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UNCLASSIFIED

TECHNICAL MANUAL

*for*

SIDEBAND EXCITER

MODEL CMRA-1



THE TECHNICAL MATERIEL CORPORATION  
MAMARONECK, N.Y.

OTTAWA, ONTARIO

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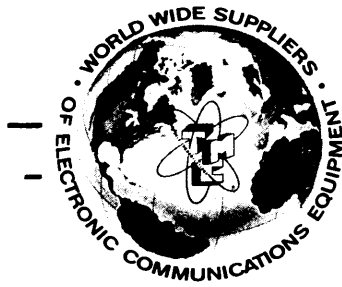
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IN-2012C

Issue Date: 1 June 1966

## NOTICE

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# THE TECHNICAL MATERIEL CORPORATION

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700 FENIMORE ROAD

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\*Electron tubes also include semi-conductor devices.

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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.

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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.

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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





SIDEBAND EXCITER CMR-4

1. INTRODUCTION

TMC Model CMR-4 Sideband Exciter includes all circuitry of Model CMRA-1 except alarm and automation circuitry, plus a keying MODE switch (S1005) to permit a choice of keying sources. Both terminal board TB1002 and relay K1002 (formerly used to trigger an external alarm and/or indicator in the presence of audio input) are now modified, rewired, and relabelled for use with the MODE switch. Alarm circuitry has been deleted in the CMR-4.

2. TB1002

Terminal board TB1002 is mounted on the lower rear panel of the CMR. TB1002 is an 18-terminal barrier-type strip; however, connections are made only to terminals 3 thru 10, inclusive. The remaining terminals are not connected. TB1002 terminal connections (via the front-panel MODE switch) are outlined in Table 1. When the CMR-4 is used with a suitable external translator (such as TMC Model CHGR-4) having external keying inputs, the external translator will key with the CMR-4, by means of an interconnecting cable between appropriate terminals of TB1002 and the translator itself.

3. K1002

Relay K1002 is mounted within the main chassis of the CMR-4, and operates in conjunction with MODE switch S1005 and Logic card Z1002. K1002 is energized via a ground supplied by the Logic card, in presence of suitable audio input to the CMR. K1002 closure causes TB1002 terminal 8 to be grounded, when MODE switch S1005 is in the VOX position. External equipment, therefore, will key with K1002 as noted in (2) above.

4. S1005

MODE switch S1005 provides the various enables and disables of, and interconnects between, the appropriate terminals of TB1002, such that proper mode switching and keying occurs in both CMR-4 and associated external equipment. Table 2 shows the various TB1002 switching functions that occur in each position of S1005. Note that Table 1 treats the interconnects in terms of individual TB1002 terminals, whereas Table 2 approaches the TB1002 terminal functions in terms of S1005 position.

Figure 1 is a simplified schematic diagram depicting MODE switch connections to TB1002, and also depicting TB1002 connections to an external frequency translator (in the case of Figure 1, TMC Model CHGR-4).





TB1002 TerminalFUNCTION

3	ground.
4	to external PTT contacts (connect to term 3 for keying).
5	internally connected to term. 6 in PTT, VOX, and NORM positions of MODE switch for external equipment keying (eg. CHG( )-4).
6	internally connected to term. 5 in PTT, VOX, and NORM positions of MODE switch; in CW position of MODE, routed thru a blocking diode to term. 9 for eventual ground thru external CW hand key.
7	internally connected to term. 8 in CW position of MODE switch; also routed thru a blocking diode to term. 9 (CW) in all modes, for eventual ground thru a CW hand key.
8	CW pos: internally connected directly to term. 7; also connected to term. 9 (CW) thru blocking diode. PTT pos: connected directly to term. 4 (PTT) via MODE switch. VOX pos: routed to arm of VOX relay K1002; grounded upon VOX actuation. NORM pos: routed directly to ground, for direct actuation of external equipment.
9	to external CW hand key (short to term. 10 for keying).
10	ground.

Table 1. TB1002 TERMINAL CONNECTIONS



<u>S1005 position</u>	<u>terminal</u>	Connected to	<u>terminal</u>	
CW	3		ground.	
	4		open.	
	5		open.	
	6		9, thru blocking diode.	
	7		9, thru blocking diode.*	
	8		7, directly; therefore, to 9, thru diode.	
	9		6, 7, as above.	
	10		ground.	
	*isolated from term. 6 by diode.			
	PTT	3		ground.
4			8, directly.	
5			6, directly.	
6			5, directly.	
7			9, thru blocking diode.	
8			4, directly.	
9			7, thru blocking diode.	
10			ground.	
VOX		3		ground.
		4		open.
	5		6, directly.	
	6		5, directly.	
	7		9, thru blocking diode.	
	8		Arm of VOX relay (gnd upon actuation).	
	9		7, thru blocking diode.	
	10		ground.	

Table 2. S1005 FUNCTIONS



Table 2. S1005 FUNCTIONS (Cont'd)

<u>TB1002</u>		
<u>S1005 position</u>	<u>terminal</u>	Connected to <u>terminal</u>
NORM	3	ground.
	4	open.
	5	6, directly.
	6	5, directly.
	7	9, thru blocking diode.
	8	ground, directly.
	9	7, thru blocking diode.
	10	ground.



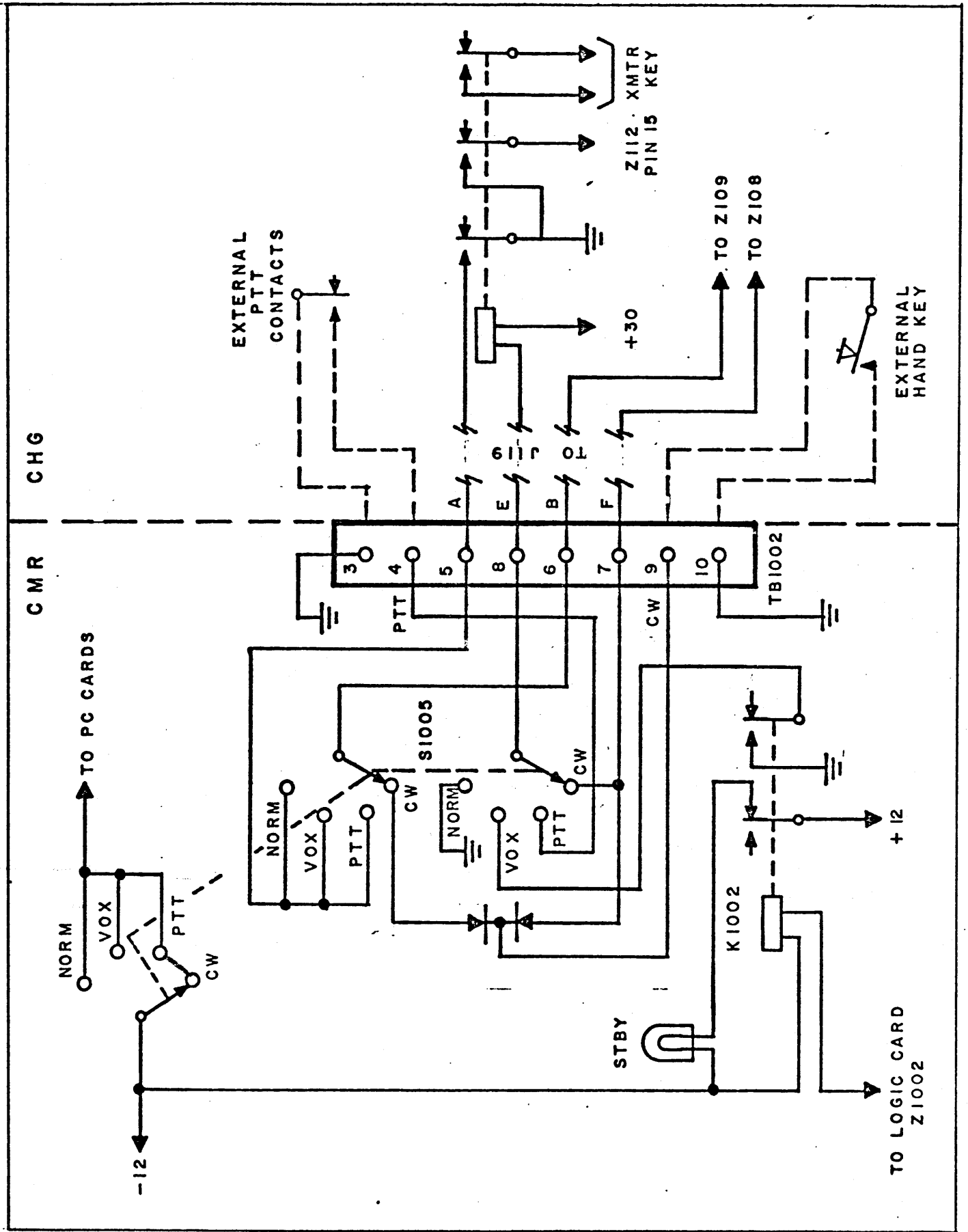


FIGURE 1 SIMPLIFIED SCHEMATIC, CMR 4 MODE SWITCH CONNECTIONS







## INSTRUCTION BOOK CHANGE NOTICE

Date 6/7/67Manual affected: Sideband Exciter, Model CMRA-1 IN -2012-C

Issue Date: 1 June 1966

1. Parts List - Change the Description of the following accordingly:

<u>REF. SYMBOL</u>	<u>DESCRIPTION</u>	<u>TMC PART #</u>
Q508	TRANSISTOR	2N3646
R537	Same as R542	RC20GF682J
S1004	Switch, Rotary: 1 section 4 position; 30° angle of throw; Silver plated brass contacts; bahelite wafer insulation.	S120

2. Schematic Diagram (CK-947C) change TRANSISTOR Q<sub>8</sub> to 2N3646.

SHOULD ADDITIONAL COPIES OF THIS CHANGE NOTICE BE REQUIRED, PLEASE CONTACT:

THE TECHNICAL MATERIEL CORP., 700 Fenimore Road, Mamaroneck, New York

Attn.: Director of Eng. Services.



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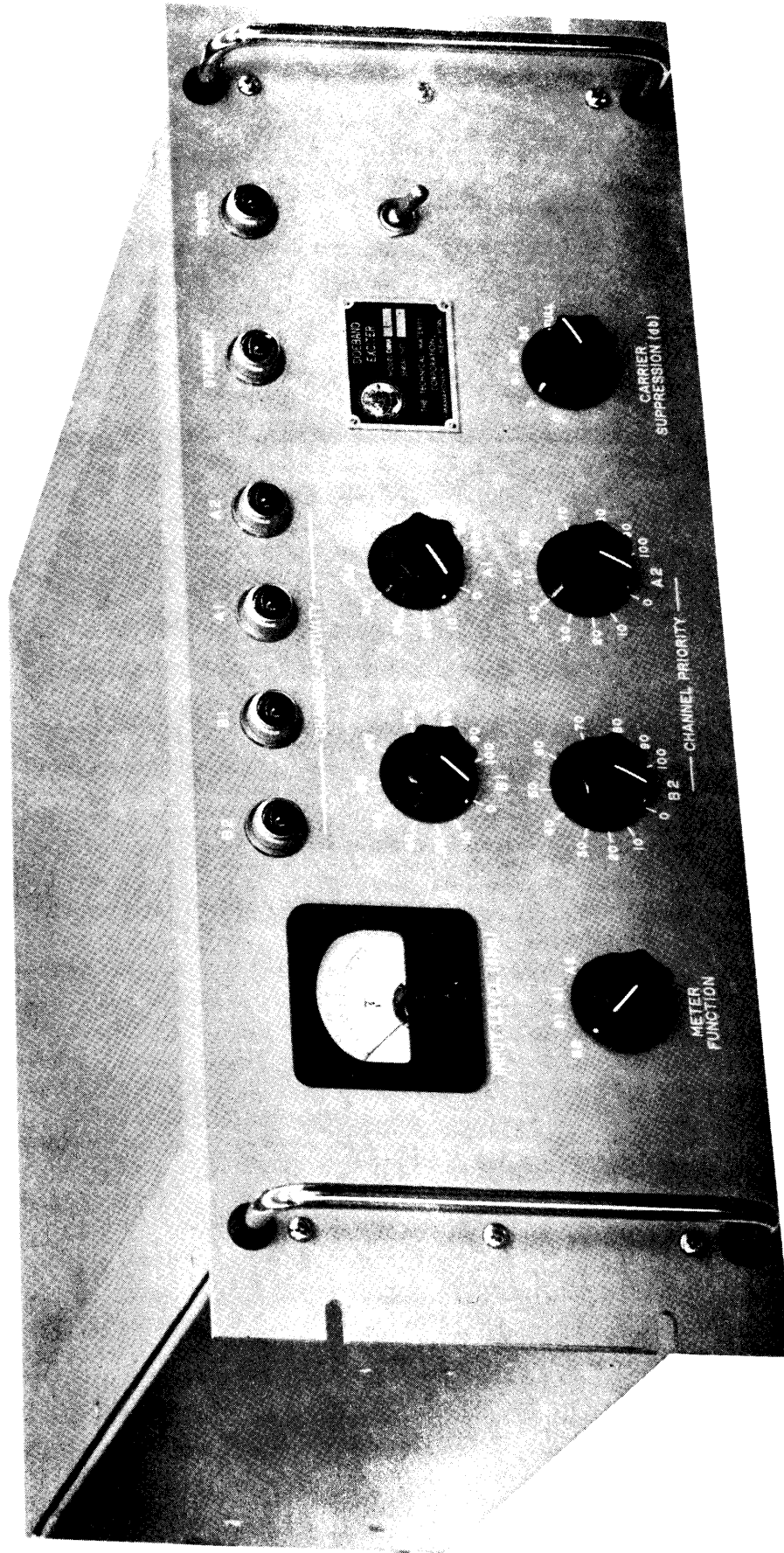
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Figure 1-1. Sideband Exciter, Model CMRA-1

657.30-2

SECTION 1  
GENERAL INFORMATION

1-1. FUNCTIONAL DESCRIPTION.

Sideband Exciter, Model CMRA-1 (figure 1-1) provides the primary stage of frequency conversion and frequency-division multiplexing in a 4-channel independent sideband transmitting system. The CMRA accepts up to four 600-ohm audio input signals; each of these signals is processed separately by independent amplification, modulation, filtering, and gain-control circuits (channels A1, A2, B1, and B2). The outputs of each of these channel circuits are then combined to yield an independent sideband output that is centered at a frequency of 1.75 mc.

The CMRA contains circuitry (similar to a receiver squelch system) to prevent the transmission of noise during the absence of an audio input signal; front-panel indicator lights associated with this circuitry are also provided. Channel power level and carrier insertion are controllable at the front panel of the unit.

The 1.75-mc carrier (used for channels A1 and B1) and the multiplexing sub-carriers (1.74371 mc and 1.75629 mc used for channels A2 and B2) are synthesized within the CMRA from a 1-mc reference signal; this 1-mc signal is supplied by an associated control synthesizer or similar equipment.

The functional relationship of the CMRA with other units of a high-frequency exciter system is shown in figure 1-2.



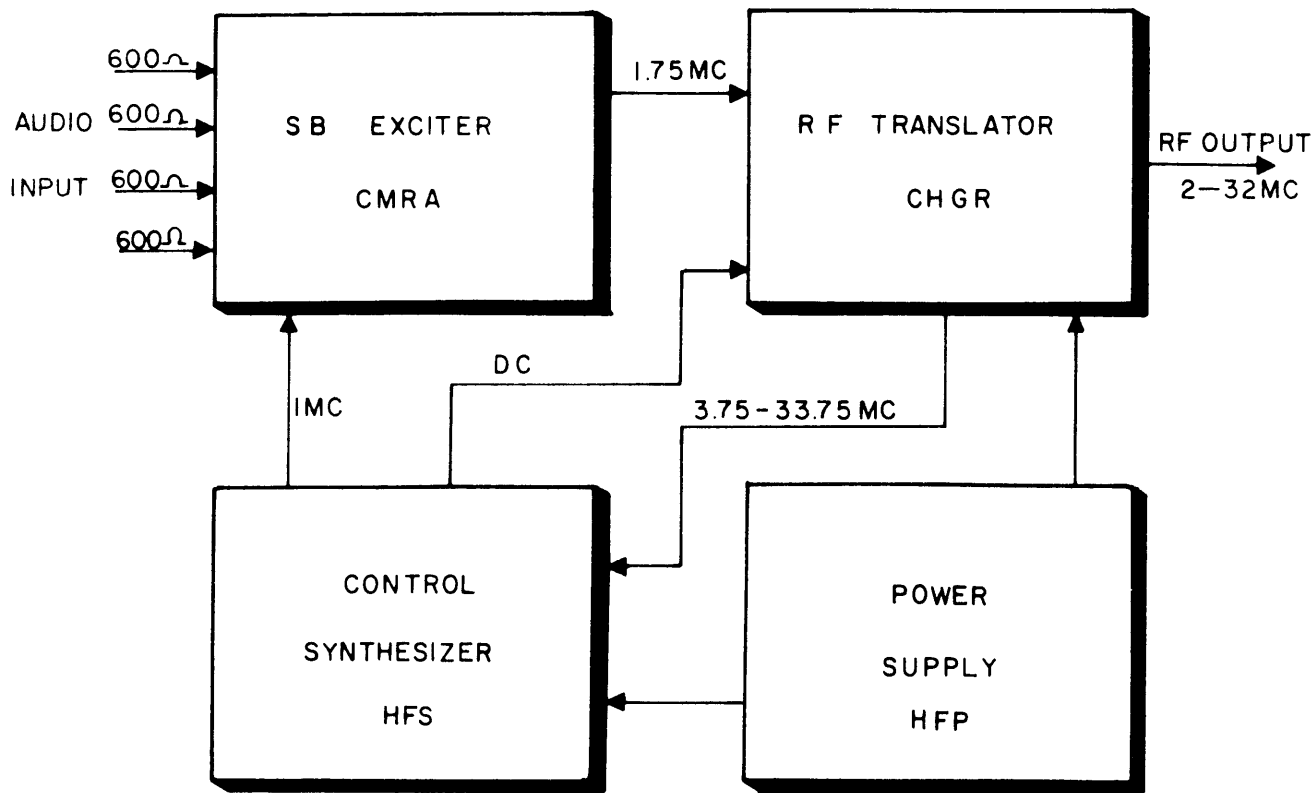


Figure 1-2. Functional Block Diagram, CMRA

### 1-2. PHYSICAL DESCRIPTION.

The CMRA is designed for installation in a standard 19-inch wide equipment cabinet. All controls and indicators necessary for operation of the unit are located on the front panel. Most of the components are mounted on printed-circuit cards; these cards are then plugged into jacks on the chassis. Tilt-lock slide mechanisms are provided with the CMRA to facilitate troubleshooting and maintenance. Removable top and bottom protective covers are provided. The CMRA is 19 inches wide, 7 inches high, 20 inches deep, and weighs approximately 28 lbs.

### 1-3. ELECTRICAL SPECIFICATIONS.

Number of Channels:	Four, designated A1, A2, B1, and B2
Channel Input Impedance:	600 ohms each, nominal
Channel Response:	350- to 3040-cps each
Input Dynamic Range:	-25 dbm to +5 dbm
Reference Input:	1-mc at 1v p-p across 50-ohms
Carrier Frequency:	1.75 mc
Displacement of Multi-plexing Sub-carriers:	6290 cps from carrier frequency
Output Level:	36 mv across 50 ohms.
Channel Priority Control:	Power allocation for each channel controllable from 5% to 100% at the front panel.
Carrier Insertion/Rejection:	Carrier power set at 0 db, -3 db, -6 db, -20 db, -30 db, or -55 db by front panel control; this function also remotely controllable.

Squelch:	Inactive channels automatically disabled to prevent transmission of noise; channel activity indicator lamps provided.
Frequency Stability:	Equal to that of reference signal input.
Metering:	Front panel meter indicates channel input level.
In-channel Distortion:	Distortion products at least 55 db below full output.
Adjacent Channel Distortion: (between channels A1 and A2, or between channels B1 and B2)	At least 50 db below full output.
Adjacent Sideband Distortion: (between Channels A1 and B1)	At least 70 db below full output.
Suppression of Multiplexing Sub-carriers:	At least 55 db below full output.
Power Requirements:	115/230 vac, single-phase, 47.5- to 63-cps.
Environment:	Operates with ambient temperature between 0°C and 50°C.

SECTION 2  
INSTALLATION

2-1. GENERAL.

