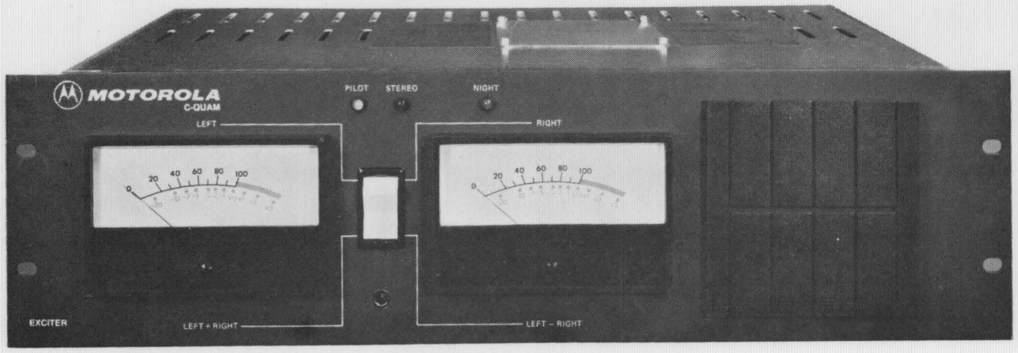
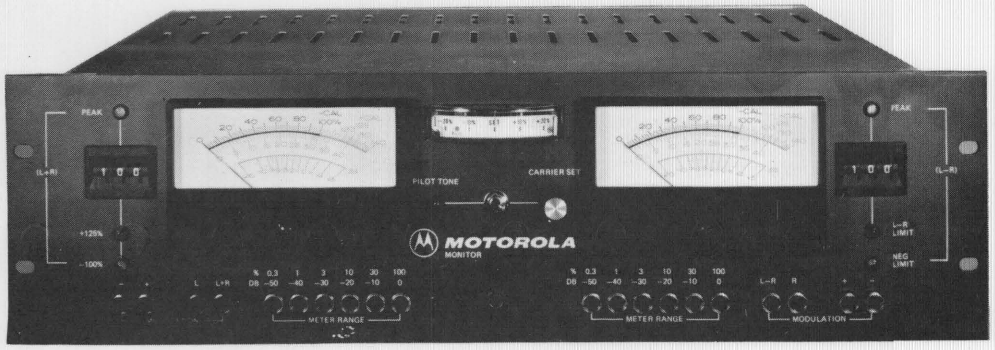
MOTOROLA INC.



EXCITER
MODEL 1300



MONITOR
MODEL 1310

C-QUAM®
AM STEREO
OWNERS MANUAL

NOTICE

The Motorola Model 1300 AM stereo exciter has met the Federal Communications Commission requirements for Type Acceptance under Part 73 and Part 2 of the Commission's Rules and was granted Type Acceptance, FCC ID ABY89F1300.

Any modifications to this equipment by the user may be a violation of Section 2.1001(e) and/or Section 73.1660 of the FCC rules and may void the Type Acceptance.

If a user is considering a modification to this equipment, it is strongly recommmended that Motorola AM Stereo be contacted for technical and procedural guidance prior to attempting any changes. For infomation, telephone (312) 576-2879.

Motorola, Inc.
AM Stereo
Schaumburg, Illinois

CAUTION: READ THIS BEFORE OPERATING EQUIPMENT

These technical comments regarding control adjustment of your Motorola AM Stereo equipment represent a few of the critical areas that can affect your station's stereo performance.

1. FRONT PANEL CONTROLS

A. – LIMITING. **Do not touch this control.** It should be set only by Motorola authorized personnel.

B. L + R ADJ-1. Sets output level of L + R signal fed to modulation input of station transmitter number 1. This is **not** a means of increasing the amount of modulation into your transmitter. To make C-Quam compatible, two L + R's are sent through your transmitter; one in the standard envelope channel and one in quadrature through the RF channel. In order to work properly the two L + R's must have the same percentage of modulation, however, the quadrature is controlled by the exciter and the envelope is dependent on the audio sensitivity of the transmitter. The L + R ADJ control is put on the exciter in order to **match** these modulation levels. If not adjusted properly the **stereo** performance is affected.

Should you require **additional envelope audio** it can be obtained by adjusting your **audio processor** outputs. If you are adjusting L and R gains, "mono" the signal from the generator and set for minimum L – R at the new level. Don't forget to turn off the pilot for best indication of L – R rejection.

C. L + R ADJ-2. Same as L + R ADJ-1 except used only with a second (night) transmitter.

D. BALANCE. **This control should not be touched.** The audio processor gain controls provide this feature.

FRONT PANEL SWITCHES

A. MONO/STEREO. This switch was intended as an analysis tool and is not for the demonstration of stereo. If switched while the transmitter is running do it **SHARPLY** or drive may momentarily be affected and cause breakers to trip! A better practice is to avoid its use except when the plate power is off.

B. PILOT. Remember to turn the pilot on to trigger Motorola decoders into the stereo mode. Also remember to remove the pilot when measurements are being taken or the readings will all show 5% (pilot level) distortion and limited separation.

C. NIGHT. This switch is active only if your exciter is equiped with a full night board. It does the same thing as contact closure on the rear contacts. **Remember:** If the front switch is "ON", the rear contacts will not function so if used in a remote situation remember to leave it in the "DAY" position.

D. L + R ENV. This switch momentarily interupts the left hand meter function and indicates envelope drive regardless of the position of the front panel rocker switch.

No other switches or controls should be touched in day-to-day operation. Before you touch anything else either read the manual or call Motorola.

NOTE: The L + R's in the phase and envelope channels MUST be in phase. It is imperative that the envelope polarity not be disturbed. To establish the correct polarity use the sample transmitter on the exciter and your transmitter monitor sample on a dual trace oscilloscope.

+ PEAK POLARITY. Sometimes phase reversals occur in the audio chain that cause positive peaks to end up driving the carrier towards the trough. This can be corrected by reversing both L and R leads at the exciter. DO NOT CORRECT THIS CONDITION BY REVERSING THE ENVELOPE!

Your Motorola C-Quam system is installed by a specially trained broadcast engineer to insure optimum performance. Do not adjust any controls unless you have a complete understanding of the system and alignment procedure. If you are uncertain, telephone the Motorola AM Stereo Engineering Department for direction.

MOTOROLA INC.

AM STEREO SYSTEM C-QUAM®

EXCITER MODEL 1300
MONITOR MODEL 1310

FCC I.D. ABY89F1300

MOTOROLA INC., 1216 Remington Road, Schaumburg, IL 60195 (312) 576-2879

GENERAL INFORMATION

SAFETY PRECAUTIONS

This manual is intended for trained and qualified operating or service personnel who are familiar with the dangers inherent to handling potentially hazardous electrical and/or electronic circuits. It is not intended to contain a complete statement of all safety precautions which should be observed by personnel in using this or other electronic equipment.

As with all electronic equipment, care should be taken to avoid electrical shock in all circuits where substantial currents or voltages may be present.

The procedures outlined in this Manual are based on the information available at the time of publication. However, the manufacturer cannot assume liability with respect to technical application of the contents and shall, under no circumstances, be responsible for damage or injury (whether to person or property) resulting from its use.

REPLACEMENT PARTS

To obtain new service replacement or warranty items, contact Motorola at the location shown below and please supply Product Identification (Model Number, and Serial Number) and Replacement Part Identification (including Stock Number and Description). Requests for replacements may be unduly delayed if all this information is not supplied. A complete parts list is provided in this manual.

EQUIPMENT DAMAGED IN TRANSIT

If concealed damage is discovered, immediately notify the carrier, confirming the notification in writing, and secure an inspection report. This item should be unpacked and inspected for damage WITHIN 15 DAYS after receipt. Report all shortages and damages to Motorola at the location shown below.

Motorola will file all claims for loss and damage on this equipment so long as the inspection report is obtained. Disposition of the damaged item will be furnished by Motorola.

FIELD ENGINEERING SERVICE

Requests for installation, field engineering or service assistance should be directed to Motorola at the location shown below.

MOTOROLA INC., 1216 REMINGTON ROAD, SCHAUMBURG, IL 60195 **312/576-2879**

COMMERCIAL WARRANTY
(STANDARD)

Motorola AM stereo radio broadcast products are warranted to be free from defects in material and workmanship for a period of one (1) year, (except for crystals and channel elements which are warranted for a period of ten (10) years) from the date of shipment. In the event of a defect during the applicable warranty period, if customer returns the defective part or product to Motorola, transportation prepaid, Motorola, at its option, will either repair or replace such part or product, and such action by Motorola shall be the full extent of Motorola's obligation hereunder. Motorola will pay the transportation charges to return the part or product to customer. Parts, including crystals and channel elements, will be replaced free of charge for the full applicable warranty period, but the labor to repair the product or replace defective parts will only be provided for One Hundred-Twenty (120) days from the date of shipment. Thereafter, customer must pay for labor involved in repairing the product or replacing defective parts at Motorola's then prevailing rates together with any transportation charges to and from the place where warranty service is provided.

This warranty is void if:

a. the product is used in other than its normal and customary manner;
b. the product is subject to misuse, accident, neglect or damage;
c. unauthorized alterations or repairs are made, or unapproved parts are used in the equipment.

This warranty extends only to individual products. Because each radio broadcast system is unique, Motorola disclaims liability under this warranty or otherwise for range, coverage, performance or operation of the system as a whole. This warranty applies only within the United States and is extended by Motorola Inc., 1216 Remington Road, Schaumburg, Illinois 60195, to the original purchaser, and only to those purchasing the product solely for commercial, industrial, or governmental use. In order to obtain performance of this warranty, customer must contact its Motorola salesperson or Motorola at the address stated herein, attention: Quality Assurance Department.

THIS WARRANTY IS GIVEN IN LIEU OF ALL OTHER WARRANTIES EXPRESS OR IMPLIED, ALL OF WHICH ARE SPECIFICALLY EXCLUDED, INCLUDING, BUT NOT LIMITED TO, THE WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL MOTOROLA BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.

MOTOROLA C-QUAM AM STEREO BROADCAST EQUIPMENT

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SECTION A. INSTALLATION

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SECTION B. PERFORMANCE MEASUREMENTS (Audio Proof, Instructions and Forms)

SECTION C. PRINCIPLES OF OPERATION

SECTION D. MAINTENANCE/TROUBLESHOOTING

SECTION E. SCHEMATICS, CIRCUIT CARDS, & PARTS LISTS

INSTALLATION

I. UNPACKING AND MECHANICAL CHECKOUT

The shipping cartons for the exciter and monitor are designed to protect the equipment for normal handling during shipment. Thoroughly inspect the equipment for any evidence of mishandling and report damage to the carrier immediately.

For additional information, refer to the general information section.

CAUTION! COMPLETE THIS PROCEDURE BEFORE
APPLYING POWER TO UNITS

To prevent breakage, the circuit cards are not rigidly secured in their guides. Therefore, occasonally during shipment, the circuit cards may become loose. Prior to operating this equipment, all circuit cards should be reseated in their sockets as follows:

Remove all screws from the top and back panels of both the exciter and the monitor. Carefully move each circuit card from its socket by pulling it toward the rear of the cabinet and then push it back into its socket until fully seated. The circuit cards should only be moved by pulling on the top of the card itself and NOT by any components.

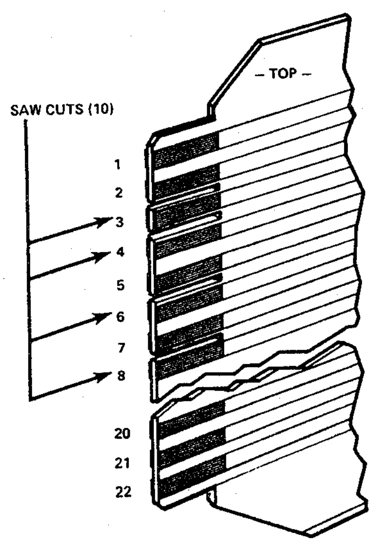
After reseating all circuit cards, secure the top metal cover to the monitor only. The exciter cover and back will be replaced after adjustments have been completed, however, on models incorporating a top access plate, the exciter cover may also be secured now.

II. CLOSED LOOP CHECKOUT

Recommended Test Equipment

The following test equiment is recommended for use during installation of the Motorola AM stereo exciter and monitor.

1. Low distortion oscillator, 600 ohms output, +10 dBm, less than 0.1% distortion.
2. Distortion analyzer, capable of indicating distortion levels of less than 0.1% distortion.
3. Oscilloscope, bandwidth 10 MHz or better, capable of X-Y display of audio frequencies with no appreciable phase shift.
4. Spectrum analyzer, frequency range covering the AM broadcast band, better than 60 dB logarithmic scale, and a resolution of better than 300 Hz.
5. Vector card extender with receptacle, part number 3690-6 which must be modified as shown below.



MODIFICATION TO BYPASS KEYING PLUGS

1. Designate a "TOP" reference
2. Make (10) Saw Cuts Approximately 1/16" wide by 3/8" deep between the following lands.

2/3	11/12
3/4	12/13
5/6	14/15
7/8	16/17
9/10	18/19

The spectrum analyzer may not normally be part of a broadcast station test equipment. It can normally be rented for a reasonable fee, and it is highly recommended that it be available during the installation.

Checkout and Installation Outline

There are a number of steps which should be taken in sequence to achieve the best results with the Motorola AM stereo system. The first part of the procedure involves checking the exciter and monitor connected directly together (closed loop) in order to confirm that the equipment operates with essentially the same performance as it did when final tested at the factory.

After it has been confirmed that the Motorola equipment is operating properly, the monitor is then used to make performance measurements on the broadcast transmitter. Of particular importance is the level of incidental phase modulation generated by the broadcast transmitter. This level of IPM must be sufficiently low before attempting stereophonic operation.

When the broadcast transmitter has achieved acceptable IPM performance, then the Motorola AM stereo exciter is connected. First the R.F. interface is completed so that the transmitter takes its R.F. drive from the exciter, and then audio connections are made.

Adjustments of audio drive, the delay networks, and other procedures are then conducted until the overall stereo performance meets the FCC and the more stringent Motorola standards. Finally, the required FCC equipment performance measurements are made.

After the technical specifications are met and proven, tests are made under program conditions including adjustment of modulation and audio processing equipment.

Closed Loop Connections

The distortion analyzer, oscilloscope and spectrum analyzer should be initially connected to the exciter and monitor as shown below in Figure 1.

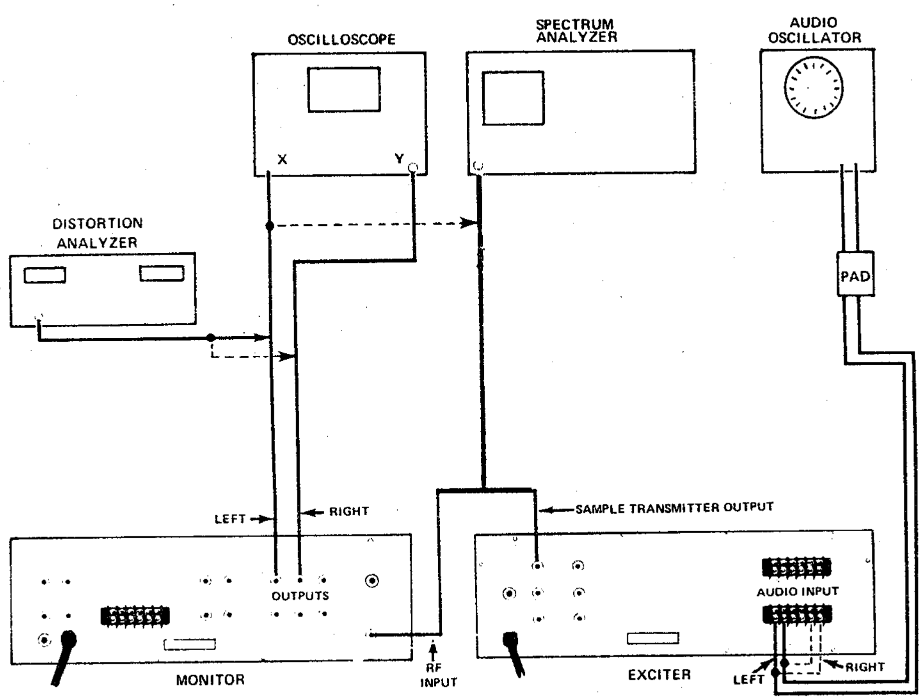


Figure 1. Closed Loop Equipment Arrangement

The input impedance to the spectrum analyzer is usually 50 ohms as is the input impedance of the monitor and the output of the exciter sample transmitter. The oscilloscope input can be paralled with the spectrum analyzer input because the oscilloscope input is usually high impedance. The distortion analyzer input can also be unbalanced and it will be used to take measurements from several of the monitor outputs appearing at BNC connectors on the rear of the unit.

An audio oscillator is connected to 600 ohm unbalanced exciter input terminals, and the following test input modes are required: left only, right only, left plus right and left minus right. In the left or right only function, the audio oscillator (balanced or unbalanced) can be directly connected to the input terminals. For L+R or L−R, the exciter audio inputs are paralleled either in phase, or out of phase. In either case, the input impedance of the paralleled inputs is 300 ohms. Although usually not necessary with high quality audio oscillators, a matching pad can be constructed as follows.

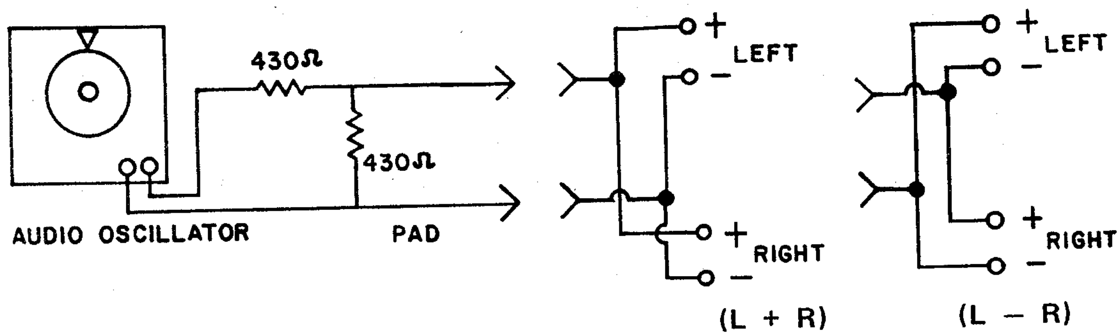


Figure 2.

Some oscillators already contain the switching and matching for the four modes of operation which simplify testing for AM or FM stereo.

Exciter to Monitor Closed Loop Checkout (Start of Test)

Before attempting to connect the Motorola AM stereo equipment to the station transmitter, it is most important to make a check of the stereo equipment performance by directly connecting the AM stereo exciter to the modulation monitor. This not only will provide a check of the equipment performance prior to installation, but will also help acquaint the broadcast station personnel with the operation of the stereo equipment.

The exciter unit has a self-contained amplitude modulator which provides an output signal of approximately 1 volt RMS at 50 ohms and contains the completely encoded C-Quam AM stereo signal. This output (labeled – Sample Transmitter Output) could also be used to test receivers without having to use the broadcast transmitter.

The Sample Transmitter Output should be connected to the monitor "R.F. Input" with a BNC to BNC coaxial cable. The A.C. power to the exciter and the monitor can be applied by plugging in the line cords to a suitable A.C. outlet. There are no power switches to either the exciter or the monitor. Therefore, the line cords must be unplugged to turn either unit off.

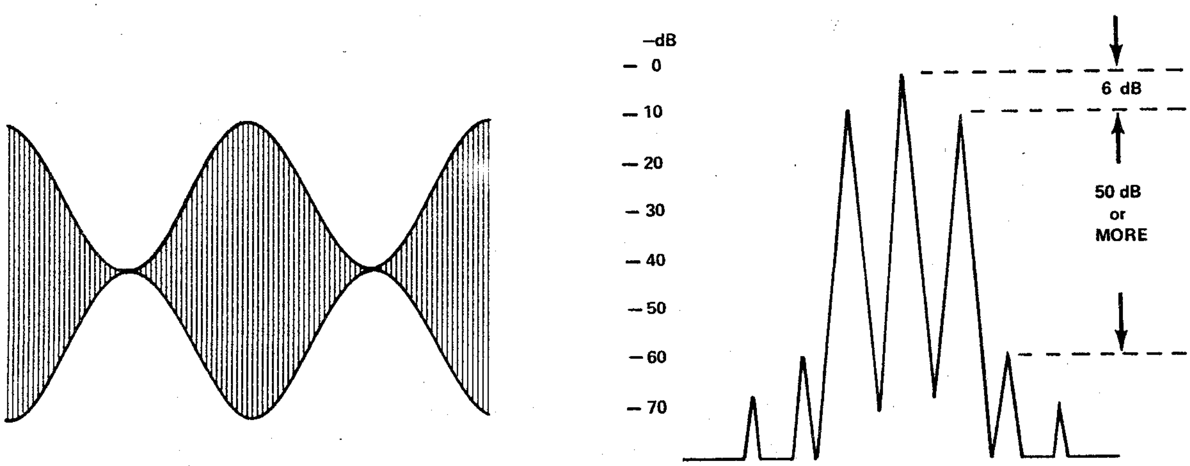
After applying A.C. power, the lights for all meters should be illuminated. The small toggle switch on the monitor under the carrier level meter should be thrown to the right-hand position, toward the carrier set knob. This is a meter switch and normally will be switched to the right-hand position except when checking the pilot tone level.

The appropriate R.F. input level to the monitor is adjusted by a step attenuator which is controlled by a rotary switch on the rear of the monitor (MR8) and the potentiometer front panel control (MF11). Observe the carrier level meter while adjusting the input level using the front panel knob. The time constant for the meter circuitry is very long, so wait about one (1) second after adjusting the knob to determine if the adjustment is within range of the front panel control. If not, reset the switch attenuator and readjust the front panel control for a center indication on the carrier meter.

With no audio input to the exciter, the noise level indicated on the monitor should be lower than 50 dB for L+R or –40 dB for L–R. This is read by selecting on the monitor front panel L+R for the left meter (MF4) and L–R for the right-hand meter with (MF6). For each meter there is a row of pushbuttons providing meter ranges in 10 dB steps. The push button selection and the meter indication on the red dB scale are added together for a measurement referenced to 100% modulation.

Left Plus Right (AM) Operation

The output of the audio oscillator should now be connected through the pad to the left and right audio input terminals of the exciter, phasing the inputs for L+R operation. The monitor left-hand meter control buttons (MF4) should select (+) and (L+R). Set the oscillator frequency to 1 kHz and advance the audio level from the audio oscillator until the meter reads 100 percent modulation. Observe both the oscilloscope display of envelope modulation, and the spectrum analyzer (at the exciter sample transmitter output). If the range of the instruments are set properly, the displays should appear as follows:



Oscilloscope Envelope **Spectrum Analyzer**

Figure 3.

At 100 percent negative modulation, the oscilloscope envelope pattern should just pinch off to zero signal and the first order sidebands on the spectrum analyzer display should be exactly 6 dB down from the carrier. The high order sidebands on the spectrum analyzer should be at least 50 dB below the fundamental sidebands indicating AM distortion less than 0.3 percent. However, be careful in setting the oscillator level because if the modulation is even slightly more than 100 percent negative, the high order distortion sidebands will increase very rapidly. Make the adjustment in modulation level more than 100 percent and watch the high order sidebands change.

After finding the 100 percent negative point from the test instruments, observe the monitor modulation meter indication and flasher lights. The 100 percent negative light should be illuminated and the left-hand panel meter should indicate 100 percent modulation. Adjust the digital switch immediately to the left of the meter to 100 percent, and the corresponding LED indicator should also light.

For distortion measurements on L+R, it is recommended that 95% modulation be used preventing erroneous distortion measurements which can result from inadvertant over modulation. So, reduce slightly the oscillator level until 95% modulation is shown on the meter. Connect the distortion analyzer to the L+R (MR11) BNC connector on the rear of the monitor.

At this time a series of audio measurements can be made to determine if the performance is within specifications. Generally the performance should be at least as follows:

Frequency response:	±1.0 dB from 30 Hz to 10 kHz
Distortion:	Less than 0.3%
Noise:	Lower than 60 dB below 100% modulation

Main to Subchannel Crosstalk (L+R to L–R Crosstalk)

The isolation between the normal amplitude modulation and the added stereo information will have a direct bearing on the separation obtainable between the left and right stereo channels. Closed loop measurements should be made to confirm that the exciter to monitor operation is capable of transmitting and indicating sufficient isolation.

The transmitted signal is the same as the previous L+R (AM) measurements. However, instead of looking at the L+R monitor output, measurements will be made of the residual signal in the L–R detector.

First modulate the exciter with 95% L+R with a 1 kHz tone and observe the right-hand meter (MF1). Select the L–R function with the push buttons (MF6), and push the range selector buttons (MF3) until a reading is obtained. On the exciter, adjust balance control (EF13) until a null in the monitor L–R indicator is obtained. Readjust the oscillator output for 95% amplitude (L+R) modulation.

The main to subchannel crosstalk can now be measured over the audio frequency range. The measurements should be within the following specifications:

Crosstalk, L+R to L–R:	35 dB from 20 Hz to 5 kHz
	25 dB from 20 Hz to 10 kHz

The residual signal which appears in the L–R channel can result from the limitations in the modulation monitor but under normal broadcast transmitter operation the first limitation is likely to be the incidental phase modulation (IPM) of the transmitter. When the AM transmitter is modulated, not only is the RF amplitude modulated, but there is a small amount of phase modulation, especially at higher negative levels of modulation. The readings of L–R modulation on the monitor will be used later to adjust the transmitter for minimum incidental phase modulation, or more accurately, for the Motorola system, minimum incidental quadrature modulation.

– NOTE –

The following forms are provided for your convenience to record measurements while becoming familiarized with the equipment. It is left to your judgement if the indicated measurements are to be recorded.

Exciter to Monitor Closed Loop Checkout
L + R Performance

Exciter Serial ______________

Monitor Serial ______________

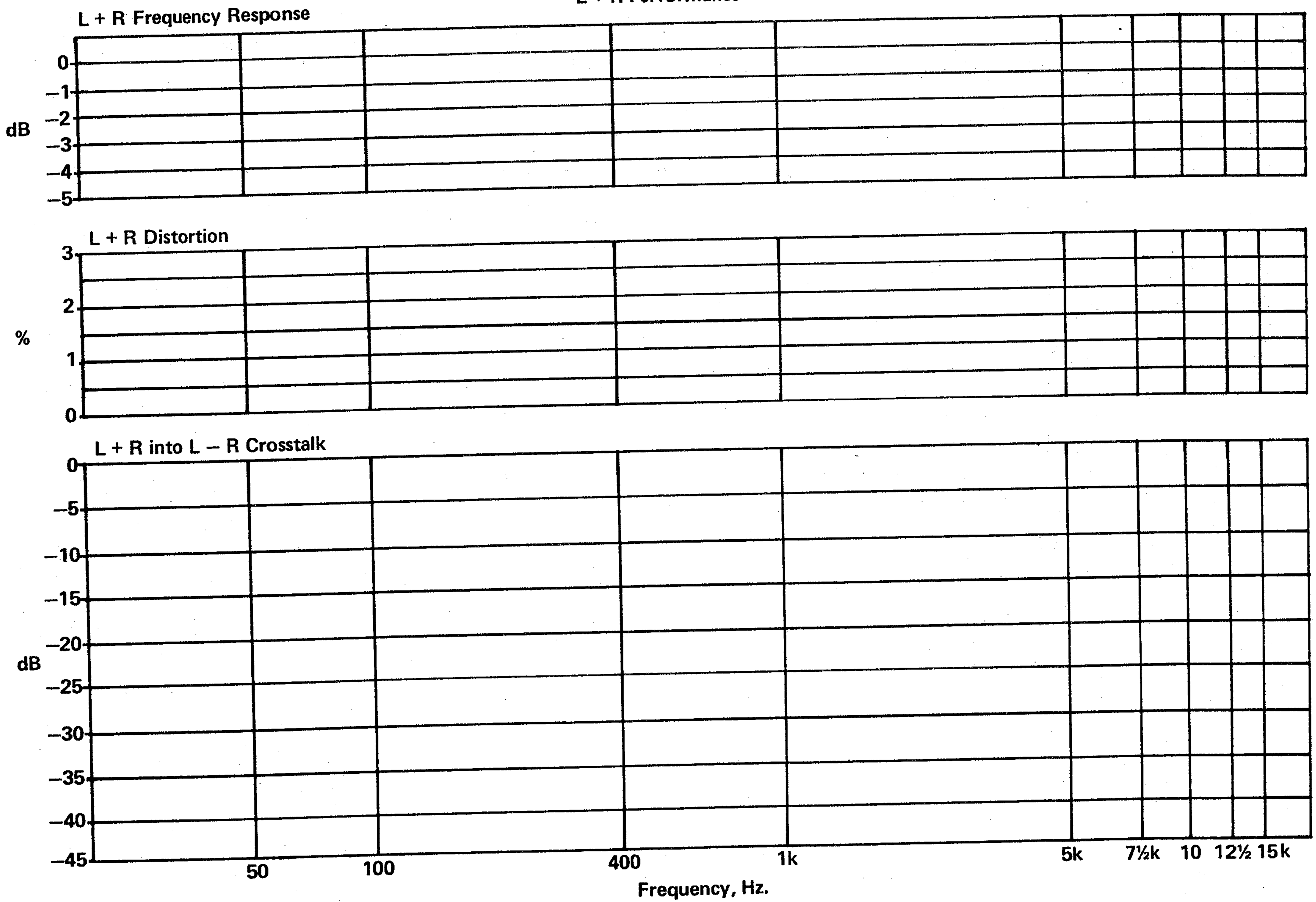
Radio Station ______________

Date ______________

Frequency, Hz.

	50	100	400	1k	5k	7½k	10k	12½k	15k
L + R Frequency Response 95% Modulation				0 dB					
L + R Distortion 95% Modulation									
L + R into L – R Crosstalk (IPM)									
L + R Noise Level									

Exciter to Monitor Closed Loop Checkout
L + R Performance



Subchannel (L–R) Performance Fidelity

Turn off the 25 Hz pilot using the pushbutton located on the front panel of the exciter. Set up the exciter with a 1 kHz tone set to 95% amplitude modulation (L+R). Reverse the polarity of one of the inputs to the exciter which switches the modulation to 95% L–R modulation. Observe the monitor right-hand meter and set the selector pushbutton (MF6) to "L–R". The meter should read within a few percent of 95%. The distortion and noise meter are connected to the BNC connector in the rear of the monitor labeled "L–R". Fidelity measurements should show performance within the following specification:

Frequency response:	±1.0 dB from 30 Hz to 10 kHz
Distortion:	Less then 0.5%
Noise:	Lower than 40 dB below 100% modulation

Subchannel (L–R) Crosstalk Performance

In addition to the fidelity assessment, measurement of the "crosstalk" or L–R into L+R should be made. The exciter audio input connections remain as above but the distortion meter should be connected to L+R BNC connector at the rear of the monitor. Crosstalk measurements can be observed by setting the right front panel meter to L+R and reading directly from the modulation monitor.

Subchannel (IAM) Indicated Amplitude Modulation

The L–R into L+R crosstalk minimum performance should exceed the value shown in Figure 8.

Exciter to Monitor Closed Loop Checkout
L — R Performance

Exciter Serial ____________

Monitor Serial ____________

Radio Station ____________

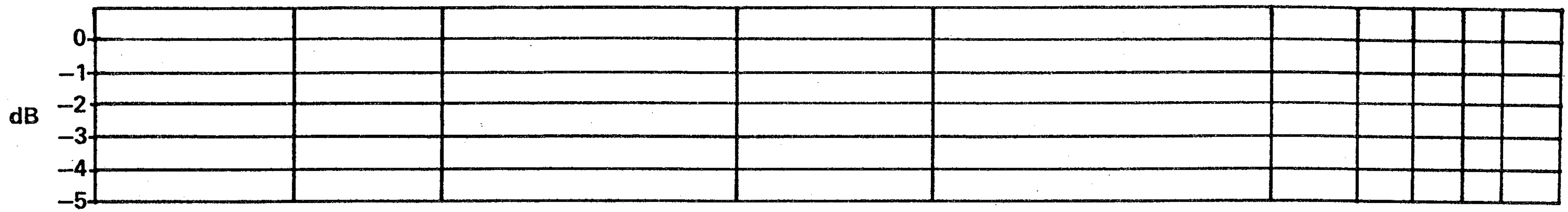
Date ____________

Frequency, Hz.

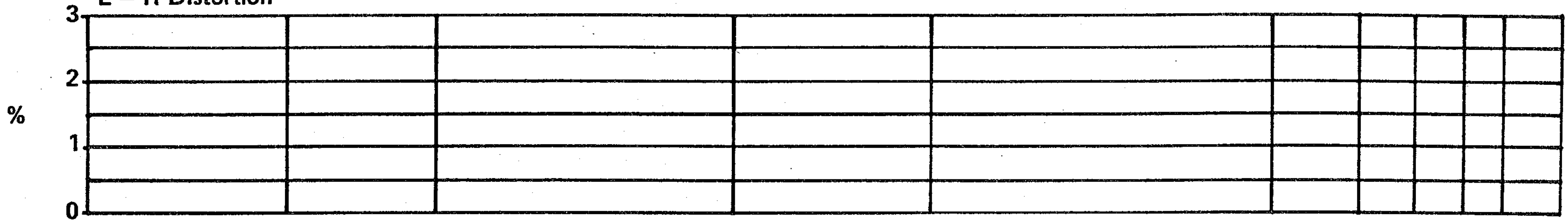
	50	100	400	1k	5k	7½k	10k	12½k	15k
L — R Frequency Response, 95% Modulation				0 dB					
L — R Distortion 95% Modulation									
L — R into L + R Crosstalk, (Incidential Amplitude Modulation)									
L — R Noise Level									

Exciter to Monitor Closed Loop Checkout
L – R Performance

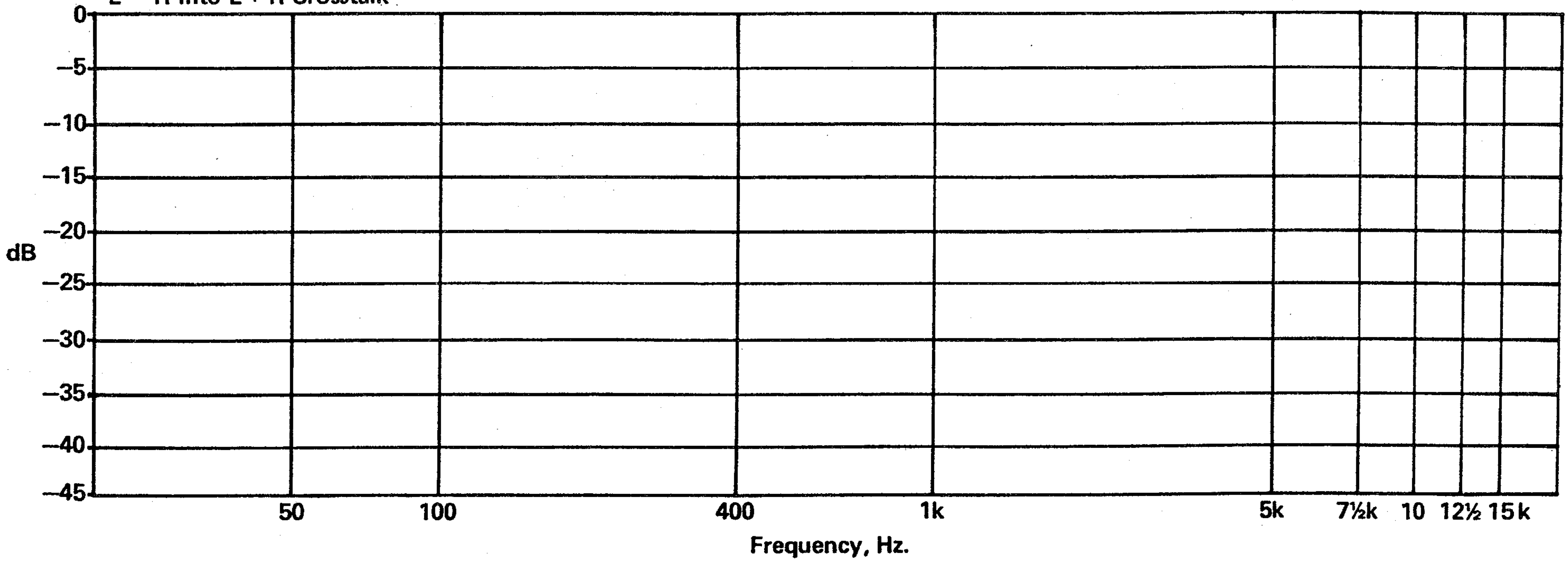
L – R Frequency Response



L – R Distortion



L – R into L + R Crosstalk



Single Channel Performance

Connect the audio oscillator to the exciter left channel input and adjust a 1 kHz tone to 50% modulation. The monitor indication of 50% modulation should be shown on the left meter in the L+R and left positions. The left-hand meter on the modulation monitor is switched from reading L+R to Left with pushbuttons (MF4). The right-hand meter can be switched from reading L–R to Right channel output using pushbutton (MF6). The separation for 100% modulation can be read directly on the right meter by selecting the appropriate scale with pushbuttons (MF3).

– NOTE –

For 50% modulation, the reference (on the dB scale) is 6 dB lower, therefore the separation will be 6 dB less than that indicated. This would be called the left into right separation. Connecting the oscillator to the right channel and reading the residual into the left channel would be the right into left separation.

The separation between the two channels should meet the following specification both ways.

Separation between:	200 Hz and 5 kHz – 30 dB
	30 Hz and 15 kHz – 15 dB

If the separation specification is not obtainable, then the setting of the delay equalization should be checked, see page number 23.

Meter Compression

The circuits driving the meters use an active multiplier keeping the audio output constant regardless of the RF input over any given range. Because the multipliers tend to compress the dynamic range of the signal it may limit the reading obtainable with the meters. Expect a noise floor on (L–R) of about –40 dB and errors in separation ranging from approximately zero to 6 dB. It is therefore mandatory that actual proof numbers be taken from rear connectors with the RF set on centerline for best results. The rear connectors are not influenced by the multipliers so their level is signal dependent and calibration of the system is done at the RF set position.

Exciter Serial ____________

Monitor Serial ____________

Radio Station ____________

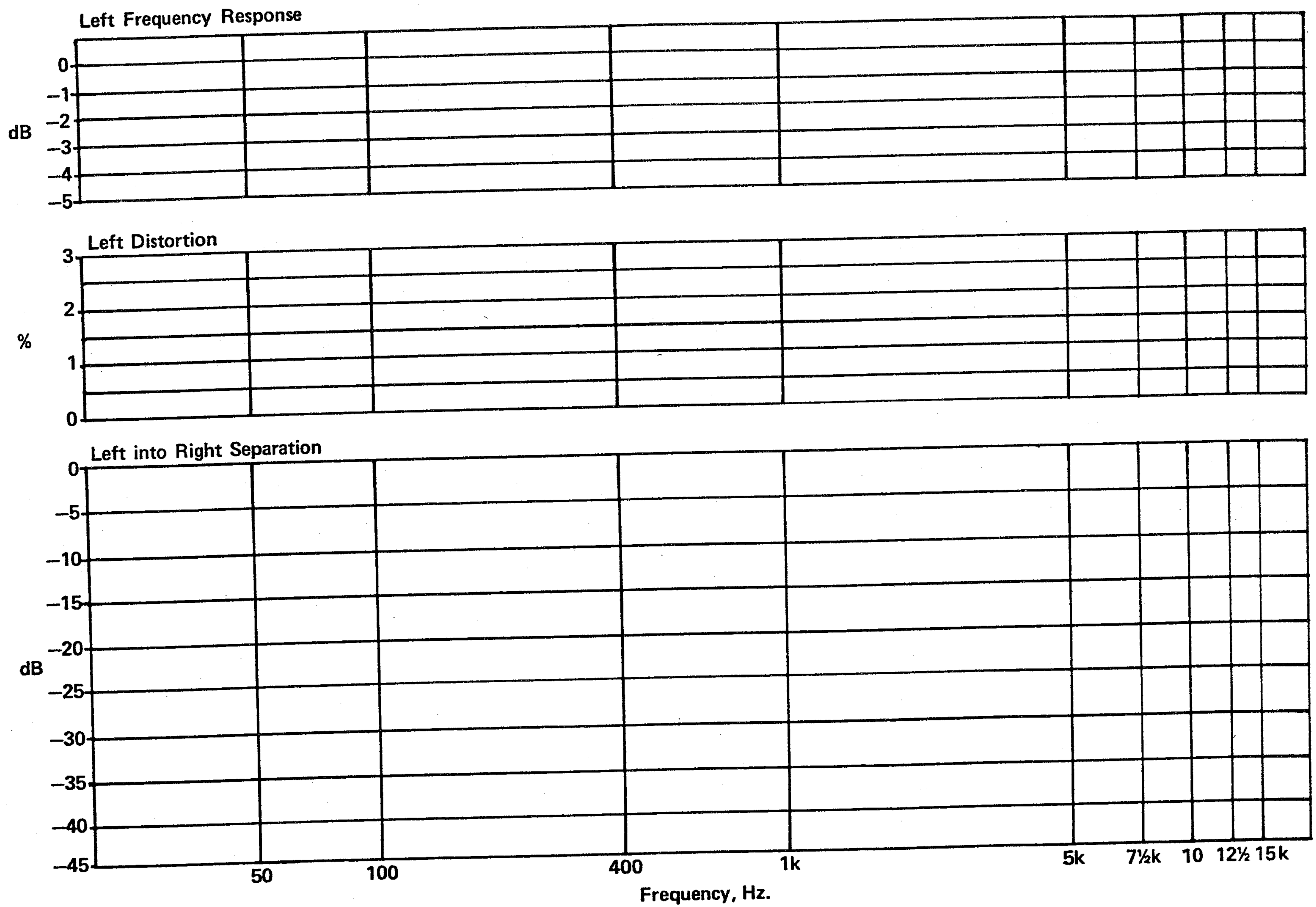
Date ____________

Exciter to Monitor Closed Loop Checkout
Right Channel Performance

Frequency, Hz.

	50	100	400	1k	5k	7½k	10k	12½k	15k
Right Channel Audio Frequency Response, 50% Modulation				0 dB					
Right Channel Distortion 50% Modulation									
Right Channel into Left Separation, 50% Modulation									
Right Channel Noise Level									

Exciter to Monitor Closed Loop Checkout
Left Channel Performance



Exciter to Monitor Closed Loop Performance
Left Channel Performance

Exciter Serial ______________

Monitor Serial ______________

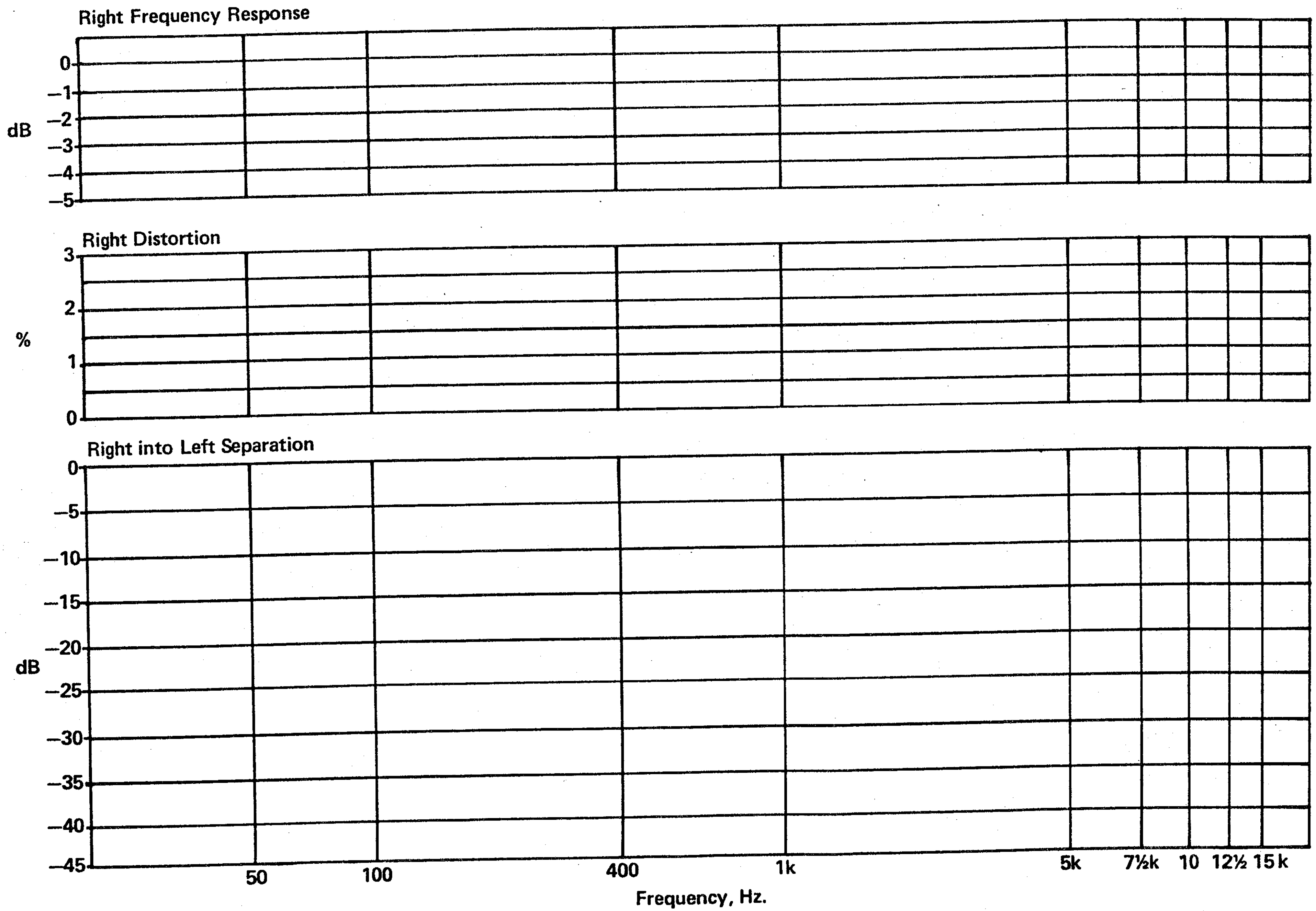
Radio Station ______________

Date ______________

Frequency, Hz.

	50	100	400	1k	5k	7½k	10k	12½k	15k
Left Channel Frequency Response, 50% Modulation				0 dB					
Left Channel Distortion 50% Modulation									
Left Channel into Right, Separation, 50% Modulation									
Left Channel Noise Level									

Exciter to Monitor Closed Loop Checkout
Right Channel Performance



Exciter Delay Equalization (for sample transmitter)

The Motorola AM stereo system is connected to the AM broadcast transmitter via two inputs; audio and R.F. In most transmitters, the amount of time it takes for the R.F. and the audio to propagate through the transmitter is different, (usually the audio takes longer). If the difference in propagation time is not corrected, the L+R and L–R information contained in the R.F. channel will arrive at the receiver earlier than the L+R information with the resultant loss of separation due to improper dematrixing. Thus, the exciter contains circuitry which can be switched in and adjusted to delay the audio fed to the exciter internal modulators to match the characteristics of the transmitter.

The exciter SAMPLE TRANSMITTER is used for CLOSED LOOP testing of the EXCITER and MONITOR. Normally it is necessary to delay the "Q" channel because the propagation times through the SAMPLE TRANSMITTER are different, therefore requiring compensation. Set FRONT PANEL "NIGHT/ DAY" switch to the "DAY" position. Check on the NIGHT AUDIO CIRCUIT CARD (refer to component view in back of manual) that the DELAY SWITCHES S608 and S609 (located near the rear of the card) are set to zero position and that the PROCESS DEFEAT switch S607 is in the DEFEAT position (switch handle pointing to the outer edge of the NIGHT AUDIO CIRCUIT CARD. Using and oscilloscope set for x-y display, observe the LEFT and RIGHT unbalanced signal outputs at the ports J808 and J809 on the monitor. Compare the oscilloscope display with those shown on Page 18, 19 and 24.

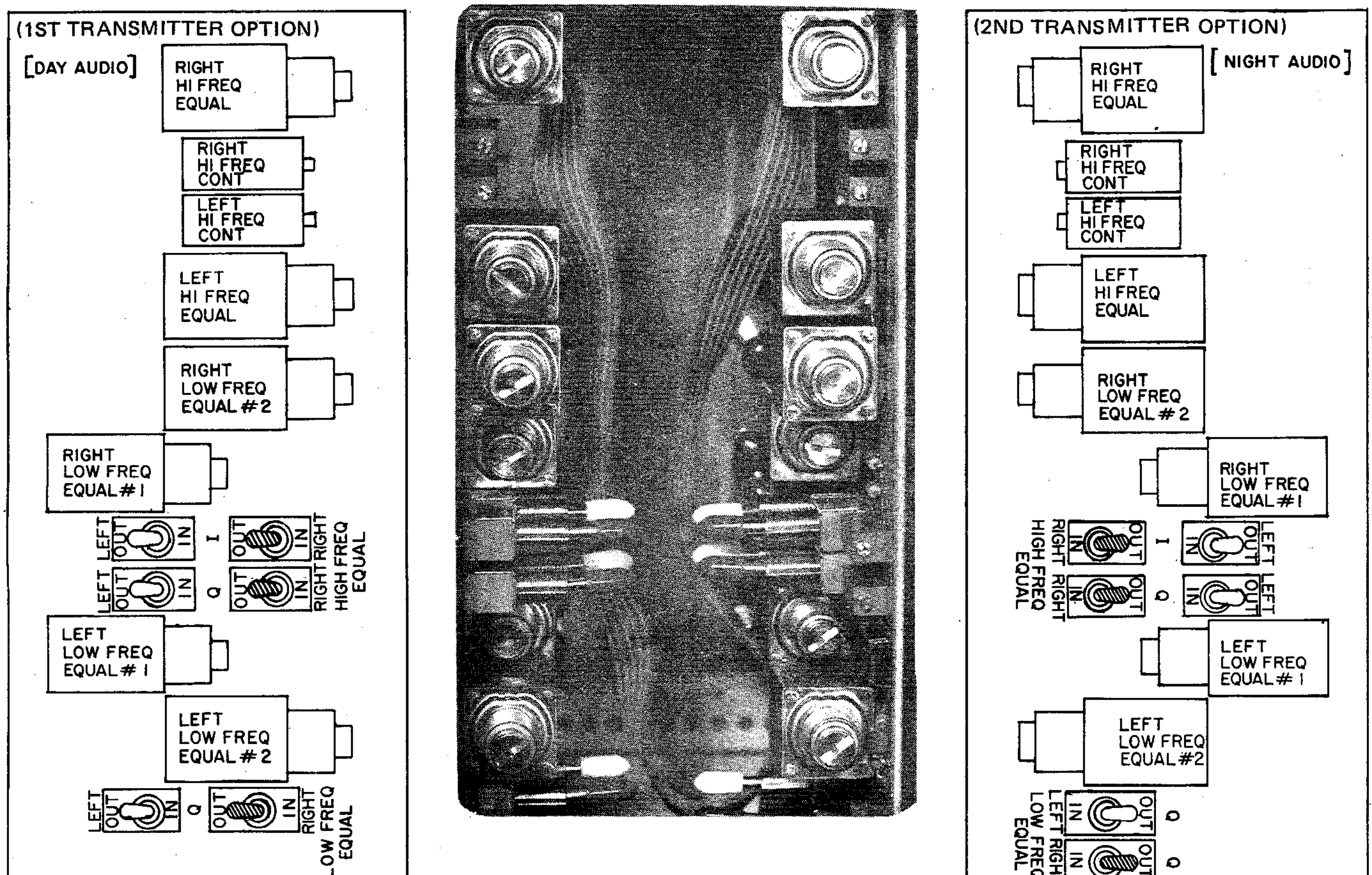


Figure 4.

Exciter Equalization Adjustments (Under Top Cover Access)

If delay equalization corrections are necessary, proceed as follows and then repeat the single channel performance measurements on Page 11. The corrections are performed ON THE DAY AUDIO CIRCUIT CARD by setting (HI FREQ EQUAL "I") switches S303 and S305 (shown in Figure 4) to the "IN" position. Adjust R389 and R391 (LEFT HI FREQ CONT) and (RIGHT HI FREQ CONT) fully CW, then adjust the high frequency equalization using a 10 kHz signal. When adjustment is complete, set all switches back to the "OUT" position.

– NOTE –

If night audio card is installed, set FRONT PANEL "NIGHT/DAY" switch to the "NIGHT" position and repeat all delay equalization corrections identical to those performed on the DAY AUDIO CIRCUIT CARD. The corrections are performed on the NIGHT AUDIO CIRCUIT CARD by first setting the NIGHT CARD SWITCHES S603 and S605 (HI FREQ EQUAL "I") to the "IN" position, and adjust R689 and R391 (LEFT HI FREQ CONT) and (RIGHT HI FREQ CONT) fully CW, and then adjust the high frequency equalization using a 10 kHz signal. Monitor the LEFT and RIGHT signal as described in the DAY AUDIO CIRCUIT CARD section outlined above. When adjustment is complete, set all switches back to the "OUT" position.

– NOTE –

The points of maximum separation and minimum total harmonic distortion (THD) should fall at the same point. However, the final adjustment may be a compromise requiring your best judgement.

III. MONITOR MEASUREMENTS OF BROADCAST TRANSMITTER

– NOTE –

The monitor can be a valuable tool in defining trouble in your transmitter, however, it is important to realize several things. The envelope detector is driven by a fully limited RF signal which contains the phase information that encoded into your AM stereo signal. If any condition in your transmitter system causes a serious phase problem it will be reflected in unusual meter readings. If you experience this situation, go to a lower frequency where RF phase is not as important and see if the problem is eliminated. If the condition changes or is elminated, an impedance measurement may be necesssary (possibly from the plate to the load).

Phase Hum and Noise, and Incidental Phase Modulation

Before attempting to initiate stereophonic operation with the broadcast transmitter, the Motorola AM stereo modulation monitor should be connected to a transmitter R.F. sample so that hum, noise phase modulation and incidental phase modulation can be measured.

CAUTION: Check the sample level at your station before connecting it to the monitor preventing possible overload damage as follows:

The monitor can be calibrated on input R.F. levels from 300 mV to 10 volts RMS unmodulated. A 10 dB per step attenuator is controlled by a knob at the rear of the monitor, and the fine adjustment is made with a knob on the front panel. Using an unmodulated transmitter, set the monitor R.F. input level for a center indication on the carrier meter.

The broadcast transmitter can now be modulated with a 1 kHz tone inserted at the normal audio input terminals. The Motorola monitor can simultaneously monitor the normal AM on the left-hand meter (button MF4 set to L+R) and the incidental phase (or quadrature) modulation on the right-hand meter by selecting L–R on pushbutton (MF6).

Although most AM broadcast transmitters can easily meet the FCC AM noise specification of 45 dB down and many can make more than 60 dB down, the transmitter phase hum can be very different. Power supply PM hum and residual phase noise can originate in the transmitter and be completely harmless for AM operation, but can become very troublesome for stereo broadcasting.

After the Motorola stereo modulation monitor is calibrated for the correct R.F. input level, the audio input to the transmitter should be terminated and a measurement of the L–R modulation level be made. It would be useful to look at the audio output of the L–R channel with a conventional display on the oscilloscope to determine the waveform of the residual noise. The scope can be triggered with a line signal to observe if hum components are the primary component to the residual signal.

Generally, the residual L–R noise should be at least 40 dB below 100% L–R modulation. If this is not the case, then work needs to be done on the transmitter to improve the noise level. This generally consists of improving the power supply filtering on the lower level R.F. stages in the transmitter, but also can be traced to the dressing of leads having A.C. currents on them. The transmitter manufacturer may have some experience or may be willing to help solve the P.M. hum problems in order to make the transmitter more usable for AM stereo operation.

Stereophonic X–Y Oscilloscope Display

It is recommended that an oscilloscope be continually used in an X–Y mode to display the stereophonic operation of the Motorola exciter and monitor. The X–Y display requires an oscilloscope of sufficient sensitivity, bandwidth and phase characteristics such that both the horizontal and vertical axes display audio signals of approximately 0.5 volts peak to peak with no appreciable phase shifting. Figure 5 indicates the ideal displays of sine wave modulation under the indicated modes of stereo operation. Additional sample X–Y displays are shown in Figures 6, 7 and 11.

Refering to Figure 1 on Page 2, the oscilloscope should be connected to the monitor unbalanced left and right BNC outputs (MR6 and MR7). The left output should be connected to the X axis oscilloscope input. Under no modulation conditions, the trace will consist of a single dot which could burn the phospher of the cathode ray tube. The intensity of the oscilloscope should, therefore, be reduced if the no modulation condition exists over an extended period of time.

The X–Y display can be very useful in troubleshooting and adjusting AM stereo. It can indicate the amount and nature of incidental phase modulation, audio delays or phase shifts, operation of audio processing equipment, amount of stereo in programming and many other characteristics limited only by the expertise of the observer.

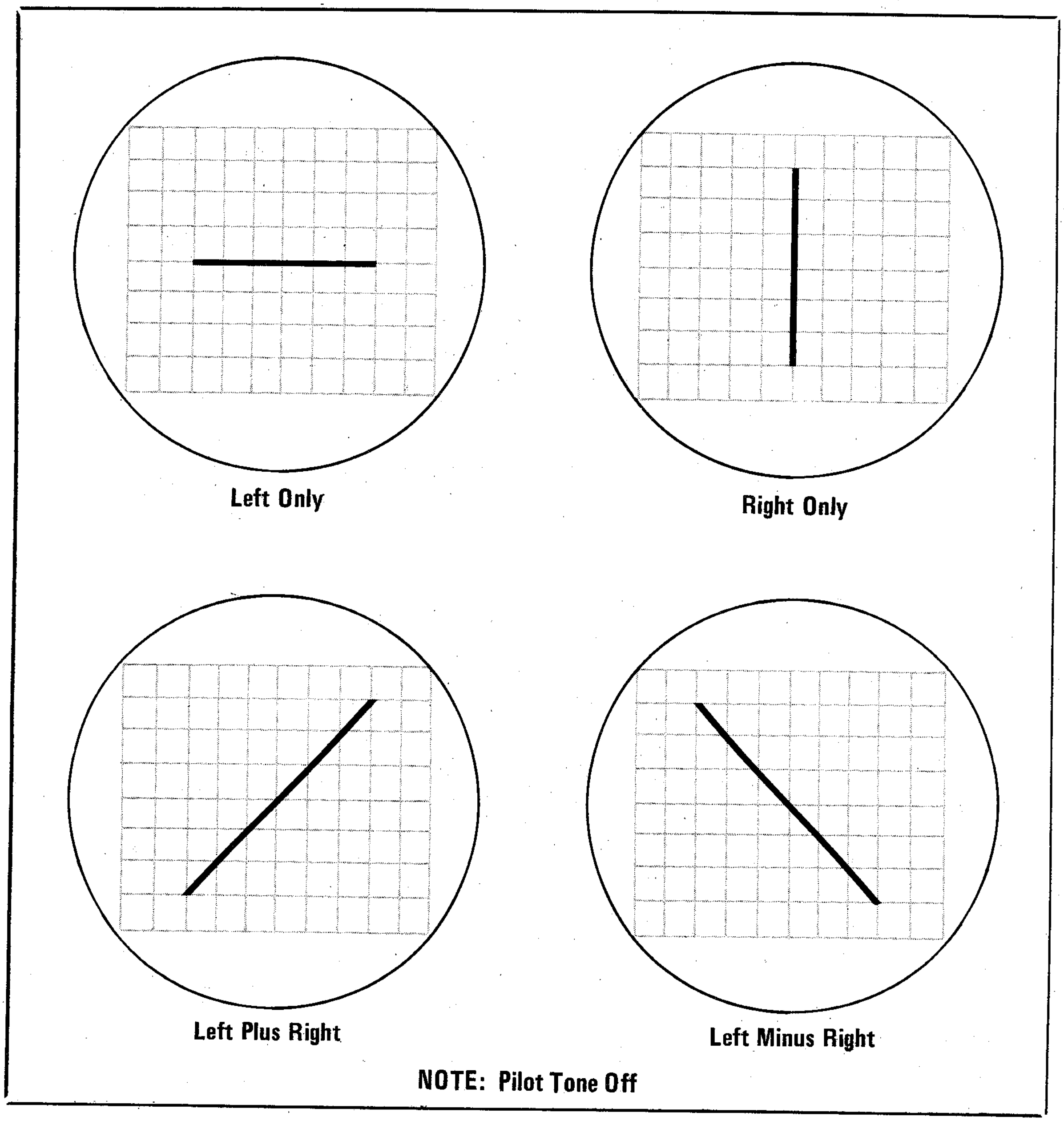


Figure 5. Ideal Oscilloscope Displays of Stereo Signals

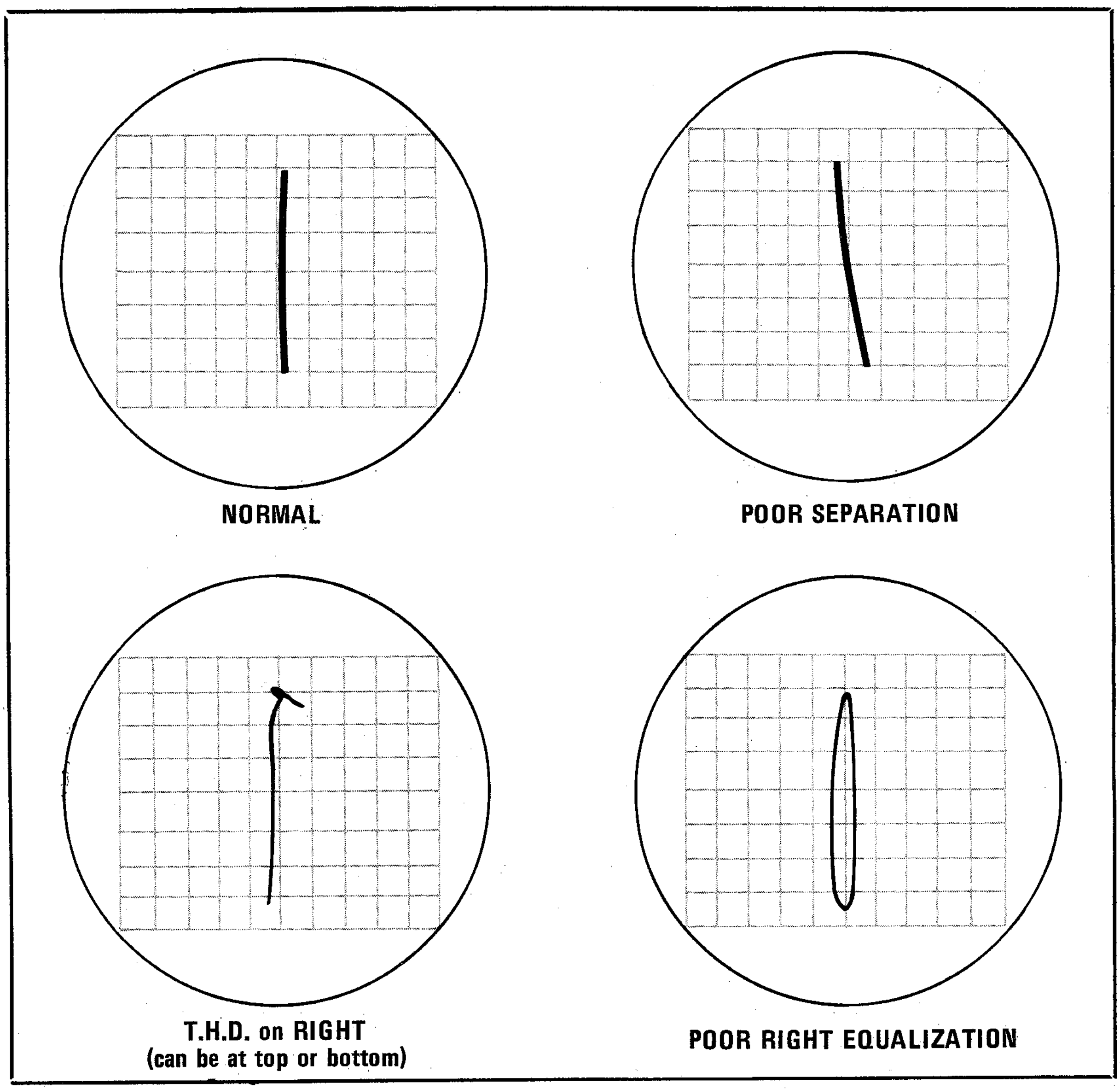


Figure 6. Sample Oscilloscope Displays of Stereo Signals

Incidental Phase Modulation

With the transmitter modulated at 25, 50, 75, and 95% AM with a 1 kHz tone, measurements of L–R should be made. This information can be dynamically read on the X–Y display and could look like the simulated displays shown below.

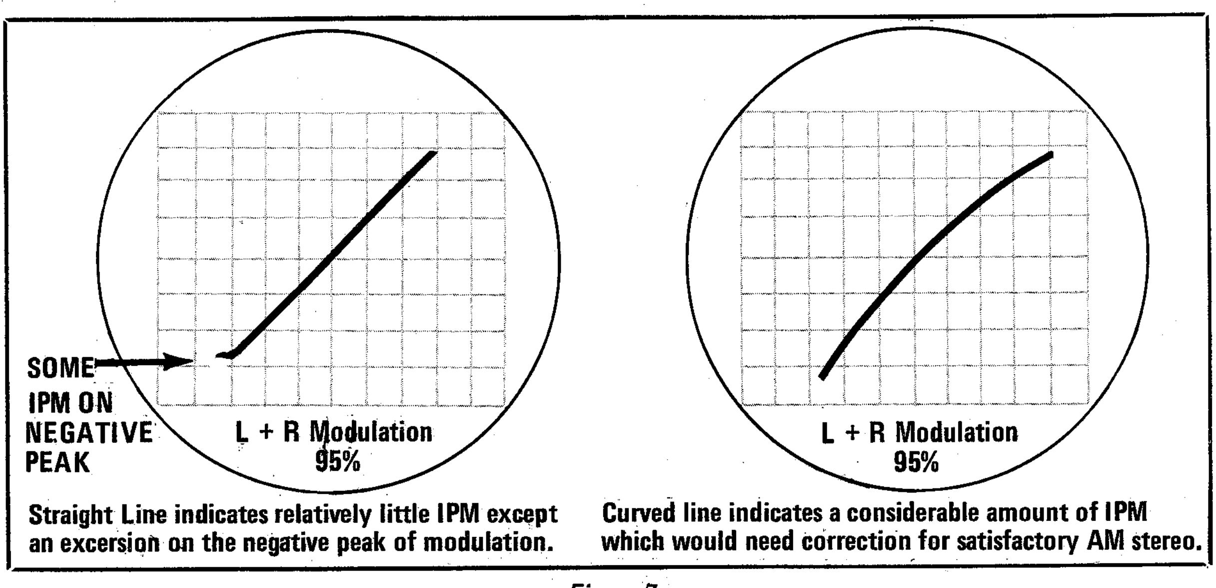


Figure 7

The audio modulating frequency should be varied and measurements made of the crosstalk due to IPM. Generally for at least 25 dB of separation under typical stereo program modulation, the measured L+R to L−R cross talk should be less than indicated in Figure 8.

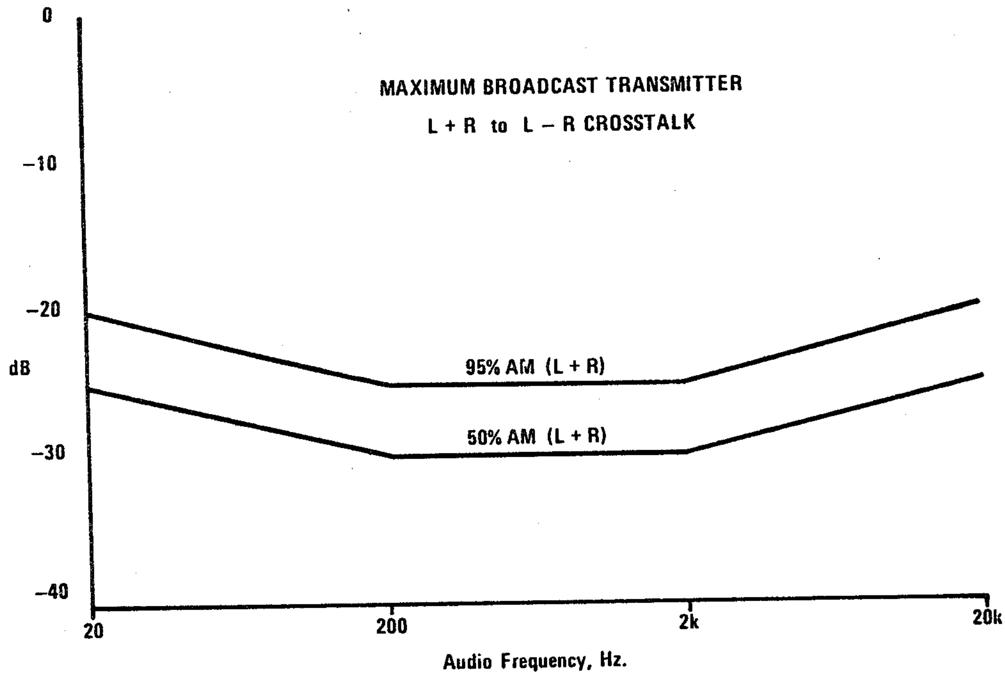


Figure 8

The sources of incidental phase modulation in AM broadcast transmitters vary considerably. However, two contributing areas often are: 1) the final amplifier tuning and 2) the final amplifier neutralization. In the case of conventional AM, neither adjustment is usually very critical. However, in AM stereo these adjustments can have a substantial effect in IPM. If the IPM measurement show that the transmitter does not make the maximum values indicated in Figure 8, or if it is desired to improve on the performance, adjustments to tuning and neutralization can be made. This is usually done by modulating the transmitter with a higher frequency audio tone, (5 or 7.5 kHz) and watching the crosstalk in the L−R channel on the monitor as the tuning and loading is adjusted. Neutralization adjustment often can not be made from the transmitter front panel, but has to be done with the transmitter plate voltage off and then the transmitter put back on for a measurement.

The following represents some general causes of IPM other than those mentioned above and are listed by transmitter type;

High Level Modulation

1. Neutralization of final
2. Neutralization of driver
3. Poor power supply filtering
4. Bad tubes (modulator and RF)
5. Poor filtering at screen on driver
6. Poor final loading
7. Tight coupling circuits
8. Poor grounding
9. Poor modulation transformer
10. Poor tuning 3rd harmonic resonator
11. Bad sample

Pulse Modulated

1. Poor neutralization
2. Bad PDM coils (out of resistance spec)
3. PDM not set for duty cycle and frequency
4. Bad tubes
5. Poor power supply filtering
6. Tight coupling circuits
7. Poor tuning 3rd harmonic resonator
8. Bad sample

Doherty

1. Poor neutralization (driver + final)
2. Bad tubes
3. Bad bias on doherty driver
4. Tight tuning circuits
5. Consult factor for mods needed
6. Bad power supplier

These are the most common problem areas. It is always advisable to consult your transmitter manufacturer for any additional input that they may be able to provide in the form of modification kits or recommendations for changes to improve AM stereo performance.

When you have found all sources of IPM you should have –30 to –40 dB of separation between the L+R and the L–R channel and the L+R should look very straight and intercept on a 45^{o} angle when viewed on a x/y base of the scope. This is accomplished by going through a normal tuning procedure and finding elements that seem to have a great effect on IPM. If nothing seems to help much in tuning, the indication is that a tube is bad.

IV. STEREO EXCITER R.F. CONNECTIONS TO BROADCAST TRANSMITTER (BROADCAST TRANSMITTER SET-UP)

The Motorola AM stereo exciter includes several R.F. outputs designed to interface with most, if not all, existing AM broadcast transmitters. One is a 5 volt logic level output designed to drive standard digital circuitry. The other is 40 VPP into 50 ohms which is used to drive a lower level R.F. stage in the transmitter. This amplifier can be internally programmed for lower output levels if required. Both of these outputs have no amplitude modulation, but do have the proper phase modulation required for C-Quam AM stereo. Another output is available at the rear of the exciter which is not modulated in either amplitude or phase. This output is provided to trigger an oscilloscope for observations of phase modulation, or can be used to drive frequency measurement equipment.

The Motorola exciter will be preadjusted to the station frequency and all R.F. outputs of the exciter are on the station's carrier frequency. The oscillator in the exciter is designed to hold the station frequency well within the F.C.C. specification over a temperature range from 0 to 50 degrees centigrade. Generally, the output should stay within a few Hertz of the assigned frequency.

If the transmitter has a TTL input, then the TTL output of the exciter is to be connected to the transmitter digital circuitry at a point where it is operating on the station frequency. Some transmitters now use higher frequency crystals which are divided down to the operating frequency. The input is to be made after the division.

Many transmitters, however, will be best interfaced by taking the 5 watt exciter output and applying it to the highest level R.F. stage in the transmitter which can be fully driven. It is possible for the transmitter output signal to be coupled back through the exciter and the connecting cables which in turn can cause incidental phase modulation. Therefore, the higher the level on the cable and the higher the R.F. stage in the transmitter being driven, the less opportunity for incidental phase modulation.

The 5 watt amplifier in the exciter has a square wave output with a level of approximately 42 volts peak to peak into 50 ohms resistive. The lower level R.F. stages in the transmitter should be studied to determine where is the best point for inserting drive of this voltage level. If the instruction book for the transmitter does not indicate the normal R.F. levels, they can be measured with a suitable R.F. voltmeter or the manufacturer can be consulted.

In the case of driving a tube R.F. stage, the 50 ohm inpedance can be stepped up by tapping down on a coil in the grid circuit of the stage if it is tuned, or by using a toroidal step up transformer as shown in figure 9.

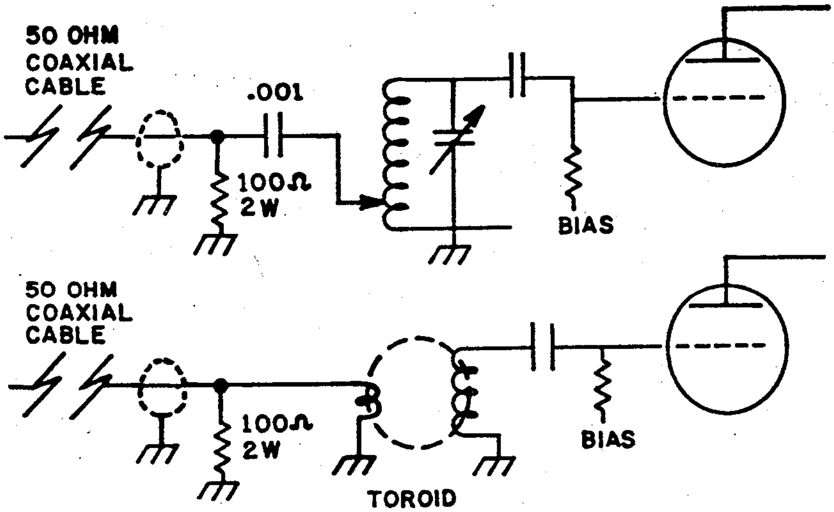


Figure 9.

After sufficient drive from the stereo exciter to your transmitter has been accomplished, a recheck of the phase modulated hum and noise, and incidental phase modulation should be made. Using the normal audio input to the transmitter, checks should be made of the L–R noise level and crosstalk between AM (L+R) and L–R channels as was perviously done. It is also advisable to check the audio performance of the L–R channel to be sure that the broadcast transmitter is not substantially degrading the L–R performance (see Page 8).

V. STEREO EXCITER AUDIO CONNECTIONS TO THE BROADCAST TRANSMITTER

The Motorola AM stereo exciter simply takes the left and right audio channels and sums them into L+R for the broadcast transmitter audio input. Two basic objectives must be met in connections to the transmitter. One is the phasing of the transmitter audio input, and two the input level must be precisely adjusted so that the C-Quam modulation will be transmitted properly. The audio frequency response and distortion of the circuitry is sufficiently low that it should not affect the monaural performance of the transmitter. Initially, an audio oscillator set to 100 Hz should be connected to the left and right audio inputs of the stereo exciter, phased for L+R modulation.

The phasing of the exciter audio output to the broadcast transmitter can be checked by comparing the envelope display of the exciter sample transmitter output with the broadcast transmitter envelope. This should be done with a dual trace oscilloscope in the chop mode with the triggering taken from the audio oscillator (see Figure 10).

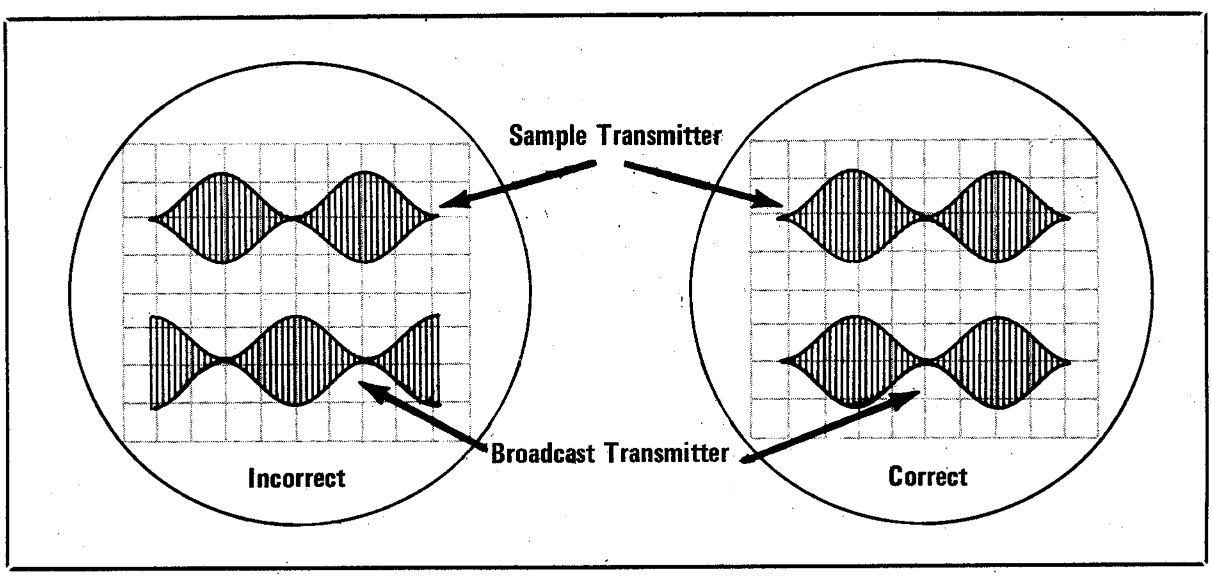


Figure 10 Phasing of Broadcast Transmitter Audio Input

While observing the dual trace display of envelope modulation at the sample transmitter output (ER3) the depth of modulation can also be approximately adjusted. Start by adjusting the tone to the exciter left plus right channels from the oscillator until the broadcast transmitter is modulating about 50%. Next, adjust the exciter audio drive "L+R ADJ." to the broadcast transmitter (EF8), (a screwdriver adjust on the front panel under the plastic cover) until the envelope modulation is the same as the sample transmitter. Increase the audio input to the exciter until the sample transmitter modulation is 100%, and then adjust the broadcast transmitter modulation to the same value with the front panel screwdriver adjust.

The precise setting of the L+R drive to the broadcast transmitter can be more accurately set by observing separation. However, separation at this time is most likely limited by the difference in delays between L+R and L–R.

An alternator method of adjusting L+R gain is to set up for x/y display and adjust the gain so right is straight up and down and left is straight in the horizontal plane. This should be done with about 50% single channel modulation.

VI. ADJUSTING THE DELAY NETWORKS AND EQUALIZATION

– NOTE –

1. The 25 Hz pilot tone must be turned off with the front panel switch.
2. The process defeat switch S607 must be in the "DEFEAT" position (located on the night audio circuit card.)
3. CAUTION: Do not touch the following setting on the front panel at this time. Refer to section VII Limiter Adjustments and the Alignment Procedure.
   - 3.1 + LIMIT
   - 3.2 – LIMIT
   - 3.3 BALANCE
4. The night circuit card is an option and may not be used in your exciter.

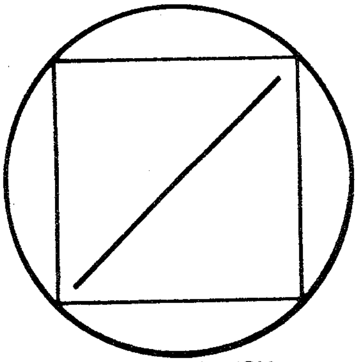
Delay Adjustments

In order to adjust the delay, the cover plate in the middle of the top cover must be removed and the back cover must be opened. At this time it might be easier to have the EXCITER placed on a table rather than in a rack so that the switches and controls can be more accessible. Even without setting the delay networks it is quite possible to achieve 15 dB of separation or more, however, this varies considerably with the transmitter type.

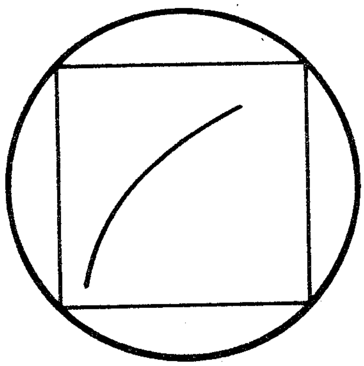
To start the process, set the OSCILLATOR to 1 kHz 50% envelope modulation, LEFT input only. Using an oscilloscope set for X-Y display, observe the LEFT and RIGHT unbalanced signal outputs at the ports J808 and J809 on the monitor. Adjust LEFT DELAY SWITCH S608 from its zero position in 1 microsecond steps for best closure. Compare the oscilloscope display with those shown on Pages 18, 19 and 24.

Repeat procedure for RIGHT input only by adjusting RIGHT DELAY SWITCH S609 from its zero position in 1 microsecond steps for best closure.

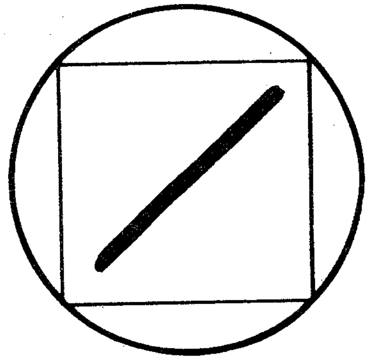
Figure 11. Sample of IPM Oscilloscope Displays



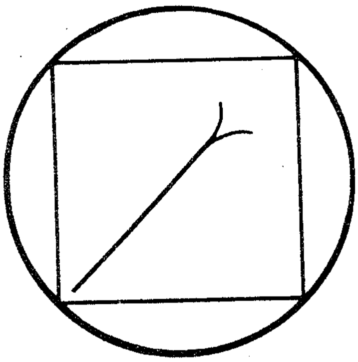
Correct No IPM.



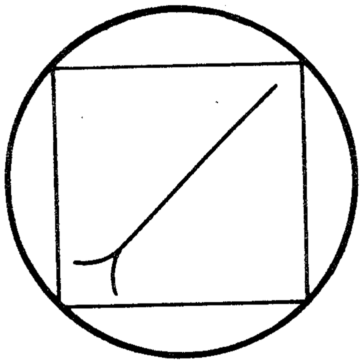
Linear IPM.



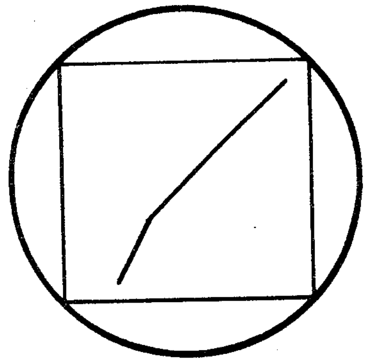
IPM indicating Phase modulated hum.



IPM indicating Poor Power supply filtering. Note IPM is in Peaks as dropping supply voltages cause changes in Phase rather than amplitude.



IPM indicating Poor neutralization. Note IPM is in trough as the transmitter changes Phase as drive is lessened.



IPM indicating misadjustment of transmitters 3rd harmonics trap.

Bulk Delay Adjustment

– NOTE –

If the maximum of 15 microseconds of delay does not produce adequate closure add BULK DELAY CARD BD705 to the bottom of the NIGHT AUDIO CIRCUIT CARD and connect into circuit. Each switch section on the BULK DELAY CARD adds 10 microseconds of delay for a total of 40 microseconds. Tha maximum total system delay for both the LEFT and RIGHT audio channels with the BULK DELAY is 40 + 15 or 55 microseconds.

Return the LEFT and RIGHT DELAY SWITCHES S608 and S609 to their ZERO position. Repeat the above procedure for both the LEFT only and RIGHT only sections by adding BULK DELAY in 10 microsecond groups and using LEFT and RIGHT DELAY SWITCHES S608 and S609 for fine adjustment until best closure is obtained.

Note: It may be necessary to increase the oscillator frequency up to a maximum of 2 kHz for complete closure.

HiFrequency Equalization Adjustment

To continue the equalization, set the HI FREQ EQUAL "I" switches on both the DAY and NIGHT CIRCUIT CARDS (S303, S305, S603, S605) to the "OUT" positions. Set the HI FREQ EQUAL "Q" and LOW FREQ EQUAL "Q" switches on both the DAY and NIGHT CIRCUIT CARDS (S304, S306, S302, S301, S604, S606, S602 and S601) to the "IN" position. See Figure 4.

Set the OSCILLATOR to 10 kHz 50% envelope modulation, FRONT PANEL NIGHT/DAY SWITCH to DAY position, LEFT input only.

Adjust LEFT HI FREQ EQUAL CONTROLS, R302 C-D and R389 for best closure.

Change to RIGHT input only and adjust RIGHT HI-FREQ EQUAL controls, R302 A-B and R391 for best closure.

Optional Night Function Adjustment

Set FRONT PANEL NIGHT/DAY SWITCH to NIGHT position with EXCITER switched to NIGHT TRANSMITTER.

Repeat LEFT and RIGHT HI FREQ EQUALIZATION using the identical controls on the NIGHT CIRCUIT CARD directly opposite the DAY CIRCUIT CARD controls described above.

Low Frequency Equalization Adjustment

To continue the equalization, set the OSCILLATOR to 100 Hz 50% envelope modulation, FRONT PANEL NIGHT/DAY SWITCH to DAY position LEFT input only.

Adjust LEFT LOW FREQ EQUAL No. 1 and No. 2 controls, R304 C-D and R307 C-D for best closure.

Change to RIGHT input only and adjust RIGHT LOW FREQ EQUAL No. 1 and No. 2 CONTROLS, R304 A-B and R307 A-B for best closure.

Optional Night Function Adjustment

Set FRONT PANEL NIGHT&DAY SWITCH to NIGHT position with EXCITER switched to NIGHT TRANSMITTER.

Repeat LEFT and RIGHT LOW FREQ EQUALIZATION using the identical controls on the NIGHT CIRCUIT CARD directly opposite the DAY CIRCUIT CARD controls described above.

Separation Checks

Separation measurements should now be made over the audio spectrum with the LEFT channel driven and then the same measurements with the RIGHT channel driven. It is most useful to prepare a graph of the separation in order to judge the action of the various controls. Also, the stereophonic distortion should be measured, that is the LEFT channel distortion when LEFT is driven, and the RIGHT channel distortion when RIGHT is driven. Many times there will be a tradeoff between separation and distortion, and there may be very good separation in one direction (RIGHT into LEFT) and marginal separation the other way (LEFT into RIGHT).

At this point, separation should be better than 25 dB both ways. The adjustments will not follow a prescribed pattern, but improvements can be made by trial and error. Include in the adjustments a trimming of the FRONT PANEL "L+R ADJ" audio drive control. If the transmitter has sufficient low Incidental Phase Modulation (IPM), there should typically be 30 dB separation between 100 Hz and 5 kHz.

