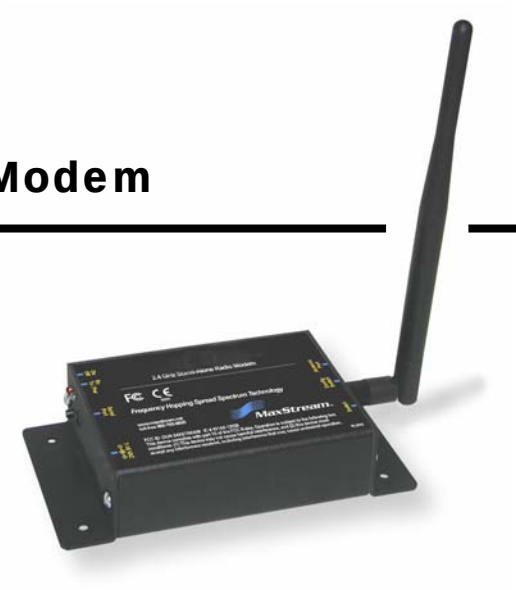
9XCite-PKG-R™ RS-232/485 RF Modem



9XCite RS-232/485 RF Modem

Interfacing Protocol

RF Modem Operation

RF Modem Configuration

Advanced Networking & Security

Product Manual v2.1

XCite RF Modem Part Numbers: XC09-009PKC-R XC09-038PKC-R
XC09-009PKC-RA XC09-038PKC-RA

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Contents

9XCite RS-232/485 RF Modem

The XCite RS-232/485 RF Modem is a drop-in wireless solution that is used to provide wireless links for any data system. It transfers a standard asynchronous serial data stream and features the following:

- Continuous data stream of up to 38400 bps (factory-set, RF baud rate)
- Serial Interfacing from 1200 to 57600 bps
- Software selectable between Hopping (FHSS) and Single Frequency Channel Modes
- Approved by the FCC under Part 15 of the FCC Rules and Regulations
- Variable input supply voltage (7 - 18 VDC)

Key Features

Long Range

- Indoor/Urban Range: **Up to 300'** (90 m)
- Outdoor/RF Line-of-sight Range: **Up to 1000'** (300 m)
- Receiver Sensitivity: **-108 dBm** (@9600 Baud), **-104 dBm** (@38400 Baud)

Low Power

- Transmit Power Output: **4 mW** [40 mW effective considering excellent receiver sensitivity]
- **105 mA** transmit / **55 mA** receive current consumption
- Power-down current as low as **6 mA**

Advanced Networking & Security (True Peer-to-Peer (no "master" required), Point-to-Point, Point-to-Multipoint, Multidrop)

Specifications [refer to following page]

1-Year Warranty [Appendix B]

Free & Unlimited Technical Support

Worldwide Acceptance

FCC Approved (USA) [Go to Appendix A for FCC Requirements]
Devices that embed XCite Radio Modems inherit MaxStream's FCC certification

IC (Industry Canada) **Certified**

ISM (Industrial, Scientific & Medical) frequency band

MaxStream products manufactured under **ISO 9001:2000 registered standards**

Specifications

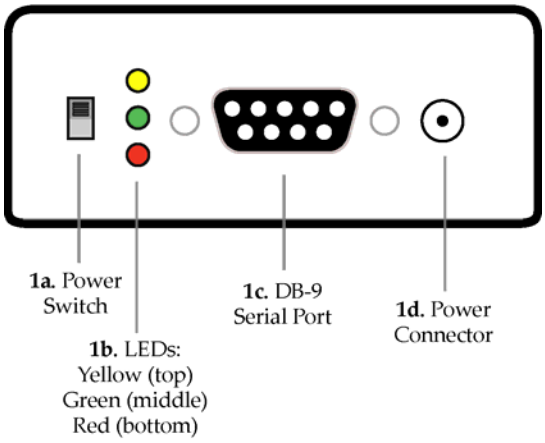
Table 1. XCite-PKG-R RS-232/485 RF Modem (900 MHz) Specifications

Specification	9XCite-PKG-R (900 MHz) RS-232/485 RF Modem	
Performance		
Indoor/Urban Range	Up to 300' (90 m)	
Outdoor LOS Range	Up to 1000' (300 m) w/ 2.1 dB dipole antenna	
Transmit Power Output	4 mW (6 dBm)	4 mW (6 dBm)
Interface Data Rate	Software selectable 1200 - 57600 bps	
Throughput Data Rate	9,600 bps	38,400 bps
RF Data Rate	10,000 bps	41,666 bps
Receiver Sensitivity	-108 dBm	-104 dBm
General		
Frequency	902-928 MHz	
Spread Spectrum	Frequency Hopping, Wide band FM modulator	
Network Topology	Peer-to-Peer, Point-to-Point, Point-to-Multipoint, Multidrop	
Channel Capacity	Hopping Mode - 7 hop sequences share 25 frequencies Single Frequency Mode – 25 available frequencies	
Serial Data Interface	RS-232/485/422	
Power Requirements		
Supply Voltage	7-18 VDC	
Transmit Current	105 mA	
Receive Current	55 mA	
Power Down Current	6 mA	
Physical Properties		
Enclosure	7.1 oz. (200 g), Extruded aluminum, black anodized	
Enclosure Size	2.75" x 5.50" x 1.124" (7.90 cm x 13.90 cm x3.80 cm)	
Operating Temperature	Commercial (0 to 70º C) or Industrial (-40 to 85º C)	
Antenna		
Type	½ wave dipole whip, 6.75" (17.1 cm), 2.1 dBi Gain	
Connector	Reverse-polarity SMA	
Impedance	50 ohms unbalanced	
Certifications (For additional certifications, go to www.maxstream.net or call (801) 765-9885.)		
FCC Part 15.247	OUR-9XCITE	
Industry Canada (IC)	4214A-9XCITE	

External Interface

Front and Back Views

Figure 1. Front View



1a. Power Switch

Move Power Switch to the ON (up) position to power the XCite-PKG-E RS-232/485 RF Modem.

1b. LEDs

LED indicators visualize diagnostic status information. RF Modem's status is represented as follows:

Yellow (top) = Serial data out (to host)
Green (middle) = Serial data in (from host)
Red (bottom) = Power/TX Indicator (Red light is on when modem is powered, pulses off and on briefly during RF transmission)

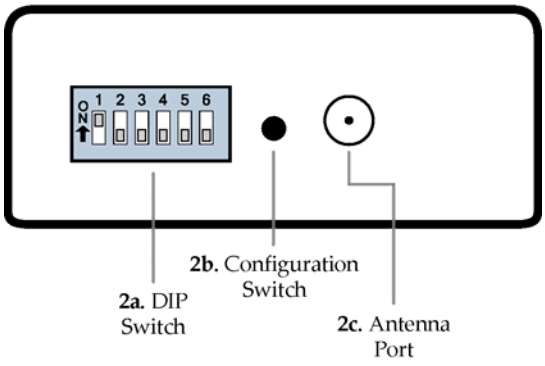
1c. DB-9 Serial Port

Standard female RS-232 (DB-9) DCE connector – Port is also used for RS-485 and RS-422 connections.

1d. Power Connector

7-18 VDC Power Connector (Center positive, 5.5/2.1 mm) – Power can also be supplied through Pin 9 of the serial port [1c].

Figure 2. Back View



2a. DIP Switch

DIP Switch automatically configures the XCite Module to operate in different modes. Each time the RF modem is powered-on, intelligence on the XIB-R interface board programs the embedded module according to the positions of the DIP Switch. [See Figure 3 below for DIP Switch settings.]

In cases where AT Commands should not be sent each time the RF Modem is powered on, the processor must be disabled by populating J7 on the interface board. [See "Automatic DIP Switch Configurations" section [page 24] for more information].

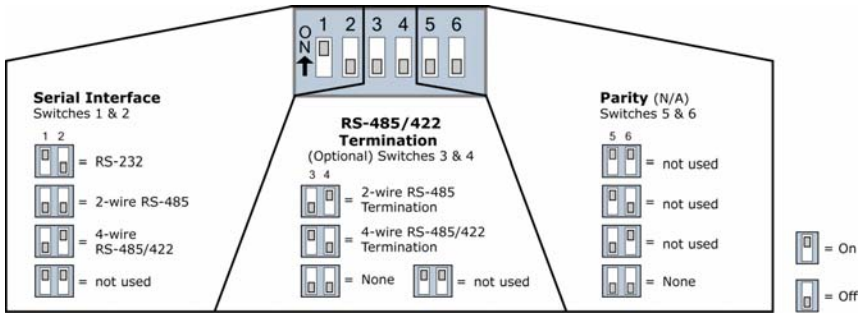
2b. Config (Configuration) Switch

Configuration Switch provides an alternate way to enter "AT Command Mode". To enter "AT Command Mode" at the RF modem's default baud rate, hold the Configuration Switch down while powering on the modem using the Power Switch [1a].

2c. Antenna Port

Antenna Port is a 50 Ω RF signal connector for connecting to an external antenna. Connector type is Reverse Polarity (RPSMA) female. The RPSMA has threads on the outside of a barrel and a male center conductor.

Figure 3. DIP Switch Settings



Adapters

The XCite-PKG-RA RS-232/485 RF Modems come with several adapters. The adapters facilitate basic functions, such as the following:

- Performing Range Tests
- Testing Cables
- Connecting to other RS-232 DCE and DTE devices
- Connecting to terminal blocks or RJ-45 (for RS-485/422 devices)

NULL Modem Adapter (male-to-male)

Part Number: JD2D2-CDN-A (Black, DB9 M-M) The male-to-male NULL modem adapter can be used to connect two DCE devices. A DCE device is one that connects with a straight-through cable to the male serial port of a computer (DTE).

Figure 4. Male NULL modem adapter and pinouts

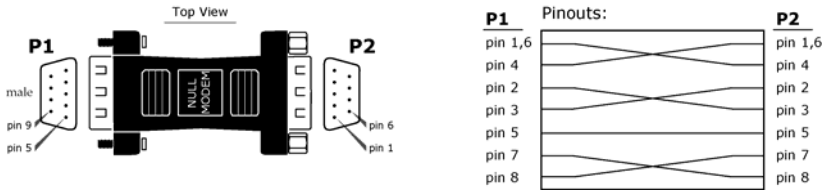
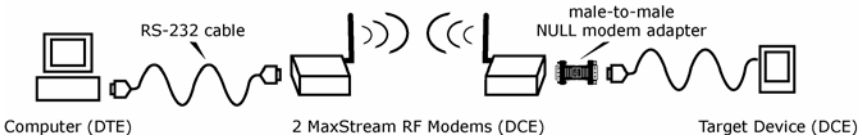


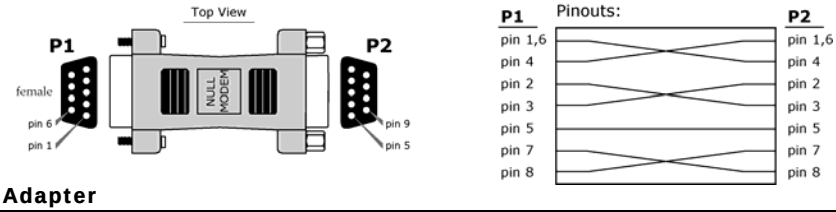
Figure 5. Example of a MaxStream RF Modem (DCE Device) connecting to another DCE device)



NULL Modem Adapter (female-to-female)

Part Number: JD3D3-CDN-A (Gray, DB9 F-F) The female-to-female NULL modem adapter can be used to verify serial cabling is functioning properly. To test cables, insert the female-to-female NULL modem adapter in place of a pair of RF Modems and test the connection without any RF Modems in the connection.

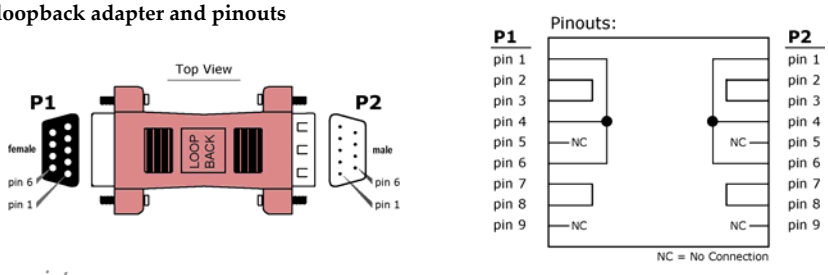
Figure 6. Female NULL modem adapter and pinouts



Serial Loopback Adapter

Part Number: JD2D3-CDL-A (Red, DB9 M-F) The serial loopback adapter is used for range testing. During a range test, the serial loopback adapter configures the RF Modem to function as a repeater by looping serial data back into the radio for retransmission.

Figure 7. Serial loopback adapter and pinouts

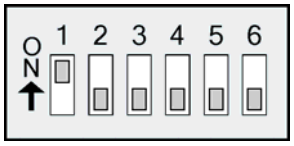


Interfacing Protocol

RS-232 Operation

DIP Switch Settings and Serial Port Connections

Figure 8.
RS-232 DIP Switch Settings



DIP Switch settings are read and applied only while powering-on.

