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XStream-PKG-R™ RS-232/485 RF Modem

Product Manual v5.x00

For XStream RF Modem Part Numbers:	X09-001PK…-R…	X24-009PK…-R…	XH9-001PK…-R…
	X09-009PK…-R…	X24-019PK…-R…	XH9-009PK…-R…
	X09-019PK…-R…		XH9-019PK…-R…

900 MHz and 2.4 GHz Stand-alone RF Modems by Digi International Inc.

Digi®

XStream-PKG-R RS-232/485 RF Modem – Product Manual v5.x00

(Part number 90002211 B)

Revision	Date	Description
B	10/15//14	Minor changes and new part number

Contents

1. XStream RS-232/485 RF Modem

The XStream-PKG-R RF Modem provides long range data communications and advanced networking for OEMs and system integrators. Out-of-box, the modem is equipped to sustain long range wireless links between devices. Simply enter serial data into one modem and the data surfaces on the other end of the wireless link.

The modem transfers a standard asynchronous serial data stream between two or more modems. Its built-in RS-232/485/422 interfacing facilitates rapid integration into existing data systems.

1.1. Features

Long Range

9XStream-PKG-R (900 MHz) Range:

- Indoor/Urban: **up to 1500'** (450 m)
- Outdoor line-of-sight: **up to 7 miles** (11 km) w/ 2.1 dBm dipole antenna
- Outdoor line-of-sight: **up to 20 miles** (32 km) w/ high gain antenna

24XStream-PKG-R (2.4 GHz) Range:

- Indoor/Urban: **up to 600'** (180 m)
- Outdoor line-of-sight: **up to 3 miles** (5 km) w/ 2.1 dBm dipole antenna
- Outdoor line-of-sight: **up to 10 miles** (16 km) w/ high gain antenna

Receiver Sensitivity: -**110 dBm** (900 MHz), **-105 dBm** (2.4 GHz)

Advanced Networking and Security

True peer-to-peer (no "master" required), point-to-point, point-to-multipoint, multidrop

Retries and Acknowledgements

7 hopping channels, each with over 65,000 available network addresses

FHSS (Frequency Hopping Spread Spectrum)

Easy-to-Use

Out-of-Box RF Communications - no configuration required

External DIP Switch for configuring:

- RS-232/485/422 support (multidrop included)
- 2-wire (half-duplex) or 4-wire RS-485/422 operation
- Parity options

7-18 VDC power supply

Simple AT and Binary commands for programming the modem

Software-selectable serial interfacing rates

MODBUS, CTS, RTS, DTR, DCD (and more) I/O Support

XII™ Interference Blocking

Power-saving Sleep Modes (as low as 6 mA)

1.1.1. Worldwide Acceptance

FCC Certified (USA) - Refer to Appendix A for FCC Requirements.
Systems that contain XStream RF Modems automatically inherit Digi Certifications.

ISM (Industrial, Scientific and Medical) frequency band

Manufactured under **ISO 9001:2000 registered standards**

9XStream (900 MHz) RF Modems are approved for use in **US**, **Canada**, **Australia** and **Israel** (and more).

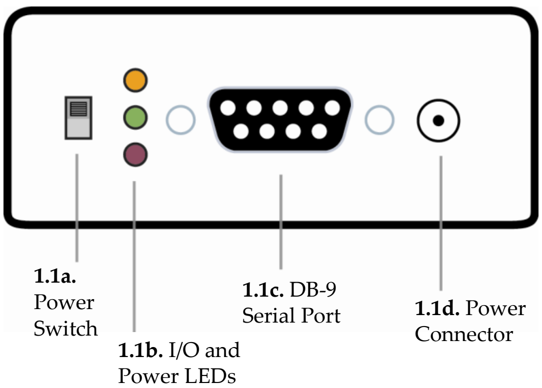
1.2. Specifications

Table 1.1. XStream-PKG-R RS-232/485 RF Modem Specifications

Specification	9XStream-PKG-R (900 MHz)		24XStream-PKG-R (2.4 GHz)	
Performance				
Indoor/Urban Range	Up to 1500' (450 m)		Up to 600' (180 m)	
Outdoor LOS Range	Up to 7 miles (11 km) w/ dipole antenna Up to 20 miles (32 km) w/ high-gain antenna		Up to 3 miles (5 km) w/ dipole antenna Up to 10 miles (16 km) w/ high-gain antenna	
Transmit Power Output	100 mW (20 dBm)		50 mW (17 dBm)	
Interface Data Rate	125 – 65,000 bps (software selectable)		125 – 65,000 bps (software selectable)	
Throughput Data Rate	**9,600 bps**	**19,200 bps**	**9,600 bps**	**19,200 bps**
RF Data Rate	10,000 bps	20,000 bps	10,000 bps	20,000 bps
Receiver Sensitivity	-110 dBm	-107 dBm	-105 dBm	-102 dBm
Power Requirements				
Supply Voltage	7-18 VDC		7-18 VDC	
Receive Current	70 mA		90 mA	
Transmit Current	170 mA		180 mA	
Pin Sleep Power-Down	6 mA		6 mA	
General				
Frequency	902-928 MHz		2.4000-2.4835 GHz	
Spread Spectrum	Frequency Hopping, Wide band FM modulator		Frequency Hopping, Wide band FM modulator	
Network Topology	Peer-to-Peer, Point-to-Multipoint, Point-to-Point, Multidrop		Peer-to-Peer, Point-to-multipoint, Point-to-Point, Multidrop	
Channel Capacity	7 hop sequences share 25 frequencies		7 hop sequences share 25 frequencies	
Data Connection	DB-9		DB-9	
Physical Properties				
Enclosure	7.1 oz. (200g), Extruded aluminum, black anodized		7.1 oz. (200g), Extruded aluminum, black anodized	
Enclosure Size	2.750" x 5.500" x 1.125" (6.99cm x 13.97" x 2.86cm)		2.750" x 5.500" x 1.125" (6.99cm x 13.97" x 2.86cm)	
Operating Temperature	0 to 70º C (commercial), -40 to 85º C (industrial)		0 to 70º C (commercial), -40 to 85º C (industrial)	
Antenna				
Type	½ wave dipole whip, 6.75" (17.1 cm), 2.1 dBi Gain		½ wave dipole whip, 5.25" (13.3 cm), 2.1 dBi Gain	
Connector	Reverse-polarity SMA		Reverse-polarity SMA	
Impedance	50 ohms unbalanced		50 ohms unbalanced	
Certifications (Refer to www.digi.com for additional certifications)				
FCC Part 15.247	OUR9XSTREAM		OUR-24XSTREAM	
Industry Canada (IC)	4214A-9XSTREAM		4214A 12008	

1.3. External Interface

Figure 1.1. Front View



1.1a. Power Switch

Move the Power Switch to the on (up) position to power the Interface Board. DIP Switch (1.2a) settings are only read during a power-up sequence.

1.1b. I/O and Power LEDs

The LED indicators visualize diagnostic status information. The modem's status is represented as follows:

Yellow (top LED) = Serial Data Out (to host)

Green (middle) = Serial Data In (from host)

Red (bottom) = Power/TX Indicator (Red light is on when powered, off briefly during RF transmission)

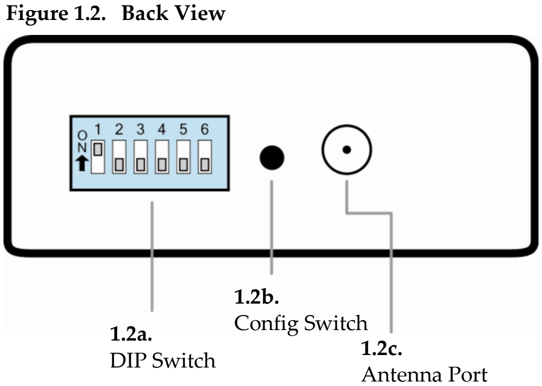
1.1c. Serial Port (DB-9 Connector)

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

1.1d. Power Connector

7-18 VDC Power Connector (Center positive, 5.5/2.1mm) – Power can also be supplied through Pin 9 of the DB-9 Serial Port.

Figure 1.2. Back View



1.2a. DIP Switch

The DIP Switch automatically configures the XStream RF Modem to operate in different modes. Each time the modem is powered-on, intelligence inside the XIB-R interface board (inside the modem) programs the modem according to the positions of the DIP Switch. (See figure below for DIP Switch settings]

NOTE: 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 inside the modem (p21).

1.2b. Config (Configuration) Switch

The 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 (1.1a).

