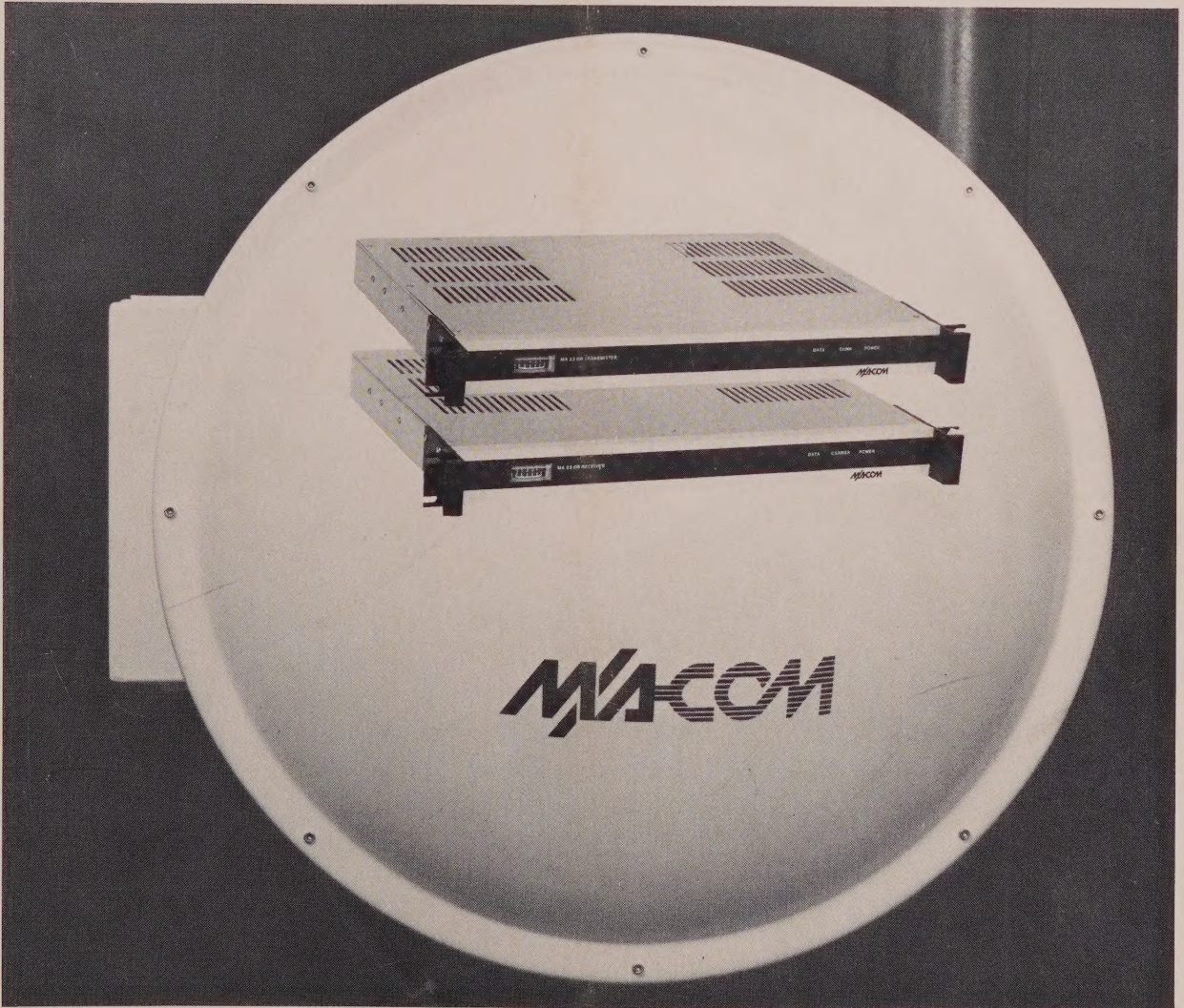


# MA-23DR

## TRANSMITTER/RECEIVER



# OPERATOR'S MANUAL





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# SECTION 1

# EQUIPMENT DESCRIPTION

## INTRODUCTION

M/A-COM's MA-23DR System (Figure 1-1) is a low cost, solid-state digital microwave system that provides reliable digital communications in the 21.2 to 23.6 GHz frequency band at ranges up to 15 miles. The MA-23DR is FCC type accepted for operation throughout the Common Carrier (Part 21) and Private Operational Fixed (Part 94) bands. This System is ideal for common carrier or private digital spurs, PBX-to-PBX links, local area network (LAN) traffic, and other telephony and data transmission services.

The MA-23DR system is based on a frequency-modulated, frequency shift keyed (FM-FSK), solid-state radio operating at 23 GHz that is capable of handling T1, T1C, T2 (T-Carrier), CEPT1 or CEPT2 (CCIR) digital data rates. A 4-T1 capacity is available when the system is equipped with an optional M12 Muldem. The MA-23DR is compatible with Bell interface standards for channel banks, multiplexers, and other digital interface equipment.

For digital data rates greater than 4-T1, M/A-COM's high capacity MA-23DR12T/20T Digital Radio Systems are available which provide data handling capacities up to 12-T1 or 20-T1 channels.

The MA-23DR FM digital radios are inherently less susceptible to noise interference than AM systems. This characteristic, coupled with MA-23DR's higher system gain translates into higher quality transmission under adverse environmental conditions, low bit error rate (BER), and superb multihop performance for extended area coverage.

Since the MA-23DR is a fully equipped digital transmission system, repeater hops do not degrade performance. Receiver matched filtering and complete bit and clock reconstruction eliminate noise at the Receiver output of each hop. Thus, each succeeding hop transmits noise-free bits.

The MA-23DR System is available with an optional Data Encryption/Decryption Unit that provides secure transmission of sensitive data. This unit is a high speed, full duplex digital data encryption/decryption device (true cypher encryption; not pseudo-random scrambling) capable of operation at data rates from 9.6 kbps to 6 Mbps. The digital baseband signal is encrypted bit-by-bit in accordance with the Data Encryption Standard (DES) algorithm endorsed by the National Bureau of Standards and specified for use by the Departments and Agencies of the U.S. Government under Federal Standard 1027. M/A-COM's Data Encryption/

Decryption Security Unit features extensive built-in diagnostics with plaintext and ciphertext loopback test capabilities. The unit can be configured as a single duplex channel, 1:1 redundant (with automatic switchover) or as two independent full duplex units per chassis. A single channel unit can be field upgraded to dual channel by simply installing additional circuit cards.

The compact, lightweight MA-23DR System is engineered to provide troublefree performance and simplicity of operation with a full range of system configuration options including multiplexing (up to four duplex systems with a single antenna using optional Stacking/Combiner Kits) or fully redundant hot standby duplex systems. The compact MA-23DR radio is optionally available with 4 foot or 6 foot parabolic antennas (2 foot dishes standard) and is readily adaptable for roof or tower mounting. Installation is simple, and typically, can be completed within one day.

Easy access is provided to all RF and electronic assemblies. Transmitter and Receiver antenna assemblies consist of weather-resistant integrated antenna /RF assemblies designed for outdoor use and rack mountable indoor Digital Interface Units containing power supply and baseband circuits. Interconnection between indoor and outdoor units is via coaxial cable and power cable. No waveguide is necessary.

The Transmitter and Receiver Digital Interface Units contain power supplies that operate from -24 volt or -48 volt dc power sources, or from 120/230 Vac line power. The power supplies can tolerate relatively wide variations and still deliver precisely regulated voltages to the system: a capability which insures component longevity, eliminates shutdown losses and prevents unnecessary maintenance costs. RF Units are powered by their respective Digital Interface Units via interconnection cables.

Field alterations of data rate are accomplished through the replacement of the baseband processing board of the Digital Interface Units at each end of the link. The only tool required is a screwdriver and there is no need to access the outdoor RF Assemblies.

## FREQUENCY USAGE INFORMATION

The MA-23DR Digital Radio System is type accepted by the FCC throughout the Common Carrier [Part 21 (21.2 to 21.8;

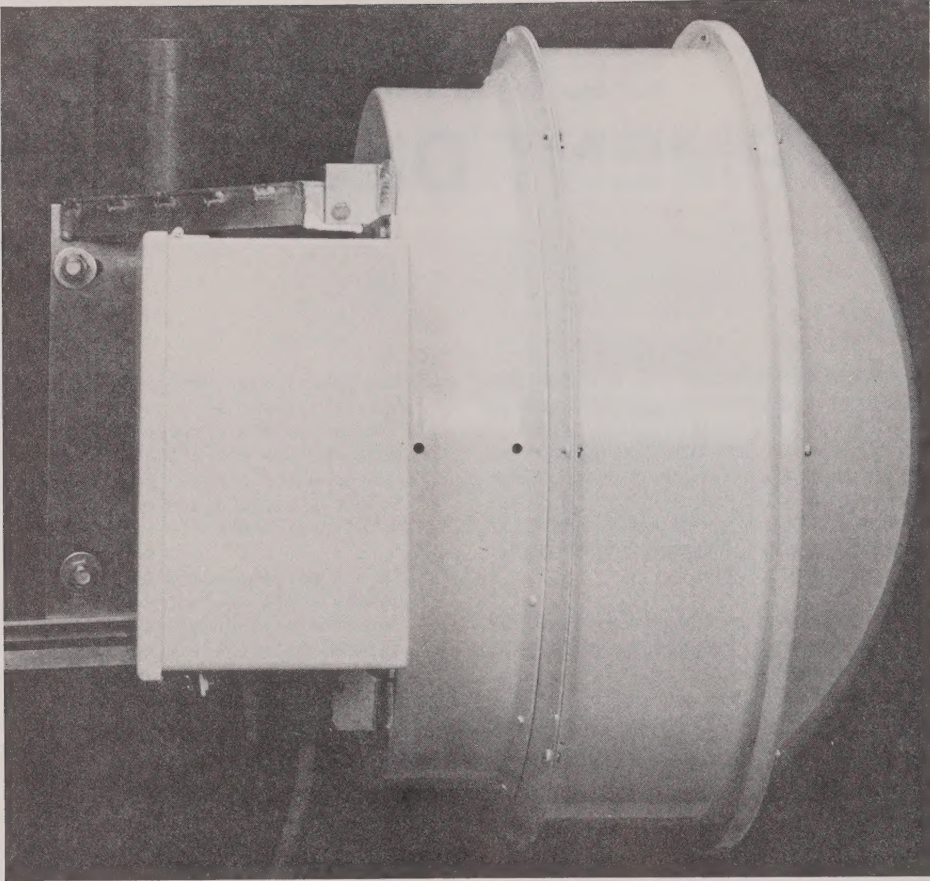


Figure 1-1. Equipment of a MA-23DR DUPLEX Link – One End of Link

22.4 to 23.0 GHz]) and the Private Operational Fixed [Part 94 (21.8 to 22.4; 23.0 to 23.6 GHz)] frequency bands. A complete list of center frequencies in all bands is given in Table 1-1).

## TYPICAL SYSTEMS CONFIGURATIONS

Typical systems configurations of the MA-23DR Digital Radio are shown in Figures 1-2 through 1-4. Only one antenna is required at each end of the link for all configurations shown.

## APPLICATION OF THE MA-23DR: T-CARRIER AND CEPT

The MA-23DR is a digital microwave radio system which permits transmission of digital T-Carrier or CCITT CEPT signals between two locations without the use of wires. The input to the Transmitter must always be one of the T-Carrier or CEPT digital baseband signals and the output of the Receiver is always in the same format as that input to the Transmitter. The digital formats mentioned above are standard North American (T-Carrier) and CCITT (CEPT) digital serial signals used to transmit multiple voice or data channels. T-Carrier is transmitted at any of the following data rates: T1 (1.544 Mbs), T1C (3.152 Mbs), T2 (6.312 Mbs). CCITT digital transmission is carried out at either CEPT1 (2.048 Mbs) or CEPT2 (8.448 Mbs) data rates. Further explanation of T-Carrier along with some of the interface equipment involved is discussed later.

Since the MA-23DR must always "see" a T-Carrier input (or CEPT input) and always produces a T-Carrier or CEPT output, interface equipment is necessary to convert analog signals to digital and vice versa when voice information is transmitted. Also, when data circuits at rates or formats other than T-Carrier or CEPT are to be transmitted, multiplex and interface card equipment is necessary at each end of the MA-23DR link.

Figures 1-6 through 1-11 show the interface equipment involved at each of the T-Carrier data rates. The equipment shown can be used to interface analog voice to T-Carrier or to convert and multiplex low speed data (56 kbs or less) into T-Carrier for MA-23DR transmission.

The interface equipment shown in the figures is easily obtained off-the-shelf from a variety of suppliers. Any such standard equipment with inputs and outputs at the Bell standards: T1 – DSX-1, T1C – DSX-1C, and T2 – DSX-2 will work with the MA-23DR. The wiring between the interface equipment and MA-23DR's is usually twisted pair, shielded or unshielded, gauge from 18 to 24.

Data rates and standards other than T1, T1C, and T2 can be interfaced to the MA-23DR by means of off-the-shelf equipment. Some channel bank manufacturers sell cards which fit into the channel bank card rack and provide, for example, RS-449 interface at any N x 64 kbs data rate (Figure 1-11).

Cards also exist for program audio channels (8 and 15 kHz) and interface as in Figure 1-11.

## WHAT IS A T-CARRIER?

A T-Carrier is an alternate mark inversion (AMI) baseband digital signal used to carry multiple voice and data channels over a single pair of wires (one pair for each direction).

The T1 Multiplexer was developed to digitally carry 24 voice channels A/D converted at 64 kbps per channel over a single pair of wires as shown in Figure 1-12. A pair of wires is used in each direction of transmission. The T1 data rate is 1.544 Mbps (million bits per second). As shown in the figure, a Channel Bank is the device which interfaces 24 voice channels to the 4-wire T1 data stream. Data at 56 kbps or less can be substituted for any or all of the 24 voice channels. The number of voice channels in the T1 data stream can be increased to 48 voice channels by using 32 kbps per channel coding, or increased to 96 voice channels by using 16 kbps adaptive differential pulse code modulation (ADPCM) coding.

T1C (3.152 Mbps data rate) consists of two T1 data streams multiplexed together. Using a standard D4 Channel Bank (Figure 1-13), up to 48 channels are A/D converted at 64 kbps per channel coding and multiplexed to the T1C data rate.

Each of the 48 channels can accommodate voice (4 kHz) or data (56 kbps or less). T1C also results from use of an M1C Multiplexer to combine two asynchronous T1's as shown in Figure 1-14.

T2 (6.312 Mbps data rate) can be formed by combining four T1 data streams through an M12 Multiplexer (or Muldem) as shown in Figure 1-15.

T2 also results from operating two D4 Channel Banks in mode 4 to directly A/D convert (at 64 kbps per channel coding) and multiplex up to 96 voice channels, each of which can carry analog voice or data at 56 kbps or less as shown in Figure 1-16.

Table 1-1. USA Center Frequencies Available

<b>COMMON CARRIER (FCC PART 21) (21.2 to 21.8 GHz)</b>	<b>INDUSTRIAL/PSIT (FCC PART 94) (21.8 to 22.4 GHz)</b>	<b>COMMON CARRIER (FCC PART 21) (22.4 to 23.0 GHz)</b>	<b>INDUSTRIAL/PSIT (FCC PART 94) (23.0 to 23.6 GHz)</b>
21.225	21.825	22.425	23.025
21.275	21.875	22.475	23.075
21.325	21.925	22.525	23.125
21.375	21.975	22.575	23.175
21.425	22.025	22.625	23.225
21.475	22.075	22.675	23.275
21.525	22.125	22.725	23.325
21.575	22.175	22.775	23.375
21.625	22.225	22.825	23.425
21.675	22.275	22.875	23.475
21.725	22.325	22.925	23.525
21.775	22.375	22.975	23.575

For other frequencies, contact the factory.

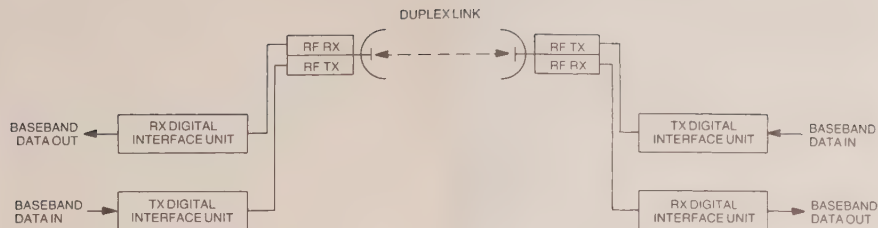


Figure 1-2. Typical MA-23DR Duplex Link Configuration

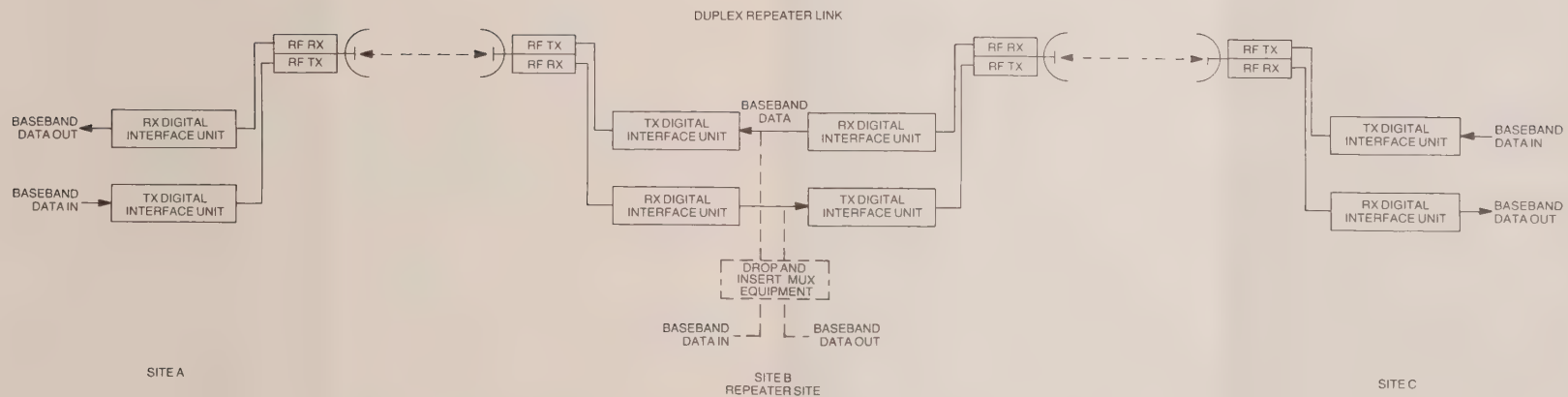


Figure 1-3. Typical MA-23DR Duplex Repeater Link Configuration



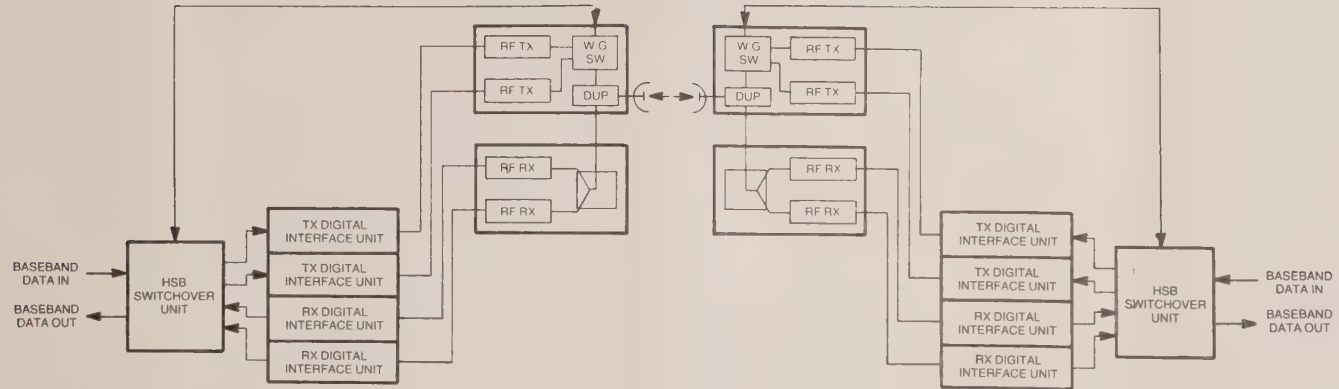


Figure 1-4. Typical MA-23DR Hot Standby (Duplex) Link Configuration



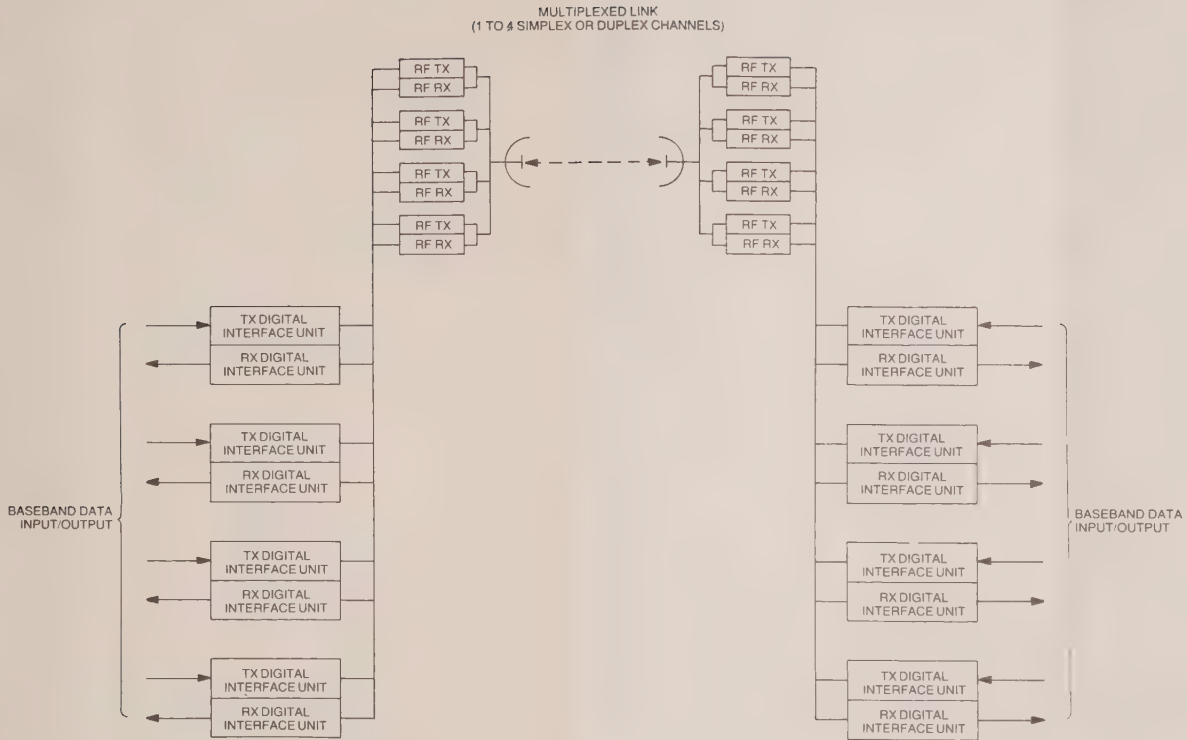


Figure 1-5. Typical MA-23DR Multiplex Link Configuration



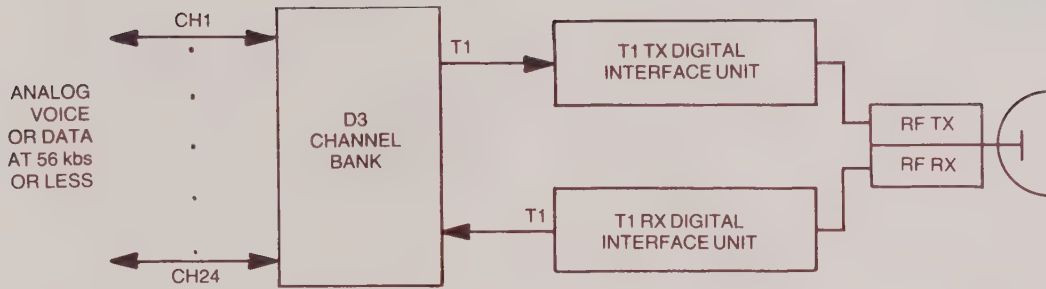


Figure 1-6. One End of a DUPLEX Link – 24 Channels of Voice and/or Data at 56 kbs or Less

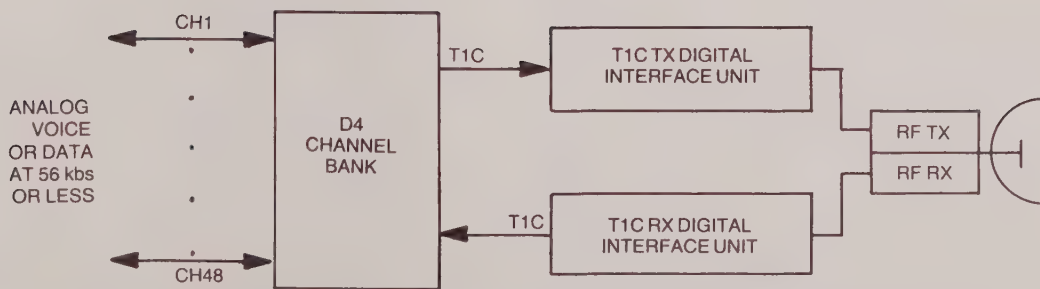


Figure 1-7. One End of a DUPLEX Link – 48 Channels of Voice and/or Data at 56 kbs or Less

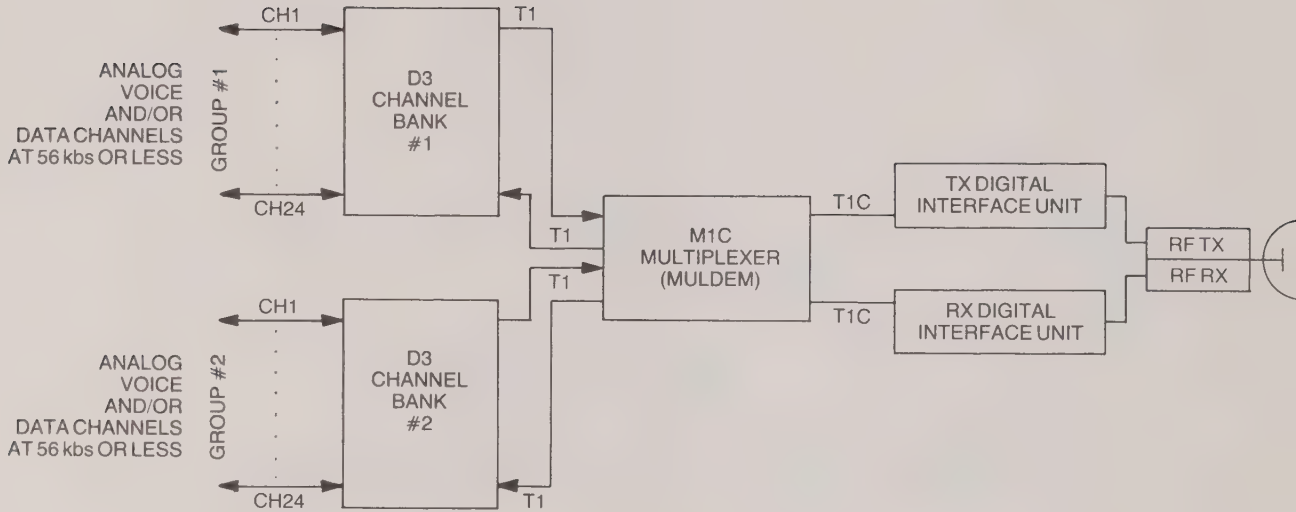


Figure 1-8. One End of a DUPLEX Link – 48 Channels of Voice and/or Data at 56 kbs or Less [2 Independent (Asynchronous) Groups of 24 Channels Each]