Figure 9.
Pins used on the female RS-232 (DB-9) Serial Connector

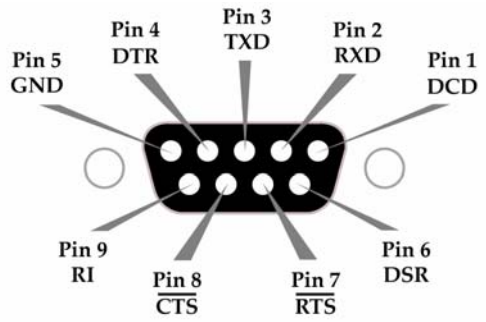
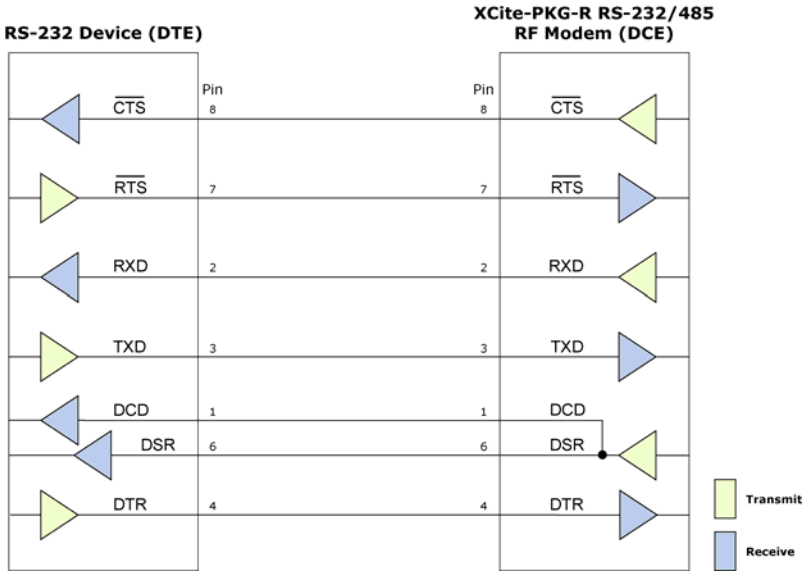


Table 2. RS-232 Signals and their implementations on the XCite-PKG-R RF Modem
(Low-asserted signals are distinguished by horizontal line over pin name.)

DB-9 Pin	RS-232 Name	Description	Implementation
1	DCD	Data-Carrier-Detect	Connected to DSR (pin 6)
2	RXD	Received Data	Serial data OUT (over-the-air) of RF Modem
3	TXD	Transmitted Data	Serial data IN to RF Modem
4	DTR	Data-Terminal-Ready	Can enable POWER-DOWN on the RF Modem
5	GND	Ground Signal	Ground
6	DSR	Data-Set-Ready	Connected to DCD (pin 1)
7	$\overline{\text{RTS}}$	Request-to-Send	Enables "Command Mode" on the RF Modem or provides RTS flow control
8	$\overline{\text{CTS}}$	Clear-to-Send	Provides Clear-to-Send flow control
9	RI	Ring Indicator	Optional power input that is connected internally to the front power connector

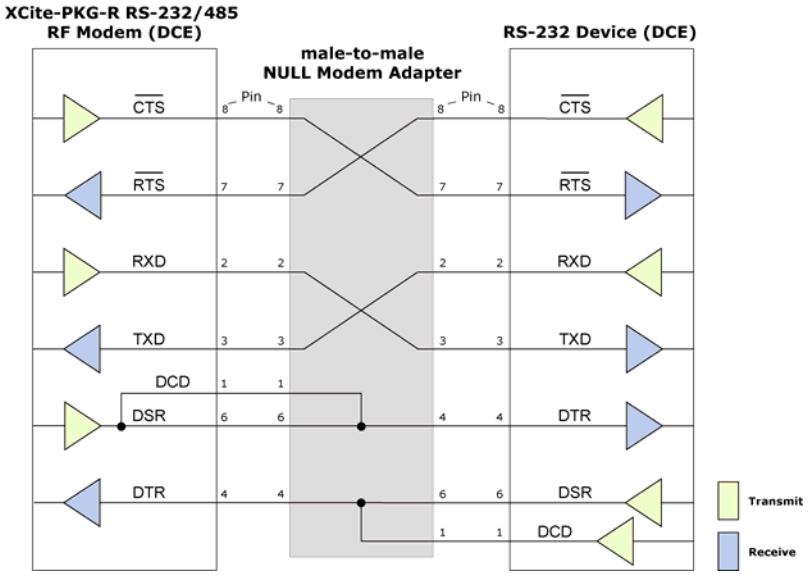
Wiring Diagram: RS-232 DTE Device to an RF Modem

Figure 10. XCite RF Modem wired to an RS-232 DTE (male connector) device



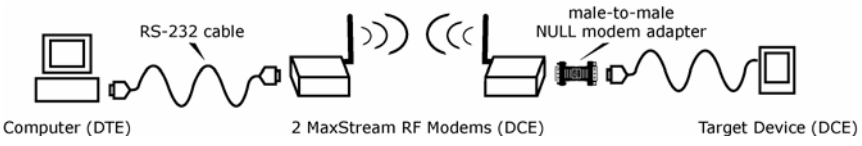
Wiring Diagram: RF Modem to an RS-232 DCE Device

Figure 11. XCite RF Modem wired to an RS-232 DCE (female connector) device



Sample Wireless Connection: DTE ⇔ DCE DCE ⇔ DCE

Figure 12. Typical wireless connection between DTE and DCE devices



RS-485 (2-wire) Half-Duplex Operation

DIP Switch Settings and Serial Port Connections

Figure 13.
RS-485 (2-wire) Half-Duplex DIP Switch Settings

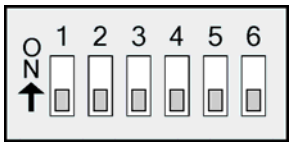
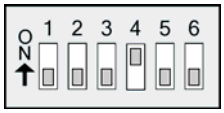


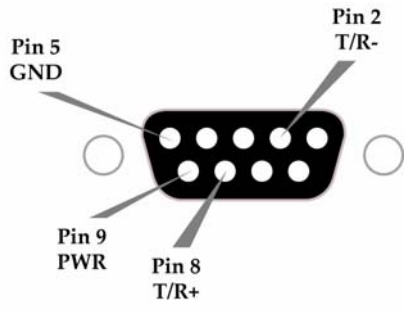
Figure 15.
RS-485 (2-wire) with Termination (Optional)



Termination is the 120Ω resistor between T+ and T-.

DIP Switch Settings are read and applied only while powering-on.

Figure 14
Pins used on the female DB-9 Serial Connector



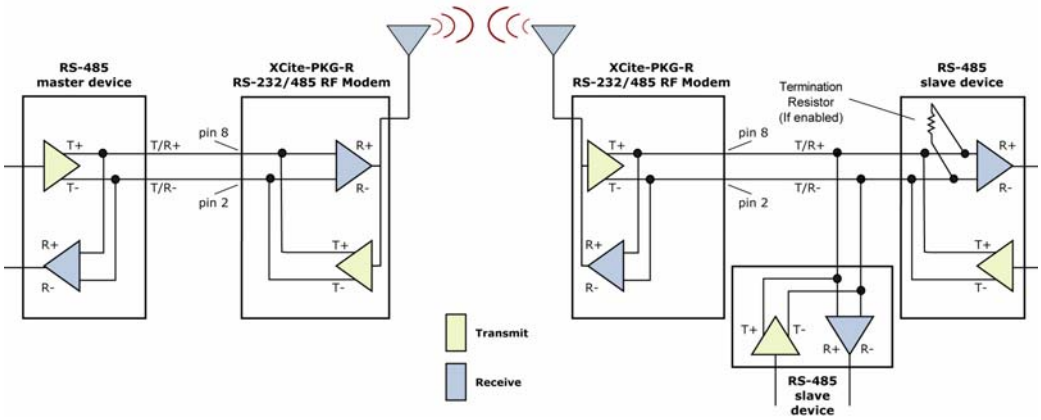
Note: Refer to Figures 22 and 23 [page 12] for RJ-45 connector pin designations used in RS-485/422 environments.

Table 3. RS-485 (2-wire Half-duplex) Signals and their implementations on the XCite-PKG-R RF Modem

DB-9 Pin	RS-485 Name	Description	Implementation
2	T/R- (TRA)	Negative Data Line	Transmit serial data to and from the XCite-PKG-R RF Modem
5	GND	Ground Signal	Ground
8	T/R+ (TRB)	Positive Data Line	Transmit serial data to and from the XCite-PKG-R RF Modem
9	PWR	Power	Optional power input that is connected internally to the front power connector
1, 3, 4, 6, 7	Not used		

Wiring Diagram: RS-485 (2-wire) Half-Duplex

Figure 16. XCite-PKG-R RF Modem in a 2-wire (half-duplex) RS-485 environment



RS-485 (4-wire) and RS-422 Operation

DIP Switch Settings and Serial Port Connections

Figure 17.
RS-485 (4-wire) and RS-422
DIP Switch Settings

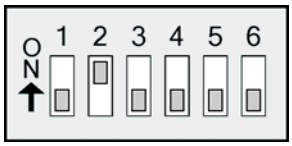


Figure 18.
Pins used on the female DB-9
Serial Connector

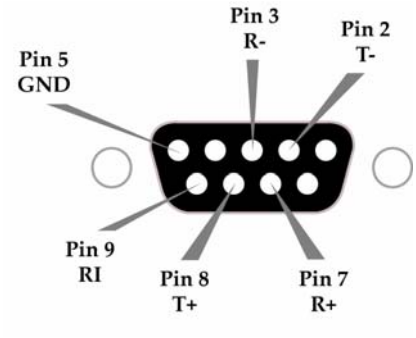
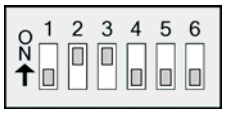


Figure 19.
RS-485/422 (4-wire) with Termination (Optional)



Termination is the 120Ω resistor between T+ and T-.

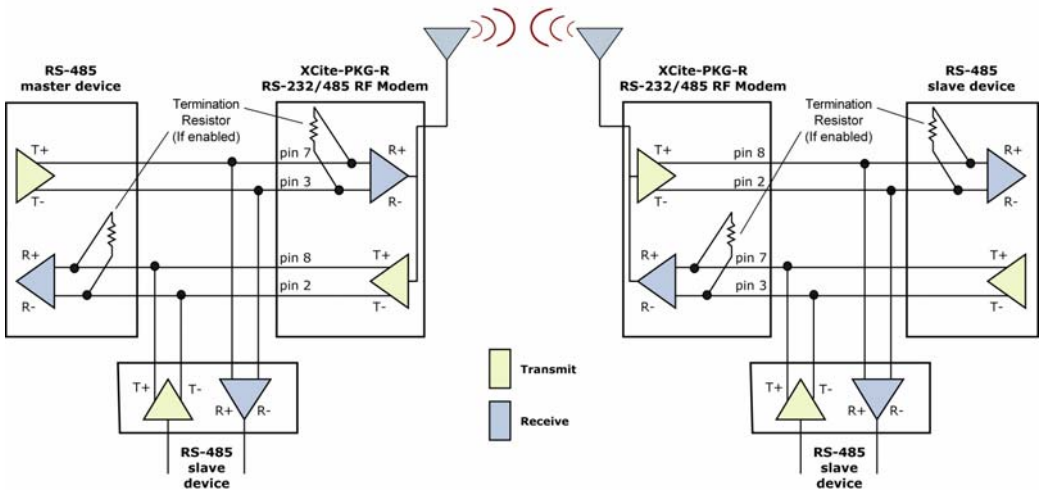
DIP Switch Settings are read and applied only while powering-on.

Table 4. RS-485/422 (4-wire) Signals and their implementations with the XCite-PKG-R RF Modem

DB-9 Pin	RS-485/422	Description	Implementation
2	T- (TA)	Transmit Negative Data Line	Serial data Sent from the XCite-PKG-R RF Modem
3	R- (RA)	Receive Negative Data Line	Serial data Received by the XCite-PKG-R RF Modem
5	GND	Signal Ground	Ground
7	R+ (RB)	Receive Positive Data Line	Serial data Received by the XCite-PKG-R RF Modem
8	T+ (TB)	Transmit Positive Data Line	Serial data Sent from the XCite-PKG-R RF Modem
9	PWR	POWER	Optional power input that is connected internally to the front power connector
1, 4, 6	Not Used		

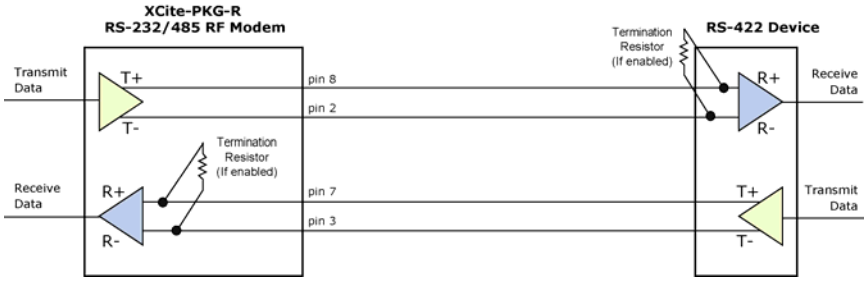
Wiring Diagram: RS-485 (4 wire)

Figure 20. XCite-PKG-R RF Modem in an RS-485 (4-wire) environment



Wiring Diagram: RS-422

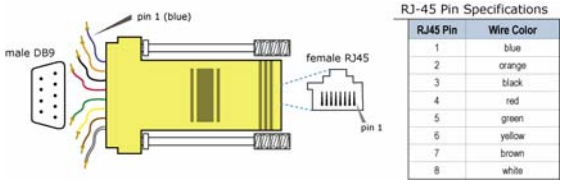
Figure 21. XCite-PKG-R RF Modem in an RS-422 environment



Male DB-9 to RJ-45 Adapter

Part Number: JE1D2-CDA-A (Yellow, RJ45 female to DB-9 male) This adapter facilitates adapting a DB-9 connector to a CAT5 cable.

