Whistler and the Arctic!

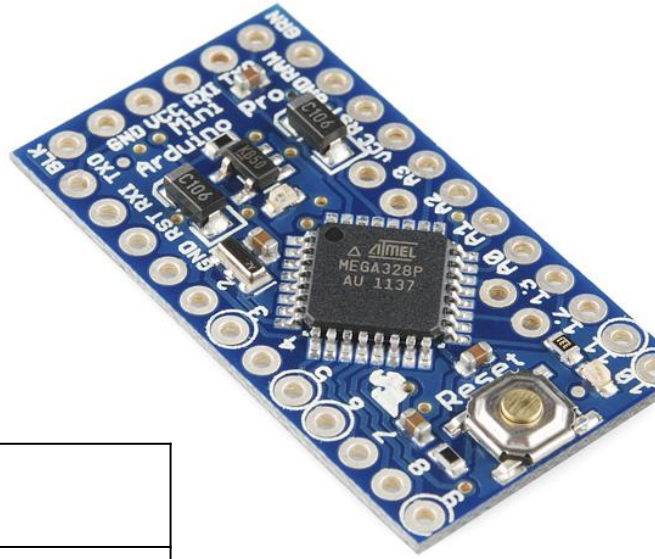
January 2014

What shall we learn today?

- ★ What parts make up Whistler?
- ★ FTDI what??
- ★ What is Git, and why do I care?
  - ○ What do you mean fork a repo?
  - ○ Now you want me to do a pull request to give you my changes?

Whistler Parts: Arduino Pro Mini

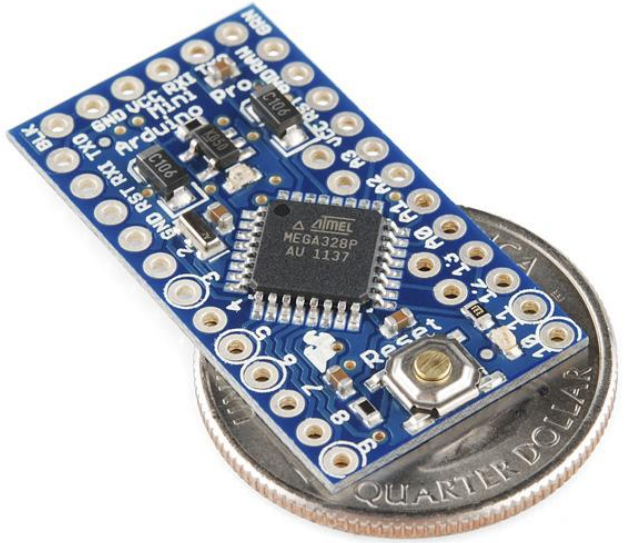
- Uses ATmega328
  - Same as Arduino Uno
- Nothing is free. (you must pay for the small size)



Uno	**Pro Mini**
5V or 3.3V, same board	Choose either 5V or 3.3V
40mA per output pin	40mA per output pin
32KB Flash memory	16KB Flash memory
16MHz clock speed	16MHz clock (5V), 8MHz (3.3V)
7V-12V (20V) input supply	5V-12V input supply
14 Digital (6PWM), 6 Analog pins	14 Digital (6PWM), 8 Analog pins

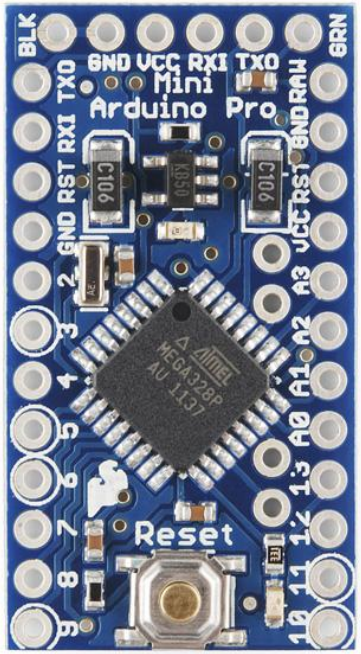
Whistler Parts: Arduino Pro Mini

- No secondary chip for programming
- Must use FTDI board
  - more later
- Pin spacing allows the use of breadboards
  - Excluding FTDI headers
  - Excluding Analog 4-7
    - A4 and A5 are needed for I^2C



