P 46.9

INSTRUCTION MANUAL

MODEL 129

AM/FM FUNCTION GENERATOR

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EXACT electronics, inc.
A subsidiary of Danalab, Inc.

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AND

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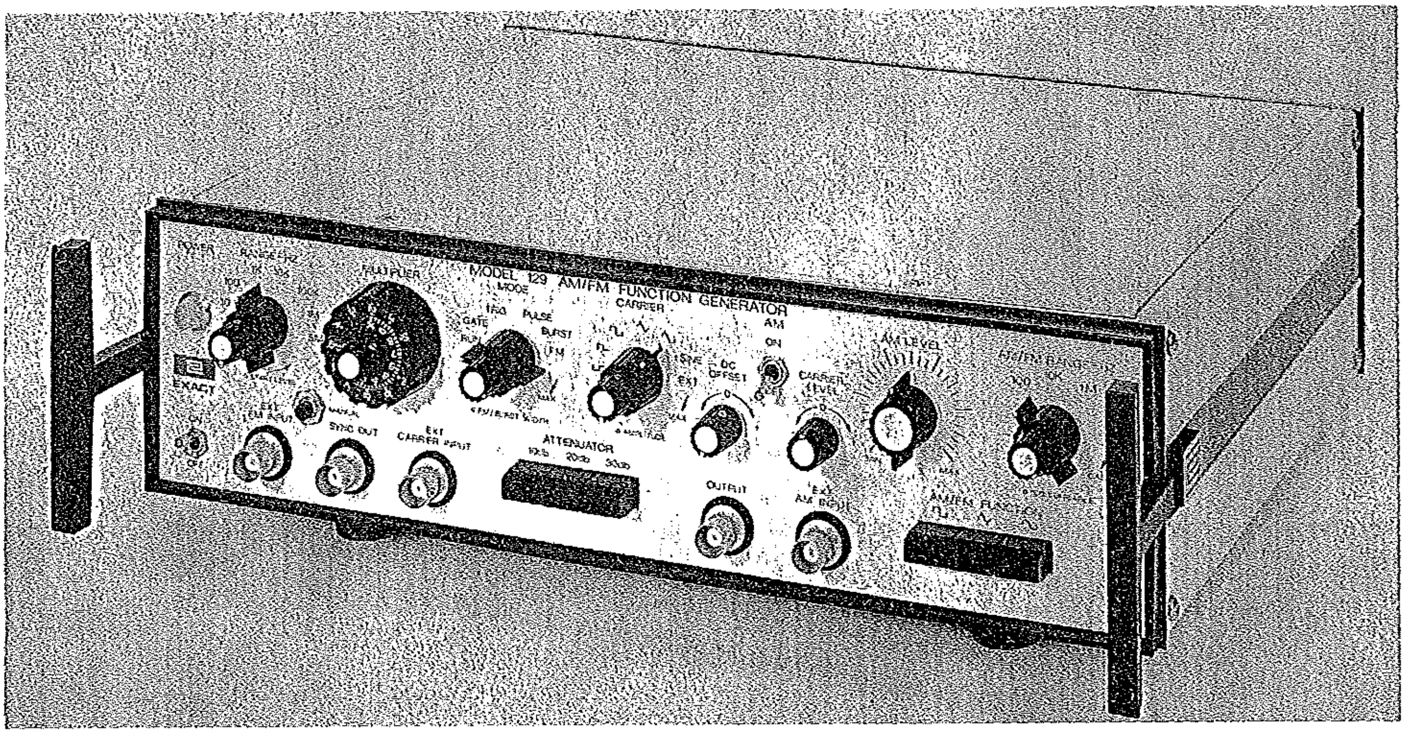

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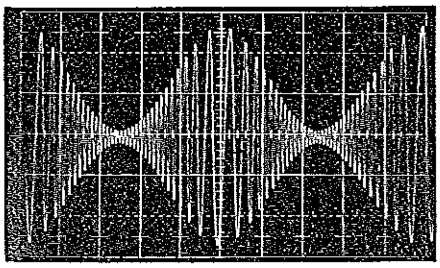
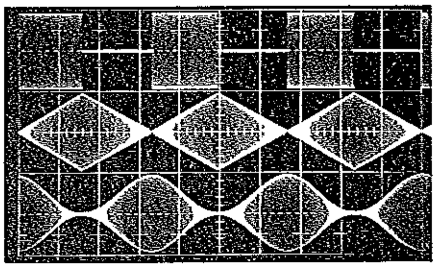
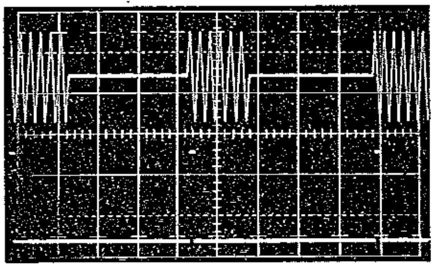


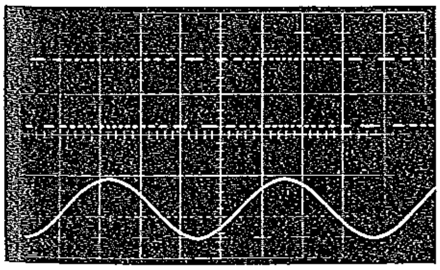
SIMULTANEOUS AM/FM MODULATION



SQUARE, TRIANGLE AND SINEWAVE AM



BURST MODE — PULSE MODE



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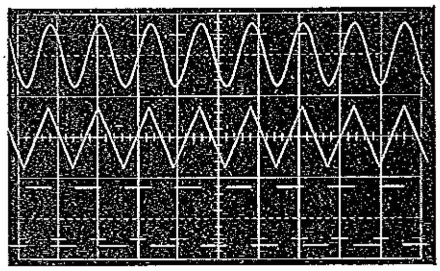
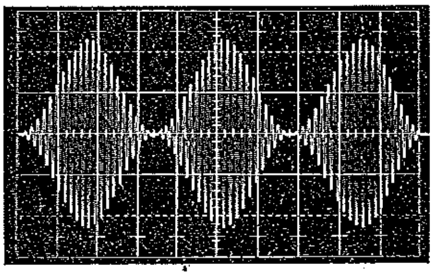


SINE, TRIANGLE AND SQUARE



100% SINE WAVE AM

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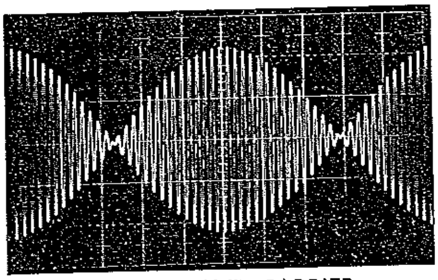
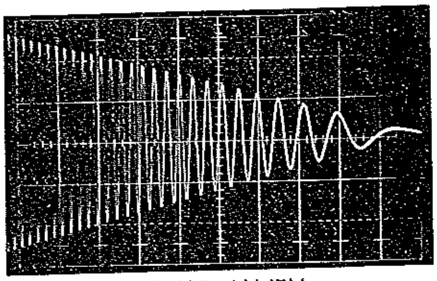
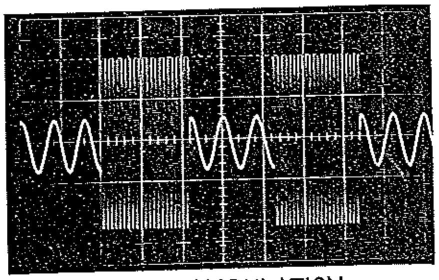


