



JULY 1975

INSTRUCTION MANUAL FOR AEL MODEL

FM-15QE/SG STEREO GENERATOR



A **M** **E** **L** **A** **M** **E** **R** **I** **C** **A** **N** **E** **L** **E** **C** **T** **R** **O** **N** **I** **C** **L** **A** **B** **O** **R** **A** **T** **O** **R** **I** **E** **S**

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SECTION 1

GENERAL INFORMATION

1-1 Description

The AEL Model FM-15QE/SG Stereo Generator, Fig. 1-1, is an all solid state unit designed to meet or exceed the Federal Communications Commission requirements for stereo multiplex FM transmission.

The Generator is manufactured in a standard $3\frac{1}{2}$ " X 19" rack mount and is completely self-contained. All operator controls and indicators are located on the front panel. Input and output connections are located on the rear panel.

The unit features all silicon transistors, diodes and integrated circuits. The composite signal is generated using the time division technique thereby reducing the complexity of the circuit and the number of adjustments.

1-2 Electrical Specifications

Inputs (Right and Left)

- | | |
|--------------------|--------------------|
| a) Frequency Range | 30 Hz - 15 KHz |
| b) Impedance | 600 ohms balanced |
| c) Level | +10 dbm \pm 1 db |

Frequency Response (30 Hz-15 KHz)

- | | |
|-------------------|-------------------|
| a) Flat | \pm 0.5 db |
| b) Pre-emphasized | 75usec \pm 1 db |

Output (Composite)

- | | |
|--------------|--------------------|
| a) Impedance | less than 300 ohms |
| b) Level | 4V _{pp} |

Stereo Separation (30 Hz-15 KHz)	Greater than 300 ohms
----------------------------------	-----------------------

Crosstalk (30 Hz-15 KHz)

- | | |
|----------------|-------|
| a) Main to Sub | 46 db |
| b) Sub to Main | 46 db |

38 KHz Suppression	55 db
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Noise (below 4V _{pp} output)	70 db
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Distortion (Left or Right)	0.25% THD
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Pilot Frequency	19 KHz \pm 1 Hz
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Power Requirement

105-125Vac or 210-250Vac
50/60 Hz

Ambient Temperature

0°C to 55°C

1-3 Mechanical Specifications

Dimensions

3½" X 19" X 12"D

Mounting Dimensions

Figure 2-1

Net Weight

Shipping Weight

Maximum Operating Temperature

131°F (55°C) Ambient

SECTION 2

INSTALLATION

2-1 Initial Inspection

Check the shipping carton for external damage. If the carton exhibits evidence of abuse in handling (holes, broken corners, etc.) ask the carrier agent to be present when the unit is unpacked. Carefully unpack the unit and inspect all equipment for physical damage. Immediately after unpacking, any bent or broken parts or scratches should be noted. Keep all packing material for proof of damage claim or for possible future use.

2-2 Preparation For Use

The unit is designed to be mounted in a standard 19" rack. Air space should be provided above and below the unit so that heat generated by the circuitry may be dissipated. Additional cooling may be required if the unit is placed above high heat generating equipment in order to keep the ambient temperature below the maximum specified.

Mount the unit to the rack using (4) #10 countersunk screws and finishing washers.

Connect left and right audio lines to appropriate terminals on TB1. Be sure lines are phased properly. Connect a coax cable from J1 OUTPUT jack on Stereo Generator to COMPOSITE INPUT jack on Exciter.

2-3 Repacking For Shipment

NOTE: Before returning a unit for repair or calibration, contact the factory or your authorized representative for a Return Authorization. Attach a tag showing owner's name and address. A description of the service required should also be included. Unit must be shipped prepaid and insured for full value. Use the original shipping carton and packing material for re-shipment. If they are not available, proceed as follows:

- A. Use a carton with a minimum test strength of 250 lbs.
- B. Use heavy paper or sheets of cardboard to protect all surfaces.
- C. Use at least four inches of tightly packed shock absorbing material such as extra firm polyurethane foam or rubberized hair. **NEWSPAPER IS NOT SUFFICIENT CUSHIONING MATERIAL.**

- D. Use heavy reinforced shipping tape to secure the outside of the carton.
- E. Use large FRAGILE labels on each surface.

SECTION 3

OPERATION

3-1 Operator Controls and Indicators (Front Panel)

1. POWER Switch S1 and LED CR1

This is the primary power switch for the unit. LED CR1 will light indicating power on.

