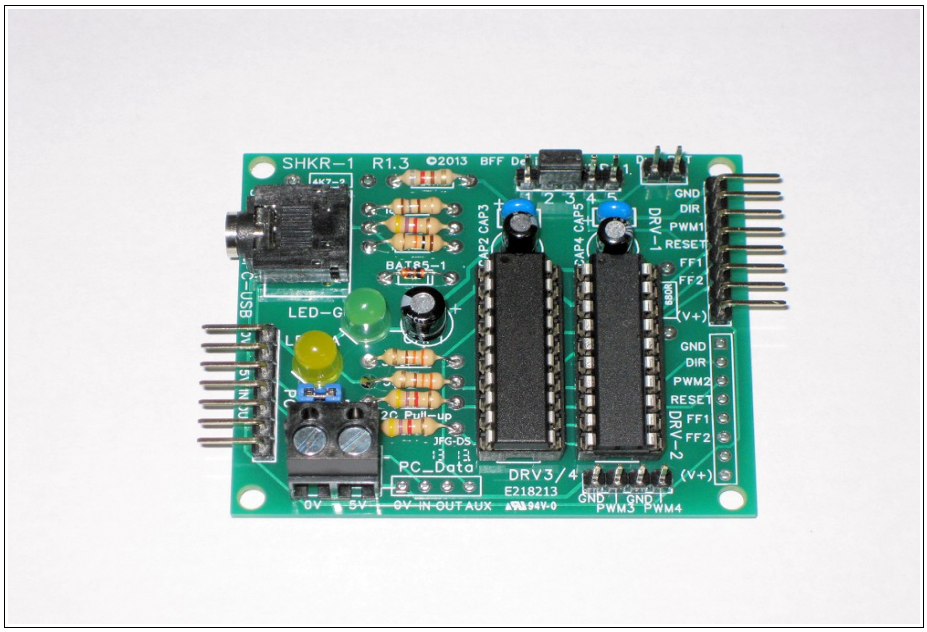
BFF Design Ltd – SHKR-1 Shaker Card Data Sheet



1. Introduction

The BFF SHKR-1 card is used with the BFF Shaker software and separate DC motor drive hardware to provide vibration/rumble for flight simulation cockpits. It is a data processing card which accepts vibration demand signals as serial data from the PC software, and outputs PWM voltage signals compatible with Pololu Motor Drivers to drive low voltage DC PM motors. The oscillation of the DC PM motor rotor generates mechanical vibrations which are transferred into the cockpit structure onto which the motor is mounted. The effectiveness of the vibration transfer depends on proper mounting of the motor on the structure.

The voltage and current rating of the Pololu motor driver(s) used determine the size of the DC motor(s) that can be driven by the system.

The SHKR-1 card simulates vibrations as mixes of square waves. The frequency range of the wave components output by the card is approximately 10 to 150Hz. The BFF Shaker software controls the amplitude and frequencies of the wave mixes according to user configuration settings and live flight data extracted from FS9/X or X-Plane flight simulator – so the vibration feel and level changes with the changing simulated flight conditions.

Vibration effects generated by the system include engine and runway vibrations, landing gear transition and buffeting effects, flap and spoiler buffeting, engine start/stop shudders etc... For a fuller description of the effects please see the BFF Shaker software web pages.

This data sheet describes setup and operation of the SHKR-1 card.

