OPERATION AND MAINTENANCE MANUAL
For the
MOBILE DATA RADIO AND
BASE DATA RADIO

MANUAL NO. 385700-1006
REVISION 6

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SAFETY SUMMARY

High voltage is used in the operation of this equipment. Death on contact may result, if personnel fail to observe the following safety precautions:

- Do not be misled by the term “Low Voltage.” Potentials as low as 50 Volts may cause death under adverse conditions.
- Do not crush, puncture, disassemble or otherwise mutilate batteries. Leaking batteries can cause serious damage to equipment and injury to personnel.
- Do not remove covers or access plates on the equipment, unless you are authorized to do so.
- Do not work on electronic equipment unless there is another person nearby who is familiar with the operation of the equipment and is trained in administering first aid.
- Whenever possible, disconnect the equipment from the power source before beginning maintenance.
- To prevent electrical shock or damage to the equipment, do not operate it until you thoroughly understand the operation and function of all controls, indicators, and connectors.
- Turn off all power to the equipment before replacing any fuses.

FIRST AID

In case of electrical shock:

- Do not try to pull or grab the individual.
- If possible, turn off the electrical power.
- If you cannot turn off the electrical power, pull, push, or lift the person to safety using a dry wooden pole, a dry rope, or some other insulating material.
- Send for help as soon as possible.
- After the injured person is no longer in contact with the source of electrical shock, move the person a short distance away and immediately administer first aid and artificial resuscitation as required.

WARNING

This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions:

(1) This device may not cause harmful interference, and
(2) This device must accept any interference received, including interference that may cause undesired operation

WARNING

The Base Data Radio and Mobile Data Radios are unlicensed devices operating under the conditions of FCC part 15 regulations. This equipment is intended to be installed and operated by professional parties. It is the responsibility of those parties to insure that the equipment is operated in compliance with the applicable FCC part 15 specifications and the requirements contained in this document.

LIST OF ABBREVIATIONS AND ACRONYMS

NOTE

All abbreviations/acronyms used in this manual, other than those listed on this page, are used per MIL-STD-12D.

BDR	Base Data Radio
CDMA	Code Division Multiple Access
EEPROM	Electrically Erasable Programmable Read Only Memory
ESDS	Electrostatic Discharge Sensitive
LCP	Local Command Processor
LRU	Line Replaceable Unit
MDR	Mobile Data Radio
PC	Personal Computer
PN	Pseudo Noise
RBW	Resolution Bandwidth
RCS	Radio Communication Subsystem
SSR	Spread Spectrum Radio
TDMA	Time Division Multiple Access
VBW	Video Bandwidth

LIST OF REFERENCE DOCUMENTS

Interface Control Document

Drawings:

Assembly, Mobile Data Radio	3385700-1000
Cable Assembly:	
Diagnostic, MDR	385700-1805
Power Out, MDR	385700-1806
Power In, MDR	385700-1807
Data, MDR	385700-1808
RCS to Diagnostic, MDR	385700-1811
RCS to RS232, MDR	385700-1812
RCS to SCP, MDR	385700-1813
Assembly, Base Data Radio	385700-3000
Cable Assembly:	
Diagnostic, BDR	385700-3805
Power, BDR	385700-3806
Data, BDR	385700-3808
RCS to Diagnostic. BDR	385700-3811
RCS to SCP1, BDR	385700-3812
RCS to SCP2, BDR	385700-3813

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CHAPTER 1
INTRODUCTION

1.1 GENERAL MANUAL INFORMATION

This manual contains instructions for the operation, maintenance, and support of the mobile data radio (MDR) assembly and the base station radio (BDR) assembly. This manual describes each entity of the radio assemblies in detail. It provides the necessary information for qualified technical personnel to install, repair, and maintain the MDR and BDR assemblies to the line replaceable unit (LRU).

This manual is divided into six chapters, which consist of sections to describe the information or procedures in detail. The six chapters are as follows:

- Chapter 1 outlines the contents of this manual and provides a basic equipment description of the MDR and BDR.
- Chapter 2 provides preparation for use and installation information.
- Chapter 3 provides operating procedures for the equipment.
- Chapter 4 provides the principles of operation.
- Chapter 5 provides preventive and corrective maintenance of the radio assemblies.
- Chapter 6 contains a vendor list and parts list for procurement of replacement parts.
- Chapter 7 contains mechanical outlines of the data radios.

1.2 PREPARATION FOR STORAGE OR SHIPMENT

The following paragraphs describe guidelines for long term storage and the shipment of the equipment.

1.2.1 STORAGE

Before storage, wrap the equipment in static shielding bubble wrap. Bubble wrap protects internal electrostatic discharge sensitive (ESDS) assemblies, external panels, and connectors. Place wrapped equipment in the original shipping containers and seal. Store in a cool dry place, away from the elements.

1.2.2 SHIPMENT

Ship equipment in the original shipping containers or in a container that provides sufficient protection for ESDS equipment. Pack the equipment in a manner that provides protection for all external switches and mountings, because these items are most vulnerable to damage during shipment.

1.3 DESCRIPTION OF EQUIPMENT

The Radio Communications Network consists of Base and Mobile Radio Communication Systems (RCS). The Base RCS includes Base Data Radios (BDR) connected to wayside Control Equipment. The Mobile RCS includes Mobile Data Radios connected to Control Equipment on board the vehicle. The Radio Communications Systems provide bi-directional communications. The systems operate in a combined Time Division Multiple Access (TDMA) and Code Division Multiple Access (CDMA) environment.

The Mobile Data Radio (MDR) and Base Data Radios (BDR) in the technical manual are Spread Spectrum non-licensed RF transceivers.

1.3.1 TYPE OF EQUIPMENT

The MDR and BDR are non-licensed spread spectrum transceivers that operate in the ISM 2400-2483.5 MHz frequency band. Antennas connected to MDR and BDR may come from different vendors. Antennas should support the 2400-2483 MHz frequency band, be compliant with FCC part 15 regulations, and are to be installed by professional parties.

Refer to Table 1-1 MDR/BDR Types and Applications. The following table contains part numbers for different versions of MDR and BDR.

Part No.	Type	Application
385700-1000-001	MDR	Input Voltage 18-32 VDC
385700-1000-002	MDR	Input Voltage 21-56 VDC
385700-3000-001	BDR	Rack Mounted
385700-3000-002	BDR	Wall Mounted
385700-3000-003	BDR	Pole Mounted

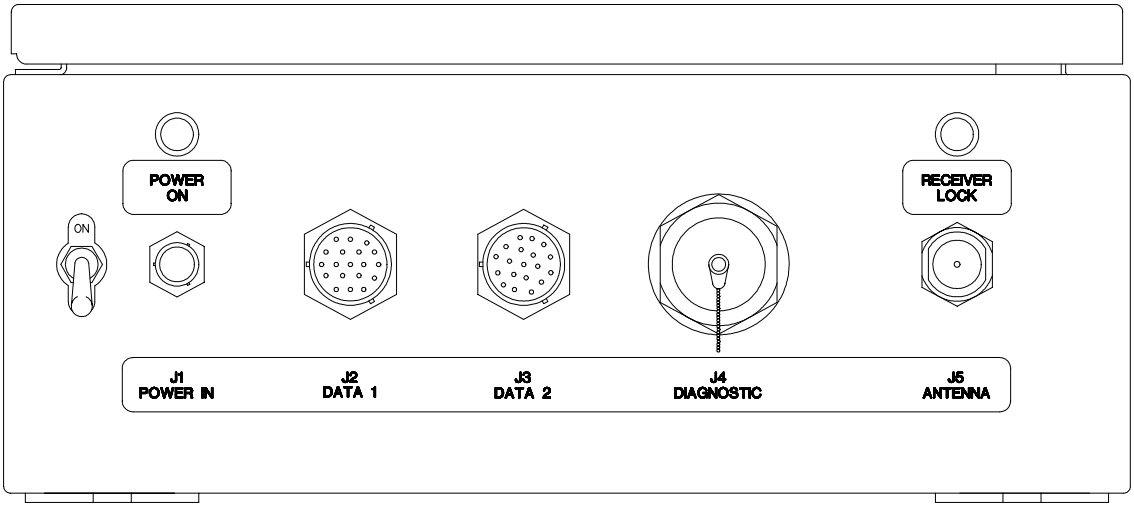
Table 1-1 MDR/BDR Types and Applications

1.3.2 PURPOSE OF THE EQUIPMENT

The radio provides a bi-directional communication link between the wayside and the vehicle control equipment. The wayside control equipment generates data and sends it to the BDR. The BDR transmits data over the radio channel to the appropriate MDR. The MDR communicates with the vehicle control equipment, obtains the response, and transmits it to the BDR via the RF link.

1.4 LOCATIONS AND DESCRIPTIONS OF MAJOR COMPONENTS

Refer to Figure 1-1 Mobile and Base Radio Assemblies and Components. The following paragraphs contain the complete descriptions and locations of the mobile data radio and base data radio.



Mobile Data Radio

Base Data Radio

Figure 1-1 Mobile and Base Radio Assemblies and Components

1.4.1 MOBILE DATA RADIO ASSEMBLY

The mobile data radio (MDR) uses direct sequence spread spectrum modulation techniques. The MDR transmits at a center frequency of 2467.84 MHz. and receives at a center frequency of 2416.64 MHz.

The MDR communicates with the vehicle control equipment across an EIA 530 (RS-422) interface at J2. The MDR can also send messages to external equipment via an RS-232 interface at J3. An operator can also communicate with the MDR through the diagnostic port across an RS-232 interface (refer to paragraph 2.5.2) at J4. This interface is referred to as the Local Command Processor (LCP) terminal and is used to load user supplied parameters into the radio's non-volatile memory when the radio is initially delivered to the customer. This RS-232 interface is not used during normal operation of the radio. The MDR receives power from a nominal 28 VDC (or a nominal 36 VDC depending on application), power source at J1. Refer to Table 1-2 Mobile Data Radio Assembly Specifications.

1.4.2 BASE STATION RADIO ASSEMBLY

The base data radio (BDR), like the MDR, is a spread spectrum transceiver. The BDR transmits at a center frequency of 2416.64 MHz frequency and receives at a center frequency of 2457.84 MHz band. Refer to Table 1-3 Base Station Radio Assembly Specifications. The BDR communicates across an EIA 530 (RS-422) interface to the wayside control equipment at J2 or J3 (see Figure 2-10). An operator can also communicate with the BDR through the diagnostic port, J4, across an RS-232 interface (refer to paragraph 2.5.2). This interface is referred to as the Local Command Processor (LCP) terminal and is used to load user supplied parameters into the radio's non-volatile memory when the radio is initially delivered to the customer. This RS-232 interface is not used during normal operation of the radio. The BDR receives its AC input power at J1. Tables 1-2 through 1-3 contain the specifications for the MDR and BDR. The tables include characteristics and specifications in three categories: technical, environmental, and physical.

Document use is restricted to that described on cover.

Figure 1-2 Transmitter Block Diagram

1.5 EQUIPMENT CHARACTERISTICS

1.5.1 POWER AND UTILITY REQUIREMENTS

The MDR requires a nominal 28 VDC (or a nominal 36 VDC depending on application) power source to operate. Refer to Table 1-2 Mobile Data Radio Assembly Specifications for more detailed information. The BDR requires nominally 120 VAC to operate. Refer to Table 1-3 Base Station Radio Assembly Specifications, for more detailed information.

1.5.2 ENVIRONMENTAL INFORMATION

The MDR assembly can withstand the shock and vibration associated with mobile environments. It is contained in a weatherproof enclosure. Refer to Table 1-2 Mobile Data Radio Assembly Specifications, for more detailed information.

The BDR assembly is designed for an environment away from the elements. It can be rack-mounted, or wall mounted. Refer to Table 1-3 Base Station Radio Assembly Specifications, for more detailed information. There are provisions for the BDR assembly to be delivered in a pole-mounted configuration. Its environmental characteristics will be similar to MDR.

Transmitter	
Transmitter Center Frequency	2467.84 MHz
Output Power	(+24 dBm linear) – adjustable
Transmitter Duty Cycle	Up to 100% continuous operation
Modulation	Gaussian Phase Shift Keying
Receiver	
Receiver Center Frequency	2416.64 MHz
Receiver Input Impedance	50 ohms
Receiver Noise Figure	≤7 dB
Maximum Input	0 dBm
BER in AWGN	≤ 1 * 10E-05 for a –90 dBm input
Power Supply	
Inputs	People Mover: 18-32 VDC Mass Transit: 21-56 VDC
Power Consumption	<50 watts
Transient Protection	Yes
Reverse Polarity protection	Yes
Environment	
Operating Temperature	-40 °C to +70°C
Storage Temperature	-50°C to +85°C
Operating Humidity	10 to 95%
Storage Humidity	10 to 95%
Shock	3 g's peak, 7-10 ms
Vibration	0.4 g's peak, 5-100 Hz
Physical	
Size	16.5" (l) x 13.0" (w) x 5.5" (h)
Weight	<50 pounds
Enclosure	Weatherproof
Regulatory	
FCC Part 15	Compliant

Table 1-2 Mobile Data Radio Assembly Specifications

Transmitter	
Transmitter Center Frequency	2416.64 MHz
Output Power	(+24 dBm linear) – adjustable
Transmitter Duty Cycle	Up to 100% continuous operation
Modulation	Gaussian Phase Shift Keying
Receiver	
Receiver Center Frequency	2467.84 MHz
Receiver Input Impedance	50 ohms
Receiver Noise Figure	≤ 7 dB
Maximum Input	0 dBm
BER in AWGN	≤1 * 10E-05 for a –90 dBm input
Power Supply	
Inputs	87 to 265 VAC, 47-63 Hz
Power Consumption	<50 watts
Transient Protection	Yes
Reverse Polarity protection	NA
Environment	
Operating Temperature	-25°C to +70°C rack mounted -40°C to +70°C pole mounted
Storage Temperature	-50°C to +85°C
Operating Humidity	10 to 95%
Storage Humidity	10 to 95%
Shock	NA
Vibration	0.4 g's peak, 5-100 Hz
Physical	
Size	15.0" (l) x 19" (w) x 5.22" (h) (indoor) 16.5" (l) x 13.0" (w) x 5.5" (h)
Weight	<50 pounds
Enclosure	Weatherproof (outdoor) Standard 19" rack mount (indoor)
Regulatory	
FCC Part 15	Compliant

Table 1-3 Base Station Radio Assembly Specifications

CHAPTER 2
INSTALLATION

2.1 INSTALLING THE RADIO EQUIPMENT

This chapter provides information to install the base and mobile data radios (MDR and BDR) and related equipment and to prepare the equipment for use.

2.1.1 UNPACKING AND INSPECTION

Unpacking the mobile and base station data radios does not require special procedures. Use normal shop procedures to unpack the equipment.

Carefully inspect the shipping containers and equipment. If the containers show damage, inspect the equipment in those containers with extra care. Do not open containers with extreme damage.

Check equipment for bent frames, protrusions, and dents. Pay close attention to external brackets, controls and connectors, because they are especially susceptible to damage during shipment.

If you find damage to the equipment, notify Andrew Corporation's at

- 1-800-854-7732 (Inside the USA)
- 972-235-1222 (Outside the USA)

2.1.2 PROPER INSTALLATION OF UNITS

The MDR is designed to be attached to a mounting plate or bracket using standard 3/8" hardware. Connect the MDR to the appropriate DC power source and antenna. The operator is responsible for insuring that the selected antennas and radio are operated in compliance with FCC Part 15 regulations.

The typical BDR is installed in standard 19" equipment racks. It can also be mounted on a wall in a stand-alone configuration. Optionally, the BDR can be configured to be mounted on poles, similar to a MDR.

2.2 INTERCONNECTIONS

Refer to Figure 2-1 MDR/BDR Interconnect Diagram, for a block diagram of wiring runs and connector designations. The following paragraphs describe the interconnections directly related to the mobile data and base station radios.

WARNING

The antenna is an electrical conductor. Contact with power lines may cause death or serious injury. Do not install these antennas where there is any possibility of contact with or high voltage arc-over from power cables or service drops to buildings. The antennas and mast must not be near power lines during installation, use, or removal.

WARNING

Before applying power, verify that the antenna is securely connected to the MDR and BDR. Failure to observe these warnings will damage the equipment.

2.2.1 MOBILE CONFIGURATION INTERCONNECTION

Refer to the mobile configuration diagram in Figure 2-1 MDR/BDR Interconnect Diagram. Connect the vehicle control equipment to the MDR at the **DATA 1** (J2) port on the front panel of the unit. Connect the appropriate DC power source to the front panel **POWER IN** (J1) port. Connect an antenna to **ANTENNA** (J5) port. The **DIAGNOSTIC** port (J4) is not connected during normal operation. It is used for testing purposes. (Refer to paragraph 2.5.2.) . **DATA 2** (J3) port may or may not be used in a particular implementation. Its operation is defined in the ICD.

2.2.2 WAYSIDE CONFIGURATION INTERCONNECTION

Refer to the wayside configuration diagram in Figure 2-1 MDR/BDR Interconnect Diagram. The BDR rear panel port **ANTENNA** (J5) connects to the wayside antenna subsystem. The base station radios connect directly to the wayside control equipment. The BDR rear panel port **DATA 1** (J2) connects to the wayside control equipment. The BDR rear panel port **DATA 2** (J3) connects to the redundant set of wayside control equipment. The active control equipment will provide a differential signal to enable either **DATA 1** or **DATA 2** port. This

signal will be provided via a pair of dry contacts. The BDR provides the source voltage of nominally +5 VDC and the return path to drive the signals. Refer to BDR Data 1 Port Cable Pin-outs, for EIA-530 pin assignments. The diagnostic port (J4) is not connected during normal operation. It is used for testing purposes. (Refer to paragraph 2.5.2.)

2.3 CABLE AND GROUND REQUIREMENTS

The following paragraphs contain the requirements for constructing the interconnect cabling between the Andrew and vendor supplied equipment.

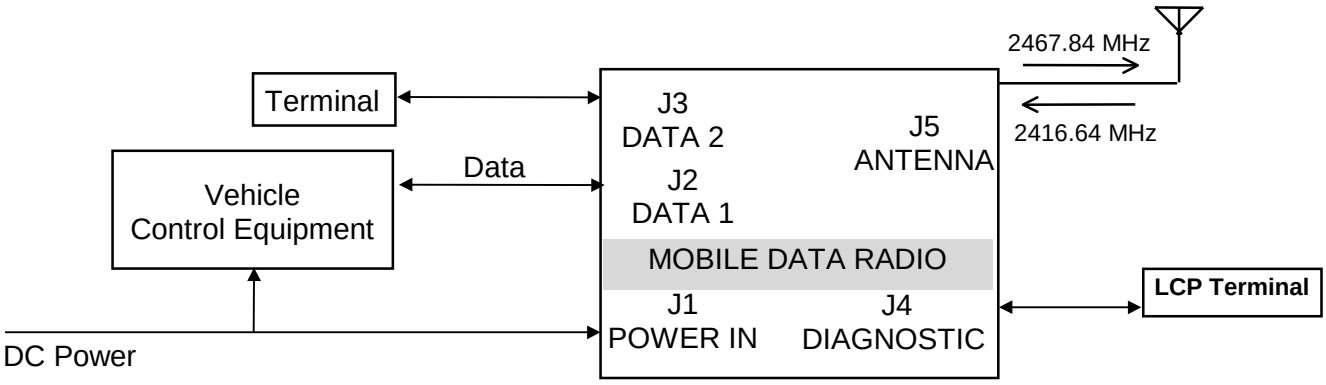
Construct the MDR power cables, using at least 16-gauge cable. Use the power cable to ground the MDR.

