AR2200 (Version 2) RF Module User Guide

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TRANSCORE

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WARNING TO USERS IN THE UNITED STATES

FEDERAL COMMUNICATIONS COMMISSION (FCC)
LOCATION AND MONITORING SERVICE STATEMENT
47 CFR §90.351

NOTE: The user is required to obtain a Part 90 site license from the FCC to operate this radio frequency identification (RFID) device in the United States. See product label for FCC ID number. Access the FCC Web site at www.fcc.gov/Forms/Form601/601.html or wireless.fcc.gov/index.htm?job=online_filing to obtain additional information concerning licensing requirements.

NOTE: Users in all countries should check with the appropriate local authorities for licensing requirements.

FCC RADIO FREQUENCY INTERFERENCE STATEMENT
47 CFR §15.105(a)

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate RF energy and may cause harmful interference to radio communications if not installed and used in accordance with the instruction manual. Operating this equipment in a residential area is likely to cause harmful interference, in which case, depending on the regulations in effect, the user may be required to correct the interference at their own expense.

NO UNAUTHORIZED MODIFICATIONS
47 CFR §15.21

CAUTION: This equipment may not be modified, altered, or changed in any way without permission from TransCore, LP. Unauthorized modification may void the equipment authorization from the FCC and will void the TransCore warranty.

USE OF SHIELDED CABLES IS REQUIRED
47 CFR §15.27(a)

NOTE: Shielded cables must be used with this equipment to comply with FCC regulations.

TransCore, LP
USA

Health Limits

Within the United States, environmental guidelines regulating safe exposure levels are issued by the Occupational Safety and Health Administration (OSHA).

Section 1910.97 of OSHA Safety and Health Standards 2206 legislates a maximum safe exposure limit of 10 milliwatts per square centimeter (mW/cm^2) averaged over 6 minutes at both 915 and 2450 MHz.

Although not binding, other organizations such as the American National Standards Institute (ANSI) have issued similar guidelines that are more restrictive than the OSHA limits (ANSI C95.1). ANSI guidelines recommend a maximum safe power density in mW/cm^2 of:

***Frequency* (in MHz)**
1500

Thus, the maximum permissible exposure for general population/uncontrolled exposure at 915 MHz is 0.61 mW/cm^2. The power limit is a six-minute average.

The RF power density generated by the AR2200 (Version 2) RF Module was calculated using a maximum antenna gain of 14 dBi, equivalent to the antenna gain used in a typical AR2200 (Version 2) RF Module installation.

Note: *The calculated RF power density that is presented here assumes a 3 dB cable loss. If your installation's cable loss is less than 3 dB, you must increase RF attenuation to reduce the output power and meet the safe operating distances listed here.*

Caution

The antenna gain should not exceed 14 dBi. The antennas used for this transmitter must not be located within 8 inches (20 cm) of or operated in conjunction with any other antenna or transmitter.

Warning

At 1.8 W transmitted power and a distance of 22 inches (55 cm) from the antenna, the maximum power density calculated was 0.6 mW/cm^2. Install the antennas at least 22 inches (55 cm) from the general public. Maintenance personnel must remain at least 9.7 inches (24.5 cm) from antennas when system is operating.

The data confirms that the TransCore AR2200 (Version 2) RF Module System effectively meets OSHA requirements and thus does not represent an operating hazard to either the general public or maintenance personnel.

Contents

Contents

3 Installing the AR2200 RF Module

4 Testing the RF Module

5 Indicator Lights

6 Range Modulation Sensitivity Adjustment

A AR2200 RF Module Technical Specifications

Index

List of Figures

List of Tables

1

Before You Begin

Chapter 1

Before You Begin

This chapter describes this guide's purpose and intended audience. It provides a list of topics covered in each section, a list of related documents, and the symbols and typographical conventions used.

Purpose

This guide provides the information necessary for TransCore-certified personnel to successfully install and test the AR2200 (Version 2) Radio Frequency (RF) Module. Hereafter, the product is referred to as the AR2200 RF Module or RF module.

Intended Audience

This guide was written for TransCore-certified personnel who design, configure, install, test, and maintain TransCore systems in the field.

Guide Topics

This document presents the following information.

Chapter 1–Before You Begin	Describes the purpose, intended audience, guide topics, related documentation, and document conventions.
Chapter 2–AR2200 RF Module Overview	Provides an overview of the AR2200 RF Module's features, options, and accessories.
Chapter 3–Installing the AR2200 RF Module	Presents information and procedures for mounting and installing a stand-alone RF module in a NEMA-4 enclosure or on a baseplate. This chapter discusses connecting one or two RF modules to a single AI1200-series reader or AI1301 Reader Card. This chapter also identifies old and new AI1200 Reader power supplies. You must install a new power supply to use the AR2200 RF Module.
Chapter 4–Testing the AR2200 RF Module	Provides instructions for testing the installed RF module.
Chapter 5–Indicator Lights	Describes the locations and features of the RF module's indicator lights.
Chapter 6–Sensitivity Range Adjustment	Explains how to adjust the range sensitivity to screen unwanted tag signals.
Appendix A–Technical Specifications	Presents reference information on the AR2200 RF Module.

Typographical Conventions

Table 1-2 lists the conventions used in this manual:

Table 1-2 Typographical Conventions

Convention	Indication
	This procedure might cause harm to the equipment and/or the user
	Concerns about a procedure
`Code`	Code, including keywords and variables within text and as separate paragraphs, and user-defined program elements within text appear in courier typeface
Dialog Box Title	Title of a dialog box as it appears on screen
Function	Start with the characters G4, and are in mixed case with no underscores, and include parentheses after the name, as in G4FunctionName().
Menu Item	Appears on a menu. Capitalization follows the interface
Note	Auxiliary information that further clarifies the current discussion. These important points require the user's attention. The paragraph is in italics and the word Note is boldface.
NUL	Zero-value ASCII character or a zero-value byte
NULL	Zero-value pointers. Null-terminated string refers to strings of printable ASCII characters with a zero-value byte placed in memory directly after the last printable character of the string.

Licensing Requirements

To operate a radio frequency (RF) system in a given country, the user must first obtain permission from the regulatory agency that controls radio operations in that country. Most countries require type and safety approval, as well as licensing for RF transmitters. Users in all countries should check with the appropriate local authorities for licensing requirements.

U.S. Licensing

This AR2200 RF Module requires an FCC Part 90 license to operate in the U.S. The authorized *continuous wave* frequencies for use in the U.S. are 902.25 to 903.75 MHz and 910.00 to 921.50 MHz.

The user is responsible for filing the FCC license according to FCC regulations. You can access the necessary forms by accessing the FCC Web site at www.fcc.gov/forms/form601/601.html or wireless.fcc.gov/index.htm?job=online_filing.

Note: *The FCC ID is FIH22000555201.*

An FCC license provides the user with the legal authorization to operate the RFID systems on the licensed frequencies at the site specified in the license. Only an authorized installer or service technician can set the frequency for the AR2200 RF Module to that specified in the FCC site license.

The FCC license also provides the user with protection and authorization to maintain the system should any other RFID be used in the licensed area after the AR2200 RF Module is installed.

2

AR2200 RF Module Overview

Chapter 2

AR2200 RF Module Overview

This chapter presents an overview of the AR2200 RF Module's features, options, and accessories.

Overview

The AR2200 RF Module is a dual-output radio transmitter/receiver that, on command from a TransCore reader, generates a radio frequency (RF) signal in the 902.250- to 928.000-MHz radio frequency range over three bands and delivers the signal to the antenna for broadcast. Figure 2-1 shows the top view of the RF module input/output (I/O) interface board.

