance and repair. Equivalent products may be substituted if their characteristics are similar.

Table 6-4
Maintenance Aids

Description	Specification	Usage	Example
Soldering Iron	15 to 25 W.	General soldering and unsoldering.	Antex Precision Model C.
Nutdrivers	1/4.	Assembly and disassembly.	Xcelite #8.
Phillips Screwdriver		Assembly and disassembly.	
Open-end Wrench	1/4 inch, 7/16 inch	Assembly and disassembly.	
Long-nose Pliers		Component removal and replacement.	Diamalloy Model LN55-3.
Diagonal Cutters		Component removal and replacement.	Diamalloy Model M554-3.
Vacuum Solder Extractor	No Static Charge Retention.	Unsoldering components.	Pace Model PC-10.
Contact Cleaner	No-Noise.®	Switch lubrication.	Tektronix Part Number 006-0442-02.
IC-removal Tool		Removing DIP IC	Augat T114-1.
Isopropyl Alcohol	Reagent grade.	Cleaning.	2-Isopropanol.

INTERCONNECTIONS

Pin connectors used to connect the wires to the interconnect pins are factory assembled. They consist of machine-inserted pin connectors mounted in plastic holders. If the connectors are faulty, the entire assembly should be replaced.

TRANSISTORS AND INTEGRATED CIRCUITS

Transistors and integrated circuits should not be replaced unless they are actually defective. If one is removed from its socket or unsoldered from the circuit board during routine maintenance, return it to its original board location. Unnecessary replacement or transposing of semiconductor devices may affect the adjustment of the instrument. When a semiconductor is replaced, check the performance of any circuit that may be affected.

Any replacement component should be of the original type or a direct replacement. Bend component leads to fit their circuit board holes, and cut the leads to the same length as the original component. See Figure 9-2 in the Diagrams section for the semiconductor lead configurations.

CAUTION

After replacing a power transistor, check that the collector is not shorted to the chassis before applying power to the instrument.

To remove socketed dual-in-line packaged (DIP) integrated circuits, pull slowly and evenly on both ends of the device. Avoid disengaging one end of the integrated circuit from the socket before the other, since this may damage the pins.

To remove a soldered DIP IC when it is going to be replaced, clip all the leads of the device and remove the leads from the circuit board one at a time. If the device must be removed intact for possible reinstallation, do not heat adjacent conductors consecutively. Apply heat to pins at alternate sides and ends of the IC as solder is removed. Allow a moment for the circuit board to cool before proceeding to the next pin.

SOLDERING TECHNIQUES

The reliability and accuracy of this instrument can be maintained only if proper soldering techniques are used to remove or replace parts. General soldering techniques that apply to maintenance of any precision electronic equipment should be used when working on this instrument.

WARNING

To avoid an electrical shock hazard, observe the following precautions before attempting any soldering: turn the instrument off, disconnect it from the ac power source, and wait at least three minutes for line-rectifier filter capacitors to discharge.

Use rosin-core wire solder containing 63% tin and 37% lead. Contact your local Tektronix Field Office or representative to obtain the names of approved solder types.

When soldering on circuit boards or small insulated wires, use only a 15-watt, pencil-type soldering iron. A higher wattage soldering iron may cause etched circuit conductors to separate from the board base material and melt the insulation on small wires. Always keep the soldering iron tip properly tinned to ensure the best heat transfer from the tip to the solder joint. Apply only enough solder to make a firm joint. After soldering, clean the area around the solder connection with an approved flux-removing solvent (such as isopropyl alcohol) and allow it to air dry.

CAUTION

Only a maintenance person experienced in the use of vacuum-type desoldering equipment should attempt repair of any circuit board in this instrument. Many integrated circuits are static sensitive and may be damaged by solder extractors that generate static charges. Perform work involving static-sensitive devices only at a static-free work station while wearing a grounded antistatic wrist strap. Use only an antistatic vacuum-type solder extractor approved by a Tektronix Service Center.

CAUTION

Attempts to unsolder, remove, and resolder leads from the component side of a circuit board may cause damage to the reverse side of the circuit board. The following techniques should be used to replace a component on a circuit board:

1. Touch the vacuum desoldering tool tip to the lead at the solder connection. Never place the tip directly on the board; doing so may damage the board.

NOTE

Some components are difficult to remove from the circuit board due to a bend placed in the component leads during machine insertion. To make removal of machine-inserted components easier, straighten the component leads on the reverse side of the circuit board.

2. When removing a multipin component, especially an IC, do not heat adjacent pins consecutively. Apply heat to the pins at alternate sides and ends of the IC as solder is removed. Allow a moment for the circuit board to cool before proceeding to the next pin.

CAUTION

Excessive heat can cause the etched circuit conductors to separate from the circuit board. Never allow the solder extractor tip to remain at one place on the board for more than three seconds. Solder wick, spring-actuated or squeeze-bulb solder suckers, and heat blocks (for desoldering multipin components) must not be used. Damage caused by poor soldering techniques can void the instrument warranty.

3. Bend the leads of the replacement component to fit the holes in the circuit board. If the component is replaced while the board is installed in the instrument, cut the leads so they protrude only a small amount through the reverse side of the circuit board. Excess lead length may cause shorting to other conductive parts.

4. Insert the leads into the holes of the board so that the replacement component is positioned the same as the original component. Most components should be firmly seated against the circuit board.

5. Touch the soldering iron tip to the connection and apply enough solder to make a firm solder joint. Do not move the component while the solder hardens.

6. Cut off any excess lead protruding through the circuit board (if not clipped to the correct length in step 3).

7. Clean the area around the solder connection with an approved flux-removing solvent. Be careful not to remove any of the printed information from the circuit board.

REMOVAL AND REPLACEMENT INSTRUCTIONS

WARNING

To avoid electrical shock, disconnect the instrument from the power input source before removing or replacing any component or assembly.

The exploded-view drawings in the Replaceable Parts list may be helpful during removal and replacement procedure. Component locations are shown in the Diagram section.

Read these instructions before attempting to remove or install any assemblies or components.

Cabinet Assembly

The removal procedure for the cabinet assembly is divided into two parts. the first part removes the top cabinet for servicing the top portion of the instrument. The second part describe how to remove the bottom cabinet from the instrument.

To remove the Cabinet Assembly from the instrument perform the following procedure:

1. Unplug the power cord from its rear-panel connector.

2. Place the instrument upside down on a clean, flat surface.

NOTE

Do not remove the two front rubber pads from the bottom cabinet.

3. Remove the four cabinet-securing screws from the bottom of the instrument. The two front screws are located between the two front feet and the edge of the bottom cabinet. The two rear screws secure the rear rubber pads to the bottom cabinet. Remove the rear pads that are loose and save for reinstallation.

WARNING

Potentially dangerous voltages exist at several points throughout this instrument. If it is operated with the covers removed, do not touch exposed connections or components. Before replacing parts, disconnect the ac-power source from the instrument.

4. Remove the bottom cabinet and handle from the instrument.

NOTE

Removal of the bottom cabinet and handle will access the component side of the circuit boards and internal adjustments (see the Adjustment Procedure in section 5).

5. Remove four support posts (one at each corner) and one screw (middle of the Main board) near the rear-panel mounted transformer securing the Main board to the top cabinet.

