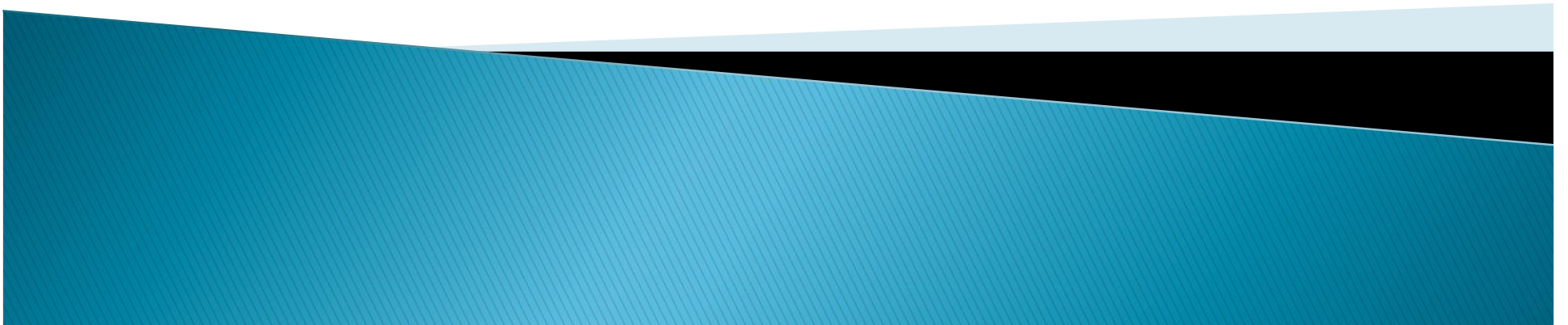# Maslab – Sensors 2011
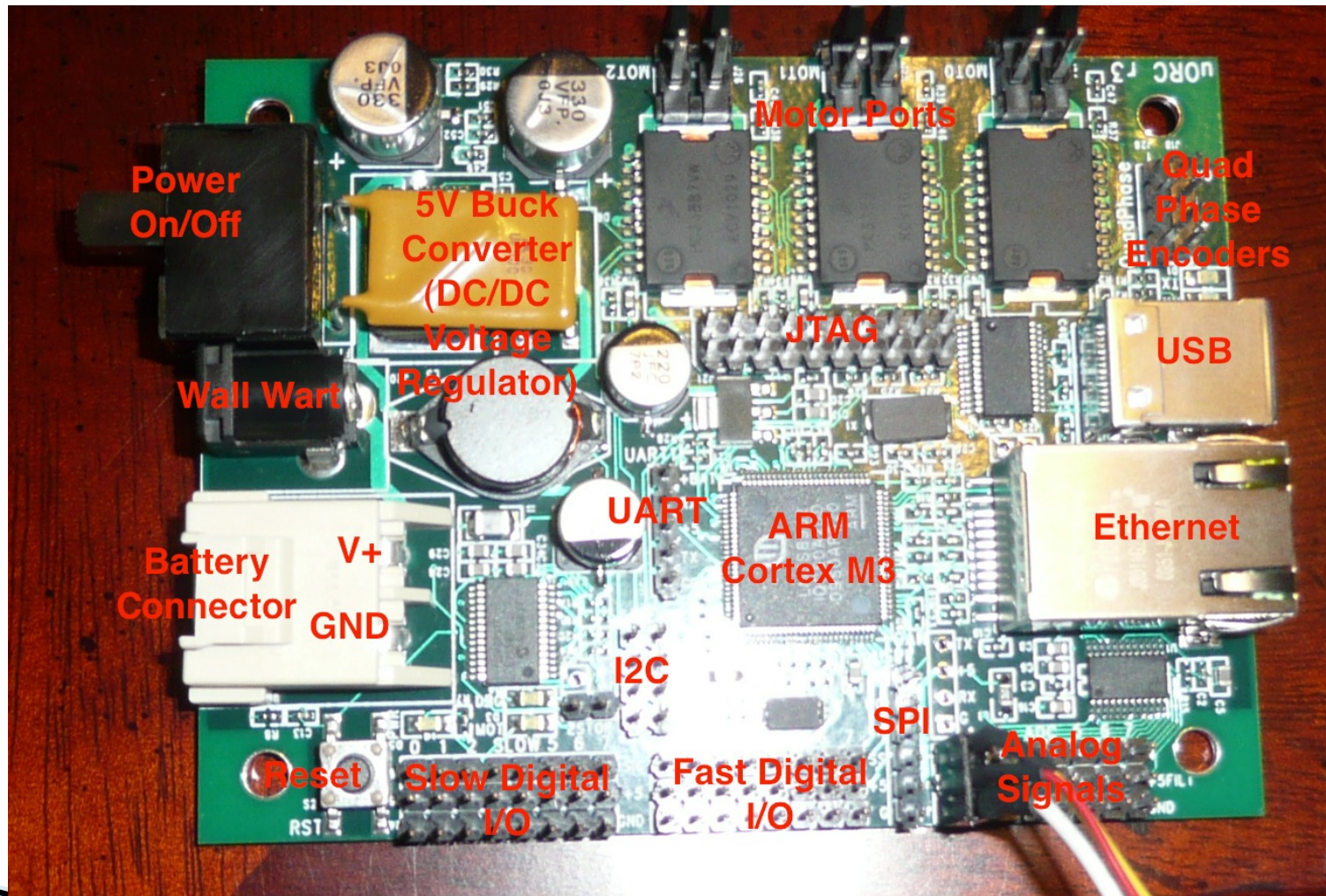
Topics