2. STEREO Switch S1 and LED CR2

- a. In the ON position, the Generator is placed in the stereo mode with 19 KHz Pilot.
- b. In the OFF position, the Generator is placed in the mono mode and Pilot is removed. In addition, the gain of the generator is changed to compensate for the removal of the Pilot.

3. PILOT LEVEL Control R1

This pot controls the Pilot Level from 0 to over 12%. It is used to set the pilot level to the FCC specified 8-10%.

4. PRE-EMPHASIS Switch S3

- a. In the ON position, both inputs are pre-emphasized in accordance with the 75usec curve. Phase and amplitude tracking of the inputs is such that the Main to Sub and Sub to Main Crosstalk is better than 46 db from 30 Hz to 15 KHz.
- b. In the OFF position, both inputs have a flat response. Crosstalk will also be better than 46 db from 30 Hz to 15 KHz.

3-2 Controls and Connections (Rear Panel)

1. TB1

The left and right audio input connections are made to this terminal block. The impedance is 600 ohms balanced and the level required is +10 dbm.

2. J1 OUTPUT jack

The composite output signal is available at this jack. Level is 4V_{pp} for a +10 dbm input signal.

3. F1 and XF1 Fuse and Holder

This is the input power fuse for the unit. Replace this fuse only with same type and rating as original.

3-3 Initial Operation/Performance Check

1. Equipment required but not supplied

- a. Audio Generator (+10 dbm out @ 600 ohms)
- b. Wideband DC coupled oscilloscope - Telequipment D54 or equivalent.

NOTE: Do NOT use a scope probe for these checks.

2. Use a short coax cable to connect J1 OUTPUT to the DC coupled scope input.

NOTE: Be sure that the scope is adequate for stereo measurements.

3. Connect the Audio Generator to LEFT INPUT on TB1. Set Frequency at 400 Hz and level at 10 dbm ($2.45V_{rms}$).

4. Turn POWER switch S1 on and observe that LED CR1 lights.

5. Place STEREO switch S2 in the OFF position and PRE-EMPHASIS switch S3 in the OFF position.

6. Observe that a $2V_{pp}$ 400 Hz sine wave is displayed on scope.

7. Disconnect Audio Generator from LEFT INPUT and connect to RIGHT INPUT. Observe $2V_{pp}$ 400 Hz sine wave. Remove Audio Generator.

8. Place STEREO switch S2 in ON position. Observe that LED CR2 lights.

9. Adjust Pilot Level control R1 for a $.4V_{pp}$ 19 KHz signal on scope.

10. Connect the Audio Generator to LEFT INPUT on TB1 (Level +10 dbm @ 400 Hz). Observe a $4V_{pp}$ composite signal on scope. Repeat using RIGHT INPUT.

11. Connect the Audio Generator to both inputs out of phase. Use the audio signal to externally trigger the scope. Observe an L-R signal with pilot. Note the crossover point in the waveform. The two points should align indicating pilot phase is correct.
12. Remove test equipment and reconnect Stereo Generator as in Section 2. Complete system proof of performance should then be checked using the FM Exciter and/or transmitter and FCC Type Approved monitors.

3-4 Normal Operation

For normal operation, control the modulation percentage with the audio input level supplied to the Generator. Control the Pilot Level with PILOT LEVEL pot R1. Use pre-emphasis if required. It is suggested that if at all possible, the built-in pre-emphasis in the Stereo Generator be used. This is because both pre-emphasis networks are factory tracked in phase and amplitude.

The normal 100% output level for this Generator is $4V_{pp}$. See Section 5 for instructions on changing this level in the event it is incompatible with the exciter used.

SECTION 4

THEORY OF OPERATION

4-1 General

Figure 4-1 is a block diagram of the Generator. The Generator circuitry is on three circuit boards. A2 - Stereo Generator Assembly; A3 - Filter and Power Supply Assembly; A4 - Power Supply and Regulator Assembly.

1. A2 - Stereo Generator Assembly

Right and Left channel audio is fed through two identical amplifiers. The outputs of these amplifiers are fed to a two transistor chopper. The 38 KHz drive for the chopper is derived from a 9.728 MHz crystal oscillator. The output of this oscillator is digitally divided to produce both the 38 KHz chopper drive and the 19 KHz pilot. The 19 KHz square wave is filtered and summed with the output of the chopper. This square wave switched composite signal is then filtered to remove the odd harmonics of 38 KHz. The output of the low pass filter is then amplified to the 4V_{pp} output level of the Generator.

2. A3 - Filter and Power Supply Assembly

This board contains the 5V regulator (which supplies the digital integrated circuits) and the 53 KHz low pass phase linear filter.

