SERIAL NO. _____ INSTRUCTION MANUAL/PM-0302F

rf

RF-302

ANTENNA COUPLER

R F COMMUNICATIONS, INC. ■ ROCHESTER, NEW YORK, U.S.A.

WARRANTY

R F Communications, Inc. warrants the equipment purchased hereunder to be free from defect in material and workmanship under normal use and service, when used for the purpose for which the same is designed, for a period of one year from the date of delivery, provided that notice of such defect is given to R F Communications within sixty (60) days after the discovery thereof and provided that inspection by R F Communications indicates the parts are defective to R F Communications' reasonable satisfaction. R F Communications' obligations under this warranty are limited to the repair or replacement of defective parts and the return of such repaired or replaced parts to the purchaser F.O.B factory. At R F Communications' option, any defective part shall be returned to R F Communications' factory for inspection, properly packed and all expenses prepaid. No parts shall be returned unless the purchaser first obtains a return authorization number, which will be furnished on request. Electron tubes are warranted in accordance with the manufacturer's standard tube warranty policy, which will be furnished on request. Equipment furnished by R F Communications, but manufactured by another, bears only the warranty given by such other manufacturer, which will be furnished on request. No warranties other than those set forth in this section are given or are to be implied with respect to the equipment furnished hereunder and R F Communications shall in no event be liable for consequential damages, or for loss, damage, or expense directly or indirectly arising from the use of the products, or any inability to use them either separately or in combination with other equipment or materials, or from any other cause.

CORRESPONDENCE AND PARTS ORDERING

Whenever writing about this unit or ordering parts, always refer to the model and serial numbers and the approximate date of purchase. Special parts should be ordered by the R F part number and the schematic designation number. Standard parts can be obtained from your local parts distributor.

RETURN OF EQUIPMENT

No part shall be returned to RF Communications Field Service Department unless the purchaser first obtains a return merchandise authorization number (RM). This number is to be marked on the shipping container.

ACCESSORIES

From time to time, new accessories are added to our product line. Often, these are a result of particular customer needs. Our sales department will be happy to discuss your requirements and suggest possible solutions.

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SECTION I
GENERAL INFORMATION

1.1 PURPOSE.

The RF-302 is a manually tuned antenna coupler designed to efficiently match a variety of unbalanced antennas to the output of medium power HF transmitters from 2 to 15 Mc. It is intended for use in fixed or mobile installations where a fast, effective means of matching the antenna to the transmitter at several transmitting frequencies is required.

1.2 PHYSICAL DESCRIPTION.

The RF-302 is housed in a ruggedized, gray splashproof metal case. All operating controls are conveniently mounted on the front panel. Antenna, transmission line, and ground connections are made at the rear. Four rubber covered feet permit the RF-302 to be set on any reasonably flat surface. Accessory brackets can be used to mount the RF-302 in any position, or it can be secured to the RF-305 Shockmount, which is designed to hold the RF-301 Transceiver and the RF-302.

The RF-302 is 9-1/4 inches high, 4-3/4 inches wide, 14-3/4 inches deep, and weighs approximately 7 pounds.

1.3 ELECTRICAL DESCRIPTION.

The RF-302 will efficiently match the impedance of any long-wire or whip-type antenna 16 feet in length or longer to the 52 ohm output of a transmitter over a frequency range of 1.6 to 16 MC/S. Shorter antennas may be tuned; however, they are not as efficient at the lower frequencies. The RF-302 is capable of operation with transmitter outputs of up to 150 watts, and requires no external power other than the transmitter RF output. A built-in directional wattmeter monitors forward and reflected power.

1.4 ANTENNAS.

The following antenna kits are available from RF Communications, Inc. for use with the RF-302.

MODEL	DESCRIPTION
SB-V9	9 FT Stainless Steel Whip Antenna Kit
SB-V16	16 FT Fiberglass Whip Antenna Kit
SB-V16A	16 FT Aluminum Whip Antenna Kit
SB-V35	35 FT Fiberglass Whip Antenna Kit
SB-V35A	35 FT Aluminum Whip Antenna Kit
SB-A75	75 FT Long-Wire Antenna Kit
SB-A150	150 FT Long-Wire Antenna Kit

1.5 CABLE AND CONNECTORS.

The RF input termination on the rear of the RF-302 is a coaxial UHF connector. The RF output (antenna) connection is a threaded No. 10 stud mounted on a high voltage insulator. The ground connection is a threaded 1/4 in. stud on the chassis. A 2-1/2 foot insulated stranded antenna lead-in wire and a 2-1/2 foot braided ground strap are shipped with the RF-302. Since it is desirable to have both the antenna lead-in and the ground strap as short as possible, the RF-302 should be positioned close to the antenna base, and the lead-in and ground wires cut to length at the time of installation. When the RF-302 is supplied with the RF-301 transceiver for shock mounting on the RF-305 Shockmount, the RF transmission line (coaxial cable

assembly) from the RF-301 to the RF-302 is supplied with the equipment.

1.6 ACCESSORIES.

A No. 162-2170 Mounting Bracket Kit is available as an accessory from RF Communications. The brackets attach to the sides of the RF-302 case, and permit the case to be mounted in any position.

Also available from RF Communications, Inc. is a Depot Spare Parts Kit (model RF-313), which contains all parts needed for major repairs to the RF-302.

SECTION II
INSTALLATION

2.1 GENERAL.

The RF-302 requires no special adjustment procedures during installation. The Antenna Coupler is fully adjusted and ready to use as shipped from the factory. However, one important factor should be considered: while the addition of an efficient antenna coupler such as the RF-302 is an improvement for any antenna system, it will not immediately solve all antenna system problems. Antenna sites should be selected with care, and good engineering practices observed for all phases of the installation. The importance of having the RF-302 as close as possible to the antenna cannot be overemphasized. Any length of lead between the RF-302 and the antenna acts as part of the antenna itself, radiates, causes mistuning and results in inefficiency. Likewise, any extended length of lead between the RF-302 and a good electrical ground acts as a part of the antenna, resulting in poor operation of the antenna system. In addition, a long ground lead may result in an RF voltage on the RF-302 chassis, causing improper operation and presenting a shock hazard.

