THEORY OF OPERATION

The block diagram, Fig. 28, is located at the rear of this manual on a fold-out page that may be unfolded and used for reference while reading the associated text which follows. The block diagram defines the circuit breakdown of the generator. Refer to the separately supplied schematic diagram for circuit details.

GENERAL CIRCUIT DESCRIPTION

The basic waveform generated in the Model 3020 is the triangle wave. This is accomplished by charging and then discharging a capacitor by equal magnitude currents. A dual comparator and flip-flop determine whether the capacitor is being charged or discharged. When the voltage on the capacitor reaches the positive limit, the charging current is switched off and the capacitor discharges until the lower limit is reached at which time the charging current is then reapplied. The output of the dual comparator is a square wave.

To produce a sine wave, the triangle wave is shaped by a special amplifier. Range switching is accomplished by changing the magnitude of the current sources and the timing capacitors. Dial frequency tuning is done by changing the magnitude of the current sources. A frequency change of over a 1000:1 is possible with the frequency dial.

The peak-to-peak voltage of the triangle wave generated is 2.0 volts. the frequency of operation is determined by the currents, the capacitor value and the peak-to-peak voltage of the triangle wave.

DETAILED CIRCUIT DESCRIPTION

Frequency Control Voltage Reference (IC1A)

The frequency control voltage reference is composed of five trimpots (R2 thru R6), two resistors and IC1A, which divide the +15 volts supply and provide a reference voltage of approximately +10 volts to the FREQ dial potentiometer. Each trimpot is adjusted to compensate for the tolerance variations of the timing capacitors.

Tuning Amplifier (IC1B)

The tuning amplifier is provided to buffer the output of the FREQ dial pot. This assures that this voltage will be as linear as frequency pot R3 itself. If not, R9 would be in parallel with frequency pot R3 and the action of the frequency pot would be non-linear.

Current Summing Amplifier (IC1C, Q2)

The current summing amplifier sums the current from the tuning amp, VCG IN jack, and sweep generator. The current from the tuning amp is simply the voltage at its output divided by the value of R9 (1K). The current from the VCG IN input is normally zero. When a voltage is applied, the current into the summer is the voltage divided by R11 (1KΩ). For a 1000:1 sweep, the voltage has to be approximately +10 V. The output current (collector of Q2) creates a voltage across R18 (1K) that tracks the voltage of the tuning amplifier.

Current Source Driver (IC2, Q3)

Q3 is a FET driver used in conjunction with the operational amplifier IC2. IC2 and Q3 are connected as a voltage follower with a closed loop gain of +1. The voltage at the source and drain of Q3 follow the input voltage of pin 3 but are of opposite polarity. In this way the current source driver provides both current sources with equal voltages.

Positive and Negative Current Sources (IC3, Q4, IC4, Q5)

The current sources provide two switchable sets of currents. IC4 and Q5 are connected as a voltage follower. The voltage at the drain of Q5 is equal to the voltage at the input to IC4 (pin 3). The current produced, -I, is equal to the -15 volt supply minus the voltage at the drain of Q5, divided by the total resistance R_{T1} (which equals R31). The current -10I is produced by the same voltage but R32 has been switched in parallel with R31 and the total resistance is now the parallel combination R_{T10} (R32 in parallel with R31).

The voltage across R21 + R22 is equal and opposite to the voltage across R24, IC3 and Q4 are connected as a voltage follower similar to IC4 and Q5. The voltage at the source of Q4 is equal to the voltage at the input to IC3 (pin 3). The current produced is equal to the +15 volt supply minus the voltage at the source of Q4 divided by the total resistance R_{T2} (which equals R29). The value of R_{T2} is half the value of R_{T1}, therefore the current is 2I. Similarly, when R30 is switched in parallel with R29, the total resistance is R_{T20}. The total current with R_{T20} is 20I.

Diode Gates (D4, D5)

The diode gates are silicon diodes D4 and D5. In the 1 and 10 ranges, the positive current source puts out 2I and the negative current source sinks -I current. The purpose of the gates is to either switch the output of the positive current source to the capacitors to charge them, or to shunt the positive current so that the negative current source can discharge the capacitors. The gates work as follows:

1. If the signal from the dual-level detector and flip-flop is high-level TTL, +5 V, it reverse-biases diode D5 and cuts it off. Diode D4 now becomes forward-biased and all the current (2I) flows through D4. The negative current source is

also operating, but can only sink -I current. A net positive current, I, is seen by the capacitors and they are linearly charged by the constant current source to produce a positive ramp.

2. If the signal from the dual-level detector and flip-flop is low-level TTL, 0 V, it forward-biases diode D5 and the level detector sinks all the current (2I) from the positive current source. Diode D4 now becomes reverse-biased and no current flows thru it. The capacitors now see only the negative current source with -I current and are linearly discharged to produce a negative ramp. In the 100 through 1M ranges the gates work exactly the same except that the currents are now 10 times greater.

Timing Capacitors (C_T)

Timing capacitors C5 through C9 are chosen for such highly desirable qualities as:

1. Low dissipation factor.
2. Low temperature coefficient.
3. Long-term capacitance stability.

C_T Buffer (Q6, Q7)

The C_T buffer has a very high impedance to minimize leakage currents and prevent loading of the timing capacitors. Q6 is a dual FET; one half is the high-impedance buffer to the capacitors while the other half provides temperature compensation to the first half. Q7 is an emitter follower and is used to provide the necessary current to drive the level detector, sine shaper, etc. The three silicon diodes along with the base-emitter junction of Q7 shifts the triangle waveform seen at the emitter of Q7 up to four diode drops (about 2.5 V) so that the diode gates can switch properly with a TTL level signal from the level detector.

