T.O. 31R2-2URC-111

TECHNICAL MANUAL

OPERATION AND MAINTENANCE INSTRUCTIONS WITH ILLUSTRATED PARTS BREAKDOWN (ORGANIZATIONAL/INTERMEDIATE)

ANTENNA COUPLER, CU-2310/URC, P/N 10094-0000

(ATOS)

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SAFETY SUMMARY

The following are general safety precautions that are not related to any specific procedures and therefore do not appear elsewhere in this publication. These are recommended precautions that personnel must understand and apply during many phases of operation and maintenance.

KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must at all times observe all safety regulations. Do not replace components with the power supply turned on. Under certain conditions, dangerous potentials may exist when the power control is in the off position, due to charges retained by capacitors. To avoid casualties, always remove power and discharge circuits to ground before touching any circuit components. Remove watches and rings before performing any maintenance procedures.

DO NOT SERVICE OR ADJUST ALONE

Under no circumstances should any person reach into or enter the enclosure for the purpose of servicing or adjusting the equipment except in the presence of someone who is capable of rendering aid.

RESUSCITATION

Personnel working with or near high voltages should be familiar with modern methods of resuscitation. Cardiopulmonary resuscitation procedures are outlined in T.O. 31-1-141-1, and annual refresher training requirements are outlined in AFOSH STD 127-50.

The following warnings appear in the text in this volume, and are repeated here for emphasis.

WARNING

Improper grounding of the 100/500 Watt Antenna Coupler equipment can cause HIGH VOLTAGE to be present on the equipment chassis. The equipment ground should be checked with VIBROGROUND and should be 10 ohms or less.

WARNING

Drilling operations create metal chips that may enter the eyes. Goggles are required.

HANDLING OF ELECTROSTATIC DISCHARGE SENSITIVE DEVICES (ESDS)

Electrostatic Discharge Sensitive Devices (ESDS) must be handled with certain precautions that must be followed to minimize the effect of static build-up. Consult T.O. 00-25-234, DOD Std-1686, and DOD HDBK 263. ESDS devices are identified in this technical order by the following symbol:

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GLOSSARY

A	Ampere(s)
A/D	Analog-to-Digital (Converter)
AFSK	Audio frequency shift keying; a baseband modulation scheme in which two audio frequencies are used to represent binary coded data; the frequency is shifted to one frequency to represent a 1 (mark) and to the other to represent a 0 (space).
AGC	Automatic gain control
ALE	Address latch enable
AM	Amplitude modulation; a modulation scheme in which the carrier is made to vary in amplitude in accordance with the modulating signal.
AME	Amplitude modulation equivalent
ANTIVOX	Prevents false VOX operation; see VOX
BFO	Beat Frequency Oscillator, used in SSB detection circuits
BIT	Built-in Test
BIU	Bus interface unit
BW	Bandwidth
CPU	Central processing unit
CREV	Converter reverse
CW	Continuous wave; a wave that does not vary in amplitude or frequency and is turned on and off to carry intelligence, e.g., Morse Code
D/A	Digital-to-Analog (Converter)
dB	Decibel(s)
dBm	Decibel(s) relative to one milliwatt
EMI	Electromagnetic interference
EPROM	Erasable programmable read-only memory
EU	Execution unit
HF	High frequency; a radio frequency band extending from about 3 MHz to 30 MHz; in this manual, HF includes 1.6 to 30 MHz.
HV	High voltage
IF	Intermediate frequency
IM	Intermodulation (distortion)
I/O	Input/Output
KREV	Keyer reverse
LCD	Liquid crystal display
LED	Light emitting diode
LPA	Linear power amplifier
LSB	Lower sideband; a modulation scheme in which the intelligence is carried on the first sideband below the carrier frequency; see SSB
MIC	Microphone
mA	Milliampere(s)
mV	Millivolt(s)
NBSV	Narrow band secure voice
PEP	Peak envelope power
PPC	Peak power control
PWB	Printed wiring board
RAM	Random access memory
rms	Root mean square
RTC	Real time clock
RX	Receive

GLOSSARY (Continued)

S TONE	Sidetone
SSB	Single sideband; a modulation scheme in which the intelligence is carried by one of the carrier sidebands, the other side band and the carrier center frequency being suppressed
TGC	Transmitter gain control
TX	Transmit
uA	Microampere(s)
uP	Microprocessor
USB	Upper sideband; a modulation scheme in which the intelligence is carried on the first sideband above the carrier frequency; see SSB
uV	Microvolt(s)
Vac	Volts, alternating current
VCO	Voltage controlled oscillator
Vdc	Volts, direct current
VOX	Voice operated transmission
VSWR	Voltage standing wave ratio; the ratio of the maximum to the minimum voltage of a standing wave on a radio frequency transmission line
W	Watt(s)

INTRODUCTION

The purpose of this on-equipment level manual is to provide all information necessary for the installation, operation and on-equipment maintenance of Coupler, Antenna, CU-2310/URC, manufactured by the RF Communications Group of Harris Corporation, Rochester, New York. The manual is divided into eight chapters. The contents of each chapter are briefly described in the following paragraphs.

Chapter 1 provides a general description and a list of capabilities and limitations of Coupler, Antenna CU-2310/URC. A list of companion equipment references are included along with the components that form the CU-2310/URC.

Chapter 2 provides the information necessary for planning and carrying out the installation of the Coupler, Antenna CU-2310/URC. A dimensional outline drawing is provided to show dimensions and other information required for proper installation.

Chapter 3 provides instructions for preparing the Coupler, Antenna, CU-2310/URC for use, including the initial application of power and checkout. Instructions for repacking the equipment for reshipment are also included in Chapter 3.

Chapter 4 provides complete operating instructions for the Coupler, Antenna, CU-2310/URC in all modes and contains a list of operating controls and indicators.

Chapter 5 provides a complete theory of operation for the Coupler, Antenna CU-2310/URC. An overall theory and detailed theory of individual functional circuits are provided.

Chapter 6 describes the on-equipment location maintenance procedures. On-equipment location maintenance is based on the use of built-in test (BIT) features of the equipment to isolate problems to the replaceable subassembly or printed wiring board (PWB) level. Depot maintenance is supplied in a separate publication, T.O. 31R2-2URC-113. The Depot Manual is based on performance testing and trouble analysis of the subassembly or PWB to locate and replace faulty parts at the lowest replaceable unit level (LRU).

Chapter 7 contains the Illustrated Parts Breakdown (IPB) information at the on-equipment level. This includes assemblies and parts that may be replaced at the on-equipment location.

Chapter 8 contains all fold-out (FO) drawings. A cross reference list is provided as well as the individual drawings referenced throughout chapters 1 to 7. The diagrams are numbered FO-1, FO-2, etc. They are printed on sheets with page-size blank aprons to permit viewing the diagram with the rest of the book closed or opened to another page.

APPLICABLE SPECIFICATIONS

The following specifications, standards, and publications were used in the preparation of this manual.

SPECIFICATION	NAME
MIL-M-38798B, para. 3.4	Combined Operation and Maintenance Instructions Manual (Equipment).
MIL-M-38807, Amend. 4	Preparation of Illustrated Parts Breakdown.
MIL-M-38790 and MIL-M-38784A	General Requirements for Preparation of Technical Manuals.

APPLICABLE STANDARDS

STANDARD	NAME
MIL-STD-12	Abbreviations for use on Drawings and in Technical Type Publications.
MIL-STD-15-1A	Graphic Symbols for Electrical Components.
MIL-STD-17-1	Mechanical Symbols.
MIL-STD-806	Graphic Symbols for Logic Diagrams.

APPLICABLE PUBLICATIONS

PUBLICATION	NAME
DOD 5200.20	Distribution Statements on Technical Documents.
USAS Y14.15-1966	Electrical and Electronic Diagrams.
USAS Y32.16-1968	Electrical and Electronic Reference Designations.
T.O. 31-1-141 (Series)	Technical Manual-Basic Electronic Technology and Testing Practices.

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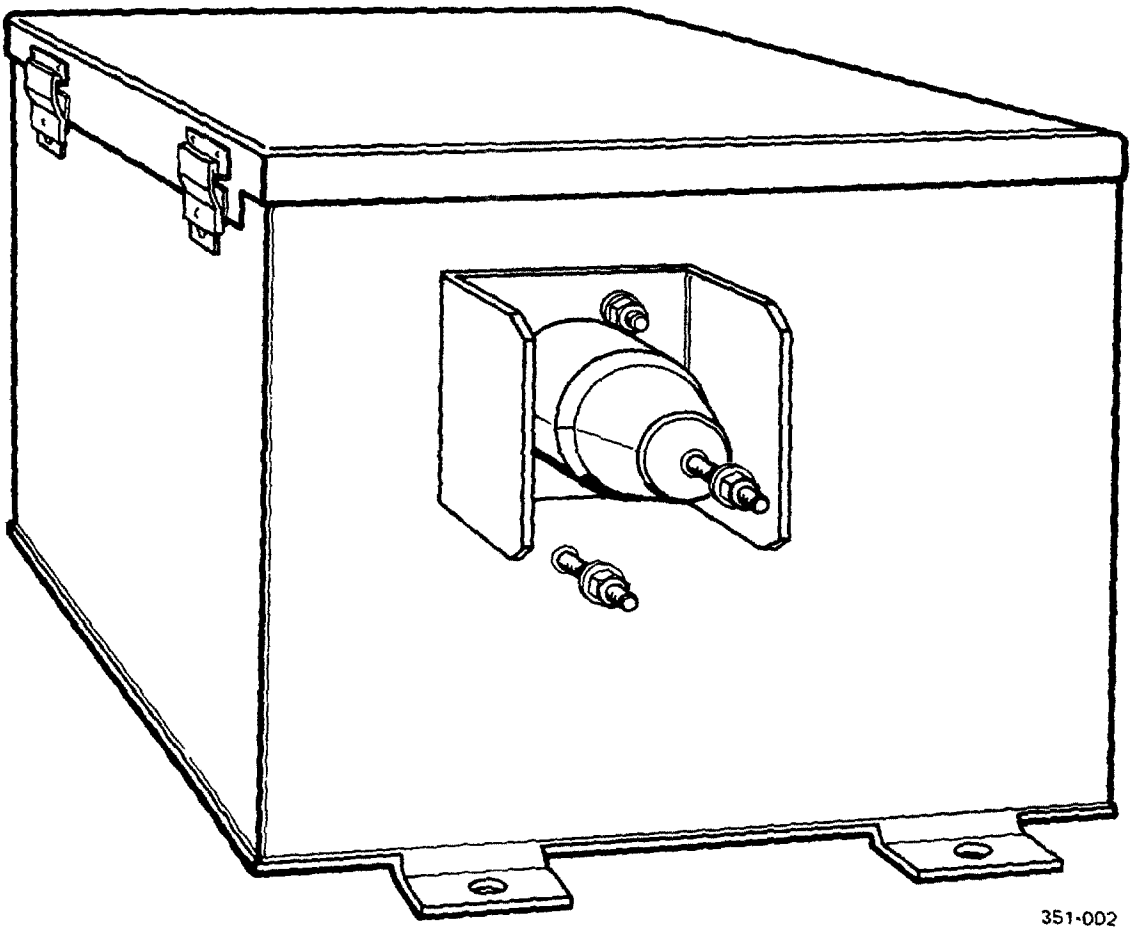


Figure 1-1. Antenna Coupler CU-2310 URC

CHAPTER 1

GENERAL INFORMATION

1-1. GENERAL DESCRIPTION AND PURPOSE. Antenna Coupler CU-2310/URC, shown in figure 1-1, and hereafter known as the 100/500 Watt Antenna Coupler, automatically matches the output impedance of the Transmitter-Receiver RT-1446/URC, (hereafter known as 100 Watt Transceiver) or Radio Frequency Amplifier AM-7223/URC, (hereafter known as 500 Watt LPA) to a whip or longwire antenna over the frequency range of 1.6 to 30 MHz. Operation, including network tuning and monitoring, is fully automatic. Tuning time is typically five to eight seconds.

a. Applications. The 100/500 Watt Antenna Coupler is used in applications where the required characteristic load impedance is other than 50 ohms. Typically, antennas do not exhibit a constant 50 ohm impedance over the 1.6 MHz to 30 MHz range. The 100/500 Watt Antenna Coupler matches the antenna to the 100 Watt Transceiver or 500 Watt LPA so that at the operating frequency a 50 ohm load is presented to the transmitter.

b. Reliability. The 100/500 Watt Antenna Coupler is designed for continuous operation under the most severe environmental conditions. Automatic sensing circuitry protects the 100/500 Watt Antenna Coupler from defective antennas or internal malfunctions.

c. Remote Operation. The 100/500 Watt Antenna Coupler permits remote location of the antenna up to 150 feet from the 100 Watt Transceiver or 250 feet from the 500 Watt LPA.

d. Test Features. The 100/500 Watt Antenna Coupler contains built-in-test (BIT) features that are used to locate malfunctions to areas of possible problems.

e. Power Requirements. Primary power at +13.6 Vdc is supplied to the 100/500 Watt Antenna Coupler from the 100 Watt Transceiver.