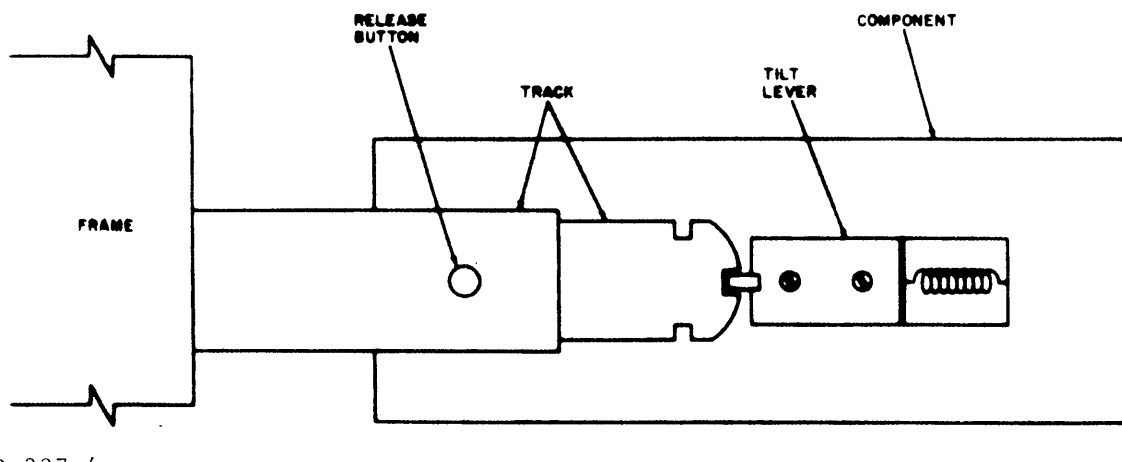
The CMRA is tested at the factory and is carefully packaged to prevent damage during shipment. When it is delivered at the operating site, inspect the packing case and its content for damage that might have occurred during transit. Unpack the equipment carefully, and inspect all packaging material for 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 furnishing of replacement parts.

2-2. MECHANICAL INSTALLATION.

The CMRA is equipped with a standard 19-inch wide front panel. Install the unit in the equipment rack as follows (refer to figure 2-1):

a. Pull out the center sections of the tracks, located in the equipment rack, until they lock in extended position.

b. Position the slide mechanisms of the CMRA in the tracks, and ease the unit into the rack until the release figures engage the holes in the tracks.



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Figure 2-1. Tilt-lock Slide Mechanism Detail.

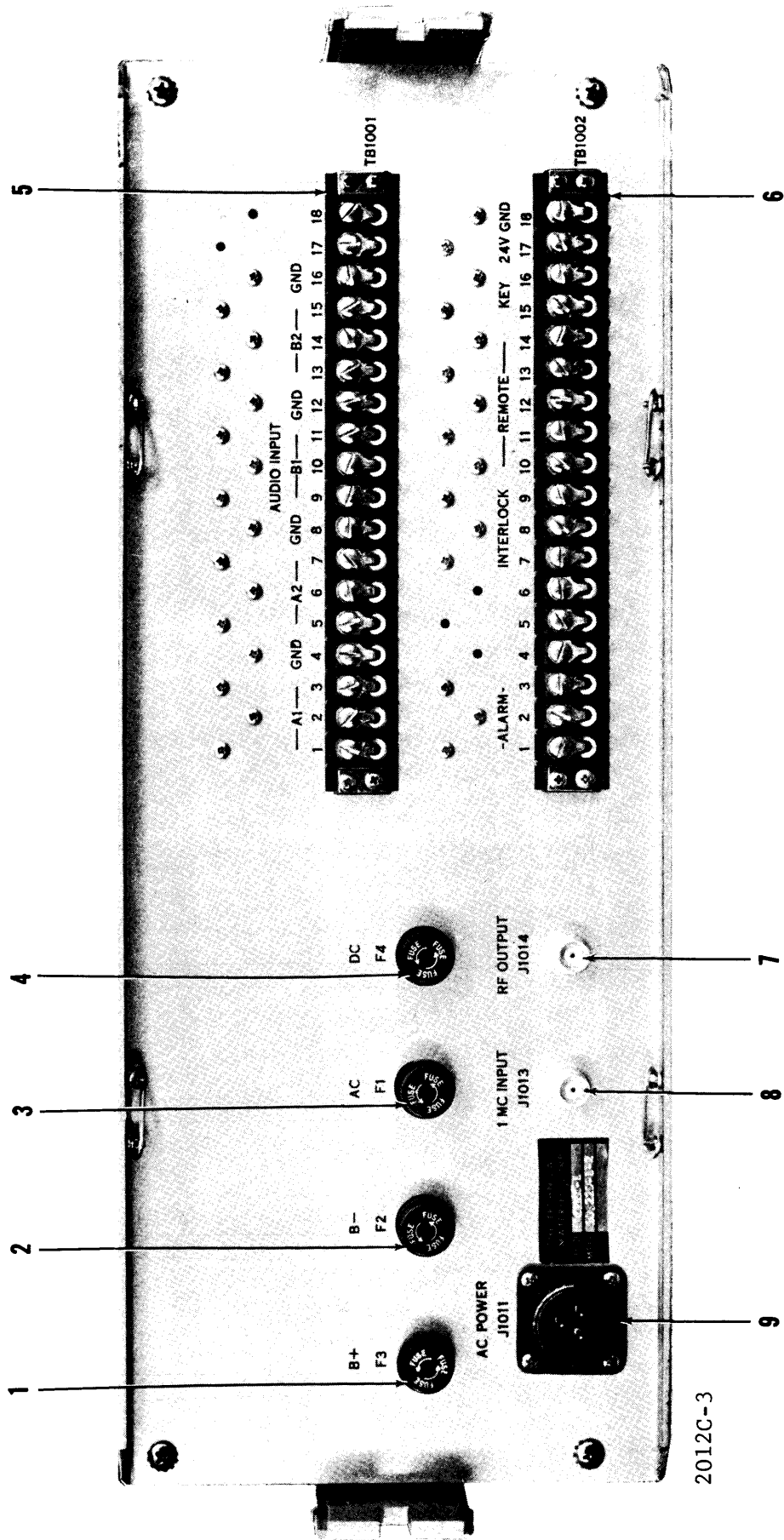


Figure 2-2. Rear Panel, CMRA

c. Depress the release fingers and slide the CMRA completely into the rack; secure front panel of the unit to the rack with screws and washers.

d. Make the necessary electrical connections, as described in paragraph 2-3.

NOTE

To prevent the cables of the unit from snagging, attach the retractors (located inside the rack) to the cables.

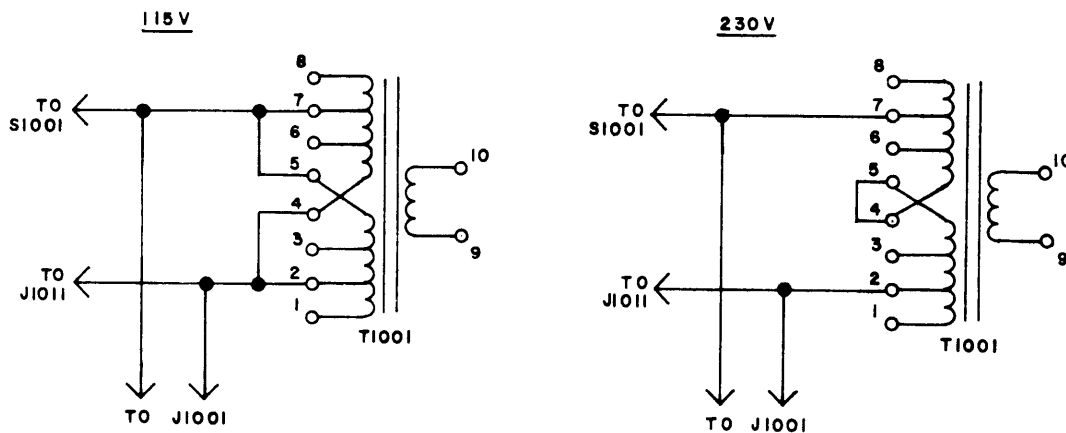
TABLE 2-1. REAR PANEL CONNECTIONS, CMRA

ITEM (See fig.2-2)	REAR PANEL DESIGNATIONS	FUNCTION
1	B+ F3 fuse	Protects external +12 volt supply.
2	B- F2 fuse	Protects external -12 volt supply.
3	AC F1 fuse	Protects internal power supply.
4	DC F4 fuse	Protects internal components.
5	TB1001 terminals	Audio input connections.
6	TB1002 terminals	Provides connection for d-c input and output control lines.
7	RF OUTPUT J1014 connector	Provides r-f output to external equipment
8	1 MC INPUT J1013 connector	Input jack from external equipment for the 1 megacycle signal.
9	AC POWER J1011 connector	3-wire a-c power jack. A and C terminals connected to the a-c line; B terminal connected to chassis ground.

2-3. ELECTRICAL INSTALLATION.

a. INTERCONNECTIONS. - Refer to the system wiring diagram provided in the system manual and make the cabling connections between the CMRA and related units, as indicated. The rear panel of the CMRA is shown in figure 2-2 (refer to table 2-1).

b. POWER SUPPLY. - Unless specified otherwise by the customer, the CMRA is shipped wired for 115 vac operation. For 230 vac operation, the wiring to transformer T1001 must be modified as indicated in figure 2-3.



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Figure 2-3. Transformer Wiring Diagram, CMRA.

SECTION 3  
OPERATOR'S SECTION

3-1. INDICATOR AND CONTROL FUNCTIONS.

The functions of the indicators (meter and lamps) and controls of the CMRA are explained in table 3-1. All indicators and controls are identified by front-panel markings, as shown in figure 3-1.

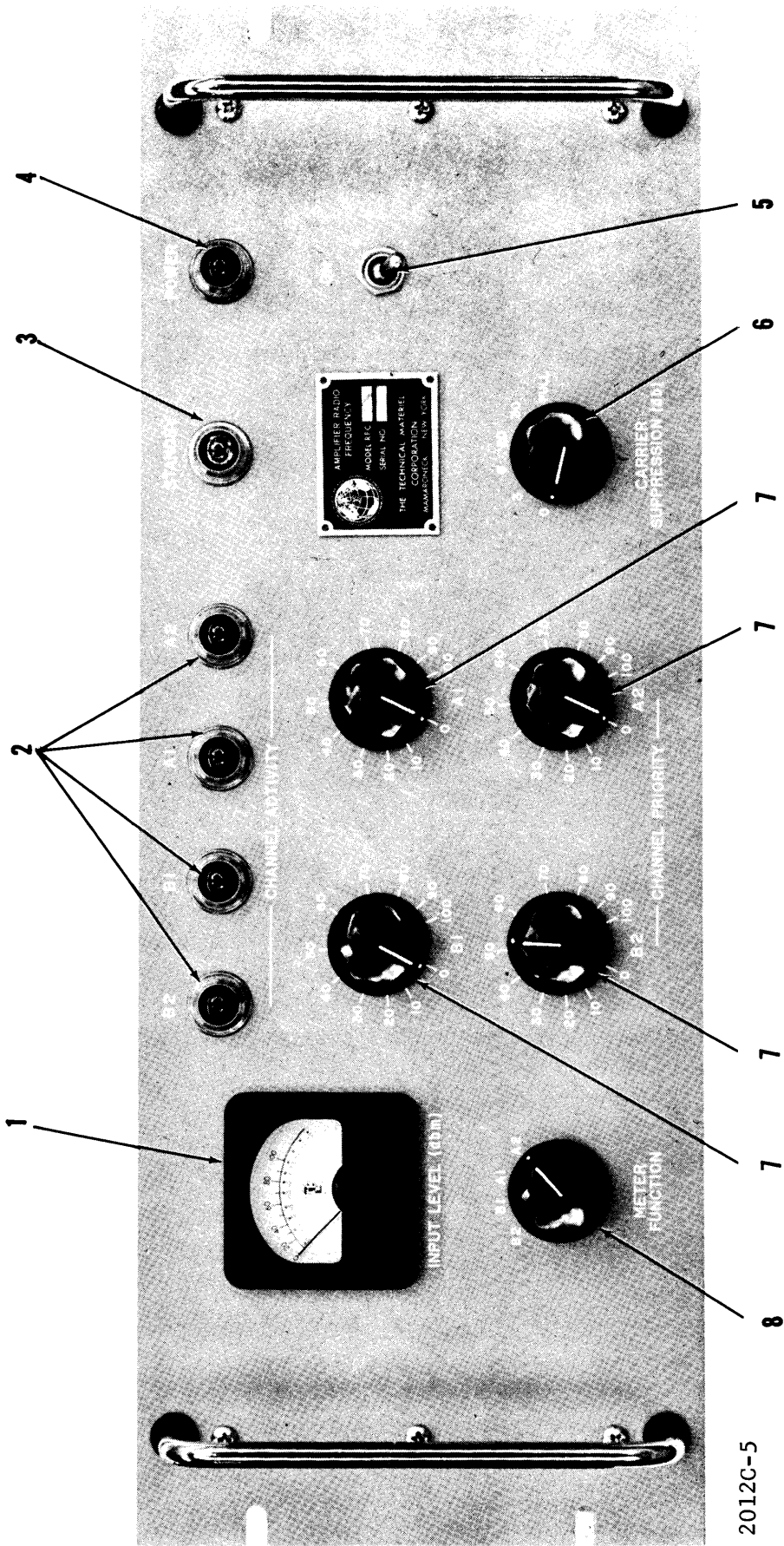
3-2. OPERATING PROCEDURES.

Operating procedures for the CMRA include setting of priority controls (A1, A2, B1, and B2) and selecting carrier suppression. Operation of these controls is dependent upon the desired mode of transmission. For detailed operating procedures of the CMRA, as to its use in the overall transmitter, refer to the applicable system operating procedures.

For remote-controlled operation, the channel priority controls should be set as indicated in table 3-2; this should be done prior to transmitter tuning. For local operation, these controls are set after completion of transmitter tuning.

The CARRIER SUPPRESSION switch should be set at positions indicated in table 3-3 for local control operation; this should be done after completion of transmitter tuning. For remote control operation, the CARRIER SUPPRESSION switch is operated automatically.





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Figure 3-1. Front Panel Controls and Indicators, CMRA

Table 3-1. OPERATING CONTROLS AND INDICATORS, CMRA

ITEM (See fig.3-1)	CONTROL or INDICATOR	FUNCTION
1	INPUT LEVEL (dbm)	Indicates power input level (to each channel) between -20 dbm and +3 dbm, as selected by METER FUNCTION switch, item 8.
2	CHANNEL ACTIVITY lamps (one for each channel)	Lights to indicate that corresponding channel is active (channel audio input level is -26dbm or higher)
3	STANDBY lamp	Lights when all channels are inactive (no audio input)
4	POWER lamp	Lights to indicate unit is in operation.
5	ON switch	When at ON position, energizes the unit.
6	CARRIER SUPPRESSION (db) switch	Reinserts carrier at indicated levels below full power output.
7	CHANNEL PRIORITY controls (one for each channel)	Controls apportionment of output power for each channel (graduated in percentages).
8	METER FUNCTION switch	Selects channel input signal for monitoring by INPUT LEVEL meter, item 1.

TABLE 3-2. CHANNEL PRIORITY CONTROL SETTINGS

MODE OF TRANSMISSION	CONTROL	SETTING
1 Channel SSB	A1 or B1	100
2 Channel ISB*	A1 and B1	50
4 Channel ISB*	A1, A2, B1, and B2	25
AME	A1 or B1	50
AM	A1 and B1	30
CW (Keyed Carrier)	A1, A2, B1, and B2	0
Tone CW, FSK, FAX*	A1 A2, B1, and B2	50 0

\* If one channel of an ISB transmission is to be used for FSK or FAX, set the priority control of the channel containing the single-tone modulation at 25 (for 2 channel ISB), or at 12.5 (for 4 channel ISB).

TABLE 3-3. CARRIER SUPPRESSION SWITCH SETTINGS

MODE OF TRANSMISSION	SETTING
CW (Keyed carrier telegraphy)	0 DB
AME	3 DB
AM	6 DB
SSB or two-channel ISB with reduced carrier	20 DB
Four channel ISB with reduced carrier	30 DB
SSB or ISB with suppressed carrier; tone CW, FSK, or FAX	FULL

SECTION 4  
PRINCIPLES OF OPERATION

4-1. GENERAL.

The sideband exciter provides four independent sideband channels centered around a 1.75 megacycles carrier frequency used in a transmitter system. The sideband exciter, which operates in conjunction with an r-f translator and a control synthesizer, consists basically of four circuits; the synthesizer, the r-f, the logic, and the power supply sections.

4-2. CIRCUIT ANALYSIS.

a. SYNTHESIZER CIRCUITRY. - The synthesizer circuit produces the 1.75 mc carrier, and the 1.75629 mc and a 1.74371 mc offset carriers. As shown in the block diagram (figure 4-1), the 1 mc signal is first divided by four by a synchronized divider and the resulting 250 kc signal is then multiplied by seven, producing the 1.750 mc signal. The 6.29 mc signal is derived by first dividing the 1 mc signal by 100 (in three steps); the resulting 10 kc signal is used to trigger the 6.29 mc multivibrator. The multivibrator produces a spectrum centered about 6.29 mc, with spectral lines spaced at 10 kc intervals. The resulting spectrum is passed through the 6.29 mc bandpass filter which passes only the 6.29 mc spectral line and rejects the others by at least 60 db.

The 6.29 mc signal is divided by 1000 (using three synchronized dividers, each dividing its incoming signal by ten) to produce the 6.29 kc signal, which is applied, with the 1.75 mc, to a balanced mixer (as shown in figure 4-1). The balanced mixer provides the following outputs: 1.75 mc,  $1.75 \text{ mc} \pm 6.29 \text{ kc}$ ,  $1.75 \text{ mc} - 6.29$  and other harmonic multiples. Appropriate bandpass filters select the 1.756290 mc and 1.743710 mc signals, which are then amplified to

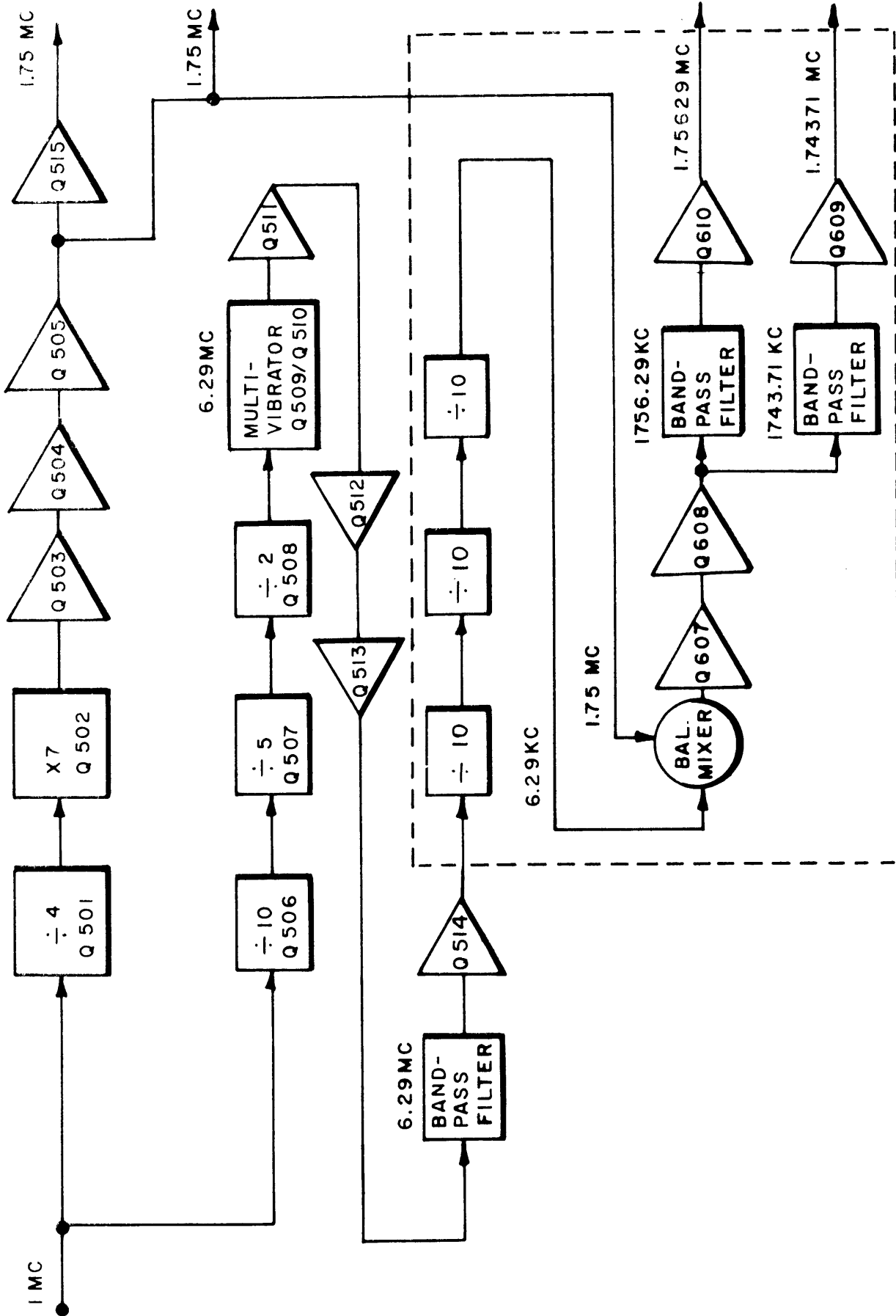


Figure 4-1. Block Diagram, Synthesizer Circuits, CMRA

required levels by the r-f section of the sideband exciter.

b. R-F CIRCUITRY. - The r-f circuitry performs the following functions:

- (1) Mixes audio and carrier signals
- (2) Provides controlled amplification of the resultant sidebands
- (3) Selects desired sideband by filtering
- (4) Provides audio level sensing for the logic circuit.