Dual-Level Detector and Flip-Flop (IC5)

The level detector senses the level of the ramp input (either positive or negative) and switches output states when the input reaches any one of two voltage limit references. The device (75107) has a dual differential input comparator stage and a dual three-input NAND gate output stage connected as an R-S flip-flop. The input limit voltage references are set by two voltage dividers on the tracking +15 V and -15 V supplies. Resistors R33 and R34 set +1.0 V for the minus input of one comparator. Resistors R38 and R39 set -1.0 V for the plus input of the other comparator. C12 couples a small positive feedback from one output of the line receiver (pins 5 and 9) to the inputs (pins 2 and 12) to speed up the switching.

TTL Buffer (IC6A, IC6B)

IC6A and IC6B are half of a quad NAND gate package. They are connected in parallel and provide a fan-out of 20 for the TTL square wave. This avoids any loading on the level detector.

Square Wave Level Shifter (IC6C, IC6D)

The square wave level shifter shifts the DC level of the TTL output of the level detector so that it is approximately symmetrical about zero. IC6C and IC6D are connected in parallel. One set of inputs (pins 2 and 12) are switched so that the level shifter operates only when the square function button is pushed on. Trimpot R46 provides an amplitude adjustment for the square wave.

Sine Wave Shaper (IC13)

The sine wave shaper takes a triangle wave input and non-linearly shapes it to produce a sine wave. The shaper utilizes the non-linear relationship of a differential transistor pair. The output is taken from one collector of the pair and buffered and level-shifted by the two other transistors in IC13. Trimpot R86 adjusts the amplitude of the sine wave and R100 adjusts its DC level at the output. Trimpots R88 and R94 are adjusted to provide the lowest distortion of the sine wave.

Output Amplifier (Q201 through Q205)

The output amplifier consists of a differential input stage (Q102 and Q202), followed by a common emitter transistor, Q203. The output from Q203 is applied to a push-pull output stage (Q204 and Q205). Feedback is applied from the output to the base Q202 by R207 and R208. The closed loop gain is approximately 10. DC offset is obtained by applying the offset voltage to the base of Q202 also.

Step Attenuator

A 3-step, pushbutton selectable, 50-ohm attenuator is provided between the output amplifier and the 50-ohm output jack. The series arrangement of 10 dB, 10 dB, and 20 dB sections makes all selected attenuation cumulative for 10 dB steps from 0 to -40 dB.

Sweep Circuits

A linear range waveform from IC7a, or a logarithmic ramp waveform from IC8a is selected by LIN/LOG switch S3. If the SWEEP WIDTH switch is on, this ramp voltage is summed with any output of tuning amplifier IC1b and VCG IN voltage to control the frequency of the generator. SWEEP WIDTH control R10 adjusts the amplitude of the sweep ramp voltage into the summing network.

The linear sweep ramp voltage waveform is also shaped into a pulse which becomes the tone burst gate.

Linear Sweep Generator (IC7a, IC7b, Q9)

Operational amplifier IC7a, capacitor C14 and resistor R57, develop a positive-going linear ramp voltage. The charge rate for C14, and thus the frequency of the ramp waveform, is adjustable by SWEEP RATE control R56. Operational amplifier IC7b switches, as does Q9, when the ramp voltage reaches the threshold of IC7b. This discharges capacitor C14 quickly, and forms the negative-going fall time of the ramp waveform.

Log Sweep Shaper (IC7c, IC8b, IC9a, IC8a)

Operational amplifier IC7c drops the level of the linear ramp waveform to appropriate levels to drive the shaper circuits. Logarithmic shaping is performed by IC8b and IC9a. The proper output level is provided by current-to-voltage converter IC8a.

Tone Burst Circuits

The internal tone burst generator uses the linear sweep generator ramp waveform as the basis of its timing. One cycle of sweep voltage ramp waveform becomes one cycle of tone burst gate pulse (tone burst and rest time). The BURST GATE control adjusts the proportion of tone burst time to rest time.

The internal or external tone burst gate is synchronized with the triangle wave signal so that the tone burst always starts and stops at the zero crossover point of the output waveform. Thus, there will always be full cycles or half cycles of signal in a tone burst. This is important for proper synchronization of an oscilloscope for measurements and testing using tone burst operation. The tone burst generator shunts the charging current from the timing capacitors to inhibit output during the rest time period of tone burst operation. The shunting action is removed during the tone burst, and output signal is permitted.

Schmitt Trigger (IC7d)

Differential amplifier IC7d effectively operates as a Schmitt trigger to produce a pulse from the linear ramp waveform. Threshold voltage is adjustable by the BURST GATE control, thus varying the width of the pulse.

Burst Gate Level Shifter (IC9d)

The pulse output from IC7d is shifted to TTL levels by IC9d for proper operation of the following gates. The INT/EXT switch selects the output of the burst gate level shifter in the INTernal position, or the GATE IN jack in the EXTernal position.

