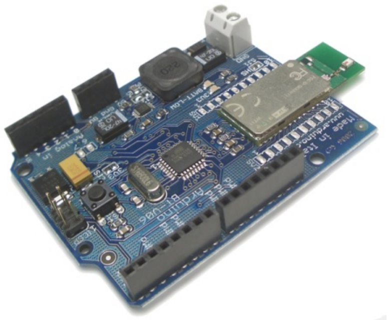
IAT 884 Week 11

Wireless Communication

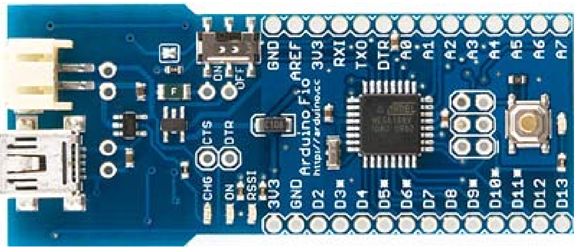
Wireless Communication

Options that work with the Arduino

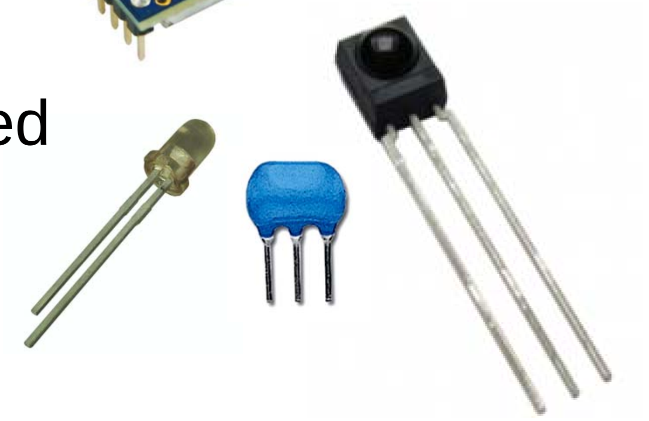
BlueTooth



XBee


Arduino Fio
GND AREF 3V3 RXI TXO DTR A0 A1 A2 A3 A4 A5 A6 A7
3V3 GND D2 D3 D4 D5 D6 D7 D8 D9 D10 D11 D12 D13

Infrared



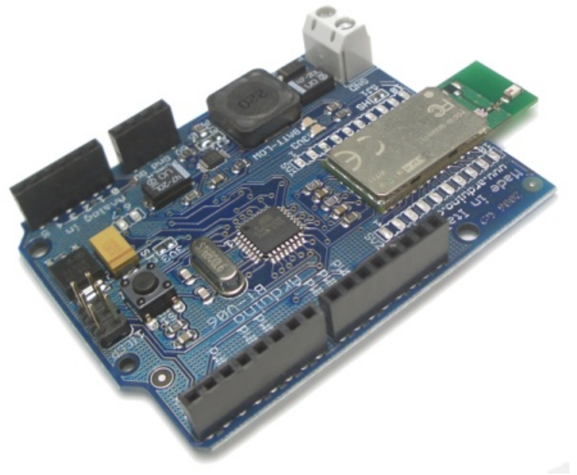
Wireless Communication

Bluetooth

Bluetooth was designed as a wireless cable replacement between two devices.

PROS:
Fairly simple setup
Built into the Bluetooth Arduino

Cons:
Requires pairing devices using a PIN#
Can only connect 2 devices
Limited Range
Expensive
Size



Wireless Communication

Infrared

Commonly used in remote control units

PROS:
DIY (Do It Yourself)

CONS:
Directional – Must face receiver
Short Range
Assembly required
One Way

Wireless Communication

Infrared

How it works

An oscillator sets a specific frequency wave on which the serial data will travel. This is known as the *carrier wave*.

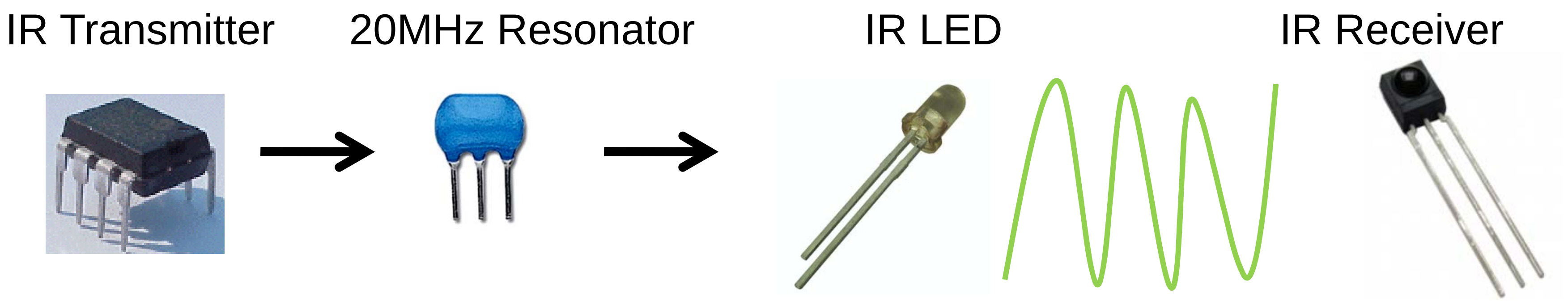
An IR LED is pulsed at a specific data rate. These pulses modulate the pulse sent by the carrier wave.

Any light not at the same frequency as the carrier wave will be filtered out by the receiver.

