Jaguar Motor Controller Frequently Asked Questions FRC 2012 Season



Black Jaguar (MDL-BDC24)



Gray Jaguar (MDL-BDC) Not recommended for new designs (NRND)

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Product Features

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What are the differences	between the MDL-BDC24 and the MDL-	-BDC?
The MDL-BDC24 and M	DL-BDC are different in the following way	/S:
Feature	MDL-BDC24	MDL-BDC (NRND)
Plastic enclosure	Black with red Texas Instruments logo	Gray with orange Luminary Micro logo
	Servo-style PWM	Servo-style PWM
Control interfaces	 CAN (one 6P6C and one 6P4C connector) 	 CAN (dual 6P4C connectors)
	 RS232 serial port (the outside two pins of the 6P6C connector) 	
Input voltage range across V+/V- inputs	6–30 V This allows the use of 24-V motors.	6–15 V
H-Bridge	Uses synchronous rectification	Does not use synchronous rectification
Terminal screws	These screws are intended to be removed.	These screws should not be removed. If removed, the screw leaves metal shavings inside the motor controller assembly which

Q2 Why did you add an RS232 serial port to the MDL-BDC24?

The RS232 serial port was added to provide a low-cost connection to the CAN network. A robot controller without a CAN interface but with an RS232 interface is able to connect to an MDL-BDC24 device that bridges commands received on the serial interface to its CAN interface (while also serving as a motor controller).

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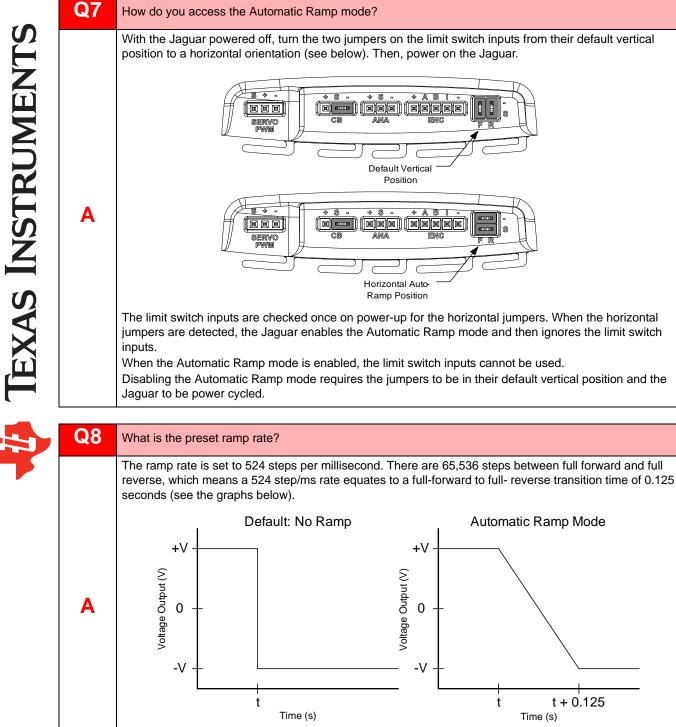
discount from the standard resale price. How do I do this?

As an FRC team member or mentor, I thought we would be able to buy extra motor controllers for a

Α	Additional motor controllers are available to FRC teams and mentors for an exclusive discount through TI's distribution partner, Digi-Key. The following link provides access to the discount program for FRC teams only: http://sales.digikey.com/dkes/FirstRoboticsCompetition.asp
Autor	natic Ramp Mode
Q4	What is the Automatic Ramp mode?
Α	Automatic Ramp mode is a feature introduced in the 2012 version of the Jaguar firmware (both black and gray Jaguar units) that, when activated, automatically ramps the output voltage to the motor at a preset ramp rate. Automatic Ramp mode is available regardless of the control mode: Servo PWM, CAN, or Serial. Automatic Ramp mode can be used as an alternative to programming a ramp function in the robot's code and/or as a quick fix during competition to remedy frequent current or voltage faults due to fast direction switching.
Q5	Which Jaguars have the Automatic Ramp mode?
Α	Jaguars purchased or received during or after the 2012 season contain the Automatic Ramp mode in the factory default firmware. Older Jaguars can be updated to the latest firmware. See the Jaguar <i>Getting Started Guide</i> for more information.
Q6	We have mixed our new and old Jaguars together. How can we tell which Jaguars have the new firmware?
Α	 The new firmware performs a one-second fan test when power is first applied; older Jaguar firmware does not turn the fan on until the motor is driven. Listen for the fan spinning up as you apply power. You can also use the CAN or Serial interface to read the firmware version. The new firmware has the following version numbers: Default from the factory: 8161 or greater
	FRC Trusted version (required to use the CAN interface for FRC): greater than 92

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At t, the user switches from full forward to full reverse.