Inverter (IC11a)

The positive (logic 1) tone burst pulse is applied to IC11a, which OR's the internal or external gating pulse and inverts to provide the necessary polarity to the dual comparator.

Zero Crossover Detector (IC10)

The triangle wave signal from C_t buffer Q7 is applied to both sides of zero crossover detector IC10. One side of the detector produces a clock pulse at zero crossover of the positive-going portion of the triangle wave. The other side produces a clock pulse at zero crossover of the negative-going portion of the triangle wave.

Dual Comparator (IC12a, IC12b)

The dual comparator consists of two type D flip-flops. The tone burst gate pulse is applied to the D input of both flip-flops. At the end of the tone burst, when the gating pulse changes states, output is delayed until the next zero crossover clock pulse. One of the comparators will then change states. Since the outputs are OR'ed by IC11b, and paralleled to Q11, either comparator will start shutdown of the output signal.

C_t Shunt Switch (IC1d, IC11b, Q10)

The outputs of both sides of the dual comparator are OR'ed by IC11b and applied to Q10. During tone burst, Q10 is off. During rest time it is on, and shunts the charging current from the timing capacitors. This inhibits the generation of an output signal. The timing of the dual comparator initiates inhibit when the timing capacitors are at the zero crossover point. The proper DC offset is provided by IC1d. Since the timing capacitors are held at the zero crossover point during inhibit, operation resumes at the zero crossover point when the inhibit pulse is ended.

Burst Gate Switch (Q11)

In addition to the inhibit provided by the C_t shunt switch, Q11 inhibits the dual-level detector and flip-flop during the same period by shifting its bias.

AM Modulation (IC201)

When the CW/AM switch is placed in the AM position, the output signal is first routed through modulator IC201. The output amplitude of the modulator is determined by the DC voltage reference set by the CARRIER LEVEL control, and the instantaneous modulating voltage applied at the AM IN jack. The MOD LEVEL control selects 0 to 100% of the AM IN voltage to be applied to IC201. The output is an amplitude-modulated signal with adjustable (suppressable) carrier level.

AM Level Shifter (Q206, Q207)

Since the output of IC201 operates at a positive DC reference, Q206 and Q207 shift the DC reference to zero. Buffer Q206 also provides impedance matching for a low-impedance output.

Power Supply (IC14, IC16, Q12, Q13)

Power transformer T1, bridge diodes D12-D15 and filter capacitors C18 and C19 generate +22 V and -22 V, unregulated. The +22 V is applied to voltage regulator IC14, which generates the +15 V supply. The +22 V also is applied through R107 to regulator IC15, which generates the +5 V. IC16B and Q13 comprise a -15 V regulator which is referenced to the +15 V via R14 and R115. In a similar manner, IC16A and Q12 comprise a -5 V regulator which is referenced to the +5 V supply via R111 and R112.

MAINTENANCE AND CALIBRATION

WARNING

1. The following instructions are for use by qualified personnel only. To avoid electric shock, do not perform servicing other than contained in the operating instructions unless you are qualified to do so.
2. A shock hazard is present when the case is removed once the line cord is plugged into an AC outlet. Avoid touching the fuse or bottom of the circuit board in the area of the fuse or power transformer. The fuse has 120 VAC (240 VAC on export models) on it even when the POWER switch is off.

REMOVAL OF REAR CASE

To remove the rear case from the generator, proceed as follows:

1. Use a coin (a quarter works best) to remove the two screws that hold the handle to the case. Use caution to avoid losing the springs beneath the screws that hold the handle on the case. Remove the handle. The handle may be reversed if the user desires. Refer to Fig. 24.
2. Remove the two Phillips-head screws from the rear case.
3. Slide the rear case from the generator.
4. Place the instrument on an insulated surface if power is to be applied with the case removed, such as during servicing and adjustment.
5. To reinstall the rear case on the generator, reverse the above procedure. Be sure the main circuit board slides into the slots inside the case.

LINE VOLTAGE CONVERSION, EXPORT MODELS

The 105-130 volt, 60 Hz power transformer (065-140-9-001), used in the 3020 standard models is replaced by a 105-130/210-260 volt, 50/60 Hz transformer

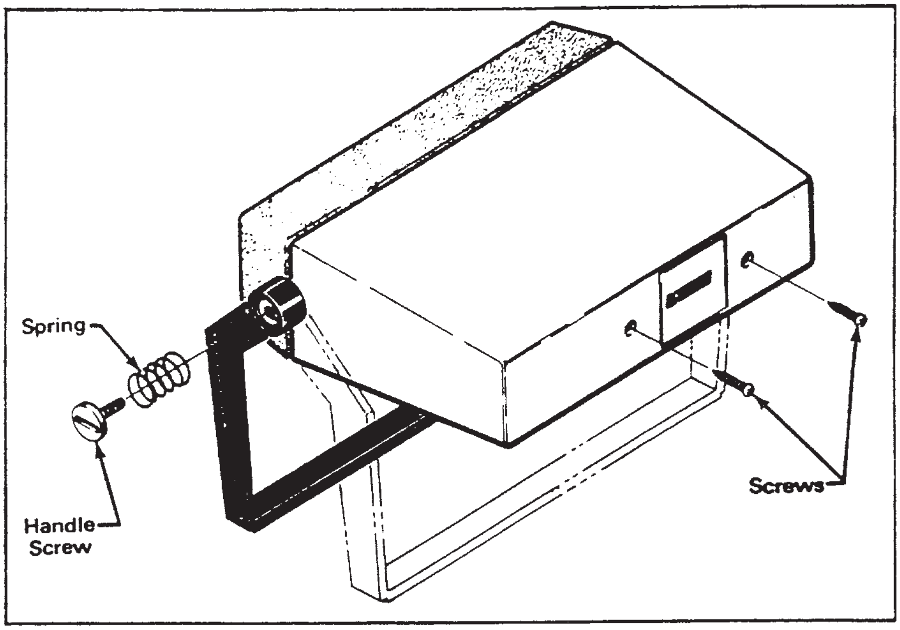

Fig. 24. Removal of rear case.