6. Remove Rear-Panel and Front-Panel Assemblies from the slots in the top cabinet.

7. Remove the top cabinet from the instrument.

To reinstall the Cabinet Assembly, perform the reverse of the preceding steps.

Front-Panel Assembly

The Front-Panel Assembly can be removed and reinstalled a follows:

1. Perform the Cabinet Assembly removal procedure steps 1 through 7.

2. Disconnect the following connectors from the Main board, noting their locations for reinstallation reference:

   a. J1, a three-wire connector located at the left edge of the Main board.

   b. J2, a six-wire connector located at the left edge of the Main board.

   c. J3, a three-wire connector located at the left side of the Main board.

   d. J4, a two-wire connector located at the right side of the Main board.

   e. J5, a four-wire connector located at the right side of the Main board.

3. Remove two screws securing the POWER switch to the Front-Panel Assembly. Pull the Power switch button out of the Front-Panel Assembly hole.

4. Remove the screw securing the ground lug and ground wire to the Front-Panel Assembly ground post.

5. Disconnect the left-center connector (three wires) from the Switch board.

NOTE

The left-center connector is part of the Main board assembly. Remove the tiedown strap that secures the left-center connector wires to the Front-Panel assembly wiring harness.

6. Remove the left-center connector wires from the Front-Panel assembly wiring harness.

7. Unsolder the two coaxial cables from the right-rear sides of the Main board to the six-wire connector on the Switch board.

8. Remove the Front-Panel Assembly away from the Main Assembly.

To reinstall the Front-Panel Assembly, perform the reverse of the preceding steps.

Switch Board

The Switch Board Assembly can be removed and reinstalled a follows:

1. Perform the Cabinet Assembly removal procedure steps 1 through 4.

2. Remove all four connectors from the Switch board, noting their location for reinstallation reference.

3. Unsolder the wire from G11 solder pad at the left rear corner of the Switch board.

4. Remove the two top screws that secures the Switch board to the Front-Panel Assembly. Remove the Switch board from the instrument.

To reinstall the Switch Board Assembly, perform the reverse of the preceding steps.

Rear-Panel Assembly

The Front-Panel Assembly can be removed and reinstalled a follows:

1. Perform the Cabinet Assembly removal procedure steps 1 through 6.

2. Perform the Front-Panel Assembly removal procedure steps 3 and 4.

3. Disconnect J6, six-wire connector located at the middle of the Main board near fuses FS1 and FS2.

4. Unsolder two wires from VCF INPUT connector at the G9 and ground pads on the Main board.

5. Unsolder the green wire from the Rear Assembly ground lug at the ground pad on the Main board. The ground pad is located on the right side of the Main board near the power transformer.

6. Remove the Rear-Panel Assembly away from the Main Assembly.

To reinstall the Rear-Panel Assembly, perform the reverse of the preceding steps.

Main Board

The Main Board Assembly can be removed and reinstalled a follows:

1. Perform the Cabinet Assembly removal procedure steps 1 through 6.

2. Perform the Front-Panel Assembly removal procedure steps 1 through 8.

3. Perform the Rear-Panel Assembly removal procedure steps 1 through 6.

To reinstall the Main Board, perform the reverse of the preceding steps.

NOTE

When replacing assemblies in the instrument replace any tiedown straps that was clipped during disassembly.

OPTIONS

INTERNATIONAL POWER CORDS

Instruments are shipped with the detachable power cord option ordered by the customer. Descriptive information about international power cord options is given in Section 2. The following list describes the power cords available for this instrument.

Standard	North American, 120 V
Option A1	Universal Euro, 220 V
Option A2	UK, 240 V
Option A3	Australian, 240 V
Option A4	North American, 240 V
Option A5	Switzerland, 220 V

REPLACEABLE 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.

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.

FIGURE AND INDEX NUMBERS

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

INDENTATION SYSTEM

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

1 2 3 4 5   Name & Description

Assembly and/or Component
Attaching parts for Assembly and/or Component
**** END ATTACHING PARTS ****
  Detail Part of Assembly and/or Component
  Attaching parts for Detail Part
  **** END ATTACHING PARTS ****
    Parts of Detail Part
    Attaching parts for Parts of Detail Part
    **** END ATTACHING PARTS ****

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.

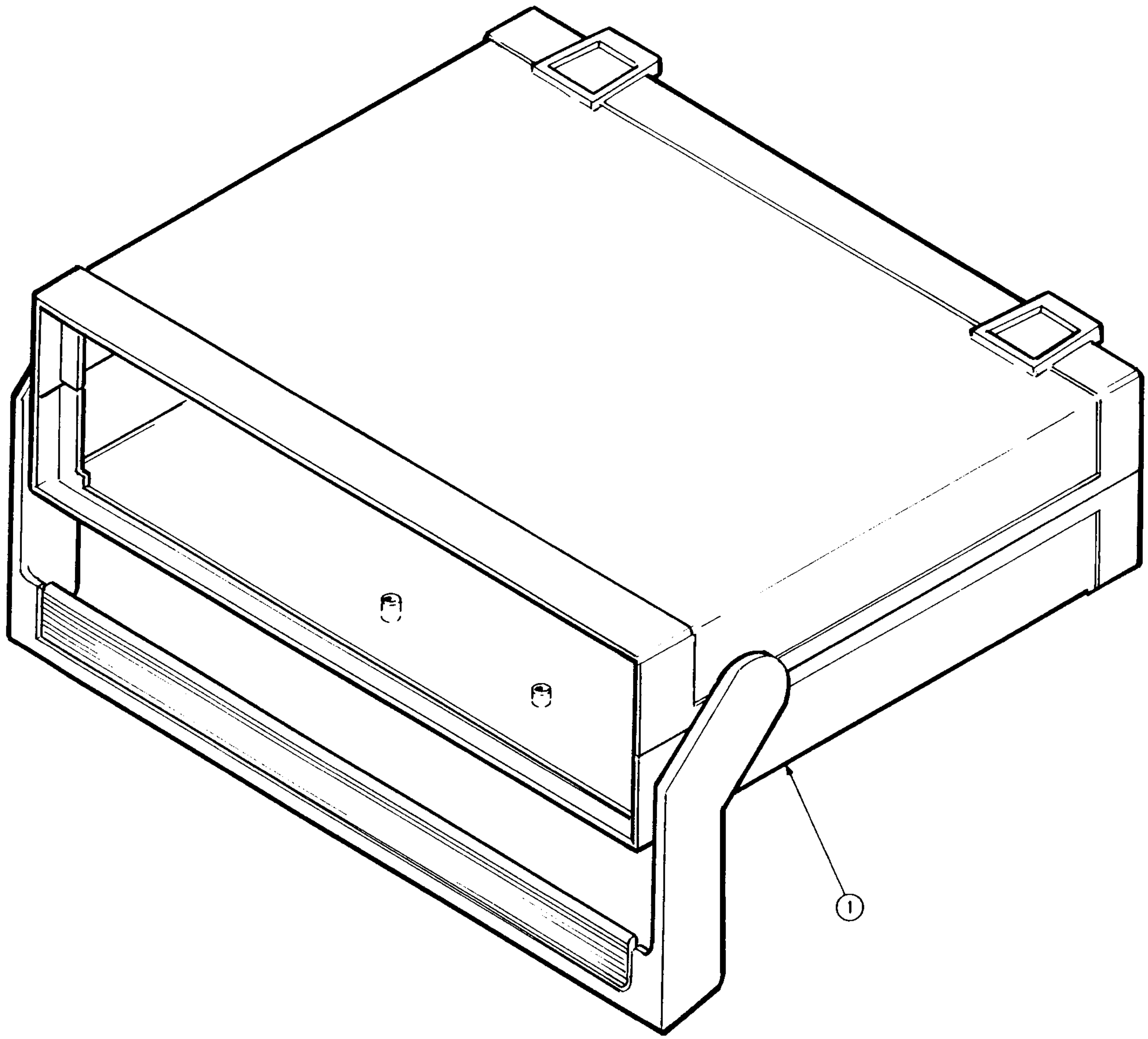
ABBREVIATIONS

"	INCH	ELCTRN	ELECTRON	IN	INCH	SE	SINGLE END
#	NUMBER SIZE	ELEC	ELECTRICAL	INCAND	INCANDESCENT	SECT	SECTION
ACTR	ACTUATOR	ELCTLT	ELECTROLYTIC	INSUL	INSULATOR	SEMICOND	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	SLEEVING
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

CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
	ESCORT	2ND FLOOR NO.37 POA HSIN RD SHIN TIEN	TAI PEI, TAIWAN
80009	TEKTRONIX INC	14150 SW KARL BRAUN DR PO BOX 500	BEAVERTON OR 97707-0001

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
1-1	118-7936-00			1	CABINET ASSY:	80009	118-7936-00
					CASE,TOP: (QTY. 1)		15-25585-6
					.WTIH SHIELDING FOIL ATTACHED		11-25005-1
					CASE,BOTTOM: (QTY. 1)		15-25585-6A
					HANDLE: (QTY. 1)		15-25598-4
					FOOT,FRONT: (QTY. 2)		16-25593-5
					SCREW,PLASTIC; (QTY. 2)		15-25047-1
					POST,INSERT: (QTY. 4)		3-25595-1
					FOOT,REAR:BLACK (QTY. 2)(348-1105-00)		16-25593-6



CFG250

FIG. 1 CABINET

Scan by Zenith

CFG250

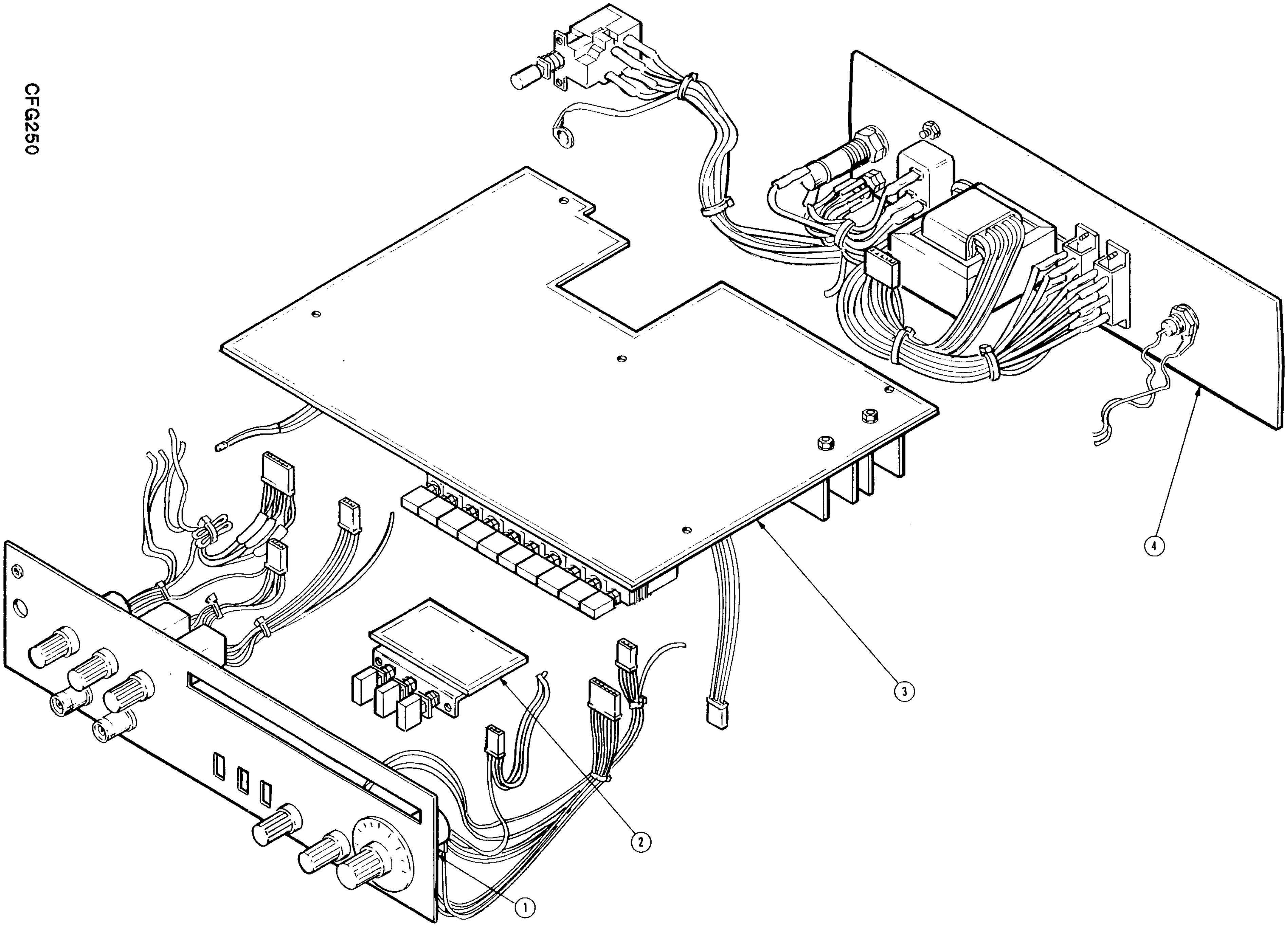


Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
2-1	118-7937-00			1	FRONT PNL ASSY:	80009	118-7937-00
					FRONT PANEL: (QTY. 1)		1-25002-4
					CFG250 OVERLAY: (QTY. 1)		24-25107-1
					HOLDER,LED: (QTY. 1)		15-25489-1
					SOCKET,BNC:W/NUT (QTY. 3)		30-25437-1
					SWITCH,PUSH:10 POLE,INTERLOCK (QTY. 1)		80-25588-2
					BUTTON:GY,RECTANGULAR(QTY. 10)(134-0211-00)		15-25426-5
					KNOB:DOVE GRAY,94HB (QTY. 5)(366-0701-00)		15-25713-4
					KNOB:DOVE GRAY,94HB (QTY. 1)		15A-25717-3
-2	118-7940-00			1	CIRCUIT BD ASSY:SWITCH	80009	118-7940-00
					CIRCUIT BD ASSY:SWITCH (QTY. 1)		25-25020-1A
					SOCKET:3 POSITION (QTY. 2)		30-2210T-4
					SOCKET:4 POSITION (QTY. 1)		30-2210T-2
					SOCKET:6 POSITION (QTY. 1)		30-2210T-3U
					WAFER:3 POSITION (QTY. 2)		30-25663-3
					WAFER:4 POSITION (QTY. 1)		30-25663-4
					WAFER:6 POSITION (QTY. 1)		30-25663-6
					SWITCH,PUSH:3 POLE,PUSH-PUSH (QTY. 1)		80-25598-1
					PIN:2.4 (QTY. 1)		30-25628-4
					BUTTON:GY,RECTANGULAR(QTY. 3)(134-0211-00)		15-25426-5
-3	118-7939-00			1	CIRCUIT BD ASSY:MAIN	80009	118-7939-00
					CAPACITOR:10UF,+80/-20%,25V (C20,21,33,34,37,38,50)		31-106Z25-2
					CAP:220UF,+80/-20%,35V (C19,46,48,97,100)		31-227Z35-2
					CAPACITOR:1000UF,+80/-20%,35V (C41,43)		31-108Z35-2
					CAPACITOR:100PF,5%,500V (C2,3)		31-101J500-3
					CAPACITOR:0.01UF,10%,100V (C23,24,39,40,40,44,47,49)		31-103K100-3