- General
  - uORC Layout
  - Electrical Safety
  - Digital Inputs
  - Cable Assembly
- Primary Sensors
  - Infrared
  - Optical Encoders
  - Bump Sensrors
  - Gyroscope
  - IR Optical Encoders
- Ideas/Reminders
  - Hacks – USB Mouse Odometry
 - Phototransducers, etc.
  - Reminders
- uORC errata

uORC Layout

Electrical Safety

▶ Don't Damage Yourself or Your OrcBoard!!
- Avoid Shorts: Use electrical tape on the back of your OrcBoard
- Avoid Ground Loops: Keep cables short and twisted
- Check polarity of connections
- Insert sensors with the OrcBoard off
- Connect to power LAST!
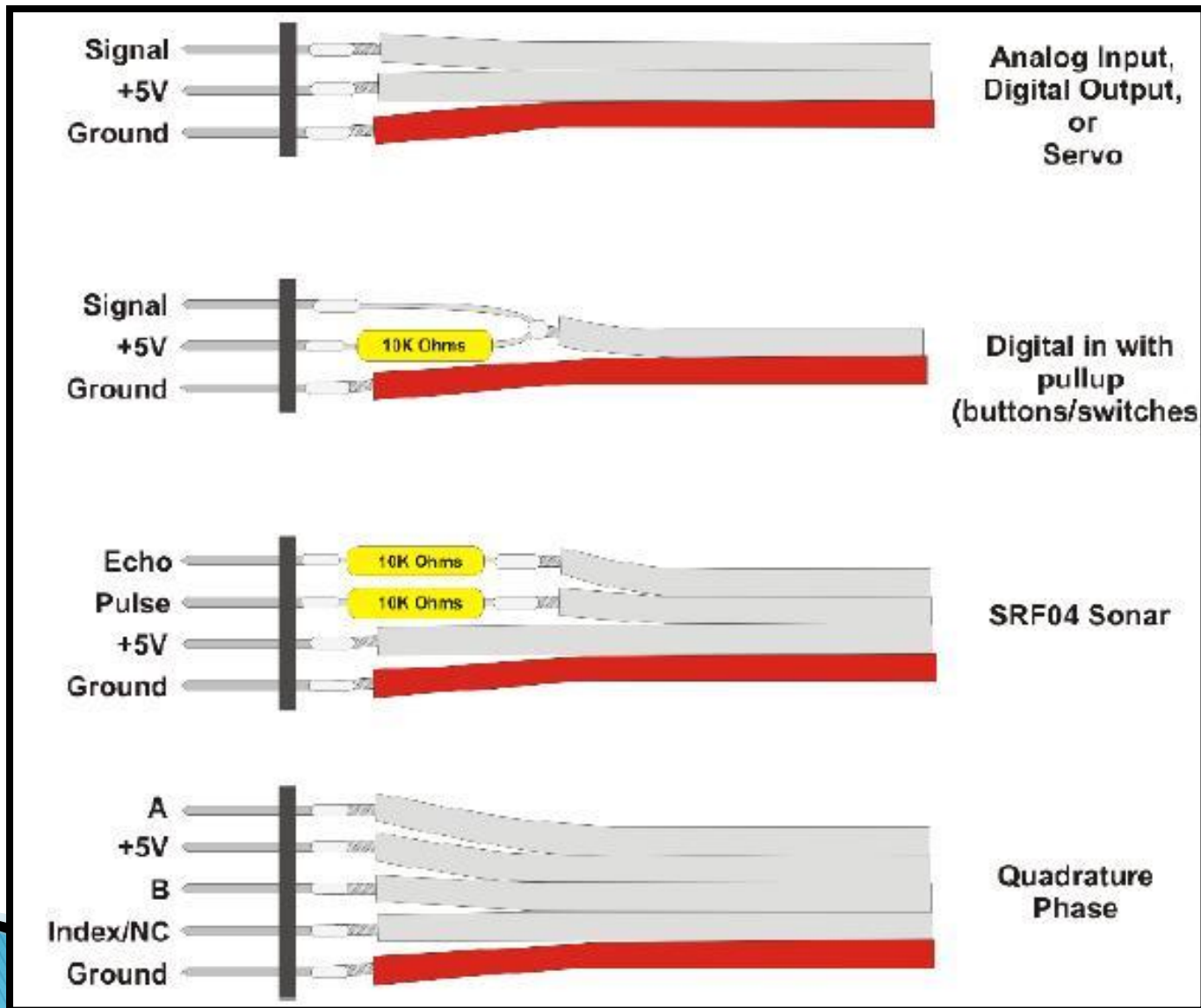- Replacement fee for damanged OrcBoards
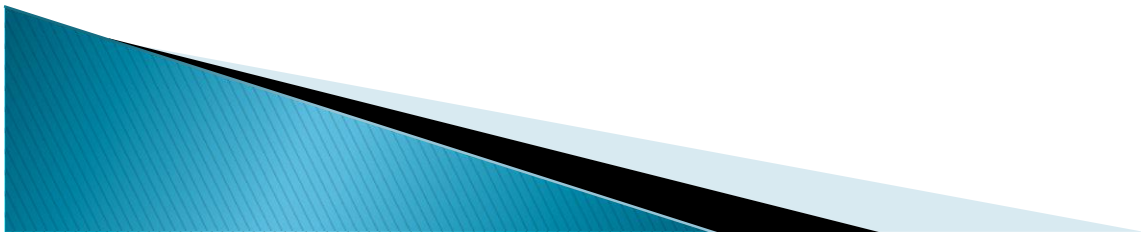
Digital Inputs

