IAT 884 Workshop 9 Wireless Communication

Wireless Communication Options that work with the Arduino



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

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></enter>	OK <cr></cr>		
Send Command to Write ID	Expected Response		
ATID3137 <enter></enter>	OK <cr></cr>		
Send Command to Verify Setting	Expected Response		
ATID <enter></enter>	3137 <cr></cr>		

🗞 xbee - HyperTerminal	
<u>File Edit View Call Iransfer H</u> elp	
++++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 eg

Networking two XBees

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

The ATMY 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	

PC Settings

H X-CTU		×)
About PC Settings Range Test Terminal Modern Configu	uration	_
Select Com Port		H
User (COM10)	Baud 38400 🔽	
	Flow Control NONE	
	Data Bits 8 💌	
	Parity NONE 💌	
	Stop Bits 1	[
	Test / Query	
Host Setup User Com Ports Network Interface		
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)		
Modem Flash Update		
I No baud change		
		-



Source:

http://forums.trossenrobotics.com/tutorials/how-to-diy-128/xbeebasics-3259/

XBee Configuration

Get current settings

<u>.</u>	X-CTU [COM10]			×
Remote Configuration					
PC Settings Range T	st Terminal Mo	dem Configura	ition		
Modem Parameters and	Firmware	meter View	Profile	-Versio	ns
Read Write	Restore Clea	ar Screen	Save	Dow	nload new
🗖 Always update firmv	are Show	w Defaults	Load	ve	rsions
Modem: XBEE	metion Cot				Version
💶 🗙 B24 🛛 🔽 🖹	BEE 802.15.4				1084 🔽
📘 (1388) ST - 1	ime before Sleep				
📴 (0) SP - Cycli	: Sleep Period				
📗 🕴 📖 🖥 (3E8) DP - D	sassociated Cyclic S	Sleep Period			

XBee Configuration Adjust Settings

😬 X-CTU [COM10]
Remote Configuration
PC Settings Range Test Terminal Modern Configuration
Modem Parameters and Firmware Parameter View Profile Versions
Read Write Restore Clear Screen Save Download new
Always update firmware Show Defaults Load versions
Modem: XBEE Function Set Version
×B24 ▼ XBEE 802.15.4 ▼ 1084 ▼
📮 🔄 Networking & Security 📃
🖬 (13) CH - Channel
[0] DH - Destination Address Fligh [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
[U] UL - Coordinator Enable
(IFFE) SC - Scan Channels [4] SD - Scan Duration
- D (0) A1 - End Device Association
(0) A2 - Coordinator Association
🖕 🔓 (00) Al - Association Status
🛱 🔄 RF Interfacing
📮 (4) PL - Power Level
E (2C) CA - CCA Threshold
Sleep Modes (NonBeacon)
Read parametersOK
COM10 38400 8-N-1 FLOW:NONE XB24 Ver:1084
, , , , , , , , , , , , , , , , , , , ,

(13) CH - Channel
 (4779) D 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

XBee Configuration

Adjust Settings

T X-CTU [COM10]			
Remote Configuration			
PC Settings Range Test Terminal Modern Configuration			
Modem Parameters and Firmware Parameter View Profile Versions			
Read Write Restore Clear Screen Save Download and			
Always update firmware Show Defaults Load versions			
Modem: XBEE Function Set Version			
XB24 VBEE 802.15.4 1084 V			
I (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) RD - Packetization Timeout			
🖬 (1) D7 - DI07 Configuration			
📱 (0) D6 - DIO6 configuration			
🖬 (1) D5 - DI05 configuration			
📓 (1) PU - PWMU Configuration			
(U) AP - API Enable			
Fr - Pull-up Resistor Enable			
- Magnosucs			
1742) HV - Hardware Version			
(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			



XBee Configuration

Write Settings to XBee

<u>10</u>	X-CTU [COM10]	
Remote Configuration		
PC Settings Range Tes	st Terminal Modem Configuration	
Modem Parameters and F	Firmware Parameter View Profile Ver	sions
Read Write	Restore Clear Screen Save Do	ownload new
🔲 Always update firmwa	are Show Defaults Load	versions
Modem: XBEE Fur	nction Set	Version
XB24 🔽 XE	BEE 802.15.4	1084 💌
📘 (1388) ST - Tin	me before Sleep	
🖥 (0) SP - Cyclic	Sleep Period	
📔 👘 🔚 (3E8) DP - Disa	associated Cyclic Sleep Period	

XBee Configuration

Updating Firmware

11	X-CT	U [COM10]			
Remote Configuration	Remote Configuration					
PC Settings Range	Test Terminal	Modem Configura	ation			
Modem Parameters a	nd Firmware	Parameter View	Profile	Versions		
Read Write	Restore	Clear Screen	Save	Download new		
🛛 🛛 🗛 🗛 🛛 🕅	nware	Show Defaults	Load	versions		
Modem: XBEE	Function Set			Version		
XB24 💌	XBEE 802.15.4	4		1084		
🖥 (1388) ST	- Time before Sle	еер				
📴 (0) SP - Cy	clic Sleep Period	ł				
📗 🦾 🔓 (3E8) DP -	Disassociated C	yclic Sleep Period				

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

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 $\ensuremath{\mathsf{WR}}$

Reboot the radio. apply changes "AC" should also suffice $\ensuremath{\mathsf{FR}}$

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

XBee Configuration

Selecting the End Device



Source:

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

XBee Configuration

Selecting the Coordinator



Source:

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

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 "ATDNxxxxx" where xxxxx 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%2Fwpcontent%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.