					CAPACITOR:0.047UF,+80/-20%,50V (C1,4,18,22,35,36)		31-473Z50-3
					CAPACIATOR:100UF (C15)		
					CAPACITOR:1.5PF,+/-0.25PF,50V (C30)		31-1R5Y50-3N
					CAPACITOR:5PF,+/-0.25PF,50V (C28,26)		31-5R0Y50-3N
					CAPACITOR:22PF,10%,50V (C25)		31-220K50-3N
					CAPACITOR:29PF,10%,50V (C27,29)		31-390K50-3N
					CAPACITOR:56PF,10%,50V (C16)		31-560K50-3N
					CAPACITOR:68PF,10%,50V (C7)		31-680K50-3N
					CAPACITOR:0.01UF,2%,630V (C10)		31-103G630-4M
					CAPACITOR:0.1UF,2%,100V (C11)		31-104G100-4M
					CAPACITOR:0.33UF,10%,100V (C45)		31-334K100-4M
					CAPACITOR:1.0UF,2%,250V (C12)		31-105G250-4M
					CAPACITOR:10UF,10%,25V (C17)		31-106K25-6
					CAPACITOR:0.001UF,2%,50V (C9)		31-102G50-8
					TRIMMER:2-8PF (C31)		32-25559-1
					TRIMMER:6-70PF (C8)		32-25401-1
					RESISTOR:15 OHM,5%,1W (R93,94)		33-150J1-5
					RESISTOR:47 OHM,5%,2W (R97,100)		33-470J2-5
					RESISTOR:51 OHM,5%,1/2W (R99)		33-510J2T-3
					RESISTOR:100 OHM,5%,1W (R95,96)		33-101J1-5
					RESISTOR:470 OHM,5%,1/2W (R98)		33-471J2T-3
					RESISTOR:49.9 OHM,1%,1/8W (R57)		33-49R9F8T-6DT
					RESISTOR:63.4 OHM,1%,1/8W (R69)		33-63R4F8T-6DT
					RESISTOR:127 OHM,1%,1/8W (R66)		33-1270F8T-6DT
					RESISTOR:162 OHM,1%,1/8W (R79)		33-1620F8T-6DT
					RESISTOR:200 OHM,1%,1/8W (R63)		33-2000F8T-6DT
					RESISTOR:309 OHM,1%,1/8W (R60)		33-3090F8T-6DT
					RESISTOR:316 OHM,1%,1/8W (R88)		33-3160F8T-6DT
					RESISTOR:348 OHM,1%,1/8W (R23,28)		33-3480F8T-6DT
					RESISTOR:499 OHM,1%,1/8W (R42)		33-4990F8T-6DT
					RESISTOR:1K OHM,1%,1/8W (R12,14,35,36,119)		33-1001F8T-6DT
					RESISTOR:2K OHM,1%,1/8W (R39,78)		33-2001F8T-6DT
					RESISTOR:2.26K OHM,1%,1/8W (R86)		33-2261F8T-6DT
					RESISTOR:3.01K OHM,1%,1/8W (R11,19)		33-3011F8T-6DT
					RESISTOR:4.02K OHM,1%,1/8W (R37,38)		33-4021F8T-6DT
					RESISTOR:4.99K OHM,1%,1/8W (R21,26)		33-4991F8T-6DT
					RESISTOR:7.15K OHM,1%,1/8W (R22,27)		33-7151F8T-6DT
					RESISTOR:7.5K OHM,1%,1/8W (R52)		33-7501F8T-6DT
					RESISTOR:10K OHM,1%,1/8W (R41,58)		33-1002F8T-6DT
					RESISTOR:10.5K OHM,1%,1/8W (R54,55)		33-1052F8T-6DT