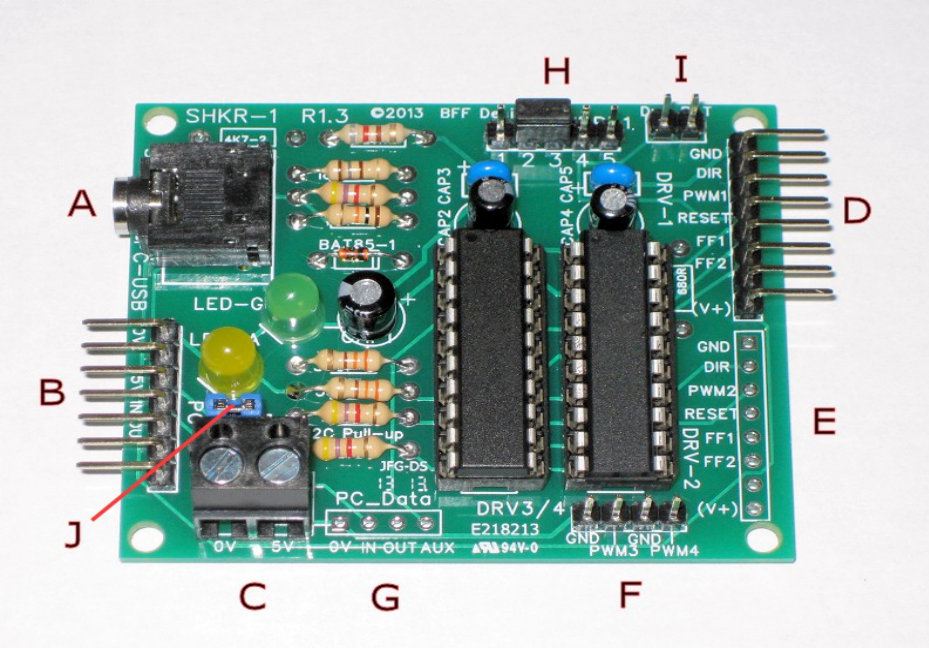
2. Connections and Settings

Refer to the lettered photo overleaf-

A) Data input from PC (marked SKT1 on the PCB) – stereo jack socket suitable for PICAXE AXE027 download cable.

B) Alternative right angled 0.1” 7 pin header (PC) – alternative data and power input connector suitable for 7 pin **FTDI chipset based** USB-TTL cables such as Tronix Model TRX1400. The serial data in/out and 5V/0V pins are marked on the PCB– **PLEASE check the pin compatibility with your cable BEFORE using**. The serial data should be 5V level, idle low (inverted RS232). FTDI chipset USB cables can be configured using the FTDI FT_Prog utility to invert the TXD and RXD lines if necessary (see the FTDI web site).

   Voltage supplied by the cable should be DC 5V regulated with a minimum capacity of approx 50mA. If power is supplied by this connection it is recommended that the USB cable is connected via a powered USB hub.



The baud rate used by the card is 516129, this is a non-standard baud which is supported by FTDI cables – other USB-TTL converter chipsets may not be suitable.

C) Logic voltage input (CN2-1). When jack socket A (SKT1) is in use for data input a separate **regulated** 5V logic supply is needed for the card. The card will draw typically 25 to30 mA in normal use so please ensure the voltage supply has sufficient current capacity. This power connector is NOT polarity protected – ensure your supply polarity is correct before connecting it to the card.

D) Motor driver PWM output 1 (DRV-1). This is an 8 pin 0.1" header for connection to Pololu 8 pin High Power Motor Drivers (the narrow NON-CS ones) such as the 36v15 or 24v12. The main signal output is on the DIR and PWM1 pins. DIR carries the high/low direction signal, PWM1 carries the 16KHz PWM magnitude signal. Pins FF1 & FF2 report the driver error status to the SHKR-1 card (when error reporting is enabled in the BFF Shaker software). Pin RESET can be used in conjunction with jumper I (Drv_RST) to manually pull the motor driver into its reset mode.

By default DRV-1 is fitted with a right angled male header, DRV-2 is left without a header to allow the user to fit their own. A single right angled female header is included with the card which can be fitted to the Pololu driver to allow it to be connected directly to the SHKR-1 card. Options are available for the 8 pin header configuration. These are straight or right angled, male or female headers – if you have a specific requirement contact me at the time of ordering.

