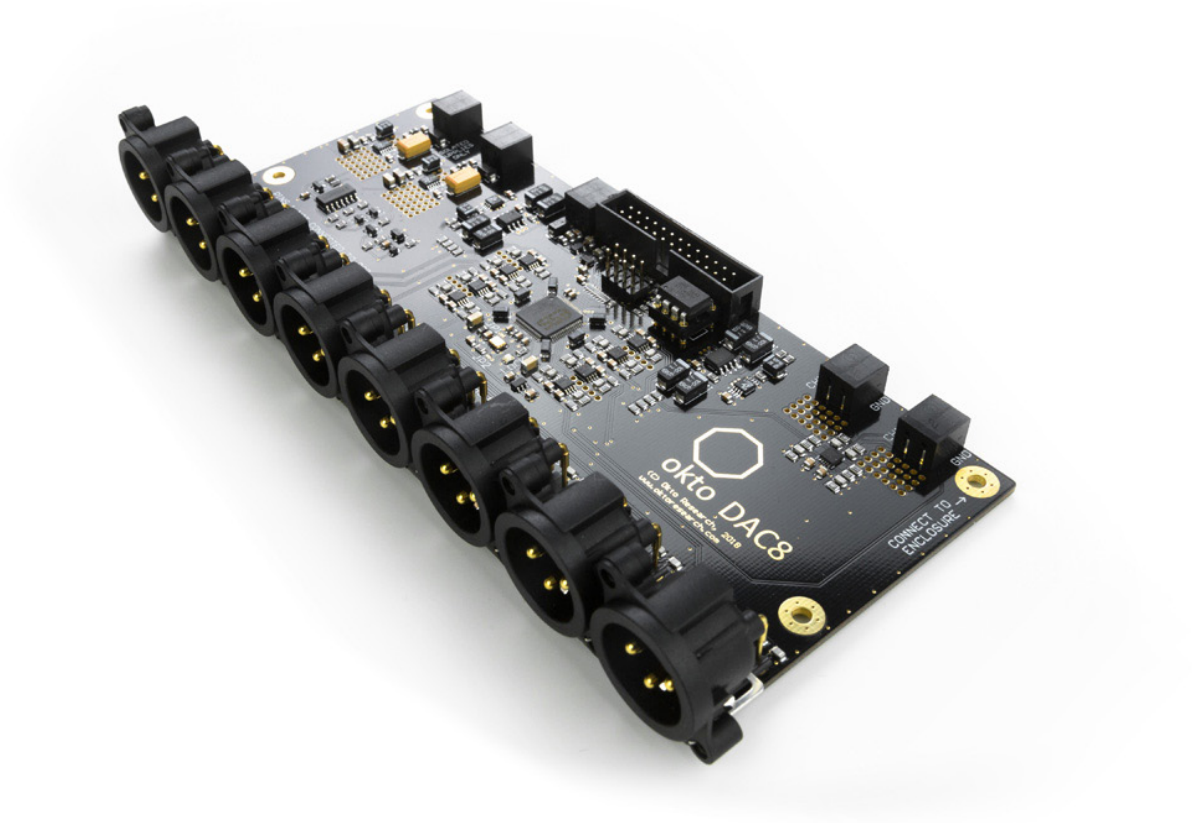
Okto Research DAC8

D/A Module User Manual



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Introduction

DAC8 by Okto Research is a stereo and 8-channel high-performance digital-to-analog converter module. It is designed to be used in home audio systems as well as in professional studio / on-stage environment.