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
2-					RESISTOR:11K OHM,1%,1/8W (R102,103)		33-1102F8T-6DT
					RESISTOR:11.3K,1%,1/8W (R59)		33-1132F8T-6DT
					RESISTOR:12.1K,1%,1/8W (R61,62)		33-1212F8T-6DT
					RESISTOR:13K,1%,1/8W (R44,45)		33-1302F8T-6DT
					RESISTOR:18.2K,1%,1/8W (R87)		33-1822F8T-6DT
					RESISTOR:24.9K,1%,1/8W (R64,65)		33-2492F8T-6DT
					RESISTOR:30.1K,1%,1/8W (R40)		33-3012F8T-6DT
					RESISTOR:33.2K,1%,1/8W (R9)		33-3322F8T-6DT
					RESISTOR:49.9K,1%,1/8W (R17)		33-4992F8T-6DT
					RESISTOR:75K,1%,1/8W (R24,29)		33-7502F8T-6DT
					RESISTOR:100K,1%,1/8W (R2,5,8,13,15,16)		33-1003F8T-6DT
					RESISTOR:750K,1%,1/8W (R25,30)		33-7503F8T-6DT
					RESISTOR:0 OHM,5%,1/8W (R118)		33-000J8T-7
					RESISTOR:47 OHM,5%,1/8W (R121)		33-470J8T-7
					RESISTOR:51 OHM,5%,1/8W (R53,107)		33-510J8T-7
					RESISTOR:100 OHM,5%,1/8W (R89)		33-101J8T-7
					RESISTOR:150 OHM,5%,1/8W (R73)		33-151J8T-7
					RESISTOR:220 OHM,5%,1/8W (R50)		33-221J8T-7
					RESISTOR:240 OHM,5%,1/8W (R117)		33-241J8T-7
					RESISTOR:470 OHM,5%,1/8W (R32)		33-471J8T-7
					RESISTOR:680 OHM,5%,1/8W (R72)		33-681J8T-7
					RESISTOR:910 OHM,5%,1/8W (R47)		33-911J8T-7
					RESISTOR:1K,5%,1/8W (R31,68,70,76)		33-102J8T-7
					RESISTOR:1.2K,5%,1/8W (R51,80)		33-122J8T-7
					RESISTOR:1.5K,5%,1/8W (R104)		33-152J8T-7
					RESISTOR:2.2K,5%,1/8W (R101)		33-222J8T-7
					RESISTOR:2.7K,5%,1/8W (R34,48,49,116)		33-272J8T-7
					RESISTOR:3K,5%,1/8W (R90,92)		33-302J8T-7
					RESISTOR:4.7K,5%,1/8W (R81)		33-472J8T-7
					RES:5.1K,5%,1/8W (R71,83,105,109,111,113)		33-512J8T-7
					RESISTOR:6.8K,5%,1/8W (R75)		33-682J8T-7
					RESISTOR:10K,5%,1/8W (R1,110,112,114,120)		33-103J8T-7
					RESISTOR:12K,5%,1/8W (R84)		33-123J8T-7
					RESISTOR:15K,5%,1/8W (R7)		33-153J8T-7
					RESISTOR:33K,5%,1/8W (R91)		33-333J8T-7
					RESISTOR:39K,5%,1/8W (R108)		33-393J8T-7
					RESISTOR:3.3K,5%,1/8W (R3)		33-332J8T-7
					RES,VAR:10K W/SWITCH (R20,85)		33-1033-02D
					RES,VAR:1K (R77)		34-1022-05D
					RES,VAR:10K (R106,115)		34-1032-05D
					RES,VAR:5K (R4)		34-5022-06D
					SVR:1K,20% (R74,82)		34-1021-08E
					SVR:2.2K,20% (R43,46,56)		34-2221-08E
					SVR:4.7K,20% (R33)		34-4721-08E
					SVR:10K,20% (R10,18)		34-1031-08E
					SVR:22K,20% (R6)		34-2231-08E
					DIODE:ZENER,10V,10%,1/2W (D50)		35-25113-10
					DIODE:ZENER,RD5.6EB2 (D31)		35-25113-5R6
					DIODE:1N4148 (D1 THRU 30,32 THRU 49,56)		35-25111-1
					DIODE:1N4001 (D52 THRU 55)		35-25112-1
					TRANSISTOR:2SC1815GR (Q1,4,8,12)		36-25238-3
					TRANSISTOR:2SA1015GR (Q2,3,6,7,11,17)		36-25239-3
					TRANSISTOR:2SC1674K (Q9,10)		36-25340-1
					TRANSISTOR:2N2219A (Q13)		36-25342-1
					TRANSISTOR:2N2905 (14)		36-25343-1
					TRANSISTOR:TIP32B (Q16)		36-25367-1
					MICROCKT:FET,2N5485 (Q5)		37-25522-1
					MICROCKT:HA17741 (Q5)		38-25411-1
					MICROCKT:UA308 (U3,4)		38-25412-1
					MICROCKT:MC3386P (U5)		38-25406-1
					MICROCKT:CA3030 (U7)		38-25413-1
					MICROCKT:HA17358 (U9)		38-25410-1
					MICROCKT:HD7420 (U6)		39-25575-1
					MICROCKT:LM317T (Q15)		41-25422-1
					LT EMITTING DIODE:ORANGE (D51)		64-25232-10
					FUSE:250V,250MA,SLOW (F1,2)(159-0309-00)		62-25592-3U
					INDUCTANCE:1MH,10% (L1)		43-1001K-4
-4	118-7938-00			1	REAR PNL ASSY:	80009	118-7938-00

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
2-					REAR PANEL: (QTY. 1)		1-25053-1
					FUSE:250V,0.2A,SLOW BLOW (FS3)		62-25611-1U
					FUSE HOLDER:CARRIER (QTY. 1)		62-25604-1
					FUSE HOLDER:BASE (QTY. 1)		62-25604-3
					SWITCH:LINE VOLTAGE (S4,S5)		80-25605-1
					AC POWER JACK: (QTY. 1)		30-25625-1
					TRANSFORMER:EI-48 (T1)		36-1923-915
					SWITCH:POWER (S3)		80-25604-1
					.HOLDER: (QTY. 1)		1-25057-1
					.SCREW: (QTY. 2)		4-11103-0602
					.WASHER: (QTY. 2)		6-12103-03
					SAFETY GROUND CONNECTION:		
					.LUG:FOUR LEG (QTY. 1)		1-25071-1
					.LUG,GROUND: (QTY. 1)		6-13103-02A
					.SCREW,GROUND: (QTY. 1)		4-1113R5-1002
					.NUT,GROUND: (QTY. 1)		5-1429R5-02
					.WASHER,GROUND:FLAT (QTY. 1)		6-1113R5-02
					.BNC,VFC INPUT:W/NUT (QTY. 1)		30-25437-1
					BUTTON:RED,ROUND (QTY. 1)(134-0210-00)		15-25619-1A

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
3-							
					ACCESSORIES		
	070-6737-00			1	MANUAL,TECH:SERVICE,CFG250	80009	070-6737-00
	161-0248-00			1	CABLE ASSY,PWR,:	80009	161-0248-00
	214-4205-00			1	HARDWARE KIT:CFG250	80009	214-4205-00

DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

Symbols

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

Logic symbology is based on ANSI/IEEE 91-1984. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

The overline on a signal name indicates that the signal performs its intended function when it is in the LO 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.
Y14.2M-1979	Line Conventions and Lettering.
ANSI/IEEE 280-1985	Letter Symbols for Quantities Used in Electrical Science and Electrical Engineering.

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

Component Values

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

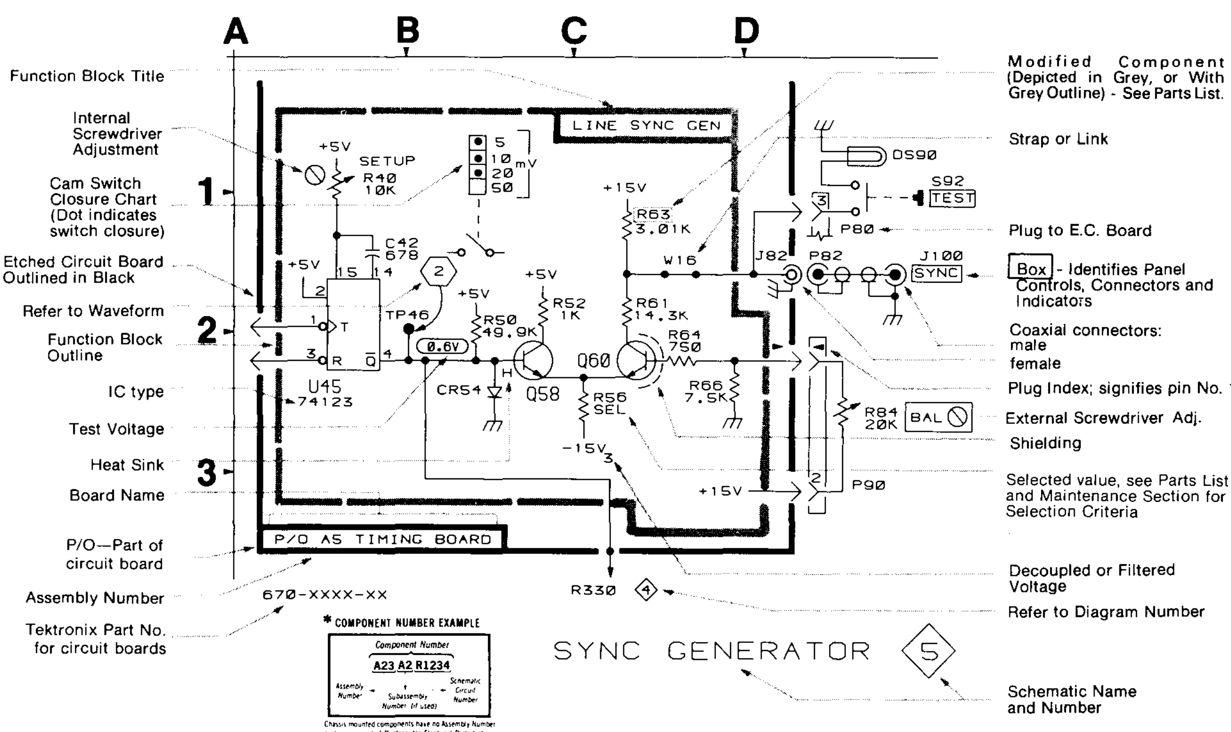
Capacitors	Values one or greater are in picofarads (pF). Values less than one are in microfarads (μF).
Resistors	Ohms (Ω).

