BELAR

Broadcast Equipment

FMS-1
STEREO MONITOR

WARRANTY AND ASSISTANCE

All Belar products are warranted against defects in materials and workmanship. This warranty applies for one year from the date or delivery, or, in the case of certain major components listed in the instruction manual, for the specified period. Belar will repair or replace products which prove to be defective during the warranty period provided that they are returned to Belar. No other warranty is expressed or implied. Belar is not liable for consequential damages.

For any assistance, contact either your Belar Sales Representative or Customer Engineering Service at the Belar factory.

Broadcast Equipment

Instructions

FMS-1
Stereo Monitor

BELAR ELECTRONICS LABORATORY, INC.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

SECTION 1

GENERAL INFORMATION

1—1 GENERAL DESCRIPTION

The Belar FMS—1 Stereo Frequency and Modulation Monitor (FCC Type Approval Number 3—146), Figure 1—1, is an all solid state stereo demodulator designed to operate in conjunction with the Belar FMM—1 Frequency and Modulation Monitor to provide all of the stereo monitoring requirements outlined in Part 73 of the Federal Communications Commission's Rules and Regulations for FM radio stations engaged in multiplex stereophonic programming. In addition, the FMS—1 may be used as a low distortion, low noise FM stereo demodulator for driving audio monitors and associated test equipment. The FMS—1, used in conjunction with the FMM—1, provides complete monitoring and test functions to meet the daily requirements for stereo monitoring and provides additional facilities for proof-of-performance measurements and for making the proper tests for weekly and monthly maintenance checks to insure maximum performance from stereo transmitters.

1—2 PHYSICAL DESCRIPTION

The FMS—1, Figure 1—2, is constructed on a standard 5¼ x 19-inch rack mount. Seldom used controls and test points are located under the hinged front cover bar. Factory adjustments are located within the unit and on the back panel. The baseband input, power connections, and monitor outputs are located at the rear of the FMS—1 chassis on individual connectors and rear terminal block as shown in Figure 1—3. The FMS—1 is completely solid state utilizing all silicon transistors for long, trouble-free life. The individual circuits are constructed on three military grade, glass-epoxy, plated printed circuit boards. High reliability industrial and military grade components are used throughout.

1—3 ELECTRICAL DESCRIPTION

The FMS—1 is a solid state stereo demodulator to accurately demodulate a stereo composite baseband signal. The pilot phase regeneration system utilizes a phase discriminator so that a null reading is obtained with the correct phase, allowing the phase to be regenerated to within ¼ degree. Various metering and testing provisions are contained within the monitor to measure stereo output characteristics. These provisions include a 19 kHz pilot center frequency deviation meter; a peak reading modulation meter; an average reading sensitive voltmeter; a function switch to measure total modulation, (L+R) modulation, (L-R) modulation, pilot modulation, left channel modulation, right channel modulation, 38 kHz

Figure 1—1

suppression, FM noise, AM noise, and incidental AM noise. Outputs obtained from the monitor include individual left and right channel distortion meter test outputs (both aural outputs and distortion meter outputs have front panel switched de-emphasis), oscilloscope output that follows the sensitivity of the average voltmeter, and pilot indicator for automatic logging. FCC Type Approved remote metering of the FMS–1 may be externally provided for the pilot center frequency deviation meter and modulation meter.

As a test instrument, the FMS–1 permits the measurement of:

1. Incidental AM
2. AM Noise
3. Pilot Phase
4. Crosstalk into the (L+R) Channel
5. Crosstalk into the (L–R) Channel
6. Suppression of the 38 kHz Carrier
7. Separation–Right into Left Channel
8. Separation–Left into Right Channel
9. Intermodulation
10. Distortion of the Left Channel
11. Distortion of the Right Channel
12. Noise of the Left Channel
13. Noise of the Right Channel
14. Response of the Left Channel
15. Response of the Right Channel

1–4 ELECTRICAL SPECIFICATIONS

Pilot Frequency Meter Range	± 3 Hz
Pilot Frequency Meter Accuracy	± 0.2 Hz (0.001%)
Modulation Meter Range	133% to –70 db
Modulation Meter Accuracy	Better than 5% over entire scale
Frequency Response (L and R)	± 0.5 db 50–15000 Hz
Separation	45 db (50–15000 Hz) (Meter range –70 db)
Crosstalk	60 db (L+R) to (L–R) 60 db (L–R) to (L+R) 66 db SCA to (L+R), (L–R)
Outputs	
Left & Right Channel Monitoring	600 Ohms, unbalanced
Left & Right Channel Test	10K, unbalanced
Oscilloscope	10K, unbalanced
Distortion (Either Channel)	0.2%
Signal-to-Noise Ratio (Either Channel)	70 db with 75 usec de-emphasis

Monitoring Modes (Modulation Meter Switched, 133% to –70 db)
Left Channel Audio, Right Channel Audio, (L+R), (L–R), 38 kHz (May be measured with modulating frequencies greater than 5 kHz), 19 kHz Pilot Injection (12% full scale), Total Modulation, FM Noise, AM Noise, Inc. AM.

Remote Metering . . . . Both pilot frequency and modulation meters may be remotely metered, 5000 Ohms external loop resistance

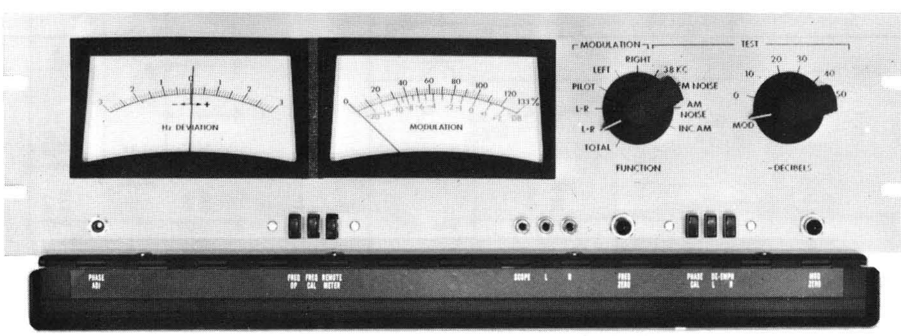


Figure 1–2

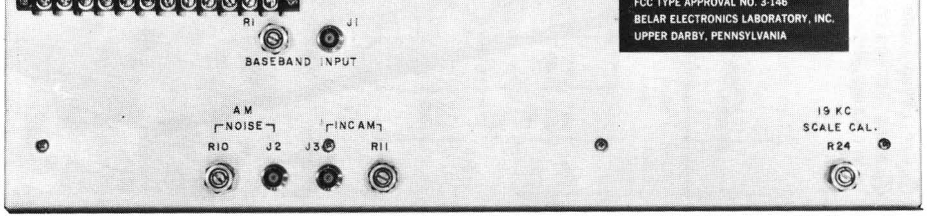


Figure 1–3

1–5 MECHANICAL SPECIFICATIONS

Dimensions	5¼ x 19 x 11 7/8 inches overall
Detailed Dimensions	Figure 1–4
Net Weight	12 pounds
Shipping Weight	16 pounds

1–6 INSTRUMENT IDENTIFICATION

The instrument is identified by the model number and a six digit serial number. The model number and serial number appear on a plate located on the rear panel, Figure 1–3. All correspondence to your Belar representative or to the Belar factory in regard to the instrument should reference the model number and complete serial number.

1–7 ACCESSORIES

The Belar FMS–1 Stereo Frequency and Modulation Monitor may be used for the remote monitoring of a stereo FM transmitter with the Belar MP–2 Remote Meter Panel. The MP–2 Remote Meter Panel contains a pilot frequency deviation meter and a modulation meter, both designed for 5000 ohms loop resistance.

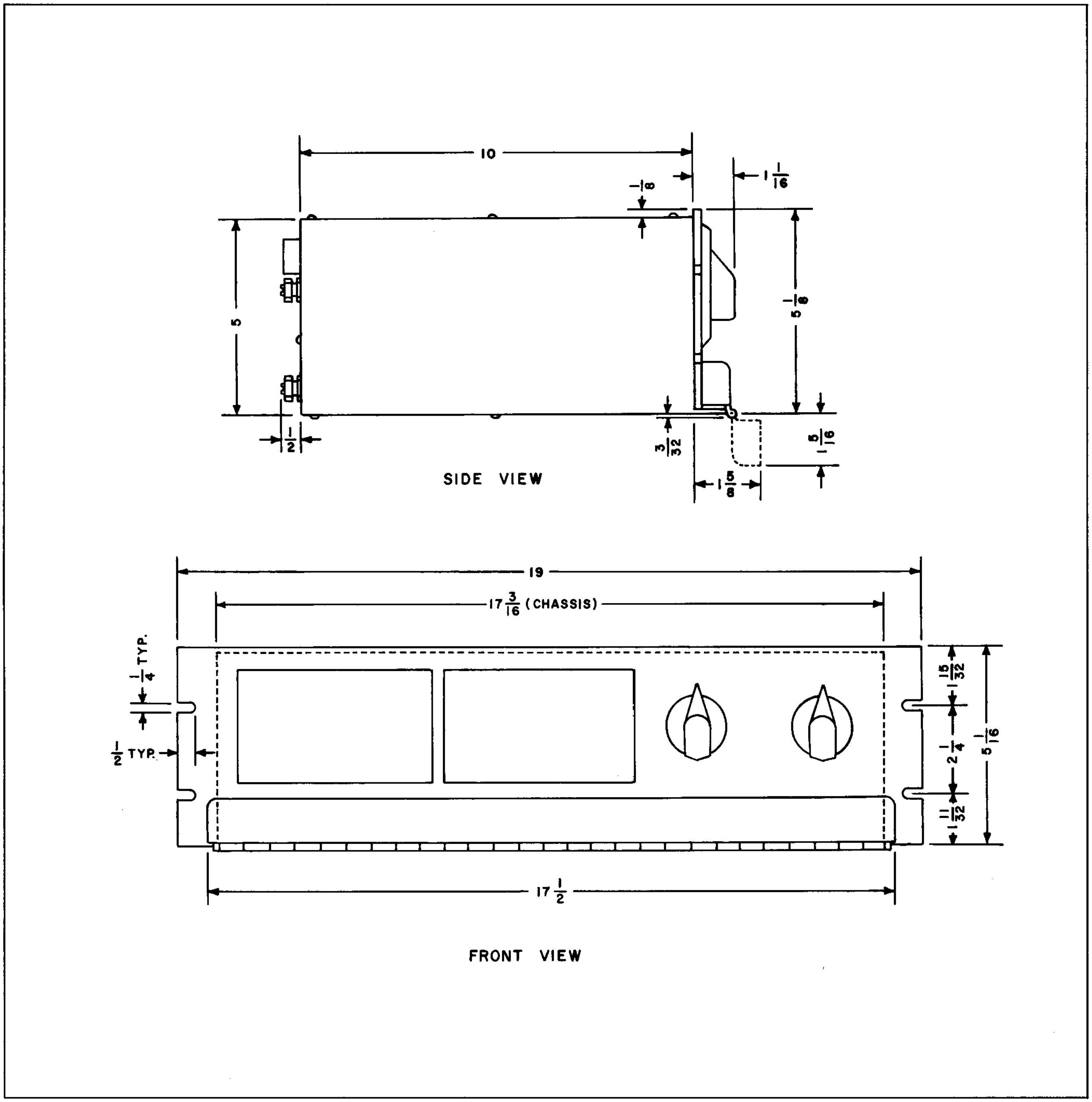


Figure 1–4

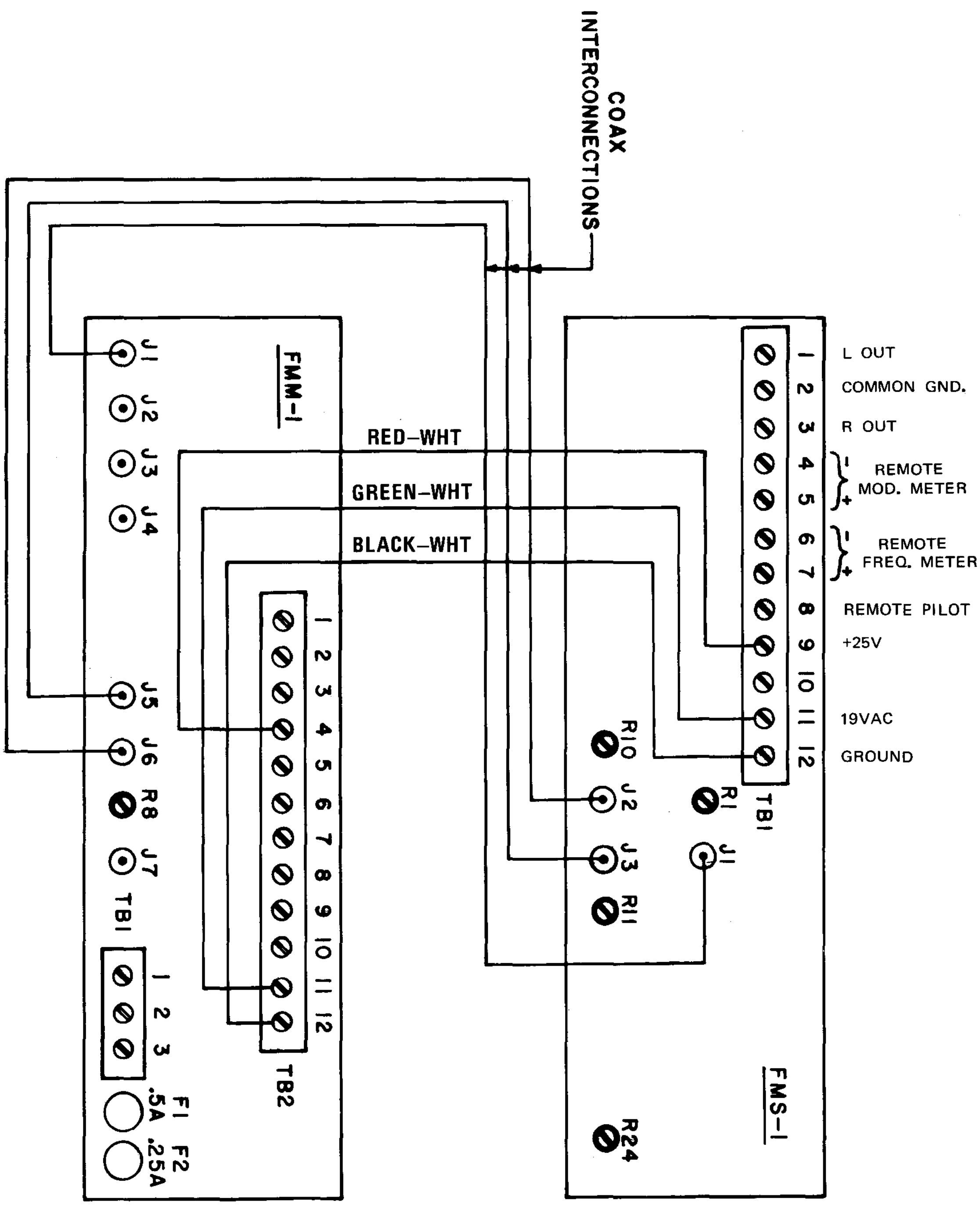

COAX
INTERCONNECTIONS
FMM-1
J1
J2
J3
J4
J5
J6
R8
J7
TB1
TB2
F1 .5A
F2 .25A
RED-WHT
GREEN-WHT
BLACK-WHT
FMS-1
R10
R1
R11
R24
TB1
L OUT
COMMON GND.
R OUT
REMOTE MOD. METER
REMOTE FREQ. METER
REMOTE PILOT
+25V
19VAC
GROUND

Figure 2—1

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's agent to be present when the unit is unpacked. Carefully unpack the unit to avoid damaging the equipment through use of careless procedures. Inspect all equipment for physical damage immediately after unpacking. Bent or broken parts, dents and scratches should be noted. If damage is found, refer to Paragraph 2–2 for the recommended claim procedure. Keep all packing material for proof of damage claim or for possible future use.

2–2 CLAIMS

If the unit has been damaged, notify the carrier immediately. File a claim with the carrier or transportation company and advise Belar of such action to arrange the repair or replacement of the unit without waiting for a claim to be settled with the carrier.

2–3 REPACKING FOR SHIPMENT

If the unit is to be returned to Belar, attach a tag to it showing owner and owner's address. A description of the service required should be included on the tag. The original shipping carton and packaging materials should be used for reshipment. If they are not available or reusable, the unit should be repackaged in the following manner:

a. Use a double-walled carton with a minimum test strength of 275 pounds.

b. Use heavy paper or sheets of cardboard to protect all surfaces.

c. Use at least 4 inches of tightly packed, industry approved, shock absorbing material such as extra firm polyurethane foam or rubberized hair. NEWSPAPER IS NOT SUFFICIENT FOR CUSHIONING MATERIAL!

d. Use heavy duty shipping tape to secure the outside of the carton.

e. Use large FRAGILE labels on each surface.

f. Return the unit, freight prepaid, via air freight. Be sure to insure the unit for full value.

