MODEL 610C SWEEP GENERATOR
INSTRUCTION MANUAL

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WILTRON COMPANY
for better electronics measurements

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3-610C-OMM

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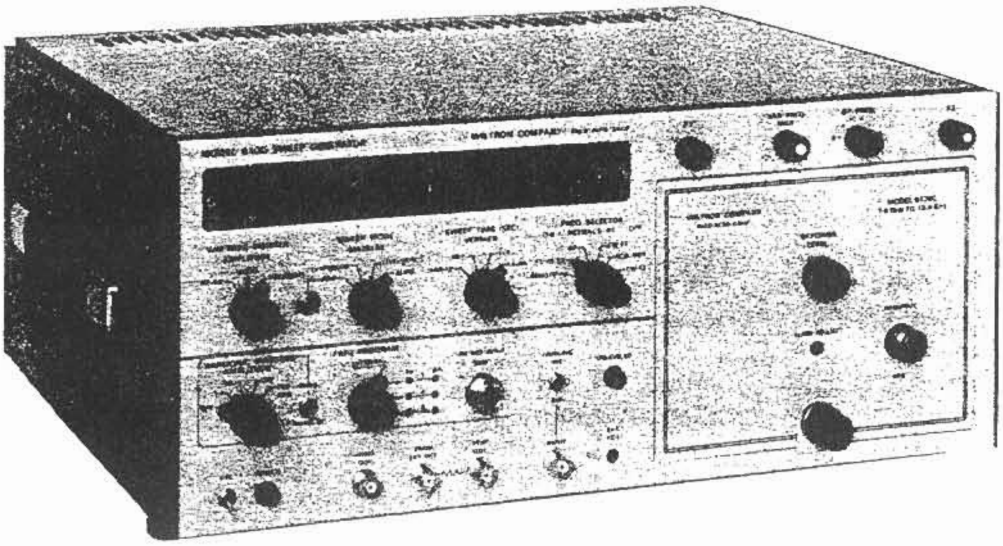

Figure 1-1 Model 610C Sweep Generator

Table 1-1 Specifications

FREQUENCY RANGE	:	100kHz to 18.5GHz (determined by RF Plug-In)
SWEEP TIME	:	Continuously adjustable in four decade ranges: 0.01 to 100 seconds per sweep
HORIZONTAL OUTPUT	:	0 to +11.2 volts
BLANKING OUTPUT	:	+6 volts during retrace
TRIGGER INPUT		
AMPLITUDE	:	+1 to +25 volts
PULSE WIDTH	:	greater than 1 microsecond
RISE TIME	:	greater than 0.1 volt per microsecond
DIMENSIONS	:	17-9/16"W x 7-1/2"H x 13-5/8"D (see Figure 1-10)
WEIGHT		
MAIN FRAME only	:	18 pounds
SHIPPING	:	26 pounds
RF PLUG-IN only	:	10 pounds (typical)
SHIPPING	:	14 pounds

SECTION I

GENERAL INFORMATION

1-1. INTRODUCTION

The purpose of this manual is to provide the necessary information to operate and maintain the WILTRON Model 610C Sweep Generator. A general description of the system, its specifications, options, and accessories are contained in this section. The information necessary to unpack and install the instrument, as well as a full description of each front and rear panel control, connector, and indicator function is presented in Section II. Section III provides the Theory of Operation for the instrument, while step-by-step procedures for the performance verification, recalibration, and troubleshooting are presented in Section IV. A complete list of the replaceable parts and the schematic diagrams can be found in Sections V and VI, respectively.

1-2. SYSTEM DESCRIPTION

The WILTRON Model 610C Sweep Generator, shown in Figure 1-1, is a precision, compact instrument used to provide high-accuracy, swept-frequency measurements from 100kHz to 18.5GHz. This solid-state unit features a very flat output, built-in leveling, low harmonics, and a versatile frequency marker system. An extensive series of RF Plug-Ins makes possible this wide frequency coverage. A variety of factory installed options extends the versatility of this instrument to suit the individual needs of the customer. The specifications for this instrument are outlined in Table 1-1.

As shipped, the Model 610C Sweep Generator is housed in its own sturdy cabinet for bench top use. A tilt stand is provided to raise the front panel for better Slide Rule Dial viewing. Rack mounting ears are available at no extra charge upon request. With these installed and the rubber feet removed, the unit will then occupy 7 inches in a standard 19-inch rack console.

The Main Frame of the Model 610C is used to generate an accurate, stable, voltage ramp which drives the oscillator control circuits in the RF Plug-In being used. Power supplies and leveling control circuitry are also housed in this unit. Refer to Section III for a functional description of each circuit and how they relate to one another.

A versatile system of variable frequency markers is incorporated into this instrument. With the RF PIP marker selected, the RF output from the RF Plug-In will be reduced momentarily to provide the marker. When set to VIDEO, a negative video pulse at the preset marker frequency is generated. With the INTENSITY marker selected, the sweep is delayed momentarily causing an intensification of the oscilloscope trace. The frequency at which the selected marker appears is determined by the VAR FREQ MKR control setting.

1-3. RF PLUG-INS

A wide range of RF Plug-In units is available to provide full frequency coverage from 100kHz to 18.5GHz. Figure 1-2 illustrates graphically the relationship of power level to frequency coverage for each of the available RF Plug-Ins. The individual parameters of each unit are outlined in Tables 1-2 and 1-3. Table 1-2 covers the Model 6100 Series and Table 1-3 the Model 6200 Series. A separate Instruction Manual is supplied at the rear of this manual for each RF Plug-In purchased.

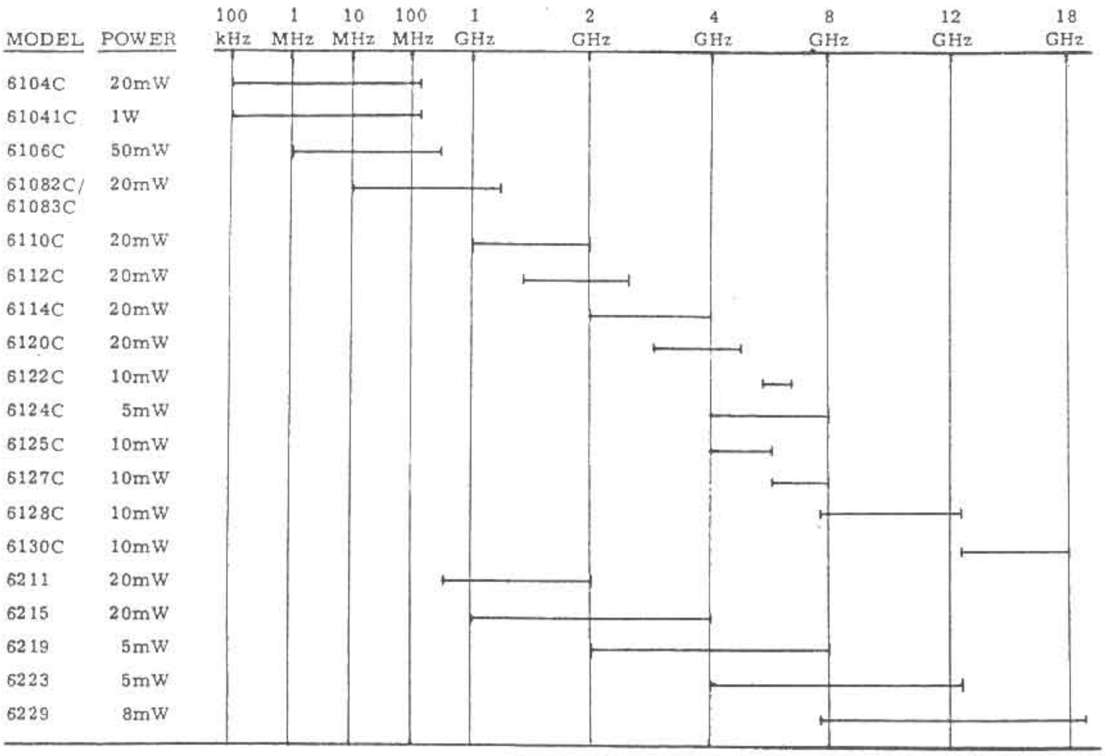

Figure 1-2 Power Level vs. Frequency Coverage

1-4. OPTIONS AND ACCESSORIES

Besides being an all solid-state sweeper with a wide range of RF Plug-Ins, the Model 610C offers a variety of optional features which may be ordered as factory installed equipment. These optional features expand the capabilities of the instrument to suit an individual need.

Option 1 provides four crystal-controlled comb marker frequencies at 1, 10, 50, and 100 MHz intervals. The crystal marker accuracy is ±0.01%. Both the amplitude and bandwidth of these markers are adjustable at the front panel. The spectrum of the markers is to 3.0GHz for the 10, 50 and 100MHz markers, and to 4.0GHz for the 1MHz marker. Figure 1-3 shows the option plate that is added when this option is installed.

Option 2 is an RF Detector that simplifies the test setup and eliminates the need to use an external RF Detector of unknown performance. An RF Detector, when installed, is located on the option plate as shown in Figure 1-4.

The RF Detector is available in one of the three following configurations:

> Option 2A - a 50-ohm RF Detector using a female BNC type input connector. The frequency range is

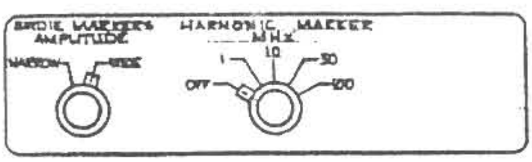

Figure 1-3 Option 1

Figure 1-4 Option 2C

100kHz to 3GHz ±0.5dB. VSWR is less than 1.25

Option 2B - a 75-ohm RF Detector using a female BNC type input connector. The frequency range is 100kHz to 3GHz ±0.5dB. VSWR is less than 1.25

Option 2C - a 50-ohm RF Detector using a female N type input connector. The frequency range is 100kHz to 3GHz ±0.3dB. VSWR is less than 1.25

Option 3 consists of a choice of up to 6 crystal-controlled, fixed-frequency markers at separate frequencies of your choosing. These markers may be ordered at frequencies of up to 100MHz and are provided with variable bandwidths and amplitudes. The accuracy is ±0.01%. This option is shown in Figure 1-5.

Option 4 provides a great assistance if your work involves repetitive testing over a few particular frequency ranges. With this option installed, a front panel switch enables the selection of any one of three center frequencies (Fo). In addition, the amount of sweep (ΔF) around this frequency can be preset from 0 to 100%. Both the center frequency and the percentage of sweep about it can easily be adjusted by the front panel screwdriver-set potentiometers shown in Figure 1-6.

It is possible to order a combination of these four basic options, factory installed, in the same instrument. The RF Detector (Option 2) can be added to Options 1, 3, or 4. Options 1, 2C, and 3 can be combined, as shown in Figure 1-7, to provide a total of 10 different marker frequencies.

Figure 1-8 shows the combination of Options 1, 2C, and 4 which will provide four crystal-controlled comb markers plus frequency programming within easy reach of an operator.

Options 5 through 9 are rear panel features which may be installed at the time of your order. Option 5 is the VERT OUT BNC type connector J108 and Option 6 is the HORIZ OUT BNC type connector J208. Both of these parallel their counterpart on the front panel and provide convenience when installing the Model 610C in a particular system configuration. Option 7 is a BNC type connector which provides rear panel access for external leveling. Option 8, another BNC type connector J110, provides rear panel access to the variable frequency marker pulse. Option 9 is the pen lift circuitry that provides a relay closure during sweep. This may be used to actuate auxiliary equipment, such as

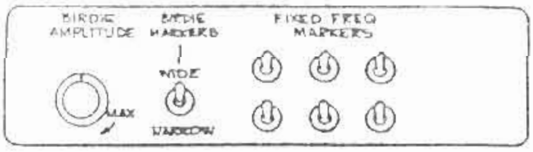

Figure 1-5 Option 3

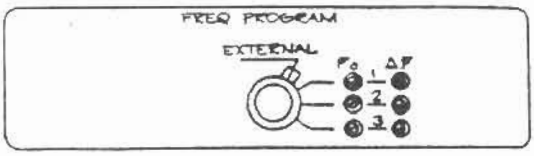

Figure 1-6 Option 4

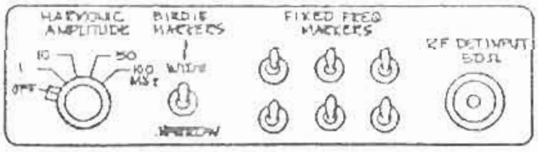

Figure 1-7, Options 1, 2C, and 3

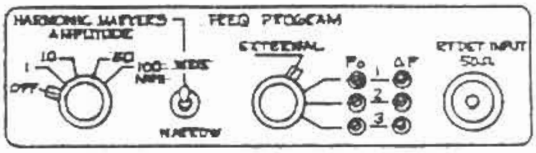

Figure 1-8 Options 1, 2C, and 4

an X-Y recorder when the PEN LIFT switch is set to ON. Option 10 provides the necessary control signals to make the Model 610C compatible with the Hewlett Packard Model 8410 Network Analyzer. The control signals provided are a 0 to 40V frequency reference voltage, a Z-axis intensity modulation output signal, and a -4V or +6V blanking output voltage. Access to the Option 10 control signals is made through rear panel connections. Figure 1-9 illustrates these rear panel options.

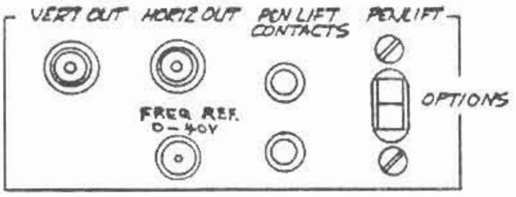

Figure 1-9 Rear Panel Options

A 610B/C Extender Card (610B-MS-588) can be used to extend any one of the printed circuit assemblies when troubleshooting. It can be ordered at any time as an accessory. If it is desired to operate the RF Plug-In externally from the Main Frame for troubleshooting purposes, the optional 610B/C Plug-In Extender Cable (610B-MS-383) can also be ordered as an accessory.

1-5. EQUIPMENT DIMENSIONS

The dimensions of the Model 610C Sweep Generator are shown in the outline drawing, Figure 1-10.

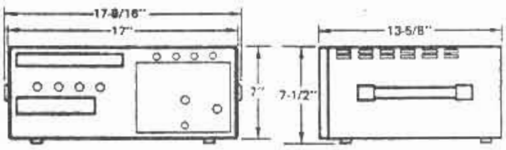

Figure 1-10 Model 610C Outline Drawing

SECTION II

INSTALLATION/OPERATION

2-1. INTRODUCTION

This section of the manual contains the information necessary to unpack, inspect, and install the Model 610C Sweep Generator. Each front and rear panel control, connector, and indicator is then identified and fully described. Finally, the procedures necessary to ensure proper operation, in either the standard or remote programmed mode, are presented.

2-2. INSPECTION

The Model 610C Sweep Generator was thoroughly inspected for electrical and mechanical operation prior to shipment. It is recommended that the unit be carefully removed from its packaging and inspected for physical damage that may have resulted during transit. Completeness of your order should be verified at this time to ensure that all purchased accessories and options have been received. Refer to the warranty in the front of this manual should damage or deficiency be evident. Original packaging should be retained to facilitate any return shipment.

2-3. INSTALLATION

This instrument is designed to operate from either a 115 or 230Vac, 50-60Hz line source. A slide switch (S502) is provided on the rear panel to permit this input line selection.

As shipped, this switch is in the 115Vac position. Verify that the switch is in the position that corresponds with the line source to be used. The input line voltage should be regulated to within ±10% for optimum results.

A three-conductor power cord (P501) is provided for the protection of operating personnel. If a two-contact outlet is all that is available, ensure that a two-prong adapter is used and ascertain that the green grounding pigtail is attached to a suitable ground, such as a cold water pipe.

A 0.8A, slo-blo fuse (F501) is incorporated to provide short circuit protection for the instrument. Whenever a replacement is necessary, be certain to use only a 0.8A, slo-blo type to ensure proper protection.

This instrument does not require forced air cooling; however, the sides, top, and bottom of the unit must not be obstructed from the normal ambient conditions (+25°C).

Optimum performance of the Model 610C is obtained after the internal temperature has stabilized. To avoid warmup time, power to the equipment may be left on for extended periods.

2-4. FRONT PANEL CONTROLS, CONNECTORS AND INDICATORS

The function of each front panel control, connector, and indicator is fully described in the following paragraphs. Refer to Figure 2-1 for the location of each item.

(1) F1 Frequency Selector - potentiometer (R242) used to preset the "start" frequency anywhere within the calibrated range of the RF Plug-In being used.

> Note: F1 may be set at a lower frequency than F2 for an upward sweep in frequency or at a higher frequency than F2 for a downward sweep in frequency.

(2) VAR FREQ MKR - potentiometer (R247) used to preset the frequency of the marker during F1 TO F2 operation. During ΔF sweep operation, the marker frequency determines the center frequency of the ΔF sweep.

(3) ΔF FREQ - potentiometer (R241) used to preset a calibrated sweep from 0 to 10% about a center frequency. This center frequency is preset by the VAR FREQ MKR potentiometer. With the ΔF FREQ potentiometer set to 10, the generator will sweep ±5% of the total frequency span(of the RF Plug-In being used) about the frequency preset by the VAR FREQ MKR potentiometer.

