TECHNICAL MANUAL

for

GENERAL PURPOSE RECEIVER

MODEL GPR-100

THE TECHNICAL MATERIEL CORPORATION

MAMARONECK, N.Y. OTTAWA, ONTARIO

THE TECHNICAL MATERIEL CORPORATION
COMMUNICATIONS ENGINEERS
700 FENIMORE ROAD MAMARONECK, N. Y.

Warranty

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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.
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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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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.

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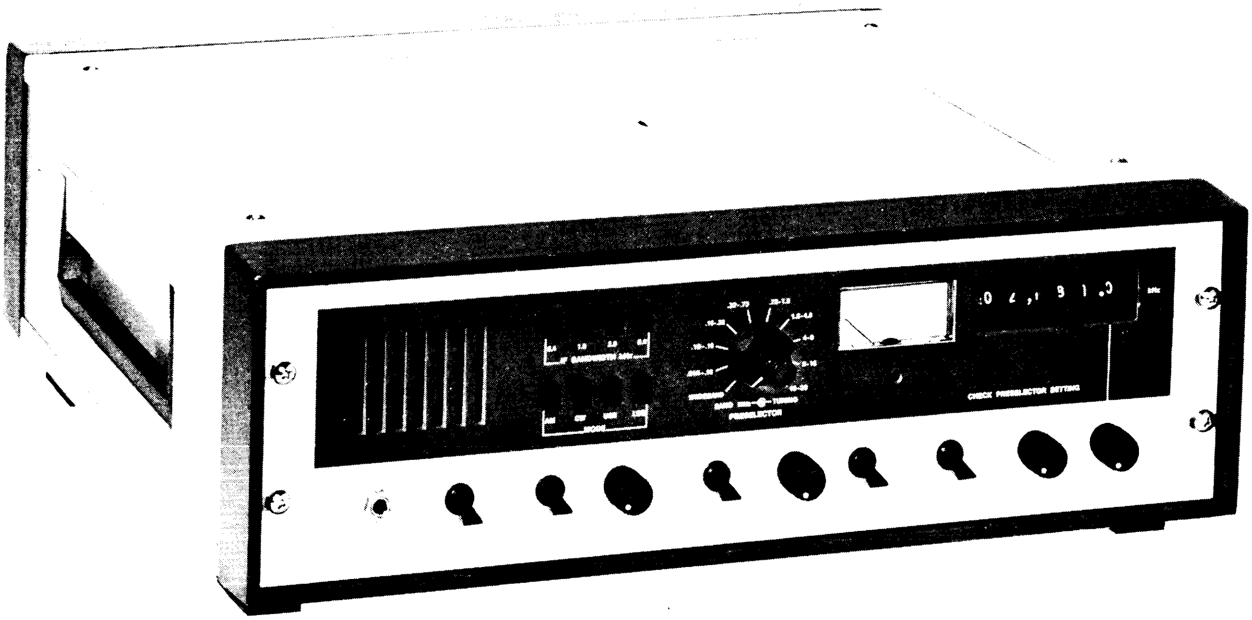
THE TECHNICAL MATERIEL CORPORATION
Engineering Services Department
700 Fenimore Road
Mamaroneck, New York



MODEL GPR-100

3020 RADIO RECEIVER

NOTICE

The policy of ITT MACKAY MARINE is to maintain continuous technical advancement and ITT MACKAY MARINE reserves the right to make any necessary modifications or changes herein without notice.

OPERATION-MAINTENANCE MANUAL
FOR
MARINE RADIO RECEIVER
ITT MACKAY MARINE TYPE 3020A, 3020B,
DEBEG 7200, EB-3026 AND EB-3028
(690001-000-001 to -005 and -007)

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SECTION 1

GENERAL DESCRIPTION

1.1 INTRODUCTION

ITT Mackay Marine Type 3020 Radio Receiver is a synthesized dual-conversion superheterodyne receiver capable of a variety of modes of operation in the frequency range of 15 to 29,999.9 kHz. The unit is designed for both high performance and ease of maintenance. Several versions of the 3020 are available and are compared in Table 1.1, page 1.6.

The 3020 uses a VHF digital synthesizer covering the frequency range of 92.0000 to 121.9999 MHz in 100 Hz steps. The synthesizer final output is phase locked to a temperature-stabilized crystal oscillator operating at 8 MHz.

The receiver achieves excellent immunity to strong off-frequency signals by careful attention to gain distribution and ultra linear active elements in the front end and by up conversion to a high (92 MHz) first IF frequency to maximize image rejection and to minimize effects of harmonic production of front end stages.

IF Bandwidth can be chosen by the operator for rejection of interfering signals. Bandwidths from 8 kHz to 400 Hz are available through front panel switched crystal filters operating at the 2nd IF (8 MHz) amplifier. Front panel selection of AM, CW, USB and LSB modes is also provided.

The muting circuit is controlled by the telegraph key of the associated transmitter. When the transmitter is keyed the IF gain of the receiver is reduced and the audio output is muted.

The 600 Ohm Line Amplifier provides audio output into a 600 ohm load. The output level of the amplifier can be adjusted without affecting the output of the speaker.

A circulating cooling fan is affixed to the 3020 rear panel to provide proper heat dissipation.

NOTE: *Refer to Section 7 for wiring and schematic diagrams, assembly drawings and parts lists.*

1.2 MECHANICAL

The 3020 Receiver is basically a rack mounted unit 5-1/4" high x 19" wide x 19" deep. The receiver also is available in an optional cabinet.

The receiver consists of a front panel, rear panel, main chassis, and connection (PC) facilities for the signal path and synthesizer plug-in printed circuit boards.

The main chassis contains the power transformer, power supply filter capacitors, PC connectors for both the signal path and synthesizer, and interconnecting wiring.

The front panel assembly contains all front panel controls as well as the variable frequency crystal BFO and the RF Preselector subassemblies.

The rear panel assembly contains the power supply rectifier bridges, series pass transistors and associated heat sinks for heat dissipation, and a circulating cooling fan. The power supply regulator PC board, the antenna input connector, 8 MHz IF monitor output, 3 ohm and 600 ohm audio output terminals, fuses and ac power cord are also located on the rear panel assembly.

1.3 FRONT PANEL CONTROLS AND SWITCHES

The following controls and switches are located on the front panel:

- IF BANDWIDTH kHz pushbutton switches (0.4, 1.0, 2.0, 8.0)
- MODE pushbutton switches (AM, CW, USB, LSB)
- PRESELECTOR (BAND MHz TUNING) dial switch and control knob
- Frequency Select Switches (kHz)
- PHONES Jack
- SPEAKER (ON/OFF) Switch
- CW PITCH (FIXED/VARIABLE) Switch
- CW PITCH (VARIABLE) Control Knob
- AGC (FAST/SLOW) Switch
- RF GAIN/AGC ON Control Knob
- METER DISPLAY (RF INPUT/AUDIO OUTPUT) Switch
- ANT. ATTEN. (OUT/IN) Switch
- AUDIO GAIN/POWER OFF Control Knob
- PULL FOR FINE TUNE Control Knob

1.4 MAJOR COMPONENTS

The following is a list of all major components of the 3020 Receiver and part numbers for ordering replacements:

ITEM	PART NUMBER
Main Chassis Assembly	600349-705

ITEM	PART NUMBER
Front Panel Assembly	600034-539
Rear Panel Assembly	600035-539
Signal Path Plug-in Units	
Preselector Assembly	600125-537
RF Section Assembly	600589-536
2nd Mixer Assembly	600590-536
8 MHz IF Amplifier Assembly	600591-536
Information Filters Assembly	600592-536
AM and Product Detectors Assembly	600593-536
AGC Amplifier Assembly	600594-536
Audio Amplifier Assembly	600595-536
Variable BFO Assembly	600124-537
Regulator (Power Supply) Assembly	600581-536
Synthesizer Plug-in Units	
Low Frequency Reference Assembly	600587-536
VHF Reference Assembly	600586-536
Minor Loop Analog Assembly	600579-536
Minor Loop Variable Divider Assembly	600588-536
Loop Translator Assembly	600585-536
Major Loop Variable Divider Assembly	600584-536
Decoder Assembly	600582-536
Major Loop Analog & Acquisition Assembly	600580-536
Major Loop VCO Buffer Assembly	600583-536
600 Ohm Line Amplifier Assembly	600719-536

1.5 SUMMARY OF TECHNICAL SPECIFICATIONS

a. GENERAL

Frequency Range	15 to 29,999.9 kHz. Full sensitivity specifications from 100 to 29,999.9 kHz. Sensitivity is reduced uniformly between 100 and 15 kHz by approximately 200 dB at 15 kHz.
Modes of Operation	Upper sideband (USB), lower sideband (LSB), amplitude modulation (AM), continuous wave (CW), radioteletype (RTTY)* and facsimile (FAX)*.
Frequency Selection	Digital, 299,850 channels in 100 Hz steps. Fine tune between 100 Hz steps.

*With optional external signal processing equipment.

Frequency Stability

Frequency drift does not exceed 1 Hz per MHz of tuned frequency over a temperature range of 0 to 50°C, and 1 Hz per MHz of tuned frequency per year after calibration of internal frequency standard.

Sensitivity

IF BANDWIDTH	MAX. APPLIED INPUT FOR 10 dB $\frac{S+N}{N}$ SSB/CW
8 kHz	0.8 microvolt
2 kHz	0.4 microvolt
1 kHz	0.3 microvolt
0.4 kHz	0.3 microvolt
SSB	0.4 microvolt

Image Rejection

>70 dB

IF Rejection

>70 dB

Sideband Suppression

≥60 dB at 500 Hz into the unwanted sideband

Cross Modulation

With a wanted signal of 500 microvolts, an unwanted signal of 10 millivolts, 30%, 400 Hz modulation and separated 10 kHz or more, produces an output at least 30 dB below output level due to the wanted signal.

Blocking

The receiver output due to a wanted signal of 500 microvolts changes less than 3 dB when an unwanted signal of 50 millivolts at least 10 kHz removed is applied.

IF Bandwidth

SWITCH POSITION	6 dB DOWN	60 dB DOWN
8 kHz	8 kHz min.	20 kHz max.
2 kHz	2 kHz min.	12 kHz max.
1 kHz	1 kHz min.	6 kHz max.
0.4 kHz	0.4 kHz max.	4 kHz max.
USB	+350 to +2700 Hz*	≤-500 Hz and ≤+3800 Hz*
LSB	-350 to -2700 Hz*	≤+500 Hz and ≤-3800 Hz*

*Referenced to Carrier

Automatic Gain Control		Output rise 6 dB max. for input from 3 to 100,000 microvolts. Output rises 11 dB max. for input from 1 microvolt to 100,000 microvolts.
AGC	SLOW	FAST
Attack Time	≤10 milliseconds	≤10 milliseconds
Release Time	2 seconds (nominal)	150 milliseconds (nominal)

Input Impedance	
15 to 29,999.9 kHz	50 ohms (nominal) with Preselector in WIDEBAND position
0.1 to 4 MHz	Preselector matches receiver input to typical electrically short antennas
4 to 29.9999 MHz	50 ohms (nominal) with Preselector in tuned position
Audio Output	
3.2 ohms	1 Watt at 5% maximum distortion (internal or external speaker)
600 ohms	10 dBm maximum
Primary Power	115/230 Volts, ±15%, single phase, 50/60 Hz
Power Requirements	90 watts at full audio output level
Ambient Operational Temperature	0 to 50°C (meets GPO specification requiring operation at -15°C)
Humidity	to 95%

b. APPROXIMATE OVERALL SIZE AND WEIGHT

HEIGHT	WIDTH	DEPTH	WEIGHT
5-1/4"	19"	19"	36 lb.

TABLE 1.1

ITT MACKAY MARINE
COMPARISON OF SYNTHESIZED RECEIVERS USED TO PROVIDE CONTINUOUS FREQUENCY COVERAGE FROM 15 TO 29,999.9 kHz

	3020A (690001-000-001)*	DEBEG 7200 (690001-000-003)	EB-3026 (690001-000-004)	EB-3028 (690001-000-005)	3020B (690001-000-007)
WIDEBAND	2nd Mixer (600590-536-001) with 8 kHz Band-pass Filter 600035-529-001	2nd Mixer (600590-536-002) with 6 kHz Band-pass Filter 600044-529-001	2nd Mixer (600590-536-002) with 6 kHz Band-pass Filter 600044-529-001	2nd Mixer (600590-536-001) with 8 kHz Band-pass Filter 600035-529-001	2nd Mixer (600590-536-001) with 8 kHz Band-pass Filter 600035-529-001
OUTPUT	600 Ohm Line Amplifier (600719-536-001) Audio Transformer for Balanced 600 Ohm Output (635160-501-001)	600 Ohm Line Amplifier (600719-536-001) Audio Transformer for Balanced 600 Ohm Output (635160-501-001)	600 Ohm Line Amplifier (600719-536-001) Audio Transformer for Balanced 600 Ohm Output (635160-501-001)	600 Ohm Line Amplifier (600719-536-001) Audio Transformer for Balanced 600 Ohm Output (635160-501-001)	600 Ohm Line Amplifier (600719-536-001) Audio Transformer for Balanced 600 Ohm Output (635160-501-001)
PRIMARY POWER	115/230 Volts ac (2A Fuse)	Rear Panel (600035-539-002) with Stripped Lead Power Cord (230 Volts ac) (600059-102-001) 1A Fuse	Rear Panel (600035-539-004) with Stripped Lead Power Cord (230 Volts ac) (600059-102-001) 1A Fuse	Rear Panel (600035-539-003) with Stripped Lead Power Cord (230 Volts ac) (600059-102-001) 1A Fuse	Rear Panel (600035-539-003) with Stripped Lead Power Cord (230 Volts ac) (600059-102-001) 1A Fuse
FRONT PANEL	Front Panel (600034-539-002)	Front Panel (600034-539-002)	Front Panel with Handles (600034-539-003)	Front Panel with Handles (600034-539-003)	Front Panel with Handles (600034-539-004)
MOUNTING	Desk Top Console or 19" Rack	Desk Top Console or 19" Rack	Desk Top Console or 19" Rack	Desk Top Console or 19" Rack	Desk Top Console or 19" Rack
NAMEPLATE	3020 Nameplate (600207-626-001) on Rear Panel	DEBEG 7200 Nameplate (600210-626-001) on Front Panel	EB-3026 Nameplate (600208-626-001) on Rear Panel	EB-3028 Nameplate (600209-626-001) on Rear Panel	None

*Except for cabinet 600078-704-001 provided with the Group -002 Receiver, Groups -001 and -002 are the same.

SECTION 2

INSTALLATION

2.1 CABINET/RACK INSTALLATION

ITT Mackay Marine Type 3020 Radio Receiver mounts in a standard 19" rack, occupying 5-1/4" of panel height and 19" of depth. *Pem* nuts are provided in side panels for installation of slides.

NOTE: *If slides are not used, do not attempt to support the receiver drawer only by the front panel. Provide braces in the cabinet or rack to support the rear of the drawer.*

To permit adequate ventilation for proper heat dissipation, the 3020 should have a minimum 2" clearance on all sides.

2.2 POWER CONNECTIONS

The input ac power to the 3020 Receiver is 115/230 Volts, ±15%, 50/60 Hz, single phase. A grounded Standard US plug is provided.

CAUTION

Verify that the power transformer is strapped for the correct ac input voltage.

For 115 Volt operation, transformer primary windings must be connected in parallel (terminals 1 and 3 must be connected together and terminals 2 and 4 must be connected together). 115 Volts is applied to terminals 1 and 4.

For 230 Volt operation, transformer primary windings must be connected in series (only terminals 2 and 3 must be connected together). 230 Volts is applied to terminals 1 and 4.

Transformer strapping is located on the underside of the receiver chassis and access is gained by removal of the underside rear cover plate.

2.3 REAR PANEL CONNECTIONS

A terminal block (TB1) is provided on the receiver rear panel for connections as indicated in Table 2.1.

The 600 ohm audio output terminals (terminals 5 and 6) and the 3 ohm speaker output terminals are provided on terminal block TB1, on the rear panel.

For connection to the 3 ohm speaker terminal, disconnect the jumper on the terminal block and connect the external 3 ohm speaker between terminal 3 and ground (terminal 2). For muting operation, connect terminals 1 and 2 to transmitter key.

NOTE: *Removing the jumper disconnects the front panel speaker.*

TABLE 2.1

TERMINAL BLOCK PIN NO.	AVAILABLE CONNECTION
1	Muting
2	Chassis ground
3*	3 ohm external speaker
4*	3 ohm line to front panel speaker
5	600 ohm Balanced
6	600 ohm Balanced

*Terminals 3 and 4 are normally jumpered.

2.4 FUSES

Three fuses (F1, F2, and F3) are used in the 3020 Receiver. F2 and F3 are located on the rear panel. F1 is located on the Regulator PC Board attached to the inside of the rear panel. Table 2.2 describes the fuses.

TABLE 2.2

DESIGNATION	RATING (AMPS)	FUNCTION
F1	1.5	Fuse following the rectifier bridge and filter for the +28 Volt dc and +24 Volt dc circuitry.

DESIGNATION	RATING (AMPS)	FUNCTION
F2	1/10*	Short circuit protection for the +28 Volt dc and +24 Volt dc circuitry.
F3	**	Primary ac fuse.

*Slo-Blo
**2 amp fuse for 115 Volt ac operation; 1 amp fuse for 230 Volt ac operation.

SECTION 3

OPERATING INSTRUCTIONS

3.1 FRONT PANEL CONTROLS

All controls required for operating the ITT Mackay Marine Type 3020 Radio Receiver are located on the front panel. The function of each is described below.

a. IF BANDWIDTH kHz PUSHBUTTON SWITCHES

Four interlocking pushbutton switches select IF bandwidth of 0.4, 1.0, 2.0 and 8.0 kHz.* These switches are automatically disabled when USB or LSB is selected.

b. MODE PUSHBUTTON SWITCHES

Allow selection of AM, CW, USB or LSB mode of operation. AM pushbutton switch enables the AM detector circuitry while the product detector circuitry and the product detector injected are disabled. CW, USB or LSB pushbutton switch causes reverse to occur.

c. PRESELECTOR (BAND MHz TUNING) CONTROL KNOB AND SWITCH

The outer control is a 10 position switch that selects the appropriate tuned frequency range. The inner variable control knob provides Preselector tuning and is used in conjunction with the RF meter to peak the receiver input signal. Frequency of tune increases as knob is rotated clockwise.

d. FREQUENCY SELECT SWITCHES

Select receiver tuned frequency in kHz and consist of six level-controlled decades. Each decade has digits 0 through 9, except the most significant decade which only has digits 0, 1, and 2. In all cases, the dialed frequency should correspond to the exact listed frequency of the station being received.

e. PHONES JACK

Connects to the 3 ohm audio output to disconnect the speaker.

*3020B has IF bandwidth of V. NAR., NAR., MED., and WIDE.

f. SPEAKER (ON/OFF) TOGGLE SWITCH

Turns speaker on and off.

g. CW PITCH (FIXED/VARIABLE) SWITCH AND (VARIABLE) CONTROL KNOB

The toggle switch selects either fixed or variable frequency product detector injection. For CW operation the variable frequency crystal oscillator is utilized for operator pitch control by the VARIABLE control knob. The tuning range is approximately 1 kHz. In the FIXED position the product detector injection is provided by the frequency standard and produces zero beat when the incoming CW signal is precisely at the frequency of the frequency select switches.

h. AGC (FAST/SLOW) TOGGLE SWITCH

Selects fast or slow AGC release time. Normally fast AGC is utilized for CW signals and slow AGC for SSB and AM signals.

i. RF GAIN/AGC ON CONTROL KNOB

Manually adjusts the 92 MHz amplifier gain and the 8 MHz IF amplifier gain. Also switches AGC on when the knob is fully counterclockwise (switched).

j. METER DISPLAY (RF INPUT/AUDIO OUTPUT) TOGGLE SWITCH

Selects either audio or RF signal strength indication on the front panel meter. Audio display is derived from the rectified audio output, while the RF level indicator is derived from the AGC dc control voltage.

k. ANT. ATTEN. (IN/OUT) TOGGLE SWITCH

Connects 20 dB (approximate) pad in receiver front end.

l. AUDIO GAIN/POWER OFF CONTROL KNOB

Controls audio volume and switches ac power on and off. Also turns on circulating cooling fan when the receiver is turned on.

m. PULL FOR FINE TUNE CONTROL KNOB

Varies tuning approximately ±100 Hz about dialed frequency when knob is pulled out.

3.2 SSB OPERATION

The 3020 Receiver normally is used with AGC enabled for all modes. AGC has a large dynamic operating range over which the output is held very constant. Further, the attack time is rapid, allowing for good transient response in SSB and CW modes of reception.

For SSB reception, select USB or LSB. The USB pushbutton is normally depressed for Marine SSB service with the CW PITCH switch set to FIXED. In this condition the frequency indicated by the frequency select switches on the front panel is that (of the suppressed carrier) of the station being received.

The frequency of the desired station is generally known and dialed. When a station frequency is not known, the band can be scanned by the 1 kHz position of the digit switch with the receiver in CW mode and the 8 kHz BANDWIDTH pushbutton depressed. When a station is found, the receiver can be returned to the normal SSB operating condition by depressing the USB pushbutton.

Above 4 MHz, the PRESELECTOR range switch is normally left in the WIDE-BAND position since the receiver meets all its sensitivity, image, cross modulation, and spurious response specifications in this mode. For frequencies below 4 MHz, when compromise electrically short antenna systems are most likely to be encountered, some benefit can be obtained by using the Preselector as a form of impedance matching network to obtain optimum sensitivity. In addition, the Preselector is effective in reducing interference from very strong off-frequency signals. The Preselector in conjunction with the Antenna Attenuator can clean up an otherwise unreadable signal.

The AGC knob is usually set to LOW for SSB reception to keep the receiver from *pumping up* between voice syllables.

3.3 CW OPERATION

The excellent selectivity characteristics of the 3020 can be more fully exploited in continuous wave (CW) operation than in voice operations when information bandwidths must be relatively wide.

With CW PITCH control set to FIXED, the frequency select switches again indicate the frequency of the carrier being received when audio output is zero beat. In CW reception the CW PITCH switch is generally set to VARIABLE position and the VARIABLE control knob is adjusted for the desired audio pitch by the operator. Note that the 0.4, 1.0, 2.0, or 8.0 kHz filters are centered on 8 MHz while the USB and LSB filters are set so that 8 MHz is on the skirts of the filters, typically 20 dB down. For CW operation when the desired station frequency is known, the frequency select switches are set to that frequency and the 0.4, 1.0, 2.0 or 8.0 kHz selectivity pushbutton is depressed. The CW PITCH VARIABLE control knob is then adjusted for the desired pitch.

USB or LSB filters can be used for CW reception. In order for the signal to be in the passband of the filter, the frequency select switches must be offset from the exact frequency of the station being received. This is inconvenient for merely dialing in a desired frequency and normally the sideband filters are not used for CW reception.

3.4 AM OPERATION

The AM pushbutton is depressed in this mode of operation and usually the 8-kHz-wide bandwidth is selected. The frequency select switches are set to the frequency of the desired signal. Reception of fading AM signals is generally enhanced by using either USB or LSB mode, with the CW PITCH switch in the FIXED position.

3.5 DUPLEX OPERATION

The 3020 Receiver may be suitable for full duplex operation if certain factors are met. Factors that affect this type of operation include transmitter power, transmitting and receiving frequency, and antenna separation and strength of received signal.

When unsatisfactory duplex operation results, an external Preselector or tunable notch filter should be used to provide required rejection of transmitter energy.

SECTION 4

TECHNICAL DESCRIPTIONS

4.1 SIGNAL PATH

a. BLOCK DIAGRAM ANALYSIS

Refer to the Signal Path Block Diagram, Figure 4.1, page 4.3.

A signal in the range of 15 to 29,999.9 kHz enters the Preselector where it passes through an overload protection circuit. At the operator's discretion the signal can pass through a single RF circuit tuned to the desired frequency or it can bypass this circuit (in the WIDEBAND position). The signal then goes through a 40 MHz low-pass filter at the Preselector output.

The signal then is fed through a bandpass RF amplifier into the 1st Mixer where it is up converted by the operator selected synthesizer output to the 92 MHz first IF amplifier. The signal from the 1st Mixer is passed through a 20 kHz wide 4 pole crystal bandpass filter centered at 92 MHz and then to the 92 MHz IF amplifier where it is amplified and passed through another bandpass filter. Delayed AGC voltage is applied to this dual gate FET IF amplifier. The output of the 2nd 92 MHz filter goes into the diode quad 2nd Mixer where it is mixed with the 84 MHz second injection signal to produce an 8 MHz signal.

The 8 MHz IF signal leaves the 2nd Mixer through an 8 kHz wide crystal bandpass filter. (This filter is the narrowest filter in the signal path when 8 kHz bandwidth is selected by the operator.)

The output from this 8 kHz wide filter is amplified by an 8 MHz IF amplifier, to which IF AGC voltage is applied. The output from the amplifier is routed through an operator selected Information Filter (2 kHz, 1 kHz, 400 Hz, USB or LSB) and then applied to the 2nd 8 MHz IF amplifier to be further amplified.

The output from this 2nd 8 MHz IF amplifier is then applied to three different detector chains: AM Detector chain, product detector chain, and the AGC chain.

The AM chain consists of an 8 MHz preamplifier and a voltage doubler diode AM detector. These circuits are enabled only when AM operation is selected.

The product detector chain consists of an 8 MHz amplifier/buffer that feeds the product detector. This chain is enabled for all modes of operation except AM.

The audio outputs from both the AM and Product Detectors chains are fed through isolating resistors to a common line feeding the audio preamplifier and then the audio power amplifier.

The AGC chain consists of an 8 MHz AGC amplifier, a full wave diode AGC detector, dc amplifiers, and AGC delay circuitry.

b. PRESELECTOR

The Preselector consists of four parts: input overload protection circuit, tunable RF circuits, a 40 MHz low-pass filter, and switchable (20 dB) attenuator.

The input overload protection circuit is a diode clipper that is set to symmetrically clip on peaks greater than approximately 3 Volts. This clipper protects the input of the RF amplifier from destruction by energy from nearby transmitters.

A low-pass filter is incorporated for the range 15 to 100 kHz. The RF coils tune in 8 ranges from 100 kHz to 30 MHz by means of a front panel adjusted variable capacitor. Below 4 MHz the tuned circuits are top-capacity-input coupled to provide a high impedance input for the type of antennas normally encountered in this frequency range. Above 4 MHz the tuned circuits are designed for 50 ohm antennas.

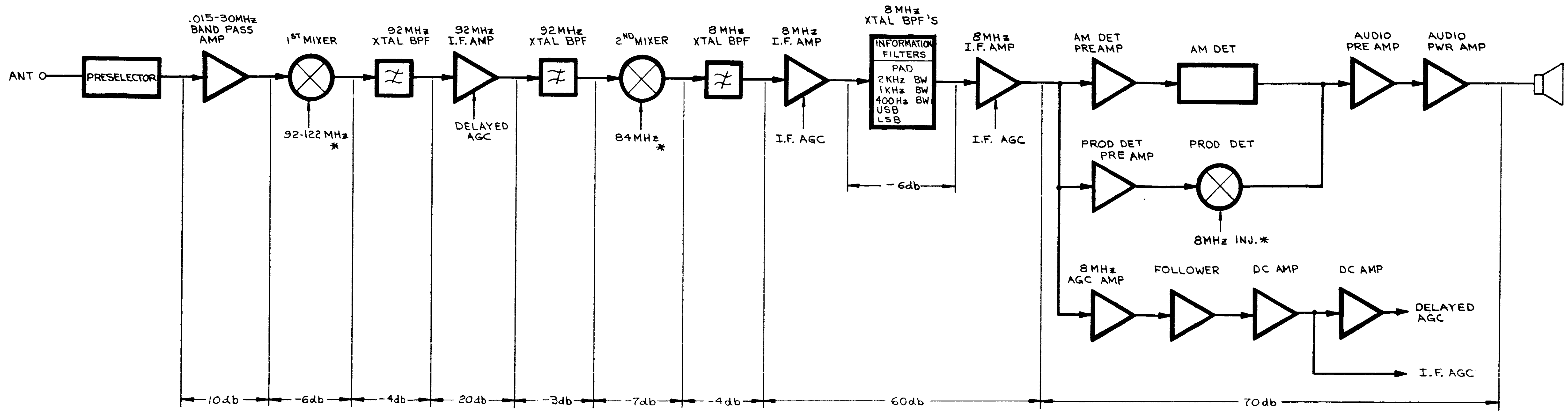
The 40 MHz low-pass filter provides attenuation for input signals above the 30 MHz top frequency limit of the receiver. A parallel-tuned trap at 92 MHz attenuates energy that might otherwise be able to feed into the first IF amplifier of the receiver.

The relay controlled 20 dB attenuator, switched in at the receiver front panel minimizes desensitization and cross modulation caused by strong off channel undesired signals.

c. RF SECTION

The RF Section card consists of four parts: wideband RF amplifier; 1st Mixer and local oscillator buffer; 4-pole, 92 MHz bandpass crystal filter; and 92 MHz amplifier.

Wideband RF amplifier Q1 is a frequency-compensated power FET operated in the common-gate mode. The low input impedance of the amplifier is transformed to approximately 50 ohms by a broadband input transformer.



* FROM SYNTHESIZER.

0895D529

ITT Mackay Marine

BLOCK DIAGRAM (SIGNAL PATH)

690001 028-001

FIGURE 4.1

Output load impedance presented to this stage is set by a second broadband transformer through a peaking network set up to compensate for the output capacitance of the active device. The dynamic range of the RF amplifier from sensitivity to the 1-dB-departure-from-linearity point is in excess of 140 dB.

The 1st Mixer (A1) receives signals from both the RF amplifier and from the synthesizer through the local oscillator common base buffer (Q3). This mixer is a double-balanced (quad) mixer that has a dynamic range of greater than 120 dB. The local oscillator is balanced and the combined signal is fed to the crystal buffer. The combination of the RF amplifier and the double-balanced quad has a dynamic signal handling capability of about 120 dB.

The 4-pole 92 MHz bandpass crystal filter (FL1) has a 6 dB bandwidth of approximately 20 kHz. It provides protection to the 92 MHz IF amplifier (Q2) by rejecting signals removed 10 kHz or more from the desired signal. Thus, even though a strong signal more than 10 kHz removed from the desired signal can be amplified by the broadband RF amplifier and be up converted in the 1st Mixer, the signal will be rejected by the 92 MHz filter.

The 92 MHz filter feeds the 92 MHz amplifier (Q2) which is a dual-gate FET. This device is a low noise figure amplifier (3 dB) with delayed AGC voltage applied to the second gate. It is operated in the grounded-source configuration to provide a high input impedance to the 92 MHz filter. The 92 MHz amplifier drives a single Pi-section filter, which matches the amplifier output to the input of the 2nd Mixer card.

d. 2nd MIXER

The 2nd Mixer card consists of three parts: a 2-pole 92 MHz crystal filter; a double-balanced 2nd Mixer and local oscillator buffer combination; and an 8-pole 8-kHz-wide crystal filter.

The 2-pole 92 MHz crystal filter (FL2) provides further attenuation of undesired signals ±10 kHz removed from the desired signal.

The 2nd Mixer is a double-balanced mixer that is fed by a local oscillator at 84 MHz through common-base buffer-amplifier Q1.

Output of the 2nd Mixer at 8 MHz is fed to the 8-pole 8-kHz-wide crystal filter (FL1). This filter is the only information filter that is used when the receiver is placed in the 8 kHz bandwidth position. The output of the 2nd Mixer is transformed up by L2,C2 to the impedance required by the 8 kHz Bandwidth Filter. This impedance is then transformed down by L3,C3 to the impedance required to match the 8 kHz output.

e. 8 MHz IF AMPLIFIER

The 8 MHz IF amplifier consists of three parts: two IC IF amplifiers, and an emitter-follower buffer amplifier.

The first IF amplifier (IC1) receives and amplifies the signal from the 2nd Mixer. The output goes to the Information Filters card where the desired bandwidth filter is selected. The output from the Information Filters reenters the 8 MHz IF amplifier and is amplified by the second amplifier (IC2). Both of these amplifiers have AGC applied to them. The signal-handling capability of the amplifier increases for increasing AGC gain cut.

The output from the second amplifier is fed to the detectors card and to an emitter-follower buffer on the 8 MHz IF amplifier card. This buffer output is available on the rear panel of the receiver.

f. INFORMATION FILTERS

Each filter on the Information Filters card is selected by means of a diode gate by applying 24 Volts to that gate. The filters not selected are automatically shorted out by the diode gates associated with them.

When the 8 kHz pushbutton is depressed, a pad rather than a filter is connected into the circuit. The amount of attenuation in the pad is equal to that found in one of the sideband filters. The total signal path gain is therefore equal for AM or sideband operation.

g. AM AND PRODUCT DETECTORS

The AM and Product Detectors card consists of four parts: product detector preamplifier; product detector; AM detector preamplifier; and AM detector.

The product detector and AM detector preamplifiers (IC1, IC3) are fed 8 MHz signals in parallel. Only one preamplifier, however, is used at any one time. The appropriate preamplifier is selected by ungrounding either the CW and SSB or the AM command bus. The product detector preamplifier feeds the product detector (IC2) which is an IC balanced mixer. The 8 MHz BFO injection is prevented from feeding back to the 8 MHz IF strip from the product detector by the reverse attenuation of the preamplifier. This prevents the BFO energy from activating the AGC detector.

The AM preamplifier is similar to the product detector preamplifier but has an input level adjustment control (R13) to equalize the audio level between AM and CW/SSB modes.

The output from the AM preamplifier feeds a diode detector whose output is combined, through an isolating resistor, with the output of the product detector and fed through a common output line to the audio amplifier card.

h. AUDIO AMPLIFIER

The Audio Amplifier card consists of three parts: audio preamplifier; audio power amplifier; and meter detector circuit.

Preamplifier Q1 provides audio drive to power amplifier IC1, a power IC with negative feedback to reduce distortion. It operates into output transformer T1 included to match the amplifier to a 3 ohm speaker load. A 560 ohm resistor (R16) provides a 600 ohm output impedance to operate telephone lines.

The meter detector is a full-wave bridge rectifier set up so that one milliwatt into a 600 ohm load indicates 0 dBm on the audio meter.

i. AGC AMPLIFIER

The AGC amplifier consists of six parts: an 8 MHz AGC amplifier; AGC rectifier; emitter follower; IF AGC dc amplifier; delayed AGC active level shifter; and delayed AGC dc amplifier.

AGC amplifier IC1 is an IC amplifier like those used in the 8 MHz IF amplifiers, the AM preamplifier, and the product detector preamplifier. It provides gain to the AGC detector diodes (CR3 and CR4). The detector is followed by emitter follower Q1, which serves as a low impedance driving source for the 22 microfarad AGC decay capacitor (C9). Various resistors shunted across the decay capacitor allow variable decay times while the emitter follower driver allows fast attack time charging to the 22 microfarad capacitor.

The decay capacitor is followed by feedback dc amplifier Q2-Q3 whose output drives the IF AGC line to the 8 MHz IF amplifier.

The IF AGC line drives active level shifter Q4-Q5 with adjustable threshold. This level shifter drives another dc amplifier pair (Q6-Q7) and provides the delayed AGC voltage to the AGC gate of the 92 MHz IF amplifier in the RF Section card. The adjustable threshold serves to determine the AGC voltage point at which the 92 MHz IF amplifier begins to cut gain. This delaying of AGC voltage to the 92 MHz IF amplifier is necessary to ensure that the signal-to-noise ratio is not degraded with AGC action at medium input signal levels, where noise figure degradation in the front end must be avoided. AGC action to the 92 MHz IF amplifier acts in a reverse direction from the 8 MHz IF amplifier in that gain is decreased as the AGC voltage falls below 8.2 Volts.

j. VARIABLE BFO

The variable BFO consists of an 8 MHz Colpitts crystal oscillator (Q1) followed by an emitter follower buffer stage (Q2). A switch built into the BFO RF-tight (shielded) compartment switches between the output of this variable BFO and the output of the fixed 8 MHz output (derived from the 8 MHz standard) and passes the signal on to the product detector. In the AM mode the +28 Volt dc supply voltage to the variable BFO is disabled. The crystal oscillator frequency is pulled by means of variable capacitor C4 in the BFO compartment.

k. REGULATOR

The regulator consists of six parts: transformer; bridge rectifiers (CR1 and CR2) and filter capacitors; 38 Volt preregulator system; 38 Volt preregulator current overload protection system; +28 Volt regulator system; +24 Volt regulator system; and +5.6 Volt regulator system.

