

## **Power-Up Calibration (PUC) Options – BLDRV3 cards**

### **GENERAL**

The drive system uses quadrature motor encoders to report motor shaft position to the drive cards. This provides the precise feedback of shaft position required for smooth motor commutation. Quadrature encoders are incremental encoders – they report change in shaft position rather than absolute shaft position.

On card power-up therefore the system does not know the absolute positions of the motor shafts and is unable to properly commutate the motors until it does so. A power-up calibration procedure is used to achieve this. It is undertaken each time the cards are powered-up.

The basic power-up calibration method is MANUAL (see below).

However, the default PUC method for the BLDRV3 cards Option 2 Automatic With Go-Ahead (Calib\_Method=4).

The APUC method is defined in the CL\_SPU\_USB card EEPROM and can be changed using the Update\_EEPROM button in the Driver Test App (USB).

### **CALIBRATION OPTIONS**

#### 1. MANUAL:

EEPROM setting Calib\_Method = 1

The operational sequence is....

Start the CL or Driver Test App software.

Power-up the CL\_SPU\_USB + BLDRV3 cards.

Manually cycle each control axis over its full range of movement (end stop to end stop) at a steady pace until the flashing Yellow LED for the axis driver card goes out and finally the CL\_SPU yellow LED goes out.

Click Ping on the software to confirm the calibration is complete and the software is reading the card status.

#### 2. AUTOMATIC - WITH WAIT FOR GO-AHEAD:

EEPROM setting Calib\_Method = 4

This is the DEFAULT mode.

The operational sequence is...

Start the CL or Driver Test App software.

Power-up the CL\_SPU\_USB + BLDRV3 cards.

The CL software will then display a pop-up window indicating cards are awaiting APUC Go-Ahead. (When using the Driver Test App you may need to click Ping to initiate the pop-up window).

When you are ready click Go-Ahead – the cards will then proceed with automatic position and range finding movements. The card Yellow LED's will go out once the procedure is complete.

Click Ping on the software to confirm the calibration is complete and the software is reading the card status.

### 3. AUTOMATIC – WITHOUT GO-AHEAD:

EEPROM setting Calib\_Method = 3

The operational sequence is...

Start the CL or Driver Test App software.

Power-up the CL\_SPU\_USB + BLDRV3 cards.

The cards will then proceed IMMEDIATELY with automatic position and range finding movements. The card Yellow LED's will go out once the procedure is complete.

Click Ping on the software to confirm the calibration is complete and the software is reading the card status.

### 4. AUTOMATIC – WITH GO-AHEAD (Use Preset Encoder CPR):

EEPROM setting Calib\_Method = 7

This mode is the same as mode 2 above (Calib\_Method=4) but instead of using the encoder PPR detected by the automatic movements it uses the PPR defined in the E\_Rollover parameter in EEPROM.

This can be useful if the automatic detection method, which determines encoder count over 2 motor electrical cycles, is not accurate enough due to variation in motor construction.

### 5. AUTOMATIC – LOOSE MOTOR TEST MODE

EEPROM setting Calib\_Method = 5

In this mode the cards determine absolute electrical position and then sets the working range to 8 x encoder rollover edge counts as defined by the E\_Rollover setting. This is equivalent to 2 x motor shaft revolutions for a 4 pole motor.

It is best suited for testing with the drive motors loose from any mechanical transmission

and therefore unable to use endstop range location.

## 6. AUTOMATIC – MOTOR TIMING DISCOVER MODE

EEPROM setting Calib\_Method = 6

This mode can be used to determine commutation details for new motor types.

It should be used with a single axis – ie one BLDRV3 card with motor connected to the CL\_SPU\_USB.

It should be used with a motor loose from any mechanical transmissions so that its rotation is not impeded mechanically.

The method generates a text file report via the Driver Test App which details the discovered motor timings and required voltage scalings etc.

For more details see Section \* below.