The following paragraphs will assist in ensuring that the RF-302 is properly installed. Read all applicable paragraphs before starting the installation.

2.2 UNPACKING AND INSPECTION.

Remove all packing material and carefully lift the RF-302 and cables from the box. Check the unit for any signs of damage. If any damage exists, save packing material to substantiate claim with transportation agency.

2.3 MOUNTING.

The RF-302 may be mounted in any position which is close to the antenna base and convenient to the operator. The only restriction on mounting the RF-302 is that the antenna lead-in should be as short as possible and must not be longer than 2-1/2 feet.

For installations where shock or vibration will be a problem, the RF-302 should be shock mounted. Figure 2.1 illustrates a typical mobile installation using the RF-305 shockmount to mount the RF-301 Transceiver and the RF-302. To install the RF-302 on the RF-305, position the RF-302 so that the rubber feet drop through the elongated holes in the shockmount plate, then tighten the shockmount clamp to secure the RF-302 in place. Finish the installation by connecting the cables as called out in paragraph 2.6, and making the ground connections as called out in paragraph 2.5.

The RF-302 may be set on any flat surface for fixed station operation. The rubber covered feet tilt the RF-302 at a convenient angle for easy manipulation of the controls. The RF-302 may be mounted in a fixed position using accessory brackets which may be obtained from RF Communications, Inc. (No. 162-2170). To mount the RF-302 with brackets proceed as follows:

a. Remove the four flat head screws and nylon inserts used to fasten each side of the RF-302 case.

b. Position the brackets on each side of the case, with the flanges facing away from the chassis.

c. Insert 1/2 inch 4-40 pan head screws and lockwashers (supplied with the brackets) through the holes in the brackets into the tapped holes in the chassis, and tighten.

d. Secure brackets to mounting surface with suitable fasteners such as wood screws or machine screws and nuts.

e. Refer to paragraphs 2.5 and 2.6 for cable connections and grounding procedures.

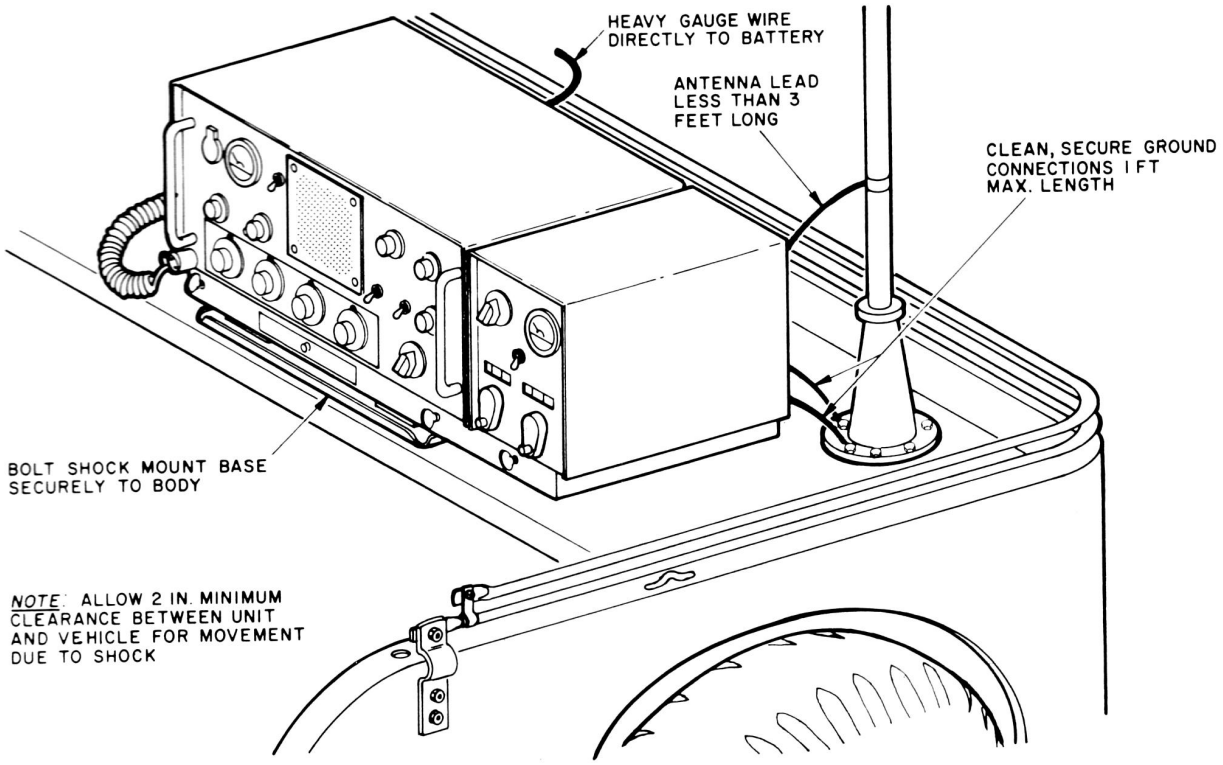

Figure 2.1 – Typical Shockmount Installation

2.4 REMOTE INSTALLATIONS.

The maximum antenna lead-in length of 2-1/2 feet limits the distance the RF-302 may be removed from the antenna base. However, the transmitter may be mounted up to 100 feet distant from the RF-302. Figure 2.2 illustrates a typical fixed station installation with the RF-302 installed at a point remote from the transmitter. The RF-302 may be mounted on a sturdy shelf as indicated, or the brackets may be used to mount it directly to a bulkhead. After mounting the equipment refer to paragraphs 2.5 and 2.6 for cable connections and grounding.

