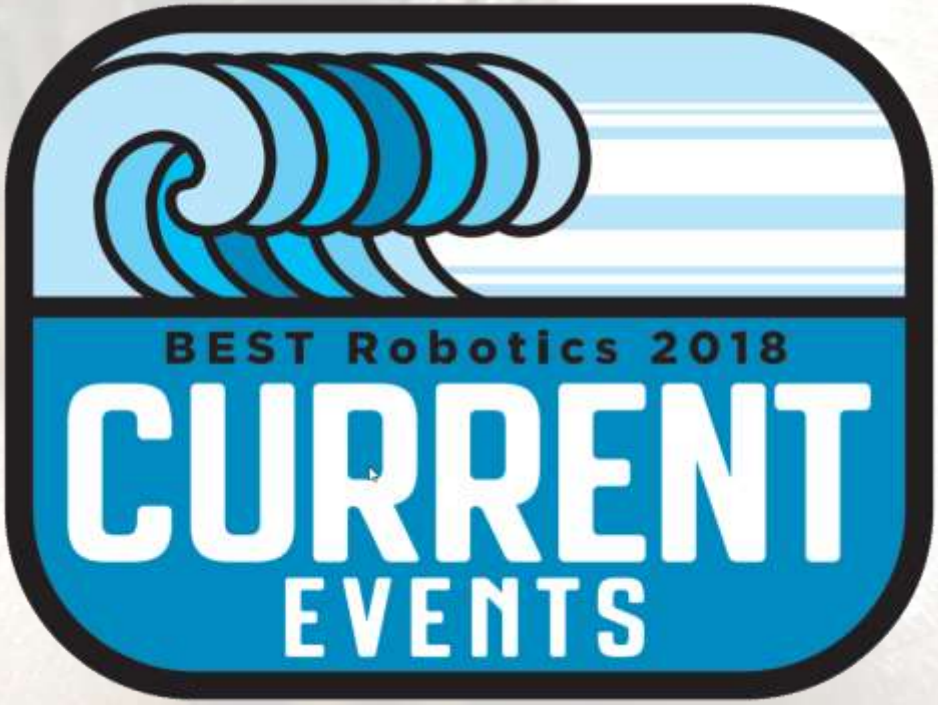
BEST Control System

BEST Robotic, Inc.



- New Cortex firmware
- VEXnet Key 2.0
  - White in color (**black** ones are **obsolete**)
  - VEXnet Key 2.0 keys and new firmware NOT COMPATIBLE with old keys and old firmware. **Can't mix and match!**
- Small motor has better gearbox, larger shaft
  - Small drive pulley now 1/4" instead of 3/16"
  - Again, **can't mix and match** with older kits
  - BE SURE GEARBOX SCREWS ARE TIGHT
- No 9-volt battery back-up battery connector

~~Return Kit~~

Servos

Joystick

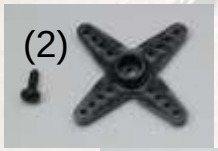
AAA Battery Charger

Servo Extensions

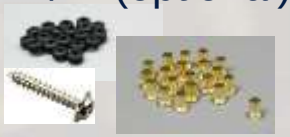
Servo Power Adaptor

Controller

Servo Horns



Servo Mounting H/W (optional)



(16)

USB A-A cable

~~Return Kit~~

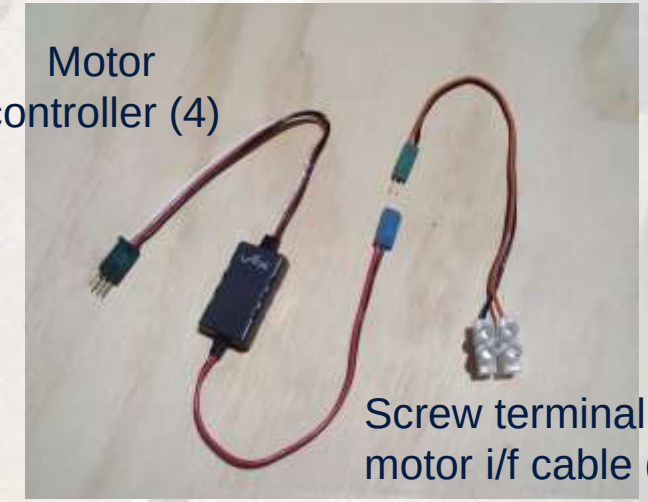
Motors

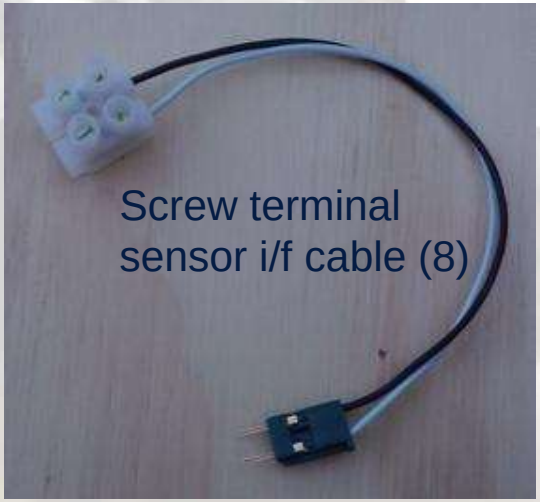
Drive components

7.2V Battery charger

Battery adapter

7.2V Battery





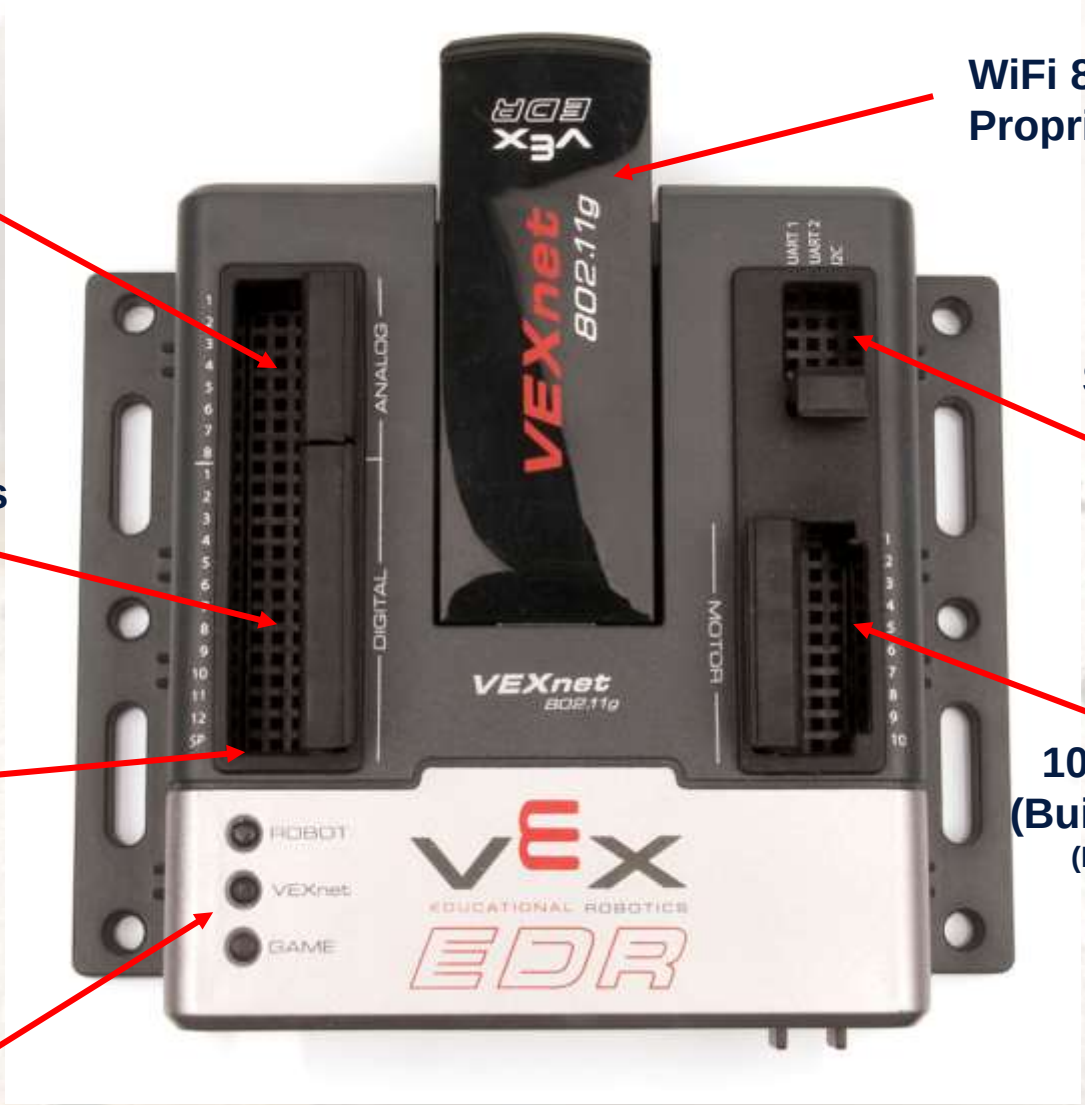
VEXnet Control System

- VEX Cortex microcontroller
- Dual ARM Cortex CPUs
- Programmable
- WiFi communications

