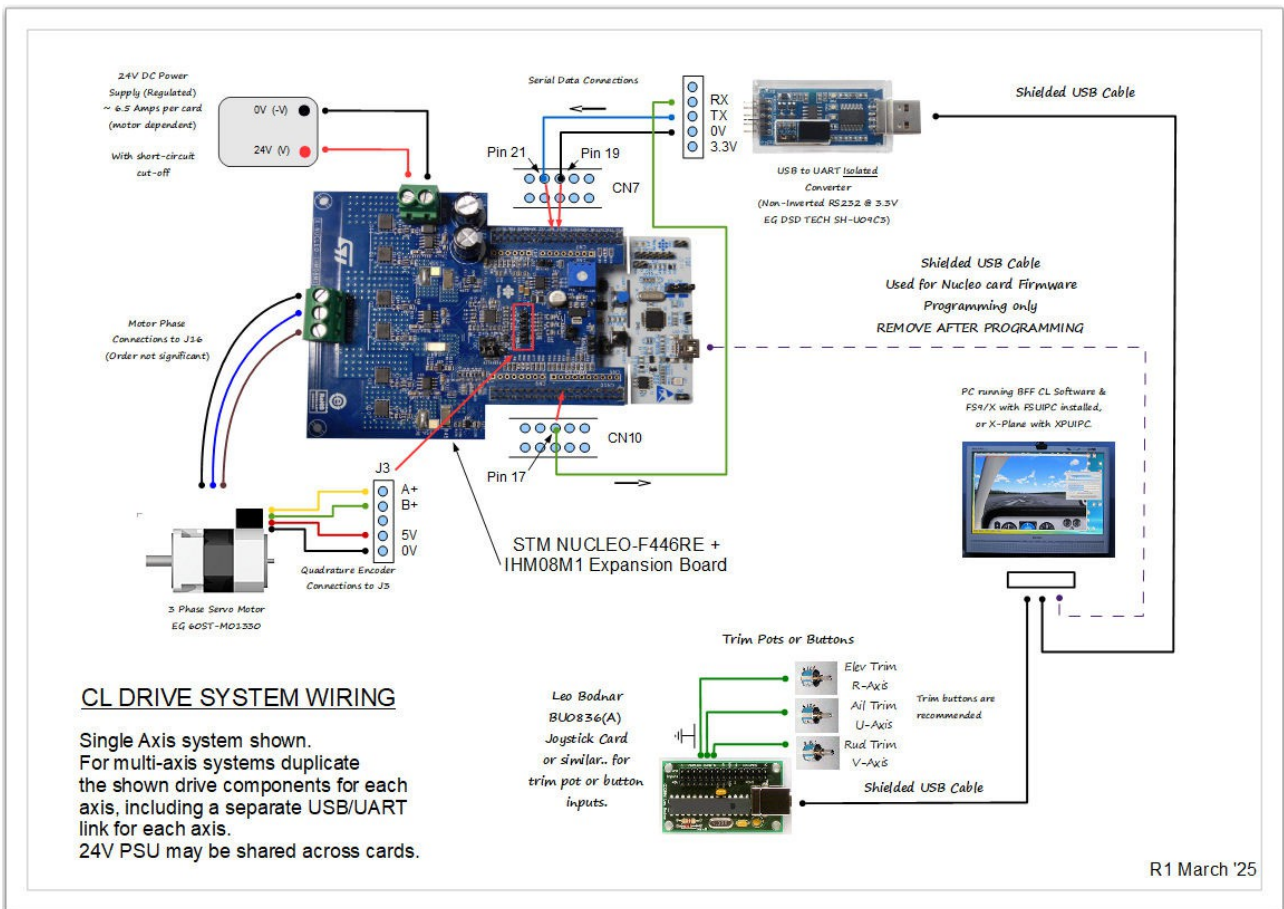


# STM based Control Loader Drive Setup R0.4

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STMicro Hardware Based Control Loader Drive

## OVERALL DRIVE SETUP STEPS

This document covers the setup steps for the STMicro hardware based CL drive demonstrator project.

It does not cover the mechanical design and build of the flight control mechanisms, nor does it provide detailed instructions on the various CL software apps.

The overall setup steps are:

1. Download and install the CL Software.
2. Download and install the STM32Cube Programmer Software.
3. Program the NUCLEO-F446RE boards with the BFF CL Drive Firmware.
4. Install the USB/UART Isolated Converters to provide comms with the boards.
5. Complete the system wiring – motor, power supply, UART.
6. Install a USB Game-controller card for trim inputs.
7. Complete the drive board CL configuration jumper settings.
8. Run the CL Controller App for initial drive testing.
9. Configure and run the main CL Software for normal flight operation.