E) Motor driver PWM output 2 (DRV-2). This provides an output which is a duplicate of DRV-1. It can be used to drive a second driver and motor with the same vibration signal for location at a different position in the cockpit.

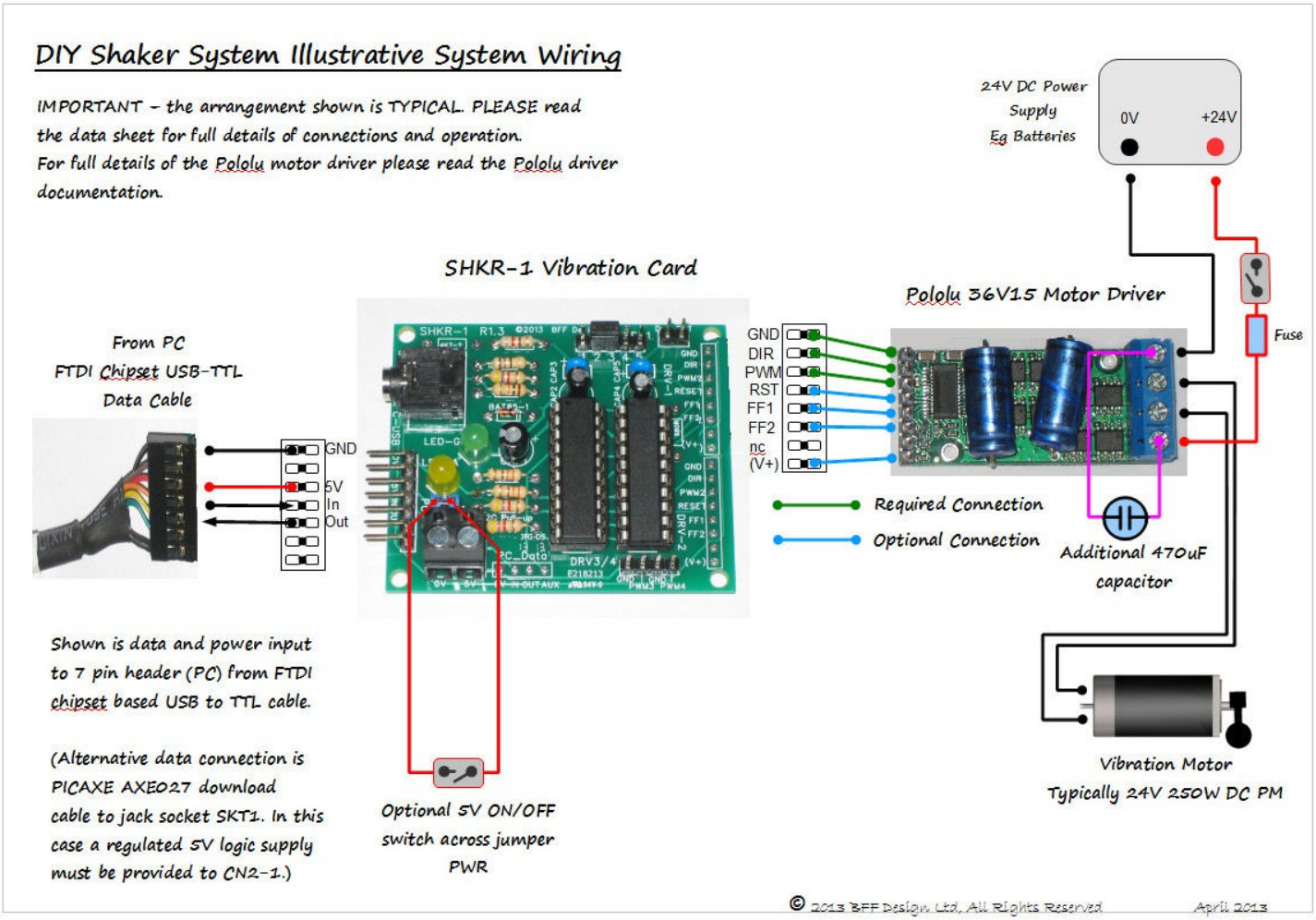
F) DRV3/4 – 4 pin header with 2 x additional PWM unipolar outputs at 16KHz. These outputs are 0 – 50% - 100% duty cycle range for min – zero – max vibration amplitude. DO NOT connect directly to low impedance devices as the resulting current draw may damage the card. If in doubt connect via a 360 Ohm resistor in series to limit current demand on the control chips.

