

EDU-RC & Motherboard

Reference Guide

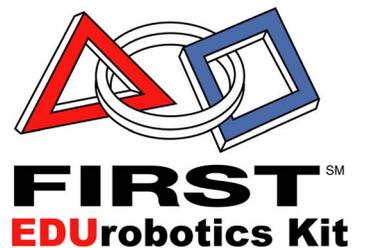
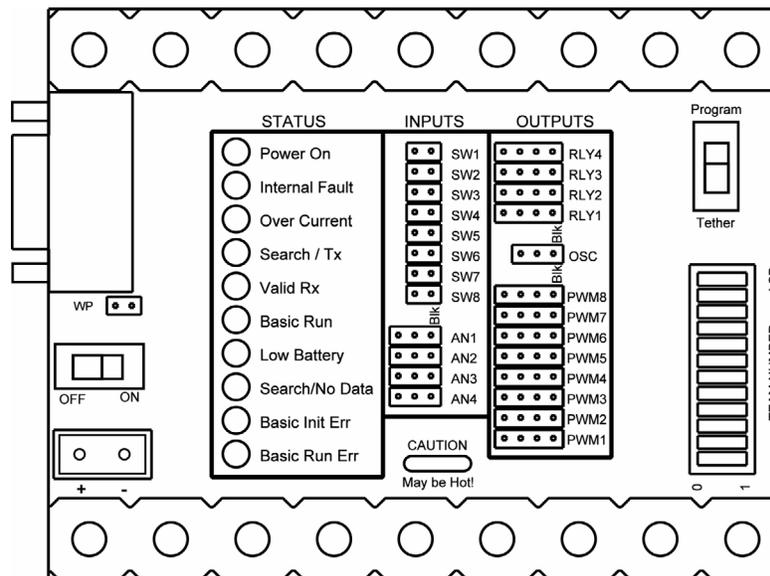


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1. Overview

The Isaac16 EDU Robot Controller and EDU Motherboard combine to function as one unit. The functionality of this smaller unit is very similar to the Full-Size Robot Controller and operates on the same basic principles. The basic differences on the EDU Robbot Controller are: 1) smaller size and reduced weight, 2) fewer inputs and outputs, 3) the RS422 Radio is integrated and internal to the unit, and 4) the Motherboard is removable.

The removable Isaac16 EDU Motherboard is designed to mate only with the Isaac16 EDU Robot Controller. The removable Motherboard allows the Isaac16 EDU Robot Controller to be used in multiple robots, while the wiring and robot specific program remain in each robot on the Motherboard. This modular design allows classrooms to build multiple robots without the need for a dedicated control system for each robot.

The Isaac16 EDU Robot Controller (RC) receives information from the Operator Interface, gathers additional information from sensors on-board the robot, determines how the robot should function, and instructs the robot to perform the functions. The EDU Robot Controller also sends data back to the Operator Interface, giving the human operator(s) feedback of critical information.

Also, the Isaac16 EDU Robot Controllers gather on-board sensor data via the ANALOG and DIGITAL inputs. There are 8 digital inputs and 4 analog inputs on the EDU Robot Controller. Switches of various types may be connected to the digital inputs. Sensors that provide a 0-5V output, such as potentiometers and gyros (yaw rate sensors) may be connected to the analog inputs.

The Isaac16 EDU Robot Controller takes the collected data from both the Operator Interface and the on-board sensors and then forwards it to the PBASIC program processor. The program, (PBASIC Code), takes the data, determines what to do with the outputs to make the robot behave as desired, and sets the PWM and Relay outputs to the appropriate states. The EDU Robot Controller comes with a default program that will handle most robot control needs. If more sophisticated control of the robot is desired, then the default program can quickly be modified to provide the required functions from the robot.

The PBASIC source code is available at www.innovationfirst.com.
Programming tools and manuals are available at www.parallaxinc.com.

The Isaac16 EDU Robot Controller has 8 PWM outputs and 4 Relay outputs. The PWM and Relay outputs are used to drive the EDU Multi Speed Motor. The PWM outputs give variable speed control of the Multi Speed Motors. The Relay outputs drive the Multi Speed Motors in full forward or reverse only. The Isaac16 EDU Robot Controller can also drive Victor 883 speed controllers and Spike relay modules.

