SkyeModule™ M9 Reference Guide
Version 080527

SkyeTek, Inc.
11030 Circle Point Rd., ste. 300
Westminster, CO 80020
U.S.A.

Copyright Information

Technical Support and Contact Information

SkyeTek, Inc.

11030 Circle Point Road, Suite 300
Westminster, CO 80020

http://www.skyetek.com

Sales:

sales@skyetek.com

Technical Support:

http://support.skyetek.com

Table of Contents

List of Figures

List of Tables

Chapter 1

SkyeModule M9 Overview

The M9 is the world's smallest multi-protocol ETSI 302 208 compliant UHF (862 - 955 Mhz) RFID reader platform that supports a variety of UHF RFID tags. The SkyeModule M9 can read and write to transponders based on the EPC Class1 Gen1, ISO 18000-6B and ISO 18000-6C (EPC C1G2/Gen2) air interface and communications standards. The RF output power of the M9 is software-adjustable from 10-500 mW. The M9 has been tested for regulatory compliance for the world's major markets including North America, Europe (ETSI 302 208) and Korea. The M9 is RoHS compliant.

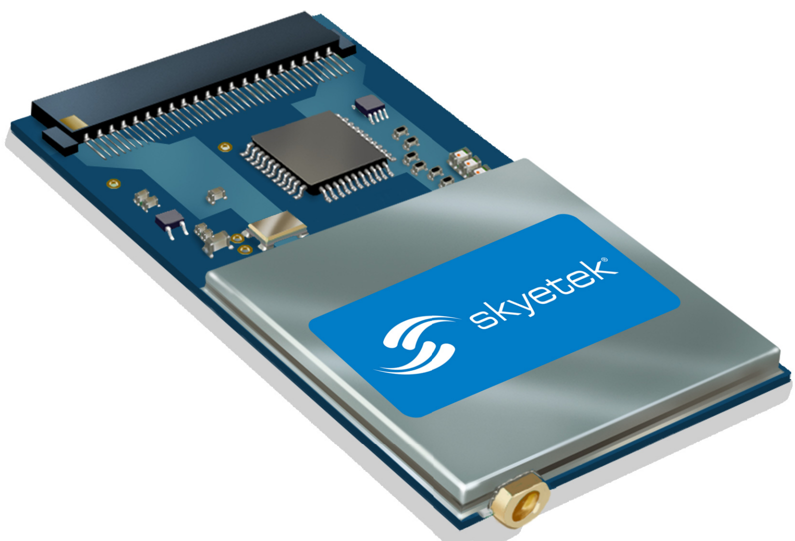


Figure 1-1 SkyeModule M9-CF

Features

Designed for item-level tagging, consumables, handhelds, and label printers, the SkyeModule M9 offers the following features:

- Common communications protocol—All SkyeTek readers use the SkyeTek Protocol v3 (STPv3) to drive low level communications. SkyeTek APIs built on top of STPv3 provide methods for exercising readers and reading tags.

- Multiple communications interfaces: TTL Serial, SPI, I^2C, and native USB for connection to a host PC with or without a serial port. These options are software-selectable to support both loosely and tightly coupled integrations. The SkyeModule M9 also has seven programmable GPIO pins for I/O connections to peripherals.
- The SkyeModule M9 is optimized to support a communication rate of 40/80 kbps. A standard 50 Ω antenna output enables use of an external antenna to optimize the read range/rate.
- Serial data rates are adjustable from 9.6 to 115.2 kbps. Field-upgradable firmware provides forward compatibility for adding future tag protocols, security features, and customized enhancements.

SkyeWare™ Software

All SkyeModule M9 developer kits ship with the SkyeWare 4 software package for Microsoft® Windows® to aid your RFID development process. This package includes

- **Setup Wizard—** This Wizard guides you through the setup, configuration, and testing of your new SkyeModule reader. It takes you through all the steps necessary for connecting your hardware, running diagnostic tests, and optimizing your reader configuration. It concludes with useful links to additional SkyeTek software and documentation.
- **Demonstration functions**– This utility offers a quick way to perform high-level demonstrations of the basic functionality of the SkyeModule M9. You can test read range, anti-collision (singulation) capabilities, and use inventory selection and memory functions.
- **Configuration** – You can easily view and change reader configuration parameters, adjust radio settings, configure tags, and update or change firmware.
- **Test Software** – The test utility provides a GUI interface for constructing the SkyeTek Protocol v3 commands in either ASCII or binary format, based on tag type and selected flags. You can build and test low-level SkyeTek protocol commands and use all the features of the reader at the protocol level. It is an excellent way to learn more about SkyeTek Protocol v3 commands. For more information, see the *SkyeTek Development Kit User Guide*.
- **APIs** – SkyeTek offers C and .NET APIs so that you can easily create interfaces between your programming language and any SkyeTek reader modules that communicate using SkyeTek Protocol v3. The APIs provide a rich assortment of functions that allows complete access to and manipulation of your SkyeModule M9. Refer to the *SkyeTek C and .NET API Reference Guide*, installed in the Documentation folder installed with SkyeWare.

Mechanical Specifications

The SkyeModule M9 has Mounting Hole (MH) and CompactFlash (CF) variants.

- See Appendix C, on page C-119 for specifications for previous versions of the M9.

Mounting Hole Variant

Figure 2-1 on page 2-14 shows the dimensions of the MH variant.

Outside dimensions: 53.0 mm x 70.0 mm = 3710 mm^2

Height: 7.7 mm

Mounting holes: 3.0 mm diameter
45.0 mm center-to-center (width)
40.0 mm center-to-center (length)

Clearance:Approx. 2.5 mm between edge of mounting hole and edge of printed circuit board (PCB) (width/side-to-side direction)

Approx. 13.2 mm between edge of mounting hole and front of PCB (main connector side)

Approx. 14.0 mm between the edge of mounting hole and back of PCB (antenna connector side)

Weight17.0 grams

Note – All drawing dimensions are in millimeters. Production units may vary slightly from the measurements given.

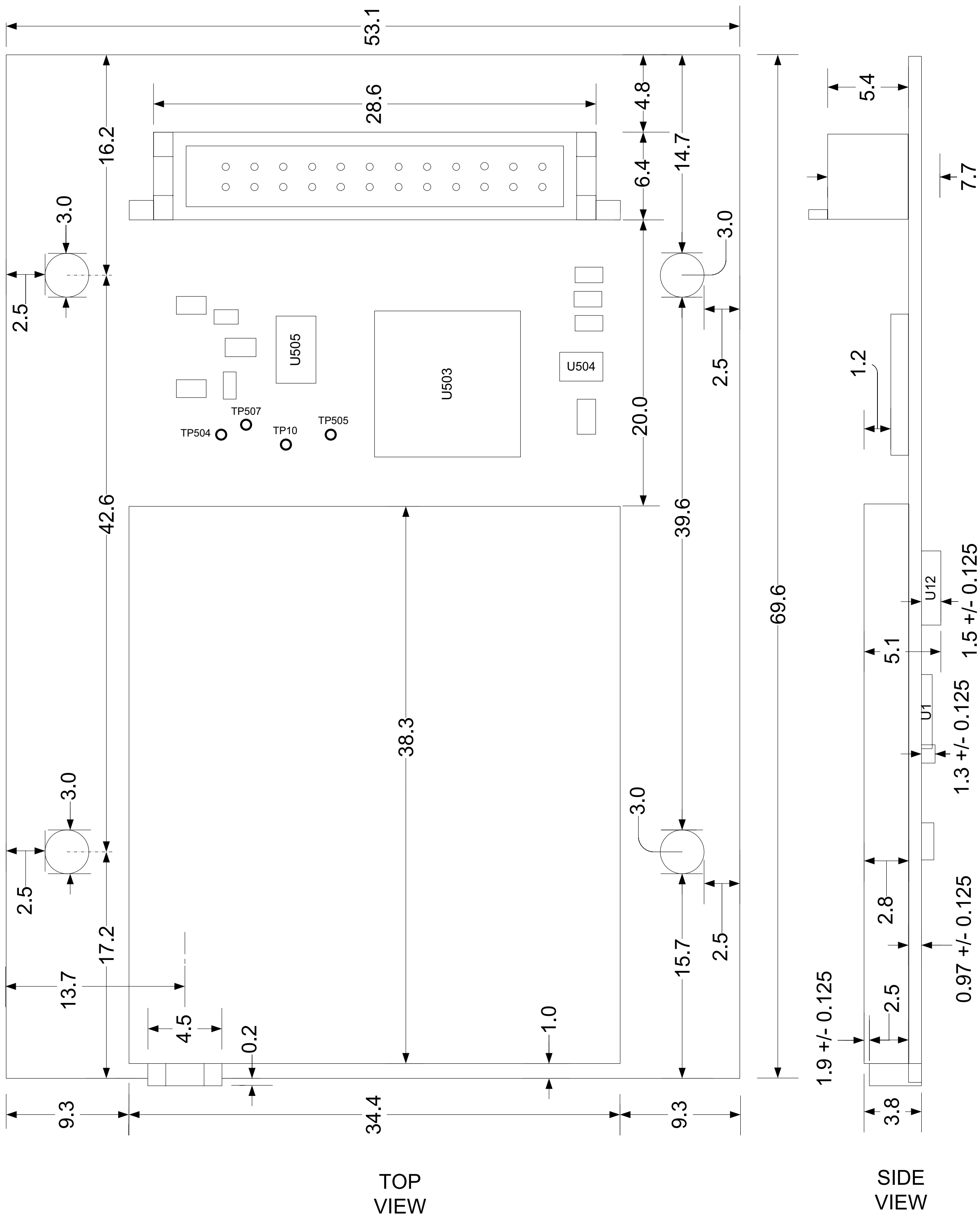


Figure 2-1 SkyeModule M9 Dimensions (MH variant)

Compact Flash Variant

Figure 2-2 on page 2-16 shows the dimensions of the compact flash (CF) variant.

Dimensions: 66.1 mm x 32.5 mm = 2148.25 mm^2

Height: 6.35 mm

Weight14.2 grams

Note – All drawing dimensions are in millimeters. Production units may vary slightly from the measurements given.

Connector Specifications

Table 2-1 SkyeModule M9 Connector Specifications

SkyeModule Type	Connector Type	Manufacturer	Manufacturer's Part Number
M9-CF	Compact flash type II (receptacle on module)	Molex	67799-0011
	CF counterpart to connect to module	Molex	67155-0002
M9-MH	Surface-mount protected header (receptacle on module)	Hirose	DF11Z-24DP-2V
	MH counterpart to connect to module	Hirose	DF11Z-24DS-2V

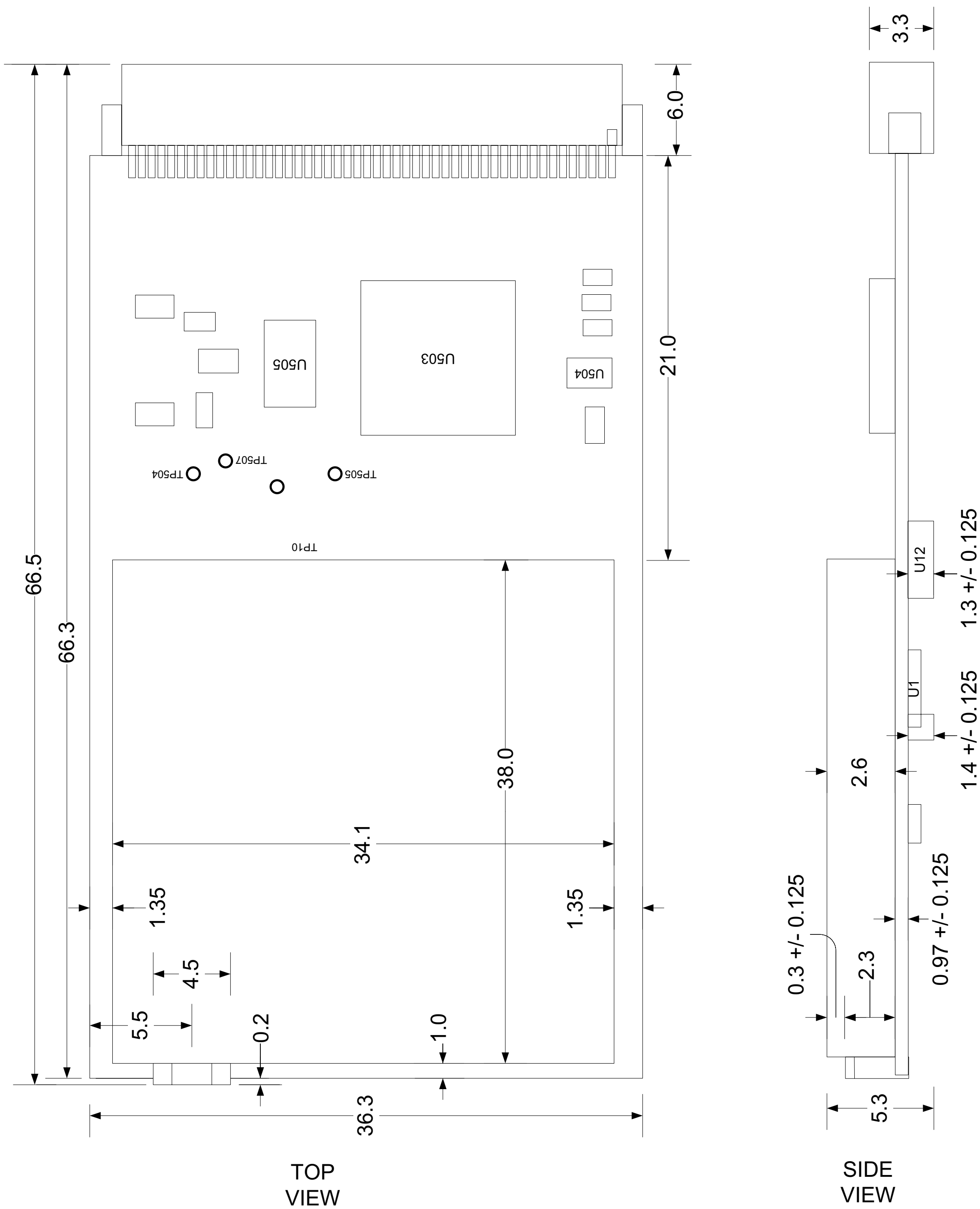


Figure 2-2 SkyeModule M9 Dimensions (CF Variant)

Chapter 3

Environmental Specifications

Note – See Appendix C, on page C-119 for specifications for previous versions of the M9.

Electrostatic Precautions

CAUTION – Failure to take proper electrostatic precautions may result in damage to or failure of your SkyeModule M9.

The SkyeModule M9 contains static-sensitive parts. Observe the following precautions to prevent damage to these parts.

- Wear a static grounding strap when handling electronic control components.
- Keep all plastic, vinyl, and styrofoam (except antistatic versions) away from printed circuit boards.
- Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.

General Ratings and Operating Conditions

Table 3-1 Environmental Ratings/Operating Conditions

Specification	**Rating**
Temperature range	Temperature is 25 degrees Celsius unless otherwise noted
Operating	-20 to +70 degrees C
Storage	-30 to +85 degrees C
Humidity	
Operating, continuous storage	10-90 percent (non-condensing)
Transient storage (<24 hours)	5-95 percent maximum (non-condensing)
ESD protection	< 1kV (ESD HBM 15500 Ω , 100pF) *—or—* 100V (ESD MM 0.75uH, 200pF)

Electrical Specifications

This chapter discusses the electrical specifications of the SkyeModule M9. Unless otherwise noted the following assumptions apply to these specifications:

- Temperature is 25 degrees Celsius.
- Frequency is 915.0 MHz.
- Supply voltage (VCC) is 5 V.

The SkyeModule M9 works under normal duty cycles at full output power without the need for external fans, additional heat sinks, etc., under the operating conditions described in these specifications.

Note – See "Electrostatic Precautions" on page 17 for electrical safety information.

Table 4-1 SkyeModule M9 Electrical Specifications

Specification	Min	Typical	Max	Units/Notes
Logic Inputs				
High state input voltage	2			V
Low state input voltage			0.8	V
Input Current (I_{INH}/I_{INL})		4	25	mA

Table 4-1 SkyeModule M9 Electrical Specifications

Specification	Min	Typical	Max	Units/Notes
Logic Outputs				
Output High Voltage (V_{OH})	2.9			V
Output Low Voltage (V_{OL})			0.4	V
Output Current (I_{INH}/I_{INL})		4	25	mA
Power Supplies				
Voltage Supply	3.5	5.0	5.5	V
Peak Transmit Current Consumption				
10 dBm	200		300	mA
21 dBm	200		500	mA
24 dBm	200		650	mA
27 dBm	200		800	mA
Low Power Sleep Mode		5		mA

Absolute Maximum Ratings

Temperature is 25 degrees Celsius unless otherwise noted.

Table 4-2 Absolute Maximum Ratings/Operating Conditions

Specification	Rating
Maximum input voltage, high (V_{INH})	5.5 V
V_{SUPPLY} to GND	5.5 V
Digital I/O voltage to GND	5.5 V
Antenna VSWR characteristic	2:1 or better, as desirable for optimum performance

Chapter 5

Host Interface Specification

The following sections describe the power and host communication connections for the SkyeModule M9.

Host to Reader Interfaces

The SkyeModule M9 supports the following microcontroller host interfaces for easy integration into existing systems:

- TTL (RS-232 can be supported with additional circuitry)
- SPI
- I^{2}C
- USB

The SkyeModule M9, when used with a host interface board, supports RS-232 and USB communications. The host interface board provides a USB connector and a TTL-to-RS-232-level converter for the TTL host interface. Each interface is software-selectable and only one host interface is active at a time. The host interface is selected based on the power-up default value and can be changed at run time using the Host Interface Type system parameter. The SkyeModule M9 operates under host control using SkyeTek Protocol v3 sent over one of the host interfaces described in this chapter.

Note – SkyeModule M9s shipped with the SkyeTek Development Kit are preset to use USB communications and a power level of 20 dBm.

TTL

A two-wire serial connection (no handshaking) is provided on the TXD and RXD lines where TXD and RXD are from the module's point of view. Data exchange between the host and the SkyeModule M9 occurs according to SkyeTek Protocol v3 (ASCII or Binary mode). Figure 5-1 shows examples of typical communication.

