

# Care and Feeding of Your SA BEST Kit Parts

15 September 2018

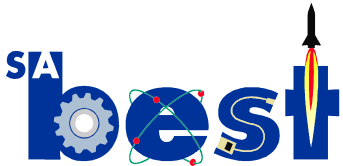
[www.sabest.org](http://www.sabest.org)

# What we will cover

---

- SA BEST Kit Hardware
- Basic control system wiring
- How NOT to destroy the parts we re-use each year
- (preloaded) BEST default code description

**NOTE: *there is NO software or programming instruction in this presentation.***



# What is in the Kit?

---

- **Return Kit (RK)**

(parts we need back to use again next year)

- Robot control system
- Batteries & chargers
- Cool drive components & sensors

- **Consumables Kit (CK)**

(parts you can use up or otherwise destroy at your option)

- Plywood, plastic sheet, metal sheet, PVC pipe & fittings
- Hardwood, metal bar/rods/conduit, wood dowel, allthread
- Metal brackets, screws, nuts, zip-ties, Velcro, glue, tape
- Brake cable, inner tube, string, rubber bands

–

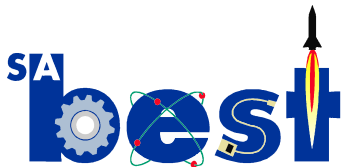
...and more!



# Don't Forget these CK parts!

- Approved Optional Items (provided by team)

Qty	Item Description
10 ea	wooden spring type clothes pins
2400 sq in	corrugated cardboard, 1/4" maximum thickness
2 ea	empty food/beverage PETE container with screw on cap/lid (2 liter max.) <sup>2</sup>
3 ea	wire coat hangers with or without plastic coating, 1/8" dia. max.
3 ea	solid core golf balls
1 ea	5 minute epoxy, 0.85 oz
3 ea	~10oz empty metal soup can with lid removed
24 lb	pennies (cannot be altered; bank wrappers allowed)
1 ea	8 oz. PVC primer
36 ea	craft "Popsicle" sticks (maximum dimensions; 4.75" long, 0.44" wide, 0.10" thick)
1 ea	aluminum paint grid for 5 gallon bucket
4 ea	CD or DVD disk (standard size: 120mm diameter x 1.2 mm thick)
25 ea	deck or drywall screws; 2-1/2" maximum length
25 ea	wire management clips/ties/wraps (can only be used on wiring)
2 ea	Team Custom Part <sup>3</sup>



# This is Your Control System



Joystick

WiFi key    USB/Tether



Analog

Digital I/O

Serial

Motors/  
Servos

Battery

Cortex Controller



Motor (2 each size)



Programming Cable



USB A-A cable



Servo (4)



Sensor Input  
(2 wire) Cable (4)



Servo Buffer (4)  
(servo power adapter cable)



Sensor Input  
(3 wire) Cable (4)

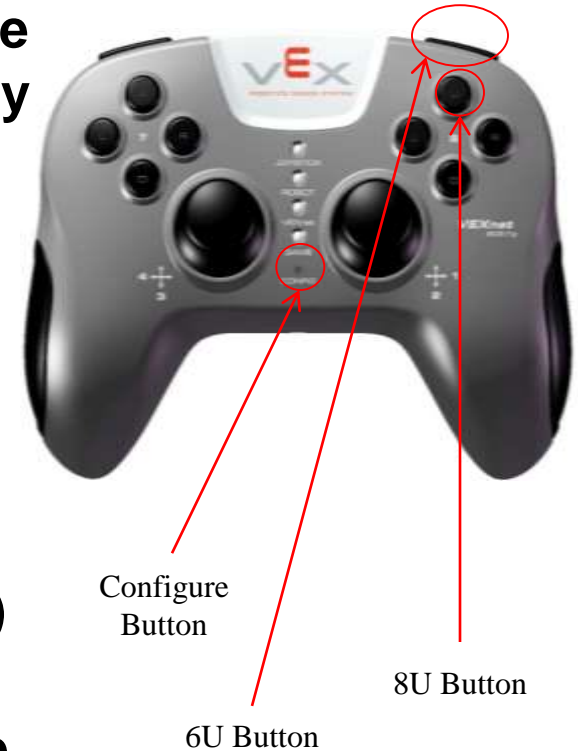


Motor Controller  
and Motor Cable (4)