The separation below and above this range will be limited by the equalization to precisely match the transmitter, and by bandwidth limits of the transmitter/antenna system.

– NOTE –

Return the PROCESS DEFEAT SWITCH S607 to the "ON" position.

VII EXCITER LIMITER ADJUSTMENTS

– NOTE –

Normally the + limit and – limit controls on the front panel are set at the factory and should not require adjustment.

The + LIMIT AND – LIMIT CONTROLS set the level beyond which the audio signals will be limited (clipped). The $(L+R)_Q$, $(L-R)_Q$ and the $(L+R)_I$ audio signals + and – limit levels are set simultaneously.

The + and – limiters for the $(L+R)_I$ audio signal that is returned to the TRANSMITTER MODULATOR are disconnected. (DIODES D302 and D308 are removed from the DAY CIRCUIT CARD). This requires that both the + and – limiting action, (to prevent over modulation), be accomplished in the stations Audio Processor or in the transmitter proper.

The – LIMITER for the $(L+R)_Q$ and $(L-R)_Q$ audio signal channels is set to the limit the C-QUAM point to approximately the 98% modulations level.

The + LIMITER is usually set for no + LIMITING unless required by the station, (control set fully ccw).

VIII OPERATION INTO THE ANTENNA

After satisfactory stereo operation into the dummy load, the final adjustment should be checked by operating into the antenna system during experimental hours. There are two basic effects to look for when operating into the antenna. One is that the impedance/bandwidth of the antenna system often is much narrower than the dummy load and the radiation from the antenna back into the transmitter building can increase the possibility of Incidental Phase Modulation.

With the transmitter operating into the antenna system, measure the stereo separation and distortion. If the high frequency performance (above 5 kHz) has degraded, readjust the high frequency equalization for the best compromise between separation and distortion. If the separation has degraded considerably on all audio frequencies, check the level of Incidental Phase Modulation by Modulating the transmitter with the audio oscillator connected directly to the transmitters audio input terminals. Measure the residual L–R out of the MONITOR and compare with previous measurements. If the level is much greater than previously measured into the DUMMY LOAD the indication is that the increase in Incidental Phase Modulation is being caused by the RADIATED R.F. signal from the ANTENNA. Appropriate corrective action must be undertaken.

This completes the check out and adjustment. Tighten all covers and position equipment in its permanent location.

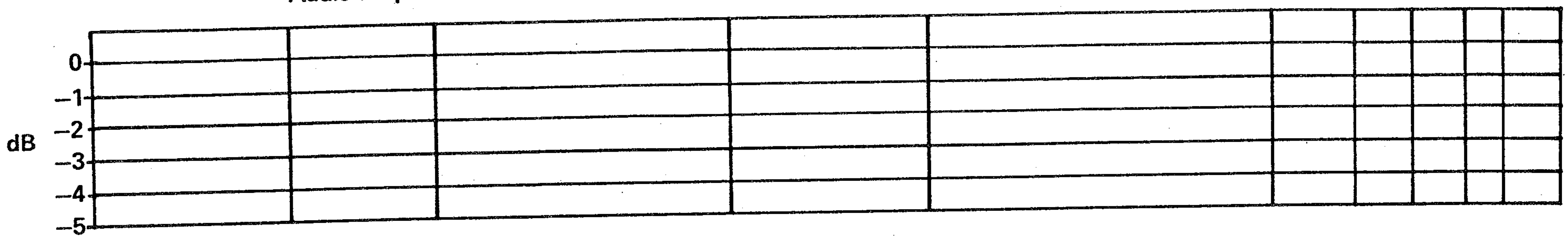
Broadcast Transmitter Worksheet

Radio Station____________________

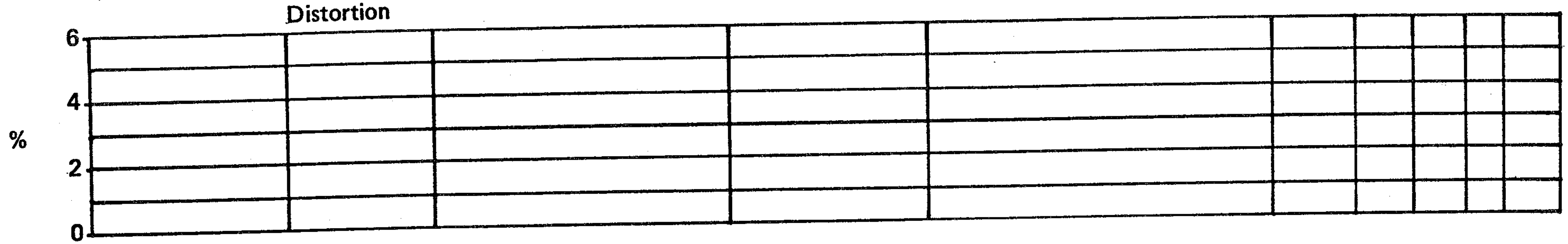
Day________Date____________________

Xmttr______Power______________Load: Dummy_____Day_____Night________________________

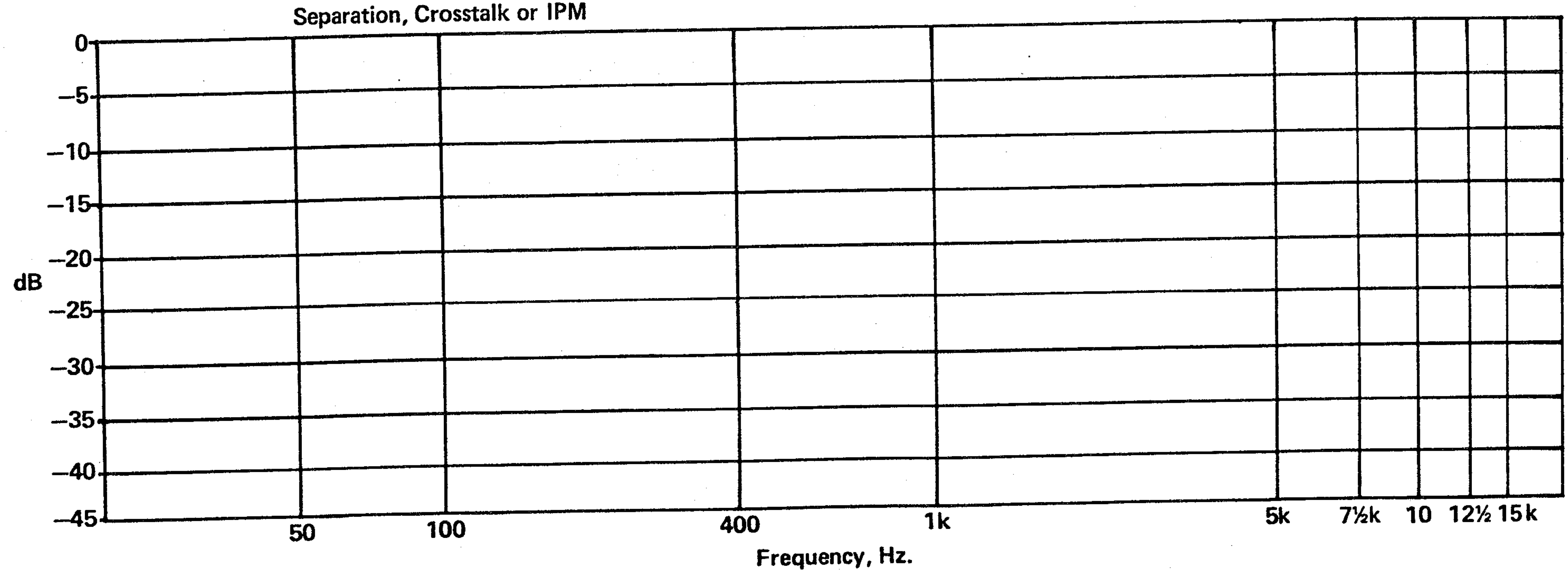
Audio Response



Distortion



Separation, Crosstalk or IPM



AM STEREO
EQUIPMENT PERFORMANCE MEASUREMENTS
(Audio Proof)

The FCC requires AM broadcast stations to conduct equipment performance measurements after installation of AM stereo transmitting equipment. The characteristics to be measured are described in Section 73.1590 and the minimum performance specifications are described in Sections 74.40 and 73.128. Copies of these sections of the FCC Rules are reproduced in Appendix A.

The FCC requirements are quite extensive and a considerable number of data points must be taken. For the broadcaster's convenience, forms for tabulating and plotting the data are included in this section. A summary of the FCC proof requirements is shown in Figure 1.

SUMMARY OF FCC REQUIRED AM STEREO EQUIPMENT PERFORMANCE MEASUREMENTS

Measurement	Modulation Level	FCC Limit	Modulation Mode L + R	Left	Right	L – R
Frequency Response	95%		X			
	75%	±2 dB	X	X	X	
	50%		X	X	X	
	25%	100 Hz – 5 kHz	X	X	X	
Harmonic Distortion	95%	7.5%	X			
	75%	5%	X	X	X	
	50%	5%	X	X	X	
	25%	5%	X	X	X	
Carrier Shift	100%	5%	X			
	85%	5%	X			
	50%	5%	X			
	25%	5%	X			
Noise Level	100%	45 dB below 400 Hz	X	X	X	
Incidental Phase Modulation	95%	None Specified	X			
Main to Subchannel Crosstalk	95%	None Specified	X			
Subchannel to Main Crosstalk	95%	None Specified				X
Separation	No Spec.	15 dB 0 – 5 years 20 dB 5+ years 400 Hz – 5 kHz	Measurement not required			
Harmonic and Spurious Radiation	95%		X			X
	75%			X	X	
	75%			X	X	

Figure 1.

PROCEDURE

Although the FCC requires that equipment performance measurements be made between a common audio input amplifier at the studio to the transmitting antenna terminals, the following instructions are written to aid the broadcaster in making initial measurements of AM stereo performance at the transmitter. After satisfactory tests have been completed with the transmitting equipment, the audio oscillator signal can be fed to the required common audio input amplifier at the studio for the actual required performance measurements. Thus, when the following specifies a connection to the exciter audio input, the connection would then be to the common audio input amplifier at the studio. If Telco lines or STL are improperly installed, the Motorola broadcast engineer will take transmitter measurements on the assumption that proper lines will yield similar results.

Motorola will provide to the broadcast station a complete AM exciter and modulation monitor capable of generating and accurately demodulating and indicating the operation of the C-Quam system. The modulation monitor is capable of demodulating and accurately indicating: amplitude modulation, left minus right modulation, left channel modulation, right channel modulation, carrier shift, right or left channel noise levels, separation, and level of pilot tone. In addition, the level of incidental phase modulation can be readily calculated from the left minus right modulation indication when modulating with AM. The frequency of pilot tone modulation can be measured with instruments connected to the modulation monitor. The distortion and noise levels of the modulation monitor are sufficiently low that the measurements made of the various performance characteristics will be reflective of the limits of the broadcast transmitter/ stereo encoder performance.

– NOTE –

In the following discussion the modulation meters should only be used for approximate measurements. The circuits driving the meters use an active multiplier keeping the audio output constant regardless of the RF input over any given range. Because the multipliers tend to compress the dynamic range of the signal it may limit the reading obtainable with the meters. Expect a noise floor on (L – R) of about –40 dB and errors in separation ranging from approximately zero to 6 dB. It is therefore mandatory that actual proof numbers be taken from rear connectors with the RF set on centerline for best results. The rear connectors are not influenced by the multipliers so their level is signal dependent and calibration of the system is done at the RF set position.

Referring to Figure 2, the measurement of main (L+R) modulation capability is made by paralleling the left (A) and right (B) audio inputs to the stereo exciter (phased for L+R modulation) and connecting the audio oscillator through the pad to the junction. The main (L+R) modulation can be read directly on the modulation monitor by selecting "L+R" for the indication on the left hand meter (see Figure 2). The level of the audio oscillator can be increased until at least 85% modulation is read on the monitor. The frequency of the oscillator can be varied over the range of 50 to 5000 Hz while observing the level on the modulation monitor for the required modulation level.

For (L) left, or (R) right only modulation, the audio oscillator should be directly connected without the pad to first the left (A), and then the right (B) inputs to the AM stereo exciter. The oscillator level should be advanced until the main channel (L+R) modulation reaches at last 75% modulation as indicated on the monitor. The oscillator frequency is then varied over the range of 50 to 5000 Hz while observing the monitor.

For measurement of distortion, the audio oscillator is connected to the stereo exciter as previously described. For main (L+R) distortion measurements, the distortion meter should be connected to the BNC connector on the rear of the modulation monitor labeled "L+R". For left or right distortion measurements, connect the oscillator directly to the left input on the exciter and connect the distortion analyzer to the left output on the modulation monitor. The same process is repeated for right only distortion measurements. If the 600 ohm balanced output is used, terminate with a 600 ohm load.

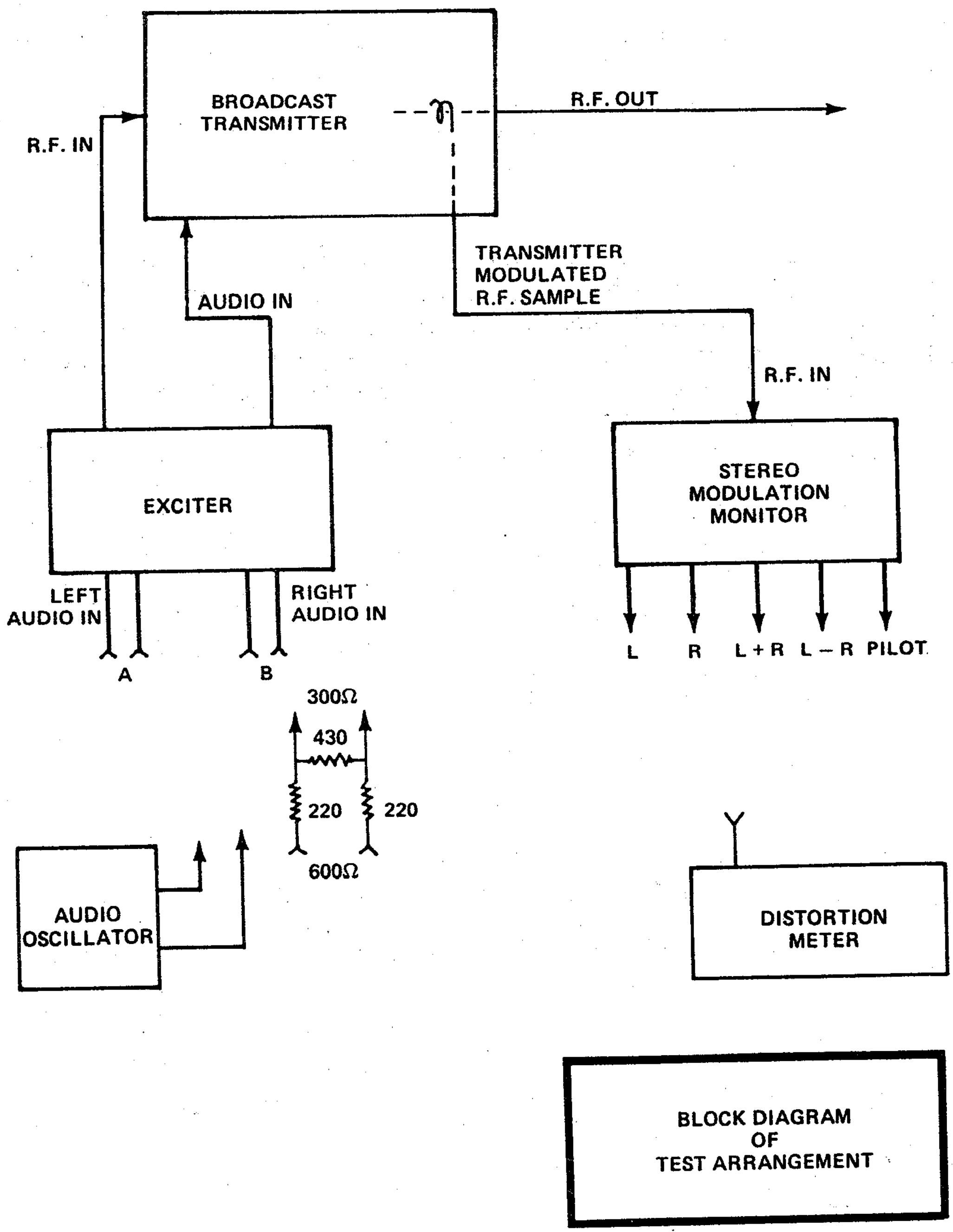


Figure 2.

The audio oscillator is connected as previously described for main (L+R), left (L) and right (R) modulation. The frequency response can be directly observed by selecting "L+R" for main channel response or "L" for the left channel response on the left meter or "R" for right channel response on the right meter of the modulation monitor. Response can also be read on the distortion meter in the audio voltmeter function by connecting to the appropriate left, right or left + right outputs of the modulation monitor at the rear of the unit.

The carrier shift can only be measured on a spectrum analyzer, or with a Belar modulation analyzer. With no modulation applied to the AM stereo exciter, the carrier level indicator should be carefully set to the zero or calibrate point. The audio oscillator is to be connected to the paralleled left and right inputs of the AM stereo encoder (phased for L + R modulation) through the pad. The output level of the oscillator is to be advanced while observing the carrier level indicator in the modulation monitor. The maximum change in carrier level indication is to be recorded for modulation levels from zero to 100% amplitude modulation.

Both left (L) and right (R) audio inputs to the AM stereo exciter are terminated with 600 ohm resistors. Main (L+R), left (L) and right (R) channel noise levels can be directly read on the Motorola AM stereo modulation monitor by selecting the appropriate mode for the left or right meters, and depressing the meter range buttons until an on scale reading is obtained. The noise level is obtained by adding the meter range value with the indication of the red dB scale on the meter. It is already calibrated against 100 percent modulation.

Indicidental phase modulation is measured as follows. Connect the audio oscillator through the pad to the parallel left and right audio inputs to the stereo exciter, making sure that the audio inputs are phased for main (L+R) modulation. The left hand meter is set to (L+R) on the modulation monitor and the right hand meter is set to (L—R). The audio oscillator output is adjusted to the various modulation levels and audio frequencies required and the readings of the (L—R) meter are observed. The meter range will have to be chosen by selecting the appropriate push button. Record the sum of the push button meter range and the red dB scale on the (L—R) meter for each combination of modulation level and frequency. The incidental phase modulation in radians is simply the voltage ratio below 100 percent L—R modulation expressed in decimal form. For instance, if the observed L—R modulation is 50 dB below 100 percent L—R modulation, the incidental phase modulation is .0032 radians or 3.2×10^{-3} radians.

For measurement of separation, the audio oscillator is connected directly to the (L) left or (R) right input of the AM stereo exciter. The left channel is modulated with a tone and a distortion meter or audio voltmeter is used to measure the audio output voltage from the left channel output of the modulation monitor. The audio voltage from the right channel output of the modulation monitor is then measured. The difference in dB is the separation. The reverse process is used to measure the separation of a modulated right channel into the left.

The front panel meters can be used directly when set to "L" and "R". The separation can be read directly on the panel meters with the meter range buttons only for 100 percent left or right only modulation. For lesser values of left or right only modulation, separation is computed by subtracting the readings in dB of the two meters added to the respective push button settings.

The relative pilot tone level may be measured directly on the modulation monitor by setting the small toggle switch under the carrier meter to the "pilot tone" side and reading the level of pilot tone on the carrier level panel meter. The correct level of pilot tone indication should be at the black block on the meter scale. To accurately measure the pilot level, set pushbuttons R-L and -20. The meter should indicate -26 dB.

Pilot tone frequency may be measured from the pilot tone port on the back of the modulation monitor. Use Sigmotek ITC-3 frequency counter or similar computing counter. Pilot tone should be 25 Hz $\pm$ 0.1 Hz.

AM STEREO

Equipment Performance Measurements

FORMS

EQUIPMENT PERFORMANCE MEASUREMENTS
TABULATION OF DATA

Station ________________

Date ________________

Audio Frequency Response

	50	100	400	1k	5k	7½k	10k	12½k	15k
L + R, 95% Modulation (± 2 dB, 100 – 5k)				0 dB					
L + R 75% Modulation (± 2 dB, 100 – 5k)				0 dB					
L + R 50% Modulation (± 2 dB, 100 – 5k)				0 dB					
L + R 25% Modulation (± 2 dB, 100 – 5k)				0 dB					
				0 dB					

L - R
Distortion

EQUIPMENT PERFORMANCE MEASUREMENTS
TABULATION OF DATA

Station ____________________

Date ____________________

Audio Frequency Harmonic Content
(Distortion)

	50	100	400	1k	5k	7½k*	10k*	12½k*	15k*
L + R, 95% Modulation (7.5% Max.)									
L + R, 75% Modulation (5% Max.)									
L + R, 50% Modulation (5% Max.)									
L + R, 25% Modulation (5% Max.)									

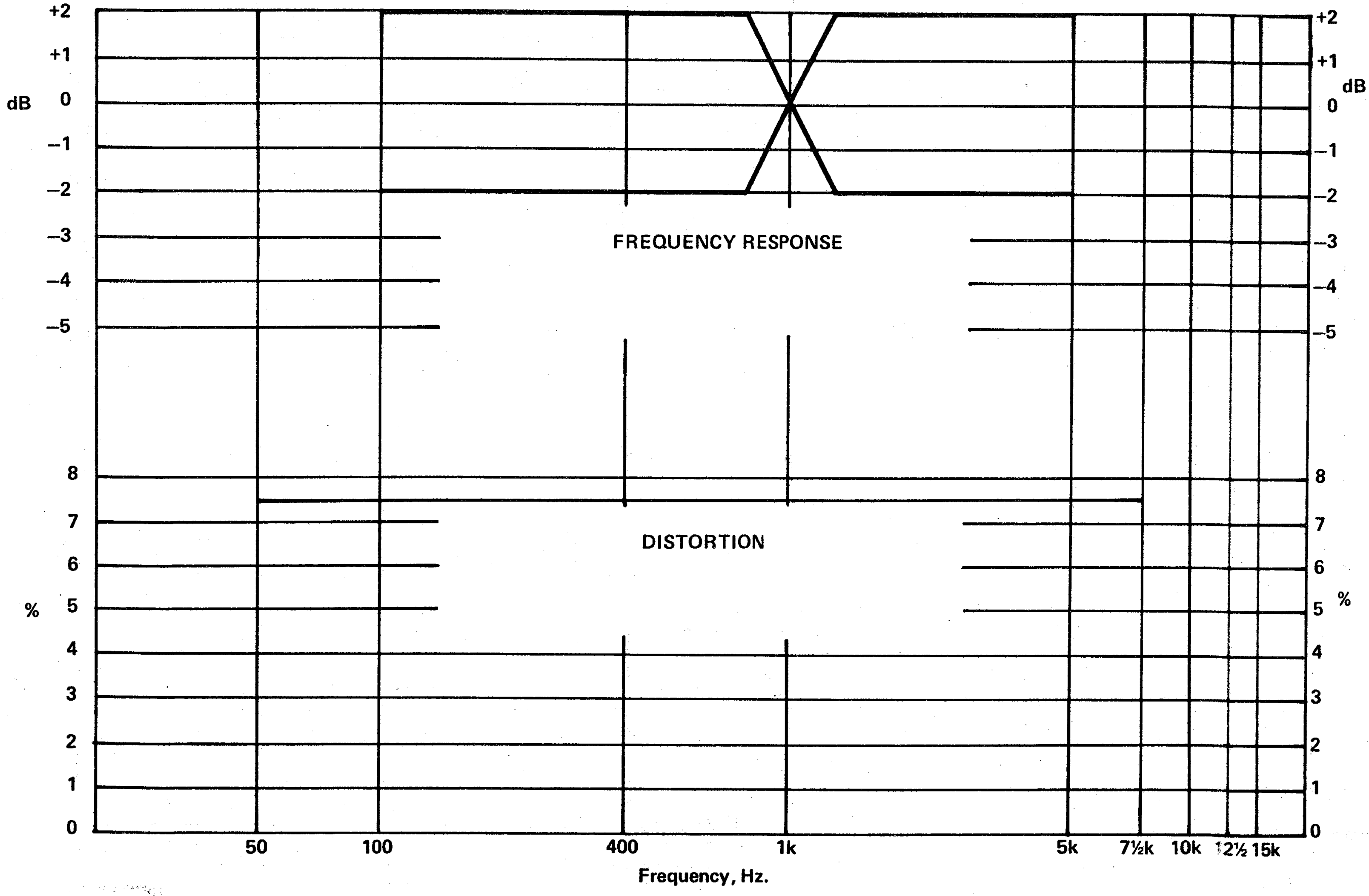
* When attainable

Radio Station ____________

Date ____________

L + R
95%

L + R
95% MODULATION

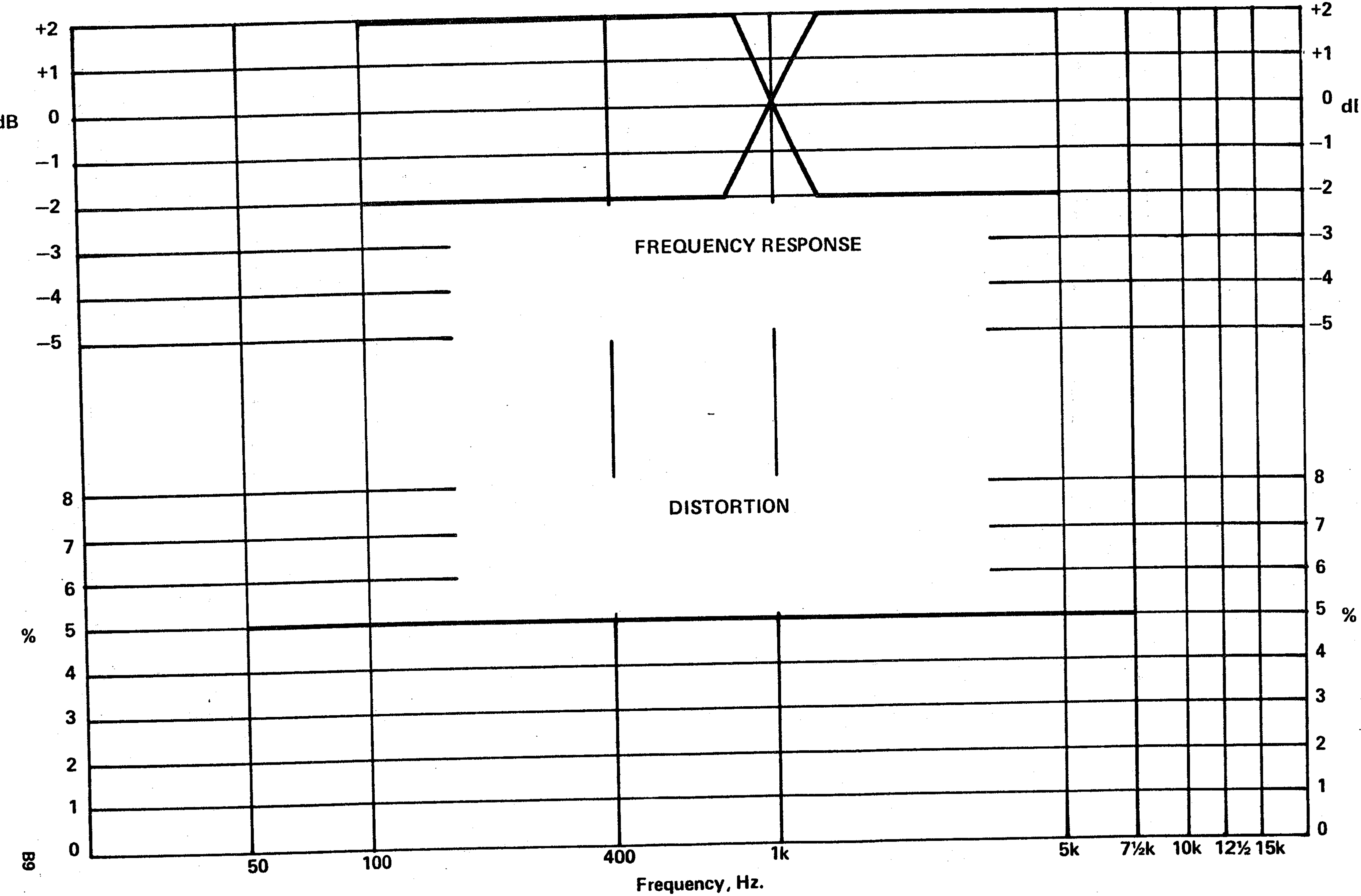


L + R
75%

Radio Station ______

Date ______

L + R
75% MODULATION

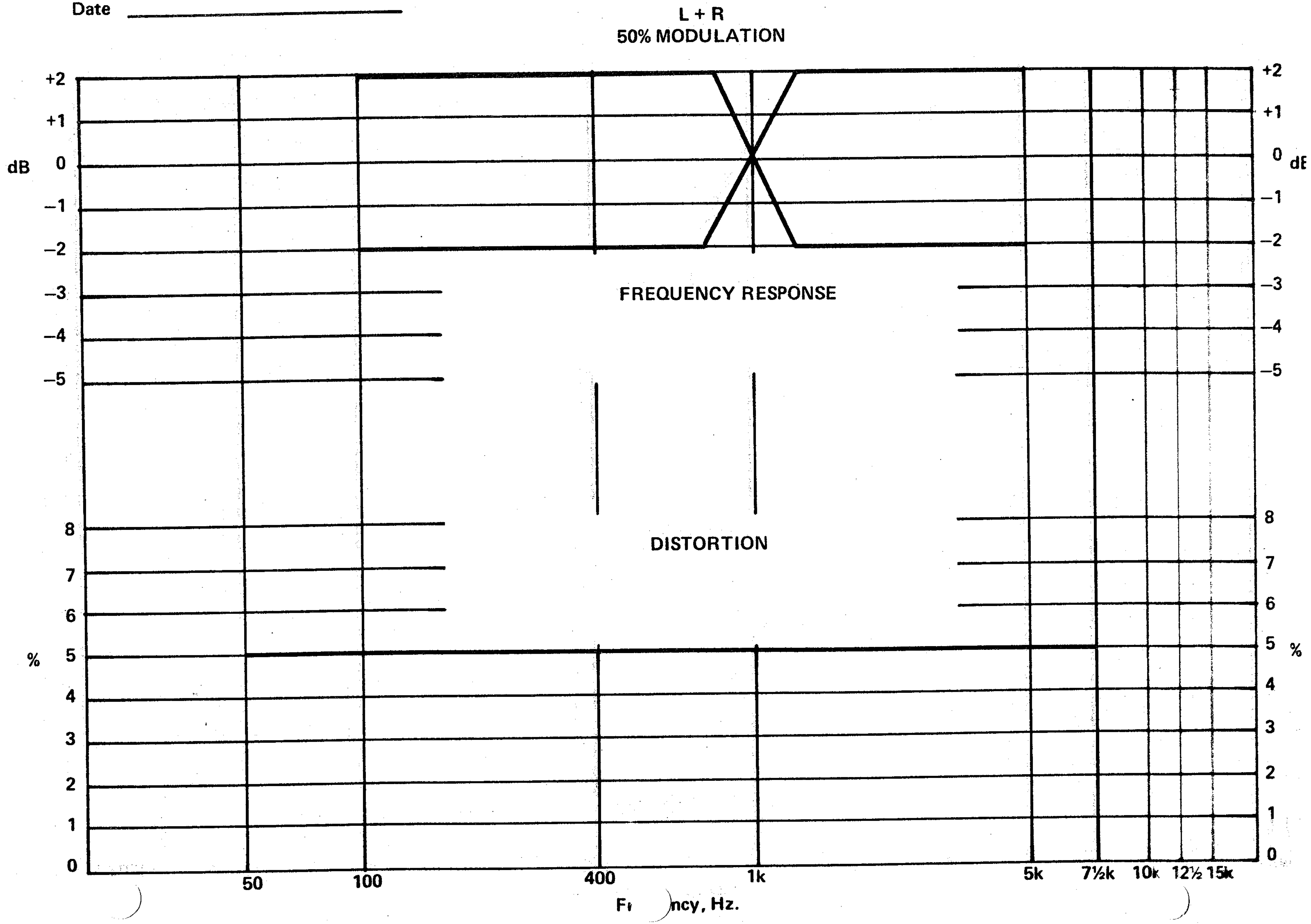


B10

Radio Station ____________

Date ____________

L + R
50%

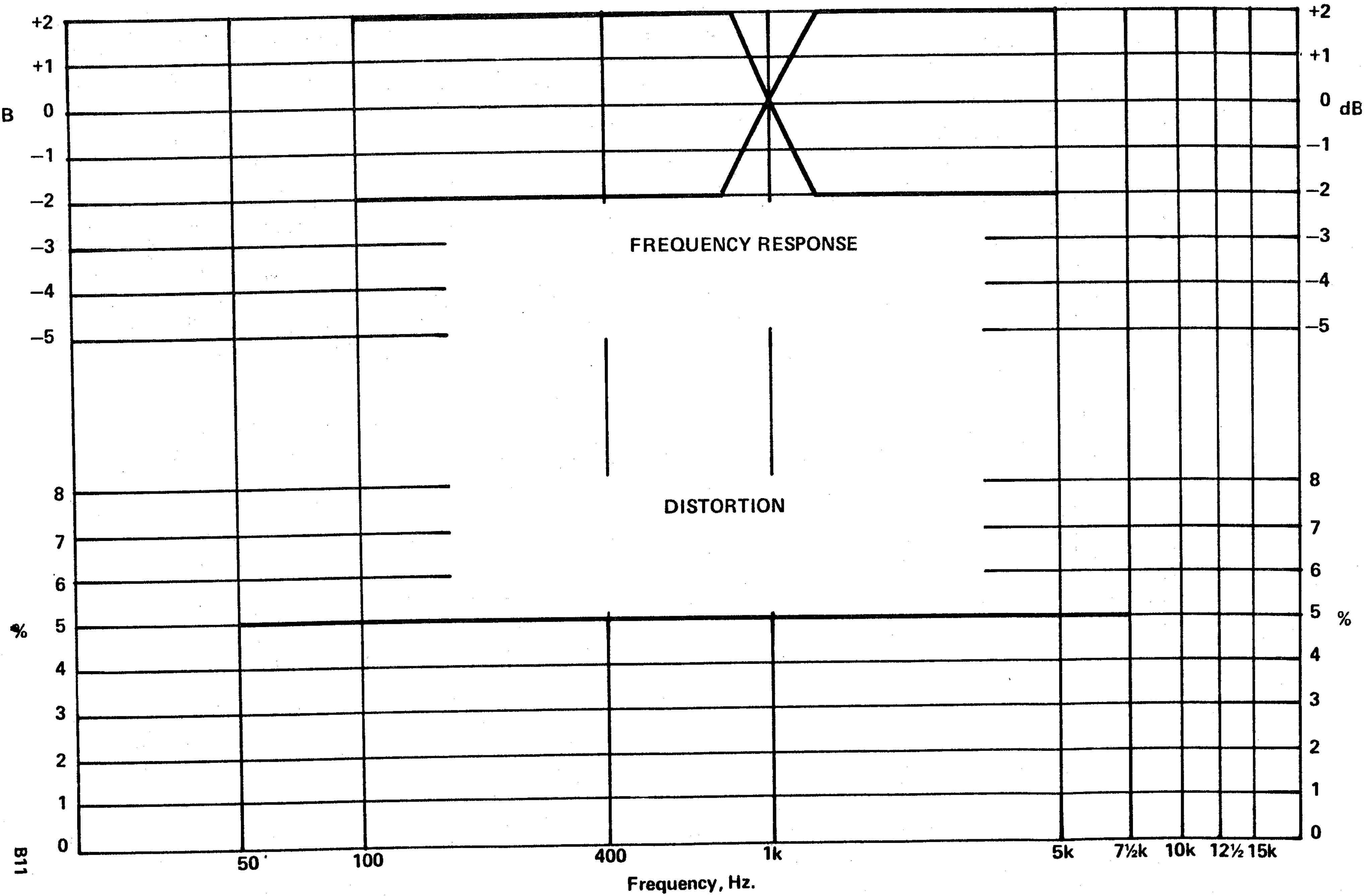


Radio Station ________________

Date ________________

L + R
25%

L + R
25% MODULATION



EQUIPMENT PERFORMANCE MEASUREMENTS
TABULATION OF DATA

Station ____________________

Date ____________________

Audio Frequency Response & Distortion

	50	100	400	1k	5k	7½k	10k	12½k	15k
Response									
Left, 75% Modulation* (± 2 dB, 100 – 5k)				0 dB					
Left, 50% Modulation (± 2 dB, 100 – 5k)				0 dB					
Left, 25% Modulation (± 2 dB, 100 – 5k)				0 dB					
Distortion									
Left, 75% Modulation* (5%)						*	*	*	*
Left, 50% Modulation (5%)						*	*	*	*
Left, 25% Modulation (5%)						*	*	*	*

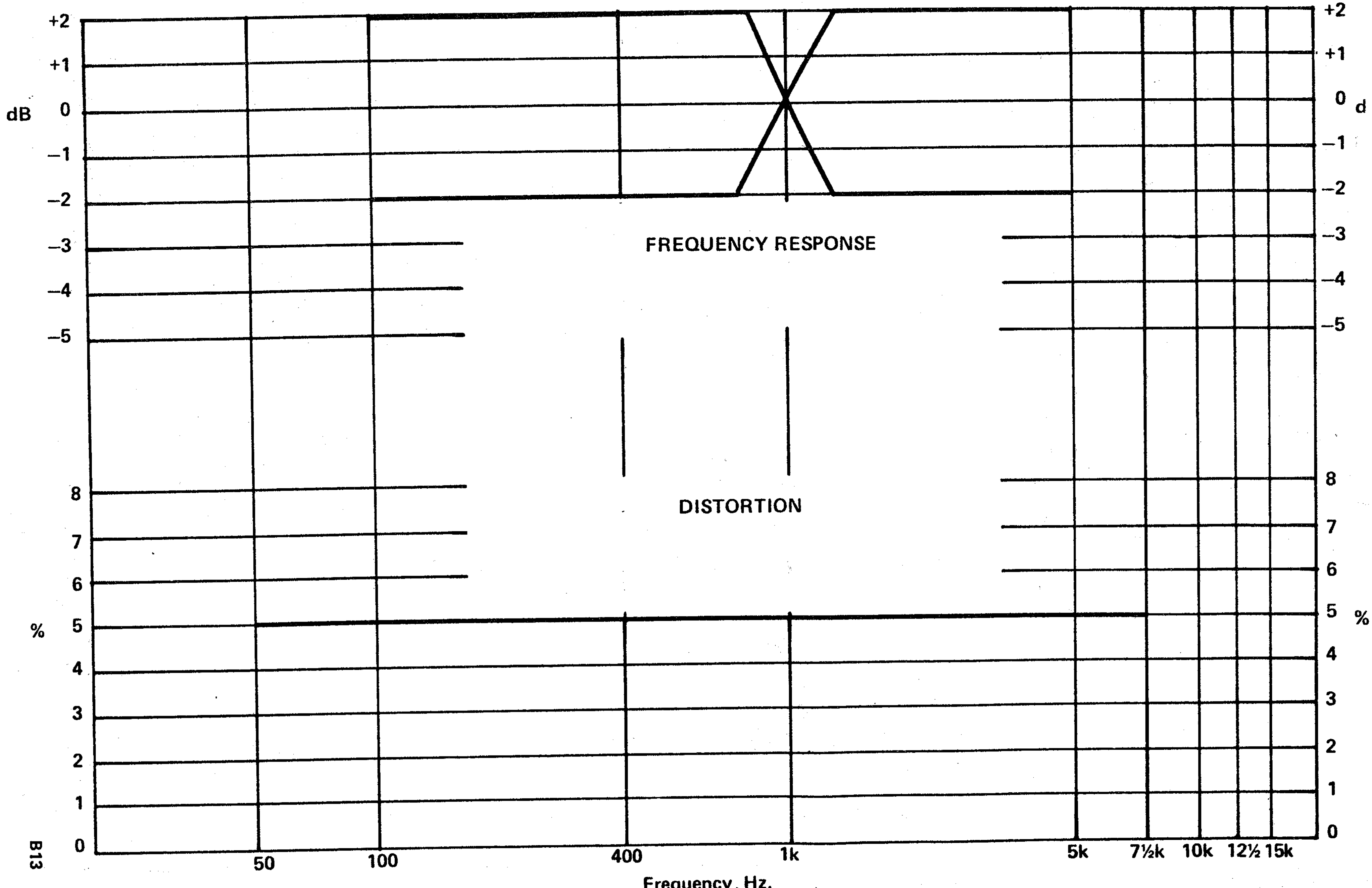
* When attainable

Radio Station ____________

Date ____________

Left
75%

LEFT CHANNEL
75% MODULATION

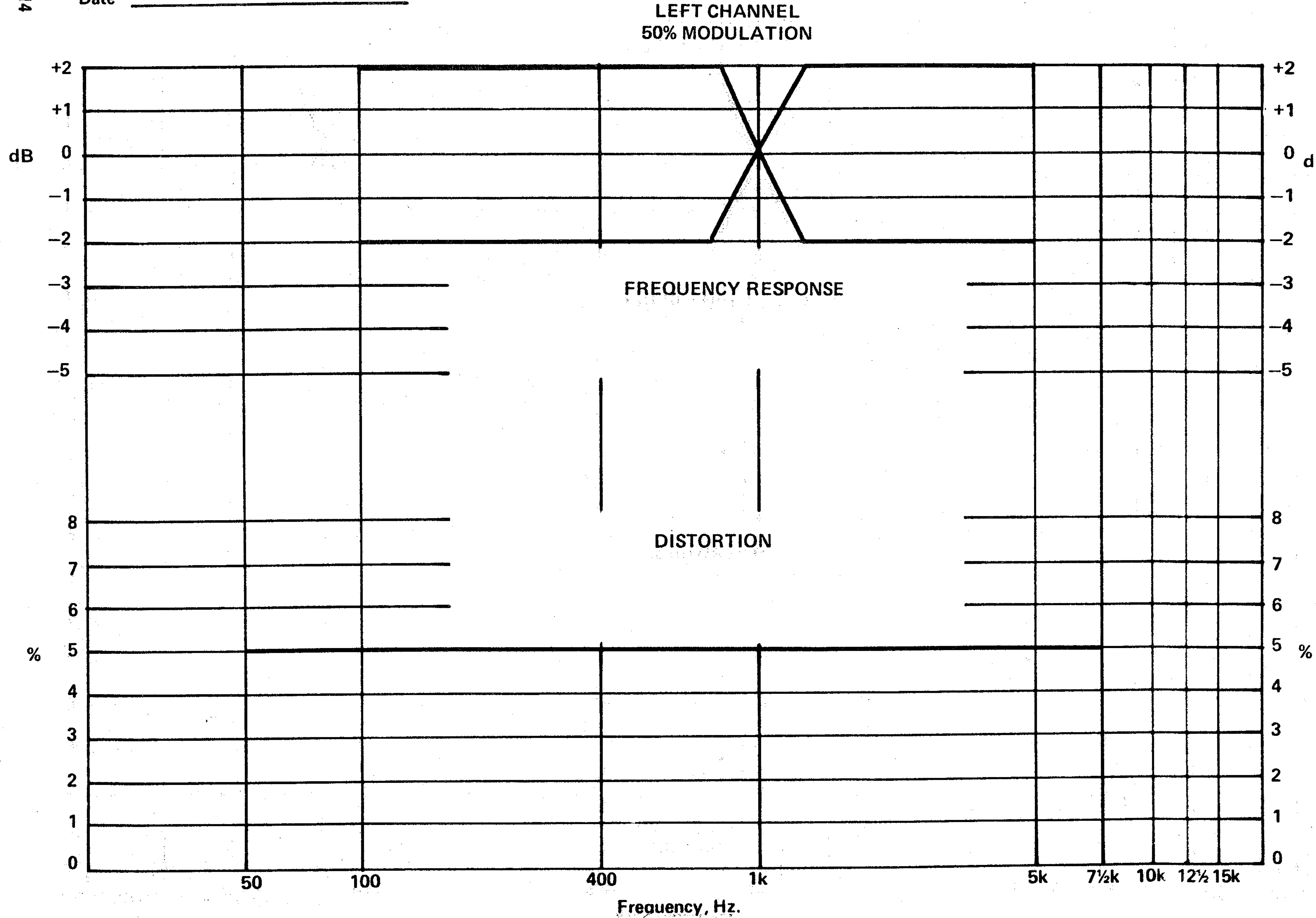


B14

Radio Station ____________

Date ____________

Left
50%

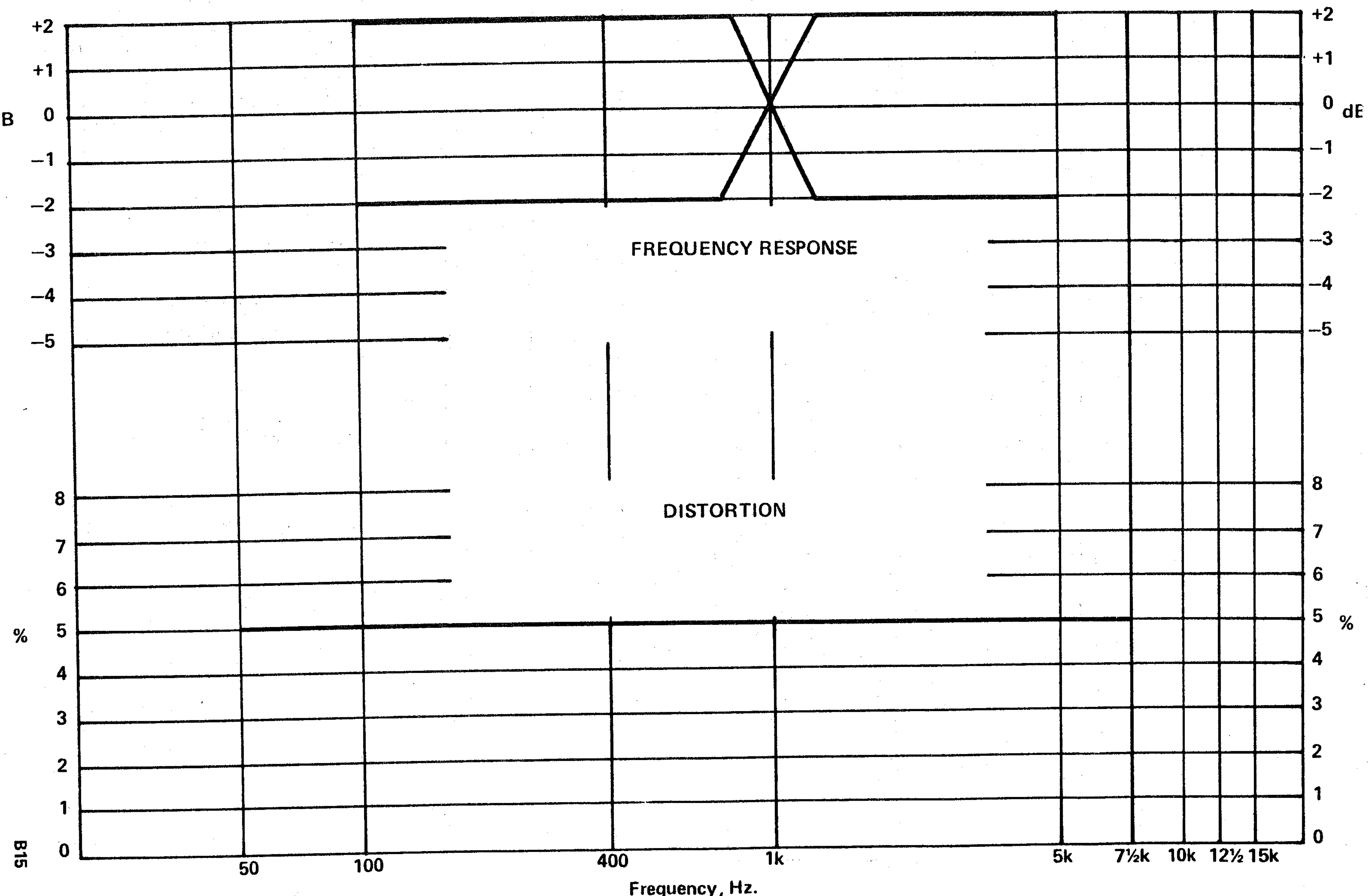


Radio Station ________

Date ________

Left
25%

LEFT CHANNEL
25% MODULATION



EQUIPMENT PERFORMANCE MEASUREMENTS
TABULATION OF DATA

Station ____________

Date ____________

Right
Audio Frequency Response & Distortion

	50	100	400	1k	5k	7½k	10k	12½k	15k
Response									
Right, 75% Modultaion* (± 2 dB, 100 – 5k)				0 dB					
Right, 50% Modulation (± 2dB, 100 – 5k)				0 dB					
Right, 25% Modulation (± 2 dB, 100 – 5k)				0 dB					
Distortion									
Right, 75% Modulation* (5%)						*	*	*	*
Right, 50% Modulation (5%)						*	*	*	*
Right, 25% Modulation (5%)						*	*	*	*

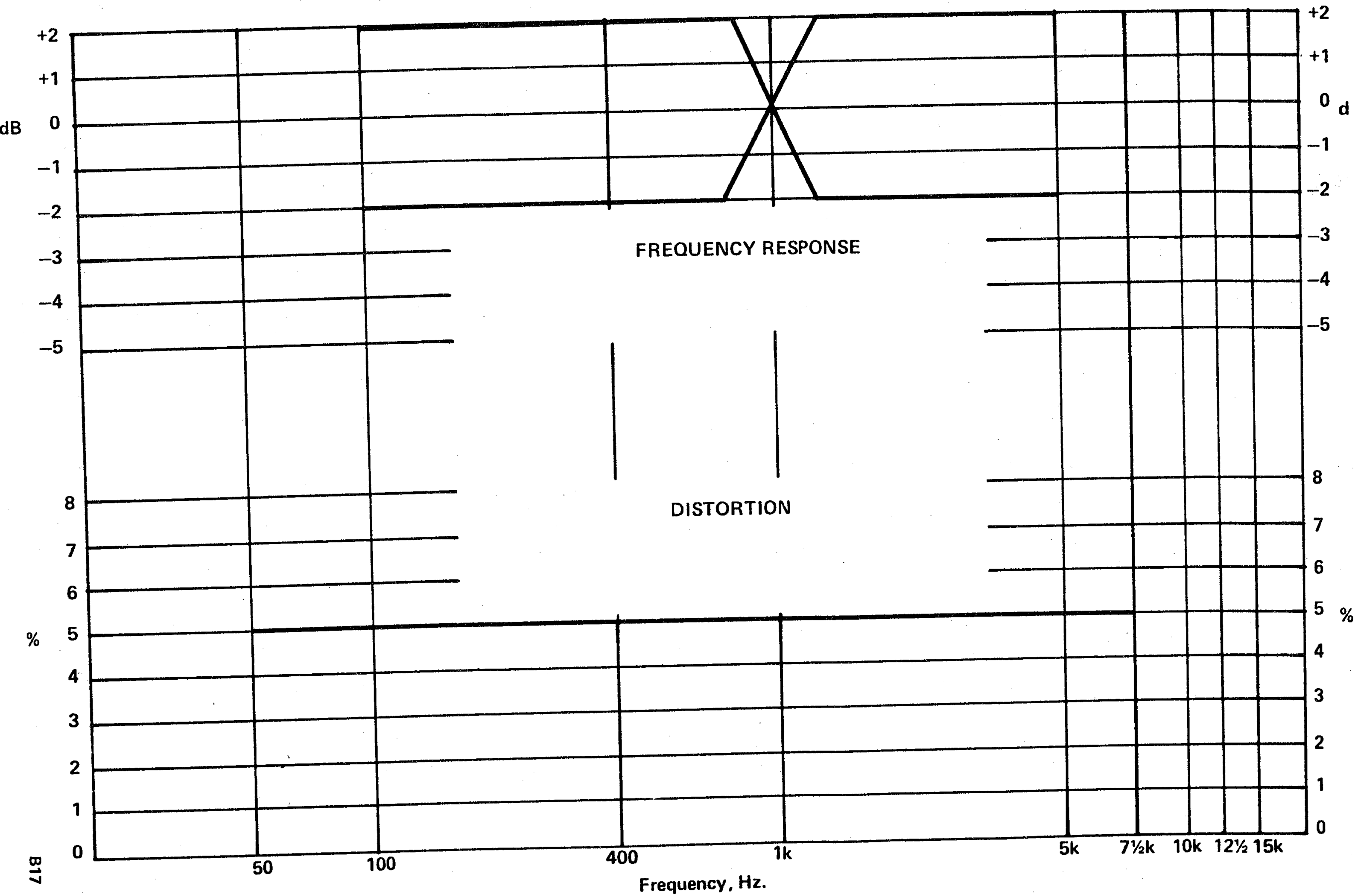
*When attainable

Radio Station ____________

Date ____________

Right
75%

RIGHT CHANNEL
75% MODULATION



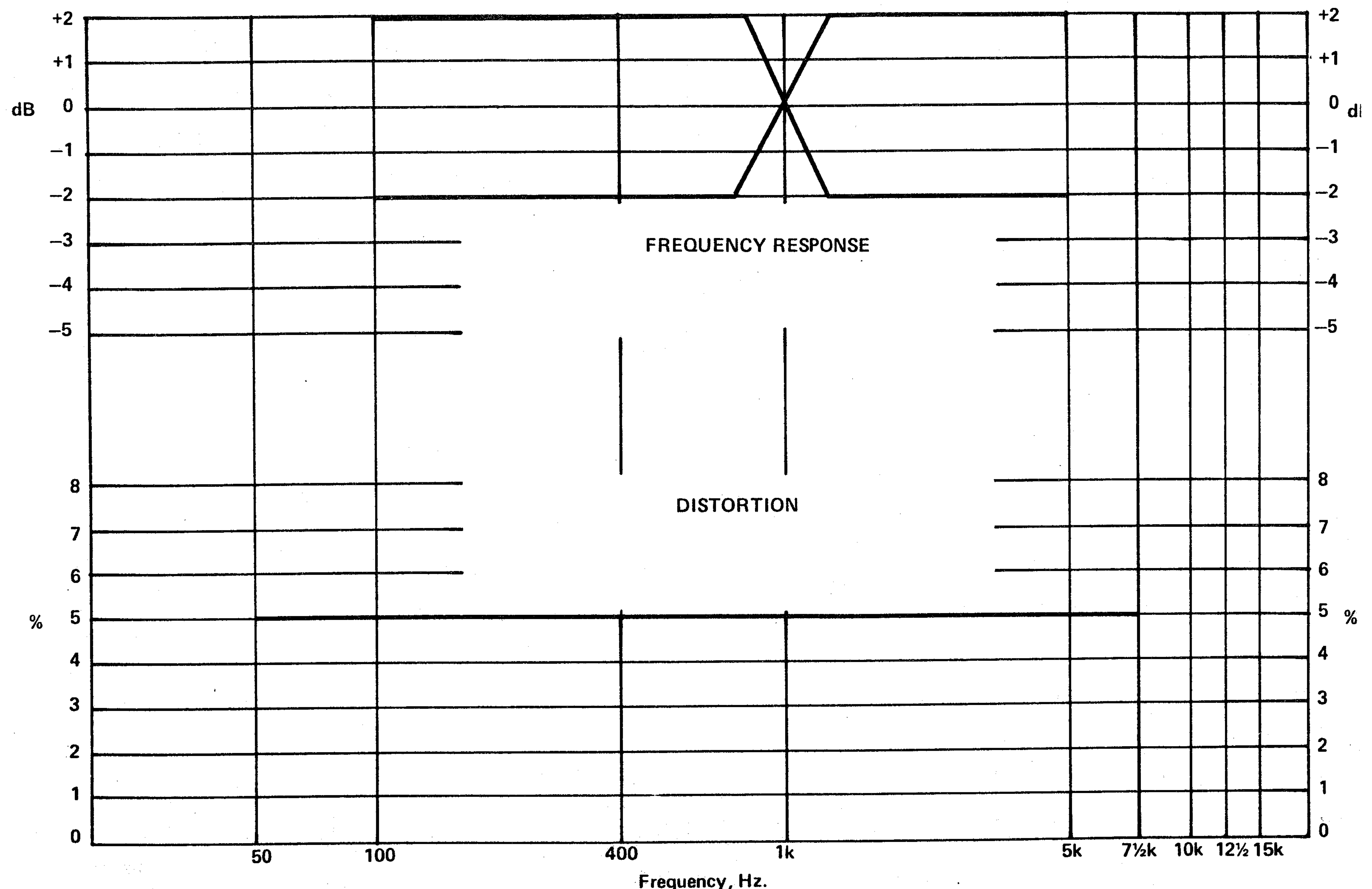
Radio Station ____________

Date ____________

B18

Right
50%

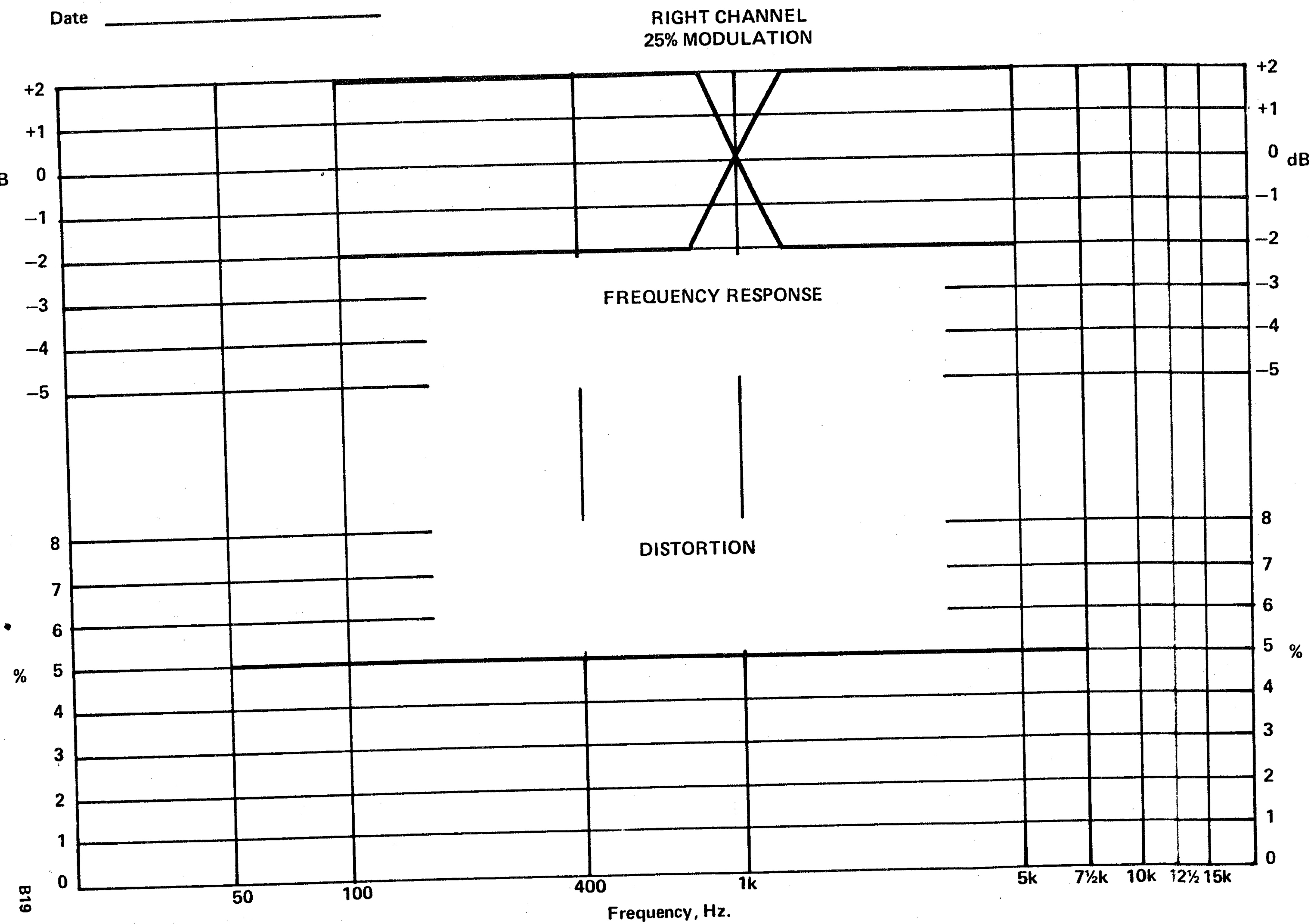
RIGHT CHANNEL
50% MODULATION



Radio Station ______

Date ______

Right
25%



EQUIPMENT PERFORMANCE MEASUREMENTS
TABULATION OF DATA

Station ____________________

Date ____________________

Separation
50% Modulation

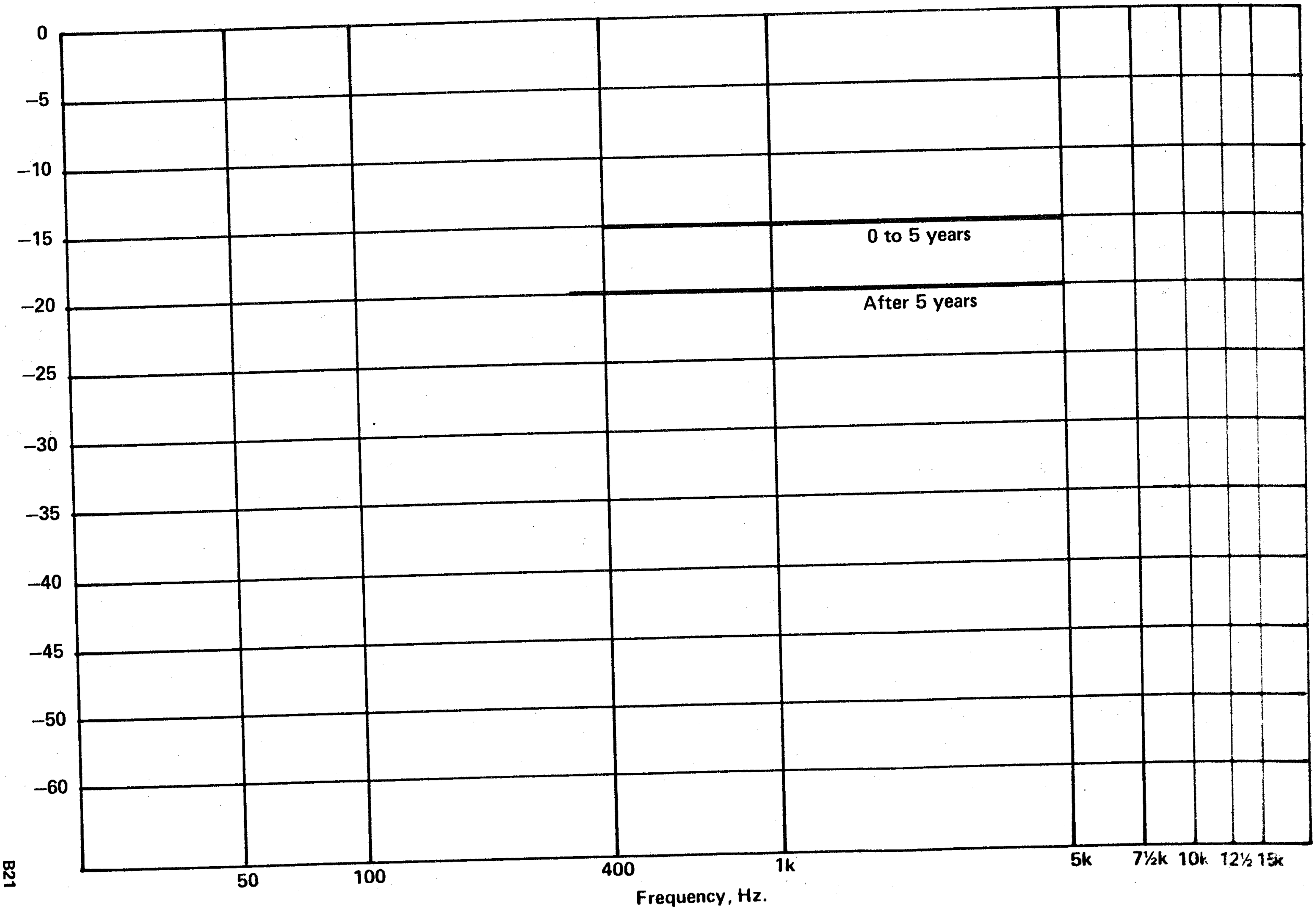
	50	100	400	1k	5k	7½k	10k	12½k	15k
Separation, Left into Right 50% Modulation									
Separation, Right into Left 50% Modulation									

Station ____________

Date ____________

SEPARATION
LEFT INTO RIGHT

50% MODULATION



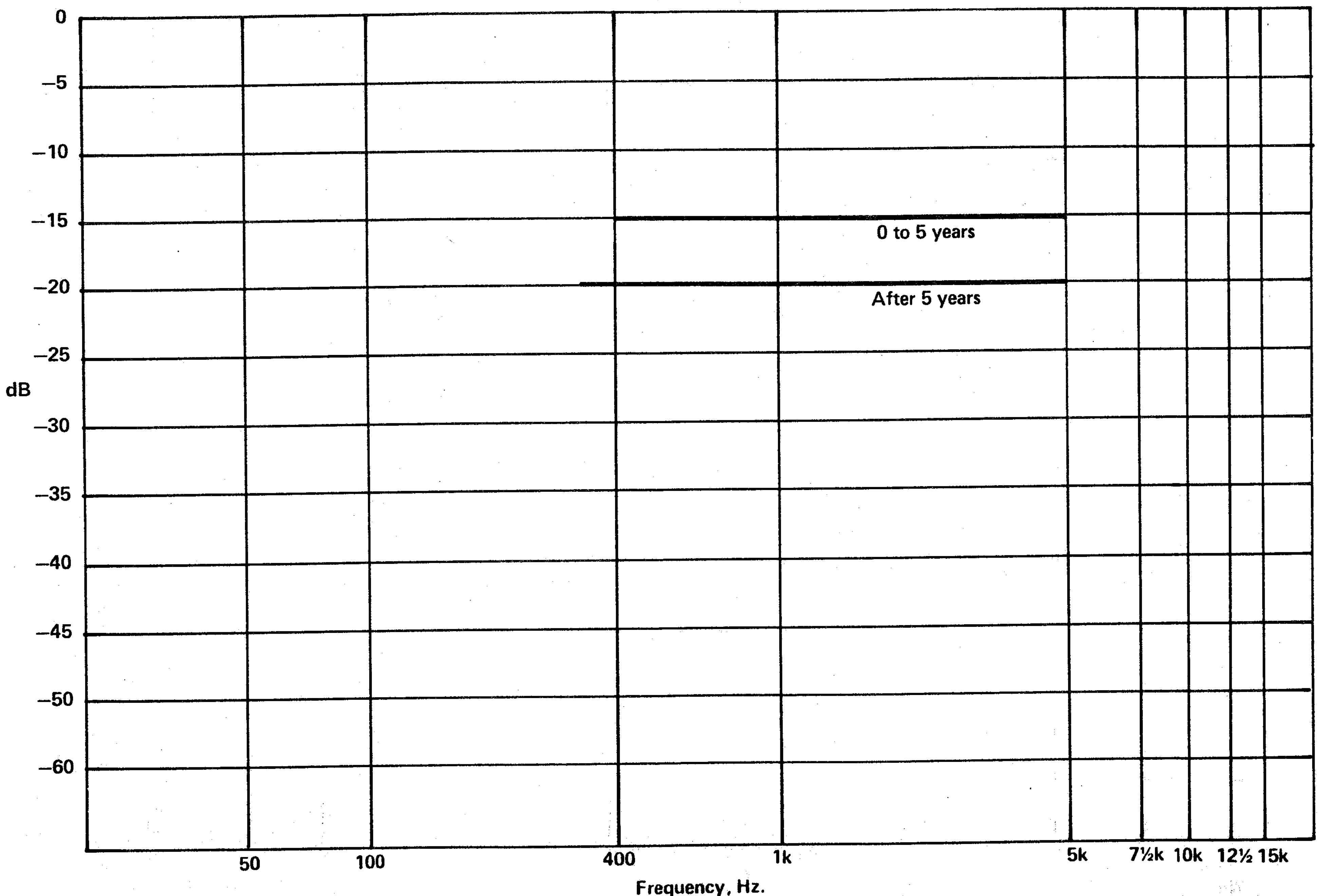
Station ______

Date ______

SEPARATION
RIGHT INTO LEFT

50% MODULATION

Right
Separation



IPM
L+R to L−R
&
L−R to L+R
Crosstalk

EQUIPMENT PERFORMANCE MEASUREMENTS
TABULATION OF DATA

Station ____________________

Date ____________________

Frequency, Hz.

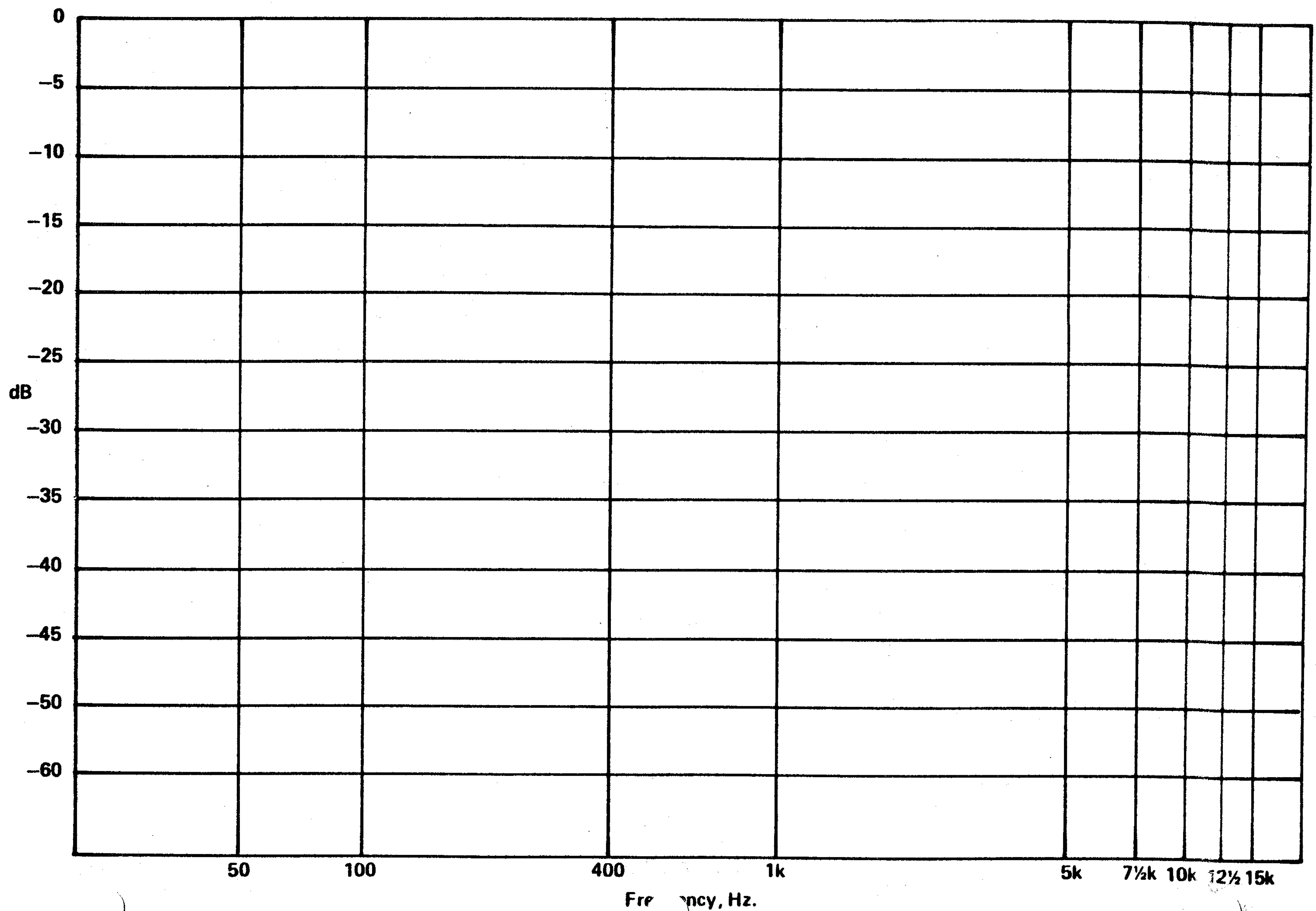
	50	100	400	1k	5k	7½k	10k	12½k	15k
Main to Subchannel Crosstalk in dB (No Specification) 95% L+R Modulation									
Incidental Phase Modulation Same as above, expressed in Radians. No Specification 95% L+R Modulation									
Subchannel to Main Crosstalk No Specification 95% L−R Modulation									

Station ____________

Date ____________

MAIN TO SUBCHANNEL CROSSTALK
(ALSO)
INCIDENTAL PHASE MODULATION
L + R, 95% MODULATION

IPM &
L + R to L – R
Crosstalk



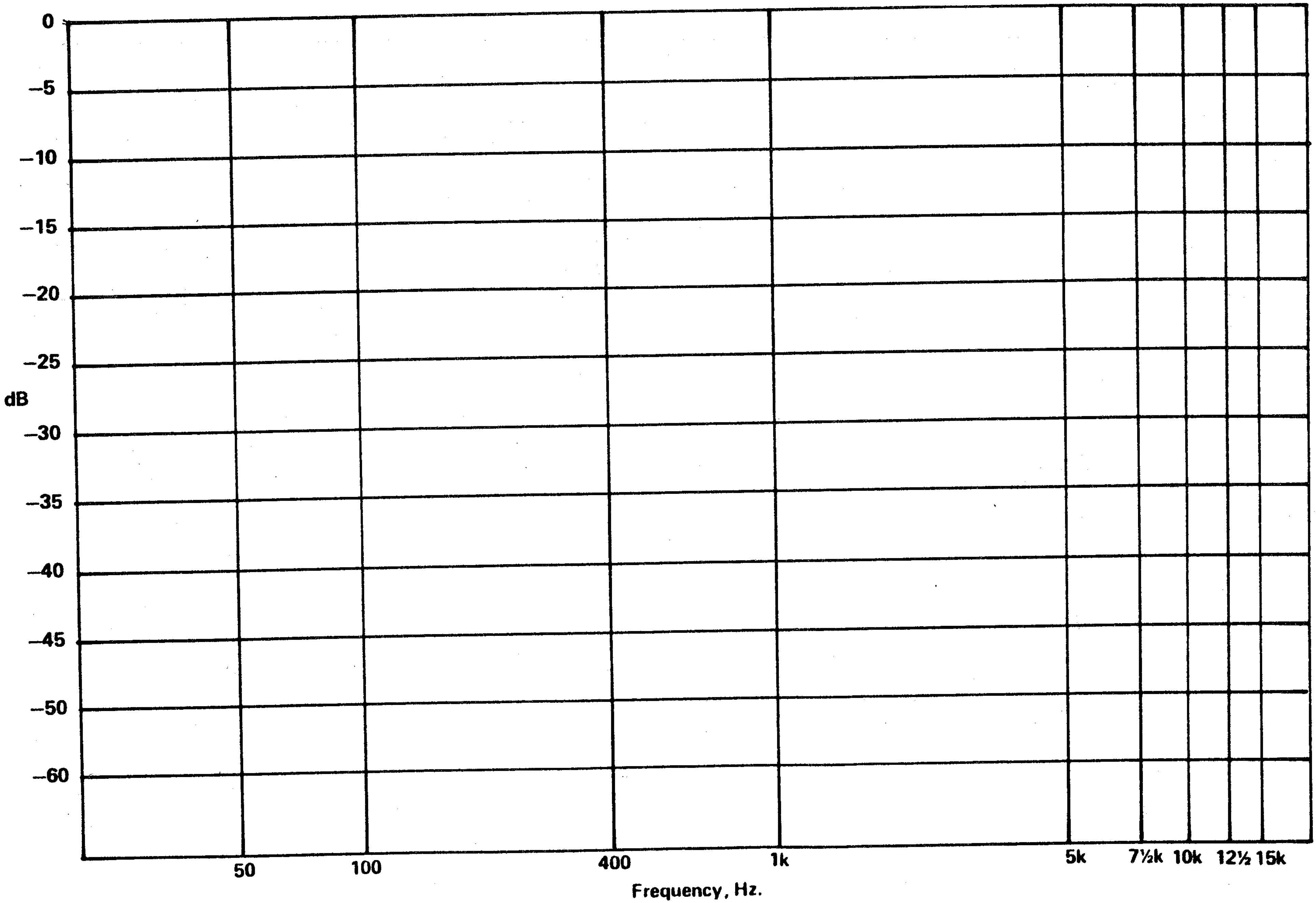
L to L + R
Crosstalk

Station ______

Date ______

SUBCHANNEL TO MAIN CROSSTALK

L – R, 95% MODULATION



Station ____________

Date ____________

EQUIPMENT PERFORMANCE MEASUREMENTS
TABULATION OF DATA

Carrier Shift

L + R, 100% Modulation ______ %

L + R, 85% Modulation ______ %

L + R, 50% Modulation ______ %

L + R, 25% Modulation ______ %

Noise Level
Below 100% at 400 Hz.

L + R ________ dB

Left ________ dB

Right ________ dB

Harmonic and Spurious Observations,
L + R, L – R, Left, & Right

Appendix A

FCC REGULATIONS FOR CONDUCTING EQUIPMENT PERFORMANCE MEASUREMENTS

§ 73.1590 Equipment Performance Measurements

a. The licensee of each AM, FM and TV station, except licensees of Class D non-commercial educational FM stations authorized to operate with 10 watts or less output power, must make equipment performance measurements for each main transmitter as follows:

1. Upon initial installation of a main new or replacement transmitter.
2. Upon modification of an existing transmitter made under the provisions of §73.1690. Modification of transmission systems, and specified therein.
3. Installation of AM stereophonic transmission equipment pursuant to §73.170.
4. Installation of FM stereophonic transmission equipment pursuant to §§73.297 or 73.597.
5. When required by other provisions of the rules or the station license.
6. AM and FM stations (except 10 watt non-commercial educational stations), once each calendar year. (One set of measurements must be made during the 4 month period immediately preceding the filing date of the application for renewal of the station license. Successive measurements are to be made at least annually by the anniversary calendar month, and completed within an additional 2 months, with no more than 14 months between measurements.)

b. *Audio measurements.* Audio equipment performance measurements must be made with the equipment adjusted for normal program operation and must include all circuits between the main studio microphone terminals or amplifier input and the antenna circuit, including any correcting equalizer circuits normally used. Any dynamic audio processing or non-correcting equalizers must be disabled or neutralized. The measurements must yield the following information:

1. *AM monophonic stations.*

   i. Data and curves showing overall audio frequency response from 50 to 5000 Hz for approximately 25, 50, 85 and if obtainable, 100% modulation. A family of curves must be plotted (one for each percentage above) with dB above and below the 1000 Hz reference frequency as ordinate and audio frequency as abscissa.

   ii. Data and curves showing audio frequency harmonic content for 25, 50, 85 and, if obtainable, 100% modulation for the audio frequencies of 50, 100, 400, 1000, 5000 and 7500 Hz (either arithmetical or RSS (root sum square) values up to the 10th harmonic or 16,000 Hz). A family of curves must be plotted (one for each percentage above) with percent distortion as ordinate and audio frequency as abscissa.

   iii. Data showing percentage of carrier amplitude regulation (carrier shift) for 25, 50, 85 and, if obtainable, 100% modulation with 400 Hz tone.

   iv. The carrier hum and extraneous noise level generated within the equipment, and measured throughout the audio spectrum, or bands, in dB below the reference level of 100% modulation by a 400 Hz tone.

   v. Measurements or evidence showing that spurious radiations, including radio frequency harmonics, are suppressed or are not present to a degree capable of causing objectionable interference to other radio services. Field strength measurements are preferred but observations made with a communications type receiver are acceptable. However, in particular cases involving interference or controversy, the FCC may require field strength measurements.

2. *AM stereophonic stations.*

i. Data and curves showing the overall audio frequency response from 50 to 15,000 Hz for approximately 25%, 50%, 75% and 100% modulation with equal left and right (L+R) main channel signal; 25%, 50%, and 75% modulation with both a left (L) channel only and right (R) channel only signals.

ii. Data and curves showing audio frequency harmonic contect for 25%, 50%, 75%, and (main channel only) 100% modulation for the audio frequencies 50, 100, 400, 1000, 5000, and when attainable 7,500, 10,000, 12,500, and 15,000 Hz (either arithmetical or RSS (root sum square) values up to the 10th harmonic or 30,000 Hz) for equal left and right (L=R), left (L) only and right (R) only signals. A family of curves must be plotted as specified in paragraph (b) (1) (ii) above.

iii. Data showing percentage of carrier amplitude regulation as specified in paragraph (b) (1) (iii) above for main channel modulation with equal left and right (L=R) signals.

iv. The carrier hum and extraneous noise level generated within the equipment, and measured throughout the audio spectrum, or band, in dB below the reference level of 100% amplitude modulation by a 400 Hz tone for the main, left, and right channels.

v. Measurements or observations for spurious and harmonic radiations as specified in paragraph (b) (1) (v) above while modulating the transmitter main (L+R) channel, left (L) channel only, right (R) channel only and a stereophonic channel only (L−R) signal. The tests shall be made with the tones and maximum attainable normal modulation as specified in 73.128 (b).

vi. The degree of incidental phase modulation of the carrier wave, in radians, when the main (L+R) channel is amplitude modulated without pilot tone. The tests shall be made with the tones and maximum attainable modulation levels as specified in (2) (i) of this paragraph.

vii. The main to stereophonic channel and the stereophonic to main channel crosstalk. The tests shall be made with the tones and maximum attainable normal modulation as specified in (2) (i) of this paragraph.

viii. In the above measurements, if 100% negative peak amplitude modulation is not attainable, the highest attainable modulation percentage between 95% and 100% modulation shall be used.

FCC MINIMUM PERFORMANCE SPECIFICATIONS FOR AM STEREO

§ 73.40 AM Transmission System Performance Requirements

a. The design, installation, and operation of a monophonic AM broadcast transmission antenna terminals must meet the following specifications.

b. The design, installation, and operation of a stereophonic AM broadcast transmission system between audio input amplifiers used for all programming for both the left and right program channels to the transmitting antenna terminals must meet the following specifications.

1. Except when due to equipment failures or other conditions beyond the licensee's control, the transmitter must be capable of operating at the authorized power for each mode of operation, with a main (L+R) channel amplitude modulation not less than 85% and a left (L) only or right (R) only signal of not less than 75% over the audio frequency range from 50 to 5,000 Hz.
2. For main channel modulation only, the transmission system shall meet the distortion specifications of paragraph (a) (2) above with harmonics observed to 20,000 Hz. When stereophonic transmission is used, the distortion must be measured in the left and right channels separately modulated using a suitable stereophonic demodulator.
3. The audio frequency transmitting characteristics for main (L+R), left (L) only and right (R) only modulation shall conform to the requirements of paragraph (a) (3) above, except that measurements shall extend to 7,500 Hz.
4. The carrier-amplitude regulation (carrier shift) at any percentage of amplitude modulation by a main (L+R) channel signal shall not exceed 5%.
5. The carrier hum and extraneous noise level, unweighted noise, over the frequency band 50 to 20,000 Hz for main channel (L+R), left (L), and right (R) channels must be at least 45 dB below the reference level of 100% amplitude modulation of the carrier by a 400 Hz tone. Measurements shall be made with a suitable stereophonic demodulator.
6. The incidental phase modulation of the transmitter must be measured with the main (L+R) channel modulated at the audio frequencies and modulation levels specified in paragraph (b) (2) above.

   NOTE: Specifications for incidental phase modulation are not established.
7. For the first five years following installation of stereophonic transmitting equipment, stereophonic separation between left and right stereophonic channels must be at least 15 dB at audio modulating frequencies between 400 and 5,000 Hz. After five years, stereophonic separation between left and right stereophonic channels must be at least 20 dB at audio modulating frequencies between 300 and 5,000 Hz.

§ 73.128 AM Stereophonic Broadcasting

a. An AM broadcast station may, without specific authority from the FCC, transmit stereophonic programs upon installation of type accepted stereophonic transmitting equipment and the necessary measuring equipment to determine that the stereophonic transmissions conform to the modulation characteristics specified for the stereophonic transmission system in use.

b. The FCC does not specify the composition of the transmitted stereophonic signal. However, the following limitations on the transmitted wave must be met to insure compliance with the occupied bandwidth limitations, compatibility with AM receivers using envelope detectors, and any applicable international agreements to which the United States is a party:

1. The transmitted wave must meet the occupied bandwidth specifications of 73.44 under all possible conditions of program modulation. Compliance with requirement shall be demonstrated either by the following specific modulation tests or other documented test procedures that are to be fully described in the application for type acceptance and the transmitting equipment instruction manual. (See 2.983 paragraphs (d) (8) and (j)).

   i. Main channel (L+R) under all conditions of amplitude modulation for the stereophonic system but not exceeding amplitude modulation on negative peaks of 100%.

   ii. Stereophonic subchannel (L–R) modulated with audio tones of the same amplitude at the transmitter input terminals as in (i) above but with the phase of either the L or R channel reversed.

   iii. Left and Right Channel only, under all conditions of modulation for the stereophonic system in use but not exceeding amplitude modulation on negative peaks of 100%.

2. The total harmonic distortion as measured by an envelope detector having an input radio frequency bandwidth of 30 kHz (3 dB points) many not exceed 5% for the conditions of modulation specified (1) of this paragraph.

c. Each licensee or permitee of an AM station engaging in stereophonic broadcasting using a system with a pilot tone shall measure the quiescent pilot tone frequency and injection level and calibrate at intervals as often as necessary to insure compliance with the specifications for the system in use. However, in any event, the measurements shall be made at least once each calendar month with not more than 40 days between successive measurements.

AM STEREO

Equipment Performance Measurements

EXTRA FORMS

EQUIPMENT PERFORMANCE MEASUREMENTS
TABULATION OF DATA

Station ____________________

Date ____________________

Audio Frequency Response

	50	100	400	1k	5k	7½k	10k	12½k	15k
L + R, 95% Modulation (± 2 dB, 100 – 5k)				0 dB					
L + R 75% Modulation (± 2 dB, 100 – 5k)				0 dB					
L + R 50% Modulation (± 2 dB, 100 – 5k)				0 dB					
L + R 25% Modulation (± 2 dB, 100 – 5k)				0 dB					
				0 dB					

L + R
Distortion

EQUIPMENT PERFORMANCE MEASUREMENTS
TABULATION OF DATA

Station ____________________

Date ____________________

Audio Frequency Harmonic Content
(Distortion)

	50	100	400	1k	5k	7½k*	10k*	12½k*	15k*
L + R, 95% Modulation (7.5% Max.)									
L + R, 75% Modulation (5% Max.)									
L + R, 50% Modulation (5% Max.)									
L + R, 25% Modulation (5% Max.)									