Figure 22. Male RS-485/422 Adapter and pin specifications



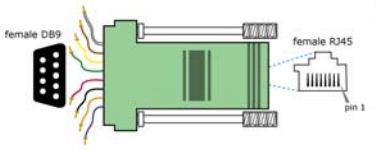
RJ-45 Pin Specifications

RJ45 Pin	Wire Color
1	blue
2	orange
3	black
4	red
5	green
6	yellow
7	brown
8	white

Female DB-9 to RJ-45 Adapter

Part Number: JE1D3-CDA-A (Green, RJ45 female to DB9 female) This adapter facilitates adapting a DB-9 connector to a CAT5 cable.

Figure 23. Female RS-485/422 Adapter and pin specifications



RJ-45 Pin Specifications

RJ45 Pin	Wire Color
1	blue
2	orange
3	black
4	red
5	green
6	yellow
7	brown
8	white

RS-485/422 Connection Guidelines

The RS-485/422 protocol provides a solution for wired communications that can tolerate high noise and push signals over long distances. RS-485/422 signals can communicate as far as 4000 feet (1200 meters). (RS-232 signals are only suitable for distances up to 100 feet (30.5 meters) RS-485 offers multidrop capability in which up to 32 nodes can be connected. The RS-422 protocol is used for point-to-point communications.

Interface voltages are interdependent of data protocol. Therefore, different RS-232/485/422 settings can be used in different nodes of one data radio system. In such a scenario, the RF Modem can function as a RS-485 to RS-232 converter.

Suggestions for integrating the XCite-PKG-R RS-232/485 RF Modem with the RS-485/422 protocol:

1. When using Ethernet twisted pair cabling: Select wires so that T+ and T- are connected to each wire in a twisted pair. Likewise, select wires so that R+ and R- are connected to a twisted pair. (For example, tie the green and white/green wires to T+ and T-.)
2. For straight-through Ethernet cable (not cross-over cable) – The following wiring pattern works well: Pin 3 to T+, Pin 4 to R+, Pin 5 to R-, Pin 6 to T-
3. Note that the connecting cable only requires 4 wires (even though there are 8 wires).
4. When using phone cabling (RJ-11) – Pin 2 in the cable maps to Pin 3 on opposite end of cable and Pin 1 maps to Pin 4 respectively.

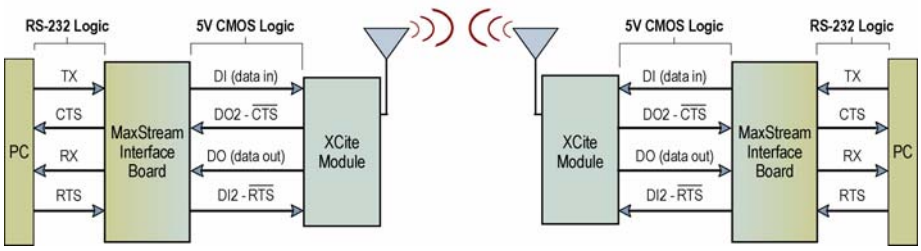
RF Modem Operation

Serial Communications

RS-232 and RS-485/422 Data Flow

The XCite Module can enable a host device to communicate wirelessly. To transmit, the host device simply sends serial data to the XCite Module pins. The XCite Module then converts the data into FCC-approved RF data. Once transmitted, the RF data can be detected by receiving XCite Modules, checked for integrity and then sent to a receiving device.

Figure 24. Data Flow in RS-232 and RS-485/422 environments.
(Low-asserted signals distinguished with a horizontal line over signal name.)

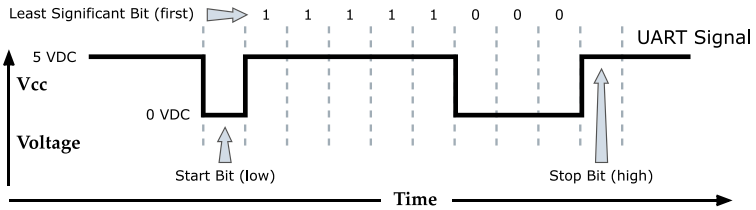


Serial Data

Data enters the MaxStream RF modem through the DI Pin (pin 4) as an asynchronous serial signal. The signal should idle high when no data is being transmitted.

The UART performs tasks (such as timing and parity checking) needed for communication. Serial communication consists of two UARTs which must be configured with compatible parameters (Baud rate, parity, start bits, stop bits, data bits) to have successful communication. Each data packet consists of a start bit (low), 8 data bits (least significant bit first) and a stop bit (high). The following figure illustrates the serial bit pattern of data passing through the modem.

Figure 25. Serial (UART) data packet 0x1F (decimal "31") as transmitted through the XCite Module
Data Format is 8-N-1 (8 bits - No Parity - 1 Stop Bit)

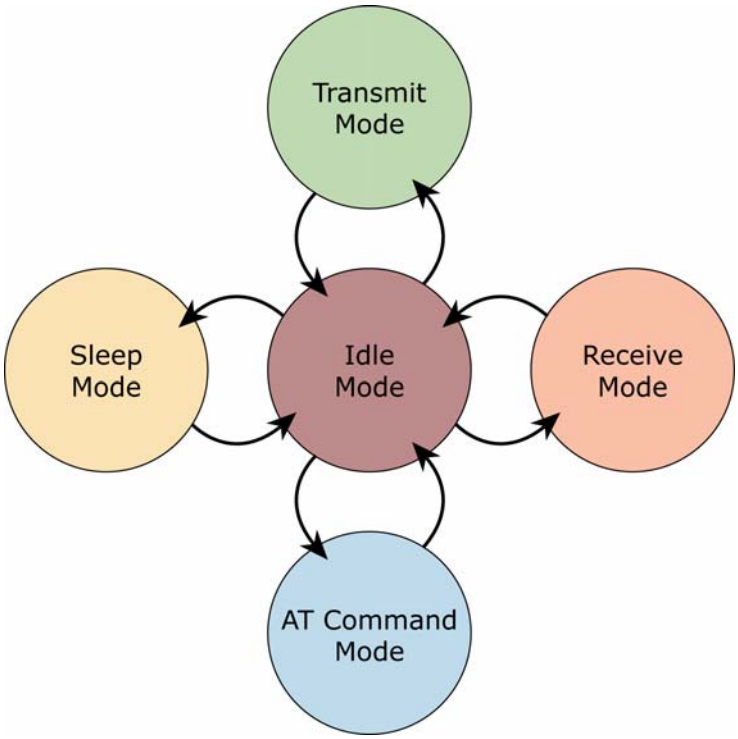


In the example above, the MaxStream Module transfer 8 bits over-the-air [Selectable using BI (Number of Bits) Parameter]. Start and stop bits of the UART signal are not transmitted over-the-air, but are regenerated by the receiving modem.

Modes of Operation

XCite Radio Modems operate in five modes. The modems operate in one mode at a time.

Figure 26. MaxStream Modes of Operation



Idle Mode

XCite Modules operate in Idle Mode when data is not being transmitted nor received. While in Idle Mode, modems use the same amount of power as they do in RX (Receive) mode. Modules will transition into other modes under any of the following conditions:

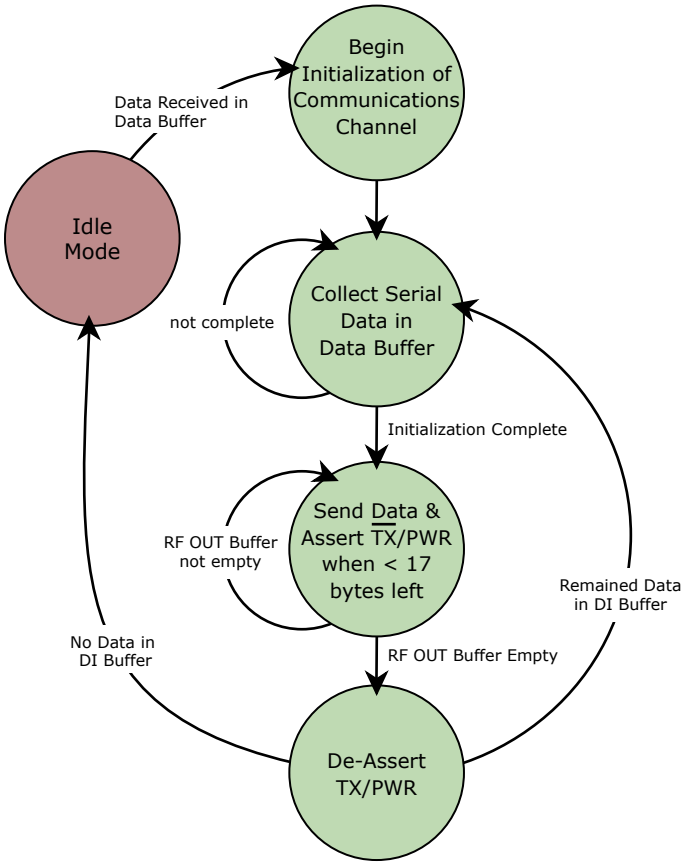
1. Serial data is received in the DI Buffer (Module then transitions into Transmit Mode)
2. Valid data is received by the antenna (Module then transitions into Receive Mode)
3. AT Command Mode Sequence is issued (Module then transitions into AT Command Mode)
4. Sleep Mode condition is met (Module then transitions into Sleep Mode)

Modules automatically transition back to Idle Mode once finished responding to these conditions.

Transmit Mode

When the first byte of serial data comes through the DI Pin and arrives in the DI Buffer, the modem transitions into Transmit Mode. Once in Transmit Mode, the modem initializes a communications channel. During channel initialization, incoming serial data accumulates in the DI buffer. After the channel is initialized, data in the DI buffer is grouped into packets (up to 64 bytes in each packet) and is transmitted. The modem continues to transmit data packets until the DI buffer is empty. Once transmission is finished, the modem returns to Idle Mode. This progression is shown below:

Figure 27. Transmission of data



Cyclic Redundancy Check (CRC)

To verify data integrity and provide built-in error checking, a 16-bit cyclic redundancy check (CRC) is computed for the transmitted data and attached to the end of each data packet before transmission. On the receiving end, the receiver computes the CRC on all incoming data. Received data that has an invalid CRC is discarded [See "Receive Mode" section on next page].

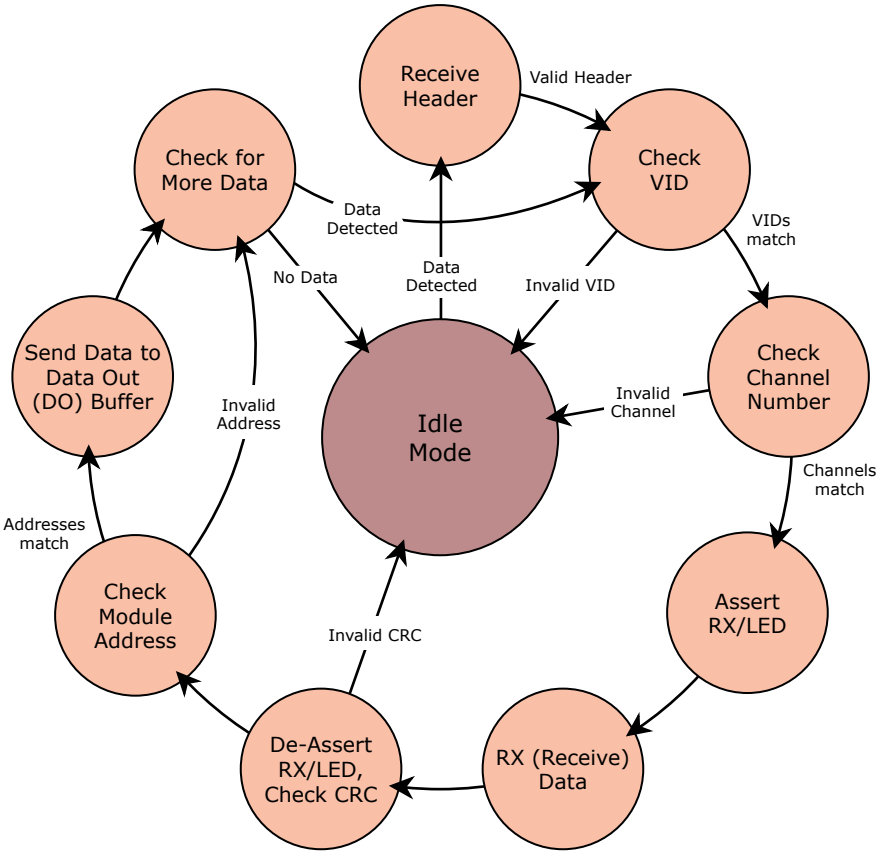
Transmission Latency

Transmission latency depends on the number of bytes contained in a packet and the baud rate of the modem. To reduce latency in the XCite Module, load in a single channel version using the X-CTU Software. Operating in Single Frequency Channel Mode greatly reduces latency.

