Revision 1.4





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Warning: Do not apply >5.5v to the center wire of the Victor BB's input connector. Doing so can damage the Victor BB circuit and render the unit non-functional.

- 1. This applies to systems using the VEX ARM® Cortex®-based Microcontroller.
- 2. This applies to systems that use a receiver battery that is charged to a voltage higher than 5.5v.

We recommend that for all application where the Victor BB is not being used in Battery Eliminator Circuit (BEC) mode that you simply cut the center wire of your PWM input cable. This will ensure the Victor BB circuit cannot be damaged.



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## 1. Purpose of this Guide

The purpose of this guide is to document the functionality of the Victor BB Motor Controller.









## 2. Installing the Victor Dashboard

The installer installs...

- Dashboard EXE and supporting DLL
- Microsoft Visual C++ 2015 redistributable (x86) if not installed already v14.0.23506
- Microsoft .NET Framework 4.5.2 if not installed already

The following also requires installing depending on which cable solution is used.

- FTDI USB Serial Drivers Drivers (v2.12.14)
- PL2303 Prolific USB Serial Drivers (1.12.0)

Download Link:

http://www.ctr-electronics.com/downloads/installers/VEX Victor BB Dashboard-Installer-1.0.0.5.zip

Download and extract the zip. Inside there is an installer and folder for USB drivers...



Run the installer to install the Dashboard.









Victor BB Dashboard v1.0.0.3 Setup



Victor BB Dashboard v1.0.0.3

Installation Successfully Completed

After install the Dashboard will be on the desktop and start menu.





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## 2.1. Installing Serial Drivers

#### There are two sets of drivers in the zip for each cable solution.

## 2.1.1. Installing Serial Drivers – Prolific PL2303

Inside the subfolder USB Drivers/PL2303/1.12.0, there is an installer exe that will install the drivers.

.	Application Tools 1.12.0		-	
File Home	Share View Manage			~ 🕐
← → ~ ↑	« New folder > VEX Victor BB Dashboard-Installer-1.0.0.3 > USB drivers > PL23	303 » 1.12.0	✓ Ö Search 1.1	2.0 <b>,</b> 0
🔮 Docume ^	Name ^	Date modified	Туре	Size
👆 Downloa	1767464-VerificationReport.pdf	10/7/2015 5:06 AM	Foxit Reader PDF	43 KB
🁌 Music	은 checkChipVersion_v1006.exe	1/15/2013 5:20 AM	Application	208 KB
📲 Nexus 5	😰 PL2303 Windows Driver User Manual v1.12.0.pdf	10/7/2015 4:55 AM	Foxit Reader PDF	1,455 KB
Pictures	PL2303_DriverInstallerv1.12.0_ReleaseNote.txt	10/7/2015 4:59 AM	Text Document	11 KB
Videos	PL2303_Prolific_DriverInstaller_v1.12.0.exe	10/7/2015 4:25 AM	Application	3,631 KB
🛀 OS (C:)	PL2303CheckChipVersion_ReadMe.txt	6/16/2015 10:16 PM	Text Document	2 KB
SD LOGGER (I				
n allwpilib				
datadirec				
eol				
· · · · · · · · · · · · · · · · · · ·				>
6 items 1 item se	lected 3.54 MB			



ν<sup>E</sup>×

At this point you can insert a Serial USB Cable and it will appear in device manager.



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## 3. Connecting to the Victor BB over UART-USB

## 3.1. Wiring requirements.

The pinout on the Victor's male 3pin UART cable is ... Ground (outside of case) Victor Receive Victor Transmit (inside of case)



You can directly connect the Adafruit UART-USB cable (Adafruit product ID: 954) to a standard PWM cable as shown above.

The wire connections are: White to white Green to red Black to black





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## **3.2. Opening Application, Selecting the port**

Open the Victor Dashboard program.



Victor BB -	Dashboard						_			$\times$
Serial Port: 🖸	M12	~ Connect	t	)isconnect	Enter Serial Port	Number	and press	Con	nect	
Status						Motor Outp	out			
App Status:		Output(%):				+100%		0.00		*
App Vers:		Current(A):				+50%				
Bootloader:		Battery(V):				0%	_			_
Hardware Ver	18:	PWM(us):				-50%				_
Manufacture	Date:					-100%	Enabl	е		le
Field-upgrade	Status (Detailed)	Configuration	Logger	Calibration	Advanced Control	E.O.L.				
CRF Path:								Brow	se	
							F	ield-Up	ograde	
										-
						Ver	sion (1.0.0	12) D	LL (1.0.	0.13) <sub>.:</sub>

Bring down the dropdown and select the appropriate COM port. If the list is empty, then no serial cable is attached to the PC or drivers are missing. See Section 2.1 for instructions.

