

STEREO "ADD ON" MONITOR MODEL 771

INSTRUCTION MANUAL

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## SECTION 1

### GENERAL INFORMATION

#### 1-1 DESCRIPTION

The QEI Model 771 Stereo "add on" Monitor, Fig. 1-1, (FCC Type Approval Number 3-228) is an all solid state Modulation Monitor which when driven by the QEI Model 671 FM Modulation Monitor meets or exceeds the Federal Communications Commission requirements for measuring the modulation characteristics of FM Stereo Multiplex Transmitters having a frequency range from 88MHz to 108MHz.

The Monitor is manufactured in a standard 5 $\frac{1}{4}$ " X 19" rack mount. All operator controls are located on the front panel. AC Power, Composite inputs and Monitor outputs are located on the rear panel.

The Monitor is all solid state, employing transistors, diodes and integrated circuits. The monitor features two modulation meters (4 $\frac{1}{2}$ " ) and the switching necessary to measure the required signal parameters. A Pilot lamp is provided to indicate when stereo transmission is being received and a null type Phase Calibrator allows accurate and easy setting of the regenerated 38KHz phase. Both meters and the Pilot lamp are remoteable with the meter requiring a 5K ohms maximum line impedance.

#### 1-2 ELECTRICAL SPECIFICATIONS

##### COMPOSITE INPUT

Impedance	10K
Sensitivity	1 to 6V <sub>pp</sub>

##### OUTPUTS

###### MONITOR AUDIO (L&R)

Impedance	600 ohms unbalanced
Level	5V <sub>rms</sub> min @ 100% at 400Hz
Distortion	less than 0.5%
Freq Response	± 0.5db, 50Hz-15KHz

###### DISTORTION AUDIO (SWITCHED)

Impedance	10K
Level	5V <sub>rms</sub> min @ 100% at 400Hz
Distortion	less than 0.25%
Freq Response	± 0.5db, 50Hz-15KHz
Noise	66db below 100% @ 400Hz (de-emp)

###### SCOPE (SWITCHED)

Impedance	2K
Level	.5V <sub>pp</sub> min
Freq Response	± 0.2db 50Hz-75KHz

##### COMPOSITE

Impedance	1K
Level	8V <sub>pp</sub> min
Freq Response	± 0.2db 50Hz-75KHz

PILOT INJECTION CKT

Accuracy	± 0.5%
Meter Indication	6-12%
Indicator (lamp)	triggers @ 3-5%
Phase Cal.	null indication

MODULATION METERS

Accuracy	± 5% entire scale
Range	133% to -70db
Freq Response	
(Total position)	± 0.2db 50Hz-75KHz
Ballistics	per F.C.C. regulations

SEPARATION

L into R or R into L	45db (50-15KHz)
Accuracy	better than ± 3db
NOTE:	Separation can be measured internally down to 70db

CROSSTALK

(L&R) into (L-R)	54db min
(L-R) into (L&R)	54db min
SCA into (L&R) or (L-R)	66db min

38KHz SUPPRESSION

Unmodulated	60db min
Modulated above 5KHz	55db min

MONITORING MODES (Meter Range 133% to -70db)

	Left Meter	Right Meter
A.	Left	Right
B.	L&R	L-R
C.	Total	Pilot Inj.
D.	38KHz Suppression	Total

REMOTE METERING

Terminations are provided for remoting both meters and the pilot lamp. Line Z to equal approximately 5K max. for meters. Terminations may be shorted or opened without affecting meters on monitor.

POWER REQUIREMENTS

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

AMBIENT TEMPERATURE

0°C to 50°C

1-3 MECHANICAL SPECIFICATIONS

Dimensions	5¼"H X 19"W X 10½"D
Mounting Dimensions	Figure 2-1
Net Weight	10 lbs.
Shipping Weight	14 lbs.
Maximum Operating Temperature	122°F (50°C) Ambient

#### 1-4 INSTRUMENT IDENTIFICATION

This monitor is identified by a Model Number and a six digit Serial Number located on the rear panel of the instrument. All correspondence to your sales representative or the factory in regard to this instrument should reference the complete Model and Serial Numbers.

#### 1-5 ACCESSORIES

The Stereo Monitor may be used for remote monitoring with the 771-MP Remote Meter Panel.

## 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 and scratches should be noted. Keep all packing material for proof of damage claim or for possible future use.

#### 2-2 PREPARATION FOR USE

The Stereo "Add On" Monitor is designed to be mounted in a standard 19 inch rack. Air spaces should be provided above and below the unit (approximately  $\frac{1}{4}$  inch) as heat generated by the circuitry should be dissipated. Additional cooling may be required if the unit is to be placed above high heat generating equipment in order to keep the ambient temperature below 50°C.

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

The Monitor requires a 105 to 125V single phase, 50 to 60Hz power source, or a 208 to 250V single phase, 50 to 60Hz power source. The identification sticker on the back panel shows for which power source the unit is wired.

