MP9320 UHF Reader

Field Installation and Calibration Guide

Fourth Edition (May 1, 2005) V4.1

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About SAMSys

SAMSys is the world leader in the design and supply of radio frequency identification (RFID) hardware solutions for high volume pallet and reusable container tracking applications in global logistics management, materials handling, and supply chain industries. SAMSys is a public company listed on the Canadian Venture Exchange under the symbol SMY.

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Federal Communications Commission (FCC) Notice

This device was tested and found to comply with the limits set forth in Part 15 of the FCC Rules. Operation is subject to the following 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. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment.

This device generates, uses, and can radiate radio frequency energy. If not installed and used in accordance with the instruction manual, the product may cause harmful interference to radio communications. Operation of this product in a residential area is likely to cause harmful interference, in which case, the user is required to correct the interference at their own expense.

The authority to operate this product is conditioned by the requirements that no modifications be made to the equipment unless the changes or modifications are expressly approved by SAMSys Technologies.

Contents

Introduction

This document is intended to assist technical service personnel engaged in the installation of the SAMSys MP9320 UHF Reader. The document includes procedures for installing and configuring the reader to meet local standards and regulatory requirements. Topics and procedures presented in this document include the following:

- Antenna Installation
- Reader Mechanical Installation
- RS-485/Ethernet Communication Selection
- RS-485 Impedance Matching Selection
- Serial (RS-232) Communication Setup
- Ethernet LAN Communication Setup
- Installing the RF Command Suite Application
- Configuring the IP Address
- Digital (TTL) Input/Output Setup
- Setting Digital Input for Reader Duty Cycle Control
- Transmit Power Calibration
- Transmitter and Antenna Configuration
- Manual Field Power Calibration - FCC Readers
- Manual Field Power Calibration - ETSI Readers

Assumptions

This document is intended for technical personnel who are trained and experienced with the setup and configuration of SAMSys radio frequency identification systems including readers and antennas. Failure to correctly follow the procedures in this manual may result in faulty reader operation that violated regulatory requirements.

Getting Technical Assistance

If you need assistance or have questions related to the installation or use of this product, call or email SAMSys Technologies' customer service department for support.

E-mail	support@samsys.com
Telephone	1-877-367-4342 (toll free) 8:00am-6:00pm EST, Mon-Fri
Fax	1-919-281-1551

Antenna Installation

The MP9320 supports from one to four external antennas in a variety of configurations. One- and two-antenna configurations are typical for most conveyor and container tracking. Four-antenna configurations are used for portals and loading dock doorways.

Caution

For uncontrolled environments (in the general population), the spacing between the antenna(s) and any persons must be at least 9 inches when the reader is operating at full power (4 Watts EIRP).

To eliminate the spacing restriction, reduce the reader power to 3 Watts EIRP.

Readers located in controlled access environments (occupational) have no spacing restrictions

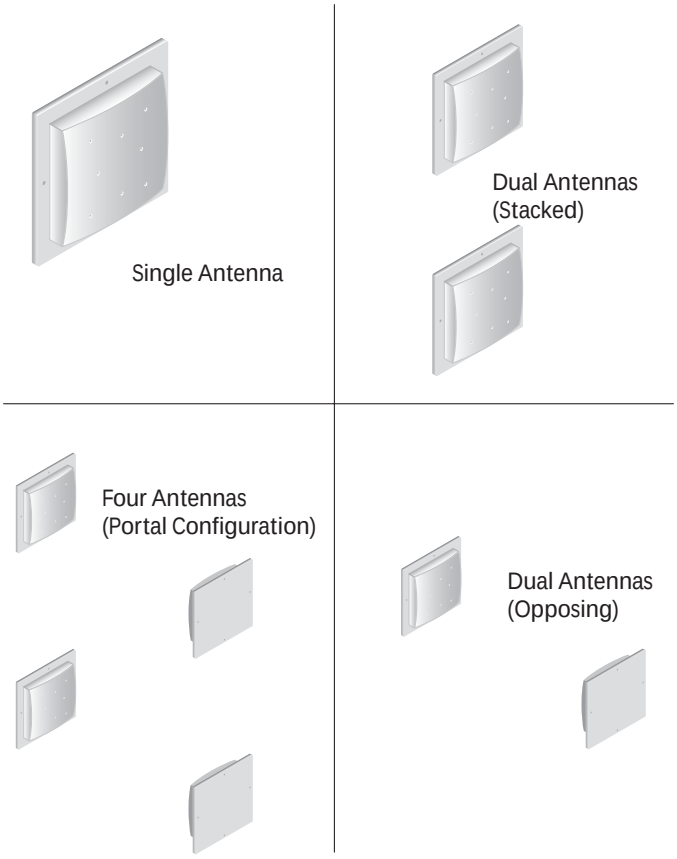


Figure 1–*MP9320 Antenna Configurations*

Antenna Specifications

The MP9320 is factory calibrated for operation with the following type of antenna:

Antenna Parameter	**FCC**	**ETSI**
Frequency	902-928 MHz	865-870 MHz
Polarization	Circular	Circular
Gain, dBic	8, max	5, max
Antenna power handling	1 W, minimum	1 W, minimum
VSWR, maximum	1.3:1	1.3:1

The following antenna cable type is suggested:

Cable Parameter	**Value**
Type	RG58C/U
Connector	SMA type plug, reader side

Caution - Regulatory Requirements

This device has been designed to operate with no more than 1 Watt into the antenna and an antenna gain of no more than 6 dBi. Antenna having a higher gain is strictly prohibited per regulations of Industry Canada, unless power into the antenna is decreased to compensate for the increased antenna gain.The required antenna impedence is 50 ohms.

To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (EIRP) is not more than that required for successful communication.

The installer of this radio equipment must ensure that the antenna is located or pointed such that it does not emit an RF field in excess of Health Canada limits for the general population; consult Safety Code 6, obtainable from Health Canada'a website at http://www.hc-sc.gc.ca/hecs-sesc/ccrpb/safetycodes.htm.

Antenna Installation Procedure

It is highly recommended that the antenna mounting be adjustable in order to obtain the best performance from the system. However, the antennas must be installed on a solid surface or frame to prevent damage or later misalignment. Perform the following to install the antennas.

NOTE: *Use the existing mounting holes on the antenna flange. Drilling new holes in the flange is not recommended.*

1. Determine the location of each antenna. Ensure the antenna(s) will not be vulnerable to damage by moving inventory or equipment.
2. Use the antenna as a template and mark the mounting holes.
3. Drill and tap (if necessary) mounting holes for #10 or 1/4 inch mounting screws. For drywall mounting, use drywall anchors or toggle screws.
4. Mount each antenna and install the mounting screws. Do not overtighten the screws. Damage to the antenna case may result.
5. Route each antenna cable back to the reader location. For dual-opposing or portal configurations, route the opposing cables so they can not be damaged by equipment or personnel.
6. Secure each antenna cable with wire ties or other restraint.

