

# Jaguar CAN Getting Started

## Contents

1. [Jaguar Background/History](#)
2. [Control Modes](#)
3. [Hardware Connections](#)
  - a. [RS232 Bridge Cable](#)
  - b. [CAN Patch Cable](#)
  - c. [CAN Terminator](#)
4. [Initial Setup](#)
5. [Firmware Setup](#)
6. [Standard Configuration Method](#)
7. [Programming with LabVIEW](#)
8. [Additional Resources](#)



## Jaguar Background/History

In 2009 *FIRST* introduced a new motor controller to the Kit of Parts (KOP). This motor controller was powered by Luminary Micro’s (now part of Texas Instruments) LM3S2616 motion control processor. This new motor controller allowed for closed loop control on the motor controller, although this was not allowed by the rules in 2009.

In 2010, the next revision of the Jaguar, known as the “Black Jaguar,” was introduced. The Black Jaguar came with many improvements including a RS232 to CAN converter. The rules were also changed to allow teams to use the closed loop functionality of the motor controller. In the 2011 season, teams can use either one of these controllers.

	MDL-BDC (Gray)	MDL-BDC24 (Black)
Feature		
Part Number	MDL-BDC	MDL-BDC24
Voltage Range	6–13 V	6–30 V
RS232C Port	No	Yes
Terminal Screws	Captive – Do not remove <sup>a</sup>	Loose – Okay to remove <sup>b</sup>

- a. Captive terminal screws should not be removed because metal debris can be created.
- b. Non-captive screws are safe to remove and are compatible with ring-terminal use.

## Control Modes

Currently there are two different methods for operating a motor controller: servo-style PWM signal and using the CAN bus.

When using the servo-style PWM method, the Jaguar works simply as a smart amplifier. It processes the PWM signal and outputs the corresponding percentage of the input voltage to power the motor.

The CAN interface allows for sensor feedback directly to the motor controller. Having feedback on the motor controller allows for faster and more precise control. However, the types of feedback are limited. Browse through Luminary Micro's Jaguar Getting Started Guide for more information.

**NOTE:** the Jaguar supports the simultaneous use of CAN for monitoring and the servo-style PWM input for speed, but this is not allowed in FRC.

## Hardware Connections

When using the CAN interface there are three types of cable/connector that may be required. They are:

- RS232 bridge cable
- CAN patch cable
- CAN terminator

There are many different methods for constructing these cables. This guide is only meant to give an overview.

For additional assistance, TI has video guides at:

<https://focus.ti.com/general/docs/video/Search.tsp?term=jaguar>

Cables can be purchased from eStop Robotics at:

<http://www.estoprobotics.com/estore/index.php? a=viewProd&productId=34>

### RS232 Bridge Cable

**NOTE:** This cable is **required** even if you are using 2CAN.

The RS232 Bridge cable is used to connect to Black Jaguar to the CompactRIO (cRIO). You will need a soldering-iron and the following parts to create this cable:



Modular adapter  
RJ12 to DB-9 Female  
CUI P/No AMK-0003  
Digikey Stock No. 046-0003-ND



Modular cord  
6 contact 6 conductor, reversed  
Assmann Elect. AT-S-26-6/6/B-7/R-R  
Digikey Stock No. A2662R-07-ND



Resistor 100Ω 1%  
Panasonic EROS2PHF1200  
Digikey Stock No. P100CACT-ND



Heatshrink tubing 1/8" diameter  
Digikey Stock No. Q2F018B-ND

Follow these steps to create the RS232 Bridge Cable.

1. Take the Modular Adapter and cut the black wire as short as possible. You will not use this wire.
2. Cut off the terminals on the red and green wires. Strip the red and green wires and then solder those two wires to the 100Ω resistor. Use a section of heat shrink to protect the resistor and solder connections.
3. Insert the remaining terminals into the DB9 receptacle. The pin numbers are indicated on the plastic connector body.
  - a. White – Pin 3
  - b. Blue – Pin 2
  - c. Yellow - Pin 5
4. Slide the back-shell over the connector and insert the modular cable to complete the assembly.

## RS232 Cable Pin Assignments

RJ12	Wire Color	Jaguar Use	PC Use	DB9 Pin
1	White	RXD	TXD	3
2	Black	-	-	-
3	Red	CAN H	-	-
4	Green	CAN L	-	-
5	Yellow	GND	GND	5
6	Blue	TXD	RXD	2

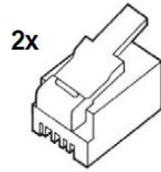
## CAN Patch Cable

To connect the Jaguars to the CAN bus, daisy-chain the network cables between Jaguar modules. Standard off-the-shelf modular RJ11/12/14 cables can be used to do this.

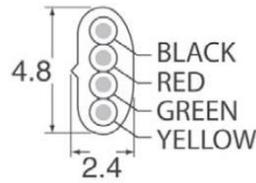
Cables must be “straight-pinned,” which means pin 1 on one end of the cable maps to pin 1 on the other end, pin 2 maps to pin 2, and so on. This is also referred to as a reverse-cable because the tabs on the connectors are on the opposite sides of the cable.

