TECHNICAL MANUAL

for

MF COMMUNICATIONS RECEIVER
MODEL VLRE-1

THE TECHNICAL MATERIEL CORPORATION
MAMARONECK, N.Y. OTTAWA, CANADA.

[illegible]

INSTRUCTION BOOK CHANGE NOTICE

DATE: 15 JANUARY, 1967

Manual Affected: RF COMMUNICATIONS RECEIVER MODEL VLRE-1.

SECTION 6

PARTS LIST

[illegible]

Under description column delete "TRANSFORMER, RF, TUNED: input impedance 2.2M ohms; output impedance 8.2M ohms, center tapped; operating frequency 5MC-100MC; stake lug terminals; encapsulated case." and under MFG PART NUMBER column delete "VRL83".

Under description column add "TRANSFORMER RF, TUNED: input impedance 2.2K ohms; output impedance 8.2K ohms, center tapped; operating frequency 100KHz-600KHz; stake lug terminals; encapsulated case", and under MFG PART NUMBER column add "VRL0002".

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

Add to the description:

[illegible] impedance 2.5K ohms, output [illegible] impedance 150 k ohms, output pwr: power level up 20 mW; frequency range 30-10,000 cps; [illegible] type terminals: encapsulated case.

Add the part number;

2P10030.

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IN-3013 Issue Date: 20 June 1966

NOTICE

TMC (Canada) LIMITED
TELECOMMUNICATIONS ENGINEERS
MAILING ADDRESS: R.R. No. 5, Ottawa, Ontario
A Subsidiary of The Technical Materiel Corporation, Mamaron ck, N.Y.

Warranty

The Technical Materiel Corporation, hereinafter referred to as TMC, warrants the equipment (except electron tubes*, fuses, lamps, batteries and articles made of glass or other fragile or other expendable materials) purchased hereunder to be free from defect in materials and workmanship under normal use and service, when used for the purposes for which the same is designed, for a period of one year from the date of delivery F.O.B. factory. TMC further warrants that the equipment will perform in a manner equal to or better than published technical specifications as amended by any additions or corrections thereto accompanying the formal equipment offer.

TMC will replace or repair any such defective items, F.O.B. factory, which may fail within the stated warranty period, PROVIDED:

1. That any claim of defect under this warranty is made within sixty (60) days after discovery thereof and that inspection by TMC, if required, indicates the validity of such claim to TMC's satisfaction.

2. That the defect is not the result of damage incurred in shipment from or to the factory.

3. That the equipment has not been altered in any way either as to design or use whether by replacement parts not supplied or approved by TMC, or otherwise.

4. That any equipment or accessories furnished but not manufactured by TMC, or not of TMC design shall be subject only to such adjustments as TMC may obtain from the supplier thereof.

Electron tubes*furnished by TMC, but manufactured by others, bear only the warranty given by such other manufacturers. Electron tube warranty claims should be made directly to the manufacturer of such tubes.

TMC's obligation under this warranty is limited to the repair or replacement of defective parts with the exceptions noted above.

At TMC's option any defective part or equipment which fails within the warranty period shall be returned to TMC's factory for inspection, properly packed with shipping charges prepaid. No parts or equipment shall be returned to TMC, unless a return authorization is issued by TMC.

No warranties, express or implied, other than those specifically set forth herein shall be applicable to any equipment manufactured or furnished by TMC and the foregoing warranty shall constitute the Buyers sole right and remedy. In no event does TMC assume any liability for consequential damages, or for loss, damage or expense directly or indirectly arising from the use of TMC Products, or any inability to use them either separately or in combination with other equipment or materials or from any other cause.

* Electron tubes also include semi-conductor devices.

PROCEDURE FOR RETURN OF MATERIAL OR EQUIPMENT

Should it be necessary to return equipment or material for repair or replacement, whether within warranty or otherwise, a return authorization must be obtained from TMC prior to shipment. The request for return authorization should include the following information:

1. Model Number of Equipment.
2. Serial Number of Equipment.
3. TMC Part Number.
4. Nature of defect or cause of failure.
5. The contract or purchase order under which equipment was delivered.

PROCEDURE FOR ORDERING REPLACEMENT PARTS

When ordering replacement parts, the following information must be included in the order as applicable:

1. Quantity Required.
2. TMC Part Number.
3. Equipment in which used by TMC or Military Model Number.
4. Brief Description of the Item.
5. The *Crystal Frequency* if the order includes crystals.

PROCEDURE IN THE EVENT OF DAMAGE INCURRED IN SHIPMENT

TMC's Warranty specifically excludes damage incurred in shipment to or from the factory. In the event equipment is received in damaged condition, the carrier should be notified immediately. Claims for such damage should be filed with the carrier involved and not with TMC.

All correspondence pertaining to Warranty Claims, return, repair, or replacement and all material or equipment returned for repair or replacement, within Warranty or otherwise, should be addressed as follows:

TMC (*Canada*) LIMITED
Engineering Services Department
R.R. No.5, Ottawa, Ontario
Telegraphic Address: TEPEI, Ottawa.

PRINTED IN CANADA

RECORD OF CORRECTIONS MADE

Change No.	Date of Change	Date Entered	Entered By

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SECTION 1
GENERAL INFORMATION

1-1. DESCRIPTION.

Medium Frequency Receiver, Model VLRE (figure 1-1), is a ten-channel crystal-controlled, narrow-band receiver covering the frequency range of 400 to 600-Kc for the reception of MCW, AM, CW, FAX, and FSK signal. The VLRE provides 3 audio outputs: one output provides up to 0 dbm across a 600-ohm line; another provides up to + 14 dbm across a 600-ohm line, the third output connects to a 4-ohm loudspeaker.

The VLRE is a completely transistorized, modular unit. It consists of a main chassis that houses a maximum of the r-f modules, one i-f module, one bfo module, one a-f module, and a power supply. The r-f modules are plug-in units that are removable from the front panel; slide fasteners permit each module to be rapidly locked or unlocked by hand. The i-f module, the bfo module, the a-f module, and the power supply are accessible from the top of the unit when the cover is removed.

A front-panel meter permits monitoring the relative strength of the HIGH and LOW LINE audio signals; All phone jack allows aural monitoring of audio output signals. All controls and indicators are locked on the front panel of the VLRE. All connections to circuits external to the VLRE are made from rear-panel jack and screw terminals. Three module extenders mounted at the rear of the unit are used to connect the modules to the main chassis so that components of the modules can be exposed for inspection during operation and maintenance.

1-2. TECHNICAL SPECIFICATIONS.

Technical specifications of the VLRE are as follows:

Operating Power	115/230 vac, ±10%, 50/60 cycles, single phase.
Power Requirements	10 watts.
Dimensions	8¾ inches high x 19 inches wide x 17½ inches deep.
Weight	Approximately 34 pounds.
Frequency Range	400-600 Kc with plug-in, fixed-tuned r-f amplifiers selectable by front-panel control.
Modes of Reception	MCW, AM, CW; FAX and FSK with the appropriate converters.
Frequency Stability	Crystal controlled. Error will not exceed 0. 01% at the operating frequency.
Antenna Input Impedance	50 ohms nominal (BNC connector).
Sensitivity	A 1.0 microvolt signal impressed across 50 ohms at the input of the receiver will produce a minimum of 10 db signal + noise /noise ratio.
IF Bandwidth	3 Kc.
Type of Detection	Product detector.
Image Rejection	120 db or more.
BFO	Adjustable ± 1 Kc from zero beat.
Distortion	Harmonic and IM-10% or less.
Audio Output	500 milliwatts, 4 ohm unbalanced; one milliwatt and 25 milliwatts 600-ohm balanced center tapped output.
Audio Response	100-2500 cps ± 1.5 db.

1-3. TRANSISTOR AND DIODE COMPLEMENT.

Table 1-1 lists the transistor and diode complement for the VLRE.

TABLE 1-1. TRANSISTOR AND DIODE COMPLEMENT

REFERENCE SYMBOL	TYPE	FUNCTION
	R-F MODULE	
Q201	2N396A	1st. RF Amplifier
Q202, Q203	2N396A	2nd. RF Amplifier
Q204	2N396A	3rd. RF Amplifier
Q205	2N396A	HFO Oscillator
Q206	2N396A	HFO Amplifier
Q207	2N396A	Noise Silencer Preamp.
	I-F MODULE	
Q301, Q302	2N396A	Mixer
Q303	2N396A	1st. I-F Amplifier
Q304	2N396A	2nd. I-F Amplifier
Q305	2N396A	3rd. I-F Amplifier
Q306	2N396A	4th. I-F Amplifier
Q307	2N396A	Noise Silencer
Q308	2N396A	Noise Silencer Amplifier
CR301, CR302	1N34A	Noise Detector
	BFO MODULE	
Q401	2N706	44-46 kc Oscillator
Q402	2N396A	44-46 kc Oscillator Amplifier
Q403	2N706	345 kc Oscillator
Q404	2N396A	Mixer
Q405	2N396A	BFO Amplifier
Q406, Q407	2N396A	Prod Detector
Q408	2N396A	Audio Amplifier
CR404, CR402	CX106-13	BFO Tuning Voltage Variable Capacitors
CR403	1N961	Regulator
	AF MODULE	
Q501	2N396A	O dbm Driver Amplifier
Q502, Q503	2N396A	O dbm Push-Pull Power Amplifier
Q504	2N396A	14 dbm Driver Amplifier
Q505, Q506	2N396A	14 dbm Power Amplifier
Q507	2N396A	Audio Voltage Amplifier
Q508, Q509	2N396A	Phase Inventer Driver Amplifier
Q510, Q511	2N2143	Audio Push-Pull Power Amplifier
	POWER SUPPLY	
Q1	2N2143	Series Regulator
CR1, CR2, CR3, CR4	1N2484	Rectifier
CR5	1N2484	Isolator
CR6	VR101-24S51	Regulator
CR8	1N2976B	Regulator
	MAIN CHASSIS	
CR601, CR602	1N34A	O dbm Meter Rectifier
CR603, CR604	1N34A	14 dbm Meter Rectifier

SECTION 2
INSTALLATION

2-1. INITIAL INSPECTION.

The VLRE is calibrated and tested at the factory prior to shipment, and is carefully packaged to prevent damage during transit. When the unit arrives at the operation site, inspect the packing case and contents for possible damage. Inspect all packing material for parts that may have been shipped as "loose items". With respect to damage to the equipment for which the carrier is liable, The Technical Materiel Corporation will assist in describing methods of repair and the furnishing of replacement parts.

The equipment is shipped with all modules and other components installed; check that all such components are properly positioned.

2-2. POWER REQUIREMENTS.

The VLRE is designed for 115 or 230 volt, 50/60 cps, single phase power. Unless specifically ordered for 230-volt operation, the unit is factory-wired for 115-volt operation. Wiring changes necessary for 230-volt operation are shown in figure 2-1. With 230-volt operation, change fuse F101 (located at the rear of the equipment) from ½ ampere to ¼ ampere.

2-3. INSTALLATION.

a. MECHANICAL, – The VLRE is designed for both cabinet and rack installation. In either case, adequate ventilation, sufficient clearance in back of the unit for access to rear-panel connections, and sufficient space for withdrawal of the unit from the cabinet for servicing are prime considerations when determining ultimate location. The VLRE is equipped with a standard 19-inch wide front panel, and is 8¾-inches high and 17½ inches deep.

When intended for rack installation, the VLRE is equipped with slide mechanisms; to install the VLRE proceed as follows:

(1) Set VLRE chassis slide mechanism in tracks.

(2) Slide chassis in tracks until release finger engages holes in track.

(3) Make necessary cable and electrical connections as described in paragraph 2-3b.

(4) Depress release fingers and slide unit completely into rack.

(5) Secure front panel to rack with screws.

b. ELECTRICAL. – The VLRE should be connected to an a-c power source, to a 50-ohm antenna, and to a 4-ohm loudspeaker; optionally, the VLRE can be connected to a frequency-shift or FAX converter. If remotely controlled operation is desired, the control receiver unit can be connected to the VLRE. All connections are made to a rear-panel jack and screw terminals (see figure 2-2). Table 2-1 lists the function and component designation of controls, jacks, switches, and module extenders mounted at the rear of the unit.

2-4. INITIAL ADJUSTMENTS.

Before the VLRE is shipped, it is aligned and thoroughly checked against the manufacturer's specifications; therefore, the unit is operable after it is properly installed.

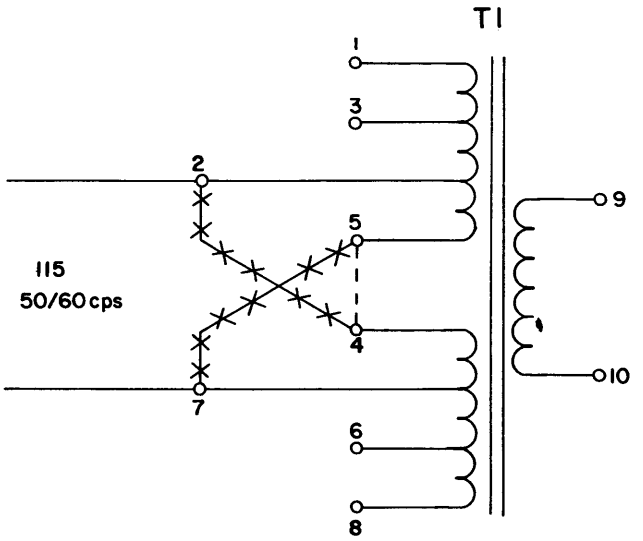


FIGURE 2-1 TRANSFORMER WIRING

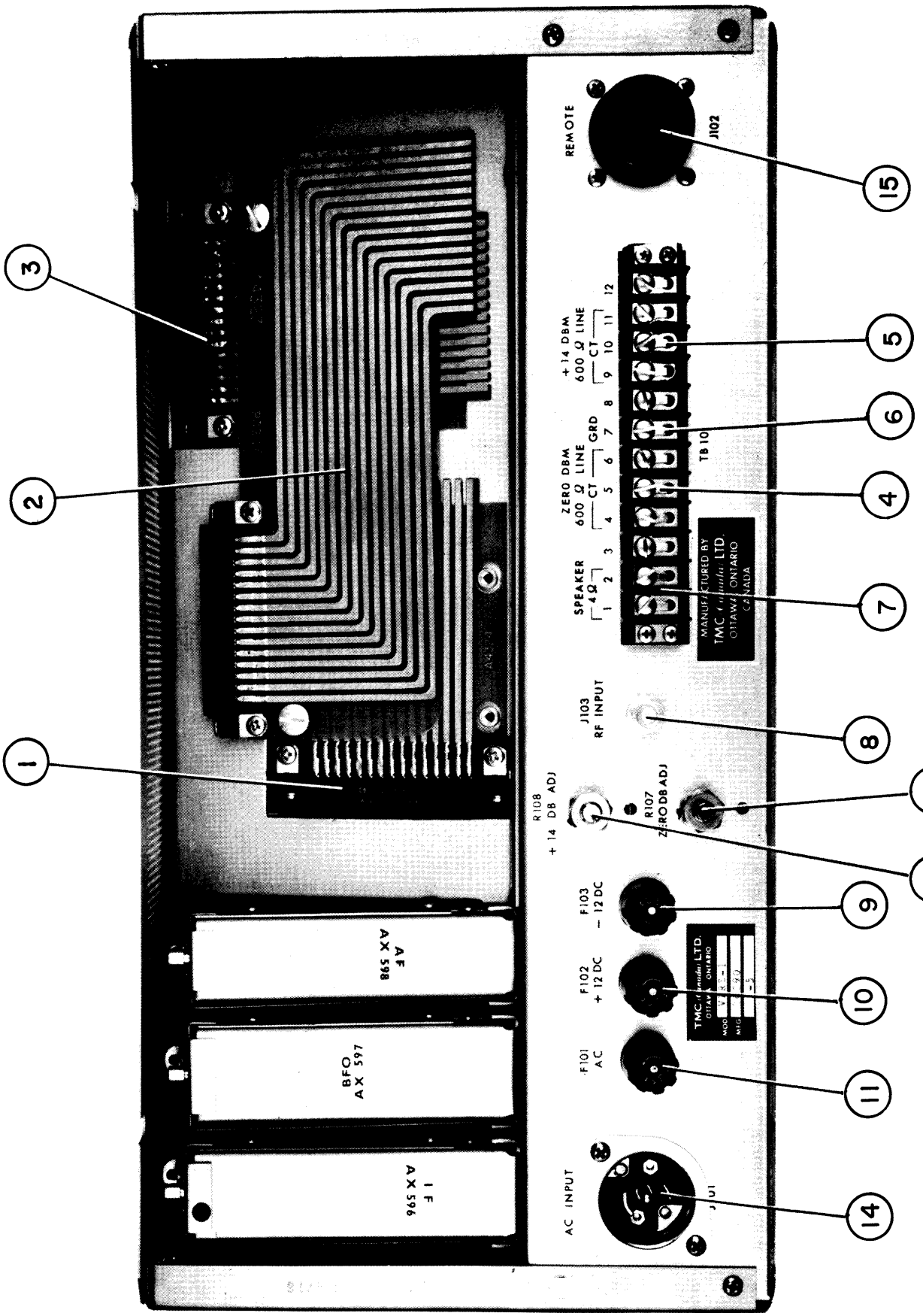


FIGURE 2-2. VLRE-1 RECEIVER REAR VIEW

TABLE 2-1. REAR PANEL CONTROLS, JACKS, AND MODULE EXTENDERS

ITEM NO. (figure 2-2)	PANEL AND COMPONENT DESIGNATION	FUNCTION
1, 3	Module Extenders (no panel or component designation).	Permits either i-f, bfo, or a-f module components to be tested using power supply. (Both module extenders are required to test the i-f module; only one module extender is required to test either the bfo, or a-f modules).
2	Module Extender (no panel or component designation).	Permits r-f module components to be tested using the receiver power supply.
4	O dbm 600 OHM LINE (terminal board TB101 terminals 4, 5, and 6).	Connects external 600-ohm line equipment such as a signal converter to output circuit of receiver line amplifier.
5	14 dbm 600 OHM LINE (terminal board TB101 terminals 9, 10, and 11).	Connects external 600-ohm line equipment when a higher level is required than (4).
6	GND (terminal board TB101, terminal 7).	Connection point for external ground to receiver chassis ground.
7	SPEAKER, 4 OHM (terminal board TB101, terminals 1 and 2).	Connects external 4-ohm speaker to output circuit of power amplifier.
8	RF INPUT jack J103	Input jack for external 50-ohm antenna.
9	F103 (-12 DC Fuse)	Protects -12 volt power supply components from receiver load short circuits.
10	F102 (+12 DC Fuse)	Protects +12 volt power supply components from receiver load short circuits.
11	F101 (AC Fuse)	Protects power supply components from internal short circuits.
12	Zero DB ADJ control R107.	Calibrates front-panel meter M101 at its O dbm setting.
13	+14 DB ADJ control R108.	Calibrates front-panel meter M101 at its +14 dbm setting.
14	AC INPUT jack J101.	Input receptacle for 115/230 volt a-c power.
15	REMOTE jack J102	Input jack for connection to remote control system.