Use RF coaxial cable to connect the antennas. The cabling must support potential bends in the path from the mobile antennas to the radios. Loss through this cable must be less than 2 dB.

Construct data and computer signal cabling using 22 AWG shielded cabling. The BDR power cable is a standard AC power cable using an IEC320 type plug.

All cables shall be shielded for EMI reduction.

MOBILE CONFIGURATION



WAYSIDE CONFIGURATION

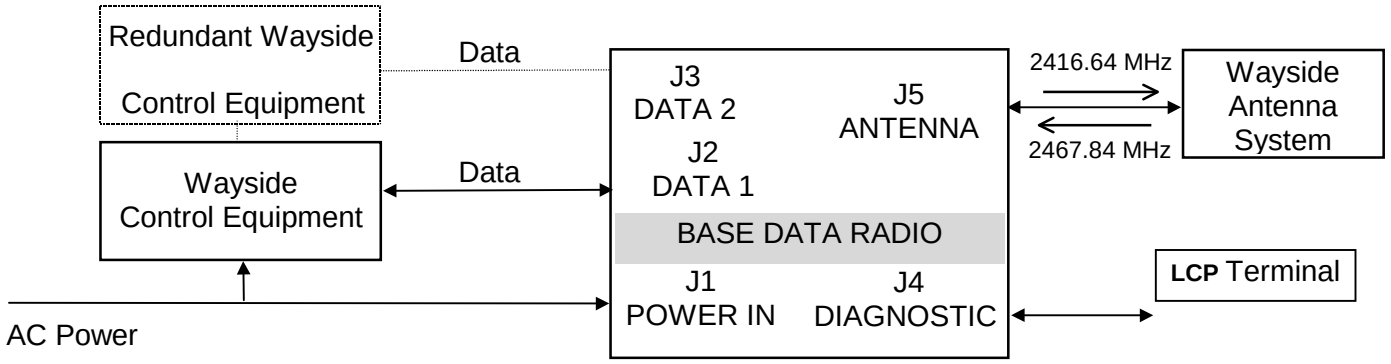
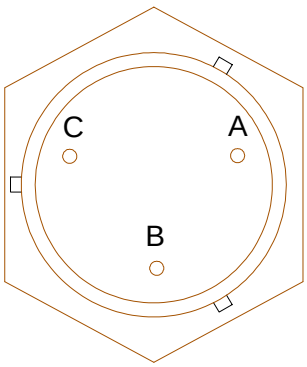


Figure 2-1 MDR/BDR Interconnect Diagram

2.3.1 CONNECTOR PIN-OUTS

Refer to Figures 2-2 through Figure 2-8 for the connector pin-out information for the MDR and BDR ports. Unlisted pins are no connects or reserved. Refer to attached cable assembly drawing package for typical external cable details.

Figure 2-2 shows the connector for the MDR front **POWER IN** connector.



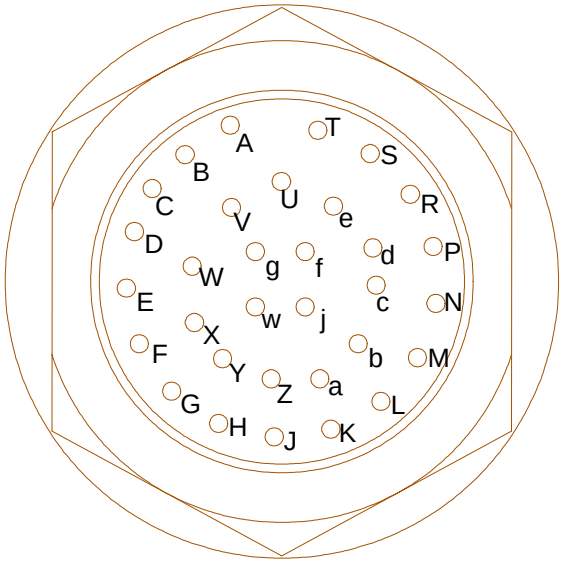
Pin Assignment	Signal
PIN A	DC(+)
PIN B	Ground
PIN C	Ground

The **Power IN** connector is a MIL-C_26482, Series 1 connector. The part number is MS3114E8-3P or equivalent. The mating connector is MS3116F8-3S or equivalent.

Figure 2-2 MDR Input DC Power Pin-outs

Figure 2-3 shows the connector for the MDR front panel **DIAGNOSTIC** port.

Note: Other pin assignments correspond to signals used for testing purposes beyond the scope of this manual.

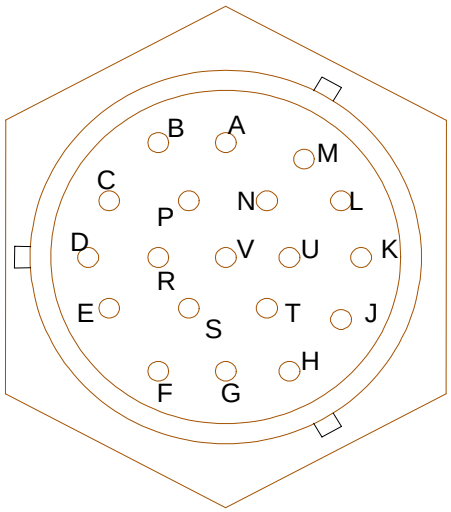


Pin Assignment	Signal
PIN e	DIAG_TXD
PIN f	DIAG_RXD
PIN g	TERM_GND

Figure 2-3 MDR Diagnostic Port LCP Terminal Port Pin-outs

The Diagnostic connector is a MIL-C-26482, Series 1 connector. The part number is MS3124E18-32S. The mating connector is MS3126F18-32P or equivalent.

Figure 2-4 shows the connector for the MDR front panel **DATA 2** port.

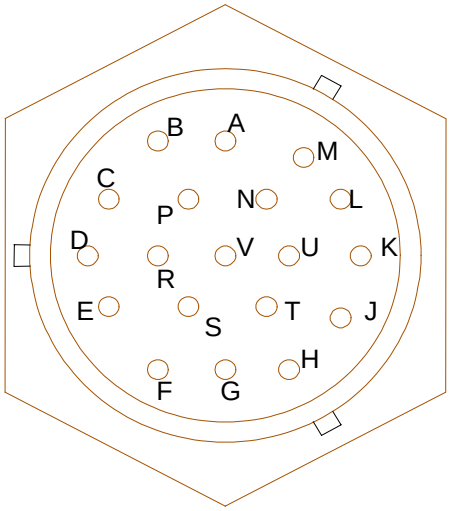


Pin Assignment	Signal
PIN A	TXD
PIN B	RXD
PIN C	SIG GND
PIN E	ANT0
PIN F	ANT1
PIN G	ANT2
PIN L	SIGA GND
PIN M	SIGA GND
PIN N	SIGA GND
PIN S	RADIO PWR
PIN T	RADIO PWR
PIN U	RADIO PWR RTN
PIN V	RADIO PWR RTN

Figure 2-4 MDR Data 2 Port Pin-outs

The Data 2 connector is a MIL-C-26482, Series 1 connector. The part number is MS3124E14-19SY. The mating connector is MS3126F14-19PY or equivalent.

Figure 2-5 shows the connector for the MDR front panel **DATA 1** port.



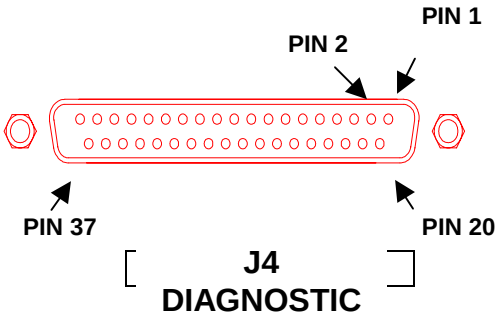
Pin Assignment	Signal
PIN A	TXD(A)
PIN B	TXD(B)
PIN C	RXD(A)
PIN D	RXD(B)
PIN E	TXCLK(A)
PIN F	TXCLK(B)
PIN G	RXCLK(A)
PIN H	RXCLK(B)
PIN J	RTS(A)
PIN K	RTS(B)
PIN L	CTS(A) - not used
PIN M	CTS(B) – not used
PIN N	CD(A)
PIN P	CD(B)
PIN R	GND

Figure 2-5 MDR Data 1 Port Pin-outs

The Data 1 connector is a MIL-C-26482, Series 1 connector. The part number is MS3124E14-19S. The mating connector is MS126F14-19P or equivalent.

The Data 1 and Data 2 connectors are uniquely polarized.

Figure 2-6 shows the connector of the BDR rear panel **DIAGNOSTIC** port. The connector is a 37 pin D-sub. The part number is CINCH 962GE DCU-37S or equivalent. A mating connector with a metal backshell for shielding purposes should be used.

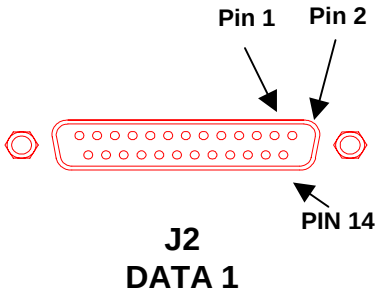


Pin Assignment	Signal
PIN 28	DIAG_TXD
PIN 29	DIAG_RXD
PIN 30	TERM_GND

Note: Other pin assignments correspond to signals used for testing purposes beyond the scope of this manual.

Figure 2-6 BDR Diagnostic Port Pin-outs

Figure 2-7 shows the connector of the BDR rear panel **DATA 1** port (J2). The connector is a 25 pin D-sub. The part number is ITT DBU-25S-FO or equivalent. A mating connector with a metal backshell for shielding purposes should be used.



Pin Assignment	Signal
PIN 1	Shield
PIN 2	TXD(A)
PIN 14	TXD(B)
PIN 3	RXD(A)
PIN 16	RXD(B)
PIN 15	TXCLK(A)
PIN 12	TXCLK(B)
PIN 17	RXCLK(A)
PIN 9	RXCLK(B)
PIN 4	RTS(A) – not used
PIN 19	RTS(B) – not used
PIN 5	CTS(A) – not used
PIN 13	CTS(B) – not used
PIN 7	GND
PIN 6	CNTL_OUT+
PIN 22	CNTL_OUT-
PIN 20	CNTL_IN+
PIN 23	CNTL_IN-

Figure 2-7 BDR Data 1 Port Cable Pin-outs

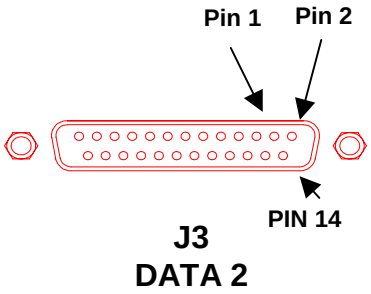
The signals on pins 6, 22, 20 and 23 are provided to enable either **DATA 1** or **DATA 2** port. Table 2-1 shows the selection of the BDR data port based on these signals.

Control Equipment Inputs	VDC (Nominal)	Control Equipment Outputs	VDC (Nominal)	Active Data Port
CNTL_OUT+ CNTL_OUT-	5 0	CNTL_IN+ CNTL_IN-	5 0	DATA 2
CNTL_OUT+ CNTL_OUT-	5 0	CNTL_IN+ CNTL_IN-	0 5	DATA 1
CNTL_OUT+ CNTL_OUT-	5 0	CNTL_IN+ CNTL_IN-	NC NC	DATA 2

Table 2-1, BDR Data Port Enable Signals

Refer to “ATCS Radio Network Interface Control Document” for complete BDR to wayside equipment interface information.

Figure 2-8 shows the connector of the BDR rear panel DATA 2 port (J3). The connector is a 25 pin D-sub. The part number is ITT DBU-25S-FO or equivalent. A mating connector with a metal backshell for shielding purposes should be used.



Pin Assignment	Signal
PIN 2	TXD(A)
PIN 14	TXD(B)
PIN 3	RXD(A)
PIN 16	RXD(B)
PIN 15	TXCLK(A)
PIN 12	TXCLK(B)
PIN 17	RXCLK(A)
PIN 9	RXCLK(B)
PIN 4	RTS(A)
PIN 19	RTS(B)
PIN 5	CTS(A)
PIN 13	CTS(B)
PIN 7	GND

Figure 2-8 BDR Data 2 Port Cable Pin-outs

2.4 COMPONENT JACK LOCATIONS

The following paragraphs describe the purpose and location of the jacks for each of the radio assemblies.

2.4.1 MOBILE DATA RADIO JACK LOCATIONS

Figure 2-9 depicts the MDR connector panel. The MDR front panel contains two data jacks**,** **DATA 1** (J2) and **DATA 2** (J3). The MDR transmits and receives data from the control equipment across the **DATA 1** port (J2). A cable connects the **ANTENNA** port (J5) to the antenna. A cable connects the **DIAGNOSTIC** port (J4) to an LCP terminal providing a menu-driven user interface (refer to paragraph 2.5.2). Port **POWER IN** (J1) connects the MDR to the VDC power source.

DATA 2 port is an RS-232 port that can be connected to customer provided equipment as required. **DATA 2** provides asynchronous data that is sent from the BDR. The parameters of this port are programmable via the diagnostic terminal. The **DIAGNOSTIC** port is unconnected during normal operation.

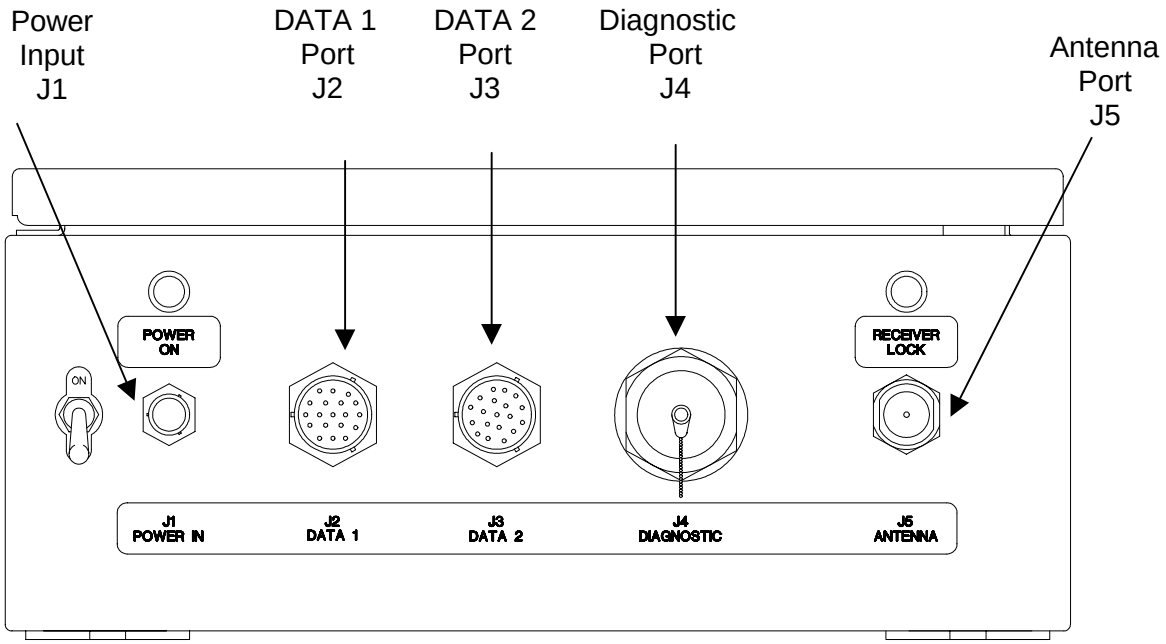


Figure 2-9 Mobile Data Radio Assembly Jack Locations

2.4.2 BASE STATION DATA RADIO JACK LOCATIONS

Refer to Base Station Data Radio Assembly Jack Locations. **DATA 1** port (J2) connects the BDR to the wayside control equipment. **DATA 2** port (J3) connects the BDR to the redundant control equipment. Four additional signals, non EIA-530 standard, are used for the selection of the data port to be used. Refer to paragraph 2.3.1 for connector pin-out information. **DIAGNOSTIC** port (J4) is connected to the LCP terminal providing a menu-driven user interface. Refer to paragraph 2.5.2. **ANTENNA** port (J5) is the RF port for the antenna. **POWER IN** port (J1) receives AC power.

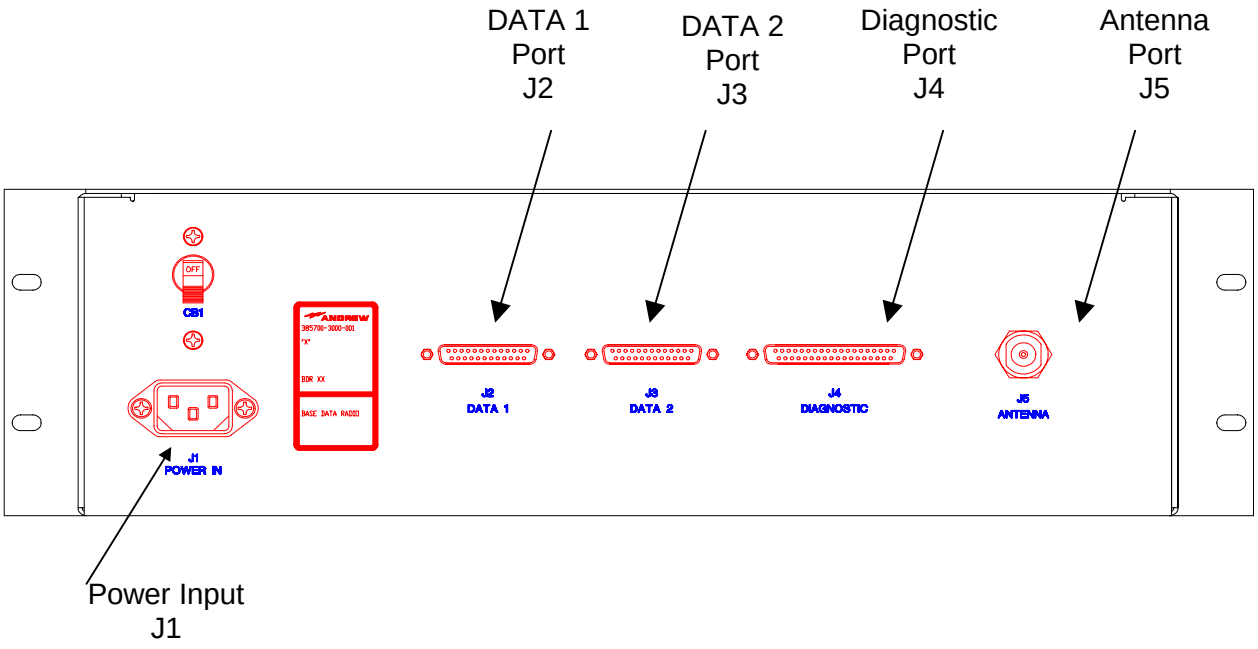


Figure 2-10 Base Station Data Radio Assembly Jack Locations

2.5 INITIAL PREPARATION FOR USE

CAUTION

Before applying power to the MDR and BDR, securely connect the RF antennas to both units. Failure to observe these cautions can damage the equipment.