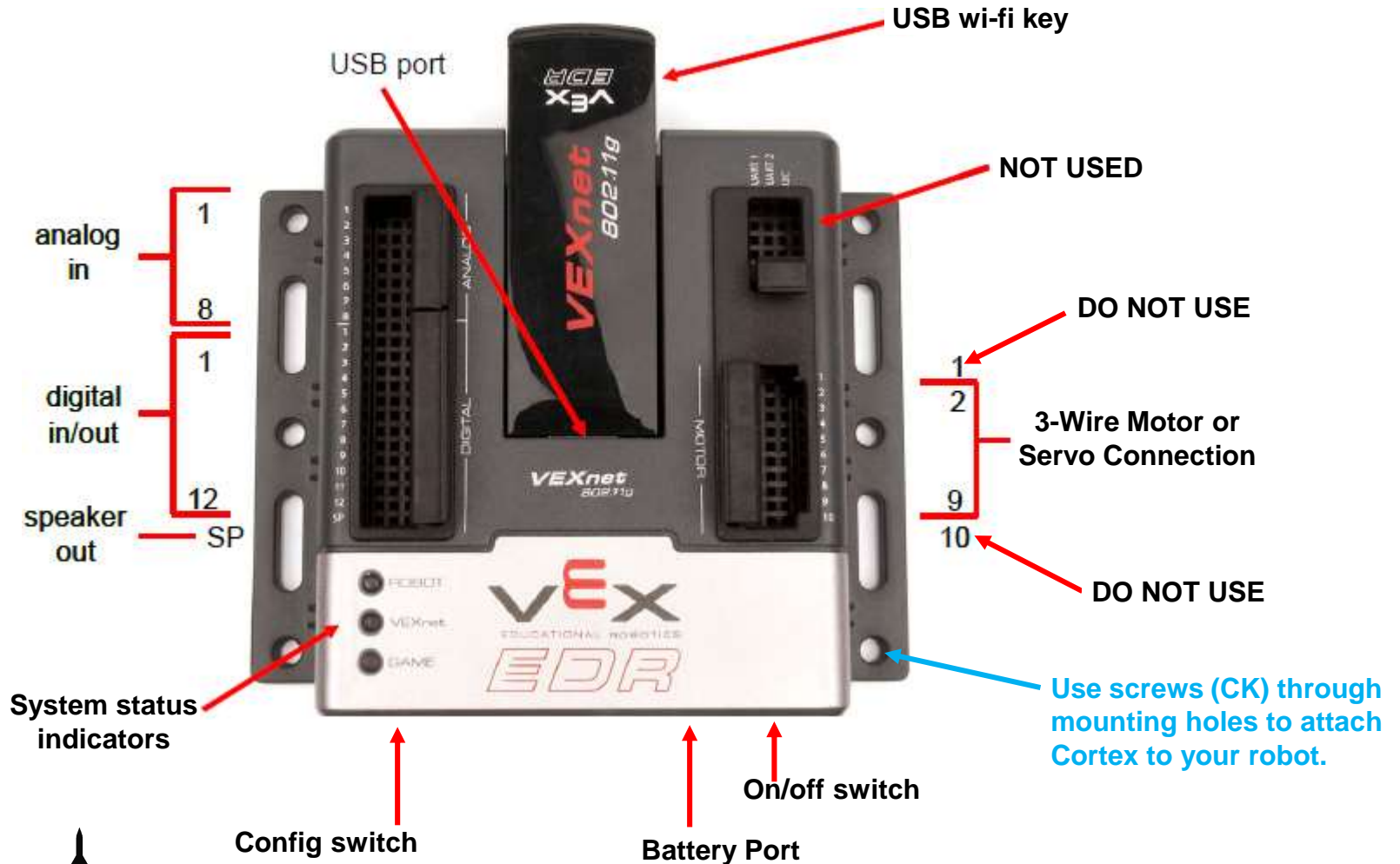


# Joystick

- **The Joystick can use either the Rechargeable AAA batteries from you RK or you can supply regular Alkaline ones.**
  - Don't mix battery types!
  - You don't need batteries if you are running in a tethered configuration.
- **You may need to Calibrate your Joystick**
  - See instructions in your "Important Info" Booklet.
- **You will probably need to "Pair" your Joystick & Cortex (maybe more than once...)**
  - See instructions in your "Important Info" Booklet.
- **The lights on the Joystick (and Cortex!) have meaning.**
  - Reference the "Troubleshooting" info in your "Important Info" Booklet.



# Cortex



# Wired vs. Wireless Control

- **Wired: reliable & easy**
  - Joystick, USB A-A cable, Cortex, Battery
  - Works even with no batteries in Joystick (and Joystick *off*)
  - No “pairing” required
  - Always use to troubleshoot
- **Wireless: freedom!**
  - Joystick, 2x USB keys, Cortex Battery
  - Must have (charged) batteries in Joystick
  - Will probably require “pairing” the first time





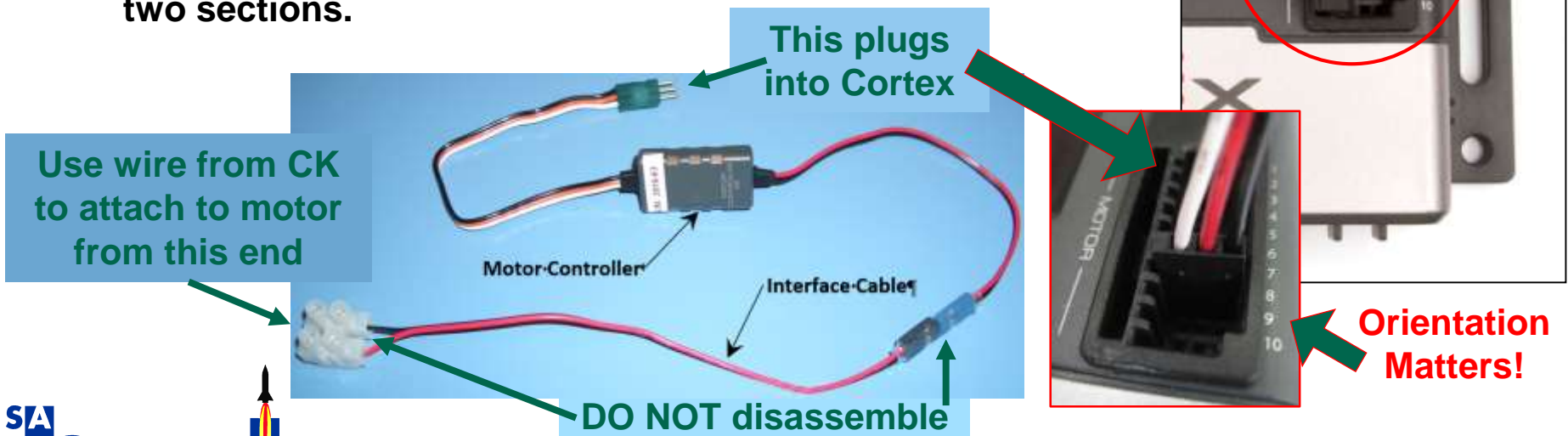
# Using Motors

- **Cortex motor connection**
- **Motor Controller Assy**
- **Motor Attachment**
  - **Wiring the Motor**
  - **Attaching to the Motor shaft**
  - **Attaching motor to the Robot**