G) PC_Data – location for optional 4 pin header .

H) Jumper JMP-1 – to set operating or programming mode. Pins 2 & 3 connected for normal operation. Pins 1 & 2 and 4 & 5 connected to put the card into PICAXE programming mode. In this mode the 20 pin PICAXE 20X2 chip socket closest to the LED's becomes a programming socket and can be used to re-flash the 20X2 chips.

I) Jumper Drv_RST – close to pull the Pololu drivers into reset mode. Normally OPEN.

J) Jumper PWR – the 5V input from the PC 7 pin header (item B above) is routed through this jumper – CLOSE to enable 5V power input from the 7 pin data/power in connecter. This can be used to wire a separate power ON/OFF switch for the card for use when the logic power is supplied by the USB cable.



ILLUSTRATIVE system arrangement – Tronix 1400 cable input and single Pololu driver

3. Typical System Configuration

The Pololu motor driver power supply and DC motor connections are the higher voltage and current part of the system. The SHKR card itself operates at 5V logic level voltages and currents in the mA range. DO NOT allow your driver / motor power supply to directly contact the SHKR-1 card at any time.

For wiring details and recommendations for the Pololu motor drivers and the DC motors please see your Pololu motor driver documentation. Appropriate fuse and cable sizes will depend on your chosen driver, motor size (current flow) and vibration demand settings.

Please pay particular attention to advice in the Pololu documentation on wiring, heating and fitting of additional capacitors across the driver supply terminals.

In my trials of the system I have used a 24V 38 AmpH Lead_Acid battery power supply with 24V 250W DC PM electric scooter motors. The drivers I have used are the 24V12 and the 36V15. The 24V12 heats more than the 36V15 under normal operation, but in both cases the drivers, motors (and cables) can become hot when the vibration demand rises to and is held at higher levels.

It is recommended that the larger current rated driver is used where possible and that additional capacitors are fitted near the driver across the power input connections. The Pololu drivers are supplied with 100uF capacitors – I have fitted an additional 470uF capacitor to assist control of heating. DO NOT IGNORE THIS.

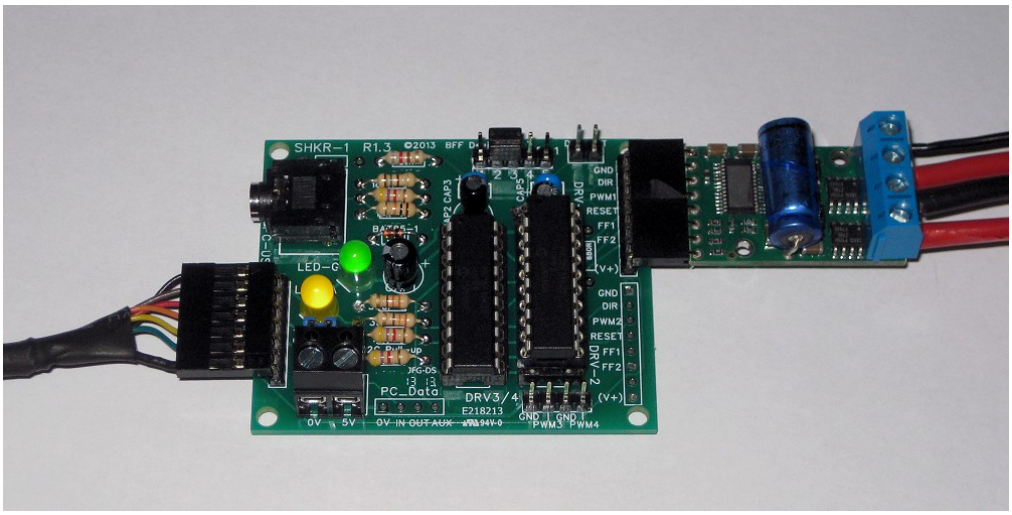
Depending on your motor choice and your vibration output settings the heating in the driver system will vary – careful monitoring of this is ESSENTIAL when you first setup and operate your system. In some cases additional heat-sinking and/or air-cooling of the driver may be required to prevent damage to the driver. Motor and cable temperature should also be carefully monitored.