NOTE: Mechanical build instructions (drawings, parts lists etc) for a CL flight yoke can be found on the web site [here](#) and [here](#).

It is, however, worth mentioning here the motor shaft working range requirement for the drive in case you are designing your own flight controls.

In order for the drives to properly complete their APUC (automatic power-up calibration) procedure the end-stop to end-stop working range of the flight control axis must be at least one full motor shaft revolution. This is for 4 pole pair motors.

For 2 pole pair motors the working range must be at least 2 shaft revolutions.

If the working range is too short the APUC procedure may not complete and may throw errors during or shortly after power-up.

## 1. CL Software download

Download the Control Loader software here -

[https://bffsimulation.com/CL\\_STM\\_Instructions.php](https://bffsimulation.com/CL_STM_Instructions.php)

Installation is simply by unzipping the package to a dedicated folder – there are no registry settings required.

The software zip includes the main CL Software, its Configuration Manager App and the CL Controller app for drive testing.

Each app can be run by double clicking on its .exe file. Do not remove any of the files from their folders and run each app from its current location in the folder structure.

## 2. NUCLEO-F446RE Programming

Install and run the STM32 Cube Programmer App -

<https://www.st.com/en/development-tools/stm32cubeprog.html>

On the NUCLEO-F446RE card check the CN2 jumpers are ON and JP5 is set for "U5V" (pins 1 & 2 connected) as shown in Fig 3 (FLASH MODE).

Connect the card to USB – the JP5 settings will allow the card to be powered from USB.

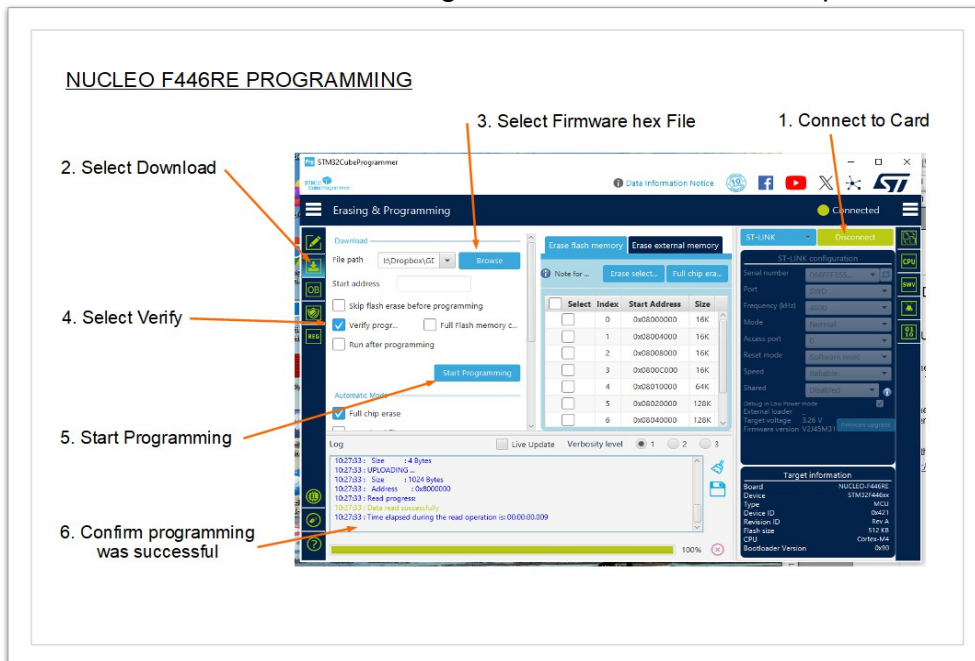


Figure 1. NUCLEO F446RE Programming Sequence

Follow the procedure shown above (Fig 1) to connect to the NUCLEO card, select download, select the firmware hex file and program the microcontroller.

Disconnect the programmer and disconnect the NUCLEO-F446RE from USB.

Following programming RETURN JP5 JUMPER TO "RUN" MODE (Pins 2 & 3 Jumped for E5V) as shown in Fig 3.