The Motherboard provides connectors for power, external devices, switches, and sensors. The Motherboard also has a combination Tether/Program connector for connecting to an Operator Interface (Tether) or a Computer (Program). Tether is used to communicate to an Operator Interface over a “hard” wire connection instead of using a wireless radio link. A connection to a Computer is only used to download/re-program the PBASIC program.

The Isaac16 EDU Robot Controller and Motherboard are keyed and can only be connected in one orientation.

CAUTION: Do not apply power unless the EDU-RC and Motherboard are firmly connected and in the proper orientation or damage may result.

The Isaac16 EDU Robot Controller has an Autonomous Mode. When in autonomous mode, the Operator Interface is not needed. The EDU RC will run as normal in Autonomous Mode, except there is no user input required from the Operator Interface. The use of Autonomous Mode requires that custom software be written to command the robot. All available inputs from on board the robot can also be used. These inputs along with the custom software are combined in the PBASIC processor to create the desired functions of the robot. Autonomous Mode can be turned “ON” by 1) turning the RC OFF, 2) setting the team number to Zero, and 3) turning the RC back ON.

2. Isaac16 EDU Motherboard Layout

Battery Connection:

7.2V Nominal

EDU-RC Absolute Voltage Range:

5.2V to 9.0V (damage may occur above 9.0V)

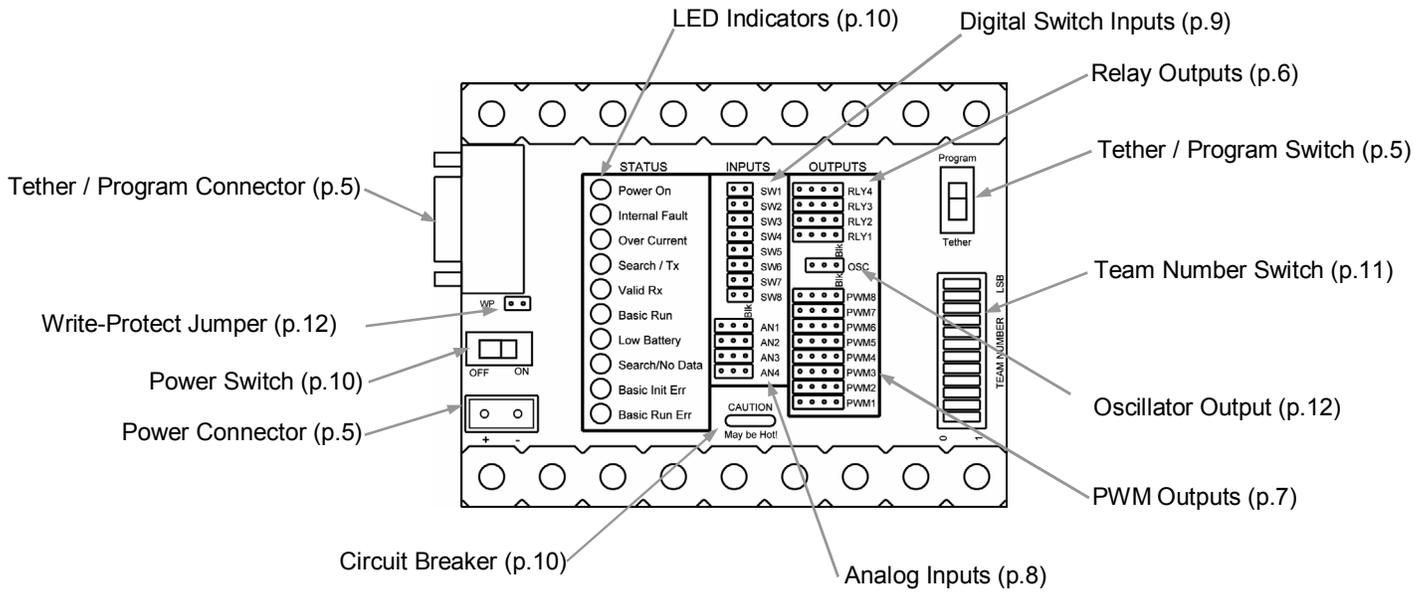


Table 2: Connector Pinout Information

Pin Header	Left Pin	Center Pin(s)	Right Pin
 AN1	+5V Output	Input Signal (0-5V)	Ground
 PWM1	+Battery	PWM Signal Output	+Battery
 RLY1	+Battery	Reverse Output	Forward Output
 SW1	Input Signal		Ground