#### Once selected press Connect.

If the wiring is correct, Dashboard will report that it's connected. The progress bars may be disabled if Victor has no firmware. This is ok, just go to section 3.3 to field-upgrade the Victor.

Victor BB - Dashboard	– 🗆 X
Setial Port: Connect Disconnect Connected	
Status	or Output
App Status: Running Output(%): -2.37%	100% 0.00 🚖
App Vers: 0.17 Current(A): 1.342 +	-50%
Bootloader: 0.4 Battery(V): 15.24	0%
Hardware Vers: 1.0 PWM(us): 1488	-50%
Manufacture Date: Feb 4, 2016	100% Enable Disable
Field-upgrade Status (Detailed) Configuration Logger Calibration Advanced Control E.C. CRF Path:	D.L. Browse Field-Upgrade
	Version (1.0.0.12) DLL (1.0.0.13);





#### 3.2.1. Troubleshooting

Victor BB - D	ashboard						_		×
Serial Port: COM	12	✓ Connect	Di	sconnect	Opening Serial F	ort			
Status						Motor Output			
App Status:		Output(%):				+100%	0.0	0	<b>+</b>
App Vers:		Current(A):				+50%		-	
Bootloader:		Battery(V):				0%			_
Hardware Vers:		PWM(us):				-50%			_
Manufacture Da	ate:					-100%		Disabl	le
Field-upgrade s	Status (Detailed)	Configuration	Logger	Calibration	Advanced Control	E.O.L.	Bro Field-U	wse Jpgrade	
	Opening	g Serial Port (	hover fo	r more)		Version	(1.0.0.12)	DLL (1.0.0	).13) .::

If application can't open the Serial Port, check device manager to confirm the correct serial port number is selected.

If Dashboard is reporting the following error, check the cable at the Victor end. Make sure Victor is powered and that the wiring is correct.

Victor BB - Dashboa	rd	- 🗆 X
Serial Port: COM13	Connect Disconnect Conn Make	ecting sure Victor is connected to serial cable.
Status		Motor Output
App Status: Running	Output(%): -2.37%	+100% 0.00
App Vers: 0.17	Current(A): 1.342	+50%
Bootloader: 0.4	Battery(V): 15.19	0%
Hardware Vers: 1.0	PWM(us): 1488	-50%
Manufacture Date: Feb	o 4, 2016	-100% Enable Disable
Field-upgrade Status (D	etailed) Configuration Logger Calibration Advan	ced Control E.O.L.
CRF Path:		Browse
		Field-Upgrade
1		
	Reading Device Info (hover for more)	Version (1.0.0.12) DLL (1.0.0.13);





Victor BB - Dashboard	I					-		×
Serial Port: COM29	✓ Connect Disc	connect	Opening Serial	Port				
Status				Motor Output				
App Status:	Output(%):			+100%	Percent:	0.00	k	-
App Vers:	Current(A):			+50%				_
Bootloader:	Battery(V):			0%		_		
Hardware Vers:	PWM(us):			-50%	Enable	e [	Disable	
Manufacture Date:				-100%				
Configuration Neutral Mode:	✓ Bat Elim: ✓	]						
Field-upgrade Status (Det	ailed) Configuration Longer (	Calibration	Advanced Contro		ent Limit (Ar	lvanced	1	
Ramping:	✓ Dat Elim. ✓ ✓ 0.00	) PerSec						
Current Limit:	✓ 0							
Apply	/ Revert							
(hhb)	I TOYOL							
Opening Seria	Port, but it appears already	opened.	(hover for more.	)	Version (1	.0.0.16)	DLL (1.0	.0.14)



If the serial port is already opened by another program (such as another Dashboard instance) the bottom status message will reflect this.





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## 3.3. Field-upgrade to latest firmware

Press the browse button under the Field-upgrade tab.