SECTION 3
OPERATOR'S SECTION

3-1. CONTROLS, JACKS, AND INDICATORS.

Before attempting to operate the VLRE, the operator should first familiarize himself with all controls, jacks, and indicators listed in table 3-1 and illustrated in figure 3-1.

3-2. OPERATING PROCEDURES.

a. STARTING. – Before applying power to the VLRE, ensure that the unit is installed in accordance with the instructions contained in section 2 and that all cables are properly connected; ensure that the controls mentioned in table 3-2 are set at their proper positions. To start the VLRE, set the POWER switch at its on position.

b. CW OPERATION. – CW operation is accomplished as follows:

(1) Turn CHAN SELswitch to channel receiving cw signals as indicated by steady reading on Meter M101.

(2) Turn the BFO ON/OFF switch to its on position.

(3) Adjust BFO control for pleasing tone in speaker or headset.

(4) Adjust AF GAIN control for proper speaker or headset audio level.

(5) Adjust NOISE SILENCER control to remove impulse noise.

c. MCW OPERATION. – MCW operation is accomplished as follows:

(1) Turn CHANNEL SELECTOR switch to channel receiving mcw signals as indicated by steady reading on Meter M101.

(2) Turn the BFO ON/ OFF switch to its off position.

(3) Adjust AF GAIN control for proper speaker or headset audio level.

(4) Adjust NOISE SILENCER control to remove impulse noise.

d. FSK OPERATION. – FSK operation is accomplished with the aid of a frequency-shift converter, such as Technical Materiel Corporation's Model CFA-1LB. Proceed as follows:

(1) Connect input circuit of a frequency-shift converter across high or low 600 OHM LINE terminals of terminal board TB301. Connect teletype terminal equipment to output of frequency-shift converter. Ensure that frequency-shift converter and teletype equipment are prepared for reception of FSK signal.

(2) Turn CHAN SEL switch to channel receiving FSK signals as indicated by intermittent reading on meter M301.

(3) Set BFO control at position suitable for best reception of FSK signals.

(4) Set HIGH/LOW switch S105 at the line being used; adjust appropriate LINE LEVEL control until front-panel meter indicates 0 or +14 dbm as the case may be.

(5) Adjust NOISE SILENCER control to remove impulse noise.

(6) At frequencies shift converter, adjust operating controls as required.

e. FAX OPERATION. – Same as for FSK operation except that a FAX converter is used instead of an FSK converter.

f. REMOTELY CONTROLLED OPERATION. – Remote operation is accomplished as follows:

(1) Connect the output of a remote receiver unit such as the receiver unit of Technical Materiel Corporation's RARB/RASB system to REMOTE jack J102.

(2) Set the LOCAL/REMOTE switch S103 to its REMOTE position.

(3) The VLRE receiver can now be operated from a remote position by the RARB/RASB controls.

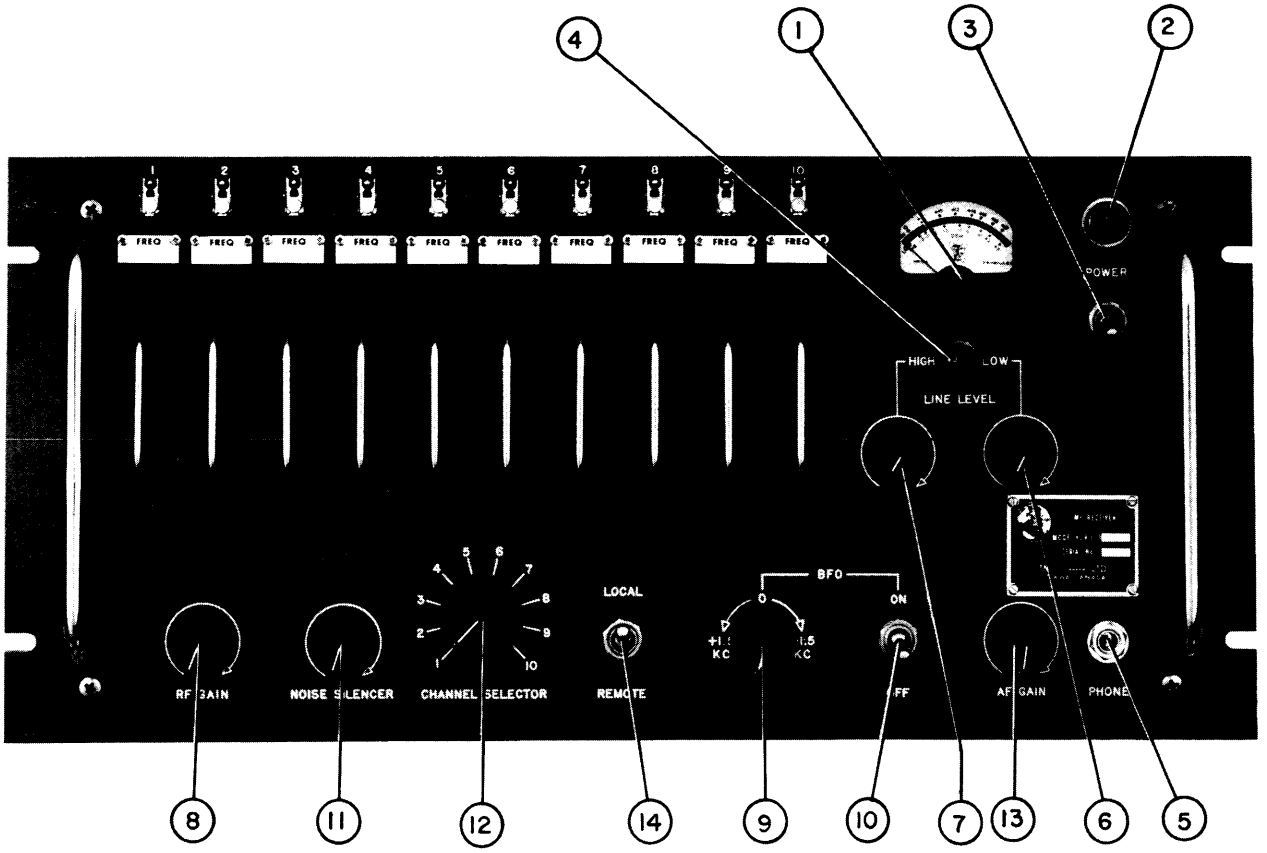


FIGURE 3-1. FRONT PANEL CONTROLS, VLRE-1

TABLE 3-1. CONTROLS, JACKS, AND INDICATORS

REFERENCE DESIGNATION (figure 3-1)	PANEL AND COMPONENT DESIGNATION	FUNCTION
1	Meter M101	Operates in conjunction with HIGH/LOW switch S105. In LOW position of switch measures strength of audio signal in dbm across low level 600 ohm line; in HIGH position measures strength of audio signal in dbm across high level 600 ohm line.
2	POWER lamp XDS101	Indicates when ac power is applied to receiver power supply circuit.
3	POWER switch S102	Connects ac power to receiver power supply circuit.
4	HIGH-LOW switch S105	A 2-position switch. In LOW position connects low level 600 ohm line amplifier audio output signal to front-panel meter M101; in HIGH position connects high level 600 ohm line amplifier output audio signal to meter.
5	PHONE jack J104	Permits headset monitoring of 4 ohm unbalanced line power amplifier output audio signal.
6	LOW LINE LEVEL control R101	Controls amplitude of audio signal applied to low level 600 ohm line.
7	HIGH LINE LEVEL control R102	Controls amplitude of audio signal applied to high level 600 ohm line.
8	RF GAIN control R105	Controls gain of r-f stages.
9	BFO Control R104	Varies frequency of tone when receiving continuous wave signals.
10	BFO ON/OFF switch S104	Turns BFO oscillator on and off.
11	NOISE SILENCER Control R106	Controls amplitude of noise silencer negative going pulses required to cut-off receiver during periods of noise.
12	CHAN SEL switch S101	A 10-pole 10-position rotary switch. Selects rf module to be connected to receiver circuits.
13	AF GAIN control R103	Controls amplitude of audio signal applied to 4 ohm speaker.
14	LOCAL-REMOTE switch S103	In LOCAL position, all receiver circuits operate by local controls; in remote position, certain functions are remotely controllable.

TABLE 3-2. PRELIMINARY CONTROL SETTINGS

CONTROL	SETTING
POWER	Off (down)
HIGH/LOW	Low
LINE LEVELS	Mid-range
RF GAIN	Mid-range
BFO ON/OFF	On for CW, Off for MCW
BFO	Mid-range
NOISE SILENCER	OFF
CHAN SEL	Any position
AF GAIN	Mid-range
LOCAL/REMOTE	LOCAL

SECTION 4
PRINCIPLES OF OPERATION

4-1. BLOCK DIAGRAM ANALYSIS (FIGURE 4-1)

R-F signals in the 400- to 600- kc range from the antenna are routed via jack J103 and channel-selector switch S101 to one of 10 r-f modules. Within the selected r-f module the signal undergoes three stages of amplification and is applied to transformer T204 where it is combined with the output signal (700- to 900- kc) of the high frequency oscillator stage contained in the r-f module. Control of the r-f gain is effected by applying a DC control voltage to the first and third r-f amplifiers by means of the RF GAIN control R105.

The combined signal from the r-f module is applied to the mixer stage in the i-f module. The output of the mixer, the difference product of the r-f and hfo signals (300 kc) undergoes four stages of amplification and is applied to transformer T309 where it is combined with the output of the beat-frequency oscillator stage contained in the bfo module. Two oscillators and a mixer in the bfo module produce a bfo signal that is tunable from 299- to 301- kc. This bfo signal, combined with the output of the fourth i-f amplifier, is applied to the product detector in the bfo module. Due to the low output of the product detector when demodulating MCW signals, an audio preamplification stage is provided when the receiver is being operated in the MCW mode (BFO OFF). The amplification of this stage is reduced in the CW mode. The output detector circuit, which in the case of CW operation is the difference product of the bfo and i-f signals (1-kc either side of zero beat), and in the case of MCW operation is the demodulated i-f signal, is applied to three audio amplifier chains. Each audio amplifier circuit has an individually adjustable gain control (LOW-and HIGH- LINE LEVEL and AF GAIN). The a-f amplifier, a three-stage circuit, provides up to 500 milliwatts output for connection to a 4-ohm speaker, and an output for headphone monitoring. The high level line amplifier provides up to 25 milliwatts (+ 14 dbm) for a 600-ohm load. The low level line amplifier provides up to 1 milliwatt (O dbm) for a 600-ohm load.

Noise silencer stages (preamplifier, amplifier, detector, and pulse amplifier) in the r-f and i-f modules utilize a portion of the first r-f amplifier output to develop a pulsating d-c signal which is routed back to the second r-f amplifier. Noise silencer control R106 in this circuit enables the operator to adjust the loop gain so that noise peaks present on th r-f envelope cause the second r-f amplifier to be momentarily gated off. This operation effectively removes noise pulses from the second r-f amplifier output.

4-2. RF MODULE CIRCUIT ANALYSIS (refer to figure 7-1 and 7-2

With the exception of selected r-f and hfo frequencies, all r-f modules are the same; therefore only channel 1 is considered in the following discussion.

The r-f signal is applied to the base of first amplifier Q201 via transformer T201. A tertiary winding of T201 and capacitor C201 form the first stage tuning circuit. The output of Q201 is transformer-coupled to the second r-f amplifier, a push-pull stage including transistors Q202 and Q203. A tertiary winding of T202 and capacitor C202 form the second stage tuning circuit. A sample of the first r-f amplifier output is applied to noise silencer amplifier Q207. The output of this stage is routed to noise silencer circuitry in the i-f module.

Negative d-c pulses, coincident with noise pulses on the r-f envelope, are supplied to the emitter circuit of Q202 and 203 via pin 5 of jack J109. The increase in IR drop across R208 cuts off the two transistors. Pulse-type noise present in the output of Q201 is therefore removed from the output of the second r-f amplifier.

The output of Q202 - Q203 is transformer-coupled to the third r-f amplifier Q204. A tertiary winding of transformer T203 and capacitor C203 form the third stage tuning circuit. Gain of the first and third r-f amplifiers is controlled by a positive d-c signal that is routed to the emitter circuits of transistors Q201 and Q204 via resistors R202 and R203 and pin 1 of jack J109. When the positive signal increases, IR drop across the emitter resistors R204 and RWQW decreases, thus increasing the bias of the two transistors. The operating points of the two transistors approach saturation, and gain therefore decreases.

The control is adjusted by means of RF GAIN control R105 via pins 11 and 12 of LOCAL/REMOTE relay K101 and wafer H of CHANNEL SELECTOR switch S101 when the LOCAL/REMOTE switch S103 is in the LOCAL position. When S103 is in the REMOTE position, the dc control voltage is applied to pin 1 of J109 from pin C of REMOTE jack J102 via pins 12 and 13 of LOCAL/REMOTE relay K101 and wafer H of CHANNEL SELECTOR switch S101, bypassing RF GAIN control R105.

The output of Q204 is transformer-coupled to the mixer stage in the i-f module; the mixer also receives an hfo signal from transistor Q206. A tertiary winding of transformer T204 and capacitor C204 form the output tuning circuit.

Transistors Q205 and Q206 form a crystal-controlled oscillator that has two stages of amplification. Feedback is from the collector of Q206 to the base of Q205 through capacitor C220, and from the collector of Q205 to the base of Q206, through capacitor C212 and crystal Y201.

4-3. I-F MODULE CIRCUIT ANALYSIS (refer to figures 7-1 and 7-3)

Combined r-f and hfo injection signals from the r-f module are routed to the mixer stage (transistors Q301, Q302) via pins 3 and 4 of jack J106. The r-f signal is applied in push-pull to the mixer stage; the hfo injection, 300 kc higher in frequency, is applied in phase to the two bases. Since the mixer output is a push-pull configuration, the hfo injection signal is self-cancelling. Resistor R305 is adjusted to balance the two sides of the mixer stage. The output of the mixer is transformer-coupled to the first i-f amplifier Q303. Tunable transformers T391, T302 and capacitors C303, C304, and C305 form a tuned circuit that passes the 300 kc i-f signal. Resistor R309 controls the gain of the first i-f amplifier. The output of Q303 is transformer-coupled to the second i-f amplifier Q304. Again, the coupling is of the narrow-bandpass type. Two further identical stages of i-f amplification are provided (transistors Q305, Q306) terminating in the output transformer T309.

Filtering to the four i-f stages is provided on the -12 volt line by four pi filters of which the one made up of C306, C307, and L301 is typical. The output of the beat frequency oscillator module is applied to the centre tap of T309 via pin 11 of jack J105. The output, from the secondary winding of T309 is routed to the product detector stage on the bfo module via pins 10 12 of jack J105.

The noise silencer circuit receives a sample of the r-f signal from the r-f module via pin 7 of jack J105. The signal is amplified by Q307 and applied to the noise silencer detector (CR301 and CR302). The output of the noise silencer detector, a pulsating negative d-c signal, is taken from the anodes of the two diodes and routed to the noise amplifier Q308 via NOISE SILENCER control R106. When R106 is properly adjusted, Q308 operates near cut-off; negative spikes (detected noise of the r-f signal) drive Q308 into heavy conduction. The resultant negative pulse signal from the emitter of Q308 is routed to the second r-f amplifier in the r-f module.

4-4. BFO MODULE CIRCUIT ANALYSIS (refer to figures 7-1 and 7-4)

The bfo module contains two oscillators and a mixer that generate a 299- to 301 kc signal for injection into the product detector. Transistor Q401 operates in the 44- to 46-kc range. Tuning is accomplished by applying a DC control voltage across voltage-variable capacitance diodes CR401, CR402, whose capacitance is a function of the DC voltage across them. The control voltage is adjusted by means of BFO control R104 and is applied to the module via pin 1 of jack J108 and pins 8 and 9 of LOCAL/REMOTE relay K101 when the LOCAL/REMOTE switch S103 is in the LOCAL position. When S103 is in the REMOTE position the control voltage is applied to jack J108 via pins 9 and 10 of LOCAL/REMOTE relay K101 and pin A of REMOTE jack J102, bypassing the local BFO tuning control R104. The output of oscillator Q401 is applied through an emitter-follower impedance converting power amplifier Q402 to the mixer Q404. Transistor Q403, a tuned-base oscillator, operates at a fixed frequency (345 kc). Mixer 1404 receives the output of Q403 at its base and the output of Q402 at its emitter. The output circuit of the mixer is tuned, by means of capacitor C417 and tunable transformer T401, to pass only the difference product (299- to 301- kc) of the two signals. The output from the secondary winding of T401 is applied to the base of bfo amplifier Q405. The load of Q405 is another tuned circuit consisting of capacitor C420 and transformer T309 in the i-f module. Voltage stabilization for the oscillators is provided by 10-volt zener diode CR403 and resistor R403.

The bfo circuit is controlled by BFO ON/OFF relay K102 through which are routed the plus and minus 12 volts d-c, the plus 12 volts via pins 6 and 7 of K102 and pin 4 of J108, the minus 12 volts d-c via pins 9 and 10 of K102 and pin 3 of J108. The relay is energized by BFO switch S104 when the LOCAL/REMOTE switch S103 is in the LOCAL position. When the VLRE receiver is being operated remotely, the BFO ON/OFF relay L102 is energized by the voltage applied to its pins 1 and 4 from pin B of REMOTE jack J102 via pins 6 and 7 of LOCAL/REMOTE relay K101.