Features

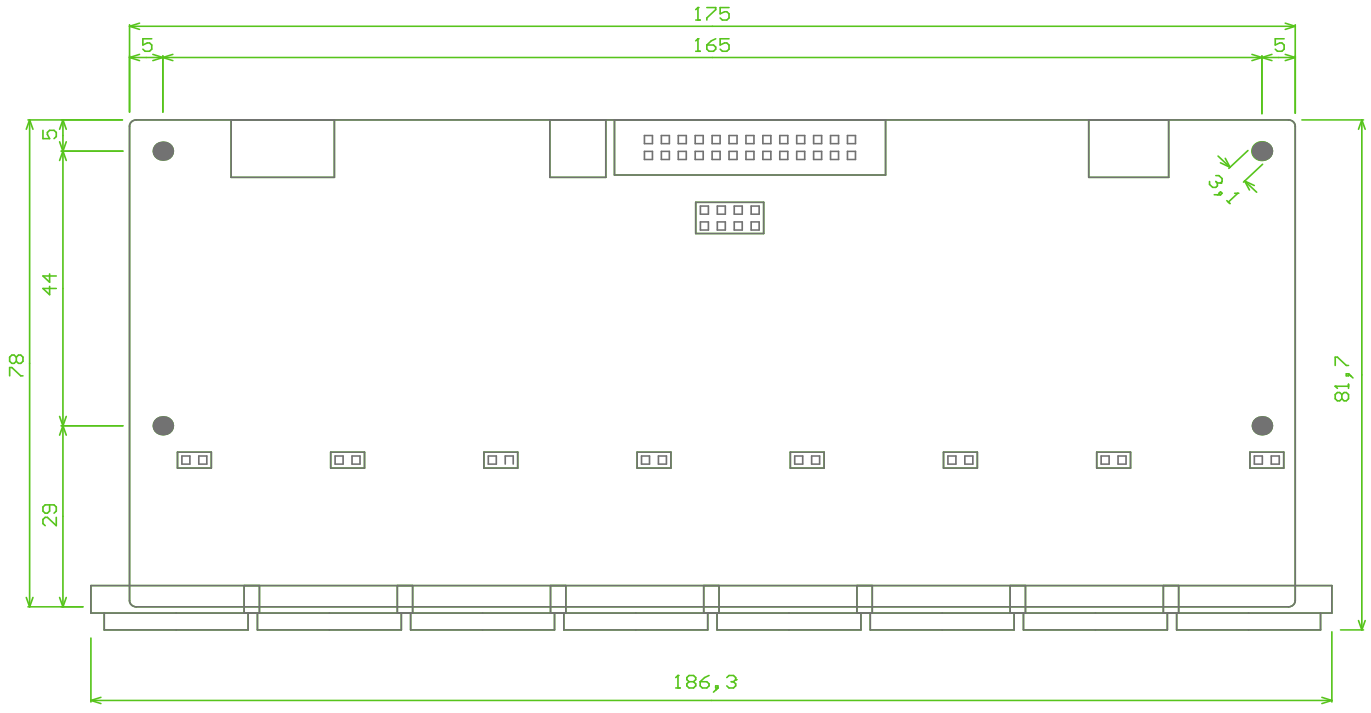
- ES9028PRO 32-bit D/A chip with HyperStream II modulator and patented time-domain jitter eliminator
- stereo mode with unique 4+4 I/V stage paralleling and 8-channel mode
- ultra-clean output spectrum with dominant 2nd harmonic at -124dB (1kHz, full scale output, worst case)
- headphone output with high current capability that drives low impedance loads with minimum distortion
- I2S/DSD/DoP digital inputs, SPDIF for stereo operation
- 32-bit volume control with a single potentiometer
- compatible with USBstreamer, NanoSHARC and MiniSHARC by MiniDSP and many other products