Wireless Communication

Infrared

Construction: What you need



Wireless Communication

XBee Radios

Pros

Multi-point networking

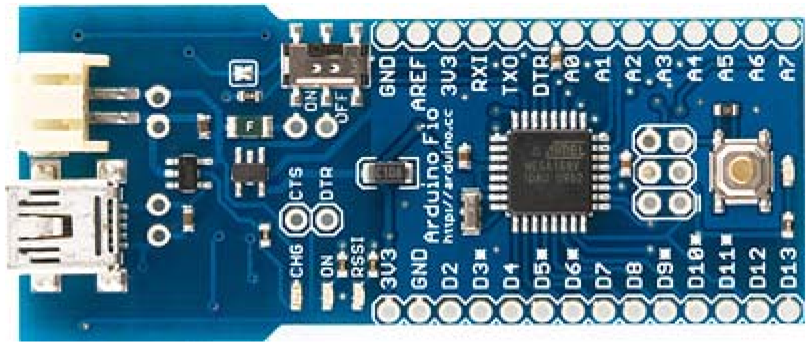
Mesh Networking capabilities

Greater Range

Cons

Energy Consumption

Configuration complexity



Wireless Communication
XBee Radios

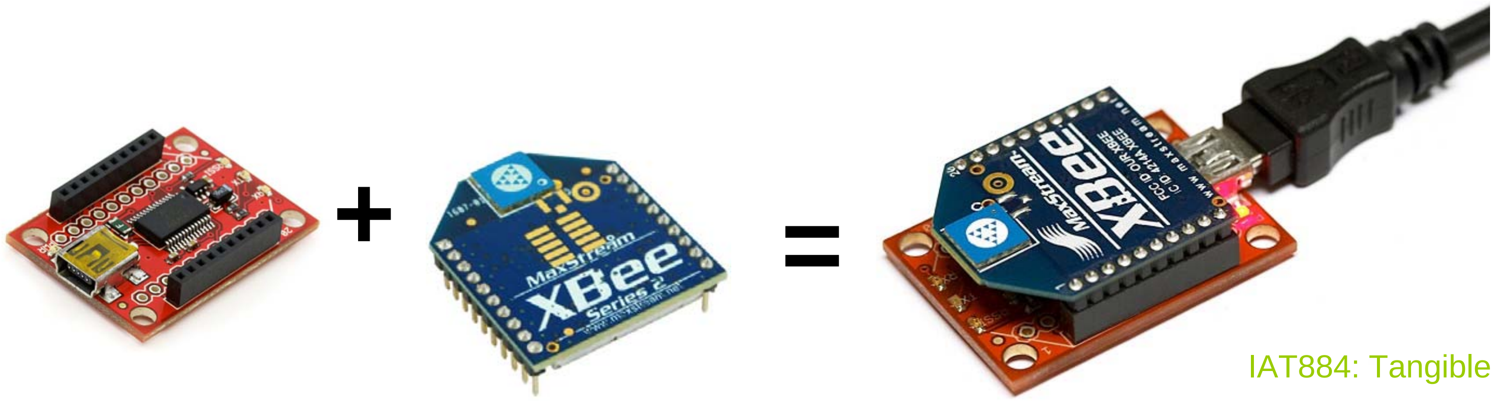
Two Versions

•Series 1 (802.15.4) – P2P Network
•Series 2.5 – Mesh Network

XBee Modules

Getting Started

- You will need at lease two XBee modules.
- You will need some way to connect them to a computer for programming. (I recommend the **XBee Explorer**)
- You will need to program each module individually
- Once the two modules are communicating you can add them to an Arduino in place of a USB cable for communication.
- They can facilitate communication between a computer and an Arduino, or between two Arduinos without the need for a computer.



Wireless Communication

XBee Series 1 (802.15.4)

- XBees send directly to another Xbee or broadcast to all Xbees at once
- 6 Analog/8 Digital I/O Pins

•XBee Series 2.5

- Data can be routed between XBees to form a mesh network
- Data can be re-broadcast by other XBee modules within range
- 4 Analog/11 Digital I/O Pins

Source: http://code.google.com/p/xbee-api/wiki/ChoosingAnXBee

Configuring an Xbee

Configuration can be done using the AT command set

or

Digi makes a program called X-CTU that makes configuration easy

http://www.digi.com/support/productdetl.jsp?pid=3352&osvid=57&tp=5&s=316

AT Command set

Data Mode – Data is interpreted as information and is passed on to a remote modem

Command Mode – Data is interpreted as configuration settings.

Command mode is activated by sending the modem "+++"

As long as a command is sent within 10 seconds of the previous command the modem will stay in command mode.

Configuring an Xbee Series 1

Using the AT Command Set

Coordinator
Restore to Factory Settings
RE

Put XBee in API mode (escape control bytes)
AP=2

Make this radio the Coordinator
CE=1

Set the address of this radio to any arbitrary two byte value
MY=1234

Set the PAN ID to a two byte arbitrary value.
Each XBee in the network must have this same value.
ID=1111

Both radios must have the same Channel and PAN ID to communicate
CH=0C

Save to non-volatile memory to survive power on/off
WR

Reboot Radio
FR

End Device
The End Device configuration is identical except for:
Make this an End Device
CE=0

Set the 16-bit address to a unique value
MY=5678

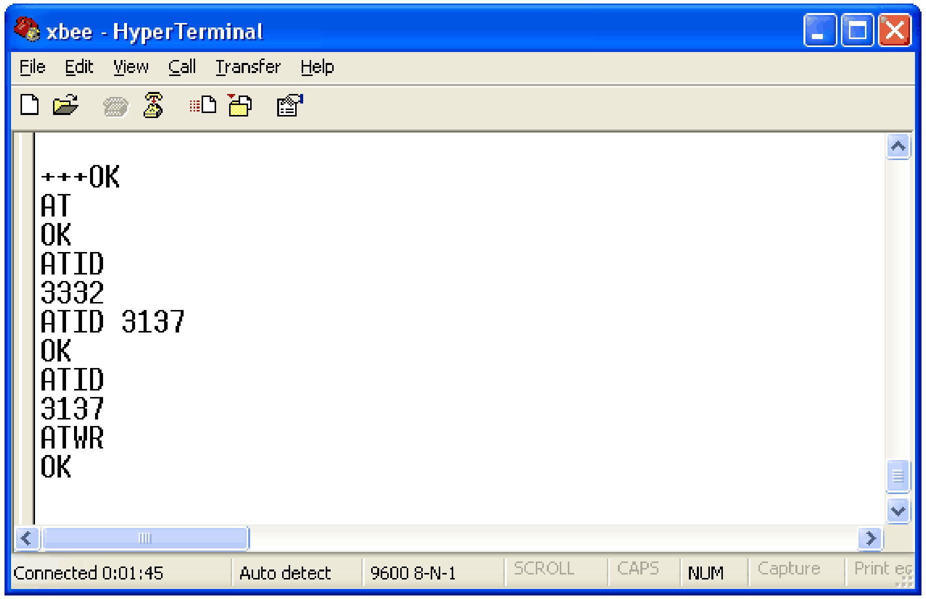
Source:
http://code.google.com/p/xbee-api/wiki/XBeeConfiguration

