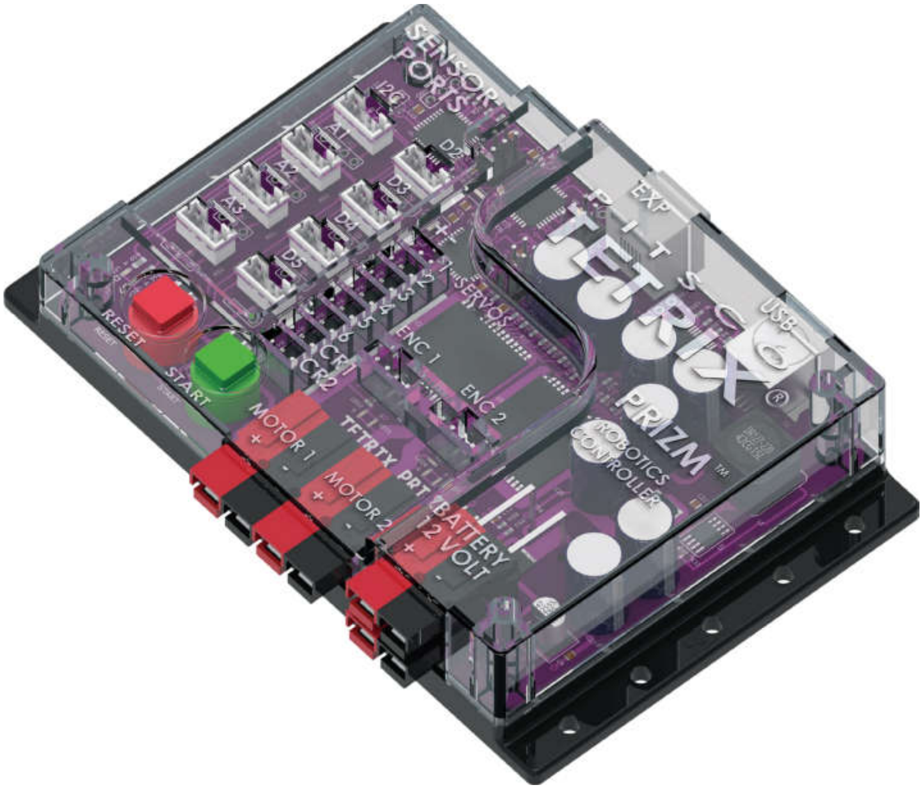
TETRIX PRIZM Robotics Controller Technical Specifications

Microcontroller:	ATmega328P with Arduino Optiboot bootloader installed
Memory:	32 KB flash programmable memory (ATmega328P)
Power:	9-18 volts DC
DC motor ports:	2 Powerpole connections; H-bridge PWM controlled; 10 amps continuous current each channel, 20-amp peak
Recommended motor:	12-Volt DC TETRIX MAX TorqueNADO Motor (44260)
DC motor control modes:	Constant power (-100% to 100%) PID constant speed (-720 to 720 degrees per second) PID constant speed to encoder target position and hold PID constant speed to encoder degrees position and hold Brake or Coast mode when stopping DC motor current monitoring (all modes)
Motor encoder ports:	2 quadrature, 5 volts DC, 50 mA max; Spec: 360 CPR, 1,440 PPR; ENC 1 and ENC 2
USB connector:	USB Type B
USB driver:	FTDI
Standard servo ports:	6 total: servo channels 1-6
Continuous rotation (CR) servo ports:	2 total: CR1 and CR2 channels
Total servo power limit:	6 volts DC, 6 amps max
Servo control modes:	Set servo speed (0% to 100%) Set servo position (0-180 degrees) Set CR servo state (Spin CW/Spin CCW)
Battery voltage monitoring:	0-18 volts range
Digital sensor ports (D2-D5):	Each can be configured as digital input or output. D2 can be configured as a serial communications port.
3 analog sensor ports (A1-A3):	Each can be configured as analog input or digital input/output ports.
1 I2C port (I2C):	100 Khz speed. This connection shares same I2C bus as internal DC motor and servo motor control chips. I2C addresses 0x01-0x06 reserved by the PRIZM controller.
Motor controller expansion port (EXP):	Additional TETRIX DC motor and servo control modules can be daisy-chained to this port.
Battery connection port:	Powerpole type; additional port for daisy-chaining battery power to motor controllers added to the expansion port
1 green Start button (START):	Programmable push button
1 red Stop/Reset button (RESET):	Non-programmable push button
1 red LED:	Programmable LED used as an indicator
1 green LED:	Programmable LED used as an indicator
1 blue LED:	Indicates the power is on when illuminated
2 yellow LEDs:	Indicates serial data activity on the USB port
1 red and 1 green DC motor LEDs:	Indicates DC motor rotation and direction for each DC motor channel

