PI 2 DESIGN

Ceres Hybrid Tube Amp
Hardware Reference Manual

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1 WARRANTY

The enclosed product ("the Product"), is warranted by Pi 2 Design for a period of 3 years (except tubes, which are warranted for 1 year) for reasonable use, all as further described and defined below. This warranty runs solely to the individual or entity purchasing the Product and is not transferable or assignable in any respect. This warranty is valid only for so long as the product is used intact as shipped from Pi 2 Design. Any attempt or effort to alter the Product, including but not limited to any attempt to solder, de-solder, unplug, replace, add or affix any part or component of or onto the Product, other than components specifically intended for the user to plug and unplug into appropriate sockets and/or Connectors to facilitate use and deployment, all as specifically described and authorized in the Product Hardware Reference Manual, shall void this warranty in all respects. Coverage under this warranty requires that the Product be used and stored at all times in conditions with proper electrostatic protection necessary and appropriate for a complex electronic device. These conditions include proper temperature, humidity, radiation, atmosphere and voltage (standard commercial environment, 0C to +70C, <60%RH). Any Product that has been modified without the express, prior written consent of Pi 2 Design is not covered by this warranty. Pi 2 Design shall not be responsible for any damage to the Product as a result of a customer's use or application of circuitry not developed or approved by Pi 2 Design for use on or in connection with the Product.

This warranty does not cover defects caused by electrical or temperature fluctuations or from stress resulting from or caused by abuse, misuse or misapplication of the Product. Any evidence of tampering with the serial number on the Product shall immediately void this warranty. This Product is not intended to be used on or embedded in or otherwise used in connection with any life-sustaining or life-saving product and this warranty is not applicable nor is Pi 2 Design liable in any respect if the Product is so used. Notwithstanding anything to the contrary herein, Pi 2 Design expressly disclaims any implied warranty of merchantability or implied warranty of fitness for a particular purpose in connection with the manufacture or use of the Product.

2 OPERATING SPECIFICATIONS

2.1 CERES OPERATING SPECIFICATIONS

Ceres conforms to the following specifications:

Specification	Value
Dimensions	96.3mm x 65.7mm x 29.6mm (w/Tube Height is 70mm)
Weight	~8oz (with tube)
Storage Temperature	0C to +70C
Operating Temperature	0C to +50C
Humidity	0% to 95% RH, Non-Condensing
Input Voltage (VIN)	+24V +/- 5% 500ma Peak
Power Consumption	8W Typical, 10W Maximum

Table 1 – Ceres Operating Specifications

3 OVERVIEW

3.1 INTRODUCTION

Ceres, designed and manufactured by Pi 2 Design, is a High-Quality Hybrid Tube Amplifier designed to accept standard line level inputs and drive Audiophile Headphones from 32 - 300 ohm with ease and fidelity.

The major features of Ceres are as follows:

- **LINE IN –** A 3.5mm Jack accepts standard Line Level signals with an input impedance of 10K ohms
- **VOLUME POT AND GAIN SELECT** – High Quality ALPS Potentiometer and Dual Attenuation settings allow the user to adjust the output voltage to the optimal level for each Headphone.
- **GROUNDED CATHODE TUBE STAGE** – A Dual Triode Tube is wired in a classic Resistor Grounded Cathode architecture for that "Sweet Tube" sound. Nichicon FG Gold series audio capacitors are used to decouple the cathode resistor to ground for highest fidelity.
- **CLASS-A OUTPUT STAGE –** An IRL510 MOSFET and LM317 Constant Current Source form a Class-A Current Buffer for up to 125ma output current.
- **AUDIOPHILE QUALITY OUTPUT CAPACITOR** – A 1,000uf/63V Panasonic FM Series Audio capacitor is used to couple the Class-A output stage to the headphone jack.
- **HEADPHONE OUT** – Rugged 3.5mm Jack plus selectable output resistance between 1.5, 47 and 100 ohms.
- **TUBE ROLLING** – Ceres supports both 6922/6DJ8 (default is JJ 6DJ8) and 12AU7 type tubes. Individual Anode Bias Adjustment Pots plus selectable Series/Parallel Heater Configuration insure the perfect setup for virtually any tube!

3.2 BLOCK DIAGRAM

Refer to the following figure for a simplified block diagram of Ceres.

