Fundamentals of Physical Computing

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Plan for Today

- Final Project Progress Reports
- Serial review
- Radios!
- Final Project Timeline
- Readings & Assignments

Final Project Progress

Radios

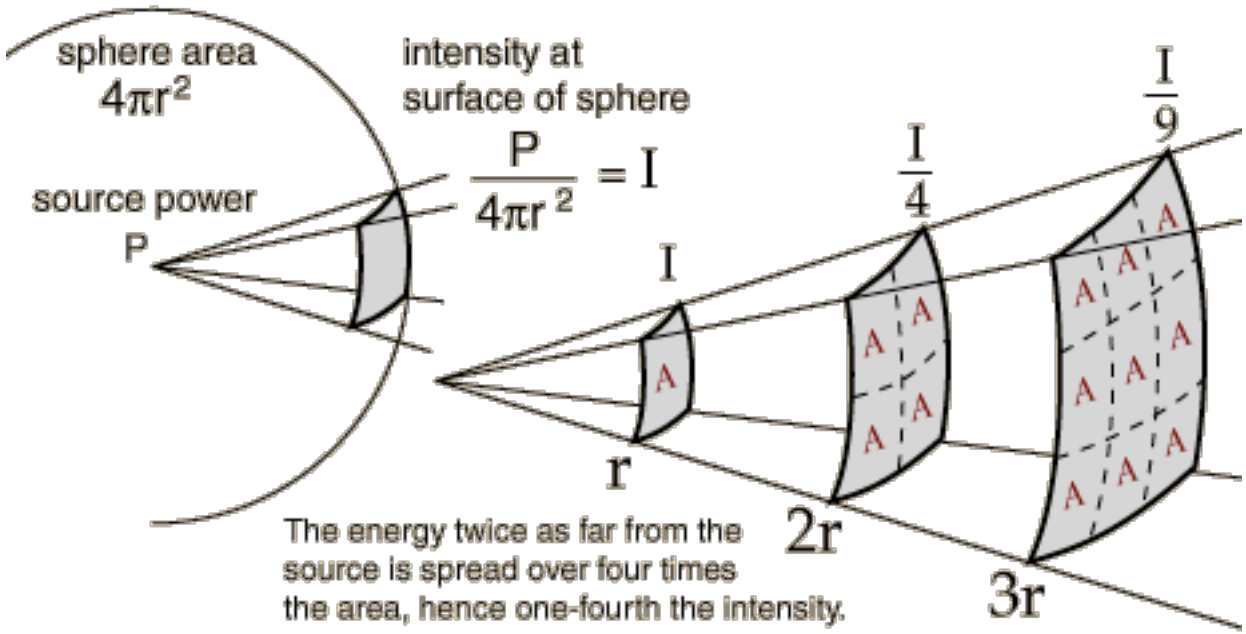
Radio Communications

- electromagnetic waves
- no medium required
- modulation

- Well-described mystery: “air waves” “wireless” “ethereal communication”

Inverse Square Law

- power needs increase exponentially with distance



ZigBee & 802.15.4

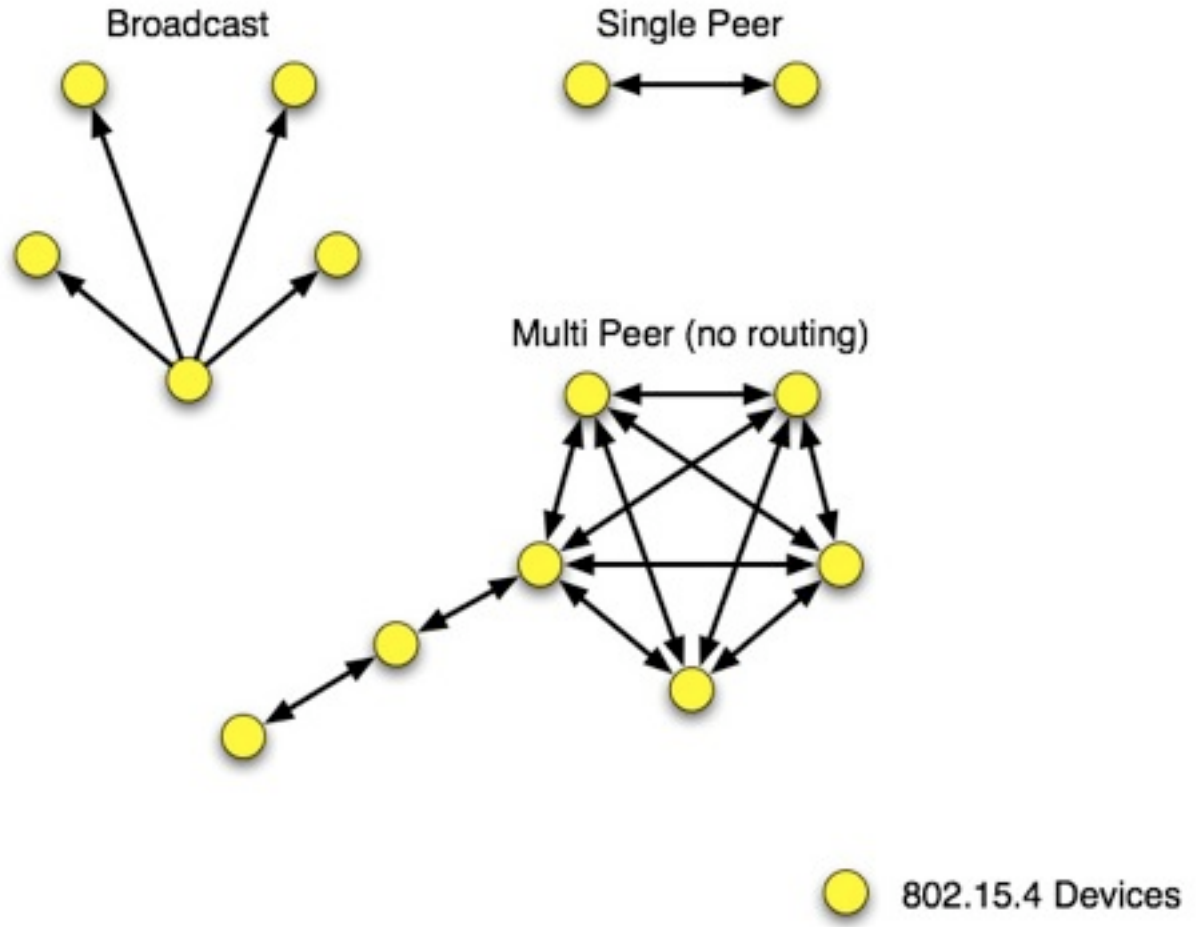
- ZigBee is built on top of the IEEE 802.15.4 protocol
- XBee radios can be purchased with or without ZigBee
- XBee 802.15.4 vs. ZNet 2.5 vs. ZB Pro vs. DigiMesh
- All ways are useful

802.15.4

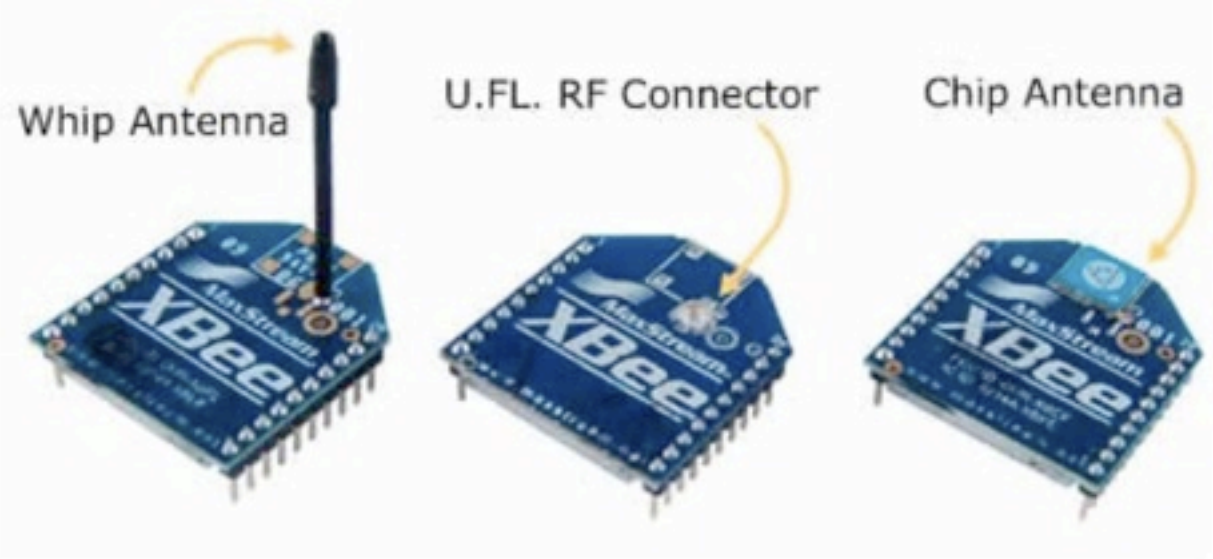
- low power
- low bandwidth
- addressing
- affordable
- small
- standardized
- popular for DIY, easy to learn