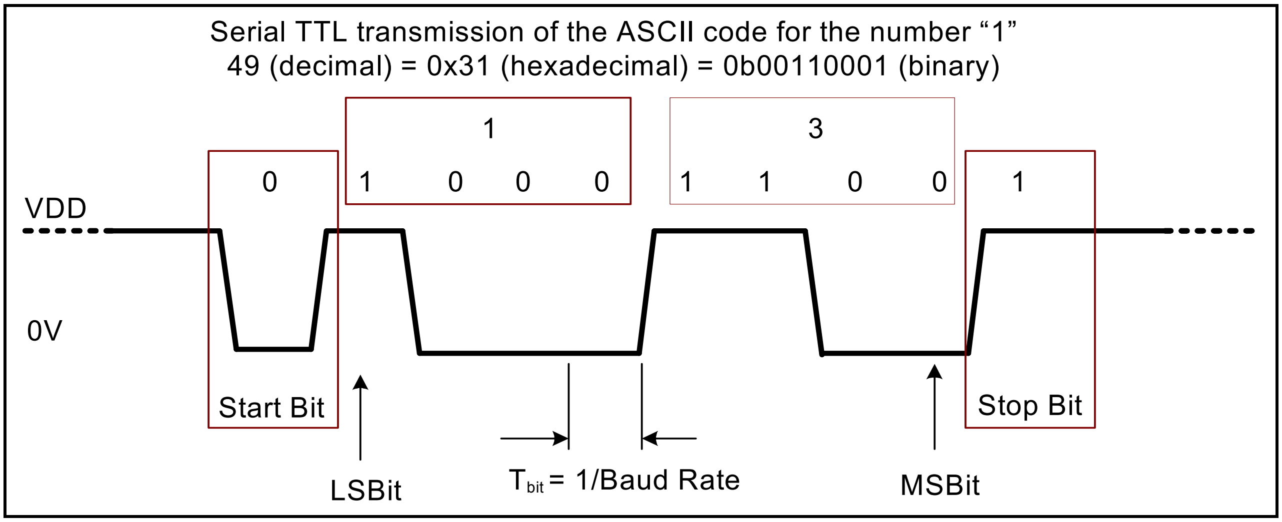


Figure 5-1 TTL Interface

- Baud rate is selectable via the appropriate system parameter. Pre-programmed factory default baud rate is 38,400 Baud, N, 8, 1 (no parity bit, 8 data bits, 1 stop bit).
- Bytes are transmitted least-significant bit (LSB) first using the typical serial data format of *Start Bit* followed by *8 data bits* followed by a *Stop Bit*.
- The TTL connection supports bit rates from 9,600 to 115,200 baud, 8 data bits, no parity, 1 stop bit.
- The option to add hardware flow control is not supported in this release.
- Host to reader interface shall be RS-232 TTL level (non-inverted).
- TTL low = 0 to 0.8V; TTL high = 2.0 to 5V.

Converting TTL and RS-232

Figure 5-2 shows a sample circuit that lets you connect the SkyeModule M9 without the host interface board.

CAUTION – Be sure to connect both of the supply voltage and both of the ground lines to allow sufficient current draw. Failure to do so could cause damage or failure of the host or the SkyeModule M9.

Note – You may need to add an additional bypass capacitor to reduce signal noise, depending on the system in which the circuit is used.

Note – SkyeTek recommends that the power supply for the circuit provides 1A of current to ensure proper operation.

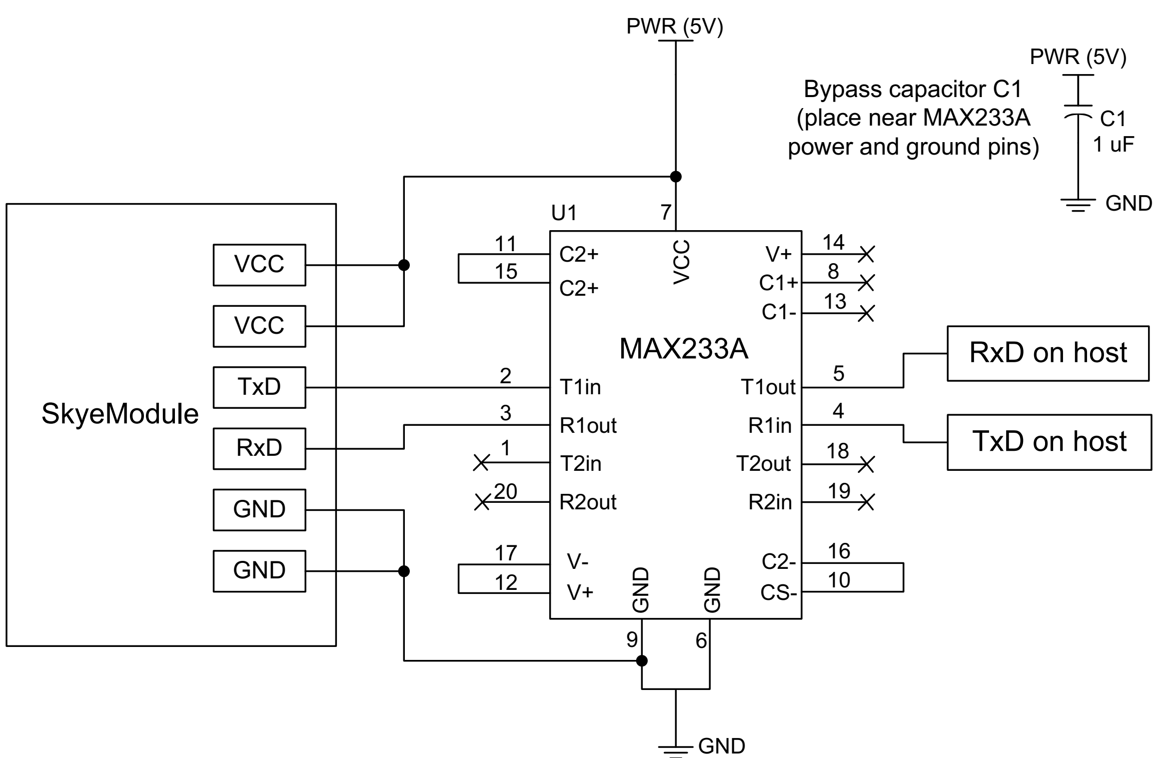


Figure 5-2 TTL and RS-232 Conversion Interface

SPI

The SkyeModule M9 provides a simple three-wire SPI host interface. Figure 5-3 shows examples of host interface connections.

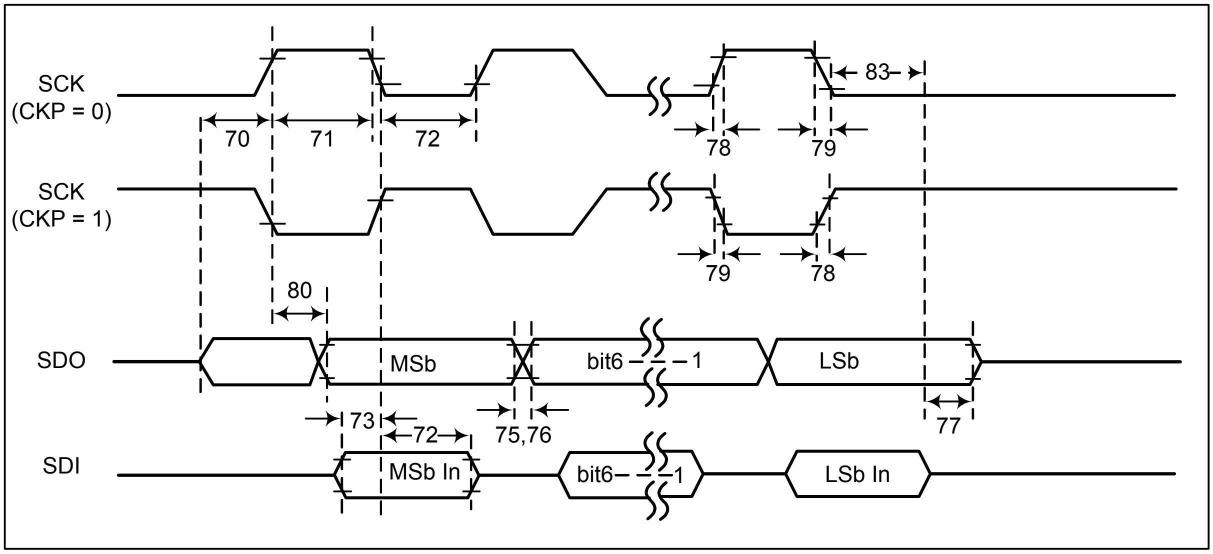


Figure 5-3 SPI Interface

- The M9 SPI interface communicates in Mode 1 (clock polarity is zero and clock phase is one).
- The host must implement SPI master functionality.
- The data packet exchange between the host (SPI Master) and the M9 (SPI Slave) uses SkyeTek Protocol v3 (Binary Mode only).
- The SCK line should be the master clock controlled by the host.
- Data is transmitted on the falling edge of SCK.
- The MOSI signal provides data from the host to the SkyeModule M9.
- For the request data on the MOSI line, the host software should keep the SSEL pin at steady state low.
- The MISO signal provides data from SkyeModule M9 to host.
- To retrieve data on the MISO line, the SSEL (Slave Select) signal must toggle low-high-low between clocked-back bytes.
- The SPI connection is capable of a 4 MHz data rate.
- A ready signal indicates the reader has data for the host—in loop or inventory modes.
- Low = 0 to 0.8 V; High = 2.0 to 5 V.

I^2C

The SkyeModule M9 supports the I^2C standard for connecting to a host controller. Figure 5-3 shows the I^2C host interface connections.

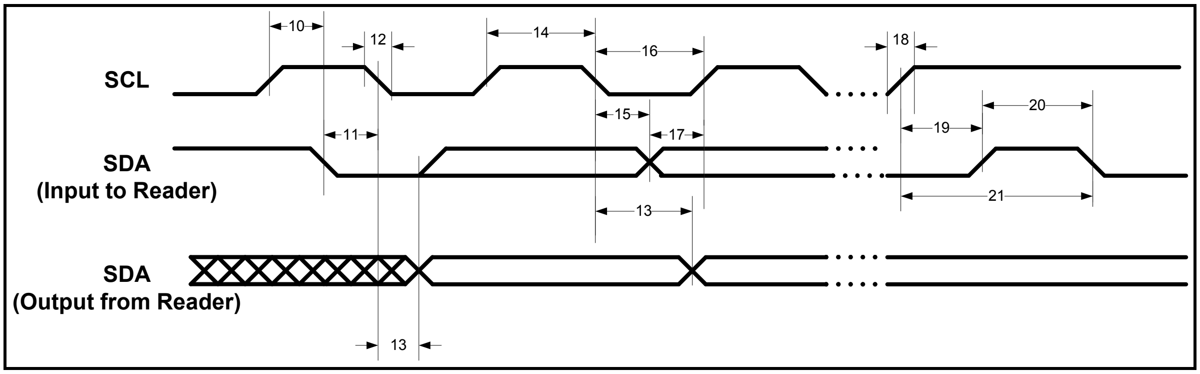


Figure 5-4 I^2C host interface

- The SkyeModule M9 requires the host to operate as a master (i.e., the M9 operates as an I^2C slave device).
- The SPI interface uses a standard two-wire connection in which SCL is the master clock and SDA is a bidirectional serial data line.
- Data exchange between the host and the SkyeModule M9 uses SkyeTek Protocol v3 (Binary Mode only).
- I^2C fast mode (400 kHz) is supported, as is the slower 100kHz data rate.
- A ready signal (GPIO 0) indicates when the reader has data for the host in loop or inventory modes.
- The data is sent and received MSB first.
- I^2C pull-up resistors are on the reader side.
- Low = 0 to 0.8V; High = 2.0 to 5V.
- Address is 0x07.
- The communication scheme from host to module is as follows:
  a. Initiate a start condition (SDA transitions low, and then SCL transitions low).
  b. Send the nine bits of the initial start packet as follows:
     1. Send the 7-bit address.
     2. Send the read/write bit as the eighth bit (0 for writing from the host to the slave).
     3. Send the ninth bit as the “acknowledge” bit (ACK), which is automatically handled.

     If the reader recognizes the address, it pulls SDA low.

c. Use the bus to clock each byte of the Skyetek protocol request.

d. After sending the request, initiate a stop condition. (SCL transitions high, and then SDA transitions high.)

Note – You may need to include from one to a few hundred milliseconds of delay. The delay may vary for tag-specific commands.

- Communication scheme from module to host is as follows:

  a. Initiate a start condition. (SDA transitions low, and then SCL transitions low.)

  b. Send the 7-bit address.

  c. Send the read/write bit as the eighth bit (1 for reading from the slave to the host).

  If the reader recognizes the address, it pulls SDA low for the ACK bit.

  d. Clock each byte of the Skyetek protocol response from the module.

  e. After receiving the response, is received, initiate a stop condition. (SCL transitions high, and then SDA transitions high.)

USB 2.0

- The SkyeModule M9 is seen by the host as a USB device.
- The SkyeModule M9 is USB 2.0 High Speed compliant.

Note – When the SkyeModule M9 is USB-bus powered, maximum transmit power should not exceed 20 dBm. SkyeModule M9s shipped with the SkyeTek Development Kit are preset to use USB communications and a power level of 20 dBm.

Bypassing the Host Interface Board

Figure 5-5 shows an example of a circuit to permit USB communications without using the host interface board.

CAUTION – Make sure the SkyeModule M9's power is turned down to at least 20 dBm to prevent damage to the host USB port.

Note – You may need to add an additional bypass capacitor to reduce signal noise, depending on the system in which the circuit is used.

Note – SkyeTek recommends that the power supply for the circuit provides 1A of current to ensure proper operation.

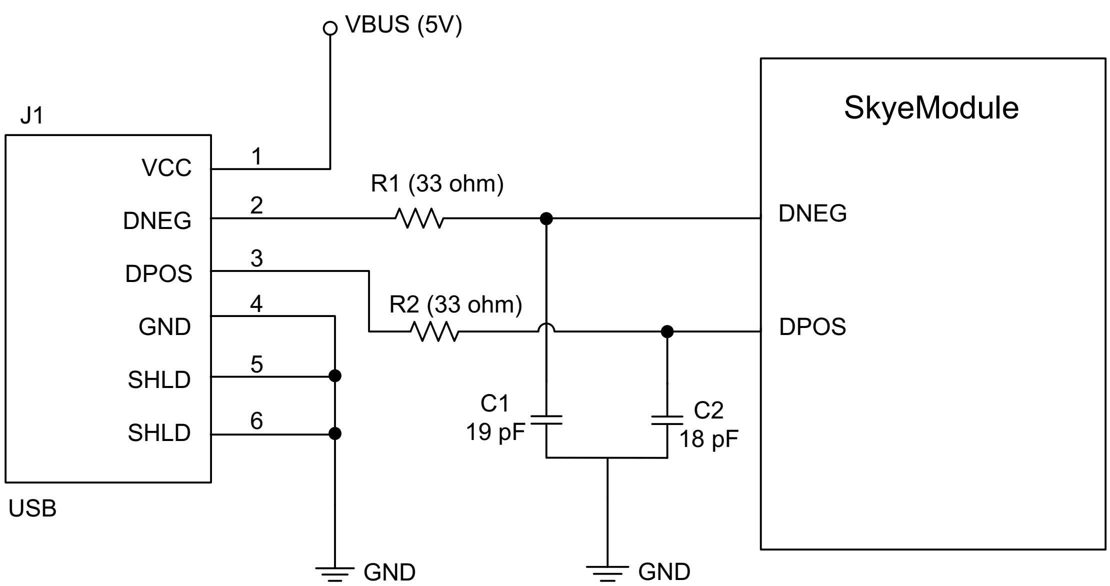


Figure 5-5 Circuit to Bypass Host Interface Board for USB Support

Connecting to the M9

Pin Mapping of the SkyeModule M9-MH Variant

The SkyeModule M9-MH host connector is a standard 24-pin male header connector. Figure 5-6 shows the pinout locations for the connector, and Table 5-1 lists the connector pin mapping.

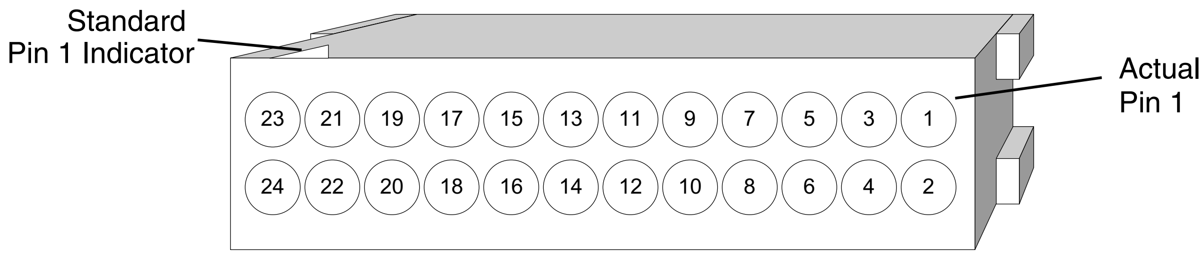


Figure 5-6 M9-MH Connector Pinouts

Note – The standard Pin 1 indicator does *not* correspond to the actual Pin 1 location on the connector. Pin 1 is located on the same side of the connector as the indicator but on the opposite end of the row of pins. (Figure 5-6).

Table 5-1 SkyeModule M9-MH Pinout

Pin	Name	Description	Pin	Name	Description
1	TXD_ISP	SkyeTek debug	13	DPOS	USB positive
2	SSEL	SkyeTek debug	14	CTS_SCL_HOST	SkyeTek debug
3	RXD_ISP	SkyeTek debug	15	VCC	Supply voltage
4	SCK	SPI clock	16	GND	Ground
5	RESET_N	SkyeTek debug	17	GPIO3_MUX	General-purpose I/O, control LED at U502
6	MOSI	SPI master-out, slave-in	18	RTS	SkyeTek debug
7	NC	Not connected	19	GPIO2_7816_IO	General-purpose I/O
8	MISO	SPI master-in, slave-out	20	CTS_SCL_HOST	SkyeTek debug
9	VCC	Supply voltage	21	GPIO1_7816_CLK	General-purpose I/O
10	GND	Ground	22	TXD	UART transmit
11	DNEG	USB negative	23	GPIO0_7816_RST	General-purpose I/O
12	SDA	SkyeTek debug	24	RXD	UART receive

CAUTION – If you perform custom integration work on your SkyeModule M9, make sure that you connect all available power and ground pins. Failure to do will reduce read range and could cause failure of the module. Pins listed as not connected can be left floating.