As shown in the block diagram (figure 4-2), the audio and the carrier signals are amplified before being applied to the balanced mixer. The carrier is amplified from 100 mv rms to approximately 3 v rms in order to provide the switching signal to the mixer; mixer linearity and the mixer carrier suppression will be adequate over the audio input range of -25 to +5 dbm.

The output from the balanced mixer (a double sideband signal with suppressed carrier) is fed into an automatic gain controlled IF amplifier, which has two stages, using emitter degenerative gain control. The output from the amplifier is thus kept constant within 0.3 db, with the audio input to the unit varying from -25 to +5 dbm. The first stage of the AGC amplifier employs a crystal trap tuned to the carrier frequency to insure that the carrier rejection is at least 40 db in the AGC amplifier.

The signal from the IF amplifier is applied to a gate amplifier stage, which serves two purposes:

- (1) Provides the proper impedance match to the channel filter.
- (2) Is gated on if the audio signal is above -26 dbm, and is gated off (after approximately one second) if the audio level falls below -30 dbm.

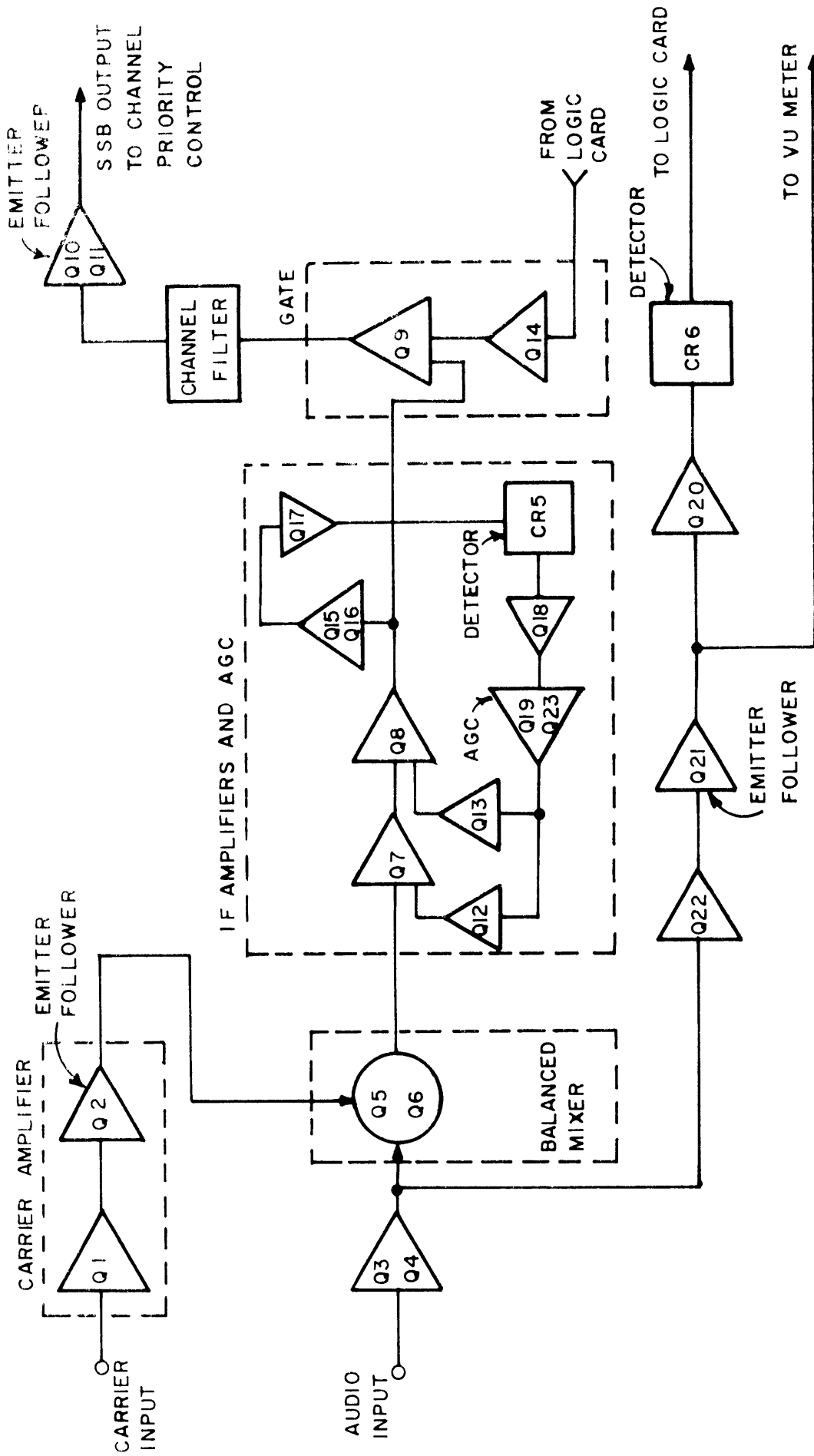


Figure 4-2. Block Diagram, R-F Circuits, CMRA

The output from the gate amplifier is fed into the channel filter, which selects the desired sideband and provides 70 db rejection to both the carrier and the unwanted sideband. The output from the channel filter is applied to a compound emitter follower which provides a low output impedance to the coaxial cable (which is routed to the priority controls).

Also included in the circuitry is an audio amplifier and detector (figure 4-2); the detector provides a d-c voltage, proportional to audio input level, that is used to control the logic circuit.

The outputs from the priority controls are fed into a summing network which combines all signals while maintaining 70 db isolation between channels (refer to figure 4-3). The output from the summing network is applied to a three-stage linear amplifier which raises the signal from approximately 6 mv to 100 mv across 50 ohms. (This output is fed directly to the r-f output jack J1014 on the rear panel of the unit.)

c. LOGIC CIRCUITRY. - Changing d-c levels from the r-f circuitry are applied to the logic circuits for control and front panel signal purposes, as follows: activation of IF gate when audio input is -26 dbm and deactivation when audio input is -30 dbm, lighting corresponding front panel lamp of activated channel, and turning on standby lamp when all channels are deactivated and turning off standby lamp when any one channel is activated. The d-c levels are set by potentiometers in the IF circuitry so that the logic circuit changes state when the audio signal goes above -26 dbm. (Refer to figure 4-4.)



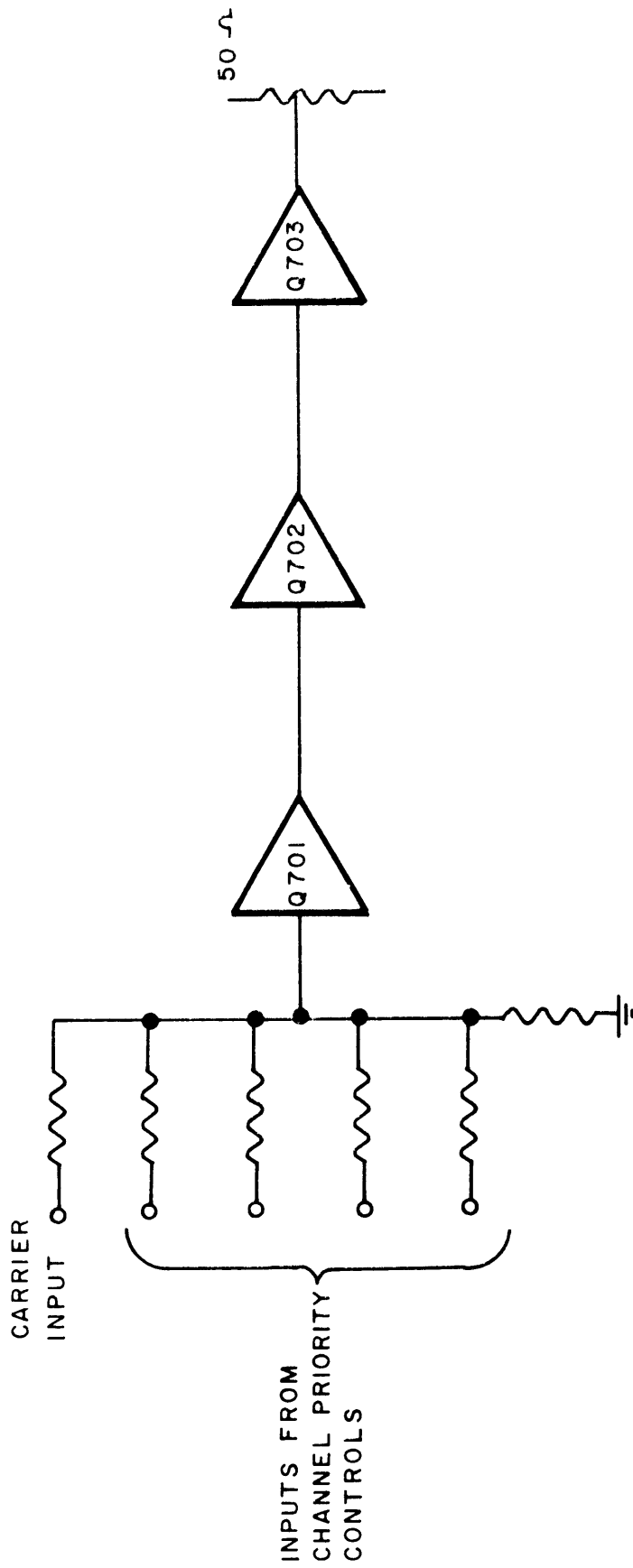


Figure 4-3. Block Diagram, Output Amplifier Circuits, CMRA

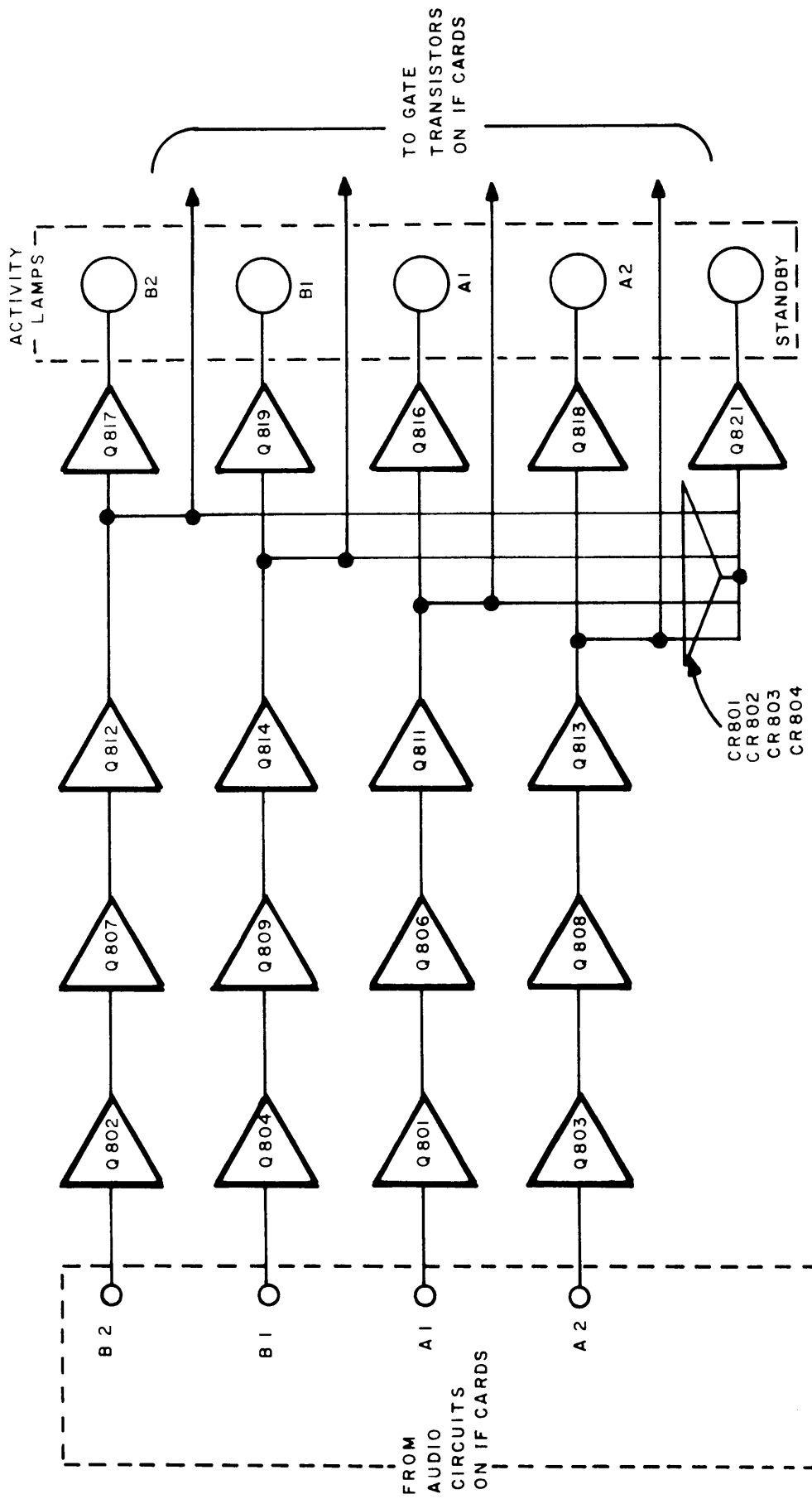


Figure 4-4. Block Diagram, Logic Circuits, CMRA

When an audio signal is present in a channel, and is above -26 dbm, the logic circuit for that channel activates a transistor stage which lights a front panel lamp and also provides the appropriate level back to the IF circuit in order to activate the gate circuit and apply an input to the NOR gate (which controls the standby lamp on the front panel). When an audio signal drops below -30 dbm, after the channel has been activated, the logic circuit again changes state to turn off the front panel lamp and the gate in the IF circuit, and removes the input to the NOR gate; the dropout has an approximate delay of one second, which is determined by the IF circuit. (Refer to the schematic diagram, Figure 7-6.)

d. POWER SUPPLY CIRCUITRY. - The power supply section of the EMRA receives a 115 volt a-c input and provides output voltages of plus and minus 12 volts d-c.

During operation, the 115 volt a-c is applied at pins A and C at jack J1011, through the protective fuse F1001, the POWER switch S1001, and terminals 2 and 7 of terminal board T1001 to the primary winding of the power transformer. The input voltage is stepped down by the secondary winding of the transformer and rectified by the bridge type rectifier circuit consisting of diodes CR1 through CR4.

Transistor Q1001, a series regulator, maintains the potential between the power supply output terminals at 24 vdc. Zener diodes CR1003 and CR1001 clamp the supply voltages at 12 v with respect to ground.

SECTION 5  
MAINTENANCE

5-1. PREVENTIVE MAINTENANCE

In order to prevent equipment failure due to dust, dirt or other destructive elements, it is suggested that a schedule of preventive maintenance be set up and adhered to.

At periodic intervals, the equipment should be removed from its mounting for cleaning and inspection. The wiring and all components should be inspected for dirt, dust, corrosion, grease or other harmful conditions. Remove dust with a soft brush or vacuum cleaner. Remove dirt or grease 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.

When a piece of equipment has been operating satisfactorily and suddenly fails, the cause of failure may be due to circumstances occurring at the time of failure, or to conditions similar to those that have occurred in the past. Therefore, the first check is to ascertain that proper equipment voltages are present and that all interconnecting wires are secure.

If these checks fail to locate the fault, the unit should be removed from the cabinet and visually checked for corrosion, dirt, or other harmful conditions.

When troubleshooting, refer to tables 5-1 and 5-2, and the schematic diagrams contained in section 7. Refer to figures 5-1 and 5-2 for the location of the printed circuit boards, associated controls, and indicators. The test equipment required for obtaining the proper waveshapes, as shown in table 5-2, is a Textronix Model 535A oscilloscope with an L-type plug-in unit and 10 megohm, 11.5 pica-farad probe.

### 5-3. REPAIR AND REPLACEMENT.

Maintenance of the CMRA will consist mainly of component replacement. It should be noted that when replacing components having many wire connections, such as switches, relays, etc., the wires should be tagged and marked for accurate identification. Use of the schematic diagrams in section 7 is advisable when replacing or disconnecting components.

TABLE 5-1. TROUBLESHOOTING CHART, CMRA

FAILURE	PROBABLE CAUSE	REMEDY
1. No output on any channel.	1. Defective transistors (Q1, Q2, Q3) on output amplifier card. 2. Defective transistors (Q1 through Q5) in the 1.75 mc chain on the synthesizer A card.	Replace defective component.
2. No output on individual channel.	1. Defective transistors of associated switching circuit on logic card. 2. Defective transistors on associated IF card.	Replace defective component.
3. No output on outboard channels (A2 and B2).	1. Transistors Q6 through Q14 on synthesizer A card. (6.29 mc chain) defective. 2. Transistors Q1 through Q10 on synthesizer B card defective.	Replace defective component.
4. No output on in-board channels.	(Covered under FAILURE #1 and #2.)	
5. Channel shut off (with high level input within tolerance).	Saturation of associated transistors.	Check associated switching circuit on logic card; replace defective transistors.
6. Channel light remains on, with no input.	Saturation of associated transistors.	Check associated switching circuit on logic card; replace defective transistor.

