

Talon SRX – User's Guide



Cross The Road Electronics

www.crosstheroadelectronics.com



Talon SRX - User's Guide

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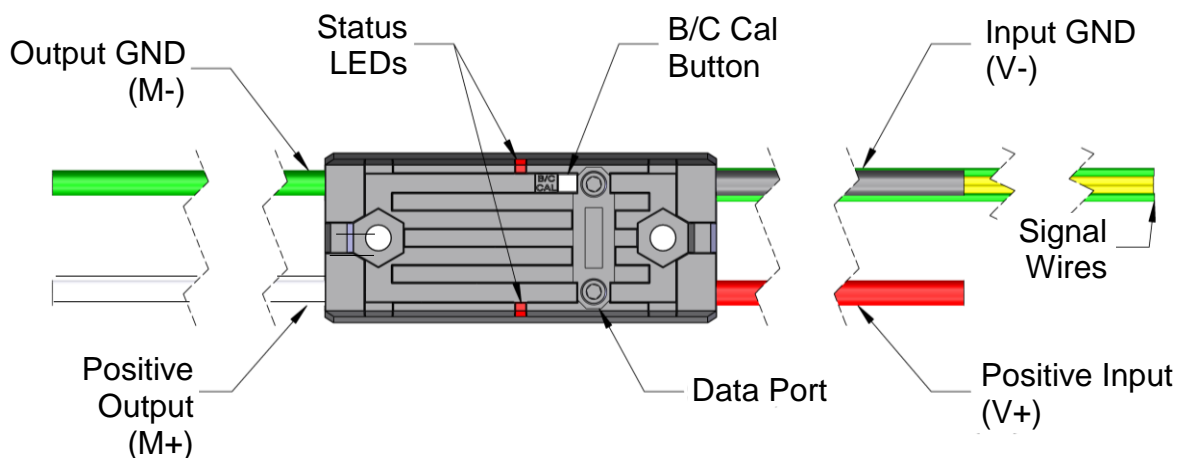
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The Talon SRX is a speed controller designed through collaboration between VEX Robotics (VEX.com) & Cross the Road Electronics (crosstheroadelectronics.com) that allows fine control and high performance of brushed DC motors in competition robotics applications. The Talon SRX handles high current loads with minimal voltage drop and heat generation. Its linear output and Brake/Coast options allow for precise motor control, making it well suited for everything from drivetrains to shooter wheels.

The Talon SRX's Data Port and CAN bus features make it the most capable motor controller available for competition robotics. The Data Port allows Quadrature Encoders, Limit Switches and Analog Sensors to be connected directly to the motor controller. Sensors that are connected through the Data Port are directly processed by the Talon SRX, freeing up resources in the primary robot controller for more complex user code. When using CAN bus, up to 63 Talon SRXs can communicate with the primary robot controller for tasks like field-upgrade, Data Port Configuration, dynamic Brake/Coast toggling, and motor control.

The lightweight aluminum case was designed using extensive Finite Element Heat Transfer Analysis (FEHTA). The result is a fully sealed design that makes fans optional. This, combined with a 3.25 sq. in footprint, a variety of built-in mounting options, and super-flexible/high-strand-count leads, makes installation a breeze.

The Talon SRX at a Glance:



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Electrical/Mechanical Specs:

Talon SRX Specs	
Outside Dimensions	2.75" x 1.185" x 0.96" [69.9mm x 30.2mm x 24.4mm]
Weight	0.23 lbf [0.10 kgf] (excluding wiring)
Supported Communication Protocols	PWM, DWCAN bus (1Mbps)
Nominal Voltage	12V
Min/Max Voltage	6 – 28V
Continuous Current	60A
Surge Current (2 sec)	100A
PWM Input Pulse (High Time)	1 – 2 ms Nominal 0.6 – 2.4ms max
PWM Input Rate (Period)	2.9 – 100ms
PWM Output Chop Rate (Switching Frequency)	15.625 kHz
Minimum Throttle (Dead band)	4%
PWM Logic High Min Voltage Threshold	1V
PWM Logic Low Max Voltage Threshold	0.4V
PWM Input Min Current	< 1mA
Max Quadrature CPR ⁽¹⁾	80,000,000 / Peak RPM
Max Quadrature RPM ⁽¹⁾	80,000,000 / CPR
Logic High Min Input Voltage Quad A/B/Idx/Limit Fwd/Rev	2.64V
Logic Low Max Input Voltage Quad A/B/Idx/Limit Fwd/Rev	0.66V
Min/Max Voltage Analog Input	0 – 3.3V
Min/Max Voltage Quad A/Limit Fwd/Rev	0 – 5V
Min/Max Voltage Quad B and Quad Idx	0 – 3.3V ⁽²⁾ (Talon revision 1.5 and earlier) 0 – 5V (Talon revision 1.6 and on)
Data Port Max Current	3.3V (pin1) : 33mA 5V (pin2) : 50mA

Note 1: This is based on the maximum quadrature edge-to-edge rating of 187.5ns.

Note 2: A late errata on the microcontroller was released after Talon SRX 2015 season production, indicating the Quad B and Quad Idx are not 5V tolerant. As a result, Talons with revision 1.5 (and earlier) should not use sensor cable/breakouts that allow >3.6V on Quad B or Quad Idx, as this may damage Talon SRX. See Talon SRX Software Reference Manual (Section 2) for how to detect Hardware Revision. See [Section 1.4.6.1](#) for the updated breakout solution.



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The power inputs and outputs of the Talon SRX are indicated by markings on the housing. They are also shown in the table below:

Wire	Case Marking	Wire Color	Wire Gauge	Wire Length ± 0.25in [6.35mm]
Positive Input	V+	Red	12 AWG (600 strand min)	5.5in [139.7mm]
Input Ground	GND	Black	12 AWG (600 strand min)	5.5in [139.7mm]
Positive Output	M+	White	12 AWG (600 strand min)	5.5in [139.7mm]
Output Ground	M-	Green	12 AWG (600 strand min)	5.5in [139.7mm]
CAN-High/ PWM Signal	None	Yellow	22 AWG	11.0in [279.4mm]
CAN-Low/ PWM Ground	None	Green	22 AWG	11.0in [279.4mm]

Note: There are (2X) yellow and (2X) green 22AWG signal wires on each Talon SRX. Signal wires of the same color are electrically identical.



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1. Installing a Talon SRX

Wiring a speed controller has never been easier than with the Talon SRX. By following a few quick steps, your robot will be up and running in no time.

1.1. Wiring the Motor Output

Connect the white wire to the M+ side of the motor and the green wire to the M- side of the motor using tightly crimped connectors.

If the motor's inputs are not marked, the polarity of the input may be chosen by the user. Be sure to connect the output wires to motors with consistent polarity so each motor will rotate the same direction when given the same PWM signal. Reversing the output wire connections will result in the motor rotating the opposite direction when given the same PWM signal.

In many cases, the output leads of the Talon SRX will not be long enough to reach the motor it is controlling, so an extension cable will be required. Extension cables should be made using appropriately sized wire and connected using tightly crimped connectors.

Note: For the most robust connection, it is **highly** recommended that all connectors are crimped **and** soldered.

1.2. Wiring the Power Input



WARNING: TO MAXIMIZE PERFORMANCE, THE TALON SRX DOES NOT INCLUDE REVERSE POLARITY PROTECTION. IF POWER IS APPLIED BACKWARDS, THE TALON SRX MAY BE PERMANENTLY DAMAGED.

To power the Talon SRX, connect the positive input (red) wire to the selected positive terminal of the Power Distribution Panel (PDP), and the input ground (black) wire to the corresponding ground terminal. In many cases, the Talon SRX may be wired directly to the robot's PDP without extension cables – this is preferable since it reduces the number of electrical connections. If the robot's design does not allow for a direct connection to the PDP, extension cables may be used.

Always keep good electrical practices in mind when designing a robot's electrical system. The Talon SRX's source voltage should never exceed 28V. In addition, a 40A or smaller breaker should be used in series with the Talon SRX's positive input.



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1.3. Wiring the Talon SRX Signal Input

The Talon SRX is capable of being controlled using either CAN bus or a PWM signal. Each input type has its own pros and cons that should be carefully considered before wiring and programming.

The CAN bus capability of the Talon SRX is one of its most powerful features. It allows up to 63 Talon SRXs to be daisy chained – this means Talon SRXs can plug into each other and only require a single output on the primary robot controller. CAN bus also allows two-way communication between the Talon SRX and the robot controller, which enables tasks like field-upgrade, Data Port configuration, dynamic Brake/Coast toggling, and motor control. When using CAN bus, sensors that are connected to the Data Port are monitored by the Talon SRX meaning that the primary robot controller has more processing power to devote to other tasks.

One of the simplest ways to control a Talon SRX is using a Pulse Width Modulation (PWM) signal. Unlike CAN bus control, using PWM requires that each Talon SRX must be individually connected to a different output on the system's primary robot controller – Talon SRXs cannot be daisy chained in PWM mode. When using PWM to control the Talon SRX, only limit switches (or equivalent binary switches) may be used with the Data Port. Encoders or Analog sensors cannot be used.

1.3.1. Configuring a Talon SRX with CAN bus on a roboRIO

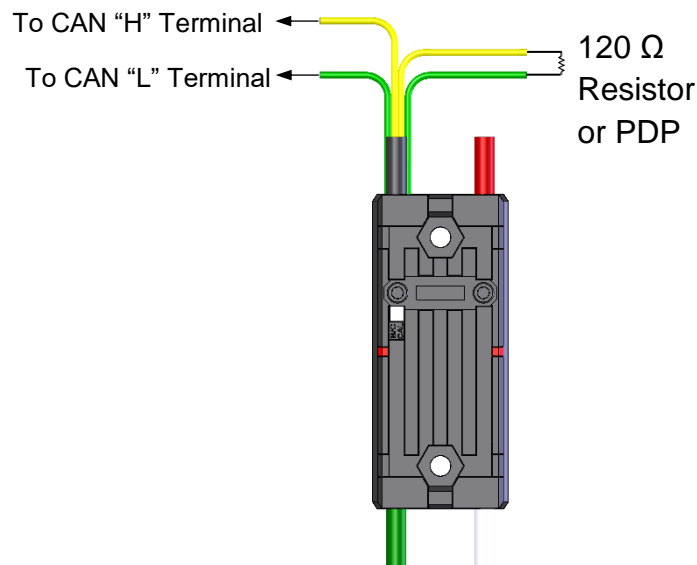
Talon SRX automatically detects CAN bus traffic so there is no need to select "CAN" vs "PWM". The only configuration that is necessary is assigning Device IDs to prevent common-ID Talons (more than one Talon with the same device ID). This is a common problem condition that prevents reliable communication between the primary robot controller and other CAN devices.