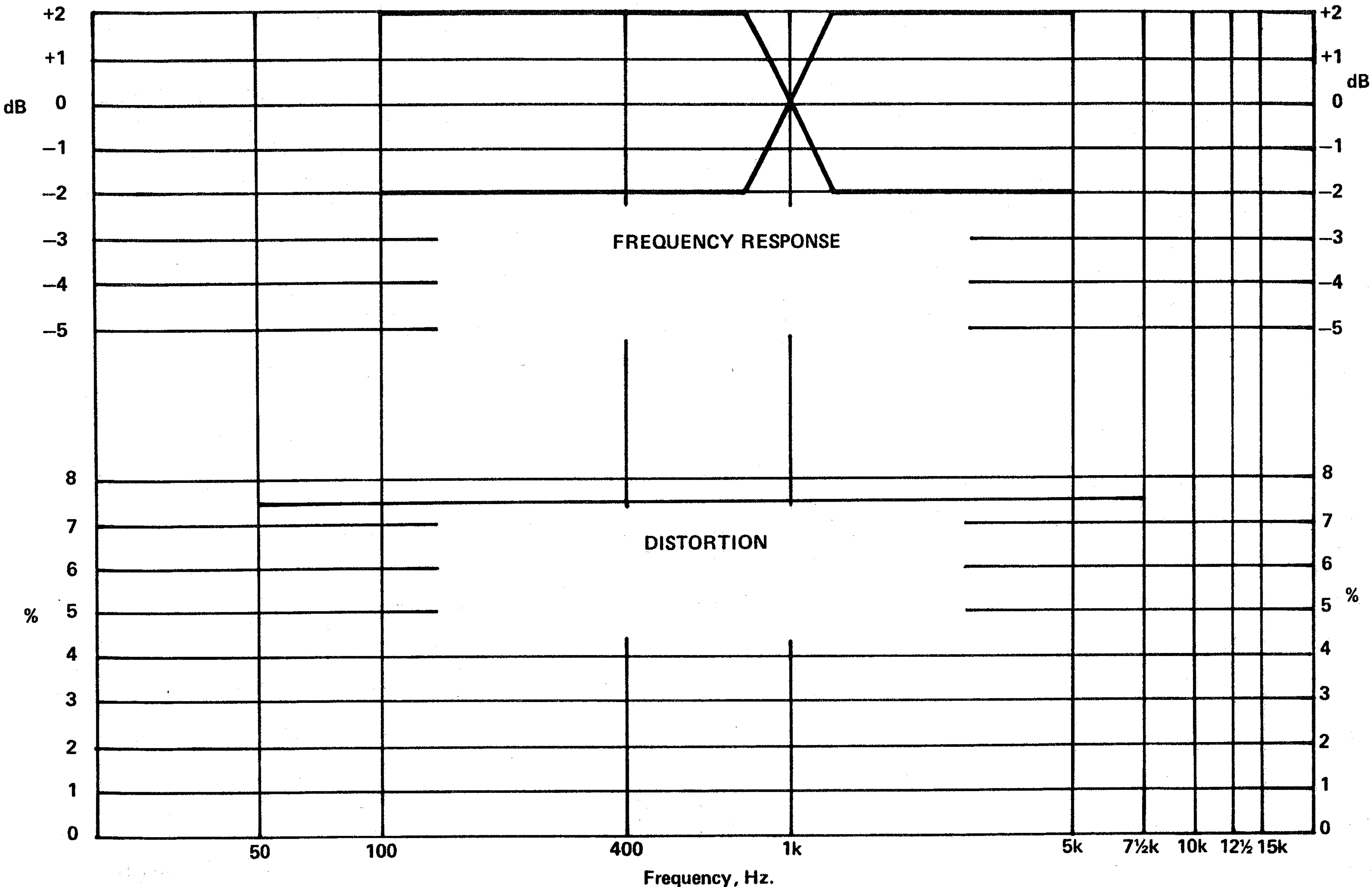
* When attainable

Radio Station ____________

Date ____________

L + R
95%

L + R
95% MODULATION

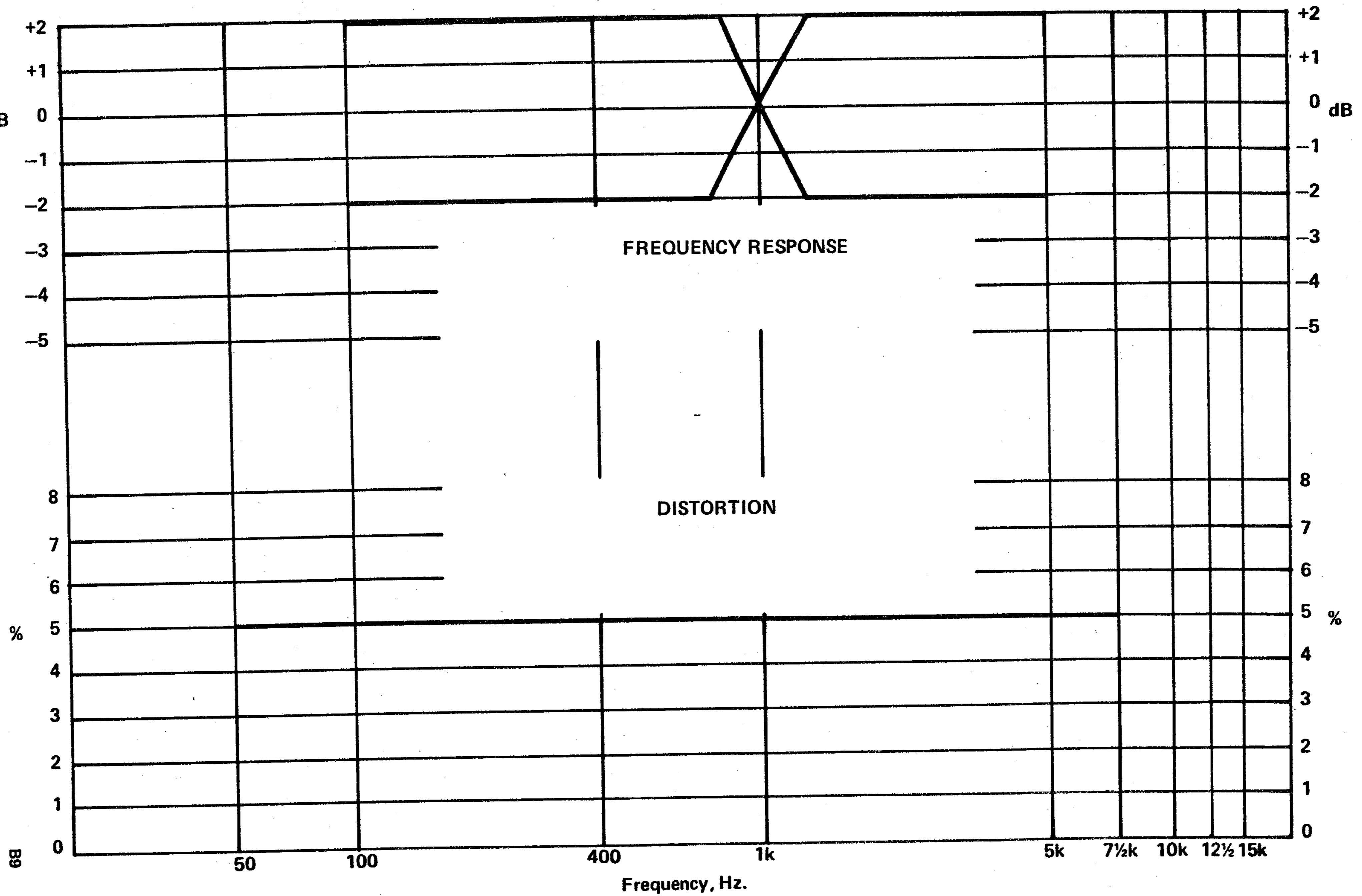


Radio Station ____________

Date ____________

L + R
75%

L + R
75% MODULATION

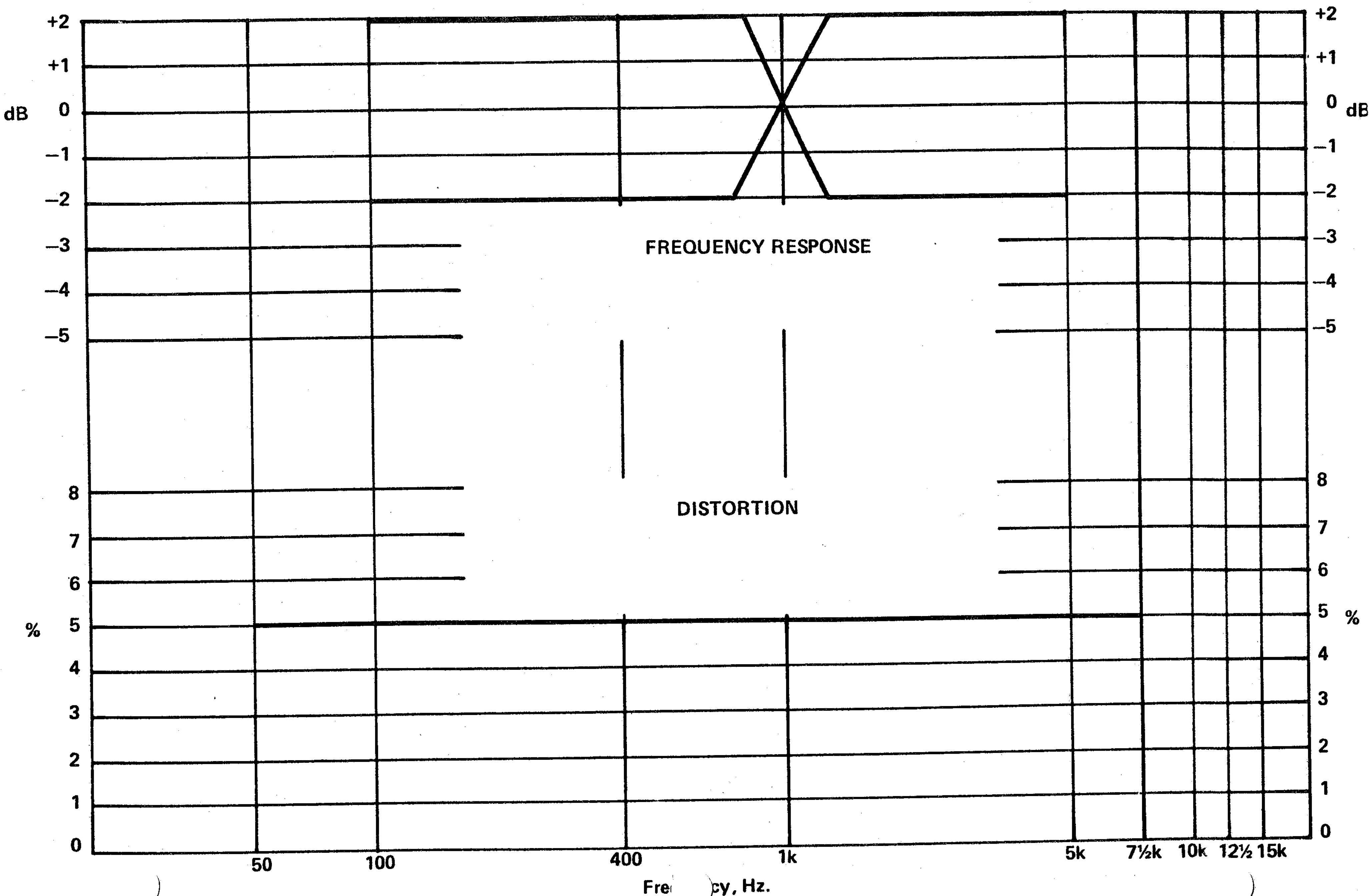


Radio Station ____________

Date ____________

L + R
50%

L + R
50% MODULATION

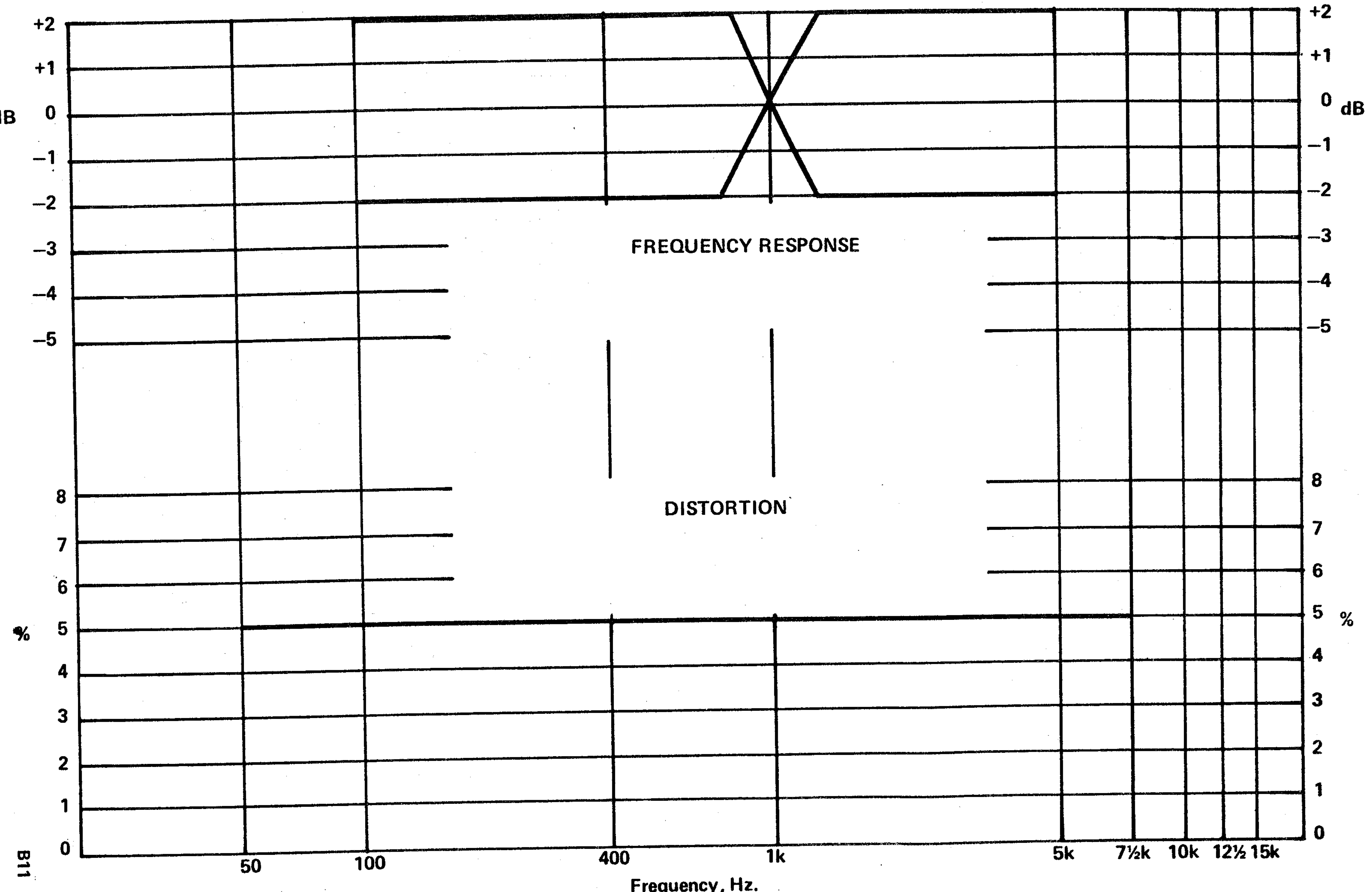


Radio Station ____________

Date ____________

L + R
25%

L + R
25% MODULATION



EQUIPMENT PERFORMANCE MEASUREMENTS
TABULATION OF DATA

Station ____________

Date ____________

Audio Frequency Response & Distortion

	50	100	400	1k	5k	7½k	10k	12½k	15k
Response									
Left, 75% Modulation* (± 2 dB, 100 – 5k)				0 dB					
Left, 50% Modulation (± 2 dB, 100 – 5k)				0 dB					
Left, 25% Modulation (± 2 dB, 100 – 5k)				0 dB					
Distortion									
Left, 75% Modulation* (5%)						*	*	*	*
Left, 50% Modulation (5%)						*	*	*	*
Left, 25% Modulation (5%)						*	*	*	*

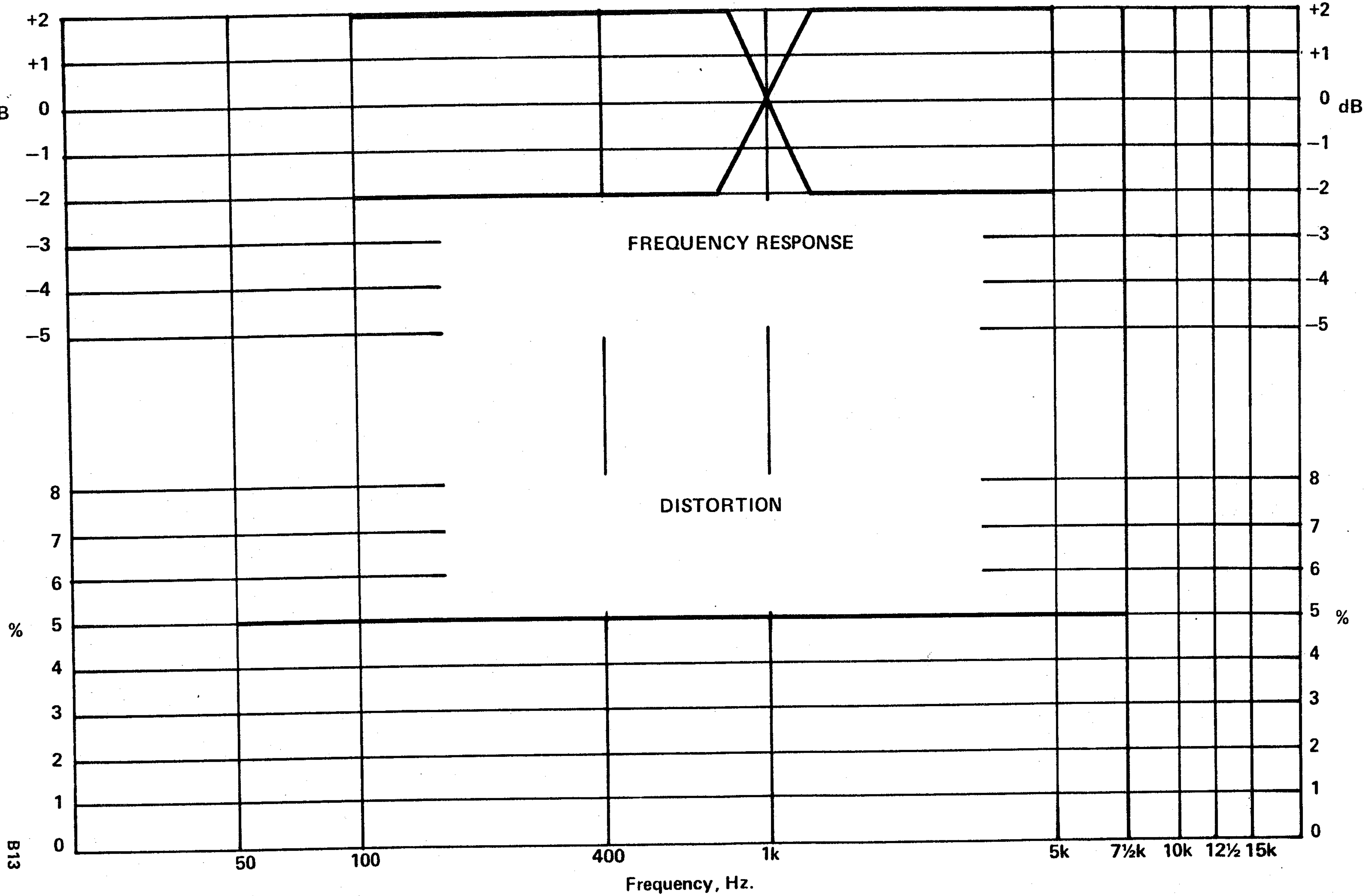
* When attainable

Radio Station ______________

Date ______________

Left
75%

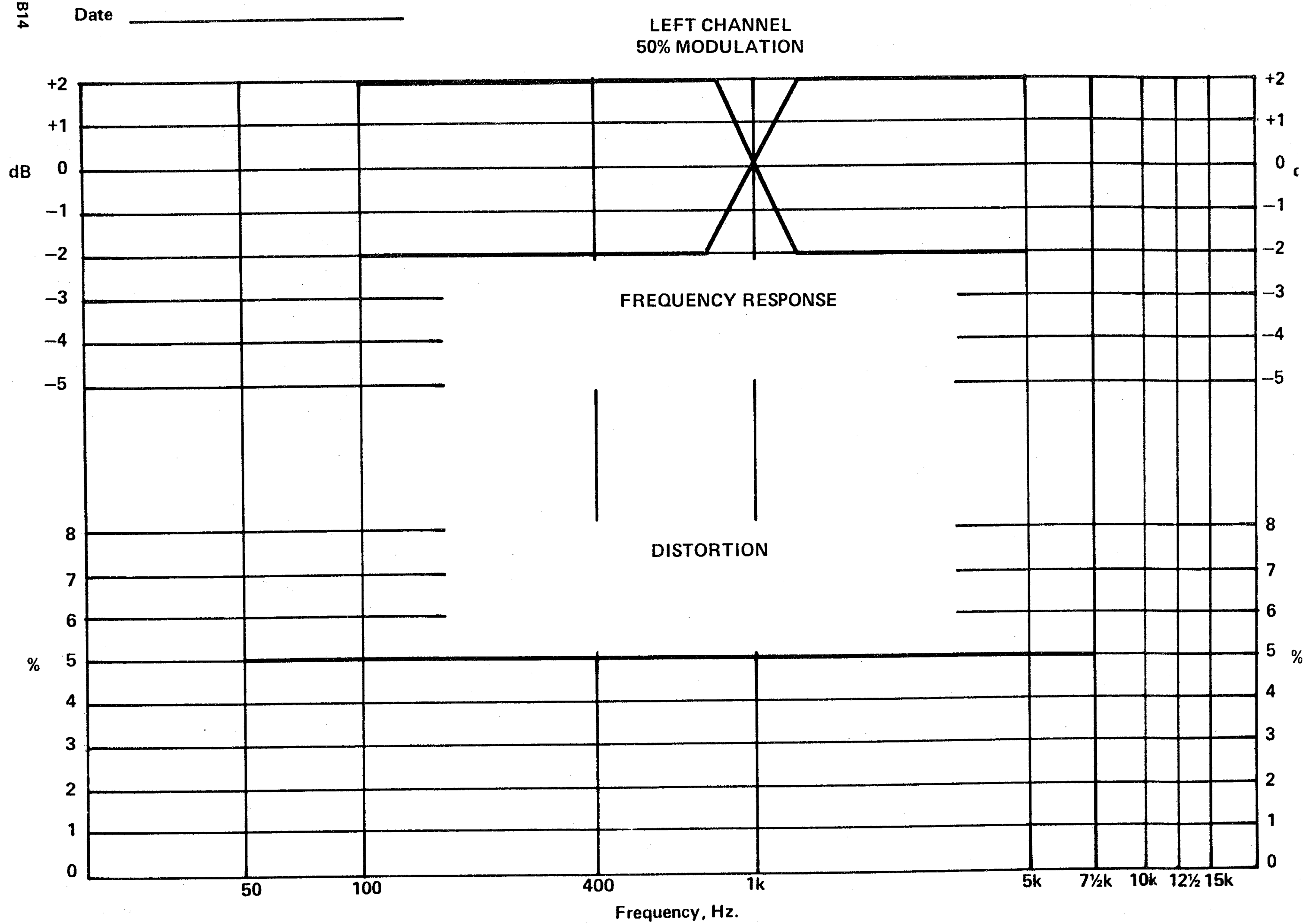
LEFT CHANNEL
75% MODULATION



Radio Station ____________

Date ____________

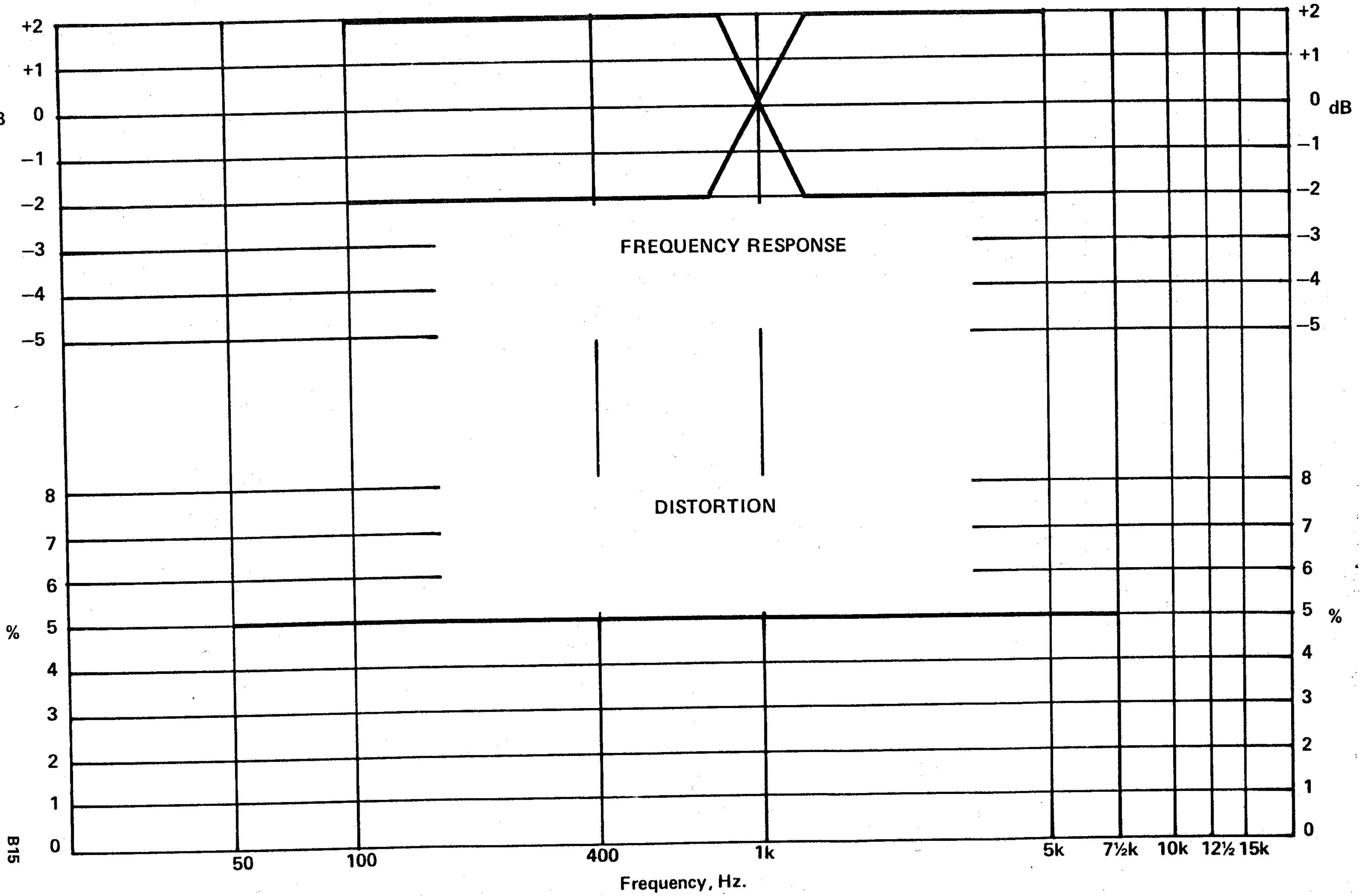
Left
50%



Radio Station ____________

Date ____________

Left
25%



EQUIPMENT PERFORMANCE MEASUREMENTS
TABULATION OF DATA

Station ____________

Date ____________

Right
Audio Frequency Response & Distortion

	50	100	400	1k	5k	7½k	10k	12½k	15k
Response									
Right, 75% Modultaion* (± 2 dB, 100 – 5k)				0 dB					
Right, 50% Modulation (± 2dB, 100 – 5k)				0 dB					
Right, 25% Modulation (± 2 dB, 100 – 5k)				0 dB					
Distortion									
Right, 75% Modulation* (5%)						*	*	*	*
Right, 50% Modulation (5%)						*	*	*	*
Right, 25% Modulation (5%)						*	*	*	*

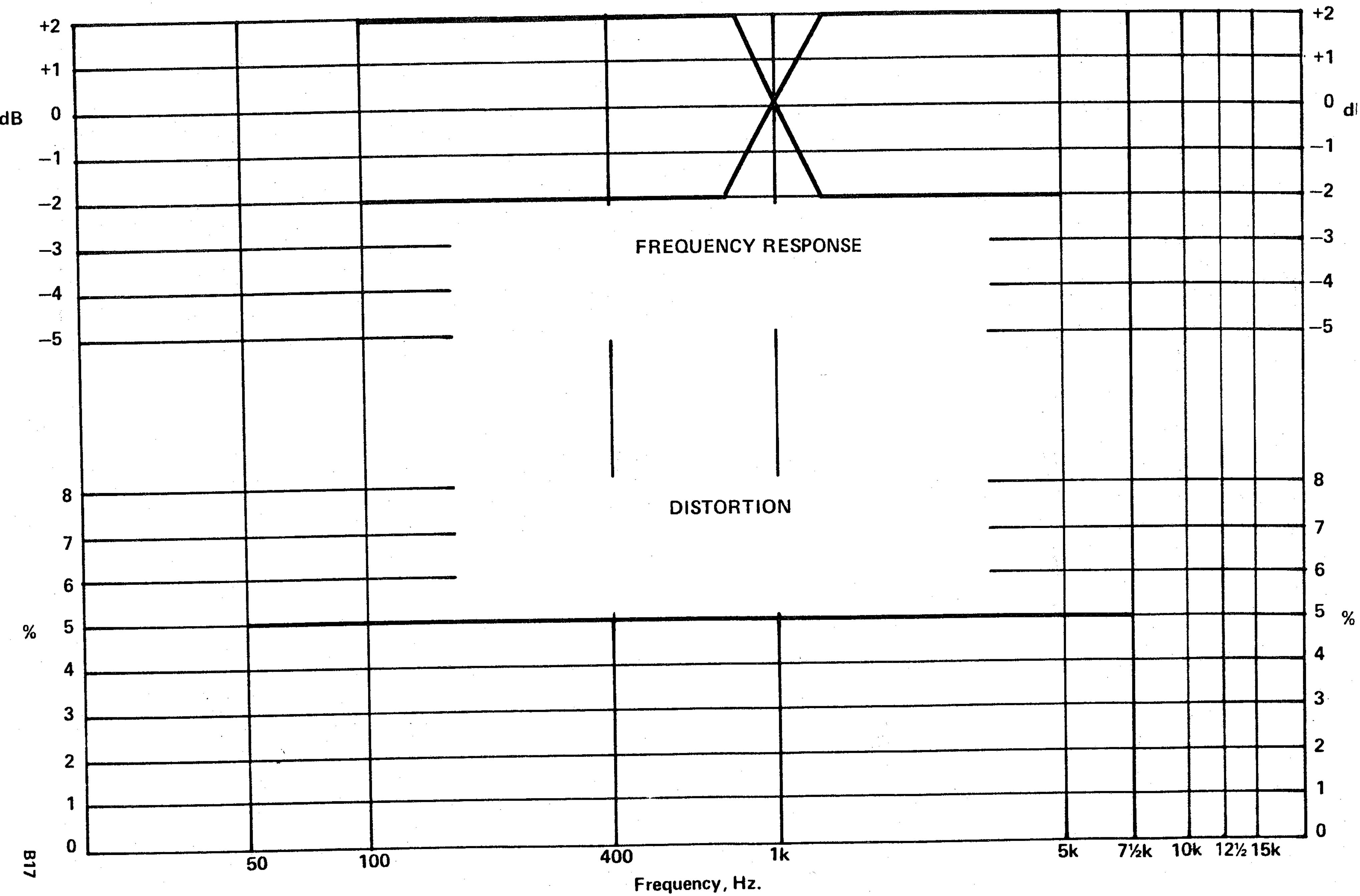
*When attainable

Radic ation ______

Date ______

Right
75%

RIGHT CHANNEL
75% MODULATION



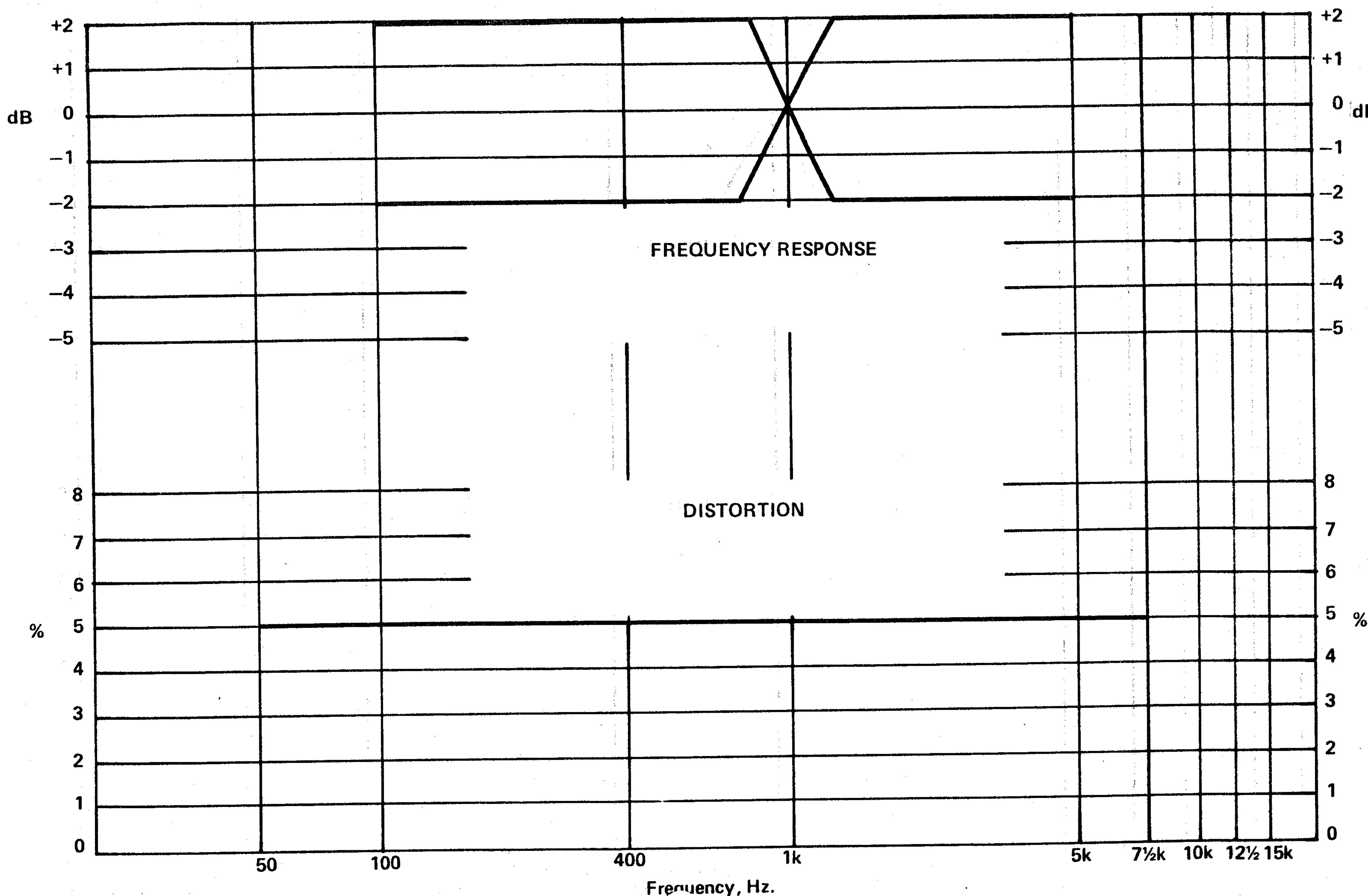
B18

Radio Station ____________

Date ____________

Right
50%

RIGHT CHANNEL
50% MODULATION

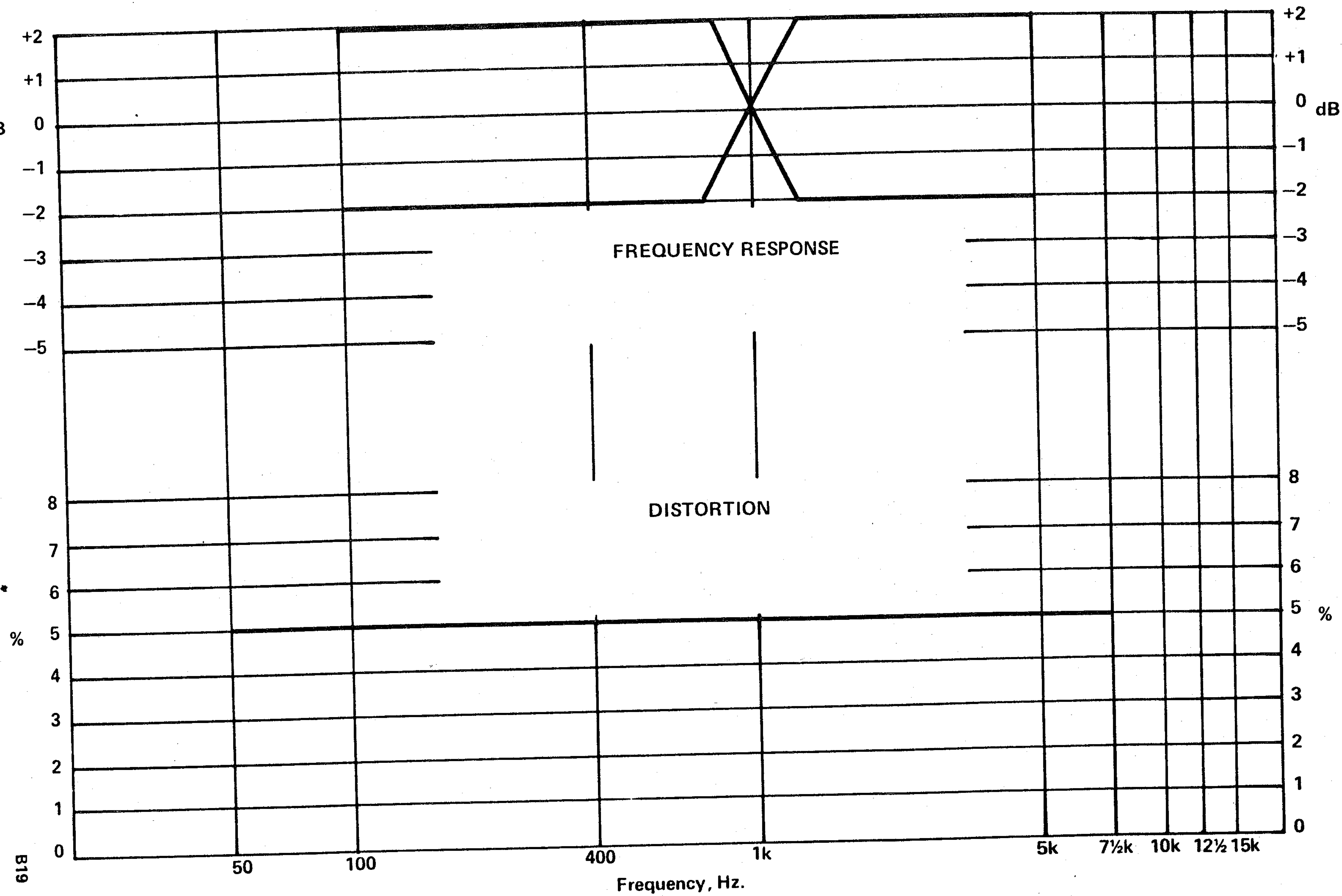


Radio Station ______________

Date ______________

Right
25%

RIGHT CHANNEL
25% MODULATION



EQUIPMENT PERFORMANCE MEASUREMENTS
TABULATION OF DATA

Station ____________________

Date ____________________

Separation
50% Modulation

	50	100	400	1k	5k	7½k	10k	12½k	15k
Separation, Left into Right 50% Modulation									
Separation, Right into Left 50% Modulation									

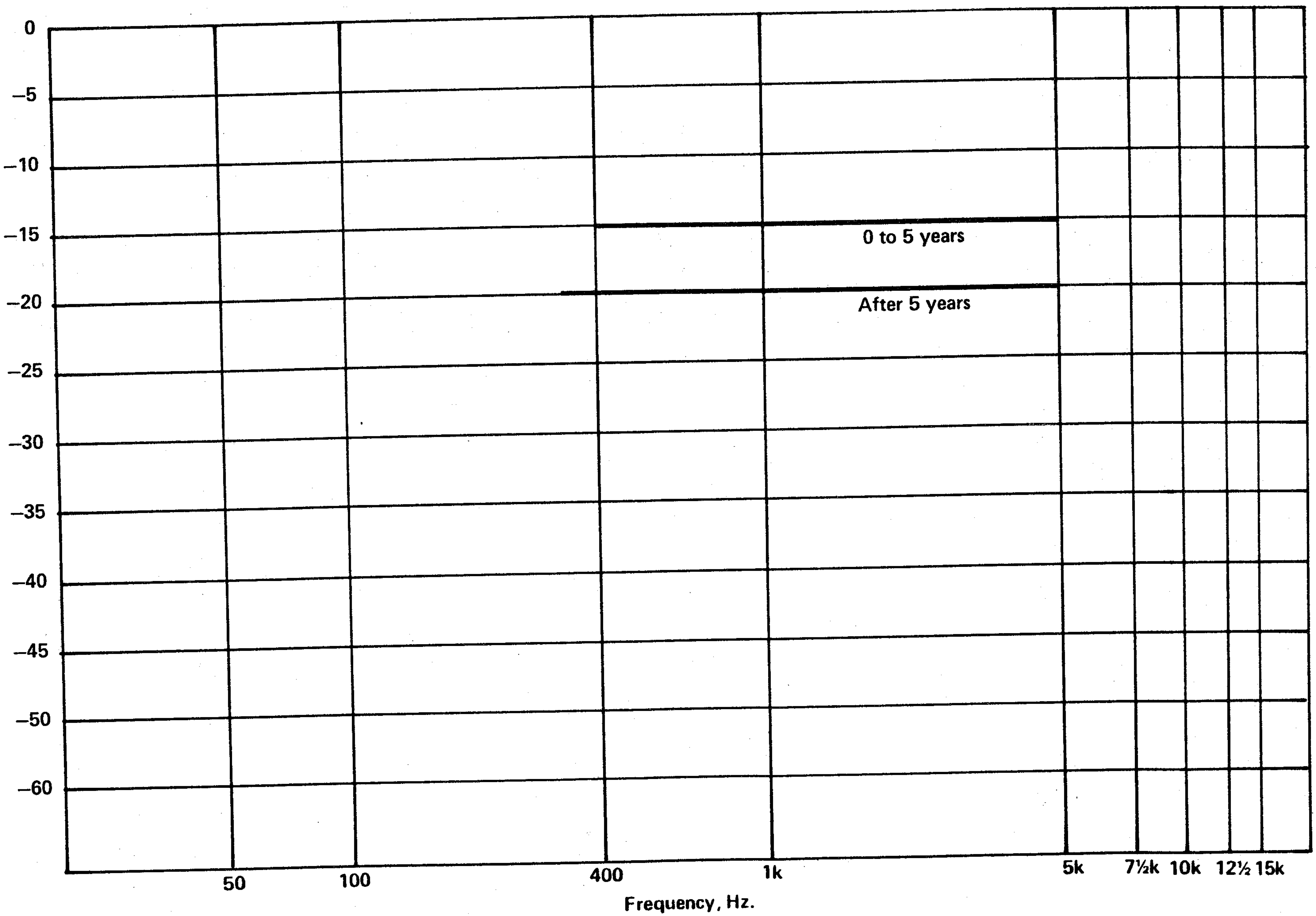
Stat[illegible] ____________

Date ____________

SEPA[illegible]TION
LEFT INTO RIGHT

50% MODULATION

[illegible]eft
[illegible]ration

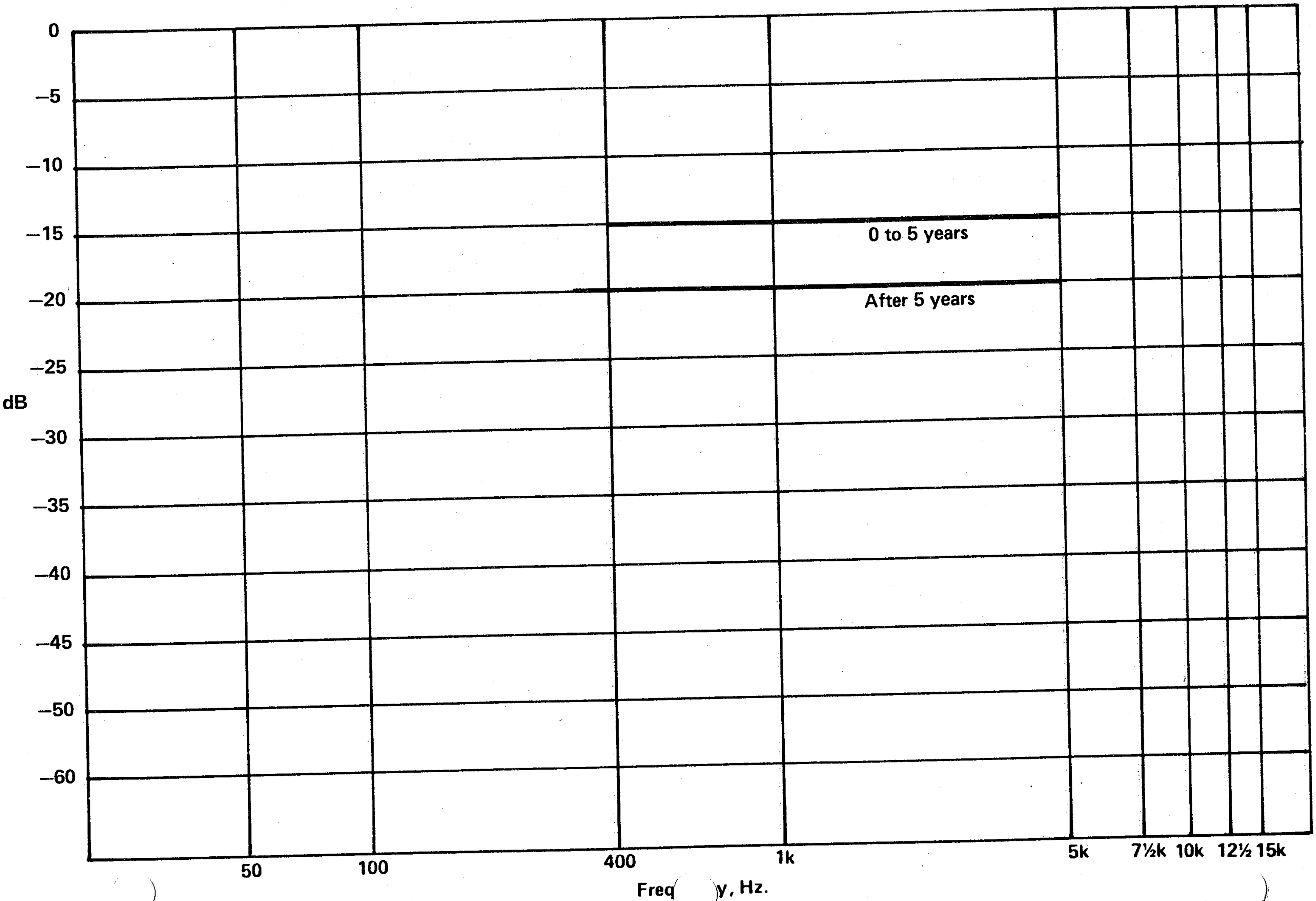


Right
Separation

Station ____________
Date ____________

SEPARATION
RIGHT INTO LEFT

50% MODULATION



IPM
L+R to L−R
&
L−R to L+R
Crosstalk

EQUIPMENT PERFORMANCE MEASUREMENTS
TABULATION OF DATA

Station ____________

Date ____________

Frequency, Hz.

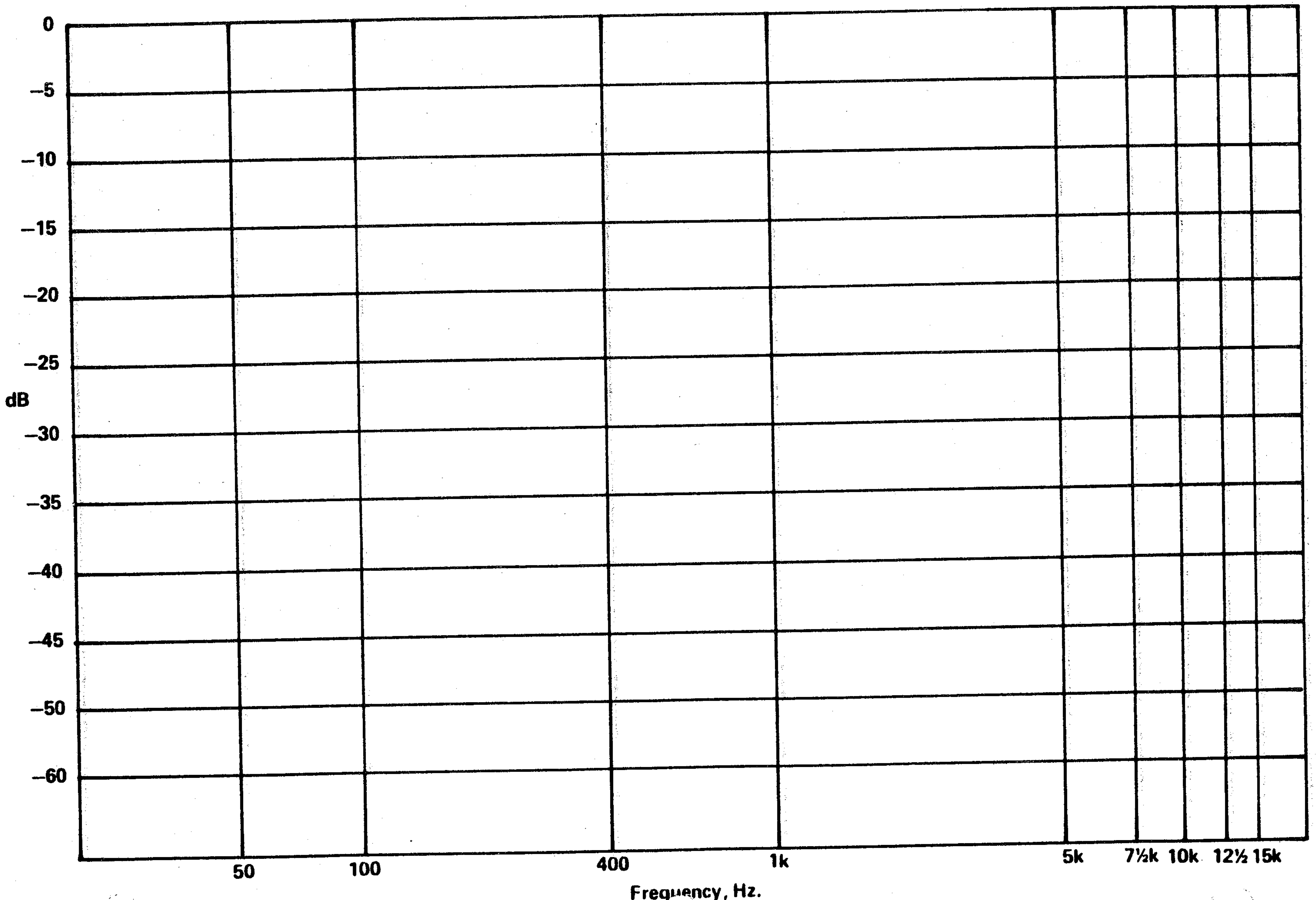
	50	100	400	1k	5k	7½k	10k	12½k	15k
Main to Subchannel Crosstalk in dB (No Specification) 95% L+R Modulation									
Incidental Phase Modulation Same as above, expressed in Radians. No Specification 95% L+R Modulation									
Subchannel to Main Crosstalk No Specification 95% L−R Modulation									

IPM &
L + R to L − R
Crosstalk

Station ________

Date ________

MAIN TO SUBCHANNEL CROSSTALK
(ALSO)
INCIDENTAL PHASE MODULATION
L + R, 95% MODULATION



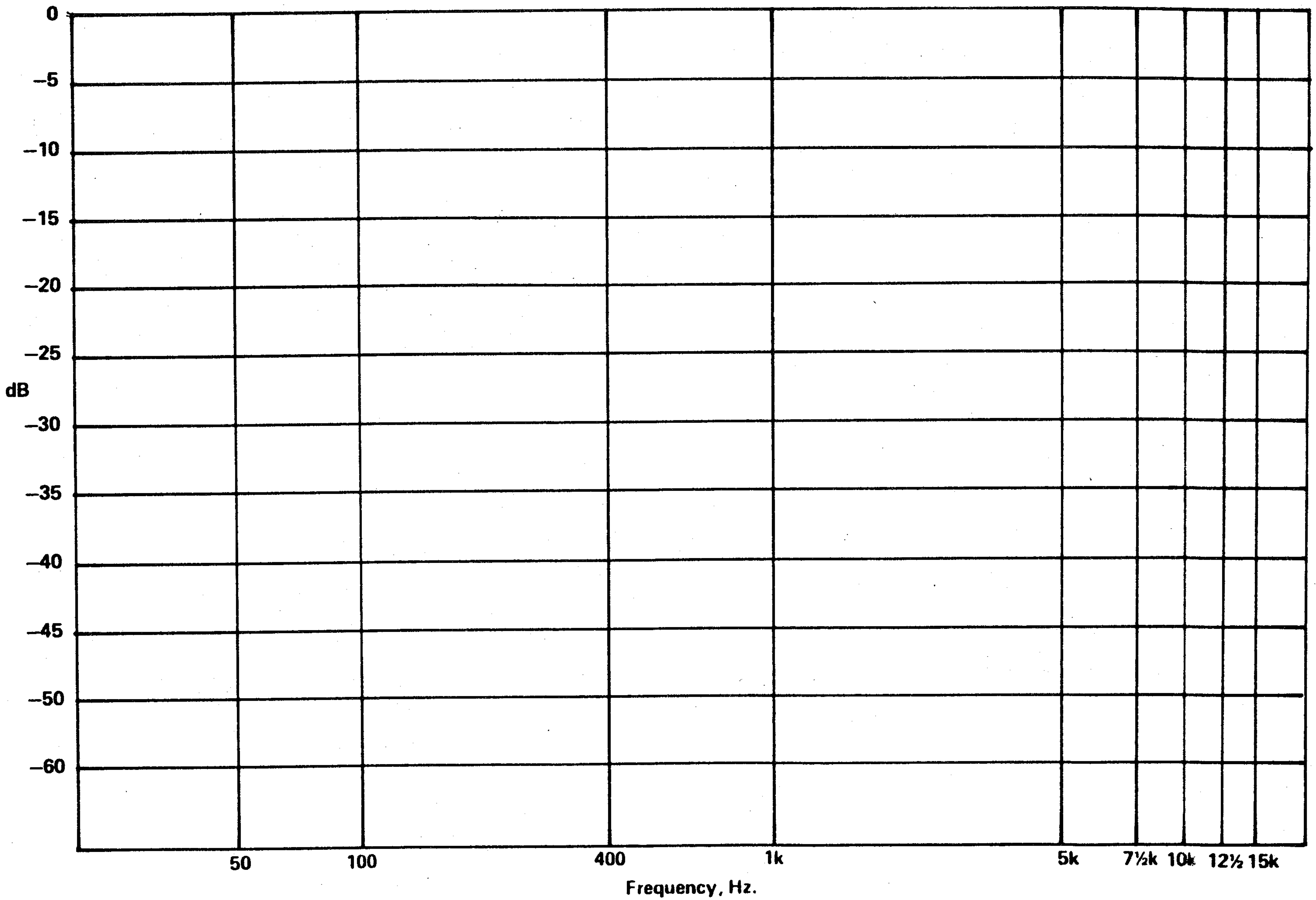
Sta..n ____________

Date ____________

L – ... L + R
... stalk

SUBCHANNEL TO MAIN CROSSTALK

L – R, 95% MODULATION



Station ______________

Date ______________

EQUIPMENT PERFORMANCE MEASUREMENTS
TABULATION OF DATA

Carrier Shift

L + R, 100% Modulation ________ %

L + R, 85% Modulation ________ %

L + R, 50% Modulation ________ %

L + R, 25% Modulation ________ %

Noise Level
Below 100% at 400 Hz.

L + R ________ dB

Left ________ dB

Right ________ dB

Harmonic and Spurious Observations,
L + R, L – R, Left, & Right

____

____

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____

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Introduction to the Motorola C-QUAM AM Stereo System

WHAT IS C-QUAM?

C-Quam is a system using amplitude modulation for the main (L + R) signal, and a quadrature type of phase modulation for the stereo information. Quadrature combines two signals at a phase angle of 90 degrees for transmission, and then at the receiver separates them again. It is another form of multiplexing. This technique is used to transmit the color information in the U.S. TV color system and is used for encoding of SQ and QS quadraphonic records. In the application to AM stereo, quadrature is really transmitting two AM signals on the same channel. For relatively narrow bandwidth applications such as we have with AM radio, AM is really the most efficient emission because amplitude modulaton requires the minimum bandwidth and it is independent of noise. What this means is that in an AM receiver, the effective background noise remains the same with or without modulation. This is not so with FM or PM, which under modulation, "kicks up" additional noise not present under no modulation conditions. So in AM quadrature, an additional channel can be created and heavily modulated without "kicking up" excessive noise. In other words, for narrow bandwidth communications systems, there is a signal to noise advantage to using AM quadrature.

Another important point for AM stereo is the long transmission path from the transmitter, through a directional antenna, over a difficult propagation path, and through a narrow bandwidth and possibly mistuned receiver, is a very rough one. In order to be demodulated with the least distortion and maintaining separation, the signal must be very resilient . . . able to withstand the difficult transmission experience. This also is best done with AM quadrature because two of the same type of signals are being transmitted and therefore undergo the same type of distortions which can in many instances be canceled at the other end. In other words, for AM stereo the differences between the two signals must be preserved, and if each undergoes the identical distortions during transmission, the differences between the two signals will be maintained. This is another reason why the AM/PM and AM/FM stereo systems are not very good because distortions to the AM component are very different from the distortions to the PM or FM component during transmission, and the result is a much more distorted AM stereo signal.

Although many have tried to use AM quadrature for AM stereo, the most difficulty is encountered when modifications are made to make it compatible with envelope detectors in existing AM radios. The Motorola scientists and engineers found a way of taking advantage of the quadrature characteristics, while transmitting a compatible AM component.

THE NATURE OF AM AND FM SIDEBANDS

In order to describe the system, some basics must be understood about certain types of modulation and how it is detected or not detected. To check our understanding, let's look at two basic types of transmission, AM and FM, modulated by a very low distortion sine wave.

When a signal is amplitude modulated by a sine wave, we can describe it in several ways. One is to simply look at the amplitude and trace it vs. time. This would be the typical display on an oscilloscope of the R.F. envelope. See Figure 1. Another is to look at it on a spectrum analyzer which would show three vertical lines, in the center, a taller line representing the carrier, and the two sidebands, lesser in amplitude, shown on either side of the carrier. In these two representations, there is no phase information given but for now think of the two sidebands as being in-phase sidebands or "I" sidebands. Thus in a perfect AM signal with no distortion there are no higher order sidebands or harmonics of the primary AM sidebands and there is no net phase modulation of the total of the carrier and the two sidebands.

The other case, FM (or PM) is where the phase or frequency is modulated according to our low distortion sine wave, and let's say the deviation is at least a few kHz. In this case, the R.F. envelope does not vary and the A.C. output of the envelope detector would be zero. The spectrum, however, would usually consist of a component at the carrier frequency and a family of sidebands located at multiples of the modulating frequency away from the carrier. For instance if the carrier frequency was 1000 kHz, and the modulation was 1 kHz, there would be symmetrical sidebands at 999, 1001 and at multiples of 1 kHz that are significant.

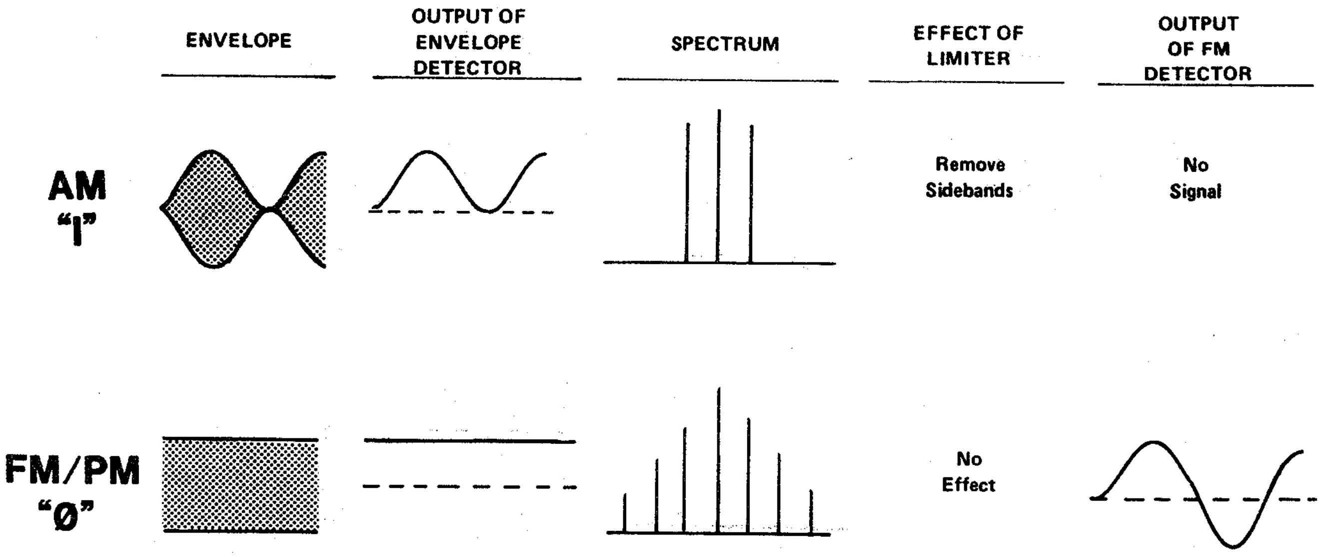


Figure 1.

If there is a carrier and sidebands, why doesn't the envelope detector detect the modulation? The reason is that in FM and PM, the instantaneous phase and amplitude of the carrier component and all the sidebands always add up to the same power as the unmodulated carrier. As the modulation is turned up, the carrier is reduced in amplitude and the missing carrier power is given to the sidebands, but the sum total at all times remains the same. It is the phasing of the sidebands that determines whether they will add and subtract with the carrier to produce differences in amplitude or whether they will add and subtract with the carrier component to always give the same amplitude. In the case of FM or PM, let's call the sidebands phase or "Ø" (phi) sidebands.

Now, the interesting thing is that "Ø" sidebands don't need a linear amplifier to be amplified and can be crunched to death by limiters and class C amplifiers and the same spectrum still comes out the other end. On the other hand "I" sidebands must have linear amplification in order to survive and can be totally stripped from the signal by a good limiter. An envelope detector will be blind to the existence of perfect PM or FM sidebands, and a phase or frequency demodulator will not see perfect "I" sidebands or amplitude modulation.

Another interesting fact is that all modulation can be represented by a combination of the "I" sideband components and the "Ø" sideband components. This is very important in AM stereo broadcasting because it is necessary to split any of the AM stereo system's signals into the "I" and "Ø" signals for transmission on an existing AM transmitter. See Figure 2. For all systems, the "I" signal is given to the transmitter in audio form at the audio input to the transmitter and then it amplitude modulates the signal in the normal way recreating an AM or an "I" sideband signal. For all systems, the "Ø" components are fed to the transmitter in R.F. form as a phase modulated signal that replaces the crystal oscillator in the transmitter. Of course the "Ø" signal sidebands can pass through the intermediate and final amplifier R.F. stages of the transmitter even though these stages are non linear and usually operate class C. The Motorola AM stereo system also required that it be reconstructed for such transmission but certain modifications are made for compatibility with the millions of existing AM radios.

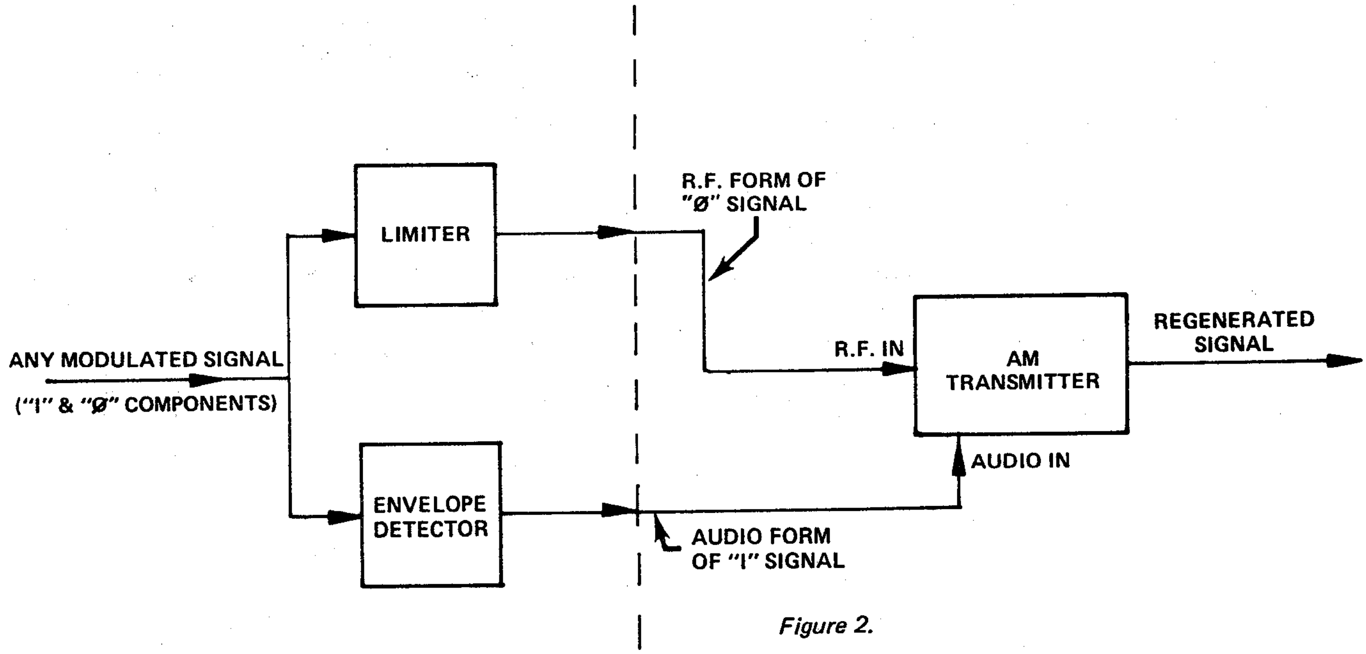


Figure 2.

PURE QUADRATURE

Observe Figure 3. Pure AM-AM quadrature can be generated by two transmitters connected so that their outputs add. One transmitter would be a standard AM generator producing the carrier at, let's say, zero phase, and sidebands associated with that carrier ("I" sidebands). A second transmitter is fed from the same master oscillator as the AM transmitter, but the phase is shifted 90 degrees. Because we already have a full carrier at zero degrees phase from the AM transmitter providing a phase reference for the receiver, the second transmitter does not need a carrier and is set up with a balanced modulator canceling out the carrier and producing only sidebands. Because these sidebands are generated from a carrier which is 90 degrees out of phase from the AM transmitter, these sidebands will be 90 degrees out of phase with the AM sidebands and "in quadrature." These become our "Q" sidebands.

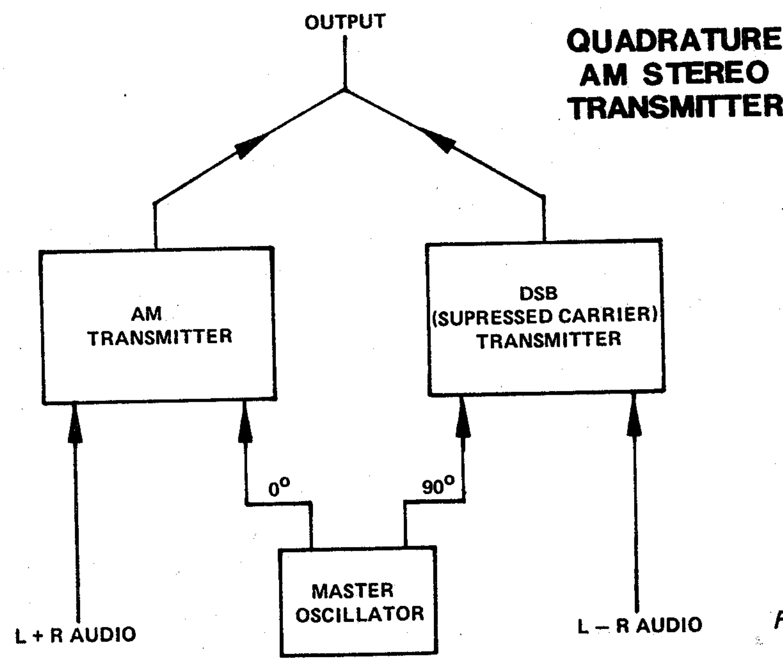


Figure 3.

If we wanted to make an AM stereo system we could transmit L + R into the AM transmitter, and L – R into the double sideband transmitter. Sounds good, but under left or right only conditions where both transmitters are contributing sidebands to the output, the resultant would be a distorted AM signal. Before we look at why, let's take a look at a quadrature demodulator which is also the widely touted synchronous detector.

THE QUADRATURE (SYNCHRONOUS) DETECTOR

To recover the audio signals separately at the receiver, a system of phase detectors is arranged. See Figure 4. First, a reference phase must be derived from the transmitted signal. This is the refeence carrier which is generated by means of a phase locked loop (PLL).

The device that is primarily responsible for the operation of the synchronous detector is the balanced demodulator or product detector. When this device is given an input signal and a reference carrier, it will provide at its output the difference of the two signals. If the two signals are identical in frequency and 90 degrees out of phase, the output will be zero. If there is a constant difference in phase it will give a D.C. output or if the phase is varying it will give an A.C. output. The D.C. output of the "Q" detector is fed back to a voltage controlled oscillator (VCO) which causes the frequency and phase of that oscillator to zero in on the input carrier frequency and phase and then lock to it.

This provides the phase reference for the "I" and "Q" detectors. The A.C. output from the "I" demodulator provides the original L + R audio from the AM transmitter, but it does not see the "Q" sidebands from the double sideband transmitter. The second demodulator is also fed from the VCO but its carrier reference signal is automatically shifted 90 degrees. Therefore it sees the "Q" sidebands from the double sideband transmitter and sees nothing from the AM transmitter input audio which is L + R.

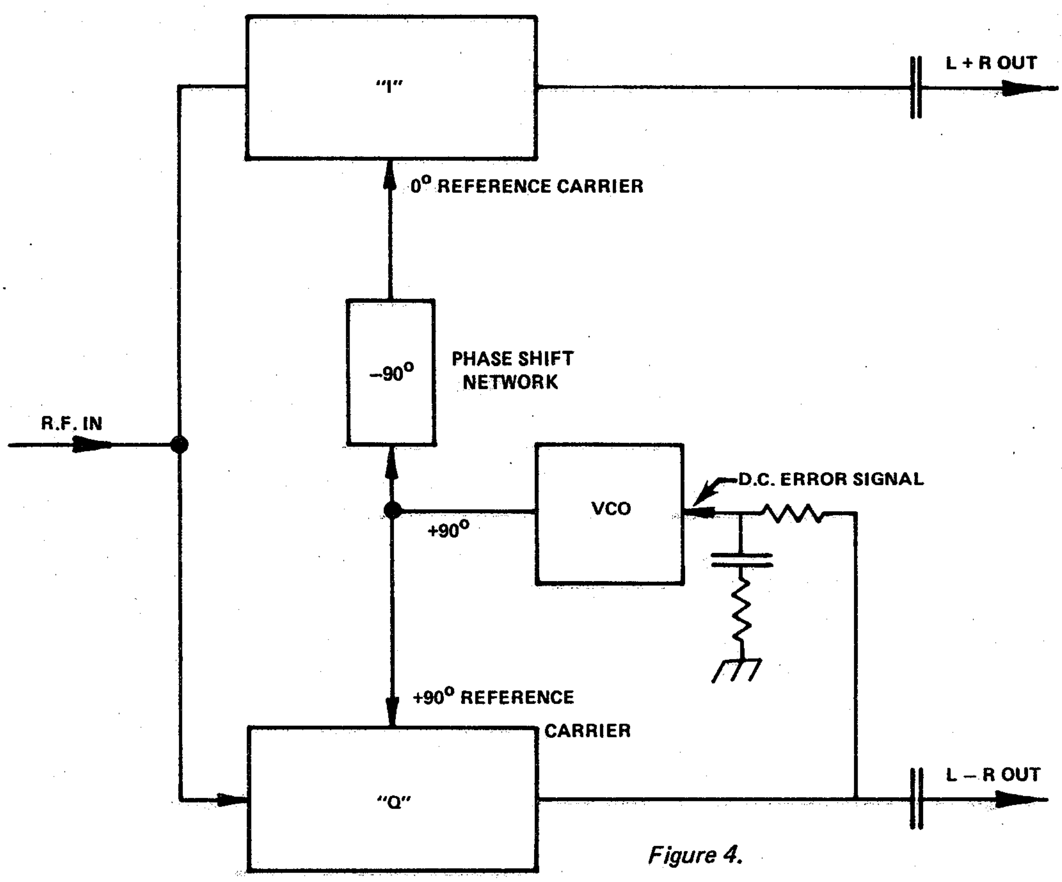
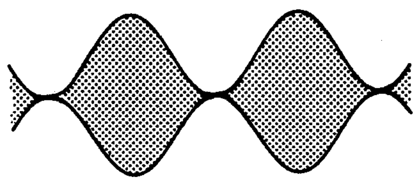


Figure 4.

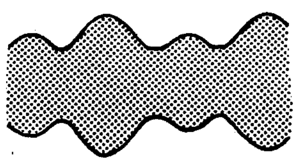
The AM-AM quadrature system would be excellent for AM stereo except that the envelope detectors in normal AM radios don't see only the "I" sidebands or the "Q" sidebands but see the simple vector addition of both. The envelope detector is not capable of seeing any phase information and only sees the RMS total of the modulation and carrier regardless of phase.

Under L + R (L = R) only modulation conditions (monaural), there is no problem, because only the AM transmitter is modulated and the envelope detector recovers AM perfectly. (The double sideband stereo transmitter receives no audio because when L = R, L – R = 0.) However, under stereo conditions, for instance, when L only is transmitted, full sideband components are contributed by both the AM and double sideband transmitters and the envelope looks like Figure 5. This would not be compatible with existing envelope detector receivers and a very distorted signal would be heard.

QUADRATURE MODULATION ENVELOPES



L + R MODULATION



L ONLY OR R ONLY

Figure 5.

COMPATIBLE QUADRATURE

The Motorola AM stereo system is not complicated at all. It simply takes a pure quadrature signal as just described, and extracts the phase modulation components of the quadrature signal and phase modulated the broadcast transmitter. At the same time it sends L + R audio to the audio input of the transmitter as usual. That's it! The advantage is that a very nice AM signal is always transmitted so that the envelope detectors are compatible, but that the phase modulation of the carrier is derived from a pure quadrature modulation. The result is a signal with most of the advantages of quadrature modulation while maintaining all important monaural compatibility.

THE C-QUAM ENCODER

The C-Quam encoder is diagramed in Figure 6. Note that pure quadrature is generated by taking L + R and L – R and modulating two balanced modulators fed with R.F. signals out of phase by 90 degrees. In this case the 90 degrees phase shift is derived by using a Johnson counter which divides an input frequency (four times station carrier frequency) by four and automatically provides digital signals precisely 90 degrees out of phase for the balanced modulators. The carrier is inserted directly from the Johnson counter. At the output of the summing network, the result is a pure quadrature AM stereo signal. From there it is passed through a limiter which strips the incompatible AM components from the signal and leaves only the phase modulation "Ø" sidebands. This is not the same as the simple output of the "Q" modulator because the addition of the "I" and "Q" balanced modulators produced some phase shifting not present in the "Q" modulator alone. The output of the limiter is amplified and sent to the broadcast transmitter in place of the crystal oscillator.

The left and right audio signals are precisely added and sent to the audio input terminals of the broadcast transmitter.

That's the essence of the Motorola C-Quam encoder.

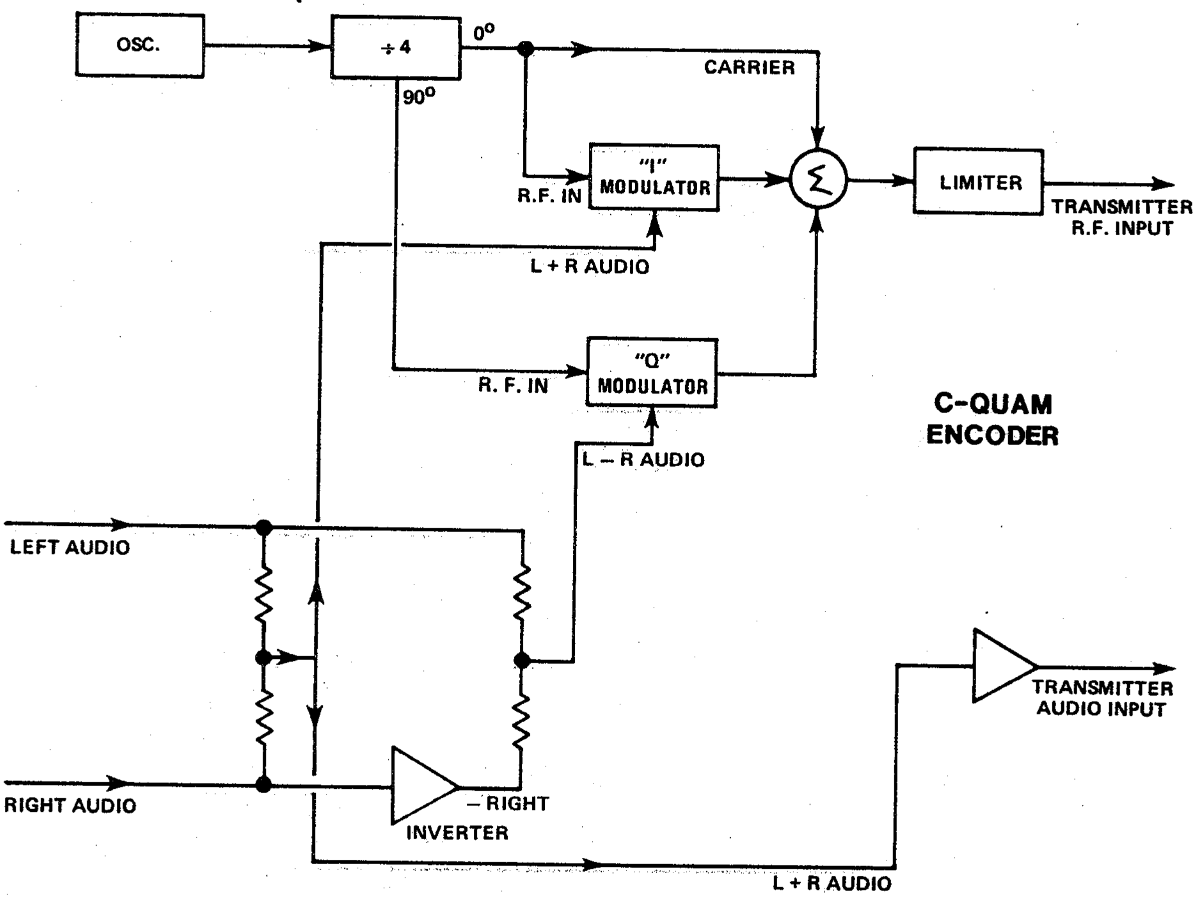


Figure 6.

DECODING C-QUAM

C-Quam is decoded by simply converting the broadcast signal which is already "almost" quadrature to quadrature and then using a quadrature detector to extract L – R. Refer to Figure 7. Note that the demodulator contains a section which is the pure quadrature demodulator as previously described. In order to prepare the broadcast signal for the quadrature demodulator, it has to be converted from the envelope detector compatible signal which is broadcast, to the original quadrature signal that was not envelope detector compatible. This is done by demodulating the broadcast signal two ways; with an envelope detector, and with an "I" detector. The two signals are compared and the resultant error signal is used to gain modulate the input of the "I" and "Q" demodulators.

When the transmitted signal is L + R (monaural, no stereo) the transmitted signal is pure AM or only "I" sidebands. In this case the envelope detector and the "I" demodulator see the same thing. There is no error signal, the gain modulator does nothing and the signal passes through without change. However, when a left or right only signal is transmitted, both AM and PM is transmitted and the input signal is shifted in phase to the "I" demodulator and loses some of its "I" amplitude. The envelope detector sees no difference in the AM because of the phase modulation, and when the envelope detector and the "I" demodulator are compared, there is an error signal. The error signal AGC's the input level to the detector. This action makes the input signal to the "I" and "Q" demodulators look like a pure quadrature signal and the "Q" audio output gives a perfect L – R signal. The demodulator output is combined with the envelope detector output in a matrix to give left and right audio outputs.

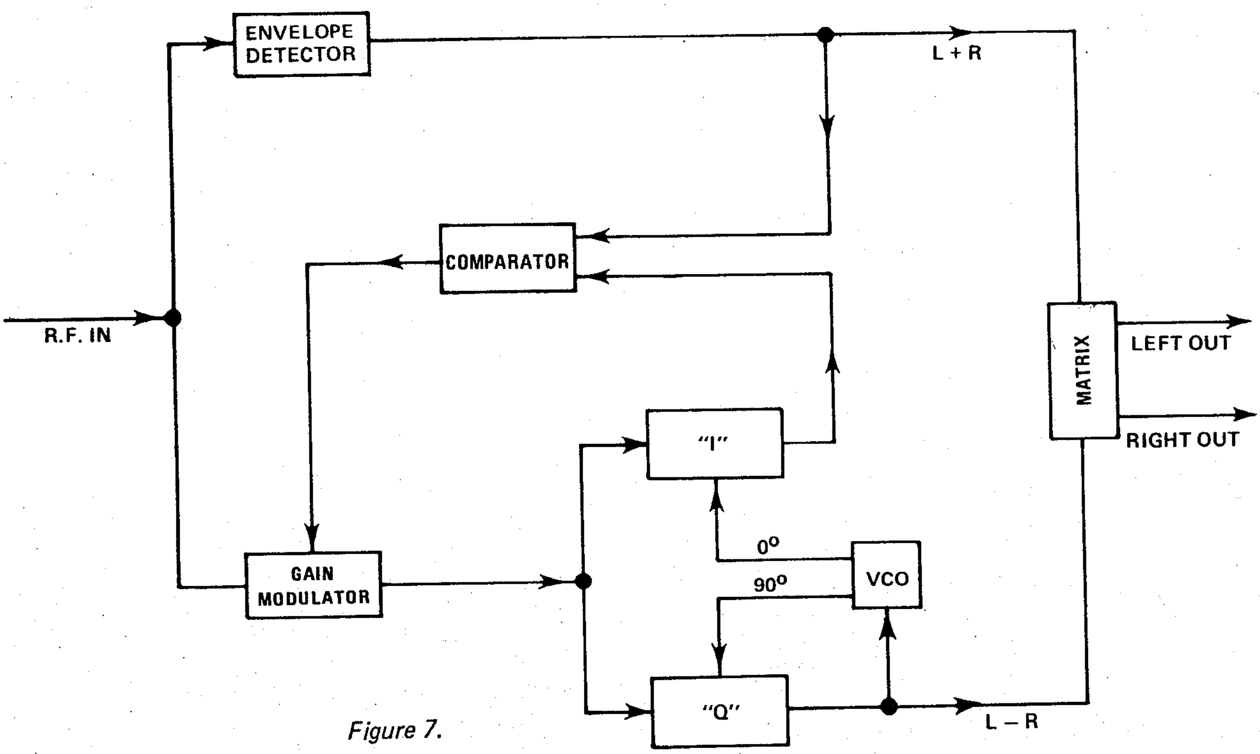


Figure 7.

SYSTEM PERFORMANCE UNDER HEAVY MODULATION

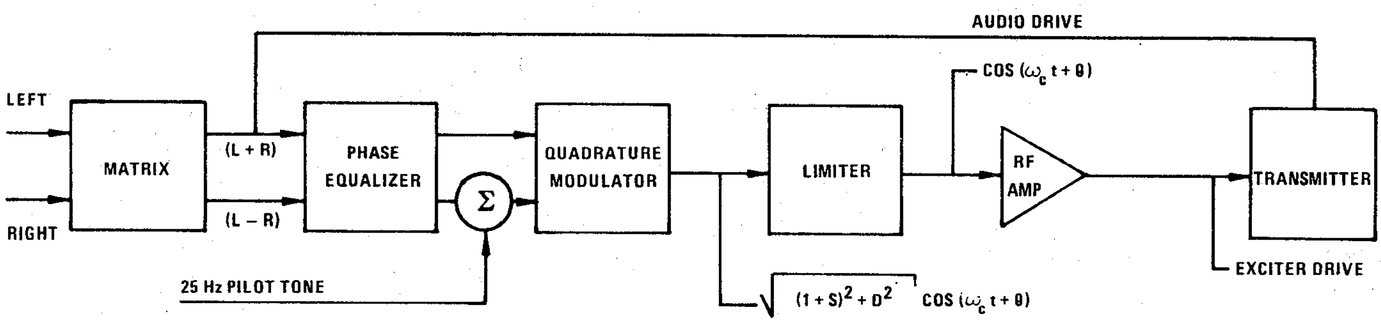
There are many advantages of the Motorola system. One is its performance under 100 percent negative amplitude modulation conditions. When the carrier momentarily becomes small as in 100 percent negative modulation, the output of the envelope detector also becomes small. Because of the action of the comparator and gain modulator, the output of the "I" demodulator is small. Simultaneously, the output of the "Q" demodulator also is forced to be small. This means that there will be no large noise popping from the stereo channel under heavy negative amplitude modulations.

APPENDIX

The following is a more detailed mathematical description of the C-Quam system.

ENCODING COMPATIBLE QUADRATURE MODULATION

The existing RF oscillator of the transmitter is replaced by a substitute reference which has the angular modulation of a quadrature signal. The existing AM modulation technique is basically unchanged.



Note that the audio modulation sum information is unchanged from the monaural case and that a quadrature phase modulated RF drive is substituted for normal RF drive. The only other change is the presence of a Phase Equalizer to compensate for the differences in Amplitude/Phase relationships between the audio signal path and the RF path. This is necessary to maintain separation over a wide bandwidth.

Any suitable stereophonic audio processors may be used.

