UNCLASSIFIED

TECHNICAL MANUAL

for

LF/MF COMMUNICATIONS RECEIVER

MODEL VLRA-1

THE TECHNICAL MATERIEL CORPORATION

MAMARONECK, N.Y. **OTTAWA, CANADA**

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IN-3008A Issue Date: 15 October 1965

THE TECHNICAL MATERIEL CORPORATION
COMMUNICATIONS ENGINEERS
700 FENIMORE ROAD MAMARONECK, 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:

THE TECHNICAL MATERIEL CORPORATION
Engineering Services Department
700 Fenimore Road
Mamaroneck, New York

CHANGE NO. 1 VLRA-1

INSTRUCTION BOOK CHANGE NOTICE

Date _____

Manual affected: LF/MF Communications Receiver, Model VLRA-1 IN -3008A

Add the following information:

SECTION 1
GENERAL INFORMATION

1-1. DESCRIPTION

When Very Low Frequency Receiver VLRA encounters interference from high power transmitters operating on LF, MF or HF frequencies, improved reception is accomplished by incorporating Low Pass Filter, FL1002 (FX211), in the antenna circuit.

1-2. TECHNICAL SPECIFICATIONS

Technical Specifications of Low Pass Filter FL1002 are as follows:

Passband	DC to 40 Kc
3db Frequency	41.5 Kc +2.5 Kc
Stopband	43 Kc to 40 Mc
Insertion Loss	Less than 0.5db to 31.5 Kc
Attenuation	70 db at 140 Kc
Insertion VSWR	Less than 1.10:1 (Will operate with VSWR of 2.0:1)
Impedance	50 ohms nominal (BNC connectors)
Maximum Signal Level	
Inband	35 VRMS
Out of Band	70 VRMS

CHANGE NO. 1 VLRA-1

INSTRUCTION BOOK CHANGE NOTICE

Date _____

Manual affected: LF/MF Communications Receiver Model VLRA-1 IN -3008A

SECTION 2
INSTALLATION

2-3. INSTALLATION

a. MECHANICAL. - Low Pass Filter FL1002 is supplied as a loose item and is installed in the rear of the enclosure containing Low Frequency Receiver VLRA. The prime consideration, when mounting FL1002, is to allow sufficient cable length to permit withdrawal of VLRA for servicing. To install FL1002, proceed as follows:

(1) Select a location in the rear of the enclosure containing Very Low Frequency Receiver VLRA that will allow access to the BNC connectors.

(2) Using FL1002 as a template, mark, drill and secure with screws, lockwashers and nuts.

b. ELECTRICAL. - Low Pass Filter FL1002 is a capacitive inductive device that does not require electrical power. Electrical connection of FL1002 is accomplished by attaching a 50 ohm VLF antenna to one of the BNC connectors of FL1002. The other connector of FL1002 is connected, via cable W1007, to J318 of Very Low Frequency Receiver VLRA.

NOTE

When VLRA is supplied in a receiver system, Low Pass Filter FL1002 (FX211) is mounted within the system container at the factory.

CHAN E NO. 1 VLRA-1

INSTRUCTION BOOK CHANGE NOTICE

Date _____

Manual affected: LF/MF Communications Receiver, IN -3008A
Model VLRA-1

SECTION 3
OPERATION

Low Pass Filter FL1002 attenuates all signals above 40 kilocycles; therefore, operation over the full frequency range of Very Low Frequency Receiver VLRA is not possible when FL1002 is connected. To obtain reception of signals above 40 kilocycles, disconnect VLF antenna from filter FL1002 and attach it directly to J318 of Very Low Frequency Receiver VLRA.

RECORD OF CORRECTIONS MADE

Change No.	Date of Change	Date Entered	Entered By

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Figure 1-1. Very Low Frequency Receiver, Model VLRA-1

SECTION 1
GENERAL INFORMATION

1-1. DESCRIPTION.

Very Low Frequency Receiver, Model VLRA (figure 1-1), is a ten-channel, crystal-controlled, narrow-band receiver covering the frequency range of 10 to 100-kc for the reception of ultra-stable continuous carrier, CW, beacon, and FSK signals. The VLRA provides two audio outputs: one output connects to a 600-ohm line; the other output connects to a 4-ohm loudspeaker. The VLRA also provides a sample of the ultra-stable incoming r-f signal which can be used as a reference signal for frequency-comparison systems. If synthesized operation is desired, an external oscillator signal can be used to control the high-frequency oscillator (hfo) contained within the VLRA. In non-synthesized operation, maximum frequency error does not exceed 0.001 percent at the operating frequency.

The VLRA is a completely transistorized, modular unit. It consists of a main chassis that houses a maximum of ten r-f modules, one i-f module, one bfo module, an 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 r-f input and audio signals; a phone jack allows aural monitoring of audio output signals. All controls and indicators are located on the front panel of the VLRA. All connections to circuits external to the VLRA 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 VLRA are as follows:

Operating Power	115/230 vac, ±10%, 50/60 cycles, single phase, with automatic switching to battery
Battery Power (optional)	24-volt external battery to provide 4-hour operation of the VLRA. When normal operation is used, the battery can be kept in a charged condition by a built-in "trickle" charger.
Battery Drain	200 milliamperes.
Dimensions	7 inches high x 19 inches wide x 17 inches deep.
Weight	Approximately 30 pounds.
Frequency Range	10 to 100 kc with plug-in, fixed-tuned r-f amplifiers selectable by front-panel control.
Modes of Reception	Continuous carrier, CW and LFSK with appropriate converter.
Frequency Stability (non-synthesized)	Crystal controlled. Error will not exceed 0.001% at the operating frequency.
Antenna Input Impedance	50 ohms nominal (BNC connector).
Sensitivity	A 0.1 microvolt signal impressed across 50 ohms at the input of the receiver will produce a minimum of 10 db signal + noise/noise ratio.
Synthesizer Input	An external oscillator signal may be inserted to a BNC connector on the rear panel for synthesized operation.

1-2. TECHNICAL SPECIFICATIONS (CONT).

TRF Output	A sample of the r-f signal is available at a BNC connector for connection to external equipment.
IF Bandwidth	100 cycles at 3 db points.
AGC	Amplified and delayed AGC provides no greater than +3 db change in output for an 80 db change in input.
Type of Detection	Product detector.
Image Rejection	60 db or better.
BFO	Adjustable 0 to 2.5 kc from i-f frequency.
Distortion	Total harmonic and intermodulation distortion 1% or less at full power output.
Audio Output	500 milliwatts, 4 ohm unbalanced; one milliwatt 600-ohm balanced center tapped output.
Audio Response	Constant within ±1.5 db from 100 to 2500 cps.

1-3. TRANSISTOR AND DIODE COMPLEMENT.

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

TABLE 1-1. TRANSISTOR AND DIODE COMPLEMENT

REFERENCE SYMBOL	TYPE	FUNCTION
R-F MODULE		
Q201	2N396A	R-f Amplifier
Q202, Q203, Q204, Q205	2N396A	Noise Silencer Pre-amplifier
Q206, Q207	2N396A	HFO Oscillator
I-F MODULE		
Q101, Q102	2N396A	First Converter
Q103, Q111	2N396A	I-f Amplifier
Q104, Q105	2N396A	AGC Amplifier
Q106, Q107	2N214A	D-c Amplifier
Q108	2N396A	TRF Amplifier
Q109	2N396A	Noise Silencer Amplifier
Q110	2N396A	D-c Amplifier
CR101	1N34A	AGC Detector
CR102	1N100	AGC Detector
CR103, CR104	1N34A	Noise Detector

TABLE 1-1. TRANSISTOR AND DIODE COMPLEMENT (CONT)

REFERENCE SYMBOL	TYPE	FUNCTION
	BFO MODULE	
Q181	2N1637	43-46 kc Oscillator
Q182	2N1637	40-kc Oscillator
Q183	2N1637	Mixer
Q184, Q185	2N396A	Product Detector
Q186	2N396A	BFO Amplifier
	AF MODULE	
Q20	2N396A	Audio Amplifier
Q21, Q22	2N1370	Push-Pull Driver Amplifier
Q23, Q24	2N2143	Push-Pull Driver Amplifier
Q25	2N396A	Driver Amplifier
Q26, Q27	2N396A	Push-Pull Driver 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	
CR301	1N34A	Isolator
CR302, CR303	1N34A	Audio Detector
CR304	1N294	RF Detector

SECTION 2
INSTALLATION

2-1. INITIAL INSPECTION.

The VLRA 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 operating 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 VLRA 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 F301 (located at the rear of the equipment) from 1/2 ampere to 1/4 ampere.

2-3. INSTALLATION.

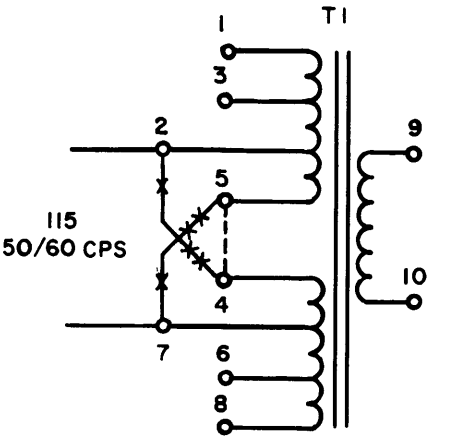
a. MECHANICAL. - The VLRA is designed for both cabinet and rack installation. In either case, adequate ventilation, sufficient clearance in back of the unit for access to rear-panel connections, and sufficient space for withdrawal of the unit from the cabinet for servicing are prime considerations when determining ultimate location. The VLRA is equipped with a standard 19-inch wide front panel, and is 7 inches high and 17 inches deep.

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

(1) Set VLRA 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.



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NOTE

For 230 volt operation, remove jumpers marked xxx and add jumpers marked ----.

Figure 2-1. Transformer Wiring, 115- Vs 230-volt Power Operation

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

(5) Secure front panel to rack with screws.

b. ELECTRICAL. - The VLRA should be connected to an a-c power source, to a 50-ohm antenna, and to a 4-ohm loudspeaker; optionally, the VLRA can be connected to a frequency-shift converter, to a synthesizer unit, and to a 24-volt external battery. 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 VLRA is shipped, it is aligned and thoroughly checked against the manufacturers specifications; therefore, the unit is operable after it is properly installed.

TABLE 2-1. REAR PANEL CONTROLS, AND 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 Extenders (no panel or component designation).	Permits r-f module components to be tested using the receiver internal power supply.
4	BATTERY jack J315.	Input receptacle for external 24-volt battery.
5	600 OHM LINE (terminal board E301, terminals 4, 5, and 6).	Connects external 600-ohm line equipment such as a signal converter to output circuit of receiver line amplifier.
6	GND (terminal board E301, terminal 3).	Connection point for external ground to receiver chassis ground.
7	SPEAKER, 4 OHM (terminal board E301, terminals 1 and 2).	Connects external 4-ohm speaker to output circuit of power amplifier.
8	BAT. Switch S305	IN position connects 24-volt external battery to VLRA circuits; OUT position disconnects external battery from circuits.
9	SYN IN jack J316	Input jack for external synthesizer signal. Connects to external equipment supplying highly-stable input signals to control the internal high-frequency oscillator.
10	TRF OUT jack J317.	Provides sample of r-f input signal. Connects to external equipment requiring ultra-stable TRF reference signal.
11	ANT IN jack J318	Input jack for external 50-ohm antenna.
12	F302 (B-Fuse).	Protects -12 volt power supply components from receiver load short circuits.
13	F303 (B+ Fuse)	Protects +12 volt power supply components from receiver load short circuits.
14	F301 (AC fuse).	Protects power supply components from internal short circuits.
15	AF CAL control R311..	Calibrates front-panel meter M301 at its 0 dbm setting.
16	RF ZERO SET control R306.	Sets front-panel meter M301 to exactly "0".
17	MAIN AC jack J319	Input receptacle for 115/230 volt a-c power.

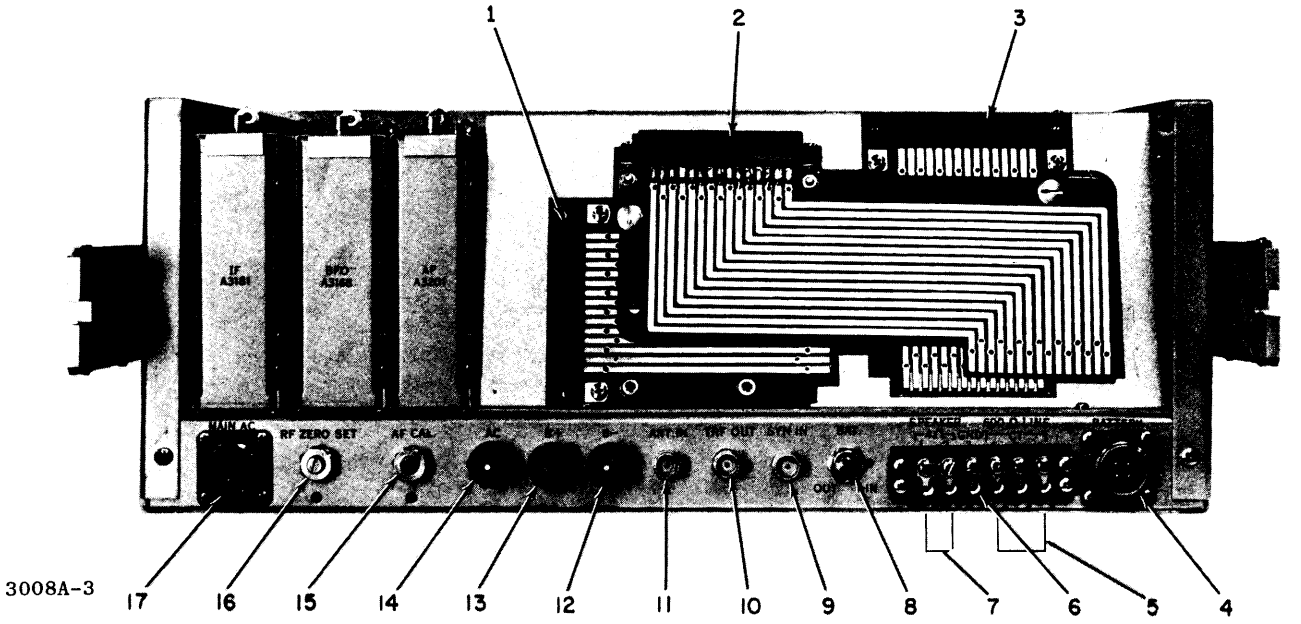

Figure 2-2. VLRA Receiver, Rear View

SECTION 3
OPERATOR'S SECTION

3-1. CONTROLS, JACKS, AND INDICATORS.

