DatraxRF Spread Spectrum Wireless Modem

Overview

The DatraxRF 12, 96, and 192 modules are 100-milliwatt, frequency-hopping wireless modules that allow wireless communication between equipment using a standard asynchronous serial data stream. The half-duplex transmission of the DatraxRF can sustain a continuous data stream at the specified data rate. The DatraxRF has been engineered for use with the following applications (among others):

- Supervisory Control and Data Acquisition (SCADA)
- Remote meter reading
- Home Automation
- Security
- Instrument monitoring
- Point of Sale Systems (POS)

The DatraxRF within the 900 MHz ISM Band and is approved by the FCC under Part 15 of FCC Rules and Regulations. A regulated 5-volt supply is required for operation.

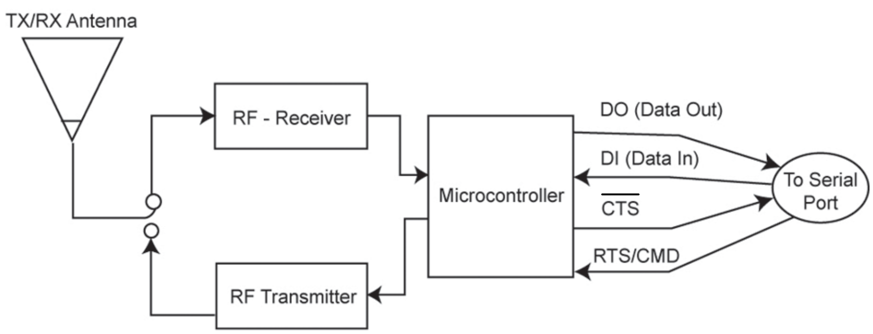

Figure 1a - Block diagram demonstrating basic module operation and data flow for both transmit and receive.

Features

- Frequency-Hopping Spread Spectrum (FHSS) technology
- Noise and interference resistance
- Enhanced sensitivity and range
- Multiple Low-power modes (down to 1 Microamp)
- Standard serial digital interface connection
- Built-in Networking and addressing
- Simple AT command interface

Simple Product Integration

The DatraxRF does not require previous knowledge of RF operation. It interfaces to any UART or PC Serial Port using the Key Telemetering board and has been developed with a small form-factor for ease of integration.

Serial Port Operation

The DatraxRF modules come equipped with a CMOS-level asynchronous serial port, which provides direct communication with any device having a UART interface (Universal Asynchronous Receiver-Transmitter). The serial port can also communicate with a COM port on a personal computer, or other RS-232 port via the Key Telemetering interface board. By connecting the DatraxRF to the serial port on a host device, the host becomes a wireless communication device. To transmit, the host device simply sends data from its serial port to the DatraxRF and the DatraxRF converts the data into spread spectrum, FCC-approved wireless data. The data is then detected by a receiving DatraxRF module, checked for integrity, and sent to a receiving device via the serial port (Figure 2a).

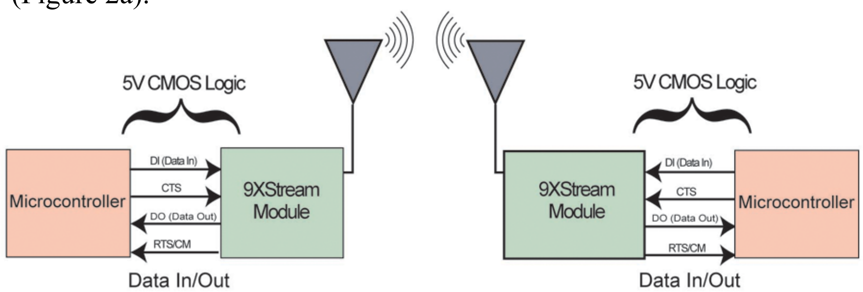

Figure 2a

Serial Pins

Figure 2a above shows 4 data lines needed to interface from a microcontroller or RS-232 device to the DatraxRF modules. These four lines represent DI (Data In), DO (Data Out), $\overline{\text{CTS}}$, and RTS/CMD (request to send/command mode). (All low-asserted pins are distinguished with a line over the top of the pin name, or a '*' symbol prefacing the pin name.) While the DI and DO pins are indispensable in almost all cases, the $\overline{\text{CTS}}$ and RTS/CMD may not be needed under certain conditions. The following includes a brief description of each of these pins and under what conditions the pins must be used. A brief explanation of the $\overline{\text{CONFIG}}$ pin is also provided.

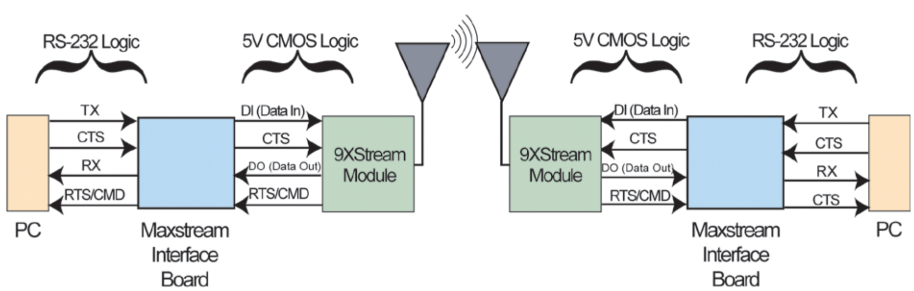

Figure 2b

DI (Data In) – Pin 4 (Input)

Data enters the DatraxRF on the DI pin as an asynchronous serial signal. The serial signal is idle (high) when no data is being transmitted. Each data packet consists of a start bit (low), 8 data bits, and a stop bit (high) as shown below in Figure 3.