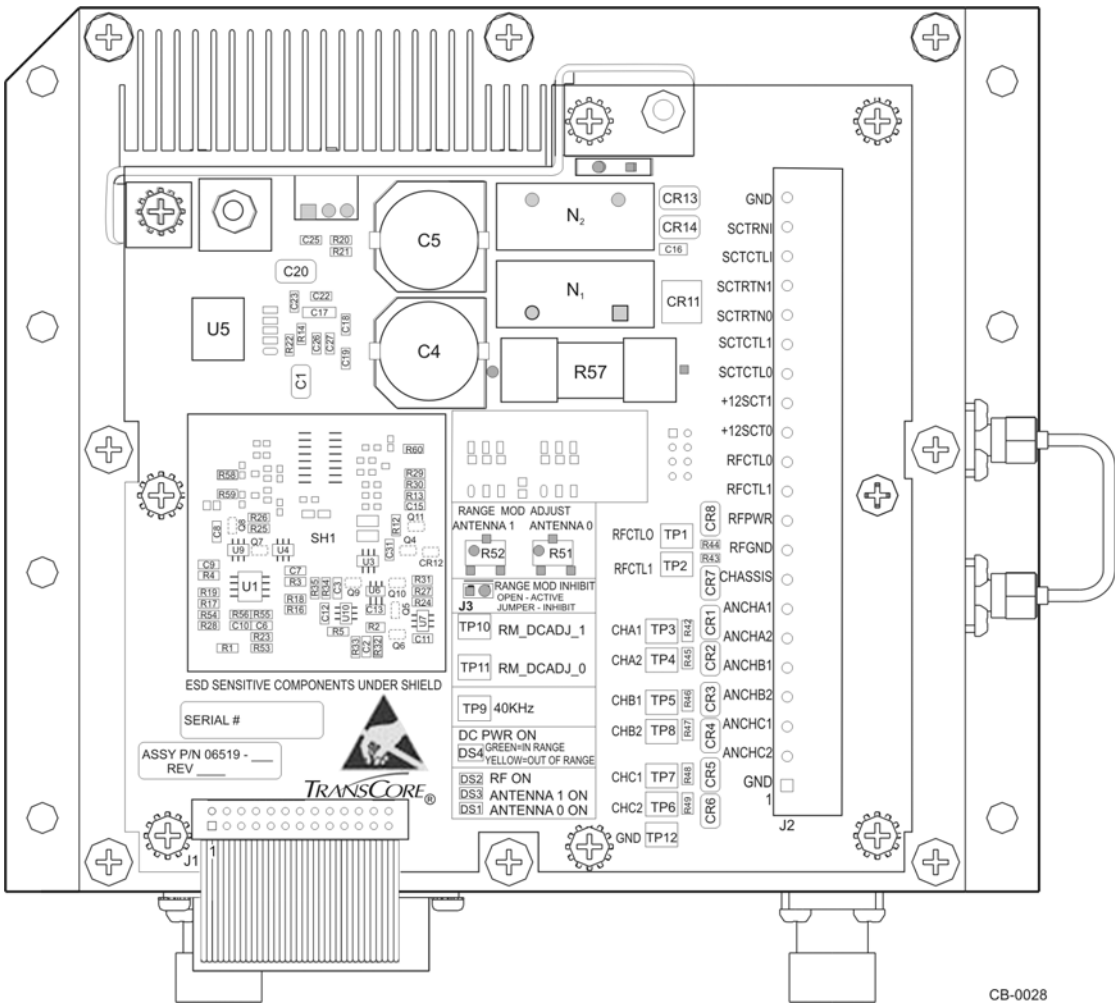

Figure 2-1 AR2200 RF Module I/O Interface Board

The RF module receives and demodulates the reflected tag signal returned through the antenna and then preamplifies and conditions the demodulated signal before sending it to the reader. The RF module generates the RF power necessary to read a TransCore tag. It also contains receiver and preamplifier circuitry to preprocess the tag signal returned through the antenna. Once connected to the antenna and reader and tuned, the RF module should require no further mechanical adjustment by the user.

The RF module receives direct current (DC) power through a cable connection made to the reader. A separate reader-to-RF module cable carries the demodulated tag signal from the RF module to the reader and the on/off control signal from the reader to the RF module.

Note: *Long coaxial cable lengths between the RF module and antenna can degrade system performance and should be avoided in system configuration.*

RF output power is on when the reader is activated with default parameters. However, RF output power may be switched off through reader firmware commands. RF output power can also be controlled through interfacing proximity sensors with the reader. Proximity sensors allow RF output power to be switched on only in the presence of objects to be identified. Proximity sensors are useful in installations using battery power or where continuous RF output power is not desirable.

The RF power can be reduced independently for each antenna port by inserting external fixed attenuators between each antenna port and its associated antenna. This method of port power reduction reduces receiver sensitivity. Decreasing the RF signal strength through attenuation directly reduces the RF system's reading range.

Note: *For any application requiring external fixed attenuators, the power rating of the attenuators should be at least two times the transmitted power.*

For ease of installation, the RF module is connected to the reader by cable attached to a removable 21-terminal plug.

Features

The RF module includes the features listed in this section.

Range Sensitivity Adjustment

The two-position programming jumper, J3 can be jumpered to inhibit the effect of the range sensitivity adjustments. By jumpering J3, you ensure use of the maximum broadcast range. Jumpering can be done when the RF module is used in a traffic monitoring system where the maximum size read zone is desired. Individual sensitivity circuit potentiometers (R51 and R52) access an infinite range of settings from maximum broadcast range (range sensitivity adjustment OFF, no mask signal injection) to maximum signal injection (minimum sensitivity). These adjustments are made independently for each antenna port.

International Organization for Standardization Compatible

The RF module meets the criteria for equipment configuration and performance specified by the International Organization for Standardization's (ISO) DIS 10374 container identification standard.

Patented Design: High-Speed Signal Capture, Noise Immunity

The RF demodulation circuitry consists of a two-channel homodyne receiver patented by TransCore that prevents signal loss, allowing the system to read tags moving at high speeds. The differential aspect of the RF module design improves system immunity to noise.

Frequency Range

The authorized continuous wave frequencies for use in the United States are 902.25 to 903.75 and 910.00 to 921.50 MHz. Contact TransCore if your application requires a different operating frequency. Local laws apply in the determination of operating frequencies.

At sites with two RF modules installed, use a 6-MHz frequency separation between the modules. At sites with three or more RF modules installed, use a lesser frequency separation, for example, 2-MHz or 1-MHz. If site requirements dictate that operating frequencies need to be separated by less than 1 MHz, the requirements must be assessed on a site-by-site basis before TransCore assigns specific RF module operating frequencies. You may be able to use any frequency (available in that country) independent of another RF module using the same frequency provided that you separate the RF modules by at least one mile. Contact your local regulatory agency for specific licensing regulations.

TransCore can provide units operating at multiple frequencies in the authorized band. TransCore also recommends even frequencies with a step size of 250 kHz, that is, 910.00, 910.25, 910.50, 910.75, and so on.

Buildable RF Modules

The RF module is available in the 902.250- to 928.000-MHz band frequencies (Table 2-1).

Table 2-1 AR2200 RF Module Options and Operating Frequency Bands

RF Module Option	Operating Frequency Range (MHz)
-03	902.250 to 908.500
-04	908.750 to 917.000
-05	917.250 to 928.000

Preamplifier Line Driver Output

The preamplifier provides balanced low-impedance analog signal lines capable of driving up to 1,000 feet (305 m) of cable. The preamplifier output incorporates electrostatic discharge protection.

Note: *Signal or data cable lengths of more than 500 feet (152.4 m) should be used with discretion; longer cables are more susceptible to receiving electrical noise. For more information on signal/data cables and cable lengths, refer to Chapter 6, System Configuration, of the AI1200 Reader System Guide. For more information on DC wiring requirements, especially RF module minimum wire gauge versus distance from reader, refer to Table 3-1 on page 3-6 of this AR2200 (Version 2) RF Module User Guide.*

Connections

The RF module is connected to the reader through cable attached to a 21-terminal plug. The 21-terminal plug mates with a 21-terminal jack on the RF module interface board. The plug, removable for servicing, uses captive-screw compression terminals. The antenna coaxial cable connects to the RF module through an N-type connector on the side of the RF subassembly.

Circuit Protection

The RF module I/O interface board filters DC power received from the reader and protects output circuitry from damage caused by transients on the cable between the reader and RF module.

International Safety Standards

The RF module complies with United States and international RF safety standards as specified by American National Standards Institute C95.1, International Electrotechnical Commission Publications 60215 and 60657, and the National Radiological Protection Board.

Output Power

The output power of the RF module is set at the factory to 1.8 watts (W).

Options

The following options are available for the RF module.

NEMA-4 Enclosure Installation

The AR2200 RF Module is available mounted on an improved, vibration-dampened baseplate and enclosed in a weatherproof NEMA-4 enclosure. In this configuration, the RF module is capable of operating in any environment. The maximum environmental levels are vibration of less than or equal to 2 G_{rms} from 5 to 500 Hz, and a 15-G half-sine shock pulse of 6-millisecond duration.

Stand-Alone Installation

The AR2200 RF Module is also available as a stand-alone unit for custom installations. The use of a TransCore standard mounting kit is recommended for customer installations. The standard mounting kit includes the following components:

- dielectric spacer
- 21-position mating connector
- ground wire
- mounting screws with insulated bushings.

Note: *Vibration and shock levels are not specified nor is operation within product specifications guaranteed by TransCore for any custom installations.*

Operating Frequencies

The RF module can be set at the factory to operate at a discrete, narrow band frequency. This option avoids frequency interference from other closely situated units operating at similar frequencies. At sites with two RF modules installed, use a 6-MHz frequency separation between the modules. At sites with three or more RF modules installed, use a lesser frequency separation, for example, 2-MHz or 1-MHz. If site requirements dictate that operating frequencies need to be separated by less than 1 MHz, the requirements must be assessed on a site-by-site basis before TransCore assigns specific RF module operating frequencies. You may be able to use any frequency (available in that country) independent of another RF module using the same frequency provided that you separate the RF modules by at least one mile. Contact your local regulatory agency for specific licensing regulations.

Note: *Contact TransCore if your application requires an operating frequency outside of the 902.25 to 903.75 MHz or 910.00 to 921.50 MHz bands. Local laws apply in the determination of operating frequencies.*

Replacement I/O Interface Board

The I/O interface board is the only replaceable part in the RF module. A ribbon cable to connect to the RF subassembly is permanently wired to the I/O interface board.

Accessories

The following accessories are available for the RF module.

Attenuators

TransCore offers 5W, 1- to 24-decibel attenuators with N-type connectors. Other attenuators may be available for specialized applications; contact TransCore for information.

Check Tag

TransCore offers an AT5720 Check Tag. A check tag is a special-purpose tag that can be permanently installed in an antenna or is installed near an antenna that does not have an internal check tag.