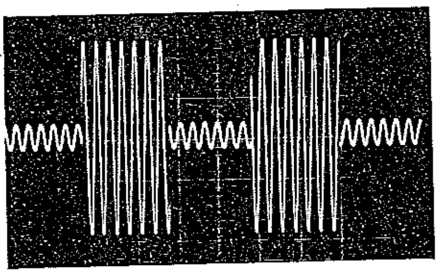
AM SUPPRESSED CARRIER



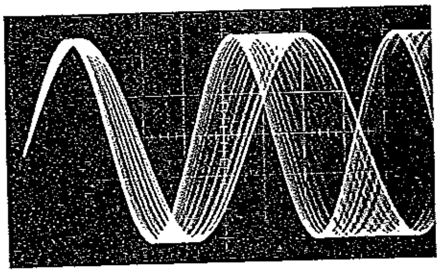
LINEAR AM/FM



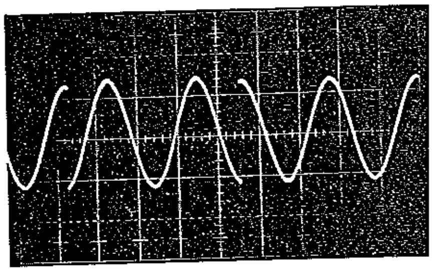
AM/FSK MODULATION



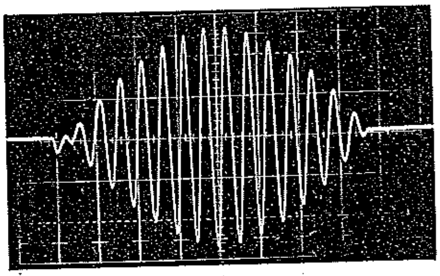
SQUARE WAVE AM



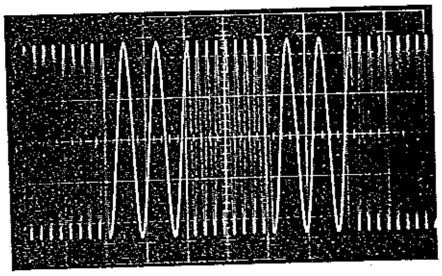
LOW FREQUENCY FM



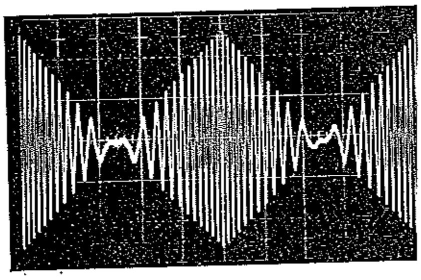
PHASE SHIFT KEYED



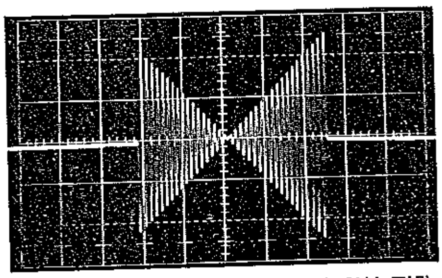
HALF SINE AM BURST



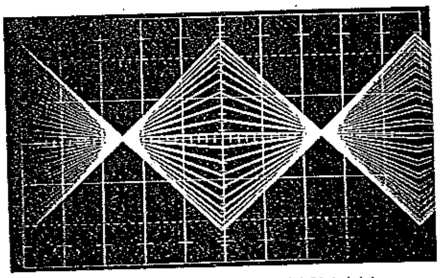
FSK



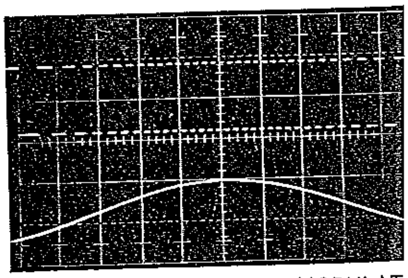
TRIANGLE AM SUPPRESSED CARRIE



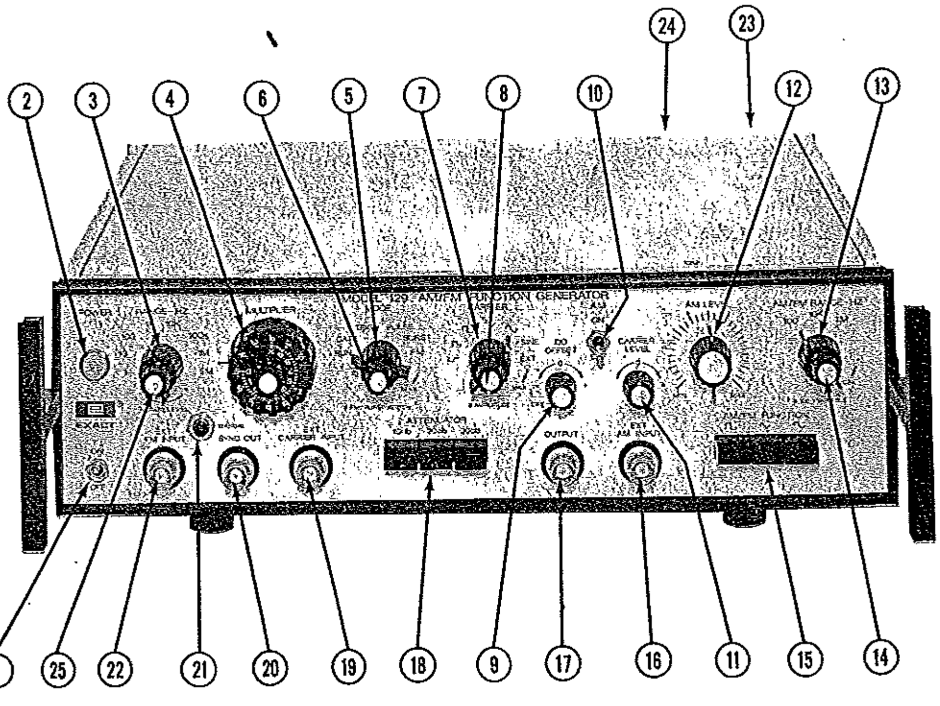
MODULATED TONE BURST (BOW TIE)



ULTRA LOW FREQUENCY AM



LINEAR FM SINE WAVE MODULAT



MODEL 129 AM/FM FUNCTION GENERATOR OPERATION

1. Power On/Off switch — Connects line voltage to the instrument.
2. Pilot Lamp — Visual indication when instrument is on.
3. Range Switch — Selects the desired range of carrier frequencies.
4. Multiplier — Provides calibrated fixed frequency steps between range settings. Each Step equals 10% of range setting. The vernier dial provides variable frequency adjustment between fixed steps.
   The "S" position on the fixed step multiplier dial places the multiplier in the search mode. The search position allows the vernier dial complete control of the frequency over a three decade range.
5. Mode Switch — Selects the desired mode of operation.
   RUN MODE—The carrier generator will free run continuously.
   GATE MODE—The carrier generator will stop running. The generator will free run only when an external signal is applied at the external trigger input or when the manual pushbutton is depressed. The generator will stop running on removal of the signal after completing the cycle it is generating.
   TRIG MODE—The carrier generator will stop running. The generator will run for one complete cycle when an external signal is applied to the Ext Trig in connector or each time the manual pushbutton is depressed.
   PULSE MODE—The pulse mode is similar to the trig mode above. The AM/FM generator triggers the carrier generator "on" for one complete cycle at the AM/FM generator rate. This allows pulsing of all carrier waveforms.
   BURST MODE—The AM/FM generator is connected internally to gate the carrier generator "on" and "off" at the AM/FM generator rate.
   FM MODE—The AM/FM generator will frequency modulate the carrier generator internally when in the FM Mode.
6. FM/Burst Width — Provides adjustment of the FM (sweep) width when in the FM Mode and Burst width in the Burst Mode.
7. Carrier Switch —Selects the desired carrier or output waveform desired. The Ext Position allows the use of an external carrier waveform.
8. Amplitude — Provides >20db variable attenuation of the output signal. Amplitude control has no effect on carrier level or AM level adjustment. (Percent of modulation.)
9. DC Offset — When switched on, provides variable control of the DC level of the output waveform.
10. AM Switch — Allows amplitude modulation of selected carrier waveform.
11. Carrier Level — When in the AM Mode, this control provides complete adjustment of the carrier amplitude from max "pos" thru "null" to max "neg." 180° Phase Shift occurs from Max + to max - setting. May be utilized as a variable PHASE CONTROL.
12. AM Level — This control adjusts the amount of AM signal applied to the modulator. The desired amount of modulation is adjusted by means of the carrier level and/or the AM level controls.
13. AM/FM Range — Selects the desired frequency range of the AM/FM generator.
14. 100:1 Variable — Provides variable adjustment of AM/FM frequency between fixed ranges. This control allows adjustment over a two decade range (100:1).
15. AM/FM Function — A Square, Triangle or Sine waveform may be selected to amplitude modulate the carrier waveform selected by the carrier switch. Simultaneous AM/FM may be obtained by placing the mode switch to FM and the AM switch on.
    The selected waveform from the AM/FM function switch will AM and/or FM the carrier signal selected.
    FM width, AM level, and Carrier level are all independent of each other.
16. External AM Input — When in the AM Mode, an external signal may be used to AM the carrier waveform selected. The AM level must be set to min to avoid mixing of the internal and external AM signal, unless mixing is desirable.
17. Output — BNC output connector providing the selected carrier at 50Ω output impedance for connection to external equipment.
18. Attenuator — A pushbutton attenuator providing a 10, 20 and 30db Pad for a total attenuation of 60db in 10db steps.
19. External Carrier Input — An external carrier or signal may be used when the carrier switch is in the Ext position. Amplitude modulation of this external waveform is easily accomplished utilizing the AM/FM generator or an external AM input.
20. Sync Out — Provides a square wave for syncronizing external equipment to the carrier generator.
21. Manual Pushbutton — The Manual pushbutton allows manual gating and triggering of the carrier generator in the gate and trig mode of operation.
22. External FM Input — Provides external control of frequency for FM, sweeping, frequency shift keying, DC frequency control etc. . . . .
23. External Trigger Input — When in the gate and trig mode, the carrier generator may be externally gated or triggered by application of an external signal at the external trigger input.
24. AM/FM Sync Output — Provides a square wave for syncronizing external equipment to the AM/FM generator.
25. Start level — When the carrier generator is in the gate, trig, pulse or burst mode of operation, the start level provides adjustment of the start phase over a $\pm 90°$ range.

GENERAL

The Model 129 is two generators in one small unique package. The main generator is a VCF (voltage co trolled frequency) generator, producing sine, square, triangle, ±square, ±pulse, +sine and sync wavefor over a dynamic frequency range of 0.1 Hz to 5 MHz. The AM/FM generator produces sine, square, and t angle waveforms over a frequency range of 1Hz to 1MHz. It is also used to gate or trigger the main genera for tone-burst and pulse generator operation.

Simultaneous AM and FM is provided by selecting both AM and FM with the mode switches. Percent modulation can be set with either carrier level or AM level and the percent of modulation remains const for all levels of output settings. Percent of modulation is adjustable from 0% through 100% and on double sideband suppressed carrier.

A search mode is provided using the Kelvin-Varley frequency multiplier vernier, so the main generator c be manually swept over three decades. In the pulse mode, pulse duration as well as repetition rate are va ble. The main generator can also be manually or externally gated or triggered. External amplitude and freque modulating signals can be applied to AM and/or FM the main generator. An external carrier mode is provi to allow the Model 129 to modulate other signals. The AM/FM generator sync output (square wave) is ava able at the output connector on the rear panel. The output amplifier has a 60db step attenuator in 1(steps and 20db variable plus 60db carrier level for greater than 120db attenuation and ± 10V of varia D.C. offset.

The Model 129 is actually a combination SINE, SQUARE, TRIANGLE, AM, FM, VCF, SWEEP, TONEBUR PULSE GENERATOR in one versatile package.

SPECIFICATIONS

WAVEFORMS
Sine, Square, Triangle, Positive Pulse, Negative Pulse, Positive Square, Negative Square, Positive Sine.

DYNAMIC FREQUENCY RANGE
Main generator, 0.1Hz to 5MHz.
AM/FM generator, 1Hz to 1MHz.

MODES OF OPERATION
Run, Gate, Trigger, Pulse, Burst, FM, AM, Simultaneous AM - FM, Ext. carrier.

SYNC OUTPUTS
Main generator, square wave approximately 2 V P-P open circuit. Approximately 100Ω output impedance.

AM/FM generator: square wave approximately 100Ω output impedance. Located on rear panel.

FREQUENCY ACCURACY
Main generator, ±2% of frequency range (typically ±2% of setting).

AM/FM generator: 1Hz to 1MHz in three calibrated steps. Accurate within ±5%. Uncalibrated continuously variable between steps: variable has 100:1 range down from calibrated step.

OUTPUT
50Ω output impedance. All waveforms 20V P-P open circuit. 10V P-P into 50Ω with exception of Positive and Negative Square and Positive Sine which are 10V peak open circuit, 5V peak into 50Ω. A full 80db of attenuation is provided in 10db steps with 20db continuously variable (greater than 120db utilizing carrier level in AM mode).

GATE AND TRIGGER MODES
Input: D.C. coupled, input impedance approximately 5K. Trigger and gate signal requirements, manual or external voltage of approximately 1.2V for turn on. TTL compatible located on rear panel.

EXTERNAL AM INPUT
Approximately 10V P-P for 100% modulation at full output. Frequency response, 1db down at 1MHz.

EXTERNAL FM INPUT
Approximately 5V P-P for Maximum deviation. Slew rate limit approximately 0.1V/μsec.

EXTERNAL CARRIER INPUT
Approximately 10V P-P for full output. Frequency Response, 3db down at 10MHz.

SINE WAVEFORM DISTORTION
<0.5% 0.1Hz to 100KHz (Typically <0.2%). No har monics. <30db down 100KHz to 5MHz

SINE FREQUENCY RESPONSE
0.1db to 100KHz, 0.5db to 5MHz.

SQUARE WAVEFORMS
Rise and fall <50 nanoseconds.
Overshoot and ringing <5%.

TRIANGLE LINEARITY
99% to 100KHz, 95% to 5MHz.

D.C. OFFSETS: Variable ±5V into 50Ω, ±10V open circui D.C. offset plus signal cannot exceed maximum voltag output or clipping will occur.

FREQUENCY STABILITY
0.05% of setting for 10 min.,
0.25% of setting for 24 hrs.

AMPLITUDE STABILITY
0.05% of maximum P-P amplitude for 10 min.,
0.25% of maximum P-P amplitude for 24 hrs.

SYMMETRY (time): ±1%

POWER REQUIREMENTS
Input Voltage — 115% VAC ±10% or 230 VAC ±10%
Frequency — 50 to 400Hz.
Power Consumption — Approximately 20W.

PHYSICAL CHARACTERISTICS
12½" wide X 3½" high X 10½" deep. Top and botto covers are easily removable, exposing all calibration ar circuit board areas.

PRICE: (f.o.b. Hillsboro, Oregon).
Option "B" $50 — 0.01Hz — 5MHz. Main generato
Option "G" $50 — 0.01Hz — 1MHz AM/FM generato

NOTE: (unless otherwise stated). Specifications apply 10(to maximum output voltage with instruments terminat into 50Ω and do not apply in the Search Mode or A Mode. Specifications are valid at 25°C ±5°C warmu time of 30 min.

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VERIFICATION OF SPECIFICATIONS

Following is a list of test equipment required to validate the specifications of the Model 129 AM/FM Generator.