Transformer T1 supplies power to both the +55 Volt (CR1) and +14 Volt (CR2) bridge rectifiers and their associated filter capacitors.

The IC regulators for the +28 Volt (IC1) and +24 Volt (IC2) power systems can operate with a maximum input voltage of +40 Volts. It is desirable to provide a degree of preregulation to these high current medium-voltage supply systems as well as to lower their input voltage. Thus, the preregulator system of Q3, Q4, CR4 and associated circuitry is used. This preregulator circuit uses a simple Darlington connected series pass regulator with a base voltage set by zener CR4.

In the event of a current overload on either the +24 Volt or +28 Volt line, transistors Q1 and Q7 conduct (the voltage drops across R1 and R15 cause them to conduct) in turn, causing Q6 to conduct. Q6 bleeds the base drive from the Q3-Q4 pair and prevents damage. This action starts for currents on either line exceeding approximately one ampere. Transistor Q6 puts a heavy current through Slo-Blo fuse F2. If the overload lasts for longer than approximately 20 seconds the fuse will blow.

4.2 FREQUENCY SYNTHESIZER

a. BLOCK DIAGRAM ANALYSIS

Refer to Frequency Synthesizer Block Diagram, Figure 4.2, page 4.9.

The synthesizer in the ITT Mackay Marine Type 3020 Radio Receiver consists of two programmable phase locked loops. The Minor Loop is controlled by the 100 Hz, 1 kHz, and the 10 kHz positions of the front panel frequency select switches. The Major Loop is controlled by both the output of the first loop and the settings of the 100 kHz, 1 MHz, and 10 MHz frequency select switches.

Both the Minor and Major Loops are phase-locked to an 8 MHz temperature compensated crystal oscillator standard, although in the interface between the two loops a conversion oscillator (84 MHz) is used that is not phase locked to the standard. Since this 84 MHz provides the injection

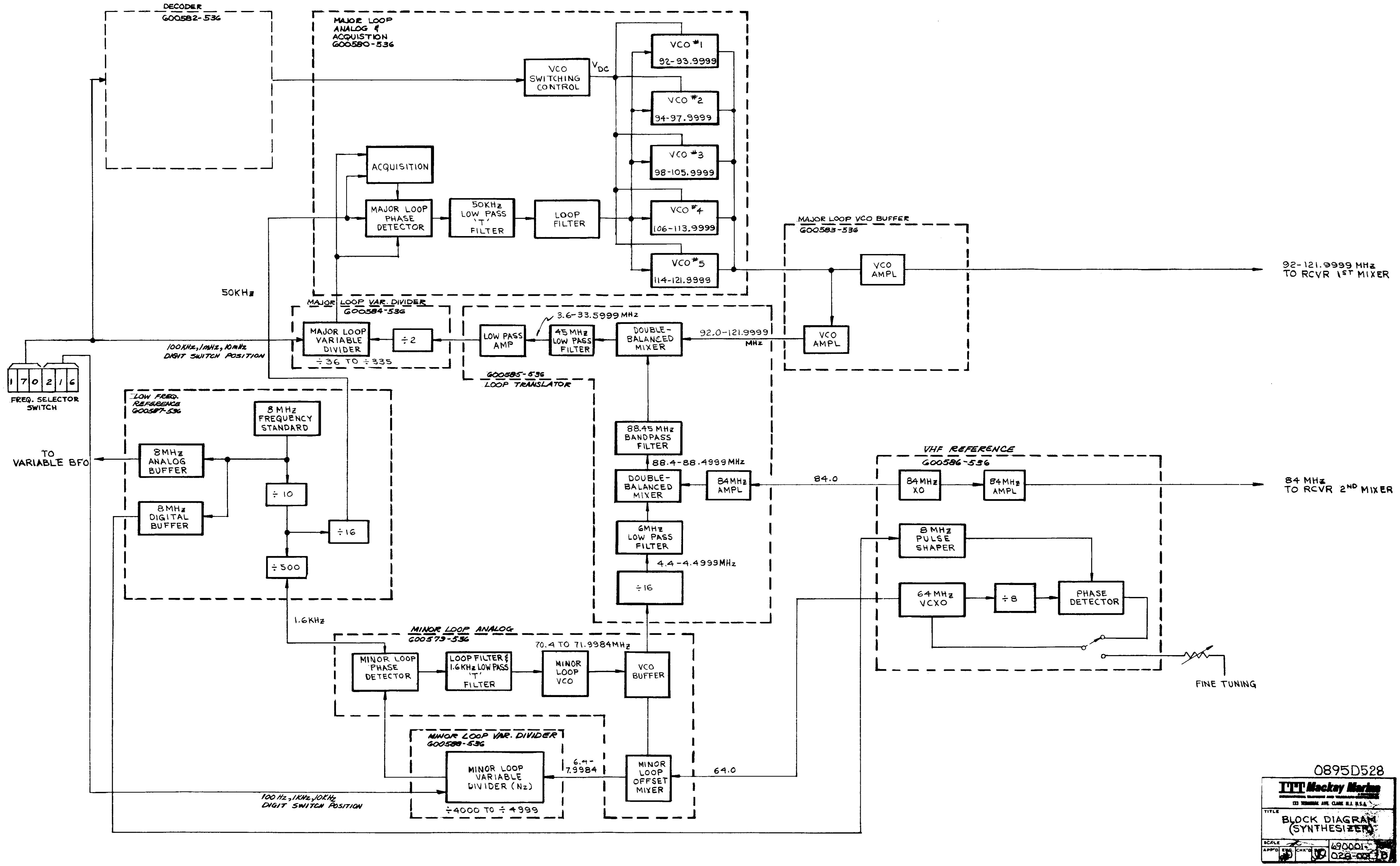
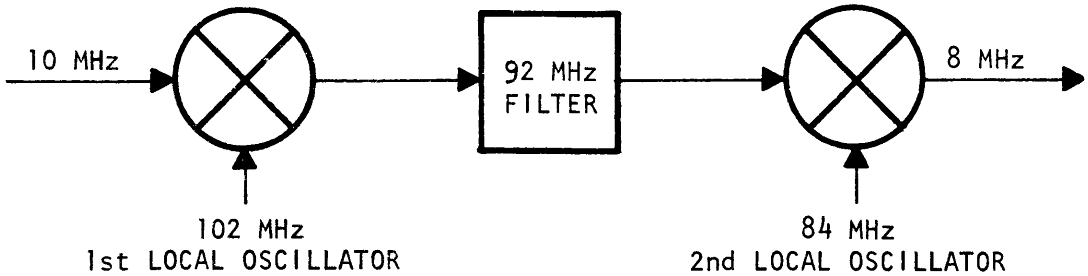

DECODER
G00582-536
MAJOR LOOP ANALOG & ACQUISTION
G00580-536
VCO SWITCHING CONTROL
V DC
VCO #1 92-93.9999
VCO #2 94-97.9999
VCO #3 98-105.9999
VCO #4 106-113.9999
VCO #5 114-121.9999
ACQUISITION
MAJOR LOOP PHASE DETECTOR
50KHz LOW PASS 'T' FILTER
LOOP FILTER
MAJOR LOOP VCO BUFFER
G00583-536
VCO AMPL
VCO AMPL
92-121.9999 MHz TO RCVR 1ST MIXER
50KHz
MAJOR LOOP VAR. DIVIDER
G00584-536
MAJOR LOOP VARIABLE DIVIDER
÷2
÷36 TO ÷335
100KHz, 1MHz, 10MHz DIGIT SWITCH POSITION
LOW PASS AMP
3.6-33.5999 MHz
45MHz LOW PASS FILTER
DOUBLE-BALANCED MIXER
92.0-121.9999 MHz
G00585-536
LOOP TRANSLATOR
1 7 0 2 1 6
FREQ. SELECTOR SWITCH
LOW FREQ. REFERENCE
G00587-536
8 MHz FREQUENCY STANDARD
TO VARIABLE BFO
8MHz ANALOG BUFFER
8MHz DIGITAL BUFFER
÷10
÷16
÷500
1.6KHz
88.45 MHz BANDPASS FILTER
88.4-88.4999 MHz
DOUBLE-BALANCED MIXER
84MHz AMPL
84.0
6MHz LOW PASS FILTER
4.4-4.4999MHz
÷16
VHF REFERENCE
G00586-536
84MHz XO
84MHz AMPL
84 MHz TO RCVR 2ND MIXER
8 MHz PULSE SHAPER
64 MHz VCXO
÷8
PHASE DETECTOR
FINE TUNING
MINOR LOOP ANALOG
G00579-536
70.4 TO 71.9984MHz
MINOR LOOP PHASE DETECTOR
LOOP FILTER & 1.6KHz LOW PASS 'T' FILTER
MINOR LOOP VCO
VCO BUFFER
MINOR LOOP VAR. DIVIDER
G00588-536
MINOR LOOP VARIABLE DIVIDER (Nz)
÷4000 TO ÷4999
6.4-7.9984
MINOR LOOP OFFSET MIXER
64.0
100Hz, 1KHz, 10KHz DIGIT SWITCH POSITION
0895D528
ITT Mackay Marine
BLOCK DIAGRAM (SYNTHESIZER)

FIGURE 4.2

to the 2nd Mixer in the receiver signal path, and since the output of the synthesizer provides the injection to the 1st Mixer in the signal path, the overall receiver becomes drift cancelled. That is, any shift in the 84 MHz oscillator away from 84 MHz is compensated for in the system on a cycle-for-cycle basis.

For example, assume that a signal of 10 MHz is to be received. The first local oscillator frequency would be 102 MHz; the second local oscillator frequency would be 84 MHz; and the final output IF frequency should be 8 MHz as indicated in the following illustration:



3020 MIXER SCHEME

If the second local oscillator frequency happens to be 84.002 MHz, the first local oscillator becomes 102.002 MHz.

The conversion then becomes 10.0 MHz to 92.002 MHz, and 92.002 MHz back to 8.000 MHz. The receiver has thus compensated for the slight change in the 84 MHz frequency and will do so as long as the signal remains within the ±10 kHz passband of the 92 MHz 1st IF filters.

The Minor Loop produces 999 steps from 70.4000 to 71.9984 MHz at its output. The output frequency is mixed with a 64 MHz signal phase locked to the 8 MHz crystal standard to yield a range from 6.4000 to 7.9984 MHz. (The 64 MHz crystal oscillator may be taken out of phase-lock mode and allowed to run free. The frequency can be pulled to provide fine tuning.) This output is divided by a divisor ratio between 4000 to 4999 to yield a 1.6 kHz output. This 1.6 kHz is compared in a phase detector to 1.6 kHz derived from the 8 MHz crystal standard. If a difference occurs between the output from the variable divider and the 1.6 kHz reference, the loop adjusts the frequency until no error occurs. For example, suppose a dial setting of the frequency select switches is chosen and the divider ratio is 4100. The VCO will adjust itself until

$$\frac{X - 64{,}000 \text{ kHz}}{4100} = 1.6 \text{ kHz}, \quad X = 70{,}560 \text{ kHz } (70.560 \text{ MHz})$$

The Major Loop produces, for any particular Minor Loop output frequency, 30 steps in its output. The output of the Major Loop varies from 92.0000 to 121.0000 MHz (with a 92.0000 MHz 1st IF this yields a receiver frequency range from 0 to 29.9999 MHz).

The Major Loop takes the 70.4 to 71.9984 MHz output from the Minor Loop and first divides it by 16 to yield a range from 4.4 to 4.4999 MHz. This range of frequencies then is mixed with the output of an 84 MHz crystal oscillator (as already discussed) to yield a range from 88.4 to 88.4999 MHz. This range then is used to mix with the output range of the Major Loop, thus producing a range from 3.6 to 33.500 MHz.

This frequency range then is fed to a variable divider, which divides by 2 and then by 36 to 335. If the loop is at the right output frequency, the final result of these operations is an output from the variable divider at 50 kHz, the sampling frequency of the Major Loop. The output of the variable divider is compared to a 50 kHz pulse train derived from the 8 MHz crystal standard.

For example, if the Minor Loop output frequency is 70.560 MHz, as in the previous example, this divided by 16 yields: 70.560/16 = 4.410 MHz. This is mixed with 84.0 MHz to yield 88.410 MHz. If the variable divider is programmed to divide by 100 (÷2, ÷50), then the output frequency will be

$$\frac{X - 88{,}410 \text{ kHz}}{100} = 50 \text{ kHz},\ X = 93{,}410 \text{ kHz (93.410 MHz)}$$

Therefore, 93.410 - 92.000 MHz IF = 1.410 MHz desired reception frequency.

b. LOW FREQUENCY REFERENCE

The purpose of the Low Frequency Reference is to provide 1.6 kHz, 50 kHz, and 8 MHz reference pulses for the Minor Loop, Major Loop, and the VHF Reference, respectively. 8 MHz output is also provided.

The output from temperature compensated crystal standard Y1 is buffered in Q1 and fed to the 8 MHz product detector. It is also buffered by Q2 and Q3 and fed into a digital buffer (the inverters in ICA) at TTL level to feed the VHF Reference card.

IC1 and IC2 divide 8 MHz by 10 and then by 16 to yield a 50 kHz output. A 1.25-microsecond-wide pulse at a 50 kHz rate is provided from gate B decoding from IC2. A positive rising and negative falling output pulse is provided for the Major Loop phase detector at 50 kHz.

The 800 kHz output from IC1 is fed to IC3, then IC4, and IC5, which form a divide-by-500. This yields a 1.6 kHz output frequency. Gates C and A decode the various dividers to produce a 12.5-microsecond-wide output pulse at a rate of 1.6 kHz. A positive rising and negative falling output pulse are provided to the Minor Loop phase detector at 1.6 kHz.

c. VHF REFERENCE CARD

The purpose of the VHF Reference card is to provide an 84 MHz output signal for the Loop Translator and signal path 2nd Mixer and to provide a

64 MHz output that is phase-locked to the 8 MHz standard for the Minor Loop Analog card.

The VHF Reference card contains five parts: an 84 MHz crystal oscillator and buffer; a 64 MHz crystal oscillator; an analog-to-ECL (emitter coupled logic) level 64 MHz buffer; an ECL divide-by-8; and a phase detector dc control system for the 64 MHz phase-locked loop.

The 84 MHz oscillator (Q2) is a modified Colpitts crystal oscillator fed into a FET buffer (Q1) and then to the signal path.

The 64 MHz oscillator (Q3) is another modified Colpitts crystal oscillator, but one whose frequency is pullable by means of varactor CR1. The 64 MHz oscillator can be phase locked to the 8 MHz standard, or can be allowed to run free. Voltage applied to CR1 can be used to fine tune the receiver.

In the phase-lock mode the 64 MHz oscillator is followed by buffer Q4-Q5, which converts the analog 64 MHz signals to emitter-coupled logic (ECL) levels to drive the ECL high speed divide-by-8 counter comprised of IC4 and IC5. This divide-by-8 produces 8 MHz pulses that are fed to low-pass filter C40, L8, and C41.

The filtered 8 MHz is then fed to the phase detector dc control system, IC3, which is a cascode mixer type phase detector. 8 MHz energy from the Low Frequency Reference is also fed to IC3. The dc output from IC3 goes to varactor CR1 through the fine-tune enable relay to complete the loop.

d. MINOR LOOP ANALOG

The Minor Loop Analog card consists of four parts: the Minor Loop offset mixer and 64 MHz buffer; the 70.4 to 71.9984 MHz VCO (voltage controlled oscillator) and buffer; the Minor Loop sample-and-hold phase detector; and the loop filter/1.6 kHz T-notch filter.

The Minor Loop offset mixer is an IC cascode mixer, IC2, which is fed local oscillator power through the 64 MHz buffer, Q11, which, in turn is fed from the VHF Reference card. The buffered output of the 70.4 to 71.9984 MHz VCO (buffered by IC3) is also fed to the mixer, and the 6.4 to 7.9984 MHz difference output from the offset mixer is fed to the Minor Loop Variable Divider.

The VCO is a form of Hartley oscillator. The frequency can be changed by varying the voltage across varactor diodes CR4 and CR5. IC3, a cascode amplifier, buffers the VCO and feeds 70.4 to 71.9984 MHz energy both to the divide-by-16 on the Loop Translator card and to the Minor Loop offset mixer.

The Minor Loop sample-and-hold phase detector system consists of Q1 through Q7.

Ramp capacitor C15 is charged by constant current generator Q2 and is discharged by ramp switch Q1 triggered by the 1.6 kHz reference pulse. During the rise of the ramp voltage the output from the Minor Loop Variable Divider pulses on sampler gate Q6 and Q7 for a short period. At this time energy is transferred from the sampler driver system Q3, Q4, and Q5 to sample capacitor C18.

The dc amplifier composed of Q8, Q12, and Q9 amplifies the voltage across the sampler capacitor and applies it to loop filter (R4, R5 and C3) and then to the 1.6 kHz T-notch filter R36, R37, R38, C20, C21, and C22. The filtered dc is then applied to varactors CR4 and CR5.

The principle of this phase lock system is that if successive voltage samples are not the same, the frequency is wrong and must be changed by the loop until successive samples are the same.

Diodes CR7 and CR8 serve to short the loop and notch filters for large voltage swings and thus serve to decrease the time to achieve acquisition and phase lock.

e. MINOR LOOP VARIABLE DIVIDER

The Minor Loop Variable Divider is composed of four programmable decade divider IC's and their associated decoding gates. Basically, the divider is preloaded with a number from the front panel frequency select switches (100 Hz, 1 kHz, 10 kHz decades) and counts down to zero. When the output recognizes a count of BCD 0000, a pulse is sent to the load data input which allows the four IC's to be preset again. At each load data point the last decade counter is preloaded to BCD 4.

For example, when the frequency select switches are set to 10 kHz = 0, 1 kHz = 0, and 100 kHz = 0, the counters are preset to ICA = 0000, ICB = 0000, ICC = 0000, and ICD = 0010. The counter counts down 4999 pulses, at which point the counters are in the state ICA = 0000, ICB = 0000, ICC = 0000, ICD = 0000. This enables all the gates and presets all the counters once again. Thus the variable counter in this case divides by 4999.

When the frequency select switches are set to 999 the counters are preset to ICA = 1001, ICB = 1001, ICC = 1001, and ICD = 0010. The counter counts down 4999 pulses. At this point the states are again all 0's, the gates are all enabled, and all the counters are preset once again. Thus, the variable counter in this case divides by 4999.

f. LOOP TRANSLATOR

The function of the Loop Translator is basically to allow the output of the Minor Loop to partially control the ultimate frequency the Major Loop assumes.

The Loop Translator consists of three parts: the divide-by-16 and associated 6 MHz low-pass filter; the 88.4 to 88.4999 MHz double-balanced mixer, associated 84 MHz local oscillator buffer amplifier, and 88.45 MHz bandpass filter, and buffer amplifier.

The 70.4 to 71.9984 MHz signal from the Minor Loop Analog card enters the Loop Translator where it is buffered through emitter-follower Q1 to ECL levels and then divided by 16 in the high speed four stage ECL divider contained in IC1 and IC2. The 4.4 to 4.4999 MHz output from the divider chain is buffered in Q2 and passed through a 6 MHz elliptical low-pass filter. The signal then goes to a double-balanced diode quad mixer. This mixer is fed from FET buffer amplifier Q5 and then is fed from the 84 MHz output of the VHF Reference card.

The resultant 88.4 to 88.4999 MHz output from the mixer is filtered in a four-section bandpass filter centered on 88.45 MHz. The output from this filter feeds another double-balanced quad mixer (A1). The local oscillator in A1 is the buffered output from the main loop VCO, from 92.0 to 121.999 MHz. The output of this mixing action is from 3.6 to 33.5000 MHz.

This range passes through an elliptical 45 MHz low-pass filter consisting of C28, C34, C35, and L9, to amplifier IC3, where it is amplified and fed to another buffer Q3, Q4. This buffer has a TTL level output signal which feeds the Major Loop Variable Divider card.

g. MAJOR LOOP VARIABLE DIVIDER

The function of the Major Loop Variable Divider is to divide by N, when N is an even integer from 72 to 670; i.e., 72, 74, 76, 78...670.

Since the counter counts even integral numbers a divide-by-two (ICA) precedes the actual programmable portion of the counter.

The frequency range fed to the variable counter card is 3.6 to 33.500 MHz. The range fed to the programmable portion of the variable counter (consisting of ICF, ICG, and ICH) is 1.8 to 16.75 MHz. The IC's used in the programmable portion of the variable counter have maximum counting rates just above the top end of this range, and the time delays involved in the presetting and count recognition process can be longer than the time between successive input pulses.

Because of excessive time delays, a side counter consisting of ICA and ICB fed in parallel with the programmable counters is used. This side counter is inhibited until the programmable counters have counted down from the number preset into them (from the frequency select switches) to the decimal number 166. The decoder gates at the programmable counter outputs then cause the side counter to start.

Once the side counter begins, further input pulses to the programmable counters are inhibited through gate K. Further, once the side counter starts, the programmable counter is allowed to preset. The side counter counts two pulses and stops. The programmable counter is again enabled to repeat the cycle.

In short, the operation proceeds as follows: the programmable counter counts [(N ÷ 2) - 2] pulses, where N is the desired divisor ratio and the divide-by-2 factor is due to the divide-by-2 preceding the programmable counters. The side counter begins at this point and counts a total of 2 pulses (4 pulses at the input to the card). When the side counter starts, the programmable counter is stopped and is preset to the number [(N ÷ 2) - 2] + 166 again. After the side counter has counted a total of 4 input pulses, the programmable counter starts again and repeats the cycle. The action of the side counter allows the presetting function ample time to perform properly.

A division operation is illustrated in the following example. Suppose the desired frequency is 0.00 MHz. The desired N for the overall counter is 72. The programmable counter must be preset to

$$(\frac{N}{2} - 2) + 166 = \frac{72}{2} - 2 + 166 = 200$$

The output of the frequency select switches on the receiver front panel is complement BCD code. The 10's of MHz decade output, however, is offset by 2; therefore, the programmed inputs are as follows for a frequency setting of 10.0 MHz:

SWITCH DECADE	COMPLEMENT BCD INPUT
10's MHz	0011
Units MHz	1111
100's kHz	1111

The programmable counters count down from 200 when gate K is enabled, i.e., after the side counter stops counting. They count down 34 pulses (68 pulses into the input ÷ 2). At this point the decoder gates are all enabled, and a logical 0 appears at pin 6 of gate J. This causes ICA pin 9 to go low, thereby preventing further pulses from entering the programmable counter (at pin 4, ICF) through gate K, and also causing the presetting to 200 to occur (data load command is given to the decade counters).

Gates L (pins 8 and 9) and M (pins 1, 2, 4, 5, and 6) delay the input signal to ICB (pin 13) referenced to the input siganl to ICA (pin 5). This delay allows ICA to control the actions of the J-K flip-flop ICB. ICB produces an output pulse, two input pulses after the decoder output has arrived. In other words, the ICA,ICB combination counts for 2 pulses after it has been enabled.

ICC (flip-flops associated with pins 12 and 9) and ICD lengthen the output pulse from ICB to a length useful for the input to the phase detector on the Major Loop Analog card.

h. DECODER

The synthesizer in the 3020 covers 92 to 121.9999 MHz in five ranges with five switchable VCO's: VCO 1, 92.0 to 93.9999 MHz; VCO 2, 94.0 to 97.9999 MHz; VCO 3, 98.0 to 105.9999 MHz; VCO 4, 106.0 to 113.9999 MHz; VCO 5, 114.0 to 121.9999 MHz.

The function of the decoder board is to decode dialed frequency and to enable the particular VCO with an output frequency range that corresponds to the dialed frequency.

i. MAJOR LOOP ANALOG AND ACQUISITION

The Major Loop Analog and Acquisition card consists of five parts: sample-and-hold phase detector system; acquisition system (frequency discriminator); 50 kHz T-notch filter and loop filter; five VCO's and the VCO switching control system.

The sample-and-hold phase detector system is very similar to that found on the Minor Loop Analog card, with the exception that the time constants are set for a 50 kHz sampling rate rather than the 1.6 kHz sampling rate found in the Minor Loop.

Ramp capacitor C26 is charged by constant current generator (Q8) and is discharged by switch Q7, when Q7 is triggered by a 50 kHz reference pulse. During the rise of the ramp voltage the output from the Major Loop Variable counter pulses-on sampler gate (Q11, Q12). This causes energy transfer from the ramp capacitor through buffer amplifiers Q9, Q5, and Q10, to sampler capacitor C19.

The dc amplifier (Q13 and Q6) amplifies the voltage across the sampler capacitor and applies this amplified voltage to the 50 kHz T-notch filter, consisting of C12, C13, C28, R32, R20, and R33. The purpose of this notch filter is to remove residual 50 kHz energy that appears as ripple on the dc amplifier output.

The output from the notch filter is applied to the loop filter (R46, R37, and C33) and then to the VCO varactor control lines.

The principle of the phase lock system, therefore, is that if successive voltage samples to the sampler capacitor are not the same, the frequency is wrong and must be changed by the loop until the levels of successive samples are the same.

Because of the relatively large frequency ranges covered by the Major Loop VCO's, however, a means must be employed to prevent false locks;

that is, loop lock-up when phase detector input frequencies are harmonically related. An acquisition circuit, consisting of flip-flop IC3, IC4, IC5, and associated gates, recognizes pulse interlace between the reference pulses and the output from the Major Loop Variable Divider (÷N) card. If in between every two reference pulses there is one and only one ÷N pulse, the frequency of the two pulse trains is the same. If pulse interlace does not occur the acquisition circuit causes the end of the ramp capacitor to go either to ground or to +5 Volts. When the ramp is sampled, the resulting lower or higher voltage causes the VCO frequency to shift off the offending false-lock point. Flip-flops IC4 and IC5 serve to lengthen the output pulses out of the discriminator system to give the VCO time to move off the false-lock point.

The five VCO's all operate in a form of Harley configuration in which frequency is changed by varying the voltage on the varactor control line.

The VCO for the desired frequency range is selected by applying a logical 0 to the control input of the desired VCO. This enables the switching transistor associated with that VCO, and then the VCO.

j. MAJOR LOOP VCO BUFFER

The VCO output of the Major Loop is fed to the local oscillator input of the 1st Mixer in the signal path, and also to the input to the Major Loop Variable Divider via the Loop Translator. However, the 1st Mixer must be free of digital switching noise from the Variable Divider contaminating its local oscillator signal. The Major Loop VCO Buffer thus has two amplifier chains (with good reverse attenuation characteristics) fed in parallel but feeding the two different output loads.

Good reverse attenuation (that is, failing to pass a signal that might appear at its output backwards to its input) is achieved with three common-base wideband transformer-coupled transistor stages per amplifier.

SECTION 5

GENERAL SERVICE INFORMATION

CAUTION

The 3020 is completely solid-state, and therefore routine periodic maintenance is not required. No attempt should be made to touchup the equipment unless specific operational difficulties are encountered and the proper test equipment is available.

5.1 INTRODUCTION

ITT Mackay Marine Type 3020 Radio Receiver is highly modularized, with approximately 90 percent of the circuit components on plug-in cards. This makes most troubleshooting a matter of simply isolating and replacing a faulty card. Repairs to the defective card preferably should be done at the factory, but can be done in the field by trained personnel familiar with 3020 equipment.

The receiver consists of three primary functional parts: Signal Path, Frequency Synthesizer and power supply. The power supply is common to both Signal Path and Synthesizer circuits.

A failure in the synthesizer may be difficult to isolate since the correct output frequency from the synthesizer is the result of the complex interaction of eight cards. If any one of these cards becomes defective the synthesizer may *break lock*; that is, not achieve phase lock at the desired frequency.

5.2 SIGNAL PATH

A defective card in the Signal Path generally can be found by proceeding from the speaker to the front end, introducing signal generators tuned to the appropriate frequency at each point, and listening for the presence or absence of audio output.

For example, assume that a malfunction occurs in the 2nd Mixer card and the desired signal is completely lost. The start of a typical service procedure would be to listen for IF noise in the speaker with the AUDIO and RF GAIN controls advanced. Noise indicates that the audio amplifier chain is functional.

The next step would be to insert a signal generator tuned to 8 MHz at the input to the 8 MHz IF amplifier card to see whether a signal can be put through the IF and detector chains. In this case a signal can indeed be fed down this chain.

Next, put a 92 MHz signal into the 2nd Mixer card. In our example no signal could be forced down the receiver at this point. If a signal is forced down the receiver, a failure exists somewhere between the input to the 2nd Mixer card and the input to the 8 MHz IF Amplifier card. Replacing the 2nd Mixer card with a known good one should restore the receiver to operation.

Figure 4.1 charts signal levels required for 10 dB (S + N)/N audio output at various points in the Signal Path. The conditions necessary for these measurements are also indicated. Further gain and level information is available from the block diagram.

5.3 FREQUENCY SYNTHESIZER

Most of the cards in the synthesizer contain high-speed digital integrated circuits. The operation of these circuits can be observed best with the aid of a high frequency oscilloscope with a bandwidth of at least 100 MHz and high frequency external triggering capability. (Familiarity with the operation of TTL digital circuitry is essential.) The gates used are primarily of the NAND, AND, and INVERT variety. Figure 5.1, page 5.3, lists truth tables for the IC logic block.

When the Minor Loop is locked, the voltage at the junction of R39, C24, C21, and R38 on the Minor Loop Analog card should be stable and within the range of 9 to 13 Volts at frequency extremes of between 00000.0 and 00999.9 kHz. When the Minor Loop is not locked, the voltage at the above point will not be a dc voltage but rather an ac voltage as the loop searches for lock.

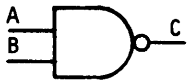
Two pulses that must be present before the Minor Loop can lock are the outputs (both positive- and negative-going) from the Minor Loop Variable Divider, and the positive- and negative-going 1.6 kHz reference pulses. These pulses are standard TTL logic level pulses (0 to 2 Volts) and are approximately 15 microseconds wide.

Another waveform that must be present before the Minor Loop can lock is the ramp voltage found at the junction of the collectors of Q1 and Q2 and C15. This is a sawtooth wave going from 0 to 7 Volts in 625 microseconds.

FIGURE 5.1
3020 TRUTH TABLES

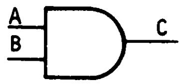
0 = 0.4 VOLTS DC MAX (TTL LOW)

1 = 2.4 VOLTS DC MIN (TTL HIGH)



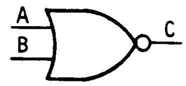
NAND

A	B	C
0	0	1
0	1	1
1	0	1
1	1	0



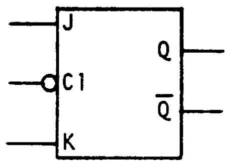
AND

A	B	C
0	0	0
0	1	0
1	0	0
1	1	1



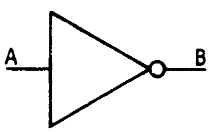
NOR

A	B	C
0	0	1
0	1	0
1	0	0
1	1	0



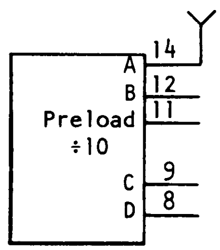
J-K FLIP-FLOP

J	K	Cl Pulse	QN + 1	
0	0	0	QN	INHIBIT
0	1	0	0	CLEAR
1	0	0	1	SET
1	1	0	$\overline{QN}$	TOGGLE

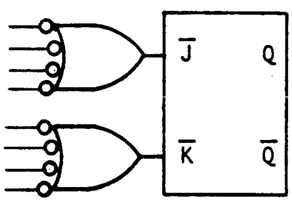


INVERTER

A	B
0	1
1	0



A	B	C	D	BCD NO.
0	0	0	0	0
1	0	0	0	1
0	1	0	0	2
1	1	0	0	3
0	0	1	0	4
1	0	1	0	5
0	1	1	0	6
1	1	1	0	7
0	0	0	1	8
1	0	0	1	9
0	0	0	0	0



J-K ECL FLIP-FLOP

$\overline{J}$	$\overline{K}$	$\overline{CD}$	QN
ND	ND	0	QN
0	0	1	$\overline{QN}$
0	1	1	1
1	0	1	0
1	1	1	QN

CD = One $\overline{J}$ and one $\overline{K}$ tied together

ND = Not defined

The loop can be made to run *open-loop* if the end of resistor R39 connected to C24, C21, and R38 is lifted from the board and connected to a variable voltage power supply. As the voltage is varied between 9 and 13 Volts the output frequency of the VCO should vary between 70.4 and 71.9984 MHz (approximately).

If the Minor Loop Variable Divider is working properly, the number of output pulses in a given time period will vary as the frequency is varied by changing the varactor voltage.

Further, if the sampler and dc amplifiers are working properly (and the loop locked when run closed-loop) the voltage appearing at the point where R39 is lifted from the board should be the same as the voltage applied to the varactors from the variable power supply.

The Major Loop cannot be locked to the correct frequency if the Minor Loop is not at the right frequency. If the Minor Loop is locked but the Major Loop still is not, test for the presence of both negative- and positive-going reference and Major Loop Variable Divider output pulses, just as for the Minor Loop.

Again, just as for the Minor Loop, a ramp is necessary for the Major Loop to function. However, due to the action of the acquisition (frequency discriminator) circuitry the ramp when the loop is out of lock can start at either 0 or roughly 5 Volts, depending on the state of the output stage of IC5 on the Major Loop Analog and Acquisition card. The ramp is capable of rising to roughly 5 or 10 Volts depending on whether it is started from 0 or 5 Volts. When the loop is locked the ramp goes from roughly 5 to 10 Volts or from 0 to 5 Volts.

The Major Loop can be run *open-loop* if CR20, CR21, and R46 are removed from the card and a variable power supply is connected to the junction of R37, R47, R48, R49, R50, R60, and C53.

If the loop is run *open-loop* the acquisition circuitry tends to cause confusing symptoms and should be disabled. This cannot be done easily but can be effected if ICL is removed from the board. The ramp will then travel between 5 and 10 Volts.

NOTE: *On sets having R63 and C52 on Major Loop Analog board, the acquisition circuit can be disabled by connecting a jumper from junction of these components to +5 Volts.*

The Loop Translator card contains four different frequency ranges since it contains two different frequency mixes and a divide-by-16. Analysis of this card is difficult without either a frequency selective voltmeter or a spectrum analyzer.

The Major and Minor Loop Variable Dividers can be confusing to trouble-shoot since high-speed digital circuitry is used. Defects can be spotted by externally synchronizing the oscilloscope to the slowest pulse in a suspicious area and observing the various command pulses that should be causing the output pulse. For example, the decoder output on the Major Loop Variable Divider available at Pin 6 of ICJ can be used to synchronize the oscilloscope while the outputs of the programmable dividers ICF, ICG, and ICH are observed.

SECTION 6

CARD TEST AND SETUP INSTRUCTIONS

CAUTION

Before removing any printed circuit card from the 3020 Receiver prior to alignment procedures, turn the AUDIO GAIN/POWER OFF control knob to POWER OFF. After inserting the extender card in the receiver and then inserting the printed circuit card being tested, turn the receiver on.

6.1 INTRODUCTION

Many of the printed circuit cards used in ITT Mackay Marine Type 3020 Radio Receiver have no adjustable components on them. For example, the variable divider cards are completely digital, with no tuning adjustments of any sort.

The cards that have adjustable components should not be adjusted indiscriminately, especially without the availability of proper test equipment. The cards are properly factory adjusted. The adjustable components have silicone rubber cement on them to lock their settings, and should not require readjustment or touchup unless major components are replaced.

6.2 SIGNAL PATH ADJUSTMENTS

Touchup or *optimization* alignment is discouraged, since the possibility of slightly enhancing performance of the receiver is far overshadowed by the probability of badly misaligning the receiver.

Only highly qualified personnel should attempt the following alignment procedures, and then only with the use of adequate test equipment.

a. RF SECTION ALIGNMENT

Refer to RF Section Schematic Diagram, page 7.9.

(1) Set up receiver as follows:

	SWITCH	SETTING
(a)	AGC	OFF
(b)	RF GAIN	Fully Clockwise
(c)	IF BANDWIDTH	8.0 kHz
(d)	MODE	CW
(e)	PRESELECTOR	WIDEBAND
(f)	ANT. ATTEN.	OUT
(g)	PULL FOR FINE TUNE	Pushed in
(h)	AUDIO GAIN	Comfortable level
(i)	SPEAKER	ON
(j)	RF Voltmeter with 50 ohm termination attached to IF output on rear panel.	