However the roboRIO Web-based Configuration page is tolerant of common-ID Talons to a degree (up to typically five or less common-ID Talons), so you can discover, firmware update, modify settings, and change the device ID of a common-ID Talon to an unused device ID. More information can be found in the Software Reference Manual.



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Another option is to explicitly ensure each Talon SRX has a unique ID assigned to it prior to wiring the entire CAN bus harness. To do this, connect a yellow signal wire to the NI roboRIO CAN terminal marked “H” and connect a green signal wire to the NI roboRIO CAN terminal marked “L” as shown in the figure below. Connect the remaining green and yellow signal wires using a 120 Ω resistor as shown in the figure below. Alternatively the Power Distribution Panel's CAN interface can be wired instead of a 120 Ω resistor since the PDP has an integrated resistor.



After the Talon SRX has been connected to the roboRIO, **ensure there are no shorts**, then apply power and use the roboRIO Web-based Configuration page to assign the Talon SRX a unique ID.

TIP: Avoid using the default ID “0”, this makes adding new default Talons easier. The unique ID is a 6-bit number; valid numbers are from 1 to 62. After the unique ID has been assigned, remove power and repeat the process for each Talon SRX.

WARNING: When applying power to the Talon SRX for programming its unique ID, it may be tempting to connect it directly to a 12V robot battery without a breaker – this is NOT recommended. If the temporary power connectors short without a breaker protecting the wires, there is a high risk of an electrical fire.



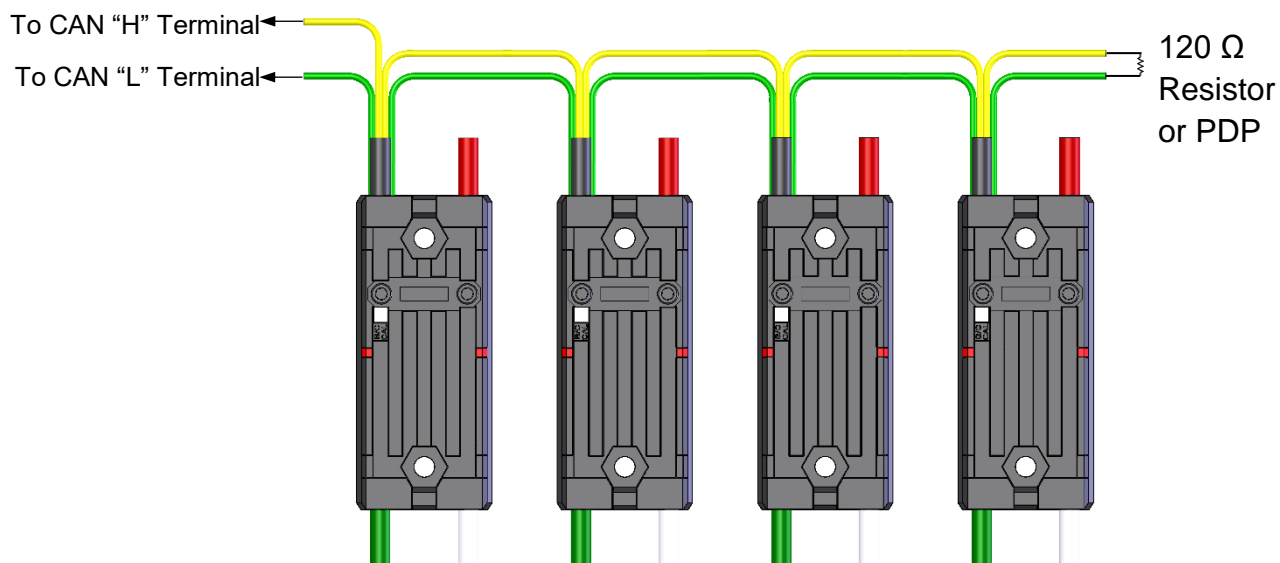
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1.3.2. Wiring the Talon SRX for use with CAN bus

To wire CAN bus, connect a yellow signal wire to the CAN terminal marked “H” on the NI roboRIO and connect a green signal wire to the CAN terminal marked “L” on the NI roboRIO.

To connect additional Talon SRXs, use tightly crimped connectors to connect the signal wires green-to-green & yellow-to-yellow as shown below. For the best connection, it is **highly** recommended that each connector is crimped **and** soldered. The yellow and green wires should also be wrapped in a twisted pair fashion (not illustrated) to maximize tolerance to electrical noise.

Note: Signal wires of the same color are electrically identical – it does not matter which wire is used as long as the color is correct.

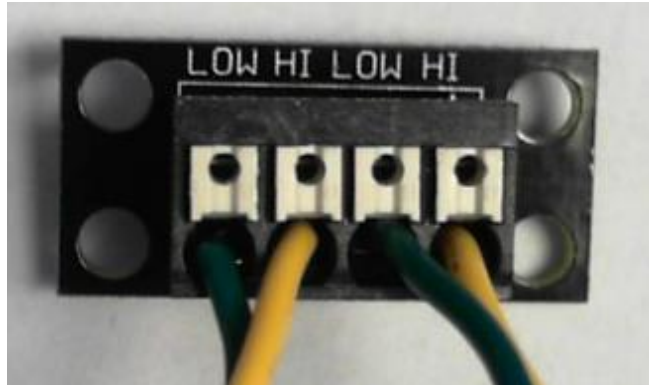


After all of the Talon SRXs have been wired, there will be 2 remaining signal wires – connect these two wires using a 120 Ω resistor or to the CAN interface on the Power Distribution Panel (PDP) to properly terminate the cable end.

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1.3.2.1. CAN Connector

The CAN Connector can be used to chain Talon SRX's together without crimping connectors or soldering. Each CAN Connector contains a four channel Weidmuller terminal block with two CAN pairs (similar to other FRC CAN devices such as the Power Distribution Panel and Pneumatic Control Module). The four holes can be used to provide strain relief to the CAN wires. Additionally the holes can be used for mounting to the robot frame. Spacers or electrical tape may be used to prevent shorting to the robot frame.



1.3.2.2. CAN Bus Wire Selection

Teams should consult the FRC game rules for CAN wiring requirements. However it is recommended to use **yellow** for CANH and **green** for CANL for the following reasons...

- ☐ Makes robot inspection and troubleshooting easier.
- ☐ The colors match what is labeled on the FRC Robot Controller, Power Distribution Panel, and Pneumatic Control Module.
- ☐ The colors match the Talon SRX cable harness.

AWG 22 or similar gauge wiring can be used. An electric drill can be used to twist the CANH/CANL wire pair.



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1.3.3. Wiring Talon SRX for PWM Control

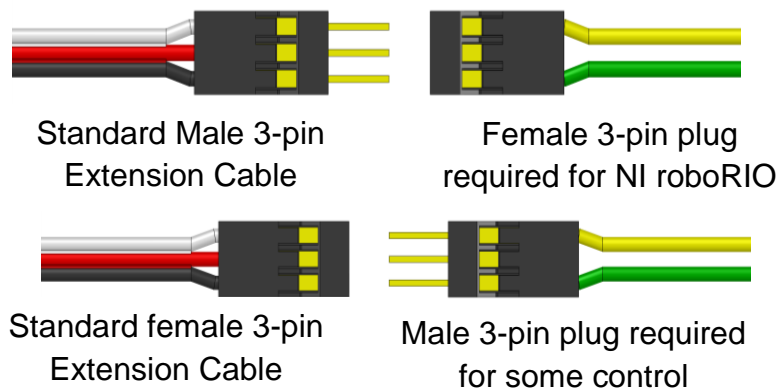
Before the Talon SRX can be controlled using a PWM signal, a standard 3-pin (0.1in pitch) PWM plug must be connected to the Talon SRX's signal wires. This can be done in one of two ways:

- PWM housings and pins or sockets may be assembled directly on the Talon SRX's signal cables. If many Talon SRXs are being wired, this option will be cheaper but may be more difficult for inexperienced users and may have a higher initial investment due to the need of a specialized crimper.
- A pre-assembled PWM cable may be cut and spliced onto the Talon SRX's signal wires. This option is more expensive if many Talon SRXs are being wired, but may be easier for inexperienced users and may require a smaller initial investment.

In either case, the PWM cable should be wired such that the green (PWM ground) and yellow (PWM signal) wires are on the outside of the PWM connector, as shown below. The center pin requires no wire.

When purchasing components, be sure to order the correct gender PWM connector – different control systems require different genders of PWM connectors. (The NI roboRIO requires a female PWM connector.)

Only (2X) of the (4X) signal wires are needed to control the Talon SRX with PWM. **Do Not connect (2X) PWM connectors to a single Talon SRX.** The (2X) wires that are not used for PWM control should be electrically isolated using tape or heat shrink tubing and neatly bundled out of the way to prevent damage.



Note: Signal wires of the same color are electrically identical – it does not matter which wire is used as long as the color is correct.

After a PWM connector is installed, the Talon SRX will readily interface with the NI roboRIO and many other microcontrollers. The PWM signal used to control the Talon SRX must be between 1-2ms in duration with a center (neutral) pulse of 1.5ms and a period between 2.9-100ms.



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Multiple Talon SRXs may be driven using a single PWM signal if a Y-Cable equivalent is used to connect multiple PWM inputs to a single PWM output.

Note: The PWM period is how fast the robot controller can send a new PWM pulse. The amount of time between the rising edges of two subsequent PWM pulses should not be less than 2.9ms nor greater than 100ms.

Note: The PWM input has a logic-high minimum threshold voltage of 1.0 V. The logic-low maximum threshold is 0.4 V. The PWM input current requirements are negligible ($<1\text{mA}$). This is sufficient for most 3.3V and 5V based microcontrollers that generate PWM.

Connecting a Talon SRX to an NI roboRIO using PWM:

To connect a Talon SRX to the NI roboRIO controller, simply plug the Talon SRX's PWM cable into the desired PWM header in the roboRIO's PWM output with the yellow (signal) wire on the "S" or "inside" of the controller. The green wire will connect to the "GND" or "outside" of the controller. If an extension cable is needed for the Talon SRX to reach the roboRIO, a standard 3-wire extension cable should be used – these extension cables are available from VEX Robotics as well as many other online retailers.



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1.3.4. Firmware requirements (PWM and CAN bus)

Typically a Talon is shipped with firmware version 0.28. Teams should always check the FRC game rules to determine what is the required minimum firmware version for Talon SRX (PWM / CAN bus).

Teams that utilize **CAN bus** will likely want to field-upgrade to the latest available firmware for the latest features and improvements (1.1 or newer). Instructions can be found in the Software Reference Manual. Additionally teams may need to field-upgrade to meet the minimum firmware version in the FRC game rules.