Receive Mode

If a modem detects RF transmitted data while operating in Idle Mode, it transitions into Receive Mode to start receiving packets. Once a packet is received, it goes through the receiving-end of a CRC (cyclic redundancy check) to ensure that the data was transmitted without error. If the CRC data bits on the incoming packet are invalid, the packet is discarded. If the CRC is valid, the packet is placed the DO Buffer. This process is shown in the figure below:

Figure 28. Receive Mode Data Flow



The modem returns to Idle Mode after valid data is no longer detected or once an error is detected in the received data. If serial data-to-transmit is stored in the DI buffer while the modem is giving precedence to Receive Mode, the data will be transmitted after the modem finishes receiving data and returns to Idle Mode.

Sleep Modes

Sleep Modes enable the XCite Radio Modem to go into states of low power-consumption when not in use. Any of three Sleep Modes configurations can be used:

1. Host Controlled
2. Wake on RF activity
3. Wake on Serial Port activity

To enter Sleep Mode, one of the following must occur (In addition to SM (Sleep Mode) Command having a non-zero value):

- The radio modem must be idle (no data transmission or reception) for a user-defined period of time [See ST (Time before Sleep) Command]
- The Sleep Pin (Pin 2) is de-asserted

Once in Sleep Mode, the radio modem does not transmit or receive data until it first returns to Idle Mode. The return into Idle Mode is triggered by the de-assertion of Pin 2 or the arrival of a serial byte through Pin 4 (Data In). Sleep Mode is enabled and disabled using SM Command.

Pin Sleep (SM = 1)

<Lowest Power Configuration> In order to achieve this low-power state, Pin 2 must be asserted (high). The modem remains in Pin Sleep until the Sleep pin is de-asserted. The modem will complete a transmission or reception before activating Pin Sleep.

After enabling Pin Sleep (SM (Sleep Mode) Parameter = 1), Pin 2 controls whether the XCite Module is active or in Sleep Mode. When Pin 2 is asserted (high), the modem transitions to Sleep Mode and remains in its lowest power-consuming state until the Sleep pin is de-asserted. The XCite Module requires 40ms to transition from Sleep Mode to Idle Mode. Pin 2 is only active if the modem is setup to operate in this mode; otherwise the pin is ignored. Once in Pin Sleep Mode, $\overline{\text{CTS}}$ is de-asserted (high), indicating that data should not be sent to the modem. The PWR pin is also de-asserted (low) when the modem is in Pin Sleep Mode.

Serial Port Sleep (SM = 2)

Serial Port Sleep is a Sleep Mode setting in which the modem runs in a low power state until data is detected on the DI pin.

When Serial Port Sleep is enabled, the modem goes into Sleep Mode after a user-defined period of inactivity (no transmitting or receiving of data). This period of time is determined by ST (Time before Sleep) Command. The modem returns to Idle Mode once a character is received through the DI pin.

Cyclic Sleep (SM = 3-8)

Cyclic Sleep is the Sleep Mode setting in which the XCite Module enters into a low power state and awakens periodically to determine if any transmissions are being sent.

When Cyclic Sleep settings are enabled, the XCite Module goes into Sleep Mode after a user-defined period of inactivity (no transmission or reception on the RF channel). The user-defined period is determined by ST Parameter. [See ST (Time before Sleep) Parameter]

While the modem is in a low-power state, $\overline{\text{CTS}}$ is de-asserted (high) to indicate that data should not be sent to the modem during this time. When the modem awakens to listen for data, $\overline{\text{CTS}}$ is asserted and any data received on the DI Pin is transmitted. The PWR pin is also de-asserted (low) when the modem is in Cyclic Sleep Mode. These pins are asserted each time the modem cycles into Idle Mode to listen for valid data packets and de-asserts when the modem returns to Sleep Mode.

The modem remains in Sleep Mode for a user-defined period of time ranging from 0.5 seconds to 16 seconds (SM Parameters 3 through 8). After this interval of time, the modem returns to Idle Mode and listens for a valid data packet for 100 ms. If the modem does not detect valid data (on any frequency), the modem returns to Sleep Mode. If valid data is detected, the modem transitions into Receive Mode and receives the incoming packets. The modem then returns to Sleep Mode after a Period of inactivity that is determined by ST "Time before Sleep" Parameter.

The modem can also be configured to Wake-up from cyclic sleep when the SLEEP pin is de-asserted (low). To configure a modem to operate in this manner, PW (Pin Wake-up) Command must be issued. Once the Sleep pin is de-asserted, the modem is forced into Idle Mode and can begin transmitting or receiving data. It remains active until no data is detected for the period of time specified by the ST parameter, at which point it resumes its low-power cyclic state.

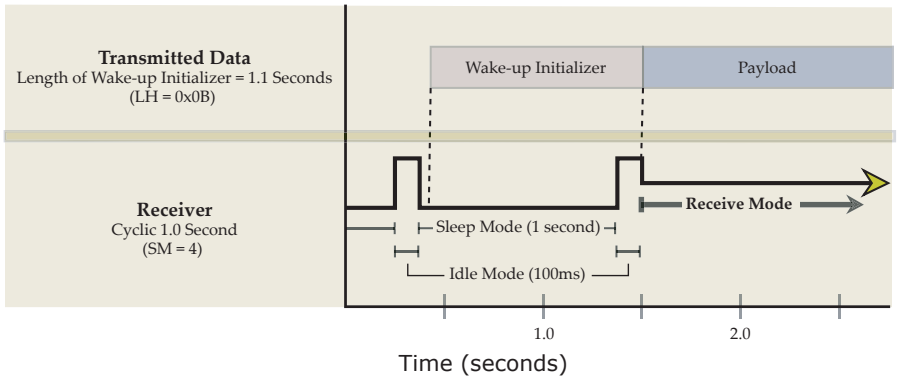
Note: The cyclic interval time defined by SM (Sleep Mode) Command must be shorter than the interval time defined by LH ("Wake-up Initializer Timer") Command. For example: If SM=4 (Cyclic 1.0 second sleep), the LH Parameter should equal 0xB ("1.1" seconds). With these parameters set, there is no risk of the receiving modem being asleep for the duration of the wake-up initializer transmission. The following section "Cyclic Scanning" explains in further detail the relationship between "Cyclic Sleep" and "Wake-up Initializer Timer"

Cyclic Scanning

Each RF transmission consists of a wake-up initializer and payload data. The wake-up initializer contains initialization information and all receiving modems must Wake-up during the wake-up initializer portion of data transmission in order to synchronize with the transmitter and receive the data.

Figure 29. Correct Configuration (LH > SM)

The length of the wake-up initializer exceeds the time interval of Cyclic Sleep. The receiver is guaranteed to detect the wake-up initializer and receive the accompanying payload data.



The wake-up initializer is sent with the initial transmitted packet after a user-defined period of inactivity (no serial or RF data is sent or received). This period of inactivity is adjusted using HT Command. [See HT (Time before Wake-up Initializer) Parameter] Sending a wake-up initializer (length slightly exceeds the cyclic sleep time interval) assures that the receiver will detect the new transmission and will be able to receive the accompanying data. If the sleeping modem misses the wake-up initializer due to interference and does not respond as expected, a new wake-up initializer can be sent using FH (Force Wake-up Initializer) Command.

Command Mode

AT Command Mode provides access to AT-Settable parameters. These parameters extend flexibility in configuring modems to fit specific design criteria such as networking modems. Not all of the parameters in the XCite Module can be adjusted using AT Commands.

AT Command Mode Protocol

Enter AT Command Mode

To issue XCite AT Commands, you must first transition out of Idle Mode and into AT Command Mode.

To enter into AT Command Mode, use any of the following means:

1. Through **X-CTU Software**: When using the X-CTU Software, any of the buttons that read or write modem parameters automatically trigger entrance into AT Command Mode. To successfully enter into AT Command Mode in this manner, the serial data baud rate [BD (Baud Rate) Parameter] of the modem must be equal to that of the PC Serial Com Port [Settable using the "PC Settings" tab of the X-CTU Software.] The X-CTU Software can be downloaded from: www.maxstream.net/support/downloads.php.
2. Through **Serial Communications Software** ("X-CTU", "HyperTerminal", "Pro Comm", etc.): When using serial communications software to enter into AT Command Mode, users must send the "AT Command Mode Sequence". The default sequence is as follows:

   a. No characters sent for 1 second. [Time can be modified using BT (Guard Time Before) Parameter]

   b. Input three (3) plus characters ("+++") within one (1) second. [Character can be modified using CC (Command Sequence Character) Parameter.]

   c. No characters sent for one (1) second. [Time can be modified using the AT (Guard Time After) Parameter.]

   "AT" & "BT" times must always be observed.
3. **Assert (low) the $\overline{\text{CONFIG}}$ pin*, then power the modem off and then on again.** (If using the MaxStream Interface Board, power and configuration switches are available to facilitate this process.)

Important: * Never tie the $\overline{\text{CONFIG}}$ pin to the microprocessor.

Configure and Read Module Parameters

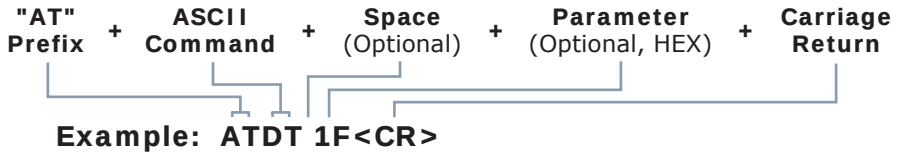
Once in AT Command Mode, parameters can be configured and read using AT Commands. Parameters changed while in AT Command Mode must be saved to non-volatile memory using WR (Write) Command for the changes to persist in memory. If WR Command is not issued, the parameters will be reset to their previously stored value the next time the modem is powered-up.

The "Modem Configuration" chapter is dedicated to explaining the methods needed to configure and read modem parameters. The following sections explain the protocols and syntax required to configure and read modem parameters.

Syntax. When using serial communications software, ASCII commands and parameters are not case sensitive. The optional space can be any non-alpha-numeric character and XCite Modules require parameter values be hexadecimal.

Figure 30. Syntax for sending AT Commands

(Sequence must be sent within 20 seconds of entering into AT Command Mode)



In example above, the "ATDT 1F" sequence would change the modem's networking address to a hexadecimal value of "1F" (decimal 31).

Queries. To query the current value of a particular parameter, send the corresponding AT command without any parameters (followed by a carriage return).

Multiple Commands. Multiple AT commands can be entered on one line with one carriage return at the end of the line. Each command must be delimited by a comma (and an optional space). The "AT" prefix is only sent before the first command and should not be included with subsequent commands in a line.

System Response. After executing a recognized AT command, the modem responds with "**OK<CR>**". If an unrecognized command or a command with a bad parameter is received, the modem responds with "**ERROR<CR>**." Modified AT values are reset to previous stored values upon modem power-down unless the WR (Write) Command was issued to save parameters to non-volatile memory.

Basic methods for sending AT Commands.

Example: Both of the following examples change the user-defined Destination Address to 0x1A0D and save changes to non-volatile memory.

Method 1 (One line per command)

Issue AT Command	System Response
+++	OK<CR> (Enter into AT Command Mode)
ATDT 1A0D<CR>	OK<CR> (Change Destination Address)
ATWR<CR>	OK<CR> (Write to non-volatile memory)
ATCN<CR>	OK<CR> (Exit AT Command Mode)

Method 2 (Multiple commands on one line)

Issue AT Command	System Response
+++	OK<CR>
ATDT 1A0D, WR, CN<CR>	OK<CR>
	OK<CR> (Write to non-volatile memory)
	OK<CR> (Exit AT Command Mode)

<CR> = Carriage Return

Exit AT Command Mode

1. If no valid AT Commands are received within the time specified by CT (Time Out) Parameter, the modem automatically returns to Idle Mode.
2. AT Command Mode can be exited explicitly by issuing CN (Exit AT Command Mode) Command.

RF Modem Configuration

X-CTU Software Configurations

The following versions of the XCite Modem are currently available:

- 900 MHz, 9600 Baud (RF data rate), Hopping Channel Mode
- 900 MHz, 9600 Baud, Single Channel mode
- 900 MHz, 38400 Baud, Hopping Channel mode
- 900 MHz, 38400 Baud, Single Channel mode

XCite Modules can operate in both Single Channel and Hopping modes. Mode is selectable using the "Function Set" dropdown list of the "XCite Configuration" tab of the MaxStream-provided X-CTU Software.

