

User's Guide

MP9311 **Low-Power UHF Reader Module**



SAMSys

MP9311 Low-Power UHF Reader Module User's Guide

Second Edition (February 22, 2006)

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SAMSys Technologies, Inc. is a world-leading provider of RFID reader hardware solutions in the LF, HF, and UHF segments of the RFID marketplace. SAMSys is a public company listed on the Toronto Stock Exchange under the symbol SMY.

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FCC Radiation Exposure Statement

The antennas used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.

REGULATORY NOTICE

Changes or modifications not expressly approved by the party responsible for compliance may void the user's authority to operate the equipment.

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Contents

Chapter 1 – Introduction	1
Unpacking the Reader	2
About the MP9311	3
Physical Description	4
MP9311 Model Variations	4
Chapter 2 – Installation and Setup	5
Reader Electrical Installation	6
Connecting Power to the MP9311	7
Connecting an RS-232 Serial Link to the MP9311	7
Connecting the Digital Input and Output Lines	8
Reader Mechanical Installation	9
Low-Power UHF Antenna Installation	10
Installing the RF Command Suite Application	11
RF Power Setting - FCC Readers	12
Setting Transmit Power - TD0	13
Setting Antenna Gain - TG0 (MP9311-Wxx only)	14
Selecting Frequency Bands	15
FCC Frequency Band Selection	15
ETSI Single Frequency Band Selection	16
ETSI Frequency Hopping Selection	17
Japan Band Selection	18
Chapter 3 – Operation	21
MP9311 Power Up and Initialization	22
Setting the RF Mode	22
Selecting Tag Protocols	22
Enabling Tag Protocols	23
Configuring Specific Protocols	23
Reading Tags	24
Tag Reading Overview	24
Reading Tags Using RF Command Suite	24
External Triggered Tag Inventory Operation	25
Writing Blank Tags	27
Modifying Tags	27
Resetting the MP9311	28
Chapter 4 – Troubleshooting	29
General Troubleshooting	30
Contact Us	31
Chapter 5 – Specifications	33
Reader Specifications	34
Antenna Requirements	35
Environmental Specifications	35
Power and Input/Output Connectors	36

Appendix A – Tag Programming	37
Overview of the Tag Writing Commands	38
Programming the EPC1 Tag	39
Programming the ISO 18000-6A Tag	41
Programming the ISO 18000-6B Tag	42
UCODE Programming	43
Programming the Impinj EPC0 Tag	45
Program a 96-Bit EPC (Impinj Zuma Tags)	46
Program a 64-Bit EPC (Impinj Zuma Tags)	46
Program a 48-Bit Product Code (Impinj Zuma Tags)	46
Program the User Data (Impinj Zuma Tags)	47
Change the Passcode (Impinj Zuma Tags)	47
Programming the Matrics Class 0+ Tag	48
Writing Initial EPC Code to Blank Matrics EPC0+ Tags	49
Writing a Kill Code and User Data	50
Writing User Data	50
Tag Erase	50
Locking Tags	51
Programming the EPC1, Generation 2 Tag	52
Access Memory	52
EPC Memory	52
TID Memory	52
User Memory	52
Writing the Tag	53

Figures

MP9311 Reader and Accessories	2
MP9311 Reader Connections	4
MP9311 System Connector	6
System Connector (SCON1) Power Connections	7
System Connector (SCON1) Serial Connections	7
System Connector (SCON1) Digital Input/Output Connections	8
Typical Digital Input and Output Circuits	8
MP9311 Enclosure Dimensions	9
Low-Power UHF Antennas	10
Label Programmer Antenna Dimensions	10
Transmit Power Adjustment	13
Transmit Gain Adjustment	14
FCC Frequency Parameter Configuration.	15
ETSI Single Frequency Parameter Configuration	16
ETSI Frequency Hopping Parameter Configuration	17
Japan Parameter Configuration	18
TPC Bit Configuration	19
Protocol Selection	23
Protocol Parameter Configuration	23
Typical Digital Input Trigger Circuit	26
Select Tag Protocol	27
Write Blank Tag	27
Select Tag to Modify	28
Modify Tag Option	28

Introduction

This chapter provides a general description of the MP9311 Low Power UHF Reader Module. Topics discussed in this chapter include the following:

- Unpacking the Reader
- About the MP9311
- Physical Description
- MP9311 Model Variations

Unpacking the Reader

After opening the shipping container perform the following:

1. Unpack the contents of the shipping container.
2. Inspect the shipping container for damage. If damaged, notify the carrier and SAMSys Technologies. Keep the shipping materials for inspection by the carrier.
3. Verify your reader package includes the following items:
 - MP9311 Low-Power UHF Reader Module
 - System documentation CD
 - Breakout Board (optional)
 - Antenna (optional)
 - Antenna cable (optional)
 - Power Supply for Breakout board (optional)
 - MP9311 I/O Cable for Breakout Board (optional)



Figure 1—MP9311 Reader and Accessories

About the MP9311

The MP9311 UHF RFID reader module provides a small footprint OEM solution for embedded applications in RFID enabled printers and other devices. The multiprotocol module supports the following UHF protocols:

- EPC Generation 2
- EPC Class 1
- EPC Class 0 (includes Impinj 0+ & Matrics 0+)
- ISO 18000-6A, -6B
- EM Marin 4022, 4222, 4223
- Intermec® Intellitag®
- Philips UCODE EPC 1.19

Available in both North American (-Nxx) and World (-Wxx) versions, the MP9311 meets all applicable regulatory requirements.

The MP9311 module can operate with active or passive tags while transmitting a modulated signal. The system receiver has input bandwidths that match the hopping channel bandwidths of the corresponding transmitters and shifts frequencies in synchronization with the transmitted signal.

In addition to multi-protocol, multi-regional architecture, the MP9311 includes:

- Full Tag Read/Write Capability
- 865 Mhz to 955 Mhz Frequency Range
- 0.6 Watt Maximum Output Power
- Single 5 Vdc supply
- Serial Port (RS-232 and TTL Interface)
- Digital Inputs (2)
- Digital Outputs (2)
- Field Programmable Firmware Upgrades

Physical Description

The MP9311 contains one MMCX type antenna port and an integral power and I/O connector for connecting the module to system power and control circuits. All digital, analog, and RF components are enclosed in a shielded aluminum case and the case is available with or without cooling fins depending on the host operational environment. Four mounting holes in the corners of the case provide easy installation in existing systems.

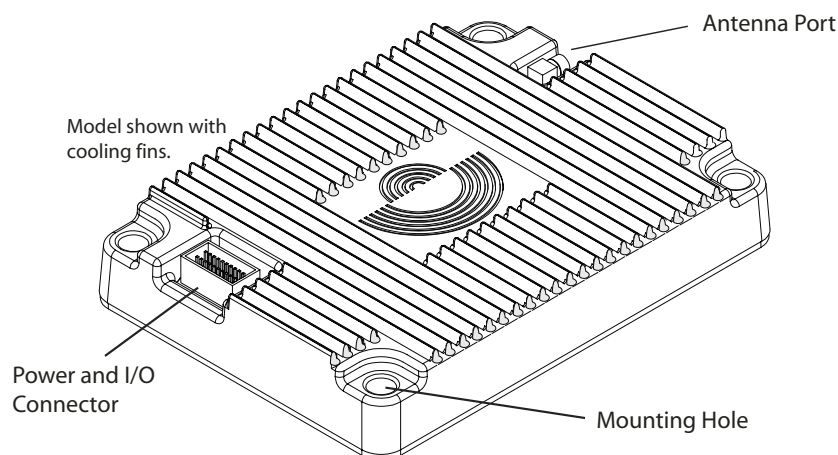


Figure 2—MP9311 Reader Connections

MP9311 Model Variations

The MP9311 is available in several variations depending on the region of use and I/O configurations. The following table summarizes the different models and configurations:

Model	Region	Case	Interface
MP9311-NRT (-PBFREE¹)	North America	Ridges	TTL
MP9311-NRR (-PBFREE¹)	North America	Ridges	RS-232
MP9311-NST (-PBFREE¹)	North America	Smooth	TTL
MP9311-NSR (-PBFREE¹)	North America	Smooth	RS-232
MP9311-WRT (-PBFREE¹)	World ²	Ridges	TTL
MP9311-WRR (-PBFREE¹)	World ²	Ridges	RS-232
MP9311-WST (-PBFREE¹)	World ²	Smooth	TTL
MP9311-WSR (-PBFREE¹)	World ²	Smooth	RS-232

Note 1: For lead-free products, add the -PBFREE suffix to the part number.

Note 2: The MP9311-Wxx models support both FCC and ETSI Frequencies. However, only ETSI is enabled when the reader leaves the factory.

Installation and Setup

This chapter provides information for installing the MP9311 Low-Power Reader Module. Topics discussed in this chapter include the following:

- Reader Electrical Installation
 - Connecting Power to the MP9311
 - Connecting an RS-232 Serial Link to the MP9311
 - Connecting the Digital Input and Output Lines
- Reader Mechanical Installation
- Low-Power UHF Antenna Installation
- Installing the RF Command Suite Application
- RF Power Setting – FCC Readers
- Setting Transmit Power – TD0
- Setting Antenna Gain
- Selecting Frequency Bands

Reader Electrical Installation

As shown in Figure 3, the MP9311 is equipped with a keyed 20-post header (2x10), 1.0 mm pitch, .02 mm square pin for power, ground, and communication connections. The antenna connection is provided by a right-angle MMCX connector.

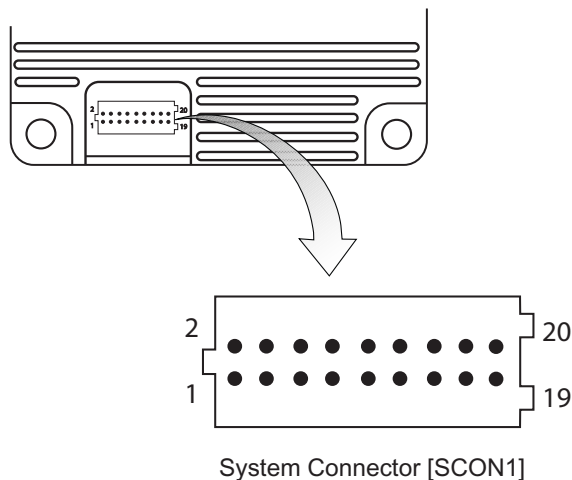


Figure 3—MP9311 System Connector

Pin No.	Name	Signal/Value
16, 18, 20	PWR	System Supply Voltage, 5.0 Vdc +/-10%, 2.0A Max (All inputs tied together)
3,10,12,14,17, 19	GND	Ground (All grounds tied together)
Pin 1	V33	3.3 Vdc Output (<i>For factory use only.</i>)
Pin 2	PROG	Program Enable (<i>For factory use only.</i>)
Pin 4	RESET	Active Low Reset
Pin 5	DIN0-	Digital Input 0 – low input (see Note 1)
Pin 6	DIN1+	Digital Input 1 – high (reference) input (see Note 1)
Pin 7	DIN1-	Digital Input 1 – low input (see Note 1)
Pin 8	DIN0+	Digital Input 0 – high (reference) input (see Note 1)
Pin 9	DOUT0	Digital output 0, open collector to ground (50 Vdc @ 40 mA max)
Pin 11	DOUT1	Digital output 1, open collector to ground (50 Vdc @ 40 mA max)
Pin 13	TXD	Transmit
Pin 15	RXD	Receive

NOTE 1:
 To activate the digital input:
 $3 \text{ Vdc} < (V_{\text{DINn+}} - V_{\text{DINn-}}) < 25 \text{ Vdc}$
 Otherwise:
 $(V_{\text{DINn+}} - V_{\text{DINn-}}) \sim 0 \text{ Vdc}$

Connecting Power to the MP9311

On the MP9311, all power inputs are tied together and all commons (grounds) are tied together. To connect power to the reader, apply 5 Vdc to all SCON1 power input pin (16,18,20) and connect ground to all SCON1 common pin (3,10,12,14,17,19). The SCON1 connector is rated to withstand a maximum current of 1.0A per pin. Therefore, it is important that all power and ground pins be connected to prevent reader damage. See Figure 4.