The product detector receives the i-f signal (300-kc) in push-pull, and a bfo injection signal (when in the CW mode) of 299- to 301- kc that is phase at the two bases. The push-pull output configuration of the of the detector eliminates the BFO component from the output signal. The output is applied to the base of audio preamplifier Q408 through a double-section pi filter. The amplification of Q408 depends on the mode of operation. In the CW mode resistors R432 and R434 provide degenerative feedback, reducing the overall gain. In the MCW mode, R432 is bypassed by means of pin 14 of jack J108, to capacitor C105, and via pins 11 and 12 of BFO ON/OFF relay K102 to ground. This decreases the degenerative feedback, thus increasing the gain. The bypass capacitor C105 is switched into the

circuit when the bfo is turned off. This action tends to equalize the output of the product detector for different types of input at the same level. The output of Q408 is applied to the audio amplifiers on the audio board via pin 13 of jack J108.

4-5. AF MODULE CIRCUIT ANALYSIS (refer to figures 7-1 and 7-5)

Audio signals from the bfo module are applied to three parallel-connected voltage dividers consisting of resistor R114 and LOW LINE LEVEL control R101, resistor R116 and HIGH LINE LEVEL control R102, and resistor R11 and AF GAIN control R103. The LOW LINE LEVEL control sets the level of the audio signal applied to the base of driver amplifier Q501 via pin 15 of jack J107. The HIGH LINE LEVEL control sets the level of the audio signal applied to driver amplifier Q504 via pin 8 of jack J107. The AF GAIN control sets the level of audio signal applied to the base of first a-f amplifier Q507 via pin 4 of jack J107.

Audio signals at the base of driver amplifier Q501 are amplified and coupled through T501 to push-pull power amplifiers Q502 and Q503. The power amplifier output is coupled from the secondary winding of the transformer T502 to terminals 4, 5, and 6 of terminal board TB101 provide an output signal of 0 dbm when connected across a 600-ohm line.

Audio signals appearing at the base of driver amplifier Q504 are amplified and coupled through transformer T503 to the base circuits of push-pull power amplifiers Q505 and Q506. The power amplifier output is coupled from the secondary winding of transformer T504 via pins 5, 6 and 7 of jack J107 to terminals 9, 10 and 11 of terminal board TB101. These terminals provide an output signal of + 14 dbm across a 600-ohm line.

The output signal provided at the collector of amplifier Q507 drives push-pull driver amplifiers Q508 and Q509. The Q508/Q509 output in turn is transformer-coupled to push-pull power amplifiers Q510 and Q511. The output signal from the power amplifier stage is coupled to PHONES jack J104 via capacitor C513, resistor R527 and pin 1 of jack J107, as well as to impedance matching transformer T101 via pins 2 and 3 of jack J107. Transformer T101 provides a 4-ohm audio output signal of up to 500 mw across terminals 1 and 2 of terminal board TB101.

The strength of the audio signal at the output terminals of the high and low line amplifiers can be measured on the front panel meter. When the HIGH/LOW LINE LEVEL switch S105 is set at HIGH, the audio signal is applied from terminals 5 and 7 of jack J107 through limiting resistors R603 and R604 to full wave rectifier diodes CR603 and CR604. The resulting pulsating dc is filtered by resistor R108 and capacitor C602 and is applied via the contacts of S105 to the meter. Terminal 6 provides the return path for the meter. The meter is calibrated by + 14 DB ADJ control R108 to read directly in dbm when the HIGH/LOW switch is set at HIGH. Similarly, when the HIGH/LOW LINE LEVEL switch is set at LOW, the audio signal is applied from terminals 9 and 11 of jack J107 through limiting resistors R601, R602, full wave rectifier diodes CR601, CR602, and filter R107, C601, to the meter through the contacts of S105. The return path is provided by terminal 10. The meter is calibrated by ZERO DB ADJ control R107 to read directly in dbm when the HIG/LOW switch is set at LOW.

4-6. POWER SUPPLY CIRCUIT ANALYSIS (refer to figures 7-1 and 7-6)

The power supply operates with an input of 115/230 volts ac and provides approximate output voltages of plus and minus 12 volts dc.

During receiver operation, the 115 volts AC appears at terminals A and C of AC INPUT jack J101 and is applied through protective fuse F101, the contacts of of POWER switch S102, and terminals 1 and 2 of terminal board E1 to the primary winding of power transformer T1. The secondary voltage of T1 is rectified by the bridge-type rectifier circuit consisting of diodes CR1 through CR4. The rectifier output voltage is applied across the armature winding of relay K1 and, through isolator diode CR5, to the 24 volt regulator circuit consisting of zener diode CR6, series regulator Q1, and resistor R3. When relay K1 is energized, minus twelve volts applied through relay contacts 6 and 7 turns on POWER lamp XDS101. Capacitor C1 filters the a-c ripple in the transformer output before regulation. Zener diode CR6 provides a regulated 24 volts across its terminals. Series regulator Q1 provides isolation and additional regulation. It keeps the voltage constant by varying its impedance directly in proportion to changes in output voltage. For example, if the output tends to increase a corresponding voltage drop appears across Q1 which results in reducing the output voltage to its normal level. The opposite reaction occurs when the output voltage tends to decrease. The regulated 24 volts dc is applied to the positive and negative 12 volt sections of the power supply.

Zener diode CR8 provides a regulated + 12 volts dc across its terminals. The difference voltage appears across R4, giving -12 volts dc. Capacitors C2 and C3 are additional a-c filters. Protective fuses F102 and F103 are connected between the power supply output terminals and the receiver circuits.

4-7. REMOTELY-CONTROLLED CHANNEL SELECTION

As well as the previously-mentioned remote functions (bfo on/off, bfo tune, and r-r gain control) channel selection can also be effected remotely. To this end, a rotary solenoid has been attached to the back of CHANNEL SELECTOR switch S101. When the LOCAL/REMOTE switch S103 is in the REMOTE position, voltage can be applied to the solenoid from the remote control system via pin D of REMOTE jack J102. When voltage is applied to the rotary solenoid, it advances the CHANNEL SELECTOR switch S101 one step (i. e. one channel). At the end of its stroke, a cam opens a pair of contacts, opening the circuit, and the solenoid returns to its original position. As it does, the contacts close, and if voltage is still being applied, the solenoid cycles again. This action continues as long as voltage is applied to the solenoid. Wafers A and B of CHANNEL SELECTOR switch S101 form a binary switching position sensor which, dependant on the voltage applied to it from the remote system via pins E, J, K, L, N, and R of REMOTE jack J102, stops the action of the solenoid by opening the solenoid circuit when the CHANNEL SELECTOR switch S101 reaches the desired position.

SIMPLIFIED BLOCK DIAGRAM

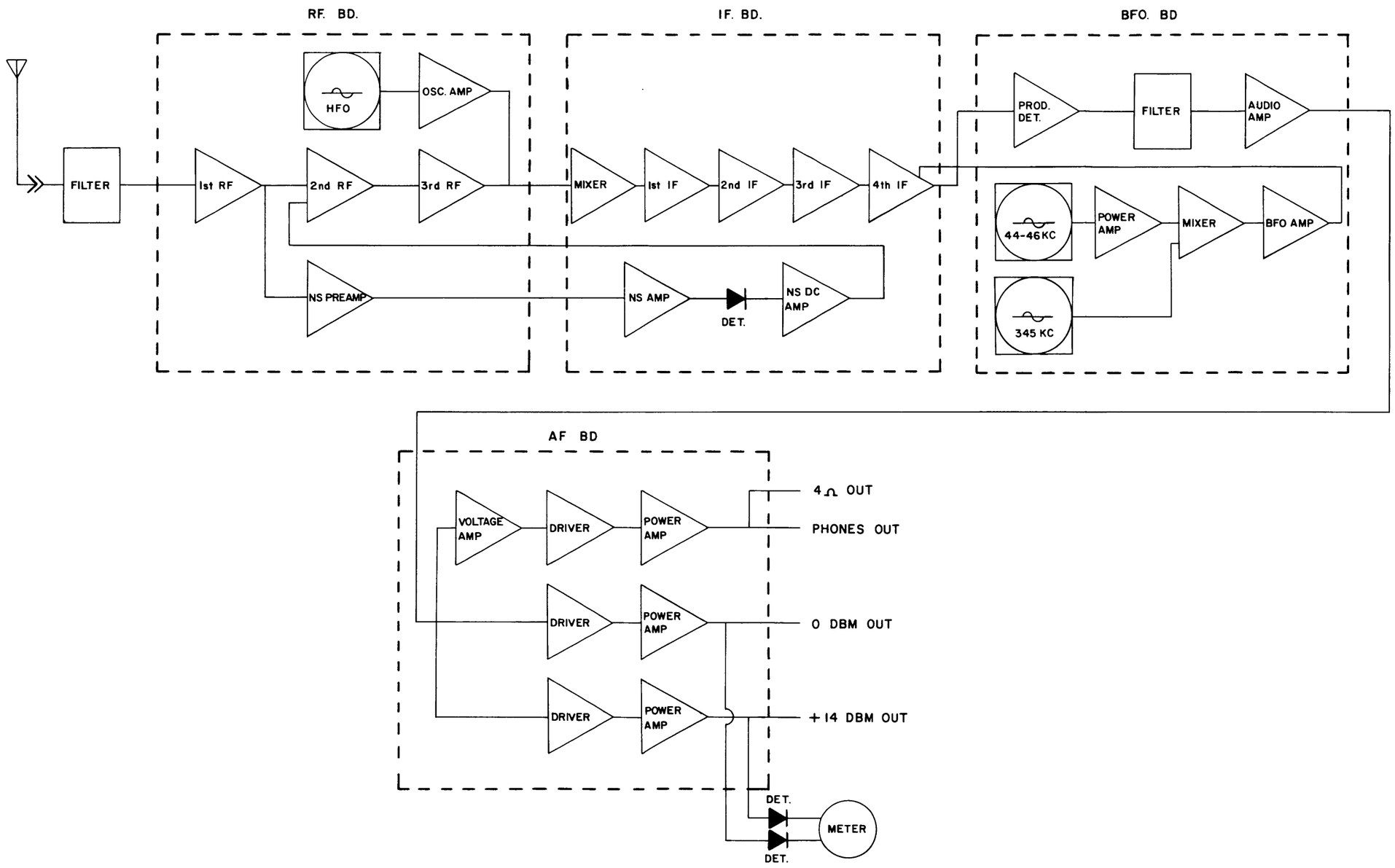


FIGURE 4-1. BLOCK DIAGRAM ANALYSIS

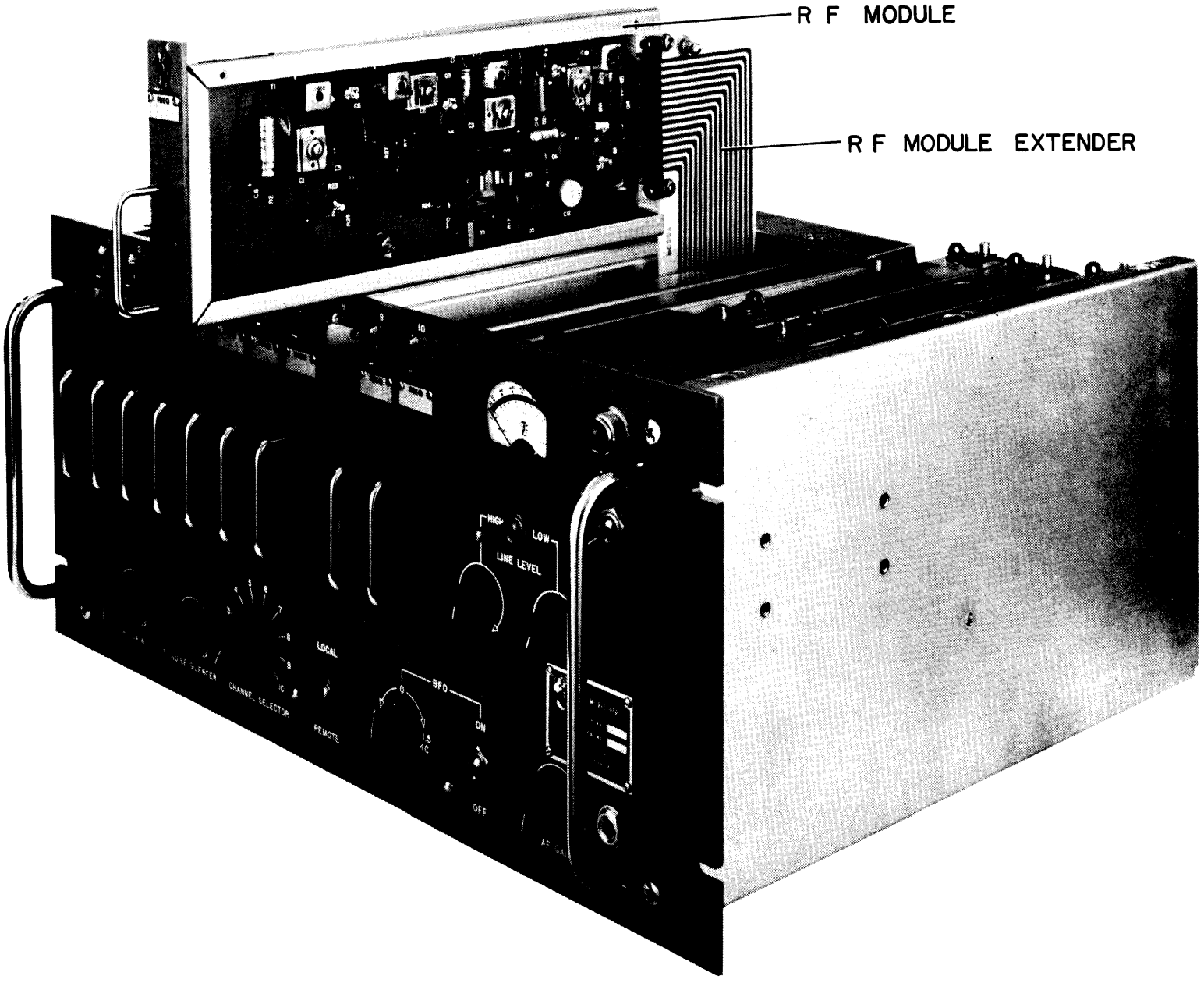


FIGURE 5-1. RF MODULE EXTENDER IN USE

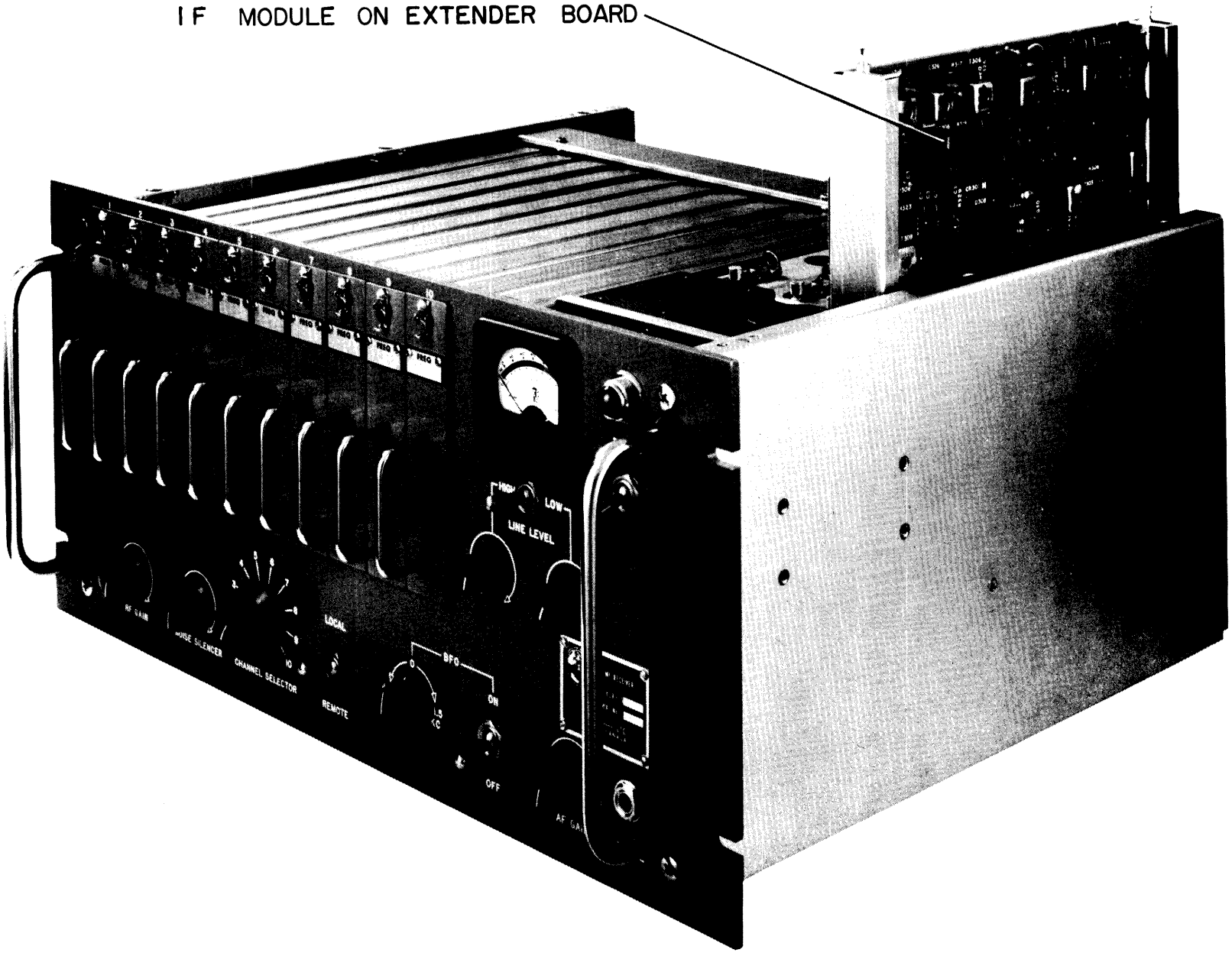


FIGURE 5-2. I-F MODULE ON EXTENDER BOARD

SECTION 5
MAINTENANCE

5-1. PREVENTIVE MAINTENANCE.

a. GENERAL. – The VLRE has been designed to provide longterm, trouble-free operation under continuous duty conditions. However, in order to prevent failure of the equipment due to corrosion, dust or other destructive elements, it is suggested that a schedule of preventive maintenance be set up and adhered to.

b. At periodic intervals, the equipment should be removed from its mounting for cleaning and inspection. All accessible covers should be removed and the wiring and all components inspected for dirt, corrosion, charring, discoloring or grease. Remove dust with a soft brush or vacuum cleaner. Remove dirt or grease from other parts with any suitable cleaning solvent. Use of carbon tetrachloride should be avoided due to its highly toxic effects. Trichlorethylene or methyl chloroform may be used, provided the necessary precautions are observed.