1-2. EQUIPMENT FUNCTIONAL DESCRIPTION.

a. Tuning. Figure 1-2 is a simplified block diagram of the 100/500 Watt Antenna Coupler. The rf signal path is shown by a heavy line. In the rf signal path are: a Discriminator Sampling Circuit, which samples voltages and current on the rf line; an Impedance Matching Transformer A1T2, which matches the coupler operating impedance of 12.5 ohms to the standard 50 ohm transmission line; Main Tuning Capacitor A2C1; Main Tuning Inductor A2L1; and Long Wire Antenna Adapter Capacitors A2A3C1, A2A3C2 and A2A3C3, which are placed in the circuit when needed to tune a long wire antenna. Relay A2K1 inserts or removes these capacitors. Relays A1A1K1 and A2K2 provide the means for bypassing the tuning elements in the rf path to provide an rf path through the 100/500 Watt Antenna Coupler when it is not tuned to a specific transmitting frequency. This allows reception to take place when the 100/500 Watt Antenna Coupler is untuned. Automatic tuning is initiated when the 100/500 Watt Antenna Coupler receives a TUNE PULSE from the 100 Watt Transceiver. The control logic circuits initiate a sequence of control signals that cause the servo system to first drive the tuning elements, A2C1 and A2L1, to their home positions without rf power applied from the 100 Watt Transceiver. Then a TUNE POWER request is sent to the 100 Watt Transceiver and A2C1 and A2L1 are tuned using a low power rf tuning signal supplied by the 100 Watt Transceiver. During tuning, the LOAD ERROR and PHASE ERROR are reduced until the voltage standing wave ratio (VSWR) on the rf line is less than 1.2:1. If this is not achieved on the first attempt, relay A2K1 energizes or deenergizes (depending on the position of the jumper on the Logic Control Board), placing the Long Wire Adapter Capacitors in the rf path or removing them, and the tuning cycle is repeated. When the VSWR is reduced below 1.2:1, the servo system is disabled and the keying circuit of the 100 Watt Transceiver is enabled so that full power transmitting can take place.

b. Monitoring. After tuning is accomplished, the discriminator continues to monitor the VSWR. If the VSWR exceeds 2:1, the logic circuits react by disabling the keying circuit, after which the tuning

cycle must be repeated. If tuning is not accomplished (VSWR < 1.2:1) within 20 seconds after the initiation of a tuning cycle, the control logic sends a TUNE TIME FAULT signal to the 100 Watt Transceiver for display. If the internal temperature of the 100/500 Watt Antenna Coupler exceeds 95°C, a THERMAL FAULT signal is sent to the 100 Watt Transceiver. Both fault signals are displayed on the 100 Watt Transceiver front panel.

1-3. MECHANICAL DESIGN. The mechanical construction of the 100/500 Watt Antenna Coupler is shown in figure 1-3. It consists of two major assemblies: Logic PWB Assembly A1 and Lower Shelf Assembly A2. Logic PWB Assembly A1, which is located in the upper portion of the Chassis Assembly, contains RF PWB Assembly A1A1. Lower Shelf Assembly A2 consists of Servo Drive Assembly A2A1, and Capacitor Assembly A2A3. The tunable components of the 100/500 Watt Antenna Coupler are located on the Lower Shelf Assembly A2 while the antenna tuning control components are located on the Logic PWB Assembly A1. An internal cooling fan operates during transmission when the 100/500 Watt Antenna Coupler is operated with a 500 Watt LPA. The top cover of the Chassis Assembly is removable so that all other assemblies are accessible for removal or maintenance. When the top cover is removed, Logic PWB Assembly A1 can be removed by unplugging four connectors. With the A1 assembly removed the Lower Shelf Assembly A2 components and subassemblies are accessible for maintenance.

1-4. LEADING PARTICULARS. The characteristics of the 100/500 Watt Antenna Coupler are summarized in table 1-1. This table includes physical data and operating/storage environment data.

1-5. CAPABILITIES AND LIMITATIONS. The capabilities and limitations of the 100/500 Watt Antenna Coupler are described in table 1-2.

1-6. EQUIPMENT AND ACCESSORIES SUPPLIED. Table 1-3 lists the supplied assemblies, components, units, cables, and accessory kits that pertain to the 100/500 Watt Antenna Coupler.

1-7. EQUIPMENT REQUIRED BUT NOT SUPPLIED. Table 1-4 lists equipment required, but not supplied, for the installation and operation of the 100/500 Watt Antenna Coupler. The 100/500 Watt Antenna Coupler is always used with an HF transmitter and/or receiver and with one of several antenna types. It requires an RF input in the HF band not exceeding 500 watts PEP and a unique set of logic control signals for its operation. It is specifically designed to interface with the equipment listed in table 1-5.

1-8. SPECIAL TOOLS AND TEST EQUIPMENT. The servicing and maintenance of the 100/500 Watt Antenna Coupler does not require any special tools, test jigs, or fixtures at the on-equipment level.

1-9. RELATED PUBLICATIONS. Table 1-6 lists the Technical Order publications related to use of the100/500 Watt Antenna Coupler.

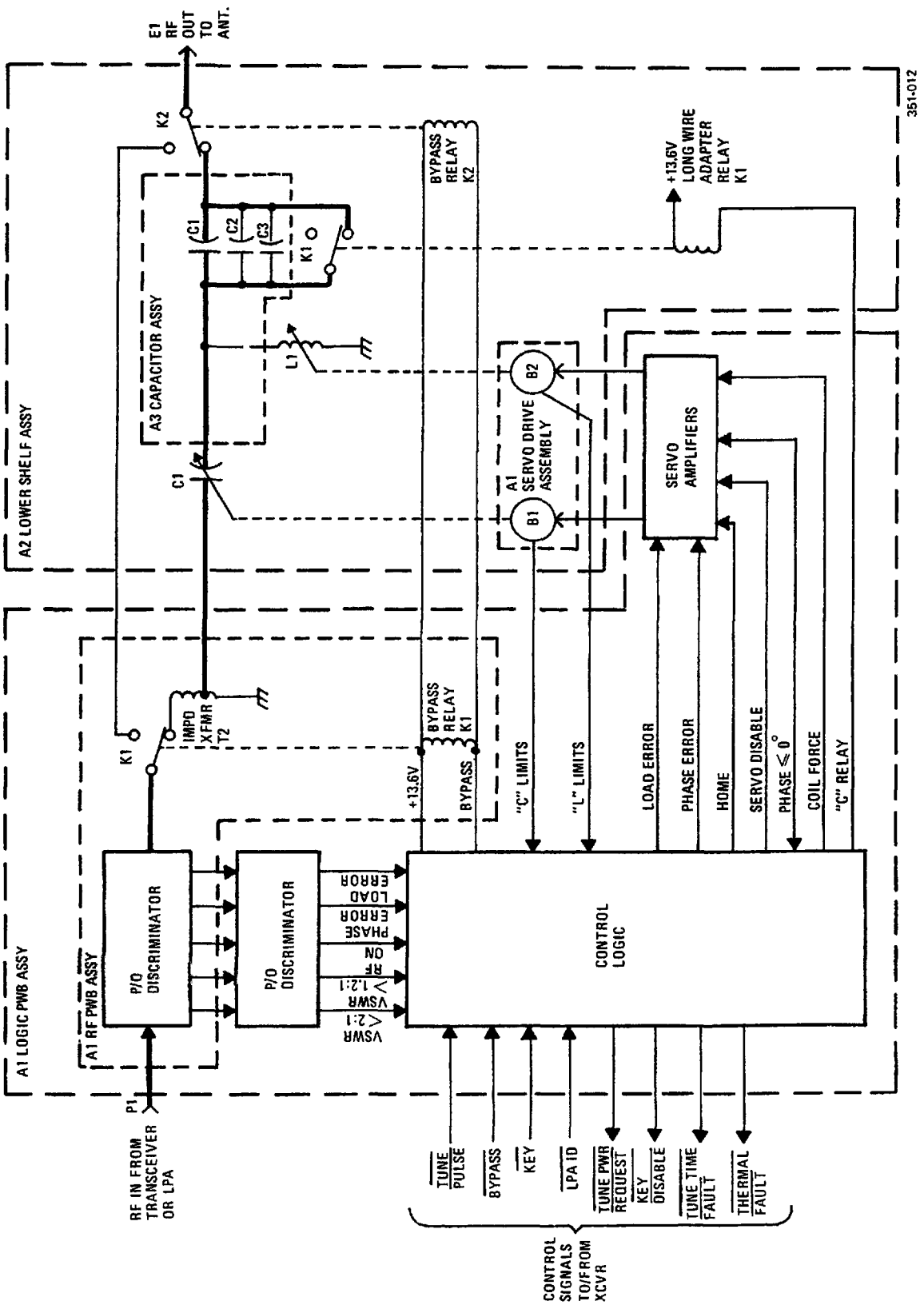


Figure 1-2. Simplified Functional Diagram

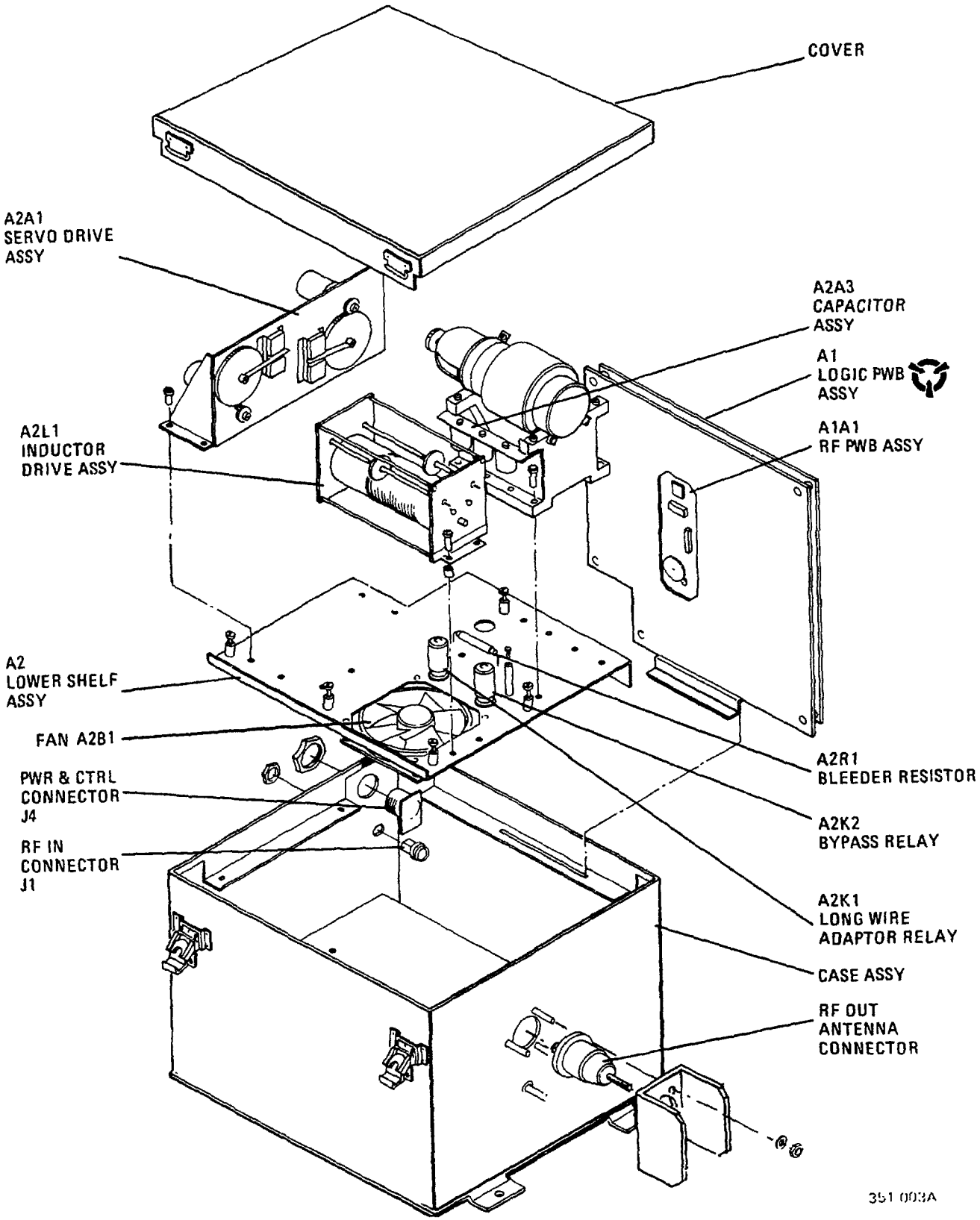


Figure 1-3. Identification of Subassemblies

Table 1-1. Leading Particulars

Item	Characteristic or Value:
Dimensions: Height: Width: Depth:	 11.0 inches (27.9 cm) 16.0 inches (40.6 cm) 18.0 inches (45.7 cm)
Weight:	25 pounds (11.3 kg)
Power Requirements:	DC power +13.6 Vdc, 5 Amps(maximum)
Operating Environment:	-30 to +65 degrees C, 95% Humidity Waterproof (sealed); designed for exposed installations
Storage Environment:	-35 to +70 degrees C, 95% Humidity
Operating Altitude:	10,000 feet
Transport Altitude:	40,000 feet
Shock/Vibration:	MIL-STD-810C
Cooling:	Convection and forced air (built-in fan)
Cabling Requirements:	Front/Rear Panel Connections W1P1 - RF Input/Output E1 - Antenna Output/Input A3P1 - Control and Power Input
Transportability:	Manual Methods Apply
Set-up Time:	Less than 1 hour

