3.0 CALIBRATION PROCEDURE (Fig. 3.0.1)

This unit must be on for one hour with the covers in place and the output terminated into 50Ω before calibration.

The following equipment or suitable equivalents of known accuracy are required for complete calibration.

Oscilloscope D.C. to 100MHz with Differential input with 5MV/cm sensitivity.
Tektronix 7704 with 7A13 plug-in.

Counter-Timer 10Hz to 10MHz.
DANA 8010B or equivalent.

Digital Voltmeter .01% accuracy with 100 megohm input impedance floating inputs.
DANA 4300.

Harmonic Distortion Analyzer .1% Residual Distortion
Hewlett Packard 333.

Model 517 only.

Voltage source 0V to +5V with 3 digit accuracy.

3.0.1 INITIAL CONTROL SETTINGS

POWER SWITCH	ON
START FREQUENCY (MULTIPLIER)	S0 (FULLY CCW)
RANGE	100KHz
FUNCTION	NORMAL SQUARE
AMPLITUDE	FULLY CW
OFFSET	OFF
ATTENUATOR	OFF

Model 516 and 517 only.

MODE	RUN
STOP FREQUENCY	.9X
RAMP TIME	1msec
RAMP VARIABLE	FULLY CW
RAMP RUN/TRIG	TRIG
RAMP CAL	CAL

Model 517 only.

LIN/LOG	LIN

Use TP276 as common for all steps of calibration.

3.0.2 POWER SUPPLIES

A. Probe to TP112 and adjust the -15V ADJ for -15.000V ± .01V.
B. Probe to TP104 and adjust the +15V ADJ for +15.000V ± .01V.
C. Repeat A and B until both are within ± .01V.

3.0.3 VCF BALANCE

A. Connect OUTPUT to scope. A square wave of approximately 100Hz or above should be seen on scope. If there is no signal or the frequency is too low, dial up on START FREQUENCY.
B. Adjust VCF BAL for no change in frequency when VCF IN is shorted to common.
C. Set START FREQUENCY to bottom of SEARCH (fully CCW). Connect DVM from common to TP230 and adjust SEARCH RANGE ADJ for -0.005mV ± .5mV.
D. Connect OUTPUT to scope. Adjust SEARCH SYM ADJs A and B for a symmetrical square of period 11 msec.

Models 516 and 517 only.

E. Connect DVM from common to TP220 and measure voltage. Move DVM to TP1130 and adjust RAMP CAL ADJ for same voltage as at TP220.
F. Switch MODE to SWEEP and move DVM to TP220. Adjust SWEEP BAL for 0.000V ± 1mV. Switch MODE to RUN.
G. Repeat E and F until no more improvement can be obtained.

Model 517 only.

H. Depress LIN/LOG. Connect clip lead from common to TP241 and connect DVM from common to TP1310 and adjust AMP 1 BAL for 0.000V as close as possible. Remove clip lead.
I. Connect DVM (floated) between TP1350 and TP1351 and adjust AMP 3 BAL for 0.000V as close as possible. Release LIN/LOG.

3.0.4 SINE DISTORTION

A. Connect OUTPUT into 50Ω to distortion analyzer. Set RANGE to 1KHz, START FREQUENCY to 1.0 and FUNCTION to SINE. Center up the 4 SINE DIST. ADJs.
B. Adjust SINE INPUT and SINE OUTPUT for minimum distortion.
C. Adjust the 4 SINE DIST. ADJs for minimum distortion.
D. Repeat B and C until no further improvement can be obtained.

3.0.5 FREQUENCY

A. Connect SYNC OUT to counter. Adjust FREQ ADJ for 1KHz ± 10Hz.

B. Set RANGE to 100Hz and adjust 100Hz ADJ for 100Hz ± 1.0Hz.
C. Set RANGE to 1MHz and adjust 1MHz ADJ for 1MHz ± 10KHz.
D. Set RANGE for 10MHz and adjust 10MHz ADJ for 10MHz ± 100KHz.
E. Repeat D and E until no further improvement can be obtained.

Model 517 only.