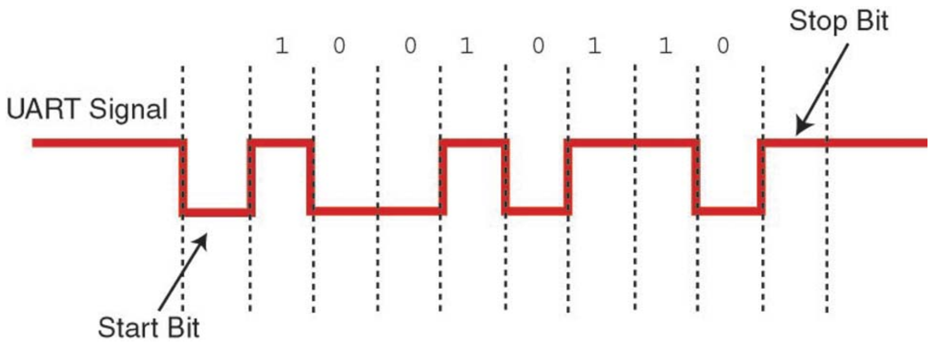

Figure 3

The DatraxRF modules transfer exactly 8-bits over the air. The start and stop bits from the UART signal are not actually transmitted, but are regenerated on the receiving module before they are sent out the serial port. This allows for the following data configurations to be sent:

- 8-bit, no parity, 1 stop bit
- 7-bit, even parity, 1 stop bit
- 7-bit, odd parity, 1 stop bit
- 7-bit, no parity, 2 stop bits

Since the DatraxRF is Half-duplex, it can only transmit or receive at a given time. Thus, once the first byte is detected on the DI pin, the DatraxRF immediately begins transmitting the incoming data unless over-the-air data is already being received. In this case, the data on the DI pin is stored in the data buffer until data is no longer being received at the antenna. If the DatraxRF receives a lengthy sequence of serial data (while receiving over-the-air data), the data buffer could reach its capacity (132 bytes) in which case the $\overline{\text{CTS}}$ signal will need to be implemented (see $\overline{\text{CTS}}$ section below).

Note: The 9600 and 19200-baud modules allow incoming serial data to be transferred at a rate of 2400-57600 bits/second. Serial data can be transferred to the module at a rate equal to or less than the module's over-the-air baud rate without any problems. However, if the serial interface rate is set to exceed the module's baud rate (9600 or 19200 bps respectively), $\overline{\text{CTS}}$ must be implemented since the data buffer may become full.

DO (Data Out) – Pin 3 (Output)

Data received from over-the-air transmissions is checked for errors and then sent to the DO pin.

$\overline{\text{CTS}}$ – Pin 1 (Output)

The $\overline{\text{CTS}}$ pin (clear to send) informs the host device whether or not serial data can be sent to the DatraxRF module. When CTS registers as ***low***, serial data can be sent to the DatraxRF module. All incoming serial data is stored in a data buffer until the next data packet is transmitted (over-the-air). The data buffer can hold up to 132 bytes of data. At 115 bytes, the DatraxRF module de-asserts the CTS signal (sets it high) to alert the host device to stop sending serial data. The CTS remains de-asserted until the number of bytes in the buffer drops below 98.

There are three cases in which the data buffer may become full:

1. When the 9600 and 19200-baud modules are configured at a higher serial data rate than the module's over-the-air baud rate causing the data buffer to become momentarily full and CTS to de-assert.

2. The DatraxRF module is a half-duplex transmitter/receiver. If the module is receiving a long, continuous string of over-the-air data, any serial data that arrives at the buffer will not be transmitted until the module no longer detects over-the-air data.

3. If any module in a network (see **Networking and Addressing**) is transmitting data, all other modules in the network will not transmit until they finish receiving data. If the network modules receive lengthy serial data, their data buffers may become full.

Note: In applications where none of these conditions occur, the CTS signal need not be monitored.

RTS/CMD – Pin 5 (Input)

RTS The RTS signal (request to send) is not implemented for flow control with the DatraxRF modules. All received data (over-the-air) is sent out the serial port regardless of the RTS signal.

CMD The DatraxRF comes with a variety of configurable settings including power-saving modes and network addressing options. This pin may be used as a way to manually configure the DaatraxRF module. When this pin is asserted (high), incoming serial data (on the DI pin) is interpreted as commands instead of data. (See the ***Command Mode*** section of this manual.)

CONFIG – Pin 9 (Input)

The $\overline{\text{CONFIG}}$ pin (low-asserted) is used to force the module to enter AT Command Mode. When asserted (low), the serial port baud rate is temporarily set to match the default baud rate of the DatraxRF module. This ensures that the module will transition into AT Command Mode at a known baud rate. Upon entering AT Command Mode, all configured parameters, including the baud rate, remain in their saved state and can be modified as described in the ***AT Command Mode*** section.

IMPORTANT:DO NOT tie the $\overline{\text{CONFIG}}$ pin to an external device as it may cause problems with module operation. The CONFIG pin should be tied to an external switch and used manually to enter AT Command Mode only when the AT Command Mode cannot be entered under the normal procedure (see the *AT Command Mode* section).

Modes of Operation

The DatraxRF wireless module features several modes of operation that allow the module to be responsive to data and yet utilize minimum power. The figure below shows these modes, followed by a comprehensive look into each and the necessary conditions for the DatraxRF module to transition from one mode to another.