Configuring an Xbee Series 1

Using the AT command set

From a terminal program send commands in the following manner:

Send Command to enter command mode	Expected Response
+++*<enter>*	OK*<CR>*
Send Command to Write ID	Expected Response
AT**ID**3137*<enter>*	OK*<CR>*
Send Command to Verify Setting	Expected Response
AT**ID***<enter>*	3137*<CR>*



```
+++OK
AT
OK
ATID
3332
ATID 3137
OK
ATID
3137
ATWR
OK
```

Connected 0:01:45 | Auto detect | 9600 8-N-1 | SCROLL | CAPS | NUM | Capture | Print echo

Configuring an XBee Series 1

Networking two XBees

Xbees must share a common Private Area Network ID (stored as the ATID)

The AT**MY** value sets an XBEE's network number (its name)

The AT**DH** value sets the destination XBEE network number (the recipient's name)

XBEE1:

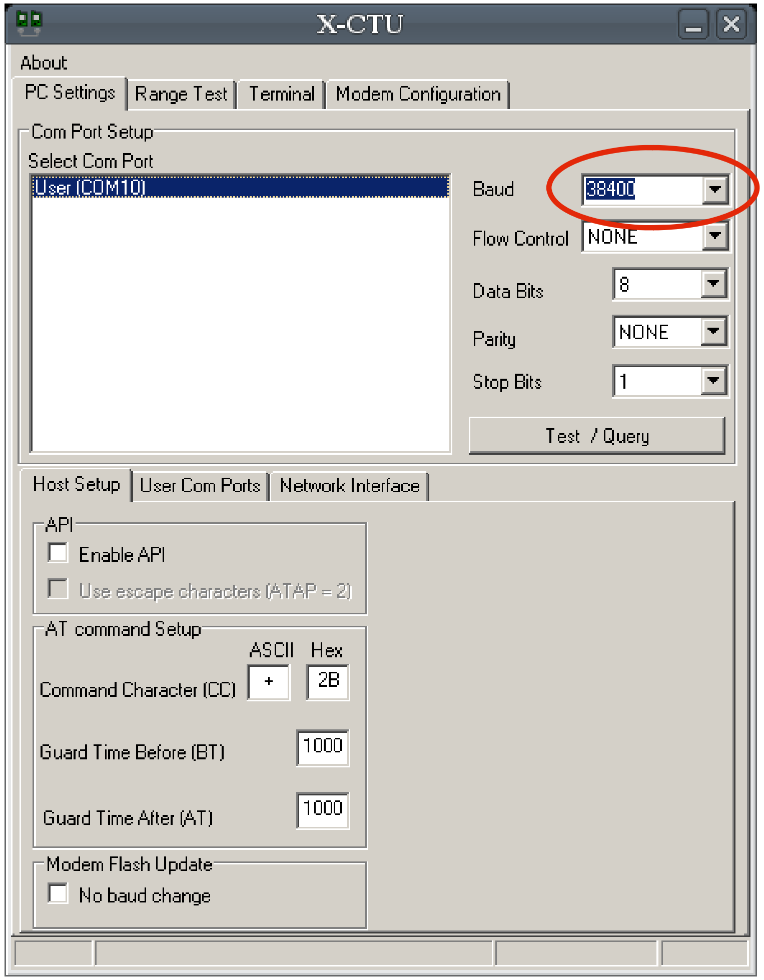
ATID = 1111	Network ID
ATMY = 10	XBee's Personal ID
ATDL = 11	Destination XBee ID
ATBD = 5	Baud Rate

XBEE2:

ATID = 1111	Network ID
ATMY = 11	XBee's Personal ID
ATDL = 10	Destination XBee ID
ATBD = 5	Baud Rate

Configuring an XBee Series 1

PC Settings


X-CTU

About

Com Port Setup

Select Com Port: User (COM10)

Baud: 38400

Flow Control: NONE

Data Bits: 8

Parity: NONE

Stop Bits: 1

API

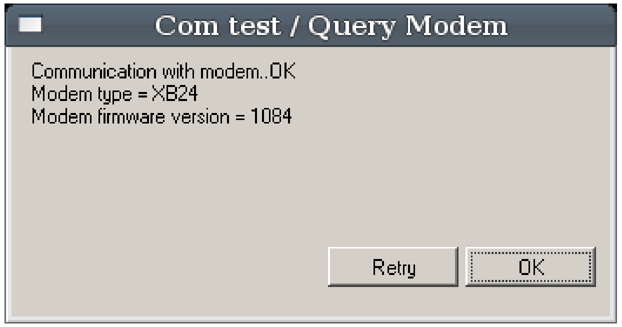
- [ ] Enable API
- [ ] Use escape characters (ATAP = 2)

AT command Setup

	ASCII	Hex
Command Character (CC)	+	2B
Guard Time Before (BT)		1000
Guard Time After (AT)		1000