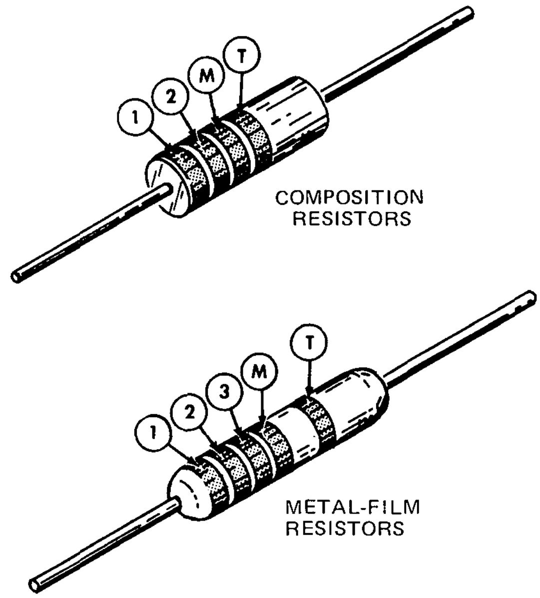
The information and special symbols below may appear in this manual.

Assembly Numbers and Grid Coordinates

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

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





(1)(2) and (3) – 1st, 2nd, and 3rd significant figures

(M) —multiplier (T) —tolerance

(TC) —temperature coefficient

(P) —polarity and voltage rating

COLOR	SIGNIFICANT FIGURES	RESISTORS	
		MULTIPLIER	TOLERANCE
BLACK	0	1	–––
BROWN	1	10	±1%
RED	2	10^2 or 100	±2%
ORANGE	3	10^3 or 1 K	±3%
YELLOW	4	10^4 or 10 K	±4%
GREEN	5	10^5 or 100 K	±½%
BLUE	6	10^6 or 1 M	±¼%
VIOLET	7	–––	±1/10%
GRAY	8	–––	–––
WHITE	9	–––	–––
GOLD	–	10^{-1} or 0.1	±5%
SILVER	–	10^{-2} or 0.01	±10%
NONE	–	–––	±20%

(1861-20A)6081-95

Figure 9-1. Color codes for resistors.

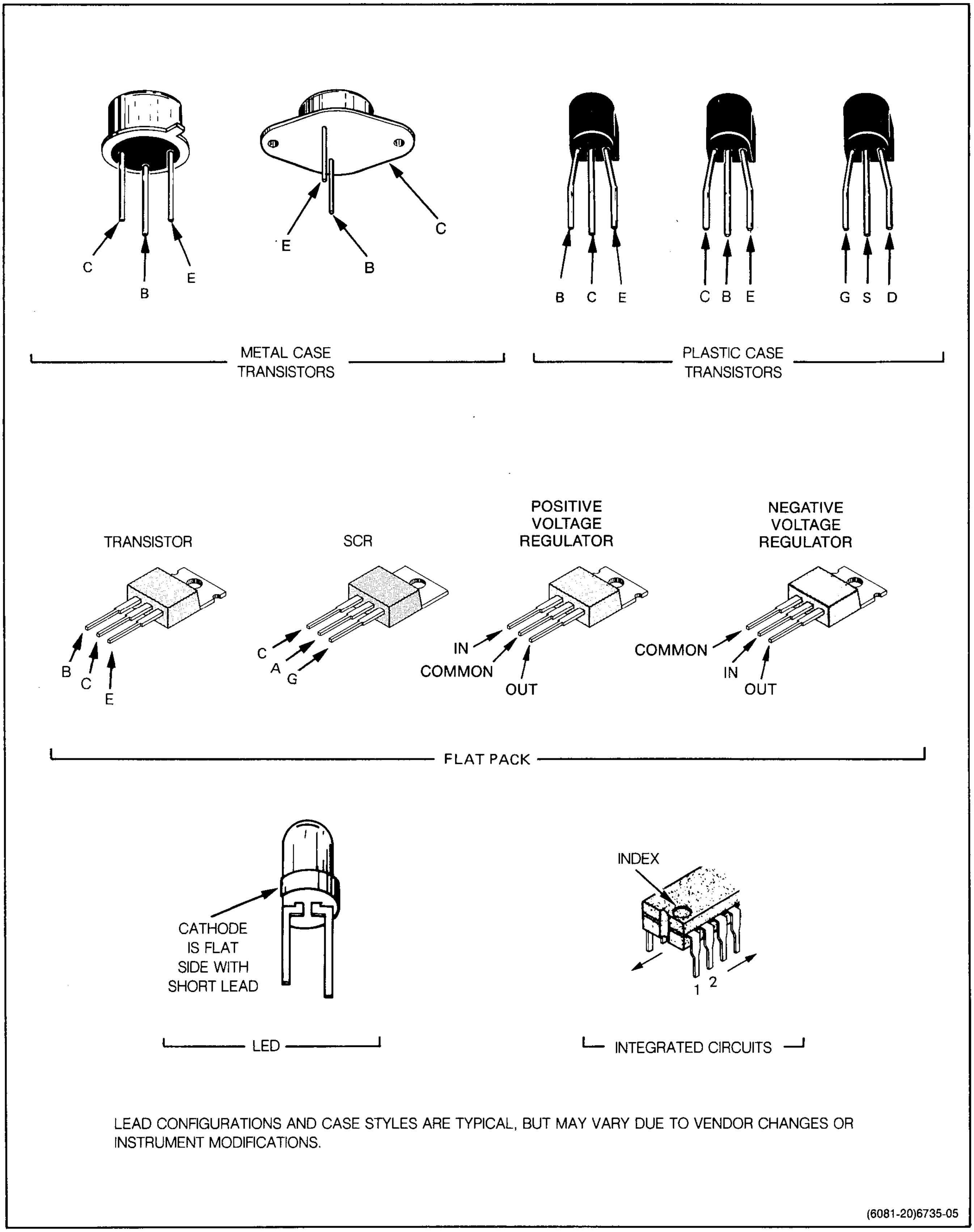


Figure 9-2. Semiconductor lead configurations.