Teams that utilize **PWM *may still*** require a firmware update if an out-of-the-box Talon has older firmware than 0.28. Firmware that predates 0.28 will have these symptoms:

- Press and holding B/C CAL Button will not enter calibration mode (**red/green** LED blink).
- Limit switch features not present (closing limit switches has no impact).
- Boot up sequence will illuminate the B/C CAL Button for ~500ms.

1.3.4.1. PWM - Checking firmware version

As a result, it is recommended that teams using PWM first determine if a Talon has adequate firmware by **press and holding** the B/C CAL button and confirming that the Talon enters calibration mode (LEDs will blink a **red/green** pattern). See [Section 2.2.1](#) for full procedure on entering calibration mode.

IMPORTANT --- Do not drive the Talon while performing these steps unless you deliberately want to recalibrate your Talon. For this reason, it's best to perform this check while robot is disabled. As a result, when you release the B/C CAL button, the Talon will blink **red**, indicating that it did not modify the calibration data.

If the Talon **does** enter calibration mode (**does** blink **red/green**) then it has adequate firmware for complete PWM functionality and **no more steps are necessary** (however FRC legality should be checked against the game rules).

If the Talon instead just changes the brake LED (brake vs. coast) and **does not** enter calibration mode then it needs to be updated once using CAN bus. See [Section 1.3.4.2](#) for a simplified procedure on how to do this.

Additional functional limitations of the “ship” firmware may be found in section 21 of the Talon SRX Software Reference Manual. Although most of the limitations relate to CAN bus features, it is recommended that teams always check section 21 for additional functional limitations that may affect them.

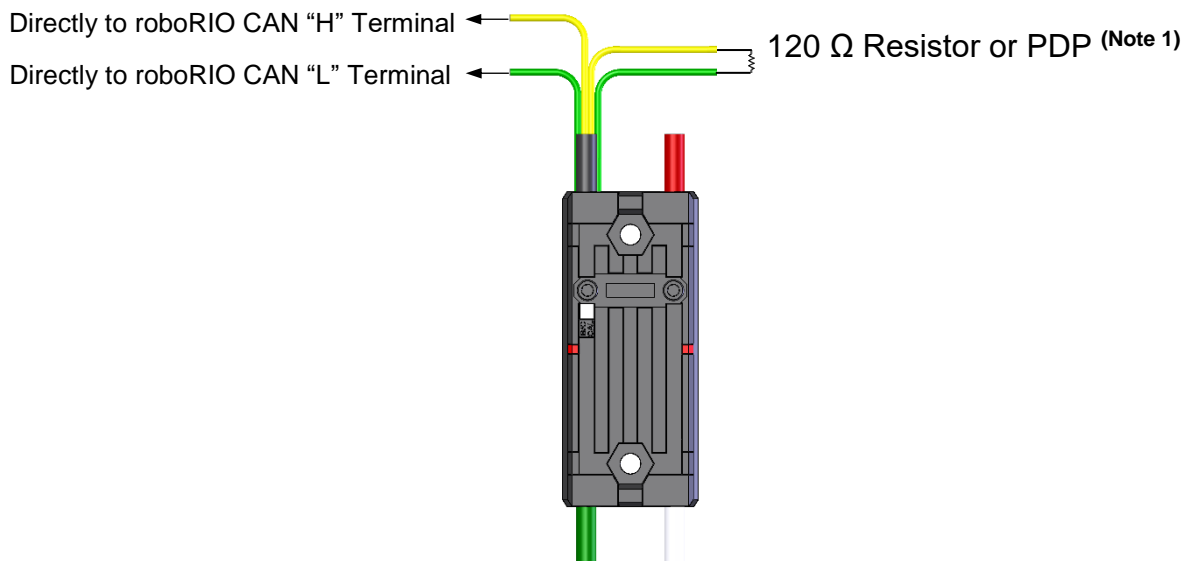


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1.3.4.2. PWM – Updating firmware for PWM use.

If the steps in [Section 1.3.4.1](#) reveals that a Talon intended for PWM use has too-old firmware, field upgrading a Talon can be done quickly with the following procedure...

- Power off robot and disconnect Talon SRX from roboRIO's PWM port if it's connected.
- Locate the free yellow/green CAN wire pair from the Talon. Since PWM-use only requires one yellow/green wire pair, the other should be free to use.
- If the roboRIO CAN bus port is in use, disconnect the CAN bus wires to free the roboRIO's CAN bus port. This is done by pressing the Weidmuller connector buttons on the roboRIO and pulling out the CAN bus wires.
- Insert the Talon's free yellow/green wire pair directly into the roboRIO's CAN bus.



Note 1: Although CAN bus requires 120Ω resistor (or PDP) at each of the two ends of the CAN bus, when connecting a single Talon to a roboRIO for the **specific purpose of updating a single Talon**, you can likely **skip** terminating this end. This is because the short bus length of a single Talon, and the 120Ω resistor integrated in the roboRIO is generally sufficient for the purpose of this procedure. This is convenient since in this specific case, the Talon wire pair not connected to the roboRIO's CAN bus port will likely have a PWM connector crimped onto it.

- Power the robot on and follow the firmware update steps in the **Software Reference Manual, Section "2.3 Firmware Field-upgrade a Talon SRX"**. The attached Talon will likely have a device ID of zero. Generally it's best to update to the latest crf file.
- Disconnect the Talon SRX from roboRIO CAN bus port. If there are additional Talons to update, go back and re-perform this procedure. Although the roboRIO and Talon



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software does not require you to power cycle the robot before re-flashing each Talon, making wire changes while the robot is powered is a risk factor for shorting. Use best judgment on how to safely replace the upgraded Talon with the “next” Talon to field-upgrade.

TIP: Robot Inspectors at competition will likely check your Talons using the same steps documented here for firmware legality, so be sure to update your competition robot Talons before the ship date for expedient robot inspection at competition.



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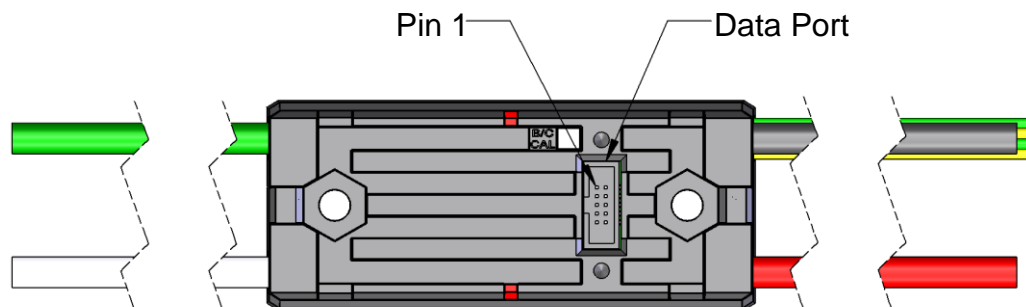
1.4. Wiring Sensors to the Talon SRX

1.4.1. Data Port Pinout

Sensors may be connected directly to the Talon SRX via the Data Port. The Talon SRX supplies the voltage and ground to the sensor devices. Do not supply external voltages or ground into the Data Port.

The Data Port accepts a 2x5 0.05 inch pitch keyed cable that is available from many online retailers as well as VEX Robotics. The ribbon cable used by the Data Cable is very thin; as a result, some teams may find a breakout board helpful when wiring sensors.

Note: Leave unused Data Port Pins floating.



+3.3V	1	●	●	2	+5V
Analog Input	3	●	●	4	Forward Limit
Quadrature B	5	●	●	6	DO NOT CONNECT
Quadrature A	7	●	●	8	Reverse Limit
Quadrature Index	9	●	●	10	GND

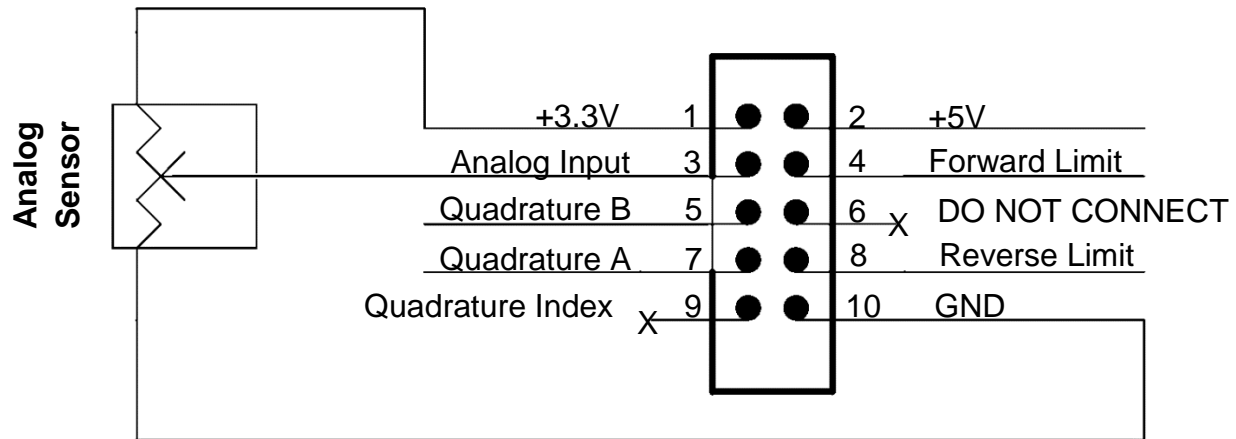
Data Port Pinout



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1.4.2. Analog Input

Attach the analog sensor as shown. Do not connect the GND line elsewhere. Only use 3.3V as the analog sensor voltage source. Although the figure explicitly shows a potentiometer, a 3.3V Analog Encoder can also be wired similarly.