802.15.4 Topologies

- single peer
- multi-peer
- broadcast

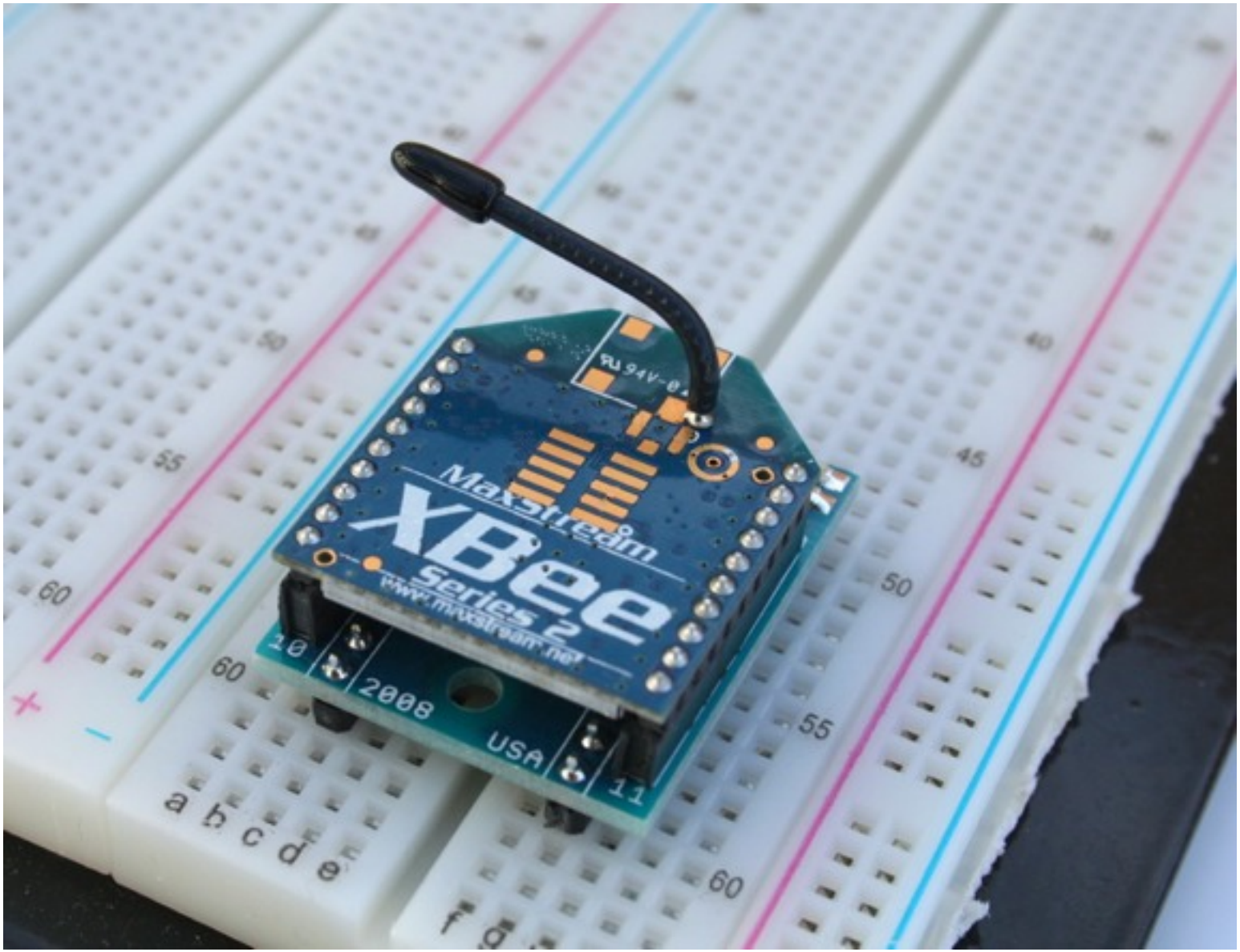


Antennas

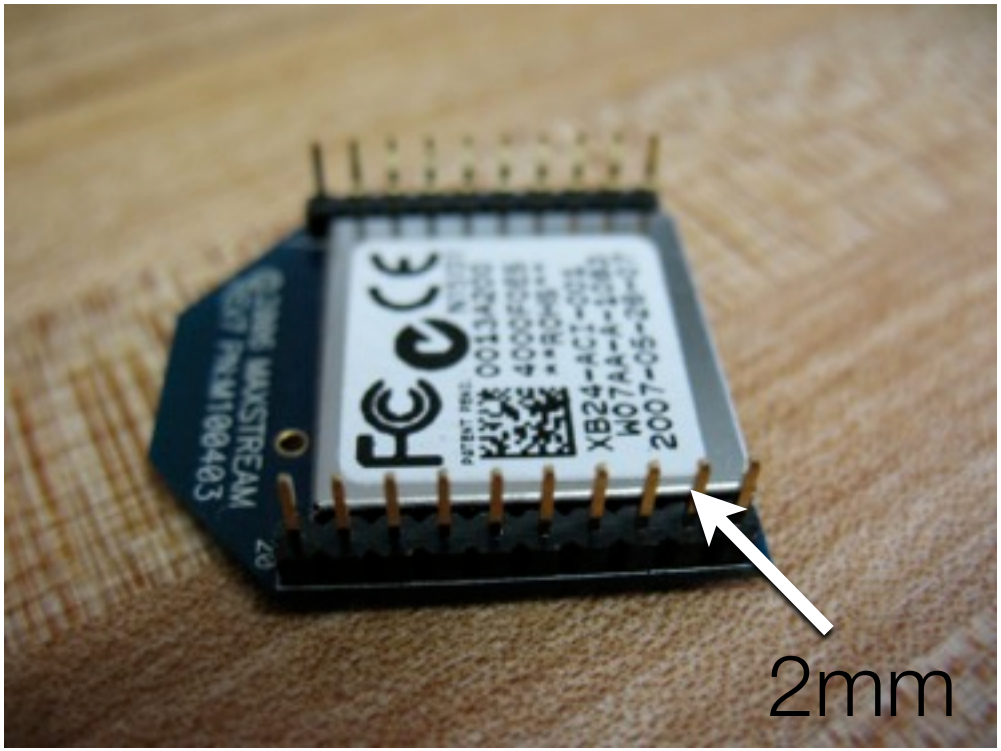


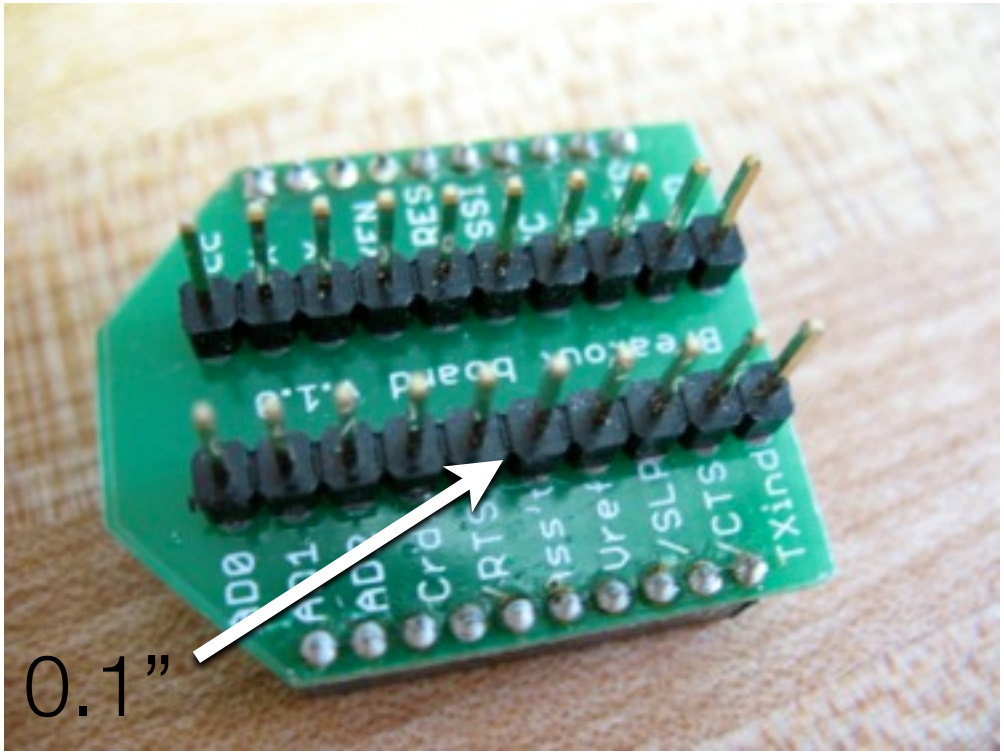
Chip Antenna on Pro

Breakout for Breadboards

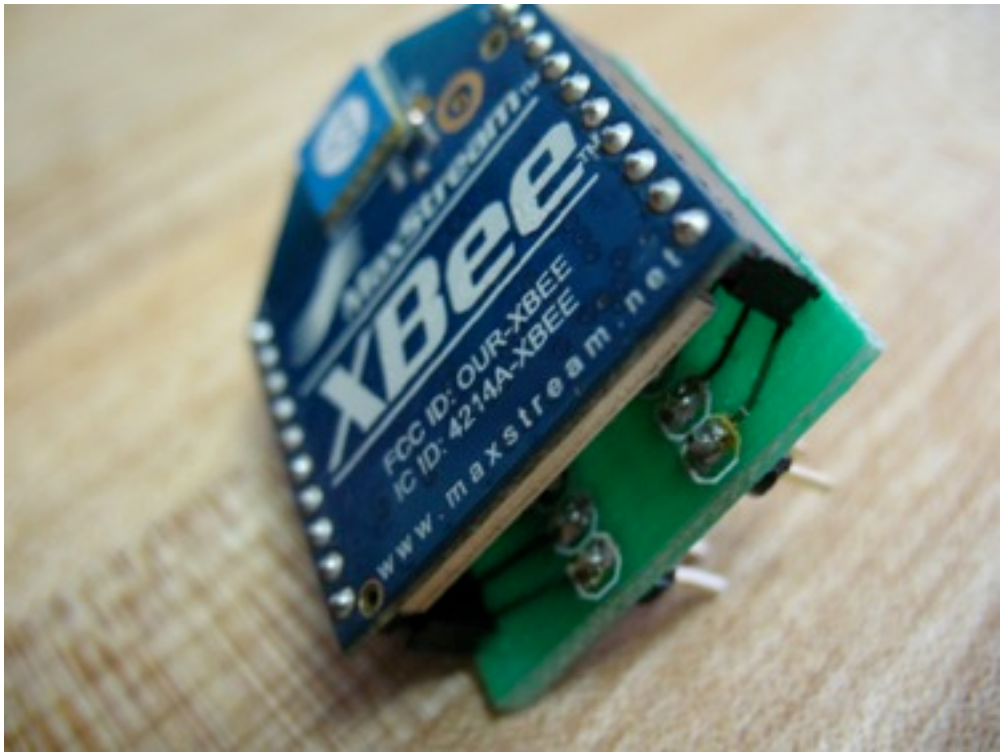


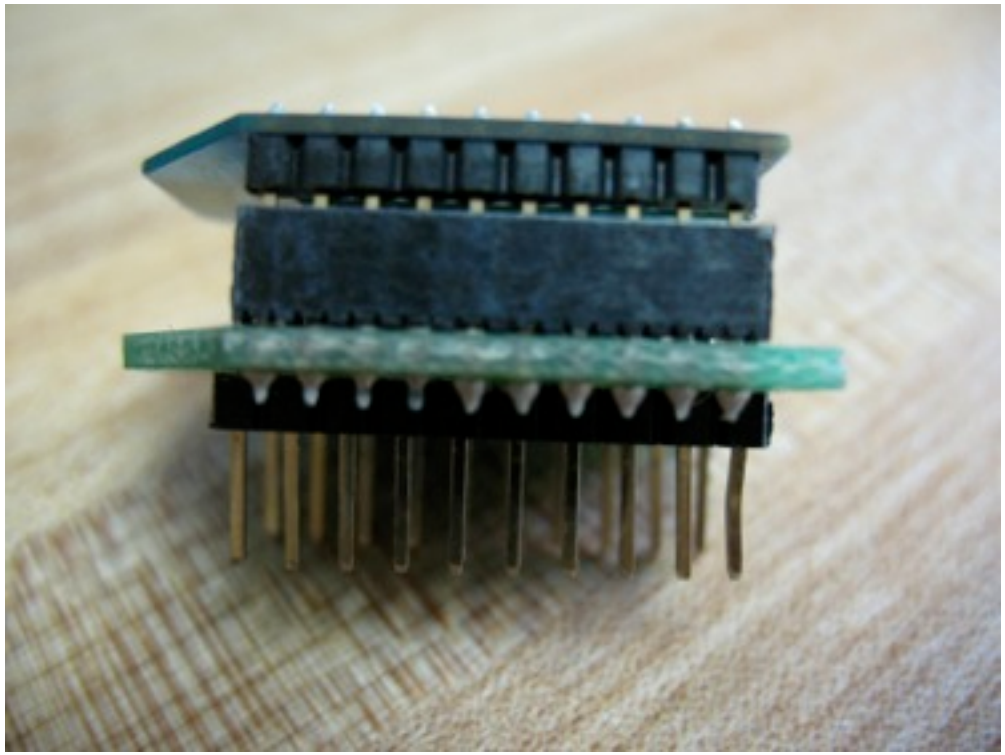
Breakout Boards for breadboarding



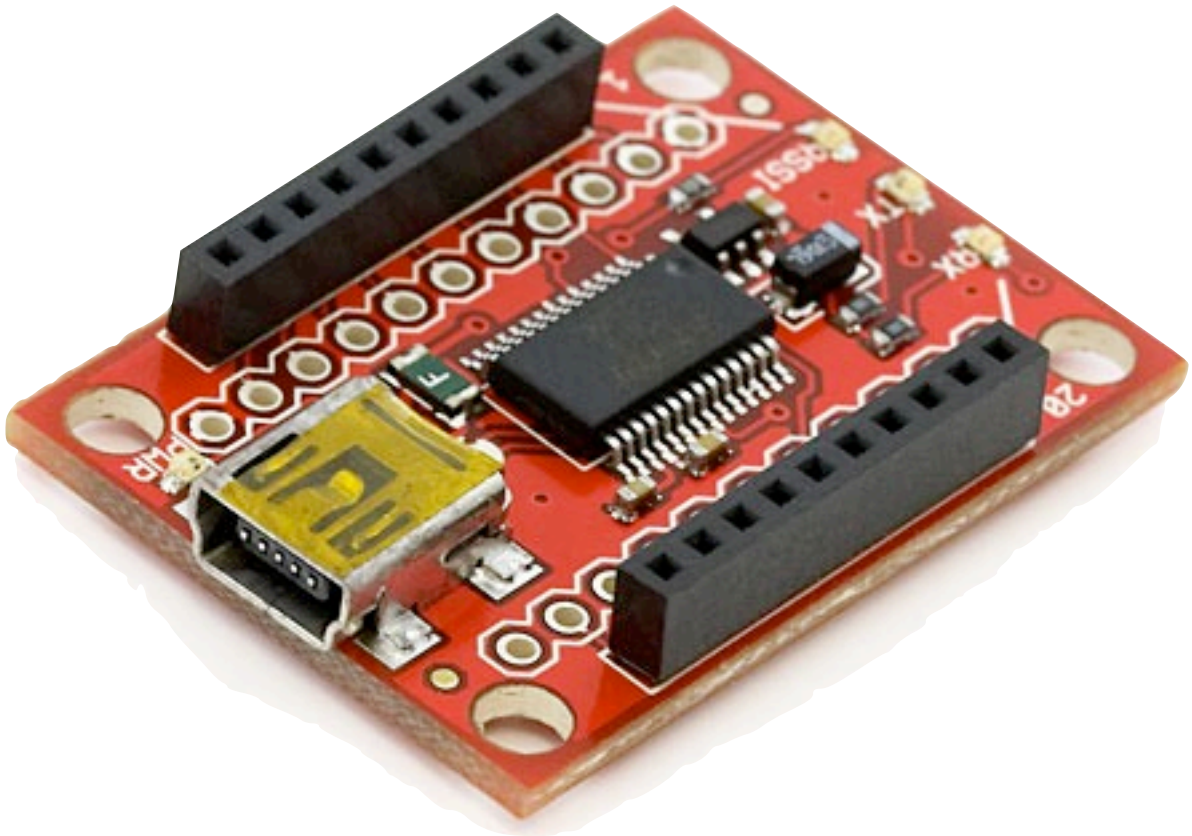


Soldering Breakout Boards: finished

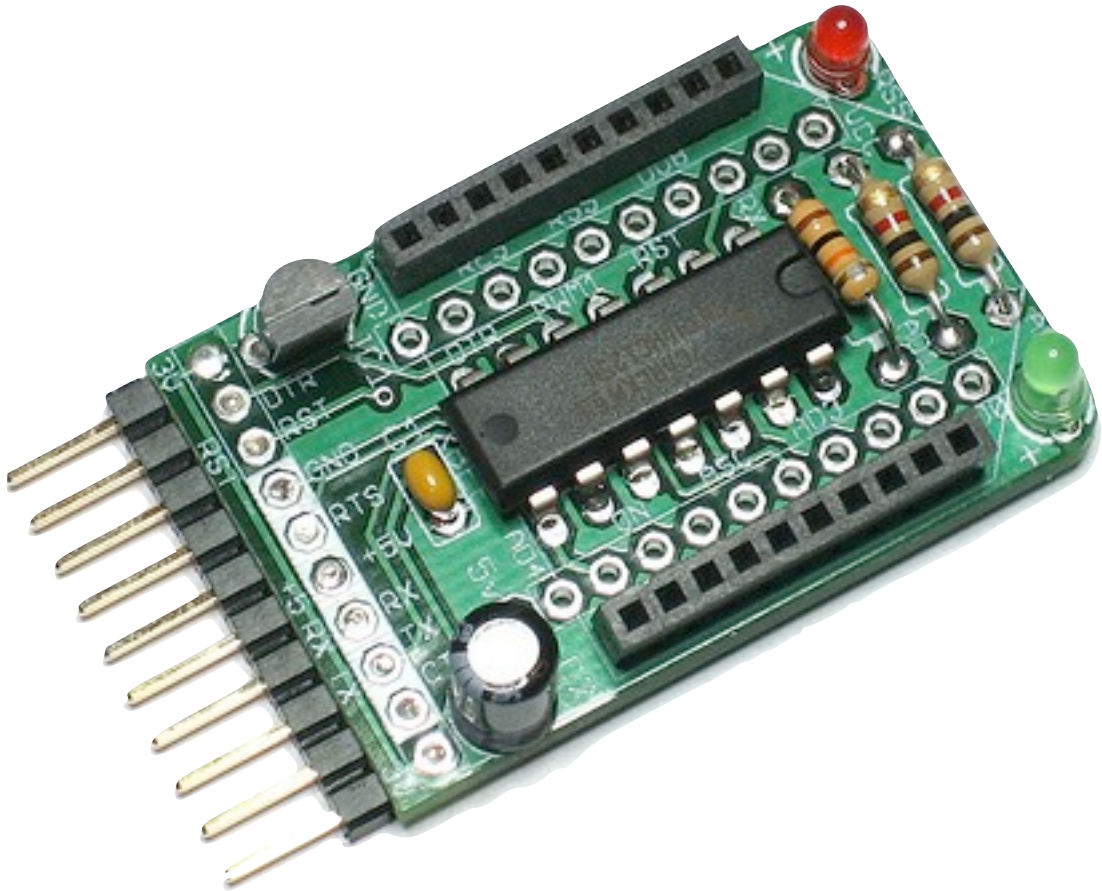