The check tag can simulate a toll transaction, thereby providing a means for the reader to check a reader's operation. The check tag, activated on command by a host computer, provides a test of the antennas, RF source, preamplifier, encoder/decoder, microprocessor, communications port, and I/O control.

3

Installing the AR2200 RF Module

Chapter 3

Installing the AR2200 RF Module

This chapter presents information and procedures for mounting and installing a stand-alone RF module in a NEMA-4 enclosure or on a baseplate. This chapter discusses connecting one or two RF modules to a single AI1200-series reader or AI1301 Reader Card. This chapter also identifies old and new AI1200-series reader power supplies. You must install a new power supply to use the AR2200 RF Module.

Information About New Power Supply Assembly

The AR2200 (Version 2) RF Module uses more current and you may need to use a DC standard power assembly that incorporates an input power supply with a higher current rating. TransCore recommends that you use an input power supply that meets the following criteria:

- 2000 milliamps (mA) typical with power on
- 400 mA typical with RF off after a 5-minute warm-up
- 2500 mA maximum with RF on from a cold start over the operating range of -40°F to +158°F (-40°C to +70°C) RF module only, or -40°F to +131°F (-40°C to +55°C) RF module in NEMA enclosure

AR2200 RF Module Installation Options

The AR2200 RF Module can be installed in either of two ways: standard or custom.

Standard Installation

The standard installation of the AR2200 RF Module is enclosed in a standard weatherproof NEMA-4 enclosure. The enclosure locking loops accept padlocks with a maximum 0.25-inch (6.3-mm) diameter shackle. The weatherproof enclosure options are available for use in normal or harsh environments. If you plan to install the RF module in a NEMA box, ensure that the maximum temperature outside the NEMA enclosure will not exceed 131°F (55°C).

Caution

TransCore cannot guarantee the product's specified performance if the NEMA enclosure is mounted in an environment that exceeds 131°F (55°C).

For AR2200 RF Modules mounted on an improved, vibration-dampened baseplate within the NEMA enclosure, the vibration specification is 2 G_{rms} from 10 to 500 Hz, and the shock specification is 15-G half-sine pulse, 6 millisecond duration.

Custom Installation

The AR2200 RF Module can be installed as a stand-alone RF module using a TransCore standard mounting kit. If you choose a custom installation, TransCore ***strongly*** recommends that you contact TransCore Technical Support to have your mounting option evaluated. The telephone number is listed on page iii of this guide. If you use a custom installation, ensure that the maximum temperature outside the RF module for this mounting option will not exceed 158°F (70°C). You must use a baseplate that serves as a heat sink to lower the RF module temperature to an acceptable level. You must leave at least 0.45 inches (1.1 cm) underneath the mounting baseplate. If you choose to not leave room for an air gap, you can install a second metal plate under the baseplate.

Caution

TransCore cannot guarantee the product's specified performance if the custom installation is mounted in an environment that exceeds 158°F (70°C). If your custom installation setup does not meet TransCore-recommended mounting constraints, temperatures above the maximum operating temperature may occur and result in premature failure of the RF module. Also, vibration and shock levels are not specified nor is the operation within the product specifications guaranteed by TransCore for any custom installations.

Recommended Cable Configurations for Standard Installation

Each coaxial cable used to connect the antenna port to the bulkhead connector on the NEMA box should have a service loop with a minimum bend radius of 2 inches (5.1 cm). TransCore recommends that you use semi-rigid coaxial cable, for example, RG-402. TransCore recommends that you maintain a service loop diameter large enough to prevent kinking and damage to the cable, but one that does permit the cable to fit into the NEMA enclosure leaving at least 0.5 inches (1.3 cm) between the cable and any surface inside the box. The service loop ensures system performance and reliability in high vibration environments.

TransCore recommends that you secure the input/output (I/O) cable to the cable tie-down located on the baseplate. Be sure to leave some slack in the cable between the cable tie-down and the connector where the I/O cable exits the NEMA box. Also, provide a service loop in the I/O cable outside the NEMA box. These measures ensure system performance and reliability in high vibration environments.

Caution

Ensure that you seal and weatherproof all bulkhead fittings and connections.

Configuring the RF Module

The RF module has a dual-antenna output and may be configured to operate in one of two modes: normal mode or compatibility mode. In normal mode, a single RF module with one or two antennas is connected to the reader through terminals identified as *0* and *1* on the RF module and the reader. In compatibility mode, two RF modules, each operating one antenna, are connected to one reader with the first RF module connected to the reader through terminals identified as *0* and the second RF module connected to the reader through terminals identified as *1*.

Figure 3-1 depicts system configurations for normal mode and compatibility mode.

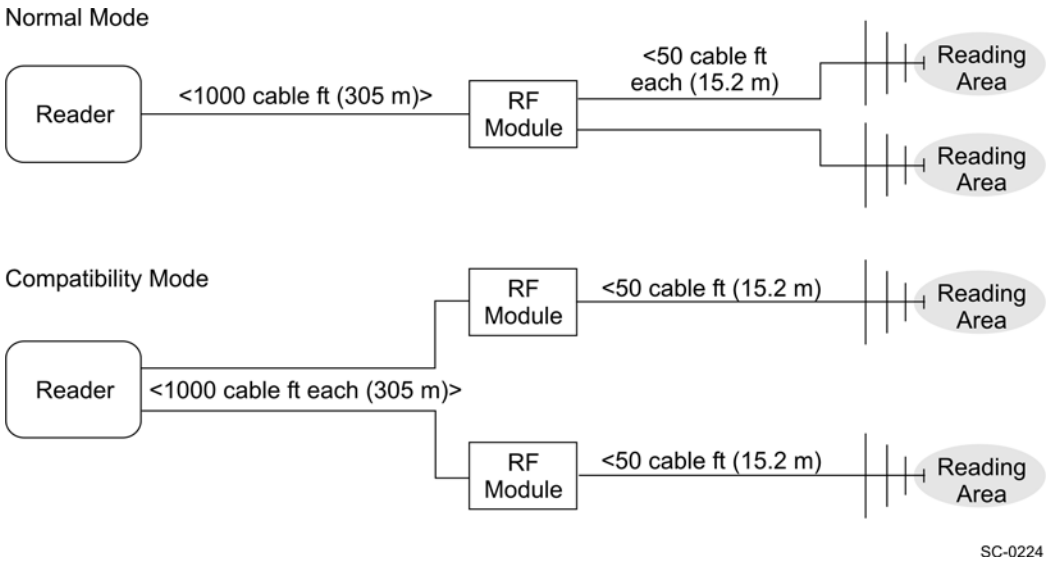

Figure 3-1 Normal Mode and Compatibility Mode Configurations

This section describes the necessary parts and tools, site preparation, and the procedure for installing an interrogator.

Required Power Wiring

Wire gauges are indicated in Table 3-1. All power wiring should be twisted pair, and shielded, if possible.

Note: *The wiring information in Table 3-1 supersedes other wiring tables shown in the TransCore AI1200 Reader documentation.*

Table 3-1 RF Module Minimum Power Wire Gauge Vs. Distance from Reader

Distance from Reader	Stranded Copper Wire (minimum gauge)
0 ft to 50 ft (0 m to 15.2 m)	AWG 18
50 ft to 100 ft (15.2 m to 30.5 m)	AWG 16
100 ft to 250 ft (30.5 m to 76.2 m)	AWG 12
250 ft to 500 ft (76.2 m to 152.4 m)	AWG 10
500 ft to 750 ft (152.4 m to 228.6 m)	AWG 8
750 ft to 1000 ft (228.6 m to 305 m)	AWG 6

Required Equipment

- Digital multimeter
- Oscilloscope, 100 MHz for monitoring intermediate frequency (IF) signals and discriminate signals
- Data terminal or computer
- Phillips and flat-blade screwdrivers
- N-type 50-ohm load placed at the antenna port for testing
- N-type attenuators, as needed to adjust RF power

Positioning the RF Module

In permanent installations, position the RF module as close as possible to the antenna and within 500 signal-cable feet (162 m) of the reader. Long cable lengths will increase system sensitivity to noise. Coaxial cable runs in excess of 50 feet (15.2 m) between the RF module and antenna are not recommended.[1] Longer signal-cable connections of up to 1,000 cable feet (305 m) could be made on the reader-to-RF module link.

Refer to the applicable reader documentation for further information concerning RF module positioning.

Terminal Connections

The RF module plug and jack connector pair have 21 terminals. Connections from the reader are made to the removable plug. After connections are made, the plug can be removed from the jack for interface board servicing or repair/replacement.

1. Based on 2 dB loss, Andrews LDF4-50A 0.5-inch OD coaxial cable. If 3 dB loss is tolerable, cable up to 75 feet (22.9 m) long may be used between the RF module and the antenna.

Figure 3-2 shows the RF module terminal connections.