- Gaming style controller
- Joysticks, buttons, accelerometers

Remove screw to access batteries

VEXnet Cortex M3 Controller



8 Analog inputs

12 Digital inputs or outputs

Speaker Output

System Status Indicators

WiFi 802.11g Proprietary Comm.

Standard Serial Interfaces (UART, I2C)

10 Motor/Servo Ports (Built-In ESC on 2 ports)
(Electronic Speed Control)

VEXnet Joystick

- "Playstation" game-style controller

8 buttons on top

2 XY analog joysticks

Plug-in USB/ WiFi Key

Power switch

6 AAA rechargeable batteries

4 buttons on front-side

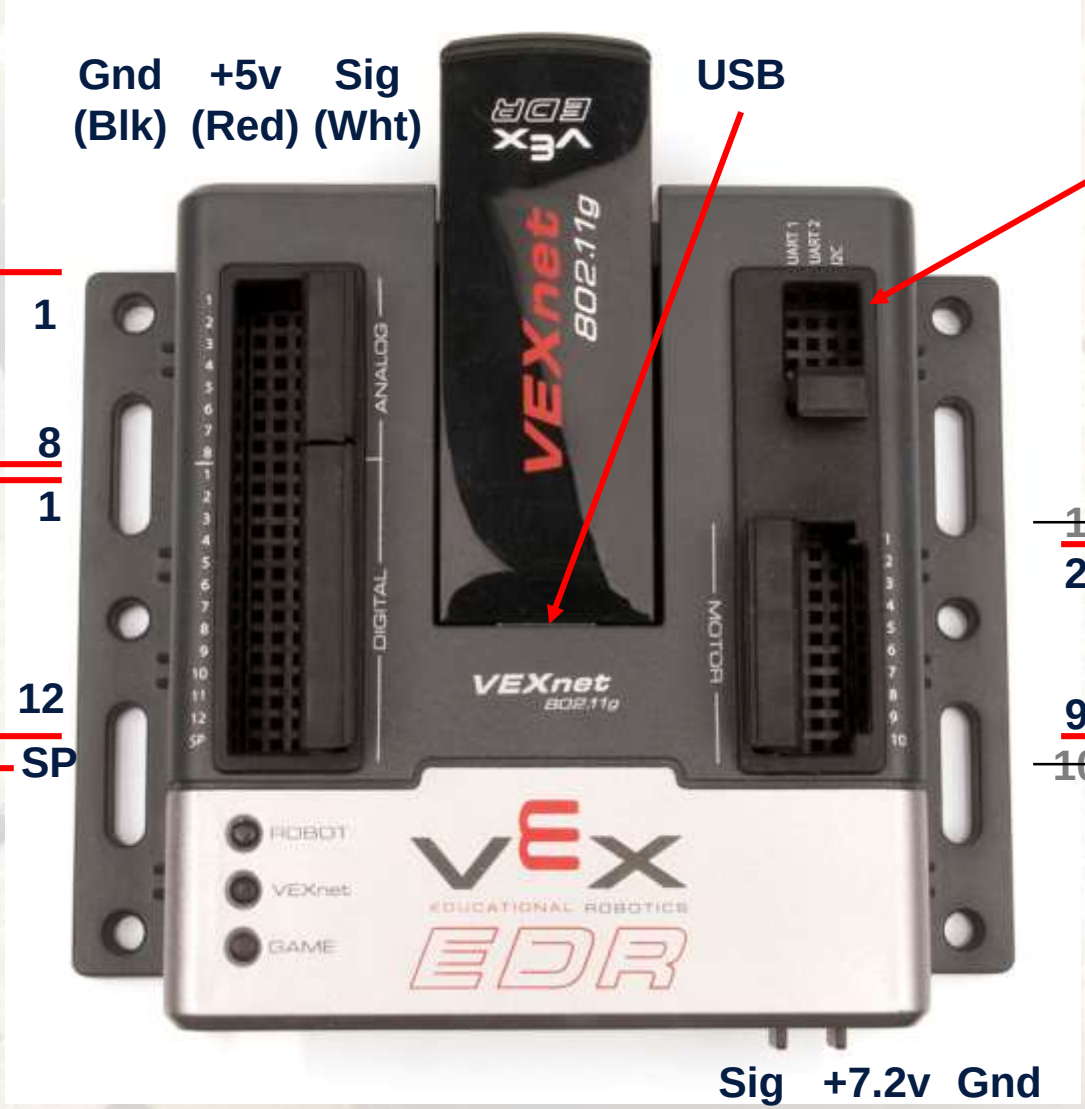
Programming Interface

2 Axis Accelerometer (X Tilt and Y Tilt)

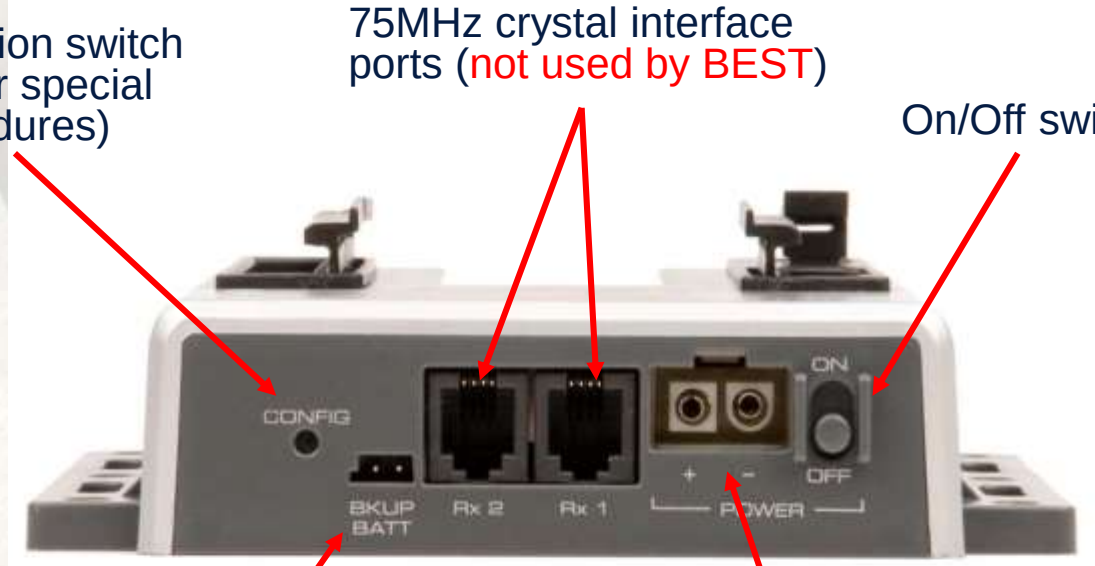
System Features

- Wireless communication using 802.11g
- Two 2-wire proportional motor control outputs (not used by BEST)
- Eight 3-wire PWM servo/motor outputs
- 12 discrete digital inputs/outputs + 1 speaker
- Wireless or direct USB port for program download
- Onboard power switch
- Built-in resettable fuse for overcurrent situations
- Powered by a single 7.2 volt RC hobby battery
- 9-volt backup battery for WiFi