The radios are configured at the factory for usage in the field. Default addresses (BDR) and ID's (MDR) are installed. The actual addresses and ID's used in a system must be programmed by the user. The following procedure explains how this data is programmed into a radio.

2.5.1 SETTING UP COMMUNICATIONS WITH THE LCP TERMINAL PORT

- Connect the **DIAGNOSTIC** ports of each of the radios to a PC running ProComm™ (or other Terminal Communication Program). Refer to the attached cable drawings for sample cable information.

- Set the Communication's program up with the following settings:

Baud Rate	=	19200
Parity	=	None
Data Bits	=	8
Stop Bits	=	1
Duplex	=	Full
Terminal Emulation	=	VT100 or compatible
Transmit Pacing	=	0 mSec

Example (if using ProComm™):

- Press ALT-P to bring up the current settings window. This window will allow you to setup the Baud Rate, Parity, Data Bits, and Stop Bits.

- Press ALT-S to bring up the Setup menu, select Terminal Options. This will allow you to set Duplex and Terminal Emulation.

- Press ALT-S to bring up the Setup menu, select General Options. This will allow you to set the Transmit Pacing.

2.5.2 DIAGNOSTIC/LCP TERMINALS

NOTE: The radio diagnostic port can be connected to either a WYSE™ 100 compatible terminal or a computer simulating such a terminal. The LCP terminal will denote all future references to the machine connected to the DIAGNOSTIC port.

1. Connect the LCP terminals to each of the radios using the cable assembly from the DIAGNOSTIC port on the radio to the serial port specified in the LCP terminal configuration. Refer to attached cable drawings for sample cable information
2. Place power switches to the **ON** position on each of the radios.
3. Upon completion of the self-test, the LCP terminal will appear as shown below.

```
**** Starting RCS Self Test... ****
68302 RAM Test:                          PASSED or FAILED
FLASH TEST:                              PASSED or FAILED
ATMEL AT59C11 EEPROM Test:               PASSED or FAILED
68302 SCC1 Internal Loopback Test:       PASSED or FAILED
68302 SCC2 Internal Loopback Test:       PASSED or FAILED
68302 SCC3 Internal Loopback Test:       PASSED or FAILED
DUART 68681 Local Loopback Test:         PASSED or FAILED
**** RCS Self Test Complete ****

Automatically running RCS ... Press 3 <CRs> to abort.
```

4. Press the <ENTER> key 3 times. This should bring up the RCS Maintenance and Upgrade menu

Note: The <ENTER> key must be pressed within 3 seconds of seeing the above message. Failure to do so will require the radio to be power cycled.

2.5.2.1 RCS MAINTENANCE AND UPGRADE MENU

```
                RCS Maintenance and Upgrade Menu
[0] Download RCS Software
[1] Download Board Level Test Software
[2]  Download Flash Download Software
[3] Download Microwave OS-9 Kernel
[4]  Download Power-on Self Test
[5]  Download Boot
[6]  Run Board Level Test
[7]  Run RCS
[8]  Run RCS, without an SCP
[9]  Display Software Version #'s
[10]Reset Radio
                Enter Option [0 - 10]:
```

NOTE: If a previous version of the application software has been previously loaded, and the <ENTER> key was not pressed within 3 seconds, the radio will attempt to communicate with attached control equipment attached to a **DATA** port. It will automatically try to bring up the RCS Application software (option #7). If this occurs, the operator will have to recycle power to the radio and hit the <ENTER> key within 3 seconds.

If there isn't any software loaded for the OS-9 program, the following error message will be displayed:

UNABLE TO RUN RCS: OS-9 Kernel is not present in Flash.

If this message appears, a terminal error has occurred and the user should contact Andrew Corporation for additional information.

If there isn't any software loaded for the RCS application program, the following error message will be displayed:

UNABLE TO RUN RCS: RCS Application is not present in Flash.

If this message appears, a terminal error has occurred and the user should contact Andrew Corporation for additional information.

2.5.3 VEHICLE LCP MENU

The following is a typical command menu that will appear on the computer monitor. The menu allows the user to manually operate the MDR.

Phase II **Vehicle LCP Menu** **SW Ver #: xxxx**

1. Vehicle Address (Train ID)
2. Set PN Index (CDMA Code)
3. Program Synthesizers
4. Reserved
5. Reset DSP
6. Reserved
7. Reset PN
8. Reset PN (RX, STROBE)
9. Reserved
10. Set Upper Threshold
11. Upper Thres w/o PN Reset
12. Set Lower Threshold
13. Lower Thres w/o PN Reset
14. Set Lower Lock Threshold
15. Disable Transmitter
16. Enable Transmitter
17. Load SC Register
18. Disable Test Port
19. Enable Test Port
20. PN Test Select
21. A/D Select
22. Set Clock Search
23. OS-9 Shell
24. Set RCS Address
25. Reserved
26. SSR Status Request
27. System Block Status
28. Status Request
29. Show Poll Counters
30. Clear Poll Counters
31. RS-232 Parameters
32. Read TRACK/AGC Values
33. Set dBm Output Level
34. Change dBm/DAC Values
35. Serial EEPROM Display
36. Save Current Settings
37. Load Tnd SC Register
38. Reserved
39. Reserved
40. Display System Log

Enter Selection

2.5.4 MDR INITIAL OPERATIONAL ADJUSTMENTS

2.5.4.1 UNIQUE ADDRESS QUALIFIER

Perform the following procedures only when first receiving an MDR from the manufacturer.

1. Connect the MDR to the appropriate DC power.
2. Attach a 2 watt or greater, 20 dB power attenuator to the radio's **ANTENNA** port.
3. Connect cabling between the radio **DIAGNOSTIC** port and dumb terminal, an IBM PC with Procomm™ Software, or any communications software that supports VT100 emulation.
4. Place the radio power switch to the **ON** position.

5. Select #28 (Status Request) from the LCP menu. The Local Command Processor (LCP) screen appears on the terminal. If the LCP menu does not appear, follow instruction in Section 2.5.1 to correctly set the terminal.
6. Select #1 (Vehicle Address). Assign an address for that radio. The range of allowable hexadecimal addresses is from 0001_{16} to $FFFE_{16}$. Each mobile radio in the system must have a unique address.
7. After assigning the address for that radio, select #36 (Save Current Settings).
8. Select #35 (Setting) from the LCP menu. Verify the following settings:

    - Vehicle ID = “Value set in step 6”

2.5.4.2 THRESHOLD VERIFICATION

1. Select #28 (Status Request) from the LCP menu. The Local Command Processor (LCP) screen appears on the terminal. If the LCP menu does not appear, follow instruction in Section 2.5.1 to correctly set the terminal.

    - Lower Lock Threshold = factory settings, (thresholds per configuration sheet shipped with the radio)
    - Lower Threshold = factory settings, (thresholds per configuration sheet shipped with the radio)
    - Upper Threshold = factory settings, (thresholds per configuration sheet shipped with the radio)

2. If the thresholds are different from those on the configuration sheet, contact Andrew for additional information. These settings are configured at the factory during production test and should only be modified by qualified personnel.
3. Place the radio power switch to the **OFF** position unless the following step is to be completed.

2.5.4.3 MDR DATA 2 PORT CONFIGURATION (OPTIONAL)

The following procedure needs to be completed for those systems in which the Mobile Data Radio **Data 2** port will be utilized.

The **DATA 2** port is designed to transmit RS-232 data to a vehicle-mounted instrument. In order to do this, the **DATA 2** port must be configured via the LCP menu prior to operation of the radio on the vehicle. The allowable RS-232 options are:

Data Rate:	**9**600 or **1**9200
Parity:	**E**ven, **O**dd, or **N**one
Data Bits:	**7** or **8**
Stop Bits:	**1** or **2**

For example, to set DATA2 for a data rate of 9600, Even parity, 7 data bits, and 2 stop bits perform the following commands on the LCP menu

Select the RS-232 Parameters
31↵
Set the Data Rate to 9600:
9↵
Set the Parity to Even:
E↵
Set the Data Bits to 7:
7↵
Set the Stop Bits to 2:
2↵
Upon display of the LCP Menu,
35↵
Read the current RS-232 parameters and verify that the above changes remain.

Place the radio power switch to the **OFF** position.

2.5.5 WAYSIDE LCP MENU

The following is a typical command menu that will appear on the computer monitor. The menu allows the user to manually operate the BDR.

Phase II **Wayside LCP Menu** **SW Ver #: xxxx**

1. Send Poll Requests
2. Set PN Index (CDMA Code)
3. Program Synthesizers
4. Reset Receiver
5. Reset DSP
6. Reserved
7. Reset PN
8. Reset PN (RX, STROBE)
9. Reserved
10. Set Upper Threshold
11. Upper Thres w/o PN Reset
12. Set Lower Threshold
13. Lower Thres w/o PN Reset
14. Set Lower Lock Threshold
15. Disable Transmitter
16. Enable Transmitter
17. Load SC Register
18. Disable Test Port
19. Enable Test Port
20. PN Test Select
21. A/D Select
22. Set Clock Search
23. OS-9 Shell
24. Set RCS Address
25. Set Frame Count
26. SSR Status Request
27. System Block Status
28. Status Request
29. Show Poll Counters
30. Clear Poll Counters
31. Reserved
32. Read TRACK/AGC Values
33. Set dBm Output Level
34. Change dBm/DAC Values
35. Serial EEPROM Display
36. Save Current Settings
37. Load TnD SC Register
38. Reserved
39. Reserved
40. Display System Log

Enter Selection

2.5.6 BDR INITIAL OPERATIONAL ADJUSTMENTS

2.5.6.1 UNIQUE RCS ADDRESS QUALIFIER

Perform the following procedures only when first receiving an BDR from the manufacturer.

1. Connect the BDR to the appropriate AC power.
2. Attach a 2 watt or greater, 20 dB power attenuator to the radio's **ANTENNA** port.
3. Connect cabling between the radio **DIAGNOSTIC** port and dumb terminal, an IBM PC with Procomm™ Software, or any communications software that supports VT100 emulation.
4. Place the radio power switch to the **ON** position.

5. Select #28 (Status Request) from the LCP menu. The Local Command Processor (LCP) screen appears on the terminal. If the LCP menu does not appear, follow instructions in Section 1.4.1 to correctly set the terminal.
6. Select #24 (Set RCS Address). Assign an address for that radio. The range of allowable hexadecimal addresses is from 01_{16} to FE_{16}. Each base radio in the system must have a unique address.
7. After assigning the address for that radio, select #36 (Save Current Settings).
8. Select #35 (Setting) from the LCP menu. Verify the following settings:

   RCS Address = “Value set in step 6”

2.5.6.2 THRESHOLD VERIFICATION

1. Select #28 (Status Request) from the LCP menu. The Local Command Processor (LCP) screen appears on the terminal. If the LCP menu does not appear, follow instruction in Section 2.5.1 to correctly set the terminal.

   - Lower Lock Threshold = factory settings, (thresholds per configuration sheet shipped with the radio)
   - Lower Threshold = factory settings, (thresholds per configuration sheet shipped with the radio)
   - Upper Threshold = factory settings, (thresholds per configuration sheet shipped with the radio)

2. If the thresholds are different from those on the configuration sheet, contact Andrew for additional information. These settings are configured at the factory during production test and should only be modified by qualified personnel.
3. Place the radio power switch to the **OFF** position unless the following step is to be completed.

2.6 RADIO APPLICATION CODE UPGRADE

The BDR and MDR application codes are field upgradeable. Using the LCP terminal and a disk supplied by Andrew, the application code can be downloaded into a radio with the following procedure. The application code diskette (mobile radio = 385700-5002 or base radio =385700-5003) includes the software version number.

1. Connect the radio to the appropriate input power.
2. Attach a 2 watt or greater, 20 dB power attenuator to the radio’s **ANTENNA** port.

3. Connect cabling between the radio **DIAGNOSTIC** port and dumb terminal, an IBM PC with Procomm™ Software, or any communications software that supports VT100 emulation.
4. Place the radio power switch to the **ON** position.
9. Upon completion of the self-test, the LCP terminal will appear as shown below.

```
**** Starting RCS Self Test... ****
68302 RAM Test:                          PASSED or FAILED
FLASH TEST:                              PASSED or FAILED
ATMEL AT59C11 EEPROM Test:               PASSED or FAILED
68302 SCC1 Internal Loopback Test:       PASSED or FAILED
68302 SCC2 Internal Loopback Test:       PASSED or FAILED
68302 SCC3 Internal Loopback Test:       PASSED or FAILED
DUART 68681 Local Loopback Test:         PASSED or FAILED
**** RCS Self Test Complete ****

Automatically running RCS ... Press 3 <CRs> to abort.
```

10. Press the <ENTER> key 3 times. This should bring up the RCS Maintenance and Upgrade menu

```
                RCS Maintenance and Upgrade Menu
[0]  Download RCS Software
[1]  Download Board Level Test Software
[2]  Download Flash Download Software
[3]  Download Microwave OS-9 Kernel
[4]  Download Power-on Self Test
[5]  Download Boot
[6]  Run Board Level Test
[7]  Run RCS
[8]  Run RCS, without an SCP
[9]  Display Software Version #'s
[10]Reset Radio
                Enter Option [0 - 10]:
```

11. Select #0 (Download RCS Software). From the terminal computer communications program select the SEND FILE function with RAW ASCII as the protocol. Select the drive and directory where the application code diskette is located.
12. After the download is complete, select #9 from the RCS Maintenance and Upgrade Menu. Verify that the application code version corresponds to the version loaded in the previous step. Record the software versions on the configuration sheet if

one is included with the radio.

13. From the RCS Maintenance and Upgrade menu, select option 8 (by pressing '8' and then <ENTER>) to run the RCS application software without an SCP connected. Verify that the appropriate LCP Menu Screen appears on the LCP terminal.
14. Place the radio power switch to the **OFF** position.

2.7 PN SPREADING CODE SELECTION

In order for a BDR to communicate with and MDR, and vice versa, the spreading codes of the radio must be set to the correct values. The user during system configuration determines the initial spreading code selected. The spreading code is changed dynamically during operation based on the user's system design.

The process to select the spreading code via the LCP menu is given below.

1. Connect the radio to the appropriate input power.
2. Attach a 2 watt or greater, 20 dB power attenuator to the radio's **ANTENNA** port.
3. Connect cabling between the radio **DIAGNOSTIC** port and dumb terminal, an IBM PC with Procomm™ Software, or any communications software that supports VT100 emulation.
4. Place the radio power switch to the **ON** position.
5. Upon completion of the self-test, the LCP terminal will appear as shown below.

```
**** Starting RCS Self Test... ****
68302 RAM Test:                          PASSED or FAILED
FLASH TEST:                              PASSED or FAILED
ATMEL AT59C11 EEPROM Test:               PASSED or FAILED
68302 SCC1 Internal Loopback Test:       PASSED or FAILED
68302 SCC2 Internal Loopback Test:       PASSED or FAILED
68302 SCC3 Internal Loopback Test:       PASSED or FAILED
DUART 68681 Local Loopback Test:         PASSED or FAILED
**** RCS Self Test Complete ****

Automatically running RCS ... Press 3 <CRs> to abort.
```

6. Press the <ENTER> key 3 times. This should bring up the RCS Maintenance and Upgrade menu. Select option 8 (by pressing '8' and then <ENTER>) to run the RCS application software without an SCP connected. Verify that the appropriate LCP Menu Screen appears on the LCP terminal.

```
                    RCS Maintenance and Upgrade Menu
[0]  Download RCS Software
[1]  Download Board Level Test Software
[2]  Download Flash Download Software
[3]  Download Microwave OS-9 Kernel
[4]  Download Power-on Self Test
[5]  Download Boot
[6]  Run Board Level Test
[7]  Run RCS
[8]  Run RCS, without an SCP
[9]  Display Software Version #'s
[10]Reset Radio
                    Enter Option [0 - 10]:
```

7. After the LCP menu appears, select #2 to Set PN Code Index. The user will be prompted to enter T (transmitter) or R (receiver) to choose which code to set. Choose T (transmitter) and press <ENTER>. The user is then prompted to select a number that corresponds to the PN spreading code to be selected. The range of allowable values is listed on the screen as part of the user prompt. This process is repeated to set the receiver code.
8. Place the radio power switch to the **OFF** position.

2.8 ANTENNA AND CABLE INSTALLATION

After integrating the MDRs and BDRs into the RCS, ensure that all cabling is securely and properly attached to each unit. The cable assemblies attached to the individual radio data ports must be properly shielded. Connect the antenna cable to the radios. Place the MDR and BDR power switches to the up position (**ON**). Verify that each unit lights its **POWER ON** indicator. Refer to Mobile Data Radio Controls and Indicators, and Base Station Data Radio Assembly Controls and Indicators.

CHAPTER 3
OPERATIONS

3.1 CONTROLS AND INDICATORS

The following paragraphs outline the controls and indicators for the MDR and BDR.

3.1.1 MDR CONTROLS AND INDICATORS

Refer to Mobile Data Radio Controls and Indicators. The power switch is on the MDR's front panel. With its power switch in the **ON** position, the front panel **POWER ON** indicator remains lit. After the BDR and MDR establish communication, the MDR lights its **RECEIVER LOCK** indicator until it loses the RF signal.

3.1.2 BDR CONTROLS AND INDICATORS

Refer to Base Station Data Radio Assembly Controls and Indicators. The BDR has one control switch, **CB1**, located on its rear panel. With this switch in the up position, the unit is **ON**. With the switch in the **ON** position, the unit lights its **POWER ON** indicator. When **CB1** is in the down position, the unit is **OFF**.

Once the BDR has established communication with an MDR, the BDR lights its **RECEIVER LOCK** indicator until it loses the RF signal.

CAUTION

Before beginning transmission between the MDR and BDR, securely connect the RF antennas to both units. Failure to observe these cautions can damage the equipment.

The Base Data Radio and Mobile Data Radios are unlicensed devices operating under the conditions of FCC part 15 regulations. This equipment is intended to be installed and operated by professional parties. It is the responsibility of those parties to insure that the equipment is operated in compliance with the applicable FCC part 15 specifications.

