



ElectroCraft[®]

CompleteArchitect[™]

CompletePower[™] Plus – Universal Drive Configuration Software

Software User Manual

ElectroCraft CompletePower[™] Plus Universal Servo Drive

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Read This First

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About This Manual

This document is the software manual for ElectroCraft CompletePower™ Plus Universal servo drives. This document covers the download, installation and operation of the ElectroCraft CompleteArchitect™ software needed for configuring all ElectroCraft CompletePower™ Plus Universal servo drives.

CompletePower™ Plus Universal Drive Technical User Manuals

- CPP-A06V48A-SA-USB Technical Reference, ElectroCraft document number 198-0000019.
- CPP-B06V48A-SA-USB Technical Reference, ElectroCraft document number 198-0000019.
- CPP-A12V80A-SA-USB Technical Reference, ElectroCraft document number 198-0000023.
- CPP-A24V80A-SA-USB Technical Reference, ElectroCraft document number 198-0000026.

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1 Software Overview

This manual covers the download, installation and operation of the ElectroCraft CompleteArchitect™ software to configure ElectroCraft CompletePower™ Plus Universal servo drives.

1.1 Key Features

ElectroCraft CompleteArchitect™ is a Windows®-based software tool that includes the following key features:

- Easy installation
- An Interactive graphical user interface
- A user configurable motor database
- Detailed video tutorials
- An online monitor for visualizing application parameters such as bus voltage and motor speed
- An oscilloscope for measuring high speed waveforms such as motor phase currents
- Diagnostic test scripts for verifying control loop parameters
- I/O monitor to display the physical state of all the digital and analog inputs and outputs
- Configurable application protection
- Selectable measurement units

1.2 Simplified Process Flow

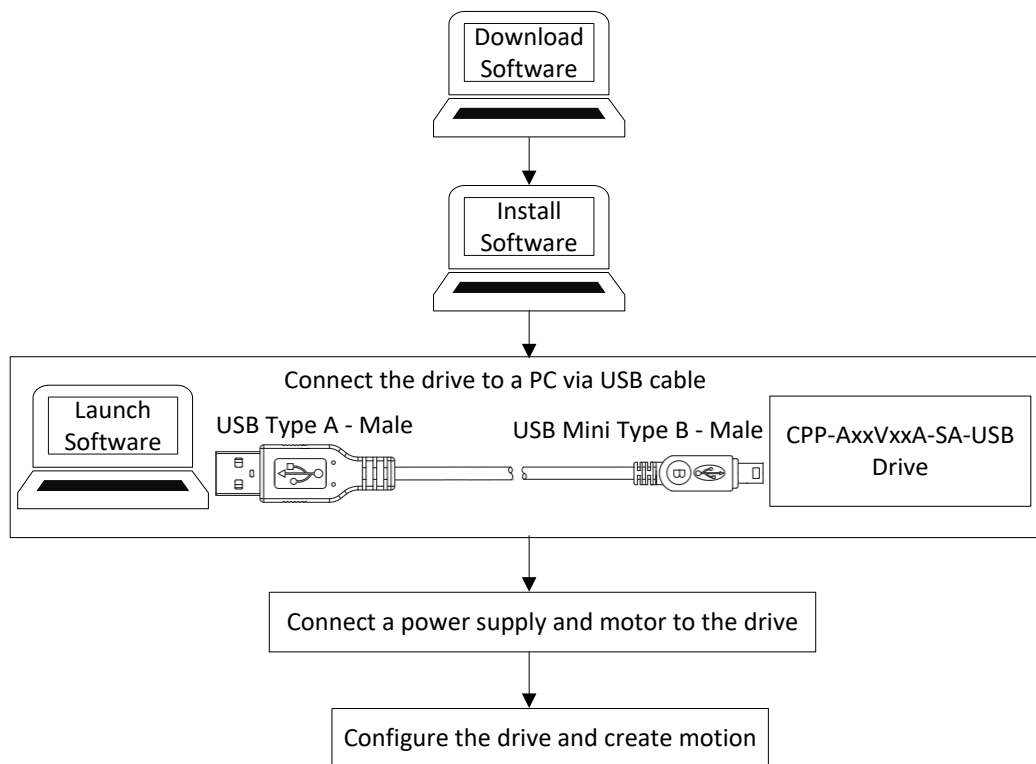


Figure 1: Simplified Block Diagram

Note: The CPP-AxxVxxA-SA-USB and CPP-BxxVxxA-SA-USB drive can be configured by software through USB when no power is supplied to the drive. Power must be applied to the drive before operation.

1.3 Software Setup

1.3.1 Software Download


Launch your preferred internet browser and go to the [ElectroCraft website](#). Navigate to the CompletePower™ Plus Universal Drives page to download the CompleteArchitect™ Software.

1.3.2 Software Installation

Once the download is complete, launch the software installer (ElectroCraft CompleteArchitect Setup vxxx.exe). The window shown in Figure 2 will appear.



Figure 2: Initial Installation Window

Follow the instructions in the installation window. Once the installation is successfully complete, the CompleteArchitect™ software icon  will be accessible from the desktop and Windows Start menu.

1.3.3 Software Launch

Open CompleteArchitect™. The window shown in Figure 3 will appear.



Figure 3: CompleteArchitect™ Software Initial Window

Connect the drive to the PC using a USB cable and supply power to the drive. Status will change to *Connected* and the Drive type, Drive serial number, Firmware version and Drive configuration will change to reflect the characteristics of the connected drive. An example of a connected drive is shown in Figure 4.

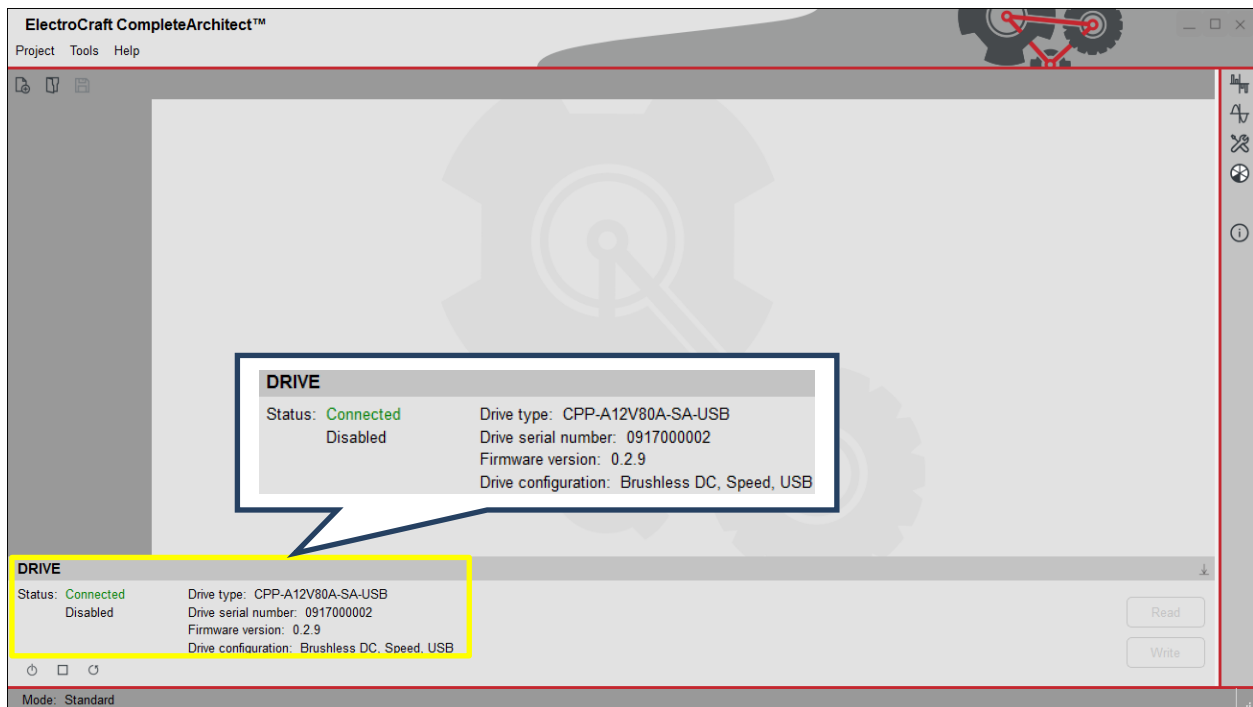


Figure 4: Drive Information

1.4 Software Window Overview

The fundamental symbols and sections of the program are labelled in the example window shown in Figure 5. A description of the function of each fundamental symbol is provided in the accompanying table. The image also highlights the locations and terminology used to describe the different functional groups in this document.

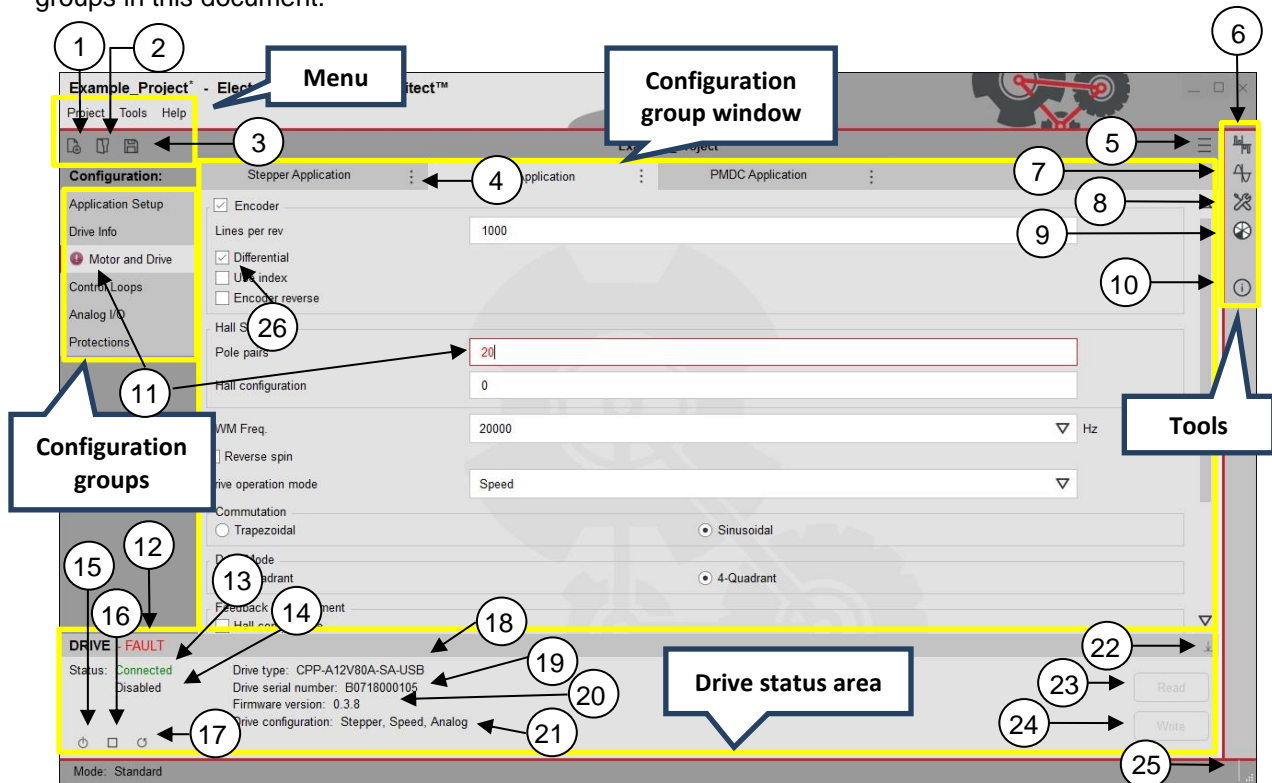


Figure 5: Fundamental Symbols

1. New project – Create a new project.
2. Open project – Open an existing project.
3. Save project – Save the current project.
4. Rename application - Modify the application name.
5. Edit project description – Modify the project description.
6. Online monitor – Open the Online monitor tool.
7. Oscilloscope – Open the Oscilloscope tool.
8. Diagnostic – Open the Diagnostic tool.
9. I/O Monitor – Open the I/O Monitor tool.
10. Help – Open the most recently viewed help notes. Right click any of the drive or motor parameters and select *Help* to open the help window which has a concise explanation about the selected parameter.
11. Attention – This indicates an issue with a drive setting or parameter value.
12. **FAULT** – This status will be displayed when a fault is triggered. Click on the status to see which protection caused the fault.
13. **Connected** – Indicates that the drive is connected to the software successfully. The status changes to **Disconnected** when the drive is not connected to the software.
14. **Disabled** – Indicates that the drive is disabled. The status changes to Enabled when the drive is enabled.
15. Enable drive – Enable the drive. When the control interface is set to “Analog,” this symbol will function as an indicator and cannot be toggled.
16. Brake/Release drive – Apply Brake. When the control interface is set to “Analog,” this symbol will function as an indicator and cannot be toggled.
17. Reset drive – Reset drive.
18. Drive type – Displays drive model.
19. Drive serial number – Displays serial number.
20. Firmware version – Displays the current firmware version of the drive.
21. Drive configuration – Displays a summary of the configuration of the drive.
22. Minimize – Minimize the drive status area.
23. Read – Read the parameters saved in the drive.
24. Write – Write parameters into the drive. In case any error, this button will be disabled.
25. Resize – Click and drag on this symbol to change software window size.
26. Checkbox – click a checkbox to enable / disable the function.

1.5 Database Updates

Electrocraft makes routine updates to the CompleteArchitect™ motor database as new motors become available. The database (DB) and software (SW) can be updated at any time from the tools menu. Check the server for updates by clicking *Tools -> Check for Updates*. The *Updates* window shown in Figure 6 will search the server for all available updates and gives an option to download the latest database and software versions. After downloading, click *Update* to update the software to downloaded database version.

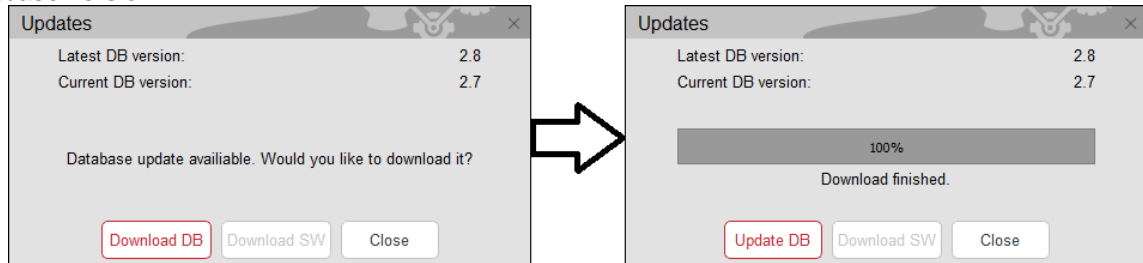


Figure 6: Database Update Window

Click *Yes* when prompted to close the program as shown in Figure 7.

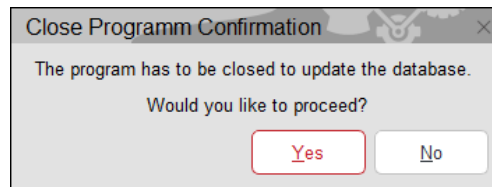


Figure 7: Close Program Confirmation Window

Click *Update* and *Close* in the *Updater* window as shown in Figure 8. The program will then close.

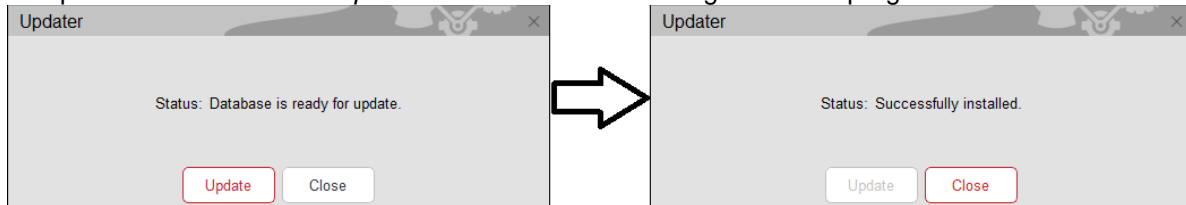


Figure 8: Updater Window

Follow similar steps by clicking “*Download SW*” to download and install the latest software version. To confirm that the latest DB was been successfully updated, reopen CompleteArchitect™ and click *Tools -> Check for DB Updates* from the menu. Confirm that the DB update window indicates that *No updates available* as shown in Figure 9.

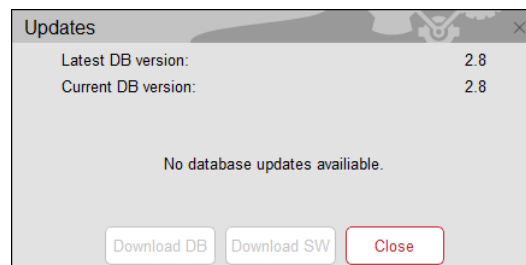


Figure 9: Database Update Window after Update

2 Help

2.1 About

To view the product version, end user license agreement and open source license list, click *Help -> About* from the menu. The window shown in Figure 10 will appear.



Figure 10: About Window

2.2 Tutorial

The software contains video tutorials to demonstrate commonly used software features. Select *Help -> Tutorials* from the menu and the window shown in Figure 11 will appear. Select *New Project* and click *Start* to learn about new project creation. Select *Read/Write Configuration* and click *Start* to learn about reading, modifying and writing drive parameters. Select *New User Motor* and click *Start* to learn about creating and storing a custom motor model in the software motor database.

The tutorial will open in the user's default web browser.

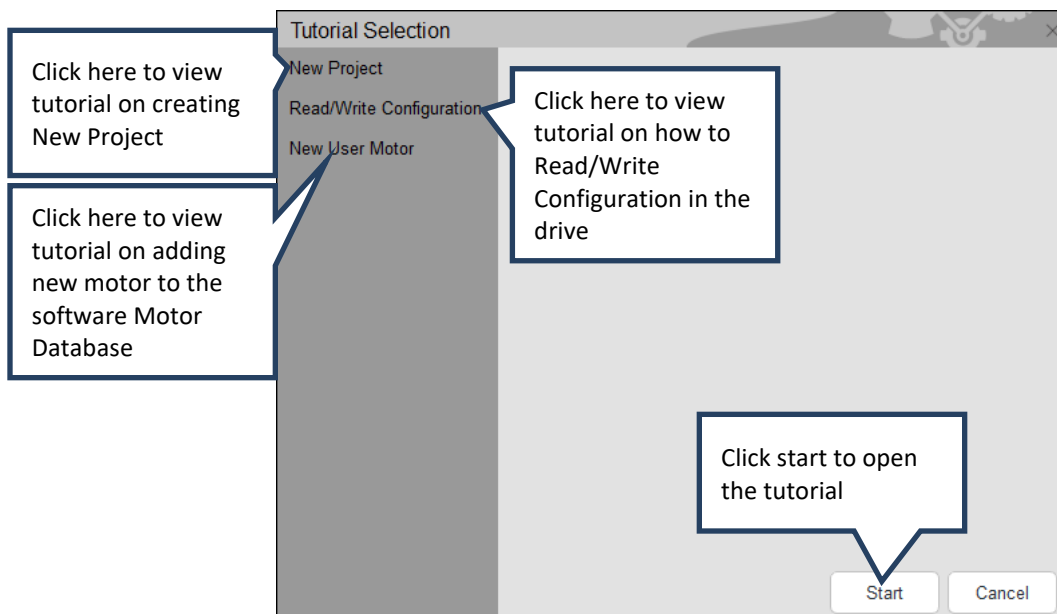


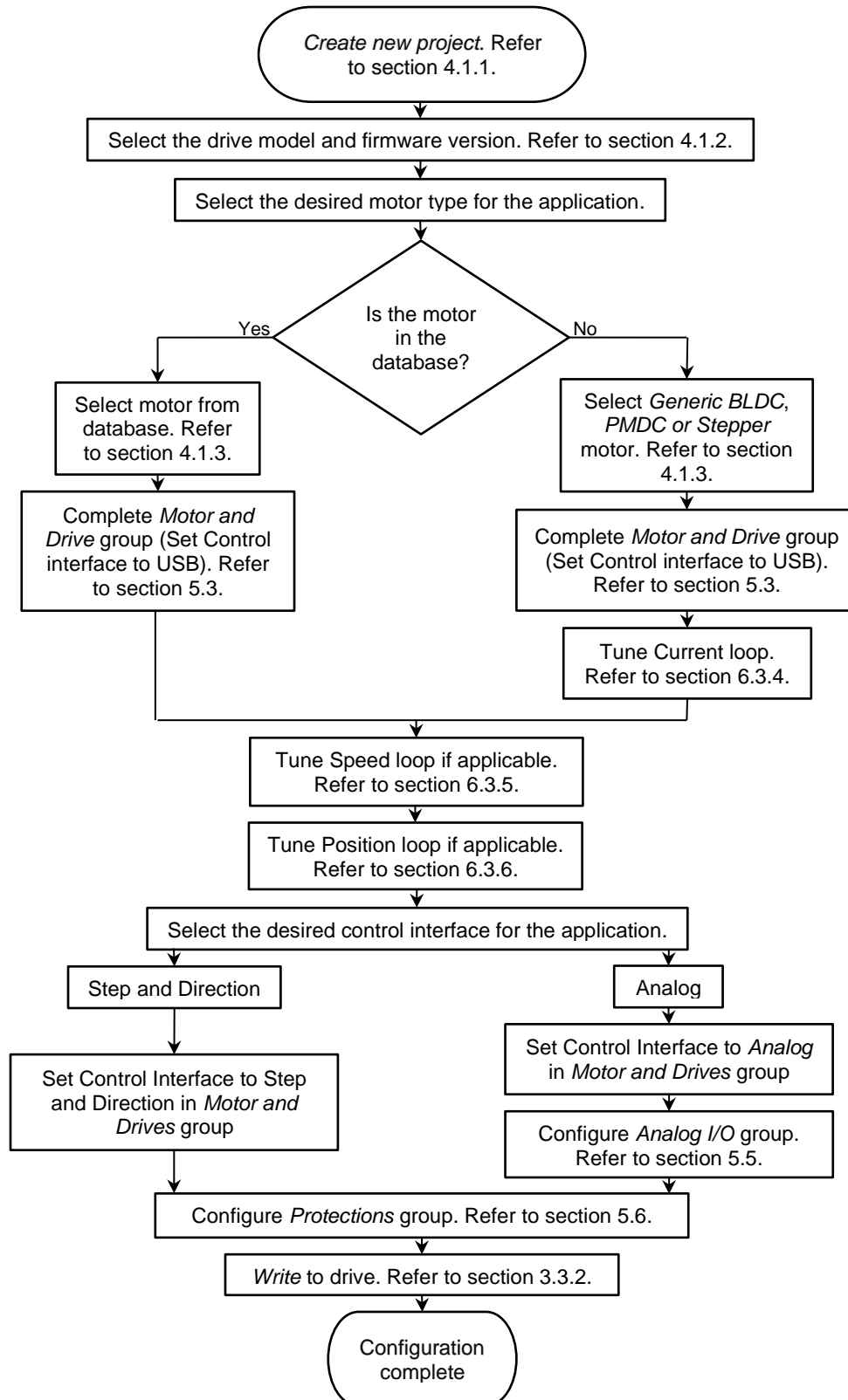
Figure 11: Tutorial Select Window

3 Drive Configuration Process Flowchart

3.1 Flowchart to Configure a Blank Drive or Reconfigure a Drive

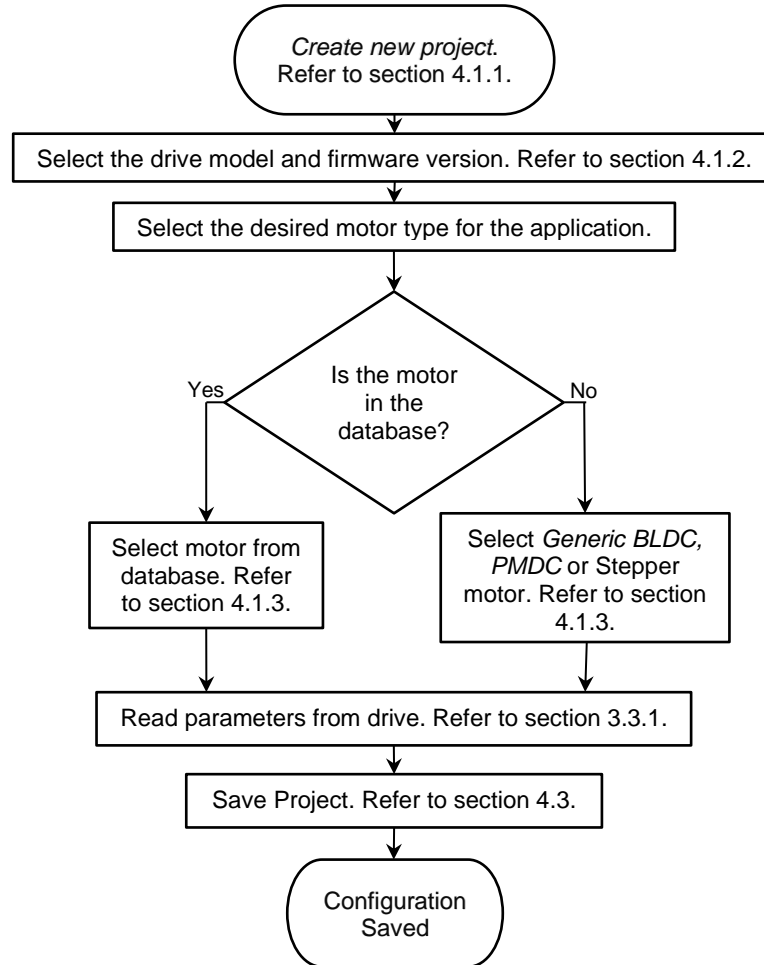
Follow the flow chart below to configure the drive for a BLDC, PMDC or Stepper motor application using CompleteArchitect™. Launch the software on a PC and connect the drive to the PC via USB cable. Connect the motor and power supply to the drive as described in the Technical user manual.