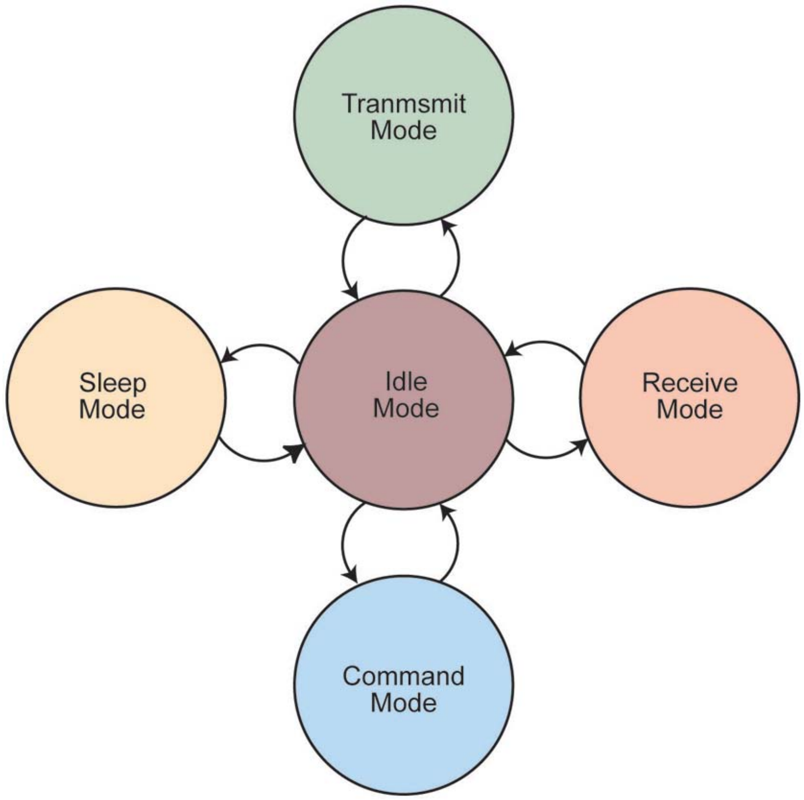

Figure 4

Idle Mode

The DatraxRF module operates in **Idle Mode** when there is no data being transmitted or received. The module transitions to **Transmit Mode** once data is presented on the DI pin. If valid data is detected at the antenna, the module will switch from Idle Mode to **Receive Mode**. When no longer transmitting or receiving, the module returns to Idle Mode.

Transmit Mode

When the first byte arrives in the data buffer through the DI pin, the module leaves Idle Mode and transitions to **Transmit Mode**. This transition happens instantaneously from the moment the first byte of data arrives in the data buffer. In Transmit Mode, a header is sent out and is followed by the first data packet, which has a CRC (Cyclic Redundancy Check) attached (see the

Transmit Mode (cont.)

Data Validity section for more information). The first data packet contains all bytes that accumulated in the data buffer while the header was being sent. After the first data packet is sent, another header will be sent if data is available in the buffer. The header is followed by another data packet. The second data packet (and all subsequent data packets) will consist of data that accumulated in the buffer while the previous data packet and header were being sent (see Figure 5a). The size of each data packet can vary up to 64 bytes. This progression is shown in Figure 5b.

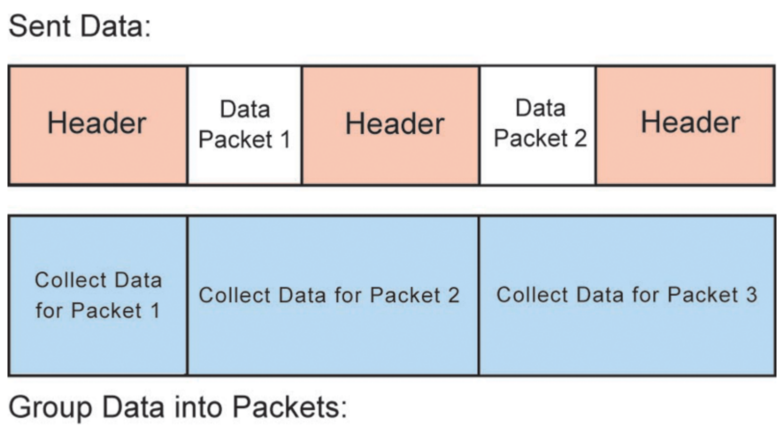

Figure 5a – Generation of data packets

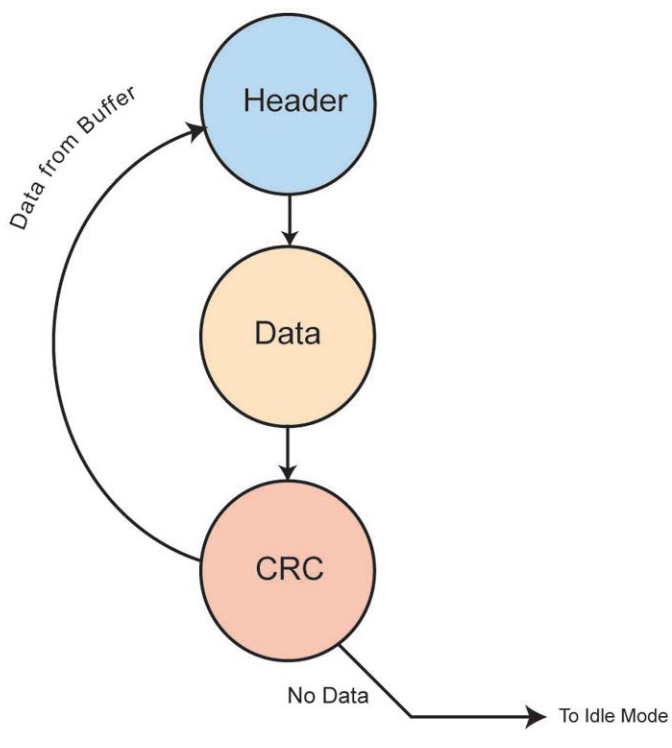

Figure 5b – Transmit Mode description

Data Validity

To verify data integrity, a 16-bit cyclic redundancy check (CRC) is computed for the transmitted data and attached to the end of each data packet before transmission. The receiver will then compute the CRC on all incoming data. Any received data that has an invalid CRC is discarded.