Whistler Parts: Arduino Pro Mini

- I^2C pins
  - A4: SDA (Serial Data Line)
  - A5: SCL (Serial Clock Line)
- Allows for 1-wire sensors
- Needed for MLX90614
  - IR sensor (more to come)



Whistler Parts: MLX90614-ACC

- I^2C non-contact (IR) thermal sensor
- ACC
  - (A) 5V supply
  - (C) Gradient Compensated
  - (C) 35º FOV
- Must be uncovered to work
- Around ±1ºC to ±3ºC accuracy
- Gradient Compensation measures ambient temperature to improve accuracy

Whistler Parts: MLX90614-ACC

It is very important for the application designer to understand that these accuracies are only guaranteed and achievable when the sensor is in thermal equilibrium and under isothermal conditions (there are no temperature differences across the sensor package). The accuracy of the thermometer can be influenced by temperature differences in the package induced by causes like (among others): Hot electronics behind the sensor, heaters/coolers behind or beside the sensor or by a hot/cold object very close to the sensor that not only heats the sensing element in the thermometer but also the thermometer package.

This effect is especially relevant for thermometers with a small FOV like the xxC and xxF as the energy received by the sensor from the object is reduced. Therefore, Melexis has introduced the xCx version of the MLX90614. In these MLX90614xCx, the thermal gradients are measured internally and the measured temperature is compensated for them. In this way, the xCx version of the MLX90614 is much less sensitive to thermal gradients, but the effect is not totally eliminated. It is therefore important to avoid the causes of thermal gradients as much as possible or to shield the sensor from them.

(from the datasheet page 2)

Whistler Parts: MLX90614-ACC

- FWHM

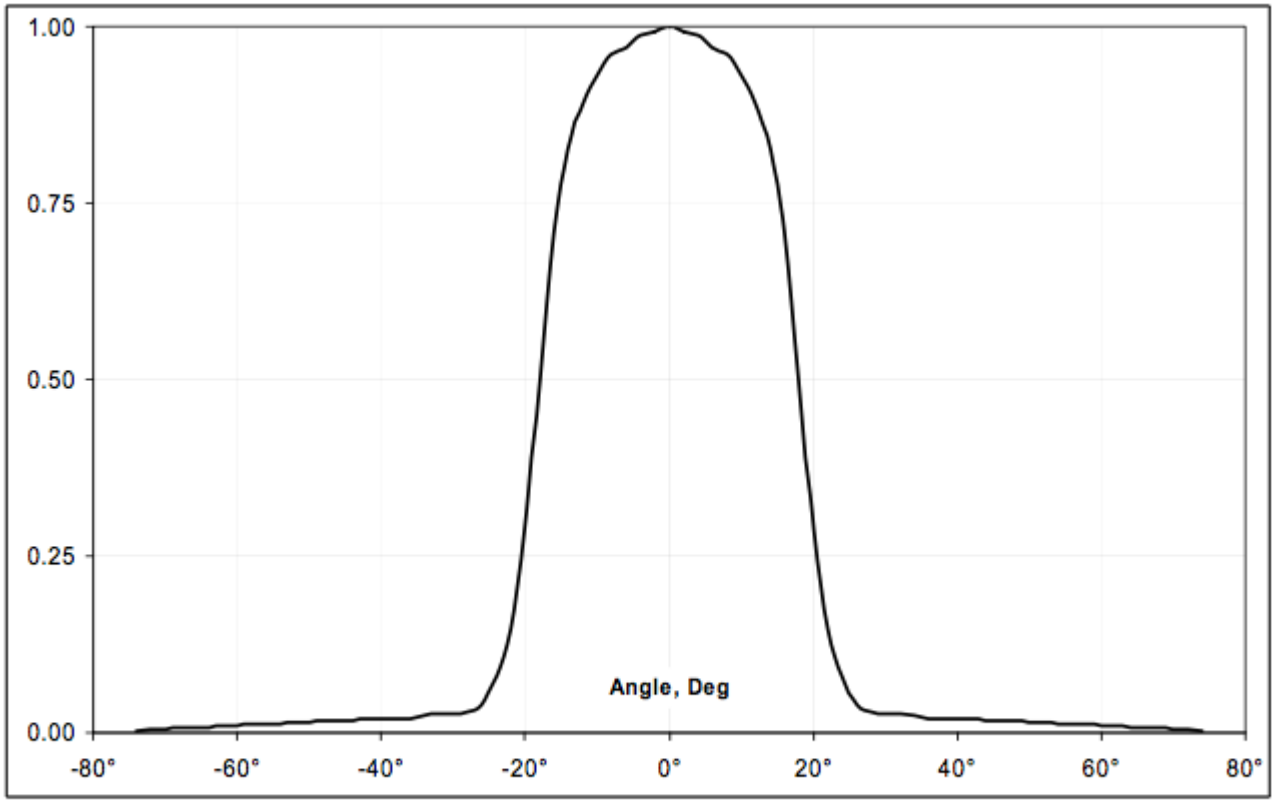
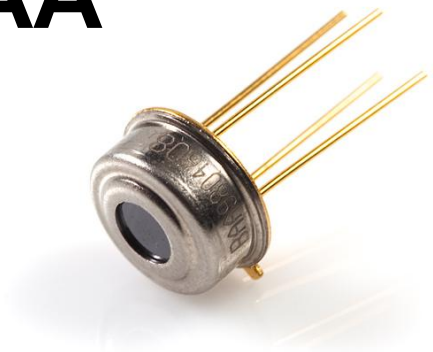


