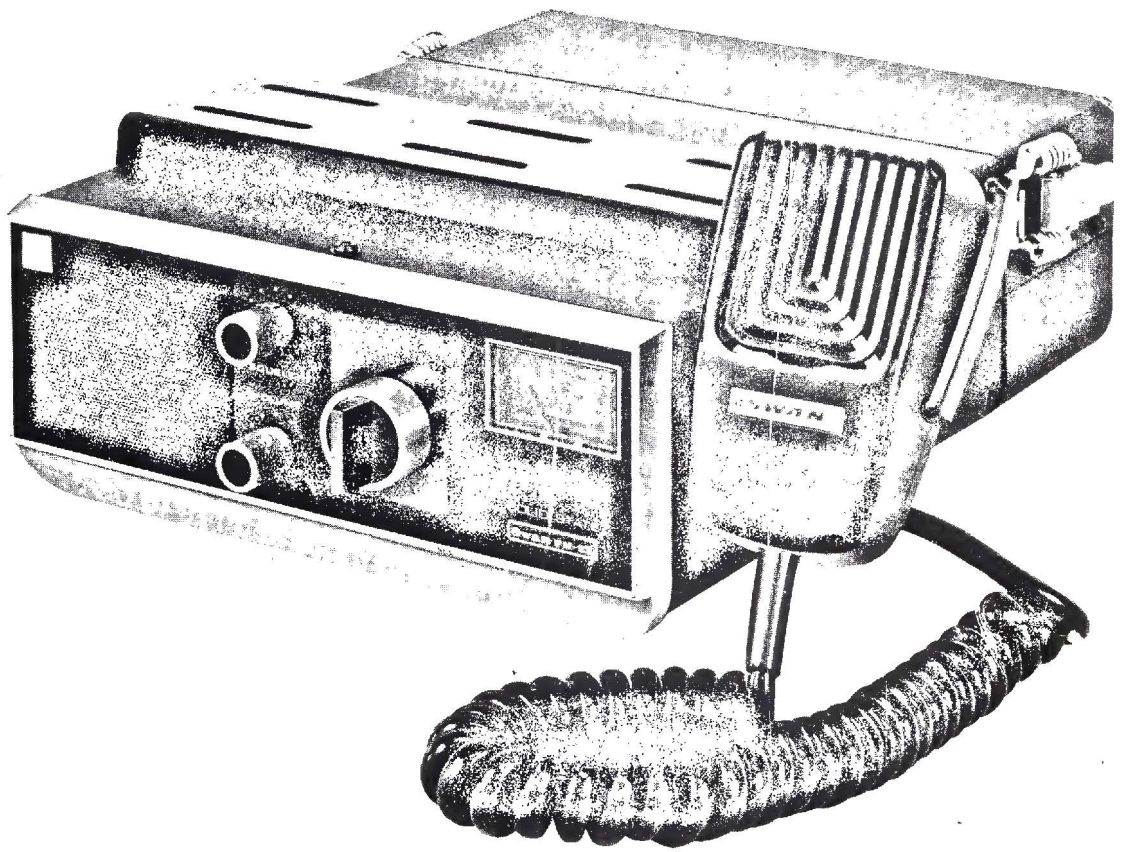
OPERATION AND MAINTENANCE

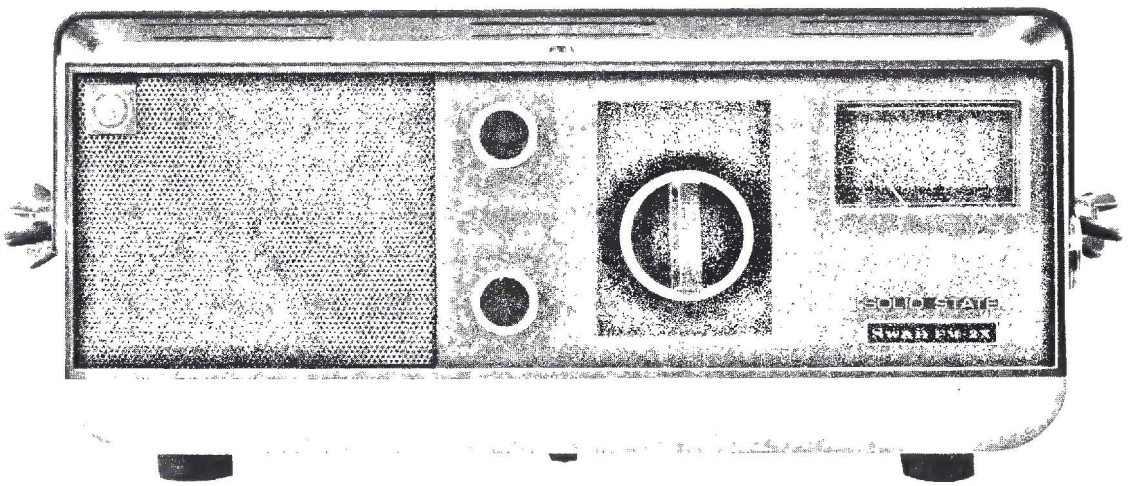


SWAN FM-2X

FM-2X

SWAN
ELECTRONICS
OCEANSIDE, CALIFORNIA
A subsidiary of Cubic Corporation

OPERATION AND MAINTENANCE
SWAN FM2X 2 METER FM
Transceiver



INTRODUCTION

The Swan FM-2X 2 meter FM transceiver is a high quality product designed for no compromise performance. Using the popular frequency modulation system, it provides noise free mobile or home station operation in your local area, or through the use of a repeater the FM-2X can provide you with wide area coverage.

By utlization of a FET in the front end, excellent sensitivity is achieved with excellent cross-modulation and overload characteristics. Outstanding adjacent channel rejection is achieved through the use of a ceramic filter in the 455 KHz I.F.

The transmitter section of the FM-2X incorporates a unique IDC (instantaneous deviation control) to prevent over deviation when the unit is over modulated, and pre-emphasis to increase effective range. The output transistor in the FM-2X is completely protected from open or shorted antennas by a circuit that senses incorrect loads, and removes drive from the early stages of the unit.

The FM-2X is furnished with everything you need to get on the air, with the exception of an antenna.

SWAN FM-2X SPECIFICATIONS

RECEIVER

CIRCUIT TYPE	:	Dobule Superheterodyne
FREQUENCY COVERAGE	:	144 - 148 MHz
BUILT-IN FREQUENCIES	:	Ch. 1 - 146. 94, Ch. 2 - 146.94, Ch. 3 - 146.76 MHz
SENSITIVITY	:	.5 uv for 20 db quieting
SELECTIVITY	:	6dB down at ±15 KHz 50dB at ±25 KHz
AUDIO OUTPUT	:	1 Watt (Distortion: 10%)
SQUELCH SENSITIVITY	:	Less than 0.3 uV

TRANSMITTER

TYPE OF WAVE	:	Frequency modulation (F3)
FREQUENCY COVERAGE	:	144. - 148 MHz
BUILT-IN FREQUENCIES	:	146.94, 146.34, 146.34 MHz
ANTENNA OUTPUT POWOR	:	10 Watt (at 13.8V)
FINAL-STAGE INPUT POWER	:	20 Wat (at 13.8V)
MODULATION METHOD	:	Variable reactance phase modulation
FREQUENCY DEVIATION	:	7 KHz (Maximum) at 1 KHz. Factory adjusted to 5KHz (−0, +1 KHz)
OSCILLATING METHOD	:	Crystal oscillation
MULTIPLICATION METHOD	:	× 3 × 2 × 2 = 12 multiple
OUTPUT IMPEDANCE	:	50 - 75 Ohms
SPURIOUS RESPONSE	:	−60 dB or better

GENERAL

Microphone	:	Press-to-talk dynamic microphone (600 ohm)

CIRCUIT THEORY OF OPERATION

While reviewing this theory of operation, it is suggested that either the schematic diagram or the block diagram be followed for clarity of thought.

RECEIVER SECTION

A 144-148 megahertz signal appearing on the antenna terminals of the transceiver, is first amplified by the RF amplifier stages Q101 and Q102. These two stages are stagger-tuned to provide full sensitivity across the entire 4 megahertz range. From there the signal is passed to the bace of Q103 where it is mixed with a signal in the 133.3 to 137.3 megahertz range that is provided by the 1st oscillator, Q105 and its associated tripler, Q106. The resultant 10.7 megahertz signal is passed to the 1st IF amplifier, Q104, where further amplification and limiting takes place. From there the signal is passed to the base of Q107, the second mixer where it is converted to 455 kc's by injection of the 2nd oscillator frequency Q108 of 11.155 megahertz. After passing through the 2nd IF amplifier, Q107 selectivity is obtained by passing the 455 kilohertz signal through the ceramic filter. The squelch determining signal is also obtained at this point. A further discussion of the squelch circuitry will be made later. From the ceramic filter the 455 kc signal is passed through the integrated circuit IF amplifier, Q109. After amplification and limiting by Q109, the signal is detected by the discriminator diodes D107 and D108. The detected audio from the discriminator is passed through VR102 the volume control, and into the base of the 1st audio amplifier, Q114. Further amplification is obtained from the audio driver Q115 and is applied to the bases of the audio output transistors by means of an audio transformer T117. Final audio amplification is provided by the complimentary output pair, Q116 and Q117 and into the speaker. Squelch action is derived from the IF signal appearing at the output of ceramic filter and is fed to the base of Q110 where the signal is amplified and passed on the Q111 where further amplification takes place. This signal is then detected by diodes D105 and D106 and further amplified by Q112 and this signal is passed to the squelch switch, Q113, that supplies the biasing for the audio driver transistor, Q114. Received signal strength is metered by the signal that appears on the collector of Q111 and is rectified by diodes D103 and D104.

TRANSMITTER

The transmitted signal originated from a crystal controlled oscillator, Q203 and crystals in the 12 megahertz range are used in the FM-2X. The output from Q203 is fed to Q204 where phase modulation of this signal takes place, and the modulation signal is provided as follows.

The input from the microphone is fed through VR201, which is both a microphone gain and deviation level control. This audio signal is fed to the base of Q201 where it is amplified, and passed to Q202 for further amplification. The audio signal at this stage is fed to the deviation limiting device, which is a combination of diodes D201 and D202. These diodes perform a limiting action that is adjusted by means of VR202 to prevent over deviation of the unit under high audio inputs. This signal is fed into the secondary side of T201 where phase modulation of the twelve megacycle signal is achieved through the variation of inter electrode capacitance of D203, this

signal is then passed to the base of Q205 which acts as a buffer stage to provide maximum stability of the crystal oscillator. From here the twelve megacycle signal is passed through Q206, where it is tripled to 36 megacycles via the transformers T204 and T205, the signal is fed to the base of Q207 where it is doubled to the 72 megacycle range from the collector of Q207, the signal is coupled to the base of Q208 through transformers T206 and T207. Q208 is another doubler and places our signal in the 2 meter range or 144 to 148 megacycles. At this point the signal is further amplified by Q209, 210, and 211 and fed to the base of the driver transistor, Q212. The output of Q212 is fed to the base of Q213 where final output is attained. From this point the output of Q213 is fed through the pi network comprised of CV220, L215 and CV221, and passed through the low pass filter comprised of C288, L216, C289, L217, and C291. At this point the signal is applied to the output terminal and is radiated. A no antenna or shorted condition is detected by the automatic protection circuitry as comprised primarily of diodes D207 and D208 and their associated components. Sensitivity of this circuitry is determined by VR203 and 204. Should an open or shorted antenna condition exist, this circuitry biases off Q205and Q206 and prevents damaged to any of the high level stages of the transmitter.

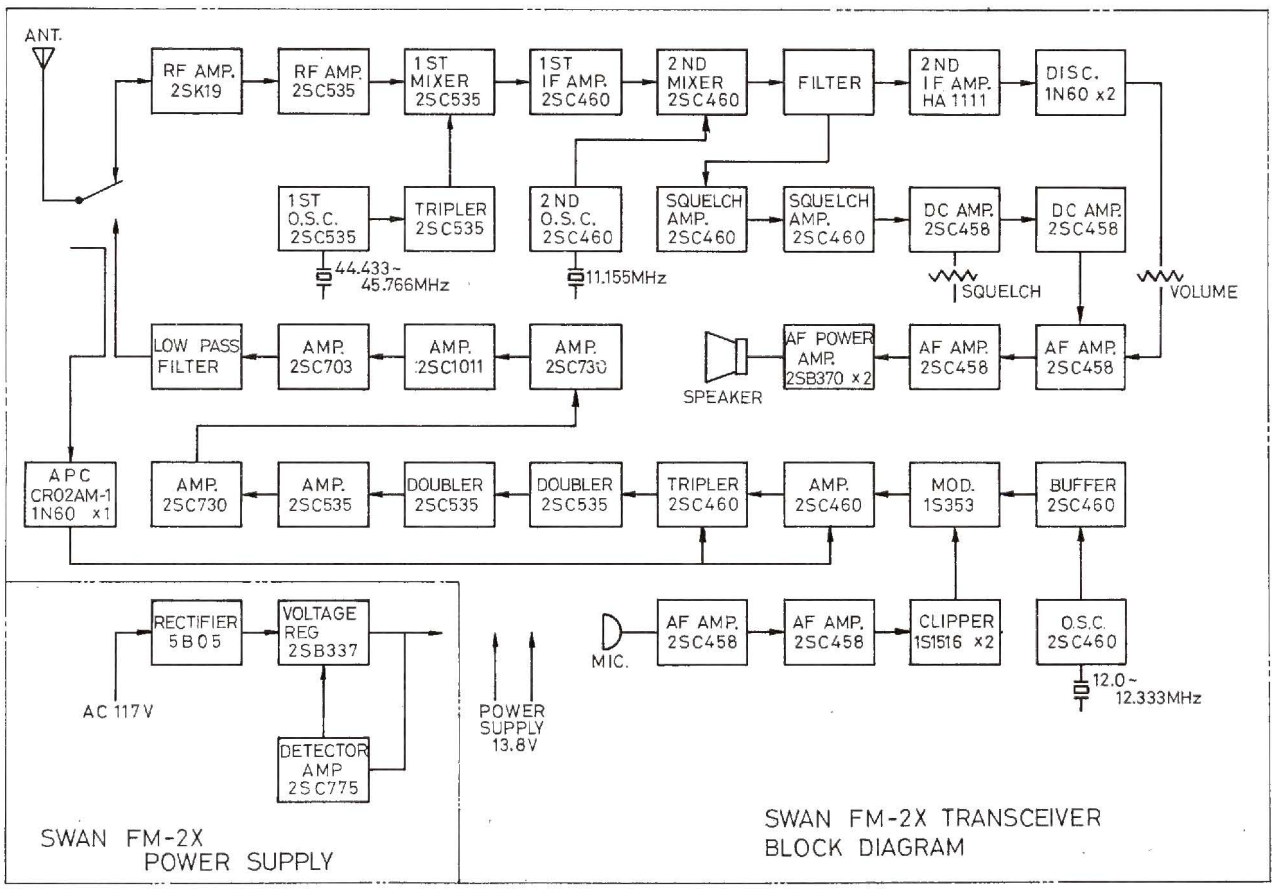


Figure 1

BLOCK DIAGRAM

CONTROLS AND FUNCTIONS

1. Speaker — built in 8 ohm speaker.
2. Squelch — This control adjusts the squelch threshold, and should be adjusted in a clockwise direction until background noise just disappears. If this control is advanced further, weaker signals will not break the squelch.
3. Channel Indicator: This control may be rotated in any direction for the selection of the desired channel 1 through 12.
4. Meter: Indicated relative output in transmit, and received signsl strength in receive.
5. Microphone connector: Matched the microphone supplied with the unit.
6. On-Off/Volume: Rotation of this control in a clockwise direction turn the unit on and increase the Audio volume.
7. External speaker jack: In the event an external speaker is desired at a remote location, using this jack with the plug provided will disconnect the internal speaker.