TABLE 5-2. CMRA TEST POINTS AND WAVESHAPES

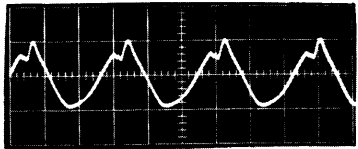
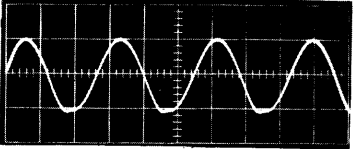
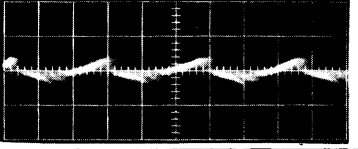
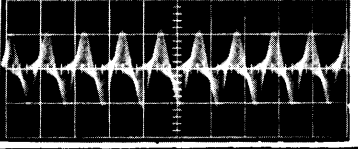
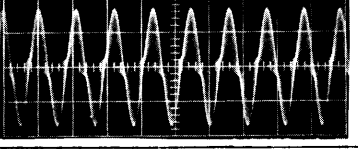
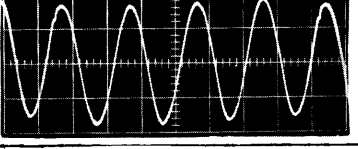
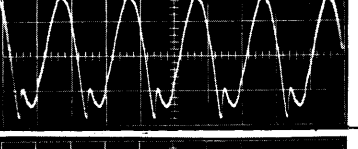
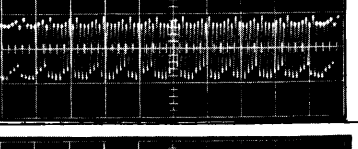
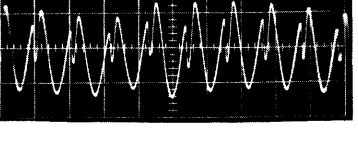
MODULE	TEST POINT	CONTROL SETTINGS	WAVESHAPE
IF Amplifier	TP1	VOLTS/CM: 0.5V TIME/CM: 0.2 us AC/DC: ACX10	
	TP2	VOLTS/CM: 5V TIME/CM: 0.2 us AC/DC: ACX10	
	TP3	VOLTS/CM: 0.5V TIME/CM: 0.2 us AC/DC: ACX10	
	TP4	VOLTS/CM: 0.2V TIME/CM: 0.5 us AC/DC: ACX10	
	TP5	VOLTS/CM: 0.1V TIME/CM: 0.5 us AC/DC: ACX10	
Synthesizer A	TP501	VOLTS/CM: 0.5V TIME/CM: 0.5 us AC/DC: ACX10	
	TP502	VOLTS/CM: 0.5V TIME/CM: 0.5 us AC/DC: ACX10	
	TP503	VOLTS/CM: 0.2V TIME/CM: 5 us AC/DC: ACX10	
	TP504	VOLTS/CM: 0.5 TIME/CM: 0.5 us AC/DC: ACX10	

TABLE 5-2. CMRA TEST POINTS AND WAVESHAPES (CONT)

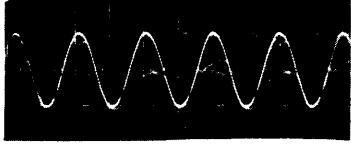
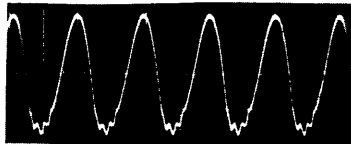
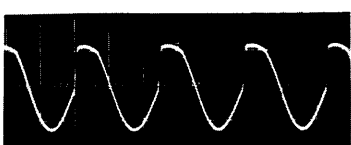
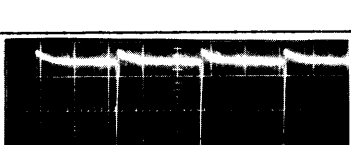
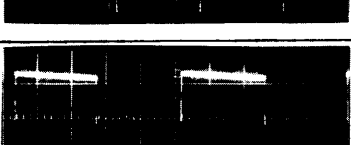
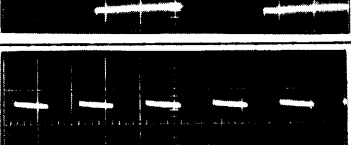
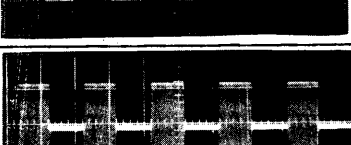
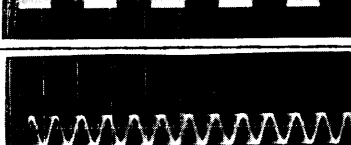
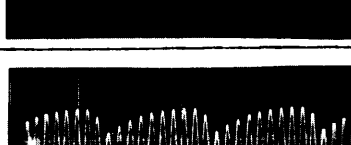
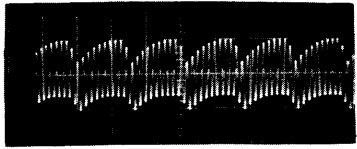
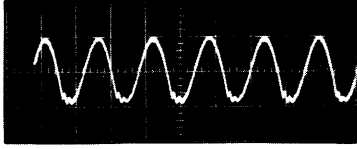
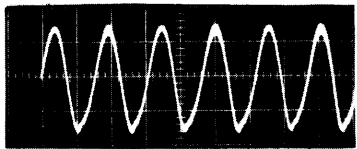
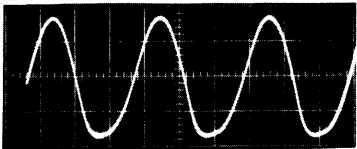
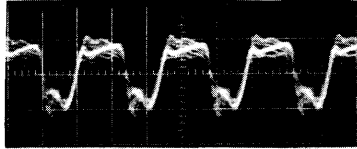
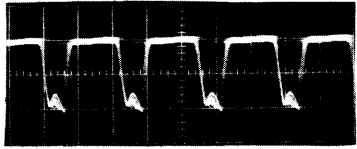
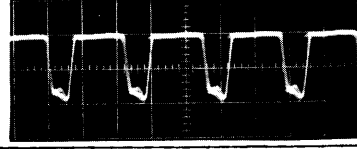
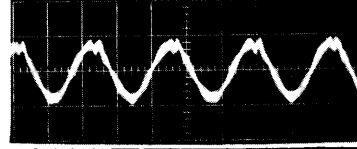
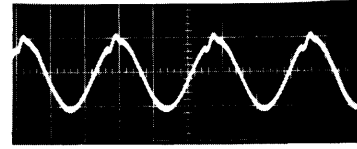
MODULE	TEST POINT	CONTROL SETTINGS	WAVESHAPE
Synthesizer A (cont)	TP506	VOLTS/CM: 0.5V TIME/CM: 0.5 us AC/DC: ACX10	
	TP507	VOLTS/CM: 0.5 TIME/CM: 5 us AC/DC: ACX10	
	TP508	VOLTS/CM: 10V TIME/CM: 20 us AC/DC: ACX10	
	TP509	VOLTS/CM: 2 V TIME/CM: 20 us AC/DC: ACX10	
	TP510	VOLTS/CM: 2V TIME/CM: 20 us AC/DC: ACX10	
	TP511	VOLTS/CM: 1V TIME/CM: 50 us AC/DC: ACX10	
	TP512	VOLTS/CM: 0.5V TIME/CM: 50 us AC/DC: ACX10	
	TP513	VOLTS/CM: 0.5V TIME/CM: 0.2 us AC/DC: ACX10	
	TP514	VOLTS/CM: 0.2V TIME/CM: 0.5 us AC/DC: ACX10	



TABLE 5-2. CMRA TEST POINTS AND WAVESHAPES (CONT)

MODULE	TEST POINT	CONTROL SETTINGS	WAVESHAPE
Synthesizer B	TP601	VOLTS/CM: 1V TIME CM: 1 us AC/DC: ACX10	
	TP602	VOLTS/CM: 1V TIME/CM: 1 us AC/DC: ACX10	
	TP603	VOLTS/CM: 0.1V TIME/CM: 10 us AC/DC: ACX10	
	TP604	VOLTS/CM: 0.5V TIME/CM: 50 us AC/DC: ACX10	
	TP605	VOLTS/CM: 1V TIME/CM: 0.2 us AC/DC: ACX10	
	TP606	VOLTS/CM: 2V TIME/CM: 0.2 us AC/DC: ACX10	
	TP607	VOLTS/CM: 2V TIME/CM: 0.2 us AC/DC: ACX10	
	TP608	VOLTS/CM: 0.2V TIME/CM: 0.2 us AC/DC: ACX10	
	TP609	VOLTS/CM: 0.2V TIME/CM: 0.2 us AC/DC: ACX10	

5-4. ALIGNMENT.

NOTE

The alignment procedure must be performed in the order given, and with all cards energized. If trouble is experienced at any step during the alignment procedure, the trouble must be located and corrected before proceeding to the next step.

CAUTION

Do not perform any alignment procedure unless all cards are in place.

The test equipment required is listed in table 5-3.

TABLE 5-3. TEST EQUIPMENT

ITEM	MANUFACTURER
1-mc reference signal source	TMC, Control Synthesizer Model HFS, or equivalent
Oscilloscope	Tektronix, Model 541A, (with type "L" preamplifier and vertical output jack) or equivalent
Frequency Counter	Hewlett Packard, Model 5245L or equivalent
Spectrum Analyzer	Singer Metrics, Model SB-12A or equivalent
Audio Signal Generator	Hewlett Packard, Model 200CD or equivalent
VTVM	Ballantine, Model 314A or equivalent
47 ohm Load Resistor	

a. SYNTHESIZER A CARD (REFER TO FIGURE 7-2).

(1) Plug the test card, with synthesizer A card mounted, into the CMRA, and place the 47-ohm load resistor on the output jack J1014. Turn CMRA power switch to ON position.

(2) Connect the frequency standard to the 1 MC input jack J1013, and apply a 1-mc 1 v p-p signal.

(3) Place oscilloscope probe on terminal point TP501, and adjust coil L501 for maximum level (approximately 2.5 v p-p).

(4) Place oscilloscope probe on TP502; apply an input to the frequency counter from the vertical output of the oscilloscope. Adjust coil L502 until a waveform is obtained as illustrated in table 5-2, with the small pip at the position shown; the frequency counter would indicate a 250,000 cps locked condition (adjust to approximate center of lock-in range).

(5) Place oscilloscope probe on TP505, and adjust transformer T501 until the frequency counter indicates a 1,750,000 cps locked condition (adjust to approximate center of lock-in range). Signal level should be approximately 200 mv p-p.

(6) Place oscilloscope probe on TP504. Signal level should be approximately 1 v p-p.

(7) Place oscilloscope probe on TP505, and tune T502 for maximum signal level (approximately 1 v p-p). Set potentiometer R564 for maximum signal. Place oscilloscope probe on pin 16 of J1010, and tune T503 for maximum signal level (approximately 1 v p-p).

(8) Place oscilloscope probe on TP507, and adjust L503 until frequency counter indicates a 100,000 cps locked condition (adjust to approximate center of lock-in range). The signal level should be approximately 3 v p-p.

(9) Place oscilloscope probe on TP508, and adjust L504 until frequency counter indicates a 20,000 cps locked condition (adjust to approximate center of lock-in range). The signal level should be approximately 24 v p-p.

(10) Place oscilloscope probe on TP510. The frequency counter should indicate 10,000 cps; the oscilloscope should display

a 5 v p-p square wave.

(11) Place oscilloscope probe on TP513, and adjust L505 for maximum level of 6.29-mc signal; readjust L505 until level is approximately 250 mv p-p.

NOTE

This circuit has a resonance curve with a gradual slope and a sharp slope. For proper operation, coil L505 must be adjusted for approximately 3 db down on the gradual slope.

(12) Ground TP602 of synthesizer B card, and place oscilloscope probe on TP514. Adjust L506 for maximum signal level (6.29 mc, and approximately 1 v p-p).

b. SYNTHESIZER B CARD (REFER TO FIGURE 7-3).

(1) Plug the test card, with synthesizer B card mounted, into the CMRA.

(2) Place oscilloscope probe on TP601. Adjust L601 until a waveform is obtained as illustrated in table 5-2; the valleys of dip 1 and dip 2 must be adjusted to the same level for proper operation.

(3) Ground TP603, and place oscilloscope probe on TP602. The frequency counter should indicate 629,000 cps locked condition (adjust L601 to approximate center of lock-in range). The signal level should be approximately 2 v p-p.

(4) Ground TP604, and place oscilloscope probe on TP603. Adjust L602 until the frequency counter indicates a 62,900 cps locked condition (adjust to approximate center of lock-in range). The signal level should be approximately 0.4 v p-p.

(5) Place oscilloscope probe on TP604, and adjust T601 until the frequency counter indicates a 6,290 cps locked condition (adjust to approximate center of lock-in range). The signal level

should be approximately 2 v p-p.

(6) Place oscilloscope probe on TP607, and adjust until a waveform is obtained as illustrated in table 5-2.

(7) Place oscilloscope probe on TP608, and adjust T603 for maximum signal level (approximately 250 mv p-p). The signal frequency should be locked at 1743.710 kc.

(8) Place oscilloscope probe on TP609, and adjust T604 for maximum signal level (approximately 250 mv p-p). The signal frequency should be locked at 1756.290 kc.

c. IF CARD (REFER TO FIGURE 7-4).

(1) Mount channel A1 IF card to the test card, and plug test card into the CMRA.

(2) Place oscilloscope probe on TP1; signal level should be approximately 30 mv p-p.

(3) Place oscilloscope probe on TP2, and adjust T1 for maximum (approximately 8 v p-p) signal level.

(4) Adjust potentiometer R47 (AGC) to full clockwise position.

(5) Apply a 50 mv audio signal at 2000 cps from the audio generator to the channel A1 audio input terminals (16, 17, 18) at the rear panel of the CMRA.

(6) Place oscilloscope probe on TP4 and adjust T4, T5, and T6 for maximum output level.

(7) Tune T7 for minimum inductance (slug at minimum engagement with coil). Adjust R47 for +4.0 vdc level; adjust T7 for maximum (approximately 6 vdc) indication on VTVM.

(8) Connect input of spectrum analyzer to TP4, and adjust analyzer for a 14-kc sweep width centered about the carrier frequency, and with 60 db of dynamic range available.

(9) Alternately, adjust potentiometers R13 and R15 for maximum carrier suppression. Adjust T4 for maximum carrier suppression; adjust variable capacitor C18 for maximum carrier suppression. Alternately, repeat the above adjustments until carrier suppression is at a maximum ( $40 \text{ db} \pm 10 \text{ db}$ ).

(10) Connect spectrum analyzer to TP 4, and adjust audio input level from 78 mv to 1370 mv. If carrier suppression does not remain  $40 \text{ db} \pm 10 \text{ db}$ , repeat adjustment performed in step c9 above.

NOTE

All intermodulation and distortion products should be at least 55 db below the double sideband signal. (Carriers of the other channels may be observed at this test stage, but will be eliminated by the sideband filter.)

(11) Set the audio input frequency to 1500 cps and minimum output level, then slowly bring the input level to 38 mv. Adjust potentiometer R58 so that the channel activity lamp comes on when the audio signal level reaches 38 mv. Increase the audio signal level to 1 volt. Channel activity lamp should remain on. Decrease the audio signal level to 24 mv; the channel activity lamp should go out after approximately one second.

(12) While monitoring the output signal with the VTVM, use a standard two-tone generator (TTG) and apply a 935 cps and a 2805 cps signal to the audio input terminals. Connect the spectrum analyzer to TP5, and vary the total audio level from 44 mv to 1370 mv. All distortion and intermodulation products displayed on the analyzer should be at least 55 db below the level of the two signal tones.

(13) Repeat the procedure outlined in c. IF CARD for each of the other channel cards, changing the input signals and the IF cards accordingly.

d. OUTPUT AMPLIFIER (REFER TO FIGURE 7-5).

(1) Mount output amplifier card to the test card, plug test card into the CMRA, and place the 47-ohm load resistor on the output jack J1014.

(2) Place VTVM probe on TP12. Apply a 1000 cps audio input signal to all channels at a level of 780 mv.

(3) Set front panel control A2 fully clockwise and controls A1, B1, and B2 fully counterclockwise.

(4) Peak T1, T2, and T3, alternately, until maximum output is obtained (approximately 70 mv rms).

NOTE

Potentiometer R47 on IF card for channel A2 may require a slight adjustment for a 70 mv output.

(5) Set front panel control A1 fully clockwise and controls A2, B1, and B2 fully counterclockwise.

(6) Make necessary adjustment on potentiometer R47 on channel A1 IF card for 70 mv output.

(7) Set front panel control B1 fully clockwise and controls B2, A1, and A2 fully counterclockwise.

(8) Make necessary adjustment on potentiometer R47 on channel B1 IF card for 70 mv output.

(9) Set front panel B2 control fully clockwise set A1, A2 and B1 controls fully counterclockwise.

(10) Make necessary adjustment on potentiometer R47 on channel B2 IF card for 70 mv output.

NOTE

Before proceeding to next step set all channel controls fully counterclockwise.

(11) Connect spectrum analyzer to TP12; set front panel CARRIER SUPPRESSION switch to 0 db position.

(12) Adjust potentiometer R64 until the carrier is at 36 mv output.

(13) Use analyzer to check outputs at other switch position settings.

(14) When CARRIER SUPPRESSION switch is set to full, carrier should not appear.

(15) Set TEST NORMAL switch of CMRA to NORMAL position. Carrier should reappear.





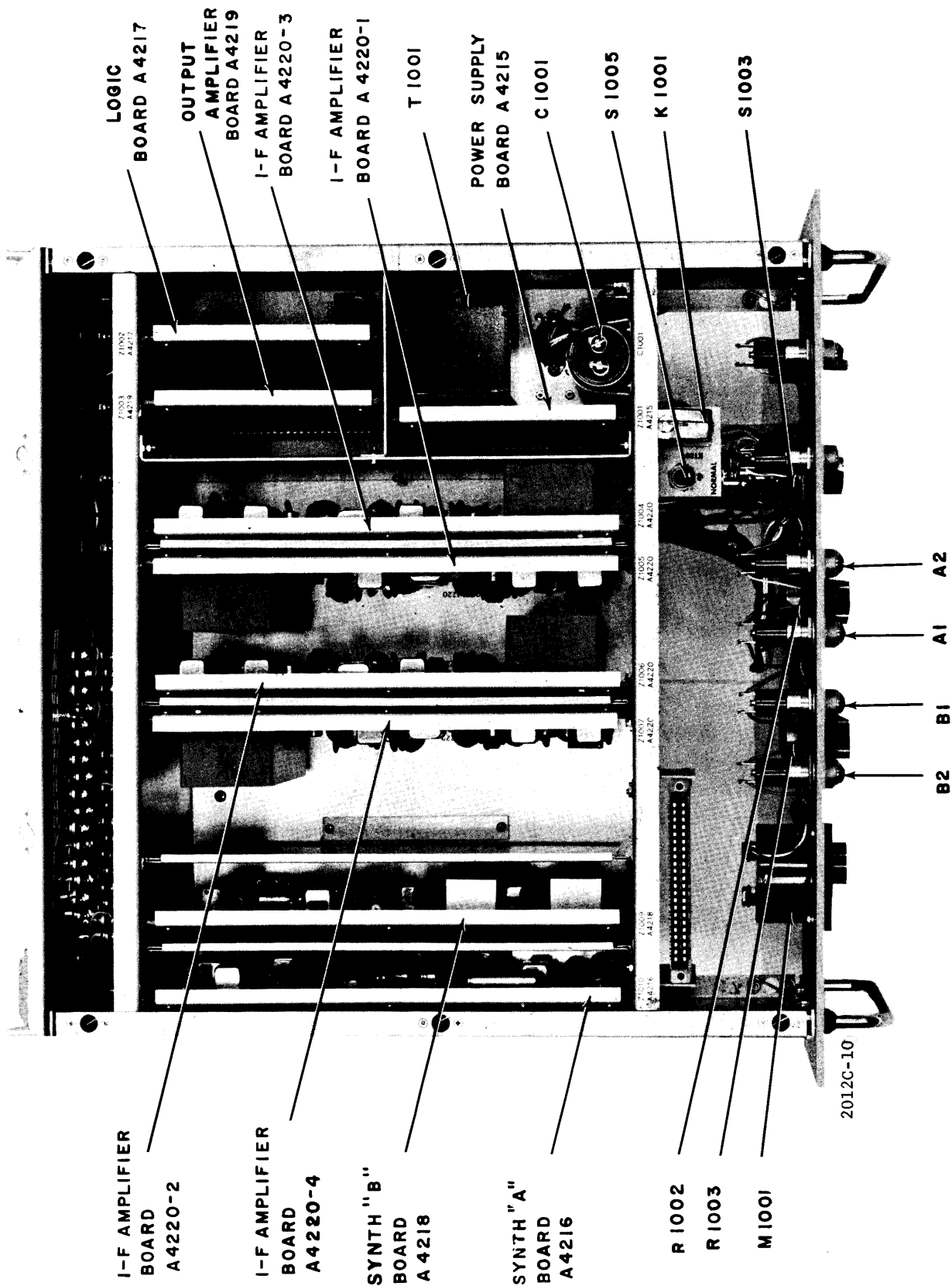


Figure 5-1. Top View (Cover Removed), CMRA







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 10544

<u>Assembly or Sub-assembly</u>	<u>Page</u>
IF Amplifier (Symbol Series 10) . . . . .	6-2
Synth A Module (Symbol Series 500) . . . . .	6-11
Synth E Module (Symbol Series 300) . . . . .	6-20
Output Amplifier Module (Symbol Series 700) . . . . .	6-26
Logic Module (Symbol Series 800) . . . . .	6-29
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IF AMPLIFIER

A4220

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C1	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 100,000 uuf, +80% -20%; 100 WVDC.	CC100-28
C2 thru C6	Same as C1.	
C7	CAPACITOR, FIXED, MICA DIELECTRIC: 150 uuf, +5%; 500 WVDC; straight wire leads.	CM111F151J-5S
C8 thru C10	Same as C1.	
C11	CAPACITORS, FIXED, CERAMIC DIELECTRIC: 1000 uuf, GMV; 500 WVDC.	CC100-29
C12	Same as C11.	
C13	CAPACITOR, FIXED, MICA DIELECTRIC: 47 uuf, +5%; 500 WVDC; straight wire leads.	CM111E470J-5S
C14	Same as C7.	
C15	Same as C13.	
C16	Same as C1.	
C17	Same as C7.	
C18	CAPACITOR, VARIABLE, CERAMIC DIELECTRIC: miniature disc type; 5.5 - 18 uuf; 200 WVDC; operating temperature range -55°C to +125°C; silver plated terminals; steatite ceramic base.	CV112-1
C19	Same as C1.	
C20	Same as C7.	
C21 thru C28	Same as C1.	
C29	CAPACITOR, FIXED, ELECTROLYTIC: tantilum; 25 uf, 50 WVDC; -15% - +50%; polarized; tubular case.	CE107-6
C30	Same as C1.	