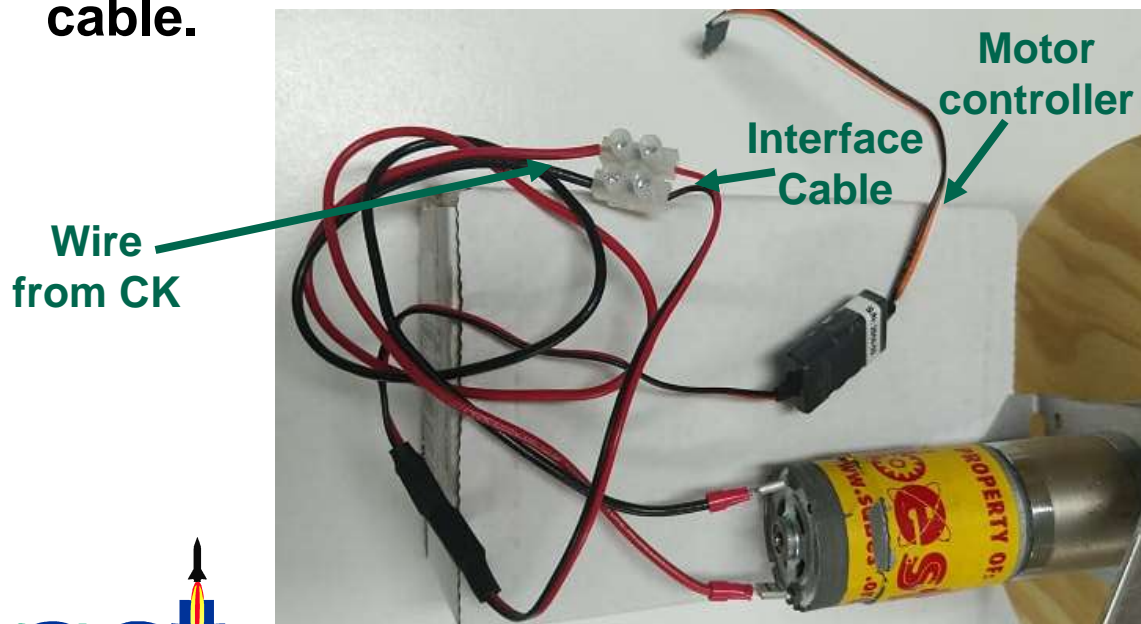
# Cortex Motor Connection

- Motor attaches to Cortex through the external Motor Controller & Interface Cable.
- Motors can be installed to cortex motor channels 2-9 (internal motor controllers on channels 1 & 10 are not powerful enough for BEST robots, and *may damage the Cortex*).
- Cortex motor channels 2-5 are on one internal fuse, and channels 6-9 are on another internal fuse. If you are using several motors, split these “heavy” loads between the two sections.



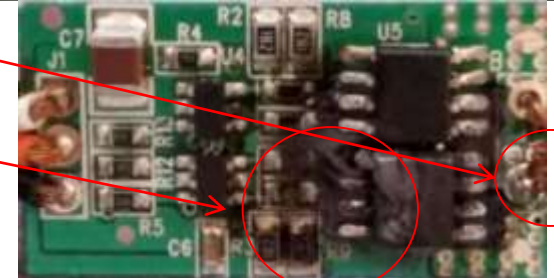
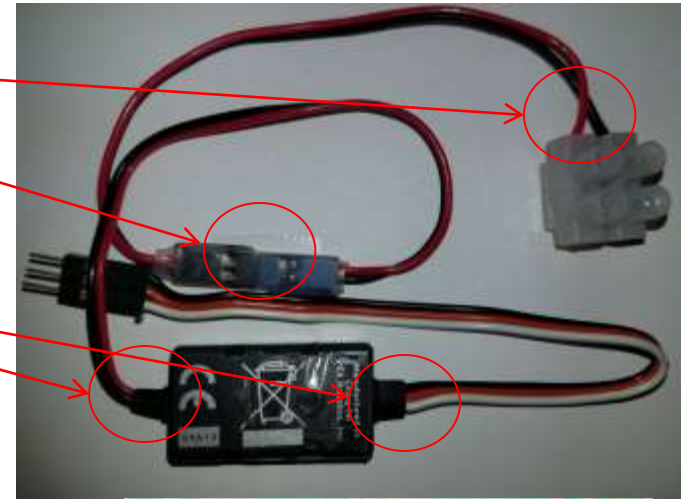
# Motor Attach - Wiring

- **Do not solder to the motor tabs!**
- **Use the Spade Connectors from the CK** (“quick-disconnect terminal, insulated, female” on your kit list – look in “bag 3” in the small box in your CK).
- **Other end of the wires go into the terminal block on the motor speed controller interface cable.**



# Care and feeding of your motor controllers

- Do not disassemble
- Do not pull on wires
  - Insulation can move
  - Wires can short (this is bad, overheats)
  - Too hot: melts, burns
- Don't pinch or cut wires
- Keep away from moving parts

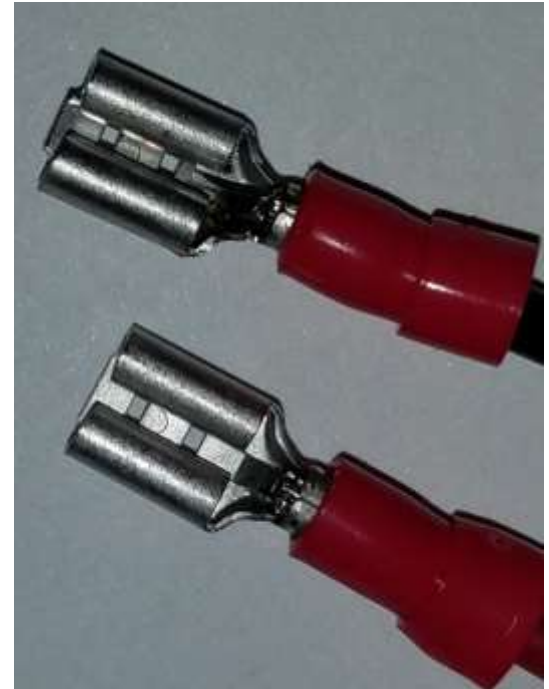


# Hookup Tips

---

## Crimp spade lugs to supplied wire

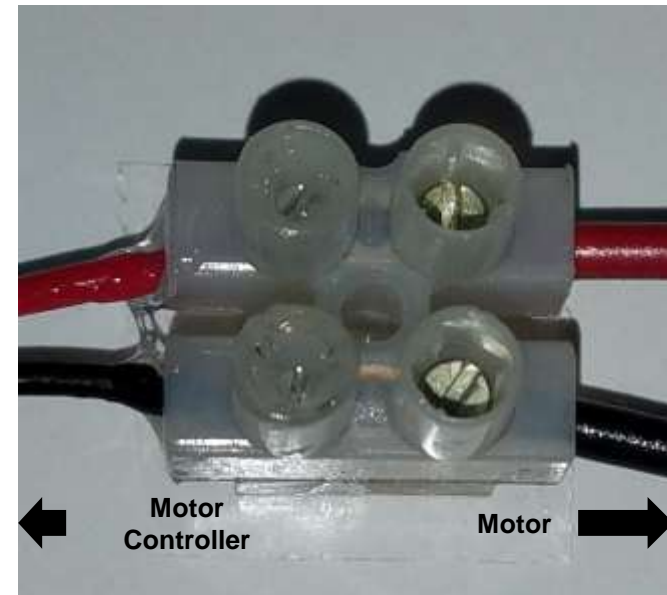
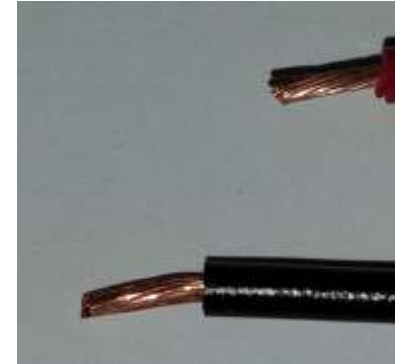
- You shouldn't be able to pull the wire out of the crimp
- Solder the wire to the spade lug if you can't get a good crimp.
  - Note: Plastic insulation on the lug may (i.e. will) shrink from the heat. This is OK.
- Keep solder out of the mating area
  - Top lug: OK, but solder shouldn't go any further
  - Bottom lug: Ideal, solder doesn't go past wire stop
- Heat Shrink or electrical tape (CK) may be used to insulate the exposed metal