2–4 PREPARATION FOR USE

The FMS–1 Stereo Frequency and Modulation Monitor is designed to be mounted in a standard 19-inch rack mount. The monitor may be mounted below the companion Model FMM–1 FM Frequency and Modulation Monitor. When the monitor is mounted above high heat generation equipment such as vacuum-tube power supplies, consideration should be given to cooling requirements which allow a free movement of cooler air around the FMS–1. In no instance should the ambient chassis temperature be allowed to rise above 50 degrees C (122 degrees F). Mount the FMS–1 to the rack mount using four No. 10 screws and four No. 10 countersunk finishing washers.

The Model FMS–1 derives its power from the Model FMM–1. The FMS–1 also derives the baseband signal and AM signals from the FMM–1. Interconnect the FMS–1 to the FMM–1 with the cables supplied as shown in Figure 2–1 – that is, connect an 18-inch 75 ohm coaxial cable (RG–59) between the wideband output jack (J–1) of the FMM–1 Frequency and Modulation Monitor and the composite input jack (J–1) of the FMS–1 Stereo Monitor; connect an 18-inch 75 ohm coaxial cable (RG–59) between the INC AM jack (J–5) of the FMM–1 and the INC AM jack (J–3) of the FMS–1; connect an 18-inch 75 ohm coaxial cable (RG–59) between the AM NOISE jack (J–6) of the FMM–1 and the AM NOISE jack (J–2) of the FMS–1; connect the red-white lead between TB2–4 of FMM–1 and TB1–9 of FMS–1; connect the green-white lead between TB2–11 of FMM–1 and TB1–11 of FMS–1; and connect the black-white lead between TB2–12 of FMM–1 and TB1–12 of FMS–1.

CAUTION: DO NOT SHORT TERMINALS 9 and 11 TO GROUND.

If desired, connect external aural left and right channel monitoring amplifiers to terminals 1, 2 and 3 on TB1. Note that these are unbalanced 600 ohm outputs with terminal 2 being the common ground. A remote pilot center frequency deviation meter and remote modulation meter may be connected to terminals 6, 7 and 4, 5 respectively, if desired. Observe the proper polarities (5 and 7 are positive) and note that the external loop resistance not including meters must be 5000 ohms. These meters must be obtained from BELAR in order to comply with FCC regulations on remote metering. The remote meters are contained in the Remote Meter Panel MP–2.

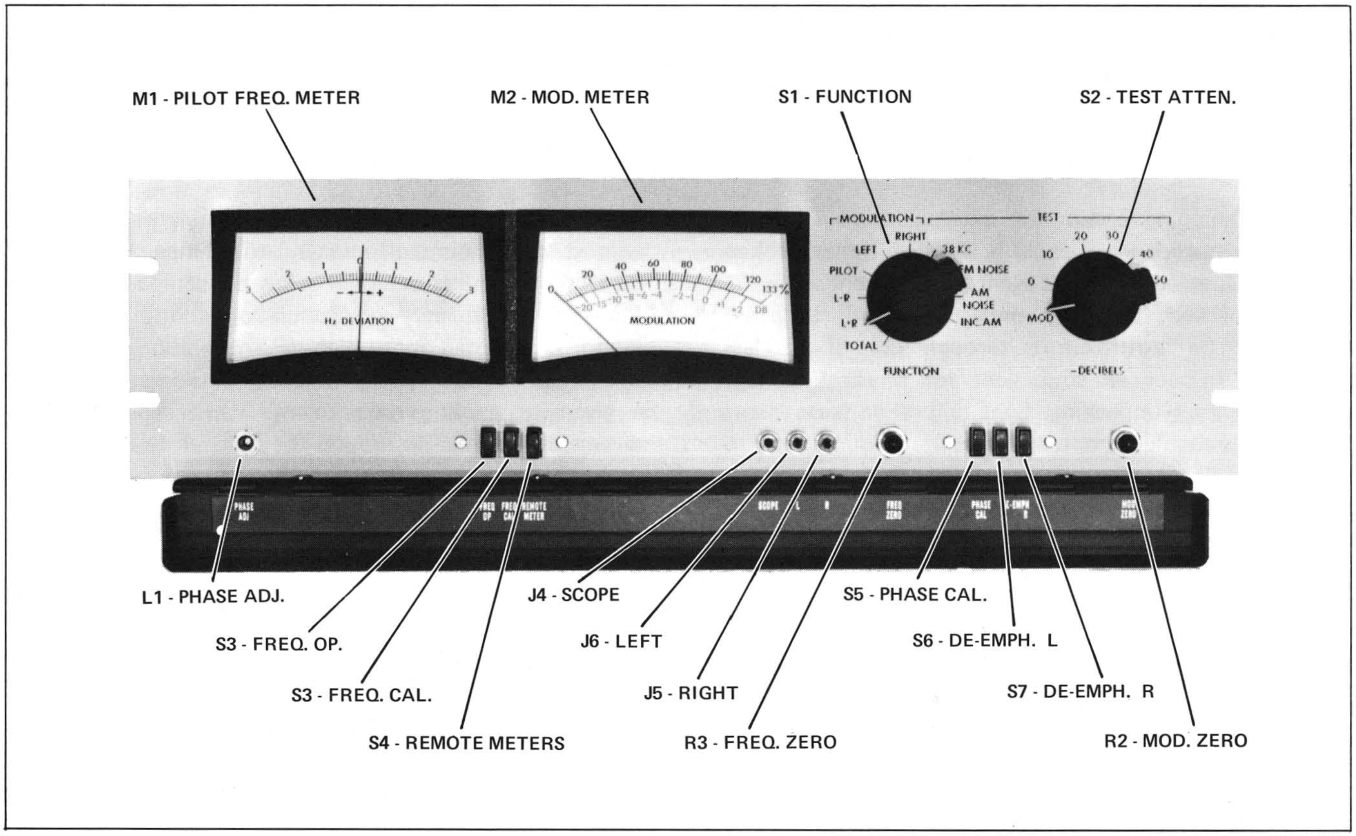


Figure 3–1

1. FUNCTION SWITCH–When in TOTAL position, measures the total negative modulation of the baseband including the main channel and all subcarriers. Note that this is the same reading as the reading on the modulation meter on the FMM–1.

2. FUNCTION SWITCH–When in (L+R) position, measures the main channel modulation.

3. FUNCTION SWITCH–When in (L–R) position, measures the stereo subchannel (38 kHz DSB suppressed carrier modulation.

4. FUNCTION SWITCH–When in PILOT position, measures the 19 kHz pilot amplitude.

5. FUNCTION SWITCH–When in LEFT position, measures peak left channel modulation when the test attenuator is in the MOD position. When the test attenuator is in the 0–50 position, the meter reads the average left channel modulation.

6. FUNCTION SWITCH–When in RIGHT position, measures peak right channel modulation when the test attenuator is in the MOD position. When the test attenuator is in the 0–50 position, the meter reads the average right channel modulation.

7. FUNCTION SWITCH–When in 38 kHz position, measures the 38 kHz subcarrier suppression of the balanced modulator. When the monitor is used as an intermodulation analyzer, this position measures the difference products or distortion products in the (L–R) channel.

8. FUNCTION SWITCH–When in FM NOISE position, measures the de-emphasized FM noise of the transmitted baseband signal.

9. FUNCTION SWITCH–When in AM NOISE position, measures the de-emphasized AM noise of the transmitted signal.

10. FUNCTION SWITCH–When in INC. AM position, measures the AM generated by the FM modulation process in the transmitter.

11. METER RANGE SWITCH–When in MOD position, measures the percentage of modulation with the peak reading voltmeter.

12. METER RANGE SWITCH–When in 0 to 50 DECIBELS positions, measures the crosstalk, noise and intermodulation with the average reading voltmeter.

13. FREQUENCY CALIBRATE SWITCH–When depressed, permits the 19 kHz frequency deviation meter to be calibrated.

14. FREQUENCY OPERATE SWITCH–When depressed, places the unit in operation for measurement of the 19 kHz pilot frequency deviation.

15. REMOTE METER SWITCH–When depressed, removes both metering circuits from the remote metering terminals and substitutes the equivalent resistance.

16. PHASE CAL SWITCH–When depressed, places into operation the phase discriminator to calibrate the phase of the monitor regenerated subcarrier with the 19 kHz pilot carrier so that exact zero crossing is obtained.

17. DE–EMPHASIS SWITCH L–When released, removes the 75 usec de-emphasis from the left monitoring amplifier. This is also effective on the left audio output test jack.

18. DE–EMPHASIS SWITCH R–When released, removes the 75 usec de-emphasis from the right monitoring amplifier. This is also effective on the right audio output test jack.

19. PHASE ADJUST–Adjusts the phase of the monitor subcarrier with respect to the 19 kHz pilot carrier.

20. FREQUENCY ADJUST–Adjusts the zero center of the pilot frequency deviation meter.

21. OSCILLOSCOPE TEST JACK–Permits visual observation of the signal selected by the FUNCTION switch.

22. LEFT AUDIO TEST JACK–Permits monitoring of the left audio channel.

23. RIGHT AUDIO TEST JACK–Permits monitoring of the right audio channel.

SECTION 3

OPERATION

3–1 INITIAL OPERATION

The following procedure should be followed for placing the unit into initial operation. Refer to Figure 3–1 for location of the control functions.

1. Place the FMM–1 Frequency and Modulation Monitor into normal operation as outlined in the FMM–1 instruction book.

2. Turn the FMS–1 Stereo Monitor FUNCTION switch to TOTAL and the RANGE switch to MOD positions.

3. On the FMM–1, release the MOD POL switch S4 (negative modulation) and depress the MOD CAL switch.

4. Adjust R1 on the rear of the FMS–1 chassis so that the FMS–1 modulation meter reads 100%. This adjustment will be necessary only during the initial set-up or installation. The modulation percentage meter on both the FMM–1 and the FMS–1 will read 100%. This adjustment standardizes the FMS–1 with the FMM–1.

5. Depress the OP switch on the FMM–1.

6. Place the transmitter into the stereo mode of operation with approximately 9% pilot and WITH NO OTHER MODULATION. Depress the PHASE CAL switch on the FMS–1 and adjust the PHASE control for a minimum reading (null) on the modulation meter. This procedure establishes the exact phase relation between the 19 kHz pilot and the regenerated 38 kHz carrier.

7. On the FMS–1 depress the FREQ CAL switch and adjust the FREQ ZERO potentiometer to read center zero on the pilot frequency deviation meter.

8. Depress FREQ OP switch and the monitors are ready for normal operation.

3–2 NORMAL OPERATION

To monitor normal stereo programming, it is recommended that the FREQ OP switch be left depressed for continuous pilot frequency monitoring. The FUNCTION switch should be turned to the (L–R) position and the RANGE switch turned to the MOD position. Thus the FMM–1 will monitor total modulation and the FMS–1 will monitor the (L–R) or the separation of the stereo program material. Monaural programming should indicate zero and good stereo programming will peak up scale. Note that monaural program material will indicate approximately the same modulation levels on the left and right channel metering positions as with a well balanced stereo program. This is why it is preferable to monitor the (L–R) level which indicates the degree of separation. This also is an easy way to precisely balance the left and right channel levels into a stereo transmitter. If monaural programming is applied to the stereo transmitter, the balance may be adjusted to indicate a minimum (L–R). In this manner, the whole audio-transmitter system becomes dynamically balanced.

3–3 STEREO MEASUREMENTS

The following operating procedures describe methods that may be used to operated each of the functions of the FMS–1 Stereo Monitor. Refer to Figure 3–1 for the location of the front panel controls, etc. Figure 3–1 also gives a brief explanation of the controls.

3–3–1 TOTAL MODULATION

Turn the FUNCTION switch to TOTAL and the RANGE switch to MOD. The FMS–1 measures total negative modulation. If the FMM–1 MOD POL switch is depressed (positive modulation), both positive and negative modulation polarities may be observed simultaneously to check asymmetrical program material and/or stereo modulator unbalance.

3–3–2 LEFT CHANNEL MODULATION

Turn the FUNCTION switch to LEFT and the RANGE switch to MOD. A fully modulated left channel signal will indicate 90% on the modulation meter.

3–3–3 RIGHT CHANNEL MODULATION

Turn the FUNCTION switch to RIGHT and the RANGE switch to MOD. A fully modulated right channel signal will indicate 90% on the modulation meter.

3–3–4 L+R MODULATION

Turn the FUNCTION switch to (L+R) and the RANGE switch to MOD. A fully modulated left channel only signal will indicate 45% on the modulation meter. A fully modulated L=R signal will indicate 90% and a fully modulated L= –R signal will indicate 0.

3–3–5 L–R MODULATION

Turn the FUNCTION switch to (L–R) and the RANGE switch to MOD. A fully modulated left channel only signal will indicate 45% on the modulation meter. A fully modulated L= –R signal will indicate 90% and a fully modulated L=R signal will indicate 0.

3–3–6 PILOT CARRIER MODULATION

Turn the FUNCTION switch to PILOT and the RANGE switch to MOD. The modulation meter indicates pilot modulation level automatically normalized with the 100% reading representing 10% pilot carrier injection. A normal pilot carrier level is 9% (90% on scale) — halfway between the FCC specified 8 to 10%.

3–3–7 38 kHz SUBCARRIER SUPPRESSION

Apply a 5 to 15 kHz modulating signal to either the left or right channel of the stereo transmitter and adjust the level to 90%. Turn the FUNCTION switch to 38 kHz and the RANGE switch from 0 to a position that a reading is obtained on the modulation meter. The algebraic sum of the meter reading and the range switch setting is the 38 kHz subcarrier suppression normalized to 100% total modulation. For example, a meter reading of –8 db and a range switch setting of –40 db yields a 38 kHz suppression of –48 db below 100% modulation.

3–3–8 STEREO SEPARATION

Apply a 50 to 15 kHz modulating signal to the left channel of the stereo transmitter and adjust the level to 90% as read on the modulation meter with the FUNCTION switch turned to LEFT. Now turn the FUNCTION switch to RIGHT and the RANGE switch from 0 to a position that a reading is obtained on the modulation meter. The algebraic sum of the meter reading and the range switch setting is the separation from left channel into right channel, subtracting 1 db from the reading since the left channel was set to 90% (–1 db). For example, a meter reading of –6 db and a range switch setting of –30 db yields –36 db, and subtracting the 1 db (90% left channel level) provides a separation reading of –35 db.

To measure separations at other levels, subtract the level from the algebraic sum of the meter reading and range switch setting. For example, 50% left channel level (–6 db), –1 db meter reading and –40 db range switch setting on the right channel yields a separation reading of –35 db. To measure separation from right channel into left channel, repeat the above measurements applying modulating to the right channel, taking the measurements on the left channel, and substituting right for left and left for right.

3–3–9 CROSSTALK (MAIN TO SUB)

To measure crosstalk from main channel (L+R) into subchannel (L–R), apply an L=R modulating signal to the stereo transmitter and adjust the level for 90% (L+R) reading with the FUNCTION switch turned to (L+R) and the RANGE switch to MOD positions. Now turn the FUNCTION switch to (L–R) and the RANGE switch from 0 to a position that a reading is obtained on the modulation meter. The algebraic sum of the meter reading and the range switch setting is the crosstalk, subtracting 1 db from the reading since the (L+R) was set at 90% (–1 db). Note that since this reading is a function of L being exactly equal to R, the amplitude of one or the other may be adjusted to minimize the reading in the (L–R) channel. Also note that any harmonic distortion in the (L+R) channel may appear as a reading in the (L–R) channel. For example, the second and third harmonics of 15 kHz are 30 and 45 kHz and may appear as a crosstalk reading (2% distortion is only 34 db down).

3–3–10 CROSSTALK (SUB TO MAIN)

To measure crosstalk from subchannel (L–R) into main channel (L+R), apply an L= –R modulating signal to the stereo transmitter and adjust the level for 90% (L–R) reading with the FUNCTION switch turned to (L–R) and the RANGE switch to MOD positions. Now turn the FUNCTION switch to (L+R) and the RANGE switch from 0 to a position that a reading is obtained on the modulation meter. The algebraic sum of the meter reading and the range switch setting is the crosstalk, subtracting 1 db from the reading since the (L–R) was set to 90% (–1 db). Note that since this reading is a function of L being exactly equal to R in amplitude but opposite in phase, the amplitude of one or the other may be adjusted to minimize the reading in the (L+R) channel. Also note that any distortion in the transmitter's stereo modulator may appear as a reading in the (L+R) channel. For example, the second harmonic of a 15 kHz modulating signal has sidebands of 38 kHz 30 kHz so that 8 kHz will be measured in the (L+R) channel.