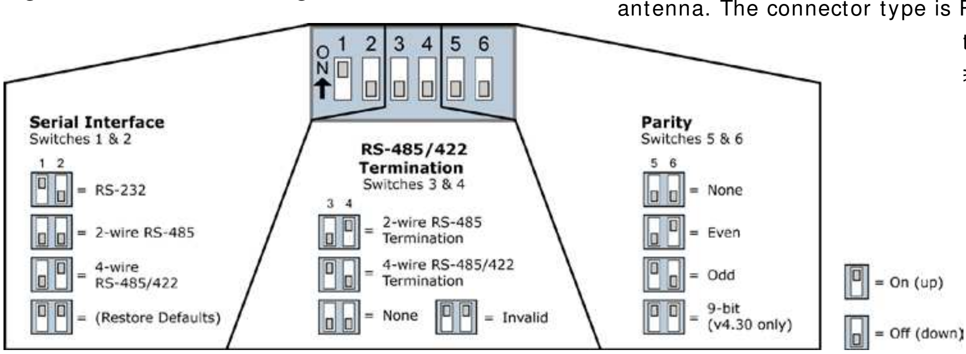
1.2c. Antenna Port

Port is a 50Ω RF signal connector for connecting to an external antenna. The connector type is RPSMA (Reverse Polarity SMA) female.

tor has threads on the outside of a

a male center conductor.

Figure 1.3. DIP Switch Settings



Refer to table in the "Automatic DIP Switch Configurations" (p19] section for more information about configurations triggered by the DIP Switch.

2. Interfacing Protocol

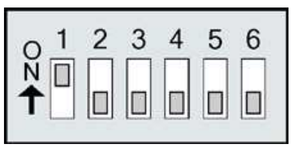
The XStream-PKG-R RF Modem supports the following interfacing protocols:

- RS-232
- RS-485 (2-wire) Half-Duplex
- RS-485 (4-wire) and RS-422

2.1. RS-232 Operation

2.1.1. DIP Switch Settings and Pin Signals

Figure 2.1.
RS-232 DIP Switch Settings



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

Figure 2.2.
Pins used on the female RS-232 (DB-9) Serial Connector

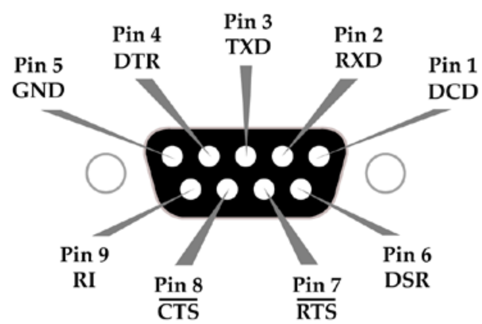


Table 2.1. RS-232 Signals and their implementations on the XStream RF Modem
(Low-asserted signals are distinguished by horizontal line over pin name.)

DB-9 Pin	RS-232 Name	AT Command Reference*	Description	Implementation
1	DCD	DO3	Data-Carrier-Detect	Connected to DSR (pin6)
2	RXD	DO	Received Data	Serial data exiting the RF Modem (to host)
3	TXD	DI	Transmitted Data	Serial data entering into the RF modem (from host)
4	DTR	DI3	Data-Terminal-Ready	Can enable POWER-DOWN on the RF Modem
5	GND	-	Ground Signal	Ground
6	DSR	DO3	Data-Set-Ready	Connected to DCD (pin1)
7	$\overline{RTS}$ / CMD	DI2	Request-to-Send	Provides $\overline{RTS}$ flow control or enables "Command Mode" on the RF Modem
8	$\overline{CTS}$	DO2	Clear-to-Send	Provides $\overline{CTS}$ flow control
9	RI	-	Ring Indicator	Optional power input that is connected internally to the positive lead of the front power connector

* Inside the XStream RF Modem is an XStream OEM RF Module. The names in this column refer to the pin signals of the embedded RF module. XStream Commands (p24) used to configure pin behaviors are named according to the pins of the module, not the RS-232 connection pins.

Wiring Diagram: RS-232 DTE Device to a DCE RF Modem

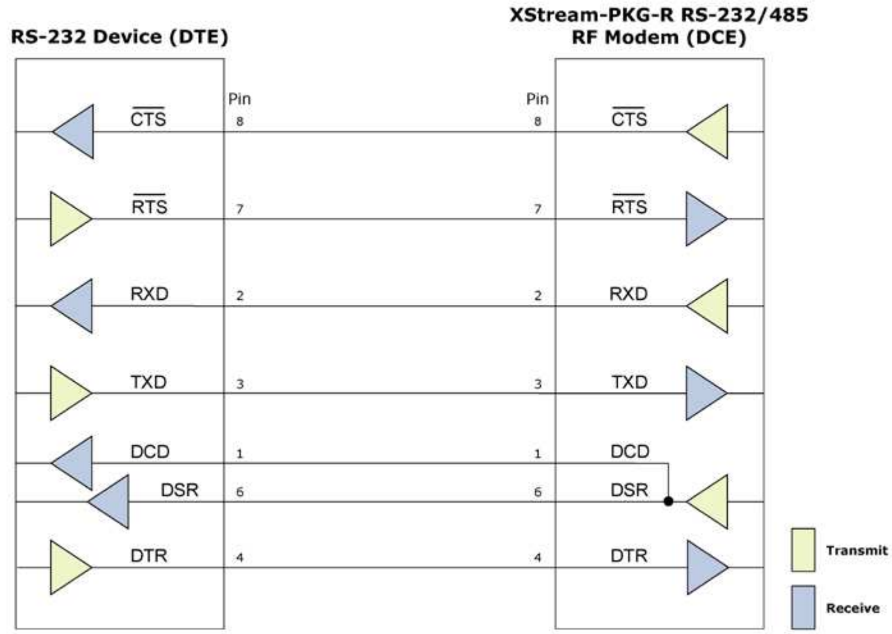


Figure 2.3. RS-232 DTE (male connector) device wired to an XStream RF Modem (female connector)

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

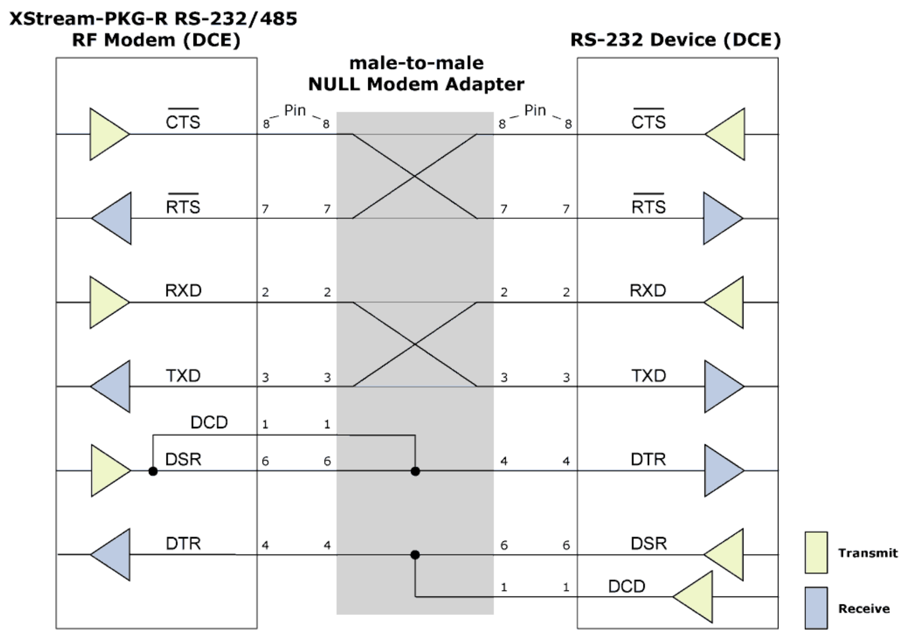


Figure 2.4. XStream RF Modem (female connector) wired to an RS-232 DTE (male connector) device

Sample Wireless Connection: DTE ←→ DCE ⚡ DCE ←→ DCE

Figure 2.5. Typical wireless link between DTE and DCE devices

2.2. RS-485 (2-wire) Operation

2.2.1. DIP Switch Settings and Pin Signals

Figure 2.6.
RS-485 (2-wire) Half-Duplex
DIP Switch Settings

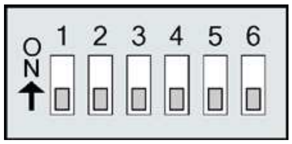


Figure 2.7.
Pins used on the female RS-232 (DB-9)
Serial Connector

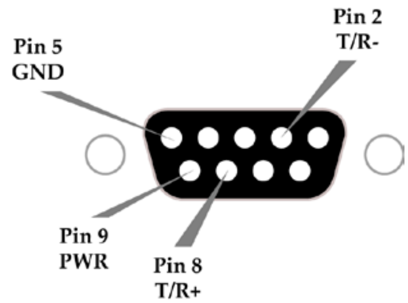
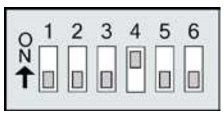