The XCite Module is shipped with a unique parameter set in its memory. Parameters within the set are organized under the following categories: AT Commands & Non-AT Settable Parameters.

Command & Parameter Types

AT Commands

AT Commands can be changed at any time by entering AT Command Mode and sending commands to the modem. [AT Commands are listed in Table 5.]

AT Commands can be modified using the any of the following means:

- X-CTU Software "Modem Configuration" tab
- X-CTU Software "Terminal" tab
- Terminal software program (such as "HyperTerminal")
- Microcontroller

Non-AT Settable Parameters

Non-AT Settable Parameters can only be adjusted using the MaxStream-provided X-CTU Software. To modify Non-AT Settable Parameter, connect the modem to the serial com port of a PC (interface board is necessary for RS-232 connection) and modify parameter values through the X-CTU Software interface. These parameters enable features that need to be set before the modem is used in the field. [Non-AT Settable Parameters are listed in Table 6.]

Non-AT Settable Parameters can only be modified using the following means:

- X-CTU Software "Modem Configuration" tab

Command Reference Tables

XCite AT Commands and Non-AT Settable Parameters are organized under the following command categories:

- AT Command Mode Options
- Diagnostic
- Networking
- Serial Interfacing
- Sleep Mode (Low Power)

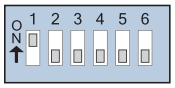
Table 7. XCite AT Commands
(Settable/Readable using X-CTU Software, serial communications software or microcontroller)

AT Designator	Command Description	Parameters	Command Category	# Bytes Returned	Factory Default
CD	DI3 Configuration. Redefines the RX LED I/O line (RX LED signal).	Range: 0 – 2 0 = RX LED 1 = high 2 = low	Serial Interfacing	1	0
CN	Exit AT Command Mode. Explicitly exit radio modem from AT Command Mode and return it to Idle Mode.	-	AT Command Mode Options	-	-
CS	DO2 Configuration. Select behavior of DI2 (Digital Output 2) between $\overline{CTS}$ and RS-485 options.	Range: 0 – 4 0 = normal $\overline{CTS}$ 1 = RS-485 enable low 2 = high 3 = RS-485 enable high 4 = low	Serial Interfacing	1	0
DB	Receive Signal Strength. Returns the signal strength (in decibels) of the last received packet.	Range: 0x25 – 0x6A (Read-only)	Diagnostic	1	-
DT	Destination Address. Set the address that identifies the destination of the RF packet. Only radio modems having matching addresses can communicate with each other.	Range: 0 – 0xFFFF	Networking	2	0
FH	Force Wake-up Initializer. Force a Wake-up Initializer to be sent on the next transmission. WR (Write) Command does not need to be issued with FH Command. Use only with cyclic sleep modes (SM = 3-8) active on remote modems.	-	Sleep (Low Power)	-	-
HP	Channel *. Select "Hopping" or "Single Frequency" channel on which the radio modem is to communicate. Channels are not non-interfering.	Range (Hopping): 0 – 6 Range (Single Frequency): 0 – 0x18	Networking	1	0
HV	Hardware Version. Read the hardware version of the modem.	Range: 0 – 0xFFFF (Read-only)	Diagnostic	2	-
MK	Address Mask. Set address mask to configure local and global address space.	Range: 0 – 0xFFFF	Networking	2	0xFFFF (65535d)
RE	Restore Defaults. Restore AT-settable parameters to the factory default configuration.	-	(Special)	-	-
SH	Serial Number High. Read High 16 bits of unique serial number of radio modem.	0 – 0xFFFF (Read-only)	Diagnostic	2	-
SL	Serial Number Low. Read Low 16 bits of unique serial number of radio modem.	0 – 0xFFFF (Read-only)	Diagnostic	2	-
VR	Firmware Version. Read firmware version currently loaded on radio modem.	0 x 0xFFFF (Read-only)	Diagnostic	2	-
WR	Write. Write parameters to radio modem's non-volatile memory in order for changes to persist through next power-up or reset.	-	(Special)	-	-

Table 8. Non-AT Settable Parameters
(Settable/Readable using the X-CTU Software's "Modem Configuration" tab only)

AT Designator	Command Description	Parameters	Command Category	# Bytes Returned	Factory Default
AT	Guard Time After. Set required DI pin silent time after the Command Sequence Characters of the AT Command Mode Sequence (BT+ CC + AT).	Range: 0 – 0xFFFF (x 1 ms)	AT Command Mode Options	2	0x1F4 (500d)
BD	Interface Data Rate. Set serial data rate (baud rate at which radio modem interfaces with host). Serial data rate is different than RF data rate which is fixed and factory-set. If the serial data rate is set higher than RF data rate, $\overline{CTS}$ may need to be observed to prevent DI buffer overrun.	Range: 0 – 6 (1200 - 57600 bps)	Serial Interfacing	1	Set to equal radio modem's fixed RF data rate.
BI	Number of Bits. (7 or 8) – Sets number of data bits per character (bits between start and stop bits).	Range: 0 – 1 0 = 7 bits 1 = 8 bits	Serial Interfacing	1	1
BT	Guard Time Before. Set required DI pin silent time before the Command Sequence Characters of the Command Mode Sequence (BT+ CC + AT).	Range: 0 – 0xFFFF (x 1 ms)	AT Command Mode Options	2	0x1F4 (500d)
CC	Command Sequence Character. Set the ASCII character to be used between Guard Times of the AT Command Mode Sequence (BT+ CC + AT). The AT Command Mode Sequence enters the radio modem to AT Command Mode (from Idle Mode).	Range: 0x20 – 0x7F	AT Command Mode Options	1	0x2B (plus sign (+) in ASCII)
CT	Time before Exit AT Command Mode. Set time period of inactivity (no valid commands received) after which radio modem automatically exits from AT Command Mode.	Range: 0x02 – 0xFFFF (x 100 ms)	AT Command Mode Options	2	0xC8 (200d)
FL	Software Flow Control. Enable serial software flow control on the radio modem. (Hardware flow control ($\overline{CTS}$) is on by default.)	Range: 0 - 1 0 = disable 1 = enabled	Serial Interfacing	1	0
HT	Time before Wake-up Initializer. Set time period of inactivity (no serial or RF data is sent or received) before a Wake-up Initializer is sent. Base station tracks awake-status of remote radios. HT of base radio should be set shorter than ST of remote radios.	Range: 0 – 0xFFFF (x 100 ms)	Sleep (Low Power)	2	0xFFFF (no wake-up Initializer will be sent)
ID	Modem VID. Read radio modem VID (Vendor Identification Number). Only radio modems with matching VIDs can communicate with each other.	Range: 0 – 0x7FFF (above this range is Read-only)	Networking	2	0x3332
LH	Wake-up Initializer Time. Set time of the Wake-up Initializer used to wake remote radios that are in cyclic sleep mode. Time of Wake-up Initializer should be longer than that of the remote radio's cyclic sleep cycle (SM 3 - 8).	Range: 0 – 0xFF (x 100 ms)	Sleep (Low Power)	1	1
NB	Parity. Select parity format. Settings 0-4 transfer only 8 bits out the antenna port and generate the parity bit on the radio modem receiving side.	Range: 0 – 4 0 = 8-none-1, 7-any-1 1 = 8-even-1 2 = 8-odd-1 3 = 8-mark-1, 8-none-2 4 = 8-space-1	Serial Interfacing	1	0
PW	Pin Wake-up. Enable pin wake-up from Cyclic Sleep Mode.	Range: 0 – 1 0 = disabled 1 = enabled	Sleep (Low Power)	1	0
RT	DI2 Configuration. Enable $\overline{RTS}$ Mode	Range: 0 - 1 0 = Disabled 1 = $\overline{RTS}$ flow control	Serial Interfacing	1	0
SB	Stop Bits. Set number of stop bits.	Range: 0 – 1 0 = 1 stop bit 1 = 2 stop bits	Serial Interfacing	1	0
SM	Sleep Mode. Specify Sleep Mode settings.	Range: 0 – 8 0 = No sleep 1 = Pin Sleep 2 = Serial Port Sleep 3 to 8 = Cyclic intervals ranging from 0.5 to16.0 seconds	Sleep (Low Power)	1	0
ST	Time before Sleep. Set time period of inactivity (no serial or RF data is sent or received) before activating Sleep Mode. Use with Cyclic Sleep and Serial Port Sleep. (see SM Command)	Range: 0x10 – 0xFFFF (x 100 ms)	Sleep (Low Power)	2	0x64 (100d)

Automatic DIP Switch Configurations



Each time the RF Modem is powered-on, intelligence on the MaxStream Interface Board (located inside the RF Modem) sends AT Commands that program the RF Modem based on positions of the DIP Switch. Automatic configurations that take place during the power-on sequence affect RF Modem parameter values as shown below [Table 6].

To avoid overwriting previously stored custom configurations (due to the automatic configurations that take place each time the RF Modem is powered-on), it is necessary to disable a processor located on the XIB-R interface board. To disable the processor, populate J7 of the XIB-R Interface Board. (By default, J7 jumper is not populated.)

Table 9. RF Modem Power-up Options (J7 jumper and Config Switch)

Condition	Behavior
If J7 is populated	Processor is disabled and AT Commands are not sent to the RF Modem
If Config Switch is pressed	Processor is disabled and RF Modem enters into AT Command Mode
If J7 is NOT populated and Config Switch is NOT pressed	Execute logic as shown in Table 6.

Table 10. AT Commands Sent as result of DIP Switch Settings (SW = DIP Switch)

Condition	Behavior
Serial Interfacing Options	
If SW1 is ON (up)	AT Commands sent: ATCS 0 (RS-232 Operation: $\overline{CTS}$ function for $\overline{CTS}$ line) ATCD 2 (DO3 - RX LED = low)
If SW1 is OFF (down)	AT Commands sent: ATCS 3 (RS-485 or RS-422 Operation) ATCD 2 (DO3 - RX LED = low)
Exit AT Command Mode	
Always	AT Commands sent: ATCN (Exit AT Command Mode)

Modem Profiles

Modem Profiles provide a method of saving radio parameters to a computer for later use. When configuring a RF Modem, use the "Save Profile" button to store custom settings.

How to Use Modem Profiles

1. Connect the RF Modem to the serial port of a PC (Using an RS-232 cable)
2. Launch the X-CTU software
3. Click the "Modem Configuration" tab
4. Set modem parameters according to data radio system criteria.
5. Click the "Save Profile" button to any folder located on the PC.

→ To view previously saves profiles, click the "Load Profile" button and navigate to the saved file.

Full-Duplex

USE:	Profile can be used to simulate Full-Duplex communication between 2 MaxStream radios. Use this profile if communication may be initiated from either RF Modem simultaneously.	**Parameters:** RT = 2 RR = 20 RN = 4
DESCRIPTION:	When streaming data, this profile inserts delays (RN) after it has transmitted the number of bytes determined by the TT command. This allows the other radio the opportunity to transmit its data and simulates a full-Duplex mode. Flow control should be observed.	

Low Power Cyclic Sleep (Base)

USE:	To wake a remote radio in cyclic sleep mode.	**Parameters:** SM = 0 HT = 13 LH = [0x6 - 0x51]
DESCRIPTION:	Set a RF Modem to send a .6 second to 16.1 second channel initialization header that will wake a modem in the .5 second to 16 second cyclic sleep mode. Notice that Time-to-Sleep (ST) on the remote must be a tenth of a second shorter than the time-to-Long-Header (HT) on the base modem.	
SPECIAL:	Profile should be programmed into the base modem that is to initiate communication. Use "Lower Power Cyclic Sleep Remote" profile for remote.	

Low Power Cyclic Sleep (Remote)

USE:	To have a radio go to low power mode.	**Parameters:** ST = 14 SM = [3 - 7]
DESCRIPTION:	Use profile to set a modem to a low power mode where it will wake up every (.5 to 16) seconds to check for a transmission. If there is a transmission the radio will wake up and receive the incoming data, returning to sleep after 2 seconds (ST) of no transmitting or receiving data.	
SPECIAL:	Profile should be programmed into the low power remote modem. Use "Low Power Cyclic Sleep Base Station" profile for base.	

Low Power Mode (Pin Sleep)

USE:	Pin sleep mode can be used to control the sleep and wake states of the radio.
DESCRIPTION:	This profile tells the radio to monitor the DTR pin to control the sleep and wake states.

Parameter:
SM = 1

Low Power Mode (Serial Port Sleep)

USE:	Radio is in low power mode until an RS-232 character is received.
DESCRIPTION:	If this state is enabled, the modem goes into Sleep Mode after a user-defined period of inactivity (no transmitting or receiving of data). In this mode, the PWR LED is off. The modem will return to Idle Mode after the (ST) inactivity time.

Parameter:
SM = 2

Modem Emulation (Base)

USE:	This allows a PC to initiate point-to-point connections between a "base modem" and multiple "remote modems" - one at a time.
DESCRIPTION:	This profile configures a "base modem" to "dial" uniquely addressed remote modems using an ATDT dialing string. The modem will default to command mode when turned on - use DTR to control power. After 60 seconds, the modem will automatically revert to data mode (CT) using the previously saved modem address (DT). Retries (RR) are enabled to ensure a reliable connection.
SPECIAL:	Use in conjunction with the Modem Emulation (Remote Modem) profile.