Modem Flash Update

- [ ] No baud change


Com test / Query Modem

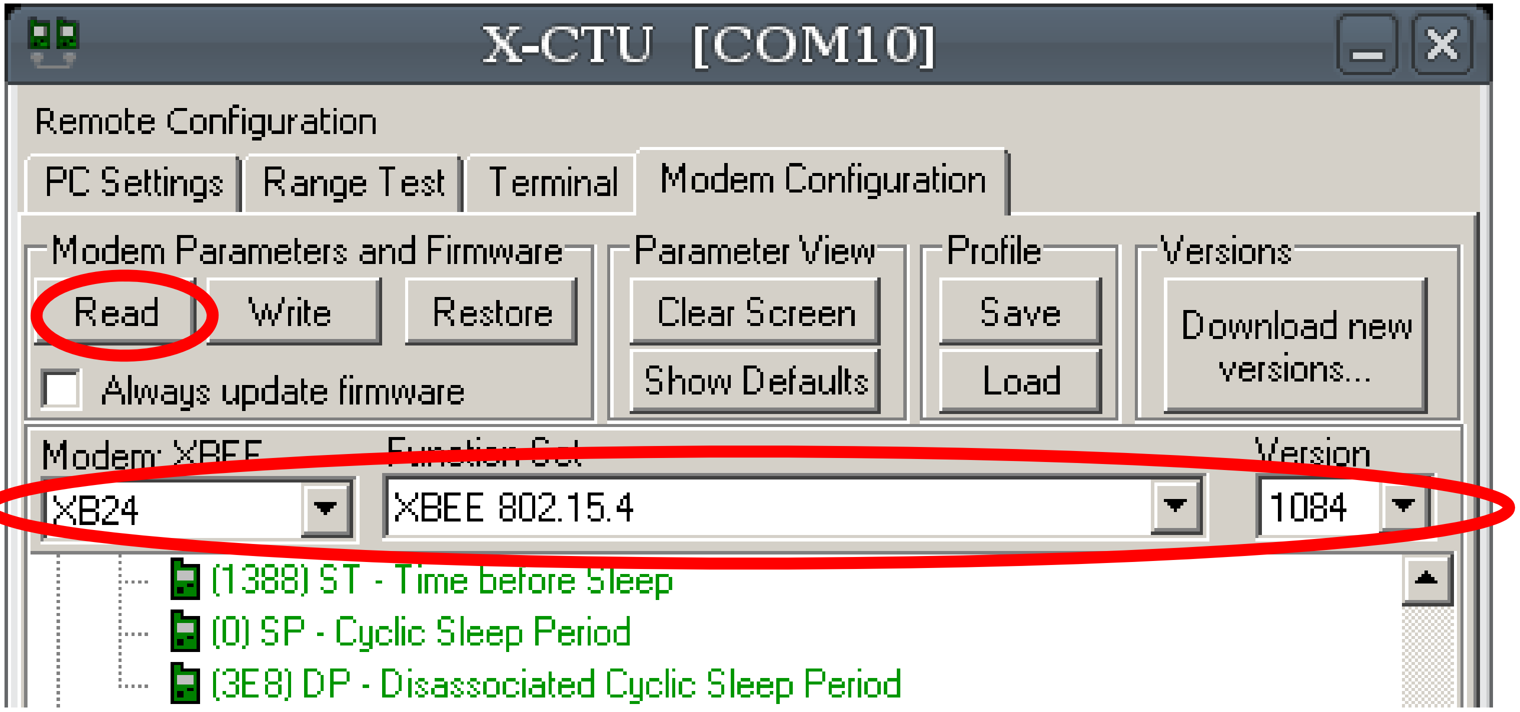
```
Communication with modem..OK
Modem type = XB24
Modem firmware version = 1084
```

Source:
http://forums.trossenrobotics.com/tutorials/how-to-diy-128/xbee-basics-3259/

Configuring an XBee Series 1

XBee Configuration

Get current settings



X-CTU [COM10]

Remote Configuration

PC Settings | Range Test | Terminal | Modem Configuration

Modem Parameters and Firmware: Read, Write, Restore

Always update firmware

Parameter View: Clear Screen, Show Defaults

Profile: Save, Load

Versions: Download new versions...

Modem: XBEE: XB24

Function Set: XBEE 802.15.4

Version: 1084

(1388) ST - Time before Sleep

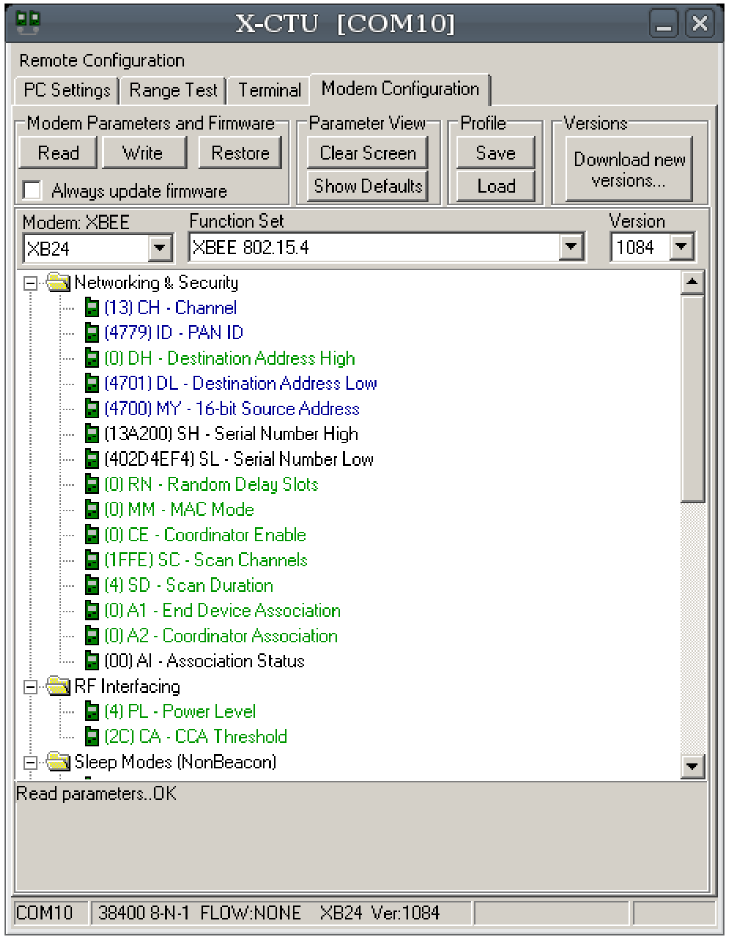
(0) SP - Cyclic Sleep Period

(3E8) DP - Disassociated Cyclic Sleep Period

Configuring an XBee Series 1

XBee Configuration

Adjust Settings



X-CTU [COM10]