REAR APRON CONTROLS

8. Output Adjustment: While attached to the Antenna, these two controls should be carefully adjusted for maximum output as indicated on the front panel meter.
9. Antenna connector: A standard UHF fitting, a mating plug is furnished.
10. Power connector: a 6 pin "Jones" plug to facilitate the application of primary power to the unit. Matches the provided DC power cord and AC power supply. An accessory extension cord for the AC power supply is furnished for adjustment of the output while using the AC supply.
11. Mounting bracket: To facilitate installation of the unit in a mobile configuration.
12. Mounting bracket wingnuts: To facilitate removal of the unit at will.

INSTALLATION AND OPERATION

If you are new to 2 meter FM operation, a few words may help you to understand your new equipment, and thus get the most pleasure from it's operation.

First of all, it is important to understand that 2 meter operation provides primarily line of sight communications. However, under certain atmospheric conditions, long range communications are possible in this frequency range. Since you will be most concerned with the line of sight type of communications, our discussion will deal only with this type of operation.

Your anntenna should be given a lot of thought. Are you interested in covering only in one direction or all directions? If omni-directional operation is desired, vertical polarization is used nationwide due to the simplicity of mobile vertical antennae. If possible, you should install the antenna at the highest point accessable to you. If it is your automobile, the antenna should be placed on the roof in the center. If this is not possible, then the center of the trunk lid is the next most desirable location. A "Gain" antenna will greatly increase range, and the most widely used is the 5/8 wave antenna for mobile application. A 5/8 wave mobile antenna is approximately 47" long, and requires a matching network at the base of the antenna to provide the necessary 50 ohm load to your Swan FM-2X. In home station applications, the 5/8 wave antenna is also very popular, and is used with a ground plane of 1/4 wave radials. The 5/8 wave antenna gives approximately 3 db of gain and an extremely low angle of radiation. Omni-directional antennas of up to 9 db of gain are readily available on the market for home station use.

If you want point to point communications in one given direction, then the yagi or other high gain arrays may be used. There are any number of this type available, and vertical or horizontal polarization may be used. Again, get the antenna as high as possible.

MOBILE INSTALLATION OF THE FM-2X

Select a convenient location for the transceiver that will provide ease of reach, and not interfere with the operating controls of your vehicle. Mark the surface where the bracket is to be installed, and drill the 4 holes for the self-tapping sheet metal screws using a 1/32" drill bit. Install the bracket. If possible, mount the bracket on a sheet metal surface. If you have only plastic available to mount the bracket on, use bolts and nuts with large washers.

Install the power cord to a 12VDC source that is preferrably energized by the ignition switch to prevent leaving the unit turned on by accident. The red lead of the power cord should be attached to the positive source, and the black lead to ground.

CAUTION: The FM-2X is designed for operation from a Negative ground electrical system only.

The trnsceiver installation is complete, and need only the application of a proper antenna for operation.

HOME STATION INSTALLATION

Home station installation requires use of the matching AC power supply which snaps on to the rear of the transceiver, and a suitable 2 meter antenna. Once the unit has been plugged into the AC mains, and the antenna installed, you are ready for 2 meter FM operation.

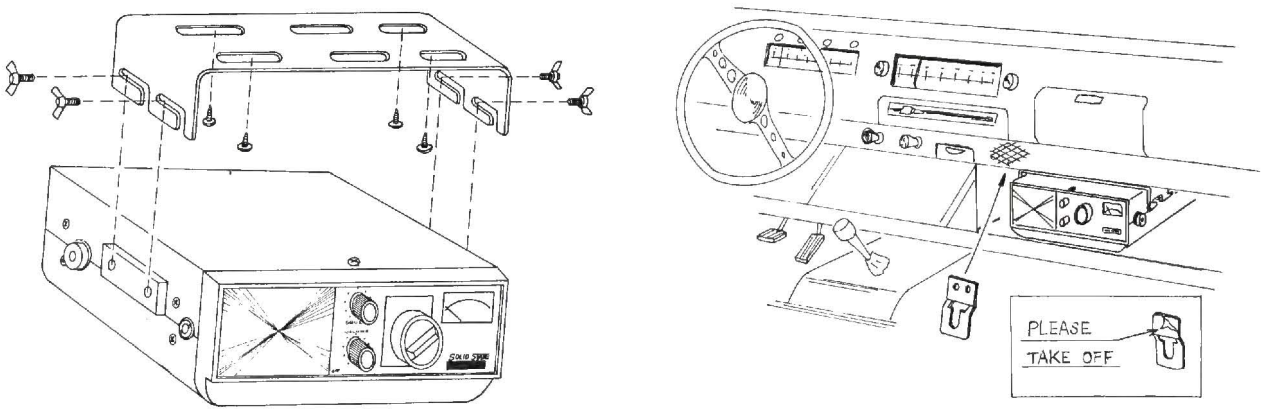


Figure 2

MOBILE MOUNTING

APC (automatic final transistor protective circuit)

This circuit has been factoty adjusted, and should require no further field adjustment. However. if for any reason it should become necessary to readjust this circuitry, the following procedure should be adhered to.

1. Rotate VR 204 completely clockwise (wiper toward ground).
2. Connect a 20,000 ohm per volt VOM across VR204 and set range switch on VOM for 10 volts DC.
3. Connect a normal antenna or 50 ohm dummy load.
4. Key the transceiver and adjust VR203 for minimum reading on the VOM.
5. Remove the meter and disconnect the antenna.
6. Key the transceiver and adjust VR204 for a "O" reading on the front panel meter.
7. Short the antenna terminal and be sure the unit indicates "O" on the meter when keyed. Adjustment is now complete.

ADDITION OF NEW CHANNELS

The FM-2X is furnished to you with the following channel frequencies:

Channel	Transmit	Receive
1	146.940	146.940
2	146.340	146.940
3	146.340	146.760

If additional frequency coverage is desired, the following information is given. Crystal frequency determining formulae

Transmit crystals

$$\text{crystal frequency} = \frac{\text{desired frequency}}{12}$$

32pf parallel resonant HC-25/u pin type.
Grinding tolerance 0.01%.
Temp. Tolerance 0.005% -10 to +60 Deg C

Receive crystals

$$\text{crystal frequency} = \frac{\text{desired frequency} - 10.7\ \text{mHz}}{3}$$

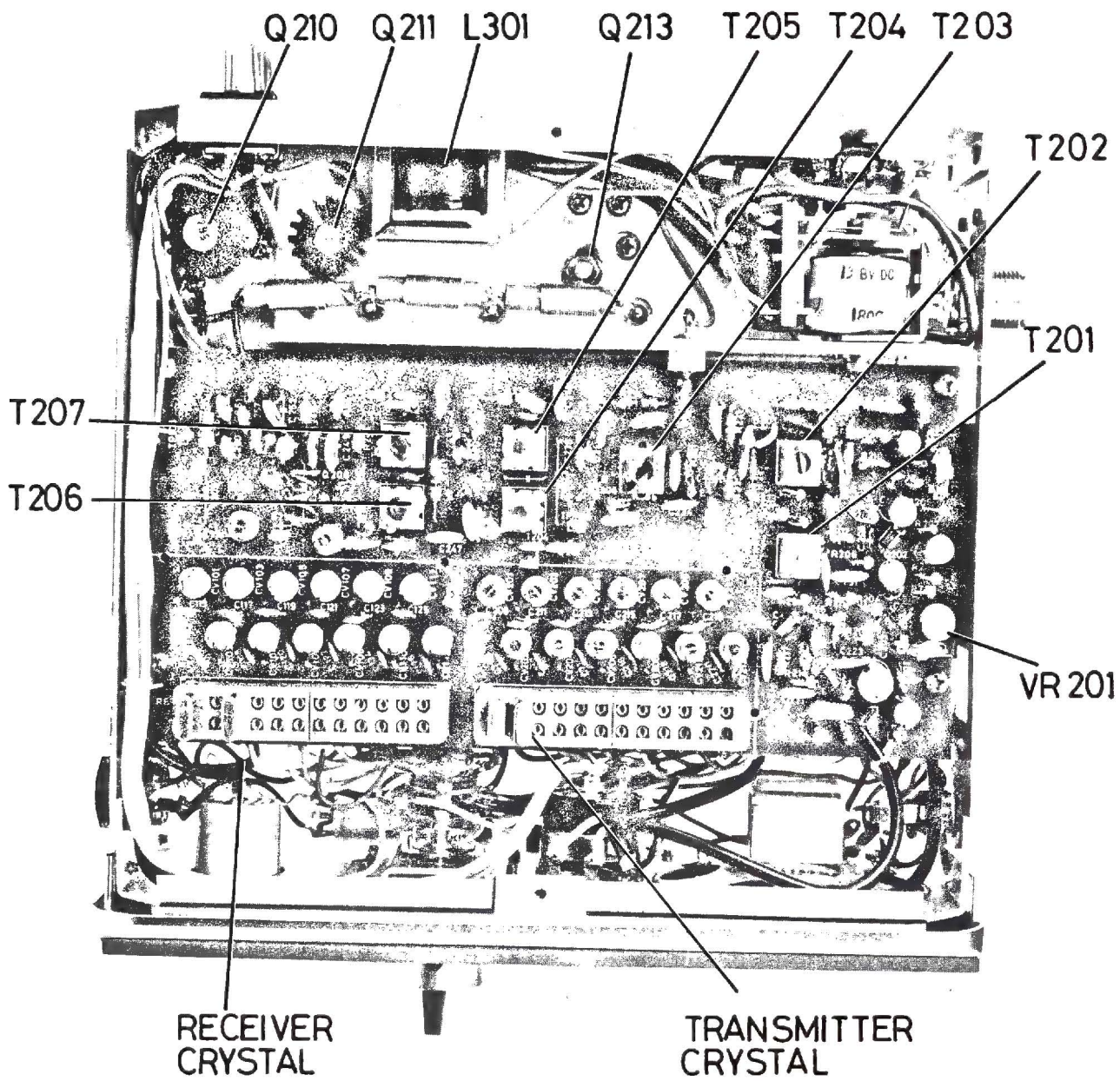
Same as transmit crystals

To install the crystals in the unit, remove the bottom cover of the cabinet and install in the socket desired. To adjust the crystal to exact frequency, use the corresponding ceramic trimmer capacitor.

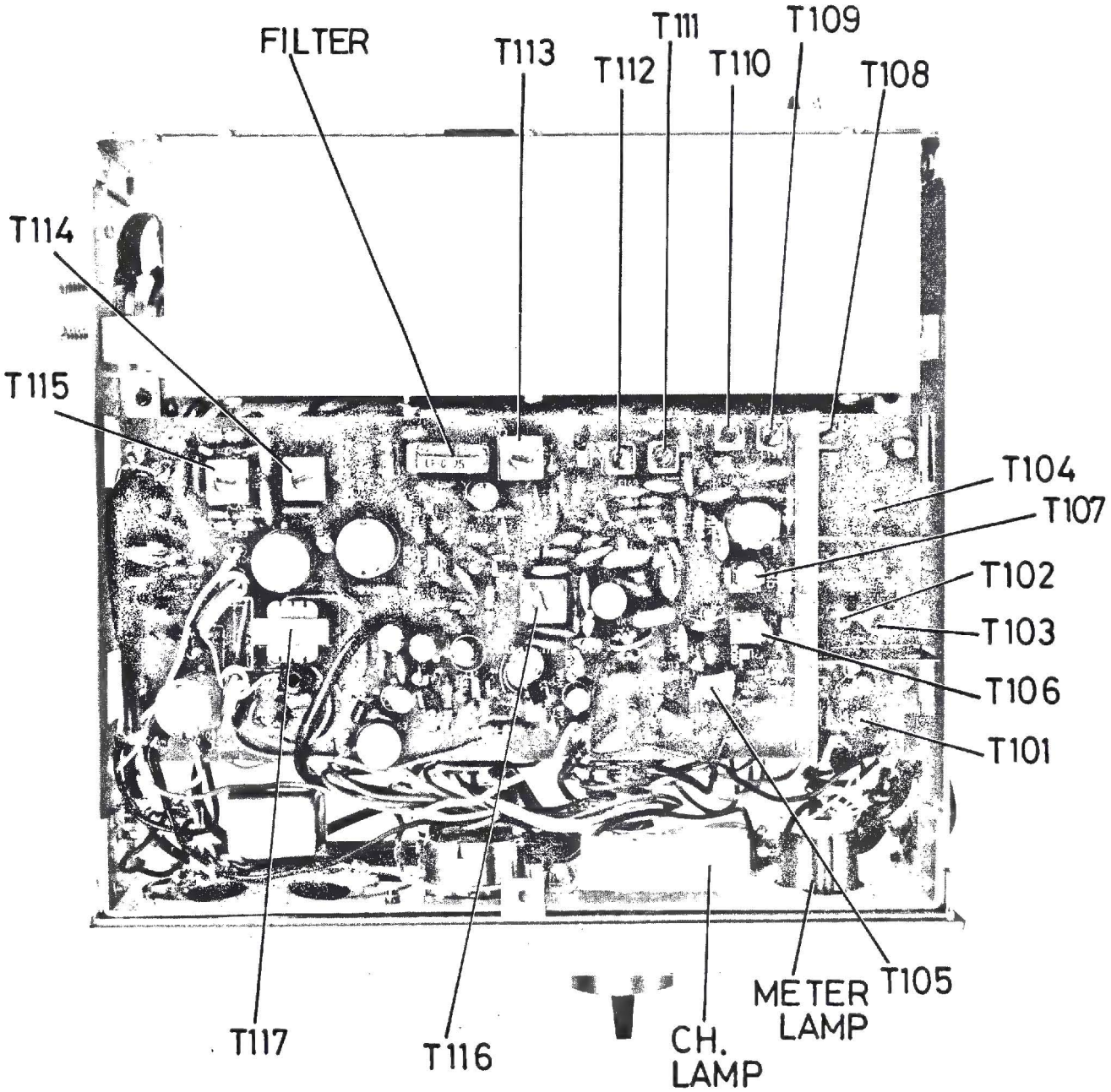
TROUBLESHOOTING

Symptom	Check	Cure
No transmit/receive	Is unit plugged into power source. . . . . fuse?	Plug into AC mains or 12VDC source. Replace fuse if blown.
Works on some channel but not others	Defective crystal. . . Loose crystal contact.	Replace crystal. . . . Tighten crystal socket with sharp tool.
Receive ok — no transmit	APC circuit disabling transmit. Bad mic contact.	Antenna defective — correct. Clean contacts on mic connector.
Unit performs, no pilot lamps.	Pilot lamps burned out.	Replace with spares furnished.

As with any other piece of electronics equipment, failures are bound to occur. To assist you in repairs, a schematic diagram is included with this manual. Normal troubleshooting procedures should be used. If you are unable to diagnose a problem, and require assistance, feel free to contact our customer service department for further information. If for any reason you find it necessary to return the unit to the factory for service, please obtain a return authorization prior to shipping the unit to us.


Q210
Q211
L301
Q213
T205
T204
T203
T202
T201
T207
T206
VR 201
RECEIVER CRYSTAL
TRANSMITTER CRYSTAL

BOTTOM VIEW


FILTER
T113
T112
T111
T110
T109
T108
T114
T115
T104
T107
T102
T103
T106
T101
T105
METER LAMP
CH. LAMP
T116
T117

TOP VIEW

INSTRUCTIONS FOR JUMPING CRYSTALS IN THE SWAN FM-2X

1. Remove TOP and BOTTOM covers from the FM-2X.

2. With the unit in the normal upright position, remove the four Phillips head screws holding the RECEIVER board in place.

3. Lift the RECEIVER board up by pulling upwards on the rear of the board.

CAUTION

CARE SHOULD BE EXERCISED WHEN LIFTING UP THE RECEIVER BOARD. THERE IS A SMALL CHOKE CONNECTED BETWEEN THE TOP OF THE RECEIVER BOARD AND THE SWITCH. EXCESSIVE PRESSURE CAN CAUSE THE SWITCH WAFER OR THE SOLDER CONNECTION TO BREAK.