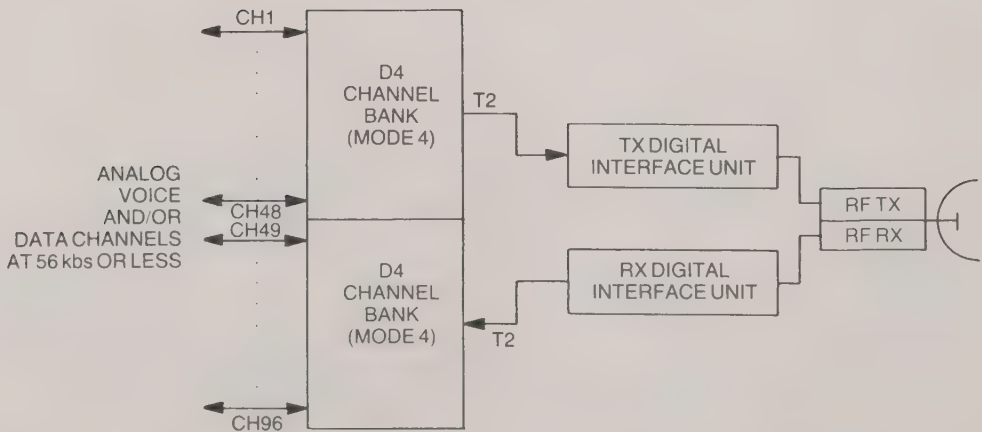


Figure 1-9. One End of a DUPLEX Link – 96 Channels of Voice and/or Data at 56 kbs or Less

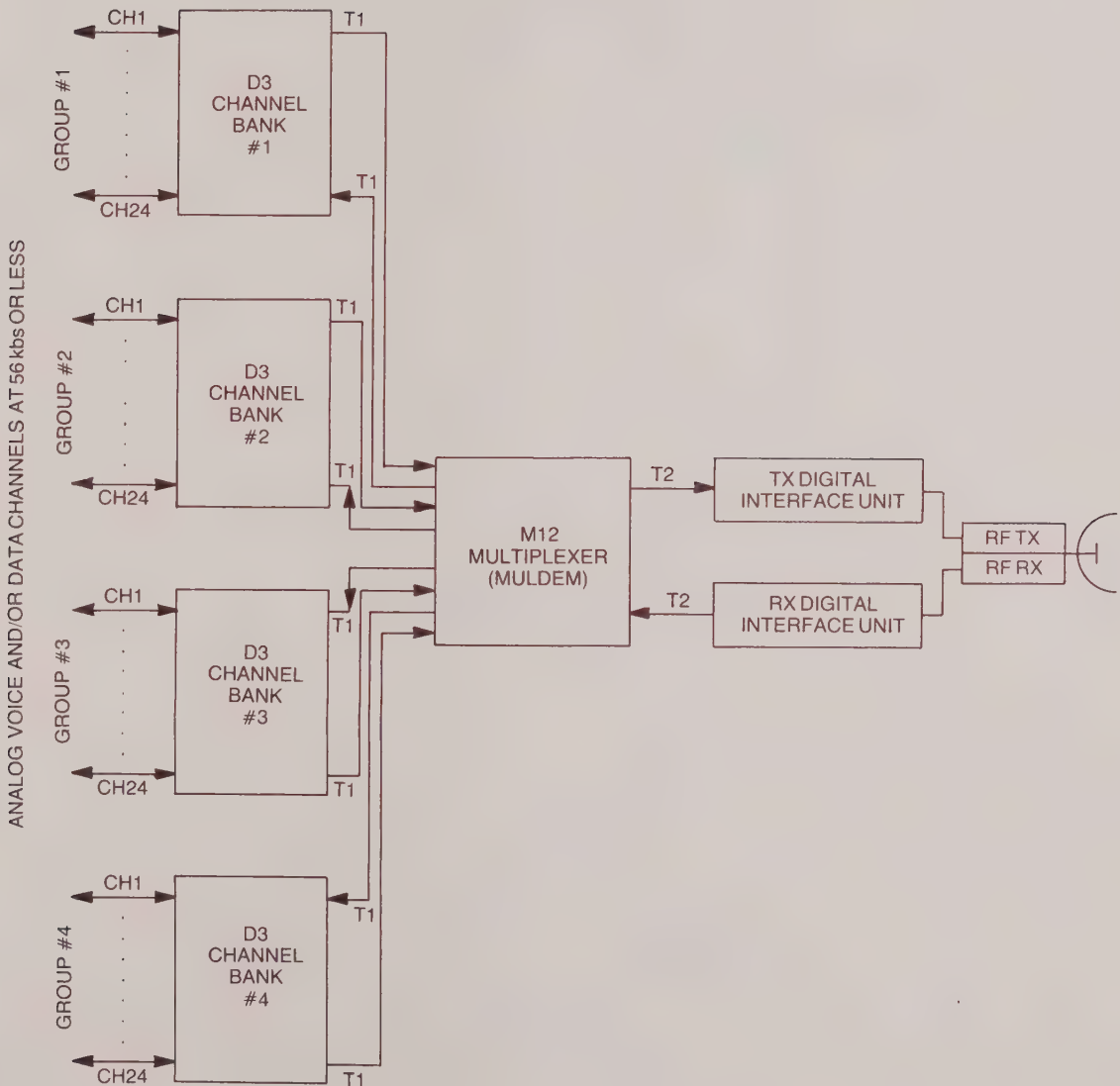


Figure 1-10. One End of a DUPLEX Link – 96 Channels of Voice and/or Data at 56 kbs or Less [4 Independent (Asynchronous) Groups of 24 Channels Each]

Equipment Description

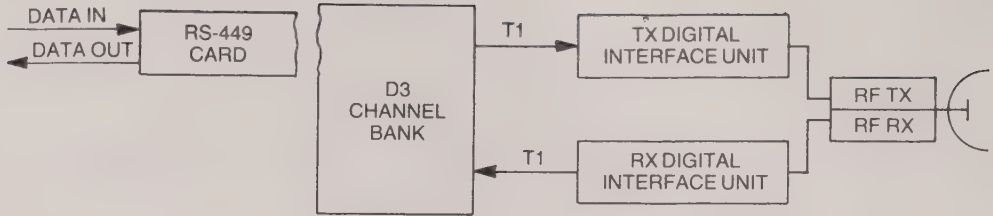


Figure 1-11. Interface of MA-23DR With Other Than T-Carrier or CEPT Data Formats

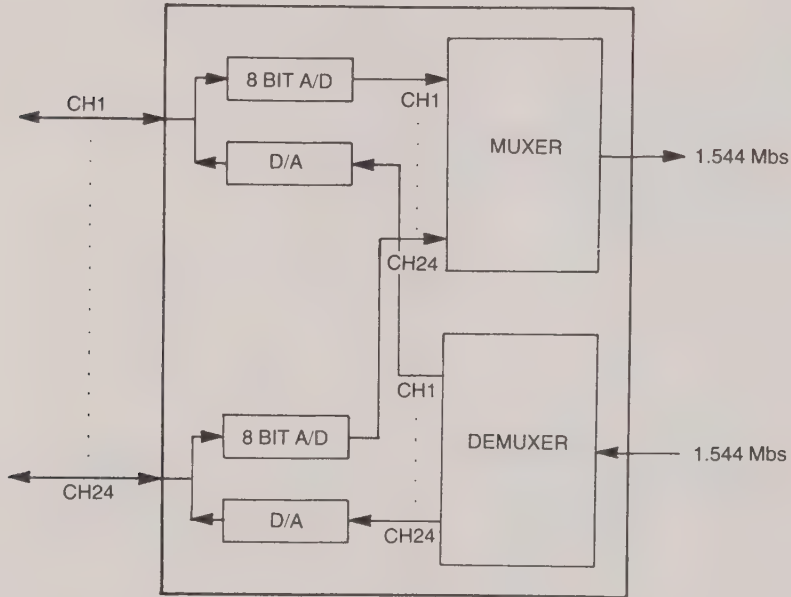


Figure 1-12. D4 Channel Bank

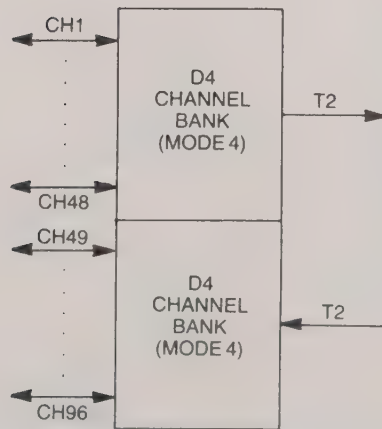


Figure 1-13. D4 Channel Bank

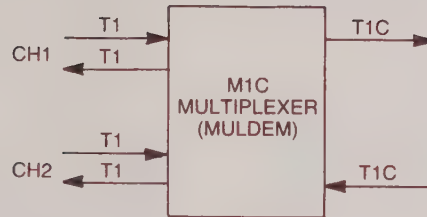


Figure 1-14. M1C Multiplexer (Muldem)

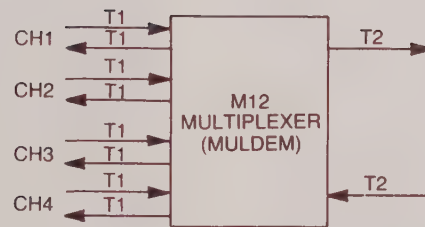


Figure 1-15. M12 Multiplexer

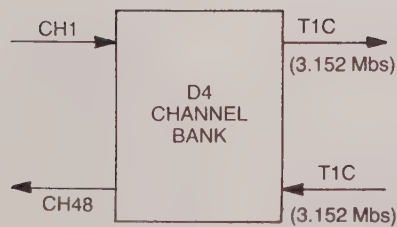


Figure 1-16. D4 Channel Bank

**GENERAL SPECIFICATIONS**

**GENERAL**

Operating Frequency Range ..... 21.2 to 23.6 GHz  
 (Entire Part 21 and 94 Bands)  
 Input/Output ..... differential twisted pair barrier strip  
 connector, or single-ended coax (75 ohm)  
 Bit Rate Stability ..... up to ±250 ppm  
 Unfaded BER ..... 10<sup>-12</sup> or better  
 Power Requirements ..... 120/230 Vac (50 to 60 Hz), 70W.  
 24 or 48 Vdc optional  
 Digital Line Interface ..... see Table below

**TRANSMITTER**

Power Output  
 Minimum ..... 50 mW (+17 dBm)  
 Typical ..... 66 mW (+18 dBm)  
 Maximum ..... 100 mW (+20 dBm)  
 Frequency Stability ..... ±0.03% (-30 to +50°C)  
 Spurious Response ..... meets FCC Part 94 and Part 21  
 requirements  
 Modulation ..... FSK

**RECEIVER**

Noise Figure ..... 12 dB  
 Threshold Sensitivity  
 10<sup>-6</sup> BER  
 T1 ..... -81 dBm  
 CEPT1 ..... -80 dBm  
 T1C ..... -78 dBm  
 T2 ..... -75 dBm  
 CEPT2 ..... -74 dBm  
 10<sup>-8</sup> BER  
 T1 ..... -78 dBm  
 CEPT1 ..... -78 dBm  
 T1C ..... -76 dBm  
 T2 ..... -73 dBm  
 CEPT2 ..... -72 dBm  
 IF ..... 140 MHz

**STATUS INDICATORS AND ALARMS**

TX Metering ..... TX Source Current  
 RX Metering ..... AGC Voltage  
 Visual Alarm TX (LED) .. TX Source Current; Data Present;  
 Prime Power  
 Visual Alarm RX (LED) ..... IF Lock; Bit Sync Lock;  
 Prime Power  
 Summed Alarm (TX and RX) ... Form C Dry Relay Contact;  
 Rear Panel  
 Test Points ..... Provided for Eye Pattern; Supply Voltages

**BRANCHING LOSSES**

	Transmit	Receive
Duplex (Unprotected)	1.3 dB	1.6 dB
Hot Standby (Protected)	2.3 dB	5 dB
Stacking/Combiner Kits (4 Channel Multiplex)	4.1 dB	3.2 dB

**ANTENNAS**

**2 Foot Model (SIMPLEX, DUPLEX, or MULTIPLEX)**  
 Size ..... 24" diameter (0.6m)  
 Type ..... FCC Category A  
 FCC Licensed Use ..... Entire Part 21 and 94 bands  
 Gain ..... 40 dBi  
 Beamwidth (3 dB) ..... 1.8°  
 Effective Radiated Power (ERP) ..... 58 dBm  
 Mount ..... 3' to 4" pole or wall  
 RF Interface ..... WR-42 choke and "O" ring  
 Weight ..... 24 lbs. (10.9 kg)  
 Windloading (w/Radome at 125 mph)  
 F<sub>S</sub> ..... 90 lbs. (40.9 kg)  
 F<sub>A</sub> ..... 110 lbs. (50.0 kg)  
 MT ..... 125 lbs. (56.8 kg)

**4 Foot Model (SIMPLEX, DUPLEX, or MULTIPLEX)**  
 Size ..... 48" diameter (1.2m)  
 Type ..... FCC Category A or B  
 FCC Licensed Use ..... Entire Part 21 and 94 bands  
 Gain ..... 46.5 dBi  
 Beamwidth (3 dB) ..... 0.8°  
 Effective Radiated Power (ERP) ..... 63 dBm  
 Mount ..... 3" to 4" pole or wall  
 RF Interface ..... WR-42 choke and "O" ring  
 Weight ..... 65 lbs. (29.5 kg)  
 Windloading (w/Radome at 125 mph)  
 F<sub>S</sub> ..... 315 lbs. (143.1 kg)  
 F<sub>A</sub> ..... 640 lbs. (290.7 kg)  
 MT ..... 815 lbs. (370.2 kg)

**6 Foot Model (SIMPLEX, DUPLEX, or MULTIPLEX)**  
 Gain ..... 49.5 dBi  
 Beamwidth (3 dB) ..... 0.6°  
 Contact factory for additional specifications.

**OPERATING ENVIRONMENT**

Temperature Range  
 RF Unit ..... -30 to +50°C  
 Digital Interface Unit ..... +10 to +40°C  
 Relative Humidity  
 RF Unit ..... up to 100%  
 Digital Interface Unit ..... up to 95%

**PHYSICAL**

Size (TX or RX)  
 RF Unit (Unprotected) ..... 6.5" (h) x 12" (d) x 9.875" (w)  
 (16.5 x 30.5 x 25.1 cm)  
 RF Unit (Protected) ..... 16.75" (h) x 5.5" (d) x 16.25" (w)  
 (42.5 x 14.0 x 41.3 cm)  
 Digital Interface Unit ..... 1.75" (h) x 13" (d) x 19" (w)  
 (4.5 x 33.0 x 48.3 cm)

**Weight**

RF Unit - Duplex ..... 9 lbs. (4.1 kg)  
 RF Unit (Protected) ..... 20 lbs. (9.1 kg)  
 TX Digital Interface Unit ..... 8.5 lbs. (3.9 kg)  
 RX Digital Interface Unit ..... 8.75 lbs. (4.0 kg)  
 Interconnection Cables ..... 50, 100, 250 foot standard kits.  
 up to 1000 feet on request.

**FCC DATA**

Type Accepted ..... Parts 21 and 94  
 FCC Identifier ..... BV88U4MA23DR  
 Emission Designator ..... 29690F9Y

All specifications are subject to change without notice.

	T1	T1C	T2	CEPT1	CEPT2
Line Rate	1.544 Mbps	3.152 Mbps	6.312 Mbps	2.048 Mbps	8.448 Mbps
Line Code*	AMI	AMI	AMI	Bipolar, HDB3	Bipolar, HDB3
I/O	100 Ohms, 6V P-P, DSX-1	100 Ohms, 6V P-P, DSX-1C	110 Ohms, 6V P-P, DSX-2	120 Ohms, 6V P-P	150 Ohms, 6V P-P

\*Transparent to zero substitution codes.

# SECTION 2

# FUNCTIONAL DESCRIPTION

## INTRODUCTION

The MA-23DR Digital Radio interfaces with U.S. and European data systems at 1.544, 3.152, 6.312, 2.048, and 8.448 Mbs. All of these interfaces employ alternate mark inversion (AMI) formats as described in CCITT G703. This baseband modulation technique is dc free and can be ac coupled, eliminating baseband wander.

At some rates, zero substitution codes are used to prevent long runs of zeros. The MA-23DR is transparent to all zero substitution codes as well as any bipolar violations that may be present in the source data. However, the MA-23DR Hot Standby System uses bipolar violations to measure bit error rate (BER).

A functional block diagram of the Transmitter is given in Figure 2-1. The signaling pulse used at the data interface is of duration  $T/2$ , where  $T$  equals the  $1/\text{bit rate}$ . This half period pulse has significant energy at frequencies beyond bit rate. To provide a better controlled RF spectrum, these  $T/2$  pulses are filtered to produce a full period square root of Nyquist signaling. Automatic threshold adjustment is provided to assure reliable pulse detection at the data interface.

The filtered pulses are applied via 75 ohm coaxial cable to a 23 GHz VCO, thus creating a frequency shift keyed radio frequency carrier. The Transmitter has a front panel meter to monitor TX source current. Indicators are provided for TX source current, data activity, and prime power. Test points are provided on the rear panel for input data, transmit filtered data, and internal supply voltages.

The Receiver (Figure 2-2) is a dual conversion type using a phase locked loop automatic frequency control (AFC) system. The received carrier is downconverted from 23 GHz to 140 MHz in the outdoor mounted RF Box.

The second conversion from 140 MHz to 40 MHz is performed within the indoor unit with AFC provided with a phase lock loop with a crystal reference. A convenient feature of AMI-FM modulation is that a carrier component can be easily attained by dividing the carrier by a modest  $N$  (in this case 4). Thus, the phase comparison actually occurs at 10 MHz. Demodulation is achieved with a time delay discriminator. This type of discriminator is simple, reliable, and does not require tuning.

The demodulated data is processed by a square root of Nyquist filter and synchronously clocked. The data is then

applied to a line driver to produce the appropriate output format. Carrier recovery and bit timing loops are monitored and an alarm provided. The Receiver has a front panel meter to monitor received carrier signal level. Indicators are provided for carrier recovery, data activity, and primary power. Test points are provided on the rear panel for recovered clock, eye pattern, and internal supply voltages.

## DUPLEX SYSTEM (UNPROTECTED)

Each terminal of the basic MA-23DR Digital Radio Duplex System is comprised of a 2-foot high performance parabolic antenna, a Duplex RF Assembly, a Transmitter Digital Interface Unit, and a Receiver Digital Interface Unit. A simplified block diagram of the system is given in Figure 2-3.

## HOT STANDBY DUPLEX SYSTEM

Each terminal of the MA-23DR Automatic Hot Standby Digital Radio System is comprised of a high performance parabolic antenna, a Hot Standby Duplex RF Assembly with mounting hardware, two Transmitter Digital Interface Units, two Receiver Digital Interface Units, an Automatic Hot Standby Switchover Unit and interconnect cabling. A simplified block diagram of the system is given in Figure 2-4.

The Automatic Hot Standby Switchover Unit employs solid state logic circuits with sensing and alarms to provide uninterrupted transmission of data when operating in the automatic switching mode. The Unit allows manual override of the switching logic circuits to force the selected Transmitter or Receiver on-line. A loopback feature is incorporated for troubleshooting purposes. The loopback mode can be locally or remotely enabled. Remote loopback enabling is accomplished by supplying a contact closure to the remote loopback connector on the rear panel. The operator may override a remote loopback command to resume normal operation.

In the automatic switching mode, fault alarms from the Transmitter and Receiver Digital Interface Units initiate logic circuit action to place the standby units on-line. Priority circuits ensure that TX1 and RX1 are on-line if no faults are present. When a Transmitter fault occurs, an alarm is received from the corresponding Digital Interface Unit and a control signal is sent to the switching circuits of the Hot Standby

## Functional Description

Transmitter RF Unit to terminate the RF signal of the faulted Transmitter and route the signal of the standby unit to the antenna. Transmitter switching time is typically less than 400 ms. The procedure is similar on the receive side except that switching action takes place in the baseband switch of the Automatic Hot Standby Switchover Unit. Receiver switching time is typically less than 400 ms.

The Automatic Hot Standby Switchover Unit contains redundant power supplies that operate from  $-24$  or  $-48$  Vdc power sources, or from 115/230 Vac line power, which must be specified. This unit powers the Switchover logic and switching circuits as well as the Hot Standby Transmitter RF switching circuits.

When equipped with optional BER cards, the unit provides external alarms if the bit error rate exceeds permissible limits.

The MA-23DR Hot Standby Duplex RF Assembly consists of two weather-resistant RF Units designed for pole or tower mounting: a Hot Standby Transmitter RF Unit and a Hot Standby Receiver RF Unit. These units contain redundant Transmitter and Receiver RF chains, respectively, utilizing the proven RF components of basic MA-23DR Systems.

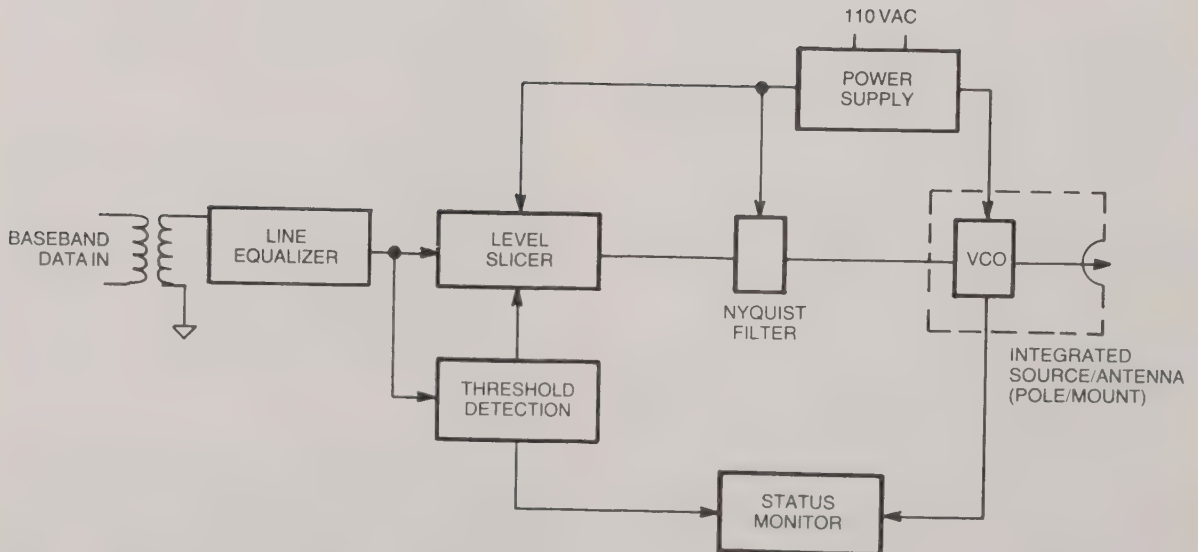


Figure 2-1. MA-23DR Transmitter – Block Diagram

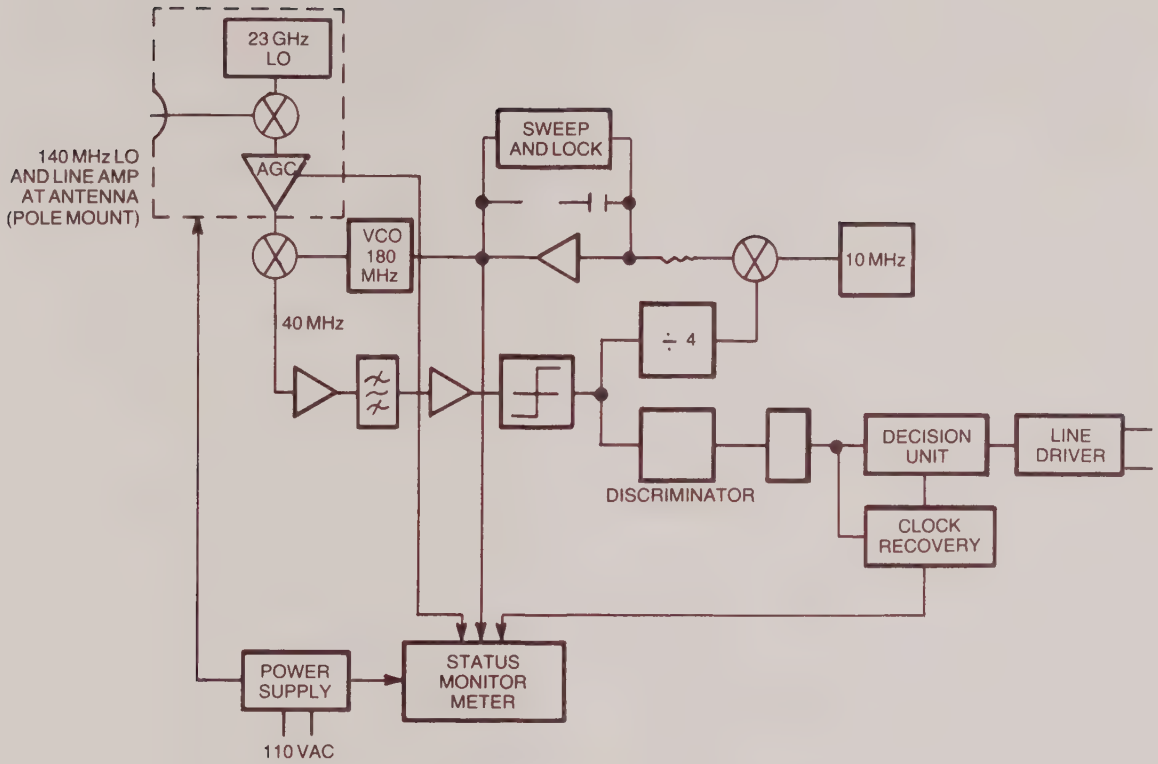


Figure 2-2. MA-23DR Receiver – Block Diagram

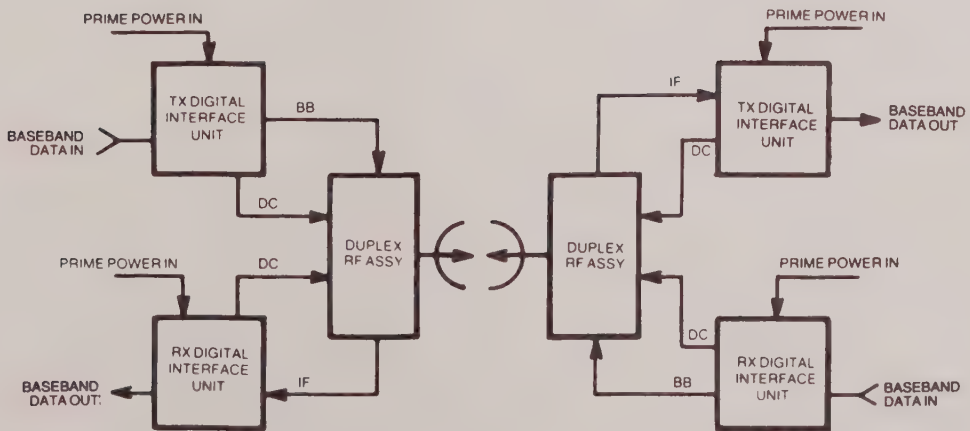


Figure 2-3. Duplex System (Unprotected) – Component Interconnection and Signal Flow