(065-140-9-002) for the export models. This tranformer is prewired to match the power source in the country of original sale. The transformer can be rewired to the alternate line voltage (see Fig. 25).

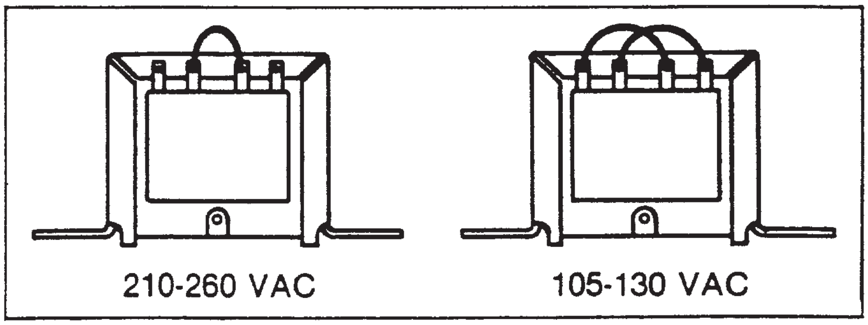

Fig. 25. Transformer wiring, export version.

FUSE REPLACEMENT

The AC line power fuse F1 should not open unless some defect has developed in the instrument. Replace the fuse *only* after investigation of the reason for its opening. Refer to Fig. 26 for fuse location on the main circuit board.

CALIBRATION ADJUSTMENTS

This unit was carefully checked and calibrated at the factory prior to shipment. Readjustment is recommended only if repairs have been made in a circuit affecting calibration, or if you have reason to believe the unit may be out of calibration. Complete recalibration procedures are given in this manual. However, calibration adjustments should be attempted only if the proper test equipment is available, and you are experienced and qualified in its use. If the accuracy of the test equipment used for calibration is less than specified, the accuracy of the 3020 will be proportionately degraded. Perform related adjustments in the specified sequence to avoid any undesirable interaction of adjustments.

Test Equipment Required

1. **DC Voltmeter.** 100 millivolt or 10 millivolt range; 1% of reading, ±0.2% of full-scale accuracy or better on 100 millivolt range (**B & K-PRECISION** Model 2810 or 2830).

2. **Frequency Counter.** 10 ppm time base or better, 200 Hz to 2 MHz (**B & K-PRECISION** Model 1820 or equivalent).

3. **Distortion Analyzer.** (Hewlett-Packard Model 331A or equivalent).

4. **Oscilloscope.** Any model **B & K-PRECISION** oscilloscope or equivalent.

Initial Set-Up Conditions

At the beginning of each calibration adjustment procedure, the controls of the 3020 should be set as follows:

- RANGE switch to 1kHz
- SWEEP WIDTH control to OFF
- SYMMETRY control to CAL
- NOR/INV switch to NOR
- EXT/INT switch to EXT
- CW/AM switch to CW
- No attenuation (ATTENUATOR buttons all out)
- 50Ω output jack terminated into 50-ohm load
- No connections to rear panel jacks
- All other controls to any position

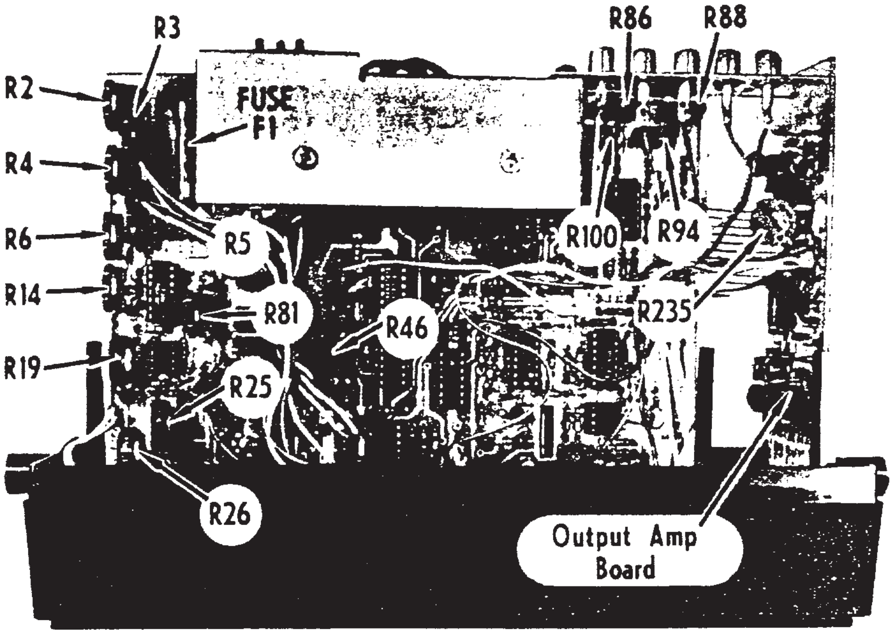

Fig. 26. Location of fuse and calibration adjustments.