3–3–11 FM NOISE

Turn the FUNCTION switch to FM NOISE and the RANGE switch from 0 to a position that a reading is obtained. The algebraic sum of the meter reading and the range switch setting is the monaural FM noise. With the transmitter pilot carrier turned off, this is equivalent to the noise on the (L+R) channel. For example, a meter reading of –13 db and a range switch setting of –50 db yields a –63 db FM signal-to-noise ratio.

3–3–12 AM NOISE

Turn the FUNCTION switch to AM NOISE and the RANGE switch from 0 to a position that a reading is obtained. The algebraic sum of the meter reading and the range switch setting is the AM noise reading WHEN THE RF LEVEL IS SET TO 100% on the FMM–1. For example, a meter reading of –5 db and a range switch setting of –50 db yields an AM noise measurements of –55 db.

3–3–13 INCIDENTAL AM

Turn the FUNCTION switch to INC. AM and the RANGE switch from 0 to a position that a reading is obtained. The transmitter is modulated for this measurement. The algebraic sum of the meter reading and the range switch setting is the incidental AM noise. There is no FCC specification on this measurement but it may be used as an aid for proper tuning of an FM transmitter.

If a transmitter is tuned so that the VSWR is a minimum in all of the tuned circuits, the incidental AM will also be a minimum. Conversely, if the transmitter is tuned so that the incidental AM is a minimum, the VSWR is also minimum. A VSWR that is not constant over a bandwidth will cause crosstalk and distortion, hence it is desirable to maintain a low VSWR or low incidental AM.

Using this procedure, apply a 15 kHz modulating signal to the left channel and adjust the level for 90%. Note the INC. AM reading. Change the IPA loading slightly and readjust the IPA tuning for a plate current dip. Note the INC. AM reading. It may have either increased or decreased. Adjust the IPA loading in the direction to obtain a minimum INC. AM reading. Repeat these steps in the remaining coupling stages, i.e., exciter to IPA and final output stage.

3–3–14 FREQUENCY RESPONSE

Frequency response may be measured by applying the modulating signal to the transmitter and measuring the input signal level from the audio oscillator with an AC audio voltmeter, such as one contained in a distortion analyzer. For monaural, adjust the level at 400 Hz to indicate the desired modulation as read on the FMM–1, usually 100%, 50% or 25% modulation. Change the frequency of the audio oscillator to all the frequencies to be measured, adjusting the audio oscillator output to keep the total modulation constant. The AC voltmeter indication of the oscillator output should follow the standard FCC 75 usec de-emphasis. Standard modulating frequencies used are 50, 100, 400, 1000, 5000, 7500, 10,000 and 15,000 Hz.

To measure frequency response of the left and right channels, repeat the above steps, but apply the modulating signal to the left and right channels respectively. Standard levels are 99% (90% signal plus 9% pilot), 59% (50% signal plus 9% pilot), and 34% (25% signal plus 9% pilot). Note that 90% signal plus 9% pilot will not add on total modulation to yield exactly 99%. This is because the peaks of the 19 kHz pilot do not occur simultaneously with the peaks of the 38 kHz double sideband (L–R) signal. The reading is about 1½% lower.

3–3–15 DISTORTION MEASUREMENTS

Distortion measurements may be made by connecting an external distortion analyzer to the L or R output jacks on the front panel and applying a modulating signal to the respective channel of the transmitter. The measurements may be made with de-emphasis by depressing the respective DE-EMPH switch.

Monaural distortion measurements may be made using the AUDIO TEST jack on the FMM–1 monitor in the same manner. De-emphasis is controlled by its DE-EMPH switch.

3–3–16 LEFT CHANNEL NOISE MEASUREMENT

Left channel noise may be measured using the L output jack on the front panel. The measurement may be made with de-emphasis by depressing the L DE-EMPH switch. Apply a 400 Hz modulating signal to the left channel of the transmitter and adjust the level for 100% total modulation. Normalize the voltmeter in the distortion analyzer, remove the modulation and take the noise reading in the conventional manner.

3–3–17 RIGHT CHANNEL NOISE MEASUREMENT

Right channel noise may be measured as in step 3–3–16 and substituting left for right and right for left.

3–3–18 INTERMODULATION

Intermodulation may be measured with FMS–1 by using the internal (L–R) and 38 kHz bandpass filters. The principle of the measurement is that when two tones are used to modulate the transmitter whose stereo modulator is

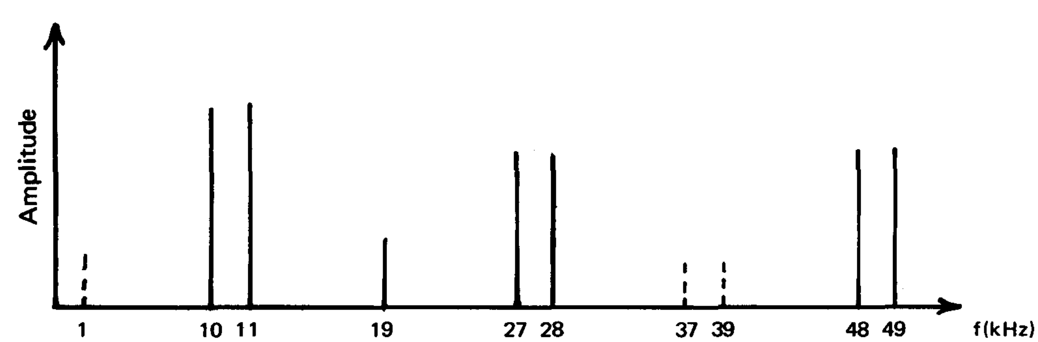


Figure 3–2

non-linear, difference frequencies will be produced that are equal in frequency to the difference between the two modulating frequencies. These difference frequencies appear in the (L+R) channel in addition to appearing as sidebands around the 38 kHz as shown in Figure 3–2.

The ratio of the desired sidebands (due to modulation) to the unwanted sidebands (due to the difference frequencies) is the intermodulation. The amplitudes of the desired sidebands are measured with the (L–R) filter and the amplitudes of the unwanted sidebands are measured with the 38 kHz filter. The frequencies of the two modulating signals must be greater than 5 kHz so that the 38 kHz filter will reject the desired sidebands. The difference between the two modulating signals must be less than 1200 Hz so that the 38 kHz filter will pass the unwanted sidebands.

For example, apply a 10 kHz modulating signal to the left channel, adjusting its level for 90% left channel modulation. Apply an 11 kHz modulating signal to the right channel, adjusting its level for a 90% right channel modulation. Turn the FUNCTION switch to (L–R) and the RANGE switch to 0 and note the reading on the modulation meter. Turn the FUNCTION switch to 38 kHz and the RANGE switch from 0 to a position that a reading is obtained on the modulation meter. The algebraic sum of the meter reading and the range switch setting is the measurement of the unwanted sidebands. The difference between the (L+R) and 38 kHz readings is the ratio between the desired sidebands and unwanted sidebands and is the intermodulation between the left and right channels.

There are no standards for this measurement, but it is a useful test since harmonic distortion of a stereo signal above 5 kHz is filtered out by the 15 kHz filters, rendering a harmonic distortion test invalid.

3–3–19 PHASE CALIBRATE

Place the transmitter into the stereo mode of operation with pilot modulation only. It is important that there is no other modulation present, hence remove audio modulations and any subcarriers if present. Depress the PHASE CAL switch on the FMS–1 and adjust the PHASE control for a minimum reading (null) on the modulation meter. This procedure establishes the exact phase relation between the 19 kHz pilot and the regenerated 38 kHz carrier.

To set the transmitter phase, apply a 400 Hz L= –R modulating signal to the stereo transmitter and adjust the level for 90% (L–R) reading with the FUNCTION switch turned to (L–R) and the RANGE switch turned to MOD. Now turn the FUNCTION switch to either LEFT or RIGHT channel and adjust the transmitter pilot carrier phase for a maximum reading on the modulation meter.

The transmitter phase may also be set by using a left only modulating signal and adjusting the transmitter pilot carrier phase for a maximum reading on the LEFT channel.

3–3–20 PILOT FREQUENCY

Depress FREQ CAL switch and adjust FREQ ZERO potentiometer, R3, to read center zero on the pilot frequency deviation meter. This calibration may be done with program material.

Depress FREQ OP switch and read pilot frequency deviation from 19.0000 kHz.

SECTION 4

PRINCIPLES OF OPERATION

4–1 CIRCUIT DESCRIPTION

Figure 7–4 is the chassis schematic and may be referred to for operation along with the individual card schematics, Figures 7–1, 2 and 3. The incoming stereo composite input is applied to the BASEBAND INPUT J1. Buffer amplifier A2Q1 and Q2 on CARD A2 applies the signal to both the stereo demodulator, on CARD A1, and the FUNCTION switch S1.

The stereo and phase discriminator CARD A1 regenerates the 38 kHz suppressed carrier, demodulates the stereo composite signal with the regenerated subcarrier, and provides phase calibration. The outputs of the stereo demodulator are applied to the left and right channel filters FL1 and FL2, which are in turn applied to the left and right channel monitoring amplifiers on CARD A2. A filtered 19 kHz output is also taken from the A1 card and applied to the FUNCTION switch for pilot amplitude measurement.

The FUNCTION switch S1 selects the particular function to be measured and applies it to the voltmeter circuits on CARD A2. Note that the (L+R), (L–R), and 38 kHz filters as well as the TOTAL modulation potentiometer R4 are disconnected from the circuit when not switched in. The FM NOISE position switches in the inductor L2 to de-emphasize the baseband signal.

CARD A2 contains the peak and average voltmeter circuits for the various measurements. It also contains the left and right channel monitoring amplifiers that are used for aural monitoring as well as audio tests. Switches S6 and S7 de-emphasize the individual amplifiers.

CARD A3 contains the pilot frequency meter circuit. The 19 kHz pilot is multiplied to 190 kHz and is compared with a reference oscillator. The difference frequency is measured with a counter discriminator and displayed on the pilot frequency deviation meter.

Power is supplied to the FMS–1 from the FMM–1 through the terminal blocks. Twenty-five volts DC supplies the operating power and 19 volts AC powers the calibrating circuits. The FMM–1 is protected against short circuiting the 25 volt DC bus connecting the FMS–1.

4–1–1 STEREO DEMODULATOR AND PHASE DISCRIMINATOR CARD A1

The baseband signal containing the stereo composite signal is applied to pin 14 of the stereo demodulator and Phase Discriminator CARD A1. The 19 kHz pilot is filtered out by the bandpass filter consisting of inductors A1L1 through L3 and capacitors A1C1 through C5. The output of the 19 kHz filter is buffered by emitter follower A1Q1 and is applied to the FUNCTION switch through pin 9 to be measured in the PILOT position. The output of A1Q1 is also amplified by A1Q2 and applied to the 19 kHz doubler consisting of the phase splitter A1Q3 and full wave rectifier A1CR1 and CR2.

The 38 kHz output of the doubler is amplified by A1Q4. PHASE ADJUST inductor L1, with capacitor A1C12, filters the 38 kHz and provides the necessary phase adjustment for pilot phase calibration. The output of the 38 kHz amplifier is applied to the limiter A1Q5 and Q6, which amplifies and squares the 38 kHz waveform. Potentiometer A1R25 provides a symmetry adjustment for the square-wave. Transistors A1Q7 and Q8 buffer the limiter output and provide a very low output impedance to drive the stereo demodulator through transformer A1T1. The square-wave drive to the stereo demodulator allows the demodulator to be relatively independent of pilot level.

The stereo demodulator is the series diode type for maximum stereo performance. Its function is to separate the original left and right channels from the wideband stereo composite signal. Matched diodes A1CR4 through CR7 and resistors A1R47 through R52 form a bridge which is driven at a 38 kHz rate by the output of transformer A1T1. The wideband stereo composite signal is applied in series through the center-tap of transformer A1T1.

Since the incoming stereo composite signal was formed by alternate switching of the left and right channels at a 38 kHz rate (time division multiplex system), the demodulation process is just the reverse. The diode switches are alternately turned on and off at the 38 kHz rate to allow the left and right channels to pass at the prescribed time.

The left and right outputs of the demodulator are applied to the amplitude correction amplifiers, transistors A1Q11 and Q12. Since the original stereo composite signal consists of equal amplitude (L+R) and (L–R) signals and no odd harmonic components of the 38 kHz subcarrier, square-wave switching in the demodulator adds an (L–R) component which is $4/\pi$ times the original (L–R), and this difference in amplitude is corrected in the amplitude correction amplifier by cross coupling the outputs through A1R36 and R37. If the transmitted stereo composite signal contained an (L–R) signal that was square-wave switched without filtering out the odd harmonic components the amplitude correction would not be needed. The amplitude correction may be eliminated by removing the short from pins 19 and 20. The outputs of the amplitude correction amplifiers are buffered by emitter followers A1Q9 and Q10 and applied to 15 kHz lowpass filters FL1 and FL2 to remove all frequencies above 15 kHz present on the demodulated left and right channels.

For accurate stereo demodulation it is important that the exact phase relationship be maintained between the 19 kHz and the regenerated 38 kHz subcarrier that drives the demodulator. Proper phasing is indicated when the 19 kHz component from either side of the demodulator is exactly equal to the other. The conventional method of measuring this is to filter out the 19 kHz from one side of the demodulator and measure its amplitude and then reverse the phase of the 38 kHz with a relay or switch and compare the new amplitude, trying to adjust the phase for equal amplitudes. As the correct phase is approached, the difference in amplitude becomes very small, hence the method is subject to error.

The phase discriminator on the A1 card does not have the above disadvantage in that the amplitude difference is a null reading rather than a peak reading. Each side of the demodulator is buffered by emitter followers A1Q13 and Q14. The outputs of the buffer amplifiers which contain the 19 kHz components are alternately switched at a 60 Hz rate by diodes A1CR8 and CR9 to form an amplitude modulated signal whose degree of modulation is a function of the inequality of the 19 kHz components from each side of the demodulator. The 19 kHz component is amplified by transistor A1Q15 filtered by the bandpass filter consisting of inductors A1L4 through L6 and capacitors AC31 through C35. The bandpass filter is wide enough to pass the harmonics of the 60 Hz square-wave modulation. Figure 5–1–11 illustrates this waveform with correct phase. Figure 5–1–12 shows that there is a phase difference between the 19 kHz and regenerated 38 kHz subcarrier.

The output of the bandpass filter is buffered by emitter follower A1Q16 and demodulated by the envelope detector A1CR10 and CR11. The phase error output is a square-wave whose amplitude is proportional to the phase difference. This output is measured by the sensitive voltmeter as a null reading for the correct phase. Depressing the PHASE CAL switch applies 60 Hz to pin 16 to switch diodes A1CR8 and CR9. At the same time the input of the sensitive average voltmeter amplifier is switched to the phase error output and the PHASE ADJUST inductor L1 may be adjusted for the null reading.

4–1–2 AUDIO AND VOLTMETER CARD A2

The incoming baseband signal is amplified by transistor A2Q1. Potentiometer R1 (INPUT LEVEL) adjusts the gain slightly to allow the FMS–1 to be normalized with the FMM–1. Transistor A2Q2 provides a low impedance to drive the stereo demodulator on CARD A1 and also the FUNCTION switch S1. The FUNCTION switch applies the particular function selected to the input of the wideband feedback amplifier A2Q3, Q4 and Q5 which drives the peak voltmeter circuit. Section 4–2–3, in the FMM–1 manual, may be referred to for its operation since the circuits are the same.

The output of the feedback amplifier also drives the RANGE switch S2 which provides attenuation steps for the sensitive average voltmeter. The output of the RANGE switch S2 is applied to the average voltmeter amplifier A2Q9 and Q10. Diode bridge A2CR3 through CR6 rectifies the output to drive the modulation meter. A sample of the output is applied to the emitter of A2Q9 to provide feedback to stabilize the gain and linearize the meter reading. The gain is adjusted by A2R41. An output is also taken from the amplifier to provide an oscilloscope output (SCOPE) that follows the sensitivity setting of the RANGE switch.