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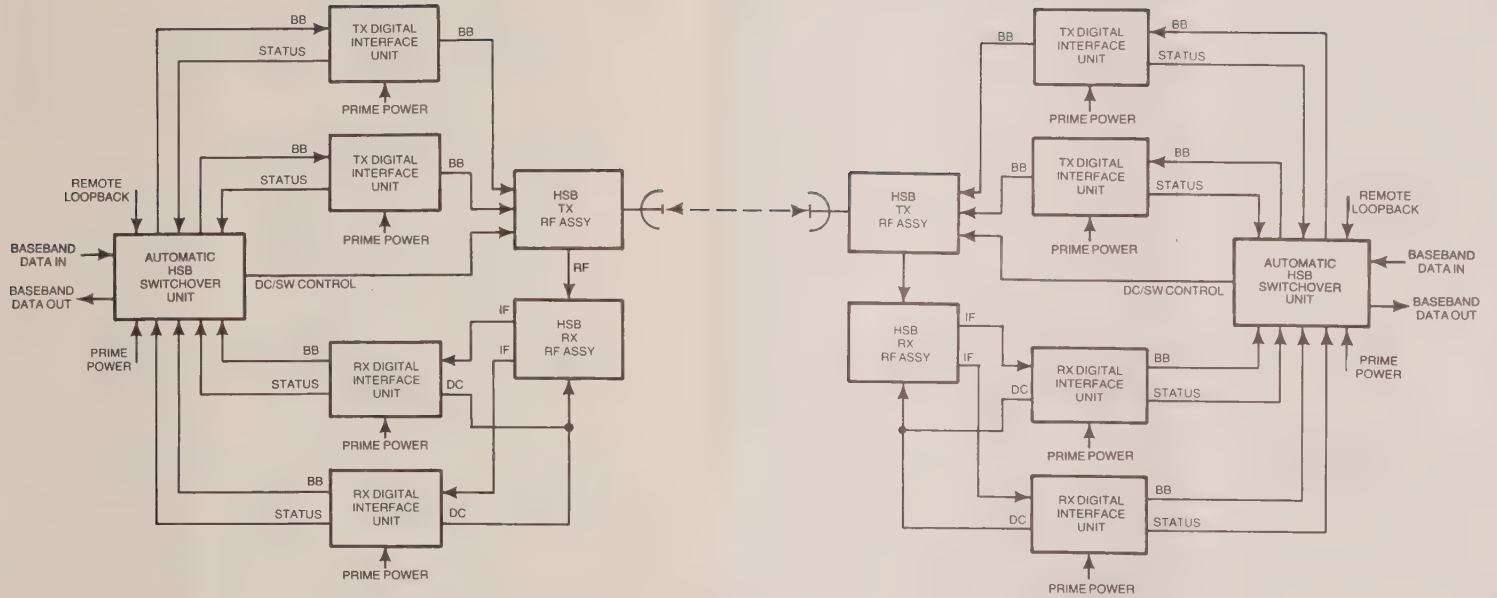


Figure 2-4. Hot Standby Duplex System – Block Diagram



# SECTION 3

# INSTALLATION

## GENERAL

Installation of the MA-23DR System, including antenna alignment, is a relatively simple procedure as outlined in this section of the manual. However, the installer should be thoroughly knowledgeable of the system and all factors which may affect performance. Therefore, it is strongly recommended that the installer read the complete manual and become as familiar as possible with the system before proceeding with installation of equipment.

## UNPACKING AND HANDLING

**UNPACKING.** Table 3-1 lists the equipment shipped in the equipment crate of a typical MA-23DR Duplex System (unprotected) and a MA-23DR Hot Standby Duplex System.

Care should be taken when removing equipment from containers to prevent damage to the units. Ensure that all parts and accessories are removed from the container and packing material before they are discarded.

**DO NOT** discard the container or any packing material until mechanical inspection has been satisfactorily completed. This material must be available if a damage claim is to be made with the carrier.

**MECHANICAL INSPECTION.** Mechanically inspect the equipment for shipping damage. Make sure that the equipment is clean and no connectors, controls or indicators are broken, damaged, or loose.

**DAMAGE IN SHIPMENT.** Should any damage be discovered after unpacking the system, immediately file a claim with the carrier. A full report of the damage should be made and a copy forwarded to your M/A-COM dealer. The dealer will then advise disposition of the equipment.

**RETURN AUTHORIZATION.** Subject to standard terms of the warranty policy, M/A-COM MAC, Inc., or its dealers, will repair all defective equipment.

Contact your dealer before returning any equipment for repair. A Return Authorization Tag which is available from your dealer on behalf of M/A-COM must accompany any returned

goods. Your dealer will provide instructions for forwarding material to his repair facility, or when necessary, to M/A-COM's Chelmsford, Massachusetts factory.

## NOTE

Do not alter any internal controls unless so directed in the following procedures. Units are completely aligned at the factory and may require only minor adjustments once installed.

**TOOLS REQUIRED (Not Supplied).** The following tools are required to install a typical MA-23DR System:

1. 5/16" box wrench
2. screwdriver set – standard (slotted) and Phillips
3. adjustable wrench (6" or 8")
4. safety collar
5. crimping tool
6. sealing compound
7. high impedance voltmeter – 20 Vdc
8. two-way radios
9. 140 MHz power meter (not required, but strongly recommended).

## PRECAUTIONS

Adherence to the initial installation precautions outlined in Table 3-2 will help prevent problems arising during installation and operation of the equipment.

## INSTALLATION PRACTICES

**GENERAL.** Installation of MA-23DR Digital Radio Systems require real-time communications between each end of the link to properly align the antennas.

The following tasks must be performed by the installer in the order listed. Detailed procedures for each of these tasks follow this listing.

1. Fabricate the RF and power interconnection cables (if not purchased already fabricated).

Table 3-1. Equipment Lists

DESCRIPTION	DUPLEX SYSTEM (UNPROTECTED)	DUPLEX SYSTEM (HOT STANDBY)
<b>INDOOR EQUIPMENT</b>		
TX Digital Interface Unit	2	4
RX Digital Interface Unit	2	4
HSB Switchover Unit	–	2
<b>OUTDOOR EQUIPMENT</b>		
Duplex RF Assembly (Unprotected)	2	–
Hot Standby Duplex RF Assembly w/Mounting Bracket	–	2
2 Foot Parabolic Antenna (Note 1)	2	2
Antenna Mounting Bracket	2	2
<b>OPTIONAL INTERCONNECTION CABLES (Note 2)</b>		
RF Cables	4	8
Power Cable (8-Conductor)	2	2
Power Cable (15-Conductor)	–	2

Notes:

- Optional 4 foot or 6 foot high performance antennas and mounting brackets will be shipped in separate crates. Mounting brackets will be shipped with the RF Units.
- Normally, RF and power interconnection cables are fabricated by the installer (connectors are provided). However, cables are optionally available from the factory in standard lengths of 50 feet, 100 feet, or 250 feet.

Table 3-2. Installation Precautions

PRECAUTION	REQUIREMENT
Ensure adequate ventilation.	Allow a minimum of one rack space above and below each unit mounted in the rack to prevent heat build-up. If an enclosed cabinet is used, a ventilation fan is recommended.
Ensure easy access to rack wiring.	Allow a minimum of 18 inches clearance behind the equipment racks.
Facilitate servicing and maintenance.	Allow a minimum of 36 inches clearance in front of equipment racks.
Avoid direct heating or air conditioning.	If unavoidable, use deflector plates.
AC power source outlets.	Locate equipment near sufficient outlets to provide power for test equipment and power tools.
Rack support.	Make certain rack supports are sufficiently rigid to support the rack.
Building leakage.	Beware of dripping water onto equipment from leaky roofs, cable entries, and cold water pipe condensations.
Service access (outdoor units).	Be sure to provide sufficient clearance to permit opening of access doors for servicing purposes.
Grounding (see Caution).	Ground the outdoor RF Units and interconnection cables to prevent damage from lightning and to eliminate ground loops.
Weatherproof connectors.	Apply RTV sealant to all exposed connectors.
Ice shields.	In certain geographical areas where tower structures may be subject to a radial ice build-up of 1/2 inch or more, provide overhead ice shield protection.

**CAUTION**

*MA-23DR Systems are provided with lightning surge protection circuits. The equipment must be connected to station ground using standard grounding practices.*

*M/A-COM MAC, Inc. will not be liable for damages to equipment incurred as a result of failure to ground the system properly.*

2. Install the RF and power interconnection cables between the predetermined indoor and outdoor equipment locations.

3. Install the indoor units in the equipment rack.

4. Prepare the antenna/RF assembly for installation.

a. Elevation tilt range.

b. Antenna polarization.

1) Option A – horizontal polarization.

2) Option B – vertical polarization.

5. Mount the outdoor equipment in their predetermined outdoor locations.

a. Mounting of Antenna/RF Assemblies [Duplex (unprotected) Systems].

b. Mounting of Hot Standby Duplex RF Assembly.

c. Mounting of Multiplex RF Assemblies.

6. Connect RF and power interconnection cables to RF Units.

a. Duplex (unprotected) Systems.

b. Hot Standby Systems.

7. Connect RF and power interconnection cables to indoor units.

8. Electrical interface and power connections.

a. Data interface connections.

b. Alarm interface connections.

c. Primary connections.

1) Option A – dc powered systems.

2) Option B – ac powered systems.

**FABRICATE RF AND POWER INTERCONNECTION CABLES**

Interconnection cables (between the indoor units and the outdoor units) may be purchased from the factory or fabricated by the installer prior to installation. RF and power interconnection cables are available from the factory in standard lengths of 50 feet, 100 feet, and 250 feet.

Tables 3-3 and 3-4 list the requirements for RF and power cables. Details of cable fabrication are provided in Figures 3-1 through 3-6.

Be sure to mark all cable ends to ensure proper connections when installed.

Interconnection diagrams are shown in Figures 3-7 through 3-10.

Table 3-3. Cabling Requirements – RF Box to Digital Interface Unit

CABLE LENGTH	COAXIAL CABLE	POWER CABLE*
Up to 250 Feet	RG-6/U Foam, Double Shielded (Comm/Scope Paramedrop F660BV, 0.272" o.d. nom.) Type F connector (Gilbert GF6AHS-342) at both ends.	#18 AWG, Shielded
250 to 400 Feet	RG-11/U Foam, Double Shielded (Comm/Scope Paramedrop F1160BV, 0.405" o.d. nom.) Type F connector (Gilbert GF11AHS-480) at both ends.	#16 AWG, Shielded
400 to 500 Feet	Solid Shielded (Comm/Scope Parameter P3-75-412JCA, 0.512" o.d. nom.) Conversion Connector (Gilbert GRS-412-BAFF-DU-01) at both ends.	#16 AWG, Shielded
500 to 800 Feet	Solid Shielded (Comm/Scope Parameter P3-75-750JCA, 0.850" o.d. nom.) Conversion Connector (Gilbert GRS-750-BAFF-DU-01) at both ends.	#14 AWG, Shielded
800 to 1000 Feet	Solid Shielded (Comm/Scope Parameter P3-75-1000JCA, 1.10" o.d. nom.) Conversion Connector (Gilbert GRS-1000-BAFF-DU-01) at both ends.	#12 AWG Shielded #12 to #14 conversion connector

\*Power Cables: Simplex (4-Conductor); Duplex (8-Conductor); Hot Standby Transmitter (15-Conductor); Hot Standby Receiver (8-Conductor).

Table 3-4. Cabling Requirements – RF Box to Digital Interface Unit

CABLE LENGTH	PLENUM CABLE	POWER CABLE*
Up to 250 Feet	Comm/Scope Plenum 2275, 0.251" o.d. nom. Type F connector (Gilbert GF6AHP-312) at both ends.	#18 AWG, Shielded
250 to 400 Feet	Comm/Scope Plenum 2285, 0.372" o.d. nom. Type F connector (Gilbert GS11AHS-460) at both ends.	#16 AWG, Shielded
400 to 500 Feet	Comm/Scope Plenum 2311, 0.500" o.d. nom. Conversion connector (Gilbert GRS-500-BAFF-DU-03) at both ends.	#16 AWG, Shielded

\*Power Cables: Simplex (4-Conductor); Duplex (8-Conductor); Hot Standby Transmitter (15-Conductor); Hot Standby Receiver (8-Conductor).

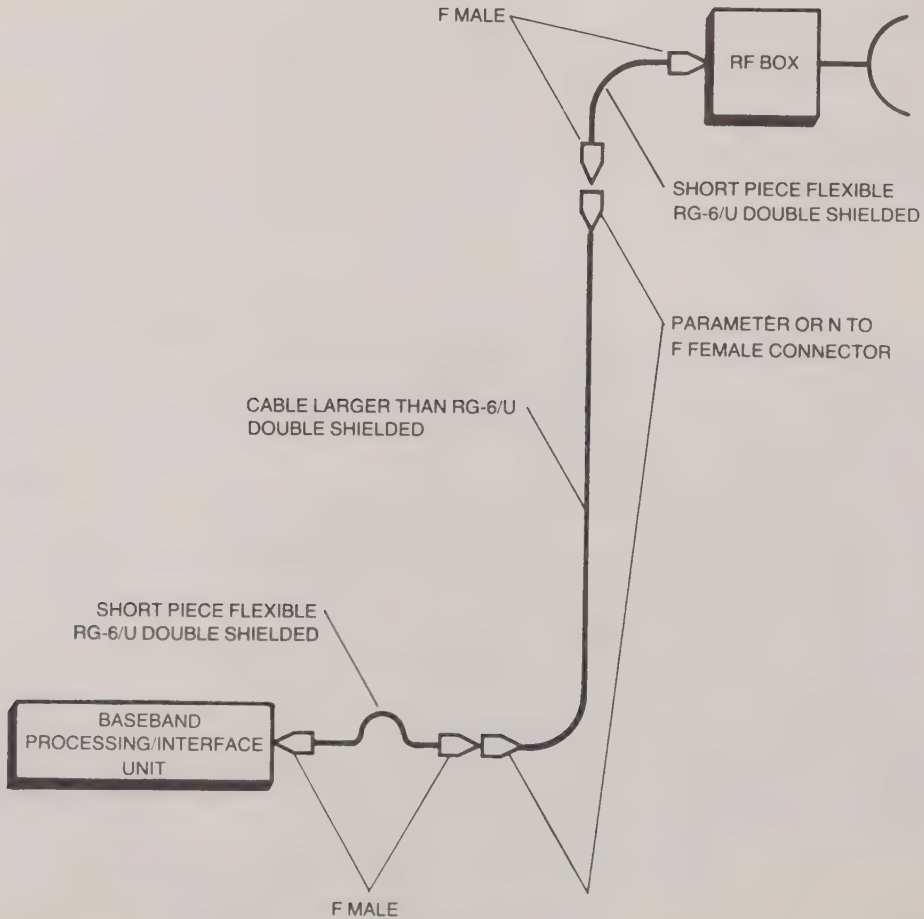


Figure 3-1. Cable Configuration for 400 to 1000 Feet

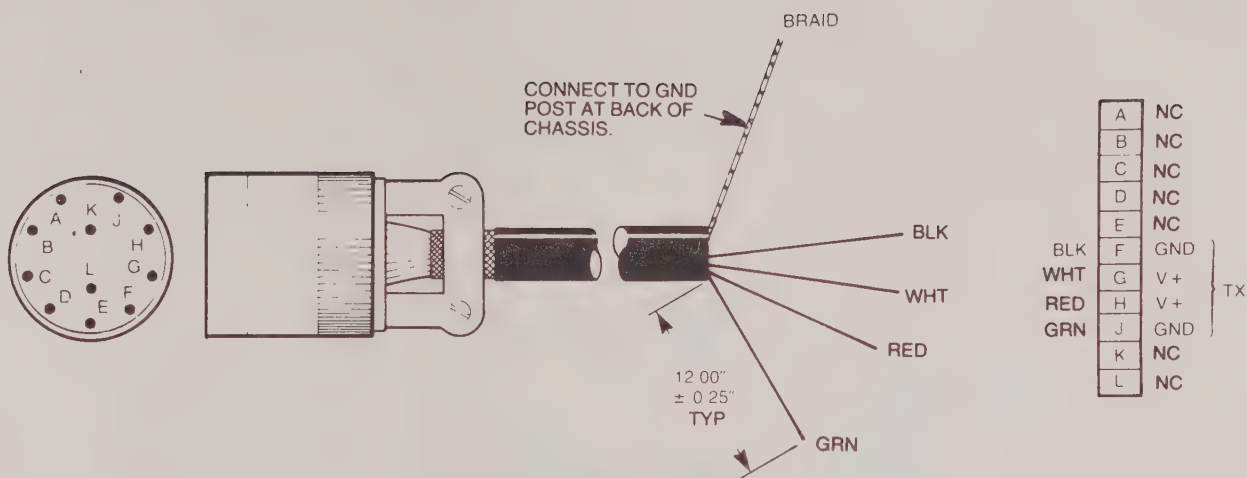


Figure 3-2. Simplex Power Cable – Transmitter

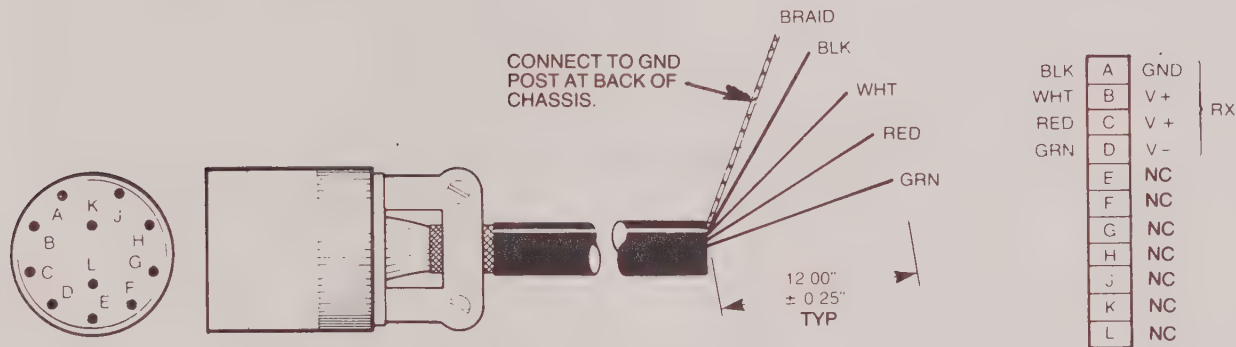


Figure 3-3. Simplex Power Cable – Receiver

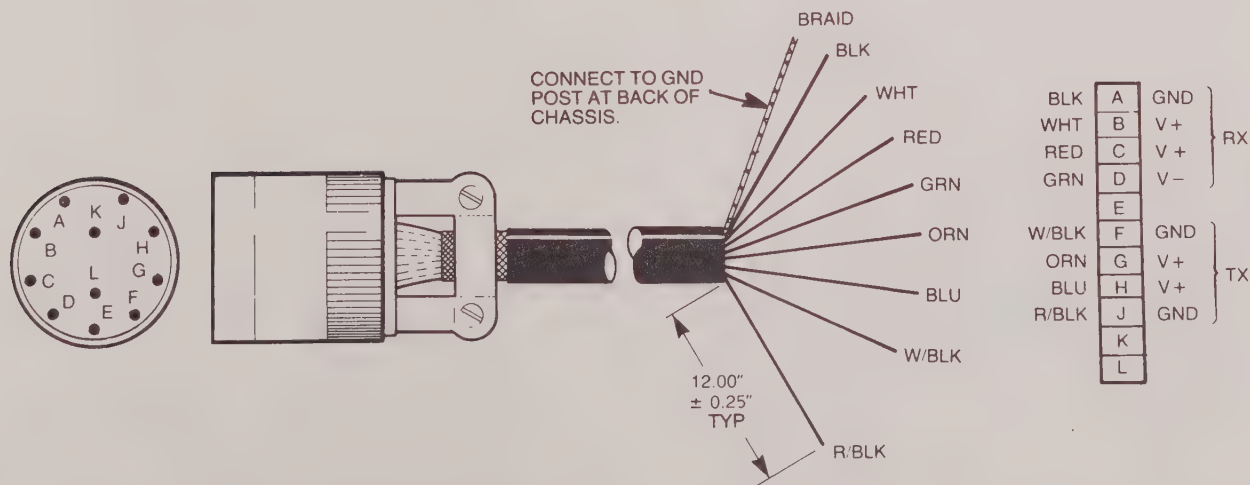


Figure 3-4. Duplex Power Cable

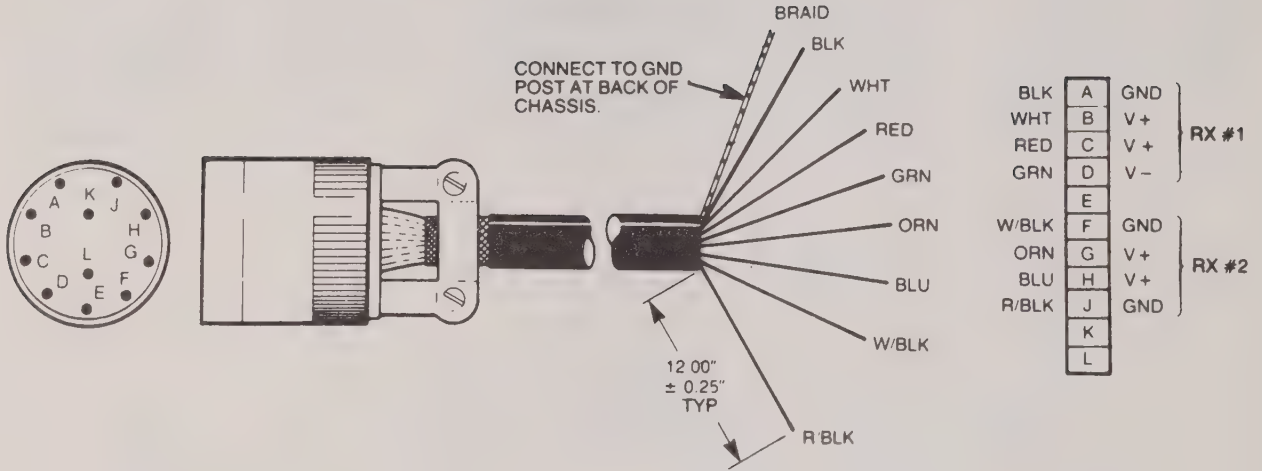


Figure 3-5. Hot Standby Power Cable – Receiver

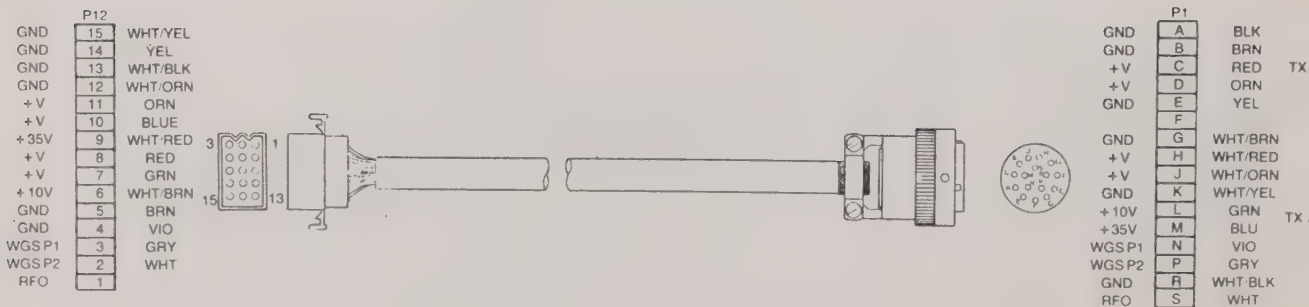
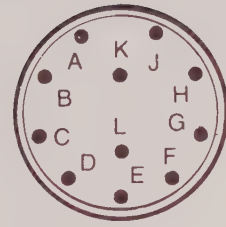
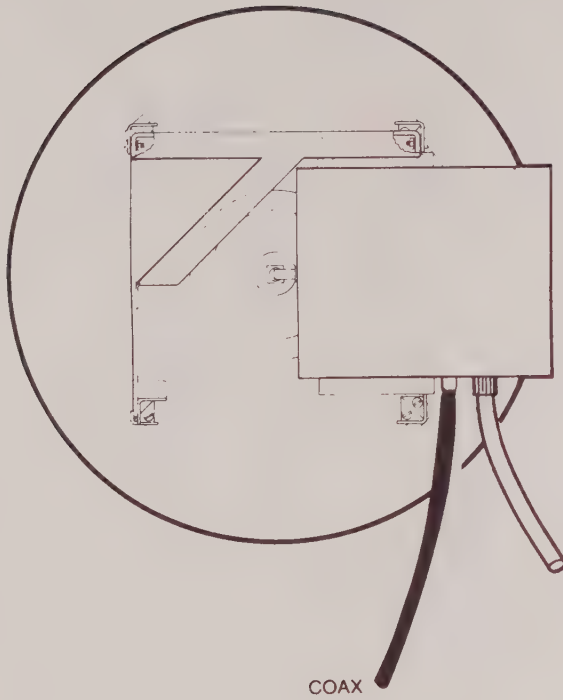


Figure 3-6. Hot Standby Power Cable – Transmitter



TX DC POWER CONNECTOR DETAIL

PIN	FUNCTION
F, J	GND
G, H	+V
A-E, K, L	N.C.