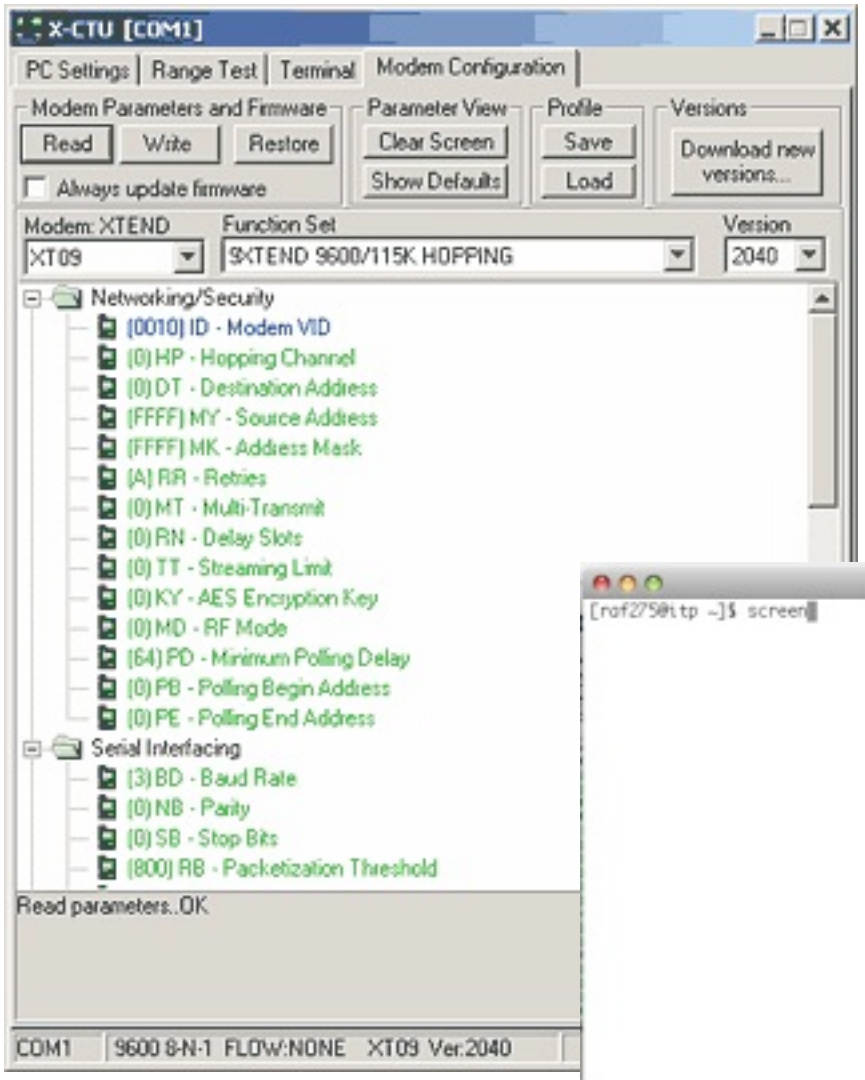
XBee Explorer from Sparkfun



XBee Adapter kit from Adafruit



Serial Terminal Programs



Serial Terminal Programs

- X-CTU: http://www.digi.com/support/productdetl.jsp?pid=3352&osvid=57&tp=4&s=316
- CoolTerm http://freeware.the-meiers.org/
- HyperTerm: Windows Start Menu, Accessories, Communication
- screen: Terminal program on the Mac (or Linux)
- plenty of others!
- settings: 9600 baud, 8 bits, no parity, one stop bit, no flow control