(2) Connect voltmeter between junction of R1, R2 and ground. If Q1 is defective, replace Q1 and then select R1 for 0.4 Volt dc. This level corresponds to 40 milliamps of drain current through Q1.

(3) Introduce signal at 5.005 MHz at a 5 microvolt level, and tune generator into antenna jack for zero beat. Set RF meter to 0.03 Volt scale.

Put RF Section card on extender card, and tune L4 and L5 for maximum output.

NOTE: *The 92 to 122 MHz Synthesizer input to RF Section is approximately 400 mVrms. Delayed AGC voltage goes between about 8.2 Volts at maximum RF gain to 1.4 Volts with RF GAIN fully counterclockwise.*

b. 2nd MIXER ALIGNMENT

Refer to 2nd Mixer Schematic Diagram, page 7.11.

(1) Set up receiver as for RF Section Alignment, Step (1).

(2) Test 8 kHz wide passband response: Introduce signal into receiver tuned to 5.005 MHz at a 5 microvolt level and tune for maximum level on RF voltmeter connected to IF output jack. While observing RF voltmeter, change receiver 1 kHz digiswitch until output drops 6 dB. The upper and lower -6 dB points frequencies should be greater than 8.0 kHz apart, and the passband ripples should be less than 3 dB. If these conditions are not met L2 and L3 must be adjusted.

(3) The tuning of L2 and L3 has a major effect on the bandwidth and the passband ripples in FL1.

L2 and L3 can most easily be adjusted with use of a sweep generator. (They can be adjusted alternately, however, but a *cut and try* method, tuning first one and checking the passband, then the other, until the passband shape and width are satisfactory.) A sweep generator that can be set to a center frequency of 10 kHz and that can be adjusted to a sweep width of about 10 kHz is necessary, as in an oscilloscope with external sweep input terminals, and with a 30 mV per centimeter sensitivity at 8 MHz.

(4) Set receiver up as follows:

	SWITCH	SETTING
(a)	AGC	ON
(b)	IF BANDWIDTH	8 kHz
(c)	MODE	CW
(d)	PRESELECTOR	WIDEBAND
(e)	ANT. ATTEN.	OUT
(f)	PULL FOR FINE TUNE	Pushed in
(g)	AUDIO GAIN	Comfortable level
(h)	SPEAKER	ON
(i)	Oscilloscope connected to IF output jack on rear panel	
(j)	AGC	SLOW
(k)	METER DISPLAY	RF INPUT
(l)	Frequency Select	1000.0 kHz

(5) Set up sweep generator for approximately 1 mVrms output at 10.0 MHz, with a sweep rate of about 10 sweeps per second. Connect sweep generator to receiver. Tune sweep generator carefully for audio output and observe level on RF In Meter. Remove generator from receiver input and turn RF GAIN control clockwise until RF In Meter indicates level observed above. Replace sweep generator at receiver level observed above. Replace sweep generator at receiver input and observe swept display on oscilloscope.

(6) Put 2nd Mixer card on extender card and adjust L3 and L2 for the combination that results in maximum amplitude, consistent with least ripples in the passband.

(7) Put 2nd Mixer back in receiver and repeat Step (2) to check flatness.

(8) Perform Steps (1) and (2) for the 8 MHz IF amplifier.

NOTE: *84 MHz input level to the 2nd Mixer board is 100 mVrms.*

c. 8 MHz IF AMPLIFIER ALIGNMENT

Refer to 8 MHz IF Amplifier Schematic Diagram, page 7.13.

(1) Input coil L1 on this card affects the passband shape of the 8 kHz wide filter (FL1) on the 2nd Mixer card. L1 should be tuned by using an extender card and following the same test setup and procedure employed to tune L2 and L3 on the 2nd Mixer card.

(2) Use the same setup as in Step (1). Tune L7 for maximum output amplitude of the 8 MHz output signal. Repeat Steps (6), (7), and (8) in 2nd Mixer alignment procedure.

(3) Depress USB IF BANDWIDTH pushbutton. Slow sweep speed down to about 3 to 4 sweeps per second and adjust L3 for best passband shape (i.e., lack of passband ripples). Hum on the sweep generator output can cause presentation of a confusing picture. If the hum is excessive, the generator may have to be replaced with a hum-free generator that can be swept *by hand* while observing passband ripples. Since this adjustment involves only one coil, the correct spot can be found quickly.

(4) Remove 2nd Mixer card. Put signal generator tuned to 8.0 MHz at 3 mVrms output between terminal B on 8 MHz IF amplifier connector and ground. Set up receiver as in Step (1) for RF Section Alignment, except turn RF GAIN switch clockwise just enough for switch to click (RF In meter will indicate full scale).

Turn R2 (multiturn pot) until output read on RF voltmeter at the 8 MHz output jack is 14 ±1 mV.

Remove signal generator and replace the 2nd Mixer card to restore receiver to operating condition.

NOTE: *The AGC control voltage at Pin L of the connector goes from 1.45 Volts when the RF GAIN control is fully counterclockwise (AGC on) to 11.1 Volts when the RF GAIN control is turned clockwise just past the point where the switch clicks.*

d. AM AND PRODUCT DETECTORS ALIGNMENT

Refer to AM and Product Detectors Schematic Diagram, page 7.17.

(1) Remove 8 MHz IF Amplifier card from receiver. Place AM and Product Detectors card on extender card. Depress AM MODE pushbutton.

(2) Set up signal generator for 3 mVrms output, modulated 30 percent at 1000 Hz, at 8.0 MHz. Apply generator's output between terminal L and the AM and Product Detectors connector and ground. Connect

oscilloscope to terminal Y of the same connector. Turn R13 for maximum output, and then peak L6 for maximum output. Back off R13 until the peak-to-peak oscilloscope indication is 120 mV peak-to-peak.

(3) Set signal generator for 7 mVrms output with 80 percent modulation at 1000 Hz. Connect audio distortion analyzer to terminal Y and ground and trim L6 for minimum distortion, which should be less than 5 percent. If necessary, readjust R13 for 120 mV peak-to-peak output level for 30 percent 1000 Hz modulation at 3 mV input.

(4) Depress CW MODE pushbutton. Set signal generator to CW with 3 mVrms output. Connect oscilloscope to junction of R3, R4, and C9; tune L1 and L2 for maximum indication. Adjust R10 for 120 mV peak-to-peak output at terminal Y.

NOTE: *The product detector BFO injection level should indicate 1 Vrms.*

e. AGC AMPLIFIER ALIGNMENT

Refer to AGC Amplifier Schematic Diagram, page 7.19.

(1) Use extender card. Set AGC to on position and remove 8 MHz IF amplifier and AM and Product Detectors cards.

(2) Adjust R12 and R21 fully clockwise. Tune signal generator to 8.0 MHz with 3 mVrms output between terminal Y of the AGC Amplifier connector and ground. Set digital voltmeter (or accurate VTVM) between IF AGC, terminal K, and ground. Adjust R4 for maximum voltage, and peak L1 for maximum voltage. Readjust R4 for 5 Volts dc.

(3) Increase signal generator to 7 mVrms output. The IF AGC voltage should rise to 11.4 ±0.5 Volts dc.

(4) Decrease signal generator level to point where IF AGC output voltage is 9 Volts dc. Connect digital voltmeter to delayed AGC output, terminal B. Adjust R12 for 7 Volts dc. Adjust signal generator output level for 7.5 mVrms. Adjust R21 for minimum output level, which should be less than 2.5 Volts dc.

(5) Repeat Step (4) as many times as necessary to achieve the limits of 7 Volts dc at delayed AGC output for 9 Volts dc at 8 MHz.

(6) Observe RF meter reading. Set signal generator for 5 mVrms output and adjust R14 for a -3 dBm reading. Set signal generator for 7 mVrms and adjust R16 for an 80 dB reading.

(7) Repeat Step (6) as many times as necessary to achieve the two limit conditions.

f. REGULATOR ALIGNMENT

Refer to Regulator Schematic Diagram, page 7.25.

(1) Remove rear cover on bottom of receiver.

(2) Connect digital voltmeter between C55 and ground. Adjust R7 for +28.0 Volts dc.

(3) Connect digital voltmeter between C25 and ground. Adjust R19 for +24.0 Volts dc.

(4) Connect digital voltmeter between C56 and ground. Adjust R26 for +5.6 Volts dc.

(5) Replace cover.

6.3 SYNTHESIZER ADJUSTMENTS

a. VHF REFERENCE ALIGNMENT

Refer to VHF Reference Schematic Diagram, page 7.31.

(1) Use extender card. Connect voltmeter across C9. If Q1 is defective, replace Q1 and then select R14 until voltmeter indicates 21 ±0.5 Volts dc. This level corresponds to 7 mA of drain current through Q1.

(2) Disconnect 84 MHz coax (push-on connector) from jack on bulkhead shielding signal path compartment from synthesizer compartment, J23 (second jack from rear of receiver). Connect RF voltmeter with 50 ohm termination to 84 MHz output plug using proper connector.

(3) Tune L1 and L2 (slug position should be near bottom of coil) for maximum output, which should be greater than 150 mVrms. Disconnect RF voltmeter and replace with high frequency counter with 50 ohm termination. Frequency indicated should be 84.003 MHz ±1 kHz. Fine tune L1 if necessary to obtain this frequency. Recheck output level. It should remain greater than 150 mVrms.

(4) Pull out FINE TUNE knob. Connect digital voltmeter (or accurate VTVM) at terminal M of connector. Adjust FINE TUNE knob for 11 Volts dc. Remove Minor Loop Analog card from receiver. Connect high frequency counter with 50 ohm termination between terminal R and ground. Tune C27 and L4 until counter indicates 64.0 MHz ±100 kHz.

(5) Turn FINE TUNE knob fully clockwise. Counter should indicate higher than 64.0016 MHz.

(6) Turn FINE TUNE knob fully counterclockwise. Counter should indicate lower than 63.9984 MHz. By changing C27 and retuning L4 attempt to center 64.0 MHz ±100 Hz in center of FINE TUNE knob's rotation.

(7) Reconnect RF voltmeter in place of counter. Output should exceed 50 mVrms.

b. MINOR LOOP ANALOG ALIGNMENT

Refer to Minor Loop Analog Schematic Diagram, page 7.33.

(1) Use extender card. Put a dc-coupled oscilloscope at the junction of R39, C24, CR8, CR7, CR21, and R38 (varactor voltage test point).

(2) Set front panel frequency select switches to 00000.0 kHz and depress FINE TUNE control on front panel. Turn on receiver. The voltage seen on the scope should be dc if the Minor Loop is in-lock. (If the loop is not locked there will be a voltage varying at a slow rate.) Measure the voltage at the varactor voltage test point. It should be 9.0 Volts when locked.

Set front panel frequency select switches to 00099.9 kHz. The voltage at the varactor voltage test point should be 13.0 Volts dc.

(3) If the loop is either out of lock or not at the voltages listed in Step (2), adjust C31 and T3. Set C31 to the middle of its range. Adjust T3 until phase lock is achieved. Repeat Step (2). If the varactor voltage excursion is too small between the extremes of the switch settings (smaller than 9 to 13 Volts) C31 must be adjusted for more capacity and T3 adjusted for less inductance. If the varactor voltage excursion is too large C31 must be adjusted for less capacity. Trimmer C31 controls the frequency range spread and T3 shifts the frequency, keeping the range essentially the same.

(4) Repeat Steps (2) and (3) until conditions are correct.

(5) Rapidly change 10 kHz switch from 0 to 9, and back again. The loop should rapidly respond by locking (the transient ac waveform at the varactor voltage test point should rapidly go to a dc voltage).

NOTE: *The level of the 70.4 to 71.9984 MHz output should be 300 mVrms across 50 ohms (terminal Z on the connector). The voltage level fed to the Minor Locp Variable Divider should be a minimum of 150 mV across 50 ohms (terminal W). The level of the 64 MHz signal from the VHF Reference card should be 50 mVrms into 50 ohms (at terminal M or Minor Loop Analog connector).*

c. LOOP TRANSLATOR ALIGNMENT

Refer to Loop Translator Schematic Diagram, page 7.37.

(1) Use extender card. Connect voltmeter across C31. Select R21 until voltmeter indicates 21 ±0.5 Volts dc. This level corresponds to 7 mA of drain current through Q5.

(2) Use extender card. Connect high impedance probe of RF voltmeter (Boonton 91 CA recommended) between junction of C27, T1 and ground. Adjust L8 for maximum output, which should be greater than 500 mVrms.

(3) The alignment of the 4-pole 88.45 MHz bandpass filter must be done with a sweep generator that has 50 ohm output terminals. The green output lead from T1 must be disconnected and the A1 mixer must be removed to gain access to the filter. Connect equipment according to Figure 6.1. The filter should be tuned according to Figure 6.2. (The insertion loss should be less than 14 dB.)

(4) The response should be 35 dB minimum down at 93.45 and 83.45 MHz (reading referenced to 0 dB = insertion loss level). Note that this particular measurement should be performed with the sweep generator set for CW and an RF voltmeter with 50 ohm termination (Boonton 91 CA recommended) at the output of the filters.

(5) Carefully reconnect T1 output transformer green lead and mixer A1.

NOTE: *The 3.6 to 33.5999 MHz output level between terminal Z and ground of the connector should be at TTL level, i.e., 0.8 Volt maximum for logical 0 and 2 Volt minimum for logical 1.*

The level of the 92 to 121.9999 MHz signal from the Major Loop VCO Buffer at terminal U should be 300 mVrms minimum into 50 ohms.

The level of the 70.4 to 71.9984 MHz signal from the Minor Loop Analog card at terminal D should also be 400 mVrms minimum into 50 ohms.

The level of the 84 MHz signal from the VHF Reference card at terminal L should be 100 mVrms minimum into 50 ohms.

d. MAJOR LOOP ANALOG AND ACQUISITION ALIGNMENT

Refer to Major Loop Analog and Acquisition Schematic Diagram, page 7.43.

NOTE: *There are two methods of adjusting the VCO's used on the Major Loop Analog and Acquisition card: Either open-loop (preferred) or closed-loop (alternate).*

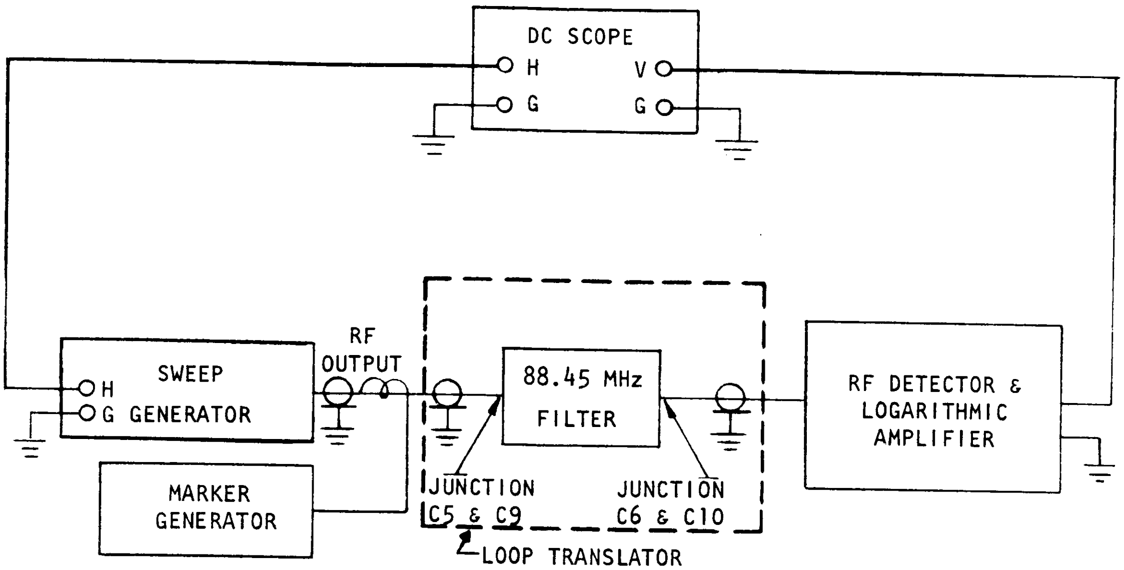


FIGURE 6.1 TEST SETUP FOR
88.45 MHz FILTER ALIGNMENT

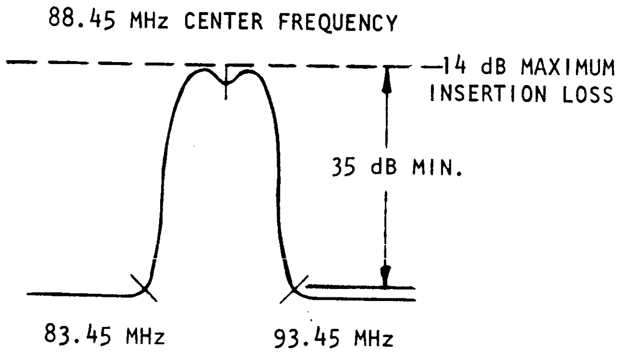


FIGURE 6.2 RESPONSE OF 88.45 MHz FILTER

(1) Open Loop Method of Adjustment (Preferred)

(a) Remove R46, CR20, and CR21 from board. Attach variable power supply capable of going between roughly 8 to 20 Volts dc to junction of R37 and C53. (Note that a variable power supply can be made by connecting a 10K potentiometer across the 24 Volts dc bus to ground.) Use extender card so that adjustment points can be easily reached.

(b) Disconnect synthesizer output plug from signal path bulkhead push-on connector J24 (one nearest rear of receiver). Through suitable adapters, connect synthesizer output to high frequency counter with 50 ohm termination.

(c) VCO #1

(1) Set C40 to the middle of its range. Set front panel frequency select switches to 01000.0 kHz. Set variable power supply to 10 Volts dc. Adjust T3 until the counter reads 92 MHz ±50 kHz.

(2) Adjust power supply to 15 Volts dc. Counter should indicate 94 MHz ±50 kHz.

(3) If the range is too small, i.e., frequency at 15 Volts dc is lower than 94 MHz ±50 kHz, C40 capacitance must be reduced. If frequency at 15 Volts dc is higher than 4 MHz ±50 kHz, C40 capacitance must be increased. Repeat until range is correct.

(d) Repeat preceding Steps a, b, and c for the following table:

FREQUENCY SELECT SWITCH	FREQUENCY LIMIT	POWER SUPPLY	FREQUENCY LIMIT	POWER SUPPLY	ADJUST
01000.0 kHz	92 MHz ±50 kHz	10 VDC	94 MHz ±50 kHz	15 VDC	C40,T3
03000.0 kHz	94 MHz ±50 kHz	10 VDC	98 MHz ±50 kHz	16 VDC	C41,T4
07000.0 kHz	98 MHz ±50 kHz	9 VDC	106 MHz ±50 kHz	17 VDC	C42,T5
15000.0 kHz	106 MHz ±50 kHz	9 VDC	114 MHz ±50 kHz	17 VDC	C43,T6
25000.0 kHz	114 MHz ±50 kHz	9 VDC	122 MHz ±50 kHz	17 VDC	C48,T7

In each VCO note that the trimmer capacitor spreads out the range while the inductor shifts the frequency range keeping the frequency spread relatively the same.

(e) Replace R46, CR20, and CR21 on board and remove the variable power supply. Put a scope probe at the point where the variable power supply was formerly connected. Move the front panel frequency select switches through all MHz positions and observe to see that the loop locks at all frequencies. Lock is indicated when a steady dc voltage is observed on the scope rather than an ac beat note.

(2) Closed Loop Method of Adjustment (Alternate)

NOTE: *The loop is kept closed in this method and the trimmer capacitor and inductor for each VCO are adjusted so that the loop remains in lock and also so that the correct voltage appears at the varactor control line over the frequency range the particular VCO covers.*

(a) The scope is left hooked to the junction of R46, CR20, CR21, and R37. A digital voltmeter is also placed on the varactor control line to monitor dc voltage when the loop is in lock through a 10K resistor.

(b) For each VCO adjustable components are tuned until the loop is locked and until the correct varactor voltage appears as per the following chart. (The capacitors, as before, are first preset to the middle of their ranges.)

MAJOR LOOP VCO SETUP

VCO NO.	FREQUENCY SELECT SWITCH	VARACTOR VOLTAGE	ADJUSTABLE COMPONENTS
1	00000.0 kHz	10 VDC	C40,T3
1	01999.9 kHz	15 VDC	C40,T3
2	02000.0 kHz	10 VDC	C41,T4
2	05999.9 kHz	16 VDC	C41,T4
3	06000.0 kHz	9 VDC	C42,T5
3	13999.9 kHz	17 VDC	C42,T5
4	14000.0 kHz	9 VDC	C43,T6
4	21999.9 kHz	17 VDC	C43,T6
5	22000.0 kHz	9 VDC	C48,T7
5	29999.9 kHz	17 VDC	C48,T7

As before, the trimmer capacitor for each VCO spreads out the range while the inductor shifts the frequency range, keeping the frequency range relatively the same.

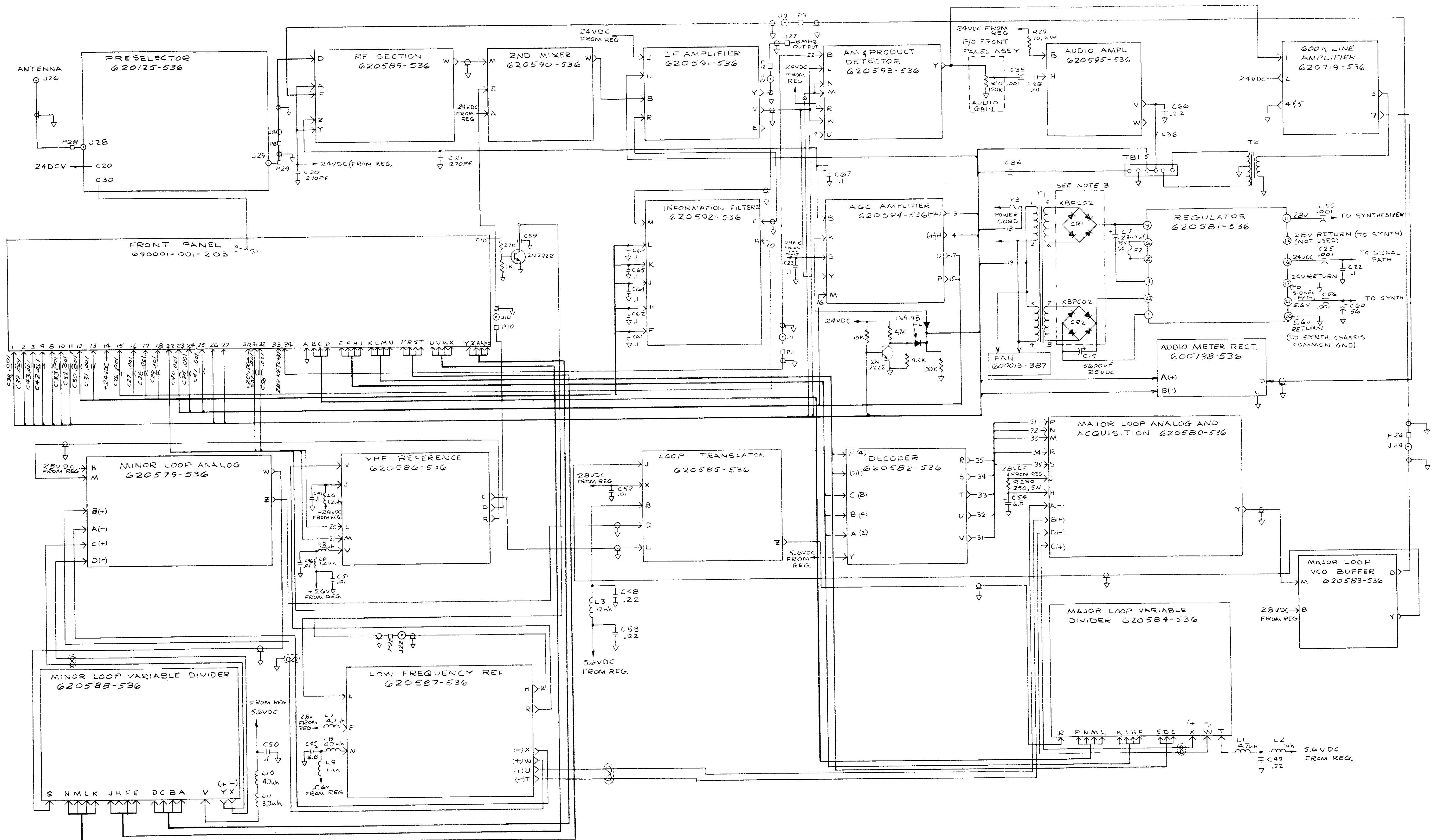
NOTE: *The output of the card into a 50 ohm load (with VCO buffer card removed) is 100 mVrms minimum from 92 to 122 MHz.*

SECTION 7

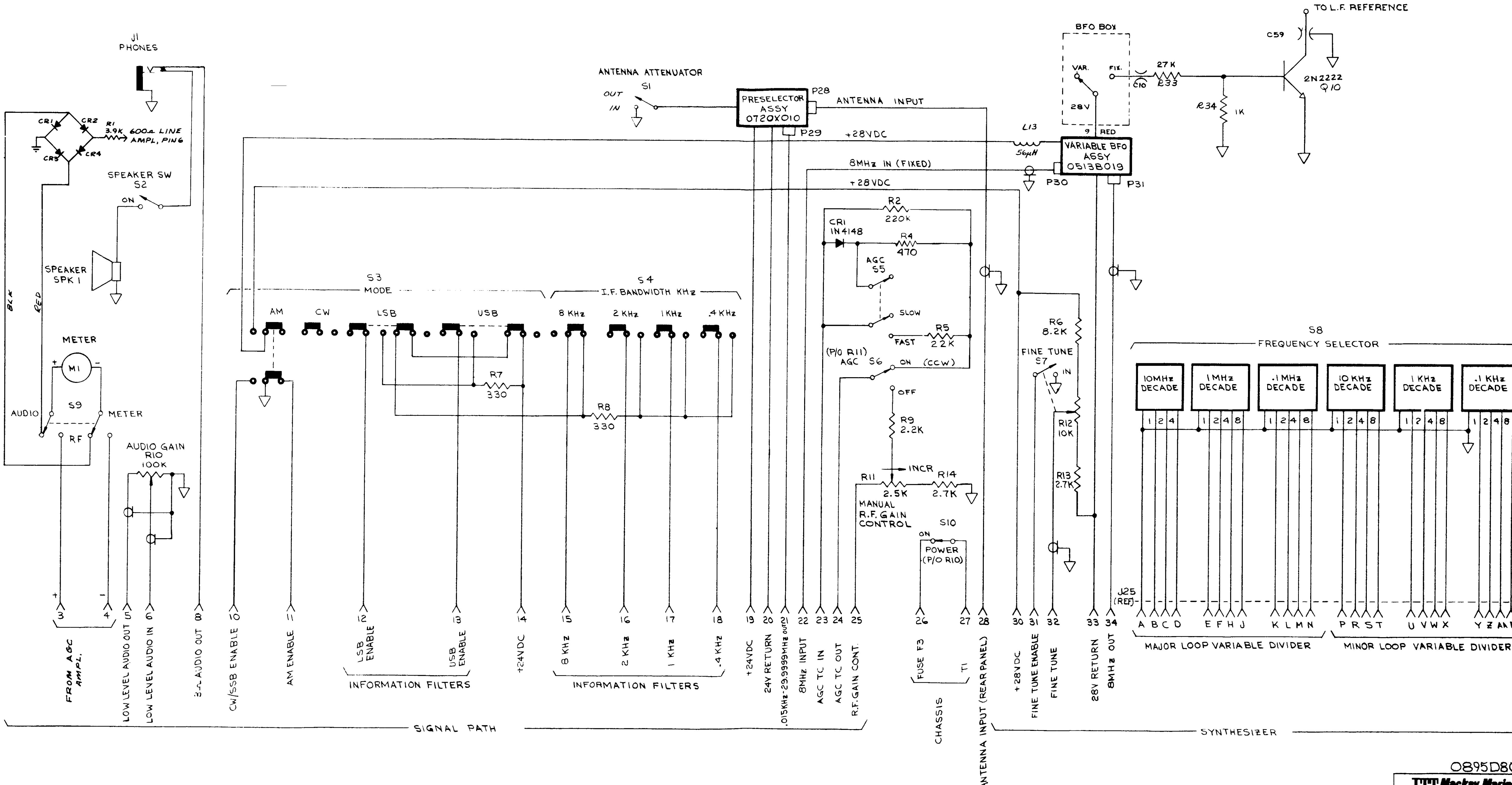
SCHEMATICS, WIRING DIAGRAMS, PHOTOGRAPHS, REPLACEABLE PARTS AND SPARE PARTS

CONTENTS

CONTENTS (CONT)



3020 SCHEMATIC
DIAGRAM



NOTES:

1- ALL SLIDE SWITCHES IN ⟶ OUT ⟵

2- MODE, I.F. BANDWIDTH AND AGC SWITCHES INTERLOCK.

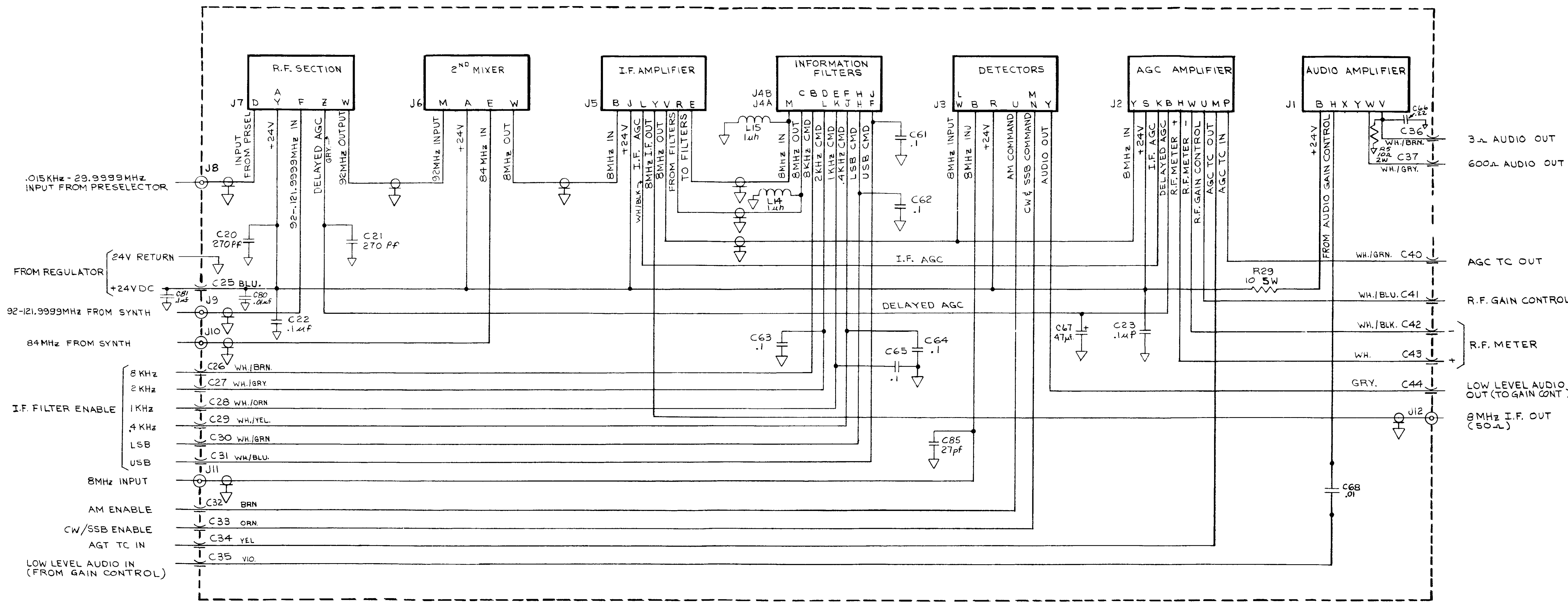
3- UNLESS OTHERWISE SPECIFIED: ALL RESISTANCE IN OHMS K=1000

0895D805

ITT Mackay Marine

TITLE SCHEMATIC FRONT PANEL

690001-001-203 H



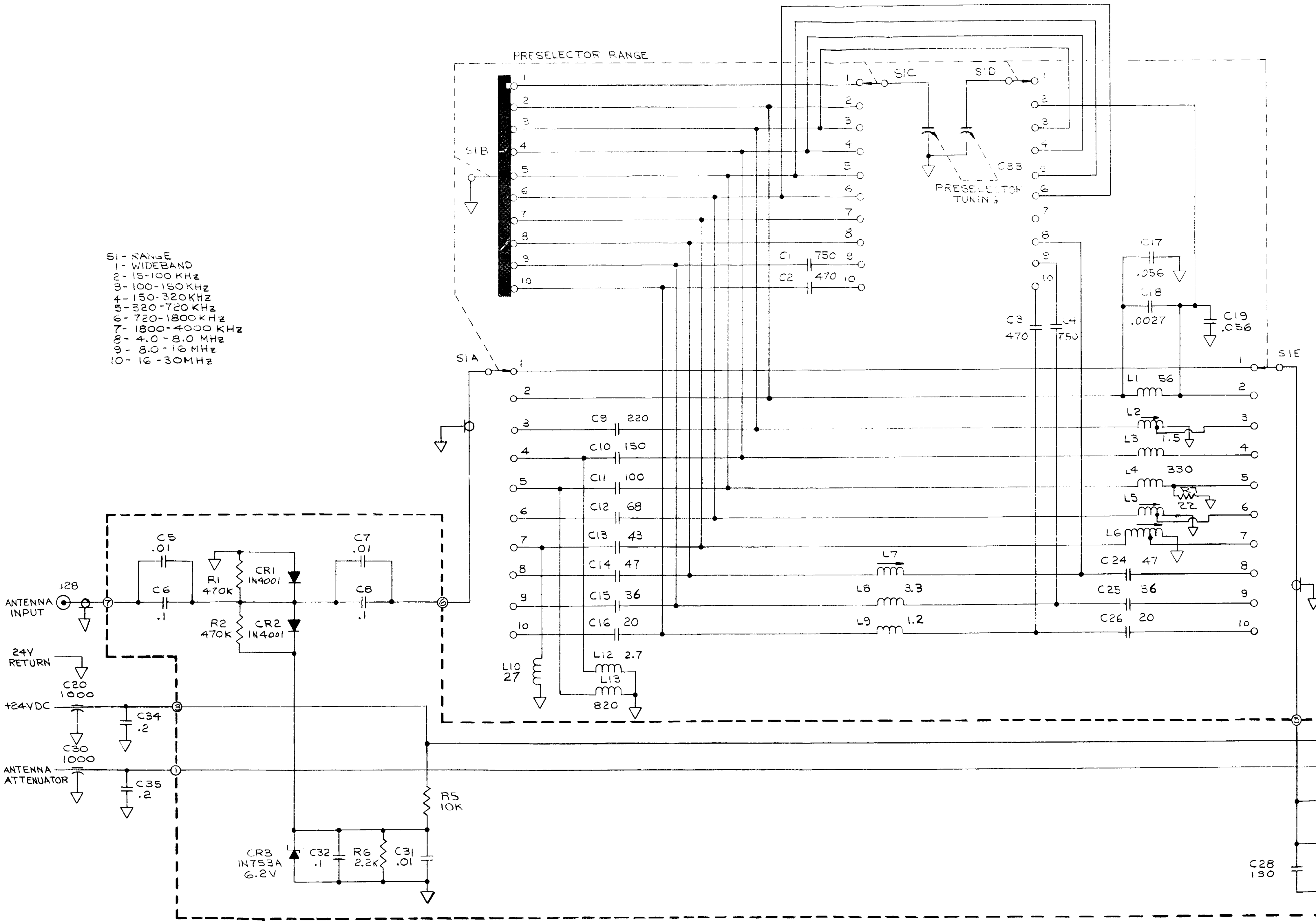
TITLES	GRD
R.F. SECTION	J7- B,C,E,H,J,K,L,M,N,P,R,S,T,U,V,X
2ND MIXER	J6- B,C,D,F,H,J,K,L,N,P,R,S,T,U,V,X,Y,Z
I.F. AMPLIFIER	J5- A,C,D,F,H,K,M,N,P,S,T,U,W,X,Z
INFO FILTER	J4A- C,D,E,N J4B - A,K,L
DETECTORS	J3- A,C,D,E,F,H,J,K,P,S,T,V,X,Z
AGC AMP.	J2- A,C,D,E,F,J,L,N,R,T,V,X,Z
AUDIO AMP	J1- A,C,D,E,F,J,K,L,M,N,P,R,S,T,U,Z

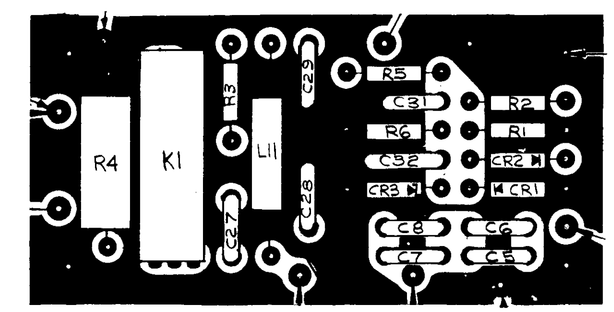
0895D806

ITT Mackay Marine

TITLE: FRAME WIRING DIAGRAM SIGNAL PATH

690001-001-202 REV F





0562B108

ITT Mackay Marine

PRESELECTOR P.C. BD. ASSY.