When the RANGE switch is on MOD, the modulation meter is switched to the peak reading voltmeter circuit on pins 24 and 25. When the RANGE switch is on 0–50 db positions, the modulation meter is switched to the diode bridge A2CR3 through CR6. Note that if a remote modulation meter is used, it always remains on the peak voltmeter circuit. When the RANGE switch is on MOD, the average voltmeter is connected to the –20 db position of the attenuator through a jumper on switch section S2–C. This is to normalize the PILOT reading on the FUNCTION switch. Since the average voltmeter is connected to the –20 db position of the attenuator, the SCOPE output will indicate a distorted waveform when the RANGE switch is in the MOD position.

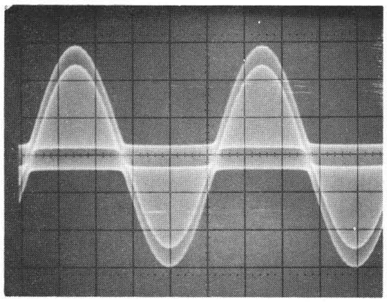
The input circuits to left and right channel monitoring amplifiers terminate the left and right channel lowpass filters FL1 and FL2. The amplifiers are the same as used in the FMM–1 and its manual may be referred to for operation.

4–1–3 PILOT FREQUENCY METER CARD A3

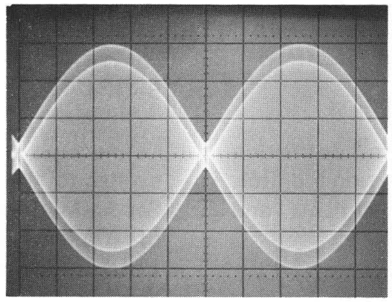
The square-wave output from pin 1 on CARD A1 is applied to the input of the frequency multiplier A3Q9 and Q10. The bandpass filter consisting of inductors A2L1 and L2 and capacitors A2C16 through C18 select the fifth harmonic of the 38 kHz. This harmonic is also the tenth harmonic of 19 kHz. The 190 kHz output of the filter is mixed with the 190.060 kHz local oscillator frequency in the balanced mixer A2Q7 and Q8. The output of the mixer is the 60 Hz difference frequency. One Hz deviation at 19 kHz then causes 10 Hz difference frequency deviation.

The 60 Hz difference frequency is applied to the pulse counter discriminator consisting of the Schmitt trigger and monostable multivibrator through the switching diode A3CR2. The output of the monostable multivibrator is integrated by A3R16, A3C23 and A3R23, A3C24 and applied to the pilot frequency deviation meter through pins 7 and 10. FREQ ZERO potentiometer R3 calibrates the discriminator. In the absence of pilot, transistor A3Q5 is conducting and transistor A3Q3 is off, which will cause the meter to read off scale. Transistor A3Q4 clamps pin 7 to ground to return the meter to zero Diodes A3CR3 and CR4 rectify an output from the Schmitt trigger to provide a negative voltage to turn off A3Q4 when there is 19 kHz pilot.

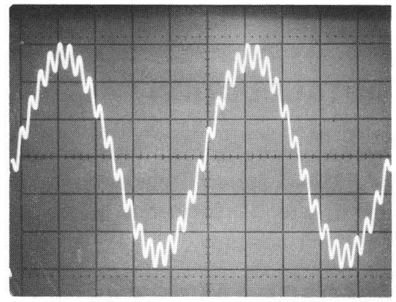
The pulse counter discriminator is calibrated with the 60 Hz line frequency. Depressing the FREQ CAL switch S3 applies 60 Hz line frequency to pin 2. Fifteen volts DC is also applied to pin 4 to turn on diode A3CR1 to permit calibration. Depressing the FREQ OP switch removes the 60 Hz line frequency and returns the 15 volts DC to pin 3 to turn on diode A3CR2. Capacitor A3C9 calibrates the 190.060 kHz local oscillator.



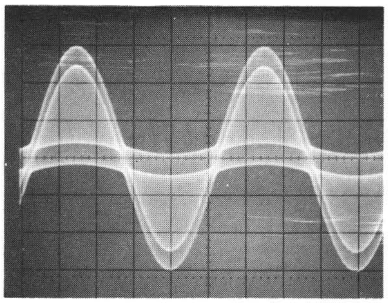
1.
Composite Stereo Waveform



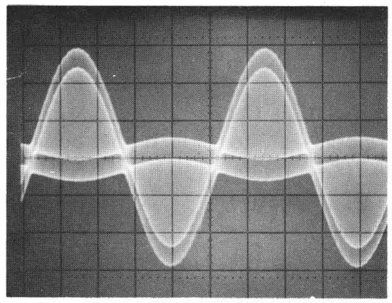
2.
(L–R) Subcarrier with Pilot



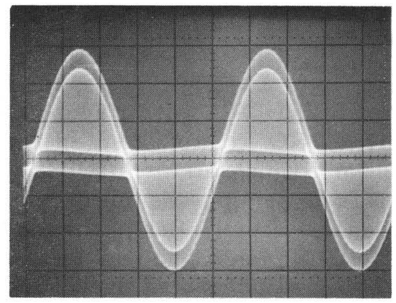
3.
(L+R) Main Channel with Pilot



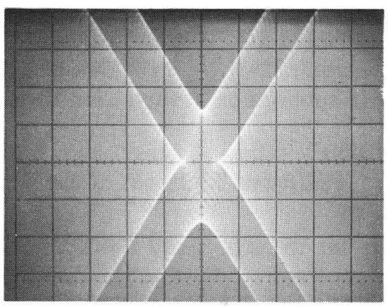
4.
Composite Stereo Waveform,
Insufficient (L–R)



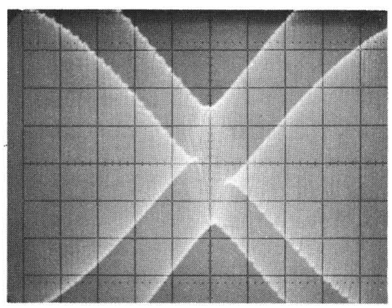
5.
Composite Stereo Waveform,
Excess (L–R)



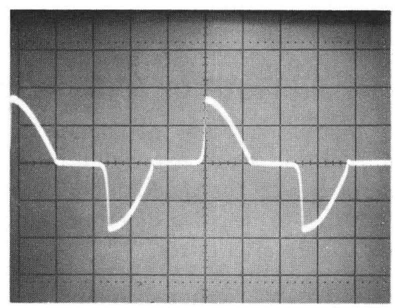
6.
Composite Stereo Waveform, Phase
Error Between (L+R) and (L–R)



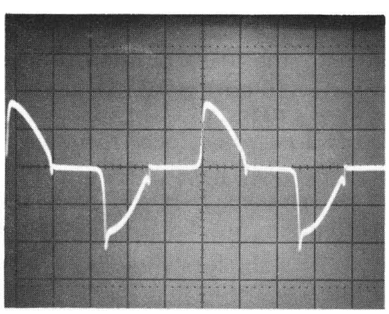
7.
(L–R) Subcarrier with Pilot,
Pilot in Phase



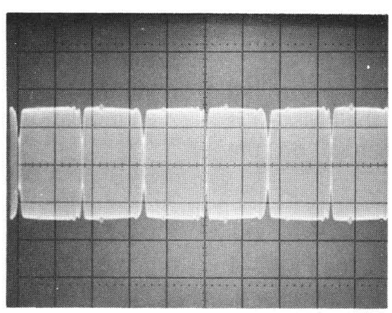
8.
(L–R Subcarrier with Pilot,
Pilot Phase Incorrect



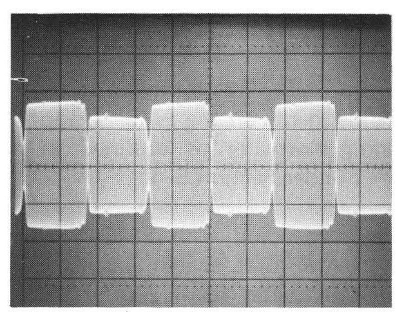
9.
Stereo Demodulator Waveform,
No Modulation



10.
Stereo Demodulator Waveform,
Incorrect Balance



11.
Phase Discriminator Carrier



12.
Phase Discriminator Carrier,
Incorrect Pilot Phase

Figure 5–1

SECTION 5

MAINTENANCE

5–1 INTRODUCTION

This section contains maintenance and service information for the FMS–1 Stereo Frequency and Modulation Monitor. Included are Performance Checks, Adjustments and Calibration Procedures.

5–2 PERFORMANCE CHECKS

Before performing any checks on the FMS–1, it is suggested that the FMM–1 performance be verified. See the instruction manual for the FMM–1.

5–2–1 FREQUENCY DEVIATION METER CHECK

Depress FREQ CAL switch. Verify that by rotating the FREQ ZERO control from maximum clockwise to maximum counterclockwise the Hz DEVIATION meter pointer will go up scale in the positive and negative directions respectively. Return the pointer to zero. Depress the FREQ OP switch and read the deviation. Depress the FREQ CAL switch and set the pointer to –1 Hz. Depress the FREQ OP switch and read the deviation. By algebraically adding the –1 Hz, the same deviation should be obtained as in the preceding test where the FREQ CAL is set at zero. Rezero the FREQ CAL control after test and return to FREQ OP mode.

5–2–2 MODULATION MOD ZERO METER CHECK

Verify that without any modulation, by rotating the MOD ZERO control from maximum clockwise to maximum counterclockwise the modulation meter pointer will move in a positive to negative direction about zero. Return the pointer to zero after check.

5–2–3 FUNCTION

Sections 3–3–1 through 3–3–20 may be used for the remainder of the performance checks.

5–3 ADJUSTMENTS AND CALIBRATIONS

Place the FMM–1 in normal operation. Before performing any adjustments on the FMS–1, verify that the FMM–1 is operating normally as outlined in the manual on the FMM–1 under Section 5–2.

Before proceeding with FMS–1 alignment, depress the FMM–1 AMP BAL switch and make sure that the FMM–1 modulation meter reads zero: reset to zero if necessary, using the MOD ZERO control on the FMM–1.

Place the FMS–1 FUNCTION switch to the TOTAL position. Adjust the FMS–1 MOD ZERO control for zero indication on the FMS–1 modulation meter.

5–3–1 PRELIMINARY

Connect an RF sample from a properly operating stereo exciter to the RF input jack of the FMM–1 FM monitor. Set FMM–1 input level potentiometer R7 for an indication of 100% on the FMM–1 modulation meter with the RF LEVEL switch depressed. Apply pilot tone in stereo generator. Set pilot level to approximately 9% using FMM–1 modulation meter. Verify that pilot phase is correct by the following procedure:

a. With scope connected to WIDEBAND TEST output jack of FMM–1, with external sync fed directly from audio generator, feed L = –R signals to the stereo generator audio inputs (400 Hz).

b. Set audio level for 100% modulation of main carrier.

c. Adjust exciter PILOT PHASE adjustment (in the stereo generator) for alignment of crossover points on scope presentation, Figure 5–1–7.

Remove audio and depress PHASE CAL switch and adjust PHASE CAL control for minimum indication on the FMS–1 modulation meter.

Set FMS–1 FUNCTION switch to the 38 kHz position (with no audio input to exciter, exciter set to STEREO mode). Set stereo generator CARRIER BALANCE control for optimum 38 kHz suppression (suppression should be greater than 40 db).

5–3–2 A2R15 ADJUSTMENT

With pilot amplitude set to zero, apply a 400 Hz L only signal to the stereo generator. Adjust audio level for 90% modulation of the FM carrier, referring to the FMM–1 modulation meter. Insert approximately 9% pilot tone by setting stereo generator PILOT LEVEL control for a FMM–1 modulation meter indication of 99%.

Set the FMS–1 FUNCTION switch to the L position, and the DECIBELS switch to the MOD position. Adjust the voltmeter gain control A2R15 on the A2 circuit board for an indication of 90% on the FMS–1 modulation meter.

5–3–3 A1R47 AND A1R50 ADJUSTMENT

Perform the following adjustment of the stereo demodulator circuitry only if absolutely necessary.

Balance stereo demodulator as follows: Connect scope at the junction of A1R50 and A1C23 in the FMS–1 stereo demodulator (A1 circuit board). With no modulation applied, but with pilot still present, adjust control A1R50 for optimum waveform, Figure 5–1–9. There should be no overshoot (or spike) or appreciable rounding of the positive or negative extremity of the waveform. Connect scope at the junction of A1R47 and A1C22 in the stereo demodulator circuitry and adjust A1R47 for proper waveform similar to the procedure described for adjustment of A1R50. In this case the waveform will be inverted from the waveform at A1R50–A1C23. Figure 5–1–10 shows the improper waveform.

Referring to FMS–1 modulation meter, make sure that the L channel modulation is 90% (reset if necessary) as read with function switch set to the L position. Switch to the TOTAL position. Adjust stereo generator PILOT LEVEL control as required to give an indication of 99% on the FMM–1 modulation meter. This gives a pilot level of approximately 9%.

Verify that exciter pilot phase is correct by repeating step 5–3–1.

5–3–4 A1R40 ADJUSTMENT

Feed 400 Hz L= –R signals to stereo generator audio input jacks. Set audio level for 90% indication on FMM–1 modulation meter. Again, observe WIDEBAND test signal on scope, with external sync from audio generator, Figure 5–1–2. Set scope sweep so that three or four peaks of the (L–R) waveform are displayed. If adjacent peaks of the pattern are not equal, adjust the stereo generator for equal amplitude on successive peaks on oscilloscope display. If necessary, remove pilot tone during this adjustment. However, if this is done, the phase calibration procedure above must be repeated when pilot is restored.

Adjust A1R40 for equal L and R indications on FMS–1 modulation meter as the FUNCTION switch is set alternately to the LEFT and RIGHT positions.

5–3–5 A1R25 ADJUSTMENT

Feed L=R signals (400 Hz) into the stereo generator, Figure 5–1–3. Leave pilot unchanged. Set audio level for 99% total modulation as read on the FMM–1 modulation meter. Adjust A1R25 for equal L and R indications on FMS–1 modulation meter as the FUNCTION switch is set alternately to the LEFT and RIGHT positions.

5–3–6 A1R36 ADJUSTMENT

Remove pilot tone. Apply an L only signal (400 Hz) to the stereo generator. Adjust audio level for 90% total modulation (FMM–1 modulation meter). Adjust exciter separation control for optimum scope pattern (best separation indicated by flat base line on scope pattern), (Figure 5–1–1). Reinsert 9% pilot tone. Check exciter pilot phase. Set the FUNCTION switch to the RIGHT position. Adjust FMS–1 separation calibrate potentiometer A1R36 for minimum indication on FMS–1 modulation meter. Set DECIBELS switch to required sensivity.

Repeat the preceding adjustment procedure given for A1R40.

Repeat the preceding adjustment procedure given for A1R25.

Repeat the preceding adjustment procedure given for A1R36.

Repeat the preceding adjustment procedure given for A2R15.

5–3–7 NORMALIZATION

Apply a 1 kHz tone to the exciter WIDEBAND input. No pilot should be present.

Set audio level for 100% indication on the FMM–1 modulation meter. Set FUNCTION switch to TOTAL position. Set DECIBELS switch to MOD. Adjust FMS–1 total modulation calibrate potentiometer R4 for 100% reading on FMS–1 modulation meter.

Set FUNCTION switch to the L + R position. Adjust L + R calibrate control R6 for 100% indication on FMS–1 modulation meter.

Set the DECIBELS switch to the 0 db position. Adjust calibrate control A2R41 for an indication of 100% on FMS–1 modulation meter (actually, for equal readings in the MOD and 0 db positions of the DECIBELS switch).

Set DECIBELS switch to the MOD position. Place FUNCTION switch to the FM NOISE position. Verify that this monitor function is operative by noting the FMS–1 modulation meter indication. The indication (with 1 kHz audio) should be –1.2 db ±0.5 db.

Connect the output of an audio oscillator to the wideband input of the exciter. Set frequency to 38 kHz. Adjust level for 100% reading on FMM–1 modulation meter.

Set FUNCTION switch to the 38 kHz position. Adjust 38 kHz calibrate potentiometer, R8, for a meter indication of 100%.

Set the FUNCTION switch to the (L–R) position. Adjust the oscillator frequency to a value slightly below the 38 kHz stereo subcarrier frequency, such as to peak the (L–R) indication on the FMS–1 modulation meter. Adjust (L–R) calibrate potentiometer R7 for a meter indicationn of 102%.

Remove wideband input. With stereo generator set to the STEREO mode (pilot on), and with no audio modulation, set the FUNCTION switch to TOTAL and the DECIBELS switch to the 20 db position. Adjust stereo generator PILOT LEVEL control for an indication of 90% on the FMS–1 modulation meter.

Set FUNCTION switch to the PILOT position. Set DECIBELS switch to the MOD position. Adjust 19 kHz calibrate potentiometer R9 for an indication of 90%.