VEX Cortex Connectors



VEX Cortex Connectors



VEX Cortex Pinouts

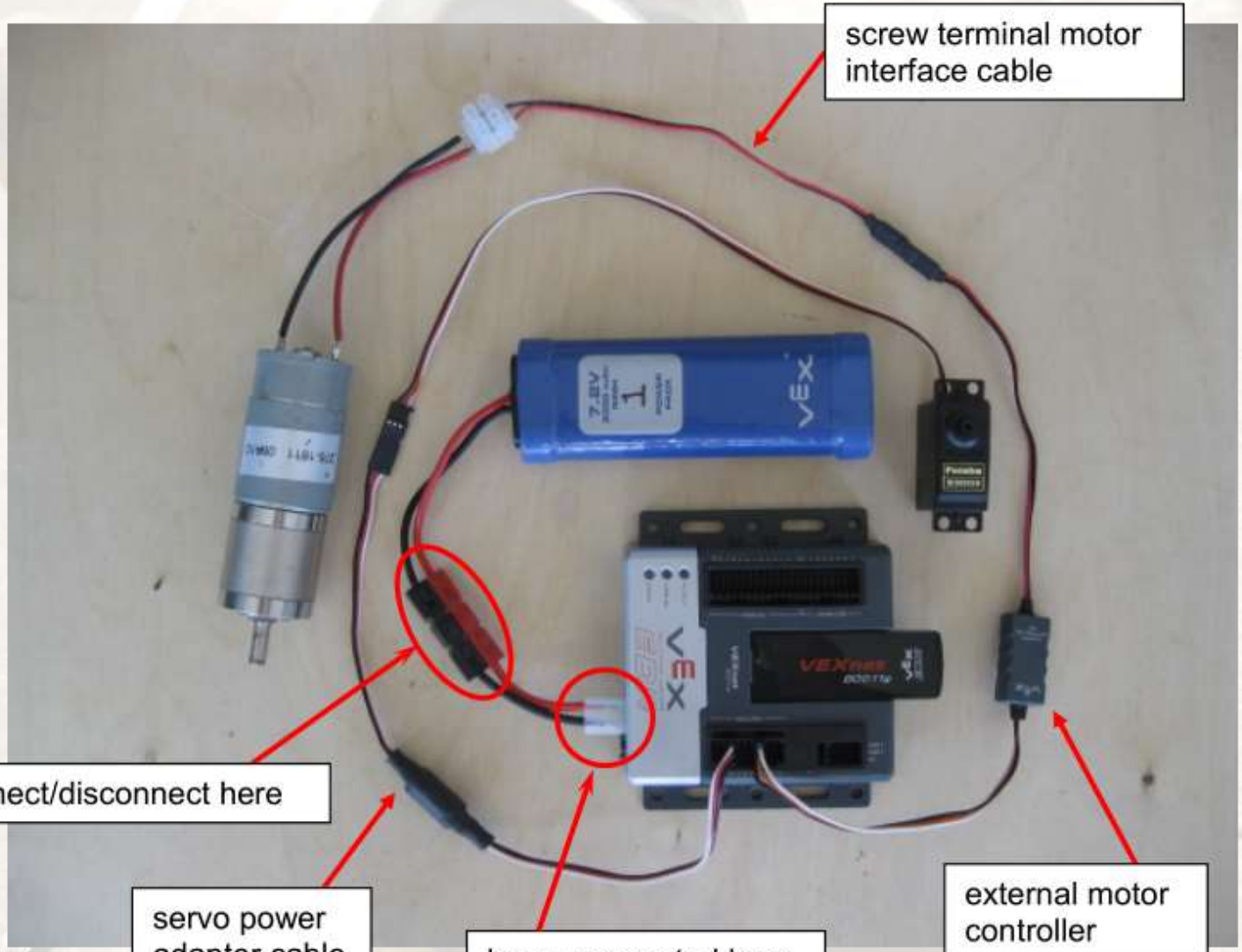
- Ground
- + 5V
- Signal/Control
- + Battery Power

- + Battery Power (for + control input)
- + Battery Power (for – control input)

DC Motors

- Use of **internal motor controllers** (motor ports 1 and 10) is **not allowed**
- External motor controller(s)
  - connect via 3-wire external motor controller plus the 2-wire screw terminal cable
  - use motor ports **2 thru 9 only**

Example Hookup



DC Motors

- Servo/motor ports are divided into **two banks**
  - Bank1 = Ports 1-5 (2-5 for BEST)
  - Bank2 = Ports 6-10 (6-9 for BEST)
- Each bank can support a max of 4 Amps of current
  - BEST large motor stall current can reach 3.5 Amps.
- For power reasons, spread your motors so that
  - no more than 2 motors are plugged into ports 2-5, and
  - no more than 2 motors are plugged into ports 6-9.
- You risk **overcurrent/shutdown** of the processor
- Sheet metal shield around the large motors IS needed and **should not be removed**

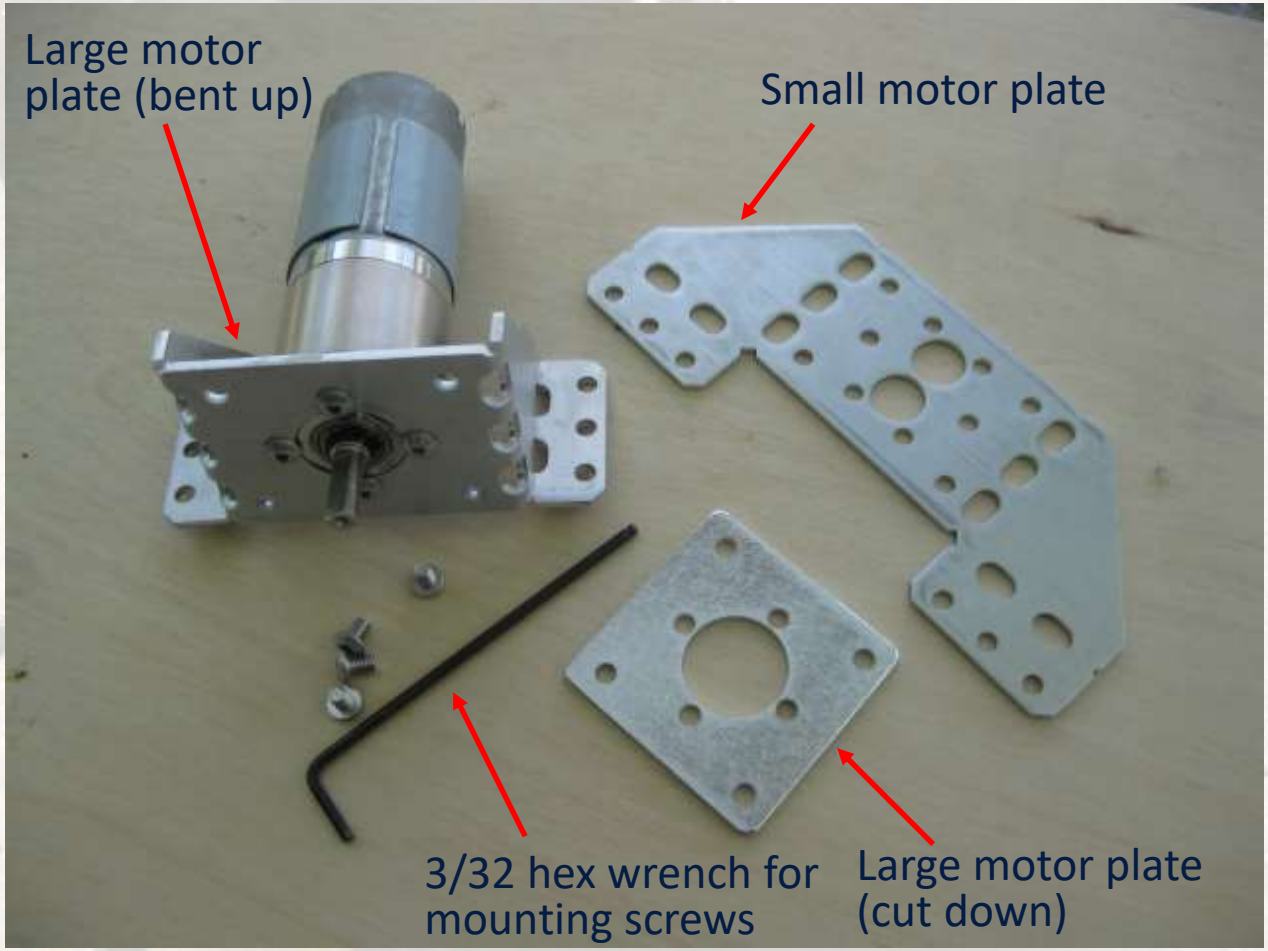
DC Motors

- Solder wires to motor terminals or with the optional quick-disconnect (spade) terminals
- Polarity is **NOT** marked on motors: positive(+), negative(-)
- Wiring (and programming) will determine clockwise or counter clockwise rotation for positive stick movement