Note: Following the steps in the flowchart in this section will overwrite the configuration present in the drive.



3.2 Flowchart to Read and Save Configuration from Drive

Follow the flow chart below to save the configuration in the drive into a project for a BLDC, PMDC or Stepper motor application using CompleteArchitect™. Launch the software on a PC and connect the drive to the PC via USB cable. Connect the motor and power supply to the drive as described in the Technical user manual.



3.3 Read and Write from the Drive

This section will describe the read and write features of the software.

3.3.1 Read

The read function will load all of the parameters that exist in the connected drive into the software interface. Follow the steps shown in Figure 12 to load and verify the parameters present in the drive.

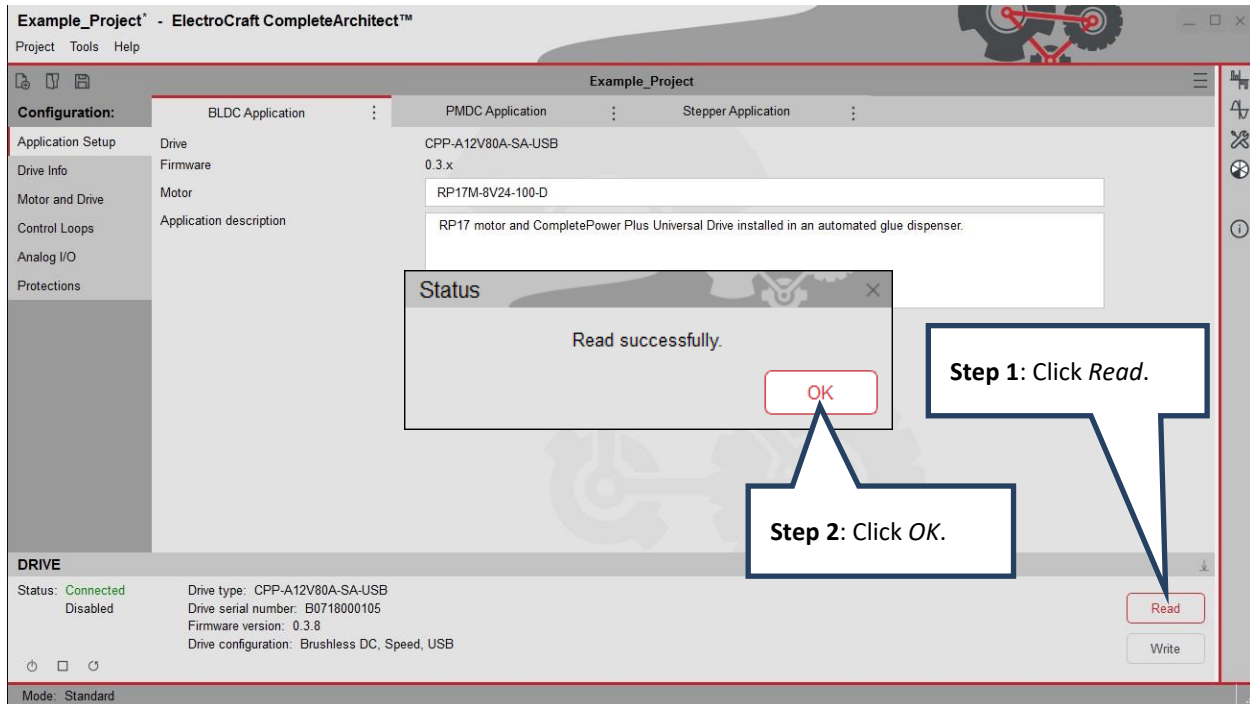


Figure 12: Read Drive Parameters

The error message shown in Figure 13 will be displayed when there is a problem reading the parameters from the drive.

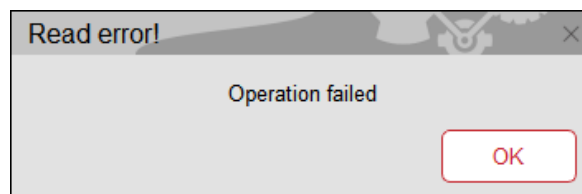


Figure 13: Read Error Window

3.3.2 Write

The Write function will transfer all the parameters of a project into the connected drive. CompleteArchitect™ will only allow the user to write to the drive when all of the required fields have been filled with values that are within allowable ranges. When a value falls outside of this range, the value will turn red, an exclamation point appears next to the group that needs correction and the “Write” button is disabled. The user must correct all problematic entries before the “Write” button will become enabled. Follow the steps shown in Figure 14 and Figure 15 to write all the parameters into drive.

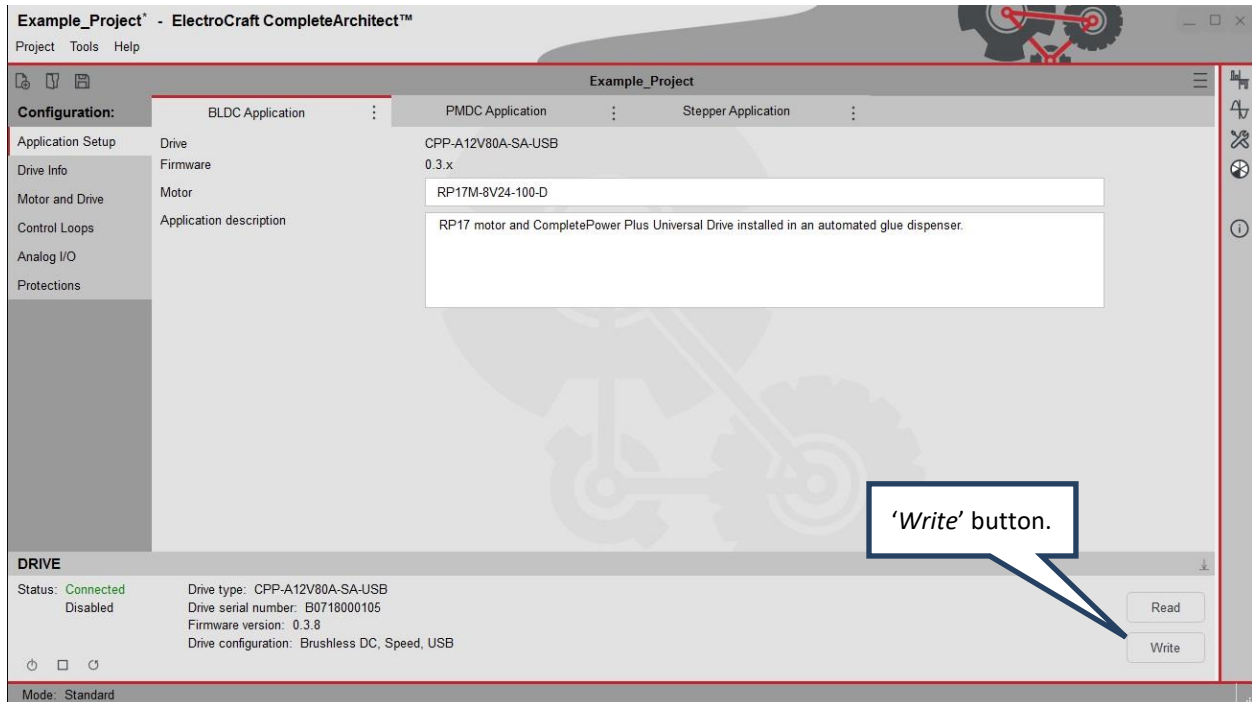


Figure 14: Write Drive Parameters

A prompt window as shown in Figure 15 will appear. Checking the save to EEPROM box will permanently write the drive parameters into the drive’s EEPROM. Leaving the *save to EEPROM* box unchecked and clicking *OK* will write the parameters into volatile memory and resetting the drive will return the parameters to the values saved in EEPROM.

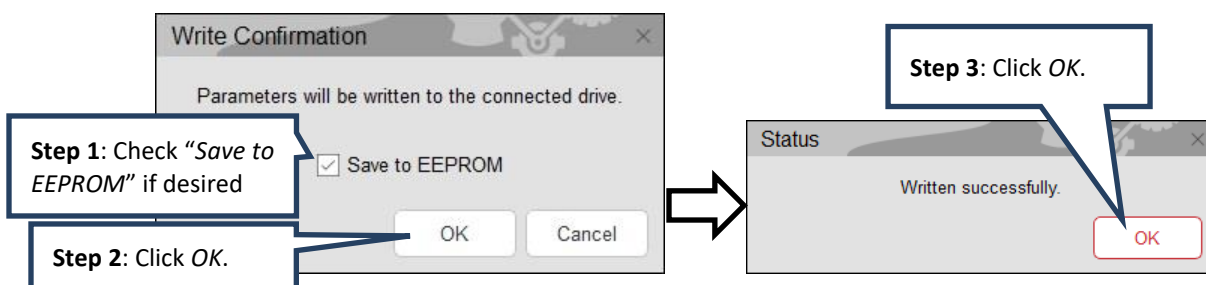


Figure 15: Write Prompt Window

Note that the Save to EEPROM checkbox selection is “sticky”, it retains the previous selection. If the box is checked on a write, on the next write operation the box will be checked and vice-versa.

4 Project Menu

4.1 New

Refer to Section 2.2 to access a video tutorial on creating new project. In this section a new project is created which contains one application (refer section 4.6 to add more applications to the same project) using a CPP-A12V80A-SA-USB servo drive and a RP17M-8V24-100-D motor as an example.

4.1.1 Name a New Project

Follow the steps in the Figure 16 to create and name a new project.

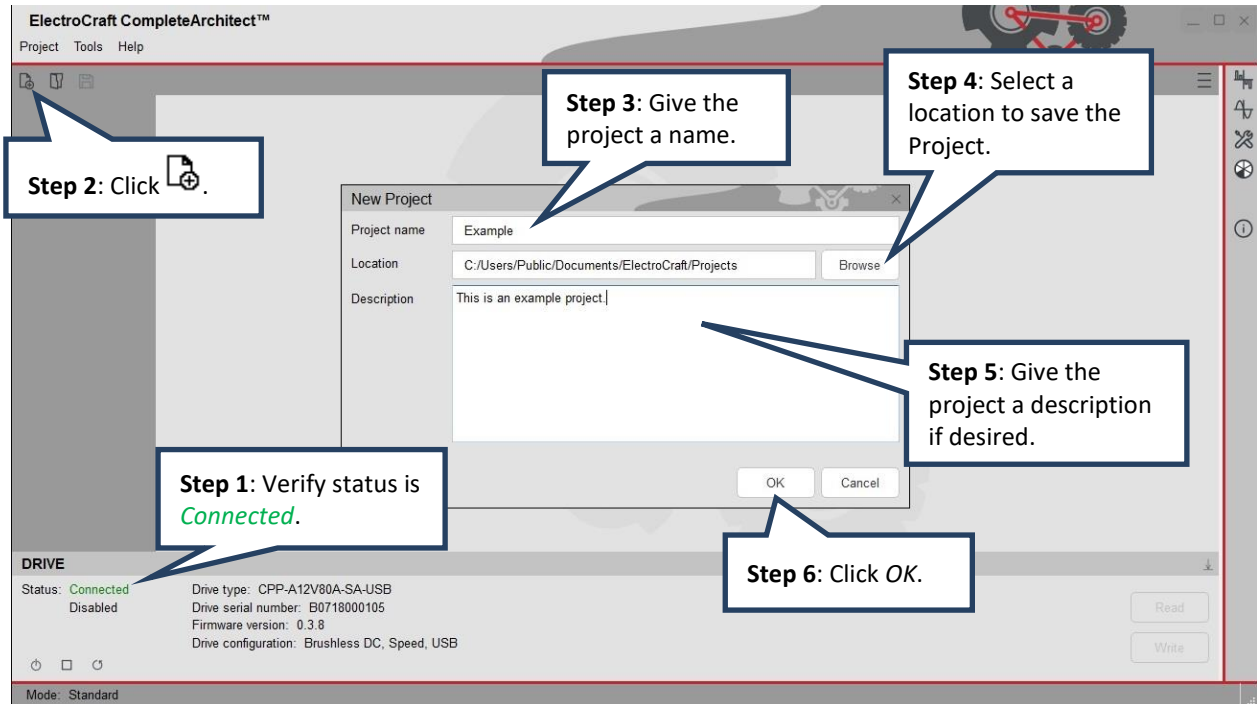


Figure 16: Creating and Naming New Project

4.1.2 Select the Drive and Firmware version

Follow the steps in the Figure 17 to select the drive model and firmware version. The drive model and firmware version can be found in drive status area as shown in section 1.4.

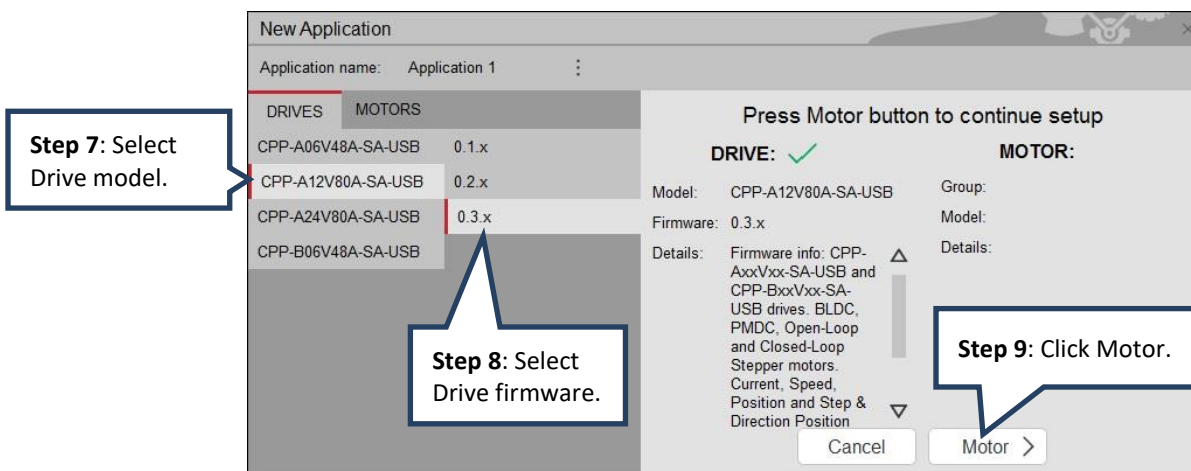


Figure 17: Selecting the Drive and Firmware version

4.1.3 Select the Motor

Follow the steps in the Figure 18 to select the motor model from the ElectroCraft motor database. If the specific motor used is not available in the database, a minimally populated project can be created by selecting the *Generic BLDC motor* model. Selecting this model will require the user to gather additional information regarding the operating characteristics of the motor before completing the configuration.

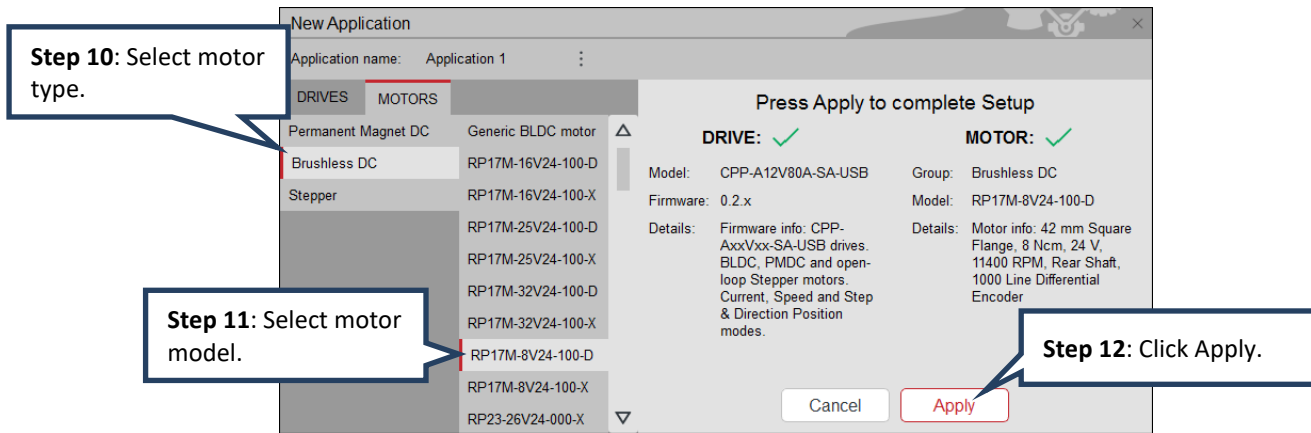



Figure 18: Selecting the Motor

4.2 Open

To open a project previously created, select *Project -> Open* or click the  icon from the menu and the window shown in Figure 19 will appear. Select the project folder and click *Open*.

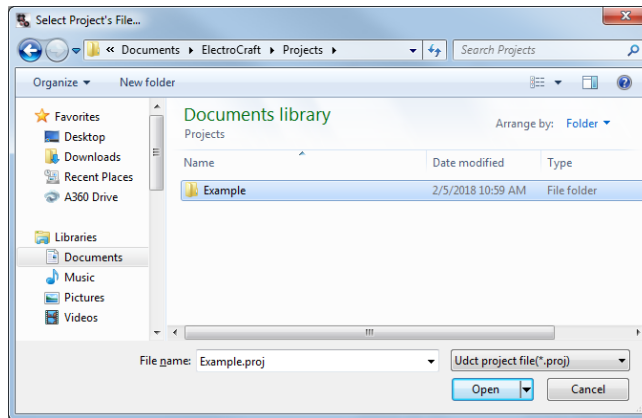


Figure 19: Select Project File Window

Select the project file and click open as shown in Figure 20.

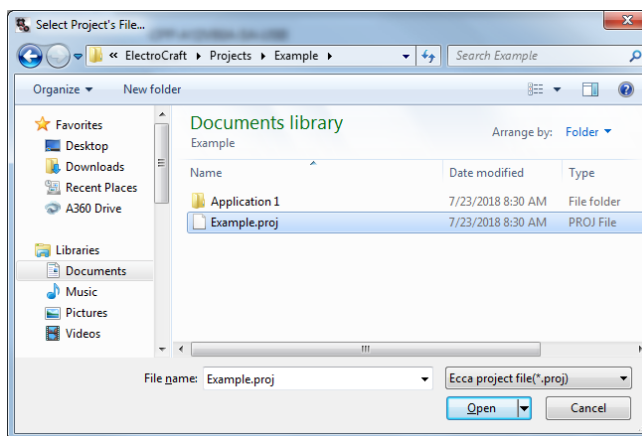


Figure 20: Select ".proj" File

4.3 Save

To save a project, select *Project -> Save* or click the  icon from the menu.

4.4 Save as

To save a project with a different name or in a different location in the computer, select *Project -> Save as* from the menu and the window shown in Figure 21 will appear. Make the necessary changes to the project file name, location and description and click *OK*.

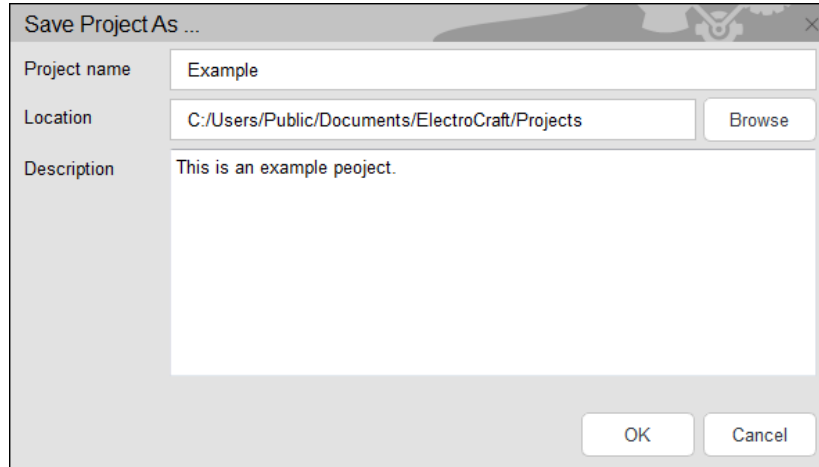


Figure 21: Save as Window

4.5 Close

To close a project, select *Project -> Close Project* from the menu. The window shown in Figure 22 will appear if the project was not saved prior to closing. Selecting *Save* will save any changes made to the project. Selecting *Discard* will close the project without saving any changes.

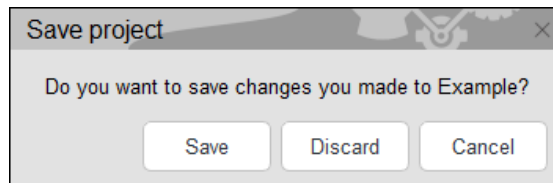


Figure 22: Save Project Prompt

4.6 New Application

To create a new application within the same project, select *Project -> New Application* from the menu. The window shown in Figure 23 will appear. Select the drive & motor and click *Apply* to create the new application.

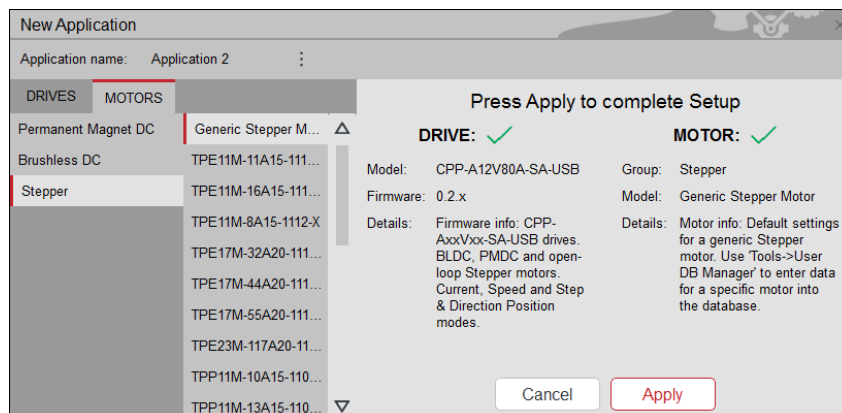


Figure 23: Creating New Application

4.7 Import Application

To import an application into the current project from another project, select **Project -> Import Application** from the menu. The window shown in Figure 24 will appear. Open the project file and select the specific application and click **OK** to add the application to the existing project.