Pin Mapping of the SkyeModule M9-CF Variant

The SkyeModule M9-CF host connector is a standard 50-pin CF female connector. Figure 5-7 shows the connector pinout, and Table 5-2 lists the connector pin mappings.

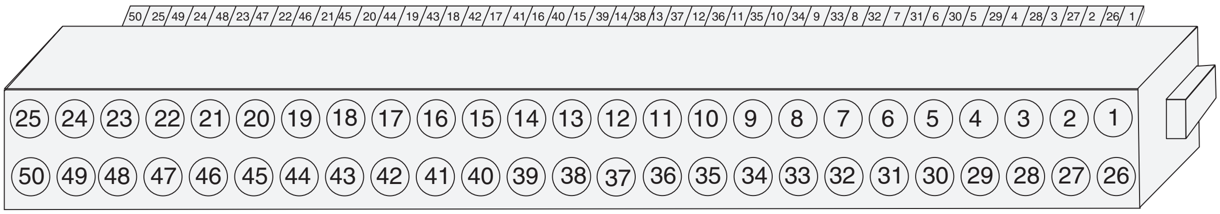
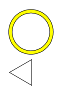


Figure 5-7 M9-CF Connector Pinout



Pin 1 is located to the left of a hole and arrow on the top of the M9-CF board (Figure 5-8).

Figure 5-8 Hole and Arrow for Locating Pin 1

Table 5-2 SkyeModule M9-CF Connector Pinout

Pin	Name	Description	Pin	Name	Description
1	GND	Ground	26	GND	Ground
2	VCC	Supply voltage	27	GND	Ground
3	VCC	Supply voltage	28	CTS_SCL_HOST	I^2C SCL
4	DPOS	USB positive	29	SDA_HOST	I^2C SDA
5	DNEG	USB negative	30	NC	Not connected
6	GND	Ground	31	NC	Not connected
7	MISO	SPI master-in, slave-out	32	GPIO0_7816_RST	General-purpose I/O
8	MOSI	Master-out, slave-in for SPI	33	GPIO1_7816_CLK	General-purpose I/O
9	SSEL	Slave select for SPI	34	GPIO2_7816_IO	General-purpose I/O
10	SCK	SPI clock	35	TXD_ISP	SkyeTek debug
11	SCL_EEPROM	SkyeTek debug	36	RXD_ISP	SkyeTek debug
12	SDA_EEPROM	SkyeTek debug	37	NC	Not connected
13	NC	Not connected	38	NC	Not connected
14	RXD	UART receive	39	NC	Not connected
15	TXD	UART transmit	40	READY_N	SkyeTek debug
16	CTS_SCL_HOST	UART CTS	41	RESET_N	SkyeTek debug
17	RTS	SkyeTek debug	42	NC	Not connected
18	NC	Not connected	43	GPIO3_MUX_EN	General-purpose I/O
19	TRST_N	SkyeTek debug	44	GPIO4_MUX_CNTRL2	General-purpose I/O
20	RTCK	SkyeTek debug	45	GPIO5_MUX_CNTRL1	General-purpose I/O
21	TMS	SkyeTek debug	46	GPIO6_MUX_CNTRL0	General-purpose I/O
22	TCK	SkyeTek debug	47	NC	Not connected
23	TDI	SkyeTek debug	48	NC	Not connected
24	TDO	SkyeTek debug	49	GND	Ground
25	GND	Ground	50	NC	Not connected

CAUTION – If you perform custom integration work on your SkyeModule M9, make sure that you connect all available power and ground pins. Failure to do will reduce read range and could cause failure of the module. Pins listed as not connected can be left floating.

Using the GPIO Pins

You can use the User Port Direction and User Port Value system parameters to address the GPIO pins to set the user port direction (input or output) and the user port value (high or low). For more information, see the following:

- "User Port Direction" on page 60
- "User Port Value" on page 61

Note – GPIO 3 is not available for user I/O; it is connected to the on-board amber LED, which indicates when a successful tag command occurs.

Chapter 6

Radio Specifications and Regional Compliance

RF Radio Power

To minimize power consumption for systems that have lower power requirements, the RF transmit power of the SkyeModule M9 is user configurable from 10-27 dBm in steps of 0.1 dB with an accuracy of +/-1 dB across a temperature range of -20 to +70 degrees Celsius. The resolution steps are smaller than the accuracy so that you can fine tune the power level to lower current consumption. See Chapter 10, for information on how to change the RF power level.

Frequency Range

The M9 is a multi-frequency device that operates in the 862-955 MHz range, which span the world's major UHF RFID bands. See “Adjusting System Parameters” below for information on changing operating frequency and region of operation of the M9.

Tag Protocols

The SkyeModule M9 supports the basic tag commands (identify, read, and write) for the following tag protocols:

- EPC C1G1
- EPC C1G2 (ISO18000-6C)
- ISO 18000-6B

Note – For the most current listing of supported tags and features, see the Tag Support list included in the documentation folder installed from your distribution CD or on the SkyeTek Support Portal.

Recommended Radio Settings for Regional Compliance

The following settings are recommended to assist you in obtaining regulatory certification.

Table 6-1 Recommended Reader Settings for Regional Compliances

Region	Spectral Mask Settings (SkyeModule M9 System Parameters)								Tag Types Supported[a]
	Start Freq. (MHz)	Current (Center) Freq. (MHz)	Stop Freq. (MHz)	Output Power (conducted) (dBm)	Hop Channel Spacing (KHz)	Modulation Depth (%)	Frequency Hopping Sequence	Regulatory Mode	
Australia/New Zealand	918.3	922.0	925.7	25	200	100	0x01	0x00	all
Europe	865.7	866.7	867.9	25	200	30	0x00	0x01	ISO 18000-6B
Europe	865.7	866.7	867.9	25[b]	200	80	0x00	0x01	ISO 18000-6C (Gen2)
Hong Kong	920.3	920.5	924.7	27	200	100	0x01	0x00	all
Korea	910.3	912.0	913.7	27	200	100	0x01	0x04	all
North America	902.3	915.0	927.7	27	200	100	0x01	0x00	all
Singapore	920.5	922.5	924.7	27	200	100	0x01	0x00	all
Taiwan	922.3	925.0	927.7	27	200	100	0x01	0x00	all

a. For the most current listing of supported tags and features, see the Tag Support list included in the documentation folder installed from your distribution CD or on the SkyeTek Support Portal.

b. With firmware version1DA and hardware version 3.0. This setting is 22 dBm for previous hardware/firmware versions.

Adjusting System Parameters

The SkyeModule M9 provides an adjustable system parameter for each spectral mask settings required to comply with the regions listed in Table 6-1. See "Customizing System Parameters" on page 51 for additional information on setting the system parameters.

Radio Test Modes

For regulatory testing, the SkyeModule M9 now has a special system parameter that lets you set various test modes such as:

- Leaving the carrier on constantly, with or without closed loop power control
- Disabling listen before talk (LBT) to better view the regulatory spectrum.
- Combining these test modes to best suit your test needs.

Please contact SkyeTek technical support for more information.

Regional Regulations

The SkyeModule M9 has been tested at a certified testing laboratory for agency compliance with the regulations shown in the table below. All module testing is done as a pre-scan for each regulation. SkyeTek has not obtained any official agency certifications for the SkyeModule M9.

Table 6-2 SkyeModule M9 Agency Compliance

Region	Agency	Approvals	Publications/Regulations
North America	FCC	Part 15 standards	
Europe	ETSI	EN 301-489	"Electromagnetic and Radio Spectrum matters (ERM); Electromagnetic Compatibility (EMC); standard for radio equipment and services; Part 1: Common technical requirements"
		EN 61000-4-3	"Radio Frequency Electromagnetic Field"
		EN 302-208	"Electromagnetic Compatibility and Radio Spectrum Matters (ERM): Radio Frequency Identification equipment operating in the band 865 MHz with power levels up to 2 W: Part 2 Harmonized EN under article 3.2 of the R&TTE directive"
Taiwan		LP002	"Low Power Radio Frequency devices"
Hong Kong		HKTA 1049	"Performance Specification for Radio Frequency Identification (RFID) Equipment Operating in the 865-868 and/or 920-925 MHz bands"
Korea	Radio Research Laboratory	Notification No. 2005-50	"Technical Requirements for the Radio Equipment for Other Services than Broadcasting, Maritime, Aeronautical and Telecommunications Service"
Singapore		IDA TS SRD	
Australia		AS/NZS 4268:2003	"Radio equipment and systems – Short range devices – Limits and methods of measurement"

Radio Specifications

Specification	Min	Typical	Max	Units/Notes
RF Characteristics				
Frequency ranges (Direct output)	862.000	915.000	955.000	MHz
Hop channel spacing	100	200	300	KHz
Transmission Parameters				
Transmit Power	10	12	20/27*	dBm (See "Recommended Radio Settings for Regional Compliance" on page 32 for maximum power ratings under different regulatory environments.) * When the SkyeModule M9 is USB-bus powered, maximum transmit power should not exceed 20 dBm. SkyeModule M9s shipped with the SkyeTek Development Kit are preset to use USB communications at a 20 dBm power level.
Transmit Power Variation vs. Temperature		+/- 1		dB (Temperature range is -10 C to +55 C.)
Transmit Power Variation vs. VCC		+/- 1		dB (VCC is from 3.5-5 V)
Transmit Power Flatness vs. Frequency		+/- 1		dB (Frequency range is from 862-955 MHz)
Optimum PA Load Impedance		50		Ohms
Receiver Parameters				
Sensitivity at 40 kbps	45	50	55	dBm (at transmit power of 27 dBm and measured from 860-960 MHz)
Sensitivity at 80 kbps	40	45	50	dBm (at transmit power of 27 dBm and measured from 860-960 MHz)

Chapter 7

Antenna Options

The SkyeModule M9 supports any 50 Ohm antenna tuned to the correct frequency range. Read range is highly dependent on antenna selection, tag selection, and operating environment.

Read range depends on your specific settings, including:

- Environment (to maximize accuracy for testing, SkyeTek recommends that you use an outdoor free-space test)
- Antenna gain: a higher-gain antenna provides a longer read range. However, this longer range is achieved through a smaller beam width, which in turn reduces the size of the read field, affecting read reliability.
- Antenna cable length: antenna-cable gain/loss is approximately -0.49 dB/meter (-0.15 dB/foot) for a standard RG58 coaxial cable.
- RF power: maximum RF power is 27 dBm.
- Frequency hopping settings (depends on antenna)
- Antenna polarization
- Tag orientation
- Tag type, manufacturer, and individual tag
- Tag mounting surface
- Tag dynamics (speed, moving, rotating)

Note – The MMCX antenna connector for the M9 allows quick connections but can let a loose antenna cable rotate, yaw, or pitch in the connector socket if you do not secure the cable. Cable motion increases the VSWR to the radio receiver and degrades performance. Make sure that you provide strain relief for the antenna cable to prevent any motion or mechanical stress at the MMCX connector.

Chapter 8

Software Interface Specifications

Host Communication – SkyeTek Protocol v3

The SkyeModule M9 operates under host control according to SkyeTek Protocol v3. For more information about this protocol, including commands, flags, request and response formats, please see the *SkyeTek Protocol v3 Reference Guide*.

The basic command and response format is illustrated below.

Table 8-1 Request Format (bytes), ASCII Mode

Flags	Cmd.	RID	Tag Type	TID Len.	TID	AFI	Addr.	# of Blks.	Data Len.	Data	CRC
4	4	8	4	4	32 (max)	2	4	4	4	2K	4

Table 8-2 Request Format (bytes), Binary Mode

Msg. Len.	Flags	Cmd.	RID	Tag Type	TID Len.	TID	AFI	Addr .	# of Blks.	Data Len.	Data	CRC
2	2	2	4	2	1	16 (max)	1	2	2	2	1K	2

	Required fields (must be present at all times)
	Optional fields (depending on the command and flags)
	Required fields, depending on the command

Table 8-3 Response Format (bytes), ASCII Mode

Response Code	RID	Tag Type	Data Length	Response Data	CRC
4	8	4	4	2K	4

Table 8-4 Response Format (bytes), Binary Mode

Message Length	Response Code	RID	Tag Type	Data Length	Response Data	CRC
2	2	4	2	2	1K	2

(dark grey)	Required fields (must be present at all times)
(light grey)	Optional fields (depending on the command and flags)
(white)	Required fields, depending on the command

Chapter 9

Using Secure Memory

Note – Use of Secure Memory features requires a specific version of the SkyeModule M9 firmware. Please contact your SkyeTek sales representative to obtain the correct firmware.

As part of the Readerware™ Security Suite, the Secure Memory feature uses the SkyeModule M9's firmware to add cryptographic functionality to RFID tags that do not ordinarily have built-in security. Specifically, Secure Memory allows data written to RFID tags to be signed, encrypted, or both. The M9 supports several encryption ciphers (DES, 3DES, and AES) and several cryptographic hash functions (SHA, MD5, and SHA-224/256/384/512) to sign or verify the integrity and authenticity of a message.

When using Secure Memory, the M9 treats the entire tag memory as secure; user-accessible blocks are not needed. The M9 stores algorithm information, initialization vectors, and ciphertext on the tag.

Signing lets you verify data authenticity and integrity. When signing, the reader appends a hash to either plaintext or ciphertext and stores it on the tag along with other header information. By computing the hash using the known shared key and the plaintext and by checking the result against the appended hash, the you can confirm that the message was generated by an authorized user or determine that the tag data on the tag was tampered with or altered during transmission.

Encryption lets you hide plaintext data as ciphertext, obscuring information that is sent over the air or stored on a tag. Only authorized users with the proper key can decode the ciphertext.

This chapter provides examples of using Secure Memory commands. Please contact SkyeTek for more information about the Readerware Security Suite.

Using Secure Memory Commands

Secure Memory is implemented by issuing a Setup Secure Memory or Initialize Secure Memory commands, described in this chapter.

Once enabled, all security operations are handled transparently for the following commands:

- Read Tag Data
- Write Tag Data
- Get Tag Info

There are two major modes of operation:

- **Data Integrity mode.** In this mode, there is no encryption, but the reader verifies data integrity. When writing data to a tag, the reader automatically computes a secure hash for the data. The reader writes the data and a hash message authentication code (HMAC) to the tag. When reading the data back from the tag, the reader verifies that the HMAC matches the data that it initially wrote to the tag. If the HMAC does not match, this indicates the data has been corrupted or tampered with, and the reader returns a fail message to the host.
- **Encryption and Data Integrity mode.** In this mode, the reader verifies the data integrity (as in Data Integrity mode) *and* encrypts the data. The reader then writes the encrypted data and HMAC to the tag. When reading the data back from the tag, the reader verifies that the HMAC matches the data that it initially wrote to the tag, deciphers the data, and reports the plaintext data to the host. If the data has been altered, the reader returns a fail message to the host.

Other Secure Memory notes:

- You must use the HMAC (data integrity) and Encryption flags with these commands after you begin using Secure Memory.
- Secure Memory automatically reformats the tag for secure use. Thus, block 0 in Secure Memory mode does not correspond to block 0 in the physical tag memory. The Initialize Secure Memory command automatically reserves a number of blocks at the beginning of the tag for algorithm and key information. The command also resizes the tag memory, provides a new user memory size for the tag, and then initializes the user memory area to 0s. For example, if you write to block 0 in Data Integrity mode, you cannot read back the plaintext data from the tag's physical block 0 location.
- If you try to read the contents of a Secure Memory tag that has been initialized and written in Encryption and Data Integrity mode with a reader that is *not* in Secure Memory mode, you will read the encrypted text or the initialization information, depending on which block you read from.

- If you read the contents of a Secure Memory tag that has been initialized and written in Encryption and Data Integrity mode with a reader that *is* in Secure memory mode, you can read the plaintext data (as long as the tag has not been tampered with or the data altered).
- Read and write commands are used to read and write to Secure Memory once a Secure Memory session has been initialized. The read and write command should look the same as a normal read an write command to a non-secure-memory tag except that the session flag must be specified and the HMAC_F should be specified if HMAC is used and the ENC_F should be specified if encryption is used.
- After you begin using Secure Memory with a tag, the tag size appears to change. In normal operations, the Get Tag Info command returns the physical memory layout of the tag. In Secure Memory mode, the Get Tag Info command returns the starting block, max block, and number of blocks of the reformatted and available user memory.
- You can stop using Secure Memory functionality by deselecting an initialized tag and then reselecting the tag without the flags set.

Note – If you write to a Secure Memory tag without the HMAC or Encryption flag enabled, you may lose some or all of the data being written. (Reading encrypted data without one of the flags set does not affect the data, although the data appears in its encrypted state.)

Choosing Security Algorithms

Secure memory lets you select the algorithm used to compute the hash message authentication code (HMAC) used by either Data Integrity mode or Encryption with Data Integrity mode (Table 9-1).

- For Data Integrity mode, you can choose any of the Hashes listed in the table.
- For Encryption with Data Integrity mode, you can use any of the hashes below and any of the ciphers.

Table 9-1 SkyeTek ReaderWare Security Algorithms

Function:	**Algorithm:**	**Options/Notes:**
Cipher	TDEA (Triple-DES)	Key Sizes: 56, 112 and 168 bits
		Modes: ECB, CBC, CTR
	AES (Rijndael)	Key Sizes: 128, 192 and 256 bits
		Modes: ECB, CBC, CTR
Hash	SHA-1	Modes: Iterative, One Pass
	SHA-224	Modes: Iterative, One Pass
	SHA-256	Modes: Iterative, One Pass
	SHA-384	Modes: Iterative, One Pass
	SHA-512	Modes: Iterative, One Pass
	MD5	Modes: Iterative, One Pass
HMAC (keyed hash message authentication code)		
	HMAC	Hashes: All available
		Modes: Iterative, One Pass
PRNG (pseudo random number generator)		
	SHA1PRNG	

- Due to space trade-offs, not all supported tags support all algorithm choices. This ensures that a reasonable amount of usable space remains on the tag after Secure Memory is enabled.
- When you use any of the ciphers supported by SkyeTek's ReaderWare (Table 9-1 above), Secure Memory always uses the cipher's counter (CTR) mode. This mode provides cryptographic stream capabilities that let Secure Memory use the full tag memory without need for block padding and rounding. It also lets Secure Memory update a only a portion of a tag instead of rewriting the entire tag. This would not be possible with the cipher block chaining (CBC) or electronic code book (ECB) modes also available for each of the ciphers.