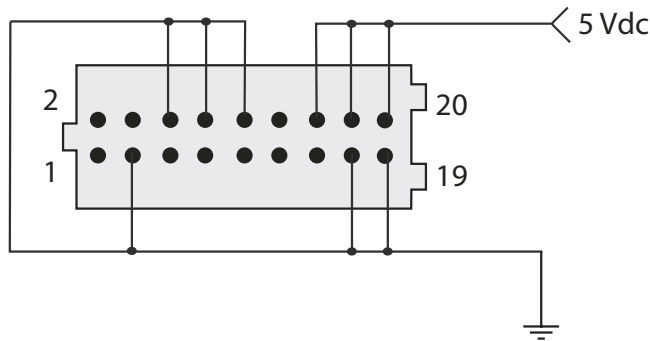


Figure 4—System Connector (SCON1) Power Connections

Connecting an RS-232/TTL Serial Link to the MP9311

On the MP9311, RS-232/TTL signals are located on pins 13 (TXD) and 15 (RXD). The ground signals are connected as shown in Figure 4.

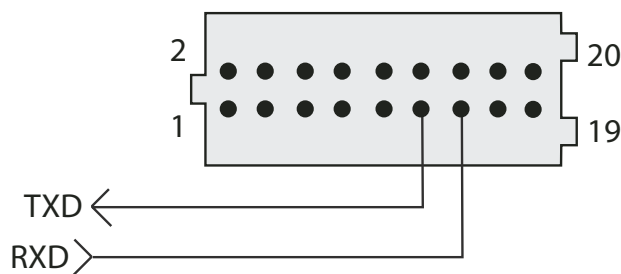


Figure 5—System Connector (SCON1) Serial Connections

Connecting the Digital Input and Output Lines

The MP9311 is equipped with two logic-level input signals (DIN0/DIN1) and two open-collector output signals (DOUT0/DOUT1). To activate the digital inputs apply a minimum 3.0 Volt differential across the DINn+ and DINn-. The outputs require a 4.7K Ohm pull-up to 5V. See Figure 7 for typical input and output circuits.

Refer to the *SAMSys Forth Programming Language Reference Guide* for programming information. To set up the I/Os to trigger tag reading and indicated tag sensing, refer to the *CHUMP Reference Guide* and the Protocol Configuration Word (PCW) register.

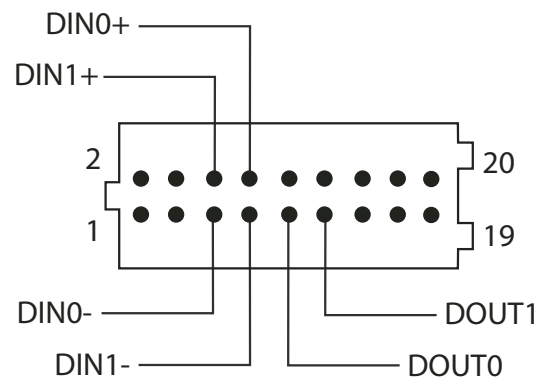


Figure 6—System Connector (SCON1) Digital Input/Output Connections

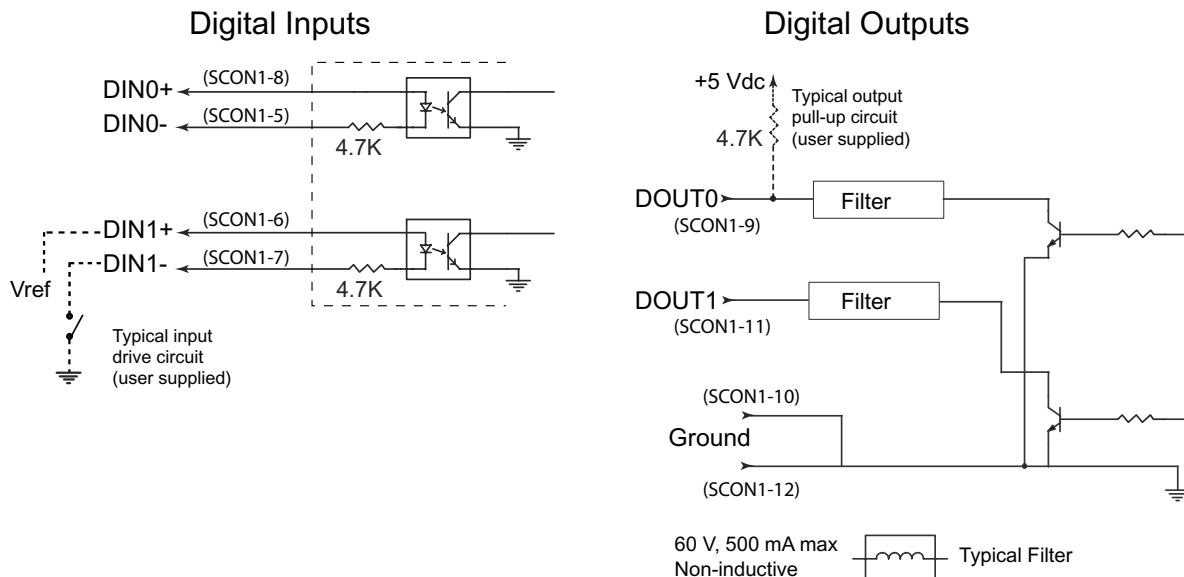


Figure 7—Typical Digital Input and Output Circuits

Reader Mechanical Installation

The MP9311 is designed for installation within an enclosure. The housing is provided with four M4 clearance through-holes for module mounting. The reader dimensions are shown in Figure 8.



Caution

Prior to mounting the reader in an enclosure, you must evaluate the operating conditions and resulting thermal profile. When operated at maximum RF power and input supply voltage, the MP9311 can dissipate as much as 11W of power. As a result, any enclosure design must dissipate the generated thermal energy and maintain the internal reader temperature below +85 degrees C. Mounting the bottom surface of the reader in direct contact with a metal plate will provide the most efficient method of dissipating heat.

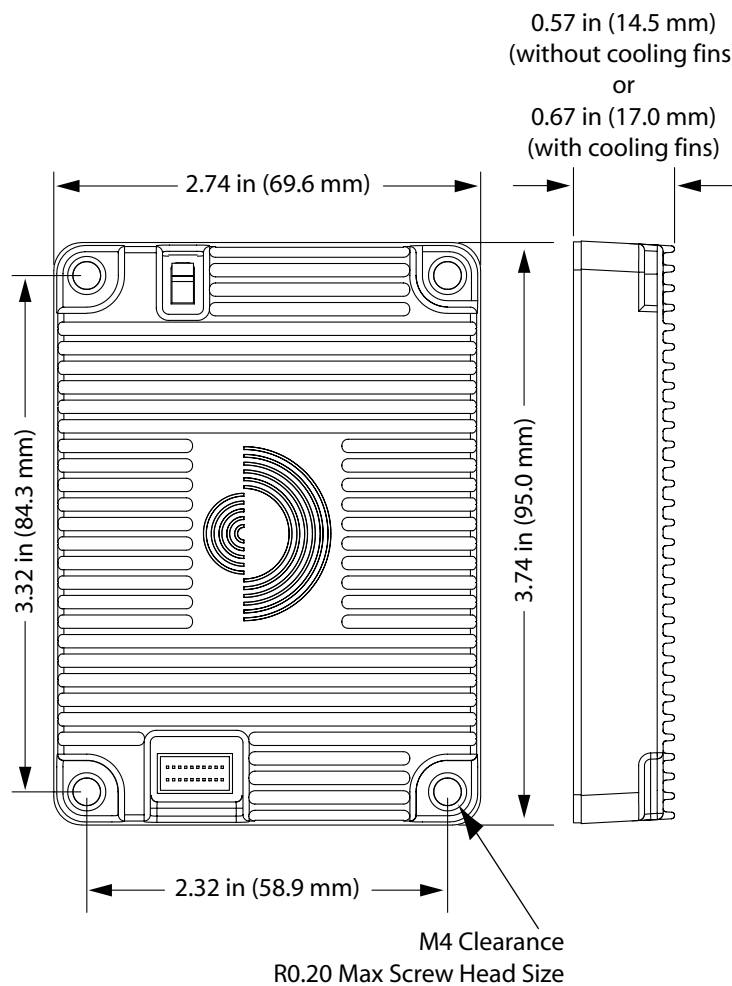


Figure 8—MP9311 Enclosure Dimensions

Low-Power UHF Antenna Installation

The MP9311 is designed to operate with the SAMSys Label Printer Antenna. This antenna has an expected read range of 1-12 inches and only requires a power output of approximately 17 dBm for optimal performance.

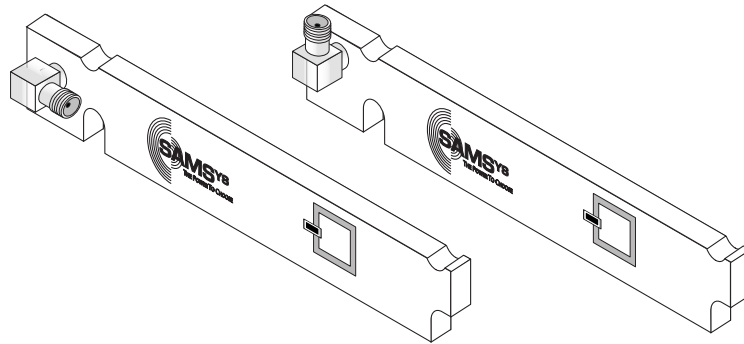


Figure 9—Low-Power UHF Antennas

As shown in Figure 10, mounting slots/cutouts are provided. Do not attempt to drill new mounting holes in the antenna.

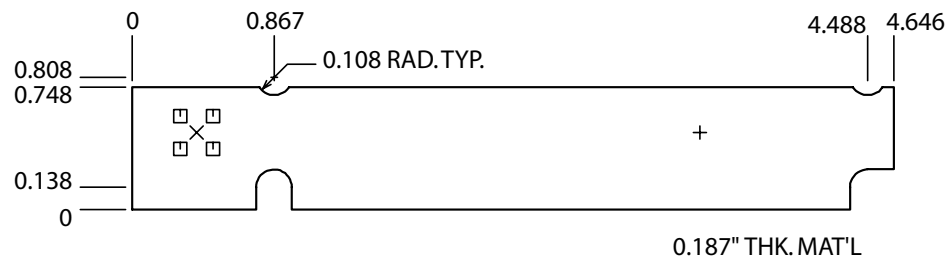


Figure 10—Label Programmer Antenna Dimensions



Caution

To prevent reader damage, the RF port must be properly terminated with a 50 Ohm load or a functional UHF RFID antenna before power up. Never power up the reader unless the loads or antennas are connected. Always power down the reader before removing an antenna or load from an RF port.




FCC Radiation Exposure Statement

The antennas used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.

Installing the RF Command Suite Application

The SAMSys RF Command Suite (RFCS) 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 RFCS is the preferred method for sending commands to a reader.

The RFCS application is provided on the CD shipped with your reader and can be installed on a personal computer. To install RFCS and verify the reader connection, perform the following:

1. Insert the Product Documentation CD provided with the reader into the PC's CD drive.
2. Double click the **Setup_RFCommandSuite_x_yy_zz.msi** file where x_yy_zz is the version number.
3. Follow the on-screen instructions for installing the RF Command Suite application.
4. To start RF Command suite, select:
Start > Programs > SAMSys > SAMSys RF Command Suite
5. Follow the system prompts or from the upper RFCS tool bar, select:
Reader Connection > Auto Connect
6. Look in the lower left corner of the window and verify the Connected to Reader message is displayed.
7. From the **Reader Config** tab, select press the Browse button  at the bottom of the screen and navigate to **RFCS > XML Data**.
8. Select **MP9311.XML** and press **Open**.
9. From the upper RFCS tool bar, select:
File > Load Macro File
10. Navigate to **RFCS > Macros** and select **MP9310_Default.txt**.
11. All function keys and reader configuration directories should now be configured for the MP9311 reader.

RF Power Setting - FCC Readers



Caution

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

For FCC regulatory compliance, the maximum conducted power level allowed at an RFID antenna input port is 1 W (+30 dBm) (per Code of Federal Regulations, Title 47, Part 15). The maximum radiated power of the antenna allowed is 4W EIRP (+36 dBm). Consequently, if an antenna is used that exceeds 6 dBi, the maximum power level delivered to the antenna must be reduced below this +30 dBm level by the amount of antenna gain in excess of 6 dBi (antenna gain is specified in dBi, where i = isotropic). Considering the power to the antenna and the gain of the antenna, it can be seen that the maximum allowed radiated power from the antenna is +36 dBm EIRP (+30 dBm + 6 dB gain; 4w EIRP).