Reader Mechanical Installation

The MP9320 is designed for easy installation. The following instructions provide the information to install your UHF reader.

As shown in Figure 2, the reader is designed for horizontal or vertical installation. Mounting keyholes are provided on each side of the base plate for easy, non-permanent, installation and removal.

Caution

To ensure proper cooling of the reader, verify that the fan intakes and vents are free of obstructions.

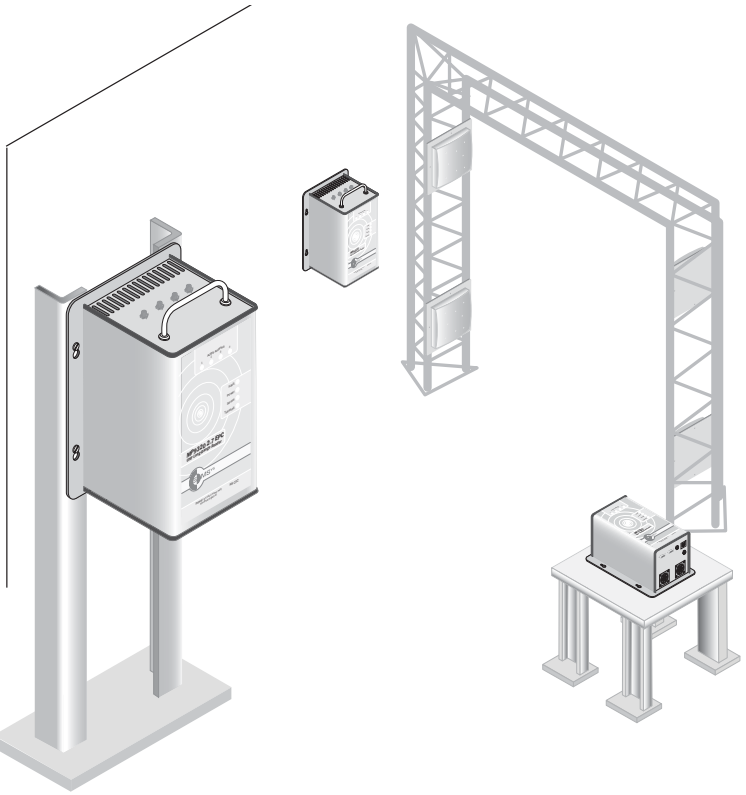


Figure 2–*MP9320 Reader Installations*

For horizontal or table mounting, ensure the reader and all cabling is secured to the surface or frame.

SAMSys recommends that the MP9320 be mounted on a horizontal surface. However, if vertical surface installation is required, refer to the following sections for the appropriate mounting. As shown in Figure 3, keyhole slots are provided for easy installation and removal.

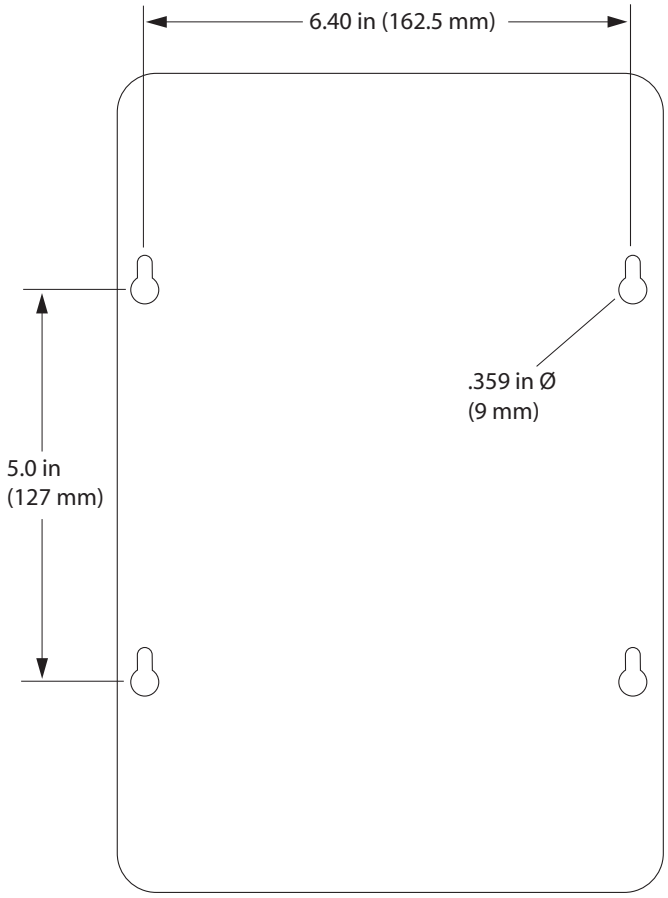


Figure 3–*MP9320 Base Plate with Mounting Keyholes*

Hollow Concrete Block Wall Mounting

To temporarily mount the MP9320 to a hollow concrete block wall, SAMSys recommends metal sleeve type concrete anchors that accept a #10 screw and flat washer. To install the MP9320 on a hollow concrete block wall, perform the following.

1. Refer to Figure 3, and mark the location of the mounting screws. Do not install the anchors into the mortar joint.
2. Drill the appropriate size hole for a metal sleeve type anchor.
3. Install the anchors.
4. Install the washers and insert the screws.
5. Tighten the screws to within .375” of the anchor.
6. Install the reader and finish tightening the screws.

Solid Concrete Wall Mounting

To temporarily mount the MP9320 to a solid concrete wall, SAMSys recommends one-piece expansion type concrete anchors that accept a #10 screw and flat washer. To install the MP9320 on a solid concrete wall, perform the following.

1. Refer to Figure 3, and mark the location of the mounting screws.
2. Drill the appropriate size hole for a expansion type anchor.
3. Install the anchors
4. Install the washers and insert the screws.
5. Tighten the screws to within .375” of the anchor.
6. Install the reader and finish tightening the screws.

Wood or Metal Wall Mounting

To temporarily mount the MP9320 to a wood or sheet metal wall, SAMSys recommends either #10 x 1 inch wood screws or #10 x 3/4 inch sheet metal screws and flat washers. To install the MP9320 on a wood or metal wall, perform the following.

1. Refer to Figure 3, and mark the location of the mounting screws.
2. Drill the appropriate size hole for screws.
3. Install the washers and insert the screws.
4. Tighten the screws to within .375” of the surface.
5. Install the reader and finish tightening the screws.

Drywall Mounting

To temporarily mount the MP9320 to drywall, SAMSys recommends either #10 toggle bolts or #10 drywall anchors.