4. When the RECEIVER board is lifted up, the bottom of the TRANSMITTER board will be exposed. Locate the wires coming to the TRANSMITTER board from the switch. As you view the bottom of the TRANSMITTER board from the rear of the FM-2X, the RECEIVER terminals are to your left, and the TRANSMITTER terminals are to your right. (See Diagram #1).

5. As supplied from the factory, the FM-2X has the following frequencies installed.

	CHANNEL 1	CHANNEL 2	CHANNEL 3
TRANSMIT	146.94	146.34	146.34
RECEIVE	146.94	146.94	146.76

6. To illustrate jumping crystals, suppose you desire to operate channel 4 as follows:

	CHANNEL 4
TRANSMIT	146.94
RECEIVE	146.76

7. As can be seen from the above, to operate Channel 4 at these frequencies, you must jumper the transmit crystal on Channel 1 to Channel 4, and you must jumper the receive crystal on Channel 3 to Channel 4.

WARNING

THE JUMPING MUST BE ACCOMPLISHED AT THE SWITCH. DO NOT ATTEMPT TO JUMPER ON THE TRANSMITTER BOARD.

8. Locate the Transmit Channel 4 wire (White/Brown). (See Diagram #1) Unsolder this wire from the board. Pull the wire around the switch until it is on the bottom side of the TRANSMITTER board.

9. Locate the Channel 1 wire (Green) on the switch. (See diagram #1)

10. Cut the Channel 4 wire to the proper length for connecting the wire to the Channel 1 switch connection. Strip the end of the Channel 4 wire, and solder it to the Channel 1 wire connection at the switch. (See diagram #2).

11. Locate the Receive Channel 4 wire (White/Brown). (See diagram #1) Unsolder this wire from the board.

12. Locate the Channel 3 wire (Orange/White) on the switch. (See diagram #1)

13. Cut the Channel 4 wire to the proper length for connecting the wire to the Channel 3 switch connection. Strip the end of the Channel 4 wire, and solder it to the Channel 3 wire connection at the switch. (See diagram #3).

14. This completes the jumping procedure. Carefully replace the RECEIVER board, and replace the four Phillips head screws. Tighten securely.

15. Replace the TOP and BOTTOM covers.

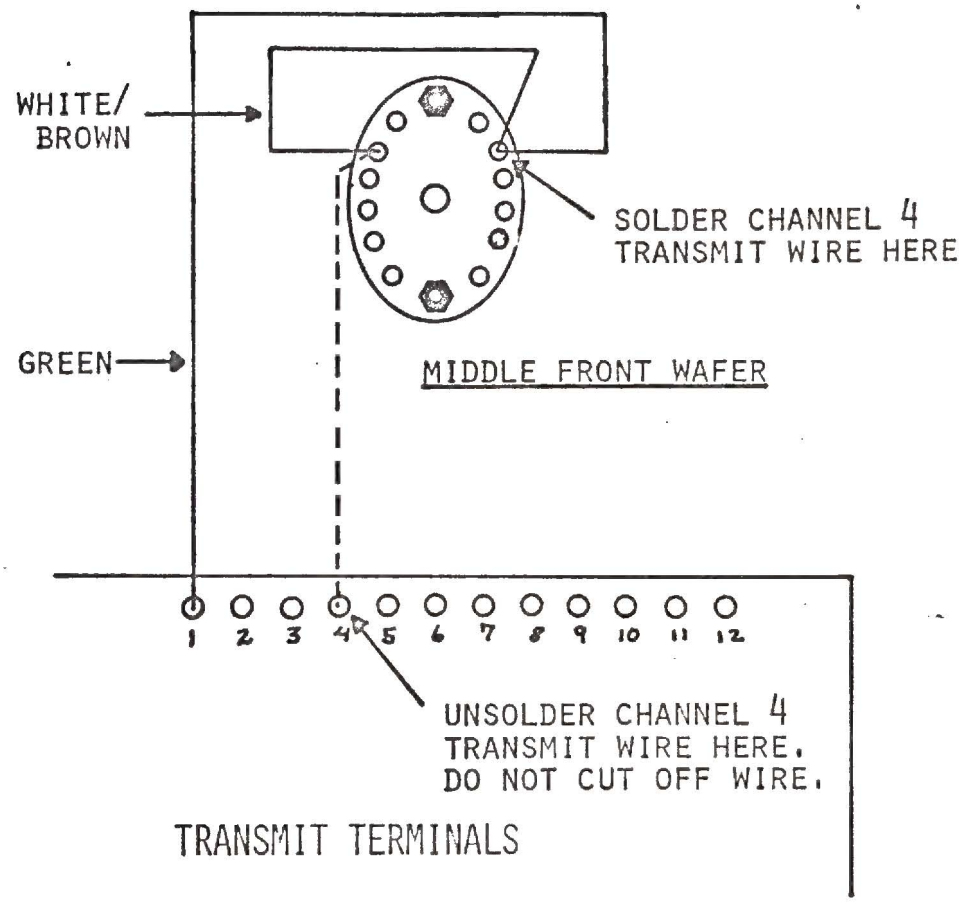


DIAGRAM #2

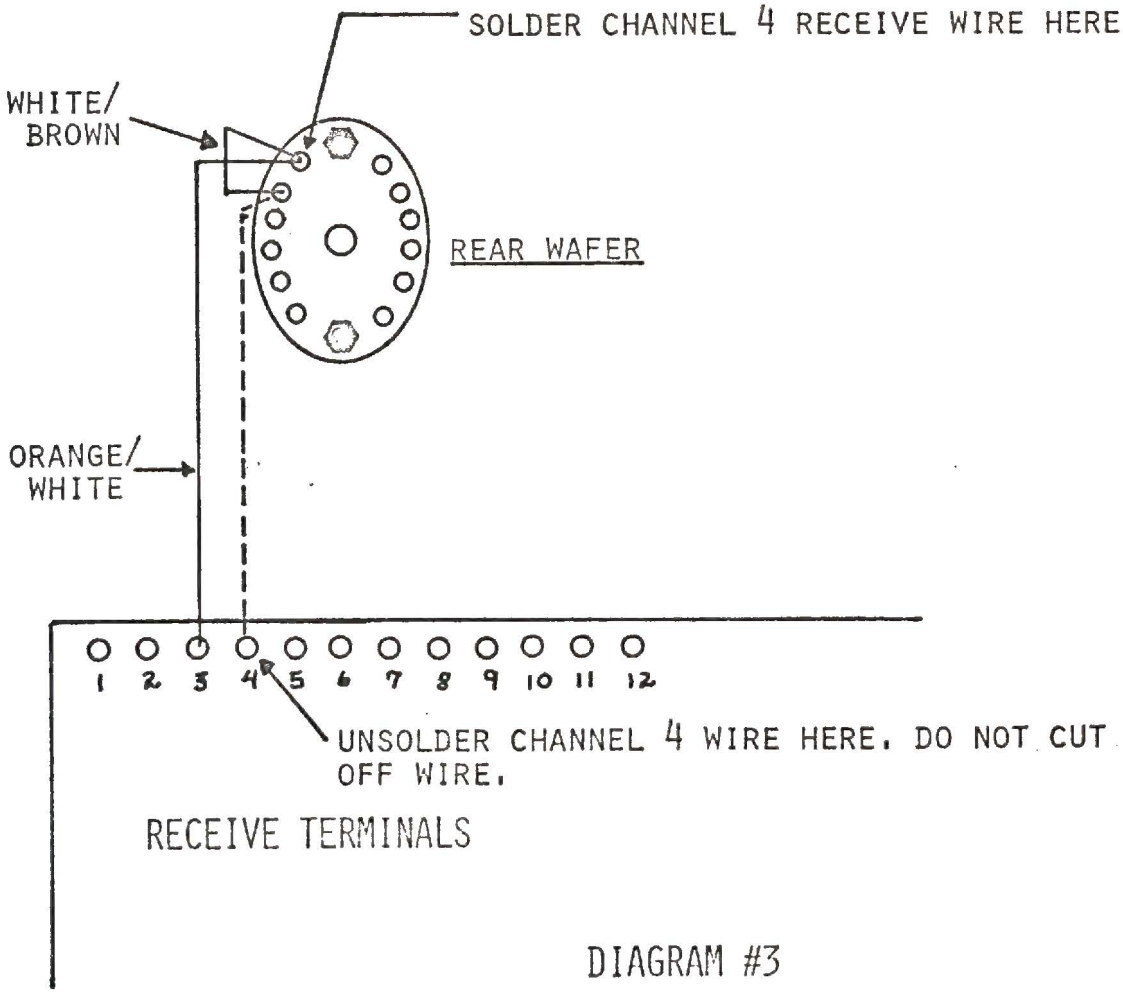


DIAGRAM #3

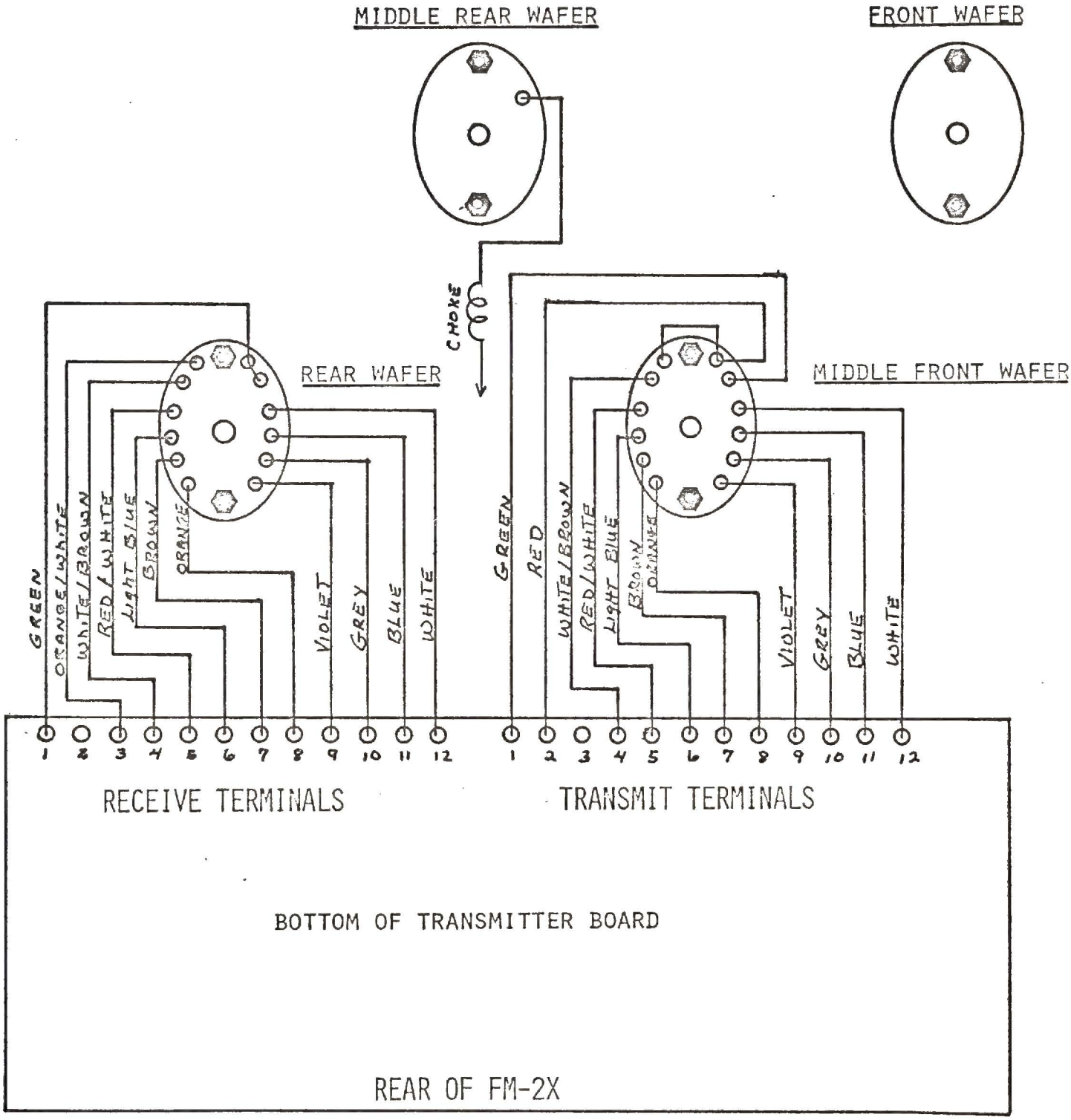

MIDDLE REAR WAFER
FRONT WAFER
CHOKE
REAR WAFER
MIDDLE FRONT WAFER
GREEN
ORANGE/WHITE
WHITE/BROWN
RED/WHITE
LIGHT BLUE
BROWN
ORANGE
VIOLET
GREY
BLUE
WHITE
GREEN
RED
WHITE/BROWN
RED/WHITE
LIGHT BLUE
BROWN
ORANGE
VIOLET
GREY
BLUE
WHITE
1 2 3 4 5 6 7 8 9 10 11 12
1 2 3 4 5 6 7 8 9 10 11 12
RECEIVE TERMINALS
TRANSMIT TERMINALS
BOTTOM OF TRANSMITTER BOARD
REAR OF FM-2X

DIAGRAM #3

N O T E:

PLEASE SEE ENCLOSED ADDENDUMS 1 & 2

FOR CORRECT CRYSTAL SPECIFICATIONS.

ADDENDUM 1

TITLE: Quartz Crystal for SWAN FM-2X (Receiver)

1.0 ELECTRICAL CHARACTERISTIC

1.1	Frequency Range:	44.44 to 45.76 MHz
1.2	Mode of Oscillation:	3rd Overtone
1.3	Crystal cut:	~~AF~~ AT
1.4	Resonance:	Series
1.5	Frequency Tolerance:	$\pm 0.002\%$ at $+25^{\circ}C \pm 1^{\circ}C$
1.6	Operating Temperature Range:	$-20^{\circ}C$ to $+70^{\circ}C$
1.7	Parallel Capacitance (Co.):	7.0pF Max
1.8	Drive level. Rated:	2.0 ± 0.4mW
1.9	Resistance Equivalent:	40 ohm (Max)
1.10	Load Capacitance:	32pF $\pm$ 1pF

2.0 MECHANICAL CHARACTERISTIC:

2.1	Holder Type:	MIL Type HC - 25/U

3.0 Frequency Calculation:

Receive Crystal Frequency = $\frac{\text{Receiver Frequency - 10.7MHz}}{3}$

ADDENDUM 2

TITLE: Quartz Crystal for SWAN FM-2X (Transmitter)

1.0 ELECTRICAL CHARACTERISTIC:

1.1	Frequency Range:	12.00 to 12.33 MHz
1.2	Mode of Oscillation:	Fundamental
1.3	Crystal Cut:	AT
1.4	Resonance:	Parallel
1.5	Frequency Tolerance:	$\pm 0.03^{-.003}_{}\%$ at $25^{\circ} \pm 1^{\circ}C$
1.6	Operating Temperature Range:	$-20^{\circ}C$ to $+70^{\circ}C$
1.7	Parallel Capacitance (Co.):	7.0pF Max.
1.8	Drive Level, Rated:	5 ± 1.0mW
1.9	Resistance Equivalent:	37 ohm (Max)
1.10	Load Capacitance:	25 pf $\pm$ 1pf

2.0 MECHANICAL CHARACTERISTIC

2.1	Holder Type:	MIL Type HC - 25/U

3.0 Frequency Caculation

$$\text{Transmitter Crystal Frequency} = \frac{\text{Carrier Frequency to be transmitted}}{12}$$

General Specifications on Crystals for Swan Transceivers FM-2X,FM-1210A,FM-1210.