IF AMPLIFIER (cont)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C31	CAPACITOR, FIXED, ELECTROLYTIC: polarized: 5 uf, -10% +150% at 120 cps at 25°C; 25 WVDC insulated tubular case.	CE105-5-25
C32 thru C35	Same as C1.	
C36	CAPACITOR, FIXED, ELECTROLYTIC: polarized: 20 uf, -10% +150% at 120 cps at 25°C; 15 WVDC; insulated tubular case.	CE105-20-15
C37 thru C39	Same as C31.	
C40	NOT USED	
C41	Same as C31.	
C42	Same as C31.	
C43	Same as C1.	
C44	Same as C1.	
C45	Same as C7.	
C46	Same as C11.	
C47	Same as C1.	
C48	Same as C11;	
CR1	SEMICONDUCTOR DEVICE, DIODE: Zener; nominal voltage 10 volts; power dissipation .40 watts at 25°C; max. current rating 13 ma; max. operating temperature 175°C; hermetically sealed.	1N961B
CR2	Same as CR1.	
CR3	SEMICONDUCTOR DEVICE, DIODE: silicon; Zener voltage 7.5 volts at 10 ma; average forward current 230 ma at 25°C or 85 ma at 150°C; power dissipation 400 mw at 25°C or 100 mw at 150°C; operating temperature range -65°C to 175°C; hermetically sealed.	1N754



IF AMPLIFIER (cont)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
CR4	Same as CR3.	
CR5	SEMICONDUCTOR DEVICE, DIODE: reverse working voltage 100 VDC; forward current 4 mh at 25°C at 1.5 volts; reverse current 1 ma at 75 volts; power dissipation 200 mw; operating temperature range -80°C to +150°C; hermetically sealed.	1N627
CR6	Same as CR5.	
CR7	Same as CR1.	
CR8/CR9	Same as CR5.	
CR10	Same as CR5.	
Q1	TRANSISTOR: NPN diffused silicon; collector to base voltage 25 volts; collector to emitter voltage 20 volts; emitter to base voltage 3 volts; collector current 200 ma; power dissipation 1 watt at 25°C; junction temperature range -65°C to +175°C; metal case.	2N706
Q2 thru Q4	Same as Q1.	
*Q5	TRANSISTOR: NPN diffused silicon.	TX102
Q6	Same as Q5.	
Q7	TRANSISTOR: germanium; emitter to base voltage 0.5 volts; collector to base voltage 40 volts; power dissipation 120 mw; junction temperature 100°C; metal case.	2N1225
Q8	Same as Q7.	
Q9	Same as Q7.	
Q10	Same as Q1.	
Q11	Same as Q1.	

\*Q5 is supplied as a matched pair, and should only be replaced as a matched pair.

IF AMPLIFIER (cont)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
Q12	TRANSISTOR: PNP silicon; collector to base voltage 15 volts; collector current 0.1 ma; storage temperature 140°C; metal case.	2N863
Q13	Same as Q12.	
Q14	Same as Q12.	
Q15	Same as Q1.	
Q16	Same as Q1.	
Q17	Same as Q7.	
Q18	Same as Q12.	
Q19	Same as Q12.	
Q20 thru Q22	Same as Q1.	
Q23	Same as Q12.	
R1	RESISTOR, FIXED, COMPOSITION: 39 ohms, $\pm 5\%$ 1/2 watt.	RC20GF390J
R2	Same as R1.	
R3	RESISTOR, FIXED, COMPOSITION: 47 ohms, $\pm 5\%$ 1/2 watt.	RC20GF470J
R4	RESISTOR, FIXED, COMPOSITION: 1,000 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF102J
R5	RESISTOR, FIXED, COMPOSITION: 150 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF151J
R6	RESISTOR, FIXED, COMPOSITION: 5,600 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF562J
R7	NOT USED.	
R8	RESISTOR, FIXED, COMPOSITION: 100 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF101J

IF AMPLIFIER (cont)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R9	RESISTOR, FIXED, COMPOSITION: 470 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF471J
R10	Same as R9.	
R11	RESISTOR, FIXED, COMPOSITION: 220 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF221J
R12	Same as R11.	
R13	RESISTOR, VARIABLE, COMPOSITION: 100 ohms, $\pm 10\%$ ; nom. power rating 0.25 watt at 70°C; linear taper.	RV111U101A
R14	RESISTOR, FIXED, COMPOSITION: 10,000 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF103J
R15	RESISTOR, VARIABLE, COMPOSITION: 5,000 ohms, $\pm 10\%$ ; nom. power rating 0.25 watt at 70°C; linear taper.	RV111U502A
R16 thru R18	Same as R14.	
R19	Same as R9.	
R20	RESISTOR, FIXED, COMPOSITION: 12,000 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF123J
R21	Same as R20.	
R22	RESISTOR, FIXED, COMPOSITION: 330 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF331J
R23	Same as R22.	
R24	NOT USED.	
R25	RESISTOR, FIXED, COMPOSITION: 2,700 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF272J
R26	Same as R4.	
R27	RESISTOR, FIXED, COMPOSITION: 22 ohms, $\pm 5\%$ 1/2 watt.	RC20GF220J
R28	Same as R22	

IF AMPLIFIER (cont)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R29	Same as R4.	
R30	Same as R27.	
R31	RESISTOR, FIXED, COMPOSITION: 3,300 ohms. +5%; 1/2 watt.	RC20GF332J
R32	Same as R31.	
R33	RESISTOR, FIXED, COMPOSITION: 270 ohms. +5%; 1/2 watt.	RC20GF271J
R34	Same as R14.	
R35	Same as R33.	
R36	Same as R14.	
R37	Same as R22.	
R38	Same as R4.	
R39	RESISTOR, FIXED, COMPOSITION: 470 ohms, +5%; 1/2 watt.	RC20GF471J
R40	Same as R8.	
R41	Same as R31.	
R42	Same as R39.	
R43	Same as R4.	
R44	RESISTOR, FIXED, COMPOSITION: 2,200 ohms. +5%; 1/2 watt.	RC20GF222J
R45	Same as R8.	
R46	Same as R44.	
R47	Same as R15.	
R48	Same as R4.	
R49	RESISTOR, FIXED, COMPOSITION: 6,800 ohms, +5%; 1/2 watt.	RC20GF682J

IF AMPLIFIER (cont)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R50	Same as R3.	
R51	RESISTOR, FIXED, COMPOSITION: 4,700 ohms, +5%; 1/2 watt.	RC20GF472J
R52	Same as R8.	
R53	Same as R49.	
R54	RESISTOR, FIXED, COMPOSITION: 150,000 ohms, +5%; 1/2 watt.	RC20GF154J
R55	RESISTOR, Fixed, COMPOSITION: 47,000 ohms, +5%; 1/2 watt.	RC20GF473J
R56	NOT USED	
R57	Same as R14.	
R58	RESISTOR, VARIABLE, COMPOSITION: 500 ohms, +10%; nom. power rating 0.25 watt at 70°C; Linear taper.	RV111U501A
R59	RESISTOR, FIXED, COMPOSITION: 15,000 ohms, +5%; 1/2 watt.	RC20GF153J
R60	Same as R44.	
R61	NOT USED	
R62	NOT USED	
R63	RESISTOR, FIXED, COMPOSITION: 27,000 ohms, +5%; 1/2 watt.	RC20GF273J
R64	Same as R51.	
R65	RESISTOR, FIXED, COMPOSITION: 1,500 ohms, +5%; 1/2 watt.	RC20GF152J
R66	Same as R14.	
R67	RESISTOR, FIXED, COMPOSITION: 56,000 ohms, +5%; 1/2 watt.	RC20GF563J
R68	Same as R5.	
R69	Same as R4.	

IF AMPLIFIER (cont)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R70	Same as R3.	
R71	RESISTOR, FIXED, COMPOSITION: 330,000 ohms, <u>+5%</u> ; 1/2 watt.	RC20GF334J
T1	TRANSFORMER, RADIO FREQUENCY: adjustable; operating frequency, inductance rated at 1.75 mc; primary 10 uh, <u>+0.5 uh</u> ; four solder lug type terminals; copper can case.	TT258
T2	TRANSFORMER, AUDIO: interstage; primary impedance 10,000 ohms ct; secondary 1.5K ohms ct; power rating 100 mw; operating frequency 50 to 10,000 cps; encapsulated.	TF270
T3	Same as T2.	
T4	TRANSFORMER, RADIO FREQUENCY: adjustable; operating frequency, inductance rated at 2.5 mc; primary 15.5 uh, <u>+0.8 uh</u> ; six solder lug type terminals; copper can case, tin plated.	TT259
T5	TRANSFORMER, RADIO FREQUENCY: adjustable; operating frequency, inductance rated at 1.75 mc; primary 9.5 uh, <u>+0.5 uh</u> ; four solder lug type terminals; copper can case, tin plated.	TT260
T6	TRANSFORMER, RADIO FREQUENCY: adjustable; operating frequency, inductance rated at 1.75 mc; primary 9.5 uh, <u>+0.5 uh</u> ; four solder lug type terminals; copper can case, tin plated.	TT261
T7	TRANSFORMER, RADIO FREQUENCY: adjustable; operating frequency, inductance rated at 2.5 mc; primary 1.75 uh, <u>+0.5 uh</u> ; four solder lug type terminals; copper can case, tin plated.	TT262
TP1	TERMINAL, STUD: 3/32 board mounting; brass.	TE127-3
TP2 thru TP6	Same as TP1.	
TP7	NOT USED	

IF AMPLIFIER (cont)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
TP8	Same as TP1.	
XY1	SOCKET, CRYSTAL: clip type; 2 cadmium plated contacts; 3/64" x 5/32" tail slots.	TS167-1
*Y1-1	CRYSTAL, QUARTZ: operating frequency 1.75000 mc; two male type contacts; metal case.	CR109-81
*Y1-2	Same as Y1-1.	
*Y1-3 **	CRYSTAL, QUARTZ: operating frequency 1.75629 mc; two male type contacts; metal case.	CR109-82
*Y1-4 **	CRYSTAL, QUARTZ: operating frequency 1.74371 mc; two male type contacts; metal case.	CR109-83
*Y2-1	FILTER, BANDPASS: inner/upper sideband; carrier frequency 1750 KCS; carrier suppression 55 db min.; max. passband ripple 1 db at 25°C; input/output impedance 500 ohms; hermetically sealed.	FX216
*Y2-2	FILTER, BANDPASS: inner/lower sideband; carrier frequency 1750 KCS; carrier suppression 55 db min.; max. passband ripple 1 db at 25°C; input/output impedance 500 ohms; hermetically sealed.	FX218
*Y2-3 **	FILTER, BANDPASS: outer/upper sideband; carrier frequency 1756.290 KCS; carrier suppression 55 db min.; max. passband ripple 1 db at 25°C; input/output impedance 500 ohms; hermetically sealed.	FX217
*Y2-4 **	FILTER, BANDPASS: outer/lower sideband; carrier frequency 1743.710 KCS; carrier suppression 55 db min.; max. passband ripple 1 db at 25°C; input/output impedance 500 ohms; hermetically sealed.	FX219

\* All items used on A4220 with a dash No. suffix are used only on the dash No. indicated. All other items are used on all boards.

\*\* When the CMRA is used with a translator having an odd number of inversions, the A2 and B2 channel assignments for bandpass filters and crystals are interchanged.

## SYNTH A MODULE

A4216

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C501	CAPACITOR, FIXED, ELECTROLYTIC: 50 uf, -10% +50% at 120 cps at 25°C; 25 WVDC; polarized; insulated tubular case.	CE105-50-25
C502	Same as C501.	
C503	NOT USED.	
C504	NOT USED.	
C505	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 100,000 uuf, +80% -20%; 100 WVDC.	CC100-28
C506	Same as C505.	
C507	Same as C505.	
C508	CAPACITOR, FIXED, MICA DIELECTRIC: 1500 uuf, +5%; 500 WVDC; straight wire leads.	CM112F1027-5S
C509	CAPACITOR, FIXED, MICA DIELECTRIC: 10,000 uuf, +5%; 500 WVDC; straight wire leads.	CM112F1034-5S
C510	CAPACITOR, FIXED, CERAMIC DIELECTRIC: rated at 470,000 uuf, +20%; radial lead type terminals.	CC112R474M
C511	Same as C505.	
C512	CAPACITOR, FIXED, MICA DIELECTRIC: 470 uuf, +5%; 500 WVDC; straight wire leads.	CM111F4711-5S
C513	CAPACITOR, FIXED, MICA DIELECTRIC: 2700 uuf, +5%; 500 WVDC; straight wire leads.	CM112F2721-5S
C514	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 10,000 uuf, GMV; 500 WVDC.	CC100-16
C515	CAPACITOR, FIXED, MICA DIELECTRIC: 150 uuf, +5%; 500 WVDC; straight wire leads.	CM111F151J-5S
C516	Same as C510.	
C517	Same as C510.	
C518 thru C520	Same as C505.	



SYNTH A MODULE (cont)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C521	Same as C515.	
C522	Same as C505.	
C523	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 1,000 uuf, GMV; 500 WVDC.	CC100-29
C524	CAPACITOR, FIXED, MICA DIELECTRIC: 820 uuf, <u>+5%</u> ; 500 WVDC; straight wire leads.	CM111F821J-5S
C525	CAPACITOR, FIXED, MICA DIELECTRIC: 5100 uuf, <u>+5%</u> ; 500 WVDC; straight wire leads.	CM112F512J-5S
C526	CAPACITOR, FIXED, MICA DIELECTRIC: 390 uuf, <u>+5%</u> ; 500 WVDC; straight wire leads.	CM111F391J-5S
C527	CAPACITOR, FIXED, ELECTROLYTIC: 10 uf, -10% +150% at 120 cps at 25°C; 25 WVDC; polarized; insulated tubular case. Temperature range 20°C - +85°C; hermetically sealed aluminum case w/clear vinyl plastic sleeve.	CE105-10-25
C528	Same as C527.	
C529	CAPACITOR, FIXED, MICA DIELECTRIC: 3900 uuf, <u>+5%</u> ; 500 WVDC; straight wire leads.	CM112F392J-5S
C530	CAPACITOR, FIXED, MICA DIELECTRIC: 6200 uuf; <u>+5%</u> ; 500 WVDC; straight wire leads.	CM112F622J-5S
C531	CAPACITOR, FIXED, MICA DIELECTRIC: 180 uuf, <u>+5%</u> ; 500 WVDC; straight wire leads.	CM111F181J-5S
C532	Same as C527.	
C533	Same as C524.	
C534	Same as C514.	
C535	CAPACITOR, FIXED, ELECTROLYTIC: 20 uf, -10% +150% at 120 cps at 25°C; 50 WVDC; polarized; insulated tubular case.	CE105-20-50
C536	CAPACITOR, FIXED, MICA DIELECTRIC: 47 uuf, <u>+5%</u> ; 500 WVDC; straight wire leads.	CM111F470J-5S
C537	Same as C536.	

SYNTH A MODULE (cont)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C538	Same as C535.	
C539	Same as C535.	
C540	CAPACITOR, FIXED, ELECTROLYTIC: 200 uf, -10% +150% at 120 cps at 25°C; 15 WVDC; polar- ized; insulated tubular case.	CE105-200- 15
C541	Same as C531.	
C542	Same as C531.	
C543	NOT USED.	
C544	NOT USED.	
C545 thru C550	Same as C514	
C551	CAPACITOR, FIXED, MICA DIELECTRIC: 120 uuf, +5%; 500 WVDC; straight wire leads.	CM111F121J- 5S
C552	CAPACITOR, FIXED, MICA DIELECTRIC: 330 uuf, +5%; 500 WVDC; straight wire leads.	CM111F331J- 5S
C553	CAPACITOR, FIXED, MICA DIELECTRIC: 22 uuf, +5%; 500 WVDC; straight wire leads.	CM111E220J- 5S
C554	Same as C514.	
C555	Same as C505.	
C556	Same as C505.	
C557	Same as C527.	
C558	Same as C527.	
C559	Same as C505.	
C560	Same as C505.	
C561	CAPACITOR, FIXED, MICA DIELECTRIC: 1,000 uuf, +5%; 500 WVDC; straight wire leads.	CM112F102J- 5S
C562	Same as C505.	

SYNTH A MODULE (cont)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
CR501	SEMICONDUCTOR DEVICE, DIODE: germanium; max. peak inverse voltage 60V; continuous average forward current 50 ma; max. peak forward current 150 ma; surge current 500 ma; max. inverse current ua at 50 volts or 30 ua at 10 volts.	IN34A
CR502 thru CR504	Same as CR501.	
CR505	SEMICONDUCTOR DEVICE, DIODE: Zener; nominal voltage 10 volts; power dissipation .40 watts at 25°C; current rating 13 ma; max. operating temperature 175°C; hermetically sealed.	1N961B
CR506	Same as CR505.	
CR507	SEMICONDUCTOR DEVICE, DIODE: silicon; nominal ref. voltage 5.6 volts; max. dynamic impedance 11 ohms; Zener test current 20 ma; max. power dissipation 0.40 watts at 25°C; max. operating temperature 175°C; JEDEC type A1 case.	1N752
L501	COIL, RADIO FREQUENCY: adjustable, operating frequency, inductance rated at 3 mc; primary 12 uh, +0.5 uh; four solder lug type terminals; copper can case, tin plated.	CL379
L502	COIL, RADIO FREQUENCY: adjustable; operating frequency, inductance rated at 350 KC; primary 1.25 mh, +0.10 mh; four solder lug type terminals; copper can case, tin plated.	CL378
L503	COIL, RADIO FREQUENCY: adjustable; operating frequency, inductance rated at 250 KC; primary 2.2 mh, +0.2 mh; four solder lug type terminals; copper can case, tin plated.	CL375
L504	COIL, RADIO FREQUENCY: adjustable; operating frequency, inductance rated at 79.5 KC; primary 32 uh, +0.5 mh; bottom retainer nickel silver H/H; ferrite core and slug.	AC211
L505	COIL, RADIO FREQUENCY: adjustable; operating frequency, inductance rated at 6 mc; primary 2.0 uh, +0.2 uh; four solder lug type	CL376

SYNTH A MODULE (cont)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
	terminals; copper can case, tin plated.	
L506	COIL, RADIO FREQUENCY: adjustable; operating frequency, inductance rated at 6 mc; primary 2.0 uh $\pm$ 0.2 uh; four solder lug type terminals; copper can case, tin plated.	CL377
L507	COIL, RADIO FREQUENCY: fixed; 4,700 uh, $\pm$ 10%; molded case.	CL275-472
Q501	TRANSISTOR: NPN diffused silicon; collector to base voltage 25 volts; collector to emitter voltage 20 volts; emitter to base voltage 3 volts; collector current 200 ma; power dissipation 1 watt at 25°C; junction temperature range -65°C to +175°C; metal case.	2N706
Q502 thru Q506	Same as Q501	
Q507	TRANSISTOR: PNP silicon; collector to base voltage 15 volts; collector current 0.1 ma; storage temperature 140°C; metal case.	2N863
Q508 thru Q511	Same as Q501.	
Q512	TRANSISTOR: germanium; emitter to base voltage 0.5 volts; collector to base voltage 40 volts; power dissipation 120 mw; junction temperature 100°C; metal case.	2N1225
Q513 thru Q515	Same as Q501.	
R501	RESISTOR, FIXED, COMPOSITION: 27 ohms, $\pm$ 5%; 1/2 watt.	RC20GF270J
R502	Same as R501.	
R503	RESISTOR, FIXED, COMPOSITION: 1,000 ohms, $\pm$ 5%; 1/2 watt.	RC20GF102J
R504	RESISTOR, FIXED, COMPOSITION: 180 ohms, $\pm$ 5% 1/2 watt.	RC20GF181J

SYNTH A MODULE (cont)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R505	RESISTOR, FIXED, COMPOSITION: 8,200 ohms, <u>+5%</u> ; 1/2 watt.	RC20GF822J
R506	RESISTOR, FIXED, COMPOSITION: 100 ohms, <u>+5%</u> ; 1/2 watt.	RC20GF101J
R507	Same as R503.	
R508	Same as R503.	
R509	RESISTOR, FIXED, COMPOSITION: 4,700 ohms, <u>+5%</u> ; 1/2 watt.	RC20GF472J
R510	RESISTOR, FIXED, COMPOSITION: 3,300 ohms, <u>+5%</u> ; 1/2 watt.	RC20GF332J
R511 thru R513	Same as R503.	
R514	NOT USED	
R515	Same as R510.	
R516	NOT USED	
R517	RESISTOR, FIXED, COMPOSITION: 1,500 ohms, <u>+5%</u> ; 1/2 watt.	RC20GF152J
R518	RESISTOR, FIXED, COMPOSITION: 220 ohms, <u>+5%</u> ; 1/2 watt.	RC20GF221J
R519	NOT USED	
R520	Same as R518.	
R521	Same as R510.	
R522	Same as R503.	
R523	NOT USED	
R524	Same as R510.	
R525	Same as R503.	
R526	RESISTOR, FIXED, COMPOSITION: 56 ohms, <u>+5%</u> ; 1/2 watt.	RC20GF560J
R527	Same as R504.	

