

# DAC1 USB

2-Channel 24-bit 192kHz D/A Converter

*Benchmark*  
...the measure of excellence!™



## Unmask Your Audio™ with the DAC1 USB

- a reference-quality, 2-channel 192-kHz 24-bit digital-to-analog audio converter featuring Benchmark's Advanced USB Audio technology, UltraLock™ clock system, and HPA2™ headphone amplifier.

## DAC1 Heritage

The pristine audio path of the award-winning DAC1 has made it the Benchmark of stand-alone D/A converters. The DAC1 USB preserves the exact topology of this audio path while adding some of the most frequently requested features.

The DAC1 USB includes a very unique USB input with bit-transparent native 96/24 capability, a programmable mute function, programmable headphone gain range, an automatic standby/resume feature, and a high-current output stage designed to drive long cables or low-impedance loads, such as high-end power-amplifiers.

The DAC1 USB looks sounds and measures the same as the DAC1 with added benefits of convenience, flexibility, and performance.

## Wide Range of Applications

The DAC1 USB is designed for maximum transparency and is well suited for critical playback in studio control rooms, mastering rooms, and high-end audiophile applications.

Benchmark's Advanced USB Audio interface makes the DAC1 an ideal primary output device for digital audio workstations, desktop audio editing applications, computer-based media playback, home media servers, and computer-based radio broadcast systems.

The rugged and compact rack-mount option makes the DAC1 USB an excellent choice for location recording, broadcast facilities, and mobile trucks.

## Features

- USB, XLR balanced, BNC coaxial, and TOSLINK optical digital inputs
- Compatible with Windows Vista/XP/2000 and Mac OS X without driver installation
- Elected low-impedance 10, 20, or 30 db pads on balanced outputs
- Jumper-selected low-impedance 10, 20, or 30 dB pads on balanced outputs
- -10 dBV unbalanced RCA analog outputs, +13.5 dBu maximum output level
- Two HPA2™ high-current, 0-Ohm, high-output 1/4" headphone outputs
- HPA2™ gain jumpers to match gain to headphone sensitivity
- Front-panel volume control for headphone outputs
- Front-panel volume control of all analog outputs (in "Variable" mode)
- Rear-panel "Variable/Calibrated" mode switch enables volume control of analog outputs

## Digital Inputs

There are four digital input connectors (coaxial, balanced XLR, optical, and USB). The coaxial, XLR, and optical digital inputs all accept professional (AES) and consumer (SP-DIF) data formats at sample rates up to 192 kHz.

## Advanced USB Audio Technology

The USB input is compatible with Windows Vista/XP/2000 and Mac OS X, and does not require driver installation or system configuration.

Unlike all previous driverless USB audio interfaces, Benchmark's Advanced USB Audio technology supports sample rates up to 96 kHz and word lengths up to 24-bits.

The DAC1 USB is a true plug-and-play solution, and is designed to begin playback immediately after the unit is connected to a USB port for the first time.

## Jitter-Immune UltraLock™

The Benchmark UltraLock™ system is nearly 100% jitter immune. The D/A conversion clock is totally isolated from the input digital audio clock in a topology that outperforms two-stage PLL designs. In fact, no jitter-induced artifacts can be detected using an Audio Precision System 2 Cascade test set.

Measurement limits include detection of artifacts as low as -140 dBFS, application of jitter amplitudes as high as 12.75 unit intervals (UI) and application of jitter over a frequency range of 2 Hz to 200 kHz.

Any signal that can be decoded by the USB or AES/EBU receivers will be reproduced without the addition of any measurable jitter artifacts. The AES/EBU receiver IC has been selected for its ability to accurately recover data in the presence of very high jitter levels.

## HPA2™ Headphone Amplifier

Two 1/4" headphone jacks are driven by the HPA2™ - Benchmark's signature high-current, 0-Ohm headphone amplifier. The HPA2™ is capable of delivering the full performance of the DAC1 USB into the difficult loading presented by headphones. The HPA2™ maintains less than 0.0003% THD+N under full load.

## Mute Function

The left-hand headphone jack includes a switch that mutes the XLR and RCA analog outputs when a headphone plug is inserted. This mute feature can be disabled with internal jumpers.

## Volume Control

The front-panel volume control sets the output level of the headphone jacks. It can also be used to control the output level of the balanced XLR and unbalanced RCA analog outputs. A rear-panel switch selects Variable or Calibrated output levels, respectively enabling or disabling the front-panel volume control.

## Direct Interfacing to Power Amplifiers

The DAC1 USB is designed to interface directly to power amps and powered studio monitors in order to provide the cleanest and shortest path from the digital source to the monitor output. This often results in a substantial improvement in sound quality.

10, 20, and 30 dB pads are provided for interfacing directly to monitors and amplifiers that often have too much input sensitivity to handle high-level (+29 dBu) signal levels.  
High-Current Output Drivers

The DAC1 USB features new high-current output drivers that are capable of driving 300-Ohm loads without an increase in distortion. They are also well suited for driving long cables or high-capacitance loads.