Parameters:
RR = 14
SM = 1
CT = 258
PC = 1

Modem Emulation (Remote)

USE:	Allow a PC to initiate point-to-point connections between a "base modem" and multiple "remote modems" - one at a time.
DESCRIPTION:	This profile configures a "remote modem" to respond when the base modem "dials" the address "1 to n" using an ATDT dialing string. Retries (RR) are enabled to ensure a reliable connection.
SPECIAL:	To contact this modem, send the dialing string "ATDT4,CN"<CR> to the base modem to initiate the communication. Use in conjunction with the Modem Emulation (Base Station) profile.

Parameters:
RR = 14
DT = [1 - 4]

RS-485

USE:	This profile is for half-duplex RS-485 operation.
DESCRIPTION:	This profile programs the radio to use the CTS as an RS-485 Transmit Enable.
SPECIAL:	This mode is configured automatically through proper DIP Switch settings. This mode will be overwritten if the RF Modem is configured through the DIP Switch for RS-232 operation.

Parameter:
CS = 1

Command Descriptions

Commands and parameters are listed alphabetically. Parameter types and categories are designated between "< >" symbols. For example: <AT Command: Networking>. "AT Command" is the command/parameter type and "Networking" is the command/parameter category.

AT (Guard Time After) Parameter

<Non-AT Settable Parameter: AT Command Options> AT Parameter is used to set the DI pin silent time that follows the command sequence character (CC Parameter). By default, 1 half of a second (500 milliseconds) must elapse before entering another character. The AT Command Mode Sequence used to enter AT Command Mode is as follows:

- No characters sent for 1 millisecond [BT (Guard Time Before) Parameter]
- Send three plus characters "+++" [CC (Command Sequence Character) Parameter]
- No characters sent for 1 millisecond [AT (Guard Time After) Parameter]

All of the values in this sequence can be adjusted. AT Parameter is used to adjust the period of silence that follows the command sequence character.

Parameter Range: 0x02 – 0xFFFF (x 1 millisecond)

# of bytes returned: 2

Default Parameter Value: 0x1F4 (500 decimal)

Related Commands: BT (Silence before Sequence), CC (Commands Sequence Character)

BD (Interface Data Rate) Parameter

<Non-AT Settable Parameter: Serial Interfacing> BD Parameter allows the user to adjust the UART baud rate and thus modify the rate at which serial data is sent to the modem. Baud rates range from 1200 to 57600 baud (bps). The new baud rate does not take effect until CN (Exit AT Command Mode) Command is issued.

Note: If the serial data baud rate is set to exceed the fixed RF data baud rate of the XCite radio modem, $\overline{\text{CTS}}$ flow control may need to be implemented as is described in the "I/O Pin Signals" section of this Manual.

Parameter Range: 0 – 6

# of bytes returned: 1

Default Parameter Value: Set to equal radio modem's fixed RF data rate (baud).

Parameter Value	Configuration
0	1200 Baud (bps)
1	2400
2	4800
3	9600
4	19200
5	38400
6	57600

BI (Number of Bits) Parameter

<Non-AT Settable Parameter: Serial Interfacing> BI Parameter allows the user to define the number of data bits between the start and stop bits. Setting 7 bits and Mark or Space parity (NB Parameter) will result in a setting of 7 bits and no parity.

Parameter Range: 0 – 1

# of bytes returned: 1

Default Parameter Value: 1

Parameter Value	Configuration
0	7 bits
1	8

BT (Guard Time Before) Parameter

<Non-AT Settable Parameter: AT Command Options> BT Parameter is used to set the DI pin silent time that precedes the command sequence character (CC Parameter). By default, 1 half of a second (500 milliseconds) must elapse before entering another character. The AT Command Mode Sequence used to enter AT Command Mode is as follows:

- No characters sent for 1 millisecond [BT (Guard Time Before) Parameter]
- Send three plus characters "+++" [CC (Command Sequence Character) Parameter]
- No characters sent for 1 millisecond [AT (Guard Time After) Parameter]

All of the values in this sequence can be adjusted. AT Command is used to adjust the period of silence that precedes the command sequence character.

Parameter Range: 0 - 0xFFFF (x 1 millisecond)

# of bytes returned: 2

Default Parameter Value: 0x1F4 (500 decimal)

Related Commands: AT (Guard Time After), CC (Commands Sequence Character)

CC (Command Sequence Character) Parameter

<Non-AT Settable Parameter: AT Command Options> CC Parameter is used to adjust the command sequence character used when entering AT Command Mode.

The AT Command Mode Sequence used to enter AT Command Mode is as follows:

- No characters sent for 1 millisecond [BT (Guard Time Before) Parameter]
- Send three plus characters "+++" [CC (Command Sequence Character) Parameter]
- No characters sent for 1 millisecond [AT (Guard Time After) Parameter]

Parameter Range: 0x20 – 0x7F

# of bytes returned: 1

Default Parameter Value: 0x2B (ASCII "+" sign)

Related Parameters: AT (Guard Time After), BT (Guard Time Before)

CD (DO3 Configuration) Command

<AT Command: Serial Interfacing> Used to redefine the RX LED I/O line.

AT Command: CD

Parameter Range: 0 – 5

# of bytes returned: 1

Default Parameter Value: 0

Parameter Value	Configuration
0	RX LED
1	High
2	Low

CN (Exit AT Command Mode) Command

<AT Command: AT Command Mode Options> CN Command allows users to explicitly exit AT Command Mode and return the radio modem into Idle Mode.

AT Command: CN

CS (DO2 Configuration) Command

<AT Command: Serial Interfacing> CS Command is used to modify the behavior of the $\overline{CTS}$ signal such that it either provides RS-232 flow control, enables RS-485 transmission / reception or determines RS-422 transmit enable. By default, $\overline{CTS}$ provides RS-232 flow control. CS Parameter must be adjusted for the modem to operate in RS-485/422 environments.

AT Command: CS

Parameter Range: 0 – 4

# of bytes returned: 1

Default Parameter Value: 0

Parameter Value	Configuration
0	Normal
1	RS-485 Enable (low)
2	high
3	RS-485 Enable (high)
4	low

CT (Time before Exit AT Command Mode) Parameter

<Non-AT Settable Parameter: AT Command Options> AT Command Mode can be exited manually using CN (Exit AT Command Mode) Command or, after a given time of inactivity, the modem exits AT Command Mode on its own and return to Idle Mode. CT Command sets the amount of time before AT Command Mode is exited automatically. If no characters are received before this time elapses, the modem will return to Idle Mode.

Parameter Range: 0x02 – 0xFFFF [x 100 ms]

# of bytes returned: 2

Default Parameter Value: 0xC8 (20 seconds decimal)

DB (Receive Signal Strength) Command

<AT Command: Diagnostic> DB Parameter returns the receive signal strength (in decibels) of the last received packet. This Parameter is useful in determining range characteristics of the XCite Modules under various conditions.

AT Command: DB

Parameter Range: 0x25 – 0x6A [Read-only]

# of bytes returned: 1

DT (Destination Address) Command

<AT Command: Networking> DT Command is used to set the address of the XCite Radio Modem. XCite Radio Modems use three network layers – the Vendor Identification Number (ATID), Channels (ATHP) and Destination Addresses (ATDT).

DT Command assigns an address to a radio modem that enables it to communicate only with radio modems that have matching addresses. This is similar to interconnecting several PCs under a common hub. All radio modems that share the same destination address can communicate freely with each other. Radio Modems in the same network with a different destination address (than that of the transmitter) will listen to all transmissions to stay synchronized, but will not send any of the data out their serial ports.

AT Command: DT

Parameter Range: 0 - 0xFFFF

# of bytes returned: 2

Default Parameter Value: 0

Related Commands: ID (Modem ID), HP (Channel), MK (Address Mask)

FH (Force Wake-up Initializer) Command

<AT Command: Sleep (Low Power)> FH Command is used to force a Wake-up Initializer to be sent on the next transmission. WR (Write) Command does not need to be issued with FH Command. Use only with cyclic sleep modes active on remote modems.

FL (Software Flow Control) Parameter

<Non-AT Settable Parameter: Serial Interfacing> FL Parameter is used to adjust serial flow control. Hardware flow control is implemented with the XCite Radio Modem as the $\overline{CTS}$ pin (which regulates when serial data can be transferred to the radio modem). FL Parameter can be used to allow software flow control to also be enabled. The XON character to use is 0x11 ("17" decimal). The XOFF character to use is 0x13 ("19" decimal)

Parameter Range: 0 – 1

# of bytes returned: 1

Default Parameter Value: 0

Parameter Value	Configuration
0	No Software Flow Control
1	Use Software Flow Control

HP (Channel) Command

<AT Command: Networking> HP Command is used to set the radio modem channel number. A channel is one of three layers of addressing available to the XCite Radio Modem. In order for radio modems to communicate with each other, the modems must have the same channel number since each channel uses a different hopping sequence or single frequency. Different channels can be used to prevent modems in one network from listening to transmissions of another.

The XCite Radio Modem can operate both in Hopping and Single Frequency Channel Modes. Switching between Single Channel and Hopping Modes can only be done only using the "Function Set" dropdown list on the "Modem Configuration" tab of the X-CTU Software.

AT Command: HP

Hopping Channel Range: 0 – 6

Single Frequency Channel Range: 0 - 0x18

# of bytes returned: 1

Default Parameter Value: 0

Related Parameters: DT (Destination Address), ID (Modem ID), MK (Address Mask)

A "**Hopping Channel**" is a channel comprised of a group of frequencies. When in Hopping Channel Mode, the radio modem hops between the frequencies them when transmitting data. This option utilizes FHSS (Frequency Hopping Spread Spectrum) technology. This option helps bolster security in wireless data communications and also makes the system less prone to interference.

The 25 center frequencies available in **Single Frequency Channel Mode** are spaced 300 KHz apart. Since each channel occupies a 500 KHz bandwidth, adjacent channels therefore overlap. If modems are used in the same vicinity but on different channels, the channels used should occupy every other channel at a minimum separation. If channels used on different radio modems can be separated more they should be. This will provide for more isolation and less interference.

Single Frequency Channel Mode Parameters

Parameter Value	Frequency (MHz)
0x00	910.5
0x01	910.8
0x02	911.1
0x03	911.4
0x04	911.7
0x05	912.0
0x06	912.3
0x07	912.6
0x08	912.9
0x09	913.2
0x0A	913.5
0x0B	913.8
0x0C	914.1
0x0D	914.4
0x0E	914.7
0x0F	915.0
0x10	915.3
0x11	915.6
0x12	915.9
0x13	916.2
0x14	916.5
0x15	916.8
0x16	917.1
0x17	917.4
0x18	917.7

HT (Time before Wake-up Initializer) Parameter

<Non-AT Settable Parameter: Sleep (Low Power)> If any modems within range are running in a "Cyclic Sleep Setting", a wake-up initializer must be sent by the transmitter for the other radio modems to synchronize to the transmitter [see LH ("Wake-up Initializer Timer") Command]. When a receiving radio modem in Cyclic Sleep wakes, it must detect the wake-up initializer portion of the RF packet in order to synchronize to the transmitter and receive data. HT Parameter sets time period of inactivity (no serial or RF data is sent or received) before a Wake-up Initializer is sent. Base station tracks awake-status of remote radios. HT of base radio should be set shorter than ST (Time before Sleep) of remote radios.

From the receiver perspective, after "HT" time elapses and the ST (Time before Sleep) Parameter is met, the receiver goes into cyclic sleep. Once in cyclic sleep, the radio modem must first detect the wake-up initializer and synchronize to the transmitter before it can receive data. Thus, when time "HT" time elapses, the transmitter then knows it needs to send a long wake-up initializer for all receivers to be able to synchronize to its next transmission. Matching "HT" to the "ST" time on the receiver(s) guarantees that all receivers will detect the next transmission.

Parameter Range: 0 - 0xFFFF [x 100 ms]

# of bytes returned: 2

Default Parameter Value: 0xFFFF (long wake-up initializer will not be sent)

Related Parameters: LH (Wake-up Initializer Timer), SM (Sleep Mode), ST (Time before Sleep)

HV (Hardware Version) Command

<AT Command: AT Command Options> Reads and returns the hardware version of the XCite Module.

AT Command: HV

Parameter Range: 0 – 0xFFFF [Read-only]

# of bytes returned: 2

ID (Modem VID) Parameter

<Non-AT Settable Parameter: Networking> ID Parameter reads and edits the modem's VID. VID is a MaxStream-specific acronym that stands for "Vendor Identification Number". Modules can only communicate with other modems having the same VID.