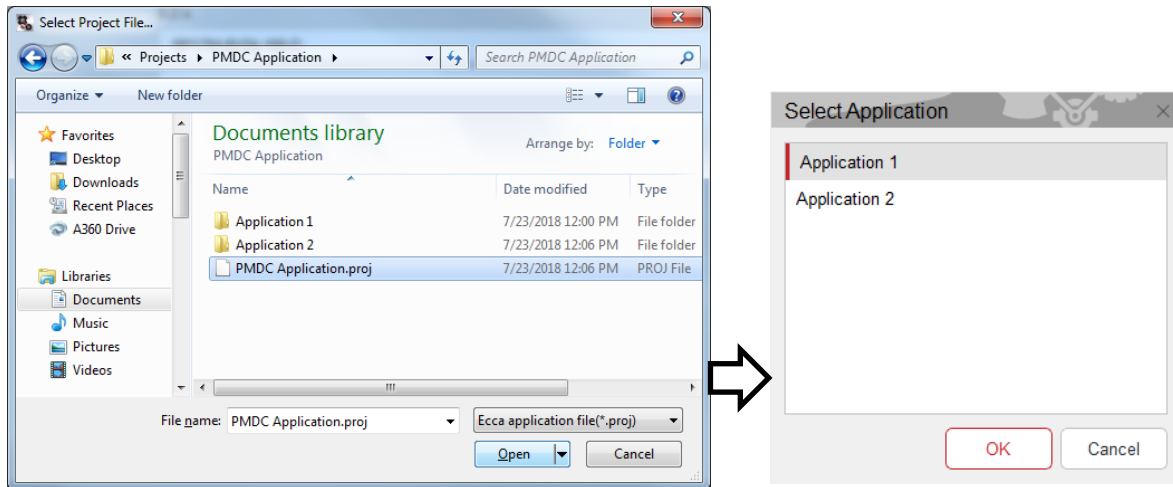


Figure 24: Importing application

4.8 Archive

Archiving a project will bundle all files associated with the project and store them as a single **.zip** file for future use at any location in the computer. The default archive location in the computer is "C:\Users\Public\Documents\ElectroCraft\Archives".

To archive a project, select **Project -> Archive** from the menu. The window shown in Figure 25 will appear. Select the location to archive the project, then click **OK** and in the progress window click **OK** when the status changes to completed.

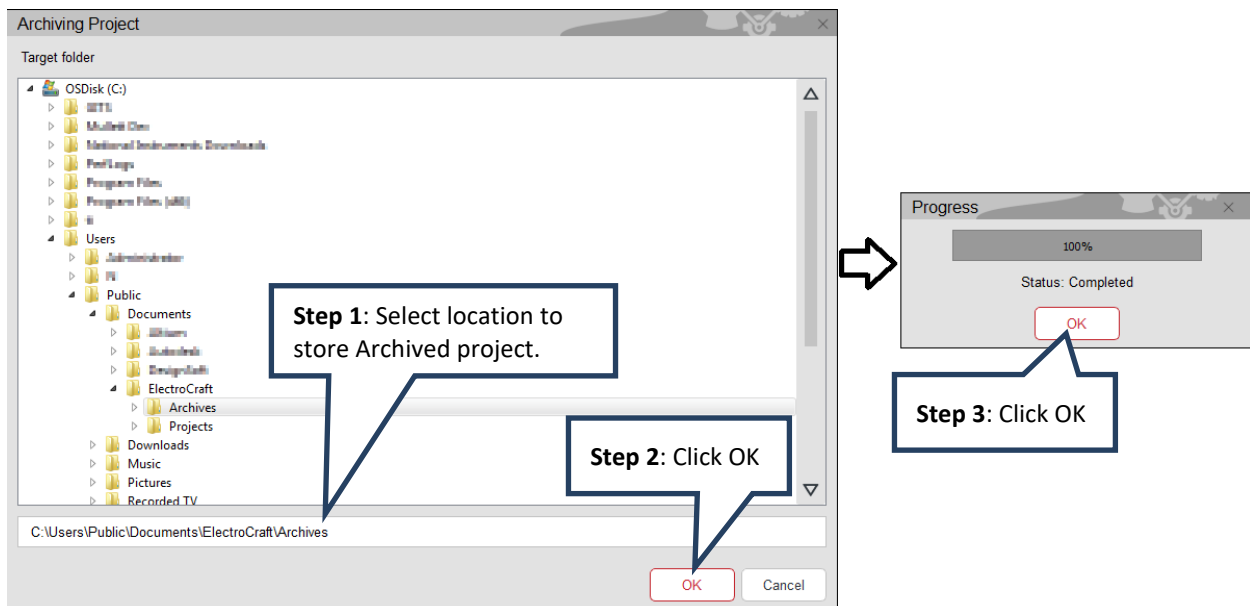


Figure 25: Archive Project Folder Path and Progress Window

4.9 Extract

An archived project can be unzipped and restored by extracting the project into any location in the computer. To extract a project, select *Project -> Extract* from the menu. The window shown in Figure 26 will appear. Select the source archive folder location and target folder for extracted project, then click *OK* and in the progress window click *OK* when the status changes to completed.

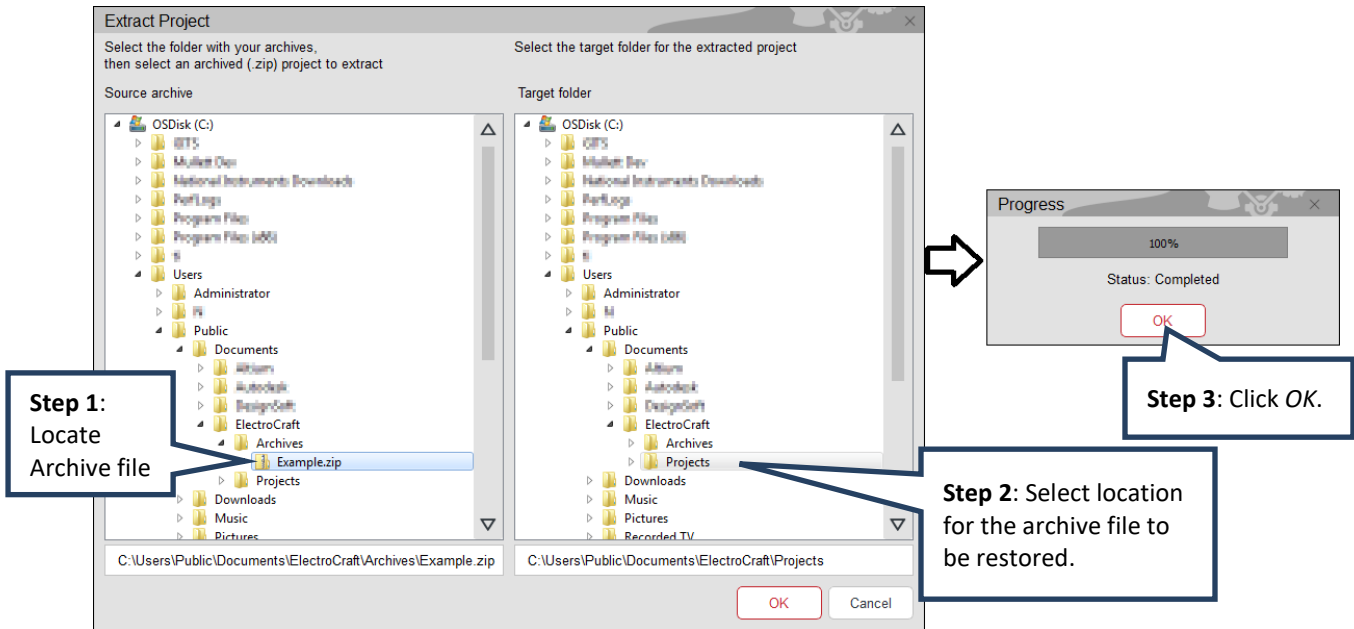


Figure 26: Extract Project Folder path and Progress Window

4.10 Settings

Select *Project -> Settings* from the menu to open the *Settings* window shown in Figure 27. The purpose of this window is to select different measuring units and languages in the software. Select the Measure or General menu and adjust the settings according to the user's preferences.

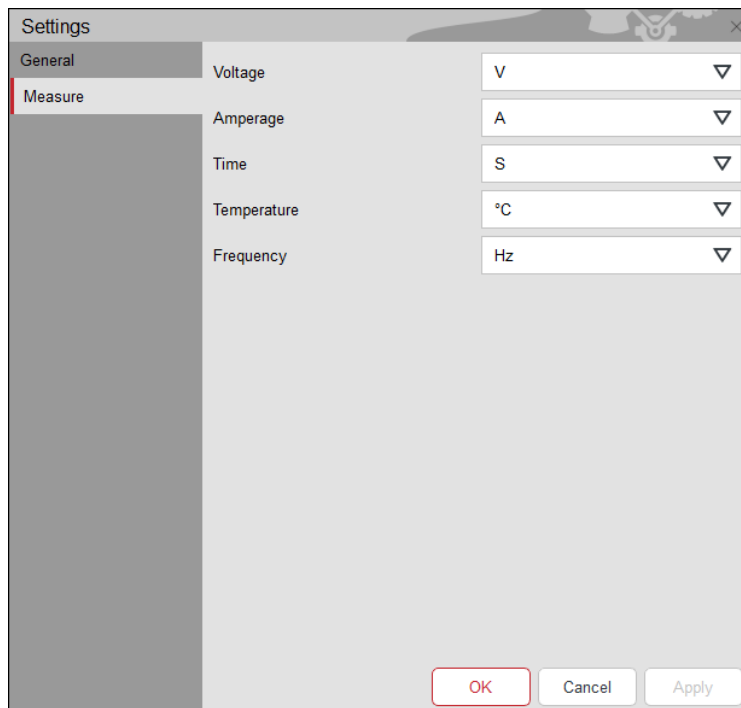


Figure 27: Project Settings Window

5 Configuration Groups

5.1 Application Setup

The Application Setup group shows the drive model number, firmware, motor name and application description as shown in Figure 28. The *Drive*, *Firmware* and *Motor* fields are populated from the database. The *Motor name* can be edited if desired. The *Application Description* is a place to enter background data to aid in understanding the concept and context of the application. This optional text entry is only for the operators use.

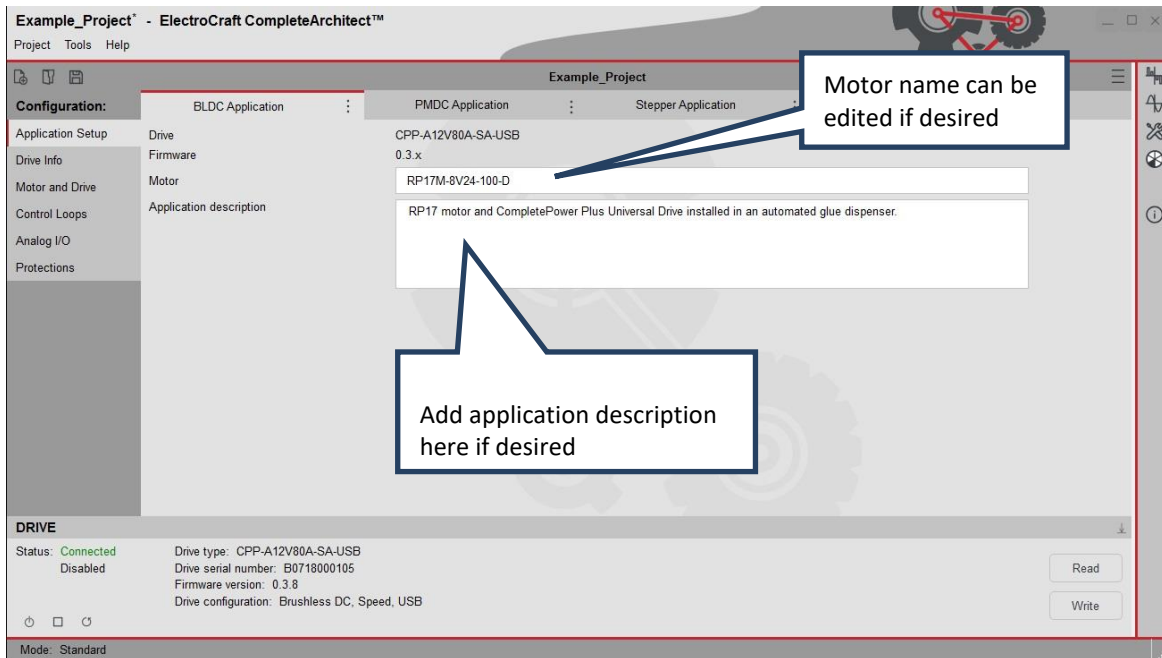


Figure 28: Application Setup Window

5.2 Drive Info

The Drive info group shows the details about the drive. All of the fields in this window are write-protected and the data varies depending on the drive selected, an example of this window is shown in Figure 29.

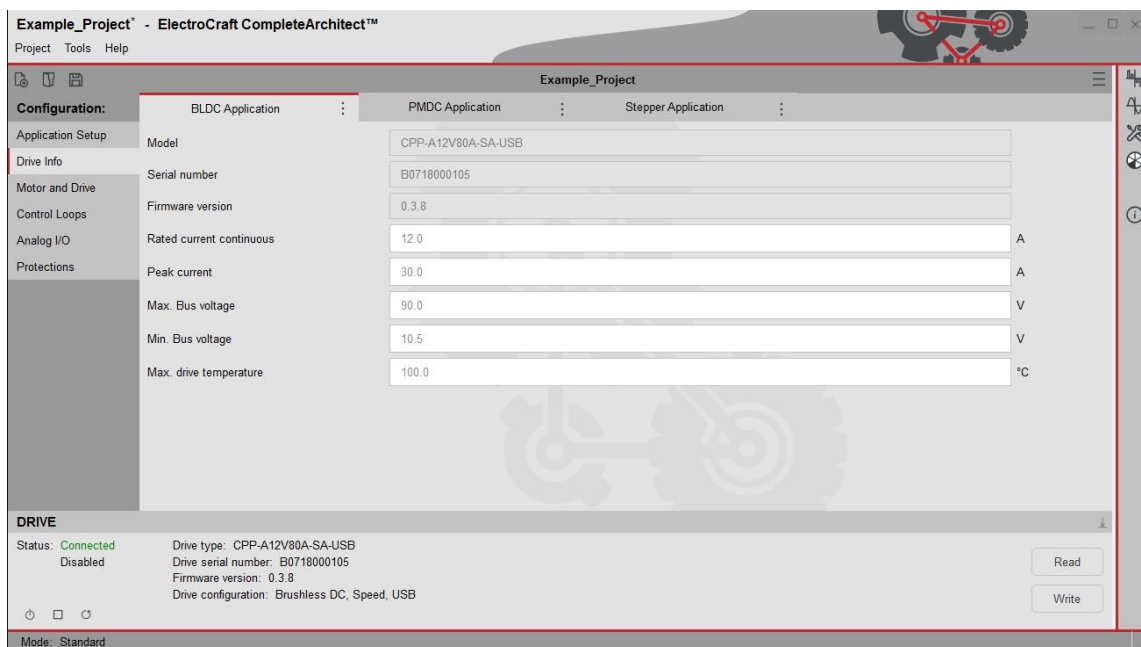


Figure 29: Drive Info Window

5.3 Motor and Drive

The Motor and Drive group allows the user to set the motor and drive parameters for their specific application. This configuration group is different for BLDC, PMDC and Stepper motors which are discussed below.

5.3.1 Motor and Drive Configuration Group for BLDC Motor

The Motor and Drive window for a BLDC motor is shown in Figure 30.

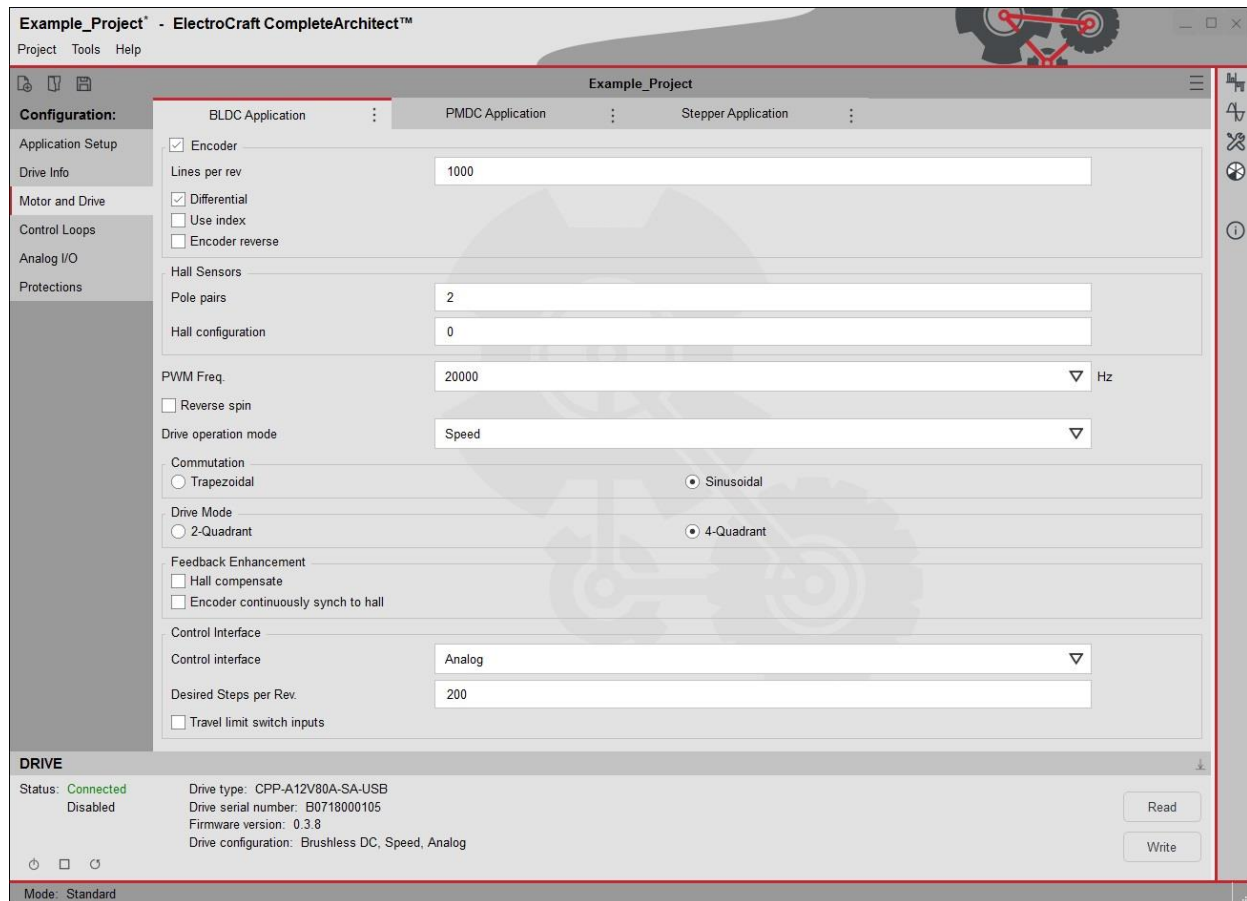


Figure 30: Motor and Drive Window for BLDC Motor

All parameters in this window are described below:

Encoder - When enabled, the encoder will be used for speed and position feedback. When disabled, the hall sensors will be used for speed feedback.

Lines per rev – This field represents the resolution of the encoder in units of lines per revolution. An encoder datasheet may specify resolution in units of lines, cycles per revolution (CPR), pulses per revolution (PPR) or quadrature counts per revolution. Lines, CPR and PPR are same and are often used interchangeably. To convert quadrature counts per revolution to lines, divide by 4. Example: 4000 quadrature counts = 1000 lines.

Differential - When enabled, the drive enables the differential encoder transceiver. When disabled, the drive will accept a single ended encoder input. A differential encoder may be more immune to electrically noise than a single-ended encoder. Reference the drive's user manual for electrical connection requirements and compatibility.

Use Index - When enabled, the drive will use the encoder index to synchronize motor commutation while rotating. This is useful to re-align the sine wave commutation when using single-ended encoders in electrically noisy environments. This option will not compensate for corrupted speed or position feedback

due to electrical noise on the encoder signals. This function is recommended for use in current mode operation.

Encoder Reverse - Encoder manufacturers do not use a common mechanical convention for “positive” direction. Some encoders count positive when turning clockwise (CW) and some when turning counter-clockwise (CCW). When enabled, this option reverses the polarity of the encoder counting and encoder speed reporting.

Hall Sensors:

Pole pairs – This represents the number of pole pairs that the connected motor possesses. This should be listed on the motor datasheet as either Poles or Pole Pairs. Motor Poles / 2 = Pole Pairs.

Example: 4 Motor Poles = 2 Motor Pole Pairs.

Hall configuration – This setting is an adjustment to align hall sensor states to the motor phase output sequence. Each increment of this variable shifts the commutation alignment by 60 electrical degrees.

The Hall configuration value is divided into two parts:

- Configurations 0 through 5 = Standard table
- Configurations 6 through 11 = Alternate table

Each table is separate from the other and circular in function. Incrementing values for the standard table are: 0 - 1 - 2 - 3 - 4 - 5 - 0 - 1 - etc. Incrementing values for the alternate table are: 6 - 7 - 8 - 9 - 10 - 11 - 6 - 7 - etc.

Below is the procedure to find the correct Hall configuration for a new motor:

1. Start with Hall configuration = 0 (beginning of the standard hall table).
2. Disable the encoder to force the drive to use the hall sensors for commutation and speed feedback.
3. Disable the Reverse Spin option.
4. Configure the drive for current mode.
5. Setup the analog input command to allow a safe current level.
6. Enable the drive and observe the motor.
7. If the motor will not turn, is difficult to turn or seems like the motor wants to hold a position, the alternate hall table may be required. Disable the drive and set Hall Configuration = 6 to use the alternate table.
8. If the motor is able to turn, but seems like a reduced torque, increment the Hall configuration by 1.
9. With the motor spinning, verify that the no-load speed is the same for both directions.
10. If the motor does not spin the same speed in both directions, increment the Hall configuration by 1. Repeat step 6.
11. Verify that the speed reported by the drive is positive when a positive current command is applied. It is important that the command input and the reported speed are of the same polarity.
12. If the polarity of the command and speed are different, increment the Hall configuration by 3 (creating a 180 electrical degree shift). Remember that the tables are circular and to stay within the selected hall table. Example: Incrementing Hall configuration 1 by 3 results in Hall configuration 4 (1 -> 2 -> 3 -> 4). Incrementing Hall configuration 5 by 3 results in Hall configuration 2 (5 -> 0 -> 1 -> 2).
13. Verify that the speed reported by the drive is positive when a positive current command is applied.
14. Use the Reverse Spin option to configure whether a positive command produces clockwise (CW) or counter-clockwise (CCW) physical rotation of the motor.

A motor should spin with balanced speed in both directions with Hall configurations 0, 1 or 2 for the standard hall table or 6, 7 or 8 for the alternate table. Generally, values of 3, 4 or 5 and 9, 10, or 11 are used when the reported speed and command polarity do not match.

As the motor rotates, the hall signal pattern will progress from one state in the table to the next. When the hall signal pattern reaches the end of the table, it will loop back to the top. The motor outputs will energize in the sequence shown in the tables below.

Note: An increment of 3 within either table will create a shift of 180 electrical degrees, resulting in an inversion of the motor outputs.

Standard Commutation Table:

Hall Configuration = 0					
Hall 1	Hall 2	Hall 3	Motor A	Motor B	Motor C
0	0	1	x	H	L
0	1	1	H	x	L
0	1	0	H	L	x
1	1	0	x	L	H
1	0	0	L	x	H
1	0	1	L	H	x

Hall Configuration = 1					
Hall 1	Hall 2	Hall 3	Motor A	Motor B	Motor C
0	0	1	H	x	L
0	1	1	H	L	x
0	1	0	x	L	H
1	1	0	L	x	H
1	0	0	L	H	x
1	0	1	x	H	L

Hall Configuration = 2					
Hall 1	Hall 2	Hall 3	Motor A	Motor B	Motor C
0	0	1	H	L	x
0	1	1	x	L	H
0	1	0	L	x	H
1	1	0	L	H	x
1	0	0	x	H	L
1	0	1	H	x	L

Hall Configuration = 3					
Hall 1	Hall 2	Hall 3	Motor A	Motor B	Motor C
0	0	1	x	L	H
0	1	1	L	x	H
0	1	0	L	H	x
1	1	0	x	H	L
1	0	0	H	x	L
1	0	1	H	L	x

Hall Configuration = 4					
Hall 1	Hall 2	Hall 3	Motor A	Motor B	Motor C
0	0	1	L	x	H
0	1	1	L	H	x
0	1	0	x	H	L
1	1	0	H	x	L
1	0	0	H	L	x
1	0	1	x	L	H

Hall Configuration = 5					
Hall 1	Hall 2	Hall 3	Motor A	Motor B	Motor C
0	0	1	L	H	x
0	1	1	x	H	L
0	1	0	H	x	L
1	1	0	H	L	x
1	0	0	x	L	H
1	0	1	L	x	H

Alternate Commutation Tables:

Hall Configuration = 6					
Hall 1	Hall 2	Hall 3	Motor A	Motor B	Motor C
0	0	1	H	L	x
0	1	1	H	x	L
0	1	0	x	H	L
1	1	0	L	H	x
1	0	0	L	x	H
1	0	1	x	L	H

Hall Configuration = 7					
Hall 1	Hall 2	Hall 3	Motor A	Motor B	Motor C
0	0	1	H	x	L
0	1	1	x	H	L
0	1	0	L	H	x
1	1	0	L	x	H
1	0	0	x	L	H
1	0	1	H	L	x

Hall Configuration = 8					
Hall 1	Hall 2	Hall 3	Motor A	Motor B	Motor C
0	0	1	x	H	L
0	1	1	L	H	x
0	1	0	L	x	H
1	1	0	x	L	H
1	0	0	H	L	x
1	0	1	H	x	L

Hall Configuration = 9					
Hall 1	Hall 2	Hall 3	Motor A	Motor B	Motor C
0	0	1	L	H	x
0	1	1	L	x	H
0	1	0	x	L	H
1	1	0	H	L	x
1	0	0	H	x	L
1	0	1	x	H	L

Hall Configuration = 10					
Hall 1	Hall 2	Hall 3	Motor A	Motor B	Motor C
0	0	1	L	x	H
0	1	1	x	L	H
0	1	0	H	L	x
1	1	0	H	x	L
1	0	0	x	H	L
1	0	1	L	H	x

Hall Configuration = 11					
Hall 1	Hall 2	Hall 3	Motor A	Motor B	Motor C
0	0	1	x	L	H
0	1	1	H	L	x
0	1	0	H	x	L
1	1	0	x	H	L
1	0	0	L	H	x
1	0	1	L	x	H

PWM Freq. - This option controls the drive output switching frequency. ElectroCraft recommends using a lower PWM frequency unless there is a valid reason to use a higher frequency. Higher switching frequency will increase the switching losses and reduces the drive efficiency. Refer to the product user manual for recommendations and limitations related to PWM Frequency.