Table 1-2. Capabilities and Limitations

Description of Characteristic	
Use:	Impedance matching between an antenna and a 100 to 500 watt transmitter or a 500 watt power amplifier (e.g. Receiver-Transmitter, Radio, RT-1446/URC and Amplifier, Radio Frequency, AM-7223/URC).
Frequency Range and Tuning Capability:	1.6 to 30 MHz: Tunes to 15 to 35 ft.(4.52 to 10.67m) whip antennas. Tunes to 75 to 150 ft. (22.86 to 45.72m) long wire antennas.
Maximum Rated RF Input Power:	250 watts average, 500 watts PEP
Tuning Mode:	Fully automatic
Tuning Accuracy:	1.2:1 VSWR or less, referenced to 50 ohms
Features:	Automatic re-tune if high VSWR; automatic receive capability in untuned state; BIT (Built-in Test)
Primary Power:	13.6 Vdc±10%
Remote Capability:	Up to 150 ft. (45.7m) separation between 100 Watt Transceiver and the 100/500 Watt Antenna Coupler; up to 250 ft. (76.2m) separation between the 500 Watt LPA and the 100/500 Watt Antenna Coupler
Control Lines: NOTE: An overlined signal name indicates that the signal is active when the logic level is zero (ground)	$\overline{\text{TUNE PULSE}}$: Ground when 100 Watt Transceiver requests tuning $\overline{\text{FAULT}}$: Ground when reporting TUNE TIME faults $\overline{\text{KEY}}$: Ground when transmitter is keyed $\overline{\text{LPA ID}}$: Ground when 100/500 Watt Antenna Coupler is connected to 500W LPA $\overline{\text{KEY DISABLE}}$: Ground sent to 100 Watt Transceiver to disable the KEY signal

Table 1-2. Capabilities and Limitations (Continued)

Description of Characteristic	
	THERMAL FAULT: Ground when reporting a coupler over temperature BYPASS: Ground when 100 Watt Transceiver requests bypass of 100/500 Antenna Coupler TUNE PWR REQ: Ground when 100/500 Watt Antenna Coupler requests tuning power from the 100 Watt Transceiver
100 Watt Transceiver Interfaces:	RF coaxial line and a twelve wire power and control cable
Tune Power Requirements:	25 watts carrier

Table 1-3. Equipment and Accessories Supplied

Qty	Item	Use
1	100/500 Watt Antenna Coupler CU-2310/URC, 10094-0100	
1	Ancillary Kit, 10094-0060, consisting of the items listed below	Provides mounting hardware and interface connectors
1	Connector, 14 Pin MS3106A20-27SC	Mates with A3P1 on Rear Panel of Antenna Coupler
2	Cable Clamp M85049/1-12B	Clamps Connectors at each End of Control Cable
2	Cable Clamp 10-36233-243	Clamps Connectors at each End of Control Cable

Table 1-3. Equipment and Accessories Supplied (Continued)

Qty	Item	Use
2	Bushing MS3420-12A	Used with above listed Clamps
1	Connector MS3106A20-27P	Mates with J5 on 100 Watt Transceiver

Table 1-4. Equipment Required But Not Supplied*

Qty	Item	Use
1	Antenna (See table 1-2)	Required for reception and transmission of radio signals
1	Receiver-Transmitter, Radio RT-1446/URC NSN-5820-01-162-3402	Companion equipment used for reception and transmission of RF signals.
As required	Silicone Compound, Dow Corning No DC-5 (FSCM: 71984)	Used to seal cork gasket and insulator assembly to antenna coupler case
As required	Coaxial cable, RG-142 B/U	Used to fabricate RF cables W1 and W2

* See table 6-3 for test equipment required

Table 1-5. Optional Equipment

Qty	Item	Use
1	Remote Control Unit C-11329/URC	Companion equipment used where it is desired to operate the 100 Watt Transceiver from a remote location.
1	Amplifier, Radio Frequency AM-7223/URC	Companion equipment used for increased (500 W) RF power.
1	Transport Case CY-8361/URC	Optional case for transporting the 100/500 Watt Antenna Coupler and connecting cables.
1	Control Cable (150 ft.) 10094-4150	Connects to 100 Watt Transceiver.
3	RF Cables (50 ft.) 10094-5050	Connects to 100 Watt Transceiver or 500 Watt LPA.
2	Adapter, Female M55339/07-00029	For connecting the RF cables.

Table 1-6. Related Publications

Title	Publication No.
100/500 Watt Antenna Coupler, CU-2310/URC	
On-Equipment Manual	T.O. 31R2-2URC-111
Depot Manual	T.O. 31R2-2URC-113
Work Cards	T.O. 31R2-2URC-116WC-1
Receiver-Transmitter, Radio, RT-1446/URC	
On-Equipment Manual	T.O. 31R2-2URC-81
Depot Manual	T.O. 31R2-2URC-83
Work Cards	T.O. 31R2-2URC-86WC-1
Amplifier, Radio Frequency, AM-7223/URC	
On-Equipment Manual	T.O. 31R2-2URC-101
Depot Manual	T.O. 31R2-2URC-103
Work Cards	T.O. 31R2-2URC-106WC-1
Power Supply, PP-7913/URC	
On-Equipment Manual	T.O. 35C1-2-892-1
Depot Manual	T.O. 35C1-2-892-3
Work Cards	T.O. 35C1-2-892-6WC-1
Amplifier, Radio Frequency, AM-7224/URC	
On-Equipment Manual	T.O. 31R2-2URC-121
Depot Manual	T.O. 31R2-2URC-123
Work Cards	T.O. 35C1-2-892-6WC-1
Remote Control Unit, C-11329/URC	
On-Equipment Manual	T.O. 31R2-2URC-91
Depot Manual	T.O. 31R2-2URC-93
Work Cards	T.O. 31R2-2URC-96WC-1
Overall System	
Work Cards	T.O. 31R2-2URC-126WC-1

CHAPTER 2

INSTALLATION

WARNING

Dangerous voltages exist in this radio equipment. Before removing any covers, disconnect the primary power and the RF source.

Section I. INSTALLATION LOGISTICS

2-1. EQUIPMENT UNPACKING PROCEDURE. The 100/500 Watt Antenna Coupler is packed in a corrugated cardboard box for shipment. A two-piece foam enclosure protects the equipment from rough handling.

a. When the unit is received, carefully inspect the exterior of the box. Look for any damage, signs of rough handling or weather exposure (e.g., water damage) or signs that the box may have been tampered with. If any of these conditions are present, carefully note and report them to the proper authority (refer to T.O. 00-35D-54). An external sticker on the shipping box provides additional instructions concerning inspection of the package.

b. Refer to figure 2-1 for instructions concerning unpacking the box. Since the box consists of double-walled cardboard with reinforced strapping tape, the tool required to open the box is a sharp knife. Use the knife carefully to avoid injury when opening the box. Keep the packing box in a secure place for possible future use.

c. After removing the equipment from the box, use the packing list in the ancillary package to verify the presence of each item in the shipment. Any shortages of items should be reported to the proper authority (refer to T.O. 00-35D-54).

d. The boxed equipment weighs a total of 35 pounds (15.8 Kg). Use normal care to move the boxed equipment into the general location where it is to be installed. Once unpacked, the 100/500 Watt Antenna Coupler weighs a total of 25 pounds and may be handled by one individual.

2-2. PREPARATION FOR INSTALLATION. Site selection is the most important consideration in preparing for installation of the equipment. Details for site selection will vary depending on the use of the 100/500 Watt Antenna Coupler.

2-3. SITE CONSIDERATIONS. A number of factors should be considered, from security to operational requirements, and it is the responsibility of the user to determine which has precedence. Each of the following items should be considered in site selection:

a. Power Source. Power requirements are identified in table 1-1.

b. Loading. Depending on the installation method, be sure the selected space has adequate strength to support the weight of the equipment.

c. Accessibility. Consider the space needed for access to the equipment for servicing, operating, maintenance, etc.

d. Antenna System. Location of the 100/500 Watt Antenna Coupler should take into account the antenna cable and, if used, antenna patch panel equipment. Avoid unnecessarily long antenna cable runs. Be sure the maximum length of the 100/500 Watt Antenna Coupler control cable does not exceed 150 ft. The 100/500 Watt Antenna Coupler should not be more than 150 ft. from the 100 Watt Transceiver or 250 ft. from the 500 Watt LPA.

e. System Ground. Make sure the system is properly grounded, both for safety (e.g., lightning hazard) and for proper operation of the antenna system. Refer to T.O. 31-10-24. A good ground is 10 ohms or less.

f. Environment. The 100/500 Watt Antenna Coupler will operate normally over an ambient temperature range of -30 to + 65 degrees C.

g. Interaction. The possiblity of interaction between the 100/500 Watt Antenna Coupler and other electronic equipment in the vicinity does exist. Avoid this possibility whenever possible by installing the 100/500 Watt Antenna Coupler in a location well away from other equipment. Avoid running the coupler control cable parallel to the antenna or the ground strap.

h. Heat Dissipation. Heat dissipation is not normally a problem with the 100/500 Watt Antenna Coupler.

i. Mounting. When the site has been selected, the method of mounting the equipment should be considered. Most installations of the equipment will result in one of the mounting techniques described in the following paragraphs.

j. Installation Configuration. As shown in figure 2-2, there are two basic equipment configurations for 100/500 Watt Antenna Coupler site installation: in one configuration, the 100/500 Watt Antenna Coupler is connected directly to the 100 Watt Transceiver. In the other configuration, the 100/500 Watt Antenna Coupler is connected to a 500 Watt Linear Power Amplifier and is controlled by the 100 Watt Transceiver. Either of the two equipment configurations may be used with a whip or a long-wire antenna, depending upon the particular application of the equipment.

k. Grounding. Proper grounding of the 100 Watt Antenna Coupler is necessary to prevent degraded operation of the system. Improper grounding can cause equipment malfunctions and possible serious personnel hazards. Refer to T.O. 31-10-24. A good ground is 10 ohms or less.

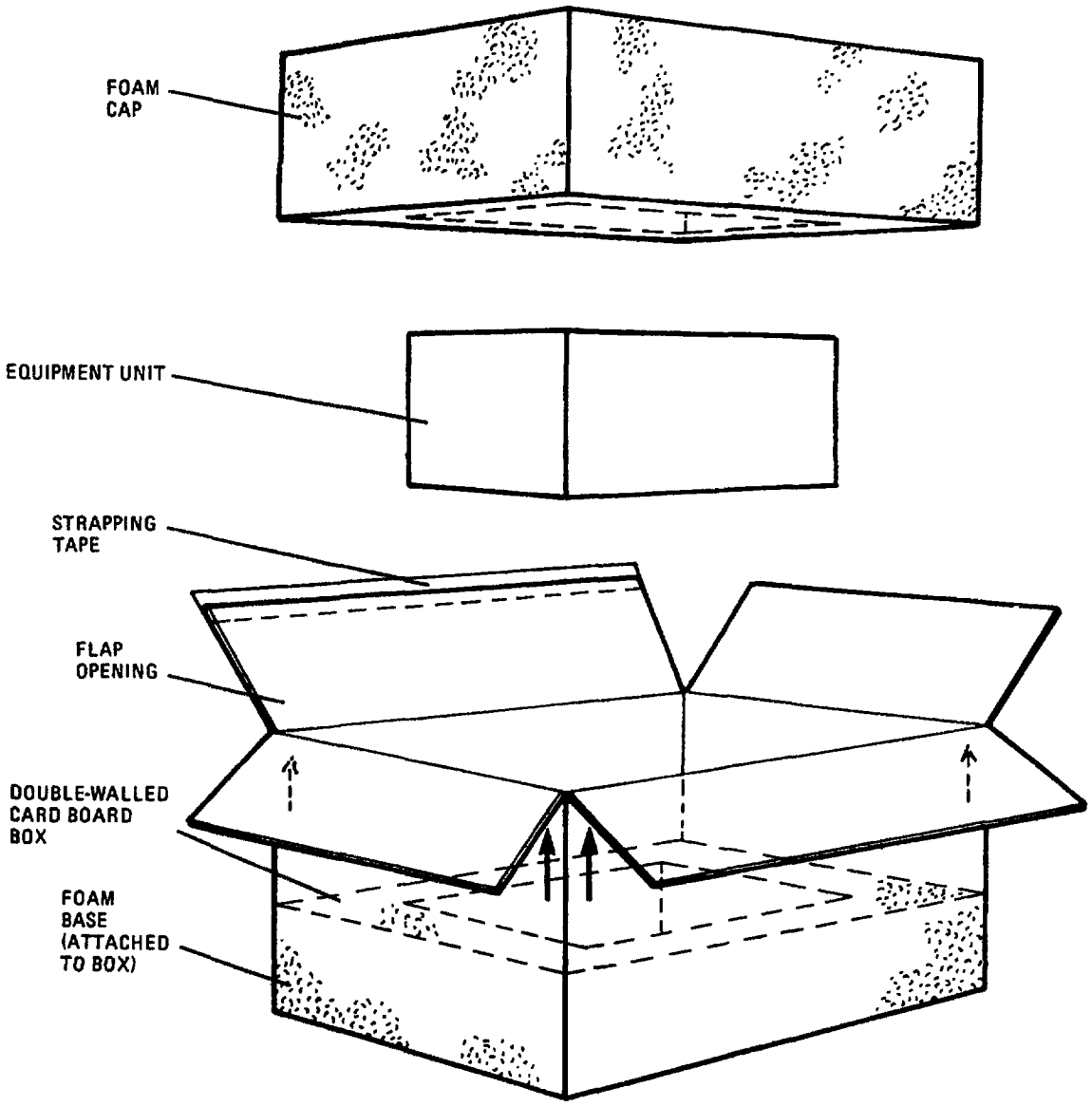
WARNING

Improper grounding of the 100/500 Watt Antenna Coupler equipment can cause HIGH VOLTAGE to be present on the equipment chassis. The equipment ground should be checked with VIBROGROUND and should be 10 ohms or less.