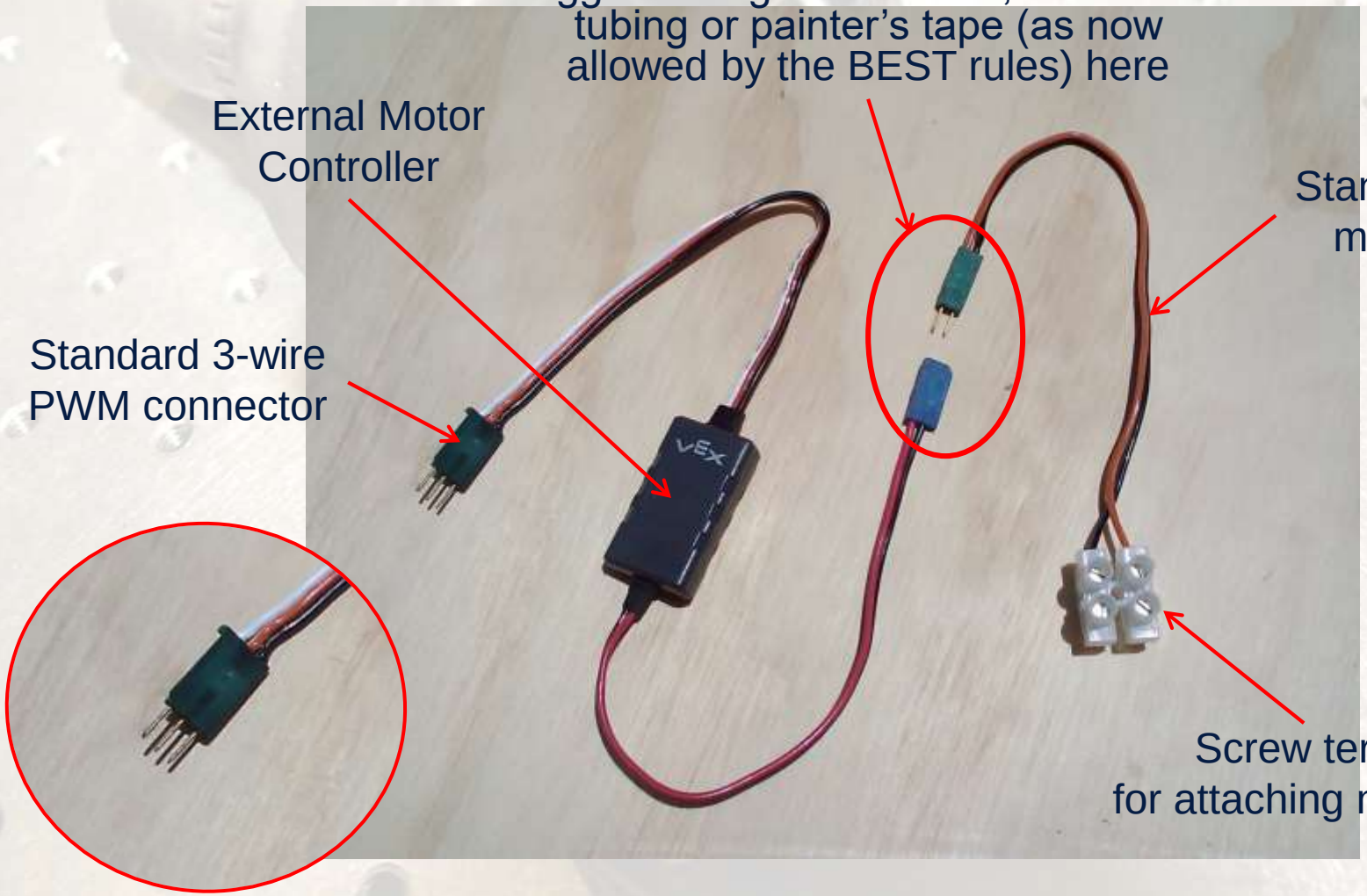
For Music City BEST, wires are **pre-soldered** and include **bullet** connectors

DC Motors

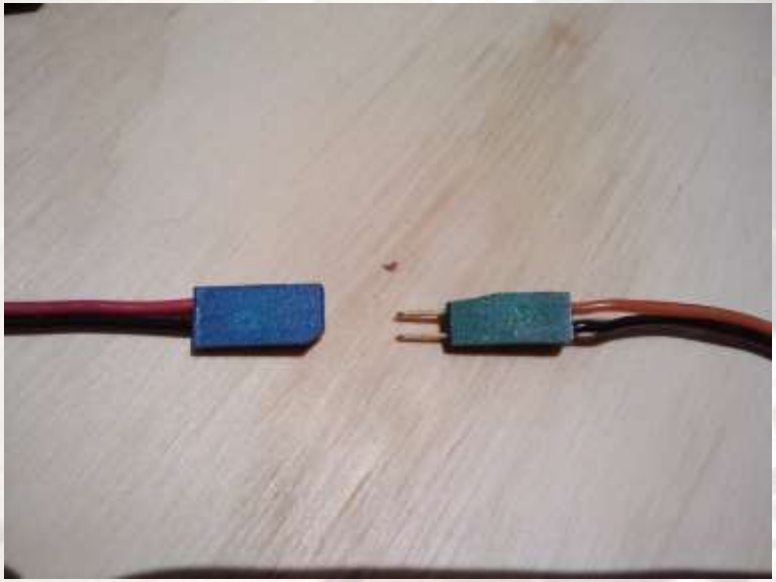
- Motors can be mounted with VEX Motor Mounting Kit provided in the consumables kit



3-Wire Motor Connection



3-Wire Motor Connection

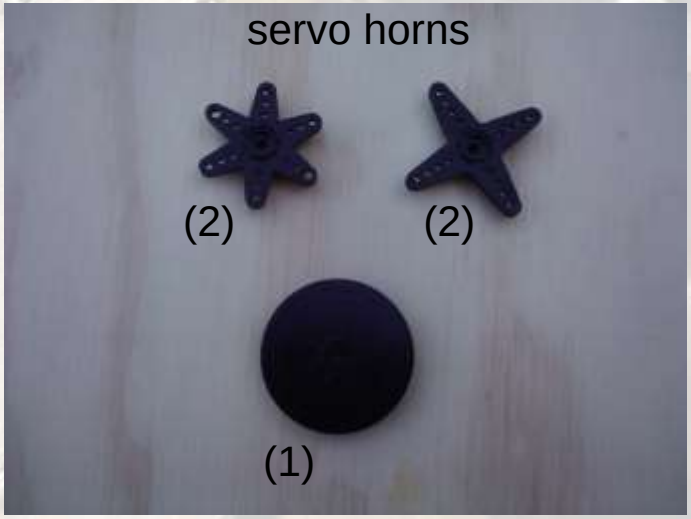


- Connectors are not keyed
- Connect red to red, black to black or reverse to change the motor response