F. Set START FREQUENCY to bottom of search (fully CCW) and RANGE to 100KHz. Depress LIN/LOG and adjust AMP 3 BAL for same frequency as in LIN.
G. Set START FREQUENCY to 1.0 and adjust SPAN ADJ for same frequency in LOG as in LIN.
H. Depress LIN/LOG and set START FREQUENCY for 100Hz ± 2Hz.
J. Apply positive voltage at VCF IN until frequency increases to 100KHz ± 1KHz (approximately 4.5V) and record voltage.
K. Apply 1/2 of voltage measured in step 1 and adjust ORIGIN ADJ. for 3.16KHz ± 40Hz.
L. Repeat steps F through K until no further improvement can be obtained.

3.0.6 RAMP

Models 516 and 517 only.

A. Connect OUTPUT to scope. Set MODE to SWEEP, set FUNCTION to SQUARE, set RANGE to 100KHz, and START FREQUENCY fully CCW and release RAMP CAL. Adjust RAMP LOCKOUT ADJ for frequency, with MODE in SWEEP, to be the same as when MODE in in RUN.
B. Set FUNCTION to RAMP. Depress RAMP RUN/TRIG and adjust RAMP DC ADJ for the negative peak to be equal to the same DC voltage as measured when RAMP RUN/TRIG is released +0V -.010V. Leave RUN/TRIG depressed.
C. Adjust RAMP PEAK ADJ for the positive peak to be equal to the DC voltage measured when RAMP CAL is depressed -0V + .010V. Release RAMP CAL.
D. Connect RAMP SYNC OUT to counter reading time interval A to B (positive to negative slope) and adjust RAMP TIME ADJ for 1msec ± 10μsec. Set MODE to RUN, release RAMP RUN/TRIG and set START FREQUENCY to 1.0.

3.0.7 OUTPUT WAVEFORMS

A. Connect OUTPUT to scope, set RANGE to 100Hz, START FREQUENCY (MULTIPLIER) to 1.0 and AMPLITUDE fully CCW. Connect a clip lead across R800 and adjust PA BAL for zero offset. Remove clip lead and rotate AMPLITUDE fully CW.
B. Set FUNCTION to TRIANGLE. Adjust TRI AMPL ADJ and TRI D.C. ADJ for ±5V + 100mV -0mV.
C. Set FUNCTION to SINE. Adjust SINE AMPL ADJ and SINE D.C. ADJ for ±5V + 100mV -0mV.

D. Set FUNCTION to SQUARE. (Allow 1 min. warmup time). Adjust SQU AMPL ADJ and SQU D.C. ADJ for ±5V + 100mV -0mV.

Models 516 and 517 only.

F. Set FUNCTION to INVERTED SQUARE. (Allow 1 min. warmup time). Adjust INV SQU AMPL ADJ and INV SQU D.C. ADJ for ±5V + 100mV -0mV.
G. Set FUNCTION to INVERTED TRIANGLE. Adjust INV AMP GAIN ADJ and INV AMP D.C. ADJ for ±5V + 100mV -0mV.

4.1 CIRCUIT DESCRIPTION (Fig. 4.1.1 or 4.1.2)

4.1.1 MAIN GENERATOR

Common to all models.

The instrument contains a triangle generator loop. The process of generating the triangle also generates a square wave. The triangle is shaped into a sine wave. The selected waveform is then amplified and sent to the output.

The VCF AMPLIFIER is a summing amplifier accepting input, from the MULTIPLIER and VCF IN.

The output voltage of the VCF AMPLIFIER is level shifted to generate the voltage levels required by the POSITIVE CURRENT SOURCE and the NEGATIVE CURRENT SOURCE. The current sources are voltage to current converters. A capacitor is alternately charged and discharged by the two current sources through a current switching bridge. Frequency range selection is made by changing current setting resistors in the current sources and by changing the timing capacitor and by use of the CAPACITANCE MULTIPLIER. The capacitor voltage is routed to the LEVEL DETECTOR through the high input impedance, low output impedance TRIANGLE BUFFER. The LEVEL DETECTOR is a bistable, voltage level detector which switches states as the capacitor voltage reaches the preset plus and minus triangle peak voltages. The square wave thus generated drives the current switching bridge, the SYNC OUT BUFFER and the SQUARE SWITCH.