Connect the coax cable provided from J2 STEREO jack on the F.M. Monitor to J1 COMP INPUT on the Stereo Monitor.

#### 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 and owner's address. A description of the service required should also be included on the tag. Unit should be shipped prepaid and insured for full value. Use the original shipping carton and packing material for re-shipment. If they are not available or reusable, proceed in the following manner:

- A. Use a double-walled carton with a minimum test strength of 275 lbs.
- B. Use heavy paper or sheets of cardboard to protect all surfaces.
- C. Use at least 4 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 duty shipping tape to secure the outside of the carton.
- E. Use large FRAGILE labels on each surface.

If only a PC assembly is to be returned, attach a tag showing owner and owner's address. A description explaining the problem, including the troubleshooting step failed, should be included on the tag. Assembly should be shipped prepaid and insured for \$100.00. To repack assembly proceed as follows.

- A. Use double-walled carton with minimum test strength of 50 lbs.
- B. Use at least 1 inch of tightly packed shock absorbing material such as extra firm polyurethane foam or rubberized hair.
- C. Use heavy duty shipping tape to secure the outside of the carton.
- D. Use FRAGILE labels on carton.

## SECTION 3

### OPERATION

#### 3-1 OPERATOR CONTROLS AND INDICATORS (FRONT PANEL)

##### 1. FUNCTION SWITCH A1S1

- a. When the PWR switch is depressed, the unit will be operable.
- b. When the LEFT-RIGHT button is depressed, the LEFT METER will indicate left channel modulation and the RIGHT METER will indicate right channel modulation.
- c. When the L&R - L-R button is depressed, the LEFT METER will indicate L&R (Main) channel modulation and the RIGHT METER will indicate L-R (Sub) channel modulation.
- d. When the TOTAL-PILOT button is depressed, the LEFT METER will indicate total modulation and the RIGHT METER will indicate pilot (19KHz) modulation.
- e. When the 38KHz-TOTAL button is depressed, the LEFT METER will indicate subcarrier (38KHz) suppression and the RIGHT METER will indicate TOTAL modulation.

##### 2. LEFT - RIGHT SWITCH S2

- a. When in LEFT position left channel audio appears at J4 and the signal being displayed on the LEFT METER appears at J5.
- b. When in RIGHT position right channel audio appears at J4 and whatever is being displayed on the RIGHT METER appears at J5.

##### 3. TEST-DECIBELS SWITCH S3

- a. When in MOD position, all functions on both meters (except 38KHz and PILOT) are displayed with semi-peak ballistics.
- b. When rotated CCW from MOD (R into L), the RIGHT METER maintains semi-peak ballistics and the LEFT METER becomes an average reading voltmeter with 10db steps.
- c. When rotated CW from MOD (L into R), the LEFT METER maintains semi-peak ballistics and the RIGHT METER becomes an average reading voltmeter with 10db steps.

NOTE: This switch has no effect on the meter for which TOTAL function is selected.



#### 4. DE-EMPH SWITCH S4

- a. When in down position, both the audio output at J4 and the monitor audio outputs on the rear of the unit are de-emphasized in accordance with the 75usec curve.

#### 5. PILOT lamp and Ø CAL PUSH DS1 and Ø CAL ADJ R2

- a. When lit indicates stereo pilot is present.
- b. When depressed with function switch A1S1 in TOTAL-PILOT position, energizes Phase Cal circuitry.

#### 6. J4 AUDIO

- a. Demodulated left or right channel high-impedance (10K) audio is available at this jack for distortion and noise measurements.

#### 7. J5 SCOPE

- a. Whatever is displayed on the LEFT or RIGHT METER is available at this jack. This is a wideband signal and will change gain with S3 TEST switch.

#### 8. J6 COMP

- a. A low impedance (1K) high level (8V<sub>pp</sub>) composite signal is available at this jack for scope investigation.

### 3-2 OPERATOR CONTROLS & INDICATORS (REAR PANEL)

#### 1. COMP LEVEL Control R2

- a. This control is used to attenuate the input composite signal to the level required by the monitor.

#### 2. COMP INPUT jack J1

- a. This is the input signal connection to the monitor.

#### 3. FREQ OUT Jack J2

- a. A TTL compatible signal 100 or 50 times the pilot frequency is available at this jack. This enables pilot frequency to be measured to an accuracy of 0.1Hz with a .1 sec time base.

### 3-3 INITIAL OPERATION/PERFORMANCE CHECKS

1. Plug the power cord into a receptacle supplying power for which the unit is wired. (105-125Vac or 210-250Vac, 50/60Hz).

2. Depress PWR switches on F.M. Monitor and Stereo Monitor and allow 15 minutes warm up.
3. Depress CAL switch on F.M. Monitor. F.M. Monitor MOD METER and PEAK FLASHER should indicate 100%.
4. Depress TOTAL-PILOT switch on Stereo Monitor. Adjust R1 COMP LEVEL control on rear panel until LEFT METER indicates the same (100%) as the meter on the F.M. Monitor.
5. Depress 38KHz-TOTAL switch on Stereo Monitor. RIGHT METER should indicate the same (100%) as the meter on the F.M. Monitor.