V Open							×
$\leftarrow \rightarrow \checkmark \uparrow \square \rightarrow$ This	← → × ↑ 📑 > This PC > OS (C:) > Program Files (x86) > VEX Robotics > v 🖏 Search VEX Robotics >						
Organize 🔻 New folder							?
Desktop	Name	Date modified	Туре	Size			
Documents	Victor BB Dashboard	2/22/2016 11:57 PM	File folder				
Downloads							
Music							
📲 Nexus 5							
Pictures							
🚼 Videos							
🛄 OS (C:)							
LOGGER (E:)							
LOGGER (E:)							
nallwpilib							
datadirec							
eol							
hero tester							
Hero-Vortex-Kit 💙							
File <u>n</u> ar	me:						~
	L				<u>O</u> pen	Cancel	

Navigate into Program Files (x86)\VEX Robotics\Victor BB Dashboard\Firmware files

Open										×
← → ~ ↑ 📙	> Thi	s PC > OS (C:) > Program Files (x86) > VE	X Robotics > Victor BB Da	shboard > Firmware	Files		√ Ū	Search Firmware Files		P
Organize 🔻 New	v folde	r								?
E Desktop	^	Name	Date modified	Туре	Size					
Documents		RELEASE_NOTES	2/22/2016 11:47 PM	File		1 KB				
👆 Downloads		VicBB-Application-0.17.crf	2/19/2016 2:01 AM	CRF File		31 KB				
👌 Music										
📕 Nexus 5										
Pictures										
📑 Videos										
🟪 OS (C:)										
SD LOGGER (E:)	5									
	File <u>n</u> a	ime:								~
								<u>O</u> pen	Cancel	

Select the latest CRF and press Open.







#### Then press field-upgrade...

Victor BB - Dashboard					_		×
Serial Port: COM13	✓ Connect	Disconnect	Reflashing				
Status				Motor Output			
App Status: Running	Output(%): -2.37%			+100%	0.0	00	-
App Vers: 0.17	Current(A): 1.342			+50%			
Bootloader: 0.4	Battery(V): 15.19			0%			_
Hardware Vers: 1.0	PWM(us): 1488			-50%			_
Manufacture Date: Feb 4, 20	)16			-100%	Enable	Disa	ble
Field-upgrade Status (Detailed) CRF Path: C:\Program Files	(x86)\VEX Robotics\V	ger Calibration	Advanced Control	E.O.L. VicBB-Application	n· Bro Field-	owse Upgrade	
P	Reflashing			Version	(1.0.0.12)	DLL (1.0	.0.13) .:

#### The field-upgrade should take about eight seconds.

Victor BB - Dashboard			_		×
Serial Port: COM13	Connect Disconnect Connected				
Status		Motor Output			
App Status: Running	Output(%): -2.37%	+100%	0.00	)	-
App Vers: 0.17	Current(A): 0.472	+50%	_		
Bootloader: 0.4	Battery(V): 15.19	0%			_
Hardware Vers: 1.0	PWM(us): 1488	-50%			
Manufacture Date: Feb 4, 20	16	-100%	Enable	Disabl	le
Field-upgrade Status (Detailed)	Configuration Logger Calibration Advanced C	ontrol EOI			
CRF Path: C:\Program Files	(x86)/VEX Robotics/Victor BB Dashboard/Firmware F	-iles\VicBB-Application	Brow	vse	
			Field-U	pgrade	
Flash Success					-
Field-upgrade Duration: 00:07.	.24				
I					
		Version	(10012)	011 (1.0.0	) 13)
		version	(10012)0	22 (1.0.0	





/ictor BB C	ompr Sig	ehens nals	sive Gu	uide	
Victor BB - Dashboard				- 🗆 X	
erial Port: COM13 Status	✓ Conn	Disconr	nect Connecte	d Motor Output	Motor output (4% deadband not factored)
App Status: Running	Output(%): -	2.37%	_	+100% 0.00	Decoded Current Draw
App Vers: 0.17	Current(A):	0.472	_	+50%	
Bootloader: 04	Battery(V):	15.19		10%	Decoded Battery Voltage
Hardware Vers: 10	PWM(us):	1488		-50%	Sensed RWM pulse width 0 if RWM is not present
Field-upgrade Status (Detaile	d) Configuration	n Logger Calib	pration Advanced (	Control E.O.L.	
✓ Update					
Name	Value	Pin Voltage	Decoded		
eAppliedOutput	-38				
eBatteryVoltageAdc	294	948mV	15189 mV bat		
eCurrentAdc	511	1648mV	472mA (est)		
eCurrentTare	511	1648mV	biased:0		
eDecodedCurrent_mA	472				
eDecodedVbat_mV	15189				
ePulseWidthUs	1488				
erwmFreq	10000				
e StatusCount	1900				
e Temp Adc	251	809mV	30degC		
				Version (1.0.0.12) DLL (1.0.0.13)	