PRIZM Robotics Controller Functional Overview

The PRIZM controller is connected to a computer using a standard USB cable connection. Power is supplied from an external TETRIX 12-Volt Rechargeable NiMH Battery Pack. The controller has a dual high-current DC motor drive system, each motor having quadrature encoder support for implementing precise PID DC motor velocity and position control. In addition there are six standard control servo ports and two continuous rotation servo ports. There are four digital sensor ports, three analog sensor ports, and one I2C port for use with external sensors. Digital port D2 can also be configured with Arduino's software serial library for serial data communications. The digital sensor ports can be configured as input or output. The analog sensor ports can be configured for analog input or digital output mode. Also onboard are two LEDs – one Red and one Green – that can be used as visual indicators.

The PRIZM controller functions are driven by an ATmega328P chip using the Optiboot bootloader for uploading program code via a USB connection to the processor chip. There are two additional processor chips used to control motor functions: a DC motor control and encoder interface chip and a servo control chip. These chips communicate with the main processor chip via I2C communication. Each motor control chip contains firmware, which handles all of the complex DC motor, encoder, and servo control functions, thereby freeing up the main processor for running program code. The green Start button is used to begin running a program that has been uploaded to the controller. The red Reset button is used to stop a running program. Pressing the red Reset button resets the main processor chip and the DC and servo control chips and initializes all stored memory values to 0.



PRIZM Controller Component Overview and Pinout Diagrams

PRIZM Sensor Ports

The PRIZM controller uses Arduino UNO-compatible pin assignments. The sensors that are supported in the Arduino PRIZM coding library are set up automatically using the library functions. Support for different types of sensors will be added as they become available. However, the ports are all directly accessible using Arduino coding functions if you wish to work with them. With the exception of the I2C port, all others can be configured as inputs or outputs using the Arduino pinMode function. To learn more, visit the Language Reference section at **www.arduino.cc**.

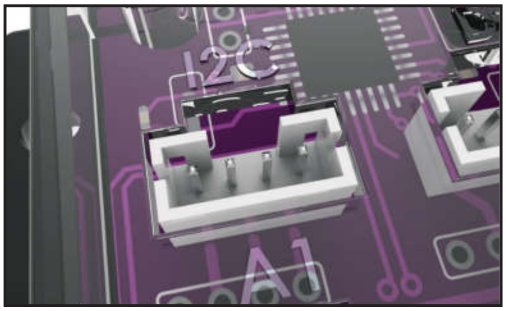


Figure 29: PRIZM Sensor Port (Pins are left to right: 1, 2, 3, 4.)

Table 1: I2C port pin assignments

Pin	Function	*Arduino Software (IDE)* pin assignment ( )
Pin 1	Ground	N/A
Pin 2	+5 volts, 100 mA	N/A
Pin 3	SDA (I2C serial data)	ADC4 input channel (A4)
Pin 4	SCL (I2C serial clock)	ADC5 input channel (A5)

Note: The PRIZM I2C port can be used only in I2C mode. It may not be configured for analog or digital mode.

Table 2: Analog Sensor Port (A1)

Pin	Function	*Arduino Software (IDE)* pin assignment ( )
Pin 1	Ground	N/A
Pin 2	+5 volts, 100 mA	N/A
Pin 3	No connect	N/A
Pin 4	Analog input or digital input/output	Analog input (A1) | digital I/O (15)

Table 3: Analog Sensor Port (A2)

Pin	Function	*Arduino Software (IDE)* pin assignment ( )
Pin 1	Ground	N/A
Pin 2	+5 volts, 100 mA	N/A
Pin 3	No connect	N/A
Pin 4	Analog input or digital input/output	Analog input (A2) | digital I/O (16)

Table 4 Analog Sensor Port (A3)

Pin	Function	*Arduino Software (IDE)* pin assignment ( )
Pin 1	Ground	N/A
Pin 2	+5 volts, 100 mA	N/A
Pin 3	No connect	N/A
Pin 4	Analog input or digital input/output	Analog input (A3) | digital I/O (17)

Note: The PRIZM I2C port can be used only in I2C mode. It may not be configured for analog or digital mode.