3. POWER Input

The Power connector on the Isaac16 EDU Motherboard is intended to accept power from a 7.2V battery. The current draw for the EDU Robot Controller is typically between 0.20A to 3.0A. The maximum voltage allowable is 9.0V. Exceeding the 9.0V limit will damage voltage regulators in the EDU Robot Controller and will void the warranty. The minimum required voltage is 5.2V.

Caution: Exceeding 9.0V on the Input Power connection may permanently damage any EDU Multi-Speed Motor connected to the EDU Motherboard.

A 7.2V Battery with the proper mating connector is available from www.InnovationFirst.com. Replacement connectors are also available at www.InnovationFirst.com. Use a minimum of 16GA wire to minimize voltage drop to the Robot Controller. Fuses prior to the Motherboard are not required.

Connect +Battery to the corner contact and Ground to the inside contact (see Page 4). The EDU Robot Controller is internally protected from reverse polarity.

4. TETHER / PROGRAM Port

The Isaac16 EDU Motherboard uses a combination TETHER and PROGRAM port. When connecting a tether cable to the Motherboard, be sure the TETHER/PROGRAM switch is in the down position towards the Team Number switch to select "TETHER". Use a DB9 Male-Female Pin-to-Pin cable (maximum length 6 ft.) to connect the TETHER port on the Motherboard to the TETHER port on the Operator Interface.

The PROGRAM port on the Motherboard is used to change the PBASIC program. The PBASIC program is stored on the PBASIC program memory chip located on the bottom side of the motherboard. When connecting a Program cable to the Motherboard, be sure the TETHER/PROGRAM switch is in the up position away from the Team Number switch to select "PROGRAM". This port is intended to connect to a PC's serial port. Use a DB9 Male-Female Pin-to-Pin cable (maximum length 6 ft.) to connect the PROGRAM port on the Motherboard to a PC serial port.

5. Radio

The EDU Robot Controller does not need an external radio or radio cable. The 900Mhz radio that the EDU Robot Controller uses is internal to the EDU-RC unit. The internal radio module is design to only "talk" with the Operator Interface radio. Any attempt to modify the radio output or antenna will void your warranty and may subject you to FCC violations.

6. RELAY Outputs

The Isaac16 EDU Motherboard has four 4-pin RELAY connectors (abbreviated RLY). The Relay outputs are most commonly used to drive Multi-Speed Motors. These outputs can only drive the Multi-Speed Motors in Full Forward (clockwise), Full Reverse (counter-clockwise), or Off. The Multi-Speed Motors can be connected directly to the Relay outputs. Be sure to connect the cable so the black wire is on the indicated pin (on the right side of the connector).

The Relay outputs can also drive Spike Relay Modules. The Spike Relays can be connected directly to the Relay outputs. Use a 3-wire PWM/Relay extension cable to connect a Spike to one of the Relay outputs. When connecting Spike Relay Modules, use the right 3 pins of the Relay port. Be sure to connect the cable so the black wire is on the indicated pin (on the right side of the connector). Shown below is the Relay port pin-out to aid in the connection of a Multi-Speed Motor and/or Spike Relay Modul to a Relay output.