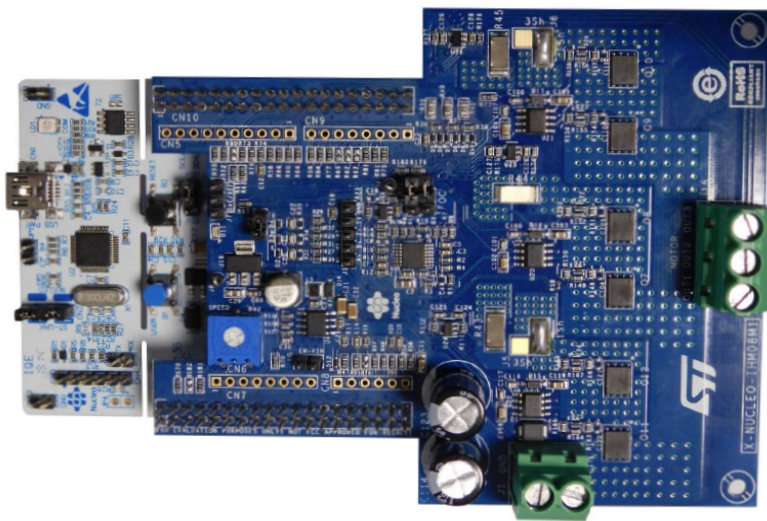
This will enable the NUCLEO card to be powered from the IHM08M1 expansion board and so ensure the correct boot sequence when the expansion board is powered from the 24V supply.

**NOTE:** Although the NUCLEO-F446RE virtual COM port could be used for serial comms between the CL Software and the cards it is restrictively cumbersome to do so. It can only be used if the NUCLEO-F446RE card is connected to USB AFTER the IHM08M1 is powered-up. This would require the cards to be disconnected from USB after each time they are used.

Instead the system uses separate UART comms via an external USB/UART converter. This ensures the correct card boot sequence at power-up and the USB/UART converter(s) can be left connected to USB.

### 3. Mount IHM08M1 on NUCLEO-F446RE and Set Jumpers

Mount the IHM08M1 expansion board on the NUCLEO-F446RE via the CN7 and CN10 headers (as shown Fig 2).



*Figure 2. NUCLEO-F446RE with IHM08M1 Mounted*

Make sure all Jumper settings on the cards are set as shown in Figure 3 below.