Transmit	Receive
Holder Type HC-25	Same
Osc.Mode-Fundamental	3rd Overtone
Pin to Pin Capacity 7pf Max.	Same
Load Capacity 32pf + or -0.5pf	Same
Series Resonance 32 ohms Max.	Series Resonance 40 ohms Max.
Frequency Tolerance $\frac{.005\%}{30\times10^{-6}}$ @250 Degrees C. + or - 1 Deg.C	Same
Crystal Form ULA	Same
Formula is:	
$\frac{\text{Desired Frequency}}{12}$	$\frac{\text{Desired Frequency-16.9MHZ}}{3}$
Grinding Tolerance 0.01%	Same
Crystal Cut AT	Same

FM-2X Hi-Lo Power Modification

Materials Required: SPST Switch
15 ohm 5 watt resistor
6.8 ohm 5 watt resistor
Small terminal strip
Mounting hardware

1. Remove bottom coyer.

2. Locate L209, L219 and C280 inside compartment at rear of transceiver.

3. Lift L209 from C280.

4. Install SPST switch and terminal strip at a convenient location.

5. Connect L209 to one terminal of terminal strip, do not solder.

6. Connect the two resistors on the terminal strip and to the junction of C280 and L219, do not solder.

7. Connect a wire from the junction of C280, L219 and the added resistor to one pole of the switch. Route wire to prevent stray signal pickup.

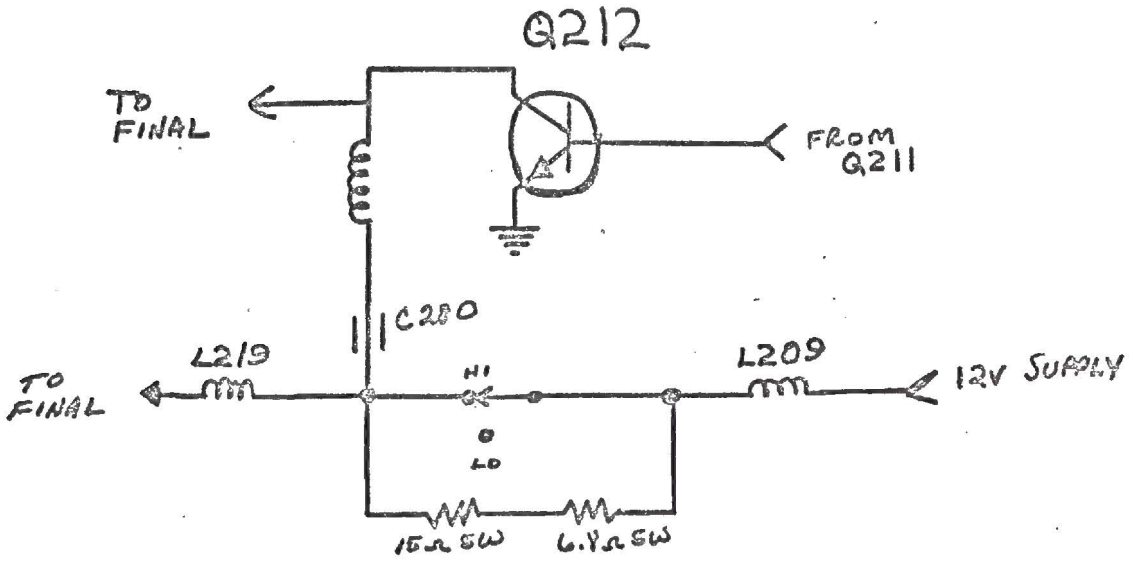
8. Connect a wire from the junction of L209 and the added resistor to the other pole of the switch. Route wire to prevent stray signal pickup.

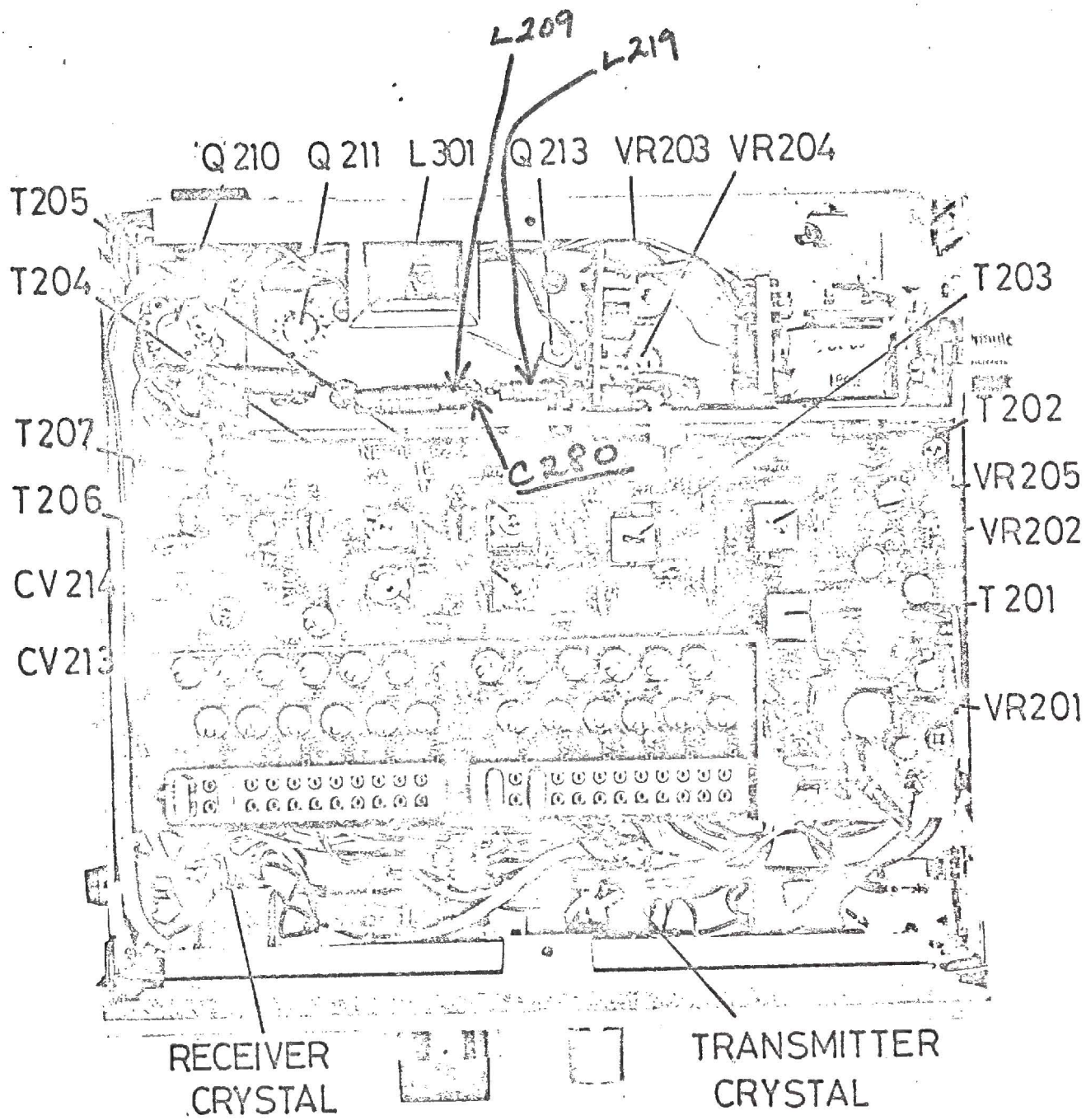
9. Check all connections against the schematic and solder.

10. Connect transceiver to a power source, wattmeter and dummy load.

11. High power will occur with the switch contacts closed, low power with the switch contacts open.

12. To achieve proper low power level the 6.8 ohm resistor value may have to be changed. Decreasing resistance to increase power and increasing resistance to decrease power. (Do not reduce the power output to less than 1 watt as spurious radiation may occur).




L209
L219
Q210
Q211
L301
Q213
VR203
VR204
T205
T204
T203
T207
T202
C280
T206
VR205
VR202
CV214
T201
CV213
VR201
RECEIVER CRYSTAL
TRANSMITTER CRYSTAL

MARS FREQUENCIES IN THE FM-2X

The FM-2X is designed for frequencies between 144-148 Mhz. It has been found, however, that most of these sets will accept xmit frequencies up to 150.2 Mhz., although reduced power may be experienced (usually the power will be down to about 9 watts.)

Great care in tuning should be exercised, as spurious radiation may result from a mistuned set.

1. Put set on desired channel. Check output and do not realign if output is adequate.

2. With VTVM connected to emitter of doubler stage Q208, measure the DC voltage at this point. There should be a minimum of 2 VDC at this point.

3. If there is less than 2 volts, tune the multiplier stages- (T204-T207) until 2 volts or more is obtained.

4. It may be necessary to check the other channels to make sure that 2 volts or more is measured at these frequencies also. It is desireable that the voltage be approximately the same for all frequencies installed.

5. Using an R.F. voltmeter, or sensitive field strength meter, tune each succeeding stage for maximum. This involves adjustment of CV213, 214, 216, 217, 218, 219, 220, and 221. In some sets, a variable coupling capacitor between the 1st and 2nd R.F. stages is employed. This must be tuned also.

When all stages have been tuned at the desired MARS frequency, a wattmeter should be connected to the antenna jack and each stage retuned for maximum power. Check the other channels to be sure the same power is obtained on each. As mentioned previously, it may not be possible to get a full 10 watts on all channels.

WARNING

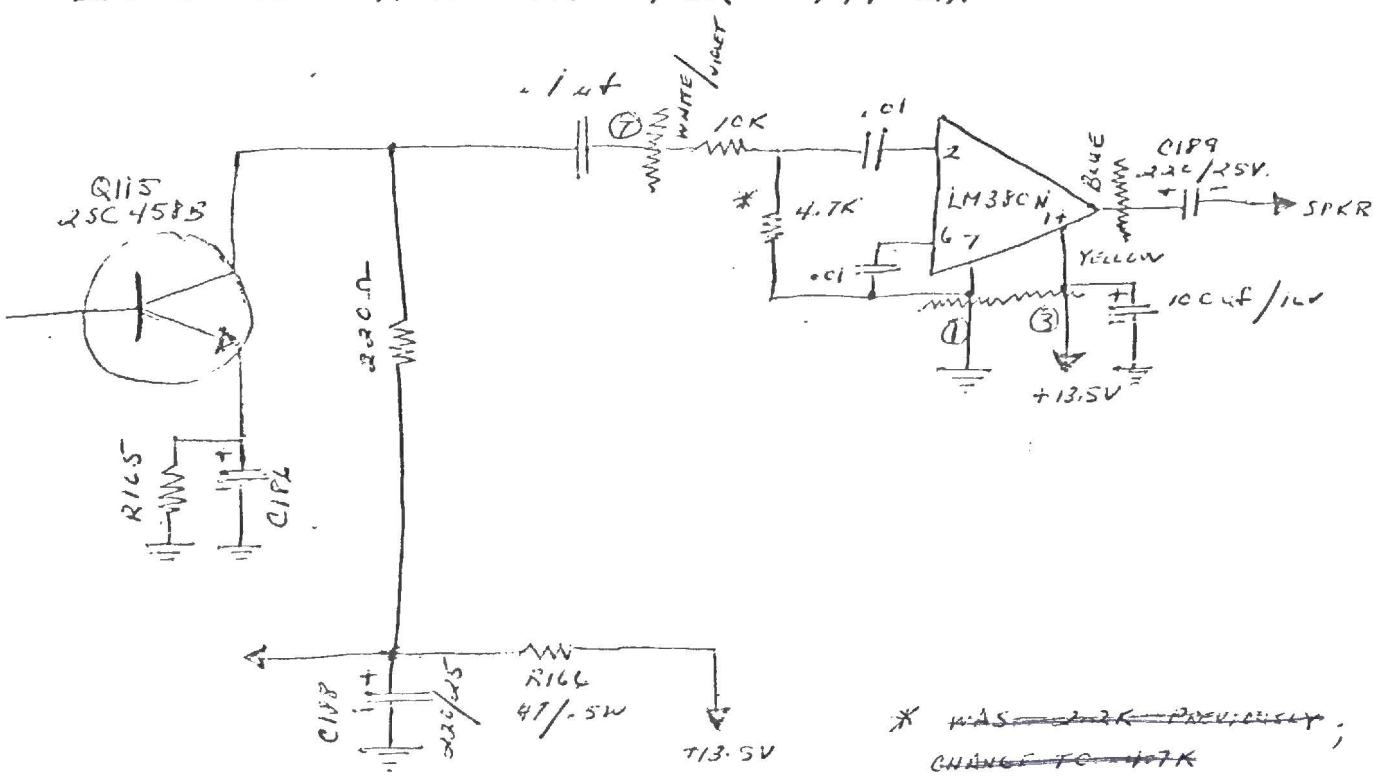
Re-alignment should be made on the spectrum analyzer. Any other means can cause spurious signals. If one is not available, it may be done at our plant. Enclosed are shipping instructions if you wish to return the unit.

Enc: FL #37

SWAN ELECTRONICS CORPORATION
Oceanside, California

December, 1972

LM-380N ADAPTOR FOR FM-2X



① REMOVE AUDIO XMFR + 2SB370 TRANSISTORS

② REMOVE C187, R167, R168, R169, R170, TH101, TH102, R171, R172

PARTS NEEDED:

1 — LM380N ADAPTOR

1 — 100 uf / ~~16V~~ 25V CAPACITOR (073-050)

1 — 220 Ω, 1/2 W RESISTOR (042-221)

1 — ~~4.7K, 1/2 W RESISTOR~~

1 — .1 uf CAPACITOR (072-038)

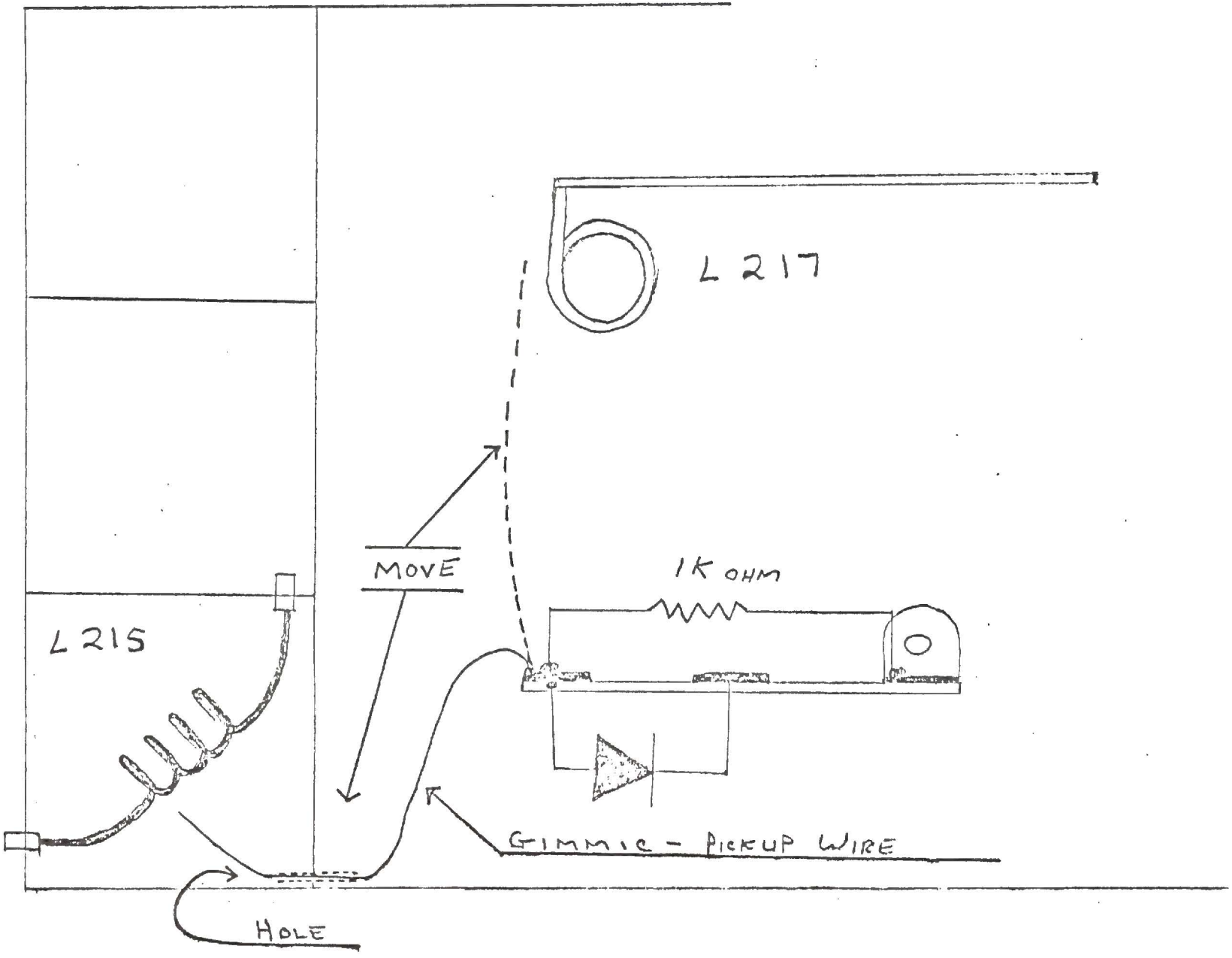
FM-2X Relative Output

A few cases have been reported that the FM-2X Meter is not properly indicating maximum output.