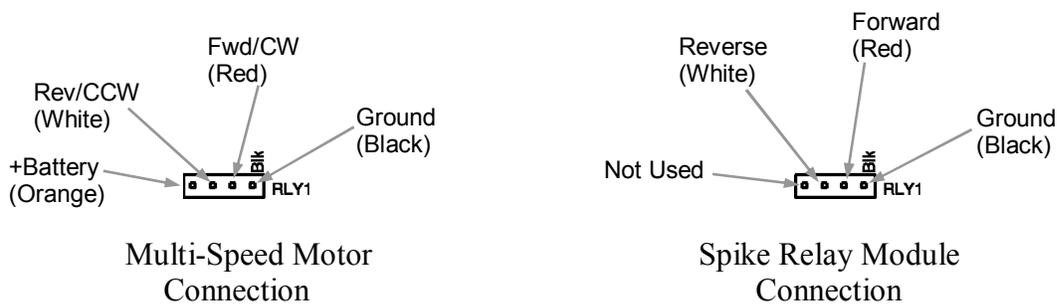


Table 6: Relay Output Map

Relay Port	Shaft Rotation	PBASIC Variable	Alias PBASIC Variable	Pin Location	Wire Color
RLY 1	CW	RelayA.bit0	Relay1_fwd	Center Right	Red
RLY 1	CCW	RelayA.bit1	Relay1_rev	Center Left	White
RLY 2	CW	RelayA.bit2	Relay1_fwd	Center Right	Red
RLY 2	CCW	RelayA.bit3	Relay1_rev	Center Left	White
RLY 3	CW	RelayA.bit4	Relay1_fwd	Center Right	Red
RLY 3	CCW	RelayA.bit5	Relay1_rev	Center Left	White
RLY 4	CW	RelayA.bit6	Relay1_fwd	Center Right	Red
RLY 4	CCW	RelayA.bit7	Relay1_rev	Center Left	White

7. PWM Outputs

The Isaac16 EDU Motherboard has eight 4-pin PWM connectors. The PWM outputs are most commonly used to drive Multi-Speed Motors. These outputs can cause the speed to vary on the Multi-Speed Motors in a range from Full Forward, to Full Reverse, or Off. The Multi-Speed Motors can be connected directly to the PWM outputs. Be sure to connect the cable so the black wire is on the indicated pin (on the right side of the connector).

The PWM outputs can also drive the Victor 883 Speed controller. The Victor 883 can be connected directly to the PWM outputs. Use a 3-wire PWM/Relay extension cable to connect a speed controller or servo to one of the PWM output ports. When connecting a Victor speed controller, use the right 3 pins of a PWM port. Be sure to connect the cable so the black wire is on the indicated pin (on the right side of the connector).

Caution: The center right pin and the left pin on the PWM connector is connected to the Battery input voltage. Depending on your battery, this voltage may be too high for servos and some speed controllers. We recommend you disconnect the center wire on a 3-wire cable when connecting to other manufacturers speed controllers. You must then supply the required voltage, if needed, for that specific speed controller. Disconnecting the center wire is not necessary for the Victor 883. Most servos are rated at 4.8V to 6.0V. The total current draw on all PWM and Relay +Battery pins is limited to 11 Amps by the Motherboard’s circuit breaker.

Shown below is the PWM port pin-out to aid in the connection of a Multi-Speed Motor or a Victor 883 Speed Controller to a PWM output.

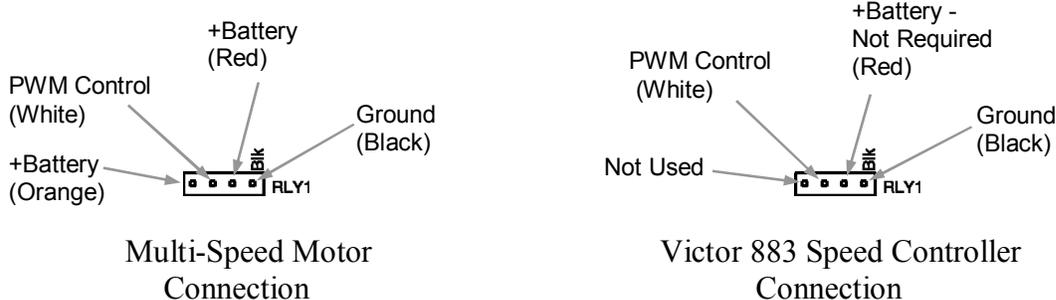


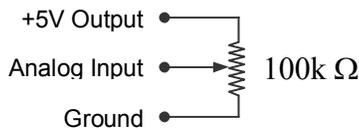
Table 7: PWM Output Map

PWM Port	Shaft Rotation	PBASIC Variable	Pin Location	Wire Color
PWM1	CCW	p1_y	Center Right	White
PWM2	CW	p3_y	Center Right	White
PWM3	CCW	p1_y	Center Right	White
PWM4	CW	p3_y	Center Right	White
PWM5	CW	p1_x	Center Right	White
PWM6	CW	p3_x	Center Right	White
PWM7	CCW	p1_wheel	Center Right	White
PWM8	CCW	p3_wheel	Center Right	White