Before attempting to operate the VLRA, 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 VLRA, 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

TABLE 3-1. CONTROLS, JACKS, AND INDICATORS

ITEM NO. (Figure 3-1)	PANEL AND COMPONENT DESIGNATION	FUNCTION
1	Meter M301	Operates in conjunction with AF/RF switch S304. With S304 set at AF, M301 measures strength (in dbm) of audio signal across 600-ohm line; with S304 set a RF, M301 measures strength (in db above 0.1 uv) of incoming r-f signal.
2	POWER lamp DS301	Indicates when a-c power is applied to internal power supply circuit.
3	POWER switch S302	Connects a-c power to internal power supply circuit.
4	AF/RF switch S304	AF position connects output audio signal to front-panel meter M301; RF position connects agc output d-c signal to meter.
5	BATTERY lamp DS302	Indicates when battery power is applied to VLRA.
6	PHONE jack J320	Permits headset monitoring of Audio Output signal.
7	LINE LEVEL control R309	Controls level of audio signal applied to 600 ohm line.
8	RF GAIN control R302.	Controls gain of r-f stages when AGC DECAY switch S303 is MAN RF.
9	BFO Control C304	Varies frequency of tone when receiving CW signals.
10	NOISE SILENCER Control R301	Used to remove impulse noise.
11	CHAN SEL switch S301	Ten-pole ten-position rotary switch. Connects selected r-f module to VLRA circuits.
12	AGC DECAY switch S303	Four-position rotary switch. MAN RF position permits RF GAIN control to control gain of r-f amplifier stages. FAST, MED, and SLOW positions permit agc circuit to control the gain; also permits selection of

TABLE 3-1. CONTROLS, JACKS, AND INDICATORS (CONT)

ITEM NO. (Figure 3-1)	PANEL AND COMPONENT DESIGNATION	FUNCTION
12 (cont)		time constants that change the decay time of the agc signal.
13	AF GAIN control R307	Controls amplitude of audio output signal applied to 4-ohm speaker and to headset.
*	BAT. switch S305	IN position connects 24-volt external battery to VLRA circuits; automatic battery switching should be accomplished if a-c power fails. OUT position disconnects external battery from VLRA circuits.

*Mounted on rear panel. (See figure 2-2.)

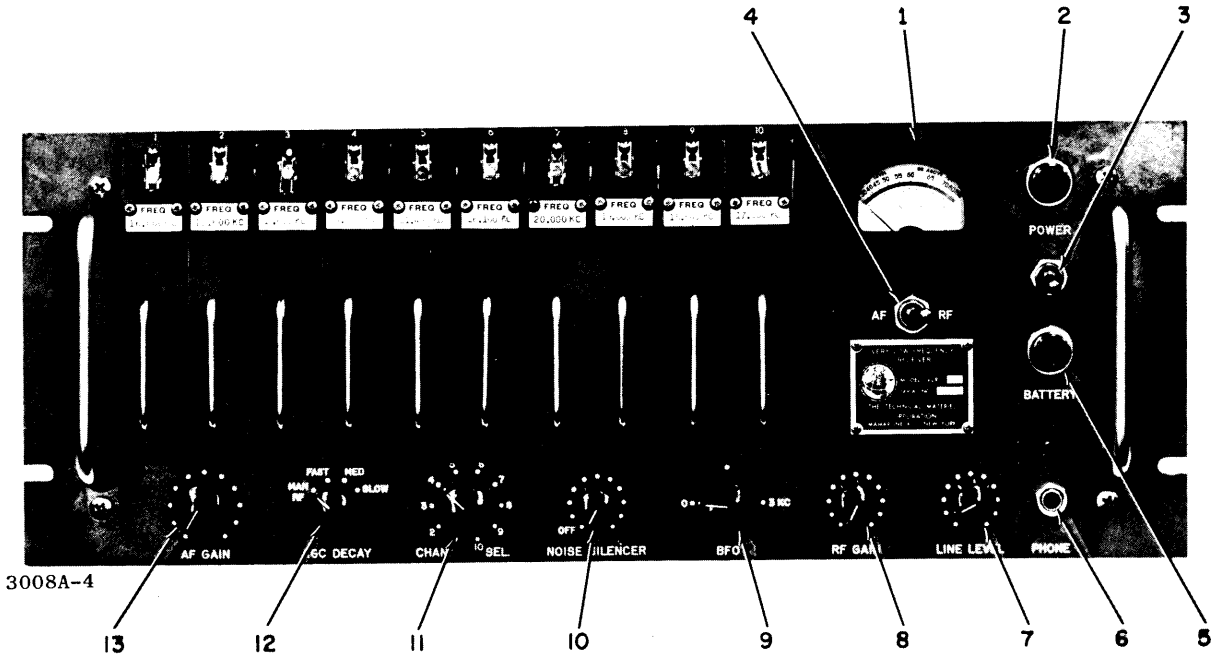

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Figure 3-1. Front Panel Controls, VLRA-1

controls mentioned in table 3-2 are set at their proper positions. To start the VLRA, set the POWER switch at its on position. If an external 24-volt battery is connected to BATTERY jack J315 located on the rear panel, set the BAT. switch at IN.

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

(1) Turn CHAN SEL switch to channel receiving cw signals as indicated by steady reading on Meter M301.

(2) Set AGC DECAY switch to position suitable for speed of CW transmission.

(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. 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 600 OHM LINE terminals of terminal board E301. Connect teletype terminal equipment to output of frequency-shift converter. Ensure that frequency-shift converter and teletype

equipment are prepared for reception of FSK signals.

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

(3) Set AGC DECAY switch and BFO control at positions suitable for best reception of FSK signals.

(4) Set AF/RF switch S304 at AF; adjust LINE LEVEL control until front-panel meter indicates 0 dbm (0.78 volts).

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

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

TABLE 3-2. PRELIMINARY CONTROL SETTINGS

CONTROL	SETTING
NOTE Numbers enclosed in parentheses are callouts referenced in figure 3-1.	
POWER (3)	Off
AF/RF (4)	RF
LINE LEVEL (7)	Mid-range
RF GAIN (8)	Full clockwise
BFO (9)	Mid-range
NOISE SILENCER (10)	OFF
CHAN SEL (11)	Any position
AGC DECAY (12)	MAN RF
AF GAIN (13)	Mid-range
*BAT.	OUT

*Located on rear panel.

SECTION 4
PRINCIPLES OF OPERATION

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

R-f signals in the 10- to 100-kc range from the antenna are routed via jack J318 and channel-selector switch S301 to one of 10 r-f modules. Within the selected r-f module the incoming r-f signal undergoes three stages of amplification and is applied to transformer T204 where it is combined with the output signal (13- to 103-kc) of a high-frequency oscillator stage contained in the r-f module.

NOTE

The high-frequency oscillator, contained in the r-f module, may either be free-running or it may be controlled by an r-f signal applied to SYN IN jack J316. The receiver can, therefore, be used in a synthesizer-stabilized system.

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 (3kc)), undergoes two stages of amplification and is applied to the transformer T105 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 3- to 6-kc; this bfo signal, combined with the output of the second i-f amplifier, is applied to the product detector in the bfo module. The output of the product detector, the difference product of the bfo and i-f signals (0- to 3-kc), is applied to two audio amplifier chains. The two-audio-amplifier circuits have individually adjustable gain controls (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 line amplifier, a two-stage circuit, provides up to 1 milliwatt (0 dbm) for a 600-ohm load.

Noise-silencer stages (pre-amplifier, amplifier, and detector) 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 R301 in this circuit enables the operator to adjust the loop gain so that noise peaks present on the 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.

Agc circuitry (amplifiers and detector) contained in the i-f module utilizes a portion of the first i-f amplifier output to develop a d-c signal which is routed back to the first and third r-f amplifiers in the r-f module. Alternately, a manually adjustable d-c gain-control signal can be routed to the first and third r-f amplifiers.

4-2. R-F MODULE CIRCUIT ANALYSIS. (Refer to figures 7-1 and 7-2.)

With the exception of selected r-f and hfo frequencies, all r-f modules are similar; 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 forms 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 sample of the first r-f amplifier output is applied to noise silencer amplifier Q205. The output of this stage is routed to noise-silencer circuitry in the i-f module.

Negative d-c pulses, concident with noise pulses on the r-f envelope, are applied to the emitter circuit of Q202 and Q203 via pin of jack J301. The increase in IR drop across R205 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 teritary winding of transformer T203 and capacitor C206 form the second amplifier tuned circuit. A sample of the signal at the T203 secondary is routed via pin 2 of J301 to the trf amplifier in the i-f module. 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 R201 and R229, and pin 7 of jack J301. When the positive signal increases, IR drop across emitter resistors R202 and R209 decreases, thus increasing the bias of the two transistors. The operating points of the two transistors approach saturation, and gain therefore decreases.

The output of Q204 is transformer-coupled to the mixer stage in the i-f module; the mixer also receives an hfo injection signal from transistor Q207.

Transistor Q206 and Q207 form a crystal-controlled oscillator that has two stages of amplification. Feedback is from the collector of Q207, to the base of Q206 through capacitor C210, and from the collector of Q206 to the base of Q207, through

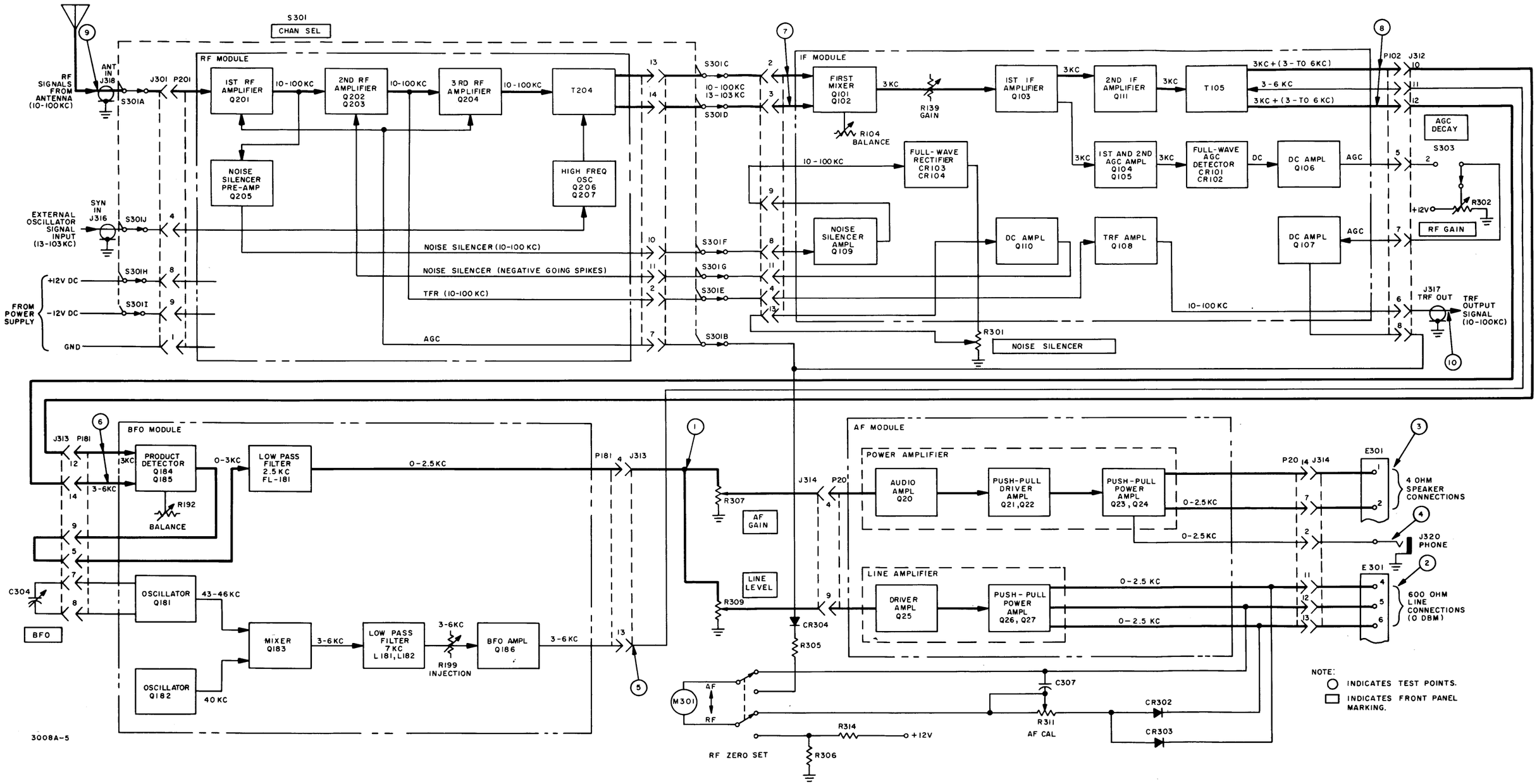

Figure 4-1. VLRA Receiver, Functional Block Diagram

capacitor C213 and crystal Y201. When an r-f signal of appropriate frequency is applied to SYN IN jack J316, the hfo operates as a regenerative amplifier. Synthesizer control of the receiver is thus facilitated.

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 Q101 and Q102), via pins 2 and 3 of jack J311. The r-f signal is applied in push-pull to the mixer stage; the hfo injection, 3 kc higher in frequency, is applied in-phase to the two bases. Since the mixer output circuit is a push-pull configuration, the hfo injection signal is self-canceling. Resistor R104 is adjusted to balance the two sides of the mixer stage. The output of the mixer is transformer-coupled to first i-f amplifier Q103. A tertiary winding of transformer T101, and capacitor C103 tunes the mixer output to 3 kc. Resistor R139 controls the gain of the first i-f amplifier. The output of Q103 is autotransformer-capacitor coupled to the second i-f amplifier Q111; a sample of the first i-f amplifier is applied to the first agc amplifier, Q104. The output of Q111 is transformer-coupled to the product detector stage in the bfo module.

Transistors Q104 and Q105 constitute a two-stage i-f amplifier that supplies the input to the agc detector, diodes CR101 and CR102. The output of the agc detector, a d-c signal proportional to the i-f signal envelope, is amplified by Q106. When AGC DECAY switch S303 is set at FAST, MEDIUM or SLOW, the output of Q106 is applied to emitter follower Q107. When S303 is set at MAN RF, Q107 receives its input from RF GAIN control R302. The output of Q107 controls the gain of the first and third r-f amplifiers in the r-f module.

The noise silencer circuit receives a sample of the r-f signal from the r-f module via pin 8 of jack J311. This signal is amplified by Q109 and applied to the noise silencer detector (CR104 and CR103). 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 noise amplifier Q110 via NOISE SILENCER control R301. When R301 is properly adjusted, Q110 operates near cut off; negative spikes (detected noise of the r-f signal) drive Q110 into heavy conduction. The resultant negative pulse signal from the emitter of Q110 is routed to the second r-f amplifier in the r-f module.

A sample of the r-f signal from the r-f module is routed via pin 4 of jack J311 to amplifier Q108. The output of Q108 is routed via pin 6 of J311 to TRF jack J317.

4-4. BFO MODULE CIRCUIT ANALYSIS. (Refer to figure 7-1 and 7-4.)

The bfo module contains two oscillators and a mixer that generate a 3- to 6-kc signal for injection into the product detector. Transistor Q181, a Hartley oscillator, operates in the 43- to 46-kc range. A tertiary winding of transformer T181, capacitors C181 and C311, and BFO control C304, constitute the oscillator tuning circuit. Transistor Q182, also a Hartley circuit, operates at a fixed frequency (40-kc). Mixer Q183 receives the output of Q181 at its emitter, and the output of Q182 at its base. The output of mixer Q183, which includes the two original frequencies (43- to 46-kc) and the sum and difference products (83- to 86-kc and 3- to 6-kc), is applied to a low-pass filter. The low-pass filter, comprising inductors L181 and L182, and capacitors C189, C192 and C193, couples the difference product output to amplifier Q186. The original signals and sum product are attenuated. The output of amplifier Q186 is routed to the product detector, Q185/Q185, via transformer T105 in the i-f module.