Q9	Can we change the ramp rate for the Automatic Ramp mode?
Α	No, the ramp rate is set to the preset value every time the mode is activated at power-up. A different ramp rate can be achieved by disabling the Automatic Ramp mode and either setting the internal ramp rate using the CAN or Serial interface, or by programming a ramp in your software running on the cRIO.
Q10	Can we update old Jaguars to the new firmware with the new mode?

Can we update old Jaguars to the new firmware with the new mode?

Yes, you can update the firmware using one of the following methods:

- Updating a Black Jaguar
 - Use BDC-COMM and the Serial interface
 - Use a 2CAN Ethernet-to-CAN bridge
- Updating a Gray Jaguar
 - Use a Black Jaguar as a Serial-to-Can bridge with BDC-COMM
 - Use a 2CAN Ethernet-to-CAN bridge

Metal Debris and Misuse

Q11 Is metal debris really something to worry about?

Of course! By far the most common cause of Jaguar failures has been misuse, including metal debris.

Do not drill, file, or cut metal on the robot while any electrical component is present.

We suggest removing all electronics from the robot when metal is being modified in any way. However, removing the electronics does not guarantee debris-free electronics. Metal debris on the robot chassis can shake loose and fall into the electrical system. Before reinstalling the electronics, use a vacuum to clean up debris on the robot.

Q12	What if we can't remove the electronics from the robot while cutting metal?	
A	 It is often the case that the electronics are highly integrated into the robot or a quick modification must be made during competition and it is not feasible to remove the electronics before working on the robot. Protect the electronics as much as possible by following some of these suggestions: Use blue painters tape to cover the Jaguar vents. Use a tarp or a blanket to cover the electronics. Work carefully to avoid accidentally dumping debris over the electronics as you remove the tarp. Remove tarps carefully so that the debris is contained. Use a vacuum to suck up any remaining debris. 	
	Do not use compressed air which can scatter debris and push it into components.	
	Remember to remove any tape covering the Jaguar's air vents!	

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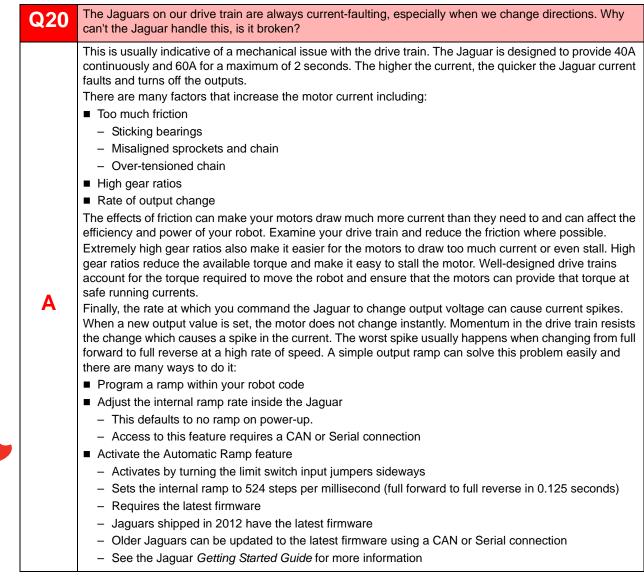
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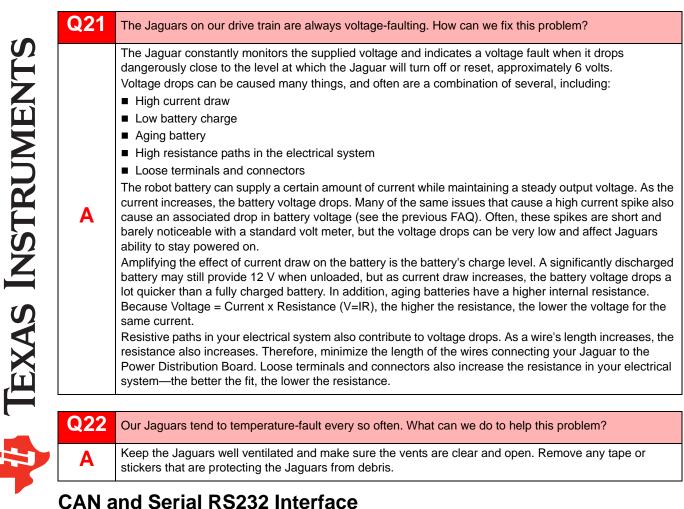