- Low Pass Filter on Analog I/O
- Built-in (approximate) current sense (All motors, Servos 0/1)
- 12 bit, 400 Hz ADC, CMOS compatible:
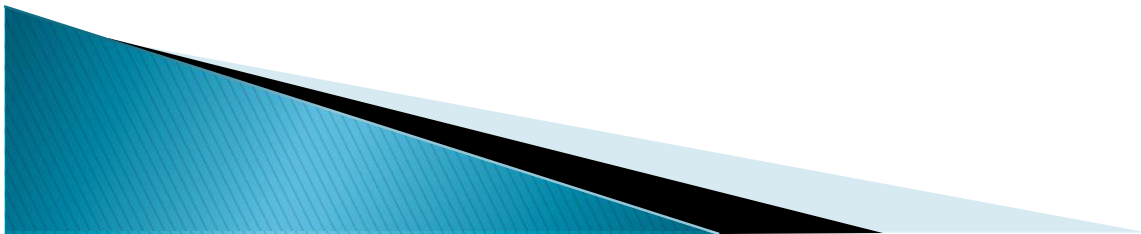 - Bump Sensors
  - Hall Magnetic Sensors
  - Reed Switches, etc.
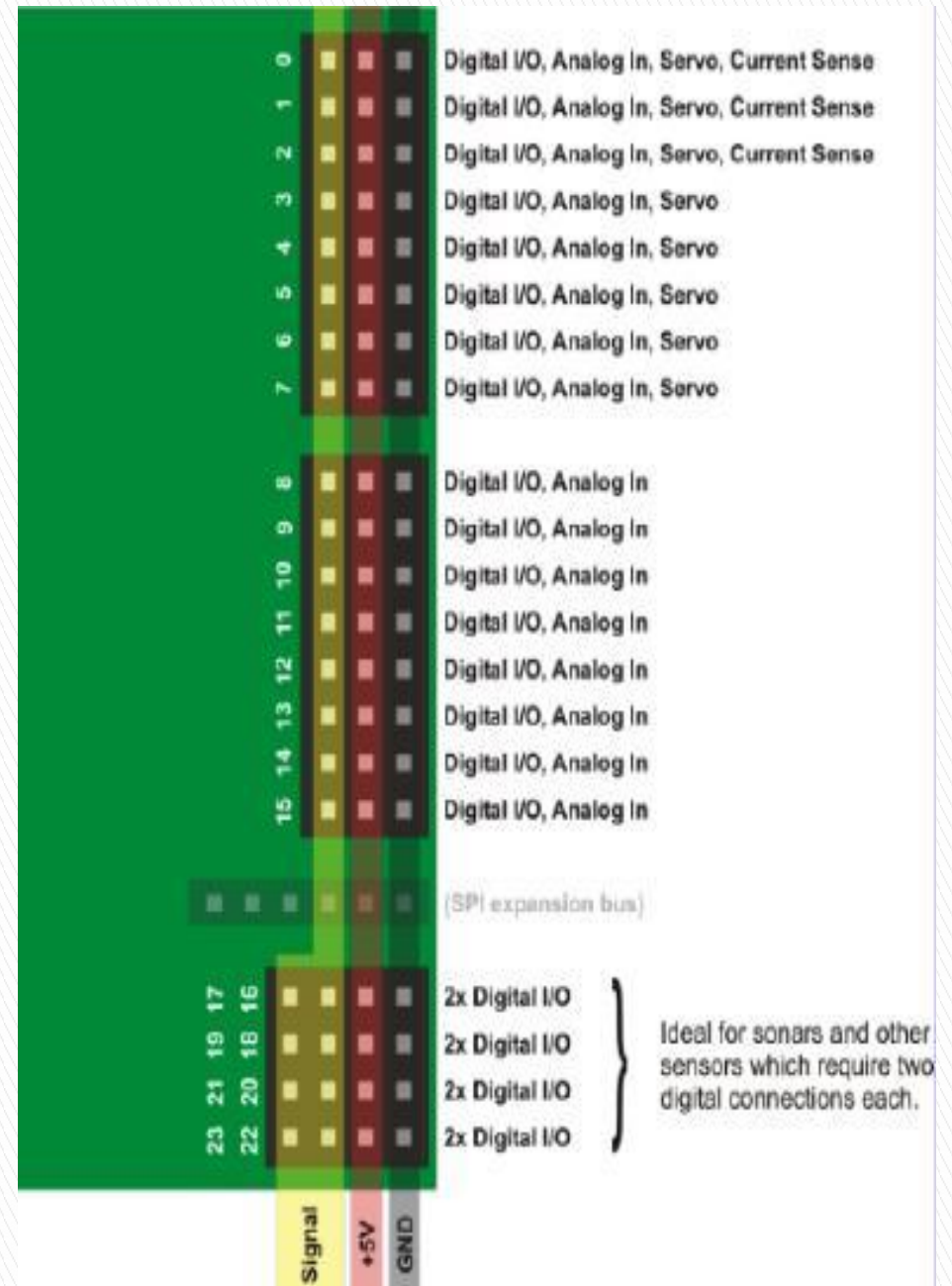
Cable Assembly

Suggestions for Cable Assembly:

- Use ¼" stranded wire
- Tin wire leads and header
- Protect connections with heatshrink (hot air gun)
- Plastic header melts easily
- Reinforce connections with hot glue (avoid shorting)
- Color code consistently for polarity (eg. Ground – Black, +5 Volts – Red, etc.)
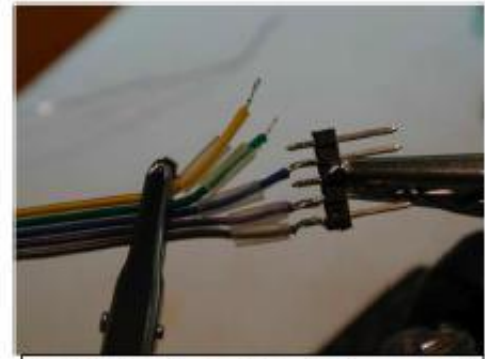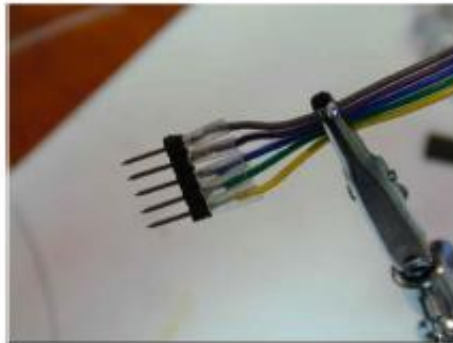
Cable Assembly Cont'd:

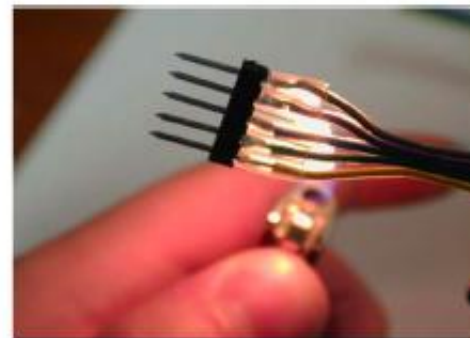Pre-tin (add some solder) the stranded wire.

Pre-tin the connector.
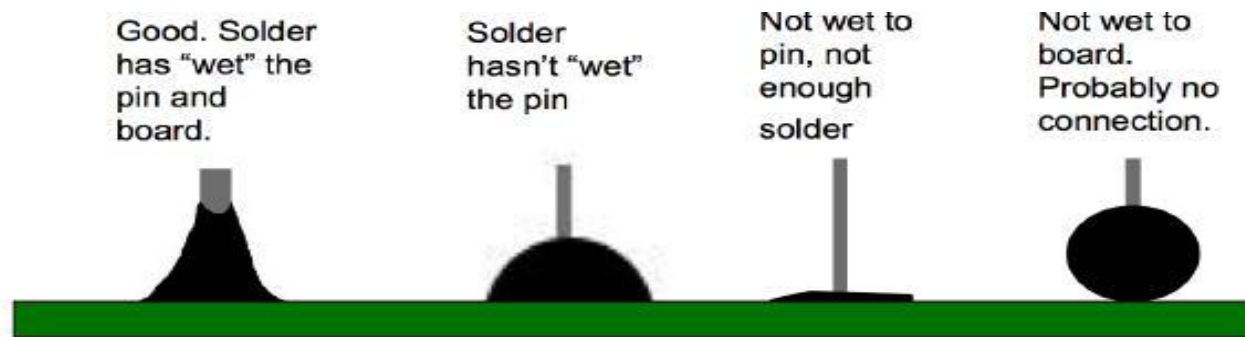

Add heat shrink tubing and solder the pins together.

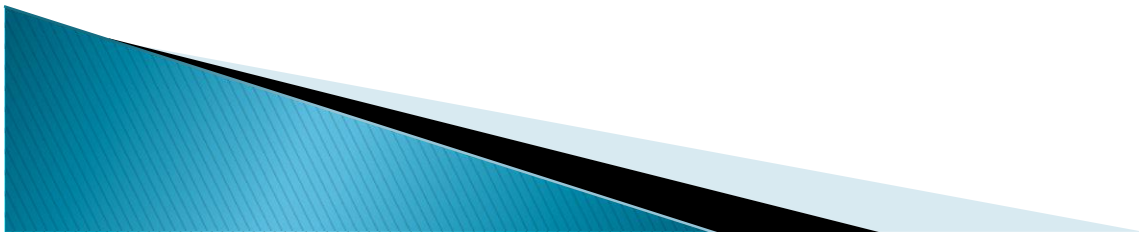This cable is now ready for shrinking.

Shrink the heatshrink tubing.

Tips for Soldering

- Keep a WET sponge for cleaning the iron tip
- Heat joining surfaces
- Beware joint oxidation and other bad connections:

Good. Solder has "wet" the pin and board.

Solder hasn't "wet" the pin

Not wet to pin, not enough solder

Not wet to board. Probably no connection.

- See also:
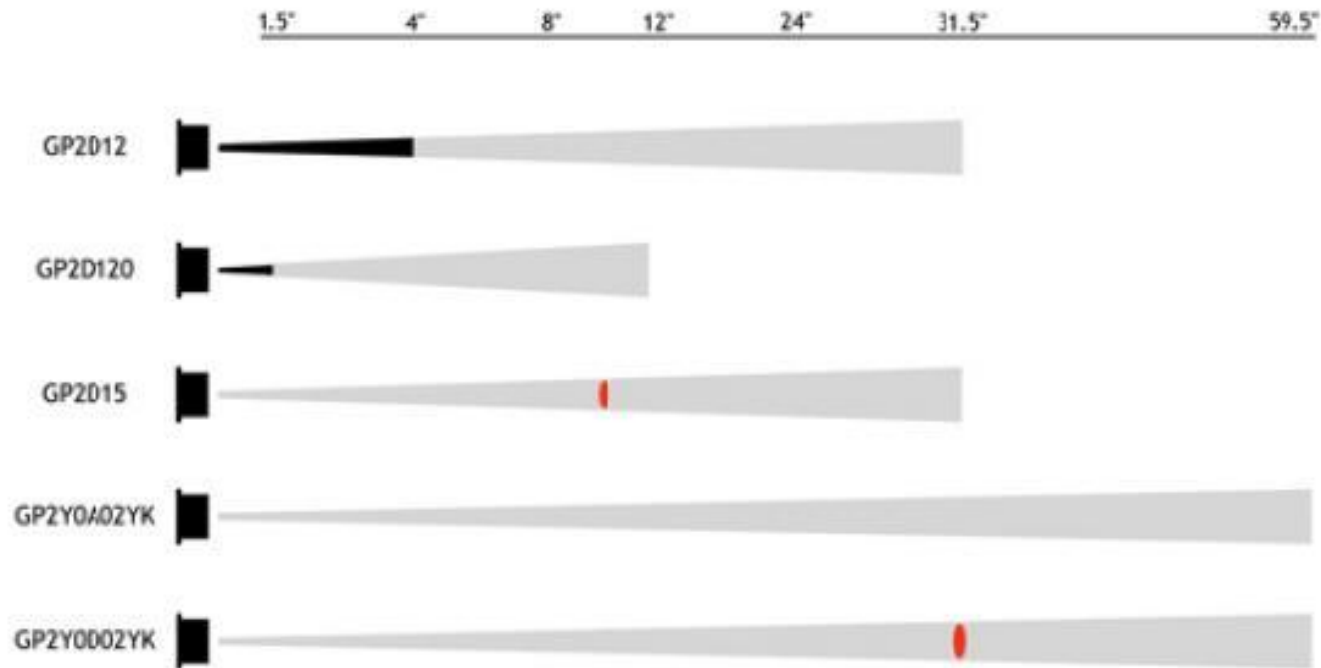 - http://www.sparkfun.com/commerce/tutorials.php