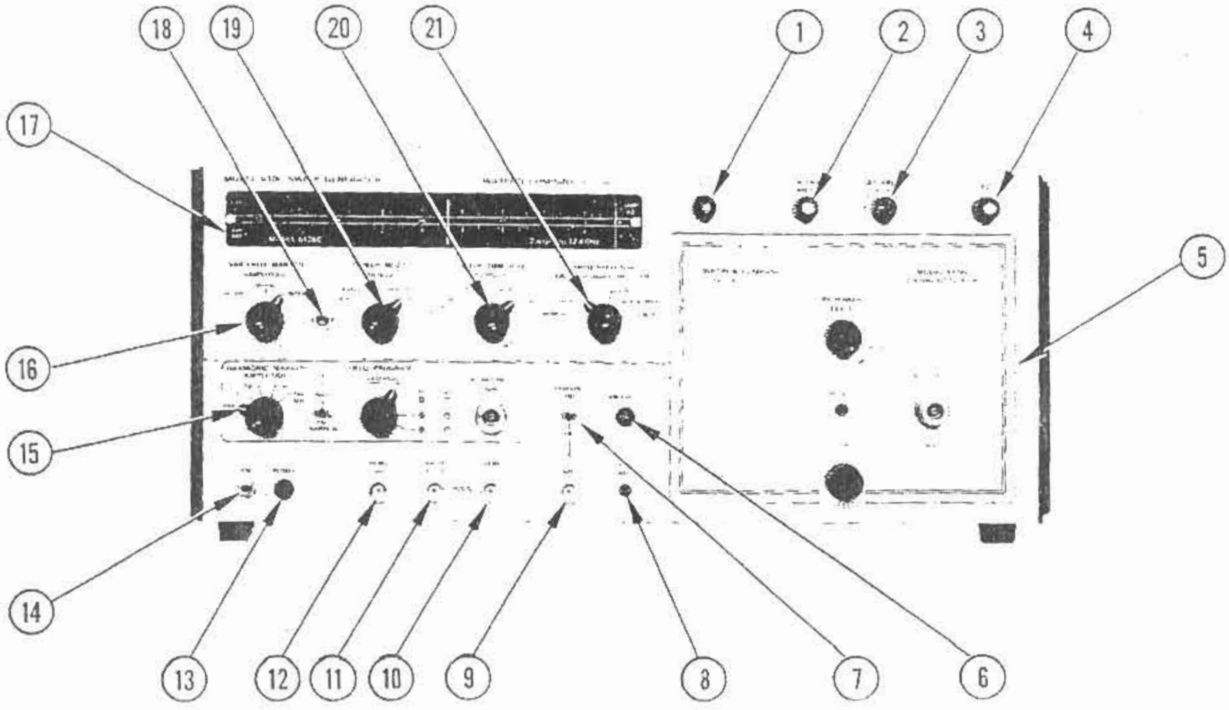

Figure 2-1 Front Panel Controls, Connectors, and Indicators

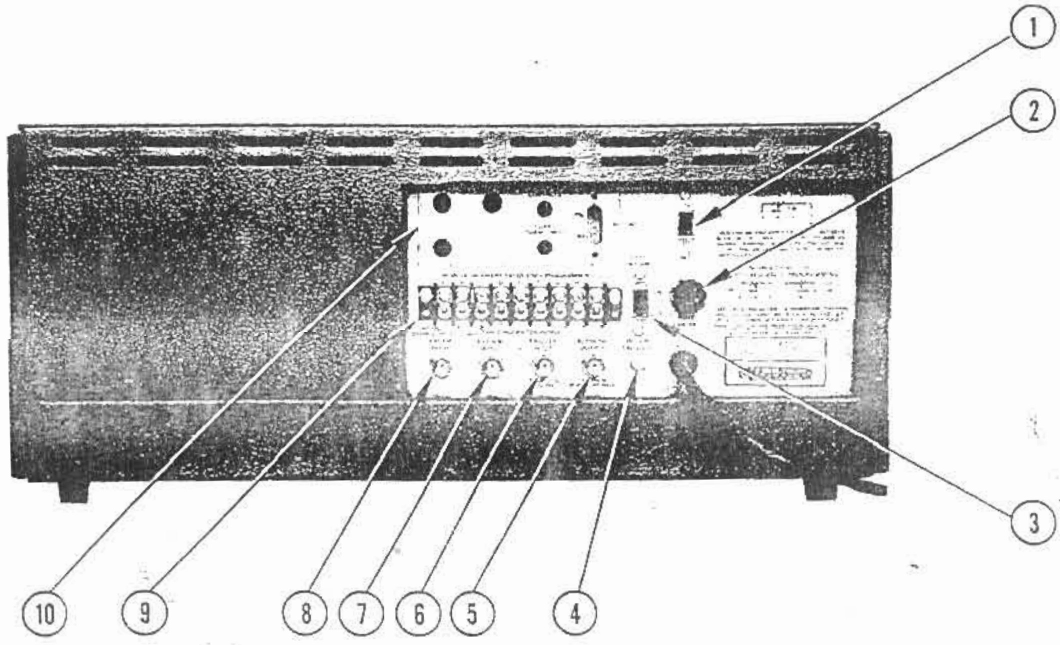

Figure 2-2 Rear Panel Controls and Connectors

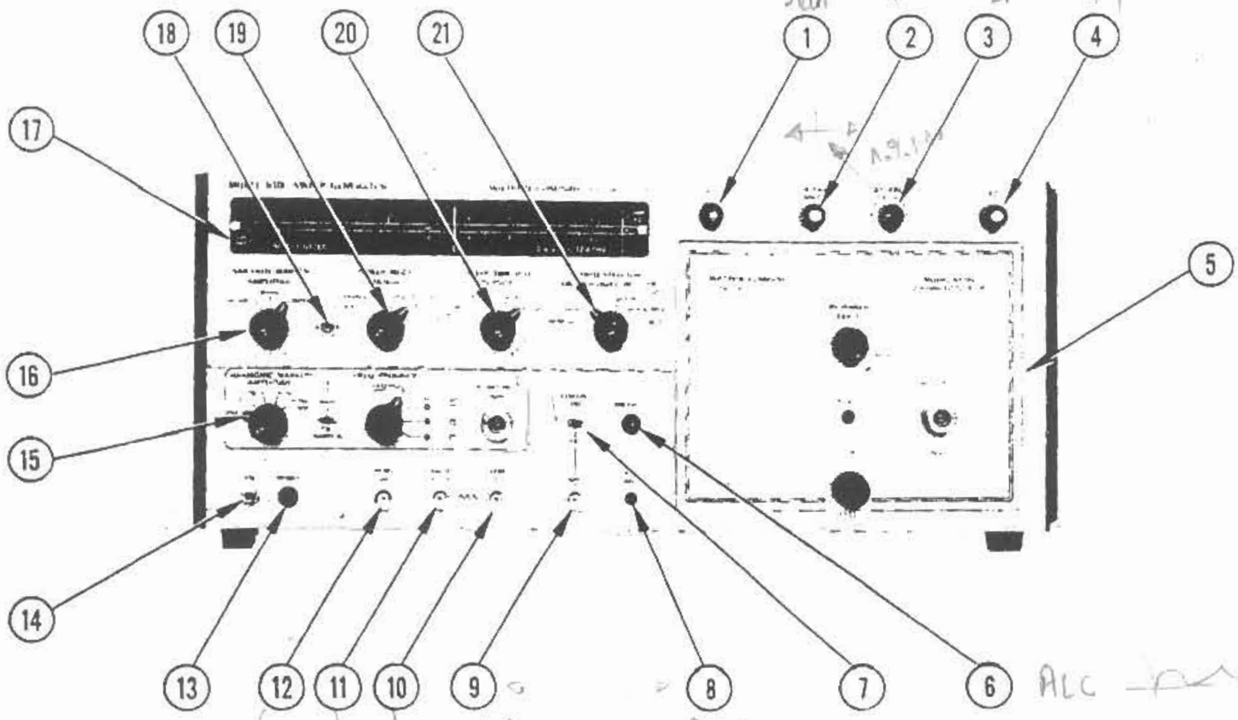

Figure 2-1 Front Panel Controls, Connectors, and Indicators

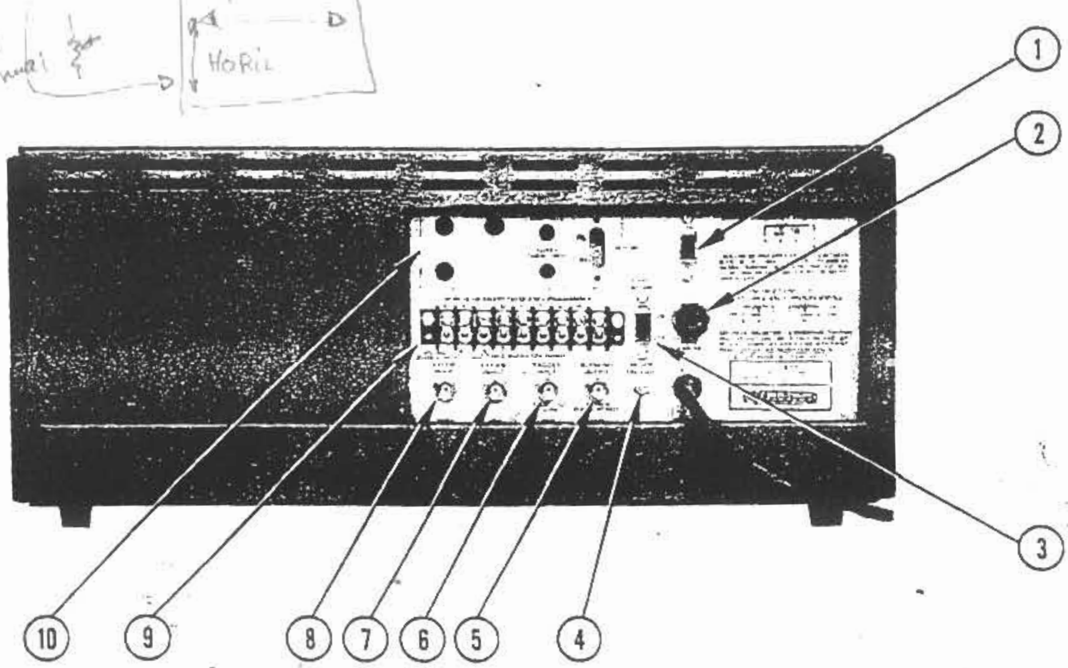

Figure 2-2 Rear Panel Controls and Connectors

(4) F2 Frequency Selector - potentiometer (R244) used to preset the "stop" frequency anywhere within the calibrated range of the RF Plug-In being used.

Note: F2 may be set at a higher frequency than F1 for an upward sweep in frequency or at a lower frequency than F1 for a downward sweep in frequency.

(5) RF Plug-In - one of 19 optional RF plug-ins are available for use in conjunction with the Model 610C Sweep Generator to provide a specific band of frequency output.

(6) UNLEVELED - amber indicator lamp (DS401) used to indicate that the limits of the internal automatic level control (ALC) loop have been exceeded and as a result the leveled RF output is no longer being maintained over the full frequency range.

(7) LEVELING INT/EXT - DPDT toggle switch (S401) used to select either the internal (INT) automatic level control loop or external (EXT) leveling control from some remote source, i.e., an external directional coupler and negative detector.

(8) ALC ADJ - screwdriver adjusted potentiometer (R402) used to adjust the dc level from the external leveling source.

(9) INPUT - BNC connector (J402) used to connect an external leveling source.

(10) VERT OUT - BNC connector (J107) used to provide an output from an internal detector, video marker pulse, optional Birdie markers, or detected RF. This output is normally applied to the vertical input of an oscilloscope or X-Y recorder.

(11) FROM EXT DET - BNC connector (J109) used to connect the output signal from an external detector for the purpose of mixing this signal with the marker pips. The combined signals are then internally connected to the VERT OUT connector for use with an oscilloscope or X-Y recorder.

(12) HORIZ OUT - BNC connector (J201) used to provide a 0 to +11.2V sweep voltage output during REMOTE (PROGRAM), F1 TO F2, ΔF, and MANUAL sweep operations. This output is normally applied to the horizontal input of an oscilloscope or X-Y recorder. The output impedance is 10,000 ohms.

(13) POWER - red indicator lamp (DS501) used to indicate that primary power is applied to the Model 610C Sweep Generator.

(14) Main Power ON - SPDT toggle switch (S501) used to apply primary power to the Model 610C Sweep Generator.

(15) Optional Control Panel - used to provide control over a variety of factory installed options. A combination of Option 1, 2C, and 4 is shown in Figure 2-1. Refer to paragraph 1-4 for further details on each.

(16) VAR FREQ MARKER - three position rotary selector switch (S302) used to select one of the three available variable frequency markers. The frequency at which these markers will appear is preset by the VAR FREQ MKR potentiometer.

When set to RF PIP, the RF output will be blanked at the preset marker frequency thus producing a marker.

When set to VIDEO, a negative video pulse at the preset marker frequency will be generated as a marker.

When set to INTENSITY, an intensity spot at the preset marker frequency will be generated as a marker.

AMPLITUDE - potentiometer (R327) used to adjust the amplitude of the RF and video pulse during RF PIP and VIDEO operation, respectively and the intensity of the spot during INTENSITY operation.

(17) Slide Rule Dial - replaceable 8-inch slide rule dial that provides a calibrated graticule which corresponds to the particular frequency range of the RF Plug-In being used.

(18) Trigger - pushbutton (S103) used to provide a single sweep operation each time it is depressed and released. The SWEEP MODE selector switch must be set to TRIG for this operation.

(19) SWEEP MODE - Four-position rotary selector switch (S101) used to select the mode of operation.

When set to TRIG, a single sweep operation is commanded each time the Trigger pushbutton is depressed and released. Repetitive sweep operations can be commanded by connecting an external trigger source. The pen lift contacts (Option 9) are used in this mode to actuate auxiliary equipment, such as an X-Y recorder.

When set to MANUAL, the operation is controlled by the MANUAL potentiometer (inner red control knob). During manual tuning, the horizontal output is proportional to the frequency excursion.

When set to LINE SYNC, the sweep operation is synchronized to multiples or sub-multiples of the 60Hz line. This position is often useful when examining hum or other effects that may be related to the line frequency.

When set to AUTO, the sweep operation reoccurs periodically with a minimum delay (Hold Off Time) between sweeps.

MANUAL - potentiometer (R144) used to manually tune the frequency range preset by the F1 and F2 Frequency Selectors during F1 TO F2 sweep operation or by the VAR FREQ MKR during ΔF sweep operation.

(20) SWEEP TIME (SEC) - four-position rotary selector switch (S102) used to select the period of time for the frequency to sweep from F1 to F2. Four overlapping ranges are selectable: .1-.01, 1-.1, 10-1, 100-10 seconds.

VERNIER - potentiometer (R134) used to tune the particular SWEEP TIME (SEC) range selected. With the SWEEP TIME (SEC) selector switch set to the 100-10 position, the sweep time will be greater than 100 seconds with the VERNIER potentiometer fully counterclockwise and less than 10 seconds with it in the fully clockwise (CAL) position.

(21) FREQ SELECTOR - six-position rotary selector switch (S201) used to select the particular frequency characteristics of the sweep operation.

When set to REMOTE (PROGRAM), the swept output is determined by the setting of the remote programming controls. Refer to paragraph 2-8 for remote programming information. The FREQ SELECTOR must also be set to this position when Option 4 is used.

When set to F1 TO F2, the frequency is swept between two limits preset by the F1 and F2 Frequency Selectors.

When set to ΔF, the frequency is swept at a given percentage around a center frequency preset by the VAR FREQ MKR potentiometer. The percentage of sweep is preset by the ΔF FREQ potentiometer.

When set to CW F1, the frequency output is a fixed-frequency, non-swept signal selected by the F1 Frequency Selector.

When set to CW MKR, the frequency output is a fixed-frequency, non-swept signal selected by the VAR FREQ MKR potentiometer.

When set to CW F2, the frequency output is a fixed-frequency, non-swept signal selected by the F2 Frequency Selector.

RETRACE RF ON/OFF - two position rotary selector switch (S104) used to select the state of the RF signal between sweeps.

When set to ON, the RF signal remains on between sweeps. This position should be used when making swept RF power measurements in conjunction with a WILTRON Model 501 Logarithmic Level Meter.

When set to OFF, the RF signal remains off between sweeps.

2-5. REAR PANEL CONTROLS AND CONNECTORS

The function of each rear panel control and connector is fully described in the following paragraphs. Refer to Figure 2-2 for the location of each item.

(1) Input Line Selector - DPDT slide (S502) used to select the

OUT connector and the vertical input of a dc coupled oscilloscope.

8. Connect a suitable cable between the HORIZ OUT connector and the horizontal input of a dc coupled oscilloscope.

9. Connect an RF detector, such as a WILTRON Model 74N50, between the device under test and the FROM EXT DET connector, located on the front panel of the instrument.

10. Set the desired test signal level using the RF POWER LEVEL control or controls, located on the RF Plug-In.

11. Connect a suitable cable between the RF OUTPUT connector, located on the RF Plug-In, and the input to the device under test.

12. Observe the frequency response displayed on the oscilloscope screen.

2-7. VARIATIONS

The instructions presented in paragraph 2-6 pertain to the basic method of plotting the frequency response of a device. The following outlines some of the variations which may be made to this basic method.

- Should it be desired to have a graphic plot of the frequency response, proceed as follows:

  1. Connect a suitable cable between the VERT OUT connector and the Y input to an X-Y recorder.

  2. Connect a suitable cable between the HORIZ OUT connector and the X input to an X-Y recorder.

  3. Set the front panel controls as indicated:

VAR FREQ MARKER . .	INTENSITY
AMPLITUDE	Fully CCW
SWEEP MODE	TRIG
SWEEP TIME (SEC) . .	100-10
VERNIER.	Mid-range
FREQ SELECTOR	F1 TO F2
RETRACE RF.	OFF
F1.	desired lower test freq.
F2.	desired upper test freq.
LEVELING INT/EXT . . .	INT

  4. With the device under test connected as described in paragraph 2-6, depress and release the Trigger pushbutton to actuate the sweep operation.

- Should a sweep operation around a center frequency be desired, proceed as follows:

  1. Make the necessary connections outlined in paragraph 2-6.

  2. Set the front panel controls as indicated:

VAR FREQ MARKER. .	INTENSITY
AMPLITUDE.	Fully CCW
SWEEP MODE	AUTO
SWEEP TIME (SEC) . .	1-.1
VERNIER.	CAL(fully CW)
FREQ SELECTOR . . .	ΔF
RETRACE RF	as desired
VAR FREQ MKR .	desired center freq.
ΔF FREQ.	as desired
LEVELING INT/EXT. .	INT

- Should variable frequency markers be desired, proceed as follows:

  1. Make the necessary connections and set the front panel controls as outlined in paragraph 2-6.

  2. Set the VAR FREQ MKR potentiometer for the desired marker frequency.

  3. For an RF PIP marker (blanked RF output), set the VAR FREQ MARKER selector switch to RF PIP and adjust the AMPLITUDE potentiometer for the desired amplitude of the marker.

  4. For a VIDEO marker (negative-going pulse), set the VAR FREQ MARKER selector switch to VIDEO and adjust the AMPLITUDE potentiometer for the desired amplitude of the marker.

proper transformer primary winding configuration, either 115 or 230Vac, to correspond with the input line source to be used.

(2) FUSE 0.8A SB - 0.8 ampere, slo-blo fuse and fuseholder (F501) used to provide short circuit protection for the instrument.

(3) 1KHz INT AM ON/OFF - SPST slide switch (S402) used to actuate the internal 1kHz square wave generator. With this generator actuated, the RF output will be 100% amplitude modulated at a 1kHz rate.

(4) INT AM FREQ ADJ - screwdriver adjusted potentiometer (R247) used to vary the frequency of the internal 1kHz squarewave generator ±5% around 1kHz.

(5) BLANKING OUTPUT - BNC connector (J102) used to provide access to a +6V pulse during retrace which may be used to blank the oscilloscope display or generate a reference level for a WILTRON Model 501 Logarithmic Level Meter.

(6) TRIGGER INPUT - BNC connector (J101) used to provide sweep triggering access from an external positive pulse with an amplitude of 1 to 25V, a pulse width greater than 1μs, and a rise time greater than 0.1V/μs. The SWEEP MODE selector switch must be set to TRIG for this operation.

(7) EXT AM INPUT - BNC connector (J403) used to connect an external signal source which is used to modulate the amplitude of the sweep output. A 60kHz bandwidth is typical and the ac coupled, input impedance is approximately 15,000 ohms.

(8) EXT FM INPUT - BNC connector (J203) used to connect an external signal source which is used to modulate the frequency of the sweep output. A 1MHz bandwidth is typical, with a sensitivity of 0.1% of full scale bandwidth per volt. The ac coupled, input impedance is approximately 20,000 ohms. Maximum deviation available is ±2% of the RF Plug-In frequency band.

(9) REMOTE OR SWEPT FREQUENCY PROGRAMMING - terminal strip (TB201) used for external programming of the swept frequency. See paragraph 2-8 for remote frequency control and programming instructions.

(10) OPTIONS - area used to provide the optional factory installed controls and connectors (Options 5 through 10). See paragraph 1-4 for a description of each.

2-6. HOW TO PLOT FREQUENCY RESPONSE

The following step-by-step procedure is recommended when plotting the amplitude response of a device as a function of frequency.

1. Select an appropriate RF Plug-In in the desired frequency range of the test to be made.

2. Secure both the RF Plug-In and its corresponding Slide Rule Dial in their respective locations.

3. Verify that the Input Line Selector is set to correspond with the line source being used (115 or 230Vac).

4. With the Main Power ON switch set to the off (down) position, plug the power cord into the line source.

5. Set the Main Power ON switch to ON and allow a 30 minute warmup period for the circuits of the instrument to stabilize with temperature.

6. Set the front panel controls as indicated:

VAR FREQ MARKER . .	INTENSITY
AMPLITUDE	Fully CCW
SWEEP MODE	AUTO
SWEEP TIME (SEC) . . .	1-.1
VERNIER.	CAL(fully CW)
FREQ SELECTOR	F1 TO F2
RETRACE RF	as desired
F1.	desired lower test freq.
F2.	desired upper test freq.
LEVELING INT/EXT . .	INT

7. Connect a suitable cable between the VERT

5. For an INTENSITY spot marker, set the VAR FREQ MARKER selector switch to INTENSITY and adjust the AMPLITUDE potentiometer for the desired intensity of the marker.

6. For optional comb markers, set the HARMONIC MARKER selector switch, located on the Marker Comb Generator control panel (Option 1), to the desired frequency of the comb markers. Set the BIRDIE MARKERS selector switch to either NARROW or WIDE, as required and adjust the AMPLITUDE potentiometer, as necessary.

- Should it be desired to manually tune the frequency response of a device, proceed as follows:

1. Make the necessary connections and set the front panel controls as outlined in paragraph 2-6.

2. Set the SWEEP MODE selector switch to MANUAL and adjust the MANUAL potentiometer clockwise to sweep up the band and counterclockwise to sweep down the band. The sweep frequency limits are preset by the F1 and F2 Frequency Selectors.

- Should it be desired to internally or externally modulate the sweep, proceed as follows:

1. Make the necessary connections and set the front panel controls as outlined in paragraph 2-6.

2. For internal AM, set the 1kHz INT AM slide switch, located on the rear panel, to ON and adjust the INT AM FREQ ADJ for the desired frequency variation of ±5% about 1kHz.

3. For external AM, connect a source of amplitude modulation to the EXT AM INPUT connector, located on the rear panel of the instrument.

4. For external FM, connect a source of frequency modulation to the EXT FM INPUT connector, located on the rear panel of the instrument.

- Should it be desired to externally level the RF output, proceed as follows:

1. Make the necessary connections and set the front panel controls as outlined in paragraph 2-6.

2. For maximum signal level at the sacrifice of internal leveling, set the LEVELING INT/EXT switch to EXT. Ensure that there is no connection made at the INPUT connector and that the ALC ADJ potentiometer is set fully clockwise.

3. For leveling with an external directional detector, set the LEVELING INT/EXT switch to EXT and apply a negative leveling voltage from the detected output of the directional coupler to the INPUT connector. Adjust the ALC ADJ potentiometer for the proper leveled output. Leveling can typically be obtained from voltages of -150 to -5mV. The UNLEVELED lamp will illuminate if the signal is not properly leveled across the entire frequency band being used.