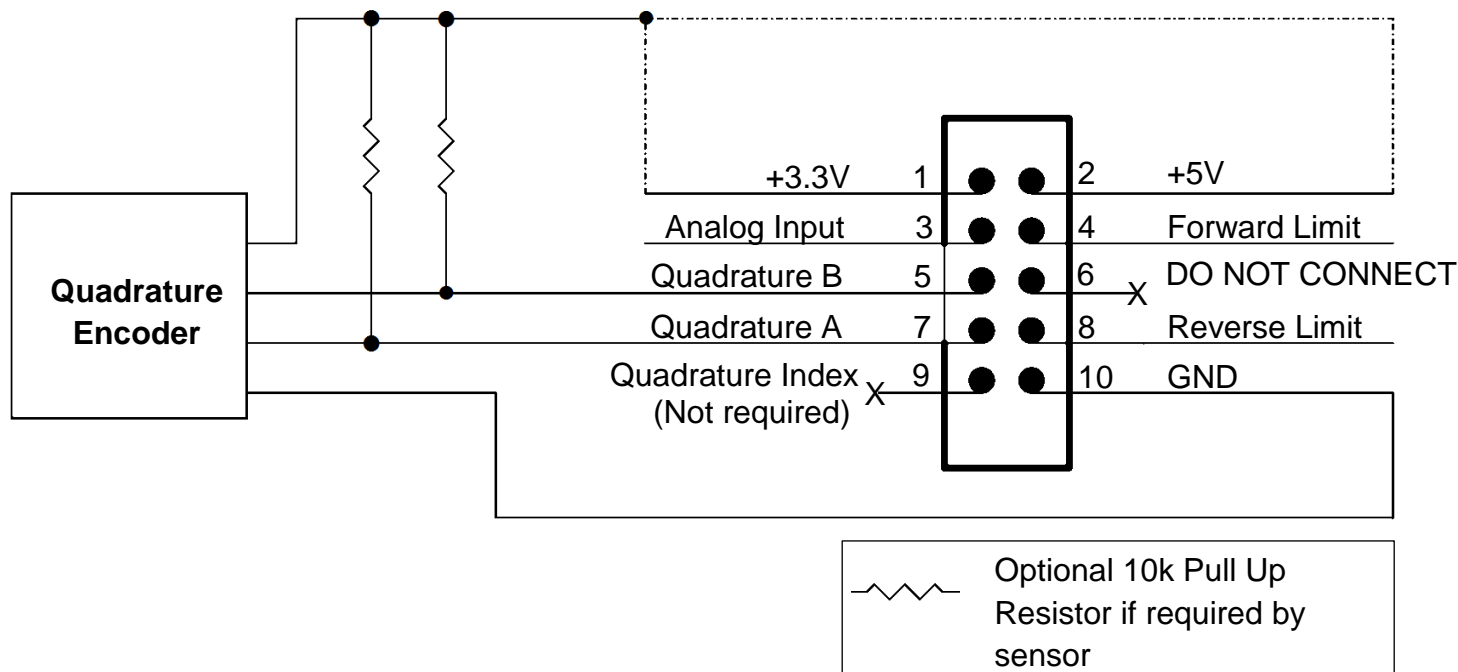
Analog Sensor Input



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1.4.3. Quadrature Encoder Input

Attach the Quadrature Encoder as shown. Do not ground the GND line elsewhere. Connect either the 3.3V or 5.0V as required by your sensor. DO NOT CONNECT THE 3.3V OUTPUT TO THE 5V OUTPUT. Some encoders may have an Index pin. Talon supports counting the rising edges on the Index rail so that robot controller can react to it. However wiring index is not required for decoding the position and velocity of the encoder.

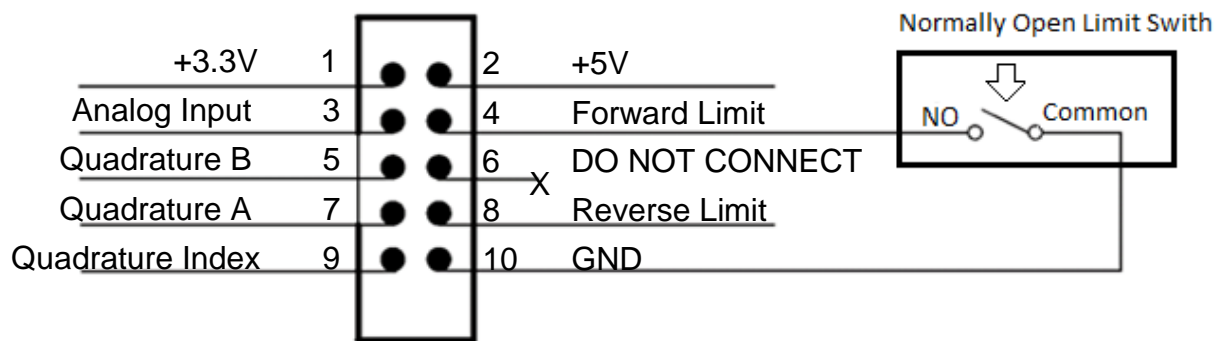


Quadrature Encoder Input

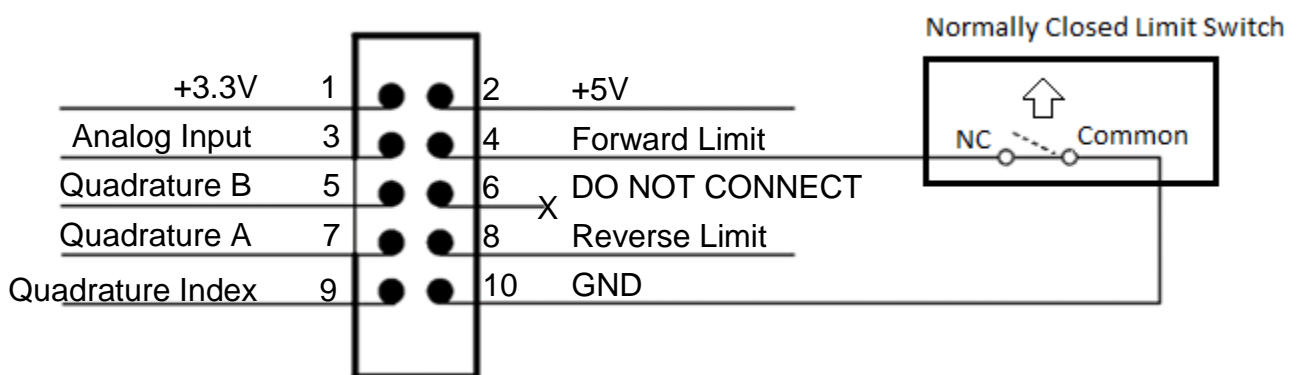
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1.4.4. Forward & Reverse Limit Switch Inputs

Attach the Forward/Reverse Limit Switch as shown. Do not connect the GND elsewhere. The Talon SRX provides a pull-up to 2.5v, so typically an external pull-up is not needed. Only use Talon SRX 3.3V or 5.0V power if an external pull-up is used. The default setting of "Normally Open" ensures an "out of the box" Talon SRX functions even if no limit switch is connected. See the Software Reference Manual to change the default Limit Switch behavior from "Normally Open".



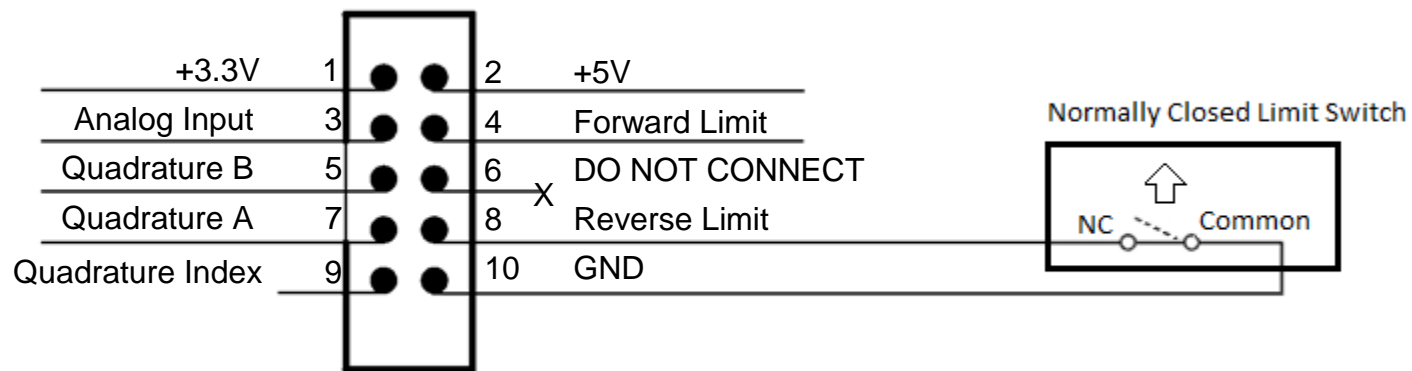
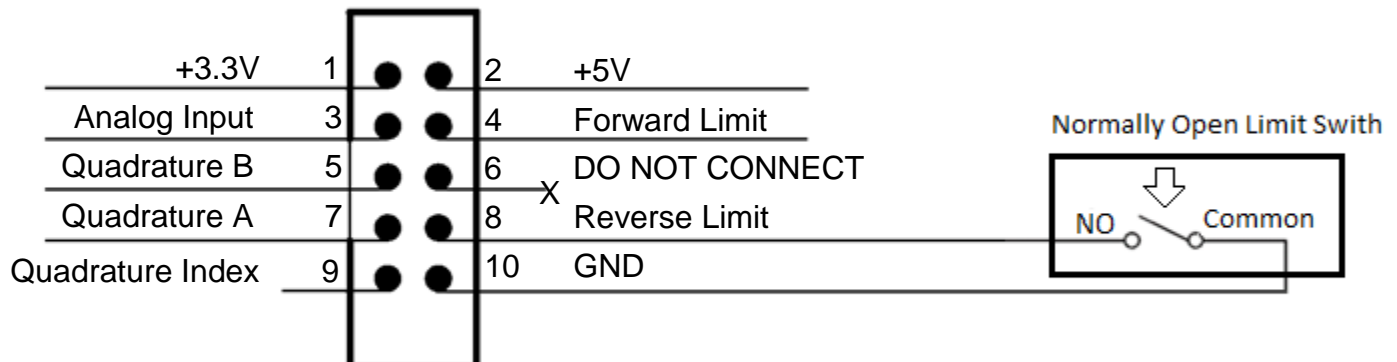
Forward Limit Switch - Normally Open (default)



Forward Limit Switch - Normally Closed



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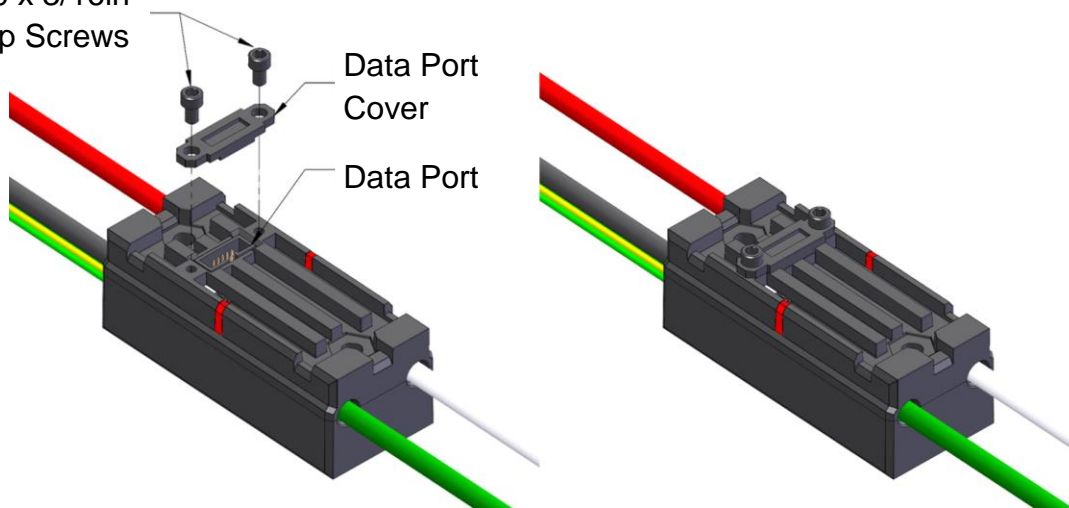