Reverse Spin - This option is used to configure whether a positive command produces clockwise (CW) or counter-clockwise (CCW) physical rotation of the motor output. This option does not correct for a polarity mismatch in command input vs speed feedback. Use Hall configuration to resolve a polarity mismatch with the hall sensors (reference Hall configuration) and Encoder Reverse to resolve a polarity mismatch with the encoder (reference Encoder reverse).

Drive operation mode:

Current – This mode configures the drive to run in current control mode. In this mode, the drive operates the motor at a commanded current value for a required amount of torque from the motor. Speed of the motor is not controlled in this mode.

Speed – This mode configures the drive to run in speed control mode. In this mode, the drive operates the motor at a commanded speed. In order to maintain the commanded speed, the current supplied to the motor is controlled depending on the load in this mode.

Note: Control interface cannot be *Step and Direction* for Current and Speed drive operation modes.

Position – This mode configures the drive to run in position control mode. In this mode, the drive operates the motor in closed-Loop position control. Position and Current control loops are active in this control mode and can be used only with *Step and Direction* or *USB* control interface. All position commands from *Step and Direction* or *USB* interface are immediate. There is no Ramp or Trajectory generation in this mode.

Position with Speed – This mode configures the drive to run in position with speed control mode. In this mode, the drive operates the motor in closed-Loop position control. Position, Speed and Current control loops are active in this control mode and can be used only with *Step and Direction* or *USB* control interface. All position commands from Step and Direction or USB interface are immediate. There is no Ramp or Trajectory generation in this mode.

Note: Control interface cannot be *Analog* and Drive Mode must be *4-Quadrant* for Position and Position with Speed drive operation modes. BLDC motors require an encoder for Position or Position with Speed mode operation.

Commutation:

Trapezoidal - Trapezoidal or '6-step' commutation mode produces current in the motor by sourcing current in one phase, sinking current in another, leaving the third phase a high impedance state . It is recommended for use with 'Trap-wound' BLDC motors typically associated with high-speed applications.

Sinusoidal - Sinusoidal commutation produces 3-phase sinusoidal current on all three phase outputs. Sinusoidal commutation produces less torque ripple than trapezoidal commutation. Audible motor noise may also be reduced while rotating.

Drive Mode:

2-Quadrant - 2-Quadrant mode allows the drive to output current to accelerate the motor, but not decelerate the motor. This mode is especially useful in unidirectional applications where the motor does not need to (or it is best not to) actively decelerate the motor. Examples of applications where 2-Quadrant mode may be useful are: Loads with a drive belt and tensioner, a pump, a blower, a grinder or a compressor.

4-Quadrant - This mode allows the drive to output current to accelerate and decelerate the motor. This mode is used in servo applications where speed overshoot is not desired or when the application requires the motor to be actively controlled during deceleration.

Feedback Enhancement:

Hall Compensate – This feature compensates for minor variations of hall signal symmetry for speed calculations. It is applicable only when using a BLDC motor with hall switches without an encoder.

Encoder continuously synch to hall - When enabled, the drive will synchronize the encoder to the hall sensor 1 while rotating. This is useful to re-align the sine wave commutation when using single-ended encoders in electrically noisy environments. This option will not compensate for corrupted speed or position feedback due to electrical noise on the encoder signals. It is recommended only for use in current mode operation.

Control Interface:

Control Interface - Selects how a control command is communicated to the drive.

Analog: Sets command source to analog input signals on the I/O connector. Polarity of the command can be changed using the Direction digital input.

Step and Direction: Sets command source to Step and Direction digital inputs.

USB: Sets command source to the USB communications port. This mode is used with the Online Monitor and Diagnostics tools within CompleteArchitect™ software.

Note: Regardless of the control interface selected, the drive's digital input 'Enable' must be in an enabled state for the drive to operate. Refer to the product user manual for details of the Enable input.

Desired Steps per Rev. – For BLDC motors this is the desired number of steps per revolution of the motor when in Step and Direction mode. The motor will move one Step for each rising edge on the Step digital input. The Step pulse input from the user is converted into encoder counts. The position displayed in Online Monitor and Diagnostics are in Encoder Counts (IU = Internal Units). The user may enter any value $1 \leq \text{steps} \leq 65535$. The Universal Drive will divide the Desired Steps per Rev. into the Encoder resolution. Step pulse input accuracy on this conversion is +/- 1 encoder count.

Travel limit switch inputs – This feature enables and disables the limit switch functionality of the Limit+ and Limit- digital inputs. When enabled, the Limit+ input will inhibit torque output in the positive direction and the Limit- input will inhibit torque output in the negative direction. Refer to the product technical user manual for connection details for these inputs.

5.3.2 Motor and Drive Configuration Group for PMDC Motor

The Motor and Drive window for a PMDC motor is shown in Figure 31.

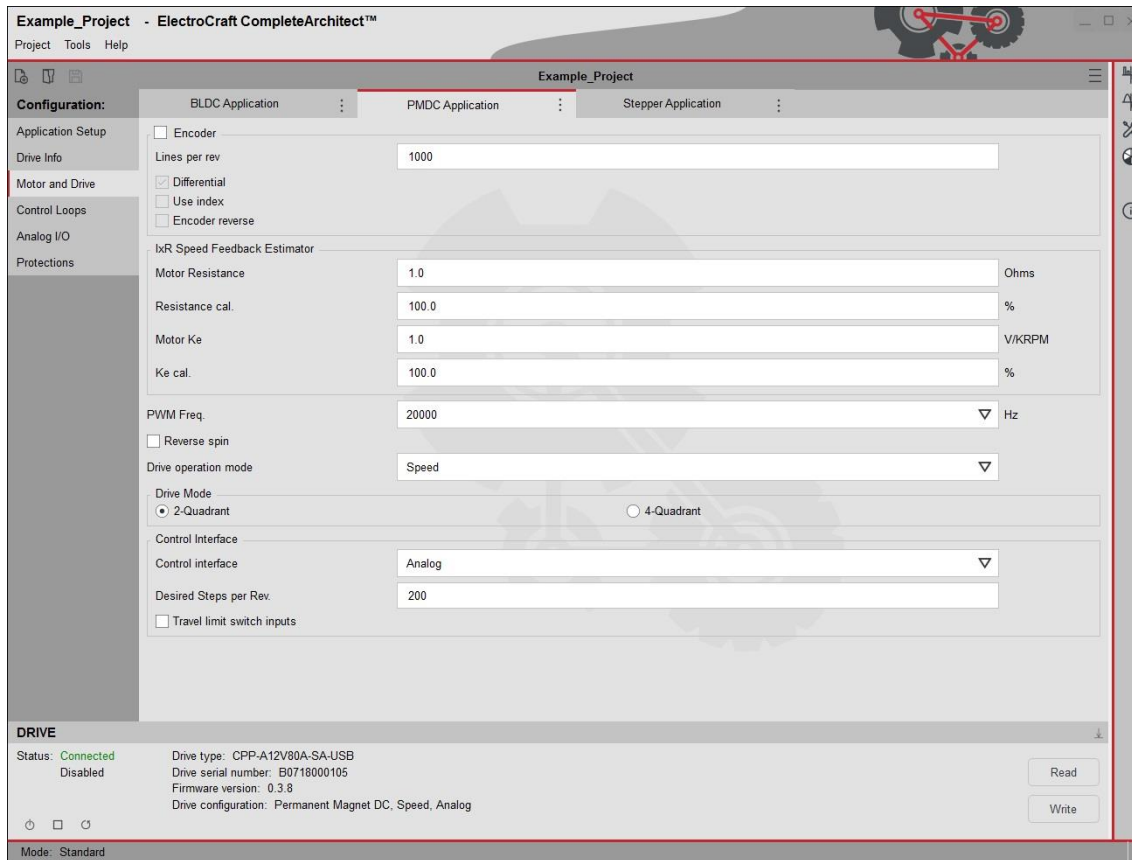


Figure 31: Motor and Drive Window for PMDC Motor

All parameters in this window are described below:

Encoder - When enabled, the encoder will be used for speed and position feedback. When disabled, the IxR Speed Feedback Estimator will be used for speed estimation.

Lines per rev – This field represents the resolution of the encoder in units of lines per revolution. An encoder datasheet may specify resolution in units of lines, cycles per revolution (CPR), pulses per revolution (PPR) or quadrature counts per revolution. Lines, CPR and PPR are same and are often used interchangeably. To convert quadrature counts per revolution to lines, divide by 4. Example: 4000 quadrature counts = 1000 lines.

Differential - When enabled, the drive enables the differential encoder transceiver. When disabled, the drive will accept a single ended encoder input. A differential encoder may be more immune to electrically noise than a single-ended encoder. Reference the drive's user manual for electrical connection requirements and compatibility.

Use Index - When enabled, the drive will use the encoder index to synchronize motor commutation while rotating. This is useful to re-align the sine wave commutation when using single-ended encoders in electrically noisy environments. This option will not compensate for corrupted speed or position feedback due to electrical noise on the encoder signals. This function is recommended for use in current mode operation.

Encoder Reverse - Encoder manufacturers do not use a common mechanical convention for “positive” direction. Some encoders count positive when turning clockwise (CW) and some when turning counter-clockwise (CCW). When enabled, this option reverses the polarity of the encoder counting and encoder speed reporting.

IxR Speed Feedback Estimator - This feature estimates motor speed using the motor’s Resistance and motor’s back EMF (Ke). It is used when an actual speed feedback device (an encoder or other sensor) is unavailable. Refer section 5.3.3 for details. If the Encoder is enabled, the encoder will be used for speed and position feedback and IxR Speed Feedback Estimator will not be used.

Motor Resistance - Resistance of the motor winding in units of Ohms. This value can be found on the motor datasheet.

Resistance cal. - The Resistance Compensation (Resistance cal) value is used to calibrate the IxR speed feedback estimator for speed regulation under changing loads. Refer section 5.3.3 for details.

Motor Ke - This is the motor’s BEMF (Back EMF) voltage constant in units of V/KRPM. This value can be found on the motor datasheet.

Ke cal. - The Motor Ke Compensation (Ke cal) value is used to calibrate the IxR Compensation speed feedback estimator under steady state no load conditions. Refer section 5.3.3 for details.

PWM Freq. - This option controls the drive output switching frequency. ElectroCraft recommends using a lower PWM frequency unless there is a valid reason to use a higher frequency. Higher switching frequency will increase the switching losses and reduces the drive efficiency. Refer to the product user manual for recommendations and limitations related to PWM Frequency.

Reverse Spin - This option is used to configure whether a positive command produces clockwise (CW) or counter-clockwise (CCW) physical rotation of the motor output. This option does not correct for a polarity mismatch in command input vs speed feedback. Use Encoder Reverse to resolve a polarity mismatch with the encoder (reference Encoder reverse).

Drive operation mode:

Current – This mode configures the drive to run in current control mode. In this mode, the drive operates the motor at a commanded current value for a required amount of torque from the motor. Speed of the motor is not controlled in this mode.

Speed – This mode configures the drive to run in speed control mode. In this mode, the drive operates the motor at a commanded speed. In order to maintain the commanded speed, the current supplied to the motor is controlled depending on the load in this mode.

Note: Control interface cannot be *Step and Direction* for Current and Speed drive operation modes.

Position – In this mode, the drive operates the motor in position control mode. The Current control loop and Position control loops are active in this control mode. Position mode can only be used with *Step and Direction* or *USB* control interface. All position commands from *Step and Direction* or *USB* interface are immediate. There is no Ramp or Trajectory generation in this mode.

Position with Speed – This mode configures the drive to run in position with speed control mode. In this mode, the drive operates the motor in closed-loop position control. Position, Speed and Current control loops are active in this control mode and can be used only with *Step and Direction* or *USB* control interface. All position commands from *Step and Direction* or *USB* interface are immediate. There is no Ramp or Trajectory generation in this mode.

Note: Control interface cannot be *Analog* and Drive Mode must be *4-Quadrant* when using Position and Position with Speed drive operation modes. PMDC motor requires an Encoder for Position or Position with Speed mode operation.

Drive Mode:

2-Quadrant - 2-Quadrant mode allows the drive to output current to accelerate the motor, but not decelerate the motor. This mode is especially useful in unidirectional applications where the motor does not need to (or it is best not to) actively decelerate the motor. Examples of applications where 2-Quadrant mode may be useful are: Loads with a drive belt and tensioner, a pump, a blower, a grinder or a compressor.

4-Quadrant - This mode allows the drive to output current to accelerate and decelerate the motor. This mode is used in servo applications where speed overshoot is not desired or when the application requires the motor to be actively controlled during deceleration.

Control Interface:

Control Interface - Selects how a control command is communicated to the drive.

Analog: Sets command source to analog input signals on the I/O connector. Polarity of the command can be changed using the Direction digital input.

Step and Direction: Sets command source to Step and Direction digital inputs.

USB: Sets command source to the USB communications port. This mode is used with the Online Monitor and Diagnostics tools within CompleteArchitect™ software.

Note: Regardless of the control interface selected, the drive's digital input 'Enable' must be in an enabled state for the drive to operate. Refer to the product user manual for details of the Enable input.

Desired Steps per Rev. – For PMDC motors this is the desired number of steps per revolution of the motor. The motor will move one Step for each rising edge on the Step digital input. The Step pulse input from the user is converted into encoder counts. The position displayed in Online Monitor and Diagnostics are in Encoder Counts (IU = Internal Units). The user may enter any value $1 \leq \text{steps} \leq 65535$. The Universal Drive will divide the Desired Steps per Rev. into the Encoder resolution. Step pulse input accuracy on this conversion is +/- 1 encoder count.

Travel limit switch inputs – This feature enables and disables the limit switch functionality of the Limit+ and Limit- digital inputs. When enabled, the Limit+ input will inhibit torque output in the positive direction and the Limit- input will inhibit torque output in the negative direction. Refer to the product technical user manual for connection details for these inputs.

5.3.3 IxR Speed Feedback Estimator

The IxR Speed Feedback Estimator is used to estimate motor speed when an actual speed feedback device (an encoder or other sensor) is unavailable. It uses the motor resistance and motor's BEMF (Back EMF) voltage constant (Ke) to estimate the speed of the PMDC motor. When properly adjusted, the speed displayed in CompleteArchitect should be close to the motor's actual speed when measured by an external device. IxR Speed Feedback Estimator can be used to monitor the speed of the motor in Current operation mode and can be used to input the speed to the speed control loop in Speed operation mode.

IxR Speed Feedback Estimator		
Motor Resistance	2.4	Ohms
Resistance cal.	90.0	%
Motor Ke	5.0	V/KRPM
Ke cal.	110.0	%

Figure 32: Example of IxR Speed Feedback Estimator section

Derivation of parameter values

Motor Resistance: This value can be obtained from the motor datasheet. If the data is unavailable, use an ohm meter to measure the resistance between the PMDC motor positive and negative terminals when the motor shaft is not rotating. Take multiple readings of the resistance value at different motor shaft positions and use the average of all measurements as the resistance value.

Resistance cal.: The Resistance Calibration (Resistance cal.) value is used to calibrate the IxR Speed Feedback Estimator for speed regulation under changing loads. Increase or decrease this value to change the speed estimate of the motor when loaded (lowering the Resistance Cal. reduces motor speed and vice versa). Typical range of adjustment is 90% to 110%. A possible way to set Resistance Cal parameter value is to lock the motor output shaft and output current to the motor. Adjust Resistance cal. value so that speed feedback is zero. This parameter is used with Motor Ke by the IxR Speed Feedback Estimator to compute an estimated motor speed.

Motor Ke (Back EMF): This value can be obtained from the motor datasheet. If the data is unavailable, look for rated voltage of the motor and maximum motor RPM at no load. Use the equation below to obtain the Ke value. Another method is to back drive the motor at a known RPM and measure the voltage generated at the PMDC motor positive and negative terminals using volt meter. Use the equation below to obtain the Ke value.

$$Ke = (\text{Voltage} \times 1000) / \text{RPM}$$

For example, if the back driven PMDC motor generates 24 V at 10,000 RPM; Ke is found to be 2.4 V/KRPM using the formula.

$$Ke = (24 \times 1000) / 10,000 = 2.4 \text{ V/KRPM}$$

Ke cal.: The Motor Ke Calibration (Ke cal.) value is used to calibrate the IxR Speed Feedback Estimator under steady state no load conditions. Increase or decrease this value to change the no-load speed estimate of the motor (lowering Ke cal. reduces motor speed and vice versa). Typical range of adjustment is 90% to 110%. This parameter is used with Motor Resistance by the IxR Speed Feedback Estimator to compute an estimated motor speed. Adjust motor Ke cal. first to calibrate no-load speed and then adjust Resistance cal. to calibrate speed regulation for load changes. The recommended procedure to set the Ke Cal parameter value is to run motor at no-load and adjust Ke Cal parameter value so that IxR Speed Feedback Estimator reported speed equals the actual measured speed.

Setting up IxR Speed Feedback Estimator

- Step 1: Open the Motor and Drive configuration group in a PMDC project window.
- Step 2: Enter the Motor Resistance and Motor Ke in the appropriate boxes in IxR Speed Feedback Estimator section.
- Step 3: Enter 100% in the Resistance cal. and Ke cal. boxes in IxR Speed Feedback Estimator section.
- Step 4: Run the motor at a known RPM without any load and check the motor speed using an external speed measuring device like a tachometer. If the speed of the motor displayed in the software is greater than the external speed measuring device, then reduce the Ke cal. value until both the speed measurements are approximately the same. If the speed displayed in the software is less than the external speed measuring device, then increase the Ke cal. value until both the speed measurements are approximately the same.
- Step 5: Run the motor at a known RPM with load and check the motor speed using an external speed measuring device. If the speed of the motor displayed in the software is greater than the external speed measuring device, then reduce the Resistance cal. value until both the speed measurements are approximately the same. If the speed displayed in the software is lesser than the external speed measuring device, then increase the Resistance cal. value until both the speed measurements are approximately the same.

Note: As a PMDC motor heats up, the motor resistance will also increase which causes error in the IxR speed feedback estimation. IxR speed feedback is best used for applications where precise control of speed is not important.

5.3.4 Motor and Drive Configuration Group for Open-Loop Stepper Motor

The Motor and Drive window for an open-loop stepper motor motor is shown in Figure 33.

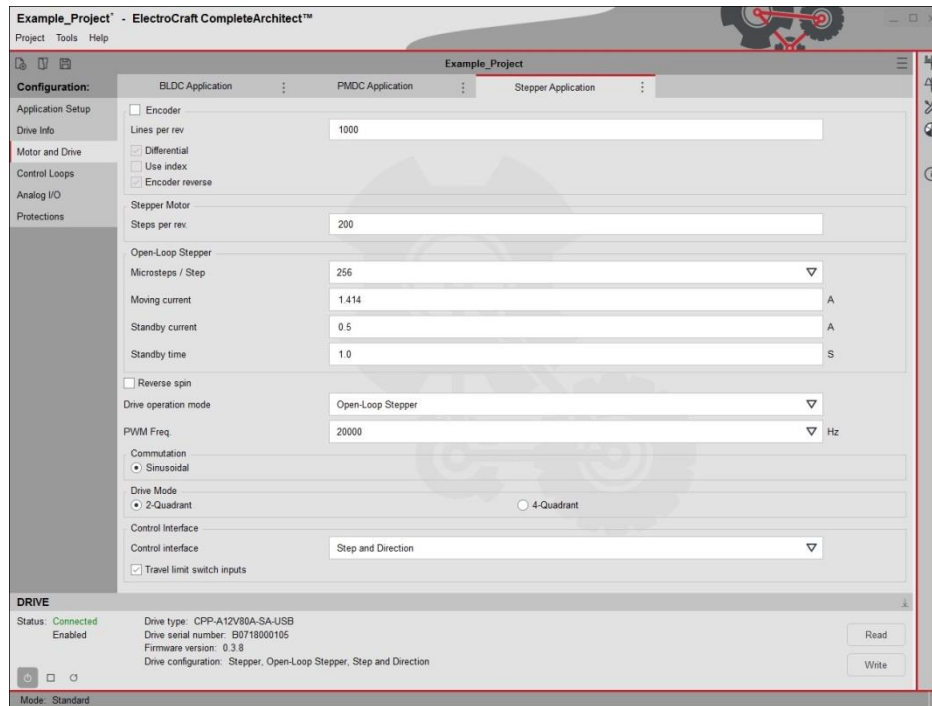


Figure 33: Motor and Drive Window for Open-Loop Stepper Motor

All parameters in this window are described below:

Encoder – Not used for open-loop stepper. Checking this box will not have any effect.

Stepper Motor:

Steps per rev. - This is the physical/mechanical Steps per Revolution of the stepper motor. The correct value should be listed on the motor datasheet. The User may then select a number of Microsteps per Rev for more resolution.

Open-Loop Stepper:

Microsteps / Step - This value divides each physical/mechanical step of a Stepper motor (set by the *Steps per rev.* parameter) into fractional steps.

Moving current - This sets the amount of current that the drive will output to the open-loop Stepper motor while the motor is commanded to move.

Standby current - This sets the amount of current that the drive will output to the open-loop Stepper motor when the motor has stopped for longer than the Standby Time.

Standby time - This sets the amount of time after the open-loop Stepper motor stops before the drive's output current changes from the *Moving Current* level to the *Standby Current* level.

Reverse Spin - This option is used to configure whether a positive command produces clockwise (CW) or counter-clockwise (CCW) physical rotation of the motor output. This option does not correct for a polarity mismatch in command input vs speed feedback.

Drive operation mode:

From the drop down menu, selecting Open-Loop Stepper configures the application for open-loop mode and enables the Open-Loop Stepper parameter group. All other modes in this drop down menu box will configure the application for closed-loop stepper mode.

Open-Loop Stepper – In this mode, the drive operates the motor in open-loop position control. The Current control loop is active in this control mode. Open-Loop Stepper mode can only be used with *Step and Direction* or *USB* control interface. All position commands from *Step and Direction* or *USB* interface are immediate. There is no Ramp or Trajectory generation in this mode. USB commands for Open-Loop Stepper motors in Online Monitor are normalized for all Microstep settings to approximately 23 RPM for a 200 Step per Rev motor. The motor speed is not calculated by the drive.

PWM Freq. - This option controls the drive output switching frequency. ElectroCraft recommends using a lower PWM frequency unless there is a valid reason to use a higher frequency. Higher switching frequency will increase the switching losses and reduces the drive efficiency. Refer to the product user manual for recommendations and limitations related to PWM Frequency.

Commutation – Sinusoidal is the only supported type of commutation for stepper motors and cannot be changed.

Drive Mode:

2-Quadrant / 4-Quadrant - This selection has no effect in open-loop stepper mode.

Control Interface:

Control Interface - Selects how a control command is communicated to the drive.