Table 5: Digital Sensor Port (D2)

Pin	Function	***Arduino Software (IDE)*** **pin assignment ( )**
Pin 1	Ground	N/A
Pin 2	+5 volts, 100 mA	N/A
Pin 3	Digital input/output	Digital I/O (9)
Pin 4	Digital input/output	Digital I/O (2)

Note: Digital Port D2 can also be configured as a software-implemented serial port using the *Arduino Software (IDE) Serial Library*. Pins D9 and D2 can be set to RX/TX for serial port communications.

Table 6: Digital Sensor Port (D3)

Pin	Function	***Arduino Software (IDE)*** **pin assignment ( )**
Pin 1	Ground	N/A
Pin 2	+5 volts, 100 mA	N/A
Pin 3	No connect	N/A
Pin 4	Digital input/output	Digital I/O (3)

Table 7: Digital Sensor Port (D4)

Pin	Function	***Arduino Software (IDE)*** **pin assignment ( )**
Pin 1	Ground	N/A
Pin 2	+5 volts, 100 mA	N/A
Pin 3	No connect	N/A
Pin 4	Digital input/output	Digital I/O (4)

Table 8: Digital Sensor Port (D5)

Pin	Function	***Arduino Software (IDE)*** **pin assignment ( )**
Pin 1	Ground	N/A
Pin 2	+5 volts, 100 mA	N/A
Pin 3	No connect	N/A
Pin 4	Digital input/output	Digital I/O (5)

PRIZM Servo Ports

The PRIZM controller has six position-controlled servo ports labeled 1 through 6. Each servo channel can power and control one standard hobby-type servo motor. The TETRIX PRIZM library for the *Arduino Software (IDE)* does all of the complex work of controlling the servo motors.

Note: We recommend the following servo motors, which are available at **Pitsco.com**: the TETRIX MAX Standard-Scale Servo Motor (39197), the Quarter-Scale HS-785HB Winch Servo Motor with Horn (39905), and the Quarter-Scale HS-755HB Servo Motor with Horn (39904).

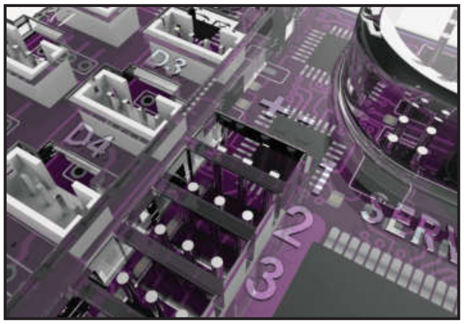


Figure 30: PRIZM Servo Motor Ports (Pins are left to right: 1, 2, 3.) (Labeled as SERVOS 1-6)

Pin 1: Servo PWM signal. It is usually the yellow or white wire.

Pin 2: Servo power supply wire. It is the red wire. PRIZM supplies +6 volt power.

Pin 3: Servo ground wire. It is the black wire.

Reversing the servo connection polarity will not damage the PRIZM controller. However, if not inserted properly, the servo motor will not function. The PRIZM controller can supply a total of 6 amps of DC power at 6 volts DC to the servo ports. The amount of current draw is limited by a thermal (self-resetting fuse).

PRIZM Continuous Rotation (CR) Servo Ports

The PRIZM controller has two additional specialized servo ports for connection of two continuous rotation servo motors. Continuous rotation servo motors are designed to rotate continuously either clockwise or counterclockwise and can be used as smaller, lightweight DC gearbox motors. The CR1 and CR2 ports are designed to be connected to these types of servo motors and can spin them continuously in either direction controlled by the commands in the PRIZM library.

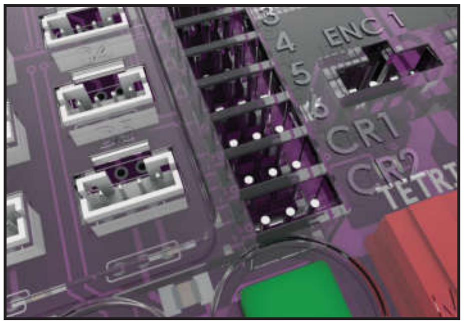


Figure 31: PRIZM Continuous Rotation (CR) Servo Motor Ports (Pins are left to right: 1, 2, 3.) (Labeled as CR1 and CR2)

Pin 1: Servo PWM signal. It is usually the yellow or white wire.