Remote Configuration

PC Settings | Range Test | Terminal | Modem Configuration

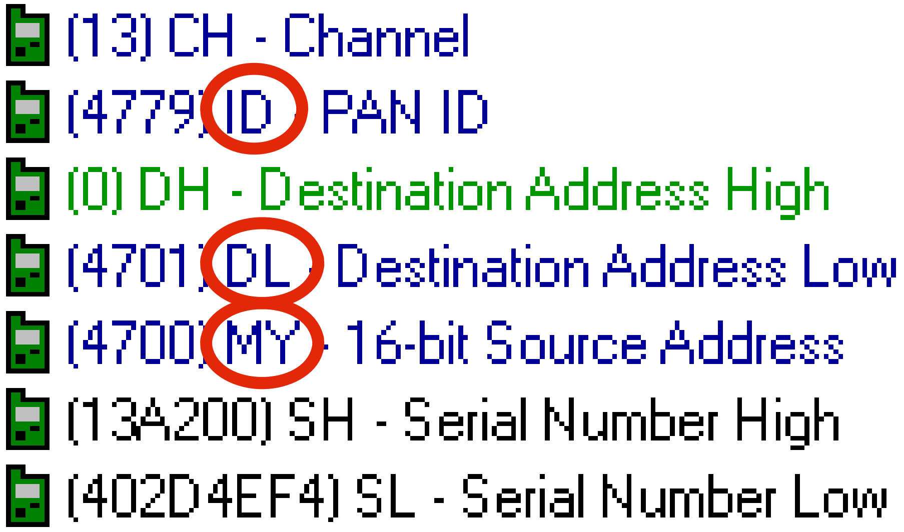
Modem Parameters and Firmware: Read | Write | Restore | Always update firmware
Parameter View: Clear Screen | Show Defaults
Profile: Save | Load
Versions: Download new versions...

Modem: XBEE: XB24
Function Set: XBEE 802.15.4
Version: 1084

```
Networking & Security
    (13) CH - Channel
    (4779) ID - PAN ID
    (0) DH - Destination Address High
    (4701) DL - Destination Address Low
    (4700) MY - 16-bit Source Address
    (13A200) SH - Serial Number High
    (402D4EF4) SL - Serial Number Low
    (0) RN - Random Delay Slots
    (0) MM - MAC Mode
    (0) CE - Coordinator Enable
    (1FFE) SC - Scan Channels
    (4) SD - Scan Duration
    (0) A1 - End Device Association
    (0) A2 - Coordinator Association
    (00) AI - Association Status
RF Interfacing
    (4) PL - Power Level
    (2C) CA - CCA Threshold
Sleep Modes (NonBeacon)
```

Read parameters..OK

COM10 | 38400 8-N-1 FLOW:NONE | XB24 Ver:1084



(13) CH - Channel
(4779) ID - PAN ID
(0) DH - Destination Address High
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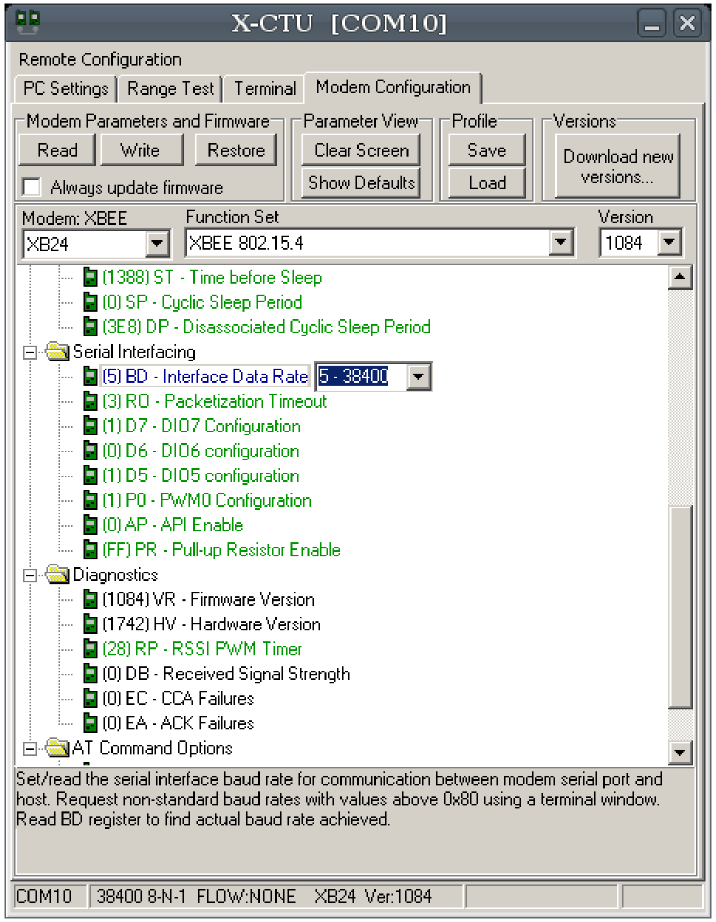
(4700) MY - 16-bit Source Address
(13A200) SH - Serial Number High
(402D4EF4) SL - Serial Number Low