### 3-4 NORMAL OPERATION

1. Set up the F.M. Monitor as outlined in its manual.
2. Depress TOTAL-PILOT switch on Stereo Monitor.
3. Bring transmitter pilot level up until RIGHT METER indicates between 8 and 10% on PILOT scale. LEFT METER and F.M. Monitor meter should indicate 8 to 10% and PILOT lamp should be lit.
4. Depress PILOT lamp and adjust R2  $\emptyset$  CAL ADJ for null on RIGHT METER.

NOTE 1: TEST switch S3 may be rotated CW to increase RIGHT METER gain for a more accurate null.

NOTE 2: This adjustment may be made with audio modulation applied. However, the audio will cause some fluctuation of the meter as you approach null.

NOTE 3: It is suggested that before accurate separation measurements are taken, the phase calibration be checked without modulation.

NOTE 4: The function switch must be in TOTAL-PILOT position in order to perform phase calibration.

### 3-5 STEREO MEASUREMENTS

1. LEFT and RIGHT CHANNEL MODULATION

Depress LEFT-RIGHT button and TEST switch to MOD. The LEFT METER will display left channel modulation and the RIGHT METER will display right channel modulation. A fully modulated left or right signal will indicate 90% on its respective meter. A fully modulated L&R or L-R signal will indicate 90% on both meters. If pilot is lost, both meters will indicate the same as the Modulation Meter on the F.M. Monitor.

2. SEPARATION (R into L or L into R)

Depress LEFT-RIGHT button and TEST switch to MOD. Apply a fully modulated left or right only signal to the transmitter. Rotate the TEST switch CW (L into R) if left is applied or CCW (R into L) if right is applied until reading appears on unmodulated channel's meter. The separation is the algebraic sum of the meter and range switch -ldb. Fully modulated signal = 90% (-ldb)

3. L&R and L-R MODULATION

Depress L&R - L-R button and TEST switch to MOD. The LEFT METER will display L&R (Main) channel modulation and the RIGHT METER will display L-R (Sub) channel modulation. A fully modulated L&R or L-R signal will indicate 90% on its respective meter. A fully modulated left or right only signal will indicate 45% on both meters.

4. CROSSTALK (Main to Sub or Sub to Main)

Depress L&R - L-R button and TEST switch to MOD. Apply a fully modulated L&R or L-R signal to the transmitter. Rotate the TEST switch CW (L into R) if L&R (Main) is applied or CCW (R into L) if L-R (Sub) is applied until reading appears on unmodulated channel's meter. The crosstalk is the algebraic sum of the meter and range switch -ldb. Fully modulated signal = 90% (-ldb) .

5. 38KHz SUBCARRIER SUPPRESSION

Depress 38KHz-TOTAL button and TEST switch to MOD. Apply a 5KHz to 15KHz left or right fully modulated signal to the transmitter. The total modulation will appear on the modulation meter on the F.M. Monitor and on the RIGHT meter of the Stereo Monitor. Rotate the TEST switch CCW until a reading appears on the LEFT METER. The algebraic sum of the meter reading and range switch indicates subcarrier suppression referenced to 100% modulation.