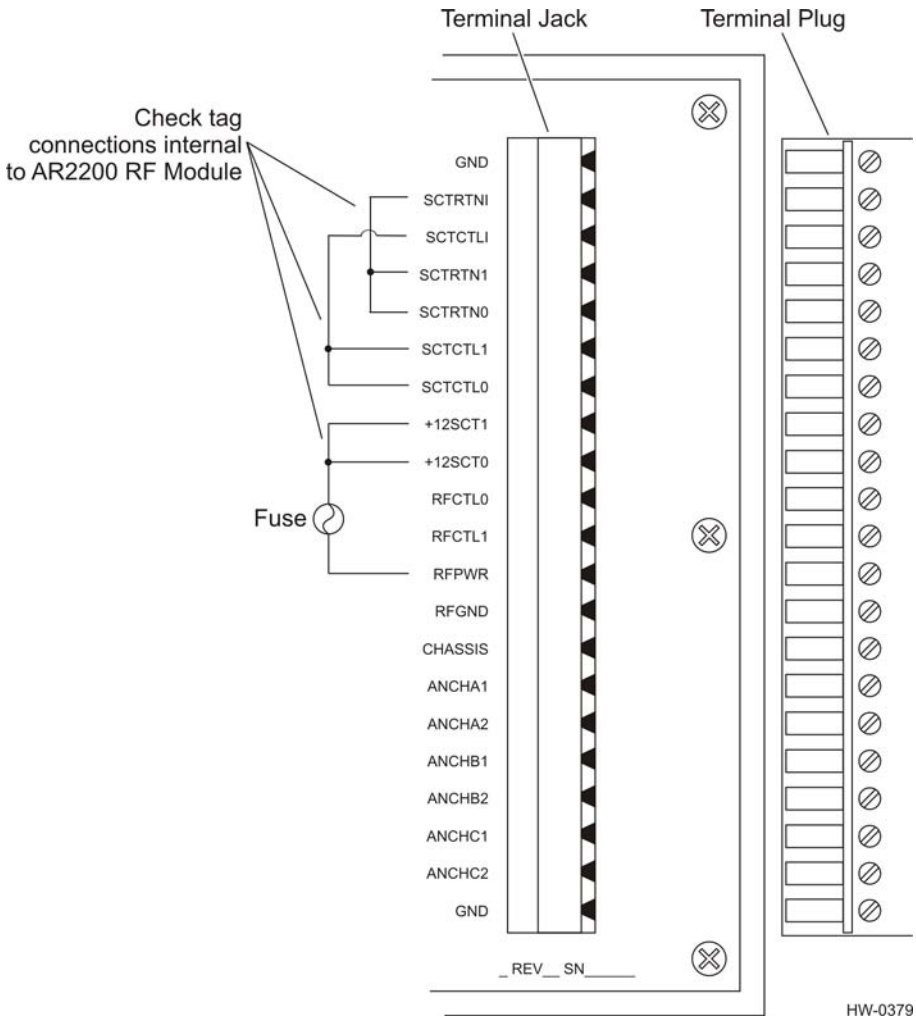

Figure 3-2 RF Module Terminal Connections

Grounding the RF Module

The chassis terminal is electrically connected to the NEMA case ground at the factory. The NEMA case ground must be connected to earth ground. TransCore does not recommend that a conduit connection be used as a grounding point. Ground points must make metal-to-metal connections.

Note: *TransCore does not recommend grounding the case through nonconducting finishes, such as paint, anodize, or irudite.*

Refer to the reader documentation for further information concerning grounding. The chassis terminal jack is shown in Figure 3-2.

Terminal Designations

The jack and plug terminals are designated for use as listed in Table 3-2.

Table 3-2 Jack and Plug Terminal Designations

Designation	Purpose
GND	Chassis ground terminal
SCTRTNI	System check tag DC return input (RFGND from reader)
SCTCTLI	System check tag control input (AUXIO0 from reader)
SCTRTN1	System check tag DC return (RF module 1) [a]
SCTRTN0	System check tag DC return (RF module 0)
SCTCTL1	System check tag control line (RF module 1) [a]
SCTCTL0	System check tag control line (RF module 0)
+12SCT1	System check tag power (RF module 1) [a]
+12SCT0	System check tag 12 V DC power
RFCTL0	RF output control channel 0 (RF module 0)
RFCTL1	RF output control channel 1 (RF module 1) [b]
RFPWR	RF power
RFGND	RF ground
CHASSIS	Connection to NEMA ground  ***Caution: Do not remove the ground connector from the NEMA enclosure. Damage to equipment can occur.***
ANCHA1	IF signal A1
ANCHA2	IF signal A2
ANCHB1	IF signal B1
ANCHB2	IF signal B2
ANCHC1	IF signal C1
ANCHC2	IF signal C2
GND	Chassis ground terminal

a. Used only in compatibility mode

b. RFCTL1 connects to a second RF module (RF module 1) when configured for compatibility mode.

Normal Mode Connections

In normal mode, only one RF module (with one or two antennas) is connected to a reader. Figure 3-3 shows the connections used for normal mode.

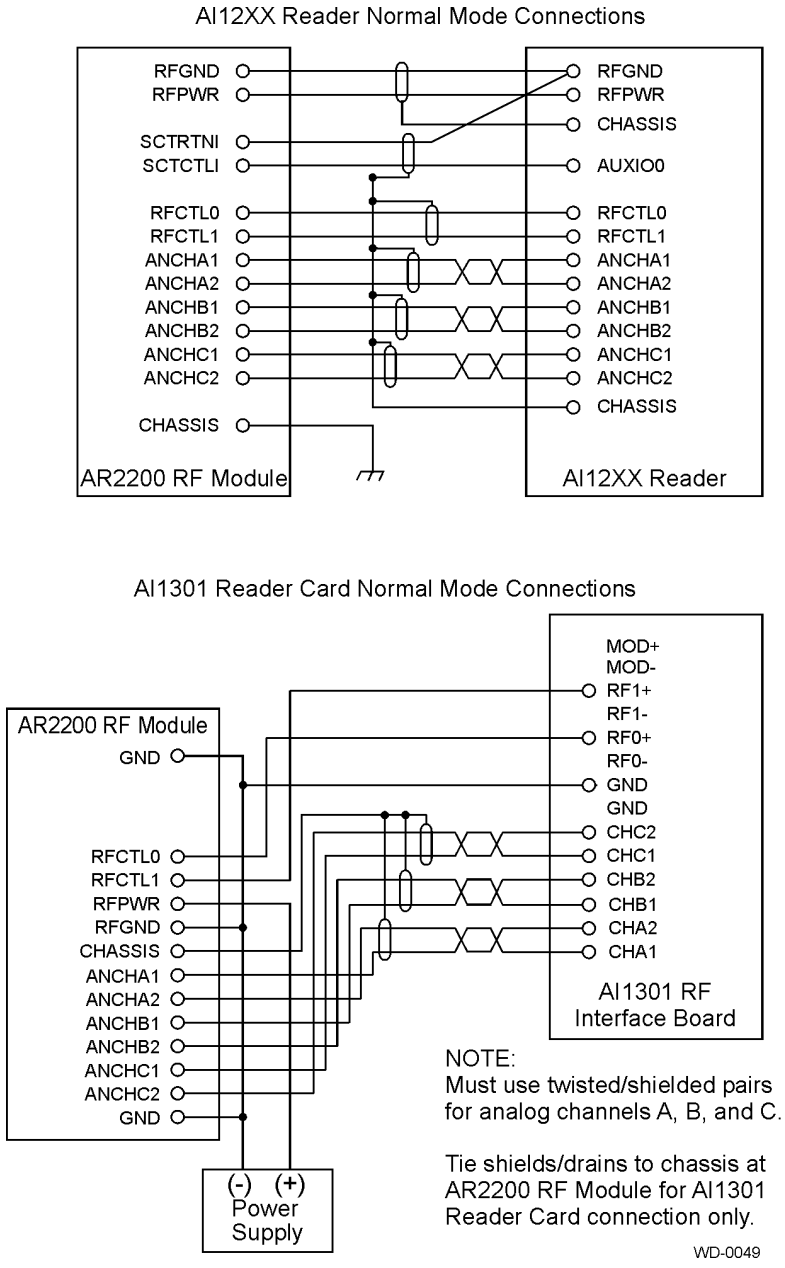

Figure 3-3 Normal Mode Connections

To install your RF module for operation in normal mode, follow these steps:

1. Turn off power to the RF module and the reader.

2. Connect signal wires between the RF module and the reader interface as shown in Table 3-3. Observe the maximum cable lengths shown in Table 3-4 and follow-on paragraph.

Table 3-3 Signal Wire Connections Between RF Module and Reader Interface

RF Module Signal	AI12XX Terminal	AI1301 RF Interface Board Terminal
RFGND	43	NA
RFPWR	42	NA
SCTRTNI	43	NA
SCTCTLI	36	NA
RFCTL0	40	10
RFCTL1	41	12
ANCHA1	45	1
ANACA2	46	2
ANCHB1	47	3
ANCHB2	48	4
ANCHC1	49	5
ANCHC2	50	6

Table 3-4 Maximum Power Cable Lengths

Distance from Reader	Stranded Copper Wire (minimum gauge)
0 ft to 50 ft (0 m to 15.2 m)	AWG 18
50 ft to 100 ft (15.2 m to 30.5m)	AWG 16
100 ft to 250 ft (30.5 m to 76.2 m)	AWG 12
250 ft to 500 ft (76.2 m to 152.4 m)	AWG 10
500 ft to 750 ft (152.4 m to 228.6 m)	AWG 8
750 ft to 1000 ft (228.6 m to 305 m)	AWG 6

The maximum signal wiring cable length is 500 feet (152.4 m). TransCore recommends that you use Belden 9775 cable or equivalent.