- Should it be desired to externally trigger the sweep operation, proceed as follows:

1. Make the necessary connections and set the front panel controls as outlined in paragraph 2-6.

2. Connect the external trigger source to the TRIGGER INPUT connector, located on the rear panel. The trigger pulse should have the following characteristics:

AMPLITUDE . . . . . +1 to +25V

PULSE WIDTH. . . . . >1μs

RISE TIME. . . . . . . >0.1V/μs

3. Set the SWEEP MODE selector switch to TRIG.

2-8. REMOTE FREQUENCY CONTROL AND PROGRAMMING

The Model 610C Sweep Generator has provisions, via the rear panel terminal strip (TB201), for two methods of remote frequency programming. One method provides for remote frequency control. This enables the user to manually sweep the full frequency range, of the RF Plug-In being used, from a remote location. The other method provides for remote programming of a center frequency (F_o) and the percentage of sweep (ΔF) about that center frequency. The internal sweep of the generator is used, but two separate controls are externally connected to establish the frequency constraints. These remote controls function the same as the VAR FREQ MKR and ΔF FREQ potentiometer, located on the front panel, except that the percentage of frequency span is increased from 0-10% to 0-100%. In the standard operating configuration, terminal B of TB201 is directly coupled to terminal C via a shorting link. When remote frequency control is desired, this shorting link is removed and the required external resistive or voltage connections are made.

In addition, Option 4 provides the means to select from three preset center frequencies (F_o) and a corresponding frequency span (ΔF). Refer to paragraph 1-4 for further details on this option.

2-8.1 HOW TO REMOTELY CONTROL THE FREQUENCY

The following outlines those steps necessary to connect and establish remote frequency control.

1. Loosen the screws and remove the shorting link from terminals B and C of TB201.

2. Apply a 0 to +9.75Vdc level between terminals B and D or connect a 10,000 ohm potentiometer between terminals A, B, and D as shown in Figure 2-3.

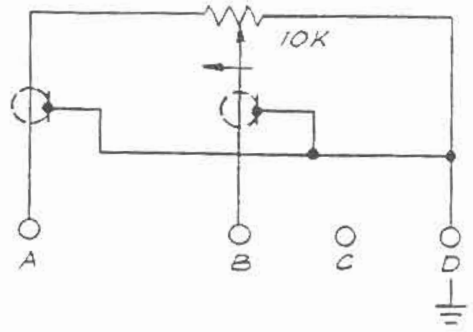

Figure 2-3 Potentiometer Connections for Remote Frequency Control

Terminal A provides a voltage source (+11.2V thru 620 ohms) for an external 10,000 ohm potentiometer or resistive divider, terminal B is the voltage control input, and terminal D is ground.

In remote situations, well shielded leads and minimum ground loops are required to minimize the effects of unwanted frequency modulation on the sweep output. For stability and accuracy, a precision wire-wound potentiometer with good linearity should be used.

A specific fixed frequency can be established with a fixed resistor divider network as shown in Figure 2-4.

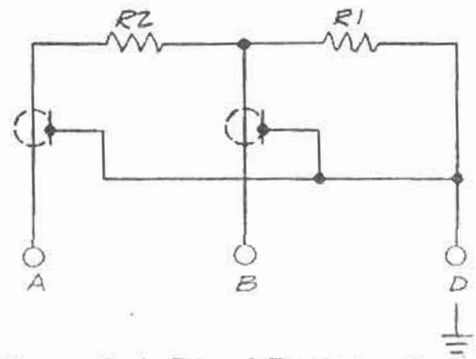

Figure 2-4 Fixed Resistor Connections for Remote Frequency Control

When using this configuration:

R1 = F x 10,000 ohms (1)
R2 = 10,000 ohms - R1

....where F is the desired fixed frequency expressed as a percentage of the full RF Plug-In frequency range.

For the purpose of illustration, let's assume that a fixed, non-swept frequency of 75MHz is desired. A Model 6104 RF Plug-In would be used to provide the necessary band of frequencies. To calculate the value of F, simply divide the desired frequency by the upper frequency of the RF Plug-In.

$$F = \frac{75MHz}{100MHz} = .75 \text{ or } 75\% \qquad (2)$$

To calculate the value of R1, multiply the total resistance of the network (10,000 ohms) by the value calculated for F.

$$R1 = 10{,}000 \text{ ohms} \times .75 = 7{,}500 \text{ ohms} \qquad (3)$$

To calculate the value of R2, subtract the value of R1 from the total resistance of the network.

$$R2 = 10{,}000 \text{ ohms} - 7{,}500 \text{ ohms} = 2{,}500 \text{ ohms} \qquad (4)$$

Connect resistors of the values calculated in the configuration shown in Figure 2-4. For stability and accuracy, precision metal film or wire-wound resistors should be used.

> Note: Due to the tolerances involved, this method will provide a fixed, non-swept frequency near 75MHz. It will be necessary to trim R1 or R2 to achieve the exact frequency.

Similarly, adding a selector switch between terminal B and additional taps along the total resistance path would provide a multiple of fixed frequencies.

2-8.2 HOW TO REMOTELY PROGRAM F_O AND ΔF

The following outlines those steps necessary to connect and establish remotely programmed control of a center frequency (F_O) and the percentage of sweep (ΔF) about that center frequency.

1. Set the FREQ SELECTOR to REMOTE (PROGRAM).
2. Ensure that the shorting link is securely connected between terminals B and C.
3. Connect a 10,000 and a 50,000 ohm potentiometer as shown in Figure 2-5.

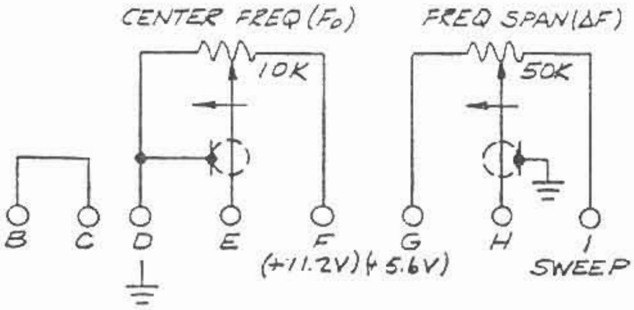

Figure 2-5 Potentiometer Connections for Remote F_O and ΔF Programming

Both potentiometers should be linear so that the percentage of resolution equals the percentage of the RF Plug-In frequency band. The indicated resistance shown in Figure 2-5 must be observed for optimum results.

The WILTRON factory installed option (Option 4) can be used to provide three selectable center frequencies (F_O) and a corresponding frequency span (ΔF). Potentiometers on the control panel provide adjustment of the center frequency and the percentage of sweep (0 to 100%) about this frequency. In this way three distinct programs can be established and selected at the front panel of the instrument. Refer to paragraph 1-4 for further details on this option.

A WILTRON Model 6111 Frequency Programmer can be used to provide 10 swept frequency programs, each selectable with a front panel switch. Connections are made at the rear of the Model 610C Sweep Generator. Each program can then be preset by the user to result in the desired frequency range.

SECTION III

THEORY OF OPERATION

3-1. INTRODUCTION

This section of the manual contains information regarding the circuit operation of those assemblies that comprise the Model 610C Sweep Generator. Included are separate discussuions on the Sweep Generator, Frequency Instruction, Variable and Birdie Markers, Level and High Voltage Regulators, and Power Supply assemblies. Each discussion begins with a functional description of the circuit which is supported by a functional block diagram of that particular assembly. This is followed by a stage-by-stage discussion of how the actual components function within the circuit. A schematic representation of each assembly is provided for reference in Section VI. See Figure 4-10 for a simplified signal flow diagram of the 610C.

3-2. SWEEP GENERATOR

The Sweep Generator assembly (610C-ML-835) contains the basic circuit elements of the Model 610C Sweep Generator. Refer to Figure 6-1 during the following discussion.

As shown in the simplified functional diagram of Figure 3-1, a Miller Integrator functions as the heart of the generator. It consists of a high gain amplifier with selectable capacitive feedback C_T. A charging current i_T is generated by the voltage source comprised of a voltage -E through the series resistance R_T. A Schmitt Trigger circuit controls the magnitude and direction, either positive or negative, of the charging current i_T. It also triggers the blanking circuits which provide

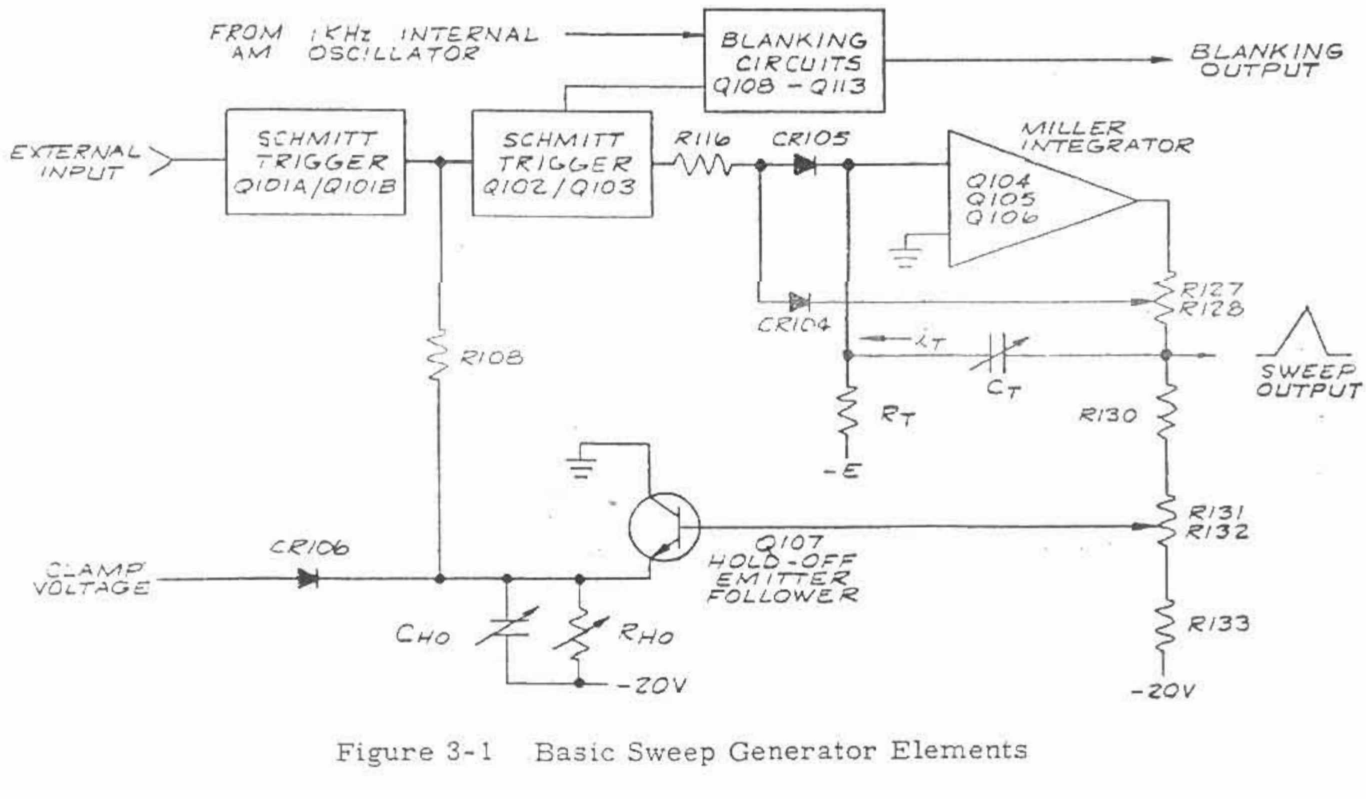

Figure 3-1 Basic Sweep Generator Elements

leveling and RF Plug-In control. The ramp output of the amplifier is attenuated and voltage offset by the resistive divider network. A portion of this output is coupled back through the Hold-Off Emitter Follower stage to the input of the Schmitt Trigger.

This loop controls the state of the Schmitt Trigger which in turn controls the magnitude and direction of the charging current i_T. A second Schmitt Trigger circuit provides uniform trigger pulses for a variety of triggered input sources.

The amplifier used in the Miller Integrator is comprised of Q104, Q105, and Q106. A field-effect-transistor (FET) Q104 is used in the input of this amplifier to provide the very high input impedance required to permit slow sweep rates with capacitors of a reasonable size. Selection of the feedback capacitor C_T is performed by the SWEEP TIME (SEC) switch S102 which provides one of four basic ramp rates. The selected capacitor is charged by the voltage -E through the series resistance R_T. This voltage -E is the output of the dwell circuit shown in Figure 6-3 and its value is determined by the setting of the SWEEP TIME (SEC) VERNIER potentiometer R134. Varying -E adjusts the charging current i_T which controls the ramp rate over a given range. Full coverage from .01s to 100s is achieved through the combined use of the SWEEP TIME (SEC) switch and the SWEEP TIME (SEC) VERNIER potentiometer.

The Schmitt Trigger circuit, Q102 and Q103, controls the action of the Miller Integrator through R116 and CR105. Initially, Q103 is biased on while Q102 remains off. This causes CR105 to open allowing the charging current i_T to charge C_T in a positive direction producing an increasing ramp voltage, at the output of the high gain amplifier, which is linear with respect to time. The ramp continues to increase until the portion which is fed back through the Hold-Off Emitter Follower circuit Q107 causes the Schmitt Trigger to change state. This occurs when the upper hysterysis level (UHL) of Q102 and Q103 is reached. At this point, Q103 is biased off, CR105 conducts and a current which is approximately seven times that of i_T is coupled through R116. The integrating process now reverses and C_T charges linearly, but in a negative direction at a rate six times faster than its previously positive charge rate. The ramp output continues to decrease until CR104 conducts providing a path around the amplifier thus bypassing C_T. This establishes a stable starting level for the next sweep. Current continues to flow through CR104 and the resistive divider charging the hold-off capacitor C_{HO}. A slower time constant is set up by C_{HO} and the hold-off resistive network R_{HO}. The value of C_{HO} is determined by the SWEEP TIME (SEC) switch setting, while the value of R_{HO} is set by the Hold-Off Adj. potentiometer R151. This slower time constant causes the emitter voltage of Q107 to decay at the slower rate until the lower hysterysis level (LHL) of the Schmitt Trigger circuit is reached. At this point, Q102 and Q103 change state to initiate another sweep.

Figure 3-2 illustrates the generated sweep voltage output of the Miller Integrator, the two states of the Schmitt Trigger circuit, and the base and emitter voltages of the Hold-Off Emitter Follower Q107. All of these waveforms are generated while operating in the AUTO mode. As can be seen, the base voltage is that portion of the sweep voltage sampled by the resistive divider and therefore it follows the full excursion of the sweep voltage. When the base becomes more positive than the emitter, Q107 conducts and it too begins to follow the sweep voltage excursion. The level at which Q107 conducts is established by the clamp voltage applied through CR106. In the AUTO mode of operation, a more negative clamp voltage is applied which allows Q107 to conduct at a more negative level than the lower hysterysis level of the Schmitt Trigger. In this way, the output from Q107, during Sweep Recovery Time, is sufficient to change the state of the Schmitt Trigger circuit. With the SWEEP MODE switch S101 set to LINE SYNC or TRIG, a less negative clamp voltage is applied which

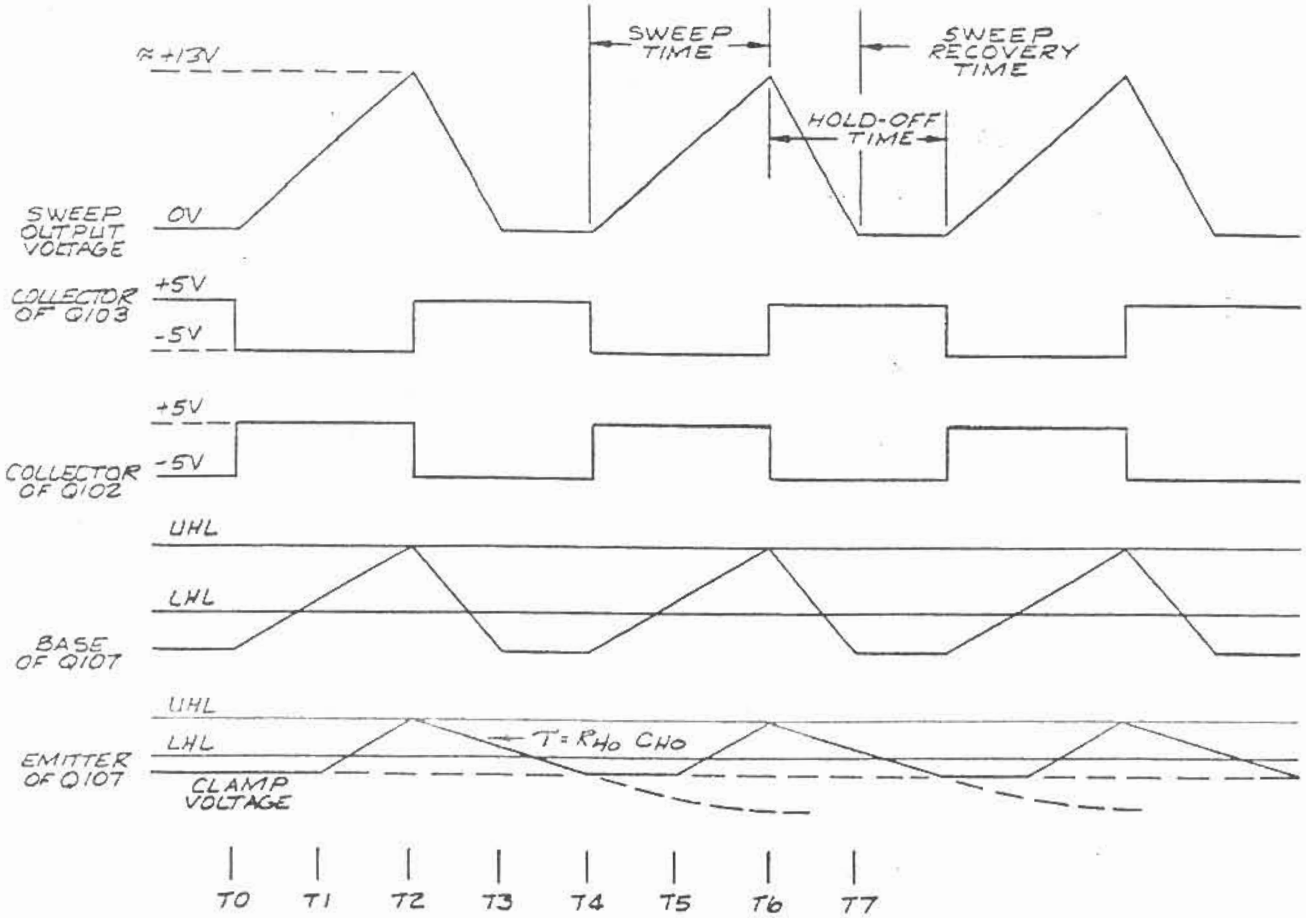

Figure 3-2 Sweep Waveforms in the AUTO Mode

prevents the output of Q107 from reaching the lower hysterysis level. The Trigger Adj. potentiometer R138 sets the clamp voltage at this less negative level. A negative spike of voltage must be summed with the output of Q107 in order to exceed the lower hysterysis level and thus cause the Schmitt Trigger circuit to change state. Figure 3-3 illustrates the addition of these negative trigger pulses to the output excursion of Q107. These pulses are generated by the Schmitt Trigger, Q101A and Q101B. This circuit provides a uniform pulsed output for a variety of trigger inputs. A sinusoidal waveform triggers the Schmitt Trigger when S101 is set to LINE SYNC. Positive pulses from an externally connected source trigger it when S101 is set to TRIG. Either input is differentiated by C101 and R101 and it is the resultant that triggers Q101A and Q101B. The output is then differentiated by C103 and R107 and the diodes CR102 and CR103 couple the negative trigger pulses through C104 to the input of Q102. Here they are summed with the output of Q107. Manual triggering is accomplished with S101 set to TRIG and the Trigger pushbutton momentarily depressed. This discharges the selected hold-off capacitor and upon release, the discharged capacitor causes the emitter voltage to go more negative crossing the lower hysterysis level of the Schmitt Trigger. When this occurs during Sweep Recovery Time Q102 and Q103 change state and another sweep is initiated.

The blanking circuits, Q108 through Q113, provide leveling and RF Plug-In control. Figure 3-4 illustrates the waveforms generated by these circuits. During Sweep Time, Q102 of the Schmitt Trigger, is biased off and the voltage at its collector is positive. This positive voltage causes Q108 through Q113 to conduct. With Q111 conducting, the Blanking (+) output drops to 0V. The Blanking (-) output goes to +29V (due to the drop across R146) and remains there until Q112 ceases to conduct.