2.5 GROUNDING.

A good ground should be used with a vertical antenna for efficient radiation. Grounds for long-wire antennas are not as critical, but are still necessary. Use copper strap or braided wire lead for all ground connections. Keep ground leads as short as possible. If the RF-302 is located physically away from the ground plane, the ground lead acts as part of the antenna and the RF-302 chassis may be at some RF voltage above ground and consequently a possible shock hazard.

A 2-1/2 foot braided ground strap is supplied with the RF-302. Cut the strap to length at the time of installation.

Note

In shock mount installations, ground both the coupler and the shockmount. Allow enough play in the shockmount ground connection for movement of the shockmount during vibration.

In vehicular installations, connect the RF-302 ground terminal on the rear of the case (see figure 2.3) to the metal body of the vehicle. The surface at the point of connection should be clean and free of paint to ensure good bonding.

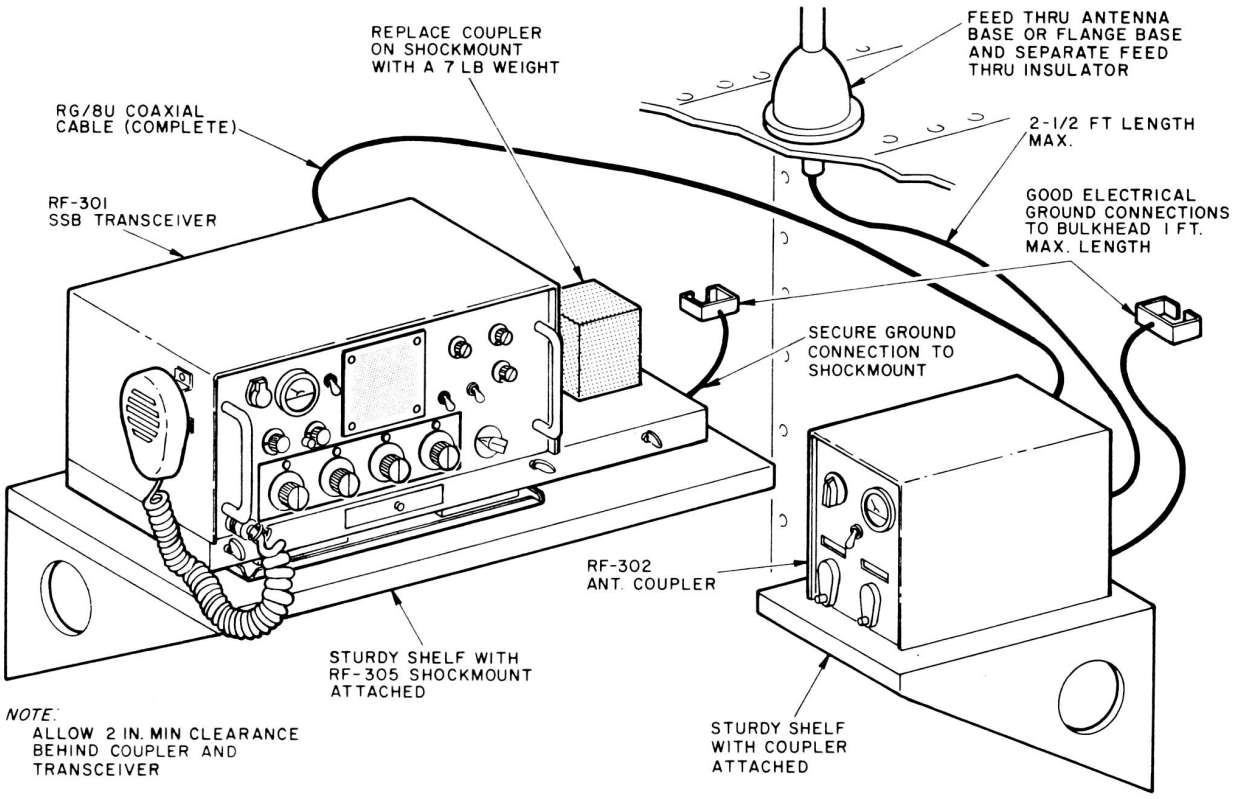

Figure 2.2 – Typical Remote Installation

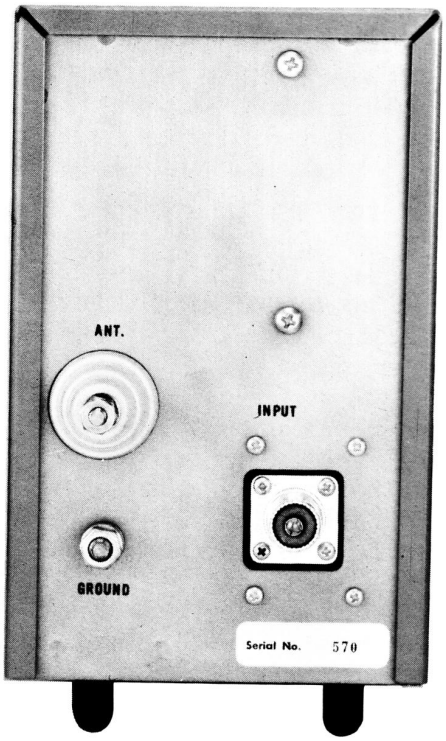

Figure 2.3 – Rear Panel Connectors

In fixed station installations, one or two ground rods six to eight feet in length can be driven into the ground, providing that the soil is moist and conductive. A connection to a water pipe system at the point where the pipe comes out of the ground might also serve as a good ground. In dry regions, a system of radials can be buried six to eight inches under the surface of the earth, extending away from the base of the antenna. These radials act as an artificial ground. The radials should be made of heavy gauge wire, at least one quarter wave-length long at the lowest operating frequency. A minimum of 4 radials should be used for vertical antennas. For long wire antennas, one or two radials running under the antenna may be sufficient.