NOTE: *There are many types of screw-in, hammer-in, and predrill drywall anchors. Each one is designed for specific applications and pull-out ratings. Ensure that the anchor you select has a pull-out rating of at least 12 lbs.*

To install the MP9320 on drywall, perform the following.

1. Refer to Figure 3, and mark the location of the mounting screws.
2. Refer to the anchor manufacturers instructions for installing the anchors.
3. Install the washers and insert the screws.
4. Tighten the screws to within .375” of the surface.
5. Install the reader and finish tightening the screws.

RS-485/Ethernet Communication Selection

The MP9320 is equipped with both RS-485 and Ethernet communication ports. However, only one can be selected at a time. The reader is typically shipped with Ethernet communication enabled. To enable RS-485 communication, perform the following:

Caution - ESD

The following procedures involve electrostatic discharge sensitive components. ESD protection is required. Damage to the reader can occur if proper ESD equipment such as grounded wrist straps and ESD protected work surfaces are not used.

1. Disconnect all power and communication cables from the reader.
2. Remove the outer reader cover by removing the 8 screws on each side and carefully lifting the cover straight up.
3. Locate Jumper J4 on the connector end of the digital board (top circuit board).
4. Move the jumper to Pins 1-2 (Pin 1 is closest to the end of the board).
5. To re-enable Ethernet communication, move the jumper to Pins 2-3.
6. Replace the cover and the 16 screws.

RS-485 Impedance Matching Selection

The MP9320 2.5 and later readers are equipped with RS-485 impedance matching jumpers. These jumpers configure the RS-485 link for a given topology. To configure the RS-485 link, perform the following:

Caution - ESD

The following procedures involve electrostatic discharge sensitive components. ESD protection is required. Damage to the reader can occur if proper ESD equipment such as grounded wrist straps and ESD protected work surfaces are not used.

1. Disconnect all power and communication cables from the reader.
2. Remove the outer reader cover by removing the 8 screws on each side and carefully lifting the cover straight up.
3. Locate jumpers J1 and J2 on the the connector end of the digital board (top circuit board).
4. Install the jumpers as follows:
   - To set the RS485A signal to a logic high (3.3V), install Jumper J1.
   - To set the RS485B signal to a logic low (0V), install Jumper J2.
   - To set the RS485A to 1.76V and the RS485B to 1.53V, install Jumpers J1 and J2. These jumpers assure a differential voltage of 200 mV.

Serial (RS-232) Communication Setup

The reader is equipped with a 9-pin RS-232 communication port for communication directly with a PC or other serial device. Refer to the *Specifications* chapter in the *MP9320 User's Guide* for information on the port.

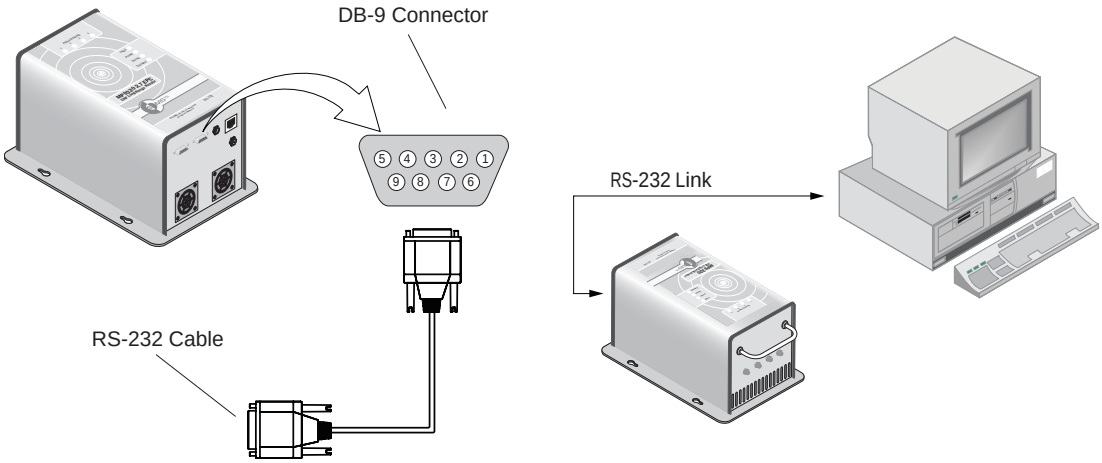


Figure 4–*MP9320 Standalone RS-232 Communication Setup*

NOTE: *A serial port adapter may be required if the device has a different connector type. For example, some PCs may have 25-pin serial connectors.*

Every effort has been made to ensure the MP9320 is configured to match your application. However, it is recommended that the reader configuration be verified before placing the reader into service. If the system is to be used as a local, standalone reader connected to a terminal or PC, perform the following:

1. Verify all antennas, cabling and power supplies are secure.
2. Verify the operator terminal or PC is connected to the reader and operational.
3. Power up the reader.
4. Launch RF Command Suite.
5. Select **Auto Connect** from the **Reader Connection** pull-down menu. RF Command Suite will attempt to connect with the reader.
6. For maximum reader performance, set the terminal serial port baud rate to 57600. (Set all three UARTs to 57600 baud.)
7. Introduce a test tag into the RF field.
8. Verify the tag was read correctly.

9. If the tag did not read correctly, use RF Command Suite to verify the reader operating mode matches the application requirement. If necessary, reconfigure the reader operating modes.

NOTE: *Refer to the* RF Command Suite User's Guide *and the* Comprehensive Heuristic Unified Messaging Protocol (CHUMP) Reference Guide *for detailed information on configuring the reader.*

Ethernet LAN Communication Setup

The MP9320 can be networked with other readers on an enterprise 10/100 BaseT Ethernet LAN. Each reader is equipped with an embedded IP device server that allows the unit to be assigned an IP address. This address can then be accessed by your network server or host computer.