Infrared Sensors

- IR Sensors (λ = 850 ± 70 nm)
  - ◦ IR pulse is emitted
  - ◦ Lens transmits reflected light onto linear CCD array
  - ◦ Angle of reflected light gives barrier range
- Two types:
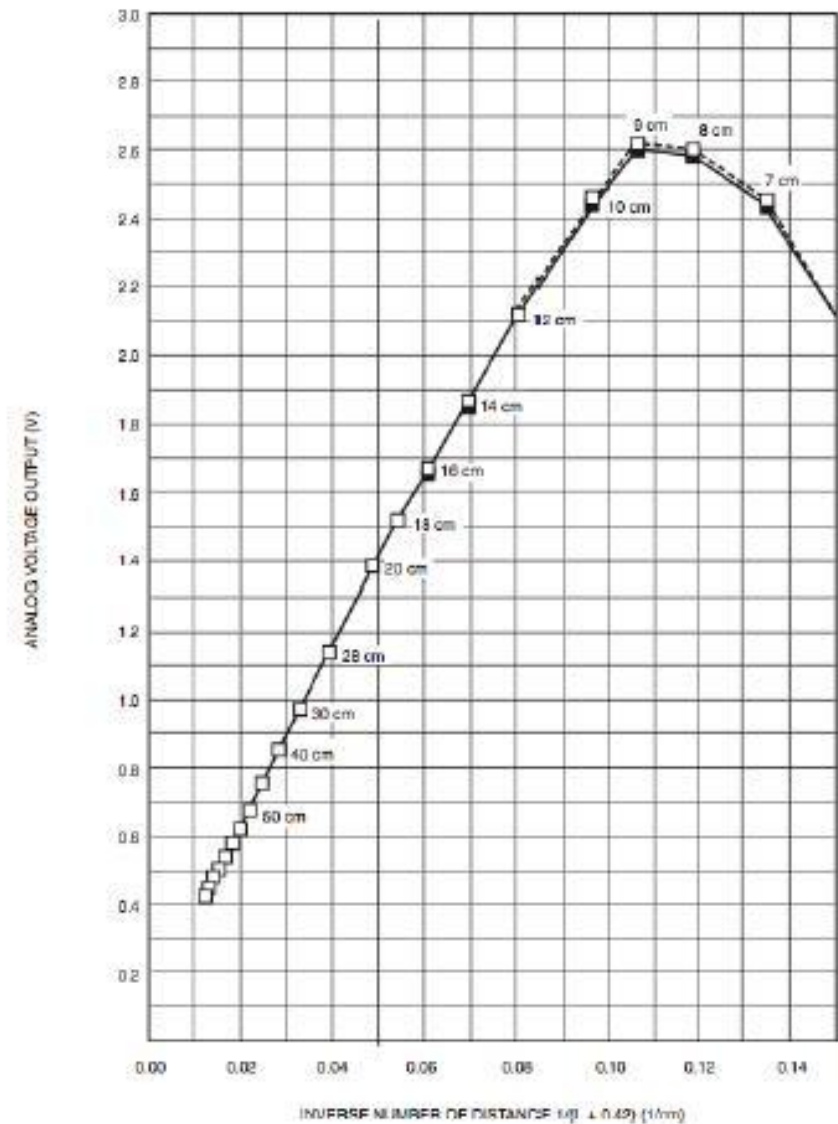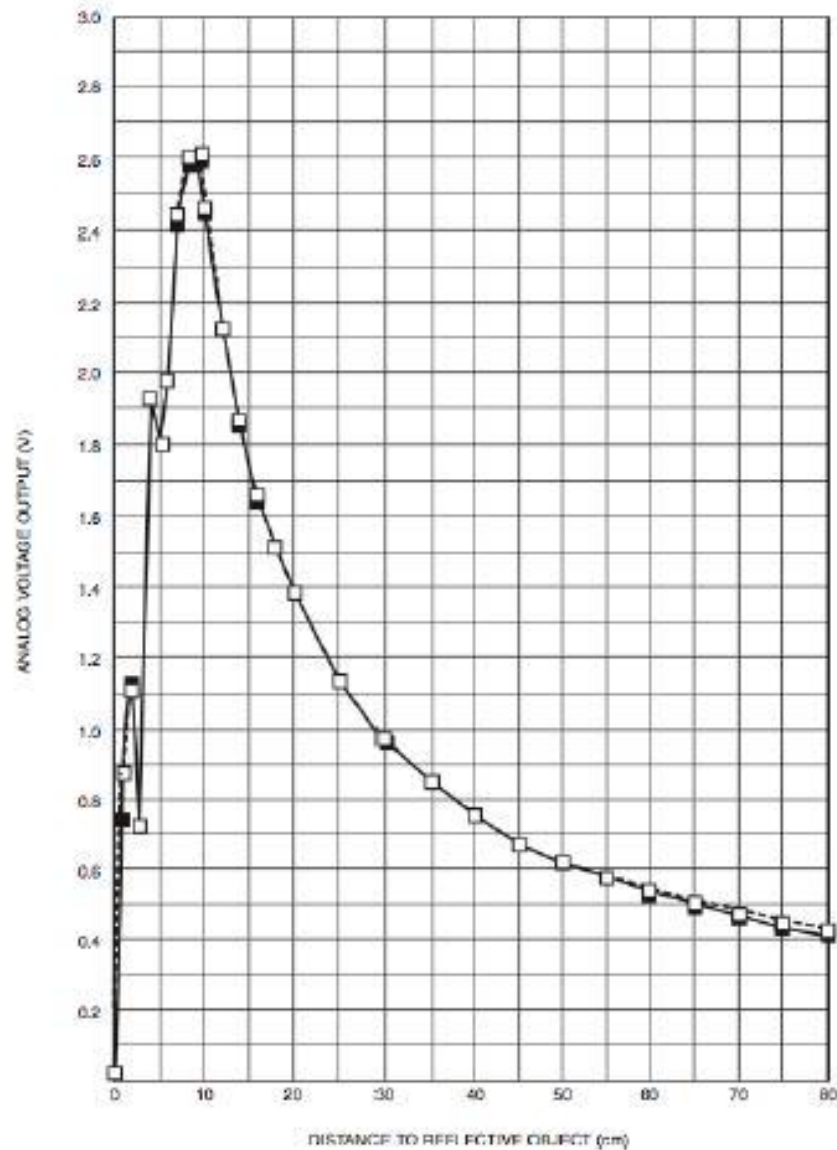 - ◦ GP2D12 (short range)
  - ◦ GP2Y0A02YK (long range)
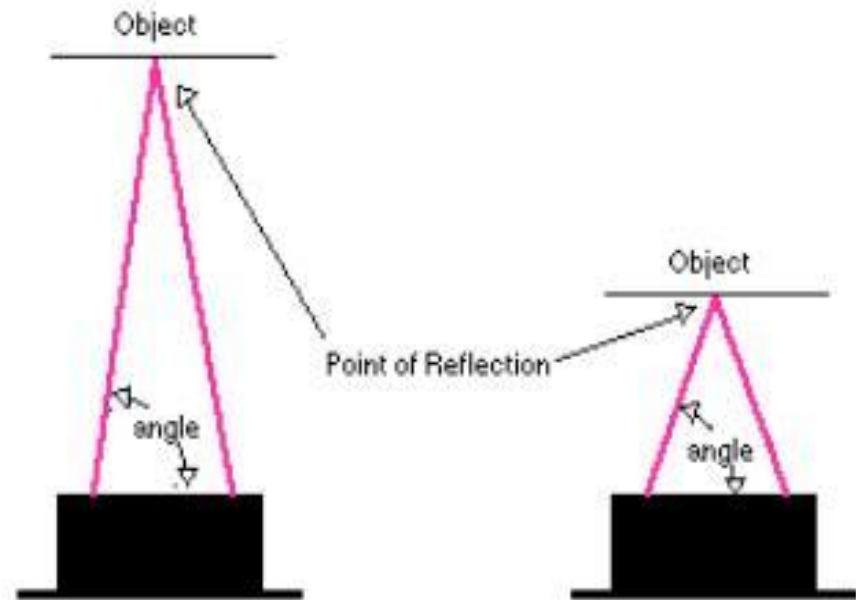
IR Cont'd