Configuring an XBee Series 1

XBee Configuration

Adjust Settings

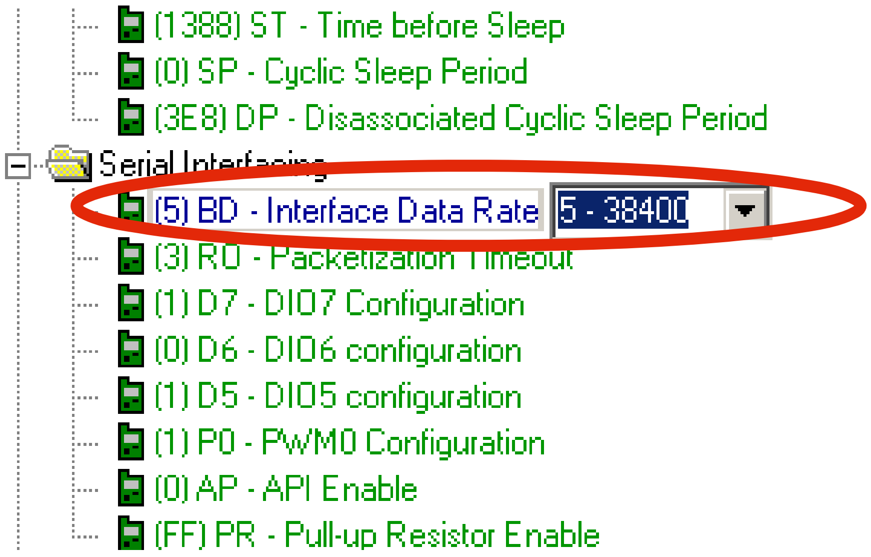


Modem: XBEE — XB24
Function Set — XBEE 802.15.4
Version — 1084

(1388) ST - Time before Sleep
(0) SP - Cyclic Sleep Period
(3E8) DP - Disassociated Cyclic Sleep Period
Serial Interfacing
(5) BD - Interface Data Rate — 5 - 38400
(3) RO - Packetization Timeout
(1) D7 - DIO7 Configuration
(0) D6 - DIO6 configuration
(1) D5 - DIO5 configuration
(1) P0 - PWM0 Configuration
(0) AP - API Enable
(FF) PR - Pull-up Resistor Enable
Diagnostics
(1084) VR - Firmware Version
(1742) HV - Hardware Version
(28) RP - RSSI PWM Timer
(0) DB - Received Signal Strength
(0) EC - CCA Failures
(0) EA - ACK Failures
AT Command Options

Set/read the serial interface baud rate for communication between modem serial port and host. Request non-standard baud rates with values above 0x80 using a terminal window. Read BD register to find actual baud rate achieved.

COM10 | 38400 8-N-1 FLOW:NONE | XB24 Ver:1084



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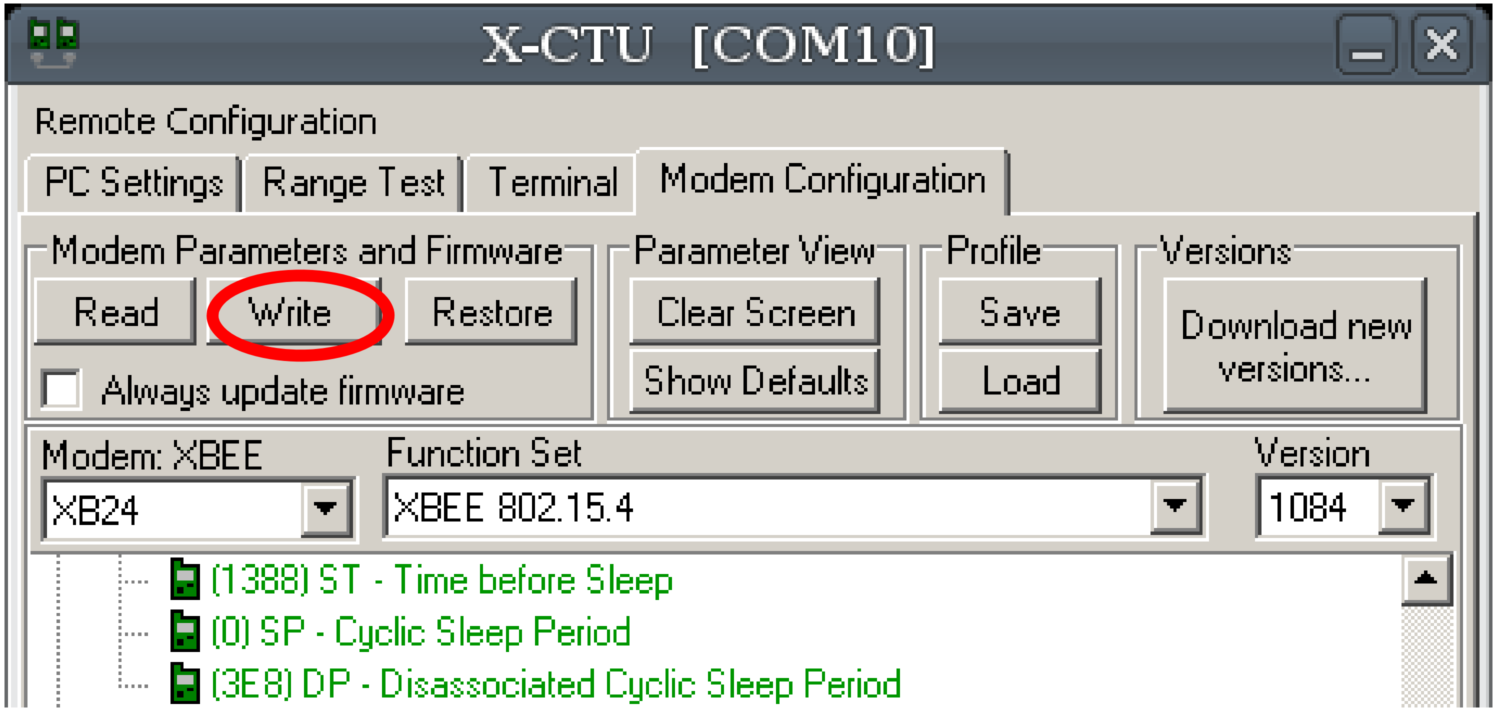
Serial Interfacing
(5) BD - Interface Data Rate — 5 - 38400
(3) RO - Packetization Timeout
(1) D7 - DIO7 Configuration
(0) D6 - DIO6 configuration
(1) D5 - DIO5 configuration
(1) P0 - PWM0 Configuration
(0) AP - API Enable
(FF) PR - Pull-up Resistor Enable