1. Terminate cable shields at the reader end for the AI1200-series reader only.

2. For AI1301 Reader Cards connect the RF module RFGND and RFPWR terminals to the negative and positive terminals, respectively, of the power supply.

   Note: *If your power supply has a separate ground terminal, tie the negative and ground connections together.*

3. Terminate the two antenna output ports, located on the side of the RF subassembly below the internal ribbon cable, with a cable that is connected to an antenna or a 50-ohm, N-type, connector load. The antenna output ports must be terminated before turning on power to the reader and RF module. Figure 3-4 shows the antenna output port locations.

Caution

Turning on RF power with an unterminated antenna port could result in damage to the RF module.

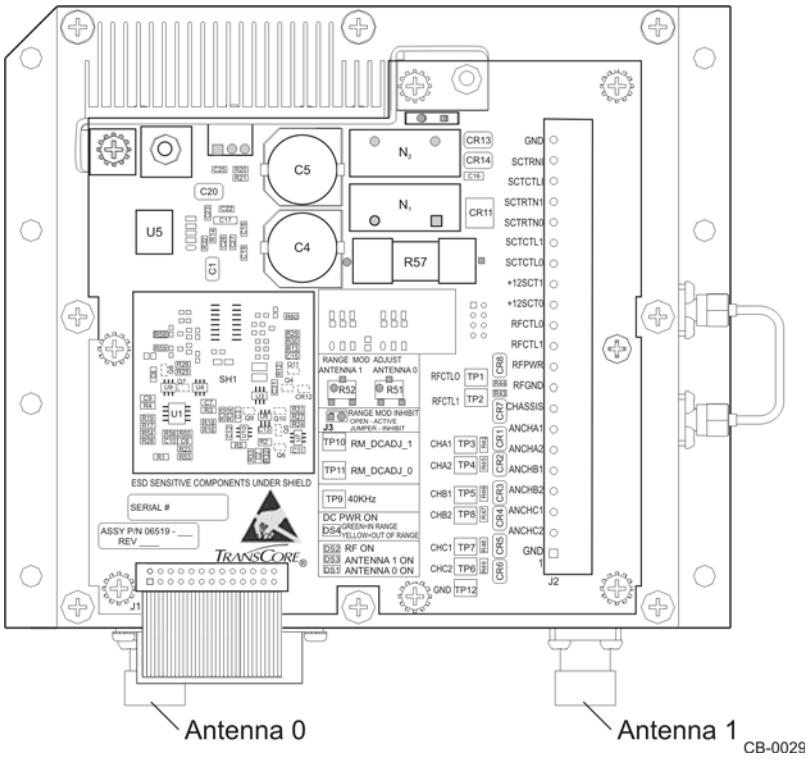

Figure 3-4 Antenna Output Port Locations

4. If using a check tag, connect the system check tag cable shown in Table 3-5. Observe the maximum power cable and check tag cable lengths shown in Table 3-6 and follow-on paragraph.

Table 3-5 Connecting the AT5720 Check Tag Cable

Check Tag Line	RF Module Terminal
Red	+12SCT0
Black	SCTRTN0
White	SCTCTL0

Table 3-6 Maximum Power Cable Lengths

Distance from Reader	Stranded Copper Wire (minimum gauge)
0 ft to 50 ft (0 m to 15.2 m)	AWG 18
50 ft to 100 ft (15.2 m to 30.5m)	AWG 16
100 ft to 250 ft (30.5 m to 76.2 m)	AWG 12
250 ft to 500 ft (76.2 m to 152.4 m)	AWG 10
500 ft to 750 ft (152.4 m to 228.6 m)	AWG 8
750 ft to 1000 ft (228.6 m to 305 m)	AWG 6

The maximum check tag cable length is 100 feet (30.5 m). TransCore recommends that you use AWG 24 wire.

Note: *TransCore supplies AT5720 Check Tags with either 10-foot or 50-foot leads.*

Note: *Voltage standing wave ratio (VSWR) measurements must be made at the antenna. Readings should correspond to antenna specifications. See the appropriate antenna technical specifications for correct VSWR readings.*

Compatibility Mode Connections

In compatibility mode, two RF modules are connected to a single reader. In compatibility mode, each RF module operates only one antenna.

Make all compatibility mode connections in parallel, except for the RF control connections. Only one RF control line from the reader (RFCTL0 or RFCTL1) is connected to each RF module.

Figure 3-5 shows compatibility mode connections.

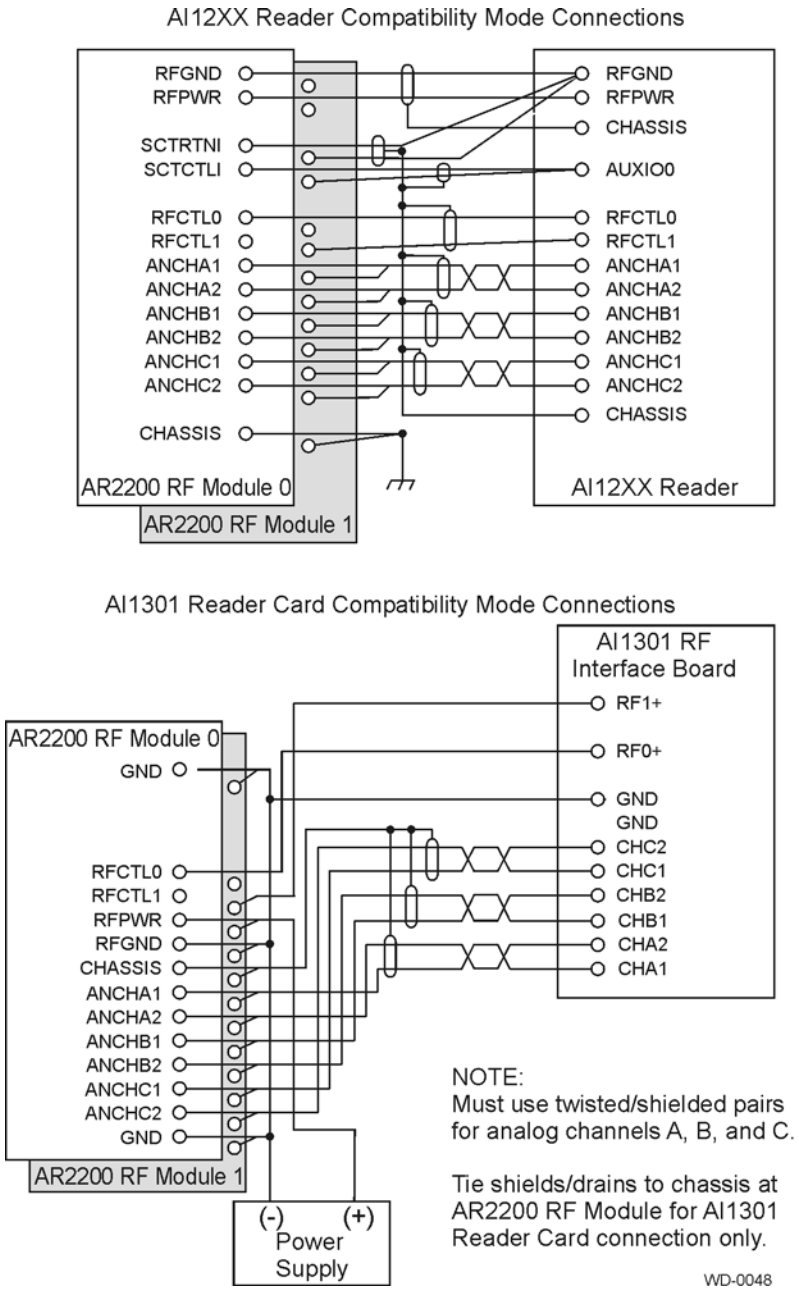

Figure 3-5 Compatibility Mode Connections

To install your RF module in compatibility mode, follow these steps:

1. Turn off power to the RF module and the reader.
2. Connect wires between the RF modules and the reader interface shown in Table 3-7. Observe the maximum power cable and signal wiring cable lengths listed in Table 3-8 and follow-on paragraph.

Table 3-7 Wire Connections Between RF Modules and Reader Interface

RF Module Signal	AI12XX Terminal	AI1301 RF Interface Board Terminal
RFGND	43	NA
RFPWR	42	NA
SCTRTNI	43	NA
SCTCTLI	36	NA
RFCTL0	40 (RF module 0 only)	10 (RF module 0 only)
RFCTL1	41 (RF module 1 only)	12 (RF module 1 only)
ANCHA1	45	1
ANACA2	46	2
ANCHB1	47	3
ANCHB2	48	4
ANCHC1	49	5
ANCHC2	50	6

Table 3-8 Maximum Power Cable Lengths

Distance from Reader	Stranded Copper Wire (minimum gauge)
0 ft to 50 ft (0 m to 15.2 m)	AWG 18
50 ft to 100 ft (15.2 m to 30.5m)	AWG 16
100 ft to 250 ft (30.5 m to 76.2 m)	AWG 12
250 ft to 500 ft (76.2 m to 152.4 m)	AWG 10
500 ft to 750 ft (152.4 m to 228.6 m)	AWG 8
750 ft to 1000 ft (228.6 m to 305 m)	AWG 6

The maximum signal wiring cable length is 500 feet (152.4 m). TransCore recommends that you use Belden 9775 cable or equivalent.