Calibration Adjustment	Function	Calibration Adjustment	Function
R2	100 Hz range frequency	R26	Negative current balance
R3	1 kHz range frequency	R46	Square wave amplitude
R4	10 kHz range frequency	R81	C_t shunt DC level
R5	100 kHz range frequency	R86	Sine wave amplitude
R6	1 MHz range frequency	R88	Sine wave distortion #1
R14	Low end dial calibrate	R94	Sine wave distortion #2
R19	Current source driver offset	R100	Sine wave DC level
R25	Positive current balance	R235	AM DC level

Current Source Calibration

1. Set FREQ dial to reading of .002.
2. Connect the DC voltmeter across R18 and adjust R14 for exactly 10 millivolts on the meter.
3. Connect the DC voltmeter across R24 and adjust R19 for exactly 10 millivolts on the meter.

4. Connect the DC voltmeter across R31 and adjust R26 for exactly 10 millivolts on the meter.

5. Connect the DC voltmeter across R29 and adjust R25 for exactly 10 millivolts on the meter.

Frequency Dial Calibration

1. Set the FREQ dial to 1.5.

2. Connect the TTL OUT signal to a frequency counter.

3. Set RANGE switch to 1M and adjust R6 for 1.5 MHz on counter.

4. Set the FREQ dial to 2.0.

5. Set RANGE switch to 100K and adjust R5 for 200 kHz on counter.

6. Set RANGE switch to 10K and adjust R4 for 20 kHz on counter.

7. Set RANGE switch to 1K and adjust R3 for 2 kHz on counter.

8. Set RANGE switch to 100 and adjust R2 for 200 Hz on counter. For more accuracy, set counter for period measurement operation and adjust R2 for 5000 μSEC reading on counter.

DC Level Adjustments

1. Connect DC voltmeter to measure DC voltage at 50Ω output jack.

2. Select triangle wave output at 1 kHz.

3. Adjust the front panel DC OFFSET control for zero volts DC on meter.

4. Set CW/AM switch to AM. Adjust R235 for zero volts DC on meter. Return switch to CW position.

5. Select sine wave signal. Adjust R100 for zero volts DC on meter. Return to triangle wave signal.

6. Display TTL OUT signal on oscilloscope.

7. Set front panel controls for tone burst operation: EXT/INT switch to INT, SWEEP RATE control to highest repetition rate (fully clockwise), BURST GATE control to display only a few cycles tone burst, with output predominantly rest time.

8. Adjust R81 for zero volts DC on meter.

Sine Wave Distortion Adjustment

1. Set FREQ dial to 1.0 and RANGE switch to 1K (1 kHz output).
2. Select sine wave signal.
3. Make sure the output signal is not clipped. Keep the AMPLITUDE control to a mid-range setting and zero out the DC OFFSET control.
4. Connect distortion analyzer to measure the 3020's output signal.
5. Adjust the distortion analyzer for minimum distortion reading.
6. Adjust R88, then R94, for minimum distortion. Repeat until no improvement is noted. Distortion should be below 0.5%.

Amplitude Adjustment

1. Select 1 kHz triangle wave output.
2. Display triangle wave signal on oscilloscope and adjust oscilloscope controls and AMPLITUDE control of 3020 for convenient reference amplitude. Zero out any DC offset with DC OFFSET control.
3. Select square wave signal and adjust R46 for same peak-to-peak amplitude as the triangle wave reference signal.
4. Select sine wave signal and adjust R86 for same peak-to-peak amplitude as triangle wave reference signal. If sine wave distortion adjustments are being performed, complete them before performing this step.

FREQUENCY RESPONSE MEASUREMENTS, LINEAR/LOG DISPLAY (See page 37 for Linear Only Display Method)

Introduction

The linear/log display method of frequency response measurement gives the user the choice of linear or logarithmic display by merely selecting the LIN (linear) or LOG (logarithmic) position of the LIN/LOG switch on the 3020. This method uses the internally generated sweep of the oscilloscope for horizontal deflection, which is linear with respect to time. Thus, when LIN sweep is selected, the sweep voltage and frequency increase linearly. The time period for each increment of frequency is equal; that is, it requires the same amount of time to sweep from 20 Hz to 2 kHz as from 18 kHz to 20 kHz, or any other 2 kHz increment, when using 20 Hz to 20 kHz sweep. When LOG sweep is selected, the sweep voltage and frequency increase at a logarithmic rate; that is, the time period for each decade of frequency increase (for example, 20 Hz to 200 Hz, 200 Hz to 2000 Hz, and 2000 Hz to 20,000 Hz when using 20 Hz to 20 kHz sweep) is equal.