3. A4 - Power Supply Regulator

This board contains a plus and minus 12 volt tracking regulated power supply.

4-2 Detail Circuit Description

1. A2 - Stereo Generator Assembly

Right and Left channel audio is fed through identical circuitry to the time division chopper. This circuitry consists of input transformers T1 and T2 and attenuating and pre-emphasis networks made up of R1, R2, R3, R4 and C1 for the left channel and R13, R14, R15, R16 and C7 for the right channel. R13 is used to exactly match the gain of the circuits and thereby minimize crosstalk. C1A or C7A are factory selected

to phase and amplitude track the pre-emphasis networks. Q1, Q2 and Q3 form a wideband amplifier which raises the signal level to that required by the chopper. Q5, Q6 and Q7 form an identical amplifier for the other channel. Transistors Q4 and Q8 form the time division chopper. These transistors alternately short the left and right signals to ground at 38 KHz rate. This 38 KHz is derived from a 9.728 MHz crystal oscillator made up of Q13, Y1 and associated circuitry. U4A and U4B shape the output of this oscillator and drive the divide chain made up of U1, U2 and U3. The two phase 38 KHz output of U1 is exactly 50% duty cycle. These outputs are buffered by U4C and U4D and then used to drive chopper transistors Q4 and Q8. The 19 KHz square wave output of U1 is filtered by L1, L2 and associated circuitry. L1 is used as a pilot phase adjustment. The sine wave output of this filter is fed through the PILOT LEVEL control A1R1 and R36 to the junction of R24, R25, R26 and R36. This is the summing point where the square wave switched composite signal and the pilot are combined. This signal is then filtered to remove the odd order harmonics of the 38 KHz switching square wave. This converts the composite signal to the sine wave switched signal identical to the composite signal obtained with the balanced modulator type of generator. The output of the filter is fed through the composite gain control R27 to the output amplifier made up of Q9, Q10 and Q11. The gain of this amplifier is determined by R31 and R32 when Q12 is turned on (Stereo mode) and by R31 and R32, R33 and R34 when Q12 is turned off (Mono mode). R34 is used to match the Mono gain to the Stereo gain.

2. A3 - Filter and Power Supply Assembly

Diode CR1 is a 5.6 volt zener. Q1 buffers the voltage across this diode and provides 5 volts to the digital integrated circuits on the A2 Assembly. Filter FL1 is a precision low pass filter with a very linear phase characteristic. This linear phase characteristic is necessary in order to pass the entire composite signal without degradation.

3. A4 - Power Supply Regulator Assembly

STEREO GENERATOR ASSEMBLY A2

PARTS LIST

<u>REF DES</u>	<u>DESCRIPTION</u>
A2	Assembly, P.C.
A2C1	Cap, Poly 10000 pf 5%
A2C1A	Cap, Mica, DM15
A2C2	Cap, Cer .1uf 16V
A2C3	Cap, Cer .1uf 16V
A2C4	Cap, Mica 10pf DM15
A2C4A	Cap, Mica 10pf DM15
A2C5	Cap, Elect 200uf 12V
A2C6	Cap, Cer. .05uf 16V
A2C7	Cap, Poly 10000 pf 5%
A2C7A	Cap, Mica, DM15
A2C8	Cap, Mica 10pf DM15
A2C8A	Cap, Mica, 10pf DM15
A2C9	Cap, Cer. .1uf 16V
A2C10	Cap, Elect. 200uf 12V
A2C11	Cap, Cer. .05uf 16V
A2C12	Cap, Mica DM15
A2C13	Cap, Cer. .1uf 16V
A2C14	Cap, Cer., .1uf 16V
A2C15	Cap, Elect 100uf 25V
A2C16	Cap, Elect. 100uf 25V
A2C17	Cap, Poly 10000pf
A2C18	Cap, Poly 2200pf
A2C19	Cap, Poly 2200pf
A2C20	Cap, Poly 10000pf
A2C21	Cap, Poly 10000pf
A2C22	Cap, Mica 820pf
A2C23	Cap, Poly 10000pf
A2C24	Cap, Poly 3000pf
A2C25	Cap, Cer. .1uf 16V
A2C26	Cap, Cer. .1uf 16V
A2C27	Cap, Mica 470pf DM15
A2C28	Cap, Mica 470pf DM15
A2Q1	Trans., NPN
A2Q2	Trans., NPN
A2Q3	Trans., PNP
A2Q4	Trans., NPN
A2Q5	Trans., NPN
A2Q6	Trans., NPN
A2Q7	Trans., PNP
A2Q8	Trans., NPN
A2Q9	Trans., NPN
A2Q10	Trans., NPN
A2Q11	Trans., PNP
A2Q12	Trans., NPN
A2Q13	Trans., NPN