# Hookup Tips (cont)

## Connect Wires to EuroBlocks

- Motor Controllers
- Sensor Input Cables (2 or 3)
- Strip 6mm (1/4") from each wire
  - For smaller wire, double the strip and fold in half
  - Don't solder tin the bare wire, bare wire makes a better connection in the EuroBlocks
- Loosen Screws (counter clockwise) as needed
- Insert wire, bare wire must not be outside of the EuroBlock.
- Tighten Screws (clockwise) until tight (wire does come out with a light tug)
- **DO NOT REMOVE** EuroBlocks from RK parts!



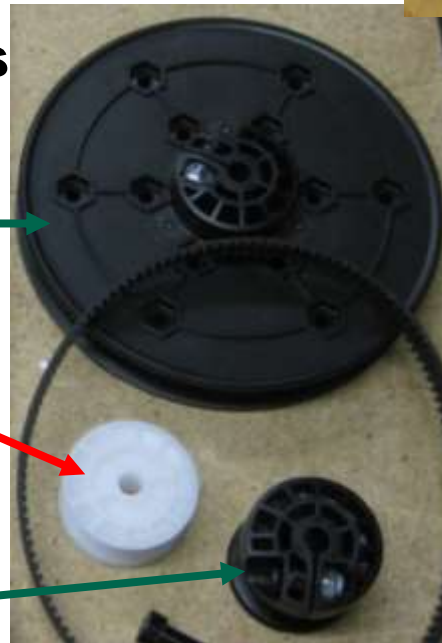
# Motor Attach – Drive Shaft

- Do not use any glue/tape/epoxy on the motor.
- The Generic Kit Usage Guide shows a couple of methods of building hubs (similar to the one at right) to attach wheels to motors.
- Can also use drive parts provided in the RK:

Large Drive Pulley →

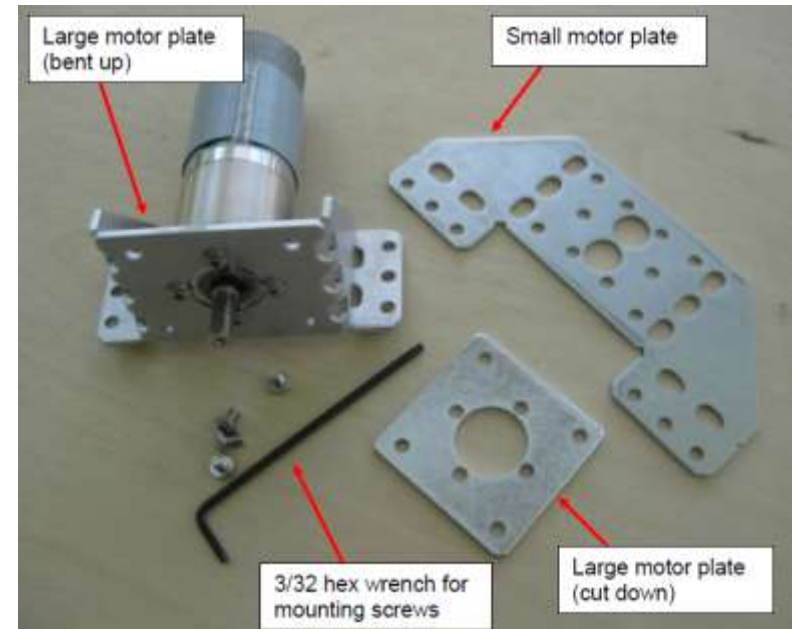
**NOTE:** the idler pulley (actually black in our kits) does NOT attach to motor shaft, it only spins. NOT legal to modify this part (no glue, etc.).

Small Drive Pulley →



# Motor Attach - Mounting

- **Motor mounting plates & screws are provided in the CK.**
  - They are not required, but are convenient!
  - You have only one chance to bend the mounting plate – if you try to bend it back it will crack.
- **If face mounting, use the short screws from the mounting bracket kit (or make certain that any other screw does not extend into the motor case more than 0.2”).**
- **If clamping the case, only clamp around the gearbox (closest to shaft), not armature section (closest to wires).**





# Motor Mounting

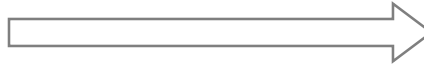
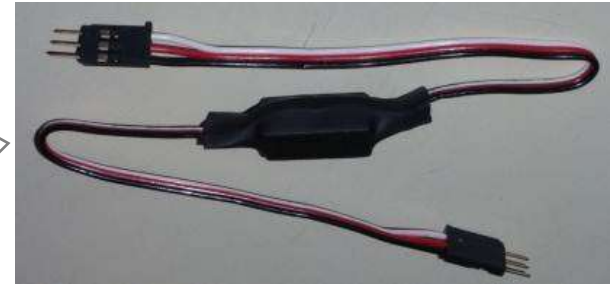
- **Motor Brackets**
  - Bend on oval holes
  - Start all 4 screws before tightening
  - Flanges can fold either way or even be broken off
  - Bend only once!
  - Brackets are optional
  - Supplied screws must be used on motors
- **Small Motor Bracket**
  - Motor can mount in either hole



# Using Servos

## Connections:

- Servos use same Cortex connection as Motor Controllers (channels 2-9)
- Each Servo needs a Servo Buffer (servo power adapter cable)
- Plug the Buffer directly into the Cortex
- Connect the Servo to the Buffer directly or via an extension cable
- Make sure the wire colors line up