## 5-2 Calibration

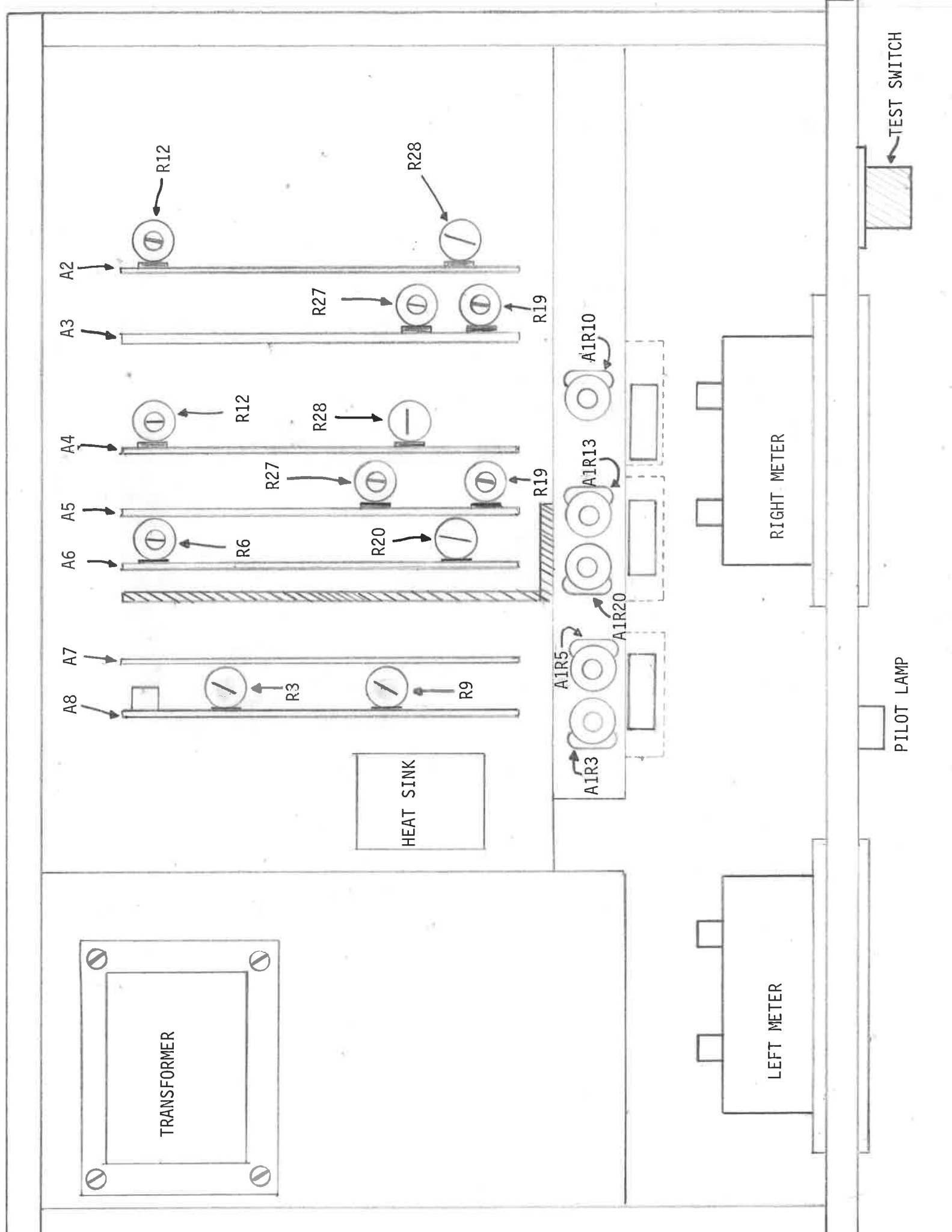
### A. Equipment Required But Not Supplied

- 1) Stereo Generator (QEI Model 772 or equivalent)
- 2) Audio Oscillator (Khron-Hite 4200 or equivalent)
- 3) Distortion Analyzer (Hewlett Packard 331 or equivalent)
- 4) Oscilloscope
- 5) Voltmeter
- 6) Assorted leads and cables
- 7) Audio 10 db step attenuator

### B. Alignment Procedure

- 1) Turn unit on and verify that all supply voltages are correct. Turn unit off.
- 2) Remove A2 and A4 assemblies.
- 3) With no input connected, turn unit on.
- 4) Adjust A3R27 to zero the right meter, and A5R27 to zero the left meter.
- 5) Turn unit off and re-install A2 and A4 assemblies.
- 6) Turn unit on and adjust A2R28 to zero the right meter and A4R28 to zero the left meter.
- 7) Apply a 400 Hz tone from the Audio Generator to J1 Comp. Input). Set audio generator for approximately 1V p-p. Set R1 (Comp. Level) to full clockwise.
- 8) Depress TOTAL, PILOT and adjust A5R19 for 100% on left meter.
- 9) Increase frequency, meter should read 100% to beyond 75KHz (Note: Be sure of flatness of your Audio Generator.)
- 10) Depress 38KHz, TOTAL and adjust A3R19 for 100% on right meter.
- 11) Repeat Step 9.
- 12) Set Audio Generator to 400 Hz. Depress L+R, L-R. Adjust A1R13 until left meter reads 100%.
- 13) Reduce input level by exactly 10 db, turn TEST switch CCW to -10 dB position. Adjust A4R12 until left meter reads 0 db (100%). Reduce level in 10 db steps while rotating TEST switch CCW to check attenuator.
- 14) Set Audio Generator to 40 KHz (1v p-p). Adjust A1R10 until right meter reads 100%.
- 15) Repeat Step 13 except adjust A2R12 until right meter reads 0 db (100%).
- 16) Set audio generator to 400 Hz (1v p-p). Depress LEFT, RIGHT button. Adjust A1R3 until left meter reads 100%. Adjust A1R5 until right meter reads 100%.
- 17) Set Audio Generator to exactly 19 KHz. Reduce input level by exactly 20 dB. Depress TOTAL, PILOT. Adjust A8R3 until right meter reads 100% (10% pilot injection).
- 18) Reduce input level until right meter reads 4% injection. Adjust A8R9 until pilot lamp just lights.
- 19) Set Audio Generator for exactly 38KHz (1v p-p). Depress 38 KHz, TOTAL button. Adjust A1R20 until left meter reads 100%.
- 20) Apply output of your stereo generator to J1 of Stereo Monitor. Depress TOTAL, PILOT button and adjust A1R1 until proper pilot level is noted on right meter.
- 21) Phase calibrate the monitor as described in Section 3-4.