Transmission Latency

The length of time required to send a packet of data depends on the number of bytes being sent and the baud rate. In addition, modules have a Synchronization Timer option that can be manually configured using the **SY** command as discussed in the **DatraxRF Commands Table** (Appendix E). Modifying this parameter can significantly change the transmission latency. See the **Timing Diagrams** section for more information on transmission latencies.

Note: As outlined in Figure 5a, a header always prefaces a data packet. The header contains information that is used by all receivers (within range) to synchronize their hopping patterns to the transmitter. The length of the header can be reduced in some applications by eliminating the synchronization information. See *Timing Diagrams* for more information.

Receive Mode

If over-the-air data is present at the RF receiver when the module is in Idle Mode, it will transition to Receive Mode and start receiving packets. Once a packet is received, it goes through a CRC (cyclic redundancy check) to ensure that the data was transmitted correctly. If the CRC data bits on the incoming packet are invalid, the packet is discarded. If the CRC is valid, the packet is sent to the serial port via the DO pin. This process is shown in Figure 6 below.

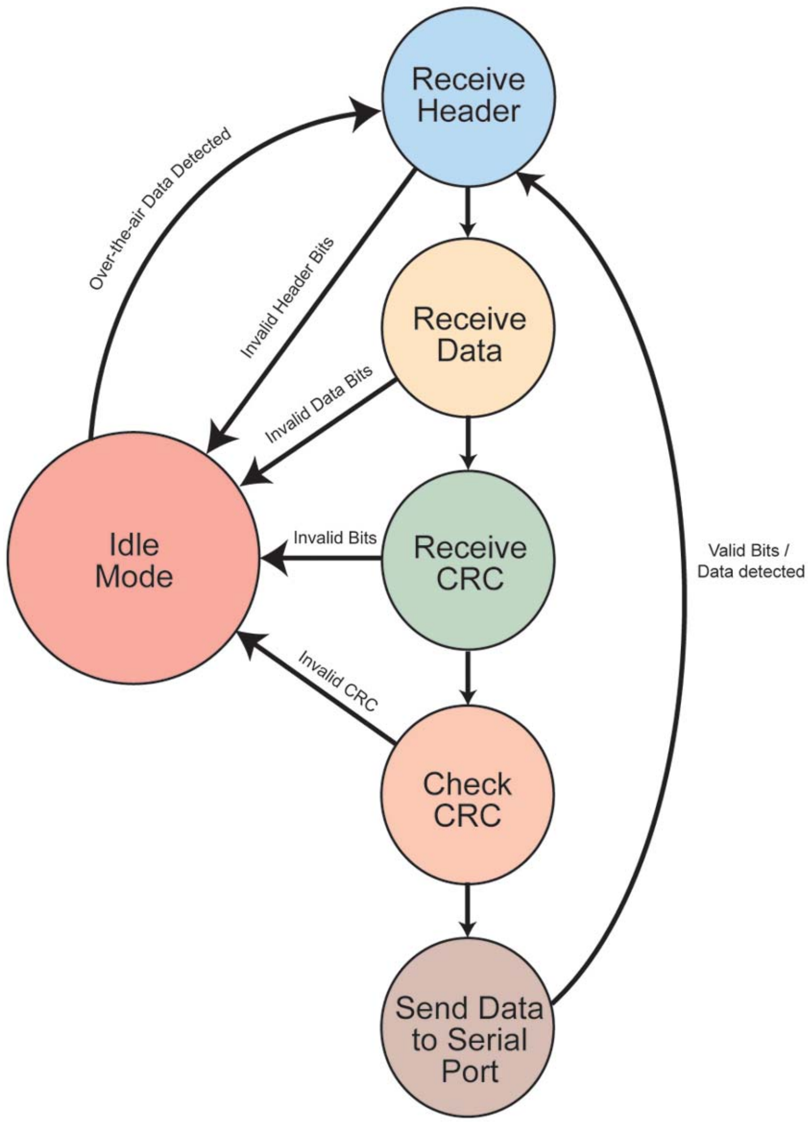

Figure 6 – Receive Mode description

Receive Mode (cont.)

The module will remain in Receive Mode until an error is detected in the received data, or data is no longer transmitted, at which point, the module transitions to Idle Mode. If serial data was stored in the data buffer while the module was in Receive Mode, the data will be transmitted after the module returns to Idle Mode.

Sleep Mode

Sleep Mode enables the DatraxRF module to go into a low-power state in which minimal power is consumed when the module is not in use. Once in Sleep Mode, the module will not transmit or receive data until it first returns to Idle Mode. To enter Sleep Mode, the module must be inactive (no data transmission or reception) for a user-defined period of time (specified by the ST command). After this time elapses, the module transitions to Sleep Mode. By default, Sleep Mode is disabled and must be enabled using the SM command.

The DatraxRF features several Sleep Mode settings, each of which makes use of different mechanisms to enter or leave Sleep Mode. The table in **Appendix H** lists the various Sleep Mode settings and the requirements to transition to and from Sleep Mode for each setting.

Pin Sleep (SM=1)

After enabling the **Pin Sleep** setting, the Sleep pin (Pin 2) controls whether the DatraxRF is active or in Sleep Mode. If Sleep is de-asserted, the module is fully operational. Once Sleep is asserted, the module transitions to Sleep Mode and remains in its lowest power consuming state until the Sleep pin is de-asserted. The DatraxRF requires 85 ms to transition from Sleep Mode to Idle Mode. The Sleep pin is only active if the module is set up to operate in this mode; otherwise the pin is ignored. (See the **SM** command in the **DatraxRF Commands Table** (Appendix E), for more information.) Once in Pin Sleep Mode, the $\overline{\text{CTS}}$ pin (Pin 1) is de-asserted (high) to indicate that data should not be sent to the module during this time. The TX/PWR pin (Pin 8) is also de-asserted (low) when the module is in Pin Sleep Mode.