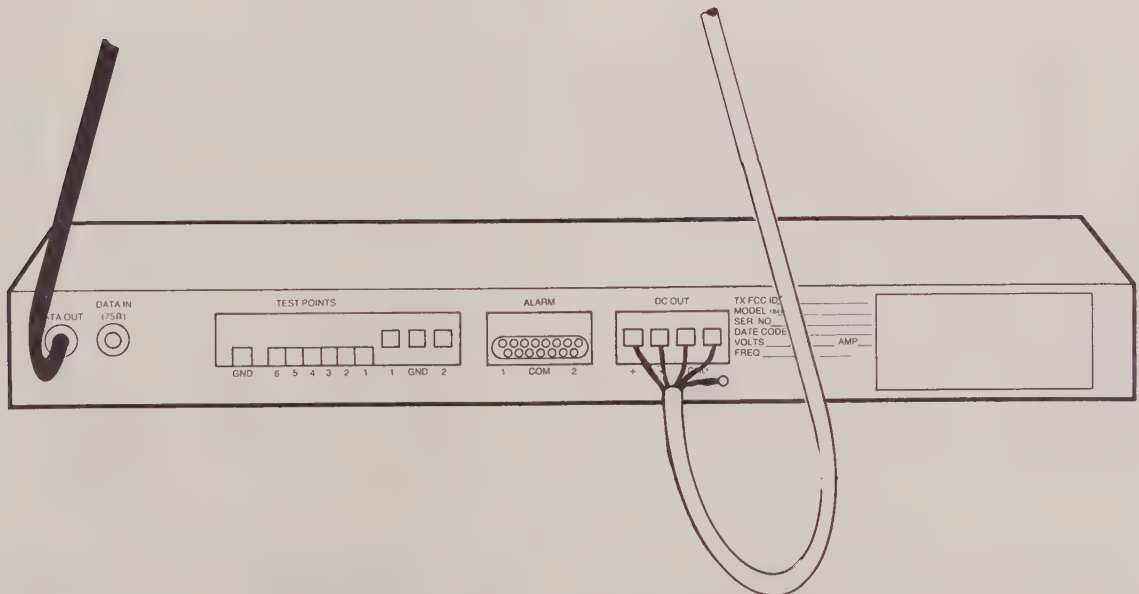
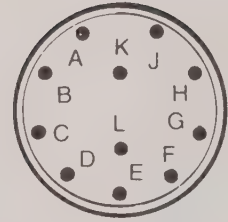
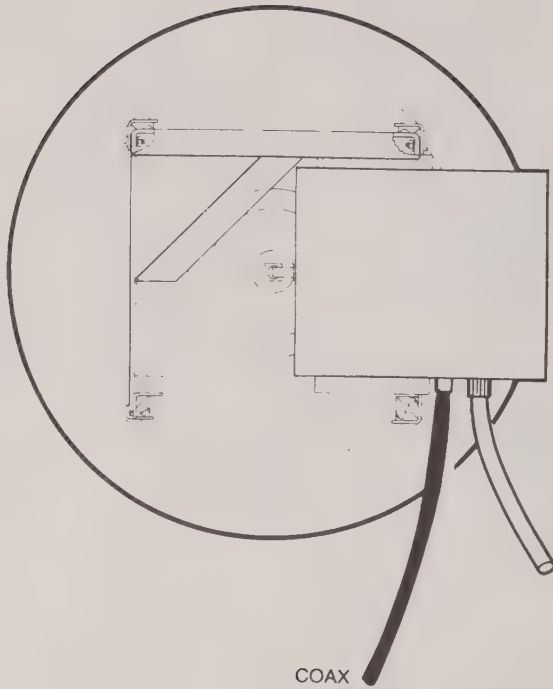


Figure 3-7. Simplex Link – Transmitter End (Used With Stacking/Combiner Kits Only)



RX DC POWER CONNECTOR DETAIL

PIN	FUNCTION
A	GND
B,C	+V
D	-V
E-L	N.C.

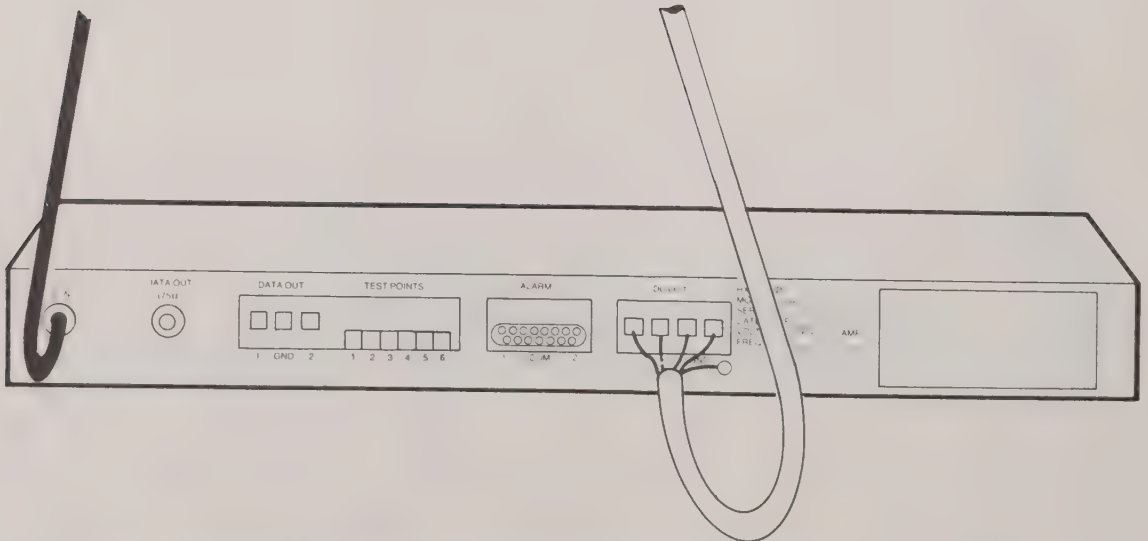
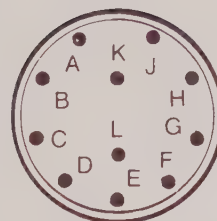
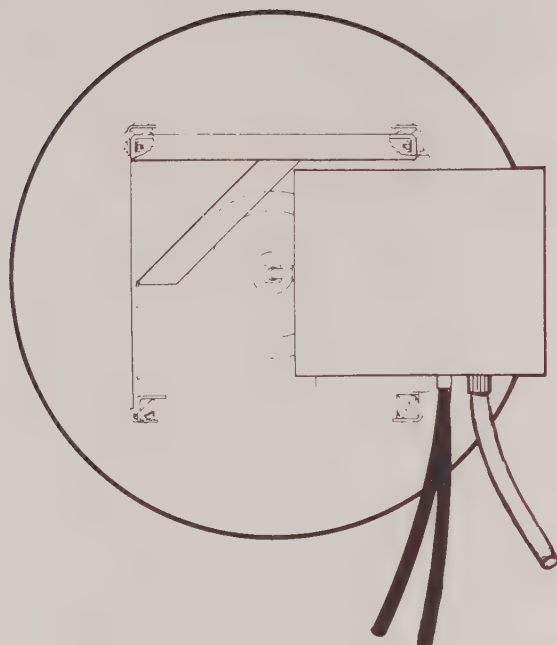


Figure 3-8. Simplex Link – Receiver End (Used With Stacking/Combiner Kits Only)



DUPLEX DC POWER CONNECTOR DETAIL

PIN	FUNCTION
A	RX GND
B,C	RX +V
D	RX -V
E,K,L	N.C.
F,J	TX GND
G,H	TX +V

RECOMMENDED COLOR CODE

- A - BLK
- B - WHT
- C - RED
- D - GRN
- F - W/BLK
- G - ORN
- H - BLU
- J - R/BLK

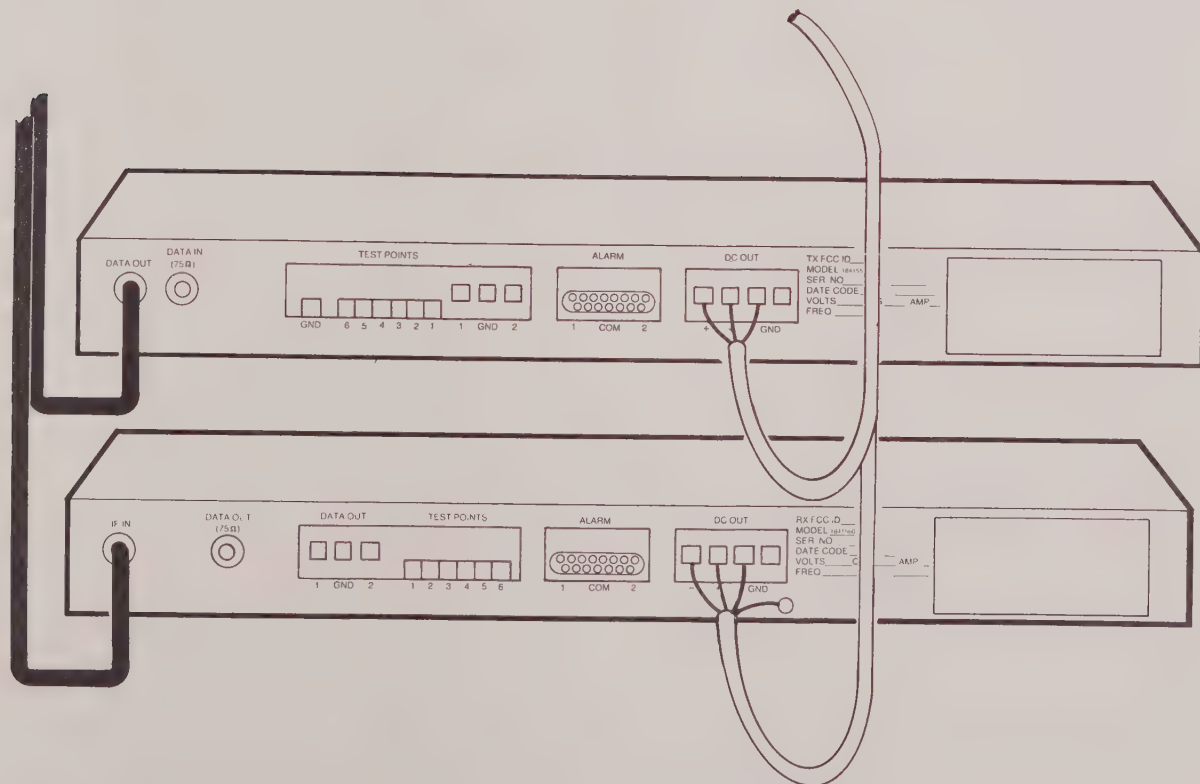


Figure 3-9. One End of Duplex Link (Unprotected)

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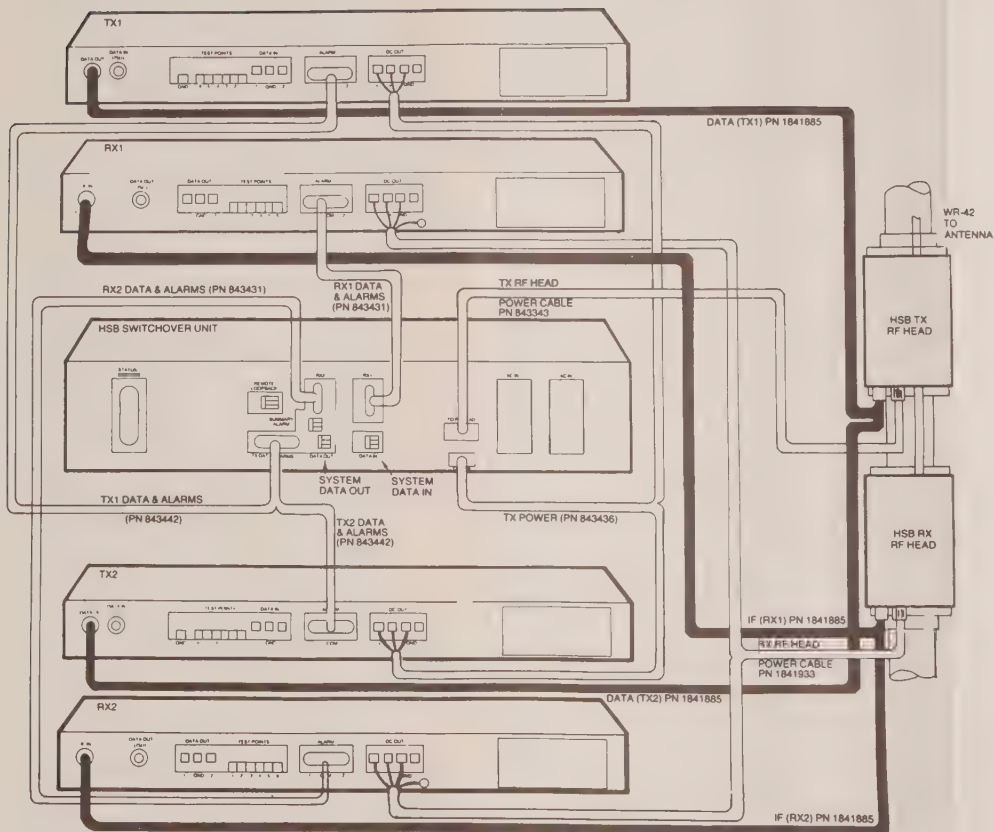


Figure 3-10. One End of Hot Standby Duplex Link



## INSTALLATION OF INTERCONNECTION CABLES

Run the RF and power interconnection cables between the indoor and outdoor units. Follow standard cabling practices. Avoid sharp corners and secure cables to tower or mast using hangers installed at 3 foot intervals.

Although MA-23DR Systems are equipped with lightning surge protection, it is necessary to ground interconnection cables using commercially available grounding kits. One grounding kit should be installed at the Antenna/RF Assembly location on the tower or mast and a second kit should be applied to the interconnection cables at the base of the tower, or just before it enters the building.

## INSTALLATION OF INDOOR UNITS

The indoor components of MA-23DR Systems are designed for installation in standard 19-inch EIA equipment racks in a well ventilated area. The Transmitter and Receiver Digital Interface Units each occupy a single rack space (1-3/4 inches). The Hot Standby Switchover Unit (Hot Standby Duplex Systems only) occupies three rack spaces (5-1/4 inches).

Install the units in the rack allowing at least one rack space above and below each unit mounted in the rack (Figures 3-11 and 3-12).

Be sure to observe the precautions noted in Table 3-2.

## PREPARATION OF ANTENNA/RF ASSEMBLY FOR INSTALLATION

The Antenna/RF Assembly should be prepared indoors before proceeding to the antenna mounting location. The fully assembled Antenna/RF Assembly is shown in Figure 3-13. A side view of the assembly is given in Figure 3-14 showing the elevation adjustment.

The antenna mounting bracket is designed so it can be installed on the antenna for vertical or horizontal polarization (antennas at each end of the link must have the same polarization). Also, several elevation tilt adjustment ranges are possible. This requirement may be different for each end of the link.

The standard 2 foot antenna is designed so that the Duplex RF Box (unprotected) can be mounted on the rear of the antenna. When optional high performance 4 foot or 6 foot antennas are used, the RF Box must be mounted separately. Special mounting kits are available for this purpose. See the reference drawing section of this manual.

**ELEVATION TILT RANGE.** The antenna mounting bracket is attached to the reflector using three reflector standoffs (or ears). The mounting kit contains a total of five ears (two extra ears); three short ears and two tall ears. The desired elevation tilt range determines which ears are used (Table 3-5 and Figures 3-15 through 3-24).

Table 3-5. Elevation Tilt Range

ELEVATION TILT RANGE	REMARKS
- 15 to + 24°	Use two tall ears at points A and B, short ear at C. Mount rightside up.
- 24 to + 15°	Use two tall ears at points A and B, short ear at C. Mount upside down.
- 4 to + 30°	Use the same length ears (all short) at points A, B, and C. Mount rightside up.
- 30 to + 4°	Use the same length ears (all short) at points A, B, and C. Mount upside down.

NOTE: Unless the Antenna/RF Assembly will be mounted rightside up, horizontal polarization as shown in Figure 3-17, install a weatherproof right angle adapter (not supplied) onto each F connector of the RF Units.

**ANTENNA POLARIZATION.** The placement of the ears (reflector standoffs) on the reflector in relation to the location of the RF Box mounting bolt locations determines the antenna polarization (horizontal or vertical).

### Option A – Horizontal Polarization

For horizontal polarization, perform the following steps:

Step 1. Attach the corner ears as shown in Figure 3-15. Make sure the waveguide slot has the long dimension situated vertically as shown.

#### NOTE

Be sure that ears at points A and B are of the correct length for the desired elevation tilt range in accordance with Table 3-5.

Step 2. Mount the bracket assembly to the ears as shown in Figure 3-16 using the hex head bolts and nuts (3 places).

Step 3. Mount the RF Unit on the reflector using screws at points D, E, F, and G with the connectors pointing down as shown in Figure 3-17.

Step 4. Connect one end of the short piece of flexguide to point H using four screws (#4-40 x 1/2" long).

Step 5. Connect the other end of the flexguide to point I using four screws (#4-40 x 3/8" long).

#### CAUTION

*Be sure that O-rings are properly in place in each choke and O-ring flange.*

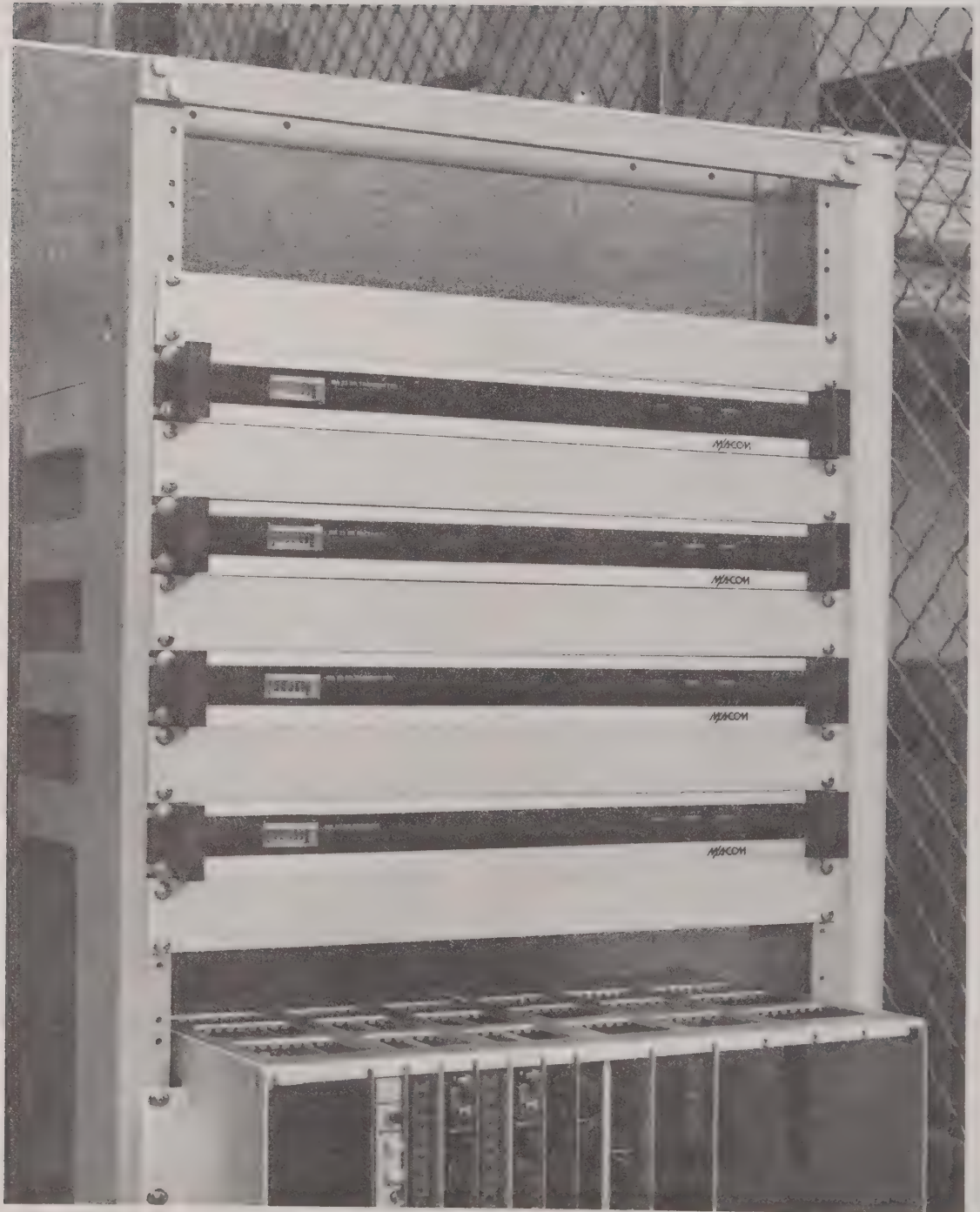


Figure 3-11. Typical Rack Containing Two Duplex Channels

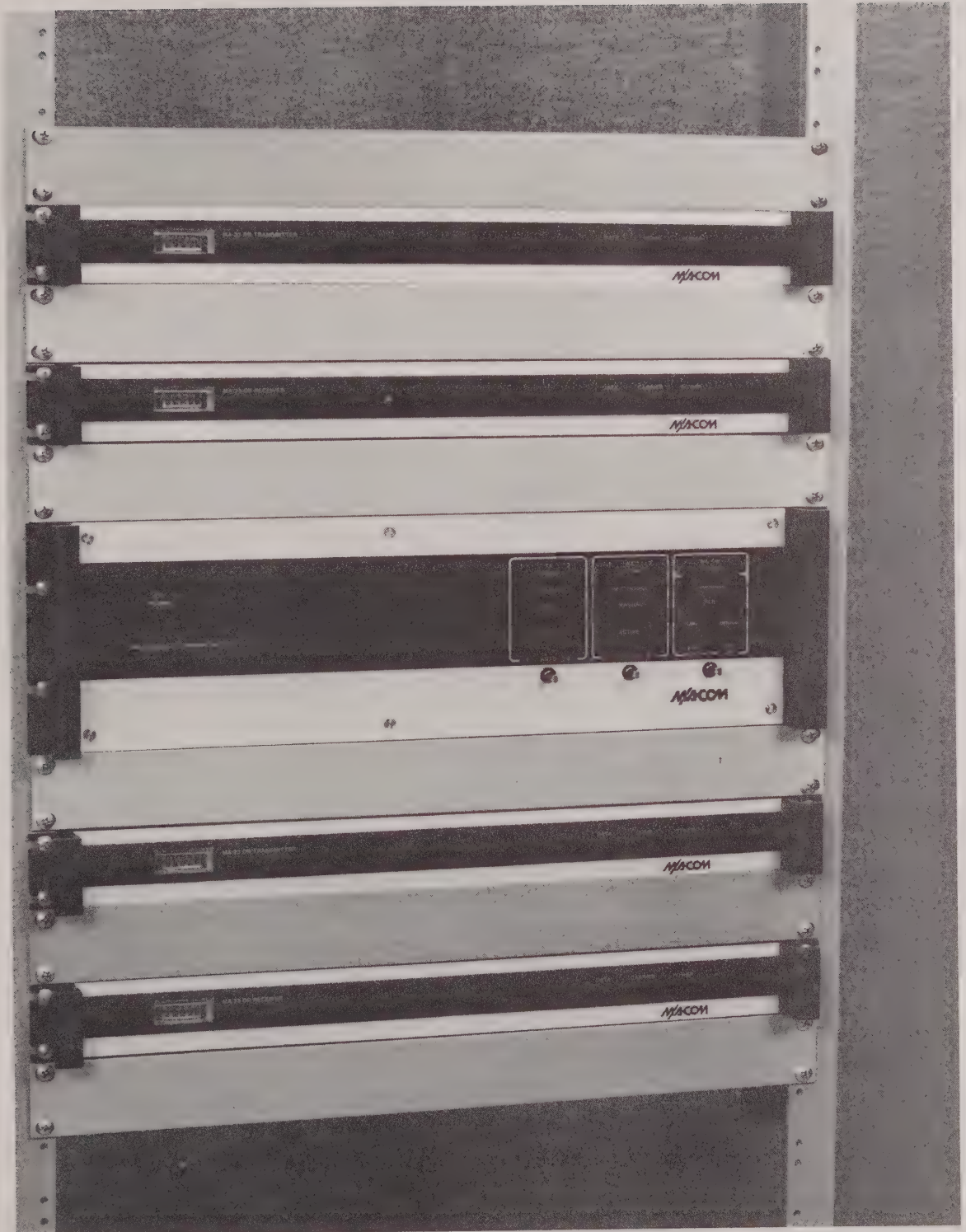


Figure 3-12. Typical Rack Containing Hot Standby Duplex Indoor Units

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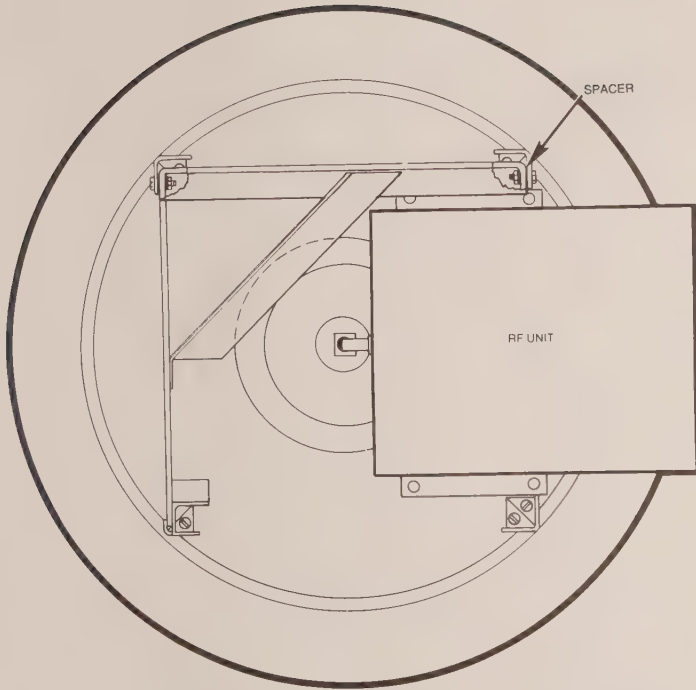