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1.4.5. Connecting to the Data Port

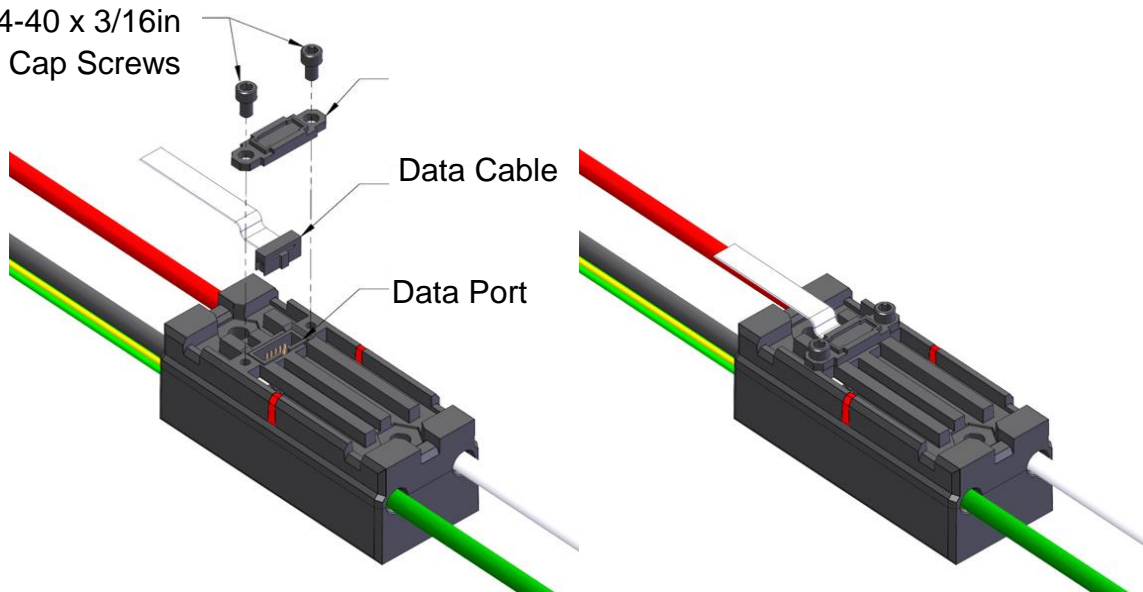
To maintain a sealed case, the Talon SRX includes a plastic cover for the Data Port. When the port is not being used, the plastic cover should be installed on the case, as shown below, to protect the pins from foreign objects. When installing the cover, be sure to note its orientation.

(2X) #4-40 x 3/16in
Socket Cap Screws



To use the Data Port, a 2x5 0.05 inch pitch connector should be wired as detailed in the previous sections and plugged in as shown below. After the connector is plugged it, the plastic cover may be used to retain the connector, as shown below – be sure to note the plastic cover's orientation.

(2X) #4-40 x 3/16in
Socket Cap Screws

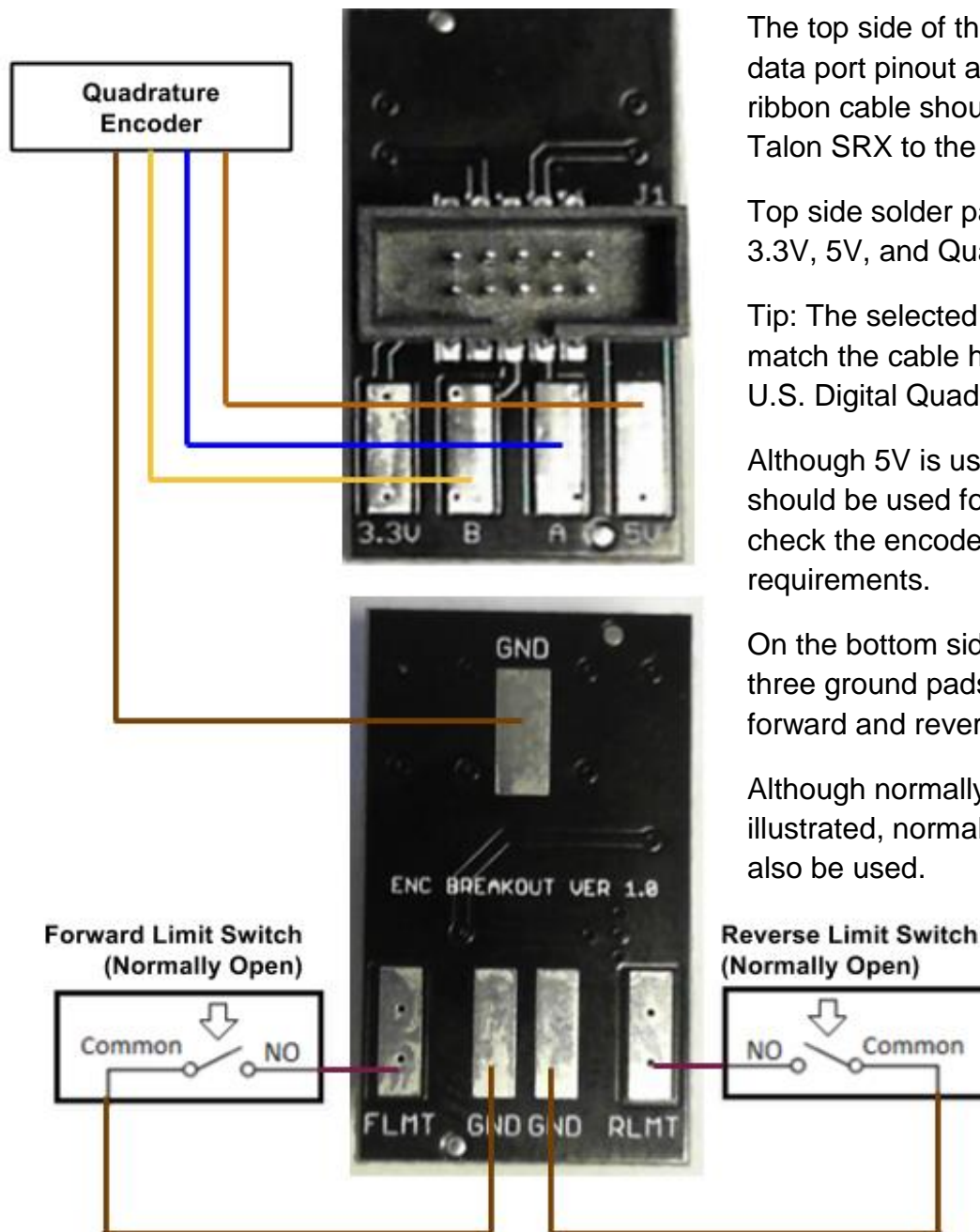


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1.4.6. Encoder (and Limit Switch) Breakout

The Encoder Breakout makes breaking out the encoder and limit switch pins even easier.

Part Numbers: **CTRE_ENC_BRK**, 217-4398(vexrobotics.com), **am-2633**(andymark.com)



The top side of the breakout has the same data port pinout as the Talon SRX. A ribbon cable should be used to connect the Talon SRX to the breakout.

Top side solder pads are broken out for 3.3V, 5V, and Quadrature A and B.

Tip: The selected colors in the diagram match the cable harness colors for some U.S. Digital Quadrature Encoders.

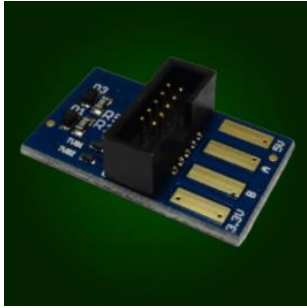
Although 5V is used in this example, 3.3V should be used for 3.3V encoders. Always check the encoder data sheet for voltage requirements.

On the bottom side of the breakout are three ground pads and the two pads for forward and reverse limit switch inputs.

Although normally open switches are illustrated, normally closed switches can also be used.

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1.4.6.1. Encoder (and Limit Switch) Breakout – Blue Revision



The latest revision of the Talon SRX Encoder Breakout Board has additional level shifting to ensure proper operation with 5V Quadrature sensors, regardless of Talon SRX hardware revision (see Electrical/Mechanical Specs – Note 1). These boards are easy to identify as they are **blue**.

NOTE: Quad A and Quad B are reversed on this revision. Users intending to use features that require the Talon's Quad A pin should wire to the Breakout's Quad B pad (Rising Edge Counter for example). Additionally, migrating from the **black** to **blue** revision will cause the sensor direction orientation to change.



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1.4.7. Analog 5V Encoder (and Limit Switch) Breakout

The Analog 5V Breakout is for wiring a 5V analog sensor and limit switches. What makes this breakout unique is that it scales a 5V analog signal to 3.3V using a resistor divider and voltage buffer.

Part Number: **217-4401(vexrobotics.com)**, **am-2634(andymark.com)**

5V Magnetic Shaft Encoders like the U.S. Digital MA3 “just work” since the breakout shifts the encoders native 5V output to a Talon SRX compliant 3.3V signal.

