# Buffalo
# Stereo ESS ES9008 Sabre Reference Audio DAC
## Russ White – Twisted Pear Audio

**Introduction:**

The Buffalo DAC is a reference audio DAC module which is designed for uncompromising audio quality. It is a stereo DAC which accepts SPDIF, PCM, and DSD digital audio. The module can accept DSD input and SPDIF/PCM at sample rates up to 192khz 24 bit. The circuit is actually two sets of 4 parallel DACs per channel.

**Power Supply:**

VD(digital supply) 5-15 VDC. (6VDC recommended)

VA(analog supply) 6-12VDC (6.6 VDC recommended)

It is acceptable to use the same supply for VA and VD, but performance will be better with split/dedicated supplies. The dual supply LCDPS is a very good match for the Buffalo.

**Configuration:**

There are 3 labeled headers and a set of 4 tri-state DIP switches.

The SPDIF switch must be "ON" to use the SPDIF input and "OFF" for PCM/DSD.

The ADDRESS header is used to select the I2C address of the DAC. You should leave the header open for the on-board controller to function correctly with the provided basic firmware.

The RESET header is used to externally reset the DAC if necessary. The are no known conditions which require a reset, but the header is there just in case.

With the DIP switch all in the open or "+" position the DAC will be in the SPDIF default mode.

The following table shows the switch functions (* denotes default):

| PIN/NAME | Low "-" | High "+" |
|---|---|---|
| 1 - INPUT SELECT | PCM/DSD | *SPDIF |
| 2 - FILTER MODE | SLOW ROLL OFF | *FAST ROLL OFF |
| 3 - NOTCH DELAY | NONE | *MCK/64 |
| 4 - DPLL BW | MEDIUM | *LOWEST |

**I2C interface:**

If you wish to provide your own firmware and/or control the DAC via I2C there is a three pin header for SDA,SCL, and GND. The SDA and SCL line are pulled up to VDD(3.3V) by 2.2K resistors.

**Output Characteristics:**

The output of the buffalo can be used as a voltage source or a current source. Best DNR and THD will be achieved using it as a current source.

The differential output of the buffalo is 0.924*1.65V (3.1746 Peak) + 1.65 DC bias and the series output resistance is nominally 195 Ohms at each output.

**I2S/PCM input (INPUT SELECT - LOW):**

The SPDIF switch should be "OFF" for PCM input. The default basic firmware is setup for 24bit I2S PCM format.

For I2S/PCM input you should wire the following:

| Bit Clock (BCK) | DCK |
|---|---|
| Word Clock (LRCK) | D1 |
| Serial DATA | D2 |
| GND | G |

**DSD input (INPUT SELECT - LOW):**

For stereo DSD input you will wire as follows:

| Bit Clock (BCK) | DCK |
|---|---|
| Channel 1 Data | D1 |
| Channel 2 Data | D2 |
| GND | G |

The DAC can be operated mono with DSD input by supply the same data to D1 and D2.

**Normal SPDIF Input (INPUT SELECT - OPEN/HIGH):**
The circuit includes a comparator input with hysteresis for normal SPDIF level signals. Connect the SPDIF signal to SPDIF terminal and GND to G and set the SPDIF switch to "ON".

**TTL level SPDIF input (INPUT SELECT -OPEN/HGH):**

If you have a SPDIF source which is already TTL level (3.3V max) you can leave the SPDIF switch open(OFF), and use D1 terminal and G o input the SPDIF. This allows you to either go directly from an existing circuit with SPDIF output or to roll your own SPDIF input circuit if you like.

**On Board Clock:**

The on board master clock is generally used, but if desired you may supply an external master clock by shunting the "disable" header on version 1.1 boards or by pulling pin one of the clock to GND on version 1.0 boards. You can supply your own clock signal at the pads next to the oscillator when the on board clock is disabled. You can also use the pads to output the clock if you need it.

**Firmware Notes:**

The Buffalo PCB is designed  for Stereo input for all of the Sabre's supported formats (PCM/DSD/SPDIF). As such the DAC input sources need to be remapped in the firmware to allow this flexibility. If you are writing your own firmware, keep in mind that to work correctly register 14 bits 7:3 need be set to 0b1111.

**PCB Errata:**

**!!!IMPORTANT!!!** On the first run of PCBs which are marked "V 1.0" on the lower right hand corner there are two silkscreen errors:

SDA and SCL are swapped.
D2 and DCK are swapped.

The silkscreen has been corrected on version 1.1 boards. Nothing catastrophic will happen if you did not read this note before wiring, you just won't get any music.

**PCB Changes:**

Version 1.1
–   Added the "disable" header to easily disable the on board master clock. The header simply pulls the enable pin (pin 1) of the XO to GND. You can disable the on board clock on version 1.0 boards also if you need to by connecting pin 1 of the XO to GND with a piece of wire.
–   Fixed silkscreen.