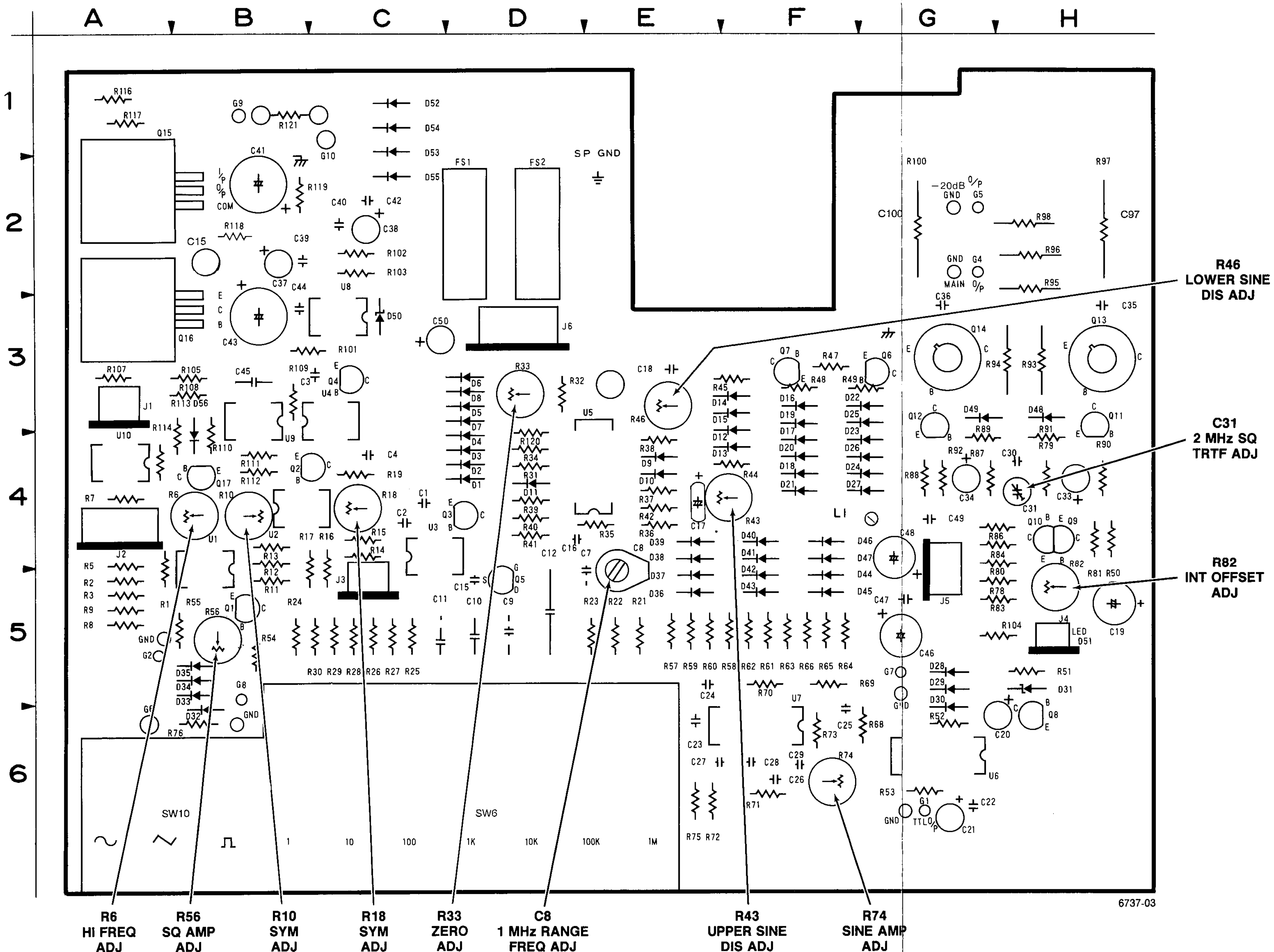


Figure 9-3. Main board and adjustment locations.

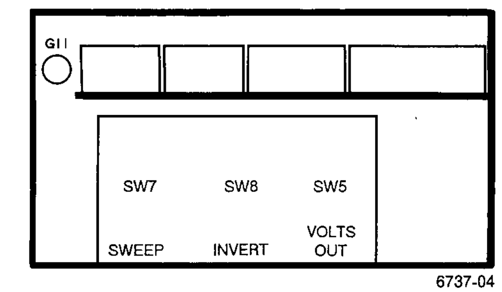


Figure 9-4. Switch board.