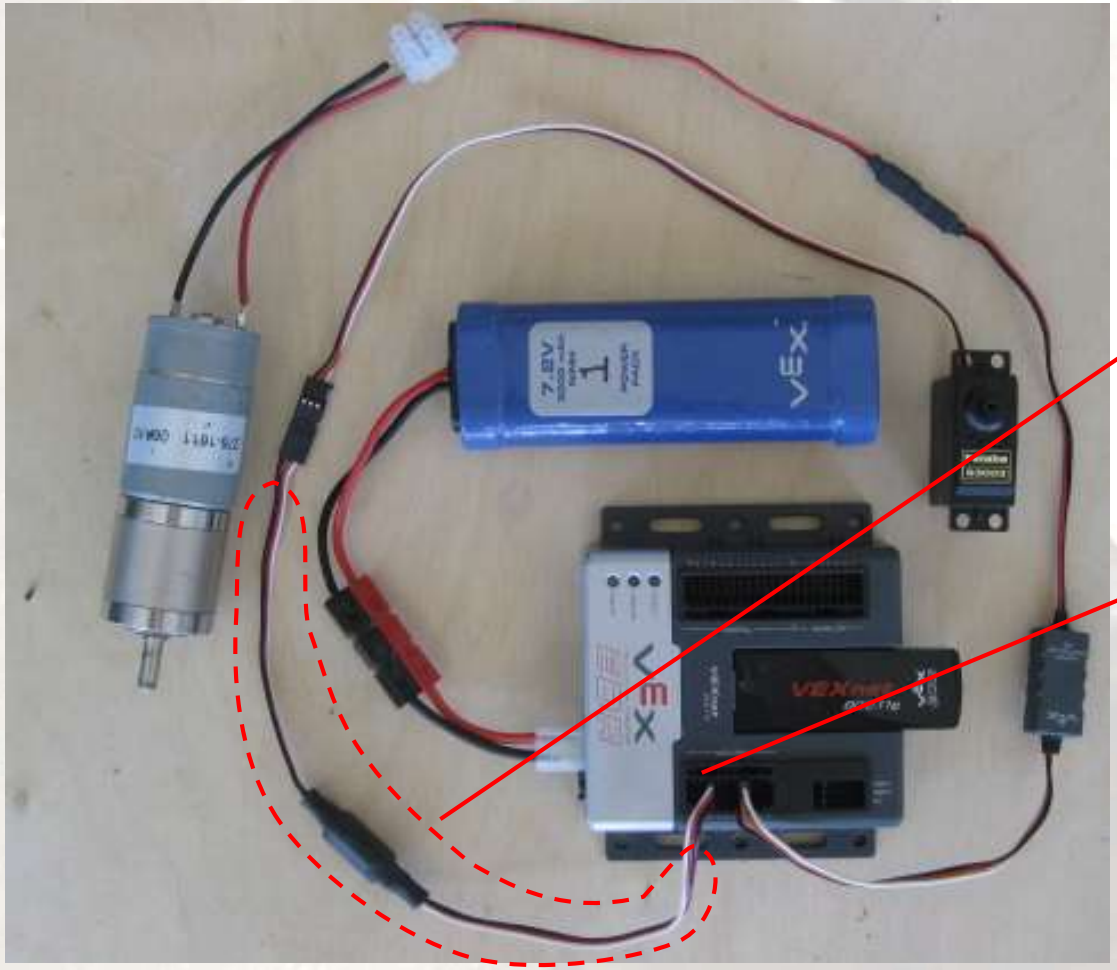
Servos

- Futaba S3003 or S3004 series
- Maximum 120 degree rotation (+60, -60)
- Connection to Cortex controller
  - via 3-wire PWM + Servo Power Adaptor
  - use motor ports 2 thru 9 only
- Servo horns may be modified

Servo Power Adaptors

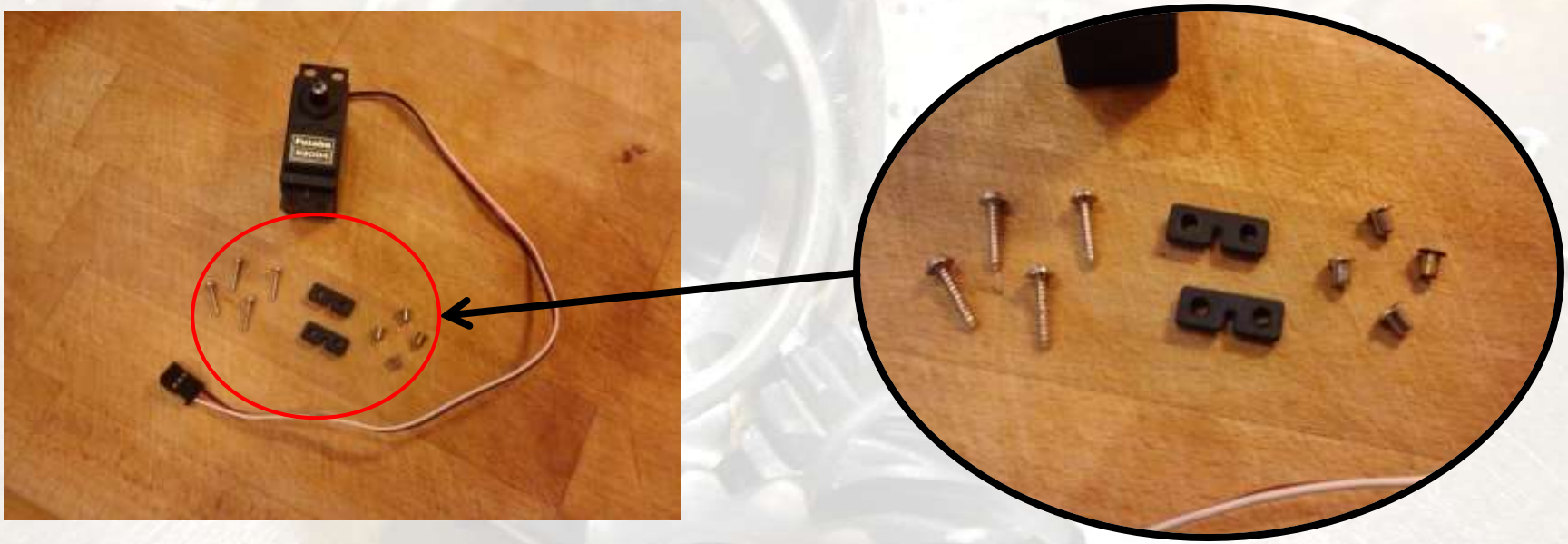


Connecting a Servo



- Connect a servo (or servo extension cable) to the **Servo Power Adaptor cable**
- Insert a Servo Power Adaptor cable into a **motor port** (2 through 9)

Servo Mounting with Optional Hardware



- Futaba 3003/3004 Servos
  - 4 per Kit
  - Mounting Hardware for each
  - To eliminate damage to mounting holes
- Servo Mounting Hardware
  - Rubber grommet (2)
  - Brass spacer (4)
  - Mounting screw (4)

Note: There are 16 of each screw, spacer, grommet in the Return Kit for BEST Hubs that provide servo mounting hardware.