Specifications

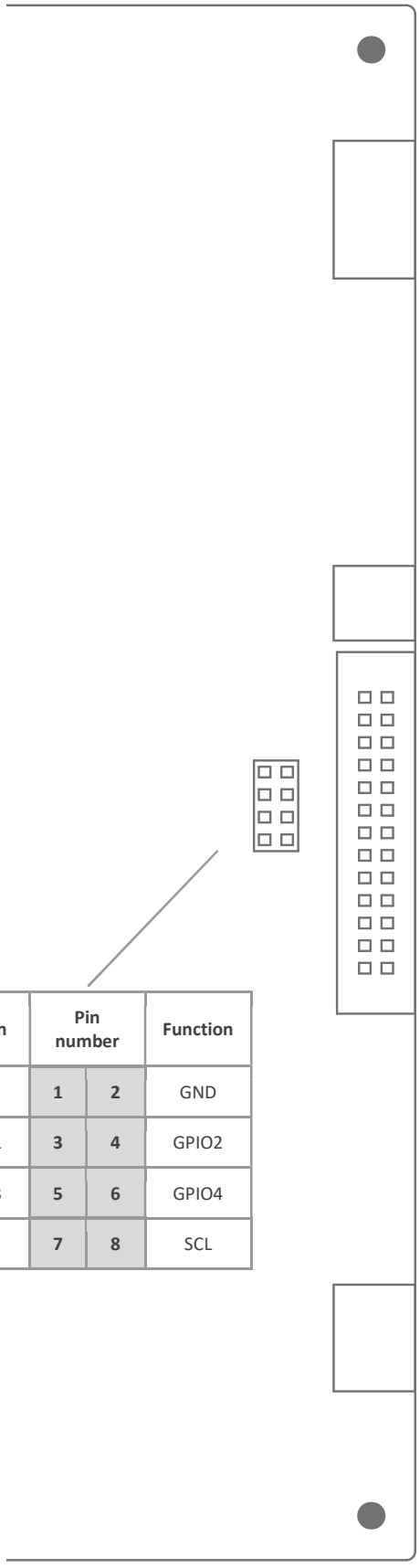
- Mechanical
  - dimensions
    - 175 x 78mm (PCB only)
    - 186.3mm x 81.7mm (including connectors)
  - weight: 110g
- Electrical
  - supply voltages (mutually isolated, see the Integration Guide)
    - 15V ± 5%, 0.5A
    - 15V ± 5%, 0.5A
    - 5V ± 5%, 0.5A
  - digital inputs / outputs
    - maximum sampling frequency
      - I^2S/PCM: 384kHz
      - DSD: 11.2896MHz (DSD256)
      - DoP (DSD over PCM): 5.448MHz (DSD128)
      - SPDIF: 96kHz (stereo only)
    - voltage levels
      - audio data inputs
        - high-level input voltage > 2V (5V tolerant)
        - low-level input voltage: < 0.4V
        - high-level output voltage > 3.1V
        - low-level output voltage < 0.2V
  - I^2C address: 0x90

- balanced outputs
  - output level 3.4V_{RMS} full scale
  - output impedance
    - 100 ohms (8-channel mode)
    - 25 ohms (stereo mode)
  - THD+N
    - < -117 dB or 0.00014 % (8-channel mode, full scale, 1kHz, 20kHz BW)
    - < -120 dB or 0.0001 % (stereo mode, full scale, 1kHz, 20kHz BW)
  - THD
    - < -124 dB or 0.000063 % (full scale, 1kHz, 20kHz BW)
  - dynamic range
    - > 125 dB-A (8-channel mode, 20kHz BW)
    - > 132 dB-A (stereo mode, 20kHz BW)
- headphone outputs
  - output voltage: 1.7 V_{RMS} full scale
  - output impedance: <100 milliohm
  - minimum load impedance: 16 ohm
  - THD
    - < -123 dB or 0.00007 % with 600-ohm load (full scale, 1kHz, 5mW)
    - < -123 dB or 0.00007 % with 300-ohm load (full scale, 1kHz, 10mW)
    - < -116 dB or 0.00016 % with 32-ohm load (full scale, 1kHz, 90mW)

Mechanical drawing



Connectors



Pin number	Function
1	GND A
2	+15V A
3	GND B
4	+15V B

Pin number	Function
1	+5V C
2	GND C

Function			Pin number		Function
I²S	DSD	SPDIF			
BCLK	CLK	Input 1	1	2	GND
WCLK	DSD1	Input 2	3	4	GND
DATA1 (CH1&2)	DSD2	Input 3	5	6	GND
DATA2 (CH3&4)	DSD3	Input 4	7	8	GND
DATA3 (CH5&6)	DSD4	Input 5	9	10	GND
DATA4 (CH7&8)	DSD5	Input 6	11	12	GND
-	DSD6	Input 7	13	14	GND
-	DSD7	Input 8	15	16	GND
-	DSD8	Input 9	17	18	GND
MCLK_IO (see *Clocking options*)			19	20	GND
SCL (I²C clock)			21	22	GND
SDA (I²C data)			23	24	GND
3.3V			25	26	GND