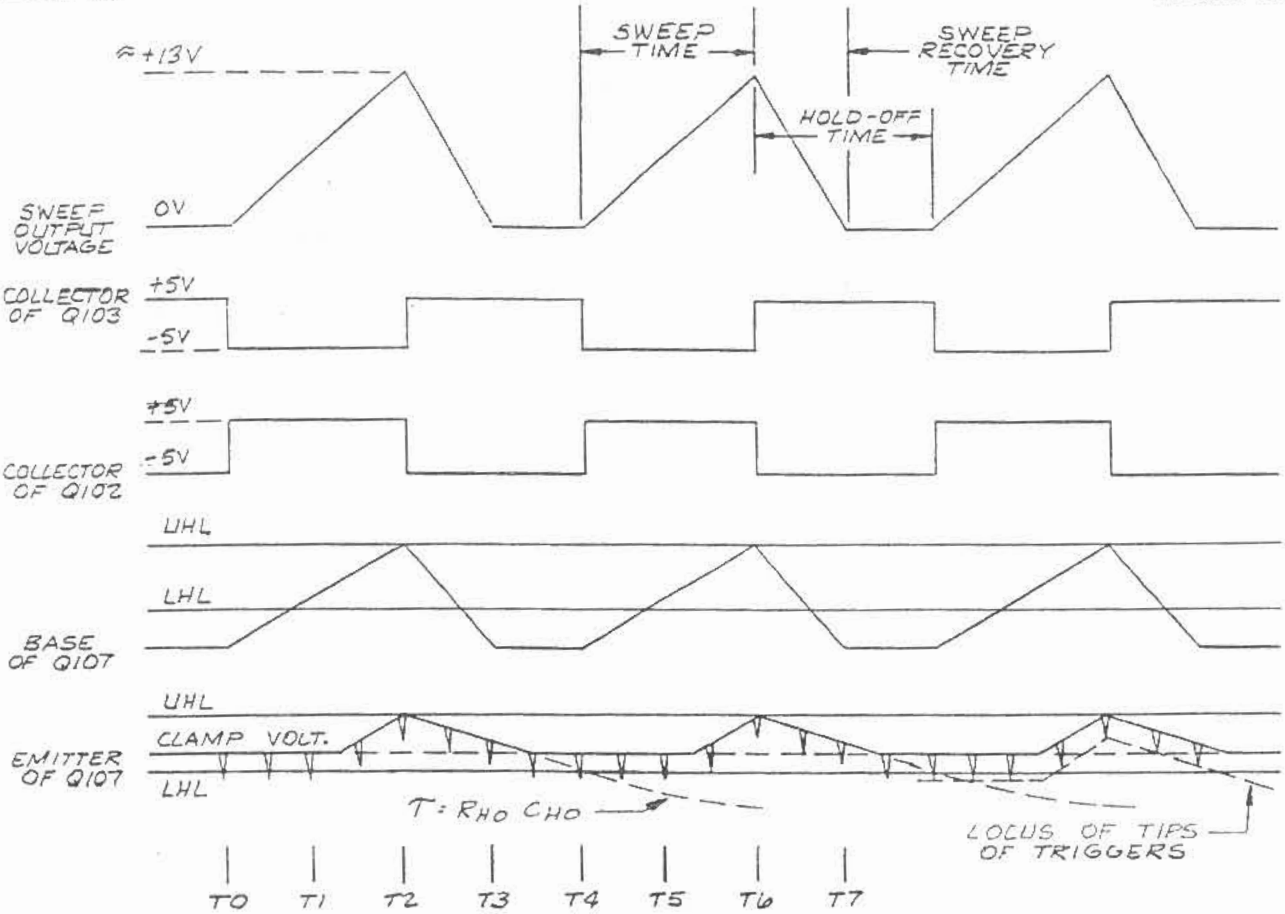

Figure 3-3 Triggered Sweep Waveforms

During Hold-Off Time, Q102 is biased on causing a negative voltage at its collector. This negative voltage causes Q108 and Q113 to be off which provides a +6V level at the BLANKING OUTPUT connector J102. A +30V level is provided to the Variable and Birdie Markers assembly (610C-ML-834) and to the optional pen lift relay circuitry (Option 9). With the RETRACE RF ON/OFF switch S104 set to ON, the emitter of Q109 is grounded causing it to conduct. This in turn causes Q111 and Q112 to conduct and remain on as long as S104 is set to ON. The Blanking (+) output will then be at 0V, while the Blanking (-) output remains at +29V. In the INT AM mode, the output of the 1kHz Internal AM Oscillator causes Q109 to cycle at a 1kHz rate. This causes the Blanking (+) and Blanking (-) outputs to cycle at the same rate These blanking outputs are supplied to the circuits of the RF Plug-In being used and to the leveling circuitry shown in Figure 6-4.

When operating in the MANUAL mode, the Schmitt Trigger, Q102 and Q103, is disabled. The output of the amplifier remains at the starting level and the blanking outputs are set to function as though a sweep were activated. The MANUAL potentiometer R144, which is part of the SWEEP MODE switch, provides a linear ramp of voltage as it is adjusted. This ramp simulates the ramp output of the Miller Integrator except that it is completely adjustable. In this mode, the remainder of the instrument functions in the normal manner.

3-3. FREQUENCY INSTRUCTION

The Frequency Instruction assembly (610C-ML-833) provides the circuitry that conditions the sweep output. A clamp circuit, differential comparator amplifier, and impedance converter constitute the majority of this assembly. Their functions are controlled by the switching arrangement of the FREQ SELECTOR. Refer to Figure 6-2 during the following discussion.

The sweep output, generated by the Sweep Generator assembly (610C-ML-835), is coupled through the SWEEP MODE switch to the input of the clamp circuit. Here it

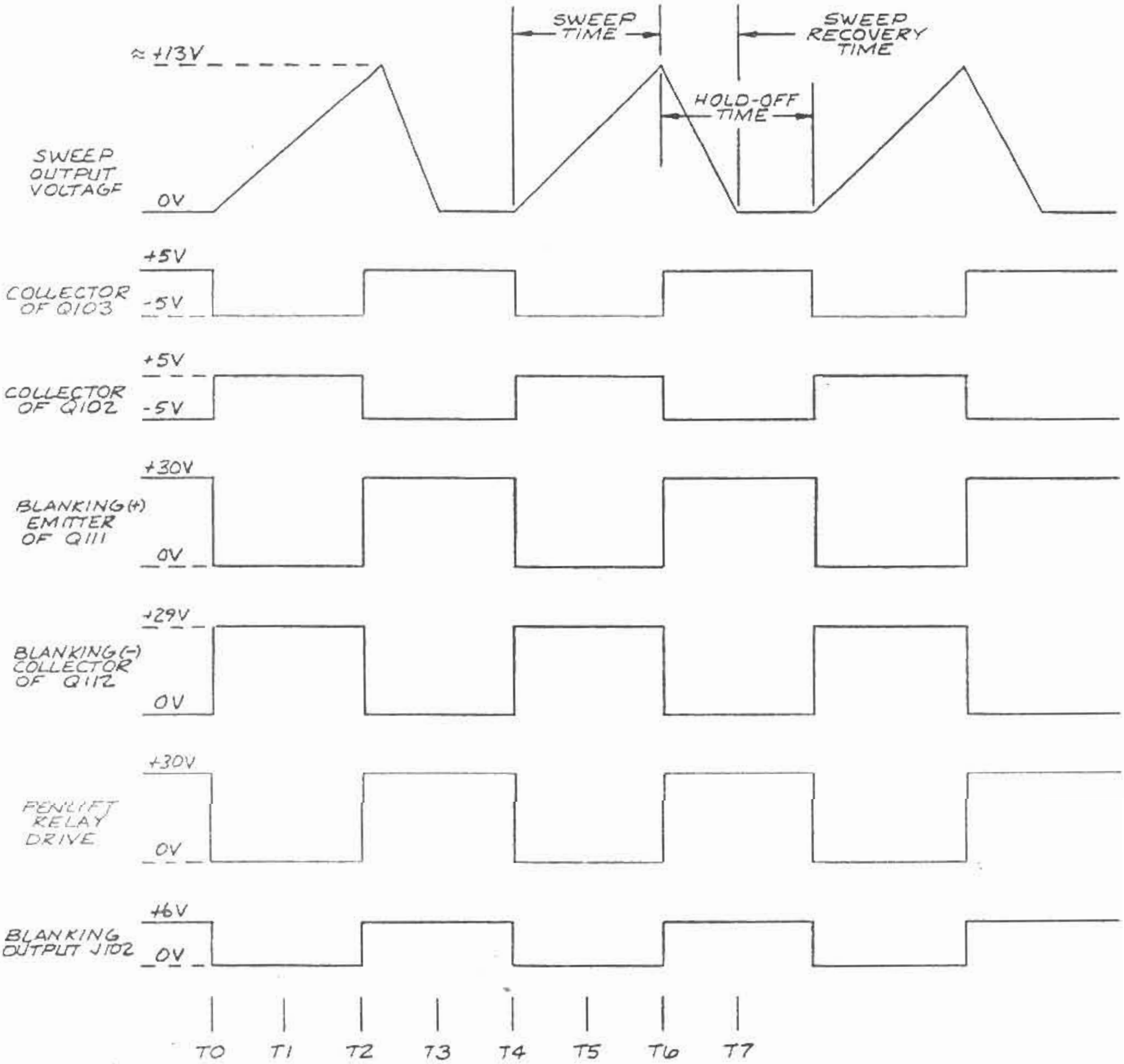

Figure 3-4 Blanking Waveforms

is clamped between two stable reference voltages so that the levels traversed by the sweep can accurately be established. The sweep voltage is truncated to 0 to +11.2V and supplied through the FREQ SELECTOR switch and Frequency Selectors F1 and F2 to the inputs of the differential amplifier. It is also coupled to the HORIZ OUT connector where it can be used to sweep the horizontal circuits of an oscilloscope or X-Y recorder. The F1 Frequency Selector is referenced to the +11.2V supply and F2 is referenced to ground. The voltages established by these controls (E1 and E2) are compared by the differential amplifier and the difference voltage (Eo) is coupled to the impedance converter. This circuit converts the high output impedance of the differential amplifier to one of approximately 100 ohms to provide a greater current driving capability. The output from the impedance converter is coupled through the shorting link on the real panel terminal strip to the frequency control circuits of the RF Plug-In being used. A simplified functional block diagram of this assembly is shown in Figure 3-5. It is representative of the circuit in the F1 TO F2 mode of operation.

A set of vector diagrams, for operation in the F1 TO F2 mode, is shown in Figure 3-6. As can be seen from Figure 3-6A, the output of the differential amplifier (Eo) is at a level that represents a full sweep output to the RF Plug-In being used. This condition occurs when F1 is set to 0% (fully CCW) and F2 is set to 100% (fully CW). This produces the corresponding input voltages (E1 and E2). With F1 set to 0%, the full 0 to +11.2V sweep output from the clamp circuit is applied as voltage E1 to one input of the differential amplifier. The other input is grounded (E2=0V) since F2 is set to 100%. The resultant differential voltage (Eo) will follow the full sweep output, but the amplifier has been set to produce a 0 to +10V excursion for a 0 to +11.2V differential input. The loading effect of the impedance converter drops this output to 0 to +9.750V and this is the sweep voltage used to drive the frequency control circuits of the RF Plug-In. Three other combinations of Frequency Selector settings are shown in Figure 3-6. The resultant differential voltage(Eo) in each case equates to the percentage of sweep output. Although the circuit operation shown in Figure 3-6A has F1 set below F2, these settings may be reversed with the operation remaining the same, except that the output will traverse from the higher level set by F1 to the lower level set by F2.

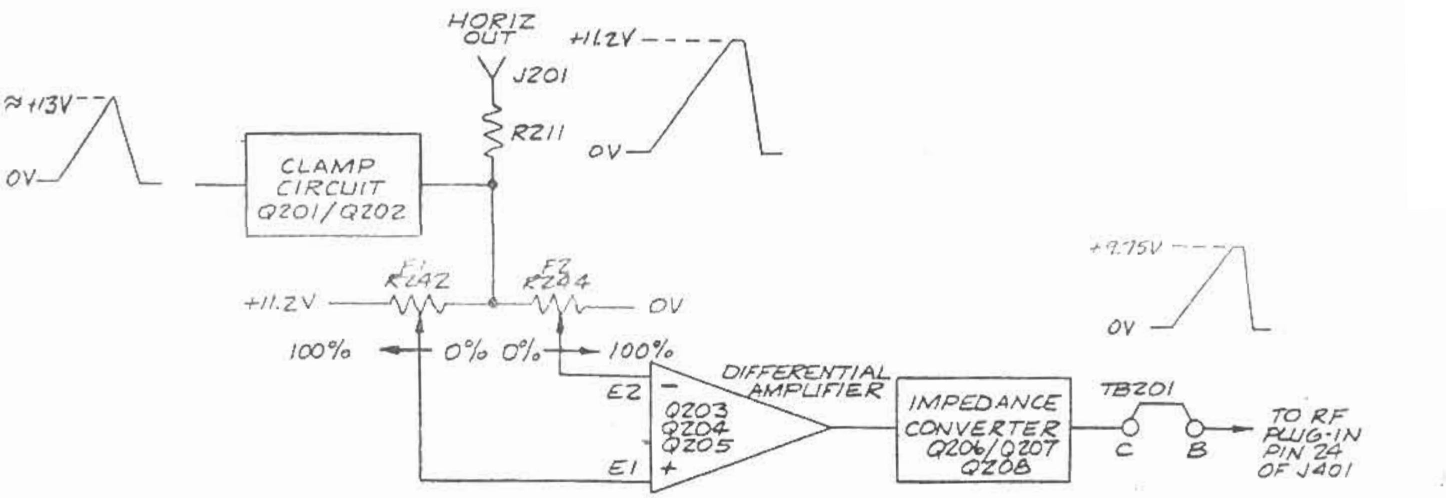

Figure 3-5 Basic Frequency Instruction Circuit

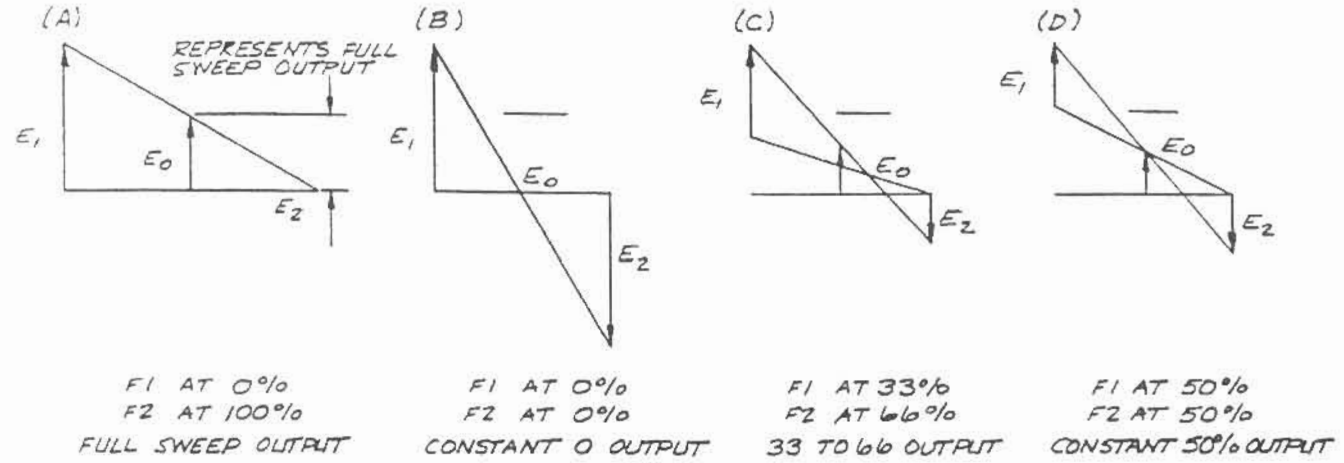

Figure 3-6 Vector Summing Diagrams

The sweep output from the Sweep Generator assembly is coupled through S101 and R205 to the input of the clamp circuit, Q201 and Q202. The upper end of the sweep voltage is clamped to the +11.2V supply and the lower end to a voltage equal to the forward drops of CR201 and Q201. Each clamp voltage is adjustable and temperature compensated so that the output of Q201 can be set to traverse from zero to the voltage of the +11.2V reference supply. The upper end is set by the End Adj potentiometer R201, while the Begin Adj potentiometer R206 sets the lower end. The output is then coupled to the switching arrangement of the FREQ SELECTOR S201, for proper routing, to terminal I of TB201 for remote programming, and through R211 to the HORIZ OUT connector J201 to be used to externally synchronize an oscilloscope or X-Y recorder.

In the F1 TO F2 mode of operation, this output is connected to the center of the voltage divider established by the Frequency Selectors F1 and F2. The +11.2V supply is used to reference the F1 Frequency Selector, while F2 is referenced to ground. The F2 CAL potentiometer R245 is used to compensate for the electrical versus mechanical tracking of the circuit. The wipers of F1 and F2 are connected to the inputs of the differential comparator amplifier, Q203. The reversible current source, Q204 and Q205, provides the emitter drive source for the amplifier. The Amplitude potentiometer R218 sets the output swing of the amplifier to 0 to +10V for a differential input swing of 0 to +11.2V. The Tracking potentiometer R215 balances the inputs to the amplifier so that with 0V into each input the output will be 0V. The emitter current of the current source is set by the ΔF Offset potentiometer R225.

The impedance converter, Q206, Q207, and Q208, converts the high output impedance of the amplifier to one of approximately 100 ohms. This provides a greater current driving capability for the variety of RF Plug-Ins available. The Freq Zero potentiometer R237 adjusts out any offset voltage in the circuit and thus permits the electrical zero of the circuit to correspond with the mechanical zero of the Slide Rule Dial. The conditioned swept output is then coupled through the shorting link, placed between the terminals B and C on the rear panel terminal strip TB201, to the frequency control circuits of the RF Plug-In being used. It is also directly coupled to the input of the variable frequency marker circuit. See Figure 6-3.

When set for ΔF operation, the output from the clamp circuit is coupled to the divider network of R210 and R241. The +5.6V supply is used to reference this divider. The adjustable output, taken at the wiper of the ΔF FREQ potentiometer R241, is coupled through the FREQ SELECTOR to one input of the differential amplifier. The other input is connected to the wiper of the VAR FREQ MKR potentiometer R247 which together with the Marker Cal potentiometer R248 form another voltage divider. These connections are shown simplified in Figure 3-7. The voltage established by the setting of the VAR FREQ MKR potentiometer determines the center frequency of the ΔF sweep. The swept output of the clamp circuit is sampled and set between 0 and 10% of its total value by the ΔF FREQ potentiometer. The current source, Q204 and Q205 is also switched to compensate for the decrease in the reference supply from +11.2V to +5.6V. The sweep voltage applied to the RF Plug-In will vary 0 to 10% about the frequency that corresponds to the voltage established by the setting of the VAR FREQ MKR potentiometer.

With any one of the three CW operations selected, one input of the differential amplifier is referenced to the +5.6V supply. The remaining input is switched to the corresponding voltage divider tap, F1 (R242 and R243), VAR FREQ MKR (R247 and R248), or F2 (R244 and R245) which produces a voltage proportional to the frequency set on the Slide Rule Dial. The current source is switched to correct for the +5.6V offset voltage caused by the lower reference voltage. The differential voltage output (Eo) will represent a non-swept, fixed-frequency to the RF Plug-In. Capacitor C202 is shunted by the larger capacitor C201 to provide better stability and less noise. The smaller capacitor had to be used in the other modes of operation to allow full passage of the sweep. A simplified drawing of those connections made during CWF1, CW MKR, or CWF2 operation is shown in Figure 3-8.

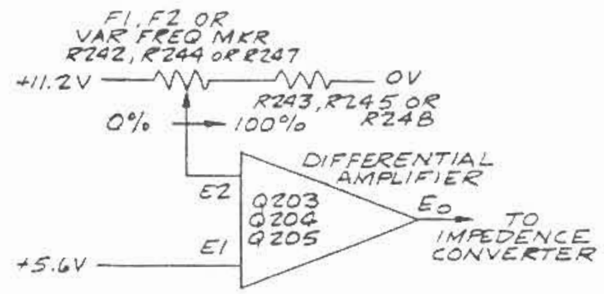

Figure 3-8 Simplified CW Operation

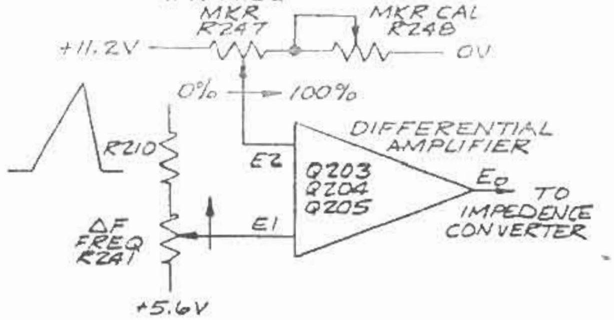

Figure 3-7 Simplified ΔF Operation

In the REMOTE (PROGRAM) mode of operation, the two inputs to the differential amplifier are switched to the rear panel terminal strip TB201. This provides direct access for the external connection of two potentiometers which simulate the functions of the ΔF FREQ and VAR FREQ MKR controls. The only difference in the operation is that the frequency span controlled by the remote ΔF FREQ potentiometer is increased to 0 to 100% rather than 0 to 10%. The shorting link connected between terminals B and C can also be removed and replaced by a potentiometer when remote manual frequency control is desired. Here the +11.2V reference supply is connected in series with a 620 ohm resistor to form a voltage source. When a 10,000 ohm potentiometer is connected between terminals A and D of TB201 and the wiper to terminal B, a voltage which is proportional to a given frequency will be coupled to the frequency control circuits of the RF Plug-In. Refer to paragraph 2-8 for further details regarding remote frequency control and programming.