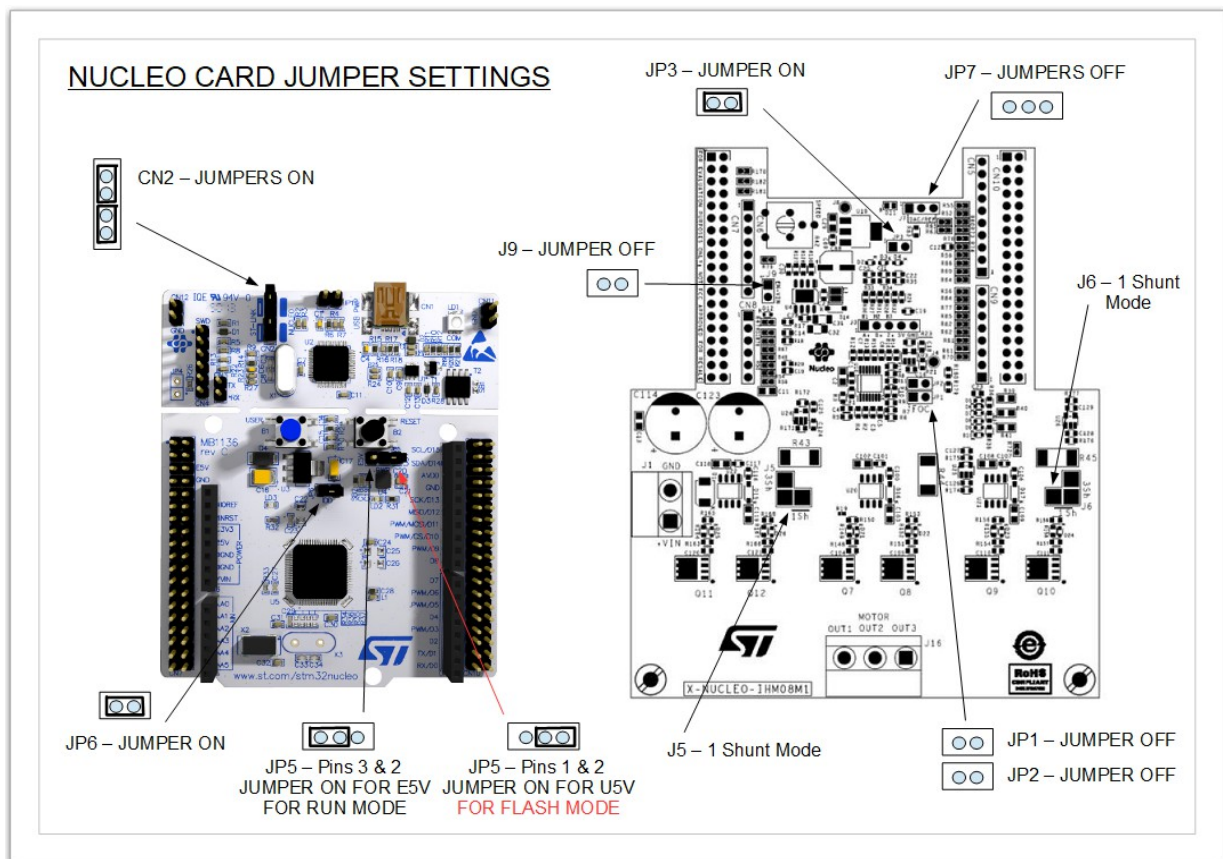


Figure 3 NUCLEO Card Jumper Settings

#### 4. REPEAT Steps 2 & 3 For Each Axis

Repeat steps 2 & 3 to prepare additional cards for each additional CL axis.

Each Control Loader axis (elevator, aileron and rudder) requires its own NUCLEO-F446RE + IHM08M1 drive card pair (the IHM08M1 motor driver board drives a single 3 phase motor and is therefore a single axis drive).

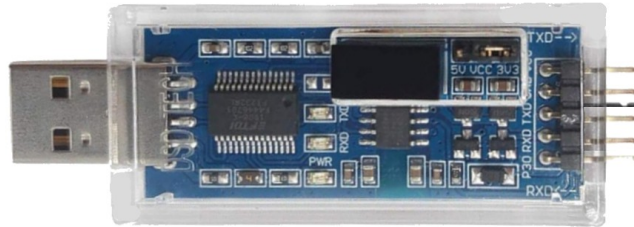
#### 5. Install USB/UART Isolated Converters

Each drive axis card pair requires its own serial COM port.

It is strongly recommended that a USB/UART isolator device is used to provide the serial comms. This will ensure that the drive cards are fully electrically isolated from the PC's USB system and so minimise the risk of damage to the PC in the event of a drive card failure or other electrical issue.

The serial comms is non-inverted RS232 running at 3.3V, the BAUD is 500000. So your UART device must be compatible with these requirements.

The [DSD TECH SH-U09C3 Isolated USB/UART converter](#) is suggested. It is an FTDI chipset based device. It is provided in a transparent case with activity indicator LED's, selectable 3.3V operation and comes with 0.1" straight connector cable tails which can be used to connect directly to the IHM08M1 connectors.



Once installed on USB check Device Manager for the COM Port numbers of each device. These MUST be in the range COM1 to COM9 in order for the CL software to access them. The COM port numbers must be set in the CL software.

To do this manually edit the Configuration Manager\Motor Settings\STM.ini text file and enter the COM Port numbers in the [Comms] section...

```
[COMMS]
```

```
COMPort1=COM6
```

```
COMPort2=COM5
```

```
COMPort3=.etc.
```

```
COMPort4=NONE
```

```
Baud=500000
```

The settings can also be made using the CL Controller App – Update\_Motor\_Settings button.

NOTE that the port order is not significant – the software will interrogate each COM Port listed to determine if an active drive card is present and then which CL axis the card is for.

The USB/UART converters can now be wired to the IHM08M1 driver cards as shown in Figure 4 below.

Take particular care to connect the serial lines to the correct pins on the CN7 & CN10 headers. For details of the header pin numbering refer to the IHM08M1 user documentation provided by STM.

## 6. 3 Phase Motor and Power Supply Wiring

Refer to Figure 4 for wiring details.

Wire the 3 motor phases to connector J16 on the IHM08M1. Use a wire gauge consistent with the motor current draw – AWG14 or 12 is suggested.

Note the phase wire ordering is not significant – the power-up calibration process will determine the correct drive commutation for the motor.