The MP9311 antenna port must be configured to operate within regulatory limits. The output power level must consider the previously noted regulatory rules, antenna gain, and cable loss. Because the maximum power out of the MP9311 is +28 dBm (0.63W), it is impossible to exceed the +30 dBm conducted limit into the antenna. Considering the previous paragraph, an antenna gain of 8 dBi or less meets the FCC regulatory compliance criteria (+28 dBm + 8dBi = +36 dBm EIRP).

If the antenna gain minus the cable loss exceeds 8 dB, then the MP9311 power must be reduced. Otherwise, the +36 dBm EIRP level will be violated. For example, if a 10 dBiL linear gain antenna is used and there is 1 dB loss in the cable, then the transmitter power out of the reader must be reduced to 27dBm (+36 dBm limit - 10 dBi antenna + 1 dB loss = +27 dBm).

If a circular polarized antenna is used, subtract 3 dB from the manufacturer specified antenna gain to obtain the applicable linear gain. For example, if the manufacturer specified antenna gain is 7.5 dBiC, circular polarization, the equivalent linear antenna gain is 4.5 dBiL.



Warning

Antennas used with the MP9311 are typically small, embedded, low power, low gain antennas. Antenna gain is typically much less than the 6 dBi considered in the FCC regulations. These antennas operate best at low power levels due to their construction and close proximity to the tags. Therefore, please consult the manufacturer of the antenna for ideal power settings. Operation of the MP9311 at FCC maximum power level (28 dBm) into a small embedded antenna will probably damage the antenna, reader and tags, and lead to poor tag reading performance.

To set power in the reader, refer to the following section, *Setting Transmit Power - TD0*.

Setting Transmit Power - TD0

Output power on the MP9311 is set by configuring the Transmit Power (**TD0**) register. The output power is entered in tenths (1/10) of dBm with steps of 1/10 dBm. All values are in decimal. For example, entering a value of 121 equates to 12.1 dBm. The valid range of values for TD0 is from 0 (0 dBm) to 280 (28 dBm).

Reader power values can be set using either RF Command Suite or by sending CHUMP commands directly to the reader. To set reader power values using RF Command Suite, perform the following:

1. Start RF Command Suite and select the **Reader Config** tab.
2. Select **General Configuration**.
3. Select **Transmitter > Transmit dBm Antenna 0 > Power Level in tenths of dBm**
4. Enter the value in tenths of dBm. For example, to set the antenna port to 17.5 dBm, enter a value of 175.
5. Select **Add Persistence Flag** and press **Send Changes to Reader**.

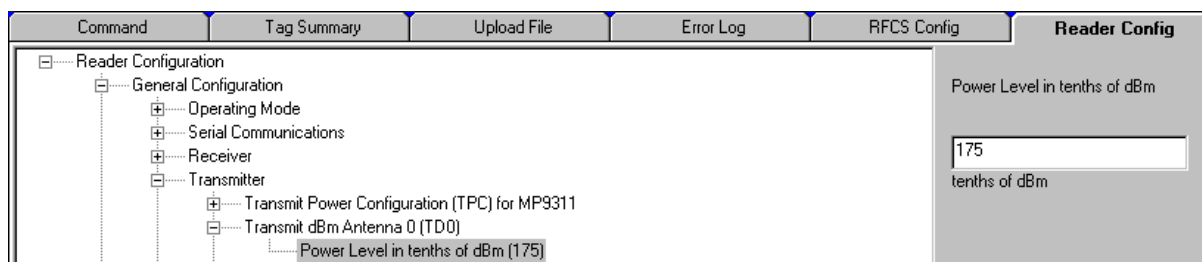


Figure 11 – Transmit Power Adjustment

Adjusting Transmit Power with CHUMP Commands

The following example shows the CHUMP command to set the MP9311 output power to 17.5 dBm:

```
}Cw,d:TD0,b:175,f:1!
```

The valid range of values for TD0 is from 0 (0 dBm) to 280 (28 dBm).

Setting Antenna Gain - TG0 (MP9311-Wxx only)

In order to comply with ERP and threshold limits according to EN 302 208, MP9311-Wxx models must be configured with the proper antenna gain. Antenna gain is set by the TG0 register. Before operation, you must determine the actual antenna gain used in the installation, G_A .

The gain value to write to the reader is computed as follows:

$$\text{xxx} = (G_A \text{ (dB)} + 13.0) * 10$$

where **xxx** is 000 through 230. These values provide an allowable antenna gain range of -13dB to +10dB. Proper LBT operation according to EN 302 208 is not guaranteed with antennas outside of this range.

To set antenna gain, perform the following:

1. Start RF Command Suite and select the **Reader Config** tab.
2. Select **General Configuration**.
3. Select **Transmitter > Transmitter, Gain for Cable/Antenna 0 (TG0) > Total Antenna/Cable Gain in tenths of dBm plus 130 (130)**
4. Enter the value in tenths of dBm. To set the port to 15.0 dBm, enter a value of 150.
5. Select **Add Persistence Flag** and press **Send Changes to Reader**.

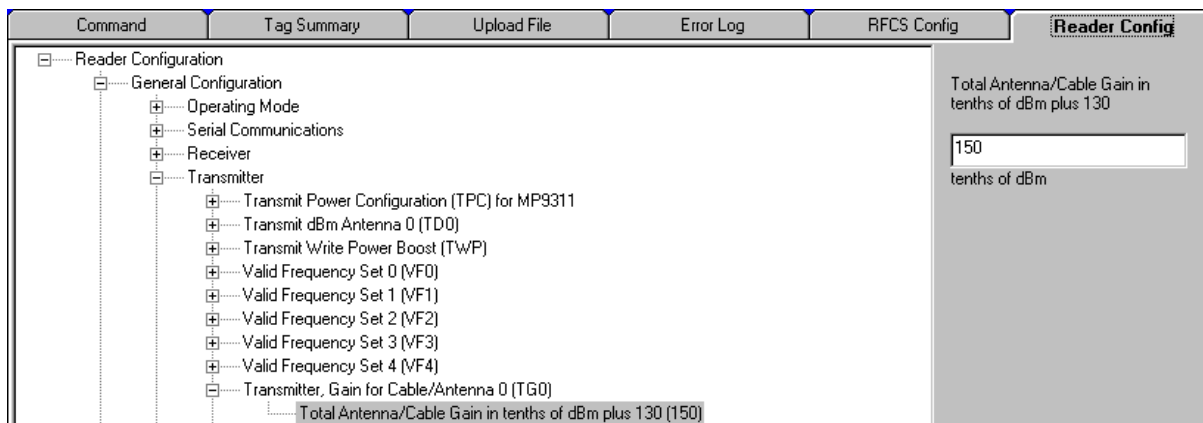


Figure 12 – Transmit Gain Adjustment

Selecting Frequency Bands

The MP9311 reader can be configured for the following frequency bands:

- FCC Band (902 to 928 MHz)
- ETSI Single Frequency (869.525 MHz or 869.850 MHz)
- ETSI Frequency Hopping (865.100 MHz to 867.9 MHz)
- Japan Band (952 MHz to 955 MHz)

Use RF Command Suite to configure the transmitter parameters for the particular region of operation. After connecting the reader to your computer, perform the following:

1. Start RF Command Suite and select the **Reader Config** tab.
2. Select **General Configuration**.
3. Select **Transmitter > Transmit Power Configuration (TPC) for MP9311 > ...**
4. Refer to the following sections for the specific parameter settings.

FCC Frequency Band Selection

The MP9311 can be configured for FCC operation in North America. This configuration sets the reader to operate in the 902 to 928 MHz band. Use RF Command Suite to set the following transmitter parameters:

Parameter	Setting
FCC Band	Enable
ETSI Band	Single Frequency
Listen Before Talk	Disable
Japan Band	Disable

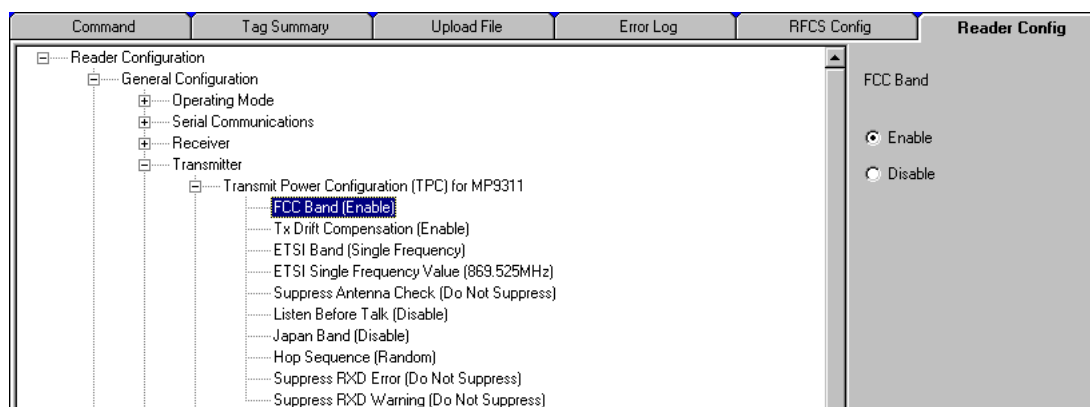


Figure 13–FCC Frequency Parameter Configuration

The following shows the CHUMP command used to set the MP9311 to FCC mode:

```
}Cw,d:TPC,b:10000!
```

Refer to Figure 17 for details on the TPC register.

ETSI Single Frequency Band Selection

The MP9311-Wxx readers can be configured to operate in one of the following ETSI single frequency bands (as defined in ERC/REC 70-03 and EN302-220).

- Annex 1 Band I - 869.525 MHz
- Annex 1 Band k - 869.850 MHz.

Set the following transmitter parameters:

Parameter	Setting
FCC Band	Disable
ETSI Band	Single Frequency
ETSI Single Frequency Value	869.525 MHz (or) 869.850 MHz
Listen Before Talk	Disable
Japan Band	Disable

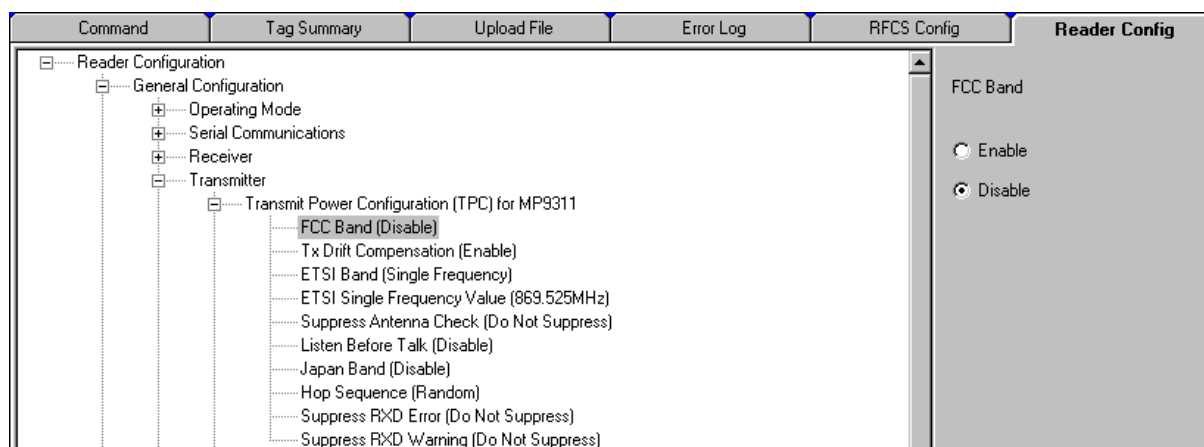


Figure 14–ETSI Single Frequency Parameter Configuration

The following shows the CHUMP command used to set the MP9311 to ETSI Single Frequency mode:

```
}Cw,d:TPC,b:0!
```

Refer to Figure 17 for details on the TPC register.