2.6 CABLE CONNECTIONS.

A 2-1/2 foot antenna lead-in wire is supplied with the RF-302. Any short length of heavy gauge wire (No. 10 or larger) can be used. It must be heavily insulated. It should not be shielded. Cut the lead to the proper length at the time of installation. After the lead is

installed, tighten the connection at each end carefully, and then dress the lead well away from any surrounding metal. (See figure 2.3 for rear panel connections.) When the RF-302 is supplied with the RF-301 Transceiver, the transmission line from the transceiver to the RF-302 is supplied. However, if the RF-302 is used in an installation where the transmission line is not supplied (or the supplied cable is not long enough), the transmission line will have to be fabricated. Use 52-ohm coaxial cable such as type RG-8/U and UHF type coaxial connectors such as type PL-259. When the transceiver is located next to the RF-302, the smaller type RG-58/U cable may be used, if convenient. If the transmission line connections will be exposed to the weather, wrap the connections with plastic conformal tape to reduce corrosion.

Note

To reduce the corrosion of the connections between whip antenna sections, coat mating connections lightly with Dow Corning DC #5 before assembly, and then wrap each connection with plastic conformal tape.

SECTION III
OPERATION

3.1 GENERAL.

The RF-302 is initially tuned to a transmitting frequency by using a low power RF input and adjusting the controls for a minimum reflected power indication on the built-in directional wattmeter. No external meter is required for tuning. After the RF-302 has been tuned to a frequency and the control settings recorded, it may be quickly retuned to that frequency without an RF input by positioning the controls to the pre-logged settings. The paragraphs below detail the procedures for tuning, with or without pre-logged information.

Note

The RF-302 should be tuned with transmitter power set at about one third maximum output. When the RF-302 is not properly tuned, it does not provide a proper load for the transmitter. Plate current in the transmitter final stage will be excessive and damage to the transmitter may result.

3.2 PRINCIPLES OF OPERATION.

In order to understand the method of tuning the RF-302, it is helpful to know how it operates. Figure 3.2 shows the RF-302 components. Two variable coils are tuned such that the antenna impedance at the operating frequency is matched to the 52 ohm transmitter output impedance for efficient power transfer to the antenna. The coils are adjusted with the FINE TUNE and LOAD controls. The inductances are at maximum with the dials set to 000. The COARSE TUNE control switches fixed capacitors in series with or across the antenna to ground in such a manner that the antenna can be properly tuned by the coils. The COARSE TUNE control can be thought of as altering the reactance of the antenna to make it easier to match. Figure 5.1 shows how the components are connected.

The meter on the RF-302 is used to monitor forward power (power to antenna) and reflected power (power reflected from antenna