SYNTH A MODULE (cont)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R528	Same as R509.	
R529	Same as R510.	
R530	Same as R503.	
R531	Same as R503.	
R532	Same as R509.	
R533	Same as R510.	
R534	Same as R503.	
R535	Same as R503.	
R536	Same as R510.	
R537	RESISTOR, FIXED, COMPOSITION: 680 ohms, +5%; 1/2 watt.	RC20GF681J
R538	RESISTOR, FIXED, COMPOSITION: 470 ohms, +5%; 1/2 watt.	RC20GF471J
R539	RESISTOR, FIXED, COMPOSITION: 68,000 ohms, +5%; 1/2 watt.	RC20GF683J
R540	Same as R537.	
R541	Same as R537.	
R542	RESISTOR, FIXED, COMPOSITION: 6,800 ohms, +5%; 1/2 watt.	RC20GF682J
R543	Same as R542.	
R544	Same as R509.	
R545	RESISTOR, FIXED, COMPOSITION: 33,000 ohms, +5%; 1/2 watt.	RC20GF333J
R546	Same as R537.	
R547	Same as R545.	
R548	Same as R503.	
R549	Same as R509.	

SYNTH A MODULE (cont)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R550	Same as R509.	
R551 thru R554	Same as R503.	
R555	Same as R510.	
R556	Same as R503.	
R557	Same as R538.	
R558	Same as R518	
R559	Same as R510.	
R560	Same as R538.	
R561	Same as R503.	
R562	Same as R538.	
R563	Same as R510.	
R564	RESISTOR, VARIABLE, COMPOSITION: 1,000 ohms, +20%; nom. power rating 0.25 watt at 70°C; linear taper.	RV111U102B
R565	NOT USED.	
R566	Same as R503.	
R567	Same as R510.	
R568	RESISTOR, FIXED, COMPOSITION: 2,200 ohms; +5%; 1/2 watt.	RC20GF222J
R569	Same as R503.	
R570	Same as R506.	
T501	TRANSFORMER, RADIO FREQUENCY: adjustable; operating frequency, inductance rated at 1.75 mc; primary 10 uh, +0.5 uh; four solder lug type terminals; copper can case, tin plated.	TT263

SYNTH A MODULE (cont)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
T502	TRANSFORMER, RADIO FREQUENCY: adjustable; operating frequency, inductance rated at 1.75 mc; primary 9.5 uh, +0.5 uh; four solder lug type terminals; copper can case, tin plated.	TT264
T503	TRANSFORMER, RADIO FREQUENCY: adjustable; operating frequency, inductance rated at 7.9 mc; primary 3.35 uh, +0.17 uh; four solder lug type terminals; copper can case, tin plated.	TT265
TP501	TERMINAL, STUD: 3/32 board mounting; brass.	TE127-3
TP502 thru TP515	Same as TP501.	
Y501	FILTER, BAND PASS: operating frequency 6.290 mc; bandwidth 500 cps min. at 3 db; operating temperature range 0°C to 50°C; hermetically sealed.	FX220



## SYNTH B MODULE

A4218

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C601	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 100,000 uuf, +80% -20%; 100 WVDC.	CC100-28
C602	NOT USED	
C603	CAPACITOR, FIXED, ELECTROLYTIC: polarized: 50 uf, 25 WVDC; -10% +150% at 120 cps at 25°C; insulated tubular case.	CE105-50-25
C604	Same as C601.	
C605	NOT USED	
C606	Same as C603.	
C607	CAPACITOR, FIXED, MICA DIELECTRIC: 150 uuf, +5%; 500 WVDC, straight wire leads.	CM111F151J5S
C608	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 470,000 uuf, +20%; radial lead type terminals.	CC112R474M
C609	Same as C608.	
C610	CAPACITOR, FIXED, MICA DIELECTRIC: 680 uuf, +5%; 500 WVDC, straight wire leads.	CM111F681J5S
C611	CAPACITOR, FIXED, MICA DIELECTRIC: 100 uuf, +5%; 500 WVDC, straight wire leads.	CM111F101J5S
C612	CAPACITOR, FIXED, ELECTROLYTIC: polarized; 20 uf, 50 WVDC; -10% +150% at 120 cps at 25°C; insulated tubular case.	CE105-20-50
C613	Same as C612.	
C614	CAPACITOR, FIXED, MICA DIELECTRIC: 1300 uuf, +5%; 500 WVDC, straight wire leads.	CM112F132J5S
C615	CAPACITOR, FIXED, PLASTIC DIELECTRIC: 0.10 uf, +5%; 200 WVDC; operating range -55°C to +130°C; epoxy encapsulated.	CN114R102J
C616	CAPACITOR, FIXED, MICA DIELECTRIC: 1000 uuf, 500 WVDC, straight wire leads.	CM111F102J5S
C617	Same as C603.	

SYNTH B MODULE (cont)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C618	CAPACITOR, FIXED, MICA DIELECTRIC: polarized; 10 uf, 25 WVDC; -10% +150% at 120 cps at 25 °C; insulated tubular case.	CE105-10-25
C619	CAPACITOR, FIXED, MICA DIELECTRIC: 10,000 uuf, +1%; 100 WVDC, straight wire leads.	CM112F103F1S
C620	CAPACITOR, FIXED, PLASTIC DIELECTRIC: 0.15 uf, +5%; 200 WVDC; operating range -55°C to +150°C; epoxy encapsulated.	CN114R152J
C621 thru C623	Same as C601.	
C624	Same as C603.	
C625	Same as C607.	
C626/C627	Same as C601.	
C628	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 10,000 uuf, +80% -20%; 500 WVDC.	CC100-16
C629	Same as C601.	
C630	CAPACITOR, FIXED, ELECTROLYTIC: polarized; 2 uf, 50 WVDC; -10% +150% at 120 cps at 25°C; insulated tubular case.	CE105-2-50
C631/C632	Same as C601.	
C633	Same as C607.	
C634/C635	Same as C601.	
C636	Same as C607.	
C637	Same as C601.	
C638	Same as C628.	
CR601	SEMICONDUCTOR DEVICE, DIODE: silicon; nominal ref. voltage 10 volts; max. dynamic impedance 8.5 ohms; Zener test current 13 ma; max. power dissipation 0.40 watts at 25°C; operating storage temperature 175°C; JEDEC type DO-7 case.	IN961B
CR602	Same as CR601.	

SYNTH B MODULE (cont)

RFF SYMBOL	DESCRIPTION	TMC PART NUMBER
L601	COIL, RADIO FREQUENCY: adjustable; inductance rated at 795 KC; primary 370 uh + 25 uh; 4 solder lug type terminals; copper can case, tin plated.	CL374
L602	COIL, RADIO FREQUENCY: adjustable; inductance rated at 250 KC; primary 5.2 mh +.15 mh.	AC212
Q601	TRANSISTOR: NPN diffused silicon; collector to base voltage 25 volts; collector to emitter voltage 20 volts; emitter to base voltage 3 volts; collector current 200 ma; power dissipation 1 watt at 25°C; junction temperature range -65°C to +175°C; metal case.	2N706
Q602 thru Q610	Same as Q601.	
R601	RESISTOR, FIXED, COMPOSITION: 1,000 ohms, +5%; 1/2 watt.	RC20GF102J
R602	RESISTOR, FIXED, COMPOSITION: 4,700 ohms, +5%; 1/2 watt.	RC20GF472J
R603	RESISTOR, FIXED, COMPOSITION: 3,300 ohms, +5%; 1/2 watt.	RC20GF332J
R604 thru R606	Same as R601.	
R607	Same as R602.	
R608	Same as R603.	
R609	Same as R601.	
R610	Same as R601.	
R611	Same as R602.	
R612	Same as R603.	
R613	RESISTOR, FIXED, COMPOSITION: 10,000 ohms, +5%; 1/2 watt.	RC20GF103J

SYNTH B MODULE (cont)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R614	RESISTOR, FIXED, COMPOSITION: 2,200 ohms, +5%; 1/2 watt.	RC20GF222J
R615	Same as R614.	
R616	Same as R613.	
R617	Same as R601.	
R618	RESISTOR, FIXED, COMPOSITION: 5,600 ohms, +5%; 1/2 watt.	RC20GF562J
R619	Same as R602.	
R620	RESISTOR, FIXED, COMPOSITION: 47 ohms, +5%; 1/2 watt.	RC20GF470J
R621	Same as R620.	
R622	RESISTOR, FIXED, COMPOSITION: 470 ohms, +5%; 1/2 watt.	RC20GF471J
R623	RESISTOR, FIXED, COMPOSITION: 100 ohms, +5%; 1/2 watt.	RC20GF101J
R624	Same as R623.	
R625	RESISTOR, FIXED, COMPOSITION: 1,500 ohms, +5%; 1/2 watt.	RC20GF152J
R626	Same as R622.	
R627	RESISTOR, FIXED, COMPOSITION: 220 ohms, +5%; 1/2 watt.	RC20GF221J
R628	Same as R602.	
R629	Same as R614.	
R630	Same as R601.	
R631	Same as R625.	
R632	Same as R601.	
R633	RESISTOR, FIXED, COMPOSITION: 1,200 ohms, +5%; 1/2 watt.	RC20GF122J

SYNTH B MODULE (cont)

RFF SYMBOL	DESCRIPTION	TMC PART NUMBER
R634	Same as R633.	
R635	Same as R601.	
R636	Same as R620.	
R637	RESISTOR, FIXED, COMPOSITION: 680 ohms, +5%; 1/2 watt.	RC20GF681J
R638	Same as R603.	
R639	Same as R633.	
R640	Same as R633.	
R641	Same as R601.	
R642	Same as R620.	
R643	Same as R637.	
R644	Same as R603.	
R645	RESISTOR, FIXED, COMPOSITION: 27 ohms, +5%; 1/2 watt.	RC20GF270J
R646	Same as R645.	
R647	RESISTOR, FIXED, COMPOSITION: 22,000 ohms, +5%; 1/2 watt.	RC20GF223J
T601	TRANSFORMER, RADIO FREQUENCY: adjustable; inductance rated at 50 KC; primary 34 mh +0.5 mh; top retainer nickel silver h/h, bottom retainer brass cad plated.	TT255
T602	TRANSFORMER, RADIO FREQUENCY: adjustable: inductance rated at 1.75 mc; primary 10 uh +0.5 uh; six solder lug type terminals; copper can case, tin plated.	TT266
T603	TRANSFORMER, RADIO FREQUENCY: adjustable; inductance rated at 1.75 mc; primary 9.5 uh, +0.5 uh; four solder lug type terminals; copper can case, tin plated.	TT267
T604	TRANSFORMER, RADIO FREQUENCY: adjustable; inductance rated at 1.75 mc; primary 9.5 uh, + 1.0 uh; four solder lug type term- inals; copper can case, tin plated.	TT268

SYNTH B MODULE (cont)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
TP601	TERMINAL, STUD: 3/32" board mounting; brass	TE127-3
TP602 thru TP610	Same as TP601.	
Y601	FILTER, CRYSTAL: 3 db B.W., 1,743, 610 cps max; 70 db B.W., 1,750,000 cps max; load impedance 1.2 K ohms, +10%; operating temperature range 0°C to 50°C; hermetically sealed.	FX221
Y602	FILTER, CRYSTAL: 3 db B.W., 1,756,190 cps max; 70 db B.W., 1,762,580 cps max; load impedance 1.2 K ohms, +10%; operating temperature range 0°C to 50°C; hermetically sealed.	FX222

OUTPUT AMPLIFIER MODULE

A4219

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C701	NOT USED	
C702	NOT USED	
C703	CAPACITOR, FIXED, MICA DIELECTRIC: 18 uuf, +10%; 500 WVDC; straight wire leads.	CM111C180K5S
C704	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 100,000 uuf, +80% -20%; 100 WVDC.	CC100-28
C705	Same as C703.	
C706	Same as C704.	
C707	CAPACITOR, FIXED, MICA DIELECTRIC: 47 uuf, WVDC; straight wire leads.	CM111E470-J5S
C708 thru C713	Same as C704	
C714	CAPACITOR, FIXED, ELECTROLYTIC: 50 uf, -10% +150% at 120 cps at 25°C; 25 WVDC; polarized insulated tubular case.	CE105-50-25
C715	Same as C714.	
C716	NOT USED	
C717	NOT USED	
L701	NOT USED	
L702	NOT USED	
Q701	TRANSISTOR: NPN silicon; collector to base voltage 75 volts; collector to emitter voltage 50 volts; emitter to base voltage 7 volts; power dissipation 3 watts at 25°C; junction temperature range -65°C to 200°C; hermetically sealed.	2N1711
Q702	Same as Q701.	

OUTPUT AMPLIFIER MODULE (cont)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
Q703	TRANSISTOR: silicon; NPN; JEDEC type 2N706 transistor with a controlled hfe limit of 40-60; JEDEC type T05 case.	TX112
R701 thru R705	NOT USED.	
R706	RESISTOR, FIXED, COMPOSITION: 33,000 ohms, <u>+5%</u> ; 1/2 watt.	RC20GF333J
R707 thru R710	Same as R706.	
R711	NOT USED.	
R712	RESISTOR, FIXED, COMPOSITION: 27,000 ohms, <u>+5%</u> ; 1/2 watt.	RC20GF273J
R713	RESISTOR, FIXED, COMPOSITION: 470 ohms, <u>+5%</u> 1/2 watt.	RC20GF471J
R714	RESISTOR, FIXED, COMPOSITION: 2,700 ohms, <u>+5%</u> ; 1/2 watt.	RC20GF272J
R715	RESISTOR, FIXED, COMPOSITION: 330 ohms, <u>+5%</u> 1/2 watt.	RC20GF331J
R716	RESISTOR, FIXED, COMPOSITION: 8,200 ohms, <u>+5%</u> ; 1/2 watt.	RC20GF822J
R717	Same as R713.	
R718	RESISTOR, FIXED, COMPOSITION: 12,000 ohms, <u>+5%</u> ; 1/2 watt.	RC20GF123J
R719	Same as R716.	
R720	RESISTOR, FIXED, COMPOSITION: 220 ohms, <u>+5%</u> 1/2 watt.	RC20GF221J
R721	RESISTOR, FIXED, COMPOSITION: 15,000 ohms, <u>+5%</u> ; 1/2 watt.	RC20GF153J
R722	Same as R713.	
R723	Same as R718.	



OUTPUT AMPLIFIER MODULE (cont)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R724	Same as R720.	
R725	RESISTOR, FIXED, COMPOSITION: 3,300 ohms, +5%; 1/2 watt.	RC20GF332J
T701	TRANSFORMER, RADIO FREQUENCY: adjustable; operating frequency; inductance at 900 kc, primary 100 uh, +5.0 uh; 4 solder type terminals; copper can case, tin plated.	TT256
T702	Same as T701.	
T703	TRANSFORMER, RADIO FREQUENCY: adjustable; operating frequency; inductance at 795 kc, primary 100 uh, +5.0 uh; 4 solder type terminals; copper can case, tin plated.	TT257
TP701	TERMINAL, STUD: 3/32" board mounting; brass.	TE127-3
TP702 thru TP706	Same as TP701.	
TP707	NOT USED.	
TP708 thru TP712	Same as TP701.	

LOGIC MODULE

A4217

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C801	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 100,000 uuf, +80% -20%; 100 WVDC.	CC100-28
C802	Same as C801.	
C803	CAPACITOR, FIXED, ELECTROLYTIC: 10 uf, -10% +150% at 120 cps at 25°C; 25 WVDC; polarized; insulated tubular case.	CE105-10-25
C804	CAPACITOR, FIXED, ELECTROLYTIC: tantalum; 50 uf, +50% -15%; 60 WVDC; polarized; insulated tubular case.	CE107-1
C805 thru C807	Same as C804.	
CR801	SEMICONDUCTOR DEVICE, DIODE: reverse working voltage 100 VDC; forward current 4 mh at 25°C at 1.5 volts; reverse current 1 ma at 75 volts; power dissipation 200 mw; temperature range -80°C +150°C; heretically sealed.	1N627
CR802 thru CR804	Same as CR801.	
CR805	NOT USED.	
CR806 thru CR809	Same as CR801.	
CR810	NOT USED.	
CR811	NOT USED.	
CR812	Same as CR801.	
Q801	TRANSISTOR: NPN diffused silicon; collector to base voltage 25 volts; collector to emitter voltage 20 volts; emitter to base voltage 3 volts; collector current 200 ma; power dissipation 1 watt at 25°C; junction temperature range -65°C to +175°C; metal case.	2N706

LOGIC MODULE (cont)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
Q802 thru Q804	Same as Q801.	
Q805	NOT USED.	
Q806 thru Q809	Same as Q801.	
Q810	NOT USED.	
Q811 thru Q814	Same as Q801.	
Q815	NOT USED.	
Q816	TRANSISTOR: germanium; PNP; base to emitter voltage -0.15 to 0.35 volts; collector to emitter saturation voltage -0.2 volts; metal case.	2N1305
Q817 thru Q819	Same as Q816.	
Q820	NOT USED.	
Q821	Same as Q816.	
R801	RESISTOR, FIXED, COMPOSITION: 150,000 ohms, +5%; 1/2 watt.	RC20GF154J
R802 thru R804	Same as R801.	
R805	NOT USED.	
R806	RESISTOR, FIXED, COMPOSITION: 10,000 ohms, +5%; 1/2 watt.	RC20GF103J
R807 thru R809	Same as R806.	

LOGIC MODULE (cont)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R810	NOT USED.	
R811 thru R814	Same as R806.	
R815	NOT USED.	
R816	RESISTOR, FIXED, COMPOSITION: 15,000 ohms, +5%; 1/2 watt.	RC20GF153J
R817 thru R819	Same as R816.	
R820	NOT USED.	
R821	RESISTOR, FIXED, COMPOSITION: 8,200 ohms, +5%; 1/2 watt.	RC20GF822J
R822 thru R824	Same as R821.	
R825	NOT USED.	
R826 thru R829	Same as R816.	
R830	NOT USED.	
R831	RESISTOR, FIXED, COMPOSITION: 1,000 ohms, +5%; 1/2 watt.	RC20GF102J
R832 thru R834	Same as R831.	
R835	NOT USED.	
R836	Same as R816.	
R837	Same as R821.	
R838	RESISTOR, FIXED, COMPOSITION: 39 ohms, +5%; 1/2 watt.	RC20GF390J

LOGIC MODULE (cont)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
TP801	TERMINAL, STUD: 3/32" board mounting; brass	TE127-3
TP802 thru TP804	Same as TP801.	
TP805	NOT USED.	
TP806 thru TP809	Same as TP801.	
TP810	NOT USED.	
TP811 thru TP814	Same as TP801.	
TP815	NOT USED.	
TP816	Same as TP801.	
TP817	Same as TP801.	

## POWER SUPPLY MODULE

A4215

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C901	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 5,000 uuf, GMV; 500 WVDC.	CC100-15
C902 thru C904	Same as C901	
C905	CAPACITOR, FIXED, ELECTROLYTIC: polarized; 500 uf; 15 WVDC; operating temperature range 0°C to +85°C; hermetically sealed aluminium case with clear vinyl plastic sleeve.	CE116-6VN
C906	Same as C905.	
CR901	SEMICONDUCTOR DEVICE, DIODE: silicon; 600 volts; max. continuous DC current .50 amps at 100°C; surge current peak 75 amps; max. operating temperature 150°C; max. forward voltage drop 1.0 volts; max. reverse current 1000 ua.	1N2484
CR902 thru CR905	Same as CR901.	
R901	RESISTOR, FIXED, COMPOSITION: 220 ohms, +5%; 2 watts.	RC42GF221J
R902	NOT USED.	
R903	RESISTOR, FIXED, COMPOSITION: 1,000 ohms, +5%; 2 watts.	RC42GF102J
TP901	TERMINAL, STUD: 3/32" board mounting; brass	TE127-3
TP902	Same as TP901.	
TP903	Same as TP901.	