- Rear-panel "Variable/Calibrated" mode switch includes a mute position
- In "Calibrated" mode, levels are set by 10-turn trimmers (20 dB Range, 2 dB/turn)
- XLR outputs are preset to +4dBu at 0 dBFS in "Calibrated" mode (20-dB Pad enabled)"
- RCA outputs are preset to +2 Vrms (8.2 dBu) at 0 dBFS in "Calibrated" mode"
- Headphone jack 1 mutes XLR and RCA outputs (feature may be disabled)
- Benchmark's phase-accurate UltraLock™ technology for total jitter immunity
- Status LED's - display input selection and error conditions
- Automatic "Standby Mode" - activated after 15 seconds of loss of digital input signal
- Instant wake-up from "Standby Mode" - no loss of audio
- THD+N = -107 dB, 0.00045% @ -3 dBFS input, -105 dB, 0.00056% @ 0 dBFS input
- Automatic de-emphasis in response to consumer pre-emphasis bit (44.1, 48, 88.2, and 96 kHz)
- Reliable and consistent performance under adverse operating conditions
- 115 V, 230 V, 50-60 Hz international power supply with very wide operating range
- Low radiation toroidal power transformer significantly reduces hum and line related interference
- Low power consumption (8 Watts typical program, 16 Watts peak)
- Meets FCC Class B and CE emissions requirements

## **‘Audio-Always’ Design Philosophy**

The DAC1 USB is designed to perform gracefully in the presence of errors and interruptions at the digital audio inputs. A soft mute circuit eliminates pops when a digital signal is applied. Power management circuitry controls the muting and resetting of all digital circuits upon removal and application of power. Audio is present at the outputs only 60 ms after applying a digital input signal and only 500 ms after applying power to the unit.

The DAC1 USB is designed to avoid all unnecessary mute scenarios. Muting is only enabled upon loss of power, or when digital transmission errors occur. The DAC1 USB does not mute when the input data is all zeros. Consequently, no audio is lost when an audio transient follows full silence. Furthermore, the DAC1 USB signal-to-noise specifications represent the true system performance, not just the performance of an output mute circuit.

The DAC1 USB will operate even when sample rate status bits are set incorrectly. Sample rate is determined by measuring the incoming signal. Lack of sample rate status bits or incorrectly set status bits will not cause loss of audio.

## **Error Display**

When the selected digital input signal is disconnected, incompatible, or drops out, the Input Selection Status LEDs will flash indicating a signal error. This flashing will stop when the error is corrected. If the error persists for more than 15 seconds, the DAC1 USB will enter ‘Standby Mode’.

## **Automatic Standby/Resume**

The DAC1 USB features an automatic standby mode that eliminates the need to turn the converter on and off. ‘Standby Mode’ starts 15 seconds after a digital source device is turned off, disconnected, or contains errors that prevent D/A conversion. All LED’s are off while in standby mode.

While in ‘Standby Mode’, the DAC1 USB continues to monitor the selected digital input and will immediately resume normal operation when an error-free signal is restored.

## **Low-Noise Internal Power Supply**

The internal power supply supports all international voltages and has generous margins for over and under voltage conditions. It has excellent immunity to noise on the AC line and no external AC filtering is required.

## **Phase-Accurate Multi-Track and 5.1**

The DAC1 is phase accurate between channels at all sample rates, and is phase accurate between other DAC1s at sample rates up to 96 kHz. Phase-accurate multi-track and 5.1 surround systems are easily constructed using multiple DAC1 converters.

## **Automatic Digital De-Emphasis**

Pre-emphasis was used on many early CD recordings. It is rarely used on newer recordings and consequently some D/A converters omit de-emphasis. The DAC1 USB will correctly apply precise digital de-emphasis when and if it is needed. The de-emphasis circuit supports 44.1, 48, 88.2 and 96-kHz sample rates and is automatically enabled in response to the pre-emphasis status bits in consumer format digital signals.

# Specifications

## Digital Audio Inputs

**Number of Digital Inputs**  
4 (Coaxial, XLR, Optical, USB)

**Number of Channels**  
2

**Input Sample Frequency Range**  
28 to 195 kHz

**Maximum Input Word Length**  
24 bits

**Digital Input Impedance on XLR input**  
110  $\Omega$

**Digital Input Impedance on Coaxial input (Jumper selected)**  
75  $\Omega$  or Hi-Z (Bridging)

**Transformer Coupled Digital Inputs**  
Yes

**DC Blocking Capacitors on Digital Inputs**  
Yes

**Transient and Over-Voltage Protection on Digital Inputs**  
Yes

**Minimum Digital Input Level**  
300 mVpp on XLR, 150 mVpp on Coaxial

**Jitter Tolerance (With no Measurable Change in Performance)**  
> 12.75 UI sine, 100 Hz to 10 kHz  
> 3.5 UI since at 20 kHz  
> 1.2 UI since at 40 kHz  
> 0.4 UI since at 80 kHz  
> 0.29 UI since at 90 kHz  
> 0.25 UI since above 160 kHz