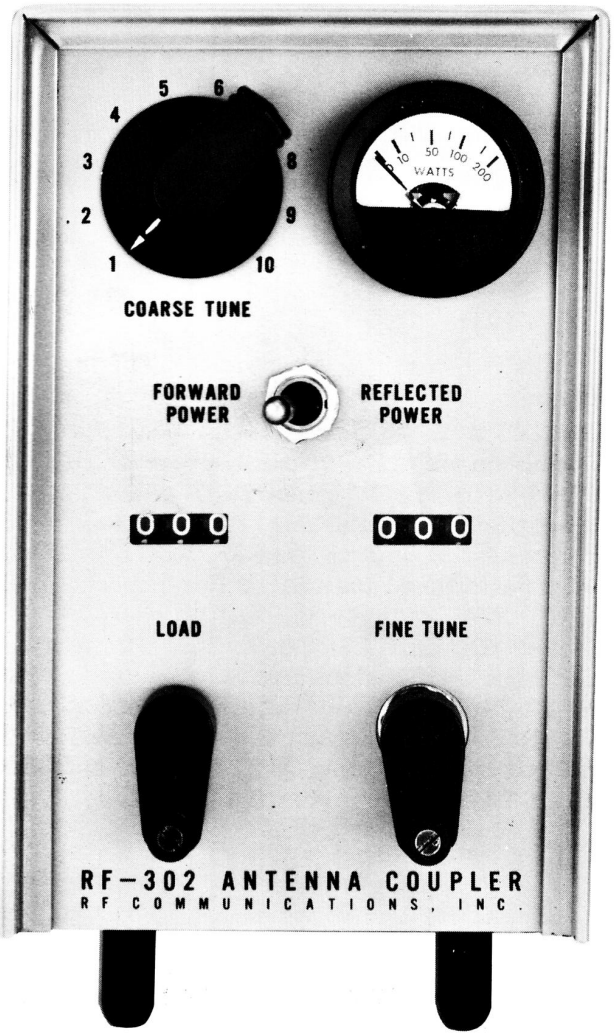

Figure 3.1 – Operating Controls

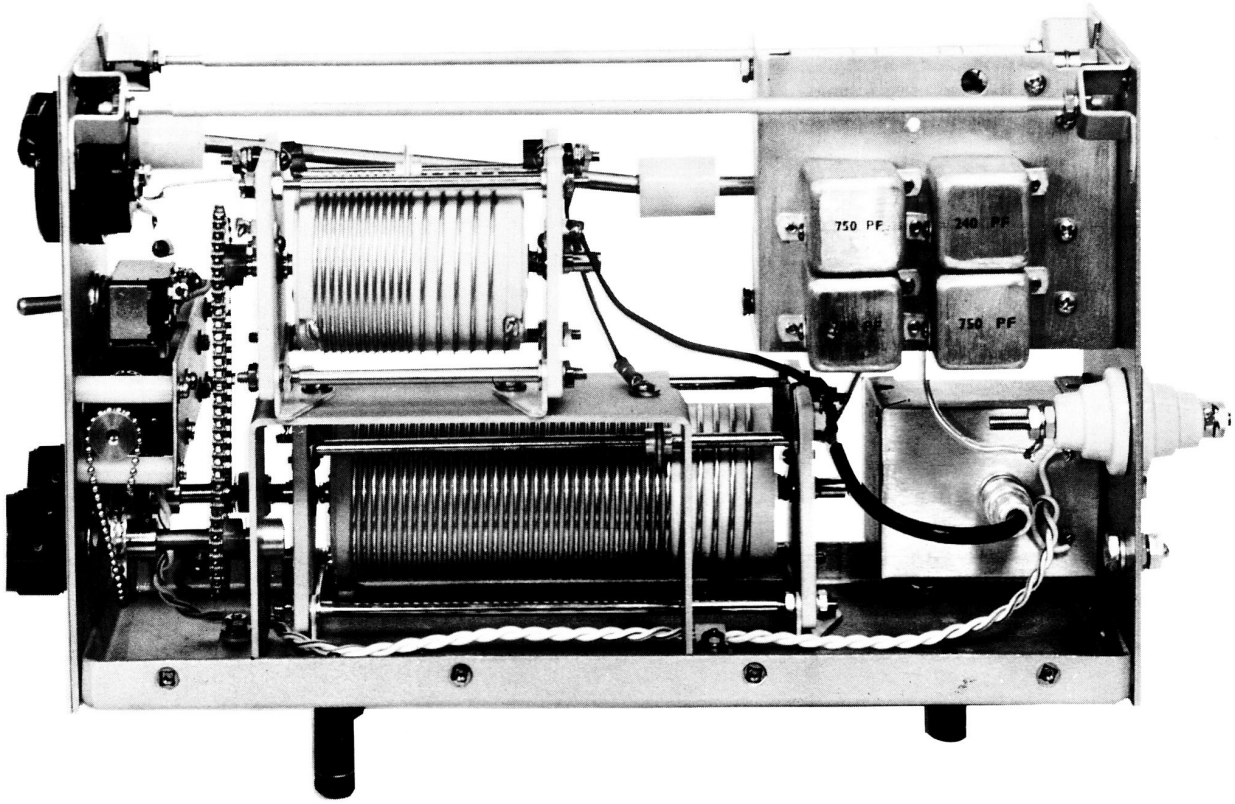

Figure 3.2 – Major Coupler Components

because it is inefficiently matched). A toggle switch on the RF-302 panel is used to select FORWARD or REFLECTED power meter operation. By adjusting the RF-302 for a minimum reflected power indication, the antenna is tuned for peak efficiency.

A zero REFLECTED power indication means that exactly 52 ohms resistive load is presented to the transmitter output, i.e., a VSWR of 1/1. Figure 3.3 gives the VSWR values corresponding to FORWARD and REFLECTED power meter indications.

3.3 TUNING PROCEDURES.

When tuning the RF-302 with an RF input, a single tone signal (such as a CW signal, or an unmodulated AM carrier) should be used. Before attempting to tune the RF-302, tune the transmitter to the desired frequency by following the procedures in the transmitter instruction manual.

Note

Although it is possible to perfectly tune most antennas and bring the REFLECTED power indication to zero, it should be noted that such precise tuning isn't essential. It is usually considered adequate and no appreciable loss of effectiveness will be evident if the REFLECTED power is kept less than 5% of the FORWARD power.

When no previous tuning information is known, the procedure in section 3.3.2 should be used to tune the RF-302. Once the RF-302 is tuned, record the control settings for future use.