The product detector receives an i-f signal (3-kc) in push-pull, and a BFO injection signal (3- to 6-kc) that is in-phase at the two bases. The push-pull output configuration of the detector eliminates the BFO component from the output signal. The detector output signal contains the i-f signal (3-kc), sum products (6- to 9-kc), and difference products (0- to 3-kc). Low pass filter FL181, interposed between the product detector, and AF GAIN control R307 and LINE LEVEL control R309, passes only frequencies below 2.5-kc. Therefore, only the difference products are passed to the audio circuits.

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

Incoming audio signals (0-2.5 kc) from the BFO module are applied to two parallel-connected voltage dividers consisting of resistor R315 and AF GAIN control R301, and resistor R308 and LINE LEVEL control R309. The AF GAIN control sets the level of the audio signal applied to the base of first a-f amplifier Q20 via pin 4 of jack J314 and plug P20, and capacitor C20. The LINE LEVEL control sets the level of the audio signal applied to driver amplifier Q25 via pin 9 of jack J314 and plug P20.

The output signal provided at the collector of amplifier Q20 drives push-pull driver amplifiers Q21 and Q22. The Q21/Q22 output in turn is used to drive push-pull power amplifiers Q23 and Q24. The output signal from the power amplifier stage is coupled to PHONE jack J320 via capacitor C23, resistor R34 and pin 2 of plug 20 and jack J314, as well as to impedance matching transformer T301 via pins 7 and 14 of plug P20 and jack J314. Transformer T301 provides a 4-ohm audio output signal across terminals 1 and 2 of terminal board E301.

Audio signals appearing at the base of drive amplifier Q25 are amplified and coupled through transformer T21 to the base circuits of push-pull power amplifiers Q26 and Q27. These signals are equal in amplitude but opposite in phase. The power amplifier output is coupled from the secondary winding of the transformer T22 via pins 12 and 13 of plug P20 and jack J314 to terminals 4, 5 and 6 of terminal board E301. These terminals provide an output signal of 0 when connected across a 600-ohm line

The strength of the audio signal at the output terminals of the line amplifier can be measured on the

front-panel meter. When AF/RF switch S304 is set at AF, the audio signal is applied from terminals 11 and 13 of jack J314 and plug P20 through limiting resistors R312 and R313 to full-wave rectifier diodes CR302 and CR303. The resulting pulsating dc is filtered by resistor R311 and capacitor C307 and is applied via the contacts of C304 to the meter. Terminal 12 provides the dc return for the meter. The meter is calibrated by AF CAL control resistor R311 to read directly in dbm when the AF/RF switch is set at AF.

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 voltage of plus and minus 12 volts dc. In addition, facilities for switching over to battery-powered operation are provided.

During normal operation, the 115 volts AC appears at pins A and C of MAIN AC jack J319 and is applied through protective fuse F301, the contacts of POWER switch S302, and terminals 1 and 2 of terminal board E302 to the primary winding of power transformer T1. The secondary voltage of T1 is rectified by the bridge type rectifier circuit consisting of the diodes CR1 through CR4. The rectifier output voltage is applied across the armature winding of relay K1 and the 24 volt regulator circuit consisting of zener diode CR6 and resistor R2. When relay K1 is energized, minus 12 volts applied through relay contacts 6 and 7 turns on POWER lamp DS301. Zener diode CR6 provides a regulated 24 volts dc across its terminals. Capacitor C1 filters the a-c ripple. The regulated 24 volts dc is applied to the positive and negative regulated 12 volt sections of the power supply.

Zener diode CR8 provides a regulated plus 12 volts dc across its terminals. The plus 12 volts is available at terminal 3 of terminal board E302. Series regulator Q1 produces a regulated minus 12 volts at its emitter terminal which is available at terminal 4 of terminal board E302: terminal 3 is the ground return point for the plus and minus 12 volt circuits. Capacitors C2 and C3 are additional a-c filters. Series regulator Q1 keeps the voltage constant by varying its impedance directly in proportion to changes in output voltage. For example, if the output voltage tends to increase, a correspondingly larger 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. Protective fuses F302 and F303 are connected between the power supply output terminals and the receiver circuits.

In the event of a-c power failure, the receiver circuits can be automatically powered by an external 24 volt battery. With BAT. switch S305 set at IN, the positive battery leg is connected through terminal A of Battery jack J315, the contacts of BAT. switch S305, to the plus 12 volt terminal. The negative battery leg is connected through terminal D of J315, the contacts of S305, and terminal 8 of terminal board E302 to the base of transistor Q1. In this case, Q1 acts as an ordinary diode to couple the negative battery voltage to the -12 volt terminal. Isolator diode CR5 is back biased by the positive voltage at its cathode; this deenergizes relay K1. When relay K1 is deenergized, minus 12 volts applied through relay contacts 8 and 9 turns to BATTERY lamp DS302. When normal ac power is used, the external battery charges through resistor R3.

SECTION 5
MAINTENANCE

5-1. PREVENTIVE MAINTENANCE.

a. GENERAL. - The VLRA 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, providing 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 VLRA 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 VLRA.

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 VLRA. To use this chart follow the steps in numerical sequence.

Certain test points given in this troubleshooting chart are used when troubleshooting the VLRA. These points are shown in figure 4-1.

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 VLRA

QTY.	ITEM	MANUFACTURER
1	Audio Signal Generator	Hewlett Packard, Model 200 CD
1	AC Voltmeter	Ballantine, Model 314
1	Oscilloscope	Tektronix, Model 545 with type "L" plug-in
1	VTVM	Hewlett Packard Model 410B
1	Signal Generator	Marconi Instruments Ltd., Model TF144H
1	Counter	Hewlett Packard, Model 525A
1	Headset	600 ohms or better

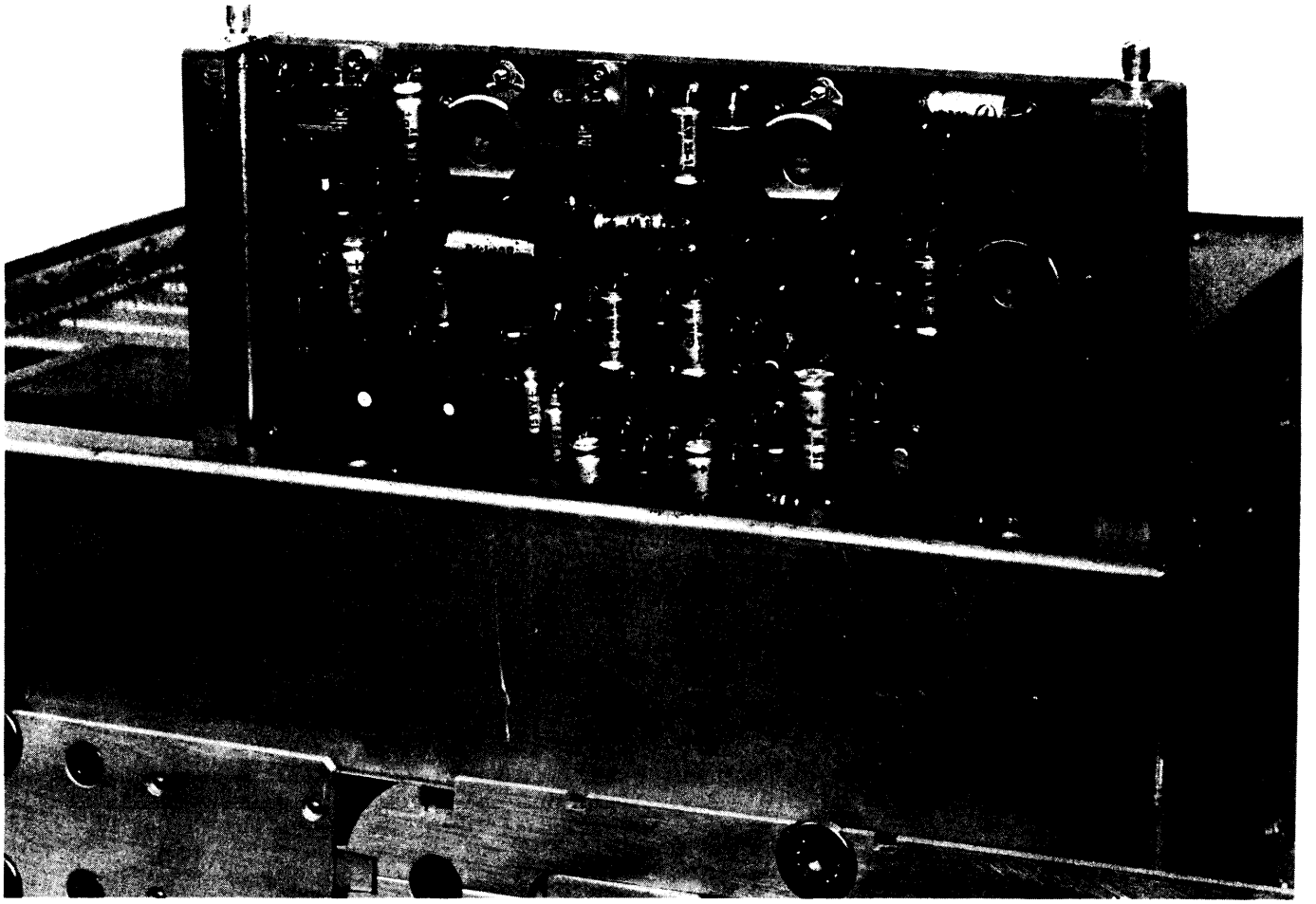

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Figure 5-1. Using Module Extender with I-F Module

TABLE 5-2. TROUBLESHOOTING CHART

STEP	OPERATION	NORMAL INDICATION	PROBABLE CAUSE OF ABNORMAL INDICATION
1	Set POWER switch S302 at its on position	POWER lamp DS301 should light	Open filament
		+12 volts dc ±10% from any B+ or B- point to ground	Blown fuses F301, F302, or F303
			Defective power supply
2	Set POWER switch S302 at its off position; set BAT. switch S305 at IN if 24 volt external battery is connected to BATTERY jack J315	BATTERY lamp DS302 should light; POWER lamp should go off	Open filament
			Defective relay K1
			Defective BAT. switch
			Short circuited diode CR5

TABLE 5-2. TROUBLESHOOTING CHART (CONT)

STEP	OPERATION	NORMAL INDICATION	PROBABLE CAUSE OF ABNORMAL INDICATION
2 (cont)		-13 volts dc ±10% from any B- point to ground; +12 volts dc ±10% from any B+ point to ground	
3	Set POWER switch S302 at on position		
4	Set LINE LEVEL fully counterclockwise; set AF/RF; switch S304 at AF; set audio signal generator to deliver 70 millivolt signals at 1 kc; connect signal generator to jack J313 pin 4 and ground (test point 1, see figure 4-1). Connect a-c voltmeter and oscilloscope across 600 OHM LINE terminals (figure 4-3, test point 2)	Turn LINE LEVEL control R309 clockwise (approximately mid-range) until a-c voltmeter and front-panel meter indicate 0 dbm (0.78 volts). Oscilloscope should indicate clean sine wave	Defective stages Q25, Q26, or Q27 Movable arm of LINE LEVEL control R309 open Shorted resistor R310 Open diodes CR302 Defective AF/RF switch S304
5	Turn AF GAIN control R307 fully counterclockwise Audio signal generator connected as in step 4. Connect a-c voltmeter and oscilloscope across 4 OHM SPEAKER terminals (test point 3) Connect headset to PHONE jack J320 (test point 4) Connect counter to pin 13 of J313 (test point 5). Vary BFO control C304 from extreme CCW position to extreme CW position Connect a-c voltmeter to test point 5	Turn AF GAIN control R307 clockwise until a-c voltmeter indicates 1.75 v. Oscilloscope should indicate a clean sine wave 1 KC signal should be heard Counter should indicate a frequency reading of 3.00 ±.005 kc at extreme CCW position of BFO control; and 6.250 +500 cps at extreme CW position Meter should indicate 0.7 volts RMS	Defective stages Q20, Q21, Q22, Q23, or Q24 Movable arm AF GAIN control open circuited Capacitor C20, or C22 open circuited Defective PHONE jack Open capacitor C23 Open resistor R34 Defective stages Q181, Q182, Q183, or Q186 Open circuited capacitors C188 or C194 Defective low pass filter network (refer to Variable resistor R199 not properly adjusted
6	Set signal generator to deliver a 2.0 volt signal at 3 kc; connect generator across pins 12 and 14 of jack J313 (test point 6). Connect counter and a-c voltmeter across 600 OHM LINE terminals (test point 2). Set BFO control to zero	Ac voltmeter should read 0 dbm (0.78 volts)	If necessary, readjust LINE LEVEL control R309

TABLE 5-2. TROUBLESHOOTING CHART (CONT)

STEP	OPERATION	NORMAL INDICATION	PROBABLE CAUSE OF ABNORMAL INDICATION
6 (cont)	Vary BFO control C304 from zero setting to approximately 2 o'clock position	Counter should indicate frequency change from zero to approximately 2500 cps (at 2500 cps point, ac voltmeter should read approximately 3 dbm)	Defective stages Q181, Q182, Q183, Q184, Q185, or Q186 Defective filter unit FL181
	Continue to vary BFO control further towards 3 KC position	A-1 voltmeter should fall off rapidly and reaches 0 db at approximately 2:30 o'clock position of BFO control	Defective filter FL181
7	Set signal generator to deliver a 10 millivolt signal at 3 KC; connect generator across pins 2 and 3 of jack J311 (test point 7). Connect ac voltmeter across pins 10 and 12 of jack J312 (test point 8)	AC voltmeter should indicate approximately 2 volts	Defective stages Q101, Q102, Q103, or Q111 Capacitor C105, C107, C109, C122 open Variable resistors R104, R139 misadjusted (refer to Transformers T101, T102, T105 misaligned (refer to
8	Set AGC DECAY switch S303 to FAST: CHAN SEL switch S301 to channel No. 1. Remove antenna cable from ANT IN jack J318; set signal generator to operating frequency of channel 1 and inject a 1 microvolt signal through the 50-ohm to 50-ohm attenuator box to ANT IN jack (test point 9). Connect AC voltmeter and counter to the TRF OUT jack J317 (test point 10)	AC voltmeter should read 10 ±2 millivolts Frequency counter should indicate frequency of operating channel	Defective r-f stages Q201, Q202, Q203, or Q108 Open contacts CHAN SEL switch S301 Short circuited ANT IN jack J318
	Connect ac voltmeter and counter to pins 10 and 12 of jack J312 (test point 8)	Counter should indicate frequency of 3 kc	Defective stages Q204, Q206, Q207 Open circuited capacitors C211 or C213 Defective crystal Y201
	Set signal generator output signal to 0.1 microvolts. Connect ac voltmeter and oscilloscope across 600 OHM LINE terminals (test point 2)	AC voltmeter should indicate 0. Oscilloscope should indicate a clean sine wave	
	Increase signal generator signal to + 80 db	AC voltmeter should not increase more than 3 db	Defective stages Q104, Q105, Q106, or Q107 Open circuited capacitors C110, C113, or C114 Defective AGC DECAY switch S303

