BEST Control System
BEST Robotics, Inc.
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Return Kit

- Servos
- Joystick
- Controller
- Servo Power Adaptor
- AAA Battery Charger
- WiFi key
- USB/Tether Serial
  - motors/servos
  - battery
- Servo Horns
- Servo Mounting H/W (optional)
- AAA Battery Charger
- USB A-A cable
- New 2.0 key
- Servo Extensions (2)
- Servo Horns (2)
- Servo Mounting H/W (optional) (2)
- USB A-A cable (16)
Return Kit

Drive components

Motors

Motor controller (4)

Screw terminal motor i/f cable (4)

Screw terminal sensor i/f cable (8)

7.2V Battery

7.2V Battery charger

Battery adapter

7.2V Battery

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Example Hookup
VEXnet Control System

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

- Gaming style controller
- Joysticks, buttons and accelerometers
VEXnet Cortex M3 Controller

- WiFi 802.11 Proprietary Comm.
- Standard Serial Interfaces (UART, I2C)
- 8 Analog inputs
- 12 Digital inputs or outputs
- Speaker Output
- System Status Indicators
- 10 Motor/Servo Ports (Built-In ESC on 2 ports)
VEXnet Joystick

- “Playstation” game-style controller
- 8 buttons on top
- 2 XY analog joysticks
- Power switch
- 6 AAA rechargeable batteries
- Plug-in USB/ WiFi Key
- 4 Button on front-side
- Programming Interface
- 2 Axis Accelerometer (X Tilt and Y Tilt)
System Features

- Wireless communication using 802.11g
- 2 2-wire proportional motor control outputs (not used by BEST)
- 8 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

- Gnd (Blk)
- +5v (Red)
- Sig (Wht)
- USB

Standard Serial Interfaces (UART, I2C)

1. Analog in
2. Digital in/out
3. Speaker Out

1. 2-wire motor
2. 3-wire PWM servo/motor ctrl
3. 2-wire motor

July, 2012

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VEX Cortex Connectors

- Configuration switch (used for special procedures)
- Backup battery port for WiFi communications (9V)
- 75MHz crystal interface ports (not used by BEST)
- Main battery port (7.2V)
- On/Off switch
VEX Cortex Pinouts

- Ground
- + 5V
- Signal/Control
- + Battery Power (for + control input)
- + Battery Power (for – control input)
DC Motors (1)

- Use of internal motor controllers is not allowed (motor ports 1 and 10)

- External motor controller(s)
  - connect via 3-wire external motor controller + 2-wire screw terminal cable
  - use motor ports 2 thru 9 only
DC Motors (2)

- For power reasons, spread your motors so that you have
  - no more than 2 motors plugged into ports 2-5 and
  - no more than 2 motors plugged into ports 6-9.
- You risk overcurrent and shutdown of the processor.
- Servo/motor ports are divided into 2 banks
  - Bank1 = Ports 1-5
  - Bank2 = Ports 6-10
  - Each bank can support a maximum of 4 Amps of current
  - BEST large motor stall current can reach 3.5 Amps.
- Sheet metal shield around the large motors IS needed and should not be removed.
DC Motors (3)

- 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
DC Motors (4)

- Motors can be mounted with VEX Motor Mounting Kit provided in the consumables kit
3-Wire Motor Connection (1)

External Motor Controller

Standard 3-wire PWM connector

Standard 2-wire motor cable

Screw terminals for attaching motor leads

Suggest using a 4” wire tie, heat shrink tubing or painter’s tape (as now allowed by the 2012 rules) here.

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3-Wire Motor Connection (2)

- 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
Connecting a Servo (1)

- Insert a Servo Power Adaptor cable into a motor port (2 through 9)
- Connect a servo (or servo extension cable) to the Servo Power Adaptor cable
Servo Mounting with Optional Hardware (1)

- 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)

1. No h/w attached

2. Attach rubber grommets

3. Insert brass spacers

4. Secure servo with screws
Digital Input Connections (1)

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

- 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 (1)

- 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”

Connect to switch

Connect to cortex analog input port
Analog Input Connections (2)

- 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**.
<table>
<thead>
<tr>
<th>Motor/Servo Port</th>
<th>Function</th>
<th>Joystick Channel</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Port 1 Not Allowed</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Right Motor</td>
<td>Channel 1 (Lt, Rt)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Channel 2 (Fwd/Rev)</td>
</tr>
<tr>
<td>3</td>
<td>Empty</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Empty</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Servo</td>
<td>Channel 3 Inversed</td>
</tr>
<tr>
<td>6</td>
<td>Motor</td>
<td>Channel 4</td>
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<tr>
<td>7</td>
<td>Empty</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Empty</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Left Motor</td>
<td>Channel 1 (Lt, Rt)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Channel 2 (Fwd/Rev)</td>
</tr>
<tr>
<td>10</td>
<td>Port 10 Not Allowed</td>
<td></td>
</tr>
</tbody>
</table>
BEST Robotics Options

- Three different programming environments available
  - easyCv5 [http://www.intelitekdownloads.com/easyCV5]
  - RobotC [http://www.robotc.net/download/cortex]

- Simulink is a graphical programming/modeling environment with simulation capability (see what your program will do before you download it to the Cortex)

- 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)
Downloading a Program

Option 1: Direct USB Download

Uses only the A-A USB cable.

Battery is not needed
Downloading a Program

Option 2: Tethered Download

Uses the optional programming cable with A-A USB tether.

Allows advanced debugging.
Downloading a Program
Option 3: Wireless Download

Uses the optional programming cable with WiFi USB Keys.

Battery is needed

Allows advanced debugging.
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

Game status (not used by BEST)
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?

- Online resources/documentation (BRI Site)
- BEST Public Message Board (for anyone)
  - [http://tech.groups.yahoo.com/group/bestinc/](http://tech.groups.yahoo.com/group/bestinc/)
  - Must register for login account
  - Share ideas, resolve issues, …
- Official Q&A “Control System” Category
  - [http://best.eng.auburn.edu/cgi-bin/bestqna.pl](http://best.eng.auburn.edu/cgi-bin/bestqna.pl)
  - Use “Official Q&A” page during contest for “rules specific” questions
  - Is this legal?
Where to find help? (2)

- VEX Forum
  - Technical questions about VEX equipment
  - easyC and RobotC dedicated forums included here