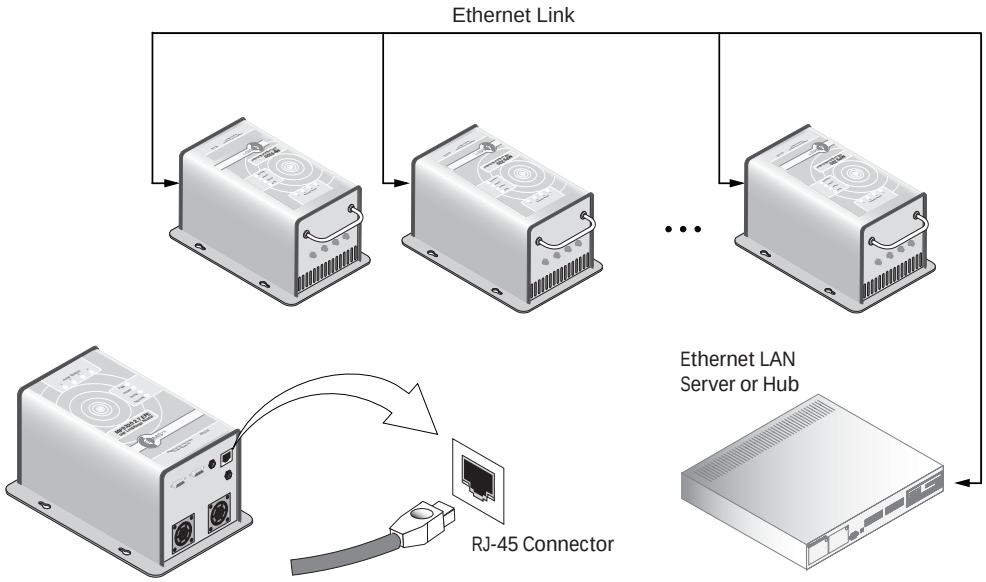


Figure 5–*MP9320 Ethernet LAN Communication Setup*

Installing the RF Command Suite Application

The SAMSys RF Command Suite is a Microsoft Windows application that provides a Graphical User Interface (GUI) for SAMSys RFID Reader Products. The application allows you to easily view tag data, configure the reader, and perform other tag data functions. In addition, the RF Command Suite is the preferred method for sending CHUMP commands to a reader. The RF Command Suite application is provided on the CD shipped with your reader and can be installed on a personal computer. To install RF Command Suite, refer to Chapter 1 - *Introduction* in the *RF Command Suite User's Guide*.

Configuring the IP Address

The MP9320 is equipped with an optional TCP/IP Ethernet port and embedded IP device server. This reader is configured for automatic IP address allocation using the Dynamic Host Configuration Protocol (DHCP) Mode and the reader automatically extracts the IP address from the DHCP server. This is the default mode for the reader as it is shipped from the factory.

Digital (TTL) Input/Output Setup

The MP9320 is equipped with a digital I/O port that provides four logic-level (TTL) input signals and four output signals. Refer to the *SAMSys Forth Programming Language Reference Guide* for programming information. The digital inputs are optically isolated. The outputs are open collector.

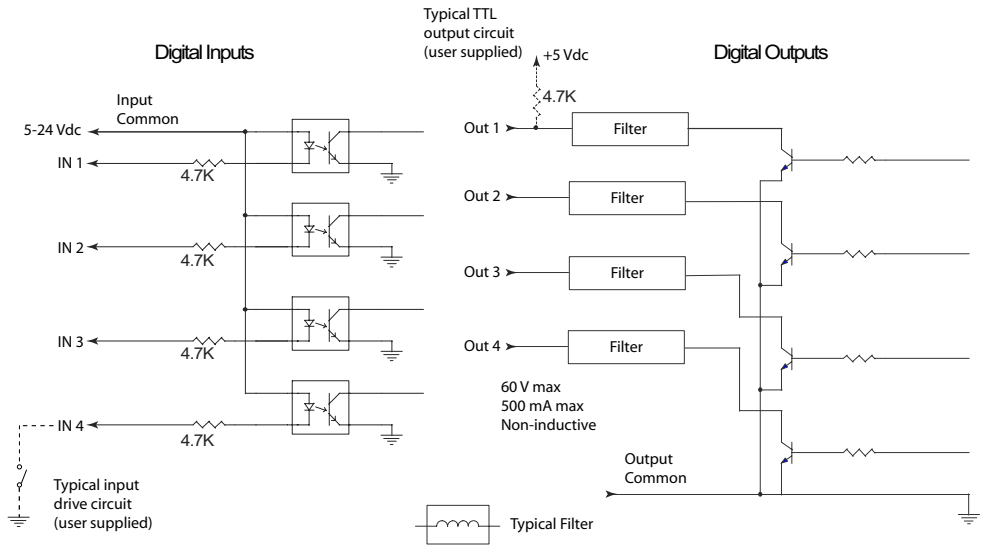


Figure 6–*Digital Input/Output Port Configuration*

Signal Name	Pin No.	Description
Input 1	7	Input - optically isolated
Input 2	14	Input - optically isolated
Input 3	13	Input - optically isolated
Input 4	5	Input - optically isolated
Digital input common	8, 15	Input commmon
Output 1	4	Output - open collector
Output 2	11	Output - open collector
Output 3	10	Output - open collector
Output 4	2	Output - open collector
Digital output common	1,9,3,6,12	Output common

Setting Digital Input for Reader Duty Cycle Control

MP9320 readers with software version 1.33.04 or later can be configured for limited duty cycle (trigger enabled RF output) by setting one of the digital inputs. This functionality can be enabled to meet regulatory requirements or to set the reader to respond to external events.

In order for the reader to recognize a trigger, the Protocol Control Word (PCW) must be configured. Perform the following to setup the reader for external trigger:

1. Place the reader into one of the following automatic modes:
   - Field Off between reads: **`}Cw,d:GCW,b:03,f:01!`**
   - Field On between reads: **`}Cw,d:GCW,b:07,f:01!`**

2. Set PCW bit 13 (mask 0x2000). Typically, the PCW is set to 0x100 to enable the tag activity buzzer. As a result, a typical setup command is as follows:

   `}Cw,d:PCW,b:2100,f:01!`

3. The reader should now be in limited duty cycle mode.
4. Apply +5 to 24 Vdc to Digital Input Common pin 8 or 15 (D connector) or pin “N” (round, MilSpec connector).
5. To trigger a read, apply 0 Vdc to digital input 1. As shown in the previous table and in Figure 7, digital input 1 is pin “7” on the 15-pin D type connector or pin “a” on the 26-pin MilSpec connector.

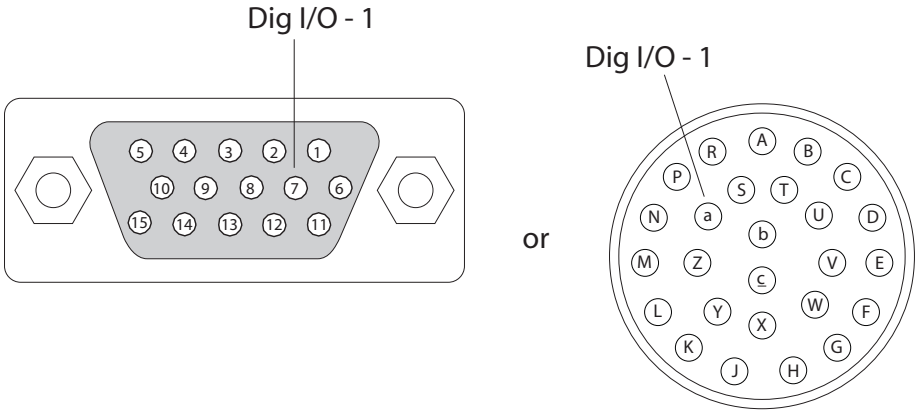


Figure 7–*Main I/O Connector(s)*

6. At this point, the reader should only radiate RF energy when digital input 1 is pulled low (0 Vdc). Otherwise, the reader’s RF field shuts down.
7. For more information on reader configuration and control settings, refer to the *Comprehensive Heuristic Unified Messaging Protocol Reference Guide*.