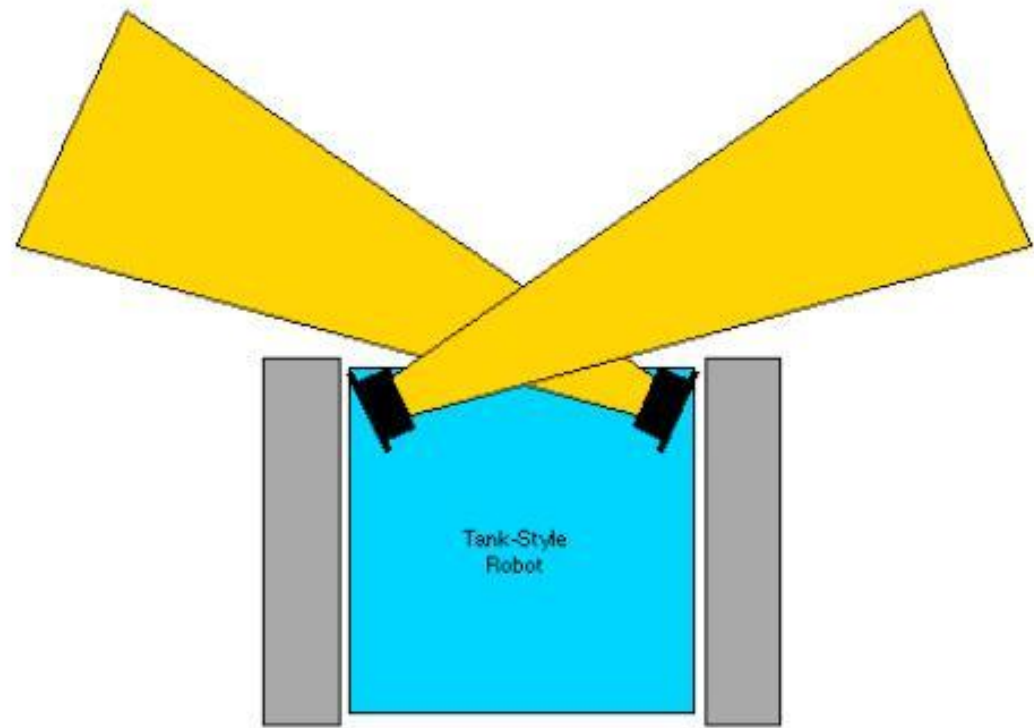- Non-linear response: Accuracy, Resolution, and Range
- Short readings look far away