Matching Algorithms to Security Level

When possible, you should pair algorithms according to the comparable security level. The security level describes the expected difficulty of attacking the algorithm. For example, a security level of 80 means that on the order of 2^{80} operations would be required to break the algorithm. Algorithms with security levels below 80 should not be used for new applications. The table below lists the security levels for the available algorithms:

Table 9-2 Security Levels

Security Level	Algorithms
< 64 (legacy applications only)	TDEA-56, MD5
80	SHA-1, TDEA-112
112	SHA-224, TDEA-168
128	AES-128, SHA-256, SHA1PRNG
192	AES-192, SHA-384
256	AES-256, SHA-512

Enhancing Security with the Key Derivation Function

You can also use a key derivation function (KDF) with Secure Memory. When enabled, the KDF applies an HMAC using the keys you specify, the tag ID, and application type (integrity or encryption) to derive a tag-specific and application-specific key before you set up or initialize Secure Memory. Using the KDF increases the security of applications that you build with Secure Memory: even if a brute-force attack succeeds against an individual tag, it does not compromise the master keys used for multiple tags.

To use the KDF, enable the useKeyDerivationFunc flag in the ASN1.BER encoded data for the Initialize Secure Memory or the Setup Secure Memory command.

Initialize Secure Memory (0x0203)

The Initialize Secure Memory command sets up a supported memory tag to use the Secure Memory feature. It sets all algorithm and mode settings and then initializes the tag's secured data into a zeroed state. Subsequent sessions using the initialized Secure Memory tag should use Setup Secure Memory command (see "Setup Secure Memory (0x0204)" on page 49).

- This command requires that you first create a session for the tag (i.e., include the tag ID with a Select Tag command).
- The request and response data fields use ASN.1 BER (Tag Length Value) encoding, as specified in the Data Field Format, although you do not need knowledge of the ASN.1 BER standard to use the command.

These template examples should be sent in the “data” portion of a SkyeTek protocol message. For more information, see the command examples section.

Data Field Format (ASN.1BER Encoding)

This information is sent in the “data” portion of the SkyeTek protocol command for Initialize Secure Memory.

Request

```
SEQUENCE {
   macAlgorithm           ENUMERATED {
   HMAC-SHA1(1), HMAC-SHA224(2), HMAC-SHA256(3),
   HMAC-SHA384(4), HMAC-SHA512(5), HMAC-MD5(6)
    },
  macKeyName         [1] OCTET STRING OPTIONAL,
  macKey                 OCTET STRING,
  cipherAlgorithm        ENUMERATED OPTIONAL {
    TDEA-56(18), TDEA-112(34), TDEA-168(66),
    AES-128(49), AES-192(81), AES-256(97)
    },
  cipherKeyName      [2] OCTET STRING OPTIONAL,
  cipherKey              OCTET STRING OPTIONAL,
  useKeyDerivationFunc   BOOLEAN OPTIONAL
}
```

Response

(There is no response data.)

Example—Initializing Secure Memory (Data Integrity Only)

For initialize Data Integrity mode, using HMAC-SHA1:

Request

Place this information in the data field of the Initialize Secure Memory command:

30800A01**01**042*0***FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF**
FFFFFFFFFFFFFFFFFFFFFFFFFFFFFF0000

- The first **bold** region is the HMAC algorithm identifier (01 for HMAC-SHA1).

Identifier	Algorithm
1 (0x01)	HMAC-SHA1
2 (0x02)	HMAC-SHA224
3 (0x03)	HMAC-SHA256
4 (0x04)	HMAC-SHA384
5 (0x05)	HMAC-SHA512
6 (0x06)	HMAC-MD5

- The first region in *italics* (20) is length of the HMAC key.
- The second **bold** region is the HMAC key.

Response

(There is no response data.)

Example—Initializing Secure Memory (Encryption and Data Integrity)

To set up Encryption and Data Integrity mode, using AES128 with HMAC-SHA1:

Request

Place this information in the data field of the Initialize Secure Memory command:

30800A01**01**04*20***FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF**
FFFFFFFFFFFFFFFFFFFFFFFFFFFFFF0A01**31**04*20***FFFFFFFF**
FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF
FFFFFFFF0000

- The first **bold** region is the HMAC algorithm identifier (01 for HMAC-SHA1).
- The first region in *italics* is length of the subsequent HMAC key.
- The second **bold** region is the HMAC key.
- s specify the cipher algorithm identifier and cipher key respectively. The second region in *italics* specifies the subsequent cipher key.
- The third **bold** region is the cipher algorithm identifier:

Identifier	Cipher
18 (0x12)	TDEA-56
34 (0x22)	TDEA-112
66 (0x42)	TDEA-168
49 (0x31)	AES-128
81 (0x51)	AES-192
97 (0x61)	AES-256

- The second region in *italics* specifies the subsequent cipher key.
- The fourth bold region is the cipher key.

Response

(There is no response data.)

Setup Secure Memory (0x0204)

The Setup Secure Memory command changes a memory tag that has already been initialized for use by Secure Memory (see "Initialize Secure Memory (0x0203)" on page 45).

- This command requires that you first create a session for the tag (i.e., include the tag ID with a Select Tag command).
- The request and response data fields use ASN.1 BER (Tag Length Value) encoding, as specified in the Data Field Format, although you do not need knowledge of the ASN.1 BER standard to use the command.

ASN.1 Description of Command Data

This information is sent in the "data" portion of the SkyeTek protocol command for Setup Secure Memory:

Request

```
SEQUENCE {
  macKeyName          [1] OCTET STRING OPTIONAL,
  macKey                  OCTET STRING,
  cipherKeyName       [2] OCTET STRING OPTIONAL,
  cipherKey               OCTET STRING OPTIONAL
  useKeyDerivationFunc    BOOLEAN OPTIONAL
}
```

Response

(There is no response data.)

Example—Changing Data Integrity Strings (Data Integrity Only)

To use change Data Integrity settings only using HMAC-SHA1:

Request

Place this information in the data field of the Setup Secure Memory command:

08004*20***FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF**

FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF0000

- The region in *italics* (20) is length of the HMAC key.
- The **bold** region is the HMAC key

Response

(There is no response data.)

Example—Changing Encryption and Data Integrity Settings

To use Encryption and Data Integrity using the AES128 cipher with HMAC-SHA1:

Request

Place this information in the data field of the Setup Secure Memory command:

308004*20***FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF**
FFFFFFFFFFFFFFFFFFFFFFFF04*20***FFFFFFFFFFFFFFFFFFFF**
FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF0000

- The first region in *italics* (20) is length of the HMAC key.
- The first **bold** region is the HMAC key.
- The second *italics* region is the cipher key length.
- The second **bold** region is the cipher key.

Response

(There is no response data.)

Chapter 10

Customizing System Parameters

System parameters let you configure reader settings to customize them for your environment. You can temporarily alter parameters in memory or change the default values that are stored on the SkyeModule M9 EEPROM. The following table summarizes the parameters for the SkyeModule M9. (See "System Parameter Descriptions" on page 57 for detailed information on each parameter.)

Table 10-1 System Parameter Addresses, Lengths, and Default Values

Parameter	Address	Length (bytes)	Default Value
Serial Number	0x0000	0x0004	0x00000000
Firmware Version	0x0001	0x0004	0xXXXXXXXX (depends on release)
Hardware Version	0x0002	0x0004	0xXXXXXXXX (depends on release)
Product Code	0x0003	0x0002	0x0009
Reader ID	0x0004	0x0004	0xFFFFFFFF
Reader Name	0x0005	0x0020	SkyeModule M9 (in hex)
Host Interface Type	0x0006	0x0001	0x00 (TTL)
Host Interface Baud Rate	0x0007	0x0001	0x02 (38400)
User Port Direction	0x0008	0x0001	0x00
User Port Value	0x0009	0x0001	0x00
MUX Control	0x000A	0x0001	0x00
Operating Mode	0x000C	0x0001	0x00
Command Retry	0x0011	0x0001	0x05
Power Level	0x0012	0x0001	0xDC (27 dBm)
Current Frequency	0x0004	0x0004	0x3689CAC0 (915 MHz)
Start Frequency	0x0031	0x0004	0x35C80160 (902.3 MHz)
Stop Frequency	0x0032	0x0004	0x374B9420 (927.7 MHz)
Hop Channel Spacing	0x0034	0x0004	0x00030D40 (200 KHz)
Frequency Hopping Sequence	0x0035	0x0001	0x01 (pseudo-random)
Modulation Depth	0x0036	0x0001	0x64 (100%)
Regulatory Mode	0x0037	0x0001	0x00
LBT Antenna Gain	0x0038	0x0001	0x00

Changing System Parameters

The default settings take effect after a power cycle or reset.

CAUTION – Changing system parameter values—especially the default values—can render your SkyeModule M9 nonoperational in your environment. Research, record, and test all planned changes to make sure they are compatible with your system.

You can read or write system parameters via the following commands:

- Read System Parameter—reads the current value of the system parameter at the memory address specified.
- Write System Parameter—writes a new value to the system parameter at the memory address specified.
- Store Default System Parameter—writes a new system parameter value to the EEPROM.
- Retrieve Default System Parameter—reads the system parameter value at the address specified out of EEPROM.

See the *SkyeTek Protocol v3 Reference Guide* for a complete list of commands.

See “Understanding System Parameter Formats” on page 53 for more information about using these commands.

See “System Parameter Descriptions” on page 57 for information about individual parameters.

The default settings take effect after a power cycle or reset.

CAUTION – Resetting (cycling power) on your SkyeModule M9 causes all system parameters to revert to their default values. Any changes made to system parameters in memory are lost at reset unless you write them to the EEPROM as the new default values. Any changes to the default values do not take effect until the reader is reset.

Understanding System Parameter Formats

This section provides format details for the commands used to change system parameters.

Note – The Number of Blocks field for each command in this section should equal the byte length for each system parameter. (See “System Parameter Descriptions” on page 57 and “Software Specification” on page 39 for more information.)

Read System Parameter Command Format

Table 10-2 Read System Parameter Command, ASCII Mode Request

System Parameter	Start:	Flags:	Command:	Address (hex):	Hex # of Blocks:	CRC	End:
Serial Number	<CR>	0020	1201	0000	0004	calculated by user*	<CR>
Firmware Version				0001	0004		
Hardware Version				0002	0004		
Product Code				0003	0002		
Reader ID				0004	0004		
Reader Name				0005	0020		
Host Interface Type				0006	0001		
Host Interface Baud Rate				0007	0001		
User Port Direction				0008	0001		
User Port Value				0009	0001		
MUX Control				000A	0001		
Operating Mode				000C	0001		
Command Retry				0011	0001		
Power Level				0012	0001		
Current Frequency				0030	0004		
Start Frequency				0031	0004		
Stop Frequency				0032	0004		
Hop Channel Spacing				0034	0004		
Frequency Hopping Sequence				0035	0001		
Modulation Depth				0036	0001		
Regulatory Mode				0037	0001		
LBT Antenna Gain				0038	0001		

* Calculated as per CRC definition. See the *SkyeTek Protocol v3 Reference Guide*.

	Values that are constant for all commands

Table 10-3 Read System Parameter Command, ASCII Mode Response

Start:	Response Code:	Data Length:	Data:	CRC:	End:
<LF>	1201	depends on system parameter		as calculated by the reader	<CR><LF>

Table 10-4 Read System Parameter Command, Binary Mode Request

System Parameter	STX:	Message Length	Flags:	Com-mand:	Address (hex):	Hex # of Blocks:	CRC
Serial Number	02	calculated by user*	0020	1201	0000	0004	calculated by user*
Firmware Version					0001	0004	
Hardware Version					0002	0004	
Product Code					0003	0002	
Reader ID					0004	0004	
Reader Name					0005	0020	
Host Interface Type					0006	0001	
Host Interface Baud Rate					0007	0001	
User Port Direction					0008	0001	
User Port Value					0009	0001	
MUX Control					000A	0001	
Operating Mode					000C	0001	
Command Retry					0011	0001	
Power Level					0012	0001	
Current Frequency					0030	0004	
Start Frequency					0031	0004	
Stop Frequency					0032	0004	
Hop Channel Spacing					0034	0004	
Frequency Hopping Sequence					0035	0001	
Modulation Depth					0036	0001	
Regulatory Mode					0037	0001	
LBT Antenna Gain					0038	0001	

* See the *SkyeTek Protocol v3 Reference Guide* for more information.

	Values that are constant for all commands

Table 10-5 Read System Parameter Command, Binary Mode Response.

STX:	Message Length:	Response Code:	Data Length:	Data:	CRC:
<02>	0007	1201	varies with system parameter	varies with system parameter	calculated by the reader

This format is the same for all read commands

Write System Parameter Command Format

Table 10-6 Write System Parameter Command, ASCII Mode Request

System Command	Start	Flags	Com-mand	Address (hex)	Hex # or Blocks	Data Length	Data	CRC	End
Serial Number	<CR>	0820	1202	0000	0004	user defined*	user defined	Calculated by user	<CR>
Firmware Version				0001	0004				
Hardware Version				0002	0004				
Product Code				0003	0002				
Reader ID				0004	0004				
Reader Name				0005	0020				
Host Interface Type				0006	0001				
Host Interface Baud Rate				0007	0001				
User Port Direction				0008	0001				
User Port Value				0009	0001				
MUX Control				000A	0001				
Operating Mode				000C	0001				
Command Retry				0011	0001				
Power Level				0012	0001				
Current Frequency				0030	0004				
Start Frequency				0031	0004				
Stop Frequency				0032	0004				
Hop Channel Spacing				0034	0004				
Frequency Hopping Sequence				0035	0001				
Modulation Depth				0036	0001				
Regulatory Mode				0037	0001				
LBT Antenna Gain				0038	0001				

* See the *SkyeTek Protocol v3 Reference Guide* for more information.

	Values that are constant for all commands

Table 10-7 Write System Parameter Command, ASCII Mode Response

Action:	Start:	Response Code:	CRC:	End:
Response	<LF>	1202	<8533>	<CR><LF>

This format is the same for all write commands.

Table 10-8 Write System Parameter Command, Binary Mode Request

System Parameter	STX:	Message Length:	Flags:	Command:	Address (hex):	Hex # of Blocks:	CRC
Serial Number	02	calculated by user*	0820	1202	0000	0004	calculated by user*
Firmware Version					0001	0004	
Hardware Version					0002	0004	
Product Code					0003	0002	
Reader ID					0004	0004	
Reader Name					0005	0020	
Host Interface Type					0006	0001	
Host Interface Baud Rate					0007	0001	
User Port Direction					0008	0001	
User Port Value					0009	0001	
MUX Control					000A	0001	
Operating Mode					000C	0001	
Command Retry					0011	0001	
Power Level					0012	0001	
Current Frequency					0030	0004	
Start Frequency					0031	0004	
Stop Frequency					0032	0004	
Hop Channel Spacing					0034	0004	
Frequency Hopping Sequence					0035	0001	
Modulation Depth					0036	0001	
Regulatory Mode					0037	0001	
LBT Antenna Gain					0038	0001	

* See the *SkyeTek Protocol v3 Reference Guide* for more information.

	Values that are constant for all commands

Table 10-9 Write System Parameter Command, Binary Mode Response

STX:	Message Length:	Response Code:	CRC:
<02>	0004	1202	<E652>

This format is the same for all write commands.

System Parameter Descriptions

This section describes the SkyeModule M9 system parameters. See “Understanding System Parameter Formats” on page 53 for formats to use each parameter in a system command.

Serial Number

- Returns the serial number of the reader
- Parameter address: 0x0000
- Length (bytes): 4
- Default value: 0x00000000
- Read-only

Firmware Version

- Returns the firmware version currently loaded on the reader
- Refer to the SkyeModule M9 *Release Notes* for more information about the firmware release.
- Parameter address: 0x0001
- Length (bytes): 4
- Default value: 0xXXXXXXXX (depending on release)
- The firmware version uses this format:
  f. Major revision (1 Byte)
  g. Minor revision (1 Byte)
  h. Current build number (2 bytes)
- Read-only

Hardware Version

- Returns the current hardware version of the reader
- Parameter address: 0x0002
- Length (bytes): 4
- Default value: 0xXXXXXXXX (depending on release)
- The hardware version uses the following format:
  a. Major revision (1 Byte)

   b. Minor revision (1 Byte)
   c. Current build number (2 bytes)
- Read-only

Product Code

- Returns the SkyeTek product code identifier. (Each SkyeTek product has a unique product code.)
- Parameter address: 0x0003
- Length (bytes): 2
- Default value: 0x0009
- Read-only

Reader ID

- Specifies the Reader ID, which is a reader-specific identifier. It lets the reader execute and respond only to those commands intended for it. The reader determines if the Reader ID in the request matches its internal Reader ID. If the ID does not match, the reader does not respond.
- Parameter address: 0x0004
- Length (bytes): 4
- Default value: 0xFFFFFFFF (depending on release)
- Select the Reader ID functionality by specifying the RID Flag in the request. This setting lets you use multiple readers on the same bus or networked together.
- Read/write

Note – Changing the reader ID from the factory default of FFFFFFFF to any other value disables Loop Mode, which is used for read range demonstrations. See “Selecting Any Supported Tag Continuously (Loop Mode)” on page 70 for an example of using Loop Mode.

Reader Name

- Identifies a reader with a 32-byte user-defined name.
- Parameter address: 0x0005
- Length (bytes): 32
- Default value: SkyeModule M9 (in hex)
- Read/write

Host Interface Type

- Identifies the type of host interface for the reader to use.
- Parameter address: 0x0006
- Length (bytes): 1
- Default value: 0x00 (TTL)
- Valid host interface values are:
  - 0x00 – TTL
  - 0x01 – TTL Serial
  - 0x03 – SPI
  - 0x04 – I^2C
  - 0x06 – USB
  - Any other values are invalid and are ignored.
- Read/write

Note – SkyeModule M9s shipped with the SkyeTek Development Kit are preset to use USB communications.