With 9% pilot injection and 100% total modulation of the FM carrier, as read from the FMM–1 modulation meter, make sure that the FMS–1 reads very nearly 100% (FUNCTION switch on TOTAL, DECIBELS switch on MOD). Now depress the FMM–1 MOD CAL switch. In general, when the FMM–1 calibration signal is used (and the two units have been adjusted so that the modulation indications agree, with tones as signals), the FMS–1 modulation indication may be slightly different from the FMM–1 indication. Adjust FMS–1 calibration control R4 (TOTAL modulation calibrate) so the difference in indication is changed to one-half its initial value.

5–3–8 19 kHz FILTER ADJUSTMENTS

As previously mentioned, field adjustment of the monitor filters is not normally recommended. The following information is given for those cases where filter alignment is unavoidably required, such as a drift of pilot level indication. When the 19 kHz filter is realigned, the 19 kHz pilot calibrate potentiometer R9 must be reset.

a. 19 kHz Filter Alignment – Remove modulation but apply pilot tone. Set FMS–1 FUNCTION switch to the PILOT position. Unscrew the cores of 19 kHz filter variable inductors so that the cores are almost out. Now reset the cores for maximum indication on the FMS–1 modulation meter, setting A1L3 (output coil) first, then A1L2, and A1L1 (input) last.

b. Phase Regeneration Filter Alignment – With pilot in use but no audio signal applied, connect scope at junction of A1CR10 and A1C37. Adjust variable inductors A1L6, L5 and L4 (in order) for maximum scope indication.

5–3–9 INCIDENTIAL AM CALIBRATION

Apply a 400 Hz audio signal to the INC. AM jack J3 on the back panel of the FMS–1. Adjust the level to 0.9 volts RMS. Turn the function switch to INC. AM and RANGE switch to 0. Adjust R11 to indicate 100% on the modulation meter.

5–3–10 AM NOISE CALIBRATION

Apply a 400 Hz audio signal to the AM NOISE jack J2 on the back panel of the FMS–1. Adjust the level to 0.78 volts RMS. Turn the function switch to AM NOISE and the RANGE switch to 0. Adjust the R10 to indicate 100% on the modulation meter.

5–3–11 19 kHz SCALE CALIBRATION (R24)

Disconnect the lead from TB1-11 located at the back of the unit. Connect an audio generator between TB1-11 and TB1-12 (GND). Depress FREQ CAL switch.

Adjust the output of the audio generator for 40 Hz 10V RMS. Adjust R24 for 2 Hz deviation as indicated on Hz DEVIATION meter.

Adjust the output of the audio generator for 80 Hz 10V RMS. Indication on Hz DEVIATION meter should be 2 Hz of opposite polarity to that obtained above.

5–3–12 19 kHz FREQUENCY CALIBRATION

Remove bottom plate from FMS–1. Depress FREQ CAL switch and adjust FREQ ZERO potentiometer, R3, to read center zero on the pilot frequency deviation meter.

Depress FREQ OP switch and read pilot frequency deviation. Adjust capacitor A3C9 on A3 board to set pilot frequency deviation to exactly that deviation as read by an outside frequency measuring source.

An alternate method may be used if a frequency counter and 10:1 low capacity probe is available. Attach probe to the base of transistor A3Q7 (junction of A3R29, A3R30, and A3C13). Adjust A3C9 to read exactly 190.060 kHz on frequency counter.

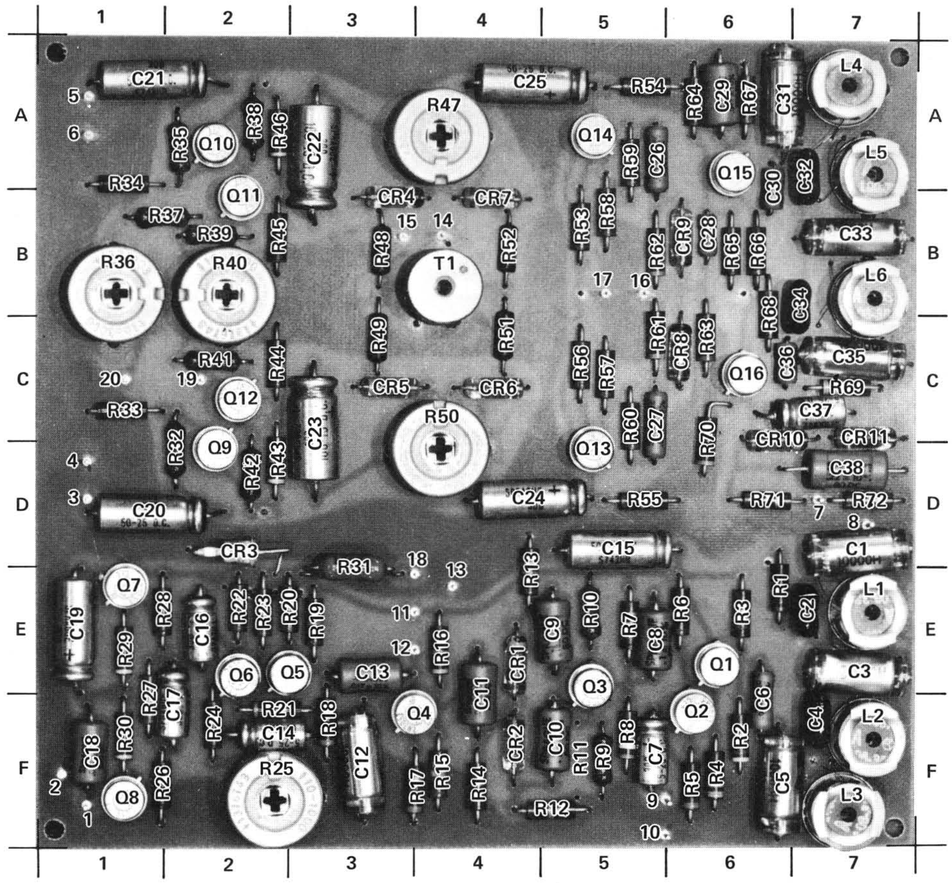


Figure 5–2. A1 Card

REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
R1	E6	R25	F2	R49	C3	Q1	E6	C2	E7	C26	A5	PINS	
R2	F6	R26	F2	R50	C4	Q2	F6	C3	E7	C27	C5	1	F1
R3	E6	R27	F1	R51	C4	Q3	E5	C4	F7	C28	B6	2	F1
R4	F6	R28	E2	R52	B4	Q4	F4	C5	F6	C29	A6	3	D1
R5	F6	R29	E1	R53	B5	Q5	E3	C6	F6	C30	A6	4	D1
R6	E6	R30	F1	B54	A5	Q6	E2	C7	F5	C31	A6	5	A1
R7	E5	R31	E3	R55	D5	Q7	E1	C8	E5	C32	A7	6	A1
R8	F5	R32	D2	R56	C5	Q1	F1	C9	E5	C33	B7	7	D7
R9	F5	R33	C1	R57	C5	Q9	D2	C10	F5	C34	B7	8	D7
R10	E5	R34	A1	R58	B5	Q10	A2	C11	F4	C35	C7	9	F5
R11	F5	R35	A2	R59	A5	Q11	B2	C12	F3	C36	C6	10	F5
R12	F5	R36	B1	R60	C5	Q12	C2	C13	E3	C37	C7	11	E3
R13	E4	R37	B2	R61	C5	Q13	D5	C14	F2	C38	D7	12	E3
R14	F4	R38	A2	R62	B5	Q14	A5	C15	D5	CR1	E4	13	E4
R15	F4	R39	B2	R63	C6	Q15	A6	C16	E2	CR2	F4	14	B4
R16	E4	R40	B2	R64	A6	Q16	C6	C17	F2	CR3	D2	15	B3
R17	F4	R41	C2	R65	B6	T1	B4	C18	F1	CR4	B3	16	B5
R18	F3	R42	D2	R66	B6	L1	E7	C19	E1	CR5	C3	17	B5
R19	E3	R43	D2	R67	A6	L2	F7	C20	D1	CR6	C4	18	E3
R20	E3	R44	C2	R68	B6	L3	F7	C11	A1	CR7	B4	19	C2
R21	F2	R45	B2	R69	C7	L4	A7	C22	A3	CR8	C6	20	C1
R22	E2	R46	A2	R70	C6	L5	A7	C23	C3	CR9	B6		
R23	E2	R47	A4	R71	D6	L6	B7	C24	D4	CR10	C6		
R24	F2	R48	B3	R72	D7	C1	D7	C25	A4	CR11	C7		

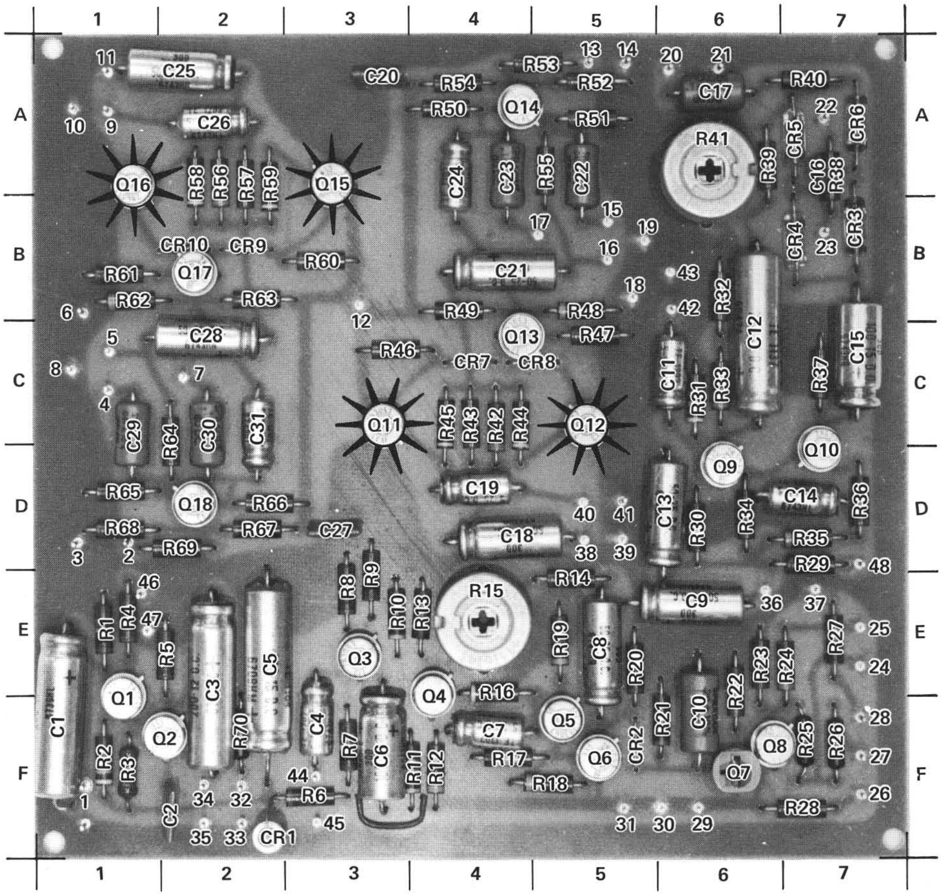


Figure 5–3. A2 Card

REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
R1	E1	R27	E7	R53	A5	Q9	D6	C17	A6	PINS		26	F7
R2	F1	R28	F7	R54	A4	Q10	A4	Q18	D4	1	F1	27	F7
R3	F1	R29	D7	R55	A5	Q11	C3	C19	D4	2	D1	28	F7
R4	E1	R30	D6	R56	A2	Q12	C5	C20	A3	3	D1	29	F6
R5	E2	R31	C6	R57	A2	Q13	C4	C21	B4	4	C1	30	E6
R6	F3	R32	B6	R58	A2	Q14	A4	C22	A5	5	C1	31	F5
R7	F3	R33	C6	R59	A2	Q15	A3	C23	A4	6	B1	32	F2
R8	E3	R34	D6	R60	B3	Q16	A1	C24	A4	7	C2	33	F2
R9	E3	R35	D7	R61	B1	Q17	B2	C25	A2	8	C1	34	F2
R10	E3	R36	D7	R62	B1	Q18	D2	C26	A2	9	A1	35	F2
R11	F4	R37	C7	R63	B2	C1	F1	C27	D3	10	A1	36	E6
R12	F4	R38	A7	R64	C2	C2	F2	C28	C2	11	A1	37	E7
R13	E4	R39	A6	R65	D1	C3	E2	C29	C1	12	B3	38	D5
R14	E5	R40	A7	R66	D2	C4	F3	C30	C2	13	A5	39	D5
R15	E4	R41	A6	R67	D2	C5	E2	C31	C2	14	A5	40	D5
R16	E4	R42	C4	R68	D1	C6	F3	CR1	F2	15	B5	41	D5
R17	F4	R43	C4	R69	D2	C7	F4	CR2	F5	16	B5	42	B6
R18	F5	R44	C4	R70	F2	C8	E5	CR3	B7	17	B5	43	B6
R19	E5	R45	C4	Q1	E1	C9	E6	CR4	B7	18	B5	44	E3
R20	E5	R46	C3	Q2	F2	C10	F6	CR5	A7	19	B5	45	F3
R21	F6	R47	C5	Q3	E3	C11	C6	CR6	A7	20	A6	46	E1
R22	E6	R48	B5	Q4	E4	C12	C6	CR7	C4	21	A6	47	E1
R23	E6	R49	B4	Q5	F5	C13	D6	CR8	C5	22	A7	48	D7
R24	E7	R50	A4	Q6	F5	C14	D7	CR9	B2	23	B7		
R25	F7	R51	A5	Q7	F6	C15	C7	CR10	B2	24	E7		
R26	F7	R52	A5	Q8	F6	C16	A7			25	E7		

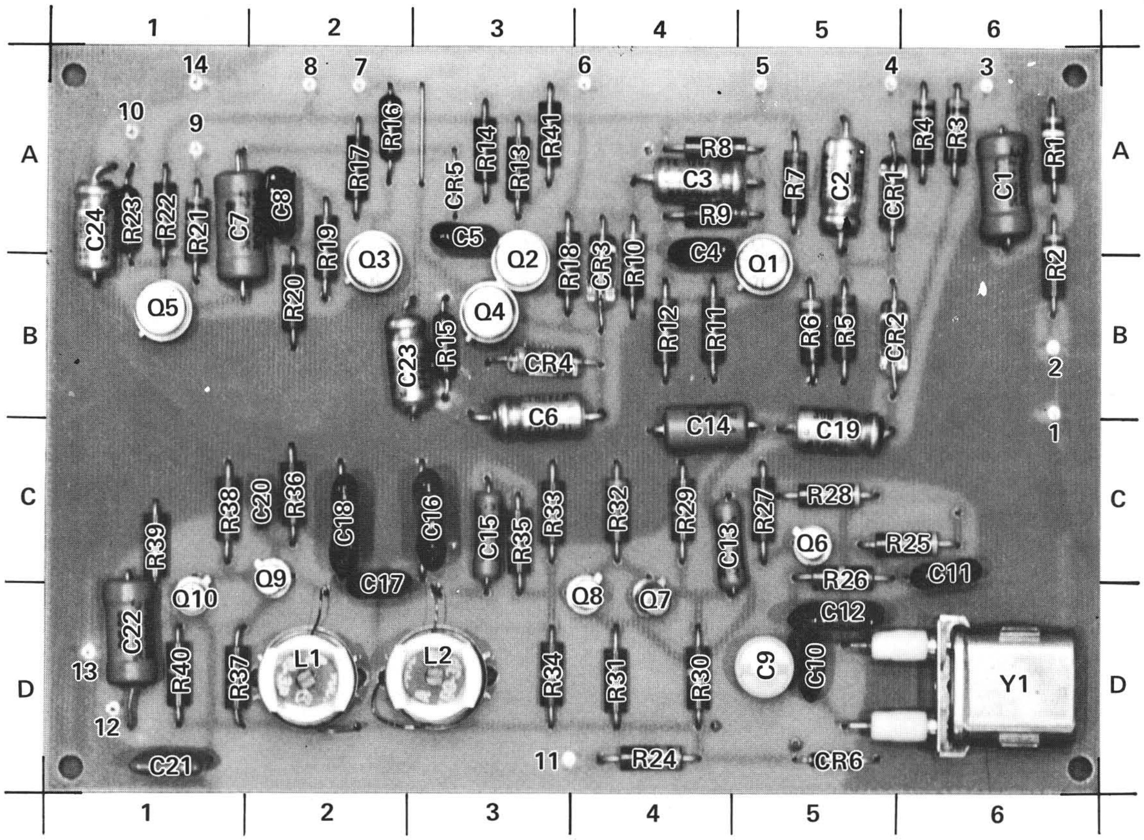


Figure 5–4. A3 Card

REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
R1	A6	R15	B3	R29	C4	L2	D3	C13	C4	Q3	B2	PINS	
R2	A6	R16	A2	R30	D4	Y1	D6	C14	C4	Q4	B3	1	C6
R3	A6	R17	A2	R31	D4	C1	A6	C15	C3	Q5	B1	2	B6
R4	A6	R18	B3	B32	C4	C2	A5	C16	C3	Q6	C5	3	A6
R5	B5	R19	A2	R33	C3	C3	A4	C17	C2	Q7	D4	4	A5
R6	B5	R20	B2	R34	D3	C4	A4	C18	C2	Q8	D4	5	A5
R7	A5	R21	A1	R35	C3	C5	A3	C19	C5	Q9	C2	6	A4
R8	A4	R22	A1	R36	C2	C6	B3	C20	C2	Q10	D1	7	A2
R9	A4	R23	A1	R27	D1	C7	A1	C21	D1	CR1	A5	8	A2
R10	B4	R24	D4	R38	C1	C8	A2	C22	D1	CR2	B5	9	A1
R11	B4	R25	C6	R39	C1	C9	D5	C23	B2	CR3	B4	10	A1
R12	B4	R26	C5	R40	D1	C10	D5	C24	A1	CR4	B3	11	D3