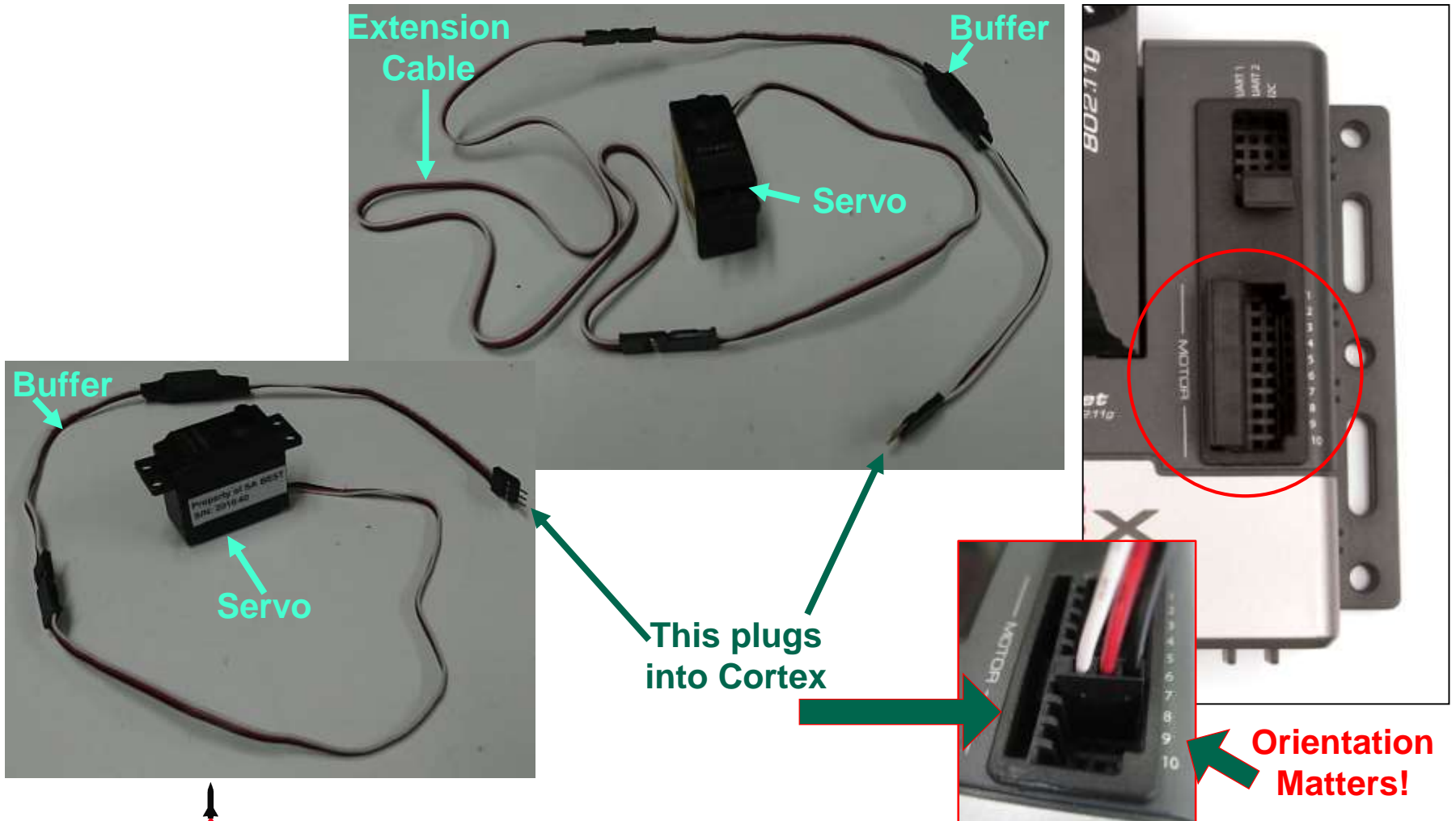


## Use:

- Servos Rotate  $\pm 45^\circ$  from center
- Do not manually move servo with power applied
- Do not overload the servo. If the servo 'chatters' or stalls, STOP: it is overloaded!
- If servo "hums" it is draining the battery. It needs to be adjusted.

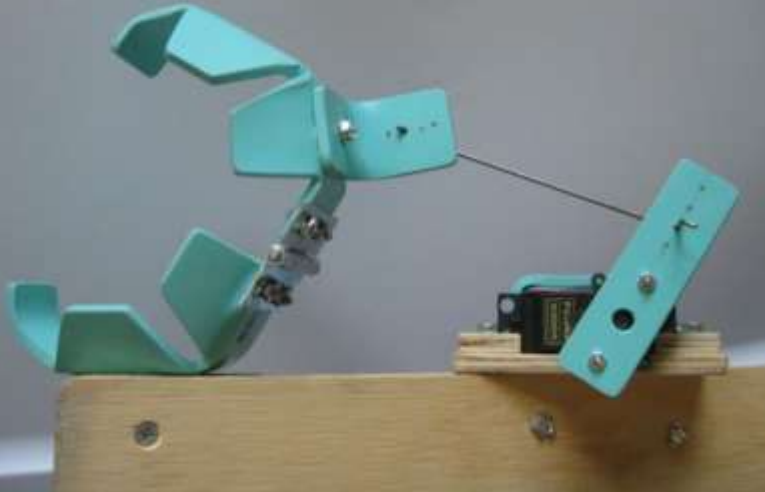


# Cortex Servo Output

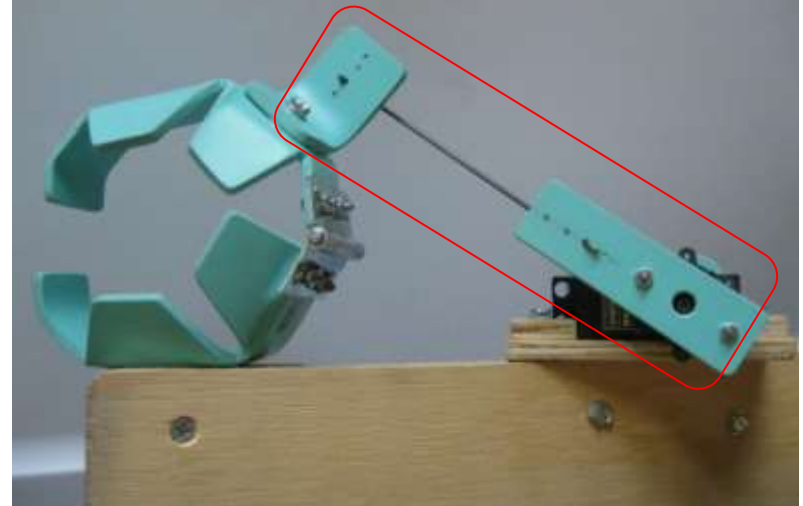


# Servo Mounting

Running into something with this gripper open will strip the servo gears.