Host Interface Baud Rate

- Sets the baud rate of the host interface.
- Parameter address: 0x0007
- Length (bytes): 1
- Default value: 0x02 (38,400)
- Works for the TTL Serial host interface only

- Valid baud rate values are:
  - 0x01 – 19,200
  - 0x02 – 38,400
  - 0x03 – 57,600
  - 0x04 – 115,200
  - Specifying any other value sets the baud rate to 9,600
- Write-only

Note – For firmware updates, you may need to limit the baud rate to 38,400.

User Port Direction

- Sets the direction of the GPIO pins of the reader.
- Parameter address: 0x0008
- Length (bytes): 1
- Default value: 0x00
- A one in the bit position indicates that the corresponding GPIO pin is an input.
- A zero in the bit position indicates that the corresponding GPIO pin is an output.
- Bits correspond to the pins as follows:
  - BIT0 – GPIO 0
  - BIT1 – GPIO 1
  - BIT2 – GPIO 2
  - BIT3 – GPIO 3 (not available for user I/O)
  - BIT4 – GPIO 4
  - BIT5 – GPIO 5
  - BIT6 – GPIO 6
  - BIT7 – reserved for future use
- Read/write

User Port Value

- Sets the value of the GPIO pins of the reader.
- Parameter address: 0x0009
- Length (bytes): 1
- Default value: 0x00
- A one in the bit position indicates that the corresponding GPIO pin is a logic high.
- A zero in the bit position indicates that the corresponding GPIO pin is logic low.
- The enable bit (bit 7) must be set for the settings to take effect.
- Bits correspond to the pins as follows:
  - BIT0 – GPIO 0
  - BIT1 – GPIO 1
  - BIT2 – GPIO 2
  - BIT3 – GPIO 3 (not available for user I/O)
  - BIT4 – GPIO 4
  - BIT5 – GPIO 5
  - BIT6 – GPIO 6
  - BIT7 – enable
- Read/write

MUX Control

- Controls a SkyePlus multiplexer. See the *SkyePlus Multiplexer Reference Guide* for complete information about using this parameter.
- Parameter address: 0x000A
- Length (bytes): 1
- Default value: 0x00
- Read/write

Operating Mode

- Puts the reader into sleep mode.
- Parameter address: 0x000C
- Length (bytes): 1
- Default value: 0x00
- Writing a value 0x01 to this parameter puts the reader into sleep mode.
- Sending any command on any interface wakes the reader from sleep mode.
- Read/write

Note – Sleep mode is not supported when the SkyeModule reader uses the USB host interface.

Command Retry

- One-byte value.
- Parameter address: 0x0011
- Length (bytes): 1
- Default value: 0x05
- Can be set by the host.
- Specifies the number of times a tag command is executed internally in the reader before responding with a failure response.
- Applies only to tag-specific SkyeTek Protocol commands.
- Valid range of values is 0-255 (0x00–0xFF).
- The command is repeated internally "n" number of times, where n is the value specified by the host, unless there is a successful response. When a successful response occurs, the reader stops repeating the command and sends a success response back to the host.
- Read/write

Note – Increasing the value for this parameter increases the time that the reader takes before it sends a failure message when a failure occurs. To avoid unnecessary delays, be sure to determine the optimal number of retries for your particular use.

Power Level

- Configures the power level for the reader.
- Parameter address: 0x0012
- Length (bytes): 1
- Default value: 0xDC (27 dBm)
- Power level is set in steps of 0.1 dB from 10 dBm to 27 dBm.
- Power levels are written in hex corresponding to a decimal value between 50 and 220 (see Table 10-10).
- Use the following equation to calculate the value to be written for a desired power level:

  (Desired power in dBm - 5)/0.1 = decimal value to write to system parameter

Table 10-10 Common Power Values

Power (dBm)	SkyeTek Decimal Value	Hex Equivalent
10	50	0x32
12	70	0x46
15	100	0x64
17	120	0x78
20	150	0x96
21	160	0xA0
24	190	0xBE
27	220	0xDC

- Read/write

Note – SkyeModule M9s shipped with the SkyeTek Development Kit are preset to a power level of 20 dBm.

Current Frequency

- Sets the current frequency with which the reader singulates a tag.
- Parameter address: 0x0030
- Length (bytes): 4
- Default value: 0x3689CAC0 (915 MHz)
- This parameter is a 4-byte hex equivalent of the frequency. Table 10-11 shows hex values for commonly used frequencies.
- Read/write

Note – See "Recommended Radio Settings for Regional Compliance" on page 34 to view compliance information and recommended reader settings.

Start Frequency

- Sets the low end of the frequency range under which the reader operates.
- Parameter address: 0x0031
- Length (bytes): 4
- Default value: 0x35C80160 (902.3 MHz)
- This parameter is written with a 4-byte hex equivalent of the frequency desired. See Table 10-11 for commonly used frequencies and their hex values.
- To enable frequency hopping, set a frequency range using the Start Frequency and Stop Frequency system parameters. Then use the Frequency Hopping Sequence parameter to set the frequency hopping mode (either sequential or pseudo-random). To disable frequency hopping, set the Start Frequency and Stop Frequency parameter to the same value.
- Read/write

Note – See "Recommended Radio Settings for Regional Compliance" on page 32 to view compliance information and recommended reader settings.

Stop Frequency

- Sets the high end of the frequency range under which the reader operates.
- Parameter address: 0x0032
- Length (bytes): 4
- Default value: 0x374B9420 (927.7 MHz)
- This parameter is written with a 4-byte hex equivalent of the frequency desired. See Table 10-11 for commonly used frequencies and their hex values.
- To enable frequency hopping, set a frequency range using the Start Frequency and Stop Frequency system parameters. Then use the Frequency Hopping Sequence parameter to set the frequency hopping mode (either sequential or pseudo-random). To disable frequency hopping, set the Start Frequency and Stop Frequency parameter to the same value.
- Read/write

Note – See "Recommended Radio Settings for Regional Compliance" on page 32 to view compliance information and recommended reader settings.

Table 10-11 Commonly Used Frequencies

Frequency (MHz)	Hex Equivalent	Description
865.7	0x339988A0	EU Start
866.7	0x33A8CAE0	EU Center
867.9	0x33BB1A60	EU Stop
902.3	0x35C80160	NA Start
915.0	0x3689CAC0	NA Center
927.7	0x374B9420	NA Stop

Hop Channel Spacing

- Controls the hop channel spacing when frequency hopping is enabled.
- Parameter address: 0x0034
- Length (bytes): 4
- Default value: 0x00030D40 (200 KHz)
- To enable frequency hopping, set a frequency range using the Start Frequency and Stop Frequency system parameters. Then use the Frequency Hopping Sequence parameter to set the frequency hopping mode (either sequential or pseudo-random). To disable frequency hopping, set the Start Frequency and Stop Frequency parameter to the same value.
- Read/write

Note – See “Recommended Radio Settings for Regional Compliance” on page 32 to view compliance information and recommended reader settings.

Frequency Hopping Sequence

- Switches the hopping sequence between pseudo-random and sequential mode.
- Parameter address: 0x0035
- Length (bytes): 1
- Default value: 0x01 (pseudo-random)
- To set the reader to sequential hopping mode, write 0x00 to this parameter.
- To reset the reader to pseudo-random hopping sequence, write 0x01 to this parameter.
- To enable frequency hopping, set a frequency range using the Start Frequency and Stop Frequency system parameters. Then use the Frequency Hopping Sequence parameter to set the frequency hopping mode (either sequential or pseudo-random). To disable frequency hopping, set the Start Frequency and Stop Frequency parameter to the same value.
- Read/write

Note – See “Recommended Radio Settings for Regional Compliance” on page 32 to view compliance information and recommended reader settings.

Modulation Depth

- Sets the modulation depth of the reader-to-tag transmissions, as calculated by the equation: (Vmax - Vmin)/Vmax.
- Parameter address: 0x0036
- Length (bytes): 1
- Default value: 100%
- The values for the modulation depths are in steps of 10, ranging from 10% to 100%.
- The values are the hex equivalent of the corresponding modulation depth.

Table 10-12 Common Modulation Depth Values

Modulation Depth (%)	Hex Equivalent
30	0x1E
80	0x50
90	0x5A
100	0x64

- The modulation depth is calculated by the reader using the equation:

  $(V_{MAX} - V_{MIN})/V_{MAX}$ where V_{MAX} is the RF voltage when transmit power is maximum and V_{MIN} is the RF voltage when transmit power is minimum. (For 100% modulation depth, V_{MIN} equals zero.)
- See the manufacturer's tag data sheet for the modulation depth supported for the tags in your application.
- Read/write

Note – See "Recommended Radio Settings for Regional Compliance" on page 32 to view compliance information and recommended reader settings.

Regulatory Mode

- Enables pulse shaping, listen before talk, and timing modifications for regions with special regulatory requirements, such as Europe.
- Parameter address: 0x0037
- Length (bytes): 1
- Default value: 0x00 (no pulse shaping)
- Read/write

Note – See “Recommended Radio Settings for Regional Compliance” on page 32 to view compliance information and recommended reader settings.

Table 10-13 Regulatory Mode Values

Mode	Hex Value
No pulse shaping—Australia/New Zealand, Hong Kong, North America, Singapore, Taiwan	0x00
ETSI/Europe	0x01
Not used	0x02
Not used	0x03
Korea	0x04

LBT Antenna Gain

- Controls the sensitivity of the listen-before-talk receiver.
- Setting this parameter can cancel out the gain from an external antenna when listening for other transmitting signals.
- Use this parameter only with European (ETSI) regional settings when the LBT radio is on.
- Do not use this parameter with FCC regional settings.
- Parameter address: 0x0038
- Length (bytes): 1
- Default value: 0x00 (no LBT antenna gain)
- Read/write
- Possible values are 0-255 (0x00 to 0xFF), using a signed 8-bit value that represents the range of -127 dBm to +128 dBm. The values 0x00 to 0x80 represent the zero to +128 dBm range, and the values 0x81 to 0xFF represent the -127 to -1 dBm range (see Table 10-14).

Note – See "Recommended Radio Settings for Regional Compliance" on page 32 to view compliance information and recommended reader settings.

Table 10-14 Examples of LBT Antenna Gain Adjustment Values

Hex Value	Antenna Gain (dBm)
0x81	-127
0x82	-126
. . .	. . .
0xFE	-2
0xFF	-1
0x00	0
0x01	+1
0x02	+2
. . .	. . .
0x7F	+127
0x80	+128

Appendix A

Troubleshooting

This appendix describes how to diagnose and fix common problems that you may encounter.

Firmware Updates

Firmware updates may require that you temporarily limit the SkyeModule M9 to a baud rate to 38,400. For more information on how to set or reset the baud rate, see “Host Interface Baud Rate” on page 59.

Visual Indicators

The SkyeModule M9 has three LEDs: red, amber, and green.

- When lit, the red LED indicates the M9 has power. This LED is always on while the M9 is connected to a valid voltage source.
- When lit, the green LED indicates that the M9 achieved a frequency lock. This LED is usually on if the frequency of operation is within the valid range. (See the RF specifications in “Electrical Specifications” on page 121 for more information.) If this LED is off, the M9 will not function until the problem is resolved.
- The GPIO 3 pin connection controls LED D502, which toggles when a successful tag command occurs.

Reset Button

If you are using the SkyeModule M9 with a SkyeTek host interface board, you can restart the reader by pressing the reset button on the top of the host interface board and holding it down for a few seconds. (The button is labeled SW1 RESET.)

Additional Information

See the SkyeTek Support Portal for additional troubleshooting information.

Appendix B

Examples of Tag Usage

Overview

This appendix provides examples of how to use the various tag functions supported by the SkyeModule M9, including selecting, reading, writing, locking, killing, using tag passwords, and authenticating.

Except for tag select operations, which apply to all tags, different tags support different tag functions. For a complete list of supported tags and which functions apply to each tags, see the file, SkyeModule M9 *Tag Support List*, available from the SkyeWare Help tab, as a link from the SkyeWare Documentation folder in the Windows Start menu, or as a file on your SkyeWare installation CD.

Some tag operations apply to all tags (see “Selecting Tags” on page 75). Other tag operations depend on the type of tag:

Table B-1 Operations Supported for Each Tag Type

Tag Type	Tag Operations Supported	More Information
Class1 Gen1	Select only (no inventory)	“Commands for EPC Class1 Gen1 Tags” on page 80
Class1 Gen2	Select, read, write, lock, and kill; tag password operations.	“Commands for EPC Class1 Gen2 (ISO 18000-6C) Tags” on page 86
ISO18000-6B	Select, Read, Write and Lock	“Commands for ISO18000-6B Tags” on page 107

Sending Commands to the Reader

All commands in the following examples are sent to the reader using the SkyeTek Protocol v3 in binary mode. You can send commands to the reader using SkyeWare 4 (Test tab), the SkyeWare C API, the SkyeWare .NET API, or any custom software that you create that uses SkyeTek Protocol v3 to interact with the reader.

For additional information on system parameters and command formats, see

- Chapter 10, "Customizing System Parameters" on page 51
- *SkyeTek Protocol v3 Reference Guide*
- *SkyeTek Protocol v3 Examples*
- Appendix C, "Using DESFire Commands" on page 109 for commands specific to DESFire tags.

Note – If you set the tag type to Auto-Detect, the reader automatically includes the tag type in its response when a tag is successfully detected.

Setting Up RF Regional Compliance

See "Recommended Radio Settings for Regional Compliance" on page 32 to view compliance information and recommended reader settings. For additional information on system parameters and command formats, see "Customizing System Parameters" on page 51.

Summary of Tag Functions

Using SkyeTek Protocol v3 commands, you can control the following tag functions with the SkyeModule M9:

- Select – Queries tags in the field of the reader for their unique IDs or EPCs.
- Read – Reads data from the nonvolatile memory of a tag.
- Write – Writes data to the nonvolatile memory in a block or group of blocks on a tag specified.
- Lock – Locks a nonvolatile memory block specified of the tag specified.
  - Get Lock Status – Gets the lock status of the block specified.
- Kill – Permanently disables a tag.
- Tag Password – Writes a password to a tag or presents the tag with a password for operations that require password authentication.

Selecting Tags

Selection operations apply to all tag types.

The Select Tag command returns the Unique ID or the EPC code of a tag in the field of the reader. The UID or EPC can later be used to address a specific tag when executing tag-specific commands. The reader has several modes for selecting tags:

Autodetect Mode: Reader automatically selects any recognized tag placed in the detection field.

Loop Mode: Reader detects tags in a continuous loop until loop mode is turned off or until another command stops the loop. (This function works only when the Reader ID system parameter is set to FFFFFFFF. See “Selecting Any Supported Tag Continuously” on page 77 for more information.)

Inventory Mode: Reader selects all tags in the detection field until a tag is placed in the field or until the inventory times out. This lets you read a “stack” of tags instead of reading and selecting each type of tag individually.

Note – The format of the Select Tag response is the same for Loop and Inventory Modes.

Using Auto-Detect Functionality

When you set the tag type to Auto-Detect, the reader determines the tag type of any tags in the field and include this information in the response if any tags are successfully detected. There are several levels of Auto-Detect functionality:

- Auto-Detect – The reader scans for any tag type that it supports and reports back the UID (or EPC) and tag type of the first tag it detects.
- Air Interface Auto-Detect – The reader scans for the first tag with the specified air interface and reports back its UID (or EPC) and the tag type it detected. Tag types of different air interfaces are reported.
- Manufacturer and Air Interface Specific Auto-Detect – The reader scans for the first tag with the specified manufacturer and air interface and reports back its UID (or EPC) and tag type. Tag types of different manufacturers with the same air interface are not reported.
- Tag Type Specific Select – The reader scans for the first tag of the specified tag type and report its UID (or EPC). The tag type is *not* reported, nor are any other tag types in the field.

Selecting Any Tag (Auto Detect)

Request

To select any type of supported tag, send the following parameter information to the reader:

- Command = Select Tag
- Mandatory Flags = None (CRC Flag in Binary Mode)
- Tag Type = Auto-Detect (causes reader to include the tag type in its response)

STX	Msg. Length	Flags	Command	Tag Type	CRC
02	0008	0020	0101	0000	F81A

Response

Based on the request, the reader returns the following information:

STX	Msg. Length	Response Code	Tag Type	TID Length	TID / EPC	CRC
02	0010	0101	8300	0008	E0040000B32A8D01	E1FF

Selecting Any Supported Tag Continuously

Sending the following command sets up continuous monitoring of whatever supported tag type is detected. The first time you send this command, it places the reader into loop mode, which sends a response whenever a tag enters the detection field or when there is a change in the field. Sending any command to the reader turns off loop mode.

Note – Loop mode is designed for demonstrations and read range testing. Therefore, loop mode only works when the reader ID is set to the factory default of FFFFFFFF. In typical working applications, readers with unique reader ID's are grouped together on one port or host; they do not need to remain in loop mode, because the host system usually switches between different readers quickly and frequently.

Note – When using Loop mode, place only one tag at a time in the reader's detection field. Refer to the *SkyeTek Development Kit User Guide* for more information about using Loop mode to test read range and about anti-collision capabilities for multiple tags.

Request

To set up continuous monitoring, send the following parameter information to the reader:

- Command = Select Tag
- Mandatory Flags = Loop Flag (CRC Flag in Binary Mode)
- Tag Type = Auto-Detect

STX	Msg. Length	Flags	Command	Tag Type	CRC
02	0008	0021	0101	0000	F35E

Response

Start of Loop Mode

The reader returns the following information when it starts loop mode:

STX	Msg. Length	Response Code	CRC
02	0004	01C1	AD3C

Reading Tags

The following table shows sample responses from the reader while in loop mode as the user places various tags one-at-a-time in the detection field. There can be any number of reads.

STX	Msg. Length	Response Code	Tag Type	TID Length	TID / EPC	CRC
02	0010	0101	8300	0008	E0040000B32A8D01	E1FF
02	0010	0101	8300	0008	E0040000B32A8D01	E1FF
02	0010	0101	8300	0008	E0040000B32A8D01	E1FF
			⋮			
02	0014	0101	8200	000C	334455660000000000000000	421E
02	0014	0101	8200	000C	334455660000000000000000	421E
02	0014	0101	8200	000C	334455660000000000000000	421E

End Loop Mode

The reader exits loop mode when you send another command.