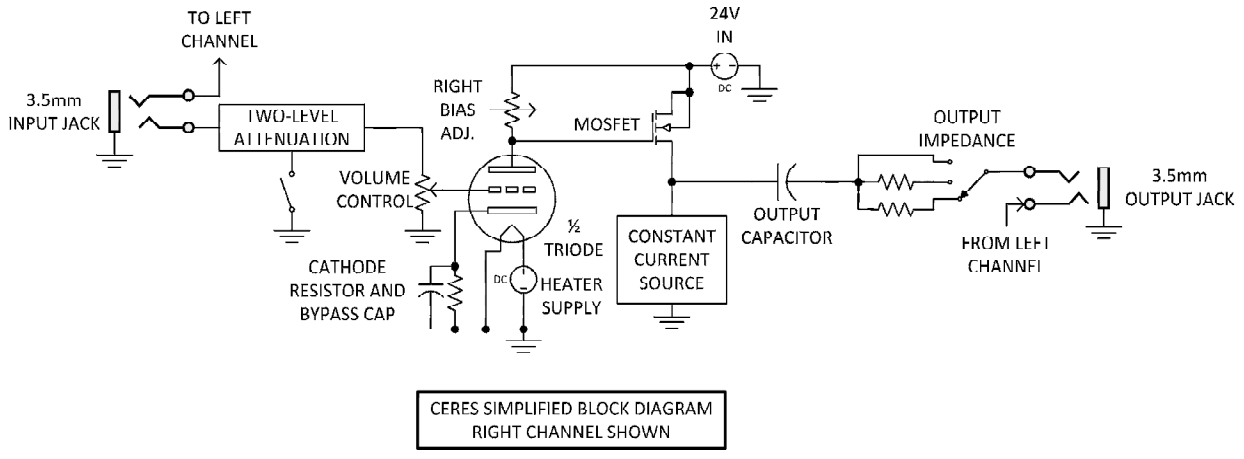


Figure 1 – Ceres Simplified Block Diagram

4 ON-BOARD FUNCTIONS

4.1 OVERVIEW

This section describes in detail the functionality located on Ceres.

4.2 DUAL TRIODE AMPLIFER

A Dual Triode Amplifier provides the voltage amplification of the input signal (DAC or Line In). This circuit designed to provide 10dB (3.3x) of overall gain (Attenuation Switch Low Position, Volume Control at 100%).

4.2.1 DUAL TRIODE AMPLIFER NOTES

1. There is an attenuation switch which, when enabled (up position) reduces the input to the Amp by 10dB, thus reducing overall maximum gain to ~0dB. The actual gain is set by the tube and it's cathode resistor. It may vary as much as +/- 1dB.
2. The Amp is driven from the 3.5mm Line In jack.
3. An ALPS 10K Dual Potentiometer provides volume control and a power on/off switch.
4. If the output is to be driven at line level input to another device, the user should enable the high attenuation. With this enabled (switch up) and the volume control at 100% the overall gain is ~0dB.

4.3 CLASS-A MOSFET BUFFER

A Class-A Buffer consisting of the IRL510 MOSFET and LM317 Constant Current Source provides up to 125ma (peak) of output current to drive Headphones from 32 to 600 ohm.

4.3.1 CLASS-A MOSFET BUFFER NOTES

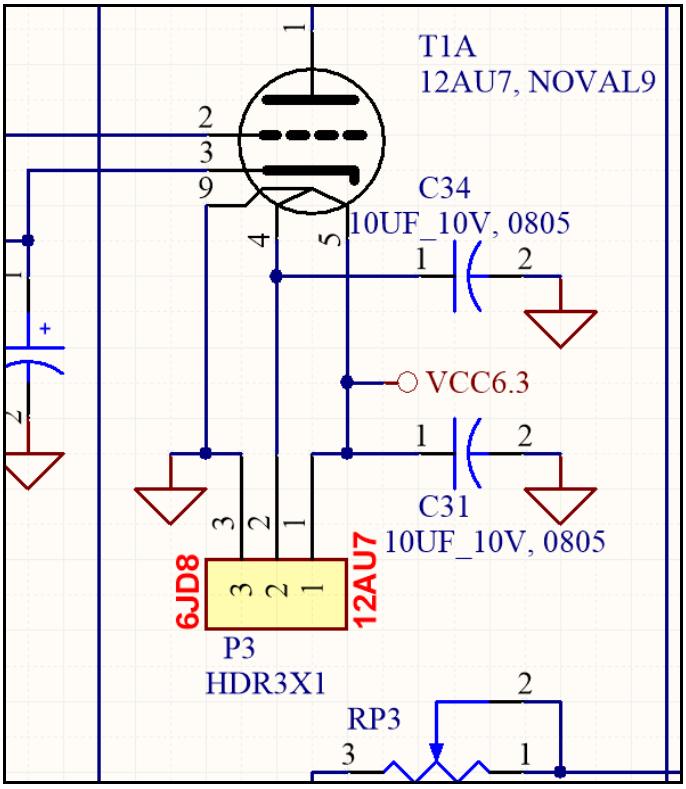
1. A three position slide switch adds 0, 47 or 100 ohm in series with the output. This allows low ohm headphones to be driven with much lower noise and overall power consumption. For the best experience, the user should start at the highest resistance and reduce only if the output levels are not satisfactory.
2. There is a 25 second delay from power up before the headphone output is enabled. This allows the tube to warm up and reduces power on thumps. The output is disabled immediately when power is removed.