Test equipment with accuracy equal to the following list of test equipment will be acceptable for specification validation.

Oscilloscope, DC to 50MHz
Plug-In, Differential 20mv/cm sensitivity
Counter/Timer, .1μsec time base
DVM, .01% accuracy
Harmonic Distortion Analyzer, less than 0.1% residual distortion
Spectrum Analyzer, 1KHz to 100MHz

NOTE: Allow 60 minutes for warm-up.

FREQUENCY ACCURACY:

Main Generator:

1. Set controls as follows:

RANGE	1K
MULTIPLIER	1.0
MODE	RUN
CARRIER	TRI
ATTENUATORS	OFF (OUT)
AMPLITUDE	MAX
D.C. OFFSET	OFF
AM/FM RANGE	10KHz
100:1 VAR	CAL
AM	OFF

2. Connect the Counter/Timer to the Sync Output jack on the front panel with an appropriate coaxial cable to the A.C. input.

3. Observe time interval on counter of 1000μsec ±20μsec.

4. Set Range to 100. Observe time interval of 10msec± .2msec.

5. Set Range to 10. Observe time interval of 100msec ±2msec.

6. Set Range to 1. Observe time interval of 1000msec ±20msec.

7. Set Multiplier to .10. Observe time interval between 8.33sec and 12.50sec.

FREQUENCY ACCURACY, Main Generator (Continued)

8. Set Range to 10. Observe time interval between 833msec and 1250msec.

9. Set Range to 100. Observe time interval between 83.3msec and 125msec.

10. Set Range to 1K. Observe time interval between 8.33msec and 12.5msec.

11. Set Range to 10K. Observe frequency of 1KHz ±200Hz.

12. Set Range to 100K. Observe frequency of 10KHz ±2KHz.

13. Set Range to 1M. Observe frequency of 100KHz ±20KHz.

14. Set Range to 3M. Observe frequency of 500KHz ±100KHz.

15. Set Multiplier to 1.0 Observe frequency of 5MHz ±100KHz.

16. Set Range to 1M. Observe frequency of 1MHz ±20KHz.

17. Set Range to 100K. Observe frequency of 100KHz ±2KHz.

18. Set Range to 10K. Observe frequency of 10KHz ±.2KHz.

19. Set Range to 1K. Observe frequency of 1KHz ±20Hz.

20. Set Multiplier to .50. Observe frequency of 500Hz ±20Hz.

21. Set Multiplier to 1.0

AM/FM GENERATOR

1. Connect the Counter/Timer to the AM/FM Sync Output on rear panel with an app priate coaxial cable to the AC input.

2. Set 100:1 VAR to CAL position.

3. Set AM/FM Range to 1MHz. Observe frequency of 1MHz ±50KHz.

4. Set AM/FM Range to 10KHz. Observe frequency of 10KHz ±500Hz.

5. Set AM/FM Range to 100Hz. Observe period of 10ms ±.5ms.

6. Set 100:1 VAR full CCW. Observe period > 1sec.

7. Set AM/FM Range to 10KHz. Observe period > 10ms.

8. Set AM/FM Range to 1MHz. Observe frequency < 10KHz.

FREQUENCY ACCURACY, AM/FM Generator (Continued)

9. Set 100:1 VAR to CAL and AM/FM Range to 10KHz.

TIME SYMMETRY

1. Connect the Counter/Timer to the Sync output jack on the front panel.
2. Set Range to 10K.
3. Set Multiplier to 1.0.
4. Set Counter/Timer to read time interval A to B and B to A. Observe time symmetry error $< 1\%$.
5. Set Range to 1K. Observe time symmetry error $< 1\%$.
6. Set Range to 100. Observe time symmetry error $< 1\%$.
7. Set Range to 10. Observe time symmetry error $< 1\%$.
8. Set Range to 1. Observe time symmetry error $< 1\%$.
9. Set Multiplier to .10. Observe time symmetry error $< 1\%$.
10. Set Range to 1K.
11. Set Multiplier to 1.0.

FREQUENCY STABILITY

Observe that the frequency remains within 0.05% for 10 minutes.

SYNC OUTPUT

1. Connect oscilloscope to the Sync output on front panel with an appropriate coaxial cable.
2. Observe square wave of approximately 2V P-P open circuit.
3. Connect oscilloscope to the AM/FM Sync output on rear panel.
4. Observe Sync pulse approximately 2V P-P open circuit.

CARRIER OUTPUT

1. Set amplitude to MAX. Connect the main output to the oscilloscope with a 50Ω coaxial cable terminated into 50Ω.
2. Observe Tri $>$ 10V P-P.

CARRIER OUTPUT (Continued)

3. Switch through square, triangle and sine waveform, observing > 10V P-P amplit

4. Switch to negative square, positive square, and + sine observing > 5V peak amp

5. Remove 50Ω terminator and observe > 20V P-P open circuit for square, triangle sine waveforms and > 10V peak for positive and negative square and + sine.

6. Add 50Ω terminator, set attenuator 10db, 20db, 30db, 40db, 50db, and 60db anc observe corresponding attenuation.

7. Rotate amplitude vernier and observe another 20db of attenuation.

8. Set amplitude to MAX, attenuator to 0db. (out)

GATE AND TRIGGER MODES

1. Set:

MODE	GATE
START LEVEL	0

2. Monitor output with oscilloscope.

3. Apply signal at Trig input jack, increase signal and observe main generator runs at approximately 1.2V of signal.

4. Depress Manual pushbutton and observe generator runs when button is depressed.

5. Set:

MODE-----------TRIGGER

Apply signal at trigger input. Increase signal and observe main generator produ one complete cycle when trigger input rises to approximately 1.2V.

6. Depress Manual pushbutton and observe one complete cycle each time the Manu pushbutton is depressed.

SINE WAVE DISTORTION

1. Set:

MODE	RUN
RANGE	10K
MULT	1.0
AMPLITUDE	MID RANGE
FUNCTION	SINE

SINE WAVE DISTORTION (Continued)

2. Connect distortion analyzer to the output, terminated into 50Ω. Measure sine distortion of < .5%, typically .2%.

3. Set Range to 100K and measure sine distortion < .5%.

4. Set Range to 5M. Connect spectrum analyzer to main output jack and measure harmonic content. Observe no harmonics <30db down.

SINE FREQUENCY RESPONSE

1. Set Range to 10K.

2. Connect oscilloscope to output terminated into 50Ω.

3. Observe sine wave amplitude.

4. Set Range to 100K. Observe sine amplitude drop <.1db.

5. Set Range to 5M. Observe sine amplitude drop <.5db.

SQUARE WAVEFORM

1. Set:

RANGE	1M
FUNCTION	SQUARE
AMPLITUDE	MAX

2. Connect output through a 50Ω coaxial cable terminated into 50Ω to the oscilloscope.

3. Observe risetime and falltime of square <50ns at main output.

4. Observe overshoot and ringing <5% of P-P amplitude.

D.C. OFFSET

1. Set Range to 1K, amplitude vernier to MIN.

2. Rotate D.C. offset switch and observe D.C. level shift ±5V into 50Ω.

3. Remove terminator and observe D.C. level shift ±10V open circuit.

NOTE: D.C. offset plus signal cannot exceed maximum voltage output or clipping will occur.

AMPLITUDE STABILITY

1. Set amplitude to MAX, D.C. offset to OFF, function to TRIANGLE.

2. Connect output through a 50Ω coaxial cable terminated into 50Ω.

3. Set plug-in sensitivity to 20mv/cm.

4. Measure accurately the positive peak of triangle and negative peak of triangle ar record.

5. Wait 10 minutes and measure positive and negative peaks again. Observe amplit change < 10mv.

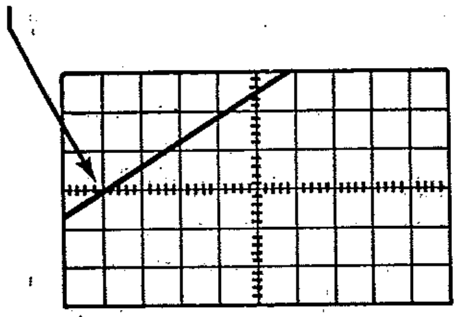
TRIANGLE LINEARITY

1. Connect the output to the differential plug-in through a 50Ω coaxial cable terminated into 50Ω.

2. Adjust oscilloscope to obtain one-half cycle of triangle across full horizontal gric on oscilloscope CRT.

3. Set differential plug-in sensitivity at 20mv/cm.

4. Adjust comparison voltage until the slope of the triangle waveform intersects the mid-scale horizontal grid line at the second major mark as shown below:



5. Record reference voltage using DVM accurate to 1mv.

6. Adjust comparison voltage until slope of triangle intersects next major horizontal grid mark.

7. Record accurately the new reference voltage.

8. Repeat to obtain as many points as desired.

TRIANGLE LINEARITY (Continued)

9. Calculate linearity and observe linearity is 99% or better.

NOTE: Horizontal time base accuracy of oscilloscope and accuracy of DVM are important to obtain meaningful data.

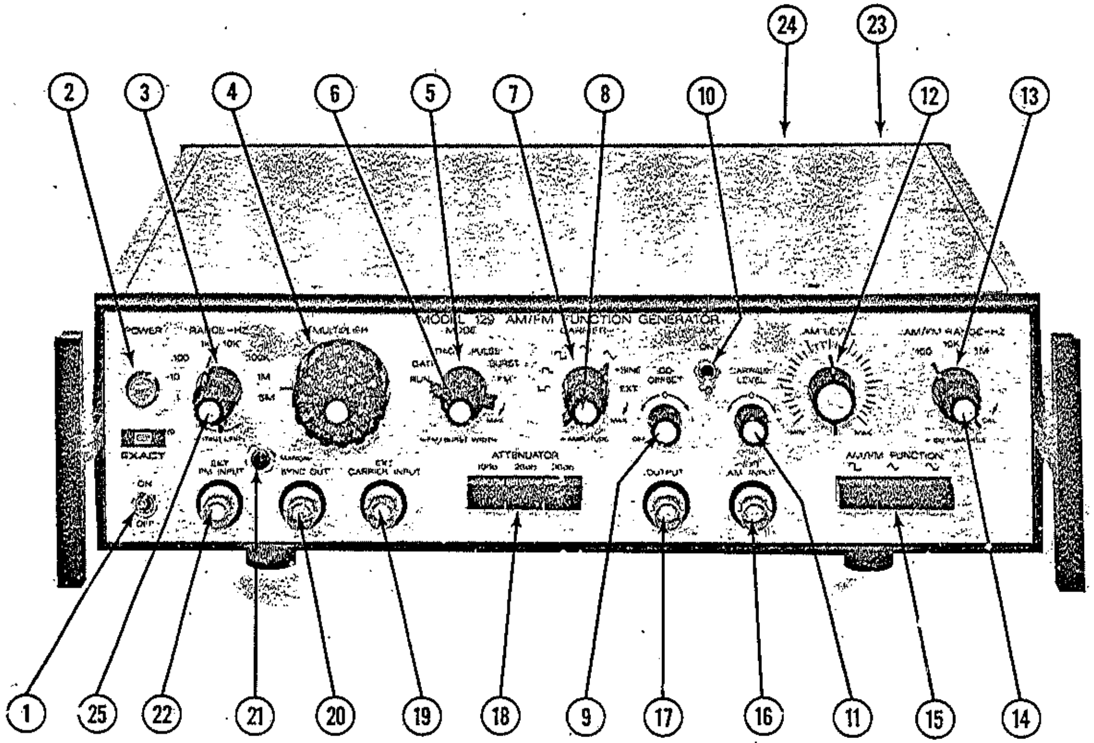


FIGURE 2.2.1
FRONT AND REAR
PANEL FAMILIARITY

2.1.0 FRONT PANEL FAMILIARITY (Figure 2.1.1)

1. POWER ON/OFF SWITCH - Connects line voltage to the instrument.

2. PILOT LAMP - Visual indication when instrument is on.

3. RANGE SWITCH - Selects the desired range of CARRIER frequency.

4. MULTIPLIER - provides calibrated fixed steps between range settings. Each step equals 10% of range setting. The vernier dial provides variable frequency adjustment between fixed steps.