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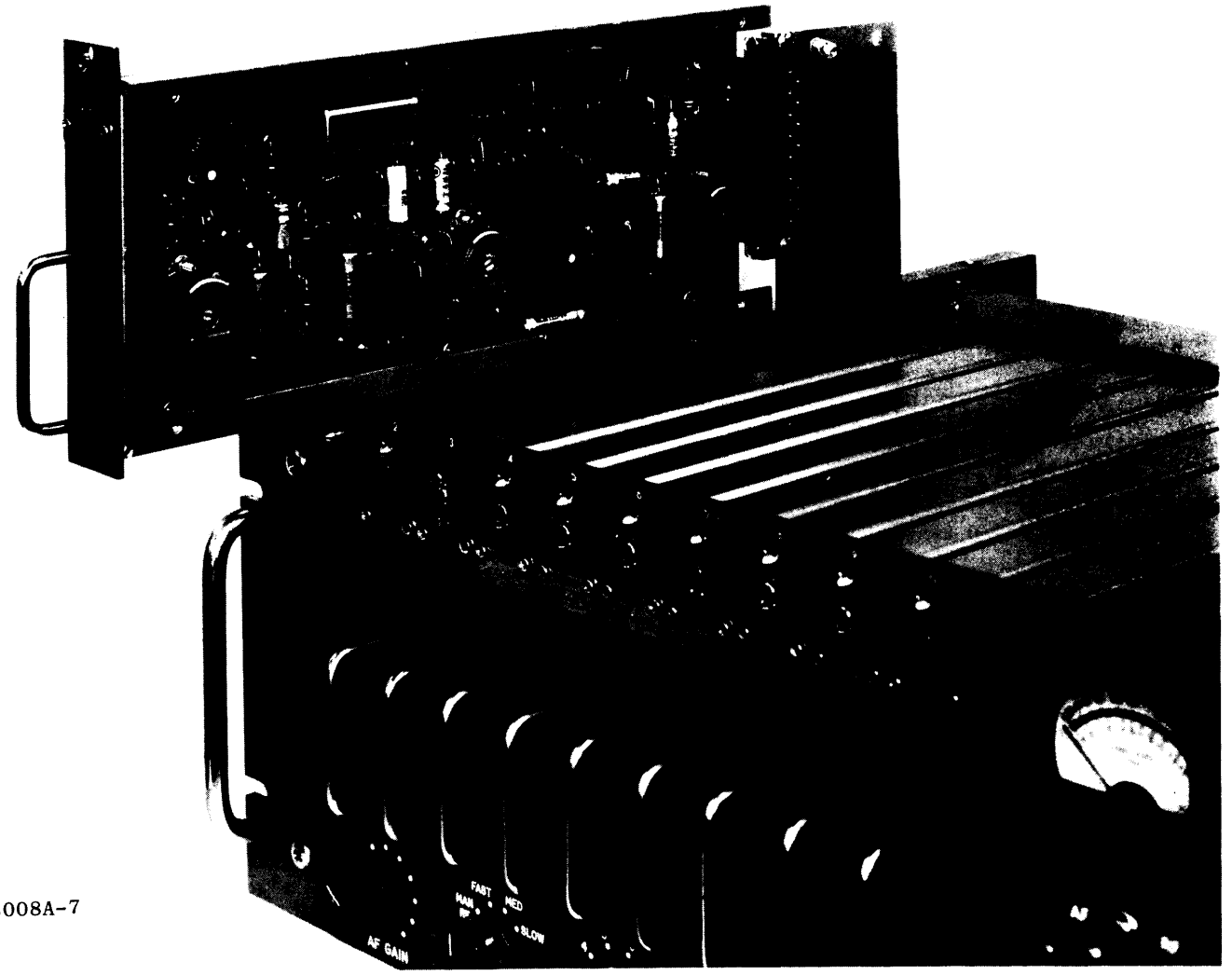

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Figure 5-2. Using Module Extender with R-F Module

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

TABLE 5-3. VOLTAGE READINGS

REFERENCE DESIGNATION	EMITTER	BASE	COLLECTOR
R-F MODULE			
Q201	+0.18	+0.02	-0.06
Q202	+0.1	0	-7.5
Q203	+0.1	0	-7.5
Q204	+0.17	+0.02	-0.35
Q205	+0.20	+0.06	-6.6
Q206	-0.60	-0.65	-1.75
Q207	+0.18	+0.14	-8.4

TABLE 5-3. VOLTAGE READINGS (CONT)

REFERENCE DESIGNATION	EMITTER	BASE	COLLECTOR
I-F MODULE			
Q101	+0.10	0	-7.50
Q102	+0.10	0	-7.50
Q103	+0.15	0	-11.2
Q104	+0.15	+0.02	-7.40
Q105	+0.17	+0.04	-7.40
Q106	+1.00	+1.05	+11.5
Q107	+0.85	+0.95	+11.5
Q108	+0.13	0	-7.75
Q109	+0.22	+0.08	-11.0
Q110	+0.10	+0.02	-12.5

TABLE 5-3. VOLTAGE READINGS (CONT)

REFERENCE DESIGNATION	EMITTER	BASE	COLLECTOR
BFO MODULE			
Q181	0	-0.20	-3.00
Q182	0	-0.20	-2.85
Q183	-0.40	0	-7.50
Q184	-0.82	+0.07	-10.5
Q185	-0.82	+0.07	-10.5
Q186	+0.28	+0.15	-10.5
AF MODULE			
Q20	-0.28	-0.43	-1.00
Q21	+0.18	+0.04	-11.5
Q22	+0.18	+0.04	-11.5
Q23	+11.0	+11.0	-12.5
Q24	+11.0	+11.0	-12.5
Q25	+0.15	0	-10.0
Q26	+0.17	0	-10.5
Q27	+0.17	0	-10.5
POWER SUPPLY			
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 20K-ohms 1 volt minimum.
3. NOISE SILENCER control R301 set to OFF.
4. AGC DECAY switch S303 set to SLOW.

5-3. REPAIR OF PRINTED CIRCUITS.

a. GENERAL. - Although the troubleshooting procedure 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 length 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 an 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 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 the 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 module that is to be aligned, and connect to receiver using module extender.

(1) Set CHAN SEL switch to position that corresponds with extended module.

(2) Connect r-f signal generator to ANT IN jack. Adjust generator to deliver desired operating frequency ±2 cps at 1 microvolt.

(3) Remove crystal Y201.

(4) Connect a-c voltmeter across resistor R225.

(5) Tune transformers T201, T203, and T204 to obtain maximum voltmeter indication. The tuning of each successive stage will have an effect on the preceding stage. Therefore, each transformer must be retuned until no further increase in voltmeter indication is obtainable. Minimum indication is 30 millivolts.

(6) Replace crystal Y201, remove test equipment, and return module to normal operating position.

b. I-F MODULE ALIGNMENT. - Remove i-f module, and connect to receiver using module extender.

(1) Remove channel r-f module, and set CHAN SEL switch at 1.

(2) Connect a-f generator to pins 13 and 14 of jack J301 and ground. Adjust generator to deliver a 3-kc signal at 10 millivolts.

(3) Connect a-c voltmeter to collector to Q103.

(4) Rotate R104 fully clockwise or fully counterclockwise.

(5) Adjust transformers T101 and T102 to obtain maximum voltmeter indication.

(6) Adjust R104 to obtain minimum voltmeter indication.

(7) Connect a-c voltmeter across resistor R138.

(8) Connect generator to the junction of R108 and T101 secondary.

(9) Adjust first T102, and then T105, to obtain maximum voltmeter indication.

(10) Adjust R139 until a-c voltmeter indicates 2 v rms.

(11) Disconnect test equipment, and return r-f and i-f modules to their normal positions.

c. BFO MODULE ALIGNMENT. - Remove bfo module, and connect to receiver using module extender.

(1) Connect jumper between pins 7 and 8 of J313.

(2) Connect frequency counter to collector of Q183. Adjust T182 and C185 until counter indicates 40,000 cps.

(3) Remove jumper from pins 7 and 8 of J313, and connect jumper across C185.

(4) Set BFO control at 0; then adjust T181 until counter indicates 43,000 cps.

(5) Set BFO control at 3; then adjust capacitor C311 (on chassis of receiver) until counter indicates 46,000 cps.

(6) Repeat steps d and e until both high and low counter indications are obtained at correct BFO control setting.

(7) Remove jumper from C185. Connect counter to pin 13 of J313.

(8) Set BFO control at 0; counter should indicate 3000 cps. Set BFO control at 3; counter should indicate 6000 cps. Adjust C185, T181, or C311 slightly if the above stated mixer output frequencies are not obtained.

(9) Disconnect counter, and connect a-c voltmeter to pin 13 of J313.

(10) Adjust R199 until voltmeter indicates 0.7 v rms.

(11) Remove i-f module; connect a jumper wire between pins 10, 11, and 12 of J312.

(12) Connect a-c voltmeter to pin 5 of J313; adjust BFO control to obtain maximum voltmeter indication.

(13) Adjust R192 to obtain minimum indication on voltmeter.

(14) Disconnect test equipment, and return all modules to their normal operating positions.

SECTION 6
PARTS 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:

The Technical Materiel Corporation
Attention: Sales Department
700 Fenimore Road
Mamaroneck, New York

Assembly or Sub-assembly

VLF RECEIVER ACCESSORIES

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
FL301	FILTER, LOW PASS: 40 Kc. (See separate parts list for breakdown).	FX211
J1	CONNECTOR, RECEPTACLE, ELECTRICAL: 15 female contacts; 5 amps, 1,800 volts RMS; 3.20" long x 0.440" wide x 0.75" high o/a dim.; floating bushing.	JJ293-15SFE
J2	Same as J1.	
P318	CONNECTOR, PLUG, ELECTRICAL: 1 male contact, BNC type; polarized, bayonet lock type.	PL244-1
P319	Same as P318.	
W301	CABLE ASSEMBLY, RADIO FREQUENCY, ELECTRICAL: consists of 60" length of RG174/U coaxial cable; 2 connectors, J1, J2.	CA480-3-60

40 KC LOW PASS FILTER

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C1	CAPACITOR, FIXED, PLASTIC: 150,000 uuf, ±1%; 100 WVDC.	CN112A154F1
C2	CAPACITOR, FIXED, PLASTIC: 100,000 uuf, ±1%; 100 WVDC.	CN112A104F1
C3	Same as C1.	
J1	CONNECTOR, RECEPTACLE, ELECTRICAL: RF type; 1 round male contact, straight type; series BNC to BNC.	UG625B/U
J2	Same as J1.	
L1	COIL, RADIO FREQUENCY, TOROID: frequency range 30-600 Kc; 360 uh, ±5% at 790 Kc; powdered iron core.	CL350
L2	COIL, RADIO FREQUENCY, TOROID: frequency range 30-600 Kc; 89 uh, ±5%; at 2.52 Mc; powdered iron core.	CL351
L3	Same as L2.	
L4	Same as L1.	

POWER SUPPLY

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
A1	PRINTED CIRCUIT BOARD ASSEMBLY: power supply.	A3211-5
C1	CAPACITOR, FIXED, ELECTROLYTIC: rated at 2,000 uf; 50 WVDC; max. operating temperature -20 to +85°C; polarized; metal case.	CE117-1
C2	CAPACITOR, FIXED, ELECTROLYTIC: polarized; 500 uf; 15 WVDC; max. temp. range 0 - 85°C; hermetically sealed aluminum case w/ clear vinyl plastic sleeve.	CE116-6VN
C3	Same as C2.	
CR1	SEMICONDUCTOR DEVICE, DIODE: silicon; 600 volts; max. continuous DC current .50 amp at 100°C; surge current peak 75 amps; max. operating temp. 150 °C; max. forward voltage drop 1.0V; max. reverse current 1000 ua.	1N2484
CR2 thru 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

POWER SUPPLY

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
CR7	NOT USED.	
CR8	SEMICONDUCTOR DEVICE, DIODE: silicon; 12 volts nom., ±5%; 10 watts max. dissipation at 25°C; max. current rating 210 ma; max. impedance 3.0 ohms; storage temperature 175°C.	1N2976B
CR9	NOT USED.	
CR10	Same as CR1.	
E1	TERMINAL BOARD: barrier type; ten 6-32 x 1/4" binding head machine screws.	TM100-10
K1	RELAY ARMATURE: DPDT; 700 ohms, ±10% DC resistant; 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, ±10%; 1 watt.	RC32GF471K
R2	RESISTOR, FIXED, COMPOSITION: 150 ohms, ±10%; 2 watts.	RC42GF151K
R3	RESISTOR, FIXED, WIREWOUND: 100 ohms; ±5%; 5 watts.	RW107-18
R4	RESISTOR, FIXED, COMPOSITION: 4,700 ohms, ±10%; 2 watts.	RC42GF472K
R5	Same as R3.	
*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

*For 115 VAC operation use jumper between pins 2 & 4 and 5 & 7.
For 230 VAC operation use jumper between pins 4 & 5 only.

AF MODULE

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C20	CAPACITOR, FIXED, ELECTROLYTIC: 10 uf, -10% +150% at 120 cps, 25°C; 15 WVDC; polarized; insulated tubular case.	CE105-10-15
C21	Same as C20.	
C22	Same as C20.	

AF MODULE

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C23	CAPACITOR, FIXED, CERAMIC DIELECTRIC: rated at 470,000 uuf, ±20%; radial lead type terminals.	CC112R474M
C24	CAPACITOR, FIXED, ELECTROLYTIC: 100 uf, -10% +150% at 120 cps, 25°C; 15 WVDC; polarized; insulated tubular case.	CE105-100-15
C25	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 0.3 uf, +80% -20%; 1000 WVDC.	CC100-36
C26	CAPACITOR, FIXED, ELECTROLYTIC: 175 uf, -10% +150% at 120 cps, 25°C; 15 WVDC; polarized; insulated tubular case.	CE105-175-15
C27	CAPACITOR, FIXED, ELECTROLYTIC: tantalum; 50 uf, +50% -15%; 60 WVDC; polarized; tubular case.	CE107-1
C28	Same as C27.	
P20	Non-replaceable item. Integral part of TMC part number A3201-4.	
Q20	TRANSISTOR: germanium; PNP; JEDEC type 2N396A transistor with a controlled hfe limit of 85-105; JEDEC type T05 case.	TX101-1
Q21	TRANSISTOR: germanium; JEDEC type 2N1370 transistor with a controlled hfe limit of 60-750; JEDEC type T09 case.	TX107
Q22	Same as Q21.	
*Q23	TRANSISTOR: germanium; PNP; matched pair of JEDEC type 2N2143 transistors with a controlled hfe limit of 50-100; JEDEC type T03 case.	TX103
*Q24	Same as Q23.	
Q25	Same as Q20.	
Q26	Same as Q20.	
Q27	Same as Q20.	
R20	RESISTOR, FIXED, COMPOSITION: 3,900 ohms, ±10%; 1/2 watt.	RC20GF392K
R21	RESISTOR, FIXED, COMPOSITION: 3,300 ohms, ±10%; 1/2 watt.	RC20GF332K
R22	RESISTOR, FIXED, COMPOSITION: 8,200 ohms, ±10%; 1/2 watt.	RC20GF822K
R23	RESISTOR, FIXED, COMPOSITION: 220 ohms, ±10%; 1/2 watt.	RC20GF221K
R24	Same as R21.	
R25	Same as R21.	