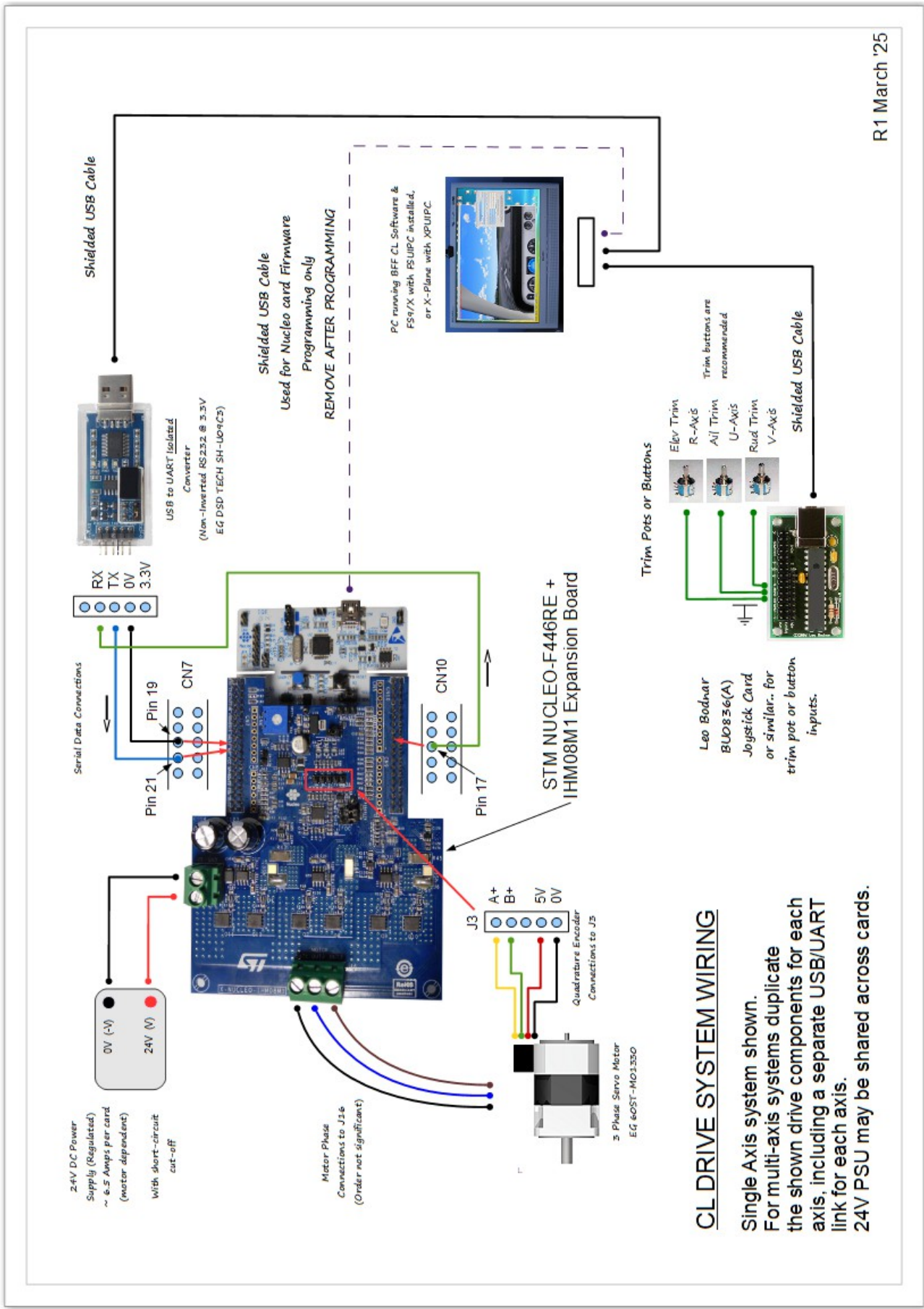


Figure 4 - CL Drive Wiring

Wire the 24V DC PSU to J1 on the IHM08M1. Again use a suitable cable gauge. Keep the PSU wiring as short as possible.

Use a PSU with automatic over-current and short-circuit cut-off – this will avoid the need for mechanical fuses in the supply line to the cards.

Connect the motor quadrature encoder to J3 on the IHM08M1. J3 is a 0.1" 5 pin straight header – so you will need to make up appropriate connectors. Shielded small signal data cable should be used for the encoder lines.

Note the order of the A & B connections is not significant as the power-up calibration process will determine correct count and drive directions.

## 7. USB Game-controller Card

Note, as shown in Figure 4 the CL software requires available game-controller buttons/pots for trim functions and various load engage/disengage functions. So a USB game-controller card or similar should be installed on the system.