   The "S" position on the fixed step MULTIPLIER dial places the MULTIPLIER in the search mode. The search position allows the vernier dial complete control of the frequency over a three decade range.

5. MODE SWITCH - Selects the desired mode of operation.

   RUN MODE - The carrier generator will free run continuously.

   GATE MODE - The carrier generator will stop running. The generator will free run when an external signal is applied at the EXTERNAL TRIGGER INPUT or when the MANUAL PUSHBUTTON is depressed.

   TRIG MODE - The carrier generator will stop running. The generator will run for one complete cycle from an external signal or each time the MANUAL PUSHBUTTON is depressed.

   PULSE MODE - The PULSE MODE is similar to the TRIG MODE above. The AM/FM Generator will trig the carrier generator "ON" for one complete cycle at the AM/FM Generator rate.

   BURST MODE - The AM/FM Generator is connected internally to gate the carrier generator "ON" and "OFF" at the AM/FM Generator rate.

   FM MODE - The AM/FM Generator will frequency modulate the carrier generator internally when in the FM MODE.

6. FM/BURST WIDTH - Provides adjustment of the FM (sweep) width when in the FM MODE and burst width in the BURST MODE.

7. CARRIER SWITCH - Selects the desired carrier or output waveform desired. The EXT position allows the use of an external carrier or waveform.

8. AMPLITUDE - Provides > 20db variable attenuation of the output signal. Amplitude control has no effect on carrier level or AM level adjustment.

FRONT PANEL FAMILIARITY (Figure 2.1.1) Continued

9. DC OFFSET - When switched on, provides variable control of the D.C. level of the output waveform.

10. AM SWITCH - Allows amplitude modulation of the selected carrier waveform.

11. CARRIER LEVEL - When in the AM MODE, this control provides complete adjustment of the Carrier Amplitude from Max Pos through 'Null' to Max 'Neg'. 180° phase shift occurs from Max + to Max - setting. May be utilized as a variable phase contrc

12. AM LEVEL - This control adjusts the amount of AM signal applied to the modulator. The desired amount of modulation is adjusted by means of the CARRIER LEVEL and/or the AM LEVEL controls.

13. AM/FM RANGE - Selects the desired frequency range of the AM/FM generator.

14. 100:1 VARIABLE - Provides variable adjustment of AM/FM frequency between fixed ranges.

    This control allows adjustment over a two decade range or 100:1.

15. AM/FM FUNCTION - A SQUARE, TRIANGLE, or SINE WAVEFORM may be selecte to amplitude modulate the carrier waveform selected by the CARRIER SWITCH.

    Symultaneous AM/FM may be obtained by placing the MODE SWITCH to FM and th AM switch ON.

    The selected waveform from the AM/FM FUNCTION SWITCH will AM and/or FM th carrier signal selected.

    FM width, AM level, and CARRIER level are all independent of each other.

16. EXTERNAL AM INPUT - When in the AM Mode, an external signal may be used to AM the Carrier Waveform selected. The AM level must be set to min. to avoid mixing of the internal and external AM signals, unless mixing is desirable.

17. OUTPUT - BNC output connector providing 50Ω output impedance for connection to external equipment.

18. ATTENUATOR - A pushbutton attenuator providing a 10, 20, and 30db PAD for a total attenuation of 60db in 10db steps.

19. EXTERNAL CARRIER INPUT- An external carrier or signal may be used when the CARRIER SWITCH is in the EXT position. Amplitude modulation of this external waveform is easily accomplished utilizing the AM/FM Generator.

FRONT PANEL FAMILIARITY (Figure 2.1.1) continued.

20. SYNC OUT - Provides a SQUARE WAVE for syncronizing external equipment to the Carrier Generator.

21. MANUAL PUSHBUTTON - The MANUAL PUSHBUTTON allows manual gating and triggering of the Carrier Generator in the GATE and TRIG MODE of operation.

22. EXTERNAL FM INPUT - Provides external control of frequency for FM, sweeping, frequency shift keying, D.C. frequency control, etc.

23. EXTERNAL TRIGGER INPUT - When in the GATE and TRIG MODE, the Carrier Generator may be externally gated or triggered by application of an external signal at the EXTERNAL TRIGGER INPUT.

24. AM/FM SYNC OUTPUT - Provides a square wave for syncronizing external equipment to the AM/FM Generator.

2.2.0 FIRST TIME OPERATION

NOTE: Before applying power to the instrument, the input power line switch must be in the proper position corresponding to the line voltage source which will be applied. The instrument comes supplied with the proper fuse for 117V operation. If the unit is to be operated from 230V AC line, place the line switch located on the rear panel to the 230V position and change the fuse as indicated by the fuse data silkscreened on the rear panel.

Plug the power cord into the proper source of 117V AC or 230V AC 50-400Hz and turn on the power switch.

NOTE: It is recommended that the rear panel chassis ground and circuit ground be connected together with the grounding strap provided unless it is necessary to float the instrument ground.

Set controls as follows:

RANGE	10K
MULTIPLIER	1.0
MODE	RUN
FUNCTION	∧/
AMPLITUDE	MAX
ATTENUATOR	0db (OFF)
D.C. OFFSET	OFF
AM/FM RANGE	10KHz
100:1 VAR	CAL
AM	OFF

FIRST TIME OPERATION (Continued)

1. Connect the main output through a 50Ω coaxial cable into a 50Ω terminator to a suitable oscilloscope. A 10KHz 10V P-P triangle waveform should be observed under these conditions.

2. Switch the Function switch through its various output waveforms.

3. The frequency may be selected by the Range switch and/or the Multiplier dial.

4. Switch the D.C. Offset switch ON and observe the waveform D.C. level may be adjusted as desired.

   NOTE: Reduce output amplitude while changing D.C. offset to prevent saturation of waveform.

5. Observe the output amplitude can be adjusted over its 80db of dynamic range by the Amplitude vernier and the pushbutton attenuator.

GATE MODE

6. Place the Mode switch in the Gate position. Observe the main generator is now locked out. Observe the output while depressing the Manual pushbutton. The generator will free run as long as the pushbutton is depressed.

7. Rotate the Start Level control and observe the lockout level may be adjusted to the desired level or phase.

NOTE: The generator will free run if the Start Level is rotated too far (90 degree phase shift).

TRIG MODE

8. Set the Main Mode switch to the Trig position. Observe one complete cycle each time the Manual pushbutton is depressed.

PULSE MODE

9. Set the Mode switch to Pulse.

   Set controls as follows:

FUNCTION	SQUARE
RANGE	10K
MULTIPLIER	1.0
AM/FM RANGE	10KHz
100:1 VAR	MID RANGE
OSCILLOSCOPE	2 ms/cm

FIRST TIME OPERATION (Continued)

Trigger scope from rear panel AM/FM Sync output.

The generator is now being triggered by the AM/FM Generator, providing a pulse output.

Observe that the carrier generator Range and Multiplier controls vary the pulse width. The repetition rate is variable by varying the AM/FM frequency.

BURST MODE

10. Place the Mode switch to Burst. The main generator is now being gated by the AM/FM Generator, producing a burst (more than one cycle) at the output.

Set the generator controls as follows:

FUNCTION	SINE
RANGE	10K
MULTIPLIER	1.0
AM/FM RANGE	10KHz
100:1 VAR	MID RANGE
OSCILLOSCOPEq	2 ms/cm

Trigger the scope from AM/FM Sync output on rear panel.

Observe by adjusting the FM/Burst width and AM/FM frequency the burst "on" and "off" time may be varied. The frequency of the main generator determines the frequency of each cycle in the Burst.

FM MODE

11. In the FM Mode, the AM/FM source is connected to the FM input internally via the FM/Burst width potentiometer.

Set controls as follows:

MODE	FM
RANGE	10K
MULTIPLIER	.10
CARRIER	TRI
AMPLITUDE	MAX
D.C. OFFSET	OFF
AM/FM RANGE	100Hz
100:1 VAR	FULL CCW (1Hz)
FM/BURST WIDTH	MID RANGE
AM/FM FUNCTION	∿

FIRST TIME OPERATION (Continued)

Observe the main generator triangle is being swept about the center frequency 1KHz.

Observe the FM width change while adjusting the FM/Burst width control.

Observe the FM sweep rate change while adjusting the AM/FM frequency.

AM MODE

12. Amplitude Modulation

Set controls as follows:

RANGE	100K
MULTIPLIER	1.0
CARRIER	∿
AMPLITUDE	MAX
D.C. OFFSET	OFF
MODE	RUN
AM/FM RANGE	10K
100:1 VAR	CAL
AM LEVEL	MAX
AM	ON
AM/FM FUNCTION	∿

100%:

Connect an oscilloscope to the output. Trigger the oscilloscope from the AM/FM sync output on the rear panel.

Adjust the Carrier level until 100% modulation is obtained.

Select TRI and SQ with the AM/FM Function switch and observe the carrier modulation corresponding to the waveform selected.

SUPPRESSED CARRIER

Set the AM level to min. Adjust the carrier level for a Null at the output.

AM/FM Function to ∿

Set the AM Level to Max and obseive suppressed carrier Modulation.

SECTION 3

CIRCUIT DESCRIPTION

3.1.0 BLOCK DIAGRAM (Figure 3.1.1)

MAIN GENERATOR

The Summing Amplifier sums the currents from the Multiplier dial, VCF input and internal sweep signal. The output of the Summing Amplifier drives the Positive and Negative current sources. A diode gate alternately connects the Positive and Negative constant current sources to the timing capacitor selected by the Range switch. This constant current charging and discharging the timing capacitors produces the required triangle. The Tri Buffer supplies the power to drive the associated circuitry without loading the current sources. Switching signal for the Diode Gate is supplied from the Bi-Stable switch in conjunction with the Level Detector. The Sync signal from the Level Detector and Bi-Stable switch is brought out through the Sync Output Buffer to prevent loading of the Bi-Stable switch.

The Lockout current source sinks the timing current from the current source during Gate, Trigger, Pulse and Burst Modes. Logic for these modes is obtained from the Main Generator Lockout Amplifier. The Reset Buffer supplies a signal from the Level Detector- Bi-Stable switch, needed for completion of last cycle and reset for the Logic Gate.

D.C. coupled gating and triggering is accomplished by the Trig Level Comparator. Signal from the Trig Level Comparator enables the Lockout Logic Gate during lockout modes. The Manual Gate and Trig switch serves to eliminate contact bounce of the Manual Pushbutton switch during manual triggering and gating to prevent multiple triggering. The triangle from the Tri Buffer is shaped by the Sine Converter and amplified by the Sine Amplifier to produce the sinewave.

All output waveforms pass through the Input Buffer and are then connected to the Output Amplifier. The Output Amplifier provides the necessary power to drive the Main Output. The pushbutton Output Attenuator provides 60db of attenuation in 10db steps.