Figure 3-13. Fully Assembled RF/Antenna Assembly – Horizontal Polarization

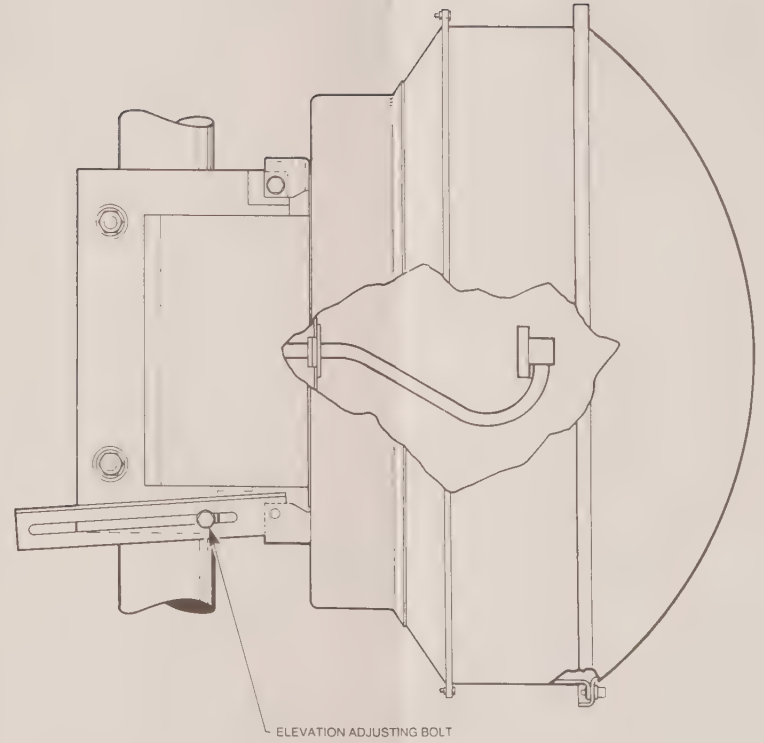


Figure 3-14. Side View Showing Elevation Adjustment Bolt



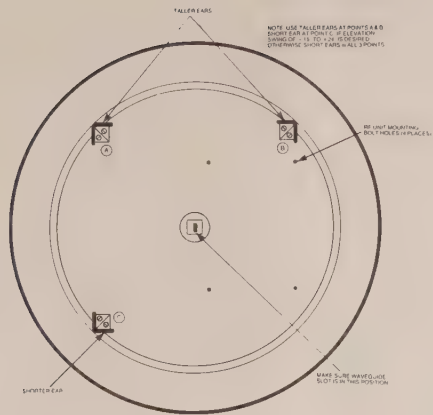


Figure 3-15. Corner Ear Installation For Horizontal Polarization

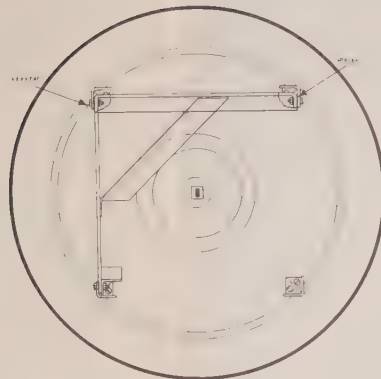


Figure 3-16. Mounting Bracket Installation - Horizontal Polarization

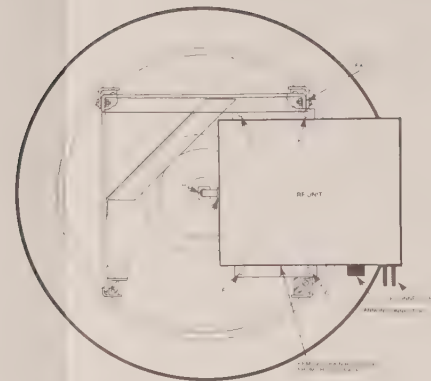


Figure 3-17. Fully Assembled RF/Antenna Assembly - Horizontal Polarization

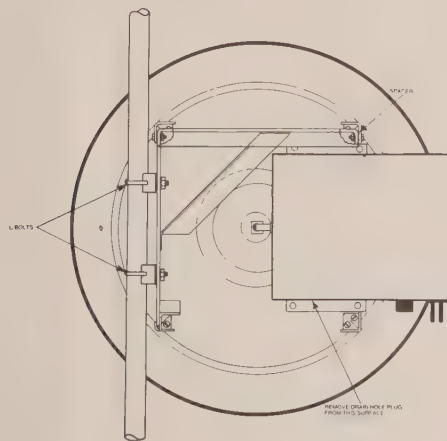


Figure 3-18. Horizontal Polarization - Mount for Elevation Tilt -15° to +24° Range or -4° to +30° Range

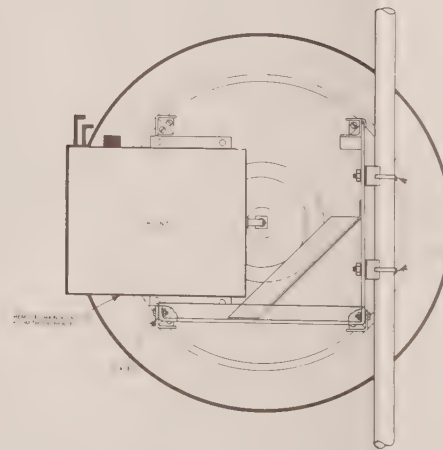


Figure 3-19. Horizontal Polarization - Mount for Elevation Tilt -24° to +15° Range or -30° to +4° Range



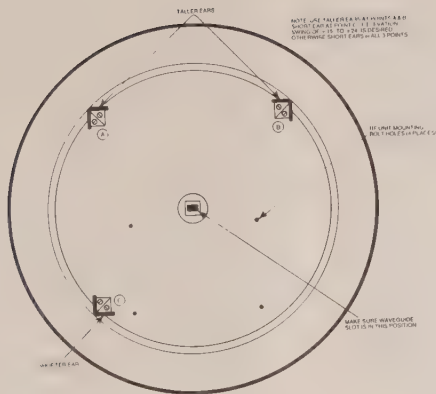


Figure 3-20. Corner Ear Installation For Vertical Polarization

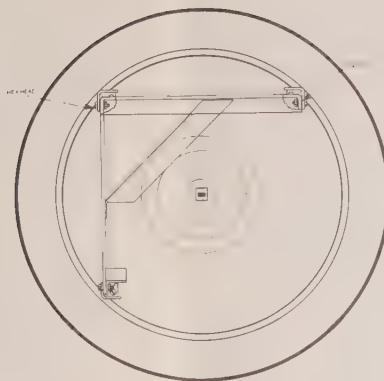


Figure 3-21. Mounting Bracket Installation - Vertical Polarization

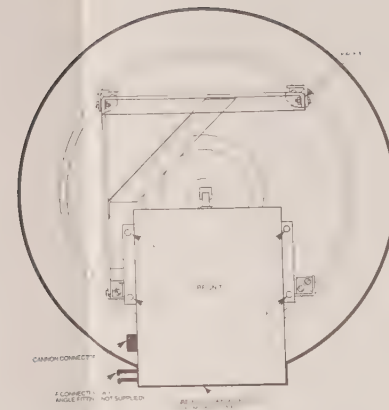


Figure 3-22. Fully Assembled RF Antenna Assembly - Vertical Polarization

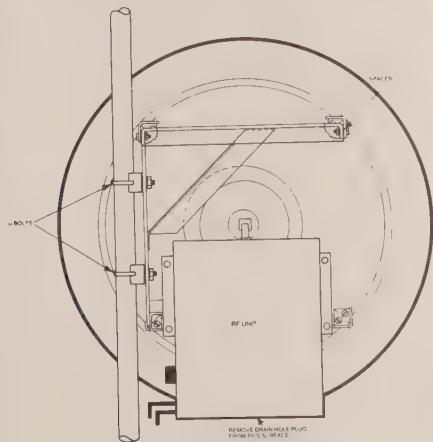


Figure 3-23. Vertical Polarization - Mount for Elevation Tilt -15° to +24° Range or -4° to +30° Range

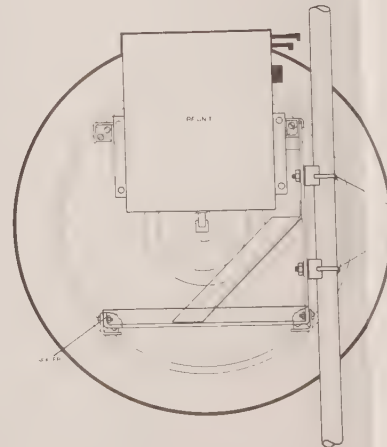


Figure 3-24. Vertical Polarization - Mount for Elevation Tilt -24° to +15° Range or -30° to +4° Range



## Option B – Vertical Polarization

For vertical polarization, perform the following steps:

Step 1. Attach the corner ears as shown in Figure 3-20. Make sure the waveguide slot has the long dimension situated horizontally as shown.

### NOTE

Be sure that ears at points A and B are of the correct length for the desired elevation tilt range in accordance with Table 3-5.

Step 2. Mount the bracket assembly to the ears as shown in Figure 3-21 using the hex head bolts and nuts (3 places).

Step 3. Mount the RF Unit on the reflector using screws at points D, E, F, and G with the connectors pointing down as shown in Figure 3-22.

Step 4. Connect one end of the short piece of flexguide to point H using four screws (#4-40 x 1/2" long).

Step 5. Connect the other end of the flexguide to point I using four screws (#4-40 x 3/8" long).

### CAUTION

*Be sure that O-rings are properly in place in each choke and O-ring flange.*

## MOUNT THE OUTDOOR EQUIPMENT IN THEIR PREDETERMINED OUTDOOR LOCATIONS

**MOUNTING OF ANTENNA/RF ASSEMBLY [DUPLEX (UNPROTECTED) SYSTEMS].** At each end of the link, install the Antenna/RF Assemblies in their respective permanent locations as follows:

### NOTE

1. If greater uptilt than downtilt is required, mount the assembly with the pole to the left of the antenna center (reference Table 3-3 and Figures 3-18 and 3-23).
2. If greater downtilt than uptilt is required, mount the assembly with the pole to the right of the antenna center; i.e., upside down (reference Figures 3-19 and 3-24).

Step 1. Clamp the Antenna/RF Assembly to a vertical mast (4 to 4.5" O.D.) using the two larger U-bolts and associated hardware (supplied). If the mast O.D. is less than 4", use the two smaller U-bolts (supplied).

Step 2. Use a safety collar (not supplied) installed below the bottom U-bolt to hold the assembly in place until the antenna alignment is completed.

Step 3. The RF Unit has drain plugs on each of four surfaces. Remove only the drain plug from the bottom surface (as mounted).

**MOUNTING OF HOT STANDBY DUPLEX RF ASSEMBLY.** The MA-23DR Hot Standby RF Assembly (Figure 3-25) consists of two weather-resistant RF Units designed for pole or tower mounting, a Hot Standby Transmitter RF Unit, and a Hot Standby Receiver RF Unit interconnected by a straight piece of WR-42 waveguide and assembled to a common mounting channel. Three U-bolts are provided for mounting on a vertical mast (4 to 4.5" O.D.). A 3 foot length of flexible WR-42 is provided for connection to the antenna.

### CAUTION

*Be sure to mount the assembly in accordance with precautionary labels to prevent the entrance of moisture.*

**MOUNTING OF MULTIPLEX RF ASSEMBLIES.** Up to four duplex systems can be multiplexed onto a single antenna using Stacking/Combiner Kits as shown in Figures 3-26 and 3-27. The Stacking/Combiner Kits provide mounting and waveguide interconnection facilities for up to four weather-resistant RF Units on a common mounting channel. Three U-bolts are provided for mounting on a vertical mast (4 to 4.5" O.D.). A 3 foot length of flexible WR-42 waveguide is provided for connection to the antenna.

## CONNECT RF AND POWER INTERCONNECTION CABLES TO RF UNITS

**DUPLEX (UNPROTECTED) SYSTEMS.** RF and power interconnection cable connections between the indoor Transmitter and Receiver Digital Interface Units and the outdoor Antenna/Duplex RF Assembly for a duplex (unprotected) system are shown in Figure 3-9.

Step 1. Connect the coax cable from the Transmitter Digital Interface Unit to the BB IN Type F connector on the RF Unit.

Step 2. Connect the coax cable from the Receiver Digital Interface Unit to the IF OUT Type F connector on the RF Unit.

Step 3. Connect the power cable to the POWER connector on the RF Unit.

Step 4. Apply RTV sealing compound (not supplied) to all exposed connectors.

**HOT STANDBY DUPLEX SYSTEMS.** RF and power interconnection cable connections between the indoor units (Hot Standby Switchover Unit, Transmitter Digital Interface Units, and Receiver Digital Interface Units) and the outdoor Hot Standby Duplex RF Assembly are shown in Figure 3-10.

Step 1. Connect the coax cables from Transmitter Digital Interface Units (TX1 and TX2) to the corresponding Type F connector (BB1 and BB2, respectively) on the Hot Standby Transmitter RF Unit.

Step 2. Connect the coax cables from the Receiver Digital

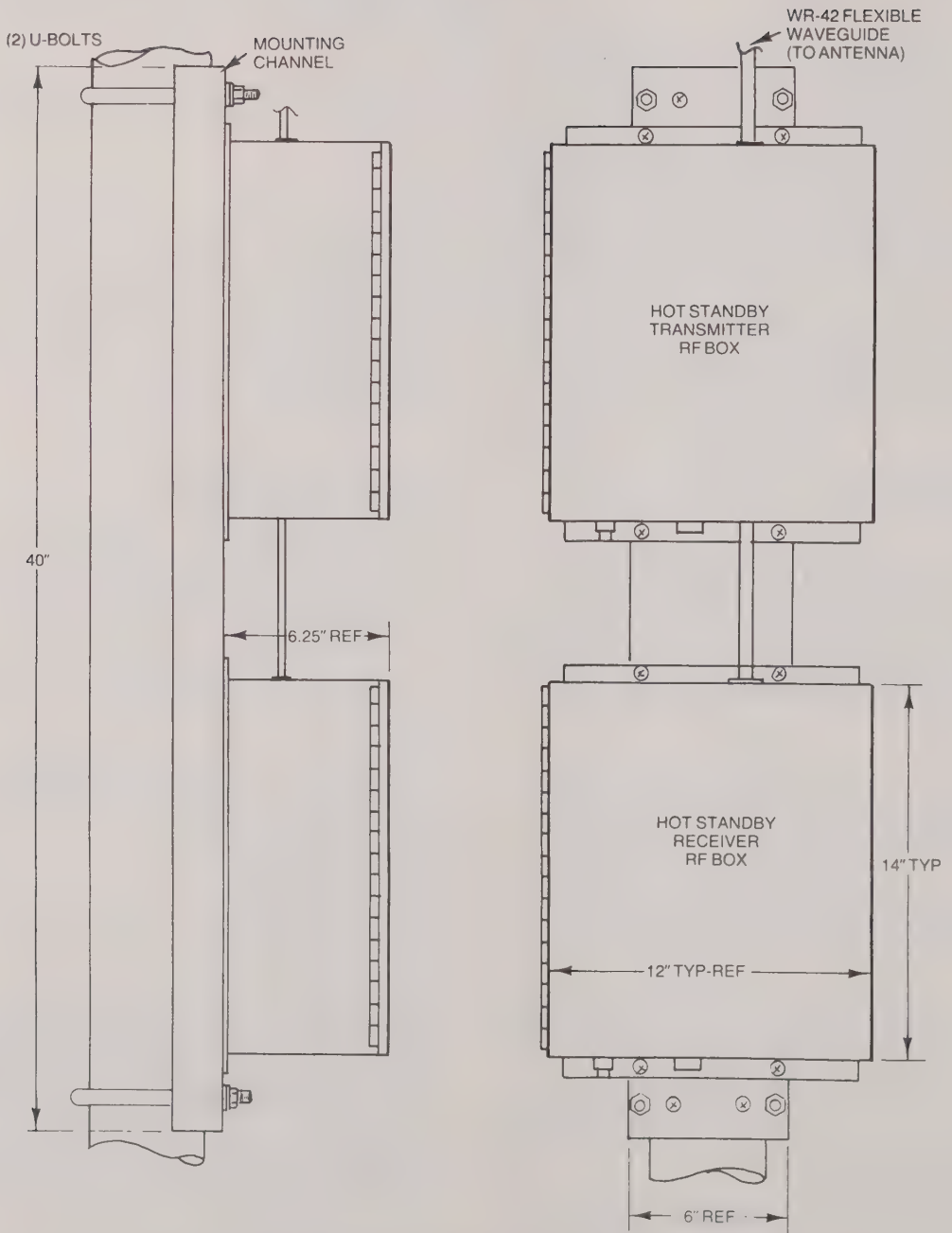


Figure 3-25. Hot Standby Duplex RF Assembly

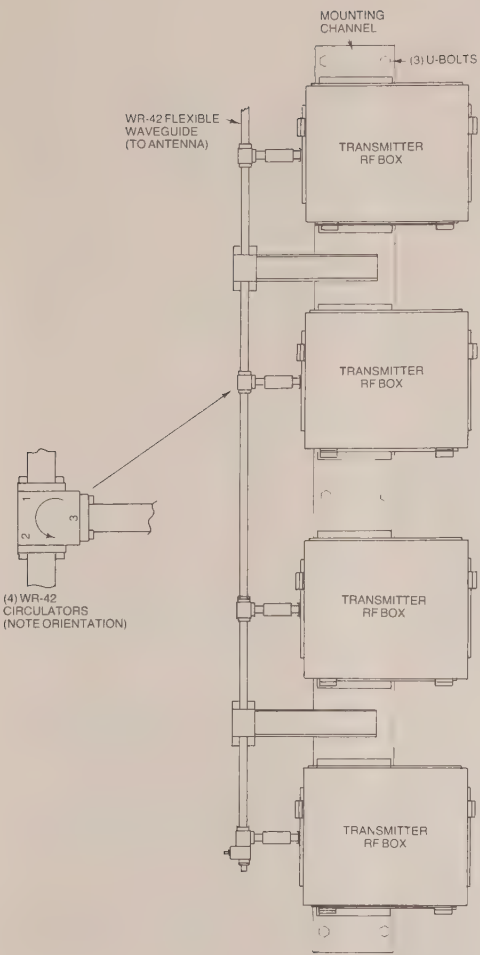


Figure 3-26. Stacking/Combiner Kit – 4 TX Channels

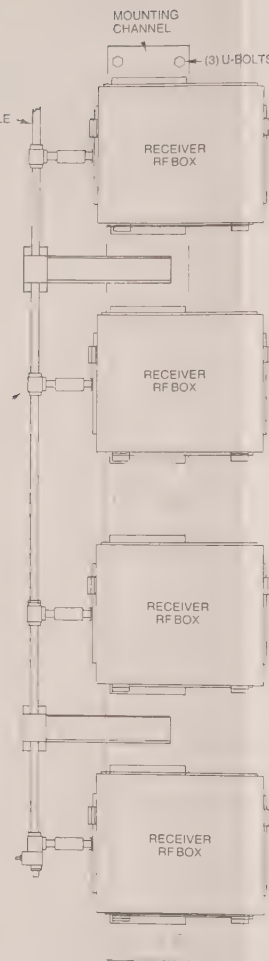
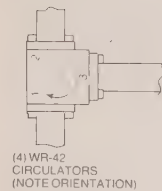
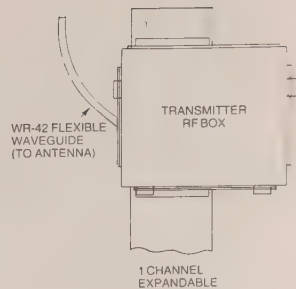
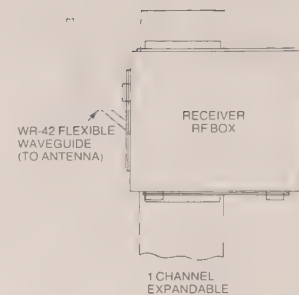


Figure 3-27. Stacking/Combiner Kit – 4 RX Channels





Interface Units (RX1 and RX2) to the corresponding Type F connector (IF1 and IF2, respectively) on the Hot Standby Receiver RF Unit.

Step 3. Connect the power cable from the Hot Standby Switchover Unit to the mating Power Connector (16-pin Cannon connector) on the Hot Standby Transmitter RF Unit.

Step 4. Connect the power cable from the Receiver Digital Interface Units to the mating POWER connector (12-pin Cannon connector) on the Hot Standby Receiver RF Unit.

Step 5. Apply RTV sealing compound (not supplied) to all exposed connectors.

## CONNECT RF AND POWER INTERCONNECTION CABLES TO INDOOR UNITS

Figures 3-7 through 3-10 show coax and power interconnection cable connections to the indoor units for Simplex Transmitter, Simplex Receiver, Duplex (unprotected) Systems, and Duplex Hot Standby Systems, respectively.

### NOTE

1. The braid on the power cable must be grounded at both ends of the cable; i.e., one end on the Cannon connector and the other at the Digital Interface Unit.
2. If stranded wire is used, make sure no loose strands are shorted to case.

## ELECTRICAL INTERFACE AND POWER CONNECTIONS

**DATA INTERFACE CONNECTIONS.** For unprotected MA-23DR Systems, data interface connections are made to the Transmitter and Receiver Digital Interface Units. (Figure 3-28 and 3-29). On the MA-23DR Hot Standby Duplex Systems, data interface connections are made to the Automatic Hot Standby Switchover Unit (Figure 3-30) as specified herein.

Unless otherwise specified, the Transmitter and Receiver Digital Interface Units and Automatic Hot Standby Switchover Units (Hot Standby Systems only) are setup at the factory for balanced data inputs and outputs.

### NOTE

On Hot Standby Duplex Systems, data inputs/outputs of the Transmitter and Receiver Digital Interface Units are connected to the Hot Standby Switchover Unit. They are not available for external connection in this instance. In a Hot Standby System, all data interface connections are made to the Hot Standby Switchover Unit only.

The Transmitter and Receiver Digital Interface Units can be configured for either 75 ohm coaxial or balanced data inputs/outputs (see Table 3-6) by moving jumpers on the main cir-

cuit boards. The top covers of the Interface Units must be removed for access to the jumpers.

### 1. Transmitter Digital Interface Units

- a. For 75 ohm coaxial data input at J6: install W1 between terminals E2 and E3, W2 between E5 and E6.
- b. For balanced data input at TB3: install W1 between terminals E1 and E3, W2 between E4 and E6.

### 2. Receiver Digital Interface Units

- a. For 75 ohm coaxial data input at J2: install W1 between terminals E8 and E10, W2 between E11 and E13, and remove jumpers W5 and W7.
- b. For balanced data input at TB1: install W1 between terminals E8 and E9, W2 between E11 and E12, W5 between E4 and E6, and W7 between E6 and E7.

Balanced data input/output cross-connect requirements are given in Table 3-6.

**ALARM INTERFACE CONNECTIONS.** For unprotected MA-23DR Systems, external alarm interface connections are made to the Transmitter and Receiver Digital Interface Units. On MA-23DR Hot Standby Duplex Systems, external alarm interface connections are made to the Automatic Hot Standby Switchover Unit as specified herein.

The Transmitter Digital Interface Unit provides a Form C, dry relay contact summary alarm under the following conditions; TX source (Gunn) current too high or too low, loss of data, or prime power failure. The Receiver Digital Interface Unit provides a Form C, dry relay contact summary alarm under the following conditions; loss of carrier, loss of bit-sync lock, or prime power failure. Summary alarm connections for Transmitter and Receiver Digital Interface Units are available at the D-type panel connector located on the rear panel of each unit (reference Tables 3-7 and 3-8).

### NOTE

On Hot Standby Duplex Systems, alarm relay contacts of the Transmitter and Receiver Digital Interface Units are connected to the Hot Standby Switchover Unit. They are not available for external connection in this instance. In a Hot Standby System, external alarm connections are made to the Hot Standby Switchover Unit only.

The Hot Standby Switchover Shelf (Hot Standby Systems only) provides a Form C, dry relay contact summary alarm under the following conditions; any of the alarm conditions listed above for the Transmitter and Digital Interface Units, excessive bit error rate (when equipped with optional BER cards), or prime power failure. Alarm connections for the Hot Standby Switchover Unit are available for supervisory use at the plug-in terminal strip labeled SUMMARY ALARM located on the rear panel.

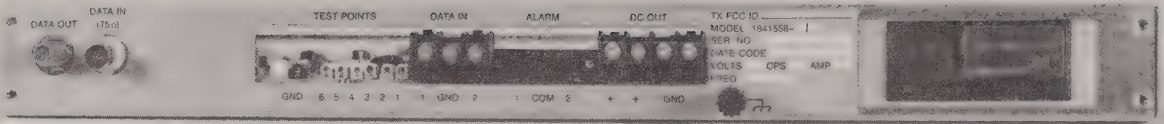


Figure 3-28. Transmitter Digital Interface Unit – Rear View



Figure 3-29. Receiver Digital Interface Unit – Rear View



Figure 3-30. Hot Standby Switchover Unit – Rear View

**PRIMARY POWER CONNECTIONS.** MA-23DR Systems operate from –24 or –48 Vdc power sources, or from 115/230 Vac line power, which must be specified for each system. Primary power connections are made to the indoor Transmitter and Receiver Digital Interface Units (all systems), and to the Automatic Hot Standby Switchover Unit (Hot Standby Systems only).

The outdoor RF Units are powered by the indoor units via the power interconnection cables. When primary power connections are made to the indoor units, the outdoor RF Units are energized.

Since MA-23DR Systems are designed for continuous, unattended operation, there are no power switches. Once primary power connections are made, the system is operational.

**NOTE**

The Hot Standby Switchover Unit contains redundant power supplies. Each power supply requires connection to separate power sources.

**Option A – DC Powered Systems**

DC power connections are made to terminal strips located on the rear panels of the indoor units.

Carefully observe conductor polarity and cross section requirements before making primary power connections. Note that use of 100V PC card orientation yields identical performance to 120V orientation. Use of 220V card orientation yields identical performance to 240V orientation.

**Option B – AC Powered Systems**

AC powered systems will operate from 115 or 230 Vac mains. Be sure the mains selecting card is positioned to the correct voltage and that the correct fuse is installed.

Note that use of 100 Vac mains selecting card orientation yields identical performance to 120 Vac orientation. Also, 220 Vac card orientation yields identical performance to 240 Vac orientation.

Table 3-6. Cross-Connect Requirements (Balanced Data)

DATA RATE	CROSS-CONNECT SPEC
T1	Bell DSX-1; 100 ohm twisted pair, ±3V peak
T1C	Bell DSX-1C; 100 ohm twisted pair, ±3V peak
T2	Bell DSX-2; 110 ohm twisted pair, ±3V peak
CEPT1	120 ohm twisted pair, ±3V peak
CEPT2	150 ohm twisted pair, ±3V peak

Table 3-7. TX Pin Connector Pin Outs

J7 PIN NUMBER	FUNCTION
1	Auxiliary Baseband Input
2	No Connection
3	Alarm Normally Open (Closed When OK)
4	Alarm Normally Closed (Open When OK)
5	Ground
6	Balance Data Input
7	Ground
8	No Connection
9	Ground
10	No Connection
11	Alarm Relay Common
12	No Connection
13	Balance Data Input
14	No Connection
15	No Connection

Table 3-8. RX “D” Connector Pin Outs (With Data ON)

J5 PIN NUMBER	FUNCTION
1	First LO Control Voltage
2	Recovered Clock
3	Alarm Normally Open From Pin 11 (Closed When OK)
4	Alarm Normally Closed To Pin 11 (Open When OK)
5	Ground
6	Differential Data Out A (E8)
7	Ground
8	No Connection
9	Ground Return For Pin 1
10	Ground Return For Pin 2
11	Alarm Relay Common
12	No Connection
13	Differential Data Out B (E11)
14	No Connection
15	No Connection



# SECTION 4

# ANTENNA ALIGNMENT

# AND FINE TUNING

## ANTENNA ALIGNMENT

It is assumed that prior to installation, proper line-of-sight (LOS) has been assured.