- 22) Apply a left only signal (400 Hz) to the unit. Connect the output of the Stereo Generator to an oscilloscope. Inject a signal into the right channel that is 30 db below the left channel. Note the separation on the scope. Now change the phase of the right channel signal, the separation should be the same. If it is different, the Stereo Generator needs adjustment. When this is set up, apply signal to the monitor. Read the L into R separation and adjust A6R6 so that 30 db separation is indicated with either phase of the right channel applied.
- 23) Repeat step 22 except use a right only signal and inject a signal 30 db down into the left channel. Adjust A6R20 for balance.



## SECTION 6

## PARTS LISTS

<u>REF</u>	<u>DES</u>	<u>DESCRIPTION</u>	<u>PART NO.</u>
A1		Assembly, Chassis	
C1		C: Elect 100uf 12V min	110-3107-
C2		" Cer .01 uf 1KV	110-0103-K
C3		" " " "	110-0103-K
C4		" " " "	110-0103-K
C5		" " " "	110-0103-K
C6		" " " "	110-0103-K
C7		" " " "	110-0103-K
C8		" " " "	110-0103-K
C9		" " " "	110-0103-K
C10		" Elect 5000uf 25V min	110-3508
C11		" " " "	110-3508
CR1		D: Bridge Rectifier	113-1000
CR2		" Light Emitting	113-3000
DS1		Lamp: Incandescent	117-0001
F1		Fuse: $\frac{1}{2}$ A SB	120-0001
F2		" "	120-0004
FL1		Filter: L and R	QEI P/N L15K6B
FL2		" L&R 38KHz	QEI P/N L15B38K6
FL3		" L-R	QEI P/N B2353K6
J1		Jack: BNC	130-0001
J2		" "	130-0001
J3		" Power Input	130-5000
J4		" BNC	130-0001
J5		" "	130-0001
J6		" "	130-0001
M1		Meter: Modulation	145-0002
M2		" Modulation & Pilot	145-0005
R1		R: Var 10K	RV4LAYS A103A
R2		" " 1K	RA2ONASD102A
R3		" " 250 ohm	167-0002
R4		" Carb 390 ohm $\frac{1}{2}$ W 5%	RC20GF391J
R5		" Var 250 ohm	167-0002
R6		" Carb 390 ohm	RC20GF391J
R7		" " 620 ohm	RC20GF621J
R8		" " " "	RC20GF621J
R9		" " 560 ohm	SELECT
R10		" Var 250 ohm	167-0002
R11		" Carb 390 ohm	SELECT
R12		" " 620 ohm	RC20GF621J
R13		" Var 250 ohm	167-0002
R14		" Carb 390 ohm	RC20GF391J
R15		" Neg Temp Coef.	168-0001
R16		" Carb	SELECT
R17		" Neg Temp Coef.	168-0001
R18		" Carb	SELECT
R19		" " 330 ohm	SELECT
R20		" Var 250 ohm	167-0002
S1		Switch: PB P/O XDS1	192-1001
S2		" DPDT	175-0003
S3		" Rotary 4P 11 pos.	175-1002

<u>REF</u>	<u>DES</u>	<u>DESCRIPTION</u>	<u>PART NO.</u>
S4		Switch: DPDT	175-0003
T1		Transformer: Power 115/230-26 CT	180-0002
TB1		Terminal Board 13 pt.	181-0013
U1		IC: Voltage Regulator	182-1461/1469
XDS1		Socket	192-1001
SF1		Fuseholder	193-0001
XF2		Fuseholder	193-0001
A1A1		Assembly, "Mother" Board	
A1C1		C: Mica 5pf DM15	110-1050
A1C2		" Cer .001uf	110-0102
A1C3		" Mica DM15	SELECT
A1C4		" Elect 15uf 6V min	110-3156-
A1C5		" " " "	110-3156-
A1C6		" " 100uf 16V min	110-3107-
A1C7		" " " "	110-3107-
A1C8		" Cer .1uf 16V	110-0104
A1C9		" Elect 100uf 16V min	110-3107-
A1C10		" Cer .1uf 16V	110-0104
A1CR1		D: Silicon	113-0002
A1CR2		" "	113-0002
A1CR3		" "	113-0002
A1CR4		" " Zener 5.6V 400mw.	113-2056
A1Q1		Transistor, Silicon NPN	160-0002
A1Q2		" " "	160-0002
A1Q3		" " PNP	160-0004
A1Q4		" " NPN	160-0002
A1Q5		" " PNP	160-0004
A1Q6		" " "	160-0004
A1Q7		" " NPN	160-0001
A1Q8		" " "	160-0002
A1Q9		" " "	160-0001
A1R1		R: Carb 470 ohm $\frac{1}{2}$ W 5%	RC20GF471J
A1R2		" " 4.7K "	RC20GF472J
A1R3		" " 1.5K "	RC20GF152J
A1R4		" " 100 ohm "	RC20GF101J
A1R5		" " 22K "	RC20GF223J
A1R6		" " 1.5K "	RC20GF152J
A1R7		" " 220 ohm "	SELECT
A1R8		" " 51 ohm "	RC20GF510J
A1R9		" " 4.7 ohm "	RC20GF4R7J
A1R10		" " " "	RC20GF4R7J
A1R11		" " 51 " "	RC20GF510J
A1R12		" " 1K "	RC20GF102J
A1R13		" " 68 ohm 2W 10%	RC42GF680J
A1R14		" " " "	RC42GF680J
A1R15		" " 1.2K $\frac{1}{2}$ W 5%	RC20GF122J
A1R16		" " 1K "	SELECT
A1R17		" " 2.2K "	RC20GF222J
A1R18		" " 10K "	RC20GF103J
A1R19		" " " "	RC20GF103J
A1R20		" " 2.2K "	RC20GF222J
A1R21		" " 15K "	RC20GF153J