REF DESDESCRIPTION

A2R1	Res, Carb 120ohm $\frac{1}{2}w$ 5%
A2R2	Res, Carb 470ohm $\frac{1}{2}w$ 5%
A2R3	Res, Film 7.87K $\frac{1}{4}w$ 1%
A2R4	Res, Film 332ohm $\frac{1}{4}w$ 1%
A2R5	Res, Carb 4.7K $\frac{1}{2}w$ 5%
A2R6	Res, Carb 1K $\frac{1}{2}w$ 5%
A2R7	Res, Carb 470ohm $\frac{1}{2}w$ 5%
A2R8	Res, Carb 10K $\frac{1}{2}w$ 5%
A2R9	Res, Carb 1.2K $\frac{1}{2}w$ 5%
A2R10	Res Film 2.67K $\frac{1}{4}w$ 1%
A2R11	Res, Var., Cermet 200
A2R12	Res, Carb. 8.2K $\frac{1}{2}w$ 5%
A2R13	Res, Var, Carb 250
A2R14	Res, Carb, 330 $\frac{1}{2}w$ 5%
A2R15	Res, Film, 7.87K $\frac{1}{4}w$ 1%
A2R16	Res, Film, 332ohm $\frac{1}{4}w$ 1%
A2R17	Res, Carb 1K $\frac{1}{2}w$ 5%
A2R18	Res, Carb 10K $\frac{1}{2}w$ 5%
A2R19	Res, Carb 470 ohm $\frac{1}{2}w$ 5%
A2R20	Res, Carb 1.2K $\frac{1}{2}w$ 5%
A2R21	Res, Film 2.67K $\frac{1}{4}w$ 1%
A2R22	Res, Var. Cermet 200 ohm
A2R23	Res, Carb 8.2K $\frac{1}{2}w$ 5%
A2R24	Res, Film 2.21K $\frac{1}{4}w$ 1%
A2R25	Res, Film 2.21K $\frac{1}{4}w$ 1%
A2R26	Res, Carb 620ohm $\frac{1}{2}w$ 5%
A2R27	Res, Carb 220ohm $\frac{1}{2}w$ 5%
A2R28	Res, Carb, 2.2K $\frac{1}{2}w$ 5%
A2R29	Res, Carb, 1K $\frac{1}{2}w$ 5%
A2R30	Res, Carb. 1.2K $\frac{1}{2}w$ 5%
A2R31	Res, Carb 120ohm $\frac{1}{2}w$ 5%
A2R32	Res, Carb 820ohm $\frac{1}{2}w$ 5%
A2R33	Res, Carb 470ohm $\frac{1}{2}w$ 5%
A2R34	Res, Var Carb 1K
A2R35	Res, Carb 4.7K $\frac{1}{2}w$ 5%
A2R36	Res, Carb 12K $\frac{1}{2}w$ 5%
A2R37	Res, Carb 1.5K $\frac{1}{2}w$ 5%
A2R38	Res, Carb 620ohm $\frac{1}{2}w$ 5%
A2R39	Res, Carb 3.3K $\frac{1}{2}w$ 5%
A2R40	Res, Carb 100ohm $\frac{1}{2}w$ 5%
A2R41	Res, Carb 4.7K $\frac{1}{2}w$ 5%
A2R42	Res, Carb 4.7K $\frac{1}{2}w$ 5%
A2R43	Res, Carb 120 ohm $\frac{1}{2}w$ 5%
A2R44	Res, Carb 120ohm $\frac{1}{2}w$ 5%
A2R45	Res, Carb 1.2K $\frac{1}{2}w$ 5%
A2U1	IC, TTL
A2U2	IC, TTL
A2U3	IC, TTL
A2U4	Xtal. 9.728MHz

FILTER & POWER SUPPLY ASSEMBLY A3

PARTS LIST

REF DES

DESCRIPTION

A3	Assembly, P.C.
A3C1	Cap, Cer. .05uf 16V
A3CR1	Diode, Zener
A3FL1	Filter, Low Pass
A3Q1	Trans., NPN
A3R1	Res. Carb. 1.2K $\frac{1}{2}$ w 5%
A3R2	Res Carb 330 $\frac{1}{2}$ w 5%
A3R3	Res. Carb. 1.2K $\frac{1}{2}$ w 5%
A3R4	Res. Carb. 6.8K
A3R5	Res. Carb. 12K $\frac{1}{2}$ w 5%