Q13	What if we accidentally get debris in our Jaguar?
Α	 Do not turn it on! Open the Jaguar to clean it out before turning it on. Follow these steps: Remove the bottom shell by removing the four screws on the bottom of the Jaguar with a Phillips-head screwdriver. Carefully remove the circuit board by slowly pressing the screw terminals through the top shell. Do no push too hard—the fan is attached to the top shell and the circuit board, and you can damage the far by pulling too hard. Press the white tab on the fan wire connector and gently pull the wire out of the circuit board connector (off-white in color). Use a vacuum to clean out the circuit board and the plastic housing. Reconnect the fan before reassembling the Jaguar. It is a good idea to clean your old Jaguars before reusing them. As always, when handling exposed electronic components, be sure to practice appropriate preventive measures to reduce the chance of Electrostatic Discharge (ESD).
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Q14	When should we remove the Debris Warning stickers from our Jaguars?
Α	In addition to reminding users about metal debris, the sticker acts as primitive barrier against debris entering the main air vent. The other air vents are still open and vulnerable to debris. Leave the sticker in place during robot construction as a reminder to team members to remove the electronics from the robot when metal is being cut, filed, or drilled. The sticker can remain in place during light robot testing to help reduce the chance of metal debris falling into the Jaguar while the robot is in motion—a time when debris tends to shake loose. Remove the sticker before heavy use, such as prolonged use at high or stall current and during competition. Also, remove the sticker if the Jaguar reports a Temperature Fault.
Q15	Won't the debris sticker restrict air flow and damage the Jaguar?
A	The sticker does block the main air intake vent. However, the Jaguar has a built-in temperature sensor that allows the Jaguar to monitor the temperature inside the case. The Jaguar indicates a Temperature Fault and turns off the output when the temperature is too high. The fault should trigger before damage occurs. Remove the sticker before running the robot during competition or other periods of heavy use regardless of whether you experienced temperature faults.
Q16	Can reversed polarity on the power connections damage a Jaguar?
	Yes! Reverse polarity will damage the Jaguar and may void your warranty.
A	 Evidence of reverse polarity damage might not be apparent right away. When the reverse connection is corrected, the Jaguar may power up and operate correctly, however, the damage will worsen over time until the unit fails. There are many visual cues to help prevent reverse connection: Raised lettering in the plastic: V+ and V- Red and black screws A warning sticker on newer model Jaguars The red and black screws can be removed and replaced incorrectly which makes the color coding useless. Always double-check your entire electrical system for reverse connections.



	Yes! Powering the output will damage a Jaguar and may void your warranty.
Α	 The Jaguar might not fail immediately, but the damage will worsen over time eventually leading to failu There are a couple visual cues to help prevent reverse connection: Raised lettering in the plastic: M+ for Motor+ and M- for Motor - Green and white screws The green and white screws can be removed and replaced with the red and black screws which make the color coding useless. Always double-check to make sure the Jaguars is correctly connected to pow
Q18	Because of a wiring mishap we connected a wire directly across the motor terminals and tried to run the Jaguar. The Jaguar no longer runs a motor. Isn't Jaguar supposed to have over-current protection?
Α	Yes, the Jaguar has software-based over-current protection. However, the over-current protection is designed to prevent damage from a motor drawing too much current not a dead short. A dead short can create a huge current spike in a very short amount of time. If the spike is quick and lar enough, the Jaguar cannot react fast enough to shut off the outputs. Whether or not you see a current fault depends on if the Jaguar was able to detect the spike. Damage also depends on magnitude and duration, so even if you see a current fault, the current spike might still be high enough to damage a Jaguar.
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Q19	We notice that when we (accidentally) run our robot into a wall or obstacle and the robot is pushing real hard, the robot seems to shut down for a couple of seconds. Why does this happen?
Α	The Jaguar modules have a self-protection feature that do not allow excessive current to be drawn. The feature protects both the motor and the motor controller from damage. The Jaguar module typically provides up to 40 A of continuous current to a heavily loaded motor. However, it is capable of providing much higher currents, but for shorter periods of time. Jaguar provides 60 A for up to two seconds and provides 100 A for approximately 0.2 s. The 2011 version of the Jaguar firmware provides a unique LE error code when this self-protection feature is tripped; the LEDs flash an repeating slow red then yellow sequence.