DECODING THE COMPATIBLE QUADRATURE SIGNAL

The received compatible quadrature signal is a quadrature signal which has been modulated by the cosine of its relative phase angle information. It is also a compatible envelope detector signal. Therefore, sum information may be decoded with either an envelope detector or with a synchronous detector that is inversely modulated by the cosine of the phase modulation. Difference information may be decoded with a synchronous quadrature demodulator which is in inversely modulated by the cosine of the phase modulation. In fact, there exists a multiplicity of decoding methods since:

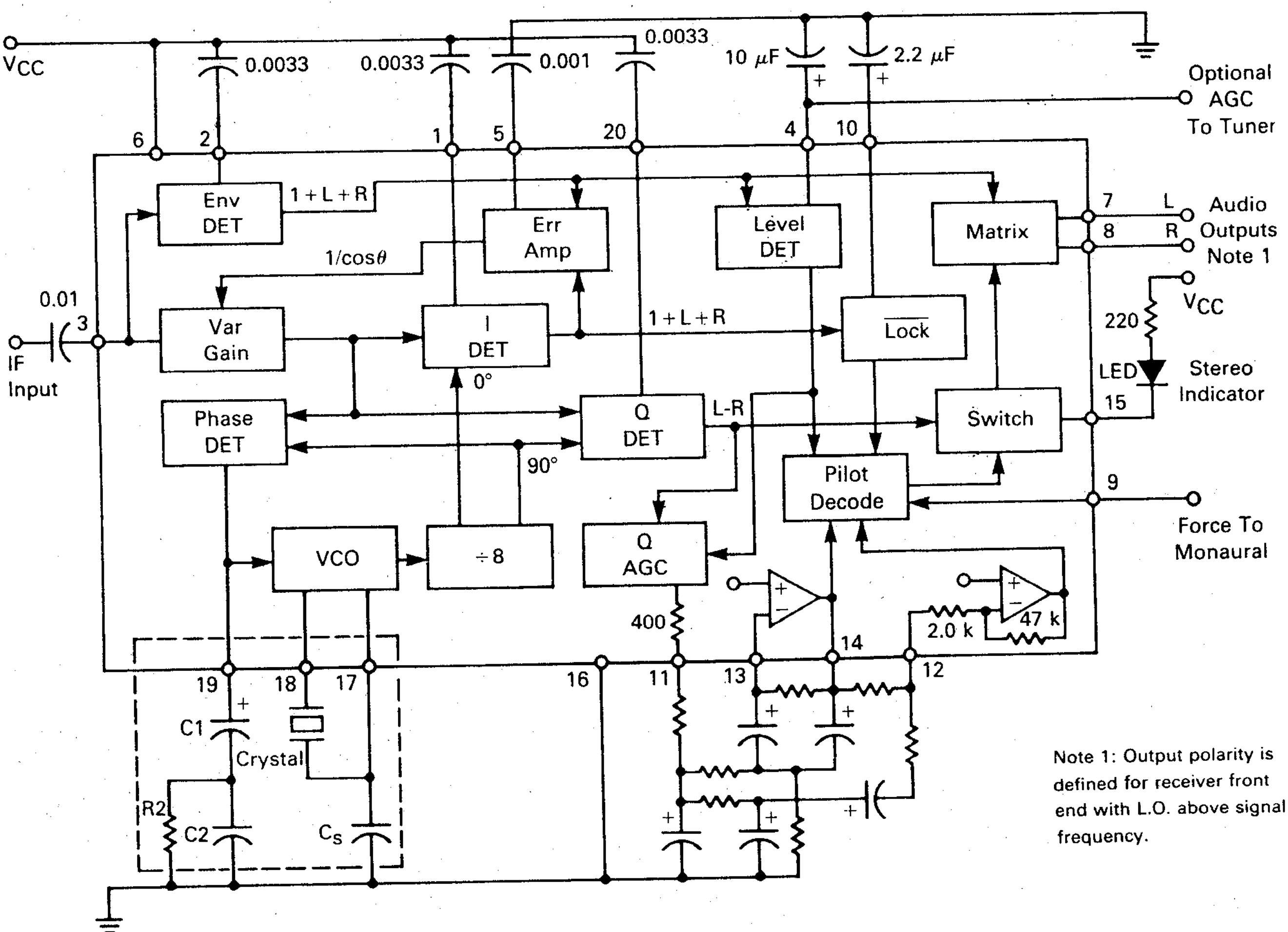
$$L - R = (1 + S)\tan\theta = \frac{(1 + S)\sin\theta}{\cos\theta}$$

Where: $S = L + R$

Hence, any sequence of operations which results in L − R is a valid decoding algorithm. Even non-PLL decoders are allowed since a discriminator, integrator, tangent function sequence results in L−R.

Motorola has evolved a first generation decoder design already discussed, which maximizes performance benefits at a minimum of cost and adjustments. Second and third generation decoders are under development which will further advance the state of the art.

PRESENT C-QUAM RECEIVER DECODER IC



Note 1: Output polarity is defined for receiver front end with L.O. above signal frequency.

SIGNAL EQUATION FOR MOTOROLA COMPATIBLE QUADRATURE SYSTEM

$$E_c = A_c \,(1 + M_s\,(L(t) + R\,(t))\,\cos\left[\omega_c t + \tan^{-1}\left\{\frac{M_d\,(L\,(t) - R\,(t)) + .05\sin 50\pi t}{1 + M_s\,(L\,(t) + R\,(t))}\right\}\right]$$

where: M_s = index of modulation for sum information
M_d = index of modulation for difference information
$.05\sin 50\pi t$ = 25 Hz. pilot tone.

INCIDENTAL PHASE MODULATION

Engineers and technicians associated with AM stereo constantly use the buzz letters "IPM." You may realize that these letters stand for (Incidental Phase Modulation) . . . but what is it? Simply defined, it is the un-intentional phase modulation of an RF carrier. An envelope modulated carrier (amplitude modulation) should not contain phase modulation. The normal envelope detector in the average AM receiver is oblivious to moderate amounts of phase modulation, as is most of the test and monitoring equipment in the average AM radio station. The addition of AM stereo (phase channel) to a transmitter makes it mandatory that IPM be reduced to an absolute minimum. That phase channel will now be used to transmit program material, and the incidental (un-intentional) modulation must be removed. Think of IPM as noise, hum or undesired sound. If the IPM in a transmitter is down 20dB, THEN YOUR STEREO NOISE FLOOR IS ONLY –20dB. The maximum separation of your stereo signal, anywhere within the audio spectrum, is therefore limited to 20dB!

The causes of IPM are varied, and some can be elusive. Transmitter final amplifier stages that are not completely neutralized contribute greatly to the cause; whereby, if a stage is "sliding around" looking for a different frequency to operate on it can generate considerable IPM. Driver stages can sometimes benefit from neutralization. Low power driver stages are often best neutralized by using Bruene, or bridge, neutralization. "Ageing" low voltage power supply filter capacitors can suffer from reduced capacity causing phase hum or IPM. Drive regulator circuitry and/or general lead dress in some transmitters can cause phase hum and noise. Radiated RF that is picked up on audio cables and fed back into transmitters causes IPM.

If a station does not have an AM stereo monitor or a spectrum analyzer, it is difficult to undertake an IPM reduction project. A narrow band AM stereo receiver can be a helpful aid in evaluating IPM and other nonlinearities occurring in an AM transmitter. Connect one audio channel of this receiver to the "X" input of your scope and the other audio channel to the "Y" input. Left channel out is normally used for vertical scope drive and right channel out is used for horizontal scope drive. Single tone amplitude modulation of the transmitter should produce a diagonal straight line on the scope – any deviation from a straight line represents non-linearity of some sort; distortion, IPM, etc. Shown in the installation section "A" of this manual are drawings depicting several IPM conditions as they would be displayed on a scope, plus additional information and measuring procedures.

Circuit Description AM Stereo Exciter

Audio Input - The audio input signal is connected from the exciter's rear terminals to the Audio Interface circuit card E7. The interface circuit card has both fixed and step pads for adjusting the input levels to a standard internal level that is used for all exciters. The circuit card also has provisions for an input filter to be used, if necessary, in high RF environments.

NOTE: Early units with serial numbers up to 67 have transformers and input networks mounted on the E2 audio circuit card.

Units starting with serial number 365 use the differential amplifier circuit card EIO containing an active input circuitry that replaces the transformers previously used.

After being set by the level control, the audio goes through a balance control and the blend resistors (see E6 circuit description) and then into the E2 audio circuit card.

Audio Equalization and Matrix Card E2 - There are two versions of this card, both have similar circuitry with a few exceptions. The original card, with the transformers mounted on it, does not have provisions for adding a night card, the audio passes through at a lower level and the equalization switches are configured differently.

The current production card has a higher level audio signal which is divided down at the op-amp output to reduce the effects of DC offset into the modulators. It also has a high frequency equalization "Q" control eliminating the need to change capacitor ratios in the equalization circuit to achieve different responses for transmitter variations when using separate day/night transmitters or diverse antenna patterns.

Audio Circuitry Description - The (R and L) inputs are connected into a buffer then via switch selection, either bypasses or is fed through the high frequency equalization.

The high frequency equalization consists of a low pass filter used to adust high frequency phase and amplitude, compensating for effects in the transmitter which can cause information to arrive in a non time coincident manner at the antenna. The output of the high frequency equalization can be switched out or switched either to the "I" matrix or "Q" matrix through the low frequency equalization, binary and bulk delays.

The low frequency equalization is a 2 section high pass circuit used to compensate for low frequency effects in the transmitter such as those generated in the modulation transformers or coupling capacitors. The circuitry will produce lead to lag phase response and under to over damped amplitude response.

Both controls on each channel are adjusted to achieve best low frequency single channel performance. On DC coupled transmitters, the low frequency equalization is not needed and should be turned off for best results. Also note that the low frequency equalization is not used in the closed loop mode.

The matrix combines the left and right channels to form $L + R_Q$, $L - R_Q$ and $L + R_I$. The $L + R_Q$ and $L - R_Q$ are used for the quadrature or phase modulators and the $L + R_I$ is returned to the transmitter's envelope through the L + R amplifier.

To limit single channel excursions the E2 card was supplied with diode limiters on all 3 audio channels ($L + R_Q$, $L - R_Q$, $L + R_I$) in both positive and negative directions. From experience we learned that the positive clippers were never used and diodes D307, D310 and D308 are lifted from the card after testing. The negative through of L - R is not limited therefore diode D309 is deleted. An additional diode drop is added to the $L + R_I$ clipper to allow it to limit after closure (100% neg.) and the $L + R_Q$ limits before closure to prevent the transmitter from being starved for RF drive which can cause serious problems in some transmitters. The $L + R_I$ to the sample transmitter is buffered with its own buffer amplifier from the $L + R_I$ for the station transmitter envelope. This prevents interaction which occured with some transmitters when using exciters with sn < 67.

Meter Drive Circuits - The meter drive circuits are also on the E2 card and consist of a simple rectifier and D.C. drive amp. It should be pointed out that the exciter meters do not indicate modulation but only the presence of audio at the exciter input. Also, the meters are not precise anywhere other than the calibration point (75%) and they do not respond to peaks of program content.

The meters on the modulation monitor are the only practical means of determining actual modulation levels.

E6 Night Circuit Card - This card has 2 versions; (1.) full night (2.) half night. The half night contains the single channel limiter and the binary delay with a bulk delay mounted piggyback on the night card. The full night has single channel limiter, binary delay, a duplication of both high and low frequency equalization circuits, the relay for switching the equalization circuits and mounted piggyback is a circuit card containing 2 bulk delays and a second binary delay for totally independent setting between the day and night positions. Also provided on the full night card are, pad resistors and controls for setting equal L and R gains in both the day and night position.

The high and low frequency equalization circuits are identical to the E2 card. Switching is by relay contact which are not used in the half day, however, the circuitry is essentially hard wired to the day position.

The blend/audio processor/single channel limited function compares the $L + R_I$ and when a pre-determined ratio (absolute amount) is exceeded the blend is activated which shorts the L to the R channel using a photo cell, limiting the total L - R that can be produced. The L - R signal produces the phase information which has all the sidebands and can produce spectrum problems if not limited. The process defeat switch allows the circuit to be turned off (with switch bat handle to the rear) and on (with bat handle to the front). R655 sets the point at which the limiter takes effect and R662 sets the "on" resistance of the photo cell determining the max L - R level when overdriven. The binary delay provides one microsecond steps of broadband delay between 1 and 15 microseconds, which allows fine adjustment of discrete delays. The bulk delay in 10 microsecond steps allows up to a total of 55 microseconds between both the bulk and binary delays. The broadband delay may be necessary for transmitters where propagation delay differences in the transmitter, between the envelope and phase paths, can not be corrected by equalization alone.

Circuit Description/Encoder Board, Exciter - The carrier oscillator operates four times above the carrier frequency. This is necessary in order to establish the quadrature relationship in the division. You cannot obtain 90° with anything less than 4 times FC. The temperature co-efficient and values of the circuit are critical. However, stability figures are equal or better than the average transmitter.

The FET crystal oscillator is coupled into a Johnson Divider IC. Two balanced output signals are recovered from the IC, one at 0° phase and another at exactly 90° to the first signal. These outputs are 1/4 of the original crystal frequency.

The output resistor values establish the correct driving voltage for the modulators on a signal or AC basis.

U102 and U103 are driven by what we call the in "phase clock." Notice that U102 function as the carrier reinserter. The modulators are double side-band supressed carrier modulators. The system requires that the carrier be restored and that is the purpose of the third modulator. The input (pin 4) of U102 receives the left plus right signal so think of the left plus right signal as being the in phase and the left minus right as being the 90° quadrature relationship to that phase. The adjustment of these modulators is covered in the alignment procedure. The ratio of R103 to R104 (22K over 220 ohms) limits the amount of adjustment range for the pot.

The DC offset of the output op-amps must fall within this adjustment range or proper AM carrier surpression cannot be achieved.

R123 allows the carrier level to be set so these are entirely different values than the other pots. This sets the DC range to achieve the proper insertion of the carrier. It is biased, to insure that the carrier is reinserted in the proper phase. If you reverse these resistor ratios you would get an out of phase carry insertion and a channel reversal.

In the coupling or transfomer design, there is no selectivity requirement for this circuit. Its only function is to round off the rather sharp clock edges of the signal through the modulator and make them sinusoidul again. If the Q total L - R that can be produced. The L - R signal produces the phase information which has all the sidebands and can produce spectrum problems if not limited. The process defeat switch allows the circuit to be turned off (with switch bat handle to the rear) and on (with bat handle to the front). R655 sets the point at which the limiter takes effect and R662 sets the "on" resistance of the photo cell determining the max L - R level when overdriven. The binary delay provides one microsecond steps of broadband delay between 1 and 15 microseconds, which allows fine adjustment of discrete delays. The bulk delay in 10 microsecond steps allows up to a total of 55 microseconds between both the bulk and binary delays. The broadband delay may be necessary for transmitters where propagation delay differences in the transmitter, between the envelope and phase paths, can not be corrected by equalization alone.

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In the coupling or transfomer design, there is no selectivity requirement for this circuit. Its only function is to round off the rather sharp clock edges of the signal through the modulator and make them sinusoidul again. If the Q becomes too high on this circuit you will see a definite effect on the quam, which is covered in the quam alignment.

There is no requirement for restricting the bandwidth except possibly the elimination of the third harmonic of the carrier frequency. If it gets too tight the quadrature performance will be affected by limiting or cutting off some of the side band information or making them not appear in the proper ratio to reproduce the sideband information accurately.

The darlington differential amplifier is after the transformer. The purpose of this amplifier (it has a gain of less than 2), is its very high front to back rejection or reverse transfer ratio. The limiter switches are at a low impedance and it drives the RF amplifier which also is switching at a low impedance. Without the darlington the signal switching transient would be coupled back and cause the sine wave appearing at the input to be highly distorted or wrinkled due to the switching transient.

If the switching occurs through the zero crossing of the signal, phase error or incidental phase modulation can take place and this is undesirable. The balance control R155 allows the exact symmetry setting of the square wave going into the limiter and the gain control allows the absolute maximum limiting to be obtained before a crushing or distortion, known as break up and described in the alignment procedure, takes place.

Pilot Oscillator. Trimmer C147 has minimal affect because of the high division ratio. The circuit, as presently implemented, requires the MC14040 to be used and not a 4040, one is an edge trigger device the other a level trigger device. You will get a frequency of around 40 Hz if you try to use the 4040 as a substitute for the other part even through literature says they are pin for pin compatible, that is not the case in this application.

The division ratios input the clock frequency at 25 Hz, it actually runs slightly on the low side. The amplifier rounds off the edges of the square wave. The values are reasonably cirtical and should be 5% parts. The basic thing is to assure that the distortion makes the FCC spec which is 2% of the 25Hz frequency.

A nonpolarized electrolytic C163, is in series with the 4.7K R218. Previously, as you went up and down on the pilot level adjust pot, you actually affected the offset setting and the left minus right circuit.

E3 Sample Transmitter/L + R amp - The sample transmitter is used to create a total C-Quam signal for marking closed loop tests. The fully limited quadrature phase modulated signal is injected into a 1596 modulator at pins 8 and 10. The audio is inserted in pin 4 of IC901. The output passes through tuned circuits whose function is to round off the edges of the clock signal. Two transistors (Q901, 902) give enough gain to drive 1V (no modulation) into 50 ohms. The sample transmitter's closure sensitivity is set by changing the DC at pin 1, U901. The AM closure of the sample transmitter should exactly equal the closure at TP110 (Quam point) for proper system operation.

The L + R amp (U902) is a 4 section op-amp used as a bridge amplifier to get the L + R level high enough to drive your transmitters envelope. The IC must have low offset to keep power consumption low.

E5 RF Amplifier - The RF amp drives the transmitter with the quadrature modulated phase signal and replaces the transmitters own oscilator. The output is between 5 and 40 Vpp. A TTL output is also provided.

The input from the encoder card and is coupled in through a minicircuits transformer. Two small signal transistors (Q501 and Q502) increase the signal to a level sufficient to drive the VMOS power FETS. In the drive stage, R502 is used to set rise time or gain, and R508 is used to adjust symmetry. The VMOS power FETS have adjustable bias because of the wide range in their turn on spec (.7 to 2.5 VDC). The bias is set with an idle current of 5mA to assure conduction through the temperature range. Diodes D501 and D502 prevent the FET from being damaged when the direction of current is reversed and the field collapses.

The TTL output has had 2 versions; a discrete unit with limited drive capability and an IC version that can drive 50 ohms through 100 feet of coax.

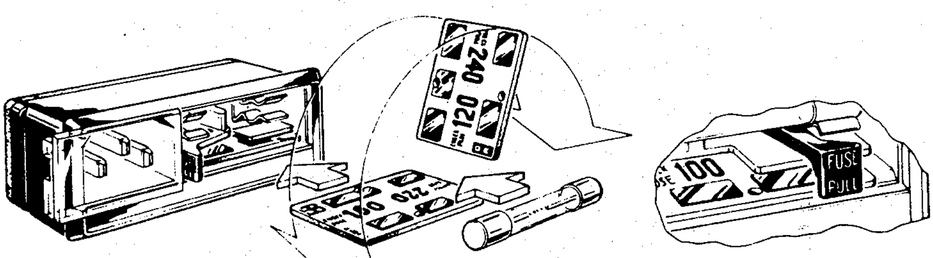
The RF voltage output was adjusted by changing zeners on the original units and is adjusted with a variable voltage regulator on the later units.

Power Supply - The power supply uses 2 full wave supplies to furnish unregulated B+, B-. Solid state regulators (7815, 7805, 7915) provide the regulated outputs. The diodes across the regulators provide protection from back biasing which would destroy the regulator. It should always be remembered that the negative regulator has a greater tendency to oscillate and sometimes external systems problems can agrivate this problem.

EXCITER AND MONITOR

OUTPUTS AND CONTROLS
DESCRIPTION AND FUNCTION

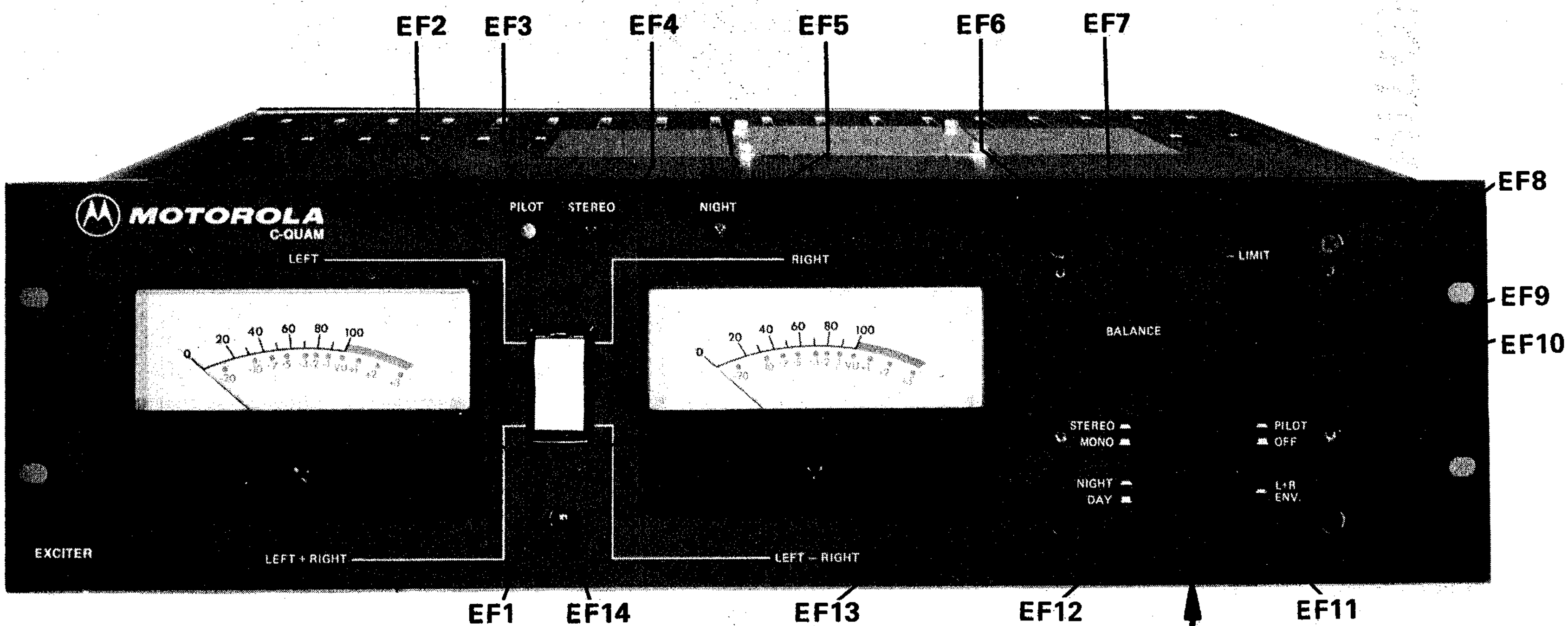
AC Line Voltage Selection



SHOWN SET TO 100VAC

1. Slide door to open position and rotate fuse-pull to left.
2. Select operating voltage by orienting PC card to desired voltage. Push firmly back into module slot.
3. Rotate fuse–pull back into normal position and re-insert fuse into holders.

   CAUTION: This is not intended as a field adjustment – exercise care in removing card.



EXCITER FRONT VIEW

REMOVAL OF FRONT TRIM ESCUTCHEON

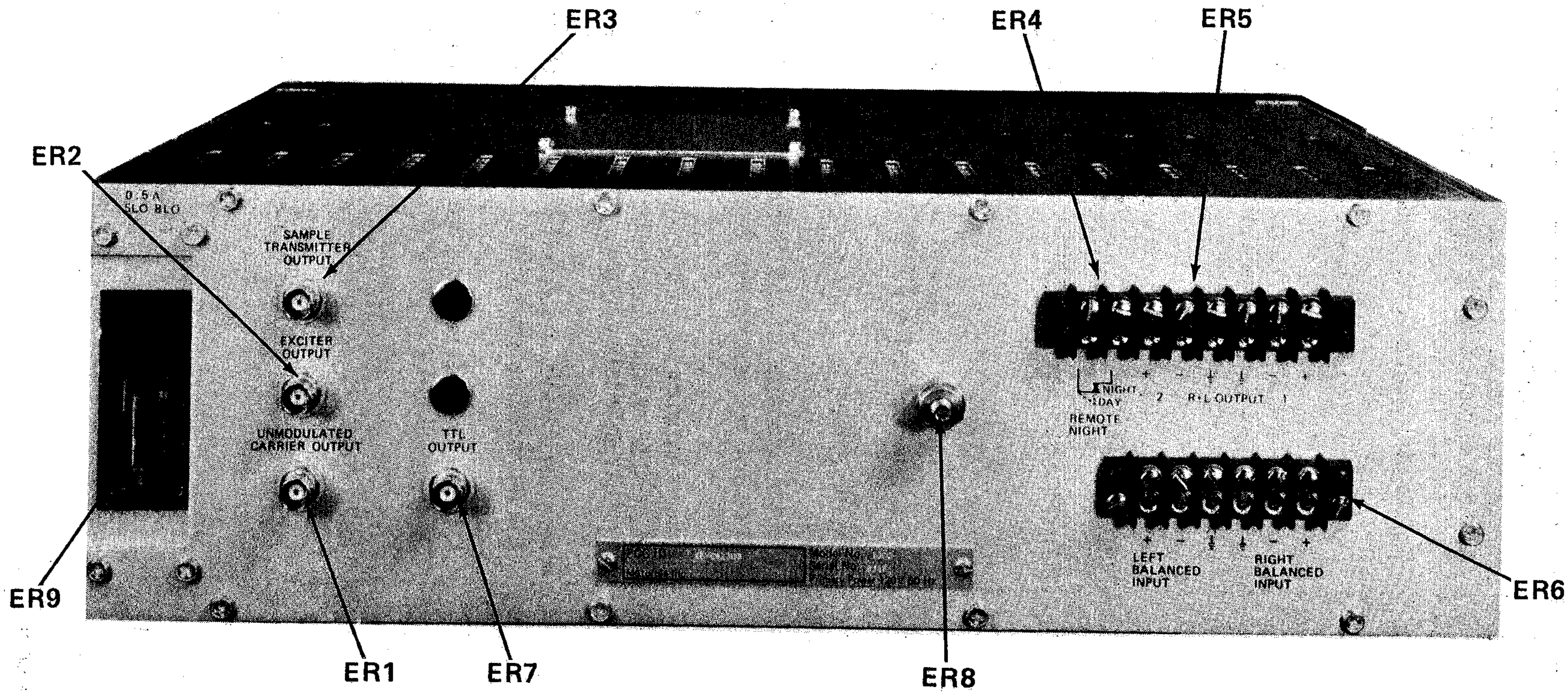
1) TO ACCESS THE FRONT CONTROLS, FIRST REMOVE THE LEFT AND RIGHT TRIM PIECES BY PULLING STRAIGHT BACK

2) REMOVE THE FOUR (4) SCREWS AND REMOVE COVER.

EXCITER
FRONT PANEL CONTROLS

REF	DESCRIPTION	FUNCTION
EF1	Meters	Audio level meters for test and set up
EF2	Pilot Indicator Light	Go/No-go indication of pilot output
EF3	Stereo Indicator Light	Go/No-go indication of stereo operating mode
EF4	Function Switch	Top – ($L + R_I$) Set up position indicating the relative level of left and right channel audio drive. Note: the meters are not to be used as an indication of modulation. Bottom – ($L + R_Q$) indicates L + R and L – R audio drive levels
EF5	Night Indicator Light (Transmitter No. 2)	Go/No-go indication of night operating mode
EF6	L + R Adj-2	Sets output level of L + R signal fed to modulation input of station transmitter No. 2
EF7	– Limit	*Audio drive level limiting adjustment
EF8	L + R Adj-1	Sets output level of L + R signal fed to modulation input of station transmitter No. 1
EF9	Mono/Stereo Switch	Selects between mono and stereo mode
EF10	Stereo Pilot Switch	On-Off carrier pilot switch
EF11	L + R Envelope Switch	Momentary push on type of switch to test if drive to the $L + R_I$ envelope is present
EF12	Night Day Switch (Transmitter No. 2)	Changes equalization for use with another transmitter or antenna. Works in parallel with remote switch on back. Optional control used only if exciter is equipped with the night equalization feature.
EF13	Balance	Allows slight amplitude adjustment between left and right inputs.
EF14	Earphone Jack	For evaluation of decoder output

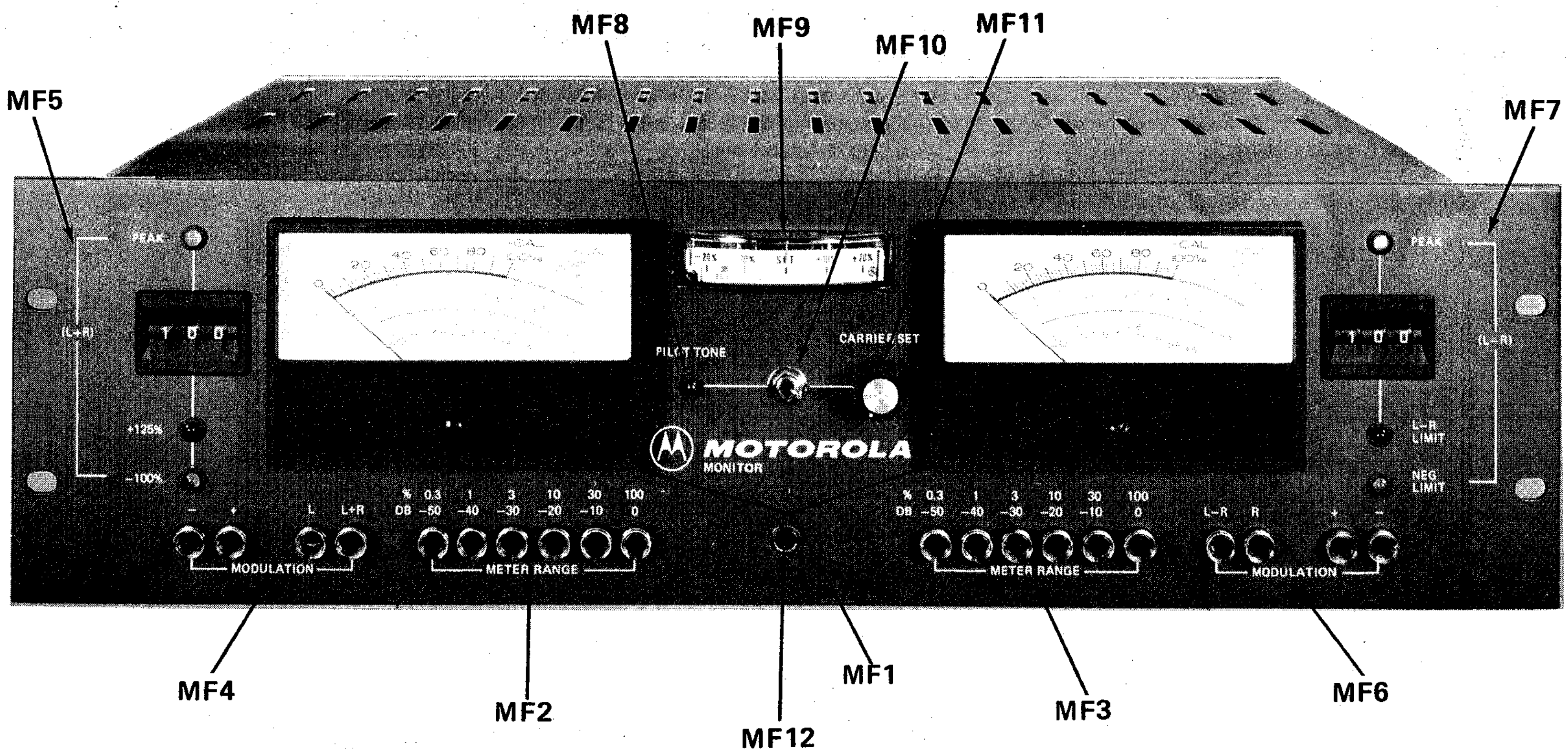
*Misadjustment will reduce stereo separation.



EXCITER REAR VIEW

EXCITER REAR PANEL OUTPUTS

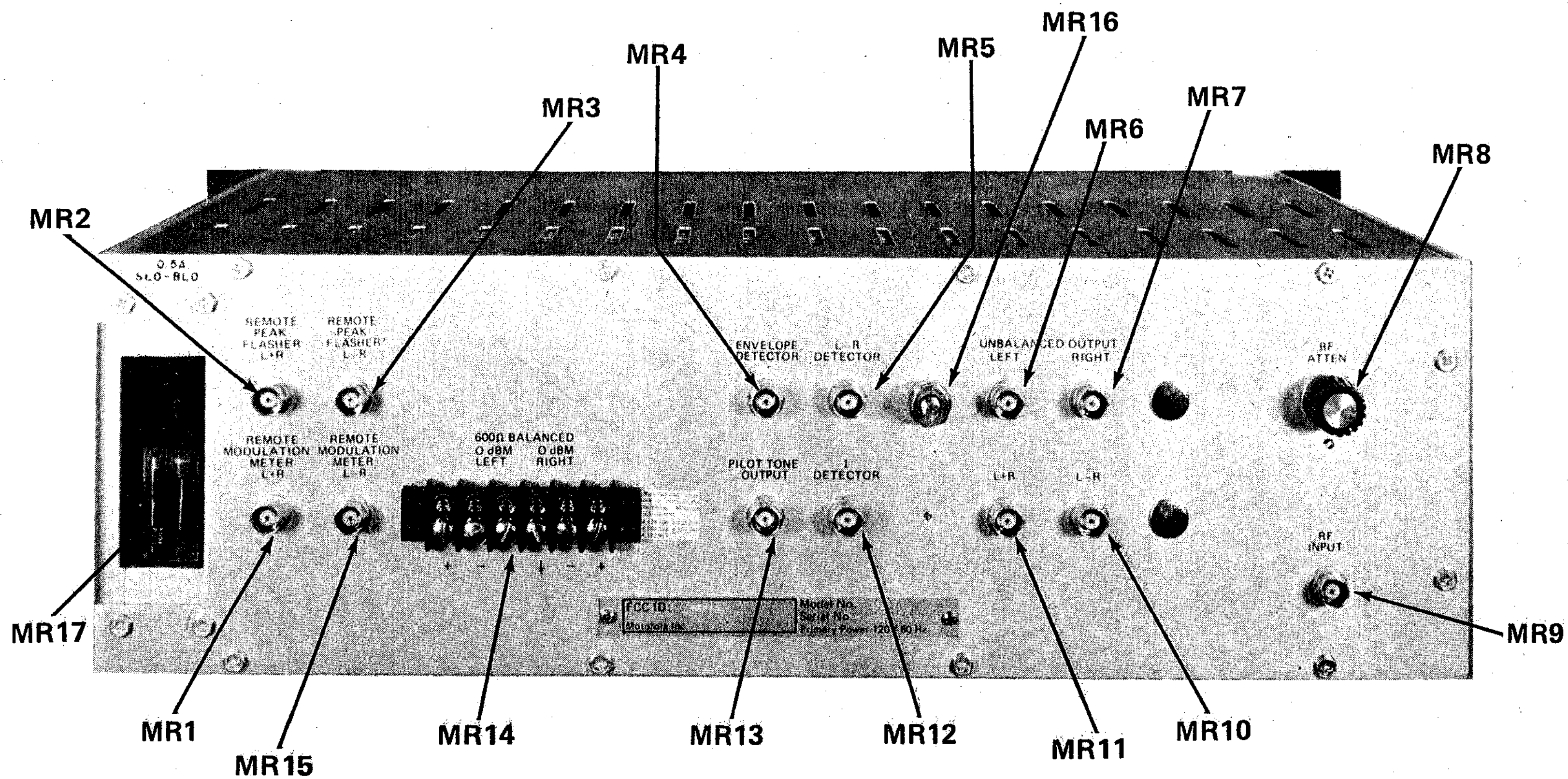
REF	DESCRIPTION	FUNCTION
ER1	Unmodulated Carrier	Sync from encoder to evaluate amount of phase modulation of master carrier frequency.
ER2	Exciter Output	Square wave output to AM transmitter for high power drive (0.5 to 5.0 watts in steps). This signal is the phase modulated substitute for the transmitters oscillator.
ER3	Sample Transmitter Output	Composite output for test of exciter to monitor.
ER4	Remote Night Day Switch	Works in parallel with front panel switch for changing equalization when using another transmitter or antenna. (See exciter front panel controls.)
ER5	R + L Output No. 1 and No. 2 (Envelope Modulation)	Balanced output from L + R amplifier to station transmitter (normal AM modulation input). Adjusted by L + R Adj. front panel controls, +16 dBm maximum.
ER6	Audio Input	Left and right 600 Ω balanced audio input 0 dBm to 15 dBm (determined at time of installation).
ER7	TTL Output	Phase modulated signal which is acceptable for TTL compatible transmitters. Substitutes for normal oscillator of station transmitter.
ER8	Ground	To station ground.
ER9	Power Module	Fuse and AC line voltage selector.



MONITOR FRONT VIEW

MONITOR FRONT PANEL CONTROLS

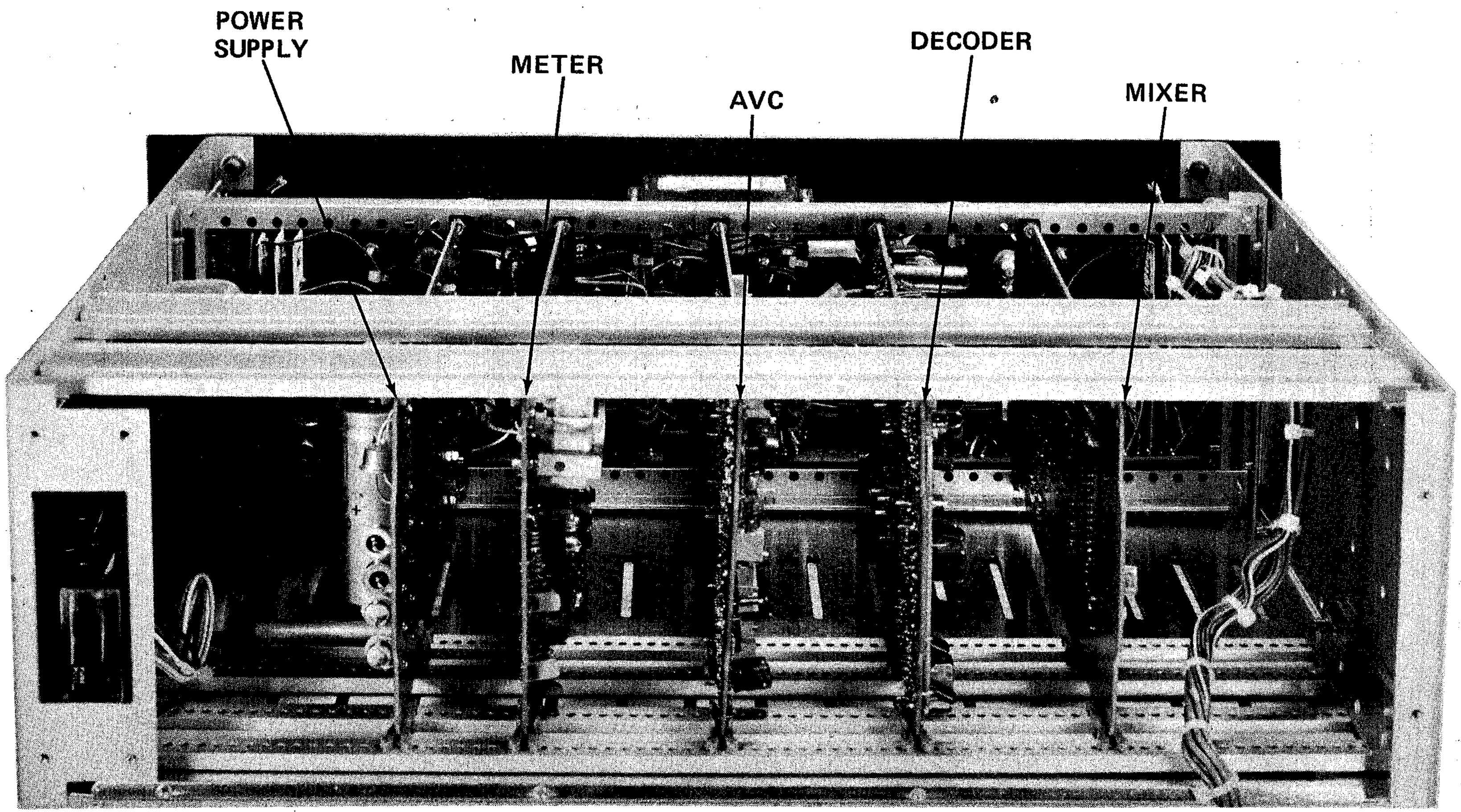
REF	DESCRIPTION	FUNCTION
MF1	Meters	Modulation meters for test and set up.
MF2	Meter Range Switches	Left channel meter range selection switches.
MF3	Meter Range Switches	Right channel meter range selection switches.
MF4	Left Channel Modulation Function Switch	Switches peak flasher (MF5) and left meter between (L + R), (L), (+) or (–) functions.
MF5	(L + R) Flashers and Controls	The yellow (L + R) peak flasher modulation range is set via the front thumb wheel switch. Its function depends on the modulation switch setting (MF4). The monaural red (–100%) envelope and green (+125%) envelope limits have no external settings and are both fixed factory adjustments. Peak amplitude can be accurately determined by increasing the reading on the thumb wheel until the light goes out. The number on the thumb wheel will be the peak modulation.
MF6	Right Channel Modulation Function Switch	Switches peak flasher (MF7) and right meter between (L – R), (R), (+) or (–) functions.
MF7	(L – R) Flashers and Controls	The yellow (L – R) peak flasher modulation range is set via the front thumb wheel switch. Its function depends on the modulation switch setting (MF6). The red (L – R limit) and green (neg limit) have no external setting and are both fixed factory adjustments. The (L – R limit) is equivalent of a 100% phase modulation signal. The (neg limit) indicates that the L – R component is overmodulating the combined modulation envelope. Peak amplitude can be accurately determined by increasing the reading on the thumb wheel until the light goes out. The number on the thumb wheel will be the peak modulation.
MF8	Pilot Tone Indicator	Indicates presence of 25 Hz pilot tone.
MF9	Carrier Level Meter	Establishes a carrier reference level necessary to insure that the circuits driving the modulation meters are affected only by modulation changes. The carrier level meter indicates the average RF signal level input to the monitor decoder circuits. The RF signal input is set to a level (indicated on the meter and determined by the manufacturer) by means of the carrier set control (MF11). As long as the carrier level indication is within the range of the meter (± 20% change of RF level), the modulation circuits will be within their design accuracy.
MF10	Switch	Two position calibration meter function switch. In the pilot tone position, the carrier meter must indicate in the black square (pilot) position. This is a fixed factory adjustment which does not have an external setting. In the carrier set position, the meter must indicate in the center on (set). The set position can be adjusted with the (carrier set) and rear panel (RF attenuator) controls.
MF11	Carrier Set Control	Vernier control which operates in conjunction with the 60 dB RF step attentuator on the back panel.
MF12	Earphone Jack	To evaluate decoder output.



MONITOR REAR VIEW

MONITOR
REAR PANEL OUTPUTS

REF	DESCRIPTION	FUNCTION
MR1	Remote Modulation Meter L + R	DC drive current for remote panel meter operation
MR2	Remote Peak Flasher L + R	Drive signal for remote operation of flasher
MR3	Remote Peak Flasher L – R	Drive signal for remote operation of flasher
MR4	Envelope Detector	Test output to evaluate monitor decoder
MR5	L – R Detector	L – R (quad) detector test output to evaluate monitor decoder
MR6	Unbalanced Output Left	For distortion measurements of left audio channel
MR7	Unbalanced Output Right	For distortion measurements of right audio channel
MR8	RF Attenuator	A 60 dB step attenuator in 10 dB steps used with the front panel carrier set control to calibrate the monitor
MR9	RF Input	RF input from transmitter link
MR10	L – R	L – R output for transmitter testing of stereo signal
MR11	L + R	L + R (mono) output for transmitter testing of monaural signal
MR12	In Phase Detector (I Det)	Test output to evaluate monitor decoder operation.
MR13	Pilot Tone Output	Counter connection for measurement of pilot frequency
MR14	600 Ω Balanced	Balanced 600 ohm audio output
MR15	Remote Modulation Meter L – R	DC drive current for remote panel meter operation
MR16	Ground	To station ground
MR17	Power module	Fuse and AC line voltage selector



MONITOR CIRCUIT CARD LOCATION

MONITOR

BASIC CIRCUIT CARD FUNCTIONS

POWER SUPPLY: The power supply operates from a 110V AC source and is protected with a 0.5 amp Slo Blo fuse. It provides (+5), (−15) and (+15) volt DC outputs, and the 28 volts for the modulation meter lamps.

METER: This circuit card contains the audio amplifiers and peak detectors which drive the DC meters. Additionally, it provides the circuitry to drive both right and left yellow peak flashers operating in conjunction with the front panel mounted thumb wheels. It also provides the audio matrix of balanced and unbalanced outputs to the rear cabinet ports. Pilot reject filters are included on this circuit card which eliminate the 25 Hz pilot tone from the meters when making measurements of the left or right channel.

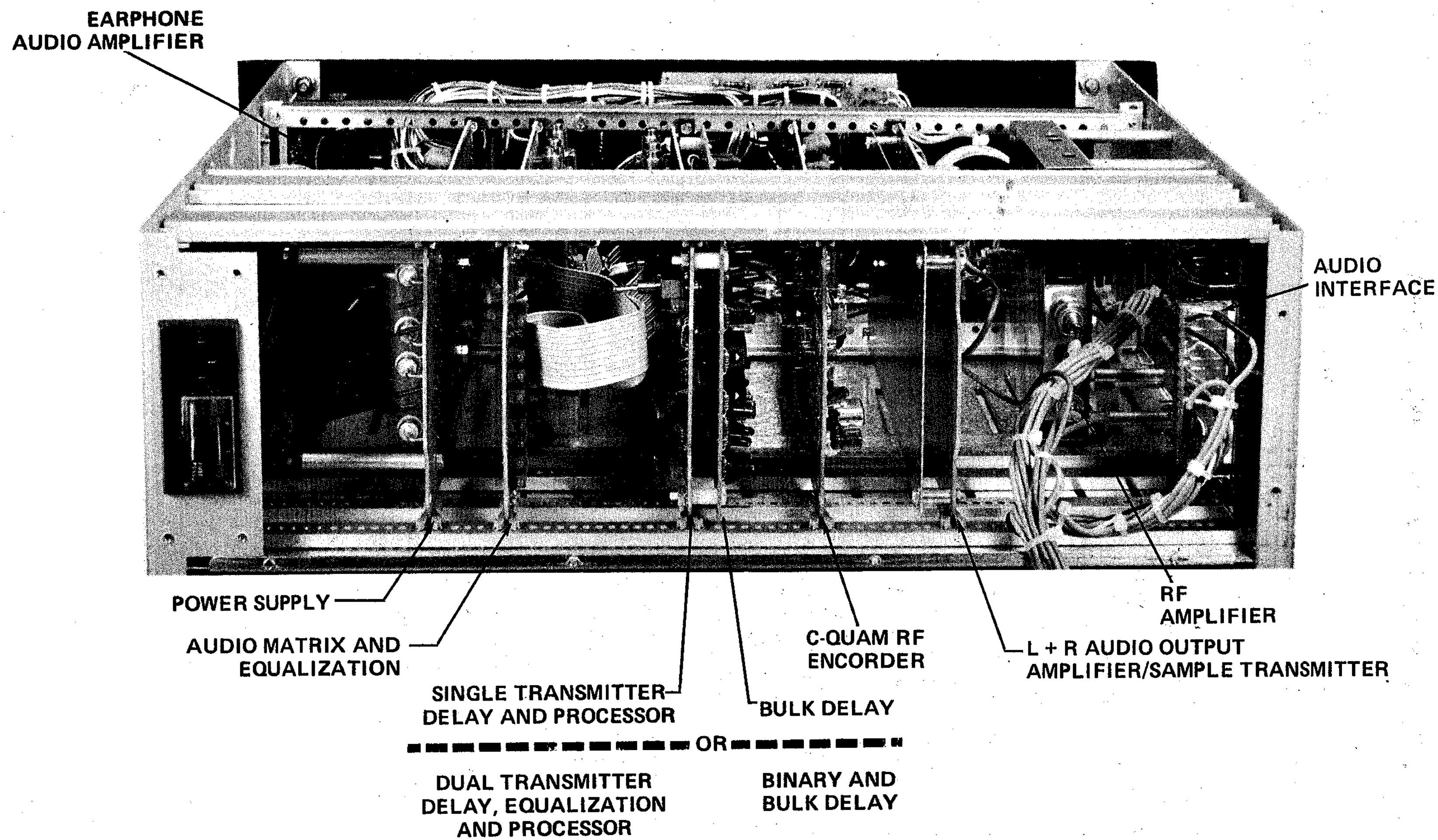
AVC: The AVC circuit card controls the audio signal level allowing the audio signal to be used as an instantaneous indication of the modulation level. This card also contains the carrier level detector and carrier meter drive circuitry, along with the pilot detector and meter drive circuits. With the exception of the two yellow peak flashers, the five remaining flasher drivers are on the AVC panel:

1) +125% envelope limit
2) −100% envelope
3) L − R limit (measures recovered audio)
4) Neg limit (combined overmodulation indicator)
5) Pilot tone indicator

DECODER: The decoder receives 450 KHz from the mixer circuit card, then detects and separates the envelope and $(L - R)_Q$ signals which are sent to the AVC card. For test purposes it provides three detected outputs to rear cabinet ports:

1) Envelope detector output
2) In-phase detector
3) L − R quadrature detector

MIXER: The station RF signal is coupled to this panel via a link or antenna. It has a wide band front end which is switch programmed to the station frequency at the factory.



EXCITER II CIRCUIT CARD LOCATION

EXCITER BASIC CIRCUIT CARD FUNCTIONS

Power Supply

The POWER SUPPLY operates from a 117V AC, 60 Hz source and is protected with a 1.5 amp fuse. It provides (+5), (−15), and (+15) volt DC regulated outputs and −24V DC unregulated for the meter lamps and front panel LED's.

Audio-Equalization, Matrix (Day Card)

This unit receives the LEFT and RIGHT audio inputs and passes these signals through the HIGH and LOW FREQUENCY EQUALIZATION sections, compensating for signal path differences in various transmitters. The signals then pass to the audio matrix circuitry that produces the L+R and L−R,I and Q signals. + and − limiting of these signals is provided and finally this unit drives the front panel meters that display the relative audio drive levels.

Audio, Night, Processor (Night Card)

This unit, when the FRONT PANEL SWITCH is in the NIGHT position receives the LEFT, and RIGHT audio inputs and passes these signals through the HIGH and LOW FREQUENCY EQUALIZATION sections, compensating for signal path differences in the NIGHT transmitter. LEFT and RIGHT audio signal DELAY from 0 to 15 microseconds is also provided to compensate for both the DAY and NIGHT transmitter signal path delay differences.

A PROCESSOR circuit prevents excessive levels of single channel modulation which could exceed FCC specifications.

Encoder

The encoder generates the primary frequency of the station. It causes the carrier to be modulated with two "Q" signals $(R + L)_Q$ and $(R - L)_Q$ 90^o out of phase. Limiters are provided to eliminate AM modulation. The source for the pilot frequency is located on this card.

L+R Amplifier/Sample Transmitter

The L+R amplifier located on this circuit card generates an output which drives the envelope modulation of the normal station transmission. It also originates a sample C-Quam transmitter signal which simulates the full transmitted stereo for the purpose of checking the monitor receiver.

RF Amplifier

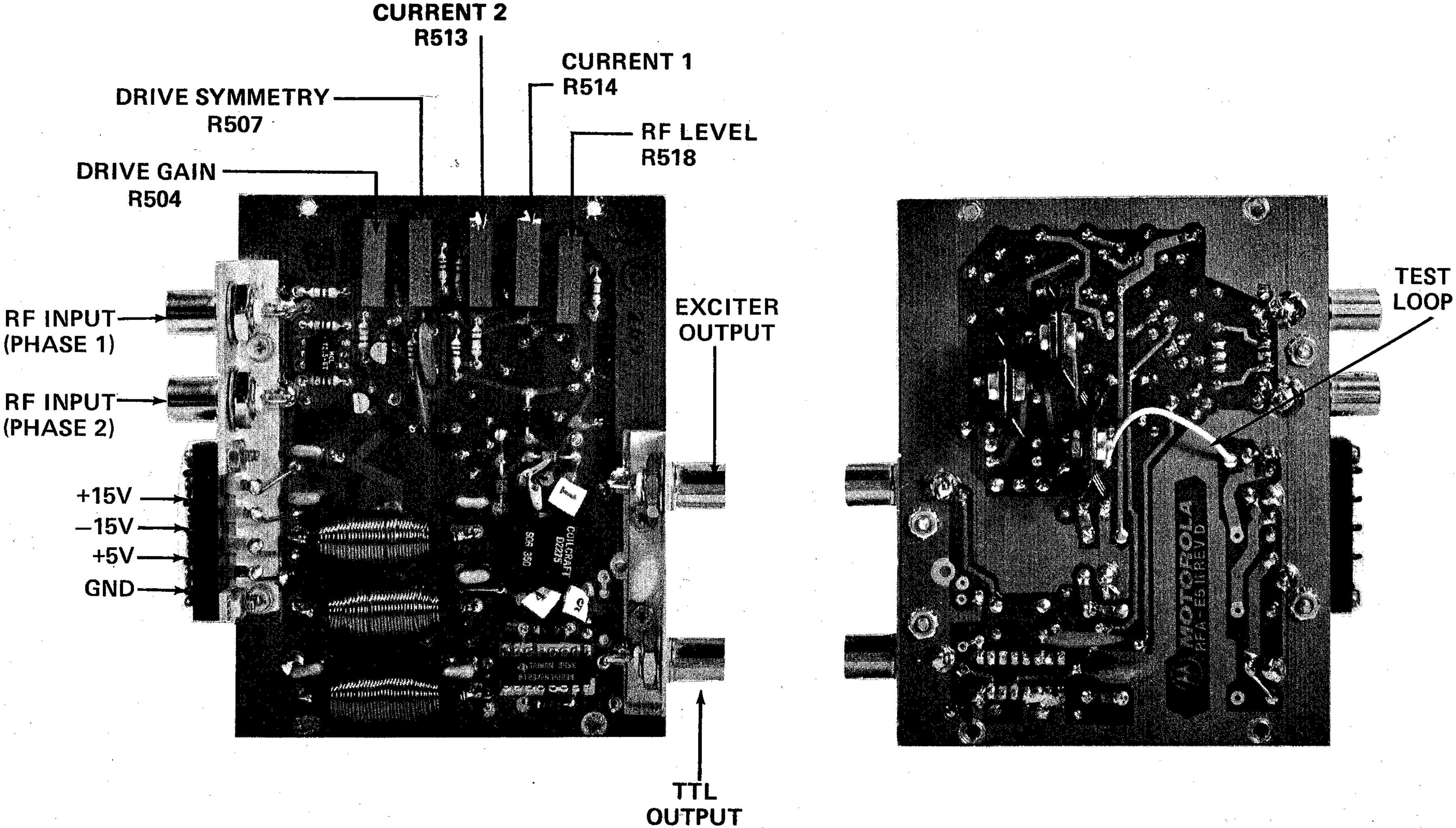
The RF amplifier produces a variable high power phase modulated output and a TTL level output which replaced the transmitter master oscillator.

Bulk Delay Card (Not Shown)

This unit supplements the LEFT and RIGHT audio signal DELAY of the AUDIO, NIGHT, PROCESSOR (NIGHT CARD) by providing four 10 microsecond delay sections for a total of 40 microseconds of addition delay. This unit is only added into the EXCITER when required.

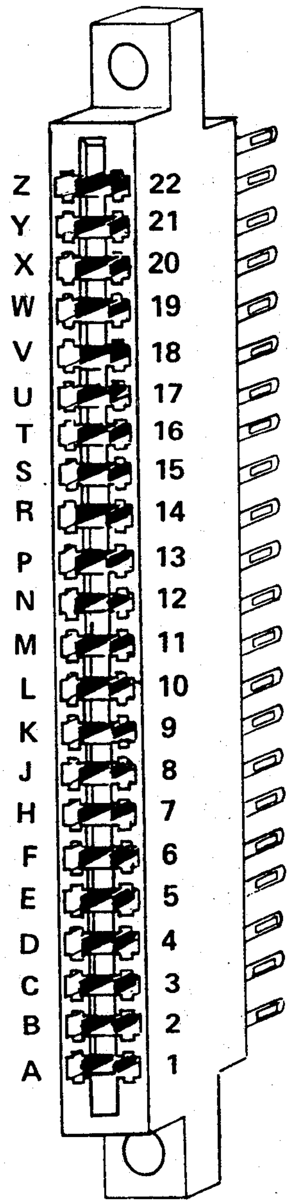
Audio Interface Card

This circuit card mounted on the left side of the EXCITER provides the interconnections for the two 600 ohm attenuator pads. It is adjustable in 1 dB binary steps from 0 to +15 dB and reduces the stations left and right audio inputs (typically +10 dBm level for 100% modulation) to zero dB required by the exciter. An RF filter is provided to both left and right audio lines and can be removed via jumpers if required.



RF AMPLIFIER TYPE 2 CIRCUIT CARD CONNECTOR AND TERMINAL STRIP IDENTIFICATION

MONITOR CIRCUIT CARDS
EDGE CONNECTOR PIN IDENTIFICATION



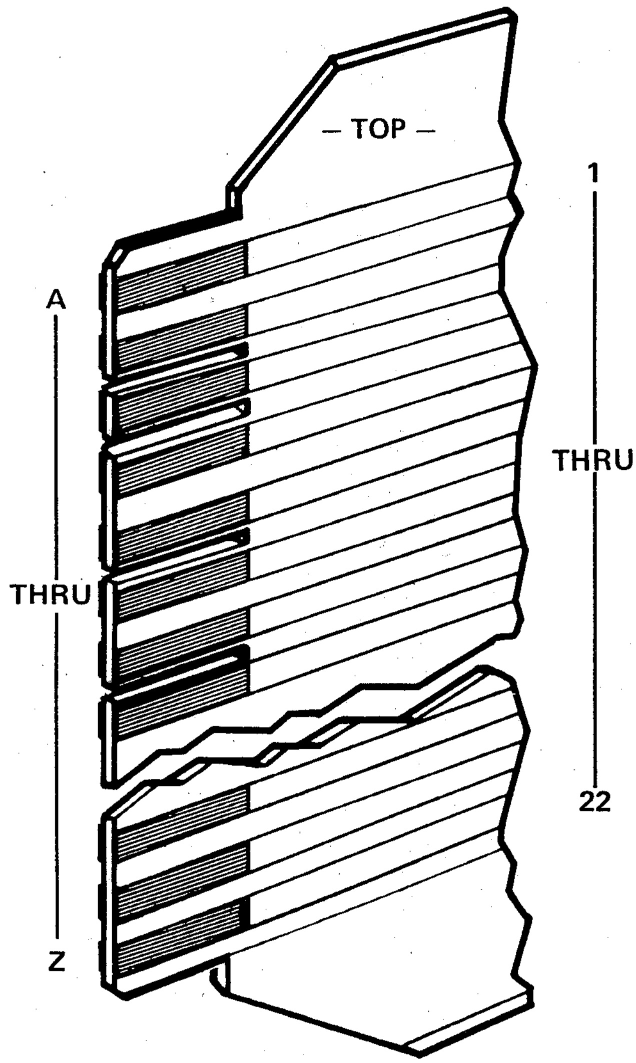
The monitor circuit card has 22 connections on each side of the card. When viewed from the rear, numerical contacts 1 through 22 are always on the right, and alpha contacts A through Z are always on the left as shown above.

NOTE: The card pin outs are keyed to the socket.

– CAUTION –

Be sure to reinsert cards oriented in the same position as they were removed.

EXCITER CIRCUIT CARDS
EDGE CONNECTOR PIN IDENTIFICATION



The exciter circuit card has 22 connections on each side of the card. When viewed as shown above, the alphabetical pin outs are always on the left and the numerical are on the right.

– CAUTION –

Be sure to reinsert cards oriented in the same position as they were removed.

EXCITER ALIGNMENT

AIDIO MATRIX AND EQUALIZATION (E2)

NOTE:

1. All adjustments are at 1kHz unless specified otherwise.
2. All adjustments are without equalization. Set the following switches and controls as follows:
   - A) Equalization switch levers down, six on audio matrix card (E2), six on night card (E6-2).
   - B) Process defeat OFF (lever toward back of card), S607 on night card (E6-2) and S701 on day card (E6-1).
   - C) Binary and bulk delays to zero, eight on night cards (E6-2/E9) and four on day card (E6-1/E8).
   - D) + Limit and – Limit on front panel fully CCW.
3. Reset switches as required after alignment.
4. Connect limiter diodes if limiting is required. Normally D301 and D302 are factory connected.

	Negative
$(L+R)_Q$	D301
$(L-R)_Q$	D309
$(L+R)_I$	D302

STEP	INPUT SETTING	ADJUST	OUTPUT	FUNCTION BEING CHECKED/REMARKS	TEST EQUIP.
1	Set Front Panel Night/Day Switch to Day Position				
2	L+R at Station Specification for 100% Modulation +10 dBm Typical	Front Panel Balance R783	Day Card TP1 and TP2 for Equal Level (–8 dBm Typical) as referenced to ground	Left and Right Audio Input Balance ± 0.1 dB Alternate method meter across TP1 and TP2 (< 100 uV at balance)	DVM, Oscilloscope and/or Distortion Analyzer
3 #	L–R at 100% Modulation	R320	Null at TP5	$(L+R)_Q$ Matrix Null	DVM, Oscilloscope and/or Distortion Analyzer
4	L+R at 100% Modulation	R322	600 mV PP at TP5	$(L+R)_Q$ Signal Level	DVM, Oscilloscope and/or Distortion Analyzer
4A*	See Below				
5 #	L+R at 100% Modulation	R334	Null at TP6	$(L-R)_Q$ Matrix Null	DVM, Oscilloscope and/or Distortion Analyzer
6	L–R at 100% Modulation	R337	600 mV PP at TP6	$(L-R)_Q$ Signal Level	DVM, Oscilloscope and/or Distortion Analyzer
6A*	See Below				
7 #	L–R at 100% Modulation	R342	Null at TP7	$(L+R)_I$ Matrix Null	DVM, Oscilloscope and/or Distortion Analyzer
8	L+R at 100% Modulation	R344	600 mV PP at TP7	$(L+R)_I$ Signal Level to Sample Transmitter	DVM Oscilloscope and/or Distortion Analyzer
8A*	See Below				
9	L+R at 100% Modulation	R378	6V PP at TP8	$(L+R)_I$ Signal Level to $(L+R)_I$ Amplifier	DVM, Oscilloscope and/or Distortion Analyzer
9A*	See Below				
10	L+R at 100% Modulation Front Panel Meter Switch L+R/L–R Position	R351 Meter Switch in L+R/L–R Position	100% Indication on L+R Front Panel Meter	Meter Calibration	
11	L–R at 100% Modulation Front Panel Meter Switch L+R/L–R Position	R359 Meter Switch in L+R/L–R Position	100% Indication on L–R Front	Meter Calibration	
12	If your exciter contains both night/day cards proceed to Step 1 of Audio Night Processor Alignment. If not, complete Steps 5 and 6 only.				
* Also See Note 4	– Limit Control 100% Modulation L+R	R782 Front Panel	Check for – Limiter Function as Control is Turned CW	– Limit Function, after Test Return to Fully CCW Position. Remove + limit diode D310 if used.	DVM, Oscilloscope and/or Distortion Analyzer

To increase bandwidth, null using a fast sweep (1 mS) between 20 – 20 kHz.

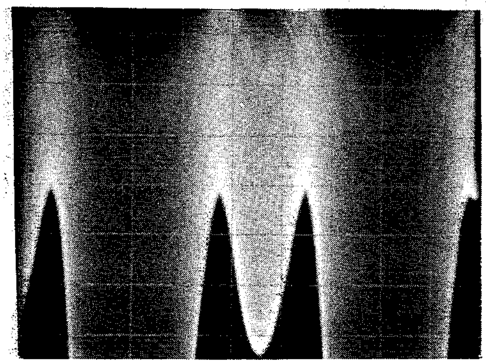


Figure 1.

SINGLE TRANSMITTER DELAY AND PROCESSOR — DAY — CIRCUIT CARD (E6-1)

— OR —

DUAL TRANSMITTER DELAY EQUALIZATION AND PROCESSOR — NIGHT — CIRCUIT CARD (E6-2)

NOTE 5: Prior to this procedure the audio equalization matrix circuit card must be aligned and the switches set as indicated in Note 4 above.

STEP	INPUT SETTING	ADJUST	OUTPUT	FUNCTION BEING CHECKED/REMARKS	TEST EQUIP.
1	L 100% Modulation	Adjust R619 from Day to Night Back & Forth Until Levels are Identical ± 0.1 dB	Day Card TP5 Approx. 300 mV PP	Sets Identical Level for Left Q Channel on Day and Night Cards	DVM, Oscilloscope and/or Distortion Analyzer
2	R 100% Modulation	R622 – Same Procedure	Day Card TP5 Approx. 300 mV PP	Sets Identical Level for Right Q Channel on Day and Night Cards	DVM, Oscilloscope and/or Distortion Analyzer
3	L 100% Modulation	R611 – Same Procedure	Day Card TP7 Approx. 300 mV PP	Sets Identical Level for Left I Channel on Day and Night Cards	DVM, Oscilloscope and/or Distortion Analyzer
4	R 100% Modulation	R625 – Same Procedure	Day Card TP7 Approx. 300 mV PP	Sets Identical Level for Right I Channel on Day and Night Cards	DVM, Oscilloscope and/or Distortion Analyzer
5	Front Panel Meter Switch L+R/L–R Position. R655 Fully CW. R662 Fully CCW. S607 to On Position (Handle Towards Connector End of Card).				
6	L Only Input – Adjust Level for 75% Modulation on Both Meters	R655	CCW Until Right Meter Just Starts to Drop Below 65% Modulation Point	Processor Function	

C-QUAM ENCODER CIRCUIT CARD (E1)

STEP	INPUT SETTING	ADJUST	OUTPUT	FUNCTION BEING CHECKED/REMARKS	TEST EQUIP.
1	None*	C151	Sample Transmitter Port or TP102	Sets Carrier Frequency	Digital Counter
2	Remove AC Power Plug From Source and Remove IC U102 From Its Socket				
3	None**	R135 and R205	Minimum RF at TP110		Oscilloscope
4	Remove AC Power Plug From Source and Insert IC U102 Back in Its Socket				
5	L+R at Station Specification for 100% Modulation	R123	Closure at TP110	Should Track Output at Sample Transmitter J901	Oscilloscope
6	L or R at 10 kHz	T101 and T102	Maximum at TP110 and Symmetry of Depth of Trough (See Figure 1)	Assures Proper Quam Bandwidth (See Alternate Method on Last Page This Section)	Oscilloscope
7	L+R at 100% Modulation	R158	4.0V PP at TP110		Oscilloscope
8	L+R and L–R at 100% Modulation	R129 (L+R) and R200 (L–R)	Sideband Amplitude at TP110, Repeat until L+R Spectrum = L–R Spectrum	Sets Defined System Performance for C-Quam	Spectrum Analyzer
9	L+R at 105% Modulation	R782 – Limit Front Panel	Until Audio Becomes Fuzzy at TP112 or Pin 8 U105 (See Fig 2)	Sync Scope on TP102	Oscilloscope
10	L+R at 105% Modulation	R155 and R205	Center Incidental Phase at TP112 or Pin 8 U105 (See Fig 3)	Sync Scope on TP102, Reduces Incidental Phase to Minimum	Oscilloscope
11	L+R at 125% Modulation	R782 – Limit Front Panel	Until Phase Noise is Minimum at TP112 or Pin 8 U105	Sync Scope on TP102	Oscilloscope
12	L+R at 125% Modulation		Check for 95% or Greater Modulation in Trough at TP110		Oscilloscope

* Front panel stereo/mono switch in mono position.

** Front panel stereo/mono switch in stereo position, 0% modulation (no audio signal)

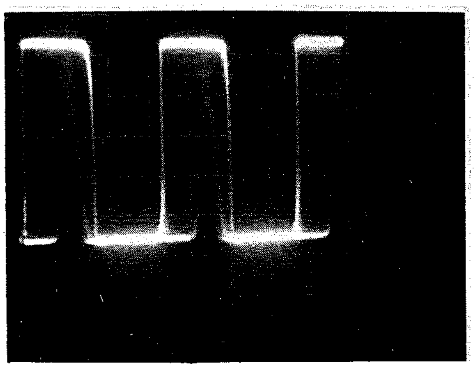


Figure 2.

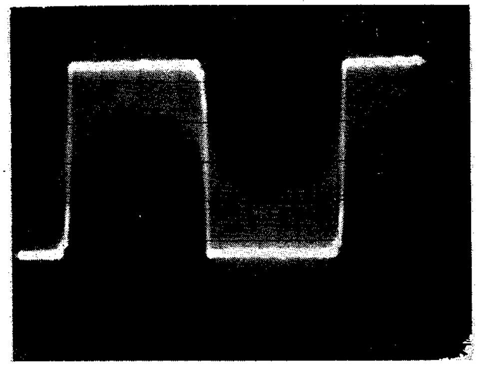


Figure 3.

L+R AUDIO OUTPUT AMPLIFIER/SAMPLE TRANSMITTER CIRCUIT CARD (E3)

STEP	INPUT SETTING	ADJUST	OUTPUT	FUNCTION BEING CHECKED/REMARKS	TEST EQUIP.
1	L+R Station Specification for 100% Modulation	[illegible]	Closure at J901 (No Load)	Should Track with TP110	Oscilloscope
2	L+R Station Specification for 100% Modulation at 40 kHz	T901, T902 and C913	Maximum Output and Symetry of Sidebands at J901 (No Load)	The RF Sine Wave Should Be Clean	Spectrum Analyzer
3	L+R Station Specification for 100% Modulation	R938	4.0V PP at J901		
4	L+R Station Specification for 100% Modulation Day Transmitter	L+R Adj-1 (Front Panel)	Per Stations Specified Output at R+L Rear Terminal Strip with 600 Ω Load	Test of tht L+R Amplifier	DVM
5	L+R Station Specification for 100% Modulation Night Transmitter	L+R Adj-2 (Front Panel)			

RF AMPLIFIER – TYPE 1 CIRCUIT CARD (E5)

STEP	INPUT SETTING	ADJUST	OUTPUT	FUNCTION BEING CHECKED/REMARKS	TEST EQUIP.
1	Set R518 and R250 Fully CW Before AC is Applied				
2	Remove Input Drive, (2) BNC Connectors From RF Amplifier				
3	None	R518 and R520 Fully CCW	Add 10mA Total Current on +15V Input Lead (5mA With Each Control)	Insures Drive Over Ambient Temperature Range	Clip-On DC Milliammeter
4	Replace (2) BNC Connectors on RF Amplifier				
5	Normal Encoder Drive	R508	Symetry at J503 with a 50 Ω Load	Slight Correction Only	Oscilloscope
6	Normal Encoder Drive	R502	Maximum Rise Time With Minimum Ringing at J503	Will Vary with Zener Voltage. Note Zener Value Selected per Station Requirement	Oscilloscope
7	Normal Encoder Drive	R502 and R508	Best Symetry and Minimum Ringing at TTL Output	Sets TTL Output (If Required)	Oscilloscope

RF AMPLIFIER – TYPE 2 CIRCUIT CARD (E5)

STEP	INPUT SETTING	ADJUST	OUTPUT	FUNCTION BEHIND CHECKED/REMARKS	TEST EQUIP.
1	Skip to Step 4 unless Q503 or Q504 have been replaced. Before AC is applied, remove shield, set R513 and R514 fully CCW, terminate RF and TTL outputs with 50 ohm loads.				
2	Remove two BNC input connectors J501 and J502.				
3	None	R513 and R514	Add 10mA total current on +15V red lead (5mA with each control)	Adjust quiesent current (5mA) through each output fet Q503, Q504 to insure proper drive over ambient temperature range. Replace shield and BNC connectors	Clip-on DC millimmeter in +15V lead
4	Set R504 drive gain fully CCW and R507 drive symmetry to mid position				
5	Normal drive	R504	TP1 and TP2 adjust CW until saw tooth waveform rounds off at peak. Turn CCW one turn.	Sets drive level to fet output amplifier and TTL line drivers	Oscilloscope
6	Normal drive	R507	Exciter or TTL output (J503/J505). Adjust for symmetry of square wave	Sets exciter and TTL output symmetry	Oscilloscope
7	Normal drive	R518	Set R518 RF level to desired output from 5 to 40 vPP.	Matches transmitter input drive level to exciter output	Oscilloscope

C–QUAM ENCODER CIRCUIT CARD (E1)

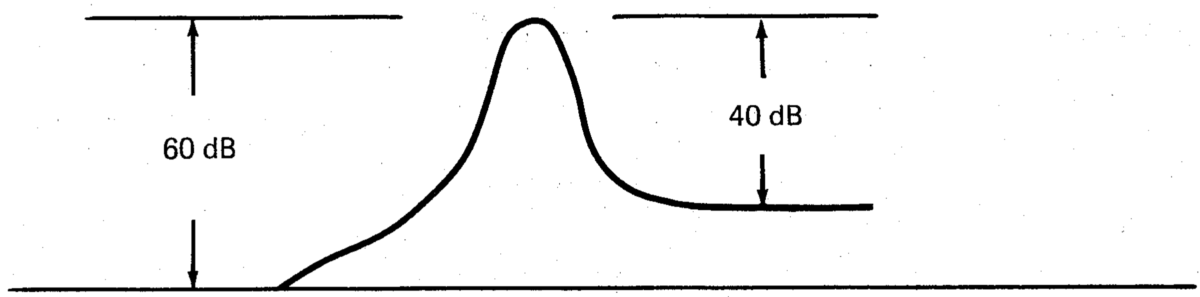
QUAM bandwidth Step 6 alternate method of adjustment. If a spectrum analyzer equipped with a tracking generator is available proceed as follows.

1. Connect tracking generator signal to TP108

2. Disconnect capacitor C105.

3. Input probe to TP110.

4. Set spectrum analyzer to 30 kHz resolution, 200 kHz/CM bandwidth, 10 dB/CM sensitivity. Output should be on frequency with only one major response.



5. Switch to 1kHz resolution, 10 kHz/CM bandwidth, 2 dB/CM sensitivity. Align T101 and T102 for symmetry of waveform at 30 kHz.

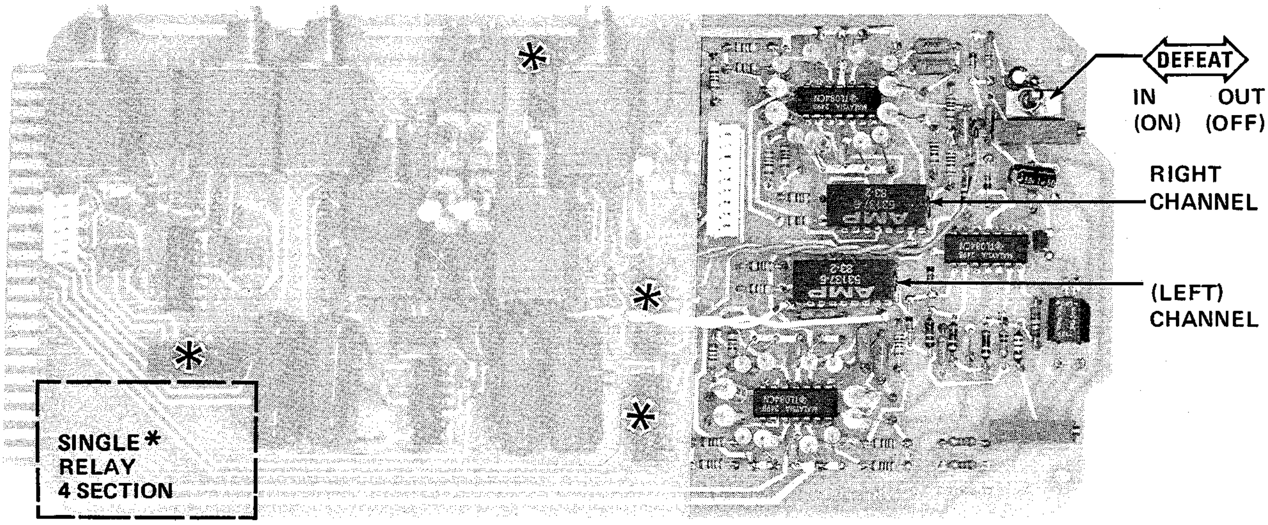
6. Momentarily connect C105 and observe RF amplitude at TP110. Adjust R158 for proper amplitude, repeating steps 2 through 6 until no further shifts occur.

7. On sample transmitter card (E3), observe signal at J901 repeating Steps 4 through 6 using T901, T902 for alignment and R938 for amplitude.

8. Permanently connect C105 and resume encoder alignment at Step 8.

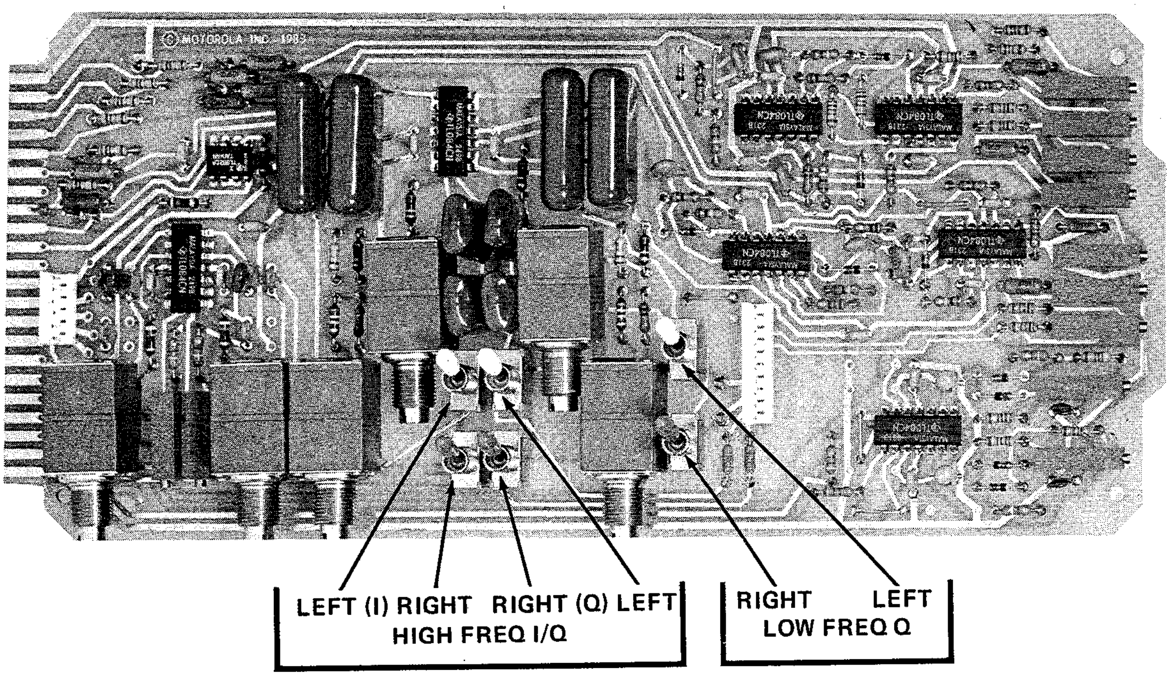
EXCITER II ALIGNMENT SWITCH LOCATION

SHADED AREA COMPONENTS NOT ON
E6-1 SINGLE TRANSMITTER CARD



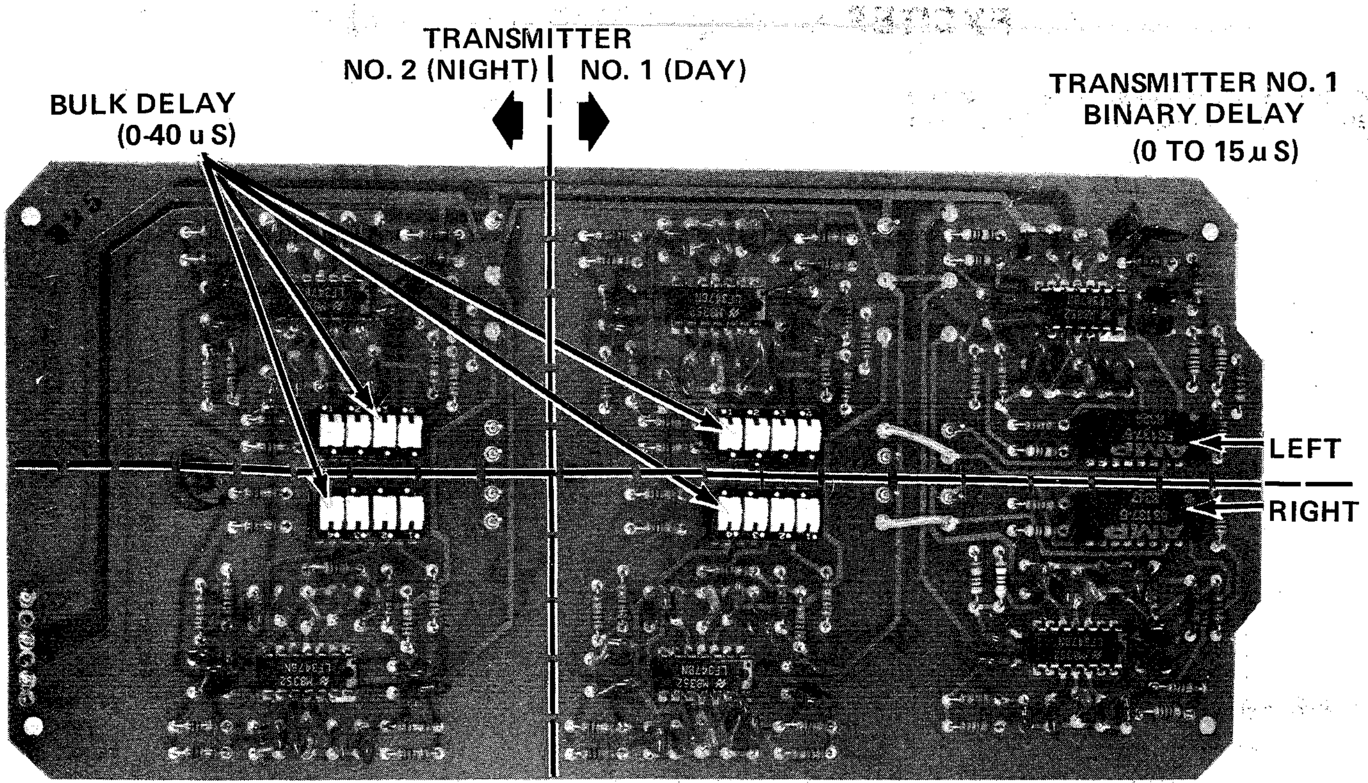
*FOUR SECTION SINGLE RELAY REPLACES THE FOUR (4) INDIVIDUAL RELAYS ON SOME VERSIONS.

__SINGLE__ TRANSMITTER DELAY AND PROCESSOR CIRCUIT CARD E6-1

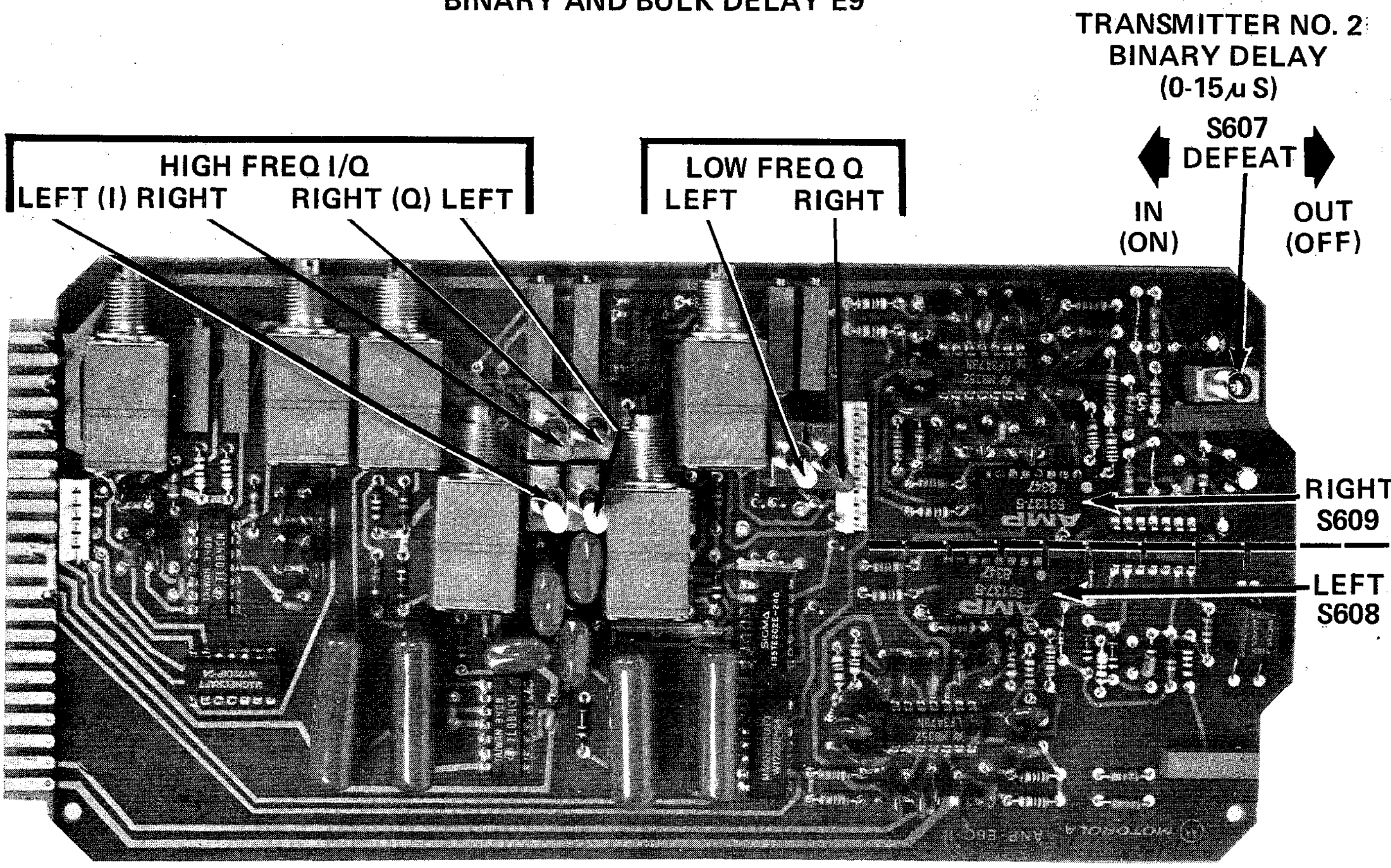


ALL SWITCHES SHOWN IN (OUT) POSITION

AUDIO MATRIX AND EQUALIZATION CIRCUIT CARD E2



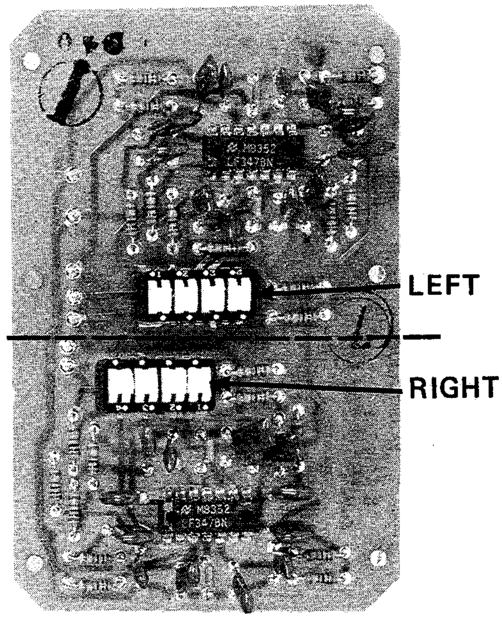
BINARY AND BULK DELAY E9



DUAL TRANSMITTER DELAY, EQUALIZATION AND PROCESSOR E6–2

EXCITER II DUAL TRANSMITTER AUDIO PROCESSOR CIRCUIT CARDS (NIGHT)

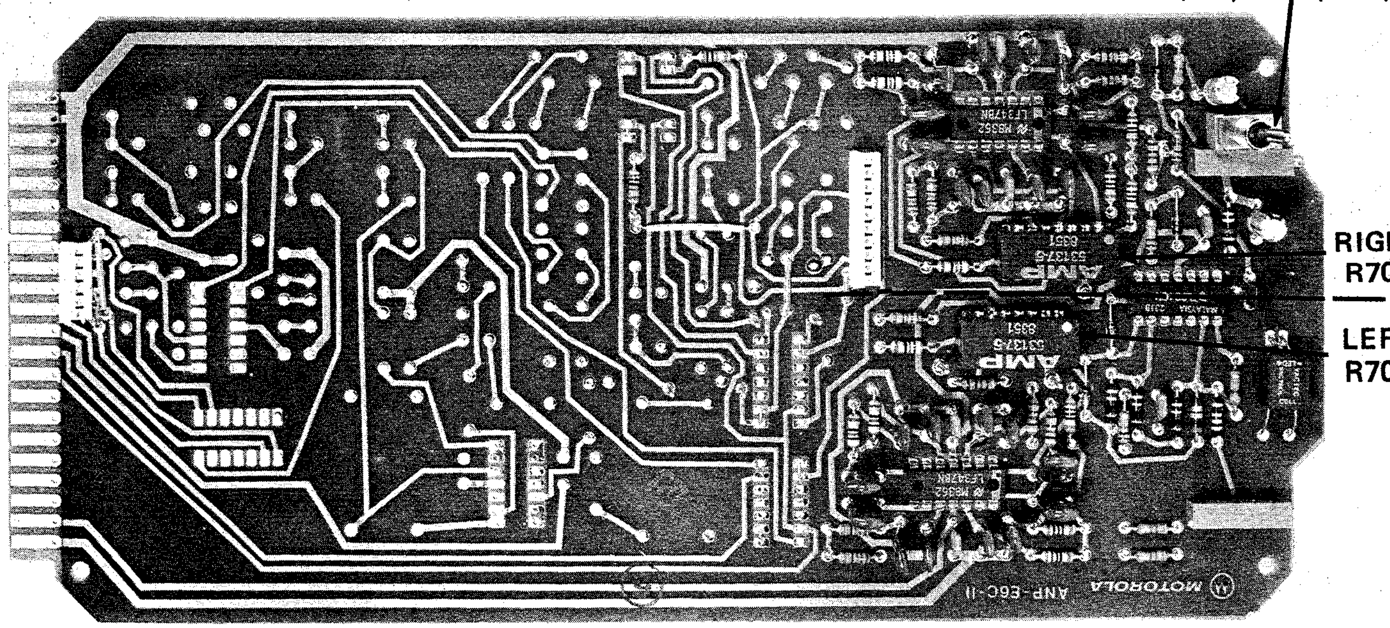
BULK DELAY
(0-40μS)



BULK DELAY E8

S701
DEFEAT
IN
(ON)
OUT
(OFF)

BINARY DELAY
(0-15μS)



SINGLE TRANSMITTER DELAY AND PROCESSOR E6 1

EXCITER II SINGLE TRANSMITTER AUDIO PROCESSOR CIRCUIT CARDS (DAY)

MONITOR ALIGNMENT

M27 CIRCUIT CARD

A. SETTING THE LOCAL OSCILLATOR FREQUENCY

Setting the Frequency Select Switches:

Determine the DIP switch settings by consulting Table I. Corresponding to each station frequency, the table lists an 8 bit binary number identifying the on or off condition of each of the 8 switches contained in the 16 pin DIP pack. To set the switches, remove and hold the card such that the large synthesizer IC is between you and the switch block. The switches now lie in the same order as the binary number, the first bit in the number (left end) corresponding to the left most switch in the block. A "1" bit means that the switch should be "on". The switch should be depressed away from you (away from the large IC). A "0" bit means that the switch should be "off". The switch should be depressed toward you.