<u>REF DES</u>	<u>DESCRIPTION</u>	<u>PART NO.</u>
A1R22	R: Carb 4.7K $\frac{1}{2}$ W 5%	RC20GF472J
A1R23	" " 2.7K "	RC20GF272J
A1R24	" " 680 ohm $\frac{1}{2}$ W 5%	RC20GF681J
A1R25	" " 100 ohm "	RC20GF101J
A1R26	" WW .56 ohm 3W 10%	166-0056
A1R27	" " " "	166-0056
A1R28	" Carb 6.8K $\frac{1}{2}$ W 5%	RC20GF682J
A1R29	" " 18K "	SELECT
A1R30	" " 4.7K "	RC20GF472J
A1R31	" " 10K "	RC20GF103J
A1R32	" " " "	RC20GF103J
A1R33	" " 270 ohm "	RC20GF271J
A1R34	" WW 40 ohm 3W 10%	166-0400
A1R35	" Carb 1K $\frac{1}{2}$ W 5%	RC20GF102J
ALS1	Switch: Function P.B.	175-0002
A2-A4	Assembly, Printed Ckt.	7713004
A_C1	C: Cer 0.1uf	110-0104
A_C2	" " "	110-0104
A_C3	" Mica 10pf	110-1100
A_C4	" " 470pf	110-1471
A_C5	" " 10pf	110-1100
A_C6	" Elect 100uf 16V	110-3107-15
A_C7	" " 15uf 15V	110-3156-15
A_C8	" " 50uf 25V	110-3506-25
A_C9	" " 100uf 16V	110-3107-15
A_R1	R: Carb 47K $\frac{1}{2}$ W 5%	RC20GF473J
A_R2	" " 13K "	SELECTED
A_R3	" " 10K "	RC20GF103J
A_R4	" " 1K "	RC20GF102J
A_R5	" " 47K "	RC20GF473J
A_R6	" " 212K "	RC20GF222J
A_R7	" " 470K "	RC20GF474J
A_R8	" " 1K "	RC20GF102J
A_R9	" " 1K "	RC20GF102J
A_R10	" " 10K "	RC20GF103J
A_R11	" Prec 23.7K $\frac{1}{4}$ W 1%	165-2372
A_R12	" Var 1K	167-3001
A_R13	" Carb 2.2K $\frac{1}{2}$ W 5%	RC20GF222J
A_R14	" " 10K "	RC20GF102J
A_R15	" Prec 11K $\frac{1}{4}$ W 1%	165-1102
A_R16	" " 2.67K "	165-2671
A_R17	" " 760 ohm "	165-7600
A_R18	" " 226 ohm "	165-2260
A_R19	" " 73.2 ohm "	165-73R2
A_R20	" Carb 5.6K $\frac{1}{2}$ W 5%	RC20GF562J
A_R21	" " 2.2K "	RC20GF222J
A_R22	" " 27K "	RC20GF273J
A_R23	" " 27K "	RC20GF273J
A_R24	" " 15K "	RC20GF153J
A_R25	" " 5.6K "	RC20GF562J
A_R26	" " 1K "	RC20GF102J
A_R27	" " 10K "	RC20GF103J
A_R28	" Var 10K	167-3002