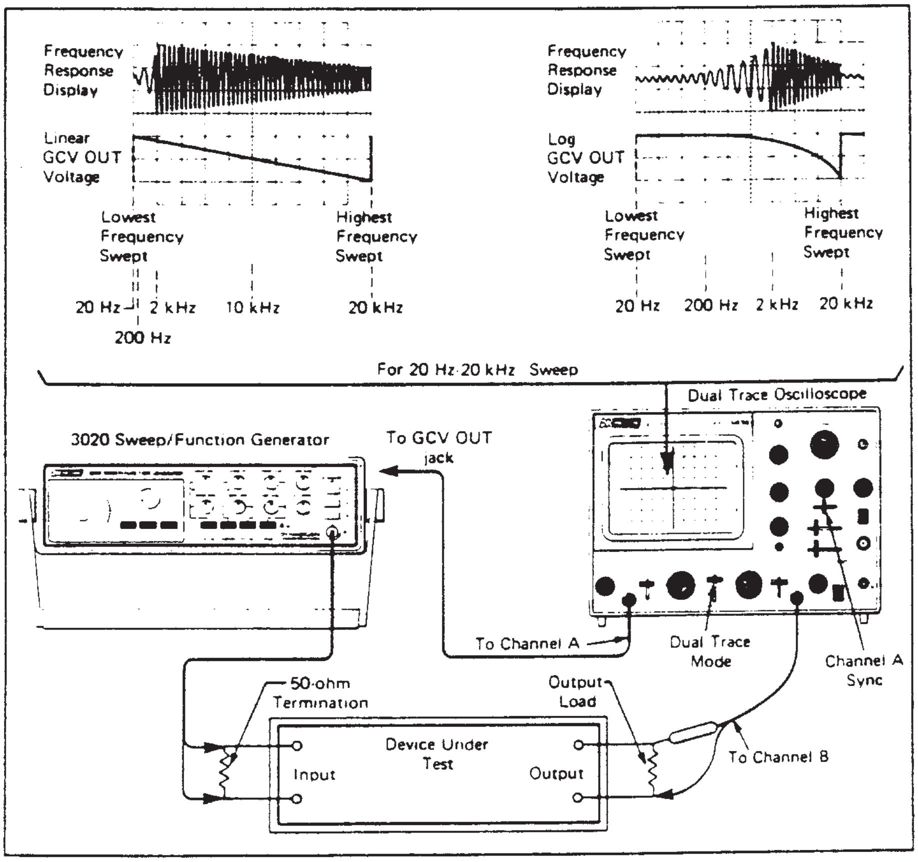

Fig. 27. Frequency response measurement, linear/log display method.

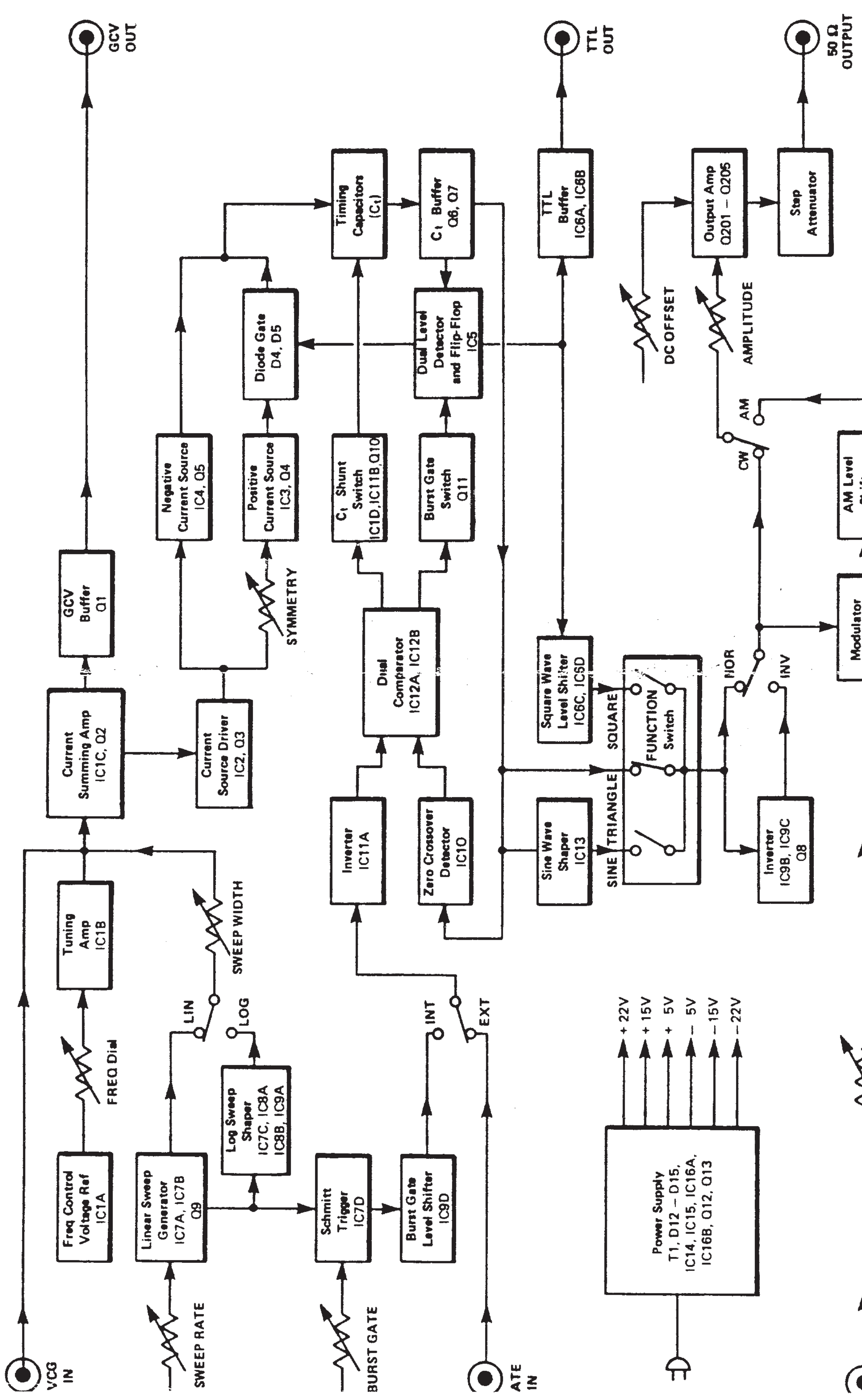
VCG IN
Freq Control Voltage Ref IC1A
FREQ Dial
Tuning Amp IC1B
Current Summing Amp IC1C, Q2
GCV Buffer Q1
GCV OUT
SWEEP RATE
Linear Sweep Generator IC7A, IC7B Q9
Log Sweep Shaper IC7C, IC8A IC8B, IC9A
LIN
LOG
SWEEP WIDTH
Current Source Driver IC2, Q3
Negative Current Source IC4, Q5
Positive Current Source IC3, Q4
SYMMETRY
Diode Gate D4, D5
Timing Capacitors (Ct)
BURST GATE
Schmitt Trigger IC7D
Burst Gate Level Shifter IC9D
INT
EXT
GATE IN
Inverter IC11A
Zero Crossover Detector IC10
Dual Comparator IC12A, IC12B
Ct Shunt Switch IC1D, IC11B, Q10
Burst Gate Switch Q11
Dual Level Detector and Flip-Flop IC5
Ct Buffer Q6, Q7
TTL Buffer IC6A, IC6B
TTL OUT
Square Wave Level Shifter IC6C, IC6D
Sine Wave Shaper IC13
SINE
TRIANGLE
SQUARE
FUNCTION Switch
NOR
INV
Inverter IC9B, IC9C Q8
+22V
+15V
+5V
−5V
−15V
−22V
Power Supply T1, D12 − D15, IC14, IC15, IC16A, IC16B, Q12, Q13
MOD LEVEL
AM IN
CARRIER LEVEL
Modulator IC201
AM Level Shifter Q206, Q207
CW
AM
AMPLITUDE
DC OFFSET
Output Amp Q201 − Q205
Step Attenuator
50 Ω OUTPUT