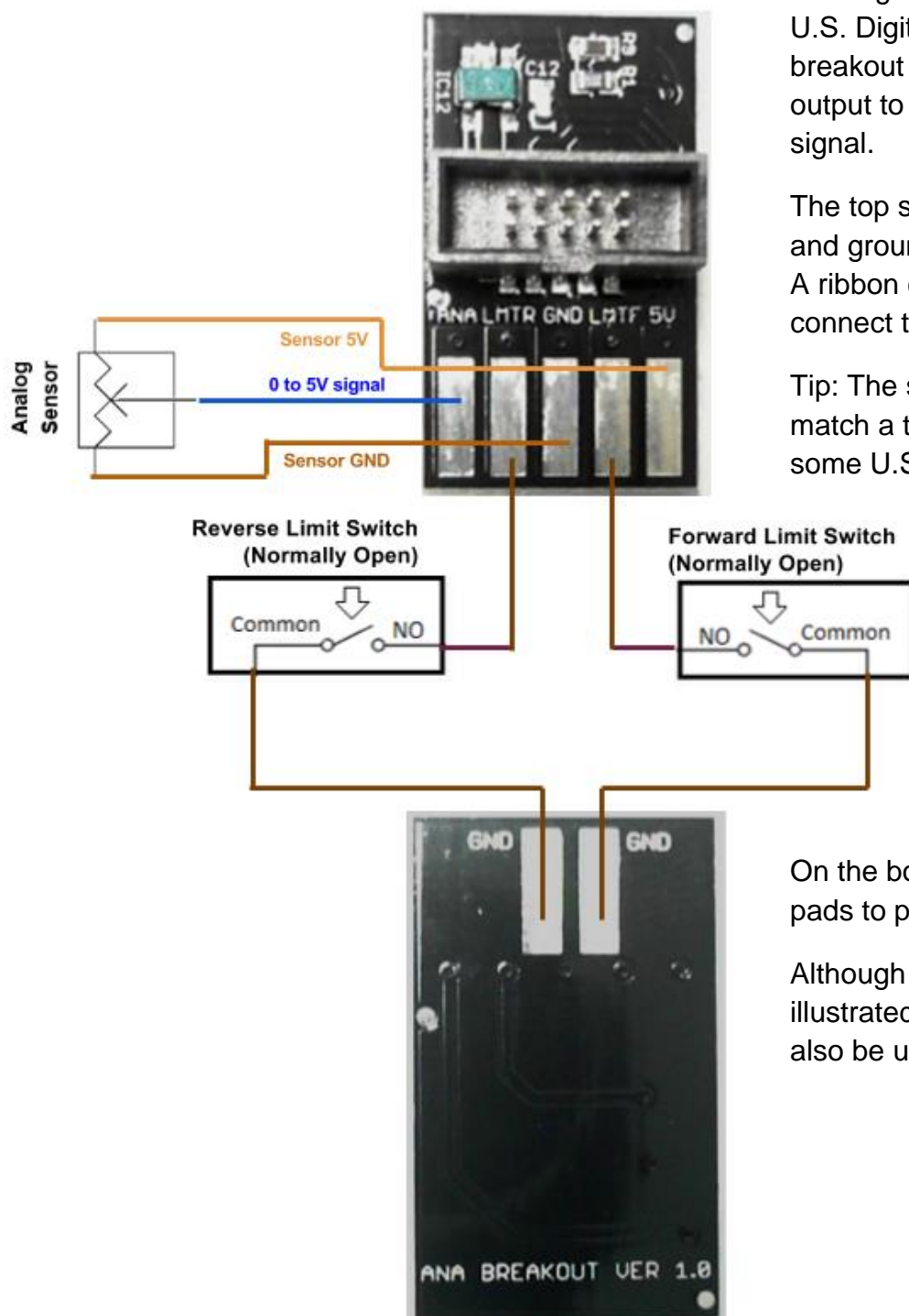
The top side has the 5V power, signal, and ground pads for the analog sensor. A ribbon cable should be used to connect the Talon SRX to the breakout.

Tip: The selected colors in the diagram match a typical cable harness colors for some U.S. Digital Magnetic Encoders.

Additionally, the limit switch pads are also available on the top side. Note that the **reverse** limit switch is on the **left** side.

On the bottom are two additional ground pads to pair with the limit switch pads.

Although normally open switches are illustrated, normally closed switches can also be used.



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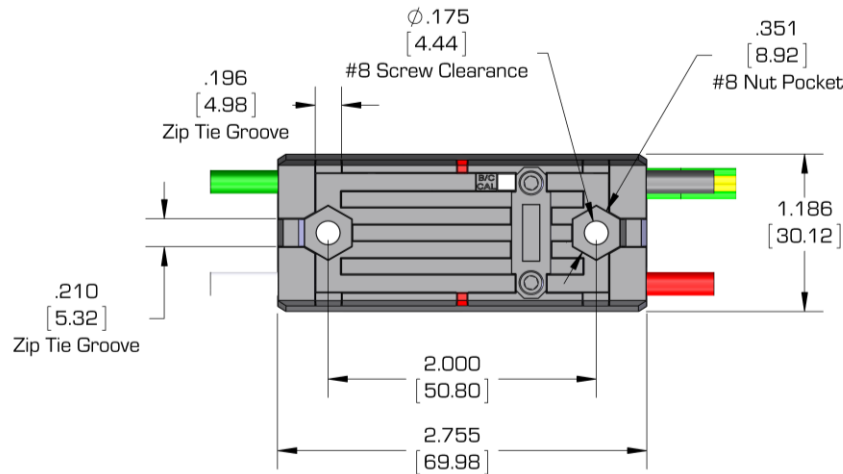
1.4.8. Heat Shrink Use with Breakout

Another advantage to using the Quadrature or Analog Encoder Breakout is that they are designed to be encapsulated with large diameter heat shrink. This ensures that there is no risk of shorting the breakout to robot frame (or other conductive surfaces). This method works particularly well when using a wire loom (green loom in example below).



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1.5. Mounting the Talon SRX



The Talon SRX can be mounted using either (2X) #8-32 screws or zip-ties. The Talon SRX's aluminum case is electrically isolated from the electronics, meaning it is safe to mount directly to a robot's frame!

The Talon SRX's mounting location should be chosen to allow for adequate air flow around the heat fins and sides of the case. For maximum heat dissipation it is recommended that the Talon SRX be securely mounted to a robot's metal frame – this allows the robot to be used as a giant heat sink to aid in cooling.



CAUTION: IN RARE CIRCUMSTANCES, THE TALON SRX MAY BECOME HOT DURING USE. USE CAUTION AROUND ANY TALON SRX THAT HAS RECENTLY BEEN USED, ESPECIALLY ONES USED FOR HIGH CURRENT APPLICATIONS. IF PROTECTED BY A 40A BREAKER, THE TALON SRX MAY BECOME HOT BUT WILL NOT BECOME HOT ENOUGH TO DAMAGE ITSELF.

1.6. General Robot Wiring Guidelines

An important (yet frequently forgotten) aspect of wiring is strain relief. All electrical connections should be isolated from any pulling or tugging that may result in a poor connection. Once the Talon SRX is fully wired, zip ties should be used to ensure that all electrical connections are protected.

Note: When zip tying wires down, it is crucial to avoid sharp edges on the robot. Wires that are anchored to sharp edges can become worn over time and cause a short.



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1.7. Applying Power for the First Time

Before applying power for the first time, it is a good idea to double check the following:

- ☐ The red wire is connected to the positive source.
- ☐ The black wire is connected to the source ground.
All electrical connections are secure and electrically isolated (wrapped in electrical tape, heat shrink tubing or similar).
- ☐ A 40A or smaller breaker is in series with the Talon SRX's positive power input.
- ☐ There are no short circuits on the Talon SRX's output.

If using CAN bus to control Talon SRXs, it is a good idea to double check the following:

- ☐ A unique ID has been assigned to each Talon SRX.
- ☐ A yellow signal wire is plugged into the "H" terminal of the CAN controller.
- ☐ A green signal wire is plugged into the "L" terminal of the CAN controller.
- ☐ The CAN bus has two "ends" each ending in either the roboRIO, the PDP (with the termination resistor jumper placed in the ON position), or a 120 Ω resistor.
- ☐ If the PDP is not at the end of the CAN bus, its termination resistor jumper should be in the OFF position, and an explicit 120 Ω resistor should be present at the end of the bus.

If using a PWM signal to control Talon SRXs, it is a good idea to double check the following:

- ☐ The PWM connector is wired as shown on page 10.
- ☐ The PWM connector is plugged in with the correct orientation.
- ☐ The spare Yellow and Green wires of the twisted pair are electrically insulated from each other.
- ☐ The Talon SRX automatically checks for valid PWM or CAN bus on power up. No additional configuration is necessary.



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2. Additional Information

2.1. Brake & Coast Modes

The Talon SRX has two modes: Brake and Coast. When a neutral signal is applied to the Talon SRX in Brake mode, the motor will resist rotation, especially high speed rotation. This is accomplished by essentially shorting the motor leads together, which causes a Back Electromotive Force (Back-EMF) to resist the rotation of the motor. Brake mode does not have any effect when the motor is not rotating, but can make a large difference in robot behavior when used on a motor attached to a high reduction gearbox. Brake mode does not impact performance when the motor is being driven by the Talon SRX.

When a neutral signal is applied to the Talon SRX in Coast mode, Back-EMF will not be generated, so the motor's rotation will not be affected by the Talon SRX.

An added feature of the Talon SRX is its ability to toggle between Brake & Coast modes during operation using CAN bus.

2.1.1. Switching Between Brake & Coast Using the B/C CAL Button:

To switch between Brake and Coast mode, simply push the B/C CAL button at any time. The Talon SRX is in Brake mode when the button is illuminated red and Coast when the red light is turned off. Brake/Coast settings are saved even if power is removed from the Talon SRX.

2.1.2. Switching Between Brake & Coast Using CAN bus:

Use the roboRIO Web-based Configuration page for CAN selection between Brake and Coast Modes.

2.1.3. Switching Between Brake & Coast Using CAN Control Frames

Each supported programming language includes an API that allows active switching between Brake & Coast modes during a match. See Software Reference Manual for more information.



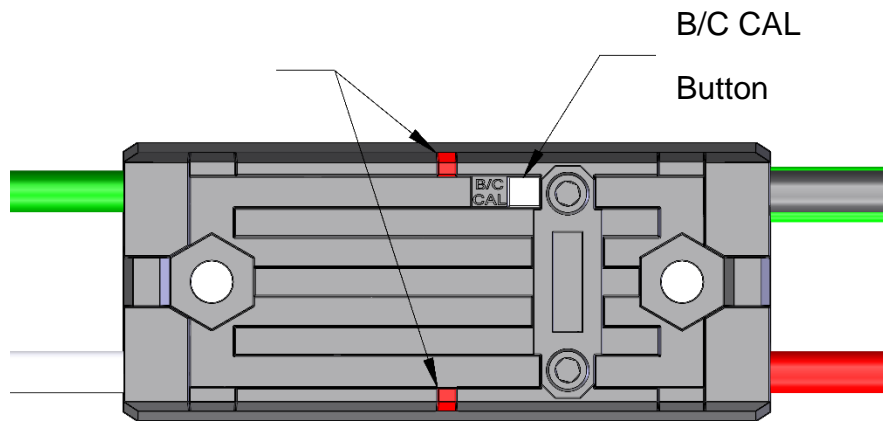
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2.2. PWM Calibration

The PWM calibration of a Talon SRX determines how to scale the PWM input signal to output voltage. Different controllers may have different “max” and “min” PWM signals that may not correspond to the same Talon SRX outputs. Calibrating the Talon SRX allows it to adjust for these differences so that a “max” signal results in a “max” output. Calibrating can also correct issues caused by joysticks or gamepads with off-center neutral outputs. The Talon SRX’s default calibration is compatible with the NI roboRIO control system.

2.2.1. To Calibrate the Talon SRX:

- 1) Press and hold the B/C CAL button until the Status LEDs begin to rapidly blink red & green.