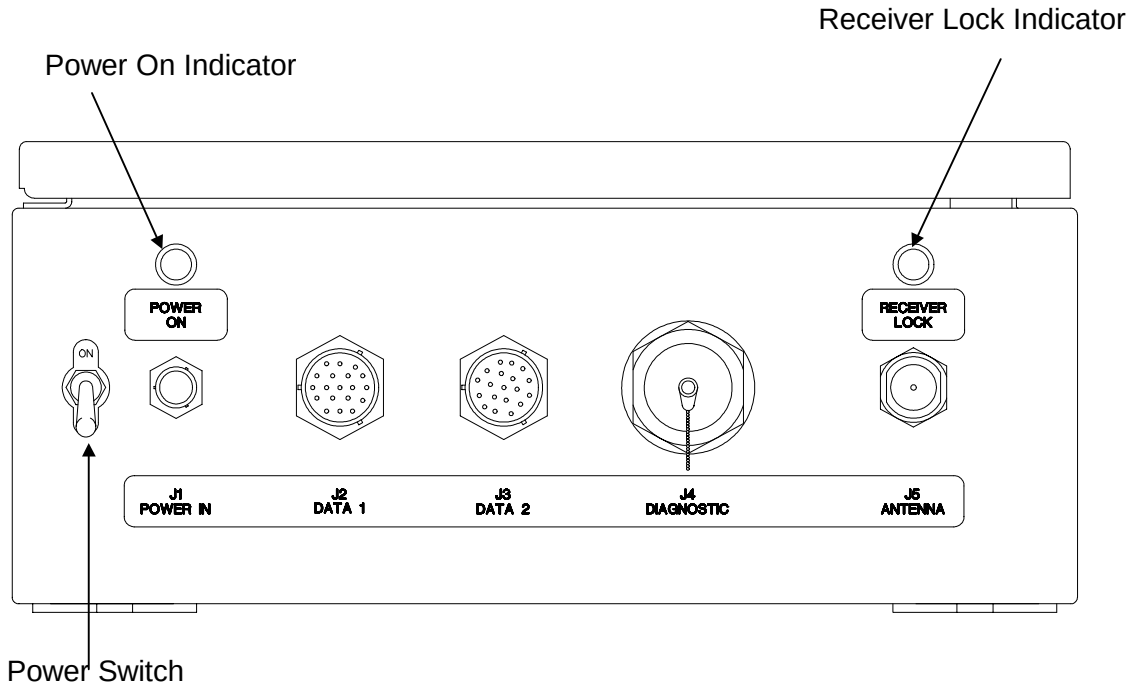
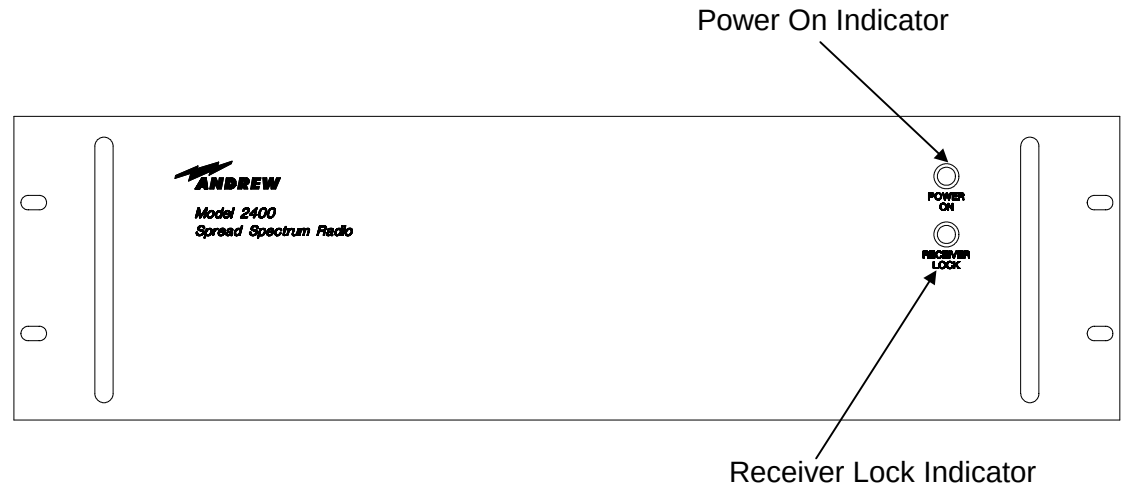


Figure 3-1 Mobile Data Radio Controls and Indicators



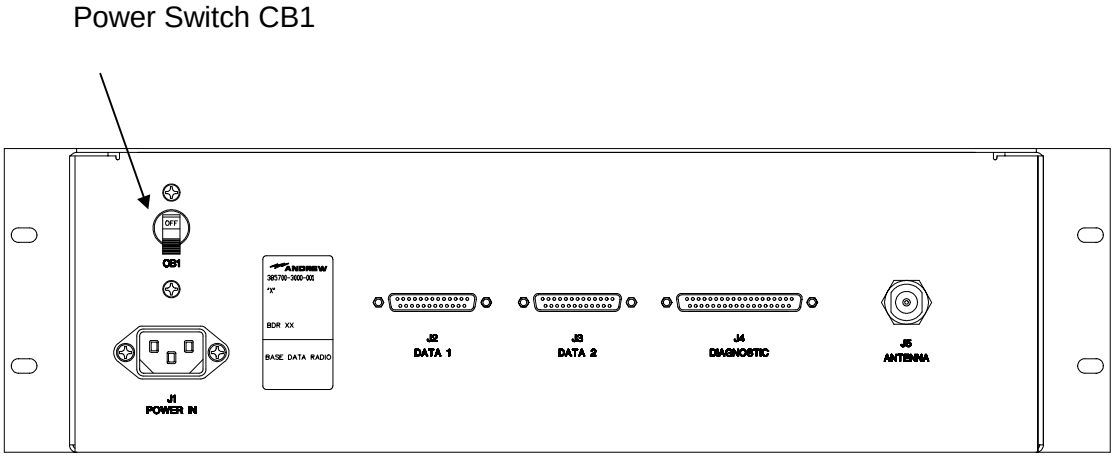


Figure 3-2 Base Station Data Radio Assembly Controls and Indicators

3.2 STARTUP AND SHUTDOWN PRODECURES

The following procedures ensure that installation does not damage the equipment.

3.2.1 MDR STARTUP

Refer to paragraph 5.3.1, place MDR, for procedures to properly install the MDR. Mount the MDR on the vehicle with the power switch in the **OFF** position. Securely connect all cabling and connect the RF antenna to the front panel **ANTENNA** port. To start the MDR, perform the following:

1. Connect the control equipment to the MDR front panel **DATA 1**.
2. Place MDR power switch to the **ON** position.
3. Allow up to two minutes for the MDR to warm-up.

3.2.2 BDR STARTUP

Refer to paragraph 5.3.2, place BDR, for procedures to properly install the BDR. To start the BDR, perform the following:

1. Connect the control equipment to the BDR back panel **DATA 1** port.
2. Place CB1 switch on the rear panel of the BDR to the ON position.
3. Allow up to two minutes for the BDR to warm-up before beginning transmission.

3.2.3 NORMAL OPERATION

Figure 3-4 shows a spectrum analyzer's possible display (when the MDR is operating normally with transmitter enabled). Figure 3-3 shows a spectrum analyzer's possible display when the BDR is operating normally with the transmitter enabled.

3.2.4 SHUTDOWN

Disconnect all non-RF signals to the MDR and BDR after placing power switches to the **OFF** position.

WARNING

IN CASE OF EMERGENCY; Immediately turn off power to both units.

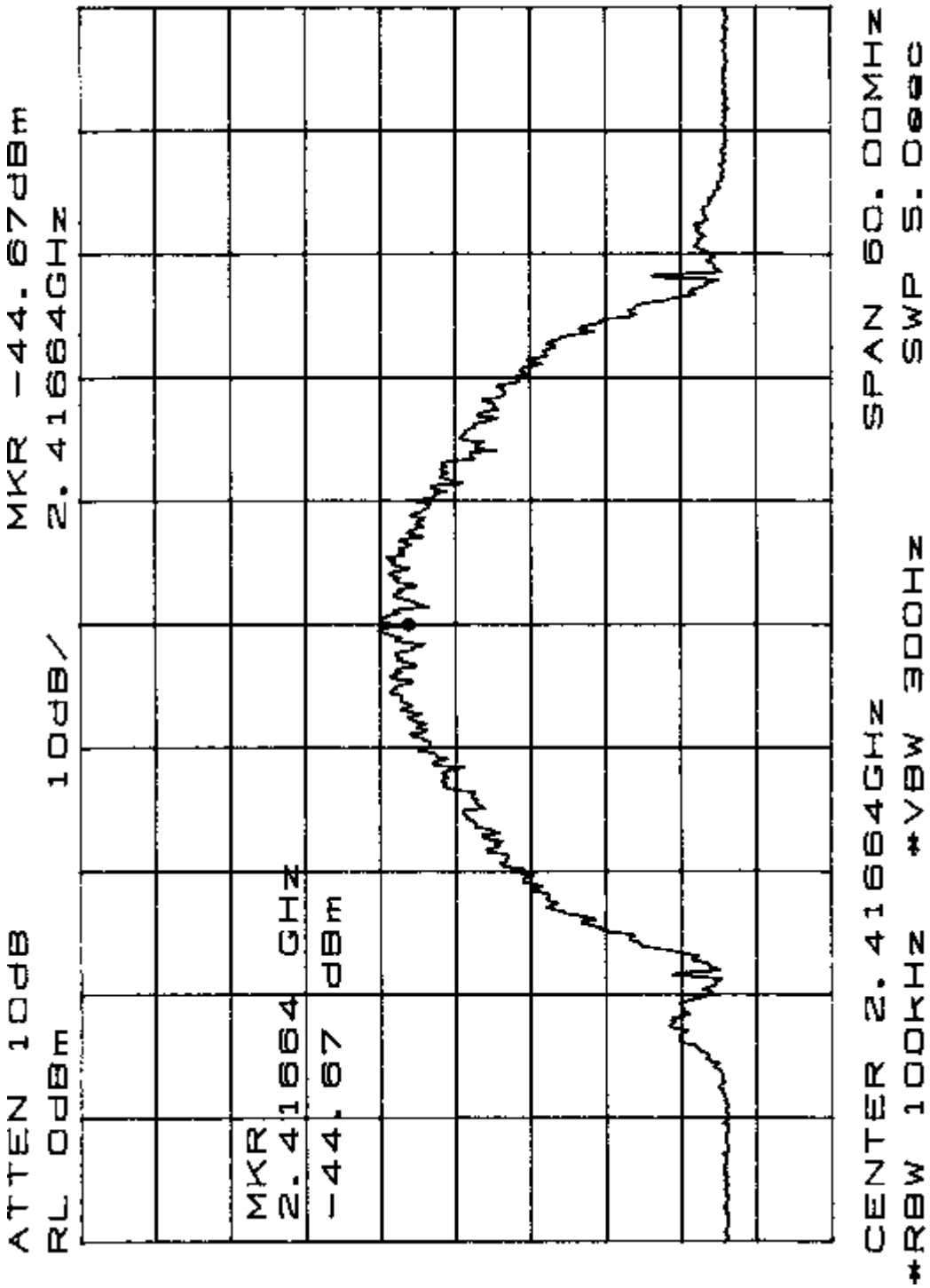


Figure 3-3 BDR Output Spectrum

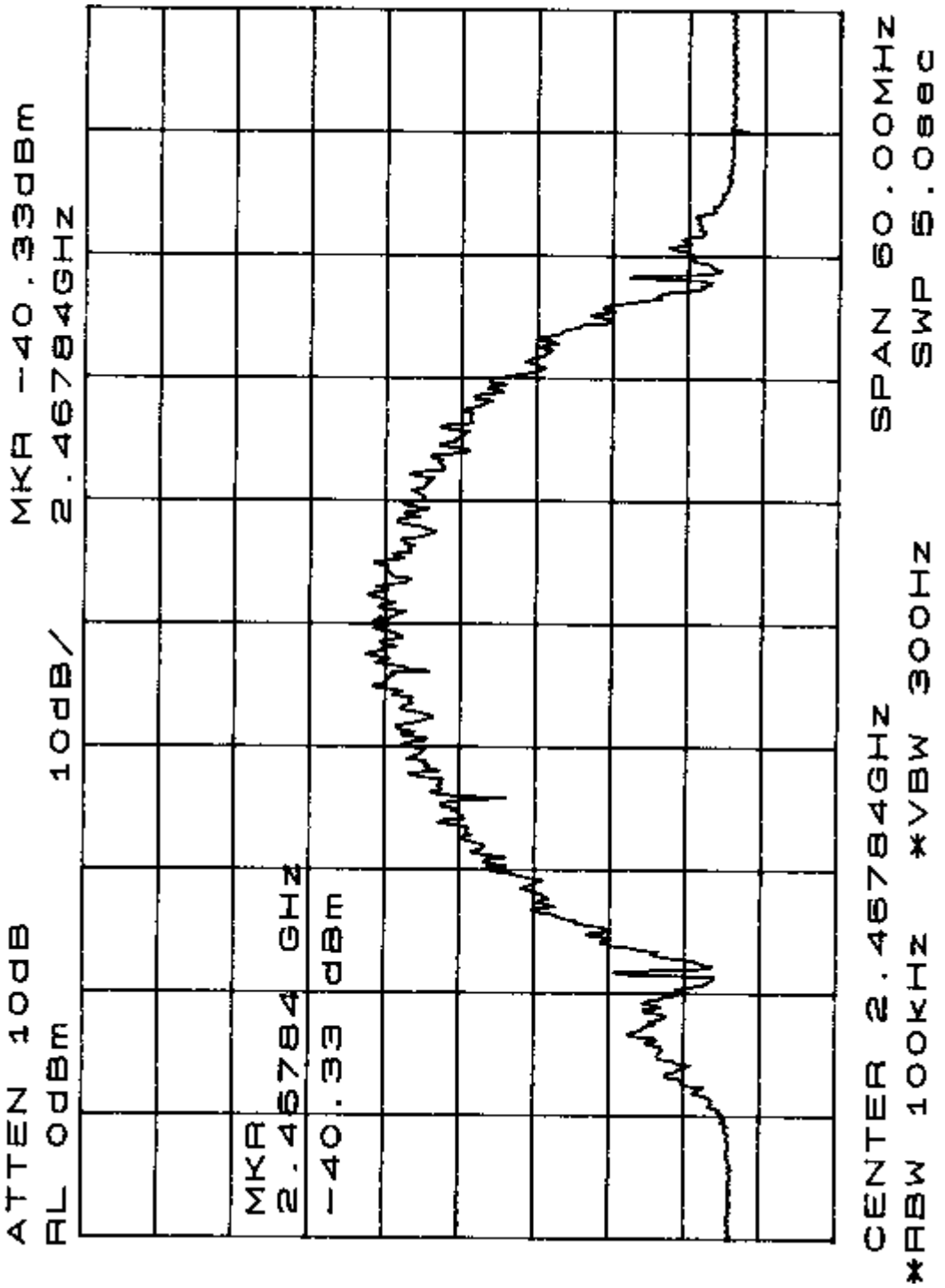


Figure 3-4 MDR Output Spectrum

3.3 OUTPUT POWER SETTINGS

The Base Data Radio and Mobile Data Radios are unlicensed devices operating under the conditions of FCC part 15 regulations. This equipment is intended to be installed and operated by professional parties. It is the responsibility of those parties to insure that the equipment is operated in compliance with the applicable FCC part 15 specifications.

The transmitter output power setting is set at the factory. Additionally, the output level can be adjusted via computer control of the equipment as defined in the Interface Document. The actual maximum allowable output level is based on the FCC part 15 Regulations. Table 3-1 lists the maximum allowable output level based on the antenna gain.

Antenna Gain (dBi)	Maximum Output Power (dBm)
0	30
1	30
2	30
3	30
4	30
5	30
6	30
7	29
8	28
9	27
10	26
11	25
12	24
13	23
14	22
15	21
For each additional dB of antenna gain	Reduce the Output power by 1 dB

Table 3-1 – Antenna Gain versus Maximum Output Power

3.4 ANTENNA PLACEMENT

FCC Part 15 Regulation, Section 15.247(b)4, provides for RF safety requirements. The regulation defines the allowable Maximum Permissible RF Exposure. In order to meet Maximum Permissible RF Exposure requirements, the user **MUST INSURE** that the antenna is located based on the following:

1. When the device will be installed with an external antenna (non leaky feeder type)the radiator **MUST BE** located more than 20 cm from the general public.

2. When the device is installed with leaky feader cable the nominal measured radiated field at 3 meters is 65.2 dBuV/m which relates to 1 microwatt E.I.R.P. Although these levels would allow for closer that 20 cm spacing, it is recommended that the cable be located at a minimum 20 cm separation between the radiator and the general public.

CHAPTER 4
PRINCIPLES OF OPERATION

4.1 FUNCTIONAL DESCRIPTION OF EQUIPMENT

4.1.1 MOBILE DATA RADIO AND BASE DATA RADIO

The BDR and MDR are full duplex transceivers that operate as intentional radiators in the FCC's 2400-2483.5 MHz industrial, scientific, and medical (ISM) band in North America and within 2400-2500 MHz international band. They operate as unlicensed devices and are compliant to the applicable FCC part 15 regulations.

The MDR employs both Code Division Multiple Access (CDMA) and Time Division Multiple Access (TDMA) techniques. CDMA is a function of the Pseudo-random Noise (PN) code selected for transmission and reception. The particular technique used in Andrew Base and Mobile Data Radios is Direct Sequence Spread Spectrum (DSSS) technique. In the direct sequence technique, the information spectrum is spread into a bandwidth many times wider than the bandwidth of the data alone by using a pseudorandom noise sequence clocked at a rate significantly greater than the information rate. Each data bit is encoded with a pseudorandom spreading code. The receiver can recover the original data by using the same sequence to decode the encoded data bits. Any other selected pseudorandom sequence simply appears as additional noise at the receiver.

When power is applied to a radio, the radio configures the transmit and receiver spreading sequences from data stored in the radio’s nonvolatile memory. After the radio configuration is completed, the Control Equipment can change the spreading sequences. The base station radios and mobile data radios maintain a pool of available PN codes or channels. Each radio requires a code. The transmit and receive codes are different. The receive code of the MDR or BDR must equal the other unit’s transmit code. Adjacent BDRs should not have the same codes.

In normal operation, all MDR’s in the same control zone operate with the same set of transmit and receive spreading codes. Time Division Multiple Access techniques are used to minimize interference between the MDR’s.

Normally, the BDR keeps its transmitter on all the time. The MDR on the vehicle turns on its transmitters in response to being specifically polled by a BDR. The BDR commands the MDR to bring up its transmitter and send any pending poll responses from the vehicle control equipment. The MDR turns off its transmitter if it fails to get confirmation in a certain period of time that the BDR has “locked” to the MDR. Also, MDR will turn off its transmitter after the BDR successfully “locks” to the MDR transmitter and the MDR sends its response to the BDR.