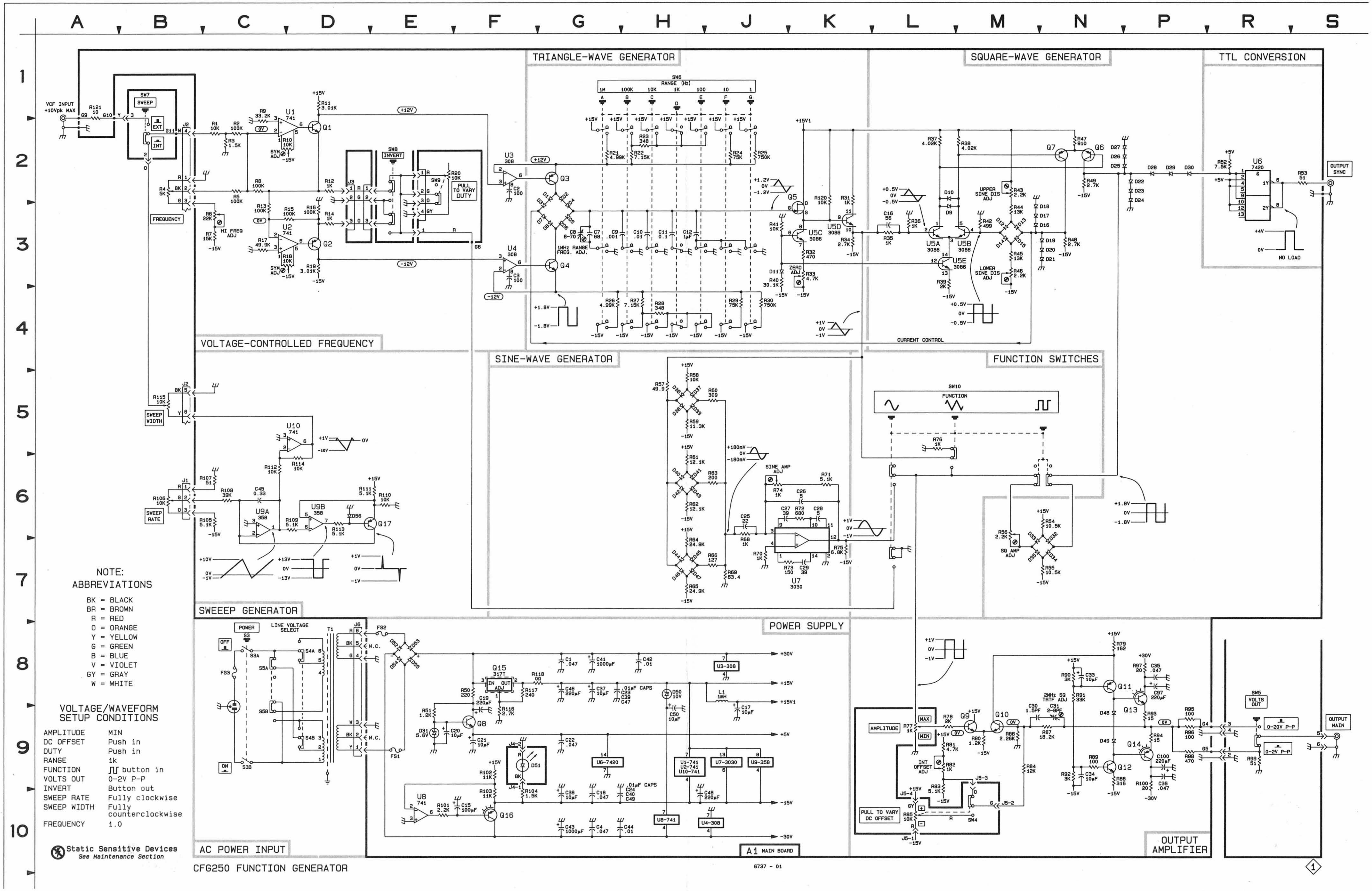
CFG250 DIAGRAM

A-1 MAIN BOARD

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C1	8G	4C	D29	2P	5G	R102	9F	2C	R59	5H	5E
C10	3H	5D	D3	3G	4D	R103	10F	2C	R6	3C	4B
C100	10p	2G	D30	2P	5G	R104	10F	5H	R60	5J	4B
C11	3H	5C	D31	9E	5H	R105	6C	3B	R61	6H	5F
C12	3H	4D	D32	7N	6B	R107	6C	3A	R62	6H	5F
C15	10F	2B	D33	7M	5B	R108	6C	3B	R63	6J	5F
C16	3L	4D	D34	7N	5B	R109	6D	3B	R64	7H	5F
C17	9J	4E	D35	7M	5B	R11	1D	5B	R65	7H	5F
C18	10G	3E	D36	5H	5E	R110	6E	4B	R66	7J	5F
C19	8F	5H	D37	5H	5E	R111	6D	4B	R68	6J	6G
C2	2F	4C	D38	5H	4E	R112	6C	4B	R69	7J	5G
C20	9E	6H	D39	5H	4E	R113	6D	3B	R7	3C	4A
C21	9F	6G	D4	3G	4D	R114	6D	3A	R70	7J	5F
C22	9G	6G	D40	6H	4F	R116	9F	1A	R71	6K	6F
C23	8H	6E	D41	6H	4F	R117	8F	1A	R72	6K	6E
C24	10H	5E	D42	6H	5F	R118	8F	2B	R73	7K	6F
C25	6J	6F	D43	6H	5F	R12	2D	5B	R74	6J	6F
C26	6K	6F	D44	7H	5G	R120	2K	4D	R75	7K	6E
C27	6J	6E	D45	7H	5G	R121	1A	1B	R76	5L	6B
C28	6K	6F	D46	7H	4G	R13	3C	4B	R78	9L	5H
C29	7K	6F	D47	7H	4G	R14	3D	4C	R79	8N	4H
C3	3F	3B	D48	9N	3H	R15	3D	4C	R8	2C	5A
C30	9M	4H	D49	9N	3G	R16	3D	4C	R80	9M	5H
C31	9N	4H	D5	3G	3D	R17	3C	4C	R81	9L	5H
C33	8N	4H	D50	8H	3C	R18	3D	4C	R82	9L	4H
C34	9N	4G	D51	9F	5H	R19	3D	4C	R83	9L	5H
C35	8P	3H	D52	8E	1C	R2	2C	5A	R84	9M	4H
C36	9P	3G	D53	8E	1C	R21	2G	5E	R86	9M	4H
C37	8G	2B	D54	8E	1C	R22	2H	5E	R87	9N	4G
C38	10G	2C	D55	8E	2C	R23	2H	5E	R88	9N	4G
C39	8H	2B	D56	6D	3B	R24	2J	5B	R89	9N	4G
C4	10G	4C	D6	3G	3D	R25	2J	5C	R9	1C	5A
C40	10H	2C	D7	3G	3D	R26	4G	5C	R90	8N	4H
C41	8G	2B	D8	3G	3D	R27	4H	5C	R91	8N	4H
C42	8H	2C	D9	3L	4E	R28	4H	5C	R92	9N	4G
C43	10G	3B	FS1	9E	2D	R29	4J	5C	R93	9P	3H
C44	10H	2B	FS2	8E	2D	R3	2C	5A	R94	9P	3H
C45	6C	3B	J1	6B	3A	R30	4J	5C	R95	9P	2H
C46	8G	5G	J2	2B	4A	R31	2K	4D	R96	9P	2H
C47	8H	5G	J2	5B	4A	R32	3K	3D	R97	8P	2H
C48	10J	4G	J3	2D	5C	R33	3K	3D	R98	9P	2H
C49	10H	4G	J4	9F	5H	R34	3K	4D	SW10	5L	6A
C50	9H	3C	J5	10L	5G	R35	3L	4E	SW6	1H	6C
C7	3G	4D	J5	10M	5G	R36	3L	4E	U1	1D	4B
C8	3G	4E	J5	9M	5G	R37	2L	4E	U1	9H	4B
C9	3G	5D	J6	8D	3D	R38	2M	4E	U10	5D	4A
C97	8P	2H	L1	8J	4F	R39	3L	4D	U10	9H	4A
D1	2G	4D	Q1	2D	5B	R40	3J	4D	U2	3D	4B
D10	2L	4E	Q10	9M	4H	R41	3J	4D	U2	9H	4B
D11	3J	4D	Q11	8N	3H	R42	3M	4E	U3	2F	4C
D12	3M	4F	Q12	9N	3G	R43	2M	4F	U3	8J	4C
D13	3M	4F	Q13	9P	3H	R44	3M	4F	U4	10J	3C
D14	3M	3F	Q14	9P	3G	R45	3M	3F	U4	3F	3C
D15	3M	3F	Q15	8F	1A	R46	3M	3E	U5A	3L	3E
D16	3N	3F	Q16	10F	3B	R47	2N	3F	U5B	3M	3E
D17	3N	4F	Q17	6E	4B	R48	3N	3F	U5C	3K	3E
D18	3N	4F	Q2	3D	4B	R49	2N	3F	U5D	3K	3E
D19	3N	3F	Q3	2G	4D	R5	2C	4A	U5E	3L	3E
D2	2G	4D	Q4	3G	3C	R50	8F	5H	U6	2R	6G
D20	3N	4F	Q5	2K	5D	R51	9E	5H	U6	9G	6G
D21	3N	4F	Q6	2N	3G	R52	2R	6G	U7	7K	5F
D22	2P	3F	Q7	2N	3F	R53	2S	6G	U7	9J	5F
D23	2P	4F	Q8	9F	6H	R54	6N	5B	U8	10E	2C
D24	2P	4F	Q9	9M	4H	R55	7N	5B	U8	10H	2C
D25	2N	3F	R1	2C	5A	R56	6M	5B	U9	9J	4B
D26	2N	4F	R10	2D	4B	R57	5H	5E	U9A	6C	4B
D27	2N	4F	R100	9P	2G	R58	5H	5F	U9B	6D	4B
D28	2P	5G	R101	10E	3C						

OTHER PARTS

FS3	8C	CHASSIS	R77	9L	CHASSIS	S3B	9C	CHASSIS	SW4	10M	SWITCH BD
R106	6B	CHASSIS	R85	10L	CHASSIS	S4A	8D	CHASSIS	SW5	8R	SWITCH BD
R115	5B	CHASSIS	R99	9R	CHASSIS	S4B	9D	CHASSIS	SW7	1B	SWITCH BD
R20	2E	CHASSIS	S3	8C	CHASSIS	S5A	8C	CHASSIS	SW9	2E	CHASSIS
R4	2B	CHASSIS	S3A	8C	CHASSIS	S5B	9C	CHASSIS	T1	8D	CHASSIS



SCHEMATIC DIAGRAM