1. Terminate cable shields at the reader end for the AI1200-series reader only.
2. For AI1301 Reader Cards connect the RF module RFGND and RFPWR terminals to the negative and positive terminals, respectively, of the power supply.

   Note: *If your power supply has a separate ground terminal, tie the negative and ground connections together.*

3. Terminate the two antenna output ports, located on the side of the RF subassembly below the internal ribbon cable, with a cable that is connected to an antenna or a 50-ohm, N-type, male load as shown below.

RF module 0: ANTENNA 0 to antenna cable
ANTENNA 1 terminated with 50-ohm load

RF module 1: ANTENNA 0 terminated with 50-ohm load
ANTENNA 1 to antenna cable

The antenna output ports must be terminated before turning on power to the reader and RF module. Figure 3-4 on page 3-11 shows the antenna output port locations.

Caution

Turning on RF power with an unterminated antenna port can damage the RF module.

4. If using check tags, connect the system check tag cables as shown in Table 3-9 and Table 3-10.

Table 3-9 Connecting the System Check Tag 0 Cable

Check Tag Line	RF Module Terminal
Red	+12SCT0
Black	SCTRTN0
White	SCTCTL0

Table 3-10 Connecting the System Check Tag 1 Cable

Check Tag Line	RF Module Terminal
Red	+12SCT1
Black	SCTRTN1
White	SCTCTL1

Note: *You must record VSWR measurements at the antenna. Readings should be in line with antenna specifications. See the antenna technical specifications for information on appropriate VSWR readings.*

Troubleshooting Check Tag Wiring

If the check tag is not performing as expected, check that the wiring to the check tag is correct.

To verify the check tag wiring and orientation

1. Disconnect check tag from RF module.
2. Set digital multimeter to diode setting.

3. Check voltage reading to the check tag wires as listed in Table 3-11.

Table 3-11 Expected Voltage Readings for Check Tag Wires

+ DVM	- DVM	Expected Reading Range
Red	Black	1.25V – 1.75V
Black	White	0.50V – 0.75V

AI1200 Reader AC Power Supply Upgrade

This section explains how to replace an existing KEPCO power supply assembly with a new YK power supply assembly (P/N 76-0006-100).

Note: *The new YK power supply is labeled with a 05446-01 or 05446-02 label on the backplane.*

Required Supplies

Before proceeding, make sure you have the YK power supply kit (TransCore P/N 76-0006-100).

You need a Phillips screwdriver to replace the power supply assembly.

Replacing AC Power Supply Assembly

Warning

Do not service the power supply assembly unless you have turned off the power through a circuit breaker or other means.

To remove the KEPCO power supply assembly

1. After you have turned off the power source, turn off power to the assembly with the power switch located on the back of the assembly (Figure 3-6).

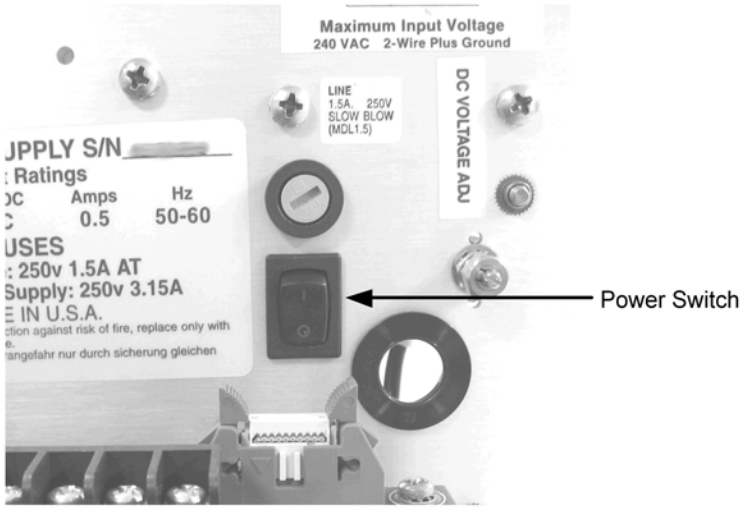

Figure 3-6 Power Switch on KEPCO Power Supply Assembly

2. Disconnect the external power supply wires from the power supply assembly terminal block (Figure 3-7).

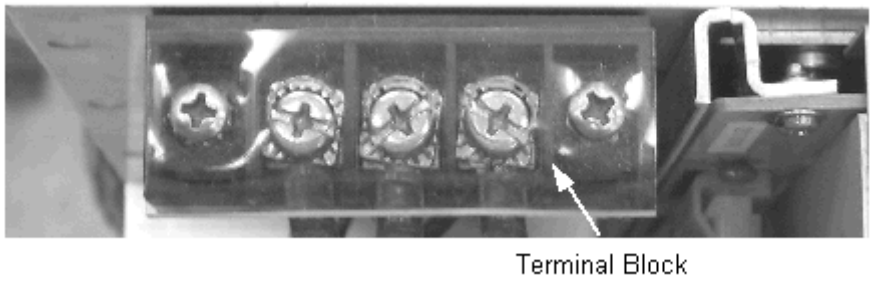

Figure 3-7 Power Supply Assembly Terminal Block

3. Remove the mounting screws from the baseplate. If the AI1200 is mounted in a NEMA box, remove the additional mounting screws from the baseplate (Figure 3-8).