3.3.1 TUNING WITH KNOWN CONTROL SETTINGS. When the control settings for the frequency and the antenna setup in use

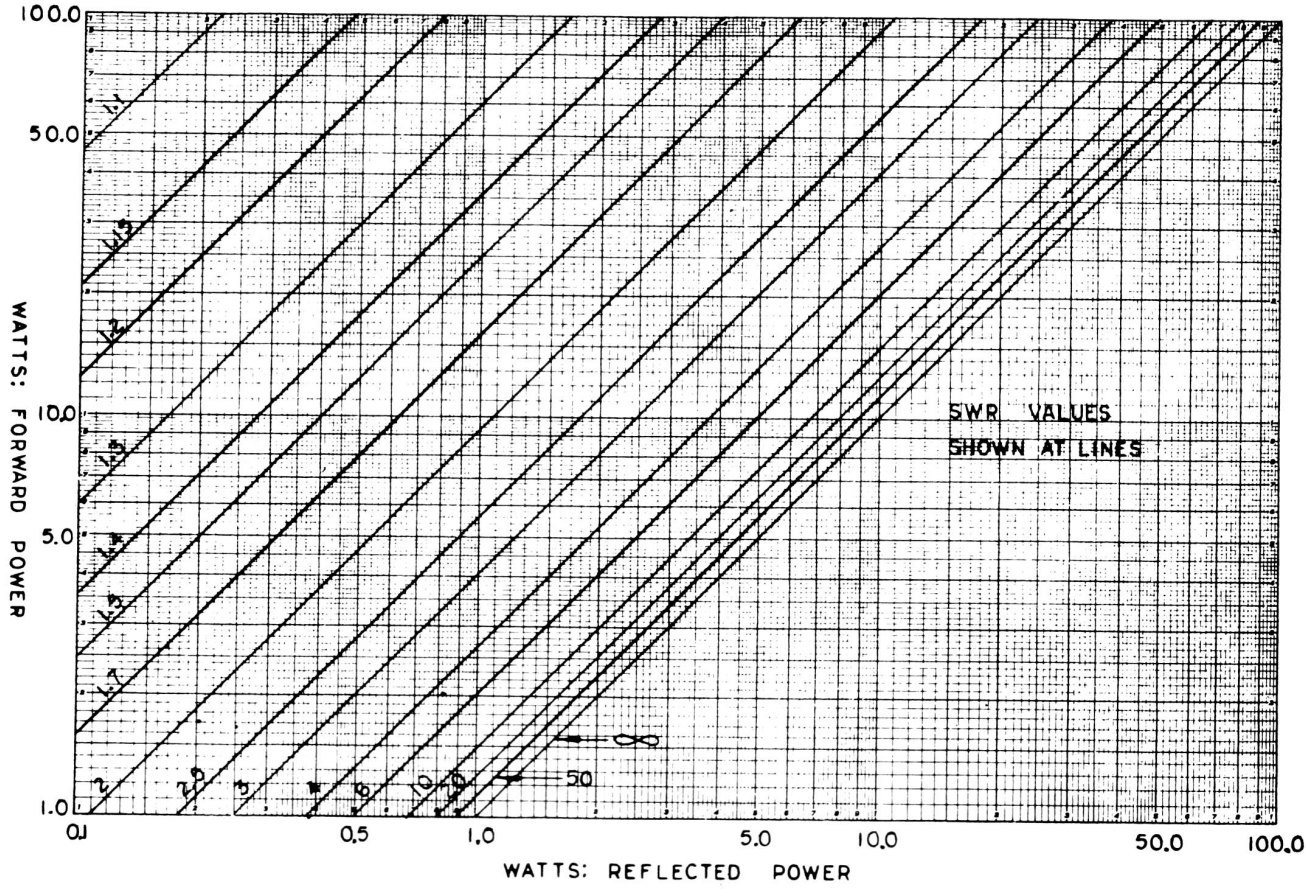

Figure 3.3 – VSWR vs FORWARD and REFLECTED Power Readings

have been previously recorded, proceed as follows:

a. Set the RF-302 controls to the positions recorded in the charts for the desired frequency.

b. Set up the transmitter for 50 W output at the desired frequency.

c. Key the transmitter.

d. Set the RF-302 meter switch at REFLECTED POWER.

e. Carefully check LOAD and FINE TUNE controls to see if a slight readjustment will improve the tuning (reduce the reflected power).

f. After tuning increase power and operate.

3.3.2 TUNING WITHOUT KNOWN CONTROL SETTINGS. When the control settings for the desired transmitting frequency are not known, a search will have to be conducted to find settings which will produce the lowest VSWR. The VSWR is lowest when the ratio of forward power to reflected power is greatest.

Typical settings of the RF-302 controls for different types of whip antennas are listed in table 3.1. These settings will be useful in indicating approximate settings for starting the search. When table 3.1 cannot be used, set COARSE TUNE at 1, FINE TUNE at 360, and LOAD at 900, then proceed as follows:

Note

The lowest numbered COARSE TUNE switch position should be used that will allow correct tuning. It is sometimes possible to tune in more than one position. The lowest numbered position will provide the most efficient operation.

TABLE 3.1 – TYPICAL CONTROL SETTINGS.

35 FT. Whip* SB-V35				16 FT Whip* SB-V16			9 FT Whip* SB-V9		
F	CT	FT	L	CT	FT	L	CT	FT	L
2.0	6	338	103	7	360	290	7	346	264
2.5	5	339	177	6	364	229	7	368	445
3.0	1	339	067	5	363	169	5	305	057
3.5	1	348	278	5	375	336	5	330	247
4.0	1	348	420	5	382	449	1	293	067
4.5	1	347	525	1	374	336	1	321	214
5.1	1	325	621	1	374	447	1	338	339.
5.5	1	325	663	1	376	503	1	351	402
6.0	1	335	717	1	386	557	1	365	463
6.5	1	338	775	1	394	603	1	366	517
7.0	2	296	800	1	395	643	1	374	559
7.5	2	292	798	1	395	677	1	374	596
8.0	2	133	857	1	396	707	1	382	624
8.5	4	234	560	1	396	735	1	389	649
9.0	6	254	753	1	396	763	1	394	669
9.5	6	345	795	1	394	792	1	398	688
10.1	6	371	819	1	392	828	1	402	709
11	5	308	767	1	377	907	1	406	735
12	3	102	691	4	382	682	1	410	761
13	3	348	736	4	369	725	1	413	785
14	3	368	769	4	221	760	1	413	806
14.999	3	382	800	6	400	862	1	406	825

F - FREQUENCY (MCS)
CT - COARSE TUNE
FT - FINE TUNE
L - LOAD

*These settings are typical - but actual settings will vary between installations.

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F	CT	FT	L	F	CT	FT	L	F	CT	FT	L

F – FREQUENCY
CT – COARSE TUNE
FT – FINE TUNE
L – LOAD

Figure 3.4 - Logging Chart

a. Set meter switch at REFLECTED POWER.

b. Key and tune transmitter for 50 W output at desired frequency.

c. Rotate LOAD control over complete range or until a null indication is obtained on the power meter.

d. If no null indication is obtained, advance COARSE TUNE switch one position and repeat step c, continuing until a null indication is obtained.

Note

A sharp rise in reflected power may occur just before a null, due to the fact that the power from the transmitter builds up quite rapidly as the proper tuning point is approached.

e. When a null indication is obtained, alternately adjust LOAD and FINE TUNE controls for minimum reflected power.

f. Record the control settings for future use.

g. Increase to full power and operate.

SECTION IV
MAINTENANCE

4.1 GENERAL.

Simplicity of design, and rugged construction limit the requirements for maintenance in the RF-302 to cleaning and occasional lubrication. The only electrical alignment, adjustment of the VSWR bridge, will not be required unless repairs have upset the original factory adjustment.

4.2 VISUAL INSPECTION AND LUBRICATION.

Periodically, depending upon the amount of usage, the chassis should be removed from the case for a cleaning and visual inspection. When the RF-302 is cleaned, check the coils and roller bars for signs of wear. Inspect switch contacts and leads for signs of arcing. Check the chain drives and the mechanical couplings for excessive play. Replace any badly worn or damaged parts.

CAUTION

Do not disturb lead dress unnecessarily while cleaning or repairing the RF-302. Control settings for tuning may be affected.

Use a soft bristle brush and a lint free cloth to clean the chassis. Lightly wipe the variable inductors, then lubricate. Use Molykote "G" made by Alpha-Molykote Corp; Stamford, Connecticut. Apply a very light coating to the shaft bearings and the roller rods of the variable inductors. Also apply a light film of lubricant to the chain drives, and to the front panel bearings.

4.3 TEST EQUIPMENT AND TOOLS REQUIRED.

The following tools and test equipment will be required for alignment of the VSWR bridge.