STX	Msg. Len	Response Code	CRC
02	0004	81C1	21F0

Selecting All Tags of Any Type (Inventory Mode)

Inventory mode permits reading of all tags in the detection field. This lets you read a “stack” of tags instead of having to read each type of tag individually. This mode gives you an easy way to test or demonstrate the reader’s anti-collision capabilities.

Request

To set up monitoring, send the following parameter information to the reader:

- Command = Select Tag
- Mandatory Flags = Inventory Flag (CRC Flag in Binary Mode)
- Tag Type = Auto-Detect

STX	Msg. Len	Flags	Command	Tag Type	CRC
02	0008	0022	0101	0000	EE92

Response

The reader returns information for all tag types detected. At the end of the tag Inventory, the reader will send the Inventory Complete Response code (810F).

STX	Msg. Length	Response Code	Tag Type	TID Length	TID / EPC	CRC
02	0014	0101	8100	000C	000000000000610222103654	084F
02	0014	0101	8200	000C	1122334407070808090 90A0A	DF0B
02	0014	0101	8200	000C	A01A050821A142106A010802	C354
02	0010	0101	8300	0008	E0040000989C6001	ABC3
02	0004	810F				0E82

Commands for EPC Class1 Gen1 Tags

This section discusses tag commands that specifically apply to EPC Class1 Gen1 tags. The commands for loop and inventory mode discussed in the section (“Selecting Tags” on page 75) also apply to these tags.

Selecting Only EPC Class1 Gen1 Tags

Request

To detect only EPC Class1 Gen1 tags, send the following parameter information to the reader. (If you set the tag type to EPC Class1 Gen1 Auto-Detect, the reader includes the tag type in the response when a tag is successfully detected.)

- Command = Select Tag
- Mandatory Flags = None (CRC Flag in Binary Mode)
- Tag Type = EPC Class1 Gen1

STX	Msg. Len	Flags	Command	Tag Type	CRC
02	0008	0020	0101	8100	6D0E

Response

The reader sends the following response:

STX	Msg. Length	Response Code	Tag Type	TID Length	TID / EPC	CRC
02	0014	0101	8100	000C	000000000000610222103654	084F

Reading a Single Block

Request

To read a single block from the EPC memory:

- Command = Read Tag
- Mandatory Flags = None (CRC Flag in Binary Mode)
- Tag Type = EPC Class1 Gen1
- The tag memory consists of the EPC and 2 bytes for Lock and Kill values.
- Each block is a single byte in length.

STX	Msg. Length	Flags	Command	Tag Type	Address	Number Blocks	CRC
02	000C	0020	0102	8100	0002	0001	067A

Response

STX	Msg. Len	Response Code	Data Length	Data	CRC
02	0007	0102	0001	01	26B2

Each block is 1 byte long, so the Data Length value should be the same as the Number of Blocks being read.

Reading Multiple Blocks from an EPC Class1 Gen1 Tag

Request

To read multiple blocks from the EPC memory:

- Command = Read Tag
- Mandatory Flags = None in ASCII mode, CRC flag in Binary Mode)
- Tag Type = EPC Class1 Gen1

STX	Msg. Length	Flags	Command	Tag Type	Address	Num. Blocks	CRC
02	000C	0020	0102	8100	0002	0003	2568

Response

STX	Msg. Length	Response Code	Data Length	Data	CRC
02	0009	0102	0003	010200	7721

Each block is one byte long, so the Data Length value should be the same as the Number of Blocks being read.

Writing an 8-Byte EPC to an EPC Class1 Gen1 Tag

Request

To write an 8-byte (64-bit) EPC value to an EPC Class1 Gen1 tag:

- Command = Write Tag
- Mandatory Flags = Data
- Tag Type = EPC Class1 Gen1
- The Address must be set to 0x0000 in order to write the EPC.
- Each block is a single byte, so you must set the Number of Blocks and Data Length to eight (0x0008).

STX	Msg. Len	Flags	Command	Tag Type	Address	Num Blocks	Data Len	Data	CRC
02	0016	0820	0103	8100	0000	0008	0008	0000B0B0C0C0D0D0	6ACF

Response

STX	Msg. Len	Response Code	CRC
02	0004	0103	4822

After writing the EPC, you can verify it by sending the Select Tag command with the tag type set to EPC Class1 Gen1.

Note – This technique works for both 64-bit and 96-bit memory tags. However, writing a 64-bit EPC to a 96-bit memory tag prevents the Kill and Lock functionality from working with that tag. Lock and Kill work normally when you write a 64-bit EPC to a 64-bit memory tag.

Writing a 12-Byte EPC

Request

To write a 96-bit EPC value to an EPC Class1 Gen1 tag:

- Command = Write Tag
- Mandatory Flags = Data
- Tag Type = EPC Class1 Gen1
- The Address must be set to 0x0000 in order to write the EPC.
- Each block is one byte, so the Number of Blocks must be set to 12 i.e. 0x000C and the data length should also be 12 bytes.

STX	Msg. Len.	Flags	Cmd.	Tag Type	Addr.	Num. Blocks	Data Len.	Data	CRC
02	001A	0820	0103	8100	0000	000C	000C	111122223333444455556666	4B41

Response

STX	Msg. Len	Response Code	CRC
02	0004	0103	4822

After writing the EPC, you can verify it by sending the Select Tag command with the tag type set to EPC Class1 Gen1.

Locking an EPC Class1 Gen1 Tag

Request

To lock an EPC Class1 Gen1 tag:

- Command = Write Tag
- Mandatory Flags = Lock, Data (CRC Flag in Binary Mode)
- Tag Type = EPC Class1 Gen1
- Send a write command with no data in the data field and the data length set to ‘0’.
- The address field must be ‘0x0F’ for 96-bit EPC tags and ‘0x0B’ for 64-bit EPC tags.

STX	Msg. Len	Flags	Command	Tag Type	Address	Num Blocks	Data Len	Data	CRC
02	000E	0824	0103	8100	000F	0000	0000	-	5C34

Response

STX	Msg. Len	Response Code	CRC
02	0004	0103	4822

CAUTION – Once you lock a tag, you can only select the tag (using the Select Tag command) or kill the tag; you can no longer erase, read data from, or write data to the tag. You must write all data—including the kill password—to the tag before you lock it.

Setting the Kill Password

Request

To set the kill password for an EPC Class1 Gen1 tag:

- Command = Write Tag
- Mandatory Flags = Data (CRC Flag in Binary Mode)
- Tag Type = EPC Class1 Gen1
- The Kill password is a single byte value, so the Number of Blocks and Data Length fields should be set to 1.
- For a 96-bit tag, the address for writing the Kill password is ‘0x0E’ and for the 64-bit tag the address is ‘0x0A’.

Note – If you write a 64-bit EPC to a 96-bit Class1 Gen1 tag, then you must write the kill password to the kill password address of a 96-bit tag.

STX	Msg. Len	Flags	Command	Tag Type	Address	Num Blocks	Data Len	Data	CRC
02	000F	0820	0103	8100	000E	0001	0001	66	0B1F

Response

STX	Msg. Len	Response Code	CRC
02	0004	0103	4822

Killing an EPC Class1 Gen1 Tag

Request

To kill an EPC Class1 Gen1 tag:

- Command = Kill Tag
- Mandatory Flags = Data (CRC Flag in Binary Mode)
- Tag Type = EPC Class1 Gen1
- Send the Kill command with the 8-bit Kill password in the data field. If the Kill password does not match the password stored on the tag, the tag cannot be killed.

STX	Msg. Len	Flags	Command	Tag Type	Data Len	Data	CRC
02	000B	0820	0109	8100	0001	66	F025

Response

STX	Msg. Len	Response Code	CRC
02	0004	0109	E778

CAUTION – After you kill the tag, you cannot carry out any more operations on that tag.

Commands for EPC Class1 Gen2 (ISO 18000-6C) Tags

This section discusses tag commands that specifically apply to EPC Class1 Gen2 tags. The commands for loop and inventory mode discussed in the section, “Selecting Tags” on page 75, also apply to these tags.

Address Organization of Tag Memory

Class1 Gen2 tags support four memory banks. Memory within each memory bank is divided into 2-byte blocks.

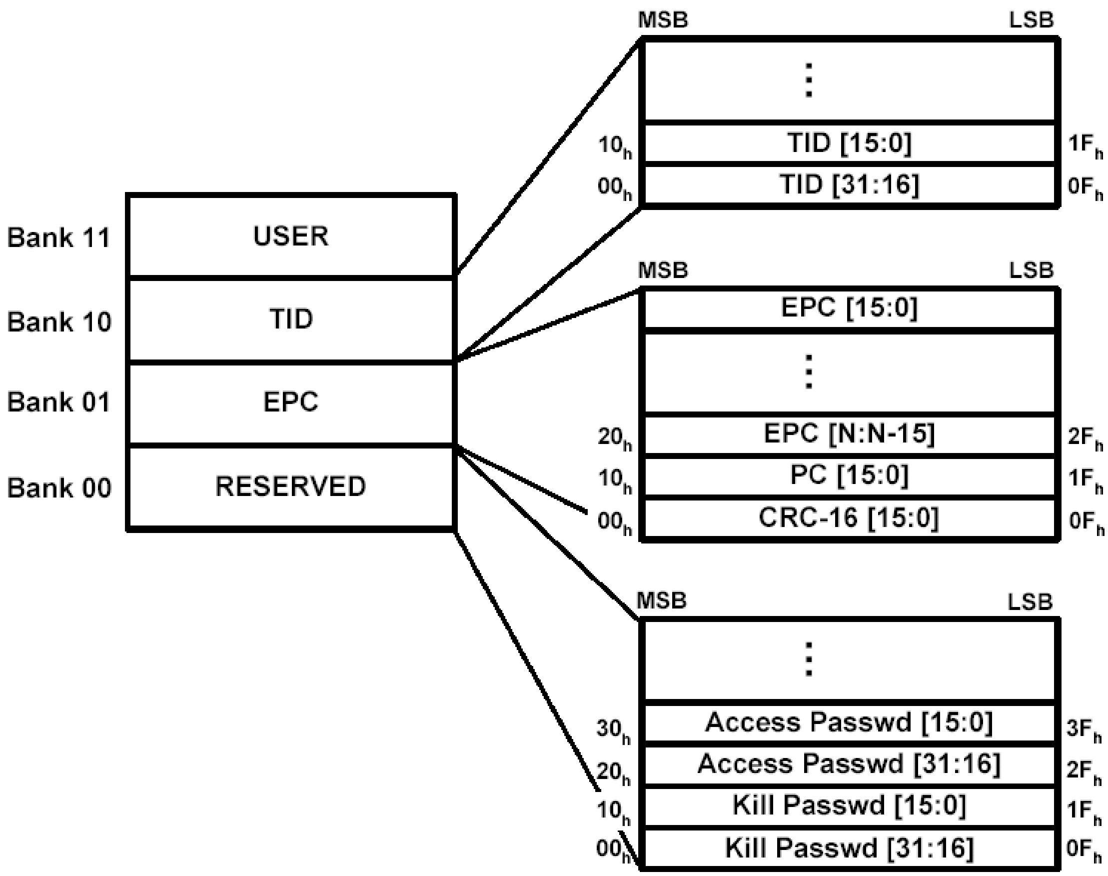


Figure B-1 Class1 Gen2 Tag Memory Banks and Blocks

The SkyeTek Protocol splits the 16-bit address field for reading and writing tag memory. The first nibble (4 MSBs) specifies the memory bank number and the remaining 12-bits specify the block address in the memory bank. For example, to address block #2 of the EPC memory bank, the address field in SkyeTek Protocol is 0x1002. The first nibble, “0x1,” specifies the EPC memory bank (i.e., bank 01), and the next 12-bits specify the block number (0x002).

Selecting Only EPC Class1 Gen2 Tags

Request

To detect only EPC Class1 Gen2 tags, send the following command and parameter information to the reader. (If you set the tag type to EPC Class1 Gen2 Auto-Detect, the reader includes the tag type in the response when a tag is successfully detected.)

- Command = Select Tag
- Mandatory Flags = None (CRC Flag in Binary Mode)
- Tag Type = EPC Class1 Gen2

STX	Msg. Len	Flags	Command	Tag Type	CRC
02	0008	0020	0101	8200	4766

Response

STX	Msg. Length	Response Code	Tag Type	TID Length	TID / EPC	CRC
02	0014	0101	8200	000C	A01A050821A142106A010802	C354

Performing a Fast Inventory

Fast Inventory improves the speed and reliability for inventory of Class 1 Gen 2 tags. This feature is unique to Class 1 Gen 2 tags.

Request

To invoke Fast Inventory, send a Select Tag command to three Class 1 Gen 2 tags with the Inventory_F flag set:

- Command = Select Tag
- Mandatory Flags = Inventory_F (CRC Flag in Binary Mode)
- Tag Type = EPC Class1 Gen2

STX	Msg. Len	Flags	Command	Tag Type	CRC
02	0008	0022	0101	8200	51EE

Response

A response appears for each tag, followed by an inventory complete response.

STX	Msg. Length	Response Code	Tag Type	TID Length	TID / EPC	CRC
02	0014	0101	8200	000C	000000000000000000000028	6F55
02	0014	0101	8200	000C	000000000000000000000027	97A2
02	0014	0101	8200	000C	000000000000000000000031	E215
02	0004	810F				0E82

To optimize Fast Inventory, set the Command Retry system parameter (0x11) to approximately double the number of anticipated tags in the field.

- To decrease the inventory time, decrease the Command Retry time until you find the shortest time at which the reader can still identify all tags in the field.
- Increase the Command Retry time for situations in which tags are difficult to read.
- See "Command Retry" on page 50 for more information on the system parameter.

Selecting Tags by TID

You can use the tag ID (TID) to select a single Class 1 Gen 2 tag by EPC. This is a two-step process in which you first detect the tag to determine the EPC, the use the EPC as a TID so that you can communicate with an individual tag out of a population of tags.

Request 1

Perform a fast inventory (as described in “Performing a Fast Inventory” on page 88) to locate the desired EPC

- Command = Select Tag
- Mandatory Flags = Inventory_F (CRC Flag in Binary Mode)
- Tag Type = EPC Class1 Gen2

STX	Msg. Len	Flags	Command	Tag Type	CRC
02	0008	0022	0101	8200	51EE

Response 1

A response appears for each tag, followed by an inventory complete response.

STX	Msg. Length	Response Code	Tag Type	TID Length	TID / EPC	CRC
02	0014	0101	8200	000C	000000000000000000000028	6F55
02	0014	0101	8200	000C	000000000000000000000027	97A2
02	0014	0101	8200	000C	000000000000000000000031	E215
02	0004	810F				0E82

Request 2

Use the EPC in the TID field for the desired tag to select the individual tag.

- Command = Select Tag
- Mandatory Flags = TID_F (CRC Flag in Binary Mode)
- Tag Type = EPC Class1 Gen2

STX	Msg. Len	Flags	Command	Tag Type	TID Len.	TID	CRC
02	0015	006	0101	8200	12	000000000000 000000000031	2A68

Response 2

STX	Msg. Length	Response Code	Tag Type	Data Length	TID / EPC	CRC
02	0009	0101	8200	01	01	A371

Selecting by Partial EPC

You can select tags by searching for the beginning portions of an EPC. For example, you may want to search a group of tags and locate only those tags that begin with a certain part of the EPC.

To use this feature, send a Select Tag command with the Inventory_F and TID_F flags set and with a variable length TID that contains the beginning of an EPC number. The command then returns all EPCs that begin with the TID you provided. For example, if you send a TID of 1234, the command returns a list of all tags with an EPC that starts with 1234. (If the TID is blank, the command returns all tags. If you send the full TID, the command returns only the tag with the matching EPC.)

Request

Perform a fast inventory (as described in "Performing a Fast Inventory" on page 88) to locate the desired EPC:

- Command = Select Tag
- Mandatory Flags = Inventory_F (CRC Flag in Binary Mode)
- Tag Type = EPC Class1 Gen2

STX	Msg. Len	Flags	Command	Tag Type	TID Len.	TID	CRC
02	0015	006	0101	8200	7	A01A050821A143	1BCE

Response

A response appears for two matching tags, followed by an inventory complete response. (The portion of the EPC matching the TID is shown in bold.)

STX	Msg. Length	Response Code	Tag Type	TID Length	TID / EPC	CRC
02	0014	0101	8200	000C	**A01A050821A143**139A011802	3809
02	0014	0101	8200	000C	**A01A050821A143**107A010802	04DE
02	0004	810F				0E82

Reading a Single Block from an EPC Class1 Gen2 tag

Request

To detect a single block from the EPC memory bank, send the following command and parameter information to the reader. The EPC is stored starting at block address 0x02 in the EPC memory bank (bank 1). (If you set the tag type to EPC Class1 Gen2 Auto-Detect, the reader includes the tag type in the response when a tag is successfully detected.)

- Command = Read Tag
- Mandatory Flags = None (CRC Flag in Binary Mode)
- Tag Type = EPC Class1 Gen2

STX	**Msg. Length**	**Flags**	**Command**	**Tag Type**	**Address**	**Num. Blocks**	**CRC**
02	000C	0020	0102	8200	1002	0001	C9A6

Response

Each block is 2-bytes long, so the data length value should be twice the number of blocks being read.

STX	**Msg. Length**	**Response Code**	**Data Length**	**Data**	**CRC**
02	0008	0102	0002	1122	F7AE

Reading Multiple Blocks

Request

To read multiple blocks from the EPC memory bank, send the following command and parameter information to the reader. The EPC is stored starting at block address 0x02 in the EPC memory bank (bank 1). (If you set the tag type to EPC Class1 Gen2 Auto-Detect, the reader includes the tag type in the response when a tag is successfully detected.)

- Command = Read Tag
- Mandatory Flags = None (CRC Flag in Binary Mode)
- Tag Type = EPC Class1 Gen2

STX	Msg. Length	Flags	Command	Tag Type	Address	Num. Blocks	CRC
02	000C	0020	0102	8200	1002	0003	EAB4

Response

Each block is 2-bytes long, so the data length value is twice the number of blocks being read.