*To be supplied in matched pairs.

AF MODULE

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R26	RESISTOR, FIXED, COMPOSITION: 100 ohms, ±5%; 1/2 watt.	RC20GF101J
R27	Same as R26.	
R28	RESISTOR, FIXED, COMPOSITION: 1,200 ohms, ±10%; 1/2 watt.	RC20GF122K
R29	RESISTOR, FIXED, COMPOSITION: 1,200 ohms, ±5%; 1/2 watt.	RC20GF122J
R30	RESISTOR, FIXED, COMPOSITION: 820 ohms, ±10%; 1/2 watt.	RC20GF821K
R31	RESISTOR, FIXED, COMPOSITION: 4.7 ohms, ±5%; 1/2 watt.	RC20GF4R7J
R32	RESISTOR, FIXED, COMPOSITION: 15 ohms, ±5%; 1/2 watt.	RC20GF150J
R33	Same as R32.	
R34	RESISTOR, FIXED, COMPOSITION: 22,000 ohms, ±10%; 1/2 watt.	RC20GF223K
R35	Same as R34.	
R36	RESISTOR, FIXED, COMPOSITION: 2,700 ohms, ±10%; 1/2 watt.	RC20GF272K
R37	RESISTOR, FIXED, COMPOSITION: 1,500 ohms, ±5%; 1/2 watt.	RC20GF152J
R38	Same as R37.	
R39	Same as R21.	
R40	Same as R21.	
R41	RESISTOR, FIXED, COMPOSITION: 270 ohms, ±5%; 1/2 watt.	RC20GF271J
R42	RESISTOR, FIXED, COMPOSITION: 1,000 ohms, ±10%; 1/2 watt.	RC20GF102K
T20	TRANSFORMER, AF: interstage; primary impedance 10K ohms, center tap; secondary 1.5K ohms, center tap; power rated at 100 mw; frequency range 50-10,000 cps; wire lead type terminals; encapsulated case.	TF270
T21	TRANSFORMER, AF: line output; primary impedance 5K ohms, center tap; secondary 600 ohms, center tap; power rated at 10 mw; frequency range 50-10,000 cps; wire lead type terminals; encapsulated case.	TF271
T22	Same as T20.	

IF AMPLIFIER MODULE

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C101	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 1,000 uf; +80% -20%; 3 WVDC.	CC100-34
C102	CAPACITOR, FIXED, ELECTROLYTIC: 25 uf, -10% +150% at 120 cps, 25°C; 15 WVDC; polarized; insulated tubular case.	CE105-25-15
C103	CAPACITOR, FIXED, PLASTIC DIELECTRIC: 100,000 uuf, ±5%; 30 WVDC; 1" long x 13/32" dia. o/a.	CX104-58
C104	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 50,000 uuf, +80% -20%; 500 WVDC.	CC100-27
C105	Same as C102.	
C106	Same as C103.	
C107	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 220,000 uuf, +80% -20%; 10 WVDC.	CC100-33
C108	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 20,000 uuf, +60% -40%; 150 WVDC.	CC100-35
C109	Same as C102.	
C110	Same as C102.	
C111	Same as C108.	
C112	Same as C102.	
C113	Same as C102.	
C114	CAPACITOR, FIXED, ELECTROLYTIC: 75 uf, -10% +150% at 120 cps, 25°C; 15 WVDC; polarized; insulated tubular case.	CE105-75-15
C115	Same as C101.	
C116	Same as C102.	
C117	CAPACITOR, FIXED, ELECTROLYTIC: 2.0 uf, -10% +150% at 120 cps, 25°C; 15 WVDC; polarized, insulated tubular case.	CE105-2-15
C118	CAPACITOR, FIXED, ELECTROLYTIC: 6.0 uf, -10% +150% at 120 cps, 25°C; 15 WVDC; polarized, insulated tubular case.	CE105-6-15
C119	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 10,000 uuf; GMV; 500 WVDC.	CC100-16
C120	CAPACITOR, FIXED, ELECTROLYTIC: 1.0 uf, -10% +150% at 120 cps, 25°C; 15 WVDC; polarized; insulated tubular case.	CE105-1-15
C121	Same as C104.	
C122	Same as C102.	
C123	Same as C102.	
C124	Same as C103.	
C125	Same as C102.	

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
CR101	SEMICONDUCTOR, DEVICE, DIODE: germanium; max. peak inverse voltage 60V; continuous average forward current 50 ma; max. peak forward current 150 ma; max. surge current 500 ma; max. inverse current 500 ua at 50 volts or 30 ua at 10 volts.	1N34A
CR102	SEMICONDUCTOR, DEVICE, DIODE: germanium; 100V min. peak inverse voltage; 60 ma at 250°C; axial wire lead type terminals; hermetically sealed glass case.	1N100
CR103	Same as CR101.	
CR104	Same as CR101.	
P101	Non-replaceable item. Integral part of TMC part number A3181-4.	
P102	Non-replaceable item. Integral part of TMC part number A3181-4.	
Q101	TRANSISTOR: germanium, PNP; JEDEC type 2N396A transistor with a controlled hfe limit of 85-105; JEDEC type T05 case.	TX101-1
Q102	Same as Q101.	
Q103	Same as Q101.	
Q104	Same as Q101.	
Q105	Same as Q101.	
Q106	TRANSISTOR: germanium; junction type contacts, PNP configuration; rating at 25°C, collector to base, 40 volts; collector to emitter 25 volts; collector to current 100 ma; wire lead terminals; hermetically sealed metal case; .190" x .340" o/a.	2N214A
Q107	Same as Q106.	
Q108	Same as Q101.	
Q109	Same as Q101.	
Q110	Same as Q101.	
Q111	Same as Q101.	
R101	RESISTOR, FIXED, COMPOSITION: 10,000 ohms, ±10%; 1/2 watt.	RC20GF103K
R102	Same as R101.	
R103	RESISTOR, FIXED, COMPOSITION: 470 ohms, ±10%; 1/2 watt.	RC20GF471K
R104	RESISTOR, VARIABLE, COMPOSITION: standard linear taper; 1,000 ohms, ±10%; power rated at 0.5 watt at 70°C; temperature range -55°C to +120°C; max. continuous voltage 350V rms; slotted locking shaft with bushing.	RV106UX9B102A

IF AMPLIFIER MODULE

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R105	Same as R103.	
R106	RESISTOR, FIXED, COMPOSITION: 22,000 ohms, ±10%; 1/2 watt.	RC20GF223K
R107	Same as R101.	
R108	Same as R103.	
R109	RESISTOR, FIXED, COMPOSITION: 6,800 ohms, ±10%; 1/2 watt.	RC20GF682K
R110	RESISTOR, FIXED, COMPOSITION: 1,000 ohms, ±10%; 1/2 watt.	RC20GF102K
R111	Same as R110.	
R112	RESISTOR, FIXED, COMPOSITION: 3,300 ohms, ±10%; 1/2 watt.	RC20GF332K
R113	Same as R101.	
R114	RESISTOR, FIXED, COMPOSITION: 5,600 ohms, ±10%; 1/2 watt.	RC20GF562K
R115	Same as R112.	
R116	Same as R101.	
R117	Same as R114.	
R118	RESISTOR, FIXED, COMPOSITION: 27,000 ohms, ±10%; 1/2 watt.	RC20GF273K
R119	RESISTOR, FIXED, COMPOSITION: 33,000 ohms, ±10%; 1/2 watt.	RC20GF333K
R120	RESISTOR, FIXED, COMPOSITION: 8,200 ohms, ±10%; 1/2 watt.	RC20GF822K
R121	RESISTOR, FIXED, COMPOSITION: 12,000 ohms, ±10%; 1/2 watt.	RC20GF123K
R122	RESISTOR, FIXED, COMPOSITION: 3,900 ohms, ±10%; 1/2 watt.	RC20GF392K
R123	RESISTOR, FIXED, COMPOSITION: 220 ohms, ±10%; 1/2 watt.	RC20GF221K
R124	Same as R122.	
R125	Same as R121.	
R126	NOT USED.	
R127	Same as R114.	
R128	Same as R114.	
R129	Same as R101.	

IF AMPLIFIER MODULE

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R130	RESISTOR, FIXED, COMPOSITION: 1,800 ohms, ±10%; 1/2 watt.	RC20GF182K
R131	RESISTOR, FIXED, COMPOSITION: 39,000 ohms, ±10%; 1/2 watt.	RC20GF393K
R132	RESISTOR, FIXED, COMPOSITION: 47,000 ohms, ±10%; 1/2 watt.	RC20GF473K
R133	Same as R122.	
R134	Same as R110.	
R135	RESISTOR, FIXED, COMPOSITION: 680 ohms, ±10%; 1/2 watt.	RC20GF681K
R136	Same as R109.	
R137	Same as R110.	
R138	RESISTOR, FIXED, COMPOSITION: 2,200 ohms, ±10%; 1/2 watt.	RC20GF222K
R139	Same as R104.	
R140	RESISTOR, FIXED, COMPOSITION: 2,700 ohms, ±10%; 1/2 watt.	RC20GF272K
T101	TRANSFORMER, RF, TUNED: operating frequency 3 Kc; primary-nom. inductance 26 - 27.5 mhy; tertiary-inductance 3.2 - 3.8 mhy; secondary- 3.2 - 3.8 mhy, tapped; adjustable ferrite core; wire lead type terminals; metal case.	TT199
T102	TRANSFORMER, RF, TUNED: operating frequency 3 Kc; nom. inductance 28 mhy, ±1%; 100 VDC min.; adjustable ferrite core; wire lead type terminals.	TT197-1
T103	TRANSFORMER, RF, TUNED: input impedance 2.2K ohms, center tapped; output impedance 10K ohms; operating frequency 5 Kc - 100 Kc; stake lug terminals; hermetically sealed metal case.	TR182
T104	TRANSFORMER, RF, TUNED: input impedance 2.2K ohms; output impedance 8.2K ohms, center tapped; operating frequency 5 Kc - 100 Kc; stake lug terminals; hermetically sealed metal case.	TR183
T105	TRANSFORMER, RF, TUNED: operating frequency 3 Kc; primary- nom. inductance 28 mhy; tertiary- inductance 6.2 mhy; secondary-inductance 6.2 mhy, tapped; min. voltage rating 100 VDC; adjustable ferrite core; wire lead type terminals; hermetically sealed metal case.	TT198-1

BFO MODULE

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C181	CAPACITOR, FIXED, MICA DIELECTRIC: capacitance drift ±(0.05% - 0.1 uuf) at 0° - 70°C; 620 uuf, ±2%; 500 volts, ±2%; straight wire leads.	CM111F621G5S
C182	CAPACITOR, FIXED, MICA DIELECTRIC: 1,000 uuf, ±2%; Char. E; 500 WVDC.	CM20E102G
C183	CAPACITOR, FIXED, ELECTROLYTIC: 10 uf, -10% +150% 120 cps, 25°C; 15 WVDC; polarized; insulated tubular case.	CE105-10-15
C184	CAPACITOR, FIXED, MICA DIELECTRIC: capacitance drift ±(0.05% - 0.1 uuf) at 0° - 70°C; 1,000 uuf, ±2%; 500 volts, ±2%; straight wire leads.	CM111F102G5S
C185	CAPACITOR, VARIABLE, CERAMIC DIELECTRIC: miniature disc type; 5.5 - 18 uuf; 200 WVDC; operating temperature range -55°C - +125°C; silver plated terminals; steatite ceramic base.	CV112-1
C186	Same as C182.	
C187	Same as C183.	
C188	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 100,000 uuf, +80% -20%; 100 WVDC.	CC100-28
C189	Same as C182.	
C190	CAPACITOR, FIXED, ELECTROLYTIC: 2.0 uf, -10% +150% at 120 cps, 25°C; 15 WVDC; polarized; insulated tubular case.	CE105-2-15
C191	CAPACITOR, FIXED, ELECTROLYTIC: 25 uf, -10% +150% at 120 cps, 25°C; 15 WVDC; polarized; insulated tubular case.	CE105-25-15
C192	CAPACITOR, FIXED, MICA DIELECTRIC: 2000 uuf, ±2%; 500 WVDC; straight wire leads.	CM112D202G5S
C193	Same as C192.	
C194	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 220,000 uuf, +80% -20%; 10 WVDC.	CC100-33
C195	CAPACITOR, FIXED, ELECTROLYTIC: 15 uf, -10% +150% at 120 cps, 25°C; 15 WVDC; polarized; insulated tubular case.	CE105-15-15
F181	FILTER, LP, 2.5 Kc low pass; passband ripple ±1.5 db; down 3 db at 2.5 Kc and 60 db or better at 30 Kc and up; operating temperature range 0° - 50°C; input and output impedance 600 ohms; glass insulated terminals; hermetically sealed steel case.	FX194
L181	COIL, RF, FIXED: solenoid; inductance 240 mh, ±10%; staked lug type terminals; red aluminum case.	CL316
L182	COIL, RF, FIXED: solenoid; inductance 350 mh, ±10%; staked lug type terminals; red aluminum case.	CL320
P181	Non-replaceable item. Integral part of TMC part number A3168-4.	