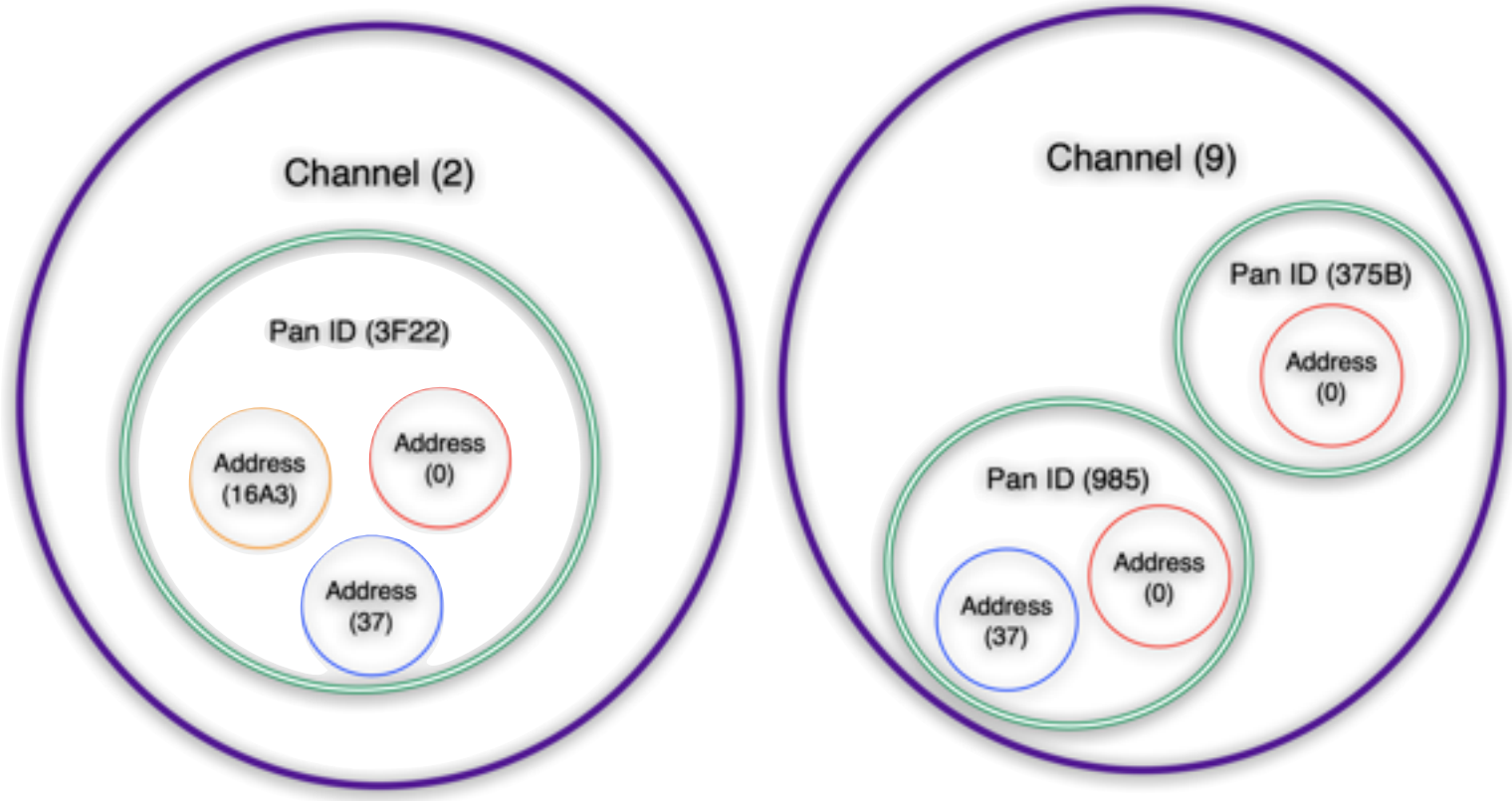
XBee Addressing

Addressing Basics

- channels
- PAN ID
- 64 bit addresses, aka serial numbers
- 16 bit addresses

Addressing Basics

- channels
- PAN ID
- 64 bit addresses (SN)
- 16 bit addresses



Basic Configuration

Download and Install Software & Drivers

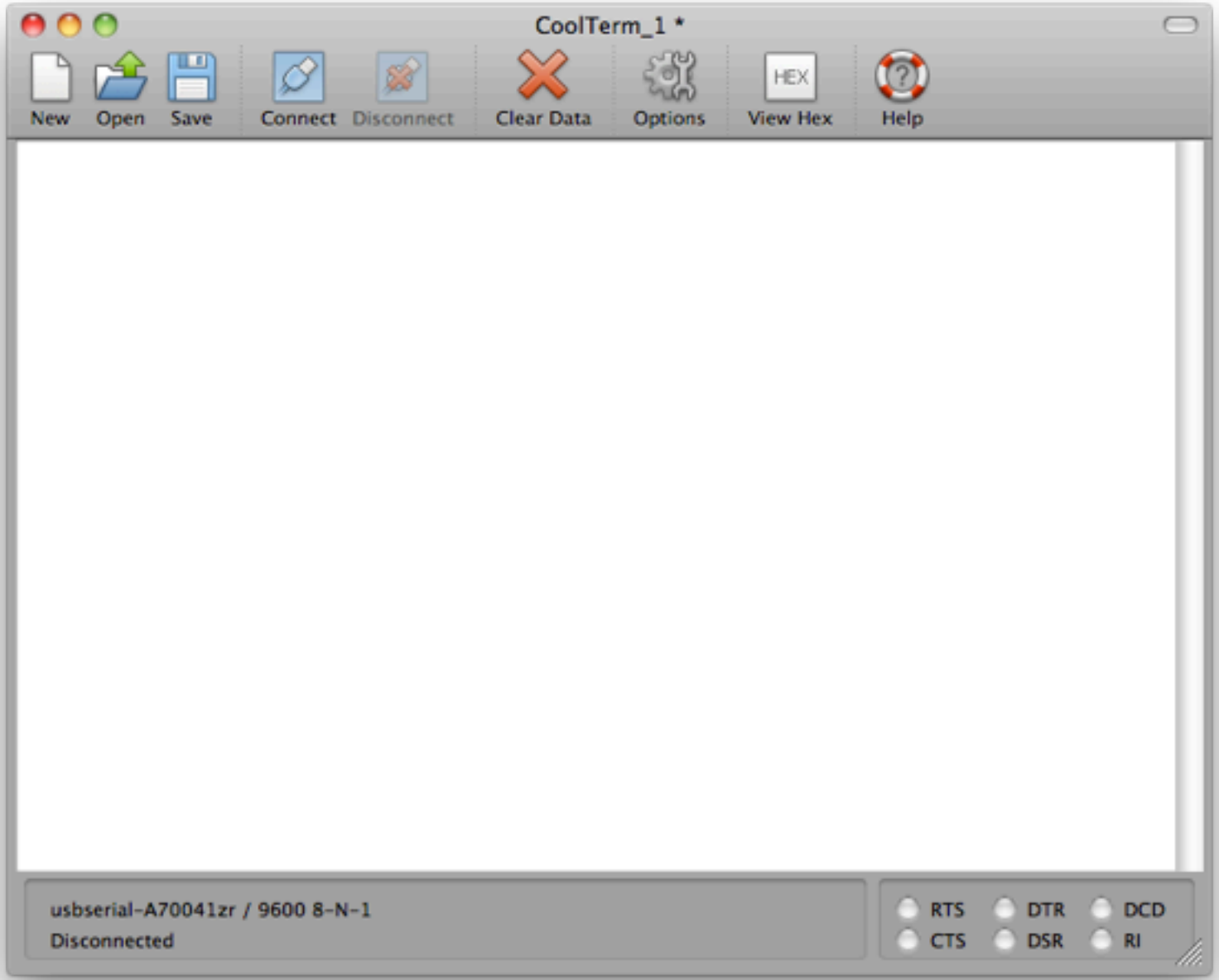
- Download & install the FTDI USB drivers:
  http://www.ftdichip.com/Drivers/VCP.htm

- Download the CoolTerm:
  http://freeware.the-meiers.org/

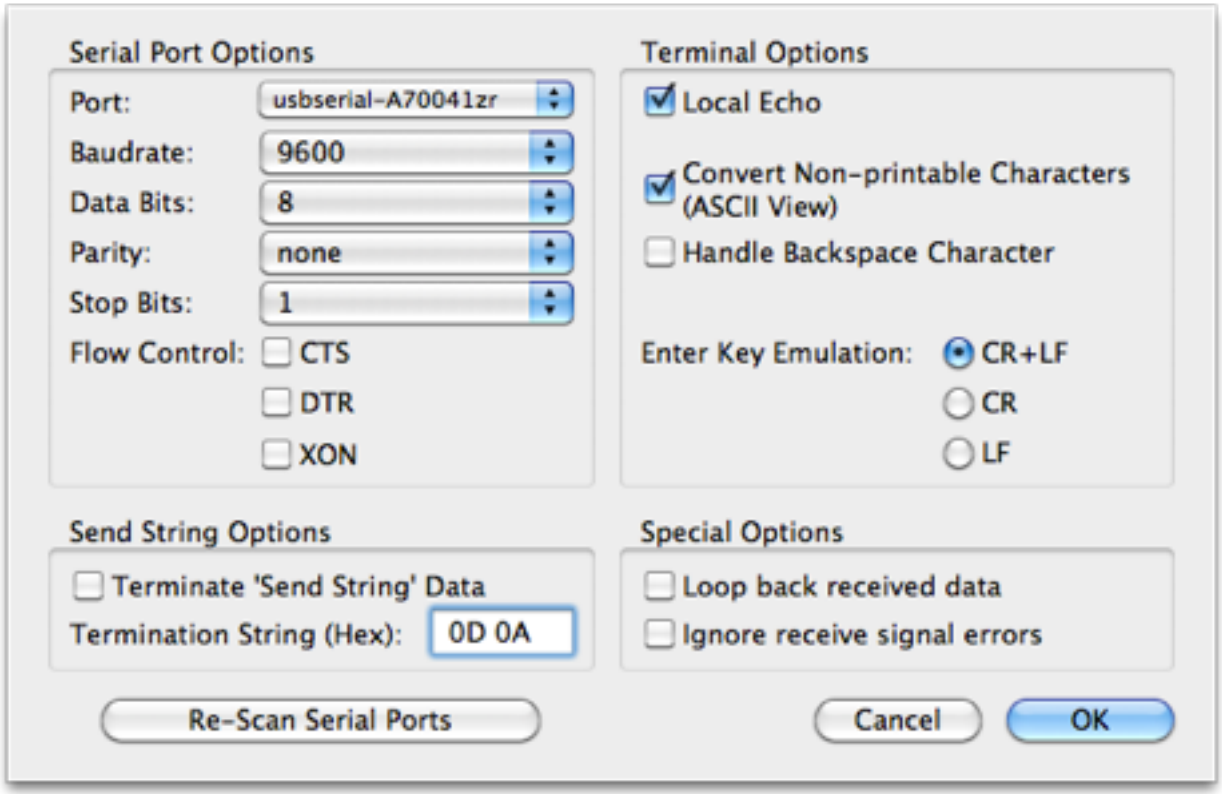
Other Serial Terminal Options:
settings: 9600 baud, 8 bits, no parity, one stop bit, no flow control

- X-CTU: http://www.digi.com/support/productdetl.jsp?pid=3352&osvid=57&tp=4&s=316
- Z-Term: http://homepage.mac.com/dalverson/zterm/
- HyperTerm: Windows Start Menu, Accessories, Communication
- Screen: Terminal program on the Mac (or Linux)