Fig. 27 shows that LIN sweep gives more resolution of high frequency response and LOG sweep gives more resolution of low frequency response. Sometimes it is desirable to examine the frequency response characteristics of a device using both LIN and LOG sweep. Notice that this method also provides the conventional left-to-right sweep pattern to which most technicians are accustomed.

Procedure

The following procedures, along with Fig. 27, describes the typical set-up and technique for linear/log frequency response measurements.

1. Select the desired frequency range with the RANGE switch. Choose the range at which the *highest* frequency of the sweep would be selected if dialed in manually.
2. Set the FREQ dial to select the *lowest* frequency to be swept.
3. During initial set-up, turn the SWEEP WIDTH control to OFF, and the SWEEP RATE control to mid-position.
4. Connect a cable from the GCV OUT jack to the vertical input of an oscilloscope (channel A input if a dual-trace oscilloscope is used). Select normal sweep operation; not X-Y operation.
5. Use DC coupling for the oscilloscope vertical input and adjust the oscilloscope controls to display a trace. Use automatic sync on triggered sweep scopes.
6. Use the oscilloscope vertical position control to locate the trace at a convenient reference point toward the top of the screen.
7. Now, set the FREQ dial to the *highest* frequency to be swept. As the frequency is increased, the oscilloscope trace will move down.
8. Use the oscilloscope vertical attenuator/gain controls to position the trace at a convenient reference point toward the bottom of the screen.
9. Repeat steps 2, 6, 7, and 8 so that the low and high frequency trace positions are both at convenient reference points (for example, four vertical divisions apart), and so that any interaction between oscilloscope controls is eliminated.
10. Now return the FREQ dial to the *lowest* frequency to be sweep in preparation for sweep operation.

11. As the SWEEP WIDTH control is turned clockwise, a sweep voltage waveform will be displayed. The amplitude of this waveform increases as the SWEEP WIDTH control is turned further clockwise. Adjust oscilloscope controls to display a few cycles of the waveform. Adjust the SWEEP WIDTH control so that the amplitude of the waveform exactly spans the vertical distance between the low and high frequency reference points from step 9. Do not change the SWEEP WIDTH control setting after this step.

12. Adjust the SWEEP RATE control to the desired repetition rate. For viewing convenience, the highest possible setting is desirable. However, it must be set low enough to obtain a few cycles at the lowest frequencies being swept. Readjust the oscilloscope sweep speed to display one cycle of the sweep voltage waveform. The time period of the sweep may be measured on the oscilloscope if desired. At very low SWEEP RATE settings, the trace may appear as a dot moving across the oscilloscope screen. Watch for the positive-going transition at the end of the waveform to define one cycle.