<u>REF DES</u>	<u>DESCRIPTION</u>	<u>PART NO.</u>
A_R29	R: Carb 47K $\frac{1}{2}$ W 5%	RC20GF473J
A_R30	" " 2.2K "	RC20GF222J
A_Q1	Transistor: Silicon NPN	160-0002
A_Q2	" " " "	160-0002
A_Q3	" " PNP	160-0004
A_Q4	" " NPN	160-0002
A_Q5	" " " "	160-0002
A_Q6	" " PNP	160-0004
A_Q7	" " NPN	160-0002
A_Q8	" " " "	160-0002
A_U1	IC: Op Amp	182-1741
A3-A5	Assembly, Printed Ckt.	7713014
A_C1	C: Elect 15uf 15V	110-3156-15
A_C2	" Poly 3000pf	110-4302
A_C3	" Mica 250pf	110-1251
A_C4	" " 5pf	110-15R0
A_C5	" " 250pf	110-1251
A_C6	" " 5pf	110-15R0
A_C7	" Elect 2.2uf 15V min	110-3225
A_C8	" Film .22uf	110-5224
A_CR1	D: Silicon	113-0002
A_CR2	" " "	113-0002
A_CR3	" Schottky	113-0005
A_CR4	" " "	113-0005
A_CR5	" Ge	113-0003
A_Q1	Transistor: Silicon NPN	160-0002
A_Q2	" " " PNP	160-0004
A_R1	R: Carb 4.7K $\frac{1}{2}$ W 5%	RC20GF472J
A_R2	" " 1K "	RC20GF102J
A_R3	" " 22K "	RC20GF223J
A_R4	" " 8.2K "	RC20GF822J
A_R5	" " 100K "	RC20GF104J
A_R6	" " 1.5K "	RC20GF152J
A_R7	" " 10K "	RC20GF103J
A_R8	" " 220 ohm "	RC20GF221J
A_R9	" " 6.8K "	RC20GF682J
A_R10	" " " "	RC20GF682J
A_R11	" " 470 ohm "	RC20GF471J
A_R12	" " 4.7K "	RC20GF4R7J
A_R13	" " " "	RC20GF4R7J
A_R14	" " 620 ohm "	RC20GF621J
A_R15	" " 470 ohm "	RC20GF471J
A_R16	" " 10K "	RC20GF103J
A_R17	" " 8.2K "	RC20GF822J
A_R18	" " 1.5K "	RC20GF152J
A_R19	" Var 10K	167-3002
A_R20	" Carb 27K	RC20GF273J
A_R21	" " 1.5K	RC20GF152J
A_R22	" " 10K	RC20GF103J
A_R23	" " 10M	SELECTED
A_R24	" " 130 ohm	RC20GF131J
A_R25	" " 27K	SELECTED

<u>REF DES</u>	<u>DESCRIPTION</u>	<u>PART NO.</u>
A6R16	R: Carb 10K $\frac{1}{2}$ W 5%	RC20GF103J
A6R17	" " 5.1K "	RC20GF512J
A6R18	" " 1.2K "	RC20GF122J
A6R19	" " 33K "	SELECT
A6R20	" Var 25K	167-3004
A6R21	" Carb 3.3K "	RC20GF332J
A6R22	" " 10K "	RC20GF103J
A6R23	" " 10K "	RC20GF103J
A6R24	" " 100K "	RC20GF104J
A6R25	" " 2.2M "	RC20GF225J
A6R26	" " 100K "	RC20GF104J
A6R27	" " 100K "	RC20GF104J
A6R28	" " 4.7K "	RC20GF472J
A6R29	" " 10K "	RC20GF103J
A6R30	" " 470K "	RC20GF474J
A6U1	IC: Op Amp	182-1741
A6U2	IC: Op Amp	182-1741
A7	Assembly, Printed Ckt.	7713003
A7C1	C: Elect 5uf 15V min	110-3505
A7C2	" Poly 3000pf	110-4302
A7C3	" Elect luf	110-3105
A7C4	" Mica 120pf	110-1121
A7C5	" Elect luf	110-3105
A7C6	" Mica 120pf	110-1121
A7C7	" " "	110-1121
A7CR1	D: Silicon	113-0002
A7R1	R: Carb 4.7K $\frac{1}{2}$ W 5%	RC20GF472J
A7R2	" " " "	RC20GF472J
A7R3	" " 10K "	RC20GF103J
A7R4	" " 33K "	RC20GF333J
A7R5	" " 6.8K "	RC20GF682J
A7R6	" " 2.2M "	RC20GF225J
A7R7	" " 15K "	RC20GF153J
A7R8	" " 1.2K "	RC20GF122J
A7R9	" " 47K "	RC20GF473J
A7R10	" " 1.2K "	RC20GF122J
A7R11	" " 10K "	RC20GF103J
A7R12	" " 33K "	RC20GF333J
A7R13	" " 100 ohm "	RC20GF101J
A7R14	" " 4.7K "	SELECTED
A7R15	" " 15K "	RC20GF153J
A7Q1	Transistor: Silicon PNP	160-0004
A7U1	IC: Quad 2 input NAND	182-7400
A7U2	" Phase Detector	182-4044
A7U3	" Op Amp	182-1741
A7U4	" VCO	182-4024
A7U5	" Decade Counter	182-7490
A7U6	" " "	182-7490
A7U7	" Flip Flop	182-7474
A7U8	" Comparator	182-1710