8. ANALOG Inputs

The analog inputs on the Isaac16 EDU Robot Controller can be used to measure various conditions on the robot and trigger automatic responses by the control (PBASIC) program. The Isaac16 EDU Motherboard has four 3-pin ANALOG connectors (abbreviated AN). Potentiometers and gyros (yaw rate sensors) may be connected to the analog inputs. For wiring 0-5V sensors such as gyros, refer to the sensor manufacturer's data sheet. The ANALOG pin headers are typically wired using 3-wire PWM cables.

Potentiometers should be wired per the diagram below when connecting to the Analog Inputs. Always use 100kΩ potentiometers.



Shown below is the Analog Input port pin-out to aid in the connection of potentiometers, gyros and other 0-5V output devices to an Analog Input.

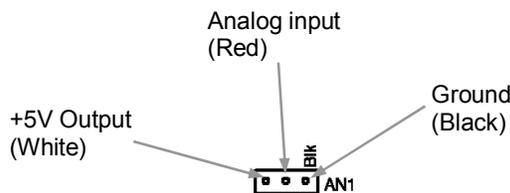


Table 7.1: Analog Inputs and Software Function

Pin	Function	PBASIC Variable
AN1	Analog 1	sensor1
AN2	Analog 2	sensor2
AN3	Analog 3	sensor3
AN4	Analog 4	sensor4

9. DIGITAL SWITCH Inputs

The digital inputs on the Isaac16 EDU Robot Controller can be used to monitor various conditions on the robot and trigger automatic responses by the control (PBASIC) program. The Isaac16 EDU Motherboard has eight 2-pin DIGITAL SWITCH connectors (abbreviated SW). Pre-wired switches are available from Innovation First. Various switches may be connected to the digital inputs.

Connect switches between the desired digital input signal pin and the ground pin only. Digital inputs are “looking” only for ground signals to become active. Do not connect positive voltage to any switch or digital input pin, only ground. Switches may be wired individually, in parallel, or in series. The SWITCH pin headers are typically wired using 2-wire extension cables.

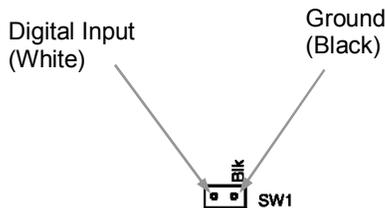


Table 8.1: Digital Inputs and Software Function

Switch	Function	PBASIC Variable
SW1	Switch 1	rc_sw1
SW2	Switch 2	rc_sw2
SW3	Switch 3	rc_sw3
SW4	Switch 4	rc_sw4
SW5	Switch 5	rc_sw5
SW6	Switch 6	rc_sw6
SW7	Switch 7	rc_sw7
SW8	Switch 8	rc_sw8

10. LED Indicators

The Isaac16 EDU Motherboard has the following LED indicators.

Power ON	Solid	Input power is applied. Input Power is controlled from the ON / OFF switch.
Internal Fault	Solid	An internal power fault has occurred. Turn the EDU Robot Controller OFF, disconnect all wiring except the power, and then turn the EDU Robot Controller back ON. If this does not clear the Fault, contact Innovation First.
Over Current	Solid	A over current fault has occurred. Turn the EDU Robot Controller OFF, disconnect all wiring except the power, and then turn the EDU Robot Controller back ON. If this does not clear the Fault, contact Innovation First.
Search/TX	Blinking	Transmitting data packets to Radio Modem.
Valid RX	Blinking	Receiving data packets with correct Team Number and Channel Number.
Basic Run	Blinking	User CPU is running PBASIC code. The PBASIC code has stopped executing if the light is ON Solid or OFF. (This may be disabled in custom PBASIC programs)
Low Battery	Blinking	Low battery voltage detected. Replace or recharge battery soon. Low Battery will remain blinking if the voltage ever drops below 6.5V. The Low Battery Blink threshold is user definable in the PBASIC code.
Low Battery	Solid	Low battery voltage detected. Replace or recharge battery now. Low Battery will remain solid if the voltage ever drops below 6.0V.
Search/No Data	Blinking	No data packets received or bad data packets received.
Search/No Data	Solid	Radio Modem not found.
Basic Init Err	Solid	PBASIC code did not initialize properly with main CPU. Check your code. Re-download the “default” code to help verify a coding problem.
Basic Run Err	Solid	PBASIC code has no output. Check code or Power Cycle the unit. You can also try re-downloading the “default” code to help verify a coding problem.