AM/FM GENERATOR

The AM/FM Generator loop consists of an integrator and a level detector. This loop produces the square and triangle waveform for internal gating, pulsing, FM and AM. The Sync Buffer provides a square wave sync pulse for synchronizing external equipment to the AM/FM Generator.

AM MODULATOR

The Am Modulator provides amplitude modulation of the carrier waveform selected by the Carrier Switch. The Am signal may be selected by the AM/FM Function switch. The Square switch produces the required square wave for the modulator from the AM/FM Level Detector. The Triangle from the AM/FM integrator is level shifted in the Tri level Shift Amplifier. It is used to AM and FM the

3.1.0 BLOCK DIAGRAM (Figure 3.1.1) Continued

Carrier Generator. The tri from the Level Shift Amplifier is converted to a sine wave by the sine converter providing the third waveform to be used for AM and FM.

3.2.0 CIRCUIT DESCRIPTION

3.2.1 POWER SUPPLY (Figure 6.2.1)

Line voltage is connected to transformer T100 through S101, a line voltage switch. This switch selects either the 117V or the 230V tap on the transformer. Full wave rectification is accomplished by D100 from the center tapped secondary. C101 and C102 provide ±23V filtering.

+12V SUPPLY

Q100 is a precision voltage regulator. The output is connected to a series pass driver Q110 which supplies the necessary current for the +12V supply. The reference divider, R111, R112 and R113, is connected across the +12V supply. R112 adjusts the reference to the voltage regulator, establishing +12V at the output. Q100 is short circuit protected internally. Q100, pin 10, senses the output current through R110 and will turn off the +12V supply in the event of a short circuit of 500ma.

-12V SUPPLY

Q135 is an operational amplifier. The +12V is connected through R114 and -12V adjust R115 to the inverting input (pin 2). The output of Q135 is offset by Zener Diode D135 to keep the operational amplifier output level within safe limits. Q130 is an emitter follower which drives the series pass transistor (Q125). Feedback resistor R120 establishes the proper amount of negative feedback. Q120 senses the output current through R121 providing short circuit limiting at about 500ma.

+5V SUPPLY

The +5V supply is simply an emitter follower. R141 and R140 provide approximately +5.6V at Q150 base, establishing +5V at the emitter.

-7V SUPPLY

The -7V supply is also an emitter follower. R161 and R160 provide approximately -7.6V at Q170 base, establishing -7V at Q170 emitter.

3.2.2 SUMMING AMPLIFIER AND CURRENT SOURCES (Figure 6.2.2)

Q200 is an operational amplifier connected for a voltage gain of -1. The Main Multiplier dial (S200) forms a Kelvin-Varley Voltage Divider providing approximately

3.2.2 SUMMING AMPLIFIER AND CURRENT SOURCES (Figure 6.2.2) Continued

+5V to +.5V to the Summing Amplifier Input (TP209). By varying the applied input voltage, the signal to the Constant Current Source Drivers can be varied thus providing a method for changing the timing current and thus the frequency. The Summing Amplifier inverts the applied input voltage. When S200 (Mult) is in the Search Mode, the vernier (R210) is connected between +12V and ground to supply a 1000:1 voltage ratio, thus a 1000:1 frequency deviation. Main Timing Adjust (R207) establishes the correct input voltage to the Kelvin-Varley Divider to obtain the correct timing during calibration. D200 and D201 provide input protection for the μ A709 operational amplifier. R201 (1000:1 Adj) provides input current to Q200 to adjust the 1000:1 range when the multiplier is in search.

The FM Input is connected to the Summing Amplifier at TP205, providing an external source of frequency control. By applying voltage at the FM input, the frequency may be varied as with the Multiplier dial. The applied input voltage will add to or subtract from that established by the Multiplier dial setting. If the Multiplier dial is set at position 1.0, approximately +5V is applied to the input of the Summing Amplifier. If a positive voltage is now applied to the FM Input Jack, the Summing Amplifier will saturate. If -5V is applied at the FM Input this will add to the +5V applied by the Multiplier dial and the resultant input voltage will approach OV, driving the Summing Amplifier output to approximately 1/1000 of the frequency of the Range and Multiplier setting. If the Multiplier dial were in the Search Mode of operation and set at approximately 0V at TP209 by the Search vernier (R210), the frequency would be approximately 1/1000 of the Range setting. By applying +5V at the FM Input, the two voltages will sum, establishing approximately +5V at the Summing Amplifier input. This will cause the frequency to sweep up to approximately the frequency of the Range setting.

TP204 is the internal FM input, connected to the AM/FM Generator when in the FM Mode of operation. The desired waveform may be selected by the AM/FM Function switch.

The FM/Burst width potentiometer R502 FIG. 6.2.4 allows the amount of FM to be set as desired. The Center Frequency is set by the Range and Multiplier switch.

All three FM waveforms are bi-polar and will FM the carrier about the Center Frequency set by the Range and Multiplier switch.

NOTE: The FM width is capable of 1000:1 frequency ratio. If the Multiplier is set at 1.0 and the Range is set at 10KHz, the generator will only sweep up to approximately 11KHz, the current sources will saturate and slightly distort the output waveform until the FM signal drives the current sources below 11KHz. Below 11KHz, the current sources are again within their operating range.

3.2.2 SUMMING AMPLIFIER AND CURRENT SOURCES (Figure 6.2.2) Continued

The current source will then FM the carrier down in frequency to below 10Hz with sufficient FM signal applied.

To obtain the best results, set the center frequency using the range and Multiplier controls and adjust the FM Width until the correct upper and lower frequency limits are obtained.

The VCF Balance (R229) compensates for the input offset voltage of the Summing Amplifier Q200. The output range of the Summing Amplifier is approximately 0V to -5V and drives the Positive and Negative Current Source Drivers.

POSITIVE AND NEGATIVE CURRENT SOURCE DRIVERS

The output of the Summing Amplifier (0V to -5V) is connected to Q240, the Positive Current Source Driver, through R260B. Q255 and Q240 provide a constant current source in the feedback loop of the Positive Current Source Driver. Q240 will turn on Q255 until a feedback current equal to the input current through R260B is equalized. This current causes a voltage drop across R255A which equals the voltage drop across R260B.

The Search Sym Adj (R242) compensates for offset in the operational amplifier, establishing a 0V reference at Q240 input and balancing the two Current Source Drivers at 1000:1 to obtain correct symmetry at 1000:1.

Q250 in conjunction with Q260 make up the Negative Current Source Driver. The output signal from Q200 Summing Amplifier is connected to Q250 operational amplifier at the Non-Inverting Input. Q250 is connected as a voltage follower. Q260 establishes a constant current equal to the input voltage ÷ R260A. This constant current causes a voltage drop equal to the output voltage of the Summing Amplifier, across R255B, exactly equal to and of opposite polarity of that across R255A.

POSITIVE AND NEGATIVE CONSTANT CURRENT SOURCE.

Q275, Q280, Q285, and Q290 are the Positive and Negative Constant Current Sources providing the constant timing current to charge and discharge the timing capacitor. Q275 operational amplifier and Q280 FET are connected to form a constant current source.

The signal across R255A is connected to Q275 operational amplifier at the non-inverting input. This causes a voltage of exactly the same polarity and amplitude across R276A timing resistor. This causes a constant current E(R276A) ÷ R(R276A) to charge the timing capacitor when the Diode Gate is turned on, connecting the Positive Current Source. The FET (Q280) prevents loading of the current sources at very low timing currents (1000:1).

3.2.2 POSITIVE AND NEGATIVE CONSTANT CURRENT SOURCE (Continued)

Q285 operational amplifier and Q290 FET provide the negative constant current needed to charge the timing capacitor in exactly the same way. The 0.1Hz symmetry (R292) compensates for offset current in the operational amplifiers (Q285 and Q290) to establish the correct symmetry on slow timing ranges with large timing resistors. This adjustment is made on the 1Hz range at the .1 setting on the Multiplier Dial.

The Diode Gate is made up of D280, D281, D282 and D283. The timing capacitors are connected at TP330 through the Range Switch, which also switches the Timing resistors.

Gate switching signal is connected at D280 and D282 junction. When the Gate signal is positive, D282 is forward biased and sinks the timing current from the Negative Current Source, thus disconnecting the Negative Current Source. D280 is now reverse biased, allowing timing current to charge the timing capacitor through D281 from the Positive Current Source. When the Gate signal switches negative, D280 is forward biased, thus sinking the positive timing current through D280. D282 is now reverse biased, allowing timing current to charge the timing capacitor from the Negative Current Source through D283. D301 is connected to the Lockout Current Source and sinks the timing current during lockout.

TRIANGLE BUFFER

Q330A and B and Q340A and B serve as a unity gain, high input impedance buffer for the triangle generated at TP330. Q330A FET prevents loading of the current sources by its very high input impedance. Q330A is a source follower driving Q340A, an emitter follower. Q340B provides offset and temperature compensation for Q340A while Q330B provides offset and temperature compensation for Q330A.

LOCKOUT CURRENT SOURCE

The lockout current source consists of Q265 (operational amplifier) and Q270 (FET) connected as a current source. The lockout current source and the positive current source are both driven by the positive current source driver Q240 and Q255 R300, R301 and R302 provide twice the current as the positive and negative current source.

In the Run mode, D525 is forward biased and sinks the lockout current from the lockout current source, and reverse biases D300 and D301. During lockout, D525 is reverse biased. D300 connected to the start level amplifier will sink all the current from the lockout current source. When the timing capacitor charges negative, D301 will become forward biased when the timing capacitor reaches the voltage level established by the start level control D306 at D300 cathode. The timing capacitor will stop charging when D301 becomes forward biased and sinks the timing current from the negative current source. D300 will sink exactly the same current as D301. The current thru D300 and D301 will always be the same because the lockout current source supplies twice the timing current as the negative current source.

3.2.2 LOCKOUT CURRENT SOURCE (Continued)

START LEVEL AMPLIFIER

The start level amplifier is a closed loop operational amplifier (Q300) with a gair slightly < 1/10. Q320 and Q325 buffer provides a very low output impedance necessary to drive lockout diode (D300). The output of the buffer will swing approximately ±1.4V depending upon the setting of the start level control R306. This setting determines the level at which the triangle will lock out.

3.2.3 LEVEL DETECTOR/BISTABLE SWITCH (Figure 6.2.3)

Level Detector/Bistable Switch Q400A, B, C is a differential amplifier used as a level detector. Q400C is a constant current source for differential amplifier Q400A and Q400B. The reference level at the base of Q400B is determined by one of the current sources connected by the diode gate, D403 -D406. D400 and D401 limit the collector swing of the differential amplifier to improve high frequency response. The Level Detector collectors drive a non-saturating current mode switch. The Bistable Switch is differential input and differential output. One output, Q430, Q435, drives the reference gate for the Level Detector, the Reset Buffer, the Sync Output Buffer and the Current Source Gate. R402 and R409 adjust the positive and negative trip points of the Level Detector, establishing the positive and negative peaks of the triangle. The other output, Q440, Q4 provides the square wave signals for the Output Amplifiers. The Norm Sq. Amp (TP459) is adjusted by R456 (+sq. amp) and R461 (-sq. amp). The Neg. Sq. Amp (TP464) is adjusted by R463 (neg. sq. amp). Q430 and Q435 provide the Pos. Sq at TP458. The Pos. Sq. Amp is adjusted by R450 (pos. sq. amp).