ETSI Frequency Hopping Selection

The MP9311-Wxx model readers can be configured to operate in the ETSI frequency hopping band (as defined in EN 302-208). Set the following transmitter parameters:

Parameter	Setting
FCC Band	Disable
ETSI Band	865.100–867.900 MHz
Listen Before Talk	Enable
Japan Band	Disable

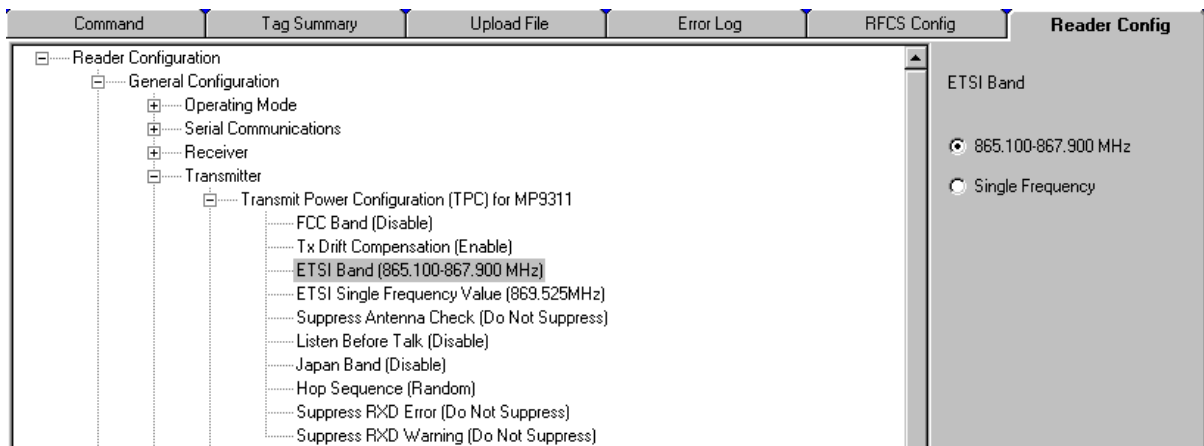


Figure 15–ETSI Frequency Hopping Parameter Configuration

The following shows the CHUMP command used to set the MP9311 to ETSI Frequency Hopping mode:

```
}Cw,d:TPC,b:0104000!
```

Refer to Figure 17 for details on the TPC register.

Japan Band Selection

The MP9311-Wxx model readers can be configured to operate in the the 952 to 955 Mhz band for use in Japan. Set the following transmitter parameters:

Parameter	Setting
FCC Band	Disable
ETSI Band	Single Frequency
Listen Before Talk	Enable
Japan Band	Enable

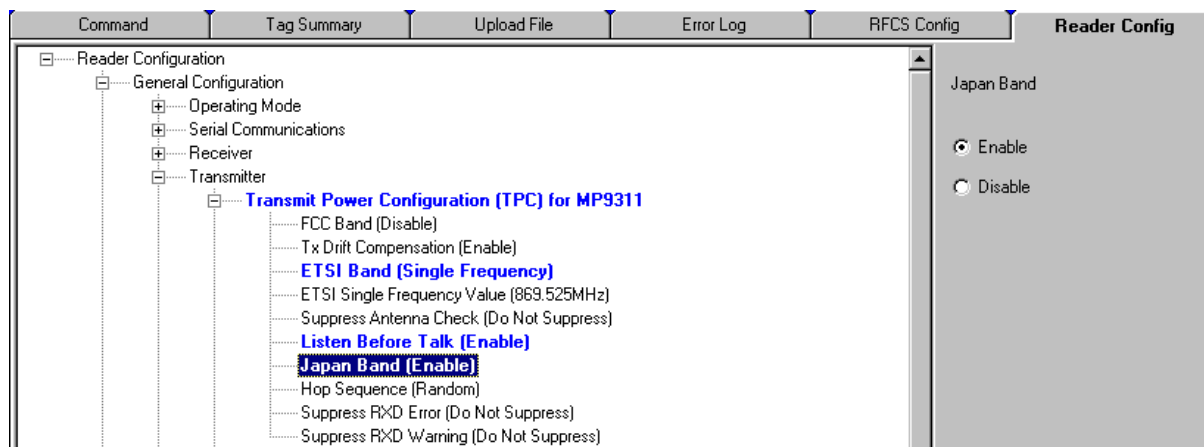


Figure 16—Japan Parameter Configuration

The following shows the CHUMP command used to set the MP9311 to Japan mode:

```
}Cw,d:TPC,b:3000000!
```

Refer to Figure 17 for details on the TPC register.

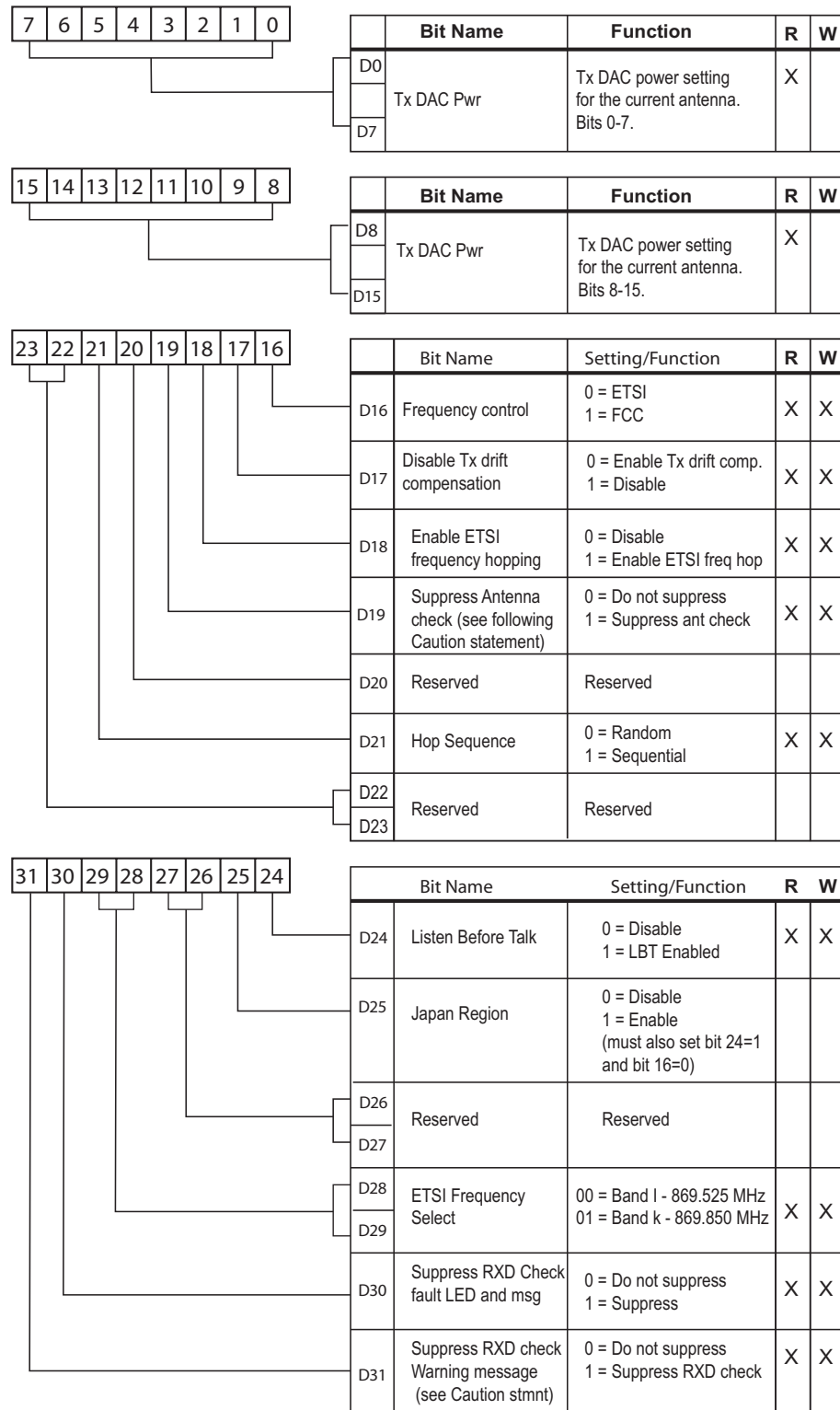


Figure 17–TPC Bit Configuration

Operation

This chapter provides general information to operate the MP9311 Low-Power UHF Reader Module. Topics discussed in this chapter include the following:

- MP9311 Power Up and Initialization
- Setting the RF Mode
- Selecting Tag Protocols
- Enabling Tag Protocols
- Configuring Specific Protocols
- Reading Tags
- Writing Blank Tags
- Modifying Tags
- Resetting the MP9311

MP9311 Power Up and Initialization

When the power supply is connected, the MP9311 starts an internal initialization sequence.

After the initialization sequence, the reader activates the RF field and, depending on the configuration, begins transmitting read detect (Rd) commands at the specified frequency.

Setting the RF Mode

The MP9311 is factory configured for continuous RF scanning or “auto-read” mode. This mode is equivalent to mode selected by the **Auto Read** function key on the RF Command Suite **Command** interface window.

If desired, you can reconfigure the reader for Polled RF mode (reader activates the transmit carrier and waits for host to send a read command). Select the **Polled Read** function key to activate Polled RF mode.

To halt the Auto Read or Polled Read mode, press the **RF Off** function key.

Selecting Tag Protocols

The MP9311 is factory configured with only those protocols selected by the user. Once protocols are activated, the **Command** tab function keys can be used to select the protocol. These function keys are programmed with specific command sequences required by the reader to select a particular protocol. To select a specific protocol, perform the following:

1. Select the **Command** interface window.
2. Select **Function Set 2** or **3** and locate the required protocol.
3. Press the function key to select the protocol.
4. To view the command sequence performed by this function, hold the mouse pointer over the key or right click while holding the mouse pointer over the key and select **Edit Macro**.
5. Do not change the command sequence unless you are experienced using SAMSys CHUMP commands to configure readers.

Enabling Tag Protocols

SAMSys readers can be configured with different tag protocols. If your reader was loaded with specific protocols at the time of purchase, these protocols can be enabled or disabled as required. To verify which protocols are enabled for your reader, select:

Reader Configuration ⇒ General Configuration ⇒ Operating Mode ⇒ Protocol Select Word

To configure the reader for a specific protocol, perform the following:

1. Select the Protocol Select Word (PSW) parameters as shown in the following:

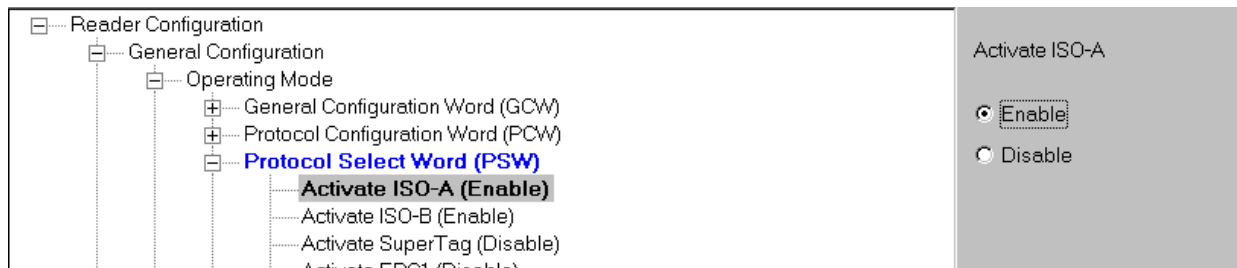


Figure 18 – Protocol Selection

2. Enable or disable a protocol by using the selectors on the right side of the display and press **Send Changes to Reader**.

Configuring Specific Protocols

Individual Protocol Configuration registers can be modified for specific tag types and read modes. For specific protocol configuration register information, refer to the *Comprehensive Heuristic Uniform Messaging Protocol (CHUMP) Reference Guide*. To configure individual protocol registers, perform the following:

1. Select the individual protocol configuration word parameters.

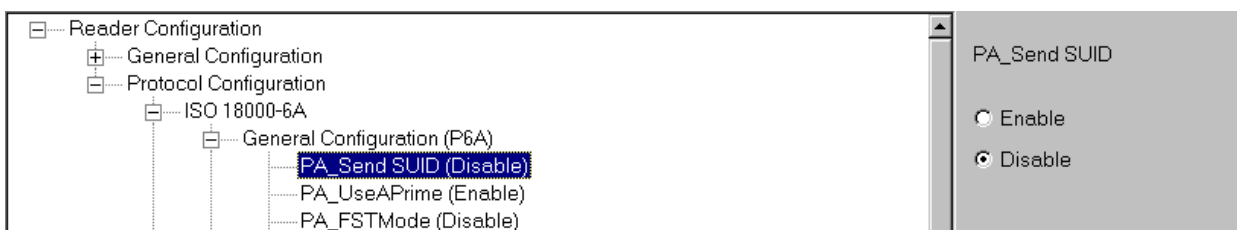


Figure 19 – Protocol Parameter Configuration

2. Enable or disable a specific protocol parameter by using the selectors on the right side of the display and press **Send Changes to Reader**.