When triangle is selected, the FUNCTION SWITCH routes the triangle to the PRE AMP and then the POWER AMP. The PRE AMP is a non-inverting operational amplifier. The POWER AMP as an inverting, high output current operational amplifier with feed forward. When sine is selected, the triangle is routed through the SINE SHAPER prior to the PRE AMP. The SINE SHAPER has three diode bridges which shape the triangle into a sine wave. The square wave is routed directly to the POWER AMP from the SQUARE SWITCH. The ATTENUATOR is a series of 50Ω 'T' attenuators.

Models 516 and 517 only.

The 516 and 517 have additional circuitry in the main generator to generate inverted waveforms. The PRE AMP output is fed to the INVERTING AMP which is a unity gain inverting operation amplifier. When inverted triangle or sine are selected, the FUNCTION switch routes the output at this amplifier to the POWER AMP. The SQUARE SWITCH has another stage which generates the inverted square.

Sweep start and stop sweep frequency are generated by summing the ramp, inverted, with the 1V already present at the top of the START FREQ control and summing the output of START FREQ into the VCF AMP with the output of the STOP FREQ control which also is driven with the ramp.

4.1.2 TRIGGER AND GATE CIRCUITRY

Models 516 and 517 only.

The TRIGGER COMPARATOR accepts inputs from MAN, TRIG IN and the ramp generator. It is a Schmitt trigger which conditions the trigger signal to a square pulse. In PULSE mode, the ramp level detector pulse is used for triggering. In BURST mode, the ramp and a DC voltage from the BURST WIDTH control are summed at the trigger comparator input. The LOCKOUT FLIP-FLOP is of the set-reset type, with one input connected to the trigger comparator and the other input to the LEVEL DETECTOR. When the flip-flop receives a signal from the TRIGGER COMPARATOR, it is set to allow the generator to run and a signal from the LEVEL DETECTOR resets it to stop the generator. In a trigger mode the signal from the trigger comparator is AC coupled whereas in a gate mode it is DC coupled so the level detector cannot reset the flip-flop until the TRIGGER COMPARATOR has reset. The mechanism of lockout is accomplished by summing positive current at the timing capacitor equal and opposite to the current from the NEGATIVE CURRENT SOURCE on the negative slope of the triangle to hold the voltage. This current is from the LOCKOUT CURRENT SOURCE which tracks the POSITIVE CURRENT SOURCE at twice the current. The lockout voltage level is set by the LOCKOUT VOLTAGE SOURCE. As the triangle approaches the lockout voltage, the lockout diode bridge begins to switch current to the timing capacitor until each side of the bridge is running at half current and the triangle holds. When not locked out, the lockout current is drawn by lockout flip-flop.

4.1.3 RAMP

Models 516 and 517 only

The ramp generator is similar to the main generator triangle generator in that two current sources charge and discharge a timing capacitor with the peak voltage controlled by a level detector.

The POSITIVE CURRENT SOURCE generates a current inversly proportional to the position of RAMP VARIABLE so that it tracks a period linearly rather than the frequency. The NEGATIVE CURRENT SOURCE tracks the POSITIVE CURRENT SOURCE and only it is switched to and from the timing capacitor by the level detector. The negative, or reset, current is 15 times the positive current giving a reset time 14 times faster than the rise time. The RAMP BUFFER and LEVEL DETECTOR are the same as in the main generator except the level detector switch points are at +1V

and 0V. Ramp lockout uses a somewhat different scheme than the main generator. The LOCKOUT FLIP-FLOP receives signals from the LEVEL DETECTOR and TRIGGER COMPARATOR to enable or disable the LOCKOUT AMP. The LOCKOUT AMP is an inverting operational amplifier with current mode output. Its inputs are connected to the output of the RAMP BUFFER and common and the output is connected to the timing capacitor. It sums enough current at the timing capacitor to hold the voltage at 0V. RAMP CAL is simply a voltage source set at the same voltage as the ramp peak to simulate the ramp being held at its peak.

4.1.4 LOG CONVERTER

Model 517 only.

The log converter is connected between the VCF inputs and the VCF AMP when LIN/LOG is depressed. It converts the 0V-5V linear VCF control voltage to a 0V-5V exponential curve by making use of the exponential characteristics of the base emitter junction of a transistor.