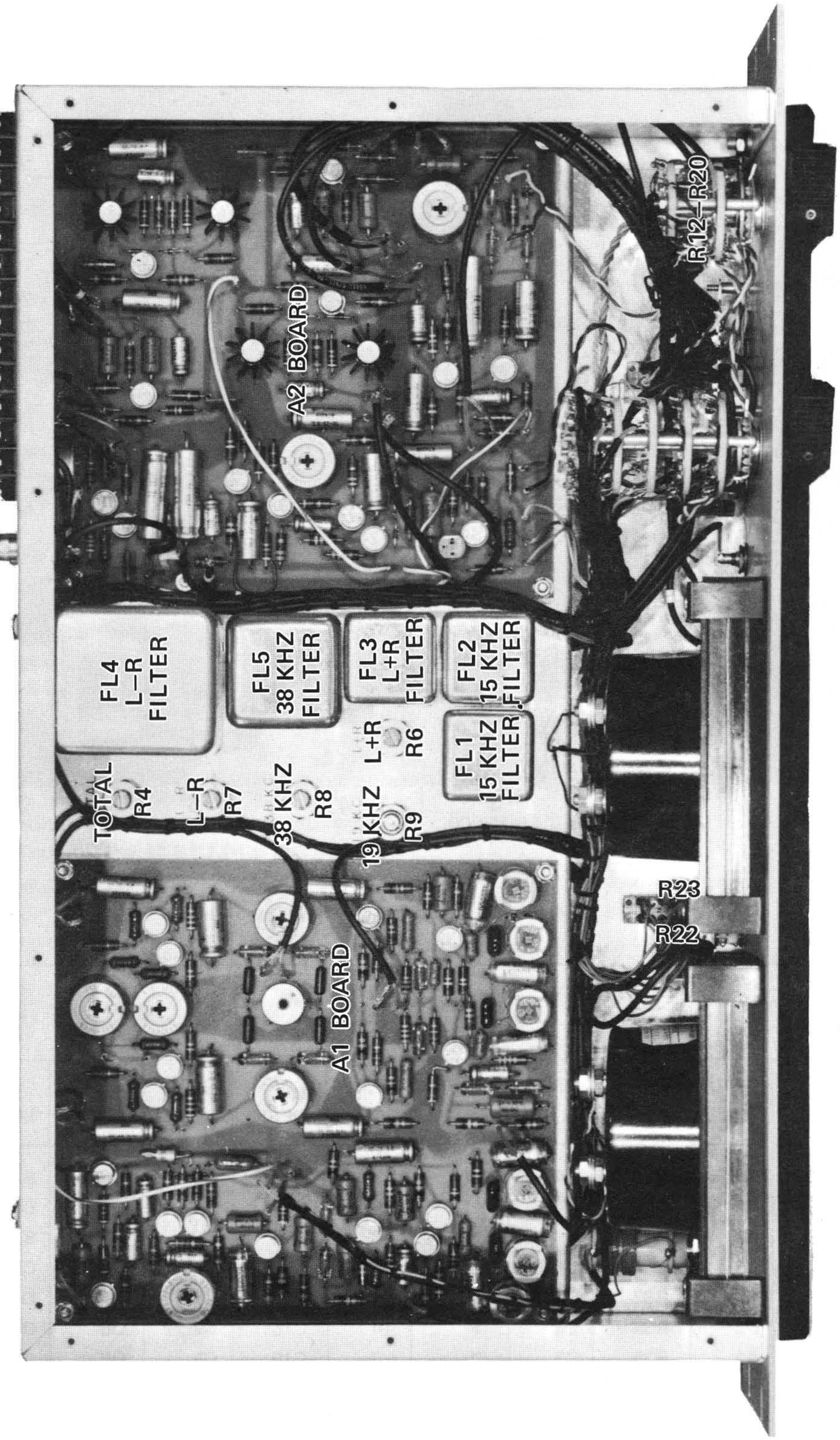


Figure 5–5. Chassis, Top View

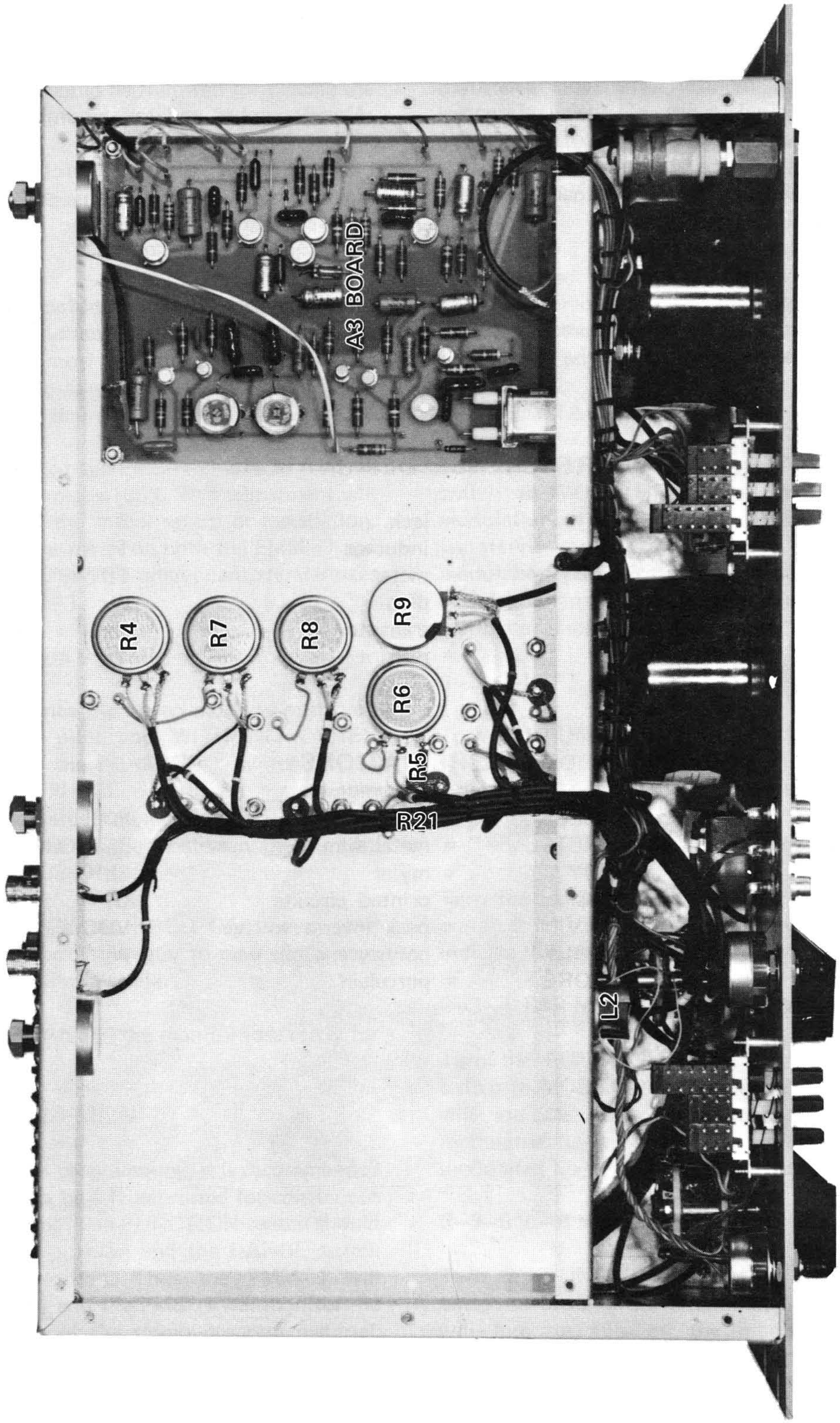


Figure 5–6. Chassis, Bottom View

SECTION 6
REPLACEABLE PARTS

6–1 INTRODUCTION

This section contains information for ordering replaceable parts for the monitor. The table lists the parts in alpha-numerical order of their reference designations and provides a description of the part with the manufacturers' number and the Belar part number. Those parts with only a Belar part number should be obtained directly from Belar.

6–2 ORDERING INFORMATION

To order a replacement part from Belar, address the order or inquiry to Belar and supply the following information:

a. Model number and serial number of unit.

b. Description of part including the reference designation and location.

c. Belar part number.

To order a part from a manufacturer other than Belar, provide the complete part description and the manufacturer's part number from the table.

REFERENCE DESIGNATORS

A	= assembly	J	= jack	S	= switch
C	= capacitor	L	= inductor	T	= transistor
CR	= diode	M	= meter	TB	= terminal board
DS	= device signaling(lamp)	P	= plug	W	= cable
F	= fuse	Q	= transistor	X	= oven
FL	= filter	R	= resistor	Y	= crystal

ABBREVIATIONS

CER	= ceramic	MEG	= meg	POT	= potentiometer
COMP	= composition	METFLM	= metal film	SEMICON	= semiconductor
CONN	= connector	MY	= mylar	SI	= silicon
ELECT	= electrolytic	PC	= printed circuits	U	= micro
F	= farads	PIV	= peak inverse voltage	VDCW	= dc working volts
FXD	= fixed	POLY	= polystyrene	W	= watts
GE	= germanium	PORC	= porcelain	WW	= wirewound
K	= kilo = 1000				

PARTS LIST

MAIN CHASSIS		
REFERENCE DESIGNATION	**DESCRIPTION**	**PART NUMBER**
FL1 thru FL3	FL: 15 kHz LOW PASS BELAR	9120-0002
FL4	FL: 23-53 kHz BAND PASS BELAR	9120-0003
FL5	FL: 38 kHz BAND PASS BELAR	9120-0004
L1	COIL: VAR PHASE ADJUST MILLER 43A223GB1	9140-0006
L2	COIL: FXD DE-EMPHASIS BELAR	9140-0007
M1	PILOT FREQUENCY METER: 3Hz	1120-0003
M2	MODULATION METER: 0 TO 133%	1120-0002
R1	R: VAR COMP 100 OHM 10% 2W RV4LAYSA101A	2100-0010
R2	R: VAR WW 100 OHM 10% 2W RA20NASD101A	2100-0003
R3	R: VAR COMP 100K OHM 10% 2W RV4NAYSD104A	2100-0011
R4,R6,R7,R8	R: VAR COMP 1K OHM 10% 2W RV4LAYSA102A	2100-0007
R5	R: FXD COMP 1.2K OHM 5% ½W RC20GF	0686-1225
R9	R: VAR COMP 5K OHM 10% 2W RV4LAYSA502A	2100-0008
R10,R11	R: VAR COMP 100K OHM 10% 2W RV4LAYSA104A	2100-0006
R12,R15,R18	R: FXD FLM 1370 OHM 1% 1/8W RN60D	0757-0008
R13,R16,R19	R: FXD FLM 442 OHM 1% 1/8W RN60D	0757-0008
R14,R17	R: FXD FLM 221 OHM 1% 1/8W RN60D	0757-0010
R20	R: FXD FLM 200 OHM 1% 1/8W RN60D	0757 0011
R21	R: FXD COMP 1.2K OHM 5% ½W RC20GF	0686-1225
R22	R: FXD COMP 5.1K OHM 5% ½W RC20GF	0686 5125
R23	R: FXD COMP 6.2K OHM 5% ½W RC20GF	0686-6225
R24	R: VAR COMP 50K OHM 10% 2W RV4LAYSA503A	2100-0009
S1	S: ROTARY 4 POLE 10 POSITION FUNCTION	3100-0001
S2	S: ROTARY 3 POLE 7 POSITION RANGE	3100-0002
S3,S4	S: PUSH BUTTON PILOT CAL-REMOTE METERS	3101-0004
S5,S6,S7	S: PUSH BUTTON PHASE CAL-DE-EMP	3101-0005
TB1	TERMINAL BLOCK: 12 PT	0360-0002
A1 CARD, STEREO DEMODULATOR AND PHASE DISCRIMINATOR		
A1C1,C5,C12,C31,C35	C: FXD POLY .01 UF 2½% 25 VDC	0130-0001
A1C2,C4	C: FXD MICA 500 PF 5% 500 VDC ELMENCO DM15	0140-0006
A1C3	C: FXD POLY .0091 UF 2½% 25 VDC	0130-0002
A1C6	C: FXD FLM .0047 UF 10% 80 VDC SPRAGUE 192P	0120-0001
A1C7,C14,C16,C17,C37	C: FXD ELECT 5 UF 25 VDC SPRAGUE 30D	0180-0007
A1C8 thru C10	C: FXD FLM 0.1 UF 10% 80 VDC SPRAGUE 192P	0120-0002
A1C11,C13,C18,C29	C: FXD FLM .047 UF 10% 200V SPRAGUE 192P	0120-0004
A1C15,C19,C20,C21,C24,C25	C: FXD ELECT 50 UF 25 VDC SPRAGUE 30D	0180-0005
A1C22,C23	C: FXD ELECT 100 UF 15 VDC SPRAGUE 30D	0180-0006
A1C26,C27	C: FXD FLM .01 UF 10% 80 VDC SPRAGUE 192P	0120-0005
A1C28	C: FXD FLM .001 UF 10% 200 VDC SPRAGUE 192P	0120-0006
A1C30,C36	C: FXD FLM .0022 UF 10% 200 VDC SPRAGUE 192P	0120-0007
A1C32,C34	C: FXD MICA 750 PF 5% 300 VDC ELMENCO DM15	0140-0013
A1C33	C: FXD POLY .0082 UF 2½% 25 VDC	0130-0003
A1C38	C: FXD FLM 0.22 UF 10% 80 VDC SPRAGUE 192P	0120-0003
A1CR1,CR2	DIODE: GERMANIUM 1N541 (Matched Pair)	1900-0011
A1CR3	DIODE: SILICON 1N1514	1900-0009
A1CR4 thru CR7	DIODE: GERMANIUM 1N541 (Matched Quad)	1900-0012
A1CR8 thru CR11	DIODE: GERMANIUM 1N541	1900-0001
A1L1,L3,L4,L6	INDUCTOR: VAR	9140-0008
A1L2,L5	INDUCTOR: VAR	9140-0009
A1Q1 thru Q7	TRANSISTOR: SILICON 2N3053	1850-0005
A1Q8	TRANSISTOR: SILICON 2N4037	1850-0011
A1Q9 thru Q16	TRANSISTOR: SILICON 2N3053	1850-0005
A1R1,R66	R: FXD COMP 15K OHM 5% ½W RC20GF	0686-1535