Servo Mounting with Optional Hardware

1. No h/w attached

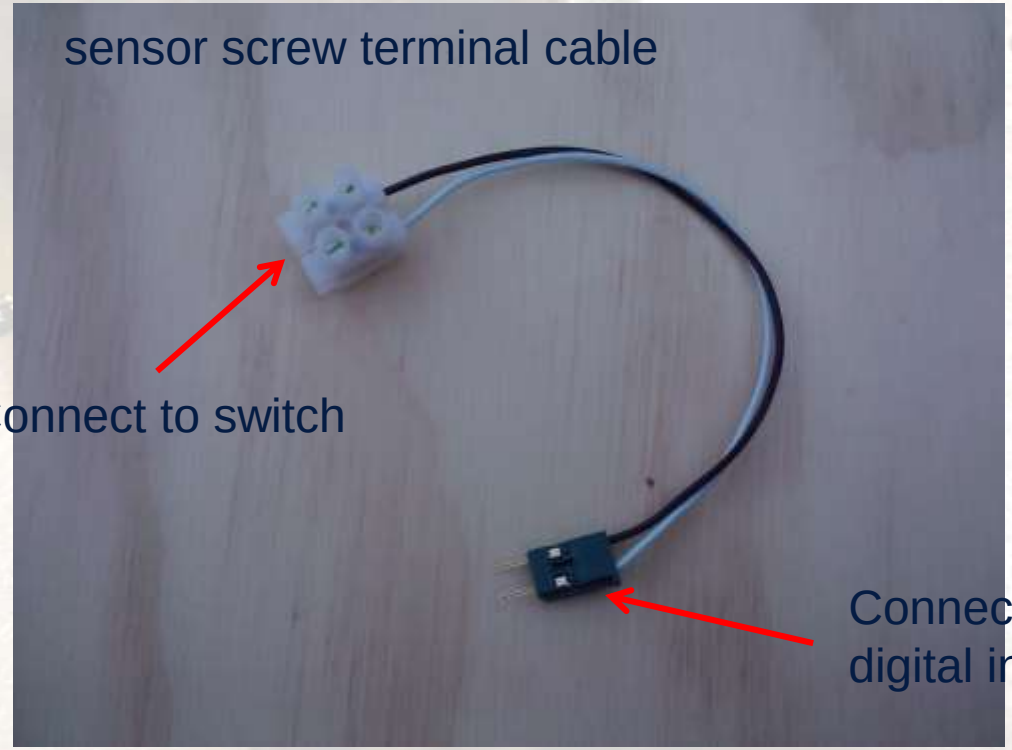
2. Attach rubber grommets

3. Insert brass spacers

4. Secure servo with screws

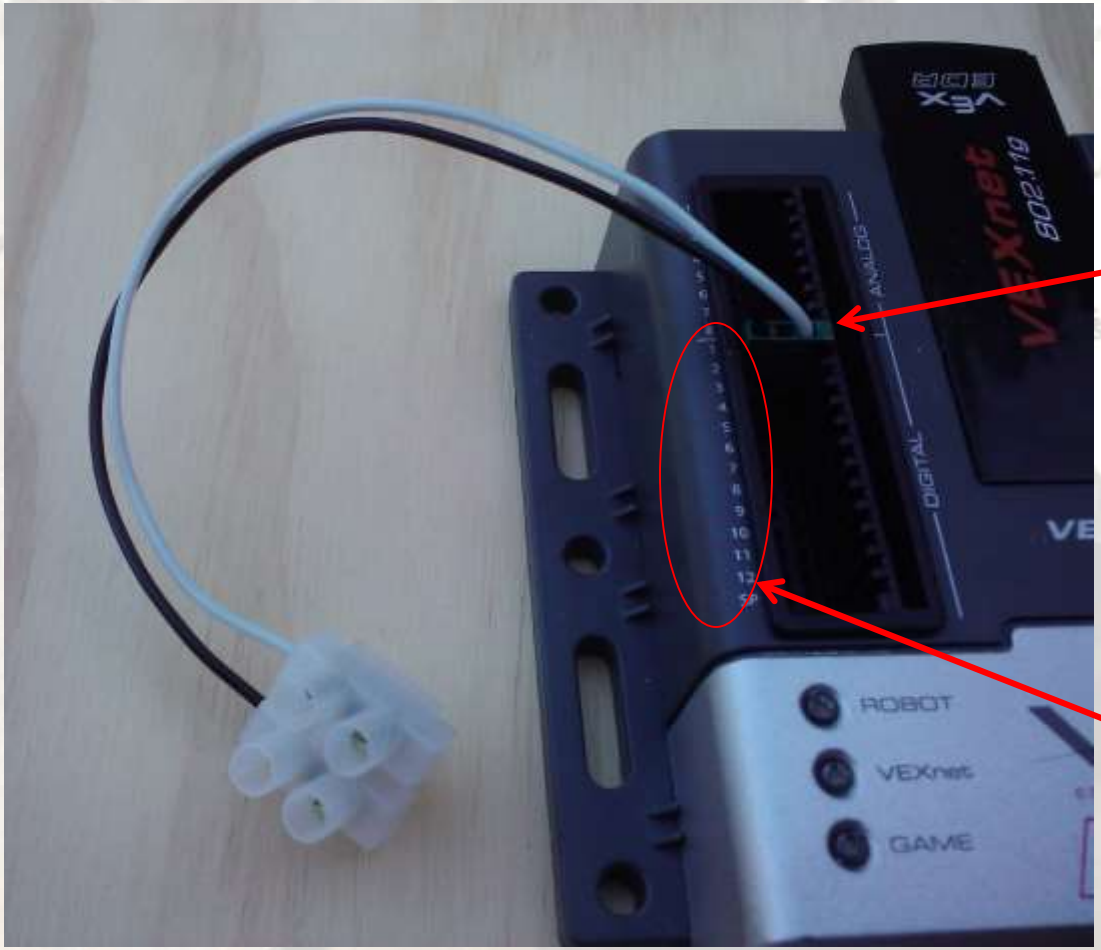
Digital Input Connections

- Use for limit switches, microswitches
- Connect to Cortex digital inputs using 2-wire sensor screw terminal cables (white/black wires)



Digital Input Connections

- must program digital port for proper direction (input)
- open = reads as ‘1’ ; closed = reads as ‘0’