Open CoolTerm

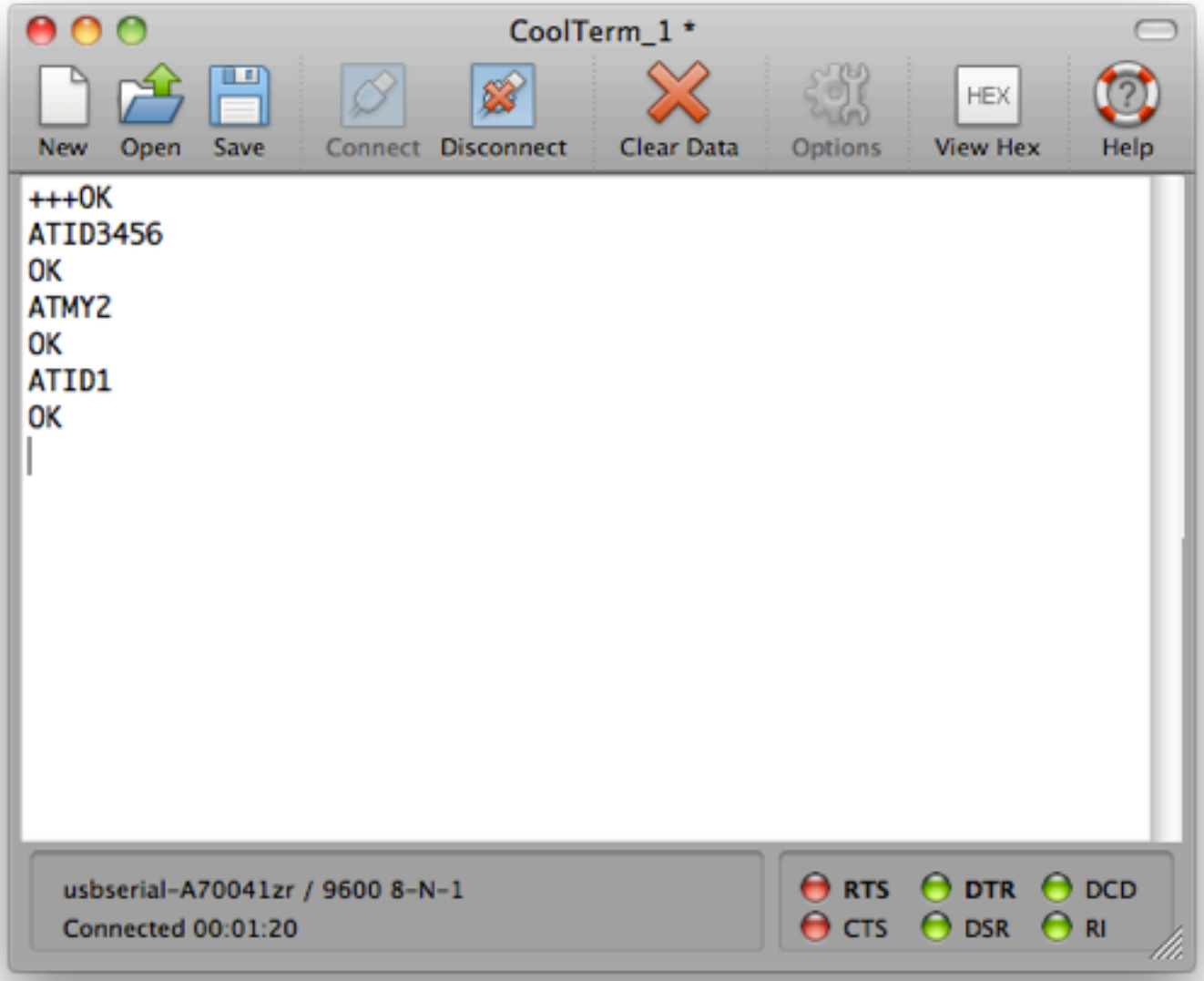


Set Connection Options



Configure your radio with AT commands

- Configure your radio



Baud, Bits and Parity

- Baud rate: 9600
- Data bits: 8
- Stop bits: 1
- Parity: None
- Flow control: none for now...

Basic Configuration

AT Commands

Data Mode vs. Command Mode

- Idle Mode, transmit and receive data
- Command Mode, talk to the XBee itself
  - +++ "*Yo, XBee*"
  - AT "*Attention!*" (Hayes command set)
    - always press enter after AT commands
    - *never* press enter after +++

Some AT Commands

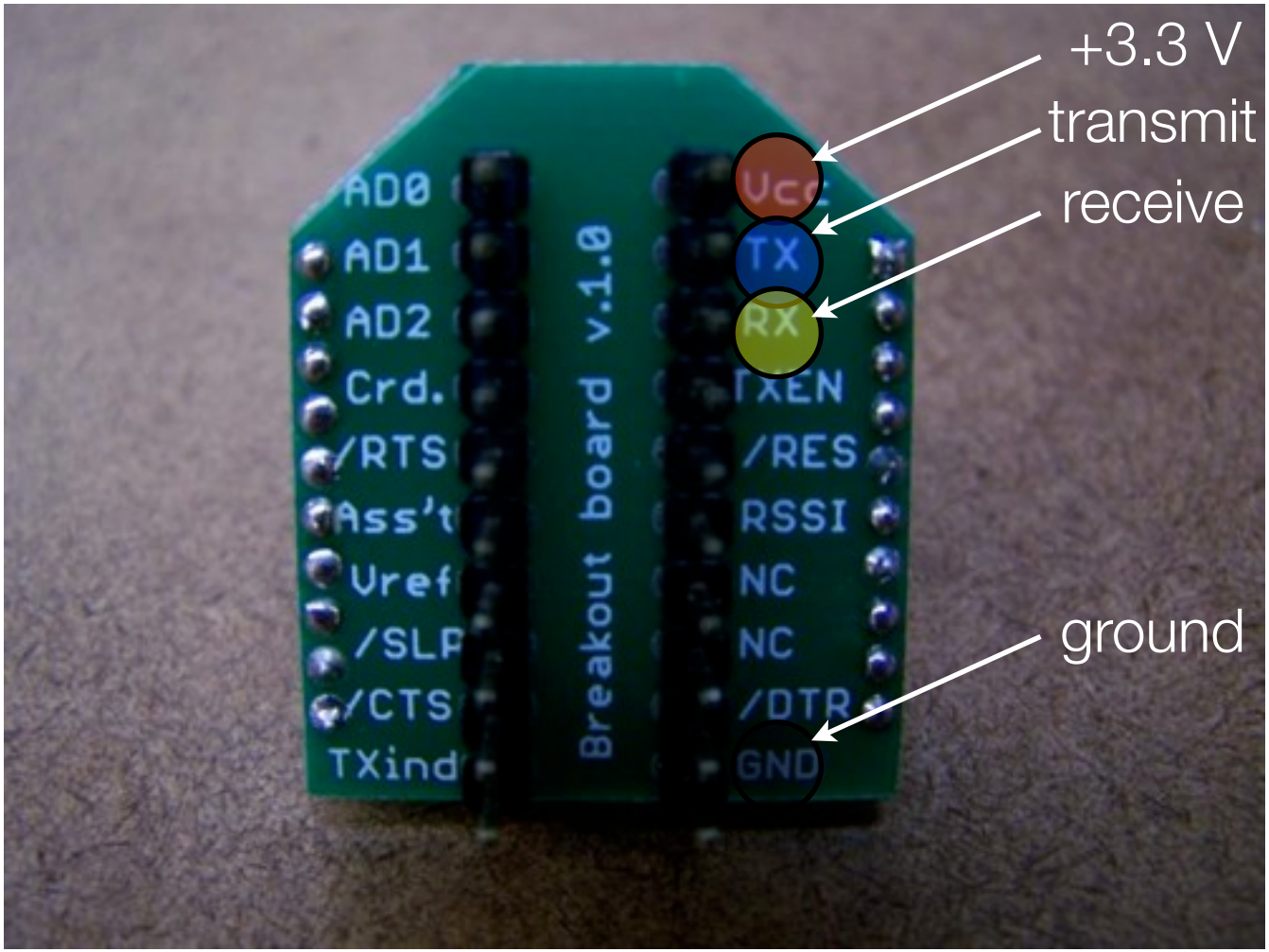
- AT -> OK
- ATDH, ATDL -> destination address hi/lo
- ATID -> personal area network ID
- ATCN -> end command mode
- ATWR -> write current configuration to firmware
- ATMY -> my address

Create a Basic XBee Pair

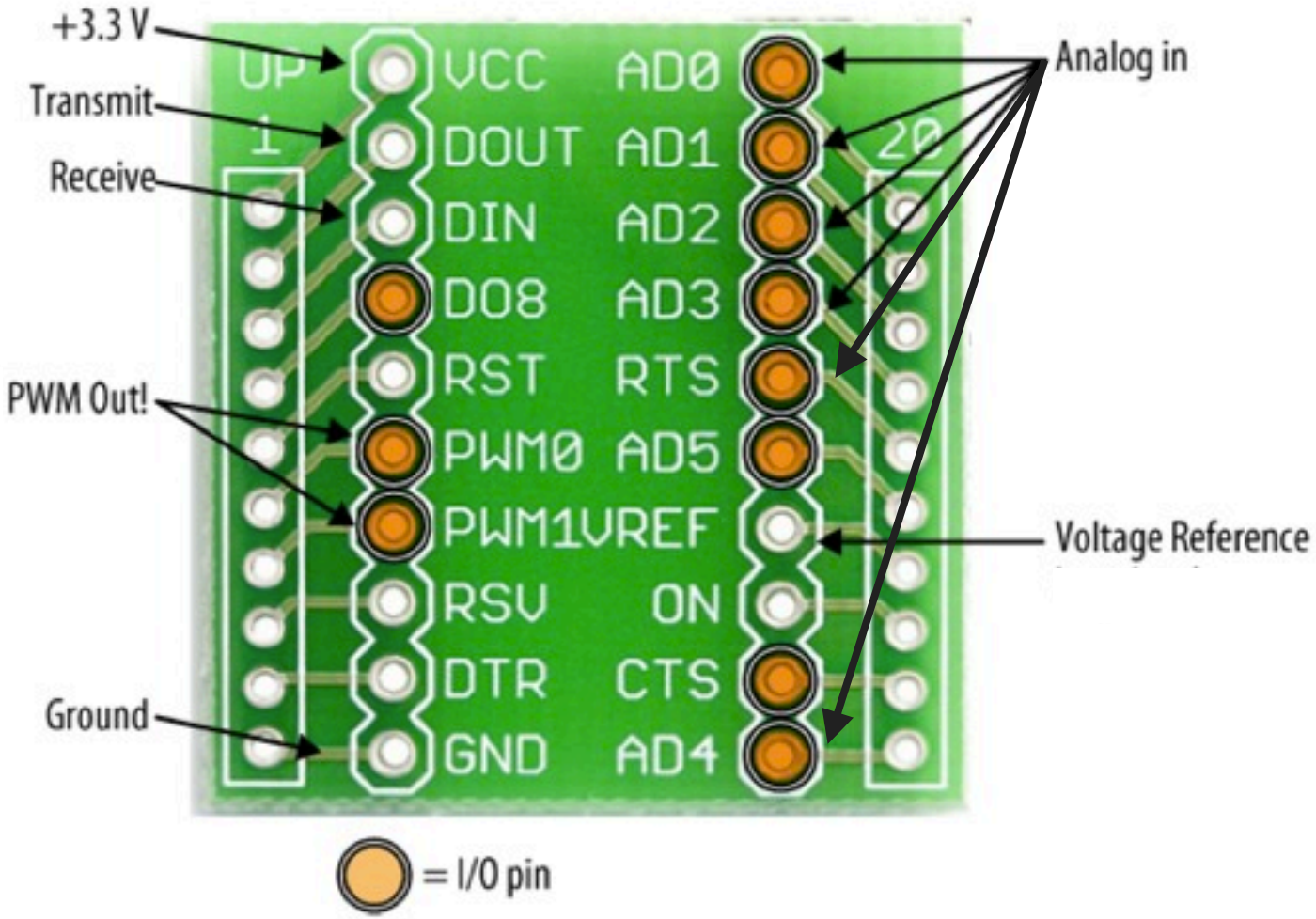
- Two radios paired together
- One's ATMY address is the other's ATDL destination
- ATRE will set your radio back to factory defaults
- ATWR will save your configuration. Use it!
- Remember, the radios work reliably, troubleshooting is mostly about figuring out what they're doing.