Transmit Power Calibration

The MP9320 can be operated with a variety of commercially available antennas and coaxial cables. As a result, the output RF power of the reader must be configured to optimize the read range for a given antenna configuration, while not violating FCC or ETSI regulations.

Calibration of the reader transmit RF power must only be performed by SAMSys authorized installation personnel or certified resellers.

Transmitter and Antenna Configuration

Multiplexer Configuration Word (MCW)

The MCW configures the MP9320 UHF reader. Parameters include the following:

- Enable/suppress antenna hopping
- Enable/suppress MUX failure messages
- Number of antennas
- Number of inventory operations before antenna hop.

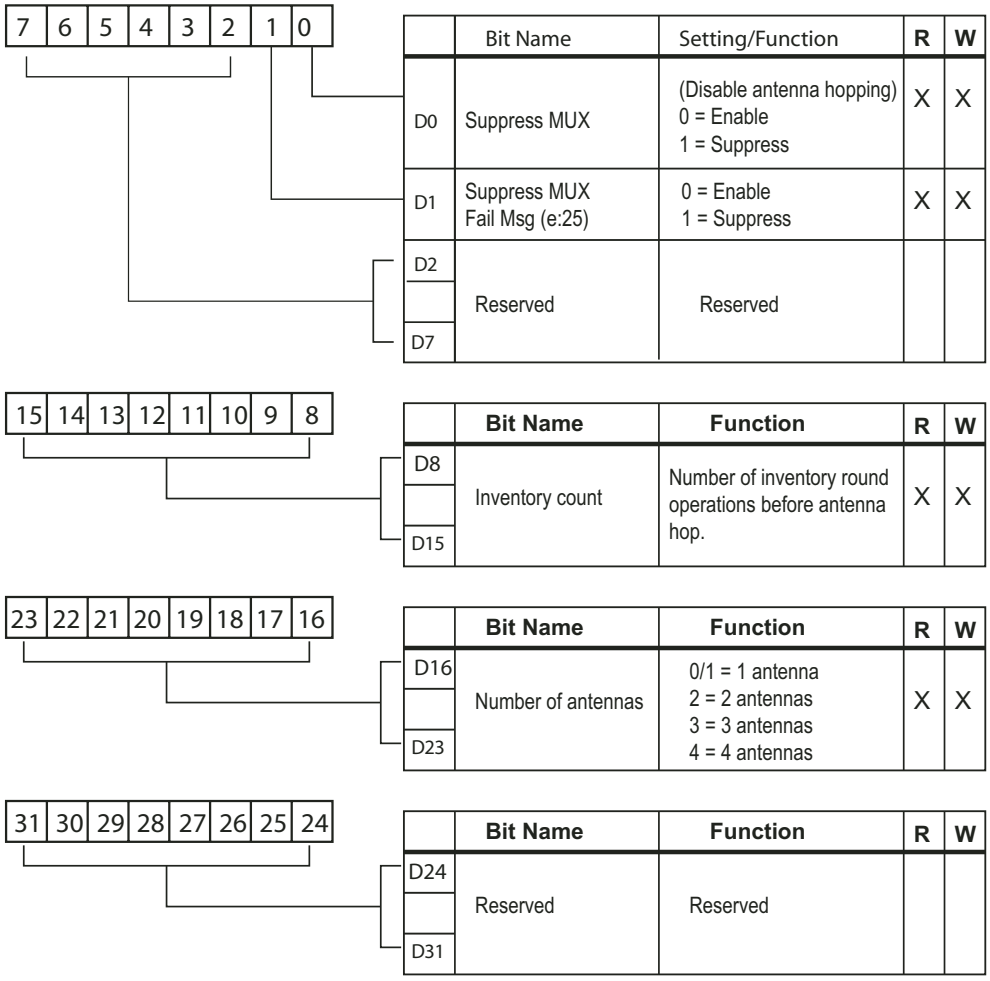


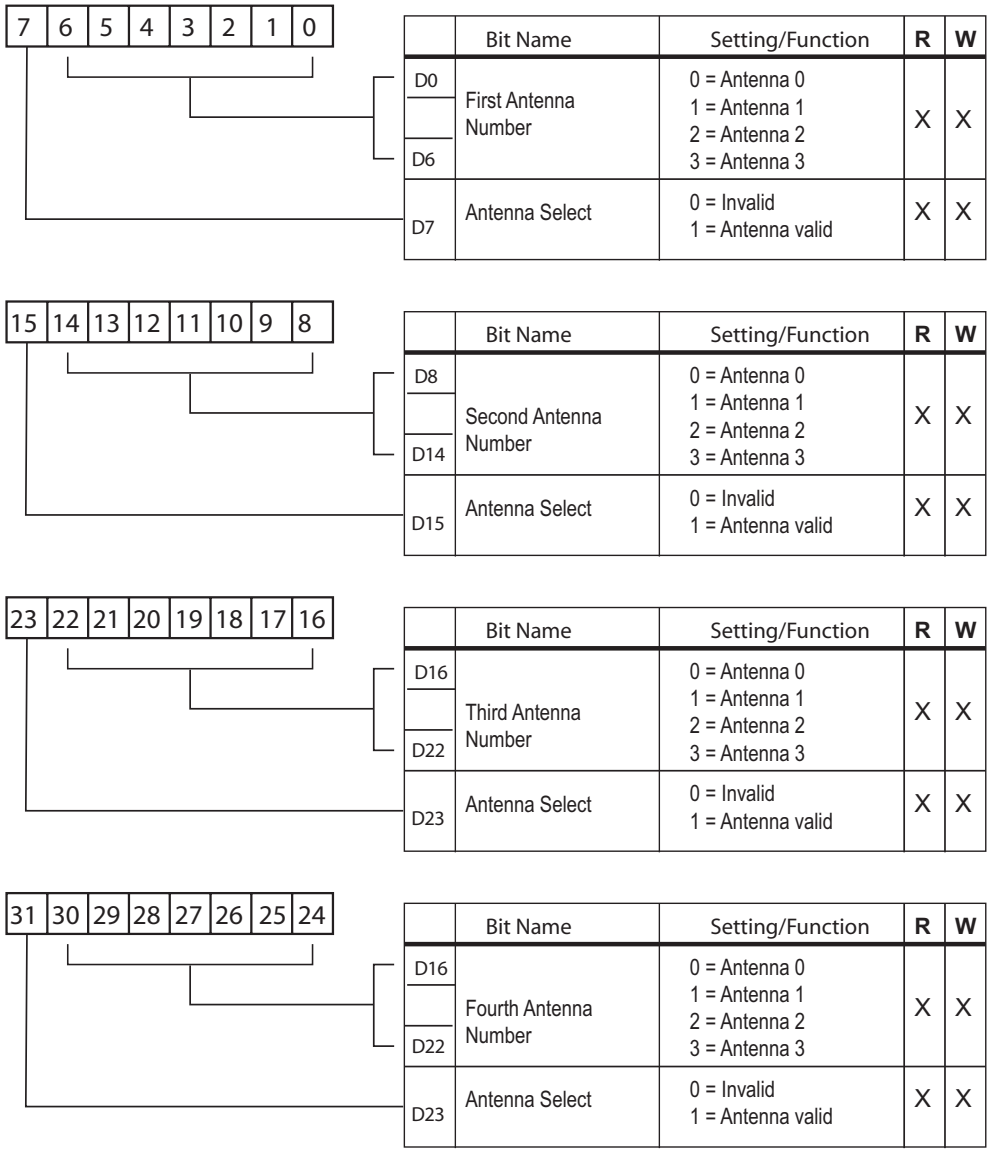
Figure 8–*MCW Bit Configuration*

The following command selects four antennas with one Inventory Read Round per antenna:

```
}Cw,d:mcw,b:40100,f:1!
```

Multiplexer Select Word (MSW)

The MSW selects which antennas are active on the MP9320 UHF reader. The variable also selects the activation order (LSB to MSB). The bit settings for the MSW are shown in Figure 8.