The ground straps should be constructed of wide copper material, and should be as short as possible. Ground straps should be clamped and bonded to at least two ground stakes or ground rods. The stakes, or rods, should be at least 6 to 8 feet (1.83 to 2.44 meters) long, and should be spaced more than one rod length apart and equally spaced about the 100/500 Watt Antenna Coupler ground terminal. Sufficient rods should be used to obtain a 10 ohms or less reading. If ground stakes or rods cannot be used (e.g., installation on a roof or inside a building), the ground connection should be made to a cold water pipe or other metal conductor that provides a good ground.

l. Typical 100/500 Watt Antenna Coupler Installation for Whip Antennas. If a whip antenna is used, connect the antenna insulator on the 100/500 Watt Antenna Coupler to the base of the whip with a heavy flexible insulated cable, such as the insulated inner conductor of a length of RG-8/U. This cable should be kept as short as possible; it should not exceed 2.5 feet (0.762m) in length. A typical fixed whip antenna installation is shown in figure 2-3.

m. Typical 100/500 Watt Antenna Coupler Installation For Long-Wire Antennas. When using 75 or 150 foot (22.86 or 45.72m) long-wire type antennas, it is advisable to mount the 100/500 Watt Antenna Coupler as close to the antenna base as possible. Cable type and installation precautions for this type of antenna installation are basically the same as for whip type antennas. A typical long-wire type antenna installation is shown in figure 2-4.



UNPACKING PROCEDURE

1. PLACE BOX ON FLOOR WITH ARROWS MARKED ON EACH SIDE POINTING UP.
2. CUT TAPE ON TOP OF BOX AND REMOVE FOAM CAP FROM BOX.
3. LIFT EQUIPMENT UNIT OUT OF BOX.
4. SAVE BOX AND FOAM CAP FOR RESHIPMENT.

350-003

Figure 2-1. Unpacking the Equipment

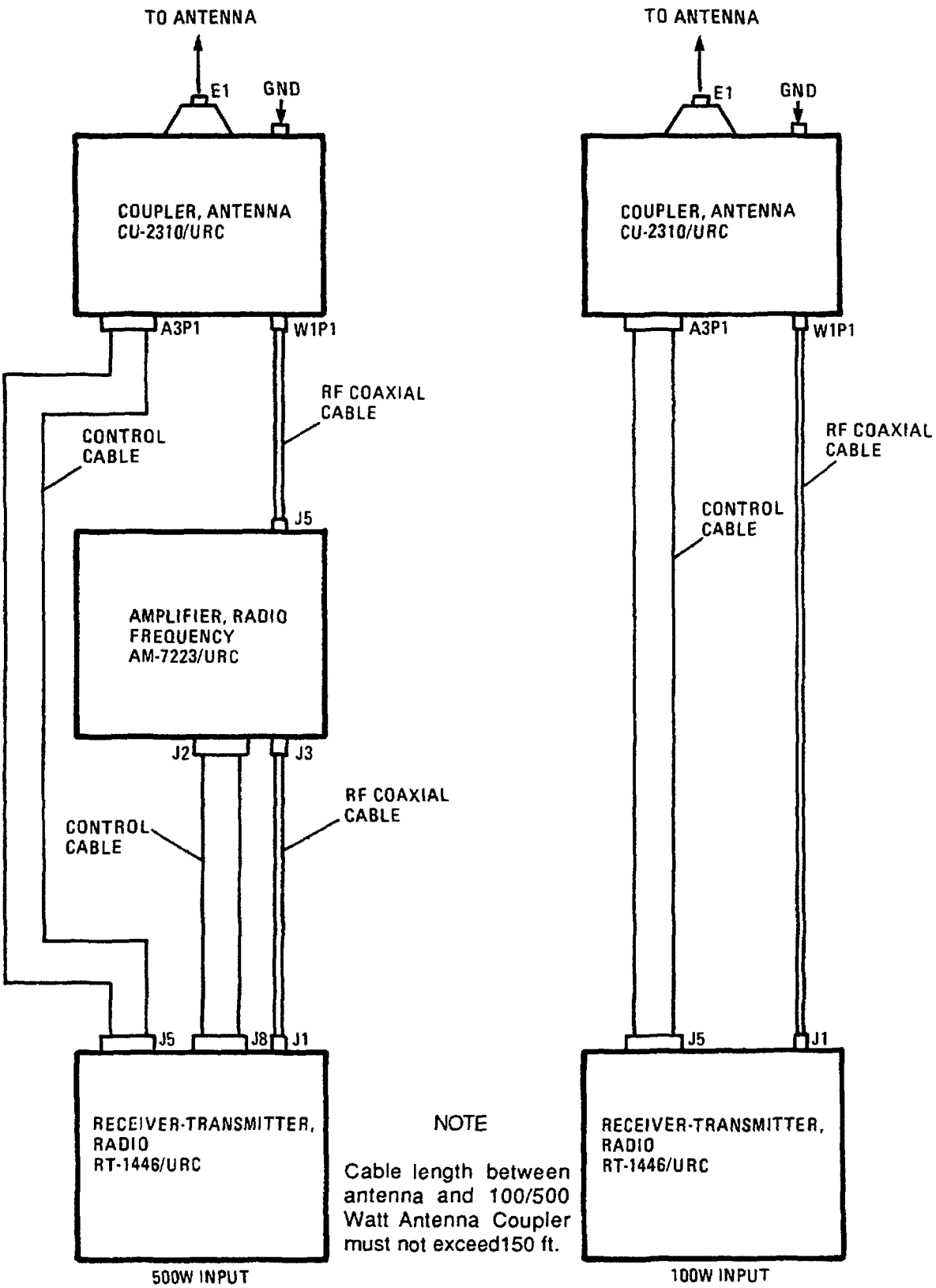


Figure 2-2. Basic 100/500 Watt Antenna Coupler Configurations 351-006

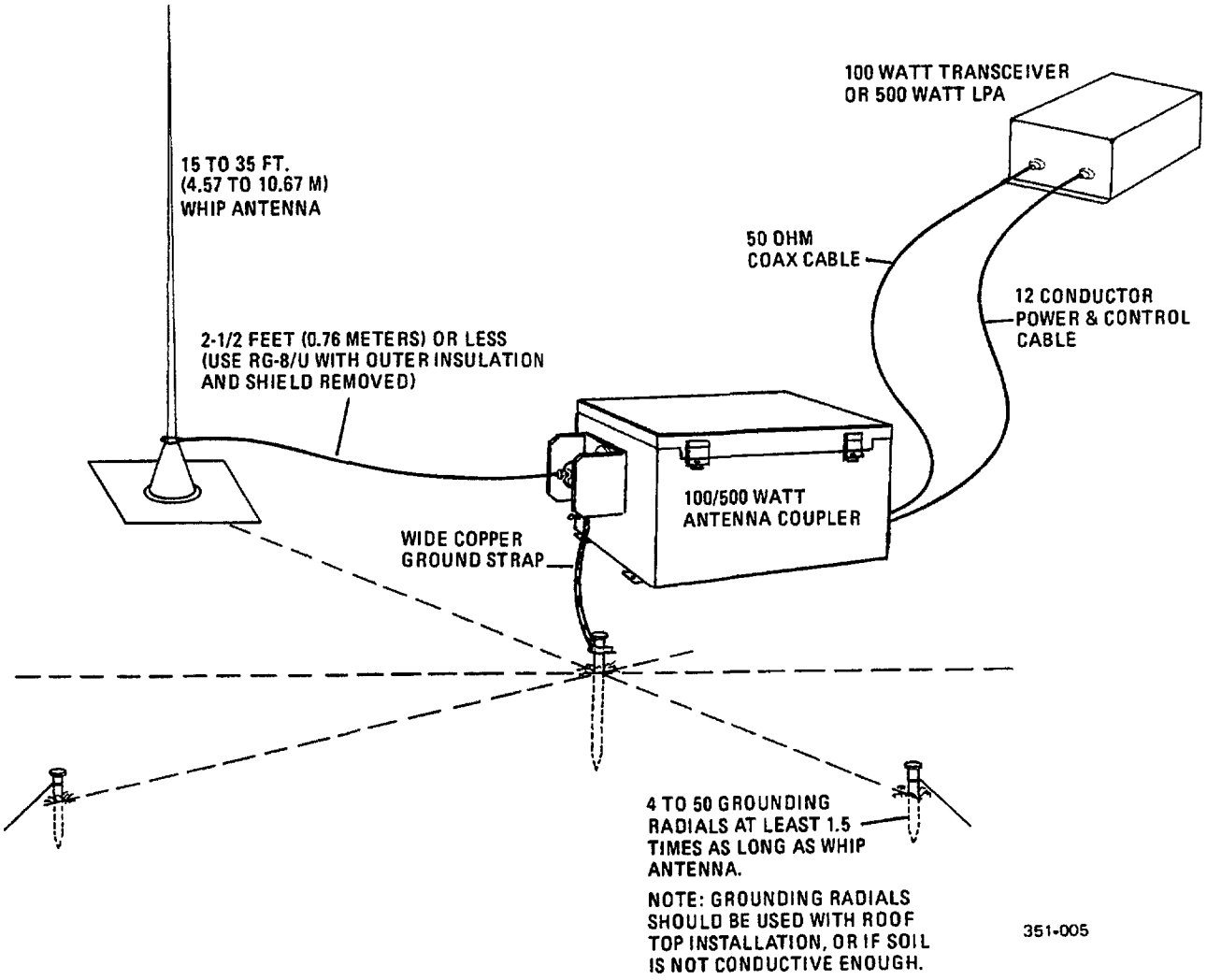


Figure 2-3. Typical 100/500 Watt Antenna Coupler Installation For Whip Antennas

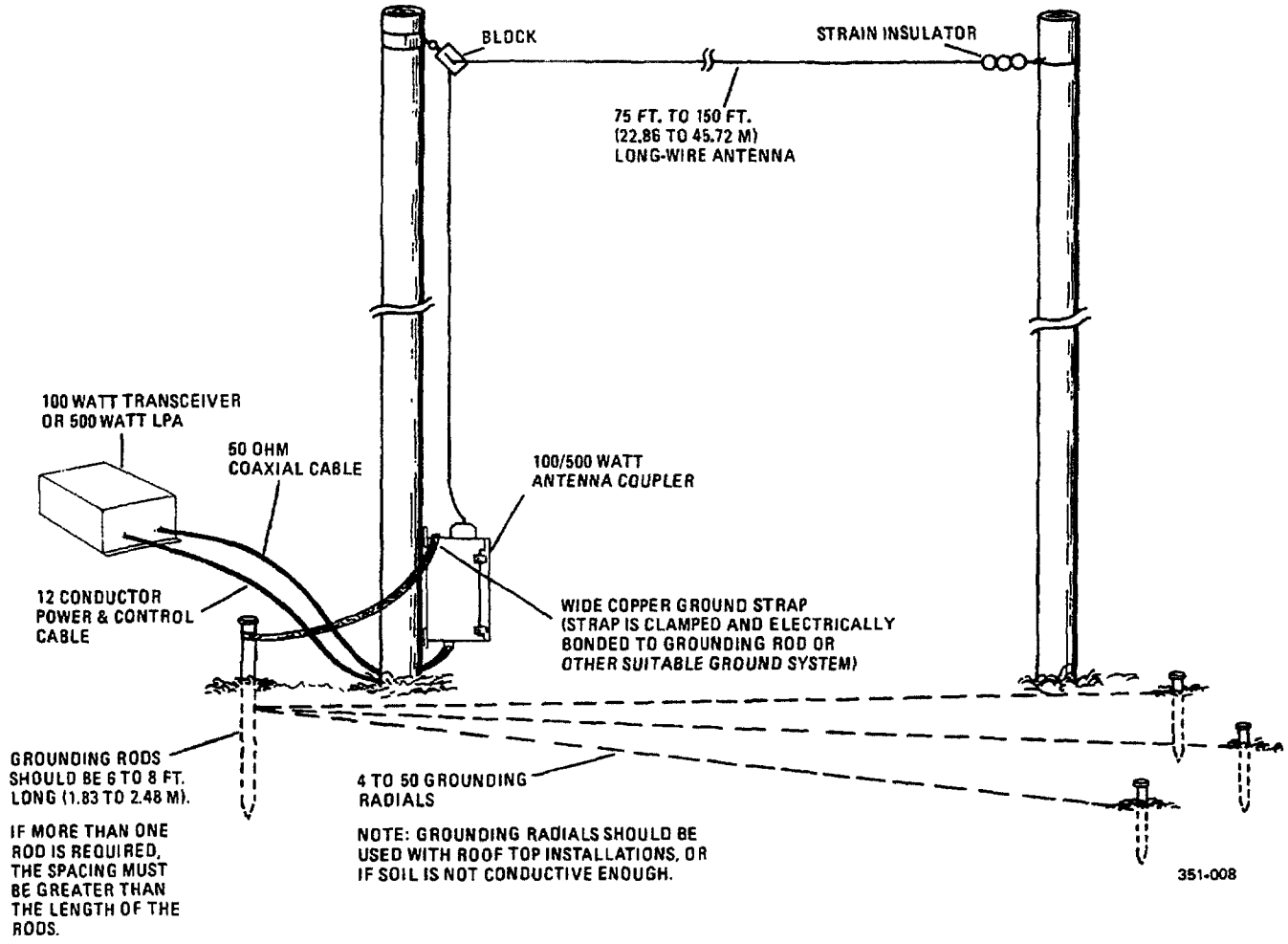


Figure 2-4. Typical 100/500 Watt Antenna Coupler Installation For Long-Wire Antennas

Section II. INSTALLATION PROCEDURE

2-4. INSTALLING THE EQUIPMENT. After unpacking the equipment and selecting the site, install the 100/500 Watt Antenna Coupler as described in the following paragraphs.

a. Time Requirement. Installation should not take more than one hour depending on the type of antenna used. This figure does not include the time necessary to install the antenna or any companion equipment, or to fabricate cables.

b. Tool Requirements. Installation is accomplished with common hand tools, e.g., socket wrenches, screwdrivers, pliers, etc.

c. Personnel Requirements. Equipment positioning requires one or two individuals to lift and place the unit in position. Once the equipment is positioned and secured, one person can complete the installation in approximately 30 minutes.

