Project Overview - Force Feedback Flight Controls (CL_SPU_USB & BLDRV3 Drivers)

SUCCESSFUL OPERATION OF THE BFF CL SYSTEM DEPENDS ON CORRECT MANUFACTURE, ASSEMBLY, INSTALLATION AND SETUP WORK BY THE BUILDER. IF YOU ARE NOT SATISFIED THAT YOU HAVE THE TECHNICAL SKILLS REQUIRED TO DO THIS WORK THEN PLEASE DO NOT ATTEMPT THIS PROJECT.

The BFF CL system is NOT a Plug 'n Play system. It is very important that you read ALL the documents and study the ALL the plans before starting the project.

If you just buy the cards, apply electrical power and fiddlle with the software there is a good chance that all you will succeed in doing is blowing up your expensive hardware.

You will need to undertake and complete the following overall steps:

1. **Transmission Mechanism Design**

   If you are NOT using the mechnical plans available on the web site then you must first design the mechanics of your yoke, column or rudder controls. This is NOT a trivial step, and it needs to be done correctly. Your controls must incorporate the correct transmission (gearing) ratios to connect the FFB motors to the control wheel/stick/peddles. And the mechanisms must be designed to be smooth and friction free. They must be completely free of play (backlash) and must be stiff enough to carry the considerable system loads induced by the motors WITHOUT undue deflection or stressing.

   Poor mechanism performance can NOT be corrected by the CL software.
2. Build the control mechanics carefully and accurately to the designs, including fitting the electric motors and transmissions.
3. Fit and electrically wire the FFB driver/controller cards.
4. Prepare the power supply for the driver cards. READ THE DATASHEET COMMENTS ON THE POWER SUPPLY.
5. Install the CL_SPU_USB card (as USB HID device) and the BFF CL Software V2.
6. Test the individual FFB channels using the BFF Driver Test application. This is IMPORTANT, damage to the equipment can be done if a step by step approach to the system set up is not taken.
7. Set up and calibrate the joystick card to be used for trim inputs. (This document assumes the CL system will provide the position input for the control axes to FS.)
8. Run with the full BFF CL Software and flight sim active to test the FFB in flight and to tune the force settings to your requirements using the Configuration Manager.
9. From here on only the BFF CL Software is used to run the system in its normal operational mode. On each system power up a simple movement calibration procedure is undertaken, following which the system is ready for use.

PLEASE FOLLOW CAREFULLY THE STEPS DETAILED BELOW.

Detailed Commissioning Steps

1. Make and assemble the mechanics of the flight controls (with brushless motors fitted). Ensure that the movement of the control axes is smooth and friction free – sticky and/or rough mechanical performance CAN NOT be improved by the CL control system! Make sure your mechanisms are completely free of play (backlash) and are stiff enough to carry the considerable system loads induced by the motors WITHOUT undue deflection or stressing.

2. FAMILIARISE yourself with the BLDRV3 data sheet! It contains important information.

   http://bffsimulation.com/BLDRV3/CL_SPU_USB_and_BLDRV3_Data_Sheet.pdf

LOCATE THE DRIVER CARDS

3. Mount the BLDRV3 cards in a location close to the control mechanism (within range of the motor and encoder cables). Ideally the card LED's should also be visible from the pilot's seated position as they will indicate the initialisation and running status of the CL system. The driver cards should NOT be enclosed in an uncooled enclosure – they require a free flow of air over the heat sinks for effective cooling (see the card data sheet for more information on card cooling, and see item 7 below). If they are to be enclosed forced (fan) air cooling should be fitted to the enclosure.

   However the card position should be out of reach during normal flight operations – to prevent physical contact by personnel whilst the cards are in operation. The card heat sinks may become hot to the touch.

4. If you intend to operate the FFB system under sustained loaded conditions – eg for flying with simulated systems failures which require large control forces to be sustained, then force air cooling MUST be used. Fit PC case or similar fans over the BLDRV3 card heat sinks. In these circumstances the operating temperature of the drive motors must also be carefully monitored – motors are less effectively cooled by external airflow.

POWER SUPPLY

5. Set up and position the power supply and wiring to the BLDRV3 cards. See the card data sheet for important information about the choice of card power supply. THE USE OF AN UNSUITABLE POWER SUPPLY CAN DAMAGE THE DRIVER CARDS OR PRODUCE POOR FORCE FEEL.

   A visually prominent and accessible power cut-off switch should be located close to the pilot/operator’s seating position to enable rapid power-down of the CL system should the need arise.

   However DO NOT connect power to the driver cards at this stage.

Note the cable type recommendations on the wiring diagram here.

DRIVER CARD WIRING

6. Wire the BLDRV3 cards to the drive motors (phases, hall sensor and encoder).

   Refer to the appropriate wiring diagram for your motor type.

   http://bffsimulation.com/BLDRV3/BLDRV3_Wiring_60ST_80ST.pdf

   Make sure all connections are secure – faulty logic connections to the hall sensor and encoder will disrupt the system operation. The motor and encoder connections are located at the heat sink end of the driver cards.

7. Set the correct address for each card (JMP-1). Elevator is address 1, Aileron is address 2, Rudder address is 3.

   Note the cable type recommendations on the wiring diagram here.

   Set the Pilot/Co-Pilot station jumper on the CL_SPU_USB. If only one station is present the jumper MUST be set to “Pilot.”