Figure 2.8.
RS-485 (2-wire) with Termination (optional)



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

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

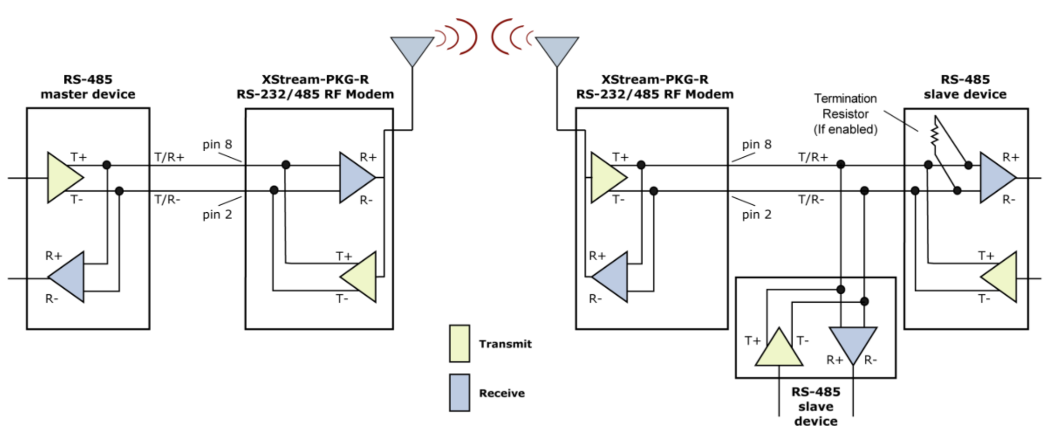
Note: Refer to Figures 2.15 and 2.16 for RJ-45 connector pin designations used in RS-485/422 environments.

Table 2.2. RS-485 (2-wire half-duplex) Signals and their implementations on the XStream RF Modem

DB-9 Pin	RS-485 Name	Description	Implementation
2	T/R- (TRA)	Negative Data Line	Transmit serial data to and from the XStream RF Modem
5	GND	Ground Signal	Ground
8	T/R+ (TRB)	Positive Data Line	Transmit serial data to and from the XStream 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 2.9. XStream RF Modem in an RS-485 (2-wire) half-duplex environment



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

2.3.1. DIP Switch Settings and Pin Signals

Figure 2.10.
RS-485 (4-wire) and RS-422 DIP Switch Settings

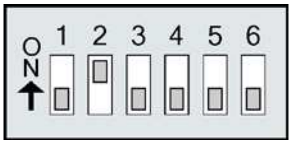


Figure 2.11.
Pins used on the female RS-232 (DB-9) Serial Connector

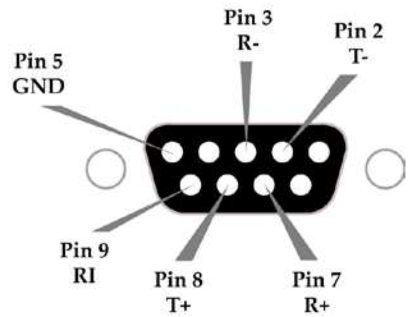
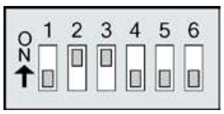


Figure 2.12.
RS-485 (4-wire) and RS-422 with Termination (optional)



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

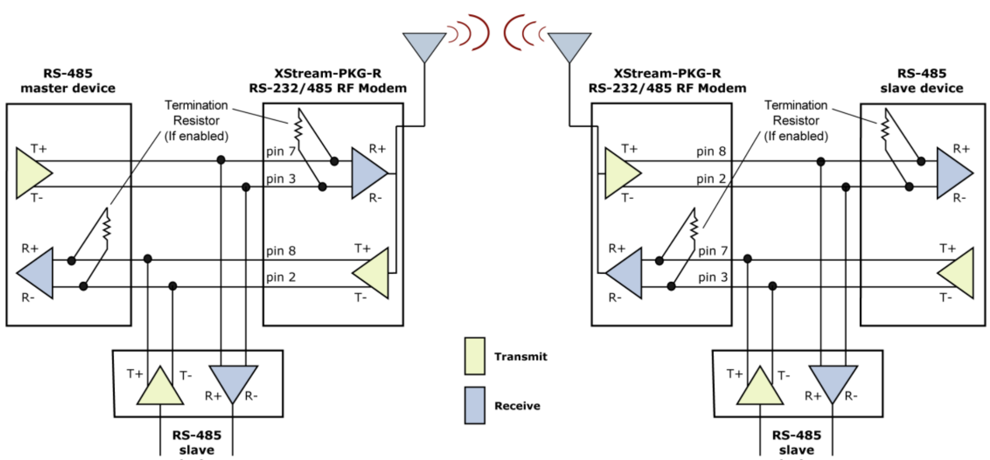
DIP Switch settings are read and applied only while powering-on.

Table 2.3. RS-485/422 (4-wire) Signals and their implementations with the XStream-PKG-R RF Modem

DB-9 Pin	RS-485/422 Name	Description	Implementation
2	T- (TA)	Transmit Negative Data Line	Serial data sent from the XStream RF Modem
3	R- (RA)	Receive Negative Data Line	Serial data received by the XStream RF Modem
5	GND	Signal Ground	Ground
7	R+ (RB)	Receive Positive Data Line	Serial data received by the XStream RF Modem
8	T+ (TB)	Transmit Positive Data Line	Serial data sent from the XStream RF Modem
9	PWR	Power	Optional power input that is connected internally to the front power connector
1, 4, 6	not used		

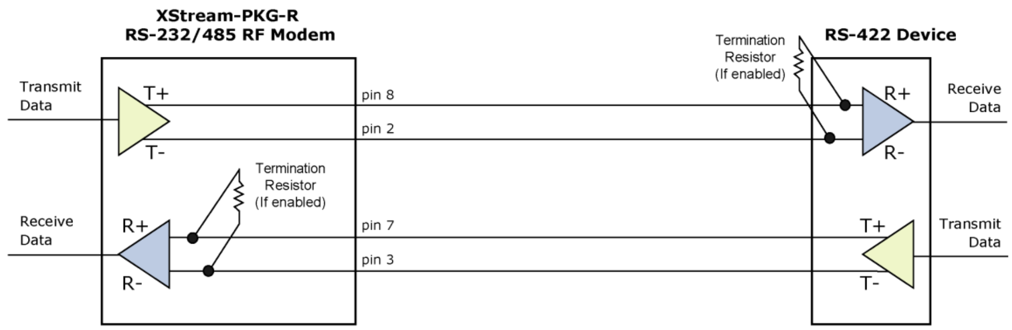
Wiring Diagram: RS-485 (4-wire) Half-Duplex

Figure 2.13. XStream RF Modem in an RS-485 (4-wire) environment



Wiring Diagram: RS-422

Figure 2.14. XStream RF Modem in an RS-485 (4-wire) environment



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 cable lengths. RS-485/422 signals can communicate as far as 4000 feet (1200 m). RS-232 signals are suitable for cable distances up to 100 feet (30.5 m).

RS-485 offers multi-drop capability in which up to 32 nodes can be connected. The RS-422 protocol is used for point-to-point communications.

Suggestions for integrating the XStream 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: Pin3 to T+, Pin4 to R+, Pin5 to R-, Pin6 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) – Pin2 in the cable maps to Pin3 on opposite end of cable and Pin1 maps to Pin4 respectively.

Figure 2.15. Male (yellow) DB-9 to RJ-45 Adapters

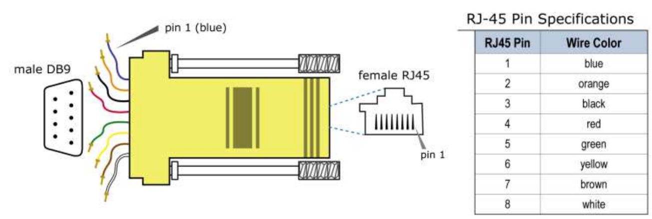
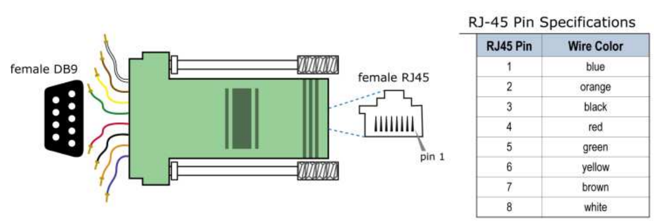


Figure 2.16. Female (green) DB-9 to RJ-45 Adapters



An RS-232 Accessories Kit is available that includes connectors that facilitate RS-232/485/422 and other serial communications. Refer to the Development Guide in Appendix B for information concerning the connectors and tools included in the kit.