Pin number	Function
1	Left (CH1)
2	Ground
3	Right (CH2)

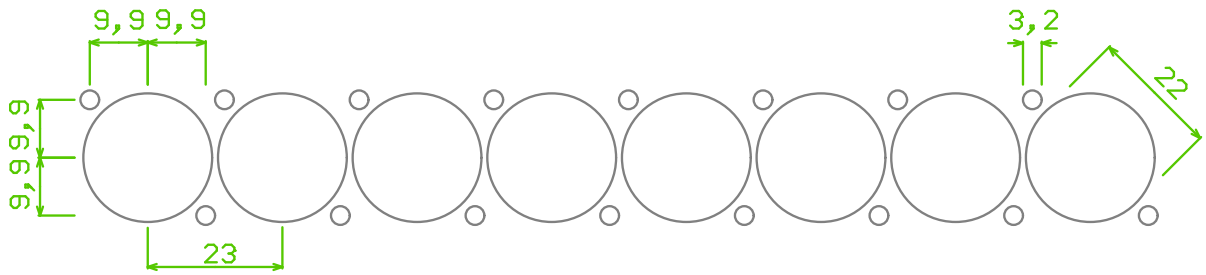
Function	Pin number		Function
3.3V	1	2	GND
GPIO1	3	4	GPIO2
GPIO3	5	6	GPIO4
SDA	7	8	SCL

Expansion header

Expansion header does not need to be used in order to operate DAC8, however it provides additional functionality if needed.

Pin name	Function	Description
GPIO1	**ON/STANDBY**	When pulled high, DAC8 enters active state if all power supplies are at nominal levels. Maximum voltage on this pin is 3.3V, use jumper to short this pin high if not in use.
GPIO2	**Stereo mode**	When pulled low, DAC8 will enter stereo mode. See “Stereo mode”.
GPIO3	-	Do not connect. Reserved for future use.
GPIO4	**Volume control**	This pin allows to control Sabre 32-bit internal volume with a single potentiometer. 3.3V means 0dB attenuation, 0V means 127dB attenuation. See “Connection diagram”.

Integration guide



Panel milling - view from the outside. Available in DXF format on our website.

Power

We recommend using Okto PSU – a power supply designed for DAC8.

DAC8 requires three stabilized voltages: 15V/500mA, 15V/500mA and 5V/500mA, which **need to be mutually isolated,** e.g. produced by separate transformers or separate transformer windings and not connected to any common conductor or to an enclosure. Note that supplies with +-15V outputs referenced to common ground cannot be used!
There is no need for these voltages to be low noise or ripple free because DAC8 is equipped with its own high-performance LT3045 regulators.

All power inputs are protected against polarity reversal.

Grounding

Always use a metal enclosure connected to the protective earth (PE). The practice of disconnecting PE conductor from an enclosure to avoid ground loops is a dangerous solution to a problem caused by using suboptimal unbalanced signal wiring. If balanced signal paths are used, as is the case of DAC8, there is no need to do so, however proper grounding techniques must be followed.

Standard method in the past was to connect Pin 1 (ground) of the XLR connectors to the PCB, which causes ground loop currents to flow through the PCB to the enclosure and then away through the PE conductor. This leads to RFI and hum introduction and is often referred to as the “Pin 1 problem”.