2-5. 100/500 WATT ANTENNA COUPLER MOUNTING INSTRUCTIONS.

a. The exact method of mounting the 100/500 Watt Antenna Coupler depends upon the type of installation selected. Refer to figure 2-5 for 100/500 Watt Antenna Coupler dimensions. Make sure that the mounting surface allows adequate room for 100/500 Watt Antenna Coupler and has proper clearance for cable interconnection.

WARNING

Drilling operations create metal chips that may enter the eyes. Goggles are required.

b. Refer to figures 2-3 and 2-4, depending upon the type of installation selected. Mark off the four mounting hole centers on the mounting surface. Drill four mounting holes using a standard 3/8 inch (3.375 inch or 0.95 cm) drill bit.

c. Secure 100/500 Watt Antenna Coupler to mounting surface using appropriate hardware. Hardware selected should be of the appropriate type for the 0.375 inch mounting holes. Use 5/16-18 bolts, nuts, washers, and lockwashers to secure the 100/500 Watt Antenna Coupler to the mounting surface.

2-6. CABLING CONNECTIONS. After the equipment has been positioned and secured, fabricate and connect the 100/500 Watt Antenna Coupler cables as described in the following paragraphs. Avoid running cables parallel to the antenna or the ground strap.

a. Interconnection and Interface. Variations among installations will determine the lengths of the cables connecting the 100/500 Watt Antenna

Coupler to the antenna and the 100 Watt Transceiver or the 500 Watt LPA. Connectors are supplied. The user is responsible for fabrication of the cables. Refer to figure 2-2 for the identification of cables required with a specific type of installation.

CAUTION

Care should be exercised when fabricating cables to insure proper wiring interconnection of cable connector pins. Miswiring can result in severe damage to equipment.

b. Cable Fabrication. Detailed information on cable fabrication is provided in table 2-1 and figures 2-6 and 2-7. Table 2-1 contains interconnection information. The fabrication of cable W1 is shown in figure 2-6. The fabrication of cable W2 is shown in figure 2-7. Equivalent wire gauge of 18 AWG is recommended for the power and ground conductors of W2.

2-7. WHIP/LONG WIRE JUMPER SELECTION. A jumper on the Logic Control PWB Assembly can be placed in one of two positions. This jumper selects whether the long wire adapter is inserted on the first tune sequence or on the second tune sequence.

a. If the antenna to be used is a whip or equivalent place the jumper in the WHIP (J9) position. This will cause the coupler to tune first without the long wire adapter in the circuit.

b. If the antenna to be used is a long wire or equivalent, place the jumper in the LONG WIRE (J10) position. This will cause the coupler to tune first with the long wire adapter in the circuit.

c. If there is any doubt as to where the jumper is to be placed, place the jumper in the WHIP (J9) position. In either case, the coupler will tune either type of antenna. The placement of the jumper will only reduce the coupler tune time and will not affect the coupler's ability to tune the antenna.

2-8. CHECKING THE INSTALLATION. After the 100/500 Watt Antenna Coupler has been installed and interconnection cables are connected, verify that each item in the list below has been completed before applying power:

a. All connectors are attached and tight.

b. Ground wires are connected between the 100/500 Watt Antenna Coupler and a known good ground. Examples of good grounds are a cold water pipe, a long copper stake pounded into solid earth, or a system ground bus at an existing site. A good ground must be 10 ohms or less.

c. Hardware for the equipment is securely tightened.

d. The antenna is in place, correctly connected, and protected against accidental contact.

After considering each item on the list above, the equipment may be considered ready for the application of power. Power application and initial equipment testing are discussed in chapter 3.

Table 2-1. Interconnection Cabling Information

W1P1 RF Input (Coaxial)
Mating connector:
MS3106A20-27SC
Cable type: RG-8/U or RG-213

A3P1 Control (Coupler end) Mating Connector: MS39012/01-0005		J5 Control (Transceiver end) Mating connector: MS3106A20-27P
J1-A	Ground	J5-A
J1-B	Key (OV=Keyed)	J5-B
J1-C	Fault (OV=Fault)	J5-C
J1-D	Ground	J5-D
J1-E	Tune Pulse (OV=Tune Request)	J5-E
J1-F	Tune Power Request (OV=Request)	J5-F
J1-G	Bypass (OV=Bypass)	J5-G
J1-H	+13.6 VDC	J5-H
J1-I	+13.6 VDC	J5-I
J1-J	Key Disable (OV=Disable)	J5-J
J1-K	LPA ID	J5-K
J1-L	Not Used	J5-L (+ 115V AC)
J1-M	Not Used	J5-M (+ 115V AC neutral)
J1-N	Thermal Fault (OV=Fault)	J5-N

E1 RF Output (Terminal Connection)

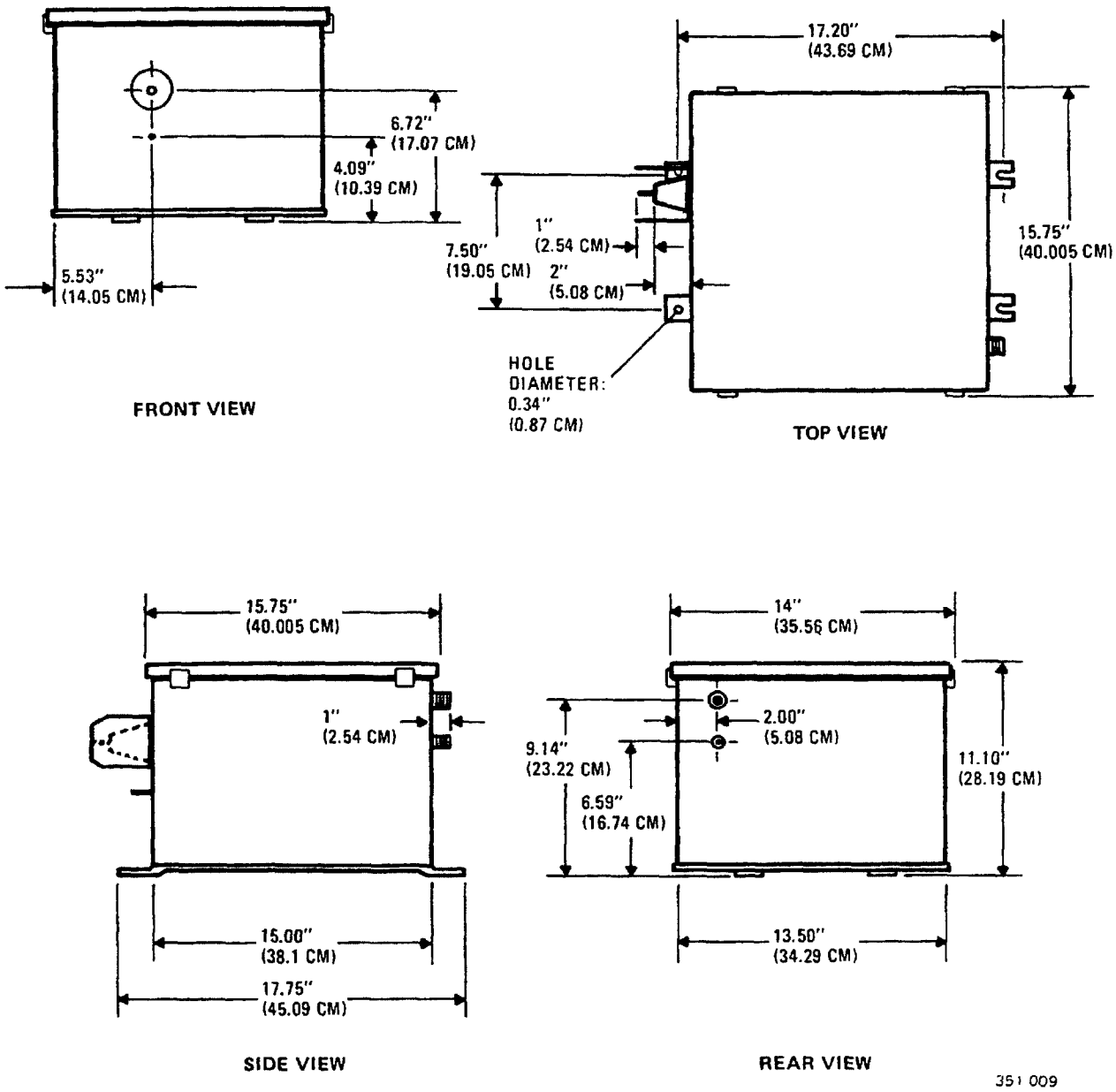
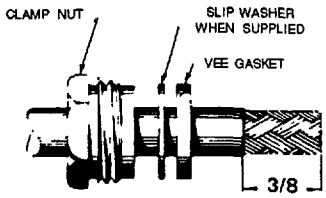
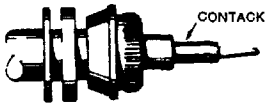
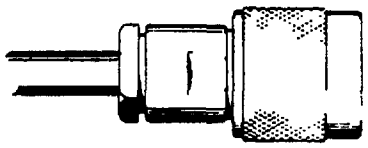


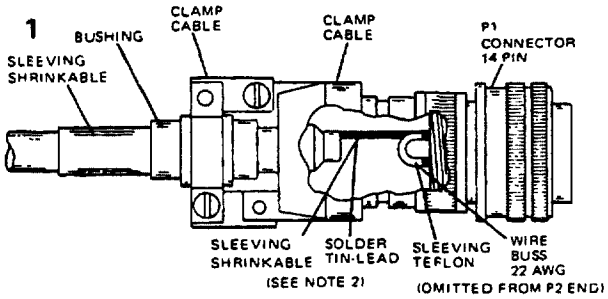
Figure 2-5. 100/500 Watt Antenna Coupler Dimensions

STEP		
1		Cut cable end square, place clamp-nut, slip washer (when supplied), and gasket over jacket. Remove 3/8" of vinyl jacket.
2		Place braid clamp over braid against jacket cut. Comb out copper braid as shown.
3		Fold braid back over braid clamp and trim as shown. Cut. off dielectric 3/16" from end. Tin center conductor.
4		Solder contact to center conductor. Avoid use of excessive heat. See that end of dielectric is clean. Contact must be flush against dielectric. Outside of contact must be free of solder.
5		Thread assembly into connector, and lock securely. Vee gasket must be split by braid clamp.

350-009

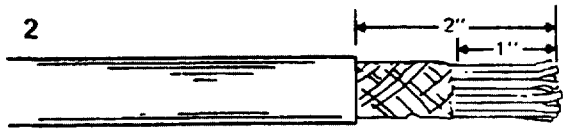
Figure 2-6. RF Input/Output Cable W1, Fabrication Detail

STEP

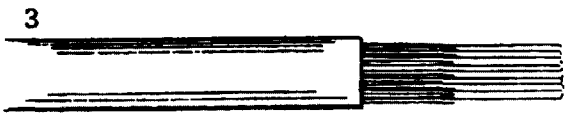


1. In Item 1, cable, clip off unused leads; yellow, violet, green, white/green, white/blue and white/yellow.

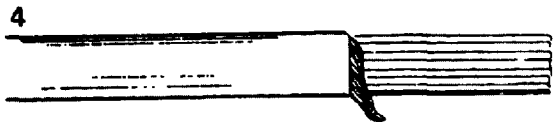
2. Twist four carriers of shield together (approximate 28 wires) and shrink Item 6 over them.