	Bit Name	Setting/Function	R	W
D0 D6	First Antenna Number	0 = Antenna 0 1 = Antenna 1 2 = Antenna 2 3 = Antenna 3	X	X
D7	Antenna Select	0 = Invalid 1 = Antenna valid	X	X

	Bit Name	Setting/Function	R	W
D8 D14	Second Antenna Number	0 = Antenna 0 1 = Antenna 1 2 = Antenna 2 3 = Antenna 3	X	X
D15	Antenna Select	0 = Invalid 1 = Antenna valid	X	X

	Bit Name	Setting/Function	R	W
D16 D22	Third Antenna Number	0 = Antenna 0 1 = Antenna 1 2 = Antenna 2 3 = Antenna 3	X	X
D23	Antenna Select	0 = Invalid 1 = Antenna valid	X	X

	Bit Name	Setting/Function	R	W
D16 D22	Fourth Antenna Number	0 = Antenna 0 1 = Antenna 1 2 = Antenna 2 3 = Antenna 3	X	X
D23	Antenna Select	0 = Invalid 1 = Antenna valid	X	X

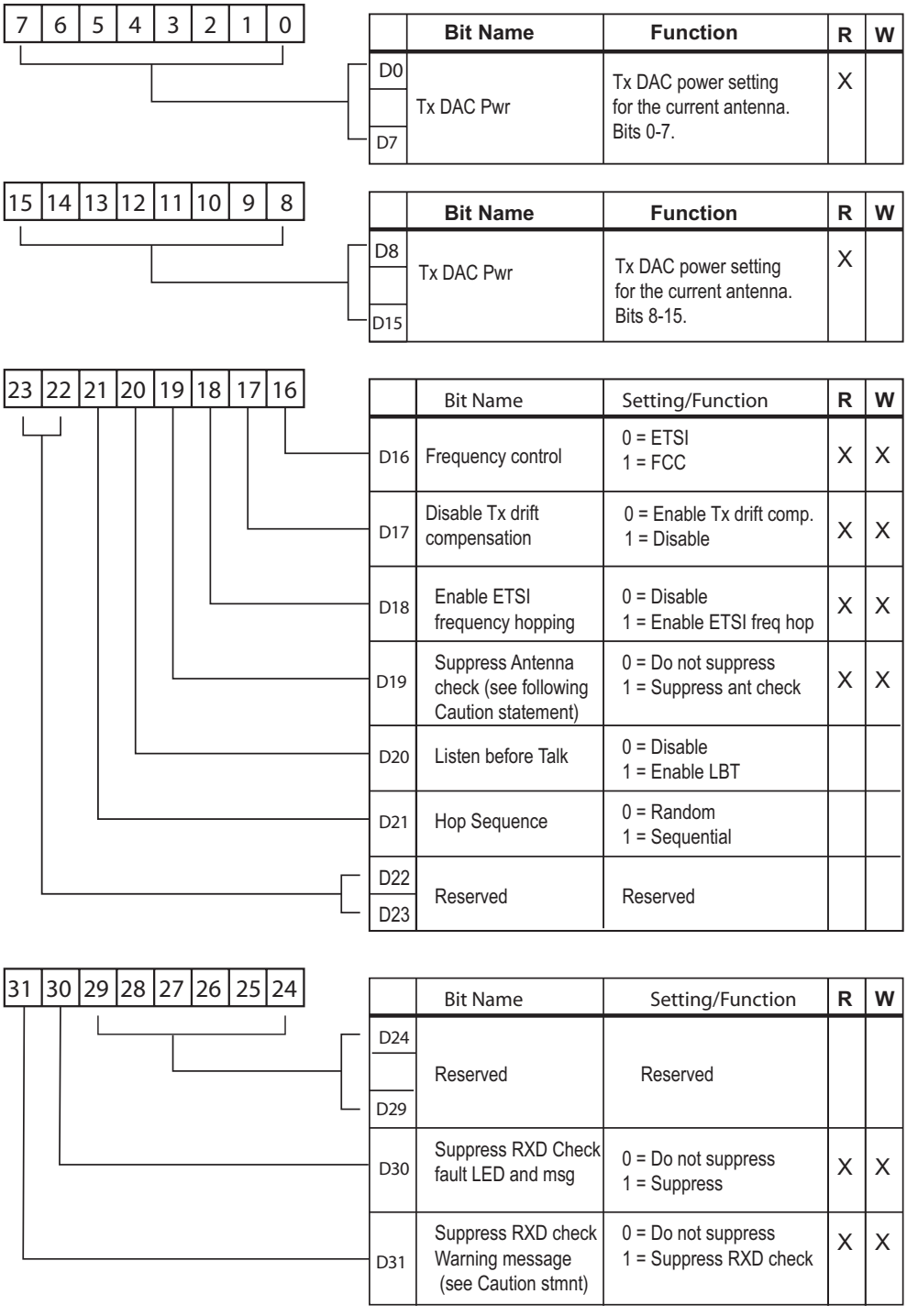
Figure 9–*MSW Bit Configuration*

The following command selects a four-antenna port activation sequence of 1, 2, 3, 4:

```
}cw,d:msw,b:83828180,f:1!
```

Transmit Power Configuration (TPC)

The transmitter configuration is controlled by the 32-bit Transmit Power Configuration (TPC) register. For bit settings, refer to Figure 10. The default setting for this register is 0x00000840.