A simple change of re-routing the gimmick pick-up lead into the compartment of L-215 coil assembly will eliminate any improper reading of maximum output.

CUSTOMER SERVICE
SWAN ELECTRONICS CORPORATION

JUNE 1971


L 217
MOVE
1K OHM
L 215
GIMMIC - PICKUP WIRE
HOLE

101.5 MHZ. TRAP INSTALLATION

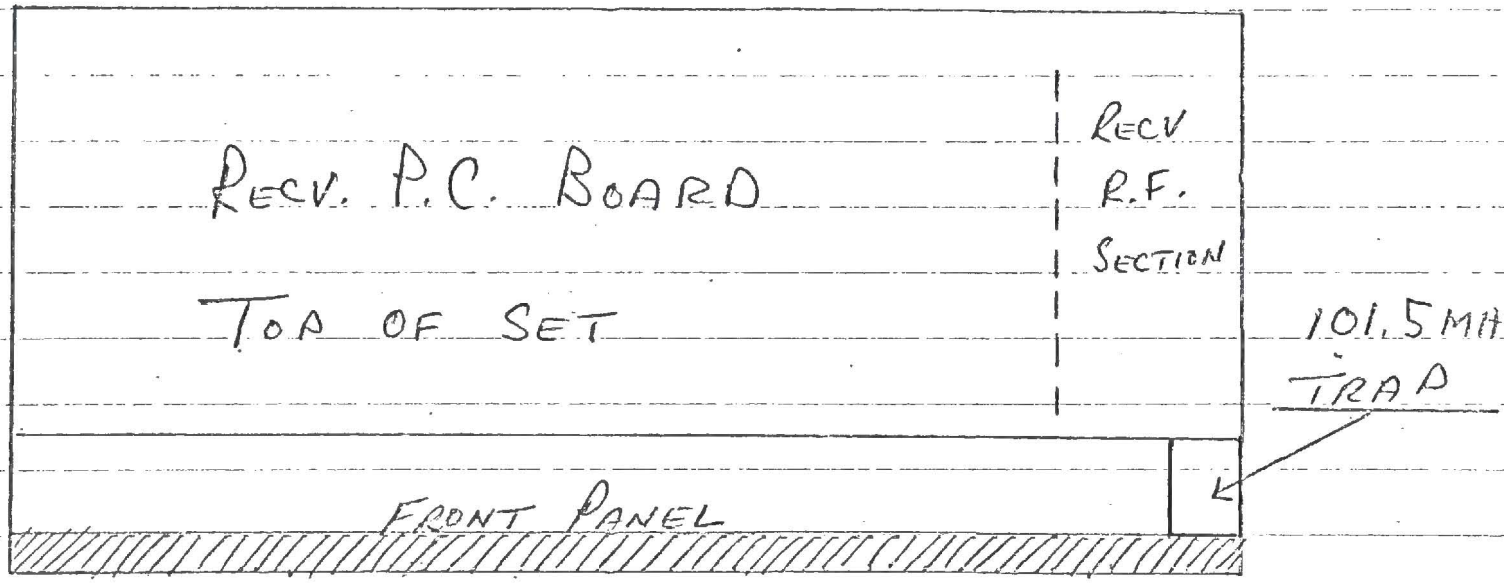
1. Remove cover to expose receive P.C. board.
2. Position trap (coils down- bracket toward rear of unit) so that the bracket fits against the right front of receive behind the meter. Make sure that the CKT (P.C.) board does not protrude above the chassis.
3. Mark the chassis for position of mounting screw holes.
4. Drill holes and counter sink.
5. Install trap with hardware provided.
6. Disconnect center conductor of antenna lead from TP101.
7. Connect center conductor of antenna lead to solder point #1.
8. Connect solid wire (size not critical) from solder point #2 to TP101.
9. Through holes provided, adjust coil to rear of board for minimum (null) 101.5 MHZ. signal.
10. Adjust coil on front of board for maximum 2 meter receive signal.

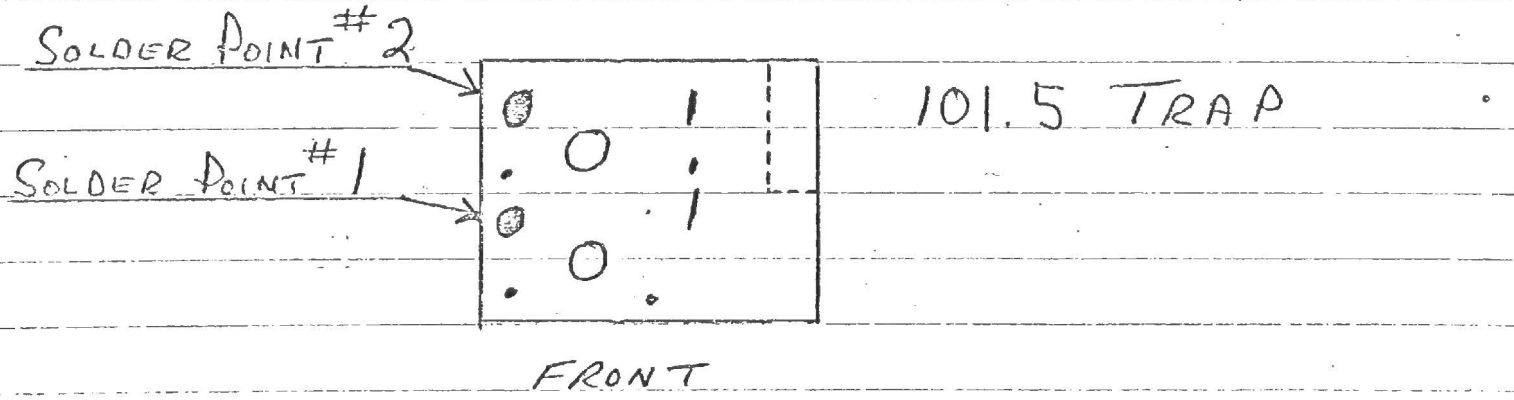
NOTE: This front coil will be a broad tuning coil and probably will not give a sharp peak.

FM-2X

SWAN ELECTRONICS CORPORATION
OCEANSIDE, CALIFORNIA 92054

OCTOBER 1972


RECV. P.C. BOARD
TOP OF SET
RECV
R.F.
SECTION
101.5 MHz
TRAP
FRONT PANEL


SOLDER POINT #2
SOLDER POINT #1
101.5 TRAP
FRONT

MODIFICATION TO FM-2X RECEIVER
BOARD FOR "INTERMODULATION"

Step I- Remove Q102 (must be F.E.T. as designated by K19 on case.)

Step 2- Substitute Q102 transistor for Q103. Install F.E.T. leads as described below (See fig. 1)

C- drain
B- gate
E- source

Step 3-Remove capacitor C192 located near T102.

Step 4-Remove R107 loacted near coil T104.

Step 5-Remove bottom tap on coil T101 and re-tap on bottom turn of coil, opposite antenna input terminac TP101. (This should correspond to 1 full turn on coil.)

Step 6-Replace Q104 transistor with F.E.T., 2SK19, supplied by Swan, Install in same manner as in step #2.

Step 7-Remove R128

Step 8- Replace resistor R110 (470 ohm) with a resistor of 2200 K ohm.

Step 9-Remove capacitor C162, located behind ceramic filter LF-C25.

Step 10-Remove capacitor C113, located next to coil T107. (Save for further use.)

Step 11-Remove capacitor C111, located next to large gray electrolytic capacitor C191 having a value of 100 MFD/16V. (Save for further use.)

This completes modification for top side of receive board.

The following is for the bottom side of the receive board:

Step 12, 13-Break printed circuit as shown in item 12, 13, figure #2.

Step 14-Remove printed circuit pad from transformer +112. (See #14, figure #2.)

Step 15-20-Install jumpers shown as #15, 16, 17, 18, 19, 20, (See fig. 2.)

Step 21-Install 2.2pf cap as shown #21,

Step 22-Install .001 MFD capacitor, item #22.

Step 23-Install 2" coax jumper as shown with a 220 pf coupling cap, item #23.

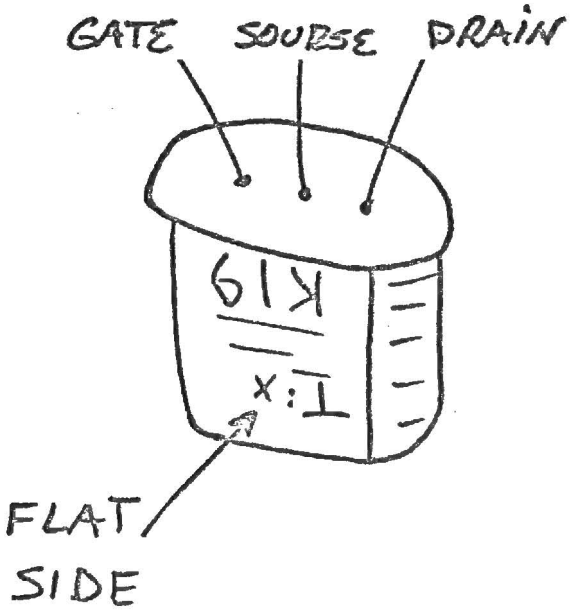


FIGURE 1

(FIELD EFFECT TRANSISTOR
2SK19)

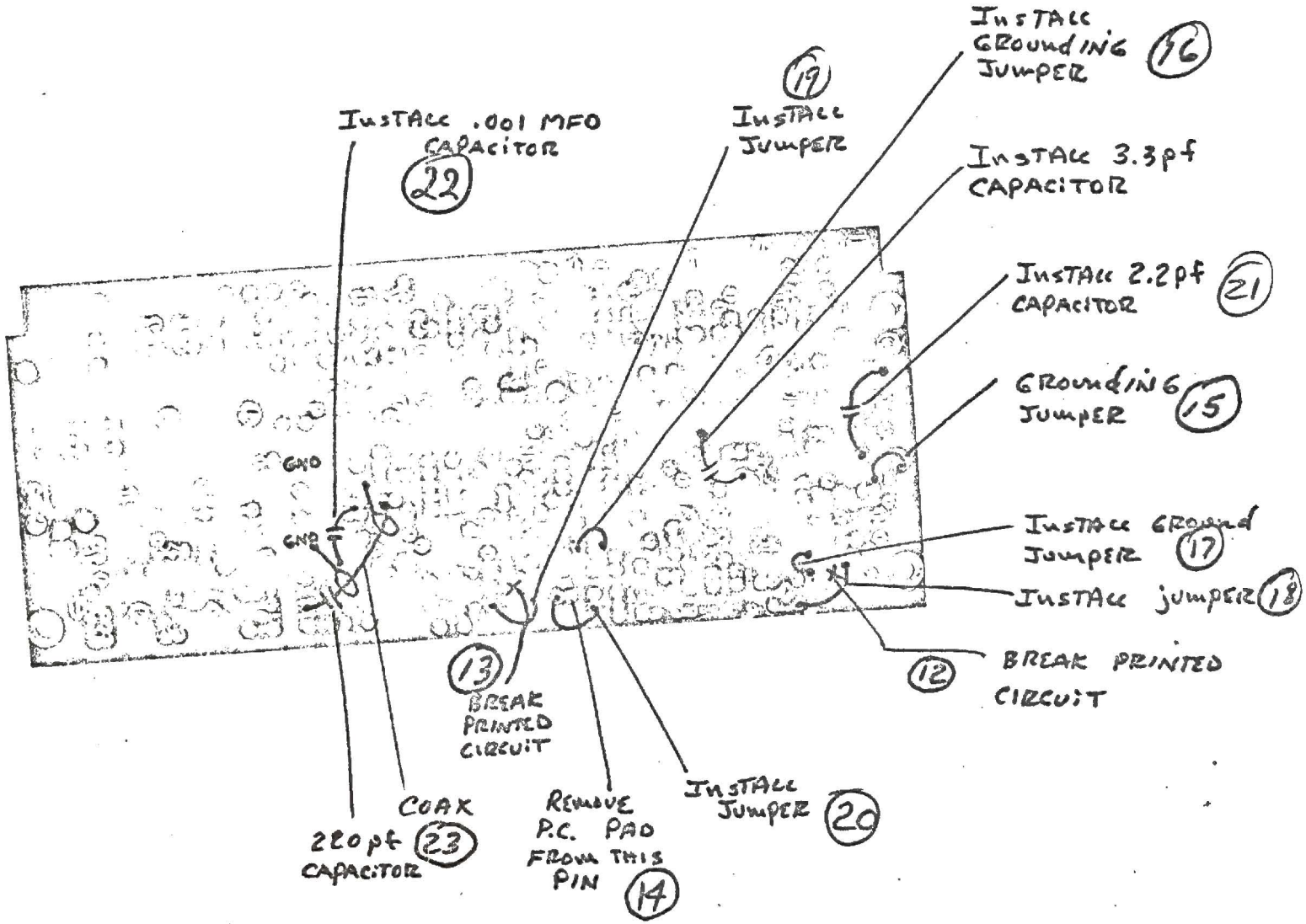

INSTALL GROUNDING JUMPER 16
19
INSTALL JUMPER
INSTALL .001 MFD CAPACITOR
22
INSTALL 3.3pf CAPACITOR
INSTALL 2.2pf CAPACITOR 21
GROUNDING JUMPER 15
GND
GND
INSTALL GROUND JUMPER 17
INSTALL JUMPER 18
12
BREAK PRINTED CIRCUIT
13
BREAK PRINTED CIRCUIT
COAX
220pf CAPACITOR 23
REMOVE P.C. PAD FROM THIS PIN 14
INSTALL JUMPER 20

FIGURE1 #2

ALIGNMENT AND TUNE-UP PROCEDURE FOR THE FM-2X

RECEIVER ALIGNMENT:

Equipment; accurate signal generator or transmitted signal of known accuracy. In both cases, a means of attenuating the signal to a low level (.3 to .7 microvolts) must be available.

VOM OR VTVM

Procedure; alignment of the FM-2X is quite simple and straightforward. Assuming the receiver is completely detuned, the I.F. string should be tuned for maximum noise (No signal applied). The 455 KHZ I.F. is tuned by T113. The 10.7 MHZ I.F. is tuned by T108 through T112.