XBee Breadboard Hookups

Wiring

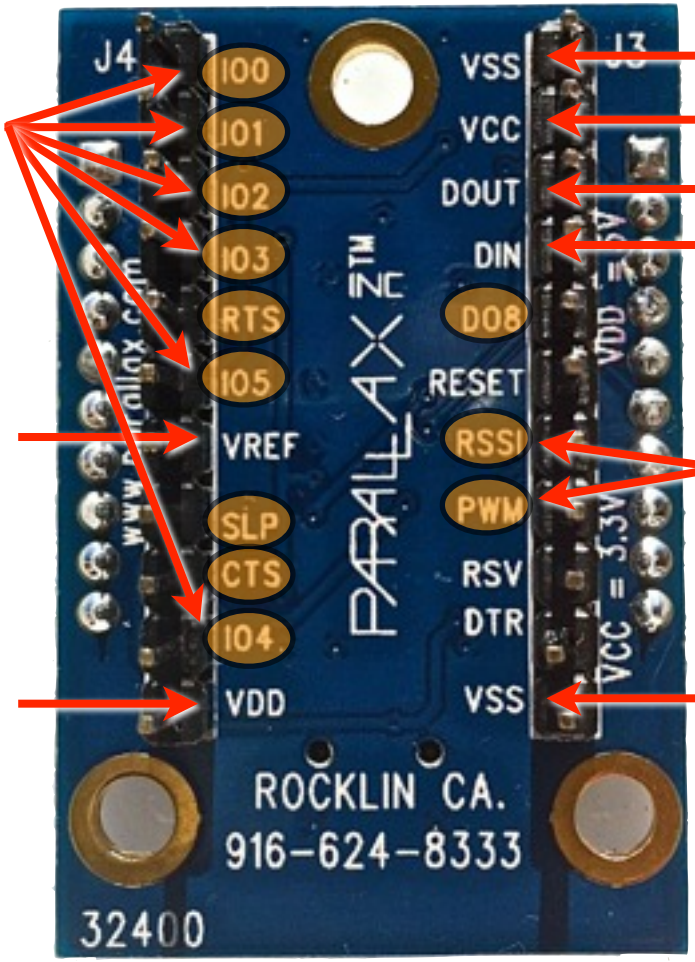

+3.3 V
transmit
receive
ground
AD0
AD1
AD2
Crd.
/RTS
Ass't
Vref
/SLP
/CTS
TXind
Breakout board v.1.0
Vcc
TX
RX
TXEN
/RES
RSSI
NC
NC
/DTR
GND