SYNC OUTPUT BUFFER

Q450 is an emitter follower which provides isolation while providing a sync pulse to the Sync Output Jack. The sync pulse is clipped by diodes D450 through D45

3.2.4 LOCKOUT LOGIC (Figure 6.2.4)

TRIGGER LEVEL COMPARATOR

Q500 is a high speed differential comparator providing D.C. coupled Triggering, Gating and Bursting modes for the Main Generator Logic Gate.

Run Mode:

In the Run mode, +12V is applied to the inverting input of Q500 through S500A. This assures that the non-inverting input always remains more negative than the inverting input. This causes Q500 output to remain negative or in the Run Mode of operation. The input of the comparator is protected by clamping diodes D500 and D501.

3.2.4 LOCKOUT LOGIC, Trigger Level Comparator (Figure 6.2.4) Continued

Gate Mode:

In the Gate mode, the +12V from S500A is disconnected, causing Q500 inverting input (pin 3) to go to a more negative state than the non-inverting input due to R509. This switches the output of the comparator to its positive or "1" state. The "1" from the comparator placed the Logic Gate in a lockout condition. The generator will remain in a lockout condition until signal is received at the comparator input (pin 2).

In the Gate mode the comparator input is connected through S500B to the External Trigger Input. A signal   1.2V will cause the Trigger Level Comparator to switch, placing the Logic Gate in a "run" condition. When the input signal is removed or falls below 1.2V, the comparator will allow the Logic Gate to return to its lockout condition.

Trigger Mode:

The only difference between the Gate and Trigger modes of operation is that the output of the comparator is AC coupled to the logic Gate instead of DC coupled. When the trigger signal causes the comparator to switch, the negative output of the comparator AC couples a differentiated negative pulse into the Logic Gate, placing it in a "run" condition. The duration of this pulse is very short, allowing the Logic Gate input to return to a "1" or a lockout condition even though the comparator may still be "OFF" in its negative state. The square wave from the level detector (R454) will couple a "0" into the Logic Gate upon completion of the first cycle and cause the generator to lock out. The external trigger signal must be removed, allowing the comparator to reset before another pulse can be coupled into the Logic Gate. One complete cycle will be generated each time a signal   1.2V is applied at the Trigger Input.

Pulse Mode:

In the Pulse Mode of operation the square wave from the AM/FM Sync Buffer is connected to the trigger comparator at TP503. The AM/FM generator will cause the carrier generator to run one cycle for each positive going edge of the AM/FM generator signal.

NOTE: The carrier generator frequency must be greater than the AM/FM generator frequency to prevent erratic pulsing of the carrier generator.

Burst Mode:

The Burst Mode functions as in the Gate Mode. The desired waveform is selected from the AM/FM function switch. The waveform selected is connected to R502 the FM/Burst width potentiometer. The Burst width potentiometer allows attenuation of the signal applied to the trigger comparator. By adjusting the amount of signal to the comparator, the duty cycle of Burst width may be adjusted.

3.2.4. LOCKOUT LOGIC, Trigger, Level Comparator (Continued)

If the square wave is selected for Burst, the duty cycle will not be adjustable by the Burst width potentiometer.

NOTE: When the Burst width period approaches the period of one cycle of the carrier generator, the generator will lock out until the Burst width is adjusted greater than the period of one cycle of the carrier generator.

FM Mode:

In the FM mode, the carrier generator is placed in a "Run" condition by the +12V at S500A. All trigger signal input paths are disconnected. The waveform selected for FM is connected to the FM input (R204) through the FM/Burst width potentiometer R502. The FM or sweep width may be adjusted as desired with the FM/Burst width. The carrier generator will sweep about the center frequency set by the Range and Multiplier.

MANUAL GATE/TRIGGER SWITCH

The Manual Pushbutton switch located on the front panel is used in conjunction with the Manual Trigger Logic Switch to provide a bounce-free switch for manually gating and triggering the Main Generator. Q520C and D are one-half of Quadruple 2 Input Positive Nand Gate. Normally S520, the Manual Pushbutto keeps one input of the Nand Gate, pin 9, at "0" and pins 8 and 12 at "1". Pi 13 is connected to +5V or a "1" through R521. With both inputs of Q520D posit the output (pin 11) will remain at "0". The output of this Positive Nand Gate i connected through R508 to the Trigger Level Comparator. When S520, the Manual Pushbutton, is depressed, pin 13 of Q520D will be set to "0". This will cause the output (pin 11) to go to a "1" or positive state. This "1" is coupled through R508 to the Trigger Level Comparator Input. This "1" will remain until the Manual Pushbutton is released, allowing the output of Q520D to return to a "0".

MAIN GENERATOR LOCKOUT LOGIC GATE

Q520A and B is one-half of a Quadruple 2 Input Positive Nand Gate which provides the necessary logic function for the lockout amplifier Q525 and Q530 wh operates as a switch. In the Run mode of operation, the trigger level comparat applies a "0" at the input of Q520A pin 1. As long as this "0" is present, the output of Q520A (pin 3) will remain positive ("1"). This positive signal will cause the lockout amplifier to remain in a "run" condition. In the Gate mode o operation, the trigger level comparator supplies a "1" to the logic input Q520 pin 1. The output will remain a "1" or in a "run" condition until a negative pu ("0") is applied at Q520B pin 5 from the square wave. This negative pulse caus Q520B pin 6 to go to a "1" state which is connected to Q520A pin 2. Q520A output will now switch to a "0" causing the generator to lock out.

3.2.4 LOCKOUT LOGIC, Trigger level Comparator (Continued)

LOCKOUT AMPLIFIER

The lockout amplifier is a differential amplifier used as a Bi-polar switch. The output of Q525 provides ±1.8V to D525. D525 is forward biased in the Run mode of operation by Q525 collector (-1.8V) disabling the lockout current source. During lockout, Q525 is "off", reverse biasing D525 enabling the lockout current source.

3.2.5 SINE SHAPER AND AMPLIFIER CIRCUITS (Figure 6.2.5)

SINE CONVERTER

The Sine Converter converts the triangle to a sine by means of a bi-polar diode shaping network. The triangle is connected at TP602. R602 and R603 form a voltage divider to correctly match the triangle amplitude to the converter network. As the triangle rises positive, each diode gate will turn on in succession, causing the output of the network to form a sine wave at the junction of the three voltage dividers. The diode gates will turn on and off in sequence following the triangle Sine A, B, C and D potentiometers. Adjust the current thru each bridge for minimum distortion.

SINE AMPLIFIER

This sine wave is amplified by differential amplifier Q600A and B. Q600C is a constant current source fc• the input differential stage. Sine D.C. Adj (R625) compensates for offset in the input pair, establishing a 0V reference at the Sine Output. A second differential stage is driven by Q600A and B. The output across R636 is connected to the Output Buffer (Q645 and Q650) through an emitter follower (Q635). The output (TP645) is connected through feedback resistors R626 and Sine Amplifier adjustment R627 to the inverting input.

± SINE

R646, R647 forms a voltage divider to decrease the sine amplitude. R649 and R648 (± Sine D.C.) provides offset current to establish a negative reference for the ± Sine. C646 (± Sine Comp.) provides high frequency compensation for the ± Sine.

3.2.6 ATTENUATOR AND AMPLIFIER CIRCUITS (Figure 6.2.6)

INPUT BUFFER

The Input Buffer Q700, Q705 prevents loading from the low input impedance of the power amplifier.

3.2.6 ATTENUATOR AND AMPLIFIER CIRCUITS (Figure 6.2.6) Continued

AMP. 1

S700 connects the various waveforms to the inverting input. Q701A and B are the input differential amplifier. Q700C is a constant current source for Q700A and B. The D.C. BAL (R723) compensates for offset of the input pair and the Input Buffer. The D.C. offset switch on the front panel supplies offset current to the non-inverl ing input for adjusting the D.C. reference at the output. Q725 and Q730 are a second differential stage driven by Q700A and B. The signal at Q730 is connectec to the output through the output buffer, Q735 and Q740. R727 is selected to adjus the quiescent current in the output buffer to approximctely 10ma. Gain is fixed by feedback resistors R731 and R704. Q745 is a current source for Q730 to improve slewing rate.

AM PREAMP

The Am preamp is the same amplifier as AMP 1 and is used to boost the current mode output of the modulator to a voltage sufficient to drive AMP 1.

OUTPUT ATTENUATORS

The Output Attenuator provides six fixed levels of attenuation at 50Ω output impedance. The three attenuators are connected to add providing 10db, 20db, 30db, 40db, 50db and 60db of attenuation in 10db steps.

3.2.7 AM AMPLIFIER

The Am Signal Amplifier (Q1000) is an operational amplifier used to interface the internal and external AM signals to the differential logarithmic voltage to current converter Q1060.

AM Switch S1001 connects either the square, triangle, or sine waveform selected by the AM/FM function switch (S1000) to the input of the Amplifier Q1000. (TP1008

R1008 (TRI AMP) provides gain adjustment of the input amplifier Q1000. R1001 (AM BAL) compensates for input offset voltage of the operational amplifier Q1000.

External AM signal is connected to the amplifier at TP1000.

The Carrier Level potentiometer R1011 adjusts the output swing of the amplifier (Q1000).

R1013 (AMP BAL) balances the output D.C. to provide equal carrier levels at both ends of the Carrier Level Control.

3.2.7 AM AMPLIFIER (Continued)

Q1060 is a differential logarithmic current to voltage converter required for driving the signal input of the double balanced modulator. The reference voltage of the input differential amplifier is approximately -3.72V. When the carrier level potentiometer is set to the Null position, the output of Q1000 will be approximately the same level -3.72V.

In this balanced condition, collector current thru the two input transistors will be equal establishing a Null condition at the signal input of the modulator Q1060 pins 14,3 and 7,11. Q1065 is a constant current source for the input differential amplifier Q1060. Q1060C and D are connected as diodes which convert the linear differential signal current to a logarithmic output voltage.

R1061 LIN ADJ is used to balance the collector current in the output diodes Q1060C and D.

CARRIER VOLTAGE TO CURRENT CONVERTER

Q1090A and B is a differential amplifier used to convert the carrier signal to a differential logarithmic output voltage for driving the Modulator carrier input pins 1 and 4.

Q1085 is the constant current source for the differential amplifier Q1090A and B.

R1092 adjusts the D.C. level of the carrier to be equal at max + and max - carrier level.

R1102 provides amplitude adjustment of the carrier.

Modulator:

Q1080 is an integrated circuit double balanced modulator. It accepts a carrier signal at its carrier inputs (pins 4 and 1) and an AM signal at its signal inputs (pins 7 and 8).

When both inputs are balanced, there will be no output at TP1082. An unbalance in the signal input channel will cause an unbalance in the output level TP1082.

When a carrier signal is applied at the carrier inputs, pins 1 and 4, the carrier signal may be controlled by varying the amount of unbalance at the signal input channel by means of the carrier level potentiometer R1011. 180° phase shift takes place from max + thru Null to max - carrier level. By applying signal to the AM signal amplifier externally or internally from the AM/FM Function switch, the carrier may be amplitude modulated as desired.

R1080 (D.C. LEVEL) provides adjustment of the modulator output D.C. level.

3.2.7 AM AMPLIFIER (Continued)

SQUARE SWITCH

The Square wave from the AM/FM level detector is connected to the Square Switch at TP1111. Q1110 and Q1120 is a Buffer used to drive the switching bridge D1111, D1110, D1122 and D1121. The square wave from the buffer is approximately ±2V. When the square wave is positive, current from the negative supply is diverted thru R112 and D112. The voltage at TP1114 is then determined by the voltage divider R1115, R1114, D1110 and R1112. R1115 provides adjustment of the output level. When the square wave from the buffer switches negative, current from the positive supply is diverted thru R1122, D1122, R1114 and R1115. The output square wave is approximately ±.75V. The square wave is connected to the AM/FM Function switch S1000.