Pin 2: Servo power supply wire. It is the red wire. PRIZM supplies +6 volt power.

Pin 3: Servo ground wire. It is the black wire.

Reversing the servo connection polarity will not damage the PRIZM controller. However, if not inserted properly, the servo motor will not function. The PRIZM controller can supply a total of 6 amps of DC power at 6 volts DC to all the servo ports – this includes both CR1 and CR2. The amount of current draw is limited by a thermal (self-resetting fuse).

PRIZM Encoder Ports

The PRIZM controller has two quadrature encoder inputs for precise control of the DC Motor 1 and Motor 2 channels. When utilized with DC motors, encoders provide position and velocity feedback that is used in programming code to implement powerful and precise DC motor speed and position control. The ENC1 port provides encoder feedback for DC Motor Channel 1, while ENC2 provides encoder feedback for DC Motor Channel 2. We have included code examples using encoders and all PRIZM Arduino library functions associated with encoders. These code examples can be found in the File > Examples > TETRIX_PRIZM drop-down menu.

Note: Encoders are included as part of the TETRIX MAX TorqueNADO Motors. To utilize the TorqueNADO motor encoder, plug the white end of the encoder cable into the TorqueNADO motor. Plug the black end of the encoder cable into the PRIZM ENC1 or ENC2 port.

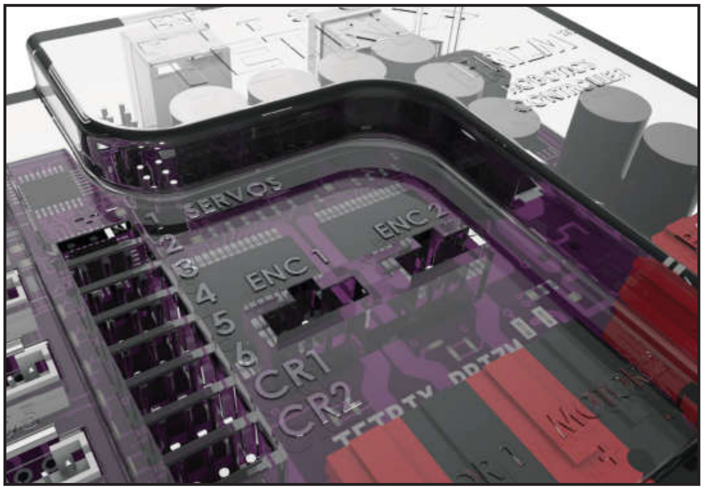


Figure 32: PRIZM Quadrature Encoder Port
(Pins are left to right: 1, 2, 3, 4.) (Labeled as ENC1 and ENC2)

Pin 1: +5 volts DC power supply

Pin 2: Encoder count signal (A)

Pin 3: Encoder ground

Pin 4: Encoder count signal (B)

Although the connector socket is "keyed" to prevent reverse polarity, take care to not force the connector into the socket in the opposite direction. Damage to the encoder or PRIZM controller could occur if the connector is forcibly inserted in the reverse polarity direction.

PRIZM Expansion Port

The PRIZM controller has a RJ-45 modular jack, labeled EXP, connected to the onboard I2C bus. This port can be used to connect additional TETRIX DC Motor Controllers and servo controllers in a daisy-chain arrangement. Up to four additional DC and/or servo motor controller boxes of any combination can be connected to the expansion port for added motor control channels. Each additional motor control box will dynamically set its own I2C address depending on its position in the daisy chain. The first box will use address "0x01", the second, "0x02", the third, "0x03", and the fourth "0x04".

When using additional I2C sensors or devices plugged into either the expansion port or the I2C sensor port, these devices may not use I2C addresses 0x01 through 0x06. These address locations are reserved by the PRIZM internal motor and servo control processor chips and any expansion motor or servo controller daisy-chained to PRIZM through the expansion port.

Note: This port is not compatible with LEGO® MINDSTORMS®-related devices. Do not plug in LEGO MINDSTORMS sensors, motors, the EV3 Brick, or any other LEGO device to this port.