Figure 24: FOV of MLX90614xCC

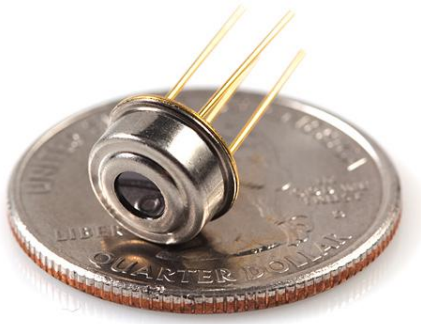
Sidebar: Data Sheets

- Data Sheets are mystical and magical scrolls that teach you to use magical powers
- You will not understand them until you have gained enough experience to wield them correctly
- Use them for good, not evil

Whistler Parts: MLX90614-BAA



- Other packages for other uses
  - (B) 3V
  - (A) Single Zone
  - (A) Standard Package (80º FOV)
- Will not work with 5V Pro Mini
- Large FOV
  - Easier to have data contamination
- Easier to buy and cheaper!



Whistler Parts: MLX90614-BAA

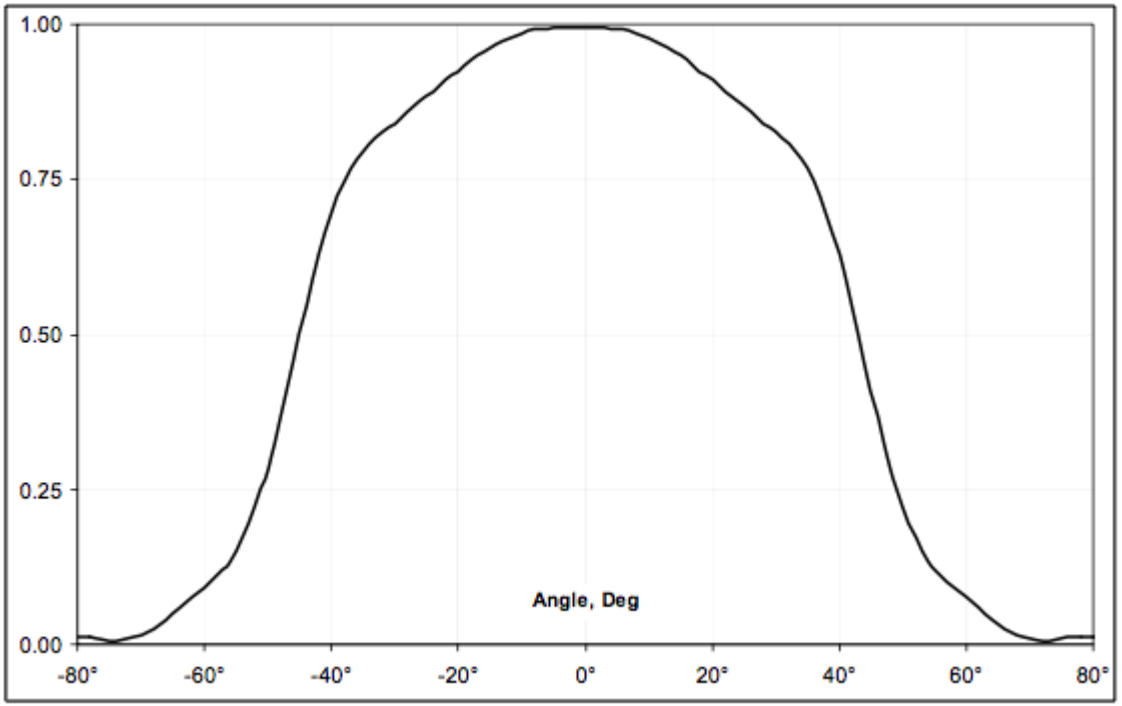
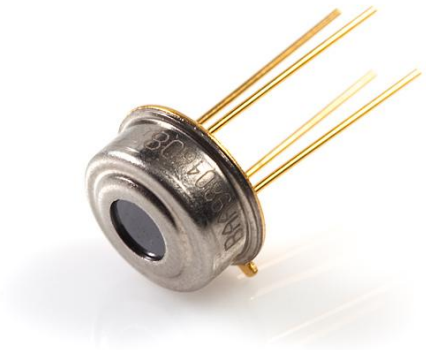
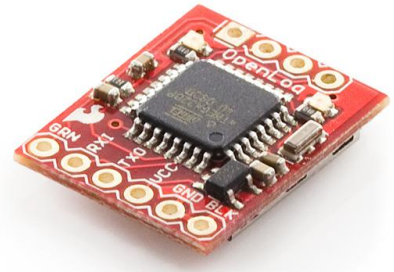


Figure 19: FOV of MLX90614xAA

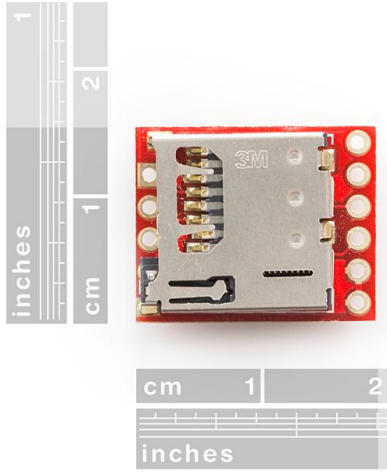


Parameter	MLX90614xAA	MLX90614xBA	MLX90614xCC	MLX90614xCF
Peak zone 1	±0°	-25°	±0°	±0°
Width zone 1	90°	70°	35°	10
Peak zone 2	Not applicable	-25°	Not applicable	Not applicable
Width zone 2		70°		