3-4. VARIABLE AND BIRDIE MARKERS

The Variable and Birdie Markers assembly (610C-ML-834) provides the circuitry for two marker systems, the Variable Frequency Markers and the Birdie Markers. Refer to Figure 6-3 during the following discussion.

The Variable Frequency Marker system provides three selectable identifying marks on the displayed sweep. The frequency at which the mark will appear is adjustable with the VAR FREQ MKR potentiometer R223. During F1 TO F2 and REMOTE (PROGRAM) sweep operations with the RF PIP selected, the RF output will be blanked at the selected frequency. With the VAR FREQ MARKER switch set to VIDEO, a negative-going pulse will be summed with the RF output at the preset marker frequency. When the INTENSITY marker is selected, the sweep will be slowed momentarily at the selected marker frequency causing an intensification of the oscilloscope trace as the marker. The optional Birdie Marker system provides a distinctive, double peaked response which is coupled to the vertical output for display on the detected RF output.

The Variable Frequency Marker circuit functions to provide a video output for display on the detected RF output. The basic circuit configuration is shown in Figure 3-9. Resistors R and 2R sum two voltages of opposite polarity, the swept output voltage used to control the frequency of the RF Plug-In and a dc voltage proportional to the marker frequency set on the Slide Rule Dial. The sum of these voltages e_s equals zero when the swept output corresponds to the

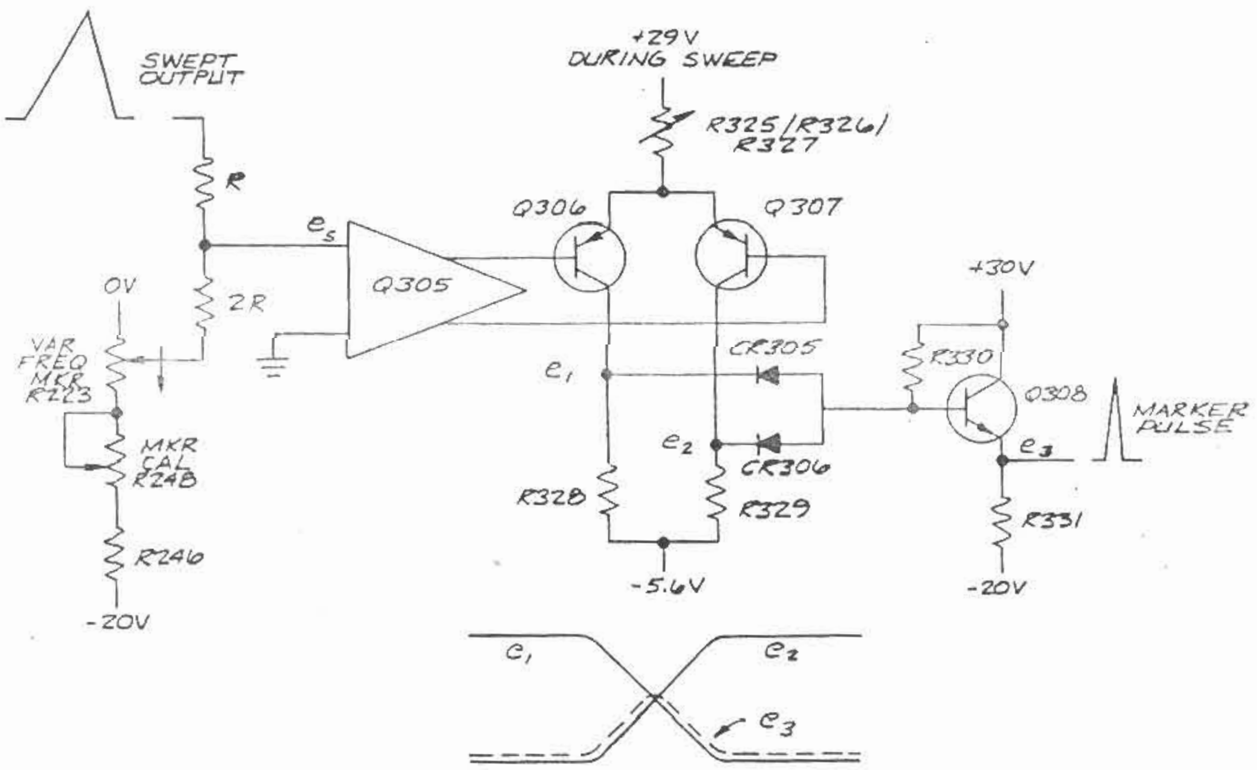

Figure 3-9 Basic Variable Frequency Marker Circuit

marker frequency voltage. This voltage e_S is coupled to a high gain comparator amplifier Q305 which is followed by a differential amplifier Q306 and Q307. As the swept output voltage causes e_S to cross zero, the current in the differential amplifier makes a linear transition from Q306 to Q307. The voltage e_2 at the collector of Q307 moves from -5.6 V to the more positive value set by R329 and the combination of R325, R326, and R327. The voltage e_1, at the collector of Q306 simultaneously makes the opposite transition. The diode logic of CR305 and CR306 couples the more negative portions of these two changing voltages to the emitter follower Q308. This thus shapes the variable frequency marker pulse e_3. Refer to the waveform shown in Figure 3-9. The Max Ampl Adj potentiometer R326 establishes the magnitude of the pulse by varying the amount of available current. The AMPLITUDE potentiometer R327, located on the front panel, provides further adjustment of the pulse amplitude. The high gain employed produces a very narrow marker pulse at full amplitude and an even narrower pulse at reduced amplitudes. The Blanking (-) signal disables the differential amplifier during retrace thus preventing retrace markers.

With the VAR FREQ MARKER switch S302 set to VIDEO, the positive-going pulse is coupled to the inverter Q303 and then to the VERT OUT connector J107. The narrow, now negative pulse is superimposed onto the signals present at J107. In the RF PIP position, the positive-going pulse is coupled through CR307 to cause a momentary decrease in the reference voltage applied to the Level Regulator circuit. This causes a momentary dip in the RF output at the preset marker frequency. When set to INTENSITY, the positive-going pulse is coupled to the dwell circuit, Q309 and Q310. This circuit produces a momentary increase in the voltage -E which is used to charge the feedback capacitor C_T in the Sweep Generator circuit. Refer to paragraph 3-2 and Figure 6-1. The normal level at the collector of Q310 is -18V, but this increases to -0.5V during the

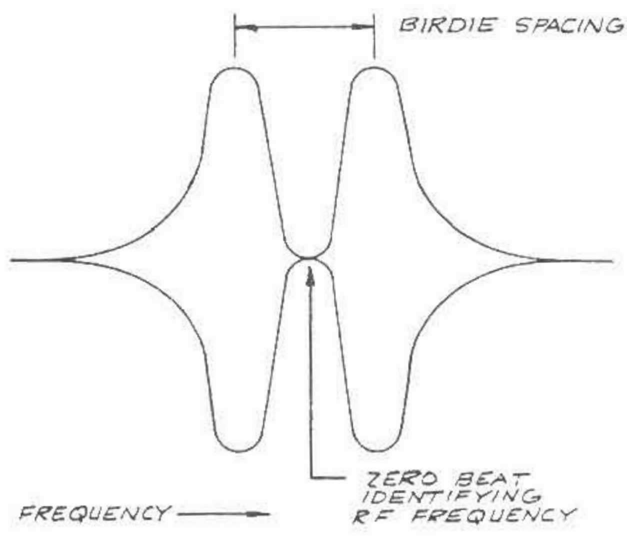

Figure 3-10 Characteristic Birdie Marker Envelope

period of the marker pulse when it is at its maximum amplitude. This reduces the charging current i_T causing the progress of the sweep to slow producing an intensification of the oscilloscope trace at the particular marker frequency. This function is also present with the RF PIP and VIDEO marker selected. It delays the sweep long enough to apply the marker. The Dwell Adj potentiometer R341 sets the gain of the dwell circuit.

The optional birdie markers are derived from a mixer, located next to the RF Plug-In connector J401 at the rear of the instrument. Every RF Plug-In below 8GHz has an internal provision for sampling a portion of the RF output and coupling it to this mixer. The sampled RF is mixed with the RF output from up to six single frequency oscillators or a harmonic train of RF frequencies. A diode in the mixer provides the non-linear mixing action and the beat frequency is brought out through a filter. The beat frequency is enlarged and shaped by the tuned amplifier Q301 to produce the typical birdie characteristic shown in Figure 3-10.

This amplifier is single-tuned to produce a response peak at its center frequency. The birdie has two response peaks since it crosses the amplifier's response twice, once as the sweeping RF approaches the marker from below and again as it passes beyond.

The spacing between the peaks is 12kHz with the Narrow tuned circuit selected and 200kHz with the Wide tuned circuit. The tuned circuit, L302 and C304 establishes the Wide response, while L301, C303, and R308 sets the Narrow. An untuned, fixed-gain amplifier Q302 provides further magnitude and this is adjusted by the Birdie Markers AMPLITUDE potentiometer R311. These two birdie marker widths are provided for use with both Wide and Narrow sweeps. The Wide marker should always be selected when sweep width permits since it receives greater energy and typically produces a larger marker. The markers will improve in appearance when lower or narrower sweeps are used since the transition rate in MHz/s through the birdie amplifier spectrum is reduced permitting the birdie envelope to contain more cycles of the beat frequency energy.

The Harmonic Marker Generator (Option 1), which attaches to the main frame, contains four crystal oscillators (1, 10, 50, and 100 MHz) which are coupled through two buffer amplifiers to a step recovery diode in the birdie marker mixer. During the reversed bias period, the diode continues to conduct as the stored charge is swept out. This reverse current suddenly drops to zero, due to the particular doping of the junction, creating a sharp voltage step which is rich in the harmonics of the RF output signal. The generator that provides the fundamental frequency at 1MHz is a crystal oscillator. The oscillator output is fed to a multivibrator which provides the necessary rapid drive signal for the step recovery diode. See Figure 6-6.

The Single Frequency Marker unit consists of a crystal oscillator and an emitter follower. The output is lightly coupled to a 50 ohm coaxial line which passes through the unit. Successive units are connected in series with a 50 ohm termination on the last and the first is connected to the birdie mixer. The available crystal frequency range is 100kHz to 100MHz. See Figure 6-7.

3-5. LEVEL AND HIGH VOLTAGE REGULATORS

The Level and High Voltage Regulators

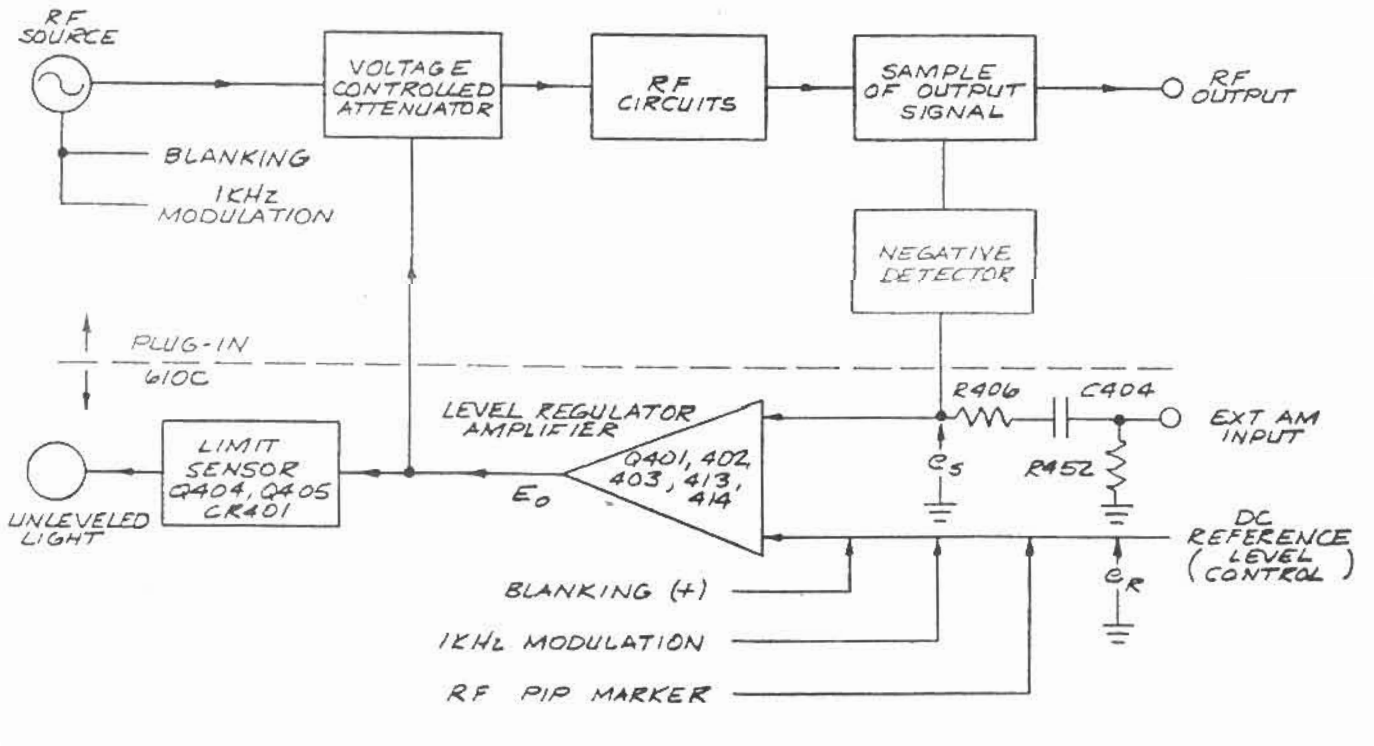

Figure 3-11 Basic ALC Loop Circuit

assembly (610C-ML-836) consists of the Level Regulator Amplifier and Limit Sensor circuits that form part of the automatic level control (ALC) loop, the 1kHz Internal AM Oscillator used to internally modulate the sweep output, and the Programmable High Voltage Regulator circuit which is used to develop the programmable +40 to +140Vdc output. Refer to Figure 6-4 during the following discussion.

The RF output signal is monitored and maintained level through the use of electrical feedback to a voltage controlled attenuator. The basic circuit configuration for the ALC loop is shown in Figure 3-11. Here the RF output from the RF Plug-In is sampled and converted to a negative dc voltage e_s through the use of a negative detector with a flat frequency response. Both the sampling and negative detector circuitry are located in the RF Plug-In. In many of the RF Plug-Ins, the sampling circuitry is a coupler which provides a signal 20dB down from the main signal. The high gain Level Regulator Amplifier compares the sampled voltage e_s against a reference voltage e_r and the difference voltage Eo is used to drive the voltage controlled attenuator in the RF Plug-In. This amplifier also supplies the means to couple a signal from an external AM source when it is desired to modulate the RF output. With the ALC loop operating in this manner, the RF output signal will be maintained level and have the same flat frequency response characteristics as the sampling and negative detector circuitry. The Limit Sensor monitors the operation of the ALC loop so that whenever level control cannot be maintained the UNLEVELED lamp will illuminate to provide a visual indication of this condition.

The Limit Regulator Amplifier consists of two differential amplifiers, Q401/Q402 and Q413/Q414, connected in cascade and an output stage Q403. The Level Balance potentiometer R408 cancels the effects of the base-emitter voltage drops of Q401 and Q402 to match both sides of the amplifier. The input impedance of the reference portion of the amplifier is established by R455 and C412, while R406, R452, and C404 match the input impedance of the sampling input. The Blanking (+) signal, generated

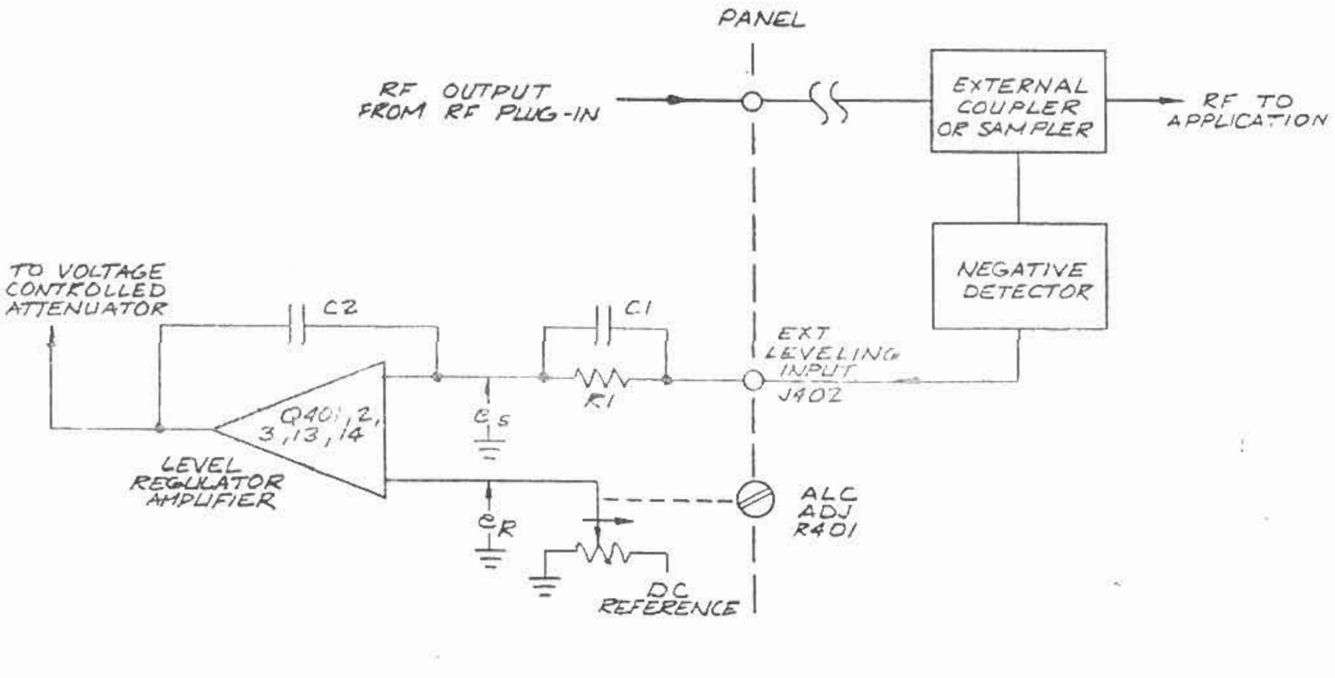

Figure 3-12 External Leveling Circuit

by the blanking circuits of the Sweep Generator assembly, is coupled to the divider network of R446 and R447. The divided output is coupled through CR407 to another voltage divider located in each RF Plug-In which is referenced to the -20V supply. This divider is controlled by the setting of the RF POWER LEVEL control or controls. The summed resultant is then coupled back through the LEVELING switch S401, which is in the INT position, to provide the reference voltage e_r for the amplifier. The RF Pip pulse from the Variable and Birdie Markers assembly can also be summed in and applied to the reference input to cause a momentary dip in the RF output. The sampled output from the level detector e_s is coupled through S401 to the base of Q402. The differential output is coupled to the driver pair Q413 and Q414 where the output stage is converted from differential to single ended. The output of this stage drives Q403 which in turn drives the voltage controlled attenuator in the RF Plug-In. This output will range from approximately +1.5V to approximately -18V depending upon the state of Q403. The loading effect of the RF Plug-In and the beta and saturation voltage of Q403 may cause these levels to vary slightly.

The Limit Sensor, Q404, Q405, and CR401, monitors this +1.5V to -18V output level. Whenever level control cannot be maintained, the feedback loop will force the output of the Level Regulator Amplifier to either its positive or negative extreme. In the case where there is an excess of RF output, the amplifier will be forced to its positive limit (approximately +1.5V). Since Q403 will then be cutoff, CR401 will conduct causing the lamp driver Q405 to activate the UNLEVELED lamp DS401. When there is insufficient RF output, the amplifier will be forced to its negative limit (approximately -18V). With Q403 saturated, Q404 will cease to conduct causing Q405 to activate the UNLEVELED lamp. The Blanking (-) signal at pin 17 is used to override the function of the lamp driver Q405 and thus prevent DS401 from flashing during retrace or when the RF output is being modulated by the 1kHz Internal AM Oscillator. The Blanking (-) signal will also deactivate Q405 when the RETRACE RF ON/OFF switch is in the OFF position.