Analog: Analog is not a valid selection for open-loop stepper and will cause a configuration error if selected.

Step and Direction: Sets command source to Step and Direction digital inputs.

USB: Sets command source to the USB communications port. This mode is used with the Online Monitor and Diagnostics tools within CompleteArchitect™ software.

Note: Regardless of the control interface selected, the drive's digital input 'Enable' must be in an enabled state for the drive to operate with all motor types. Refer to the product user manual for details of the Enable input.

Travel limit switch inputs – This feature enables and disables the limit switch functionality of the Limit+ and Limit- digital inputs. When enabled, the Limit+ input will inhibit torque output in the positive direction and the Limit- input will inhibit torque output in the negative direction. Refer to the product technical user manual for connection details for these inputs.

5.3.5 Motor and Drive Configuration Group for Closed-Loop Stepper Motor

The Motor and Drive window for an closed-loop stepper motor motor is shown in Figure 34: Motor and Drive Window for Closed-Loop Stepper Motor.

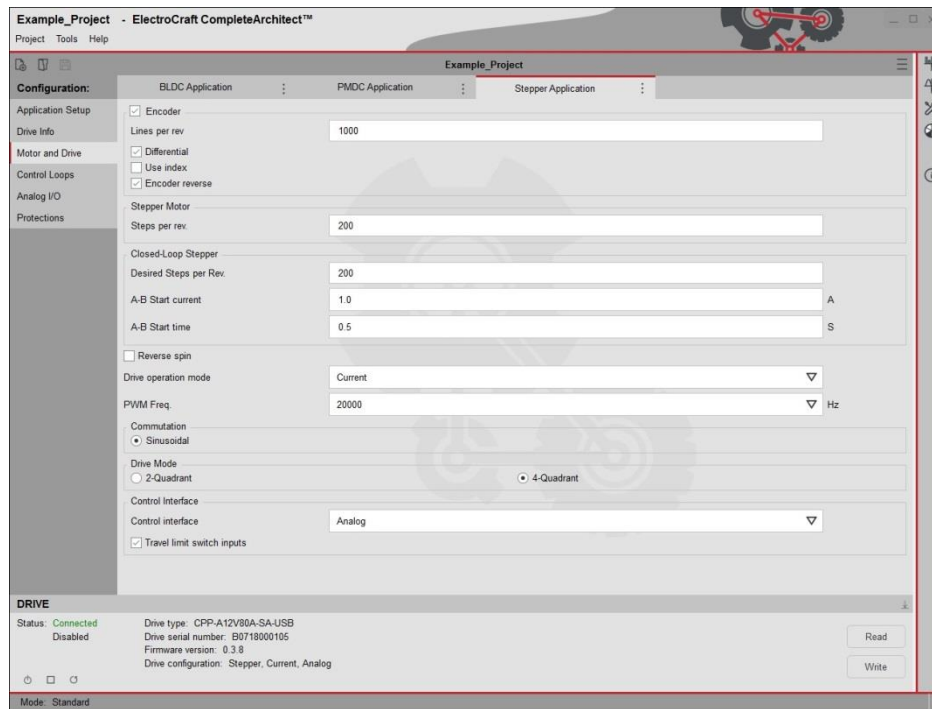


Figure 34: Motor and Drive Window for Closed-Loop Stepper Motor

All parameters in this window are described below:

Encoder – Required for closed-loop stepper. Unchecking this box in closed-loop stepper will cause a configuration error.

Lines per rev – This field represents the resolution of the encoder in units of lines per revolution. An encoder datasheet may specify resolution in units of lines, cycles per revolution (CPR), pulses per revolution (PPR) or quadrature counts per revolution. Lines, CPR and PPR are same and are often used interchangeably. To convert quadrature counts per revolution to lines, divide by 4. Example: 4000 quadrature counts = 1000 lines.

Note: In Closed-Loop Stepper mode, the encoder resolution must be a multiple of the stepper motor's Steps Per Rev. $(\text{Encoder Lines} * 4) / \text{Steps_Per_Rev}$ must be an integer.

Example 1: $(1000 * 4) / 200 = 20$. The value of 20 is an integer and is acceptable.

Example 2: $(1024 * 4) / 200 = 20.48$. The value of 20.48 is not an integer and is not acceptable.

Differential - When enabled, the drive enables the differential encoder transceiver. When disabled, the drive will accept a single ended encoder input. A differential encoder may be more immune to electrically noise than a single-ended encoder. Reference the drive's user manual for electrical connection requirements and compatibility.

Use Index - When enabled, the drive will use the encoder index to synchronize motor commutation while rotating. This is useful to re-align the sine wave commutation when using single-ended encoders in electrically noisy environments. This option will not compensate for corrupted speed or position feedback due to electrical noise on the encoder signals. This function is recommended for use in current mode operation.

Encoder Reverse - Encoder manufacturers do not use a common mechanical convention for “positive” direction. Some encoders count positive when turning clockwise (CW) and some when turning counter-clockwise (CCW). When enabled, this option reverses the polarity of the encoder counting and encoder speed reporting.

Stepper Motor:

Steps per rev. - This is the physical/mechanical Steps per Revolution of the stepper motor. The correct value should be listed on the motor datasheet. The User may then select a Desired Steps per Rev for step resolution required.

Closed-Loop Stepper:

Desired Steps per Rev - This value divides one revolution of a Stepper motor into the required step resolution. This parameter sets the size of the angle of rotation for a single step. Example: For Desired Steps per Rev = 1000, the motor will rotate $360^\circ/1000 = 0.36^\circ$. Note this value is independent of the physical Steps per rev listed on the motor datasheet. If the physical Steps per Rev. is not a factor of both Desired Steps per Rev and Encoder Lines per Rev. the actual step size will not be exactly as calculated for every step in a revolution due to rounding errors.

A-B Start current - This sets the amount of current that the drive will output to align the motor to phase A winding then phase B winding to align the encoder..

A-B Start time - This sets the time that the A-B Start current amount of current that the drive will output to the open-loop Stepper motor when the motor has stopped for longer than the Standby Time.

Reverse Spin - This option is used to configure whether a positive command produces clockwise (CW) or counter-clockwise (CCW) physical rotation of the motor output. This option does not correct for a polarity mismatch in command input vs speed feedback.

Drive operation mode:

From the drop down menu only Current, Speed, Position or Position with Speed modes are valid for closed-loop stepper. Selecting Open-Loop Stepper will change the mode to open-loop stepper.

Current – This mode configures the drive to run in current control mode. In this mode, the drive operates the motor at a commanded current value for a required amount of torque from the motor. Speed of the motor is not controlled in this mode.

Speed – This mode configures the drive to run in speed control mode. In this mode, the drive operates the motor at a commanded speed. In order to maintain the commanded speed, the current supplied to the motor is controlled depending on the load in this mode.

Note: Control interface cannot be *Step and Direction* for Current and Speed drive operation modes.

Position – In this mode, the drive operates the motor in closed-loop position control. The Current control loop and Position control loops are active in this control mode. Position mode can only be used with *Step and Direction* or *USB* control interface. All position commands from *Step and Direction* or *USB* interface are immediate. There is no Ramp or Trajectory generation in this mode.

Position with Speed – In this mode, the drive operates the motor in closed-loop position and speed control. The Current control loop. Speed control loop and Position with Speed control loops are active in this control mode. Position with speed mode can only be used with *Step and Direction* or *USB* control interface. All position commands from *Step and Direction* or *USB* interface are immediate. There is no Ramp or Trajectory generation in this mode.

PWM Freq. - This option controls the drive output switching frequency. ElectroCraft recommends using a lower PWM frequency unless there is a valid reason to use a higher frequency. Higher switching frequency will increase the switching losses and reduces the drive efficiency. Refer to the product user manual for recommendations and limitations related to PWM Frequency.

Commutation – Sinusoidal is the only supported type of commutation and cannot be changed.

Drive Mode:

2-Quadrant - 2-Quadrant mode allows the drive to output current to accelerate the motor, but not decelerate the motor. This mode is especially useful in unidirectional applications where the motor does not need to (or it is best not to) actively decelerate the motor. Examples of applications where 2-Quadrant mode may be useful are: Loads with a drive belt and tensioner, a pump, a blower, a grinder or a compressor.

4-Quadrant - This mode allows the drive to output current to accelerate and decelerate the motor. This mode is used in servo applications where speed overshoot is not desired or when the application requires the motor to be actively controlled during deceleration.

Control Interface:

Control Interface - Selects how a control command is communicated to the drive.

Analog: Sets command source to analog input signals on the I/O connector. Polarity of the command can be changed using the Direction digital input.

Step and Direction: Sets command source to Step and Direction digital inputs.

USB: Sets command source to the USB communications port. This mode is used with the Online Monitor and Diagnostics tools within CompleteArchitect™ software.

Note: Regardless of the control interface selected, the drive's digital input 'Enable' must be in an enabled state for the drive to operate with all motor types. Refer to the product user manual for details of the Enable input.

Travel limit switch inputs – This feature enables and disables the limit switch functionality of the Limit+ and Limit- digital inputs. When enabled, the Limit+ input will inhibit torque output in the positive direction and the Limit- input will inhibit torque output in the negative direction. Refer to the product technical user manual for connection details for these inputs.

5.4 Control Loops

The Control Loops group allows the user to adjust the tuning values for current, speed, position and position with speed control modes. The default tuning values will vary depending on the drive and motor selected when the project was created. An example of this window is shown in Figure 35.

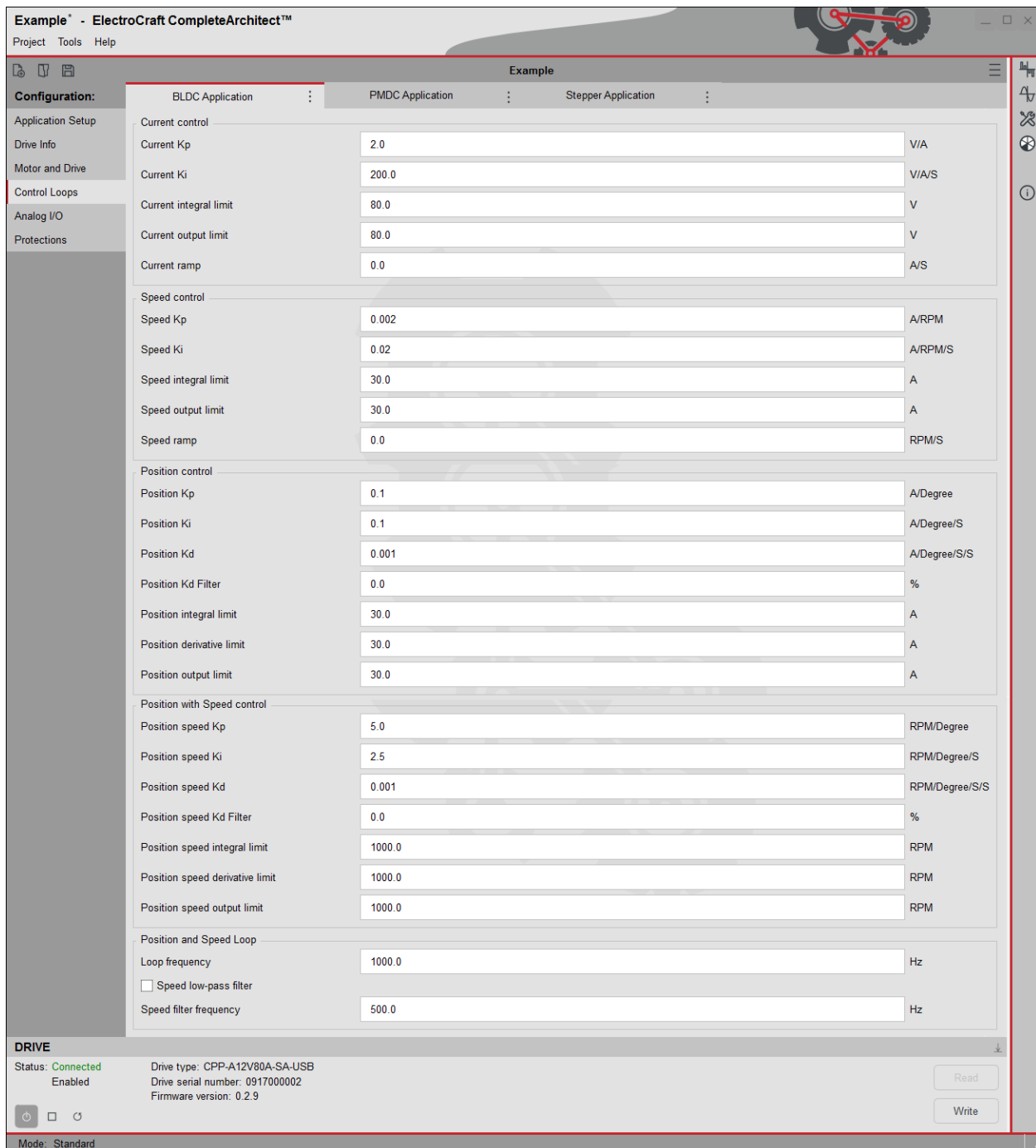


Figure 35: Control Loops Window

Depending on the Drive operation mode selected in the *Motor and Drive* configuration group, a combination of control parameters is enabled and visible. For example, if the user selects “*Current*” operation mode from the *Motor and Drive* configuration group, the *Current* control parameters will be enabled and visible. The *Speed* control, *Position* control, *Position with Speed* control parameters will be disabled and not visible.

All parameters in this group are described below:

Current control:

Current Kp – A value representing the proportional gain for the current PI control loop.

Current Ki - A value representing the integral gain for the current PI control loop.

Current integral limit – Limits the maximum voltage contribution that the integral can make to the current PI control loop output.

Current output limit - Limits the maximum voltage output of the current PI control loop.

Note: Output voltage is created using PWM to output a percentage of the power supply voltage. Therefore, the measured peak voltage will equal the power supply voltage.

Current ramp - The current ramp is only enabled in current control mode. It is disabled in all other drive operation modes. When enabled, the drive will increase (or decrease) the internal current command reference toward the user's desired current command at this ramp rate. A current ramp value of zero (0) disables the current ramp.

Speed control:

Speed Kp - A value representing the proportional gain for the speed PI control loop.

Speed Ki - A value representing the integral gain for the speed PI control loop.

Speed integral limit - This value limits the maximum current contribution the integral can make to the speed PI control loop output.

Speed output limit - This value limits the maximum current output of the speed PI control loop.

Note: The maximum current output of the drive is also limited by the I2T current limit protection settings.

Speed Ramp - The speed ramp is only enabled in speed control mode. It is disabled in all other drive operation modes. When enabled, the drive will increase (or decrease) the internal speed command reference toward the user's desired speed command as a maximum rate indicated by this value. A value of zero (0) disables the speed ramp.

Position control:

Position Kp - A value representing the proportional gain for the Position PID control loop.

Position Ki - A value representing the integral gain for the Position PID control loop.

Position Kd - A value representing the derivative gain for the Position PID control loop.

Position Kd Filter - Filter to smooth the derivative contribution to the Position PID control loop.

Position integral limit - Limits the maximum current contribution the integral can make to the Position PID control loop output.

Position derivative limit - Limits the maximum current contribution the derivative can make to the Position PID control loop output.

Position output limit - Limits the maximum current output of the Position PID control loop.

Note: Current output is also limited by the I2T current limit protection settings.

Position with Speed control:

Position speed Kp - A value representing the proportional gain for the Position PID control loop when the Speed control loop is active.

Position speed Ki - A value representing the integral gain for the Position PID control loop when the Speed control loop is active.

Position speed Kd - A value representing the derivative gain for the Position PID control loop when the Speed control loop is active.

Position speed Kd filter - Filter to smooth the derivative contribution to the Position PID control loop when the Speed control loop is active.

Position speed integral limit - Limits the maximum speed contribution the integral can make to the Position PID control loop output when the Speed control loop is active.

Position speed derivative limit - Limits the maximum speed contribution the derivative can make to the Position PID control loop output when the Speed control loop is active.

Position speed output limit - Limits the maximum speed output of the Position PID control loop.
Note: This is a limit on the maximum speed the motor will be commanded to move to follow a position command.

Position and Speed Loop:

Loop frequency – The frequency at which the motor speed is measured and speed control loop is calculated. This value must be within the range of 500-20,000Hz. Electrocraft recommends a loop frequency of 1000 Hz.

Speed low-pass filter - This feature enables or disables the low-pass filter for speed feedback.



Warning: A filter on the speed feedback can create a 'lag' or 'phase shift' in measured vs actual motor speed, resulting in an unstable system.

Speed filter frequency – This value is the response frequency for the speed low-pass filter. The value must be slower than the speed loop frequency.

Refer to section [6.3](#) for diagnostics window where the tuning graph is plotted to evaluate the speed and current mode response of the motor with respect to the parameters commanded by the drive.

5.5 Analog I/O

The Analog I/O group allows the user to modify the analog input and output parameters. The analog input parameters will be available only when the user selects “Analog” control interface in Motor and Drive group. The values entered in all the fields of this section are committed to the drive only after the user writes it.

5.5.1 Analog Input for Current Mode

The Analog I/O configuration group will display current mode parameters when the Drive operation mode is selected as “Current” in the Motor and Drive configuration group. An example of Analog I/O window for current mode is shown in the Figure 36.

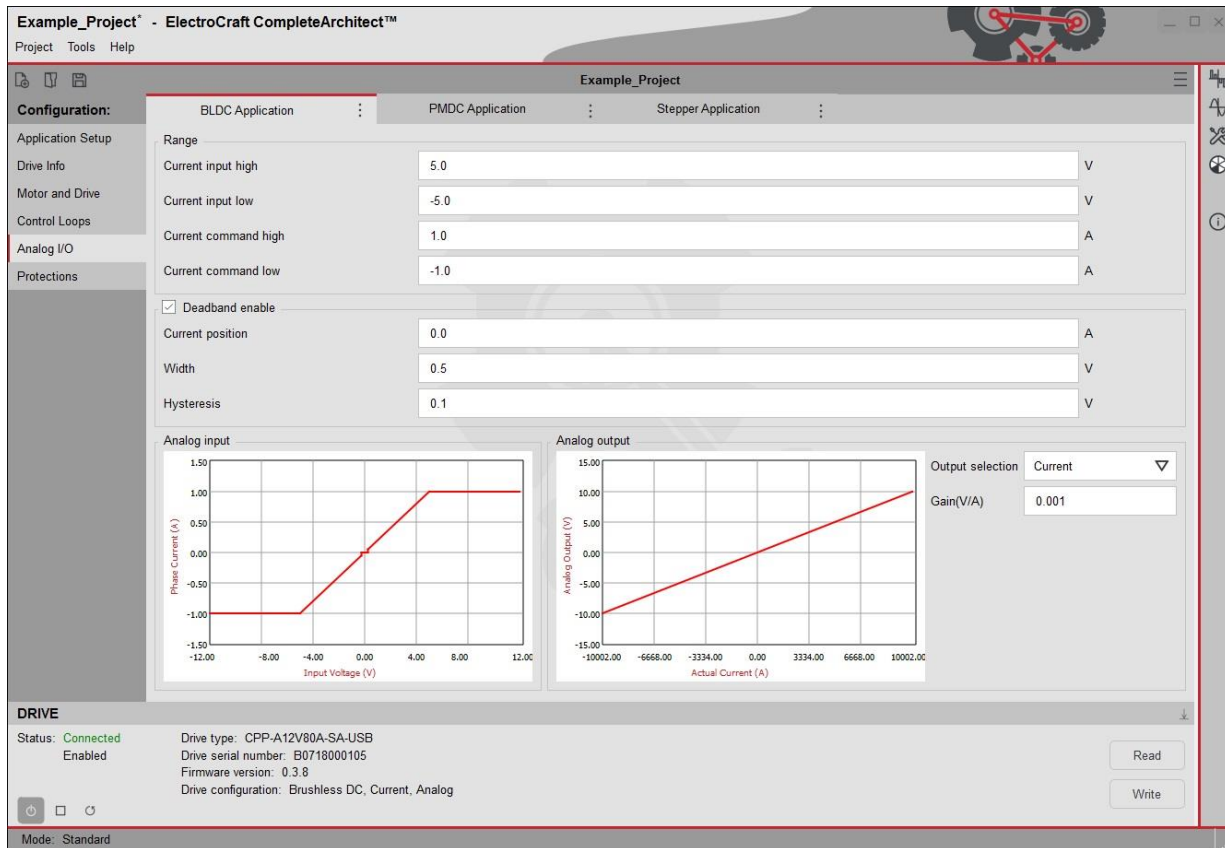


Figure 36: Analog I/O Window for Current Mode

All parameters in this window are described below:

Range

Analog input configuration. This sets up the linear current command transfer function from low to high input voltages. When changes are made the effect can be viewed in the Analog input graph.

Current input high – High level of the input current command in volts at the drive input. Any voltage above this value will be interpreted by the drive as the high current command.

Current input low – Low level on the input current command in volts at the drive input. Any voltage below this value will be interpreted by the drive as the minimum specified value.

Current command high – Current commanded when the analog input voltage is equal to or above the Current input high voltage.

Current command low - Current commanded when the analog input voltage is equal to or below the Current input low voltage.

Deadband enable

Deadband configuration on the analog command input. A deadband can be inserted into the analog input by defining the current position, width and hysteresis. Any input voltage that falls within the deadband is interpreted as a constant output.

Current position – defines the current center the deadband. The deadband can be placed anywhere in the current command range to suite the application. A common use is to place a deadband at zero current to ensure a zero current command.

Width - This value defines the width of the command input deadband in volts, centered at the current position. A width of 0.5 V results in a deadband of +/-0.25 V around the center position. If the deadband extends beyond the Range set, only the portion within the range takes effect.

Hysteresis – This value is the amount of voltage added to each side of the deadband width required for the command to exit the deadband. This option can be used to reduce dither when the analog input command is at or near the edge of the defined deadband. An example graph for Deadband position =0 A, Width = 1 V and Hysteresis = 0.1 V is shown in Figure 37.

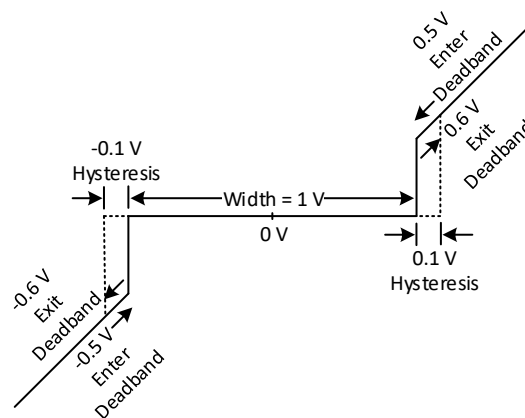


Figure 37: Deadband Hysteresis graph

Analog input graph - The input to output scaling of Range and deadband settings is displayed in the Analog input graph. The graph reflects any change to the parameter values as soon as its entered in the fields.

Figure 38 shows an example where:

- The drive is setup in current mode
- The motor input command of +5 V high, -5V low
- The motor torque command of +1 A high, -1A low
- Deadband enabled
- Deadband position = 0 A, Width = 0.5 V, Hysteresis = 0.1 V

These settings place a +/-0.25 V deadband on each side of the zero current command input voltage of 0V. Any analog input voltage between -0.25V and +0.25V will result in a zero ampere current command. The analog input voltage must be greater than 0.25 V + 0.1 V of hysteresis in order to exit the deadband. The analog voltage must be less than 0.25 V to re-enter the deadband range. Similarly, input voltage must be less than -0.25 V - 0.1 V of hysteresis in order to exit the deadband. The analog voltage must be greater than - 0.25 V to re-enter the deadband range.