When the I.F. section has been tuned for maximum noise, the output of a signal source should be applied to the antenna connector. A signal of sufficient strength to give a usable reading on the "S" meter should be applied. The RF section is now tuned for peak reading on the meter, It may be necessary to reduce the signal level as the tuning is done to prevent the meter from "Pegging". When properly aligned, the receiver will exhibit 20db quieting at .5 microvolts applied signal. (In most cases this figure will be exceeded. It is not unusual to obtain 20db quieting at .35 microvolts). The RF section is tuned by means of T101 through T104.

Repeak I.F.
Repeak RF
Peak first oscillator coil (T105) and tripler coils (T106 & T107).
(NOTE: IF NO SIGNAL IS OBTAINED WHEN GENERATOR IS FIRST APPLIED, IT MAY BE NECESSARY TO TUNE THESE COILS FIRST).

If the meter reads higher than desired at signals of low level, the squelch amp may be detuned (T116). Also the output of the first mixer (T108) may be detuned without adversely affecting the sensitivity.

DISCRIMINATOR:

With a VOM or VTVM connected to the discriminator output (no signal applied) tune T115 for zero volts. The meter should be on its lowest D.C. range. Set meter to low AC range and connect to audio output. Apply signal modulated by single tone (sine wave). Tune T114 for maximum audio consistent with good tone. Remove signal and check T115 for zero. Apply signal and adjust oscillator coil or crystal trimmer for zero volts. This puts the particular channel on frequency. Adjust each crystal trimmer in the same manner.

This completes receiver alignment.

TRANSMITTER TUNING:

CAUTION: MISTUNING OF THE TRANSMITTER, ESPECIALLY THE MULTIPLIER AND FIRST RF STAGES, WILL VERY LIKELY RESULT IN SPURIOUS SIGNALS. A SPECTRUM ANALYZER OF SOME OTHER METHOD OF RELIABLY CHECKING FOR SPURIOUS IS STRONGLY RECOMMENDED.

Equipment: Wattmeter or field strength meter and dummy load.
Frequency meter or receiver of known receive frequency accuracy.
Spectrum analyzer or other reliable means of checking for spurious.
VOM or VTVM.

Procedure: Connect positive lead of VOM or VTVM to emitter of last doubler stage (Q208). Connect dummy load and key transmitter. Tune multiplier stages for minimum of two volts at emitter of Q208. (In most cases a reading of 2.5 to 3.8 volts may be expected). The multiplier stages are tuned by T204 through T207. Check all channels with crystals installed to be sure the voltage is above two volts at the emitter of Q208. There should not be a great deal of change from channel to channel. If any of the channels gives a reading below two volts, retune the multiplier stages until all channels give a reading above two volts. This is generally obtained with little trouble; however, if the full frequency range of the transmitter is being used (144 to 148 MHZ) things may prove exasperating.

Tune the output of the modulation amp (T203) for max voltage at the emitter of Q208.

Connect wattmeter or couple a field strength meter to the transmitter output. Adjust the meter for a useful reading. Tune the last doubler, the first, second, and third RF, the driver, and final amp for maximum meter reading. This involves tuning variable capacitors CV213, 214, 215, 216, 217, 218, 219, 220, and 221. CV220 and 221 are the output tuning capacitors on the rear of the chassis. In later models, there is a variable capacitor that replaces fixed capacitor C296. It couples the signal from the first to second RF amps and is connected to the feedthrough capacitor into the shielded transmitter compartment. This is also tuned for maximum output.

During the tuning process, a careful check must be constantly made for spurious.. If spurious is observed, return CV213 and 214 for a clean signal. Then retune the RF stages for maximum.

If the transmitter has been completely detuned, it may be necessary to tune each stage as a separate unit; that is an RF voltmeter or field strength meter is coupled to the output of each stage,in turn the stage is tuned, the meter is moved to the output of the next stage, and so on.

This completes the transmitter tune up procedure.

REPEATING: WATCH OUT FOR SPURS!

TEST POINTS

TP 101- Receive antenna coil input

TP 102- Positive side of meter

TP 103- Base of 1st Oscillator-Q105

TP 104- Base of 1st DC amp- Q112

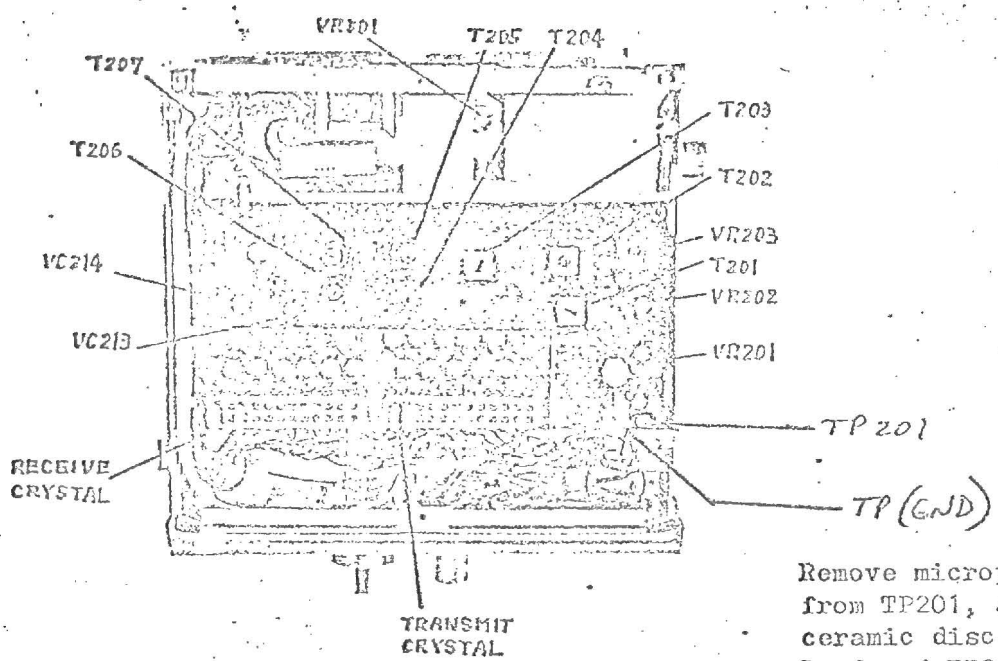
TP 105- Center lug of volume control

TP 106- 13.8 V receive- supply voltage

TP 107- Center lug of squelch set (VR104)

TP 108- Discriminator output

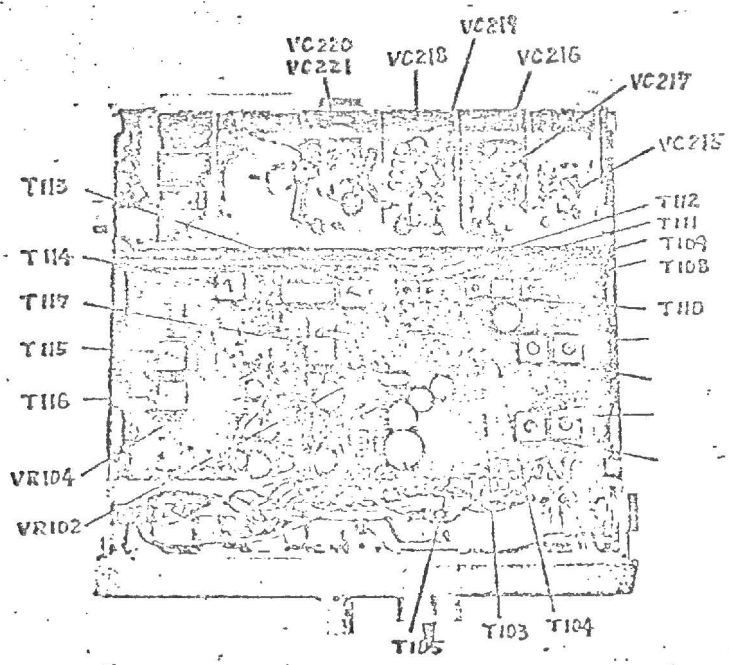
TP 109- Receive audio output



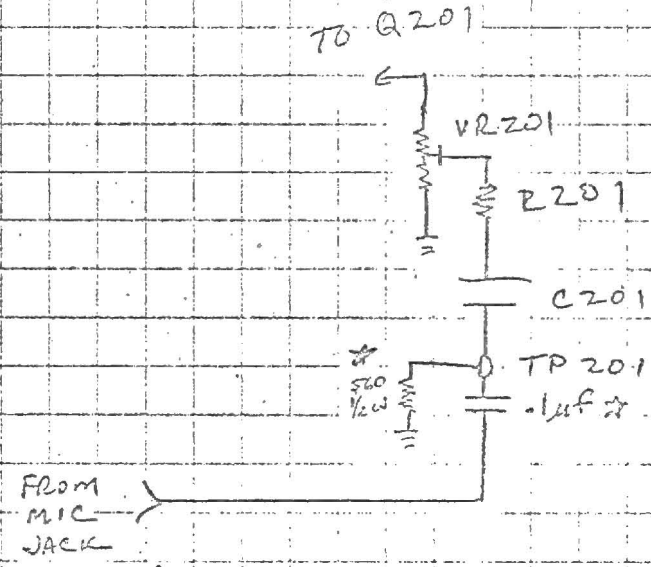
BOTTOM VIEW

Remove microphone lead from TP201, add .1 uf ceramic disc cap between lead and TP201, add 560 ohm ½w resistor between TP201 and ground TP.

To reduce bassiness of transmitted audio



TOP VIEW

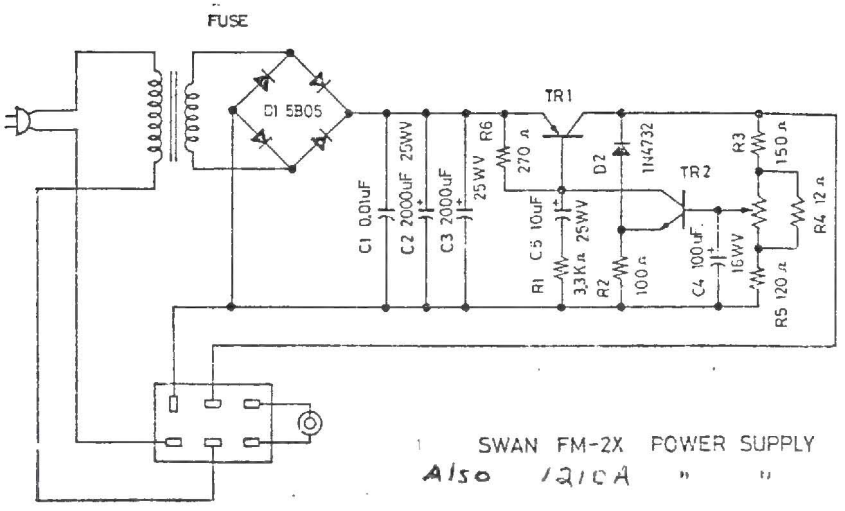


☆ ADDED COMPONENTS

.1μf GENERAL PURPOSE CERAMIC 25V

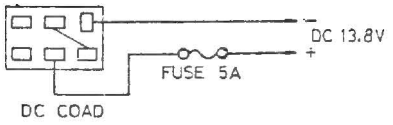
1560 ohm 1/2W 5% CARBON RESISTOR

PRE-EMPHASIS NETWORK FOR FM-2X & FM-2XA TO REDUCE BASSINESS OF TRANSMITTED AUDIO.



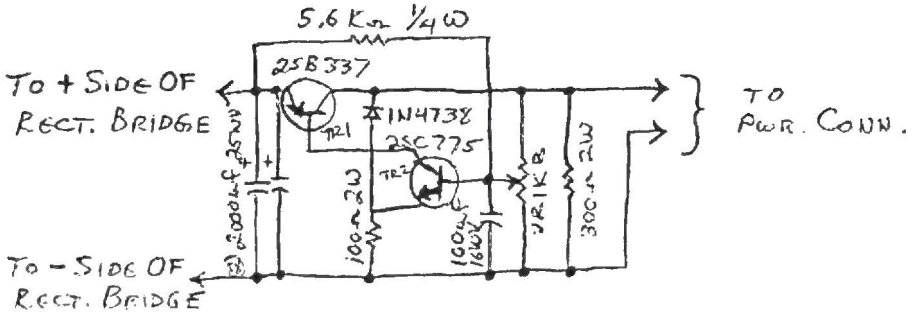
1 SWAN FM-2X POWER SUPPLY

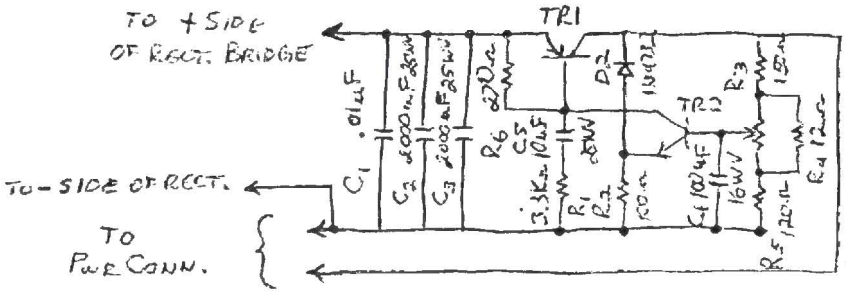
Also 12/CA " "

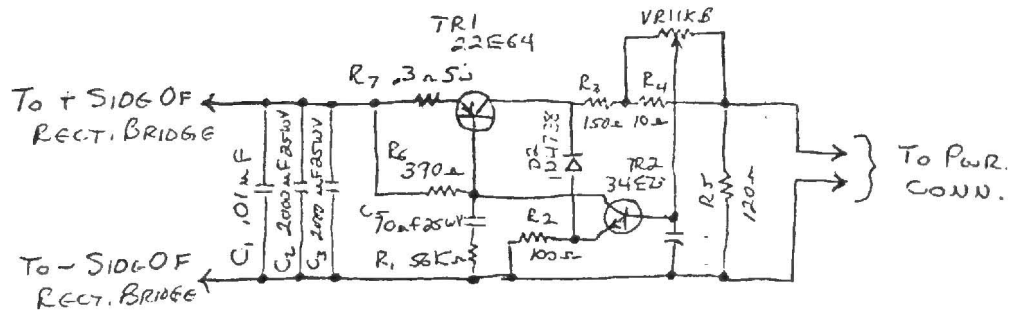


1. ALL RESISTANCES ARE IN OHMS AND WATTAGES OF RESISTOR ARE 0.25 WATT UNLESS OTHERWISE SPECIFIED.
2. CAPACITANCES FOLLOWED BY P ARE IN MICRO-MICRO FARADS OR PICO FARADS OTHERS ARE IN MICRO FARADS AND RATED VOLTAGES OF CAPACITOR ARE 50WV UNLESS OTHERWISE SPECIFIED.
3 ※ SUBJECT TO CHANGE IN INDIVIDUAL UNITS.

SWAN FM-2X 12 CHANNEL TRANSCEIVER
SWAN ELECTRONICS-OCEANSIDE, CALIF.







TRANSISTOR LIST

TR1	TR2
2SE64	2SE73
2SB337	2SC775
RCA SK3009	2SE73
	SK3047

FM-2X, A + FM-1210, A

POWER SUPPLY CONFIGURATIONS

SWAN ELECTRONICS
A subsidiary of Cubic Corporation

305 Airport Road, Oceanside, California 92054

A Cubic Corporation Company

OCTOBER, 1977

FM 2X POWER SUPPLY REGULATOR MODIFICATION

1. Remove power supply top cover, bottom cover and seperate chassis halves.

2. Remove all wiring to power transistor, regulator circuit board and potentiometer.

3. Remove regulator circuit board, potentiometer, .3 ohm 5 W resistor, A/C network inside black sleeving, power transistor, and 100 MF 25V capacitor on power connector.