**Jitter Attention Method**  
Benchmark UltraLock™

## Balanced Analog Outputs

**Number of Balanced Analog Outputs**  
2

**Output Connector**  
Gold-Pin Neutrik® male XLR

**Output Impedance**  
60  $\Omega$

**Calibration Adjustability**  
2 dB/turn

**Output Level Range (at 0 dBFS) In 'Calibrated Mode'**  
+9 to +29 dBu (Attenuator off)  
-1 to +19 dBu (Attenuator = 10 dB)  
-11 to +9 dBu (Attenuator = 20 dB)  
-21 to -1 dBu (Attenuator = 30 dB)

**Output Level Range (at 0 dBFS) In 'Variable' Mode**  
Off to +29 dBu (Attenuator off)  
Off to +19 dBu (Attenuator = 10 dB)  
Off to +9 dBu (Attenuator = 20 dB)  
Off to -1 dBu (Attenuator = 30 dB)

**Output Level Variation with Sample Rate (44.1 kHz vs. 96 kHz)**  
< +/- 0.006 dB

## Unbalanced Analog Outputs

**Number of Unbalanced Analog Outputs**  
2

**Output Connector**  
RCA

**Output Impedance**  
30  $\Omega$

**Output Level Calibration Controls**  
Shared with Balanced Outputs

**Output Level Range (at 0 dBFS) In 'Calibrated Mode'**  
-6 dBu to +13.5 dBu

**Output Level Range (at 0 dBFS) In 'Variable' Mode**  
Off to +11 dBu

**Calibration Adjustability**  
2 dB/turn

**Output Level Variation with Sample Rate (44.1 kHz vs. 96 kHz)**  
< +/- 0.006 dB

**Factory Preset**  
2vRMS (8.2 dBu)

## HPA2™ Headphone Outputs

**Number of Headphone Outputs**  
2

**Output Connector**  
1/4" TRS

**Output Impedance**  
0.01  $\Omega$

**Output Level Control**  
Stereo Control on Front Panel

**Output Level Range (at 0 dBFS) into 60  $\Omega$  Load**  
Off to +21 dBu

## Audio Performance

**SNR - A-Weighted, 0 dBFS = +20 to +29 dBu**  
116 dB

**SNR - Unweighted, 0 dBFS = +20 to +29 dBu**  
114 dB

**SNR - A-Weighted at low gain, 0 dBFS = +9 to +18 dBu**  
114 dB

**THD+N, 1 kHz at 0 dBFS**  
-105 dBFS, -105 dB, 0.00056%

**THD+N, 1 kHz at -1 dBFS**  
-107 dBFS, -106 dB, 0.00050%

**THD+N, 1 kHz at 3 dBFS**  
-110 dBFS, -107 dB, 0.00045%

**THD+N, 20 to 20 kHz test tone at -3 dBFS**  
-110 dBFS, -107 dB, 0.00045%

**Frequency Response at Fs=96 kHz**  
+/- 0.1 dB (20 to 20 kHz)  
-0.02 dB at 10 Hz  
-0.20 dB at 20 kHz  
-0.85 dB at 40 kHz  
-2.5 dB at 45 kHz

**Frequency Response at Fs=48 kHz**  
+/- 0.1 dB (20 to 20 kHz)  
-0.02 dB at 10 Hz  
-0.20 dB at 20 kHz

## Audio Performance (continued)

**Crosstalk**  
-100 dB at 20 kHz  
-125 dB at 1 kHz  
-130 dB at 20 Hz

**Maximum Amplitude of Jitter Induced Sidebands (10 kHz 0 dBFS test tone, 12.75 UI sinusoidal jitter at 1 kHz)**  
< -141 dB

**Maximum Amplitude of Spurious Tones with 0 dBFS test signal**  
< -126 dB

**Maximum Amplitude of Idle Tones**  
< -128 dB

**Maximum Amplitude of AC line related Hum & Noise**  
< -126 dB

**Inter-channel Differential Phase (Stereo Pair, any sample rate)**  
+/- 0.5 degrees at 20 kHz

**Inter-channel Differential Phase (Between DAC1 USB Units, sample-rate < 110 kHz)**  
+/- 0.5 degrees at 20 kHz

**Inter-channel Differential Phase (Between DAC1 USB Units, sample-rate > 110 kHz)**  
+/- 4.1 degrees at 20 kHz

**Maximum Lock Time after sample-rate change**  
100 ms

**Soft Mute Ramp Up/Down Time**  
10 ms

**Mute on Receive Error**  
Yes

**Mute on Lock Error**  
Yes

**Mute on Idle Channel**  
No

**50/15 us De-Emphasis Enable**  
Automatic in Consumer Mode

**De-Emphasis Method**  
Digital IIR

**De-Emphasis Supported at**  
Fs = 32, 44.1, 48, and 96 kHz

**Digital Input to Analog Output (function of sample rate) The delay can be calculated using the following formula: Delay = 1.01 ms + (48/Fs) Where Fs = the sample rate in Hz.**  
2.72 ms at 28 kHz  
2.51 ms at 32 kHz  
2.10 ms at 44.1 kHz  
2.01 ms at 48 kHz  
1.55 ms at 88.2 kHz  
1.51 ms at 96 kHz  
1.28 ms at 176.4 kHz  
1.26 ms at 192 kHz