WARNING

When using toxic solvents, make certain that adequate ventilation exists. Avoid prolonged or repeated breathing of the vapor. Avoid prolonged or repeated contact with skin. Flammable solvents shall not be used on energized equipment or near any equipment from which a spark may be received. Smoking, "hot work", etc. is prohibited in the immediate area.

CAUTION

When using trichlorethylene, avoid contact with painted surfaces, due to its paint removing effects.

5-2. TROUBLESHOOTING.

a. GENERAL. – Since the VLRE is constructed on a module concept, troubleshooting consists of sectionalizing the malfunction to a particular module. Once a module is found to be defective it should be replaced with a spare one if available, so that normal operation can be resumed with a minimum time delay.

b. TEST EQUIPMENT. – Table 5-1 lists the test equipment required for troubleshooting the VLRE.

c. TROUBLESHOOTING AIDS. – To aid troubleshooting and maintenance, use the module extenders illustrated in figure 2-1 and listed in table 2-2. Figure 5-1 shows the module extender in use with an r-f module; figure 5-2 shows the extenders in use with the i-f module.

d. TROUBLESHOOTING CHART. – The troubleshooting chart (table 5-2) should be used as a guide in locating and correcting troubles that might develop in the VLRE. To use this chart follow the steps in numerical sequence.

Once the trouble has been localized to a particular module, voltage measurements given in table 5-2 should be used to isolate the faulty component. For a better understanding of the major receiver components refer to the detailed circuit analysis given in paragraphs 4-2 through 4-6.

TABLE 5-1. TEST EQUIPMENT REQUIRED FOR TROUBLESHOOTING THE VLRE.

QTY.	ITEM	MANUFACTURER
1	Audio Signal Generator	Hewlett Packard, Model 200 C
1	AC Voltmeter	Ballantine, Model 314
1	Oscilloscope	Tektronix, Model 545 B with type "L" plug-in
1	VTVM	Hewlett Packard Model 410B
1	Signal Generator	Boonton Radio Corp., Model 82
1	Counter	Hewlett Packard, Model 524D
1	Headset	600 ohms or better

TABLE 5-2. TROUBLESHOOTING CHART

STEP	OPERATION	NORMAL INDICATION	PROBABLE CAUSE OF ABNORMAL INDICATION
1	SET POWER switch at its on position	POWER lamp DS101 should light	Open filament
		12 volts dc ± 10% from any B+ or B- point to ground	Blown fuses F102, F102, or F103
			Defective power supply
2	Set the HIGH and LOW LINE LEVEL controls and the AF GAIN control fully anti-clockwise; set the HIGH/LOW LINE switch in the LOW position; set the audio signal generator to provide a 20 mv signal; connect the signal generator to Q408 collector (on the bfo board) and ground. Connect a-c voltmeter and oscilloscope across ZERO DBM 600 OHM terminals (terminals 5 and 7, TB101)	Turn LOW LINE LEVEL control clockwise until a-c voltmeter and front panel meter indicate 0 dbm (0.78 volts). Oscilloscope should indicate clean sine wave.	Defective stages Q501, Q502, or Q503.
			Moveable arm of LOW LINE LEVEL control open circuited
			Resistor R114 defective
			Open diodes CR601, CR602
			Defective HIGH/LOW switch S105
3	With the audio signal generator connected as in step 2, connect the a-c voltmeter and oscilloscope across 14 DBM 600 OHM terminals (terminals 9 and 11, TB101). Set the HIGH/LOW LINE switch to the HIGH position.	Turn HIGH LINE LEVEL control clockwise until a-c voltmeter and front panel meter indicate +14 dbm (3.9 V). Oscilloscope should indicate clean sine wave.	Defective stages Q504, Q505, or Q506.
			Moveable arm of HIGH LINE LEVEL control open circuited
			Resistor R116 defective
			Open diodes CR603, 604
			Defective HIGH/LOW switch S105
4	With the audio signal generator connected as in step 2, connect the a-c voltmeter and oscilloscope across 4 OHM SPEAKER terminals (terminals 1 and 2, TB101)	Turn AF GAIN control R103 clockwise until a-c voltmeter indicates 1.414 volts. Oscilloscope should indicate a clean sine wave.	Defective stages Q507, Q508, Q509, Q510 or Q511.
			Moveable arm of AF GAIN control R103 open circuited
			Resistor R111 defective
	Connect headset to PHONE jack J104	1 KC signal should be heard	Defective PHONE jack
			Open capacitor C513
			Open resistor R527
5	Connect the counter to J108 pin 15. Turn on BFO. Vary BFO control from extreme clock-wise position to anti-clockwise position.	Counter should indicate a frequency of less than 299.0 KC in the extreme clock-wise position, greater than 301.0 KC in the extreme anti-clock-wise position, and approximately 300.0 KC at the midpoint of its travel.	Defective stages Q401, Q402, Q403, Q404 or Q405
			Defective resistors R404, R405
			Defective voltage variable capacitors CR401, CR402

TABLE 5-2. TROUBLESHOOTING CHART (CONT)

STEP	OPERATION	NORMAL INDICATION	PROBABLE CAUSES OF ABNORMAL INDICATION
5			Defective resistors R110, R104, R109 R405 or L401 not adjusted properly (refer to sect. 5-4) Defective relay K102 Misalignment of transformers T401 and T402 (refer to sect. 5-4)
6	Set the signal generator for 300 KC +5 cps at 10 UV. Apply this signal, through a 5000 pf capacitor, to TP301 on the if module. Connect the oscilloscope to TP309.	Oscilloscope should indicate a clean sine wave at about .1 V p-p.	Defective stages Q303, Q304, Q305 or Q306 Misalignment of transformers T301 through T309 (refer to sect. 5-4)
	Remove signal	Oscilloscope should indicate no signal	Oscillation occuring R309 defective or misadjusted (refer to sect. 5-4)
7	Apply a 10 UV signal at the operating frequency of channel 1 at the RF INPUT jack. Turn the CHANNEL SELECTOR switch to 1. Extend r-f module number 1. Place the oscilloscope at TP206. Turn RF GAIN control fully clockwise.	Oscilloscope should indicate a clean sine wave at about .07 V p-p at the module's r-f frequency.	Defective stages Q201, Q202, Q203, Q204 Misalignment of transformers T201 throught T204 and capacitor C201 throught C204 (refer to sect. 5-4) Defective filter FL101 Open contacts on CHANNEL SELECTION switch S101
	Place the oscilloscope at TP208	Oscilloscope should indicate a clean sine wave at about .4 volts p-p at the module's hfo frequency.	Defective stages Q205 or Q206 Defective crystal Y201 Defective or misadjusted C212 (refer to sect. 5-4)

e. VOLTAGE MEASUREMENTS. – Table 5-3 lists the voltage readings for the VLRE.

TABLE 5-3 VOLTAGE READINGS

REFERENCE DESIGNATION	EMITTER	BASE	COLLECTOR
	R-F MODULE		
Q201	+0.17	0	+0.13
Q202	+0.12	0	-1.48
Q203	+0.12	0	-1.48
Q204	+0.32	+0.15	+0.29
Q205	+0.85	+0.95	+0.93
Q206	-4.6	+1.1	+1.1
Q207	+0.24	+0.07	-2.85
	I-F MODULE		
Q301	0	0	-7.5
Q302	0	0	-7.5
Q303	+0.15	0	-9.5
Q304	+0.15	0	-9.5
Q305	+0.13	0	-9.3
Q306	+0.14	0	-9.4
Q307	+0.19	+0.05	-8.6
Q308	+0.11	+0.05	-10.9
	BFO MODULE		
Q401	-0.8	-0.18	+9.5
Q402	0	0	-.48
Q403	-3.4	-1.95	+10.7
Q404	-0.25	0	-11.0
Q405	+0.13	0	-9.4
Q406	+0.1	+0.17	-8.4
Q407	+0.12	+0.17	-8.4
Q408	+0.17	0	-4.3
	AF MODULE		
Q501	+0.15	0	-10.2
Q502	+0.17	0	-8.0
Q503	+0.17	0	-8.5
Q504	+0.1	0	-10.2
Q505	+0.15	0	-9.4
Q506	+0.15	0	-9.6
Q507	+0.14	0	-1.5
Q508	+0.30	+0.12	-9.3
Q509	+0.32	+0.15	-9.5
Q510	+12.5	+12.5	-11.0
Q511	+12.5	+12.5	-11.0
Q1	-13.0	-13.0	-24.2

CONDITIONS.

1. All measurements taken with no signal input.
2. All measurements are with respect to ground using VTVM with 20 K-ohms 1 volt minimum.
3. NOISE SILENCER control fully anti-clockwise.
4. BFO turned on.
5. BFO control fully anti-clockwise.
6. RF GAIN control fully clockwise.

5-3. REPAIR OF PRINTED CIRCUITS.

a. GENERAL. – Although the troubleshooting procedures for printed circuits are similar to those for conventional circuits, the repair of printed circuits requires considerably more skill and patience. The printed circuits are small and compact; therefore, personnel should become familiar with the special servicing techniques required.

The defective parts should be pinpointed by a study of the symptoms and by careful and patient analysis of the circuit before attempting to trace trouble on a printed circuit board. Ascertain whether the conducting strips are coated with a protective lacquer, epoxy resin, or similar substance. If so, carefully scrape it away.

Breaks in the conducting strip (foil) can cause permanent or intermittent trouble. In many instances, these breaks will be small that they cannot be detected by the naked eye. These almost invisible cracks (breaks) can be located only with the aid of a powerful hand- or stand-held magnifying glass.

b. MULTIMETER CHECKOUT. – The most common cause of an intermittent condition is poorly soldered connections. Other causes are: Broken boards, broken conducting strips, fused conducting strips, arc-over, loose terminals, etc.

To check out and locate trouble in the conducting strips of a printed circuit board, set up a multimeter (one which does not use a current in excess of 1 ma) for making point-to-point resistance tests, using needle point probes. Insert one point into the conducting strip, close to the end of terminal, and place the other probe on the opposite terminal end of the conducting strip. The multimeter should indicate continuity. If the multimeter indicates an open circuit, drag the probe along the strip (or if the conducting strip is coated, puncture the coating at intervals) until the multimeter indicates continuity. Mark this area then use a magnifying glass to locate the fault in the conductor.

CAUTION

Before using an ohmmeter for testing a circuit, transistors or other voltage-sensitive semiconductors, check the current it passes under test on all ranges. DO NOT use a range that passes more than 1 ma.

c. HOW TO REPAIR THE BREAK. – If the break in the conducting strip is small, lightly scrape away any coating covering the area of the conducting strip to be repaired. Clean the area with a firm-bristle brush and approved solvent. Then repair the cracked or broken area of the conducting strip by flowing solder over the break. Considerable care must be exercised to keep the solder from flowing onto an adjacent strip.

If a strip is burned out, or fused, cut and remove the damaged strip. Connect a legth of insulated wire across the breach or from solder-point to solder-point.

After the repairs are complete, clean the repaired area with a stiff brush and solvent. Allow the board to dry thoroughly, and then coat the repaired area with epoxy resin or similar compound. This coating not only will protect the repaired area but will help to strengthen it.

CAUTION

After repairs, always scrutinize the board for solder droppings that may cause possible shorts.

Frequently, a low-resistance leakage path will be created by moisture and/or dirt that has carbonized onto the phenolic board. This leakage can be detected by measuring the suspected circuit with a multimeter. To overcome this condition, thoroughly clean the carbonized area with a solvent and a stiff brush. If this does not remove it, use a scraping tool (spade end of a solder-aid tool or its equivalent) to remove the carbon, or drill a hole through the leakage path to break the continuity of the leakage. When drilling method is used, be careful not to drill into a part mounted on the other side.

5-4. ALIGNMENT.

a. R-F MODULE ALIGNMENT. – Remove the module having the lowest frequency and connect it to the receiver using the module extender.

1. Set the CHANNEL SELECTOR switch to the position that corresponds with the extended module.

2. Connect the r-f signal generator to the RF INPUT jack. Adjust the generator to deliver the desired operating frequency at 100 mv through 60 db of attenuation. The high generator level makes monitoring possible with the counter. Turn the rf gain control fully clockwise.

3. Remove the hfo crystal and rotate tuning capacitors C201-C204 fully clockwise.

4. Rotate tuning capacitors C201-C204 ¼ turn anticlockwise.

5. Peak coils T201-T204 as follows:

   a. Monitoring at TP201-peak T201
   b. Monitoring at TP202-peak T202
   c. Monitoring at TP205-peak T203
   d. Monitoring at TP206-peak T204
   e. Repeat this procedure until maximum signal is obtained.

6. Align other rf modules in the same way. After tuning coils to the lowest frequency, apply the module's operating frequency to the RF INPUT jack and, monitoring on TP206, turn C201-C204 anti-clockwise until maximum signal is obtained.

7. After aligning the rf section of the rf module, align the hfo as follows:

a. Remove signal generator
b. Reinsert crystal
c. Monitoring at TP208 with the counter, trim C212 to set the hfo to the required frequency, 300 kc higher than the module's rf frequency.

8. Monitoring at TP206 with the CRO, adjust R118 on the underside of the chassis to give the best gain control characteristic on the RF GAIN adjust.

9. Remove test equipment, and return module to its normal operating position.

b. I-F MODULE ALIGNMENT.

1. With the rf module removed, extend the if module using the two straight extender cards.

2. Short TP302 to ground.

3. Apply a .1 V 300 kc ±5 cps signal, capacitively isolated, through 40 db of attenuation to TP301.

4. Monitoring at Q202 collector, peak transformer T301.

5. Remove the ground jumper from TP302.

6. Adjust T302 for minimum signal at Q302 collector.

7. Repeat this procedure on the other stages as follows:

(a) With TP304 grounded, monitoring at TP303, peak T303.

(b) Remove the ground jumper from TP304, and dip T304.

(c) With TP306 grounded, monitoring at TP305, peak T305.

(d) Remove the ground jumper from TP306 and dip T306.

(e) With TP308 grounded, monitoring at TP307, peak T307.

(f) Remove the ground jumper from TP308 and dip T308.

(g) Monitoring at TP309, peak T309.

8. If, at any time, oscillation occurs, reduce the gain by adjusting R309.

9. Reinsert an rf module, and apply its operating frequency at the RF INPUT jack.

10. Turn the CHANNEL SELECTOR switch to the operating module's position.

11. Monitoring at TP308, adjust R305 for minimum signal.

12. Monitoring at TP309, with the CRO and counter, peak if transformers T301-T309.

13. Remove test equipment and return module to its normal operating position.

c. BFO MODULE ALIGNMENT.

1. Extend the bfo module by means of one of the straight extender cards.

2. Remove crystal Y401.

3. Turn the BFO switch to its ON position.

4. Set R405 for 6 volts at the junction of R406 and C402.

5. Adjust the BFO control for 0 volts control voltage.

6. If the 0 control voltage does not occur at the mid point of the BFO control travel, adjust R117 on the underside of the chassis until balance is obtained.

7. Monitoring with the counter at TP401, adjust L401 for 45 kc.

Note: It may be necessary in the case of low signal levels, to monitor TP401 with the oscilloscope, attaching the counter to its vertical signal output terminals.

8. Check that the frequency is adjustable 1 kc on either side of the 0 volts control setting by turning the BFO tuner on the front to its extreme clockwise and anti-clockwise positions. If not, change the setting of R405, readjust L401 for 45 kc at 0 volts control setting, and check again. Repeat until balance is obtained If balance is not obtainable in this manner, readjust R117 to give balance, then move the knob to give zero control voltage on the O line.

9. Connect the base terminal of transistor Q402 to ground.

10. Reinsert crystal Y401.

11. Monitoring with the counter at TP402, adjust capacitor C413 until a 345 kc signal is obtained.

12. Remove crystal Y401 and the ground jumper.

13. Insert a capacitively-isolated, .1 volt, 300 kc ±5 cps signal, through 40 db of attenuation, at TP402.

14. Monitoring with the AC voltmeter at the base terminal of transistor Q405, peak T401.

15. Perform the same operation on T402 inserting the signal at Q405 base, and monitoring at TP403.

16. Apply a signal of .1 volts through 60 db of attenuation at the RF INPUT jack at the frequency of the operating RF module. (no modulation).

17. Turn the BFO off.

18. Monitoring at TP404, and adjust R427 for minimum signal.

19. Reinsert crystal Y401.

20. Apply a 2 UV signal at the operating rf frequency, modulated 30% at 1000 cps, at the RF INPUT jack.

21. Monitoring across terminals 1 and 2 of terminal board TB101, observe the level of output.

22. Turn off the modulation, and turn on the bfo. Tune bfo for maximum output.

23. Without changing any other receiver control settings, observe the new signal level.

24. Adjust, R434 for equal signal levels. It will be observed that adjusting R434 affects the signal level in both the CW and MCW modes, but will have the greater effect on the MCW signal level.

25. Remove test equipment and return module to its normal operating position.

d. PANEL METER CALIBRATION.

1. Connect 600 ohms of resistance between terminals 5 and 7 and between 9 and 11 of terminal board TB101.

2. Connect the AC voltmeter ground to terminal 6, and probe to terminal 7 of TB101.

3. Apply an unmodulated 2 uv signal at the RF input jack at the frequency of one of the r-f modules.

4. Turn the CHANNEL SELECTOR switch to the required position.

5. Turn the LOW and HIGH LINE LEVEL controls fully anti-clockwise, and place the HIGH/LOW LINE switch in the LOW position.