If there is any doubt as to whether the setting is correct, attach a frequency counter as described under "Setting the reference Oscillator".

Setting the Reference Oscillator:

The accuracy of the reference oscillator is determined indirectly by reading the local oscillator frequency instead. The oscillator is then adjusted by the trimcap C710 to bring the local oscillator frequency to the correct value. The range of adjustment is only a few hertz.

Attach the counter probe to either R707 or R708. Use the end away from the U701 mixer IC. These points correspond to the output pins 14 and 15 of U704.

1. L701, L703 IF Coils

   L701 and L703 can be tuned from the peak amplitude waveform at either terminal of C728. The M41 card should be plugged in for this adjustment. As an alternate, the waveform out of the L+R jack on the rear panel can be used. Again, tune for the maximum waveform.

2. L705 RF Coil

   For those monitors having the network consisting of L705, C732, and R739, tune for maximum signal output at C728, or at the L+R rear panel jack as was described in the paragraph above.

M41 CIRCUIT CARD

Refer to Schematic SC-M41. Alignment of the decoder circuits should be done with the monitor driven by the sample transmitter in the exciter, rather than from the tap on the transmitter. All absolutely necessary alignments may be done by using the program material being broadcast, although the preferred method for complete alignment requires single tone modulation. Both methods will be covered. An oscilloscope should be used for the observations, and the scope should be in the DC mode. Voltages should be read using the scope. For waveform observations of low amplitude, the scope can be switched to AC mode.

A. ALIGNMENT USING PROGRAM MATERIAL

The paragraphs that follow are headed with the component to be adjusted.

1. L501, L502; IF Coils

   L501 and L502 can be tuned by peaking the L+R channel output at the rear panel jack.

2. R501; Corrector Line Limit Trimpot

   TP518 (at R501) should be between -5.5V and -6V at the start of alignment. Adjust R501.

3. R503; Envelope Detector Balance Trimpot, 1st Adjustment

   Disconnect the RF input to the monitor. The voltage at TP504 (on corrector line) should be -2V. This voltage should be adjustable by R503.

4. Rear Panel Step Attenuator, Front Panel RF Attenuator Pot

   The two RF attenuators should be adjusted such that the amplitude due to the carrier is nominally 100mv peak to peak at TP501(at RF input). Adjust during a null in the program.

5. R503; Envelope Detector Balance Trimpot, Final Adjustment

   The pilot tone should be off. Switch the exciter to mono modulation mode. Adjust R503 such as to null the audio appearing at TP504 (on corrector line). Avoid periods of heavy modulation, and try to adjust to where only a straight line appears on the scope.

6. R504; Quadrature Detector Balance, First Adjustment

   Switch the exciter to mono modulation, pilot off. Adjust R504 to null the audio at the L-R rear panel jack. Try to make the adjustment avoiding intervals of high level modulation.

7. R501; Corrector Line Limit Trimpot, Final Adjustment

Switch the exciter to mono modulation. The modulation level should be large enough to fire the -100% mod. indicator fairly regularly. Adjust R501 slowly CW. The corrector line voltage will be seen to move negative (TP518). The L-R output will show large spikes, with an amplitude exceeding 100% modulation. Adjustment even further may cause a large amplitude RF signal to appear on the L-R output. The scope intensity may have to be turned up to see the spikes because they are random and of short duration.

Now adjust R501 CCW. The TP518 voltage will move in a positive direction. A point of adjustment will be reached such that the amplitude of the spikes will decrease to an amplitude corresponding to 50% modulation or less. Leave the R501 adjustment at this point.

These L-R spikes are somewhat more evident if a XY type display is available on the scope. Rig the scope to display L+R vertical and L-R horizontal. The display will look like an inverted "T". The spikes are the horizontal bar on the "T". With an X/Y display, R501 may be adjusted even with the exciter in stereo mode.

8. The following adjustments should not be attempted using program material for modulation.

R505; Divider ckt phase trimpot
R674; Corrector loop gain
L503, L504, L505; 2nd. harmonic filters on the det.
L506; 4th haromic filter on the corrector line
R502, R571; Pilot filter, PLL control line

These should be adjusted only using the single tone modulation method, otherwise they should be left as set at the factory.

B. M41 ADUSTMENT WITH TONE MODULATION

Connect the monitor to the sample transmitter output of the exciter. Provide for a 1 KHz tone input to the left and right audio inputs of the exciter. Provide appropriate switching such that L only, R only, L+R and L-R modulation can be produced on the sample transmitter output.

1. L501, L502; IF Coils

L501 and L502 can be tuned by peaking the L+R channel output at the rear panel jack. Modulate with L+R.

2. R501; Corrector Line Limit Trimpot, First Adjustment

TP518 should be between -5.5V and -6V at the start of alignment. Adjust R501.

3. R503; Envelope Detector Balance Trimpot, First Adjustment

Disconnect RF input to monitor. The voltage at TP504 should be -2V. This voltage should be adjustable by R503.

4. Rear Panel Step Attenuator, Front Panel RF Attenuator Pot

Two RF attenuators should be adjusted such that the amplitude due to the carrier is nominally 100mV peak to peak at TP501 (at RF input).

5. R503; Envelope Detector Balance, Final Adjustment

Set the 1KHz tone modulation at 75% L+R. Adjust R503 such that the corrector line (TP504) is a straight line on the scope display. (Null out any "points" on the waveform.)

6. R504; Quadrature Detector Balance

With the modulation at 75% L+R, observe the L-R waveform at the rear panel jack. Null out any audio on the waveform such that only a straight line is displayed. The pilot should be switched off at the exciter.

7. R671; Corrector Loop Gain

The pilot tone should be off. Set the tone 1KHz modulation to 100% L-R. Observe the L-R output from the rear panel output jack, and test for distortion with a distortion analyzer. As the control R671 is rotated clockwise, the distortion should decrease until a point is reached such that further rotation of the control produces no reduction in distortion. The distortion that results will be somewhere in the area of 0.1% to 0.3%. R504 might need adjustment to get least distortion at this time. Then back the control such that the least distortion read is degraded by 0.05%. (This adjustment was to set the corrector loop gain.)

An alternate method to adjust R671 is as follows. Set the 1 Khz tone modulation to 100% L-R as before. Observe the waveform at TP504 (corrector line). Adjust R671 CW until the waveform is at a minimum amplitude, and the pot is at the limit of its range. Adjustment R671 CCW until the waveform amplitude increases 25% from the minimum.

8. L503 (Env. Det.); L504 (I.Det.); L505 (Q. Det.) 2nd Harmonic Trap

Set the modulation to 75% left only. Tune each coil to null the 2nd harmonic at the corresponding test point (TP507, TP508, and TP509). Other harmonics will be present, so some judgement has to be used in determining when the 2nd harmonic has been nulled in the waveform.

9. L506; 4th Harmonic Trap

Set modulation to 100% L-R. Tune L506 so as to null the IF 4th harmonic visible in the negative tips of the waveform. Other harmonics are present so some judgement will have to be used in determining when the 4th harmonic is nulled.

10. R505; Equalizing Single Channel Distortion

The pilot tone should be off. Set the modulation to 75% L only. Measure the distortion in the L-R waveform. Change the modulation to 75% R only. Again measure the distortion. Repeat these two readings several times while adjusting R505 to equalize the two readings. This control is a phase adjustment on the "divider circuit" consisting of U501 and U502.

11. R501; Corrector Line Limit

The pilot tone is off. Set the 1KHz modulation to 85% Left only. Adjust R501 to where the negative tips of the waveform just begin to limit.

12. R502, R571; Pilot Filter, PLL Control Line

Turn on pilot tone at exciter. There should be no other modulation on. Adjust R502 for maximum 25Hz signal at TP513 (U504 pin 1). Adjust R571 for the least 25Hz signal at TP514.

M10 CIRCUIT CARD, Preliminary Alignment

A. MODULATION LIMIT INDICATORS AND METER CIRCUITS

The M10 circuit card contains the circuits which operate the +125%, the -100%, the L-R Limit, and the Negative limit indicator lights. Calibration of these circuits is done with a 1 kHz tone source applied to both the "Envelope Detector" and the "Quadrature Detector" jacks on the rear panel. The M27 and the M41 circuit cards must be removed from their sockets during this adjustment. Calibration of the left and right meters also is accomplished during this adjustment. The steps in the calibration are listed below. Each begins with the control to be adjusted. All voltages should be read with an oscilloscope operating in DC mode.

Begin by removing the M27 circuit card and the M41 circuit card from their sockets.

1. R135; Zero AVC L+R Channel Output

Apply a short to the Envelope Detector jack on the rear panel. Open switch S101. Adjust R135 for 0 volts at U104, pin 8.

2. R134; Zero AVC L-R Channel Output

Appy a short to the Quadrature Detector jack on the rear panel. Open switch S101. Adjust R134 for 0 volts at U106, pin 1.

3. R132; Zero AVC L-R Channel Input

Apply a short to the Quadrature Det. rear panel jack. Close switch S101. Adjust R132 for 0 volts at U106, pin 1.

4. R133; Offset AVC L+R Channel Input for Test

Apply a short to the Envelope Detector jack on the rear panel. Close switch S101. S101 will remain closed for the remaining adjustments. Pin 1 is the top most lead of S101. Adjust R133 clockwise, such that S101, pin 1 goes to a -4V. Allow a moment for the voltage to settle.

Explanation: The M41 card inputs a DC voltage of approximately -1 volt through the edge connector, contact "P" of the M10 card. This voltage is derived from the envelope detector on the M41 card, and its magnitude is a measure of the carrier level being input to the monitor. This voltage is used by U102 (where it is input to pin 8) to derive the feedback voltage seen at S101, pin 1. In the absence of this voltage, (M41 unplugged) a positive voltage may be applied to U102, pin 4, to simulate the presence of the envelope detector voltage. R133 is adjusted to provide this voltage. The proper amount of voltage to apply is determined by observing the feedback voltage and setting it to -4 volts.

At a later point in the monitor alignment, this voltage will be readjusted to its normal operating value.

All adjustments on the M10 circuit card, that require an audio input to the envelope detector jack or to the L-R detector jack, will require R133 to be set as described in this step.

Note that the U104 pin 8 output is now at approximately +5 volts. With carrier only applied to the monitor, U104 pin 8 output would be at this voltage.

5. R252; Zero Offset Amplifier

Adjust R252 such that the voltage at U105 pin 8 is 0V. The waveform at U104 pin 8 contains a DC component of 5 volts. U105 translates the voltage down to 0 volts. This is necessary for the correct functioning of the peak modulation indicator lights.

6. R817; Calibrate Left Meter on L+R

Apply a 1 kHz tone to the Envelope Detector jack on the rear panel. Observe the waveform at U104 pin 8 using a scope in DC mode. Adjust the tone amplitude such that the negative loops of the waveform just touch the 0 volt line. The waveform out of U104 pin 8 now matches the waveform that would exist if a 100% envelope modulated signal were input to the monitor. The appropriate push button switches should be set so as to be reading +(L+R). Adjust R817 so that the left meter reads 100%. The left meter is now correctly calibrated. R817 is accessible through an opening in the bottom panel of the monitor.

7. R247; Equalizing AVC L+R and L-R Gains

Apply a 1 kHz tone to the envelope detector jack and the L-R detector jack simultaneously. Set the tone amplitude so that the left meter reads 100%. Adjust R247 such that the amplitude of the waveform at U106 pin 1 matches the amplitude of the waveform at U104 pin 8. There will be no DC component in the waveform at pin 1 of U106.

8. R818; Calibrate Right Meter on L-R

Apply the 1 kHz tone to the envelope detector jack and the L-R detector jack simultaneously. Adjust the tone amplitude such that the left meter reads 100%. The push buttons should be set such that the right meter is reading +(L-R). Adjust R818 such that the right meter reads 100%. R818 is accessible through an opening in the bottom panel of the monitor.

9. -100% Modulation Indicator

Apply the 1 kHz tone to the envelope detector jack such that the left meter reads 100% L+R. If the light is not on, do step 6 again. Any waveform at U104 pin 8 that reaches or extends below 0 volts will cause the -100% modulation indicator to turn on.

10. R255; +125% Modulation Indicator

Apply the 1 kHz tone to the envelope detector jack such that the left meter reads 125% L+R. Adjust R255 such that the +125% modulation indicator light just turns on.

11. R256; L-R Limit Indicator

Apply a 1 kHz tone to the L-R detector jack such that the right meter reads 100% L-R. Adjust R256 such that the L-R limit indicator light just turns on.

12. R258; Negative Limit Indicator

Apply a 1 kHz tone to the envelope detector jack and the L-R detector jack. Adjust the tone amplitude until both the left and right meters read 90%. Adjust R258 until the negative limit indicator light just turns on.

13. R242; Calibrate Left Meter on L

Apply a 1 kHz tone to the envelope detector jack such that the left meter reads 100% L+R. Switch the left meter to read +Left. Adjust R242 to read 50% +Left.

14. R243; Calibrate Right Meter on R

Apply a 1 kHz tone to the envelope detector jack such that the left meter reads 100% L+R. Switch the right meter to read +Right. Adjust R243 to read 50% +Right.

15. R187; Left Meter Channel Separation

Apply a 1 kHz tone to the envelope detector jack and to the L-R detector jack simultaneously. Adjust the amplitude of the tone so that the left meter reads 100% L+R. Adjust R187 to null the reading on the left meter, set to read +Left.

16. R193; Right Meter Channel Separation

Apply a 1 kHz tone to the envelope detector input so as to read 50% +Right on the right meter. Apply the same input to the L-R detector jack instead. The right meter should still read 50% +Right. Adjust R193 so that the two readings will match.

17. R230; Pilot Detector Oscillator Frequency

Connect a counter to the pilot signal jack on the back panel. Adjust R230 so that the frequency is 25 hz + or - 0.1 hz. No audio should be input during this adjustment.

18. R225, R259, R220; Pilot Level and Detector Sensitivity

R259 should be adjusted to center. This trimpot is provided as a convenience for fine adjustment of the pilot level meter.

Input a 25 hz tone at the L-R detector jack. Adjust the amplitude to 5% (-26 dB) L-R. Set the front panel toggle switch to read pilot tone level (the handle toward the pilot tone indicator light). Adjust R220 CCW (counter clockwise). This sets the sensitivity of the pilot tone detector maximum. Adjust R225 such that the meter needle is directly centered over the wide mark at the left side of the meter. At this time the pilot indicator light will be on.

Adjust R220 CW such that the pilot indicator light flashes on or turns off. Turn R220 CCW until the light is on steady. Turn two additional turns CCW.

19. M10 Final Adjustment

The adjustment of the M11 card requires the adjustments made in step 4 to remain as set. Therefore the final adjustments to the M10 circuit card are left to a later section. At that time the setting of R133 will be set to its final operating point.

M11 CIRCUIT CARD

Before adjustment of the M11 panel is begun, steps 4 thru 8 of M10 Circuit Card Alignment must be completed and the settings made in those steps must remain for this alignment. The M41 and M27 circuit cards must be out of their sockets. S101 pin 1 must be at -4 volts as set in step 4 (M10 section).

1. R402; Left Peak Indicator Light

   Apply a 1 kHz tone to the envelope detector jack. Adjust the amplitude such that the left meter reads 100% L+R. Set the left thumbwheel to read 100. Adjust R402 such that the left peak modulation indicator light just turns on.

2. R413; Right Peak Indicator Light

   Apply a 1 kHz tone to the L-R detector jack. Adjust the amplitude such that the right meter reads 100% L-R. Set the right thumb wheel to 100. Adjust R413 such that the right peak modulation indicator light just turns on.

3. R325; Left Pilot Rejection

   Apply a 1 kHz tone to the L-R detector jack and adjust the amplitude to where the left meter reads 50% L. Change the tone to 25 Hz. Adjust R325 to null the left meter reading. The resulting reading should be less than 5% L.

4. R363; Right Pilot Rejection

   Apply a 1 kHz tone to the L-R detector jack. Set the amplitude such that the right meter reads 50% R. Change the tone to 25 Hz. Adjust R363 to null the right meter reading. The resulting meter reading should be less than 5% R.

5. R385; Left Channel Output (Back Panel)

   Apply a 1 kHz tone to the envelope detector jack. Adjust the amplitude to where the left meter reads 100% L+R. Adjust R385 to where the amplitude of the signal from the left output jack is 1/2 that from the L+R output jack.

6. R387; Right Channel Output (Back Panel)

   Apply a 1 kHz tone to the envelope detector jack. Adjust the amplitude to where the left meter reads 100% L+R. Adjust R387 to where the signal amplitude from the right output jack is 1/2 that from the L+R jack.

7. R380; Left Channel Separation on Back Panel Output Jack

   Apply a 1 kHz tone simultaneously to the envelope detector and the L-R detector jack. Adjust the amplitude to where the left meter reads 100% L+R. Adjust R380 to null the signal from the left jack.

8. R383; Right Channel Separation on Back Panel Output Jack

   Apply a 1 kHz tone to the envelope detector jack. Adjust the amplitude to where the left meter reads 100% L+R. Note the amplitude of the signal from the right channel jack. Move the tone input to the L-R detector jack. The output from the right channel jack should remain the same. If the amplitudes are not the same, adjust R383 and repeat. The amplitudes should be compared with as much precision as possible.

9. R480; Remote Left Meter Calibration

   This adjustment is done where an M30 remote meter panel or other remote meter installation is present. The station engineer will have to devise a means of communicating the remote meter reading to the person doing the monitor alignment.

   Apply a 1 kHz tone to the envelope detector jack. Adjust the amplitude to read 100% L+R on the left meter. Adjust R480 such that the left remote meter reads 100%.

10. R481; Right Remote Meter Calibration

   Apply a 1 kHz tone to the L-R detector jack. Adjust the amplitude to read 100% L-R on the right meter. Adjust R481 such that the right remote meter reads 100%.

   The alignment of the M11 circuit card is now complete. The setting of R133 (M10) may now be returned to normal operating setting per the section entitled "M10 Circuit Card, Final Adjustment."

M10 CIRCUIT CARD, FINAL ADJUSTMENT

These adjustments are made using the sample transmitter on the exciter. Most of the following can be made using the program audio that would be input to the exciter when broadcasting. The remaining adjustments that require tone or single channel inputs could be omitted. The worst that could result would be a slight inaccuracy in calibration of channel separation or the gain ratio between the L+R vs the L-R channel. The adjustment of R133 is absolutely necessary.

Remove any audio connections to the back panel. Connect the RF input to the sample transmitter on the exciter. Replace the M27 and M41 circuit cards in their sockets.

The following adjustments should be performed after any adjustments have been made on the M41 circuit card.

1. R133; L+R Channel Calibration with M41 and M10 Reconnection

   Observe the signal from the envelope detector jack on the back panel. Adjust the step attenuators and the front panel pot such that the average DC value of the waveform appears to be -1 volt. (Start with the front panel pot CW and turn the step attenuator CW until the DC appears to be more negative than -1 volt. Then cut back the signal amplitude with the front panel pot to -1 volt.)

   Note: The step, on which the step attenuator is now set, will be the setting for all the adjustments that follow.

Turn the step attenuator CCW as far as the switch allows. The waveform at the envelope detector jack will have collapsed to almost a straight line. Observe the waveform at U104 pin 8 on the M10 circuit card. This waveform will also have collapsed to a small amplitude. Adjust R133 such that the DC level of the waveform is 0 volts.

Return the step attenuator to the original setting that was noted above. The L+R channel is now in calibration.

2. R246; AVC Loop Range

The purpose of this adjustment is to set the AVC feedback voltage to its designed operating point. This is accomplished by setting the level of the envelope detector waveform that is input to the AVC stage. Adjust R246 so that S101 pin 1 (top switch lead) is at -4 volts.

3. R245; Carrier Level UNMOD RF INTO M41 AT 100 MV P-P

When this control is properly adjusted, the proper level of IF input to the M41 circuit board causes the carrier (edge) meter to read at the center mark.

Move the front panel toggle switch such that the handle is toward the RF attenuator pot knob. This connects the edge meter to read IF signal level. Adjust R245 such that the carrier meter reads center.

4. R260; Carrier Meter Sensitivity

Check the voltage at S101 pin 1. Adjust the front panel RF attenuator pot CCW so that the voltage at S101 pin 1 moves negative 20%. Adjust R260 to align the carrier meter needle with the 20% mark at the left end of the meter.

5. R220; Pilot Detector Sensitivity

Adjust R220 CW such that the pilot indicator flashes or turns off. Turn back CCW so that the light turns on steady. Turn two additional turns.

6. R1002; Left Channel Earphone Output. R1003; Right Channel Earphone Output

The volume level output from the earphone jack for left or right channels are individually adjustable by the trimpots R1002 and R1003 accessible through holes in the right panel.

The following adjustment requires a single tone, or a single channel input to the exciter which are not compatible with being in the broadcast mode. These adjustments may be omitted or delayed until a better time.

1. R247; L-R vs L+R Channel Gain

Modulate the sample transmitter with a 1 kHz tone Left channel only such that the left meter reads 60% L+R. Adjust R247 so that the right meter reads 60% L-R.

2. R187; Left Channel Separation, Left Meter

   Input audio to the exciter right channel only, such that 50% modulation is indicated on monitor right meter reading +R. Adjust R187 such that the left meter reading on +L is a null.

3. R193; Right Channel Separation, Right Meter

   Input audio to the exciter left channel only, such that 50% modulation is indicated on the monitor left meter reading +L. Adjust R193 such that the right meter reading on +R is a null.

4. R383; Right Channel Separation, Back Panel Output (M11 Circuit Card)

   Input audio to the exciter left channel only, such that 50% modulation is indicated on the monitor left meter reading +L. Adjust R383 such that the back panel right channel output is a null.

5. R380; Left Channel Separation, Back Panel Output (M11 Circuit Card)

   Input audio to the exciter right channel only, such that 50% modulation is indicated on the monitor right meter reading +R. Adjust R380 such that the back panel left channel output is a null.

These should be the final steps in the monitor alignment.

TABLE 1: M27

STATION	L.O.	VCO	SET	SWITCH 87654321
530	980	3920	98	01100010
540	990	3960	99	01100011
550	1000	4000	100	01100100
560	1010	4040	101	01100101
570	1020	4080	102	01100110
580	1030	4120	103	01100111
590	1040	4160	104	01101000
600	1050	4200	105	01101001
610	1060	4240	106	01101010
620	1070	4280	107	01101011
630	1080	4320	108	01101100
640	1090	4360	109	01101101
650	1100	4400	110	01101110
660	1110	4440	111	01101111
670	1120	4480	112	01110000
680	1130	4520	113	01110001
690	1140	4560	114	01110010
700	1150	4600	115	01110011
710	1160	4640	116	01110100
720	1170	4680	117	01110101
730	1180	4720	118	01110110
740	1190	4760	119	01110111
750	1200	4800	120	01111000
760	1210	4840	121	01111001
770	1220	4880	122	01111010
780	1230	4920	123	01111011
790	1240	4960	124	01111100
800	1250	5000	125	01111101
810	1260	5040	126	01111110
820	1270	5080	127	01111111
830	1280	5120	128	10000000
840	1390	5160	129	10000001
850	1300	5200	130	10000010
860	1310	5240	131	10000011
870	1320	5280	132	10000100
880	1330	5320	133	10000101
890	1340	5360	134	10000110
900	1350	5400	135	10000111
910	1360	5440	136	10001000
920	1370	5480	137	10001001
930	1380	5520	138	10001010
940	1490	5560	139	10001011
950	1400	5600	140	10001100
960	1410	5640	141	10001101
970	1420	5680	142	10001110
980	1430	5720	143	10001111
990	1440	5760	144	10010000
1000	1450	5800	145	10010001
1010	1460	5840	146	10010010
1020	1470	5880	147	10010011
1030	1480	5920	148	10010100
1040	1490	5960	149	10010101
1050	1500	6000	150	10010110
1060	1510	6040	151	10010111
1070	1520	6080	152	10011000

TABLE 1: M27 (Cont.)

STATION	L.O.	VCO	SET	SWITCH 87654321
1080	1530	6120	153	10011001
1090	1540	6160	154	10011010
1100	1550	6200	155	10011011
1110	1560	6240	156	10011100
1120	1570	6280	157	10011101
1130	1580	6320	158	10011110
1140	1590	6360	159	10011111
1150	1600	6400	160	10100000
1160	1610	6440	161	10100001
1170	1620	6480	162	10100010
1180	1630	6520	163	10100011
1190	1640	6560	164	10100100
1200	1650	6600	165	10100101
1210	1660	6640	166	10100110
1220	1670	6680	167	10100111
1230	1680	6720	168	10101000
1240	1690	6760	169	10101001
1250	1700	6800	170	10101010
1260	1710	6840	171	10101011
1270	1720	6880	172	10101100
1280	1730	6920	173	10101101
1290	1740	6960	174	10101110
1300	1750	7000	175	10101111
1310	1760	7040	176	10110000
1320	1770	7080	177	10110001
1330	1780	7120	178	10110010
1340	1790	7160	179	10110011
1350	1800	7200	180	10110100
1360	1810	7240	181	10110101
1370	1820	7280	182	10110110
1380	1830	7320	183	10110111
1390	1840	7360	184	10111000
1400	1850	7400	185	10111001
1410	1860	7440	186	10111010
1420	1870	7480	187	10111011
1430	1880	7520	188	10111100
1440	1890	7560	189	10111101
1450	1900	7600	190	10111110
1460	1910	7640	191	10111111
1470	1920	7680	192	11000000
1480	1930	7720	193	11000001
1490	1940	7760	194	11000010
1500	1950	7800	195	11000011
1510	1960	7840	196	11000100
1520	1970	7880	197	11000101
1530	1980	7920	198	11000110
1540	1990	7960	199	11000111
1550	2000	8000	200	11001000
1560	2010	8040	201	11001001
1570	2020	8080	202	11001010
1580	2030	8120	203	11001011
1590	2040	8160	204	11001100
1600	2050	8200	205	11001101
1610	2060	8240	206	11001110
1620	2070	8280	207	11001111

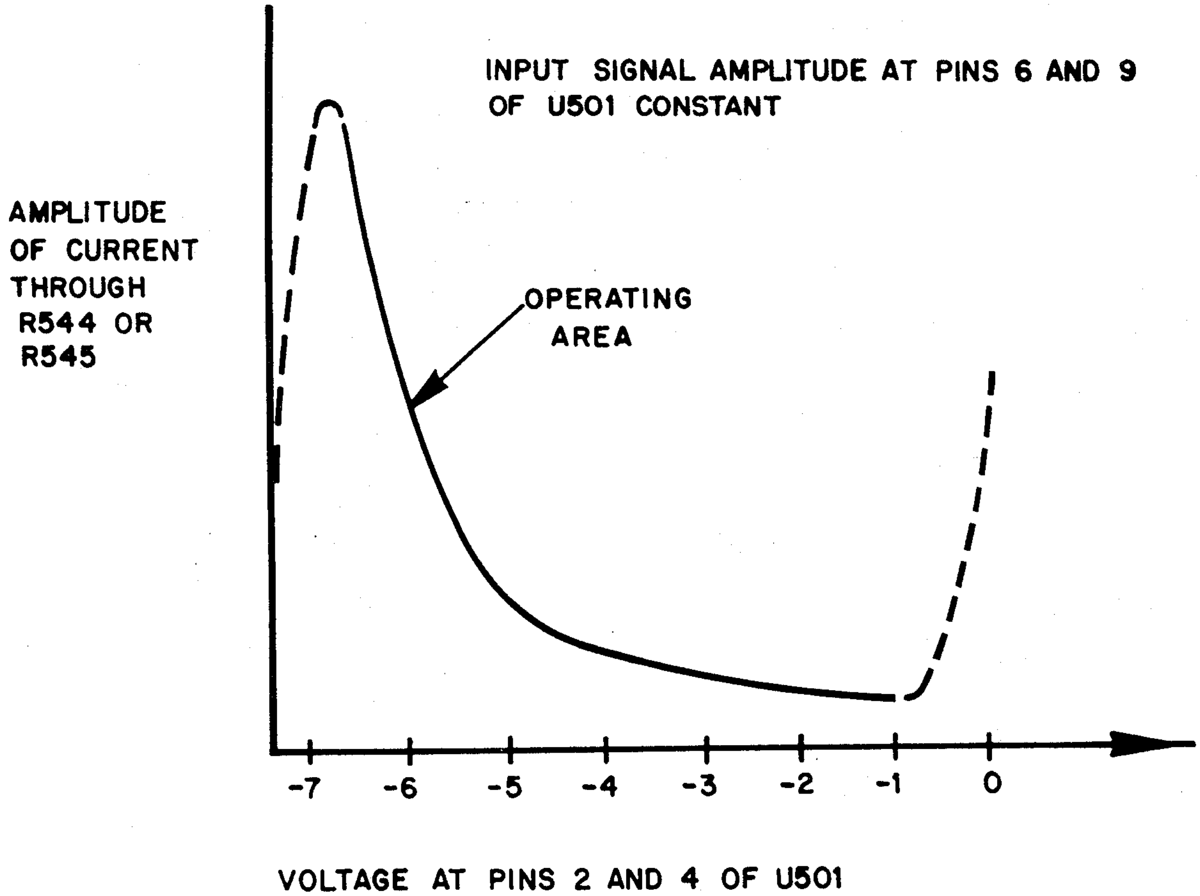


FIGURE 1.

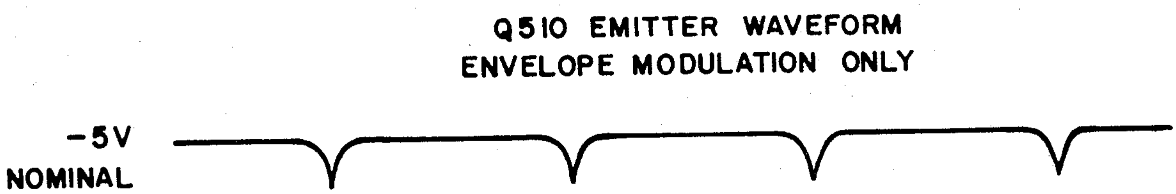
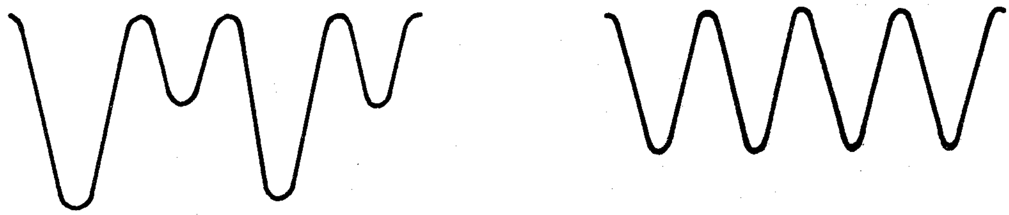


FIGURE 2.

Q510 EMITTER WAVEFORM
L–R MODULATION ONLY



A
R504 ADJUSTED WRONG

B
R504 ADJUSTED CORRECTLY

FIGURE 3.

Q510 EMITTER WAVEFORM
L ONLY OR R ONLY MODULATION

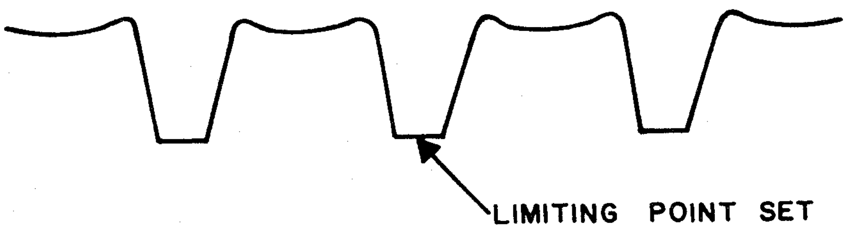


FIGURE 4.

MONITOR TROUBLE-SHOOTING

As a tool for analyzing the performance of your AM stereo system, the monitor is very useful. The problem arises when the indications on the monitor are abnormal. The question is whether the system or the monitor has failed. the following will outline some steps to try and isolate the problem.

First, what is a correct and incorrect meter reading. Normal stereo programs should produce much higher deflection on the L+R meter than on the L-R meter. When programming reverts to mono the L-R activity should drop considerably. If one channel is disconnected into the exciter, the L+R and L-R should respond equally. When switched to right and left, the disconnected channel should indicate a null of 20dB or greater, and single channel peaks should not exceed 75%. If peaks of 70% are reached, use the exciter processor to limit L-R magnitudes.

Failure of the catastrophic type.

1. No meter movement or pilot light - Check AC input, then check fuse and power supply.

2. Meters pegged to left or right - This indicates that one of the DC supplies has failed. Unplug cards starting with the mixer. If any card alleviates the situation, a short on that cards B+ or B- buss should be suspected. The investigation is then between that card and the power supply. If the power supply voltages are okay with meter card (M-11) removed the problem is on the M11, if not, the power supply has failed.

3. Meters do not move, but pilot lights function and meters are not pegged.

   Check that the +/-, L+R/L or L-R/R modulation switches and meter range switch are selected. Insure that the carrier level meter is at the set mark for an RF input at back of monitor.

   If an RF voltage is present, remove all the cards, one at a time, and clean the edge connectors and re-seat them. Caution, this should be done with the power off. If the problem has not been corrected, it will be necessary to use an oscilloscope to trace for a loss of signal.

   Place the mixer (M17 or M27) on a card extender and check for RF at the input of L702 or pins 1,4 of U701. If no signal, check input attenuator and front panel carrier set control.

   Check for signal through the mixer for unity or a slight gain. If no output, trouble-shoot the mixer.

   Insure that RF is at the decoder card by checking secondary of L501. Then check L+R and L-R at output filters. Both output signals must be present or the problem is on the decoder card.

   The output of the decoder is connected to both the A.V.C. card (M10) and the meter card M11. Check the rear L+R output to see if the signal is there. Check to see that the L+R is at the M10 card, pin 8 and at U102. Check the L-R at the rear panel port and at the input of M10, pin 8 and at U103. Note that the L+R and L-R signals at the output of the M10 card is in both polarities. If the signal disappears in the card, see M10 AVC card trouble shooting. The route of the M10 output signal is confusing, see the block diagram for the most clear understanding. The path is through the selector network, the M11 card for the meter amp, then to the meter.

Total failures tend to be easier to fix than partial failures or suspected poor performance. If you are experiencing difficulty call us for technical assistance, we may suggest that the unit be returned for repair and calibration.

4. The meter indicates something is wrong but broadcast signal appears to be normal. In order to determine broadcast signal quality a mono and stereo signal must be available. Remember that the monitor may be telling the real story and a problem could have developed in either the transmitter or the exciter. If the meter movements are unusual, connect the monitor to the sample transmitter output of the exciter with the equilization switched off. If the behavior is radically different, it is a sign that the problem is in the transmitter.

   If you have a modified Pioneer SX-6 or a Sony SRF 100 you can go to the transmitters oscillator while forcing the receiver to stereo. A switch is provided inside the SX-6 to force the receiver into stereo mode. If you still hear a lot of phase information while the transmitter is mono it is an indication that something in the transmitter is causing IPM. This must be corrected prior to evaluating the actual monitor operation.

   If no Phase information is evident on the receiver, but the monitor indicates high phase activities, the problem may well be in the monitor. One thing to remember, with no signal the monitor is likely to indicate almost anything. There are several closed loop circuits trying to lock onto a signal that isn't there.

   The oscilloscope can be used to measure phase modulation. Sync the scope at the "Unmodulated Output" on the exciter rear panel or TP102 of the encoder card. Depending upon the exciter, one of these points may provide a better source for sync.

   The phase signal should not exceed 1/3 of the alteration for 100% modulation. If the exciter modulation is low, but the monitor modulation looks high, use the same sync and look at the transmitter output. If the excurtions are worse, the transmitter may be a fault.

   Another technique is to use the scope in an X-Y mode tracing the signal through the system. Adjust the system for equal sensitivities and trace from Telco or STL to processor, exciter, monitor and another receiver source. Somewhere in the chain you should encounter an indication of trouble. Try L, R, L+R, and L-R for indications of trouble.

5. Follow the alignment procedure until an indication of trouble is encountered. This may identify the problem and ultimately lead to a repair, however, the time consumed could be prohibitive. Returning the unit for repair and calibration might be the best course of action and actually cost less. We, of course, are willing to help via the telephone, but first write down as many facts as you can gather. In any event, we would suggest that you call before returning the equipment.

TROUBLE-SHOOTING YOUR MOTOROLA C-QUAM STEREO EXCITER

With over 250 units in the field we have received enough calls from engineers to feel the need to write a piece on trouble shooting. This might aleviate some of the fears, of some engineers, of the complexity of AM Stereo. It's not really as tough as you might think. Let's get to some basic questions to try to localize the nature of the problem;

1. Does the transmitter have carrier drive?

2. Does it sound bad in stereo?

3. Does it sound bad in mono?

Let's start with audio problems. Recall that the exciter has 2 outputs (RF and Envelope) and 1 input (Right & Left channels). It is desireable to have a patch or some other method of determining whether it is getting the proper inputs and delivering the proper outputs. You should have the ability to measure with a voltmeter, observe with a scope and listen to it on a speaker. In that this paper is on trouble shooting the exciter, it should be obvious if you're not putting good audio in you can not expect good audio out. Many of the modern AM Stereo audio processors have L+R output in addition to L and R channels and it's a good idea to wire that into the patch bay and set it for the proper level to drive the audio input of your transmitter. This allows you to circumvent the audio path in the exciter with one patch cord. Recall, also, that L+R and L-R audio information is sent down the RF chain in your transmitter to produce stereo. Let's address the 2 SOUND questions one at a time.

A. Sounds good in mono but bad in stereo.

Two things should be immediately tried;

1. Switch the exciter to mono (Either move the mono/stereo switch <u>sharply</u> or switch the transmitter off before pushing the switch.)

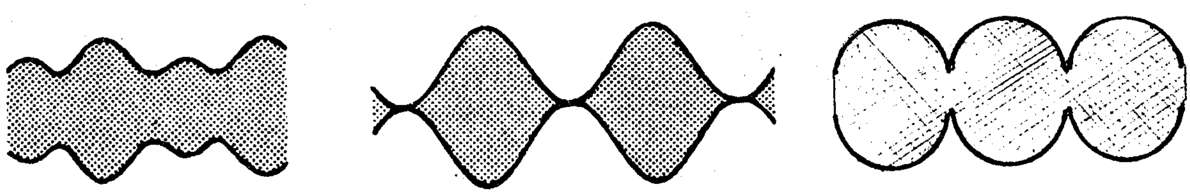
If the sound gets better when in mono the problem is in the exciter audio or in the encoder card and the RF amplifier is probably OK. This assumes that the inputs are OK. If the output still sounds bad go to step 2 as the RF amplifier would be most suspect.

Let's try to solve problem 1 first. The front panel meters will provide the first clues as they are at the half way point in the process. These L and R meters are at the end of the seperate channel processing and before matrixing. The L+R and L-R meters are past matrixing but before modulation. REMEMBER! none of the front panel meters on the exciter actually indicate that modulation has taken place. These meters do indicate that audio is present for modulation. Look first at the L and R meters. Are both present in the correct amount? Remember that the single channel meters are double faced, ie, they read twice the actual modulation. This was done to try to make people nervous about exceeding 75% single channel modulation. You should also know that the meters are neither extremely accurate or properly damped - they are intended to indicate drive. If the inputs are there but one of the single channels is missing obviously something is wrong in the signal path. The easiest thing to do is first note the position of all the equalization switches and then proceed to "excercise" each switch vigorously to see if there is any indication, on the meter, that this could be the fault. If it is, bridge the faulty contacts with a wire until you can get a replacement switch. It's not always that easy so let's trace the signal from the inputs.

NOTE: There are 2 basic exciter models in the field: 1. Old (herein referred to as "O"). EITHER a single plastic cover with 2 switches and 2 adjust pots OR 2 plastic covers with a silver tag that says "R adj --- L adj". These have serial numbers less than 0068. 2. New (herein referred to as "N"). A square hole in the top cover plate with both a day and night or a 1/2 night card connected with a 6 wire and a 10 wire ribbon cable. These have serial numbers greater than 0067. The prime difference is in the fact that the equalization feature is duplicated and switched by relay to provide the day/night feature.

To provide easy partitioning first get the signal to the input of op-amp "O" U301, pins 7 & 8 or "N" TP1 & TP2. The high frequency equalization is the next block "O" U301, pins 1 & 14 or "N" U307, pins 7 & 8. The low frequency equalization is the next block "O" U302, pins 1 & 7 or "N" TP4 & TP5. The bulk and binary delays also come before the single channel metering points and these switches should also be noted for their setting and then "excercised". The unit is DC coupled past the input transformers and you should keep your scope in DC to look for excessive offset (greater than .03VDC) which can cause problems to the modulator. If you get signal all the way through bulk and binary delay it's time to switch to the L+R, L-R meter mode (Rocker down) on the exciter. With single channel input the L+R and L-R meters should read the same and with L+R the L-R should be at a null and visa versa. If these indications are not correct you must signal trace through the matrix. Note that the meters read only the "Q" or phase channel reading unless you press the "L+R Env" switch. This analysis is done on the basis that mono was OK.

If all meter indications are proper to this point then the problem is probably in the encoder. TP110 "N" or pin 13 of U105 "O" is a key test point on the encoder.



L or R L+R L-R

The waveforms are shown above and the CW amplitude should be 2 Volts peak-to-peak (Use only a 10:1 probe). The exciter must be in the stereo mode to present these waveforms. The L+R and L-R waveforms being incorrect would be an indication that the respective modulator has failed. While many stations could probably perform the encoder alignment listed in your manual, you are advised to read the procedure several times and if it's not totally clear please give us a call. A second point of caution is to not mess with alignment unless you are TOTALLY convinced it is necessary....IF IT AINT BROKE, DON'T FIX IT!

2. Switching the exciter to mono doesn't help.

The first thing to do is switch to your transmitters own oscillator and confirm that it clears the problem (Remember, you will be in mono when you're on your transmitters oscillator.) If you can not easily switch to your transmitters own oscillator you should make a strong effort to get a switch installed to facilitate this.

One thing you should do is put a "Tee" connector on either the "Exciter" output and/or "TTL" output, whichever your transmitter(s) use(s), and also put a masking tape drawing on the back of your exciter showing the voltage and waveform of the exciter working into your transmitter under NORMAL operating conditions. This may not be an ideal square wave due to reactance in the cable and in the load. The important thing is that the transition area (where the waveform crosses the base line) be free of distortion as most of the stages in the RF chain are not running class A. The "Tee" will allow you to go in and look at the RF output without having to shut the transmitter off. If you are concerned about station personnel you should put a "Caution! Do Not Remove While Transmitter Is Operating" tag on the Tee to prevent those embarassing dead air gaps.

If the transmitter does not sound better in stereo when you switch to your own oscillator then you have something in your transmitter that is causing very high levels of Incidental Phase Modulation (IPM). This MUST be fixed before returning to stereo operation. NOTE: If you are listening on the Motorola converted Pioneer SX6 receiver, the SX6 MUST be placed into the "forced AM Stereo" mode. The Motorola Monitor always "listens" in the stereo mode.

If going to the transmitters own oscillator DOES clear the problem then the only remaining link is the exciter RF amplifier and the limiter or encoder. Check at the input of the RF amplifier to see that you have BOTH phases of RF drive and that ALL "B" voltages are present (+15, -15, +5). The alignment proceedure should reveal which stage of the RF amplifier has failed. You can order a replacement unit or fix it yourself. As always, we will be happy to help you through the investigation.

B. Sounds bad in mono.

The first thing to do is bridge around the exciter audio as mentioned at the start of this article.

If the transmitter still sounds bad then the next thing to do is go to your transmitters own oscillator. If it is still bad, then, the problem is in your transmitter. NOTE: The stereo exciters RF amplifier is about the only element that can cause BOTH mono and stereo problems.

If circumventing the exciter audio helps then you must find the problem in the exciter. The problem of bad mono can be anywhere from the input audio terminals on. Switch the exciter to mono (SHARPLY) to make sure it's not the phase information that is messing up the mono. This would be a rare instance and an attempt at aligning the encoder PER THE LISTED INSTRUCTIONS should yield an indication of the problem area. If the Mono/Stereo switch does not help then the "I" (Envelope) path must be checked to get to the problem. Check from the audio input terminals to the op-amps ("O" U301, pins 7 & 8, "N" TP1 & TP2) then to the "I" matrix ("O" U303, pin 8, "N" U301, pin 1) then through the front panel pot to the L+R amplifier on the sample transmitter, and then to the output terminals. ONCE AGAIN, THE CAUTION ABOUT WATCHING D.C. OFFSETS HOLDS TRUE. The clippers are another item that should be checked.

C. The transmitter does not have carrier.

The first thing to determine is whether the stereo exciter has failed catastrophically. You can get your first indication without removing the covers; IF the audio meters are "pinned", either to the right or left, either the +15 or -15VDC power supply is gone --- due to a failure or a short. If this is true: circumvent the exciter audio, return to your transmitters own oscillator and you will be back in business in mono (unless your transmitter has failed).

Let's start first with power supply failure. After you have returned to the air in mono, pull the exciter from the rack, remove the top lid and the back. The power supply card is the one with the large, black heat sink closest to the power transformer. The +15 is pin #3 and has a number of red wires on the pin. The -15 is pin #5 and has a number of white wires on it. The +5 is pin 7 and has orange wires. Use your trusty volt meter to determine which has failed. Leave the meter connected to the "failed" pin while completing the next step. (NOTE: The +5 is derived from the +15 so if the +15 has failed you will not have +5.) First check that the UN-REGULATED plus and minus voltages are present at the respective regulator inputs, then, with the meter back on the pin with no voltage, begin to un-plug all the cards (PC Boards) in the exciter while observing the failed power supply voltage. If removal of a card brings the power supply voltage up then a component on that card is the problem. Last, remove the power supply leads from the RF amplifier, taking care not to short them to anything. If the voltage wont come up with all loads removed, then the power supply regulator is suspect.

If the power supply is OK then the RF generators path has failed somewhere. Put a scope on the RF output and observe the output. If the waveform is OK then the link to your transmitter may have failed. Remove the transmitter connection - if the RF comes up, then the RF path must be shorted. NOTE: With no load the RF amplifier waveform exhibits a lot of ringing. If there are no indications of problems at the output then you'll have to start tracing the RF from the source. The RF starts from the 4 times carrier frequency oscillator, Q101 on the encoder card E1. Look at the source of Q101 for a 4 times carrier frequency signal. (It's not a very good looking sine wave.) From there go to the output of the divider. Look at pins 8 and 10 (inputs) on all modulators. Check the outputs, pins 6 and 12 of all modulators. The outputs are summed through 100 ohm resistors then go to the input of the buffer (Base of Q114, Q115). From the buffer the signal goes to the input of the limiter (pins 2 & 13 of U105), then to the output of the limiter (pins 7 & 8 of U105). The output of the limiters goes through buffer transistors to pins 10 & 13 of the output connector. NOTE: These outputs are symetrical and each pair of signals should be roughly identical in waveform and amplitude. The RF amplifier is next in the chain and has been discussed previously.

The only other failure is pilot failure. First, confirm that both the Motorola Monitor and a C-Quam decoder equipped receiver indicate that the pilot has failed. If the pilot has failed, the first thing to do is "excercise" the pilot switch on the exciter. If this fails then it's time to start signal tracing. Here's the path; Drain of Q113 Encoder to output of divider (25 Hertz square wave) pin #15 of U106, Output of the low pass filter, pin #1 of U107. Input of modulator, pin #1 of U104. NOTE: The pilot switch has extra contacts so you can pick another set or wire for redundancy.

I have tried to shed some light on a trouble shooting proceedure but I would like to emphasize the fact that we are always glad to answer your questions and help you as best we can.

SUMMARY

Things you should do BEFORE you have trouble.

1. Put a Tee on the RF output of the stereo exciter and record the waveform on the back of the exciter.

2. Wire your patch bay so you can monitor inputs and outputs and easily patch around the exciter.

3. Wire your transmitter so you can switch to your transmitters oscillator easily. Use a relay for remote operations. NOTE: Some input powers are high and contact ratings on the switch or relay should be observed.

4. Post a written proceedure for transmitter operation independent of the stereo exciter.

5. Make 3 copies of this troubling shooting proceedure. Put a copy in the manual, a copy at the transmitter location and one in an envelope tied to the exciter.

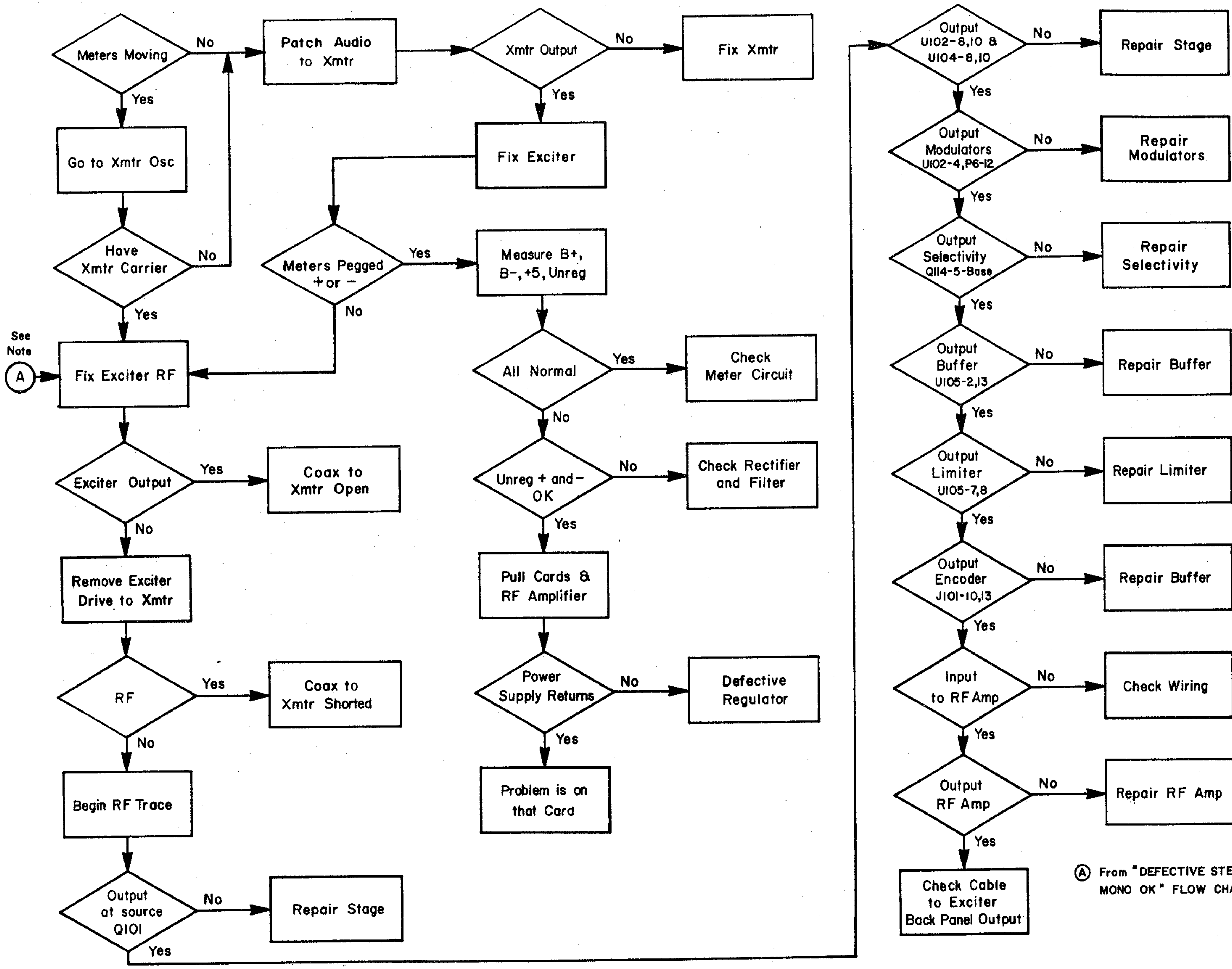
Once a year exciter maintenance.

1. Carefully remove all cards (PC boards), noting positions, and clean the edge connectors.

2. "Excercise" all switches. Note their position before starting!

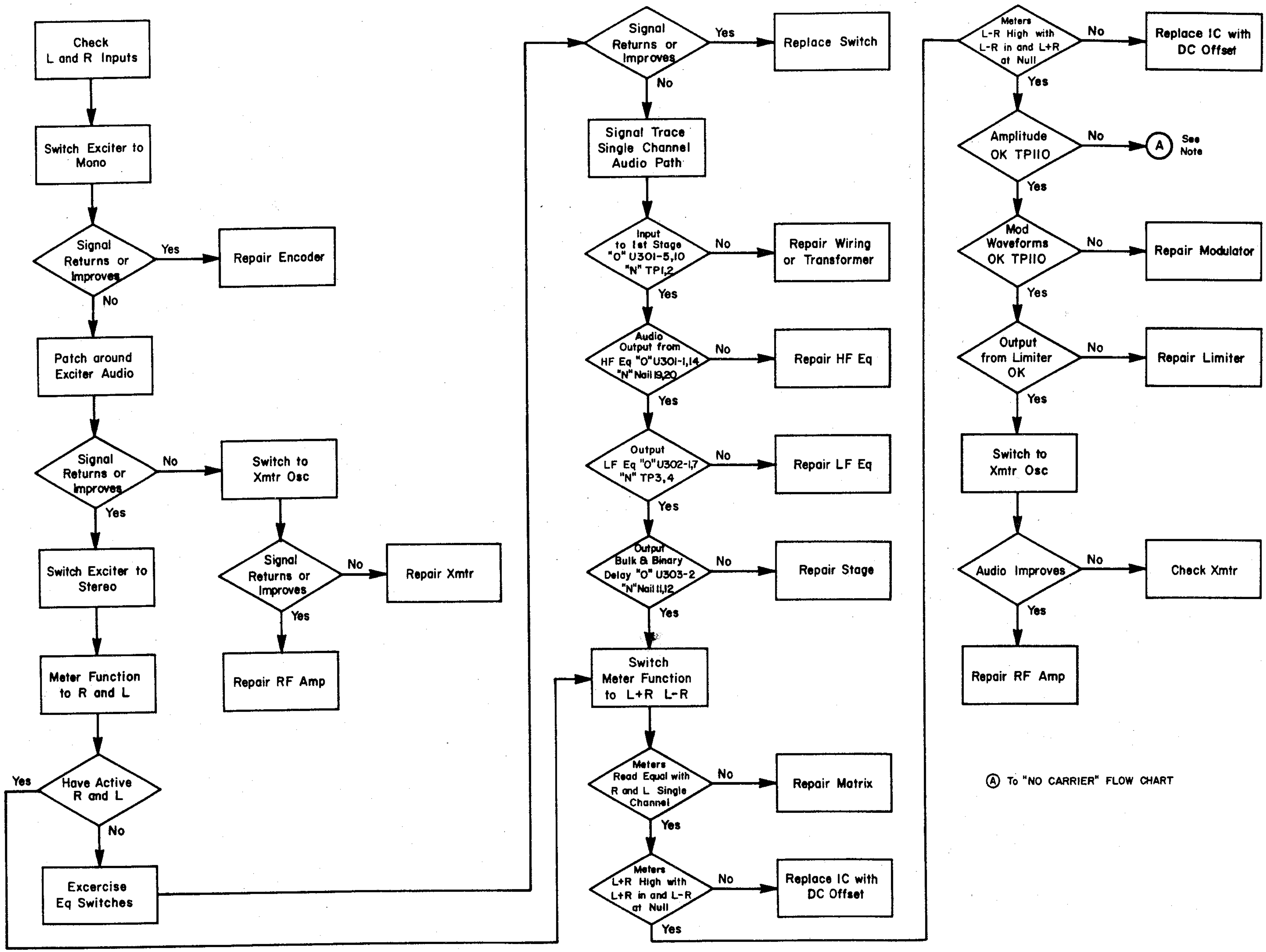
3. Inspect all cards for obvious problems.

NO CARRIER

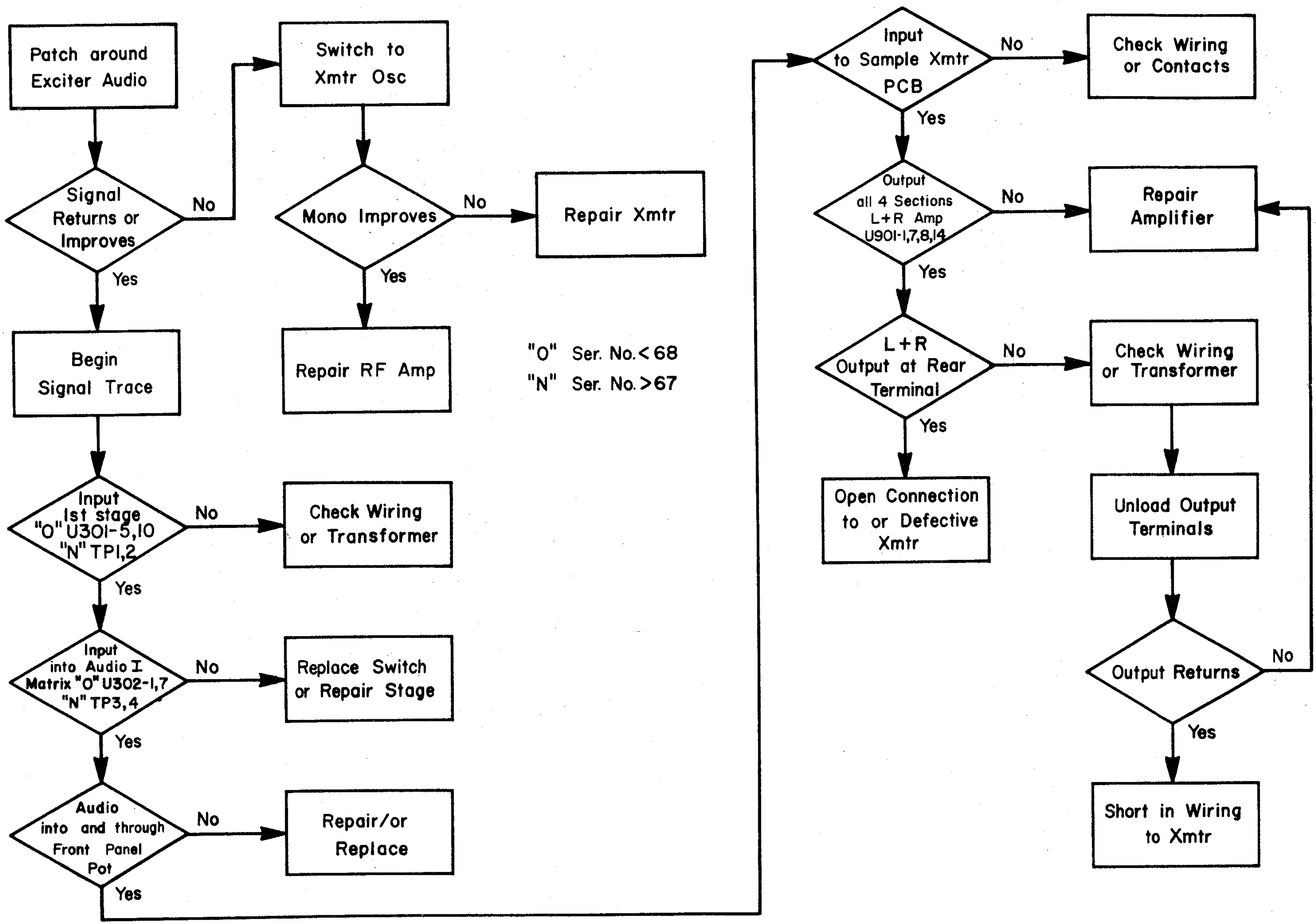


Ⓐ From "DEFECTIVE STEREO MONO OK" FLOW CHART

DEFECTIVE STERE MONO OK



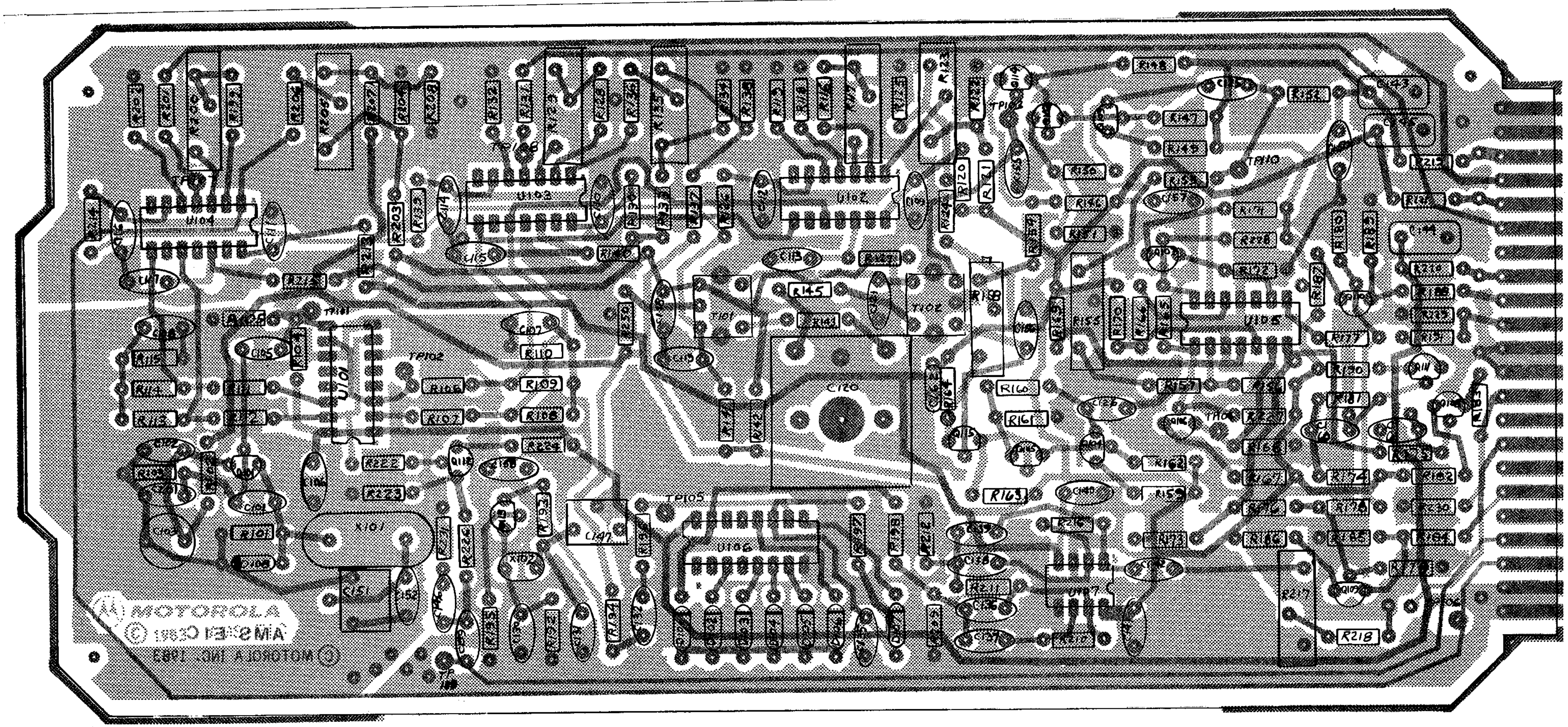
DEFECTIVE STEREO AND MONO



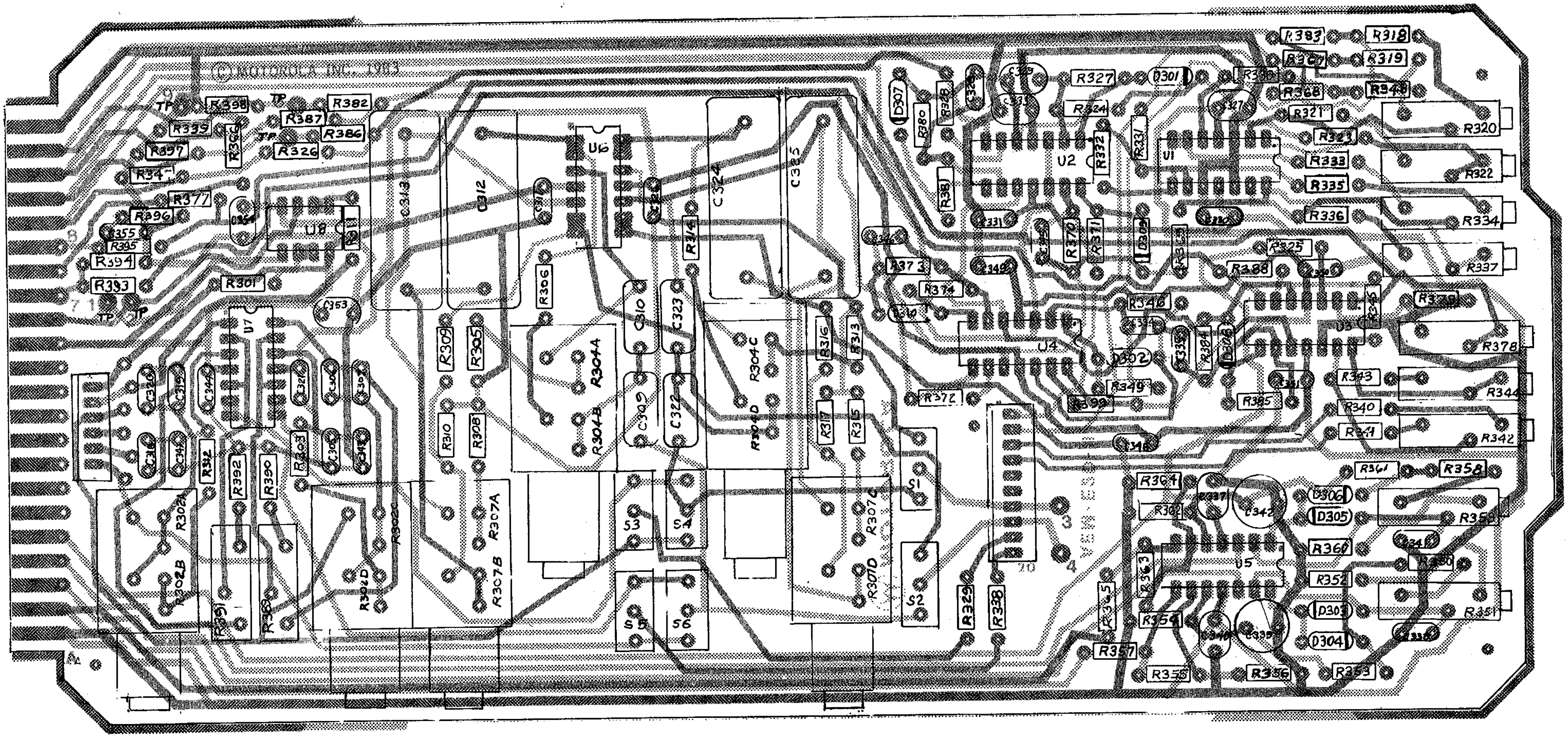
SCHEMATICS

EXCITER

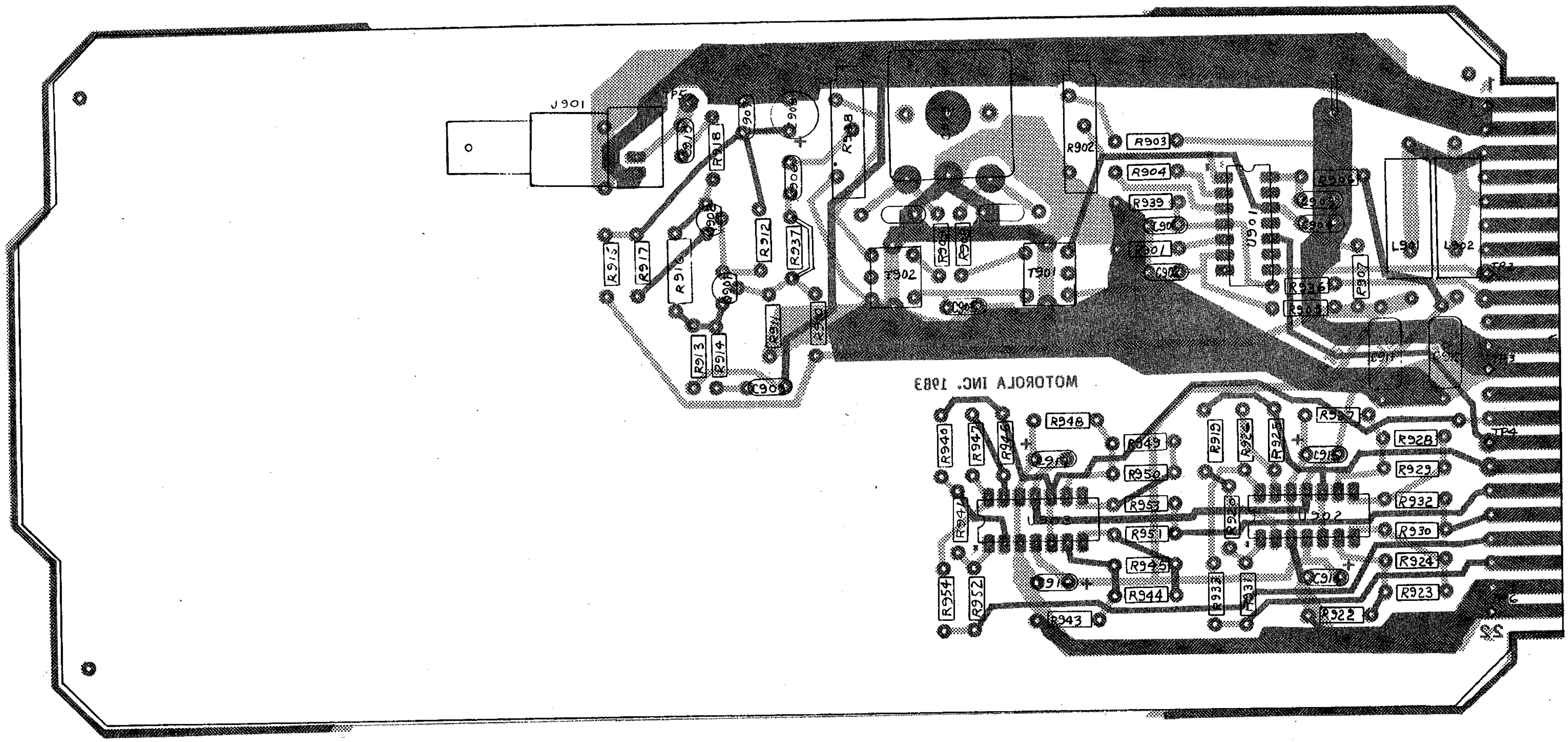
MONITOR



EXCITER ENCODER CIRCUIT CARD E1C
COMPONENT VIEW

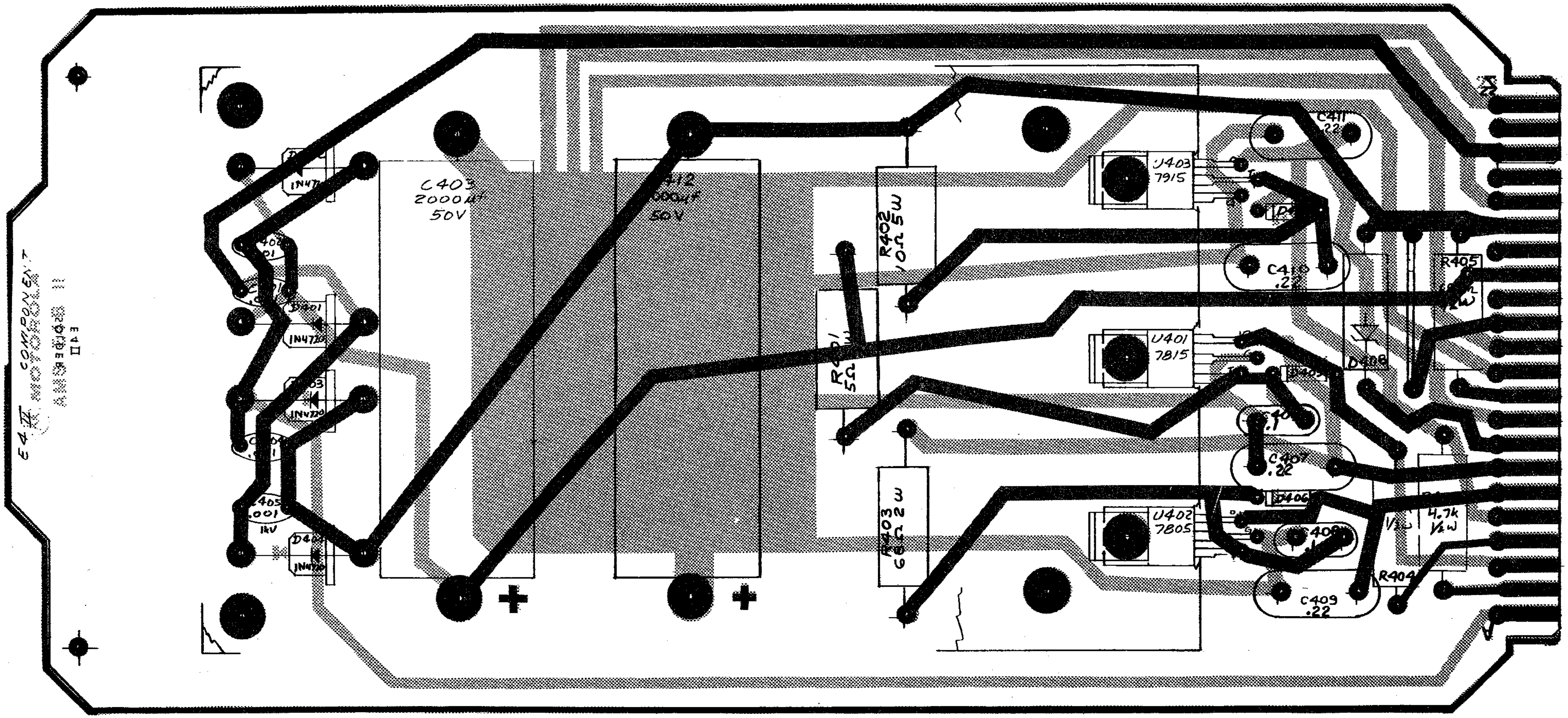


EXCITER AUDIO EQUALIZER MATRIX CIRCUIT CARD E2D-II
COMPONENT VIEW

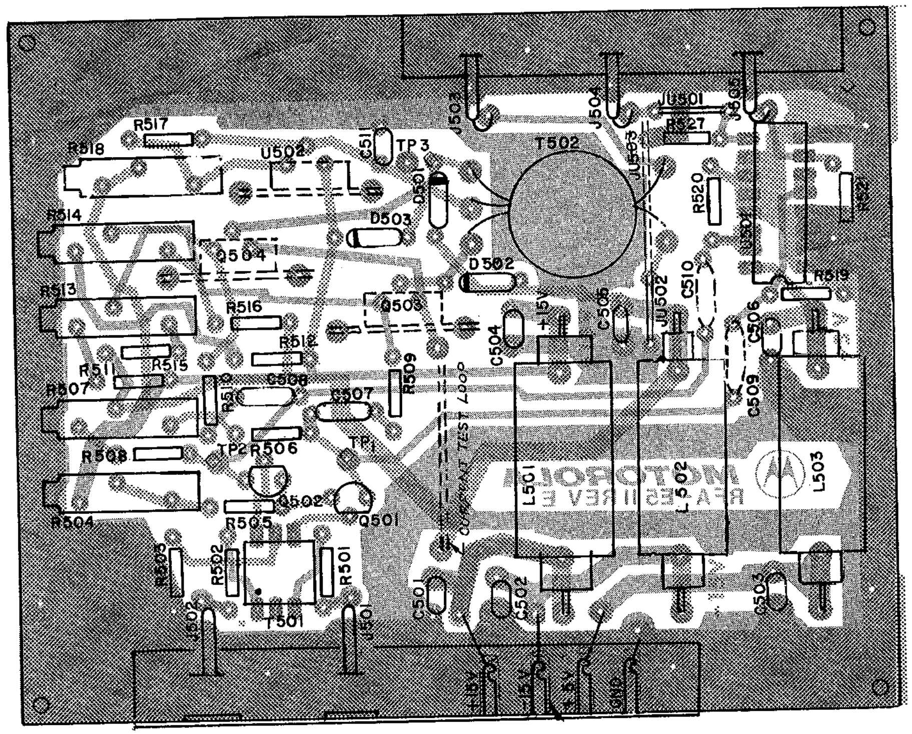


EXCITER L+R AMPLIFIER SAMPLE TRANSMITTER CIRCUIT CARD E3F

COMPONENT VIEW

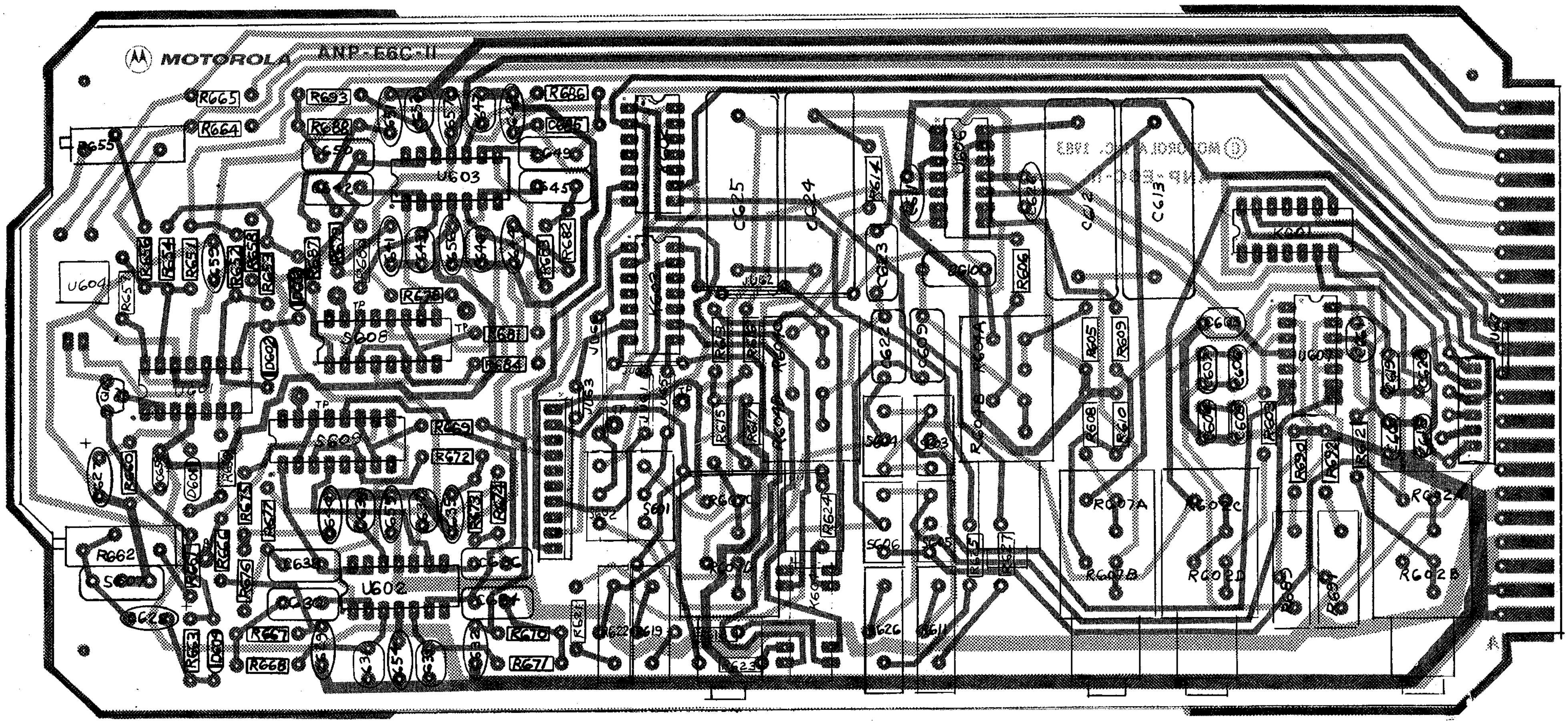


EXCITER POWER SUPPLY CIRCUIT CARD E4B-II
COMPONENT VIEW

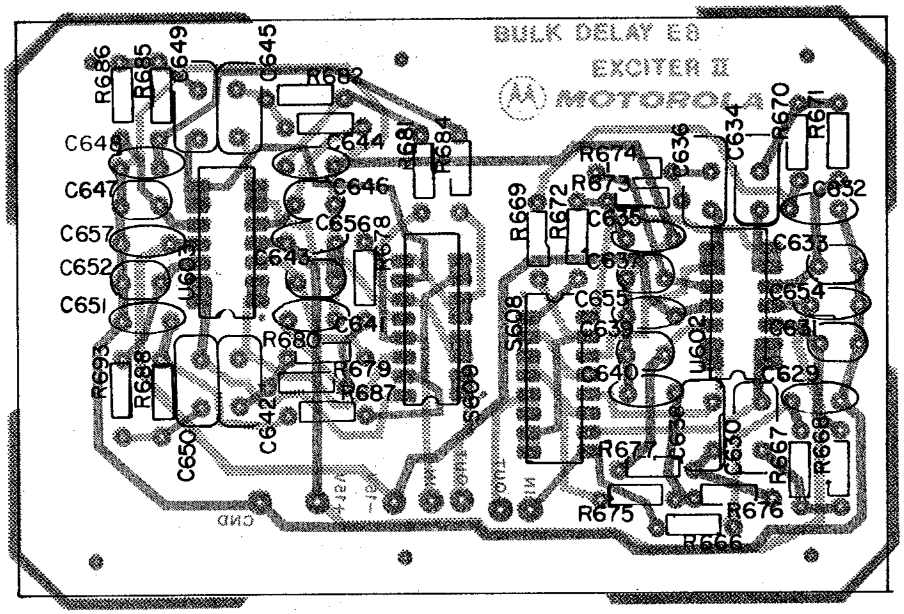


EXCITER R.F. AMPLIFIER CIRCUIT CARD E5E–II

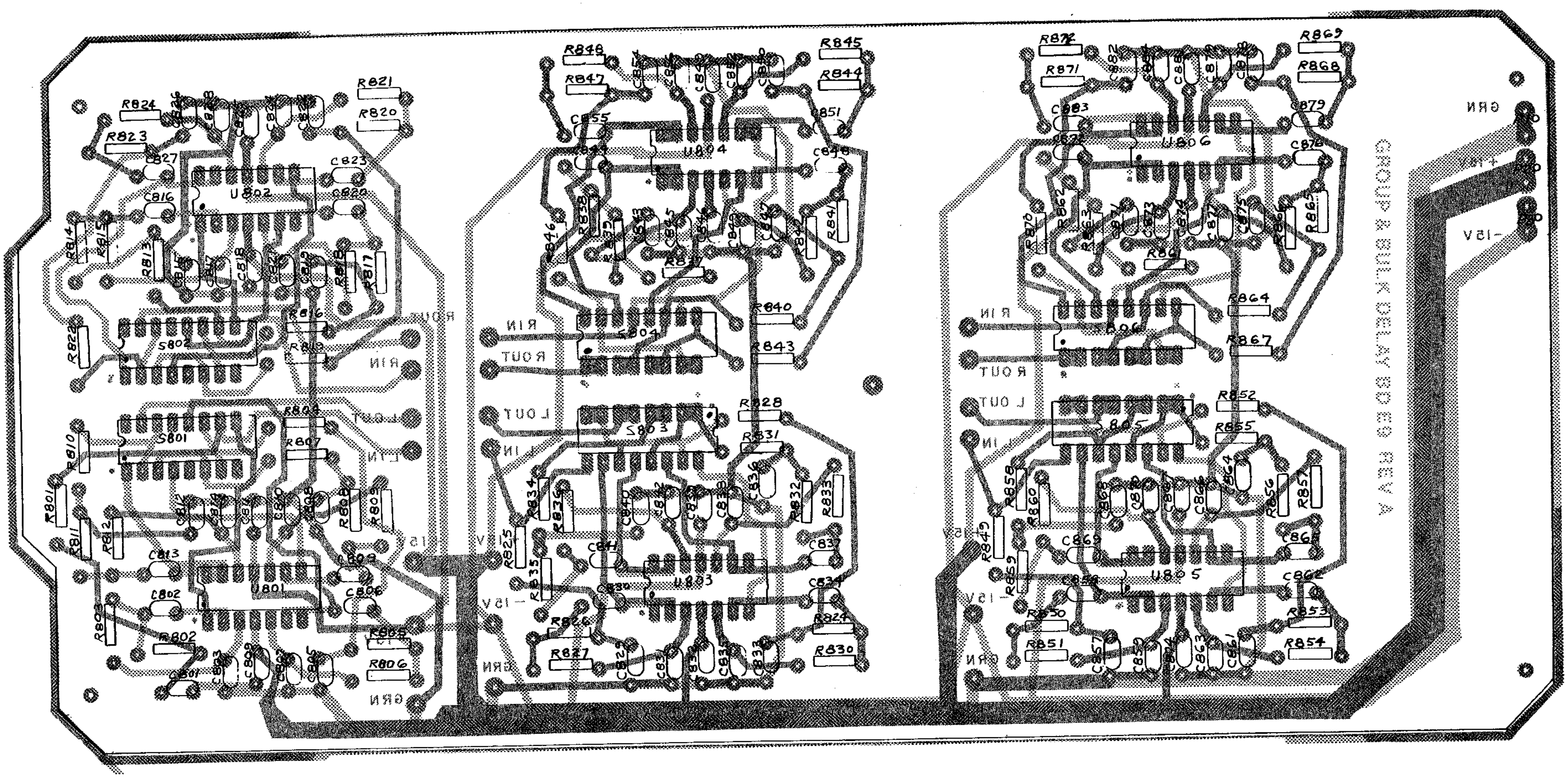
COMPONENT VIEW



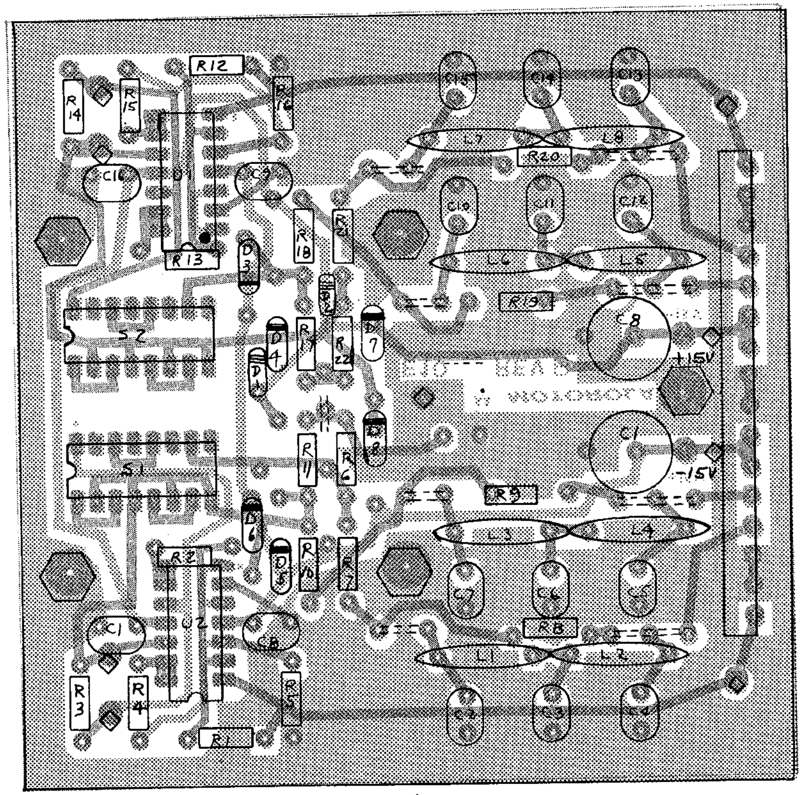
EXCITER AUDIO NIGHT PROCESSOR CIRCUIT CARD E6C-II
COMPONENT VIEW



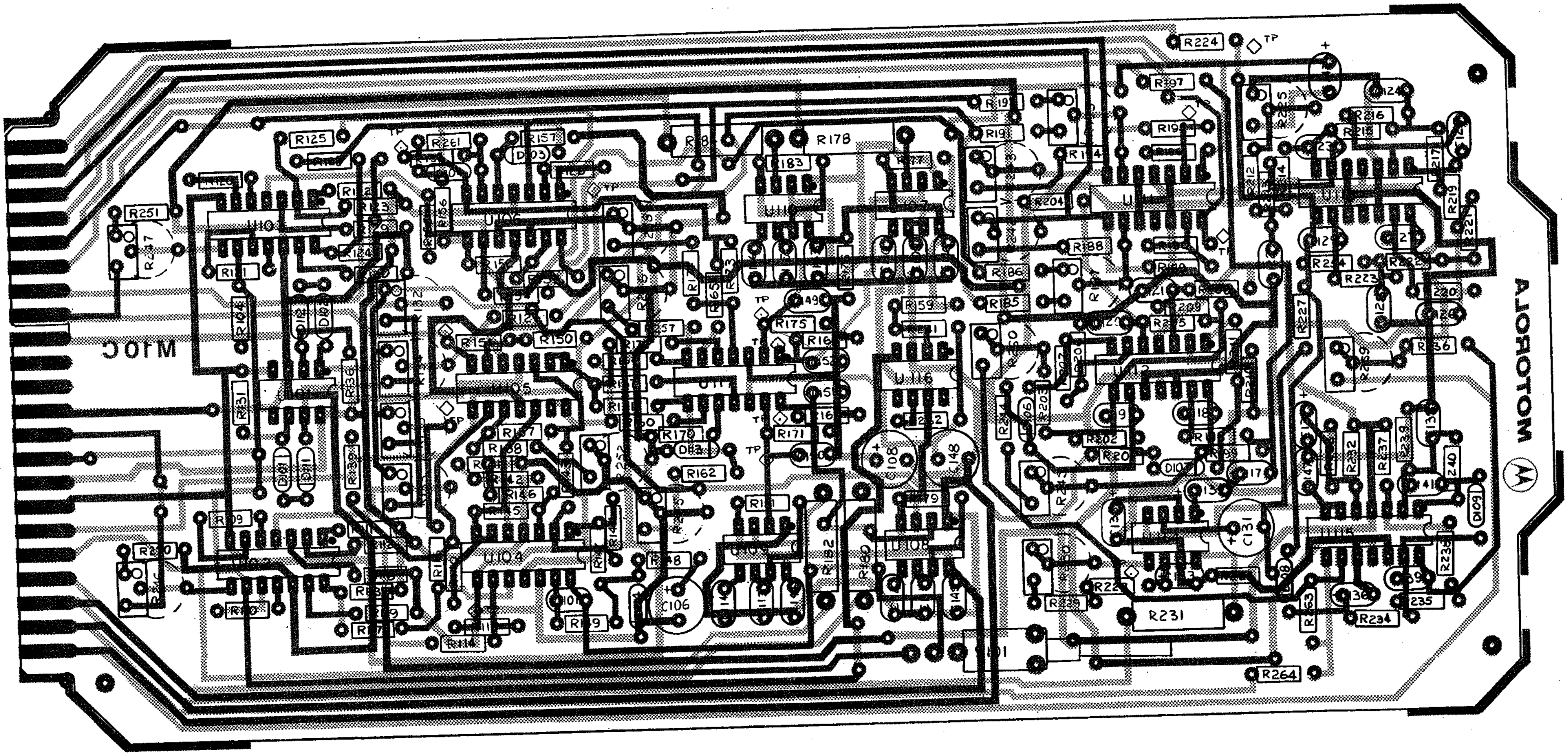
EXCITER BULK DELAY CIRCUIT CARD E8A-II
COMPONENT VIEW