BFO MODULE

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
Q181	TRANSISTOR: germanium, PNP; drift field; power gain 25.6 db at 1.5 Mc; collector-base voltage 34 VDC; emitter-base voltage 1.5 VDC; collector and emitter current 10 ma DC; dissipation 80 mu at 25°C, 50 mu at 55°C, 35 mu at 71°C; max. operating temp. 71°C; storage temp. -65 to 85°C.	2N1637
Q182	Same as Q181.	
Q183	Same as Q181.	
Q184	TRANSISTOR: germanium; PNP; JEDEC type 2N396A transistor with a controlled hfe limit of 85-105; JEDEC type T05 case.	TX101-1
Q185	Same as Q184.	
Q186	Same as Q184.	
R181	RESISTOR, FIXED, COMPOSITION: 1,800 ohms, ±10%; 1/2 watt.	RC20GF182K
R182	RESISTOR, FIXED, COMPOSITION: 12,000 ohms, ±10%; 1/2 watt.	RC20GF123K
R183	RESISTOR, FIXED, COMPOSITION: 4,700 ohms, ±10%; 1/2 watt.	RC20GF472K
R184	RESISTOR, FIXED, COMPOSITION: 1,200 ohms, ±10%; 1/2 watt.	RC20GF122K
R185	Same as R181.	
R186	Same as R182.	
R187	Same as R184.	
R188	RESISTOR, FIXED, COMPOSITION: 27,000 ohms, ±10%; 1/2 watt.	RC20GF273K
R189	RESISTOR, FIXED, COMPOSITION: 10,000 ohms, ±10%; 1/2 watt.	RC20GF103K
R190	Same as R189.	
R191	RESISTOR, FIXED, COMPOSITION: 47 ohms, ±10%; 1/2 watt.	RC20GF470K
R192	RESISTOR, VARIABLE, COMPOSITION: standard linear taper; 500 ohms, ±10%; max. continuous power rating 1/2 watt at 70°C; operating temperature range -55°C - +120°C; max. continuous voltage rating 350 V rms; slotted locking shaft with bushing.	RV106UX9B501A
R193	Same as R191.	
R194	RESISTOR, FIXED, COMPOSITION: 2,200 ohms, ±10%; 1/2 watt.	RC20GF222K
R195	Same as R181.	
R196	RESISTOR, FIXED, COMPOSITION: 8,200 ohms, ±10%; 1/2 watt.	RC20GF822K

BFO MODULE

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R197	RESISTOR, FIXED, COMPOSITION: 470 ohms, ±10%; 1/2 watt.	RC20GF471K
R198	RESISTOR, FIXED, COMPOSITION: 15,000 ohms, ±10%; 1/2 watt.	RC20GF153K
R199	RESISTOR, VARIABLE, COMPOSITION: standard linear taper; 1000 ohms, ±10%; max. continuous power rating 1/2 watt at 70°C; operating temperature range -55°C - +120°C; max. continuous voltage rating 350 V rms; slotted locking shaft with bushing.	RV106UX9B103A
T181	TRANSFORMER, RF, ADJUSTABLE: operating frequency 43 - 46 Kc; primary- nom. inductance 18.3 mhy; secondary- non-inductive, tapped; adjustable ferrite core; wire lead type terminals.	TT196-2
T182	TRANSFORMER, RF, ADJUSTABLE: operating frequency 40 Kc; primary- inductance 15.8 mhy; secondary- non-inductive, tapped; adjustable ferrite core; wire lead type terminals.	TT196-1
T183	TRANSFORMER, AUDIO FREQUENCY: primary & secondary 600 ohms, center tapped; max. primary power 350 mw.	TF263

RF MODULE

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
*C201	CAPACITOR, FIXED, PLASTIC DIELECTRIC: polystyrene.	CX104-( )
C202	CAPACITOR, FIXED, ELECTROLYTIC: 6.0 uf, -10% +150% at 120 cps, 25°C; 15 WVDC; polarized; insulated tubular case.	CE105-6-15
C203	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 220,000 uuf, +80% -20%; 10 WVDC.	CC100-33
C204	Same as C203.	
C205	CAPACITOR, FIXED, ELECTROLYTIC: 125 uf, -10% +150% at 120 cps, 25°C; 15 WVDC; polarized; insulated tubular case.	CE105-125-15
*C206	Same as C201.	
C207	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 1,000,000 uuf, +80% -20%; 3 WVDC.	CC100-34
C208	Same as C203.	
*C209	Same as C201.	
C210	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 25,000 uuf, +80% -20%; 500 WVDC.	CC100-25

*Part number will be dependent upon the operating frequency of XFMR, T201, T203 or T204 as per customer request.

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C211	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 10,000 uuf; GMV; 500 WVDC.	CC100-16
C212	Same as C210.	
C213	CAPACITOR, FIXED, MICA DIELECTRIC: 39 uuf, ±5%; 500 WVDC.	CM15B390J
C214	CAPACITOR, FIXED, ELECTROLYTIC: 25 uf, -10% +150% at 120 cps, 25°C; 15 WVDC; polarized; insulated tubular case.	CE105-25-15
C215	Same as C207.	
C216	CAPACITOR, FIXED, PLASTIC DIELECTRIC: mylar; .05 uf, ±5%; 400 WVDC.	CN113-1
C217	Same as C203.	
C218	CAPACITOR, FIXED, ELECTROLYTIC: 5.0 uf, -10% +150% at 120 cps, 25°C; 15 WVDC; polarized; insulated tubular case.	CE105-5-15
C219	Same as C203.	
C220	Same as C203.	
C221	CAPACITOR, FIXED, ELECTROLYTIC: 8.0 uf, -10% +150% at 120 cps, 25°C; 15 WVDC; polarized; insulated tubular case.	CE105-8-15
L201	COIL, RF, FIXED: solenoid type; inductance 8 - 12 mh; 1 ohm DC resistant; staked lug terminals, aluminum case.	CL321
P201	Non-replaceable item. Integral part of TMC part number A3212-4.	
Q201	TRANSISTOR: germanium; PNP; JEDEC type 2N396A transistor with a controlled hfe limit of 85-105; JEDEC type T05 case.	TX101-1
Q202 thru Q207	Same as Q201.	
R201	RESISTOR, FIXED, COMPOSITION: 1,000 ohms, ±10%; 1/2 watt.	RC20GF102K
R202	RESISTOR, FIXED, COMPOSITION: 12,000 ohms, ±10%; 1/2 watt.	RC20GF123K
R203	RESISTOR, FIXED, COMPOSITION: 8,200 ohms, ±10%; 1/2 watt.	RC20GF822K
R204	RESISTOR, FIXED, COMPOSITION: 22 ohms, ±10%; 1/2 watt.	RC20GF220K
R205	Same as R202.	
R206	Same as R203.	

RF MODULE

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R207	Same as R201.	
R208	Same as R201.	
R209	Same as R202.	
R210	RESISTOR, FIXED, COMPOSITION: 10 ohms, ±10%; 1/2 watt.	RC20GF100K
R211	Same as R203.	
R212	RESISTOR, FIXED, COMPOSITION: 2,200 ohms, ±10%; 1/2 watt.	RC20GF222K
R213	RESISTOR, FIXED, COMPOSITION: 2,700 ohms, ±10%; 1/2 watt.	RC20GF272K
R214	RESISTOR, FIXED, COMPOSITION: 5,600 ohms, ±5%; 1/2 watt.	RC20GF562J
R215	RESISTOR, FIXED, COMPOSITION: 27,000 ohms, ±10%; 1/2 watt.	RC20GF273K
R216	RESISTOR, FIXED, COMPOSITION: 1,800 ohms, ±10%; 1/2 watt.	RC20GF182K
R217	RESISTOR, FIXED, COMPOSITION: 10,000 ohms, ±10%; 1/2 watt.	RC20GF103K
R218	RESISTOR, FIXED, COMPOSITION: 22,000 ohms, ±10%; 1/2 watt.	RC20GF223K
*R219	RESISTOR, FIXED, COMPOSITION: ohms, ±5%; 1/2 watt.	RC20GF J
R220	RESISTOR, FIXED, COMPOSITION: 6,800 ohms, ±10%; 1/2 watt.	RC20GF682K
R221	Same as R202.	
R222	RESISTOR, FIXED, COMPOSITION: 3,300 ohms, ±10%; 1/2 watt.	RC20GF332K
R223	Same as R220.	
R224	RESISTOR, FIXED, COMPOSITION: 3,900 ohms, ±10%; 1/2 watt.	RC20GF392K
R225	Same as R203.	
R226	RESISTOR, FIXED, COMPOSITION: 560 ohms, ±10%; 1/2 watt.	RC20GF561K
R227	Same as R217.	
R228	Same as R201.	
R229	Same as R201.	

*Value will be determined at the factory according to the degree of crystal activity, and within a 1.2K to 8.2K ohms range.

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
T201	TRANSFORMER, RF, ADJUSTABLE: operating frequency range 10-12 Kcs; link primary-not rated; main secondary-nom. inductance 3.3 uh; link secondary-not rated, tapped; adjustable ferrite core; wire lead type terminals; nickel silver case.	TZ161-11
T201	TRANSFORMER, RF, ADJUSTABLE: operating frequency range 12-14 Kcs; link primary-not rated; main secondary-nom. inductance 2.9 uh; link secondary-not rated, tapped; adjustable ferrite core; wire lead type terminals; nickel silver case.	TZ161-13
T201	TRANSFORMER, RF, ADJUSTABLE: operating frequency range 14-18 Kcs; link primary-not rated; main secondary-nom. inductance 2.3 uh; link secondary-not rated, tapped; adjustable ferrite core; wire lead type terminals; nickel silver case.	TZ161-16
T201	TRANSFORMER, RF, ADJUSTABLE: operating frequency range 18-24 Kcs; link primary-not rated; main secondary-nom. inductance 1.8 uh; link secondary-not rated, tapped; adjustable ferrite core; wire lead type terminals; nickel silver case.	TZ161-21
T201	TRANSFORMER, RF, ADJUSTABLE: operating frequency range 24-30 Kcs; link primary-not rated; main secondary-nom. inductance 1.4 uh; link secondary-not rated, tapped; adjustable ferrite core; wire lead type terminals; nickel silver case.	TZ161-27
T201	TRANSFORMER, RF, ADJUSTABLE: operating frequency range 55-65 Kcs; link primary-not rated; main secondary-nom. inductance 0.5 uh; link secondary-not rated, tapped; adjustable ferrite core; wire lead type terminals; nickel silver case.	TZ161-60
T202	TRANSFORMER, RF, FIXED: input impedance 2.2K ohms, center tapped; output impedance 10K ohms; operating frequency 5 Kc - 100 Kc; staked lug terminals; hermetically sealed aluminum case.	TR182
T203	TRANSFORMER, RF, ADJUSTABLE: operating frequency range 10-12 Kcs; link primary-not rated, center tapped; main secondary-nom. inductance 3.3 uh; link secondary-not rated, tapped; adjustable ferrite core; wire lead type terminals; nickel silver case.	TZ162-11
T203	TRANSFORMER, RF, ADJUSTABLE: operating frequency range 12-14 Kcs; link primary-not rated, center tapped; main secondary-nom. inductance 2.9 uh; link secondary-not rated, tapped; adjustable ferrite core; wire lead type terminals; nickel silver case.	TZ162-13
T203	TRANSFORMER, RF, ADJUSTABLE: operating frequency range 14-18 Kcs; link primary-not rated, center tapped; main secondary-nom. inductance 2.3 uh; link secondary-not rated, taped; adjustable ferrite core; wire lead type terminals; nickel silver case.	TZ162-16

RF MODULE

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
T203	TRANSFORMER, RF, ADJUSTABLE: operating frequency range 18-24 Kcs; link primary-not rated, center tapped; main secondary-nom. inductance 1.8 h; link secondary-not rated, tapped; adjustable ferrite core; wire lead type terminals; nickel silver case.	TZ162-21
T203	TRANSFORMER, RF, ADJUSTABLE: operating frequency range 24-30 Kcs; link primary-not rated, center tapped; main secondary-nom. inductance 1.4 uh; link secondary-not rated, tapped; adjustable ferrite core; wire lead type terminals; nickel silver case.	TZ162-27
T203	TRANSFORMER, RF, ADJUSTABLE: operating frequency range 55-65 Kcs; link primary-not rated, center tapped; main secondary-nom. inductance 0.5 uh; link secondary-not rated, tapped; adjustable ferrite core; wire lead type terminals; nickel silver case.	TZ162-60
T204	TRANSFORMER, RF, ADJUSTABLE: operating frequency range 10-12 Kcs; main primary-nom. inductance 3.3 uh; link secondary-not rated, center tapped; adjustable ferrite core; wire lead type terminals; nickel silver case.	TZ163-11
T204	TRANSFORMER, RF, ADJUSTABLE: operating frequency range 12-14 Kcs; main primary-nom. inductance 2.9 uh; link secondary-not rated, center tapped; adjustable ferrite core; wire lead type terminals; nickel silver case.	TZ163-13
T204	TRANSFORMER, RF, ADJUSTABLE: operating frequency range 14-18 Kcs; main primary-nom. inductance 2.3 uh; link secondary-not rated, center tapped; adjustable ferrite core; wire lead type terminals; nickel silver case.	TZ163-16
T204	TRANSFORMER, RF, ADJUSTABLE: operating frequency range 18-24 Kcs; main primary-nom. inductance 1.8 uh; link secondary-not rated, center tapped; adjustable ferrite core; wire lead type terminals; nickel silver case.	TZ163-21
T204	TRANSFORMER, RF, ADJUSTABLE: operating frequency range 24-30 Kcs; main primary-nom. inductance 1.4 uh; link secondary-not rated, center tapped; adjustable ferrite core; wire lead type terminals; nickel silver case.	TZ163-27
T204	TRANSFORMER, RF, ADJUSTABLE: operating frequency range 55-65 Kcs; main primary-nom. inductance 0.5 uh; link secondary-not rated, center tapped; adjustable ferrite core; wire lead type terminals; nickel silver case.	TZ163-60
XY201	SOCKET, CRYSTAL: clip type; 2 cadmium plated contacts; 3/64" x 5/32" tail slots.	TS167-1
*Y201	CRYSTAL, QUARTZ;	CR50A/U(-)

*Frequency determined as ordered by customer. XTAL frequency shall be operating frequency plus 3 Kc.

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C301	CAPACITOR, FIXED, ELECTROLYTIC: 150 uf, -10% +150% at 120 cps, 25°C; 15 WVDC; polarized; insulated tubular case.	CE105-150-15
C302	CAPACITOR, FIXED, ELECTROLYTIC: 200 uf, -10% +150% at 120 cps, 25°C; 15 WVDC; polarized; insulated tubular case.	CE105-200-15
C303	Same as C302.	
C304	CAPACITOR, VARIABLE, AIR: 5.5 uuf to 100 uuf; 600 V rms.	CT100-2
C305	CAPACITOR, FIXED, CERAMIC DIELECTRIC: .005 uf; 500 WVDC; GMV.	CC100-15
C306	Same as C305.	
C307	CAPACITOR, FIXED, ELECTROLYTIC: 50 uf, -10% +150% at 120 cps, 25°C; 15 WVDC; polarized; insulated tubular case.	CE105-50-15
C308	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 100,000 uuf, +80% -20%; 100 WVDC.	CC100-28
C309	CAPACITOR, FIXED, ELECTROLYTIC: polarized; 500 uf; 15 WVDC; max. temp. range 0 - 85°C; hermetically sealed alumninum case w/ clear vinyl plastic sleeve.	CE116-6VN
C310	Same as C309.	
C311	CAPACITOR, VARIABLE, CERAMIC DIELECTRIC: 3-12 uuf; 500 WVDC; char. C.	CV11A120
CR301	SEMICONDUCTOR DEVICE, DIODE: germanium; max. peak inverse voltage 60 V; continuous average forward current 50 ma; max. peak forward current 150 ma; max. surge current 500 ma; max. inverse current 500 ua at 500 volts or 30 ua at 10 volts.	1N34A
CR302	Same as CR301.	
CR303	Same as CR301.	
CR304	SEMICONDUCTOR DEVICE, DIODE: germanium; min. peak inverse voltage for zero dynamic impedance 70 V; continuous reverse working voltage 60 V; average forward current 60 ma; recurrent peak forward current 150 ma; forward surge current (1 sec.) 500 ma.	1N294
DS301	LAMP, INCANDESCENT: 28 volts; 0.04 amp; miniature bayonet base T-3-1/4 bulb.	BI101-1819
DS302	Same as DS301.	
E301	TERMINAL BOARD, BARRIER: 6 terminals; solder lug terminals; phenolic black bakelite.	TM100-6
E302	TERMINAL BOARD, FANNING: 10 terminals; angle type; left end feed.	TM105-10AL