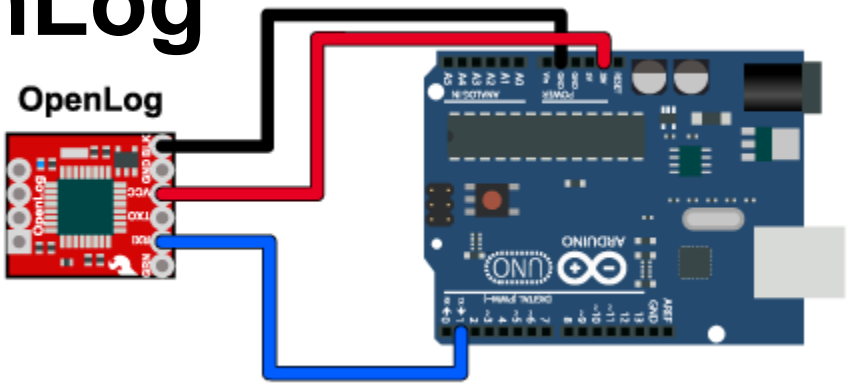
Whistler Parts: OpenLog



- Serial enabled MicroSD data logger
- Hooks up to Serial out of Arduino
  - Serial.print()
  - Serial.println()
- Serial written directly to the SD card
- Has ATmega 328 chip to process and write to SD card
- Plain text file to configure
- Hooks directly to FTDI to reprogram as needed



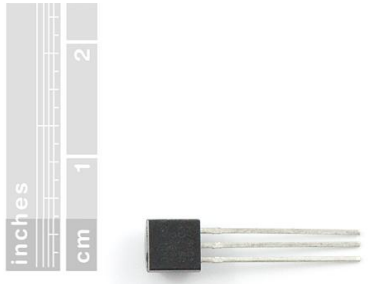
Whistler Parts: OpenLog

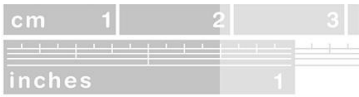


- Provide power
  - 5V
  - GND
- Connect RX pin on OpenLog to TX pin on Arduino
- Done

- Connect TX on OpenLog to RX on Arduino to have two way communication so you can do advances file commands

Whistler Parts: DS18B20

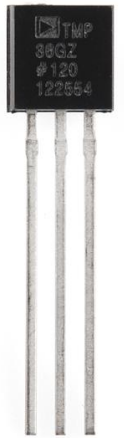




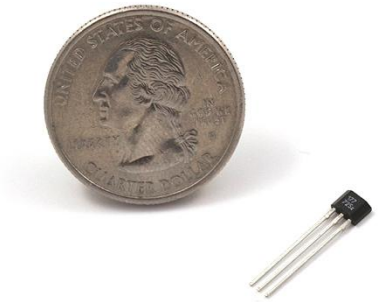
- Temperature sensor
- Addressed
- ±1ºC accuracy
  - Factory calibrated
- 12bit precision
- 750ms read time
  - SLOW due to unique address
- Control many using one digital pin

Whistler Parts: TMP36

- Low voltage (2.7V-5.5V)
- Linear temperature sensor
- 10mV per degree C
- Simple math to determine exact temperature
- Quick
- One per digital pin



Whistler Parts: Hall Effect



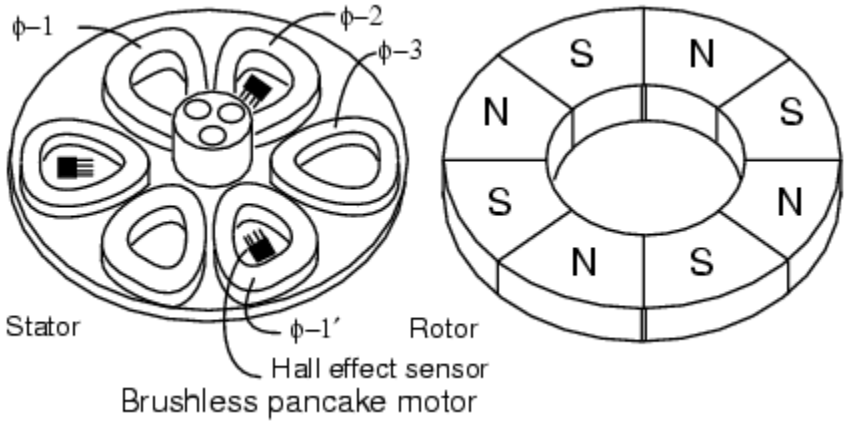
- Detect magnetic fields
- Latching (on/off) switch
- Must have field flip to change state
- NOT analog
  - You can get an analog one that can give field strength, but that is not useful for position sensing