Input/Output Wiring 802.15.4: Basic Breakout



Input/Output Wiring 802.15.4: Parallax XBee USB

= I/O pin



Analog In

Voltage Reference

+V in

Ground

+3.3V

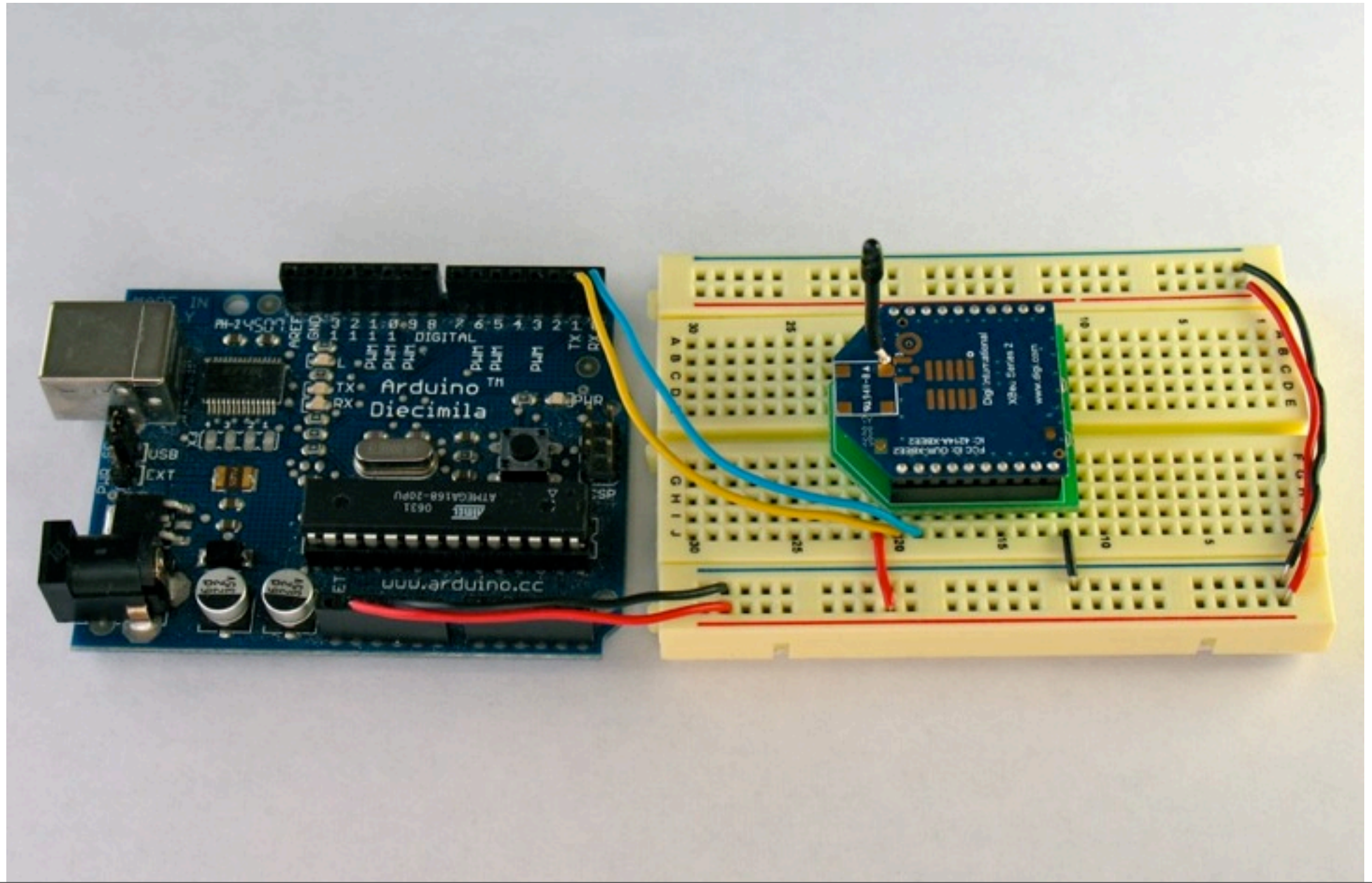
Transmit

Receive

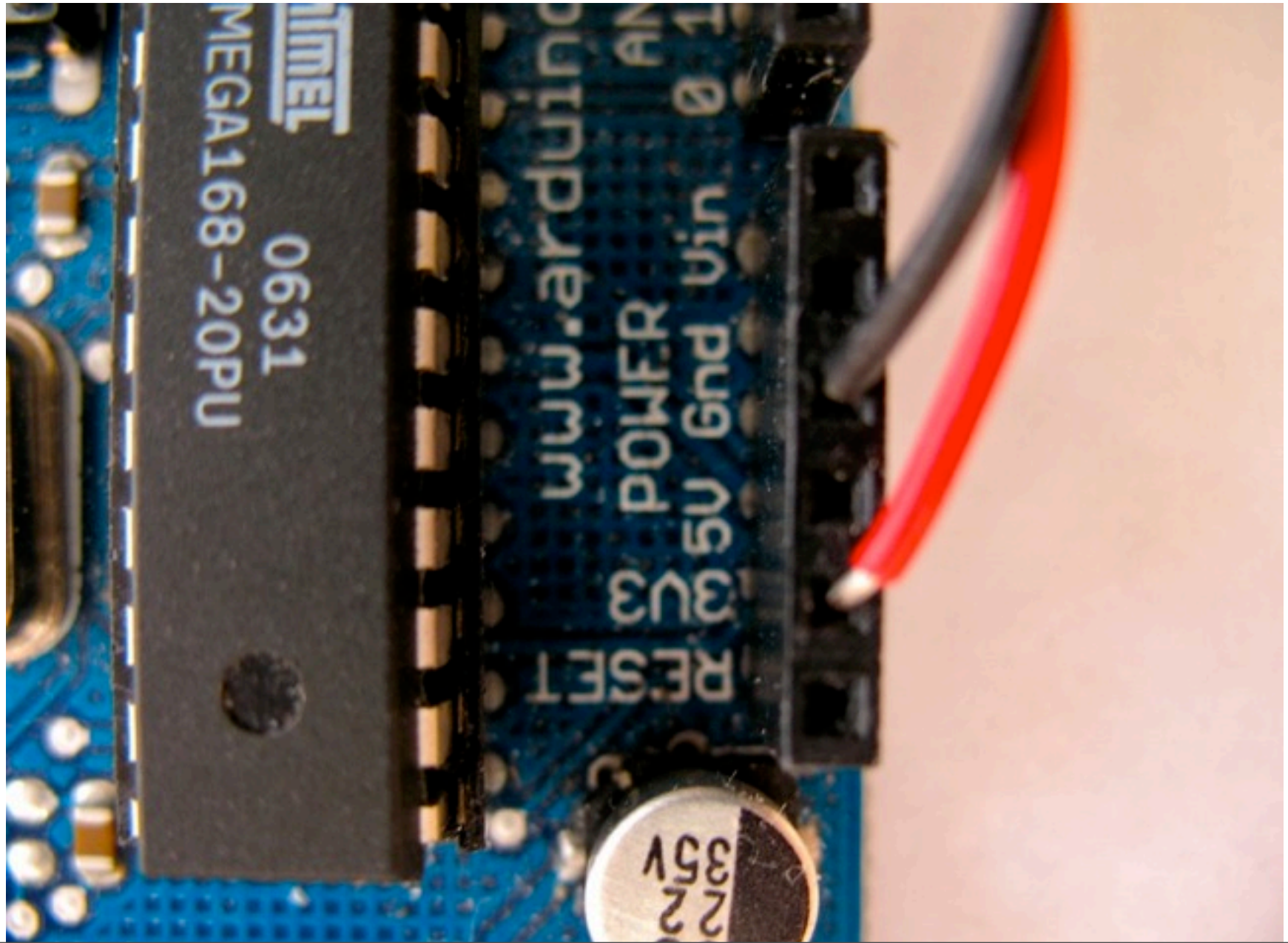
PWM Out

Ground

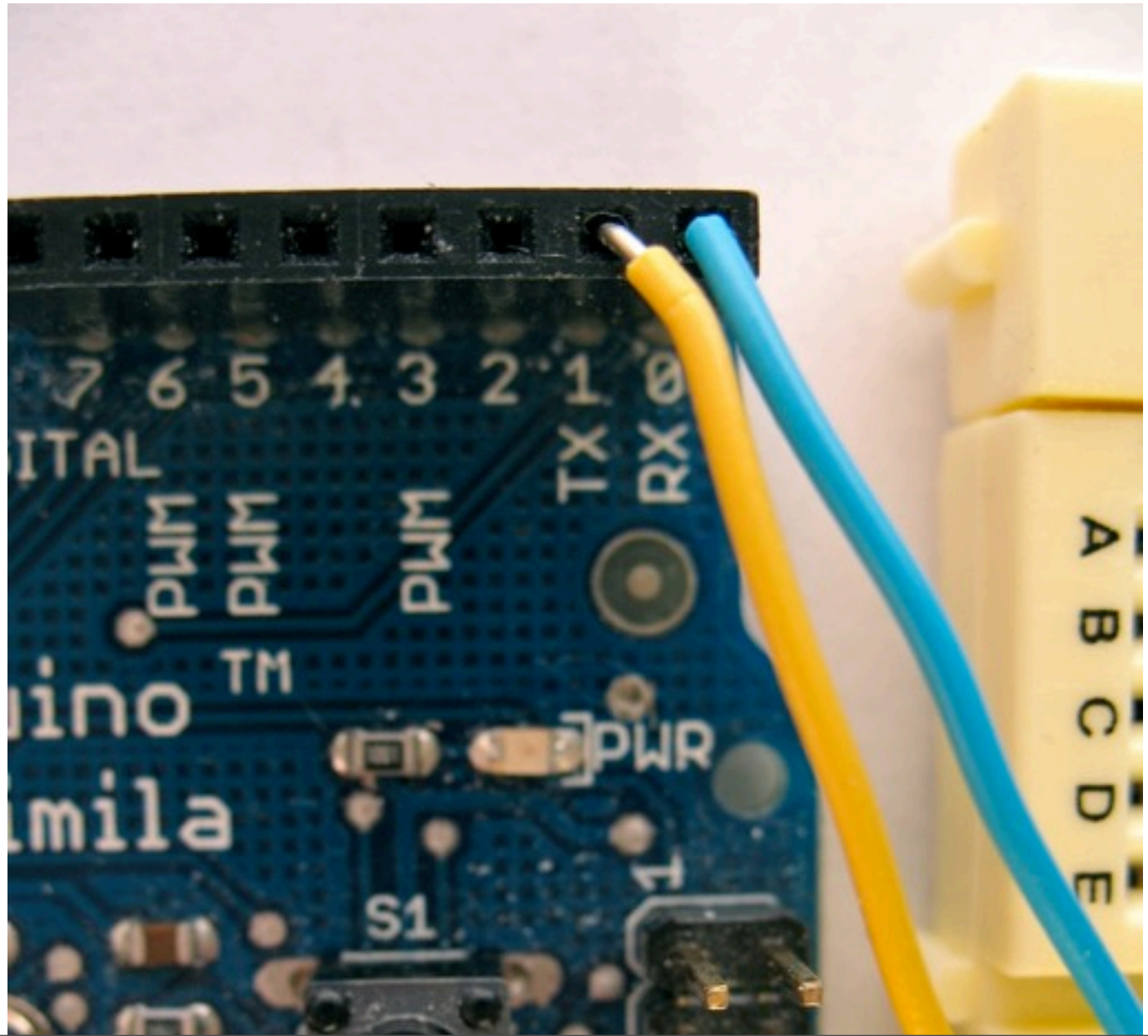
XBee Arduino Breadboard Layout



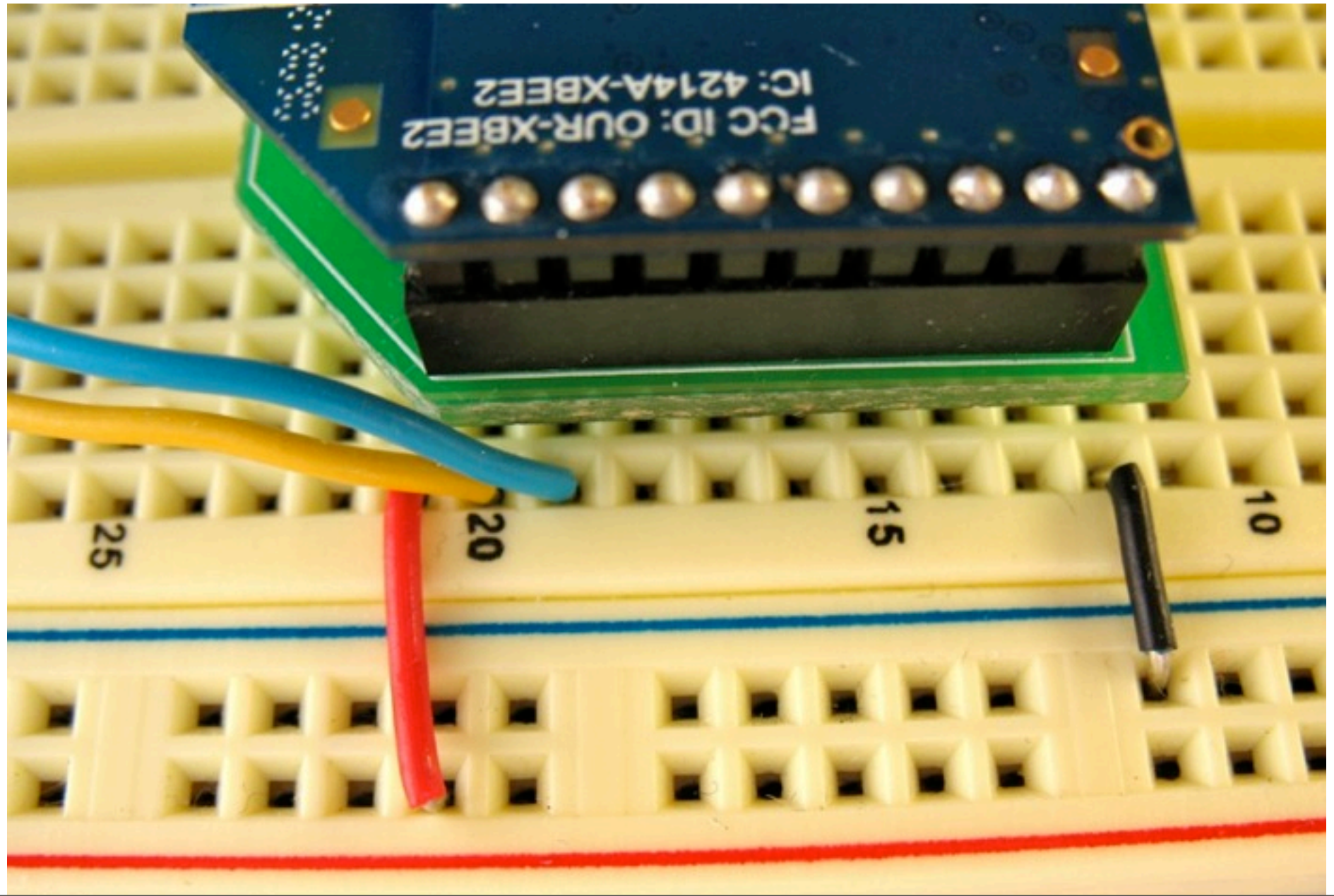
Power, Ground



TX, RX



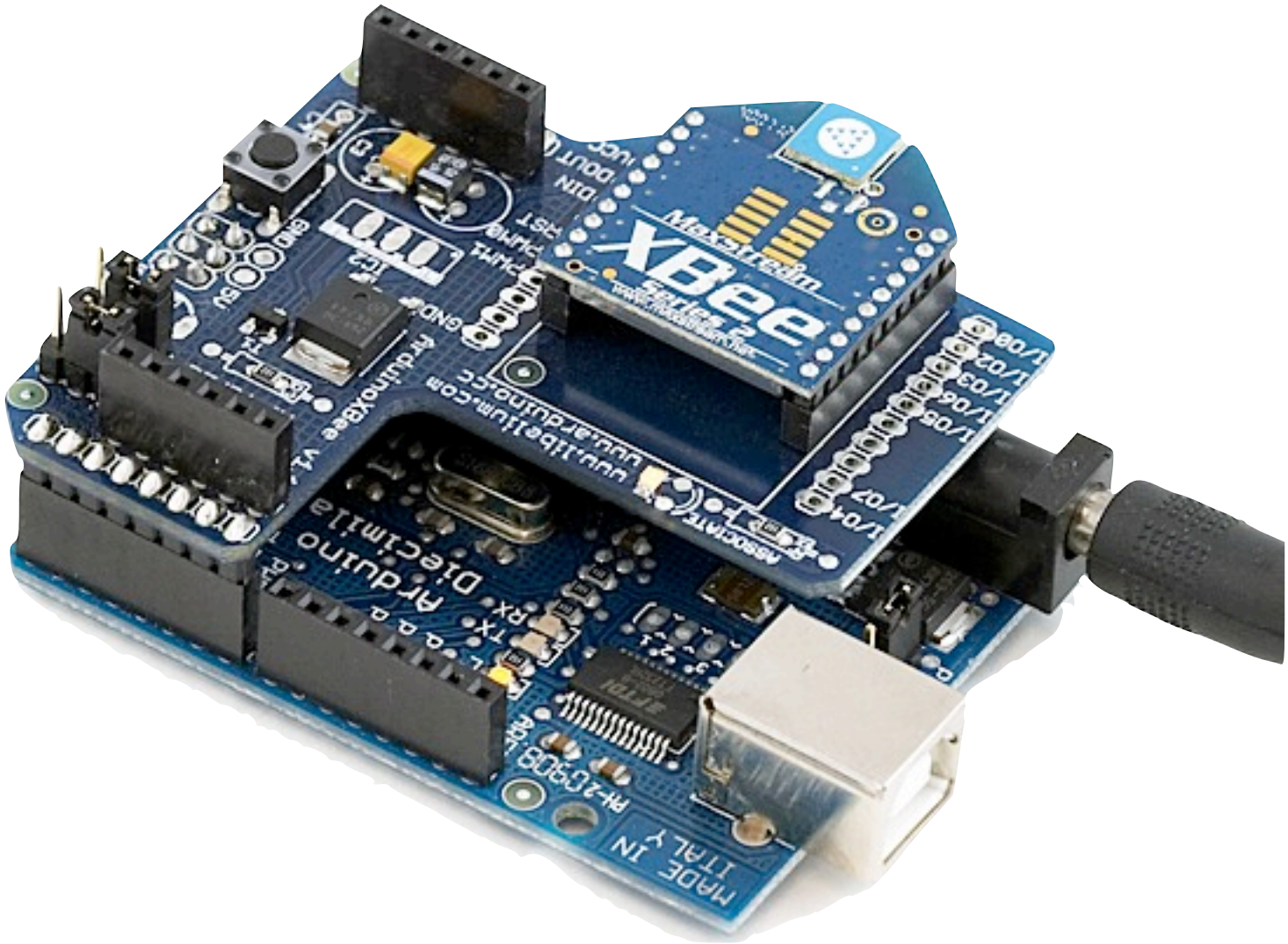
XBee Connections (pin 1, 2, 3 and 10)



Remember!