SCALE 2:1 | 600603-536 | REV

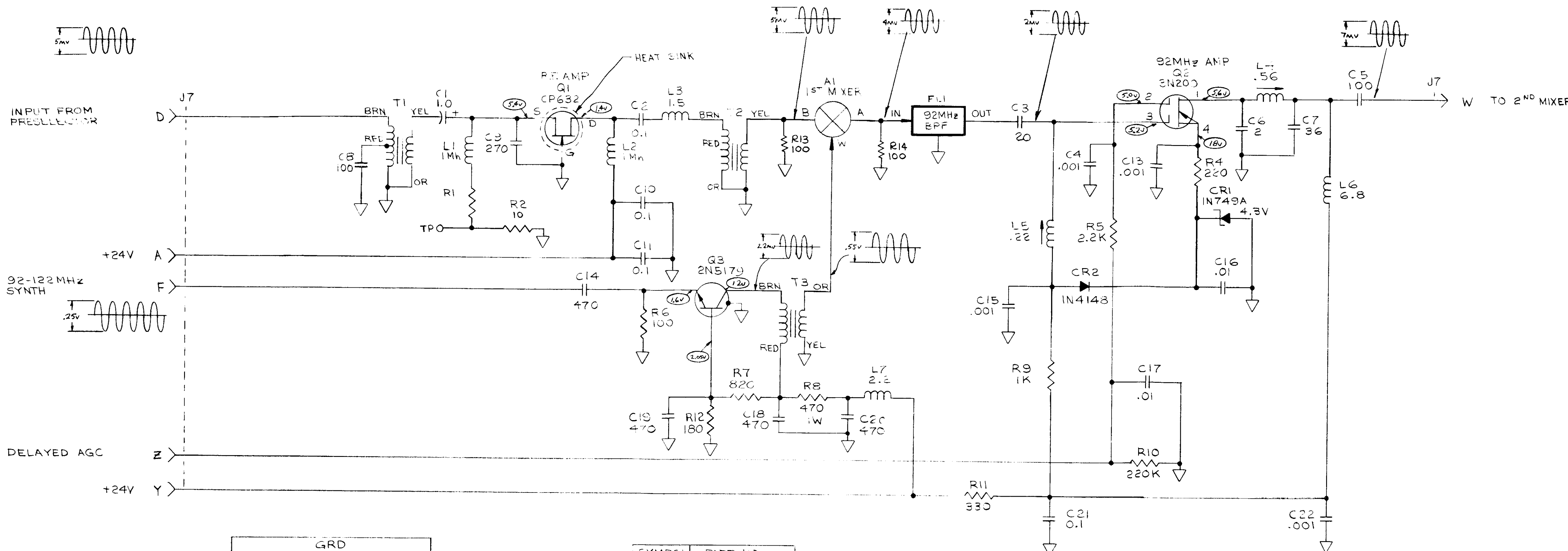
NOTES:
1-UNLESS OTHERWISE SPECIFIED;
ALL CAPACITANCE VALUES GREATER THAN 1.0 ARE IN PF.
ALL CAP VALUES 1.0 AND SMALLER ARE IN µF.
ALL INDUCTANCE VALUES µh.
ALL RESISTANCE VALUES IN OHMS.
K=1000.

0895D039

ITT Mackay Marine

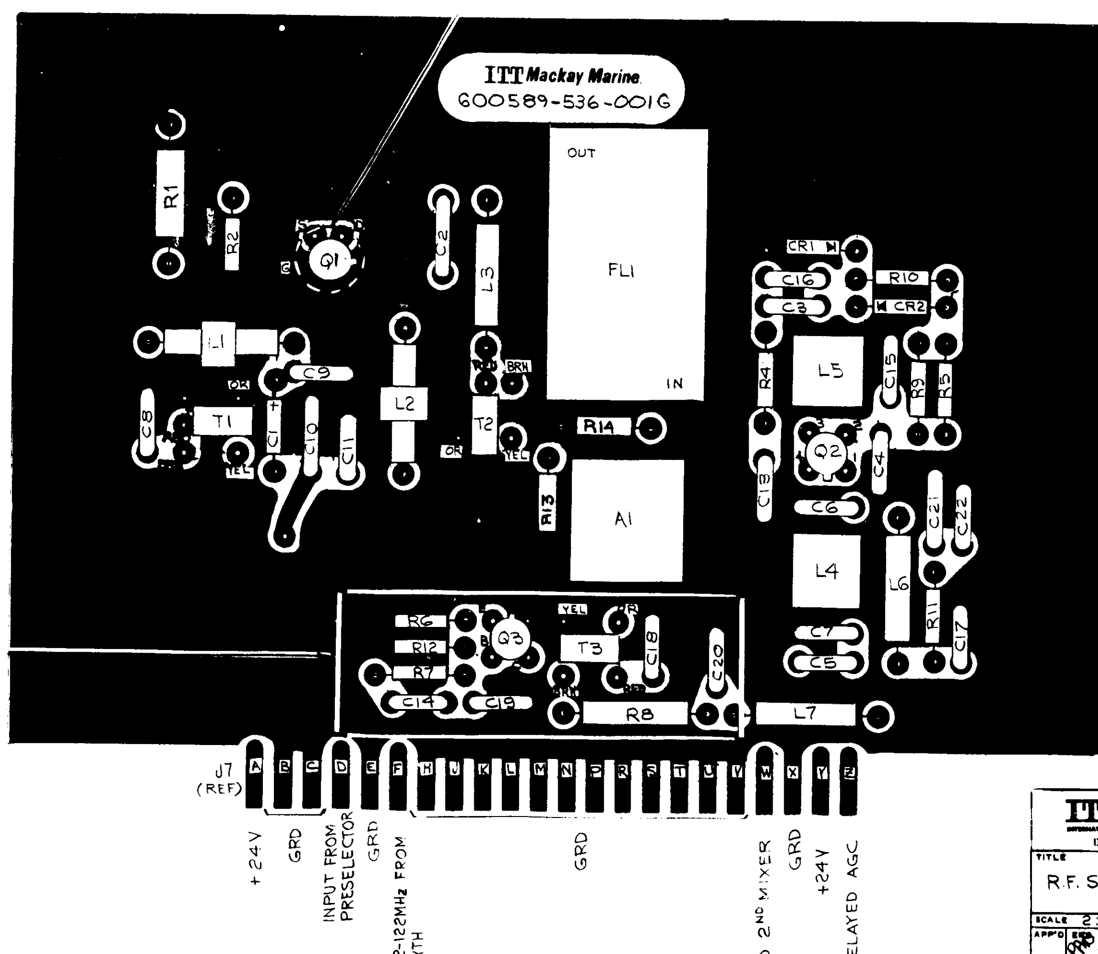
SCHEMATIC PRESELECTOR

620125-537 | REV D



GRD
J7-B,C,E,H,J,K,L,M,N,P,R,T,U,X

SYMBOL	PART NO.
T1,T2	600052-512-001
T3	600050-512-001



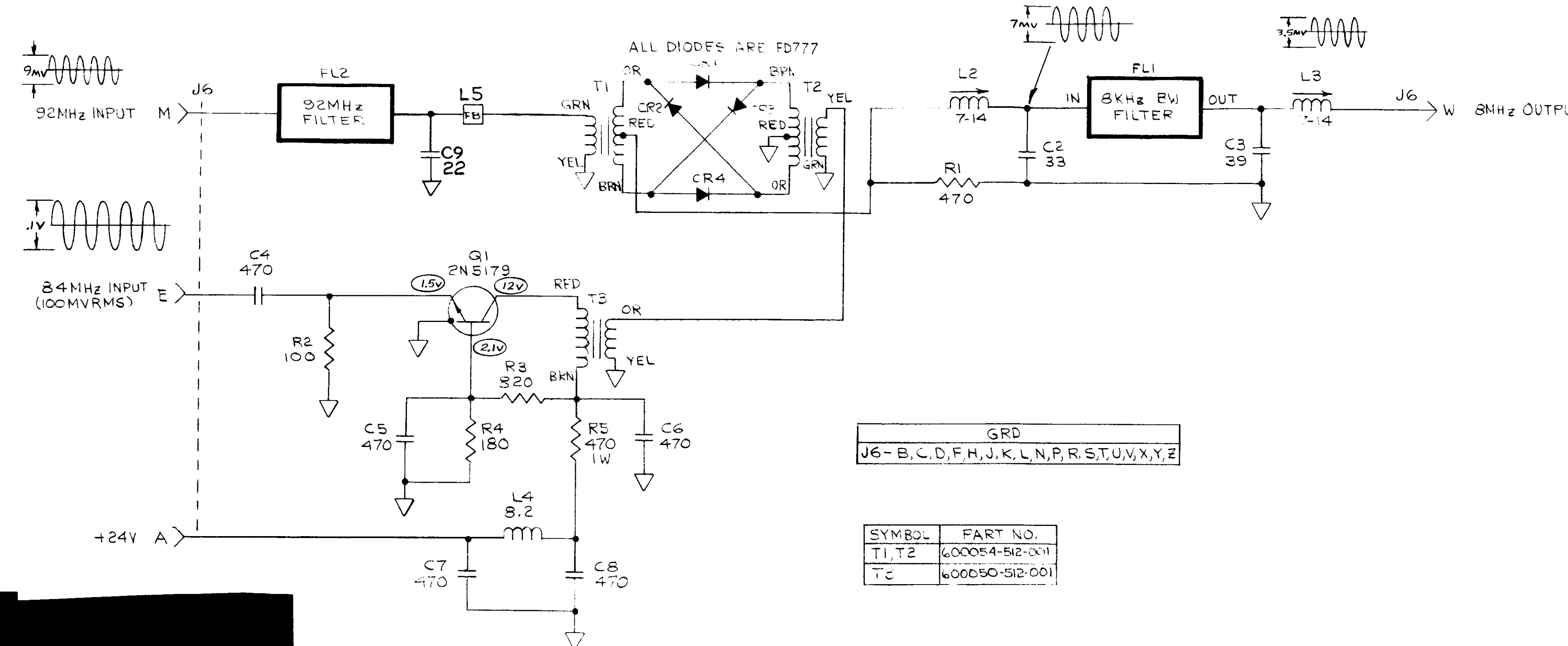
NOTES:
1-UNLESS OTHERWISE SPECIFIED;
ALL CAPACITANCE VALUES GREATER THAN 1.0 ARE IN PF.
ALL CAP VALUES 1.0 AND SMALLER ARE IN μF.
ALL INDUCTANCE VALUES μH.
ALL RESISTANCE VALUES IN OHMS
K=1000

0562C096

ITT Mackay Marine
133 TERMINAL AVE. CLARK N.J. U.S.A.
TITLE: R.F. SECTION ASSEMBLY
SCALE 2:1
600589-536 REV C

0895D021

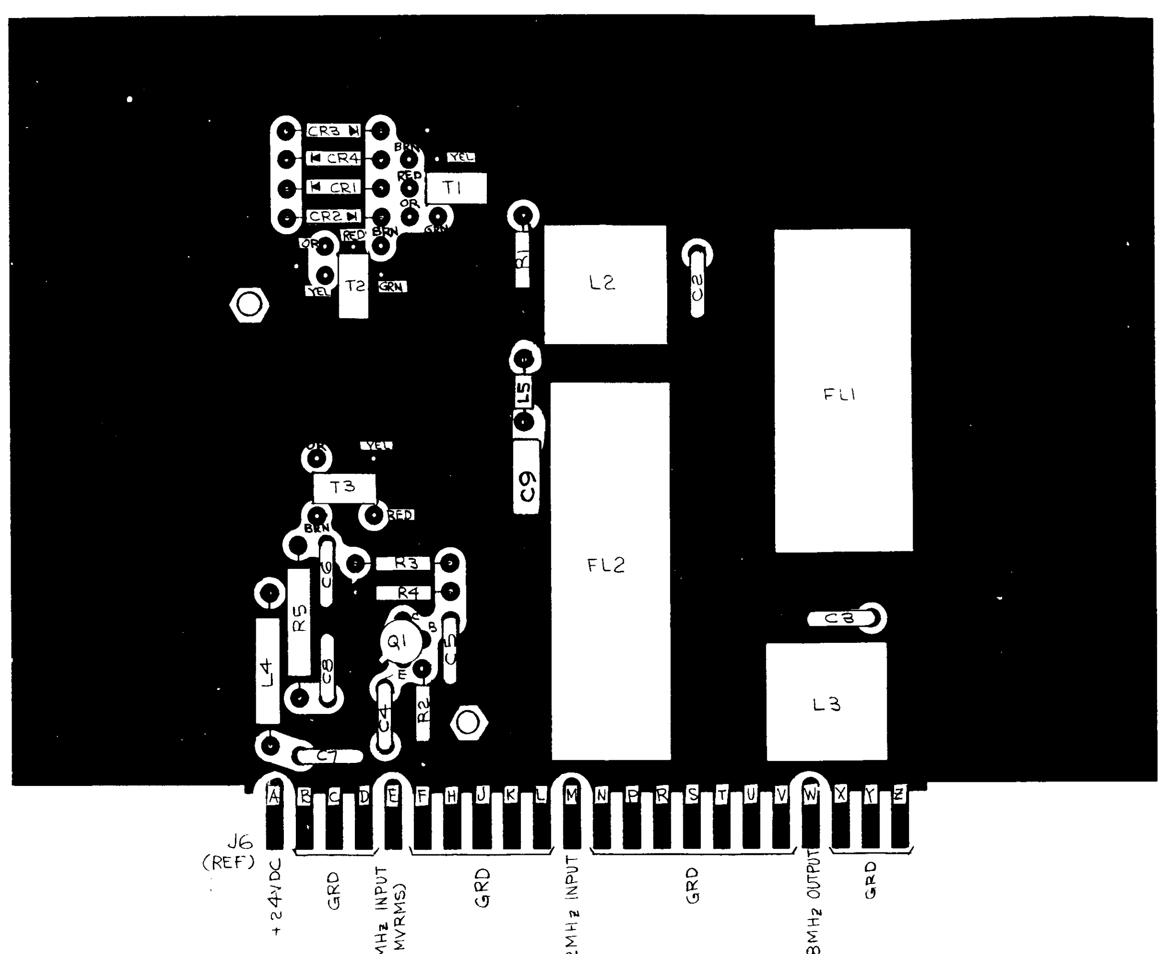
ITT Mackay Marine
133 TERMINAL AVE. CLARK N.J. U.S.A.
TITLE: SCHEMATIC R.F. SECTION
620589-534 REV P



GRD
J6-B,C,D,F,H,J,K,L,N,P,R,S,T,U,V,X,Y,Z

SYMBOL	PART NO.
T1,T2	600054-512-001
T3	600050-512-001

NOTES:
1-UNLESS OTHERWISE SPECIFIED.
ALL CAPACITANCE VALUES GREATER THAN 1.0 ARE IN PF.
ALL CAP VALUES 1.0 AND SMALLER ARE IN µf.
ALL INDUCTANCE VALUES ARE µh.
ALL RESISTANCE VALUES IN OHMS



05620097

ITT Mackay Marine
INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION
133 TERMINAL AVE CLARK N.J. U.S.A.

TITLE: 2ND MIXER ASSEMBLY

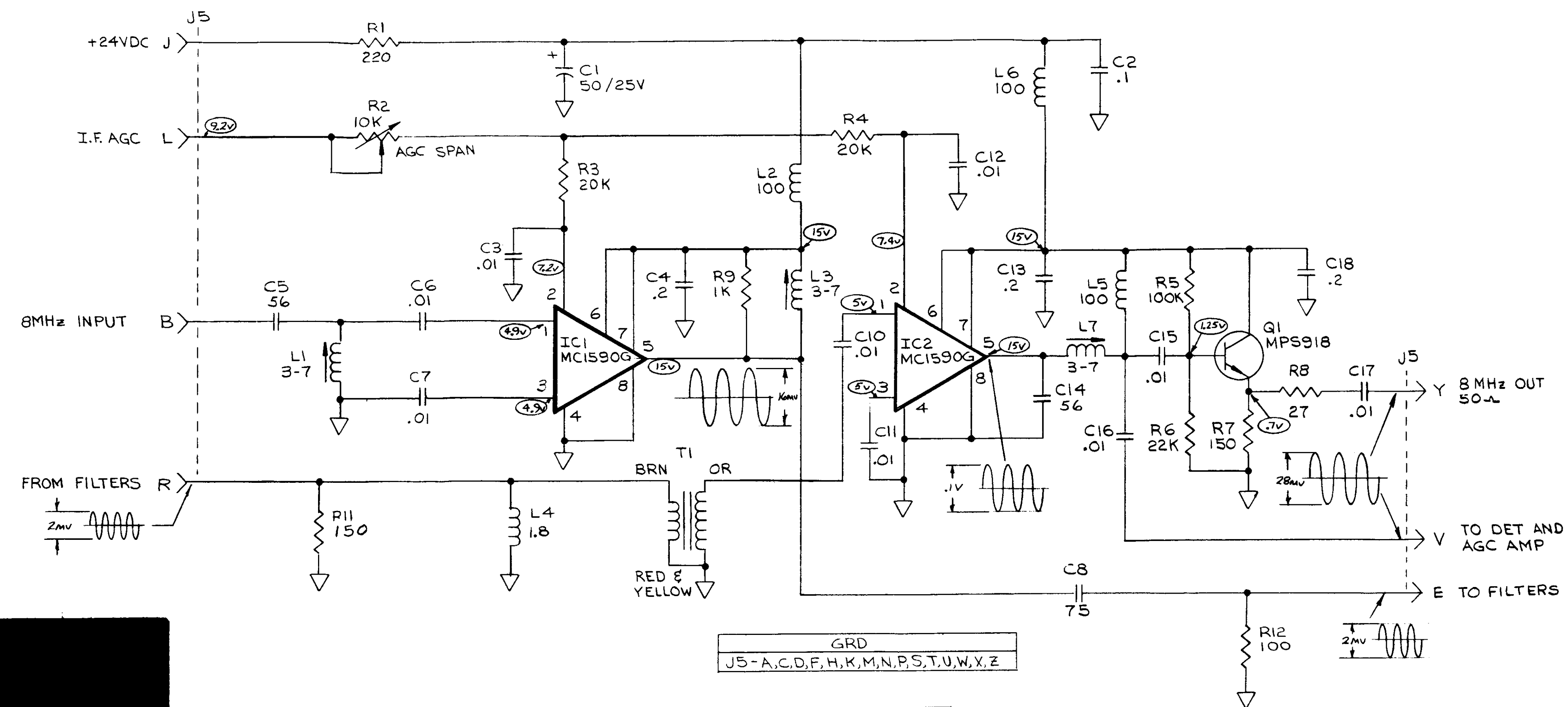
SCALE 2:1 | 600590-536 | REV F

0895-0071

ITT Mackay Marine
INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION
133 TERMINAL AVE CLARK N.J. U.S.A.

TITLE: SCHEMATIC 2ND MIXER

620590-536 | REV G



GRD
J5-A,C,D,F,H,K,M,N,P,S,T,U,W,X,Z

SYMBOL	PART NO.
T1	600055-512-001

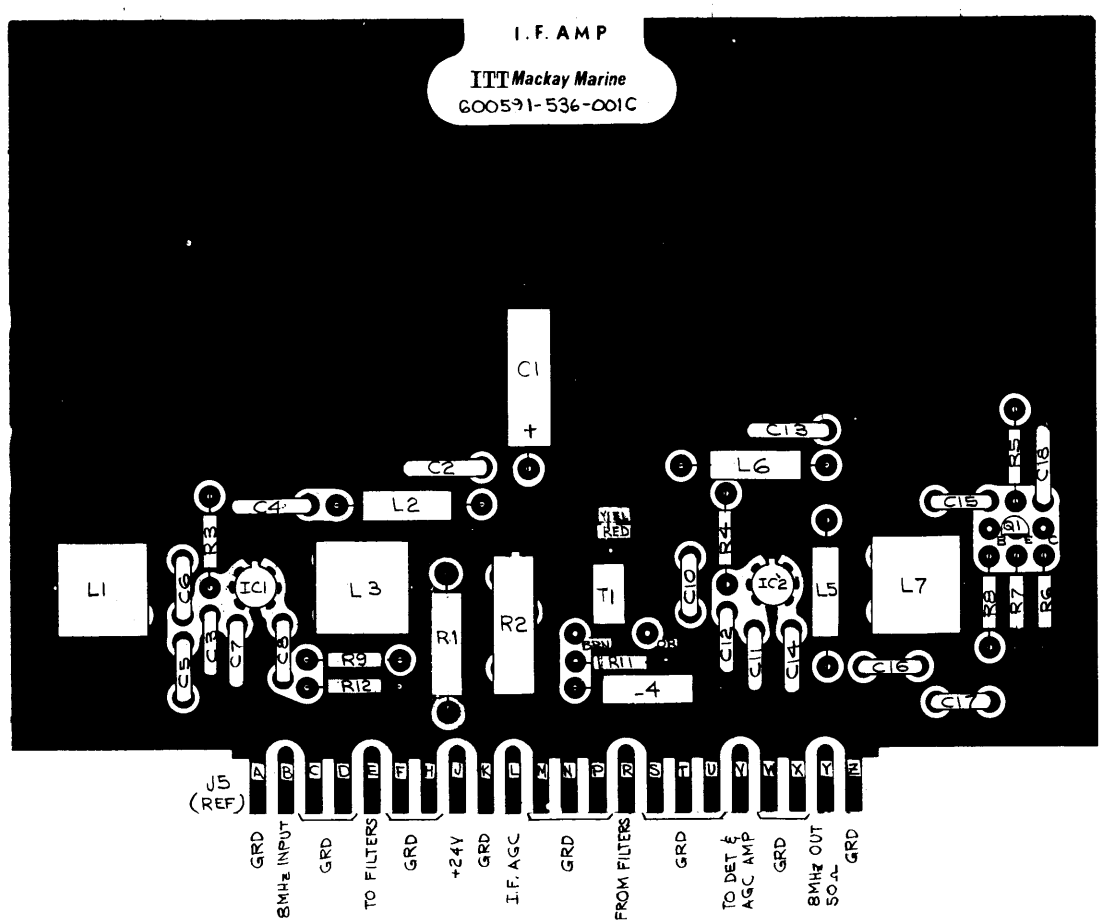
NOTES:
1-UNLESS OTHERWISE SPECIFIED:
ALL CAPACITANCE VALUES 1.0 AND SMALLER ARE IN µf.
ALL INDUCTANCE VALUES µh.
ALL RESISTANCE VALUES OHMS.
K=1000

0895C023

ITT Mackay Marine
133 TERMINAL AVE. CLARK N.J. U.S.A.

TITLE SCHEMATIC 8MHz I.F. AMPLIFIER

620591-536 REV F



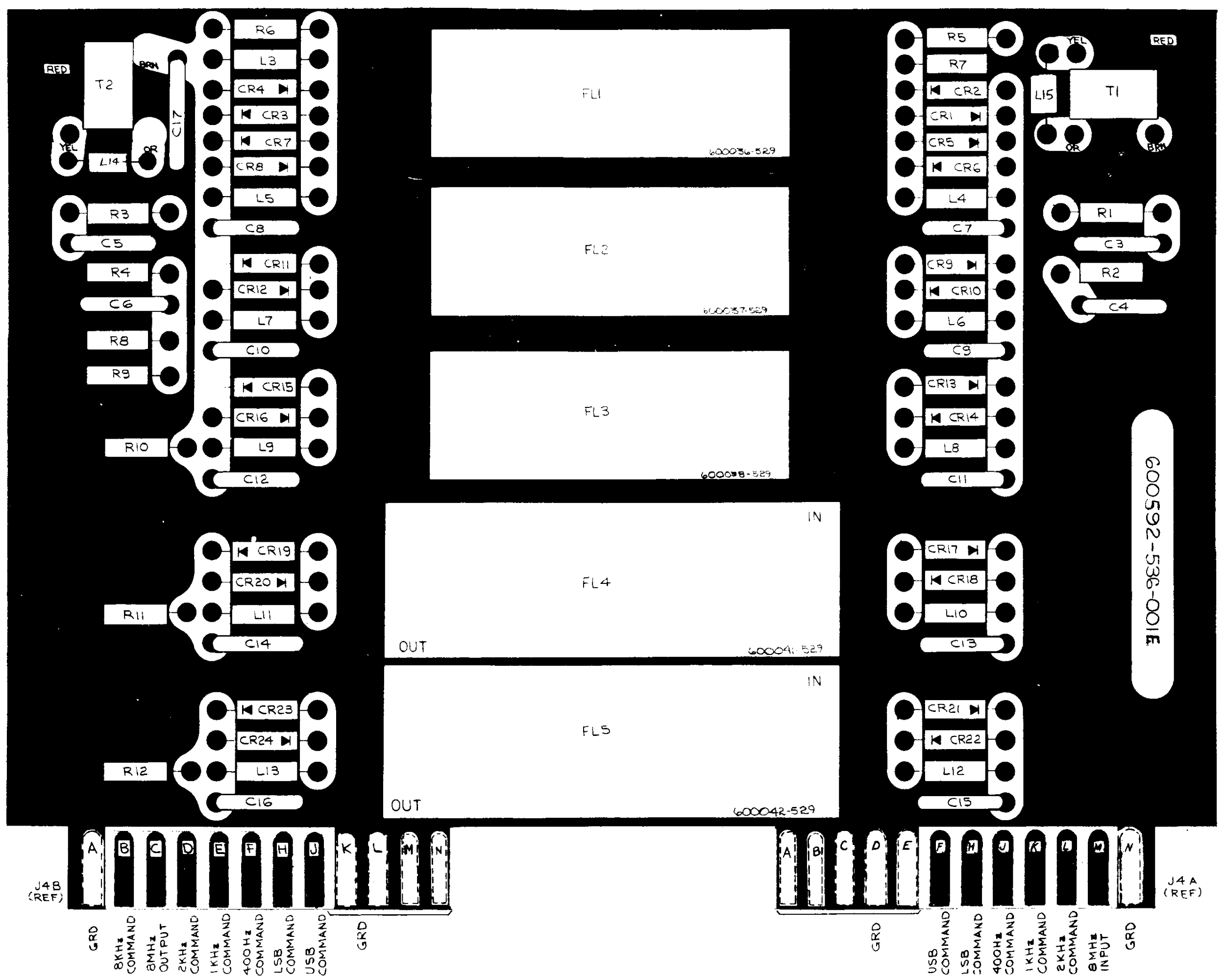
0562C098

ITT Mackay Marine
133 TERMINAL AVE. CLARK N.J. U.S.A.

TITLE 8MHz I.F. AMPLIFIER ASSEMBLY

SCALE 2:1

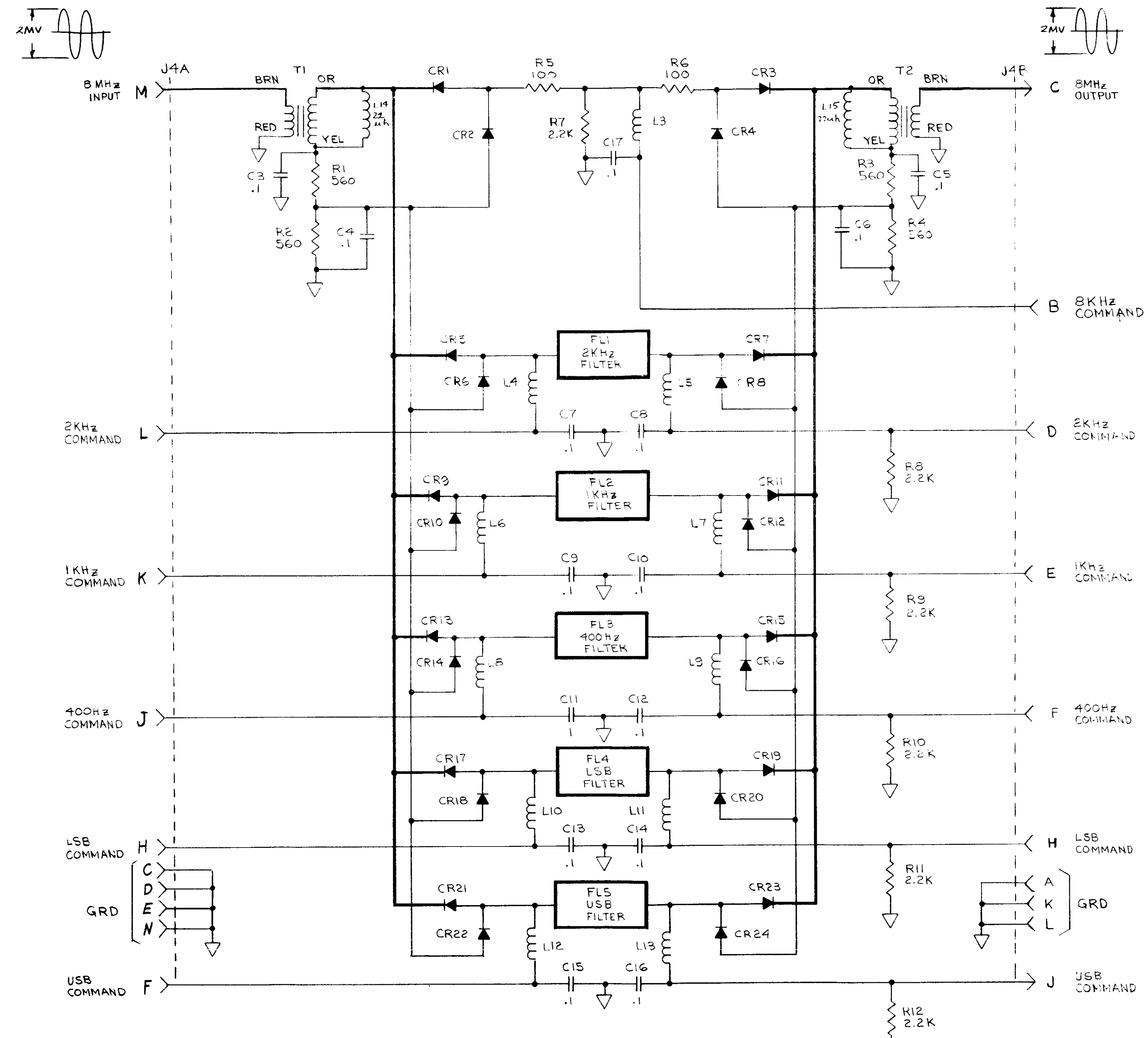
600591-536 REV F



0562D099

ITT Mackay Marine

INFORMATION FILTERS ASSEMBLY



NOTES:
1- UNLESS OTHERWISE SPECIFIED:
ALL CAPACITANCE VALUES GREATER THAN 1.0 ARE IN pf.
ALL CAP VALUES 1.0 AND SMALLER ARE IN μf.
INDUCTANCE VALUE FOR L1 THRU L13 ARE 68 μh.
ALL RESISTANCE VALUES IN OHMS.
ALL DIODES ARE 1N4148.
K = 1000.

SYMBOL	PART NO.
T1, T2	600055-512

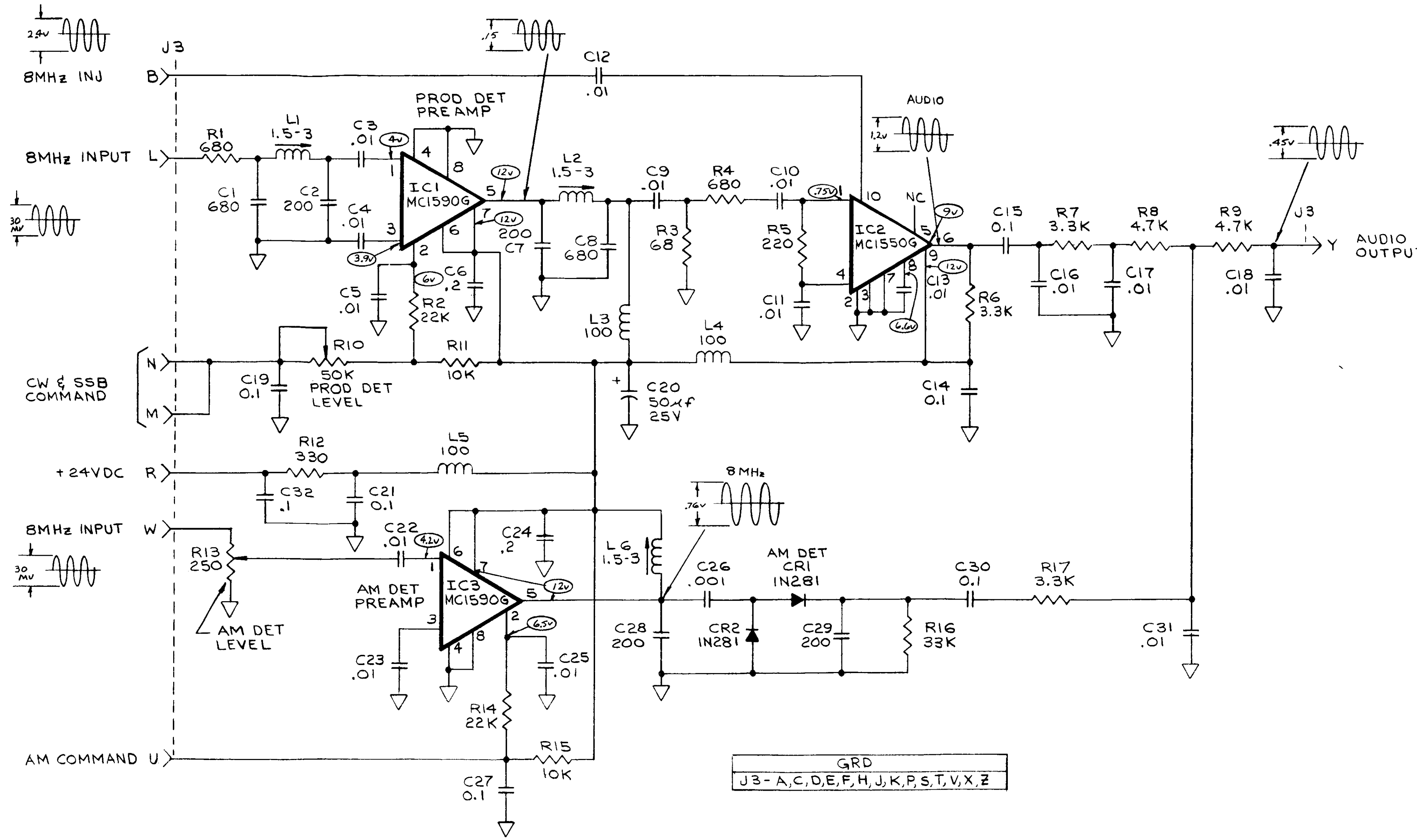
0895D024

ITT Mackay Marine

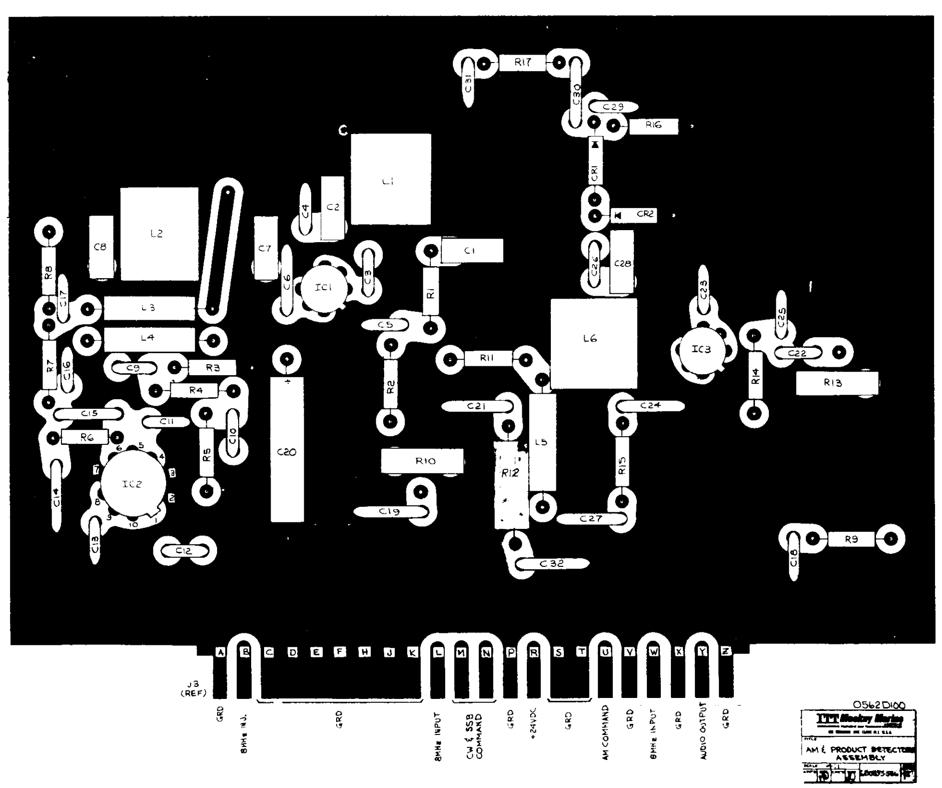
SCHEMATIC INFORMATION FILTERS

SCALE NONE

620592-536 F



NOTES:
1-UNLESS OTHERWISE SPECIFIED;
ALL CAPACITANCE VALUES GREATER THAN 1.0 ARE IN pf
ALL CAP VALUES 1.0 AND SMALLER ARE IN µf.
ALL INDUCTANCE VALUES µh.
ALL RESISTANCE IN OHMS.
K=1000.