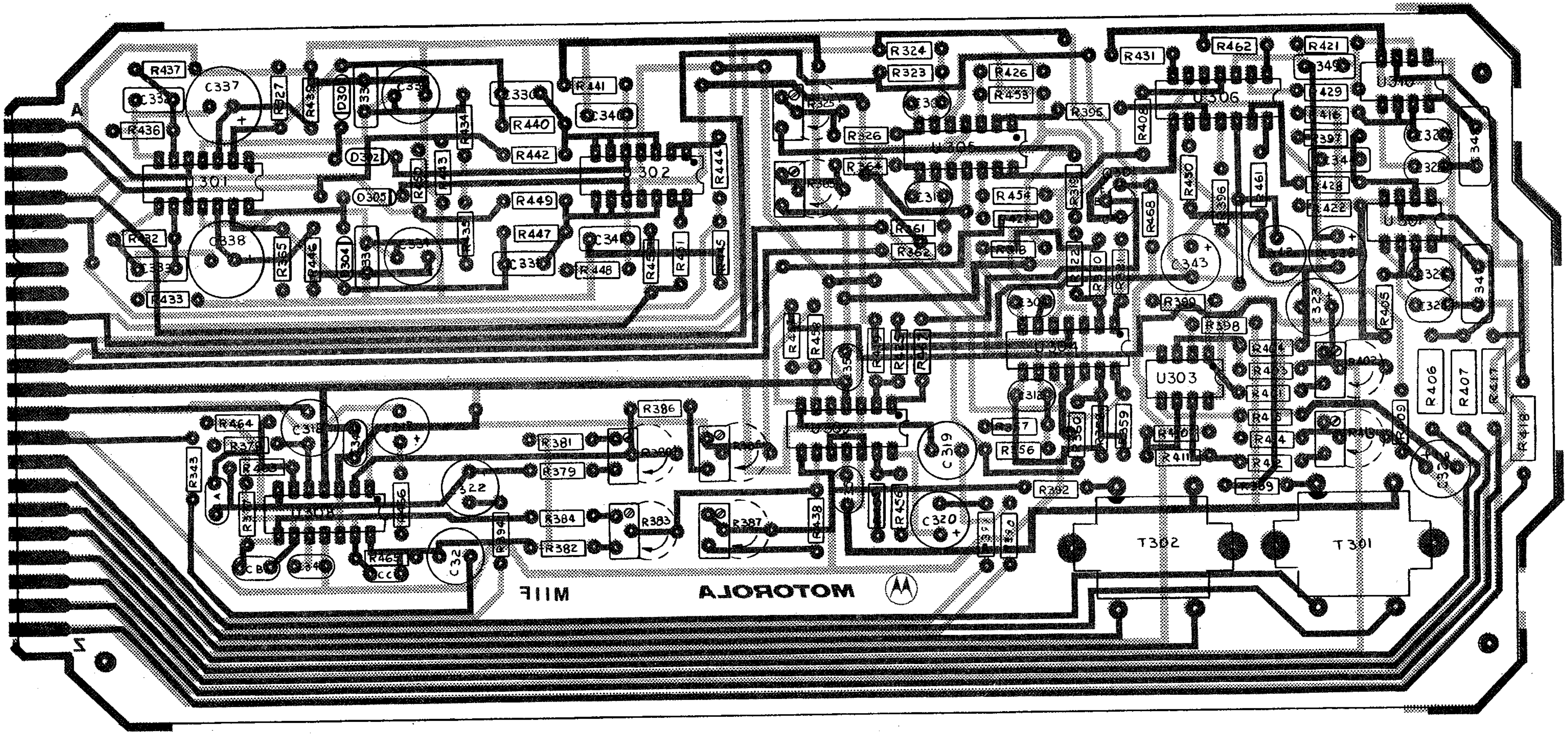
EXCITER BINARY AND BULK DELAY DUAL TRANSMITTER CIRCUIT CARD E9A
COMPONENT VIEW



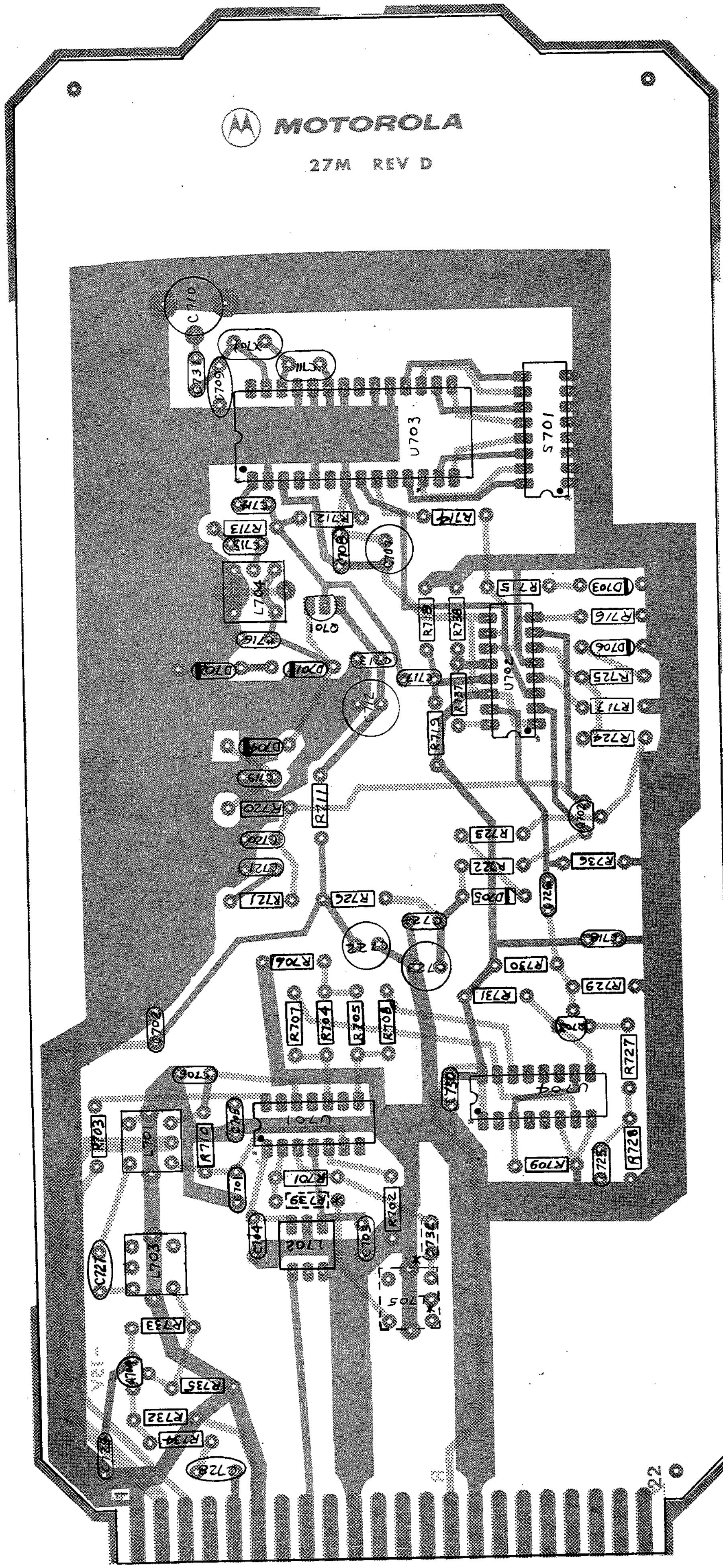
EXCITER AUDIO INTERFACE AMPLIFIER E10B



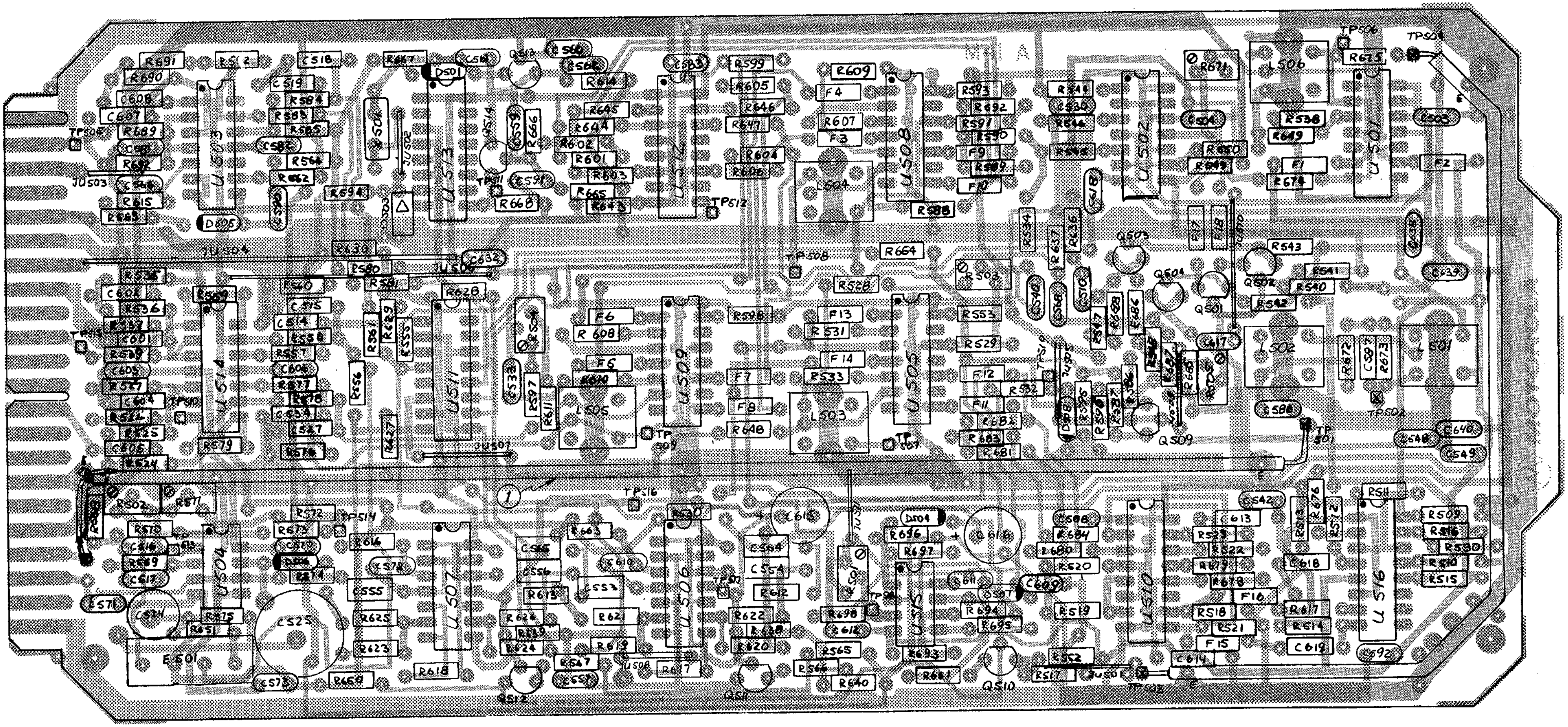
MONITOR AVC CIRCUIT CARD M10C
COMPONENT VIEW



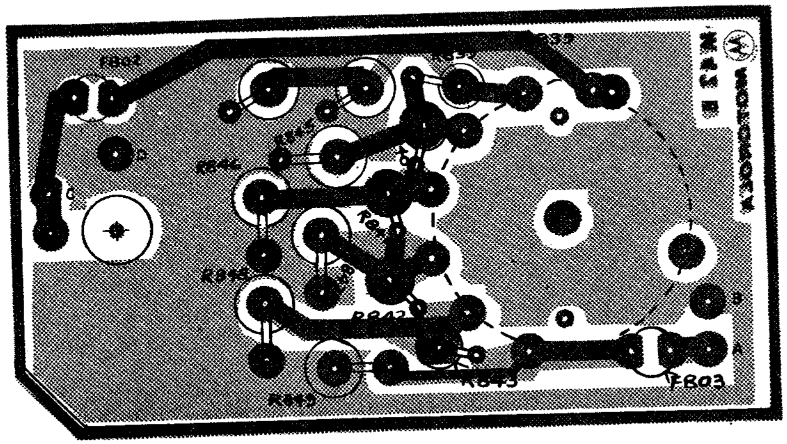
MONITOR METER CIRCUIT CARD M11F
COMPONENT VIEW



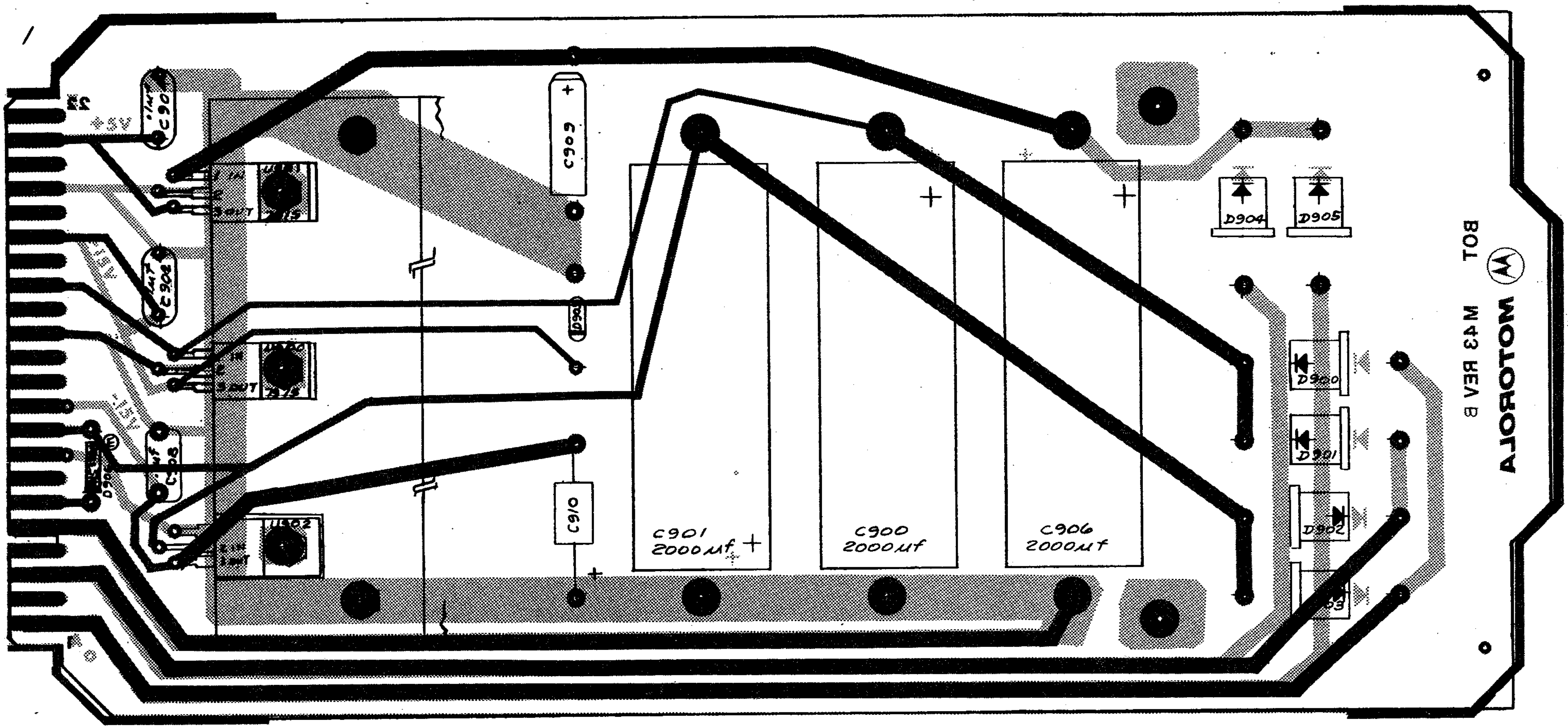
MONITOR MIXER CIRCUIT CARD M27D
COMPONENT VIEW



MONITOR DECODER CIRCUIT CARD M41A
COMPONENT VIEW



MONITOR RF ATTENUATOR CIRCUIT CARD M42B
COMPONENT VIEW



MONITOR POWER SUPPLY CIRCUIT CARD M43B
COMPONENT VIEW

EXCITER HOUSING CABLING E2-A-0

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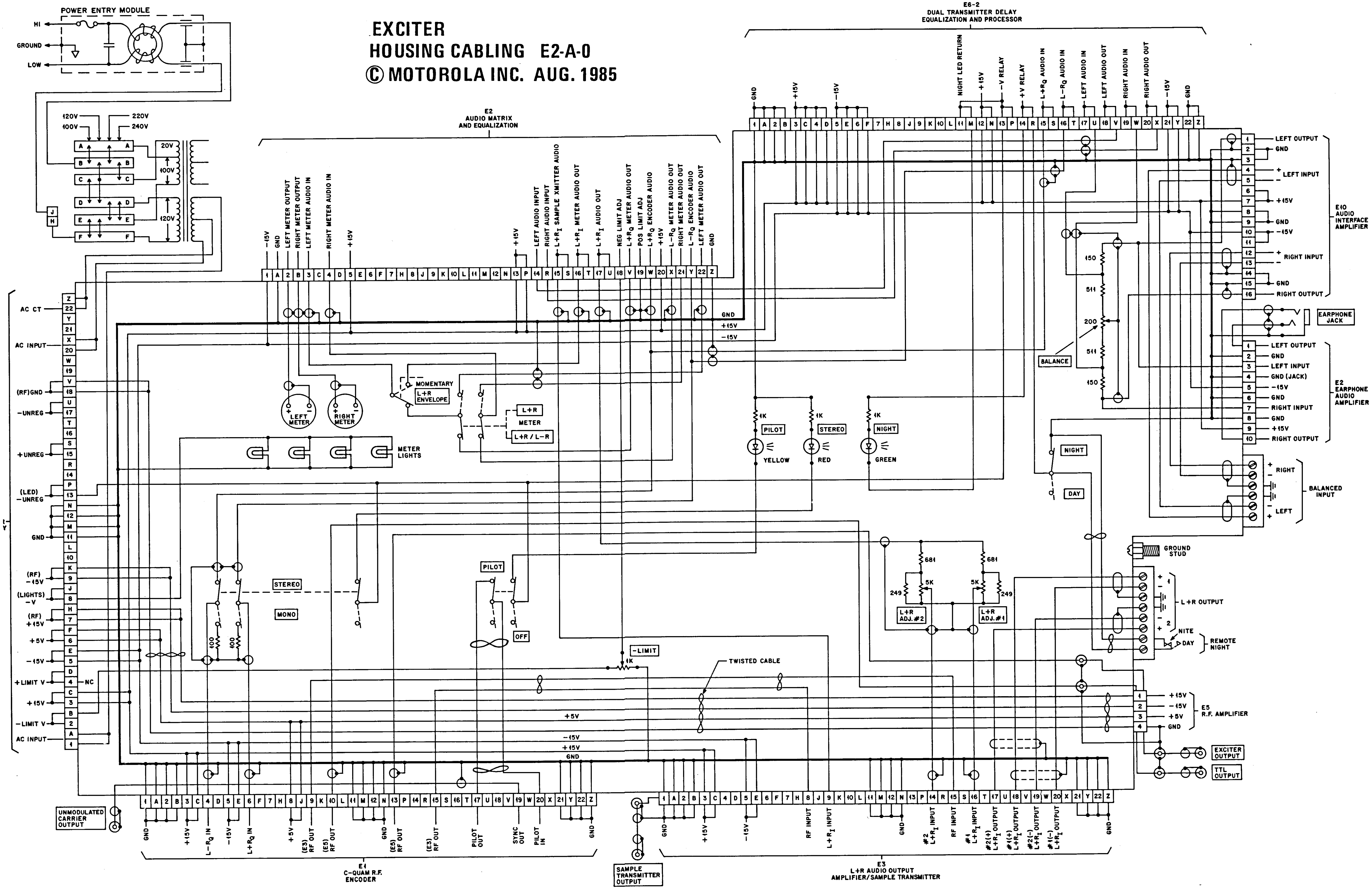
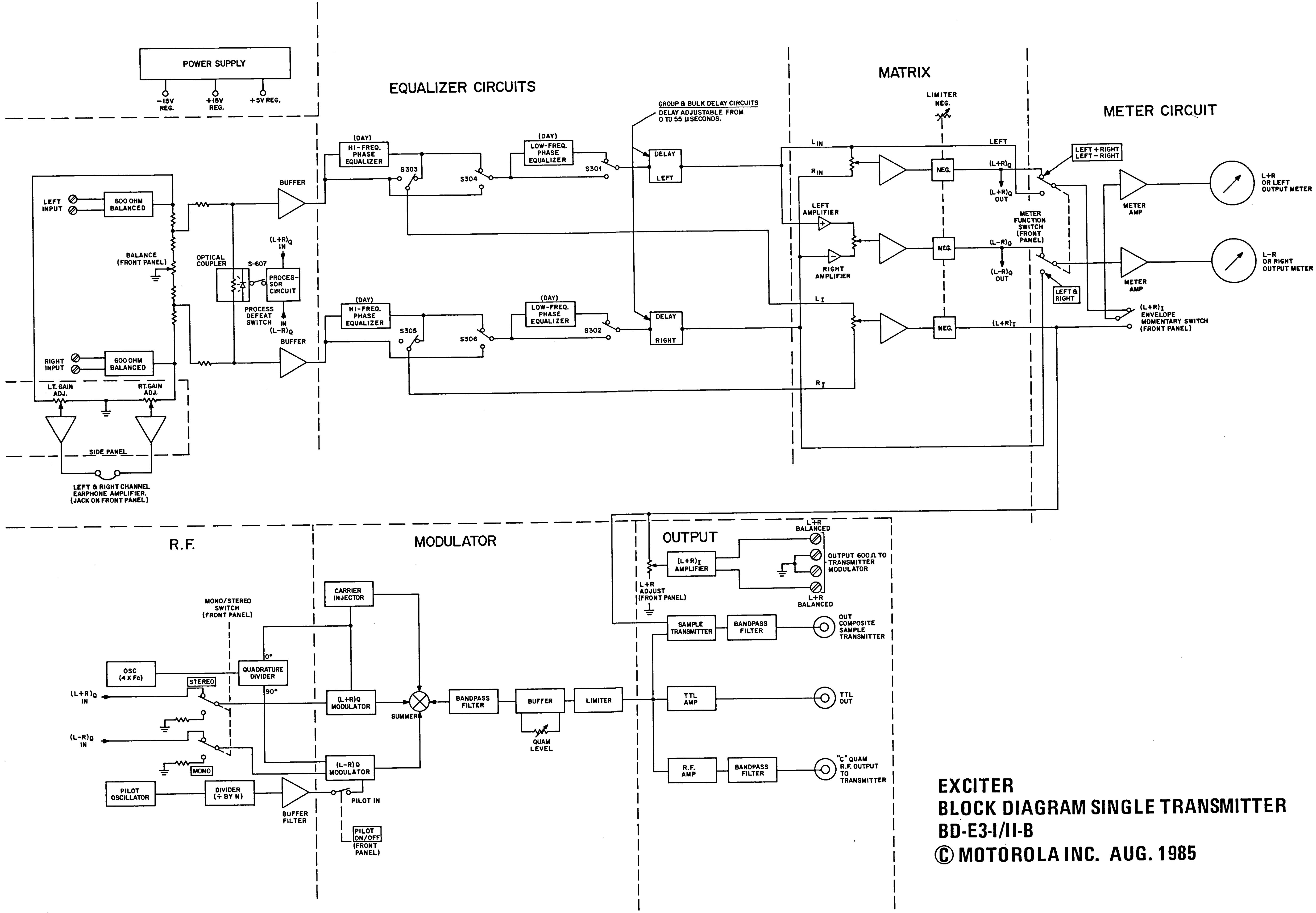
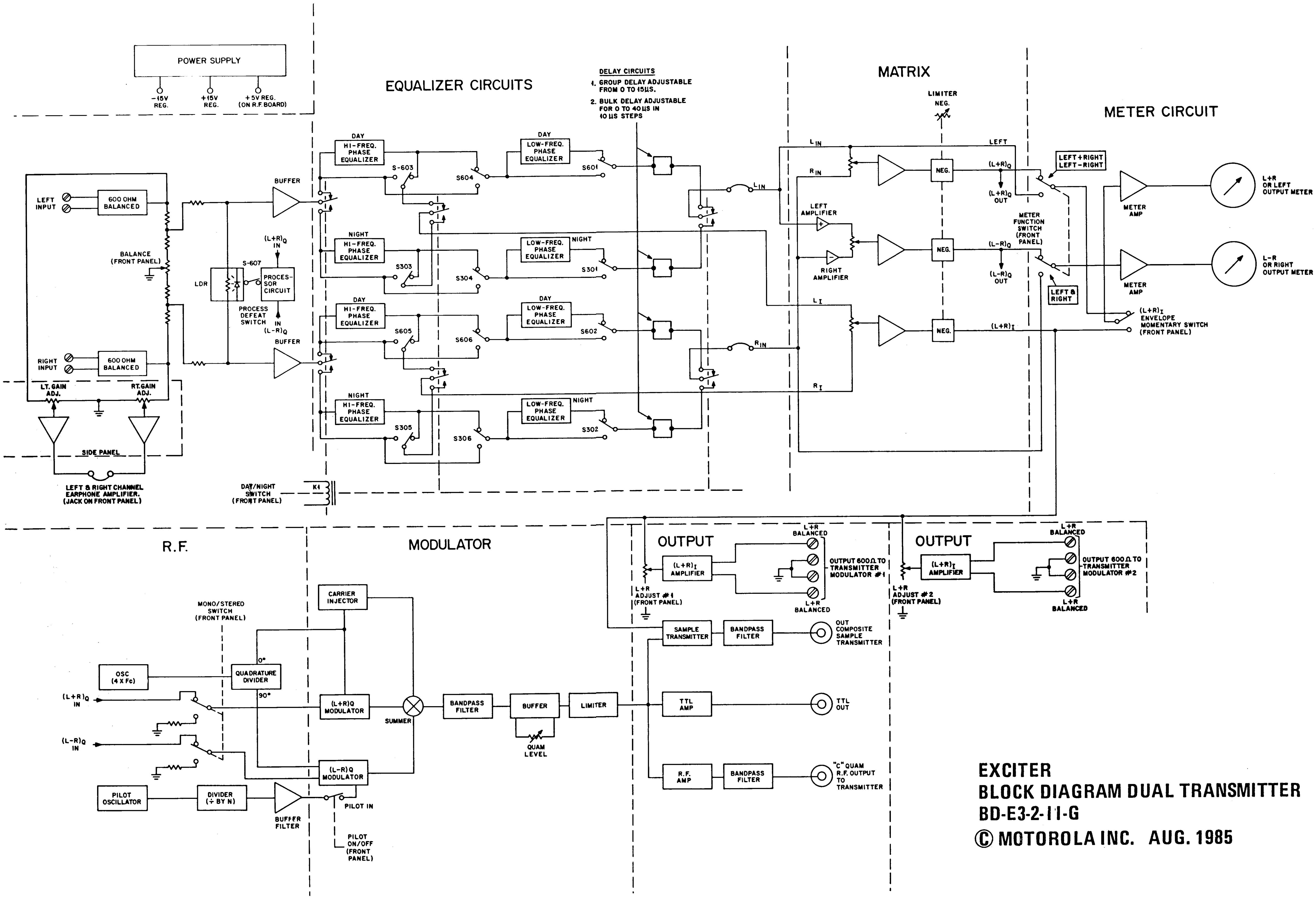
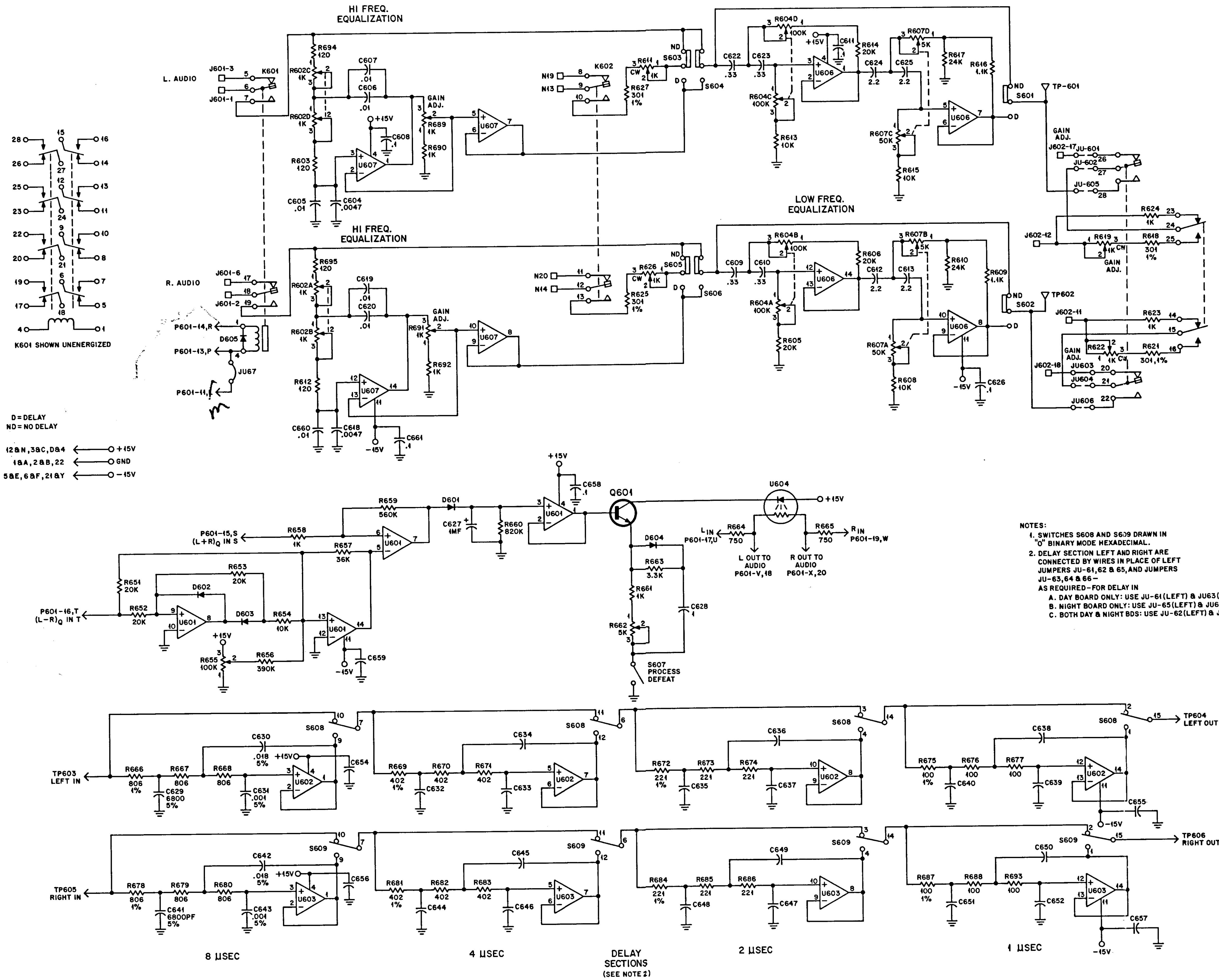




EXCITER
BLOCK DIAGRAM SINGLE TRANSMITTER
BD-E3-I/II-B
© MOTOROLA INC. AUG. 1985



EXCITER
BLOCK DIAGRAM DUAL TRANSMITTER
BD-E3-2-11-G
© MOTOROLA INC. AUG. 1985



NOTES:
1. SWITCHES S608 AND S609 DRAWN IN "0" BINARY MODE HEXADECIMAL.
2. DELAY SECTION LEFT AND RIGHT ARE CONNECTED BY WIRES IN PLACE OF LEFT JUMPERS JU-61,62 & 65, AND JUMPERS JU-63,64 & 66 — AS REQUIRED—FOR DELAY IN
   A. DAY BOARD ONLY: USE JU-61(LEFT) & JU63(RIGHT)
   B. NIGHT BOARD ONLY: USE JU-65(LEFT) & JU66(RIGHT)
   C. BOTH DAY & NIGHT BDS: USE JU-62(LEFT) & JU64(RIGHT)

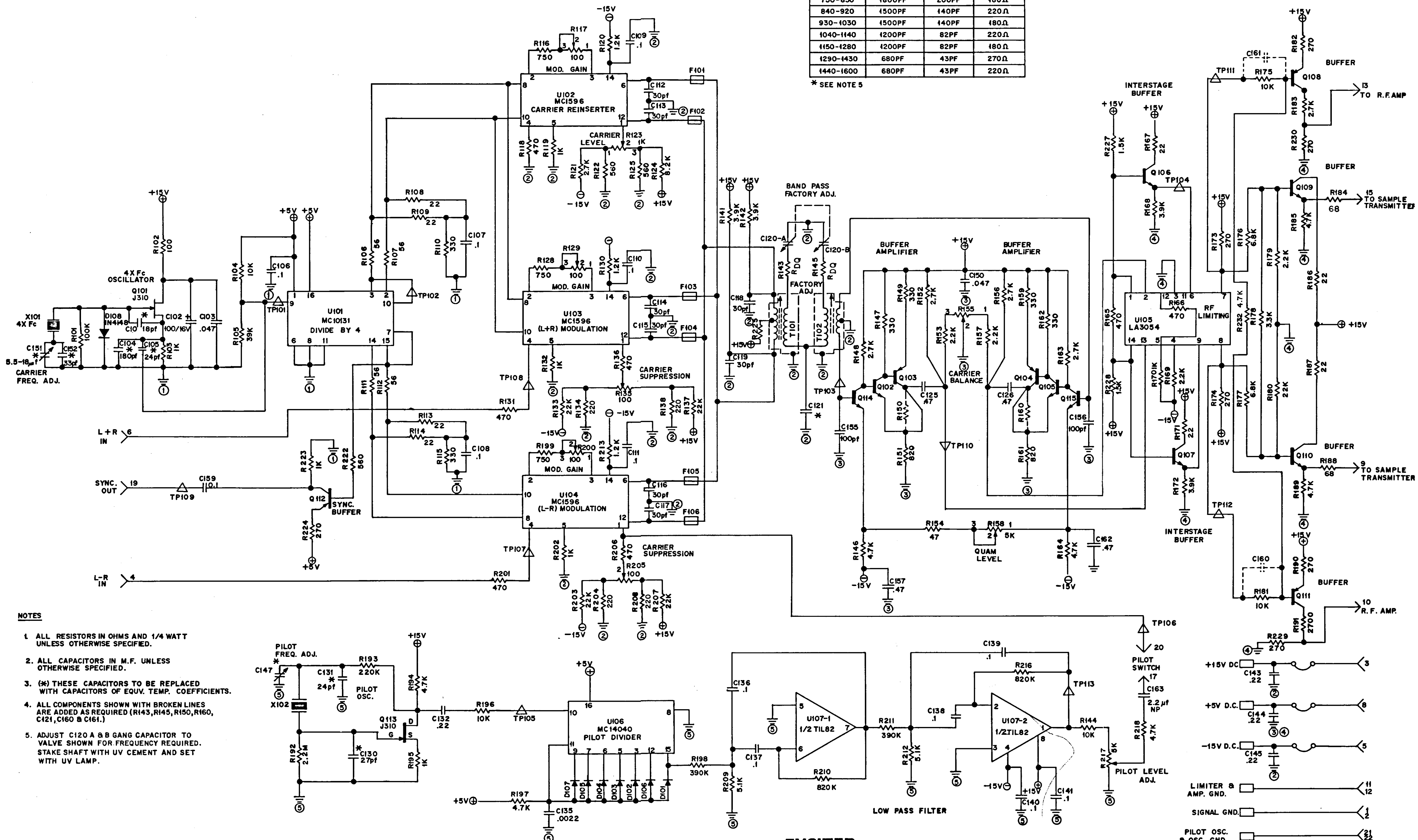
EXCITER
DUAL TRANSMITTER
DELAY
EQUALIZATION
& PROCESSOR
SC-E6-2-11-M

AUG. 1985

COMPONENT SELECTION TABLE

FREQUENCY	C121	ADJUST DUAL CAP. C120 A&B	R143, R145
540-590	2200PF	330PF	220Ω
600-660	2200PF	330PF	180Ω
670-740	1800PF	200PF	220Ω
750-830	1800PF	200PF	180Ω
840-920	1500PF	140PF	220Ω
930-1030	1500PF	140PF	180Ω
1040-1140	1200PF	82PF	220Ω
1150-1280	1200PF	82PF	180Ω
1290-1430	680PF	43PF	270Ω
1440-1600	680PF	43PF	220Ω

* SEE NOTE 5

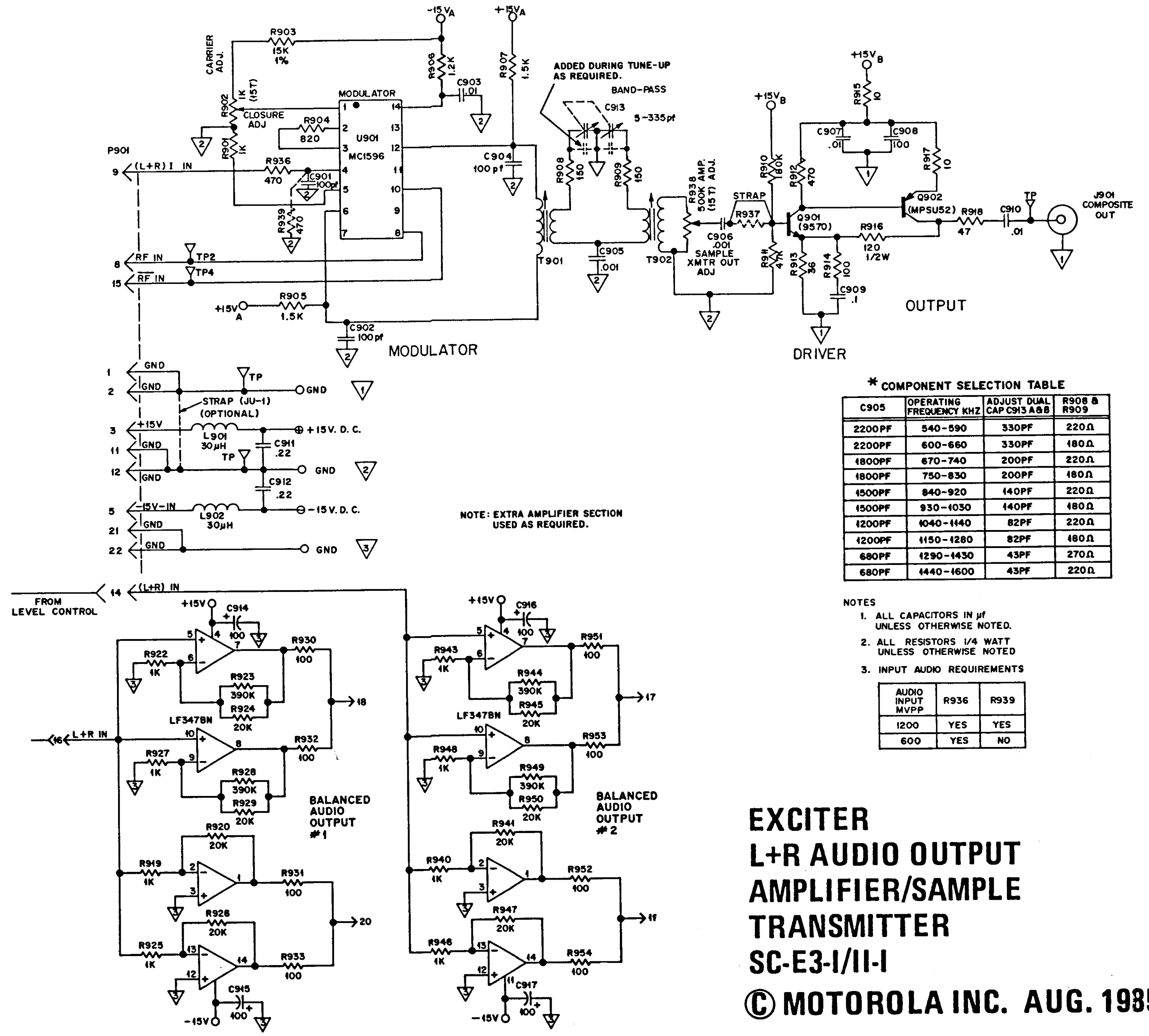


NOTES

1. ALL RESISTORS IN OHMS AND 1/4 WATT UNLESS OTHERWISE SPECIFIED.
2. ALL CAPACITORS IN M.F. UNLESS OTHERWISE SPECIFIED.
3. (*) THESE CAPACITORS TO BE REPLACED WITH CAPACITORS OF EQUV. TEMP. COEFFICIENTS.
4. ALL COMPONENTS SHOWN WITH BROKEN LINES ARE ADDED AS REQUIRED (R143, R145, R150, R160, C121, C160 & C161.)
5. ADJUST C120 A & B GANG CAPACITOR TO VALVE SHOWN FOR FREQUENCY REQUIRED. STAKE SHAFT WITH UV CEMENT AND SET WITH UV LAMP.

EXCITER

C-QUAM R.F. ENCODER SC-E1-I/II-T



* COMPONENT SELECTION TABLE

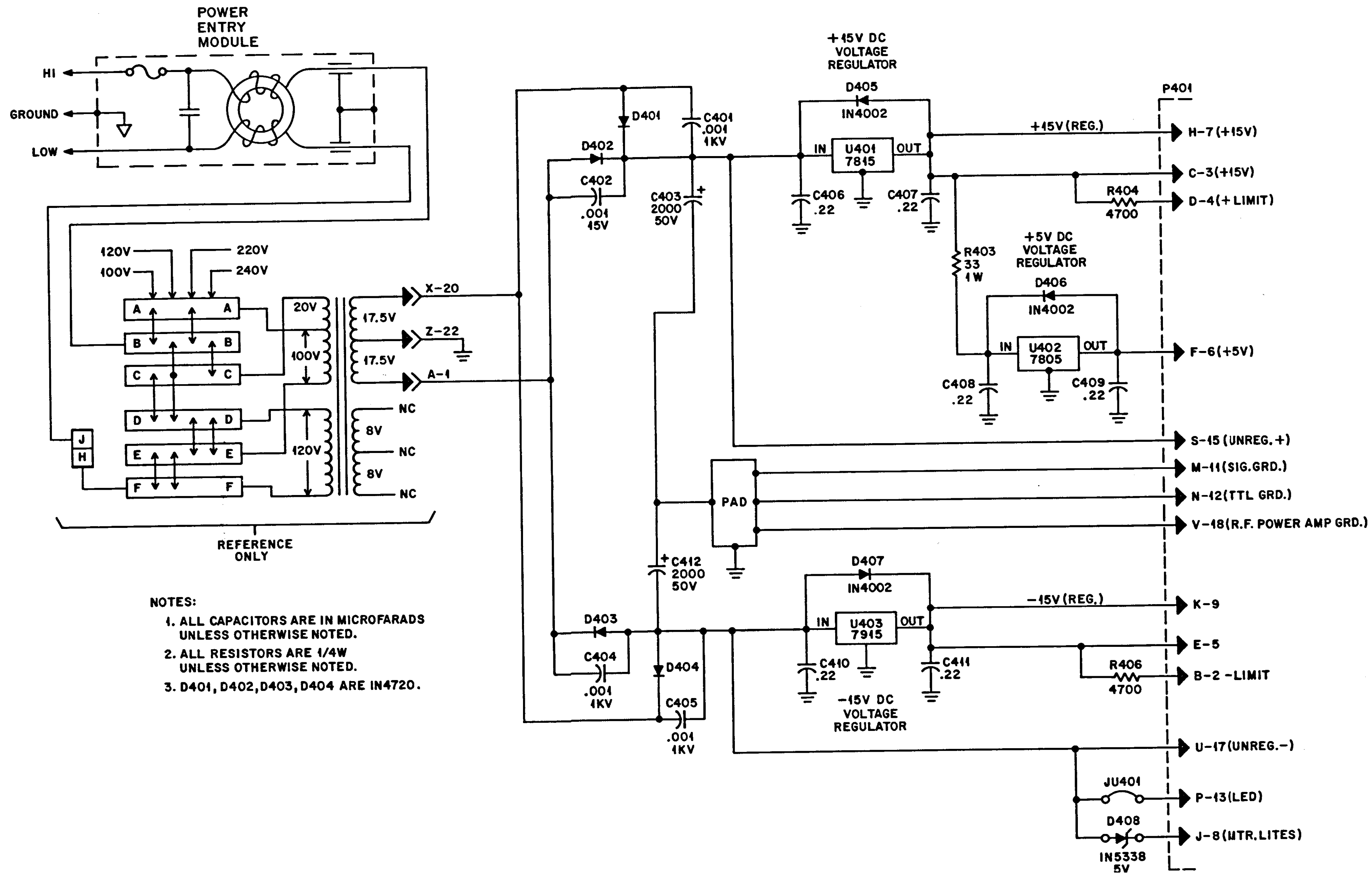
C905	OPERATING FREQUENCY KHZ	ADJUST DUAL CAP C913 A&B	R908 & R909
2200PF	540-590	330PF	220Ω
2200PF	600-660	330PF	180Ω
1800PF	670-740	200PF	220Ω
1800PF	750-830	200PF	180Ω
1500PF	840-920	140PF	220Ω
1500PF	930-1030	140PF	180Ω
1200PF	1040-1140	82PF	220Ω
1200PF	1150-1280	82PF	180Ω
680PF	1290-1430	43PF	270Ω
680PF	1440-1600	43PF	220Ω

NOTES

1. ALL CAPACITORS IN μf UNLESS OTHERWISE NOTED.
2. ALL RESISTORS 1/4 WATT UNLESS OTHERWISE NOTED
3. INPUT AUDIO REQUIREMENTS

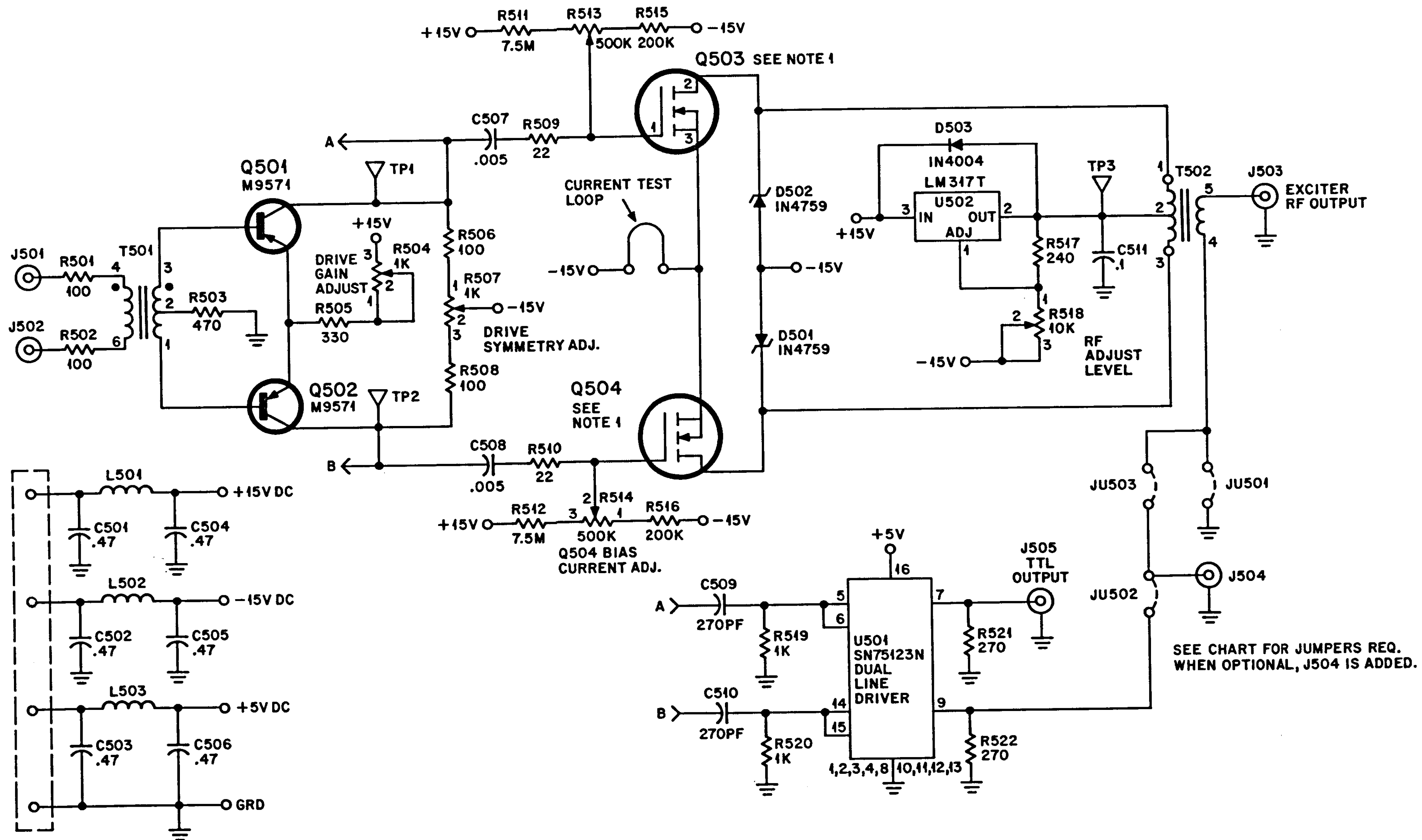
AUDIO INPUT MVPP	R936	R939
1200	YES	YES
600	YES	NO

EXCITER
L+R AUDIO OUTPUT AMPLIFIER/SAMPLE TRANSMITTER
SC-E3-I/II-I



NOTES:
1. ALL CAPACITORS ARE IN MICROFARADS UNLESS OTHERWISE NOTED.
2. ALL RESISTORS ARE 1/4W UNLESS OTHERWISE NOTED.
3. D401, D402, D403, D404 ARE 1N4720.

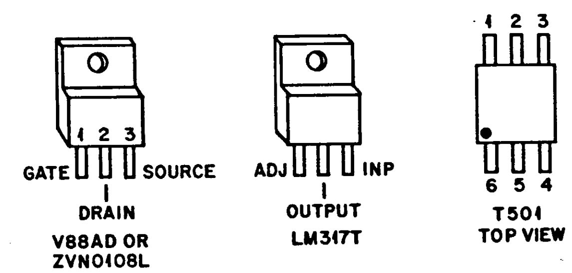
EXCITER
POWER SUPPLY
SC-E4-II-G



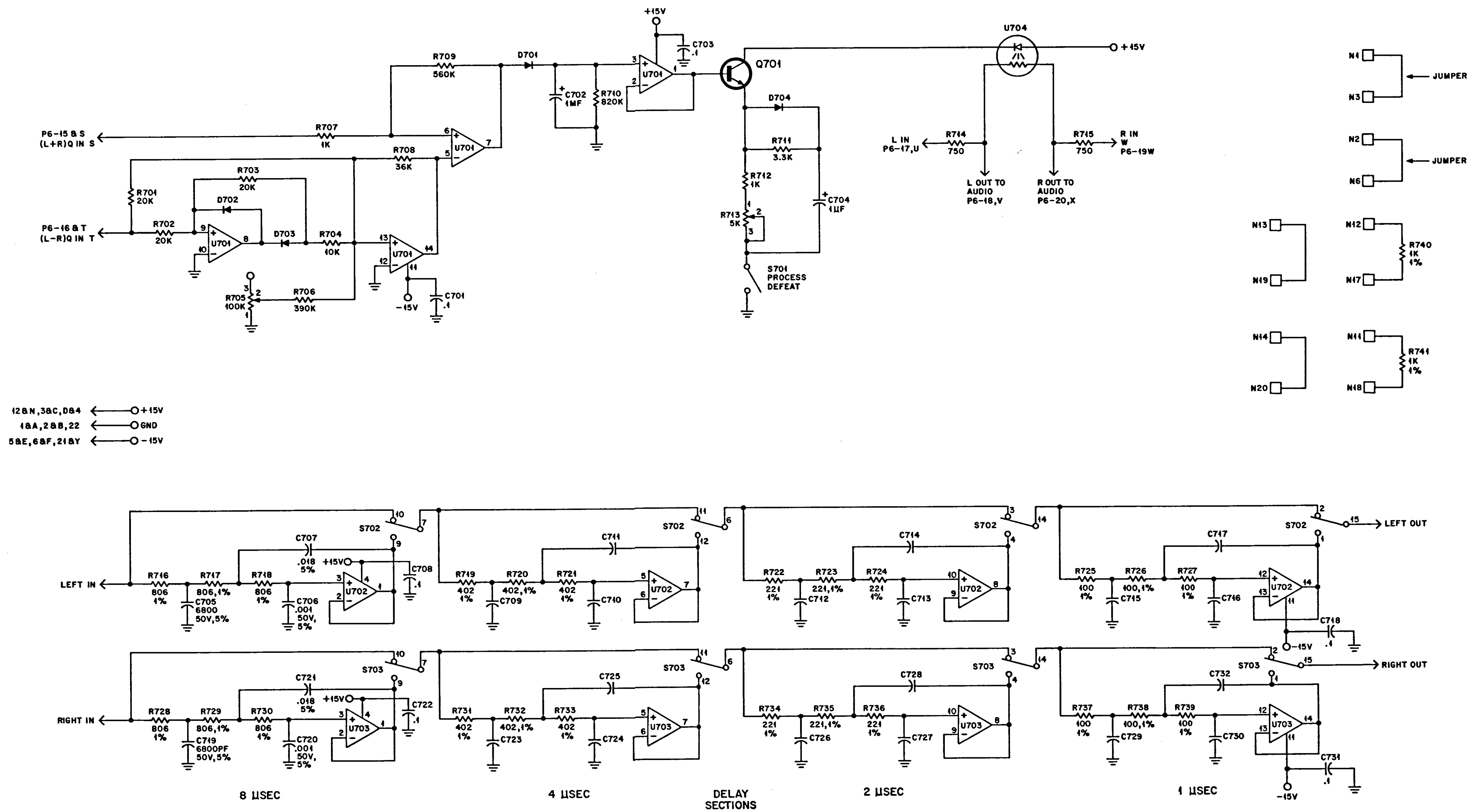
NOTE:

1. Q503 & Q504 MAY BE EITHER TWO SILICONIX VN88AD OR TWO FERRANTI ZVN0108L N-CHANNEL MOS FETS.

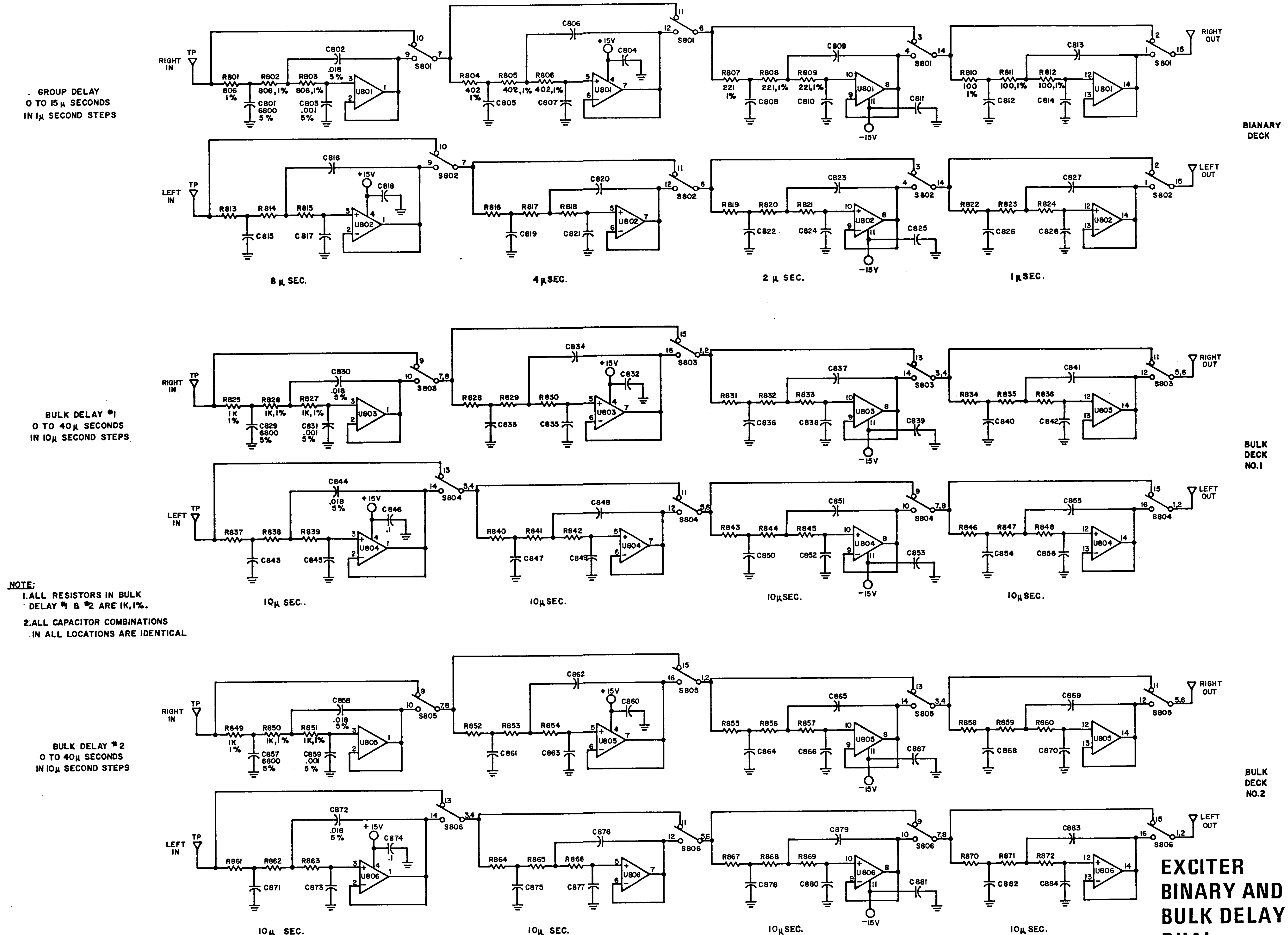
	BALANCED RF OUTPUT	COMPLIMENTARY TTL OUTPUT
JU501 NORMALLY INSTALLED	REMOVE	USE
JU502		ADD
JU503	ADD	



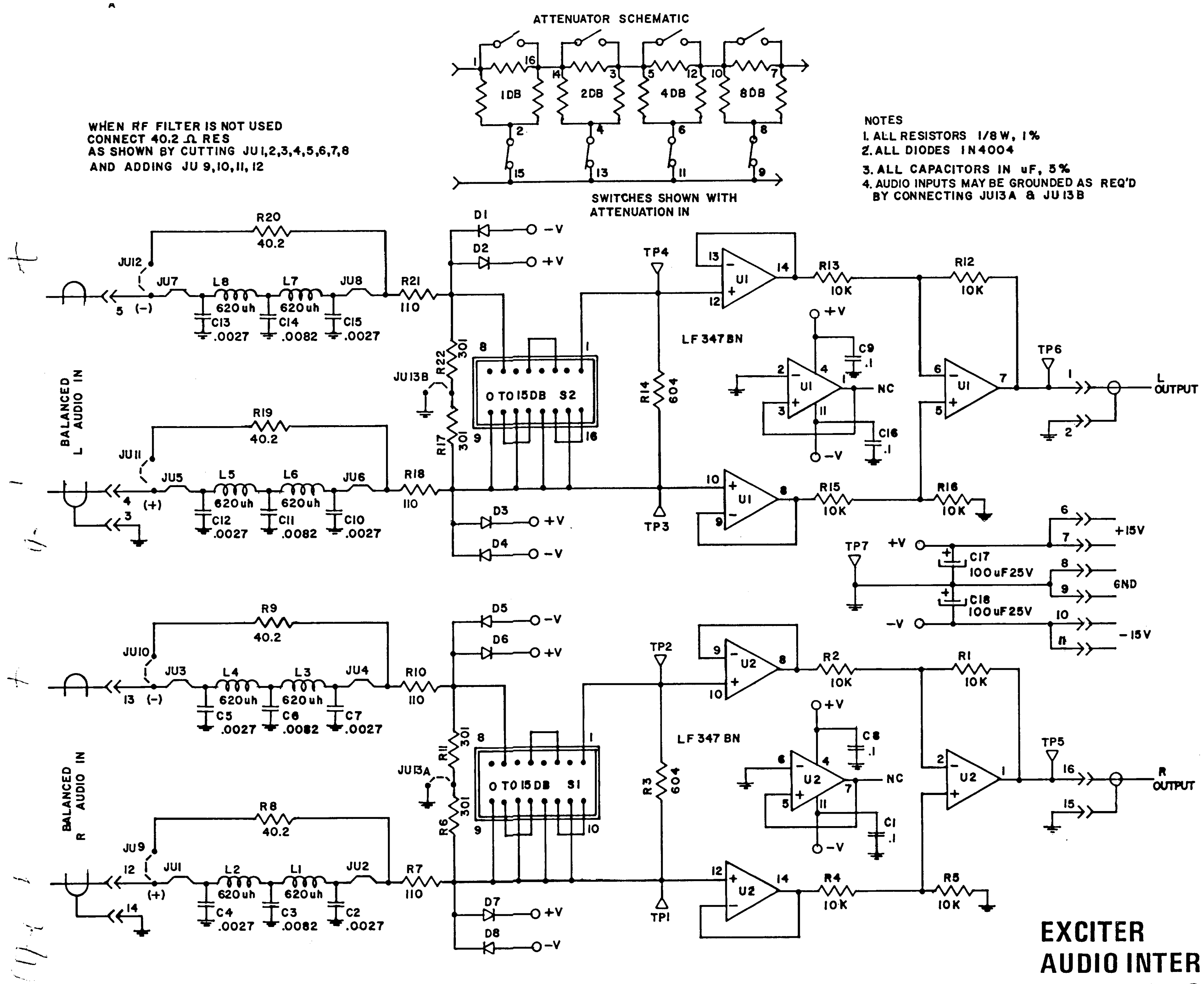
EXCITER
R.F. AMPLIFIER SC-E5-2-I/II-E



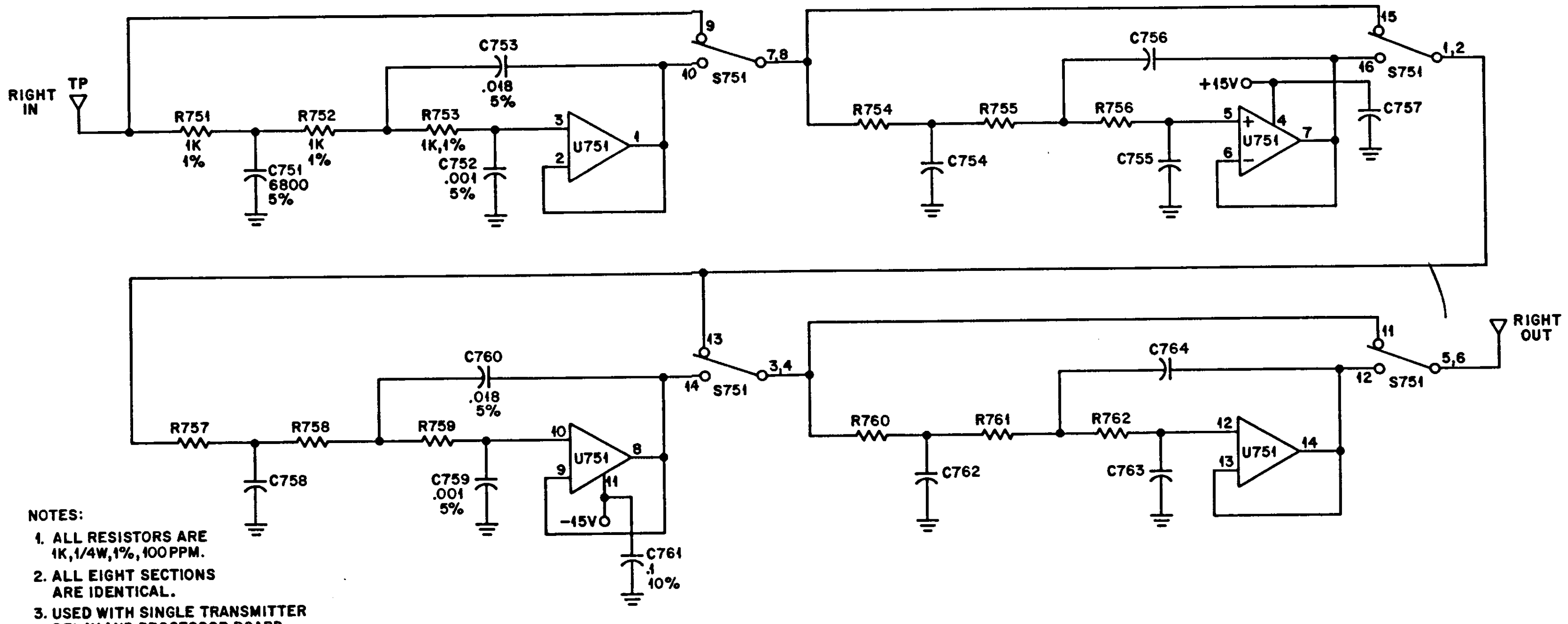
EXCITER
SINGLE TRANSMITTER DELAY AND PROCESSOR
SC-E6-I/II-A



EXCITER
BINARY AND
BULK DELAY
DUAL
TRANSMITTER
SC-E9-II-B

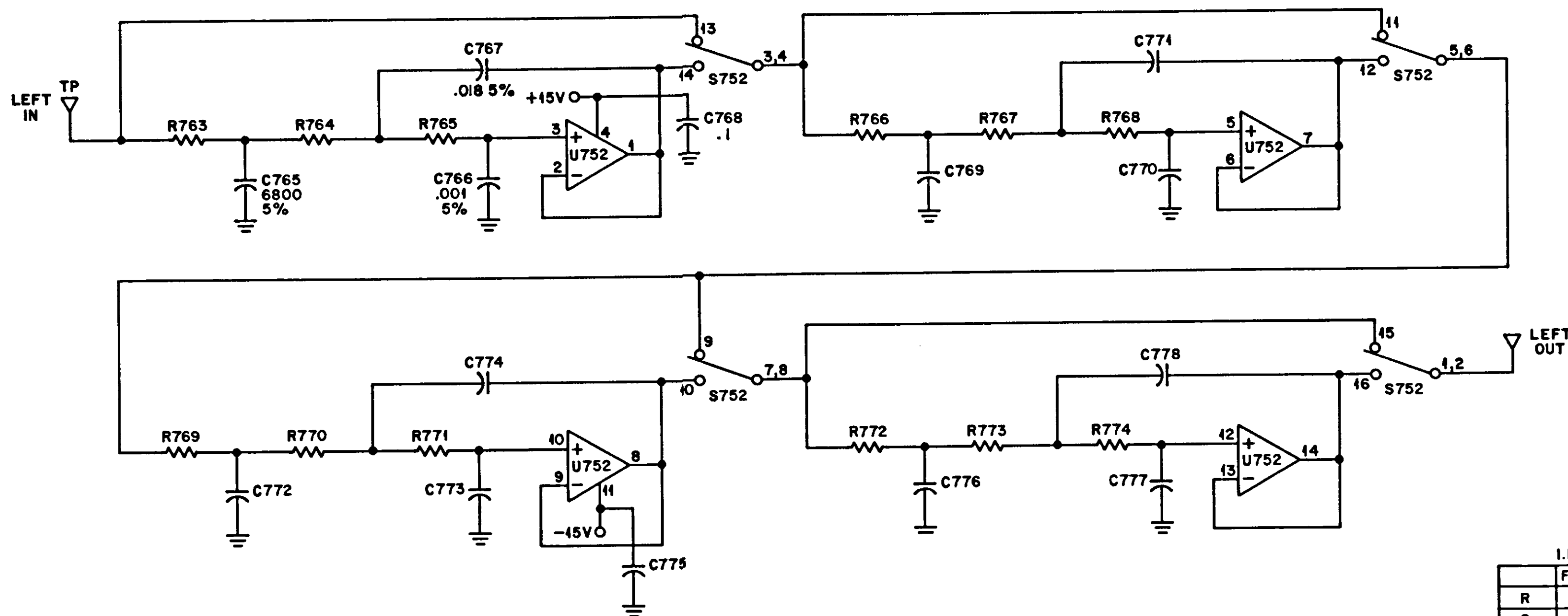


EXCITER
AUDIO INTERFACE
AMPLIFIER SC-E10-B



NOTES:

1. ALL RESISTORS ARE 1K,1/4W,1%,100PPM.
2. ALL EIGHT SECTIONS ARE IDENTICAL.
3. USED WITH SINGLE TRANSMITTER DELAY AND PROCESSOR BOARD.



