Appendix B: Xbee wireless module

Key features

Long-range Data Integrity

- Indoor/Urban: up to 100' (30 m)
- Outdoor line-of-sight: up to 300' (100m)
- Transmit Power: 1 mW (0dBm)
- Receiver Sensitivity: -92 dBm

Low Power

- TX Peak Current: 45mA
- RX Current: 50mA
- Sleep Current: <50uAXBee-

Easy-to-Use

- No configuration necessary for out-of box RF communications
- AT and API Command Modes for configuring module parameters
- Small form factor
- Extensive command set
- Free X-CTU Software (Testing and configuration software)

XBee module Specification

Performance	
Indoor/Urban Range	Up to 100 ft (30 m)
Outdoor RF line-of-sight Range	Up to 300 ft (90 m)

Transmit Power Output (software selectable)	1mW (0 dBm)
RF Data Rate	250,000 bps
Serial Interface Data Rate (software selectable)	1200 bps - 250 kbps (non-standard baud rates also supported)
Receiver Sensitivity	-92 dBm (1% packet error rate)
Power requirements	
Supply Voltage	2.8 – 3.4 V
Transmit Current (peak)	45mA (@ 3.3 V)
Idle / Receive Current (typical)	50mA (@ 3.3 V)
Power-down Current	< 50 μA
General	
Operating Frequency	ISM 2.4 GHz
Networking & Security	
Supported Network Topologies	Point-to-point, Point-to-multipoint & Peer-to-peer
Number of Channels (software selectable)	16 Direct Sequence Channels
Addressing Options	PAN ID, Channel and Addresses

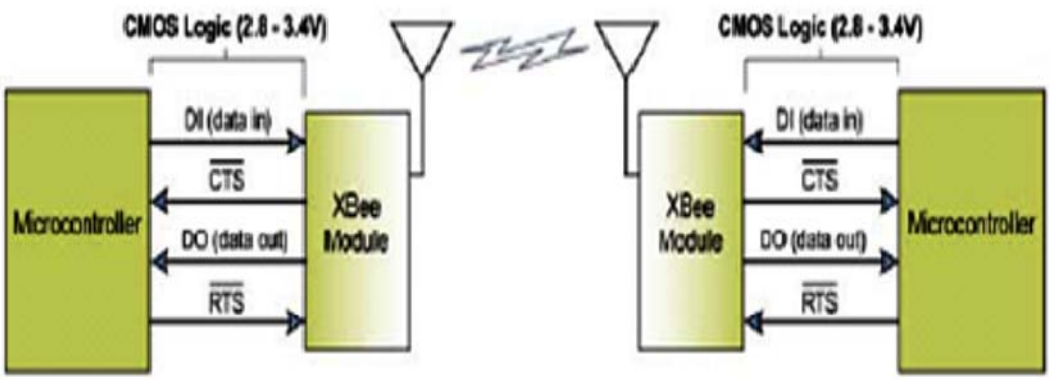
RF Module Operation

- **Serial Communications**

The XBee OEM RF Modules interface to a host device through a logic-level asynchronous serial port. Through its serial port, the module can communicate with any logic and voltage compatible UART; or through a level translator to any other serial device.

- **UART Data Flow**

Devices that have a UART interface can connect directly to the pins of the RF module as shown in the figure below.



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

- **Transparent Operation:**

By default, XBee RF Module operates in Transparent Mode. When operating in this mode, the modules act as a serial line replacement - all UART data received through the DI pin is queued up for RF transmission. When RF data is received, the data is sent out the DO pin.

- **Serial-to-RF Packetization**

Data is buffered in the DI buffer until one of the following causes the data to be packetized and transmitted:

1. No serial characters are received for the amount of time determined by the RO (Packetiza-tion Timeout) parameter. If RO = 0, packetization begins when a character is received.
2. The maximum number of characters that will fit in an RF packet (100) is received.
3. The Command Mode Sequence (GT + CC + GT) is received. Any character buffered in the DI buffer before the sequence is transmitted.

If the module cannot immediately transmit (for instance, if it is already receiving RF data), the serial data is stored in the DI Buffer. The data is packetized and sent at any RO timeout or when 100 bytes (maximum packet

size) are received. 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 module).

Flow Control

- **DI (Data In) Buffer**

When serial data enters the RF module through the DI pin, the data is stored in the DI Buffer until it can be processed. Hardware Flow Control (CTS). When the DI buffer is 17 bytes away from being full; by default, the module de-asserts CTS (high) to signal to the host device to stop sending data. CTS is re-asserted after the DI Buffer has 34 bytes of memory available.

To eliminate the need for flow control tow points shall be considered:

1. Send messages that are smaller than the DI buffer size.
2. Interface at a lower baud rate [BD (Interface Data Rate) parameter] than the throughput data rate.
3. In some case DI Buffer may become full and possibly overflow due to receiving a continuous stream of RF data, 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 module is no longer receiving RF data in the network.

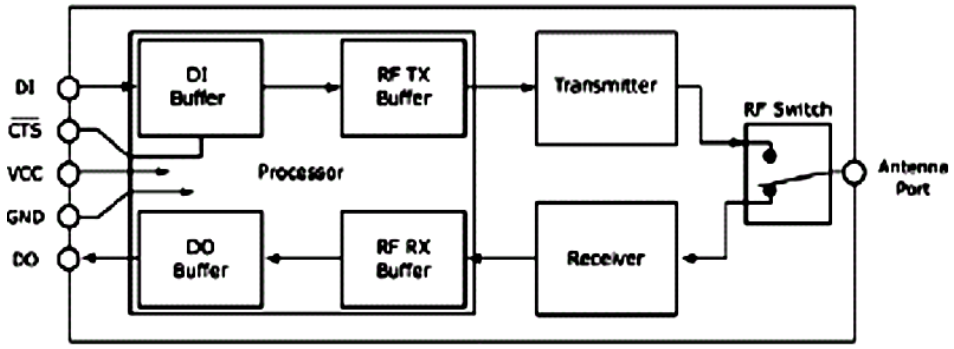
- **DO (Data Out) Buffer**

When RF data is received, the data enters the DO buffer and is sent out the serial port to a host device. Once the DO Buffer reaches capacity, any additional incoming RF data is lost. Hardware Flow Control (RTS). If RTS is enabled for flow control (D6 (DIO6 Configuration) Parameter = 1), data will not be sent out the DO Buffer as long as RTS (pin 16) is de-asserted.

There are 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 module, the module will receive data from the transmitting module faster than it can send the data to the host.

2. If the host does not allow the module to transmit data out from the DO buffer because of being held off by hardware or software flow control.



XBee module internal data flow diagram