Note: *Keep the screws to install the YK power supply assembly.*

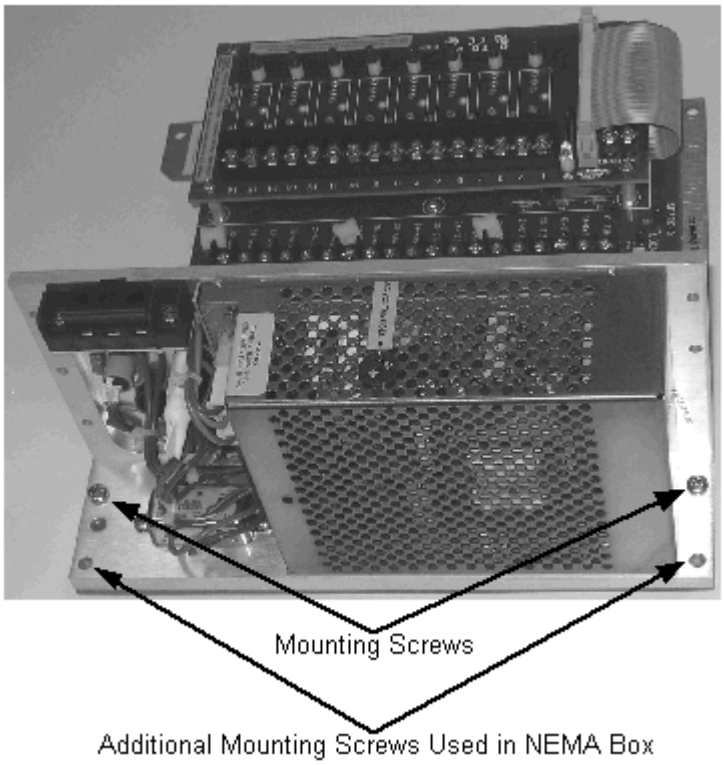

Figure 3-8 Mounting Screw Locations on KEPCO Power Supply Assembly

4. Unplug the power supply assembly connector from the AI1200 Reader (Figure 3-9).

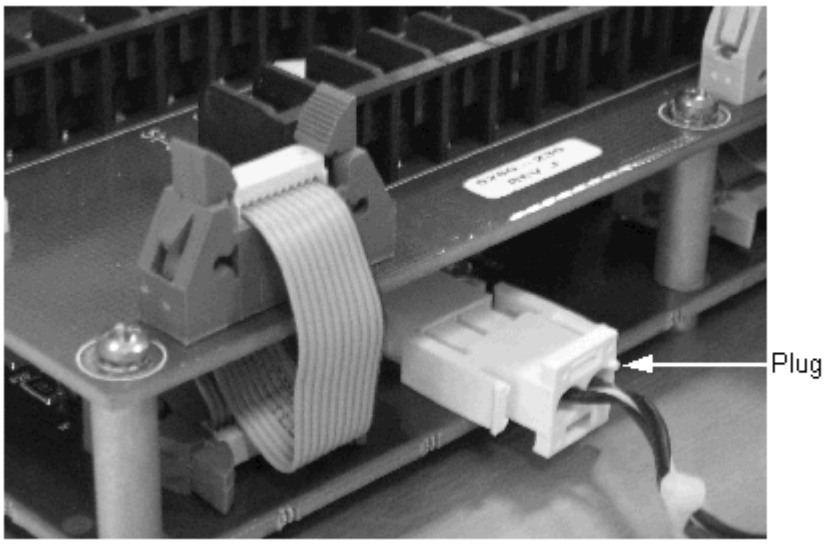

Figure 3-9 KEPCO Power Supply Assembly Plug

5. Remove the KEPCO power supply assembly from the baseplate.

To install the YK power supply assembly

6. Place the YK power supply assembly on the baseplate and plug in assembly to AI1200 Reader (Figure 3-10).

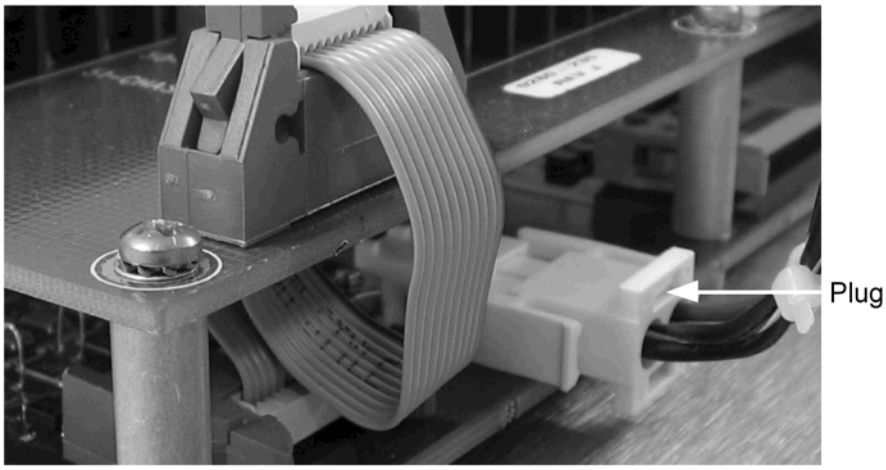

Figure 3-10 YK Power Supply Assembly Plug

7. Replace the mounting screws (Figure 3-11).

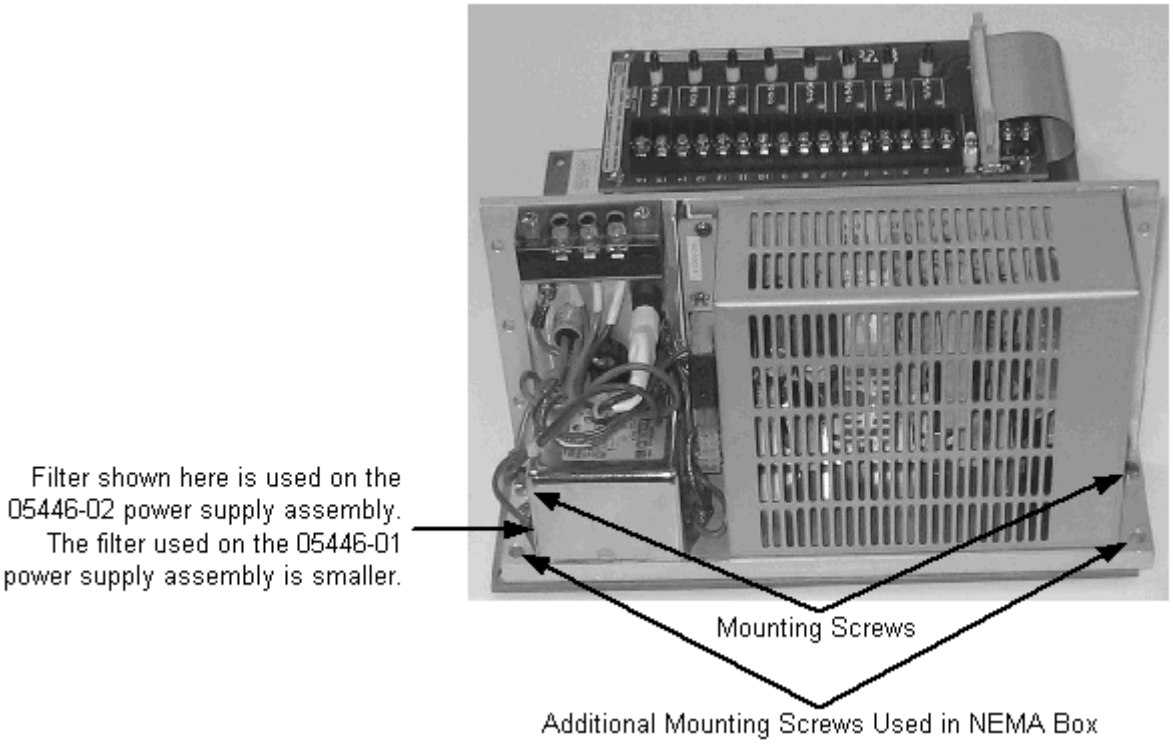

Figure 3-11 Mounting Screw Locations on YK Power Supply Assembly

8. Reconnect the external power supply wires to the power supply assembly terminal block (see Figure 3-7).

9. Turn on power at source.
10. Switch on power with the switch located on the back of the assembly (Figure 3-12).

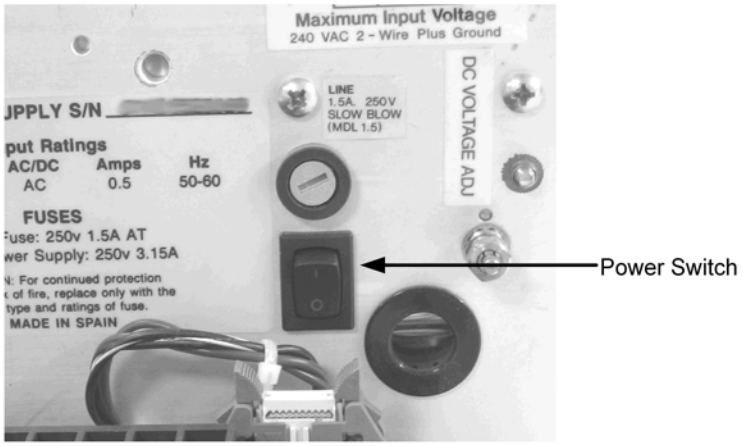

Figure 3-12 Power Switch on YK Power Supply Assembly

4

Testing the RF Module

Chapter 4

Testing the RF Module

This chapter provides instructions for testing the installed RF module.

Testing Procedures

After connecting terminals between the RF module and the reader, you should test the RF module. You will need an oscilloscope and a data terminal or computer connected to the AI1200-series reader or AI1301 Reader Card.

The RF module has 12 test points, numbered TP1 through TP12 as shown in Figure 4-1.

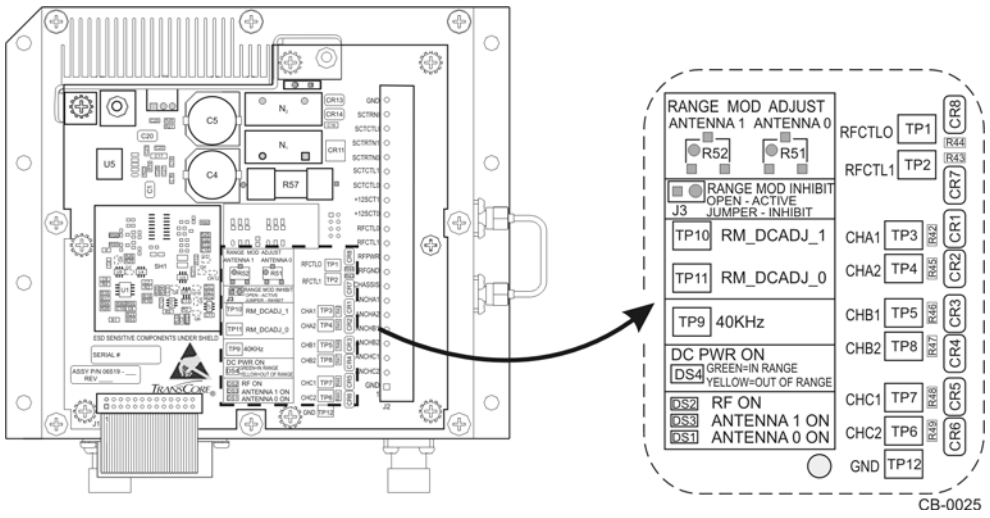

Figure 4-1 RF Board Test Points

The test points are defined in Table 4-1.

Table 4-1 Test Point Definition

Test Point	Purpose
3, 4 (CHA1, CHA2)	RF module analog signals A
5, 8 (CHB1, CHB2)	RF module analog signals B
7, 6 (CHC1, CHC2)	RF module analog signals C
9 (40 kHz)	Range modulator (unattenuated), 5-V square wave, 40 KHz
10 (RM_DCADJ_1)	RF1 range adjust level, 5.0–4.0 VDC, with 4.0 VDC minimum sensitivity and 5.0 VDC maximum sensitivity
11 (RM_DCADJ_0)	RF0 range adjust level, 5.0–4.0 VDC, with 4.0 VDC minimum sensitivity and 5.0 VDC maximum sensitivity
12 (GND)	Oscilloscope or digital multimeter ground point
2 (RFCTL1)	RF control line 1, output time on duration
1 (RFCTL0)	RF control line 0, output time on duration
J3 (RANGE MOD INHIBIT)	Shorted with jumper to disable modulation feature

For optimal RF module performance, verify the following criteria.

1. Power output is 1.6 W ±0.1 W measured after module has been powered up for 15 minutes.
2. Intermediate frequency signal noise is less than 90 mV and output ports are terminated.
3. Measured output frequency is ±25 ppm of factory-tuned frequency.
4. Maximum receiver sensitivity is achieved for Port 1 with RM_DCADJ_1 set for 5.0V DC, measured at TP10. Minimum sensitivity is achieved for Port 1 with RM_DCADJ_1 set for 4.0V DC, measured at TP10.
5. Maximum receiver sensitivity is achieved for Port 0 with RM_DCADJ_0 set for 5.0V DC, measured at TP11. Minimum sensitivity is achieved for Port 0 with RM_DCADJ_0 set for 4.0V DC, measured at TP11.