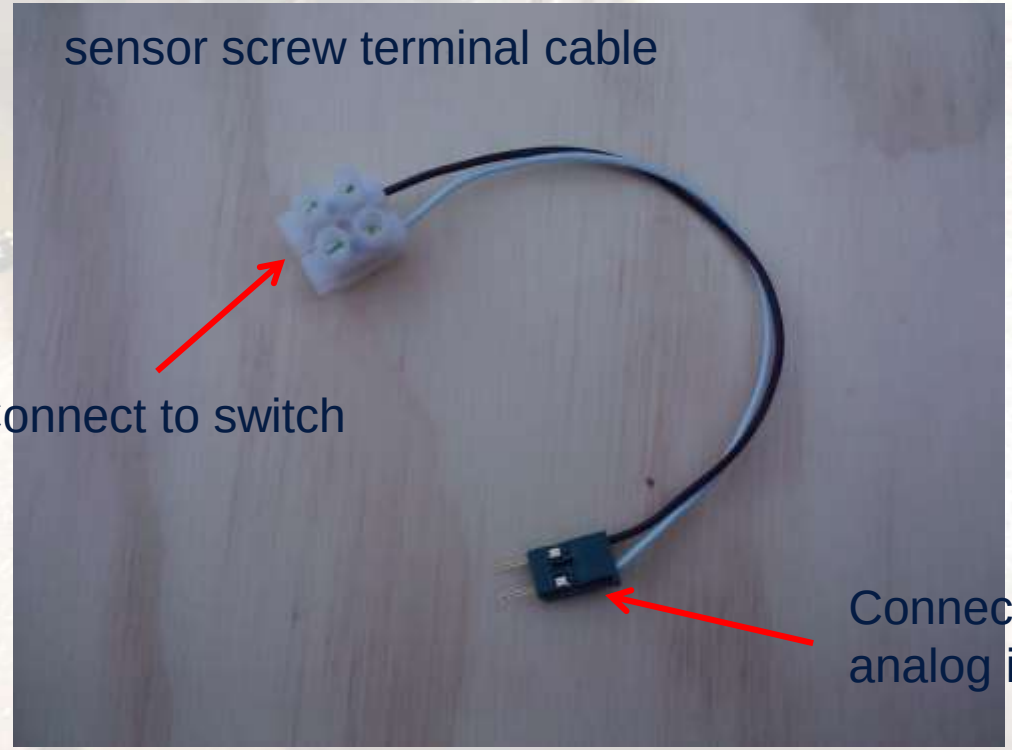


sensor cable connector is **keyed**

use digital ports 1 thru 12

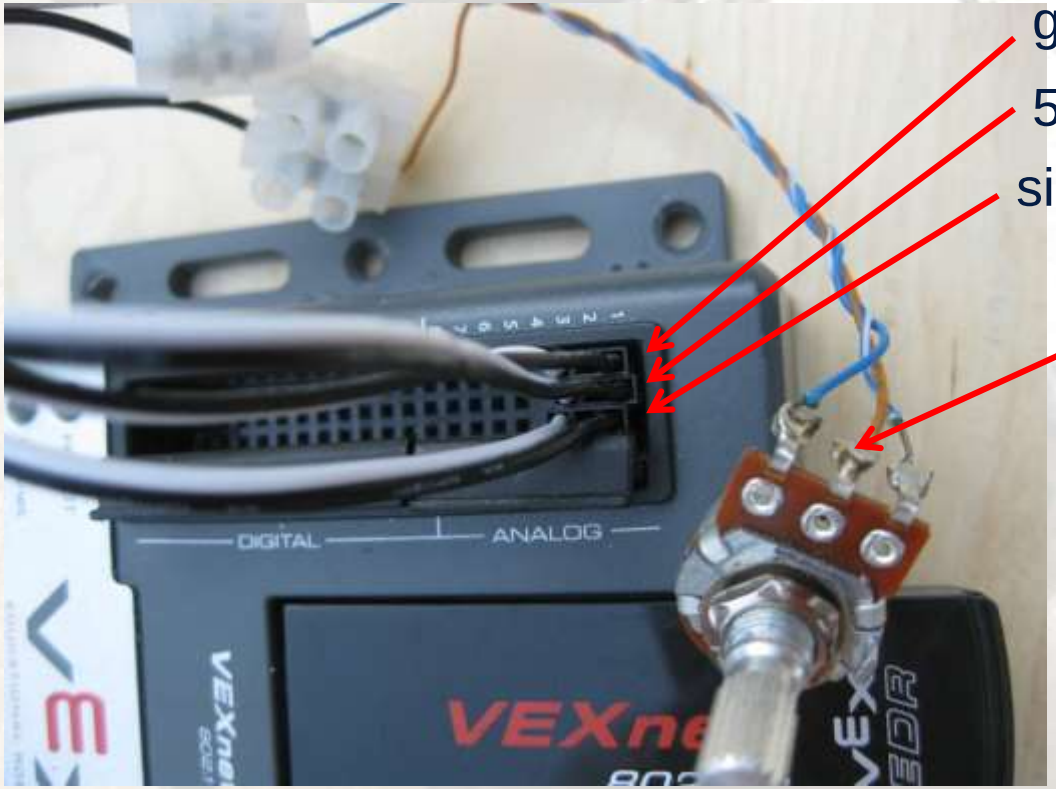
Analog Input Connections

- Use for potentiometers
- Connect to Cortex digital inputs using three of the 2-wire sensor screw terminal cables (white/black wires)
- Sensor cables must be plugged into the Cortex “sideways”



Analog Input Connections

- signal terminal of the potentiometer must be connected to the analog input signal port
- program will read a value of about zero with 0V applied (grounded) at the signal port and the maximum value (program dependent) when 5V is applied at the signal port



Re-Syncing (Pairing) VEXnet

If VEXnet does not connect, you may need to re-sync the joystick/controller pair by simply connecting a USB cable and powering on both units.

Out of the Box Configuration

- Allows a team to hook up the Cortex and have it work without having to program it.
- Referred to as the “BEST default” program.
- This is **NOT the only configuration** for the Cortex!
- Good for initial checkout, but we want teams to load a unique configuration.

BEST Default Program

Motor/Servo Port	Joystick Channel	Motor Limits	
		Positive Direction	Negative Direction
Motor 2 (pair opposite of Motor 9)	Stick 3	None	None
Motor 3	Stick 4	None	None
Motor 4 (pair opposite of Motor 7)	Button 7 and 8 Up/Down/Left/Right	None	None
Motor 5	Stick 1	Digital Input 1	Digital Input 2
Motor 6	Stick 2	Analog Input 1	Analog Input 1
Motor 7 (pair opposite of Motor 4)	Button 7 and 8 Up/Down/Left/Right	None	None
Motor 8	Button 6 Up	None	None
Motor 9 (pair opposite of Motor 2)	Stick 3	None	None

Three BEST Programming Options

- easyCv6: http://www.intelitekdownloads.com/easyCV6
  - A block programming environment (drag-and-drop elements)
  - Use link above, then select *"Download easyCV6 Version 6.0.3.0"*
  - Install the SW, select *"Run as Administrator"* and enter license key (the hub will provide your team with a valid key, good for 150 days)
- RobotC: https://www.vexrobotics.com/robotc-vexedr-vexiq.html
  - Textual programming in C, with single-step debugging (great!)
  - Use link above to create an account and log in
  - Go to https://www.vexrobotics.com/downloadable/customer/products/ and select *"ROBOTC for Vex Robotics 4.x download"* (license doesn't expire)
- MathWorks Simulink: http://www.mathworks.com/academia/best-robotics/
  - A graphical programming/modeling environment with simulation capability (visualize what your program will do before you download it to the Cortex)
  - Simulink training video available on Auburn BEST website, too

BEST Programming Options

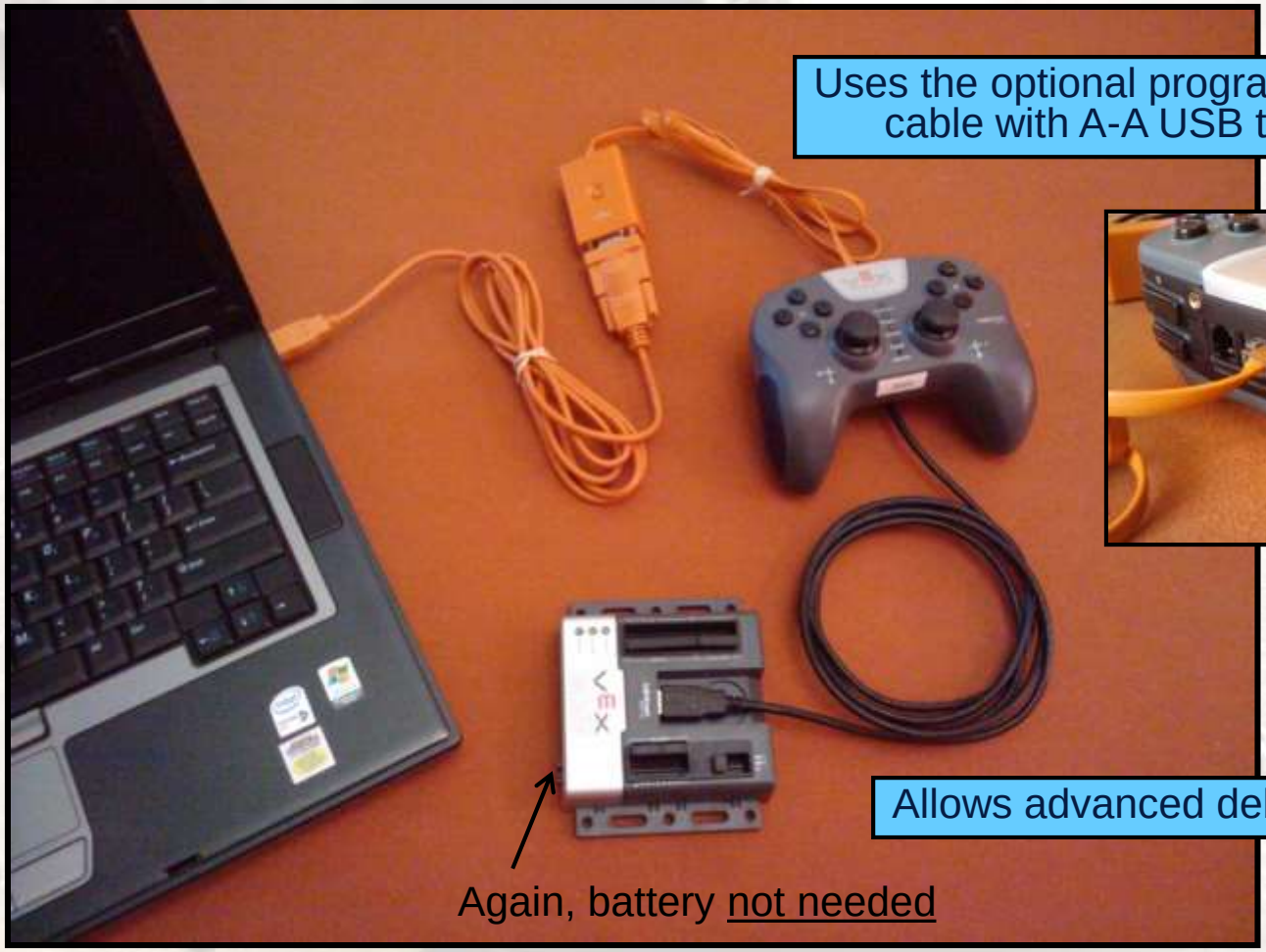
- Three different programming environments available
  - easyCv6 http://www.intelitekdownloads.com/easyCV6
  - RobotC http://www.robotc.net/download/cortex
  - MathWorks Simulink http://www.mathworks.com/academia/best-robotics/
    (Simulink training video available on Auburn BEST website, too)
- **easyC** is a block programming environment (drag and drop programming elements)
- **RobotC** programs in C with a text editor, but it has runtime debugging (can step through program line by line and see what the results are)
- **Simulink** is graphical programming/modeling environment with simulation capability (see what your program will do before you download it to the Cortex)