	Bit Name	Function	R	W
D0	Tx DAC Pwr	Tx DAC power setting for the current antenna. Bits 0-7.	X	
D7				

	Bit Name	Function	R	W
D8	Tx DAC Pwr	Tx DAC power setting for the current antenna. Bits 8-15.	X	
D15				

	Bit Name	Setting/Function	R	W
D16	Frequency control	0 = ETSI 1 = FCC	X	X
D17	Disable Tx drift compensation	0 = Enable Tx drift comp. 1 = Disable	X	X
D18	Enable ETSI frequency hopping	0 = Disable 1 = Enable ETSI freq hop	X	X
D19	Suppress Antenna check (see following Caution statement)	0 = Do not suppress 1 = Suppress ant check	X	X
D20	Listen before Talk	0 = Disable 1 = Enable LBT		
D21	Hop Sequence	0 = Random 1 = Sequential		
D22	Reserved	Reserved		
D23				

	Bit Name	Setting/Function	R	W
D24	Reserved	Reserved		
D29				
D30	Suppress RXD Check fault LED and msg	0 = Do not suppress 1 = Suppress	X	X
D31	Suppress RXD check Warning message (see Caution stmnt)	0 = Do not suppress 1 = Suppress RXD check	X	X

Figure 10–*TPC Bit Configuration*

The following command sets the reader for FCC operation:

```
}Cw,d:tpc,b:00010000,f:1!
```

The following command sets the reader for ETSI operation with Frequency Hopping:

```
}Cw,d:tpc,b:00040000,f:1!
```

NOTE: *A change in value for Frequency control or Enable ETSI frequency hopping will reset the reader when it changes modes. Writing these bits to the previous value will not affect the reader since there is no mode change.*

The reader can internally check antenna condition via the reflected power measurement. The Suppress antenna check bit controls whether this check is performed when RF power is first applied to a reader antenna port. The Suppress RXD check bit controls whether this check is performed each time a change in antenna selection is performed.

Caution

Suppressing the RXD check or Antenna check will disable protection alogorithms in the reader and is highly discouraged. Disabling these algorithms can result in serious damage to the reader under high Voltage Standing Wave Ratio (VSWR) situations. VSWR is the measure of the impedance mismatch bewteen the reader's RF transmission circuitry and the external load placed on the reader's antenna port.

Antenna Transmit Power (TPx)

This register sets the antenna power for antenna ports 1, 2, 3,and 4 (TP0, TP1, TP2, and TP3 respectively). Refer to the following sections for calculating the antenna power index values.

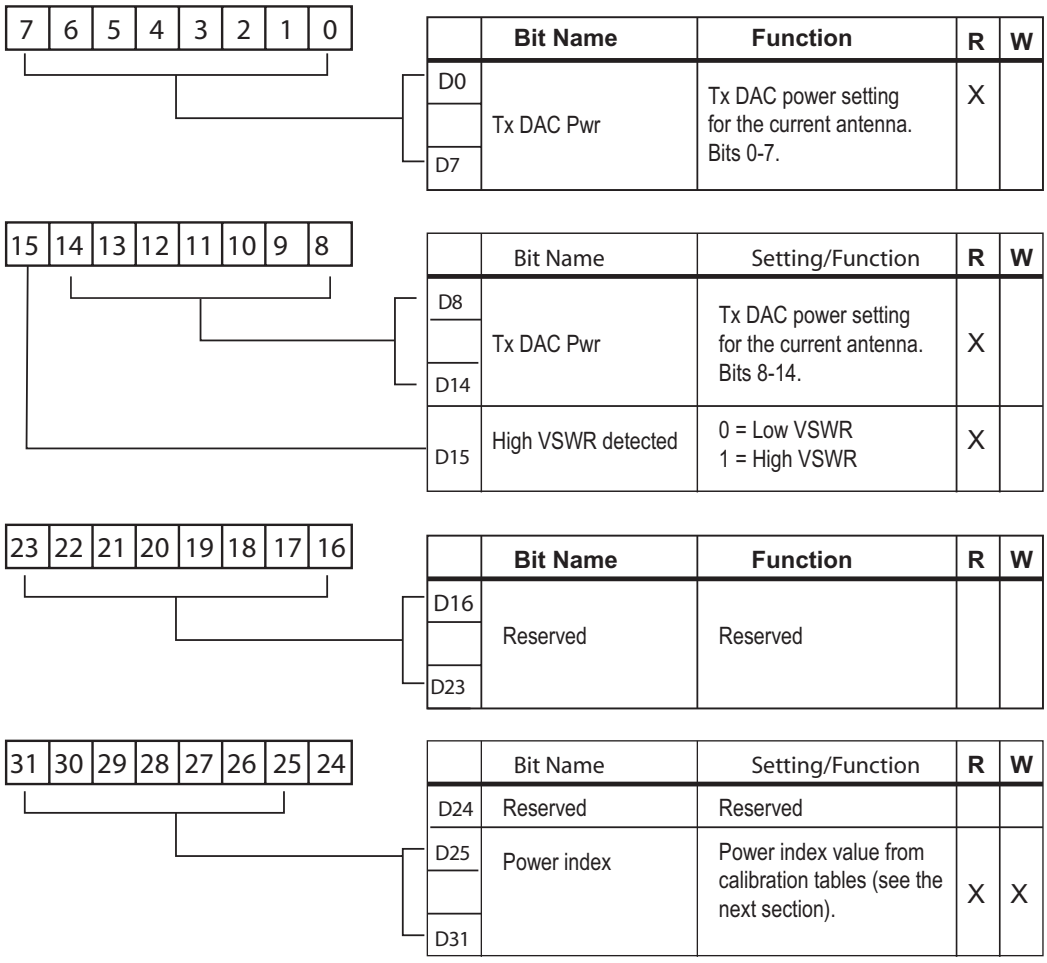


Figure 11–*TPx Bit Configuration*

NOTE: *The Power index values are obtained from the calibration tables listed in the following sections.*

Manual Field Power Calibration - FCC Readers

Caution

The following procedure involves connecting and disconnecting RF cables from the reader. The reader should be powered down (transmitter disabled) before disconnecting any antenna, cable, or power meter from any port to prevent damaging the unit. Antennas (or a power meter) should be attached to all active ports prior to transmitter power up.

To achieve optimum performance and maximum range from the SAMSys UHF reader, each active antenna port should be set to transmit at the highest power allowed within regulatory limits. This output level is obtained by calibrating the reader for antenna gain and cable loss.