The internal ALC loop can be disabled by setting the LEVELING switch S401 to the EXT position. An external leveling source can be connected in series with the RF output of the RF Plug-In and the EXT LEVELING INPUT connector J402, located on the front panel. A 20dB coupler and negative detector are generally used in conjunction with the RF output to form this external leveling source. These external leveling connections are shown in Figure 3-12. The elements C1, C2, and R1, which are part of the RF Plug-In circuitry, control the loop response to maintain stability. In the external leveling mode, the divided Blanking (+) signal is summed with a voltage level supplied by the RF Plug-In and both are coupled through the ALC ADJ divider R402 which substitutes for the RF POWER LEVEL voltage divider in the RF Plug-In. This is applicable to the reference input of the Level Regulator Amplifier. The negative detected output from the external leveling source is coupled through the loop response network in the RF Plug-In to the sampling input of the amplifier. The difference voltage that results from the comparison drives the voltage controlled attenuator.

The 1kHz Internal AM Oscillator generates a 1kHz squarewave signal which is used to internally modulate the RF output. This free-running multivibrator, Q406 and Q407, is activated when the 1kHz INT AM ON/OFF slide switch S402, located on the rear panel, is set to ON. The 1kHz squarewave output is coupled through CR404 to the input of the blanking circuit, located on the Sweep Generator assembly (610C-ML-835). See Figure 6-1. The INT AM FREQ ADJ potentiometer R427, located on the rear panel, is used to adjust the 1ms period of the squarewave ±5%.

An external source of amplitude modulation can be connected to the rear panel EXT AM INPUT connector J403. This signal will be coupled through C404 and R406 to the sampling input of the Level Regulator Amplifier where it is summed with the detected output to form the sample voltage e_s. The inverted modulation signal is imposed upon the RF signal so that the sum of the detected output plus the modulation signal equals the reference voltage e_r. It is apparent that when modulating with an external sinusoidal waveform, an increased output will be required during the peaks; therefore, the reference voltage e_r must be reduced to stay within the power output rating of the RF Plug-In. This is accomplished by the level control circuitry in the RF Plug-In.

The Programmable High Voltage Regulator circuitry is fully discussed in paragraph 3-6 which follows.

3-6. POWER SUPPLIES

The power supply section consists of two printed circuit board assemblies, namely the Rectifier (610C-ML-838) and the Power Supply (610C-ML-837). Refer to Figure 6-5 during the following discussion.

Line voltage is fed to the primary winding of transformer T501 when the Main Power ON switch S501 is closed. An 0.8A slo-blo fuse F501 provides overload protection for the instrument while the DPDT slide switch S502 serves to establish the proper primary winding configuration to correspond with the input line voltage being used, either 115 or 230Vac. Three separate secondary windings supply voltage to the input of the Rectifier assembly. This assembly is comprised of three basic rectifier circuits and their filter networks. Two of these are bridge rectifiers and the other is a fullwave. These two, practically identical, bridge rectifiers form the basis for the two primary supplies, one at +30Vdc and the other at -20Vdc. Both are designed for low ripple and high stability in the presence of temperature variations. The output of the fullwave rectifier is used in conjunction with the Programmable High Voltage Regulator circuit (part of the Level and High Voltage Regulator assembly 610C-ML-836) to develop +40 to +140Vdc.

In both the +30 and -20Vdc supplies, the bridge-rectified output is followed by a basic regulator circuit. A simplified schematic of this circuit is shown in Figure 3-13. The output voltage of either supply is sampled by a resistive voltage divider R1/R2 and is compared against a stable reference voltage e_r. A differential amplifier is used for this comparison so that the effects due to temperature are cancelled. Any difference voltage between the sampled voltage e_s and the reference voltage e_r is sensed by the comparitor and amplified. An additional stage of amplification provides further gain to drive the series regulator element which completes the feedback loop. The series element conducts until e_s equals e_r. Note that the negative output terminal may be grounded to form a positive

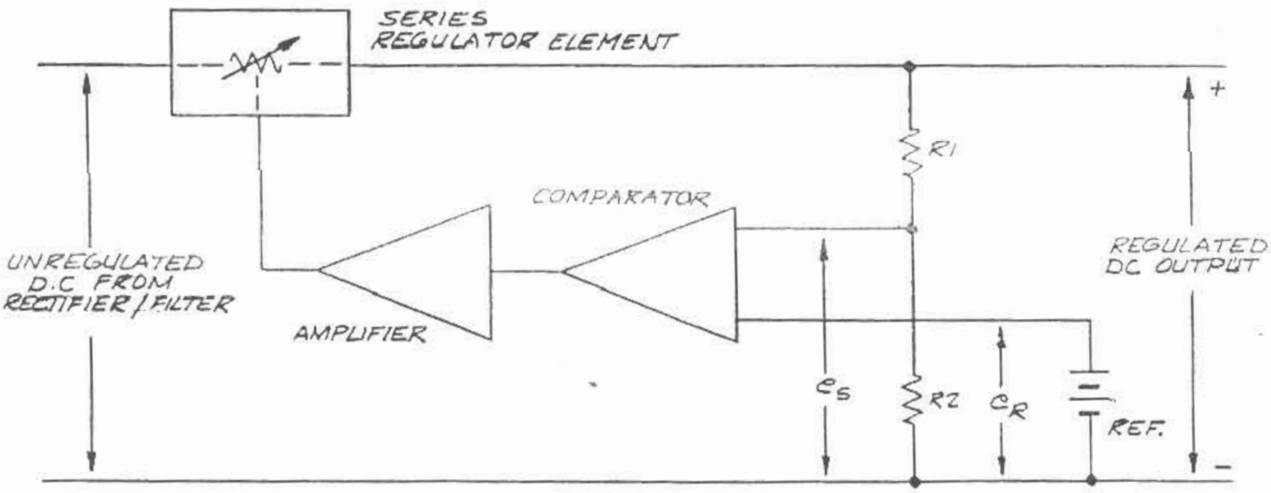

Figure 3-13 Simplified Power Supply Regulator

supply or the positive output terminal may be grounded to form a negative supply.

In the +30Vdc supply, the bridge-rectified and filtered output is applied to the regulator circuit through the pass transistor Q501. In this case, Q501 is the series regulator element shown in Figure 3-13. The output voltage is sampled by the resistive divider which consists of R510 and R513. The potentiometer R512 is connected in parallel with the divider to adjust the level of e_s and thus the output level of the supply. This sampled and adjusted output voltage e_s is then compared by Q505 against the +11.2Vdc stable reference voltage e_r. Tight regulation is maintained by the additional stage of gain provided by the amplifier Q503 and Q504. The RC network, consisting of C508 and R514, provides frequency compensation to maintain stability within the loop. This compared and amplified voltage level is then applied to the base of the driver transistor Q502 which provides the current gain necessary to control the series regulator transistor Q501. Current limiting protection against short circuit overload is provided by R503, R504, and R508. Should the output of the supply become shorted, Q501 will conduct more, causing a voltage drop across R503 proportional to the amount of current being drawn. This drop cannot exceed the drop across R504 due to the control of Q502. The amount of current being conducted by Q503 is established by R508. Thus a short circuit current would be limited and Q501 would be protected from excessive dissipation. Diode CR509 compensates for the base-emitter drop of Q502 to maintain uniform current limiting with changes in temperature.

The -20Vdc supply operates in much the same manner as that just described. Here the bridge-rectified and filtered output is applied to the regulator circuit through the pass transistor Q507. Note that the emitter is grounded. This is the positive terminal of the supply and as previously mentioned it could be grounded to form a negative supply. The output voltage is sampled with respect to the fixed +30Vdc supply by the resistive divider R525 and R527. The potentiometer R524 adjusts the level of e_s and as a result presets the output level of the supply. This sampled and adjusted output voltage e_s is compared by Q511 against a -6.2Vdc reference voltage e_r established by the temperature-compensated, zener diode CR519. Again tight regulation is ensured, this time by Q509 and Q510. The RC network C510 and R529 provides the frequency compensation to maintain stability within the loop. This compared and amplified voltage level is then applied to the base of the driver transistor Q508 which provides the current gain necessary to control the series regulator transistor Q507. Current limiting protection against short circuit overload is provided by R518, R519, and R523 in a similar manner to that previously described.

The high voltage power supply also operates in much the same manner as that described for the +30 and -20Vdc supplies. Here the center tap of the high voltage secondary winding of T501 is referenced to the +30Vdc supply. This will maintain the output of the high voltage supply at least 30V above ground reference at all times. The full-wave rectified and filtered output is applied to the Programmable High Voltage Regulator which forms a part of the Level and High Voltage Regulator assembly (610C-ML-836). Refer to Figure 6-4. This output voltage is sampled by the resistive divider R443 and R444. The 1mA current that flows through this divider causes 30V to be dropped across R444 with the remainder being dropped across the parallel combination of R443 and the fixed program resistor R801, located in each RF Plug-In. The full +140Vdc output of this supply is available at pin 2 of J401 when the RF Plug-In is removed. With this unit in the circuit, the level of e_s is preset and thus the high voltage output of the supply is programmed to a particular level for use with that unit. The sampled and programmed output voltage e_s is then compared and amplified by Q411 and Q412. One input of this differential amplifier is referenced to the +30Vdc supply which acts as the reference voltage e_r. The amplified difference voltage is applied to the base of the driver transistor

Q408. This transistor, like before, provides the current gain necessary to control the series regulator transistor Q410, which will regulate up to 40mA at any output voltage level between +40 and +140Vdc. Frequency roll-off to control the feedback loop stability is provided by C413. Short circuit protection is established by R435, R439, and R445 in the same manner as in the other supplies.

The +11.2Vdc highly regulated power supply is referenced from CR521, which is a +6.2V, ±5% temperature-compensated, zener diode. R539 and R540 provide the supply sample e_s that is compared with the zener diode reference voltage e_r. The potentiometer R536 is connected in parallel with the divider so that the level of e_s may be adjusted and as a result preset the output of the supply. Loop gain for the +11.2 Vdc regulated supply is obtained from a μA-709 integrated circuit, operational amplifier Q506. The output of Q506 controls the current through Q512 which is the series regulator element in the +11.2Vdc supply. R543 provides current limiting protection for Q512 in case of a short circuit or a current overload. CR523 protects the inputs of Q506 from excessive offset voltages which could damage the integrated circuit. Frequency compensation is provided by C515 and R541.

The +5.6Vdc supply is referenced from the +11.2Vdc supply by resistive divider network R544, R545, and R546. The series regulator transistor Q513 is driven by the differential amplifier, consisting of Q514 and Q515. Current limiting protection is provided by R547, R548, and R549 in a similar manner to that described for the +30Vdc supply.

The -5.6Vdc supply is provided by an emitter follower referenced from the -20Vdc supply. Diode CR520 compensates the reference divider for changes in Q516 emitter to base voltage due to temperature variations and thus tends to maintain a constant -5.6Vdc output with changes in temperature.

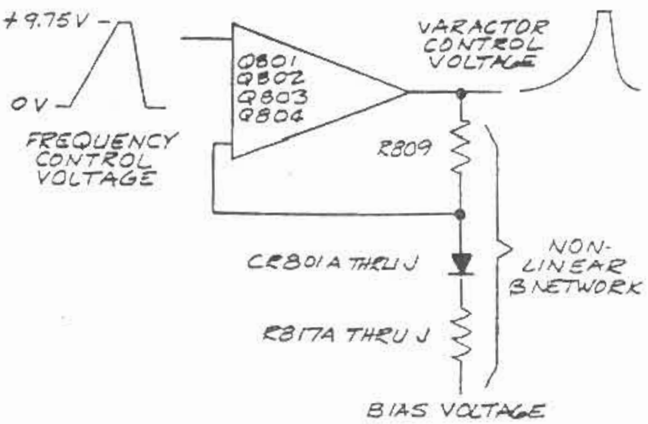

Figure 3-14 Basic Frequency Control Circuit

3-7. FREQUENCY CONTROL

The following presents a generalized discussion of the shaping circuit used in conjunction with the varactor tuned oscillators of the RF Plug-In. The Theory of Operation section in the manual that pertains to the specific RF Plug-In will note any deviations. Figure 3-14 illustrates the basic frequency control circuit configuration used in each RF Plug-In.

The linear ramp output from the Frequency Instruction assembly (610C-ML-833) is coupled to one input of a differential stage comprised of Q801 through Q804. The output is attenuated and fed back to the other input. This negative feedback causes the gain of the amplifier to be the inverse of the attenuator characteristic. The attenuator is typically made non-linear by a series of diodes, each biased at a voltage between 0 and +10V. As the control voltage reaches each of the bias levels, the corresponding diode CR801 A thru J begins to conduct lowering the impedance level of the lower portion of the attenuator. Thus the output voltage changes to a steeper slope until the next diode conducts. The resultant output voltage is composed of many straight line segments that very closely synthesize the non-linear tuning voltage of the varactor. The different bias voltages for the shaping diodes set the frequency where the bending commences and the series resistance R817 establishes the slope. The value of each resistance used for R817 A thru J is factory selected for the particular oscillator used in the particular RF Plug-In. In this way, the desired non-linear characteristics of the varactor control voltage can be shaped.

Table 4-1 List of Required Test Equipment

INSTRUMENT	REQUIRED CHARACTERISTICS	RECOMMENDED INSTRUMENT
DC DIFFERENTIAL VOLTMETER	a) Accuracy: 0.02% b) Input Impedance: greater than 5 megohms c) Resulution: greater than 1mV d) Center Scale Zero	FLUKE Model 871A
OSCILLOSCOPE	a) Bandwidth: 300kHz b) Vertical Sensitivity: 1mV/cm for ac and dc inputs c) Horizontal input for external sweep signal	TEKTRONIX Model 503 or HEWLETT PACKARD Model 1202
VOLT-OHM-METER (VOM)	a) Input Impedance 20,000 ohm/Vdc	SIMPSON Model 270
PULSE GENERATOR	a) Pulse Rate: 1kHz (1.0ms)	TEKTRONIX Model 181 Time Mark Generator
CRYSTAL DETECTOR	a) Response: Flat ±1dB 100kHz to 4GHz b) Good RF bypassing 100kHz to 4GHz	WILTRON Model 73N50
ELECTRONIC COUNTER	a) Input Impedance: 50 ohms b) Range: 100kHz to 2GHz	HEWLETT PACKARD Model HP5246L
RF POWER METER	a) Accuracy: ±0.5dBm or better b) Input Impedance: 50 ohms c) Maximum Power Reading +10dBm or greater d) Frequency Range: 10MHz to 400MHz	HEWLETT PACKARD Model 431B
RF SIGNAL GENERATOR	a) Frequency Range: 10MHz to 400 MHz b) Signal Attenuation: 40dB or greater	MEASUREMENTS Model 80 or HEWLETT PACKARD Model 608
610B/C EXTENDER CARD	---	WILTRON Model 610B-MS-588
610B/C PLUG-IN EXTENDER CABLE	---	WILTRON Model 610B-MS-383

SECTION IV

MAINTENANCE

4-1. INTRODUCTION

This section of the manual contains a list of the required test equipment, the recommended step-by-step procedures for verifying the performance of the instrument and recalibrating it, if necessary, and troubleshooting charts to aid in maintenance.

4-2. PERFORMANCE VERIFICATION/ RECALIBRATION

The following paragraphs have been prepared in such a way that the performance of a given circuit is first verified. If it is determined that the circuit is out of tolerance, then and only then should the recalibration steps be performed. If a malfunction is evident after performing the prescribed steps, a particular Troubleshooting Chart will be referenced to act as an aid in isolating the problem area or faulty component. These procedures are presented in a sequential order and should be followed in that order to achieve the best results. All of the verification steps and recalibration adjustments are to be performed with an RF Plug-In installed to provide proper loading. The top and bottom covers must be removed to provide easy access to the test points and recalibration adjustments on each printed circuit assembly. The performance verification of each assembly must be made with all assemblies firmly seated in their respective connectors. It is further recommended that all adjustments be made with all assemblies firmly seated in their connectors to obtain optimum results. If it is necessary, the assembly may be removed and then replaced on an extender card for troubleshooting or coarse adjustment purposes. The assembly should then be replaced into its connector and the performance verification procedure should be repeated. Recalibration adjustments can be made, if necessary, at this time. Refer to Table 4-1 for the List of Required Test Equipment. All dc measurements are made in reference to chassis ground unless otherwise specified.

4-2.1 INITIAL SET-UP

The following steps are used to initialize the Model 610C Sweep Generator for performance verification, recalibration, or troubleshooting. Refer to Figure 4-1 for the location of each printed circuit assembly.

1. Select an appropriate, known-good, RF Plug-In and corresponding Slide Rule Dial. Secure each into its respective location.

2. Remove the top and bottom covers from the instrument.

> **CAUTION**
> Be extremely careful not to misalign any one of the three Slide Rule Dial pointers when the top cover is removed.

3. Verify that the Input Line Selector is set to correspond with the line source being used (115 or 230Vac).

4. With the Main Power ON switch set to the off (down) position, plug the power cord into the line source.

5. Set the Main Power ON switch to ON and allow a 30-minute warmup period for the circuits of the instrument to stabilize with temperature.

6. Ensure that nothing is connected to the rear panel connectors and that the

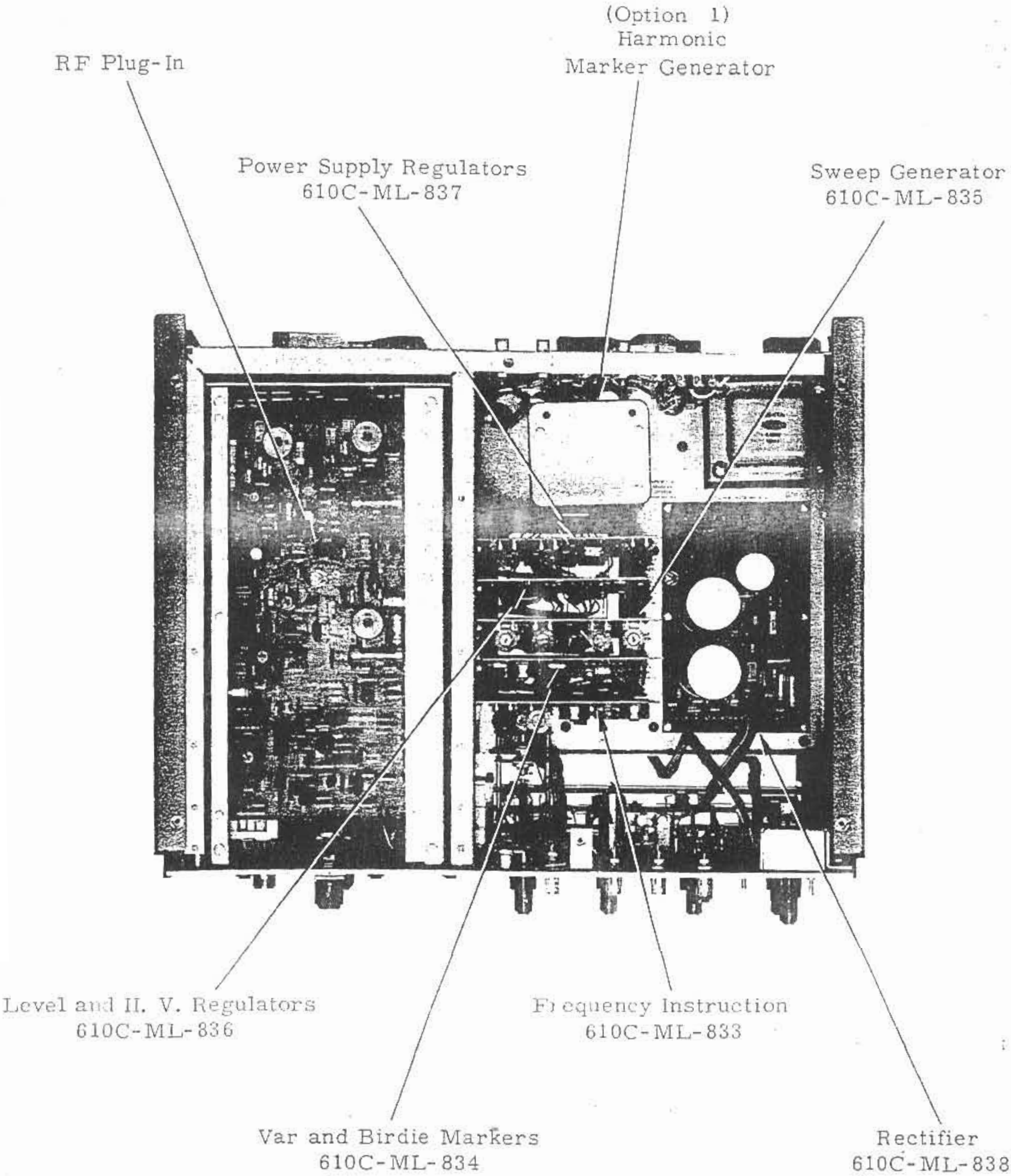

Figure 4-1 Model 610C Sweep Generator, Bottom View

1kHz INT AM ON/OFF switch is set to OFF.