Serial Port Sleep (SM=2)

If this state is enabled, the module goes into Sleep Mode after a user-defined period of inactivity (no transmitting or receiving of data). This period of time can be changed by modifying the ST command. When the module is in Serial Port Sleep Mode, the TX/PWR pin (Pin 8) is de-asserted (low). The module will return to Idle Mode once a character is received on the DI pin.

Cyclic Sleep (SM=3-7)

If the **Cyclic Sleep** setting is enabled, the DtraxRF module goes into Sleep Mode after a user-defined period of inactivity (no transmission or reception on the RF channel). The user-defined period may be set by adjusting the ST parameter (see the **ST** command in the **DtraxRF Commands Table** – Appendix E).

The module remains in Sleep Mode for a user-defined period of time ranging from 0.5 seconds to 8 seconds (adjustable using **SM** command). After this period of time, the module returns to Idle Mode and listens for a valid data packet. If no valid data packet is found (on any channel), the module returns to Sleep Mode. If a data packet is found, the module transitions into **Receive Mode** and receives the incoming packets until another ST inactivity time out occurs. When the module is awake, it requires 100 milliseconds to search for a valid data packet.

While the module is in a low-power state, the $\overline{\text{CTS}}$ pin (Pin 1) is de-asserted (high) to indicate that data should not be sent to the module during this time. When the module awakens to listen for data, the $\overline{\text{CTS}}$ pin is asserted, and any data received on the **DI** pin will be transmitted. The TX/PWR pin (Pin 8) is also de-asserted (low) when the module is in Cyclic Sleep Mode. It is asserted each time the module cycles into Idle Mode to listen for valid data packets, and then de-asserts if the module returns to Sleep Mode.

Cyclic Scanning

Each RF packet consists of a header and data as shown previously in **Figure 5a**. Since the header contains the channel synchronization information, the module must wake up during the header portion of a packet in order to synchronize with the transmitter and receive the data. To ensure that the DatraxRF module can detect the header, a long header can be sent periodically during a transmission. This long header repeats the synchronization information for a period of time defined by the **LH** command.

By default, the long header is turned off and must be enabled in order to communicate with a module operating in Cyclic Sleep Mode. To enable the long header, the LH parameter must be set to a value greater than the time of cyclic sleep to ensure accurate detection by the receiver(s). For example, if the DatraxRF is set to wake up from Sleep Mode every four seconds and check for a packet, a transmitter would need to send a long header that is just over four seconds in length to guarantee that the receiving module will detect the packet. (Exact timing requirements can be found in the **Timing Diagrams** section.) This concept of long header length versus Sleep Mode timing is displayed in **Figure 7a** and **b**.

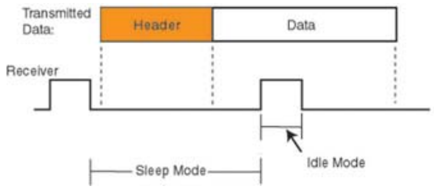

Figure 7a – The length of the long header is not as long as the period of Cyclic Sleep. It is possible for the receiver to wake and miss the header (and the data packet) in this scenario.

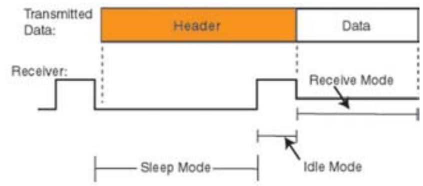

Figure 7b – The length of the long header exceeds the period of Cyclic Sleep. The receiver is guaranteed to detect and receive the data packet.

The long header is only sent with the initial transmitted packet after a user-defined period of inactivity (no serial data received and no over-the-air transmitting or receiving). This period of inactivity must be adjusted using the **HT** command as described in the **DtraxRF Commands Table** (Appendix E). Sending a long header assures that the receiver will detect the new transmission and will be able to receive the data (as long as the header length slightly exceeds the cyclic sleep time).

Command Mode

Command Mode allows several features, including the power-down and addressing options, to be configured. These adjustable parameters offer greater flexibility to designers in configuring the module to fit specific design criteria. There are three ways to enter Command Mode:

1. Assert RTS/CMD and send a binary command.
2. Send the sequence "+++" to send AT commands.
3. Assert (low) the CONFIG pin and turn the power switch off and back on.

Important: Do not tie CONFIG pin to microprocessor. (See the *Serial Port Operation* section for more information.)

Once in Command Mode, the configurable parameters can be adjusted using either AT commands or Binary commands, as explained below. Any parameters that are changed while in Command Mode must be saved to non-volatile memory using the **WR** command, or they will reset to their stored value upon **reset** or **power-up**.

Command Mode *(cont.)*

In these examples, sent or received ASCII characters are marked in quotations. Quotation marks should not be included when sending commands to the DatraxRF modules. Carriage Returns (ASCII character 13) will be denoted as <CR>. Binary values are represented in this document with < and >. These characters are also not sent as part of the actual command. All binary values are represented as hexadecimal values (HEX) in these examples, and are denoted by an H after the number. The actual Binary Command values must all be sent in binary with the Least Significant Byte (LSB) sent first followed by the Most Significant Byte (MSB) if the value is larger than one byte.

AT Commands

The following sections contain a description of the AT and Binary Command Modes along with some examples. In these examples, sent or received ASCII characters are marked in quotations.