## 8. Control Loader Axis and Power-up Calibration settings.

Figure 5 shows the CL system axis (channel) and power-up calibration (APUC) selection

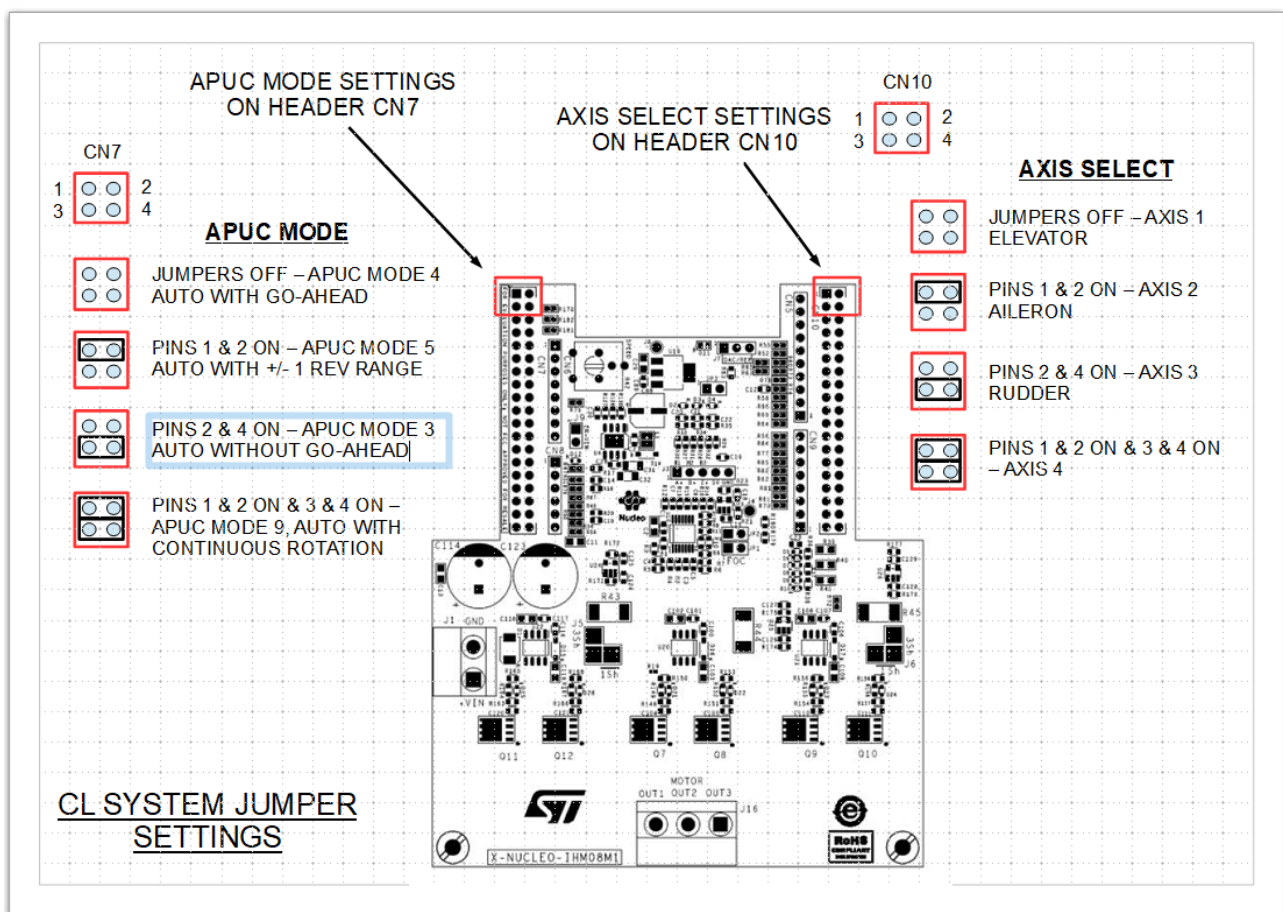


Figure 5 CL Axis and Power-up Calibration Settings

jumpers.

## AXIS SETTINGS

The CL axis setting (ie 1, 2, or 3 for elevator, aileron and rudder) is made by jumpers on pins 1-4 on IHM08M1 header CN10 as shown.

The default is axis 1 – elevator (no jumpers).

In multi-axis systems the axis settings tell the CL software which loading data to send to which drive cards and which encoder position feed to use for which control axis in the flight sim.