4.1.2 RADIO NETWORK ARCHITECTURE

The typical communication flow consists of wayside equipment (user control equipment and BDRs) communicating with mobile equipment (user control equipment and MDRs). Wayside to mobile communication can be distributed over a single or a number of radio networks. Each control region is considered as a single radio network. The regional control equipment uses a simple roll-call polling technique to communicate with all the vehicles in the region during a communication cycle. When a train approaches a region boundary it is handed over to the next region's radio network by using a software hand-off algorithm.

4.1.2.1 RF TRANSMISSIONS

Full duplex operation is achieved by utilizing separate frequency ranges within the 2400 - 2483.5 MHz band for each direction of communications. Data is transmitted from base radio to mobile using one range and from mobile to base radio over another frequency range. Refer to Table 1-2 Mobile Data Radio Assembly Specifications and Table 1-3 Base Station Radio Assembly Specifications.

4.1.2.2 BASEBAND DATA RATE

The radio network operates at a synchronous baud rate of 64Kbps.

4.1.2.3 OSI LAYERS

The radio network is developed following the ISO (International Standard Organization) Open Systems Interconnection (OSI) Reference Model. The radio network is modular in design. Industry standard protocol, interfaces and hardware are used to easily interface third party equipment.

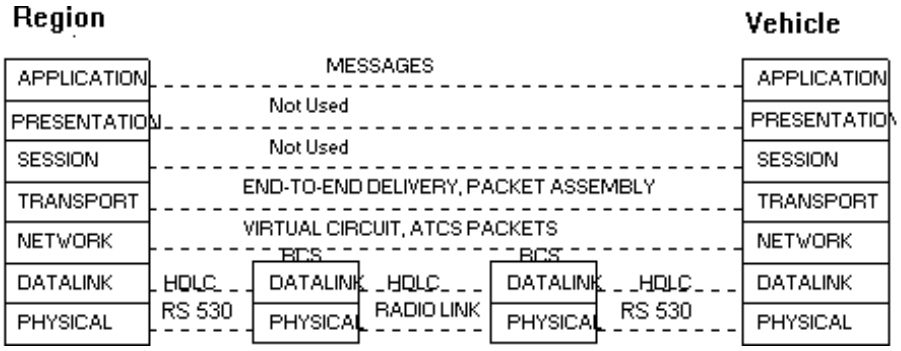


Figure 4-1 Radio Network OSI Layers

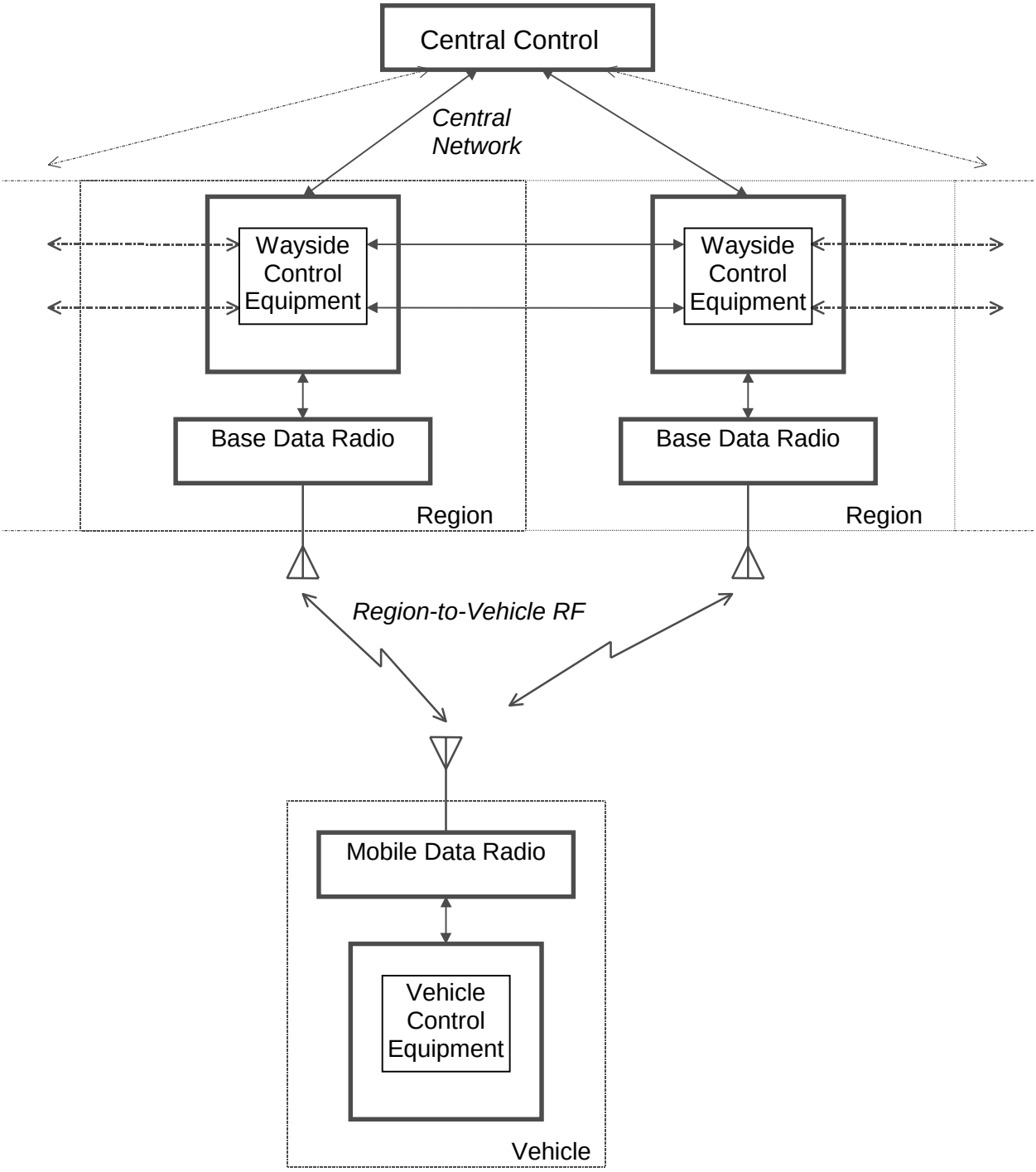


Figure 4-2 Radio Network Architecture

4.1.2.3.1 PHYSICAL LAYER

The physical layer is composed of a synchronous serial interface between the control equipment and the base or mobile transceiver and a radio to radio link based on spread spectrum technology. The baseband interfaces are based on the EIA-530 interface. The RF radio link is based on Direct Sequence Spread Spectrum modulation.

4.1.2.3.2 DATALINK LAYER

The data link layer is based on the HDLC (High-level Data Link Control) protocol to communicate over the radio channel between the base Radio Communication System (RCS) and mobile RCS. The same protocol is also used to communicate between the RCS and the control equipment over the EIA-530 interface. A sliding window of one is implemented for the transfer of HDLC Information Frames (I frames).

The HDLC Information frame (I frame) format is used to transfer data between the base radio and mobile radio as well as between the radio system and control equipment. The length of a frame is programmable. Currently is set to 81 bytes (including the two flag bytes). The wayside control equipment sends an ATC frame to the radio system along with proper RCS address, control byte and CRC. The first two bytes of the ATC frame will contain the address of the vehicle. This vehicle address will be used by the radio system to address a mobile radio on a vehicle. The control byte determines the type of frame. The radio communication system adds the CRC and flags to the ATC frame and transmits the packet over radio channel.

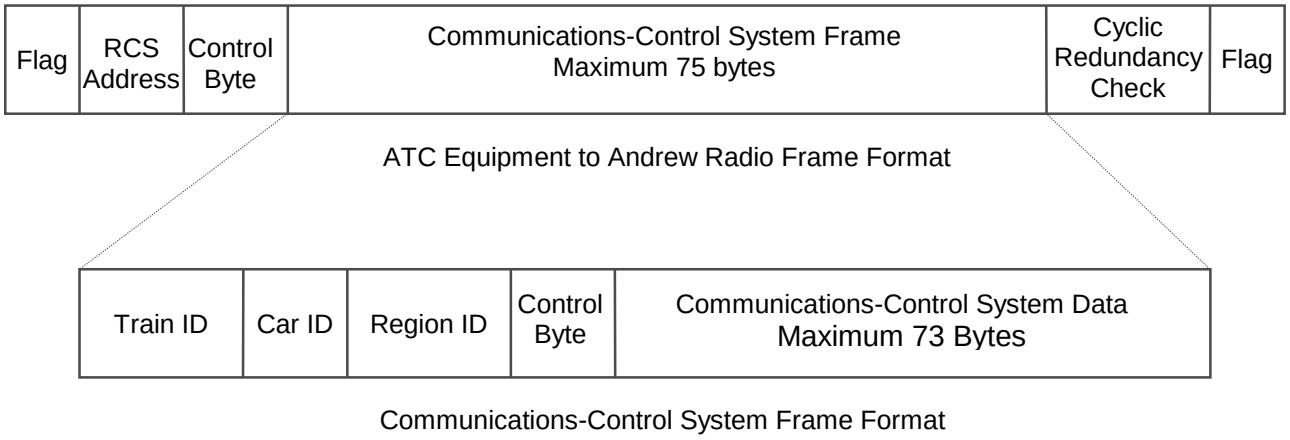


Figure 4-3 SCP to RCS Frame Format

A mobile radio is addressed by its two byte Address. Two addresses are reserved. A train address of zero hexadecimal ‘0000’ is not a legal value. The train address hexadecimal ‘FFFF’ is reserved for a broadcast message to all the trains in a region. A broadcast message will automatically be retransmitted by the BDR until the regional control equipment clears the frame. A vehicle will send no response to the broadcast message.

The radio communication system at the receiving end receives the packet and passes it to the vehicle control equipment. The successful receipt of an I frame must be acknowledged by the receiving RCS and control equipment. This is done by incrementing the Nr field of the control byte within the next frame sent.

If a vehicle has more than one radio communications system, one of them acts as the main unit and the others act as auxiliary radios. An MDR responds to a poll only if it is pre-loaded with a response message by the vehicle control equipment. For vehicles with more than one MDR, the vehicle control equipment must direct which MDR will be pre-loaded with a response. Hence, all radio systems in a train receive the message from the region control equipment but only the main radio system sends the response back.

Additional information about the message protocol can be found in the referenced ICD document.

4.1.3 MDR/BDR COMMUNICATIONS HANDLING

A communications cycle is the exchange of information between the wayside control equipment and each vehicle control equipment within the region. During a typical communications cycle, each vehicle control equipment will be sent a poll request, which will be acknowledged by a poll response from the vehicle control equipment. Each communications cycle is followed by the specific command that clears untransmitted messages before proceeding. The wayside control equipment must query the base data radio every 10 to 20 ms for a poll response, and all poll requests must be sent to the base radio at the beginning of the communications cycle (within the constraints of the protocol). Mobile radios are polled in sequence one after the other in a round robin fashion.

The data exchange is based on the High-Level Data Link Control (HDLC) standard protocol to communicate over the radio channel between the Andrew base and mobile radios. The same protocol is also used to communicate between base radio and wayside control equipment and between mobile radio and mobile control equipment over the EIA-530 interface. The handshaking sequence required by the communications protocol precedes each poll response.

The referenced Interface Control Document establishes the protocols and interfaces between wayside and vehicle Control Equipment and Mobile and Base Data Radios.

4.1.4 PN SPREADING CODES

The Direct Sequence Spread Spectrum and CDMA operation of the radios are controlled by the Pseudo Noise spreading codes contained within the non volatile memory of the radios. Normal operation of the radios requires (1) that the BDR transmit spreading code equal the MDR receive spreading code, (2) that that the MDR transmit spreading code equal the BDR receive spreading code, and (3) that the transmit and receive spreading codes within any radio be different. The radios are configured with over 80 different spreading codes. Selection of the codes by the user-supplied equipment is covered in the Radio Communication System Interface Control Document. Selection of the codes from the LCP terminal is covered in Chapter 8.

4.1.5 ANTENNA SWITCHING CONTROLS

The MDR Data 2 Port includes 3 signals, see MDR Data 2 Port Pin-outs, that can provide 20 ma of drive current. The current based signals, ANT0-ANT2, can be connected to a user supplied external switch that controls a multiple antenna configuration that is connected to the MDR. The return current path signals, SIGA GND, are tied together inside the radio. The software control of the antenna select lines is defined in the Radio Communication System Interface Control Document.

The MDR Data 2 Port also provides a power and power return path, see MDR Data 2 Port Pin-outs, to the user. The power signal, RADIO PWR, is taken directly from the user supplied input source. The electrical path is made with 22-gauge wire. The user is responsible to insure that (1) the current draw is within the limits that this gauge wire can support and (2) that the user supplied DC power source can supply this current load as well as the current load required by the MDR.

CHAPTER 5
MAINTENANCE AND TROUBLESHOOTING

5.1 PREVENTIVE MAINTENANCE, INSPECTION, AND CLEANING

This section describes preventive maintenance procedures for the MDR and BDR assemblies. Inspect and clean the MDR and BDR assemblies yearly or as required in severe environments to ensure continued operation. After inspecting the assemblies, take any necessary remedial actions. See Table 5-1 for assistance.

Table 5-1 Preventive Maintenance Inspection and Cleaning

Description	Normal Condition	Remedial Action
1. Inspect each unit for missing or loose hardware	All hardware in place and secure.	Replace missing hardware or tighten as necessary.
2. Inspect each unit for dust and dirt accumulation.	The units should remain free of dust or dirt accumulation.	Clean with a damp cloth.
3. Inspect all wiring and cabling.	No cracking, splitting, breakage, or pinching of insulation or connectors. No signs of aging.	Replace bad wiring or cabling as soon as possible.

Note: Power the equipment off during external cleaning.

5.2 TROUBLESHOOTING

Before beginning any in-depth troubleshooting, ensure that power is available to the unit. Ensure that all cable connections are secure. Refer to Figure 5-1 and Figure 5-2 for MDR and BDR initial troubleshooting.

This section describes the troubleshooting procedures for the MDR and BDR assemblies. Locate the unit's symptom in the Fault Indication column. The Fault Description column lists components or functions that can cause faults. The last column, Corrective Action, specifies the action necessary to correct the fault. After taking corrective action, perform the appropriate diagnostic procedure to verify that the correction was successful.

For malfunctions that the fault isolation table does not list, contact Andrew's technical support personnel.