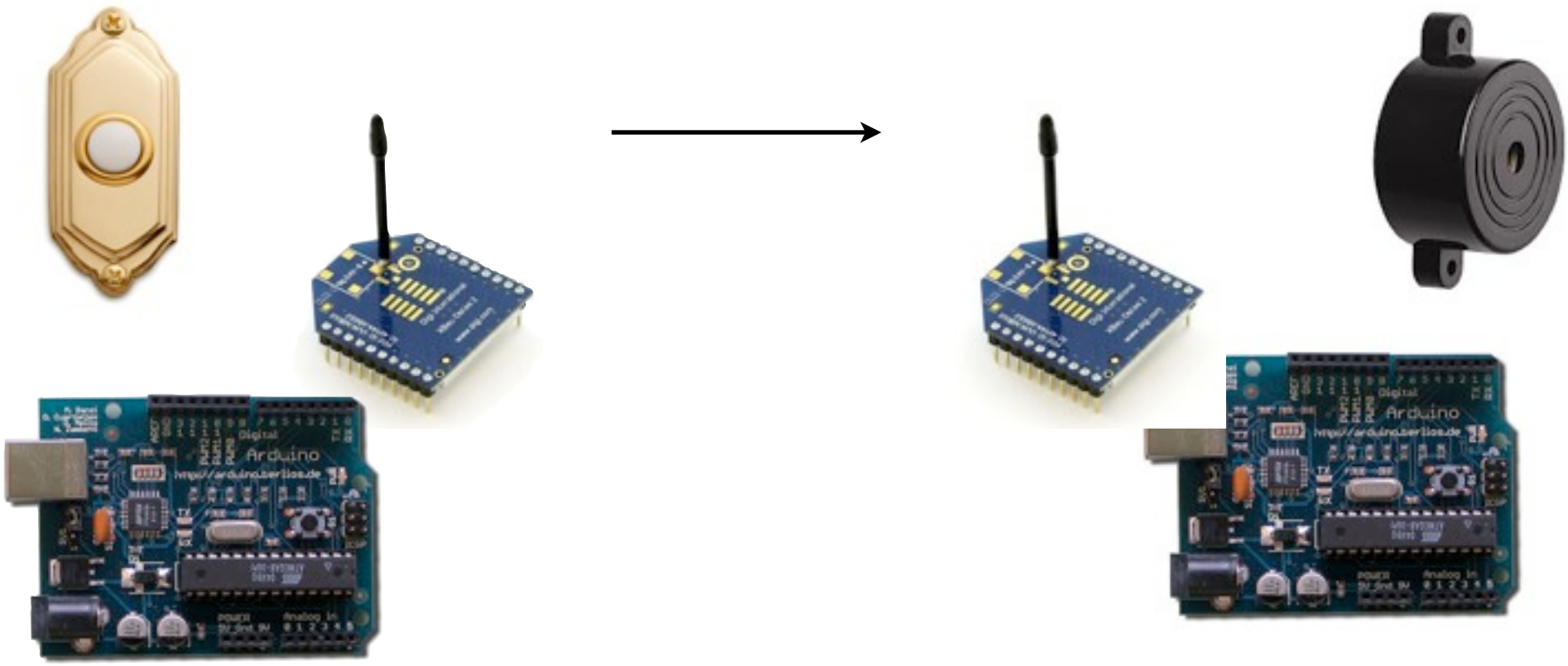
- Use only +3.3 Volts. More than +7 Volts will kill your radio
- If you use a voltage regulator, always use decoupling capacitors. The radios often don't work without them.
- XBee TX goes to Arduino RX and vice versa.
- Unplug the TX & RX before uploading Arduino code (or use switches)
- You can't send infinitely fast. Try putting a 10 ms delay into your loop.

Arduino Shield

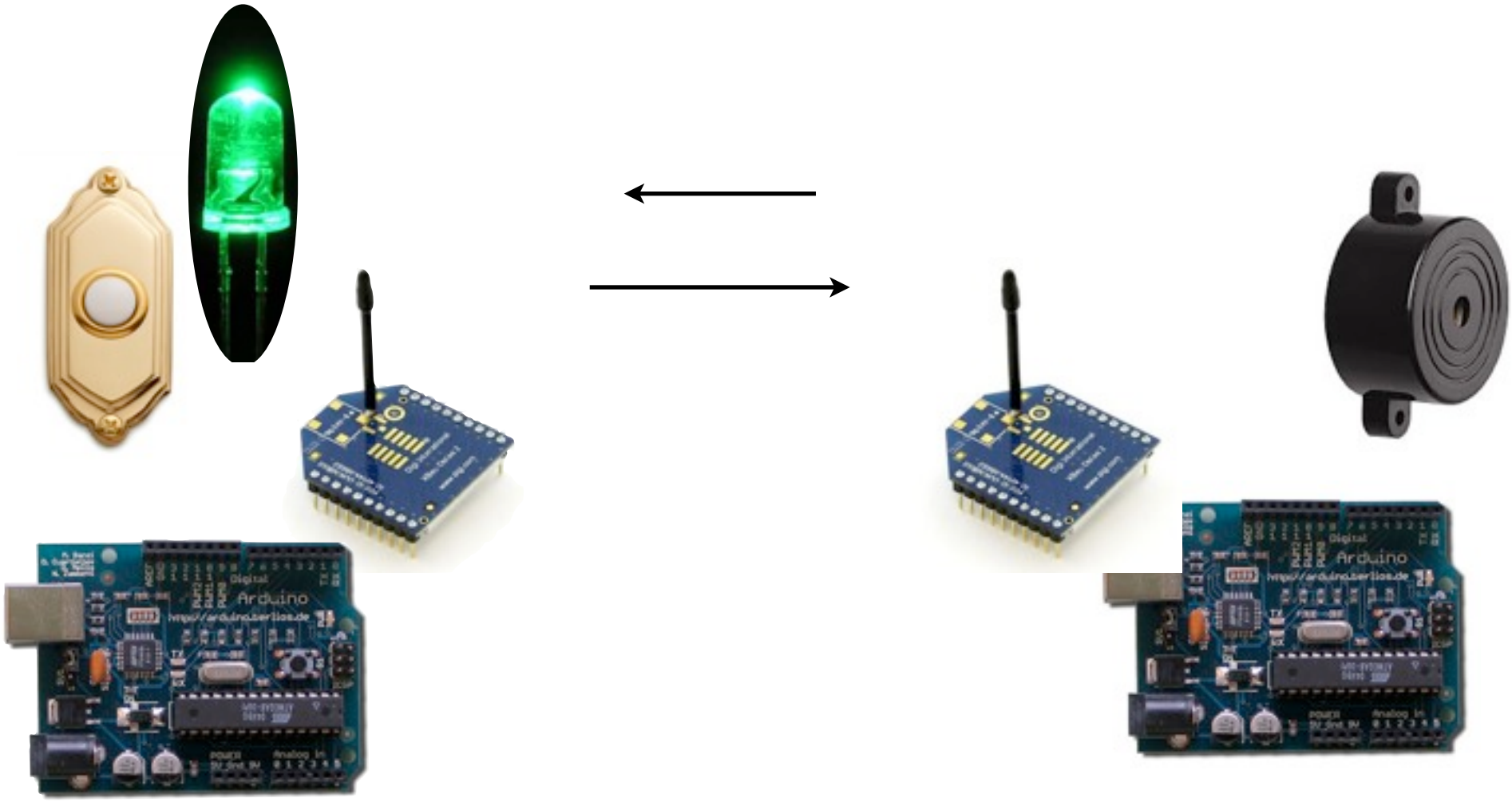


Doorbells

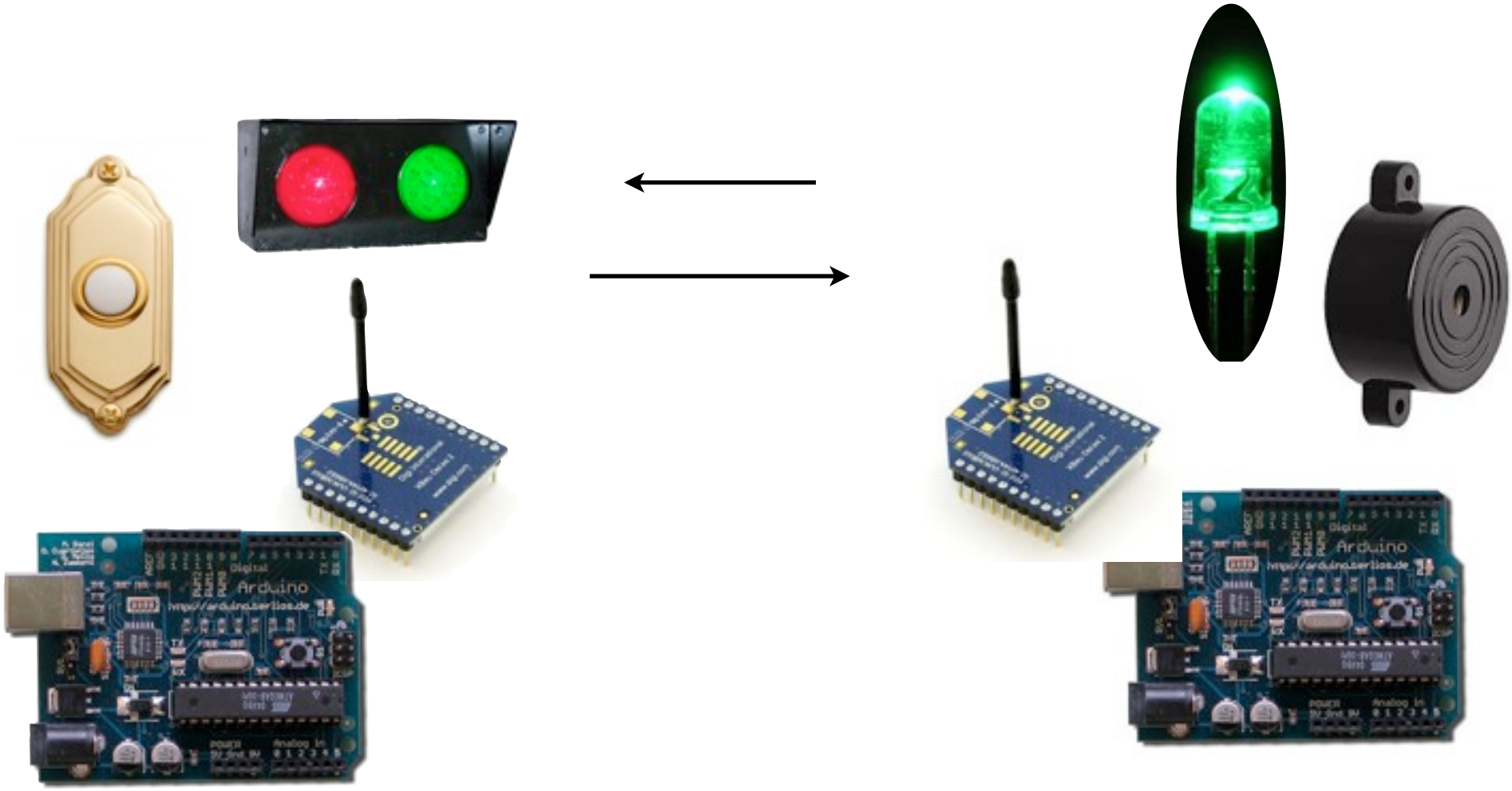
Basic Doorbell



Feedback Doorbell



Nap Doorbell



Final Project Suggested Timeline

- Week 10: ~~Make observations, select your idea and finalize your group~~
- Week 11: **Build a prototype and test it. Observe the results.**
- Week 12: Build a revision and test it. Observe the results.
- Week 13: Create a final that works well, with a presentation and demo that tells its story
- Week 14: Final Presentations
- Week 15: Final Presentations

Readings and Assignments

- ~~Readings~~
  - DOCUMENTATION OF EVERYTHING TO DATE
- Assignment
  - Wireless lab
  - Build a prototype and test it. Observe the results.