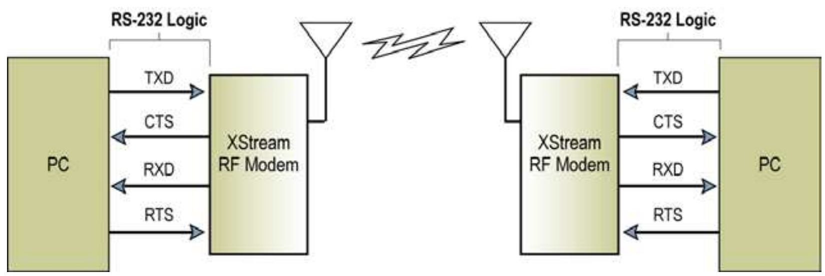
3. RF Modem Operation

3.1. Serial Communications

3.1.1. RS-232 and RS-485/422 Data Flow

Devices that have a UART interface can connect directly through the pins of the XStream Modem as is shown in the figure below.

Figure 3.1. System Data Flow Diagram in a UART-interfaced environment
(Low-asserted signals distinguished with horizontal line over signal name.)



3.1.2. Host and RF Modem I/O Settings

Serial communications between a host and an XStream RF Modem are dependent upon having matching baud rate, parity, stop bit and number of data bits settings. Failure to enter the modem into AT Command Mode is most commonly due to baud rate mismatch. Refer to the table below to ensure host serial port settings match those of the modem.

Table 3.1. Parameter values critical to serial communications between the RF Modem and host

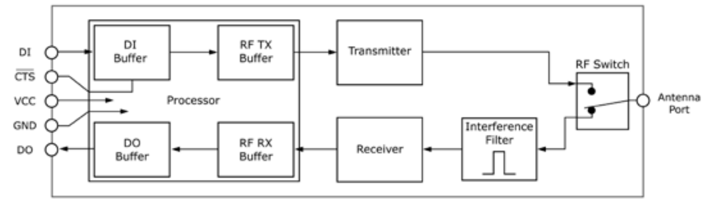
Parameter Setting	XStream RF Modem Default Parameter Value
Baud (Serial Data Rate)	9600 bps or 19200 baud (Factory-set RF data rates)
Number of Data Bits	8 (NB parameter = 0)
Parity	None (NB parameter = 0)
Number of Stop Bits	1 (NB parameter = 0)

Both the XStream RF Modem and host (PC) settings can be viewed and adjusted using Digi's proprietary XCTU Software. Use the "PC Settings" tab to configure host settings. Use the "Terminal" or "Modem Configuration" tabs to configure the RF Modem settings. Refer to the RF Modem Configuration sections for more information (p21).

3.1.3. Flow Control

Figure 3.2. Internal Data Flow Diagram

(The five most commonly-used pin signals are shown.)



DI (Data In) Buffer and Flow Control

When serial data enters the XStream Modem through the DI Pin, then the data is stored in the DI Buffer until it can be transmitted.

When the RO parameter threshold is satisfied (refer to Transmit Mode (p14) and Command Descriptions (p25) sections for more information), the modem attempts to initialize an RF connection. If the modem is already receiving RF data, the serial data is stored in the modem's DI Buffer. If the DI buffer becomes full, hardware or software flow control must be implemented in order to prevent overflow (loss of data between the host and XStream RF Modem).

How to eliminate the need for flow control:

1. Send messages that are smaller than the DI buffer size. The size of the DI buffer varies according to the packet size and parity setting used.
2. Interface at a lower baud rate (BD Command) than the fixed RF data rate.

Two cases in which the DI Buffer may become full and possibly overflow:

1. If the serial interface data rate is set higher than the RF data rate of the modem, the modem will receive data from the host faster than it can transmit the data over-the-air.
2. If the modem is receiving a continuous stream of RF data or if the modem is monitoring data on a network, any serial data that arrives on the DI pin is placed in the DI Buffer. The data in the DI buffer will be transmitted over-the-air when the modem no longer detects RF data in the network.

Hardware Flow Control ($\overline{\text{CTS}}$). When the DI buffer is 17 bytes away from being full; by default, the modem de-asserts (high) $\overline{\text{CTS}}$ to signal to the host device to stop sending data (refer to the FT (Flow Control Threshold) and CS (DO2 Configuration) commands). $\overline{\text{CTS}}$ is re-asserted after the DI Buffer has 34 bytes of memory available.

Software Flow Control (XON). XON/XOFF software flow control can be enabled using the FL (Software Flow Control) Command. This option only works with ASCII data.

DO (Data Out) Buffer and Flow Control

When RF data is received, the data enters the DO buffer and is then sent out the serial port to a host device. Once the DO Buffer reaches capacity, any additional incoming RF data is lost.

Two cases in which the DO Buffer may become full and possibly overflow:

1. If the RF data rate is set higher than the interface data rate of the modem, the modem will receive data from the transmitting modem faster than it can send the data to the host.
2. If the host does not allow the modem to transmit data out from the DO buffer because of being held off by hardware or software flow control.

Hardware Flow Control ($\overline{\text{RTS}}$). If $\overline{\text{RTS}}$ is enabled for flow control (RT Parameter = 2), data will not be sent out the DO Buffer as long as $\overline{\text{RTS}}$ is de-asserted.

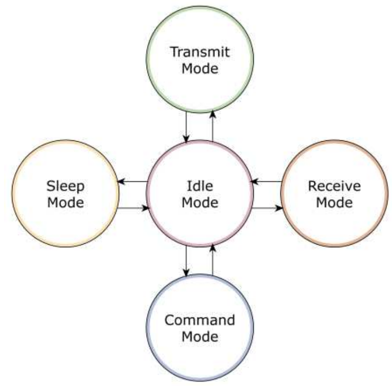
Software Flow Control (XOFF). XON/XOFF software flow control can be enabled using the FL (Software Flow Control) Command. This option only works with ASCII data.

3.2. Modes of Operation

XStream RF Modems operate in five modes.

Figure 3.3. XStream Modes of Operation

Modem can only be in one mode at a time.



3.2.1. Idle Mode

When not receiving or transmitting data, the modem is in Idle Mode. The modem uses the same amount of power in Idle Mode as it does in Receive Mode.

The modem shifts into the other modes of operation under the following conditions:

- Serial data is received in the DI Buffer (Transmit Mode)
- Valid RF data is received through the antenna (Receive Mode)
- Command Mode Sequence is issued (Command Mode)
- Sleep Mode condition is met (Sleep Mode)

After responding to any of the preceding conditions, the modem automatically transitions back into Idle Mode.

3.2.2. Transmit Mode

When the first byte of serial data is received from the UART in the DI buffer, the modem attempts to shift to Transmit Mode and initiate an RF connection with other modems. After transmission is complete, the modem returns to Idle Mode.

Note: RF reception must complete before the modem is able to enter into Transmit Mode.

RF transmission begins after either of the following criteria is met:

1. RB bytes have been received in the DI buffer and are pending for RF transmission (refer to RB (Packetization Threshold) command, p34).

   The RB parameter may be set to any value between 1 and the RF packet size (PK), inclusive. When RB = 0, the packetization threshold is ignored.

2. At least one character has been received in the DI buffer (pending for RF transmission) and RO time has been observed on the UART (refer to RO (Packetization Timeout) command).

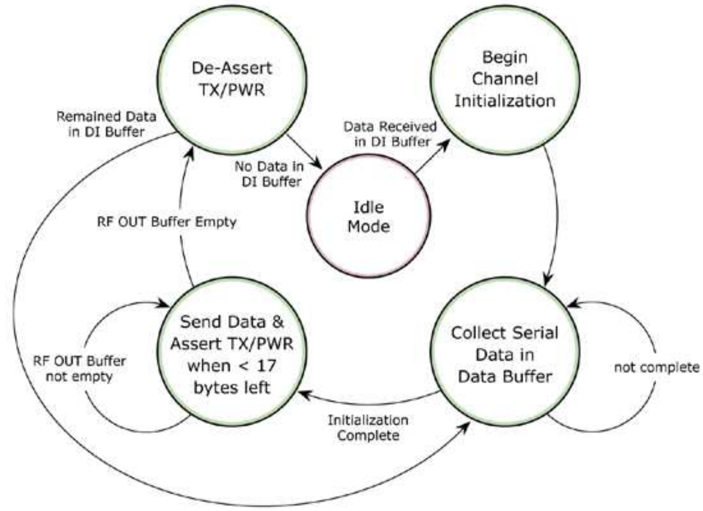
   The timeout can be disabled by setting RO to zero. In this case, transmission will begin after RB bytes have been received in the DI buffer.