### PREPARATION

Step 1. Plug in the Digital Interface Units at each end of the link. The Baseband Units will now provide power for operation of the RF/Antenna Units so that RF signals are available for alignment.

Step 2. Establish a communications link between the sites at both ends of the link using telephones or two-way radio.

**ALIGNMENT.** Alignment of the transmitting and receiving antennas is a simple procedure but requires that they be pointed toward each other in both azimuth and elevation with a reasonable degree of accuracy. Since the antenna beamwidth is 1.8° (2 foot dish), misalignment of the antennas by 0.9° means that approximately only one-half of the signal power will be received.

Step 1. *Visually Point Antennas.* The easiest method of pointing the antennas toward each other is by visually aligning them. This method is preferred for short distances when both sites are in view of each other. However, for longer paths, where there are no large easily identifiable landmarks on the horizon for visual reference, or if atmospheric conditions limit visibility during installation, then topographical maps must be used to determine antenna pointing angles. Details on this procedure, if found necessary, are provided later in this section.

Step 2. *Connection to AGC Voltage Readout.* Disconnect coax from IF OUT connector on Receiver RF Unit(s). The center conductor of the RF Box F connector has the AGC voltage on it. Use a voltmeter on the 10V scale to measure this voltage during Step 3.

Step 3. *Alignment.* On a SIMPLEX link, this operation requires a person at each antenna communicating to each other by telephone or walkie-talkie. For a DUPLEX link, each end of the link can be aligned one at a time, using the Receiver at each site.

At the Receiver site, sweep the path by slowly turning the RF/Antenna Assembly from left to right. The antenna pattern has a main lobe that provides the greatest gain. Immediately on either side of the main lobe, a sharp drop in signal strength occurs and then a slight increase in signal strength occurs. This increase is caused by the sidelobes. Peak the AGC voltage readings on the volt meter until the maximum reading is obtained (this corresponds to the point of maximum signal strength) and secure the RF/Antenna Assembly in these positions.

Step 4. Next, change the tilt of the antenna and further peak the AGC reading. The same antenna pattern considerations noted above also apply here.

Step 5. Next, align the Transmitter antenna using the same procedures as performed at the Receiver while monitoring the AGC voltage readings on the volt meter at the Receive site.

Step 6. Repeat Steps 3 through 5 until the AGC value at the Receiver is peaked (approximately 5 to 7 Vdc).

### NOTE

It is strongly recommended that a power meter be used to fine tune the system. Small imperceptible changes in AGC voltage can result in large changes in RCL as the two are not linear.

Step 7. If a power meter with a 140 MHz head is available, disconnect F connector shown in Figure 4-1 inside Receiver RF Unit and measure the RCL (received carrier level). Figure 4-2 will provide the RCL *at the measurement point* which should be attained by proper antenna alignment for a range of path lengths. If this RCL value has not been attained by Steps 3 through 6 above, the following are among the most likely causes.

a. A close enough search was not conducted to find the main lobe in the iterations of the alignment procedure. The main lobe is 25 dB or more higher than the next highest lobe (the first side lobe). Repeat Steps 3 through 5 using the power meter.

### INITIATING ANTENNA POINTING AND ALIGNMENT USING TOPOGRAPHICAL MAPS

The two antenna pointing angles that must be determined, are azimuth and elevation. Azimuth is the angle in the horizontal plane with respect to true north. The antenna can be pointed to the correct azimuth angle by turning it on the mounting pole. Elevation is the angle in the vertical plane with respect to the horizontal plane. The elevation angle of the antenna is varied by adjusting the length of the elevation adjustment pod via the bolt at the lower end of the rod (Figure 3-14).

To determine the azimuth angle between the transmitting and receiving antennas, draw a straight line on the map connecting the Transmitter and Receiver sites. If possible, locate a distinct landmark which can be used for a visual reference to align the antennas. If this landmark does not lie directly on this straight line, draw another straight line to the landmark. Using a protractor measure the angle between the two lines to determine the offset angle. Align the antenna using this offset angle.

If no distinct landmarks are available, a magnetic compass may be used for antenna alignment. First, measure the angle between true north and the straight line drawn on the map connecting the Transmitter and Receiver sites. Convert the azimuth to magnetic north using the local declination angle. The difference between true north and magnetic north as follows:

- a. If magnetic north is to the west of true north, add local declination to the azimuth.
- b. If magnetic north is to east of true north, subtract local declination from the azimuth.

The local declination angle can be obtained from topographical maps.

An example of this method is shown in Figure 4-3 for a site located in Boston, Massachusetts area where the local declination is 14°W. Note that when using the compass to align the antenna in azimuth, care should be taken not to introduce errors because of nearby metal objects.

If visual alignment is not feasible, then the elevation angle must be calculated to align the antenna. The elevation angle may be calculated by taking the arctangent of the ratio of the difference in height of the two antennas to the distance between antennas. (Note: Height and distance must be in the same units; i.e., feet or meters). The difference in antenna heights can be determined from the mean sea level (MSL) heights of the two antennas and the distance can be measured on the topographical map using the appropriate scale. An example of an elevation angle calculation is shown in Figure 4-4. In this example, the transmitting antenna located on the building would be depressed by 2.3° from the horizontal to align the antenna in elevation.

### FINAL NOTES

Once the equipment is fully installed, it is advisable to make measurements of key voltage and power values during a clear day so that a working link reference is readily available if the need for troubleshooting (Section 5) should ever arise.

The following list gives examples of a few key measurements if the proper test equipment is available.

1. AGC Voltage
  - a. At Receiver front panel meter (meter is not calibrated in volts).
  - b. At coax center conductor at Receiver chassis F connector (IF IN – Figure 3-29).
2. RCL at IF reference point of Receiver RF Unit (Figures 4-1 and 4-2).
3. Note Transmitter source current (Gunn) meter reading.

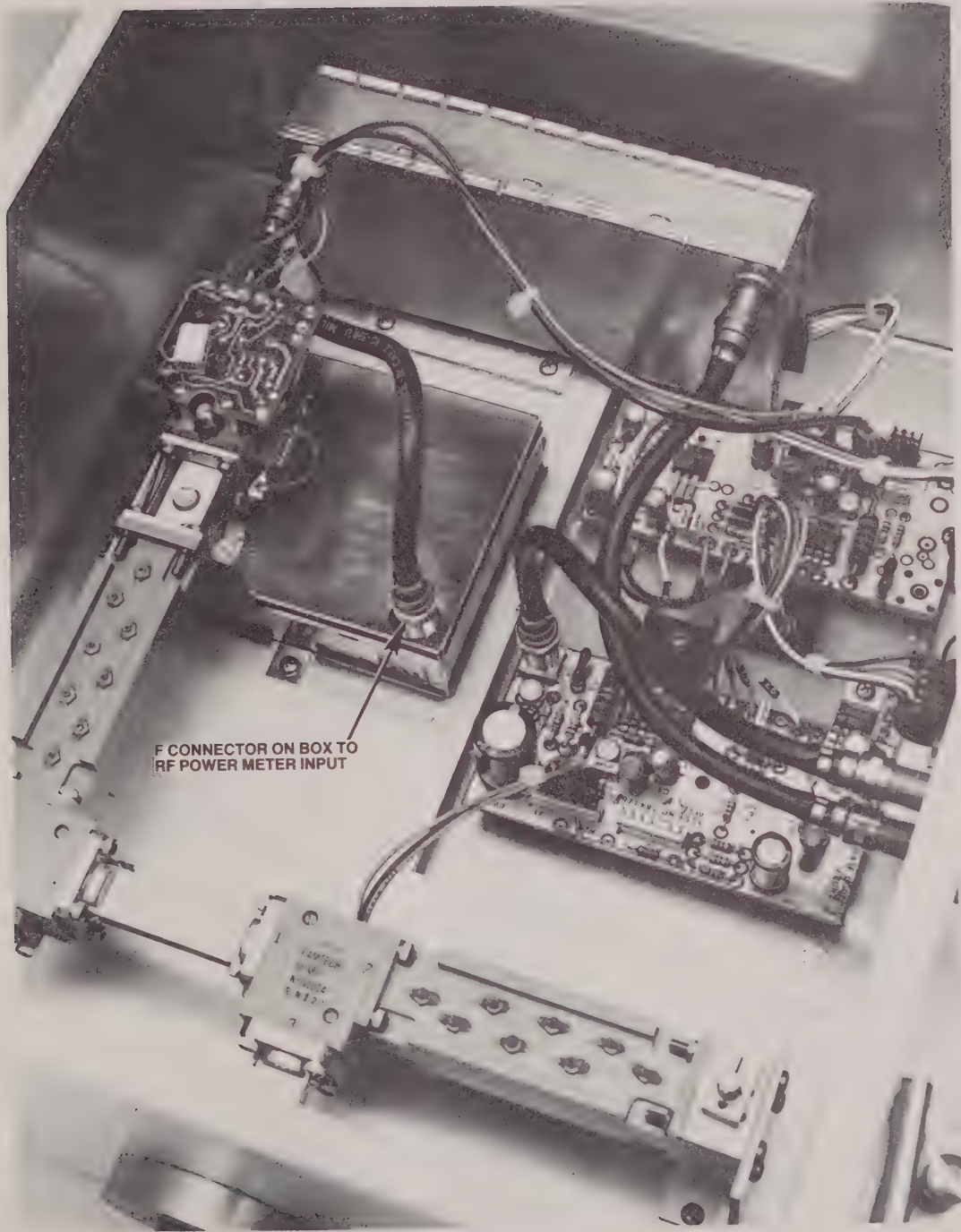


Figure 4-1. Disconnect F Connector Inside Receiver RF Unit to Access RCL Measurement by Power Meter (140 MHz Head)  
(Duplex RF Unit Shown Here)

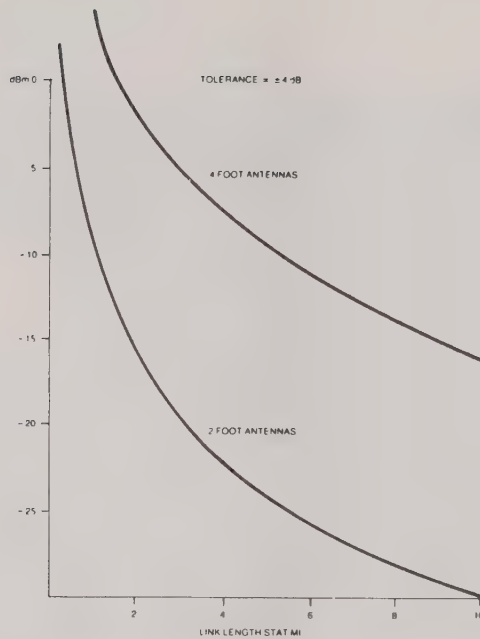
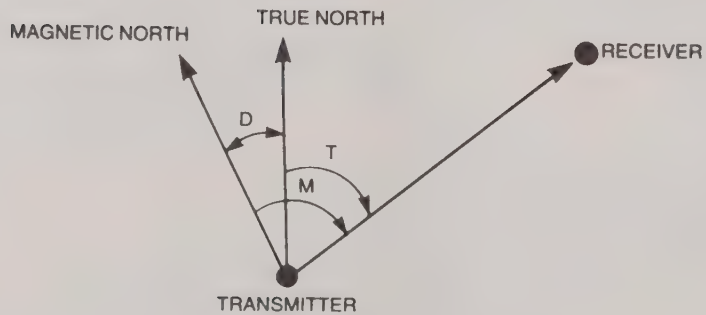


Figure 4-2. RCL at RF Unit Measurement Point vs. Link Length For Clear LOS (RCL Values On This Graph Take Into Account RF-to-IF Gain shown Here)



FORMULA:  $M = T + D$

WHERE: T = AZIMUTH ANGLE FROM TRUE NORTH  
 D = DECLINATION ANGLE (FOR YOUR AREA)  
 M = AZIMUTH ANGLE FROM MAGNETIC NORTH

EXAMPLE: (FOR BOSTON, MA AREA)

$T = 42^\circ$   
 $D = 14^\circ$   
 $M = 42^\circ + 14^\circ$   
 $= 56^\circ$

Figure 4-3. Azimuth (Magnetic Heading) Calculations

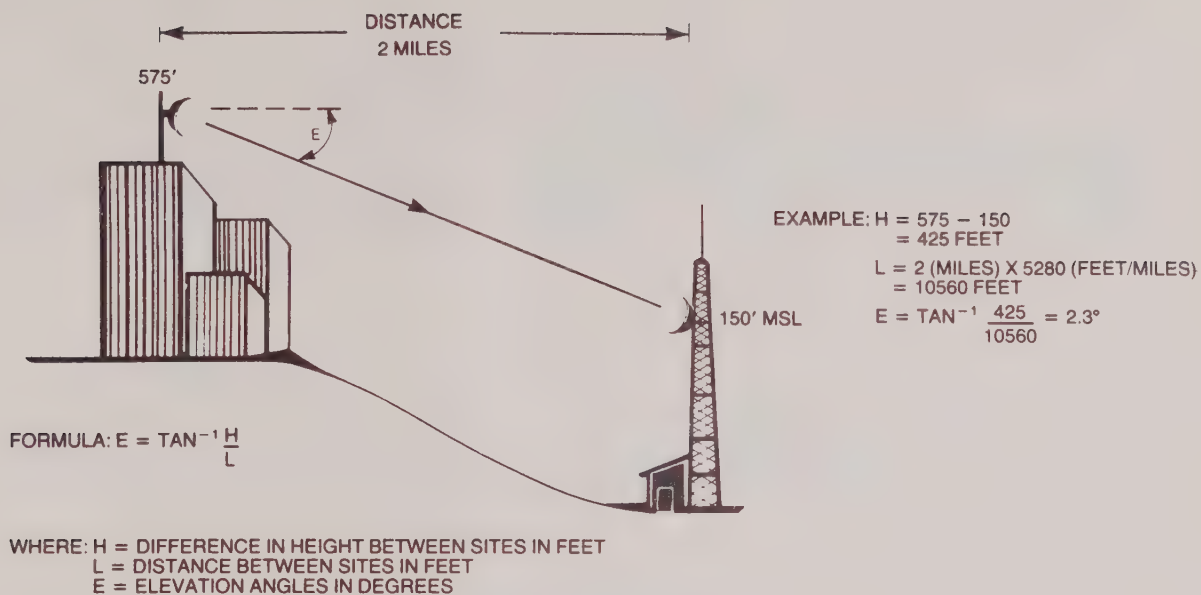


Figure 4-4. Elevation Calculations



# SECTION 5

## OPERATING INSTRUCTIONS

### OPERATING CONTROLS AND INDICATORS

All operating controls and indicators for the MA-23DR System are located on the indoor units. Controls and indicators for the Transmitter and Receiver Digital Interface Units (all MA-23DR Systems) are listed in Tables 5-1 and

5-2, respectively. Controls and indicators for the Automatic Hot Standby Switchover Unit (MA-23DR Hot Standby Systems only) are listed in Table 5-3.

Table 5-1. Transmitter Digital Interface Unit – Controls and Indicators (Figure 5-1)

CONTROL OR INDICATOR	MARKING	FUNCTION
FRONT PANEL LED (Green) LED (Green)  LED (Green) METER	POWER GUNN CURRENT  DATA	Lights when power supply is operational. ON when current to Transmitter Gunn is within acceptable limits. ON when modulation data present. Provides indication of Transmitter Source (Gunn) current.
REAR PANEL Fuse (1A for 100/120 Vac; 0.5A for 220/240 Vac)	FUSE-PULL	Fuse provides overload protection for Transmitter subsystem. Pull to remove fuse.

Table 5-2. Receiver Digital Interface Unit – Controls and Indicators (Figure 5-2)

CONTROL OR INDICATOR	MARKING	FUNCTION
FRONT PANEL LED (Green) LED (Green)  LED (Green) METER	POWER CARRIER*  DATA	Lights when power supply is operational. Lights when RF signals are received (receive carrier level, RCL, above threshold). Lights when digital bit sync lock is achieved. Indicates AGC voltage.
REAR PANEL Fuse (1A for 110/220 Vac; 0.5A for 220/240 Vac)	FUSE-PULL	Fuse provides overload protection for Receiver subsystem. Pull to remove fuse.

\*Only indicates that RF signal is present, does not mean data signals are being demodulated.

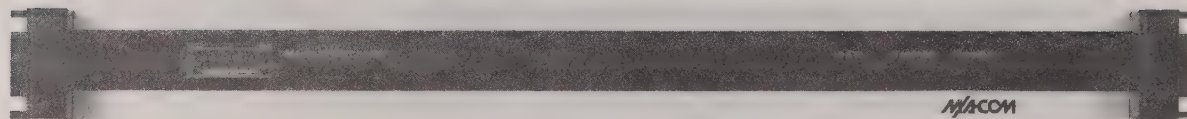


Figure 5-1. Transmitter Digital Interface Unit – Front View



Figure 5-2. Receiver Digital Interface Unit – Front View



Figure 5-3. Hot Standby Switchover Unit – Front View

Table 5-3. Automatic Hot Standby Switchover Unit – Controls and Indicators

CONTROL OR INDICATOR	MARKING	FUNCTION
POWER INDICATORS (2) LED Indicators (green)	DC POWER 1-2	Light to indicate that dc power is applied to corresponding logic circuits and Transmitter RF Head switch driver circuit.
TRANSMITTER Toggle Switch (3-position)	TX CONTROL 1-AUTO-2	Permits manual selection of either Transmitter or automatic switching mode.
(2) LED Indicators (green)	ACTIVE 1-2	Corresponding LED lights when TX1 or TX2 is on-line in automatic switching or manual (override) mode.
LED Indicator (red)	MANUAL	Lights when manual (override) operating mode is selected.
(2) LED Indicators (red)	TX ALARM 1-2	Corresponding indicator lights when TX1 or TX2 fault occurs. (Refer to faulted TX Digital Interface Unit front panel indicators to determine nature of fault.)
RECEIVER Toggle Switch (3-position)	RX CONTROL 1-AUTO-2	Permits manual selection of either Receiver or automatic switching mode.
(2) LED Indicators (green)	ACTIVE 1-2	Corresponding LED lights when RX1 or RX2 is on-line in automatic switching or manual (override) mode.
LED Indicator (red)	MANUAL	Lights when manual (override) operating mode is selected.
(2) LED Indicators (red)	RX ALARM 1-2	Corresponding indicator lights when RX1 or RX2 fault occurs. (Refer to faulted RX Digital Interface Unit front panel indicators to determine nature of fault.)
LOOPBACK Toggle Switch (3-position)	LOOPBACK OVERRIDE-NORM-B/BLB	Permits selection of loopback function for troubleshooting purposes or override of remote loopback command. – NORMAl position (listening mode) permits loopback of the local terminal only when triggered by relay closure across pins of REMOTE LOOPBACK connector on backplane of Hot Standby Switchover Unit. – B/B LB (baseband loopback) position places the local terminal in loopback mode. – OVERRIDE position overrides remote loopback of the local terminal, restoring transmission of data.
LED Indicators (red)	BBDLB	(Baseband Digital Loopback) Lights when loopback function is locally selected.
LED Indicator (red)	RLB	(Remote Loopback) Lights when remote loopback command is received and executed.
LED Indicator (red)	RLBO	(Remote Loopback Override) Lights when remote loopback command is overridden.
LED Indicator (red)	WG SW ALARM	(Waveguide Switch Alarm) Lights when waveguide switch fails to operate on control logic command. Note: There is a short delay after receiving a command before the switch carries out its switching action. During this short period, the indicator will light briefly.

## Operating Instructions

### TURN-ON PROCEDURES

#### DUPLEX (UNPROTECTED) SYSTEMS

Step 1. Turn ON the system by connecting the Transmitter and Receiver Digital Interface Units to their primary power sources. Since MA-23DR Systems are designed for continuous, unattended service, there are no power switches.

Step 2. On the Transmitter Digital Interface Units:

- a. Observe that POWER, GUNN, and DATA indicators light.
- b. Record the front panel meter reading (TX source Gunn current) and compare with readings taken during installation.

Step 3. On Receiver Digital Interface Units:

- a. Observe that POWER, CARRIER, and DATA indicators lights.
- b. Record the front panel meter reading (AGC voltage) and compare with readings taken during antenna alignment.

#### NOTE

The AGC meter reading may be affected by signal interruptions of a temporary nature, as may be caused by heavy rains or temporary path blockage. Transmission will resume once the interfering event is removed and the AGC meter reading will reach its normal level.

#### HOT STANDBY DUPLEX SYSTEMS

Step 1. Position the front panel switches of the Automatic Hot Standby Switchover Unit as follows:

- a. Place TX CONTROL toggle switch in AUTO (center) position.
- b. Place RX CONTROL toggle switch in AUTO (center) position.
- c. Place LOOPBACK toggle switch in NORM (center) position.

Step 2. Turn ON the system by connecting the Transmitter and Receiver Digital Interface Units, and the Hot Standby Switchover Unit to their primary power sources. Since the MA-23DR Systems are designed for continuous, unattended service, there are no power switches.

Step 3. On the Transmitter Digital Interface Units:

- a. Observe that POWER, GUNN, and DATA indicators light.
- b. Record the front panel meter reading (TX source Gunn current) and compare with readings taken during installation.

Step 4. On Receiver Digital Interface Units:

- a. Observe that POWER, CARRIER, and DATA indicators lights.
- b. Record the front panel meter reading (AGC voltage) and compare with readings taken during antenna alignment.

#### NOTE

The AGC meter reading may be affected by signal interruptions of a temporary nature, as may be caused by heavy rains or temporary path blockage. Transmission will resume once the interfering event is removed and the AGC meter reading will reach its normal level.

Step 5. On the Hot Standby Switchover Unit:

- a. In the dc power indicator group, observe that DC POWER 1-2 (green LED's) both light indicating that dc power is available.
- b. In TX control/indicator group, observe that the ACTIVE 1 (green LED) lights indicating that TX1 is on-line.
- c. In RX control/indicator group, observe that the ACTIVE 1 (green LED) lights indicating that RX1 is on-line.
- d. In the Loopback control/indicator group, observe that all indicators are extinguished indicating that normal operation (i.e., not operating in loopback mode and waveguide switch is operative).

#### NOTE

There is a short delay before the waveguide switch responds to a command. During this short period the WG SW ALARM (red LED) indicator will light briefly.

### SYSTEM OPERATION

The MA-23DR Systems are designed for unattended, continuous operation. After initial system turn-on, if operating conditions are achieved [i.e., POWER, GUNN, and DATA (green LED's)] on the front panel of the Transmitter Digital Interface Unit all lighted; POWER, CARRIER, and DATA (green LED's) on the front panel of the Receiver Digital Interface Unit all lighted; and no alarms, the system should require no further attention. No adjustments are necessary.

**HOT STANDBY DUPLEX.** MA-23DR Hot Standby Duplex Systems are equipped with an Automatic Hot Standby Switchover Unit that provides additional control and diagnostic capabilities beyond those provided by unprotected systems. In addition to the status indicators, as provided by the Transmitter and Receiver Digital Interface Units, the front panel status indicators on the Hot Standby Switchover Unit notifies the operator whenever a Transmitter or Receiver fault

fault occurs, the waveguide switch fails to function, the manual operating mode is selected (Transmitter or Receiver), when loopback testing is selected locally or remotely, or when a remote loopback command is overridden.

Normally, the MA-23DR Hot Standby Duplex System is operated in the automatic switching mode as noted in the turn-on procedures. For testing purposes, either Transmitter or Receiver can be manually selected for operation using the TX CONTROL or RX CONTROL toggle switches. Front panel indicators of the Hot Standby Unit will locally announce which unit is selected for operation and that the manual mode of operation is in effect.

Loopback testing may be selected locally or remotely. Note that transmission of data is interrupted when the loopback mode is invoked.

Loopback testing may be selected locally by placing the LOOPBACK toggle switch in the B/B LB (Baseband Loopback) position. The local terminal will be placed in the loopback mode and the BBDLB (Baseband Digital Loopback) indicator will light. The local loopback test can be terminated and transmission of data restored by placing the LOOPBACK toggle switch in the NORMAL position.

In order to place the remote terminal at the other end of the link into the loopback mode, an alternate communication link (such as an unconditioned, dedicated Telco line) and a customer provided interface unit (capable of placing relay closure across pins of the REMOTE LOOPBACK connector on the backplane of the Hot Standby Switchover Unit of the remote terminal) are required. (Note: The LOOPBACK

toggle switch on the Hot Standby Switchover Unit at the remote terminal must be placed in the NORMAL position in order to accept and execute a remote loopback command.) When a loopback command is received at the remote terminal (relay closure at the REMOTE LOOPBACK connector), the RLB (Remote Loopback) indicator will light to alert the operator at the remote terminal that a remote loopback command has been received and that transmission of data has been interrupted for testing purposes. The remote loopback test may be terminated at the remote terminal (restoring the transmission of data) by placing the LOOPBACK toggle switch at the remote terminal in the OVERRIDE position. The RLBO (Remote Loopback Override) indicator will light to confirm that a remote loopback command has been overridden, restoring normal transmission of data.

## FIELD MODIFICATIONS

**CHANGING DATA RATE.** To change the MA-23DR operating data rate (to any of T1 – 1.544 Mbs, T1C – 3.152 Mbs, T2 – 6.132 Mbs, CEPT1 – 2.048 Mbs, or CEPT2 – 8.448 Mbs rates), see Figures 5-4 and 5-5. The screws shown on the board must be removed and the wire harness disconnected. The front panel must be removed simply to allow clearance for board removal. Only a screwdriver is necessary.

**UNBALANCED (COAX) INPUT/OUTPUT.** Baseband data input to the Transmitter and output from the Receiver can be provided by moving the jumpers on the Transmitter and Receiver boards (Figures 5-6 and 5-7).