## APUC SETTINGS

The automatic power-up calibration mode setting is made by jumpers on pins 1-4 on IHM08M1 header CN7 as shown.

Power-up Calibration is carried out each time the cards are powered-up or reset.

**The default APUC mode is 4** – Automatic Movements with Go-Ahead. This is the normal operational mode and should be used with completed flight control mechanical builds.

In this mode the drive card will drive the motor over the full working range of the flight controls when the go-ahead is provided via the CL Software. This establishes the correct motor commutation and movement parameters for the drive. The automatic movements are used to determine motor electrical zero position, motor and encoder +ve drive directions, working travel range and flight control mid-position etc.

**APUC Mode 3** – [Firmware R100:25 or later] Automatic Movements without Go-Ahead. Power-up calibration movements commence immediately after card power-up. The APUC settings from the last successful APUC Mode 4 power-up are used in this mode. This therefore requires that the card must previously have been powered-up under mode 4 before mode 3 can become active.

The remaining APUC mode options are for test purposes and may be used with motors separate from their mechanical assembly and which are free to rotate. These modes are typically used with the CL Controller app to test motor wiring and operation etc.

They are:

**APUC Mode 5** – automatic with 1 shaft revolution working range (centred at shaft zero electrical position closest to start point).

**APUC Mode 9** – automatic with continuous shaft rotation (no spring force response available).

**NOW REMOVED** - APUC Mode 10 – automatic with 2 shaft revolution working range (centred at shaft zero electrical position closest to start point).

## 9. Software Setup for Initial System Testing

Initial system testing should be carried out using the **CL Controller** test application. This app is included in the main CL software download zip, it is in the "CL Controller" subfolder.

Before drive testing can be undertaken the correct Motor Settings must be made for the 3 phase motors used in your build. Do this using the Update\_Motor\_Settings button on the CL Controller.

The default settings are for the 60ST-M01330 servo motor (2500 encoder PPR, 80% Voltage Scaler). If you are using different motors then the settings may need to be changed.

To do so:

1. Power-down the drive cards.
2. Run the CL Controller – ignore the "no cards found" pop-up message.
3. Click the Update\_Motor\_Settings button.
4. Click the Load from File button.
5. Navigate to the "PreSets" folder and select the ini file for the motor type you are using and select and open it. The settings will be loaded into the CL Controller.
6. Check the settings, especially the encoder PPR and Voltage Scaler settings. Then click Make\_Active.  
This will save the settings to the master STM.ini file and will use them in the serial data packets sent to the drive cards. They will be used by the CL Controller and the main CL Software until they are further changed.
7. QUIT the settings window. Close the App.

Now power-up the cards and restart the CL Controller – the app can now be used to check the drive function.

**NOTE:** The BLACK user button on the NUCLEO-F446RE can also be used to re-set the cards and so cause new settings to be adopted.

Use the CL Controller App to check the operation of each card / FFB axis individually.

I suggest first loading should be with a modest "Constant Force" loading – say 50 (out of a max 255). This should produce a light but significant steady load on the axis and will drive it towards an end stop.

Check each axis for smoothness of force feel and monitor the temperatures of the driver cards for signs of overheating. If they are operating in a high ambient temperature or are loaded at high levels for periods of several minutes there may be a risk of overheating. In these circumstances it is recommended that additional forced air (fan) cooling is provided for the cards.

Test initially with light loads and then increase the loading by steps to check the integrity of the electrical and mechanical systems.

## 10. Normal Operation

In normal operation the main CL Software is used.

Further details of the software are available here -

<https://bffsimulation.com/Manual-CL-USB/Introduction.php>

Settings for the CL Software are made using the Configuration Manager Application. So run this first before using the CL software.

The Config Mngr is used to configure both hardware and flight sim integration, to set loading characteristics for each axis and Auto Pilot and trim system behaviours.

If you are migrating from an existing BFF CL setup you can use the IMPORT button to import your previous configuration settings to the new software.

Typical steps for normal system operation are:

1. Start Flight Simulator, load a flight and place the aircraft in the required situation.
2. Check all FS internal trims are initially centred (done automatically by the CL software for FSX/P3D & X-Plane but not FS9).
3. Power-up the STMicro drive cards. (If APUC mode 3 is selected, the cards will immediately proceed to their power-up calibration movements if a prior successful mode 4 calibration has already taken place.)
4. Start the CL Software and select the required configuration file.
5. If required give APUC go-ahead and allow the automatic power-up calibration to complete.
6. Engage the control loading by clicking the ENGAGE button on the CL software window or pressing any programmed joystick ENGAGE hot-button (Tab 6 Item 8).
7. To release the control loading click RELEASE on the software window or press your RELEASE joystick hot-button.