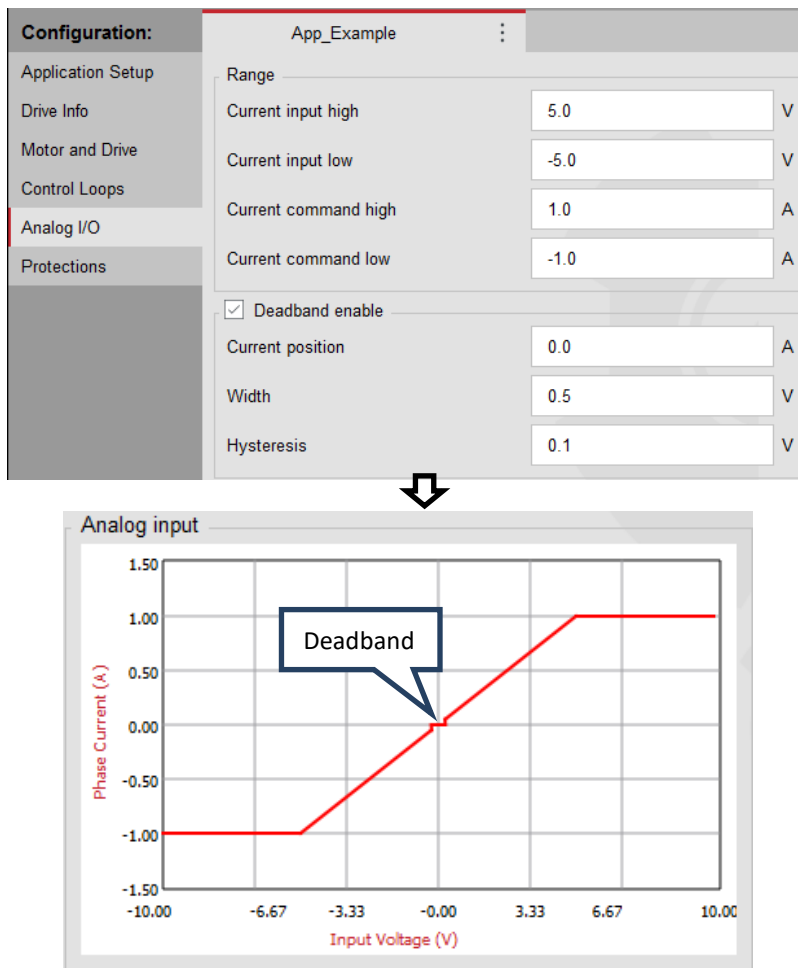


Figure 38: Analog Input Graph

5.5.2 Analog Input for Speed Mode

The Analog I/O configuration group will display speed mode parameters when the Drive operation mode is selected as “Speed” in the Motor and Drive configuration group. An example of Analog I/O window for speed mode is shown in the Figure 39.

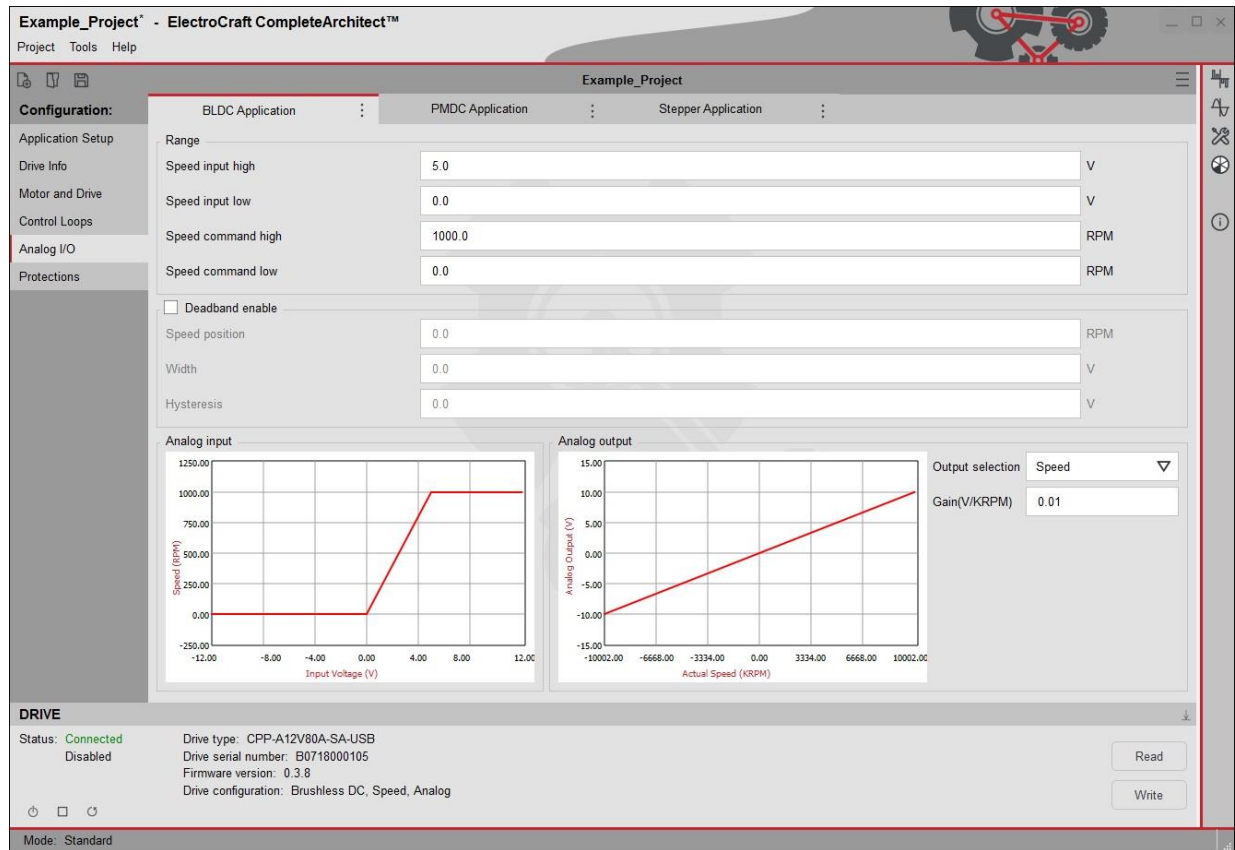


Figure 39: Analog I/O Window for Speed mode

All parameters in this window are described below:

Range - The settings input low, input high, command low and command high set the range and scale of the analog input. The input to output scaling of these settings can be seen in the Analog Input graph.

Speed input high – This is the maximum voltage accepted by the analog command input. Any voltage above this value will be interpreted by the drive as the maximum specified value.

Speed input low – This is the minimum voltage accepted by the analog command input. Any voltage below this value will be interpreted by the drive as the minimum specified value.

Speed command high – This is the motor speed desired when the analog input voltage is equal to or above the Speed input high voltage specified.

Speed command low - Motor speed desired when the analog input voltage is equal to or below the Speed input low voltage specified.

Speed position – This value defines at which position on the Analog input graph to place the deadband. This sets the center point of the deadband. A common use is to place the deadband at zero. This allows the system the ability to ensure a zero command on the analog input.

Refer section [5.5](#) for brief explanation on Deadband enable, Width, Hysteresis, Analog input graph.

5.5.3 Analog output

The drive outputs a ± 10 V analog voltage proportional to a user selected drive parameter. The Output selection dropdown lists available parameters for selection. The Gain value adjusts the output scaling of the analog voltage. The graph displays the output voltage range for the selected parameter. An example is shown in Figure 40 of Actual Speed scaled at V/KRPM.

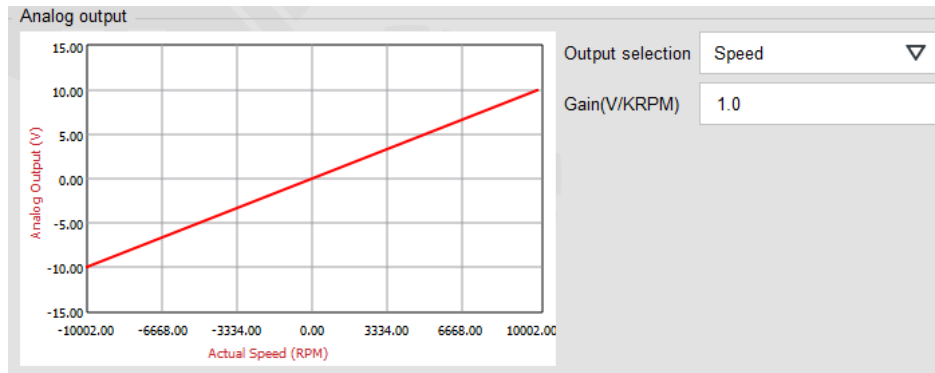


Figure 40: Analog Output Graph

5.6 Protections

The Protections group allows the user to enable or modify drive and motor protection parameters. The protections window is shown in the Figure 41. Grayed out protections are factory set and cannot be changed by the user, the remaining protections can be configured by the user. Some of these protections can only be enabled or disabled, others have an associated setting along with being enabled or disabled.

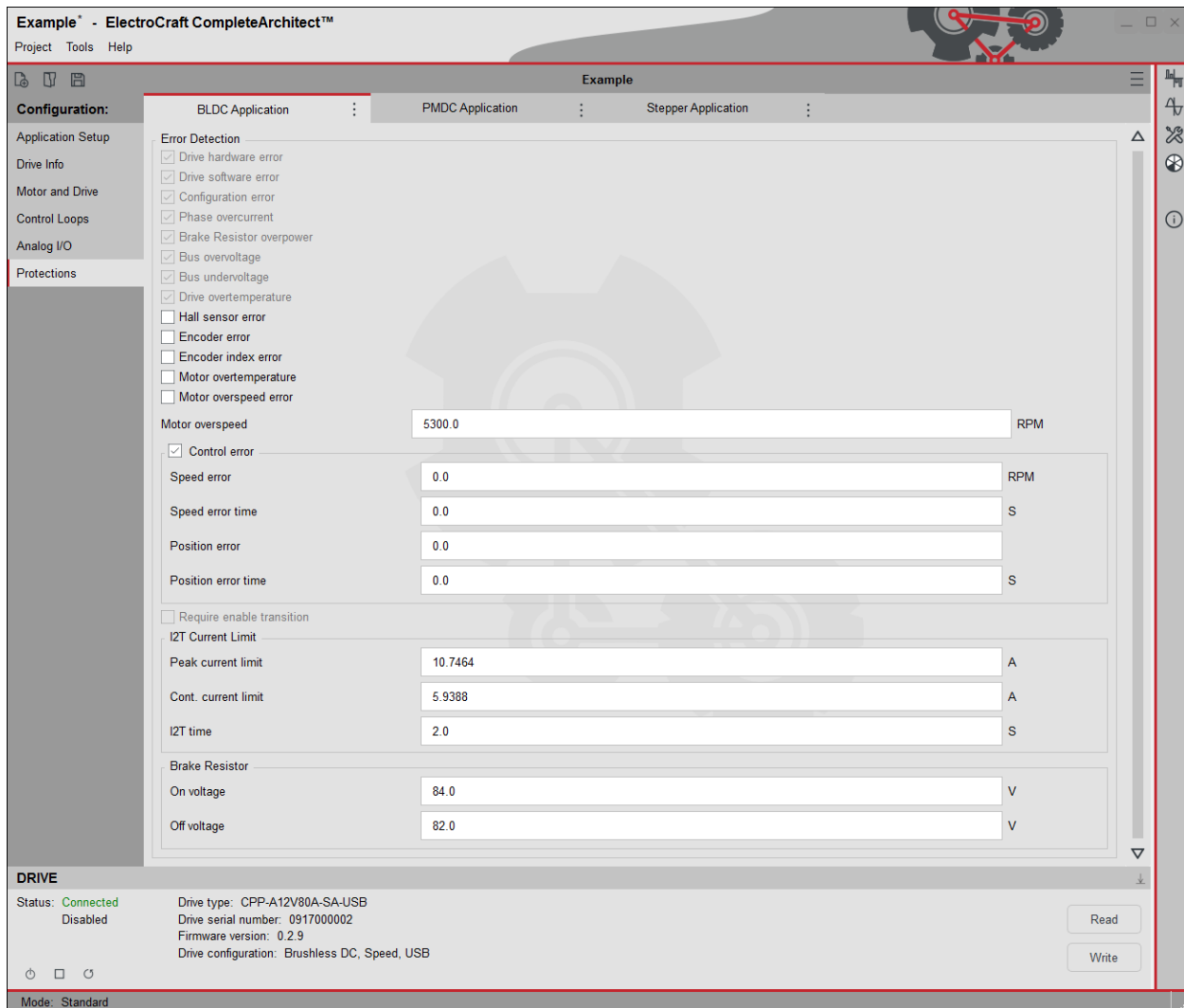


Figure 41: Protections Window

When a Protection is enabled, the drive will shut down with an error if the condition for the Protection is met. The error can be read in CompleteArchitect and the drive will also flash a code as described in Technical sur manual. In the section below the conditions for the drive to shut down on each Protection is covered and the associated setting if applicable.

In the event of a fault during operation, the drive becomes disabled and **FAULT** will appear in the DRIVE Status area and Online Monitor window as shown in Figure 42. Clicking on the **FAULT** text in either window will provide feedback as to which error has been detected.

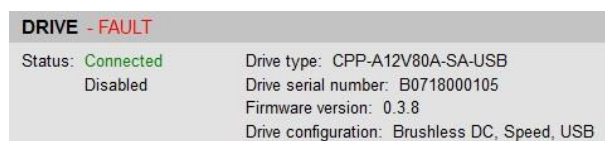


Figure 42: Fault in Drive Status Area

Drive hardware error – Not user configurable. An error is detected with the drive hardware. No setting.

Drive software error - Not user configurable. An error is detected with the drive software. No setting.

Configuration error - Not user configurable. An error is detected with the drive configuration. This could be a parameter setting out of range or an attempt to change a drive or motor parameter while the drive is enabled. No setting.

Phase overcurrent - Not user configurable. An overcurrent is detected. This is typically caused by a short circuit or very low resistance condition on the motor outputs. It can also be an indication of excessive current loop gains causing the current loop to become unstable and produce large currents or high capacitance on motor phases.

Brake Resistor overpower - Not user configurable. The brake resistor is on for too long indicating the brake resistor is undersized for the application. Refer to the product technical user manual for recommendations and limitations of the brake resistor.

Bus overvoltage - Not user configurable. Internal bus voltage is above the drive maximum voltage limit. Usually caused by excessive regeneration in operation indicating the need for a braking resistor or undersized braking. Refer to the product technical user manual for electrical specifications and recommendations on how to manage regenerated energy during deceleration.

Bus undervoltage - Not user configurable. Internal bus voltage falls below the drive minimum voltage limit. Usually caused by power supply inability to supply the current demanded by the drive. Refer to the product technical user manual for electrical specifications.

Drive overtemperature - Not user configurable. Drive internal temperature exceeds the maximum temperature limit. Usually caused by insufficient cooling. Refer to the product technical user manual for environmental, mounting, and power output specifications.

Hall sensor error - User configurable. Invalid hall state or transition is detected by the drive. Error detection is not active for PMDC or Stepper motors. This error detector requires hall signals.

Possible causes of a Hall sensor error:

- Broken hall signal wire
- Hall signal connector disconnected
- Electrical noise on the hall signals
- One or more hall signal is stuck in a state (high or low)
- Hall signal voltage level is not correct

Refer to the product technical user manual for hall input electrical specifications.

Encoder error - User configurable. Encoder position does not match hall state. Error detection is not active for PMDC or Stepper motors. This error detector requires hall signals.

Possible causes of an Encoder error:

- Encoder disconnected
- Broken encoder wire
- Noise on the encoder signals
- Noise on the hall signals
- Incorrect Encoder Lines value
- Incorrect Encoder Reverse setting
- Incorrect Motor Pole Pairs value
- Incorrect Hall Configuration value

Refer to the product technical user manual for encoder input electrical specifications.

Encoder index error - User configurable. Encoder position does not match index.

Possible causes of an Encoder Index error:

- Broken encoder wire
- Noise on the encoder signals
- Incorrect Encoder Lines value

Refer to the product technical user manual for encoder input electrical specifications.

Motor overtemperature - User configurable. A motor over-temperature condition is detected.

Motor overspeed error – User configurable. Enables or disables detection of a Motor Overspeed error.

Motor overspeed – User setting. Overspeed limit used by Motor Overspeed error.

Control error - User configurable. Enables or disables Speed Control and Position Control error protections.

Speed error – User setting. Sets an acceptance window around the commanded speed value. An error is detected if actual speed is greater or less than the commanded speed by more than the value set by the user for longer than the time period also set by the user.

Speed error time – User setting. Speed error time period that the Speed error is permitted to exceed the allowable Speed error.

Position error – User setting. Sets an acceptance window around the commanded position value. An error is detected if actual position is greater or less than the commanded position by more than the value set by the user for longer than the time period also set by the user.

Position error time – User setting. Position error time period that the Position error is permitted to exceed the allowable Position error.

Control error speed time

I2T Current Limit: This protection is always enabled but is configurable by the user. The default values are set by the lower of the drive ratings or motor ratings if a database motor is selected. These values can be further configured by the user but will always be limited by the drive rating.

Peak current limit – Peak current (peak of sine) that the drive will output to the motor. This setting is normally used to match the motor peak current rating. The drive will supply this current for a configurable period. Refer to the product technical user manual for *I2T* current limit specifications.

Cont. current limit – Continuous current (peak of sine) that the drive will output to the motor after the period of Peak current limit expires. This setting is normally used to match the motor continuous current rating. Refer to the product technical user manual for *I2T* current limit specifications.

I2T time – Time period that the drive will output Peak current to the motor. This setting is normally used to match the motor power rating. The value entered is restricted by the peak and continuous current limit values. Refer to the product technical user manual for *I2T* current limit specifications.

The *I2T* current limit values will be automatically adjusted upon Application creation depending on the limits of the motor selected from the database. If the motor's current limits exceed the drive max limit, the values will be limited by the drive and the informational window shown in Figure 43 will appear.

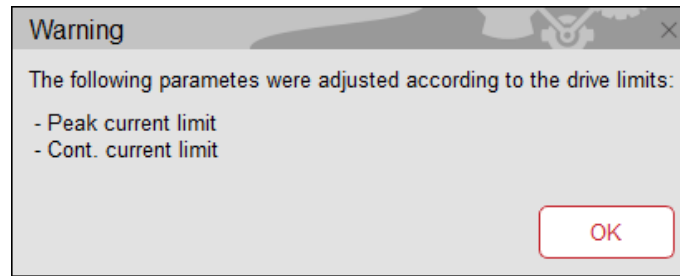


Figure 43: Warning window when I_{2T} current limits are adjusted

Brake Resistor: This protection is always enabled but is configurable by the user. If the function is not required set the *On voltage* and *Off voltage* to the drive's maximum voltage level. Refer to the product technical user manual for the maximum voltage limit.

On voltage – The voltage level where the brake resistor output will turn on. This level must be above the brake resistor turn off voltage level. Refer to the product technical user manual for brake resistor specifications.

Off voltage – The voltage level where the brake resistor output will turn off. This level must be below the brake resistor turn on voltage. Refer to the product technical user manual for brake resistor specifications.

6 Tools

6.1 Online Monitor

The Online Monitor Tool allows the user to monitor parameters of the drive such as the output voltage, output current, motor speed, PWM, bus voltage and position. It also provides a method for controlling the drive when the control interface is set to “USB”.

To open this tool, select *Tools -> Online Monitor* or select the  icon from the toolbar.

6.1.1 Operating the Drive in USB Mode

Below are the basic steps required for operating the drive in USB mode:

Step 1: Verify that the *Control interface* is set to USB in the *Motor and Drive* group.

Step 2: Select a *Drive operation mode* (*Current, Speed, Position and Position with Speed*) in the *Motor and Drive* group.

Step 3: Click *Write* in the Drive Status Area to write all the parameter changes to the drive.

Step 4: Ensure the “Enable” digital input is pulled to a low state.

Step 5: Select Online Command from the dropdown list (*Current, Speed, Position or Pos. with speed* depending on the drive operation mode selected) in the *Online Monitor* window.

Step 6: Enter an RPM value for a speed command or Ampere value for current command or Position value for Position or Pos. with speed command.

Step 7: Click *Apply* and verify that **Success** appears next to the *Apply* button.

Step 8: Click  to enable the drive. The motor will begin to run.

An example of online monitor is shown in Figure 45.

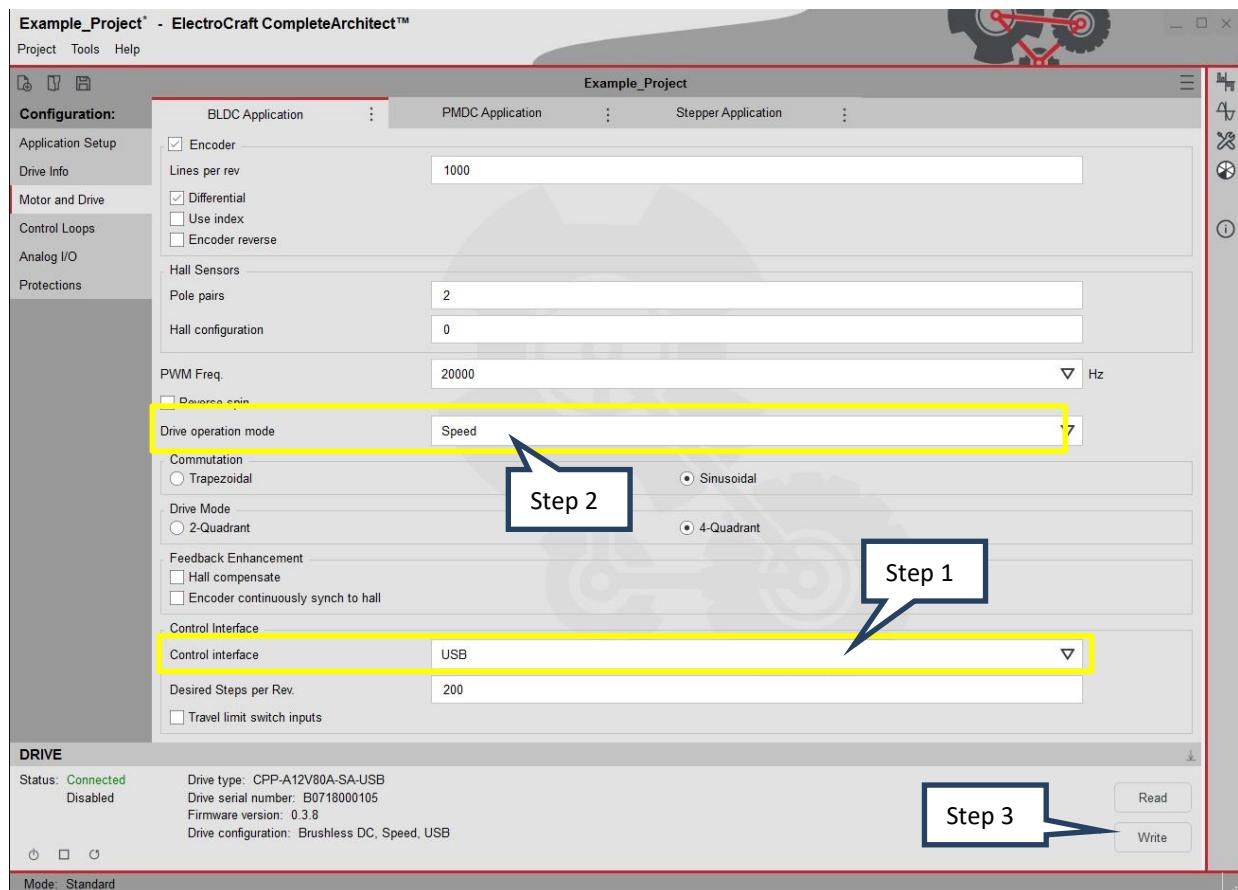


Figure 44: Motor and Drive configuration window

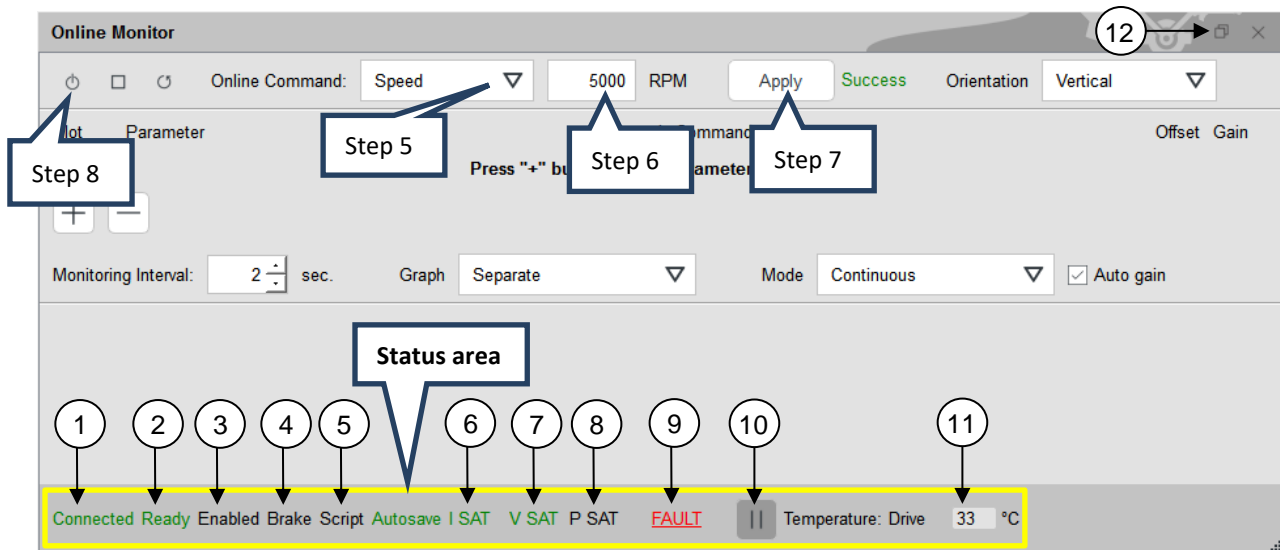


Figure 45: Online Monitor Window

Status area:

The drive status area shows the status of different characteristics of the drive. Text of the items 1 to 8 will turn green when it's active and black when it's not.