AT commands can be sent to the module using ASCII commands and parameters. A special break sequence is used so that the module will transition into AT Command Mode. The default sequence for entering AT Command Mode is as follows:

- No characters sent for one (1) second.
  *(Time modified by **BT** command.)*
- Three (3) plus characters (**+++**) sent within one (1) second.
  *(Character modified by **CC** command.)*
- No characters sent for one (1) second.
  *(Time modified by **AT** command.)*

The DatraxRF responds by sending an **OK<CR>**.

All AT commands are sent as follows:

AT	**+**	**Two (2) Character ASCII Command**	**+**	**Optional Space**	**+**	**Parameter (HEX)**	**+**	**Carriage Return**

The ASCII command consists of **AT** followed by two alphanumeric bytes, and the parameter is a number represented as ASCII hexadecimal characters (0-9, A-F). The ASCII commands and parameters are not case-sensitive. The optional space can be any non-alpha-numeric character

After executing a recognized AT command, the module responds with an **OK<CR>**. If an unrecognized command or a command with a bad parameter is received, the module will respond with an **ERROR<CR>.**

AT Commands (cont.)

A modified AT value is reset upon module power-down unless the **WR** command is issued to save the parameter to non-volatile memory.

To query the current value of a particular command, send the corresponding **AT** command without any parameters (carriage return, however, is still sent). The response will be the current value of that command reported as a hexadecimal number.

The following example demonstrates basic AT Command functionality in the DatraxRF module.

Example: This example will change the user-defined Module Address to 1A0D (HEX) and check the current value of the SM command. It will also write the new Module Address to non-volatile memory.

SEND	**RESPONSE**
+++	**OK<CR>**
ATDT 1A0D<CR>	**OK<CR>**
ATSM<CR>	**0 <CR>**
ATWR<CR> *(write to non-volatile memory)*	**OK<CR>**
ATCN<CR> *(exit AT Command Mode)*	**OK<CR>**

Exiting AT Command Mode

There are two ways to exit the AT command mode and return to Idle Mode. If no valid AT commands are received within the time specified by the AT Command Timeout parameter (CT command), the module will return to Idle Mode automatically. Alternatively, the AT command mode can be exited by sending the CN command.

Binary Commands

Binary command bytes are organized as follows:

<Command><Parameters>

1 byte *2 bytes*

When sending a Binary command to the DtraxRF the **Command byte** must be sent while the RTS/CMD pin (Pin 5) is asserted. RTS/CMD can be de-asserted 100 microseconds after the stop bit from the Command byte has been sent. It does not matter whether RTS/CMD is asserted when the **Parameter bytes** are sent. The command will execute when all the parameters associated with the command have been sent. If all parameters aren't received within 0.5 seconds the module will return to Idle Mode.

Binary Commands (cont.)

Note: When parameters are sent, they are always two bytes long with the Least Significant Byte sent first. When they are read, they are 1 or 2 bytes long as indicated in the *DatraxRF Command Table* (Appendix E).

Binary Command Mode allows multiple commands to be sent in sequence. When the RTS/CMD pin is asserted, all incoming serial data will be interpreted as commands. Commands can be sent in sequences of commands and their associated parameters. If RTS/CMD remains asserted, all received commands will be executed by the DatraxRF module. All modified parameters must be stored in non-volatile memory by sending the WR command (08H with no parameters) before powering down or resetting the module or the changes will be lost.

Commands can be queried for their current value by sending the command logically ORed with the value 80H (hexadecimal) with RTS/CMD asserted. When this binary value is sent (with no parameters) the current value of the command will be sent back, through the DO pin.

Note: For the DatraxRF module to recognize a Binary command, the RT command must be issued from AT Command Mode to enable binary programming. If binary programming is not enabled, the module will not recognize when the RTS/CMD pin is asserted and will therefore not recognize Binary Commands.

Example: This example will set Sleep Mode to the Pin Sleep setting and store the new Sleep Mode value to non-volatile memory. (Again, the RT command must be issued in AT Command Mode to enable binary programming before Binary Command Mode will work.)

Assert RTS/CMD	**(Enter command mode.)**
Send bytes:	**(Send SM1 command)**
<01H>	**(Command Byte - SM)**
<01H>	**(Least significant bit of the Parameter Bytes - 01H)**
<00H>	**(Most significant bit of the Parameter Bytes – 00H)**
Send bytes:	**(Send WR command)**
<08H>	**(Command Byte - WR)**
	De-assert RTS/CMD

Networking and Addressing

The DatraxRF modules utilize three levels of addressing to communicate between modules. This networking hierarchy is depicted in Figure 8 below. Only modules with the matching addresses are able to communicate. The three methods of addressing are: Vendor Identification number, Networks, and Module Addresses.