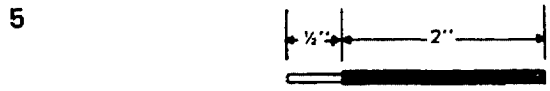
Remove 2" of vinyl jacket from cable as shown. Do not cut into shielding. Remove 1" of Shielding as shown. Take care not to damage insulation on wires in cable bundle



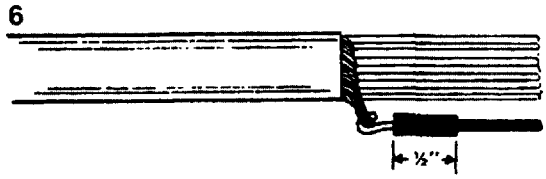
Carefully comb out shield wires as shown.



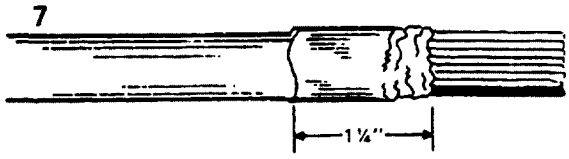
Make a part in the combed shield wires opposite the black wire in the cable. Pull the shield wires around both sides of the cable and twist together to make a pigtail as shown.



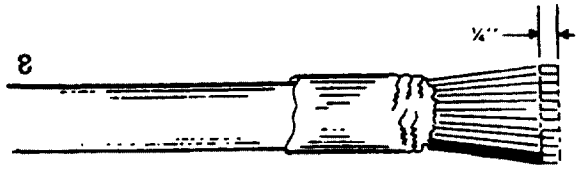
Remove 1/2" of insulation from a 2-1/2" length of No. 22 black stranded wire and tin



Twist the stripped end of black wire with the pigtail and solder. Cut 1/2" black shrink sleeving and install over soldered connection. Use a heat gun (an alternative is an open flame) to shrink sleeving exercising caution to avoid getting heat onto cable jacked.



Install shrink sleeving over cable as shown -- apply heat and "shrink" in place. Use heat gun. If no heat gun is available use open flame. Avoid getting heat on cable jacket. Rotate cable for an even shrinkage.



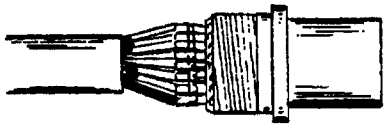
Remove ¼" insulation from wires to be used

351-007

Figure 2-7. Dc Power and Control Cable W2, Fabrication Detial

STEP

9.



Refer to Table 2-1 for interface connections, Twist and tin stripped wires together to form pairs as shown for cable lengths over 100 feet (30 meters). Twist and tin remaining stripped wires. Cut sleeving supplied in connector kits into 1/2 inch (1¼ cm) lengths and slide over each wire. Keep wires parallel as they come out of the cable bundle to the connector pins. Ensure the black wire installed in step 6 and the black wire in the cable are lined up with and soldered to pin D. Solder wires to the solder cups using Table 2-1. Slide sleeving over solder cups. Write down wire colors assigned to each pin number for reference when assembling the connector on the other end of the cable.

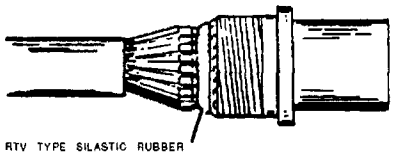
10.

Repeat assembly and soldering procedures for the other end of the cable.

11.

Check both ends of the cable for continuity, shorts between wires and shorts to the connector shell.

12.

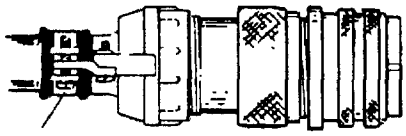


CAUTION

Care should be taken to not mix up pin J1-L with pin J1-N. which are closely adjacent to each other and can be easily misidentified.

Apply RTV type silastic rubber (supplied in RF-281 Accessory Kit) to a thickness of approximately 1/8 inch. Use small opening of nozzle to insure getting rubber between all solder cups. Use small, slender object such as a piece of wire or toothpick to insure a smooth, continuous waterseal,

13.



Assemble the plug as shown. Assemble clamp as tightly as possible onto the shell to assure a watertight connection around the cable. Repeat watersealing and assembling of connector on other end of cable. After connector has been threaded onto Antenna Coupler case connector J2, wrap both connectors with several layers of plastic electrical tape as close to the Antenna Coupler case as possible. (For protection against corrosion of mating threads in wet or humid environments.)

NOTE: To convert inches to centimeters, multiply by 2.540.

350-008

Figure 2-8. Dc Power and Control Cable W2, Fabrication Detail

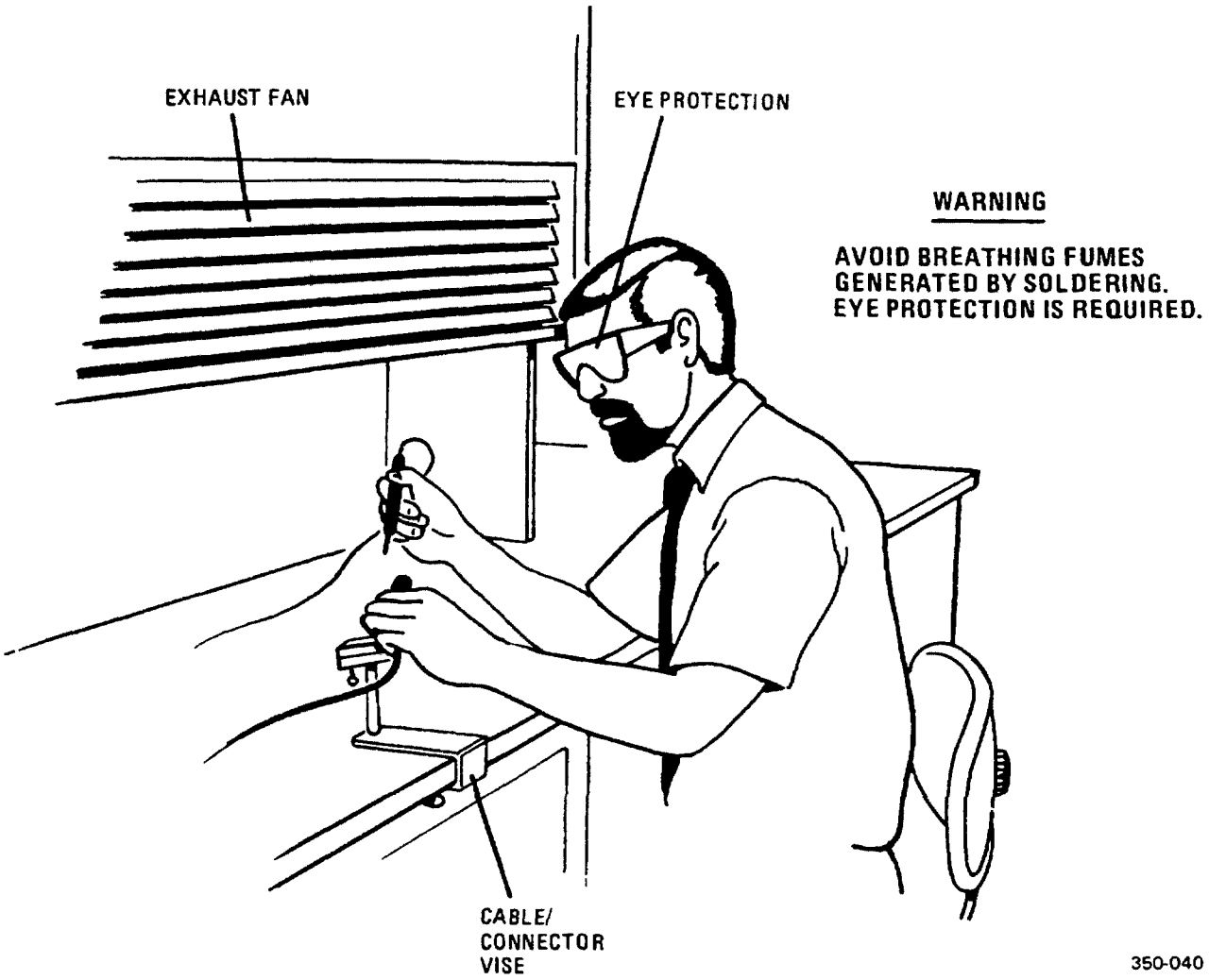


Figure 2-9. Safety Precautions for Fabrication of Cables

CHAPTER 3

PREPARATION FOR USE AND RESHIPMENT

Section I. PREPARATION FOR USE

3-1. INITIAL CONTROL SETTINGS. The 100/500 Watt Antenna Coupler does not have any external controls. All control of the 100/500 Watt Antenna Coupler is effected from the front panel of the associated 100 Watt Transceiver or from the front panel of an associated remote control unit, if used.

3-2. INITIAL POWER APPLICATION. The 100/500 Watt Antenna Coupler receives input power from the 100 Watt Transceiver. The power switch on the 100 Watt Transceiver front panel also controls power to the 100/500 Watt Antenna Coupler. Upon completion of the steps listed below, the operator will have confirmed that the 100/500 Watt Antenna Coupler is ready for the checkout test procedure given in paragraph 3-4.

3-3. STEP-BY-STEP SEQUENCE FOR INITIAL POWER APPLICATION.

a. Complete any pre-power application checks for the associated 100 Watt Transceiver as indicated in T.O. 31R2-2URC-81, chapter 3 (On-equipment manual).

b. Place 100 Watt Transceiver power switch to the POWER ON position.

c. The primary power to the 100/500 Watt Antenna Coupler is protected by current limiting and overvoltage circuits. However, if there are any abnormal indications, remove power (at the 100 Watt Transceiver) until the problem has been corrected. No BIT fault indication from the 100/500 Watt Antenna Coupler is displayed on the 100 Watt Transceiver FREQUENCY display until the after the 100/500 Watt Antenna Coupler is instructed to TUNE to a frequency.

d. Proceed to Initial Checkout procedure.

3-4. INITIAL CHECKOUT. In the initial checkout sequence, the 100/500 Watt Antenna Coupler is checked for readiness through the use of the normal front panel controls on the associated 100 Watt Transceiver. The checkout procedure provided below should be conducted after performing the initial power application procedure in paragraph 3-2.

3-5. STEP-BY-STEP SEQUENCE FOR CHECKOUT

a. Select an unmodulated carrier mode (CW or AM) at the 100 Watt Transceiver.

b. Tune the associated 100 Watt Transceiver to a specific operating frequency using instructions in the Receiver-Transmitter, Radio T.O. 31R2-2URC-81 On-equipment instruction manual.

c. Momentarily key the unit. The 100/500 Watt Antenna Coupler can be heard driving to the tuned position. If the100/500 Watt Antenna Coupler does not drive at all, a problem exists in the 100/500 Watt Antenna Coupler servo loop.

d. If the 100/500 Watt Antenna Coupler will not tune, a FAULT will be displayed on the associated 100 Watt Transceiver.

e. If no faults appear, then the 100/500 Watt Antenna Coupler can be considered operational. If fault indications occur, refer to the BIT Fault Interpretation table in chapter 6 of the technical order for the 100 Watt Transceiver.

Section II. PREPARATION FOR RESHIPMENT

3-6. PREPARATION FOR RESHIPMENT.

3-7. STEP-BY-STEP DISASSEMBLY PROCEDURE.

a. Ensure that all power sources associated with the 100/500 Watt Antenna Coupler are shut down.

b. Disconnect all interface cables and grounding straps from the 100/500 Watt Antenna Coupler.

c. Replace dust cover caps over 100/500 Watt Antenna Coupler connectors.

d. Unbolt mounting hardware and remove 100/500 Watt Antenna Coupler from its mounting. Retain mounting hardware for future installation.

3-8. STEP-BY-STEP PACKING AND CRATING PROCEDURE.

a. Refer to figure 2-1. Repackage all of the interface cables and mounting hardware associated with the 100/500 Watt Antenna Coupler in the original (or an equivalent) container.

b. Place the ancillary cables and mounting hardware into the container along with the 100/500 Watt Antenna Coupler.

c. Close and bind the container.

CHAPTER 4

OPERATION

Section I. CONTROLS AND INDICATORS

4-1. INTRODUCTION. The 100/500 Watt Antenna Coupler has no external operating controls or indicators. Its operation is automatically performed upon initiation of control signals from the associated 100 Watt Transceiver. If there is any reason to suspect a problem in the 100/500 Watt Antenna Coupler, refer to the 100 Watt Transceiver On-equipment instruction manual, T.O. 31R2-2URC-81, chapter 6, section I, and initiate the BIT test sequence.

4-2. INDICATIONS OF NORMAL OPERATION.

a. Homing. When the frequency is changed at the 100 Watt Transceiver or at the remote control unit, and the transceiver is keyed, the 100/500 Watt Antenna Coupler servos can be heard driving to the HOME positions. If the 100/500 Watt Antenna Coupler has not reached the HOME position, or does not drive at all, a problem may exist in the 100/500 Watt Antenna Coupler or in the interface between the 100 Watt Transceiver and the 100/500 Watt Antenna Coupler.

b. Bypass. When the 100/500 Watt Antenna Coupler bypass condition is initiated, the 100/500 Watt Antenna Coupler rf signal is switched from the tune path to the bypass path so that the receiver is still operational or so that transmitted signals will still reach the antenna in the event of a coupler failure.

c. Relation to 100 Watt Transceiver Operation. Refer to chapter 4, section 1 of the 100 Watt Transceiver On-equipment instruction manual, T.O. 31R2-2URC-81, for frequency and key display operation instructions that will indicate the status of the 100/500 Watt Antenna Coupler.