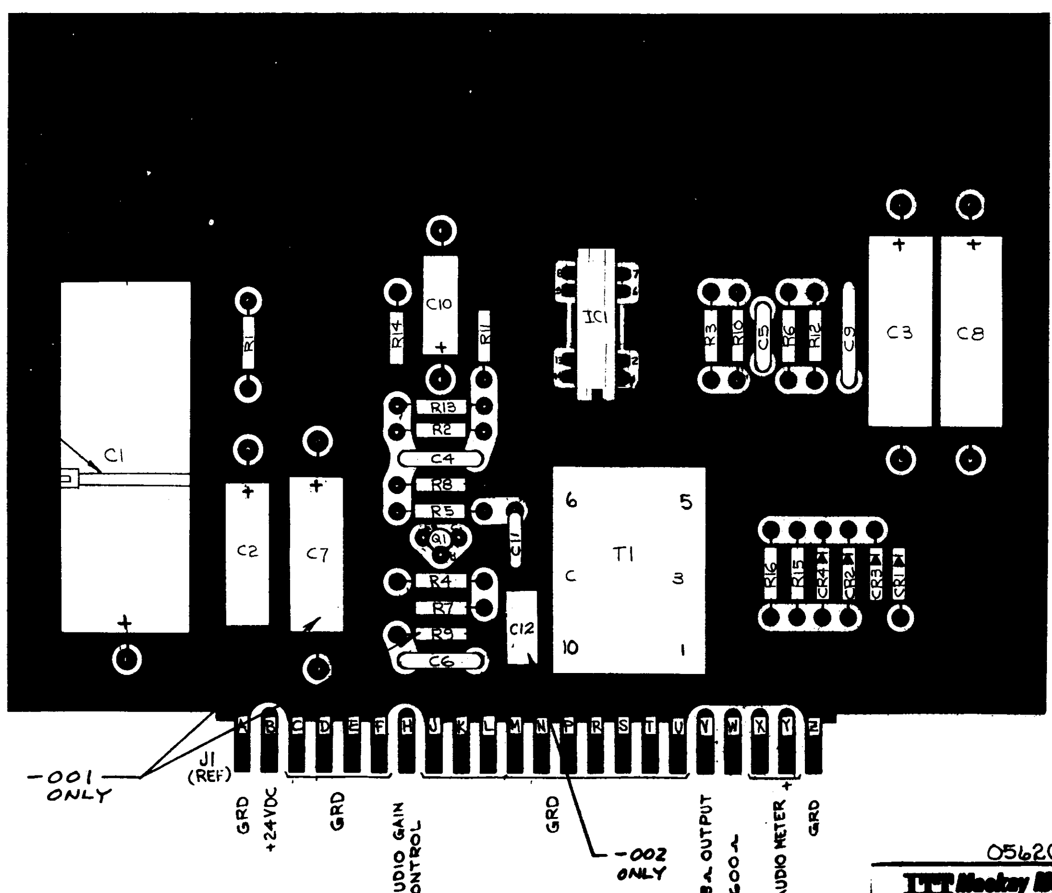


0895C025

ITT Mackay Marine
133 TERMINAL AVE. CLARK N.J. U.S.A.

TITLE SCHEMATIC AM AND PRODUCT DETECTORS

620593-534 F

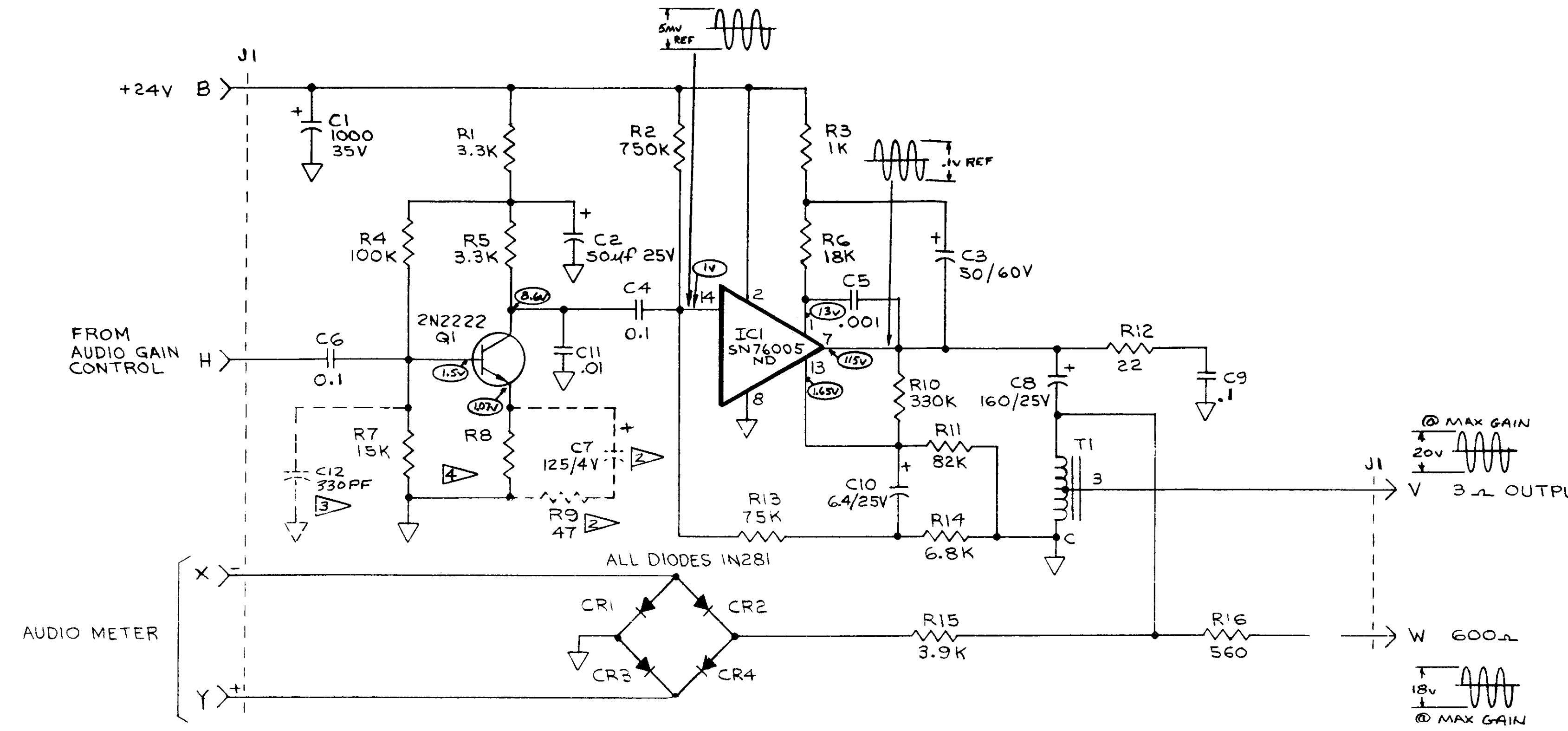


0562C102

ITT Mackay Marine

AUDIO AMPLIFIER, CARD ASSY.

NOTE:
1. SOLDER GRD. TABS OF IC1 TO COMPONENT SIDE OF BOARD.
2. INSTALL WASHER IT.7, ON PINS 6&10 OF T1 BETWEEN T1 AND BOARD WHEN ASSEMBLING.



GRD
J1-A,C,D,E,F,J,K,L,M,N,P,R,S,T,U,Z

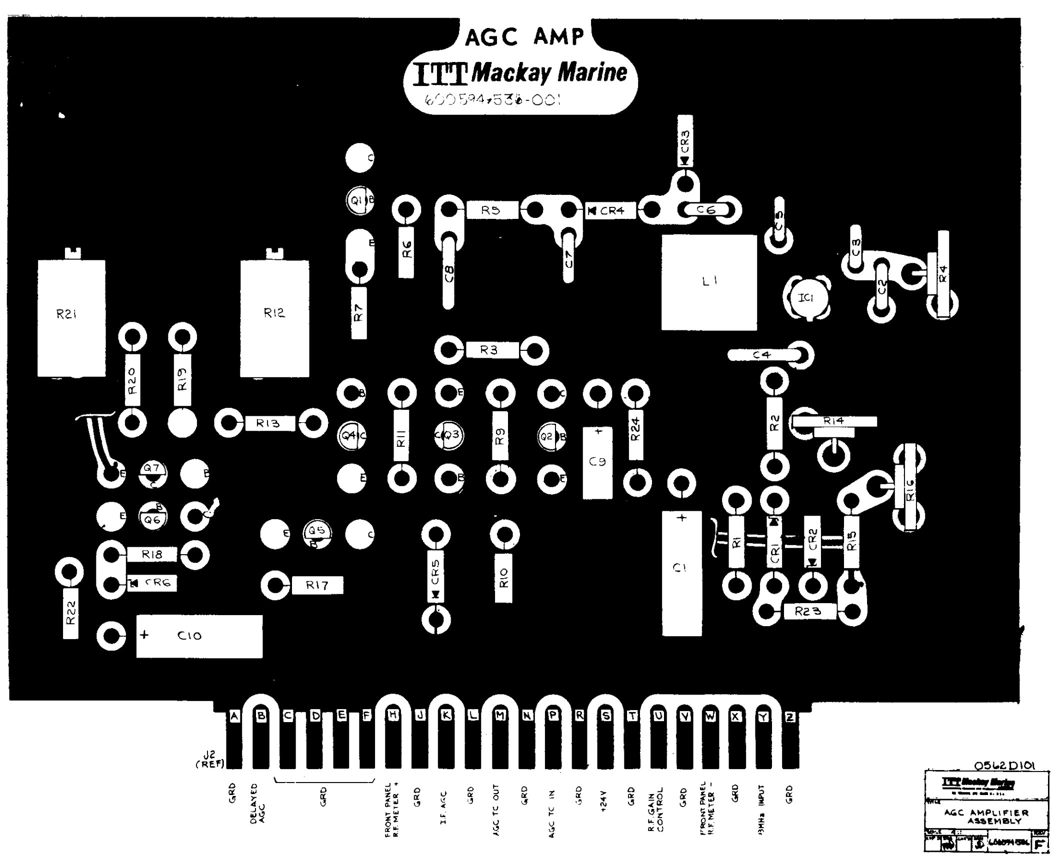
NOTES:
1-UNLESS OTHERWISE SPECIFIED;
ALL CAP VALUES ARE IN µf
ALL RESISTANCE VALUES IN OHMS
K=1000
2 -001 CONFIGURATION ONLY.
3 -002 CONFIGURATION ONLY.
4 -001 R8 VALUE 470Ω
-002 R8 VALUE 390Ω

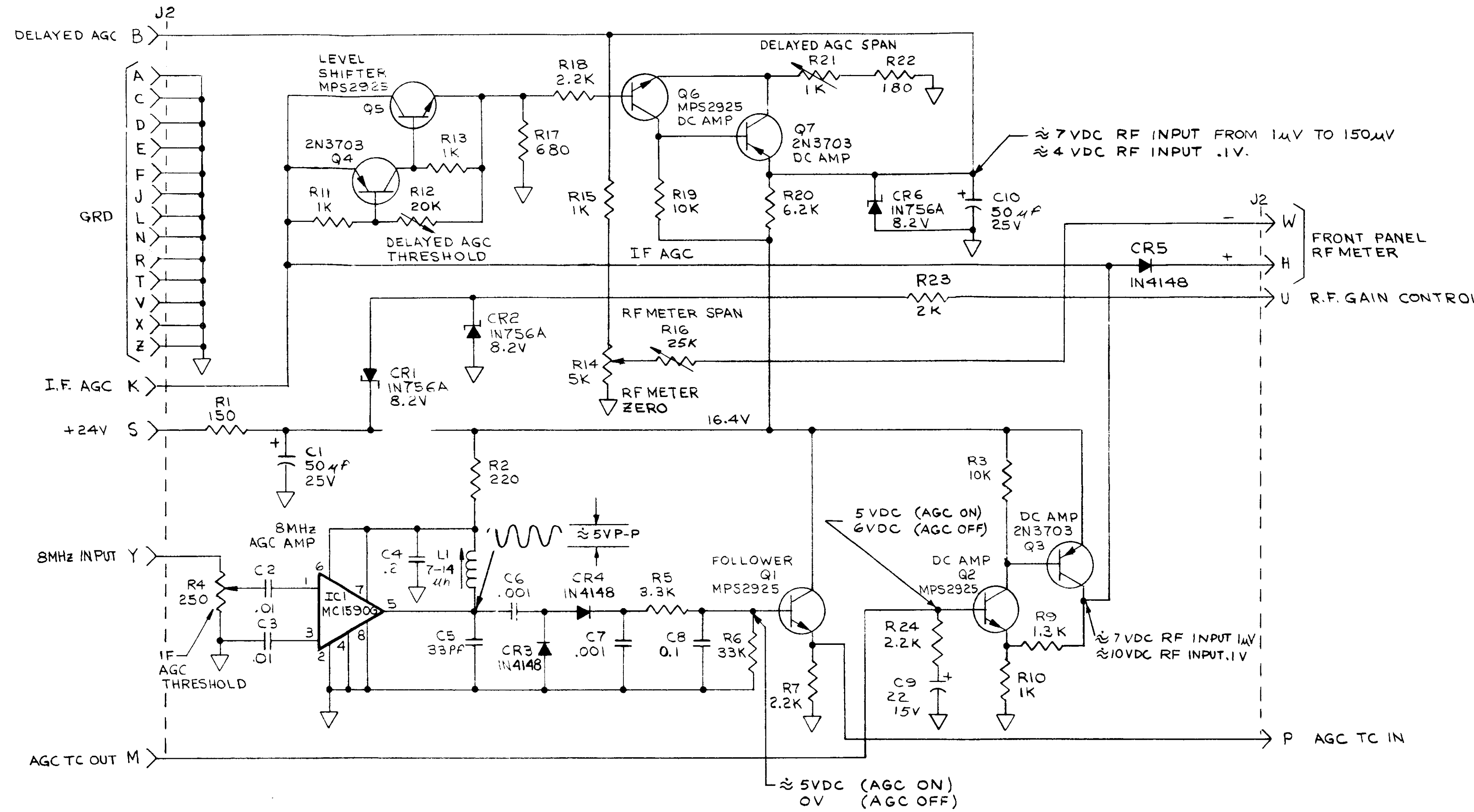
SYMBOL	PART NO.
T1	600048-512-001

0895C027

ITT Mackay Marine

AUDIO AMPLIFIER SCHEMATIC



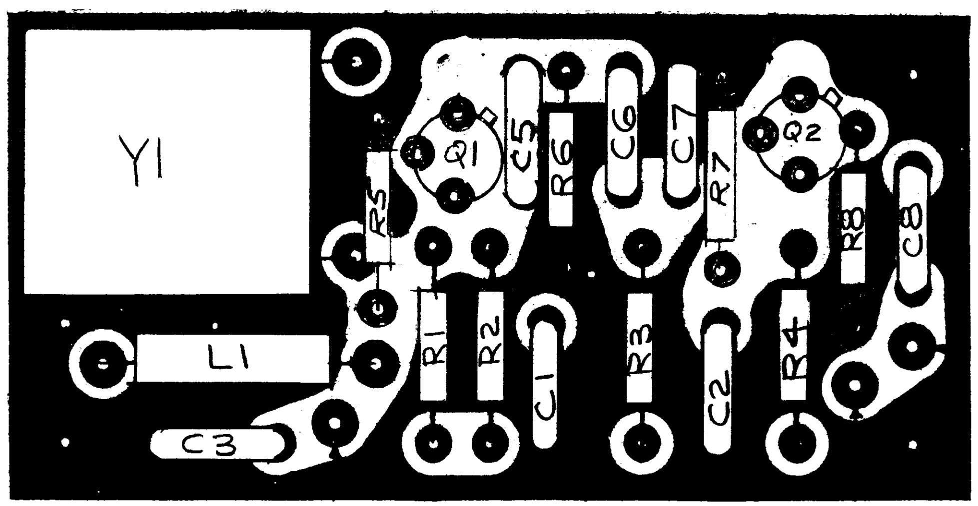


NOTES:
1- UNLESS OTHERWISE SPECIFIED;
ALL CAPACITANCE VALUES 1.0 AND SMALLER ARE IN μF
ALL RESISTANCE VALUES IN OHMS
K = 1000

ITT Mackay Marine
133 TERMINAL AVE. CLARK N.J. U.S.A.

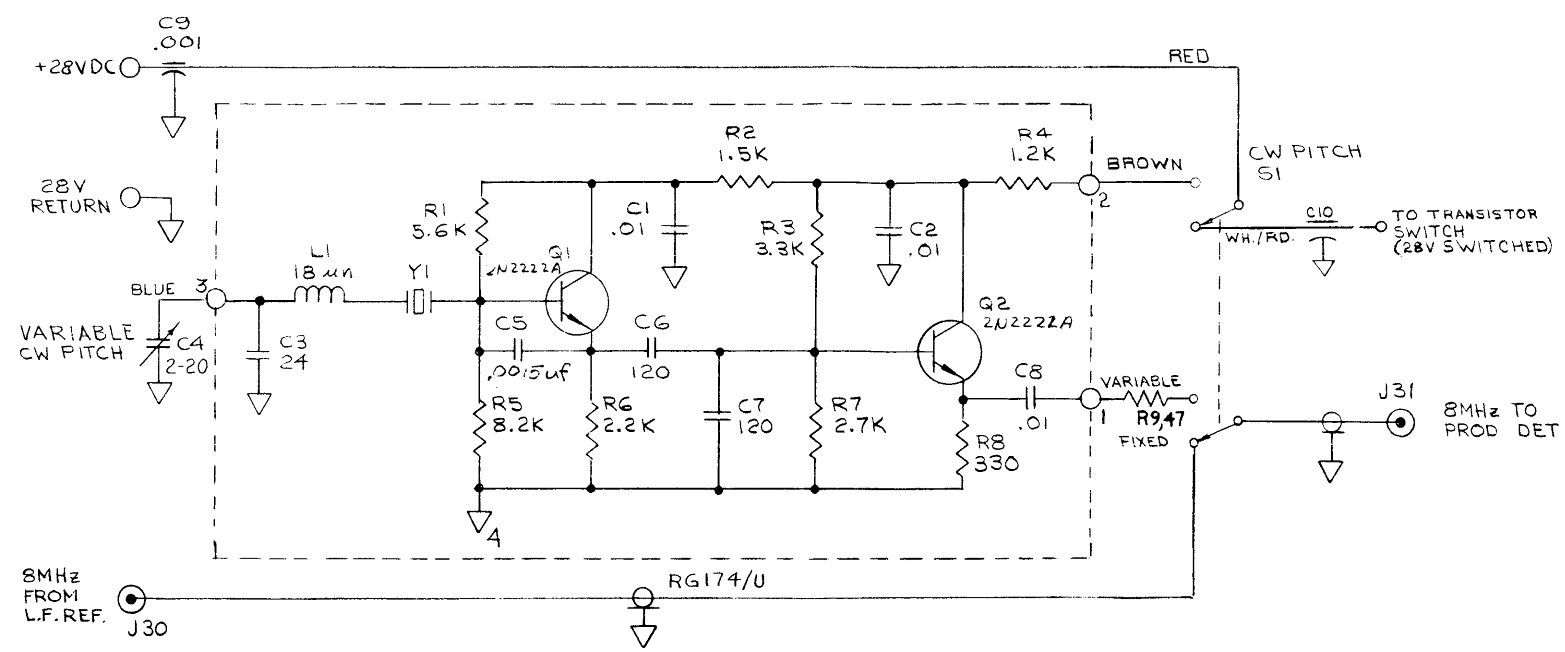
TITLE: SCHEMATIC AGC AMPLIFIER

SCALE NONE | 620594-536 | REV G



0562B107

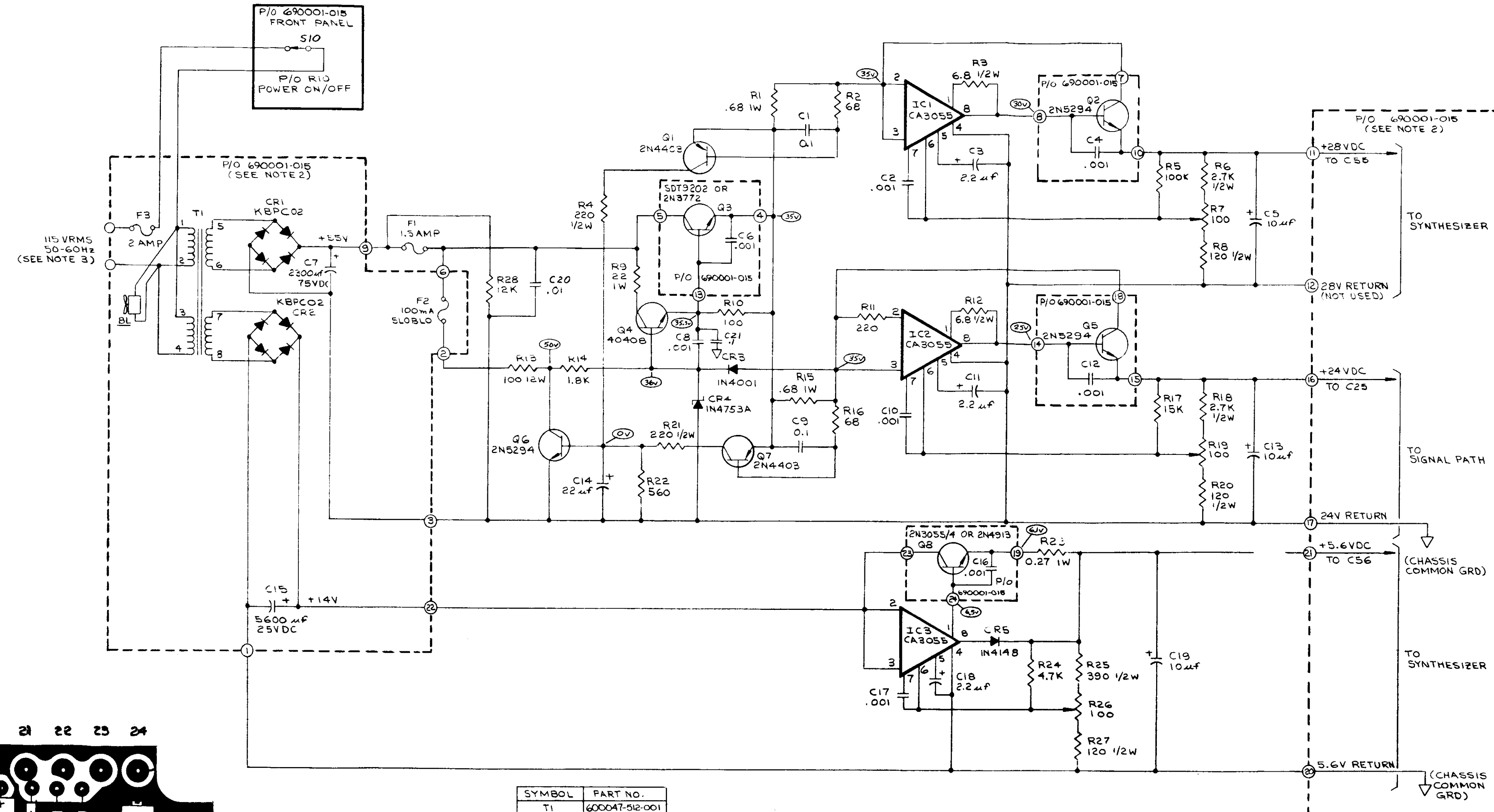
ITT Mackay Marine A DIVISION OF INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION 133 TERMINAL AVE. CLARK N. J. U.S.A., 07066	
TITLE VARIABLE B.F.O. P.C. BD. ASSY.	
SCALE 2:1	REV
APP'D / ENG. / CHK'D / DRN. — 600578-536	E



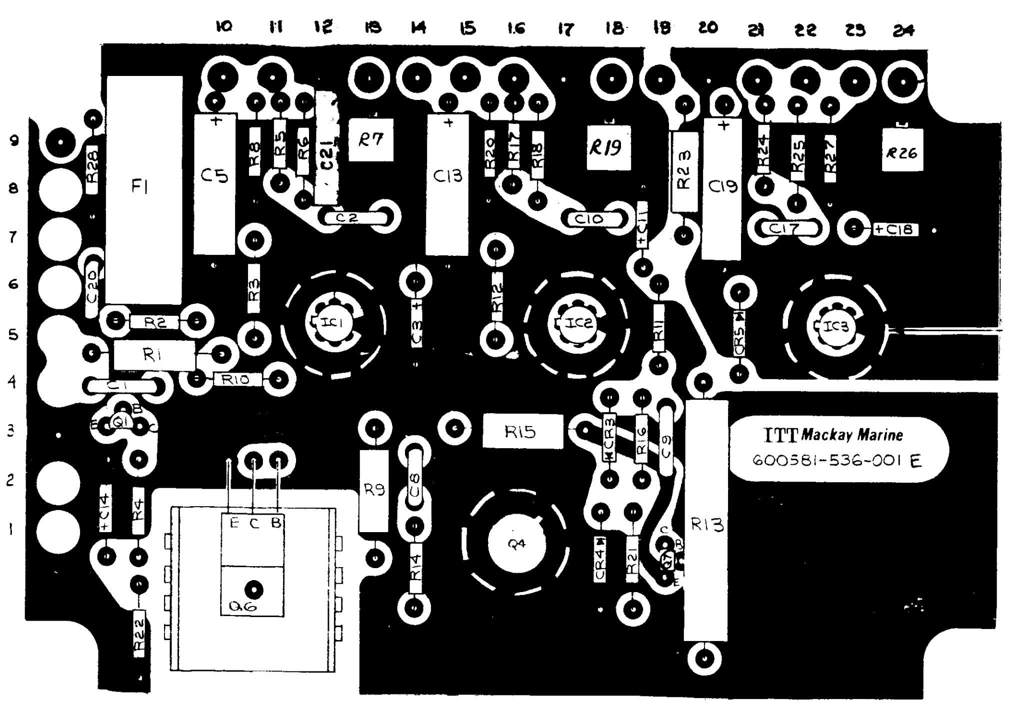
NOTES:
1-UNLESS OTHERWISE SPECIFIED;
ALL CAPACITANCE VALUES GREATER THAN 1.0 ARE IN PF
ALL CAP VALUES 1.0 AND SMALLER ARE IN uf.
ALL RESISTANCE VALUES IN OHMS.
K=1000

0895B037

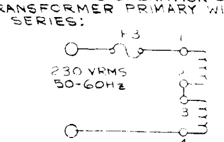
ITT Mackay Marine A DIVISION OF INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION 133 TERMINAL AVE. CLARK N. J. U.S.A., 07066	
TITLE SCHEMATIC VARIABLE BFO.	
SCALE	REV
APP'D / ENG. / CHK'D / DRN — 620124-537	F



SYMBOL	PART NO.
T1	600047-512-001



NOTES:
1. UNLESS OTHERWISE SPECIFIED; ALL CAPACITANCE VALUES 1.0 AND SMALLER ARE IN µf. ALL RESISTANCE VALUES IN OHMS K=1000.
2. ALL COMPONENTS WITHIN DOTTED LINES APPEAR ON 690001-015 INTERCONNECTION DIAGRAM.
3. FOR 230 VRMS OPERATION CONNECT TRANSFORMER PRIMARY WINDINGS IN SERIES:



AND CHANGE F3 TO 1 AMP

0562C109

ITT Mackay Marine

TITLE: REGULATOR ASSY

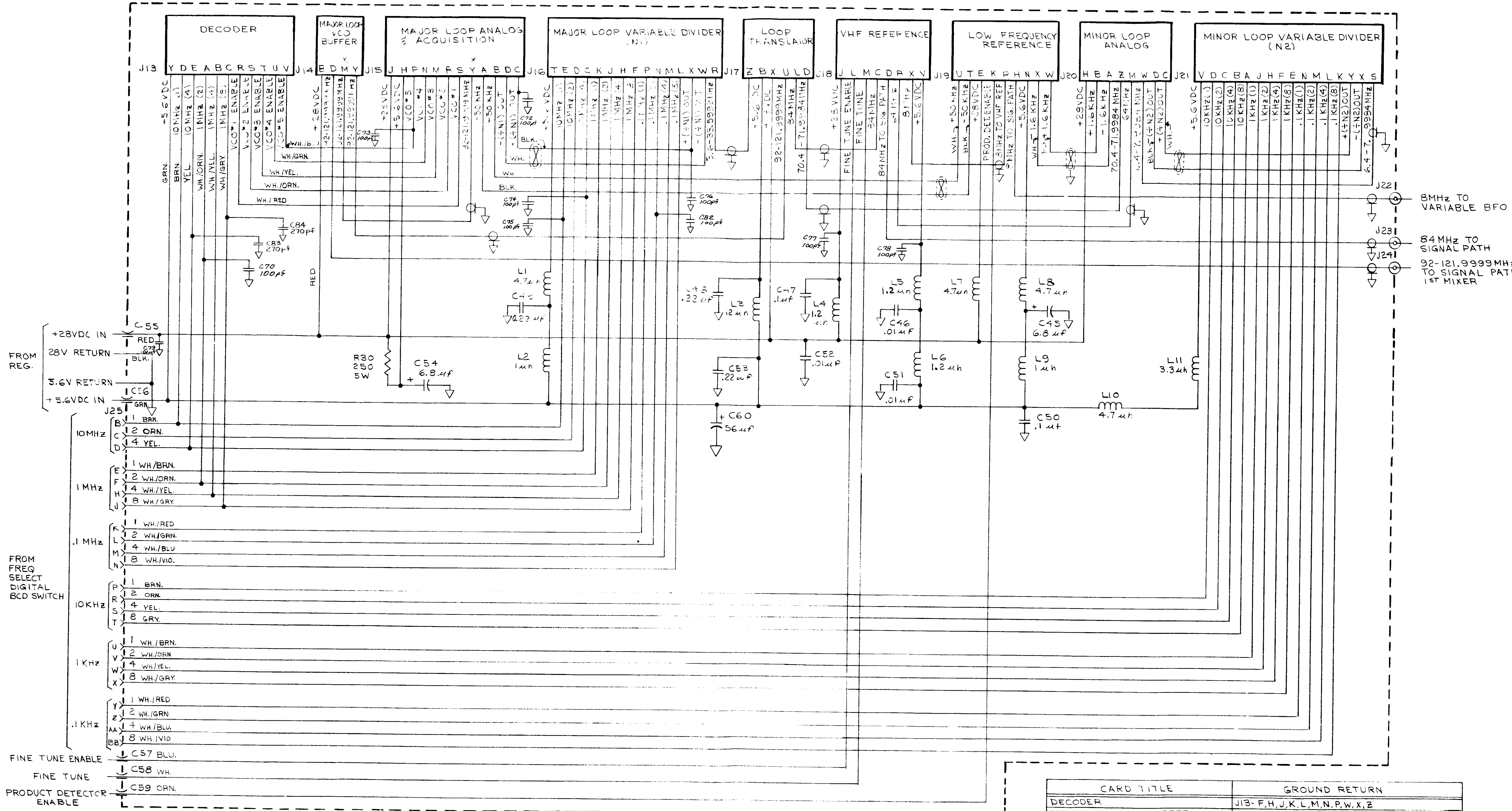
SCALE 2:1 — 600581-536 — REV E

0895D038

ITT Mackay Marine

SCHEMATIC REGULATOR

620581-536 — REV F



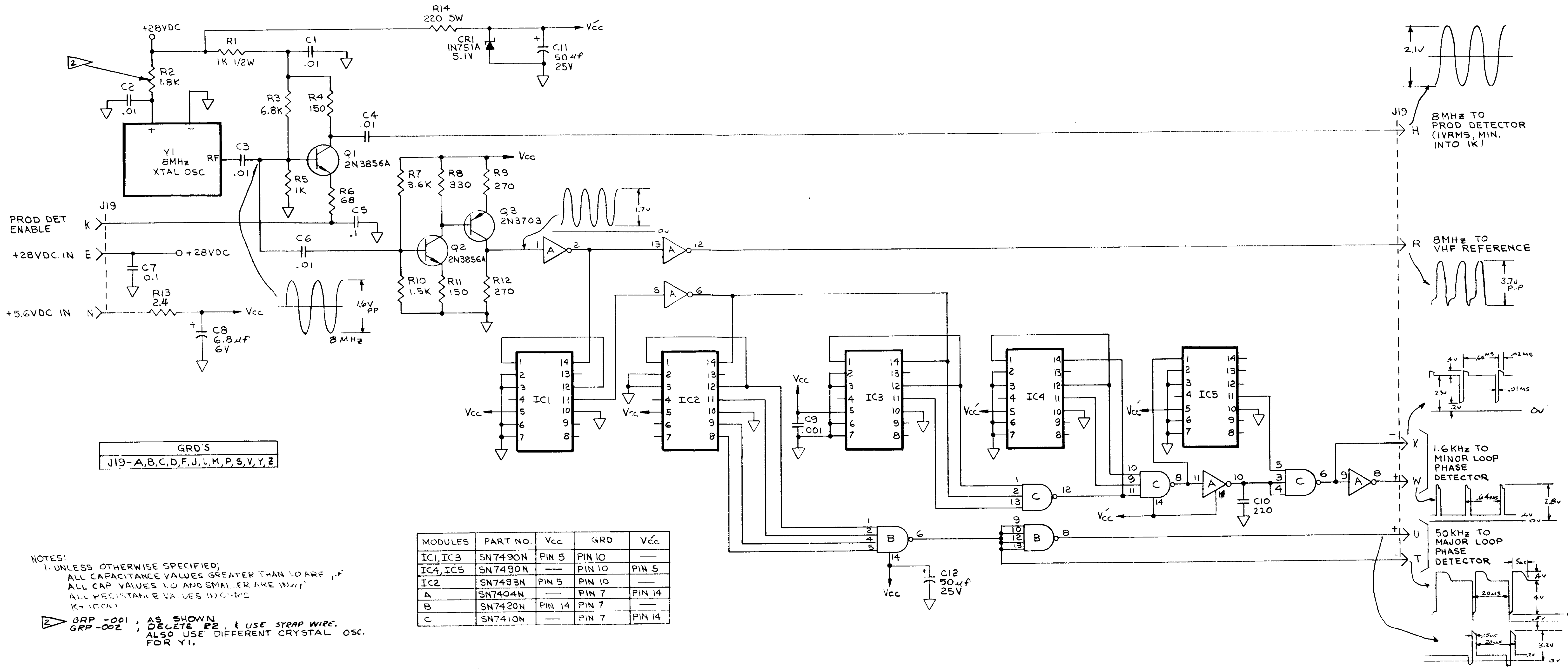
CARD TITLE	GROUND RETURN
DECODER	J13- F,H,J,K,L,M,N,P,W,X,Z
MAJOR LOOP VCO BUFFER	J14- A,C,E,F,H,J,K,L,N,P,R,S,T,U,V,W,X,Z
MAJOR LOOP ANALOG & ACQUISITION	J15- E,F,K,L,T,U,V,W,X,Z
MAJOR LOOP VARIABLE DIVIDER (N1)	J16- A,B,S,U,V,Y,Z
LOOP TRANSLATOR	J17- A,C,E,F,H,J,K,M,N,P,R,S,T,V,W,Y
VHF REFERENCE	J18- A,B,E,F,H,K,N,P,S,T,U,W,Y,Z
LOW FREQUENCE REFERENCE	J19- A,B,C,D,F,J,L,M,P,S,V,Y,Z
MINOR LOOP ANALOG	J20- E,F,J,K,L,N,P,R,S,T,U,V,X,Y
MINOR LOOP VARIABLE DIVIDER (N2)	J21- P,R,T,U,W,Z

0895D807

ITT Mackay Marine
133 TERMINAL AVE. CLARK N.J. U.S.A.