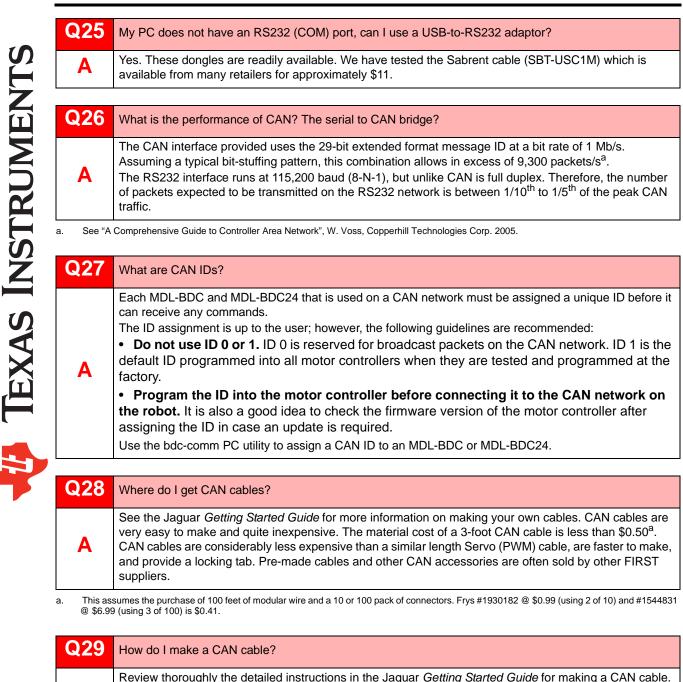




Q23	If I am not using the RS232 and/or CAN interface, what should we do with the unused interface?
Α	We recommend putting electrical tape over the top of the connectors to prevent debris from getting into the connector. Please be careful not to cover the vent slots on the side of the Jaguar plastics when putting the tape in place. Two short 1" segments should be enough to cover the connectors while not obstructing the air flow venting, the status LED, or the PWM connector.

Q24	Is there anything you can do over CAN that cannot be done over the RS232 interface?
Α	The MDL-BDC24 motor controller provides an RS232 interface that allows a robot controller with an RS232 port to send commands and get status over the serial port. The motor controller bridges between the RS232 and CAN interfaces so that any packet received on one interface is copied to the other with the exception of packets destined for the bridging device. The serial port bandwidth is lower than the native CAN bandwidth. Therefore, when using the serial-to-CAN bridging capabilities, the number of packets that can be exchanged is reduced to approximately 1/5 th of the maximum number of packets on a CAN-only network.





- A CAN cable is simple to make but you must be aware of the following:
 1. Purchase 4-conductor modular wire (for example, Frys #1544831) and 6P4C modular connectors (for example, Frys #1930182). Note: If you are making an RS232/CAN cable, the process is slightly more involved, and you should follow the detailed instructions in the GSG.
- 2. Strip only the outer insulation from the modular wire. Do not strip the color-coded insulation from the enclosed wires. The modular connector pierces the insulation when crimped (that is, it is an insulation displacement connector).
- 3. The same pin on both connectors is attached to the same wire in the cable. If you insert the wire into both connectors, a correctly wired connection has the same wire colors in the same order on both connectors (that is, from left to right: yellow, green, red, and black on both connectors).

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Most Set commands (such as VoltageSet, PositionSet, and so on) have an optional byte in the payload that allows a robot controller to specify to the MDL-BDC and MDL-BDC24 that the command should not be executed immediately, but rather that the value passed in the payload should be stored and used at a later time when all motor controllers of a specific group are updated. The synchronous update command that follows a set of 'Set' commands allows the values provided to become active at the same time.

This feature provides the same features as a Y servo (PWM) cable (splitter), except it can apply to more than just two controllers.

Limit Switches and Soft Limits

Q31 How do the limit switches work?

There are two limit switch headers, one labeled F and one R. Each header consists of two pins: one sense pin and one ground pin. The sense pin is pulled up to a positive voltage inside the motor controller. A normally-closed switch is connected across the ground and sense pins of each header thereby grounding the sense pin (low). If the switch is pressed and opens the circuit, the sense pin is disconnected from ground and the internal pull-up raises the voltage on the sense pin (high).

Direction of	Limit Switch State/Sense Pin Voltage	
Desired Rotation	Closed/Sense Pin Low	Open/Sense Pin High
Forward	Positive voltage	0 V
Reverse	Negative voltage	0 V

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52	I do not plan to use limit switches. Can I remove the jumpers?	

No. The jumpers are there to act as a limit switch in lieu of the switch being used. If you do not plan to use limit switches, leave the jumpers in place. If you remove the jumpers and cannot remember how to reinstall the jumpers, see the Jaguar *Getting Started Guide* to reinstall the jumpers. If you use a limit switch, you must remove the appropriate jumper and replace it with the limit switch circuit.