VLRA-1 MAIN CHASSIS

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
F301	FUSE, CARTRIDGE: 1/2 amp; time lag; 1-1/4" long x 1/4" dia.; slow blow.	FU102-.500
F302	Same as F301.	
F303	Same as F301.	
J301	CONNECTOR, RECEPTACLE, ELECTRICAL: 15 female, flat solid face contacts; for single sided 3/32" printed circuit board; continuous current rating 5 amps; 1800 V rms; float bushing; 3.20" lg. x 0.440" wide x 0.75" high dim. o/a.	JJ293-15SFE
J302 thru J314	Same as J301.	
J315	CONNECTOR, RECEPTACLE, ELECTRICAL: 4 number 16 male contacts; straight type.	MS3102A14S-2P
J316	CONNECTOR, RECEPTACLE, ELECTRICAL: RF type; 1 round male contact; straight type; series BNC to BNC.	UG625B/U
J317	Same as J316.	
J318	Same as J316.	
J319	CONNECTOR, RECEPTACLE, ELECTRICAL: 3 number 16 male contacts; straight type.	MS3102A14S-1P
J320	JACK, TELEPHONE: tip and sleeve; bushing mounted.	JJ034
M301	AMMETER, AF/RF: level indicating; scale- 0 -100 DB above .1 uv, -20 - 0 - +3 DBN; 50 ua movement; 2000 ohms approx. resistance; black phenolic case.	MR171
R301	RESISTOR, VARIABLE, COMPOSITION: 25,000 ohms, ±10% 2 watts; standard bushing type, slotted 5/8" shaft.	RV4NAYSA253AYY
R302	RESISTOR, VARIABLE, COMPOSITION: 3,500 ohms, ±10%; 2 watts; standard bushing type, slotted 5/8" shaft.	RV4NAYSA352AYY
R303	RESISTOR, FIXED, COMPOSITION: 270 ohms, ±10%; 1/2 watt.	RC20GF271K
R304	RESISTOR, FIXED, COMPOSITION: 220 ohms, ±10%; 1/2 watt.	RC20GF221K
R305	RESISTOR, FIXED, COMPOSITION: 18,000 ohms, ±10%; 1/2 watt.	RC20GF183K
R306	RESISTOR, VARIABLE, COMPOSITION: 50,000 ohms, ±10%; 2 watts; locking bushing type; slotted 5/8" shaft.	RV4LAYSA503A
R307	RESISTOR, VARIABLE, COMPOSITION: 1,000 ohms, ±10%; 2 watts; standard bushing type; slotted 5/8" shaft.	RV4NAYSA102AYY
R308	RESISTOR, FIXED, COMPOSITION: 1,000 ohms, ±10%; 1/2 watt.	RC20GF102K
R309	RESISTOR, VARIABLE, COMPOSITION: 100 ohms, ±10%; 2 watts; standard bushing type; slotted 5/8" shaft.	RV4NAYSA101AYY

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R310	RESISTOR, FIXED, COMPOSITION: 150 ohms, ±10%; 1/2 watt.	RC20GF151K
R311	RESISTOR, VARIABLE, COMPOSITION: 10,000 ohms, ±10%; 2 watts; locking bushing type; slotted 5/8" shaft.	RV4LAYSA103A
R312	RESISTOR, FIXED, COMPOSITION: 2,200 ohms, ±5%; 1/2 watt.	RC20GF222J
R313	Same as R312.	
R314	RESISTOR, FIXED, COMPOSITION: 100,000 ohms, ±10%; 1/2 watt.	RC20GF104K
R315	RESISTOR, FIXED, COMPOSITION: 680 ohms, ±10%; 1/2 watt.	RC20GF681K
S301	SWITCH, ROTARY: 10 sections, 10 positions, 36° angle of throw; non-shorting type contacts; rated at 50 volts, 1/2 amp max.	SW332
S302	SWITCH, TOGGLE: DPST; 2 amps rated at 250 volts; bat type handle.	ST22K
S303	SWITCH, ROTARY: 1 section, 4 positions, 36° angle of throw; shorting type contacts; rated at 50 volts, 1/2 amp max.	SW333
S304	SWITCH TOGGLE: DPDT: 6 amps rated at 250 volts AC; 28° angle of throw; solder lug terminals, (one pole unused).	ST22N
S305	Same as S304.	
T301	TRANSFORMER, AUDIO OUT: primary-500 ohms, center tapped; secondary- 4 ohms; max. audio operating level 1 watt; frequency range 50 - 10,000 cps; solder stud terminals; fully enclosed steel case.	TF272
XDS301	LIGHT, INDICATOR: with red frosted lens; for miniature bayonet base T-3-1/4 bulb.	TS106-1
XDS302	LIGHT, INDICATOR: with green frosted lens; for miniature bayonet base T-3-1/4 bulb.	TS106-3
XF301	FUSEHOLDER: extractor post type; accomodates cartridge fuse 1/4" dia. x 1-1/4" long; rated at 15 amps 250 V max.; o/a length 1-3/4"; bushing mounted.	FH103
XF302	Same as XF301.	
XF303	Same as XF301.	

SECTION 7
SCHEMATIC DIAGRAMS

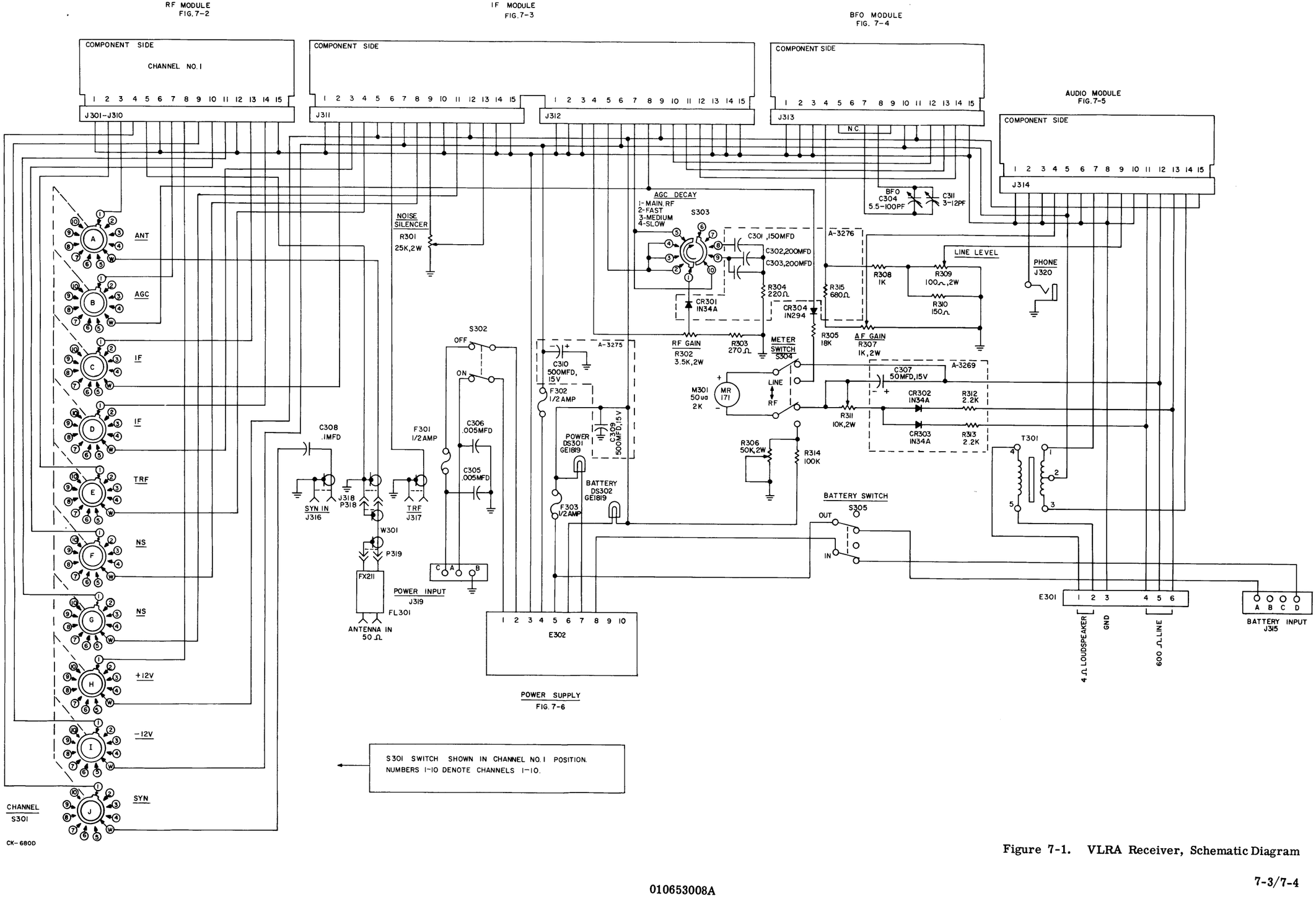
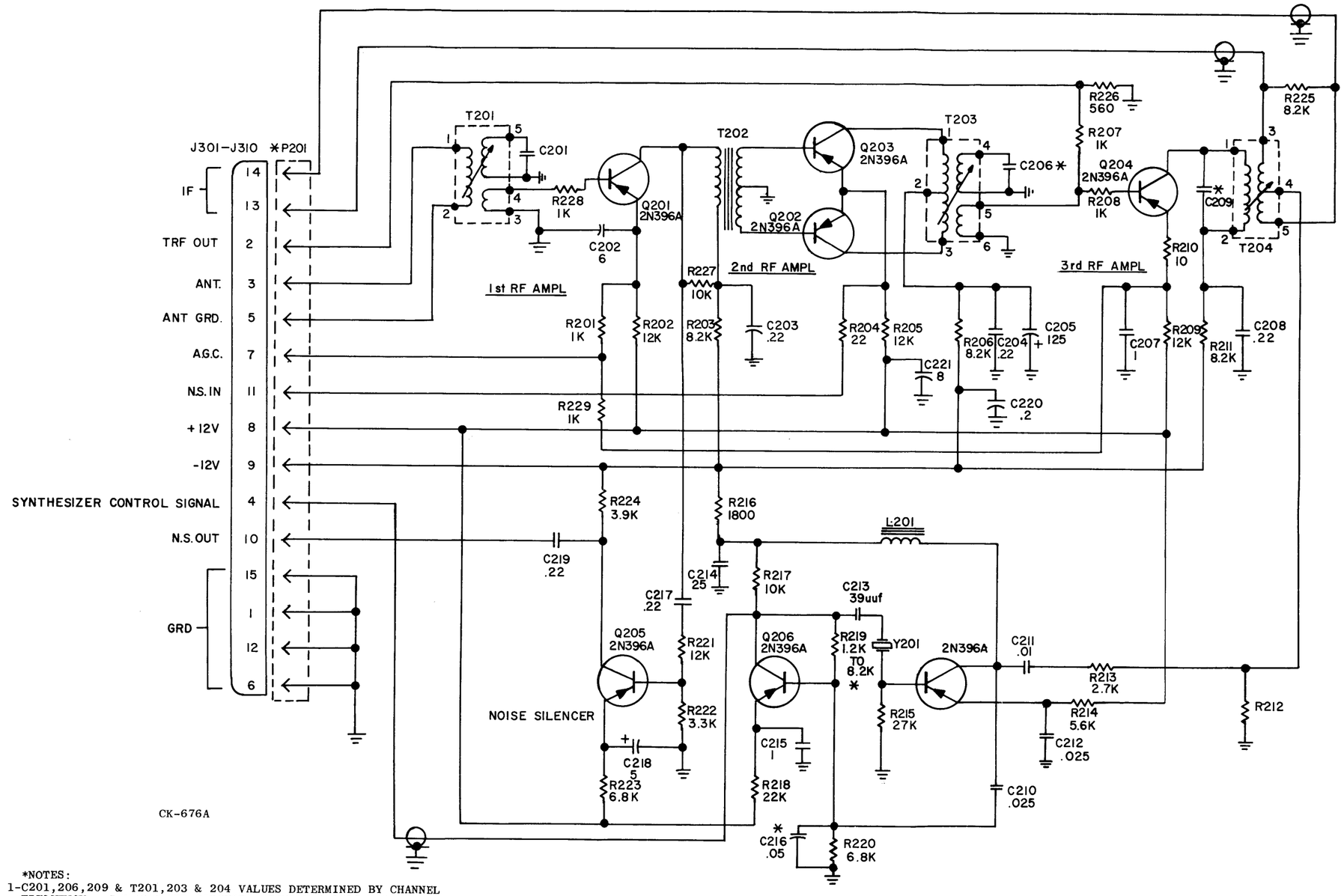


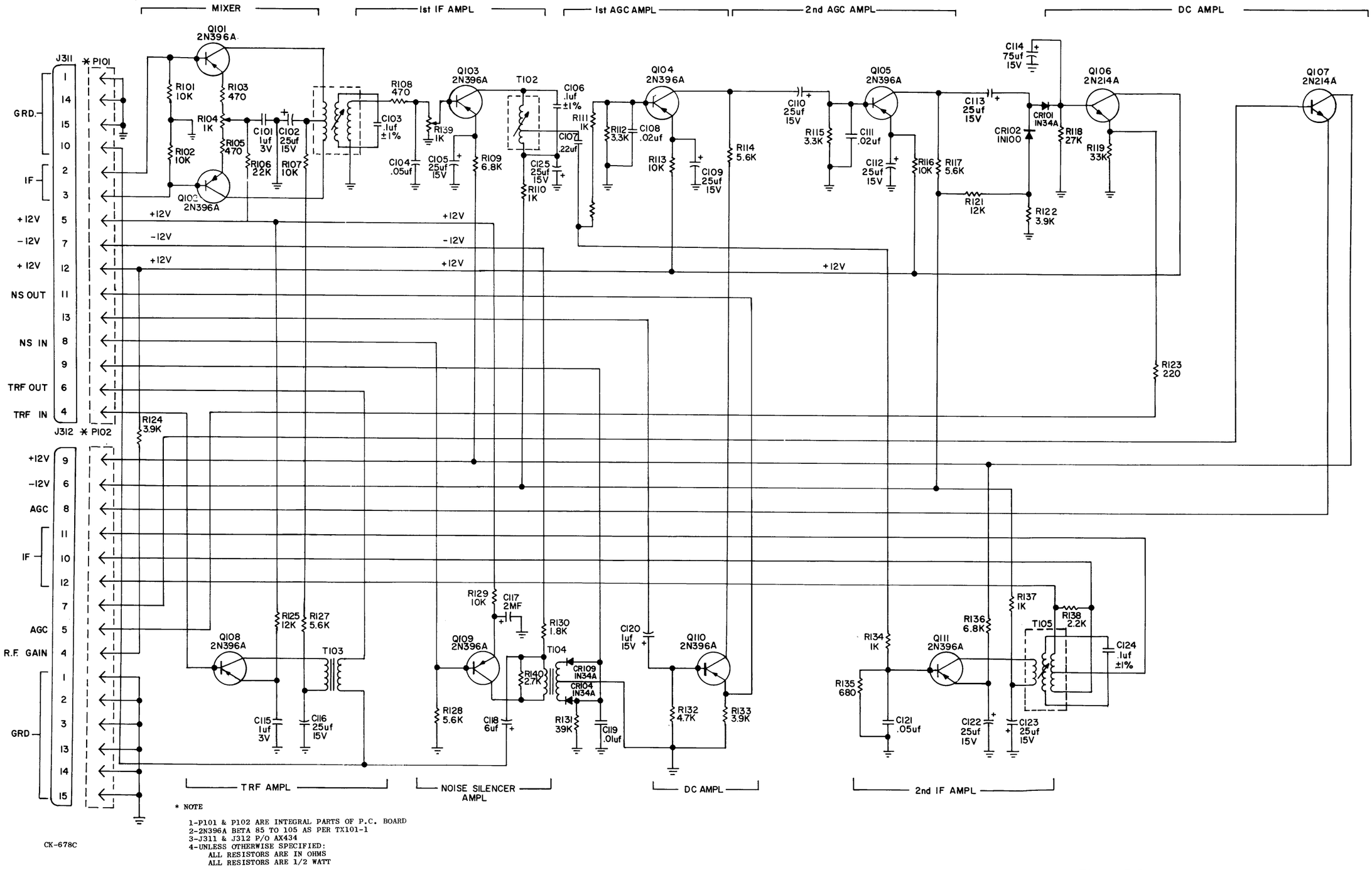
Figure 7-1. VLRA Receiver, Schematic Diagram



*NOTES:
1-C201,206,209 & T201,203 & 204 VALUES DETERMINED BY CHANNEL FREQUENCY. SEE PRINTED CIRCUIT ASSEMBLY A-3212 FOR VALUES.
2-P201 IS AN INTEGRAL PART OF PRINTED CIRCUIT BOARD.
3-C216 VALUE FROM 40KC AND UP WILL CHANGE TO .0033 MICROFARADS.
4-R219 VALUE DETERMINED BY CRYSTAL ACTIVITY.
5-2N396A BETA 85 TO 105 AS PER TX101-1

-UNLESS OTHERWISE SPECIFIED-
1-ALL CAPACITORS ARE IN MICROFARADS (uf)
2-ALL RESISTORS ARE IN OHMS (Ω).