In the closed position, the servo is protected (a lot of force would be required to snap off the drive shaft).



**There is hardware in the RK specifically for mounting the servos to the robot. If you use screws from the CK instead, be careful that you don't damage the mounting holes.**

# Sensor Input Connectors

---

## Digital Input Connection

- **2 Wire Sensor Input Cable**
  - Or
- **3 wire Sensor Input Cable**
  - Center (red) connection not needed



## Analog Input Connection

- **3 wire Sensor Input Cable**
  - All three wires are used



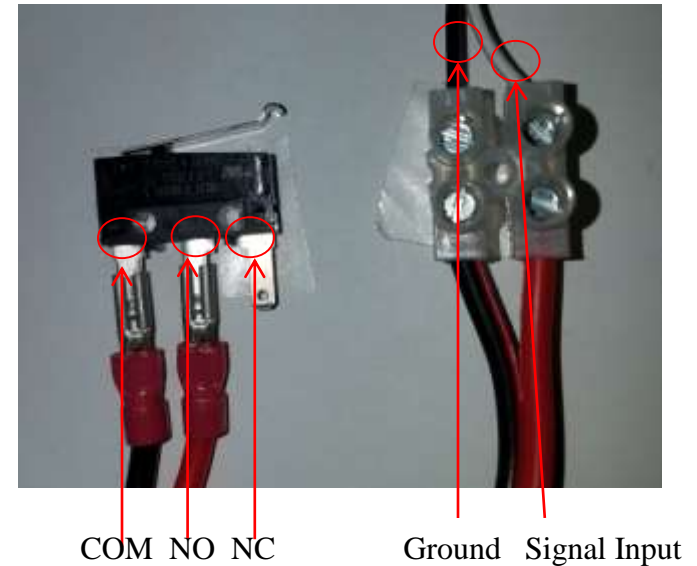
# Real World Input

- **Analog Input**
  - Continuously Variable
  - 0 to +5V
  - 0 to 1024 (EasyC – Analog Input)
  - **Example: potentiometer (CK)**
- **Digital Input**
  - Open/Close
  - Weak Pulled up to 5V
  - Open = 1
  - Closed = 0
  - **Examples: micro-switch (CK), window alarm sensor (RK)**



# Digital Connections (switch)


- **Common (COM)**
- **Normally Open (NO)**
  - Makes connection to COM when lever is pressed
- **Normally Closed (NC)**
  - Makes connection to COM until lever is pressed
  - Not normally needed
- **Directly compatible with all Limit Functions**
  - Closed to activate limit (logic 0)
- **Use Electrical Tape or Heat Shrink Tubing to insulate terminals**

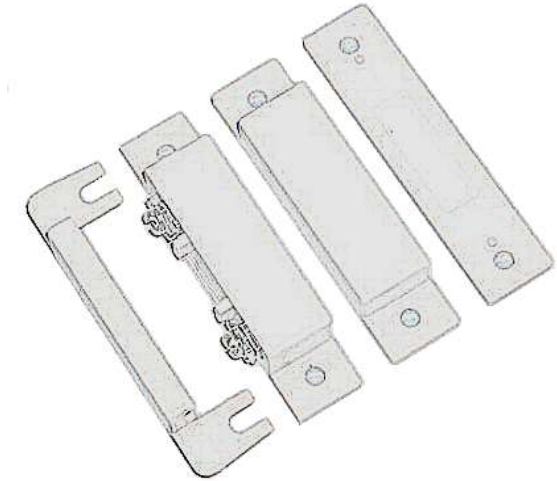


## Use for:

- **Bump sensing**
- **Motor limit detection**
- **System interrupt, etc.**

# Digital Connect. (Alarm Sensor)

- **Magnetic Reed Switch w/ Magnet**
  - Part of BEST Return Kit (RK)
- **4 Pieces**
  - Wire cover & back cover (optional)
  - Reed Switch – Returnable!
  - Magnet – Returnable!
  - Mounting hardware (not shown)
- **Single Pole, Single Throw, Normally Open (SPST-NO) contact**
- **Inside View** 
  - **Glass** encapsulated reed switch
  - **FRAGILE!**
  - **DO NOT DISASSEMBLE!**





# Digital Connect. (Alarm Sensor)

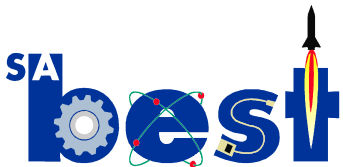
---

## •Uses:

- **Arm motion limits**
  - Place magnet on arm
  - Place sensors near upper and lower limits of motion
  - Program Cortex to stop arm motor when limit sensors are activated.
- **Position tracking**
  - Place magnets on wheels
  - Place sensors on robot chassis
  - Count switch closures on each wheel

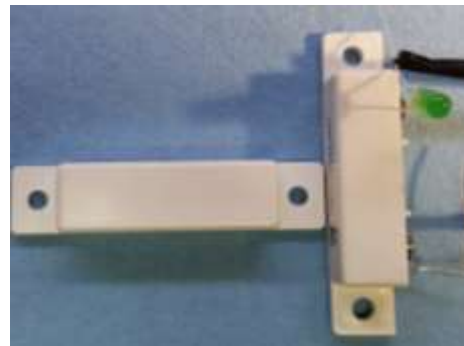
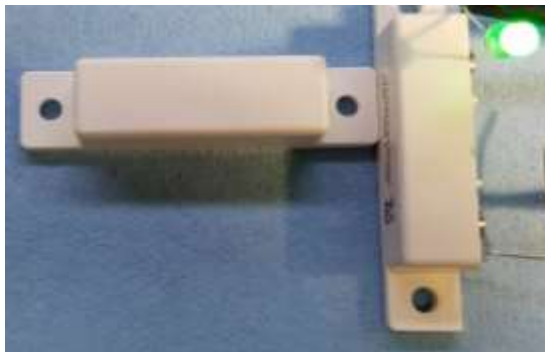
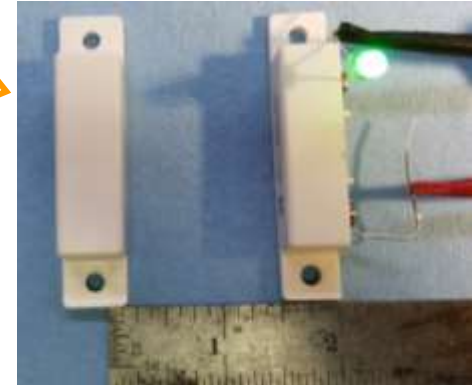
## •Mounting:

- **Supplied screws**
- **CK hardware:**
  - #6 Wood Screws
  - #4 Machine Screws & Nuts
  - Cable Ties (not too good)
  - Rubber Bands (really not good)
  - Painters Tape (temporary & testing)
- **Do not use:**
  - **Velcro (prohibited on any RK part)**
  - **Tape (any, except Painters)**
  - **Epoxy or Wood Glue**
  - **#8 or #10 hardware – will damage mounting ears**



# Digital Connect. (Alarm Sensor)

- Magnet parallel to sensor:  $\frac{3}{4}$ " to  $1\text{-}\frac{1}{2}$ "
- Magnet perpendicular to sensor:
  - Sensitive near either end of sensor
  - Dead zone in middle of sensor
- Test with Multimeter on Ohms
  - (2V power supply & LED used in pictures)



# Analog Connect. (potentiometer)

- **Consumable Kit**

- **10kΩ Potentiometer (2)**
- **Rotates 300°**

- **Connections (CW Operation):**

- **Pin 2 (Center) is the wiper**
- **Wiper moves from 1 (CCW) to 3 (CW)**
  - 1 - Black (GND)
  - 2 - White (Signal)
  - 3 - Red (+5)

- ~~**Red or Black to PIN 2?**~~

- **Pot becomes a Smoke Generator (illegal)**
- **May damage cable or Cortex (also illegal)**

Make sure the middle pin on potentiometer connects to the **WHITE WIRE** on the 3-wire sensor input cable (not to the middle wire!)

(reverse red & black for CCW operation)

(sensor input cable black wire)

GND



1

2

3

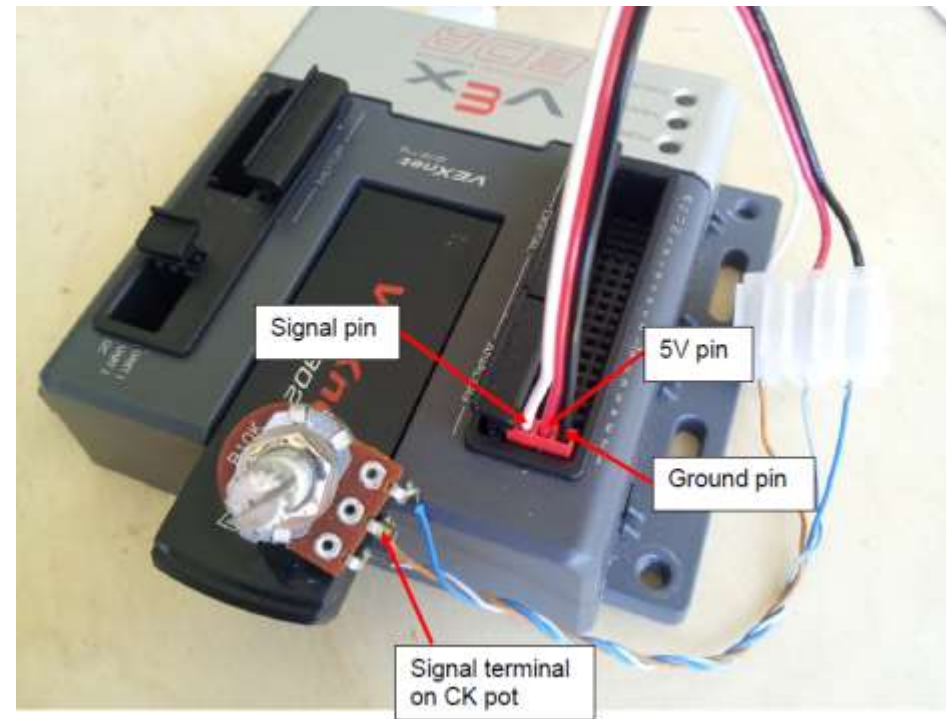
Signal Input

+5V

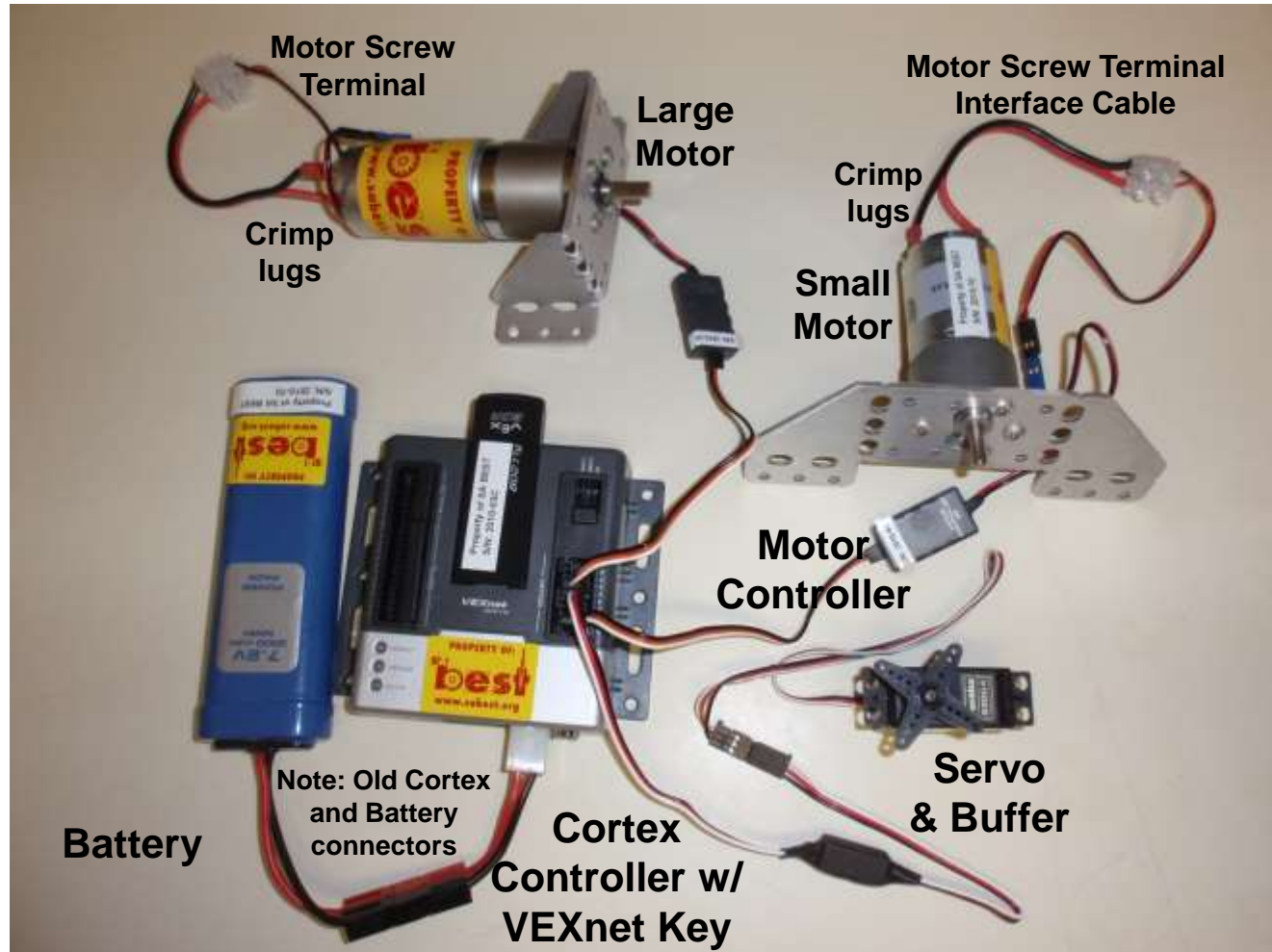
(sensor input cable red wire)