After either RB or RO conditions are met, the modem then initializes a communications channel. (Channel initialization is the process of sending an RF initializer that synchronizes receiving modems with the transmitting modem. During channel initialization, incoming serial data accumulates in the DI buffer.)

Serial data in the DI buffer is grouped into RF packets (refer to PK (RF Packet Size)); converted to RF data; then transmitted over-the-air until the DI buffer is empty.

RF data, which includes the payload data, follows the RF initializer. The payload includes up to the maximum packet size (PK Command) bytes. As the transmitting modem nears the end of the transmission, it inspects the DI buffer to see if more data exists to be transmitted. This could be the case if more than PK bytes were originally pending in the DI buffer or if more bytes arrived from the UART after the transmission began. If more data is pending, the transmitting modem assembles a subsequent packet for transmission.

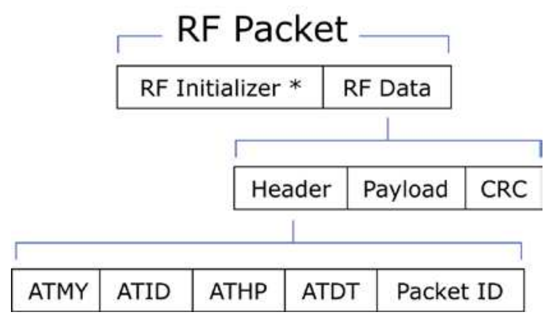
Figure 3.4. Data Transmission Sequence →



RF Data Packet

The RF packet is the sequence of data used for communicating information between Digi Modems. An RF Packet consists of an RF Initializer and RF Data.

Figure 3.5. RF Data Packet Components



* When streaming multiple RF packets, the RF Initializer is only sent in front of the first packet.

RF Initializer

An RF initializer is sent each time a new connection sequence begins. The RF initializer contains channel information that notifies receiving modems of information such as the hopping pattern used by the transmitting modem. The first transmission always sends an RF initializer.

An RF initializer can be of various lengths depending on the amount of time determined to be required to prepare a receiving modem. For example, a wake-up initializer is a type of RF initializer used to wake remote modems from Sleep Mode (Refer to the FH, LH, HT and SM Commands for more information). The length of the wake-up initializer should be longer than the length of time remote modems are in cyclic sleep.

Header

The header contains network addressing information that filters incoming RF data. The receiving modem checks for a matching Hopping Channel (HP parameter), Vendor Identification Number (ID parameter) and Destination Address (DT parameter). Data that does not pass through all three network filter layers is discarded.

CRC (Cyclic Redundancy Check)

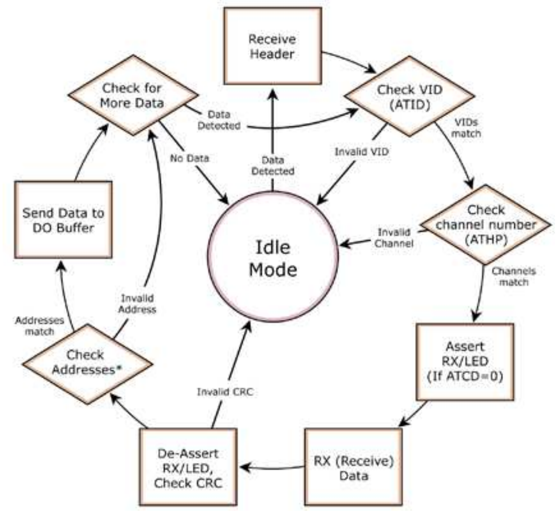
To verify data integrity and provide built-in error checking, a 16-bit CRC (Cyclic Redundancy Check) is computed for the transmitted data and attached to the end of each RF packet. On the receiving end, the receiving modem computes the CRC on all incoming RF data. Received data that has an invalid CRC is discarded (Refer to the Receive Mode section, next page).

3.2.3. Receive Mode

If the modem detects RF data while in Idle Mode, the modem transitions into Receive Mode to receive RF packets. Once a packet is received, the modem checks the CRC 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 proceeds to the DO Buffer.

The modem returns to Idle Mode when valid RF data is detected in the received RF data.

Figure 3.6. Data Reception Sequence



Refer to the Addressing section (p41) of the RF Communication Modes chapter for more information regarding address recognition.

> Note: If serial data exists in the DI buffer while the modem is in Receive Mode, the UART data will be transmitted after the modem is finished receiving the RF data and has returned to Idle Mode.

3.2.4. Sleep Modes

Sleep Modes enable the XStream Modem to operate at minimal power consumption when not in use. Three Sleep Mode options are available:

- **Pin Sleep** (Host Controlled)
- **Serial Port Sleep** (Wake on Serial Port activity)
- **Cyclic Sleep** (Wake on RF activity)

For the modem to transition into Sleep Mode, the modem must have a non-zero SM (Sleep Mode) parameter and one of the following must occur:

1. The modem is idle (no data transmission or reception) for a user-defined period of time (Refer to the ST (Time before Sleep) command).
2. SLEEP pin is asserted (only for Pin Sleep option).

In Sleep Mode, the modem will not transmit or receive data until the modem first transitions to Idle Mode. All Sleep Modes are enabled and disabled using SM Command. Transitions into and out of Sleep Modes are triggered by various mechanisms as shown in the table below.

Table 3.2. Summary of Sleep Mode Configurations

Sleep Mode Setting	Transition into Sleep Mode	Transition out of Sleep Mode	Related Commands	Typical Power Consumption
Pin Sleep (SM = 1)	A microcontroller can shut down and wake modems by asserting (high) SLEEP pin. Note: The modem will complete a transmission or reception before activating Pin Sleep.	De-assert SLEEP pin.	SM	6 mA
Serial Port Sleep (SM = 2)	Automatic transition to Sleep Mode occurs after a user-defined period of inactivity (no transmitting or receiving of data). The period of activity is defined using the ST (Time before Sleep) Command.	When serial byte is received on the DI pin.	SM, ST	25 mA
Cyclic Sleep (SM = 3-8)	Automatic transition to Sleep Mode occurs in cycles as defined by the SM (Sleep Mode) Command. Note: The cyclic sleep time interval must be shorter than the “Wake-up Initializer Timer” (set by LH Command).	After the cyclic sleep time interval elapses. Note: Modem can be forced into Idle Mode if PW (Pin Wake-up) Command is issued.	SM, ST, HT, LH, PW	6 mA when sleeping

For more information about Sleep Modes, refer to the individual commands listed in “Related Commands” column of the table. The SM command is central to all Sleep Mode configurations.

Pin Sleep (SM = 1)

Pin Sleep requires the least amount of power. In order to achieve this state, the DI3 (SLEEP) pin must be asserted (high). The modem remains in Pin Sleep until the DI3 pin is de-asserted.

After enabling Pin Sleep, the SLEEP pin controls whether the XStream Modem is active or in Sleep Mode. When DI3 is de-asserted (low), the modem is fully operational. When DI3 is asserted (high), the modem transitions to Sleep Mode and remains in its lowest power-consuming state until the DI3 (SLEEP) pin is de-asserted. DI3 is only active if the modem is setup to operate in this mode; otherwise the pin is ignored.

Once in Pin Sleep Mode, DO2 ($\overline{CTS}$) 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.

Note: The modem will complete a transmission or reception before activating Pin Sleep.

Serial Port Sleep (SM = 2)

Serial Port Sleep is a Sleep Mode in which the XStream Modem runs in a low power state until serial 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. Once a character is received through the DI pin, the modem returns to Idle Mode and is fully operational.

Cyclic Sleep (SM = 3-8)

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

When Cyclic Sleep settings are enabled, the XStream Modem 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 (Time before Sleep) Command.

While the modem is in Cyclic Sleep Mode, DO2 ($\overline{CTS}$) 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, DO2 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.

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 incoming RF packets. The modem then returns to Sleep Mode after a Period of inactivity that is determined by ST “Time before Sleep” Command.

The modem can also be configured to wake from cyclic sleep when SLEEP/DI3 is de-asserted (low). To configure a modem to operate in this manner, PW (Pin Wake-up) Command must be issued. Once DI3 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 Command, 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).