Downloading a Program

Option 1: Direct USB Download

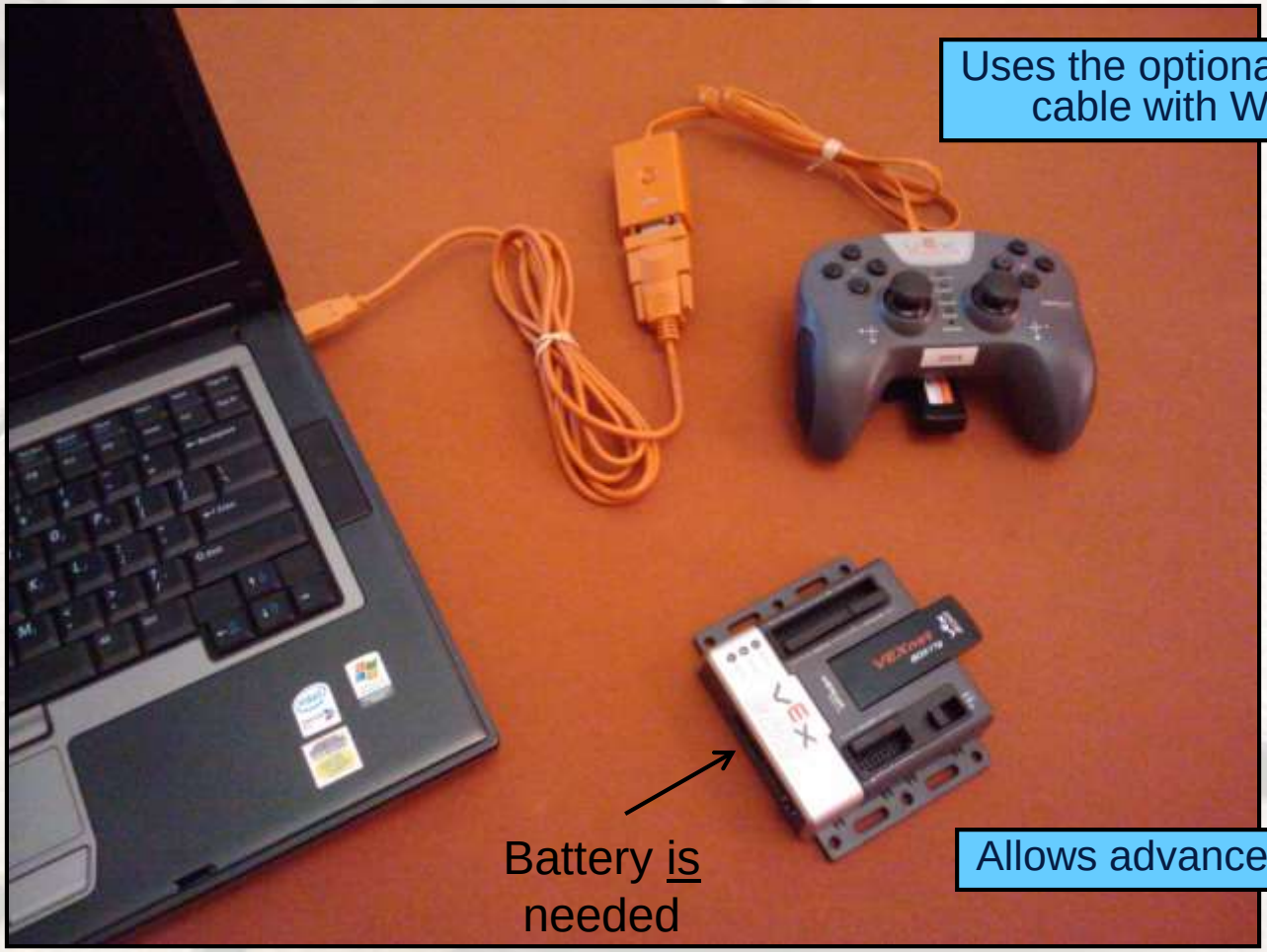
Downloading a Program

Option 2: Tethered Download



Downloading a Program

Option 3: Wireless Download



Testing Tips

- Ensure your robot is ‘safe’ to operate:
  - Can’t move or fall off table (use a jack-stand)
  - All team members clear of moving parts
- Connect either WiFi keys or tether cable between the joystick and the Cortex controller.
- Make sure Cortex switch is in OFF position.
- Attach a charged battery.
- Turn on joystick (if not using tether).
- Turn Cortex switch to on position.
- For WiFi comm, link should establish in ~10 sec
- Test robot operations with transmitter.

LED Status Lights

- Green battery – good charge
- Yellow battery - dying
- Red battery – dead

- Green VEXnet – comm. established
- Yellow VEXnet – searching
- Lights on the controller and the joystick are the same

Team Tips

- Tin motor wires with solder before attaching to screw terminals since frayed stranded wires can cause a short or use the optional quick-disconnect (spade) terminals.
- Do NOT solder wires to Cortex connectors!
- Sensor cables, servo power adapter cables and external motor controllers are all keyed in correct orientation; insert and remove carefully to avoid destroying connectors.
- Tighten screws on motor and sensor connector cables so that wires are not loose and do not pull out.
- Mount Cortex to robot using #8 screws through holes provided; be careful not to over tighten.
- Avoid “hot insertion” of USB Keys.
- You may operate tethered by removing the USB WiFi key and connecting a USB A-A cable between joystick and Cortex.

Joystick Calibration

- If the motors hum or creep (sticks not returning to zero), the joystick may need to be recalibrated
- Calibration procedure (as extracted from the easyC help file)

1) The Joystick must be "Linked" to the Cortex Microcontroller using the VEXnet Keys.
2) Hold the "6U" Back Switch depressed.
3) While the "6U" Back Switch is depressed, use a small Allen Wrench (1/16" or smaller) or similar small straight tool to depress and hold the CONFIG Switch.
4) Hold both Switches depressed until you see the Joystick LED Flash RED and GREEN - you can now release both Switches.
   a. There is a 10 second time limit to complete the following steps 5 and 6.
5) Now move both Joystick Pots to the maximum position desired in all 4 directions - Up, Back, Left, and Right.
   a. If a movement is not detected in all 4 directions, a timeout will occur after about 10 seconds and the Cal Mode will be discontinued and the VEXnet LED will briefly Flash Red.
   b. The Joystick LED will continue to Flash RED and GREEN during the calibration process.
6) After movement is detected in all 4 directions, the Joystick LED will be ON and Solid GREEN.
   a. To "Save" the Calibration, depress and release the "8U" Top Switch Button.
   b. If the calibration is accepted and Saved, the Joystick LED will start Flashing Fast GREEN for a few seconds.
   c. If the Calibration is not Saved, a timeout will occur after about 10 seconds and the Cal Mode will be discontinued and the VEXnet LED will briefly Flash Red.
   d. To cancel a calibration, depress and release the "7U" Top Switch Button. The Cal Mode will be discontinued and the VEXnet LED will briefly Flash Red.
   e. If the Cal Mode is discontinued or saved, the Joystick LEDs will resume their normal function after the VEXnet LED briefly Flashes.

Where to find help?

- Music City Best game wiki (https://cps-vo.org/group/MCBEST/wiki)
  - Lots of relevant info! (will be live by kick-off day)
- Online resources/documentation (BRI Site)
  - http://best.eng.auburn.edu/b_resources1.php
- BEST Public Message Board (http://forums.bestinc.org)
  - Must register for login account
  - Share ideas, resolve issues, …
- Official Q&A "Control System" Category
  - http://best.eng.auburn.edu/cgi-bin/bestqna.pl
  - Use "Official Q&A" page during contest for "rules specific" questions
  - e.g. *"Is this legal?"*
- VEX Forum
  - http://www.vexforum.com/forum.php
  - Technical questions about VEX equipment
  - easyC and RobotC dedicated forums included here