## 4.1. Status Signals (Detailed) Tab

The Dashboard has an advanced tab for signal values sourced from Victor Firmware. As this is an advanced feature, this tab may not be accessible in public release.

Name	Value	Pin Voltage	Decoded		Raw Duty Cycle
eAppliedOutput	-38 💶				
eBatteryVoltageAdc	294	948mV	15189 mV bat		Raw Patton: ADC value
eCurrentAdc	511	1648mV	472mA (est)		Raw Battery ADC value
eCurrent Tare	511	1648mV	biased:0		Raw Biased ADC value for curren
eDecodedCurrent_mA	472				num blabed Abe funde for darren
eDecodedVbat_mV	15189				Decoded Current and Battery Voltage
ePulseWidthUs	1488				, , ,
ePwmFreq	10000 -				
eStatusCount	1900				PWM Frequency (Hz)
eStatusFlags	0				
eTempAdc	251	809mV	30degC		





## 5. Configuration Settings



Brake vs Coast in neutral can be selected in the configuration tab. Additionally, the battery eliminator can be enabled here.

Ramping can be enabled to prevent rapid changes in motor output during PWM (and UART) control.

If firmware does not support current-limit, the following message is seen.



## 6. Controlling motor output

Victor BB - Dashboard			— C	x c	
Serial Port: COM13	Connect     Disconnect	Connected Motor Output	ıt		Proce the chortest buttons or change the
App Status: Running App Vers: 0.17	Output(%): -2.37%	+100%	20.00	<b></b>	number entry or scrollbar to override the motor output percent.
Bootloader: 0.4 Hardware Vers: 1.0	Battery(V): 15.19 PWM(us): 1488	-50%			Note user must press "Enable" to
Manufacture Date: Feb 4. 20	016	-100%	Enable Must press Er override Moto	Disable able to r Output	

## 7. Logger

Logger tab can be used to data log a CSV file format with battery voltage, current, temperature, throttle, etc...





## 8. Custom Calibration

The decoded battery voltage and current-draw values are based on an equation written in firmware. However, the Victor supports custom calibration where the ADC value and interpreted value can be hand written into flash, providing even greater accuracy for vbat measurement and/or current measurement.

Select Number of Entries of '1' to enter a single ADC/Value pair. This will perform a single point calibration from 0,0 to the entered pair.

Select Number of Entries of '2' to enter two ADC/Value pairs. This will perform a two point calibration allowing for a line that does not cross the origin.

Factory Logo	jed Se	nsor Values	Battery Voltage Calibra	ation Current Draw Calibration
Instance:	0	<b>*</b>	NumEntries: 0 🚔	NumEntries: 0 🖨
TempC:	0	-	ADC Batt Voltage (mV)	Biased ADC Current (mA)
Battery:	0	-	0 🖨 0 🖨	0 💠 0 💠
No Draw Current:	0	-	0 🖨 0 🖨	0 💠 0 🖨

## 9. Current-Limiting

Starting with firmware 0.20, current-limiting is supported. The current limit is specified in amps in the Configuration tab (See <u>section 5</u>).

## 9.1. Terms

Req-throttle: The requested throttle from PWM/UART-Dashboard after the user selected Ramp.

Output-throttle: The applied output throttle leaving the h-bridge.

"Weaker" throttle: If two throttles A and B are the same sign (both positive or both negative) and A has a less than throttle than B, then A is 'weaker' than B. For example, a throttle of 75% is weaker than 80%. Similarly -75% throttle is weaker than -80%.

Resume Rate (Kr): Rate at which current-limited ramps output-throttle back up to request-throttle if current-draw is below threshold and output-throttle is weaker than request-throtttle.



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## 9.2. Theory of operation.