6. Turn the bfo on.

7. Turn the RF GAIN control fully clockwise.

8. Rotate the LOW LINE LEVEL CONTROL clockwise until a reading of .39 volts is obtained on the ac voltmeter.

9. Adjust the ZERO DB ADJUST control R107 on the rear panel until the meter indicates 0 dbm on the LO scale.

10. Turn the HIGH/LOW LINE switch to the HIGH position.

11. Connect the ac voltmeter ground to terminal 10 and the probe to terminal of TB101.

12. Rotate the HIGH LINE LEVEL control clockwise until a reading of 1.95 volts is obtained on the ac voltmeter.

13. Adjust the 14 DB ADJUST control R108 on the rear panel until the meter indicates +14 dbm on the HI scale.

14. Remove test equipment, and terminating resistors.

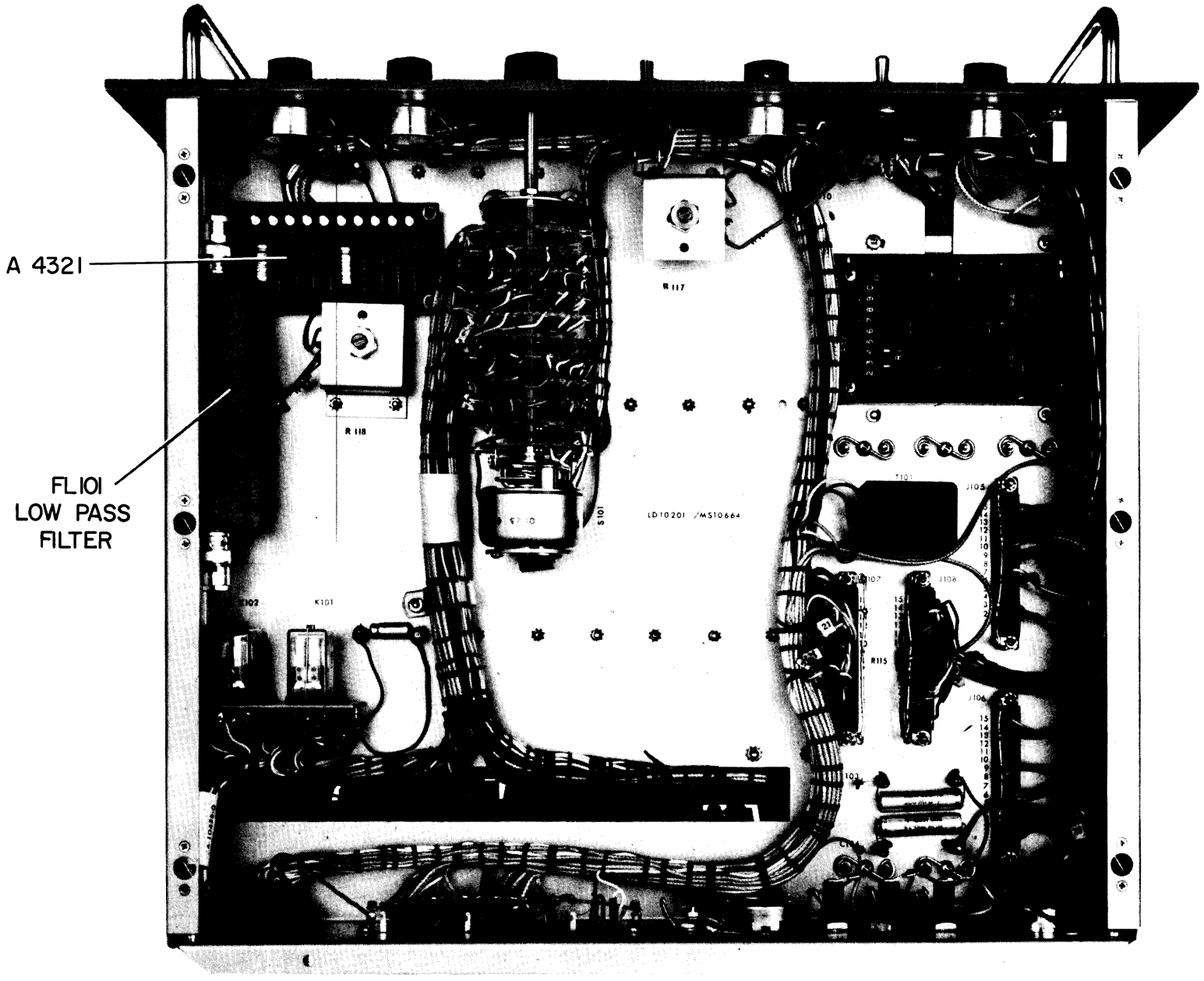


FIGURE 5-3 VLRE-1 RECEIVER BOTTOM VIEW

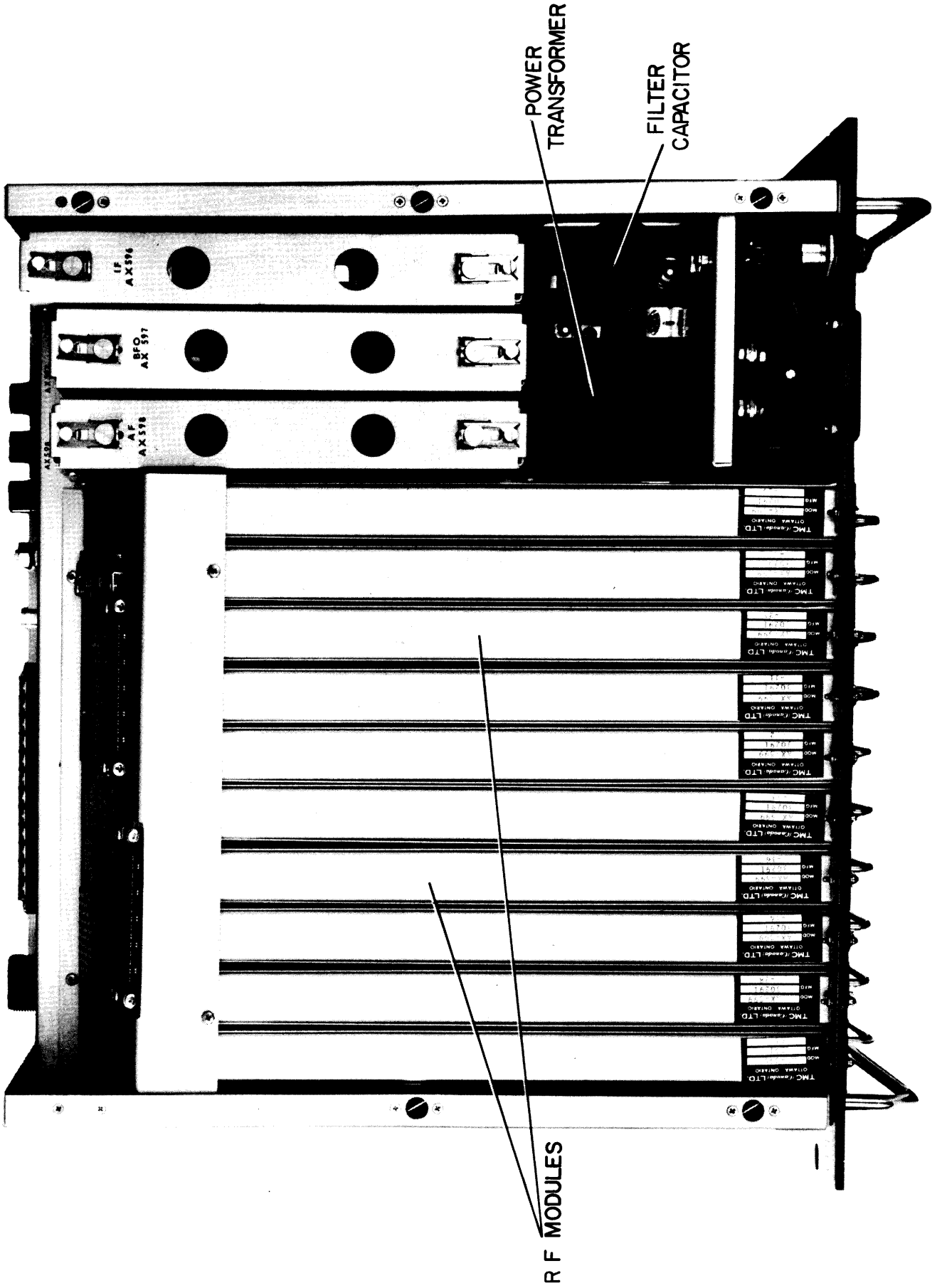


FIGURE 5-4 VLRE-1 RECIEVER TOP VIEW

SECTION 6
PART LIST

6-1. INTRODUCTION.

The parts list presented in this section is a cross-reference list of parts identified by a reference designation and TMC part number. In most cases, parts appearing on schematic diagrams are assigned reference designations in accordance with MIL–STD–16. Wherever practicable, the reference designation is marked on the equipment, close to the part it identifies. In most cases, mechanical and electro-mechanical parts have TMC part numbers stamped on them.

To expedite delivery when ordering any part, specify the following:

a. Generic name.

b. Reference designation.

c. TMC part number.

d. Model and serial numbers of the equipment containing the part being replaced; this can be obtained from the equipment nameplate. For replacement parts not covered by warranty (refer to warranty sheet in front of manual), address all purchase orders to:

TMC (CANADA) LTD.
Attention: Sales Department
R. R. No. 5
Ottawa, Ontario.

ASSEMBLY OR SUB-ASSEMBLY

VLRE-1 RECEIVER ACCESSORIES

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
	CABLE ASSEMBLY, POWER: coiled; twist lock plug; 3 conductors	CA555–4
	CONNECTOR, PLUG, ELECTRICAL: 1 male contact, BNC type; polarized, bayonet lock type.	PL244–1
	CONNECTOR, PLUG, ELECTRICAL: 17 round male contacts; 22 amperes rating.	MS3106B–20–29P
	PC BOARD ASSEMBLY, TEST CARD: 15 contacts; for extending RF modules outside of case during testing; 1 required; Offset type.	A4323
	PC BOARD ASSEMBLY, TEST CARD: 15 contacts; for extending i-f, bfo, and a-f modules outside of case during testing; 2 required.	A4324

POWER SUPPLY

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C1	CAPACITOR, FIXED, ELECTROLYTIC; rated at 2,000 uf; 50 WVDC; max. operating temperature -20 to + 85°C; hermetically sealed-metal case.	CE117
C2	CAPACITOR, FIXED, ELECTROLYTIC; 500 uf; 15 WVDC; max. temperature range 0–85°C, hermetically sealed aluminum case w/clear plastic sleeve.	CE116-6VN
C3	Same as C2.	
CR1	SEMICONDUCTOR DEVICE, DIODE: silicon: 600 volts; max. continuous DC current .5 amp at 100°C; surge current peak 75 amp; maximum operating temp. 150°C; max. forward voltage drop 1. OV; max. reserve current 1000 ua.	IN2484
CR2 through CR5	Same as CR1	
CR6	SEMICONDUCTOR DEVICE, DIODE: silicon; nom. Zener voltage 24V; standard anode-to-stud polarity, negative-grounded application; tolerance ±5%; junction and storage temperature rating -65°C to +175°C; power dissipation 10 watts DC; solder terminals; hermetically sealed metal and glass case.	VR101–24S51
CR7	NOT USED	
CR8	SEMICONDUCTOR DEVICE, DIODE: silicon; nom. Zener voltage 12V - 5%; 10 watts max. dissipation at 25°C; max current rating 210 ma; max impedance 3.0 ohms; storage temperature 175°C.	IN2976B
E1	TERMINAL BOARD: barrier type; ten 6–32 x ¼'' binding head machine screws.	TM100–10

POWER SUPPLY

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
K1	RELAY ARMATURE DPDT; 700 ohms, ±10% DC resistance; operating voltage 24 VDC; current rating 35 ma, 700 mw at 25°C; contacts rated for 5 amps at 29 VDC; clear high impact styrene dust cover case.	RL156–1
Q1	TRANSISTOR: germanium; PNP; collector-base and emitter voltage 45 VDC at 300 ma, 30 VDC at 500 ma; emitter-base voltage 25V; collector current 3 amps; power dissipation 62.5 watts at 25°C; junction temperature range -65° to + 100°C.	2N2143
R1	RESISTOR, FIXED, COMPOSITION: 470 ohms, ±5%; 1watt.	RC32GF471J
R2	NOT USED	
R3	RESISTOR, FIXED, WIREWOUND: 100 ohms, ±5%; 5 watts.	RW107–18
R4	RESISTOR, FIXED, COMPOSITION: 150 ohms; ±5%; 2 watts.	RC42GF151J
T1	TRANSFORMER, POWER, ISOLATION, STEP-DOWN: primary input 105, 115, 125 or 210, 230, 250V; frequency 50/60 cps, phase 1; secondary 28V, rated at 500 ma; 2–13/16'' lg. x 2–11/16'' wide x 2–3/8'' high; hermetically sealed steel case.	TF269

AF MODULE

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C501	CAPACITOR, FIXED, ELECTROLYTIC: 100 uf, -10% + 15 0% at 120 cps 25°C; 15 WVDC; polarized; insulated tubular case.	CE105–100–15
C502	CAPACITOR, FIXED, ELECTROLYTIC: tantalum; 50 uf, + 50% - 15%; 60 WVDC; polarized; tubular case.	CE107–1
C503	CAPACITOR, FIXED, CERAMIC: 0.3 uf, +80% - 20%; 1000 WVDC.	CC100–36
C504	CAPACITOR, FIXED, ELECTROLYTIC: 175 uf, - 10% +15 0% at 120 cps, 25°C; 15 WVDC; polarized; insulated case.	CE105–175–15
C505	Same as C501	
C506	Same as C502	
C507	Same as C503	
C508	Same as C504	
C509	NOT USED	
C510	Same as C502	

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C511	CAPACITOR, FIXED, ELECTROLYTIC: 10 uf, -10% +15 0% at 120 cps, 25° C; 15 WVDC; polarized; insulated tubular case.	CE105–10–15
C512	NOT USED	
C513	CAPACITOR, FIXED, CERAMIC: 470, 000 uuf, ± 20%; radial lead type terminals.	CC112R474M
C514	CAPACITOR, FIXED, CERAMIC: 0. 005 uf, minimum value; 500 WVDC.	CC100–15
C515	Same as C514	
Q501	TRANSISTOR: germanium; PNP; JEDC type 2N396A transistor with a controlled hfe limit of 85–105; JEDEC type T05 case.	2N396A
Q502 through Q509	Same as Q501	
Q510	TRANSISTOR: germanium; PNP; collector-base and emitter voltage 45 VDC at 300 ma, 30 VDC at 500 ma; emitter-base voltage 25V; collector current 3 amps; power dissipation 62.5 watts at 25° C; junction temperature range -65 to +100° C.	2N2143
Q511	Same as Q510	
R501	RESISTOR, FIXED, COMPOSITION: 270 ohms, ±5%; ½ watt.	RC20GF271J
R502	RESISTOR, FIXED, COMPOSITION: 22,000 ohms, ±5%; ½ watt.	RC20GF223J
R503	RESISTOR, FIXED, COMPOSITION: 1,000 ohms, ±5%; ½ watt.	RC20GF102J
R504	RESISTOR, FIXED, COMPOSITION: 2,700 ohms, ±5%; ½ watt.	RC20GF272J
R505	RESISTOR, FIXED, COMPOSITION: 1,500 ohms, ±5%; ½ watt.	RC20GF152J
R506	Same as R505	
R507	Same as R501	
R508	Same as R502	
R509	Same as R503	
R510	Same as R504	
R511	Same as R505	
R512	Same as R505	
R513	NOT USED	
R514	NOT USED	

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R515	RESISTOR, FIXED, COMPOSITION: 10,000 ohms, ±5%; ½ watt.	RC20GF103J
R516	RESISTOR, FIXED, COMPOSITION: 8,200 ohms, ±5%; ½ watt.	RC20GF822J
R517	RESISTOR, FIXED, COMPOSITION: 3,300 ohms, ±5%; ½ watt.	RC20GF332J
R518	Same as R517	
R519	RESISTOR, FIXED, COMPOSITION: 100 ohms, ±5%; ½ watt.	RC20GF101J
R520	Same as R519	
R521	RESISTOR, FIXED, COMPOSITION: 1,200 ohms, ±5%; ½ watt.	RC20GF122J
R522	Same as R521	
R523	RESISTOR, FIXED, COMPOSITION: 820 ohms, ±5%; ½ watt.	RC20GF821J
R524	RESISTOR, FIXED, COMPOSITION: 4.7 ohms, ±5%; ¼ watt.	RC07GF4R7J
R525	RESISTOR, FIXED, COMPOSITION: 15 ohms, ±5%; ½ watt.	RC20GF150J
R526	Same as R525	
R527	Same as R502	
T501	TRANSFORMER, AF: interstage; primary impedance 5K ohms, centre taps; secondary 600 ohms, centre tap; power rated at 10 mw; frequency range 50–10,000 cps; wire lead type terminals; encapsulated case.	TF271
T502	TRANSFORMER, AF: line output; primary impedance 10K ohms, centre tap; secondary 1.5K ohms, centre tap; power rated at 100 mw; frequency range 50–10,000 cps; wire lead type terminals; encapsulated case.	TF270
T503	Same as T501	
T504	TRANSFORMER, AF; line output;	
T505	TRANSFORMER, AF: interstage; primary impedance 10K ohms, centre tap; secondary 1.5K ohms, centre tap; power rated at 100 mw; frequency range 50–10,000 cps; wire lead type terminals; encapsulated case.	TF270