- 2) While holding the button, move the joystick (or other input signal) to full forward then to full reverse. This can be done multiple times. The Talon SRX is looking for max & min PWM values during this step, so ensure that the joystick reaches its full max and full min.
- 3) Release the joystick and allow it to return to neutral. After the joystick is in the neutral position, release the B/C CAL button.
- 4) If the Talon SRX was calibrated properly, the status LEDs will blink green several times. If the calibration failed, the status LEDs will blink red and the previous calibration will be kept.

Note: Calibration profiles are saved to persistent memory (persist across power cycles)



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2.2.2. To Restore Default Calibration:

- 1) Remove power from the Talon SRX
- 2) Hold the B/C CAL button down
- 3) While holding down the button, restore power to the Talon SRX
- 4) Continue holding the button until the status LEDs blink green then release the button



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2.3. Blink Codes

Blink Codes During Calibration	
Status LEDs Blink Code	Talon SRX State
Flashing Red/Green	Calibration Mode
Blinking Green	Successful Calibration
Blinking Red	Failed Calibration

Blink Codes During Normal Operation		
LEDs	Colors	Talon SRX State
Both	Blinking Green	Forward throttle is applied. Blink rate is proportional to Duty Cycle
Both	Blinking Red	Reverse throttle is applied. Blink rate is proportional to Duty Cycle
None	None	No Power is being applied to Talon SRX
LEDs Alternate ¹	Off/Orange	CAN bus detected, robot disabled
LEDs Alternate ¹	Off/Red	CAN bus/PWM is not detected
LEDs Alternate ¹	Red/Orange	Damaged Hardware
LEDs Strobe "towards" (M+) ²	Off/Red	Forward Limit Switch or Forward Soft Limit
LEDs Strobe "towards" (M-) ²	Off/Red	Reverse Limit Switch or Reverse Soft Limit
LED1 Only "closest" to M+/V+	Green/Orange	In Boot-loader
Both	Solid Orange	Neutral throttle is applied. Throttle is zero or is within dead band.

B/C CAL Blink Codes	
B/C CAL Button Color	Talon SRX State
Solid Red	Brake Mode
Off	Coast Mode

- 1: LEDs Alternate – Status LEDs are different colors at all times. The (2X) LEDs will swap colors when blinking.
- 2: (1X) Status LED will blink followed shortly by the other with a long pause before repeating. The "direction" of the blink indicates the Talon SRX's current state.

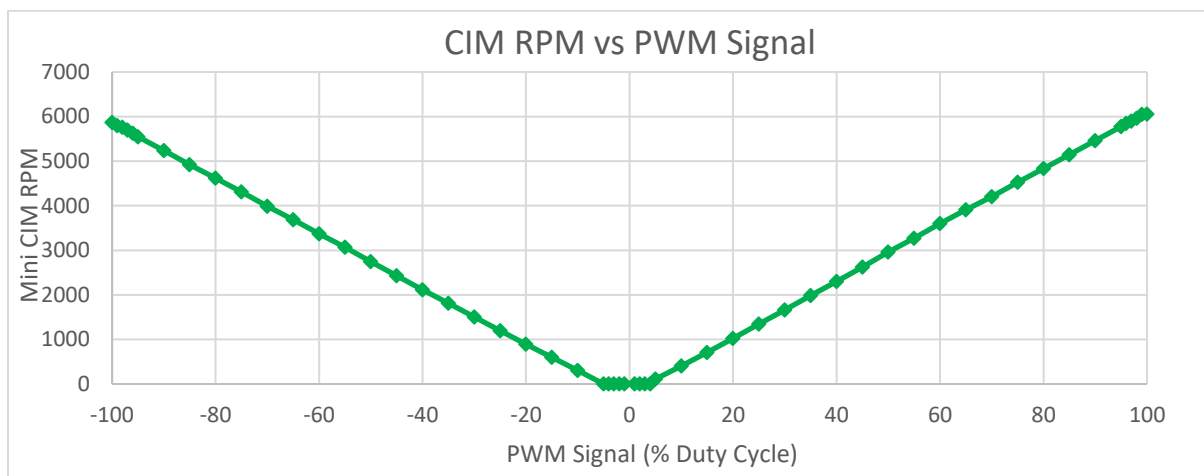


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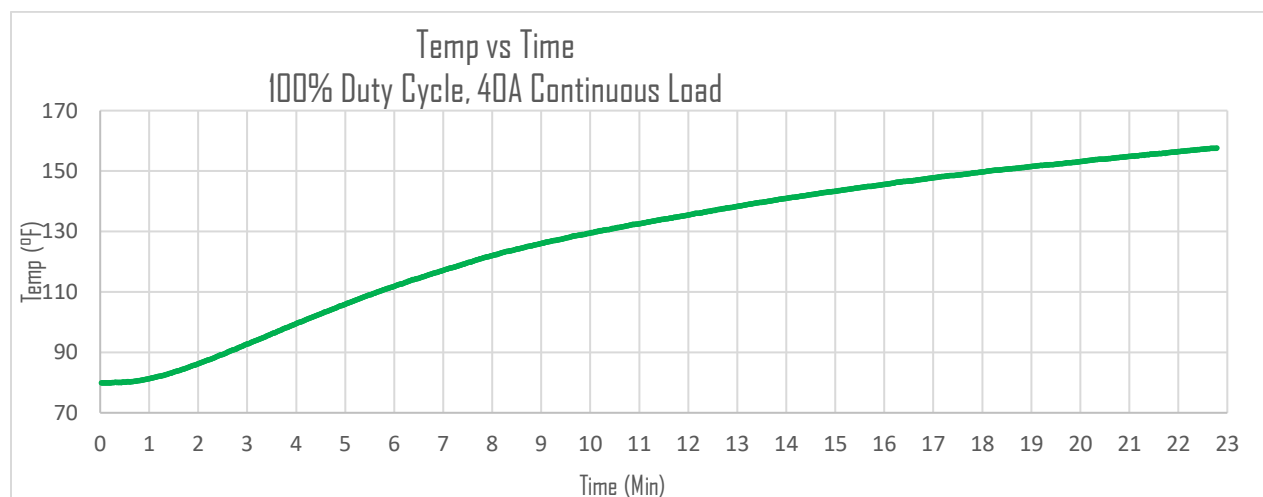
2.4. Performance Data

The Talon SRX was designed to provide a predictable linear response over a wide range of PWM signals. To demonstrate its linearity, an experiment was performed by using a calibrated Talon SRX controlled by a VEX Arm® Cortex®-based Microcontroller to drive a Mini CIM motor under no load. The PWM signal was varied from -100% to 100% at regular intervals. Finer intervals were measured near -100%, 0% and 100% duty cycle. During the test, the PWM signal and Mini CIM output were recorded and plotted, as shown below.

Note: This plot should only be used to evaluate the linearity of the Talon SRX's output. This plot should not be used to predict a motor's behavior at a specific input signal.



To evaluate the Talon SRX's thermal performance, a 40A load was applied using CIM motors and a dynamometer. Before the test, a thermocouple was attached to the top of the Talon SRX. The test was run for 10 minutes with temperature data being recorded at one second intervals then plotted, as shown below.



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2.5. Frequently Asked Questions:

Q: Is it possible to use more than one type of speed controller?

A: Yes, it is completely safe and acceptable to use multiple types of speed controllers (e.g. Victors & Talons) on a single robot.

Q: Is it safe to mount a Talon SRX directly to a robot's metal frame?

A: Yes, the electronics inside the Talon SRX are separated from the case by two different layers of electrical insulation to prevent case shorts.

Q: Does the Talon SRX require a fan?

A: The Talon SRX does not require a fan for typical FRC use but if the robot is being used for practice or many back to back matches it is a good idea to use a fan to cool the Talon SRX to prevent accidental burns.

Q: Can the Talon SRX be used with control systems other than the NI roboRIO?

A: Yes, the Talon SRX may be used with any control system that is capable of CAN bus or PWM output.

Q: What kind of electrical connectors should I use to connect wires to the Talon SRX?

A: The choice of electrical connectors is left to the user. Electrical connectors should be appropriately sized for the wire used and current requirements. For the best electrical connection, it is highly recommended that wire connectors are soldered to the wire after they are crimped on.

Q: There are (2X) yellow & (2X) green input signal wires. How do I know which one to use?

A: Signal wires of the same color are electrically identical – it does not matter which wire is used as long as the color is correct.

Q: Can two Talon SRXs drive the same motor?

A: No. DO NOT connect the outputs of two Talon SRXs together. Damage will likely occur.

Q: Can a single PWM output be used to drive (2X) Talon SRXs?

A: Yes. Two or more Talon SRXs may be driven using a single PWM signal if a 3-wire Y-Cable is used.



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Q: Will un-powering a Talon SRX in the middle of a daisy-chained CAN bus cause a problem?

A: No. This does not prevent communication with the remaining Talons on the CAN bus. Both yellow wires are electrically-common, as is the green wires. Power is not required to forward the CAN signals.



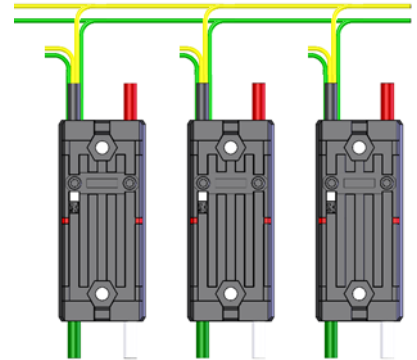
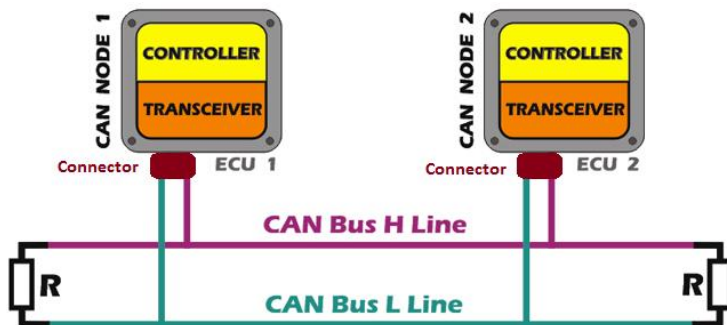
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Q: What CAN bus topologies are recommended?

A: The Talon is intended to be used in the **daisy chain fashion** explained in [Section 1.3.2](#).

Additionally, FRC Teams should always confirm what is considered “legal” per latest FRC competition rules.

Alternatively, the CAN bus may be wired in the fashion commonly seen in the automotive industry where a single harness is made (with proper termination resistor at each of the two ends). Each module can “tap” into the primary bus harness (crimp, connector, soldered, etc.) with a cable stub (maximum length of one foot).



In the automotive industry, this is accomplished with a cable design that has the cable stubs designed in with end-connectors at various places in the cable.