Section II. OPERATING INSTRUCTIONS

4-3. INTRODUCTION. Refer to chapter 4, section 2 of the 100 Watt Transceiver instruction manual, T.O. 31R2-2URC-81, for frequency change and operating instructions that will initiate automatic operation of the100/500 Watt Antenna Coupler.

CHAPTER 5

THEORY OF OPERATION

Section I. GENERAL INFORMATION

5-1. INTRODUCTION. Figure 1-2 is a simplified functional block diagram of the 100/500 Watt Antenna Coupler. For the following discussions, refer to FO-1, the detailed 100/500 Watt Antenna Coupler functional block diagram (Chapter 8 of this manual), the 100/500 Watt Antenna Coupler schematic diagram (Depot Manual), and the Logic PWB schematic diagram (Depot Manual). FO-1 includes, in simplified form, the functions of the Logic PWB Assembly A1.

5-2. FUNCTIONAL OPERATION AND SIGNAL FLOW OF RF CIRCUITS. The 100/500 Watt Antenna Coupler matches the output impedance of the 100 Watt Transceiver or the output of the 500 Watt Linear Power Amplifier to an antenna. The 100/500 Watt Antenna Coupler is fully automatic and includes all network tuning and monitoring functions. Matching between the antenna and the rf source must result in a voltage standing wave ratio of 1.2:1 or less before the 100/500 Watt Antenna Coupler allows full power transmitter keying. However, both transmission and reception can take place in an untuned condition with the tuning circuits bypassed.

a. RF Path Signal Flow. The 100 - 500 Watt rf input is routed from the RF INPUT plug P1 to the RF PWB Assembly A1A1, which incorporates two functional elements: (1) the discriminator sampling circuit and (2) the bypass relay circuit. The discriminator sampling circuit contains four voltage samplers (C1, C2, C3, and C4) and one current sampler (T1). All sampled signals are routed to the discriminator circuit on the A1 Logic PWB Assembly where they are detected to obtain control signals for the automatic tuning sequence. In bypass operation, the rf circuits may be untuned and are bypassed. The rf input is routed through normally closed contacts of bypass relays A1A1K1 and A2K2 (A2K2 is located on the Lower Shelf Assembly) to antenna terminal E1. When the 100/500 Watt Antenna Coupler is tuned, the rf signal is routed through the discriminator sampling circuit, the normally open contacts of bypass relay A1A1K1, and impedance matching transformer A1A1T2 to the main tuning elements A2C1 and A2L1 on the A2 Lower Shelf Assembly. The RF signal then passes through the normally closed contacts of relay A2K1 and the normally open contacts of relay A2K2 to the antenna output terminal E1.

b. Transformer A1A1T2. Transformer A1A1T2 matches the standard 50-ohm output impedance of the 100 Watt Transceiver or the 500 Watt LPA to the 12.5 ohm operating impedance of the 100/500 Watt Antenna Coupler system. Transformer A1A1T2 has a turns ratio of 2:1 (an impedance ratio of 4:1) and thus serves to match the optimum 12.5 ohm 100/500 Watt Antenna Coupler system impedance to the standard 50-ohm transmitter output.

c. Main Tuning Elements. Vacuum variable capacitor A2C1 and variable inductor A2L1, the main tuning elements in the rf path, are located on the Lower Shelf Assembly. They are driven by separate servo systems to automatically tune to the antenna impedance. One output of the discriminator drives the capacitor servo system and a second output drives the inductor servo system. If the jumper on the Logic PWB Assembly is in the WHIP (J9) position, long wire adapter capacitors are bypassed (shorted) through the contacts of relay A2K1 unless the 100/500 Watt Antenna Coupler fails to tune successfully on the first attempt. In such a case, relay A2K1 operates, placing the capacitors in the rf signal path, and a second attempt is made to achieve the tuned condition. If the jumper on the Logic PWB Assembly is in the LONG WIRE (J10) position, then the long wire adapter capacitors are in the rf signal path unless the coupler fails to tune successfully on the first attempt. In such a case, relay A2K1 deenergizes, bypassing the capacitors in the rf signal path. Then, a second attempt is made to achieve the tuned condition.

d. Receive RF Signal.

(1) If the 100/500W Antenna Coupler is tuned for a specific frequency, the receive rf signal is routed through the tuned path. The receive rf signal enters the 100/500 Watt Antenna Coupler through E1 and is routed through the normally open contacts of bypass relay A2K2 to either long wire adapter capacitors or to the contacts of the long wire bypass relay A2K1. The signal is then routed through the tuned circuit of A2C1 and A2L1 to the A1A1E1 connector on A1A1 RF PWB Assembly, and through impedance matching transformer A1A1T2, bypass relay A1A1K1, and the discriminator sampling circuit to connector W1P1.

(2) If the 100/500W Antenna Coupler is not tuned, a receive rf signal input from the antenna is routed through the bypass portion of A2K2, relays A2K1 and A1A1K1, and through the discriminator sampling circuit to connector W1P1.

5-3. FUNCTIONAL OPERATION OF A1 LOGIC PWB ASSEMBLY CIRCUITS. The control logic circuitry on Logic PWB Assembly A1 monitors logic control signals from the 100 Watt Transceiver and the detected VSWR, phase error and load error signals from the discriminator. The logic circuits produce an appropriate sequence of responses required to provide automatic operation. The individual functional block diagrams included in FO-1 summarize the logic elements required to generate these functions. Detailed circuit descriptions are included in section II of this chapter.

a. TUNE PULSE Signal. The sequence of events begins in the 100/500 Watt Antenna Coupler with either the initial application of power or upon receipt of a TUNE PULSE signal from the 100 Watt Transceiver. Either of these conditions generates a TUNE 1 PULSE signal, which resets all of the flip-flop latches in the 100/500 Watt Antenna Coupler control logic circuits. RF transmission is initially inhibited. The 100/500 Watt Antenna Coupler must send the 100 Watt Transceiver a TUNE PWR REQUEST signal before rf will be sent to the 100/500 Watt Antenna Coupler to allow tuning. When the TUNE PULSE is received, the 100/500 Watt Antenna Coupler starts its Homing Mode. The servo amplifiers are enabled, causing variable capacitor A2C1 and variable inductor A2L1 to drive toward the HOME positions of maximum capacitance and minimum inductance.

b. TUNE PWR REQUEST Signal. When the tuning elements reach the HOME positions, the transmitter key circuit is enabled. The RF PRESENT latch in the 100/500 Watt Antenna Coupler, the Tune 1/Tune flip-flop, and the timer fault circuit are reset. A TUNE PWR REQUEST signal is generated and sent to the100 Watt Transceiver. The 100 Watt Transceiver responds by supplying the 100/500 Watt Antenna Coupler with a low power rf signal. The servo circuits are enabled, allowing A2C1 and A2L1 to tune in accordance with LOAD and PHASE errors sensed by the discriminator. If a VSWR of less than 1.2:1 is obtained, the 100/500 Watt Antenna Coupler is fully tuned and ready for handling full rf power. If the time limit of 10 seconds is not met, or if A2L1 is driven to maximum inductance, the tuning process is interrupted, A2L1 and A2C1 are sent back to their home positions, and the tuning sequence is started over with the long wire adapter capacitor inserted in the rf path (if the jumper is in the WHIP or J9 position) or removed (if the jumper is in the LONG WIRE or J10 position).

c. TUNED Latch. When the tuned condition is achieved, the TUNED latch is set, the TUNE PWR REQUEST signal is removed, and a 100/500 Watt Antenna Coupler READY signal is generated. The timer fault circuit is disabled, the keyline (GND) is released by the keyhold circuit and the servo amplifiers are disabled. A KEY DISABLE signal is removed, allowing the 100 Watt Transceiver to transmit at full power. The 100/500 Watt Antenna Coupler is then ready to handle full power transmitting. During transmission, the 100/500 Watt Antenna Coupler will automatically correct for small changes in impedance if the VSWR becomes greater than 2:1.

5-4. FUNCTIONAL OPERATION AND SIGNAL FLOW OF LOWER SHELF ASSEMBLY A2 CIRCUITS. The rf path in Lower Shelf Assembly A2 is described in paragraph 5-3.b. Servo Driver Assembly A2A1 contains the two servo motors and limit switches that control positioning of vacuum variable capacitor A2C1 and variable inductor A2L1. Automatic braking is built into the servo system so that if the motors are not driving they are braking. This action prevents overshoot in the tuning system. All control signals to or from the servo system, the long-wire adapter relay, or the bypass relay interface directly with the Logic PWB Assembly A2A1.

Section II. 100/500 WATT ANTENNA COUPLER CIRCUIT THEORY

NOTE

The following discussion assumes that the jumper on the Logic PWB Assembly is in the WHIP (J9) position.

* Indicates that the signal is active low. On schematic diagrams, active low signals have a bar over the top.

5-5. DISCRIMINATOR CIRCUITS. Before the antenna has been tuned or matched by the reactive elements in the 100/500 Watt Antenna Coupler, the 100/500 Watt Antenna Coupler will present to the Transmitter an impedance other than 50 ohms, and the impedance will be either inductive or capacitive. The function of the discriminator is to sense the reactive component of the rf signal and to provide proportional dc outputs (PHASE ERROR and LOAD ERROR) to the servo system to drive the variable inductor and capacitor in the directions required to achieve a 50-ohm resistive load condition. In addition, the discriminator provides outputs that indicate the presence of rf (RF ON) and indicate when the VSWR is too high for transmitting (VSWR>2:1) and when the tuned condition is achieved (VSWR <1.2:1). The inputs to the discriminator circuit come from the four voltage samplers (C1, C2, C3, and C4) and one current sampler (T1) on RF PWB Assembly A1A1. The output of transformer T1 is applied to R66 and R67. A voltage drop proportional to the sampled current is developed across the two resistors. This voltage is detected by forward power detector CR42 and reflected power detector CR41.

5-6. REFLECTED POWER DETECTOR. The detected output of CR41 is added to the voltage that appears across the divider network consisting of A1A1C1, A1C29 and A1C31. The phasing of the voltage across R66 and the voltage divider capacitors A1A1C1, A1C29, and A1C30 makes the output detected by CR41 a representation of reflected power. The detected output voltage of CR41 is applied to the (+) input of operational amplifier U7-5, which is the reflected power buffer amplifier. Diode CR50 and resistor R91 are connected to U7-5 to correct for temperature variations in reflected power detector CR41. The two diodes have identical characteristics. CR50 is biased in the opposite direction from CR41 so that any variation applied to the U7-5 input by CR41 will be compensated by an opposite variation across CR50. Since CR41 is biased on by a -10 Vdc across R88 and CR50 is biased on by a +10 Vdc across R91, the voltage level at U7-5 is zero. This allows for precise detection at low signal levels. Resistors R89 and R90 provide a summing point for the voltages across the two diodes.

5-7. FORWARD POWER DETECTOR. The detected output of CR42 is added to the voltage which appears across the divider network consisting of A1A1C2 and A1C30. The phasing of the voltage across R67 and voltage divider capacitors A1A1C2 and A1C30 makes the CR42 detected output a representation of forward power. The detected output voltage of CR42 is applied to the (+) input of operational amplifier U7-3, which is the forward power buffer amplifier. Diode CR49 and resistor R82 are connected to U7-3 to correct for temperature variations in forward power detector CR42. CR49 and CR42 have identical characteristics and are oppositely biased so that any variation applied to the U7-3 input by CR42 will be subtracted by an opposite variation across CR49. Since CR42 is biased on by a -10 Vdc across R79 and CR49 is biased on by a +10 Vdc across R82, the voltage level at U7-3 is zero. This allows for precise detection at low signal levels. Resistors R80 and R81 provide a summing point for the voltages across the two diodes.

5-8. RF ON THRESHOLD DETECTOR. The U7-1 output of the forward power buffer is applied to the U10-5 input of the RF On threshold detector. The threshold is set by resistors R94 and R95 at the equivalent of an rf level of 10 watts. When the threshold is exceeded, a logic high is produced at the U10-7 output, called RF ON, which indicates there is sufficient rf to begin tuning.

5-9. 2:1 VSWR THRESHOLD DETECTOR. The output of the forward power buffer amplifier U7-1 is applied to input of the 2:1 VSWR threshold detector at U8-3. The output of reflected power buffer at U7-7 is applied to the U8-2 input of the detector.

The detector is operated at full gain and its threshold is determined by resistors R85, R86, and R87. The values of R85, R86, and R87 are chosen to set the threshold of U8 at a forward-to-reflected voltage ratio of 2:1. As long as the threshold is not exceeded (U8-2 < U8-3), a logic high is produced at U8-1, called the VSWR <2:1 signal. (The signal is used in negative logic.)

5-10. 1.2:1 VSWR THRESHOLD DETECTOR. The output of the reflected power buffer amplifier at U7-7 is applied to the input of 1.2:1 VSWR threshold detector at U8-5. The output of the forward power buffer at U7-1 is applied through the divider of R85, R86, and R87 to the U8-6 input of the detector. The detector is also operated at full gain and its threshold is also determined by resistors R85, R86, and R87. The threshold is set at a forward-to-reflected voltage ratio of 1.2:1. When the threshold is exceeded (U8-5 > U8-6), a logic high is produced at the U8-7, called the VSWR >1.2:1 signal.