4. Mount the 2N3055 (new power transistor) with the hardware left over from the old transistor. Be sure to use mica insulating washer and thermal compound between transistor and heat sink, insulating shoulder washers, and solder lug.

5. Using wire from parts already removed, connect solder lug on case of 2N3055 collector) to positive lug of either filter capacitor.

6. Connect 2N3055 emitter (lead nearest you) to output pin (positive) on power connector. See diagram

7. Mount new regulator circuit board in location vacated by old regulator board using #4 hardware provided.

8. Connect violet, gray, white wire from regulator board to output pin (positive) on on power connector.

9. Connect orange, black, white wire to base lead of 2N3055 (lead farthest away)

10. Connect blue, black, white wire to positive lug of filter cap nearest it.

11. Check all wiring against schematic to verify proper hookup.

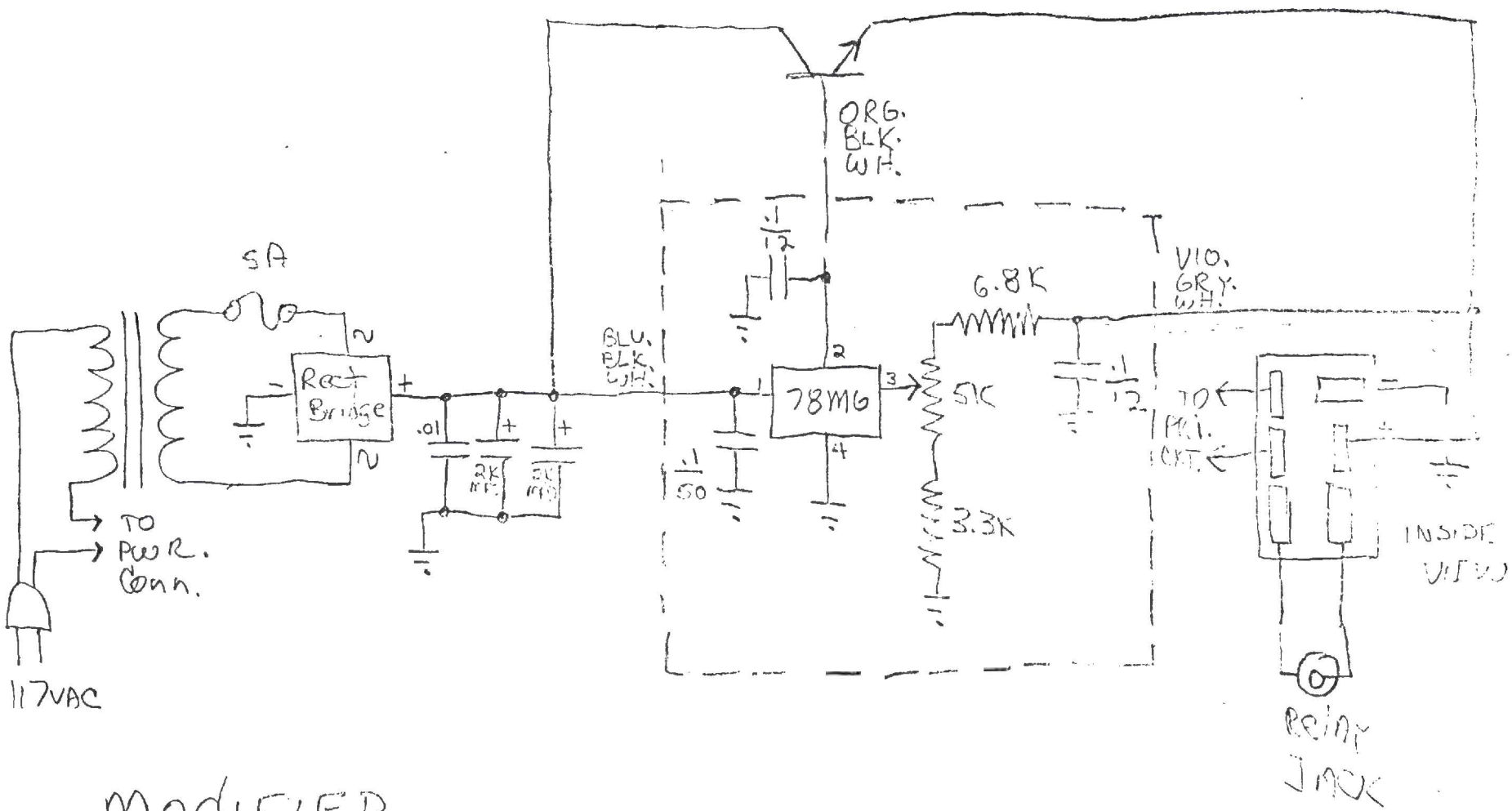
12. Turn miniature potentiometer on regulator board fully clockwise (minimum voltage).

13. With unit still opened up, connect power connector to its mate on radio, plug in A. C. power cord, and energize radio.

14. Measure voltage between output pin(positive) of power connector and ground. It should be about 9 or 10 volts. Adjust miniature potentiometer to give 13.8 volts at power connector. Verify that voltage does not drop appreciably (.1V nominal) when radio is keyed to full power out.

15. Button up unit.

2N3055



Modified
FM-2X Power
Supply- SEP 30 1973

SWAN ELECTRONICS CORPORATION 305 Airport Road, Oceanside, California 92054 714 757-7525 A Subsidiary of Cubic Corporation

VOL. I. March 20, 1972

SERVICE NOTES

SUBJECT: Alternator whine and ignition noise in the FM-2X, FM-1210A, and the FM-1210.

The alternator whine and ignition noise has been noted in the Amateur Radios which includes the FM-2X, FM-1210-A, and the Marine radio FM 1210. The following information will describe its identification and cure:

SYMPTON: Audio frequency buzz may be heard at low levels through the speaker. The level will not change with changes of volume. Also ignition hash may be heard, but this level may vary with listening level.

CAUSE: All three radios lack filtering.

CURE: This problem may be eliminated or greatly reduced by the addition of proper filtering of the DC voltage line. In the FM-2X it requires only the addition of one 1,000 MFD electrolytic capacitor. In the FM-1210-A two 1,000 MFD capacitors will be required, and in the FM-1210 Marine radio two 1,000 MFD capacitors are necessary, plus the additional filter choke.

PROCEDURE:

A. FM-2X- Install one 1,000 MFD/25 V electrolytic capacitor as per diagram.

1.. The positive lead of the capacitor will connect to the function relay at point #3. The negative lead will connect to the chassis ground.

B. FM-1210-A - Install two 1,000 MFD/25V electrolytic capacitor as per diagram 2B. Connect the positive lead of each capacitor to the function relay at point #3. The negative lead will connect to the chassis ground.

C. FM 1210- Marine Radio-Install two 1,000 MFD/25V electrolytic capacitors and one choke filter as per diagram 1C. First remove red connecting wire from pin #5 of input power plug and the connecting pin on the barrel of the fuse holder. (This may require partial removal of the fuse holder). Mount the choke filter as indicated in diagrams 1C. Re-connect one lead of the filter choke to pin #5 of the input power plug, and the other lead re-connect to the barrel pin of the fuse holder.

Next, install both capacitors as appears in the diagram, with the positive leads both connected to the rear pin of the fuse holder, and the negative leads both attached to the chassis ground.

NOTE: It may be necessary to relocate the terminal strip containing the APC circuit. In this event, drill a new locating hold in the shielding wall. Also it may be necessary to rotate the positioning of the auxiliary speaker jack.

73,
Dave Clifford
Customer Service

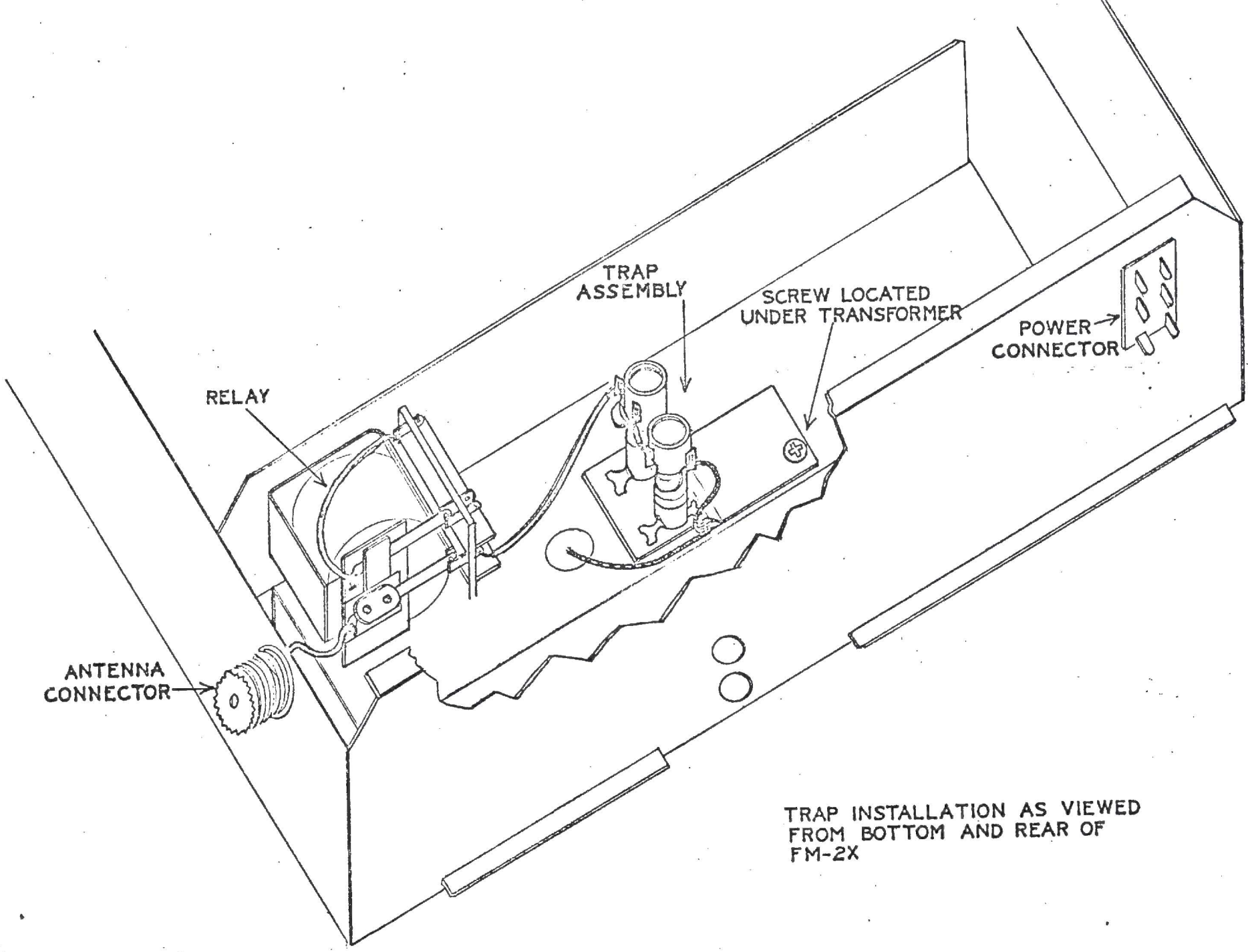
DC:lp

SWAN ELECTRONICS CORPORATION 305 Airport Road, Oceanside, California 92054 714 757-7525 A Subsidiary of Cubic Corporation

FM-2X TRAP INSTALLATION

Swan Electronics have installed two traps in series with the antenna input from the relay to the first RF stage of the receiver. One coil will trap out signals from the 88 to 108 mc. FM band, and the other coil will trap out signals in the 155 to 170 mc. range.

These coils have been installed behind the relay located on the bottom rear of the FM-2X. With the unit positioned upside down, and the front of the unit facing you, the coil on the left can be adjusted to greatly reduce or eliminate an interferring FM signal in the 88 to 108 mc. range. The coil on the right can be adjusted to eliminate an interferring signal in the 155 to 170 mc. range. If the exact frequency of the interferring signal is known, the traps can be set using a signal generator. However, it is recommended that the traps be set while listening to the interferring signal, and adjusting the appropriate trap for minimum or zero response of the FM-2X.

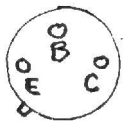


TRAP INSTALLATION AS VIEWED FROM BOTTOM AND REAR OF FM-2X

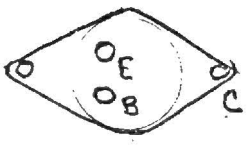
FM-2X RF VOLTAGE MEASUREMENTS

STAGE	INPUT	OUTPUT
Q203	- - -	BASE 0.5V
Q204	BASE 0.2V	COLLECTOR 2.0V
Q205	BASE 0.3V	COLLECTOR 2.2V
Q206	" 1.2V	" 3.0V
Q207	" 1.3V	" 4.1V
Q208	" 2.1V	" 3.0V
Q209	" 1.5V	" 5.0V
Q210	" 1.2V	" 6.0V
Q211	" 3.4V	" 14.0V
Q212	" 6.5V	" 20.0V
Q213	" 13V	" 20.0V

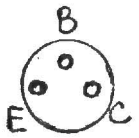
2N3866
2N706



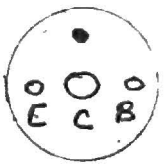
2N3055



2N5130



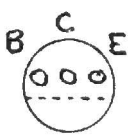
2N4049



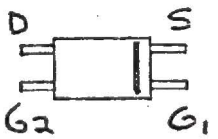
2N5814

MPF-102

2N5418



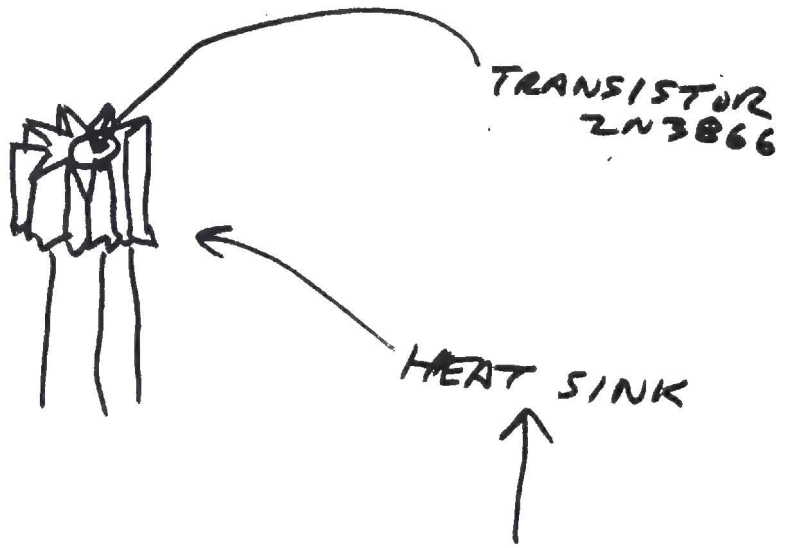
MPF-121



TOP VIEW!

TO USE 2N3866 AS SUBSTITUTE FOR 2SC730

Isolate the collector of the 2N3866 from the Chassis. Leave the leads on it long enough to extend the heat sink above the chassis.



NOTE:
KEEP
ISOLATED
FROM
CHASSIS
GROUND

Motorola equivalent to the SRF 2017 per Bob S. (Engr) and Tom (C.