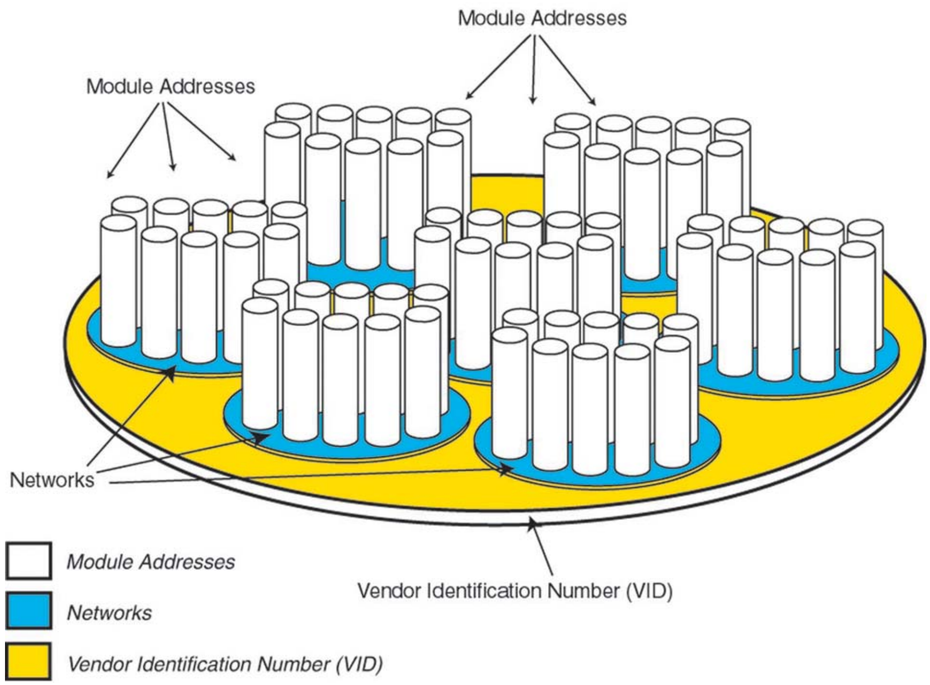

Figure 8 – Layout of a typical network configuration. The DatraxRF features a powerful set of networking and addressing options allowing the functionality of complex networking systems.

Vendor Identification Number (VID)

For network security, a unique **Vendor Identification Number (VID)** can be requested. The VID is programmed into the DatraxRF module at the factory and is stored in permanent memory. This number can only be changed at the factory. Only modules with matching VID numbers can communicate together. VID addressing ensures that modules with a given VID are immune to either transmissions or receptions with DatraxRF modules of a different VID in the same vicinity. To request a unique VID number, contact Key to obtain a **VID Request Form**.

Networks

Within each VID, there are seven available **networks**. Each network utilizes a different pseudo-random hopping sequence to navigate through the shared hopping channels. In the event that two modules from different networks collide on a channel (because they hop in a different sequence) the two modules will jump to separate channels on the next hop. Using networks, multiple module pairs can operate in the same vicinity with minimal interference from each other. The network parameter is user-definable using the **HP** command as described in the **DatraxRF Command Table** (Appendix E).

Module Address

Module Addresses and **Module Address Masks** provide another level of addressing among DatraxRF modules. Each module in a network can be configured with a 16-bit Module Address to establish selective communications within a network. This address is set to one of 65535 values using the "DT" command. The default Module Address is 0000H.

All modules with the same Module Address can transmit and receive data among themselves. Any modules on a network with different Module Addresses will still detect and listen to the data in order to maintain network synchronization. However, they will not send the data out to their serial ports if their Module Addresses don't match the Module Address of the transmitter. (The Module Address Mask can be used to provide exceptions to this rule as described in the following section.)

Module Address Mask

The Module Address Mask can be used as an additional method to facilitate communication among modules. The Module Address Mask can also be set to one of 65535 possible values using the **MK** command. The default value is FFFFH.

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

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

Module Address Mask (cont.)

Packets with a Transmitter Module Address of FFFFH are received by all modules (as shown below in Figure 9). A Transmitter Module Address that matches the Module Address Mask is called a Global Address.

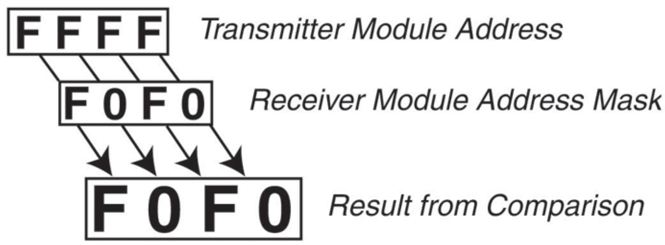

Figure 9 – Demonstration of Module Address comparison at receiver. FFFFH logically "ANDed" with any Module Address Mask will equal the Module Address Mask.

Example: Consider Module A with Module Address of 00FFH and Module Address Mask F0F0H (Figure 10).

Figure 10

Module A can receive packets from other modules in three ways:

1. **From modules with a Transmitter Module Address of 00FFH.**
2. **By logically "ANDing" a F0F0H Mask with the Receiver Module Address to receive *0XFX* (HEX).**
3. **From an address that matches the Module Address Mask of the module (F0F0H), or packets from a module having a Transmitter Module Address (Global Address) of *FXFX* (since the two *0* values in FOFOH are *insignificant*).**

Glossary

AT commands – A set of commands that can be used to customize and configure the DatraxRF module to meet specific needs. AT commands are sent via a serial communications program such as HyperTerminal.

Binary commands – A set of commands used to configure the DatraxRF module. Binary commands are sent with RTS/CMD asserted. The RT command must be used to enable binary programming prior to using binary commands. Multiple Binary commands can be issued sequentially while RTS/CMD is asserted.

Clear to send – See **CTS pin**.

CMOS logic – Logic levels used by the DatcraxRF module (0-5V).

Command Mode – A mode of operation, which manually modifies the configurable parameters of the DatraxRF module. Both Binary and AT command modes are available.

Command table – Table containing 23 currently implemented commands. This table lists all of the adjustable parameters along with a brief description of each.

CRC – See **Cyclic Redundancy Check**.

CTS pin – The low-asserted **Clear To Send** pin (Pin 1) provides flow control for the DatraxRF module. When CTS is asserted (low), serial data can be sent to the module for transmission. If the module is unable to transmit the data, CTS may de-assert (high) once the data buffer nears capacity to prevent buffer overflow.