5-11. PHASE ERROR DETECTOR. Diodes CR43, CR44, CR45, and CR46 detect the current transformer voltage developed across resistors R66 and R67. The detected output of these diodes is vector-summed to the voltage which appears across the divider network consisting of A1A1C3, A1R68 and A1R69. Capacitors C34 and C35 are rf coupling capacitors that allow the full voltage to be applied to the detectors. The vector sum voltage is the PHASE ERROR signal. It is tapped off the PHASE ERROR ADJUST potentiometer R71 and applied to the U6-5 input of the phase detector amplifier. The amplified PHASE ERROR signal from U6-7 is applied to the input of the servo amplifier circuit that drives tuning capacitor A2C1.

5-12. LOAD ERROR DETECTOR. Diodes CR47 and CR48 are load detectors. CR47 detects the voltage developed across R66 while CR48 detects the voltage at voltage divider A1A1C4, A1C36 and A1C37. Capacitor C36 is a variable capacitor which permits adjustment of the LOAD ERROR signal.The signal is summed by resistors R76 and R77 and applied to the U10-3 input of the load detector amplifier. The gain of amplifier U10-1/2/3 is controlled by resistors R104 and R106. The amplified LOAD ERROR signal from U10-1 is applied to the input of the servo amplifier circuit that drives tuning inductor A2L1.

5-13 CONTROL LOGIC. Refer to the Control Logic PWB schematic diagram (Depot Manual) for the following circuit descriptions.

NOTE

The logic circuits in the 100/500 Watt Antenna Coupler use negative logic (NAND and NOR gates). Some of the control signals use low logic levels for the active signal states. This is shown on the schematic diagrams by a bar drawn over the signal names and by the inverting symbol on the gate outputs. A NAND gate with low active inputs works in the same way that an OR gate would work with high active inputs. Also, a NOR gate with low active inputs works in the same way that an AND gate would work with high active inputs.

5-14. TUNING SEQUENCE CONTROL. Logic PWB Assembly A1 operates in two basic modes: Tune 1 and Tune 2. Tune 1 occurs first in the tuning sequence and is followed by Tune 2 only if correct tuning is not achieved in the Tune 1 mode. The difference between the two modes is that in the Tune 2 mode, a compensating capacitor for long wire antennas (A2A3C1) is inserted in the rf path. When the 100/500 Watt Antenna Coupler receives a TUNE PULSE signal, either from the 100 Watt Transceiver or from its own power-up TUNE PULSE generator, all of the 100/500 Watt Antenna Coupler latches (Home, Ready, RF Present, Fault, and Tune 1/Tune 2) become reset. The 100/500 Watt Antenna Coupler tuning elements then drive to the Home positions and try to tune to the antenna in the Tune 1 mode, using the PHASE ERROR and LOAD ERROR signals to control tuning. If a fault occurs during the Tune 1 mode, either a Tune Time Fault or a Max L Fault (motor driving A2L1 until it reaches the end stop), the 100/500 Watt Antenna Coupler will automatically rehome and go into the Tune 2 mode. If a fault should occur during the Tune 2 mode, the 100/500 Watt Antenna Coupler will report the fault to the 100 Watt Transceiver (TUNE TIME fault) and stop tuning. If a fault occurs, the 100/500 Watt Antenna Coupler must receive a new TUNE PULSE from the 100 Watt Transceiver before it will start tuning again. During tuning, the 100/500 Watt Antenna Coupler controls transmitter keying. Until homing occurs, transmitter keying is prevented. After the 100/500 Watt Antenna Coupler tuning elements have homed, the Transmitter is allowed to operate at partial power (approximately 40 watts). When a VSWR of less than

1.2:1 has been achieved after tuning, keying at full power can take place.

a. TUNE PULSE* Stretching. The TUNE PULSE* signal enters the 100/500 Watt Antenna Coupler on connector A1J4-1 and is applied to NAND gate A1U15, pins 12 and 9. The negative pulse on U15-12 is inverted and appears at the output of U15-11 as a positive-going pulse. The postive-going TUNE PULSE is applied to a pulse stretching network (R29, R30, C12, and CR17) and to inverter gates U16-9/10 and U16-11/12. The stretched pulse keeps the latches in the set condition long enough so that they do not interfere with each other. The output of NAND gate U15-10 is also applied to a pulse stretching network (R52, R53, C22, and CR36) and to inverter gates U16-5/4 and U16-3/2 for the same reason.

b. Power-Up Reset Pulse Generator. The input circuit of gates U15-8 and 13 includes a power-up reset pulse generator consisting of R26, R28, C14, and CR15. This circuit automatically furnishes a TUNE PULSE* when power is applied, resetting the latches (Home, Ready, RF Present, Fault, and TUNE1/TUNE 2). Then, the 100/500 Watt Antenna Coupler will be ready to initiate a tune cycle.

5-15. TUNE 1/TUNE 2 ELEMENTS. The Tune 1/Tune 2 circuit is used to control 100/500 Watt Antenna Coupler tuning in the Tune 1 mode or the Tune 2 mode. When the 100/500 Watt Antenna Coupler is initially turned on or when it receives a TUNE PULSE* from the 100 Watt Transceiver, the Tune 1/Tune 2 flip-flop is preset to the Tune 1 condition and all four latches (Home, Ready, Fault and RF Present) are reset. The positive-going output at U16-2 is applied to U19-1. This causes the output at U19-3 to go low and the output at U19-4 to go high, indicating a Tune 1 condition. With the U19-3 output low, the long wire adapter capacitor relay is deenergized.

(1) The U19-4 output is connected to the fault circuit at U19-9. As long as the signal at U19-9 is high, indicating a Tune 1 condition, no fault will be reported to the 100 Watt Transceiver. If variable inductor A2L1 reaches its MAX L limit during the Tune 1 mode, the MAX L* signal at U11-7 will go low. This will produce a high at U11-6, which is applied across diode CR34 to the reset input of Tune 1/Tune 2 flip-flop U19-6. Also connected to the U19-6 reset input, across diode CR35, is the U15-4 output of the Tune Time Fault flip-flop. Any time there is a Tune Time Fault, the U15-4 output will go high and reset the Tune 1/Tune 2 flip-flop. This causes the U19-3 output to go high and the U19-4 output to go low, indicating a Tune 2 condition.

(2) When the Tune 1/Tune 2 flip-flop changes to the Tune 2 state, the positive-going TUNE 2 PULSE at U19-3 is capacitively coupled by C23 to inverter U16-7/6, where the pulse is inverted to a negative-going pulse. The output of U16-6 is then applied to U15-13, but not to U15-8 because the negative-going pulse is blocked by diode CR15. The TUNE 2 PULSE resets only the Homing flip-flop, the Ready flip-flop, and the Fault flip-flop. The Tune 2 mode causes the 100/500 Watt Antenna Coupler tuning elements to Home again and clears any fault that has occurred. Because of the U19-8,-9,-10 NOR gate, no faults that occur during Tune 1 operation are passed on to the 100 Watt Transceiver. However, any fault that occurs in the Tune 2 mode is reported to the 100 Watt Transceiver.

(3) The RF Present flip-flop is not reset by the TUNE 2 PULSE so that the 100/500 Watt Antenna Coupler continues to try to tune without interruption during the whole Tune 1/ Tune 2 sequence.

5-16. BYPASS RELAY CONTROL. Part of U9 is used as the bypass relay latch to prevent hot switching of the two bypass relays in the 100/500 Watt Antenna Coupler. Should a bypass condition be required for any reason, a high occurs at U9-14. If rf is present, the bypass condition is inhibited and the output at U9-15 prevents the bypass relays from operating.

a. Bypass Relay CLOCK Signal. The bypass relay CLOCK signal at U9-5 clocks the BYPASS signal into the bypass relay latch. A high on the CLOCK input line causes U9 to LATCH (not allowing data at U9-14 to pass to U9-1), while a low causes U9 to UNLATCH (allowing data at U9-14 to be at U9-1). The generation of the bypass relay CLOCK signal begins at the relay control latch circuit U22. U22 is a 2-input NAND gate; pin 2 receives the KEY signal input from the 100 Watt Transceiver and pin 1 receives the RF PRESENT signal generated in the RF Threshold Detector U10. As long as both the KEY signal and the RF ON signal are high, a low latch signal is generated at pin 3 of U22, causing a high latch signal at U16-15 and the U9-5 clock input, latching U9 and preventing the Bypass Relay from changing state. If either of the two input signals should go low, the output signal at U22-3 goes high, signaling an UNLATCH condition, allowing data to be clocked through U9 and allowing the

Bypass Relay to operate if the bypass signal is present.

b. BYPASS Signal. The BYPASS signal at U9-14 is supplied either by the 100 Watt Transceiver or generated at one of several places on the A1 Logic PWB Assembly. The locally generated BYPASS signals are applied through an OR gate, consisting of diodes CR10, CR11, and CR78, to the latch input. The BYPASS signal from the 100 Watt Transceiver is applied as ground through connector J4-15 to the cathode of diode CR7. Diode CR7 is connected to a pullup circuit on the input of inverter U11-3. Because of the pullup circuit the output at U11-2 will normally be held low, a no-bypass condition. When the ground signal from the 100 Watt Transceiver is applied to the cathode of CR7, the signal input at pin 3 of U11 is also pulled low. This allows the output at pin 2 of U11 to go high, forcing a bypass condition. Only the bypass signal from the 100 Watt Transceiver is applied to pin 2 of NOR gate U18. This is done so that whenever a bypass is requested from the 100 Watt Transceiver, the servos are disabled. The other bypass signals generated on Logic Control PWB Assembly A1 are prevented from disabling the servos by steering diode CR9. The BYPASS signal across diode CR11 is generated by the RF PRESENT signal output of RF Present flip-flop U13-10. This signal is high after a TUNE PULSE* and when no rf is present. This places the antenna coupler in Bypass while the coupler is homing and before the tune cycle starts. The BYPASS signal across diode CR10 is generated at NOR gate U19-10 whenever an 100/500 Watt Antenna Coupler FAULT occurs in the the Tune 2 Mode. The BYPASS signal across diode CR78 is generated at NAND gate U20-10 whenever there is a THERMAL FAULT. Any one of these BYPASS signals will place a high logic level at the bypass relay latch input U9-14. This input, along with the low bypass relay CLOCK signal, will remove the positive voltage level at U9-15, which turns off driver transistor switch Q12 and removes the positive voltage from the base of Q13 and Q14. The ground is removed from bypass relays A1A1K1 and A2K2, deenergizing them. The ground is also removed from Q11, thus turning it on and placing a ground on the cathode of BYPASS indicator DS1. The indicator lights, signaling that the 100/500 Watt Antenna Coupler is in bypass mode.

5-17. HOMING CIRCUIT. The positive-going TUNE PULSE at U16-12 is applied to homing flip-flop U17-8, which presets the flip-flop to a low output at U17-10 and a high output at U17-11. The low level output of U17-10 is called the HOME signal and is coupled through diode CR53 to the base of the HOME SWITCH, Q41, in the servo amplifier circuit to initiate the homing mode.

a. HOMING Signal. The high output at U17-11, called the HOMING signal, is connected to NOR gate U17-6 to reset the timing fault circuit any time the 100/500 Watt Antenna Coupler starts homing. The U17-11 output is also connected across diode CR22 to the base of transistor switch Q22, to prevent transmitter keying while the 100/500 Watt Antenna Coupler is homing. The high level U17-11 output is also connected across diode CR24 to NOR gate U18-8 to reset the RF Present flip-flop and put the 100/500 Watt Antenna Coupler in bypass during homing.

b. High Level Fault Signal. When inductor A2L1 and capacitor A2C1 reach the home positions, the negative logic level signals (MIN L and MAX C) are applied, respectively, to pins 1 and 2 of NOR gate U17. When both signals are low, U17-3 goes high and is applied through diode CR20 to reset the homing flip-flop at U17-13 and stop the Homing Mode. If a high level FAULT signal from U15-4 is applied through diode CR21 to U17-13, the homing flip-flop will reset and stop the Homing Mode.

5-18. TUNE POWER REQUEST. When a TUNE PULSE* signal is initiated from the 100 Watt Transceiver or from the power-up pulse generator circuit, a positive-going TUNE PULSE signal at U16-12 is applied to Ready flip-flop U13-1, to preset the flip-flop to a low at U13-3 and a high at U13-4. The low at U13-3 is combined with the high output (meaning NO RF PRESENT) of rf present flip-flop U13-10 in NOR gate U21-8,9,10 to produce a low output at U21-10. The low U21-10 output is combined with the high homing flip-flop output U17-11 in NOR gate U17-6,5,4 to produce a low output at U17-4 that enables the the tune time fault circuit during homing.

a. TUNE PWR REQ Signal. The output of ready flip-flop U13-4 is connected to the base of transistor switch Q20 in the tune power request circuit. This output, called the READY* (NOT READY) signal, is active high, so that during homing, Q20 is biased on, applying +10 Vdc to the anode of TUNE PWR REQ indicator DS5. When DS5 lights, indicating a request for tuning power, a positive voltage is applied to the base of transistor switch Q21. Q21 is biased on, sending a ground signal to the 100 Watt Transceiver through connector J4-16, as the TUNE PWR REQ