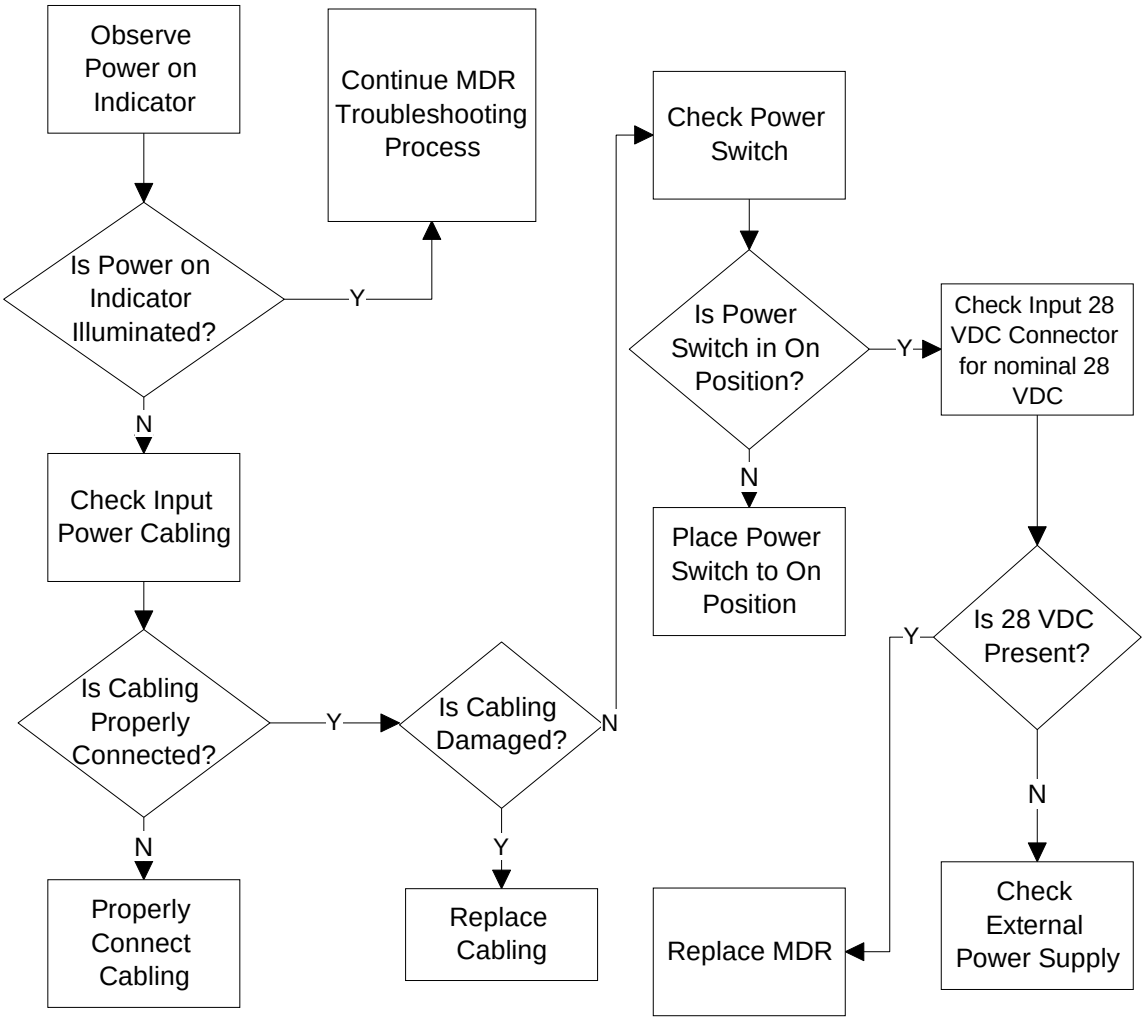


Figure 5-1 MDR Fault Isolation Flow Diagram

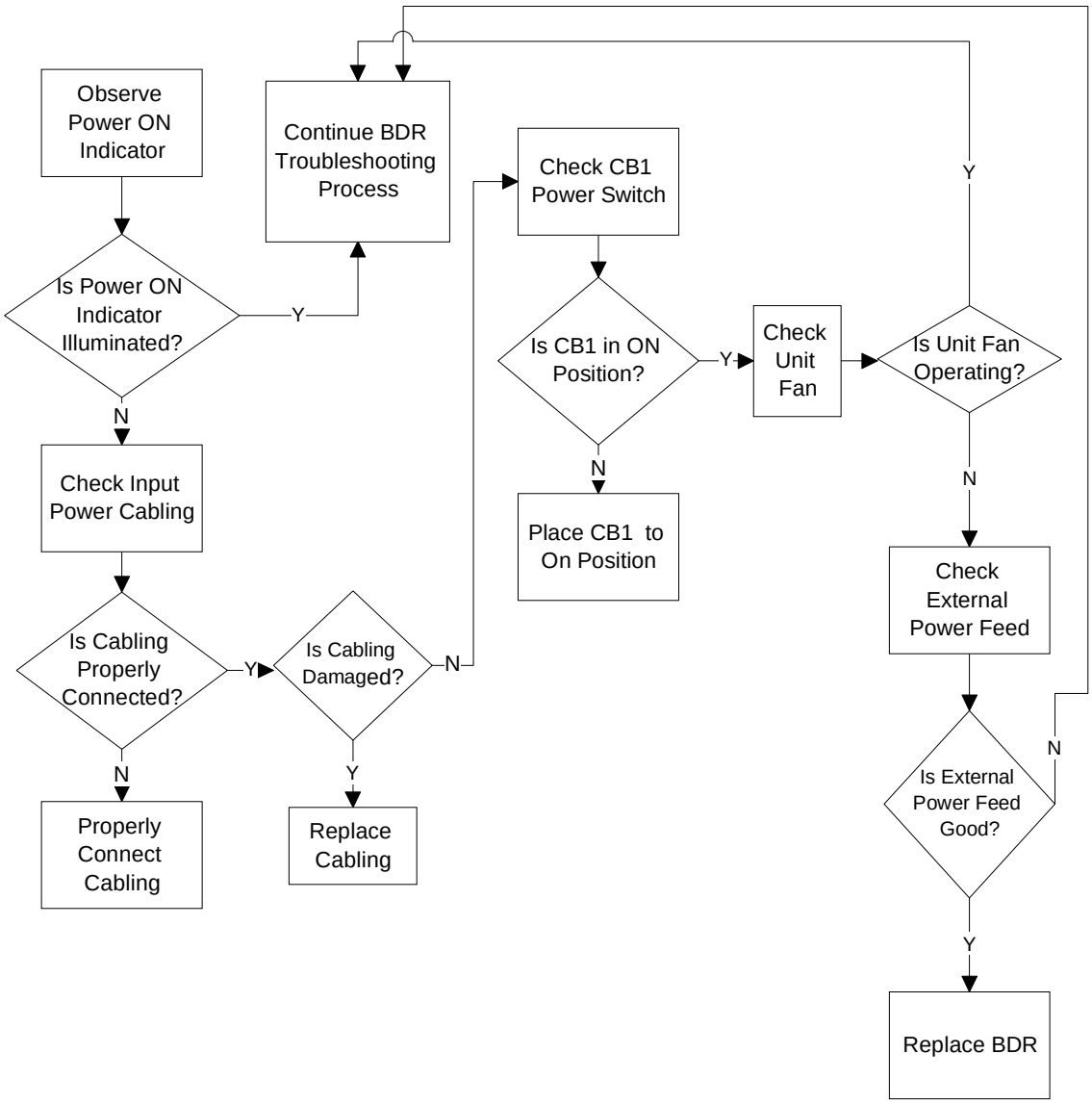


Figure 5-2 BDR Fault Isolation Flow Diagram

NOTE

The following table only isolates faults to the LRU level. The test procedures in Section III of this chapter provide assistance for further fault isolation. If an LRU fails, return it to the equipment manufacturer for maintenance or repair.

Step	Fault Indication	Fault Description	Corrective Action
1	MDR front panel **POWER ON** indicator not lit when power is on.	Possible loose power cable connection, faulty power cable, power switch in **OFF** position, faulty power supply, or faulty power indicator.	Ensure that the power cable is properly and securely connected to the radio and power supply. After the cable is properly and securely connected, place the power switch in the **ON** position. Refer to section 5.4.1, If the appropriate DC voltage is not present, the fault is elsewhere. Refer to the appropriate documentation for vendor equipment. Refer to section 5.3.1, place MDR.
2	BDR front panel **POWER ON** indicator not lit when power is on.	Possible loose cable connection, faulty power cable power switch in **OFF** position, faulty power supply, or faulty power indicator.	Ensure that the power cable is properly and securely connected to the radio and power supply. After the cable is properly and securely connected, place CB1 in the **ON** position and listen for the unit fan. If the fan is not functioning, remove and replace the radio. Refer to section 5.3.2, place BDR. Return the radio to the equipment manufacturer. Refer to section 2.1.2 for equipment returns. Refer to the appropriate documentation for vendor equipment.

NOTE: The unit voltage range for the corrective action procedure is the full input supply range of the unit.

Table 5-2 Radio Assembly Fault Isolation

5.3 CORRECTIVE MAINTENANCE

This section describes the removal and replacement of the MDR and BDR assemblies. See Section Radio Assembly Fault Isolation, to determine when to remove and replace a line replaceable unit (LRU).

5.3.1 REMOVE AND REPLACE MDR

Referring to Figure 5-3, perform the following actions to remove the MDR (shown as Item 2)

1. Place MDR (2) power switch (3) to the OFF position.
2. Disconnect the control equipment data cable that attaches to the MDR's **DATA 1** port (5), **DATA 2** port (7), and **DIAGNOSTIC** port (8) if installed.
3. Disconnect the DC power cable from POWER IN (4), the antenna feed line from **ANTENNA** port (6).
4. Remove four bolts (1) from the MDR (2) mounting brackets.
5. Remove mobile data radio (2).

Referring to Figure 5-3, perform the following actions to replace the MDR:

1. Place MDR (2) in position.
2. Secure MDR (2) with four bolts (1).
3. Reconnect the antenna feed line to port (6).
4. Reconnect the control equipment data cable to attach the MDR (2).
5. Reconnect the DC power cable to the POWER IN (4). Place MDR (2) power switch (3) to **ON** position.

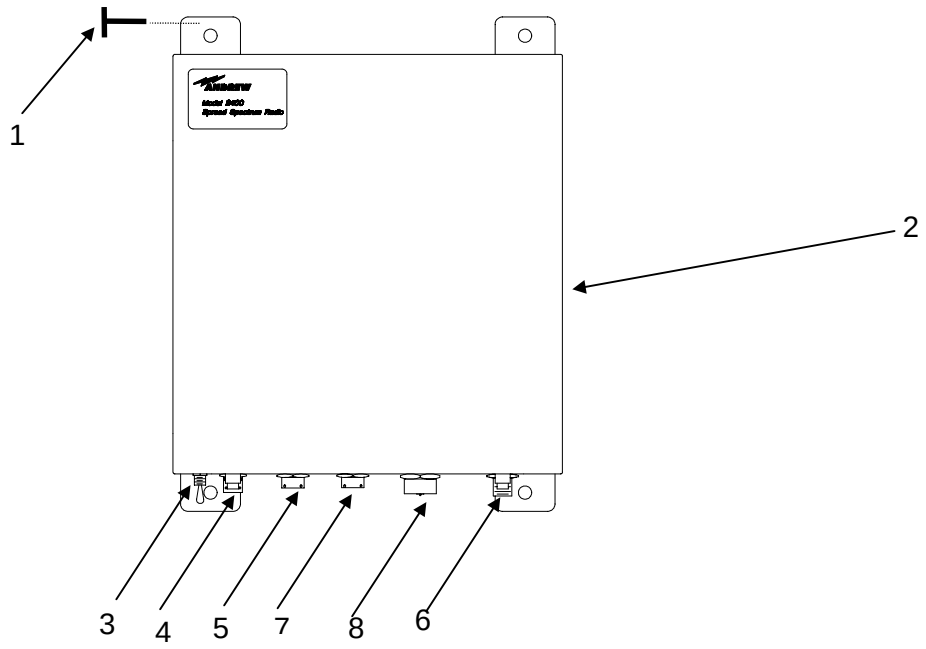


Figure 5-3 Remove and Replace MDR

5.3.2 REMOVE AND REPLACE BDR

Referring to Figure 5-4, perform the following actions to remove the BDR from the 19" rack (shown as item 2):

1. Place CB1 (3) to the OFF position.
2. Disconnect the AC power cable from J1 (5), the wayside BTC Control Equipment cabling from **DATA 1** port (4) or **DATA 2** port (7), the antenna feed line from **ANTENNA** port (5). Remove cable attached to **DIAGNOSTIC** port (8), if installed.
3. Remove and retain four rack-mounting screws (1) from the BDR (2).
4. Remove the BDR (2) from the equipment rack.

Referring to Figure 5-4, perform the following actions to replace the BDR:

1. Place the BDR (2) in the equipment rack.
2. Secure the BDR (2) to the equipment rack with four rack-mounting screws (1).
3. Reconnect the Control Equipment cable to **DATA 1** port (4), and the antenna feed line to **ANTENNA** port (5). Reconnect cables to other ports, if any.
4. Reconnect the AC power cable to **POWER IN** port (5). Place CB1 (3) to the **ON** position.

Actions to remove or replace the pole-mounted BDR are the same as described for the MDR in paragraph 5.3.1.

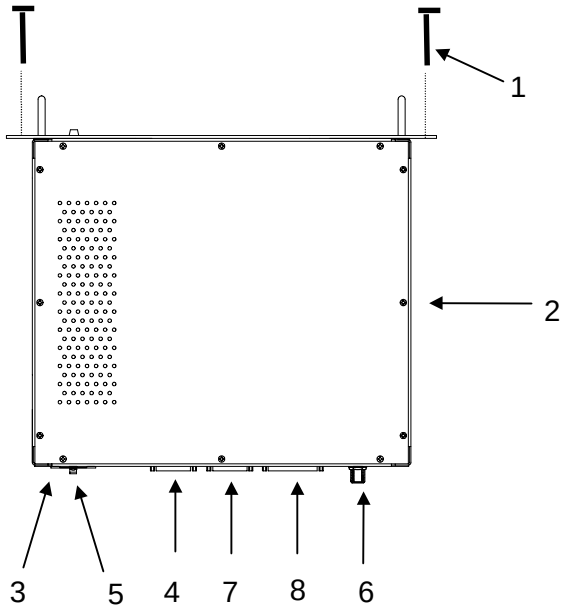


Figure 5-4 Remove and Replace BDR

5.4 TEST PROCEDURES

Refer to Table 5-3 for a list of test equipment to perform the following test procedures. If necessary, substitute an equivalent to the equipment listed.

The following test procedures help the user verify that a radio is faulty. Return faulty radios to Andrew Corporation for maintenance and repair. Refer to paragraph 2.1.1 for equipment return information.

Equipment	Qty	Part Number
Computer Terminal	1	IBM PC w/Procomm Software
Diagnostic Cable (Mobile)	1	385700-1811
Diagnostic Cable (Base)	1	385700-3811
Power Attenuator w/N Connector	1	Inmet 12N10W-20 dB
Spectrum Analyzer	1	HP8595A
RF Test Cable, w/N Connector	2	RG214
Attenuator 20 dB	A/R	Inmet 6N-20
Oscilloscope	1	Tektronics 2465 or equivalent
General Purpose Meter (DVM)	1	Fluke 77 or equivalent

Table 5-3 Test Equipment

5.4.1 MDR POWER VERIFICATION

1. Attach a 2 watt or greater, 20 dB power attenuator to the radio's ANTENNA port.
2. Using a power supply with a current and voltage meter, power up the radio with 24 VDC.
3. Place unit's power switch to the ON position.
4. For 24 VDC input, nominal current is 1.0 amps with the transmitter off. When the transmitter is on nominal current consumption is 1.6 amps.

5.4.2 BDR POWER VERIFICATION

1. Place CB1 to the **ON** position.
2. Ensure that the BDR lights its front panel **POWER ON** indicator.
3. Verify that the fan is on by listening to the sound.

NOTE

If the PC is properly connected to the radio DIAGNOSTIC PORT, the LCP menu automatically appears on the screen after the radio is ON and the radio self-test is completed.

5.5 MDR TESTS

The following sections provide procedures to test the MDR.

5.5.1 MDR TRANSMITTER TEST SETUP

Referring to MDR Transmitter Fault Isolation Test Setup, perform the following actions to prepare for the MDR transmitter test:

1. Connect the power cable to the MDR at the **POWER IN** port.
2. Connect a PC to the MDR with a diagnostic cable at the **DIAGNOSTIC** port.
3. Connect a 20 dB power attenuator to the MDR at the **ANTENNA** port.
4. Connect a 20 dB power attenuator to the spectrum analyzer RF port.
5. Connect a N cable from the **ANTENNA** port attenuator to the attenuator at the **INPUT** of the spectrum analyzer.

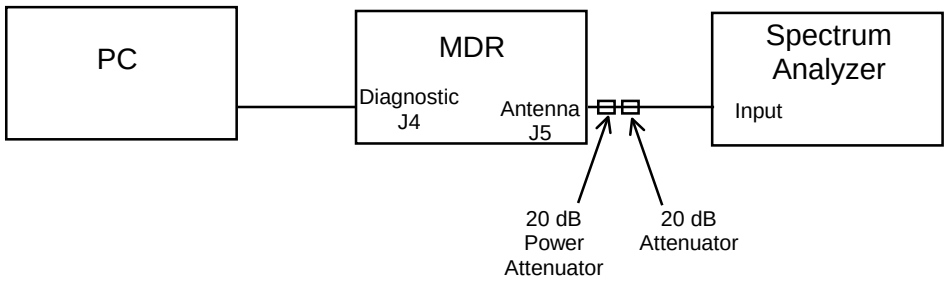


Figure 5-5 MDR Transmitter Fault Isolation Test Setup

For this test, set up the spectrum analyzer as follows:

- Center Frequency = 2467.84 MHz
- Span = 60 MHz
- Resolution Bandwidth = 100 KHz
- Video Bandwidth = 300 Hz
- Atten = 10 dB
- Ref = 0 dBm
- SWP = Auto
- Marker = 2467.84 MHz

5.5.2 MDR TRANSMITTER FAULT ISOLATION TEST

After preparing for the test, perform the following to isolate the transmitter fault:

1. Place the MDR power switch to the ON position.
2. Bring up the Diagnostic LCP screen. Refer to section 2.5.2 for details. Verify that the radio self test is completed successfully.
3. At the PC's LCP menu, select command #16 (Enable Transmitter).
4. Select command #33 (Set dBm output level.) Set output level to 24 dBm.
5. Use the spectrum analyzer's peak search function to monitor the output power.
6. Compare the output spectrum peak level to MDR Output Spectrum. The level should be within ±3 dB of the level shown in **Error! Reference source not found.**.
7. At the LCP menu, select command #15 (Disable Transmitter). The signal should be down a minimum of 40 dB from the enable levels.

5.5.3 MDR ONLY RECEIVER FAULT ISOLATION TEST SETUP

Refer to MDR Receiver Fault Isolation Test Setup. Preparation for the test to isolate the MDR receiver fault is similar to the transmitter test setup. The 20 dB attenuation may remain on the **ANTENNA** port for the remainder of this test. Referring to MDR Receiver Fault Isolation Test Setup, perform the following actions:

1. Connect the power cable to the MDR at INPUT 28 VDC.
2. Connect the PC to the MDR with a diagnostic cable at the **DIAGNOSTIC** port.

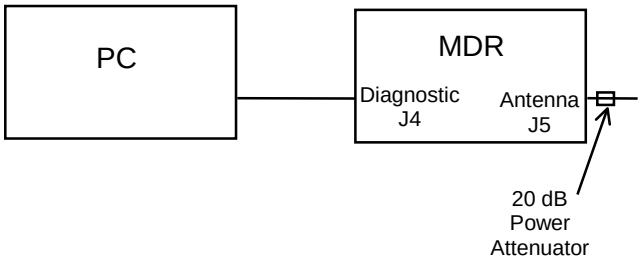


Figure 5-6 MDR Receiver Fault Isolation Test Setup

5.5.4 MDR ONLY RECEIVER FAULT ISOLATION TEST

After preparing for the test, perform the following steps to isolate the receiver fault:

8. Place MDR power switch to the **ON** position.
9. Bring up the Diagnostic LCP screen. Refer to section 2.5.2 for details. Verify that the radio self test is completed successfully.
10. After the LCP menu appears, select command #12 (Set Lower Threshold). Set the lower threshold to 01.
11. Select command #14 (Set Lower Lock Threshold). Set upper threshold to 01.
12. Select command #10 (Set Upper Threshold). Set lower lock threshold to 02.
13. If the MDR does not light the RECEIVER LOCK indicator, replace the MDR.
14. Select command #10 (Set Upper Threshold). Set the lower threshold to FF.
15. Select command #12 (Set Lower Threshold). Set upper threshold to FE.
16. Select command #14 (Set Lower Lock Threshold). Set lower lock threshold to FE.
17. If the MDR RECEIVER LOCK indicator is still on, replace the MDR.
18. Place MDR power switch to the **OFF** position.

5.5.5 MDR/BDR RECEIVER TEST SETUP

Referring to Figure 5-7, perform the following to prepare for the MDR receiver test setup:

Note: This test requires the use of a fully functional BDR.

1. Place MDR and BDR power switches to the **OFF** position.
2. Place 20 dB power attenuator on the BDR **ANTENNA** port. Place an additional 20 dB of attenuation to the power attenuator attached to the BDR. Connect a 20 dB power attenuator to the MDR at the **ANTENNA** port. Place an additional 20 dB of attenuation to the power attenuator attached to the MDR.
3. Connect a N cable from the BDR attenuator to the MDR attenuator.
4. Connect a PC to each radio with diagnostic cables at the **DIAGNOSTIC** ports.
5. Connect power to the units. Place MDR and BDR power switches to the **ON** positions, and bring up the Diagnostic LCP screens. Refer to section 2.5.2 for details. Verify that the radio self test is completed successfully.

6. After the BDR LCP menu appears, select command #28 (Status Request). Record the Transmit and Receive PN Code Indices.
7. On the MDR LCP menu, set the Transmit PN code index equal to the BDR Receive PN code index recorded above. The code is set as follows from the MDR LCP menu:

   2 ↵

   T ↵

   xx ↵ where xx is the BDR Receive PN code index

   On the MDR LCP menu, set the Receive PN code index equal to the BDR Transmit PN code index recorded above. The code is set as follows from the MDR LCP menu:

   2 ↵

   R ↵

   xx ↵ where xx is the BDR Transmit PN code index.
8. On the MDR LCP menu, select command #28 (Status Request). Verify that the Upper, Lower, and Lower Lock Thresholds are the same as written on the configuration sheet shipped with the radio.
9. On both the MDR and BDR LCP terminals, select command #33 (Set dBm output level.) Set each radio transmitter output level to 24 dBm.
10. At the BDR LCP menu, select command #16 (Enable Transmitter).
11. Verify that the MDR **RECEIVER LOCK** light is on. If it fails to illuminate, the MDR is not operational.
12. If the **RECEIVER LOCK** light is illuminated, either the MDR was not configured correctly (i.e. PN code indices) prior to this test, the antenna connection was faulty or the factory should be contacted for further information.
13. From the respective LCP terminals, shut off the radio transmitters by selecting command #15 (Disable Transmitter).
14. Place the MDR and BDR power switches to the **OFF** position.