Cyclic redundancy check (CRC) – Used by the DatraxRF module to ensure data integrity during transmission. A CRC is computed on the bits to be transmitted over-the-air and sent with each data packet. The CRC is recomputed by the receiver and compared with the original CRC bits. The packet is valid if the receiver CRC matches the CRC computed by the transmitter.

Cyclic sleep – Sleep Mode setting in which the module enters a low-power state and awakens periodically to determine if any transmissions are being sent.

Data buffer – Collects incoming serial data prior to over-the-air data transmission. The data buffer can hold up to 132 bytes at a given time. When the buffer fills to 115 bytes, the Clear To Send (CTS) pin is de-asserted to stop the flow of incoming serial data.

Data packets – A grouping of data to be sent over-the-air. Each data packet contains a header and data that is collected from the data buffer. The size of the packets varies up to 64 bytes depending on how many bytes of data are in the data buffer.

Glossary *(cont.)*

Data validity – Act of comparing received data with transmitted data to ensure accurate transmission. Data validity is verified by performing a CRC check.

DI pin – All incoming serial data enters the DatraxRF module on the Data In (DI) pin (Pin 4).

DO pin – All received over-the-air data leaves the DatraxRF module through the Data Out (DO) pin (Pin 3). The data can then be sent to a microcontroller or RS-232 device.

FCC – The Federal Communications Commission is the US government agency responsible for regulating radio communications standards in the United States.

Flow control – Method of determining when serial data can be sent to the module for over-the-air transmission. Flow control is used to prevent buffer overflow. This can be implemented in hardware and/or software. Hardware flow control is implemented in the DatraxRF module using the $\overline{\text{CTS}}$ pin.

Frequency Hopping Spread Spectrum (FHSS) – Method employed by the DatraxRF module which involves transmitting data over several different channels in a specific channel hopping sequence known by the transmitter and the receiver(s).

Half-duplex – A mode for radio operations. Radios that operate in half-duplex are able to either transmit data or receive data at a given time, but cannot do both simultaneously. When one module is transmitting, all modules (of the same VID) within range listen to the transmission and will only transmit once the transmission is complete.

Hardware flow control – See **Flow Control**.

Headers – Information that prefaces the data bits in transmitted data packets. The header contains information used by the receiver(s) to synchronize to the transmitter.

HyperTerminal – A serial communications program useful for communicating with the DatraxRF module and configuring user-defined operating parameters through AT commands.

Idle Mode – A mode of operation in which the module is neither transmitting nor receiving.

Industrial Temperature – Temperature tested version of DatraxRF modules extending beyond normal operating specifications (0ºC to 70ºC). These modules are tested for a temperature range from -40ºC to 85ºC.

Glossary (cont.)

Integration – The process of incorporating the DatraxRF module into an application in place of a serial cable.

Interface board – An optional board available with the DatraxRF module that converts RS-232-level data into CMOS logic levels.

Long header – A lengthy header (length determined by LH command – see Appendix E) sent out to ensure that modules running in a cyclic sleep mode detect the header when they awake and synchronize to the transmission.

Low-power modes – See **Sleep Mode**.

Module Addresses – Provides a layer of addressing among modules. Modules with the same Module Addresses can communicate together.

Module Address Masks – Provide a layer of filtering to over-the-air data packets that are received by the module. The address (of the transmitting module) is logically "ANDed" with the Module Address Mask of the receiver. The resulting value must match the Module Address of the receiver for the packet to be received. All **"0"** values are not compared.

Networks – Provides a layer above Module Addresses for communicating between modules. Each network has a unique hopping sequence that allows modules on the same network to remain synchronized together.

Pin layout – Describes the layout and functionality of all pins on the DatraxRF module.

Pin sleep – A Sleep Mode setting which puts the DatraxRF into a minimal power state when the SLEEP pin is asserted. It remains in Pin sleep until the SLEEP pin is de-asserted. This setting must be enabled using the SM command.

Power-saving modes – See **Sleep Mode**.

Receive Mode – A mode of operation that receives over-the-air data and transmits all valid data packets out to the serial port. The module must be in Idle Mode to transition to Receive Mode.

RS-232 logic – Standard logic levels implemented in devices using the RS-232 communication protocol.

RTS/CMD (Request to Send/Command) – The RTS/CMD pin (Pin 5) is used primarily to configure Binary commands (CMD). RTS flow control is not implemented in the DatraxRF module.

Sensitivity – A measurement specification that describes how weak a signal can be (in dBm) and still be detected by the receiver.

Glossary (cont.)

Serial data – Data that enters the DatraxRF module through its serial port.

Serial port sleep – A Sleep Mode setting in which module runs in a low power state until data is detected on the DI pin. This setting must be enabled using the SM command.

Sleep Mode – A mode of operation in which the DatraxRF enters a low power consuming state. Several Sleep Mode settings are available and can be configured using the SM command.

SLEEP pin – If Pin Sleep is enabled, the SLEEP pin (Pin 2) determines if the module is in Sleep Mode or Idle Mode. See **Pin sleep**.

Standby Mode – See **Idle Mode**.

Start bit – A low UART signal sent to signify the beginning of an eight-bit data sequence.

Stop bit – The last bit in a UART data sequence. The stop bit is high and indicates the end of an eight-bit data sequence.

Synchronization – Synchronization is used to ensure that the transmitter and receiver are communicating properly with each other and following the same channel hopping sequence.

Transmission Latency – Time required to send a packet of data. This value is dependent on the number of bytes being sent and the baud rate of the module.

Transmit Mode – Mode of operation in which over-the-air data can be transmitted from a module to other modules.

TTL (Transistor-transistor logic)

UART (Universal Asynchronous Receiver-Transmitter) – See **Serial port**.

VID (**Vendor Identification number)** – This number allows modules with the same VID to communicate. Any module with a different VID will not receive their data transmissions.