Reading Tags

Tag Reading Overview

When the reader completes the initialization sequence, the reader activates the RF field and, depending on the configuration, begins transmitting read detect (Rd) commands at the specified frequency. When a tag is placed within range, the reader activates the tag and reads the data. The following example shows a typical Rd return message with tag data that was returned by the reader:

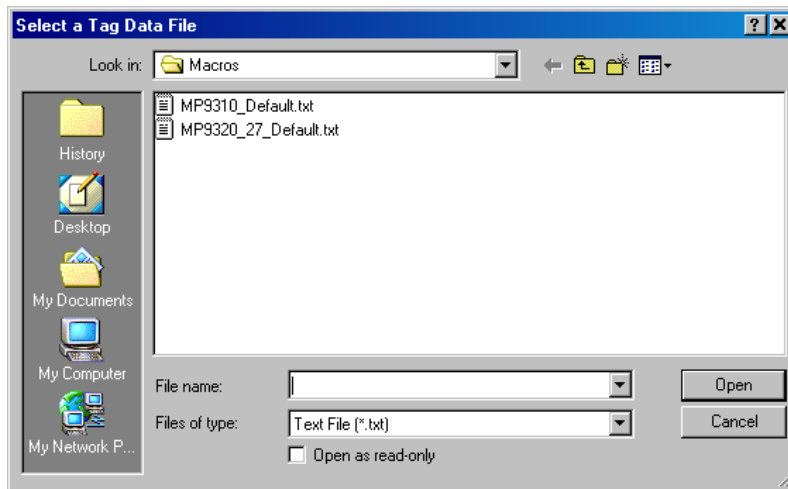
```
{Rd,d:E016000000000D53,t:IS186A;C4
```

Reading Tags Using RF Command Suite

RF Command Suite is automatically configured to display tag data as the data is received from the reader. However, tool settings can be changed to match your requirements. Refer to the following sections and the *RF Command Suite User's Guide* to configure the application.


To configure the RF Command Suite for your reader, perform the following:

1. From the tool bar pull-down menu, select **File** ⇒ **Load Macro File**.



2. Navigate to **C:\Program Files\SAMSys\RFCS\Macros** and select the **MP9310_Default.txt** file and press **Open**. This will reconfigure the function keys and other aspects of the RF Command Suite to match the MP9311.
3. In addition to the macro file, load the correct XML configuration file. Select the **Reader Config** Interface and verify the correct XML configuration file is shown in the Path to XML Configuration Definition.

C:\Program Files\SAMSys\RFCS\XML Data\MP9310.XML

4. If the path does not show the **MP9310.xml** file, press the Browse  button and choose **MP9310.xml**.

5. After selecting the correct XML configuration file, press **Open**. The file path is automatically saved.
6. Configure the reader for Auto Read. Select the **Command** interface and then select **Function Set 1**.



7. Press **Auto Read**.
8. Verify the reader is configured for the correct protocol. Select the **Command** interface and then select the radio button for **Function Set 2** or **3**.
9. After locating the protocol on the function key, press the key to activate the protocol.
10. The MP9311 is now ready to begin reading tags.

External Triggered Tag Inventory Operation

In many applications, the MP9311 can be triggered by an external device such as a proximity switch or optical sensor. In these cases, the MP9311 can be configured to generate tag inventory operations (Rd) for as long as Digital Input 0 (DIN0) is asserted. Digital Output 0 (DOUT0) can also be set to indicate that a successful tag inventory operation was performed.

NOTE: The tag inventory operation performs a process called singulation on the tag population and obtains the tag ID for those tags in the RF field.

Reader Setup

To setup the reader for external trigger, several MP9311 configuration registers must be modified. Perform the following to setup the reader for external trigger:

1. Verify you have RF Command Suite installed on your PC.
2. Start up RF Command Suite and select the **Command** interface tab.
3. Press the **Auto Read** function key (Function Set 1).
4. Place a tag in the RF field and verify the tag data is displayed on the **Tag Summary** interface.
5. Next, set the Protocol Configuration Word (PCW) to enable triggered reads on Digital Input 0 and output a read verification on Digital Output 0 (this is equivalent to setting the PCW to 0x2200).
6. On the **Reader Config** interface tab, select:

**Reader Configuration ⇒ General Configuration ⇒ Operating Mode ⇒
Protocol Configuration Word (PCW) ⇒ Digital ...**

7. Set **Digital output 0 (DOUT0) pulse on tag activity** to **Enable**.
8. Set **Digital input 0 (DIN0) gates auto read action** to **Enable**.

9. Finally, set the duration of the output pulse. On the **Reader Config** interface tab, select:

Reader Configuration ⇨ **General Configuration** ⇨ **Operating Mode** ⇨
Protocol Digital I/O Control

10. Enter a value in milliseconds.
11. Press **Send Changes to Reader** to reconfigure the reader with the news settings.

Connecting the External Trigger Circuit

12. As shown in Figure 20, apply +5 Vdc to DIN0+ (Pin 8) on SCON1.
13. To trigger a read, pull DIN0- (pin 5) Low (0 Vdc or ground) for at least 50 milliseconds.

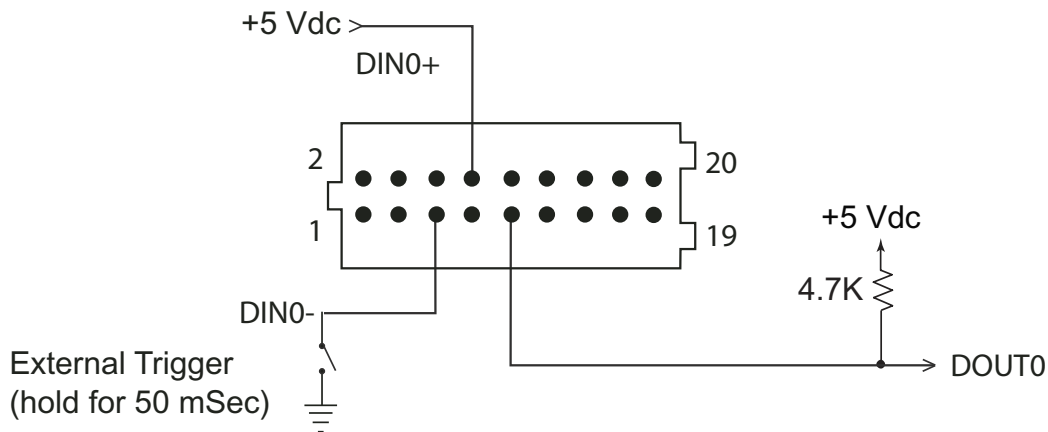


Figure 20—Typical Digital Input Trigger Circuit

14. When a tag is singulated, DOUT0 goes high for the duration set by the PIO register.

NOTE: When a tag is read, DOUT0 is asserted and stays asserted as long as tag activity continues. The pulse duration calculation is reset with each valid read. Therefore, if the pulse is still in process and a read operation is performed, the pulse will be extended by the value contained in PIO. This logic guarantees a pulse of a specific duration since the last read that occurred

Writing Blank Tags

RF Command Suite can be used to write unprogrammed or blank tags. To write blank tags, perform the following:

1. Select the **Command** interface and verify the reader is connected and the correct protocol is selected.
2. Place the reader in **Polled Read** mode.
3. Verify a single tag is in the RF field of the reader.
4. Select the **Tag Summary** interface.
5. Select the protocol from the pull-down above the **Write Blank Tag** button.

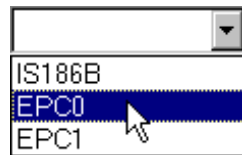



Figure 21–Select Tag Protocol

6. Press the **Write Blank Tag**  button to begin the operation and display the tag data box.

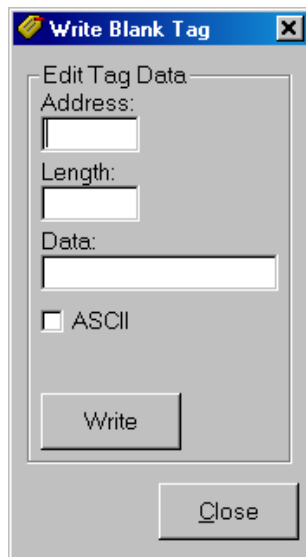



Figure 22–Write Blank Tag

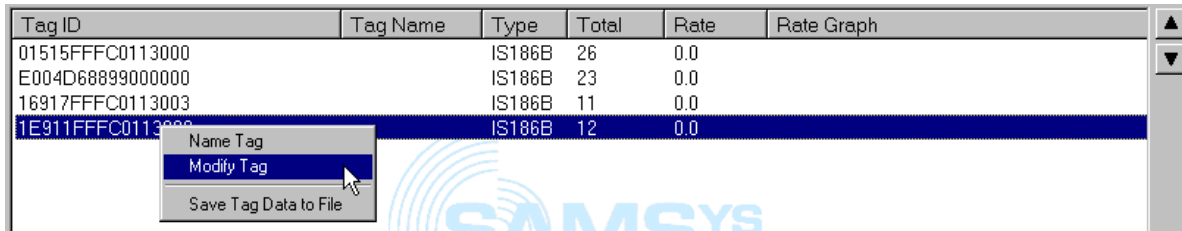
7. Fill in the appropriate data (in Hex) and press the **Write**  button to write the data to the tag.

NOTE: For detailed information on the various tag protocols and how each protocol is programmed, refer to Appendix A –Tag Programming.

Modifying Tags

(ISO 18000-6B tags only.) RF Command Suite can be used to modify previously programmed ISO 18000-6B tag data. To modify these tags, perform the following:

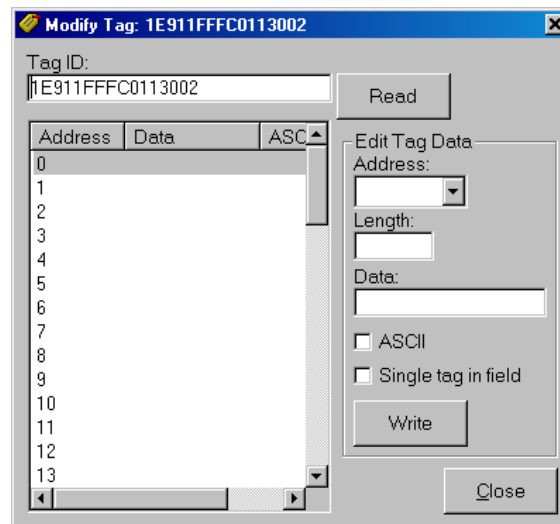
1. Select the **Tag Summary** interface and right-click on the tag.



Tag ID	Tag Name	Type	Total	Rate	Rate Graph
01515FFFC0113000		IS186B	26	0.0	
E004D68899000000		IS186B	23	0.0	
16917FFFC0113003		IS186B	11	0.0	
1E911FFFC0113002		IS186B	12	0.0	

Figure 23—Select Tag to Modify

2. Select **Modify Tag**. The tag data window is displayed.



Modify Tag: 1E911FFFC0113002

Tag ID: 1E911FFFC0113002

Read

Address	Data	ASC
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		

Edit Tag Data

Address: [Dropdown]

Length: [Text]

Data: [Text]

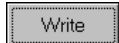
☐ ASCII

☐ Single tag in field

Write

Close

Figure 24—Modify Tag Option

3. Select the **Address** from the pull-down.
4. Enter the data **Length** and actual **Data** for the specific address
5. Select if **ASCII** data and whether or not there is a **Single tag in field**.
6. After all data and parameters are entered, press **Write** .
7. Repeat for each address.

Resetting the MP9311

To reset the MP9311, drive the reset line low for 3 ms. Refer to Chapter 5 - *Specifications* for detailed information for location of the reset pins on the system connector (SCON1).

Troubleshooting

This chapter provides general information to troubleshoot the MP9311 Low-Power UHF Reader Module. Topics discussed in this chapter include the following:

- General Troubleshooting
- Contact Us

General Troubleshooting

SAMSys readers are designed, manufactured, and tested to provide many years of trouble-free service. However, in the event of a reader malfunction or failure, refer to the following troubleshooting instructions to help identify and correct the problem.