MOTOROLA
Semiconductors
BOX 20912 • PHOENIX, ARIZONA 85036

MRF453
MRF453A

Advance Information

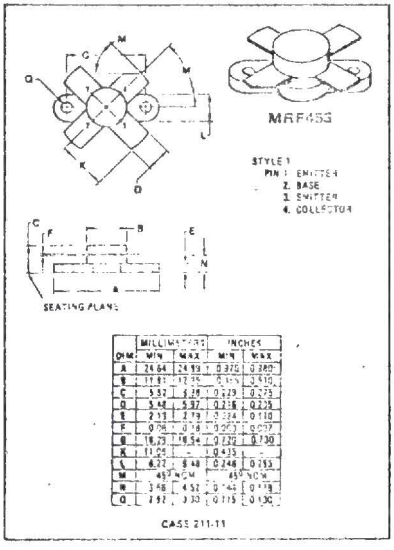
The RF Line

60 W — 30 MHz
RF POWER
TRANSISTORS
NPN SILICON

NPN SILICON RF POWER TRANSISTORS

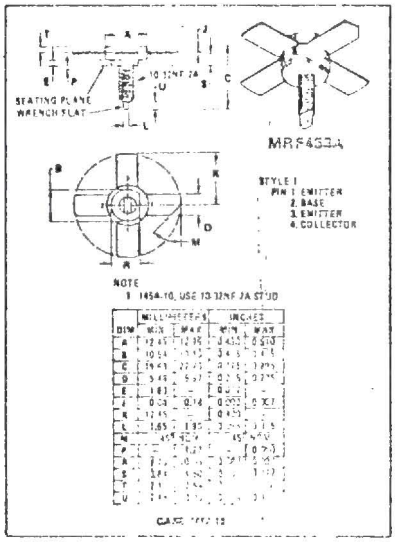
. . designed for power amplifier applications in industrial, commercial and amateur radio equipment to 30 MHz.

- Specified 12.5 Volt, 30 MHz Characteristics —
  Output Power = 60 Watts
  Minimum Gain = 13 dB
  Efficiency = 55%



DIM	MILLIMETERS MIN	MAX	INCHES MIN	MAX
A	24.64	24.89	0.970	0.980
B	13.83	13.95	0.545	0.549
C	5.92	6.28	0.233	0.247
D	5.46	5.97	0.215	0.235
E	2.93	3.18	0.115	0.125
F	0.08	0.18	0.003	0.007
G	16.29	16.54	0.641	0.651
K	11.05	—	0.435	—
L	6.22	6.48	0.245	0.255
M	45° NOM		45° NOM	
N	3.48	4.52	0.145	0.178
Q	3.97	3.33	0.115	0.130

CASE 211-11



NOTE
1. 145A-10, USE 10-32NF-2A STUD

DIM	MILLIMETERS MIN	MAX	INCHES MIN	MAX
A	12.45	12.95	0.490	0.510
B	10.54	11.05	0.415	0.435
C	19.43	22.23	0.765	0.875
D	5.46	5.97	0.215	0.235
E	1.83	—	0.072	—
F	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.65	1.95	0.065	0.076
M	45° NOM		45° NOM	
P	3.81	4.32	0.150	0.170
R	7.62	8.13	0.300	0.320
S	3.81	5.82	0.150	0.229
T	7.11	9.52	0.280	0.375
U	7.11	—	0.280	—

CASE 172-13

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Emitter Voltage	V_{CES}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	16	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	175 1.0	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.0	°C/W

MATCHING PROCEDURE

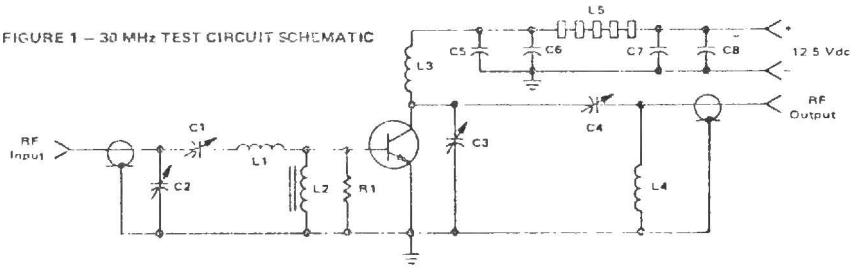
In the push-pull circuit configuration, it is preferred that the transistors are used as matched pairs to obtain optimum performance. The matching procedure used by Motorola consists of measuring [illegible] at the data sheet conditions and color coding the device to [illegible] h_{FE} ranges within the normal h_{FE} limits. A color [illegible] to the marking on top of the cap. Any two devices [illegible] same color dot can be paired together to form a matched [illegible]

[illegible]ance information and specifications are subject to change without notice.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, I_B = 0)	BV_{CEO}	18	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	BV_{CES}	36	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	BV_{EBO}	4.0	–	–	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 5.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	–	150	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	–	250	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 60 W, f = 30 MHz)	G_{pe}	13	–	–	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 60 W, f = 30 MHz)	η	55	–	–	%
Series Equivalent Input Impedance (V_{CC} = 12.5 Vdc, P_{out} = 60 W, f = 30 MHz)	Z_{in}	–	1.66-j1.844	–	Ohms
Series Equivalent Output Impedance (V_{CC} = 12.5 Vdc, P_{out} = 60 W, f = 30 MHz)	Z_{out}	–	1.73-j1.188	–	Ohms
Parallel Equivalent Input Impedance (V_{CC} = 12.5 Vdc, P_{out} = 60 W, f = 30 MHz)	Z_{in}	–	2.09/1030	–	Ω/pF
Parallel Equivalent Output Impedance (V_{CC} = 12.5 Vdc, P_{out} = 60 W, f = 30 MHz)	Z_{out}	–	1.75/330	–	Ω/pF

FIGURE 1 – 30 MHz TEST CIRCUIT SCHEMATIC



C1, C2, C4 ARCO 459
C3 ARCO 466
C5 1000 pF, UNELCO
C6, C7 0.1 μF Disk Ceramic
C8 1000 μF/15 V Electrolytic
R1 10 Ohm/1 Watt, Carbon

L1 3 Turns, #18 AWG, 5/16" I.D., 5/16" Long
L2 VK200 – 20/4B, FERROXCUBE
L3 12 Turns, #18 AWG Enameled Wire, 1/4" I.D., Close Wound
L4 3 Turns 1/8" O.D. Copper Tubing 3/8" I.D., 3/4" Long
L5 7 FERRITE Beads, FERROXCUBE #56 590 65/3B

FIGURE 2 – OUTPUT POWER versus INPUT POWER

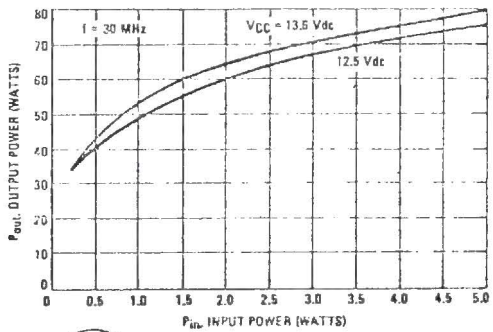
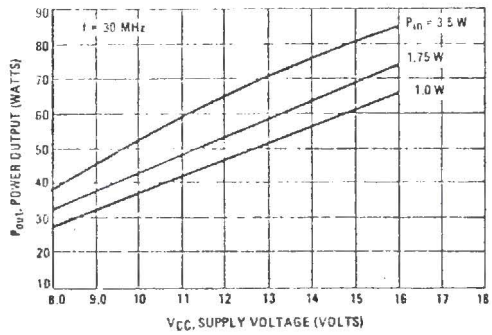
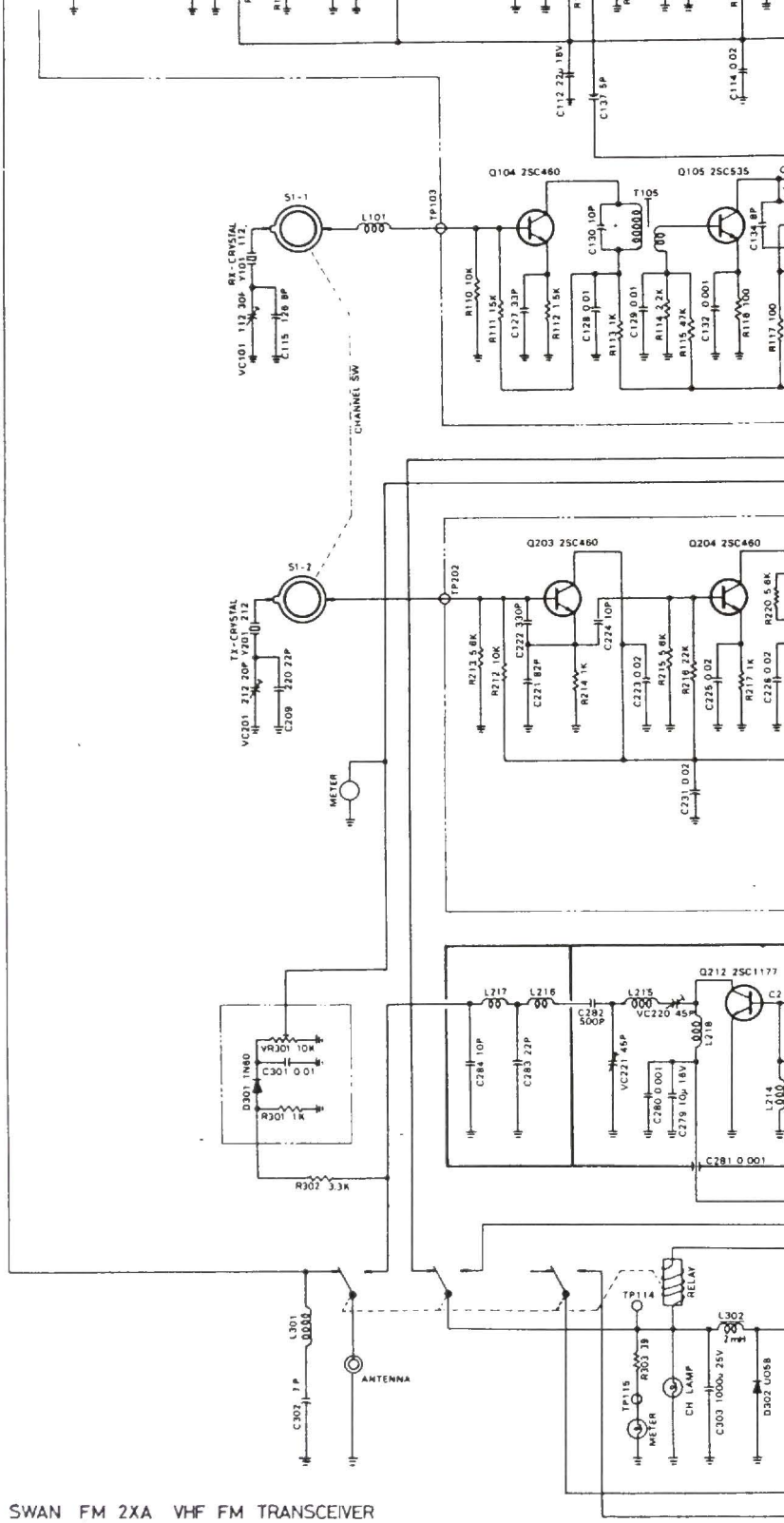


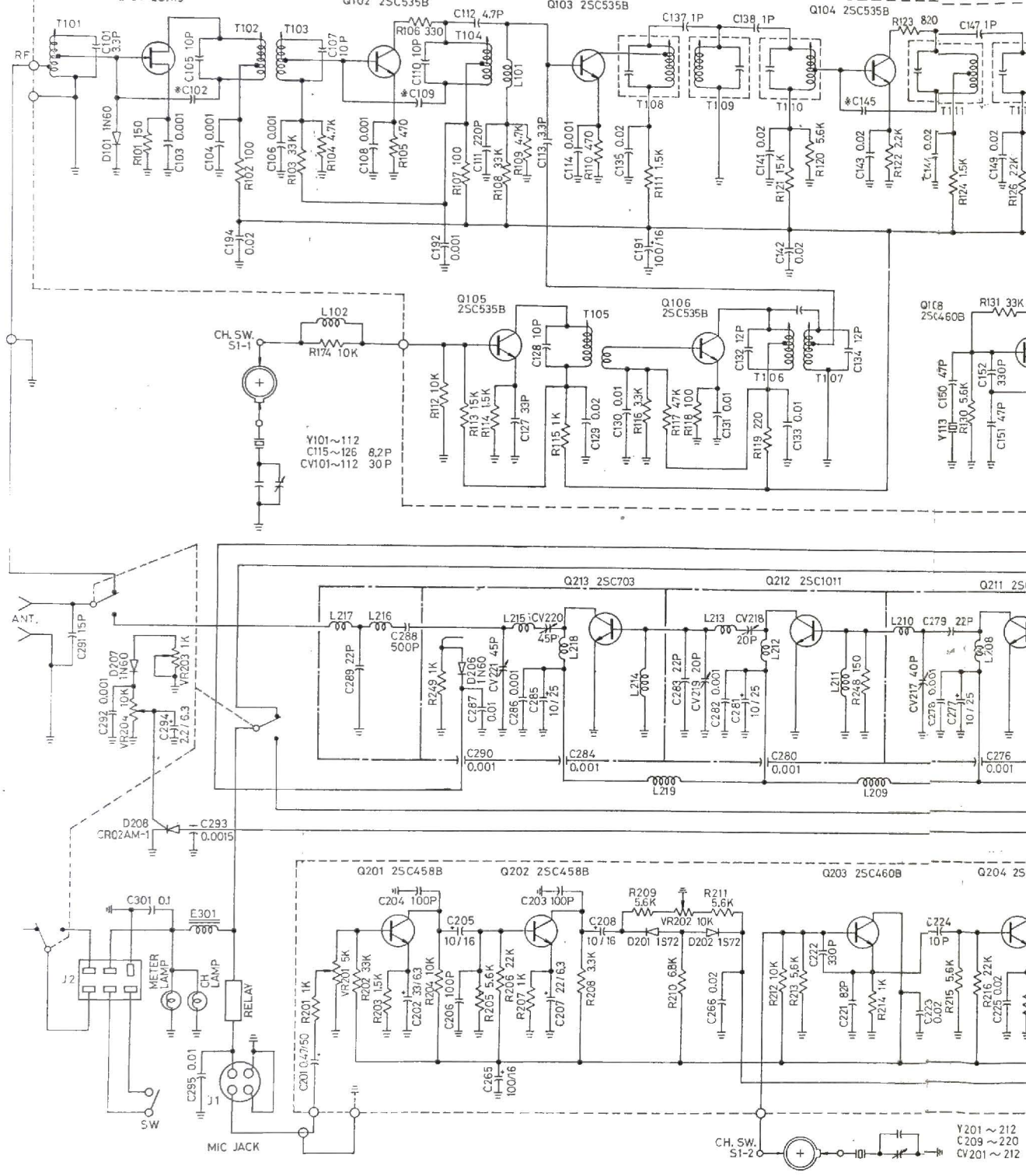
FIGURE 3 – OUTPUT POWER versus SUPPLY VOLTAGE





SWAN FM 2XA VHF FM TRANSCEIVER

SWAN ELCTRONICS OCEANSIDE CALIF.


RF
T101
T102
T103
T104
T105
T106
T107
T108
T109
T110
T111
Q102 2SC535B
Q103 2SC535B
Q104 2SC535B
Q105 2SC535B
Q106 2SC535B
Q108 2SC460B
CH. SW. S1-1
L102
R174 10K
Y101~112
C115~126 8.2P
CV101~112 30P
ANT.
C291 15P
D207 1N60
VR203 1K
VR204 10K
C292 0.001
C294 2.2/6.3
D208 CR02AM-1
C293 0.0015
Q213 2SC703
Q212 2SC1011
Q211 2S
L217
L216
C288 500P
L215
CV220 45P
L218
L214
L213
CV218 20P
L212
L211
L210
C279 22P
L208
L219
L209
C290 0.001
C284 0.001
C280 0.001
C276 0.001
Q201 2SC458B
Q202 2SC458B
Q203 2SC460B
Q204 2S
C301 0.1
E301
J2
METER LAMP
CH LAMP
RELAY
J1
S.W
MIC JACK
C295 0.01
C201 0.47/50
C265 100/16
CH. SW. S1-2
Y201 ~ 212
C209 ~220
CV201 ~ 212

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