- | | |
|--|--|
| <ul style="list-style-type: none"> 1. Connected – Drive detected. 2. Ready – Drive is ready to start motion. 3. Enabled – Drive is enabled. 4. Brake – Brake input is active. 5. Script – Script is running. 6. I SAT – Current loop is saturated. | <ul style="list-style-type: none"> 7. V SAT – Speed loop is saturated. 8. P SAT – Position loop is saturated. 9. FAULT – Appears when a fault is detected. 10. <input type="checkbox"/> Pause / <input type="checkbox"/> Play – This button will pause or resume the plots. 11. Temperature – Displays the internal temperature of the drive. 12. <input type="checkbox"/> Docking and undocking – This will dock/undock the tool from the main window. |
|--|--|

6.1.2 Plotting Drive Parameters

The Online Monitor plots the parameters using real-time data at a sampling rate of 100 ms. This is much lower than the drive sampling rate and so will miss some of the data. For this reason this display is used to provide an overview of drive operation. The Oscilloscope tool described in section [6.2](#) is available if data at the drive sampling rate is desired.

Adding parameters to monitor:

Step 1: Select  icon to open “Add Monitoring Parameter” window as shown in Figure 46.

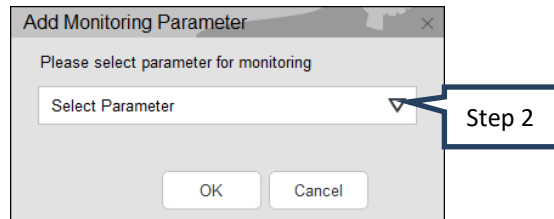





Figure 46: Add Monitoring Parameter Window

Step 2: Click the dropdown arrow  to view the drop down menu and make the desired parameter selection, and click *OK*.

Step 3: Click the checkbox to enable or disable plotting. Multiple parameters can be selected and plotted simultaneously. The enabled parameters will be plotted by default when it's initially configured.

Step 4: The plots can be paused using the  icon and resumed using the  icon at the bottom of the window. Figure 47 shows an example in which the motor speed, current and position is plotted.

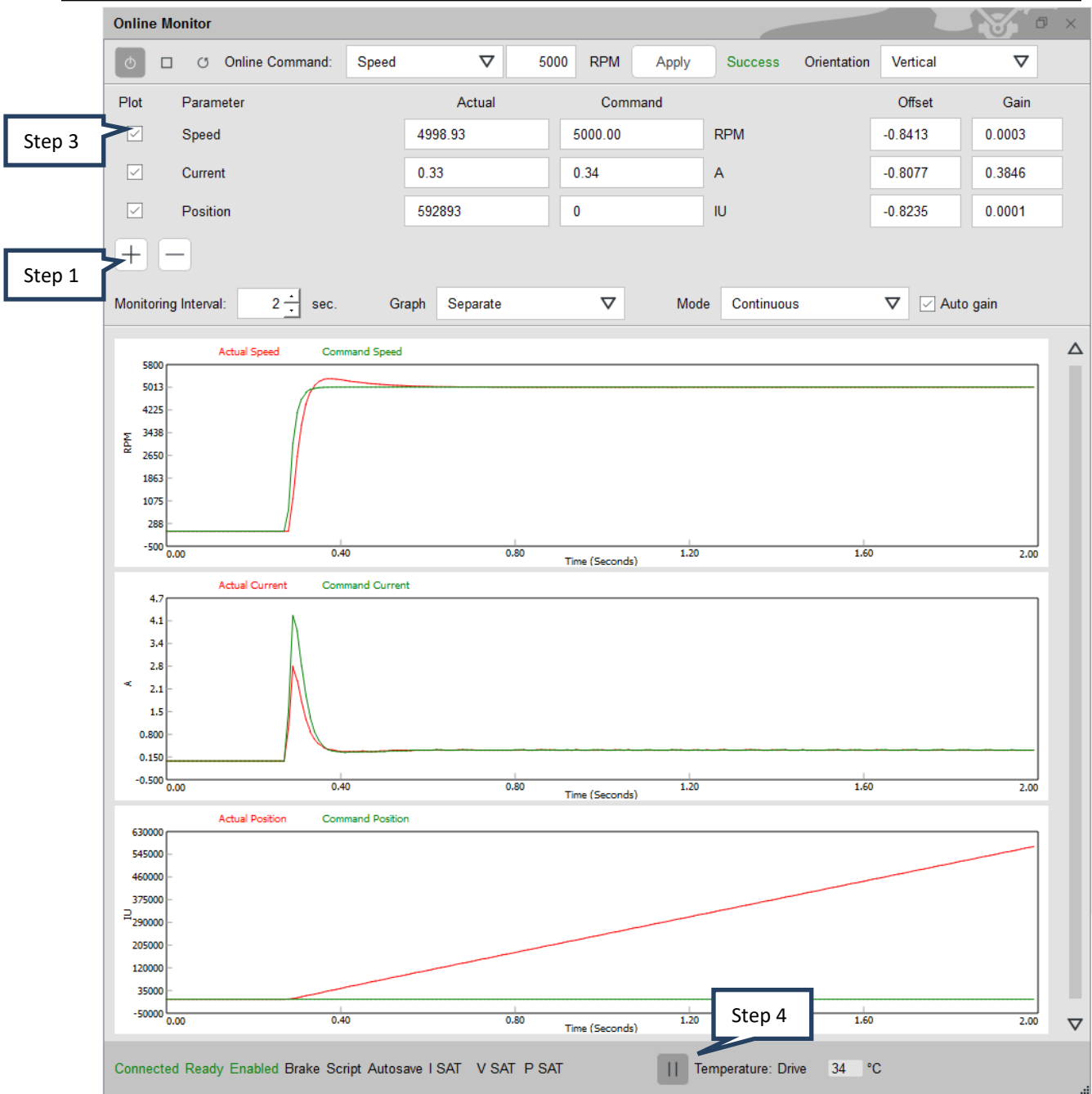





Figure 47: Motor Speed and Current Plot

Deleting monitored parameters:

- Select  icon.
- Select the cross icon  for the parameter that has to be deleted and then click the delete symbol  as shown in Figure 48.

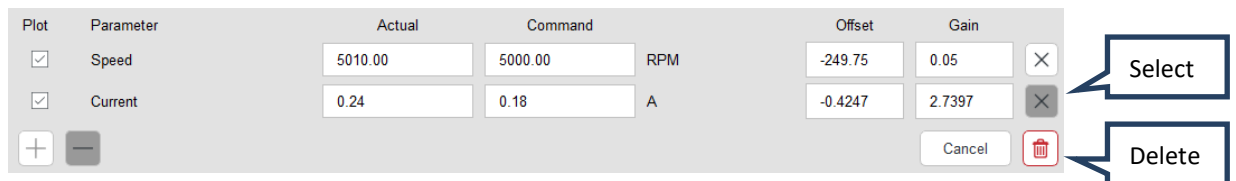



Figure 48: Delete plot

6.2 Oscilloscope

Select *Tools* -> *Oscilloscope* or select the  icon in the toolbar menu to open the Oscilloscope tool. The purpose of this tool is to observe drive parameters with a higher resolution than available in Online Monitor but for lower time periods. The observed parameters can be analyzed for such properties as amplitude, frequency, rise time, fall time. The operation of this tool will be familiar to those who have worked with Oscilloscopes.

6.2.1 Setup channels

Follow the steps below to setup the channels of the Oscilloscope:

- Select *Setup Channels* and choose up to four different channels for plotting.
- Select a time base and click *OK* as shown in Figure 49. This time-base applies to all channels

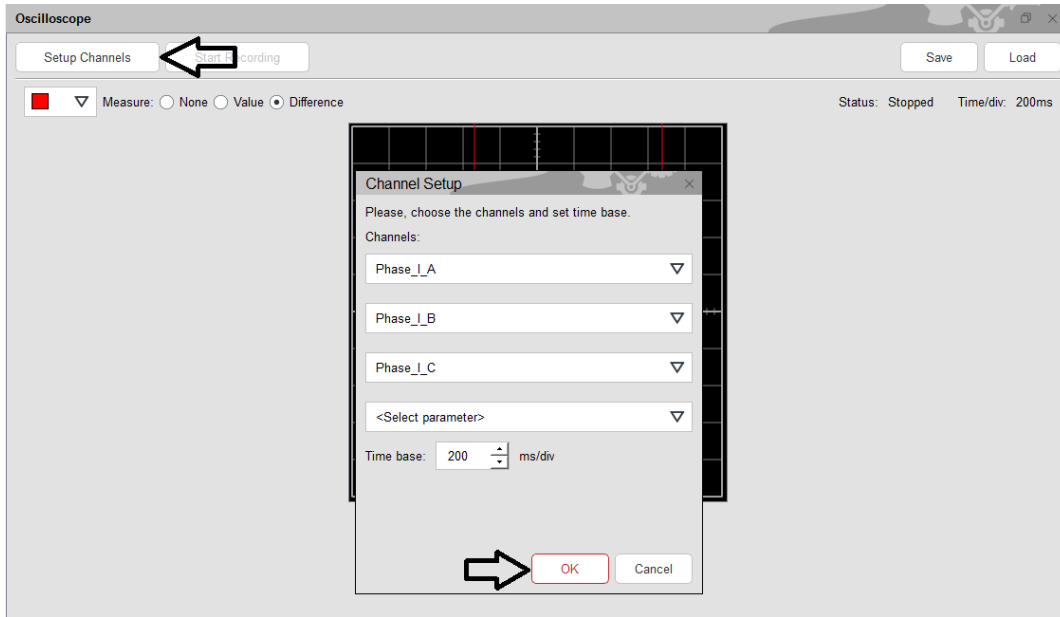


Figure 49: Setup Channels on Oscilloscope

- Choose the desired color for each channel from the color dropdown list.
- While operating the motor, click *Start Recording* to plot the channels.
- The Units, Units/div and Offset of each channel can be adjusted before or after plotting using the arrows or manually entering.
- There are two vertical cursors on the plot which can be used to find the value of each channel at a particular time by selecting *Value* in Measure options. Cursor can also be used to find the difference in values between the two cursors in each channel by selecting *Difference* in Measure options.
- To move the cursor lines, click and drag the lines to the necessary position.

In the examples shown in Figure 50 and Figure 51, the cursors are used to measuring the difference between two points in the oscilloscope plot. The channels are set at 0.5 Units/div and are offset from each other by 3 divisions.

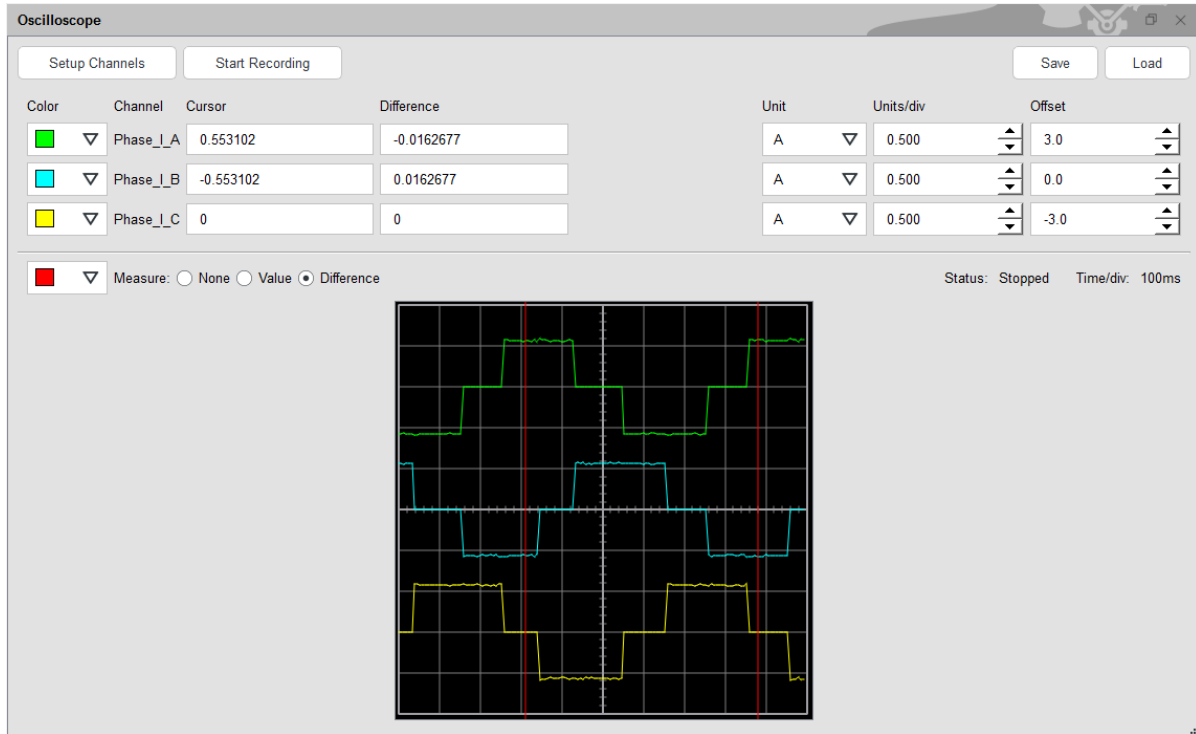


Figure 50: Trapezoidal Motor Phase Currents Plot



Figure 51: Sinusoidal Motor Phase Currents Plot

6.2.2 Save and Load Plots

Saving a plot:


- Click the *Save* button on the right-top corner of the Oscilloscope window.
- Select a location for the plot and save it either in “.xml” format or “.png” format. Default location to save the plot is “C:\Users\Public\Documents\ElectroCraft\Projects\Example\Oscilloscope”.

Note: Saving plots in “.xml” format can be loaded back into the oscilloscope unlike the “.png” files.

Loading a plot:

- Click the *Load* button on the right-top corner of the Oscilloscope window.
- Navigate to location where the plot was saved, select the file and click *Open*.

6.3 Diagnostic

Select *Tools* -> *Diagnostic* or select the  icon in the toolbar menu to open the Diagnostic tool. The purpose of this tool is to help with tuning the drive's control loops.

6.3.1 Adjusting control loop gains

When tuning the drive, the proportional gain (K_p), integral gain (K_i) and differential gain (K_d) values are changed in the Control Loops group (section 5.4). Use the Diagnostic tool to excite the drive and motor (this procedure applies for BLDC, PMDC and Stepper motors) and observe the response. Adjust the gain parameters until the system is critically-damped. When *Reverse spin* checkbox in *Motor and Drive* group is checked, the direction of motor rotation is reversed which in turn reverses the polarity of data in the diagnostic graph.

6.3.2 Selecting reference waveform shape

The shape of reference waveform can be selected from the dropdown list in the diagnostics window. The three options available are Unidirectional, Bidirectional and Gap bidirectional. Enter a Current and Speed ramp value in the Control loops group depending on the motor and load. The solid line in the Figure 52, Figure 53 and Figure 54 represents reference waveforms at ramp value zero and the broken line represents reference waveform at ramp value not equal to zero.

A unidirectional reference waveform rises up to the Height specified, stays there for the Width specified and then falls to zero. An example of unidirectional reference waveform is shown in Figure 52.



Figure 52: Unidirectional Reference Waveform

A bidirectional reference waveform rises up to the Height specified, stays there for the Width specified and then falls to negative value of Height, stays there for the width specified and comes back to zero. An example of bidirectional reference waveform is shown in Figure 53.

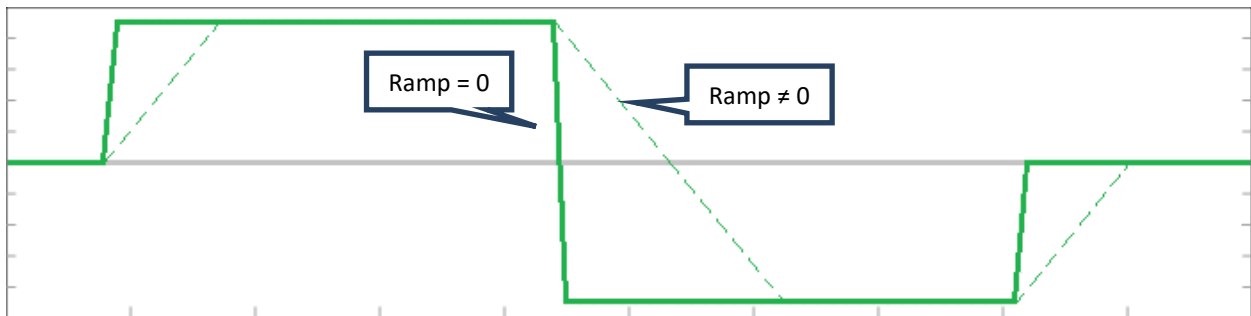


Figure 53: Bidirectional Reference Waveform

A gap-bidirectional reference waveform rises up to the Height specified, stays there for the Width specified and then falls to zero and stays there for the Width specified and falls to negative value of Height, stays there for the width specified and comes back to zero. An example of gap-bidirectional reference waveform is shown in Figure 54.

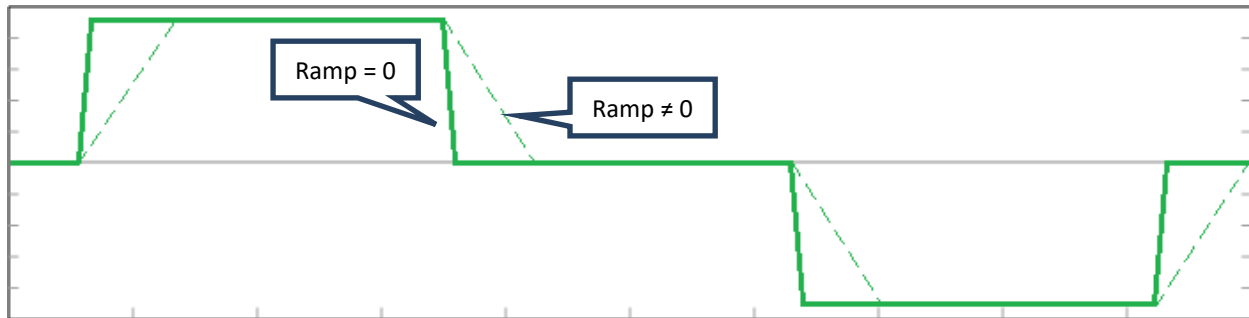


Figure 54: Gap-bidirectional Reference Waveform

Note: Diagnostic tool can be used only in USB control interface and the digital input 'Enable' must be in the Enabled state.

6.3.3 Different types of damped systems

A system is critically-damped when the actual speed/current of the motor doesn't overshoot and the speed/current of motor responds to changes in a controlled, non-oscillatory manner as shown in Figure 55. This phenomenon occurs when the correct amount of K_p and K_i gains are applied.

A system is under-damped when the actual speed/current of the motor overshoots and oscillates before settling at the reference speed/current. This phenomenon occurs due to high current/speed proportional gain (K_p). Example waveform of an under-damped system is shown in Figure 55.

A system is over-damped when the actual speed/current of the motor takes longer time to rise to the reference speed/current. This phenomenon occurs due to high current/speed integral gain (K_i). Example waveform of an over-damped system is shown in Figure 55.

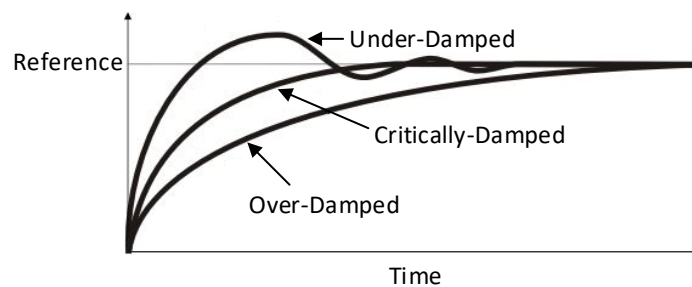


Figure 55: Under, Over, Critically Damped Systems

6.3.4 Current Loop Tuning

Current loop tuning:

Step 1: Select *Current* under *Drive operation mode* section in *Motor and Drive* group.

Step 2: In the *Diagnostic* window, select *Current PI* from the dropdown list.

Step 3: Select the required *Width* in milliseconds (default 10 ms), *Height* in Ampere (default 1 A) and *Shape* of the reference waveform from the dropdown list.

Step 4: Enter the *Current Kp* and *Ki* values in the *Control Loops* group (It is recommended to set current ramp at zero).

Step 5: Click *Write* for the parameters to be written into drive.

Step 6: Click *Test* and wait until the progress bar gets to 100%.

- It is recommended that the motor shaft does not turn during tuning (to prevent Back EMF and motor commutation from influencing the test).

- It is also recommended to use 4-Quadrant mode when tuning the current loop to allow full control of positive and negative currents.

Repeat steps 4 to 6 if the drive needs better tuning. An example of critically-damped system tuned using the software is shown in Figure 56.



Figure 56: Critically-damped Current Control Loop

6.3.5 Speed Loop Tuning

Speed loop tuning:

Step 1: Select *Speed* under *Drive operation mode* section in *Motor and Drive* group.

Step 2: In the Diagnostic window, select *Speed PI* from the dropdown list.

Step 3: Select the required *Width* in mille-seconds (default 1000 ms), *Height* in RPM (default 1000 RPM) and *Shape* of the reference waveform from the dropdown list.

Step 4: Enter the *Speed Kp* and *Ki* values in the *Control Loops* group.

Step 5: Click *Write* for the parameters to be written into drive.

Step 6: Click *Test* and wait until the progress bar gets to 100%. Apply some resistance to the motor shaft.

Repeat steps 4 to 6 if the drive needs better tuning. An example of critically-damped system tuned using the software is shown in Figure 57.

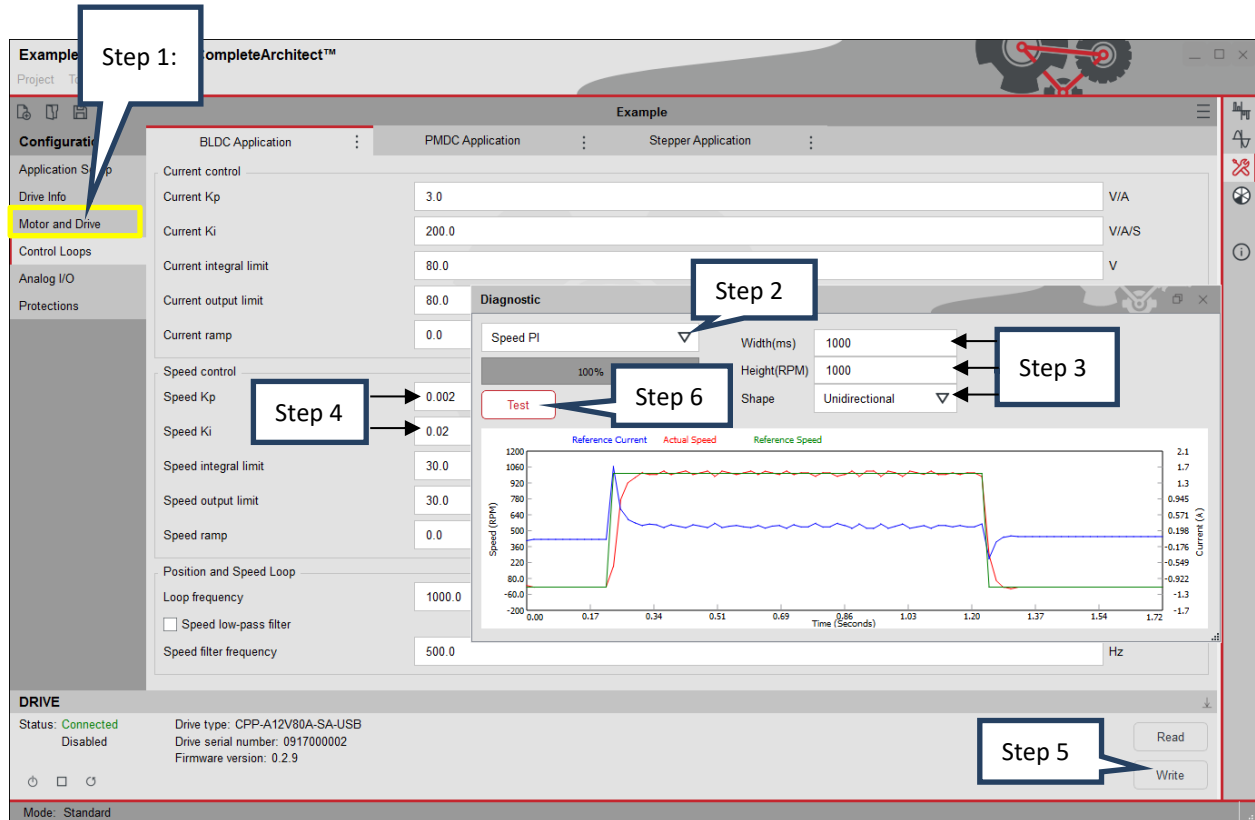


Figure 57: Critically-damped Speed Control Loop

6.3.6 Position Loop Tuning

Position loop tuning:

Step 1: Select *Position* under *Drive operation mode* section in *Motor and Drive* group. Make sure *Reverse spin* is not checked in *Motor and Drive* group.