Configuring an XBee Series 1

XBee Configuration

Write Settings to XBee



Modem: XBEE: XB24

Function Set: XBEE 802.15.4

Version: 1084

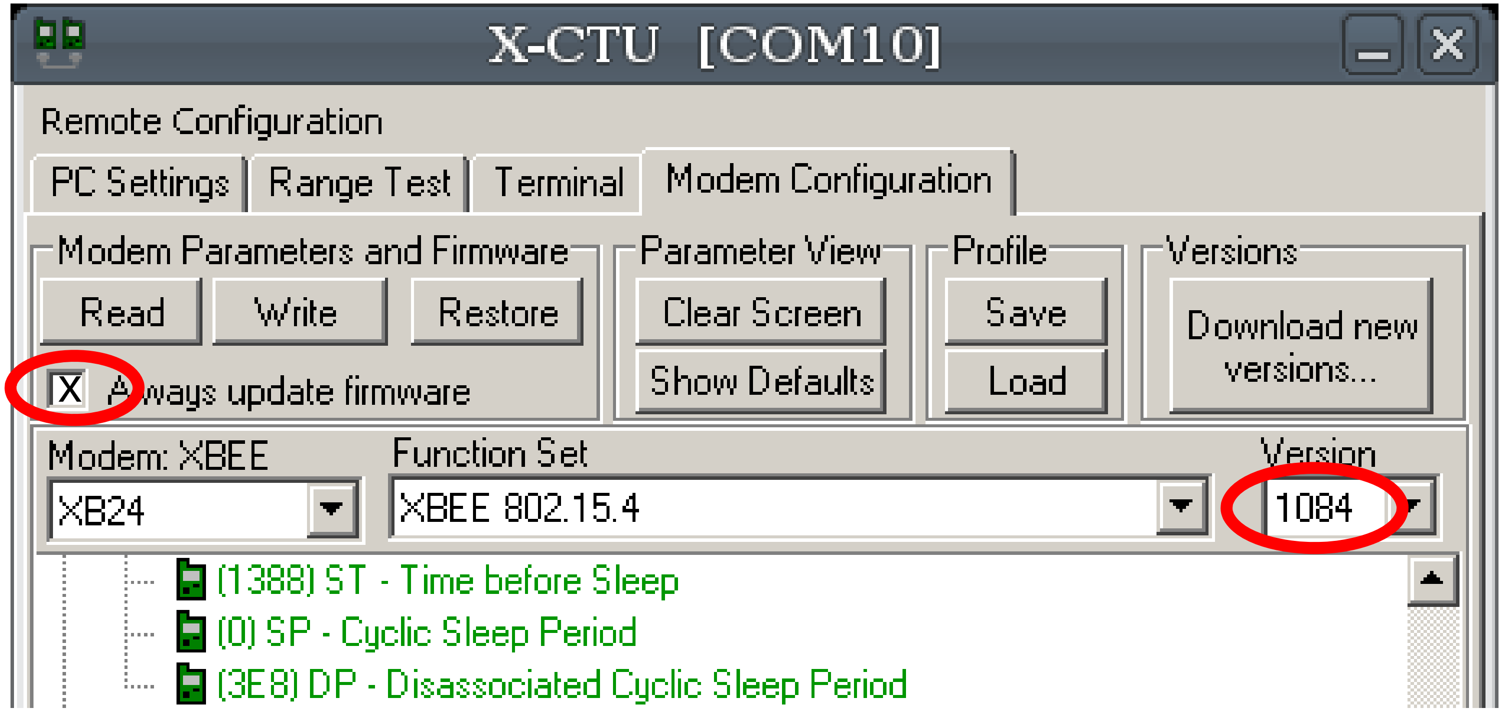
(1388) ST - Time before Sleep

(0) SP - Cyclic Sleep Period

(3E8) DP - Disassociated Cyclic Sleep Period

Configuring an XBee Series 1

XBee Configuration
Updating Firmware



[X] Always update firmware

Modem: XBEE: XB24
Function Set: XBEE 802.15.4
Version: 1084

(1388) ST - Time before Sleep
(0) SP - Cyclic Sleep Period
(3E8) DP - Disassociated Cyclic Sleep Period

Configuring an XBee Series 1

Networking two Xbees – Advanced Settings

Network Group Communication (One to Many)
If a module's **DH** is 0 (as in our example) and its **DL** is less than 0xFFFF (i.e. 16 bits), data transmitted by that module will be received by any module whose 16-bit address **MY** parameter equals **DL**.

Broadcast Mode (One to All)
If **DH** is 0 and **DL** equals 0xFFFF, the module's transmissions will be received by all modules.

One-to-One Communication
If **DH** is non-zero or **DL** is greater than 0xFFFF, the transmission will only be received by the module whose serial number equals the transmitting module's destination address (i.e. whose **SH** equals the transmitting module's **DH** and whose **SL** equals its **DL**).

Source:
http://www.arduino.cc/en/Main/ArduinoXbeeShield

Configuring an XBee Series 2

One ZNet or ZB Pro XBee with Coordinator API firmware – Master Router
One (or more) ZNet or ZB Pro XBee with End Device API firmware – Attached Devices

Coordinator
Restore to factory settings
RE

Set PAN ID to an arbitrary value.
The end device must also use this exact value
ID=1AAA

Both radios must have the same Channel
and PAN ID to communicate
CH=13

Set the node identifier to an arbitrary string. This serves as a
convenient way to identify your devices
NI=COORDINATOR

Set API mode to 2 (escape control bytes)
AP=2

Save to settings to survive power cycle
WR

Reboot the radio. apply changes "AC" should also suffice
FR

End Device
The End Device is the same except
for the Node Identifier.