Warning - Electric Shock Hazard

The following procedures may involve AC voltage. Use extreme caution when measuring voltage or installing cables and power supplies. Serious injury or death may occur if proper precautions are not observed.



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.

Symptom	Probable Cause	Corrective Action
Reader appears to lock up.	Readers are vulnerable to high ESD pulses. As a result, the reader can lock up.	Disconnect the power from the reader and reconnect. The reader should reset. If the reader does not function normally after reset, replace the reader.
No RS-232 Communication.	External RS-232 cable malfunction	Check cable connectors for bent or broken pins. Replace external RS-232 cable if necessary.
	Reader board failure.	Replace reader.
No Digital I/O signals present.	Reader board failure.	Replace reader.
	Incorrect wiring	Recheck digital I/O circuit as shown in Chapter 2 - <i>Installation</i> .
Tag ID/data is different from expected value.	Reader software version.	Program reader with latest software version release.
	Electromagnetic interference.	Shield or reposition reader
Tag read failure.	Read range exceeded.	Reposition reader or tag.
	Tag speed exceeded.	Slow tag when within range of reader.
	Faulty tag.	Verify reader operation with a known good tag.

Contact Us

For any questions regarding products and services, including returns, repairs, technical support, training, and all other available services, contact your distributor or SAMSys Customer Service at the following:

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

Specifications

This chapter describes the specifications for the MP9311 Low-Power Reader Module. Information provided includes the following:

- Reader Specifications
- Antenna Specifications
- Environmental Specifications
- Power and Input/Output Connector

Reader Specifications

Parameter	Value
Frequency	865 to 955 MHz
Transmit Power	0.002 to 0.6 Watt (conducted)
Transmit Power Step Size	0.1 dBm
Carrier Frequency Stability	+/- 10 ppm
Receive Sensitivity	-96 dBm
Connections	Serial (RS-232 or TTL), Digital I/O
Supply Voltage	5.0 Vdc +/-10%
Current	0.8 – 2.0 Amp maximum
Enclosure Material	Aluminum
Case Dimensions, MP9311-xRx (with cooling fins)	2.74 x 3.74 x 0.67 in (69.6 x 95.0 x 17.0 mm)
Case Dimensions, MP9311-xSx (without cooling fins)	2.74 x 3.74 x 0.57 in (69.6 x 95.0 x 14.5 mm)
Mounting holes	M4 Clearance Through Holes 2.32 x 3.32 in spacing (58.9 x 84.3 mm)
Weight (approx)	4.5 oz (127.6 g)

Notice

MP9311 readers marked PB Free, Lead Free or RoHS Compliant comply with Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

Antenna Requirements

The antennas used with this transmitter must be professionally installed in a manner which guarantees compliance with all local laws and regulations.

Antenna Parameter	North American (FCC)	European Union (ETSI)	
		302-208	300-220
Frequency	902 to 928 MHz	865 to 868 MHz	869.525 MHz
Polarization	Circular or Linear	Circular or Linear	Circular or Linear
Impedance	50 Ohms	50 Ohms	50 Ohms
SWR, maximum	1.75:1	1.75:1	1.75:1
Antenna gain	9 dBi, Max	See Note 1	See Note 2

Note 1: To comply with EN 302 208, the installer must use an antenna whose beamwidth shall be less than or equal to 90 degrees for transmit ERP levels less than or equal to 500 mW. For transmissions above 500mW and less than or equal to 2W, a minimum antenna beamwidth of 70 degrees is required.

Note 2: In accordance with local regulation.

FCC Radiation Exposure Statement



The antennas used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.

Caution



To prevent reader damage, the RF port must be properly terminated with a 50 Ohm load or a functional UHF RFID antenna before power up. Never power up the reader unless the loads or antennas are connected. Always power down the reader before removing an antenna or load from an RF port.

Environmental Specifications

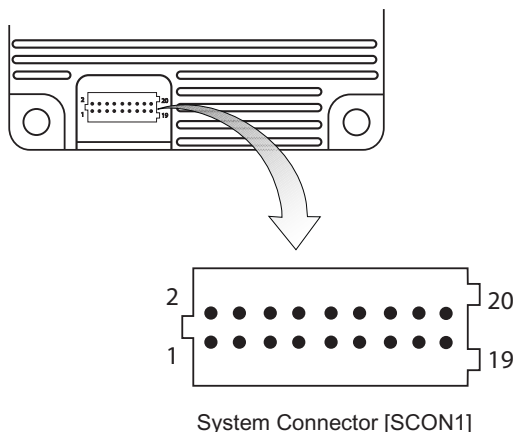
Specification	Value
Operating Temperature	-4° F to 131° F (-20° C to 55° C)
	See the following Caution statement
Storage Temperature	-40° F to 176° F (-40° C to 80° C)
Relative Humidity	5% to 80% non-condensing

Caution



The actual internal module temperature is a function of the operating conditions and end product enclosure environment. The maximum recommended module internal operating temperature is +85°C and can be monitored with host software. The embedded RFID application should be verified and monitored for compliance.

Power and Input/Output Connector



System Connector (SCON1) Specifications

Connector Type		Specification
20-Pin Dual Row		2 x 10 Header, (2x10), 1.0 mm pitch, .02 mm square pin
Pin No.	Name	Signal/Value
16, 18, 20	PWR	System Supply Voltage, 5.0 Vdc +/-10%, 2.3A Max (All inputs tied together)
3,10,12,14,17,19	GND	Ground (All grounds tied together)
Pin 1	V33	3.3 Vdc Output (<i>For factory use only.</i>)
Pin 2	PROG	Program Enable (<i>For factory use only.</i>)
Pin 4	RESET	Active Low Reset
Pin 5	DIN0-	Digital Input 0 – low input (see Note 1)
Pin 6	DIN1+	Digital Input 1 – high (reference) input (see Note 1)
Pin 7	DIN1-	Digital Input 1 – low input (see Note 1)
Pin 8	DIN0+	Digital Input 0 – high (reference) input (see Note 1)
Pin 9	DOUT0	Digital output 0, open collector to ground (50 Vdc @ 40 mA max)
Pin 11	DOUT1	Digital output 1, open collector to ground (50 Vdc @ 40 mA max)
Pin 13	TXD	Transmit
Pin 15	RXD	Receive

NOTE 1:

To activate the digital input:

$$3 \text{ Vdc} < (V_{\text{DINn+}} - V_{\text{DINn-}}) < 25 \text{ Vdc}$$

Otherwise:

$$(V_{\text{DINn+}} - V_{\text{DINn-}}) \sim 0 \text{ Vdc}$$

Tag Programming

This appendix describes how to program tags of varying protocols using CHUMP commands sent from a terminal or console.

Information provided in this appendix includes the following:

- Overview of the Tag Writing Command
- Programming the EPC1 Tag
- Programming the ISO 18000-6A Tag
- Programming the ISO 18000-6B Tag
- Programming the Impinj EPC0 Tag
- Programming the Matrics Class 0+ Tag
- Programming the EPC1, Generation 2 Tag

Overview of the Tag Writing Commands

Tag writing with SAMSys readers is performed using the Write Any (**wa**), Write Tag (**wt**), and Write Verify (**wv**) commands. **wa** must be used when writing to blank tags. **wt** is used when the tag already has a tag ID. **wv** is a multifunction command that performs any erase, write, and verification needed to program a tag in a specific protocol. This command can also lock the data. A general guideline for using each write command is as follows:

wa is used whenever the write operation affects the tag ID. **wa** can also be used for write operations to any data on a tag. This command is executed with a single tag in the RF field.

wt can only be used for write operations to a specific tag where the tag ID has already been assigned. This command can be used for write operations to any data on the tag, except the tag ID itself.

wv can be used for most protocols. However, it is typically used for EPC protocols that require multiple actions such as erasing the tag prior to writing and then locking the data.

Some tags support the ability to have a portion or all of their internal memory locked against further modification. Write operations to locked memory will not be successful. The locked status of a piece of memory can be queried via the **Y1** command. The **Y1** response is **f:0** for unlocked or **f:1** for locked.

Details of the syntax for any command found in this document can be obtained in the CHUMP Reference Guide.

Programming the EPC1 Tag

SAMSys UHF readers can be used to program 64-bit and 96-bit EPC1 tags.

Both the **Wa** and **Wv** command can be used with the EPC1 (Alien) tags. The **Wv** command is discussed at the end of this section.

Do not use **Wt** since the tag does not support singulated write operations.

Prior to writing, EPC1 tags must be erased. The **Wv** command and the **Wa** with the **f:3** option will perform the erase action during command execution. If the command specified does not erase the tag during the command execution, then specify the erase operation separately using the Tag Erase (**Ten**) command.

Also, in order to calculate the CRC, the entire tag ID must be presented to the reader in one command. EPC1 tags contain an internal CRC value which covers the EPC ID and the kill passcode. The reader always calculates the CRC and writes the correct value to the tag during the write operation. As a result, the entire tag ID and passcode must be presented to the reader in one command. The last byte of the **blk data** passed in the **Wa** command is the kill passcode. In the examples that follow, this passcode is set to **00**.

The format of the **Wa** command is as follows:

```
}Wa,a:<blk addr>,b:<blk data>[,l:<# blks>]
[,f:<control flag>]!
```

where:

a:<blk addr>. This parameter is optional since there is only a single writable piece of memory. If specified, the parameter should use block address 0x00.

l:<# blks>. This parameter reflects the number of bytes being written and should be equal to **9** if writing a 64-bit EPC ID with the kill passcode or equal to **d** if writing a 96-bit EPC ID with the kill passcode. If you are not specifying the kill code, the values should be **8** and **C**, respectively.

b:<blk data>. This parameter must contain the entire EPC ID (64- or 96-bit), followed by the one byte kill passcode. writeable

f:<control flag>. This parameter controls operations related to writing a tag. Set **f:1** to verify the data in the tag following the write operation. Set **f:2** to erase the data prior to the write operation. For most applications, set both of these bits with **f:3**.

The following is a typical command to write a 96-bit EPC1 ID tag:

```
}wa,a:0,b:80020304050607090a0b0c0e00,l:d,f:3!
```

The following is a typical command to write a 64-bit EPC1 ID tag:

```
}wa,a:0,b:800080042504600200,l:9,f:3!
```

In addition to the Wa, Te, and Tr commands, SAMSys readers also support the following EPC1 operations:

- **Lb** Lock Block
- **Yl** Query Lock Status (returns **f:0** for unlocked or **f:1** for locked)
- **Td** Tag Destroy

The Lock Block and Query Lock Status operations can only be performed with a single tag in the RF field and do not require any parameters. The Tag Destroy operation requires the **b:** parameter to specify the particular kill passcode for this tag.

For detailed information on these and other tag commands, refer to the *Comprehensive Heuristic Unified Messaging Protocol (CHUMP) Reference Guide*.

Using the Wv Command

The Wv command is a multifunction command that performs any erase, write, and verification needed to program a tag in a specific protocol. The command can also lock the data.

The format of the **Wv** command is as follows:

```
}Wv,b:<EPC data>,m:<lock mask>,k:<kill code>
```

where:

b:<EPC data> is the EPC ID to write to the tag.

k:<kill code> is the kill code to be written to the reader.

m:<lock mask> is the lock mask to indicate which tag field to lock. Each 4-bit nibble in the mask indicates the lock state to apply to a specific part of the tag. A mask nibble value of 1 locks the specific part of the tag. A mask nibble value of 0 indicates no lock is applied.

For the EPC1 protocol, the mask nibbles apply to the following fields:

Mask Nibble	4	3	2	1	0
Tag Field	Unused	Unused	Unused	Kill code	EPC data

To write an EPC ID value of 332233445566778899aabbcc and verify the write, enter:

```
}wv,b:332233445566778899aabbcc!
```

To write the EPC ID data and lock the data, enter:

```
}wv,b:332233445566778899aabbcc,m:1!
```

Programming the ISO 18000-6A Tag

Both the **Wa** and **Wt** command can be used with the ISO18000-6A tag. In addition to **Wa** and **Wt**, two additional commands can modify specific data in the tag. The **Wd** command modifies the DSFID and **Wf** modifies the AFI.

Typically, the **Wt** command is used to modify user data in the tag. The **Wt**, **Wd**, and **Wf** commands require the tag ID to be in the **d:** parameter. Also, the tag must first be put in the SELECT state using the **Ts** command with the tag ID specified in the **d:** parameter.