The CAN cable needs only 4 conductors, but it is acceptable to use a 6-conductor cable and plugs. A suitable 6ft off-the-shelf 6P4C cable is **Digikey Stock No. A2662R-07-ND**.

In order to make custom length cables you will need a modular plug crimp tool and the following supplies:



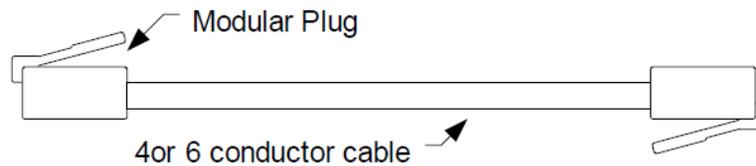
Modular plug for stranded flat - oval cable  
AMP P/No 5-641335  
Digikey Stock No. A9092-ND



Modular cable - 4 conductor  
Assmann Elect. AT-K-26-4-S/100-R  
Digikey Stock No. A0043R-100-ND

Follow these steps to create the cable:

1. Cut modular cable to length.
2. Use the crimper to strip the outer jacket from each end of the cable.
3. Insert wires into the modular plug and load into the crimper.
4. Close crimper to complete the connections and secure the cable.



Plug	Wire Color	Jaguar Use
1	Black	-
2	Red	CAN H
3	Green	CAN L
4	Yellow	GND

## CAN Terminator

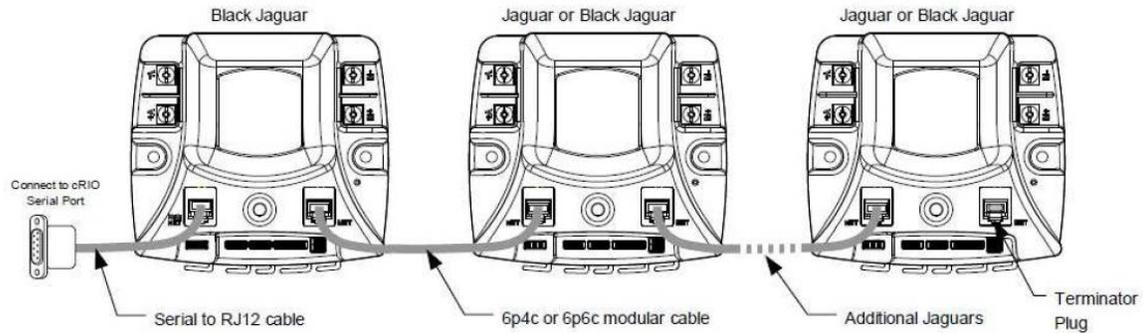
Because the CAN signals operate at high bit rates (1 Mbps), a terminator is required at each end of the network. This cable can be created one of two ways:

1. Cut a CAN patch cable in half and solder a 100Ω resistor between the red and green wires.
2. Crimp a 100Ω resistor between pins 2 and 3 (being careful that the wires do not touch).

In either case make sure that the connector is properly protected and ensure that no debris or contact will cause the terminator to short.

## Initial Setup

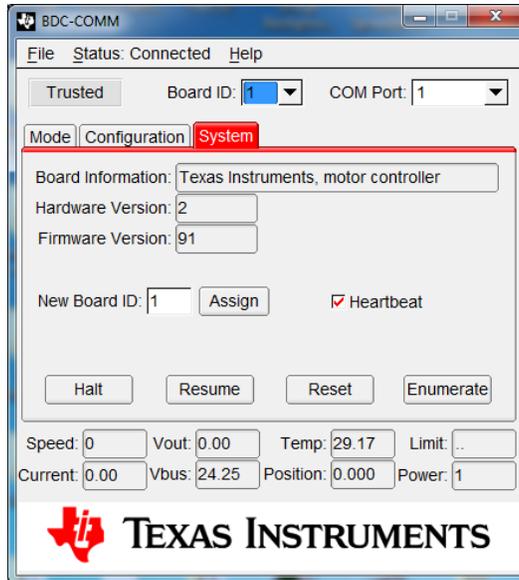
At this point, you should have created the cables needed to connect the Jaguars. If you are connecting through the Black Jaguar you will need to connect the Jaguars as shown below:



## Firmware setup

In order to use CAN, you will need to upgrade your Jaguar's firmware to the latest version. At the time this document was created, the latest version was v92. You can download the firmware from <http://luminarymicro/jaguar> or it is installed with the FRC Utilities installer to `Public Documents\FRC` on Windows 7 or `Shared Documents\FRC` on Windows XP. When you download and extract the firmware you will have two versions: `BlackJaguar-92.bin` and `Jaguar-92.bin`. Make sure to use the correct version for your device. Using the wrong firmware may break a motor controller.