The proper way is to terminate the Pin 1 as well as cable shield right at the enclosure enter point as described in AES48 standard. For that reason, pins 1 and shield of the XLR connectors are not connected to the PCB of DAC8 and thus **all the upper screws on the XLR connectors must be present to connect cable shield and pin1 to the enclosure. Separate ground contact needs to be provided to the PCB through a mounting screw (see description on the PCB).**

In case DAC8 is not mounted to a complete enclosure but rather a metal plate, for example as a part of a plate amplifier, follow the same rules.

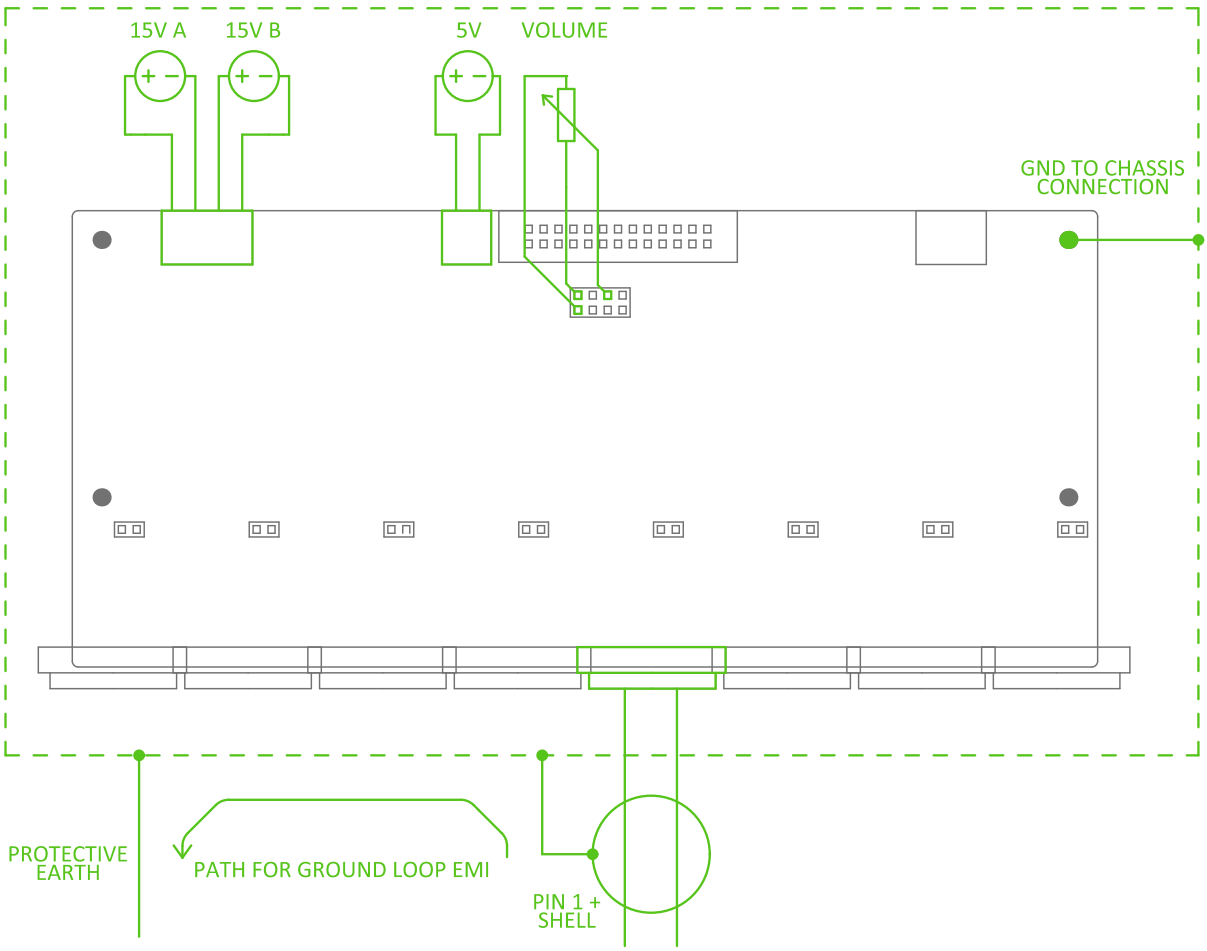
Assembly

Be careful when pushing connectors to their mating sockets and prevent bending of the PCB by providing a counterforce.