IR Sample

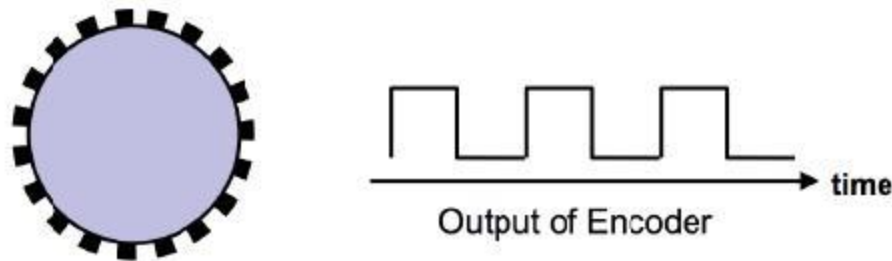# IR Beams

- Beam football-shaped, widest in the middle at 16 cm
- Wide beam pattern in front/sides of robot using servos

Tank-Style Robot

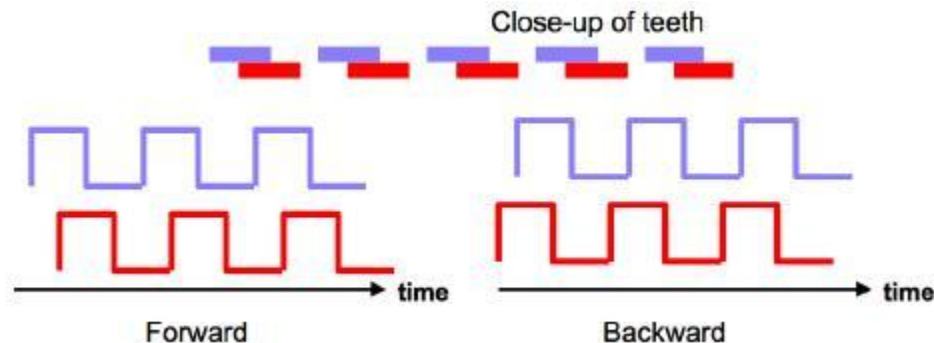# Optical Encoders

▸ Reflectivity sensor for a disc with black/white colored wedges

Output of Encoder

▸ Two single encoders: π/2 phase difference to distinguish forward/backward movement:
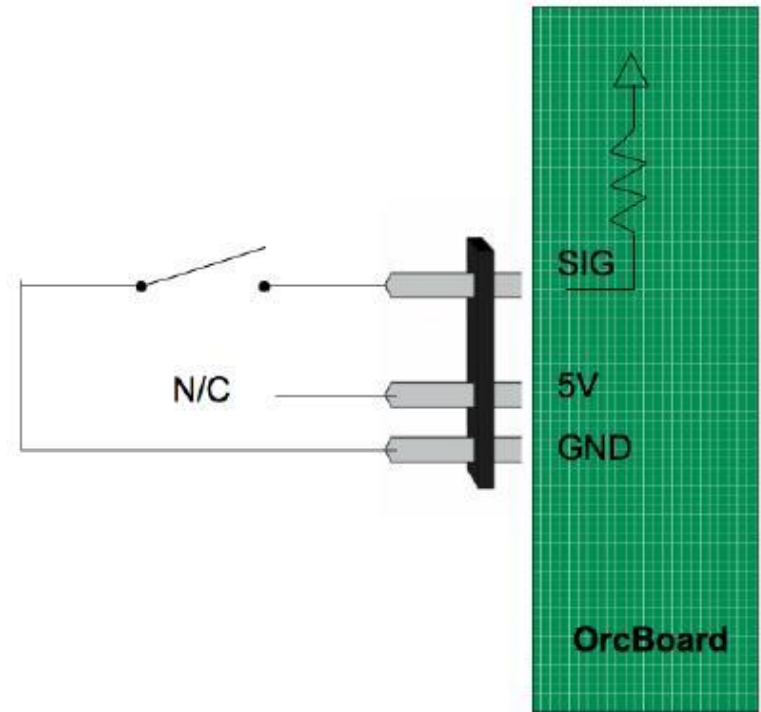

Close-up of teeth

Forward   Backward

Uses for Quad Phase Encoders

- Relative Positioning
- Velocity control and feedback (PID controller)
  - can be used to detect stalling
- Mapping and Odometry

Bump Sensors

- For reliable barrier detection
- Spring-loaded NES buttons
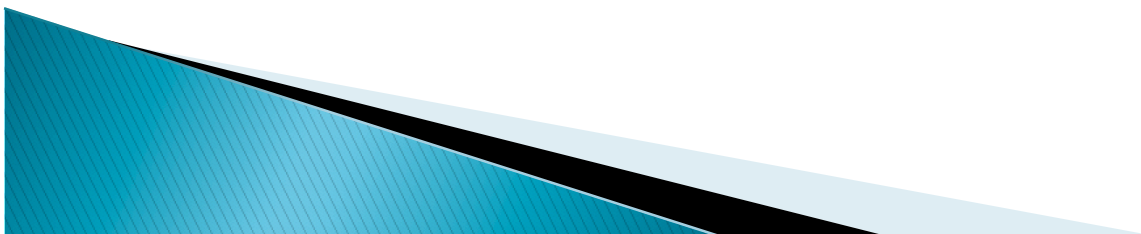- Fabricate your own whisker switches

Gyroscope

ADXRS300 and the board is manufactured by Intempco(http://www.intempco.ca/index.php3?country=can&language=en&content=products&section=motion), 0 to 5V output with 2.5V.