## **PREQUISITES**

The default APUC method for delivered BLDRV3 cards is Automatic – With Go-Ahead.

This means, when first powered-up, the cards will initialise electrically then await go-ahead via the Driver Test App USB or main CL software. Once go-ahead is given the cards will automatically drive a series of movements in all active control axes to complete the power-up calibration.

To do this successfully the motors **MUST** be already built into the flight controls; their movement range must be constrained by the hard end stops of the controls.

If you wish to test the motor drive with motors loose from their controls (ie with no end stops) then you will need to change the APUC method via the Driver Test App USB. This can be done using the Update\_EEPROM button on the Driver Test App USB GUI. It should be done with the cards powered-up, but **BEFORE** go-ahead is given for the default programmed APUC procedure.

The APUC options require the good function of the mechanical transmissions, and this should be confirmed through the standard setup and commissioning of the system.

## **MECHANICAL:**

- Solid mechanical end stops must be in place – the motors will be driven against the end stops to detect working range. If the end stops are missing or are soft the range

detection will not complete properly. Approx 30% motor torque output is used for end stop detection, although this is adjustable in EEPROM settings.

- APUC movements will generally require a minimum of about 1 complete motor shaft revolution to complete properly. Controls should be designed to allow a minimum of 1 complete shaft rotation end stop to end stop for 4 pole motors, 2 revs for 2 pole motors.

(60ST-M01330 motors are 4 pole)

- The mechanical transmissions should be stiff – ie no soft/sloppy belt stages or components that bend or slip under load.
- The controls should not have any significant unbalanced loads built-in. The motors should be free to take up position during APUC as demanded by the cards. This will normally be the case unless the controls require significant force from the motors to move them.
- Related to the above – the controls' movements should be smooth and low friction over their full range. If they are sticky or stiff in places the range finding may not work properly.
- The correct EEPROM voltage scaler settings must be active. This will not usually be an issue unless you have altered the EEPROM settings for the cards. The cards by default are programmed for 60ST-M01330 servo motors. If you are not using these motors then the EEPROM settings for the axis concerned must be updated BEFORE any APUC is attempted. Use the Update\_EEPROM button on the Driver Test App USB GUI.

The cards may briefly apply maximum current to the motors during APUC and if the wrong voltage settings are active for the motor in EEPROM this may result in over-current of the card and motor.

## SETTINGS

The PUC settings are held in the EEPROM of the CL\_SUP\_USB card.

The settings are changed manually using the Update\_EEPROM button in the Driver Test Application USB.

The EEPROM settings can be read from or saved to file. Several BLDRV3 ini files are provided in the test app zip file which can be referenced for correct motor settings for different motor types. The ini files can be opened and inspected using NotePad or a similar text editor.

The relevant settings are in the [Shared] parameters section of the ini file:

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[Shared]

*Master\_Enable=2*

*; Power-up calibration (PUC) method*

*; 1= standard manual movement calibration*

*; 2= reserved*

*; 3= automatic movement - starts immediately on power-up*

*; 4= automatic movement - awaits go-ahead from user*

*; 5= automatic movement - test mode - sets working range = 8 x encoder rollover edge counts = 2 shaft revs for 4 pole motor*

*; 6= automatic movement - "discover" mode - card will determine encoder count and phase timings automatically - with go-ahead*

*; 7= as per =4 but uses predefined value for E\_Rollover*

*; NOTE: DEFAULT is now mode 4 - APUC with go-ahead.*

*; Mode 6 can be used to discover and test the drive with the motors loose from the transmission*

*; but read supporting documentation first before using Calib\_Method=6*

*Calib\_Method=4*

*; Automatic power up calibration force level and rate*

*APUC\_Force=25*

*APUC\_Delay=20*

*; Temperature Limit at which current limiting kicks-in - in C*

*Temp\_lim=60*

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Note: the new settings can be saved to a renamed BLDRV3.ini file if required. Or a file can be edited manually and then read using the Update\_EEPROM facilities of the Driver Test App.