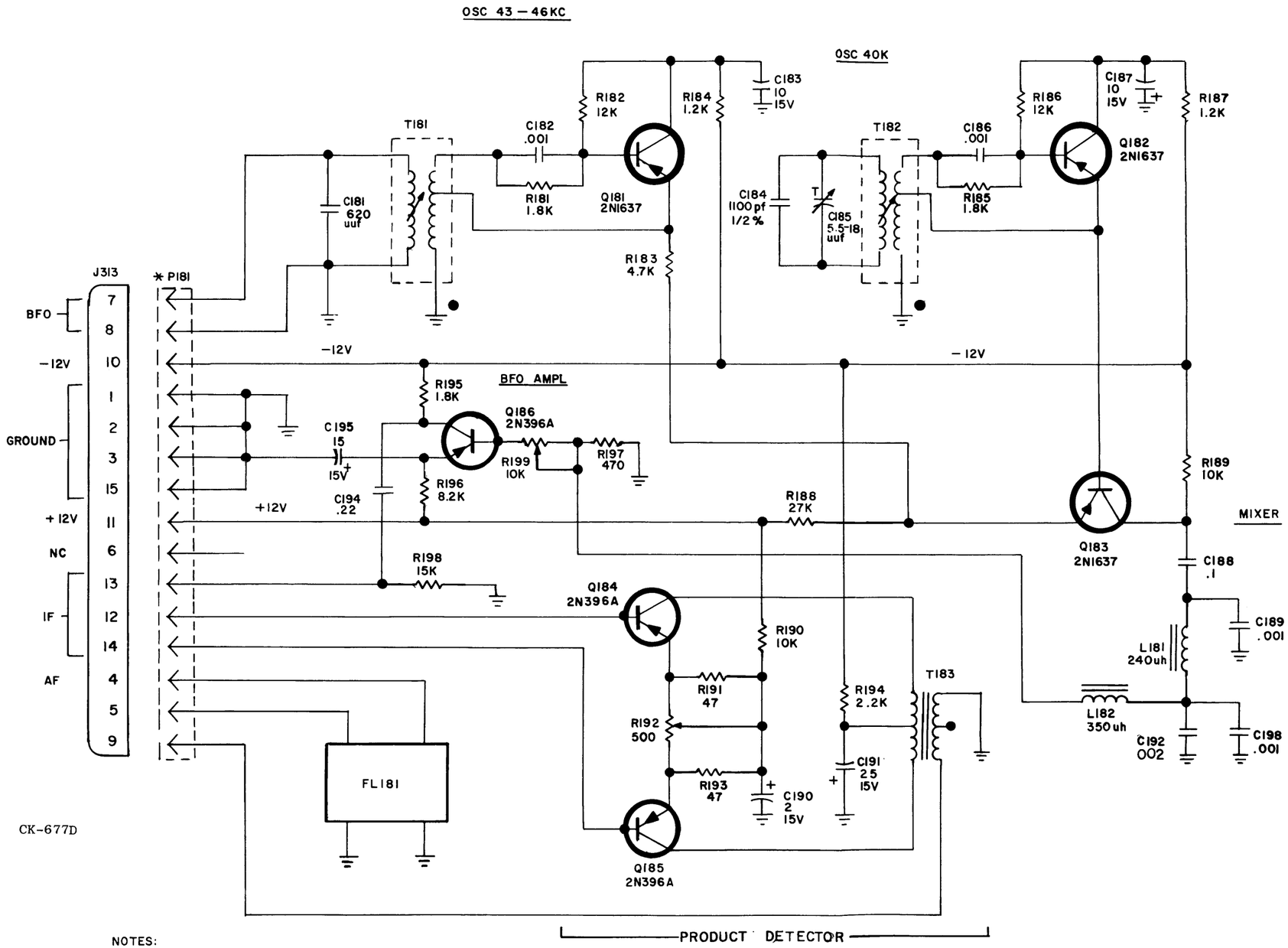
Figure 7-2. RF Module, Schematic Diagram



* NOTE

1-P101 & P102 ARE INTEGRAL PARTS OF P.C. BOARD
2-2N396A BETA 85 TO 105 AS PER TX101-1
3-J311 & J312 P/O AX434
4-UNLESS OTHERWISE SPECIFIED:
ALL RESISTORS ARE IN OHMS
ALL RESISTORS ARE 1/2 WATT

Figure 7-3. IF Module, Schematic Diagram

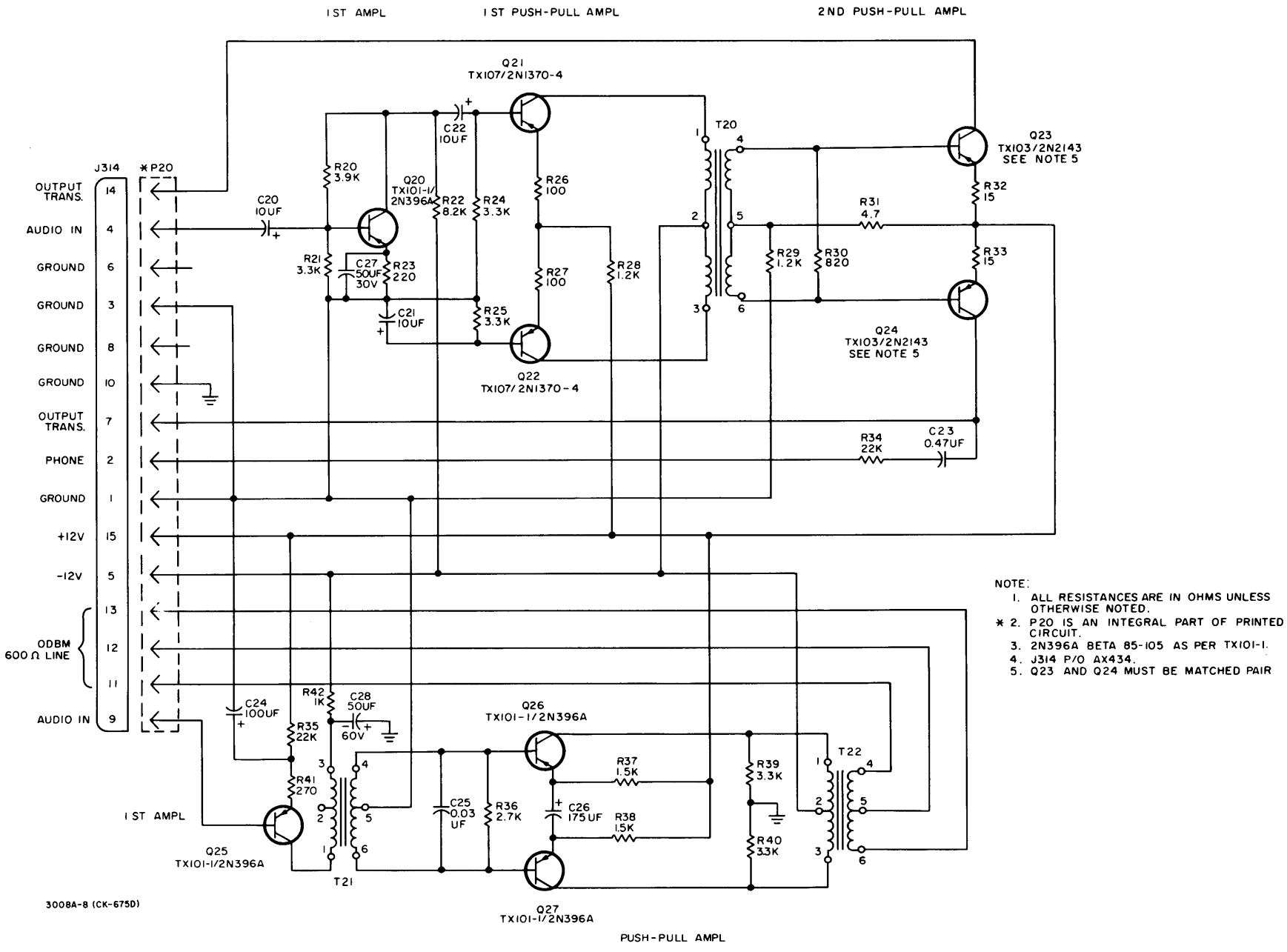


CK-677D

NOTES:

1. ALL CAPACITORS ARE IN uf UNLESS OTHERWISE NOTED:
2. ALL RESISTORS ARE IN Ω UNLESS OTHERWISE NOTED.
3. ALL RESISTORS ARE 1/2 WATT ± 10% UNLESS OTHERWISE.
* 4. P181 IS AN INTEGRAL PART OF PRINTED CIRCUIT BOARD.
5. T181 AND T182, SECONDARY WINDING MARKED WITH A BLACK DOT ( ).
6. 2N396A BETA 85-105 AS PER TX101-1.
7. J313 P/O AX434.

Figure 7-4. BFO Module, Schematic Diagram



NOTE:
1. ALL RESISTANCES ARE IN OHMS UNLESS OTHERWISE NOTED.
* 2. P20 IS AN INTEGRAL PART OF PRINTED CIRCUIT.
3. 2N396A BETA 85-105 AS PER TX101-1.
4. J314 P/O AX434.
5. Q23 AND Q24 MUST BE MATCHED PAIR

Figure 7-5. AF Module, Schematic Diagram

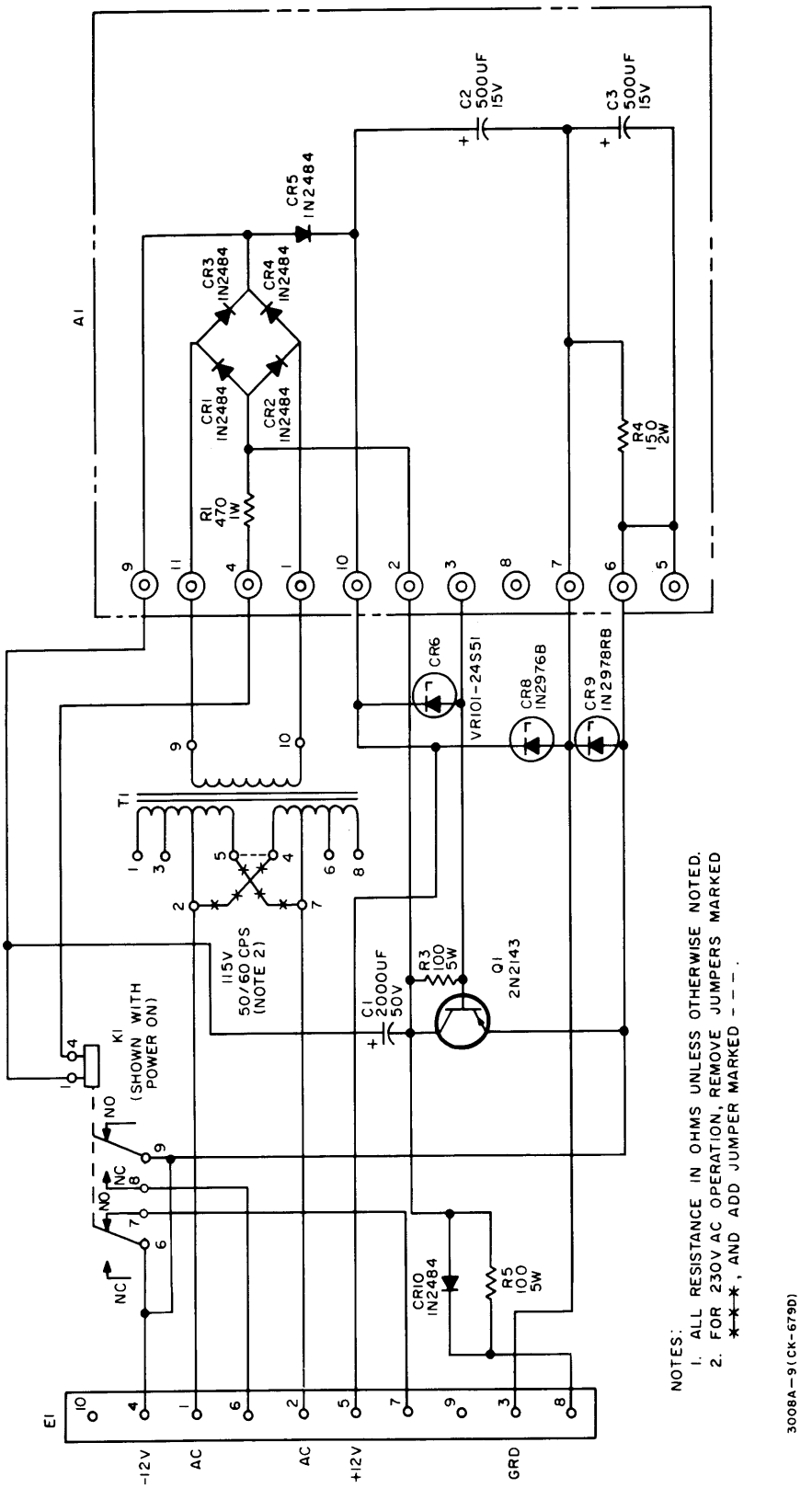


Figure 7-6. Power Supply, Schematic Diagram