For example: If SM=4 (Cyclic 1.0 second sleep), the LH Parameter should equal 0x0B (“1.1” seconds). With these parameters set, there is no risk of the receiving modem being asleep for the duration of wake-up initializer transmission. “Cyclic Scanning” explains in further detail the relationship between “Cyclic Sleep” and “Wake-up Initializer Timer”

Cyclic Scanning. Each RF transmission consists of an RF Initializer and payload. The wake-up initializer contains initialization information and all receiving modems must wake during the wake-up initializer portion of data transmission in order to be synchronized with the transmitting modem and receive the data.

Figure 3.7. Correct Configuration (LH > SM)

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.

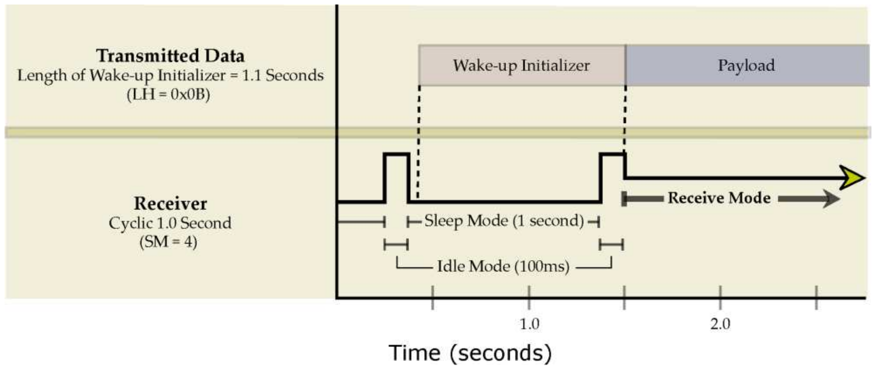
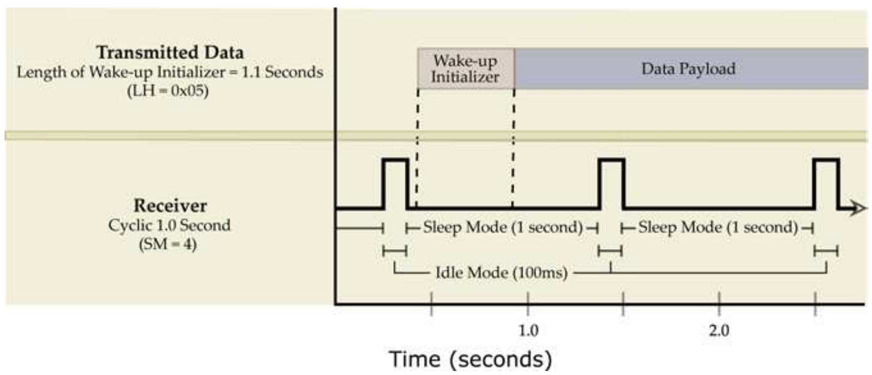


Figure 3.8. Incorrect Configuration (LH < SM)

Length of 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).



3.2.5. Command Mode

To modify or read modem parameters, the modem must first enter into Command Mode, the state in which incoming characters are interpreted as commands. Two command types are available for programming the modem:

- AT Commands
- Binary Commands

For modified parameter values to persist in the modem registry, changes must be saved to non-volatile memory using WR (Write) Command. Otherwise, parameters are restored to previously saved values when the modem is powered off and then on again.

AT Commands

To Enter AT Command Mode:

1. Send the 3-character command sequence "+++" and observe guard times before and after the command characters. (Refer to the "Default AT Command Mode Sequence" below.) The "Terminal" tab (or other serial communications software) of the XCTU Software can be used to enter the sequence.

   (OR)

2. Assert (low) the $\overline{\text{CONFIG}}$ pin and turn the power going to the modem off and back on. This result can be achieved by keeping the configuration switch pressed while turning off, then on again the power supplying the RF Modem)

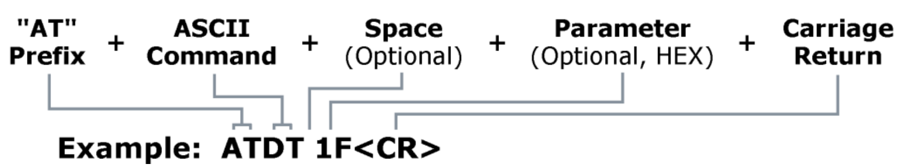
Default AT Command Mode Sequence (for transition to Command Mode):

- No characters sent for one second (refer to the BT (Guard Time Before) Command)
- Input three plus characters ("+++") within one second (refer to the CC (Command Sequence Character) Command.)
- No characters sent for one second (refer to the AT (Guard Time After) Command.)

To Send AT Commands:

Send AT commands and parameters using the syntax shown below:

Figure 3.9. Syntax for sending AT Commands



NOTE: To read a parameter value stored in a register, leave the parameter field blank.

The preceding example would change the modem Destination Address to "1F". To store the new value to non-volatile (long term) memory, the Write (ATWR) Command must follow.

System Response. When a command is sent to the modem, the modem will parse and execute the command. Upon successful execution of a command, the modem returns an "OK" message. If execution of a command results in an error, the modem returns an "ERROR" message.

To Exit AT Command Mode:

1. Send ATCN (Exit Command Mode) Command.

   (OR)

2. If no valid AT Commands are received within the time specified by CT (Command Mode Timeout) Command, the Modem automatically returns to Idle Mode.

For examples that illustrate the steps of programming the modem using AT Commands, refer to the RF Modem Configuration (p21) chapter.

Binary Commands

Sending and receiving parameter values using binary commands is the fastest way to change operating parameters of the XStream RF Modem. Binary commands are used most often to sample signal strength (RS parameter) and/or error counts; or change modem addresses and channels for polling data systems. Since the sending and receiving of register values takes place through the same serial data path as "live" data (received RF payload), interference between the two types of data can be a concern.

Common questions about using binary commands:

- What are the implications of asserting CMD while live data is being sent or received?
- After sending serial data, is there a minimum time delay before CMD can be asserted?
- Is a delay required after CMD is de-asserted before payload data can be sent?
- How does one discern between live data and data received in response to a command?

The CMD pin must be asserted in order to send binary commands to the RF modem. The CMD pin can be asserted to recognize binary commands anytime during the transmission or reception of data. The status of the CMD signal is only checked at the end of the stop bit as the byte is shifted into the serial port. The application does not allow control over when data is received, except by waiting for dead time between bursts of communication.

If the command is sent in the middle of a stream of payload data to be transmitted, the command will essentially be executed in the order it is received. If the radio is continuously receiving data, the radio will wait for a break in the received data before executing the command. The $\overline{\text{CTS}}$ signal will frame the response coming from the binary command request (Figure 3.10).

A minimum time delay of 100 µs (after the stop bit of the command byte has been sent) must be observed before the CMD pin can be de-asserted. The command executes after all parameters associated with the command have been sent. If all parameters are not received within 0.5 seconds, the modem returns to Idle Mode.

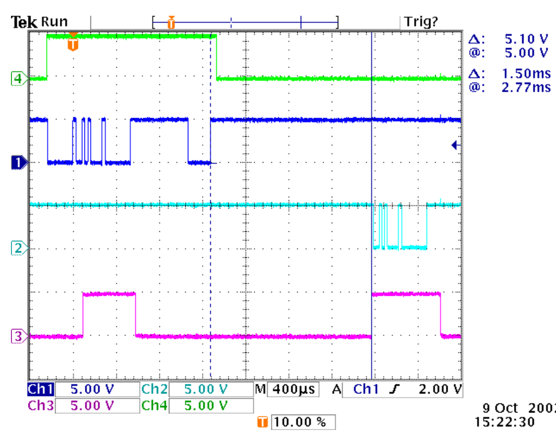
Note: When parameters are sent, they are two bytes long with the least significant byte sent first. Binary commands that return one parameter byte must be written with two parameter bytes.

Refer to p23 for a binary programming example.

Commands can be queried for their current value by sending the command logically ORed (bit-wise) with the value 0x80 (hexadecimal) with CMD asserted. When the binary value is sent (with no parameters), the current value of the command parameter is sent back through the DO pin.

Figure 3.10. Binary Command Write then Read

Signal #4 is CMD
Signal #1 is the DIN signal to the radio
Signal #2 is the DOUT signal from the radio
Signal #3 is $\overline{\text{CTS}}$



In this graph, a value was written to a register and then read out to verify it. While not in the middle of other received data, note that the $\overline{\text{CTS}}$ (DO2 pin) signal outlines the data response out of the modem.