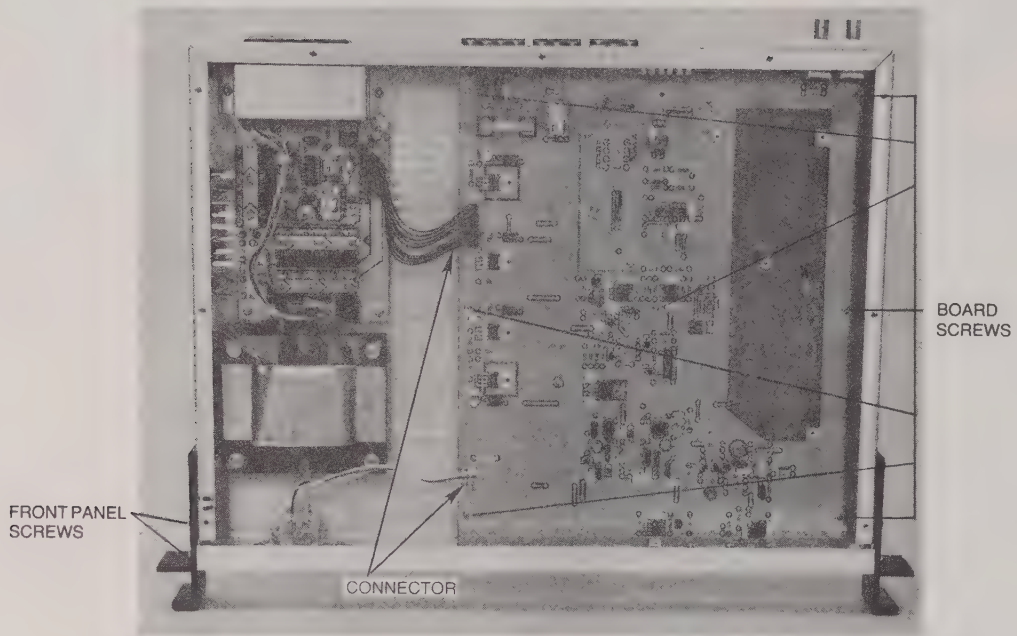


Figure 5-4. Changing Data Rate – Transmitter  
[Remove Connectors (2), Board Screws (7) and Front Panel Screws (4)]

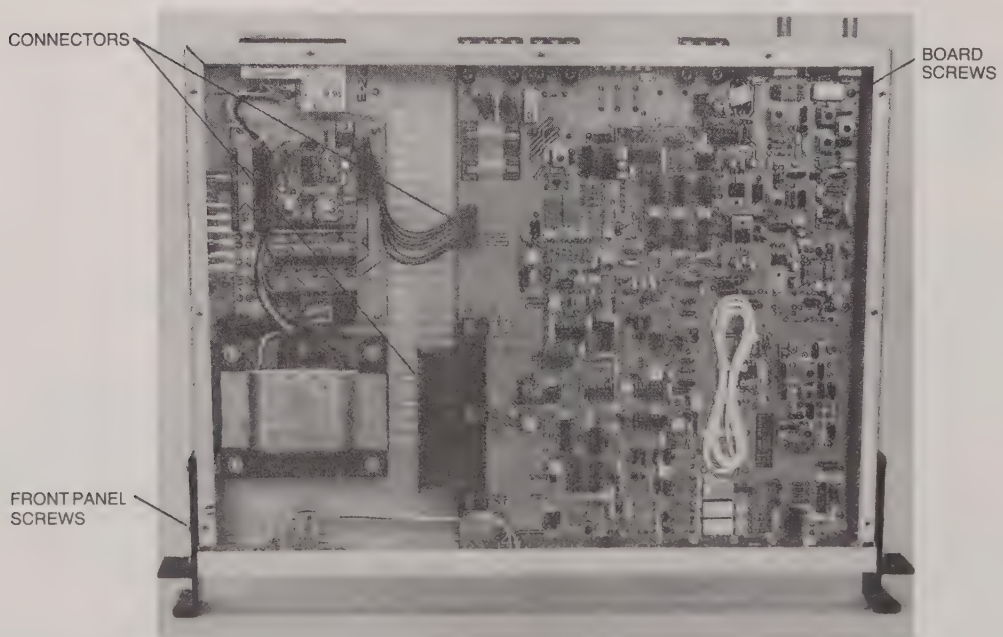


Figure 5-5. Changing Data Rate – Receiver  
[Remove Connector (1), Board Screws (7) and Front Panel Screws (4)]

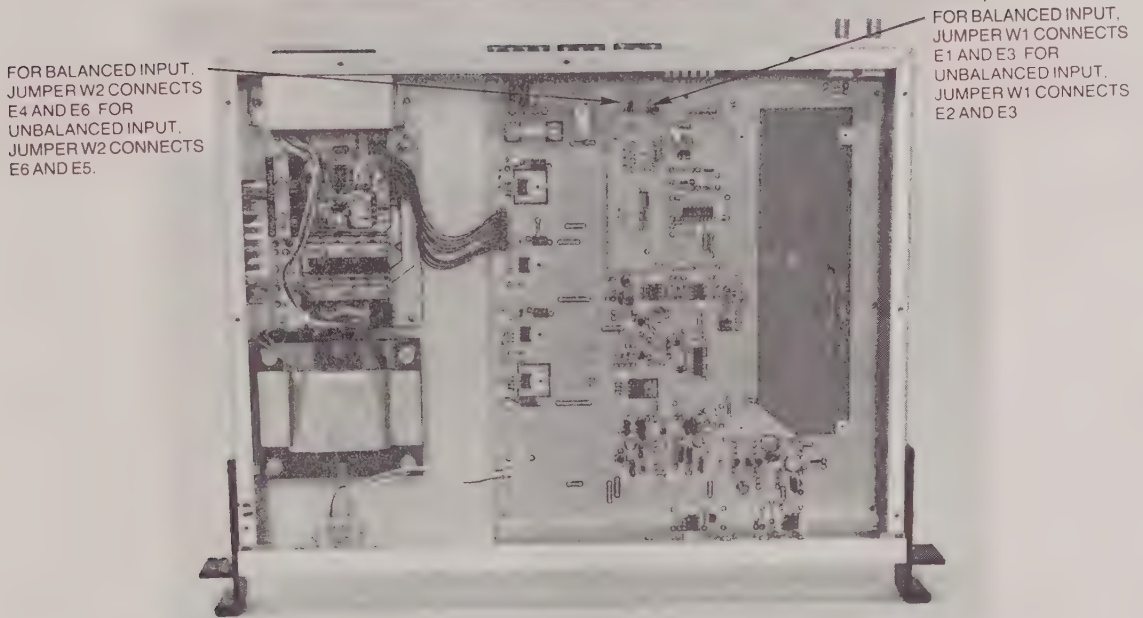


Figure 5-6. Transmitter Board – Moving Jumpers To Change From Balanced Input to Coax, Unbalanced Input



Figure 5-7. Receiver Board – Moving Jumpers To Change From Balanced Output to Coax, Unbalanced Output



# SECTION 6

# TROUBLESHOOTING

## GENERAL

The following figures are included for reference when using the troubleshooting charts (Tables 6-1 and 6-2). Most tests require only a volt-meter. For a few tests, an oscilloscope is necessary.

Table 6-1. Transmitter Controller – Troubleshooting Guide

SYMPTOMS	RECOMMENDED ACTION
1. All LED's OFF.	a. Check primary power. b. Check primary fuse on rear panel (Figure 6-1). c. Check voltage setting on rear panel (Figure 6-1). d. Check wiring harness installed on J1 Power Supply to J2 Controller Board (Figure 6-2).
2. Power and Gunn LED's ON. No data.	a. Check data at coaxial 75 ohm or balanced 100 ohm input (Figure 6-1). b. Check W1 and W2 in appropriate position (shipped in balanced, differential mode E1 to E3 and E6 to E4), internal to Transmitter Controller (Figure 6-2). c. Check line equalizer installed (internal to Controller) Assembly 1841560-x (Figure 6-2).
3. Power and data LED's ON. No Gunn.	a. Check wiring to outdoor RF Units (Figures 6-3 and 6-4). b. Check fuse internal to Transmitter Controller 2A fast (F1) – Figure 6-2. c. Check meter level of Transmitter Controller between 2-5 on meter scale (LED defective). d. Transmitter Source Assembly connected to Transmitter Regulator Assembly J1 (internal to RF Assembly) – Figures 6-3 and 6-4. e. Transmitter Regulator connected to RF/lightning (RF Assembly) – Figures 6-3 and 6-4.
4. All LED's ON. No output data.	a. Check for W4 and W5 installed at E9-E10 and E11-E12 or Scrambler Assembly installed at J3 (both internal to Transmitter Controller) – Figure 6-2.
5. All LED's ON, Meter 0, light OFF.	Check Meter Assembly cable on J5 (internal to Transmitter Controller) – Figure 6-2.

Table 6-2. Receiver Controller – Troubleshooting Guide

SYMPTOMS	RECOMMENDED ACTION
1. No LED's ON.	<ul style="list-style-type: none"> <li>a. Check primary power.</li> <li>b. Check primary fuse on rear panel (Figure 6-5).</li> <li>c. Check voltage setting on rear panel (Figure 6-5).</li> <li>d. Check power harness installed from J1 Power Supply to J4 Receiver Controller (internal Receiver Controller) – Figure 6-6.</li> </ul>
2. Power LED ON. No carrier, no data, meter 0 (light ON).	<ul style="list-style-type: none"> <li>a. Check Transmitter Gunn current and LED (Table 6-1).</li> <li>b. Check dc power cable to Transmitter and Receiver RF Unit (Figures 6-1, 6-3, 6-4, 6-5, and 6-7).</li> <li>c. Check fuses F1 (0.5A slow) and F2 (2A slow) internal to Receiver Controller (Figure 6-6).</li> <li>d. Are antennas pointed correctly?</li> <li>e. Check lightning arrestor/RFI filter board J1 connected to Receiver Regulator (RF Unit) – Figures 6-3 and 6-7.</li> <li>f. Check AGC IF Amp power cable connected J3 to J Receiver Regulator Board (RF Unit) – Figures 6-3 and 6-7.</li> <li>g. Check Preamp power connected to J Receiver Regulator board (RF Unit) – Figures 6-3 and 6-7.</li> <li>h. Check coaxial cable Preamp to AGC Amp (RF Unit) – Figures 6-3 and 6-7.</li> <li>i. Check coaxial cable AGC Amp to bulkhead feedthrough (RF Unit) – Figures 6-3 and 6-7.</li> <li>j. Check RF cable (RF Unit to Receiver Controller) – Figures 6-3, 6-5, and 6-7.</li> </ul>
3. Power LED ON, Carrier ON. No data LED.	<ul style="list-style-type: none"> <li>a. Check data LED on Transmitter Controller.</li> <li>b. Check data at Transmitter Controller DATA OUT (J4) [oscilloscope required] – Figure 6-1.</li> <li>c. Check Transmitter cable (baseband) for proper connection to RF Unit (Figures 6-1, 6-3, and 6-4).</li> </ul>
4. All LED's ON. No meter light or deflection.	Check Receiver Controller J3 to meter wiring harness (Figure 6-6).
5. All LED's ON. Meter above "1" light ON but data is not received.	Check jumpers W1 and W2 for proper installation (W1 – E9 to E8, W2 – E11 to E12, – differential 100 ohms) (W1 – E8 to E10, W2 – E11 to E13, – coaxial 75 ohms) – Figure 6-6.