Parameter Range: 0 - 0x7FFF (above this range is Read-only)

# of bytes returned: 2

Default Parameter Value: 0x3332

LH (Wake-up Initializer Timer) Parameter

<Non-AT Settable Parameter: Sleep (Low Power)> LH Parameter adjusts the duration of time in which the wake-up initializer is sent. When receiving modems are put into the Cyclic Sleep Mode, they power-down after a period of inactivity (specified by ST (Time before Sleep) Parameter) and will periodically awaken and listen for transmitted data. In order for the receiving modems to initialize with the transmitter, they must detect ~35ms of the wake-up initializer. LH Parameter must be used whenever a receiver is operating in Cyclic Sleep Mode. This lengthens the wake-up initializer to a specific amount of time (in x 100 ms). The long wake-up initializer must be longer than the cyclic sleep time that is determined by SM (Sleep Mode) Command. If the wake-up initializer time were less than the Cyclic Sleep interval, the connection would be at risk of missing the wake-up initializer transmission. The data and figures on the next page illustrate this behavior:

LH Command (continued)

Parameter Range: 0 – 0xFF [x 100 ms]

# of bytes returned: 1

Default Parameter Value: 0x01 (0.1 second)

Related Parameters: HT (Time before Wake-up Initializer), SM (Sleep Mode), ST (Time before Sleep)

Figure 31. Correct Configuration (LH > SM)

The length of the wake-up initializer exceeds the time interval of Cyclic Sleep. The receiver is guaranteed to detect the wake-up initializer and receive the accompanying payload data.

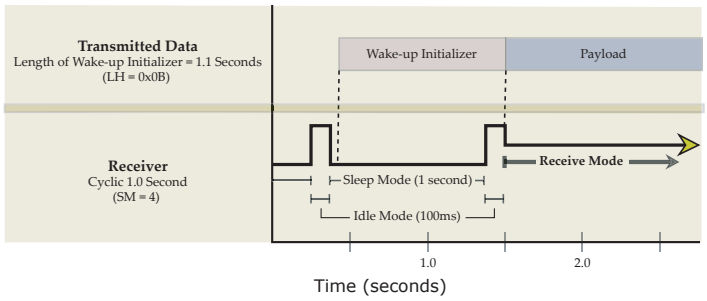
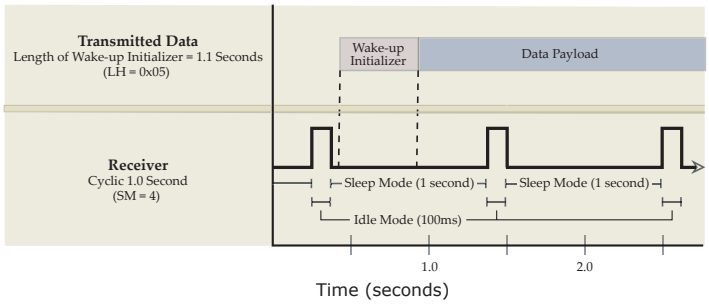


Figure 32. Incorrect Configuration (LH < SM)

The length of the wake-up initializer is shorter than the time interval of Cyclic Sleep. This configuration is vulnerable to the receiver waking and missing the wake-up initializer (and therefore also the accompanying payload data).



MK (Address Mask) Command

<AT Command: Networking> MK Command is used to set the radio modem address mask. All RF packets contain the Destination Address of the transmitting radio modem. When an RF packet is received, the transmitter's Destination Address is logically "ANDed" (bitwise) with the Address Mask of the receiver. The resulting value must match the Destination Address or the Address Mask of the receiver for the packet to be received and sent out the receiving modem serial port. If the "ANDed" value does not match either the Destination Address or the Address Mask of the receiver, the packet is discarded. (All "0" values are treated as "irrelevant" values and ignored.)

AT Command: MK

Parameter Range: 0 – 0xFFFF

# of bytes returned: 2

Default Parameter Value: 0xFFFF (When set to this value, the Destination Address of the transmitter must exactly match the Destination Address of the receiver.)

Related Commands: DT (Destination Address), HP (Channel)

NB (Parity) Parameter

<Non-AT Settable Parameter: Serial Interfacing> NB Parameter allows parity for the modem to be changed. Parity is an error detection method in which a bit (0 or 1) is added to each group of bits so that it will have either an odd number of 1's or an even number of 1's. For example, if parity is odd, then any group of bits that arrives with an even number of 1's must contain an error.

Parameter Range: 0 - 4

# of bytes returned: 1

Default Parameter Value: 0

Parameter Value	Configuration
0	8-bit (no parity) or 7-bit (with any parity)
1	8-bit even parity
2	8-bit odd parity
3	8-bit mark parity
4	8-bit space parity

PW (Pin Wake-up) Parameter

<Non-AT Settable Parameter: Sleep (Low Power)> Under normal operation, a radio modem in Cyclic Sleep Mode cycles from an active state to a low-power state at regular intervals until data is ready to be received. If PW Parameter is set to 1, the SLEEP Pin (Pin 2 of the embedded OEM RF Module) can be used to awaken the modem from Cyclic Sleep. If the SLEEP Pin is de-asserted (low), the radio modem will be fully operational and will not go into Cyclic Sleep. Once SLEEP is asserted, the radio modem will remain active for the period of time specified by ST (Time before Sleep) Command, and will return to Cyclic Sleep Mode (if no data is ready to be transmitted). PW Command is only valid if Cyclic Sleep has been enabled using SM Command.

Parameter Range: 0 – 1

# of bytes returned: 1

Default Parameter Value: 0

Related Parameters: SM (Sleep Mode), ST (Time before Sleep)

Parameter Value	Configuration
0	Disable Pin Wake-Up
1	Enable Pin Wake-Up

RE (Default Configuration) Command

<AT Command: AT Command Options> RE Command restores all AT-settable parameters to factory default settings. However, RE Command will not write the default values to non-volatile memory. Unless the WR (Write) Command is issued after the RE Parameter, the default settings will not be saved in the event of radio modem reset or power-down.

AT Command: RE

Related Command: WR (Write)

RT (DI2 Configuration) Parameter

<Non-AT Settable Parameter: Serial Interfacing> RT Parameter enables $\overline{\text{RTS}}$ Mode.

Parameter Range: 0 - 1

# of bytes returned: 1

Default Parameter Value: 0

Parameter Value	Configuration
0	Disabled
1	Enables $\overline{\text{RTS}}$ Handshaking

SB (Stop Bits) Parameter

<Non-AT Settable Parameter: Serial Interfacing> SB Parameter allows the user set the number of stop bits used in data transmission.

Parameter Range: 0 - 1

# of bytes returned: 1

Default Parameter Value: 0

Parameter Value	Configuration
0	1 stop bit
1	2 stop bits

SH (Serial Number High) Command

<AT Command: AT Command Options> SH Command reads and returns the modem serial number high word.

AT Command: SH

Parameter Range: 0 – 0xFFFF [Read-only]

# of bytes returned: 2

Related Command: SL (Serial Number Low)

SL (Serial Number Low) Command

<AT Command: AT Command Options> SL Command reads and reports the modem serial number low word.

AT Command: SL

Parameter Range: 0 – 0xFFFF [Read-only]

# of bytes returned: 2

Related Command: SH (Serial Number High)

SM (Sleep Mode) Parameter

<Non-AT Settable Parameter: Sleep Mode (Low Power)> SM Parameter is used to adjust Sleep Mode settings. By default, Sleep Mode is disabled and the radio modem remains continually active. SM Parameter allows the radio modem to run in a lower-power state and be configured in one of eight settings.

Cyclic Sleep settings wake the radio modem after the amount of time designated by SM Command. If the radio modem detects a wake-up initializer during the time it is awake, it will synchronize with the transmitting radio modem and start receiving data after the wake-up initializer runs its duration. Otherwise, it returns to Sleep Mode and continue to cycle in and out of sleep until the wake-up initializer is detected. If a Cyclic Sleep setting is chosen, the ST, LH and HT parameters must also be set as described in the "Sleep Mode" section of this manual.

Parameter Range: 0 - 8

# of bytes returned: 1

Default Parameter Value: 0

Related Parameters: LH (Wake-up Initializer Timer), HT (Time before Wake-up Initializer), PW (Pin Wake-up), ST (Time before Sleep)

Parameter Value	Configuration
0	No Sleep
1	Pin Sleep
2	Serial Port Sleep
3	Cyclic 0.5 seconds
4	Cyclic 1.0 seconds
5	Cyclic 2.0 seconds
6	Cyclic 4.0 seconds
7	Cyclic 8.0 seconds
8	Cyclic 16.0 seconds

ST (Time before Sleep) Parameter

<Non-AT Settable Parameter: Sleep Mode (Low Power)> ST Parameter sets the period of time (in tenths of seconds) in which the radio modem remains inactive before entering into Sleep Mode. For example, if the ST Parameter is set to 0x64 ("100" decimal), the radio modem will enter into Sleep Mode after 10 seconds of inactivity (no transmitting or receiving). This command can only be used if either Cyclic Sleep or Serial Port Sleep Mode settings have been selected using SM (Sleep Mode) Parameter.

Parameter Range: 0x10 – 0xFFFF [x 100 ms]

# of bytes returned: 2

Default Parameter Value: 0x64 ("100" decimal)

Related Parameters: SM (Sleep Mode), LH (Wake-up Initializer Timer), HT (Time before Wake-up Initializer)

VR (Firmware Version) Command

<AT Command: AT Command Options> Reads and returns the currently loaded firmware version of the XCite Radio Modem.

AT Command: VR

Parameter Range: 0 – 0xFFFF [Read-only]

# of bytes returned: 2

WR (Write) Command

<AT Command: (Special)> WR Command writes all configurable parameters to non-volatile memory. Using WR Command saves parameters to the radio modem's persistent memory. (This means that the parameters remain in the radio modem's memory until explicitly overwritten by future uses of WR Command.)

AT Command: WR

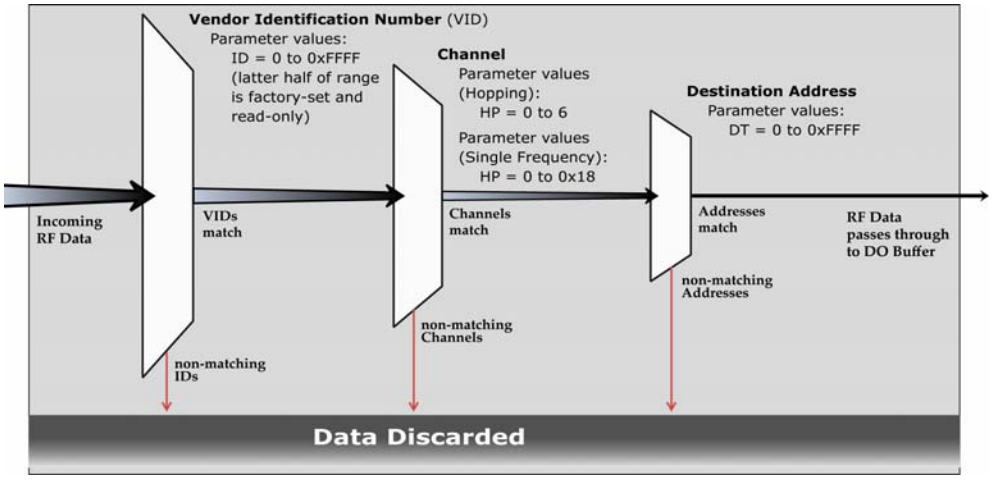
Advanced Networking and Security

Filtration Layers

The XCite Radio Modems utilize three layers of addressing to communicate between radio modems. The network layers are depicted below. Only radio modems with the matching addresses are able to communicate. The main layers of XCite Networking and Addressing are:

- Vendor Identification Number (ATID)
- Channel (ATHP)
- Destination Address (ATDT)

Figure 33. Network Addressing Layers



Each network layer provides a separate layer of filtration. The Vendor Identification Number (VID) provides the first layer of filtration through the ID (Modem ID) Parameter. If the incoming RF data carries a matching VID number, the data continues through to the subsequent Channel and Destination Address layers. The Destination Address is the last network layer and provides the most granular form of filtration. If at any point during the incoming RF data flow the numbers in question do not match, the data is discarded.

XCite Modules and RF Modems are built around a peer-to-peer protocol that inherently supports a multidrop type network (similar to RS-485). In their default state, any XCite radio modem will communicate with any other XCite radio modem in its default state.

Vendor Identification Number (ATID)

The bottom half of the ID (Vendor Identification Number) Parameter range is user-settable. The upper half of the range is factory-set and read-only. The value of the ID Command is called the Vendor Identification Number (VID). A unique VID is available upon special request. The VID is programmed to the XCite Module at the factory and is stored in the modem's permanent memory. Only modems with matching VIDs can communicate with each other.

VID addressing ensures that radio modems ignore transmissions and receptions of XCite Radio Modems having a different VID in the same vicinity. To request a unique VID, contact MaxStream to obtain the VID Request Form.

Channel (ATHP)

Channels provide a network layer from which channels can be used for isolation. HP (Channel) Parameter is used to define channel values.

Hopping Channel Mode: HP Parameter value range is 0 through 6

Single Frequency Channel Mode: HP range is 0 through 0x18 (decimal range: 0 – 24)

In "Hopping Channel Mode", each channel utilizes a different pseudo-random hopping sequence to navigate through shared hopping channels. In the event that two modems from different networks collide on a channel, the two modems will jump to separate channels on the next hop. Multiple modem pairs can operate in the same vicinity with minimal interference from each other.