Many loading settings can be adjusted whilst the system is active, to allow adjustments to be made to the force feel.

To do this start the **Configuration Manager** and load the working configuration file. Make any settings changes you require and then click **MAKE\_ACTIVE** – this will save the changes and instruct the **CL Software** to load the new settings. The CL software will **RELEASE** loading when it does this, so you will need to re-engage the loading. It is wise however to check the force level output in the progress bars before re-engaging the loading.

Data and error logging is provided in the files in the Logs sub-folder. Log files BFF\_CL.log and BFF\_Pry.log are of most use and should be consulted for error messages in the event of disruption of system operation.

The PING button on the CL software GUI is used to request status data of the cards, this data is written to the BFF\_PRY.log file. If a card error occurs (regular flashing of the RED LED on the IHM08M1 cards at 1 Hz) then use the PING button to read the card status

before powering-down the card and then inspect the BFF\_PRY.log file for details.

Card error status can also be inspected by clicking the **Cards** button on the GUI – if an error is present the latched/non-latched error LEDs will be active and an error text message displayed.

## 11. Unlocking the Drive Cards (to remove the 120 minute demo flight time limit.)

For card firmware R100:25 Beta or later.

The 120 minute demo time limit can be removed. This is done using the REGI button on the CL Controller software (V2.42 or later).

Follow the guidance in the REGI window...

Step 1. Check the unique ID's of the powered drive cards are available using the Check\_Status button.

Step 2. Save the card ID's to the Card\_Registration.ini file using the Log\_Card\_IDs button. The file is automatically saved in the CL Controller folder.

Email this ini file to the email address shown with a request for unlock keys.

Then, once you have received back your unlock keys...

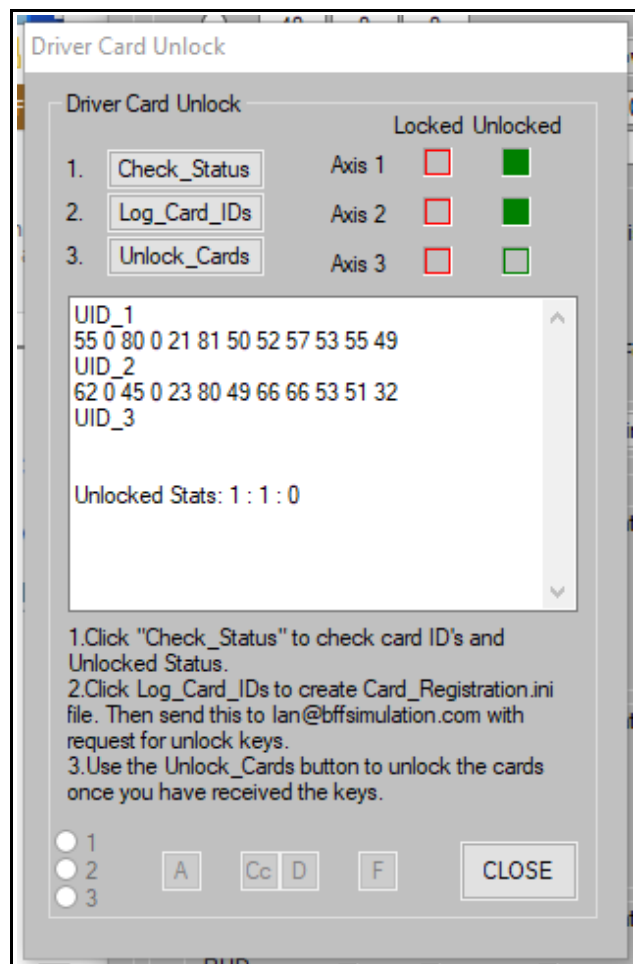
Step 3. Unlock the cards using the Unlock\_Cards button.

The unlock keys will be read from file and, if they are a correct match for the active card ID's they will be sent to the drive cards to unlock them.

If successful the card status will change to unlocked (green) and the demo time will be removed.

The unlock is permanent on a card unless the flash memory of the drive card is fully erased.

Have fun!



## Updates

October 25 – Revision 0.4 (Added APUC mode 3 text, added Section 11 on card unlock.)

June 25 - Revision 0.3 (added note on APUC working range requirements)