A Yes. Since the limit is signaled to the motor controller when the switch is open, a set of switches in series may be used. If any switch opens, the sense pin rises to a high state.	Q33	Can I have multiple limit switches independently limit a motor's rotation?
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Q34	We want to use the limit switches. What part/supplier provides 1x2 headers that fit side-by side for use with the limit switches?
Α	FCI offers part numbers 65039-035LF (housing) and 48248-000LF (receptacle), available from Digi-Key.



Q35	What are soft limits and how can I use them?
A	The motor controller allows the definition of two virtual (soft) limit switches. Soft limits can be used in position control mode. Each limit is defined by two components: the position value and the comparison direction. The direction specifies whether the limit is exceed if the current position value is <i>greater than</i> or <i>less than</i> the specified position value. Like limit switches, there are two soft limits so that a structure can be bounded on both sides. If the limit is exceeded, the motor controller behaves the same as it would if the physical limit switches
	were pressed. Soft limits are available only over CAN connections.
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Q36	Instead of putting two connectors side by side, we would rather use just one connector for the limit switches. What part/supplier provides 2x2 headers for use with the limit switches?
Α	FCI offers part numbers 65043-035LF (housing) and 48248-000LF (receptacle), available from Digi-Key.
Servo	(PWM) Interface
Q37	My Jaguar (MDL-BDC or MDL-BDC24) is receiving a good Servo (PWM) signal, but it is not generating any voltage on the output (that is, my motor isn't turning). Is my Jaguar broken?
Α	Probably not. The most likely reason for this occurrence is that the limit switch for Direction is open, or the jumper has been removed. A clue to this is the LED. If you are sending a Servo (PWM) signal, and the LED is flashing slowly red, it usually means that the Jaguar is experiencing a fault condition; the most common fault condition being the limit switch.
Q38	Do I need to calibrate the Servo (PWM) interface?
, A	It depends. The motor controller has a calibration mode, and the need to calibrate depends on the Servo (PWM) signal range generated by the robot controller. For FRC users, the answer is probably not if you are using the cRIO system and a new motor controller. The default parameters of the motor controller are tuned for use with the cRIO. The calibration mode is provided if you want to use the motor controller with another source of Servo (PWM) signal that does not have the same range of pulse widths (for example, an older robot controller). Or, if you have calibrated your Jaguar (MDL-BDC) from a different source and move it back to a cRIO system, you must recalibrate.
Brake	/Coast Interface
Q39	What is the best connection for a dynamic brake/coast interface?

Otherwise, if you are using a PWM (servo) interface, you can connect just the center pin of the brake/ coast header to a digital source (for example, for FRC users the digital side car). Note that you should not connect a ground signal because you do not want this to act as a current return path to the battery. You want the current return path exclusively through the V- screw terminal.

		We want to connect the Brake/Coast input to a robot controller and implement a dynamic Brake/Coast mechanism. What part/supplier provides a 1x3 header for use with the Brake/Coast input?
	Α	FCI offers part numbers 65039-034LF (housing) and 48248-000LF (receptacle), available from Digi-Key.



Fixed-Point Values

Q41 What are fixed-point values?

Fixed-point is similar to floating point in that it expresses a non-integer value, but as its name implies, the decimal point position in the value is fixed. Fixed-point values are used in embedded systems programming when a floating-point unit is unavailable or the execution time of a floating-point library call is too slow.

Most fixed-point values used in the motor controller are contained in a 32-bit integer and are a 16.16 format. This format uses 16 bits to represent the fractional value and 16 bits to represent the integer number. Note that the fractional value is limited to the granularity of 1/2^N, where N represents the number of bits. In the case of 16.16 format, the smallest number that can be represented is approximately 0.000015.

Value	Fixed-Point Representation in 16.16 Format	Value Converted from Fixed-Point Representation Back to Floating-Point
1	0x00010000	1
2	0x00020000	2
0.5	0x00008000	0.5
0.19	0x000030A3	0.1899
Pi	0x0003243F	3.1415863

Fan

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TEXAS INSTRUMENTS

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When we apply power to our Jaguar (MDL-BDC) module, the fan does not turn on. Is it broken?

Not necessarily. Unlike previous FRC speed controller solutions, the fan in a Jaguar module is set to turn on only when necessary. Jaguar turns the fan on when it is running a motor. By default, Jaguar does not turn the fan on until you start to drive. Jaguar turns the fan of when the module is not driving a motor and the internal temperature is safe in order to save valuable battery power.

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