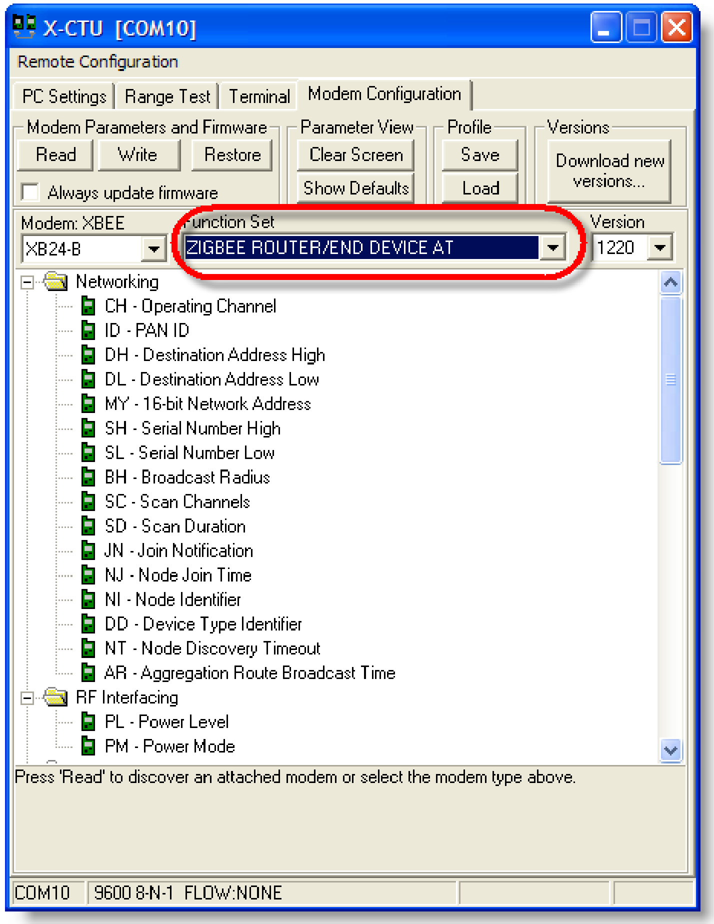
Set to any arbitrary character string
that identifies this radio
NI=END_DEVICE_1

Source:
http://code.google.com/p/xbee-api/wiki/XBeeConfiguration

Configuring an XBee Series 2

XBee Configuration

Selecting the End Device



X-CTU [COM10]

Remote Configuration

PC Settings | Range Test | Terminal | Modem Configuration

Modem Parameters and Firmware: Read, Write, Restore; Always update firmware

Parameter View: Clear Screen, Show Defaults

Profile: Save, Load

Versions: Download new versions...

Modem: XBEE: XB24-B

Function Set: ZIGBEE ROUTER/END DEVICE AT

Version: 1220

- Networking
  - CH - Operating Channel
  - ID - PAN ID
  - DH - Destination Address High
  - DL - Destination Address Low
  - MY - 16-bit Network Address
  - SH - Serial Number High
  - SL - Serial Number Low
  - BH - Broadcast Radius
  - SC - Scan Channels
  - SD - Scan Duration
  - JN - Join Notification
  - NJ - Node Join Time
  - NI - Node Identifier
  - DD - Device Type Identifier
  - NT - Node Discovery Timeout
  - AR - Aggregation Route Broadcast Time
- RF Interfacing
  - PL - Power Level
  - PM - Power Mode

Press 'Read' to discover an attached modem or select the modem type above.

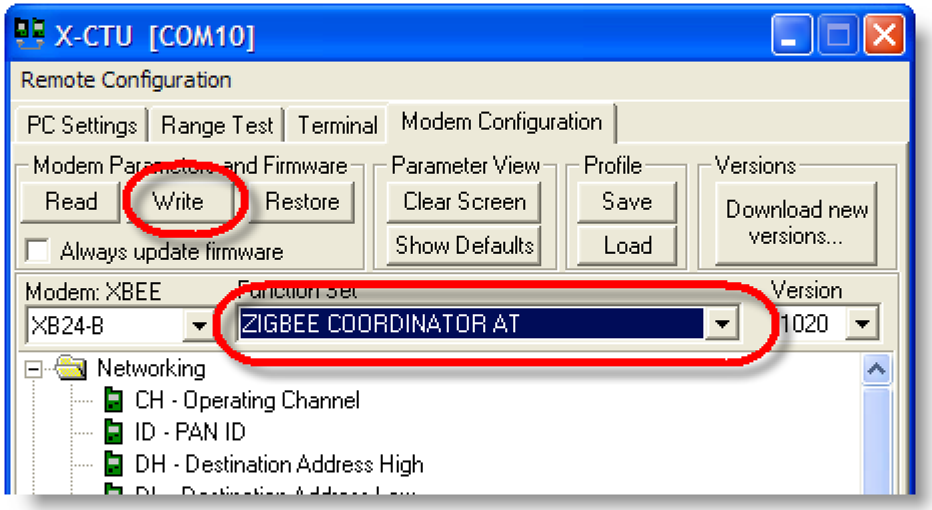
COM10 | 9600 8-N-1 FLOW:NONE

Source:
http://blog.didierstevens.com/2009/06/15/quickpost-arduino-xbee-shield-series-2-configuration/

Configuring an XBee Series 2

XBee Configuration

Selecting the Coordinator



Modem: XBEE XB24-B

Function Set: ZIGBEE COORDINATOR AT

Version: 1020

Source:
http://blog.didierstevens.com/2009/06/15/quickpost-arduino-xbee-shield-series-2-configuration/

Configuring an XBee Series 2

XBee Configuration
Selecting the Coordinator

If you will be using more than two XBee modules and you want two routers/end devices to talk to one-another, you'll need to set the Destination Nodes for each module.

You can easily do this by entering command mode (typing "+++") and then sending "ATDNxxxxxx" where xxxxxx is the Node Identifier (NI) you've set-up for the Destination Node XBee such as "router2".

This essentially replaces the "ATMYxxxx" command that is commonly used with XBee Series 1 modules.

Source:
http://www.google.com/url?sa=t&source=web&ct=res&cd=2&ved=0CAoQFjAB&url=http%3A%2F%2Fblog.kevinhoyt.org%2Fwp-content%2Fxbee-setup.pdf&ei=jwb9SrrZHIyuswOkjICICw&usg=AFQjCNHvKhMAbXBgIFjoJDeTkvqfTKT5TA&sig2=CH8R_KxM2xghQ7xW06A71Q

Configuring an XBee

Pitfalls

AT commands not working

Series 1 XBees with older firmware can have the ability to receive AT commands deactivated. Unfortunately, to restore this function you need to restore the firmware which requires these commands.

To trick the XBee into letting you upload the firmware is to reset the chip manually by touching a wire to pin 1 and 10 (ground and 5v). Immediately after this click the write button in X-CTU.

Know your baud rate

You must connect to the XBee at the correct Baud rate. If you restore or update the firmware the baud rate will default to 9600. If you have been working at a different baud rate you will need to adjust the connection speed on the X-CTU settings page.