Destination Address (ATDT) and Address Mask (ATMK)

XCite Destination Addresses and Masks provide the means to set up global or local addresses for establishing modem groups, subnets, etc. The Destination Address network layer provides for more granular isolation of radio modems. The XCite Destination Addresses and Masks can be used to:

- Set up point-to-point and point-to-multipoint network configurations
- Provide greater flexibility in establishing modem groups, subnets, etc.

Each radio modem in a network can be configured with a 16-bit Destination Address to establish selective communications within a network. This address is set to one of 65535 values using DT (Destination Address) Command. The default Destination Address is 0.

All radio modems with the same Destination Address can transmit and receive data among themselves. Radio modems having different Destination Addresses still detect and listen to the data (in order to maintain network synchronization); however, the data is discarded data rather than passing on through the DO pin.

Packet-based Radio Modems

XCite Radio Modems are packet based. This means all data shifted into one modem is packetized and sent out the antenna port. Because XCite modems use a peer-to-peer architecture, all modems on the same channel (ATHP) will receive the packet and decide whether to pass it to the host or to throw it away. Each transmitted packet contains information about the transmitting modem.

Any modem that receives a packet will check the address values and decide what to do with the packet. The options are as follows:

- Receive the packet as a global packet
- Receive the packet as a local packet
- Discard the packet

Address Mask

The mask parameter can be used to allow a base modem to receive data from a range of addresses. It may also be used to configure "subnets" of modems that communicate in a group together.

See below for the Pseudo 'C' Code that qualifies the Destination Addresses and address masks.

The Pseudo Code uses the bit-wise "AND" operation, "&". This operation is performed bit by bit on each of the 16 bits in the TXDT, RXDT and RXMK parameters.

Figure 34. Bit-wise AND Truth

Bit-wise AND Operation ("&")		
Operand 1	& Operand 2	= Result
0	0	0
0	1	0
1	0	0
1	1	1

For example: Hexadecimal: 0x3 & 0x9 = 0x1

The Address Mask can be used as an additional method of facilitating communications between modems. The Address Mask can be set to one of 65535 possible values using MK (Address Mask) Command. The default value of the MK Parameter is 0xFFFF.

All transmitted data packets contain the Destination Address of the transmitting modem. When a transmitted packet is received by a modem, the Destination Address of the transmitter (contained in the packet) is logically "ANDed" (bitwise) with the Address Mask of the Receiver. If the resulting value matches the Destination Address of the Receiver, or if it matches the Receiver Address Mask, the packet is accepted. Otherwise, the packet is discarded.

Note: When performing this comparison, any "0" values in the Receiver Address Mask are treated as irrelevant and are ignored.

Pseudo code for receiving

```
/* ******************************************************
*  Function: Receive_Data()                             *
*                                                       *
*  Description: Algorithm used by XCite Modems         *
*               to qualify incoming data packets.       *
*                                                       *
*  Variables:                                           *
*  (parameter types: short = 16 bits, char = 8 bits)    *
*                                                       *
*    short TXDT = Transmitter's Module Address   (ATDT) *
*    short RXDT = Receiver's Module Address      (ATDT) *
*    short RXMK = Receiver's Module Address Mask (ATMK) *
*                                                       *
******************************************************/

Function Receive_Data (TXDT, RXDT, RXMK, RXR)
{
  if((TXDT & RXMK) == RXMK) /* Is incoming address a global address? */
  {
    Send_data_out_port(); /* Call to function that Sends data out port */
  }

  else if((TXDT & RXMK) == (RXDT & RXMK)) /* Is TXDT a local address? */
  {
    Send_data_out_port(); /* Call to function that Sends data out port */

  }

  else     /* neither global nor local address */
  {
    Purge_buffer();  /* Call to some function that throws data away */
  }

}  /* End Function Receive_Data() */
```

Pseudo code for transmitting

```
/* ******************************************************
*  Function: RF_Transmit_Control()                      *
*                                                       *
*  Description: Algorithm used by XCite Modems         *
*               to packetize and transmit data packets.  *
*               This procedure only runs if there is    *
*               data in the data buffer and the         *
*               communication channel is clear.         *
*                                                       *
*  Variables:                                           *
*  (parameter types: short = 16 bits, char = 8 bits)    *
*                                                       *
*    char  DINC = Number of bytes in Data In Buffer     *
*                                                       *
******************************************************/

Function RF_Transmit_Control (DINC)
{

  Initialize_RF_Channel(); /* This process takes 35ms */
  while(DINC > 0)    /* Data In Buffer is not empty */
  {
    Assemble_RF_Packet(); /* Packet contains TXDT, TXVD and TXHP params*/

    {
      Transmit_Data(); /* Call function that shifts data out antenna */
    }                  /* Global packets not subject to TXRR */


  }  /* End while Data In Buffer is not empty */

  Close_RF_Channel();   /* Allows other modems to communicate */

}  /* End Function RF_Transmit_Control() */
```

Appendix A: FCC Certifications

FCC Certification

The XStream OEM RF Module complies with Part 15 of the FCC rules and regulations. Compliance with the labeling requirements, FCC notices and antenna usage guidelines is required.

OEMs and integrators must comply with the following FCC regulations:

1. The system integrator must ensure that the text on the external label provided with this device is placed on the outside of the final product [Refer to Figure A.1].
2. The XStream OEM RF Module may be used only with Approved Antennas that have been tested with this module. [Refer to Table A.1]

OEM Labeling Requirements

Label Warning

⚠ WARNING The Original Equipment Manufacturer (OEM) must ensure that FCC labeling requirements are met. This includes a clearly visible label on the outside of the final product enclosure that displays the contents shown in the figure below.

Figure A.1. Required FCC Label for OEM products containing XCite OEM RF Module

Contains FCC ID: OUR-9XCITE
The enclosed device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference and (2) this device must accept any interference received, including interference that may cause undesired operation.

FCC Notices

Adherence to the following is required:

IMPORTANT: The XCite (900 MHz) OEM RF Module has been certified by the FCC for use with other products without any further certification (as per FCC section 2.1091). Changes or modifications not expressly approved by MaxStream could void the user's authority to operate the equipment.

IMPORTANT: OEMs must test their final product to comply with unintentional radiators (FCC section 15.107 and 15.109) before declaring compliance of their final product to Part 15 of the FCC Rules.

IMPORTANT: The XCite OEM RF Module has been certified for remote and base radio applications. If the XCite will be used for portable applications, the device must undergo SAR testing.

NOTE:

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

1. Reorient or relocate the receiving antenna.
2. Increase the separation between the equipment and receiver.
3. Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
4. Consult the dealer or an experienced radio/TV technician for help.

FCC-approved Antennas (900 MHz)

ANTENNA WARNING

WARNING This device has been tested with Reverse Polarity SMA connectors with the antennas listed in the table below. When integrated into the OEM product, these fixed antennas require installation preventing end-users from replacing them with non-approved antennas. Any antenna not already tested with the XCite module must be tested to comply with FCC Section 15.203 for unique antenna connectors and Section 15.247 for emissions.

Table A.1. Antennas approved for use with the 9XCite (900 MHz) OEM RF Module

Part Number	Type	Gain	Application
*	Yagi	6.2dBi	Fixed/Mobile **
*	Yagi	7.2dBi	Fixed/Mobile **
A09-Y8	Yagi	8.2dBi	Fixed/Mobile **
	Yagi	9.2dBi	Fixed/Mobile **
	Yagi	10.2dBi	Fixed/Mobile **
A09-Y11	Yagi	11.2dBi	Fixed/Mobile **
	Yagi	12.2dBi	Fixed/Mobile **
	Yagi	13.2dBi	Fixed/Mobile **
	Yagi	14.2dBi	Fixed/Mobile **
A09-Y15	Yagi	15.2dBi	Fixed/Mobile **
A09-F2	Omni Direct	2.2dBi	Fixed **
A09-F5	Omni Direct	5.2dBi	Fixed **
A09-F8	Omni Direct	8.2dBi	Fixed **
*	Omni Direct	9.2dBi	Fixed **
*	Omni Direct	7.2dBi	Fixed **
A09-M7	Omni Direct	7.2dBi	Fixed **
A09-H	1/2 wave antenna	2.1dBi	Fixed/Mobile **
A09-HBMM-P5I	1/2 wave antenna	2.1dBi	Fixed/Mobile **
A09-QBMM-P5I	1/4 wave antenna	1.9 dBi	Fixed/Mobile **
*	1/4 wave integrated wire antenna	1.9 dBi	Fixed/Mobile **

* FCC-approved antennas not inventoried by MaxStream – Contact MaxStream for more information.

** Can be approved for portable applications if integrator gains approval through SAR testing

Over 100 additional antennas that have been tested and are approved for use with MaxStream 900 MHz Radio Modems (including "Mag Mount", "Dome", "Multi-path" and "Panel" antennas).

Because of the large number of approved antennas, MaxStream requests that you send specific information about an antenna you would like to use with the modem and MaxStream will evaluate whether the antenna is covered under our FCC filing.

Contact MaxStream (801) 765-9885 for more information.

RF EXPOSURE

WARNING Portable Antenna Applications: The antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter for satisfying RF exposure compliance.

The preceding statement must be included as a CAUTION statement in manuals for OEM products to alert users on FCC RF Exposure compliance.

IC (Industry Canada) Certification

Labeling requirements for Industry Canada are similar to those of the FCC. A clearly visible label on the outside of the final product enclosure must display the following text:

Contains Model 9XStream Radio (900 MHz), IC: 4214A-9XCITE

Integrator is responsible for its product to comply with IC ICES-003 & FCC Part 15, Sub. B - Unintentional Radiators. ICES-003 is the same as FCC Part 15 Sub. B and Industry Canada accepts FCC test report or CISPR 22 test report for compliance with ICES-003.

Appendix B: Additional Information

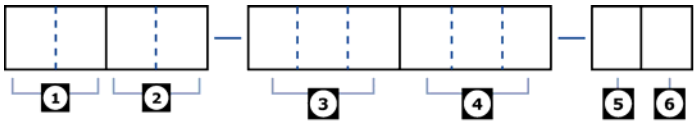
1-Year Warranty

The XCite-PKG-R RS-232/485 RF Modem from MaxStream, Inc. (the "Product") is warranted against defects in materials and workmanship under normal use, for a period of 1-year from the date of purchase. In the event of a product failure due to materials or workmanship, MaxStream will repair or replace the defective product. For warranty service, return the defective product to MaxStream, shipping prepaid, for prompt repair or replacement.

The foregoing sets forth the full extent of MaxStream's warranties regarding the Product. Repair or replacement at MaxStream's option is the exclusive remedy. THIS WARRANTY IS GIVEN IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, AND MAXSTREAM SPECIFICALLY DISCLAIMS ALL WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL MAXSTREAM, ITS SUPPLIERS OR LICENSORS BE LIABLE FOR DAMAGES IN EXCESS OF THE PURCHASE PRICE OF THE PRODUCT, FOR ANY LOSS OF USE, LOSS OF TIME, INCONVENIENCE, COMMERCIAL LOSS, LOST PROFITS OR SAVINGS, OR OTHER INCIDENTAL, SPECIAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OR INABILITY TO USE THE PRODUCT, TO THE FULL EXTENT SUCH MAY BE DISCLAIMED BY LAW. SOME STATES DO NOT ALLOW THE EXCLUSION OR LIMITATION OF INCIDENTAL OR CONSEQUENTIAL DAMAGES. THEREFOR, THE FOREGOING EXCLUSIONS MAY NOT APPLY IN ALL CASES. This warranty provides specific legal rights. Other rights which vary from state to state may also apply.

MaxStream RF Modem Part Numbers

Figure B1. XCite-PKG-R RS-232/485 RF Modem Part Number Key



Divisions of the MaxStream PKG RF Modem part numbers:

1 MaxStream Product Family
- XC = XCite
- X = XStream
- XT = XTend

2 Operating Frequency
- 09 = 902-928 MHz
- 24 = 2.4000 - 2.4835 GHz (XStream only)
- H9 = 923 MHz (XStream only)

3 RF Data Rate (baud)
- 009 = 9600 bps
- 038 = 38400 bps (XCite Only)
- (blank) All XTend RF Modems support 1200 to 115200 bps.

4 Operating Temperature
- PKC = Commercial: 0 to 70° C
- PKI = Industrial: -40 to 85° C. Embedded RF Module is Conformal Coated
- PKT = Tested Industrial: -40 to 85° C. Embedded RF Module is Conformal Coated & 100% tested

5 Interface Mode
- R = RS-232, RS-485/422
- U = USB
- E = Ethernet
- T = Telephone

6 Accessories Package
- A = Accessories Package (specific to the Interfacing Mode) Included
- (blank) means the accessories package is not included

Contact MaxStream

Free and unlimited technical support is included with every MaxStream Radio Modem sold.

Please use the following resources for additional support:

Documentation:	www.maxstream.net/support	
Technical Support:	Phone.	(866) 765-9885 U.S. & Canada (801) 765-9885 Worldwide
	Live Chat.	www.maxstream.net
	E-Mail.	rf-xperts@maxstream.net

MaxStream office hours are 8:00 am – 5:00 pm [U.S. Mountain Standard Time]