TITLE: FRAME WIRING DIAGRAM
FREQUENCY SYNTHESIZER

690001-001-201 REV D



GRD'S
J19-A,B,C,D,F,J,L,M,P,S,V,Y,Z

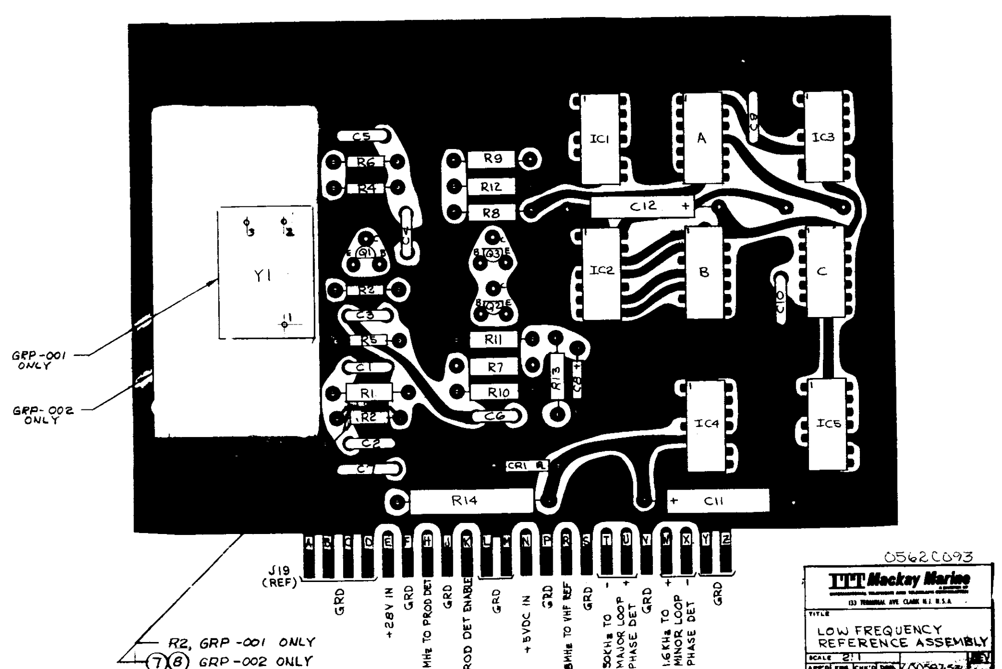
NOTES:

1. UNLESS OTHERWISE SPECIFIED; ALL CAPACITANCE VALUES GREATER THAN 1.0 ARE pf. ALL CAP VALUES 1.0 AND SMALLER ARE IN uf. ALL RESISTANCE VALUES IN OHMS K=1000

2 GRP -001 , AS SHOWN
GRP -002 ; DELETE R2 , & USE STRAP WIRE. ALSO USE DIFFERENT CRYSTAL OSC. FOR Y1.

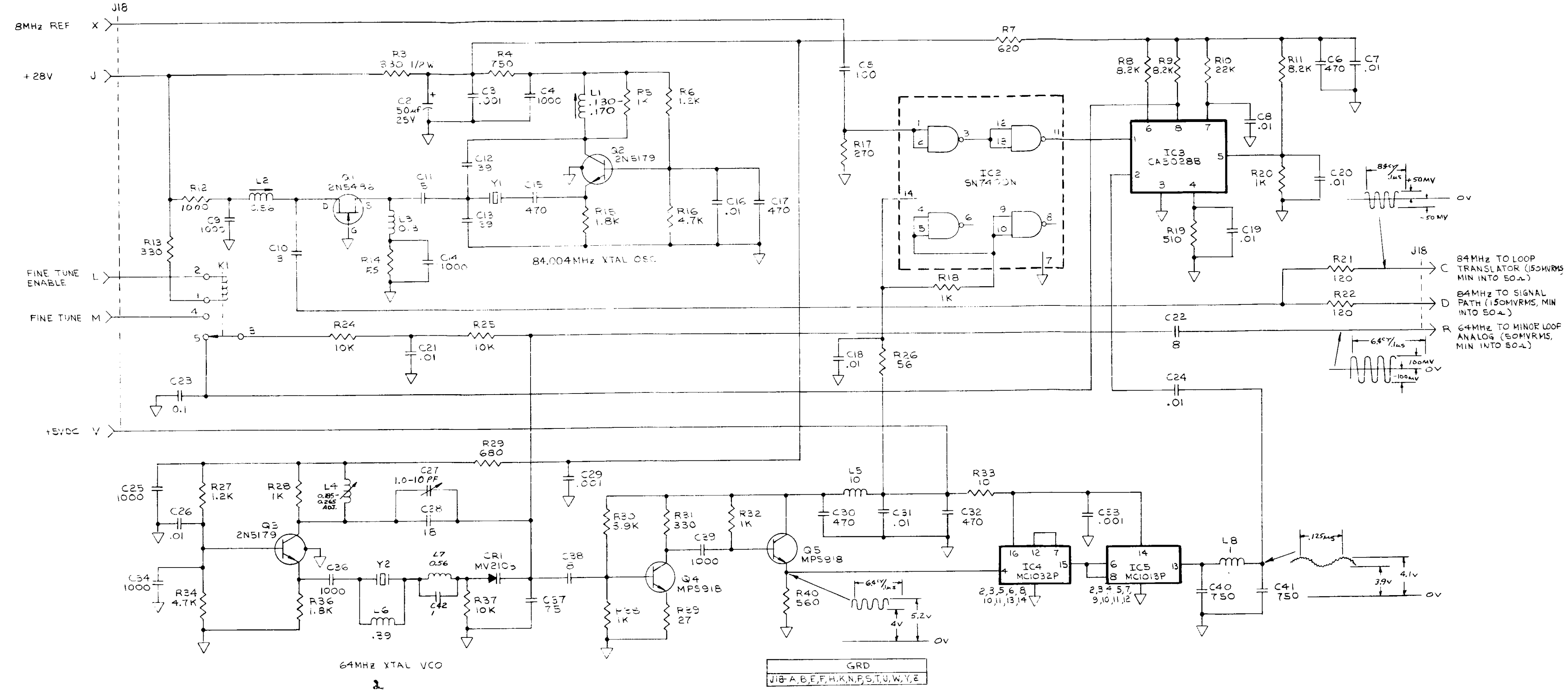
MODULES	PART NO.	Vcc	GRD	Vc'c
IC1, IC3	SN7490N	PIN 5	PIN 10	—
IC4, IC5	SN7490N	—	PIN 10	PIN 5
IC2	SN7493N	PIN 5	PIN 10	—
A	SN7404N	—	PIN 7	PIN 14
B	SN7420N	PIN 14	PIN 7	—
C	SN7410N	—	PIN 7	PIN 14

-001 3020 A
-002 MRU35 & SSB224



0562C093
ITT Mackay Marine
LOW FREQUENCY REFERENCE ASSEMBLY

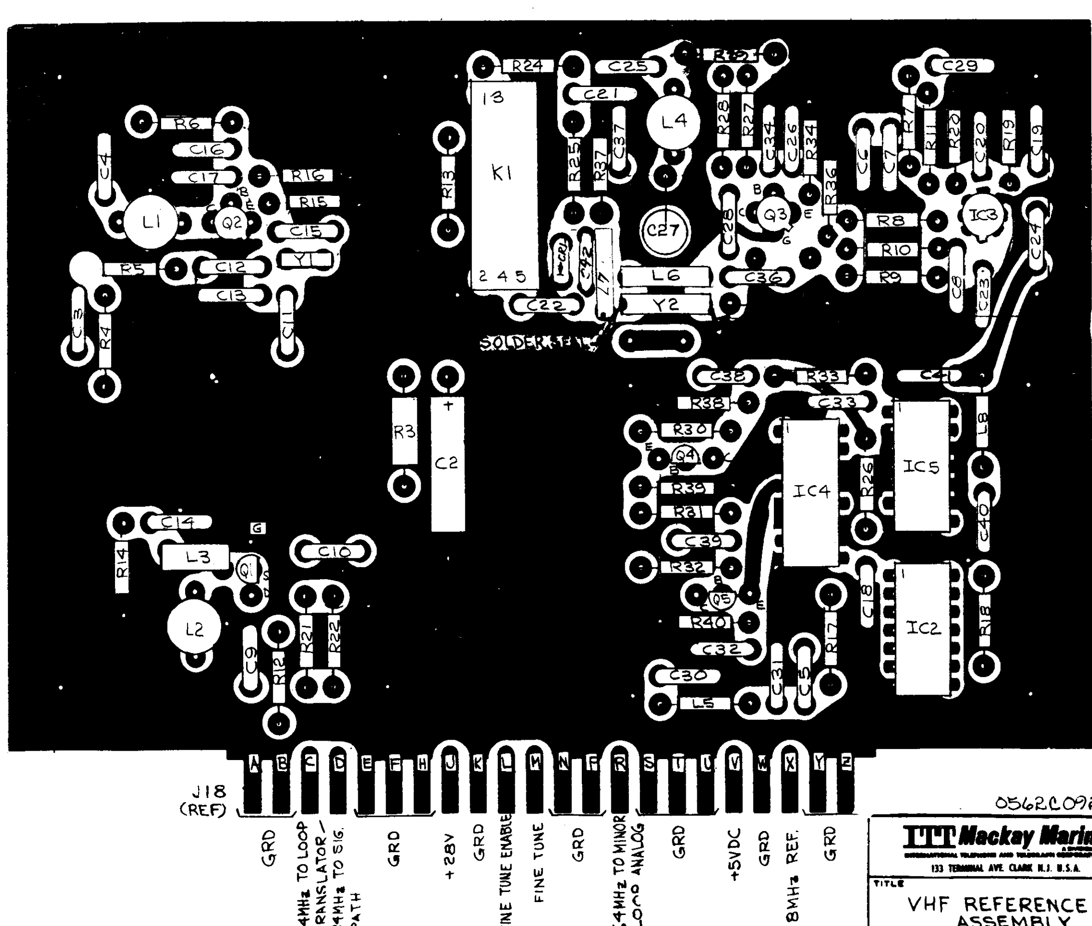
0895D034
ITT Mackay Marine
133 TERMINAL AVE. CLARK N.J. U.S.A.
TITLE SCHEMATIC LOW FREQUENCY REFERENCE
620587-536



NOTES:
1-UNLESS OTHERWISE SPECIFIED;
ALL CAPACITANCE VALUES GREATER THAN 1.0 ARE IN pF
ALL CAP VALUES 1.0 AND SMALLER ARE IN µF.
ALL INDUCTANCE VALUES ARE IN µH
ALL RESISTANCE VALUES IN OHMS.
K=1000

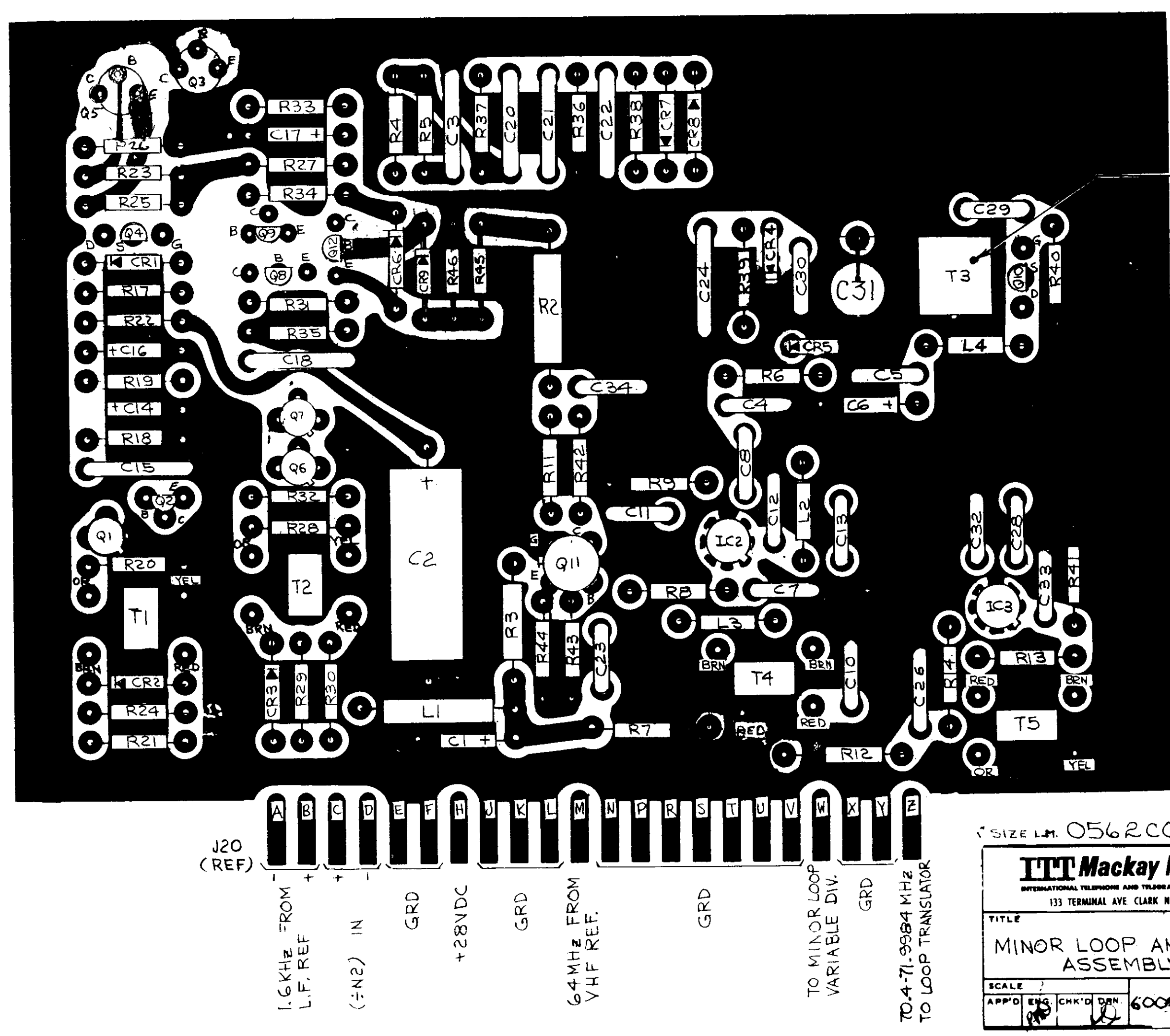
0625C033

ITT Mackay Marine
133 TERMINAL AVE. CLARK N.J. U.S.A.
TITLE: SCHEMATIC VHF REFERENCE
620586-534 REV E



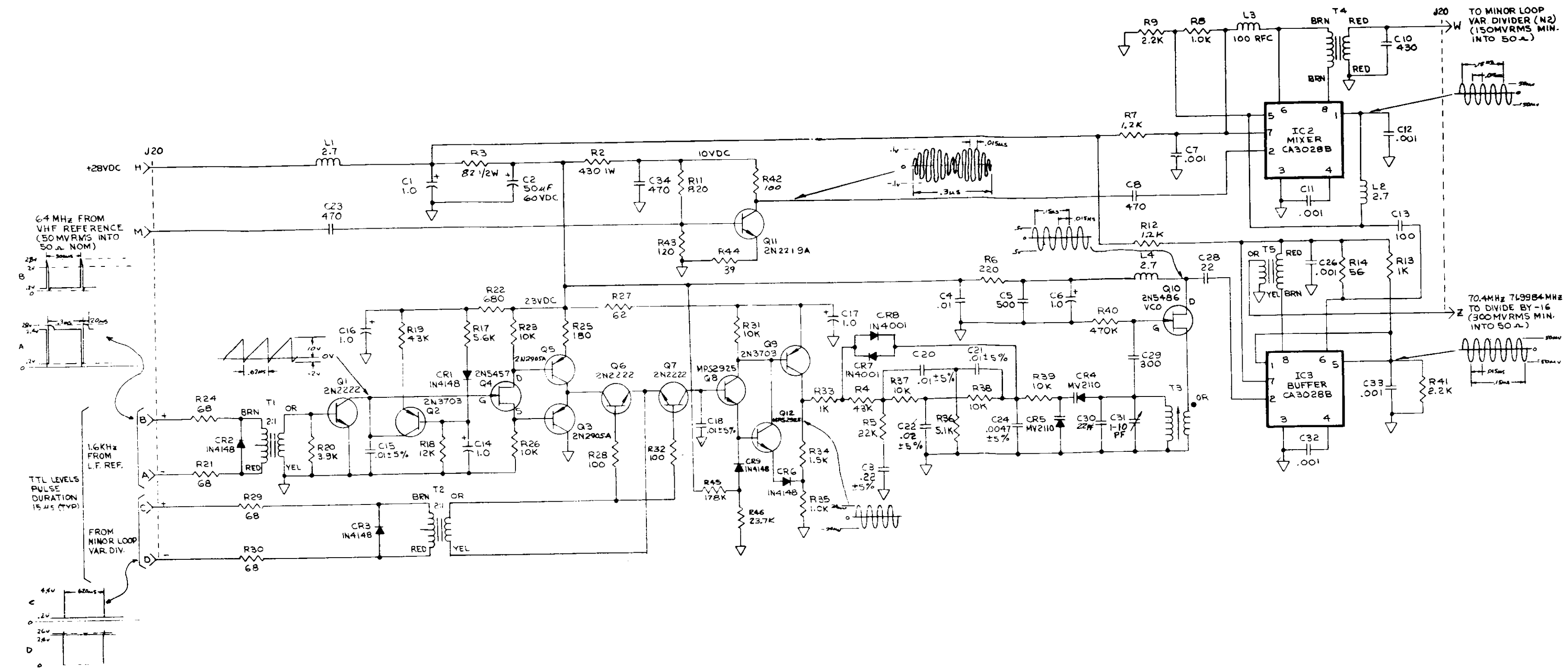
0562C092

ITT Mackay Marine
133 TERMINAL AVE. CLARK N.J. U.S.A.
TITLE: VHF REFERENCE ASSEMBLY
SCALE 2:1
600586-534 REV G



SIZE L.M. 0562C094

ITT Mackay Marine — A Division of International Telephone and Telegraph Corporation — 133 Terminal Ave. Clark N.J. U.S.A.				
TITLE: MINOR LOOP ANALOG ASSEMBLY				
SCALE			600579-53A	REV
APP'D	ENG.	CHK'D	DRN.	



NOTES:
1- UNLESS OTHERWISE SPECIFIED;
ALL CAPACITANCE VALUES GREATER THAN 1.0 ARE IN Pf.
ALL CAP VALUES 1.0 AND SMALLER ARE IN μf.
ALL INDUCTANCE VALUES μh.
ALL RESISTANCE VALUES IN OHMS.
K=1000

GRD
J20- E,F,J,K,L,N,P,R,S,T,U,V,X,Y

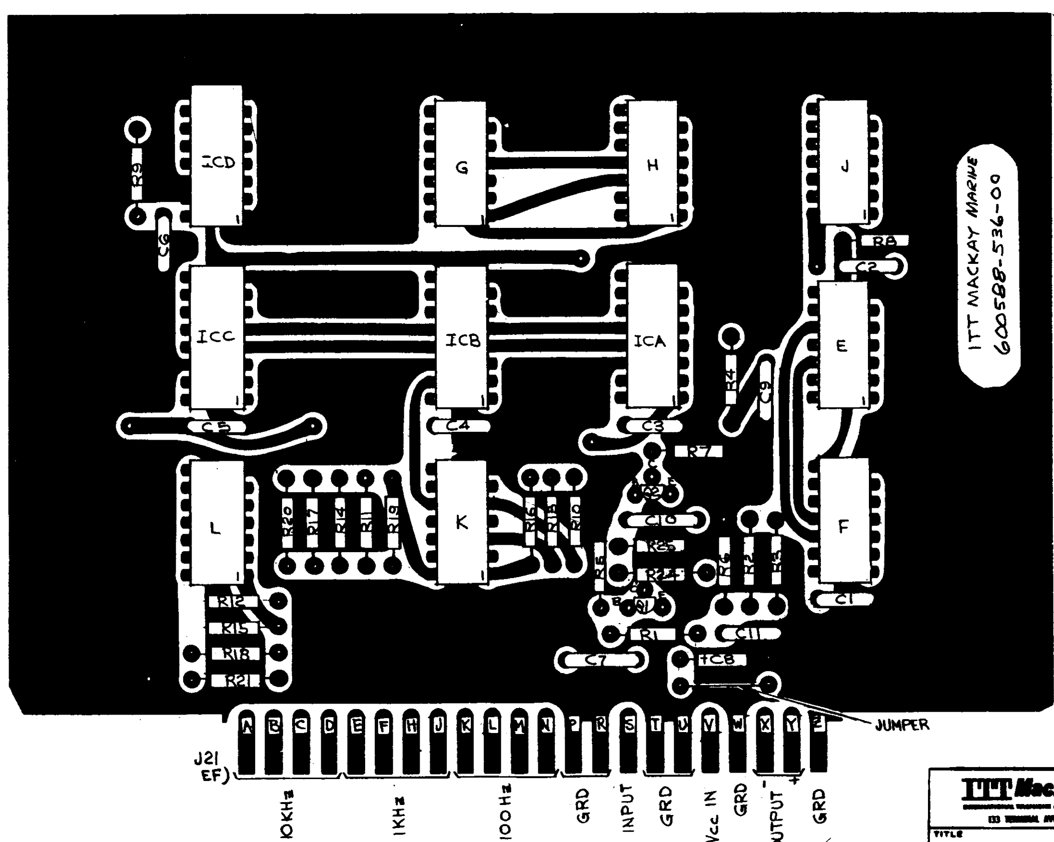
SYMBOL	PART NO.
T1,T2	600053-512-001
T3	600060-512-001
T4	600056-512-001
T5	600050-512-001

0895D035

ITT Mackay Marine

TITLE: SCHEMATIC MINOR LOOP ANALOG

620579-53A

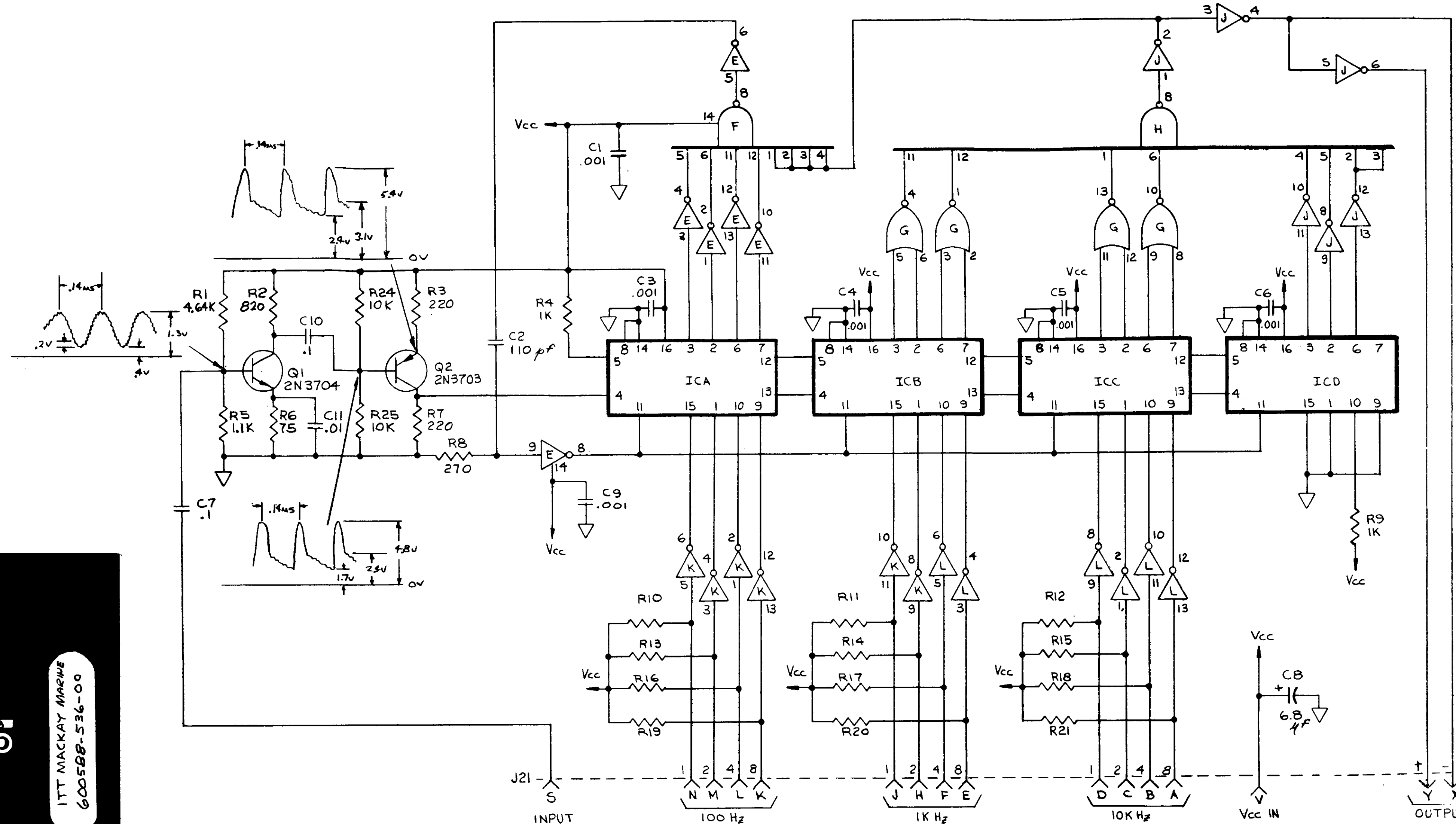


0562C095

ITT Mackay Marine

TITLE MINOR LOOP VARIABLE DIVIDER ASSEMBLY

SCALE 2:1 | 600588-536



NOTES:
1- UNLESS OTHERWISE SPECIFIED:
ALL CAP VALUES 1.0 AND SMALLER ARE IN uf
ALL RESISTANCE VALUES IN OHMS
K = 1000
2- GROUP 001 R10 TO R21 = 1K
GROUP 002 R10 TO R21 = 4.7K

MODULES	PART NO.	Vcc	GRD
ICA, ICB ICC, ICD	SN74192N	PIN 16	PIN 14,8
E	SN74H04N	PIN 14	PIN 7
F	SN74H30N	PIN 14	PIN 7
G	SN7402N	PIN 14	PIN 7
J, K, L	SN7404N	PIN 14	PIN 7
H	SN7430N	PIN 14	PIN 7

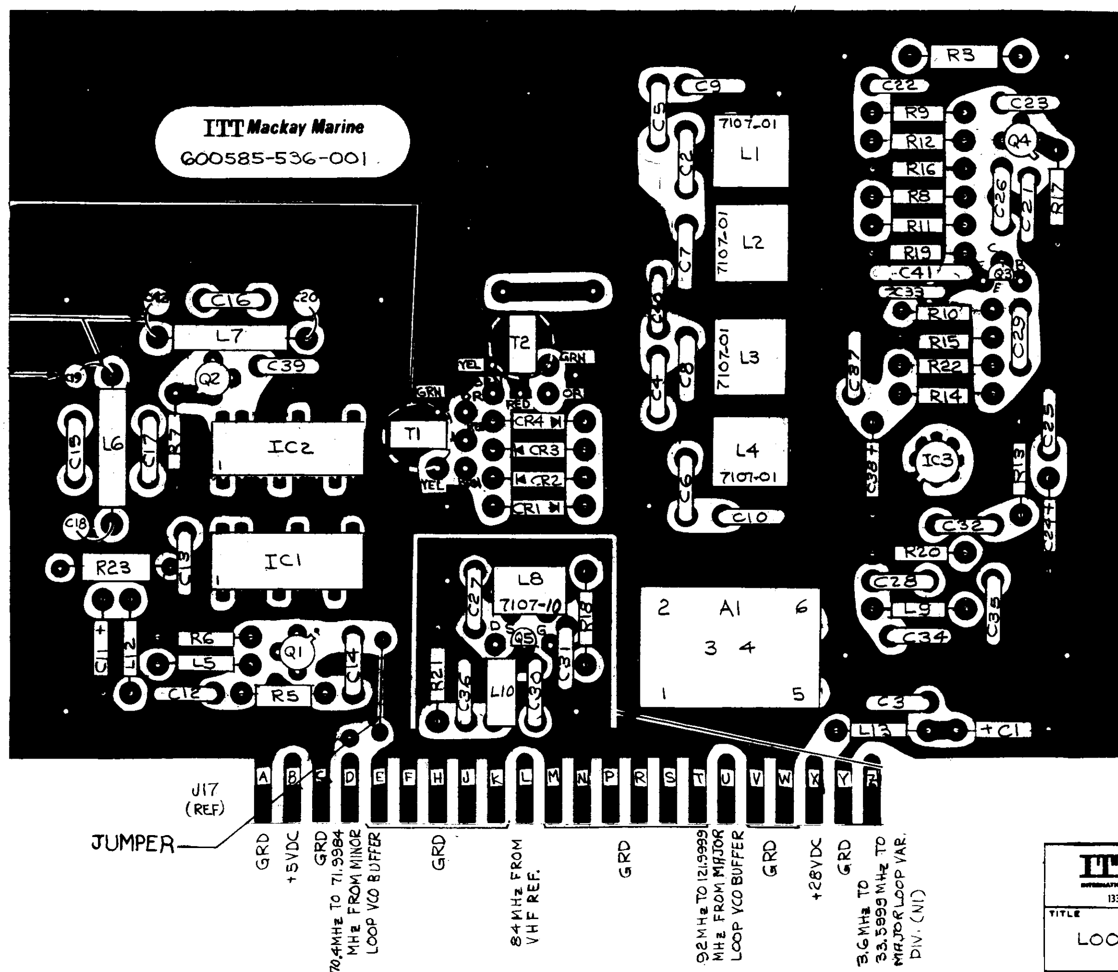
GRD
J21-P,R,T,U,W,Z

0895D036

ITT Mackay Marine

TITLE SCHEMATIC MINOR LOOP VARIABLE DIVIDER

SCALE NONE | 205

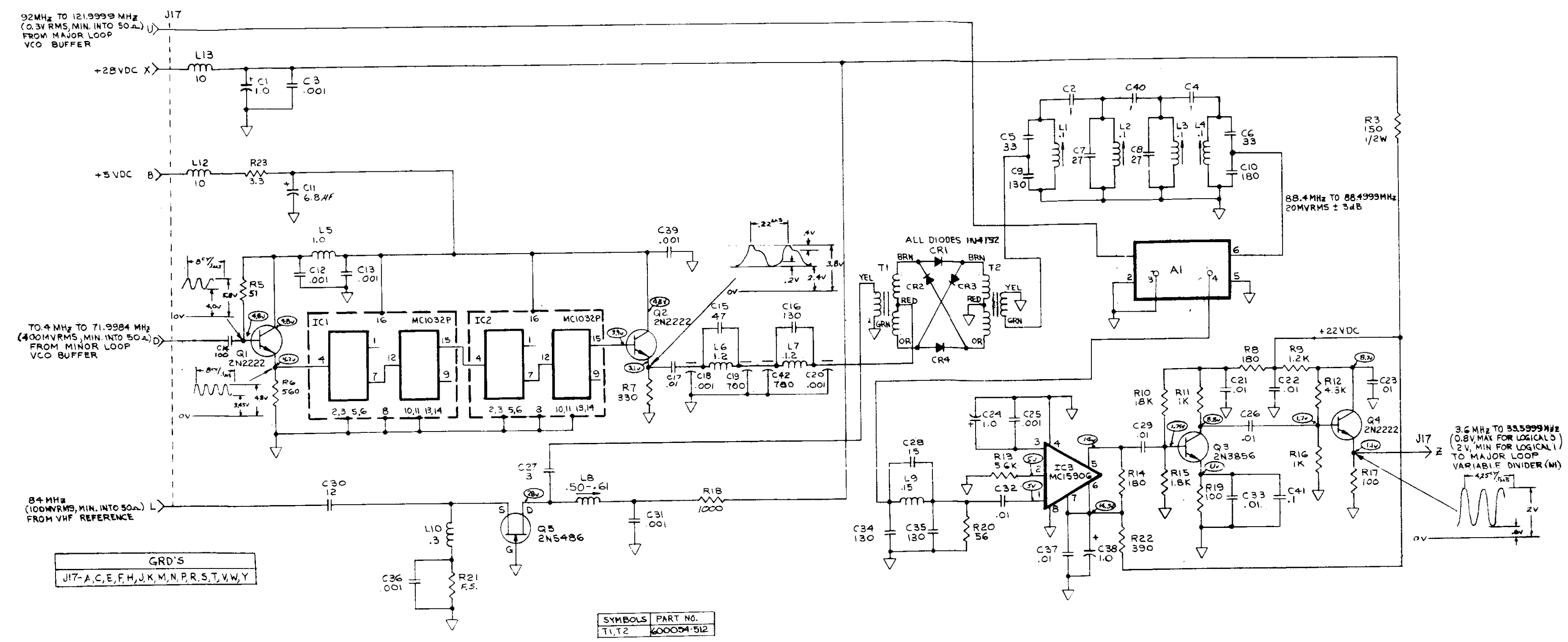


0562C091

ITT Mackay Marine
133 TERMINAL AVE. CLARK N.J. U.S.A.

TITLE: LOOP TRANSLATOR ASSY.