7. Set the front panel controls as follows:

VAR FREQ MARKER . INTENSITY
AMPLITUDE . . . . . Fully CCW
SWEEP MODE . . . . AUTO
MANUAL . . . . Fully CCW
SWEEP TIME (SEC) . . .1-.01
VERNIER . . . . CAL (Fully CW)
FREQ SELECTOR . . . F1 TO F2
RETRACE RF . . . . . OFF
F1 . . . . 10th minor Slide Rule Dial Division
VAR FREQ MKR. . . . center scale
ΔF . . . . 0 (Fully CCW)
F2 . . . . 10th from last minor Slide Rule Dial Division
LEVELING INT/EXT . INT

4-2.2 POWER SUPPLY VERIFICATION/ RECALIBRATION

The circuits of the Rectifier assembly (610C-ML-838) and Power Supply assembly (610C-ML-837) are verified and if necessary recalibrated as follows:

1. Set the front panel controls as outlined in step 7 of 4-2.1 INITIAL SET-UP.

2. Using the DC Differential Voltmeter, monitor the supply voltages at the pins outlined in Table 4-2 in the order indicated. If out of tolerance, adjust the specified recalibration potentiometers. DO NOT adjust if the measurement is within the specified tolerance. If a malfunction is evident, refer to the POWER SUPPLY TROUBLESHOOTING CHART in paragraph 4-3.

3. Monitor pin 9 of 610C-ML-837 and verify that the voltage is -5.6 ±5%. There is no adjustment for this supply.

4. Monitor the high voltage output at pin 14 of 610C-ML-836 and verify that it is within the tolerance specified in the Instruction Manual for the particular RF Plug-In being used. If a malfunction is evident, refer to the POWER SUPPLY TROUBLESHOOTING CHART in paragraph 4-3.

MONITOR 610C-ML-837 PIN NUMBER	MEASURE	ADJUST (if necessary)
5	+11.2V±5mV	R536
1	+30.0V±10mV	R512
18	-20.0V±10mV	R524
7	+ 5.6V±5mV	R545

Table 4-2 Power Supply Voltages and Adjustments

5. Using the Oscilloscope, measure the ac ripple on the +30, +11.2, and -20Vdc supplies. Monitor these supply voltages at the pins outlined in Table 4-2. The ac ripple should be less than 3mV peak-to-peak. If excessive ripple is observed, refer to the POWER SUPPLY TROUBLESHOOTING CHART in paragraph 4-3.

   Note: Disregard the voltage spikes on the measurements taken in step 5. These are blanking spikes and they occur at the beginning and end of Sweep Time. To verify this condition, set the RETRACE RF switch to ON and observe that the blanking spikes reduce in size. Return the switch to the OFF position.

4-2.3 SWEEP GENERATOR VERIFICATION/RECALIBRATION

The following outlines those steps required to verify and if necessary recalibrate the circuits of the Sweep Generator assembly (610C-ML-835).

1. Set the front panel controls as outlined in step 7 of paragraph 4-2.1 INITIAL SET-UP.

2. Connect the vertical input of the Oscilloscope to pin 2 of 610C-ML-835 and set

the vertical sensitivity for 20mV/cm.

3. Set the horizontal time base for 5ms/cm.

4. Observe that the start level of the sweep output begins at 0V±20mV. If out of tolerance, adjust the Sweep Start Level potentiometer R127. DO NOT adjust if measurement is within the specified tolerance. If a malfunction is evident, refer to the SWEEP GENERATOR TROUBLESHOOTING CHART in paragraph 4-3.

5. Set the vertical sensitivity to 2 V/cm and observe that the peak-to-peak amplitude of the sweep output is ≈+13V.

6. Set the Main Power ON switch to the off (down) position.

7. Remove the RF Plug-In and return the Main Power ON switch to ON.

8. Set the vertical sensitivity to 5 V/cm and the horizontal time base to 1s/cm.

9. While monitoring pin 2, observe a slow, positive increase in voltage from 0 to ≈+13V. If a decreasing voltage is observed, adjust the Sweep Bias Adj potentiometer R126.

10. Set the Main Power ON switch to the off (down) position.

11. Replace the RF Plug-In and return the Main Power ON switch to ON.

12. Repeat steps 2 through 9 until all specified tolerances are achieved.

13. Set the vertical sensitivity to 5 V/cm and the horizontal time base for 2ms/cm.

14. Set the SWEEP MODE switch to LINE SYNC and ensure that the SWEEP TIME (SEC) VERNIER is set to the CAL (fully CW) position.

15. Rotate the SWEEP TIME (SEC) switch through each of its four positions and verify that some Hold-Off Time is observed. If no Hold-Off Time is observed, in any one of the ranges, adjust the Hold-Off Adj potentiometer R151.

16. Connect a suitable cable between the HORIZ OUT connector and the horizontal input of the Oscilloscope.

17. Set the following controls as indicated:

    SWEEP TIME (SEC) 1-.01
    VERNIER . . . . . CAL (fully CW)
    SWEEP MODE . . . LINE SYNC

18. Observe that the display does not flicker. If flickering is observed, ensure that the SWEEP TIME (SEC) VERNIER is set to CAL (fully CW) and that the VAR FREQ MARKER AMPLITUDE potentiometer is set fully CCW.

19. Set the SWEEP MODE switch to TRIG and observe that there is no sweep.

20. Depress and release the Trigger pushbutton and observe that a single sweep appears upon release.

21. If flickering is observed in LINE SYNC or a sweep is observed in TRIG, adjust the Trigger Adj potentiometer R138 on 610C-ML-838 as follows:

    a) Set the following controls as indicated:

       SWEEP TIME (SEC) 1-.01
       VERNIER . . . . . . .CAL (fully CW)
       SWEEP MODE . . . . TRIG

    b) Using the DC Differential Voltmeter, monitor the voltage at pin 6 of 610C-ML-835.

    c) Adjust the Trigger Adj potentiometer R138 until the sweep just stops and record this voltage.

    d) Set the SWEEP MODE switch to LINE SYNC and monitor the voltage at pin 6 of 610C-ML-835.

    e) Adjust R138 until the sweep just stops and record this voltage.

    f) Return the SWEEP MODE switch to

TRIG and adjust R138 for a voltage half way between the voltages measured in steps c and e.

g) Observe that no sweep appears with the SWEEP MODE switch set to TRIG and that the sweep does not flicker when set to LINE SYNC.

22. Connect the Pulse Generator through the attenuating network to the TRIGGER INPUT connector, located at the rear of the instrument. See Figure 4-2.

23. Set the Pulse Generator to produce a pulse with an amplitude of 0.9V and a pulse width greater than 1µs.

24. With the SWEEP MODE switch set to TRIG and pin 2 of 610C-ML-835 being monitored, observe a normal sweep. If no sweep is observed, adjust the Ext Trig Adj potentiometer R148 until the sweep just appears. Note this position and continue adjusting R148 in the same direction until the sweep just disappears. Note this position and set R148 half way between the two noted positions.

25. Rotate the SWEEP TIME (SEC) switch through each of its four positions and observe that a normal sweep is triggered in each position.

26. Rotate the SWEEP TIME (SEC) VERNIER through its full range and verify that the Sweep Time makes a smooth

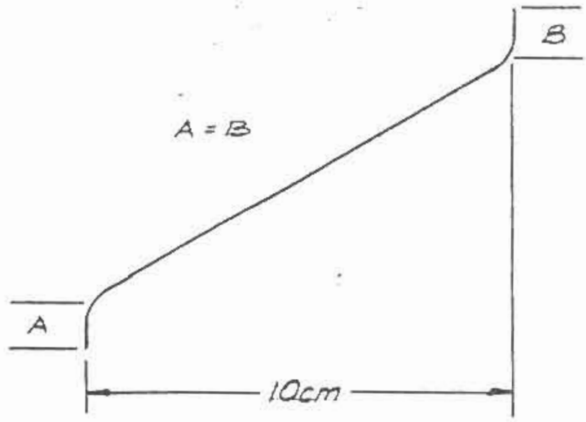

Figure 4-3 Sweep Curl Waveform

transition of at least 10 to 1 for each position of the SWEEP TIME (SEC) switch.

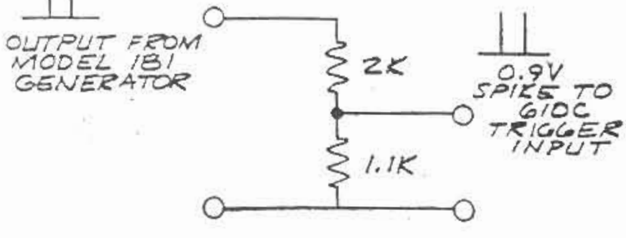

Figure 4-2 External Trigger Verification/ Recalibration Set-up

4-2.4 FREQUENCY INSTRUCTION VERIFICATION/RECALIBRATION

The following outlines the steps required to verify and if necessary recalibrate the circuits of the Frequency Instruction assembly (610C-ML-833).

1. Set the front panel controls as outlined in step 7 of paragraph 4-2.1 INITIAL SET-UP.
2. Connect the vertical input of the Oscilloscope to terminal 1 of TB201, which is located at the rear of the instrument.
3. Set the vertical sensitivity to 10mV/cm and the horizontal time base for 5ms/cm.
4. Observe that the start level of the sweep output begins at 0V±10mV. If out of tolerance, adjust the Begin Adj potentiometer R206. DO NOT adjust if measurement is within the specified tolerance. If a malfunction is evident, refer to the FREQUENCY INSTRUCTION TROUBLESHOOTING CHART in paragraph 4-3.
5. Remove the Oscilloscope ground from the instrument ground and connect it to terminal F of TB201.

> **CAUTION**
>
> Ensure that no external grounds are connected to the instrument at this time since terminal F of TB201 is the ±11.2V supply. This offsets the sweep output by ±11.2V so that the end level can be adjusted to tolerance.

6. Observe that the end level of the sweep output is 0V±50mV (actually ±11.2V ±50mV). If out of tolerance, adjust the End Adj potentiometer R201. DO NOT adjust if measurement is within the specified tolerance. If a malfunction is evident, refer to the FREQUENCY INSTRUCTION TROUBLESHOOTING CHART IN paragraph 4-3.

7. Connect the vertical input of the Oscilloscope to pin 2 of 610C-ML-835, and set the vertical sensitivity for 2V/cm.

8. Connect a suitable cable between the HORIZ OUT connector and the horizontal input of the Oscilloscope.

9. Adjust the horizontal time base vernier for a full 10cm display.

10. Observe that the curls at the beginning and end of the sweep are equal. See Figure 4-3. If the curls are not equal, adjust the Sweep End Level potentiometer R131 on 610C-ML-835.

11. Repeat steps 2 through 6 to ensure that the start level is at 0V±10mV and that the end level is at 0V±50mV (actually +11.2V±50mV).

12. Set the vertical sensitivity to 2V/cm and the horizontal time base for 2ms/cm.

13. While monitoring terminal I or TB201, measure the rise time of the ramp (Sweep Time) to be as specified in Table 4-3 for each position of the SWEEP TIME (SEC) switch. The SWEEP TIME (SEC) VERNIER must be set to CAL (fully CW) for these measurements.

SWEEP TIME (SEC) SWITCH SETTING	SWEEP TIME
.1 - .01	0.01s ±2ms
1 - .1	0.1s ±20ms
10 - 1	1 ±0.2s
100 - 10	10 ±2s

Table 4-3. Sweep Time Measurements

Note: All Sweep Times should be within ±20% of their nominal times and any two adjacent ranges should not vary more than 20% from each other; i.e., the .1-.01 range cannot be 20% high when the 1-.1 range is 20% low.

14. Ensure that the shorting link is connected between terminals B and C of TB201.

15. Using the F1, VAR FREQ MKR, and F2 control knobs, align their respective pointers such that each is in coincidence with the START F1 Calibration Mark, shown in Figure 4-4.

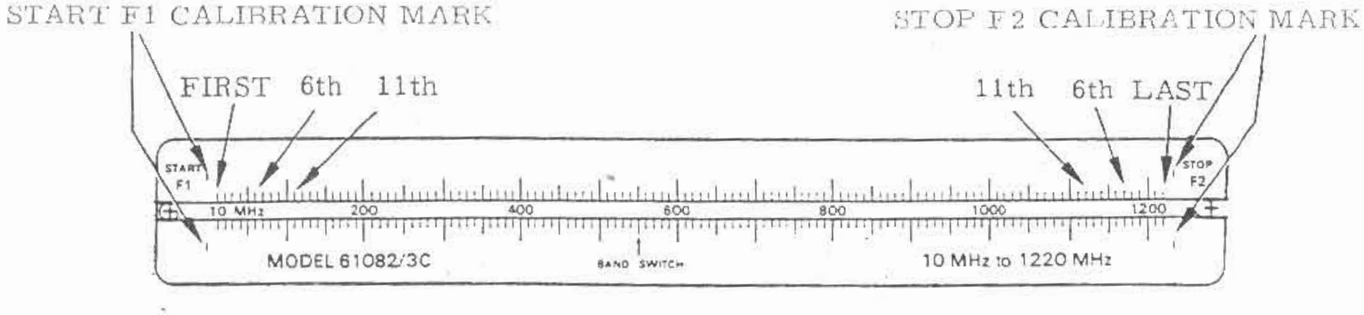

Figure 4-4 Slide Rule Dial Calibration Marks

16. Connect the DC Differential Voltmeter to pin 24 of J401, located at the rear of the instrument.

17. Rotate the FREQ SELECTOR switch through the CW F1, CW MKR, and CW F2 positions and verify that the voltages are within ±25mV of each other. If out of tolerance, slightly adjust the F1, VAR FREQ MAK, and F2 control knobs, as required, until the voltages are within tolerance. Those pointers, not in coincidence with the START F1 Calibration Mark after the adjustment, will require a slight mechanical adjustment.

18. Align all three pointers such that each is in coincidence with the STOP F2 Calibration Mark, shown in Figure 4-4.

19. Rotate the FREQ SELECTOR switch through the CW F1, CW MKR, and CW F2 positions and verify that the voltages at CW MKR and CW F2 are within ±25mV of the voltage at CW F1. If the CW MKR voltage is out of tolerance, adjust the MKR CAL potentiometer R248, which is located next to the VAR FREQ MKR potentiometer R247 at the top of the instrument. See Figure 4-5. If the CW F2 voltage is out of tolerance, adjust the F2 CAL potentiometer R245, which is located next to the F2 potentiometer R244 at the top of the instrument. See Figure 4-5.

20. Set the following controls as indicated:

FREQ SELECTOR. . . . . F1 TO F2
SWEEP MODE . . . . . LINE SYNC
SWEEP TIME (SEC) 1-.01
VERNIER . . . . CAL(fully CW)

21. Align the F1 and F2 pointers such that they are in coincidence with the START F1 Calibration Mark, shown in Figure 4-4.

22. Connect the vertical input of the Oscilloscope to pin 24 of J401.

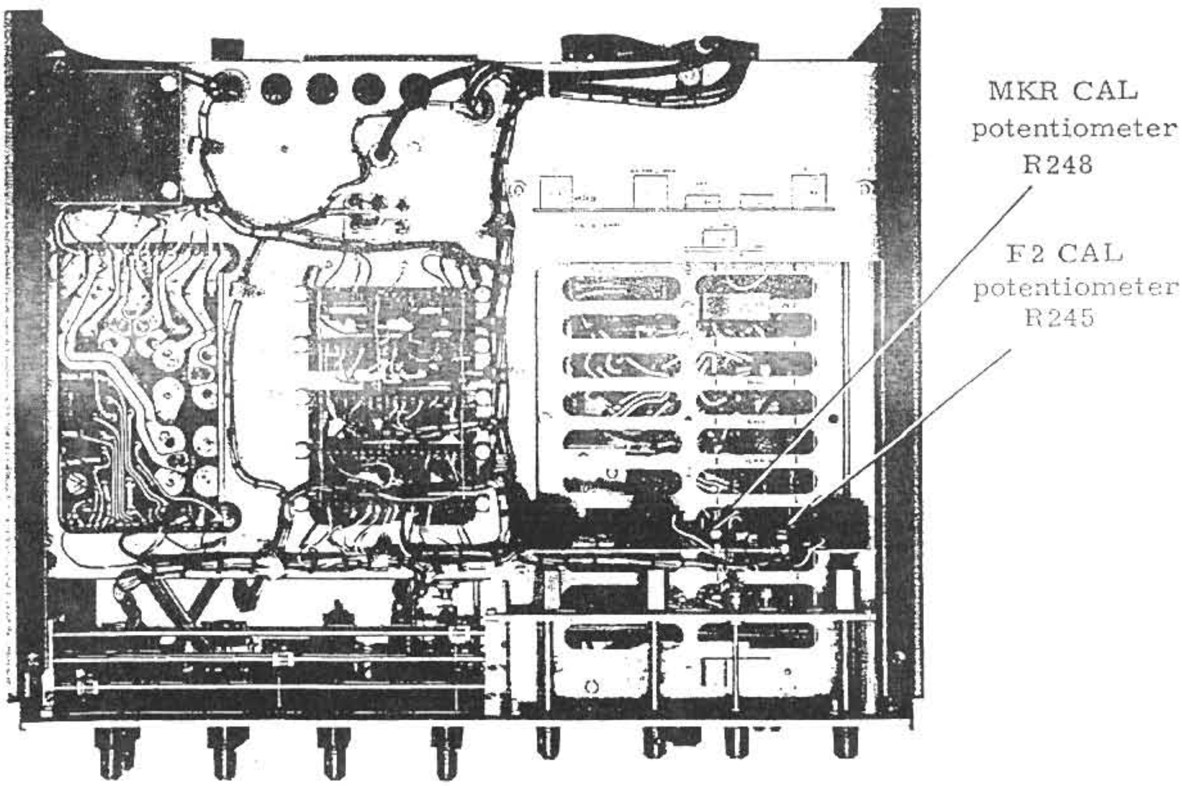

Figure 4-5 Model 610C Sweep Generator, Top View

23. Set the vertical sensitivity to 5mV/cm and the horizontal time base to 10ms/cm.

24. Observe that the ripple voltage does not exceed 10mV peak-to-peak. If excessive ripple is observed, adjust the Tracking potentiometer R215.

25. Disconnect the Oscilloscope from pin 24 of J401 and connect the DC Differential Voltmeter.

26. Verify that the voltage is 0V ±20mV. If out of tolerance, adjust the Freq Zero potentiometer R237. DO NOT adjust if measurement is within the specified tolerance. If a malfunction is evident, refer to the FREQUENCY INSTRUCTION TROUBLESHOOTING CHART in paragraph 4-3.

27. Align the F1 and F2 pointers such that they are in coincidence with the STOP F2 Calibration Mark, shown in Figure 4-4, and verify that the voltage is +9.75V ±25mV. If out of tolerance, adjust the Amplitude potentiometer R218. DO NOT adjust if measurement is within the specified tolerance. If a malfunction is evident, refer to the FREQUENCY INSTRUCTION TROUBLESHOOTING CHART in paragraph 4-3.

28. Repeat steps 21 through 27 until all specified tolerances are achieved.

29. Align the F1 pointer such that it is in coincidence with the START F1 Calibration Mark, shown in Figure 4-4 and set the FREQ SELECTOR switch to CW F1.

30. Verify that the voltage is 0V ±25mV. If out of tolerance, adjust the ΔF Offset potentiometer R225. DO NOT adjust if measurement is within the specified tolerance. If a malfunction is evident, refer to the FREQUENCY INSTRUCTION TROUBLESHOOTING CHART in paragraph 4-3.

4-2.5 LEVEL AND HIGH VOLTAGE REGULATORS VERIFICATION/RECALIBRATION

1. Set the front panel controls as outlined in step 7 of paragraph 4-2.1 INITIAL SET-UP.
2. Ensure that UNLEVELED light if off. If on, see troubleshooting chart.
3. Using the DC Differential Voltmeter, measure and record the voltage at pin 19 of J401. Measure and record the voltage at Pin 18 of J401.
4. If the voltages measured in step 3 differ by more than ±2mV, adjust the Level Balance potentiometer R408 until the voltage at pin 18 equals the voltag at pin 19 ±2mV.

4-2.6 VARIABLE FREQUENCY MARKER VERIFICATION/RECALIBRATION

1. Set the front panel controls as outlined in step 7 of paragraph 4-2.1 INITIAL SET-UP with the following exceptions:

   VAR FREQ MARKER . . . . VIDEO
   AMPLITUDE . . . . . as required
   F1 . . . . 1st minor Slide Rule Dial division
   VAR FREQ MKR . . 6th minor Slide Rule Dial division
   F2 . . . . 11th minor Slide Rule Dial division

2. Connect a suitable cable between the VERT OUT connector and the vertical input of the Oscilloscope. Set the vertical sensitivity to 0.5V/cm.
3. Connect a suitable cable between the HORIZ OUT connector and the horizontal input of the Oscilloscope. Adjust the horizontal time base vernier for a full 10 cm display.
4. Observe that a negative pulse appears at the center of the sweep. If it does not appear at the center of the sweep,

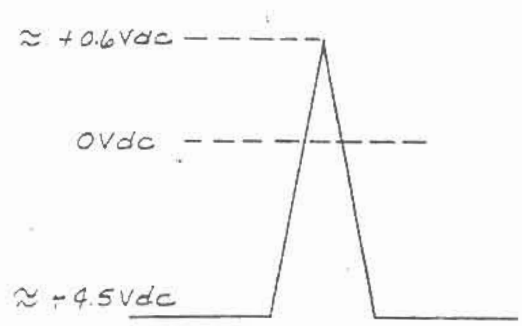

Figure 4-6 Video Marker Pulse

adjust the VFM Balance potentiometer R322.