CL SOFTWARE INSTALLATION

8. Download and Install the BFF CL Software V2.

   Check out the Configuration Manager folder – the Configuration Manager app will be used first – to set up the COM port and other hardware settings.

9. The CL_SPU_USB card will appear as a USB HID Device and does not need specialised drivers. It should be recognised and installed as an HID device automatically when you plug it into your PC.

   When plugging the CL_SPU_USB card into USB for the first time monitor the PC to ensure the OS recognises the device and installs it.

DRIVER CARD TESTING

10. FAMILIARISE yourself with the BFF Driver Test Application (USB) user guide. It contains important useful information. It is in the Documents sub-folder of your CL Software V2 folder.

11. You can use the Configuration Manager Tab 9 Item 5 – Test_App button to start the Driver Test Application.

    However this can also be done easily from the Driver Test App folder – double click the Test App .exe.

12. Ensure the 24V DC power supply voltage is within range AND THE POLARITY IS CORRECT for the connection to the BLDRV3 cards.

    Note: the default power-up calibration mode for the cards is Mode=4 Automatic Power Up Calibration (APUC) with Go-ahead.

    In this mode the cards will wait for your go-ahead (via the Test App or main CL software) then drive the motors in an automatic sequence of movements to establish motor phase timing and working range. The APUC mode requires that the motor working range is limited by hardstops – so the motors MUST be installed in the flight controls for this APUC mode to work.

    Connect power to the cards - monitor the cards for correct LED operation (if the Test App software is running and the USB comms are good the card LEDs will flash their initialisation sequence, then the Yellow LED on the CL_SPU_USB should flash rapidly and the Yellow LEDs on the BLDRV3 cards will flicker rapidly until the user gives go-ahead for the APUC movements and calibration of each axis is completed).

    The Driver Test App will detect the status of the cards and prompt the user to give Go-ahead for the automatic calibration movements.

    Other power-up calibration modes are available including manual calibration which involves manually moving the control axis back and forward at a steady pace **end stop to end stop** until the Yellow LEDs go out on the cards.

    Read the APUC Mode documentation for more details.

13. Use the BFF Driver Test Application to check the operation of each card / FFB axis individually. Note the power-up calibration procedures and LED sequences described above.

    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 towrds 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 is a danger of overheating and damage – in these circumstances it is strongly 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.

    NOTE: For manual power-up calibration - if calibration completes and gives smooth response, but on the application of a "constant force" test loading the control axis feels "coggy" then power down the system and reverse the encoder A & B channel connections to the driver card concerned. Repeat the power-up sequence and calibration and re-check the force feel under the constant force condition.....

14. Power down the cards.

JOYSTICK CARD SETUP FOR TRIM

15. Set up and connect the trim input potentiometers or buttons to a USB joystick card.

    Remember to calibrate the joystick card as a Game controller in Windows.

    Once you have set up your pots or buttons go to the Configuration Manager Tab 6 Item 7 and set the joystick card as the Primary Joystick. Use the Sel_Joy button to do this.

    Go to Tab 7 and set Items 1, 2 & 3 to specify pot or button input for each axis. Then set the pot or button inputs below as required.

    SAVE your settings....

USING USB JOYSTICK CARD INPUTS FOR POSITION

16. In the default “pot-less” operating mode the CL system will feed control axis positions to the flight sim based on the drive motor encoder data.

    If you wish instead to use your own joystick card pots to control axis position in the flight sim then go to the Configuration Manager Tab 5 and select check-box Item 2, click Apply and then SAVE.

    This will stop the CL software position feed to the flight sim. You will then need to assign your own position inputs in FS/X-Plane as normal.

NEARLY THERE

17. You can now run the main BFF Control Loader software V2 with the saved configuration file and commence to tune the settings for your system.

    Note that the flight sim can be placed in a particular flight situation and then paused to maintain specific flight conditions for loading; for example pausing during straight and level flight at a slow speed will allow the main control centering force behaviour to be checked at low force levels. Pausing the flight during takeoff whilst on the runway will allow runway vibrations to be checked etc

    Please refer to the CL software on-line user guide for information on system tuning -

    http://bffsimulation.com/Manual-CL/Introduction.php

Normal System Operation

For normal operation of the BFF CL system use the **BFF CL Software**. Further details of the software are available online – see

http://bffsimulation.com/Manual-CL/Introduction.php .

Please review this user documentation fully before using the system.

Typical steps for normal system operation are:

1. Start Flight Simulator, load a flight and place the aircraft in the required situation. Check all FS internal trims are initially centred (done automatically by the CL software for FSX/P3D & X-Plane but not FS9).

2. Start the BFF CL Software and select the required configuration file.

3. Power-up the BLDRV3 cards.

4. Allow the automatic power-up calibration to complete.

5. Engage the control loading by clicking the ENGAGE button on the BFF CL software window or pressing any programmed joystick ENGAGE hot-button (Tab 6 Item 8).

6. To release the control loading click RELEASE on the software window or press your RELEASE joystick hot-button.

Many loading settings can be adjusted whist 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 **BFF 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 both green and yellow LEDs on the CL_SPU_USB 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.

NOTE the log files are over-written each time the CL software is started.

V0.1 September 2018

Ian Hopper (BFF Design Ltd)