SCALE 2:1 | 600585-536

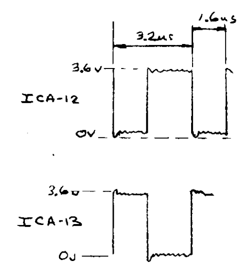


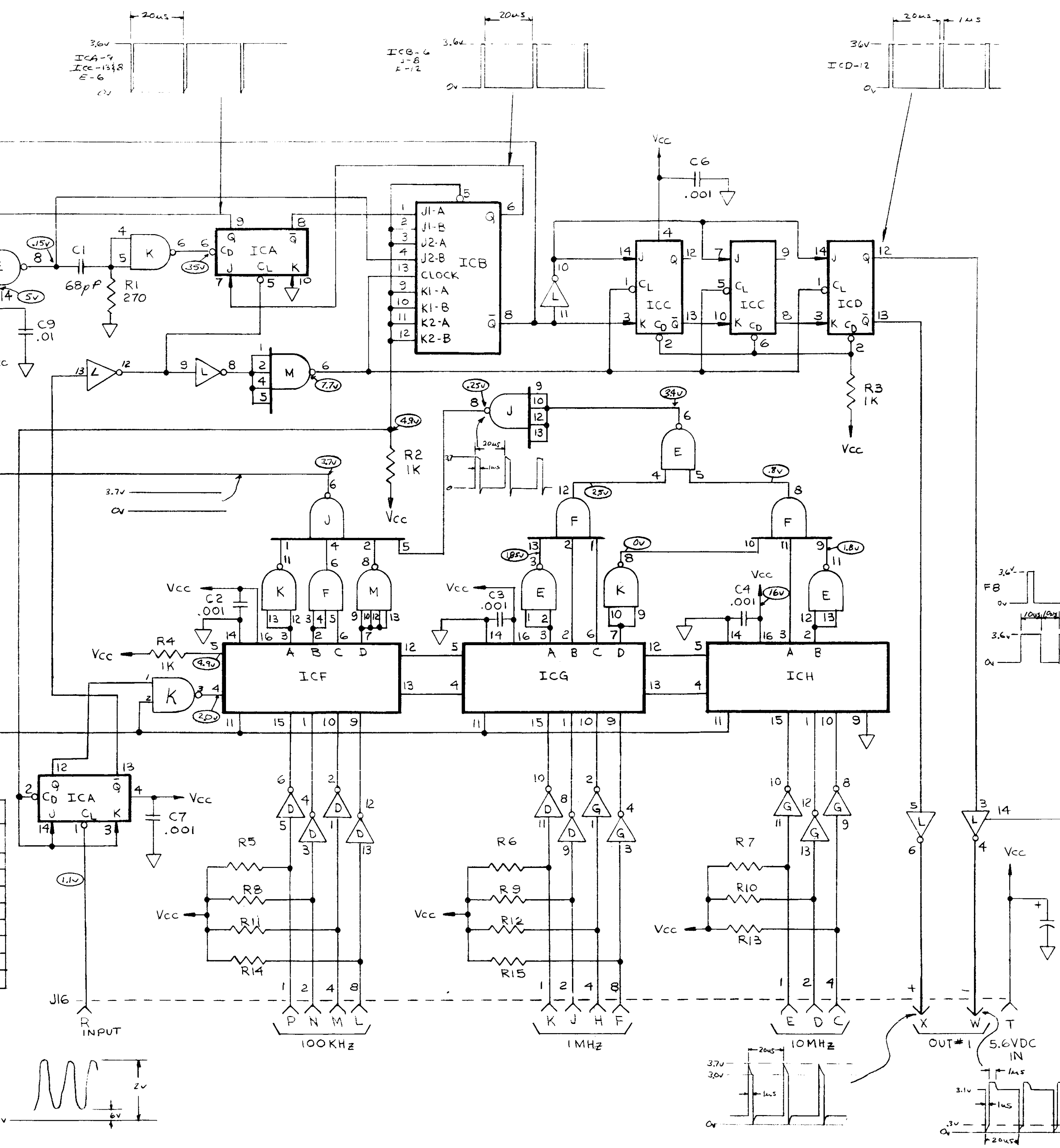
NOTES:
1- UNLESS OTHERWISE SPECIFIED
ALL CAPACITANCE VALUES GREATER THAN 1.0 ARE IN pF.
ALL CAP VALUES 1.0 AND SMALLER ARE IN uF.
ALL INDUCTANCE VALUES uH.
ALL RESISTANCE VALUES IN OHMS
K=1000

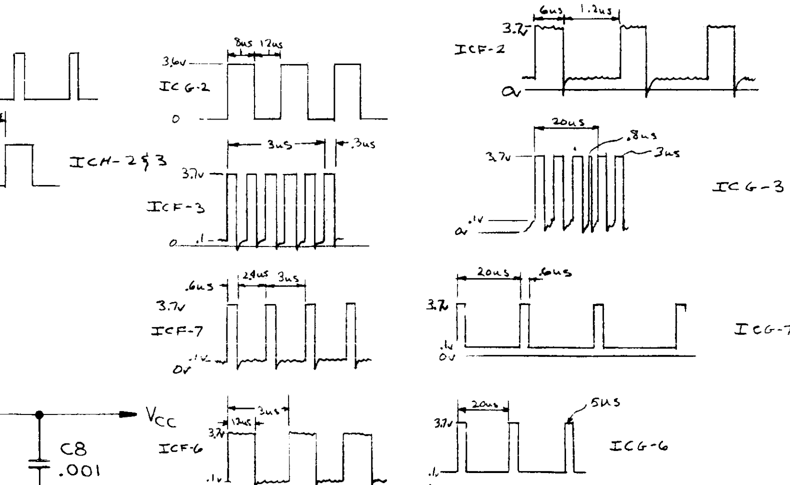
0895D034

ITT Mackay Marine

SCHEMATIC LOOP TRANSLATOR



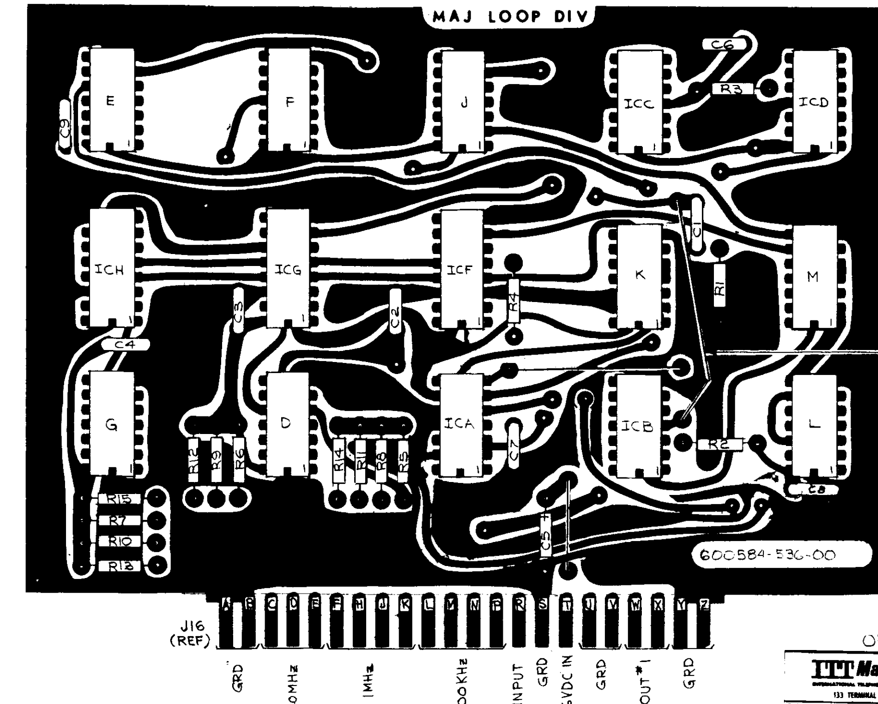




MODULES	PART NO.	Vcc	GRD
ICA, ICC, ICD	SN74H103N	PIN 4	PIN 11
ICB	SN74H101N	PIN 14	PIN 7
ICF, ICG, ICH	SN74192N	PIN 16	PIN 8
D, G	SN7404N	PIN 14	PIN 7
E, K	SN74H00N	PIN 14	PIN 7
F	SN74H11N	PIN 14	PIN 7
J	SN74H20N	PIN 14	PIN 7
L	SN74H04N	PIN 14	PIN 7
M	SN74H40N	PIN 14	PIN 7

GRD
J16-A, B, S, U, V, Y, Z

NOTES:
1- UNLESS OTHERWISE SPECIFIED; ALL RESISTANCE VALUES IN OHMS K=1000
2- R5 TO R15 ARE 1K, FOR -001. R5 TO R15 ARE 4.7K FOR -002.

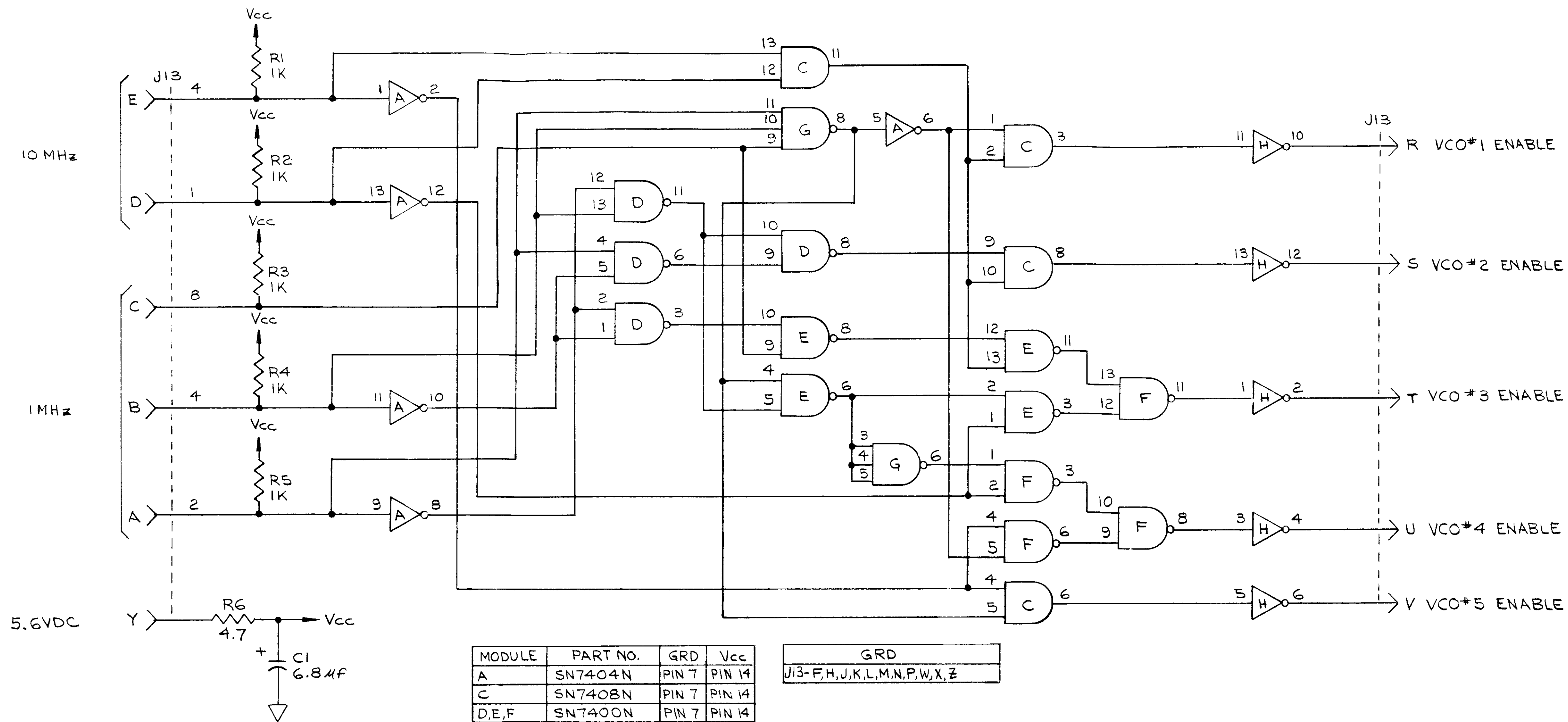


0562C090

ITT Mackay Marine
133 TERMINAL AVE. CLARK N.J. U.S.A.
TITLE MAJOR LOOP VARIABLE DIVIDER ASSEMBLY
SCALE 2:1
600584-536

0895D031

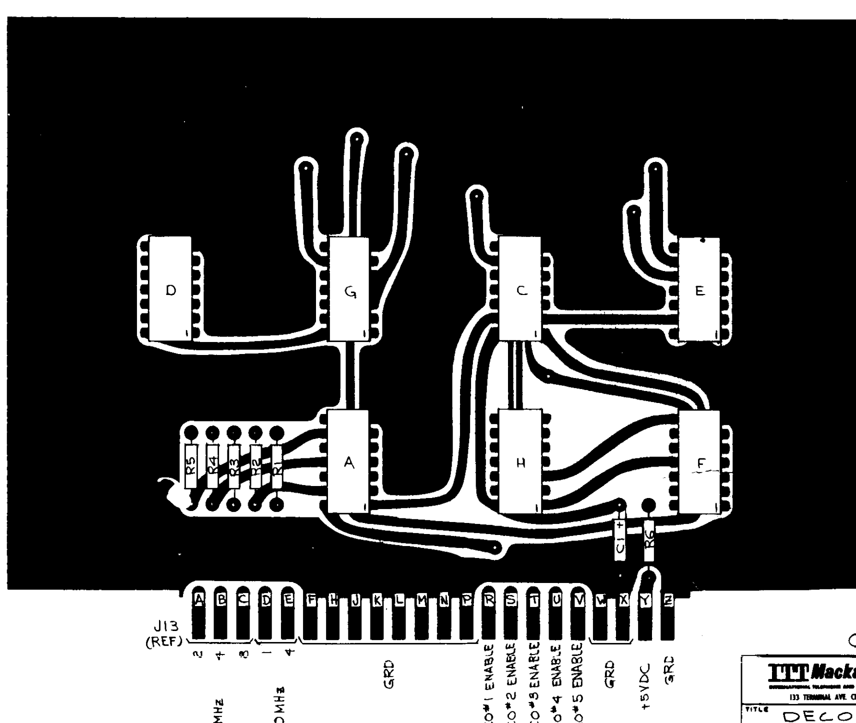
ITT Mackay Marine
133 TERMINAL AVE. CLARK N.J. U.S.A.
TITLE SCHEMATIC MAJOR LOOP VARIABLE DIVIDER
SCALE NONE
620584-536



MODULE	PART NO.	GRD	Vcc
A	SN7404N	PIN 7	PIN 14
C	SN7408N	PIN 7	PIN 14
D,E,F	SN7400N	PIN 7	PIN 14
G	SN7410N	PIN 7	PIN 14
H	SN7406N	PIN 7	PIN 14

GRD
J13-F,H,J,K,L,M,N,P,W,X,Z

NOTES:
1- UNLESS OTHERWISE SPECIFIED;
ALL RESISTANCE VALUES IN OHMS.
K=1000.



05620087

ITT Mackay Marine

TITLE DECODER, CARD ASSY

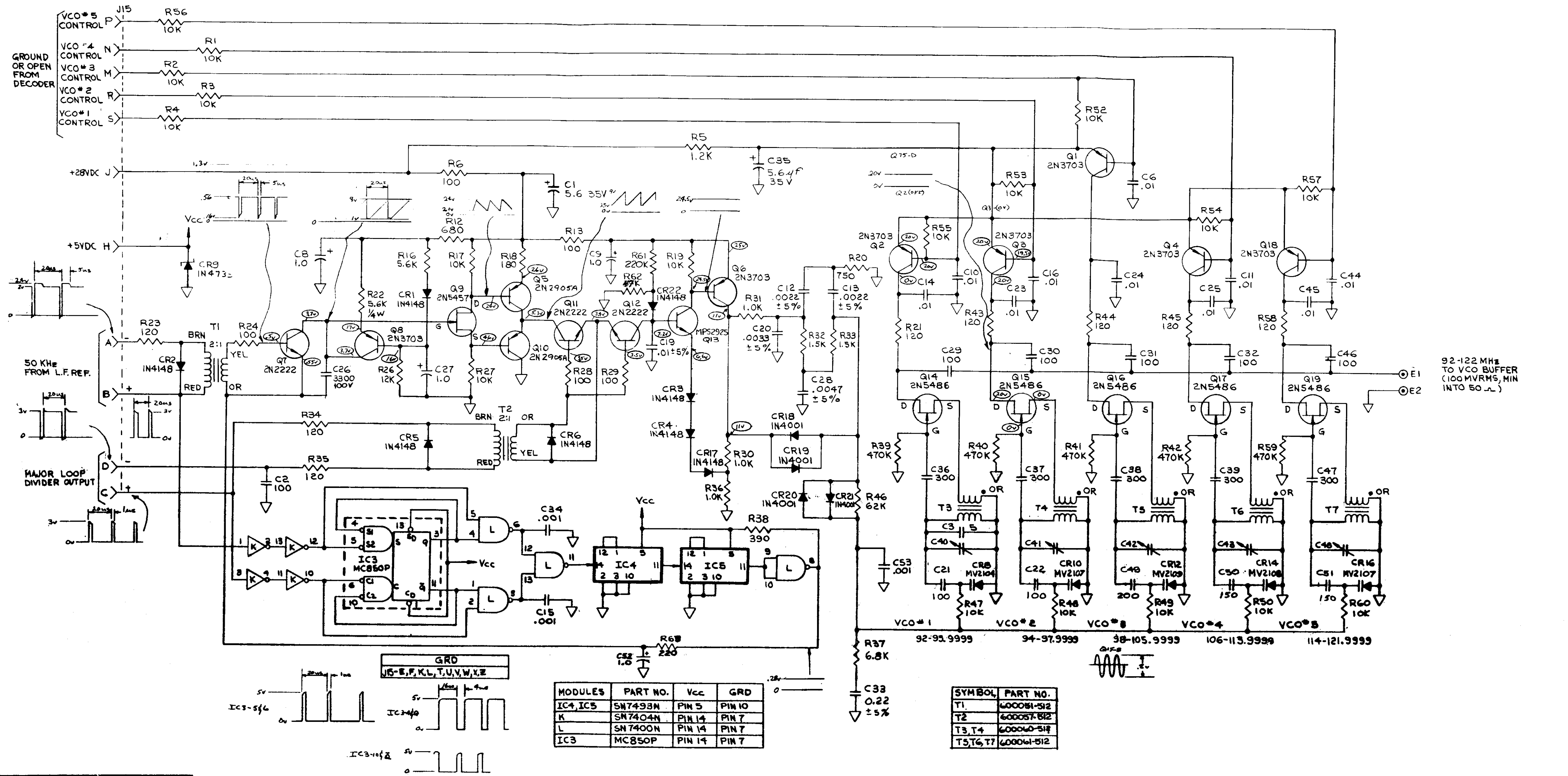
600582-534 REV D

08950028

ITT Mackay Marine
INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION
133 TERMINAL AVE. CLARK N.J. U.S.A.

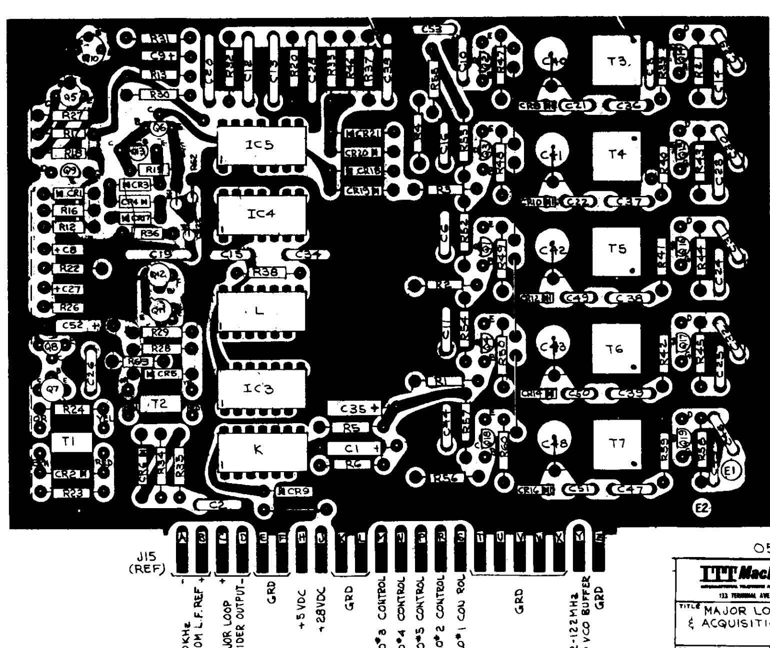
TITLE DECODER SCHEMATIC

620582-536 REV D



MODULES	PART NO.	Vcc	GRD
IC4, IC5	SN7493N	PIN 5	PIN 10
K	SN7404N	PIN 14	PIN 7
L	SN7400N	PIN 14	PIN 7
IC3	MC850P	PIN 14	PIN 7

SYMBOL	PART NO.
T1	600051-512
T2	600057-512
T3, T4	600060-512
T5, T6, T7	600061-512



0562C089

ITT Mackay Marine

TITLE MAJOR LOOP ANALOG & ACQUISITION ASSEMBLY

SCALE 2:1

600580-536 REV. F

NOTES.
1-UNLESS OTHERWISE SPECIFIED;
ALL CAPACITANCE VALUES GREATER THAN 1.0 ARE IN PF.
ALL CAP VALUES 1.0 AND SMALLER ARE IN μF.
ALL RESISTANCE VALUES IN OHMS.
K=1000

0895D030

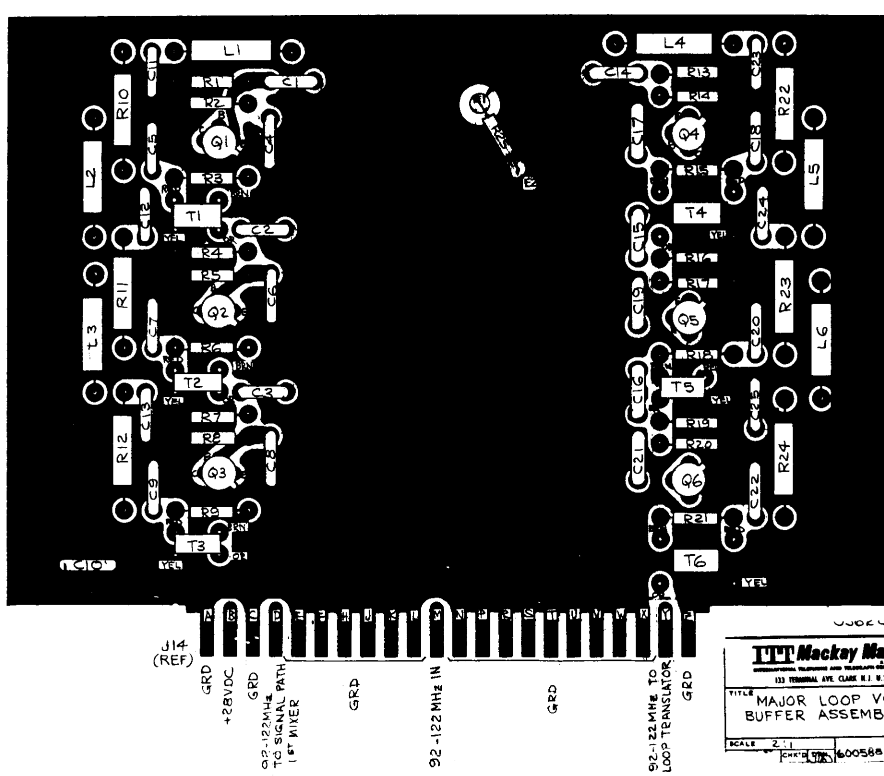
ITT Mackay Marine
133 TERMINAL AVE. CLARK N.J. U.S.A.

TITLE SCHEMATIC MAJOR LOOP ANALOG AND ACQUISITION

SCALE

APP'D ENG. CHK'D DRN.

620580-536



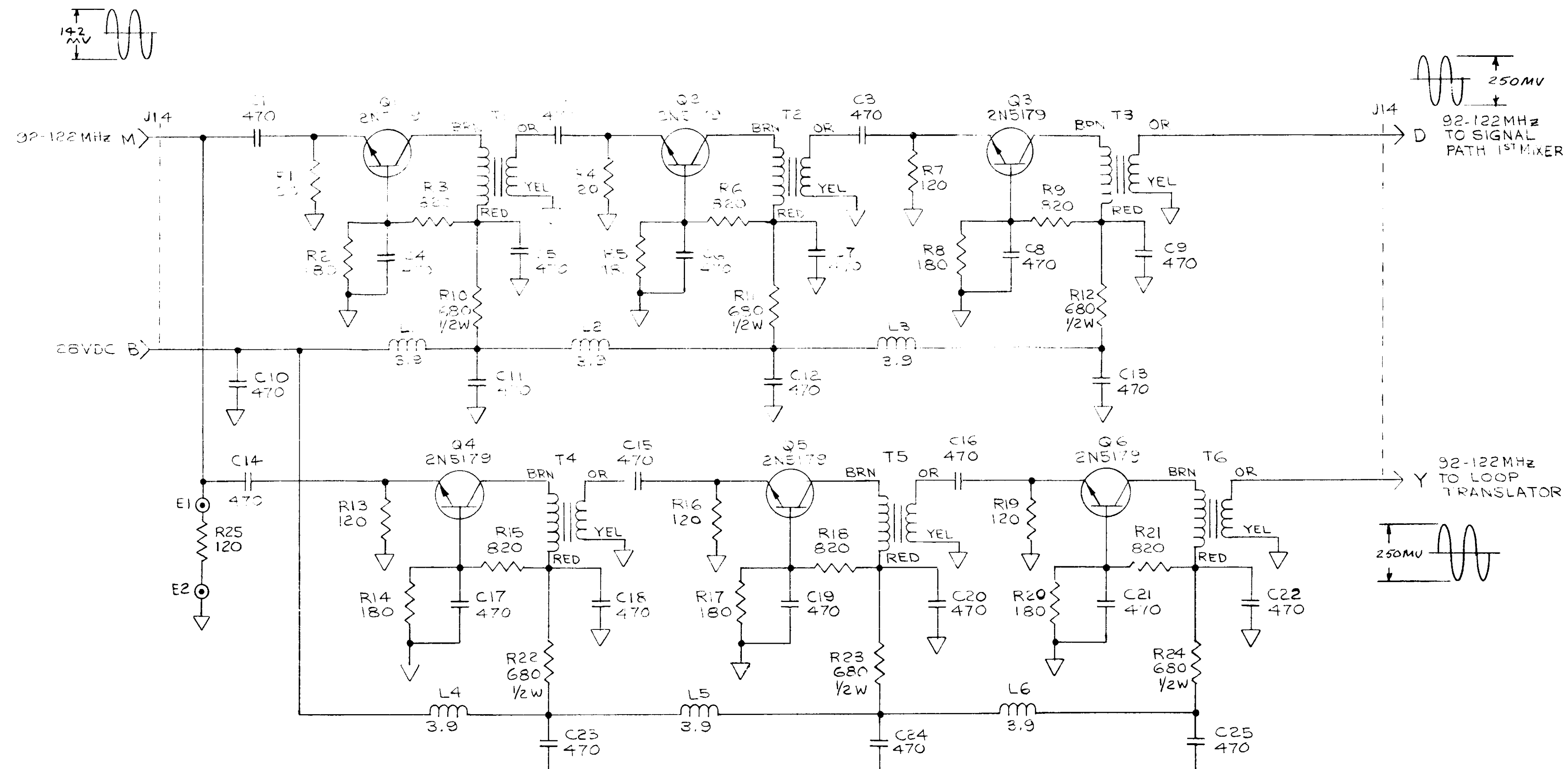
ITT Mackay Marine

133 TERMINAL AVE. CLARK N.J. U.S.A.

TITLE MAJOR LOOP VCO BUFFER ASSEMBLY

SCALE 2:1

600588-584



GRD
J14-A,C,E,F,H,J,K,L,N,P,R,S,T,U,V,W,X,Z

SYMBOLS	PART NO.
T1,T2,T3,T4,T5,T6	600059-512-001

NOTES:
1- UNLESS OTHERWISE SPECIFIED;
ALL CAPACITANCE VALUES ARE IN PF.
ALL INDUCTANCE VALUES IN μH
ALL RESISTANCE IN OHMS

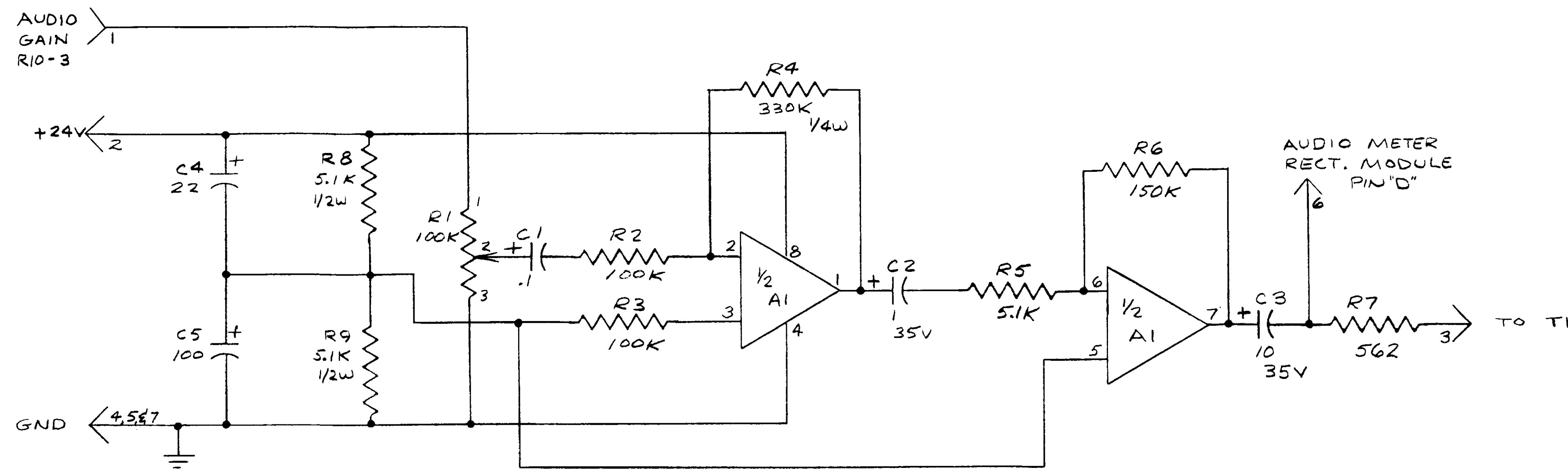
08950029

ITT Mackay Marine

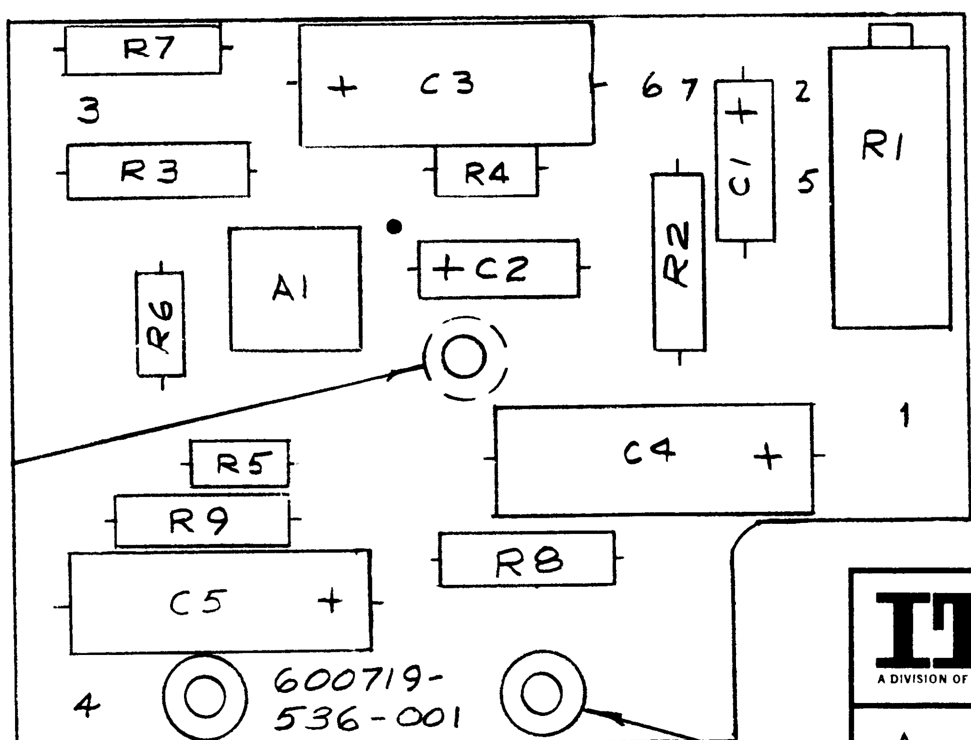
133 TERMINAL AVE. CLARK N.J. U.S.A.

TITLE SCHEMATIC MAJOR LOOP VCO BUFFER

620583-536 REV E



NOTES:
1. UNLESS OTHERWISE SPECIFIED:
ALL RESISTER ARE IN OHMS, 1/8W, 1%.
ALL CAPACITOR ARE IN MICRO-FARADS.



ITT Telecommunications
TRANSMISSION DEPARTMENT
RALEIGH, NORTH CAROLINA
A DIVISION OF INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION

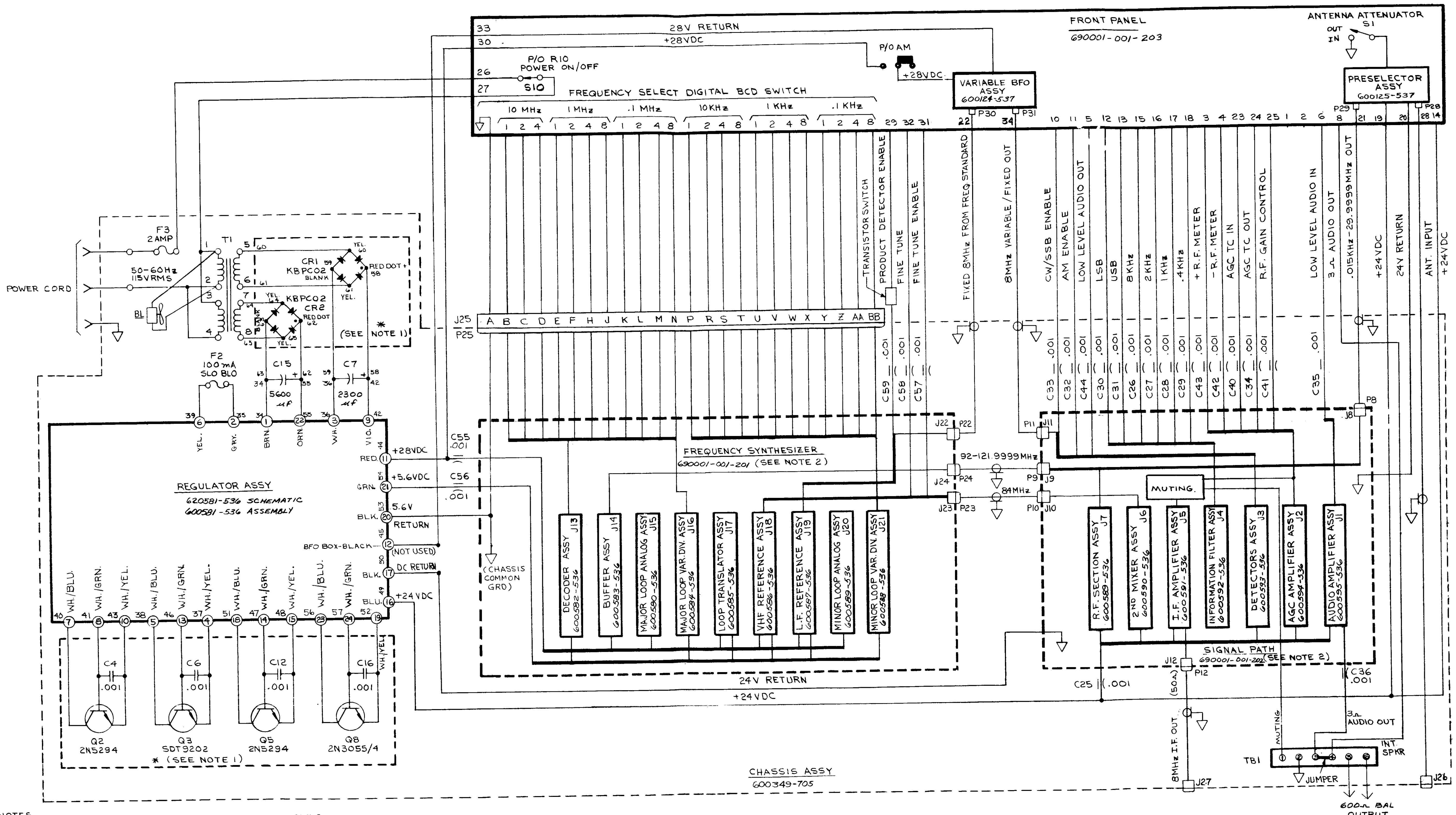
ASS'Y, 600 Ω LINE AMPLIFIER

SIZE B | DRAWING NUMBER 600719-536 | SHEET NO. 1 OF 2 | ISSUE B

ITT Telecommunications
TRANSMISSION DEPARTMENT
RALEIGH, NORTH CAROLINA
A DIVISION OF INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION

SCHEMTIC, 600 Ω LINE AMPLIFIER

SIZE C | DRAWING NUMBER 620719-536 | SHEET NO. 1 OF 1 | ISSUE B



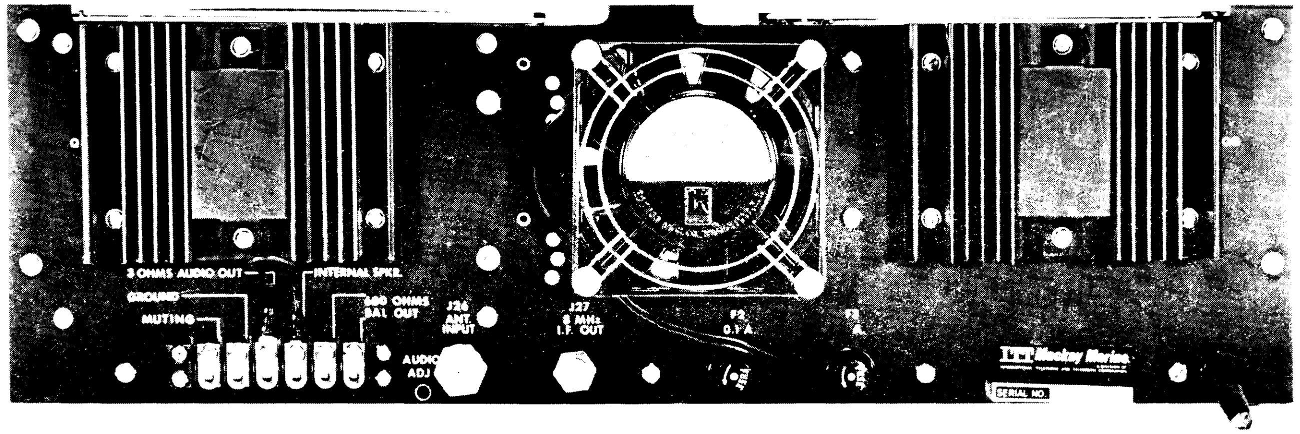
NOTES
1- * DENOTES COMPONENTS MOUNTED ON REAR HEAT SINKS.
2- FOR DETAIL WIRING OF J1 THRU J23 SEE DRAWINGS 690001-001-202 AND 690001-001-201.