NOTE: *Some varieties of ISO18000-6A tags are not writeable. Check with your tag vendor to verify if your tag supports write operations.*

The format of the **Wa** command is as follows:

```
}wa,a:<blk addr>,b:<blk data>[,l:<# blks>]!
```

where:

a: <blk addr>. In ISO18000-6A, only a single block can be written at one time and this parameter represents the specific four byte block.

l: <# blks>. This parameter is optional since each write operation must contain exactly four bytes.

b: <blk data>. This parameter must contain four bytes of data.

The following is a typical command to write to an ISO18000-6A tag:

```
}wa,a:0,b:01020304!
```

For example, to write AABBCDD to address 0x20 on a tag with ID E00300001122334455667788, issue the following command:

```
}wt,d:E00300001122334455667788,a:20,b:AABBCDD!
```

In addition to the **Wa**, **Wt**, **Wd**, and **Wf** commands, SAMSys readers also support the following EPC1 operations:

- **Lb** Lock Block
- **Y1** Query Lock Status (returns **f:0** for unlocked or **f:1** for locked)

Each of these operations must specify a particular tag ID using the **d:** parameter or first be put in the SELECT state using the **Ts** command with tag ID specified in the **d:** parameter.

Programming the ISO 18000-6B Tag

In ISO18000-6B, operations are controlled by a state machine within the tag. As a result, the tag must be in the *Data Exchange* state for the write operation to succeed. To guarantee the tag is in that state, the tag must be reset using the Tag Reset **Tr** command followed by a Read Detect **Rd** command prior to performing the first write operation.

The ISO18000-6B protocol does not provide any feedback on a global write operation and the reader always provides an Ack (**A**) after the tag receives a **Wa** command. The only way to verify success is to read the data back from the tag.

An ISO18000-6B tag write operation can fail if any byte within the addressed range is locked or if the power setting is not correct. It is not uncommon for Philips and Rafsec ISO18000-6B tags to have a portion of the first eight bytes locked. Confirm the status of the specific type of tag in use.

The **Wa**, **Wt** and **Wv** commands can be used with the ISO18000-B tag. The **Wt** command is used to modify data outside of the first 8 bytes in the tag and requires specification of the tag ID using the **d:** parameter. The **Wv** command is discussed at the end of this section.

The format of the **Wa** command is as follows:

```
}Wa,a:<blk addr>,b:<blk data>[,l:<# blks>]!
```

where:

a:<blk addr>. In ISO18000-6B, this parameter provides the address of the writeable memory block. The block size is one byte.

l:<# blks>. This parameter reflects the number of blocks being written (which is equal to the number of bytes in this case).

b:<blk data>. This parameter contains the actual data being written.

The following command example command writes AABBCDD to user memory at address 0x20 on a tag with ID EF04001122334455:

```
}wt,d:EF04001122334455,a:20,b:AABBCDD,l:4!
```

In addition to the **Wa** and **Wt** commands, SAMSys readers also support the following ISO18000-6B operations:

- **Lb** Lock Block
- **Y1** Query Lock Status (returns **f:0** for unlocked or **f:1** for locked)

Each of these operations must specify a particular tag ID with the **d:** parameter and block address with the **a:** parameter.

UCODE Programming

Writing multiple bytes anywhere in the first eight bytes of a UCODE tag requires the use of the **Wa** command. Only a single tag should be present in the RF field for a **Wa** operation. The **Wa** command can be used to modify any byte in the tag.

For single byte write operations, use the **Wt** command.

The ISO18000-6B UCODE tag can emulate a 96- or 64-bit EPC ID tag by writing data to multiple locations in the tag and enabling the appropriate mode in the reader. This capability is more fully described in the *Implementation of EPC Tag Data on UCODE EPC 1.19 Application Note* from Philips Semiconductor. For detailed information on reader configuration for this tag, refer to the P6B Configuration Register description in the *SAMSys Comprehensive Heuristic Unified Messaging Protocol (CHUMP) Reference Guide*.

To configure a UCODE tag for a 96-bit EPC ID of 3114F4DA34B2D05E01010101, send a Tag Reset **Tr** command followed by a Read Detect **Rd** command. Then issue the **Wa** commands:

```
}Tr!
}Rd!
}wa,a:2,b:315E01010101,l:6!
}wa,a:10,b:14F4Da34B2D0,l:6!
```

To configure a UCODE tag for a 64-bit EPC ID of 4066771122334455, send a Tag Reset **Tr** command followed by a Read Detect **Rd** command. Then issue the **Wa** commands:

```
}Tr!
}Rd!
}wa,a:2,b:401122334455,l:6!
}wa,a:10,b:6677,l:2!
```

Using the Wv Command

The Wv command is a multifunction command that performs any erase, write, and verification needed to program a tag in a specific protocol. The command can also lock the data.

The format of the **Wv** command is as follows:

}Wv,b:<EPC data>,u:<user memory>,m:<lock mask>!

where:

b:<EPC data> is the EPC ID to write to the tag.

u:<user memory> is the user data to be written to the tag. The number of bytes varies depending on the tag.

m:<lock mask> is the lock mask to indicate which tag field to lock. Each 4-bit nibble in the mask indicates the lock state to apply to a specific part of the tag. A mask nibble value of 1 locks the specific part of the tag. A mask nibble value of 0 indicates no lock is applied.

For the ISO18000-6B protocol, the mask nibbles apply to the following fields:

Mask Nibble	4	3	2	1	0
Tag Field	User Memory	Unused	Unused	Unused	EPC data

To write an EPC ID value of 332233445566778899aabbcc and verify the write, enter:

}wv,b:332233445566778899aabbcc!

To write the EPC ID data and lock the data, enter:

}wv,b:332233445566778899aabbcc,m:1!

Programming the Impinj EPC0 Tag

In EPC0, there is no single standard for performing write operations and there are notable differences between manufacturers. Some varieties of EPC0 tags are not writeable. This section addresses writable EPC0 tags produced by Impinj.

The **Wa**, **Wt** and **Wv** commands can be used to write EPC0 tags. The **Wv** command is discussed at the end of this section.

The format of the **Wa** command is as follows:

```
}Wa,a:<blk addr>,b:<blk data>[,l:<# blks>]  
[,d:<tag ID>]!
```

where:

a:<blk addr>. This parameter provides the address of a writeable memory block. The block size is one row which is two bytes. *The Control Word (**a:1**) must be written for the desired EPC ID length.*

l:<# blks>. This parameter is required and is the number of bytes being written.

b:<blk data>. This parameter is required and contains the data to write.

d:<tag ID>. This parameter is required for the **Wt** command (optional for **Wa**) and specifies the EPC code of the tag to which the write operation applies.

Typically, the **Wt** command would be used to modify user data in the tag. The **Wt** command requires specification of the tag ID using the **d:** parameter.

In addition to the **Wt** command, the reader also supports the following operations:

- **Lb** Lock Block
- **Yl** Query Lock Status (returns **f:0** for unlocked or **f:1** for locked)
- **Td** Tag Destroy

The Lock Block and Query Lock Status operations must be performed with a single tag in the RF field and do not require any parameters. The Tag Destroy operation requires **d:** parameter to specify a particular tag ID and the **b:** parameter to specify the particular kill passcode for this tag.

For detailed information on these and other tag commands, refer to the *Comprehensive Heuristic Unified Messaging Protocol (CHUMP) Reference Guide*.

Program a 96-Bit EPC (Impinj Zuma Tags)

To write a 96-bit EPC on an Impinj Zuma EPC0 tag, enter the following:

```
}te!  
}wa,a:1,l:1,b:7!
```

Once the tag has been set to 96 bit, use a single **Wa** command for subsequent Tag ID writes:

```
}Wa,a:4,l:6,b:306c50fd76d803cf02f47f5f,f:3!
```

where:

a:4 is the start of the EPC

l:6 is the length in rows

b:xxxx is the 96-bit EPC code

f:3 is the command to calculate the CRC. The CRC is calculated and written to the row following the EPC code.

Program a 64-Bit EPC (Impinj Zuma Tags)

To write a 64-bit EPC on an Impinj Zuma EPC0 tag, enter the following:

```
}te!  
}wa,a:1,l:1,b:5!
```

Once the tag has been set to 64 bit, use a single **Wa** command for subsequent Tag ID writes:

```
}Wa, a:4,l:5,b:c80507a8009af9d71021!
```

where:

a:4 is the start of the EPC

l:5 is the length of the EPC and CRC in rows

b:xx is EPC and CRC

Program a 48-Bit Product Code (Impinj Zuma Tags)

In the following example, the 48-bit product code is written first and then the 16-bit serial number is written at a later time. To write the 48-bit product code, enter:

```
}te!  
}wa,a:1,l:1,b:4!
```

Once the tag has been set to 48 bit, use a single **Wa** command for subsequent Tag ID writes:

```
}Wa, a:4,l:3,b:c80507a8009a!
```

To write the 16-bit serial number, enter the following:

```
}Wa, a:7,l:2,b:fa6e7380!
```

Program the User Data (Impinj Zuma Tags)

To program user data on a 96-bit Impinj Zuma Tag, data is written to specific Rows (must not be locked). To write 2 rows of user data to User Row 11 and 12 (b hex), enter:

```
}wa, a:b,b:1234abcd,1:2!
```

Change the Passcode (Impinj Zuma Tags)

To change the Passcode on an Impinj Zuma Tag, enter the following:

```
}wa,a:2,1:2,b:123456!
```

where:

l must equal 2

b must be 6 digits

Using the Wv Command

The Wv command is a multifunction command that performs any erase, write, and verification needed to program a tag in a specific protocol. The command can also lock the data.

The format of the **Wv** command is as follows:

```
}Wv,b:<EPC data>,k:<kill code>,m:<lock mask>!
```

where:

b:<EPC data> is the EPC ID to write to the tag.

k:<kill code> is the kill code to be written to the reader.

m:<lock mask> is the lock mask to indicate which tag field to lock. Each 4-bit nibble in the mask indicates the lock state to apply to a specific part of the tag. A mask nibble value of 1 locks the specific part of the tag. A mask nibble value of 0 indicates no lock is applied.

For the EPC0 protocol, the mask nibbles apply to the following fields:

Mask Nibble	4	3	2	1	0
Tag Field	User Memory	Unused	Unused	Kill code	EPC data

To write an EPC ID value of 332233445566778899aabbcc and verify the write, enter:

```
}wv,b:332233445566778899aabbcc!
```

To write the EPC ID data and lock the data, enter:

```
}wv,b:332233445566778899aabbcc,m:1!
```

Programming the Matrics Class 0+ Tag

Matrics Class 0+ tags utilize a process called Singulation. This is a process of uniquely identifying a tag in a population of tags and retrieving its Electronic Product Code (EPC). For detailed information on EPC Class 0 singulation, refer to the EPC Global Class 0 specification.

When a tag is requested to identify itself, it responds with different data based on its singulation mode. Class 0 and Class 0+ tags allow three modes of singulation:

- ID2 - This mode responds directly with the EPC. ID2 is the fastest mode (fewest bits transmitted), but requires the reader to echo the bits back to the tag. This echo can create security issues. Also, this mode can not be read when writing the EPC, since the echo will change the EPC as you write it.
- ID0 - This mode returns packets of 12 random bits that are different every time you singulate. When the reader has what it determine is the correct number, it writes the EPC. This mode is the only reliable method of singulation during writing the tag EPC.
- ID1 - This mode is the same as ID0, but every singulation returns the same bit stream. The bits are random, but they are seeded from the EPC. Writing the EPC changes these bits.

The singulation mode is controlled with the PE0 register and must be set prior to writing tags.

Matrics Class 0+ tags contain three writable pages or memory blocks: These pages are as follows:

- Page 0 – Kill code (24 bits)
- Page 2 – EPC code (64 or 96 bits)
- Page 3 – User data (104 bits)

When Page 2 or Page 3 data is written, a 16-bit CRC is appended.

The **Wa**, **Wt** and **Wv** commands can be used to write Matrics Class 0+ tags. The **Wv** command is discussed at the end of this section.

The format of the **Wa** command is as follows:

```
}Wa,a:<blk addr>,b:<blk data>[,l:<# blks>]  
[,d:<tag ID>]!
```

where:

a:<blk addr>. This represents the memory page of the tag on which the write operation will occur. Values can be 0, 2 or 3, as defined previously. If this parameter is missing, it will default to 0.

l:<# blks>. This parameter is required and is the number of bytes being written.

b:<blk data>. This parameter is required and contains the data to write.

d:<tag ID>. This parameter is required for the **Wt** command (optional for **Wa**) and specifies the EPC code of the tag to which the write operation applies.