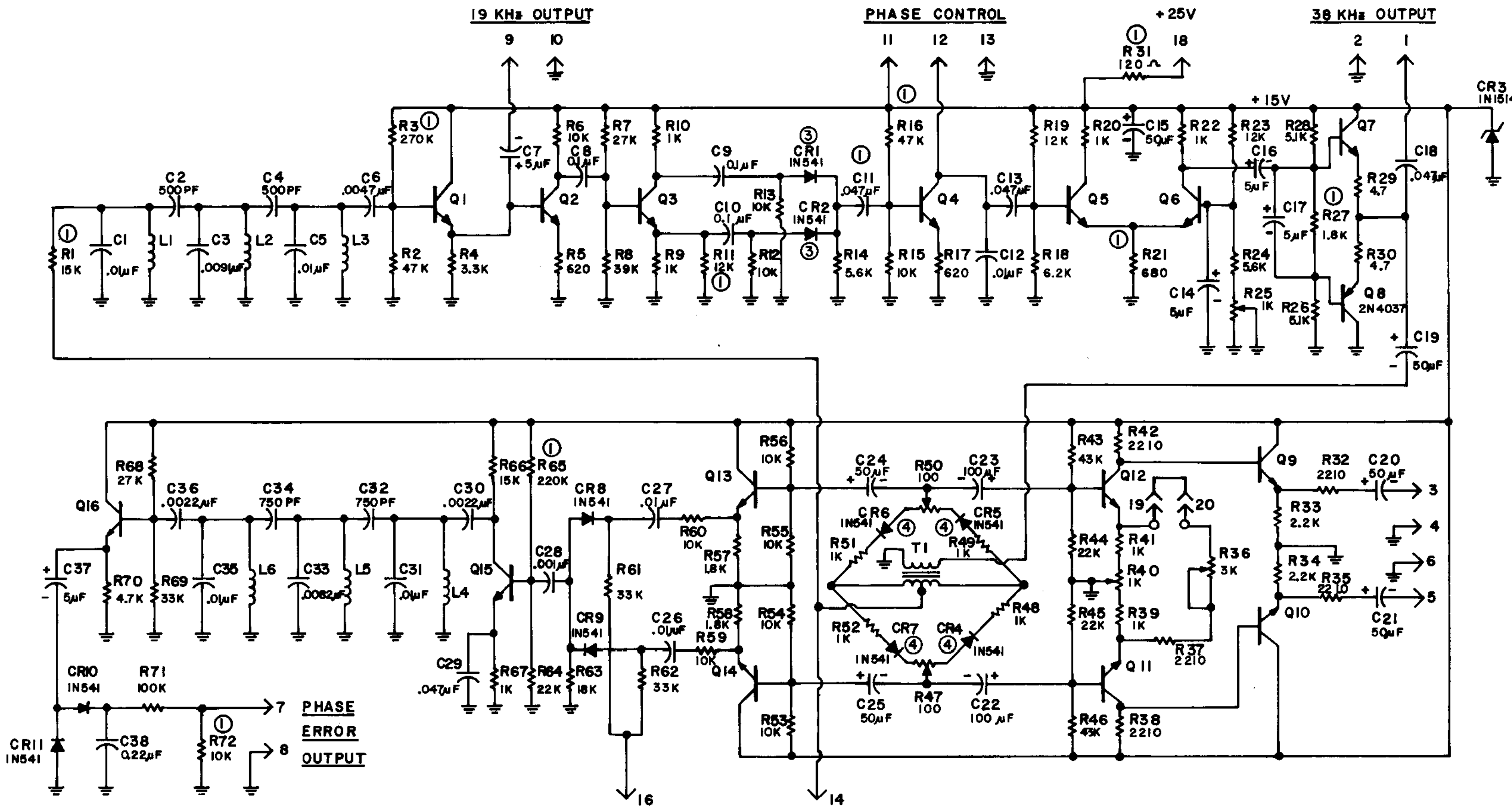
REFERENCE DESIGNATION	DESCRIPTION	PART NUMBER
A1R2,R16	R: FXD COMP 47K OHM 5% ½W RC20GF	0686-4735
A1R3	R: FXD COMP 270K OHM 5% ½W RC20GF	0686-2715
A1R4	R: FXD COMP 3.3K OHM 5% ½W RC20GF	0686-3325
A1R5,R17	R: FXD COMP 620 OHM 5% ½W RC20GF	0686-6215
A1R6,R12,R13,R15	R: FXD COMP 10K OHM 5% ½W RC20GF	0686-1035
A1R7,R68	R: FXD COMP 27K OHM 5% ½W RC20GF	0686-2735
A1R8	R: FXD COMP 39K OHM 5% ½W RC20GF	0686-3935
A1R9,R10,R39,R41	R: FXD FLM 1K OHM 1% 1/8W RN60D	0757-0002
A1R11,R19,R23	R: FXD COMP 12K OHM 5% ½W RC20GF	0686-1235
A1R14,R24	R: FXD COMP 5.6K OHM 5% ½W RC20GF	0686-5625
A1R18	R: FXD COMP 6.2K OHM 5% ½W RC20GF	0686-6225
A1R20,R22,R67	R: FXD COMP 1K OHM 5% ½W RC20GF	0686-1025
A1R21	R: FXD COMP 680 OHM 5% ½W RC20GF	0686-6815
A1R25,R40	R: VAR WW 1K OHM CTS 110-1000	2100-0012
A1R26,R28	R: FXD COMP 5.1K OHM 5% ½W RC20GF	0686-5125
A1R27,R57,R58	R: FXD COMP 1.8K OHM 5% ½W RC20GF	0686-1825
A1R29,R30	R: FXD COMP 4.7 OHM 5% ½W RC20GF	0686-0475
A1R3I	R: FXD WW 120 OHM 5% 3W SPRAGUE 242E	0811-0010
A1R32,R35,R37,R38,R42	R: FXD FLM 2.21K 1% 1/8W RN60D	0757-0001
A1R33,R34	R: FXD COMP 2.2K OHM 5% ½W RC20GF	0686-2225
A1R36	R: VAR WW 3K OHM CTS 110-3000	2100-0005
A1R43,R46	R: FXD COMP 43K OHM 5% ½W RC20GF	0686-4335
A1R44,R45	R: FXD COMP 22K OHM 5% ½W RC20GF	0686-2235
A1R47,R50	R: VAR WW 100 OHM CTS 110-100	2100-0013
A1R48,R49,R51,R52	R: FXD FLM 1K OHM 1% 1/8W RN60D	0757-0002
A1R53 thru R56	R: FXD COMP 10K OHM 5% ½W RC20GF	0686-1035
A1R59,R60,R72	R: FXD COMP 10K OHM 5% ½W RC20GF	0686-1035
A1R61,R62,R69	R: FXD COMP 33K OHM 5% ½W RC20GF	0686-3335
A1R63	R: FXD COMP 18K OHM 5% ½W RC20GF	0686-1835
A1R64	R: FXD COMP 22K OHM 5% ½W RC20GF	0686-2235
A1R65	R: FXD COMP 220K OHM 5% ½W RC20GF	0686-2245
A1R70	R: FXD COMP 4.7K OHM 5% ½W RC20GF	0686-4725
A1R71	R: FXD COMP 100K OHM 5% ½W RC20GF	0686-1045
A1T1	TRANSFORMER: BELAR	9100-0002
A2 CARD, AUDIO AND VOLTMETER		
A2C1,C3,C12	C: FXD ELECT 200 UF 12 VDC SPRAGUE 30D	0180-0004
A2C2,C20,C27	C: FXD CER 0.1 UF 50 VDC SPRAGUE 5C50	0150-0008
A2C4,C7,C11,C14	C: FXD ELECT 5 UF 25 VDC SPRAGUE 30D	0180-0007
A2C5	C: FXD ELECT 200 UF 15 VDC SPRAGUE 30D	0180-0008
A2C6,C15	C: FXD ELECT 100 UF 15 VDC SPRAGUE 30D	0180-0006
A2C8,C9,C13,C18	C: FXD ELECT 50 UF 25 VDC SPRAGUE 30D	0180-0005
A2C10	C: FXD FLM 0.22 UF 10% 80 VDC SPRAGUE 192P	0120-0003
A2C16	C: FXD CER .01 UF 100 VDC SPRAGUE TGS 10	0150-0007
A2C17,C23,C30	C: FXD FLM 0.1 UF 10% 80 VDC SPRAGUE 192P	0120-0002
A2C19,C24,C26,C31	C: FXD ELECT 5 UF 25 VDC SPRAGUE 30D	0180-0007
A2C21,C25,C28	C: FXD ELECT 50 UF 25 VDC SPRAGUE 30D	0180-0005
A2C22,C29	C: FXD FLM 0.047 UF 10% 200 VDC SPRAGUE 192P	0120-0004
A2CR1	DIODE: SILICON 1N1513	1900-0008
A2CR2	DIODE: SILICON 1N4446	1900-0002
A2CR3 thru CR6	DIODE: GERMANIUM 1N541	1900-0001
A2CR7 thru CR10	DIODE: SILICON 1N4446	1900-0002
A2Q1 thru Q6	TRANSISTOR: SILICON 2N3053	1850-0005
A2Q7	TRANSISTOR: SILICON FET	1850-0001
A2Q8,Q9,Q11	TRANSISTOR: SILICON 2N3053	1850-0005
A2Q10,Q12,Q16	TRANSISTOR: SILICON 2N4037	1850-0011

REFERENCE DESIGNATION	DESCRIPTION	PART NUMBER
A2Q13 thru Q15	TRANSISTOR: SILICON 2N3053	1850-0005
A2Q17,Q18	TRANSISTOR: SILICON 2N3053	1850-0005
A2R1,R9,R22	R: FXD COMP 10K OHM 5% ½W RC20GF	0686-1035
A2R2	R: FXD COMP 43K OHM 5% ½W RC20GF	0686-4335
A2R3	R: FXD FLM 2.21K OHM 1% 1/8W RN60D	0757-0001
A2R4	R: FXD COMP 750 OHM 5% ½W RC20GF	0686-7515
A2R5,R52,R68	R: FXD COMP 1.2K OHM 5% ½W RC20GF	0686-1225
A2R6,R46,R60	R: FXD COMP 820 OHM 5% ½W RC20GF	0686-8215
A2R7	R: FXD COMP 100K OHM 5% ½W RC20GF	0686-1045
A2R8	R: FXD COMP 120K OHM 5% ½W RC20GF	0686-1245
A2R10,R16	R: FXD COMP 4.7K OHM 5% ½W RC20GF	0686-4725
A2R11,R31	R: FXD COMP 47K OHM 5% ½W RC20GF	0686-4735
A2R12,R18	R: FXD COMP 3.3K OHM 5% ½W RC20GF	0686-3325
A2R13	R: FXD COMP 240 OHM 5% ½W RC20GF	0686-2415
A2R14	R: FXD COMP 1.8K OHM 5% ½W RC20GF	0686-1825
A2R15	R: VAR WW 3K OHM CTS-110-3000	2100-0005
A2R17	R: FXD COMP 24K OHM 5% ½W RC20GF	0686-2435
A2R19	R: FXD COMP 330 OHM 5% ½W RC20GF	0686-3315
A2R20,R29,R53,R69	R: FXD COMP 1K OHM 5% ½W RC20GF	0686-1025
A2R21	R: FXD COMP 8.2M OHM 5% ½W RC20GF	0686-8255
A2R23,R50,R66	R: FXD COMP 1.5K OHM 5% ½W RC20GF	0686-1525
A2R24,R33,R35	R: FXD COMP 6.2K OHM 5% ½W RC20GF	0686-6225
A2R25,R26,R70	R: FXD FLM 1K OHM 1% 1/8W RN60D	0757 0002
A2R27,R28	R: FXD COMP 510 OHM 5% ½W RC20GF	0686-5115
A2R30	R: FXD COMP 220K OHM 5% ½W RC20GF	0686-2245
A2R32,R36	R: FXD COMP 100 OHM 5% ½W RC20GF	0686-1015
A2R34	R: FXD COMP 12K OHM 5% ½W RC20GF	0686-1235
A2R37	R: FXD COMP 12K OHM 5% ½W RC20GF	0686-1235
A2R38,R40,R43,R57	R: FXD COMP 10K OHM 5% ½W RC20GF	0686-1035
A2R39	R: FXD COMP 180 OHM 5% ½W RC20GF	0686-1815
A2R41	R: VAR WW 100 OHM CTS-110-100	2100-0013
A2R42,R56	R: FXD COMP 620 OHM 5% ½W RC20GF	0686-6215
A2R44,R45,R58,R59	R: FXD COMP 4.7 OHM 5% ½W RC20GF	0686-0475
A2R47,R51,R61,R65	R: FXD COMP 100 OHM 5% ½W RC20GF	0686-1015
A2R48,R62	R: FXD COMP 3K OHM 5% ½W RC20GF	0686-3025
A2R49,R63	R: FXD COMP 27K OHM 5% ½W RC20GF	0686-2735
A2R54,R67	R: FXD COMP 15K OHM 5% ½W RC20GF	0686-1535
A2R55,R64	R: FXD COMP 1.6K OHM 5% ½W RC20GF	0686-1625
A3 CARD, PILOT FREQUENCY METER		
A3C1,C7,C22	C: FXD FLM 0.22 UF 10% 80 VDC SPRAGUE 192P	0120-0003
A3C2,C3,C6	C: FXD ELECT 5 UF 25 VDC SPRAGUE 30D	0180-0007
A3C4,C8	C: FXD MICA 250 PF 5% 500 VDC ELMENCO DM15	0140-0001
A3C5	C: FXD MICA 150 PF 5% 500 VDC ELMENCO DM15	0140-0014
A3C9	C: VAR CER 5.5 PF-18 PF ERIE 538-011 COPO92R	0121-0002
A3C10	C: FXD MICA 20 PF 5% 500 VDC ELMENCO DM15	0140-0004
A3C11	C: FXD MICA 500 PF 5% 500 VDC ELMENCO DM15 DM19 DM20	0140-0006
A3Cl2	C: FXD MICA 1000 PF 5% 500 VDC ELMENCO DM15 DM19 DM20	0140-0015
A3C13,C15	C: FXD FLM .01 UF 10% 200 VDC SPRAGUE 192P	0120-0005
A3C14	C: FXD FLM .047 UF 10% 200 VDC SPRAGUE 192P	0120-0004
A3C16,C18	C: FXD MICA 2000 PF 5% 500 VDC ELMENCO DM19 DM20	0140-0016
A3C17	C: FXD MICA 33 PF 5% 500 VDC ELMENCO DM15	0140-0008
A3C19,C23,C24	C: FXD ELECT 5 UF 25 VDC SPRAGUE 30D	0180-0007
A3C20	C: FXD CER .01 UF 100 VDC SPRAGUE TGS10	0150-0007
A3C21	C: FXD CER 1.0 UF 25 VDC SPRAGUE 5C13	0150-0002
A3CR1 thru CR4	DIODE: GERMANIUM 1N541	1900-0001

REFERENCE DESIGNATION	DESCRIPTION	PART NUMBER
A3CR5	DIODE: SILICON 1N4446	1900-0002
A3CR6	DIODE: SILICON 1N965B	1900-0007
A3L1,L2	INDUCTOR: VAR	9140-0010
A3Q1 thru Q5	TRANSISTOR: SILICON 2N3053	1850-0005
A3Q6 thru Q10	TRANSISTOR: SILICON 2N914	1850-0006
A3R1,R2	R: FXD COMP 3.9K OHM 5% ½W RC20GF	0686-3925
A3R3,R4,R10,R21	R: FXD COMP 33K OHM 5% ½W RC20GF	0686-3335
A3R5,R7	R: FXD COMP 18K OHM 5% ½W RC20GF	0686-1835
A3R6	R: FXD COMP 3.3K OHM 5% ½W RC20GF	0686-3325
A3R8	R: FXD COMP 1.5K OHM 5% ½W RC20GF	0686-1525
A3R9	R: FXD COMP 15K OHM 5% ½W RC20GF	0686-1535
A3R11	R: FXD COMP 120 OHM 5% ½W RC20GF	0686 1215
A3R12	R: FXD COMP 7.5K OHM 5% ½W RC20GF	0686-7525
A3R13	R: FXD COMP 1.2K OHM 5% ½W RC20GF	0686-1225
A3R14,R17,R20,R22	R: FXD COMP 2.2K OHM 5% ½W RC20GF	0686-2225
A3R15	R: FXD FLM 46.4K OHM 1% 1/8W RN60D	0757-0012
A3R16,R23	R: FXD FLM 20K OHM 1% 1/8W RN60D	0757-0013
A3R18,R26,R34	R: FXD COMP 100K OHM 5% ½W RC20GF	0686-1045
A3R19,R29,R33,R35,R37,R40	R: FXD COMP 10K OHM 5% ½W RC20GF	0686-1035
A3R24	R: FXD COMP 330 OHM 5% ½W RC20GF	0686-3315
A3R25,R28	R: FXD COMP 4.7K OHM 5% ½W RC20GF	0686-4725
A3R27	R: FXD COMP 56 OHM 5% ½W RC20GF	0686-5605
A3R30	R: FXD COMP 220K OHM 5% ½W RC20GF	0686-2045
A3R31	R: FXD COMP 5.6K OHM 5% ½W RC20GF	0686-5625
A3R32	R: FXD COMP 620 OHM 5% ½W RC20GF	0686-1035
A3R36,R39	R: FXD COMP 5.1K OHM 5% ½W RC20GF	0686-5125
A3R38	R: FXD COMP 1.6K OHM 5% ½W RC20GF	0686-1625
A3R41	R: FXD COMP 22K OHM 5% ½W RC20GF	0686-2235
A3Y1	CRYSTAL: 190.060 kHz	0410-0004

SECTION 7
SCHEMATIC DIAGRAMS

Section 7 contains circuit diagrams of the printed circuit card assemblies and chassis assembly. Note that all part numbers are prefixed by the assembly number (e.g. A2R34). The main chassis part numbers are not prefixed. Non-standard parts are labeled with only the reference designations. The parts list in Section 6 contains the Belar part number.