IMPORTANT:	For the XStream Modem to recognize a binary command, the RT (DI2 Configuration) parameter must be set to one. If binary programming is not enabled (RT ≠ 1), the modem will not recognize that the CMD pin is asserted and therefore will not recognize the data as binary commands.

4. RF Modem Configuration

4.1. Automatic DIP Switch Configurations

Each time the RF Modem is powered-on, intelligence on the XIB-R Interface Board (RS-232/485 interfacing 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 stored RF Modem parameter values as shown in the tables below.

Figure 4.1. RF Modem DIP Switch

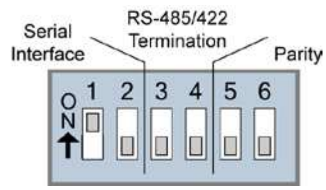


Table 4.1. RF Modem Power-up Options (J7 jumper and Config Switch)

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 below.

Table 4.2. AT Commands Sent as result of DIP Switch Settings (SW = DIP Switch)

Condition	Behavior	
Restore Default Parameter Values of the RF Modem		
If SW1 and SW2 are ON (up)	AT Commands sent:	ATRE (Restore Defaults) Command ATWR (Write) Command
Serial Interfacing Options		
If SW1 is ON (up)	AT Commands sent:	ATCS 0 (RS-232 Operation: CTS function for CTS line, DB-9 pin 8) 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)
Parity Options		
If SW5 and SW6 are OFF (down)	AT Commands sent:	ATNB 0 (parity = none)
If SW5 is OFF (down) and SW6 is ON (up)	AT Commands sent:	ATNB 1 (parity = even)
If SW5 is ON (up) and SW6 is OFF (down)	AT Commands sent:	ATNB 2 (parity = odd)
If SW5 is ON (up) and SW6 is ON (up)	AT Commands sent:	ATNB 5 (parity = 9th bit data over-the-air, v4.30 only)
Exit AT Command Mode		
Always	AT Commands sent:	ATCN (Exit AT Command Mode)

IMPORTANT: 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 the J7 jumper of the XIB-R Interface Board. By default, J7 is not populated.

4.2. Programming Examples

For information about entering and exiting AT and Binary Command Modes, refer to the Command Mode section (p19).

4.2.1. AT Commands

Digi has provided XCTU software for programming the modem using an extensive list of AT Commands. The XCTU software provides an interface that is divided into four tabs that facilitate the following functions:

- PC Settings tab - Setup PC serial port to interface with an XStream RF Modem
- Range Test tab – Test XStream RF Modem's range in varying environments
- Terminal tab – Configure and read XStream RF Modem parameters using AT Commands
- Modem Configuration tab – Configure and read RF Modem parameters

To install the XCTU Software:

Navigate to: www.digi.com/support/ . Then select "XCTU" under the product list. Select the appropriate driver to install the XCTU software.

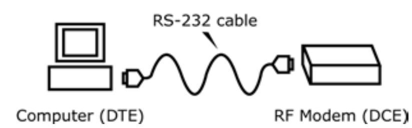
PC Settings Tab

As stated in the Serial Communications section; in order to communicate data to the RF modem through the PC, baud (serial data rate), data bit, parity and stop bit settings on the PC serial port must match those of the RF modem. The PC Settings tab provides a software user interface that facilitates the modification of PC serial port settings.

PC Setup

1. Set the DIP Switch to RS-232 mode. Switch 1 is ON (up) and the remaining 5 switches are OFF (down).
2. Connect the male DB-9 connector of the PC with the female DB-9 connector of the RF modem using an RS-232 cable.
3. Power the RF modem through the power connector.
4. Launch XCTU Software and select the PC Settings tab; then select parameter values from the dropdown lists that match the current parameter values of the RF modem. (Refer to Table 3.1 on for more information.)

Figure 4.2. RF Modem Configurations through a Serial Cable



Terminal Tab

A terminal program has been built into the XCTU software and is located under the Terminal tab. The Terminal tab provides an easy-to-use interface for programming the modem.

Multiple AT 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 (spaces in between are optional). The "AT" prefix is only sent before the first command and should not be included with subsequent commands in a line.

System Response. When a command is sent to the modem, the modem will parse and execute the command. Upon successful execution of a command, the modem returns an "OK" message. If execution of a command results in an error, the modem returns an "ERROR" message.

EXAMPLE: Restore RF Modem Defaults using the Terminal tab

The following steps show how to read currently stored modem parameter values; then restore the modem parameters to their factory-default states.

Method 1 (One line per command)

Issue AT Command	System Response
+++	OK<CR> (Enter into AT Command Mode)
ATHP <Enter>	(system shows current channel number) <CR>
ATRE <Enter>	OK<CR> (Restore modem default parameter values)
ATWR <Enter>	OK<CR> (Write new values to non-volatile memory)
ATCN <Enter>	OK<CR> (Exit AT Command Mode)

Method 2 (Multiple commands on one line)

Issue AT Command	System Response
+++	OK<CR>
ATRE, WR, CN <Enter>	OK<CR>

NOTE: Default parameter values of the RF modem can also be restored by selecting the "Restore Defaults" button located on the Modem Configuration tab (refer to the instructions below).

Modem Configuration tab

The "Modem Configuration" tab of the XCTU software provides an easy-to-use interface for reading and setting RF modem parameters.

EXAMPLE: Read Parameters and Restore Defaults using the Modem Configuration tab

The following steps show how to read currently stored modem parameter values; then restore the modem parameters to their factory-default states.

1. Open the XCTU program (Start --> Programs --> Digi --> XCTU):
2. Under the "PC Settings" tab, select the PC Serial Com Port from the dropdown list that will be used to connect to the RF Modem.
3. Select a "Baud rate" to match the default RF data rate of the RF Modem. Use default values for all other fields.
4. Select the "Modem Configuration" tab.
5. Select the "Read" button to read currently stored parameter values of the modem.
6. Select the "Restore" button to restore factory-default parameter values.
7. Select the "Write" button to save default values to non-volatile (long-term) memory.

4.2.2. Binary Commands

Example: Send Binary Commands

Example: Use binary commands to change the XStream Modem's destination address to 0x1A0D and save the new address to non-volatile memory.

1. RT Command must be set to "1" in AT Command Mode to enable binary programming.
2. Assert CMD (Pin is driven high). (Enter Binary Command Mode)
3. Send Bytes (Parameter bytes must be 2 bytes long):

00	(Send DT (Destination Address) Command)
0D	(Least significant byte of parameter bytes)
1A	(Most significant byte of parameter bytes)
08	(Send WR (Write) Command)

4. De-assert CMD (Pin is driven low). (Exit Binary Command Mode)

Note: $\overline{CTS}$ is high when command is being executed. Hardware flow control must be disabled as $\overline{CTS}$ will hold off parameter bytes.

4.3. Command Reference Table

Table 4.1. XStream Commands (The RF Modem expects numerical values in hexadecimal. "d" denotes decimal equivalent.)