To change the EEPROM settings....

1. Power-up the cards and then run the Driver Test App USB. DO NOT give Go-Ahead to any existing APUC movements at this stage. Instead...
2. Click the Update\_EEPROM button. The test app will ping the cards are read the current EEPROM settings and display them as shown in the image below...
3. In the Shared Settings area adjust the Calib\_Method, APUC\_Force and APUC\_Delay parameters as required.

(Note: holding the mouse cursor over a setting in the Elevator column will show a pop-up help tip for that setting)

4. The amended settings can be saved to file using the Save\_to\_File button for reference.

To update the new settings to EEPROM use the Write\_to\_EEPROM button. The software will send the new settings to the card and display a message when finished – it will take a few moments.

5. Power-cycle the cards to enable the new PUC settings. (Note if Calib\_Method=3 has been set the system will immediately go into its auto-movement sequence on restart.)

Once the cards have re-started use the Read\_from\_Card button to re-read the new settings from EEPROM and inspect to confirm the new settings have taken.

CL\_SPU EEPROM Settings

CL\_SPU EEPROM Settings

Shared Settings

Master Enable  Temperature Limit (C)

Power-up Calibration Method  Grip Sensor threshold

APUC Force Level (%)  Grip Sensor stab time

APUC Speed  Grip Sensor drop

Axis Settings

	ELEVATOR	AILERON	RUDDER
1:Voltage Scaler (%)	<input type="text" value="50"/>	<input type="text" value="80"/>	<input type="text" value="70"/>
2:Current Limit (Amp/10)	<input type="text" value="70"/>	<input type="text" value="45"/>	<input type="text" value="70"/>
3:Encoder Rollover	<input type="text" value="360"/>	<input type="text" value="2500"/>	<input type="text" value="2500"/>
4:Hall Edge 1	<input type="text" value="60"/>	<input type="text" value="417"/>	<input type="text" value="417"/>
5:Hall Edge 2	<input type="text" value="240"/>	<input type="text" value="1666"/>	<input type="text" value="1666"/>
6:Vibration Scaler	<input type="text" value="1"/>	<input type="text" value="1"/>	<input type="text" value="1"/>
7:Vib Wave Mix	<input type="text" value="63"/>	<input type="text" value="63"/>	<input type="text" value="63"/>
8:On Ramp	<input type="text" value="63"/>	<input type="text" value="63"/>	<input type="text" value="63"/>
9:Encoder Step Trig	<input type="text" value="200"/>	<input type="text" value="200"/>	<input type="text" value="10"/>
10:Pos Fol Force Cap	<input type="text" value="3"/>	<input type="text" value="3"/>	<input type="text" value="3"/>
11:Auto Release - Pos	<input type="text" value="90"/>	<input type="text" value="90"/>	<input type="text" value="90"/>
12:Auto Release - Force	<input type="text" value="50"/>	<input type="text" value="50"/>	<input type="text" value="50"/>
13:Auto Release - Time	<input type="text" value="6"/>	<input type="text" value="6"/>	<input type="text" value="6"/>
14:Phase Ang Cor	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>
15:Fixed Force Rev	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>
16:Breakout Rate	<input type="text" value="1"/>	<input type="text" value="1"/>	<input type="text" value="1"/>
17:Breakout Factor	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>
18:Neutral Pos Shift	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>
19:High Res Enable	<input type="text" value="1"/>	<input type="text" value="1"/>	<input type="text" value="1"/>

Read Timestamp

Time Stamp

Settings read from CL\_SPU...at 20180928082434

Buttons: Read\_from\_Card, Load\_from\_File, Save\_to\_File, Write\_to\_EEPROM, QUIT

WARNING: Don't write to card EEPROM unless you are sure you know what you are doing!

## USING “DISCOVER” MODE

TBA

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