Step 2: In the Diagnostic window, select *Position* from the dropdown list.

Step 3: Select the required *Width* in mille-seconds (default 1000 ms), *Distance* in IU (Internal Units = Encoder counts, default 1000). *Shape* of the reference waveform is always unidirectional (not user selectable).

Step 4: Enter the *Position Kp*, *Ki* and *Kd* values in the *Control Loops* group.

Step 5: Click *Write* for the parameters to be written into drive.

Step 6: Click *Test* and wait until the progress bar gets to 100%.

Repeat steps 4 to 6 if the drive needs better tuning. An example of critically-damped system tuned using the software is shown in Figure 58.

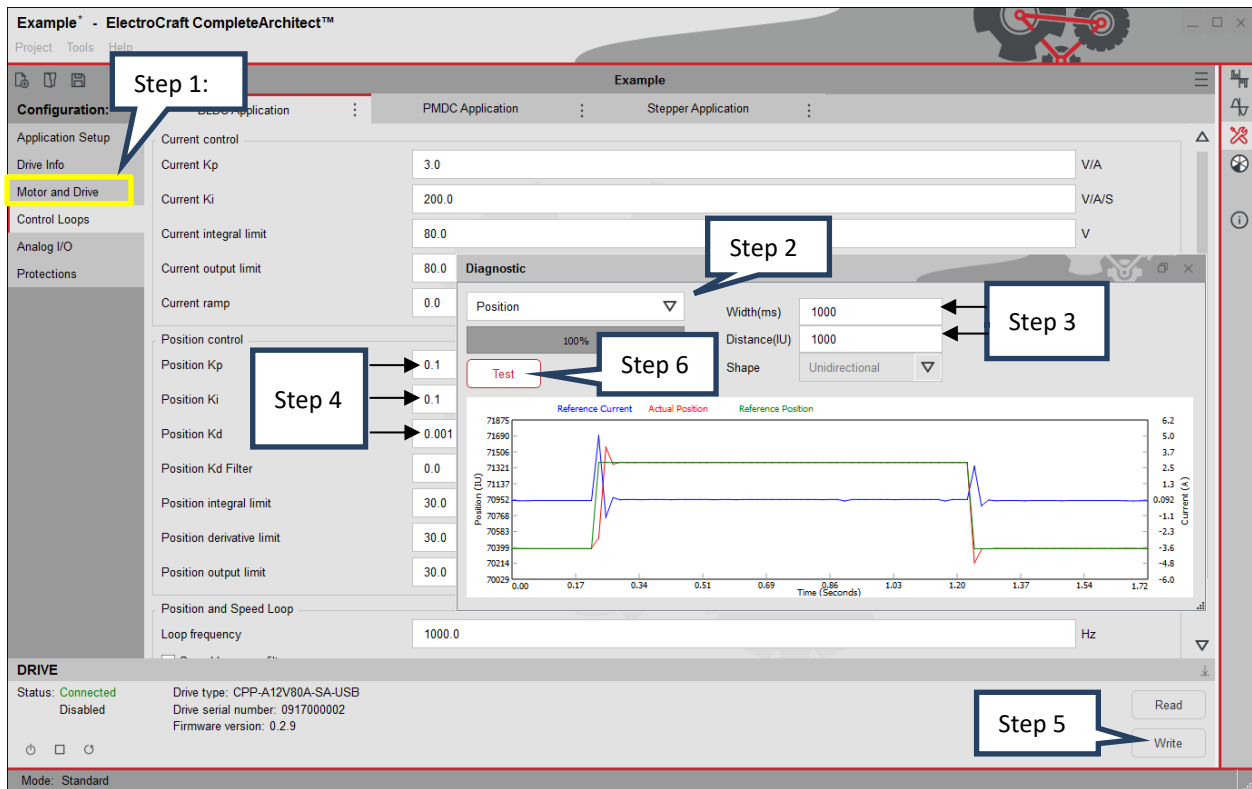


Figure 58: Critically-damped Position Control Loop

6.3.7 Position with Speed Loop Tuning

Position with Speed loop tuning:

Step 1: Select *Position with Speed* under *Drive operation mode* section in *Motor and Drive* group. Make sure *Reverse spin* is not checked in *Motor and Drive* group.

Step 2: In the Diagnostic window, select *Position with Speed* from the dropdown list.

Step 3: Select the required *Width* in mille-seconds (default 1000 ms), *Distance* in IU (Internal Units = Encoder counts, default 1000). *Shape* of the reference waveform is always unidirectional (not user selectable).

Step 4: Enter the *Position Kp*, *Ki* and *Kd* values in the *Control Loops* group.

Step 5: Click *Write* for the parameters to be written into drive.

Step 6: Click *Test* and wait until the progress bar gets to 100%.

Repeat steps 4 to 6 if the drive needs better tuning. An example of critically-damped system tuned using the software is shown in Figure 59.

The screenshot displays the ElectroCraft CompleteArchitect software interface. The left sidebar shows the 'Motor and Drive' section selected. The main configuration area is divided into several sections: 'Current control' (Current Kp: 3.0, Current Ki: 200.0, Current integral limit: 80.0, Current output limit: 80.0, Current ramp: 0.0), 'Speed control' (Speed Kp: 0.002, Speed Ki: 0.02, Speed integral limit: 30.0, Speed output limit: 30.0, Speed ramp: 0.0), and 'Position with Speed control' (Position speed Kp: 5.0, Position speed Ki: 2.5, Position speed Kd: 0.001, Position speed Kd Filter: 0.0, Position speed integral limit: 1000.0, Position speed derivative limit: 1000.0, Position speed output limit: 1000.0). The 'Position and Speed Loop' section includes 'Loop frequency' (1000.0 Hz) and 'Speed filter frequency' (500.0 Hz). The 'Diagnostic' window is open, showing a graph of 'Reference Current' (blue), 'Actual Position' (red), and 'Reference Position' (green) over time. The 'Test' button is highlighted, and the progress bar is at 100%. The 'DRIVE' status section at the bottom shows 'Status: Connected', 'Disabled', 'Drive type: CPP-A12V80A-SA-USB', 'Drive serial number: 091700002', and 'Firmware version: 0.2.9'. The 'Write' button is also highlighted.

Figure 59: Critically-damped Position with Speed Control Loop

6.4 Drive I/O Monitor

The Drive I/O Monitor tool displays the digital input, digital output, analog input, hall sensor states and encoder states with position counter.

To open this tool, select *Tools -> Drive I/O Monitor* or select the  icon from the toolbar.

Digital Inputs – This section displays the physical state (High-1 or Low-0) of digital inputs.

Digital Outputs – This section displays the physical state (High-1 or Low-0) of digital outputs.

Analog Input – This section displays the analog input which is scaled according to *Analog I/O* configuration group's parameter settings. If the analog input is not used for the selected *drive operation mode*, then it's disabled on the *Drive I/O Monitor*.

Hall Sensors – This section displays the status of hall sensor inputs. For a BLDC motor it shows the status of the inputs. Even though Stepper and PMDC motors do not have hall sensors, the display is still active and will report the status of the inputs.

Encoder – This section displays the status of encoder inputs. The scaling of the dial (counts per rotation) is based on the user entered encoder *Lines per rev* value. This section is active only if the encoder checkbox on the *Motor and Drive* configuration group is checked.

An example of online monitor is shown in Figure 60

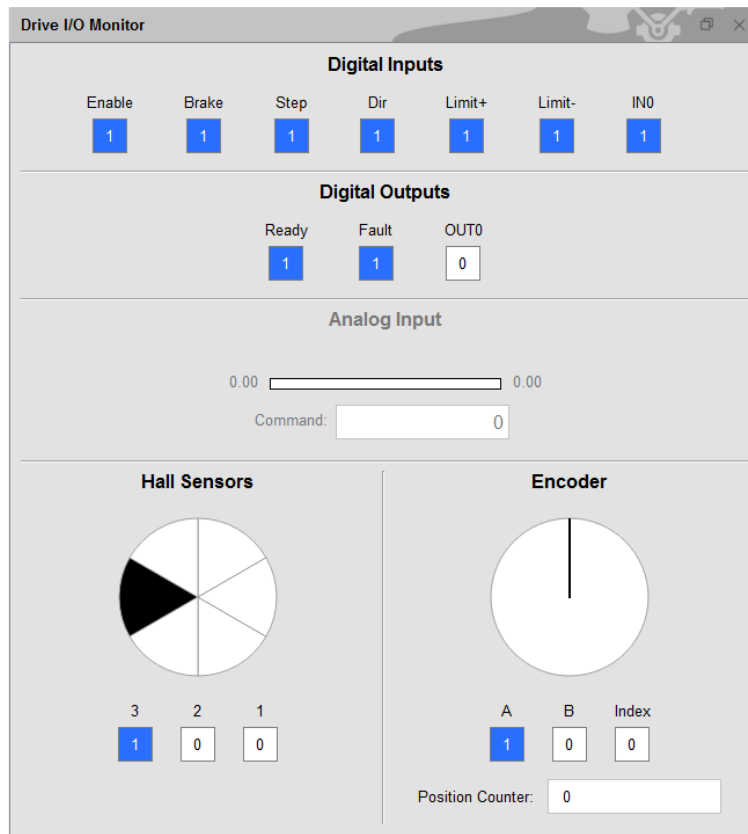


Figure 60: Drive I/O Monitor

6.5 User Motor Database Manager

Select *Tools* -> *User Motor DB Manager* from the menu to open the User Motor Database tool, the window shown in Figure 61 will appear. The purpose of this window is to add a user's custom motor into the software database.

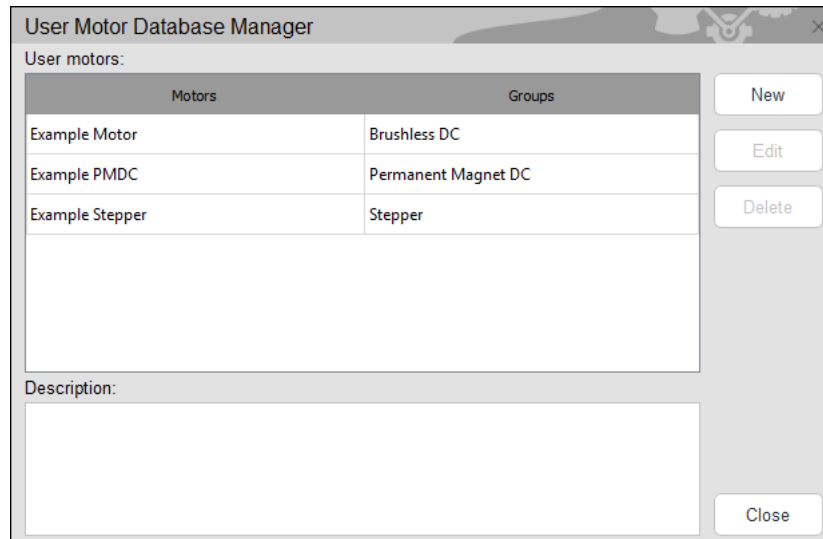


Figure 61: User Motor Database Manager Window

6.5.1 Add New Motor to the Database

- Select *New* in the *User Motor Database Manager* window and select the desired motor type from the list and click *OK* as shown in Figure 62. Brushless DC motor is selected to demonstrate this tool.

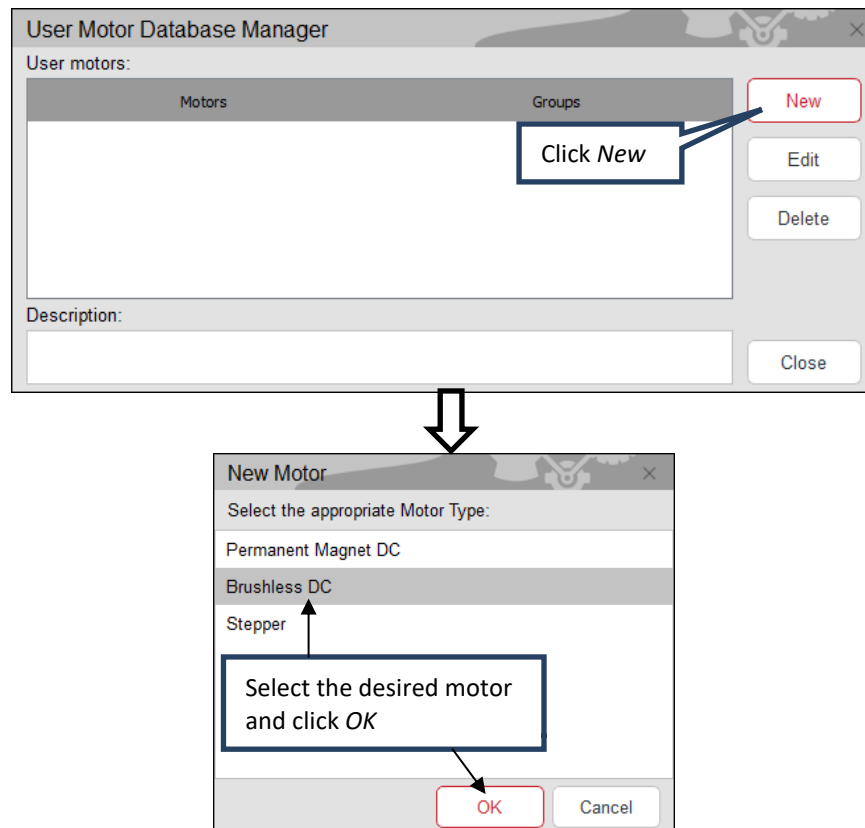


Figure 62: New Motor Type Selection Window

- The Motor settings window will appear in which all motor parameters need to be entered (for unknown parameter values, follow the suggestions specified next to each unit) as shown in Figure 63 and click **OK**.

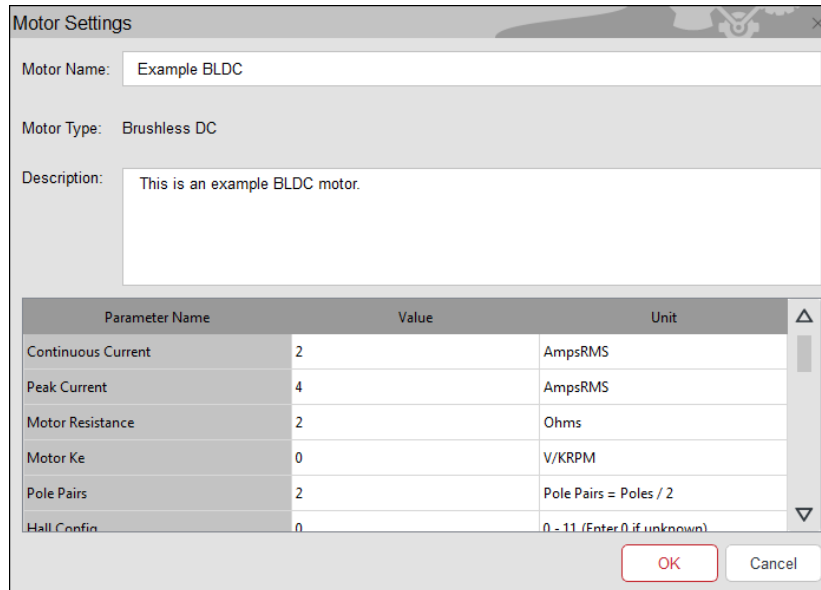


Figure 63: Motor Settings Window

- The motor should now be displayed in the *User Motor Database Manager* window as shown in Figure 64. The selected motor appears in red text.

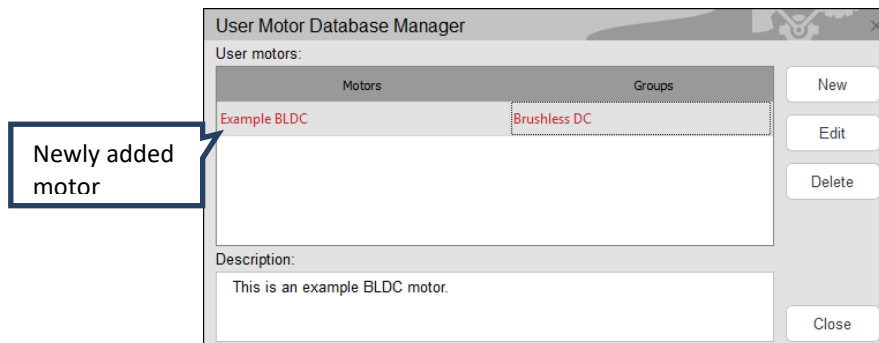


Figure 64: New Motor Added to Database

- If the motor was successfully entered into the database, it will be displayed in alphabetical order in the *New Application* window as shown in Figure 65.

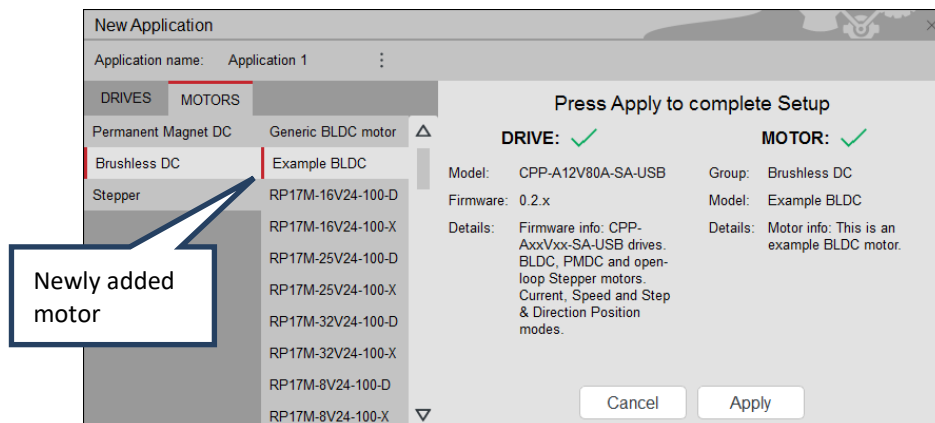


Figure 65: New Motor displayed while creating new project

6.5.2 Edit or Delete Motor from the Database

Edit a motor in the database:

- Open the *User Motor Database Manager* window and select the motor to be edited and click *Edit* as shown in Figure 66.

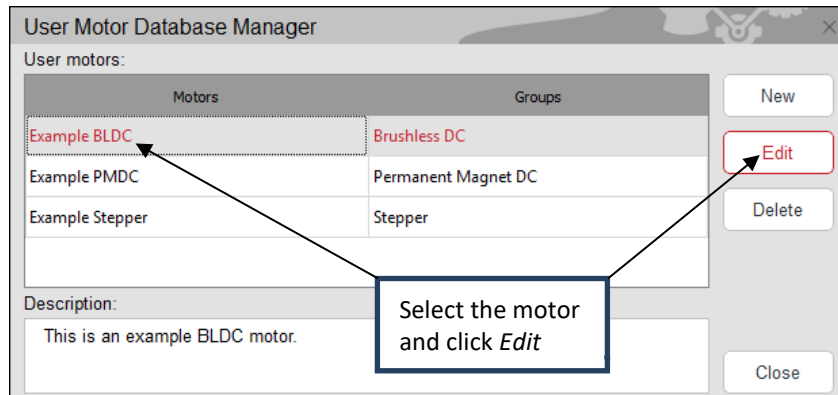


Figure 66: Edit Motor

- The Motor Settings window will appear in which all the motor parameters can be edited and click *OK* to finalize changes.

Delete a motor from user motor database:

- Open the *User Motor Database Manager* window and select the motor to be deleted and click *Delete*. Click *OK* in the information window as shown in Figure 67. This will delete the selected motor from the user motor database.

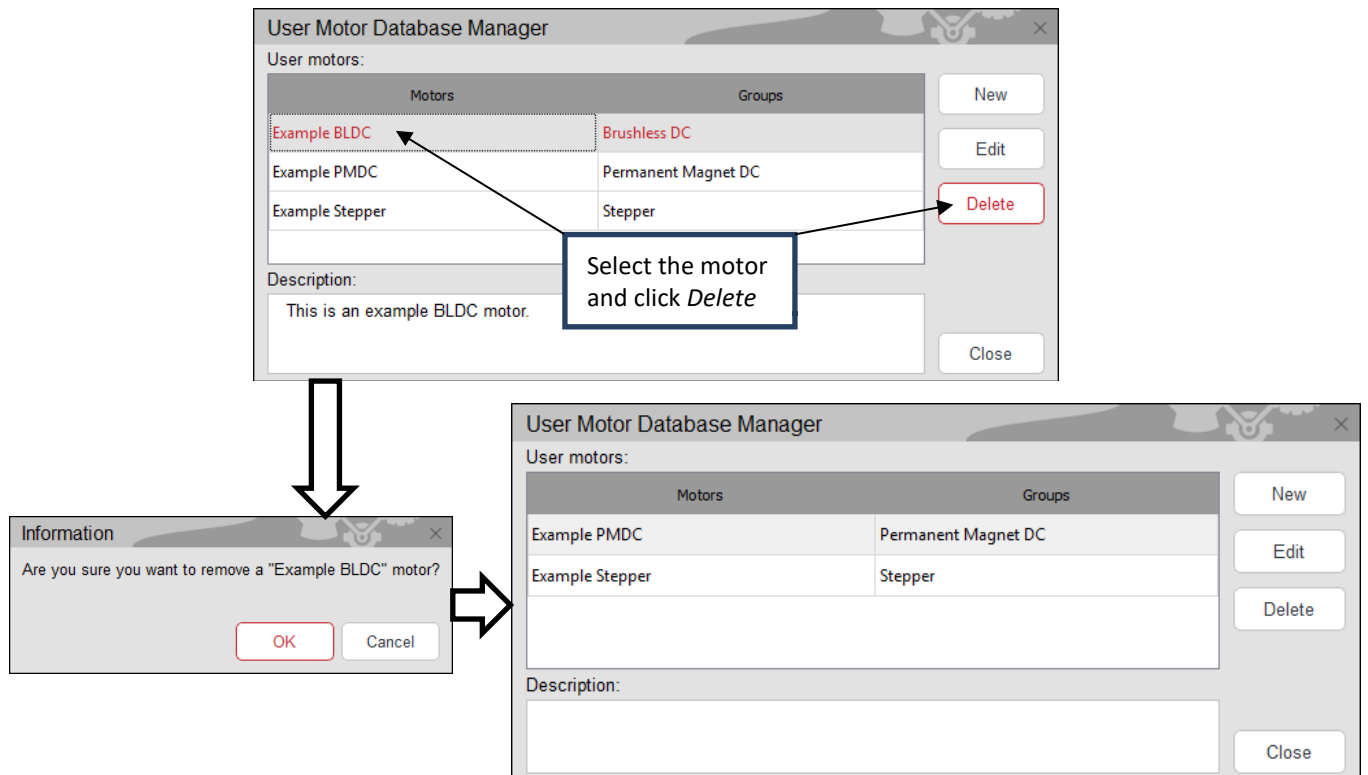


Figure 67: Delete Motor

6.6 Check for Database updates

Refer to section 1.5 for the steps to update the database.