AT Command	Binary Command	AT Command Name	Range	Command Category	# Bytes Returned	Factory Default
AM v4.30*	0x3A (58d)	Auto-set MY	-	Networking and Security	-	-
AT	0x05 (5d)	Guard Time After	0x02 – 0xFFFF (x 100 msec)	Command Mode Options	2	0x0A (10d)
BD v4.2B*	0x15 (21d)	Baud Rate	Standard baud rates: 0 – 6 (custom rates also supported)	Serial Interfacing	2	factory-set RF data rate
BK v4.30*	0x2E (46d)	Serial Break Passing	0 – 1	Serial Interfacing	1	0
BO v4.30*	0x30 (48d)	Serial Break Timeout	0 - 0xFFFF (x 1 second)	Serial Interfacing	2	0
BT	0x04 (4d)	Guard Time Before	0 – 0xFFFF (x 100 msec)	Command Mode Options	2	0x0A (10d)
CB v4.30*	0x33 (51d)	Connection Duration Timeout	0x01 – 0xFFFF (x 100 msec)	Networking and Security	2	0x28 (4d sec)
CC	0x13 (19d)	Command Sequence Character	0x20 – 0x7F	Command Mode Options	1	0x2B ("+")
CD v4.2B*	0x28 (40d)	DO3 Configuration	0 – 4	Serial Interfacing	1	0
CE v4.30*	0x34 (52d)	Connection Inactivity Timeout	0 – 0xFFFF (x 10 msec)	Networking and Security	2	0x64 (1d sec)
CF v4.30*	0x35 (53d)	Connection Failure Count	0 – 0xFFFF	Networking and Security	2	0
CL v4.30*	0x39 (57d)	Last Connection Address	(read-only)	Diagnostics	2	-
CM v4.30*	0x38 (56d)	Connection Message	0 – 1	Networking and Security	1	0
CN	0x09 (9d)	Exit AT Command Mode	-	Command Mode Options	-	-
CO v4.30*	0x2F (47d)	DO3 Timeout	0 - 0xFFFF (x 1 second)	Serial Interfacing	2	0x03
CS v4.27D*	0x1F (31d)	DO2 Configuration	0 – 4	Serial Interfacing	1	0
CT	0x06 (6d)	Command Mode Timeout	0x02 – 0xFFFF (x 100 msec)	Command Mode Options	2	0xC8 (200d)
DC v4.30*	0x37 (55d)	Disconnect	-	Networking and Security	-	-
DR v4.30*	0x2D (45d)	DI3 Configuration	0 – 4	Serial Interfacing	1	0
DT	0x00 (0d)	Destination Address	0 – 0xFFFF	Networking and Security	2	0
E0	0x0A (10d)	Echo Off	-	Command Mode Options	-	-
E1	0x0B (11d)	Echo On	-	Command Mode Options	-	-
ER	0x0F (15d)	Receive Error Count	0 – 0xFFFF	Diagnostics	2	0
FH	0x0D (13d)	Force Wake-up Initializer	-	Sleep (Low Power)	-	-
FL	0x07 (7d)	Software Flow Control	0 – 1	Serial Interfacing	1	0
FT v4.27B*	0x24 (36d)	Flow Control Threshold	0 – 0xFF (bytes)	Serial Interfacing	2	varies
GD	0x10 (16d)	Receive Good Count	0 – 0xFFFF	Diagnostics	2	0
HP	0x11 (17d)	Hopping Channel	0 – 6	Networking and Security	1	0
HT	0x03 (3d)	Time before Wake-up Initializer	0 – 0xFFFF (x 100 msec)	Sleep (Low Power)	2	0xFFFF
ID v4.2B*	0x27 (39d)	Modem VID	User-settable: 0x10 - 0x7FFF Read-only: 0x8000 – 0xFFFF	Networking and Security	2	-
IU v4.30*	0x3B (59d)	DI2, DI3 Update Timer	0 - 0xFFFF (x 100 msec)	Serial Interfacing	2	0x0A (10d)
LH	0x0C (12d)	Wake-up Initializer Timer	0 – 0xFF (x 100 msec)	Sleep (Low Power)	1	0x01
MD v4.30*	0x32 (50d)	RF Mode	0 – 4	Networking and Security	1	0
MK	0x12 (18d)	Address Mask	0 – 0xFFFF	Networking and Security	2	0xFFFF
MY v4.30*	0x2A (42d)	Source Address	0 – 0xFFFF	Networking and Security	2	0xFFFF
NB v4.30*	0x23 (35d)	Parity	0 – 5	Serial Interfacing	1	0
PC v4.22*	0x1E (30d)	Power-up Mode	0 – 1	Command Mode Options	1	0
PK v4.30*	0x29 (41d)	RF Packet Size	0 - 0x100 (bytes)	Serial Interfacing	2	0x40 (64d)
PW v4.22*	0x1D (29d)	Pin Wake-up	0 – 1	Sleep (Low Power)	1	0
RB v4.30*	0x20 (32d)	Packetization Threshold	0 - 0x100 (bytes)	Serial Interfacing	2	0x01
RE	0x0E (14d)	Restore Defaults	-	(Special)	-	-
RN v4.22*	0x19 (25d)	Delay Slots	0 – 0xFF (slots)	Networking and Security	1	0
RO v4.2A*	0x21 (33d)	Packetization Timeout	0 – 0xFFFF (x 200 µsec)	Serial Interfacing	2	0
RP v4.2A*	0x22 (34d)	RSSI PWM Timer	0 - 0x7F (x 100 msec)	Diagnostics	1	0
RR v4.22*	0x18 (24d)	Retries	0 – 0xFF	Networking and Security	1	0
RS v4.22*	0x1C (28d)	RSSI	0x06 – 0x36 (read-only)	Diagnostics	1	-
RT	0x16 (22d)	DI2 Configuration	0 - 2	Serial Interfacing	1	0
RZ v4.30*	0x2C (44d)	DI Buffer Size	(read-only)	Diagnostics	-	-
SB v4.2B*	0x36 (54d)	Stop Bits	0 - 1	Serial Interfacing	1	0
SH v4.27C*	0x25 (37d)	Serial Number High	0 – 0xFFFF (read-only)	Diagnostics	2	-
SL v4.27C*	0x26 (38d)	Serial Number Low	0 – 0xFFFF (read-only)	Diagnostics	2	-
SM	0x01 (1d)	Sleep Mode	0 – 8	Sleep (Low Power)	1	0
ST	0x02 (2d)	Time before Sleep	0x10 – 0xFFFF (x 100 msec)	Sleep (Low Power)	2	0x64 (100d)
SY	0x17 (23d)	Time before Initialization	0 – 0xFF (x 100 msec)	Networking and Security	1	0 (disabled)
TO v4.30*	0x31 (49d)	DO2 Timeout	0 - 0xFFFF (x 1 sec)	Serial Interfacing	2	0x03
TR v4.22*	0x1B (27d)	Transmit Error Count	0 – 0xFFFF	Diagnostics	2	0
TT v4.22*	0x1A (26d)	Streaming Limit	0 – 0xFFFF (0 = disabled)	Networking and Security	2	0xFFFF
VR	0x14 (20d)	Firmware Version	0 x 0xFFFF (read-only)	Diagnostics	2	-
WR	0x08 (8d)	Write	-	(Special)	-	-

* Firmware version in which command and parameter options were first supported.

NOTE: AT Commands issued without a parameter value will return the currently stored parameter.

4.4. Command Descriptions

Commands in this section are listed alphabetically. Command categories are designated between the "< >" symbols that follow each command title. XStream Modems expect numerical values in hexadecimal and those values are designated by a "0x" prefix.

AM (Auto-set MY) Command

AT Command: ATAM	
Binary Command: 0x3A (58 decimal)	
Minimum firmware version required: 4.30	

<Networking and Security> AM Command is used to automatically set the MY (Source Address) parameter from the factory-set modem serial number. The address is formed with bits 29, 28 and 13-0 of the serial number (in that order).

AT (Guard Time After) Command

AT Command: ATAT	
Binary Command: 0x05 (5 decimal)	
Parameter Range: 0x02 – 0xFFFF (x 100 milliseconds)	
Number of bytes returned: 2	
Default Parameter Value: 0x0A (10 decimal)	
Related Commands: BT (Guard Time Before), CC (Command Sequence Character)	

<Command Mode Options> AT Command is used to set the time-of-silence that follows the command sequence character (CC Command). By default, AT Command Mode will activate after one second of silence.

Refer to the AT Commands section (p19) to view the default AT Command Mode sequence.

BD (Interface Data Rate) Command

AT Command: ATBD

Binary Command: 0x15 (21 decimal)

Parameter Range (Standard baud rates): 0 – 6
(Non–standard baud rates): 0x7D – 0xFFFF

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

Number of bytes returned: 2

Default Parameter Value: Set to equal to modem's factory–set RF data rate.

Minimum firmware version required: 4.2B (Custom baud rates not previously supported)

<Serial Interfacing> BD Command allows the user to adjust the UART interface data rate and thus modify the rate at which serial data is sent to the RF modem. The new baud rate does not take effect until the CN command is issued. The RF data rate is unaffected by the BD parameter.

Most applications will require one of the seven standard baud rates; however, non-standard baud rates are also supported.

Note: If the serial data rate is set to exceed the fixed RF data rate of the modem, $\overline{\text{CTS}}$ flow control may need to be implemented in the Flow Control section (p13) of this manual.

Non-standard Interface Data Rates: When parameter values outside the range of standard baud rates are sent, the closest interface data rate represented by the number is stored in the BD register. For example, a rate of 19200 bps can be set by sending the following command line "ATBD4B00". NOTE: When using Digi's XCTU Software, non-standard interface data rates can only be set and read using the XCTU "Terminal" tab. Non-standard rates are not accessible through the "Modem Configuration" tab.

When the BD command is sent with a non-standard interface data rate, the UART will adjust to accommodate the requested interface rate. In most cases, the clock resolution will cause the stored BD parameter to vary from the parameter that was sent (refer to the table below). Reading the BD command (send "ATBD" command without an associated parameter value) will return the value that was actually stored to the BD register.

Table 4.2. Parameter Sent vs. Parameter Stored

BD Parameter Sent (HEX)	Interface Data Rate (bps)	BD Parameter Stored (HEX)
0	1200	0
4	19,200	4
7	115,200	7
12C	300	12B
1C200	115,200	1B207