CMRA-1 MAIN CHASSIS

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C1001	CAPACITOR, FIXED, ELECTROLYTIC: polarized; 3,900 uf; 50 WVDC; operating temperature range -20°C to +65°C; hermetically sealed aluminum case w/clear vinyl plastic case.	CE112-11
C1002 thru C1011	NOT USED	
C1012	CAPACITOR, FIXED, BUTTON, MICA DIELECTRIC: 1,000 uuf, +10%; 300 WVDC; two single "u" type terminals.	CB212B102K
C1013 thru C1043	Same as C1012.	
CR1001	SEMICONDUCTOR DEVICE, DIODE: nom. voltage 12 volts at 25°C; power dissipation 10 watts at 50°C; current rating 210 ma; max. impedance 3 ohms; hermetically sealed.	1N2976B
CR1002	SEMICONDUCTOR DEVICE, DIODE: silicon, nom. voltage 24 volts, +5%; power dissipation 10 watts at 25°C; current rating 105 ma; max. impedance 5 ohms; max. operating temperature 150°C; stud mounted; hermetically sealed.	1N2986B
CR1003	SEMICONDUCTOR DEVICE, DIODE: zener; nom. voltage 14 volts; power dissipation 10 watts at 25°C; current rating 180 ma; max. operating temperature 175°C; hermetically sealed.	1N2978RB
CR1004	SUPPRESSOR, ARC, DIODE: polarized; operating voltage 33 VDC max.; two wire type leads, 1 each end.	DD114-1
CR1005	SEMICONDUCTOR, DEVICE, DIODE: reverse working voltage 100 VDC; forward current 4 mh at 25°C at 1.5 volts; reverse current 1 ma at 75 volts; power dissipation 200 mw; temperature range -80°C to +150°C; hermetically sealed.	1N627

MAIN CHASSIS (cont)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
CR1006 thru CR1008	Same as CR1005.	
DS1001	LAMP, INCANDESCENT: 28 volts; 0.04 amps, bayonet base; for T-3-1/4 bulb.	BI101-1819
DS1002	NOT USED	
DS1003 thru DS1007	Same as DS1001.	
F1001	FUSE, CARTRIDGE: 1 amp; time lag; 1-1/4" long x 1/4" dia.; slow blow.	FU102-1
F1002	FUSE, CARTRIDGE: 1 amp; 250 WVDC; 1-1/4" long x 1/4" dia.; quick acting.	FU100-1
F1003	Same as F1002.	
F1004	Same as F1002.	
J1001	CONNECTOR, RECEPTACLE, ELECTRICAL: 22 female, type contacts; continuous current rating 5 amps, 1800 V RMS; float bushing.	JJ293-22STD
J1002 thru J1007	Same as J1001.	
J1008	NOT USED	
J1009	Same as J1001.	
J1010	Same as J1001.	
J1011	CONNECTOR, RECEPTACLE, ELECTRICAL: 22 amps; 3 contacts male type.	MS3102A16S5P
J1012	NOT USED	
J1013	CONNECTOR, RECEPTACLE, ELECTRICAL:	UG625*/U



MAIN CHASSIS (cont)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
J1013 (cont)	RF; 1 round female contact, straight type; 52 ohms; series BNC to BNC.	
J1014	Same as J1013.	
K1001	RELAY, ARMATURE: 6PDT; 430 ohms, $\pm 10\%$ ; oper. voltage 24 VDC, current rating 56 ma; 1500 mu at 25°C, 20 contacts rated for 5 amps at 29 VDC. Clear high impact styrene dust cover case.	RL156-5
K1002	RELAY, ARMATURE: DPDT; 700 ohms, $\pm 10\%$ , dc resistant; oper. voltage 24 VDC; current rating 35 ma, 700 mu at 25°C; contacts rated for 5 amps at 29 VDC; clear high impact styrene dust cover case.	RL156-1
L1001	COIL, RADIO FREQUENCY: fixed; 680 uh, $\pm 5\%$ ; 170 ohms dc resistance; current rating 160 ma; molded case.	CL275-681
L1002 thru L1007	Same as L1001.	
L1008	NOT USED	
L1009	Same as L1001.	
L1010	Same as L1001.	
L1011	COIL, RADIO FREQUENCY: fixed; 75 ohms ac resistance at 10 mc; 93 ohms ac resistance at 100 mc; two wire tinned leads; epoxy case.	CL349-1
L1012 thru L1022	Same as L1011.	
L1023	COIL, RADIO FREQUENCY: fixed; 120 uh, $\pm 10\%$ ; 3.2 ohms dc resistance; molded case.	CL240-120

MAIN CHASSIS (cont)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
L1024 thru L1038	Same as L1023.	
L1039 thru L1041	Same as L1011.	
L1042	Same as L1001.	
M1001	METER, AUDIO LEVEL: -20 to +3 db, 0 to 100% scale; ballistic movement; internal impedance 3900 ohms; standard 2-3/16" rectangular case.	MR154
Q1001	TRANSISTOR: germanium; PNP; collector to base, and emitter voltage 45 VDC at 300 ma, 30 VDC at 500 ma; emitter base voltage 25 volts; collector current 3 amps; power dissipation 62.5 watts at 25°C; junction temperature range -65°C to 100°C; hermetically sealed.	2N2143
R1001	RESISTOR, FIXED, COMPOSITION: 560 ohms, <u>+5%</u> ; 2 watt.	RC42GF561J
R1002	RESISTOR, VARIABLE, COMPOSITION: 1,000 ohms, <u>+10%</u> ; 2 watts.	RV4NAYSC-102AYY
R1003 thru R1005	Same as R1002.	
R1006	NOT USED	
R1007	RESISTOR, FIXED, COMPOSITION: 330 ohms, <u>+5%</u> ; 1/2 watt.	RC20GF331J
R1008 thru R1010	Same as R1007.	
R1011	NOT USED	

MAIN CHASSIS (cont)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R1012	RESISTOR, FIXED, COMPOSITION: 150 ohms, <u>+5%</u> ; 1/2 watt.	RC20GF151J
R1013	RESISTOR, FIXED, COMPOSITION: 100 ohms, <u>+5%</u> ; 1/2 watt.	RC20GF101J
R1014	RESISTOR, FIXED, COMPOSITION: 200 ohms, <u>+5%</u> ; 1/2 watt.	RC20GF201J
R1015	RESISTOR, FIXED, COMPOSITION: 33 ohms, <u>+5%</u> ; 1/2 watt.	RC20GF330J
R1016	RESISTOR, FIXED, COMPOSITION: 16 ohms, <u>+5%</u> ; 1/2 watt.	RC20GF160J
R1017	RESISTOR, FIXED, COMPOSITION: 3,900 ohms, <u>+5%</u> ; 1/2 watt.	RC20GF392J
R1018	RESISTOR, FIXED, COMPOSITION: 3,600 ohms, <u>+5%</u> ; 1/2 watt.	RC20GF362J
S1001	SWITCH, TOGGLE: SPST; 6 amps, 125 VAC; 28° angle of throw, solder lug terminal.	ST12A
S1002	NOT USED	
S1003A, B, C	SWITCH, SOLENOID, ROTARY: 3 section 12 position; 30° angle of throw; operating temperature range 0°C to +50°C; section 1 control type contacts; sections 2 and 3 non-shorting type contacts; foot mounting.	SW403
S1004	SWITCH, ROTARY: 1 section 3 position; 30° angle of throw; non-shorting type contacts, silver plated brass.	SW148
S1005	SWITCH, TOGGLE: DPDT; 6 amps rated at 250 volts ac; 28° angle of throw; solder lug terminals.	ST22N
T1001	TRANSFORMER, POWER: step down; primary voltage rating 105, 115, 125 or 210, 230, 250 volts; 50 to 60 cps; single phase; secondary voltage rating 28 volts at 700 ma DC; ten solder lug type	TF269

MAIN CHASSIS (cont)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
T1001 (cont)	terminals; fully inclosed, hermetically sealed.	
TB1001	TERMINAL BOARD: barrier type; 18 6-32 x 1/4" binding head maching screws.	TM100-18
TB1002	Same as TB1001.	
XDS1001	LIGHT, INDICATOR: with red frosted lens; for miniature bayonet base, T-3-1/4 bulb.	TS106-1
XDS1002	NOT USED	
XDS1003	LIGHT, INDICATOR: with clear unfrosted lens; for miniature bayonet base, T-3-1/4 bulb.	TS1006-2
XDS1004	LIGHT, INDICATOR: with green frosted lens; for miniature bayonet base, T-3-1/4 bulb.	TS106-3
XDS1005 thru XDS1007	Same as XDS1004.	
XF1001	FUSEHOLDER: accommodates cartridge fuse 1-1/4" lg x 1/4" dia.; two solder type terminals, stationary.	FH100-2
XF1002 thru XF1004	Same as XF1001.	
XK1001	SOCKET, RELAY W/RETAINER: 18 male type contacts, beryllium copper gold plated; black phenolic body; 31/32" long x 3/4" wide x 11/32" high.	TS171-2
XK1002	SOCKET, RELAY W/RETAINER: 6 male type contacts, beryllium copper gold plated; black phenolic base; 31/32" long x 3/4" wide x 11/32" high.	TS171-1

MAIN CHASSIS (cont)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
XQ1001	SOCKET, TRANSISTOR: 3 spring temper phosphor bronze contacts; 1 solder type terminal lug, hot tin dipped; black phenolic body.	TS166-1
Z1001	Power Supply Module (See separate parts list for breakdown)	A4215
Z1002	Logic Module (See separate parts list for breakdown)	A4217
Z1003	Output Amplifier Module (See separate parts list for breakdown)	A4219
Z1004	IF Amplifier, Channel A2 (See separate parts list for breakdown)	A4220-3
Z1005	IF Amplifier, Channel A1 (See separate parts list for breakdown)	A4220-1
Z1006	IF Amplifier, Channel B1 (See separate parts list for breakdown)	A4220-2
Z1007	IF Amplifier, Channel B2 (See separate parts list for breakdown)	A4220-4
Z1008	NOT USED	
Z1009	Synth. B Module (See separate parts list for breakdown)	A4218
Z1010	Synth. A Module (See separate parts list for breakdown)	A4216

SECTION 7  
SCHEMATIC DIAGRAMS



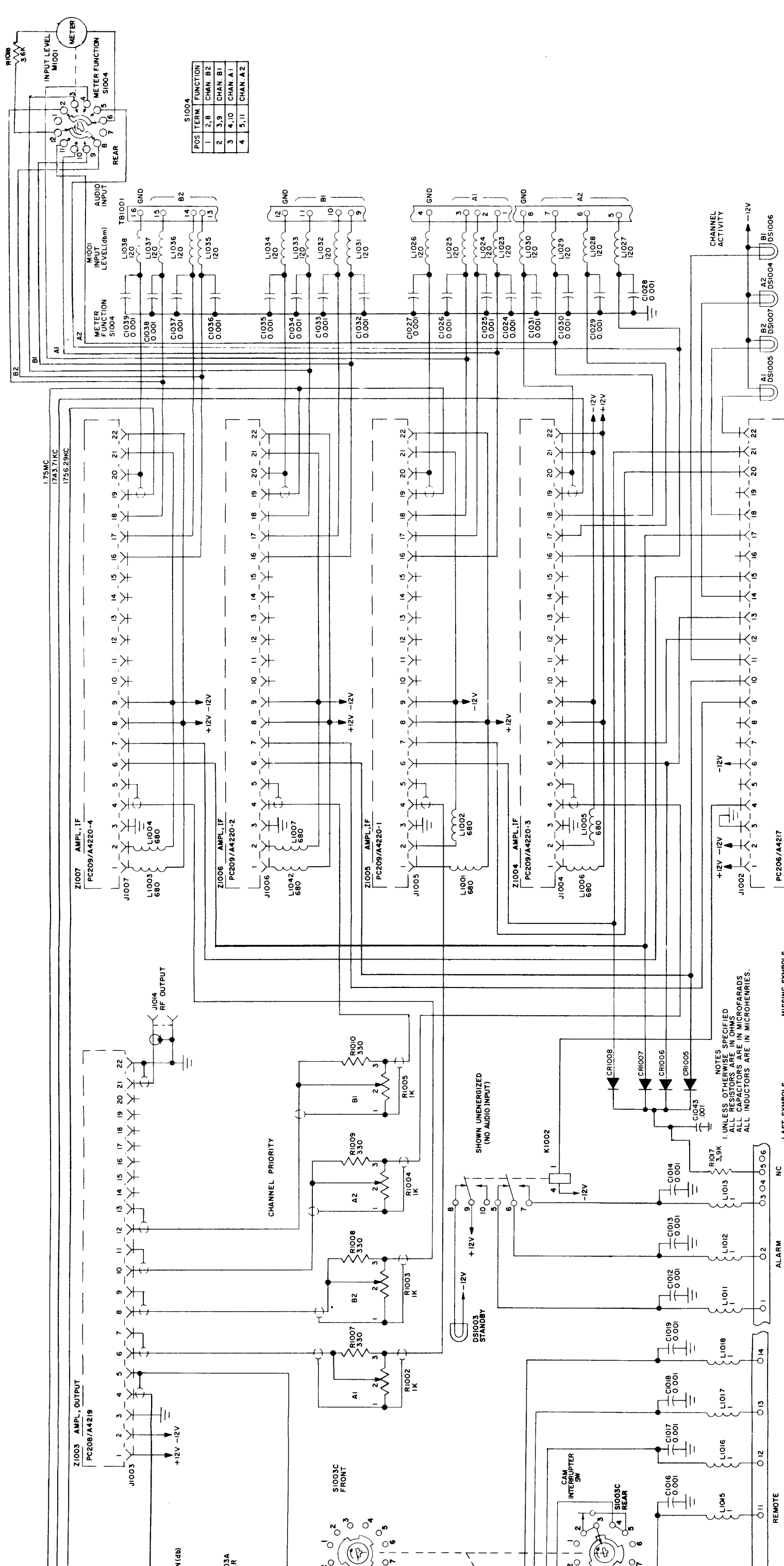


Figure 7-1. Schematic Diagram, CMRA-1.

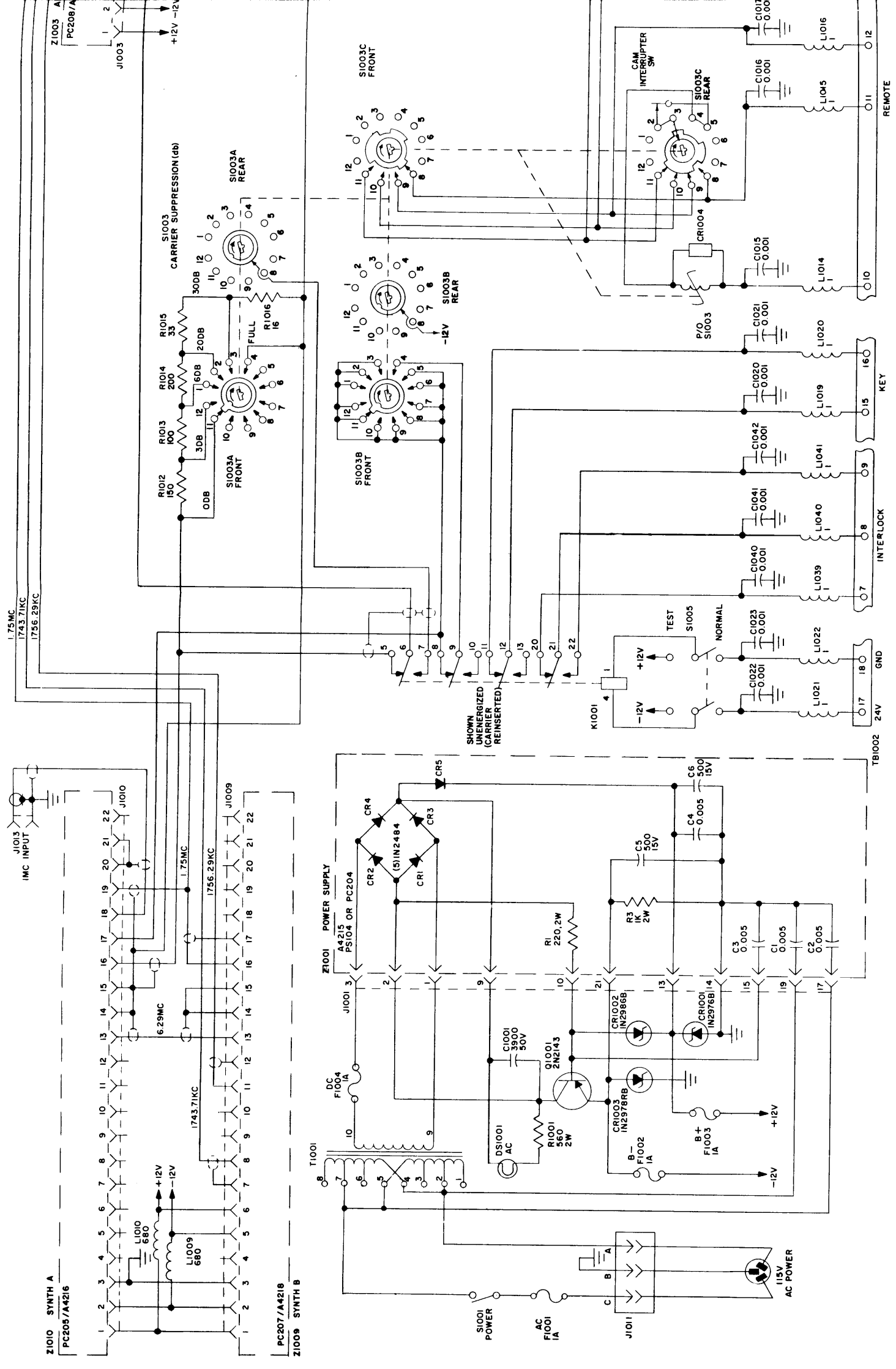
101692012C

7-3/7-4

NOTES  
 1. UNLESS OTHERWISE SPECIFIED  
 ALL RESISTORS ARE IN OHMS  
 ALL CAPACITORS ARE IN MICROFARADS  
 ALL INDUCTORS ARE IN MICROHENRIES.

- LAST SYMBOLS
- C1043 M1001
  - C1008 Q1001
  - DS1007 R1018
  - F1004 S1005
  - J1014 T1001
  - K1002 TB1002
  - L1042 Z1010
- MISSING SYMBOLS
- C1002 THRU C1011
  - DS1002 R1006, R1011, S1002
  - J1008, J1012
  - L1008
  - Z1008





CK-1020B

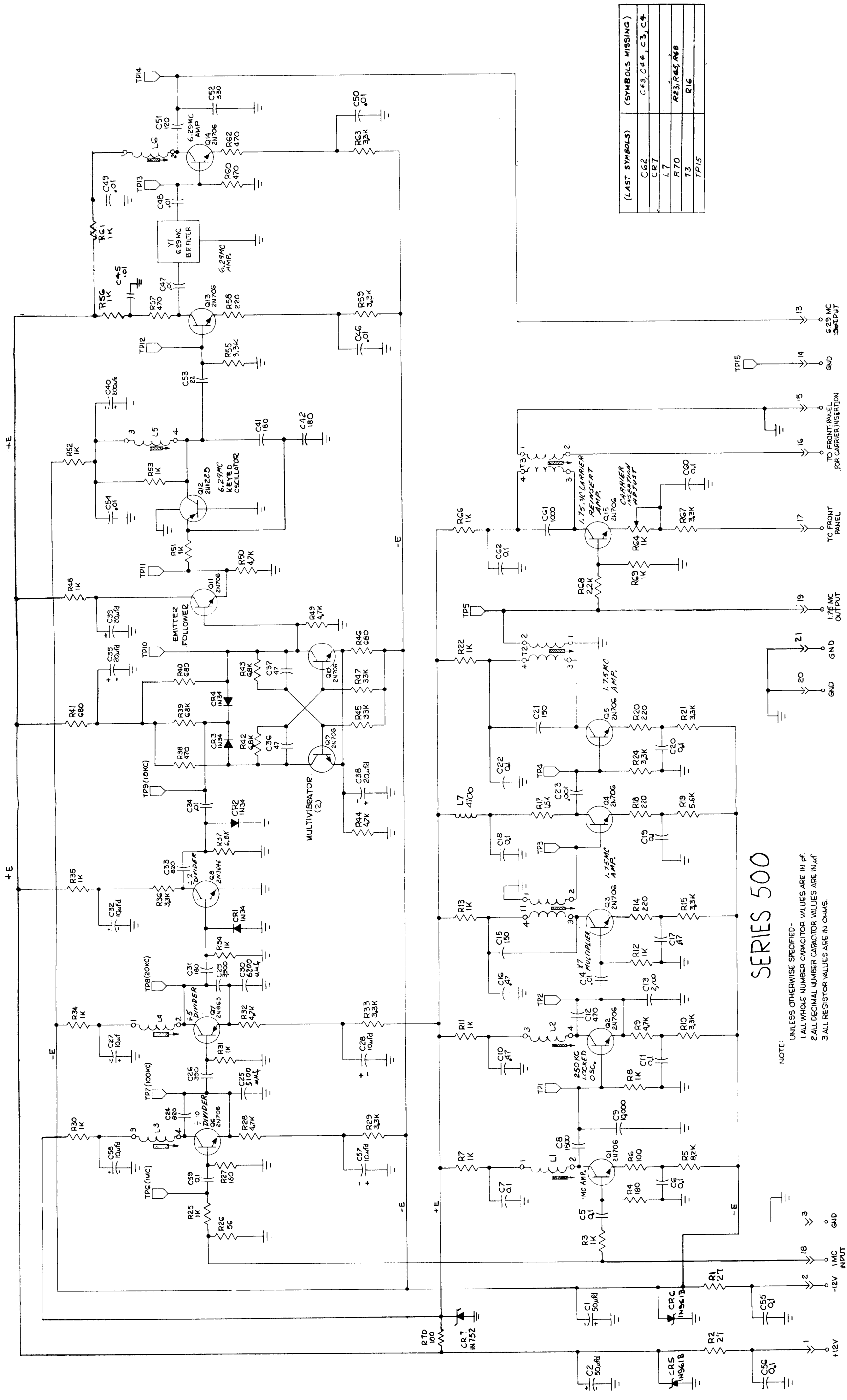
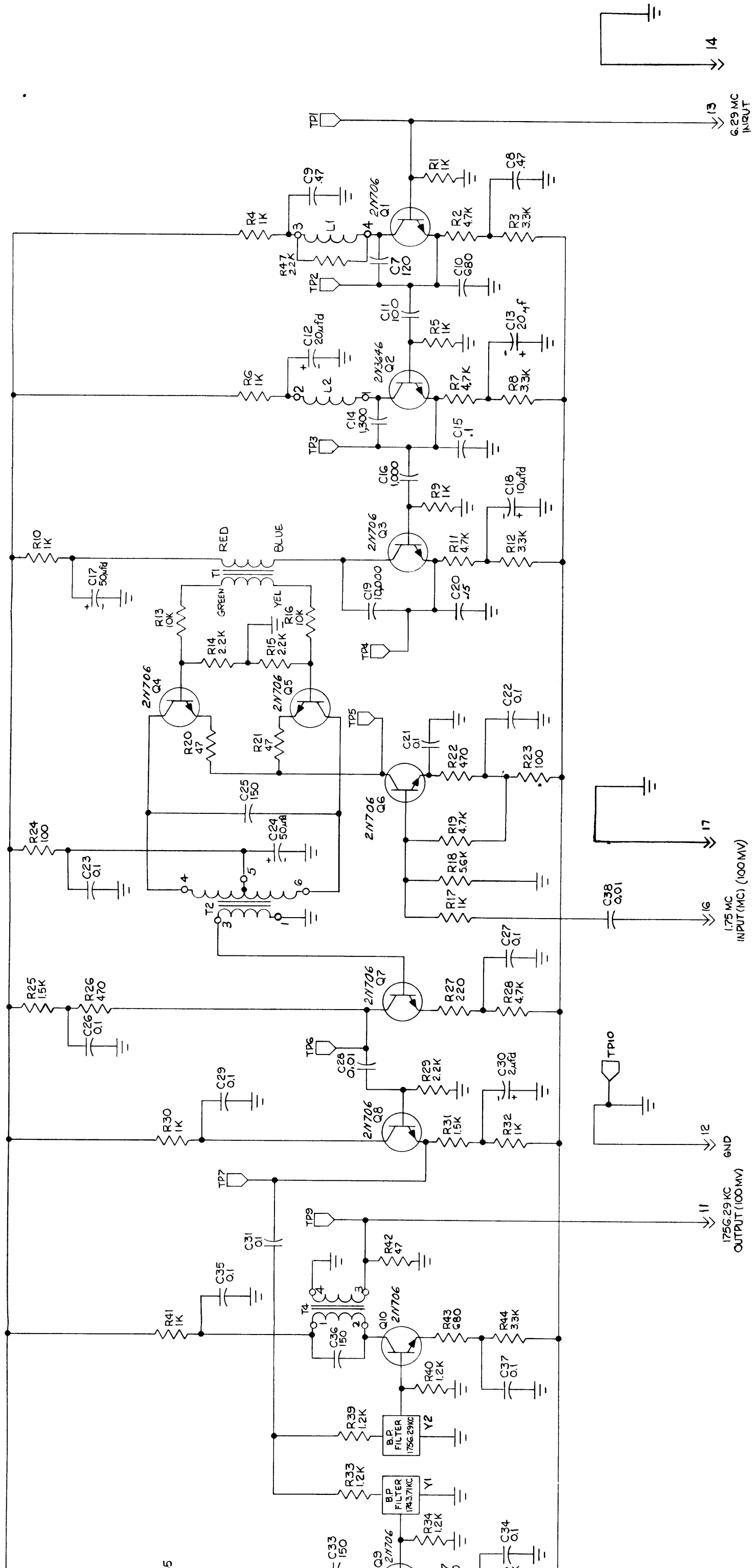