The Victor BB runs a PID closed-loop that servos to the target current-draw. The error is the difference between the target current-draw and present current-draw. Once the PID loop yields a negative term (current is too high) the output-throttle is reduced (approaches neutral) by the magnitude of the PID-output. Note that the output is registered, meaning that a constant P-error and P-gain will result in a constant reduction rate of the output throttle. As a result, I-gain is not needed as the output will latched to its previous value plus the reduction term provided by PID.



D-gain can be used to hasten the response as a function of the rate of change of the current-error.

Once the current is too high, the currentlimiting state is set to 'Limited', meaning the output throttle is ramp towards neutral according to the rate provided by PID.

If the requested throttle is changed to be "weaker" than the currently applied output-throttle, the current-limiter will reduce the output-throttle to the req-throttle and leave the limited state.

If current-draw is reduced to at or below the current-threshold, the output-throttle is then ramped up to the req-throttle at the recovery rate of Kr. Kr is in throttle units per 1ms, where 1560 units presents full throttle.

Additionally, if the user decides to change direction in req-throttle, the current-limiter will also leave the limited state and follow req-user. If this also causes a current-limit condition, the Victor will simply re-enter the limited state.





## 9.3. Additional tuning

The default gain/ramp values used were tested by stalling an Amp Flow (700A rated) motor with a 48V source.

Victor BB - Dashboard           Serial Port:         COM29         Connect         Disconnect         Connected           Status         App Status:         Running         Output(%): 0%         1100%         1100%           App Vers:         0.20         Current(A):         0.00         50%         50%           Bootloader:         0.4         Battery(V):         47.17         60%         -50%           Manufacture Date:         Feb 4, 2016         -100%         -100%         -100%	- C X	The additional advanced tab allows customization of the P-gain, D-gain, and Resume rate (Kr).
Reld-upgrade       Status (Detailed)       Configuration       Logger       Calibration       Advanced Control       E.O.L.       Curent Limit Advanced Settings         To modify Curent Limit Closed-Loop, modify the parameters and press "Apply"       P:       0.001500 to 1000 to 1000000 to 10000000 to 10000000000	urent Limit (Advanced)	This feature is not necessarily meant to be public (TBD) however may become useful as this feature sees more testing.
	Version (1.0.0.16) DLL (1.0.0.14)	

The "Pulse the Motor" button can be used to drive the motor to the selected throttle (top right) for a small fixed period of time. This allows safer testing of high current events at various current limits while oscilloscope-ing the output of the current-sense chip for tuning-feedback.

Below is a reduction in throttle (purple is M-) in response to a 2ms wide current-spike from the current-sense chip (yellow).









## **10. Status LED Blink Codes**

Blink Codes During Calibration				
Status LED Blink Code	Victor BB State			
Flashing Red/Green	Calibration Mode			
Blinking Green	Successful Calibration			
Blinking Red	Failed Calibration			

Blink Codes During Normal Operation				
Status LED Blink Code	Victor BB State			
Solid Orange	PWM signal is within 4% of deadband			
Blinking Red	Reverse PWM is applied – Blink speed is proportional to input			
Solid Red	Full Reverse PWM is applied			
Blinking Green	Forward PWM is applied – Blink speed is proportional to input			
Solid Green	Full Forward PWM is applied			
Blinking Orange	No PWM Signal			

## **11. Calibration Procedure**

Press and hold the calibration button for approximately two seconds. The LEDs will flash Red/Green when calibration mode is entered. While holding the button, press the control stick full forward, then full reverse, then let the stick center. Release the calibration button. If calibration was successful, the LEDs will flash Green, otherwise the LED will flash Red.

If the calibration procedure fails repeatedly, if possible, increase the travel of the control axis to the maximum on the transmitter and recalibrate.









## 12. CRF Firmware History

Revision	Date	Description
0.20	3/16/2016	Current limiting Added
0.18	2/25/2016	Added new signal "current ADC Sum" for current calibration. Updated the default current math based on cased Victor BB measurements.
0.17	2/20/2016	Initial testing release

## **13. Revision History**

Revision	Date	Description
1.4	10/20/2016	Added LED status light tables and calibration procedure
1.3	3/23/2016	Warning about PWM supply voltage added
1.2	3/16/2016	Current limiting Added
1.1	2/25/2016	Added more EOL content for calibration. Added EOL Victor LEDs during B/C Test.
1.0	2/23/2016	Initial draft.