IF MODULE

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C301	CAPACITOR, FIXED, ELECTROLYTIC: 1.0 uf, -10% +150% at 120 cps, 25° C; 15 WVDC; polarized; insulated tubular case.	CE105-1-15
C302	CAPACITOR, FIXED, ELECTROLYTIC: 10 uf, -10% +150% at 120 cps, 25° C; WVDC; polarized; insulated tubular case.	CE105-10-15
C303	CAPACITOR, FIXED, MICA: 5600 uuf, ±2%; temperature range -50 to +125° C; 500 WVDC.	CM35C562G03
C304	Same as C303	
C305	CAPACITOR, FIXED, MICA: 82 uuf, ±10%; temperature range -55 to +125° C; 500 WVDC.	CM15B820K03
C306	CAPACITOR, FIXED, CERAMIC: 100,000 uuf, +80% -20%; 100 WVDC.	CC100-28
C307	Same as C306	
C308	Same as C306	
C309	Same as C306	
C310	Same as C303	
C311	Same as C303	
C312	CAPACITOR, FIXED, MICA: 62 uuf, ±20%; temperature range -55 to +125° C; 500 WVDC.	CM15B620K03
C313 through C319	Same as C306	
C320	Same as C303	
C321	Same as C303	
C322	Same as C312	
C323 through C328	Same as C306	
C329	Same as C303	
C330	Same as C303	
C331	Same as C305	
C332 through C337	Same as C306	
C338	CAPACITOR, FIXED, CERAMIC: 10,000 uf; GMV; 500 WVDC.	CC100-16
C339	Same as C306	
C340	Same as C301	CE105-1-15

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C341 through C344	Same as C306	
C345	Same as C303	
CR301	SEMICONDUCTOR DEVICE, DIODE: germanium; peak inverse voltage 60V; continuous average forward current 50 ma; peak forward current 150 ma; max surge current 500 ma; max. inverse current 500 ua at 50 volts or 30 ua at 10 volts.	IN34A
CR302	Same as CR301	
L301	COIL, RF, FIXED: 10,000 uh ±10%; max. current 66 ma; minimum Q of 36.	CL275–103
L302 through L304	Same as L301	
L305	COIL, RF, FIXED: 3300 uh ±10%; max. current 82 ma; minimum Q of 52.	CL275–332
Q301	TRANSISTOR: germanium, PNP; JEDEC type 2N396A transistor with a controlled hfe limit of 85–105; JEDEC type T05 case.	2N396A
Q302 through Q308		
R301	RESISTOR, FIXED, COMPOSITION: 10,000 ohms, ±5%; ½ watt.	RC20GF103J
R302	Same as R301	
R303	RESISTOR, FIXED, COMPOSITION: 470 ohms, ±5%; ½ watt.	RC20GF471J
R304	Same as R303	
R305	RESISTOR, VARIABLE, COMPOSITION: linear taper; 1,000 ohms ±10%; ¼ watt at 70° C; temperature range −55 to +120° C.	RV111U102A
R306	RESISTOR, FIXED, COMPOSITION: 22,000 ohms, ±5%; ½ watt.	RC20GF223J
R307	Same as R301	
R308	RESISTOR, FIXED, COMPOSITION: 1,000 ohms, ±5%; ½ watt.	RC20GF102J
R309	RESISTOR, VARIABLE, COMPOSITION: linear 5,000 ohms ±10%; ¼ watt at 70° C; temperature range −55 to +120° C.	RV111U502A
R310	Same as R308	
R311	RESISTOR, FIXED, COMPOSITION: 68 ohms, ±5%; ½ watt.	RC20GF680J

IF MODULE

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R312	RESISTOR, FIXED, COMPOSITION: 6800 ohms, ±5%; ½ watt.	RC20GF682J
R313	Same as R308	
R314	Same as R308	
R315	RESISTOR, FIXED, COMPOSITION: 33 ohms, ±5%; ½ watt.	RC20GF330J
R316	Same as R312	
R317	Same as R308	
R318	Same as R308	
R319	RESISTOR, FIXED, COMPOSITION: 220 ohms, ±5%; ½ watt.	RC20GF221J
R320	Same as R312	
R321	Same as R308	
R322	Same as R308	
R323	Same as R319	
R324	Same as R312	
R325	RESISTOR, FIXED, COMPOSITION: 39,000 ohms, ±5%; ½ watt.	RC20GF393J
R326	RESISTOR, FIXED, COMPOSITION: 2700 ohms, ±5%; ½ watt.	RC20GF272J
R327	RESISTOR, FIXED, COMPOSITION: 1800 ohms, ±5%; ½ watt.	RC20GF182J
R328	RESISTOR, FIXED, COMPOSITION: 47,000 ohms, ±5%; ½ watt.	RC20GF473J
R329	RESISTOR, FIXED, COMPOSITION: 3900 ohms, ±5%; ½ watt.	RC20GF392J
R330	RESISTOR, FIXED, COMPOSITION: 5600 ohms, ±5%; ½ watt.	RC20GF562J
R331	Same as R301	
R332	RESISTOR, FIXED, COMPOSITION: 3.3 ohms, ±5%; ¼ watt.	RC07GF3REJ
R333	Same as R332	
T301	TRANSFORMER, RF, TUNED: operating frequency 300 Kc; inductance 60 uh +10%; minimum "Q" 105; primary centre tap.	TT274
T302	TRANSFORMER, RF, TUNED: operating frequency 300 Kc; inductance 60 uh ±10%; minimum "Q" 105.	TT275
T303	TRANSFORMER, RF, TUNED: operating frequency 300 Kc; inductance 60 uh ±10%; minimum "Q" 105.	TT276

IF MODULE

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
T304	Same as T302	
T305	Same as T303	
T306	Same as T302	
T307	Same as T303	
T308	Same as T303	
T309	Same as T301	
T310	TRANSFORMER, RF, TUNED: input impedance 2.2 K ohms; output impedance 8.2 K ohms, centre tapped; operating frequency 5 Kc–100 Kc; stake lug terminals; encapsulated case.	TR183

BFO MODULE

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C401	CAPACITOR, FIXED, ELECTROLYTIC: 5 uf, -10% +150% at 120 cps, 25°C; 15 WVDC; polarized; insulated tubular case.	CE105–5–15
C402	CAPACITOR, FIXED, MICA: 6200 uuf, ±2%; 300 WVDC; temperature range -55 to +125° C.	CM112F622G35
C403	Same as C402	
C404	CAPACITOR, FIXED, MICA: 470 uuf, ±2%; 500 WVDC; temperature range -55 to +125° C.	CM111F471G5S
C405	CAPACITOR, FIXED, MICA: 6200 uuf, +10%; 300 WVDC; temperature range -55 to +125° C.	CM112E622K3S
C406	Same as C401	
C407	Same as C405	
C408	CAPACITOR, FIXED, ELECTROLYTIC: 1 uf -10% +150% at 120 cps, 25° C; 15 WVDC; polarized; insulated tubular case.	CE105–1–15
C409 through C411	Same as C401	
C412	CAPACITOR, FIXED, CERAMIC: 10,000 uuf; GMV; 500 WVDC.	CC100–16
C413	CAPACITOR, VARIABLE, CERAMIC: 8–50 uuf; 350 WVDC; temperature range -55 to +85° C.	CV109–9
C414	CAPACITOR, FIXED, MICA: 1,000 uuf, ±5%; 500 WVDC; temperature range -55 to ±125° C.	CM111D102J5S

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C415	CAPACITOR, FIXED, CERAMIC: 100,000 uuf, +80% -20%; 100 WVDC.	CC100-28
C416	CAPACITOR, FIXED, MICA: 100 uuf, ±10%; 500 WVDC; temperature range -55 to +125° C.	CM111D101K5S
C147	CAPACITOR, FIXED, MICA: 5600 uuf, ±5%; 500 WVDC, temperature range -55 to +125° C.	CM112F562J5S
C418	CAPACITOR, FIXED, ELECTROLYTIC: 2 uf, -10% +150% at 120 cps, 25° C; 15 WVDC; polarized; insulated case.	CE105-2-15
C419	Same as C415	
C420	Same as C417	
C421	Same as C415	
C422	CAPACITOR, FIXED, CERAMIC: 20,000 uuf, +60% -40%; 150 WVDC.	CC100-35
C423	Same as C418	
C424	CAPACITOR, FIXED, ELECTROLYTIC: 25 uf, -10% +150% at 120 cps, 25° C; 15 WVDC; polarized; insulated case.	CE105-25-15
C425	CAPACITOR, FIXED, METALIZED, MYLAR; 0.1 uf, ±5%; 200 WVDC; temperature range -55 to +130° C; tubular, epoxy encapsulated case.	CN114R10.2J
C426 through C428	Same as C425	
C429	Same as C424	
C430	Same as C418	
C431	Same as C418	
CR401	CAPACITOR, VOLTAGE, VARIABLE: silicon; 57-250 uuf; 15 WVDC; temperature range -50 to +120° C; operating voltage range 1 to 15 volts.	CX106-13
CR402	Same as CR401	
CR403	SEMICONDUCTOR DEVICE, DIODE: silicon; nom. Zener voltage 10 volts; 400 mv dissipation; hermetically sealed glass case.	IN961
L401	COIL, RF, ADJUSTABLE: 25.25 to 26.5 mh; "Q" min. at 50 Kc-280.	CL388
L402	COIL, RF, FIXED: 56000 uh +10%; maximum current 26 ma; "Q" minimum 25; operating temperature -55 to +125° C.	CL275-563
L403	Same as L402	

BFO MODULE

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
Q401	TRANSISTOR: silicon; NPN; high frequency switch; maximum dissipation 300 mw at 25° C; hfe at 10 ma of 20.	2N706
Q402	TRANSISTOR: germanium; PNP; JEDEC type 2N396A transistor with a controlled hfe limit of 85–105; JEDEC type T05 case.	2N396A
Q403	Same as Q401	
Q404 through Q408	Same as Q402	
R401	RESISTOR, FIXED, COMPOSITION: 100,000 ohms, ±5%; ½ watt.	RC20GF104J
R402	NOT USED	
R403	RESISTOR, FIXED, COMPOSITION: 300 ohms, ±5%; ½ watt.	RC20GF331J
R404	RESISTOR, FIXED, COMPOSITION: 3900 ohms, ±5%; ½ watt.	RC20GF392J
R405	RESISTOR, VARIABLE, COMPOSITION: 10,000 ohms, ±10%; linear taper; ¼ watt.	RV111U103A
R406	Same as R401	
R407	RESISTOR, FIXED, COMPOSITION: 2200 ohms, ±5%; ½ watt.	RC20GF222J
R408	RESISTOR, FIXED, COMPOSITION: 470 ohms, ±5%; ½ watt.	RC20GF471J
R409	RESISTOR, FIXED, COMPOSITION: 4700 ohms, ±5%; ½ watt.	RC20GF472J
R410	RESISTOR, FIXED, COMPOSITION: 100 ohms, ±5%; ½ watt.	RC20GF101J
R411	RESISTOR, FIXED, COMPOSITION: 5100 ohms, ±5%; ½ watt.	RC20GF512J
R412	RESISTOR, FIXED, COMPOSITION: 1,000 ohms, ±5%; ½ watt.	RC20GF102J
R413	RESISTOR, FIXED, COMPOSITION: 10,000 ohms, ±5%; ½ watt.	RC20GF103J
R414	Same as R412	
R415	RESISTOR, FIXED, COMPOSITION: 6800 ohms, ±5%; ½ watt.	RC20GF682J
R416	RESISTOR, FIXED, COMPOSITION: 33,000 ohms, ±5%; ½ watt.	RC20GF333J
R417	Same as R413	
R418	Same as R409	
R419	Same as R412	

BFO MODULE

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R420	Same as R412	
R421	Same as R413	
R422	Same as R410	
R423	RESISTOR, FIXED, COMPOSITION: 8200 ohms, ±5%; ½ watt.	RC20GF822J
R424	Same as R412	
R425	RESISTOR, FIXED, COMPOSITION: 15,000 ohms, ±5%; ½ watt.	RC20GF153J
R426	Same as R413	
R427	RESISTOR, VARIABLE, COMPOSITION: 500 ohms, ±10%; linear taper; ¼ watt.	RV111U501A
R428	RESISTOR, FIXED, COMPOSITION: 47 ohms, ±5%; ½ watt.	RC20GF470J
R429	Same as R428	
R430	Same as R407	
R431	Same as R423	
R432	RESISTOR, FIXED, COMPOSITION: 270 ohms, ±5%; ½ watt.	RC20GF271J
R433	RESISTOR, FIXED, COMPOSITION: 5600 ohms, ±5%; ½ watt.	RC20GF562J
R434	RESISTOR, FIXED, COMPOSITION: 250 ohms, ±10%; linear taper; ¼ watt.	RV111U251A
R435	RESISTOR, FIXED, COMPOSITION: 680 ohms, ±5%; ½ watt.	RC20GF681J
T401	TRANSFORMER, RF, ADJUSTABLE: operating frequency 300 Kc; inductance -60 uh at 2.5 mc ±10%; "Q" min. of 105.	TT275
T402	Same as T401	
T403	TRANSFORMER, AUDIO FREQUENCY: primary and secondary 600 ohms, centre tapped; max primary power 350 mw.	TF263
X401	SOCKET, CRYSTAL: clip type; 2 cadmium plated contacts; 3/64" x 5/32" tail slots.	TS167-1
Y401	CRYSTAL, QUARTZ: 345.000 Kc ± 0.01%.	CR46A/4345 KC

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C201	CAPACITOR, VARIABLE, MICA: 80–480 uuf; 6–plate; 175 WVDC; compression type.	CV114–2
C202 through C204	Same as C201	
C205	CAPACITOR, FIXED, CERAMIC: 200,000 uuf, ±80% -20%; 25 WVDC.	CC100–33
C206	CAPACITOR, FIXED, CERAMIC: 100,000 uuf, +80% -20%; 100 WVDC.	CC100–28
C207	Same as C206	
C208	CAPACITOR, FIXED, ELECTROLYTIC: 125 uf, -10% +150% at 120 cps, 25° C; 15 WVDC; polarized; insulated tubular case.	CE105–125–15
C209	Same as C206	
C210	CAPACITOR, FIXED, METALLIZED, MYLAR: .82 uf, ±10%, 50 WVDC.	CN114R82–5J
C211	CAPACITOR, FIXED, CERAMIC: 1,000 uuf, ±10%; 500 WVDC.	CC100–9
C212	CAPACITOR, VARIABLE, CERAMIC: 8–50 uuf; 350 WVDC.	CV109–9
C213	CAPACITOR, FIXED, ELECTROLYTIC: 25 uf, -10% +150% at 120 cps, 25° C; 15 WVDC. polarized; insulated tubular case.	CE105–25–15
C214	CAPACITOR, FIXED, MICA: 5 uuf, ±20%; 500 WVDC.	CM15B050M03
C215	CAPACITOR, FIXED, MICA: 100 uuf, ±10%; 500 WVDC.	CM15B101K03
C216	Same as C205	
C217	Same as C206	
C218	Same as C205	
C219	CAPACITOR, FIXED, CERAMIC: 20,000 uuf, +60% -40%; 150 WVDC.	CC100–35
C220	CAPACITOR, FIXED, CERAMIC: 10,000 uuf, GMV; 500 WVDC.	CC100–16
C221	Same as C206	
C222	CAPACITOR, FIXED, ELECTROLYTIC: 8 uf, -10% +150% at 120 cps, 25° C; 15 WVDC; polarized; insulated tubular case.	CE105–8–15
C223	CAPACITOR, FIXED, MICA: 1,000 uuf, ±1%; 500 WVDC.	CM111G102F5S

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
L201	COIL, RF, FIXED: 10,000 uh, ±10%; max. current 66 ma; DC resistance 76.6Ω.	CL275–103
Q201	TRANSISTOR: germanium; PNP; JEDEC type 2N396A transistor with a controlled hfe limit of 85–105; JEDEC type T05 case.	2N396A
Q202 through Q204	Same as Q201	
R201	RESISTOR, FIXED, COMPOSITION: 100 ohms, ±5%; ½ watt.	RC20GF101J
R202	RESISTOR, FIXED, COMPOSITION: 1,000 ohms, ±5%; ½ watt.	RC20GF102J
R203	Same as R202	
R204	RESISTOR, FIXED, COMPOSITION: 33,000 ohms, ±5%; ½ watt.	RC20GF333J
R205	RESISTOR, FIXED, COMPOSITION: 8,200 ohms, ±5%; ½ watt.	RC20GF822J
R206	Same as R205	
R207	RESISTOR, FIXED, COMPOSITION: 22 ohms, ±5%; ½ watt.	RC20GF220J
R208	RESISTOR, FIXED, COMPOSITION: 12,000 ohms, ±5%; ½ watt.	RC20GF123J
R209	Same as R202	
R210	Same as R201	
R211	RESISTOR, FIXED, COMPOSITION: 68 ohms, ±5%; ½ watt.	RC20GF680J
R212	RESISTOR, FIXED, COMPOSITION: 22,000 ohms, ±5%; ½ watt.	RC20GF223J
R213	Same as R202	
R214	RESISTOR, FIXED, COMPOSITION: 4,700 ohms, ±5%; ½ watt.	RC20GF472J
R215	RESISTOR, FIXED, COMPOSITION: 5,600 ohms, ±5%; ½ watt.	RC20GF562J
R216	RESISTOR, FIXED, COMPOSITION: 27,000 ohms, ±5%; ½ watt.	RC20GF273J
R217	Same as R201	
R218	RESISTOR, FIXED, COMPOSITION: 10,000 ohms, ±5%; ½ watt.	RC20GF103J
R219	RESISTOR, FIXED, COMPOSITION: 1,800 ohms, ±5%; ½ watt.	RC20GF182J

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R220	RESISTOR, FIXED, COMPOSITION: 100,000 ohms ±5%; ½ watt.	RC20GF104J
R221	Same as R212	
R222	Same as R208	
R223	RESISTOR, FIXED, COMPOSITION: 3,300 ohms, ±5%; ½ watt.	RC20GF332J
R224	RESISTOR, FIXED, COMPOSITION: 3,900 ohms, ±5%; ½ watt.	RC20GF392J
R225	RESISTOR, FIXED, COMPOSITION: 6,800 ohms, ±5%; ½ watt.	RC20GF682J
R226	Same as R205	
R227	Same as R201	
T201	TRANSFORMER, RF, ADJUSTABLE: operating frequency range 400–600 Kcs; primary -secondary ration 1=1; neither rated; tertiary inductance 400 uh, Q of 50.	TT273
T202	TRANSFORMER, RF, ADJUSTABLE: operating frequency range 400–600 Kcs; secondary centre tapped; tertiary connected to primary, inductance 400 uh, Q of 50.	TT271
T203	TRANSFORMER, RF, ADJUSTABLE: operating frequency range 400–600 Kcs; primary centre tapped; tertiary inductance 400 uh, Q of 50.	TT272
T204	Same as T202	
XY201	SOCKET, CRYSTAL: clip type; 2 cadmium plated contacts; 3/64" x 5/32" tail slots	TS167–1
*Y201	CRYSTAL, QUARTZ	CR118–XXX

* Frequency determined as ordered by customer. XTAL frequency shall be operating frequency plus 300 Kc.