See the Orc Manual, section 4.3. You can either make a cable as shown there.
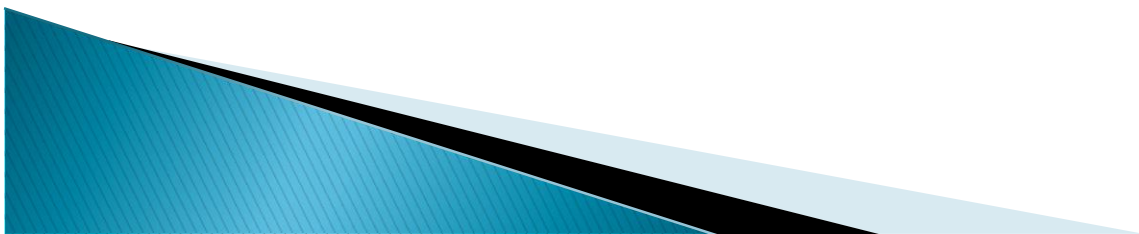
USB Mouse Hack

- Read PS/2 protocol from /dev/mouse0
- Java FileInputStream returns encoded (*dx,dy*) bytestream

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 1	Y overflow	X overflow	Y sign bit	X sign bit	Always 1	Middle Btn	Right Btn	Left Btn
Byte 2	X Movement							
Byte 3	Y Movement							

- See:
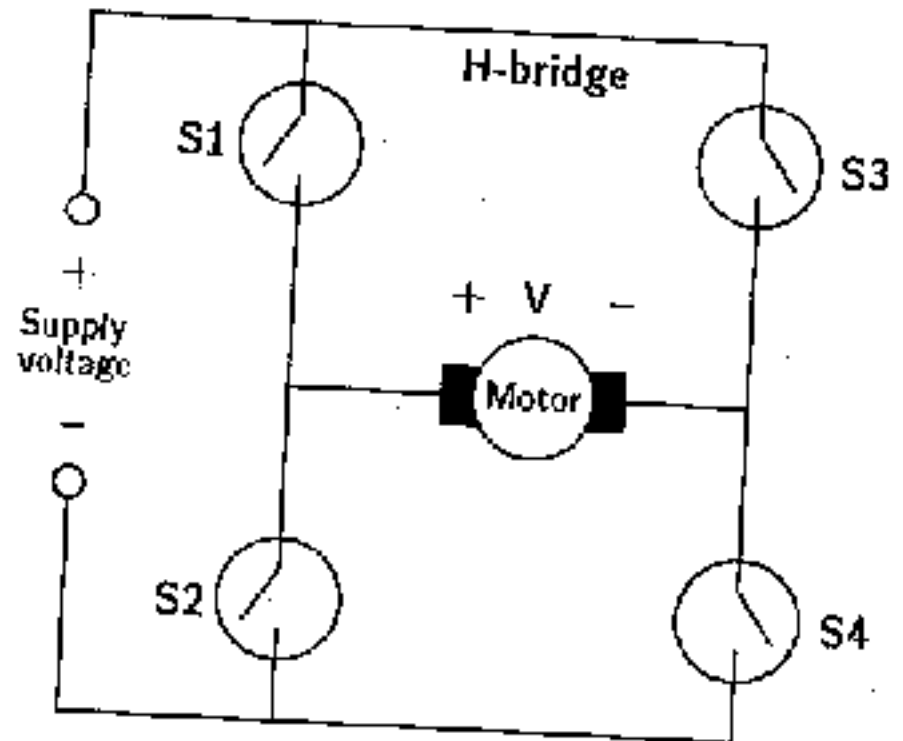 - http://www.computer-engineering.org/ps2mouse/

Other Useful Sensors

- Break beam sensor
  - Ball detection
- LED lighting
  - Useful for debugging
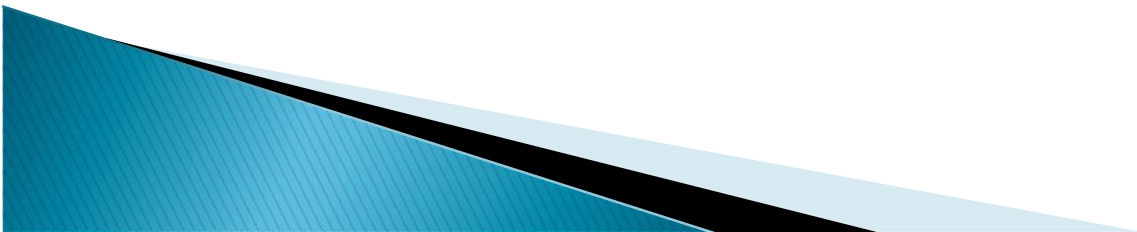
H-Bridges

- If you need to drive more than 4 high-current devices, use an H-Bridge.
- You will need to build or purchase these yourselves.

Reminders

- Start Early!!
- Pay attention to the size of your robot, camera calibration, and the limits of sensors
- Competition is timed, program accordingly
- Sensors can be noisy or fail completely, use them appropriately
- Use Athena/SVN repositories for backup control
- Read past journals/papers
- Ordering new parts?
  - http://www.allelectronics.com/
  - http://www.mcmaster.com/

Useful Things

- Difficulties with Java?
  - http://maslab.lcs.mit.edu/2004/lectures/javareference.txt
- uOrc's self-assigned IP Address is 192.168.237.7
- To connect the uOrc and eeePC:
  - sudo ifconfig eth0:1 192.168.237.7
- Updates are still being made to orc.jar:
  - Camera
  - DigitalInput, DigitalOutput