Note that DAC8 may also be mounted by the XLR connectors only, but a path to connect enclosure (or metal panel) to the PCB ground must be provided.

Both horizontal and vertical orientation of the module is acceptable. In both cases, enough space around the module needs to be kept to allow for airflow.

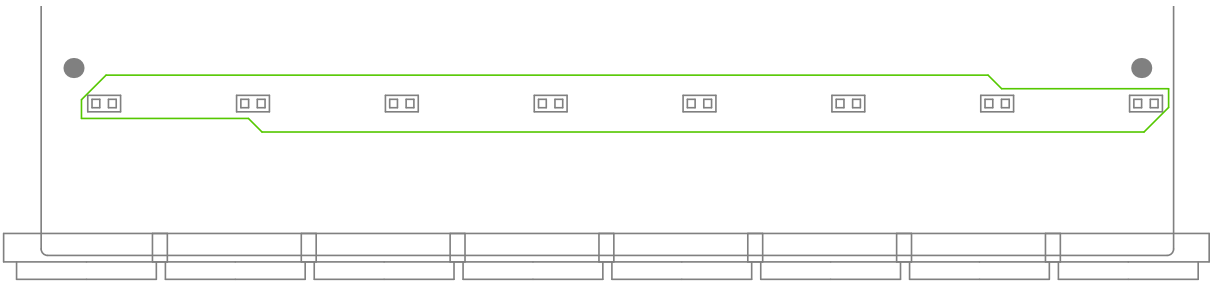
Connection diagram



Stereo mode

With our implementation of stereo mode, 4+4 I/V stages work in parallel, which is effectively a 4x averaging. Because random noise decreases (and dynamic range increases) by sqrt(N) times for each N-times averaging, this means 2x boost in case of the DAC8. This pushes dynamic range to 132dB-A and THD+N to 0.0001% (-120dB).

To enter stereo mode, remove the jumper between pins 2 and 4 on the GPIO on the Expansion connector. Then place the add-on board on the pin headers along the XLR connectors and gently push it in place.



Volume control

To make use of the 32-bit volume control of the Sabre DAC, an onboard MCU is equipped with a firmware that reads a voltage on GPIO4 and controls this internal volume via I^2C. By connecting a potentiometer on 3.3V and GND and slider on GPIO4, you can control the attenuation in 1dB steps between 0dB (3.3V on GPIO1) to -127dB (0V on GPIO1). Recommended potentiometer value is 1k to 10k and It needs to be connected according to the connection diagram.

Clocking options

By default, the board is configured to use ESS Sabre's patented time domain jitter eliminator. In this mode, DAC8 acts as an I^2S slave and no incoming MCLK signal is needed. It is the easiest way to achieve the specified performance, however, alternative clocking options are available.

PCM Synchronous Mode / OSF bypass

The board may be also modified to support synchronous PCM operation or OSF (oversampling filter) bypass mode. In this mode, internal resampling is disabled and output clock jitter is solely dependent on the jitter of the incoming clock signal. Therefore, use this option only if you have a very high quality input clock and short wiring. This modification is done by closing the JP1 solder jumper to disable an onboard oscillator and closing JP2 to actually connect the MCLK_IO pin of the main connector to the Sabre DAC.

I^2S/DSD Master Mode

In master mode, DAC8 acts as a source of MCLK, BCLK and LRCK for incoming PCM signal or as a source of MCLK and DATA_CLK for incoming DSD signal. To enable this mode, DAC chip must be appropriately configured over I^2C. Please contact us for more information.

Hardware modification needed includes soldering a 100 ohm 0603 resistor on a pad on the bottom side of the board. MCLK then appears on the MCLK_IO pin of the main connector.

Custom modifications

If you intend to use the DAC8 just in stereo mode and do not need additional XLR connectors or if you are interested in another modification, contact us on info@oktoresearch.com.