100 W, 50 ohm dummy load

Transmitter or Transceiver with at least 50 W single tone (CW or unmodulated AM carrier) output, at frequency close to 15 MCS

JFD Alignment tool #5284 or equivalent

Multimeter, Simpson Model 269 or equivalent

4.4 VSWR BRIDGE ALIGNMENT PROCEDURE.

The following procedure will be required only after repairs have disturbed the factory setting of the VSWR bridge.

a. Remove the dust cover.

b. Disconnect the BNC connector from the VSWR bridge assembly, on the chassis, and connect the dummy load to the VSWR bridge assembly.

c. Set the multimeter to 16 uA range.

d. Connect multimeter negative lead to ground.

e. Connect multimeter positive lead to terminal lug on rear of the power switch which is furthest from the power meter.

f. Set the Power switch at FORWARD POWER.

g. Connect the transmitter to RF-302 connector J1 (RF input).

h. Set up the transmitter for a single tone (CW or unmodulated AM carrier) at the highest possible frequency under 15 MC. Key the transmitter and adjust output for about 50 watts.

i. Carefully adjust A1C1 trim capacitor (see figure 4.1) for minimum current indication on the multimeter.

j. Unkey the transmitter.

k. Disconnect the transmitter and the dummy load, and reverse the connections, connecting the dummy load to J1 (RF input) and the transmitter to the BNC connector on the VSWR bridge chassis.

l. Set the Power switch at REFLECTED POWER.

m. Key the transmitter.

n. Carefully adjust A1C2 trim capacitor (see figure 4.1) for minimum current indication on the multimeter.

o. Repeat steps b through o until no further adjustment is necessary.

p. Reconnect plug from the coupler to the VSWR Bridge Assembly.

q. Remove leads and replace cover.

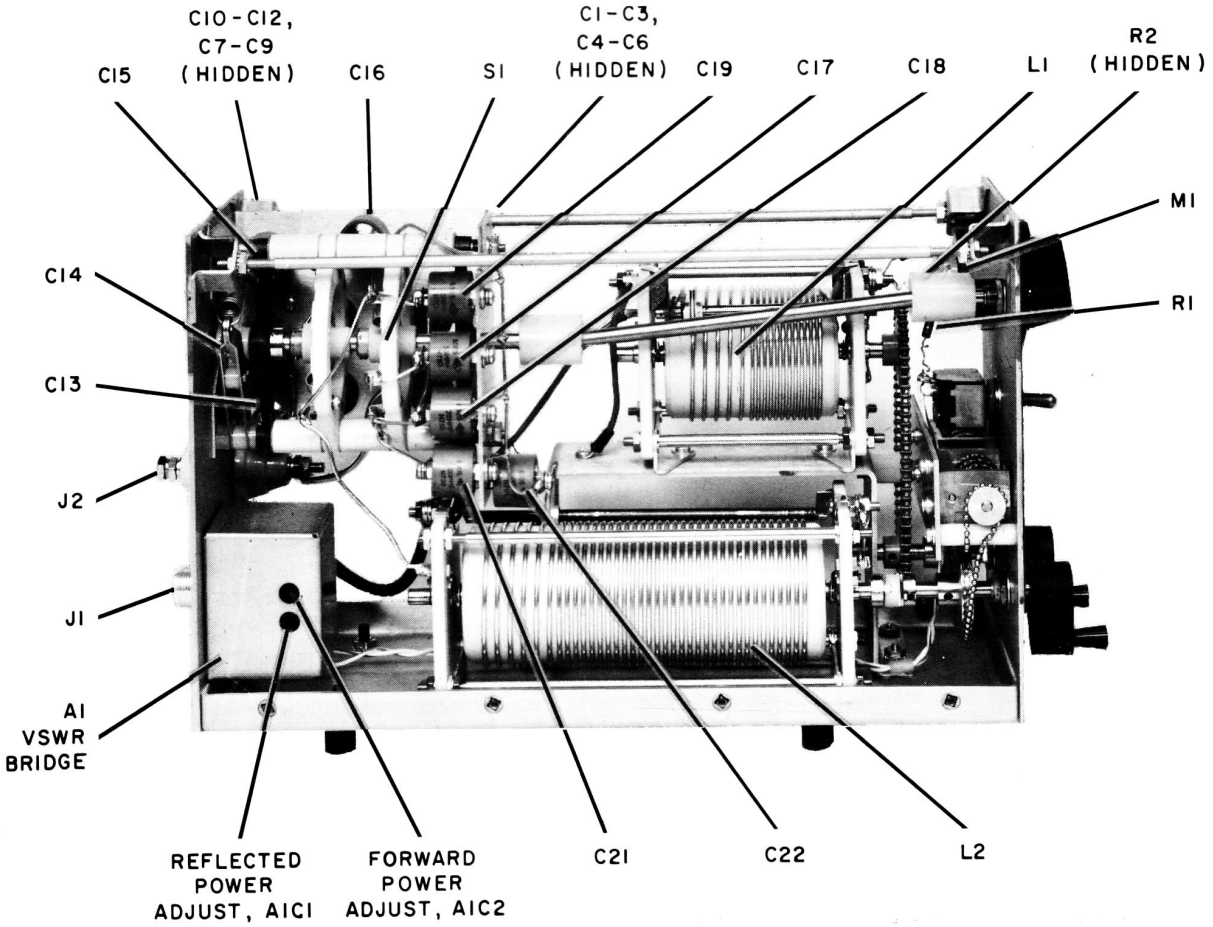
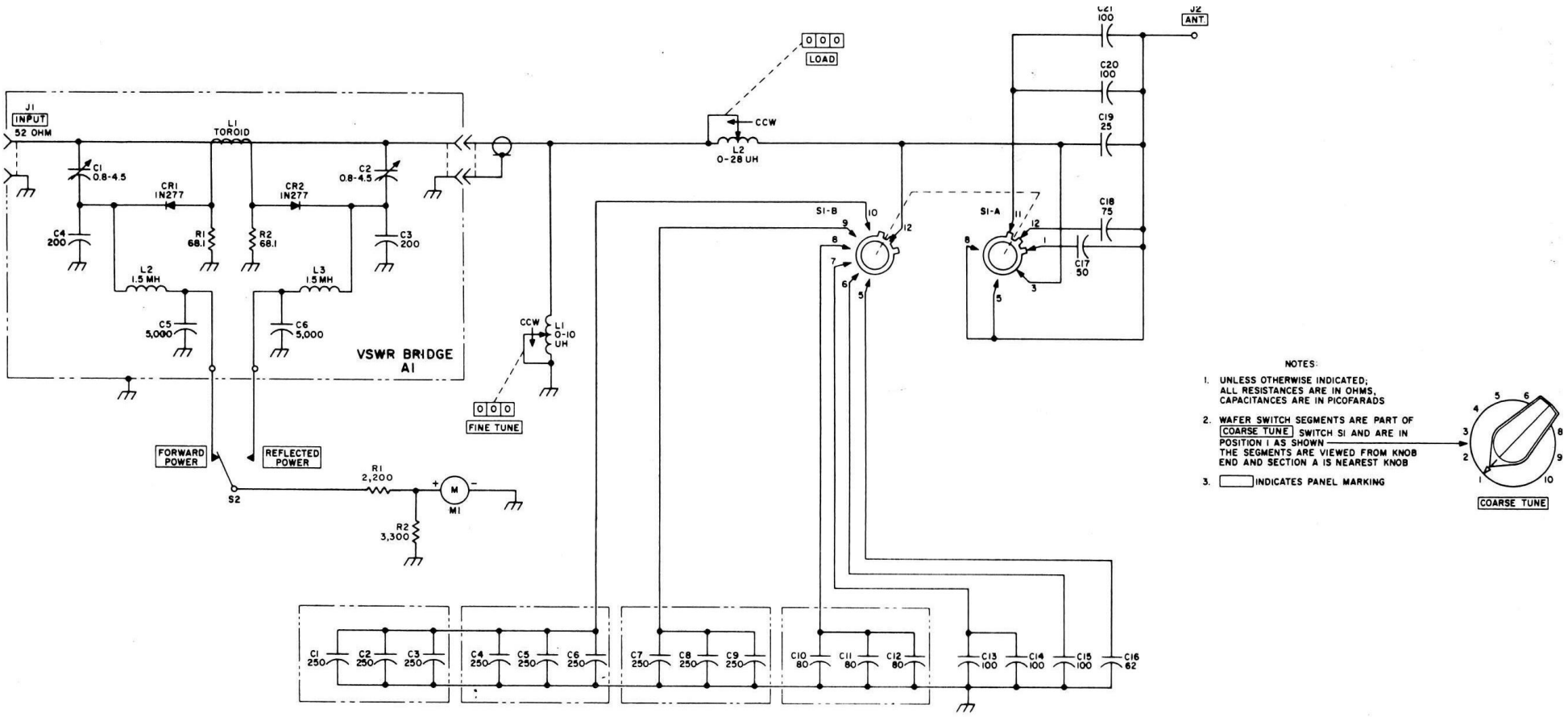