Figure 7-2. Schematic Diagram, Synthesizer A.



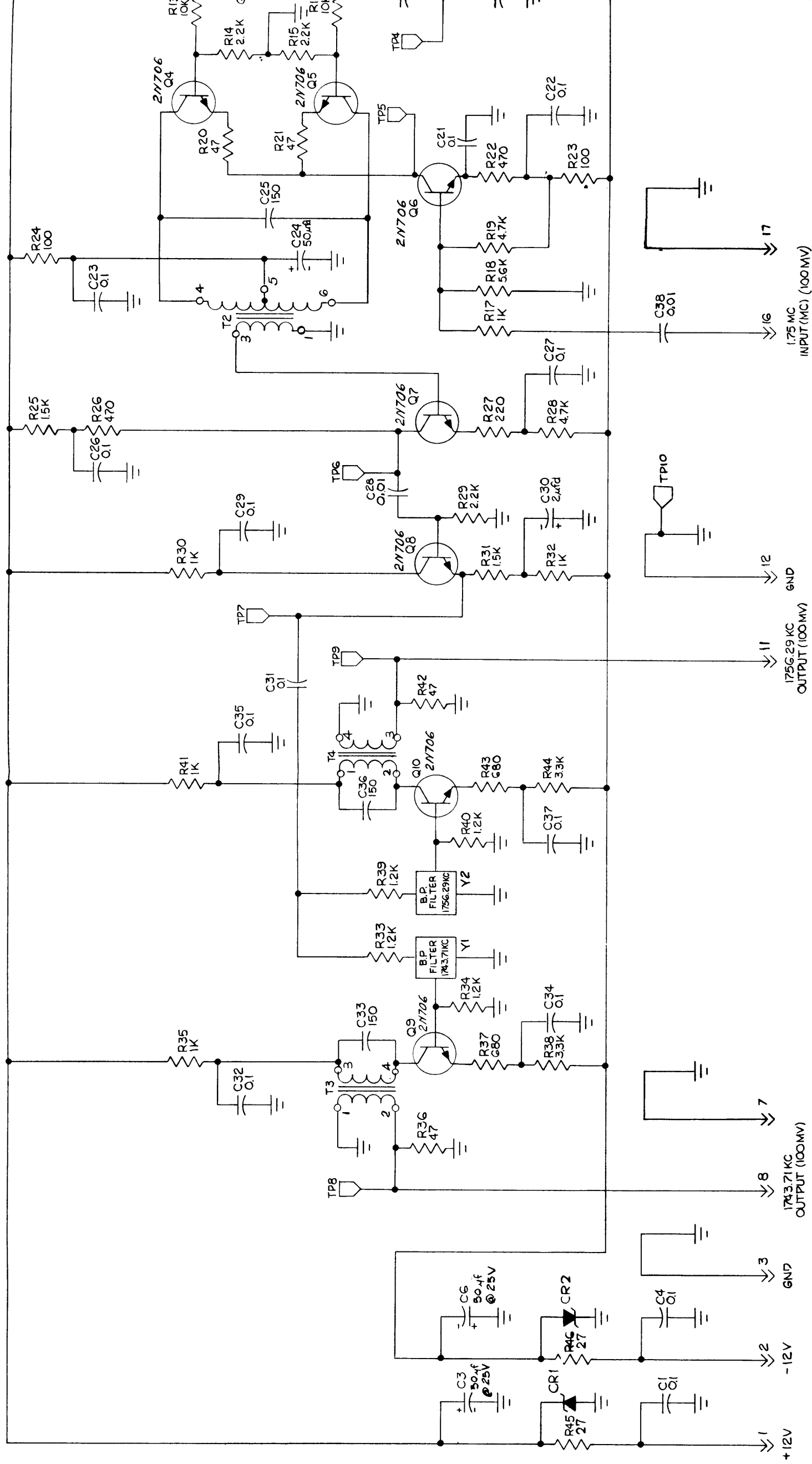
NOTE:  
 UNLESS OTHERWISE SPECIFIED-  
 1. ALL WHOLE NUMBER CAPACITOR VALUES ARE IN  $\mu$ f.  
 2. ALL DECIMAL NUMBER CAPACITOR VALUES ARE IN  $\mu$ f.  
 3. ALL RESISTOR VALUES ARE IN OHMS.

# SERIES 600

Figure 7-3 Schematic Diagram,  
 Synthesizer B.

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7-7/7-8



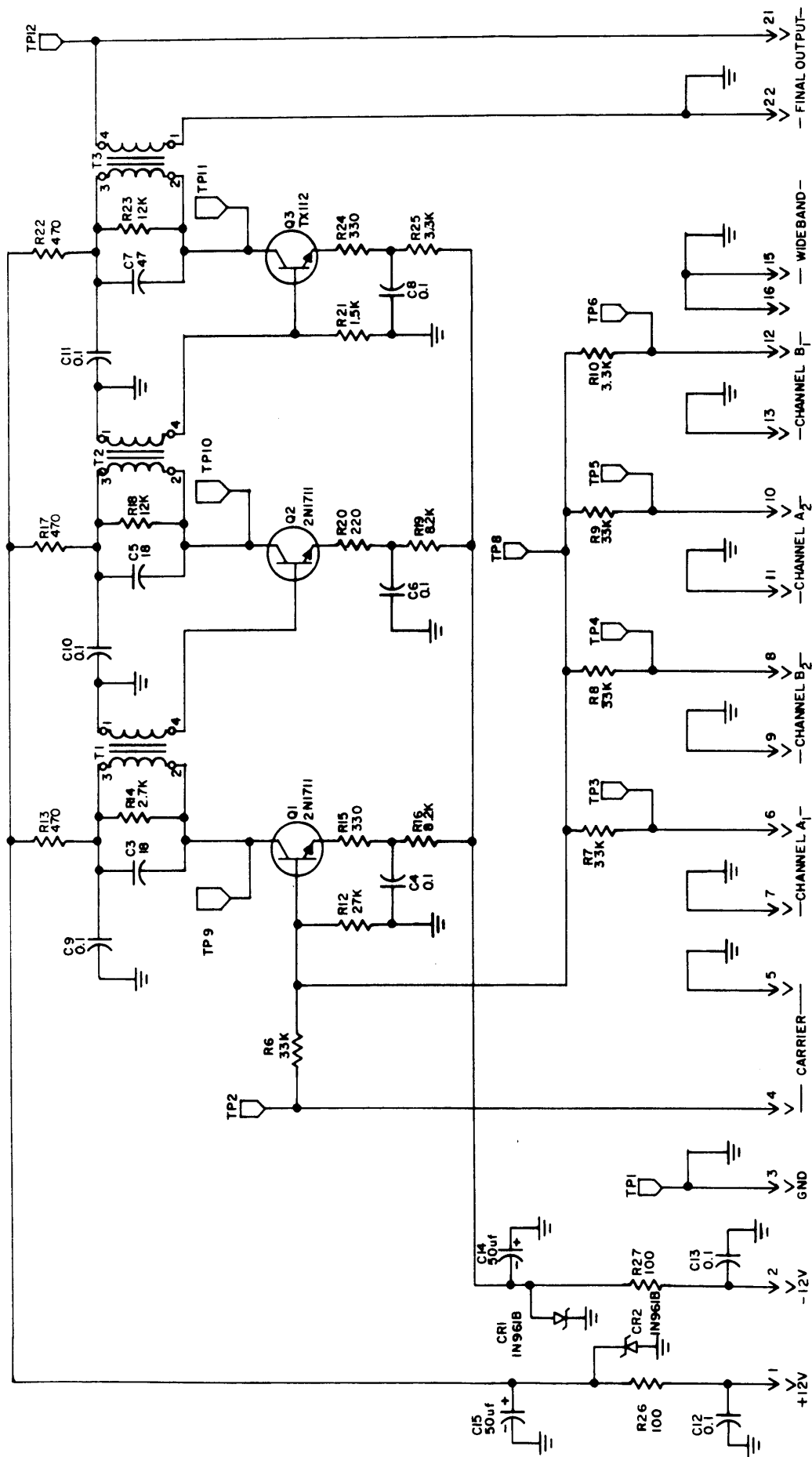
NOTE:

UNLESS OTHERWISE SPECIFIED -

1. ALL WHOLE NUMBER CAPACITOR VALUES ARE IN  $\mu$ f.
2. ALL DECIMAL NUMBER CAPACITOR VALUES ARE IN  $\mu$ f.
3. ALL RESISTOR VALUES ARE IN OHMS.

# SERIES 600



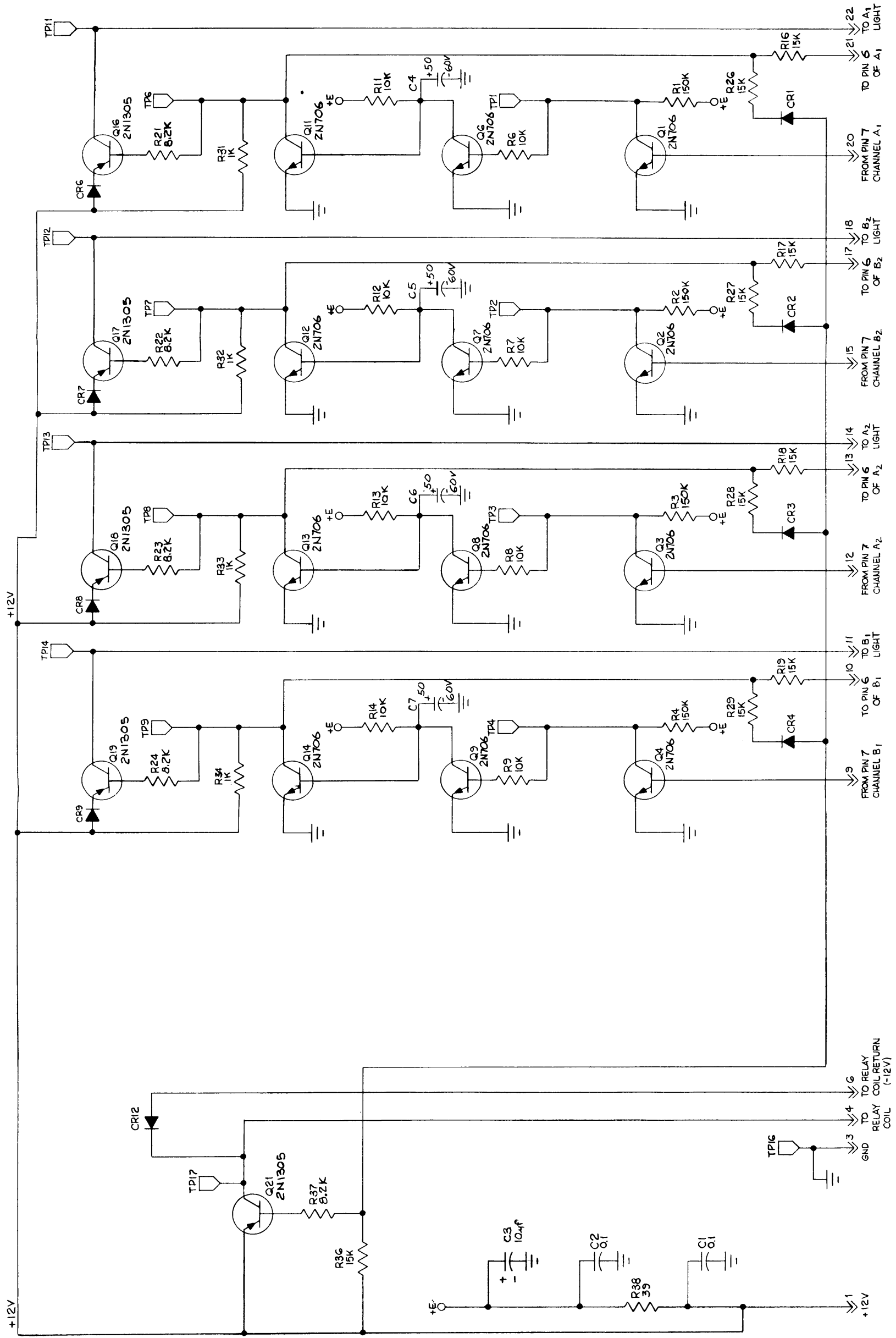


SERIES 700

NOTE:  
 1 UNLESS OTHERWISE SPECIFIED—  
 2 ALL WHOLE NUMBER CAPACITOR VALUES ARE IN  $\mu\text{f}$   
 3 ALL DECIMAL NUMBER CAPACITOR VALUES ARE IN  $\text{pF}$   
 4 ALL RESISTOR VALUES ARE IN OHMS

CK-952C

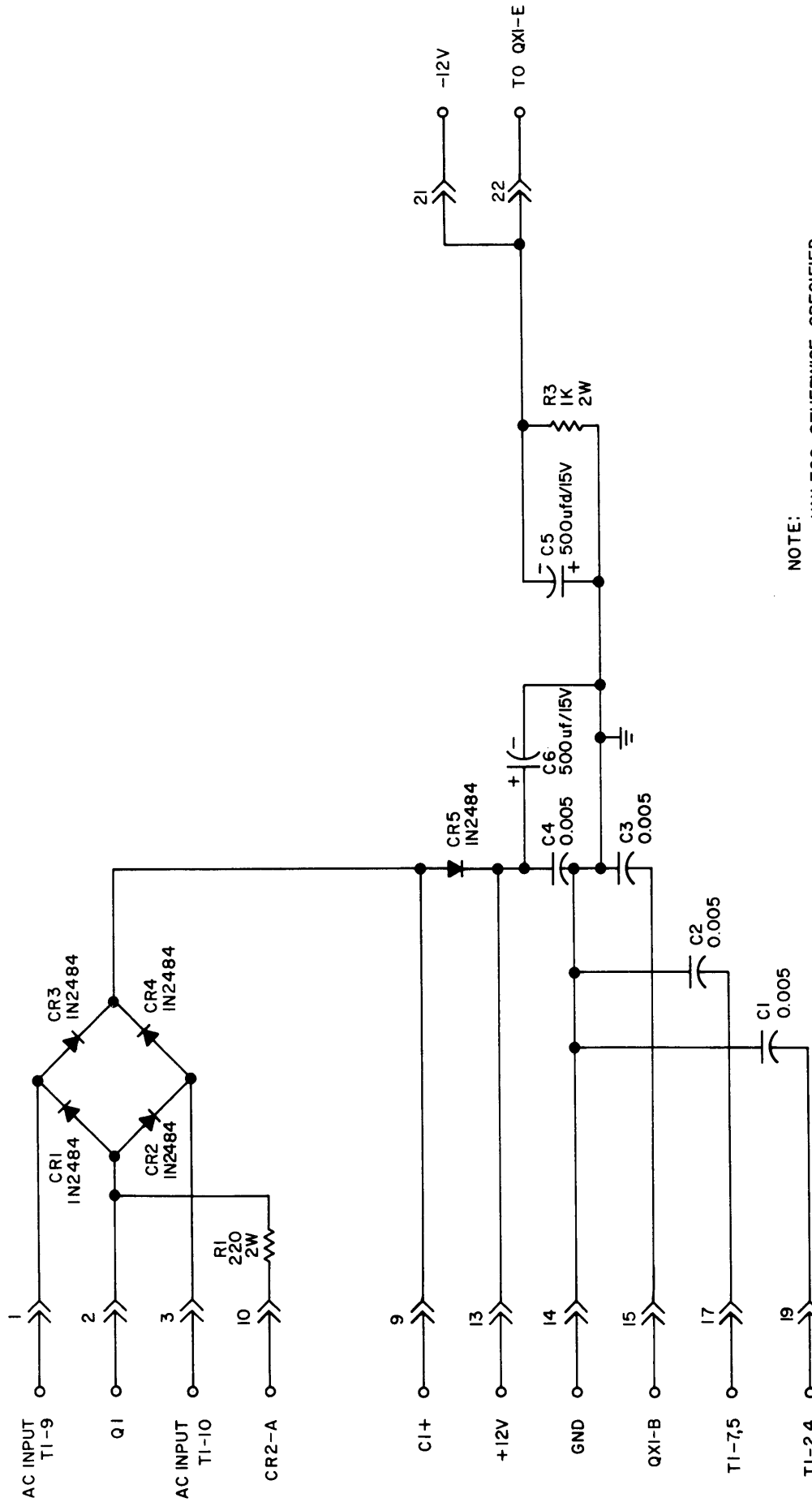
Figure 7-5. Schematic Diagram, Output Amplifier



SERIES 800

NOTES:  
 UNLESS OTHERWISE SPECIFIED-  
 1. ALL WHOLE NUMBER CAPACITOR VALUES ARE IN  $\mu$ F.  
 2. ALL DECIMAL NUMBER CAPACITOR VALUES ARE IN pF.  
 3. ALL RESISTOR VALUES ARE IN OHMS.  
 4. ALL DIODES ARE IN G27.

Figure 7-6. Schematic Diagram  
 Logic Circuit



NOTE:  
 UNLESS OTHERWISE SPECIFIED  
 1. ALL WHOLE NUMBER CAPACITOR VALUES ARE IN pf.  
 2. ALL DECIMAL NUMBER CAPACITOR VALUES ARE IN uf.  
 3. ALL RESISTOR VALUES ARE IN OHMS.

CK-9510

Figure 7-7. Schematic Diagram, Power Supply