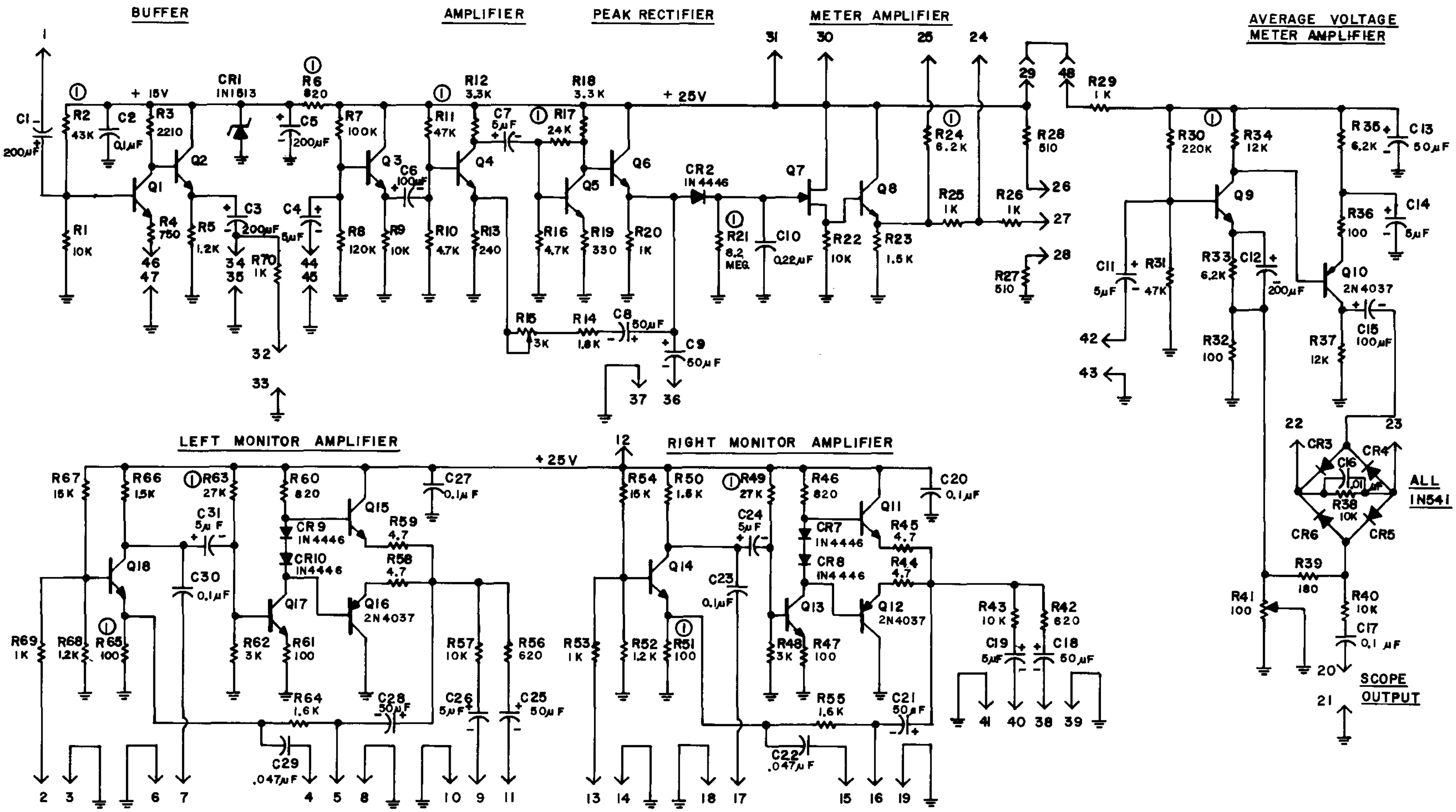
NOTES:

ALL RESISTANCE VALUES ARE IN OHMS.

1. VALUE SELECTED IN PRODUCTION, NOMINAL VALUE SHOWN.
2. ALL TRANSISTORS 2N3053 EXCEPT Q8 - 2N4037
3. MATCHED PAIR
4. MATCHED QUAD.

LAST		
	R	72
	C	38
	CR	11
	L	6
	Q	16
	T	1

Figure 7–1. A1 Card, Schematic



NOTE:
ALL RESISTANCE VALUES ARE IN OHMS.
(I) VALUES SELECTED IN PRODUCTION, NOMINAL VALUES SHOWN.

ALL TRANSISTORS 2N3053 EXCEPT Q7, Q10, Q12 & Q16

LAST Q18
CR10
C 31
R 70

Figure 7–2. A2 Card, Schematic

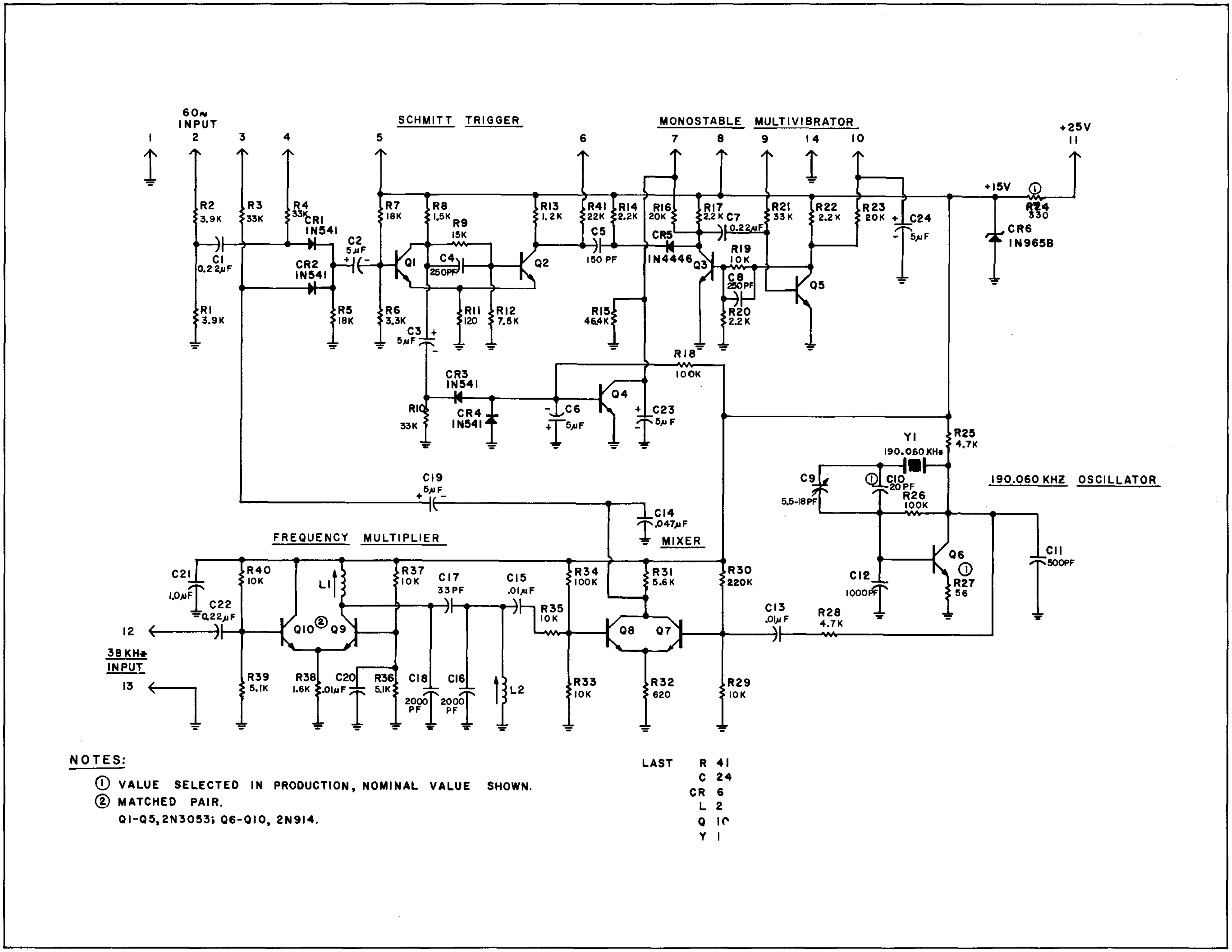
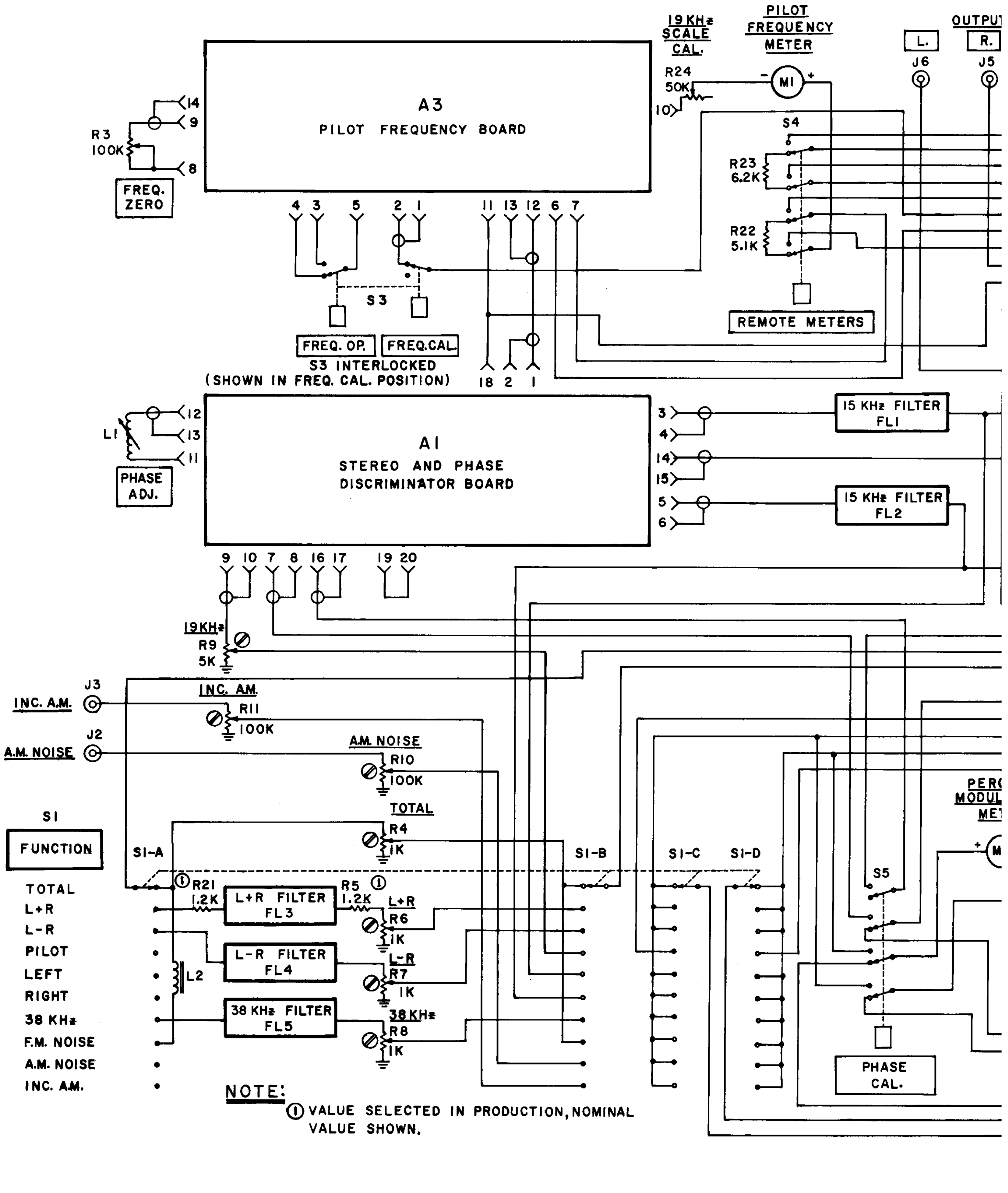


Figure 7-3. A3 Card, Schematic



NOTE:
(1) VALUE SELECTED IN PRODUCTION, NOMINAL VALUE SHOWN.

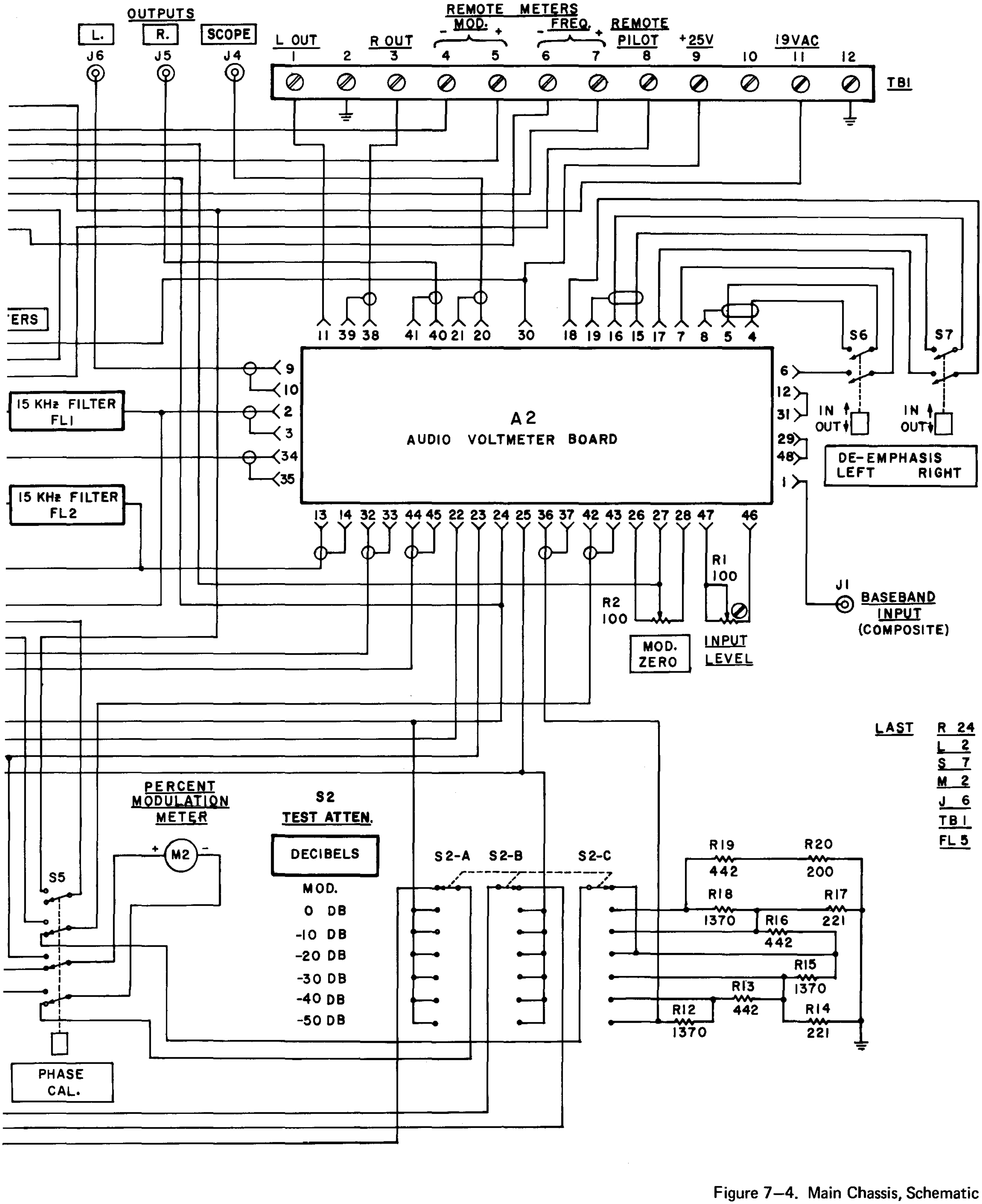


Figure 7–4. Main Chassis, Schematic

BELAR ELECTRONICS LABORATORY, INC.