I.D. REF	FIRST	LAST
R	751	774
C	751	778
U	751	752
S	751	752

EXCITER
BULK DELAY SINGLE TRANSMITTER
SC-E8-II-C

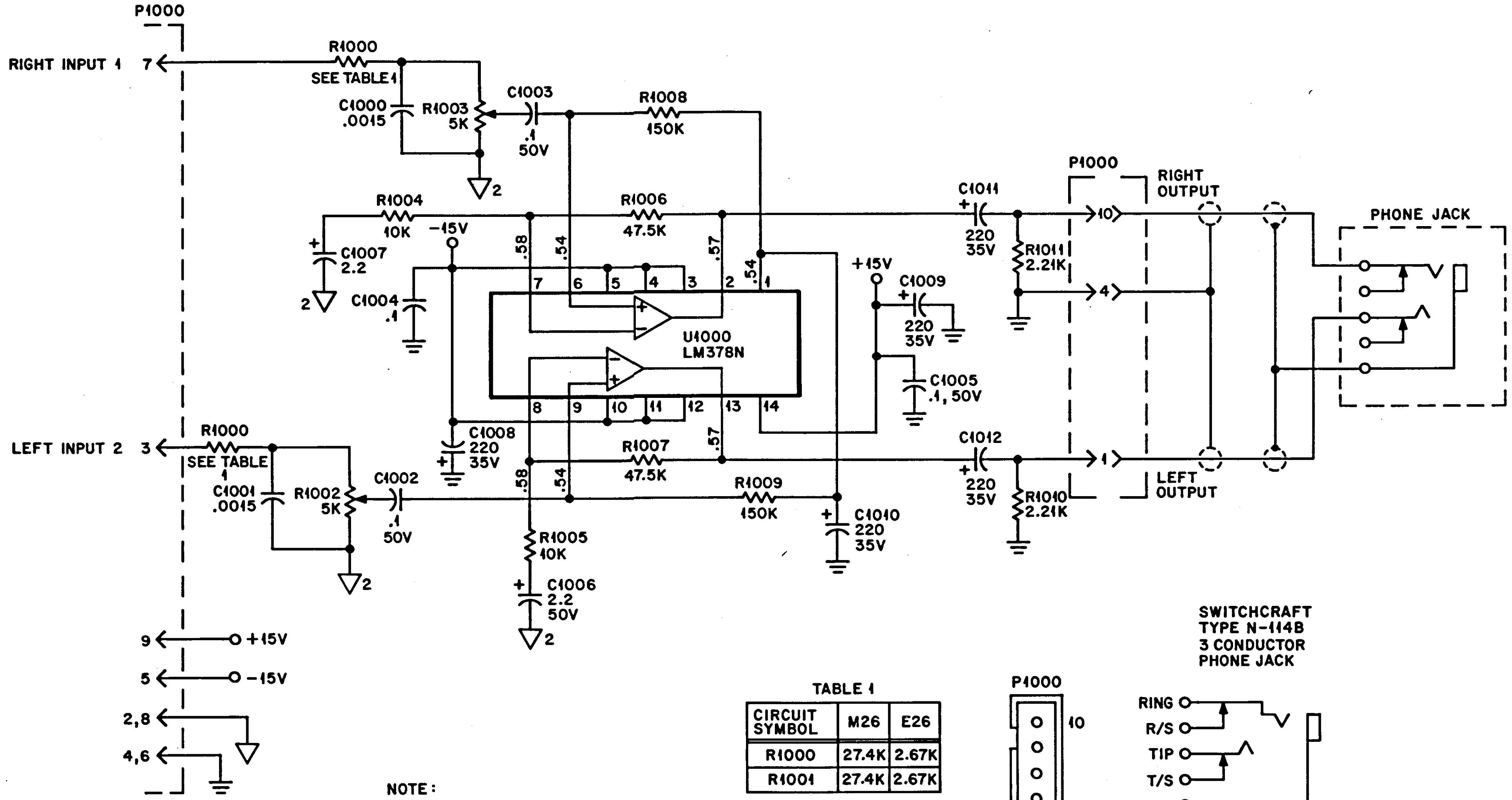
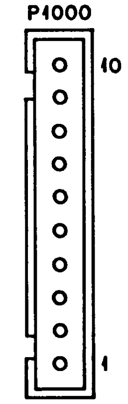


TABLE 1

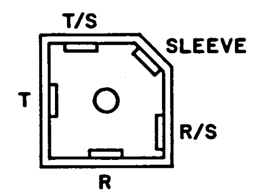
CIRCUIT SYMBOL	M26	E26
R1000	27.4K	2.67K
R1001	27.4K	2.67K

NOTE:
1. ALL RESISTORS ARE 1%
2. L1000 & L1001 ARE INDUCTOR, FILTER, TRANSIENT SUPPRESSORS MOTOROLA P/N 24PD1001



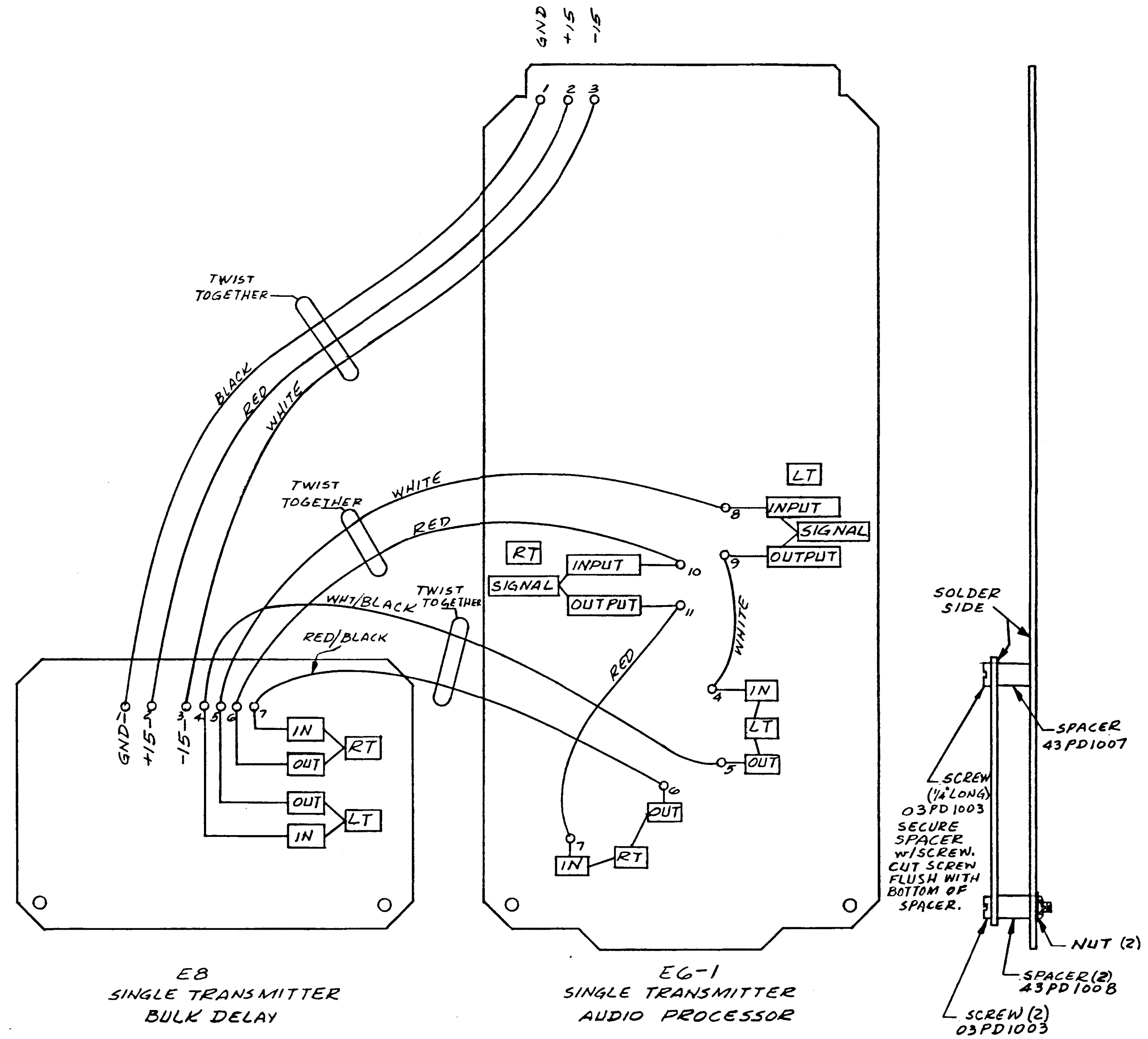
SWITCHCRAFT TYPE N-114B 3 CONDUCTOR PHONE JACK

RING
R/S
TIP
T/S
SLEEVE

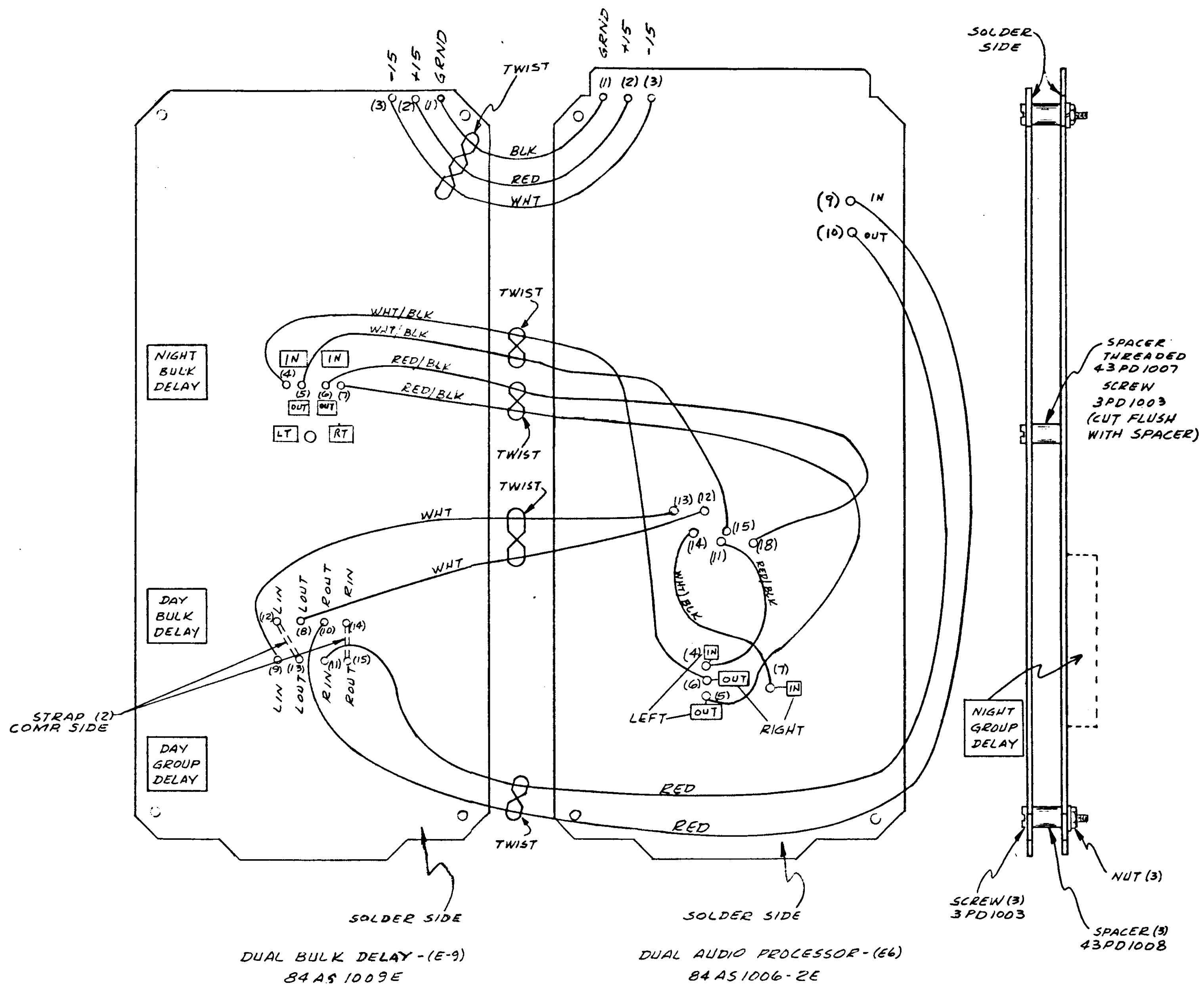


PHONE JACK REAR VIEW J-816

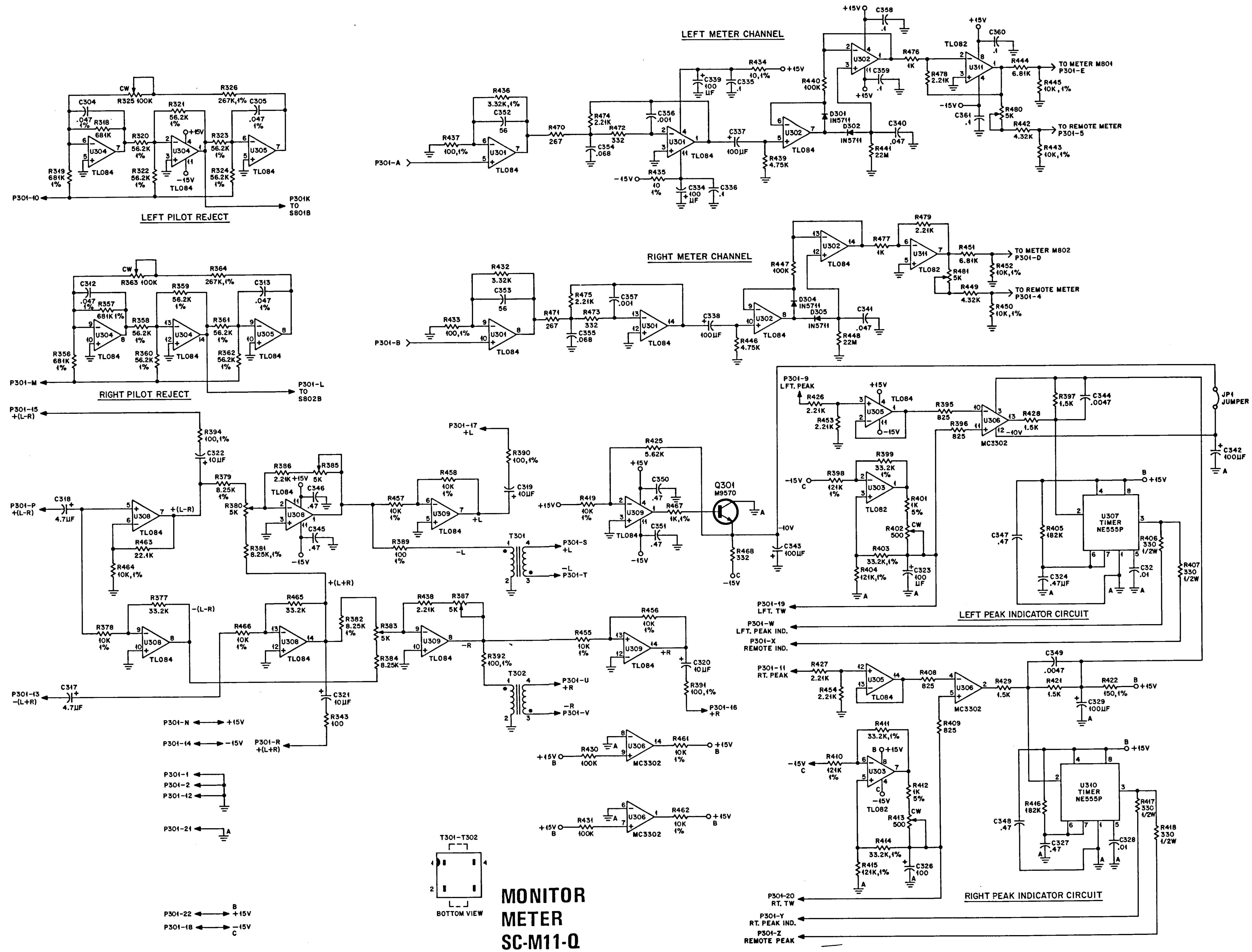
EXCITER/MONITOR EARPHONE AUDIO AMPLIFIER SC-E26-A



EXCITER
INTERCONNECT DELAY/PROCESSOR SINGLE TRANSMITTER
IC-E6/E8-II-A

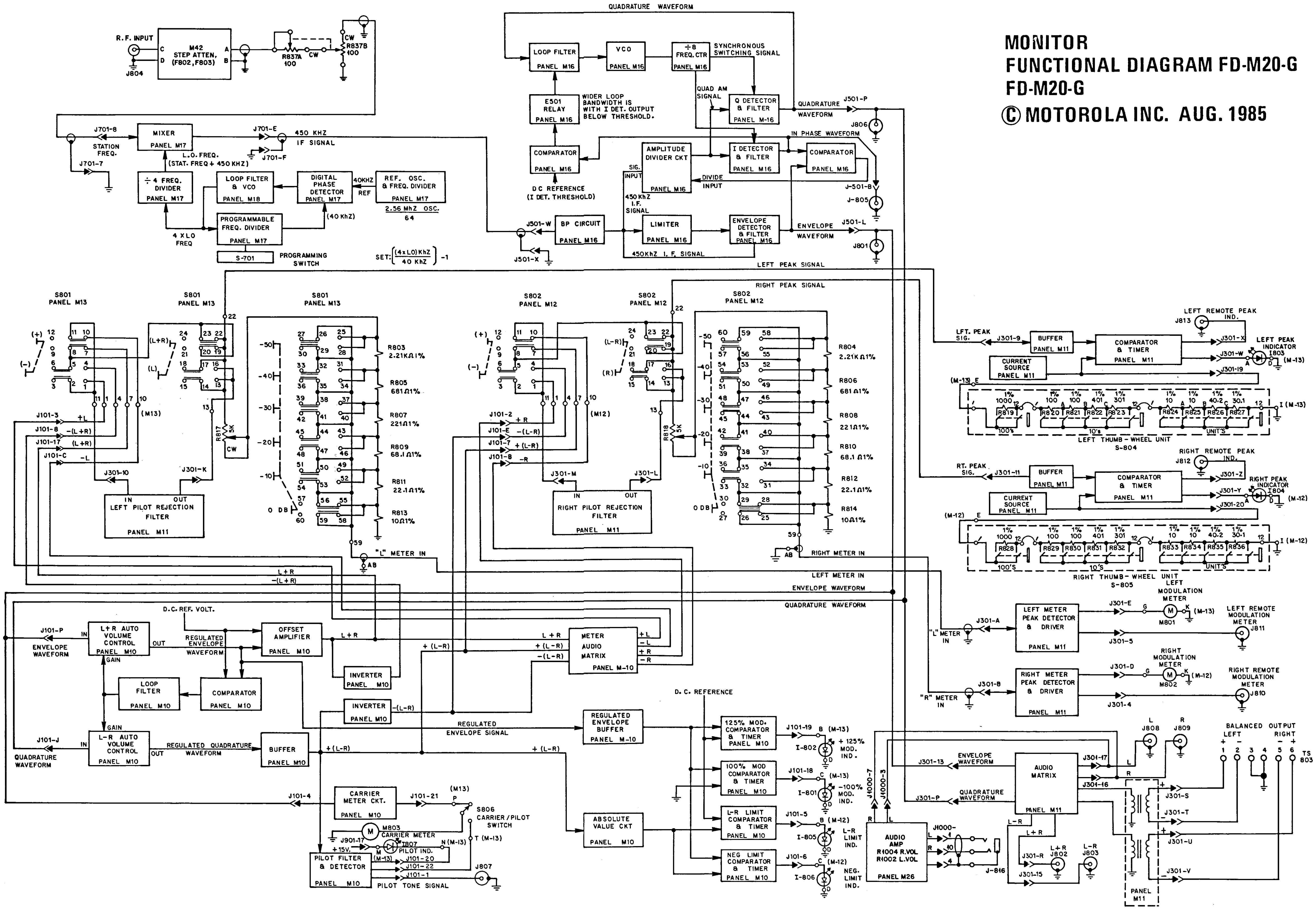


EXCITER
INTERCONNECT DELAY/PROCESSOR DUAL TRANSMITTER
IC-E6/E9-II-A



MONITOR METER SC-M11-Q

MONITOR
FUNCTIONAL DIAGRAM FD-M20-G
FD-M20-G



MONITOR
WIRING DIAGRAM WD-M20-0
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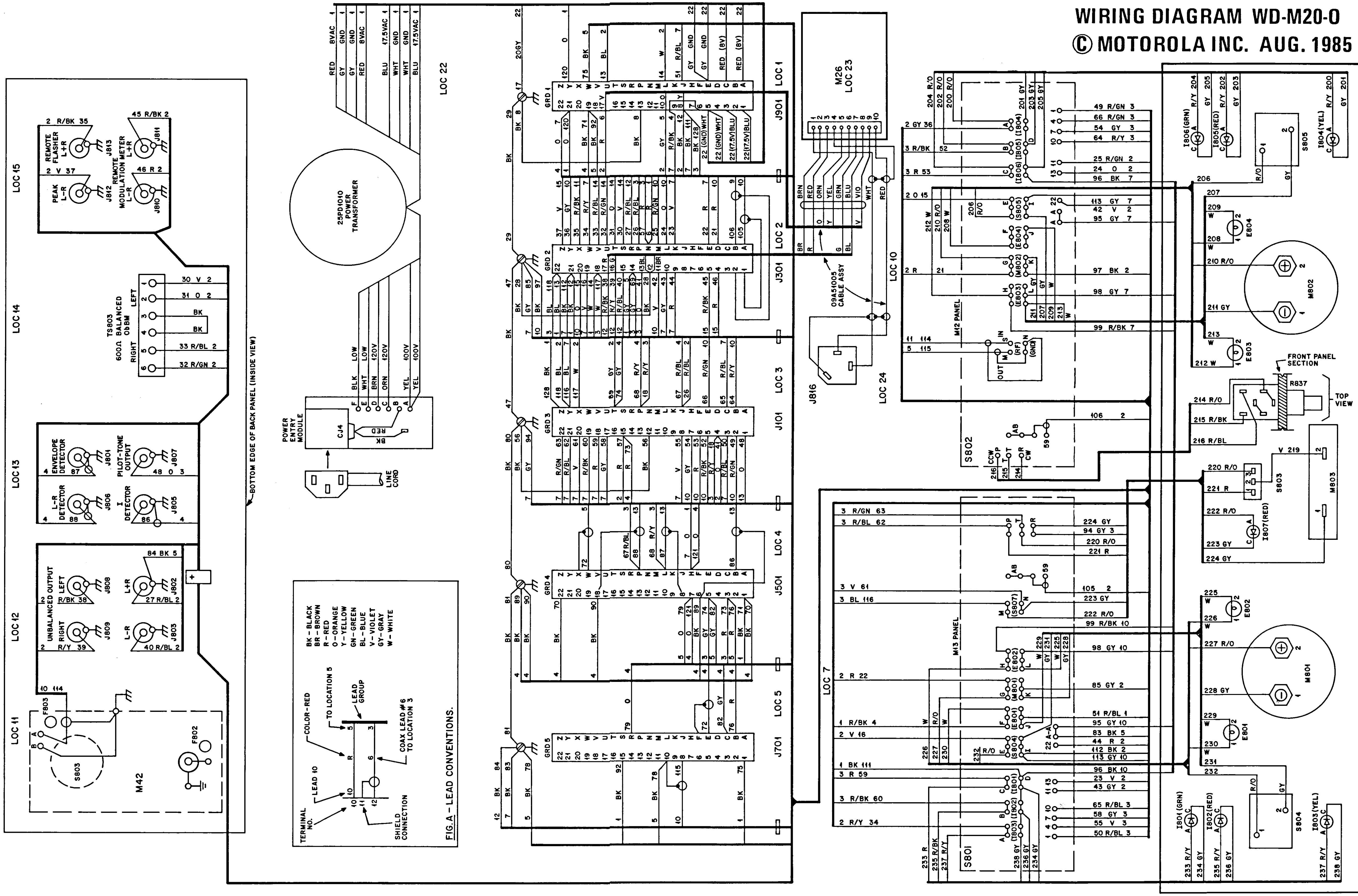

FRONT PANEL POINT TO POINT WIRING
(LEADS NOS. 200 TO 239)
24 AWG R/O UNLESS LABELED OTHERWISE.

MONITOR
AVC
SC-M10-L
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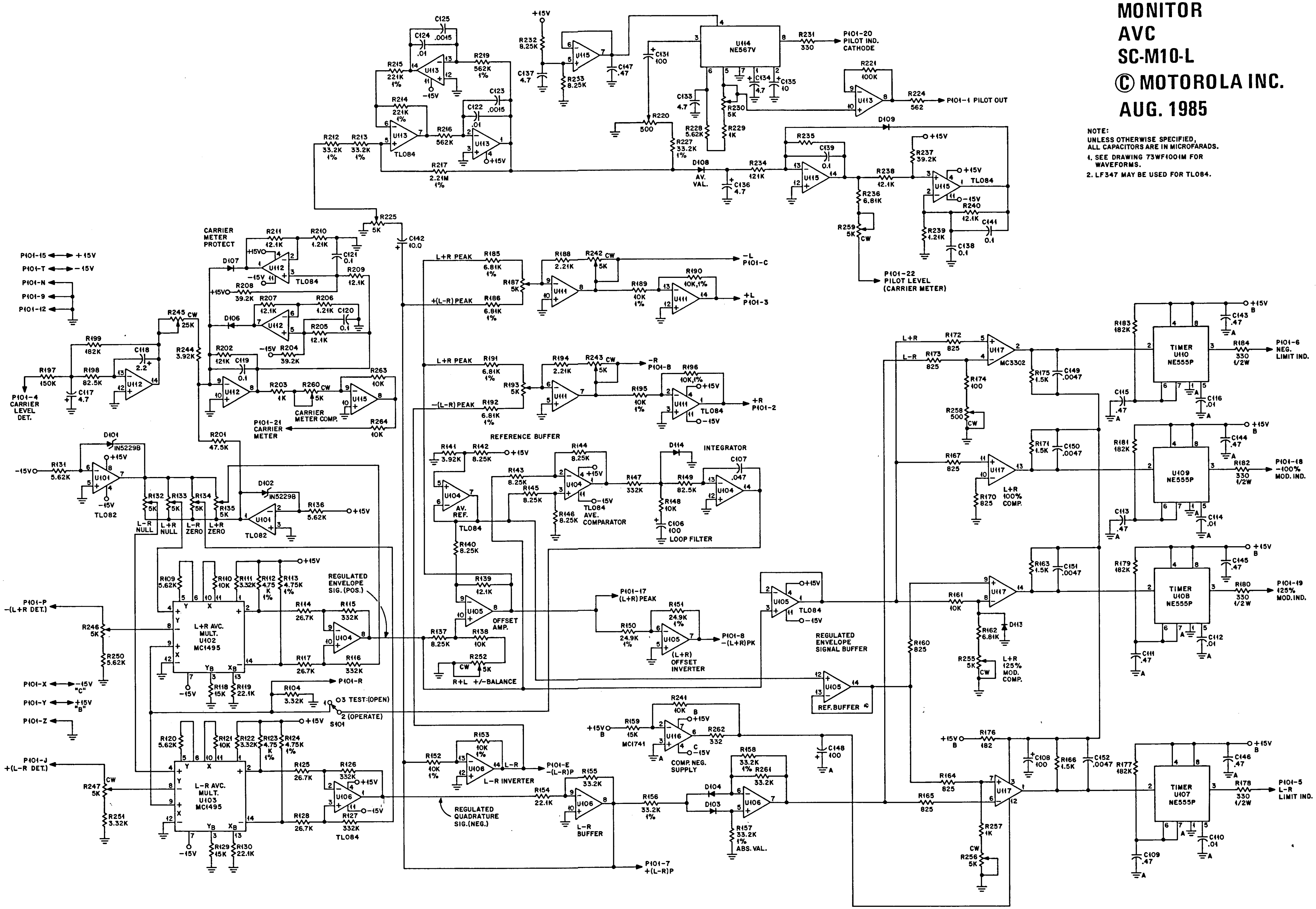
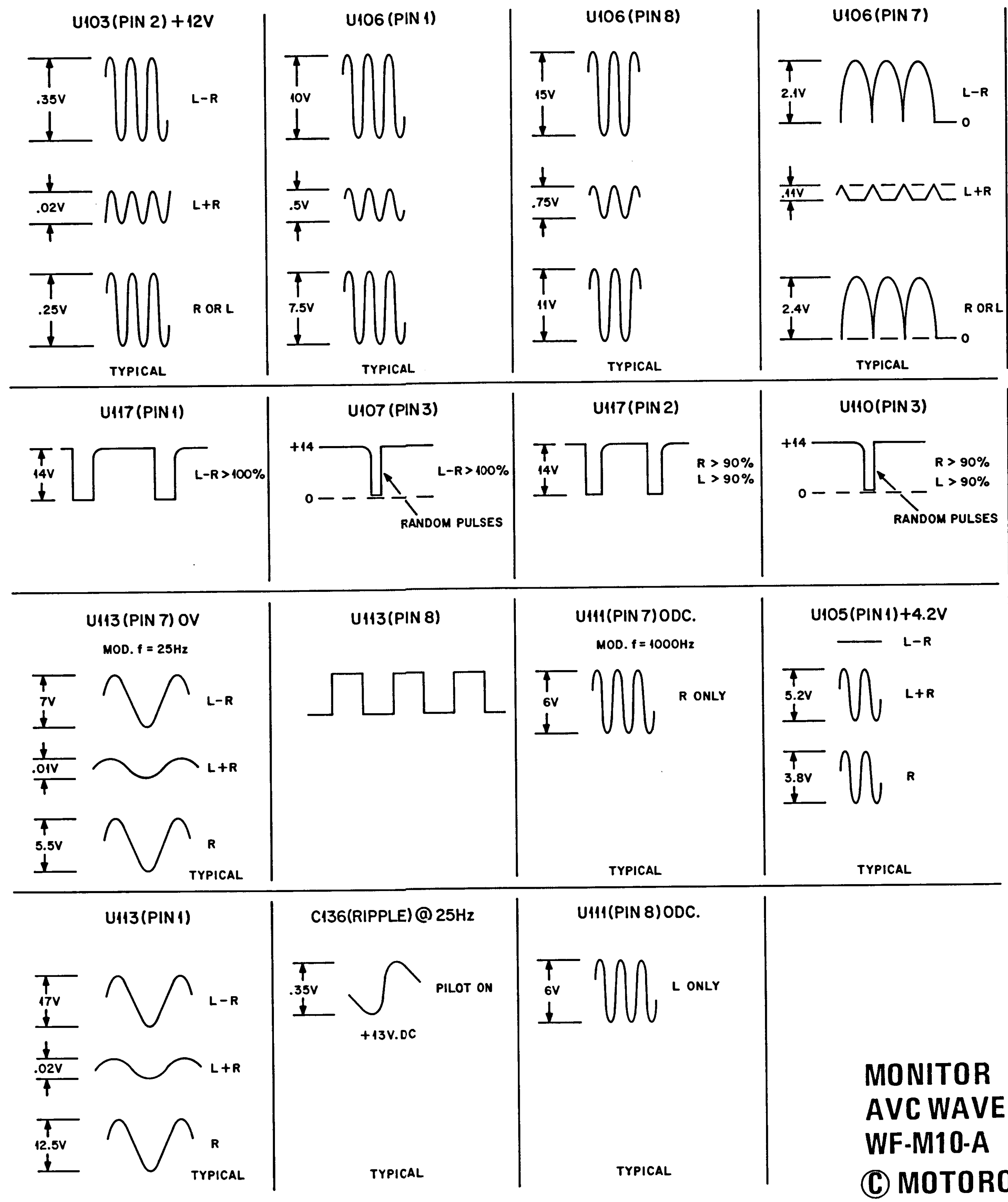
AUG. 1985

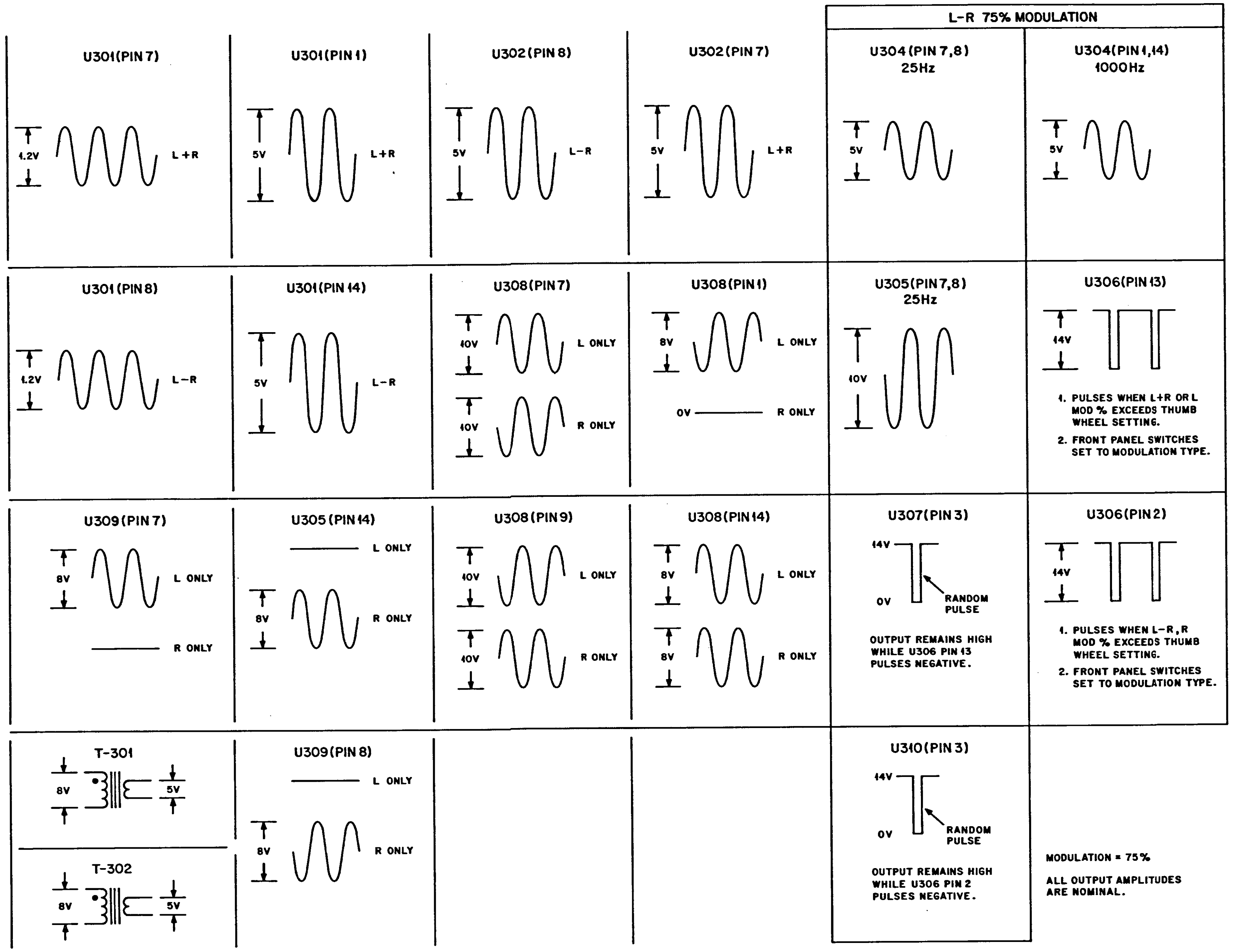
NOTE:
UNLESS OTHERWISE SPECIFIED,
ALL CAPACITORS ARE IN MICROFARADS.

1. SEE DRAWING 73WF1001M FOR WAVEFORMS.
2. LF347 MAY BE USED FOR TL084.

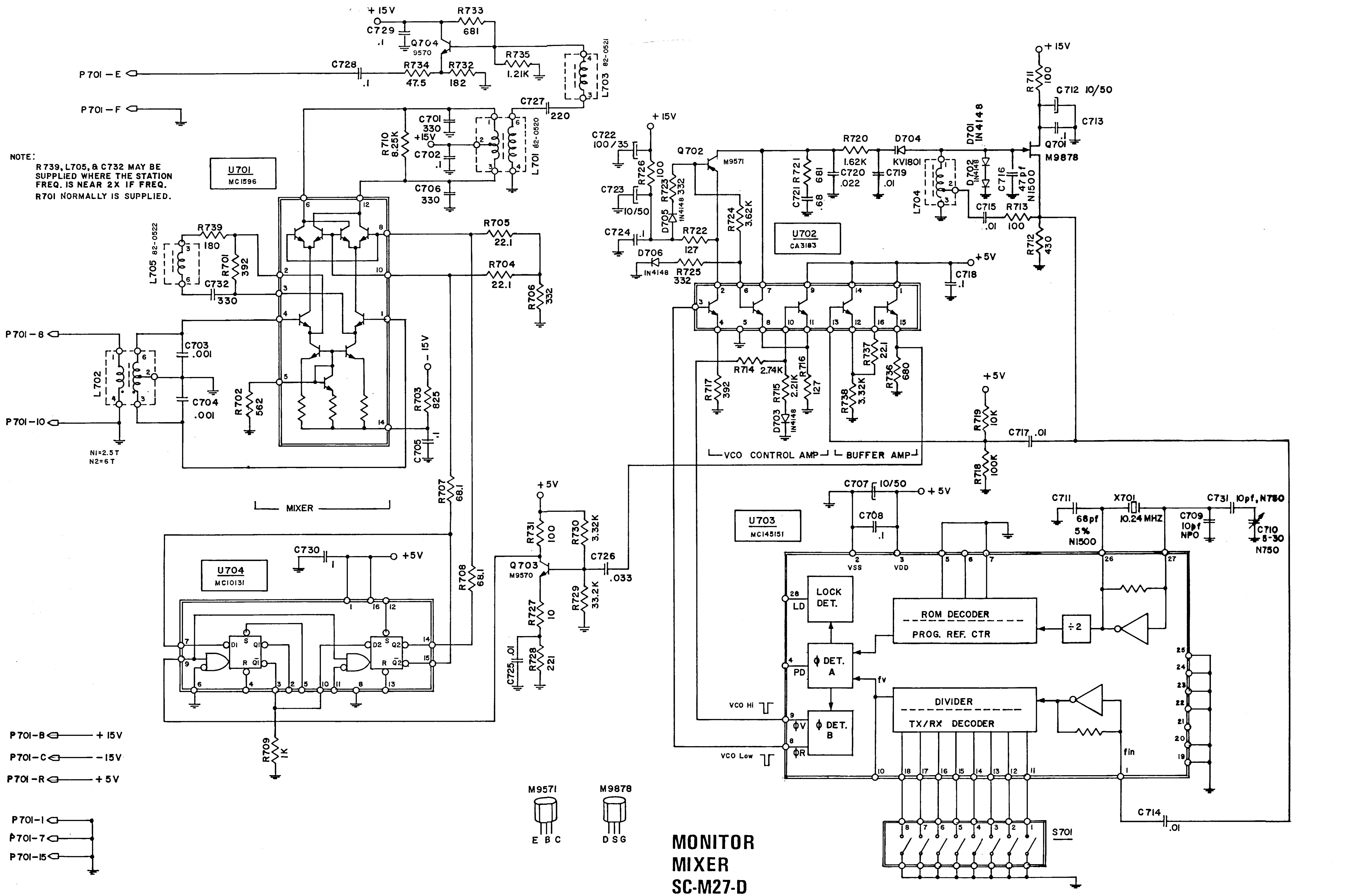




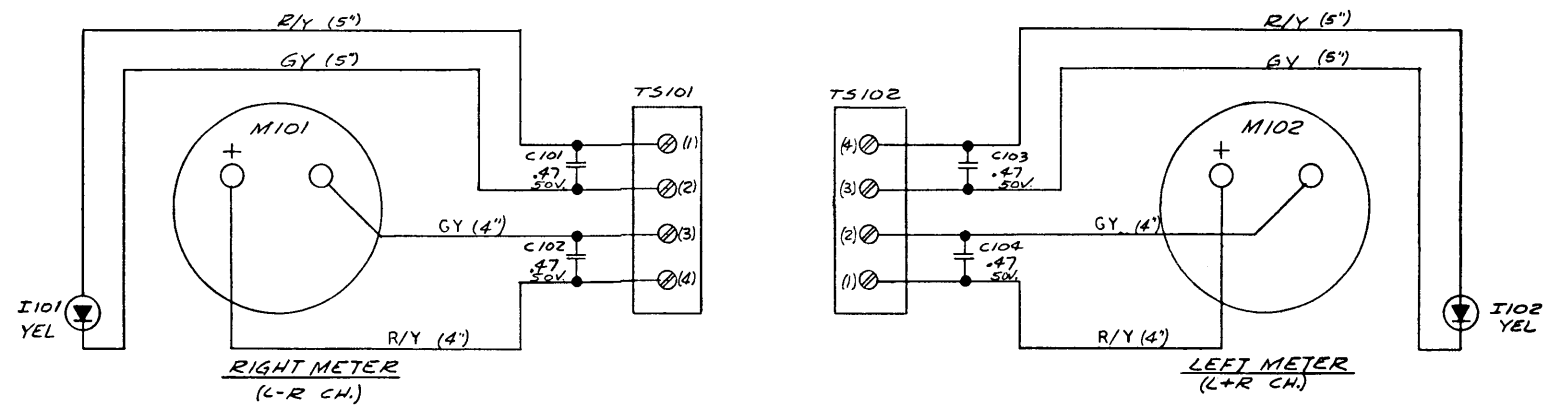
MONITOR
AVC WAVEFORMS
WF-M10-A



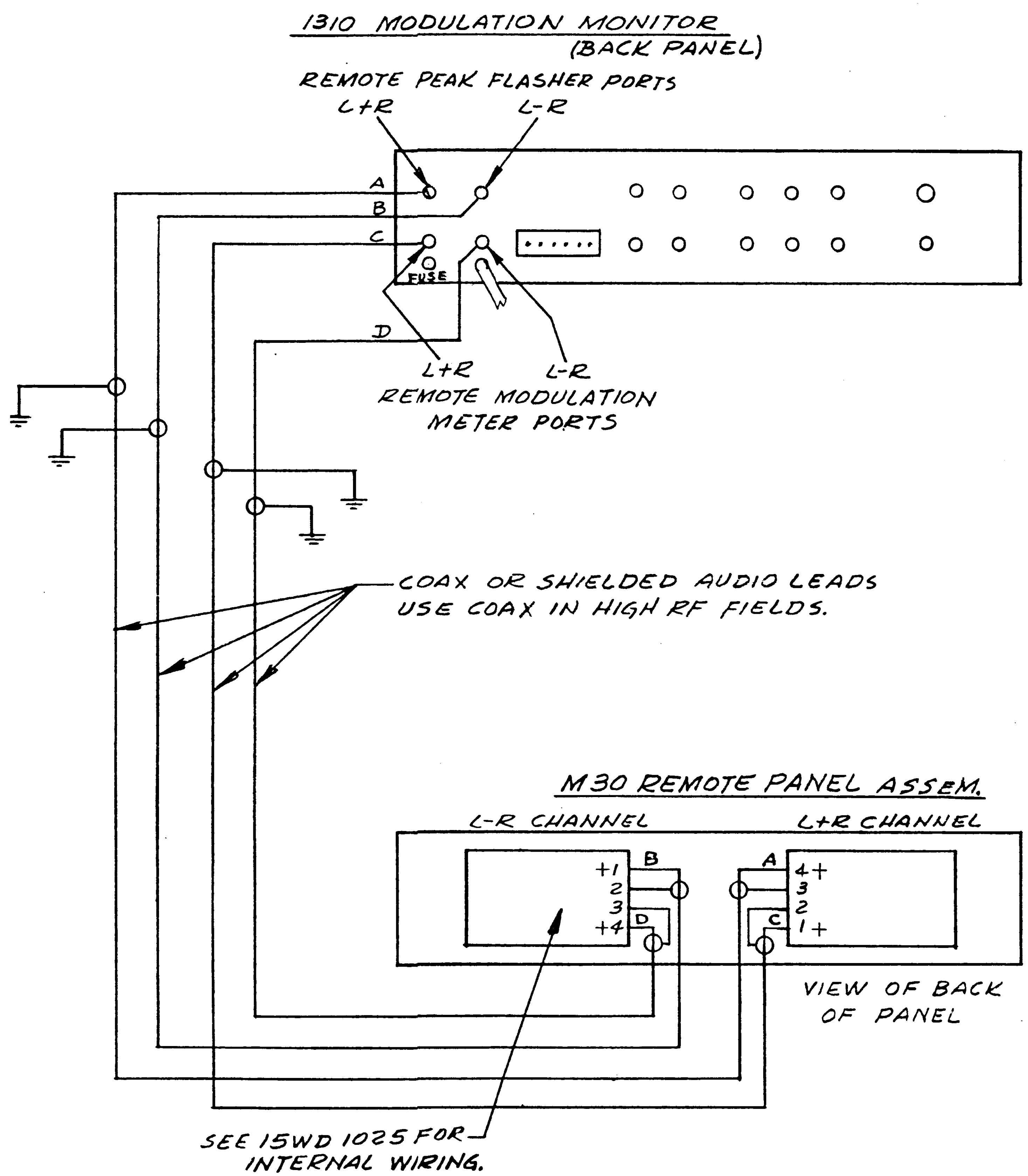
MONITOR
METER WAVEFORMS
WF-M11-A



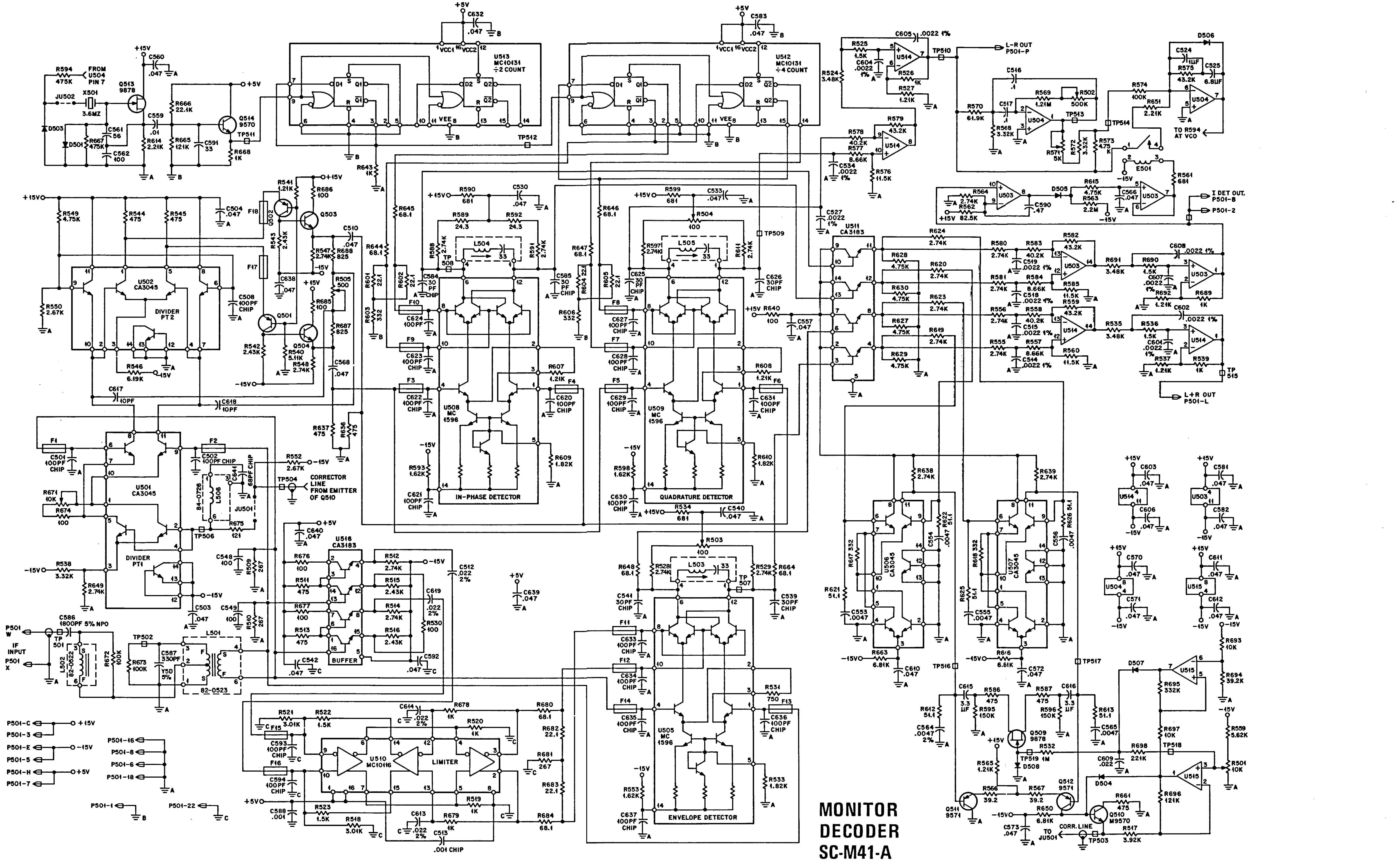
MONITOR
MIXER
SC-M27-D



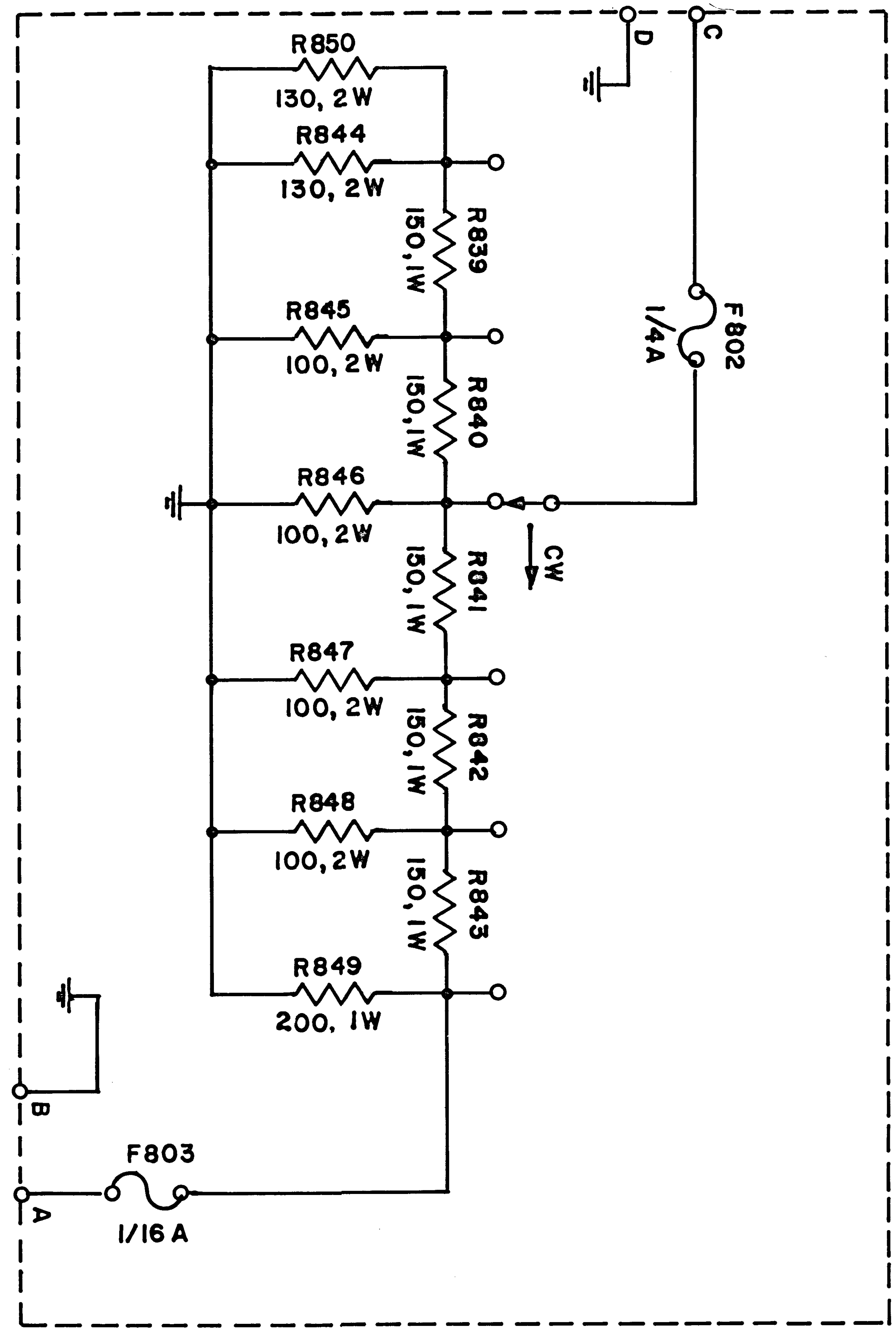
MONITOR
REMOTE PANEL
SC-M30-C



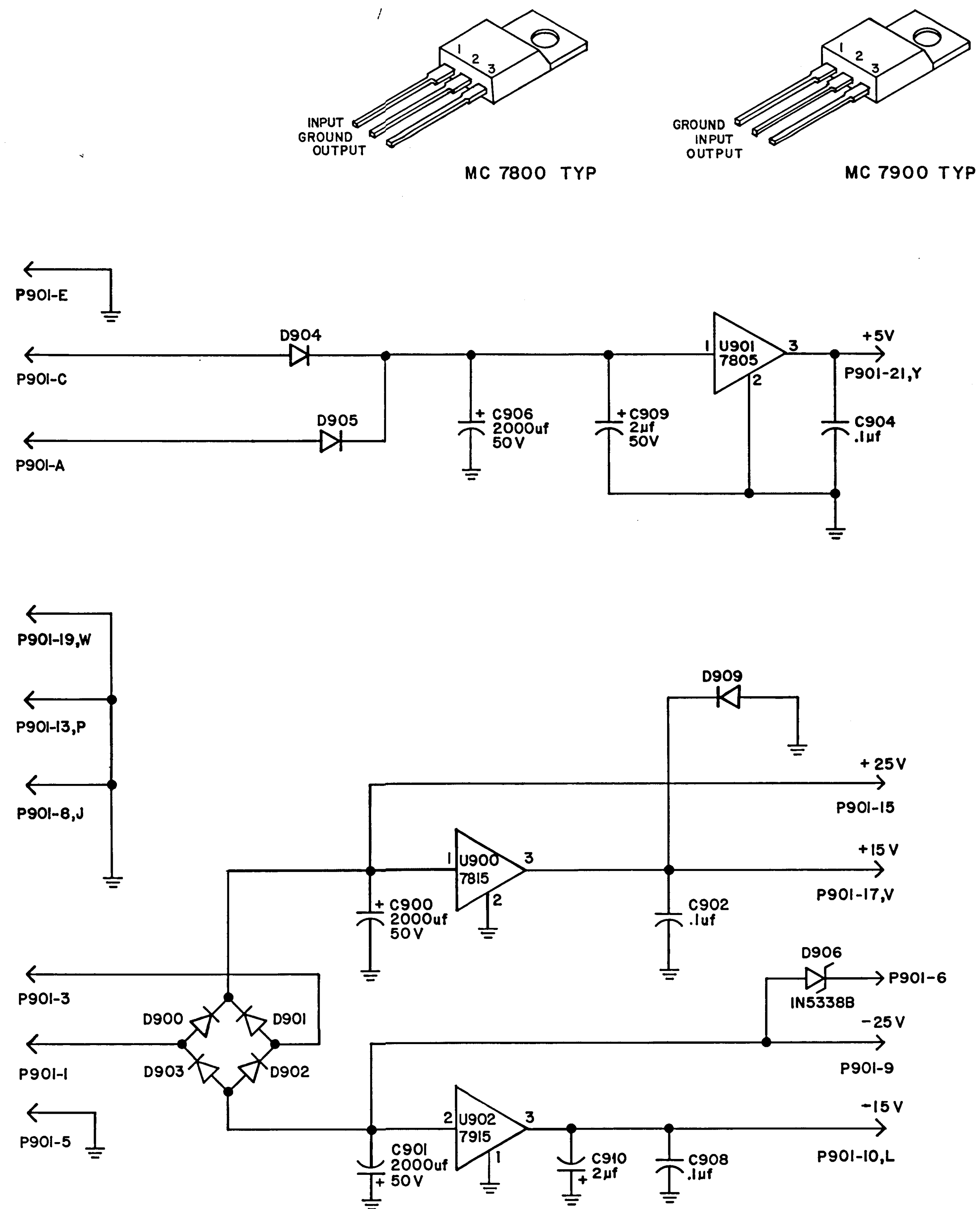
MONITOR
REMOTE PANEL INTERCONNECT
IC-30-C



MONITOR DECODER SC-M41-A

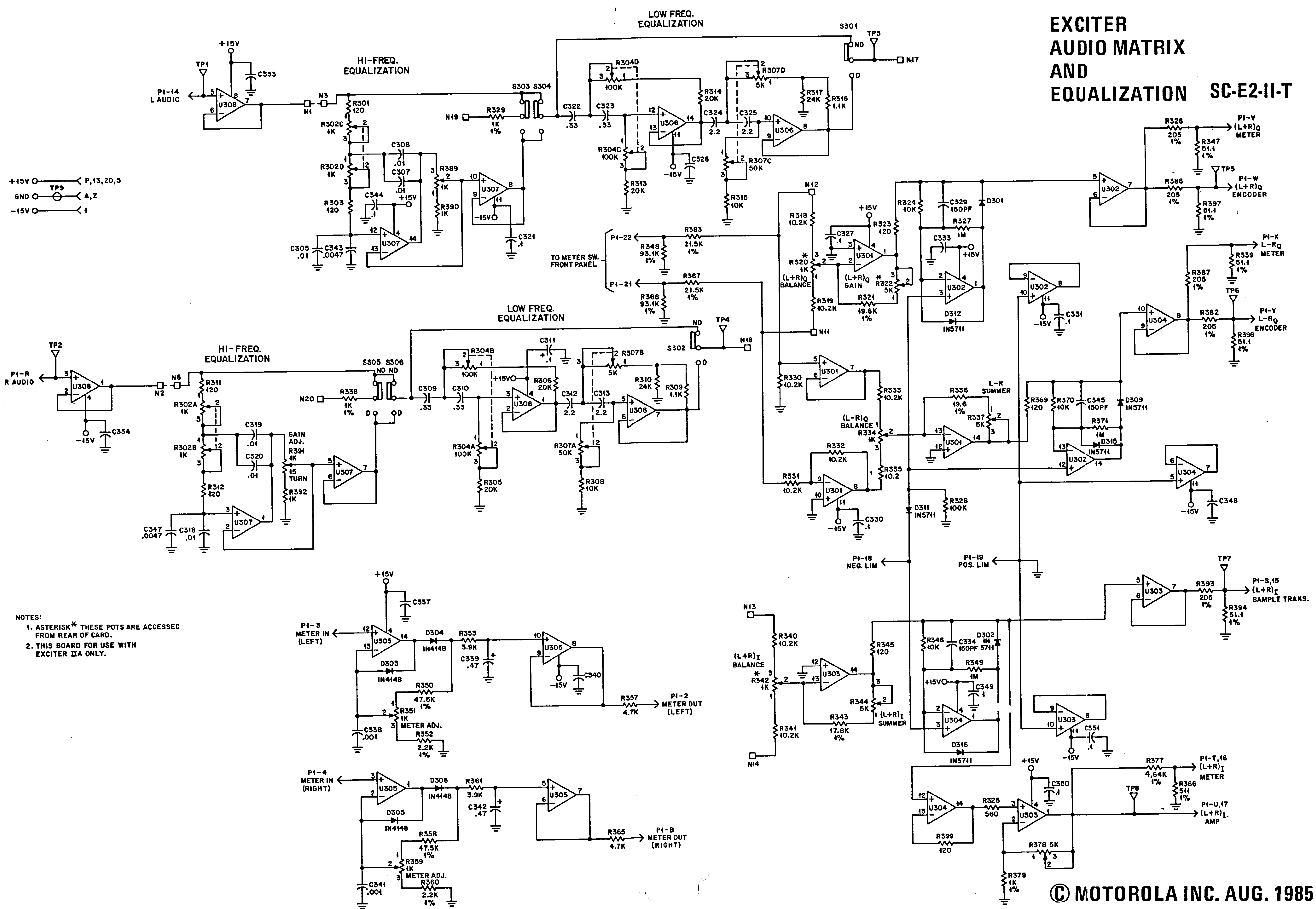


MONITOR
RF ATTENUATOR
SC-M42-B



MONITOR
POWER SUPPLY
SC-M43-A

EXCITER AUDIO MATRIX AND EQUALIZATION SC-E2-II-T



NOTES:
1. ASTERISK* THESE POTS ARE ACCESSED FROM REAR OF CARD.
2. THIS BOARD FOR USE WITH EXCITER IIA ONLY.

EXCITER PARTS LIST

E1 — ENCODER BOARD

#	ID	NAME	PART #	VALUE	W/V	TOL	DESCRIPTION
1		CAPACITOR	21K865440	180 P	300 V	5%	MICA DM5
	C101						
	C104						
2		CAPACITOR	23S11019A46	100 U	25 V	5%	LYTIC
	C102						
3		CAPACITOR	8S11017A14	.047 U	50 V	5%	MYLAR
	C103						
	C150						
4		CAPACITOR	21-84494B41	24.0 P	300 V	5%	MICA DM5
	C105						
	C131						
5		CAPACITOR	21R40020S03	.100 U	50 V	20%	CERAMIC Z5U
	C106						
	C107						
	C108						
	C109						
	C110						
	C111						
	C140						
	C141						
	C159						
6		CAPACITOR	21-84494B--	100 P	300 V	5%	MICA DM5
	C155						
	C156						
7		CAPACITOR	21R40020S14	.47 U	100 V	20%	CERAMIC Z5U
	C125						
	C126						
	C142						
	C146						
	C157						
	C158						
	C162						
8		TRIMCAP	19PD1001	5-335P			DUAL TNR KT027M1310
	C120						
9		CAPACITOR	21-84494B33	30 P	300 V	5%	MICA DM5
	C112						
	C113						
	C114						
	C115						
	C116						
	C117						
	C118						
	C119						
	C130						
10		CAPACITOR	8D82905G11	.22 U	50 V	10%	MYLAR
	C132						
	C143						
	C144						
	C145						

E1 — ENCODER BOARD

#	ID	NAME	PART #	VALUE	W/V	TOL	DESCRIPTION
11		CAPACITOR	8S11017A03	.0022U	50 V	5%	MYLAR
	C135						
12		CAPACITOR	8S11017A17	.100 U	50 V	5%	MYLAR
	C136						
	C137						
	C138						
	C139						
13		TRIMCAP	20ND1001	6-18P			GXB18000
	C147						
14		TRIMCAP	20S82399D04	5.5-18			81F3650
	C151						
15		CAPACITOR		33 P	300 V	5%	MICA DM5
	C152						
16		CAPACITOR	23D84908S01	2.2 U	50 V		LYTIC ALU NONPOL
	C163						
17		DIODE	48S02054A00				SIGNAL 1N4148
	D101						
	D102						
	D103						
	D104						
	D105						
	D106						
	D107						
	D108						
18		TRANSISTOR	48R00869878				FET J310
	Q101						
	Q113						
19		TRANSISTOR	48R00869570				NPN 2N3904
	Q102						
	Q105						
	Q106						
	Q107						
	Q109						
	Q110						
	Q114						
	Q115						
20		TRANSISTOR	48R00869571				PNP 2N3906
	Q103						
	Q104						
	Q108						
	Q111						
	Q112						
21		RESISTOR	6S11009C97	100 K	1/4 W	5%	FCF
	R101						
22		RESISTOR	6S11009C25	100	1/4 W	5%	FCF
	R102						
23		RESISTOR	6S11009C49	1.0 K	1/4 W	5%	FCF
	R103						
	R119						
	R132						
	R170						
	R195						
	R202						
	R223						

E1 — ENCODER BOARD

#	ID	NAME	PART #	VALUE	W/V	TOL	DESCRIPTION
24		RESISTOR	6S11009C73	10 K	1/4 W	5%	FCF
	R104						
	R144						
	R175						
	R181						
	R196						
25		RESISTOR	6S11009C87	39 K	1/4 W	5%	FCF
	R105						
26		RESISTOR	6S11009C19	56	1/4 W	5%	FCF
	R106						
	R107						
	R111						
	R112						
27		RESISTOR	CS11009C09	22	1/4 W	5%	FCF
	R108						
	R109						
	R113						
	R114						
	R167						
	R171						
	R186						
	R187						
28		RESISTOR	6S11009C37	330	1/4 W	5%	FCF
	R110						
	R115						
	R147						
	R149						
	R159						
	R162						
29		RESISTOR	6S11009C46	750	1/4 W	5%	FCF
	R116						
	R128						
	R199						
30		TRIMPOT	18ND1006	100			CERMET 15T
	R117						
	R129						
	R135						
	R200						
	R205						
31		RESISTOR	6S11009C41	470	1/4 W	5%	FCF
	R118						
	R131						
	R136						
	R165						
	R166						
	R201						
	R206						
32		RESISTOR	6S11009C51	1.2 K	1/4 W	5%	FCF
	R120						
	R130						
	R213						

E1 — ENCODER BOARD

#	ID	NAME	PART #	VALUE	W/V	TOL	DESCRIPTION
33		RESISTOR	6S11009C59	2.7K	1/4 W	5%	FCF
	R121						
	R148						
	R152						
	R156						
	R163						
	R183						
	R191						
34		RESISTOR	6S11009C43	560	1/4 W	5%	FCF
	R122						
	R125						
	R222						
35		TRIMPOT	18ND1005	1.0 K			CERMET 15T
	R123						
	R155						
36		RESISTOR	6S11009C71	8.2 K	1/4 W	5%	FCF
	R124						
37		RESISTOR	6S11009C81	22 K	1/4 W	5%	FCF
	R133						
	R137						
	R203						
	R207						
38		RESISTOR	6S11009C33	220	1/4 W	5%	FCF
	R134						
	R138						
	R204						
	R208						
39		RESISTOR	6S11009C63	3.9 K	1/4 W	5%	FCF
	R141						
	R142						
	R168						
	R172						
40		RESISTOR	6S11009C65	4.7 K	1/4 W	5%	FCF
	R146						
	R164						
	R185						
	R189						
	R194						
	R197						
	R218						
	R232						
41		RESISTOR	6S11009C47	820	1/4 W	5%	FCF
	R151						
	R161						
42		RESISTOR	6S11009C57	2.2 K	1/4 W	5%	FCF
	R153						
	R157						
	R169						
	R179						
	R180						

E1 — ENCODER BOARD

#	ID	NAME	PART #	VALUE	W/V	TOL	DESCRIPTION
43	R154	RESISTOR	6S11009C17	47	1/4 W	5%	FCF
44	R158 R217	TRIMPOT	18ND1007	5.0 K			CERMET 15T
45	R173 R174 R182 R190 R224 R229 R230	RESISTOR	6S11009C35	270	1/4 W	5%	FCF
46	R176 R177	RESISTOR	6S11009C69	6.8 K	1/4 W	5%	FCF
47	R178	RESISTOR	6S11009C61	3.3 K	1/4 W	5%	FCF
48	R184 R188	RESISTOR	6S11009C21	68	1/4 W	5%	FCF
49	R192	RESISTOR	6S10164K42	2.2 M	1/4 W	5%	FCF
50	R209 R212	RESISTOR	6S11009C66	5.1 K	1/4 W	5%	FCF
51	R193	RESISTOR	6S11009D06	220 K	1/4 W	5%	FCF
52	R198 R211	RESISTOR	6S11009D12	390 K	1/4 W	5%	FCF
53	R210 R216	RESISTOR	6S11009D20	820 K	1/4 W	5%	FCF
54	R225	RESISTOR	6S11009C01	10	1/4 W	5%	FCF
55	R227 R228	RESISTOR	6S11009C53	1.5 K	1/4 W	5%	FCF
56	T101 T102	TRANSFORMR	24ND1004	0.0000			RF COIL 82-0498
57	U101	IC	51R8308F07				D FF DUAL MC10131L
58	U102 U103 U104	IC	51ND1008				BAL MODU MC1596L
59	U105	IC	51ND1009				TRANS ARRAY CA3054

E1 — ENCODER BOARD

#	ID	NAME	PART #	VALUE	W/V	TOL	DESCRIPTION
60	U106	IC	51ND1010				PILOT DIV MC14040
61	U107	IC	51ND1009				R RPPL CTR TL082CP
62	X101	CRYSTAL	61A590A42-1				4 X STAT. FREQ.
63	X102	CRYSTAL	48-80055C01				PILOT FREQ.
64	E1	P.C.B.	84AW1001E				ENCODER
65		PIN	39ND1006				TEST, VECTOR K24C
66		IC SOCKET	09ND1012				31N2919
67	F101 F102 F103 F104 F105 F106	INDUCTOR	76-84069B01				FERRITE BEAD

E2 — AUDIO BOARD

#	ID	NAME	PART #	VALUE	W/V	TOL	DESCRIPTION
1		CAPACITOR		.01U	50 V	5%	MYLAR
	C305						
	C306						
	C307						
	C318						
	C319						
	C320						
2		CAPACITOR	21R40020S03	.10 U	50 V	20%	CERAMIC Z5U
	C311						
	C321						
	C326						
	C327						
	C330						
	C331						
	C333						
	C337						
	C340						
	C344						
	C348						
	C349						
	C350						
	C351						
	C353						
	C354						
3		CAPACITOR	8S82096J15	2.2 U	250 V	10%	MYLAR
	C312						
	C313						
	C324						
	C325						
4		CAPACITOR	8S11017A01	.001 U	50 V	5%	MYLAR
	C338						
	C341						
5		CAPACITOR	21R40020S14	.47 U	20 V	20%	TANTULUM
	C339						
	C342						
6		DIODE					SIGNAL 1N5711
	D301						
	D302						
	D307						
	D308						
	D309						
	D310						
	D311						
	D312						
	D313						
	D314						
	D315						
	D316						
	D317						

E2 — AUDIO BOARD

#	ID	NAME	PART #	VALUE	W/V	TOL	DESCRIPTION
7		TRIMPOT	18ND1009	1 K			2 SECT. CERMET
	R302A						
	/B						
	R302C						
	/D						
8		TRIMPOT	18ND1008	100 K			2 SECT. CERMET
	R304A						
	/B						
	R304C						
	/D						
9		SWITCH	40ND1017				TOGGLE SPDT BRD MNT
	S301						
	S302						
	S303						
	S304						
	S305						
	S306						
10		RESISTOR	6S11009C80	20 K	1/4 W	5%	FCF
	R305						
	R306						
	R313						
	R314						
11		TRIMPOT	18ND1010	50K/5K			2 SECT. CERMET
	R307A						
	/B						
	R307C						
	/D						
12		CONNECTOR	C9ND1011				6 PIN
13		RESISTOR	6S11009C73	10 K	1/4 W	5%	FCF
	R308						
	R315						
	R324						
	R346						
	R370						
	R373						
	R380						
14		RESISTOR	6S11009C50	1.1 K	1/4 W	5%	FCF
	R309						
	R316						
15		RESISTOR	6S11009C82	24 K	1/4 W	5%	FCF
	R310						
	R317						
16		RESISTOR	6S11049C92	10.2 K	1/4 W	1%	FMF 100 PPM
	R318						
	R319						
	R330						
	R331						
	R332						
	R333						
	R335						
	R340						
	R341						

E2 — AUDIO BOARD

#	ID	NAME	PART #	VALUE	W/V	TOL	DESCRIPTION
17		TRIMPOT	18ND1005	1 K			CERMET 15T
	R320						
	R334						
	R342						
	R351						
	R359						
	R389						
	R391						
18		RESISTOR	6S11049J23	19.6 K	1/4 W	1%	FMF 100 PPM
	R321						
	R336						
19		TRIMPOT	18ND1007	5 K			CERMET 15T
	R322						
	R337						
	R344						
	R378						
20		RESISTOR	6S11009C27	120	1/4 W	5%	FCF
	R301						
	R303						
	R311						
	R312						
	R323						
	R345						
	R369						
	R399						
21		RESISTOR	6S11009C43	560	1/4 W	5%	FCF
	R325						
22		RESISTOR	6S11049B28	205	1/4 W	1%	FMF 100 PPM
	R326						
	R382						
	R386						
	R387						
	R393						
23		RESISTOR	6S11009	1 M	1/4 W	5%	FCF
	R327						
	R349						
	R371						
	R374						
	R381						
	R385						
24		RESISTOR	6S11049B94	1 K	1/4 W	1%	FMF 100 PPM
	R329						
	R338						
	R379						
	R390						
	R392						
25		RESISTOR	6S11049A69	51.1	1/4 W	1%	FMF 100 PPM
	R339						
	R347						
	R394						
	R397						
	R398						

E2 — AUDIO BOARD

#	ID	NAME	PART #	VALUE	W/V	TOL	DESCRIPTION
26		RESISTOR	6S11049D16	17.8 K	1/4 W	1%	FMF 100 PPM
	R343						
27		RESISTOR	6S11049D85	93.1 K	1/4 W	1%	FMF 100 PPM
	R348						
	R368						
28		CAPACITOR	8S11044A30	.33 U	50 V	5%	MYLAR
	C309						
	C310						
	C322						
	C323						
29		RESISTOR	6S11049D57	47.5K	1/4 W	1%	FMF 100 PPM
	R350						
	R358						
30		RESISTOR	6S11049C28	2.21 K	1/4 W	1%	FMF 100 PPM
	R352						
	R360						
31		RESISTOR	6S11009C63	3.9 K	1/4 W	5%	FCF
	R353						
	R361						
35		RESISTOR	6S11009C65	4.7 K	1/4 W	5%	FCF
	R357						
	R365						
33		RESISTOR	6S11049B66	511	1/4 W	1%	FMF 100 PPM
	R366						
	R395						
34		RESISTOR	6S11049D24	21.5 K	1/4 W	1%	FMF 100 PPM
	R367						
	R383						
35		RESISTOR	6S11049C59	4.64 K	1/4 W	1%	FMF 100 PPM
	R377						
36		RESISTOR	6S11049B08	127	1/4 W	1%	FMF 100 PPM
	R396						
37		IC	51ND1007	.0000			OP AMP DUAL TL082CP
	U308						
38		IC	51ND1002				OP AMP QUAD LF347BN
	U302						
	U303						
	U304						
	U305						
	U306						
	U307						
39		CAPACITOR	8S11017A063	.0047U	50V	5%	MYLAR
	C343						
	C347						
40		P.C. BOARD	84AW1002E				AUDIO EQUAL. MATRIX
	E2						
41		CONNECTOR	09PD1010				10 PIN
42		PINS	39ND1006				TEST VECTOR K24C
43		BOOT	38ND1005				RED SWITCH BOOT

E2 — AUDIO BOARD

#	ID	NAME	PART #	VALUE	W/V	TOL	DESCRIPTION
44		BOOT	38ND1006				WHITE SWITCH BOOT
45		DIODE					SIGNAL 1N4148
	D303						
	D304						
	D305						
	D306						
46		CAPACITOR	8S11017A07	.0068U	50 V	5%	MYLAR
	C355						
47		CAPPACITOR	8S11017A10	.018 U	50 V	5%	MYLAR
	C336						
48		CAPACITOR		150 P		10%	CERAMIC DISC
	C328						
	C329						
	C334						
	C335						
	C345						
	C346						
49		RESISTOR	6S11049D88	100 K	1/4 W	1%	FMF 100 PPM
	R328						

E3 — SAMPLE TRANSMITTER

#	ID	NAME	PART #	VALUE	W/V	TOL	DESCRIPTION
1		CAPACITOR	21D82133G03	100 P	500 V	5%	DISC N750
	C901						
	C902						
	C904						
2		CAPACITOR	8S11017A08	.01 U	50 V	5%	MYLAR
	C903						
	C907						
	C910						
3		CAPACITOR	8S11017A01	.001 U	100 V	5%	MYLAR (RADIAL)
	C905						
	C906						
4		CAPACITOR	23S11019A46	100 MF	25 V	20%	LYTIC
	C908						
	C914						
	C915						
5		CAPACITOR	21R40020S03	.1 U	50 V	20%	Z5U CERAMIC
	C909						
6		CAPACITOR	8D82905G11	.22 U	50 V	10%	MYLAR
	C911						
	C912						
7		CAPACITOR	20ND1002	335 U			TUNING DUAL
	C913						
8		COIL	24S83397L01	30 U			RF CHOKE
	L901						
	L902						
9		TRANSISTOR	48R00869570				NPN 2N3904
	Q901						
10		TRANSISTOR	48ND1004				PNP MPS-U52
	Q902						
11		RESISTOR	6S11009C49	1 K	1/4 W	5%	FCF
	R901						
	R919						
	R922						
	R925						
	R927						
12		TRIMPOT	18ND1005	1K			CERMET 15T
	R902						
13		RESISTOR	6S11049K09	15K	1/4W	1%	FMF 100 PPM
	R903						
14		RESISTOR	CS11009C47	820	1/4 W	5%	FCF
	R904						
15		RESISTOR	CS11009C53	1.5 K	1/4 W	5%	FCF
	R905						
	R907						
16		RESISTOR	6S11009C51	1.2 K	1/4 W	5%	FCF
	R906						
17		RESISTOR	6S11009D04	180 K	1/4 W	5%	FCF
	R910						
18		RESISTOR	CC11009C89	47 K	1/4 W	5%	FCF
	R911						

E3 — SAMPLE TRANSMITTER

#	ID	NAME	PART #	VALUE	W/V	TOL	DESCRIPTION
19		RESISTOR	6S11009C41	470	1/4 W	5%	FCF
	R912						
	R936						
20		RESISTOR	6S11009C14	36	1/4 W	5%	FCF
	R913						
21		RESISTOR	6S11009C25	100	1/4 W	5%	FCF
	R914						
	R930						
	R931						
	R932						
	R933						
22		RESISTOR	6S11009C01	10	1/4 W	5%	FCF
	R915						
	R917						
23		RESISTOR	6S10164B10	120	1/2 W	5%	FCF
	R916						
24		RESISTOR	6S11009C17	47	1/4 W	5%	FCF
	R918						
25		RESISTOR	6S11009C80	20 K	1/4 W	5%	FCF
	R920						
	R923						
	R926						
	R929						
26		RESISTOR	6S11009D12	390 K	1/4 W	5%	FCF
	R924						
	R928						
27		TRIMPOT	18ND1011	500 K			CERMET 15T
	R938						
28		TRANSFORME	24ND1004				RF COIL 82-0984
	T901	R					
	T902						
29		IC	51ND1002				OP AMP QUAD LF347BN
	U902						
30		IC	51ND1008				MODULATOR MC1596L
	U901						
31		P.C. BOARD	84AW1003E				
	E3						
32		RECEPTACLE	09ND1013				BNC PCB MT. RT.ANGL
	J901						
33		PIN	39ND1006				TEST, VECTOR K24C
34		SCREW					4-40 x 3/16
35		POST					7/16 STANDOFF
36		PLATE	26PD1004				SHIELD

E4 – POWER SUPPLY

#	ID	NAME	PART #	VALUE	W/V	TOL	DESCRIPTION
1		CAPACITOR	8S11017A01	.001 U	50 V	5%	MYLAR (RADIAL)
	C401						
	C402						
	C404						
	C405						
2		CAPACITOR	23C05253D01	2000 U	50 V		LYTIC
	C403						
	C412						
3		CAPACITOR	8D82905G11	.22 U	50 V	10%	MYLAR
	C406						
	C407						
	C408						
	C409						
	C410						
	C411						
4		DIODE	48-82525G11	3AMP	100V		RECT. POWER IN4720
	D401						
	D402						
	D403						
	D404						
5		DIODE	48-82466H21	1AMP	200 V		RECT. IN4002
	D405						
	D406						
	D407						
6		DIODE	48ND1005	.5AMP_	5.1 V		ZENER IN5338B
	D408						
7		RESISTOR	6S10164C12	33	1 W	5%	FCF
	R403						
8		RESISTOR	6S10164A52	4.7 K	1/2 W	5%	FCF
	R404						
	R406						
9		IC	51-83222M19	.0000	+15 V		REGULATOR MC7815CT
	U401						
10		IC	51-84320A47	.0000	+5V		REGULATOR MC7805CT
	U402						
11		IC	51ND1011		-15 V		REGULATOR MC7915CT
	U403						
12		P.C. BOARD	84AW1004E				POWER SUPPLY
	E4						
13		INSULATOR	14-591A4313				MYLAR
14		INSULATOR	14-84268A01				TRANSISTOR
15		INSULATOR	14-84180C01				SHOULDER WASHER
16		RETAINER	42-82688M01				DIODE SQUARE
17		SCREW	3S400854				4-40X1/2 SL RHD EXL
18		NUT	2S131435				4-40X1/4 EXTLKW
19		SCREW	3S131281				6-32X3/8 PL HXH EXL
20		NUT	2S121841				6-32X5/16
21		SCREW					4-40X5/16 PH HXH EX
22		SPACER					4-40X2" POST FEM/FE
23		HEATSINK	591C42-21				

E5 — RF AMPLIFIER

#	ID	NAME	PART #	VALUE	W/V	TOL	DESCRIPTION
1	C511	CAPACITOR	21R40020S03	.1 U	50 V	20%	MONOLYTHIC Z5U
2	C510 C509	CAPACITOR	21V5180E62	270 PF	100 V	5%	DISC CERAMIC N150
3	C507 C508	CAPACITOR	21D82428B15	.005 U	100 V	20%	DISC CERAMIC X5R
4	C501 C502 C503 C504 C505 C506	CAPACITOR	21R40020S14	.47 U	50 V	20%	MØNØLYTHIC Z5U
5	D501 D502	DIODE	48ND1006		62 V		ZENER IN4759A
6	D503	DIODE	48ND1007		400 V		RECT 1N4004 1A
7	R501 R502 R506 R508	RESISTOR	6S11009A25	100	1/4 W	5%	FCF
8	R503	RESISTOR	6S11009C41	470	1/4 W	5%	FCF
9	R505	RESISTOR	6S11009C37	330	1/4 W	5%	FCF
10	R509 R510	RESISTOR	6S11009C09	22	1/4 W	5%	FCF
11	R511 R512	RESISTOR		7.5 M	1/4 W	5%	FCF
12	R515 R516	RESISTOR	6S11009D05	200 K	1/4 W	5%	FCF
13	R517	RESISTOR	6S11009C34	240	1/4 W	5%	FCF
14	R519 R520	RESISTOR	6S11009C49	1 K	1/4 W	5%	FCF
15	R521 R522	RESISTOR	6S11009C35	270	1/4 W	5%	FCF
16	R504 R507	TRIMPOT	18ND1005	1 K			CERMET 15T

E5 – RF AMPLIFIER

#	ID	NAME	PART #	VALUE	W/V	TOL	DESCRIPTION
17		TRIMPOT	18ND1011	500 K			CERMET 15T
	R513						
	R514						
18		TRIMPOT	18ND1012	10 K			CERMET 15T
	R518						
19		TRANSISTOR	48R00869571				2N3906 PNP
	Q501						
	Q502						
20		TRANSISTOR	48ND1008				FET 2VN0108L SILIC.
	Q503						
	Q504						
21		CHOKE		500UH			TYPE 5256
	L501						
	L502						
	L503						
22		XFORMER	25PD1006				RF MCL T2.5-6T
	T501						
23		XFORMER	25PD1005				RF D2275
	T502						
24		P.C. BOARD	84AW1005E				RF AMPLIFIER 2
	E5						
25		RECEPTACLE	09PD1007				BNC PANEL MNT SH0RT
	J501						
	J502						
	J503						
	J504						
26		BRACKET	07PD1007				FOR 3 BNC JACKS
27		BRACKET	07PD1006				FOR 2 BNC JACKS
28		PIN	39ND1006				TEST, VECTOR K24C
29		TERM. BLK.	31ND1004				4 TERMINAL BLOCK
	TB501						
30		SPACER	43ND1006				6-32 x 1/4 x 2 RND
31		HEAT SINK	26ND1005				THM6025
32		SCREWS	03-136910				4-40X1/2 PH FILHD.
33		NUTS	2-131435				4-40X1/4 NUT W/WASH
34		SCREWS	3ND1008				4-40X3/16 PHILLIPS
35		SCREWS	3-136138				6-32X3/8 PHILLIPS
36		WIRE	3DND1800				SOLID BUSS 18GA, 1/4
37		WIRE	3DND2209				22GA WHITE
38		IC	51ND1013				SN75123N DUAL DRIVE
	U501						
39		IC	51ND1012				LM317T VOLT. REG
	U502						
40		SHIELD	26PD1003				COVER
41		SCREW	3-136138				6-32 X 3/8 PHL HX

E6/1 — AUDIO BOARD (1 XMTR NITE)

#	ID	NAME	PART #	VALUE	W/V	TOL	DESCRIPTION
1		RESISTOR	6S11049B94	1 K	1/4 W	1%	FMF 100 PPM
	R740						
	R741						
2		RESISTOR	6S11009C49	1 K	1/4 W	5%	FCF
	R707						
	R712						
3		RESISTOR	6S11009D16	560 K	1/4 W	5%	CF
	R709						
4		RESISTOR	6S11009C80	20 K	1/4 W	5%	FCF
	R701						
	R702						
	R703						
5		RESISTOR	6S11009C86	36 K	1/4 W	5%	FCF
	R708						
6		RESISTOR	6S11009C73	10 K	1/4 W	5%	FCF
	R704						
7		RESISTOR	6S11009D12	390 K	1/4 W	5%	FCF
	R706						
8		TRIMPOT	18ND1013	100 K			CERMET 15T
	R705						
9		RESISTOR	6S11009D20	820 K	1/4 W	5%	FCF
	R710						
10		RESISTOR	6S11009C46	750	1/4 W	5%	FCF
	R714						
	R715						
11		RESISTOR	6S11009C61	3.3 K	1/4 W	5%	FCF
	R711						
12		TRIMPOT	18ND1007	5 K			CERMET 15T
	R713						
13		RESISTOR	6S11049B85	806	1/4 W	1%	FMF 100 PPM
	R716						
	R717						
	R718						
	R728						
	R729						
	R730						
14		RESISTOR	6S11049B56	402	1/4 W	1%	FMF 100 PPM
	R719						
	R720						
	R721						
	R731						
	R732						
	R733						
15		RESISTOR	6S11049B31	221	1/4 W	1%	FMF 100 PPM
	R722						
	R723						
	R724						
	R734						
	R735						
	R736						

E6/1 — AUDIO BOARD (1 XMTR NITE)

#	ID	NAME	PART #	VALUE	W/V	TOL	DESCRIPTION
16		RESISTOR	6S11049A97	100	1/4 W	1%	FMF 100 PPM
	R725						
	R726						
	R727						
	R737						
	R738						
	R739						
17		CAPACITOR	21R40020S03	.1 U	50 V	20%	CERAMIC Z5U
	C701						
	C703						
	C708						
	C718						
	C722						
	C731						
18		CAPACITOR	23S11019A09	1 MF	50 V	20%	LYTIC ALUM.
	C702						
	C704						
19		CAPACITOR	8S11017A07	.0068U	50 V	5%	MYLAR (RADIAL)
	C705						
	C709						
	C712						
	C715						
	C719						
	C723						
	C726						
	C729						
20		CAPACITOR	8S11017A10	.018 U	50 V	5%	MYLAR (RADIAL)
	C707						
	C711						
	C714						
	C717						
	C721						
	C725						
	C728						
	C732						
21		CAPACITOR	8S11017A01	.001 U	50 V	5%	MYLAR (RADIAL)
	C706						
	C710						
	C713						
	C716						
	C720						
	C724						
	C727						
	C730						
22		DIODE	48-02054A00				IN4148 SIGNAL
	D701						
	D702						
	D703						
	D704						

E6/1 — AUDIO BOARD (1 (XMTR NITE)

#	ID	NAME	PART #	VALUE	W/V	TOL	DESCRIPTION
23	Q701	TRANSISTOR	48R00869570				NPN 2N3904
24	U701	IC	51ND1002				OP AMP QUAD LF347BN
25	U702 U703	IC	51ND1002				OP AMP QUAD LF347BN
26	U704	IC	51ND1004				COUPLER OPT. VACTEC
27	S702 S703	SWITCH	40PD1016				16 POS DIP SPDT
28		PIN	39ND1006				TEST VECTOR K24C
29	S701	SWITCH	40ND1017				TOGGLE BRD MNT SPDT
30		CONNECTOR	09ND1011				6 PIN
31		CONNECTOR	09ND1010				10 PIN
32		P.C. BOARD	84AW1006-1				E6/1 P.C.B.