<u>REF DES</u>	<u>DESCRIPTION</u>	<u>PART NO.</u>
A_R26	R: Carb 130 ohm 1/2W 5%	RC20GF131J
A_R27	" Var 10K	167-3002
A_R28	" Carb 100K "	RC20GF104J
A_R29	" " 10K "	RC20GF103J
A_R30	" " 1K "	RC20GF102J
A_U1	IC: Op Amp	182-1709
A_U2	" " "	182-1741
A_U3	" " "	182-1709
A6	Assembly, Printed Ckt.	7713005
A6C1	C: Elect 200uf 12V min	110-3207
A6C2	" " " "	110-3207
A6C3	" " 100uf "	110-3107
A6C4	" Mica 10pf DM15	110-1100
A6C5	" " 10pf "	110-1100
A6C6	" Elect .47uf	110-3474
A6C7	" Cer .1uf	110-0104
A6C8	" Poly 3000pf	110-4302
A6C9	" Elect 5uf 15V min	110-3505
A6C10	" Cer .05uf	110-0503
A6C11	" Mica DM15	SELECT
A6C12	" " "	SELECT
A6C13	" Elect 100uf 16V min	110-3107
A6CR1	D: Silicon	113-0002
A6CR2	D: "	113-0002
A6CR3	" "	113-0002
A6CR4	" "	113-0002
A6CR5	" "	113-0002
A6CR6	" "	113-0002
A6Q1	Transistor, Silicon PNP	160-0004
A6Q2	" " "	160-0004
A6Q3	" " PNP	160-0004
A6Q4	" " NPN	160-0002
A6Q5	" " "	160-0002
A6Q6	" " PNP	160-0004
A6Q7	" " NPN	160-0002
A6Q8	" " "	160-0002
A6Q9	" " PNP	160-0004
A6R1	R: Carb 15K 1/2W 5%	RC20GF153J
A6R2	" " 4.7K "	RC20GF472J
A6R3	" " 1K "	RC20GF102J
A6R4	" " 8.2K "	RC20GF822J
A6R5	" " 33K "	SELECT
A6R6	" Var 25K	167-3004
A6R7	" Carb 5.1K "	RC20GF512J
A6R8	" " 10K "	RC20GF103J
A6R9	" " 1.2K "	RC20GF122J
A6R10	" " 10K "	RC20GF103J
A6R11	" " 15K "	RC20GF153J
A6R12	" " 10K "	RC20GF103J
A6R13	" " 4.7K "	RC20GF472J
A6R14	" " 1K "	RC20GF102J
A6R15	" " 8.2K "	RC20GF822J

<u>REF DES</u>	<u>DESCRIPTION</u>	<u>PART NO.</u>
A8	Assembly, Printed Ckt.	7713002
A8C1	C: Cer 0.1uf	110-0104
A8C2	" Poly 0.01uf	110-4103
A8C3	" " or Mica 510pf	110-4511 or 110-1511
A8C4	" " 0.01uf	110-4103
A8C5	" " or Mica 510pf	110-4511 or 110-1511
A8C6	" " 0.01uf	110-4103
A8C7	" Elect 1.0uf	110-3105
A8C8	" Cer 0.01uf	110-0103
A8C9	" Elect 1.0uf	110-3105
A8C10	" Mica 120pf	110-1121
A8C11	" " 120pf	110-1121
A8C12	" Cer 0.01uf	110-0103
A8C13	" Elect 0.22uf	110-3224
A8C14	" Poly 3000pf	110-4302
A8C15	" Cer 0.1uf	110-0104
A8C16	" Mica 120pf	110-1121
A8C17	" " "	110-1121
A8CR1	D: Silicon	113-0002
A8CR2	" "	113-0002
A8L1	Inductor: Filter	140-1600
A8L2	" "	140-1600
A8L3	" "	140-1600
A8Q1	Transistor: Silicon NPN	160-0002
A8Q2	" " NPN	160-0002
A8Q3	" " "	160-0002
A8Q4	" " JFET N Channel	160-1000
A8Q5	" " " " "	160-1000
A8R1	R: Carb	SELECTED
A8R2	" " 15K $\frac{1}{2}$ W 5%	RC20GF153J
A8R3	" Var 1K	167-3001
A8R4	" Carb 820 ohm "	RC20GF821J
A8R5	" " 470 ohm "	RC20GF471J
A8R6	" " 10K "	RC20GF103J
A8R7	" " 1.2K "	RC20GF122J
A8R8	" " 33K "	RC20GF333J
A8R9	" Var 10K	167-3002
A8R10	" Carb 100 ohm "	RC20GF101J
A8R11	" " 1.5K "	RC20GF152J
A8R12	" " 1K "	RC20GF102J
A8R13	" " 1K "	RC20GF102J
A8R14	" " 2.2K "	RC20GF222J
A8R15	" " 10K "	RC20GF103J
A8R16	" " 3.3K "	RC20GF332J
A8R17	" " 3.3K "	RC20GF332J
A8R18	" " 1.2K "	RC20GF122J
A8R19	" " 1.2K "	RC20GF122J
A8R20	" " 1.2K "	RC20GF122J
A8R21	" " 100 ohm "	RC20GF101J
A8R22	" " 100K "	RC20GF104J
A8R23	" " 10K "	RC20GF103J
A8R24	" "	SELECTED
A8U1	IC: Comp	182-1710
A8U2	" "	182-1710

SECTION 7

SCHEMATICS