STX	Msg. Length	Response Code	Data Length	Data	CRC
02	000C	0102	0006	112233440707	08F2

Writing a Single Block

Request

To write a single block of data to the EPC memory bank (bank 1), send the following command and parameter information to the reader. Each block is 2 bytes long, so the data length field must be twice the length of the number of blocks field.

- Command = Write Tag
- Mandatory Flags = Data (CRC Flag in Binary Mode)
- Tag Type = EPC Class1 Gen2

STX	Msg. Length	Flags	Command	Tag Type	Address	Num. Blocks	Data Length	Data	CRC
02	0010	0820	0103	8200	1002	0001	0002	AABB	F291

Response

STX	Msg. Len	Response Code	CRC
02	0004	0103	4822

Writing Multiple Blocks

To write three blocks of data to the EPC memory bank (bank 1), send the following command and parameter information to the reader. Each block is 2 bytes long, so the data length field must be twice the length of the number of blocks field.

Request

- Command = Write Tag
- Mandatory Flags = Data
- Tag Type = EPC Class1 Gen2

STX	Msg. Length	Flags	Command	Tag Type	Address	Num. Blocks	Data Length	Data	CRC
02	0014	0820	0103	8200	1002	0003	0006	AABBCCDDEEFF	C21E

Response

STX	Msg. Length	Response Code	CRC
02	0004	0103	4822

Writing a 12-byte EPC

To write a 12-byte (96-bit) EPC value to the EPC memory bank (bank 1), send the following command and parameter information to the reader.

Request

- Command = Write Tag
- Mandatory Flags = Data
- Tag Type = EPC Class1 Gen2

STX	Msg. Length	Flags	Command	Tag Type	Address	Num. Blocks	Data Length	Data	CRC
02	001A	0820	0103	8200	1002	0006	000C	101112131415161718191A1B	753D

Response

STX	Msg. Length	Response Code	CRC
02	0004	0103	4822

After writing the EPC to the EPC bank, make sure that the PC value (i.e., block address 0x01) is written with the correct value. The PC value determines the length of the EPC and a value of 0x3000 creates an EPC of 12-bytes (96-bits). To verify the EPC, the send the Select Tag command with the tag type set to EPC Class1 Gen2.

Writing to the User Memory Bank

Note – The user memory bank (bank 3) is not supported on all the EPC Class1 Gen2 tags.

Request

To write to the user memory bank, send the following command and parameter information to the reader:

- Command = Write Tag
- Mandatory Flags = Data
- Tag Type = EPC Class1 Gen2

STX	Msg. Length	Flags	Command	Tag Type	Address	Num. Blocks	Data Length	Data	CRC
02	0012	0820	0103	8200	3002	0002	0004	11223344	E741

Response

STX	Msg. Length	Response Code	CRC
02	0004	0103	4822

Writing a Tag Password

Note – This example applies only to tags that support access passwords.

Certain tags allow “Secure State” operations, such as setting password protection for a memory bank or supporting lock functionality. You can use the Write Tag command to assign a password to a tag. The 32-bit tag password is stored in Blocks 2 and 3 of the reserved memory bank (bank 0). Block 2 holds the higher 16-bits of the password, and Block 3 holds the lower 16-bits.

After you write the tag password, the reader requires that you use the password for Secure State transactions *with that tag*. That is, you must send the password to the reader using the Send Tag Password command before you execute another secure command for that tag. (See “Sending a Tag Password” on page 97.)

To change a password, use the Write Tag command to write a new password to the tag or use a Select Tag command with Tag Type of EPC Class1 Gen2, which resets the password to zero.

Important – When writing the 32-bit password to the tag, the password’s Least Significant Block (LSB) and Most Significant Block (MSB) are reversed in the data portion of the Write command. For example, if the password is 12345678, it would be represented in the data field of the Write Tag Password command as 56781234. In the example below, the Data field (56781234) represents a password value of 12345678.

Request

To write a tag password, send the following command and parameter information to the reader:

- Command = Write Tag
- Mandatory Flags = Data (CRC Flag in Binary Mode)
- Tag Type = EPC Class1 Gen2

STX	Msg. Length	Flags	Command	Tag Type	Address	Num. Blocks	Data Length	Data	CRC
02	0012	0820	0103	8200	0002	0002	0004	56781234	61C5

Response

STX	Msg. Length	Response Code	CRC
02	0004	0103	4822

Sending a Tag Password

After you have assigned an access password to a tag that supports passwords (see “Writing a Tag Password” on page 96), you must send the Send Tag Password command to send the password to the reader before the reader can execute any other Secure State operations for that tag. This remains a requirement until you change the password or reset the password value to zero.

This command is required *only* if a tag has an access password that was previously set is a non-zero value. If the password is set for a tag and you send a a command that requires the tag to be in the Secure State without sending the password first, the command will fail.

Request

To send a tag password, send the following command and parameter information to the reader:

- Command = Send Tag Password
- Mandatory Flags = Data (CRC Flag in Binary Mode)
- Tag Type = EPC Class1 Gen2

STX	Msg. Length	Flags	Command	Tag Type	Data Length	Data	CRC
02	000E	0820	0202	8200	0004	12345678	9139

Response

STX	Msg. Length	Response Code	CRC
02	0004	0202	73C3

Using Lock Functionality

Class 1 Gen 2 tags let you use lock functionality to set read permissions, write permissions, and passwords for tag memory. The following tables list the different values for Locking/Password protecting different sections of the tag memory for EPC Class1 Gen2 tags.

Table B-2 Lock Command Payload

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Kill mask		Access mask		EPC mask		TID mask		User mask		Kill action		Access action		EPC action		TID action		User action	

The lock contains a 20-bit payload defined as follows:

- The first 10 payload bits are Mask bits (Table B-3). A Tag interprets these bit values as follows:
  - Mask = 0: Ignore the associated Action field and retain the current lock setting.
  - Mask = 1: Implement the associated Action field and overwrite the current lock setting.

Table B-3 Masks and Associated Action Fields

	Kill pwd		**Access pwd**		**EPC memory**		**TID memory**		**User memory**	
	0	1	2	3	4	5	6	7	8	9
Mask	skip/ write	skip/ write	skip/ write	skip/ write	skip/ write	skip/ write	skip/ write	skip/ write	skip/ write	skip/ write
	10	11	12	13	14	15	16	17	18	19
Action	pwd read/ write	perma lock	pwd read/ write	perma lock	pwd write	perma lock	pwd write	perma lock	pwd write	perma lock

- The last 10 payload bits are *Action* bits (Table B-4). A Tag interprets these bit values as follows:
  - Action = 0: De-assert lock for the associated memory location.
  - Action = 1: Assert lock or permalock for the associated memory location.

Table B-4 Action Field Descriptions

Pwd write	**Permalock**	**Description**
0	0	Associated memory bank is writable from either the open or secured states.
0	1	Associated memory bank is permanently writable from either the open or secured states and can never be locked.
1	0	Associated memory bank is writable from the secured state only.
1	1	Associated memory bank is not writable from any state.
Pwd read/ write	**Permalock**	**Description**
0	0	Associated memory bank is readable and writable from either the open or secured states.
0	1	Associated memory bank is permanently readable and writable from either the open or secured states and can never be locked.
1	0	Associated memory bank is readable and writable from the secured state only.
1	1	Associated memory bank is not readable or writable from any state.

Permanently Locking a Memory Bank

You can lock a memory bank by writing the 20-bit value (encapsulated in a 32-bit number) 0x0000C030 as the Lock value. (See the above table for different values for locking different sections of the tag memory.)

CAUTION – Once a memory bank is locked, you can no longer write to it.

Request

To lock the EPC memory bank (bank 1), send the following command and parameter information to the reader.

- Command = Write Tag
- Mandatory Flags = Lock, Data (CRC Flag in Binary Mode)
- Tag Type = EPC Class1 Gen2

STX	Msg. Length	Flags	Command	Tag Type	Address	Num. Blocks	Data Length	Data	CRC
02	0012	0824	0103	8200	0000	0000	0004	0000C030	1704

Response

STX	Msg. Length	Response Code	CRC
02	0004	0103	4822

Password Protecting a Memory Bank

After you set the appropriate tag password (see “Writing a Tag Password” on page 96), you can mark a memory bank on the tag for password protection. This requires writing the correct values as the 20-bit lock value. The following example shows how to password protect the EPC memory bank by writing the value 0x0000C020.

To password protect the memory bank, send the following command and parameter information to the reader.

Request

- Command = Write Tag
- Mandatory Flags = Lock, Data (CRC Flag in Binary Mode)
- Tag Type = EPC Class1 Gen2

STX	Msg. Length	Flags	Command	Tag Type	Address	Num. Blocks	Data Length	Data	CRC
02	0012	0824	0103	8200	0000	0000	0004	0000C020	0785

Response

STX	Msg. Length	Response Code	CRC
02	0004	0103	4822

Note – After you set the password, you must send the Send Tag Password command (see “Sending a Tag Password” on page 97) before sending any Write commands to the memory banks that have been password protected.

Setting the Kill Password

The tag password sets password protection on the Kill Password command (see "Killing an EPC Class1 Gen2 Tag" on page 102). The kill password is a 32-bit (4-byte) value stored in the reserved memory bank (bank 0) of the tag memory in blocks 0 and 1. Block 0 holds the higher 16-bits of the password, and block 1 holds the lower 16-bits of the kill password.

Request

To set the kill password, send the following command and parameter information to the reader:

- Command = Write Tag
- Mandatory Flags = Data (CRC Flag in Binary Mode)
- Tag Type = EPC Class1 Gen2

STX	Msg. Length	Flags	Command	Tag Type	Address	Num. Blocks	Data Length	Data	CRC
02	0012	0820	0103	8200	0000	0002	0004	DEADBEEF	EA3A

Response

STX	Msg. Length	Response Code	CRC
02	0004	0103	4822

Killing an EPC Class1 Gen2 Tag

The kill password is a 32-bit value that must be sent to the tag along with the KillTag command.

CAUTION – If you kill a tag, you can no longer perform any operations on that tag.

Request

To kill a tag, send the following command and parameter information to the reader.

- Command = Kill Tag
- Mandatory Flags = Data (CRC Flag in Binary Mode)
- Tag Type = EPC Class1 Gen2

STX	Msg. Length	Flags	Command	Tag Type	Data Length	Data	CRC
02	000E	0820	0109	8200	0004	BEEFDEAD	1C11

Response

STX	Msg. Length	Response Code	CRC
02	0004	0109	E778

Using Load Image Functionality for Alien Higgs Tags

Higgs tags by Alien Technology Corporation have a special command "Load Image" that loads the entire memory image of the tag in a single transaction.

The different fields in the Load Image command and their possible values are shown below. The following table gives the layout of the different fields in the data payload being sent with the Load Image command. The order of the different fields in the 192 bits of data is shown below and they must be sent in that order.

Table B-5 Layout for Data Payload for Load Image Command

192-bits of Data loaded into the tag memory.				
Data Word	**Description**	**Memory Bank**	**Offset in Bank**	**Recommended Value**
1	Kill Password Lo	Reserved	1	User Defined
2	Kill Password Hi	Reserved	0	User Defined
3	Access Password Lo	Reserved	3	User Defined
4	Access Password Hi	Reserved	2	User Defined
5	EPC Word 0 (LSB)	EPC	7	User Defined
6	EPC Word 1	EPC	6	User Defined
7	EPC Word 2	EPC	5	User Defined
8	EPC Word 3	EPC	4	User Defined
9	EPC Word 4	EPC	3	User Defined
10	EPC Word 5 (MSB)	EPC	2	User Defined
11	Protocol Control Bits	EPC	1	0x3000 for 96-bit EPC. (See Gen2 v1.10 protocol document for more details.
12	Configuration Bits	TID	2	0x03B8 (unlocked memory). See details below for locking various banks.

The following table shows the different configuration values that can be sent for locking different memories of an Alien Higgs tag.

Table B-6 Configuration Values for Locking Memory

Configuration Bits (TID Bank, Row #2)																
Field Name	APW Lock	APW P-Lock	KPW Lock	KPW P-Lock	EPC Lock	EPC P-Lock	RES	RES	RES	RES	RES	RES	RES	RES	RES	RES
Field Bit #	15 MSB	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0 LSB
Lock Bits	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-	-
Reserved Bit values	-	-	-	-	-	-	1	1	1	0	1	1	1	0	0	0

- KPW=Kill Password
- APW=Access Password
- Lock Bits may be changed, but must all be 0s in the tag before performing the Load Image operation. The lock bits may also be changed after the load image function with the normal Gen2 Lock functionality if they have not been permanently locked.
- Reserved bits should not be changed to any other value and should remain as shown above.

For example, to permanently lock the Access Password field, the value should be 0x43B8.

The Protocol Control bits determine the length of the EPC as well as the Numbering System used. The following table shows the different fields in the Protocol Control Word and gives some examples.

Table B-7 Protocol Control Word Fields

Protocol Control Bits (EPC Bank Row# 1)																
Field	**Length Field**					**RFU**		**Numbering System Identifier**[1]								
Field Bit#	4	3	2	1	0	1	0	8	7	6	5	4	3	2	1	0
Bit#	15 MSB	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
96-bit EPC	0	0	1	1	0	0	0	USER DEFINED VALUE								
80-bit EPC	0	0	1	0	1	0	0									
64-bit[2] **EPC**	0	0	1	0	0	0	0									

- The NSI is optional and is user specified. Please refer to the EPC Gen2 v1.10 protocol document for details.
- Refer to the EPC Gen2 v1.10 protocol document for more details on the different length field values.

Using the LoadImage Command

The following example writes the entire tag memory of the Alien Higgs tag. This includes the 96-bit EPC, 32-bit Kill password, 32-bit Access password, Protocol Control bits, and the 16-bit Lock value. The tag type must be set to “Alien Higgs – 0x8251” and the address field is set to ‘0xFFFF’ to signify a special Write command that writes the entire tag memory of the Alien Higgs tag.

- Kill Password: 00010203
- Access Password: 01010202
- EPC: 666655554444333322221111
- Protocol Control Value: 3000
- Lock Value: 03B8

Request

- Command = Write Tag
- Mandatory Flags = Data (CRC Flag in Binary Mode)
- Tag Type = Alien Higgs

STX	Msg. Len	Flags	Command	Tag Type	Address	Num Blocks	Data Len	Data	CRC
02	0026	0820	0103	8251	FFFF	000C	0018	000102030101020266665555 444433332222111130000 3B8	4A05

Response:

STX	Msg. Len	Response Code	CRC
02	0004	0103	4822

After writing the EPC, you can verify it by sending the Select Tag command with the tag type set to EPC Class1 Gen2.

Commands for ISO18000-6B Tags

This section discusses tag commands that specifically apply to ISO18000-6B tags. The Select Tag commands discussed in the section, “Selecting Tags” on page 75, also apply to these tags.

Table B-8 Example Tag Memory Configuration for ISO18000-6B Tag.

Address	Content	Status	Comments
0x00 – 0x01	0xE0, 0x04	Locked	Unique Serial Number
0x02 – 0x07	xx	Locked	Unique Serial Number
0x08 – 0x0A	0x00	Unlocked	User Memory
0x0B	0x02	Unlocked	User Memory
0x0C – 0x11	0xFF	Unlocked	User Memory
0x12 – 0xDB	0x00	Unlocked	User Memory
0xDC – 0xDF	xx	Unlocked	User Memory

For the tags with a tag configuration as shown above, the user can read all the tag memory and can write to all the Unlocked User memory locations.

Selecting an ISO18000-6B Tag

To select an ISO18000-6B, send the following parameter information to the reader. If the tag type is set to ISO18000-6B Auto-Detect, then the reader will include the tag type in the response if a tag is successfully detected.

Request

- Command = Select Tag
- Mandatory Flags = None (CRC Flag in Binary Mode)
- Tag Type = ISO18000-6B

STX	Msg. Length	Flags	Command	Tag Type	CRC
02	0008	0020	0101	8300	5EBE

Response

STX	Msg. Length	Response Code	Tag Type	TID Len	TID / EPC	CRC
02	0010	0101	8300	0008	E0040000989C6001	ABC3

Reading a Single Block

To read a single ISO18000-6B block, send the following parameter information to the reader:

Request

- Command = Read Tag
- Mandatory Flags = TID (CRC Flag in Binary Mode)
- Tag Type = ISO18000-6B

STX	Msg. Length	Flags	Command	Tag Type	TID Len	TID	Address	Num. Blocks	CRC
02	0015	0060	0102	8300	08	E0040000989C6001	0010	0001	6519

Response

STX	Msg. Length	Response Code	Data Length	Data	CRC
02	0007	0102	0001	FF	3843

Each block is 1-byte long, so the Data Length value should equal the Number of Blocks being read.

Reading Multiple Blocks

To read multiple ISO18000-6B blocks, send the following parameter information to the reader:

Request

- Command = Read Tag
- Mandatory Flags = TID (CRC Flag in Binary Mode)
- Tag Type = ISO18000-6B

STX	Msg. Length	Flags	Command	Tag Type	TID Len	TID	Address	Num. Blocks	CRC
02	0015	0060	0102	8300	08	E0040000989C6001	0010	000A	DBCA

Response

Each block is 1-byte long, so the Data Length value should equal the Number of Blocks being read.

STX	Msg. Length	Response Code	Data Length	Data	CRC
02	0010	0102	000A	11223344556677889900	5A80

Writing a Single Block

To write to a single ISO18000-6B, send the following parameter information to the reader. (Each block is 1-byte long, so the Number of Blocks value should be same as the data length.)

Request

- Command = Write Tag
- Mandatory Flags = TID, Data (CRC Flag in Binary Mode)
- Tag Type = ISO18000-6B

STX	Msg. Len.	Flags	Command	Tag Type	TID Len	TID	Address	Num. Blocks	Data Len.	Data	CRC
02	0018	0860	0103	8300	08	E0040000989C 6001	0010	0001	0001	DD	37E1

Response

STX	Msg. Length	Response Code	CRC
02	0004	0103	4822

Writing Multiple Blocks

To write multiple ISO18000-6B blocks, send the following parameter information to the reader. (Each block is 1-byte long, so the Number of Blocks value should be same as the data length.)