TO-92 Package

- Notice all of these look almost the same
- Must be careful
- Use the standard TO-92 package
  - Hall sensors are slightly different, but close)
- Must pay attention to where components are plugged in

Whistler Parts: Magic Magnets

- 8 pole magnets
- Attached to axle
- Each pole change changes latch state of the Hall sensor
- As the wheel rotates, it will trigger the data to log



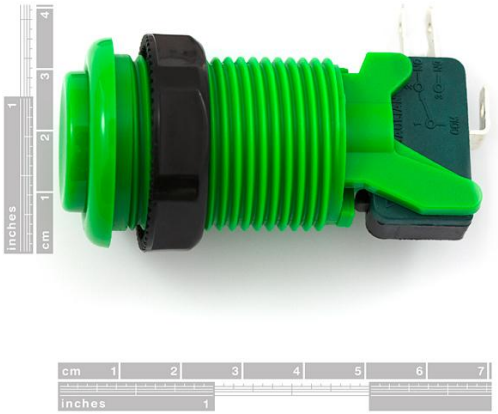
Brushless pancake motor

Whistler Parts: Toggle Switch

- Toggle switch
- Will tell Whistler to record data
  - Instrument MUST cold soak while on
- Inner ring is a locking switch
- Will not work with big gloves
- Ring should light up around button when depressed

Whistler Parts: Momentary Switch

- Arcade style momentary switch
- Will add a mark to the data when pressed
- Will mark data every 10m
- Made of plastic
  - Plastic and cold do not get along
  - Be kind to the switches

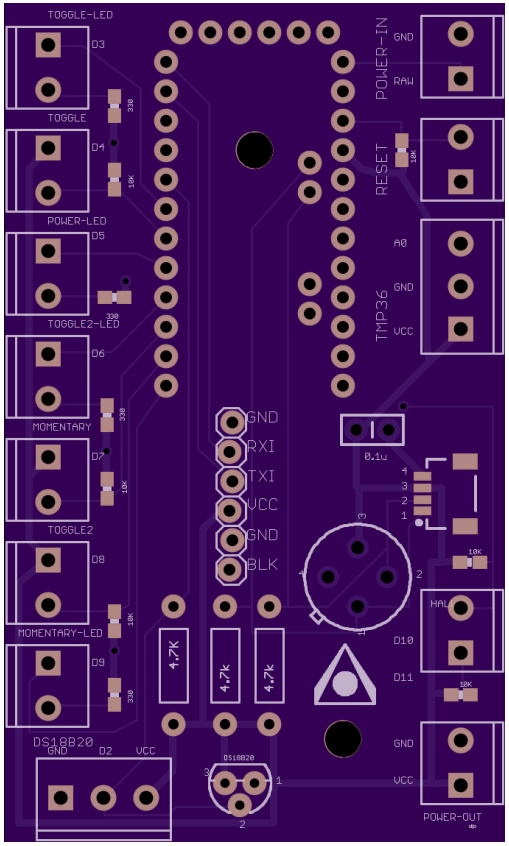


How do they fit together?