Note: Adjust the VAR FREQ MARKER AMPLITUDE potentiometer until the video marker pulse is visible on the display.

5. Set the following front panel controls as indicated:

F1 . . . . 11th from last minor Slide Rule Dial division
FAR FREQ MKR . 6th from last minor Slide Rule Dial division
F2 . . . . last minor Slide Rule Dial division

6. Observe that a negative pulse appears at the center of the sweep. If it does not appear at the center of the sweep, adjust the VFM Calibrate potentiometer R317.

7. Repeat steps 4 through 6 until no further adjustment is required.

8. Connect the vertical input of the Oscilloscope to pin 5 of 610C-ML-834. Set the vertical sensitivity to 1V/cm.

9. With the VAR FREQ MARKER AMPLITUDE potentiometer set fully CW, observe that the video marker pulse begins at approximately -4.5V and terminates at approximately +0.6V. See Figure 4-6. If it does not, adjust the Max Ampl Adj potentiometer R326 for a peak of approximately +0.6V.

10. Connect the vertical input of the Oscilloscope to pin 2 of 610C-ML-835. Set the vertical sensitivity to 2V/cm.

11. Set the following front panel controls as indicated:

VAR FREQ MARKER . . . . VIDEO
AMPLITUDE. . . . . fully CW
F1 . . . START F1 Calibration Mark
VAR FREQ MKR . . . . center scale
F2 . . . STOP F2 Calibration Mark

12. Set the horizontal time base to internal SWEEP and adjust the horizontal time base vernier for a 5cm Sweep Time display. See Figure 4-7.

13. Observe that an approximate 0.4 cm step occurs at the center of the sweep as shown in Figure 4-7. If an 0.4 cm step is not observed, adjust the Dwell Adj potentiometer R341.

14. Connect a suitable RF Detector, such as a WILTRON Model 74N50, to the RF OUTPUT connector, located on the RF Plug-In. Connect a suitable cable between the output of the RF Detector and the FROM EXT DET connector, located in the front panel of the instrument.

15. Set the VAR FREQ MARKER switch to RF PIP and the AMPLITUDE potentiometer fully CW.

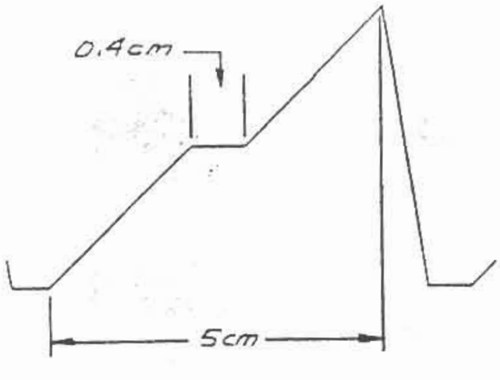

Figure 4-7 Sweep Dwell Waveform

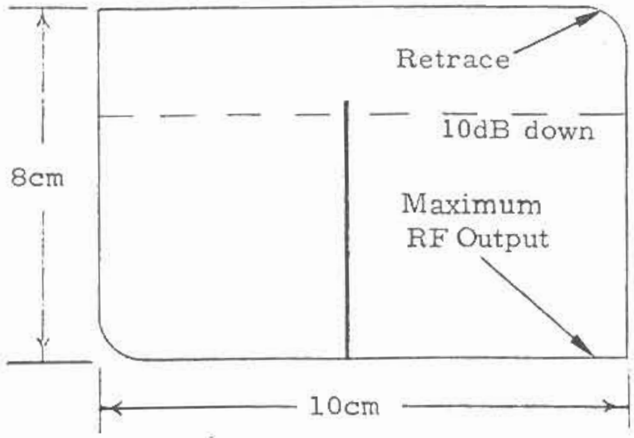

Figure 4-8 RF Pip Marker Pulse

16. Set the vertical sensitivity for a full 8 cm display. See Figure 4-8.

17. Set the horizontal time base to EXT HORIZ and adjust the horizontal time base vernier for a full 10 cm display. See Figure 4-8.

18. Verify that the maximum RF output is momentarily blanked to produce an RF PIP at the preset marker frequency (center of display) and that its level is greater than 10dB down. See Figure 4-8. If the level is less than 10dB down, repeat the marker amplitude adjustment outlined in steps 8 and 9.

19. If a malfunction is evident during any of the preceeding adjustments, refer to the VARIABLE FREQUENCY MARKER TROUBLESHOOTING CHART in paragraph 4-3.

4-2.7 OPTIONAL HARMONIC MARKER GENERATOR VERIFICATION/ RECALIBRATION

The circuits of the Harmonic Marker Generator (Option 1) are verified and if necessary recalibrated as follows:

1. With the top cover removed, disconnect the BNC cable from the mixer, located at the rear of the instrument.

2. Connect a suitable cable between this port and the input to the Electronic Counter.

3. With the Main Power ON switch set to ON, set the HARMONIC MARKER switch S901 to 1MHz and verify that the frequency is 1MHz ±100Hz. If out of tolerance, adjust the recalibration capacitor C901. DO NOT adjust if measurement is within the specified tolerance.

   Note: This adjustment, shown in Figure 4-9, can be reached by removing the three screws that secure the top cover to the unit. Refer to Figure 4-1 for the location of the optional Harmonic Marker Generator.

4. Set S901 to 10MHz and verify that the frequency is 10MHz ±1kHz. If out of tolerance, adjust the recalibration calibration capacitor C913. DO NOT adjust if measurement is within the specified tolerance.

   Note: This adjustment, shown in Figure 4-9, can be reached by removing the three screws that secure the top cover to the unit. Refer to Figure 4-1 for the location of the optional Harmonic Marker Generator.

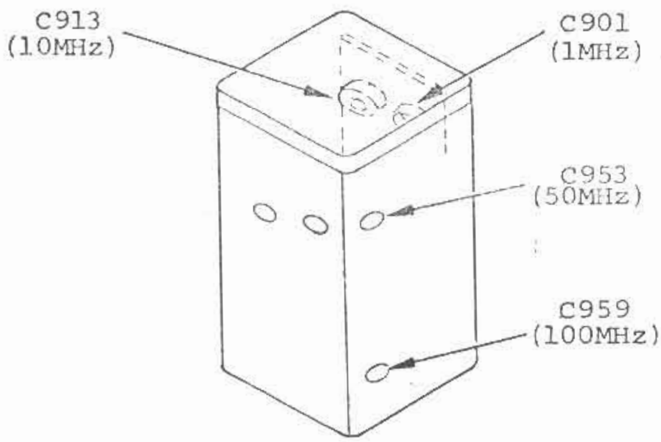

Figure 4-9 Harmonic Marker Generator (Option 1)

5. Set S901 to 50MHz and verify that the frequency is 50MHz ±5kHz. If out of tolerance, adjust the recalibration capacitor C953. DO NOT adjust if measurement is within the specified tolerance.

   Note: This adjustment, shown in Figure 4-9, is best reached with a long alignment screwdriver placed through the vents in the side of the cabinet.

6. Set S901 to 100MHz and verify that the frequency is 100MHz ±10kHz. If out of tolerance, adjust the recalibration capacitor C959. DO NOT adjust if measurement is within the specified tolerance.

   Note: This adjustment, shown in Figure 4-9, is best reached with a long alignment screwdriver placed through the vents in the side of the cabinet.

4-3. TROUBLESHOOTING

The following Troubleshooting Charts have been prepared to act as a aid in isolating a problem area or faulty component when a malfunction is evident. The simplified

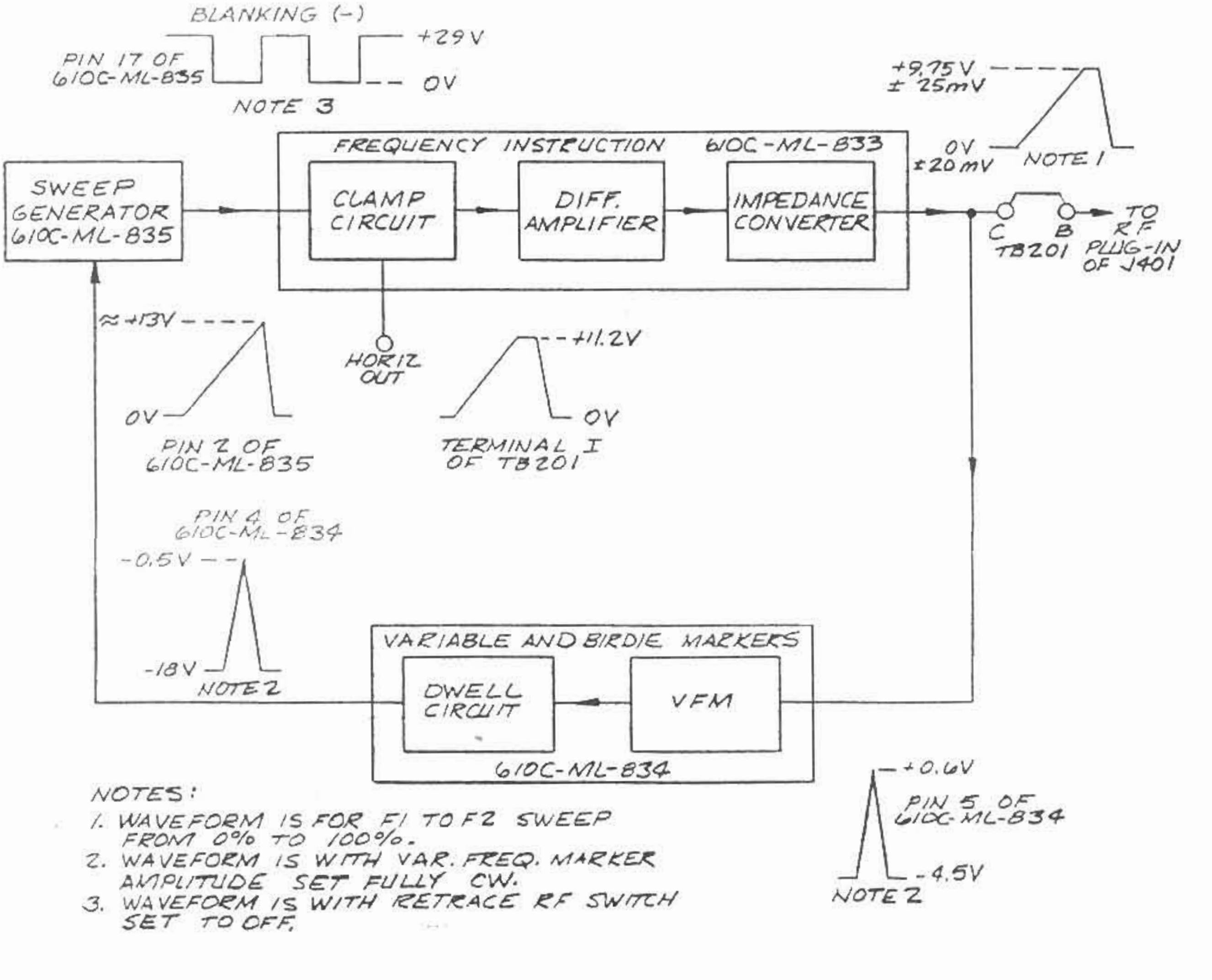

Figure 4-10 Model 610C Simplified Signal Flow Diagram

flow diagram, shown in Figure 4-10, illustrates the major signal flow path and indicates the key waveforms that should be present in a working instrument. This diagram should help to isolate a problem to a particular assembly or stage. Each assembly may be removed and replaced or an extender card for troubleshooting purposes, but once the malfunction has been rectified, the assembly should be replaced in its connector. The performance of the instrument should then be verified with all assemblies firmly seated in their respective connectors. Any recalibration adjustments may be made at that time, if necessary.

MODEL 610C

GENERAL

TROUBLESHOOTING CHART

INDICATION	POSSIBLE CAUSE AND REMEDY
No RF output.	a) Check RETRACE RF switch. If it is in the ON position there will be no base line since the RF is on during retrace. b) See RF Plug-In Troubleshooting Chart.
No horizontal sweep.	a) Check control settings. See paragraph 4-2.1 step 7. b) Check for sweep at pin 2 of 610C ML-835. 1. If good, see Frequency Instruction Troubleshooting Chart. 2. If bad, see Sweep Generator Troubleshooting Chart.
Cannot sweep full frequency range.	a) Check control settings. See paragraph 4-2.1 step 7. b) Check power supply voltages. See paragraph 4-2.2. c) Check sweep at pin 24 of J401. 1. If good, see RF Plug-In Troubleshooting Chart. 2. If bad, see Frequency Instruction and Sweep Generator Troubleshooting Charts.
No Variable Frequency Marker.	a) Check sweep at pin 24 of J401. 1. If good, see Variable Frequency Marker Troubleshooting Chart.

MODEL 610C

GENERAL

TROUBLESHOOTING CHART Continued

INDICATION	POSSIBLE CAUSE AND REMEDY
	2. If bad, see Frequency Instruction and Sweep Generator Troubleshooting Charts.
NARROW markers are poorly shaped, but WIDE markers are ok.	a) Set SWEEP TIME (SEC) switch to 1-.1 or .1-.01 range.
Noise on detected output.	a) Rotate BIRDIE MARKERS AMPLITUDE control fully CCW.
No birdie markers.	a) No output from Harmonic Marker Generator (Option 1).
	b) Mixer diode defective.
	c) Video amplifiers defective. Check Q301 and Q302.
	d) Check RF sample from RF Plug-In.
External level function does not operate.	a) Adjust ALC ADJ R402 for leveled condition.
	b) Leveling circuit out of balance. See paragraph 4-2.5.
No level control, unleveled condition, or UNLEVELED lamp DS401 remains illuminated.	a) Set LEVELING INT/EXT switch to INT.
	b) See RF Plug-In Troubleshooting Chart.
Cannot externally program frequency over the whole frequency range.	a) Set FREQ SELECTOR to REMOTE (PROGRAM).
	b) See paragraph 2-8.

POWER SUPPLY

TROUBLESHOOTING CHART

INDICATION	POSSIBLE CAUSE AND REMEDY
+11.2V supply cannot be adjusted, or excessive noise on +11.2V supply.	a) CR521 is defective.
	b) Q506 is defective.
	c) Check +30V supply for large ac ripple.

POWER SUPPLY

TROUBLESHOOTING CHART Continued

INDICATION	POSSIBLE CAUSE AND REMEDY
+30V supply cannot be adjusted, but +11.2V supply is ok.	a) Check Q502, Q503, Q504, and Q505. b) Check CR501, CR502, CR503, and CR504 for an open circuit.
+30V supply high with large ac ripple and cannot be adjusted.	a) Q501 or Q502 shorted. b) Check Q503 and Q505.
-20V supply cannot be adjusted, but +30V supply is ok.	a) CR 519 is defective b) Check Q508, Q509, Q510, and Q511. c) Check CR 505, CR506, and CR508 for an open circuit.
High voltage supply at +140V.	a) Check that RF Plug-In is properly installed. b) Q410 shorted. c) Check Q411 and Q412.
High voltage supply low or inoperative.	a) Check +30V supply for proper operation. b) Check Q411 and Q412.
Excessive noise on all supplies.	a) Ensure that a low frequency oscilloscope is being used. b) Set FREQ SELECTOR to CW F1. c) Check +11.2V supply for proper operation.
Noise on +30V supply, but +11.2V supply is ok.	a) Set FREQ SELECTOR to CW F1. b) Q503 or Q504 noisy.
Noise on -20Vsupply, but +11.2V and +30V supplies are ok.	a) Q509 or Q510 noisy. b) Q511 noisy or intermittent.

POWER SUPPLY
TROUBLESHOOTING CHART Continued

INDICATION	POSSIBLE CAUSE AND REMEDY
	c) CR519 defective.
Noise on +5.6V supply or +5.6V supply cannot be adjusted, but +11.2V supply is ok.	a) Q513 or Q514 or Q515 is defective.

SWEEP GENERATOR
TROUBLESHOOTING CHART

INDICATION	POSSIBLE CAUSE AND REMEDY
No sweep	a) Check control settings. See paragraph 4-2.1 step 7.
	b) Rotate VAR FREQ MARKER AMPLITUDE fully CCW.
	c) Check pin 2 of 610C-ML-835. If there is no sweep, check SWEEP BIAS ADJ R126 setting. See paragraph 4-2.3 step 9.
	d) Check Q104 and Q107.
SWEEP START LEVEL R127 cannot adjust start level for 0V ±20mV.	a) Check power supply voltages. See paragraph 4-2.2.
	b) Check Q106.
Sweep too slow or SWEEP TIME (SEC) VERNIER has little or no effect on Sweep Time.	a) Check that RF Plug-In is properly installed.
	b) Check -18V at pin 4 of 610C-ML-834.
Sweep Time too slow/fast on all ranges.	a) Check SWEEP BIAS ADJ R126 setting. See paragraph 4-2.3 step 9.
Flickering sweep in LINE SYNC or no sweep in TRIG, but AUTO is ok.	a) Check TRIGGER ADJ R138. See paragraph 4-2.3 steps 16 through 21.
Sweep stops part way through its cycle	a) Rotate VAR FREQ MARKER AMPLITUDE fully CCW. If this frees the sweep, see paragraph 4-2.6, steps 8 and 9, for marker amplitude

SWEEP GENERATOR

TROUBLESHOOTING CHART Continued

INDICATION	POSSIBLE CAUSE AND REMEDY
	adjustment.
No +6V BLANKING OUT pulse, but sweep is ok.	a) Check Q108 and Q113.
No base line on detected output.	a) Set RETRACE RF to OFF.
	b) Check RF output from RF Plug-In.
	c) Check Q109.

* Replacing Q104 may require R116 to be changed to achieve proper sweep time.

FREQUENCY INSTRUCTION

TROUBLESHOOTING CHART

INDICATION	POSSIBLE CAUSE AND REMEDY
BEGIN ADJ R206 cannot adjust start level for 0V ±10mV at terminal I of TB201.	a) Check output of Sweep Generator at pin 2 of 610C-ML-835 for proper sweep start level. See paragraph 4-2.3.
	b) Check power supply voltages. See paragraph 4-2.2.
END ADJ R201 cannot adjust sweep output to 0V ±50mV (actually +11.2V ±50mV) at terminal I of TB201.	a) Check output of Sweep Generator at pin 2 of 610C-ML-835 for proper sweep waveform and amplitude. See paragraph 4-2.3.
	b) Check power supply voltages. See paragraph 4-2.2.
No sweep waveform at pin 24 of J401, but sweep waveform ok at terminal C of TB201.	a) Check shorting link between terminals B and C of TB201.
	b) Check input circuit of RF Plug-In for short circuit.
FREQ ZERO R237 cannot adjust voltage for 0V ±20mV at pin 24 of J401.	a) Check setting of front panel controls. See paragraph 4-2.4 step 20.
	b) Check differential amplifier Q203 for unbalanced inputs using DC Differential Voltmeter.
AMPLITUDE R218 cannot adjust voltage for +9.75V ±25mV at pin 24 of J401.	a) Check Q203 and Q207.

FREQUENCY INSTRUCTION

TROUBLESHOOTING CHART Continued

INDICATION	POSSIBLE CAUSE AND REMEDY
ΔF OFFSET R225 cannot adjust voltage for 0V ±25mV at pin 24 of J401.	a) Check for -20V on pin 10 of 610C-ML-833. b) Check Q204 and Q205.

VARIABLE FREQUENCY MARKER

TROUBLESHOOTING CHART

INDICATION	POSSIBLE CAUSE AND REMEDY
Cannot recalibrate Variable Frequency Marker pulse.	a) Check Q306 and Q307 for balanced operation. See paragraph 4-2.6 steps 1 through 7. b) CR305 or CR306 defective. c) Q305 defective.
No Intensity marker, but Video marker is ok.	a) Check DWELL ADJ R341 setting. See paragraph 4-2.6 steps 10 through 13. b) Q309 or Q310 defective.
No RF Pip marker, but Video and Intensity markers are ok.	a) Check MAX AMPL ADJ R326 setting. See paragraph 4-2.6 steps 8 and 9. b) CR307 defective.

SECTION VI

SCHEMATIC DIAGRAMS

6-1 INTRODUCTION

This section of the manual contains the schematic diagrams for the Model 610C Sweep Generator. Table 6-1 lists those drawings included in this section.

Table 6-1 List of Schematic Diagrams