Request

- Command = Write Tag
- Mandatory Flags = TID, Data (CRC Flag in Binary Mode)
- Tag Type = ISO18000-6B

STX	Msg. Len.	Flags	Command	Tag Type	TID Len	TID	Address	Num. Blocks	Data Len.	Data	CRC
02	0021	0860	0103	8300	08	E0040000 989C6001	0010	000A	000A	BABABABACAC ACACADADA	4AA9

Response

STX	Msg. Length	Response Code	CRC
02	0004	0103	4822

Locking a Single Block

To lock a single ISO18000-6B block, send the following parameter information to the reader.

You can lock only one block at a time. To lock multiple blocks, send the command multiple times after incrementing or changing the address.

Once the tag blocks have been locked, they cannot be unlocked or written to.

Request

- Command = Write Tag
- Mandatory Flags = TID, Lock, Data (CRC Flag in Binary Mode)
- Tag Type = ISO18000-6B

STX	Msg. Len.	Flags	Command	Tag Type	TID Len	TID	Address	Num. Blocks	Data Len.	Data	CRC
02	0017	0864	0103	8300	08	E0040000989C 6001	0020	0001	0000	-	D6A5

Response

STX	Msg. Length	Response Code	CRC
02	0004	0103	4822

Commands Usable for EM Tag Types

About Mixing EM Tag Types

To achieve optimal performance with EM4444 tags, do not include EM4122 tags in the detection field when you use commands that include read or write operations.

Selecting Any EM Tag

Request

To select any type of supported tag, send the following command and parameter information to the reader:

- Command = Select Tag
- Mandatory Flags = None (CRC Flag in Binary Mode)
- Tag Type = Auto-Detect (causes reader to include the tag type in its response)

STX	Msg. Length	Flags	Command	Tag Type	CRC
02	0008	0020	0101	8500	0A6E

Response

Based on the request, the reader returns the following information for an EM4122 tag detected in the read field:

STX	Msg. Length	Response Code	Tag Type	TID Length	TID / EPC	CRC
02	000E	0101	8512	0006	058000455E49	D597

Continuously Selecting EM Tags

Sending the following command sets up continuous monitoring of whatever supported tag type is detected. The first time you send this command, it places the reader into loop mode, which sends a response whenever a tag enters the detection field or when there is a change in the field. Sending any command to the reader turns off loop mode.

Request

To set up continuous monitoring, send the following command and parameter information to the reader:

- Command = Select Tag
- Mandatory Flags = Loop Flag (CRC Flag in Binary Mode)
- Tag Type = Auto-Detect

STX	Msg. Length	Flags	Command	Tag Type	CRC
02	0008	0021	0101	8500	012A

Response

Start of Loop Mode

The reader returns the following information when it starts loop mode:

STX	Msg. Length	Response Code	CRC
02	0004	81C1	21F0

Reading Tags

The table below shows sample output from the reader after loop mode starts. (There can be any number of reads depending on the number of tags present.)

STX	Msg. Length	Response Code	Tag Type	TID Length	TID / EPC	CRC
02	000E	0101	8512	0006	058000455E49	D597
02	000E	0101	8512	0006	058000455E49	D597
02	000E	0101	8512	0006	058000455E49	D597
			⋮			
02	000E	0101	8525	0006	469900001275	F4B2
02	000E	0101	8525	0006	058000455E49	F4B2
02	000E	0101	8525	0006	058000455E49	F4B2

End Loop Mode

The reader exits loop mode when you send another command.

STX	Msg. Len	Response Code	CRC
02	0004	81C1	21F0

Selecting All Types of EM (Anti-Collision/Inventory Mode)

Selecting all supported tags in a field can be useful when trying to read a stack of tags simultaneously (inventory mode). This keeps you from having to issue commands to read each type of tag individually.

Request

To set up monitoring, send the following command and parameter information to the reader:

- Command = Select Tag
- Mandatory Flags = Inventory Flag (CRC Flag in Binary Mode)
- Tag Type = Auto-Detect

STX	Msg. Len	Flags	Command	Tag Type	CRC
02	0008	0022	0101	8500	1CE6

Response

The reader returns information for all tag types detected. At the end of the tag Inventory, the reader sends the Inventory Complete Response code (810F).

STX	Msg. Length	Response Code	Tag Type	TID Length	TID / EPC	CRC
02	000E	0101	8525	0006	469900001275	F4B2
02	000E	0101	8525	0006	46990000125E	6B63
02	000E	0101	8525	0006	469900001276	C629
02	000E	0101	8525	0006	46990000125D	59F8

Reading EM Tags

Request

To read an EMX44 tag, send the following command and parameter information to the reader:

- Command = Read Tag
- Mandatory Flags = TID (CRC Flag in Binary Mode)
- Tag Type = EMX44

STX	Msg. Length	Flags	Command	Tag Type	TID Length	TID / EPC	CRC
02	000D	0060	0102	8500	0006	46990000125D	4CAB

(The TID for the tag is returned in the response for a previous Select Tag command.)

Response

Based on the request, the reader returns the following information for an EM4444 tag detected in the read field:

STX	Msg. Length	Response Code	Tag Type	TID Length	TID / EPC	CRC
02	000E	0101	8525	0006	46990000125D	59F8

Note – To achieve optimal performance with EM4444 tags, do not include EM4122 tags in the detection field when you use commands that include read or write operations.

Writing EM Tags

Request

To write a single block of data to the EPC memory bank (bank 1), send the following command and parameter information to the reader:

- Command = Write Tag
- Mandatory Flags = TID (CRC Flag in Binary Mode)
- Tag Type = EM4X44 Auto-detect

STX	Msg. Len.	Flags	Cmd.	Tag Type	TID Len.	TID	Address	Blocks	Data Len.	Data	CRC
02	001D	0860	0103	8520	06	46990000125D	0001	0001	0008	0000000000000000	358A

Response

Based on the request, the reader returns the following information for an EM4444 tag detected in the read field:

STX	Msg. Len	Response Code	CRC
02	0004	0103	4822

Note – To achieve optimal performance with EM4444 tags, do not include EM4122 tags in the detection field when you use commands that include read or write operations.

Locking EM Tags

Request

You can lock an EM tag by sending a Write Tag command with no data and the Lock flag enabled.

CAUTION – Once a memory bank is locked, you can no longer write to it.

Note – To achieve optimal performance with EM4444 tags, do not include EM4122 tags in the detection field when you use commands that include read or write operations.

- Command = Write Tag
- Mandatory Flags = Lock, Data (CRC Flag in Binary Mode)
- Tag Type = EM4X44 Auto-detect

STX	Msg. Length	Flags	Command	Tag Type	Address	Num. Blocks	Data Length	Data	CRC
02	0015	0864	0103	8520	0001	0001	0000	n/a	2B7D

Response

STX	Msg. Length	Response Code	CRC
02	0004	0103	4822

You can verify the success of the lock operation with a GetLockStatus command:

Request

- Command = GetLockStatus
- Mandatory Flags = TID (CRC Flag in Binary Mode)
- Tag Type = EM4X44 Auto-detect

STX	Msg. Length	Flags	Command	Tag Type	TID Len.	TID	Address	Num. Blocks	CRC
02	0011	0060	0108	8520	06	46990000125D	0001	0001	2B7D

Response

STX	Msg. Length	Response Code	Data Length	Data	CRC
02	0007	0108	0001	01	4822

The response code indicates GetLockStatus: PASS (01), showing the tag is locked.

Configuring EM 4444 Tags

For EM4444 tags, the system page, memory address 000F, contains configuration information for the tag. You can access individual bytes of the system page using the Read Tag Config and Write Tag Config commands to manage tag configuration. You can also view configuration information using the Get Tag Info or Get Lock Status commands.

- The block size is always 1 for Read Tag Config and Write Tag Config.
- The address specifies a byte from the system page. For example, address 0000 is system page bits 0-7 (LOCK bits), and address 0007 is system page bits 56 to 63.
- Only addresses 0006 and 0007 are writable, as described below.
- Sending a Write Tag Config command to the Tag Talks Only (TTO) byte (address 0006) automatically calls an EM-specific TTO command. This lets you set what the tag sends when the tag transmits in TTO mode. (Although the SkyeModule M9 firmware only decodes the first page of transmitted memory.)
- Sending a Write Tag Config command to the CONFIG byte (address 0007) automatically calls an EM-specific CONFIG command. This lets you set the maximum random delay and the Tx data rate (either 64 Kbps or 256 Kbps).

Note – For additional information on configuration values, refer to the EM4444 data sheet.

Configuration Example

As an example, to configure a tag to have a maximum random delay of 4 kbits and a Tx data rate 64 kbits/s requires the following:

- Setting the delay control bits to 10 (2 decimal). This corresponds to system page bits 61-60.
- Setting the Tx baud rate to 01 (1 decimal). This corresponds to the system page bits 59-58.
- Setting system page bits 63-62 and 57-56 to 0.

The resulting byte made up of these requirements for bits 63-56 thus becomes 00100100 or 0x24. To configure the tag with the above settings, send the Write Tag Config command with the address of 0007 and the data of 24, as shown below:

Request

To change the tag configuration for an EM4444 tag with TID 469900001276:

- Command = Write Tag Config
- Mandatory Flags = TID, Data (CRC Flag in Binary Mode)
- Tag Type = EM4444

STX	Msg. Length	Flags	Command	Tag Type	TID Len.	TID	Address	Num. Blocks	Data Length	Data	CRC
02	0019	0860	0111	8525	06	469900001276	0007	0001	0004	00100100	7C9B

Note – To achieve optimal performance with EM4444 tags, do not include EM4122 tags in the detection field when you use commands that include read or write operations.

Response

STX	Msg. Length	Response Code	CRC
02	0004	0111	7BB1

Appendix C

SkyeModule M9 Version 2.0

The SkyeModule M9 v2.0 includes all versions of the M9 released before May 4, 2007. It differs from v3.0 in its mechanical, electrical, and environmental specifications and has a narrower temperature range with respect to radio power.

Mechanical Specifications

Mounting Hole Variant

See Figure C-1 on page C-120 for additional dimensions.

Outside dimensions:	53.0 mm x 70.0 mm = 3710 mm^2
Height:	9.0 mm
Mounting holes:	3.0 mm diameter 45.0 mm center-to-center (side-to-side) 40.0 mm center-to-center (front-to-back.)
Clearance:	Approx. 2.5 mm between edge of mounting hole and edge of printed circuit board (PCB) (side-to-side direction) Approx. 13.2 mm between edge of mounting hole and front of PCB Approx. 13.8 mm between the edge of mounting hole and back of PCB
Weight	11.1 grams

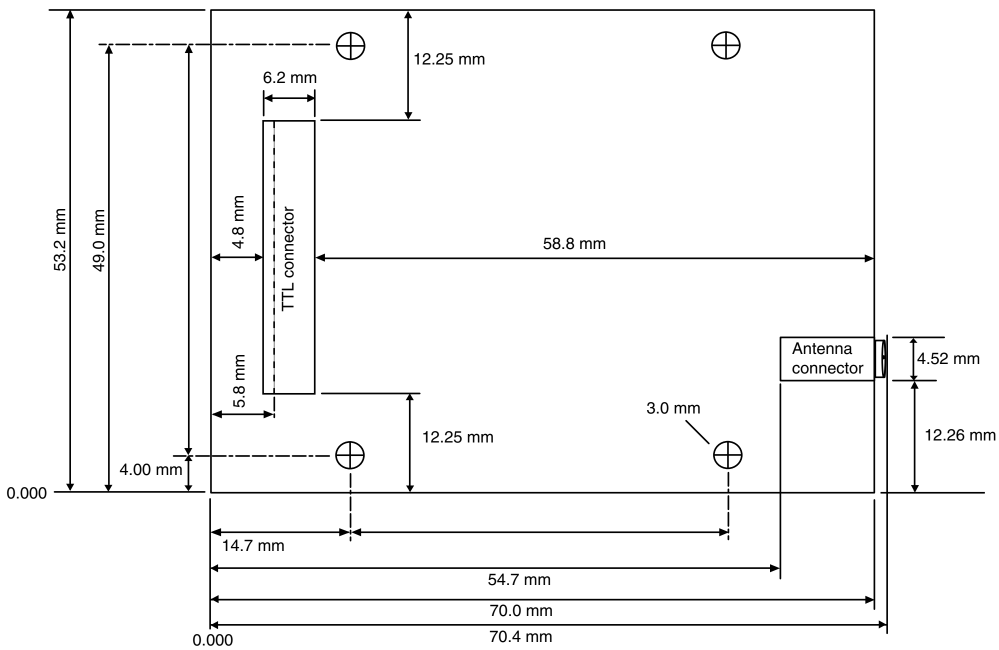


Figure C-1 SkyeModule M9 Dimensions (MH variant)

Compact Flash Variant

See Figure C-2 for additional dimensions.

Dimensions: 66.1 mm x 36.0 mm = 2379.6 mm^2

Height: 5.0 mm

Weight8.0 grams

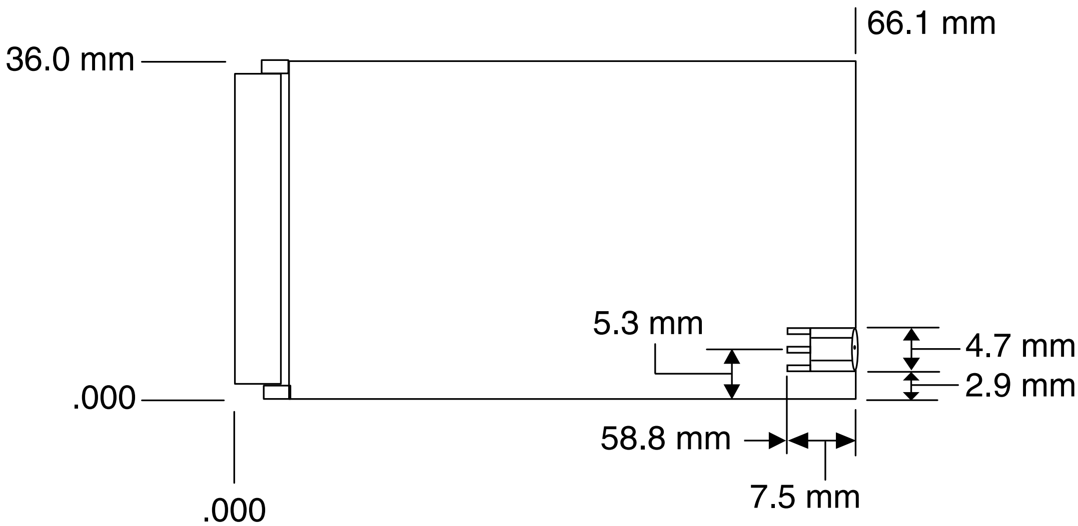


Figure C-2 SkyeModule M9 v 2.0 Dimensions (CF Variant)

Electrical Specifications

Unless otherwise noted, temperature assumed for these specifications is 25 degrees Celsius, frequency is 865.7 MHz, and supply voltage (VCC) is 5 V.

Table C-1 SkyeModule M9 v 2.0 Electrical Specifications

Specification	Min	Typical	Max	Units/Notes
RF Characteristics				
Frequency ranges (Direct output)	862.000	915.000	955.000	MHz
Hop channel spacing	100	200	300	KHz

Table C-1 SkyeModule M9 v 2.0 Electrical Specifications

Specification	Min	Typical	Max	Units/Notes
Transmission Parameters				
Transmit Power	10	12	20/27*	dBm (See “Recommended Radio Settings for Regional Compliance” on page 32 for maximum power ratings under different regulatory environments.) * When the SkyeModule M9 is USB-bus powered, maximum transmit power should not exceed 20 dBm. An M9 shipped with the SkyeTek Development Kit is preset to use USB communications at a 20 dBm power level.
Transmit Power Variation vs. Temperature		+/- 1		dB (Temperature range is -10 C to +55 C.)
Transmit Power Variation vs. VCC		+/- 1		dB (VCC is from 3.5-5 V)
Transmit Power Flatness vs. Frequency		+/- 1		dB (Frequency range is from 862-955 MHz.)
Optimum PA Load Impedance		50		Ohms
Receiver Parameters				
Sensitivity at 40 kbps		-40		dBm (at transmit power of 27 dBm)
Sensitivity at 80 kbps		-40		dBm (at transmit power of 27 dBm)
Logic Inputs				
High state input voltage	2			V
Low state input voltage			0.8	V
Input Current (I_{INH}/I_{INL})		4	25	mA

Table C-1 SkyeModule M9 v 2.0 Electrical Specifications

Specification	Min	Typical	Max	Units/Notes
Logic Outputs				
Output High Voltage (V_{OH})	2.9			V
Output Low Voltage (V_{OL})			0.4	V
Output Current (I_{INH}/I_{INL})		4	25	mA
Power Supplies				
Voltage Supply	3.5	5.0	5.5	V
Peak Transmit Current Consumption				
5 dBm		250		mA
12 dBm		300		mA
27 dBm		900		mA
Low Power Sleep Mode		5		mA

Absolute Maximum Ratings

Temperature is 25 degrees Celsius unless otherwise noted.

Table C-2 Absolute Maximum Ratings/Operating Conditions

Specification	**Rating**
Maximum input voltage, high (V_{INH})	5.5 V
V_{SUPPLY} to GND	5.5 V
Digital I/O voltage to GND	5.5 V
Temperature range	
Operating	-10 to +55 degrees C
Storage	-20 to +85 degrees C
Humidity	
Operating, continuous storage	10-90 percent (non-condensing)
Transient storage (<24 hours)	5-95 percent maximum (non-condensing)
Connectors	
MMCX Connector	< 5000 Mate Cycles
CF Connector	< 10,000 Mate Cycles
24-pin Double-row Connector	< 30 Mate Cycles
ESD protection	< 1kV (ESD HBM 15500 Ω, 100pF) *—or—* 100V (ESD MM 0.75uH, 200pF)
Antenna VSWR characteristic	2:1 or better, as desirable for optimum performance

RF Radio Power

In keeping with the narrower temperature range for the SkyeModule M9 v2.0, the RF transmit power is user configurable from 10-27 dBm in steps of 0.1 dB with an accuracy of +/-1 dB across a temperature range of -10 to +55 degrees Celsius.

- See "Radio Specifications and Regional Compliance" on page 31 for information on RF functionality.

Index

D

E

F

G

H

I

J

K

L

M

N

O

P

R

S

T

U

V

W