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C101	CAPACITOR, FIXED, CERAMIC: 100,000 uuf, +80% -20%; 300 WVDC.	CC100-37
C102	Same as C101	
C103	CAPACITOR, FIXED, ELECTROLYTIC: 200 uf, -10% +150% at 120 cps, 25° C; 15 WVDC; polarized; insulated tubular case.	CE105-200-15
C104	Same as C103	
C105	CAPACITOR, FIXED, ELECTROLYTIC: 25 uf, -10% +150% at 120 cps, 25° C; 15 WVDC; polarized; insulated tubular case.	CE105-25-15
DS101	LAMP, INCANDESCENT: 28 volts; 0.04 amp; miniature bayonet base T-3-¼ bulb.	BI101-1819
E1	TERMINAL BOARD, FANNING: 10 terminals; angle type left end feed	TM105-10AL
F101	FUSE, CARTRIDGE: ½ amp; time lag; 1-¼" long x ¼" dia.; slow blow.	FU102-.500
F102	Same as F101	
F103	Same as F101	
FL101	FILTER, LOW PASS: two BNC receptacles.	FX208
J101	PLUG, TWIST LOCK, MALE: polarized; midget size; black bakelite; 15 amps at 125 volts	JJ175
J102	CONNECTOR, RECEPTACLE BULKHEAD MOUNTING: 17 round female contacts; 22 amperes rating.	MS3102A2029S
J103	RECEPTACLE, BNC, BULKHEAD MOUNTING: RF type; 1 round female contact; 50 ohm nominal impedance.	UG625*/U
J104	JACK, TELEPHONE: tip and sleeve; bushing mounted.	JJ034
J105	CONNECTOR, RECEPTACLE, PC BOARD: 15 female contacts; for single sided PC board; floating bushing; eyelet terminals; 5 ampere rating.	JJ319A15SFE
J106 through J118	Same as J105	
K101	RELAY, ARMATURE: 4 pole, double throw; coil resistance 185 ohms; operating voltage 12 VDC; 2 amp DC rating.	RL156-2
K102	RELAY, ARMATURE: 6 pole, double throw; coil resistance 430 ohms; operating voltage 24 VDC; 5 amp DC rating.	RL156-5

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
M101	METER, AF: level indicating; scale-HI 0-+17 DBM, LO -18 +3 DBM; 50 ua movement, 2,000 ohms approx resistance black phenolic case.	MR194
PL101	CONNECTOR, PLUG, ELECTRICAL: 1 male contact, BNC type; polarized, bayonet lock type.	PL244-1
PL102	Same as PL101	
R101	RESISTOR, VARIABLE, COMPOSITION: 2,5000 ohms, ±10%; 2 watt; standard bushing type; slotted 5/8" shaft.	RV4NAYSA252A
R102 through R104	Same as R101	
R105	RESISTOR, VARIABLE, COMPOSITION: 3,500 ohms, ±20%; 2 watts; standard bushing type; slotted 5/8" shaft.	RV4NAYSA352B
R106	RESISTOR, VARIABLE, COMPOSITION: 25,000 ohms, ±10%; 2 watts; standard bushing type; slotted 5/8" shaft.	RV4NAYSA253A
R107	RESISTOR, VARIABLE, COMPOSITION: 10,000 ohms, ±10%; 2 watts; locking bushing type; slotted 5/8" shaft.	RV4LAYSA103A
R108	RESISTOR, VARIABLE, COMPOSITION: 100,000 ohms, ±10%; 2 watts; locking bushing type; slotted 5/8" shaft.	RV4LAYSA104A
R109	RESISTOR, FIXED, COMPOSITION: 4,700 ohms, ±5%; 1 watt.	RC32GF472J
R110	Same as R109	
R111	RESISTOR, FIXED, COMPOSITION: 10,000 ohms, ±5%; ½ watt.	RC20GF103J
R112	RESISTOR, FIXED, COMPOSITION: 1,000 ohms, ±5%; ½ watt.	RC20GF102J
R113	RESISTOR, FIXED, COMPOSITION: 3,300 ohms, ±5%; ½ watt.	RC20GF332J
R114	RESISTOR, FIXED, COMPOSITION: 18,000 ohms, ±5%; ½ watt.	RC20GF183J
R115	RESISTOR, FIXED, COMPOSITION: 680 ohms, ±5%; ½ watt.	RC20GF681J
R116	RESISTOR, FIXED, COMPOSITION: 4,700 ohms, ±5%; ½ watt.	RC20GF472J
S101	SWITCH, ROTARY: 10 sections; 12 positions; non-shorting contacts; rotary solenoid and two positioning sections attached to rear.	SW10023
S102	SWITCH, TOGGLE: DPST; 3 amps rated at 220 volts; bat type handle.	ST22K

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
S103	Same as S102	
S104	SWITCH, TOGGLE: SPST; 3 amps rated at 220 volts; bat type handle.	ST12A
S105	SWITCH, TOGGLE: DPDT; 3 amps rated at 220 volts; bat type handle.	ST22N
T101	TRANSFORMER, AUDIO OUTPUT: primary- 500 ohms, centre tapped; secondary - 4 ohms; max. audio operating level of 1 watt; frequency range 50–10,000 cps; solder stud terminals; fully enclosed steel case.	TF272
TB101	TERMINAL BOARD, BARRIER: 12 terminals; solder lug terminals; phenolic black bakelite.	TM100–12
XDS101	LIGHT, INDICATOR: with red frosted lens; for miniature bayonet base T-3-¼ bulb.	TS106–1
XF101	FUSEHOLDER: extractor post type; accommodates cartridge fuse ¼" dia. x 1-¼" long; rated at 15 amps 250 V max.; o/a length 1-¾"; bushing mounted.	FH103
XF102	Same as XF101	
XF103	Same as XF101	
XK101	SOCKET, RELAY: with retainer; 16 beryllium copper-gold plated contacts; eyelet type terminals.	TS171–3
XK102	SOCKET, RELAY: with retainer; 22 beryllium copper-gold plated contacts; eyelet type terminals.	TS171–2

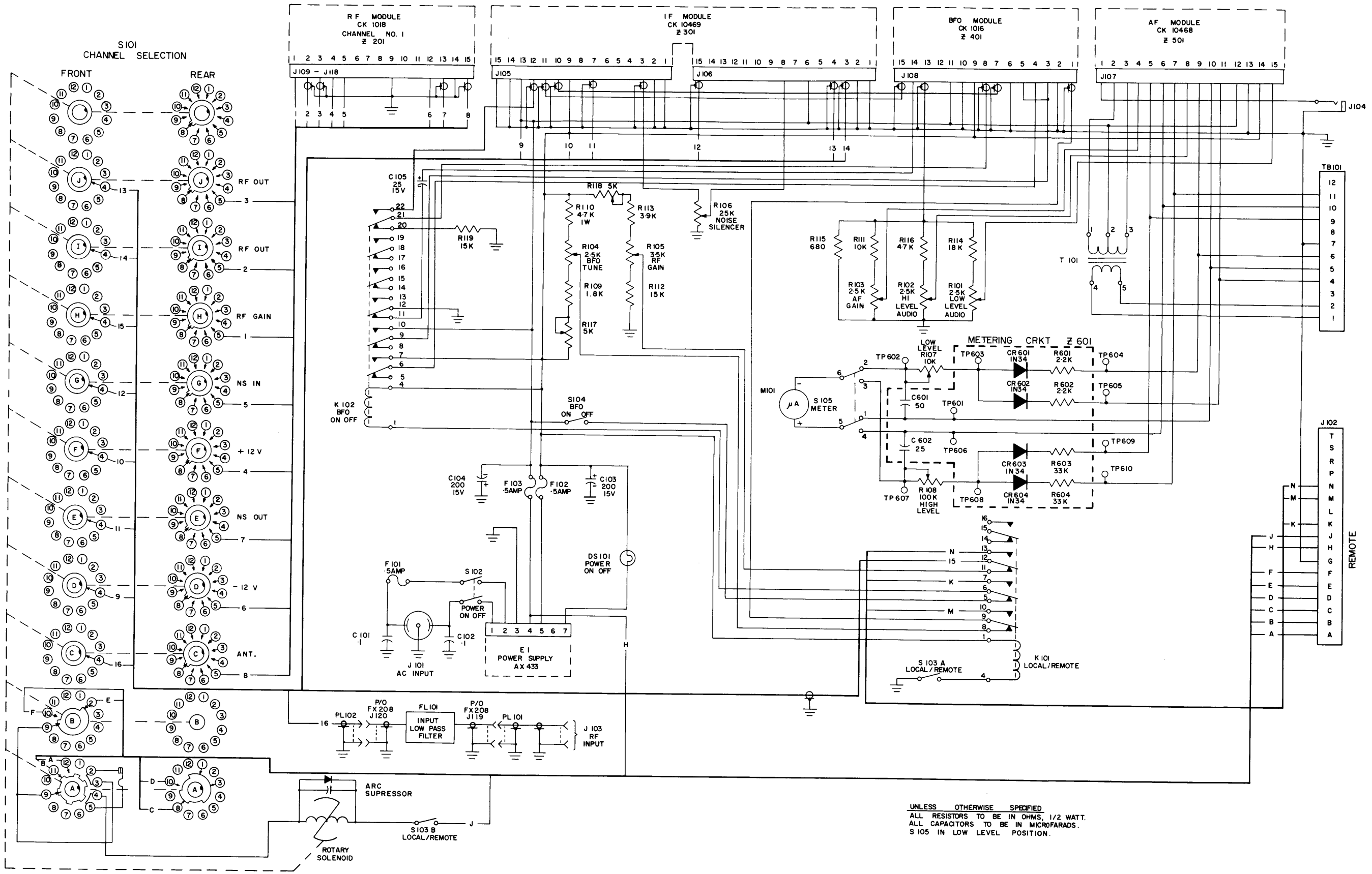
METERING CIRCUIT

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C601	CAPACITOR, FIXED, ELECTROLYTIC: 50 uf, -10% +150% at 120 cps, 25° C; 15 WVDC; polarized; insulated tubular case.	CE105–50–15
C602	CAPACITOR, FIXED, ELECTROLYTIC: 25 uf, -10% +150% at 120 cps, 25° C; 15 WVDC; polarized; insulated tubular case.	CE105–25–15
CR601	SEMICONDUCTOR DEVICE, DIODE: germanium; peak inverse voltage 60 V; continuous forward current 50 ma; peak forward current 150 ma; surge current 500 ua at 50 volts or 30 ua at 10 volts; hermetically sealed glass case.	IN34A
CR602 through CR604	Same as CR601	
R601	RESISTOR, FIXED, COMPOSITION: 2,200 ohms, ±5%; ½ watt.	RC20GF222J
R602	Same as R601	
R603	RESISTOR, FIXED, COMPOSITION: 33,000 ohms, ±5%; ½ watt.	RC20GF333J

FS TONE RECEIVER Z103–108 OF RARB

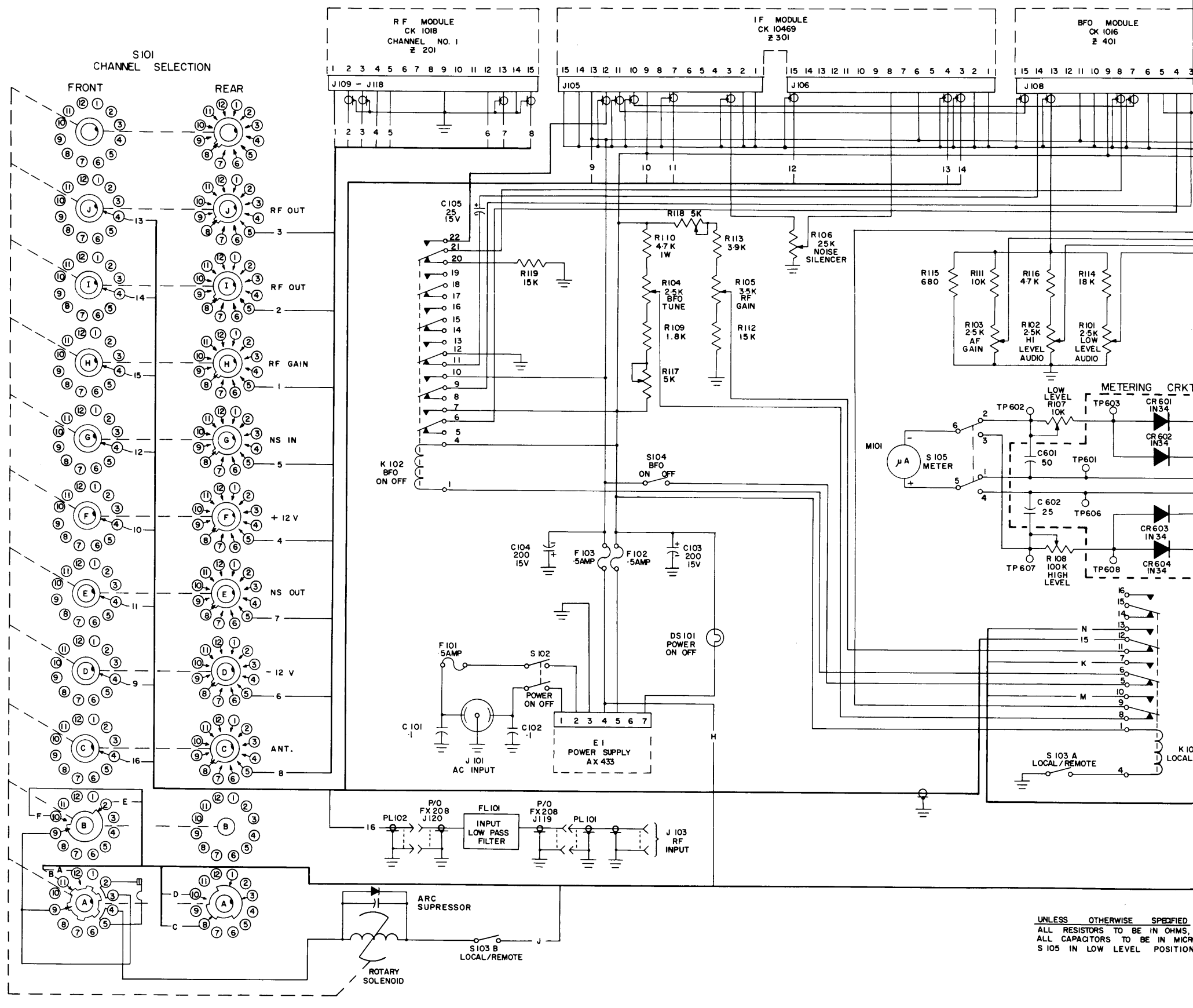
NETWORK	614X	615XR	616XR	617XR	618XR	619XR
CENTER FREQ.	1980	2100	2220	2340	2460	2580
MARK FREQ.	2010	2130	2250	2370	2490	2610
SPACE FREQ.	1950	2070	2190	2310	2430	2550
C101 and C102 (See note)	.065 uF	.058 uF	.052 uF	.094 uF	.084 uF	.077 uF
L101	100 uH	100 uH	100 uH	50 uH	50 uH	50 uH
R101	47 ohms	47 ohms	47 ohms	22 ohms	22 ohms	22 ohms

NOTE: C101 and C102 values for guidance only. Specific values are to be trimmed to actual inductance values. Factory adjusted.



UNLESS OTHERWISE SPECIFIED
ALL RESISTORS TO BE IN OHMS, 1/2 WATT.
ALL CAPACITORS TO BE IN MICROFARADS.
S 105 IN LOW LEVEL POSITION.