E6/2 — AUDIO BOARD (2 XMTR NITE)

#	ID	NAME	PART #	VALUE	W/V	TOL	DESCRIPTION
1		CAPACITOR	8S11017A07	.0068U	50 V	5%	MYLAR (RADIAL)
	C629						
	C632						
	C635						
	C640						
	C641						
	C644						
	C648						
	C651						
2		CAPACITOR	8S11017A01	.001 U	50 V	5%	MYLAR (RADIAL)
	C631						
	C633						
	C637						
	C639						
	C643						
	C646						
	C647						
	C652						
3		CAPACITOR	0811017A10	.018 U	50 V	5%	MYLAR (RADIAL)
	C630						
	C634						
	C636						
	C638						
	C642						
	C645						
	C649						
	C650						
4		CAPACITOR	8S11017A06	.0047U	50 V	5%	MYLAR
	C604						
	C606						
	C618						
	C620						
5		CAPACITOR	21R40020S03	.1 U	50 V	20%	CERAMIC
	C608						
	C611						
	C626						
	C654						
	C655						
	C656						
	C657						
	C658						
	C659						
	C661						
6		CAPACITOR	2311019A09	1MF	50 V	20%	LYTIC ALUM.
	C627						
	C628						
7		CAPACITOR	8S11017A08	.01U	50 V	5%	MYLAR (RADIAL)
	C605						
	C607						
	C619						
	C660						

E6/2 — AUDIO BOARD (2 XMTR NITE)

#	ID	NAME	PART #	VALUE	W/V	TOL	DESCRIPTION
8		CAPACITOR	8S11044A30	.33 U	50 V	5%	MYLAR
	C609						
	C610						
	C622						
	C623						
9		TRIMPOT	18PD1005	1K			CERMET 15 T
	R611						
	R619						
	R622						
	R626						
	R689						
	R691						
10		TRIMPOT	18ND1007	5K			CERMET 15 T
	R662						
11		TRIMPOT	18ND1013	100K			CERMET 15 T
	R655						
12		TRIMPOT	18ND1008	2-100K			2 SECTION CERMET
	R604A						
	/B						
	R604C						
	/D						
13		TRIMPOT	18ND1009	1K/1K			2 SECTION CERMET
	R602A						
	/B						
	R602C						
	/D						
14		TRIMPOT	18ND1010	50K/5K			2 SECTION CERMET
	R607A						
	/B						
	R607C						
	/D						
15		DIODE	48-02054A00				SIGNAL ITT 1N 4148
	D601						
	D602						
	D603						
	D604						
16		TRANSISTOR	48R00869570				NPN 2N3904
	Q601						
17		SWITCH	40ND1017				TOGGLE BRD MNT SPDT
	S601						
	S602						
	S603						
	S604						
	S605						
	S606						
	S607						
18		CAP	38ND1006				BUTTON, WHITE
19		CAP	38ND1005				BUTTON, RED
20		CONNECTOR	09ND1010				10 PIN

E6/2 — AUDIO BOARD (2 XMTR NITE)

#	ID	NAME	PART #	VALUE	W/V	TOL	DESCRIPTION
21		IC	51ND1004				OPT. COUPLER V3F885
	U604						
22		CONNECTOR	09N1011				6 PIN
23		SWITCH	40PD1016				DIP 16 POS
	S608						
	S609						
24		RELAY	80PD1001	8PDT	24V		MAGNCRFT W67TCSX-18
	K1						
25		IC	51ND1002				OP AMP QUAD LF347BN
	U601						
	U602						
	U603						
	U606						
	U607						
26		PIN	39ND1006				TEST VECTOR K24C
27		RESISTOR	6S11009C17	47	1/4 W	5%	FCF
	R603						
	R612						
28		RESISTOR	6S11009C49	1 K	1/4 W	5%	FCF
	R658						
	R661						
	R690						
	R692						
29		RESISTOR	6S11049B94	1 K	1/4 W	1%	FMF 100 PPM
	R623						
	R624						
30		RESISTOR	6S11009C82	24 K	1/4 W	5%	FCF
	R610						
	R617						
31		RESISTOR	6S11009C73	10 K	1/4 W	5%	FCF
	R608						
	R615						
	R654						
32		RESISTOR	6S11009C50	1.1 K	1/4 W	5%	FCF
	R609						
	R616						
33		RESISTOR	6S11009C80	20 K	1/4 W	5%	FCF
	R605						
	R606						
	R613						
	R614						
	R651						
	R652						
	R653						
34		RESISTOR	6S11009C46	750	1/4 W	5%	FCF
	R664						
	R665						
35		RESISTOR	6S11009D12	390 K	1/4 W	5%	FCF
	R656						

E6/2 — AUDIO BOARD (2 XMTR NITE)

#	ID	NAME	PART #	VALUE	W/V	TOL	DESCRIPTION
36	R657	RESISTOR	6S11009C86	36 K	1/4 W	5%	FCF
37	R660	RESISTOR	6S11009D20	820 K	1/4 W	5%	FCF
38	R659	RESISTOR	6S11009D16	560 K	1/4 W	5%	FCF
39	R663	RESISTOR	6S11009C61	3.3 K	1/4 W	5%	FCF
40	R618 R621 R625 R627	RESISTOR	6S11049B44	301	1/4 W	1%	FMF 100 PPM
41	R669 R670 R671 R681 R682 R683	RESISTOR	6S11049B56	402	1/4 W	1%	FMF 100 PPM
42	R672 R673 R674 R684 R685 R686	RESISTOR	6S11049B31	221	1/4 W	1%	FMF 100 PPM
43	R666 R667 R668 R678 R679 R780	RESISTOR	6S11049B85	806	1/4 W	1%	FMF 100 PPM
44	R675 R676 R677 R687 R688 R693	RESISTOR	6S11049A97	100	1/4 W	1%	FMF 100 PPM
45	E6/2	P.C. BOARD	84AW1006-2E				DUAL AUDIO PROCESSO
46	C612 C613 C624 C625	CAPACITOR	8-82096J15	2.2 U	250 V	10%	MYLAR
47	D605	DIODE	48ND1007		400V		RECTIFIER 1N4004,1A
48		SOCKET	09PD1009		RELAY		MAGNACRAFT 70-310

E8 — BULK DELAY BOARD

#	ID	NAME	PART #	VALUE	W/V	TOL	DESCRIPTION
1		RESISTOR	6S11049B94	1 K	1/4 W	1%.	FMF 100 PPM
	R751						
	TO						
	R774						
2		CAPACITOR	8S11017A07	.0068U	50 V	5%	MYLAR (RADIAL)
	C751						
	C754						
	C758						
	C762						
	C765						
	C769						
	C772						
	C776						
3		CAPACITOR	8S11017A10	.018 U	50 V	5%	MYLAR (RADIAL)
	C753						
	C756						
	C760						
	C764						
	C767						
	C771						
	C774						
	C778						
4		CAPACITOR	8S11017A01	.001U	50V	5%	MYLAR (RADIAL)
	C752						
	C755						
	C759						
	C763						
	C766						
	C770						
	C773						
	C777						
5		CAPACITOR	21R40020S03	.1 UF	50 V	20%	CERAMIC Z5U
	C757						
	C761						
	C768						
	C775						
6		IC	51ND1002				QUAD OP AMP LF347BN
	U751						
	U752						
7		SWITCH	40PD1006				DIP SPDT
	S751						
	S752						
8		P.C. BOARD	84AW1008E				SINGLE BULK DELAY
	E8						
9		PIN	39ND1006				TEST, VECTOR K24C

E9 — GROUP DELAY BOARD

#	ID	NAME	PART #	VALUE	W/V	TOL	DESCRIPTION
1		RESISTOR	6S11049B56	402	1/4 W	1%	FMF 100 PPM
	R804						
	R805						
	R806						
	R816						
	R817						
	R818						
2		RESISTOR	6S11049B85	806	1/4 W	1%	FMF 100 PPM
	R801						
	R802						
	R803						
	R813						
	R814						
	R815						
3		RESISTOR	6S11049B31	221	1/4 W	1%	FMF 100 PPM
	R807						
	R808						
	R809						
	R819						
	R820						
	R821						
4		RESISTOR	6S11049A97	100	1/4 W	1%	FMF 100 PPM
	R810						
	R811						
	R812						
	R822						
	R823						
	R824						
5		P.C. BOARD	84AW1009E				DUAL BULK DELAY
	E9						
6		RESISTOR	6S11049B94	1 K	1/4 W	1%	FMF 100 PPM
	R825						
	TO						
	R872						
7		CAPACITOR	8S11017A07	.0068U	50V	5%	MYLAR (RADIAL)
	C801						
	C805						
	C808						
	C812						
	C815						
	C819						
	C822						
	C826						
	C829						
	C833						
	C836						
	C840						
	C843						
	C847						
	C850						
	C854						
	C857						
	C861						
	C864						
	C868						

E9 — GROUP DELAY BOARD

#	ID	NAME	PART #	VALUE	W/V	TOL	DESCRIPTION
8		CAPACITOR	8S11017A01	.001 U	50 V	5%	MYLAR (RADIAL)
	C803						
	C807						
	C810						
	C814						
	C817						
	C821						
	C824						
	C828						
	C831						
	C835						
	C838						
	C842						
	C845						
	C849						
	C852						
	C856						
	C859						
	C863						
	C866						
	C870						
	873						
	877						
	880						
	884						
9		CAPACITOR	8S11017A10	.018 U	50 V	5%	MYLAR (RADIAL)
	C802						
	C806						
	C809						
	C813						
	C816						
	C820						
	C823						
	C827						
	C830						
	C834						
	C837						
	C841						
	C844						
	C848						
	C851						
	C855						
	C858						
	C862						
	C865						
	C869						
	872						
	876						
	879						
	883						

E9 — GROUP DELAY BOARD

#	ID	NAME	PART #	VALUE	W/V	TOL	DESCRIPTION
10		CAPACITOR	21R40020S03	.1 UF	50 V	20 %	Z5U CERAMIC
	C804						
	C811						
	C818						
	C825						
	C832						
	C839						
	C846						
	C853						
	C860						
	C867						
	C874						
	C881						
11		IC	51ND1002				QUAD OP AMP LF347BN
	U801						
	U802						
	U803						
	U804						
	U805						
	U806						
12		SWITCH	40PD1016				DIP 16POS
	S801						
	S802						
13		SWITCH	40PD1006				DIP SPDT
	S803						
	S804						
	S805						
	S806						
14		PIN	39ND1006				TEST, VECTOR K24C

E10 — AUDIO INPUT BOARD

#	ID	NAME	PART #	VALUE	W/V	TOL	DESCRIPTION
1		CAPACITOR	8S11017A04	.0027	50 V	5%	MYLAR
	C2						
	C4						
	C5						
	C7						
	C10						
	C12						
	C13						
	C15						
2		CAPACITOR	8S11017A25	.0082	50 V		MYLAR
	C3						
	C6						
	C11						
	C14						
3		CAPACITOR	21R40020S03	.1 U	50 V	20%	CERAMIC
	C1						
	C8						
	C9						
	C16						
4		CAPACITOR	23S11019A46	100 U	25 V	5%	ELECTROLYTIC
	C17						
	C18						
5		RESISTOR	6S11049A59	40.2	1/4 W	1%	FMF 100 PPM
	R8						
	R9						
	R19						
	R20						
6		RESISTOR	6S11049B02	110	1/4 W	1%	FMF 100 PPM
	R7						
	R10						
	R18						
	R21						
7		RESISTOR	6S11049B44	301	1/4 W	1%	FMF 100 PPM
	R6						
	R11						
	R17						
	R22						
8		RESISTOR	6S11049B73	604	1/4 W	1%	FMF 100 PPM
	R3						
	R14						
9		RESISTOR	6S11049C91	10 K	1/4 W	1%	FMF 100 PPM
	R1						
	R2						
	R4						
	R5						
	R12						
	R13						
	R15						
	R16						

E10 — AUDIO INPUT BOARD

#	ID	NAME	PART #	VALUE	W/V	TOL	DESCRIPTION
10		INDUCTOR	24-82135G08	620 uh			INDUCTOR
	L1						
	L2						
	L3						
	L4						
	L5						
	L6						
	L7						
	L8						
11		DIODE	48-82466H21	1N4004			DIODE 1N4004
	D1						
	D2						
	D3						
	D4						
	D5						
	D6						
	D7						
	D8						
12		IC, OP AMP	51ND1002				IC LF347BN
	U1						
	U2						
13		ATTENUATOR	40PD1018				ATTENUATOR, DIP
	S1						
	S2						
14		P.C.B.	84AW1010E	E10			AUDIO INPUT BOARD
	E10						
15		TEST PIN	39ND1006				VECTOR K24C
16		CONNECTOR	1-640388-6	AMP			16 PIN CONNECTOR
17		SPACER	8344		HH SMITH		1/4 x .625, 6-32
18		SCREW	3-136138				6-32 x 3/8 PHL HEX

E26 — AUDIO AMPLIFIER

#	ID	NAME	PART #	VALUE	W/V	TOL	DESCRIPTION
1		RESISTOR	6S11049C36	2.67K	1/4W	1%	FMF 100 PPM
	R1000						
	R1001						
2		TRIMPOT		5K	1/2 W	10%	WESTON 840P
	R1002						
	R1003						
3		RESISTOR	6S11049C91	10K	1/4W	1%	FMF 100 PPM
	R1004						
	R1005						
4		RESISTOR	6S11049D57	47.5K	1/4W	1%	FMF 100 PPM
	R1006						
	R1007						
5		RESISTOR	6S11049E06	150K	1/4W	1%	FMF 100 PPM
	R1008						
	R1009						
6		RESISTOR	6S11049C28	2.21K	1/4W	1%	FMF 100 PPM
	R1011						
	R1010						
7		IC	LM378N				DUAL AUDIO AMP
	U1000						
8		CAPACITOR	8S11017A02	.0015	50V	5%	POLYESTER
	C1000						
	C1001						
9		CAPACITOR	21R40020S03	.1UF	50V	20%	MONOLITHIC
	C1002						
	C1003						
	C1004						
	C1005						
10		CAPACITOR	23D84908L01	2.2U	50V		ELECTROLYTIC RADIAL
	C1006						
	C1007						
11		CAPACITOR		220U	35V		ELECTROLYTIC RADIAL
	C1008						
	C1009						
	C1010						
	C1011						
	C1012						
12		IC SOCKET	31N2918	14 PIN			VOLTREX SP-14-2G
13		HEADER	102202-7	AMP			10 PIN HEADER
	P1000						
14		PC BOARD	84AW1026E				AUDI0 AMP PCB
	E26						

CHASSIS PARTS

PART NAME	PART #	ID	DESCRIPTION	QTY
PANEL FRONT	15PD1015	FRNT	MACHINED	1
P C BOARD	84AS1031E	FRNT	L E D TERM BRD.	1
METER	72PD1003	FRNT	MODULATION	2
SWITCH ASSY	40AS1014A	FRNT	SWITCH & POT ASSY	1
SCREW	3S140257	FRNT	6-32X5/16 PHFLHD BO	4
SWITCH	40PD1015	FRNT	ROCKER	1
JACK	09PD1004	FRNT	PHONE	1
PANEL, BACK	15PD1034	BACK	MACHINED	1
TERM STRIP	31PD1001	BACK	6 TERMINAL STRIP	1
TERM STRIP	31PD	BACK	8 TERMINAL STRIP	1
SCREW		BACK	6-32 x 1/2 BND PH BO	6
RECEPTACLE	09PD1008	BACK	BNC LONG W/HRDWR	4
SCREW	03PD1001	BACK	1/4-20X1 BRASS	1
NUT	02PD1001	BACK	1/4-20 BRASS HEX	2
WASHER, LOCK	04ND1001	BACK	250 ID INTHT BRASS	1
WASHER, FLAT	4S132218	BACK	250 ID BRASS	2
SCREW		BACK	6-32 x 1 SL	2
BUSHING	43PD1005	BACK	NYLON INSULATOR	8
PLUG	38PD1002	BACK	HOLE	2
SIDE PANEL	15PD1005A	RGHT	RIGHT-MACHINED PANEL	1
TRANSFORMER	25PD1010	RGHT	POWER TRANSFORMER	1
NUT		RGHT	1/4-20	1
SCREW		RGHT	1/4-20 x 1 1/2 STOVE BOLT	1
P.C. BOARD	84AS1026E	RGHT	AUDIO AMP ASSEMBLY	1
SCREW	03ND1009	RGHT	4-40 X 3/8 PHL HXD	3
WASHER		RGHT	1/4 LOCKWASHER	1
SCREW		RGHT	8-32 x 1/2	3
P.E. MODULE	28PD1001	RGHT	6J4 LINE FILTER	1
FUSE		RGHT	0.5 AMP, 250 V SLO BLOW	1
HEAT SINK		RGHT	HEAT SINK	1
HEAT COMPOUND		RGHT	HEAT TRANSFER COMPOUND	0
SIDE PANEL	15PD1005B	LEFT	LEFT-MACHINED	1
SCREW	3-136138	LEFT	6-32 x 3/8 PH HXHD	8
PC BOARD	84AS1010E	LEFT	AUDIO INPUT CARD	1
PC BOARD	84AS1005E	LEFT	RF AMP	1
BRACKET	07PD1002	SWCH	SWITCH BRACKET	1
SWITCH	40PD1012	SWCH	2-4PDT SWITCH	1
SWITCH	40PD1013	SWCH	2-4PDT SWITCH	1
POT	35405-1-201	SWCH	BOURNS 200 OHM POT	1
POT	35405-1-102	SWCH	BOURNS 1K POT	1
POT	35405-1-502	SWCH	BOURNS 5K POT	2
TERMINAL	1102-150519	SWCH	CONCORD TERMINAL	6
RESISTOR	6S11009C25	SWCH	FCF	2
RESISTOR	6S11049H15	SWCH	FMF 100 PPM	2
RESISTOR	6S11049H36	SWCH	FMF 100 PPM	2
RESISTOR	6S11049H66	SWCH	FMF 100 PPM	2
RESISTOR	6S11049H78	SWCH	FMF 100 PPM	2
WASHER		SWCH	LOCKWASHER, I.T.	8
RAIL	46PD1003	CDBS	CONNECTOR	2

CHASSIS PARTS

PART NAME	PART #	ID	DESCRIPTION	QTY
CONNECTOR	09PD1001	CDBS	CARDEDGE,44 POS	5
SCREW	3-138929	CDBS	4-40 X 5/8 PHIL HXHD	10
NUT	2-131435	CDBS	4-40 X 1/2 EXT LOCKWASHER	10
BRACKET	07PD1001	CDBS	ANGLE, SLOTTED	2
SCREW	3-136138	CDBS	6-32 X 3/8 PLN HXHD	6
PIN	39PD1003	CDBS	CONNECTOR,POST	76
PLUG	39PD1001	CDBS	KEYING PLUG	6
PIN	39ND1005	CDBS	CONNECTOR, EYELET	2
TERM STRIP	31ND1003	CDBS	1 POS	2
NUT	2S121841	CDBS	6-32 EXT LOCKWASHER	2
BUSS BAR	47PD1001	CDBS	SOLID BRASS	1
TERMINAL	53555-1	CDBS	TOUNGE TERMINAL #2 STUD	4
BRACKET		FRAM	ANGLE BRACKET	2
RAIL		FRAM	PC BOARD GUIDE	2
GUIDE CLIP		FRAM	PLASTIC CARD GUIDE	10
SCREW		FRAM	6-32 X 3/8 PHL HXHD	4
SCREW		FRAM	4-40 X 1/4 PHL RND HD	8
FRAME ASSY	07AS1005	MAIN	CARD GUIDE FRAME ASSY	2
HARNESS ASSY	30WD1002	MAIN	HARNESS ASSEMBLY	1
NUT	2-135435	MAIN	1/4-20	4
SCREW	3-136138	MAIN	6-32 X 3/8 PHL HXHD	12
WASHER		MAIN	LOCK WASHER, 1/4	4
FOAM PAD	75PD1001	MAIN	FOAM,GREY,ADH BACK	1
PLATE,NAME	33PD1001	MAIN	MODEL & SERIAL NO.	1
SCREW	03ND1007	MAIN	4-40 X 1/4 SLT PHD	2
P C BOARD	84AS1001E	MAIN	ENCODER ASSEMBLY	1
P C BOARD	84AS1002E	MAIN	AUDIO EQUALIZER ASSEMBLY	1
P C BOARD	84AS1003E	MAIN	SAMPLE XMITTER ASSEMBLY	1
P C BOARD	84AS1004E	MAIN	POWER SUPPLY ASSEMBLY	1
P C BOARD	84AS1006E-2	MAIN	DUAL AUDIO PROCESSOR	1
RT PNL ASSY	15AS1028	MAIN	RIGHT PANEL ASSY	1
LFT PNL ASSY	15AS1029	MAIN	LEFT PANEL ASSY	1
COVER	15PD1012	FINL	TOP COVER	1
COVER	15PD1004	FINL	BOTTOM COVER	1
SCREW	3-136138	FINL	6-32 X 3/8 PHIL HXHD	16
MAIN ASSY	27AS1002	FINL	MAIN ASSEMBLY	1
PLUG	38-83037M01	FINL	PLUG BUTTON	4
COVER STRIP	64C82966K01	FINL	MODULE STRIP	2
COVER	15C82967K01	FINL	MODULE	2
SCREW	3S138971	FINL	4-40 X 1/2 PH FLHD	4
LID	15PD1020	FINL	TOP COVER	1
DECALS	54PD1001	FINL	SWITCH POSITION LABELS	2
LINE CORD		FINL	3 PRONG LINE CORD	1

MONITOR PARTS LIST

ID	PART NO.	VALUE	EXP	TYPE	DESCRIPTION

M10 CIRCUIT BOARD

ID	PART NO.	VALUE	EXP	TYPE	DESCRIPTION
C106	23-11019A46	100.0000	U	CAP	LYTIC 25V
C107	8C42208B18	.0470	U	CAP	MYLAR 50V 10%
C108	23-11019A46	100.0000	U	CAP	LYTIC 25V
C109	21R40020S14	.4700	U	CAP	CER. 50V 20% Z5U
C110	8S11017A08	.0100	U	CAP	MET. POLY. 50V 5%
C111	21R40020S14	.4700	U	CAP	CER. 50V 20% Z5U
C112	8S11017A08	.0100	U	CAP	MET. POLY. 50V 5%
C113	21R40020S14	.4700	U	CAP	CER. 50V 20% Z5U
C114	8S11017A08	.0100	U	CAP	MET. POLY. 50V 5%
C115	21R40020S14	.4700	U	CAP	CER. 50V 20% Z5U
C116	8S11017A08	.0100	U	CAP	MET. POLY. 50V 5%
C117	23D84538G02	4.7000	U	CAP	TANTALUM 20V 20%
C118	23D84908L01	2.2000	U	CAP	LYTIC 50V NONPOL
C119	21R40020S03	.1000	U	CAP	CER. 50V 20% Z5U
C120	21R40020S03	.1000	U	CAP	CER. 50V 20% Z5U
C121	21R40020S03	.1000	U	CAP	CER. 50V 20% Z5U
C122	8S11017A08	.0100	U	CAP	MET. POLY. 50V 5%
C123	YA2A152K	.0015	U	CAP	MET. POLY. NICH.
C124	8S11017A08	.0100	U	CAP	MET. POLY. 50V 5%
C125	YA2A152K	.0015	U	CAP	MET. POLY. NICH.
C131	23-11019A46	100.0000	U	CAP	LYTIC 25V
C133	23D84538G02	4.7000	U	CAP	TANTALUM 20V 20%
C134	23D84538G02	4.7000	U	CAP	TANTALUM 20V 20%
C135	23D82747L19	10.0000	U	CAP	LYTIC 50V 20%
C136	23D84538G02	4.7000	U	CAP	TANTALUM 20V 20%
C137	23D84538G02	4.7000	U	CAP	TANTALUM 20V 20%
C138	21R40020S03	.1000	U	CAP	CER. 50V 20% Z5U
C139	21R40020S03	.1000	U	CAP	CER. 50V 20% Z5U
C141	21R40020S03	.1000	U	CAP	CER. 50V 20% Z5U
C142	23D82747L19	10.0000	U	CAP	LYTIC 50V 20%
C143	21R40020S14	.4700	U	CAP	CER. 50V 20% Z5U
C144	21R40020S14	.4700	U	CAP	CER. 50V 20% Z5U
C145	21R40020S14	.4700	U	CAP	CER. 50V 20% Z5U
C146	21R40020S14	.4700	U	CAP	CER. 50V 20% Z5U
C147	21R40020S14	.4700	U	CAP	CER. 50V 20% Z5U
C148	23-11019A46	100.0000	U	CAP	LYTIC 25V
C149	21D83596E23	.0047	U	CAP	DISC 200V 10% Y5R
C150	21D83596E23	.0047	U	CAP	DISC 200V 10% Y5R
C151	21D83596E23	.0047	U	CAP	DISC 200V 10% Y5R
C152	21D83596E23	.0047	U	CAP	DISC 200V 10% Y5R
D101	1N5229B			DIODE	ZENER 4.3V
D102	1N5229B			DIODE	ZENER 4.3V
D103	1N4148			DIODE	SIGNAL ITT
D104	1N4148			DIODE	SIGNAL ITT
D106	1N4148			DIODE	SIGNAL ITT
D107	1N4148			DIODE	SIGNAL ITT
D108	1N4148			DIODE	SIGNAL ITT
D109	1N4148			DIODE	SIGNAL ITT
D113	1N4148			DIODE	SIGNAL ITT
D114	1N4148			DIODE	SIGNAL ITT
R104	6S11049C45	3.32	K	RESIST	FMF 1/4W 1% 100PPM
R109	6S11049C67	5.62	K	RESIST	FMF 1/4W 1% 100PPM

ID	PART NO.	VALUE	EXP	TYPE	DESCRIPTION

M10 CIRCUIT BOARD

R110	6S11049C91	10	K	RESIST	FMF 1/4W 1% 100PPM
R111	6S11049C45	3.32	K	RESIST	FMF 1/4W 1% 100PPM
R112	6S11049C60	4.75	K	RESIST	FMF 1/4W 1% 100PPM
R113	6S11049C60	4.75	K	RESIST	FMF 1/4W 1% 100PPM
R114	6S11049D33	26.7	K	RESIST	FMF 1/4W 1% 100PPM
R115	6S11049E39	332	K	RESIST	FMF 1/4W 1% 100PPM
R116	6S11049E39	332	K	RESIST	FMF 1/4W 1% 100PPM
R117	6S11049D33	26.7	K	RESIST	FMF 1/4W 1% 100PPM
R118	6S11049D09	15	K	RESIST	FMF 1/4W 1% 100PPM
R119	6S11049D25	22.1	K	RESIST	FMF 1/4W 1% 100PPM
R120	6S11049C67	5.62	K	RESIST	FMF 1/4W 1% 100PPM
R121	6S11049C91	10	K	RESIST	FMF 1/4W 1% 100PPM
R122	6S11049C45	3.32	K	RESIST	FMF 1/4W 1% 100PPM
R123	6S11049C60	4.75	K	RESIST	FMF 1/4W 1% 100PPM
R124	6S11049C60	4.75	K	RESIST	FMF 1/4W 1% 100PPM
R125	6S11049D33	26.7	K	RESIST	FMF 1/4W 1% 100PPM
R126	6S11049E39	332	K	RESIST	FMF 1/4W 1% 100PPM
R127	6S11049E39	332	K	RESIST	FMF 1/4W 1% 100PPM
R128	6S11049D33	26.7	K	RESIST	FMF 1/4W 1% 100PPM
R129	6S11049D09	15	K	RESIST	FMF 1/4W 1% 100PPM
R130	6S11049D25	22.1	K	RESIST	FMF 1/4W 1% 100PPM
R131	6S11049C67	5.62	K	RESIST	FMF 1/4W 1% 100PPM
R132	3299Y-001-502	5.0000	K	TRIMPOT	CERMET 25T
R133	3299Y-001-502	5.0000	K	TRIMPOT	CERMET 25T
R134	3299Y-001-502	5.0000	K	TRIMPOT	CERMET 25T
R135	3299Y-001-502	5.0000	K	TRIMPOT	CERMET 25T
R136	6S11049C67	5.62	K	RESIST	FMF 1/4W 1% 100PPM
R137	6S11049C83	8.25	K	RESIST	FMF 1/4W 1% 100PPM
R138	6S11049C91	10	K	RESIST	FMF 1/4W 1% 100PPM
R139	6S11049C99	12.1	K	RESIST	FMF 1/4W 1% 100PPM
R140	6S11049C83	8.25	K	RESIST	FMF 1/4W 1% 100PPM
R141	6S11049C52	3.92	K	RESIST	FMF 1/4W 1% 100PPM
R142	6S11049C83	8.25	K	RESIST	FMF 1/4W 1% 100PPM
R143	6S11049C83	8.25	K	RESIST	FMF 1/4W 1% 100PPM
R144	6S11049C83	8.25	K	RESIST	FMF 1/4W 1% 100PPM
R145	6S11049C83	8.25	K	RESIST	FMF 1/4W 1% 100PPM
R146	6S11049C83	8.25	K	RESIST	FMF 1/4W 1% 100PPM
R147	6S11049E39	332	K	RESIST	FMF 1/4W 1% 100PPM
R148	6S11049C91	10	K	RESIST	FMF 1/4W 1% 100PPM
R149	6S11049D80	82.5	K	RESIST	FMF 1/4W 1% 100PPM
R150	6S11049D30	24.9	K	RESIST	FMF 1/4W 1% 100PPM
R151	6S11049D30	24.9	K	RESIST	FMF 1/4W 1% 100PPM
R152	6S11049C91	10	K	RESIST	FMF 1/4W 1% 100PPM
R153	6S11049C91	10	K	RESIST	FMF 1/4W 1% 100PPM
R154	6S11049D25	22.1	K	RESIST	FMF 1/4W 1% 100PPM
R155	6S11049D42	33.2	K	RESIST	FMF 1/4W 1% 100PPM
R156	6S11049D42	33.2	K	RESIST	FMF 1/4W 1% 100PPM
R157	6S11049D42	33.2	K	RESIST	FMF 1/4W 1% 100PPM
R158	6S11049D42	33.2	K	RESIST	FMF 1/4W 1% 100PPM
R159	6S11049D09	15	K	RESIST	FMF 1/4W 1% 100PPM
R160	6S11049B86	825		RESIST	FMF 1/4W 1% 100PPM
R161	6S11049C91	10	K	RESIST	FMF 1/4W 1% 100PPM
R162	6S11049C75	6.81	K	RESIST	FMF 1/4W 1% 100PPM
R163	6S11049C12	1.5	K	RESIST	FMF 1/4W 1% 100PPM

ID	PART NO.	VALUE	EXP	TYPE	DESCRIPTION

M10 CIRCUIT BOARD

ID	PART NO.	VALUE	EXP	TYPE	DESCRIPTION
R164	6S11049B86	825		RESIST	FMF 1/4W 1% 100PPM
R165	6S11049B86	825		RESIST	FMF 1/4W 1% 100PPM
R166	6S11049C12	1.5	K	RESIST	FMF 1/4W 1% 100PPM
R167	6S11049B86	825		RESIST	FMF 1/4W 1% 100PPM
R170	6S11049B86	825		RESIST	FMF 1/4W 1% 100PPM
R171	6S11049C12	1.5	K	RESIST	FMF 1/4W 1% 100PPM
R172	6S11049B86	825		RESIST	FMF 1/4W 1% 100PPM
R173	6S11049B86	825		RESIST	FMF 1/4W 1% 100PPM
R174	6S11049A97	100		RESIST	FMF 1/4W 1% 100PPM
R175	6S11049C12	1.5	K	RESIST	FMF 1/4W 1% 100PPM
R176	6S11049B23	182		RESIST	FMF 1/4W 1% 100PPM
R177	6S11049E14	182	K	RESIST	FMF 1/4W 1% 100PPM
R178	6S10164B19	330		RESIST	FCF 1/2W 5%
R179	6S11049E14	182	K	RESIST	FMF 1/4W 1% 100PPM
R180	6S10164B19	330		RESIST	FCF 1/2W 5%
R181	6S11049E14	182	K	RESIST	FMF 1/4W 1% 100PPM
R182	6S10164B19	330		RESIST	FCF 1/2W 5%
R183	6S11049E14	182	K	RESIST	FMF 1/4W 1% 100PPM
R184	6S10164B19	330		RESIST	FCF 1/2W 5%
R185	6S11049C75	6.81	K	RESIST	FMF 1/4W 1% 100PPM
R186	6S11049C75	6.81	K	RESIST	FMF 1/4W 1% 100PPM
R187	3299Y-001-502	5.0000	K	TRIMPOT	CERMET 25T
R188	6S11049C28	2.21	K	RESIST	FMF 1/4W 1% 100PPM
R189	6S11049C91	10	K	RESIST	FMF 1/4W 1% 100PPM
R190	6S11049C91	10	K	RESIST	FMF 1/4W 1% 100PPM
R191	6S11049C75	6.81	K	RESIST	FMF 1/4W 1% 100PPM
R192	6S11049C75	6.81	K	RESIST	FMF 1/4W 1% 100PPM
R193	3299Y-001-502	5.0000	K	TRIMPOT	CERMET 25T
R194	6S11049C28	2.21	K	RESIST	FMF 1/4W 1% 100PPM
R195	6S11049C91	10	K	RESIST	FMF 1/4W 1% 100PPM
R196	6S11049C91	10	K	RESIST	FMF 1/4W 1% 100PPM
R197	6S11049E06	150	K	RESIST	FMF 1/4W 1% 100PPM
R198	6S11049D80	82.5	K	RESIST	FMF 1/4W 1% 100PPM
R199	6S11049E14	182	K	RESIST	FMF 1/4W 1% 100PPM
R201	6S11049D57	47.5	K	RESIST	FMF 1/4W 1% 100PPM
R202	6S11049D96	121	K	RESIST	FMF 1/4W 1% 100PPM
R203	6S11049B94	1	K	RESIST	FMF 1/4W 1% 100PPM
R204	6S11049D49	39.2	K	RESIST	FMF 1/4W 1% 100PPM
R205	6S11049C99	12.1	K	RESIST	FMF 1/4W 1% 100PPM
R206	6S11049C51	1.21	K	RESIST	FMF 1/4W 1% 100PPM
R207	6S11049C99	12.1	K	RESIST	FMF 1/4W 1% 100PPM
R208	6S11049D49	39.2	K	RESIST	FMF 1/4W 1% 100PPM
R209	6S11049C99	12.1	K	RESIST	FMF 1/4W 1% 100PPM
R210	6S11049C51	1.21	K	RESIST	FMF 1/4W 1% 100PPM
R211	6S11049C99	12.1	K	RESIST	FMF 1/4W 1% 100PPM
R212	6S11049D42	33.2	K	RESIST	FMF 1/4W 1% 100PPM
R213	6S11049D42	33.2	K	RESIST	FMF 1/4W 1% 100PPM
R214	6S11049E22	221	K	RESIST	FMF 1/4W 1% 100PPM
R215	6S11049E22	221	K	RESIST	FMF 1/4W 1% 100PPM
R216	6S11049E61	562	K	RESIST	FMF 1/4W 1% 100PPM
R217	MF55D2214F	2.2100	M	RESIST	FMF 1/4W 1%
R219	6S11049E61	562	K	RESIST	FMF 1/4W 1% 100PPM
R220	3299Y-001-501	500.0000		TRIMPOT	CERMET 25T

ID	PART NO.	VALUE	EXP	TYPE	DESCRIPTION

M10 – CIRCUIT BOARD

ID	PART NO.	VALUE	EXP	TYPE	DESCRIPTION
R221	6S11049D88	100	K	RESIST	FMF 1/4W 1% 100PPM
R224	6S11049B70	562		RESIST	FMF 1/4W 1% 100PPM
R225	3299Y-001-502	5.0000	K	TRIMPOT	CERMET 25T
R227	6S11049D42	33.2	K	RESIST	FMF 1/4W 1% 100PPM
R228	6S11049C67	5.62	K	RESIST	FMF 1/4W 1% 100PPM
R229	6S11049B94	1	K	RESIST	FMF 1/4W 1% 100PPM
R230	3299Y-001-502	5.0000	K	TRIMPOT	CERMET 25T
R231	6S10164B19	330		RESIST	FCF 1/2W 5%
R232	6S11049C83	8.25	K	RESIST	FMF 1/4W 1% 100PPM
R233	6S11049C83	8.25	K	RESIST	FMF 1/4W 1% 100PPM
R234	6S11049D96	121	K	RESIST	FMF 1/4W 1% 100PPM
R235	6S11049D96	121	K	RESIST	FMF 1/4W 1% 100PPM
R236	6S11049C75	6.81	K	RESIST	FMF 1/4W 1% 100PPM
R237	6S11049D49	39.2	K	RESIST	FMF 1/4W 1% 100PPM
R238	6S11049C99	12.1	K	RESIST	FMF 1/4W 1% 100PPM
R239	6S11049C51	1.21	K	RESIST	FMF 1/4W 1% 100PPM
R240	6S11049C99	12.1	K	RESIST	FMF 1/4W 1% 100PPM
R241	6S11049C91	10	K	RESIST	FMF 1/4W 1% 100PPM
R242	3299Y-001-502	5.0000	K	TRIMPOT	CERMET 25T
R243	3299Y-001-502	5.0000	K	TRIMPOT	CERMET 25T
R244	6S11049C52	3.92	K	RESIST	FMF 1/4W 1% 100PPM
R245	3299Y-001-253	25.0000	K	TRIMPOT	CERMET 25T
R246	3299Y-001-502	5.0000	K	TRIMPOT	CERMET 25T
R247	3299Y-001-502	5.0000	K	TRIMPOT	CERMET 25T
R250	6S11049C67	5.62	K	RESIST	FMF 1/4W 1% 100PPM
R251	6S11049C45	3.32	K	RESIST	FMF 1/4W 1% 100PPM
R252	3299Y-001-502	5.0000	K	TRIMPOT	CERMET 25T
R255	3299Y-001-502	5.0000	K	TRIMPOT	CERMET 25T
R256	3299Y-001-502	5.0000	K	TRIMPOT	CERMET 25T
R258	3299Y-001-501	500.0000		TRIMPOT	CERMET 25T
R259	3299Y-001-502	5.0000	K	TRIMPOT	CERMET 25T
R260	3299Y-001-502	5.0000	K	TRIMPOT	CERMET 25T
R261	6S11049D42	33.2	K	RESIST	FMF 1/4W 1% 100PPM
R263	6S11049C91	10	K	RESIST	FMF 1/4W 1% 100PPM
R264	6S11049C91	10	K	RESIST	FMF 1/4W 1% 100PPM
S101	40-83249K05			SWITCH	SPDT PC MT.RT.ANG.
U101	TL082CP			IC	OP. AMP. DUAL
U102	MC1595L			IC	ANALOG MULTIPLIER
U103	MC1595L			IC	ANALOG MULTIPLIER
U104	LF347BN			IC	OP. AMP. QUAD
U105	LF347BN			IC	OP. AMP. QUAD
U106	LF347BN			IC	OP. AMP. QUAD
U107	51R84320A35			IC	TIMER MC1455P1
U108	51R84320A35			IC	TIMER MC1455P1
U109	51R84320A35			IC	TIMER MC1455P1
U110	51R84320A35			IC	TIMER MC1455P1
U111	LF347BN			IC	OP. AMP. QUAD
U112	LF347BN			IC	OP. AMP. QUAD
U113	LF347BN			IC	OP. AMP. QUAD
U114	51R84320A50			IC	PLL NE567V
U115	LF347BN			IC	OP. AMP. QUAD
U117	51R84320A51			IC	COMPARATOR MC3302P

ID	PART NO.	VALUE	EXP	TYPE	DESCRIPTION

M11 CIRCUIT BOARD

C304	473F01PP580	.0470	U	CAP	POLYPRO. 100V 1% NPO
C305	473F01PP580	.0470	U	CAP	POLYPRO. 100V 1% NPO
C312	473F01PP580	.0470	U	CAP	POLYPRO. 100V 1% NPO
C313	473F01PP580	.0470	U	CAP	POLYPRO. 100V 1% NPO
C317	23D84538G02	4.7000	U	CAP	TANTALUM 20V 20%
C318	23D84538G02	4.7000	U	CAP	TANTALUM 20V 20%
C319	ULB1H100MAA	10.0000	U	CAP	LYTIC 50V 20%
C320	ULB1H100MAA	10.0000	U	CAP	LYTIC 50V 20%
C321	ULB1H100MAA	10.0000	U	CAP	LYTIC 50V 20%
C322	ULB1H100MAA	10.0000	U	CAP	LYTIC 50V 20%
C323	23-11019A46	100.0000	U	CAP	LYTIC 25V
C324	21R40020S14	.4700	U	CAP	CER. 50V 20% Z5U
C325	21R40020S04	.0100	U	CAP	CER. 50V 20% Z5U
C326	23-11019A46	100.0000	U	CAP	LYTIC 25V
C327	21R40020S14	.4700	U	CAP	CER. 50V 20% Z5U
C328	21R40020S04	.0100	U	CAP	CER. 50V 20% Z5U
C329	23-11019A46	100.0000	U	CAP	LYTIC 25V
C334	23-11019A46	100.0000	U	CAP	LYTIC 25V
C335	21R40020S03	.1000	U	CAP	CER. 50V 20% Z5U
C336	21R40020S03	.1000	U	CAP	CER. 50V 20% Z5U
C337	23-11019A46	100.0000	U	CAP	LYTIC 25V
C338	23-11019A46	100.0000	U	CAP	LYTIC 25V
C339	23-11019A46	100.0000	U	CAP	LYTIC 25V
C340	8S11017A14	.0470	U	CAP	MYLAR 50V 5%
C341	8S11017A14	.0470	U	CAP	MYLAR 50V 5%
C342	23-11019A46	100.0000	U	CAP	LYTIC 25V
C343	23-11019A46	100.0000	U	CAP	LYTIC 25V
C344	21D83596E23	.0047	U	CAP	DISC 200V 10% Y5R
C345	21R40020S14	.4700	U	CAP	CER. 50V 20% Z5U
C346	21R40020S14	.4700	U	CAP	CER. 50V 20% Z5U
C347	21R40020S14	.4700	U	CAP	CER. 50V 20% Z5U
C348	21R40020S14	.4700	U	CAP	CER. 50V 20% Z5U
C349	21D83596E23	.0047	U	CAP	DISC 200V 10% Y5R
C350	21R40020S14	.4700	U	CAP	CER. 50V 20% Z5U
C351	21R40020S14	.4700	U	CAP	CER. 50V 20% Z5U
C352	21D82133G35	56.0000	P	CAP	DISC 500V 5% NPO
C353	21D82133G35	56.0000	P	CAP	DISC 500V 5% NPO
C354	IR67683K/J	.068	U	CAP	MET.POLY. 63V 2%
C355	IR67683K/J	.068	U	CAP	MET.POLY. 63V 2%
C356	8S11017A01	.0010	U	CAP	MET. POLY. 50V 5%
C357	8S11017A01	.0010	U	CAP	MET. POLY. 50V 5%
C358	21R40020S03	.1000	U	CAP	CER. 50V 20% Z5U
C359	21R40020S03	.1000	U	CAP	CER. 50V 20% Z5U
C360	21R40020S03	.1000	U	CAP	CER. 50V 20% Z5U
C361	21R40020S03	.1000	U	CAP	CER. 50V 20% Z5U
D301	48D84616A04			DIODE	HOT CARRIER
D302	48D84616A04			DIODE	HOT CARRIER
D304	48D84616A04			DIODE	HOT CARRIER
D305	48D84616A04			DIODE	HOT CARRIER
Q301	48R00869570			TRANSIST	NPN 9570
R318	6S11049E69	681	K	RESIST	FMF 1/4W 1% 100PPM
R319	6S11049E69	681	K	RESIST	FMF 1/4W 1% 100PPM
R320	6S11049D64	56.2	K	RESIST	FMF 1/4W 1% 100PPM
R321	6S11049D64	56.2	K	RESIST	FMF 1/4W 1% 100PPM
R322	6S11049D64	56.2	K	RESIST	FMF 1/4W 1% 100PPM

ID	PART NO.	VALUE	EXP	TYPE	DESCRIPTION

M11 CIRCUIT BOARD

ID	PART NO.	VALUE	EXP	TYPE	DESCRIPTION
R323	6S11049D64	56.2	K	RESIST	FMF 1/4W 1% 100PPM
R324	6S11049D64	56.2	K	RESIST	FMF 1/4W 1% 100PPM
R325	3299Y-001-104	100.0000	K	TRIMPOT	CERMET 25T
R326	6S11049E30	267	K	RESIST	FMF 1/4W 1% 100PPM
R343	6S11049A97	100		RESIST	FMF 1/4W 1% 100PPM
R356	6S11049E69	681	K	RESIST	FMF 1/4W 1% 100PPM
R357	6S11049E69	681	K	RESIST	FMF 1/4W 1% 100PPM
R358	6S11049D64	56.2	K	RESIST	FMF 1/4W 1% 100PPM
R359	6S11049D64	56.2	K	RESIST	FMF 1/4W 1% 100PPM
R360	6S11049D64	56.2	K	RESIST	FMF 1/4W 1% 100PPM
R361	6S11049D64	56.2	K	RESIST	FMF 1/4W 1% 100PPM
R362	6S11049D64	56.2	K	RESIST	FMF 1/4W 1% 100PPM
R363	3299Y-001-104	100.0000	K	TRIMPOT	CERMET 25T
R364	6S11049E30	267	K	RESIST	FMF 1/4W 1% 100PPM
R377	6S11049D42	33.2	K	RESIST	FMF 1/4W 1% 100PPM
R378	6S11049C91	10	K	RESIST	FMF 1/4W 1% 100PPM
R379	6S11049C83	8.25	K	RESIST	FMF 1/4W 1% 100PPM
R380	3299Y-001-502	5.0000	K	TRIMPOT	CERMET 25T
R381	6S11049C83	8.25	K	RESIST	FMF 1/4W 1% 100PPM
R382	6S11049C83	8.25	K	RESIST	FMF 1/4W 1% 100PPM
R383	3299Y-001-502	5.0000	K	TRIMPOT	CERMET 25T
R384	6S11049C83	8.25	K	RESIST	FMF 1/4W 1% 100PPM
R385	3299Y-001-502	5.0000	K	TRIMPOT	CERMET 25T
R386	6S11049C28	2.21	K	RESIST	FMF 1/4W 1% 100PPM
R387	3299Y-001-502	5.0000	K	TRIMPOT	CERMET 25T
R389	6S11049A97	100		RESIST	FMF 1/4W 1% 100PPM
R390	6S11049A97	100		RESIST	FMF 1/4W 1% 100PPM
R391	6S11049A97	100		RESIST	FMF 1/4W 1% 100PPM
R392	6S11049A97	100		RESIST	FMF 1/4W 1% 100PPM
R394	6S11049A97	100		RESIST	FMF 1/4W 1% 100PPM
R395	6S11049B86	825		RESIST	FMF 1/4W 1% 100PPM
R396	6S11049B86	825		RESIST	FMF 1/4W 1% 100PPM
R397	6S11049C12	1.5	K	RESIST	FMF 1/4W 1% 100PPM
R398	6S11049D96	121	K	RESIST	FMF 1/4W 1% 100PPM
R399	6S11049D42	33.2	K	RESIST	FMF 1/4W 1% 100PPM
R401	6S11049B94	1	K	RESIST	FMF 1/4W 1% 100PPM
R402	3299Y-001-501	500.0000		TRIMPOT	CERMET 25T
R403	6S11049D42	33.2	K	RESIST	FMF 1/4W 1% 100PPM
R404	6S11049D96	121	K	RESIST	FMF 1/4W 1% 100PPM
R405	6S11049E14	182	K	RESIST	FMF 1/4W 1% 100PPM
R406	6S10164B19	330		RESIST	FCF 1/2W 5%
R407	6S10164B19	330		RESIST	FCF 1/2W 5%
R408	6S11049B86	825		RESIST	FMF 1/4W 1% 100PPM
R409	6S11049B86	825		RESIST	FMF 1/4W 1% 100PPM
R410	6S11049D96	121	K	RESIST	FMF 1/4W 1% 100PPM
R411	6S11049D42	33.2	K	RESIST	FMF 1/4W 1% 100PPM
R412	6S11049B94	1	K	RESIST	FMF 1/4W 1% 100PPM
R413	3299Y-001-501	500.0000		TRIMPOT	CERMET 25T
R414	6S11049D42	33.2	K	RESIST	FMF 1/4W 1% 100PPM
R415	6S11049D96	121	K	RESIST	FMF 1/4W 1% 100PPM
R416	6S11049E14	182	K	RESIST	FMF 1/4W 1% 100PPM
R417	6S10164B19	330		RESIST	FCF 1/2W 5%
R418	6S10164B19	330		RESIST	FCF 1/2W 5%
R419	6S11049C91	10	K	RESIST	FMF 1/4W 1% 100PPM

ID	PART NO.	VALUE	EXP	TYPE	DESCRIPTION

M11 CIRCUIT BOARD

ID	PART NO.	VALUE	EXP	TYPE	DESCRIPTION
R421	6S11049C12	1.5	K	RESIST	FMF 1/4W 1% 100PPM
R422	6S11049B15	150		RESIST	FMF 1/4W 1% 100PPM
R425	6S11049C67	5.62	K	RESIST	FMF 1/4W 1% 100PPM
R426	6S11049C28	2.21	K	RESIST	FMF 1/4W 1% 100PPM
R427	6S11049C28	2.21	K	RESIST	FMF 1/4W 1% 100PPM
R428	6S11049C12	1.5	K	RESIST	FMF 1/4W 1% 100PPM
R429	6S11049C12	1.5	K	RESIST	FMF 1/4W 1% 100PPM
R430	6S11049D88	100	K	RESIST	FMF 1/4W 1% 100PPM
R431	6S11049D88	100	K	RESIST	FMF 1/4W 1% 100PPM
R432	6S11049C59	4.64	K	RESIST	FMF 1/4W 1% 100PPM
R433	6S11049A97	100		RESIST	FMF 1/4W 1% 100PPM
R434	6S11049A01	10		RESIST	FMF 1/4W 1% 100PPM
R435	6S11049A01	10		RESIST	FMF 1/4W 1% 100PPM
R436	6S11049C59	4.64	K	RESIST	FMF 1/4W 1% 100PPM
R437	6S11049A97	100		RESIST	FMF 1/4W 1% 100PPM
R438	6S11049C28	2.21	K	RESIST	FMF 1/4W 1% 100PPM
R439	6S11049C60	4.75	K	RESIST	FMF 1/4W 1% 100PPM
R440	6S11049D88	100	K	RESIST	FMF 1/4W 1% 100PPM
R441	6S00124B54	22	M	RESIST	FMF 1/4W 5%
R442	6S11049C56	4.32	K	RESIST	FMF 1/4W 1% 100PPM
R443	6S11049C91	10	K	RESIST	FMF 1/4W 1% 100PPM
R444	6S11049C75	6.81	K	RESIST	FMF 1/4W 1% 100PPM
R445	6S11049C91	10	K	RESIST	FMF 1/4W 1% 100PPM
R446	6S11049C60	4.75	K	RESIST	FMF 1/4W 1% 100PPM
R447	6S11049D88	100	K	RESIST	FMF 1/4W 1% 100PPM
R448	6S00124B54	22	M	RESIST	FMF 1/4W 5%
R449	6S11049C56	4.32	K	RESIST	FMF 1/4W 1% 100PPM
R450	6S11049C91	10	K	RESIST	FMF 1/4W 1% 100PPM
R451	6S11049C75	6.81	K	RESIST	FMF 1/4W 1% 100PPM
R452	6S11049C91	10	K	RESIST	FMF 1/4W 1% 100PPM
R453	6S11049C28	2.21	K	RESIST	FMF 1/4W 1% 100PPM
R454	6S11049C28	2.21	K	RESIST	FMF 1/4W 1% 100PPM
R455	6S11049C91	10	K	RESIST	FMF 1/4W 1% 100PPM
R456	6S11049C91	10	K	RESIST	FMF 1/4W 1% 100PPM
R457	6S11049C91	10	K	RESIST	FMF 1/4W 1% 100PPM
R458	6S11049C91	10	K	RESIST	FMF 1/4W 1% 100PPM
R461	6S11049C91	10	K	RESIST	FMF 1/4W 1% 100PPM
R462	6S11049C91	10	K	RESIST	FMF 1/4W 1% 100PPM
R463	6S11049D25	22.1	K	RESIST	FMF 1/4W 1% 100PPM
R464	6S11049C91	10	K	RESIST	FMF 1/4W 1% 100PPM
R465	6S11049D42	33.2	K	RESIST	FMF 1/4W 1% 100PPM
R466	6S11049C91	10	K	RESIST	FMF 1/4W 1% 100PPM
R467	6S11049B94	1	K	RESIST	FMF 1/4W 1% 100PPM
R468	6S11049B48	332		RESIST	FMF 1/4W 1% 100PPM
R470	6S11049B39	267		RESIST	FMF 1/4W 1% 100PPM
R471	6S11049B39	267		RESIST	FMF 1/4W 1% 100PPM
R472	6S11049B48	332		RESIST	FMF 1/4W 1% 100PPM
R473	6S11049B48	332		RESIST	FMF 1/4W 1% 100PPM
R474	6S11049C28	2.21	K	RESIST	FMF 1/4W 1% 100PPM
R475	6S11049C28	2.21	K	RESIST	FMF 1/4W 1% 100PPM
R476	6S11049B94	1	K	RESIST	FMF 1/4W 1% 100PPM
R477	6S11049B94	1	K	RESIST	FMF 1/4W 1% 100PPM
R478	6S11049C28	2.21	K	RESIST	FMF 1/4W 1% 100PPM
R479	6S11049C28	2.21	K	RESIST	FMF 1/4W 1% 100PPM

ID	PART NO.	VALUE	EXP	TYPE	DESCRIPTION

M11 CIRCUIT BOARD

ID	PART NO.	VALUE	EXP	TYPE	DESCRIPTION
R480	3299Y-001-502	5.0000	K	TRIMPOT	CERMET 25T
R481	3299Y-001-502	5.0000	K	TRIMPOT	CERMET 25T
T301	M47A254			TRANSF	AUDIO 1500/600 OHM
T302	M47A254			TRANSF	AUDIO 1500/600 OHM
U301	LF347BN			IC	OP. AMP. QUAD
U302	LF347BN			IC	OP. AMP. QUAD
U303	TL082CP			IC	OP. AMP. DUAL
U304	LF347BN			IC	OP. AMP. QUAD
U305	LF347BN			IC	OP. AMP. QUAD
U306	51R84320A51			IC	COMPARATOR MC3302P
U307	51R84320A35			IC	TIMER MC1455P1
U308	LF347BN			IC	OP. AMP. QUAD
U309	LF347BN			IC	OP. AMP. QUAD
U310	51R84320A35			IC	TIMER MC1455P1

M12 CIRCUIT BOARD

ID	PART NO.	VALUE	EXP	TYPE	DESCRIPTION
R804	6S11049C28	2.2100	K	RESIST	FMF 1/4W 1% 100PPM
R806	6S11049B78	681.0000		RESIST	FMF 1/4W 1% 100PPM
R808	6S11049B31	221.0000		RESIST	FMF 1/4W 1% 100PPM
R810	6S11049A81	68.1000		RESIST	FMF 1/4W 1% 100PPM
R812	6S11049A34	22.1000		RESIST	FMF 1/4W 1% 100PPM
R814	6S11049A01	10.0000		RESIST	FMF 1/4W 1% 100PPM
R818	18D84944C12	5.0000	K	TRIMPOT	CARBON
S802	591C42-18A			SWITCH	PB 10 SECT SCHADOW R

M13 CIRCUIT BOARD

ID	PART NO.	VALUE	EXP	TYPE	DESCRIPTION
R803	6S11049C28	2.2100	K	RESIST	FMF 1/4W 1% 100PPM
R805	6S11049B78	681.0000		RESIST	FMF 1/4W 1% 100PPM
R807	6S11049B31	221.0000		RESIST	FMF 1/4W 1% 100PPM
R809	6S11049A81	68.1000		RESIST	FMF 1/4W 1% 100PPM
R811	6S11049A34	22.1000		RESIST	FMF 1/4W 1% 100PPM
R813	6S11049A01	10.0000		RESIST	FMF 1/4W 1% 100PPM
R817	18D84944C12	5.0000	K	TRIMPOT	CARBON
S801	591C42-18B			SWITCH	PB 10 SECT SCHADOW L

M26 CIRCUIT BOARD

ID	PART NO.	VALUE	EXP	TYPE	DESCRIPTION
C1000	YA2A152K	.0015	U	CAP	METALIZED POL. NICH.
C1001	YA2A152K	.0015	U	CAP	METALIZED POL. NICH.
C1002	21R40020S03	.1000	U	CAP	CER. 50V 20% Z5U
C1003	21R40020S03	.1000	U	CAP	CER. 50V 20% Z5U
C1004	21R40020S03	.1000	U	CAP	CER. 50V 20% Z5U
C1005	21R40020S03	.1000	U	CAP	CER. 50V 20% Z5U
C1006	23D84908L01	2.2000	U	CAP	LYTIC 50V NONPOLARIZED
C1007	23D84908L01	2.2000	U	CAP	LYTIC 50V NONPOLARIZED
C1008	ULB1V221M	220	U	CAP	LYTIC 35V

ID	PART NO.	VALUE	EXP	TYPE	DESCRIPTION

M26 CIRCUIT BOARD

ID	PART NO.	VALUE	EXP	TYPE	DESCRIPTION
C1009	ULB1V221M	220	U	CAP	LYTIC 35V
C1010	ULB1V221M	220	U	CAP	LYTIC 35V
C1011	ULB1V221M	220	U	CAP	LYTIC 35V
C1012	ULB1V221M	220	U	CAP	LYTIC 35V
R1000	6S11049D33	26.7000	K	RESIST	FCF 1/4W 1% 100PPM
R1001	6S11049D33	26.7000	K	RESIST	FCF 1/4W 1% 100PPM
R1002	3386P15K	5.0	K	TRIMPOT	CERMET 1T
R1003	3386P15K	5.0	K	TRIMPOT	CERMET 1T
R1004	6S11049C91	10.0000	K	RESIST	FCF 1/4W 1% 100PPM
R1005	6S11049C91	10.0000	K	RESIST	FCF 1/4W 1% 100PPM
R1006	6S11049D57	47.5	K	RESIST	FMF 1/4W 1% 100PPM
R1007	6S11049D57	47.5	K	RESIST	FMF 1/4W 1% 100PPM
R1008	6S11049E06	150.0000	K	RESIST	FCF 1/4W 1% 100PPM
R1009	6S11049E06	150.0000	K	RESIST	FCF 1/4W 1% 100PPM
R1010	6S11049C28	2.21000	K	RESIST	FCF 1/4W 1% 100PPM
R1011	6S11049C28	2.21000	K	RESIST	FCF 1/4W 1% 100PPM
U1000	LM378N			IC	AUDIO AMP

M27 CIRCUIT BOARD

*SPECIAL PARTS USED ON SOME BOARDS

ID	PART NO.	VALUE	EXP	TYPE	DESCRIPTION
*C732	*SXK333	330	P	CAP	POLY.STY. 33V 5% MALLORY
*L705	*82-0522			TRANSF	RF IF3 10MM
*R739	*6S11049B23	182		RESIST	FMF 1/4W 1% 100PPM
*X701	*48PD1003			XTAL	9.216 MHZ (CINOX)
C701	SXK333	330	P	CAP	POLY.STY. 33V 5% MALLORY
C702	21R40020S03	.1000	U	CAP	CER. 50V 20% Z5U
C703	8S11017A01	.0010	U	CAP	MET. POLY. 50V 5%
C704	8S11017A01	.0010	U	CAP	MET. POLY. 50V 5%
C705	21R40020S03	.1000	U	CAP	CER. 50V 20% Z5U
C706	SXK333	330	P	CAP	POLY.STY. 33V 5% MALLORY
C707	ULB1V100MA	10	U	CAP	LYTIC 35V
C708	21R40020S03	.1000	U	CAP	CER. 50V 20% Z5U
C709	10P/5NPO	10	P	CAP	CER EDPT 3X4(5% NPO)
C710	10-S-T-06	30.0000	P	TRIMCAP	CERAMIC 5/30 PFD N750
C711	68PN1500	68	P	CAP	CER EDPT 3X4(5% N1500)
C712	ULB1V100MA	10	U	CAP	LYTIC 35V
C713	21R40020S03	.1000	U	CAP	CER. 50V 20% Z5U
C714	8S11017A08	.0100	U	CAP	MET. POLY. 50V 5%
C715	8S11017A08	.0100	U	CAP	MET. POLY. 50V 5%
C716	47P/5N1500	47	P	CAP	CER EDPT 3X4(5% N1500)
C717	8S11017A08	.0100	U	CAP	MET. POLY. 50V 5%
C718	21R40020S03	.1000	U	CAP	CER. 50V 20% Z5U
C719	8S11017A08	.0100	U	CAP	MET. POLY. 50V 5%
C720	8S11017A11	.0220	U	CAP	MET. POLY. 50V 5%
C721	RPE113X7R684K50V	.68	U	CAP	CER 50V X7R
C722	23-11019A46	100.0000	U	CAP	LYTIC 25V
C723	ULB1V100MA	10	U	CAP	LYTIC 35V
C724	21R40020S03	.1000	U	CAP	CER. 50V 20% Z5U
C725	21R40020S03	.1000	U	CAP	CER. 50V 20% Z5U
C726	8S11017A13	.0330	U	CAP	MET. POLY. 50V 5%
C727	21D82187B08	220.0000	P	CAP	DISC 1KV 10% Z5F

M27 CIRCUIT BOARD

*SPECIAL PARTS USED ON SOME BOARDS

ID	PART NO.	VALUE	EXP	TYPE	DESCRIPTION
C728	21R40020S03	.1000	U	CAP	CER. 50V 20% Z5U
C729	21R40020S03	.1000	U	CAP	CER. 50V 20% Z5U
C730	21R40020S03	.1000	U	CAP	CER. 50V 20% Z5U
C731	15P/5N750	15	P	CAP	CER EDPT 3X4(5% N750)
D701	1N4148			DIODE	SIGNAL ITT
D702	1N4148			DIODE	SIGNAL ITT
D703	1N4148			DIODE	SIGNAL ITT
D704	MVAM109			DIODE	VARACTOR
D705	1N4148			DIODE	SIGNAL ITT
D706	1N4148			DIODE	SIGNAL ITT
L701	82-0520			TRANSF	RF IF1 10MM
L702	T2.5-6T			TRANSF	RF BROAD BAND
L703	82-0521			TRANSF	RF IF2 10MM
L704	24PD1001			TRANSF	RF VCO 840709 GRY
Q701	48R00869878			TRANSIST	FET 9878
Q702	48R00869571			TRANSIST	PNP 9571
Q703	48R00869570			TRANSIST	NPN 9570
Q704	48R00869570			TRANSIST	NPN 9570
R701	6S11049B55	392		RESIST	FMF 1/4W 1% 100PPM
R702	6S11049E61	562	K	RESIST	FMF 1/4W 1% 100PPM
R703	6S11049B86	825		RESIST	FMF 1/4W 1% 100PPM
R704	6S11049A34	22.1		RESIST	FMF 1/4W 1% 100PPM
R705	6S11049A34	22.1		RESIST	FMF 1/4W 1% 100PPM
R706	6S11049B48	332		RESIST	FMF 1/4W 1% 100PPM
R707	6S11049A81	68.1		RESIST	FMF 1/4W 1% 100PPM
R708	6S11049A81	68.1		RESIST	FMF 1/4W 1% 100PPM
R709	6S11049B94	1	K	RESIST	FMF 1/4W 1% 100PPM
R710	6S11049C83	8.25	K	RESIST	FMF 1/4W 1% 100PPM
R711	6S11049A97	100		RESIST	FMF 1/4W 1% 100PPM
R712	6S11049B59	432		RESIST	FMF 1/4W 1% 100PPM
R713	6S11049A97	100		RESIST	FMF 1/4W 1% 100PPM
R714	6S11049C37	2.74	K	RESIST	FMF 1/4W 1% 100PPM
R715	6S11049C28	2.21	K	RESIST	FMF 1/4W 1% 100PPM
R716	6S11049B08	127		RESIST	FMF 1/4W 1% 100PPM
R717	6S11049B55	392		RESIST	FMF 1/4W 1% 100PPM
R718	6S11049D88	100	K	RESIST	FMF 1/4W 1% 100PPM
R719	6S11049C91	10	K	RESIST	FMF 1/4W 1% 100PPM
R720	6S11049C15	1.62	K	RESIST	FMF 1/4W 1% 100PPM
R721	6S11049B78	681		RESIST	FMF 1/4W 1% 100PPM
R722	6S11049B08	127		RESIST	FMF 1/4W 1% 100PPM
R723	6S11049B48	332		RESIST	FMF 1/4W 1% 100PPM
R724	6S11049C49	3.65	K	RESIST	FMF 1/4W 1% 100PPM
R725	6S11049B48	332		RESIST	FMF 1/4W 1% 100PPM
R726	6S11049A97	100		RESIST	FMF 1/4W 1% 100PPM
R727	6S11049A01	10		RESIST	FMF 1/4W 1% 100PPM
R728	6S11049B31	221		RESIST	FMF 1/4W 1% 100PPM
R729	6S11049D42	33.2	K	RESIST	FMF 1/4W 1% 100PPM
R730	6S11049C45	3.32	K	RESIST	FMF 1/4W 1% 100PPM
R731	6S11049A97	100		RESIST	FMF 1/4W 1% 100PPM
R732	6S11049B23	182		RESIST	FMF 1/4W 1% 100PPM
R733	6S11049B78	681		RESIST	FMF 1/4W 1% 100PPM
R734	6S11049A66	47.5		RESIST	FMF 1/4W 1% 100PPM
R735	6S11049C51	1.21	K	RESIST	FMF 1/4W 1% 100PPM

ID	PART NO.	VALUE	EXP	TYPE	DESCRIPTION

M27 CIRCUIT BOARD

*SPECIAL PARTS USED ON SOME BOARDS

ID	PART NO.	VALUE	EXP	TYPE	DESCRIPTION
R736	6S11049B78	681		RESIST	FMF 1/4W 1% 100PPM
R737	6S11049A34	22.1		RESIST	FMF 1/4W 1% 100PPM
R738	6S11049C45	3.32	K	RESIST	FMF 1/4W 1% 100PPM
S701	76SB08S			SWITCH	8PST DIP
U701	MC1596L			IC	BALANCED MODULATOR
U702	CA3183			IC	TRANSISTOR ARRAY
U703	MC145151			IC	FREQ.SYNTH.
U704	MC10131L			IC	D FF DUAL
X701	48PD1002-X2			XTAL	10.24 MHZ (CINOX)

M41 CIRCUIT BOARD

ID	PART NO.	VALUE	EXP	TYPE	DESCRIPTION
C501	500R23N101KP4	100	P	CAP	CHIP 10% 500V NPO
C502	500R23N101KP4	100	P	CAP	CHIP 10% 500V NPO
C503	8S11017A14	.047	U	CAP	MET. POLY. 50V 5%
C504	8S11017A14	.047	U	CAP	MET. POLY. 50V 5%
C508	500R23N101KP4	100	P	CAP	CHIP 10% 500V NPO
C510	8S11017A14	.047	U	CAP	MET. POLY. 50V 5%
C512	C5A223G	.022	U	CAP	MET.POLYCAR 2% 30V
C513	*	.001	U	CAP	CHIP 10% 500V NPO
C514	A12A222FSW	.0022	U	CAP	MET.POLYCAR 30V 1%
C515	A12A222FSW	.0022	U	CAP	MET.POLYCAR 30V 1%
C516	8S11017A17	.1000	U	CAP	MET. POLY. 50V 5%
C517	8S11017A17	.1000	U	CAP	MET. POLY. 50V 5%
C518	A12A222FSW	.0022	U	CAP	MET.POLYCAR 30V 1%
C519	A12A222FSW	.0022	U	CAP	MET.POLYCAR 30V 1%
C524	8-10212A10	1.0000	U	CAP	100V 10%
C525	8-10299B13	6.8000	U	CAP	100V 10%
C527	A12A222FSW	.0022	U	CAP	MET.POLYCAR 30V 1%
C530	8S11017A14	.047	U	CAP	MET. POLY. 50V 5%
C533	8S11017A14	.047	U	CAP	MET. POLY. 50V 5%
C534	A12A222FSW	.0022	U	CAP	MET.POLYCAR 30V 1%
C539	500R16N300JP4	30	P	CAP	CHIP 10% 500V NPO
C540	8S11017A14	.047	U	CAP	MET. POLY. 50V 5%
C541	500R16N300JP4	30	P	CAP	CHIP 10% 500V NPO
C542	8S11017A14	.047	U	CAP	MET. POLY. 50V 5%
C548	21D82133G03	100	P	CAP	DISC 500V 5% N750
C549	21D82133G03	100	P	CAP	DISC 500V 5% N750
C553	KP1838	.0047	U	CAP	POLYPRO. 63V 2.5%
C554	KP1838	.0047	U	CAP	POLYPRO. 63V 2.5%
C555	KP1838	.0047	U	CAP	POLYPRO. 63V 2.5%
C556	KP1838	.0047	U	CAP	POLYPRO. 63V 2.5%
C557	8S11017A14	.047	U	CAP	MET. POLY. 50V 5%
C559	8S11017A10	.0100	U	CAP	MET. POLY. 50V 5%
C560	8S11017A14	.047	U	CAP	MET. POLY. 50V 5%
C561	21D82133G35	56	P	CAP	DISC 500V 5% NPO
C562	21D82133G03	100	P	CAP	DISC 500V 5% N750
C564	KP1838	.0047	U	CAP	POLYPRO. 63V 2.5%
C565	KP1838	.0047	U	CAP	POLYPRO. 63V 2.5%
C566	8S11017A14	.047	U	CAP	MET. POLY. 50V 5%
C568	8S11017A14	.047	U	CAP	MET. POLY. 50V 5%

ID	PART NO.	VALUE	EXP	TYPE	DESCRIPTION

M41 CIRCUIT BOARD

ID	PART NO.	VALUE	EXP	TYPE	DESCRIPTION
C570	8S11017A14	.047	U	CAP	MET. POLY. 50V 5%
C571	8S11017A14	.047	U	CAP	MET. POLY. 50V 5%
C572	8S11017A14	.047	U	CAP	MET. POLY. 50V 5%
C573	8S11017A14	.047	U	CAP	MET. POLY. 50V 5%
C581	8S11017A14	.047	U	CAP	MET. POLY. 50V 5%
C582	8S11017A14	.047	U	CAP	MET. POLY. 50V 5%
C583	8S11017A14	.047	U	CAP	MET. POLY. 50V 5%
C584	500R16N300JP4	30	P	CAP	CHIP 10% 500V NPO
C585	500R16N300JP4	30	P	CAP	CHIP 10% 500V NPO
C586	21D83162H33	.0018	U	CAP	CERAMIC 50V 5% NPO
C587	SXK333	330	U	CAP	POLY.STY. 33V 5%
C588	8S11017A01	.0010	U	CAP	MET. POLY. 50V 5%
C590	21R40020S14	.4700	U	CAP	CER. 50V 20% Z5U
C591	21D82133G83	33	P	CAP	DISC 500V 5% N150
C592	8S11017A14	.047	U	CAP	MET. POLY. 50V 5%
C593	500R23N101KP4	100	P	CAP	CHIP 10% 500V NPO
C594	500R23N101KP4	100	P	CAP	CHIP 10% 500V NPO
C601	A12A222FSW	.0022	U	CAP	MET.POLYCAR 30V 1%
C602	A12A222FSW	.0022	U	CAP	MET.POLYCAR 30V
C603	8S11017A14	.047	U	CAP	MET. POLY. 50V 5%
C604	A12A222FSW	.0022	U	CAP	MET.POLYCAR 30V 1%
C605	A12A222FSW	.0022	U	CAP	MET.POLYCAR 30V 1%
C606	8S11017A14	.047	U	CAP	MET. POLY. 50V 5%
C607	A12A222FSW	.0022	U	CAP	MET.POLYCAR 30V 1%
C608	A12A222FSW	.0022	U	CAP	MET.POLYCAR 30V 1%
C609	8S11017A11	.0220	U	CAP	MET. POLY. 50V 5%
C610	8S11017A14	.047	U	CAP	MET. POLY. 50V 5%
C611	8S11017A14	.047	U	CAP	MET. POLY. 50V 5%
C612	8S11017A14	.047	U	CAP	MET. POLY. 50V 5%
C613	C5A223G	.022	U	CAP	MET.POLYCAR 2% 30V
C614	C5A223G	.022	U	CAP	MET POLYCAR 2% 30V
C615	ULB1H3R3M	3.3	U	CAP	LYTIC 50V 20%
C616	ULB1H3R3M	3.3	U	CAP	LYTIC 50V 20%
C617	10P/5NPO	10	P	CAP	CER EDPT 3X4(5% N750)
C618	10P/5NPO	10	P	CAP	CER EDPT 3X4(5% N750)
C619	C5A223G	.022	U	CAP	MET POLYCAR 2% 30V
C620	500R23N101KP4	100	P	CAP	CHIP 10% 500V NPO
C621	500R23N101KP4	100	P	CAP	CHIP 10% 500V NPO
C622	500R23N101KP4	100	P	CAP	CHIP 10% 500V NPO
C623	500R23N101KP4	100	P	CAP	CHIP 10% 500V NPO
C624	500R23N101KP4	100	P	CAP	CHIP 10% 500V NPO
C625	500R16N300JP4	30	P	CAP	CHIP 10% 500V NPO
C626	500R16N300JP4	30	P	CAP	CHIP 10% 500V NPO
C627	500R23N101KP4	100	P	CAP	CHIP 10% 500V NPO
C628	500R23N101KP4	100	P	CAP	CHIP 10% 500V NPO
C629	500R23N101KP4	100	P	CAP	CHIP 10% 500V NPO
C630	500R23N101KP4	100	P	CAP	CHIP 10% 500V NPO
C631	500R23N101KP4	100	P	CAP	CHIP 10% 500V NPO
C632	8S11017A14	.047	U	CAP	MET. POLY. 50V 5%
C633	500R23N101KP4	100	P	CAP	CHIP 10% 500V NPO
C634	500R23N101KP4	100	P	CAP	CHIP 10% 500V NPO
C635	500R23N101KP4	100	P	CAP	CHIP 10% 500V NPO
C636	500R23N101KP4	100	P	CAP	CHIP 10% 500V NPO
C637	500R23N101KP4	100	P	CAP	CHIP 10% 500V NPO

ID	PART NO.	VALUE	EXP	TYPE	DESCRIPTION
M41 CIRCUIT BOARD					
C638	8S11017A14	.047	U	CAP	MET. POLY. 50V 5%
C639	8S11017A14	.047	U	CAP	MET. POLY. 50V 5%
C640	8S11017A14	.047	U	CAP	MET. POLY. 50V 5%
C641	**	68	P	CAP	CHIP 10% 500V NPO
D501	1N4148			DIODE	SIGNAL ITT
D503	48-82190H32			DIODE	VARACTOR MV109
D504	1N4148			DIODE	SIGNAL ITT
D505	1N4148			DIODE	SIGNAL ITT
D506	1N4148			DIODE	SIGNAL ITT
D507	1N4148			DIODE	SIGNAL ITT
D508	1N4148			DIODE	SIGNAL ITT
E501	741A7			RELAY	REED GORDOS
L501	82-0523			TRANSF	RF IF4 10MM
L502	82-0522			TRANSF	RF IF3 10MM
L503	83-0638			TRANSF	RF TRAP 900KHZ
L504	83-0638			TRANSF	RF TRAP 900KHZ
L505	83-0638			TRANSF	RF TRAP 900KHZ
L506	84-0726			COIL	RF TRAP 1800KHZ
Q501	48R00869571			TRANSIST	PNP 9571
Q502	48R00869571			TRANSIST	PNP 9571
Q503	48R00869570			TRANSIST	NPN 9570
Q504	48R00869570			TRANSIST	NPN 9570
Q509	48R00869878			TRANSIST	FET 9878
Q510	48R00869570			TRANSIST	NPN 9570
Q511	48R00869571			TRANSIST	PNP 9571
Q512	48R00869571			TRANSIST	PNP 9571
Q513	48R00869878			TRANSIST	FET 9878
Q514	48R00869570			TRANSIST	NPN 9570
R501	3299Y-001-103	10	K	TRIMPOT	CERMET 25T
R502	3299Y-001-504	500	K	TRIMPOT	CERMET 25T
R503	3299Y-001-101	100		TRIMPOT	CERMET 25T
R504	3299Y-001-101	100		TRIMPOT	CERMET 25T
R505	3299Y-001-501	500.0000		TRIMPOT	CERMET 25T
R509	6S11049B39	267		RESIST	FMF 1/4W 1% 100PPM
R510	6S11049B39	267		RESIST	FMF 1/4W 1% 100PPM
R511	6S11049B63	475		RESIST	FMF 1/4W 1% 100PPM
R512	6S11049C37	2.74	K	RESIST	FMF 1/4W 1% 100PPM
R513	6S11049B63	475		RESIST	FMF 1/4W 1% 100PPM
R514	6S11049C37	2.74	K	RESIST	FMF 1/4W 1% 100PPM
R515	6S11049C32	2.43	K	RESIST	FMF 1/4W 1% 100PPM
R516	6S11049C32	2.43	K	RESIST	FMF 1/4W 1% 100PPM
R517	6S11049C52	3.92	K	RESIST	FMF 1/4W 1% 100PPM
R518	6S11049C42	3.01	K	RESIST	FMF 1/4W 1% 100PPM
R519	6S11049B94	1	K	RESIST	FMF 1/4W 1% 100PPM
R520	6S11049B94	1	K	RESIST	FMF 1/4W 1% 100PPM
R521	6S11049C42	3.01	K	RESIST	FMF 1/4W 1% 100PPM
R522	6S11049C12	1.5	K	RESIST	FMF 1/4W 1% 100PPM
R523	6S11049C12	1.5	K	RESIST	FMF 1/4W 1% 100PPM
R524	6S11049C47	3.48	K	RESIST	FMF 1/4W 1% 100PPM
R525	6S11049C12	1.5	K	RESIST	FMF 1/4W 1% 100PPM
R526	6S11049B94	1	K	RESIST	FMF 1/4W 1% 100PPM
R527	6S11049C03	1.21	K	RESIST	FMF 1/4W 1% 100PPM
R528	6S11049C37	2.74	K	RESIST	FMF 1/4W 1% 100PPM
R529	6S11049C37	2.74	K	RESIST	FMF 1/4W 1% 100PPM
R530	6S11049A97	100		RESIST	FMF 1/4W 1% 100PPM

ID	PART NO.	VALUE	EXP	TYPE	DESCRIPTION

M41 CIRCUIT BOARD

ID	PART NO.	VALUE	EXP	TYPE	DESCRIPTION
R531	6S11049B82	750		RESIST	FMF 1/4W 1% 100PPM
R532	6S11049E85	1	M	RESIST	FMF 1/4W 1% 100PPM
R533	6S11049C20	1.82	K	RESIST	FMF 1/4W 1% 100PPM
R534	6S11049B78	681		RESIST	FMF 1/4W 1% 100PPM
R535	6S11049C47	3.48	K	RESIST	FMF 1/4W 1% 100PPM
R536	6S11049C12	1.5	K	RESIST	FMF 1/4W 1% 100PPM
R537	6S11049C03	1.21	K	RESIST	FMF 1/4W 1% 100PPM
R538	6S11049C45	3.32	K	RESIST	FMF 1/4W 1% 100PPM
R539	6S11049B94	1	K	RESIST	FMF 1/4W 1% 100PPM
R540	6S11049C63	5.11	K	RESIST	FMF 1/4W 1% 100PPM
R541	6S11049C03	1.21	K	RESIST	FMF 1/4W 1% 100PPM
R542	6S11049C32	2.43	K	RESIST	FMF 1/4W 1% 100PPM
R543	6S11049C32	2.43	K	RESIST	FMF 1/4W 1% 100PPM
R544	6S11049B63	475		RESIST	FMF 1/4W 1% 100PPM
R545	6S11049B63	475		RESIST	FMF 1/4W 1% 100PPM
R546	6S11049C71	6.19	K	RESIST	FMF 1/4W 1% 100PPM
R547	6S11049C37	2.74	K	RESIST	FMF 1/4W 1% 100PPM
R548	6S11049C37	2.74	K	RESIST	FMF 1/4W 1% 100PPM
R549	6S11049C60	4.75	K	RESIST	FMF 1/4W 1% 100PPM
R550	6S11049C36	2.67	K	RESIST	FMF 1/4W 1% 100PPM
R552	6S11049C36	2.67	K	RESIST	FMF 1/4W 1% 100PPM
R553	6S11049C15	1.62	K	RESIST	FMF 1/4W 1% 100PPM
R555	6S11049C37	2.74	K	RESIST	FMF 1/4W 1% 100PPM
R556	6S11049C37	2.74	K	RESIST	FMF 1/4W 1% 100PPM
R557	6S11049C85	8.66	K	RESIST	FMF 1/4W 1% 100PPM
R558	6S11049D50	40.2	K	RESIST	FMF 1/4W 1% 100PPM
R559	6S11049D53	43.2	K	RESIST	FMF 1/4W 1% 100PPM
R560	6S11049C97	11.5	K	RESIST	FMF 1/4W 1% 100PPM
R561	6S11049B78	681		RESIST	FMF 1/4W 1% 100PPM
R562	6S11049D80	82.5	K	RESIST	FMF 1/4W 1% 100PPM
R563	6S10164K42	2.2000	M	RESIST	FCF 1/4W 5%
R564	6S11049C37	2.74	K	RESIST	FMF 1/4W 1% 100PPM
R565	6S11049C03	1.21	K	RESIST	FMF 1/4W 1% 100PPM
R566	6S11049A58	39.2		RESIST	FMF 1/4W 1% 100PPM
R567	6S11049A58	39.2		RESIST	FMF 1/4W 1% 100PPM
R568	6S11049C45	3.32	K	RESIST	FMF 1/4W 1% 100PPM
R569	**	1.21	M	RESIST	FMF 1/4W 1% 100PPM
R570	6S11049D68	61.9	K	RESIST	FMF 1/4W 1% 100PPM
R571	3299Y-001-502	5.0000	K	TRIMPOT	CERMET 25T
R572	6S11049C45	3.32	K	RESIST	FMF 1/4W 1% 100PPM
R573	6S11049B63	475	K	RESIST	FMF 1/4W 1% 100PPM
R574	6S11049E30	267	K	RESIST	FMF 1/4W 1% 100PPM
R575	6S11049D53	43.2	K	RESIST	FMF 1/4W 1% 100PPM
R576	6S11049C97	11.5	K	RESIST	FMF 1/4W 1% 100PPM
R577	6S11049C85	8.66	K	RESIST	FMF 1/4W 1% 100PPM
R578	6S11049D50	40.2	K	RESIST	FMF 1/4W 1% 100PPM
R579	6S11049D53	43.2	K	RESIST	FMF 1/4W 1% 100PPM
R580	6S11049C37	2.74	K	RESIST	FMF 1/4W 1% 100PPM
R581	6S11049C37	2.74	K	RESIST	FMF 1/4W 1% 100PPM
R582	6S11049D53	43.2	K	RESIST	FMF 1/4W 1% 100PPM
R583	6S11049D50	40.2	K	RESIST	FMF 1/4W 1% 100PPM
R584	6S11049C85	8.66	K	RESIST	FMF 1/4W 1% 100PPM
R585	6S11049C97	11.5	K	RESIST	FMF 1/4W 1% 100PPM

ID	PART NO.	VALUE	EXP	TYPE	DESCRIPTION

M41 CIRCUIT BOARD

R586	6S11049B63	475		RESIST	FMF 1/4W 1% 100PPM
R587	6S11049B63	475		RESIST	FMF 1/4W 1% 100PPM
R588	6S11049C37	2.74	K	RESIST	FMF 1/4W 1% 100PPM
R589	6S11049A38	24.3		RESIST	FMF 1/4W 1% 100PPM
R590	6S11049B78	681		RESIST	FMF 1/4W 1% 100PPM
R591	6S11049C37	2.74	K	RESIST	FMF 1/4W 1% 100PPM
R592	6S11049A38	24.3		RESIST	FMF 1/4W 1% 100PPM
R593	6S11049C15	1.62	K	RESIST	FMF 1/4W 1% 100PPM
R594	6S11049E54	475	K	RESIST	FMF 1/4W 1% 100PPM
R595	6S11049E06	150	K	RESIST	FMF 1/4W 1% 100PPM
R596	6S11049E06	150	K	RESIST	FMF 1/4W 1% 100PPM
R597	6S11049C37	2.74	K	RESIST	FMF 1/4W 1% 100PPM
R598	6S11049C15	1.62	K	RESIST	FMF 1/4W 1% 100PPM
R599	6S11049B78	681		RESIST	FMF 1/4W 1% 100PPM
R601	6S11049A34	22.1		RESIST	FMF 1/4W 1% 100PPM
R602	6S11049A34	22.1		RESIST	FMF 1/4W 1% 100PPM
R603	6S11049B48	332		RESIST	FMF 1/4W 1% 100PPM
R604	6S11049A34	22.1		RESIST	FMF 1/4W 1% 100PPM
R605	6S11049A34	22.1		RESIST	FMF 1/4W 1% 100PPM
R606	6S11049B48	332		RESIST	FMF 1/4W 1% 100PPM
R607	6S11049C03	1.21	K	RESIST	FMF 1/4W 1% 100PPM
R608	6S11049C03	1.21	K	RESIST	FMF 1/4W 1% 100PPM
R609	6S11049C20	1.82	K	RESIST	FMF 1/4W 1% 100PPM
R610	6S11049C20	1.82	K	RESIST	FMF 1/4W 1% 100PPM
R611	6S11049C37	2.74	K	RESIST	FMF 1/4W 1% 100PPM
R612	6S11049A69	51.1		RESIST	FMF 1/4W 1% 100PPM
R613	6S11049A69	51.1		RESIST	FMF 1/4W 1% 100PPM
R614	6S11049C28	2.21	K	RESIST	FMF 1/4W 1% 100PPM
R615	6S11049C60	4.75	K	RESIST	FMF 1/4W 1% 100PPM
R616	6S11049C75	6.81	K	RESIST	FMF 1/4W 1% 100PPM
R617	6S11049B48	332		RESIST	FMF 1/4W 1% 100PPM
R618	6S11049B48	332		RESIST	FMF 1/4W 1% 100PPM
R619	6S11049C37	2.74	K	RESIST	FMF 1/4W 1% 100PPM
R620	6S11049C37	2.74	K	RESIST	FMF 1/4W 1% 100PPM
R621	6S11049A69	51.1		RESIST	FMF 1/4W 1% 100PPM
R622	6S11049A69	51.1		RESIST	FMF 1/4W 1% 100PPM
R623	6S11049C37	2.74	K	RESIST	FMF 1/4W 1% 100PPM
R624	6S11049C37	2.74	K	RESIST	FMF 1/4W 1% 100PPM
R625	6S11049A69	51.1		RESIST	FMF 1/4W 1% 100PPM
R626	6S11049A69	51.1		RESIST	FMF 1/4W 1% 100PPM
R627	6S11049C60	4.75	K	RESIST	FMF 1/4W 1% 100PPM
R628	6S11049C60	4.75	K	RESIST	FMF 1/4W 1% 100PPM
R629	6S11049C60	4.75	K	RESIST	FMF 1/4W 1% 100PPM
R630	6S11049C60	4.75	K	RESIST	FMF 1/4W 1% 100PPM
R636	6S11049B63	475		RESIST	FMF 1/4W 1% 100PPM
R637	6S11049B63	475		RESIST	FMF 1/4W 1% 100PPM
R638	6S11049C37	2.74	K	RESIST	FMF 1/4W 1% 100PPM
R639	6S11049C37	2.74	K	RESIST	FMF 1/4W 1% 100PPM
R640	6S11049A97	100		RESIST	FMF 1/4W 1% 100PPM
R643	6S11049B94	1	K	RESIST	FMF 1/4W 1% 100PPM
R644	6S11049A81	68.1		RESIST	FMF 1/4W 1% 100PPM
R645	6S11049A81	68.1		RESIST	FMF 1/4W 1% 100PPM
R646	6S11049A81	68.1		RESIST	FMF 1/4W 1% 100PPM
R647	6S11049A81	68.1		RESIST	FMF 1/4W 1% 100PPM
R648	6S11049A81	68.1		RESIST	FMF 1/4W 1% 100PPM

ID	PART NO.	VALUE	EXP	TYPE	DESCRIPTION
M41 CIRCUIT BOARD					
R649	6S11049C37	2.74	K	RESIST	FMF 1/4W 1% 100PPM
R650	6S11049C75	6.81	K	RESIST	FMF 1/4W 1% 100PPM
R651	6S11049C28	2.21	K	RESIST	FMF 1/4W 1% 100PPM
R661	6S11049B63	475		RESIST	FMF 1/4W 1% 100PPM
R663	6S11049C75	6.81	K	RESIST	FMF 1/4W 1% 100PPM
R664	6S11049A81	68.1		RESIST	FMF 1/4W 1% 100PPM
R665	6S11049D96	121	K	RESIST	FMF 1/4W 1% 100PPM
R666	6S11049D25	22.1	K	RESIST	FMF 1/4W 1% 100PPM
R667	6S11049E54	475	K	RESIST	FMF 1/4W 1% 100PPM
R668	6S11049B94	1	K	RESIST	FMF 1/4W 1% 100PPM
R671	3299Y-001-103	10	K	TRIMPOT	CERMET 25T
R672	6S11049D88	100	K	RESIST	FMF 1/4W 1% 100PPM
R673	6S11049D88	100	K	RESIST	FMF 1/4W 1% 100PPM
R674	6S11049A97	100		RESIST	FMF 1/4W 1% 100PPM
R675	6S11049B06	121		RESIST	FMF 1/4W 1% 100PPM
R676	6S11049A97	100		RESIST	FMF 1/4W 1% 100PPM
R677	6S11049A97	100		RESIST	FMF 1/4W 1% 100PPM
R678	6S11049B94	1	K	RESIST	FMF 1/4W 1% 100PPM
R679	6S11049B94	1	K	RESIST	FMF 1/4W 1% 100PPM
R680	6S11049A81	68.1		RESIST	FMF 1/4W 1% 100PPM
R681	6S11049B39	267		RESIST	FMF 1/4W 1% 100PPM
R682	6S11049A34	22.1		RESIST	FMF 1/4W 1% 100PPM
R683	6S11049A34	22.1		RESIST	FMF 1/4W 1% 100PPM
R684	6S11049A81	68.1		RESIST	FMF 1/4W 1% 100PPM
R685	6S11049A97	100		RESIST	FMF 1/4W 1% 100PPM
R686	6S11049A97	100		RESIST	FMF 1/4W 1% 100PPM
R687	6S11049B86	825		RESIST	FMF 1/4W 1% 100PPM
R688	6S11049B86	825		RESIST	FMF 1/4W 1% 100PPM
R689	6S11049B94	1	K	RESIST	FMF 1/4W 1% 100PPM
R690	6S11049C12	1.5	K	RESIST	FMF 1/4W 1% 100PPM
R691	6S11049C47	3.48	K	RESIST	FMF 1/4W 1% 100PPM
R692	6S11049C03	1.21	K	RESIST	FMF 1/4W 1% 100PPM
R693	6S11049C91	10	K	RESIST	FMF 1/4W 1% 100PPM
R694	6S11049D49	39.2	K	RESIST	FMF 1/4W 1% 100PPM
R695	6S11049E39	332	K	RESIST	FMF 1/4W 1% 100PPM
R696	6S11049D96	121	K	RESIST	FMF 1/4W 1% 100PPM
R697	6S11049C91	10	K	RESIST	FMF 1/4W 1% 100PPM
R698	6S11049E22	221	K	RESIST	FMF 1/4W 1% 100PPM
U501	CA3045			IC	TRANSISTOR ARRAY
U502	CA3045			IC	TRANSISTOR ARRAY
U503	TL084CN			IC	OP. AMP. QUAD
U504	TL082CP			IC	OP. AMP. DUAL
U505	MC1596L			IC	BALANCED MODULATOR
U506	CA3045			IC	TRANSISTOR ARRAY
U507	CA3045			IC	TRANSISTOR ARRAY
U508	MC1596L			IC	BALANCED MODULATOR
U509	MC1596L			IC	BALANCED MODULATOR
U510	MC10116L			IC	LINE RECEIVER
U511	CA3183			IC	TRANSISTOR ARRAY
U512	MC10131L			IC	D FF DUAL
U513	MC10131L			IC	D FF DUAL
U514	TL084CN			IC	OP. AMP. QUAD
U515	TL082CP			IC	OP. AMP. DUAL
U516	CA3183			IC	TRANSISTOR ARRAY
X501	84PD1004			XTAL	3.6MHZ

ID	PART NO.	VALUE	EXP	TYPE	DESCRIPTION

M42 CIRCUIT BOARD

ID	PART NO.	VALUE	EXP	TYPE	DESCRIPTION
F802	279.250	1/4		FUSE	SUBMIN RAD LEAD LITTLEFUSE
F803	279.062	1/16		FUSE	SUBMIN RAD LEAD LITTLEFUSE
R839	GB1515	150		RESIST	FC 1W 5%
R840	GB1515	150		RESIST	FC 1W 5%
R841	GB1515	150		RESIST	FC 1W 5%
R842	GB1515	150		RESIST	FC 1W 5%
R843	GB1515	150		RESIST	FC 1W 5%
R844	HB1315	130		RESIST	FC 2W 5%
R845	HB1015	100		RESIST	FC 2W 5%
R846	HB1015	100		RESIST	FC 2W 5%
R847	HB1015	100		RESIST	FC 2W 5%
R848	HB1015	100		RESIST	FC 2W 5%
R849	GB2015	200		RESIST	FC 1W 5%
R850	HB1315	130		RESIST	FC 2W 5%
S803	PA-7007			SWITCH	WAFER SP 6 POSITIONS

M43 CIRCUIT BOARD

ID	PART NO.	VALUE	EXP	TYPE	DESCRIPTION
C900	23C05253D01	2000.0000	U	CAP	LYTIC 50V
C901	23C05253D01	2000.0000	U	CAP	LYTIC 50V
C902	8S11017A17	.1000	U	CAP	METALIZED POLY. 50V 5%
C904	8S11017A17	.1000	U	CAP	METALIZED POLY. 50V 5%
C906	23C05253D01	2000.0000	U	CAP	LYTIC 50V
C908	8S11017A17	.1000	U	CAP	METALIZED POLY. 50V 5%
C909	23D84669A27	2.0000	U	CAP	LYTIC 25V +150-10%
C910	23D84669A27	2.0000	U	CAP	LYTIC 25V +150-10%
D900	IN4720			DIODE	RECTIFIER POWER
D901	IN4720			DIODE	RECTIFIER POWER
D902	IN4720			DIODE	RECTIFIER POWER
D903	IN4720			DIODE	RECTIFIER POWER
D904	IN4720			DIODE	RECTIFIER POWER
D905	IN4720			DIODE	RECTIFIER POWER
D906	1N5338B			DIODE	ZENER 5.1V
D909	IN4002			DIODE	RECTIFIER 100V
U900	MC7815CT			IC	REGULATOR 15V
U901	MC7805CT			IC	REGULATOR 5V
U902	MC7915CT			IC	REGULATOR -15

LEFT THUMB WHEEL SWITCH

ID	PART NO.	VALUE	EXP	TYPE	DESCRIPTION
R819	6S11049B94	1.0000	K	RESIST	FMF 1/4W 1% 100PPM
R820	6S11049A97	100.0000		RESIST	FMF 1/4W 1% 100PPM
R821	6S11049A97	100.0000		RESIST	FMF 1/4W 1% 100PPM
R822	6S11049B56	402.0000		RESIST	FMF 1/4W 1% 100PPM
R823	6S11049B44	301.0000		RESIST	FMF 1/4W 1% 100PPM
R824	6S11049A01	10.0000		RESIST	FMF 1/4W 1% 100PPM
R825	6S11049A01	10.0000		RESIST	FMF 1/4W 1% 100PPM
R826	6S11049A59	40.2000		RESIST	FMF 1/4W 1% 100PPM
R827	6S11049A47	30.1000		RESIST	FMF 1/4W 1% 100PPM
S804	40AS1004			SWITCH	3 DIGIT INTERSW.

ID	PART NO.	VALUE	EXP	TYPE	DESCRIPTION

RIGHT THUMB WHEEL SWITCH

ID	PART NO.	VALUE	EXP	TYPE	DESCRIPTION
R828	6S11049B94	1.0000	K	RESIST	FMF 1/4W 1% 100PPM
R829	6S11049A97	100.0000		RESIST	FMF 1/4W 1% 100PPM
R830	6S11049A97	100.0000		RESIST	FMF 1/4W 1% 100PPM
R831	6S11049B56	402.0000		RESIST	FMF 1/4W 1% 100PPM
R832	6S11049B44	301.0000		RESIST	FMF 1/4W 1% 100PPM
R833	6S11049A01	10.0000		RESIST	FMF 1/4W 1% 100PPM
R834	6S11049A01	10.0000		RESIST	FMF 1/4W 1% 100PPM
R835	6S11049A59	40.2000		RESIST	FMF 1/4W 1% 100PPM
R836	6S11049A47	30.1000		RESIST	FMF 1/4W 1% 100PPM
S805	40AS1004			SWITCH	3 DIGIT INTERSW.

FRONT PANEL

ID	PART NO.	VALUE	EXP	TYPE	DESCRIPTION
E801	EM20-1			LAMP	DIAL LAMP 28V
E802	EM20-1			LAMP	DIAL LAMP 28V
E803	EM20-1			LAMP	DIAL LAMP 28V
E804	EM20-1			LAMP	DIAL LAMP 28V
I801	48-88245C06			DIODE	LED GREEN
I802	48-88245C04			DIODE	LED RED
I803	48-88245C09			DIODE	LED YELLOW
I804	48-88245C09			DIODE	LED YELLOW
I805	48-88245C04			DIODE	LED RED
I806	48-88245C06			DIODE	LED GREEN
I807	48-88245C04			DIODE	LED RED
J816	09ND1004			JACK	SW. CRAFT N114B
M801	72PD1002			METER	PANEL MODULATION
M802	72PD1002			METER	PANEL MODULATION
M803	72PD1001			METER	PANEL EDGE
R837	70D4N048F101W	100		POT	DUAL
S806	T101S1TZGE			SWITCH	SPDT TOGLE ALCO

RIGHT SIDE PANEL

ID	PART NO.	VALUE	EXP	TYPE	DESCRIPTION
T801	25PD1010			TRANSF	TOROID POWER TRANSFORMER
-	28PD1001				POWER ENTRY MODULE