0895D808

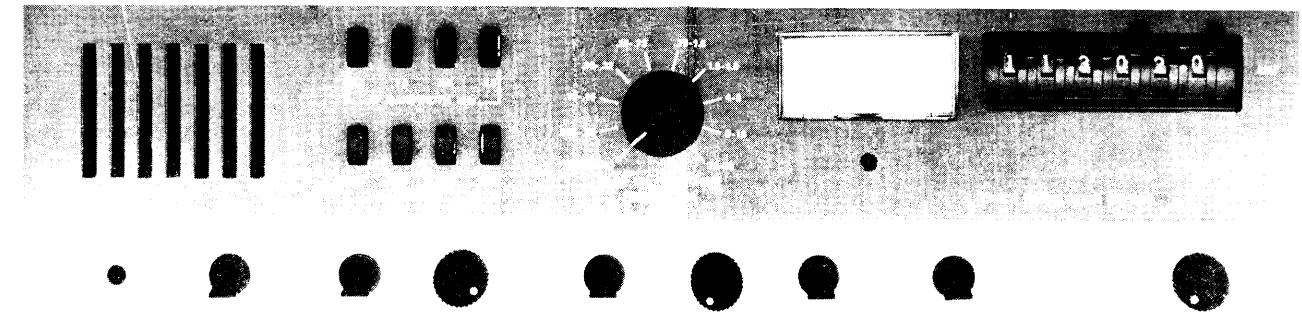
ITT Mackay Marine

TITLE INTERCONNECTION DIAGRAM 3020A

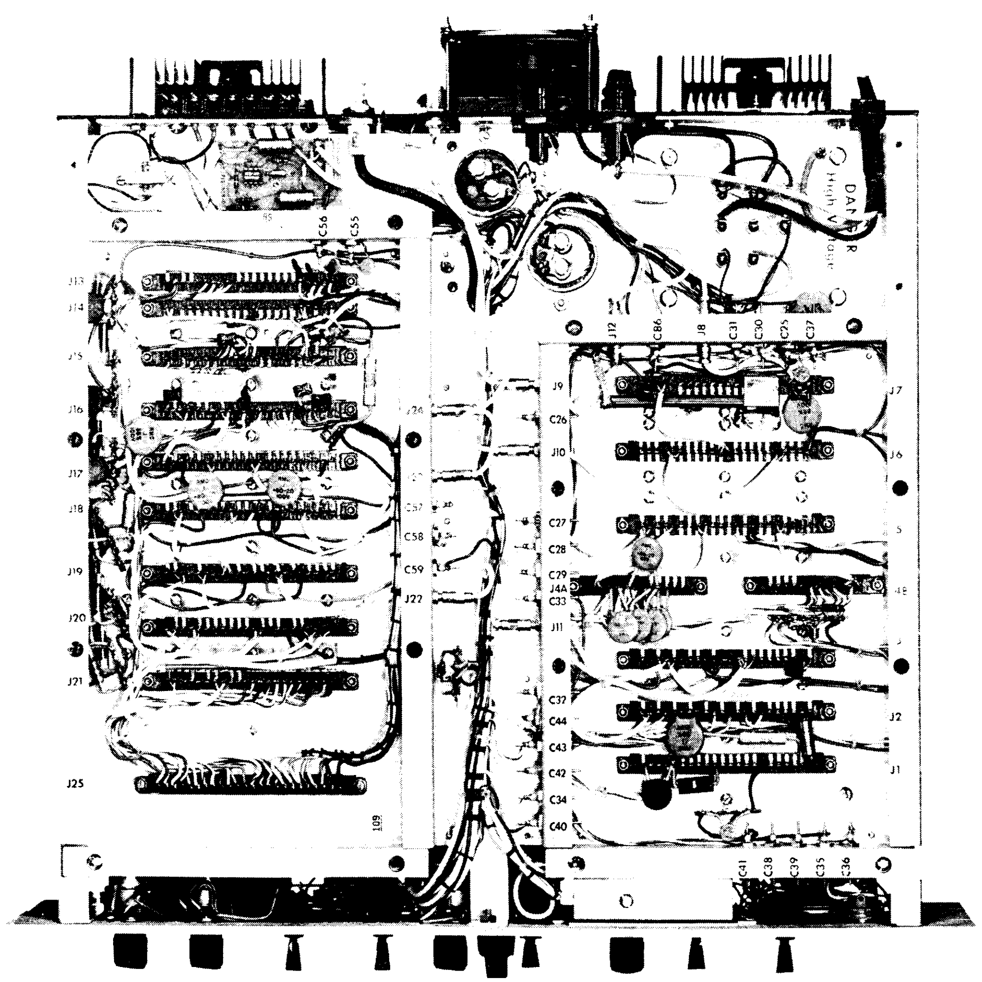
SCALE — APP'D — CHK'D — 690001-015 REV F



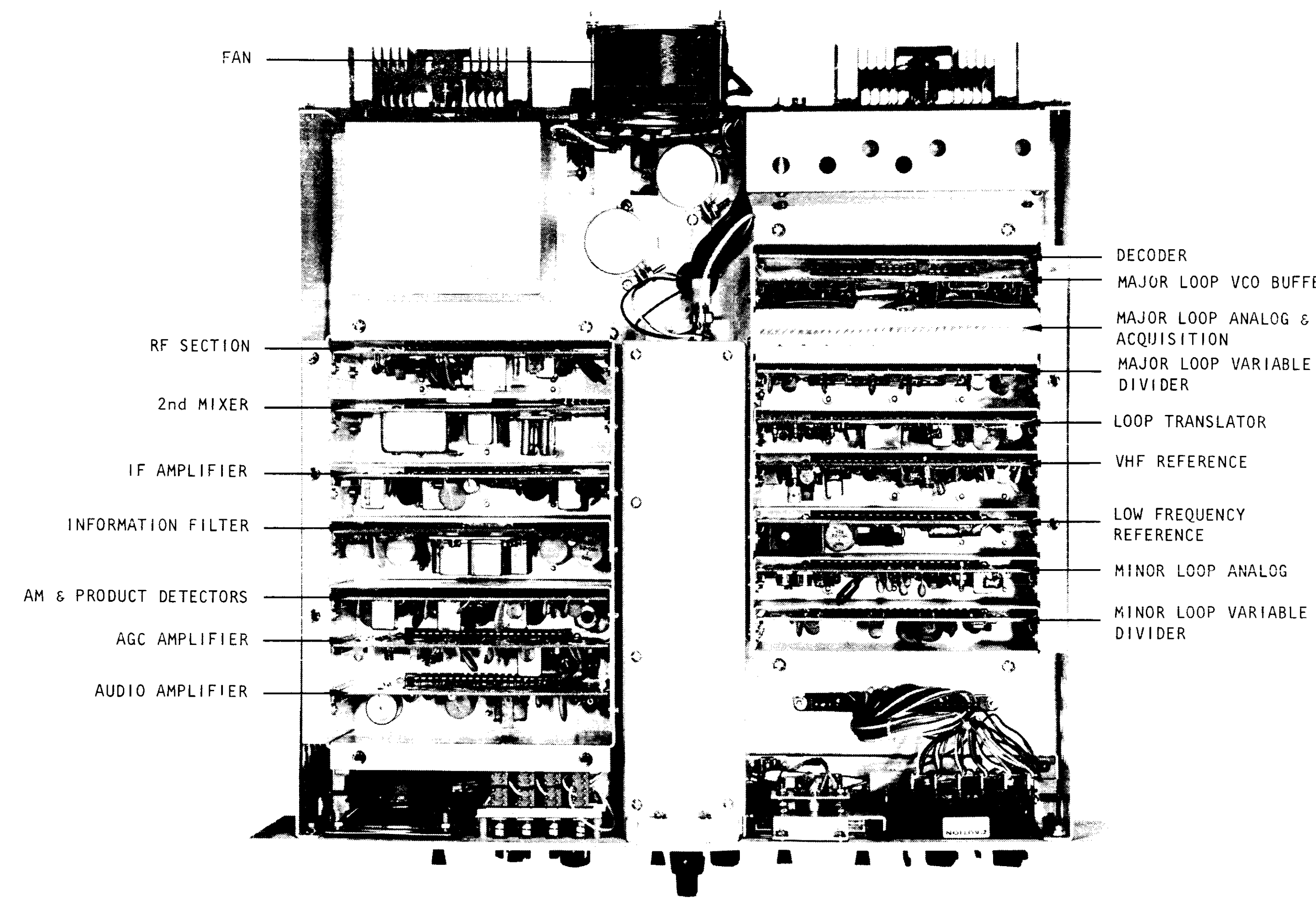
REAR PANEL



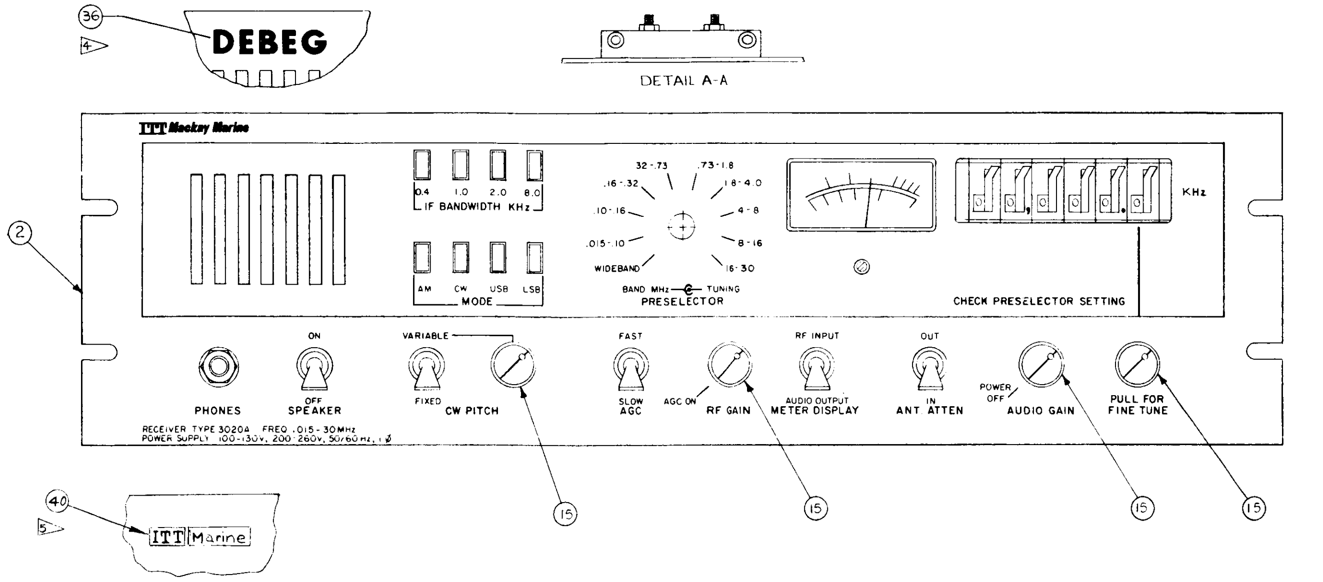
FRONT PANEL



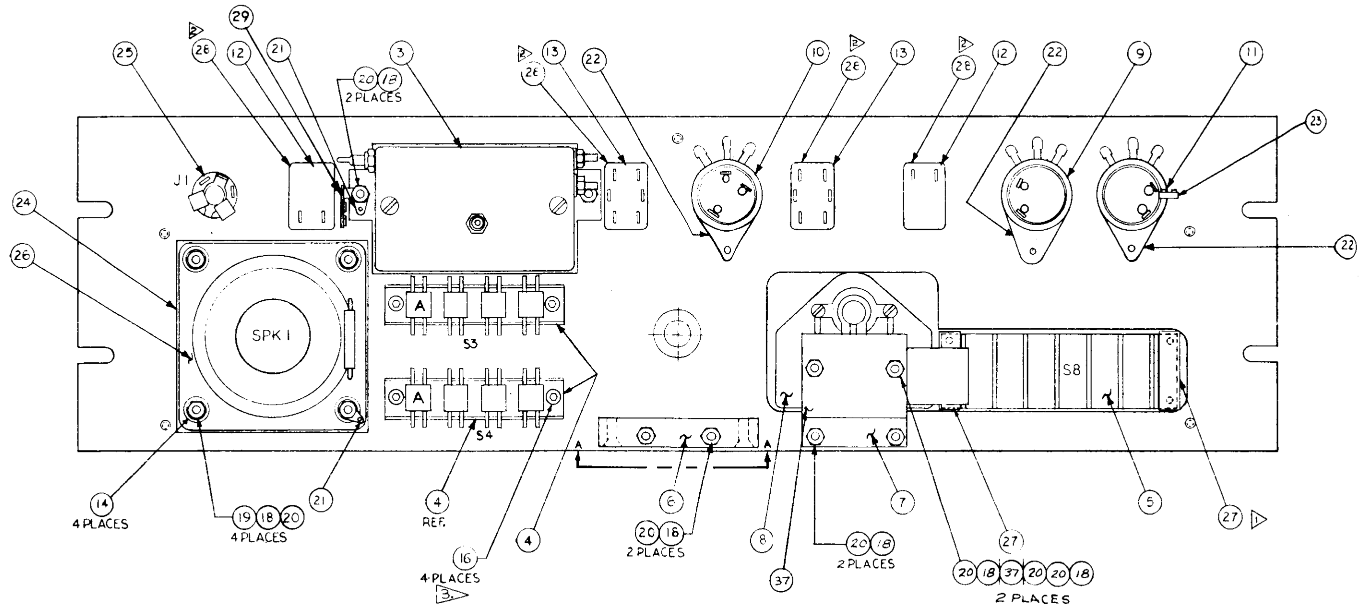
BOTTOM VIEW



TOP VIEW



FRONT PANEL CONTROLS



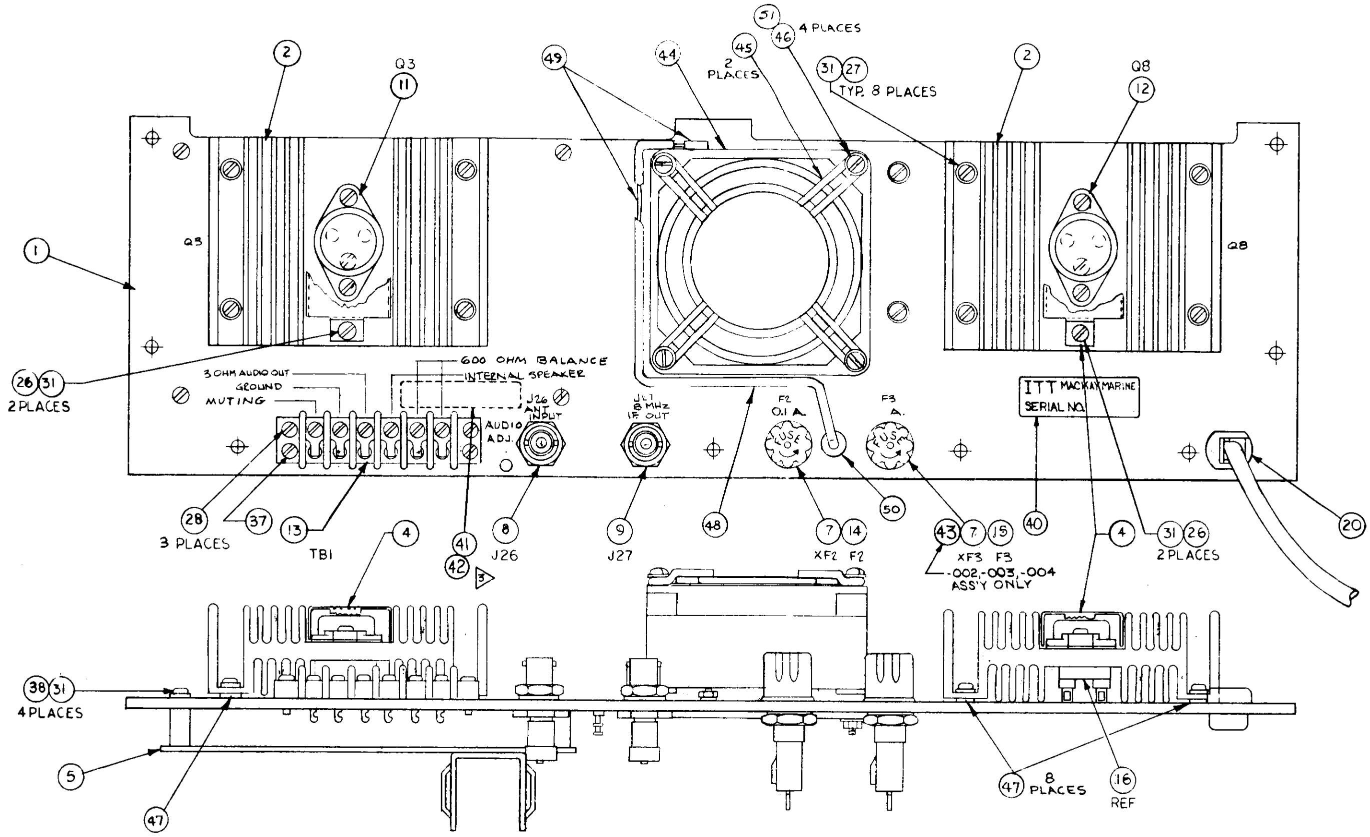
REVERSE OF FRONT PANEL

FRONT PANEL ASSEMBLY
(600034-539-001 H)

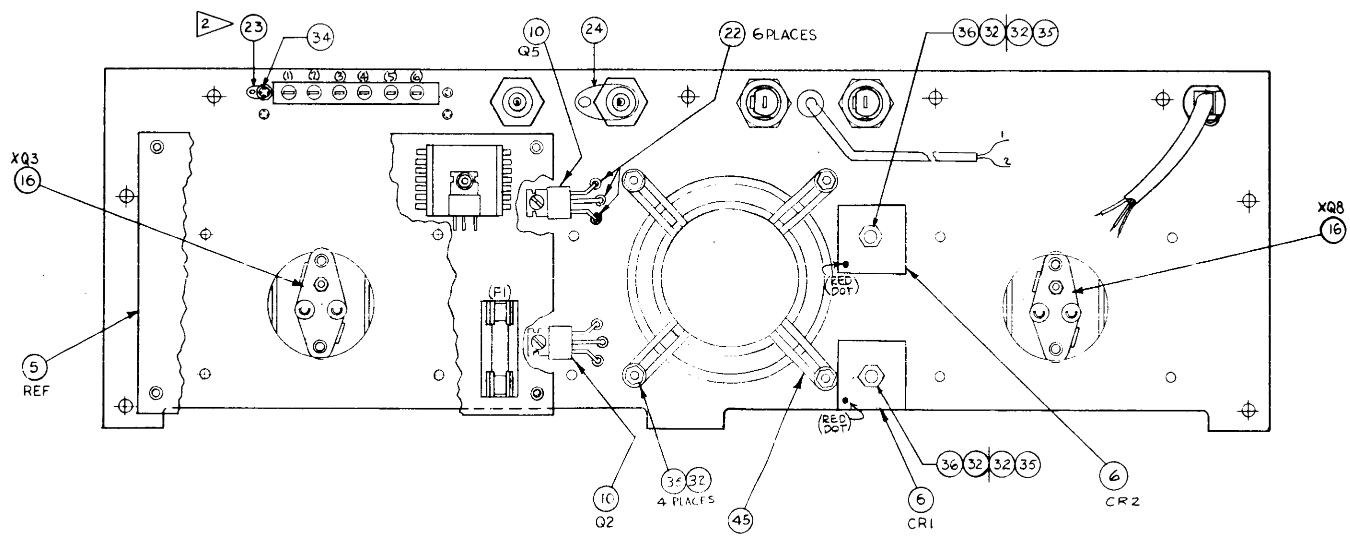
3020 RADIO-RECEIVER
FRONT PANEL REPLACEABLE PARTS
(600034-539H)

ITEM NUMBER	MACKAY MARINE PART NUMBER	DESCRIPTION
2	600123-609-001	Front Panel Marked
3	600124-537-001	Variable BFO Assembly
4	600174-713-001	Switch Assembly Wired
5	600175-713-001	Mini-Lever Switch Assembly
6	600085-636-001	Block Support
7	601424-602-001	Meter Bracket
8	600017-368-001	RF and Audio Meter
9	600068-360-001	Potentiometer, Carbon, 100K, 2 Watts, with SPST Switch (Audio Tapped)
10	600069-360-001	Potentiometer, Carbon, 2.5K, 2 Watts, with SPDT Switch (Linear Tapped)
11	600070-360-001	Potentiometer, Carbon, 10K, 2 Watts, with SPST Switch (Push-Pull)
12	600117-616-001	Toggle Switch, SPST
13	600117-616-002	Toggle Switch, DPDT
14	600204-642-001	Grommet, VIB. Mount
15	600101-618-001	Knob, Skirted, Black with White Dot
16	600073-204-005	Screw, Mach. Hex, 4-40, 3/16
18	622006-217-005	Washer, Int. Tooth #6
19	612006-217-005	Flat Washer #6
20	610632-208-226	Nut, Mach. Hex, 6-32
21	600206-230-008	Ground Lug
22	600206-230-019	Ground Lug 1/2"

ITEM NUMBER	MACKAY MARINE PART NUMBER	DESCRIPTION
23	600160-631-005	Terminal Strip Slug
24	600006-641-001	Speaker Screened Model
25	600079-611-001	Headphone Jack
26	600007-570-001	Speaker 3 X 3
27	600004-109-002	Rubber Strip
28	600074-212-001	Int. Tooth L.W. 1/2"
29	600160-631-006	Terminal Strip, Minimum
30	600001-115-002	Locktite
34	600116-618-001	Modified Handle
36	600210-626-001	DEBEG Nameplate
37	600738-536-001	Audio Meter Rec Mod
40	600264-609-001	Front Panel Marked



REAR PANEL CONTROLS



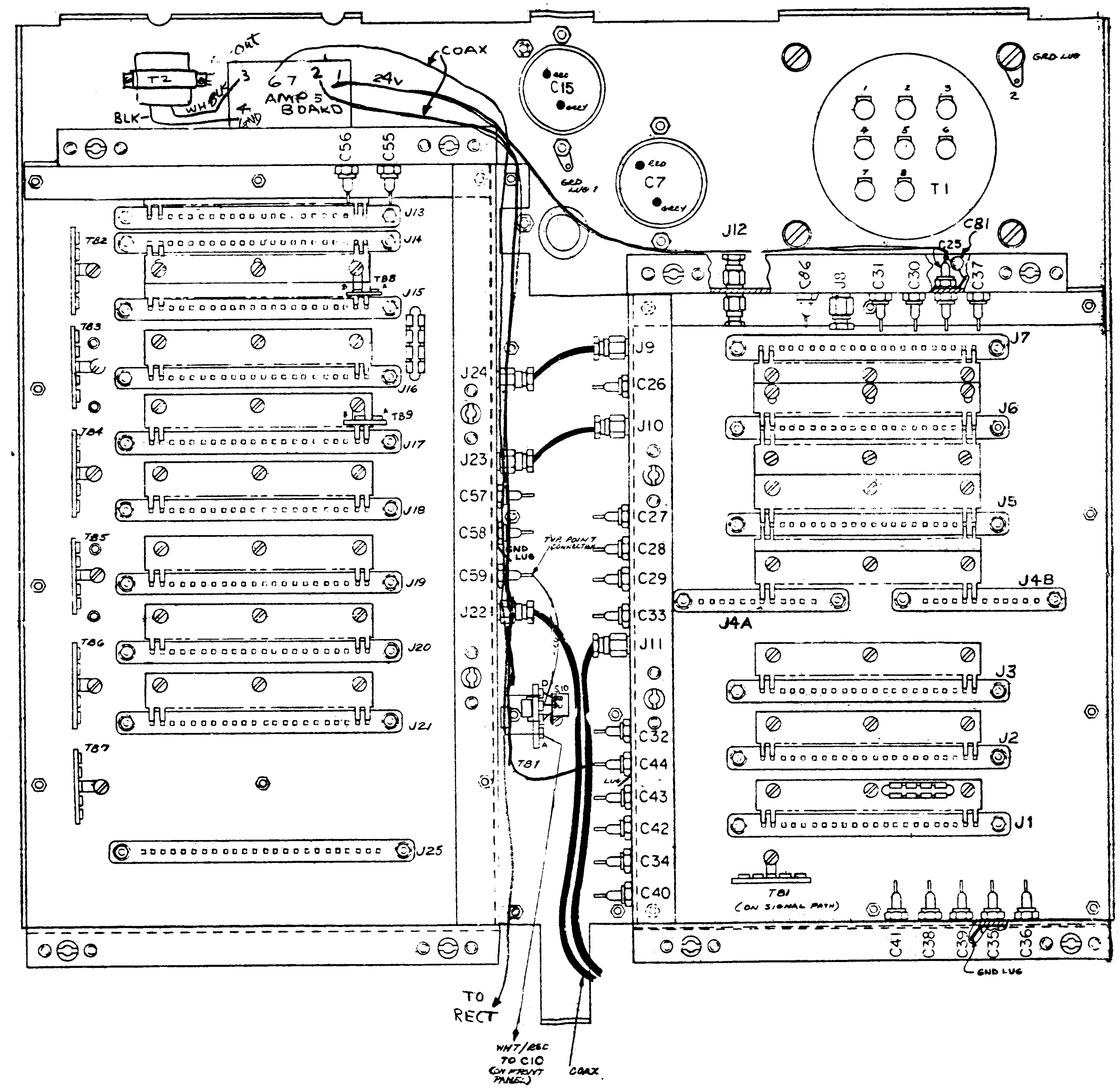
REVERSE OF REAR PANEL

REAR PANEL ASSEMBLY
(600035-539-001E)

3020 RADIO-RECEIVER
REAR PANEL REPLACEABLE PARTS
(600034-539H)

ITEM NUMBER	MACKAY MARINE PART NUMBER	DESCRIPTION
1	600122-609-001	Rear Panel Marked
2	610428-602-001	Heat Sink, Modified
3	601425-602-001	Heat Sink, Modified, Blank
4	601423-602-001	Transistor Cover
5	600581-536-001	Regulator PC Card Assembly
6	600027-416-001	Rectifier Bridge
7	600014-613-001	Fuse Holder
8	600193-606-001	Jack, Bulkhead BNC
9	600014-606-001	Jack, Bulkhead BNC
10	600178-413-001	Transistor NPN2N5294
11	600187-413-001	Transistor NPNSDT9202
12	600188-413-001	Transistor 2N3055/4
13	600099-631-002	Terminal Board
14	600006-396-004	0.1 Amp Fuse, 250 Volts, Slo-Blo
15	600006-396-024	2 Amp Fuse, 250 Volts, Slo-Blo
16	600062-419-001	Socket, Transistor
20	600041-233-004	Stain, Relief Bushing
22	600226-230-004	Double Turret Standoff Terminal
23	600206-230-008	Ground Lug
24	600206-230-020	Ground Lug 3/8"
26	690440-203-045	Screw 4-40 x 1/4 PHSS
27	690440-203-065	Screw 4-40 x 3/8 PHSS
31	622004-217-005	Washer, Int. Tooth #4

ITEM NUMBER	MACKAY MARINE PART NUMBER	DESCRIPTION
34	610440-208-126	Nut, Hex 4-40
35	610632-208-126	Nut, Hex 6-32
36	690632-203-095	Screw, 6-32 x 9/16 PHSS
37	690440-203-125	Screw, 4-40 x 3/4 PH
38	690440-203-055	Screw, 4-40 x 5/16 PH
40	600207-626-001	Name Plate 3020A
41	600209-626-001	Name Plate EB-3028
42	600208-626-001	Name Plate EB-3026
43	600004-396-011	1 Amp Fuse, 250 Volts, 3AG



MAIN CHASSIS ASSEMBLY WIRING DIAGRAM
(690001-003K)

3020 MAIN CHASSIS ASSEMBLY
REPLACEABLE PARTS
(600349-705M)

CIRCUIT REFERENCE	MACKAY MARINE PART NUMBER	DESCRIPTION
T1	600047-512-001	Power Transformer
T2	635160-501-001	Transformer
C7	600183-314-003	2300 μF, 75 Volts
C15	600183-314-004	5600 μF, 25 Volts
TS1	600160-631-004	2-pin term. strip
		SIGNAL PATH
		Connectors
J1 to J3, J5 to J7	600058-605-002	22-pin Connector
J4A, J4B	600058-605-001	12-pin Connector
J8	600102-540-005	Jack, Submin Assembly
J9, J10	600102-540-006	Jack, Submin Assembly
J11, J12	600102-540-002	Jack, Submin Assembly
		Capacitors
C20, C21	600215-314-029	270 pF, 100 Volts, ±5%
C22, C23	600215-314-027	0.1 μF, 100 Volts, +80, -20
C25 to C44	600219-314-001	0.001 μF, Feed-thru
C61 to C65	600189-314-016	0.1 μF, 25 Volts
C66	600160-314-005	0.2 μF, 25 Volts
C67	647005-319-200	47 μF, 15 Volts
C68, C80	600189-314-015	0.01 μF, 100 Volts
C85	600215-314-013	27 pF

CIRCUIT REFERENCE	MACKAY MARINE PART NUMBER	DESCRIPTION
C86	600219-314-001	0.001 pF, Feed-thru
		Diodes
CR1, CR2	600109-410-001	1N4148
		Resistors
R1	610024-341-075	10K, 1/4 Watt, ±5%
R2	647014-341-205	4.7K, 1/2 Watt, ±5%
R3	643014-341-075	4.3K, 1/4 Watt, ±5%
R4	630024-341-075	30K, 1/4 Watt, ±5%
R5	610094-341-425	10 Ohms, 2 Watts, CC
R29	600062-340-025	10 Ohms, 5 Watts, ±5%
		Terminal Strip
TB1	600160-631-003	5-pin Terminal Strip
		Transistor
Q1	600080-413-001	2N2222A
		SYNTHESIZER
		Connectors
J13 to J21	600058-605-002	22-pin Connector
J22, J23	600102-540-004	Jack, Submin Assembly
J24	600102-540-006	Jack, Submin Assembly
J25	600056-605-003	24-pin Connector

CIRCUIT REFERENCE	MACKAY MARINE PART NUMBER	DESCRIPTION
		Capacitors
C45	668045-319-609	6.8 µF, 6 Volts
C46, C51, C52 C70, C79	600189-314-015	0.01 µF, 100 Volts
C47	600189-314-029	0.10 µF, 100 Volts
C48, C49, C53	600160-314-005	0.2 µF, 25 Volts
C50	600189-314-016	0.1 µF, 25 Volts
C54	668045-319-350	6.8 µF, 35 Volts
C25 to C44, C55 to C59	600219-314-001	0.001 µF, Feed-thru
C60	656055-319-150	56 µF, 15 Volts
C72 to C76, C82	600215-314-021	100 pF
C77, C78	600189-314-017	0.1 µF, 100 Volts
C83, C84	600215-314-029	270 pF
		Chokes
L1, L7, L8, L10	600119-376-009	RF, 4.7 µH
L2, L9	600119-376-001	RF, 1.0 µH
L3	600119-376-014	RF, 12.0 µH
L4 to L6	600119-376-002	RF, 1.2 µH
L11	600119-376-007	RF, 3.3 µH
		Resistors
R30	600062-340-025	250 Ohms, 5 Watts, ±5%
R35	612004-341-075	120 Ohms, 1/4 Watt, ±5%

CIRCUIT REFERENCE	MACKAY MARINE PART NUMBER	DESCRIPTION
		Terminal Strips
TB2, TB6, TB7	600160-631-001	4-pin
TB3	600160-631-003	5-pin
TB4, TB5	600160-631-002	5-pin
TB8	600160-631-004	2-pin

3020 RADIO RECEIVER
SPARE PARTS
(LIST # 690001-017A)

QUANTITY	MACKAY MARINE PART NUMBER	DESCRIPTION
	690011-000-001	Extender Board
	690001-017-003	Spare Boards, Complete (For -001, -002, -005 and -007 Only)
	690001-017-004	Spare Boards, Complete (For -003 and -004 Only)
	692001-017-001	Spares, Inverter
	GROUPS -001, -002, -003, -004, -005, -007	
1	600103-618-001	Card Extractor
5	600004-396-013	2 Amp Fuse, 250 Volts, 3AG
5	600004-396-011	1 Amp Fuse, 250 Volts, 3AG
5	600006-396-004	0.1 Amp Fuse, 250 Volts, 3AG
5	600004-396-012	1.5 Amp Fuse, 250 Volts, 3AG
	GROUPS -001, -002, -005, -007	
1	600582-536-001	Decoder PC Card
1	600583-536-001	Major Loop VCO Buffer PC Card
1	600580-536-001	Major Loop Analog and Acquisition PC Card
1	600584-536-001	Major Loop Variable Divider PC Card
1	600585-536-001	Loop Translator PC Card
1	600586-536-001	VHF Reference PC Card
1	600587-536-001	Low Frequency Reference PC Card
1	600579-536-001	Minor Loop Analog PC Card
1	600588-536-001	Minor Loop Variable Divider PC Card

QUANTITY	MACKAY MARINE PART NUMBER	DESCRIPTION
1	600589-536-001	RF Section PC Card
1	600590-536-001	2nd Mixer (8 kHz) PC Card
1	600591-536-001	8 MHz IF Amplifier PC Card
1	600592-536-001	Information Filter PC Card
1	600593-536-001	AM and Product Detectors PC Card
1	600594-536-001	AGC Amplifier PC Card
1	600595-536-001	Audio Amplifier PC Card
1	600581-536-001	Regulator PC Card
1	600125-537-001	Preselector Filter PC Card
1	600124-537-001	Variable BFO PC Card
	GROUPS -003 and -004	
1	600582-536-001	Decoder PC Card
1	600583-536-001	Major Loop VCO Buffer PC Card
1	600580-536-001	Major Loop Analog and Acquisition PC Card
1	600584-536-001	Major Loop Variable Divider PC Card
1	600585-536-001	Loop Translator PC Card
1	600586-536-001	VHF Reference PC Card
1	600587-536-001	Low Frequency Reference PC Card
1	600579-536-001	Minor Loop Analog PC Card
1	600588-536-001	Minor Loop Variable Divider PC Card
1	600589-536-001	RF Section PC Card
1	600590-536-002	2nd Mixer (6 kHz) PC Card

QUANTITY	MACKAY MARINE PART NUMBER	DESCRIPTION
1	600591-536-001	8 MHz IF Amplifier PC Card
1	600592-536-001	Information Filter PC Card
1	600593-536-001	AM and Product Detectors PC Card
1	600594-536-001	AGC Amplifier PC Card
1	600595-536-001	Audio Amplifier PC Card
1	600581-536-001	Regulator PC Card
1	600125-537-001	Preselector Filter PC Card
1	600124-537-001	Variable BFO PC Card

3020
CHANGE LOG

ISSUE	REFERENCE DOCUMENT	DESCRIPTION	DATE
3	--	Updated manual to agree with Engineering Changes	September 1973
4	--	Added 3020B	October, 1973

RECORD OF FIELD MODIFICATIONS

Equipment Type   Serial No.

S rvice Bulletin Number	Made By	Date	Remarks