11. Power Switch (Reset)

The Isaac16 EDU Motherboard has a power switch used to turn the EDU Robot Controller ON or OFF. The Power Switch can also be used to reset the EDU Robot Controller by “Power Cycling”. Power Cycling involves turning OFF the EDU Robot Controller and then turning it back ON after a few seconds. Power Cycling performs a complete hardware Reset of the Robot Controller, including the Master, Slave, and BS2SX PBASIC processors. Power Cycling also re-initializes the internal radio to “Search” mode.

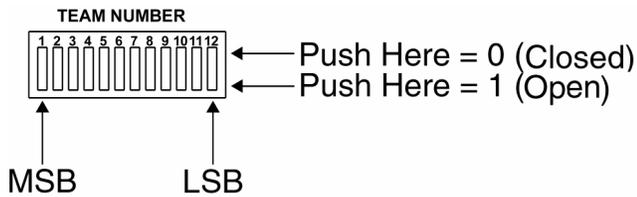
12. Circuit Breaker

The EDU Motherboard has an auto resetting circuit breaker to protect the left and center right PWM pins from short circuits. The center right pin on the PWM connectors is typically used to power servos. Also, the left RLY pins and the center OSC pin are protected by this circuit breaker.

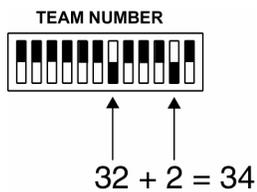
13. Team Number

Setting the Team Number on the EDU Motherboard requires changing the TEAM NUMBER dip switch settings. The Team Number is set by changing the switches to match the binary equivalent of your Team Number. The easiest way to set the team number switches is to copy them from the Operator Interface.

The diagram below shows the location of the Most Significant Bit (MSB) and the Least Significant Bit (LSB).



The following diagram is an example of setting the Team Number to **34**. The black areas on the Team Number Switch indicate which half of the switch is in the down position.



14. PBASIC Program Memory

The PBASIC program memory chip on the EDU Motherboard stores the PBASIC program. The memory chip is located on the EDU Motherboard. This allows the robot program and wired EDU Motherboard to remain in the robot while the Isaac16 EDU Robot Controller can be removed and used in multiple other robots. The program can be changed by downloading a new program into PBASIC memory through the TETHER/PROGRAM port (see Page 4). Refer to the “Programming Guide” for more information on downloading programs. Be sure the Write Protect jumper is installed before attempting to program (see Write Protect Jumper pg.12).

15. Write Protect Jumper

The Write Protect jumper on the Isaac16 EDU Motherboard is used to allow or disallow writing to the PBASIC program memory chip. The PBASIC program memory chip is located on the bottom side of the Motherboard.

The PBASIC program can be changed when the jumper is installed (Write Protect OFF).
The PBASIC program **cannot** be changed when the jumper is **not** installed (Write Protect ON).

16. Oscillator Output

The oscillator output is set by default to output a 40 KHz signal at about a 50% duty cycle. This frequency can be controlled by the 17th PWM byte in the SEROUT command in the PBASIC code. As the 17th byte varies from 2 – 254, the OSC Output frequency will vary from 19.6 KHz to 1.66 MHz. The 17th byte only needs to be sent out 1 time to set the frequency. The 17th byte does not need to be sent out again until the frequency needs to be changed. The OSC Output port also has a Ground and Power pin. The Ground pin is the left pin of OSC Output port and marked “BLK” on the EDU Motherboard. The power pin is the center pin and will supply Battery voltage. The OSC Output is the left pin.

The formula for the frequency is:

$$1/((\text{PWM value} + 1) * 4 * 0.00000005)$$

Valid PWM value range: 2 – 254.

Caution: The center pin on the OSC Output port is connected to the Battery input voltage. Depending on your battery, this voltage may be too high for some devices and they may be damaged.