TRI LEVEL SHIFT

The triangle from the AM/FM integrator is connected to TP1021 the input to the triangle level shift amplifier. Q1020 is an operational amplifier. The closed loop gain is set by input resistor R1021 and feedback resistor R1024 and R1028. R1028 provides adjustment of the output amplitude. R1022 and R1023 provides adjustment of the output D.C. level and level shifting of the input triangle. The output (TP1027) is connected to the AM/FM function switch S1000.

SINE CONVERTER/SINE AMPLIFIER

The sine converter converts the triangle waveform to a sine wave by means of a bi-polor diode shaping network. The triangle is connected to the shaping network at TP1027. As the triangle rises positive, each diode gate will turn on in succession, forming a sine wave at the output ot the three voltage dividers R1039. The diode gates will turn on and off in sequence following the triangle. The sine wave is amplified by the sine amplifier Q1050. The gain of the closed loop amplifier is fixed by input summing resistor R1051 and feedback resistor R1056 and R1058. R1056 provides adjustment of the output amplitude and R1052 provides adjustment of the output D.C. level.

The output is connected to the AM/FM Function switch S1000.

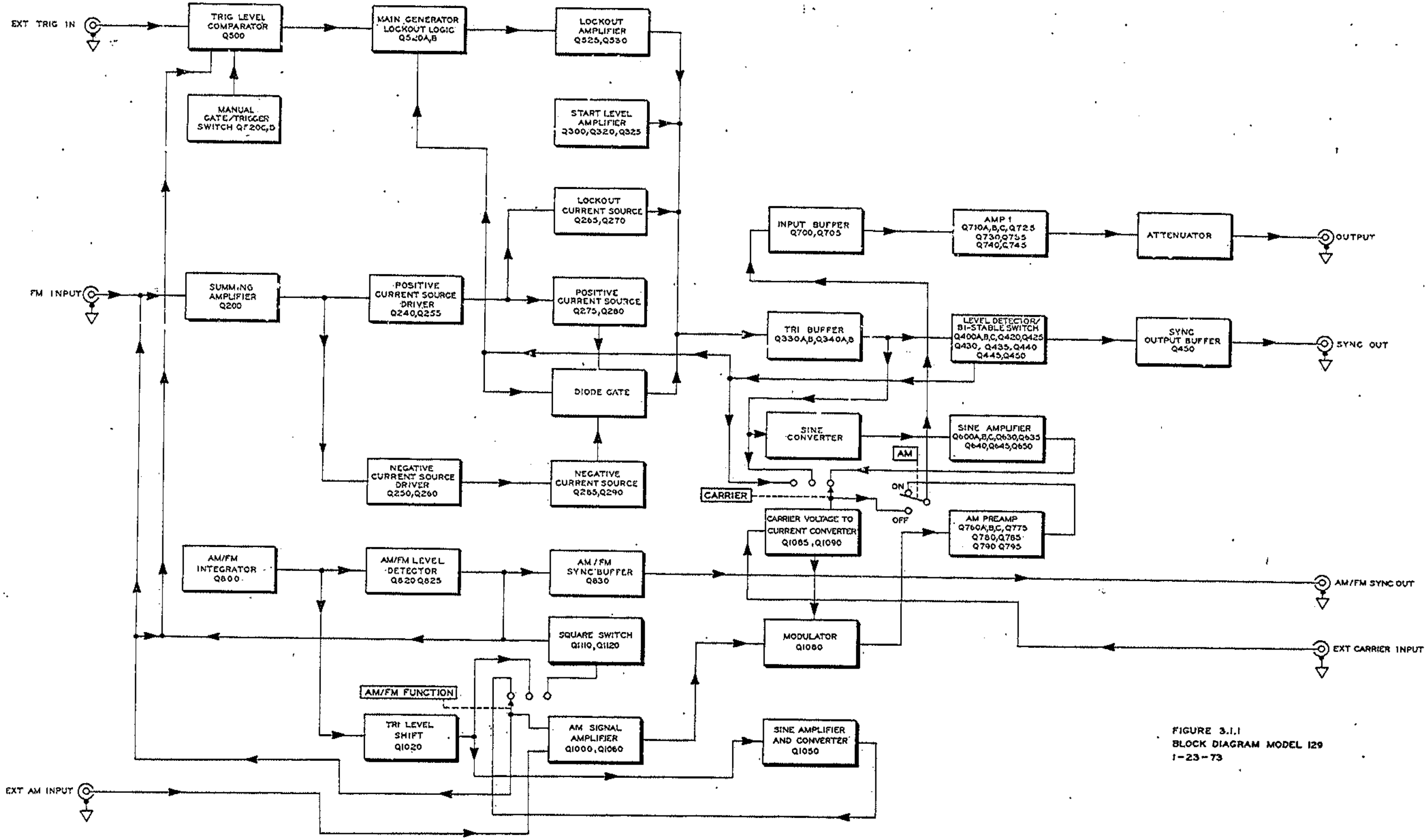


FIGURE 3.1.1
BLOCK DIAGRAM MODEL 129
1-23-73

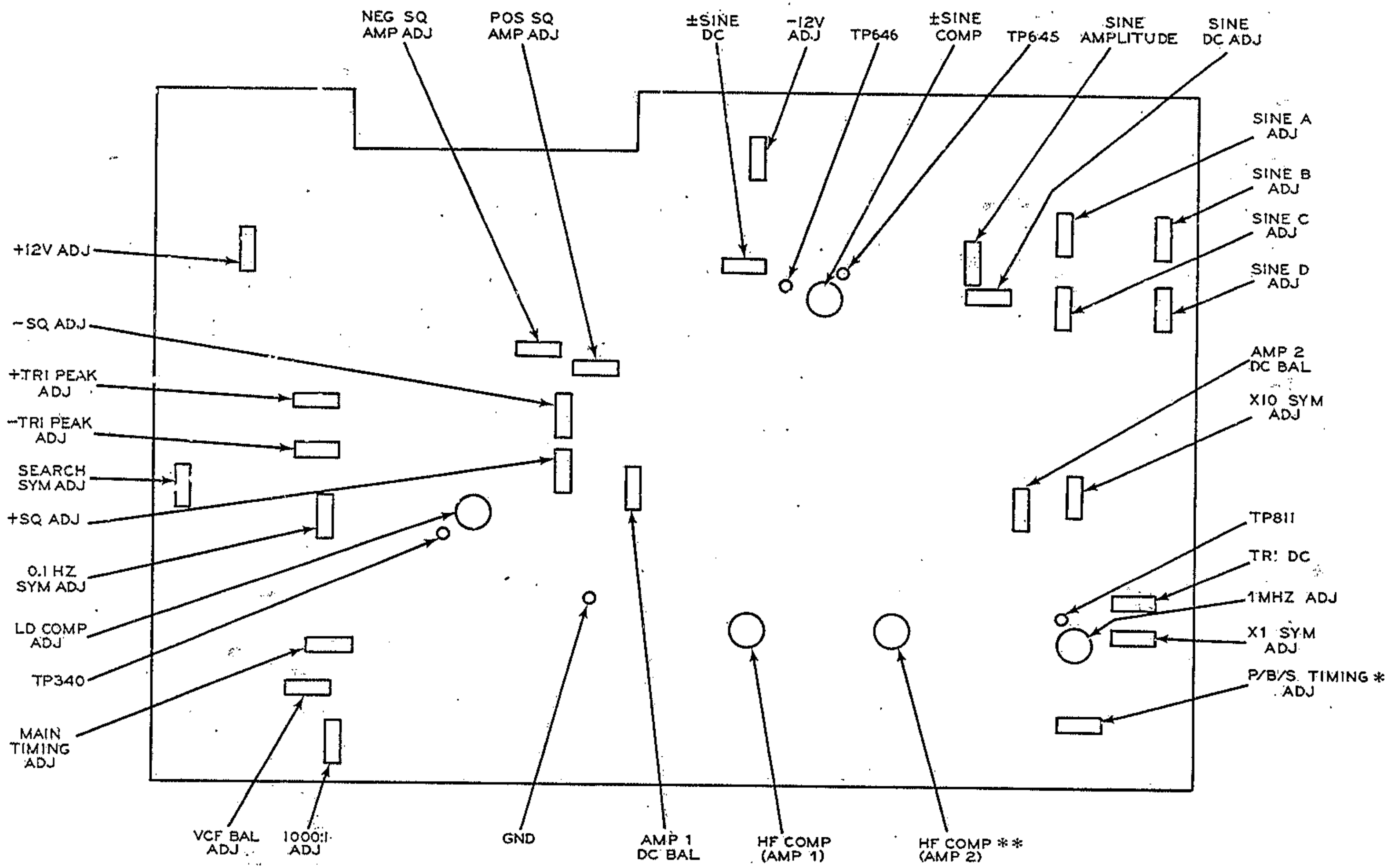
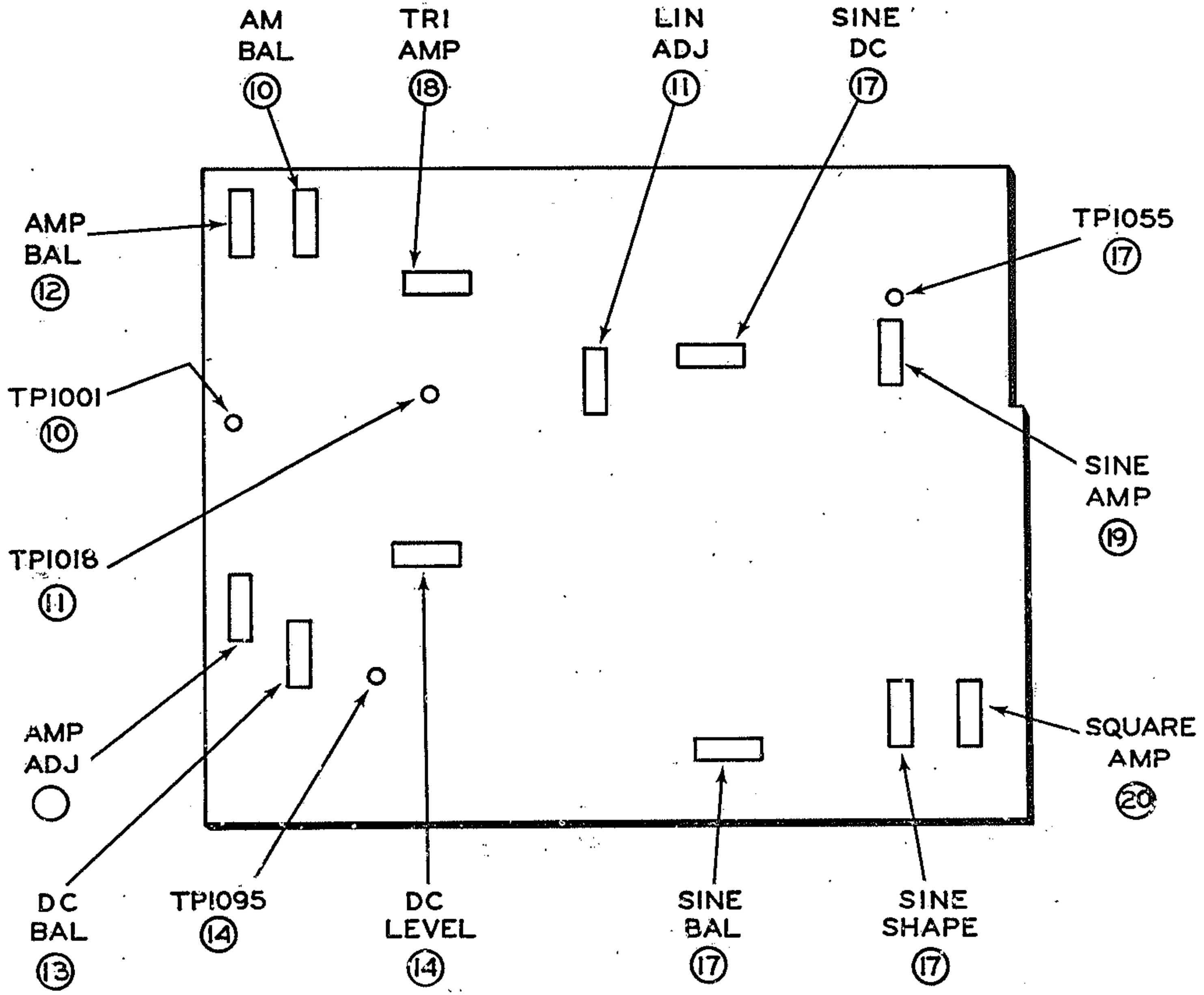