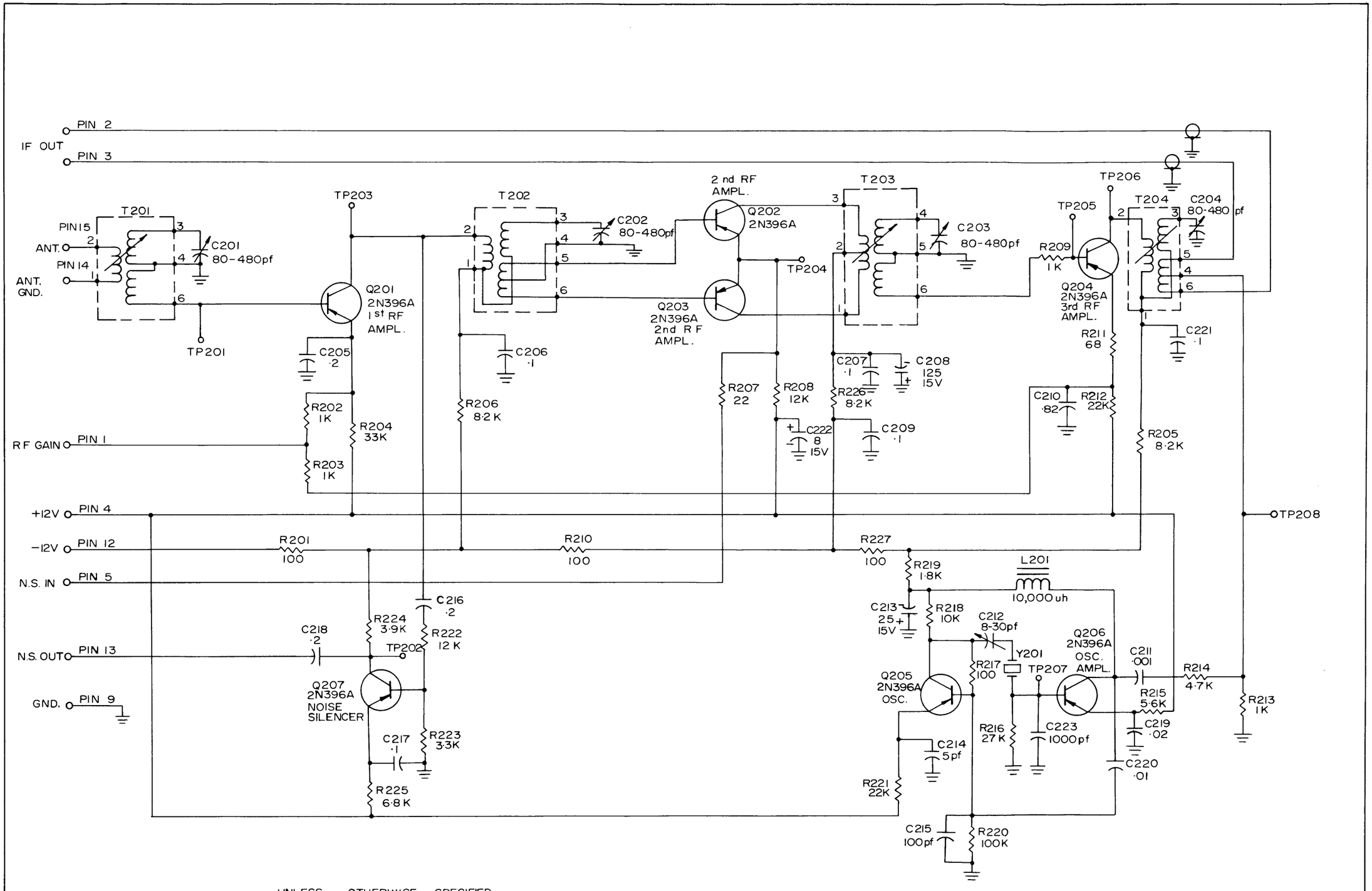
FIGURE 7–1. VLRE RECEIVER, SCHEMATIC DESIGN



UNLESS OTHERWISE SPECIFIED
ALL RESISTORS TO BE IN OHMS,
ALL CAPACITORS TO BE IN MICR
S 105 IN LOW LEVEL POSITION

011643006

FIGURE 7-1. VLRE RECEIVER, SCHEMATIC DESIGN



UNLESS OTHERWISE SPECIFIED

ALL RESISTORS TO BE IN OHMS, 1/2 W.
ALL CAPACITORS TO BE IN MICROFARADS

FIGURE 7-2. RF MODULE, SCHEMATIC DIAGRAM

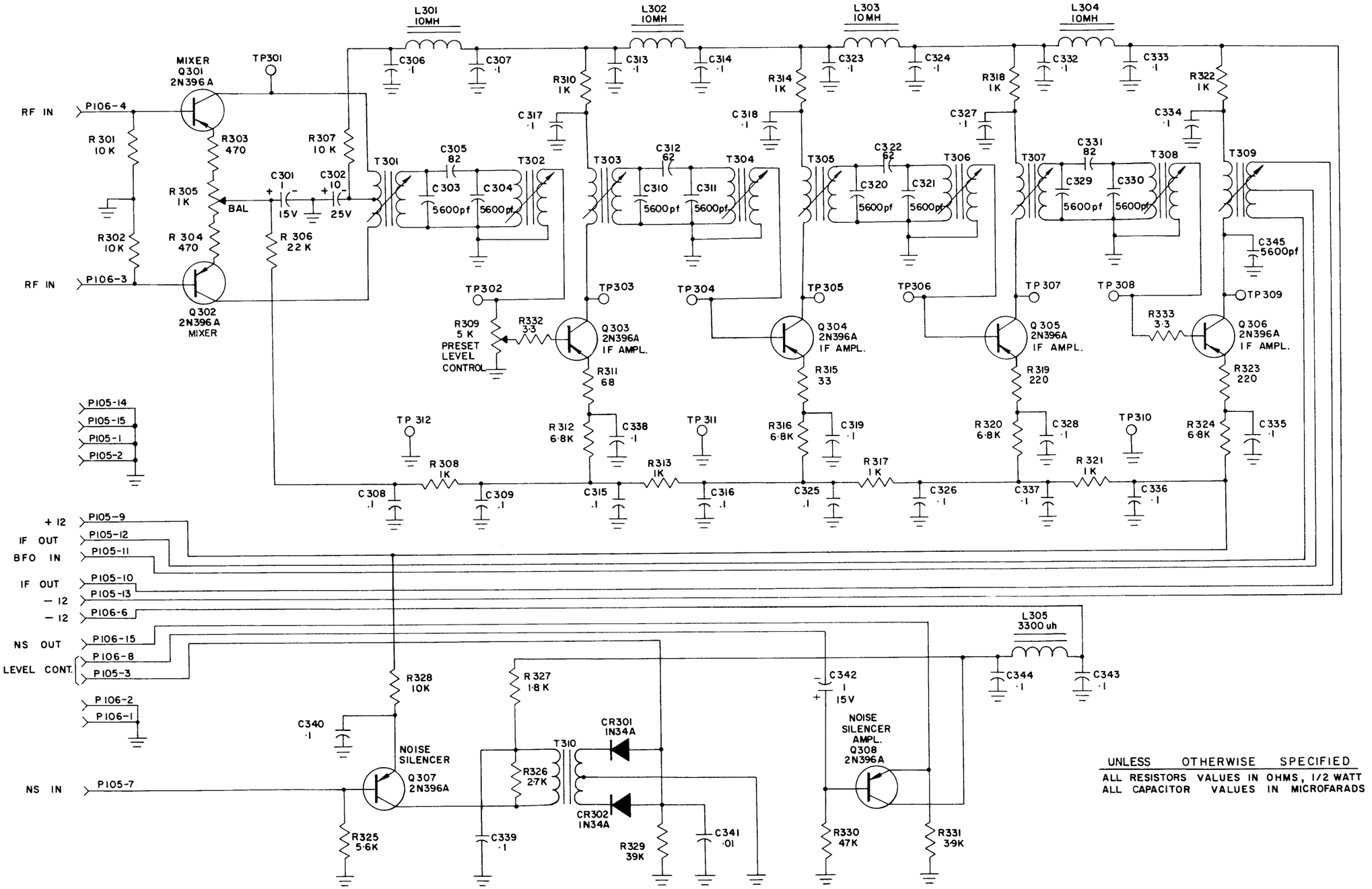
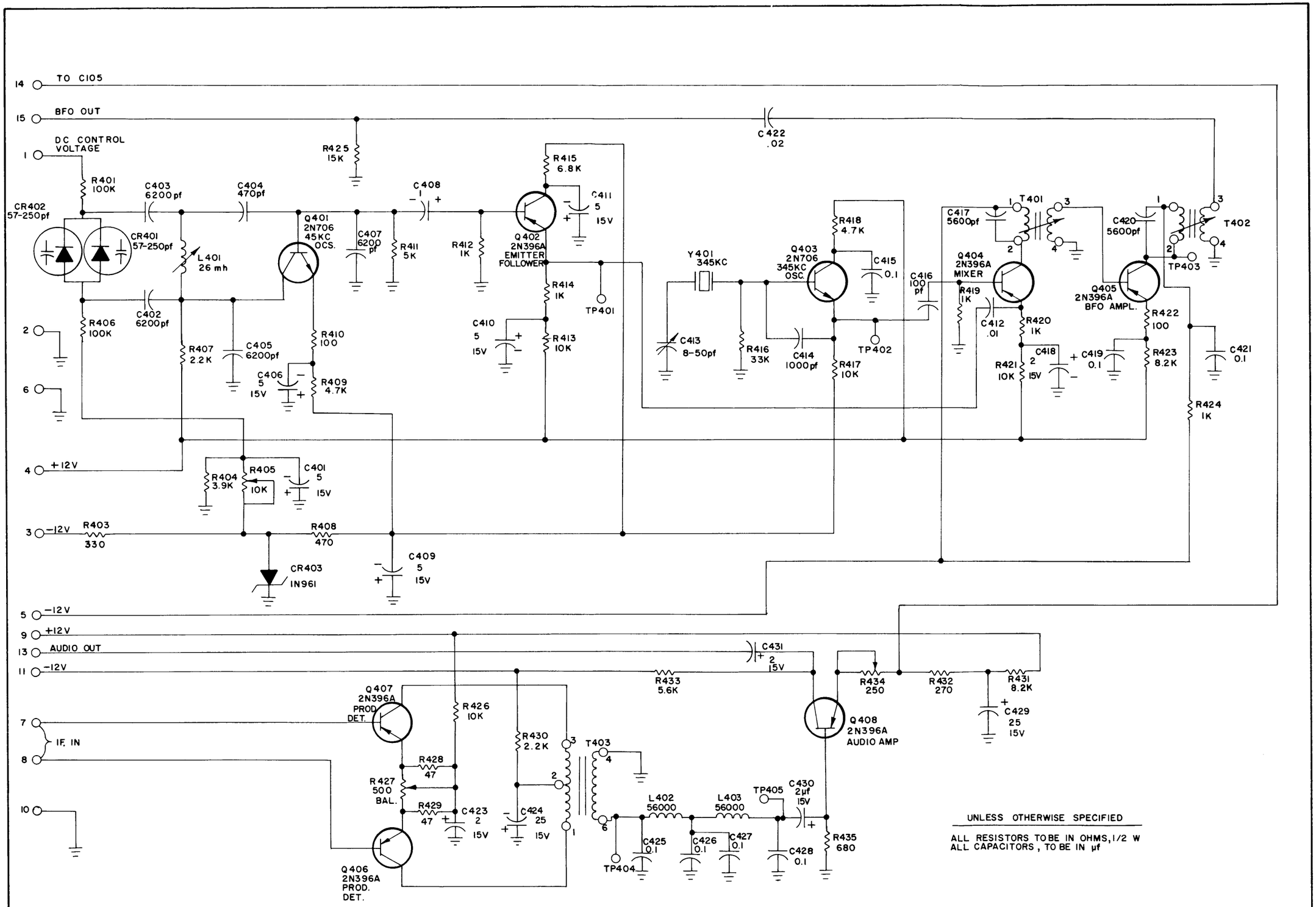


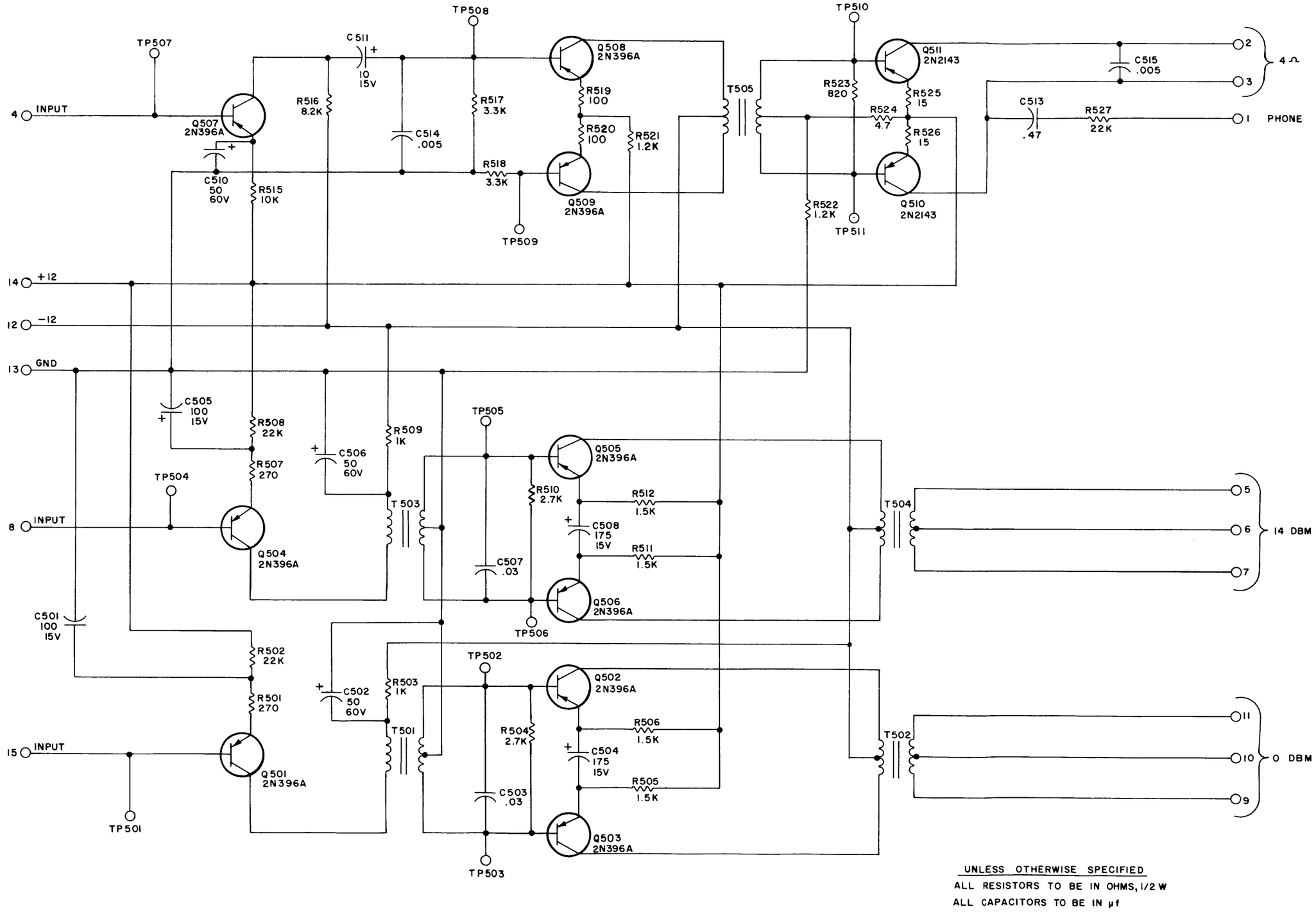
FIGURE 7-3. IF MODULE, SCHEMATIC DIAGRAM



UNLESS OTHERWISE SPECIFIED

ALL RESISTORS TO BE IN OHMS, 1/2 W
ALL CAPACITORS, TO BE IN μf

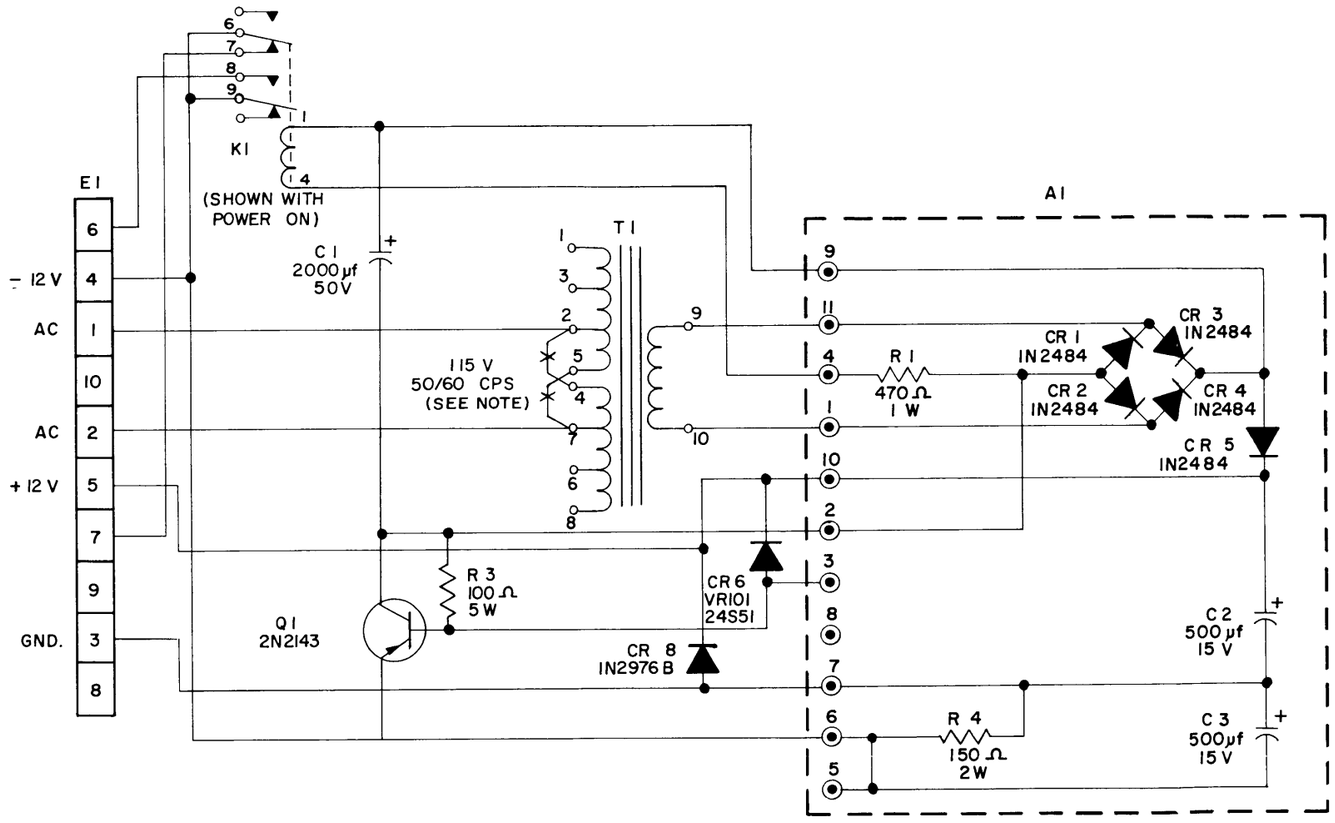
FIGURE 7–4. BFO MODULE, SCHEMATIC DIAGRAM



UNLESS OTHERWISE SPECIFIED
ALL RESISTORS TO BE IN OHMS, 1/2 W
ALL CAPACITORS TO BE IN μf

011643006

FIGURE 7–5. AF MODULE, SCHEMATIC DIAGRAM



NOTE:
- FOR 230 VAC OPERATION, REMOVE JUMPER ⟋
- PLACE A JUMPER FROM TERM. 4 TO TERM. 5

FIGURE 7-6. POWER SUPPLY, SCHEMATIC DIAGRAM