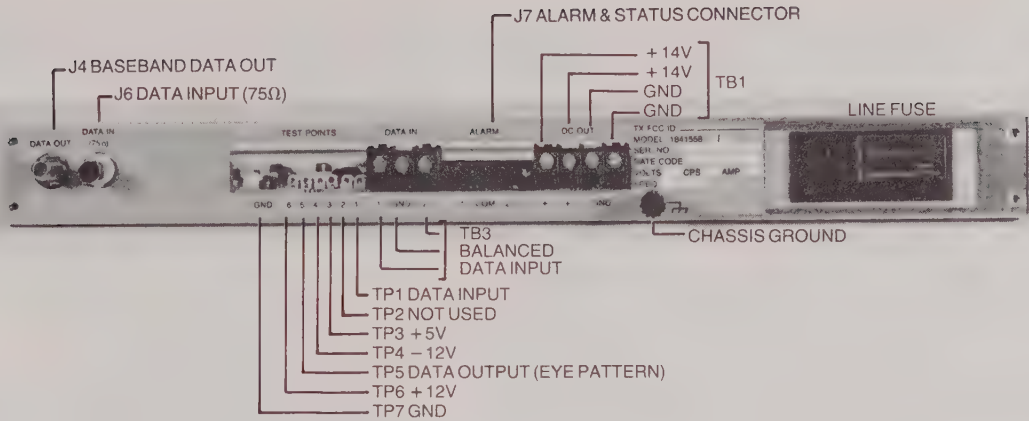


Figure 6-1. MA-23DR Transmitter Digital Interface Unit – Rear Panel

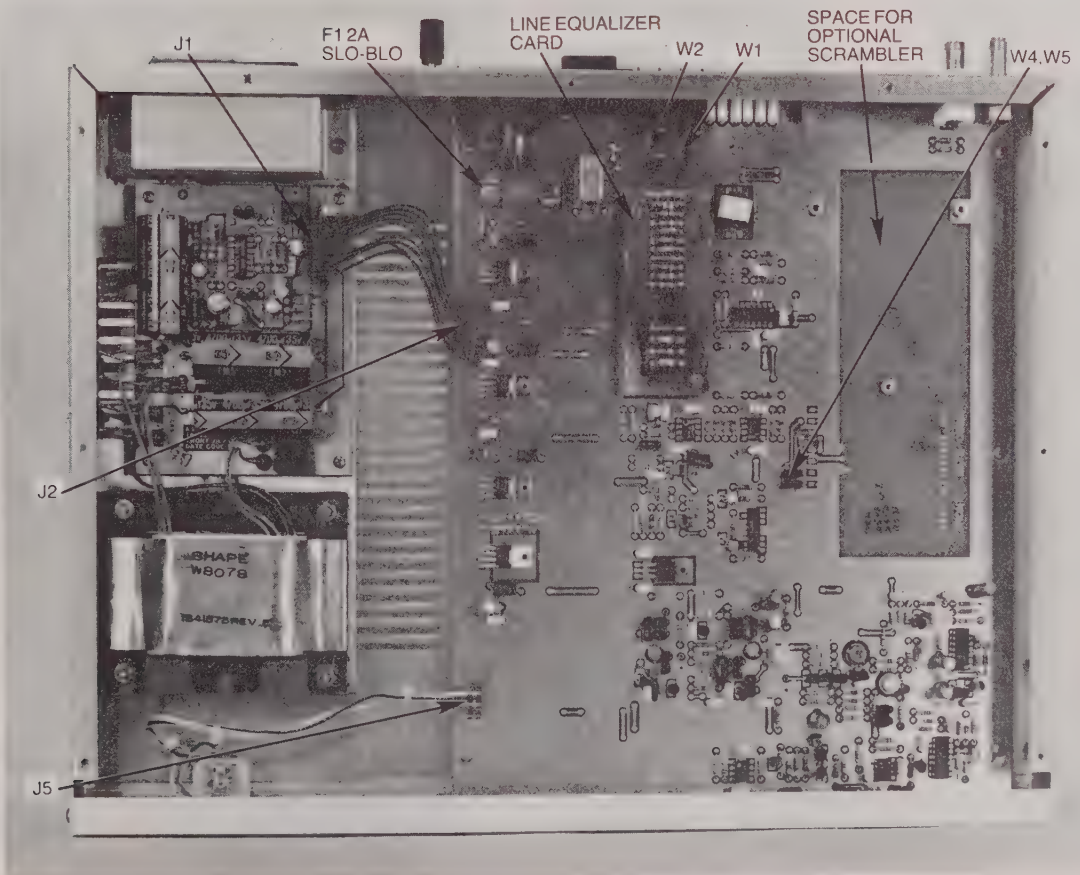


Figure 6-2. Transmitter Digital Interface Unit – Power Supply and Baseband Board

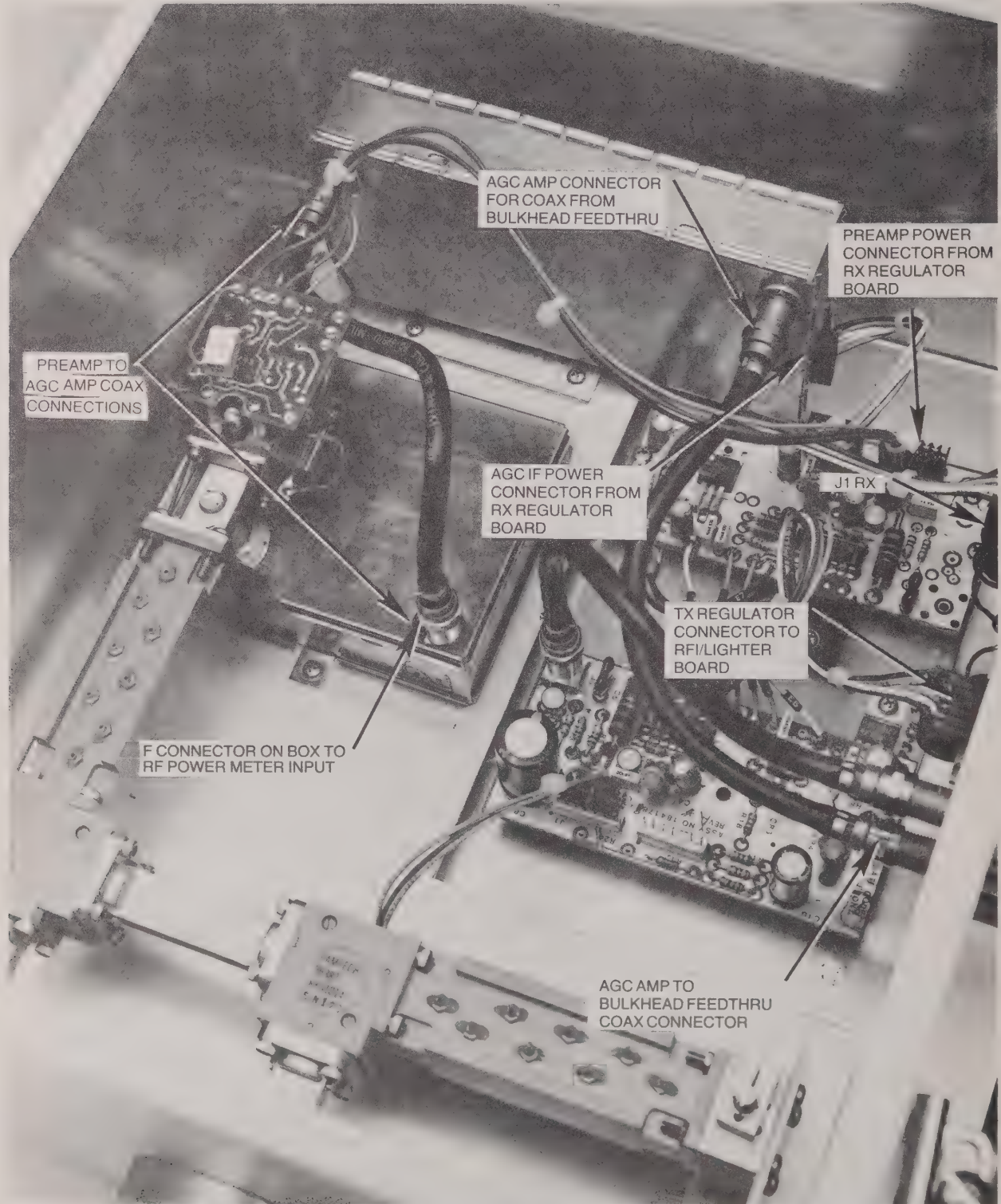


Figure 6-3. Duplex RF Unit

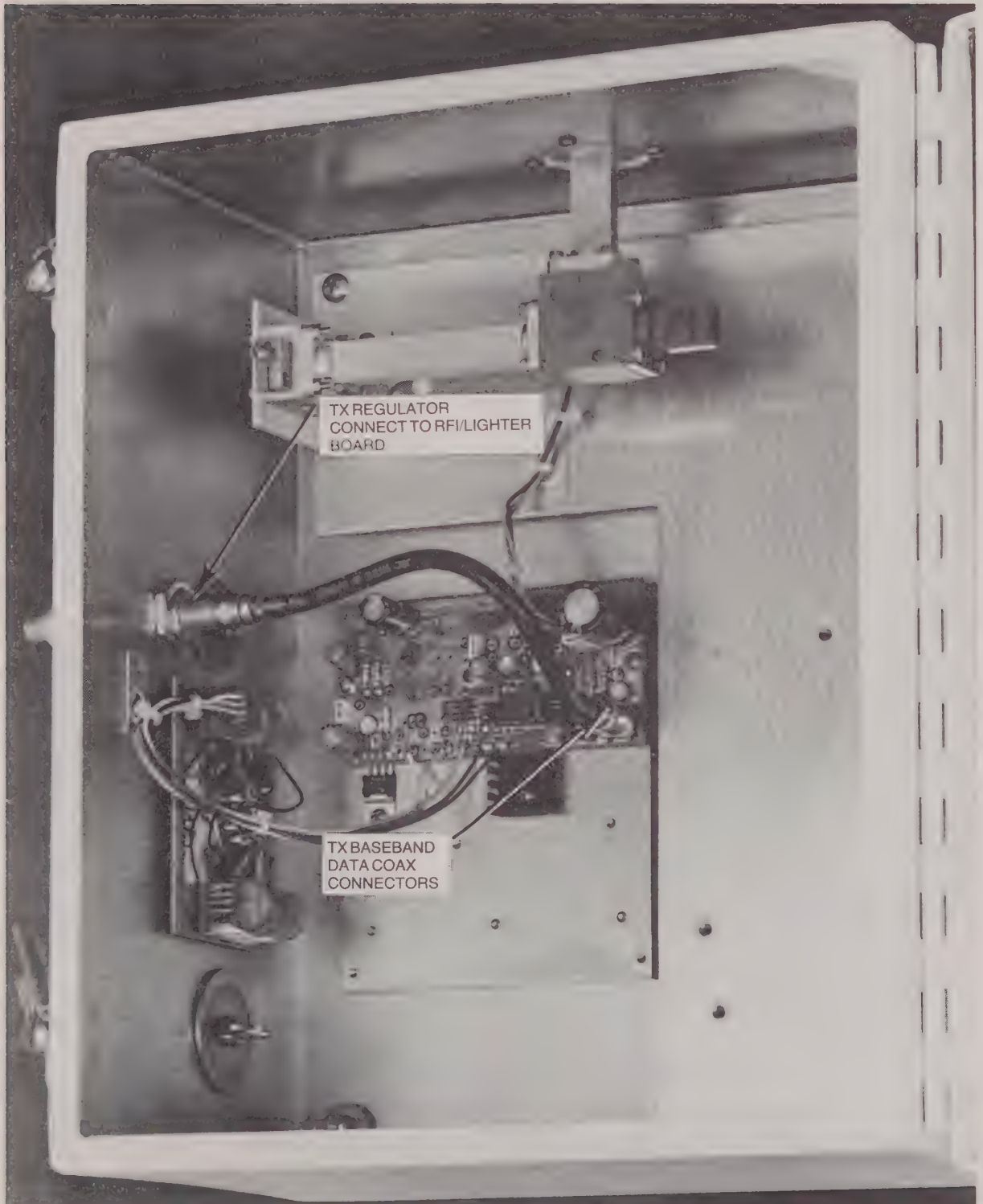


Figure 6-4. Transmitter Simplex RF Unit

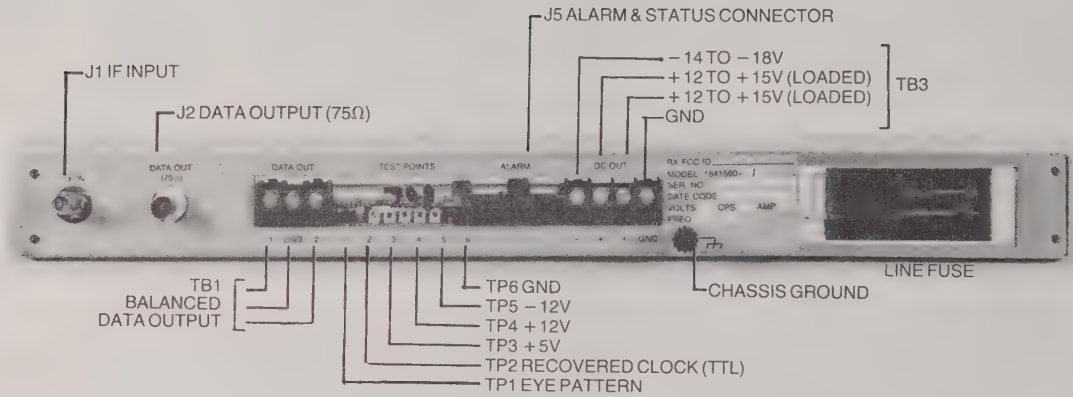


Figure 6-5. MA-23DR Receiver Digital Interface Unit – Rear Panel

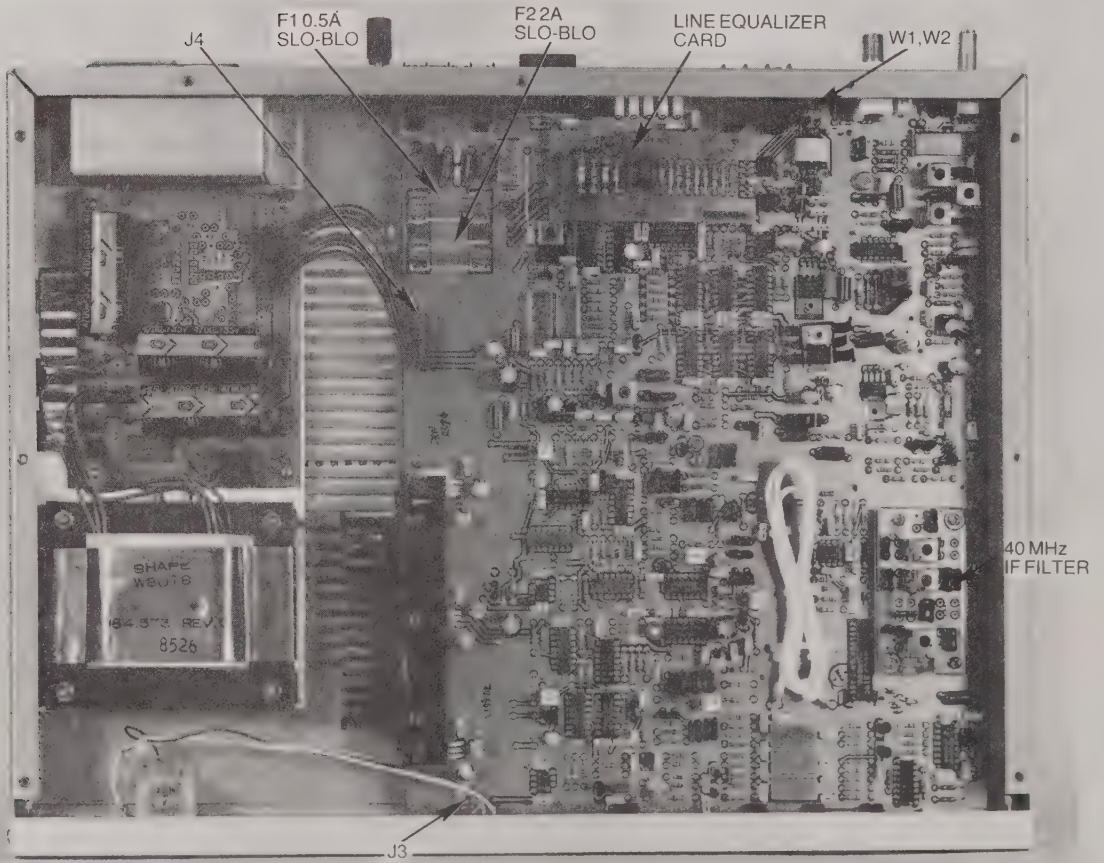


Figure 6-6. Receiver Digital Interface Unit – Power Supply and Baseband Board

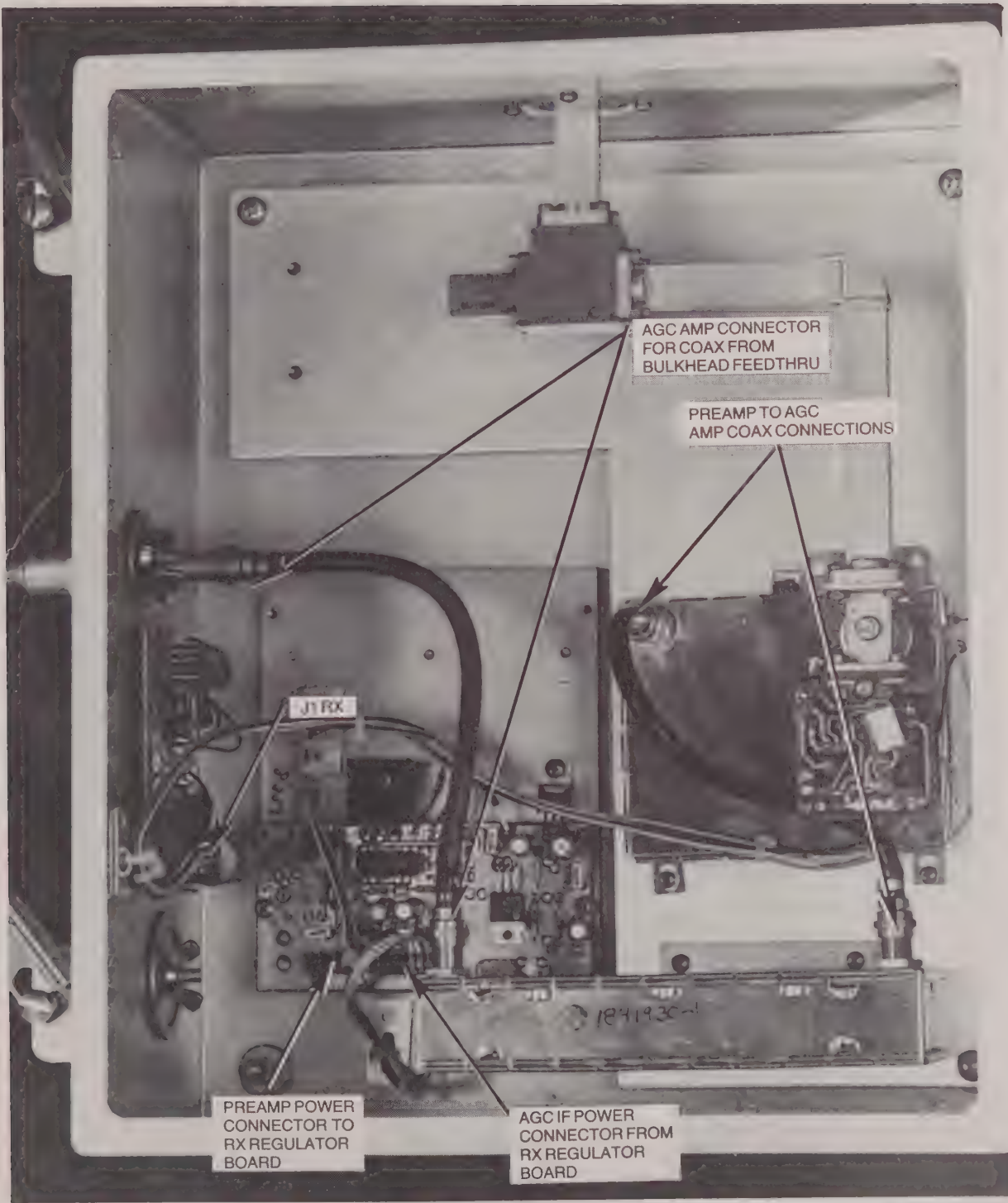


Figure 6-7. Receiver Simplex RF Unit



# SECTION 7

# WARRANTY

The M/A-COM microwave radio was designed and manufactured to provide troublefree operation. The latest technology is used. All components are solid-state which means no moving parts to wear out.

M/A-COM's warranty policy is one year all parts and labor. If, at any time, your system doesn't meet your expectations, contact the installing dealer. They are fully qualified to check out performance and isolate any inoperative subassembly.

The systems are modular and all components (except the specific frequency oscillators) are interchangeable. This allows easy troubleshooting and replacement in the field. The installing dealer is trained to expedite repair, therefore, you will experience little "down-time."

As aforementioned, your dealer is familiar with and best equipped to handle your problems. **Contact them first.** If this is impossible, please call the Customer Service Department at M/A-COM. The number is (800) 343-0864 X7591. We have engineers and service personnel available to assist you in locating problems and repairing your radio.

Being prepared to help the Customer Service Department will expedite the repair process. We will ask questions to help pinpoint the problem, i.e.:

1. What are the symptoms?
2. Distance between sites?
3. AGC voltages?
4. Meter readings?
5. Voltages out of interface units?
6. Associated equipment in use?
7. Past history of system?

If it is decided a subassembly must be returned to M/A-COM, we will ask questions such as:

1. Who was the installing dealer?
2. When was the unit purchased?
3. What was the original purchase order number or M/A-COM sales order number?
4. What is the date code?
5. What frequency are you using?
6. How soon must the system be repaired?
7. Who is our contact?
8. Who will remove and replace system?
9. Customer number?

The FCC requires a licensed technician to make adjustments and repairs so please refrain from "tweaking!" If you try to repair the system by adjusting or replacing "bad" parts — **the one year warranty will be voided.**

If you understand electronics, you must call M/A-COM for authorization to adjust or repair the system. Be aware that static sensitive parts are used which can be ruined by touching. You wouldn't operate on your own stomach so without authorization, please don't operate the "guts" of your radio.

When in doubt **CALL.**



# ASSEMBLY AND INSTALLATION PROCEDURE FOR 23 GHz 4 FOOT ANTENNA

## GENERAL

Assembly and installation of M/A-COM's high performance 23 GHz 4 Foot Antenna (M/A-COM PN 843750) requires two technicians who are qualified by training and experience for the installation of antennas.

## UNPACKING AND HANDLING

**UNPACKING.** Care should be taken when removing equipment from containers to prevent damage to the units. Ensure that all parts and accessories are removed from the container and packing material before they are discarded.

DO NOT discard the container or any packing material until inspection has been satisfactorily completed. This material must be available if a damage claim is to be made with the carrier.

**MECHANICAL INSPECTION.** Inspect the equipment for shipping damage. Make sure that no parts have been dented, scratched or otherwise damaged during shipment.

**DAMAGE IN SHIPMENT.** Should any damage be discovered after unpacking the system, immediately file a claim with the carrier. A full report of the damage should be made and a copy forwarded to your M/A-COM dealer. The dealer will then advise disposition of the equipment.

**RETURN AUTHORIZATION.** Subject to standard terms of the warranty policy, M/A-COM MAC, Inc., or its dealers, will repair all defective equipment.

Contact your dealer before returning any equipment for repair. A Return Authorization Tag which is available from your dealer must accompany any returned goods. Your dealer will provide instructions for forwarding material to his repair facility, or when necessary, to M/A-COM's Chelmsford, Massachusetts factory.

## TOOLS REQUIRED

Ratchet: 1/2 drive  
Sockets: 5/16", 1/2", and 3/4"  
Sockets (Deep): 7/16" and 11/16"  
Wrenches (Open End): 7/16", 1/2", 11/16", and 3/4"  
Allen Wrench: 7/64"  
Spring Check Gauge (supplied)

## ANTENNA/SHROUD/RADOME SUBASSEMBLY PROCEDURE

Assembly the Antenna/Shroud/Radome Subassembly on a smooth, flat work surface using the following procedure.

Step 1. Place the flat radome face down on the work surface.

Step 2. Place the shroud, face side down and centered on the radome as shown in Figure 1. Make sure to lineup the TOP label on the shroud with the top mark on the radome tab.

Step 3. Assemble the retaining pin and the spring-loaded radome hold-down assembly into tabs of radome and insert into slots of hold-down tabs on shroud (Figure 2).

Step 4. Install feed assembly into reflector using #6-32 screws, flat washers and lock washers (4 places). Orient the feed assembly for the required polarization as follows:

- a. Horizontal Polarization: the long dimension of the waveguide opening must line up with the TOP and bottom of the antenna.
- b. Vertical Polarization: the long dimension of the waveguide opening must be at a right angle with respect to the TOP and bottom of the antenna.

### NOTE

Unless otherwise specified, a lockwasher is required at all bolted joints in the following steps.

Step 5. Place the reflector/feed assembly on the shroud, using care to prevent damage to the feed assembly. Line up the TOP labels (indicated by a vertical arrow) and attach reflector/feed subassembly to shroud with 1/4-20 bolts and washers. Do not tighten.

Step 6. Install two top brackets on top rear (left and right side) of reflector using 1/4-20 nuts and washers. Install rod end bracket on bottom rear (center) of reflector using 1/4-20 nuts and washers. Do not tighten.

Step 7. Install antenna support pipe on top brackets using 5/16-18 x 3" bolts, nuts, and washers. Tighten all hardware installed in Steps 5 and 6.

Step 8. This step should be performed with installers working in pairs on opposite sides of the reflector diameter. Using spring check gauge (supplied), tighten jacking nuts

## 4 Foot Antenna

until springs are compressed as shown in Figure 2. Tighten jam nuts against jacking nuts to lock radome hold-down assemblies in place.

Step 9. Install rod end bearing into rod end bracket at bottom rear of reflector using 1/2-13 x 2" bolt, nut, and washers. Install threaded elevation adjustment rod into rod end bearing using 1/2-20 nut and washers and tighten hardware securely. Then, spin 1/2-20 nut onto free end of threaded rod at least 2 inches from end of rod.

### ASSEMBLY OF ANTENNA MOUNT ON VERTICAL TOWER OR POLE

Assemble the antenna mount on a vertical tower or pole using the following procedure.

Step 1. Install azimuth adjust clamp on pole using U-bolt and 7/16-14 nuts and washers. Orient clamp so that it points within  $\pm 5^\circ$  of desired azimuth position with long side of clamp on the right when looking in direction of antenna beam. Tighten hardware to secure clamp in place.

Step 2. Place antenna mount bracket, two large front hooks up, on opposite side of pole and install using two U-bolts, with 7/16-14 nuts and washers as shown in Figure 3, such that bottom flange racket rests on U-bolt installed in Step 1.

Nuts on U-bolts should be finger-tight at this time to allow for later azimuth adjustment.

Step 3. Install azimuth adjust bracket on bottom flange of antenna mount bracket using #10 bolts and washers. Then, install azimuth fine-adjust threaded rod on azimuth adjust bracket and azimuth adjust clamp using remaining #10 hardware plus 1/2-20 nuts and washers (flat washers only).

Step 4. Install arm bracket on right side of pole when looking in direction of antenna beam using two U-bolts and 7/16-14 nuts and washers (Figure 4). Top of arm bracket should be approximately 30 inches below the bottom of the azimuth adjust clamp.

Step 5. Install elevation adjustment arm on arm bracket using 1/2-13 x 1-1/4 bolt and washers. Elevation adjustment arm has five bolt holes, select bolt hole that provides required elevation adjustment range.

### ANTENNA INSTALLATION AND ALIGNMENT

Install the antenna on the antenna mount using the following procedure.

Step 1. Lift reflector/shroud/radome subassembly (Figure 5) and place antenna support pipe at top rear of reflector into front hooks of antenna mount bracket. Be sure that threaded elevation adjustment rod at bottom rear of assembly lines up with elevation adjustment arm.

Step 2. Secure antenna subassembly to antenna mount bracket using two clamps, 5/16-18 x 1" bolts and washers as shown in Figure 6. Do not tighten.

Step 3. Slip 1/2" flat washer on threaded elevation adjustment rod at bottom rear of reflector and guide rod into clearance hole on elevation adjustment arm as shown in Figure 6. Secure loosely with 1/2-20 nut and washers.

Step 4. Align antenna to desired pointing angle using adjustment nuts on threaded elevation adjustment rod and azimuth fine-adjust threaded rod.

Step 5. Once antenna alignment is completed, tighten all loose hardware.

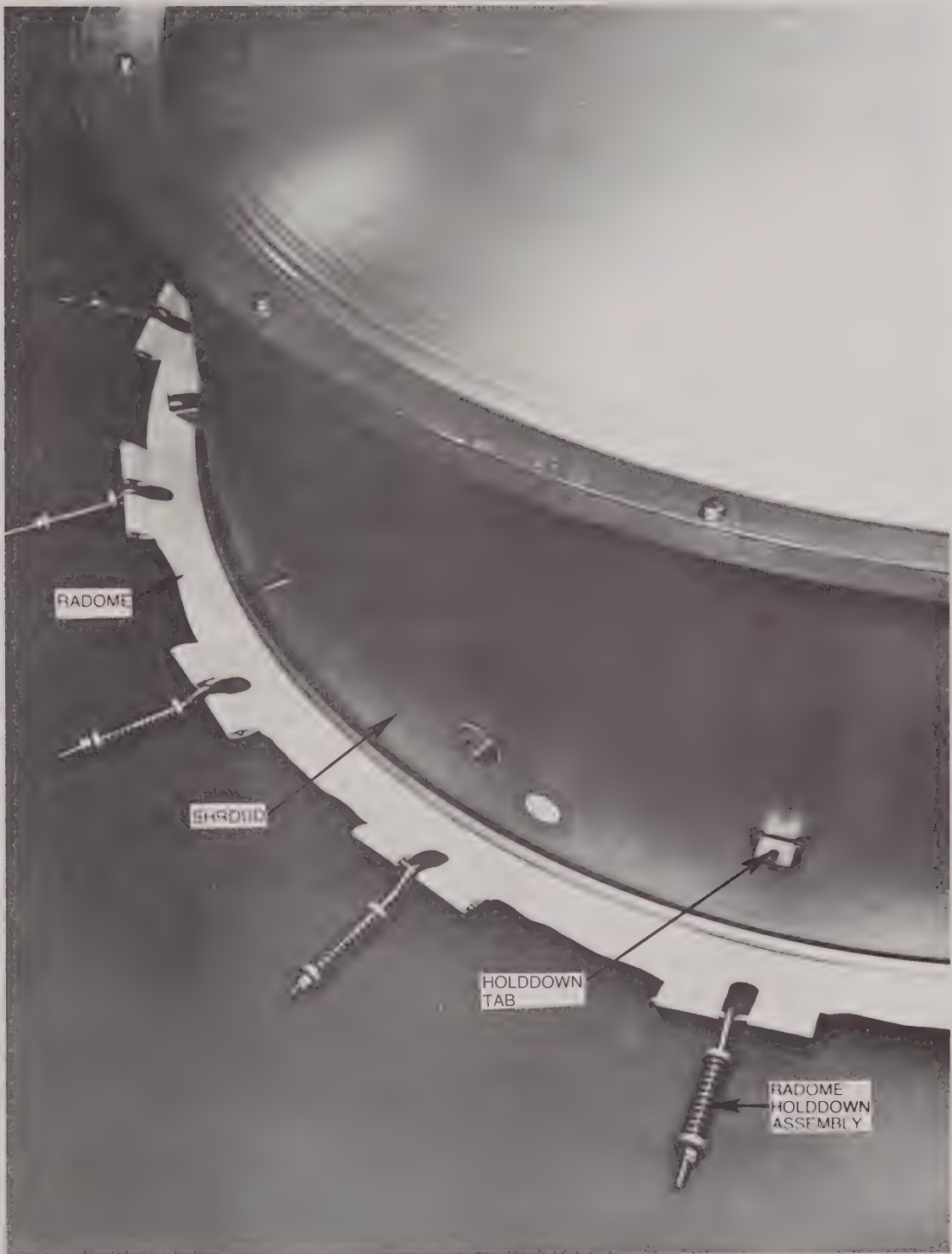


Figure 1

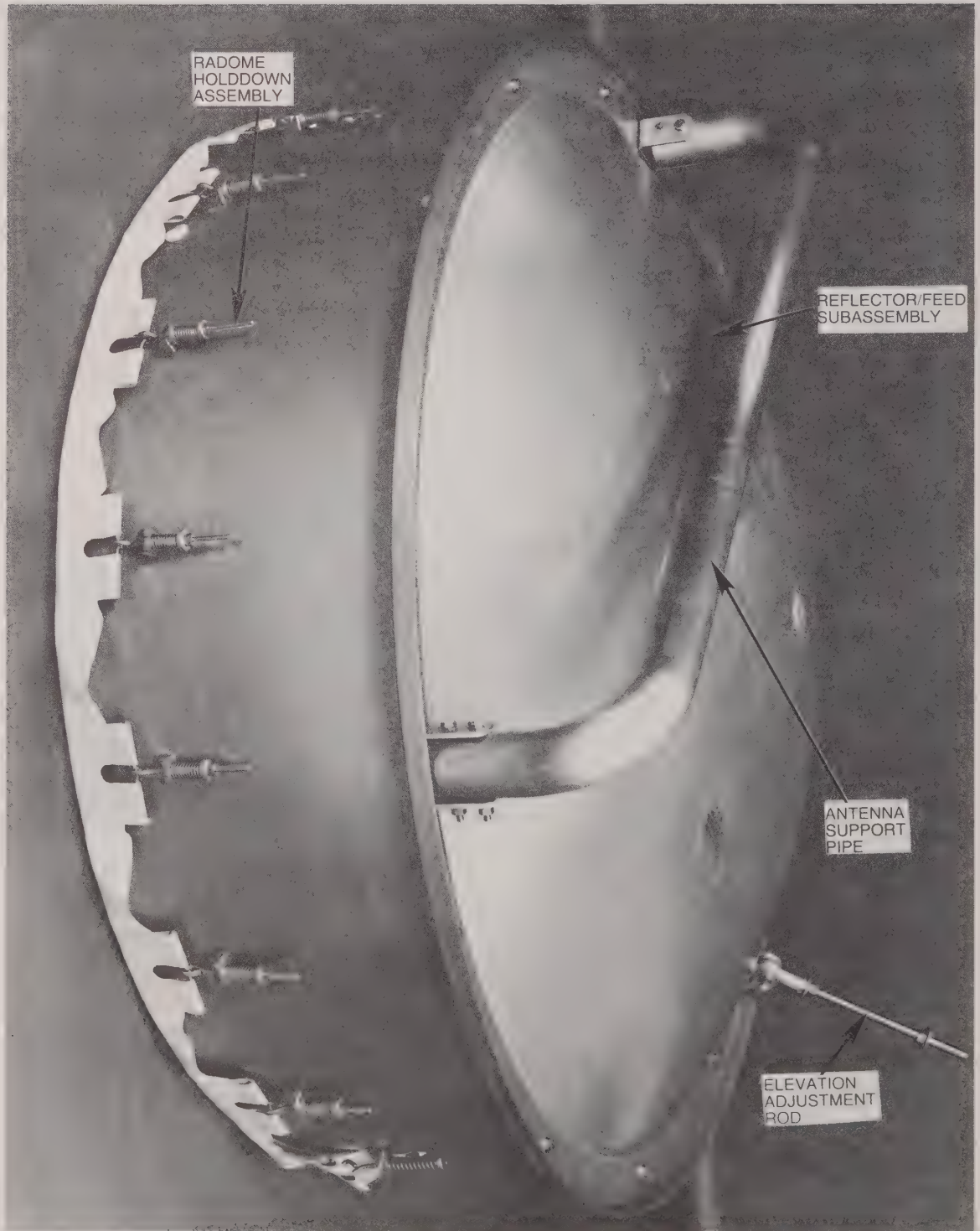


Figure 2



Figure 3

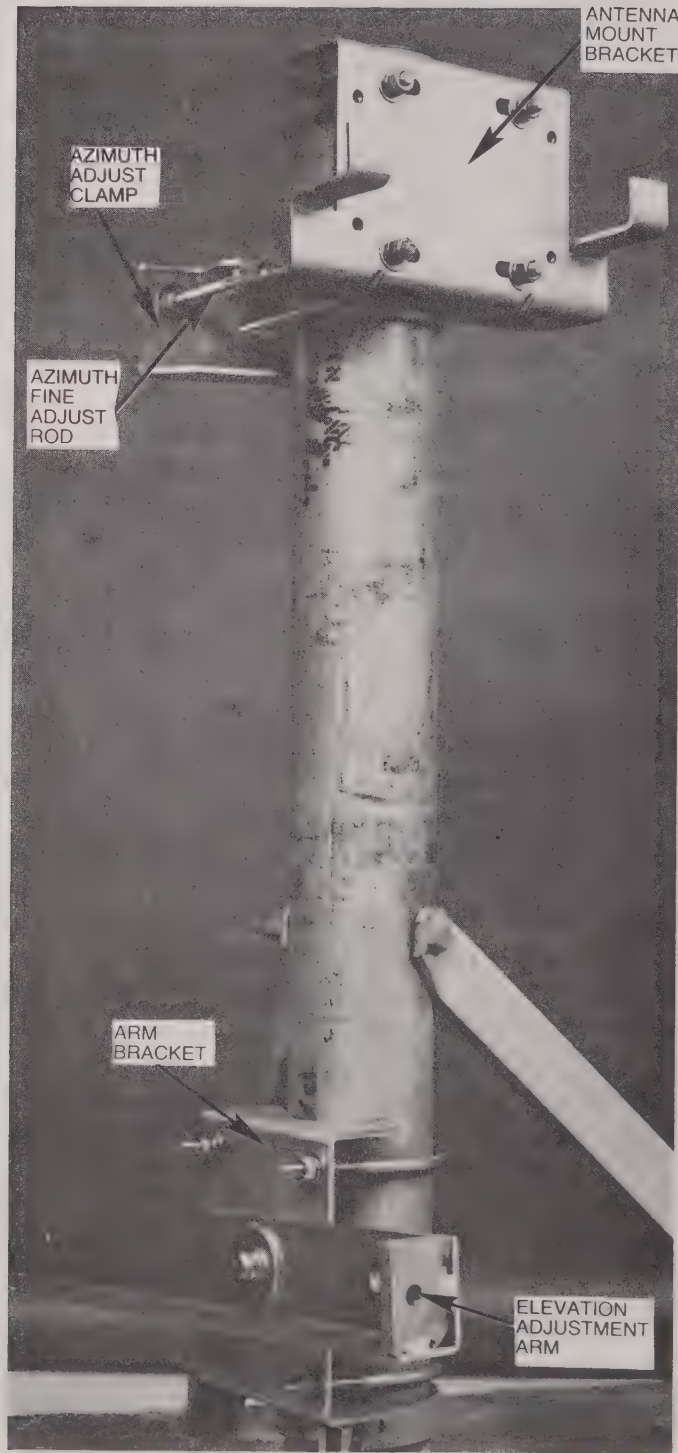


Figure 4



Figure 5

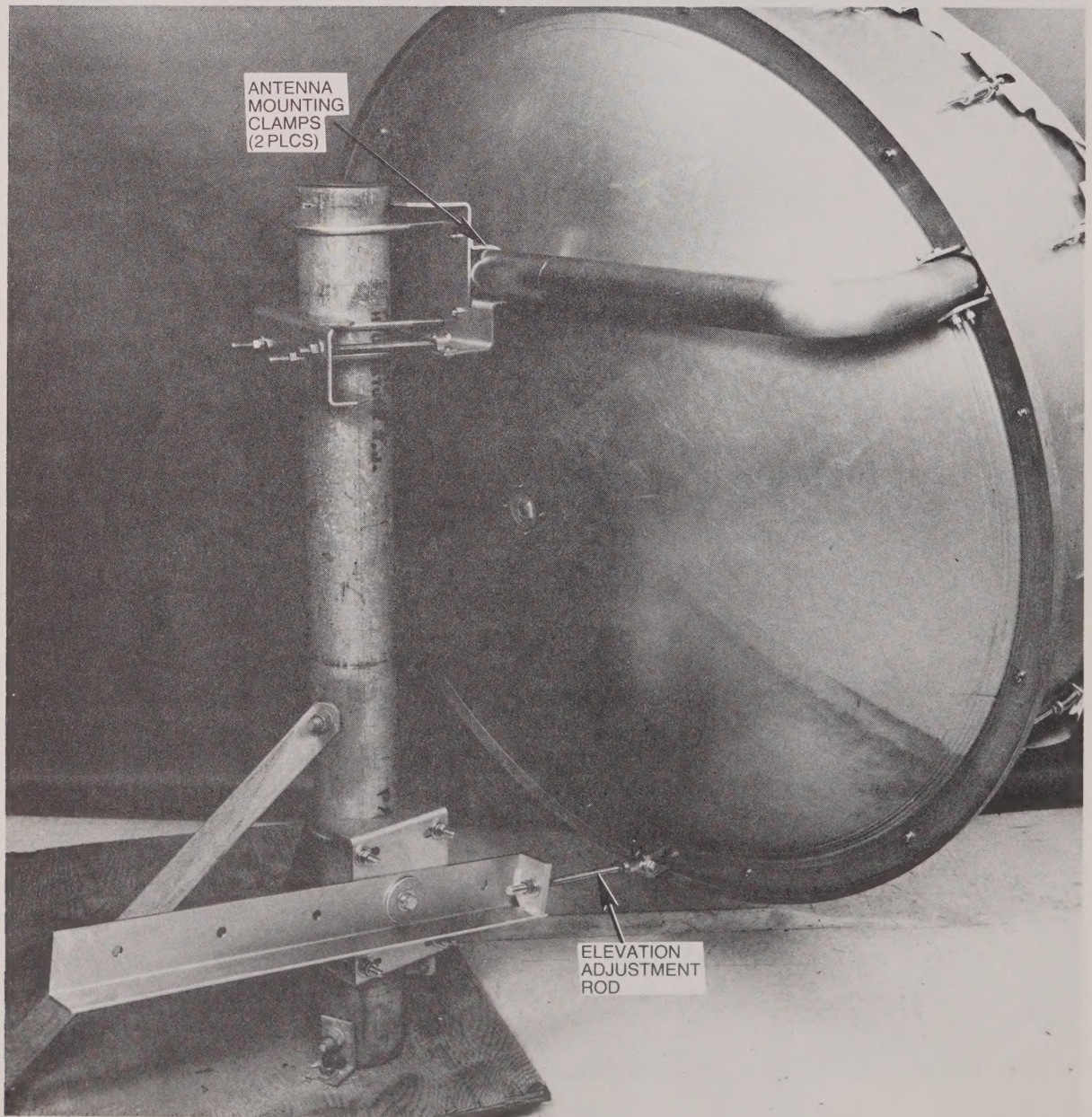
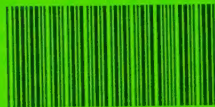


Figure 6



MP MASTER



MA29160