As documented in the DW CAN bus specification, both daisy chain or a designed master cable harness meets the specification's documented topology (diagram below).

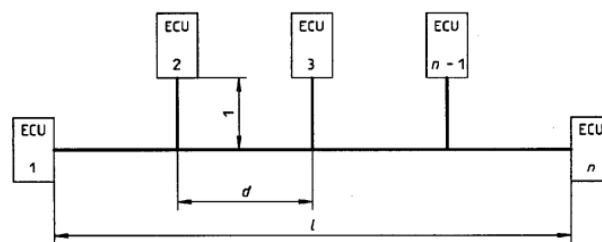


Figure 22 — Wiring network topology

Table 15 — Network topology parameters

Parameter	Notation	Unit	Value			Conditions
			min.	nom.	max.	
Bus length	L	m	0		40	
Cable stub length ¹⁾	l	m	0		0,3	Bit rate: 1 Mbit/s ²⁾
Node distance	d	m	0,1		40	

1) Dependent on the topology, the Baud rate, and the slew rate deviations from 120 Ω may be possible. It is, however, necessary to check the applicability of other resistor values in each case.

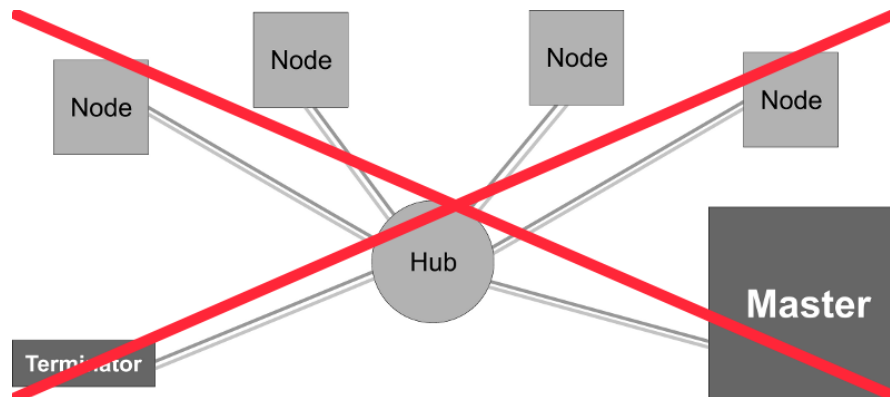
2) At bit rates lower than 1 Mbit/s the bus length may be lengthened significantly. Depending on l , the bit rate and internal capacitances of the individual ECUs, other network topologies with changed lengths l and d may be used. In this case the influence of occurring cable resonator waves on the bit representation on the bus line should be carefully checked by measurements of V_{diff} at each ECU (see also table 8, note 3).



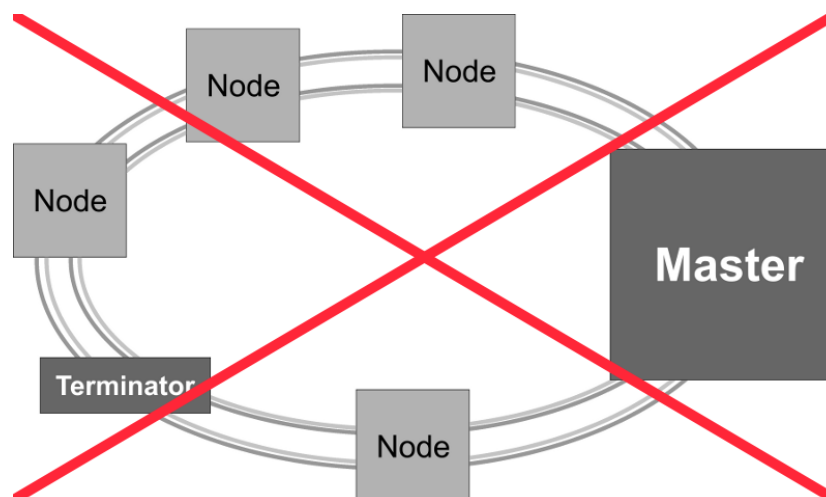
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Star topology is **not** recommended. This use case is not common, nor is it suggested in the DW CAN bus specification. This nonstandard implementation requires careful study and analysis of the candidate bus cable, which is typically beyond the capabilities of a typical FRC team.

This topology may be used when performing basic testing on a bench-setup with a small network (few modules and short cable travel). However, this use case should not be construed as evidence guaranteeing that star topology is a robust solution. Star topology is not a robust general solution to be relied on for critical applications.



Ring topology is **not** recommended. This use case is not common, nor is it suggested in the DW CAN bus specification. This nonstandard implementation requires careful study and analysis of the candidate bus cable, which is typically beyond the capabilities of a typical FRC team.



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3. Troubleshooting

Indication: Both LEDs alternate red & orange

Problem: Damaged Hardware – the device requires service

Solution:

Contact CTRE (crosstheroadelectronics.com). The Talon SRX is not warranted for use until the hardware is repaired. **DO NOT** attempt to use the Talon SRX.

Indication: Single LED alternates green & orange

Problem: The device is in Boot-loader Mode

Solution:

- 1) Download the latest firmware from crosstheroadelectronics.com
- 2) Follow directions in the Software Reference Manual to field upgrade the Talon SRX.

Indication: No LEDs are illuminated

Problem: No Power

Check the Following:

- 1) Is the robot battery is connected?
- 2) Is the main breaker is turned on?
- 3) Is the Talon SRX is connected to the Power Distribution Panel (PDP)?
- 4) Are any wires are broken or shorted?

Indication: Both LEDs slowly alternate between red & off

Problem: CAN/PWM is not detected

Check the Following:

- 1) If the robot is using PWM, is the robot disabled?
- 2) If the robot is using PWM, is the PWM cable unplugged?
- 3) If the robot is using CAN, is the CAN cable plugged in?
- 4) If the robot is using CAN, is the terminator resistor correctly wired?



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Indication: Both LEDs quickly blink red then off.

First one LED blinks red, followed immediately by the other, then finally both LEDs are off for a small period of time.

Problem: Limit Switch or Soft Limit Activated

Possible Solutions:

- 1) The most likely cause is a limit switch or soft limit fault. Test each limit switch by opening & closing it manually.
- 2) Use the roboRIO Web-based Configuration page to retrieve information over CAN bus about the Limit Switch state. See Software Reference Manual for more information.
- 3) The roboRIO Web-based Configuration page can set soft limits over CAN bus. The soft limits will be applicable with CAN control.

Indication: Both LEDs slowly alternate between orange and off.

Problem: CAN bus detected but the Talon SRX is disabled or not being addressed over CAN.

Possible Solution:

Use the roboRIO Web-based Configuration page to retrieve information over CAN bus about the fault. Most likely the device ID of that Talon is not being used. There must be an Open Motor (LabVIEW ®) or constructed CANTalon (C++/Java) with that device ID.

This can also be confirmed by doing a Self-Test in the roboRIO Web-based Configuration. If the "TALON IS NOT ENABLED!" message appears even though the robot is enabled, then recheck the device IDs in the robot application.

Indication: Flashing RED Status LEDs after calibration.

Problem: Calibration Failed.

Possible Solutions:

1. Inadequate travel in either the forward or reverse direction. Repeat the calibration procedure and move the joystick further forward and/or further reverse.
2. The joystick trim is not centered. Neutral cannot be extremely far from center.



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Indication: No power output from the speed controller although the Status LEDs work.

Problem: Possible internal damage.

Possible Solutions:

If the Status LEDs on the Talon SRX are operating properly and there is no output, the Talon SRX may be internally damaged. This condition is typically caused by a short circuit on the output or there has been an over-current condition that caused a failure.

Check the following:

1. Ensure the Status LEDs are changing between ORANGE, RED, and GREEN with joystick movement from Neutral, Full Reverse & Full Forward.
2. Disconnect the motor and check the output (M+ to M-) with a voltmeter. The meter should read between +/- battery voltage with corresponding full range joystick movement. If the Status LEDs are working properly but the outputs are not working properly, the speed controller is probably damaged. The final test to determine if the Talon SRX is damaged is to replace it with another Talon SRX that is known to function properly.

CAUTION: Prior to replacing a potentially damaged speed controller, ensure that the wires connected to the output are not shorted and the input is not reversed. Also, verify that neither of the Talon SRX's motor output leads are shorted to the motor frame or the robot chassis.

Indication: No power output from the speed controller and the Status LEDs do NOT work.

Problem: No input power or possible internal damage.

Possible Solutions:

If the Status LEDs on the Talon SRX are not operating properly and there is no output, the Talon SRX may be internally damaged. This condition is typically caused by no input power or a reversed polarity on the input.

Check the following:

1. Disconnect the output wires.
2. Ensure the Status LEDs on the Talon SRX do not illuminate at any joystick position.
3. Check the input at the Talon SRX (+BATTERY to GND) with a voltmeter. If the Status LEDs are not working properly and the input is good, the speed controller is probably damaged. The final test to determine if the Talon SRX is damaged is to replace it with another Talon SRX that is known to function properly.

CAUTION: Prior to replacing a potentially damaged speed controller, ensure that the wires connected to the output are not shorted and the input is not reversed. Also, verify



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that neither of the Talon SRX's motor output leads are shorted to motor frame or the robot chassis.



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4. Compliance

FCC Compliance Statement (United States):

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

- (1) This device may not cause harmful interference, and
- (2) This device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

ICES-003 Compliance Statement (Canada):

This Class B digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe B est conforme à la norme NMB-003 du Canada.



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5. Revision History:

2017/2/2 – Added errata under section 1.4.6.1.

2016/12/3 – Additional FAQ entries added for network topology.

2016/2/1 – Footnotes (1) and (2) added to Electrical /Mechanical specs.

- Section 1.4.6.1 Added.

2016/1/24 – CTR Logo updated.

- Section 2.3. Fault row removed.

2015/2/1 – Added current ratings for Data Port 3.3V/5V to Electrical/Mechanical specs.

- Solid Orange LED state added to Section 2.3. Blink Codes.

- Section 1.3.2.1. CAN Connector added.

- Section 1.3.2.2. CAN Bus Wire Selection.

- Additional content to Section 1.3.4 added.

2015/1/22 – Section 1.4.8. Heat Shrink Use with Breakout Added.

- Quadrature RPM and CPR added to Electrical/Mechanical specs.

- Data Port voltage thresholds and limits added to Electrical/Mechanical specs.

2015/1/12 – AndyMark part numbers added to Sections 1.4.6 and 1.4.7.

2015/1/10 – Section 1.3.4. Firmware Requirements Added

- Section 1.4.7. Analog 5V Encoder (and Limit Switch) Breakout Added

- Section 1.3.1. Adjusted CAN L and CAN H text label positions in figure.

2015/1/2 – Section 1.4.6. Encoder Breakout Added

2014/12/23 – Initial Public Release