13. Readjust oscilloscope sweep speed to spread one cycle of the waveform over some convenient number of horizontal division. Each division can later serve as a frequency marker if the corresponding frequency is calculated. For example, a linear display may be spread over 10 horizontal divisions. Since the lowest and highest frequencies are already known, the difference may be divided into 10 equal increments. The example in Fig. 27 shows a 20 Hz to 20 kHz linear sweep display spread over 10 divisions. The difference between the lowest and highest frequency is almost 20 kHz. Therefore, starting from the left of the display at 20 Hz, each division equals a frequency increase of 2 kHz. When log display is used, frequency increases at a logarithmic rate and markers between the lowest and highest frequencies must be scaled logarithmically. The example in Fig. 27 shows a 1000:1 log sweep display spread over nine horizontal divisions. Each three divisions equals a decade of frequency change; that is, after three divisions, the frequency has increased one decade or 10:1 (from 20 Hz to 200 Hz), after six divisions the frequency has increased another decade or 100:1 (to 2 kHz), and after nine divisions the frequency has increased another decade or 1000:1 (to 20 kHz).

14. Connect the 50Ω output of the 3020 to the input of the circuit being tested. Connect a 50-ohm termination across the input terminals (not required if the input impedance is 50 ohms). Connect the output of the circuit being tested into its normal load impedance.

15. If a single-trace oscilloscope is used, disconnect the GCV OUT voltage from the vertical input of the oscilloscope and use it as an external sync signal. Connect the vertical input of the oscilloscope to measure the voltage across the output of the circuit being tested.

    If a dual-trace oscilloscope is used, use the channel A attenuator/gain controls to reduce the amplitude of the sweep voltage waveform to about two vertical divisions and position the channel A trace toward the bottom of the screen as shown in Fig. 27. Sync the oscilloscope to the channel A signal. Connect the channel B input of the oscilloscope to measure the voltage across the output load of the circuit being tested.

16. Adjust the signal amplitude of the 3020 output with the AMPLITUDE control and ATTENUATION buttons. The frequency response display should now be seen on the oscilloscope screen. Adjust the oscilloscope vertical or channel B attenuator/gain controls for the desired amplitude on the display. Be sure to keep the signal level out of the 3020 below the clipping level of the circuit being tested. To prevent clipping, start with a low signal level from the 3020 and increase signal amplitude until the highest peak on the display no longer increases as the AMPLITUDE control is increased, then reduce amplitude slightly below that point.

17. Select LIN or LOG display as desired. When switching from LIN to LOG, or vice versa, you may wish to readjust the oscilloscope sweep speed to spread the display over a different number of horizontal divisions for frequency markers. On a single trace oscilloscope, it will probably be necessary to reconnect and observe the GCV OUT sweep voltage waveform for making this adjustment.

18. The SWEEP RATE may be changed if necessary by repeating steps 12 thru 17. The procedure must be started from the beginning to change the SWEEP WIDTH.

WARRANTY SERVICE INSTRUCTIONS
(For U.S.A. and its Overseas Territories)

1. Refer to the MAINTENANCE section of your **B & K-Precision** instruction manual for adjustments that may be applicable.

2. If the above-mentioned does not correct the problem you are experiencing with your unit, pack it securely (preferably in the original carton or double-packed). Enclose a letter describing the problem and include your name and address. Deliver to, or ship PREPAID (UPS preferred in U.S.A.) to the nearest **B & K-Precision** authorized service agency (see list enclosed with unit).

If your list of authorized **B & K-Precision** service agencies has been misplaced, contact your distributor for the name of your nearest service agency, or write to:

B & K-Precision, Factory Service Department
Factory Service Operation
1031 Segovia Circle
Placentia, CA 92870
Tel (714) 237-9220
Fax(714) 237-9214

Also use this address for technical inquiries
and replacement parts orders.

LIMITED ONE-YEAR WARRANTY

MAXTEC INTERNATIONAL CORPORATION warrants to the original purchaser that its **B & K-Precision** product, and the component parts thereof, will be free from defects in workmanship and materials for a period of one year from the date of purchase.

MAXTEC will, without charge, repair or replace, at its option, defective product or component parts upon delivery to an authorized **B & K-Precision** service contractor or the factory service department, accompanied by proof of the purchase date in the form of a sales receipt.

To obtain warranty coverage in the U.S.A., this product must be registered by completing and mailing the enclosed warranty registration card to MAXTEC, **B & K-Precision,** 6470 West Cortland Street, Chicago, Illinois 60635 within fifteen (15) days from the date of purchase.

Exclusions: This warranty does not apply in the event of misuse or abuse of the product or as a result of unauthorized alterations or repairs. It is void if the serial number is altered, defaced or removed.

MAXTEC shall not be liable for any consequential damages, including without limitation damages resulting from loss of use. Some states do not allow limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

This warranty gives you specific rights and you may also have other rights which vary from state to state.

For your convenience we suggest you contact your **B & K-Precision** distributor, who may be authorized to make repairs or can refer you to the nearest service contractor. If warranty service cannot be obtained locally, please send the unit to **B & K-Precision** Service Department, 6470 West Cortland Street Chicago, Illinois 60635, properly packaged to avoid damage in shipment.

B & K-Precision Test Instruments warrants products sold only in the U.S.A. and its overseas territories. In other countries, each distributor warrants the B & K-Precision products which it sells.

BK PRECISION®
1031 Segovia Circle ◆ Placentia, CA 92870

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