Setting Voltage

During initial testing, set the DC voltage level at the RF module to a minimum of 11.5V DC with RF power on and a maximum of 13.5V DC with RF power off. Make the adjustment to achieve this DC level at the reader power supply. Adjusting the DC voltage level compensates for the voltage drop within the DC power cable.

5

Indicator Lights

Chapter 5

Indicator Lights

This chapter describes the RF module's indicator lights.

Indicator Lights Specifications

The RF module has four light-emitting diode (LED) indicators on the RF interface board, labeled as shown in Figure 5-1.

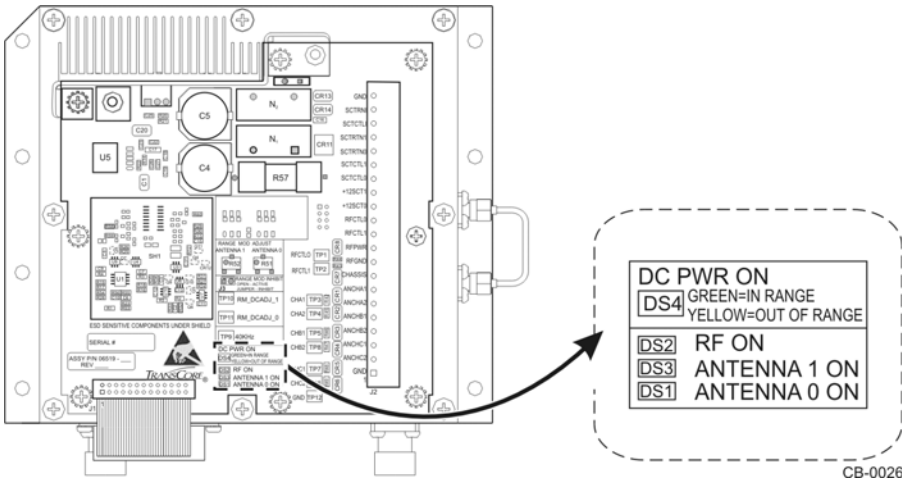

Figure 5-1 RF Module LED Indicators

Each indicator and its message are described in Table 5-1.

Table 5-1 LED Indicators and Messages

Indicator	Function	Color(s)	Message
DS4	DC PWR ON	Green/ Yellow	DC input power LEDs Green indicates that input in range of 11.5V DC to 13.5V DC. Yellow indicates that input out of range (<11.5V DC, >13.5V DC). OFF indicates that PWR is off. Adjust the input voltage level so that the DS4 LED stays green whether the RF is switched on or off. If you find an input voltage level where this LED does not stay green (in range) when the RF is switched on or off, you may need to replace the DC voltage wire (RFPWR, RFGND) with a thicker gauge wire. Recheck DS4 LED operation after you replace the wire.

Table 5-1 LED Indicators and Messages (continued)

Indicator	Function	Color(s)	Message
DS2	RF ON	Red	LED indicator on indicates that RF (CW) is active (ON). Either Port 0, Port 1, or both ports has been selected. LED indicator off indicates that RF (CW) in inactive (OFF).
DS3	ANTENNA 1 ON	Red	LED indicator on indicates that RF output channel 1 is on. LED indicator off indicates that RF output channel 1 if off.
DS1	ANTENNA 0 ON	Red	LED indicator on indicates that RF output channel 0 is on. LED indicator off indicates that RF output channel 0 if off.

6

Range Modulation Sensitivity Adjustment

Chapter 6

Range Modulation Sensitivity Adjustment

This chapter explains how to adjust the AR2200 RF Module's range modulation sensitivity to screen unwanted tag signals.

Adjusting the Range Modulation Sensitivity

The range modulation sensitivity adjustment feature of the radio frequency (RF) module is used to screen unwanted tag signals without decreasing RF power. This feature reduces the system's reading range and the difference between peak and continuous read sensitivity.

Using the range modulation feature you can independently reduce the receiver sensitivity levels for antenna port 1 or antenna port 0 via two 14-turn continuously adjustable potentiometers (one for each antenna port). You can enable the range modulation by removing programming jumper J3 (Figure 6-1). Installing J3 inhibits the range modulation.

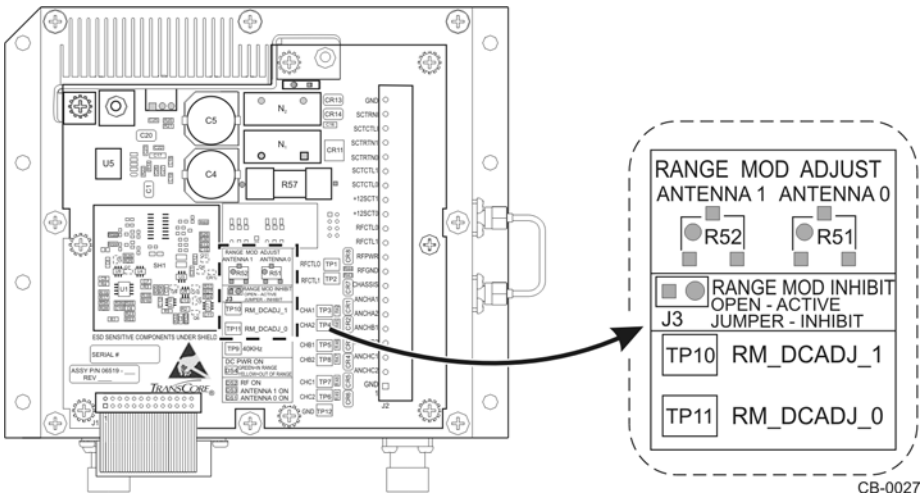

Figure 6-1 Range Modulation Sensitivity Potentiometers

You can enable or disable the range modulation using the two-position programming jumper, J3 (Figure 6-1). Installing the jumper disables the range modulation. Removing the jumper enables range modulation.

You can make continuous and independent adjustment for each antenna port via two 14-turn continuously adjustable potentiometers (one for each port) that are located on the input/output interface (Figure 6-1). The potentiometer have the following specifications:

- Antenna port 1 range modulation sensitivity adjustment: R52 (ANTENNA1)

- Antenna port 0 range modulation sensitivity adjustment: R51 (ANTENNA0)

To adjust read sensitivity, insert a small flat-blade screwdriver into the potentiometer slot for the appropriate antenna and rotate the potentiometer fully counter-clockwise for maximum receiver sensitivity/read range or fully clockwise for minimum receiver sensitivity/read range.

For antenna port 0, use test point RM_DCADJ_0 to monitor the range modulation adjustment voltage setting; for antenna port 1, use test point RM_DCADJ_1.

The sensitivity range settings are as follows:

- RM_DCADJ_1, RM_DCADJ_0 = 5.0V DC, maximum sensitivity/read range
- RM_DCADJ_1, RM_DCADJ_0 = 4.0V DC, minimum sensitivity/read range

The available adjustment range for reducing receiver sensitivity is 0 dB to 20 dB (minimum) and 0 dB to 30 dB (nominal).

The range sensitivity adjustment does not cover the system's entire tag reading capability, or dynamic range. For some installations, you may need to reduce RF power in conjunction with range sensitivity adjustment to achieve the desired results. Experiment with both RF power attenuation and range sensitivity adjustment to achieve the desired read range.

A

AR2200 RF Module Technical Specifications

Appendix A

AR2200 RF Module Technical Specifications

This appendix provides reference information for the AR2200 RF Module.

Component Specifications

This appendix describes the engineering specifications for the AR2200 RF Module.

Electrical Specifications

Table A-1 shows the electrical requirements for the AR2200 RF Module.

Table A-1 AR2200 RF Module Electrical Requirements

Characteristic	Specification
Input power	12.5V DC ±1.0V DC measured at terminal block J2 (RFPWR, RFGND)
Power consumption	35W maximum

Environmental Specifications

The AR2200 RF Module can withstand the environmental conditions shown in Table A-2.

Table A-2 AR2200 RF Module Environmental Specifications

Environment	Specification
Shock	15 G, ½-sine pulse, 6 ms duration, 3 axes
Vibration	2.0 G_{rms} 10 to 500 Hz
Operating temperature	-40°F to +158°F (-40°C to +70°C) RF module -40°F to +131°F (-40°C to +55°C) RF module in NEMA enclosure
Humidity	95% noncondensing

Physical Specifications

Table A-3 lists the physical specifications of the AR2200 RF Module when installed in NEMA-4 enclosure.

Table A-3 AR2200 RF Module Physical Specifications for Standard Installation in NEMA-4 Enclosure

Specification	Value
Size	12.0 x 12.0 x 6.0 in (30.48 x 30.48 x 15.24 cm)
Weight	15 lb (6.8 kg)

Table A-4 lists the physical specifications of the AR2200 RF Module when installed on the baseplate only.

Table A-4 AR2200 RF Module and Baseplate Physical Specifications

Specification	Value
Size	10.75 x 10.875 x 3.985 in (27.31 x 27.62 x 10.12 cm)
Weight	5.8 lb (2.6 kg)

Index

Index