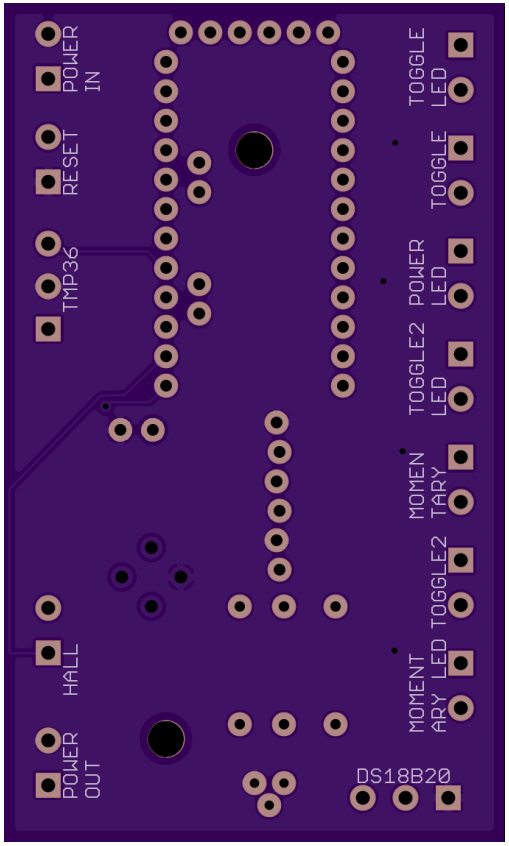
- Each sensor must connect to the Arduino
- Standard female headers create loose connections that are unreliable when anything is moved
- Soldering bare wires directly to the Pro Mini is DIFFICULT
  - Trus me I have done it
  - If you did solder directly to the Arduino, you have issues with length and moving things around
  - You have no easy way to breadboard
- Solution: Get a custom PCB (printed circuit board) made

Whistler Parts: Whistler Board

- This is Whistler
  - I forgot to write his name on him =(
- Each component connects to this board to talk to the Arduino
- Why name it Whistler
  - Because I can



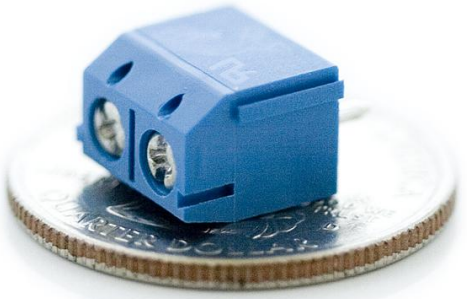
Top

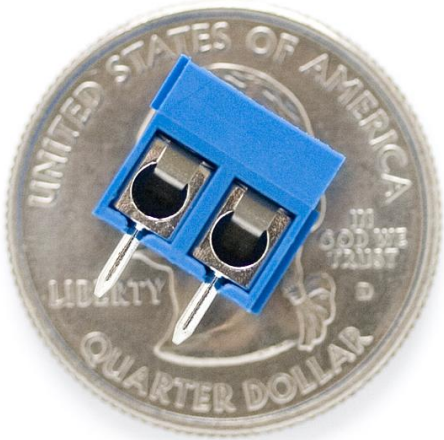


Bottom

Whistler Parts: Screw Terminals

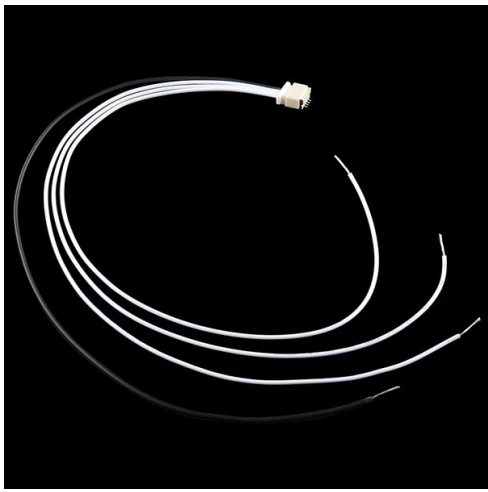
- Most connections are made with screw terminals
- Soldered directly to the board
- Simply stick wires in and tighten the screws on top
- Creates a reliable connection
  - Unless a wire snaps