Figure 4.1 – Component Locations

SECTION V
PARTS LIST AND CIRCUIT DIAGRAM

REF DESIG	DESCRIPTION	RF PART NO.
C1/C3	Capacitor assembly, 750 pF	B162-2156
C4/C6	Same as C1/C3	B162-2156
C7/C9	Same as C1/C3	B162-2156
C10/C12	Capacitor assembly, 240 pF	B162-2157
C13/C15	Capacitor, Ceramic, 100 pF, 5 KVDCW	C-1155
C16	Capacitor, Ceramic, 62 pF, 10%, 5 KVDCW	C-1157
C17	Capacitor, Ceramic, 50 pF, 10%,5 KVDCW	C-1153
C18	Capacitor, Ceramic, 75 pF, 10%, 5 KVDCW	C-1154
C19	Capacitor, Ceramic, 25 pF, 10%, 5 KVDCW	C-1151
C20/C21	Capacitor, Ceramic, 100 pF, 10%, 5 KVDCW	C-1155
J1	Connector, receptacle, UHF	J-0003
J2	Feedthru insulator, antenna	E-0032
L1	Inductor, variable, 0-10 uH	B-162-2169
L2	Inductor, variable, 0-28 uH	L-0203
M1	Meter	A162-0185

REF DESIG	DESCRIPTION	RF PART NO.
R1	Resistor, composition, 2.2K, 1/2W 5%	R-1457
R2	Resistor, composition, 3.3K 1/2W, 10%	R-0130
S1	Switch, rotary, high voltage	S-0110
S2	Switch, toggle, DPDT modified	S-0203
A1	VSWR BRIDGE ASSEMBLY	A162-2123
A1C1/C2	Capacitor, trimmer, 0.8-4.5 pF	C-2562
A1C3/C4	Capacitor, dipped mica, 200 pF, 500 VDCW	C-0133
A1C5/C6	Capacitor, ceramic, 0.005 uF, 150 VDCW	C-0064
A1CR1/CR2	Diode, germanium, type 1N277	CR-0065
A1L1	Inductor assembly, toroid	B162-2151
A1L2/L3	Choke, RF, 1.5 MH	L-0031
A1R1/R2	Resistor, metal film, 68.1 ohms 1/2W, 1%	R-7162
	Cover	162-2166
	Coarse Tune Knob	MP-1080
	Fine Tune Knob	162-2180
	Load Knob	162-2180



NOTES:

1. UNLESS OTHERWISE INDICATED; ALL RESISTANCES ARE IN OHMS, CAPACITANCES ARE IN PICOFARADS
2. WAFER SWITCH SEGMENTS ARE PART OF [COARSE TUNE] SWITCH S1 AND ARE IN POSITION 1 AS SHOWN — THE SEGMENTS ARE VIEWED FROM KNOB END AND SECTION A IS NEAREST KNOB
3. [ ] INDICATES PANEL MARKING

Figure 5.1 – Schematic Diagram of Antenna Coupler

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