# Analog Connections (cont.)

- Needs 3 wire Sensor Input Cables
- **Do not connect +5V or GND to Wiper contact on Potentiometer**
  - This could short Cortex (BAD!)
- **Clockwise (CW) Operation**
  - Input value increases with CW rotation
  - +5V to CW (3) terminal
  - GND to CCW (1) terminal
- **Counterclockwise (CCW) Operation**
  - Input value decreases with CW rotation
  - GND to CW (3) terminal
  - +5V to CCW (1) terminal



# Basic Hookup Example



# Robot Batteries

---

- **Always monitor charging batteries**
  - Batteries will be warm when charging, but...
  - If too hot to hold, something is wrong.
- **When possible, deplete batteries using robot prior to recharging.**
- **A discharged battery will take a couple of hours to charge fully (on fast charge).**
- **Use the “safe” (slower) charge cycle when you have time.**

# Programming Cable Usage



August 1, 2010

Copyright © 2010 BEST Robotics, Inc. All rights reserved.

32

# BEST Default EasyC Program

**ANALOG & DIGITAL**

#	Description
1	Angle sensor 1
2	Angle sensor 2
3	Angle sensor 3
4	Angle sensor 4
5	
6	
7	
8	
1	DigInput 1
2	DI_2
3	DI_3
4	DI_4
5	DI_5
6	DI_6
7	DI_7
8	DI_8
9	DI_9
10	DI_10
11	DI_11
12	Digital input 12

Left-Click on Arrow to Set Digital I/O

**INTEGRATED MOTOR ENCODERS**

I2C #	Motor Port #	Description
1	1	
2	2	
3	3	
4	4	
5	5	
6	6	
7	7	
8	8	
9	9	
10	10	

**MOTORS**

#	Motor Type	Description
1	n/a	Not Used
2	n/a	Arcade Right Drive Motor
3	n/a	
4	n/a	
5	n/a	M5 by ch3
6	n/a	M6 by ch4
7	n/a	
8	n/a	
9	n/a	Acade Left Drive Motor
10	n/a	Not Used

**Motor Type Information**

- n/a - Motor Type is not provided
- Standard - Motor Module without Integrated Encoder
- Small IME - 269 with Integrated Encoder
- Big IME - 393 with Integrated Encoder
- Big IME HS - 393 High Speed Gearing with Integrated Encoder

This section not used by BEST

Motors or Servos can use these channels

Motor 2 (right) & Motor 9 (Left) follows right Joystick (Arcade Drive)\*

Motor 5 follows left Joystick Vertical (Ch. 3)

Motor 6 follows left Joystick Horizontal (Ch. 4)

\* Use Motor 2 & Motor 9 channels for heavy loads since they are on different fuse blocks.





# 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

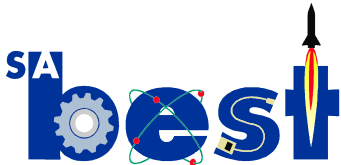
- Also reference troubleshooting info in “important info” booklet



# Keep your RK and Kit Team Happy

---

- **Do not Paint RK items.**
- **No Tape/Glue/Screws(or holes!)/etc. in RK parts**  
*(except long belt & servo horns).*
- **Remove the Cortex before drilling, cutting, painting or other ‘dirty’ operations**  
*(don’t want debris getting inside!).*
- **If you can’t remove it, cover it.**
- **Do not cut or disassemble RK items, except:**
  - Belt stock (long piece, not the loop)
  - Servo horns can be sliced and dice as needed
- **Do not solder to motor terminals: use CK spade connectors.**



# Handy Resources

---

- **“Important Info” booklet in your RK**
- **USB Thumbdrive in your RK**
- **www.sabest.org**
  - **“Kit Info” tab has links to many kit-related documents, including user’s guides & trouble-shooting info.**
  - **“Files” tab will include this presentation, as well as this afternoon’s main presentation. Pay attention to dates on any files you review!**
  - **“Rules” and “Q&A” tabs take you directly to official game information.**
  - **“Links” tab includes a link to the BEST Robotics website, or go directly to:**
- **www.bestinc.org**
  - **“Participants” | “Resources” includes links to all BEST-provided software, tutorials, control system info, and the BEST Forums.**
- **E-mail: [kitguy@sabest.org](mailto:kitguy@sabest.org) Telephone: 210-522-5556 (leave voice mail)**
  - **Include your name, school name & team number in your e-mail or message.**
  - **E-mail: Include a detailed description of your problem.**
  - **VoiceMail: Include a basic description of your problem,  
... and best way to reach you.**