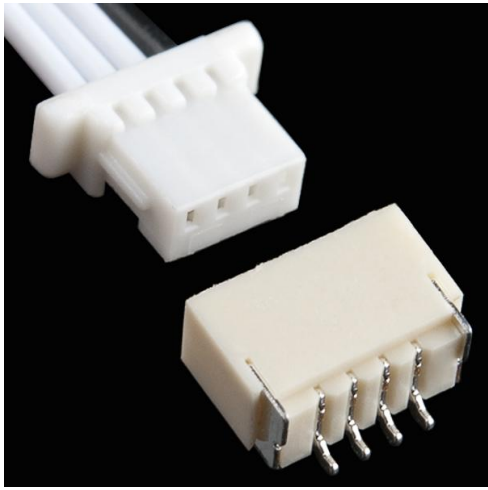




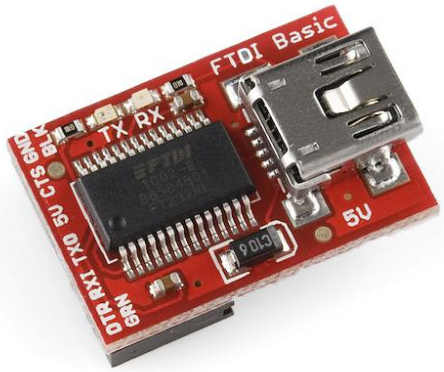
Whistler Parts: JST

- The MLX90614 has 4 pins that **<u>have</u>** to be connected correctly
- JST connectors are keyed
  - Only fit together one way
- This reduces the possibility of errors in assembly if a part has to be swapped out

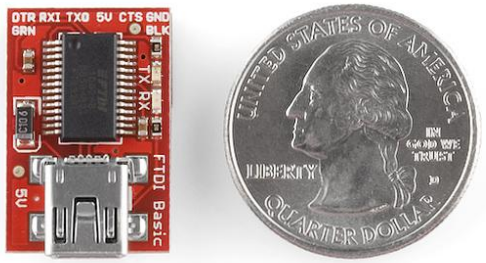




FTDI: FTD WHAT???



- FTDI: Future Technology Devices International
- Serial communication protocol
- Allows USB (universal serial bus) to work with the Arduino
- Arduino Uno does not use this
  - The Uno replaced the FTDI the Duemilanove used with an ATmega8u2
- FTDI requires drivers to be installed to work in Windows



FTDI: FTD WHAT???

USB data protocol is difficult to use. Serial data is simple. RS232, the standard connection before USB hit the streets sent simple commands. They either made it or not. USB added in hand shaking and checking, along with universal driver bases. This made it more difficult to use. FTDI is a chip that converts serial data to USB, if you have ever had to connect a DB9 cable to USB, you used an FTDI chip. FTDI is very stable and lets the computer see the device, the ATmega8u2 sacrifices some stability but can be reprogrammed to be anything you want (keyboard or mouse etc), and has a universal driver.

GitHub.com: Git what?

- Git is a version tracking system
- Instead of making program-11_18_13.pro you create a repository
- You make code changes and commit them to the repo
- Changes can be rolled back
- Versions can be compared
- Everyone can download your code (open source)
- Keeps your files orderly
- You should learn it just to be a better person!

GitHub.com: Git what?

- https://github.com/swvgs/Arctic-2014-thermal
- Get Repository for this trip
- Contains:
  - Datasheets
  - Eagle Files
  - Arduino Code
  - Scavenged code
  - Images
  - Helpful information

GitHub.com: Git what?

- If you want to make changes
- Make your own account
- Fork the repo
- Make changes
- Generate a pull request
  - This will tell admins you want to have them pull your changes to the master repo
- Admins then merge changes into the main repo

Sparkfun's getting started with Git

Other Notes

- Whistler runs on a 5V USB power adaptor
  - This should run for 48 hours with no problem
  - Should be charged daily
- Data can be collected distance based or time based
  - The choice has to be made on BOOT of the arduino
  - We will primarily use distance based data logging
- Data needs to be downloaded and archived in the Git repo daily
- Processing of data will probably be done in Python (pre-processing in excel?)