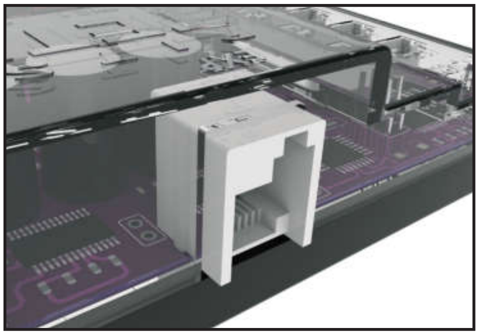


Figure 33: PRIZM Motor Controller Expansion Port
Offset tab RJ-45 modular jack

PRIZM USB Port

The PRIZM USB port is used for communication between PRIZM and a Windows, Mac, or Linux computer. Its main use is for downloading program code to the program memory processor. It can also be used to transfer data between PRIZM and a computer using serial communications protocol. For example, the *Arduino Software (IDE)* includes a built-in serial monitor display window used to display data values received from the PRIZM controller. This feature can be used to display sensor or encoder data or even other types of program data as needed.

Oftentimes, viewing data values can be very helpful when debugging program code. The serial monitor can also be used to send information to the PRIZM controller. An example of this would be to have the PRIZM controller moving DC motors or servos in response to keyboard entries. Users with advanced programming knowledge could create graphical interfaces using Java, Python, or another coding platform for monitoring data or controlling functions.

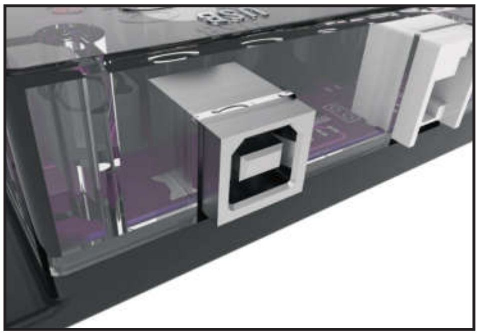


Figure 34: PRIZM USB Programming and Communication Port

PRIZM Reset Button

The red Reset button is used for two purposes. When pressed, it will terminate any program code that is being executed and reset all sensor and encoder data values to their initialized states. It effectively resets the entire system just as switching power off and back on would do.

Figure 35: PRIZM Reset button. Press down to activate.

PRIZM Start Button

The green Start button is used to begin the execution of program code that is downloaded to the PRIZM controller. When you are creating program code using the *Arduino Software (IDE)*, the PrizmBegin function executes all the instructions necessary to begin running a program. Calling this function initializes necessary parameters to their proper state and causes the program code to wait until the green Start button is pressed before execution.

Figure 36: PRIZM Start button. Press down to activate.

PRIZM DC Motor Ports

The PRIZM controller has two DC motor connection ports labeled Motor 1 and Motor 2. Each motor channel is used to control the speed and direction of DC motors via software commands defined in the PRIZM *Arduino Software (IDE)* Library. Each motor channel can provide 10 amps of continuous DC current at 12 volts. Each motor channel has a red and black connector, with red being the positive connection and black the negative connection. The TorqueNADO motor power cables come with the mating colored connectors and should be plugged red to red and black to black for proper operation.

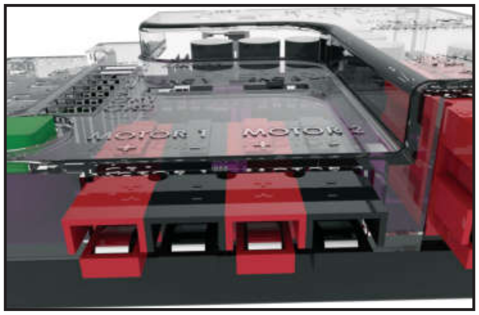


Figure 37: PRIZM DC Motor Ports

PRIZM Battery Connection Port

The PRIZM controller is powered by a TETRIX 12-Volt Rechargeable NiMH Battery Pack. Included with the PRIZM controller is a power on/off switch assembly designed to connect the battery pack connector to the PRIZM-style battery connection port. The battery pack can be plugged into either the top or bottom row of the port. The extra port is intended to be used to daisy-chain power to additional motor controllers that can be optionally added to PRIZM via the expansion port.

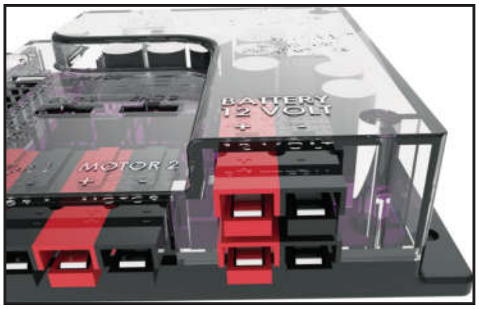


Figure 38: PRIZM Battery Power Inlet/Outlet Port