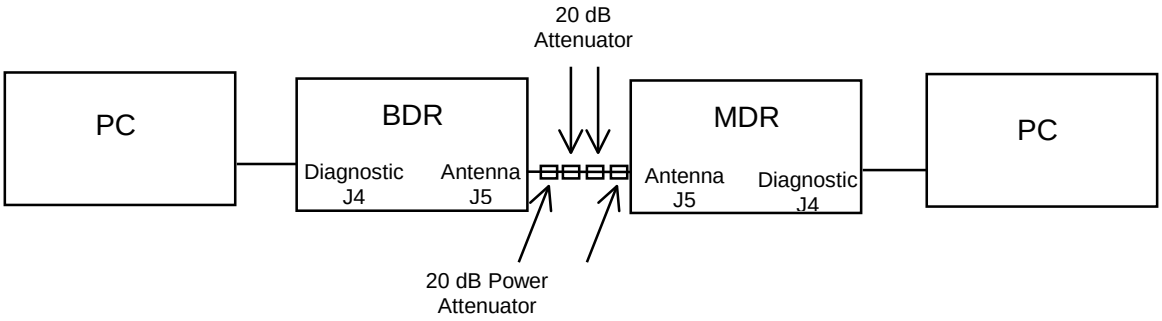


Figure 5-7 MDR Receiver Test Setup

5.6 BDR TESTS

The following sections provide test setup information for the BDR.

5.6.1 BDR TRANSMITTER SETUP

Referring to Figure 5-8, perform the following to prepare for the BDR transmitter fault isolation test:

1. Connect power cable to BDR.
2. Connect the PC to the BDR with a diagnostic cable at the **DIAGNOSTIC** port.
3. Connect a 20 dB power attenuator to the BDR at the **ANTENNA** port.
4. Connect a 20 dB power attenuator to the spectrum analyzer RF port.
5. Connect a N cable from the ANTENNA port attenuator to the attenuator at the **INPUT** of the spectrum analyzer.

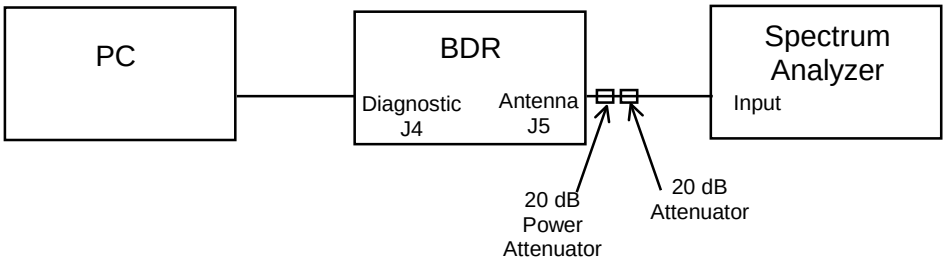


Figure 5-8 BDR Transmitter Fault Isolation Test Setup

For the BDR transmitter fault isolation test, set-up the spectrum analyzer as follows:

Center Frequency	= 2416.64 MHz
Span	= 60 MHz
Resolution Bandwidth	= 100 KHz
Video Bandwidth	= 300 Hz
Attn	= 10 dB
Ref	= 0 dBm
SWP	= Auto
Marker	= 2416.64 MHz

5.6.2 BDR TRANSMITTER FAULT ISOLATION TEST

After preparing for the test, perform the following steps to isolate the BDR transmitter fault:

1. Place BDR power to the **ON** position.
2. Bring up the Diagnostic LCP screen. Refer to section 2.5.2 for details. Verify that the radio self test is completed successfully.
3. At the LCP menu, select command #16 (Enable Transmitter).
4. Use the spectrum analyzer's peak search function to monitor the output power.

5. Compare the output spectrum peak level to BDR Output Spectrum. The level should be within ± 3 dB of **Error! Reference source not found.**.
6. At the LCP menu, select command #15 (Disable Transmitter). The signal should be a minimum of 40 dB below the enable levels.

5.6.3 BDR ONLY RECEIVER FAULT ISOLATION TEST SETUP

Preparation for the test to isolate the BDR receiver fault is similar to the transmitter test setup. Referring to Figure 5-9, BDR Receiver Fault Isolation Test Setup, perform the following actions:

1. Connect the power cable to the BDR.
2. Connect the PC to the BDR with a diagnostic cable at **DIAGNOSTIC** port.

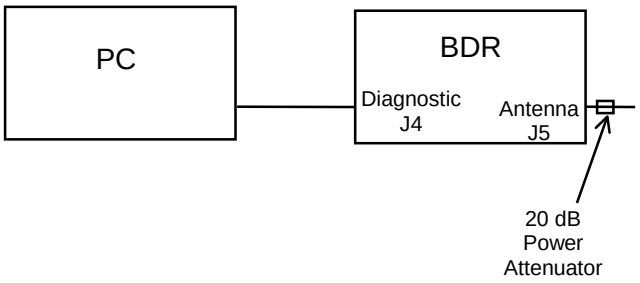


Figure 5-9 BDR Receiver Fault Isolation Test Setup

5.6.4 BDR ONLY RECEIVER FAULT ISOLATION TEST

After preparing for the test, perform the following to isolate the receiver fault:

1. Place BDR power switch to the **ON** position.
2. Bring up the Diagnostic LCP screen. Refer to section 2.5.2 for details. Verify that the radio self test is completed successfully.
3. After the LCP menu appears, select command #12 (Set Lower Threshold). Set the lower threshold to 01.
4. Select command #14 (Set Lower Lock Threshold). Set the threshold to 01.
5. Select command #10 (Set Upper Threshold). Set the threshold to 02. If the BDR does not light the RECEIVER LOCK indicator, replace the BDR.
6. Select command #12 (Set Lower Threshold). Set the lower threshold to FE.
7. Select command #14 (Set Lower Lock Threshold). Set upper threshold to FE.
8. Select command #10 (Set Upper Threshold). Set lower lock threshold to FF.
9. If the BDR RECEIVER LOCK indicator is still on, replace the BDR.
10. Place BDR power switch to the **OFF** position.

5.6.5 BDR/MDR RECEIVER TEST SETUP

Referring to Figure 5-10, perform the following for the BDR Receiver Test Setup.

Note: This test requires the use of a fully functional MDR.

1. Place MDR and BDR power switches to the **OFF** position.
2. Place a 20 dB power attenuator on the BDR **ANTENNA** port. Place an additional 20 dB of attenuation to the power attenuator attached to the BDR. Connect a 20 dB power attenuator to the MDR at the **ANTENNA** port. Place an additional 20 dB of attenuation to the power attenuator attached to the MDR
3. Connect a N cable from the BDR attenuator to the MDR's attenuator.
4. Connect a PC to each radio with diagnostic cables at the radio **DIAGNOSTIC** ports
5. Connect power to the units. Place the MDR and BDR power switches to the ON position and bring up the Diagnostic LCP screen. Refer to section 2.5.2 for details.
6. After the MDR LCP menu appears, select command #28 (Status Request). Record the Transmit and Receive PN Code Indices.
7. On the BDR LCP menu, set the Transmit PN code index equal to the MDR Receive PN code index recorded above. The code is set as follows from the BDR LCP menu.

   2 ↵

   T ↵

   xx ↵ where xx is the MDR Receive PN code index

   On the BDR LCP menu, set the Receive PN code index equal to the MDR Transmit PN code index recorded above. The code is set as follows from the BDR LCP menu.

   2 ↵

   R ↵

   xx ↵ where xx is the MDR Transmit PN code index
8. On the BDR LCP menu, select command #28 (Status Request). Verify that the Upper, Lower, and Lower Lock Thresholds are the same as written on the configuration sheet shipped with the radio.
9. On both the MDR and BDR LCP terminals, select command #33 (Set dBm output level.) Set each radio transmitter output level to 24 dBm.
10. At the MDR LCP menu, select command #16 (Enable Transmitter).
11. Verify that the BDR **RECEIVER LOCK** light is on. If it fails to illuminate, the BDR is not operational.
12. At the BDR LCP menu, select command #16 (Enable Transmitter.)
13. Verify that the MDR RECEIVER LOCK light is on. If it fails to illuminate, the BDR is not operational.
14. If both **RECEIVER LOCK** lights are illuminated, either the BDR was not configured correctly (i.e. PN code indices) prior to this test, the antenna connection was faulty, or the factory should be contacted for further

information.

15. From the respective LCP terminals, shut off the radio transmitters by selecting command #15 (Disable Transmitter).
16. Place the MDR and BDR power switches to the **OFF** positions.

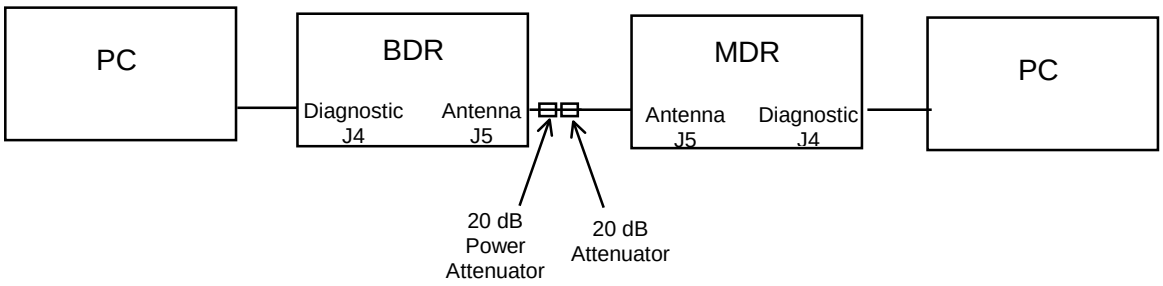


Figure 5-10 BDR Receiver Test Setup

5.7 RADIO DATA PORT TO USER SUPPLIED EQUIPMENT INTERFACE

5.7.1 EIA-530 DATA PORT TEST SETUP

Referring to MDR Transmitter Fault Isolation Test Setup, perform the following actions to prepare the MDR

1. Connect the power cable to the MDR at the **POWER IN** port.
2. Connect a PC to the MDR with a diagnostic cable at the **DIAGNOSTIC** port.
3. Connect a 20 dB power attenuator to the MDR at the **ANTENNA** port.

Referring to BDR Transmitter Fault Isolation Test Setup, perform the following to prepare for the BDR transmitter fault isolation test:

1. Connect power cable to BDR.
2. Connect the PC to the BDR with a diagnostic cable at the **DIAGNOSTIC** port.
3. Connect a 20 dB power attenuator to the BDR at the **ANTENNA** port.

5.7.2 EIA 530 DATA PORT TEST

1. From the BDR LCP terminal select command #28 (Status Request) to verify that the BDR RCS address matches the address in the frames from the user supplied equipment.
2. Remove the external cables from DATA 1 (Base and Mobile) and DATA 2 (Base) ports. With an oscilloscope, verify the presence of the 64 KHz TX and RX clocks and the RX data signals at the DATA 1 (Base and Mobile) and DATA 2 ports. Refer to BDR Data 1 Port Cable Pin-outs, BDR Data 2 Port Cable Pin-outs, and MDR Data 1 Port Pin-outs for pinout details. If the signals are inactive, the radio is not operational. If the signals are active, reattach the cables and verify the integrity of the cable assembly. If the cable is correctly configured and radio communication still does not occur, contact Andrew for

further information.

5.7.3 RS-232 DATA 2 PORT SETUP

Referring to MDR Transmitter Fault Isolation Test Setup, perform the following actions to prepare the MDR

1. Connect the power cable to the MDR at the **POWER IN** port.
2. Connect a PC to the MDR with a diagnostic cable at the **DIAGNOSTIC** port.
3. Connect a 20 dB power attenuator to the MDR at the **ANTENNA** port.
4. Connect a computer serial port to the MDR **Data Port 2** using adapters as needed. Setup the computer to run ProComm™ (or other Terminal Communication Program

5.7.4 RS-232 DATA 2 PORT TEST

1. From the MDR LCP terminal select command #28 (Status Request) to verify that the MDR **Data Port 2** parameters match those of the user supplied equipment. If the parameters are not the same, configure the MDR per section rt Configuration (Optional)
3. After verifying that **Data Port 1** is correctly attached to the user supplied equipment , the user supplied equipment should be configured to send a message to the MDR. If the message appears on the computer screen, **Data Port 2** is operational. The user supplied equipment and cabling connected to **Data Port 2** should be checked for proper configuration and operation. If the message does not appear on the computer screen and the cable is correctly configured the radio should be replaced. Contact Andrew for further information.

CHAPTER 6
ORDERING INFORMATION

6.1 PARTS LIST

This chapter provides a list of replacement parts for the radio assemblies. It also provides vendor names and addresses. Table 6-2 shows all of the items on the list. To procure any of the parts, contact Andrew Corporation or the appropriate vendor for the part.

The parts list includes three columns: Description, Part Number, and Quantity (Qty). The Description column identifies the specific part, beginning with the assembly or line-replaceable unit (LRU) that contains it. The information in the Description column includes an (AP) symbol to denote attaching hardware for the LRUs. The part number column provides the vendor's number for that drawing or part. The Quantity column defines how many of the particular part the next higher assembly (NHA) contains.

Table 6-1 provides a list of applicable vendors and their addresses.

Vendor	Address (Phone Number)
Andrew Corporation	2601 Telecom Parkway Richardson, Texas 75082-3521 (972) 235-7300
ITT Corporation, ITT Canon Division	666 East Dyer Road Santa Ana, CA 92702
Belden Wire and Cable	2200 US HWY 27 Richmond, IN 47375-0010

Table 6-1 Vendors

Table 6-2 provides a list of replaceable parts for the radio assemblies and the mating cable connectors.

Description	Part Number	Qty
Radio Assembly, Data, Mobile	385700-1000-001 385700-1000-002	1 1
Connector, Circular, Straight Plug, 14-19P	MS3126F14-19P	1
Connector, Circular, Straight Plug, 14-19PY	MS3126F14-19PY	1
Connector, Circular, Straight Plug, 18-32P	MS3126F18-32P	1
Radio Assembly, Base Station	385700-3000	1
Housing, Connector, D-Sub, 37 Pin	Available Vendor	1
Metal Backshell, D-Sub, 25 CKT	Available Vendor	2
Metal Backshell, D-Sub, 37 CKT	Available Vendor	1
Contact, Pin, 20 AWG	Available Vendor	37
Lock Assembly, Screw Lock, D-Sub	Available Vendor	2
Power Cord, 18/3, SJT, 2M	Available Vendor	1
Screw, Phillips Truss Head, 10-32 UNF w/plastic washer (AP)	Available Vendor	4

Table 6-2 Parts List

CHAPTER 7
MECHANICAL INFORMATION

7.1 BASE DATA RADIO MECHANICAL OUTLINE

The mechanical outline for the rack mounted version of the BDR, 385700-3000-001, is given in Figure 7-1 BDR Rack Mount Mechanical Outline.

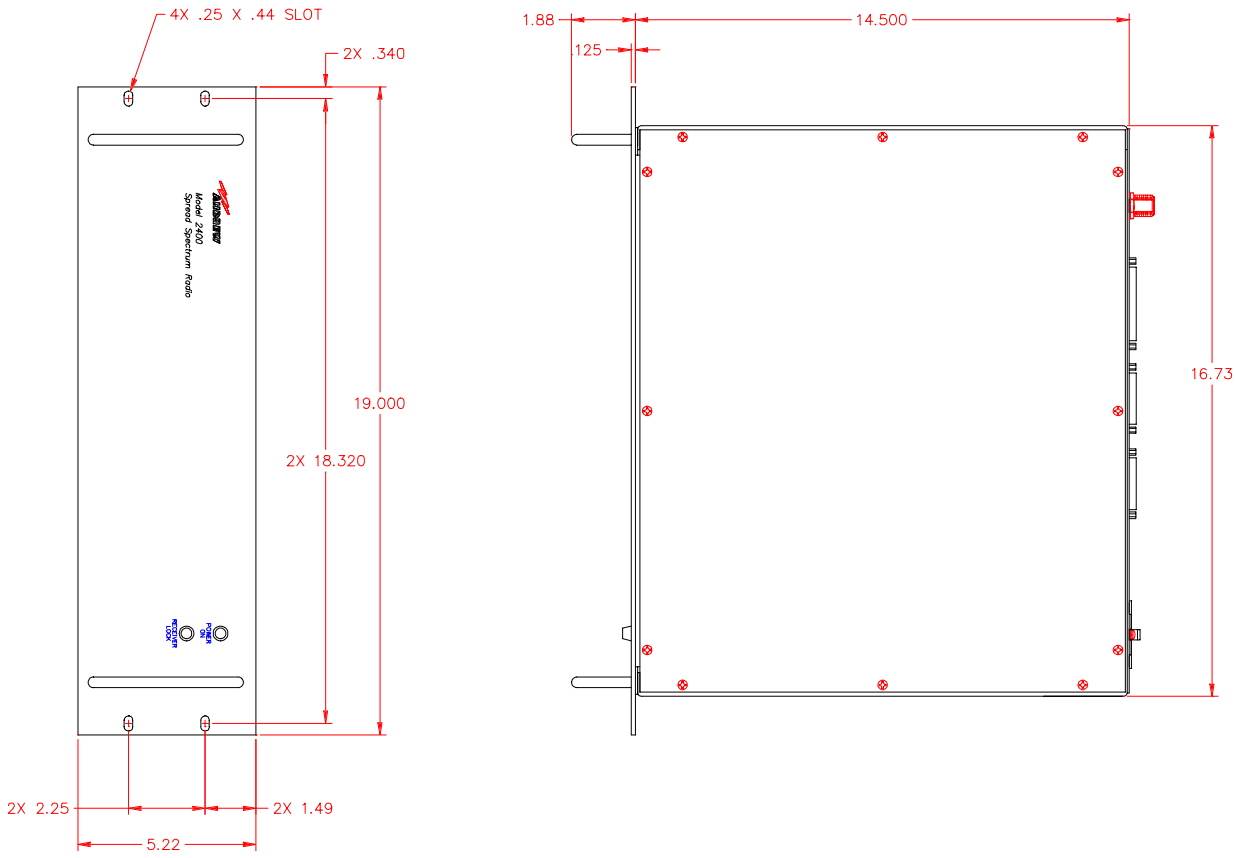


Figure 7-1 BDR Rack Mount Mechanical Outline

The mechanical outline for the wall mounted version of the BDR, 385700-3000-002, is given in Figure 7-2 BDR Wall Mount Mechanical Outline.