If you are using the Black Jaguar as a bridge you will need to download and install BDC-COMM from the above Luminary link. With the Black Jaguar connected to the RS232 bridge cable, start the BDC-COMM application and select the proper COM port. Once connected you will be presented with the following the dialog box:



To update the firmware on your Jaguar, select **File»Update Firmware**. Select the proper firmware and click **Update**. Once complete, power-cycle your Jaguar and reconnect. You should notice a **Trusted** label in the upper left corner as seen above.

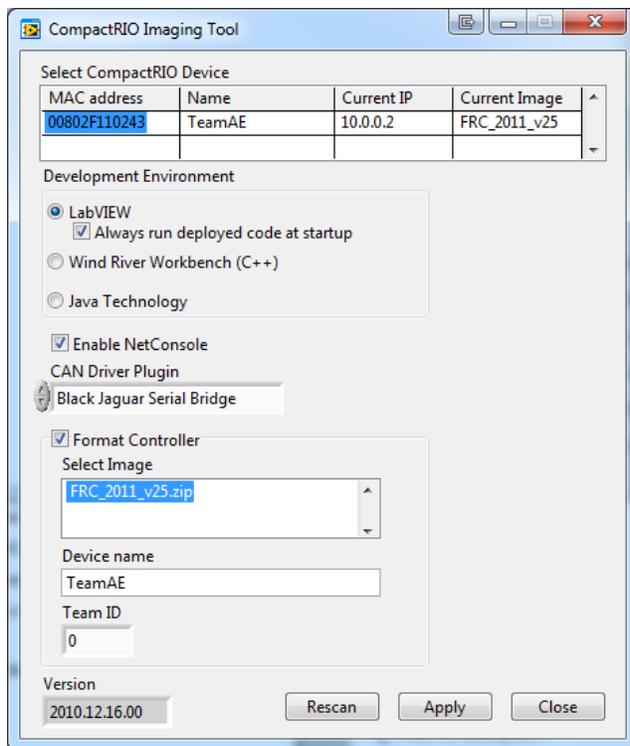
Next you will need to assign the Jaguar a unique ID on the CAN bus. By default all modules use ID 1. To do this you need a straightened paper clip. Put the new value (select a value between 2 and 63). Click **Assign** and the LED on the Jaguar will begin flashing green. Once this happens, use the paper clip to press the User button on the right side of the Jaguar. You have 5 seconds from the time you click **Assign** to press the User button on the Jaguar. If you miss that window, just repeat the process above.

A similar process will be used when working with 2CAN. The instructions for the 2CAN can be found in the user manual at: <http://crosstheroadelectronics.com/2CAN.htm>.

Once all the connections have been made and the firmware updated, verify that you can see all the Jaguars on the bus, then connect the serial cable from your PC to the cRIO. If you are using the Black Jaguar as a serial to CAN bridge, you will not be able to use serial port for the CONSOLE OUT. However, there is a utility called NetConsole that provides access to the console without needing the serial port on the cRIO. NetConsole is installed with the FRC Utilities update and must be enabled on your cRIO with the cRIO Imaging Tool.

## Standard Configuration Method

Once all the connections have been made and the firmware updated, connect the serial cable from your PC to the cRIO.



To configure CAN on the cRIO, open the cRIO Imaging Tool. If your Imaging Tool does not look the same as the one above download the FRC2011 Utilities Update from <http://joule.ni.com/nidu/cds/view/p/id/2262/lang/en>.

Image the cRIO as normal but select the following:

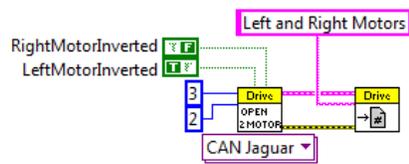
- Select **Enable NetConsole**
- Select the appropriate CAN Driver Plugin (either Black Jaguar Serial Bridge or 2CAN)

If doing this for the first time or if you have selected a different image, check the **Format Controller** checkbox. Once you've complete configuring the cRIO with the Imaging Tool, select **Apply** to update the image on the cRIO.

## Programming with LabVIEW

You can get CAN working the default LabVIEW robot code. In your Begin VI change the polymorphic selector terminal to **CAN Jaguar**. Then delete and replace the Left and Right Motor inputs with a numeric constant that represents the appropriate Device Number. Your completed code should look similar to the example below.

**NOTE:** If the Open 2 Motor.vi is not polymorphic, right click on it and select **Replace»RobotDrive Palette» WPI\_RobotDriveOpen2Motor.vi**



Using CAN also has the advantage of allowing for closed loop control. This will be discussed in future tutorials.

## More Resources

NI FIRST Support – <http://www.ni.com/first>

Luminary Micro Jaguar Microsite – <http://www.luminarymicro.com/first>

Texas Instruments Jaguar Videos – <https://focus.ti.com/general/docs/video/Search.tsp?term=jaguar>

CAN Starter Pack – [http://www.estoprobotics.com/estore/index.php?\\_a=viewProd&productId=34](http://www.estoprobotics.com/estore/index.php?_a=viewProd&productId=34)

2CAN – <http://crosstheroadelectronics.com/2CAN.htm>