For FCC mode, the maximum power level is 1 W (30 dBm) at the antenna (per Code of Federal Regulations, Title 47, Part 15). If an antenna is used that exceeds 6 dBi, the maximum power level delivered to the antenna must be reduced by the amount of antenna gain in excess of 6 dBi (antenna gain is specified in dBi, where i = isotropic).

For example, if a 9 dBi linear gain antenna is used, the transmitter power delivered to the antenna should be reduced by 3 dB to 27 dBm.

If a circular polarized antenna is used, subtract 3 dB from the manufacturer specified antenna gain to get the applicable linear gain. If the specified antenna gain is 7.5 dBi, circular polarization (7.5 dBiC), the linear antenna gain is 4.5 dBi.

In addition to the antenna gain, the reader must also be calibrated for cable loss. RG58 A/U cable typically has a loss of approximately 1 dB per six feet of cable.

For example, if a circular polarized antenna with a gain of 7.5 dBi (4.5 dBi linear) is used with 15 feet of cable, the optimum output power from the UHF reader is 32.5 dBm (30 dBm + 2.5 dB cable loss). Since the linear antenna gain does not exceed 6 dBi, no further adjustment is required.

In order to calibrate the reader for 32.5 dBm, use the following table to look-up a corresponding index number to write to the reader. As shown in the following table, 32.5 dBm corresponds to an index of 0e.

Index	Pout (dBm)	(W)	Index	Pout (dBm)	(W)	Index	Pout (dBm)	(mW)	Index	Pout (dBm)	(mW)	Index	Pout (dBm)	(mW)
00	27**	0.5	14	31	1.26	28	26	398	3c	21	126	50	16	40
02	34.7	2.95	16	30.5	1.12	2a	25.5	355	3e	20.5	112	52	15.5	35
04	34.3	2.69	18	30	1	2c	25	316	40	20	100	54	15	32
06	34	2.51	1a	29.5	0.89	2e	24.5	282	42	19.5	89	56	14.5	28
08	33.7	2.34	1c	29	0.79	30	24	251	44	19	79	58	14	25
0a	33.3	2.14	1e	28.5	0.71	32	23.5	224	46	18.5	71	5a	13.5	22
0c	33	2	20	28	0.63	34	23	200	48	18	63	5c	13	20
0e	32.5	1.78	22	27.5	0.562	36	22.5	178	4a	17.5	56	5e	12.5	18
10	32	1.58	24	27	0.501	38	22	158	4c	17	50	60	12	16
12	31.5	1.41	26	26.5	0.447	3a	21.5	141	4e	16.5	45			
** Index 00 is no longer valid, the output power is defaulted to index 24, or 500 mW (27 dBm).														

To write the index of "0e" to the reader, perform the following:

1. To set the reader for 32.5 dBm at the port 1 antenna connector, execute the following the following CHUMP command:

   `}cw,d:TP0,b:0e000000,f:1!`

   where:

   The digit following TP is the port number minus 1.

   The left two digits of the eight bit word are the index number (0e).

2. Connect a power meter connected directly to port 1. The meter should read 32.5 dBm. The power meter should read 30 dBm if connected to the end of the 15 foot cable.
3. Repeat this procedure for each port.

Manual Field Power Calibration - ETSI Readers

Caution

The following procedure involves connecting and disconnecting RF cables from the reader. The reader should be powered down (transmitter disabled) before disconnecting any antenna, cable, or power meter from any port to prevent damaging the unit. Antennas (or a power meter) should be attached to all active ports prior to transmitter power up.

To achieve optimum performance and maximum range from the SAMSys UHF reader, each active antenna port should be set to transmit at the highest power allowed within regulatory limits. This output level is obtained by calibrating the reader for antenna gain and cable loss.

For ETSI mode, the maximum power level is 500 mW ERP (27 dBm) at the antenna (per EN300 220--3 V1.1.1). This is equvalent to 820 mW (29 dBm) EIRP (equvalent isotropic radiated power). An EIRP of 29 dBm is used for the following example.

If a circular polarized antenna is used, subtract 3 dBi from the manufacturer specified antenna gain to get the applicable linear gain. If the specified antenna gain is 7.5 dBi, circular polarization (7.5 dBiC), the linear antenna gain is 4.5 dBi.

In addition to the antenna gain, the reader must also be calibrated for cable loss. RG58 A/U cable has typically has a loss of approximately 0.5 dB per meter of cable.

For example, if a circular polarized antenna with a gain of 7.5 dBi (4.5 dBi linear) is used with 5 meters of cable, the optimum output power from the UHF reader is 27 dBm (29 dBm - 4.5 dB antenna gain + 2.5 dB cable loss).

In order to calibrate the reader for 27 dBm, use the following table to look-up a corresponding index number to write to the reader. As shown in the following table, 27 dBm corresponds to an index of 24.

Index	Pout (dBm)	(W)	Index	Pout (dBm)	(W)	Index	Pout (dBm)	(mW)	Index	Pout (dBm)	(mW)	Index	Pout (dBm)	(mW)
00	27**	0.5	14	31	1.26	28	26	398	3c	21	126	50	16	40
02	34.7	2.95	16	30.5	1.12	2a	25.5	355	3e	20.5	112	52	15.5	35
04	34.3	2.69	18	30	1	2c	25	316	40	20	100	54	15	32
06	34	2.51	1a	29.5	0.89	2e	24.5	282	42	19.5	89	56	14.5	28
08	33.7	2.34	1c	29	0.79	30	24	251	44	19	79	58	14	25
0a	33.3	2.14	1e	28.5	0.71	32	23.5	224	46	18.5	71	5a	13.5	22
0c	33	2	20	28	0.63	34	23	200	48	18	63	5c	13	20
0e	32.5	1.78	22	27.5	0.562	36	22.5	178	4a	17.5	56	5e	12.5	18
10	32	1.58	24	27	0.501	38	22	158	4c	17	50	60	12	16
12	31.5	1.41	26	26.5	0.447	3a	21.5	141	4e	16.5	45			
** Index 00 is no longer valid, the output power is defaulted to index 24, or 500 mW (27 dBm).														

To write the index of "24" to the reader, perform the following:

1. To set the reader for 27 dBm at the port 1 antenna connector,execute the following the following CHUMP command:

   `}cw,d:TP0,b:24000000,f:1!`

   where:

   The digit following TP is the port number minus 1.

   The left two digits of the eight bit word are the index number (24).

2. Connect a power meter connected directly to port 1. The meter should read 27 dBm. The power meter should read 24.5 dBm if connected to the end of the 5 meter cable. EIRP should be 29 dBm (24.5 + 4.5) or 800 mW.
3. Repeat this procedure for each port.