

# NOTES – BFF CL System – Brushless Wiring & Configuration (with joystick card potentiometer position reporting).

## A) IMPORTANT – POWER SUPPLY PROVISION

The BLDRV-12/24 cards will operate on either 12V or 24V power supplies (see data sheet for details of settings). It is strongly recommended that Lead-Acid batteries are used for DIY systems; these will provide a very smooth current source and will be able to sink any current that is returned from the drivers. If a PSU is to be used it MUST be a smooth, voltage regulated supply capable of sustaining the supply voltage at the demanded current draws – variation of the supply voltage out with the data sheet requirements will damage the cards, and any electrical noise on the supply will be felt as roughness in the force feedback at the controls.

A suggested PSU is **Mean Well S-350-24**. This is a 24V 14.6 Amp power supply suitable for 2 motor systems – the current supply is a bit low for 3 cards at rated output.

See - <http://www.meanwell.com/search/s-350/s-350-spec.pdf>

### DO NOT IGNORE THE ABOVE POWER SUPPLY REQUIREMENTS.

1. BFF Control Loader software and FS9/X with FSUIPC installed. The PC should be set to run the CL Software at or around 50Hz. The CL software can be moved to a LAN PC if the software is starved of CPU resource when it tries to run alongside FS9/X – however it is recommended that the software is run on the same PC as the sim if possible. The brushless BLDRV-12/24 drivers are programmed to do much of the force calculation on the card – this allows the CL software to run with less CPU resource than when setup for use with DC drives.

The CL software will also operate with X-Plane V9.6+. XPUIPC needs to be installed – see CL Software user guide.

2. Three BLDRV-12/24 brushless motor drivers are used – one for each control axis. Each is addressed using jumper settings on the cards. The BLDRV-12/24 brushless motor drivers receive serial input via the AXE029 download cable at approx 500kbaud, the baud rate is set in the .cfg configuration file.

The single serial data connection is shared by the brushless drivers – however also see note 3 regarding dual serial cables.

The drivers process force demands from the PC software at a rate of approx 50Hz and the CL software should be set to export at this rate, the BLDRVR-12/24 internal force calculations are done at 500Hz. The data export frequency of the CL software is adjusted by altering the loop pause time in the Pry\_S.cfg file. Force demands will be held if the BLDRV-12/24's detect loss of serial data comms from the PC.

3. The BLDR-12/24 drivers are daisy chained on the same serial lines. This allows operation from a single COM port on the PC. On-board terminal CN3-1 provides access to the serial lines for wiring. Each is addressed using jumper JMP-1 settings on the cards – 1 is for Elevator, 2 is Aileron and 3 is Rudder.

Daisy chained cards must be located close to each other in order to keep the length of the daisy chain wiring short (typically less than 200mm). Use shielded low voltage signal cable (eg USB or similar) for the serial data daisy chain wiring.

Dual PICAXE download cables can be used to allow one card to be located away from the others, or to improve serial comms with the cards in some circumstances. In this case the daisy chain extends only to the two cards on the same PICAXE cable; the remaining card is alone connected to the other cable. This option is enabled using the Line 68: Cable Channel Allocation setting in the background settings area of the CL Setup application and the specification of the 2<sup>nd</sup> COM port in your CL .cfg file.

4. Wiring details are shown for the Aileron drive only – the Elevator and Rudder wiring is the same to their respective drivers. All the drivers can be supplied from the same 12/24V DC power source so long as it has adequate current capacity. A pair of 38Ah lead-acid rechargeable batteries makes a good DC source capable of high current output and capable of sinking current when required.

PLEASE NOTE the grounding requirements for the cards described in the driver card data sheet section 3.D.

The driver to motor wiring connects the 3 power phases, the quadrature encoder and one hall-effect position sensor to the driver. The hall sensor input is used to calibrate the absolute position for the quadrature encoder. The quadrature encoder provides the continuous motor shaft position feedback required for the motor commutation.

5. Bodnar BU083(A) 10 or 12bit joystick card. 10 or 12bit resolution recommended for future compatibility with pilot/co-pilot motion following features. Other joystick cards can be used, however do not use poor (8bit) resolution cards.

Note the joystick axis mappings to the control axes – Aileron – X, Elevator – Y, Rudder – Z, Elev Trim – R, Aileron Trim – U, Rudder Trim – V. Do not enable these trim axis assignments in FS9/X and do not use the FS9/X internal trim adjustments otherwise the sim and CL flight controls zero positions will not match.

Trim pots on a separate joystick card can be used – settings are made in the Pry\_S.cfg file. The joystick number and the axes letters to be used need to be specified.

It is also possible to use trim up/down buttons as an alternative to pots. Again settings are made for this in the Pry\_S.cfg file. The joystick number and the numbers of 6 up/down trim buttons (3 pairs of 2) on the joystick require to be specified. The rate at which the trim moves when a trim button is depressed can also be set.

NOTE the BFF Driver Test application can be used to examine and identify the active output axes from your joystick card.

6. Precision potentiometers must be used for the control axis position reporting. They should be mechanically geared to ensure that as much of their electrical working range is employed as possible – this helps to maximise the resolution of the position reporting. The pots should be **electrically isolated** from the drive motors to

prevent noise propagating to the position signals. The pots must be connected to the BU083(A) card using shielded (screened) cable and the cable shields should be grounded to 0V on the BU083(A) card. This will help to minimise the effects of RF radiation from the motors on the signal resolution.

7. The CL software implements trim forces separately from the FS9/X internal trim system. Three trim posts are required – connected as shown to the joystick board, or alternatively six (6) up/down trim buttons (2 for each control axis) can be used. See item 5 above for more details.

NOTE: if more analogue outputs are connected on the BU083(A) card the physical location of the trim channels on the card may move. If you think this has happened the BFF Driver Test application can be used to examine and identify the active output axes from your joystick card.

8. Force feedback motors. Brushless DC motors with near sinusoidal back EMF characteristics of the type specified. Not all low cost BLDC motors will operate satisfactorily in a CL system – even with the BLDRV-12/24 drivers. Many have trapezoidal back-emf characteristics and can not generate smooth enough torque output.

Ground the motor cases and connecting structure and power cable shielding to minimise electrical noise transmission effects. The case grounding should be direct to the power supply 0V connection and NOT via the ground connections on the BLDRV-12/24 cards.

The motors should have 360cpr quadrature encoders fitted.

The mechanical design of the motor to control drive is another critical area for the overall system performance, as is the mechanical connection of the position pots to the controls. Transmissions must be stiff and precise with low levels of friction and as little backlash as is possible.

9. The Elevator and Rudder axis wiring is the same as is shown for the Aileron. All three drivers can share the same power supply if it has adequate current capacity. PLEASE NOTE the grounding requirements for the cards described in the data sheet section 3.D.
10. To maintain smooth performance the BFF CL software needs to export the force demands to the BLDRV-12/24's at high baud rates. The default baud is 516129 to match the baud of the BLDRV-12/24 default programming. This is a non-standard baud but it is supported by FTDI chip based USB/Serial cables and so also the PICAXE AXE027 cable. To obtain best results at this baud the "Latency Timer" setting in the advanced options for the virtual com port associated with your cable should be reduced from 16 to 1 ms. Do this through the control panel – device manager on the PC.