The SHKR-1 card will monitor the FF1 and FF2 error condition pins on an attached motor driver when this option is enabled in the BFF Shaker PC software. The driver provides a weak indication of overheat conditions and the SHKR-1 card will release the vibration demand and report the error to the PC software if this error occurs. However please note

the comments on over temperature monitoring on the drivers given in the Pololu documentation – this is not to be relied upon.

By its nature the shaker system will impart strong mechanical vibrations into the motors – in time, if the vibrations are strong enough, this might damage them. I have chosen to use low cost electric scooter motors which are easy to obtain and relatively cheap to replace if necessary. They are also relatively easy to open up and so offer some possibility for repair of loose magnets etc should some mechanical damage take place.

As is always the case in DIY projects keep a close eye on your system and the behaviour of its components so that you can detect when performance is changing or otherwise indicating a problem somewhere. Only the builder/operator is in a position to do this – you must assume that the BFF SHKR-1 card and BFF Shaker software can not protect your system from damage.



Connected to USB-TTL cable and Pololu 24v12 Motor Driver. The driver is fitted with right angled female headers to fit directly to a right angled male header on the card.

The effectiveness of the vibration transmission into your cockpit structure will depend on the manner of the motor connection/mounting and its position within the structure. It is likely that you will need to do some experimentation here to determine the optimal arrangement for your cockpit.

Whatever your motor placement and mounting arrangement ENSURE that your mechanical set up is robust enough to deal with the resulting motor and shaft vibrations and that adequate arrangements are made to prevent user contact with the motor and other system components when it is in operation.

4. Operation

Please read the BFF Shaker software online user guide for details of configuration settings to set the correct COM port and serial data baud rate for communications with the card. The settings are made manually in your aircraft.cfg file. The COM port number of your USB-TTL cable can be found under the COM Port item in Device Manager. Baud should be set to 516129 in the BFF Shaker cfg file.

NOTE the power supply to the motor driver is separate from the 5V logic supply to the SHKR-1 card – both supplies require to be switched on for the motor drive to become active.

The SHKR-1 card will switch on/off the vibration output as directed by the BFF Shaker software – use the ON_OFF button on the software to control the vibration output. The composition of the vibration output during a flight is determined by the software settings and the flight simulator flight state.

LED SEQUENCES – On application of the 5V logic supply the green and yellow LEDS will light. When serial data is

received from the BFF Shaker software the yellow LED will go out and the green LED will flicker at the data reception rate.

If the serial data is interrupted the green LED will go ON and the card will cut the vibration demand outputs to the motor drivers.

In normal operation the yellow LED will only flash each time a new vibration event occurs – eg on engine start-up, runway bumps, gear bumps etc. If error reporting is enabled in the BFF Shaker software (via the config file) and the card detects any of the enabled Pololu driver FF error pins going high then the yellow LED will flash On and OFF at a steady rate (about 2 Hz), the card will cut the vibration demand output, and will signal the error pin state to the BFF Shaker software.

This error state is latched – ie it is held until the card/driver is re-started and the BF Shaker software is re-started. Some driver error conditions are also latched by the driver itself – these will require that the driver power supply is cycled to release the error condition. Check the Pololu driver user documentation for details.

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