FIGURE 4.3.1
ADJUSTMENT LOCATION DETAIL
MODEL 124, 129

FOR MODEL 129
* AM/FM TIMING ADJ
** HF COMP (AM PREAMP)


AM BAL 10
TRI AMP 18
LIN ADJ 11
SINE DC 17
AMP BAL 12
TP1055 17
TP1001 10
TP1018 11
SINE AMP 19
AMP ADJ
SQUARE AMP 20
DC BAL 13
TP1095 14
DC LEVEL 14
SINE BAL 17
SINE SHAPE 17

SECTION 4

CALIBRATION

4.1.0 CALIBRATION PROCEDURE (Figures 4.3.1 and 4.3.2)

1. EQUIPMENT REQUIRED

The following test equipment or suitable equivalents of know accuracy are required for complete calibration of the Model 129 AM/FM Generator.

Oscilloscope - D.C. to 50 MHz. Differential plug-in with 10mv resolution
Distortion Analyzer---------.1% Residual Distortion
Frequency Counter/Time Interval Counter-----.1μ sec Time Base
Differential Voltmeter - 0.01% accuracy

2. INITIAL CONTROL SETTINGS

POWER SWITCH	ON
RANGE	1K
MULTIPLIER	1.0
MODE	RUN
CARRIER	∿
AMPLITUDE	MAX
ATTENUATOR	OFF
D.C. OFFSET	OFF
AM/FM RANGE	10KHz
100:1 VARIABLE	CAL
AM	OFF

3. MAIN GENERATOR (Figure 4.3.1)

+12 ADJUST

Connect voltmeter from +12V to ground. Adjust +12V adj for +12V ± 5mv.

-12V ADJUST

Connect voltmeter from -12V to ground. Adjust -12V Adj for -12V ± 5mv.

VCF BALANCE ADJUST

Set Multiplier .10. Connect frequency counter to Sync Out jack. Adjust VCF balance until there is no frequency shift on frequency counter when the FM input is grounded.

4.1.0 CALIBRATION PROCEDURE (Figures 4.3.1 and 4.3.2) con't

3. MAIN GENERATOR (Figure 4.3.1) con't

± TRIANGLE PEAK ADJUST

Using differential plug-in, adjust +Tri Peak and -Tri Peak to obtain ±1.25V peak ± 10mv at TP340.

MAIN TIMING ADJUST

Set Multiplier 1.0. Adjust Main Timing to obtain 1KHz ± .5% at Sync Output jack as observed on frequency counter.

1000:1 ADJUST

Set Range to 100K, Multiplier to S.O. Max CCW. Monitor main output with oscilloscope and adjust 1000:1 Adj to obtain 100 Hz triangle as indicated on frequency counter.

SEARCH SYMMETRY ADJUST

Set Range to 100K, Multiplier to S.O. Max CCW. Monitor main output with oscilloscope and adjust Search Symmetry to obtain symmetrical waveform.

0.1Hz SYMMETRY ADJUST

Set Range to 1, Multiplier to .10. Connect time interval counter to the Sync Output jack and adjust 0.1Hz Sym for correct symmetry ± .5%.

Note: 0.1Hz Sym affects the -to+ half cycle.

Repeat 1000:1 Adjust, Search Symmetry and 0.1Hz sym adjustments.

LEVEL DETECTOR COMPENSATION

Monitor TP340 with oscilloscope. Connect oscilloscope probe GND lead to GND turret indicated on Figure 4.3.2. Set Mult to 1.0 Adjust L.D. Comp. (C401) for min amplitude change from 100KHz to 5 MHz.

5MHz TIMING ADJUST

Set Range to 5M, Multiplier to 1.0. Connect frequency counter to the sync Output jack. Adjust 5MHz trimmer mounted on Range switch to obtain 5MHz ± 1% on frequency counter.

4.1.0 CALIBRATION PROCEDURE (Figures 4.3.1 and 4.3.2) con't

3. MAIN GENERATOR (Figure 4.3.1) con't

± SQUARE AMPLITUDE ADJUST

Set Carrier to Square. Set Range to 1K. Using differential plug-in, adjust +Square Amp and -Square Amp to obtain ± 1.25V peak ± 10mv square wave at TP459.

POSITIVE SQUARE AMPLITUDE ADJUST

Set Carrier to Negative Square. Adjust Positive Square Amp to obtain +1.25V peak ± 10mv at TP458.

NEGATIVE SQUARE AMPLITUDE ADJUST

Set Carrier to Positive Square. Adjust Negative Square Amp to obtain -1.25V peak ± 10mv at TP464.

OFFSET ADJUST

Set Carrier to ∿, Range to 1K, Multiplier to 1.0, Amplitude to Minimum (full CCW). Monitor output with oscilloscope and adjust Amp 1 D.C. Bal to obtain OV D.C. reference at output.

AMP 1 H.F. COMP. ADJUST

Set Range to 1M, Multiplier to 1.0, Carrier to Square, Amplitude to Maximum. Terminate the main output into 50Ω and monitor with oscilloscope. Adjust Amp 1 H.F. Comp. to obtain best looking SQ Wave with $<$50ns rise and fall time and $<$5% overshoot.

SINE A, B, C, D ADJUST

Set Range to 10K, Multiplier to 1.0, Carrier to Sine. Connect distortion analyzer to Output. Adjust Sine A, B, C and D and ± triangle peaks to obtain minimum sine distortion, typically less than 0.25%.

SINE AMPLITUDE, SINE D.C. ADJUST

Connect differential plug-in to TP645. Adjust Sine Amp and Sine D.C. to obtain ± 1.25V peak ± 10mv.

Repeat previous two steps due to interaction.

4.1.0 CALIBRATION PROCEDURE (Figures 4.3.1 and 4.3.2) con't

3. MAIN GENERATOR (Figure 4.3.1) con't

± SINE D.C.

Set Carrier to +Sine; monitor TP646 with oscilloscope. Adjust ± Sine D.C. to obtain 0V reference ± 10mv at peak of sine.

± SINE COMP.

Monitor output with oscilloscope terminated into 50Ω. Adjust ± Sine Comp. for 0V reference on 5mHz frequency range.

4. AM/FM GENERATOR (Figure 4.3.2)

SET:

AM/FM RANGE	10K
100:1 VAR	CAL
AM	ON
AM LEVEL	MIN
OFFSET	OFF

5. X10 SYM

Connect time interval counter to AM/FM sync on rear panel. Adjust X10 sym to obtain symmetrical waveform as indicated on time counter.

6. X1 SYM

Set 100:1 VAR max CCW. Adjust X1 sym to obtain correct symmetry as indicated on time interval counter. Repeat X10 sym and X1 symmetry adjustments if necessary

7. TRI D.C.

Set 100:1 Variable to CAL position monitor TP811 with oscilloscope and adjust Tri D.C. to obtain 0V reference at NEG peak of tri.

8. AM/FM TIMING ADJUST

Connect frequency counter to AM/FM sync output and adjust AM/FM timing adjust to obtain 10KHz ± 3%.

9. 1MHz ADJ

SET:

AM/FM RANGE	1M
100:1 VAR	CAL

Adjust 1MHz adjust to obtain 1MHz ± 3%.

4.1.0 CALIBRATION PROCEDURE (Figures 4.3.1 and 4.3.2) con't

10. AM BALANCE (Figure 4.3.2)

Connect DVM from GND to TP1001. Adjust AM BAL to obtain 0V ± 5mv at TP1001.

11. LIN ADJUST (Figure 4.3.2)

Set: AM 'ON' and AM level min. Adjust carrier level on front panel to obtain -3.72v ± 20mv at TP1018. Connect oscilloscope to output and adjust Lin Adj for min output signal (NULL).

12. AMPLITUDE BAL (Figure 4.3.2)

SET:

RANGE	1K
MULT	1.0
CARRIER	∿
AMP	MAX
AM	ON

Connect DVM or oscilloscope to output and read AC volts. Adjust AMP Bal to obtain equal output voltage ± 50mv at max CW and max CCW setting of carrier level control.

13. D.C. BAL (Figure 4.3.2)

Connect VOM or oscilloscope to output and read D.C. level. Adjust D.C. Bal to obtain equal D.C. level of output waveform ± 50mv at Max CCW and Max CW setting of Carrier level control.

14. D.C. LEVEL (Figure 4.3.2)

Connect DVM to TP1095. Adjust D.C. level (Figure 4.3.2) to obtain -300mv.

15. AMP 2 D.C. BAL (Figure 4.3.1)

Monitor output with oscilloscope and adjust Amp 2 D.C. BAL to obtain OV D.C. level.

16. AMPLITUDE ADJUST (Figure 4.3.2)

SET: Carrier to ∿ and Carrier level to max CW position. Adjust Amp Adj to obtain equal output amplitudes when AM switch is switched on and off.

4.1.0 CALIBRATION PROCEDURE (Figures 4.3.1 and 4.3.2) con't

17. SINE SHAPE AND SINE BAL (Figure 4.3.2)

SET:

AM/FM RANGE	10K
100:1 VAR	CAL

Connect a distortion analyzer from GND to TP 1055. Adjust Sine Shape and Sine Bal (Figure 4.3.2) to obtain min sine distortion (Typ < .5%).

Adjust Sine D.C. to obtain 0V D.C. level at TP1055.

18. TRI AMP (Figure 4.3.2)

Monitor the output with an oscilloscope (terminated into 50Ω).

SET:

RANGE	100K
MULT	1.0
CARRIER	∿
AM/FM FUNCTION	TRI
AMP	MAX

Adjust the Carrier level to obtain 1/2 of the Max pp output. Set AM level Max CW. Adjust Tri Amp to obtain 100% modulation.

19. SINE AMP - SINE D.C. (Figure 4.3.2)

Set AM/FM function to Sine. Adjust Sine Amp to obtain 100% modulation.

20. SQ AMP (Figure 4.3.2)

Set AM/FM Function to SQ. Adjust SQ Amp to obtain 100% modulation.

21. AM H.F. COMP:

SET:

RANGE	1M
MULT	1.0
CARRIER	⎍
AMP	MAX
AM	ON
CARRIER LEVEL	MAX CW
AM LEVEL	MIN

Monitor the output with an oscilloscope terminated into 50Ω. Adjust Amp 2 H.F. Comp Fig (4.3.1) for best looking sq. wave with < 50 ns rise and fall time and < 5% overshoot.