Writing Initial EPC Code to Blank Matrics EPC0+ Tags

To write the EPC code to blank tags, ID0 singulation must be used.

If ID2 traversal is to be inhibited on subsequent tags, set the traversal inhibit bit in PE0. Once written, those tags will not singulate using ID2 unless the EPC code is erased and then rewritten with traversal inhibit cleared.

Once a valid EPC code is written to Page 2, it cannot be overwritten unless the tag is first erased. Tag write operations using ID0 singulation cannot distinguish if a tag has previously been singulated.

Each ID0 singulation will use a new random number. To prevent a single tag from continually being selected for EPC code writing, an error code is returned if the tag already has a valid EPC code and an overwrite is blocked.

As stated earlier, the mode must be set prior to writing tags. A typical value for the TM0 register is b:0. A typical value for the PE0 register for writing blank tags is b:12050180. This value sets PE0 for the following:

- Use ID0 singulation with 2 blocks of random bits
- Retry count set to 5 (set to a 1 speeds up the write process with only 1 retry)
- Scroll first turned on
- Autolength EPC enabled (set the right most digits to **04** for 64 bit and to **08** for 96 bit)

To write the PE0 register, enter the following: **}Cw,d:PE0,b:12050180!**

To sense a tag with a valid CRC and an EPC = all 00's, write b:1a050180 to the PE0 register. The last 4 digits displayed are the CRC. You should attempt to get good read rates before trying to write to the tags.

Use the "f:2" so you don't get an e:55 for trying to overwrite a valid EPC (make sure there is only 1 tag in the field). If you are only writing the EPC code, there is no need to do a "te", since the write command process with the f:2 always erases the memory

To write a 96-bit EPC code to a blank tag you may need to set the PE0 register to b:1a050108, and enter the following:

}Wa,a:2,b:312233445566778899aabbcc,l:c,f:2!

NOTE: *Writing to tags is very sensitive to the following:*

- *RF power (Generally need more power to write than to read tags)*
- *Tag spacing from the antenna (Need to get enough power coupled into the tag)*
- *Orientation of the tags*

Writing a Kill Code and User Data

Kill codes and user data can be written to any tag in the field in the same manner as the EPC code method described above, but typically a kill code and user data would be associated with a specific EPC code. Once written, you cannot read back the kill code.

To write a Kill Code, enter the following:

```
}Wa,a:0,b:112233,l:3!
```

To write to a specific tag, enter the EPC code as the d: parameter. The following write command would write the Kill code and singulates using ID2, so PE0 singulation bits are ignored:

```
}Wt,a:0,d:22000000000000000000003,b:112233,l:3!
```

Writing User Data

To write user data to Page 3 on any tag, enter the following (overwrites any current data):

```
}wa,a:3,d:112233445566778899AABBCC,l:c!
```

To write user data to page 3 of a specific tag, enter the EPC code as the d: parameter (singulates using ID2, so PE0 singulation bits ignored):

```
}Wt,a:3,d:30112233445566778899aabb,b:00112233445566778899  
aabbcc,l:d!
```

Tag Erase

To erase a Matrics 0+ tag, use the Tag Erase **Te** command. Only one tag should be in the field when executing this command. **All** memory pages are filled with 0's and a 16-bit CRC is appended.

After erasing, the EPC code page will be filled with 0's. Also, the user data page will have all 0's with a 16 bit CRC appended at the end. This allows the user data page to be read with the **Ra** command. However, the EPC code page will return an error on **Ra**, since there is no valid CRC. If any page is locked, then the **Te** command will fail and none of the pages will be erased.

To erase a tag, enter the following:

```
}Te!
```


Locking Tags

Individual memory pages can be locked with the **Lb** command. Once a page is locked, it cannot be unlocked or written. The following are typical Lock commands.

To lock Page 0 (Kill code of any tag singulated using PE0 bits), enter:

```
}Lb!
```

To lock Page 2 (Kill code of any tag singulated using PE0 bits), enter:

```
}Lb,a:2! (locks page 2, the EPC code of any tag singulated using PE0 bits)
```

To lock Page 3 (User data with specific EPC code), enter:

```
}Lb,a:3,d:220000000000000000000003!
```

Using the Wv Command

The **Wv** command is a multifunction command that performs any erase, write, and verification needed to program a tag in a specific protocol. The command can also lock the data.

The format of the **Wv** command is as follows:

```
}Wv,b:<EPC data>,k:<kill code>,m:<lock mask>!
```

where:

b:<EPC data> is the EPC ID to write to the tag.

k:<kill code> is the kill code to be written to the reader.

m:<lock mask> is the lock mask to indicate which tag field to lock. Each 4-bit nibble in the mask indicates the lock state to apply to a specific part of the tag. A mask nibble value of 1 locks the specific part of the tag. A mask nibble value of 0 indicates no lock is applied.

For the EPC0 protocol, the mask nibbles apply to the following fields:

Mask Nibble	4	3	2	1	0
Tag Field	Unused	Unused	Unused	Kill code	EPC data

To write an EPC ID value of 332233445566778899aabbcc and verify the write, enter:

```
}wv,b:332233445566778899aabbcc!
```

To write the EPC ID data and lock the data, enter:

```
}wv,b:332233445566778899aabbcc,m:1!
```

Programming the EPC1, Generation 2 Tag

EPC Class1, Generation 2 (Gen2) tags can be programmed by the SAMSys UHF readers.

EPC1, Gen2 tags support 4 different writable memory banks with each memory bank consisting of a series of 16 bit words. Each word can be written independently and one word is the smallest size write operation supported. In most cases, these memory banks have predefined contents and functions. The memory banks are as follows:

- Access Memory (bank 0)
- EPC Memory (bank 1)
- TID Memory (bank 2)
- User Memory (bank 3)

Access Memory

The Access Memory bank contains the 32 bit Kill Password and the 32 bit Access Password. The Kill Password is at offset 0 and the Access Password is at offset 2.

EPC Memory

The EPC Memory bank contains a CRC-16, the Protocol Control bits, and the actual EPC ID. The CRC-16 is at offset 0, the Protocol Control is at offset 1, and the EPC ID begins at offset 2.

The Gen2 tag generates the CRC-16 at power up while the Protocol Control bits. The EPC ID must be set by a RFID interrogator. The Protocol Control bits must be set initially on a blank tag prior to, or in conjunction with, writing the EPC ID. Once these bits are set, multiple writes can occur to the EPC ID.

NOTE: *After writing the EPC ID, a tag will respond but the CRC will be invalid since the tag only generates the CRC on power up. Therefore, the tag must be reset via a RF Off/On cycle following the write and prior to new tag inventory attempts. If the reader is being operated with GCW = 0, this reset is not needed since the RF field is automatically turned off at the completion of the write command.*

TID Memory

The TID Memory bank contains an 8 bit ISO/IEC 15963 allocation class identifier (the value of 111000010b is used for EPC Global). This identifier is located in the lower half of the word at offset 0. A tag may contain manufacturer specific data at offset 2 and above.

User Memory

The User Memory bank contains user specific data and its memory organization is user defined.

Writing the Tag

Three CHUMP commands can be used to write to an EPC1, Gen2 tag: **Wa**, **Wt**, and **Wv**. **Wa** writes to any tag in the field and is typically used to write the EPC ID to tag. **Wt** writes to a specific tag, as defined in the input parameter list, and is typically used to write to user data on a tag. **Wv** is a multifunction command that erases, writes, and verifies a tag.

Using the Wa Command

The format of the **Wa** command is as follows:

```
}wa,a:<blk addr>,b:<blk data>[,l:<# blks>][,s:<offset>]  
[,f:<xxx>]!
```

where:

a: <blk addr> is the block address (0 by default). For EPC1, Gen2
0=Reserved, 1=EPC, 2=TID, 3=USER memory bank

b: <blk data> is the block data to write. Must be 16-word multiple.

l: <# blks> is the length in 16-bit words. Defaults to length of data if missing.

s: <offset> is the offset to start the write (EPC1, Gen2 only). Defaults to 0 if.

f: <xxx> is protocol specific flag data. Set f=1 for read back/verify. EPC1, Gen2 tags provide SUCCESS/FAIL feedback. Defaults to 0.

To write an EPC ID value of 332233445566778899aabbcc onto a tag with the Protocol Control field set for a 96 bit tag, enter:

```
}wa,a:1,s:2,b:332233445566778899aabbcc!
```

To add the length field, enter:

```
}wa,a:1,s:2,b:332233445566778899aabbcc,l:6!
```

To request a read/verify cycle following the write operation, enter:

```
}wa,a:1,s:2,b:332233445566778899aabbcc,l:6,f:1!
```

In order to write an EPC ID to a blank tag, the Protocol Control bits must also be set. This can be accomplished in a single write command since the Protocol Control bits are contained in the same memory bank as the EPC ID. Following the previous example, the command would include setting the Protocol Control to 3000 as follows:

```
}wa,a:1,s:1,b:3000332233445566778899aabbcc!
```

The Kill and Access Passwords are contained in the Reserved Memory bank. Each password can be written with separate **Wa** commands or a single command:

To write a 32-bit Access password at offset 2, enter:

```
}wa,a:0,s:2,b:55667788!
```

To write both Access passwords with a single command, enter:

```
}wa,a:0,b:3322334455667788!
```

Using the Wt Command

The **Wt** command can also be used to write the Kill and Access passwords and the TID and User Memory banks. The **Wt** command requires the use of the EPC ID of the tag.

The format of the **Wt** command is as follows:

```
}Wt, b:<data> ,d:<tag id> a:<block address >[,l:<length>]  
[,s:<offset>][, f:<flags>]!
```

where:

a:<block address> is the block address (0 by default). For EPC1, Gen2
0=Reserved,1=EPC, 2=TID, 3=USER memory bank

b:<blk data> is the block data to write. Must be 16-word multiple.

d:<tag ID> is the tag identification.

l:<# blks> is the length in 16-bit words. Defaults to length of data if missing.

s:<offset> is the offset to start write (EPC1, Gen2 only). Defaults to 0 if missing.

f:<xxx> is protocol specific flag data. Set f=1 for read back/verify. EPC1, Gen2
tags provide SUCCESS/FAIL feedback. Defaults to 0.

To write the Kill password to a tag with EPC ID= 332233445566778899aabbcc, enter:

```
}wt,d:332233445566778899aabbcc,a:0,b:33223344!
```

Using the Wv Command

The Wv command is a multifunction command that performs any erase, write, and verification needed to program a tag in a specific protocol. The command can also lock the data.

The format of the **Wv** command is as follows:

```
}Wv,b:<EPC data>,k:<kill code>,c:<access code>,  
i:<TID data>,u:<user memory>,m:<lock mask>!
```

where:

b: <EPC data> is the EPC ID to write to the tag.

k: <kill code> is the kill code to be written to the reader.

c: <access code> is the access code to be written to the tag.

i: <TID data> is the TID data to be written to the tag. The number of bytes varies depending on the tag.

u: <user memory> is the user data to be written to the tag. The number of bytes varies depending on the tag.

m: <lock mask> is the lock mask to indicate which tag field to lock. Each 4-bit nibble in the mask indicates the lock state to apply to a specific part of the tag. A mask nibble value of 1 locks the specific part of the tag. A mask nibble value of 0 indicates no lock is applied. For the EPC1-2, the low order bit of each nibble indicates if the permalock bit should be set, and the next higher bit indicates if the pwd-write bit should be set.

For the EPC1-2 protocol, the mask nibbles apply to the following fields:

Mask Nibble	4	3	2	1	0
Tag Field	User memory	TID data	Access code	Kill code	EPC data

To write an EPC ID value of 332233445566778899aabbcc and verify the write, enter:

```
}wv,b:332233445566778899aabbcc!
```

To write the EPC data, a kill code of A391742F, an access code of 73D97412, and lock the EPC data and access code, enter:

```
}wv,b:30112233445566778899aabb,k:A391742F,c:73D97412,m:00202!
```

In this example, the lock mask of **m:00202** = 0010 0000 0010b and indicates that a pwd-lock is requested for nibble 2 (access code) and a pwd-lock is requested for nibble 0 (EPC data).



SAMSys Technologies, Inc.

Part Number: MP9311-01-UG-V2.0
Printed in U.S.A.