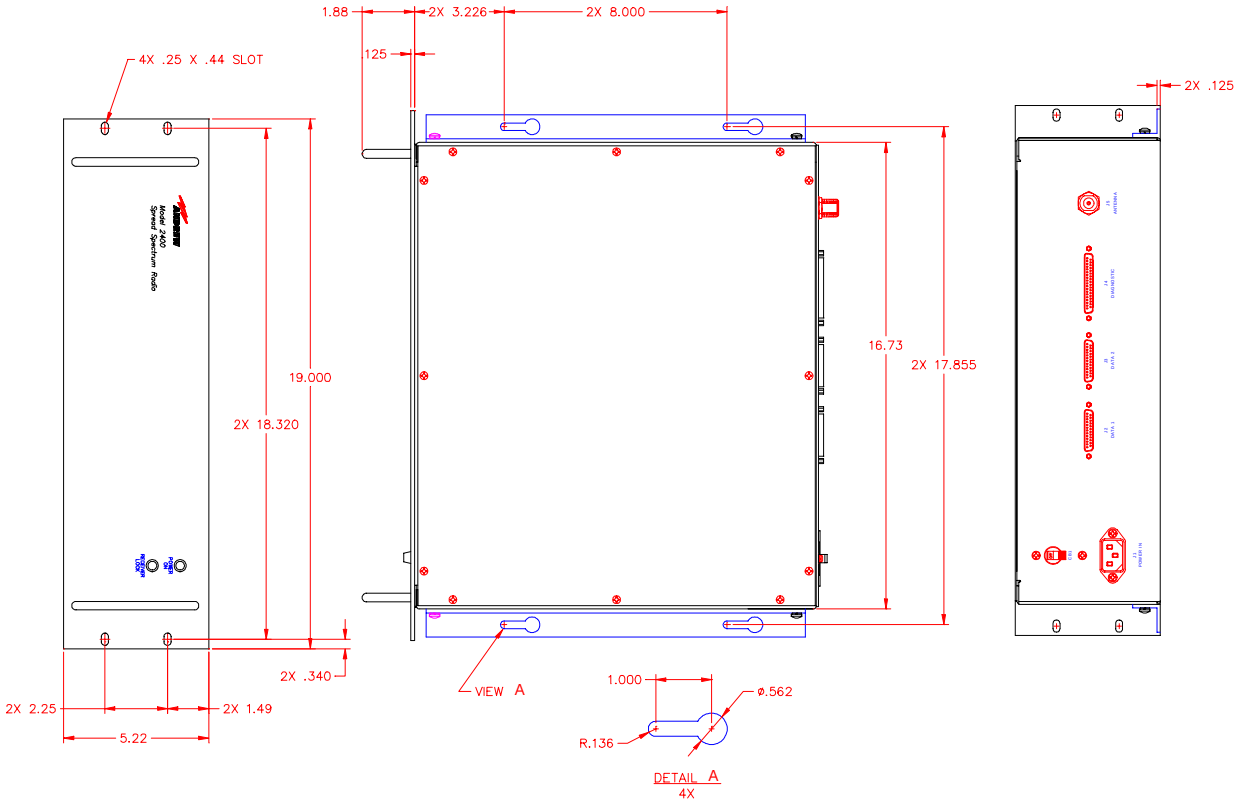


Figure 7-2 BDR Wall Mount Mechanical Outline

The mechanical outline for the Mobile Data Radio is given in Figure 7-3 Mobile Data Radio Mechanical Outline.

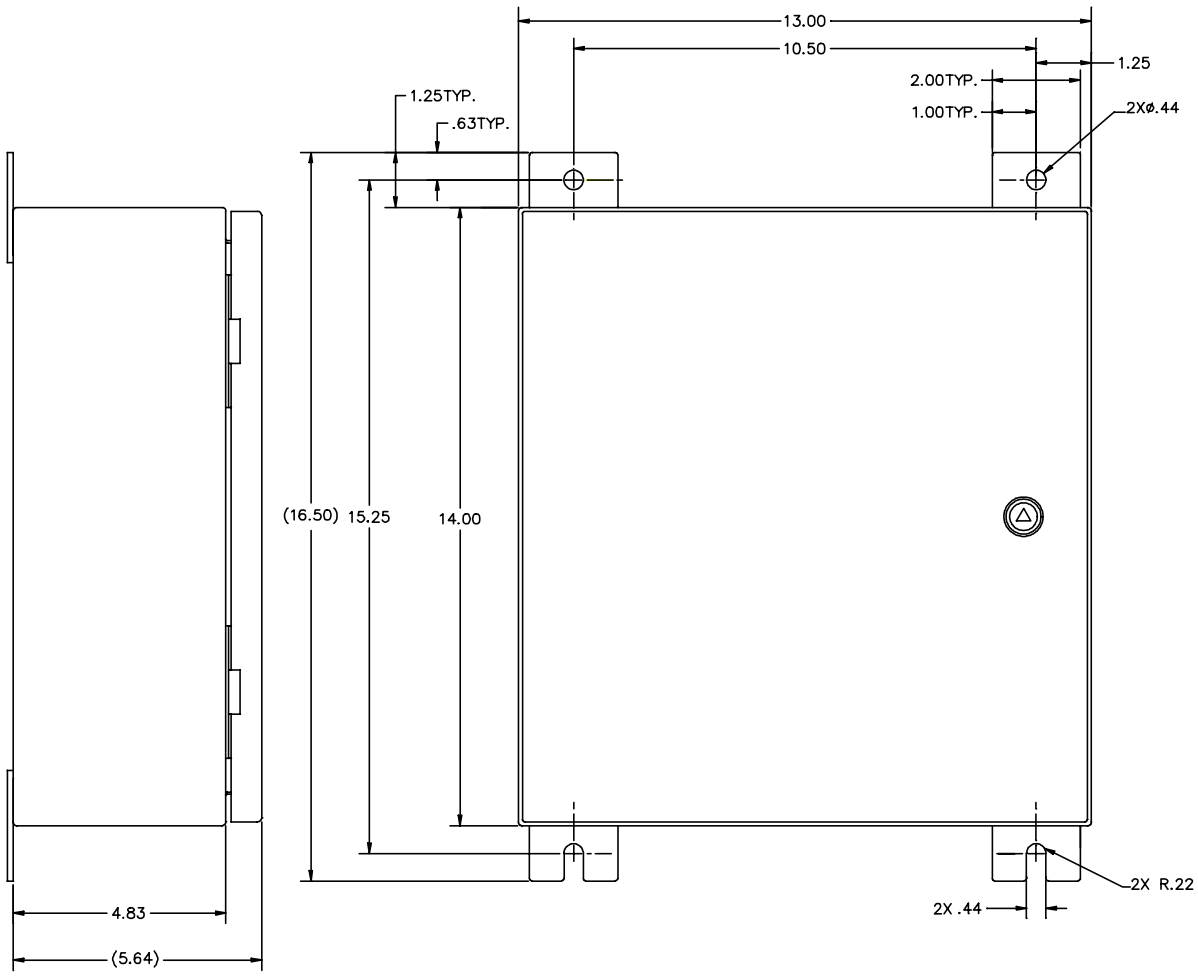


Figure 7-3 Mobile Data Radio Mechanical Outline

CHAPTER 8
DIAGNOSTIC LCP MENU

8.1 DIAGNOSTIC MENU

Initial configuration and trouble shooting of the radio equipment is accomplished through the Diagnostic port of a radio. A WYSE 100 compatible terminal or a computer running a terminal emulation program is attached to the diagnostic port. This terminal or computer is referred to as the LCP terminal elsewhere in this manual. The LCP diagnostics menu for the MDR and BDR are identical except for a few commands. The differences are noted in the following sections. The diagnostics menu includes user available selections as well as reserved commands for testing the radio. The reserved commands are intended for use by factory trained personnel only. Use of these commands by unauthorized personnel will require the user to perform a power reset to the unit before normal operation can occur. The following sections are based on a typical LCP menu. The user should contact the factory for updates.

The operator selects a particular command by typing the command number, which appears to the left of the command, followed by pressing the ENTER (↵) key. If the command requires additional parameters, the LCP program will prompt the user for inputs. All inputs are completed using the ENTER (↵) key.

BDR Diagnostic LCP Menu

Phase II WAYSIDE LCP MENU SW Ver #: 01.01

1 Send Poll Requests
2 Set PN Index (CDMA Code)
3 Program Synthesizers
4 Reserved
5 Reset DSP
6 Reserved
7 Reset PN
8 Reset PN (RX,STROBE)
9 Reserved
10 Set Upper Threshold
11 Upper Thres w/o PN Reset
12 Set Lower Threshold
13 Lower Thres w/o PN Reset
14 Set Lower Lock Threshold
15 Disable Transmitter
16 Enable Transmitter
17 Load SC Register
18 Disable Test Port
19 Enable Test Port
20 PN Test Select
21 A/D Select
22 Set Clock Search
23 OS-9 Shell
24 Set RCS Address
25 Reserved
26 SSR Status Request
27 System Block Status
28 Status Request
29 Show Poll Counters
30 Clear Poll Counters
31 Reserved
32 Read TRACK/AGC Values
33 Set dBm Output Level
34 Change dBm/DAC Values
35 Serial EEPROM Display
36 Save Current Settings
37 Load TnD SC Register
38 Reserved
39 Toggle Temp Compensation
40 Display System Log
41 Read Track
42 Read AGC
43 Power
44 Test EEPROM
45 Read PA/Temp
46 Poll Response
47 Select Antenna
48 unused
49 unused
50 Read Memory

Figure 8-1 BDR LCP Menu

8.2 MDR DIAGNOSTIC LCP MENU

Phase II WAYSIDE LCP MENU SW Ver #: 01.01

1 Vehicle Addr. (Train ID)	21 A/D Select	41 Read Track
2 Set PN Index (CDMA Code)	22 Set Clock Search	42 Read AGC
3 Program Synthesizers	23 OS-9 Shell	43 Power
4 Reserved	24 Set RCS Address	44 Test EEPROM
5 Reset DSP	25 Reserved	45 Read PA/Temp
6 Reserved	26 SSR Status Request	46 Poll Response
7 Reset PN	27 System Block Status	47 Select Antenna
8 Reset PN (RX,STROBE)	28 Status Request	48 unused
9 Reserved	29 Show Poll Counters	49 unused
10 Set Upper Threshold	30 Clear Poll Counters	50 Read Memory
11 Upper Thres w/o PN Reset	31 Reserved	
12 Set Lower Threshold	32 Read TRACK/AGC Values	
13 Lower Thres w/o PN Reset	33 Set dBm Output Level	
14 Set Lower Lock Threshold	34 Change dBm/DAC Values	
15 Disable Transmitter	35 Serial EEPROM Display	
16 Enable Transmitter	36 Save Current Settings	
17 Load SC Register	37 Load TnD SC Register	
18 Disable Test Port	38 Reserved	
19 Enable Test Port	39 Toggle Temp Compensation	
20 PN Test Select	40 Display System Log	

Figure 8-2 MDR LCP Menu

8.3 LCP COMMANDS

A description of the commands, their applicability to BDR or MDR, and the required response(s) to be entered are given below.

Send Poll Requests BDR

This command causes the BDR to send or stop sending poll requests to an MDR. The poll request is sent to Vehicle Address 1000_{16}. The poll requests are sent at an approximate rate of one request per second. The LCP displays the current state of the polling after this command is entered. The polling state toggles between sending and stopping poll requests each time the command is entered.

Vehicle Addr. (Train ID) MDR

This command is used to set the 16 bit address of an MDR. Each MDR requires a unique vehicle address. The allowable address range is 0001_{16} to $FFFE_{16}$. The address, $FFFF_{16}$, is reserved for the Broadcast message.

Set PN Index (CDMA Code) BDR and MDR

This command selects the spreading code to be used by the Transmitter and Receiver PN spreading generators. The user selects the generator(s), Tx, Rx, or Both to be loaded, and an index number which points to a lookup table of PN generator initial conditions. At the completion of this command, the selected PN generator(s) are reset, the new initial conditions are loaded into the PN generator(s), and the radio displays the new generator PN index.

Program Synthesizers BDR and MDR

This command is reserved for future use or internal unit testing.

Reserved BDR and MDR

This command is reserved for future use or internal unit testing.

Reset DSP BDR and MDR

This command is reserved for future use or internal unit testing.

Reset PN BDR and MDR

This command allows the user to start one of the PN sequences in the radio at a known state. The user is prompted for the type of generator reset (continuous, pulsed, or release from continuous) and which generator, Tx or Rx, to reset..

Reset PN (RX STROBE)

This command performs a pulsed reset of the Rx PN generator with a double keystroke entry by the user.

SET UPPER THRESHOLD BDR and MDR

The upper threshold value is part of the radio receiver's confidence test for determining PN code synchronization. The UPPER THRESHOLD must be greater than the LOWER and LOWER LOCK thresholds. The actual values used are set at the factory. Large values for the upper threshold require input high signal levels. If the levels are set too high, the radio will not be able to declare PN synchronization. If the levels are set too low, the radio will falsely declare PN synchronization. This will degrade communications throughput by increasing the amount of time to synchronize to the incoming PN code. Using this command results in an internal radio receiver reset condition. This forces a radio receiver to reacquire PN synchronization. The range of allowable values is 00_{16} to FF_{16} subject to the above stated requirements.

UPPER THRES W/O PN RESET BDR and MDR

This command is similar to the Set Upper Threshold command except it does not force the radio receiver to reacquire PN synchronization after the new threshold is loaded.

SET LOWER THRESHOLD BDR and MDR

The lower threshold value is part of the radio receiver's confidence test for determining PN code synchronization. The LOWER THRESHOLD must be less than the UPPER THRESHOLD but greater than the LOWER LOCK thresholds. The actual values used are set at the factory. Large values for the lower threshold require input high signal levels. If the levels are set too high, the radio will not be able to declare PN synchronization. If the levels are set too low, the radio will falsely declare PN

synchronization. This will degrade communications throughput by increasing the amount of time to synchronize to the incoming PN code or by preventing PN code synchronization altogether. Using this command results in an internal radio receiver reset condition, which forces a radio receiver resynchronization. The range of allowable values is 00_{16} to FF_{16} subject to the above stated requirements.

LOWER THRES W/O PN RESET BDR and MDR

This command is similar to the Set Lower Threshold command except it does not force the radio receiver to reacquire PN synchronization after the new threshold is loaded.

SET LOWER LOCK THRESHOLD BDR and MDR

The lower threshold value is part of the radio receiver's confidence test for maintaining PN code synchronization. The LOWER LOCK THRESHOLD must be less than the UPPER THRESHOLD and is normally less than the LOWER LOCK thresholds. The actual values used are set at the factory. Large values for the lower threshold require input high signal levels. If the levels are set too high, the radio will not be able to maintain PN synchronization. If the levels are set too low, the radio will falsely maintain PN synchronization. This will degrade communications throughput by increasing the amount of time to correctly synchronize to the incoming PN code or by preventing PN code synchronization altogether. Using this command results in an internal radio receiver reset condition, which forces a radio receiver resynchronization. The range of allowable values is 00_{16} to FF_{16} subject to the above stated requirements.

DISABLE TRANSMITTER BDR and MDR

This command allows the user to manually turn off the radio transmitter.

ENABLE TRANSMITTER BDR and MDR

This command allows the user to manually turn on the radio transmitter. If the radio has not been powered down, the output level will be the last loaded value. If the radio is powered down after selecting this command, the output level will be the last value saved to non volatile memory. The user can check the level with the STATUS REQUEST command. The user can change the output level with the SET dBm OUTPUT LEVEL command.

LOAD SC REGISTER BDR and MDR

This command is reserved for future use or internal unit testing.

DISABLE TEST PORT BDR and MDR

This command is reserved for future use or internal unit testing.

PN TEST SELECT BDR and MDR

This command is reserved for future use or internal unit testing.

A/D SELECT BDR and MDR

This command is reserved for future use or internal unit testing.

SET CLOCK SEARCH BDR and MDR

This command is reserved for future use or internal unit testing.

OS-9 SHELL BDR and MDR

This command is reserved for future use or internal unit testing. The ESCAPE key is used to return the radio to its normal operating condition from this state.

SET RCS ADDRESS BDR

This command sets the BDR address. It is used in multiple BDR configurations. The allowable range of address is 01_{16} to FE_{16}. A default address of 40_{16} is preloaded into the BDR upon power up initialization. See the ICD for further information.

SSR STATUS REQUEST BDR and MDR

This command reads the current configuration data stored inside various modules within the radio. It includes a display that indicates whether the data agrees with the data originally written to the modules. The parameters currently supported are the lower lock, lower, and upper thresholds, the Tx and Rx PN code, the Tx and Rx Data Rates, and the current state of the Transmitter. All other parameters are for future use.

STATUS REQUEST BDR and MDR

This command displays the current radio configuration as stored in the radio's volatile memory. The parameters currently supported are the lower lock, lower, and upper thresholds, the Tx and Rx PN code, the Tx and Rx Data Rates, and the current state of the Transmitter. All other parameters are for future use.

SHOW POLL COUNTERS BDR

This command displays a group of communication counters that monitor the polling activity between the BDR and MDR and special flags used for internal radio code debugging. The counter types currently supported are the number of poll requests input to the BDR, the number of frames transmitted from the BDR controller to the radio RF transmitter, the number of valid poll responses received from the MDR, the total number of frames received from the radio RF port at the BDR controller, and the number of poll request retransmission attempts.

CLEAR POLL COUNTERS

This command zeroes a group of communication counters that monitor the polling activity between the BDR and MDR.

READ TRACK/AGC VALUES BDR and MDR

This command is reserved for future use or internal unit testing.

SET dBM OUTPUT LEVEL BDR and MDR

This command is used to set the transmitter output power level of the radio. The range of listed output levels may be greater than the specifications of the radio. When using this command, the user must set the output level such that compliance with FCC output level requirements are maintained. The output resolution is in 1 dB increments.

CHANGE dBM/DAC VALUES BDR and MDR

This command is reserved for factory calibration or internal unit testing. The command, Set dBM Output Level, is used to enter the PA control voltages corresponding to an RF output levels. After entering the voltage/ RF levels, the user

must save the entries to non volatile memory using the SAVE CURRENT SETTINGS command.

SERIAL EEPROM DISPLAY BDR and MDR

This command displays the radio configuration parameters stored in the non volatile memory of the radio. These are the parameters loaded into the radio upon applying power to the unit.

SAVE CURRENT SETTINGS BDR and MDR

This command writes the current radio configuration parameters to the non volatile memory of the radio.

LOAD TND SC REGISTER BDR and MDR

This command is reserved for future use or internal unit testing.

TOGGLE TEMP COMPENSATION BDR and MDR

This command is reserved for future use or internal unit testing.

DISPLAY SYSTEM LOG BDR and MDR

This command is reserved for future use or internal unit testing.

Read Track BDR and MDR

This command is reserved for future use or internal unit testing.

Read AGC BDR and MDR

This command is reserved for future use or internal unit testing.

Power BDR and MDR

This command is reserved for future use or internal unit testing.

Test EEPROM BDR and MDR

This command performs a non destructive test of the EEprom circuitry.

Read PA/Temp BDR and MDR

This command is reserved for future use or internal unit testing.

Poll Response MDR

This command toggles the MDR poll response state between enabling and disabling a fixed command response. Enabling the fixed poll response configures the radio to transmit an 81 byte message whenever the MDR receives a valid poll request from the BDR.

Select Antenna MDR

This command sends a binary encoded value to the ANTn lines of the MDR Data 2 port. The ANTn lines are 20 ma driver control lines. The truth table for selecting the ANTn lies is given below:

Select Antenna Value	ANTn line selected
1	ANT0
4	ANT1
8	ANT2

Unused BDR and MDR

This command is reserved for future use or internal unit testing.

Read Memory BDR and MDR

This command is reserved for future use or internal unit testing.