4.4 6.3V HEATER SUPPLY

A low noise, high performance switching supply provides the 6.3V for the Tube Heaters.

4.4.1 6.3V HEATER SUPPLY NOTES

1. A 3-Pin Jumper is used to select how the power to the Tube Heater is fed. In 6V mode a jumper is placed on pins 2-3, while in 12V mode a jumper Is placed on pins 1-2. Note that 12V mode only works with tubes that allow 6.3V parallel operation, such as the 12AU7, not those that have true 12V heaters. The following circuit illustrates this:



5 CERES POWER

5.1 OVERVIEW

Ceres is designed to be powered from an external 24V +/- 5% source via 5.5mm x 2.1mm, Center Positive Jack. Below is the schematic of the power switch and input protection section of Ceres.

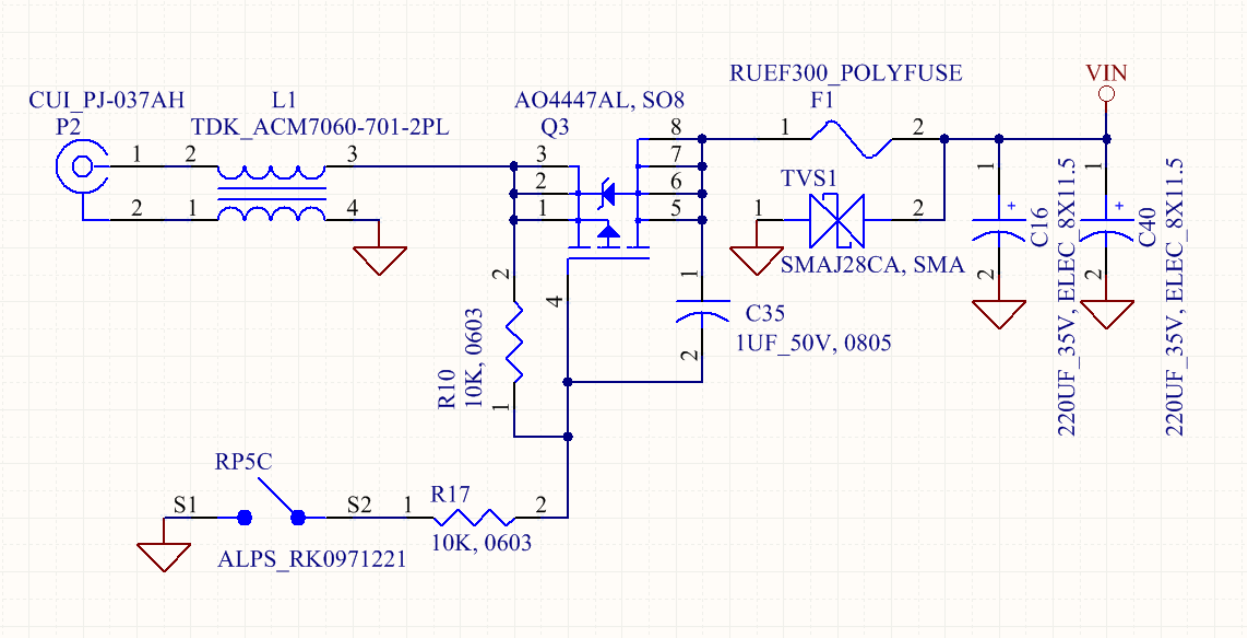


Figure 2 – Ceres Power Input and Protection Circuit

6 CONNECTORS AND SWITCHES

6.1 OVERVIEW

This section provides the type, location and pinout for the various connectors and switches on Ceres Top Side. These are shown in the 3D rendering below.

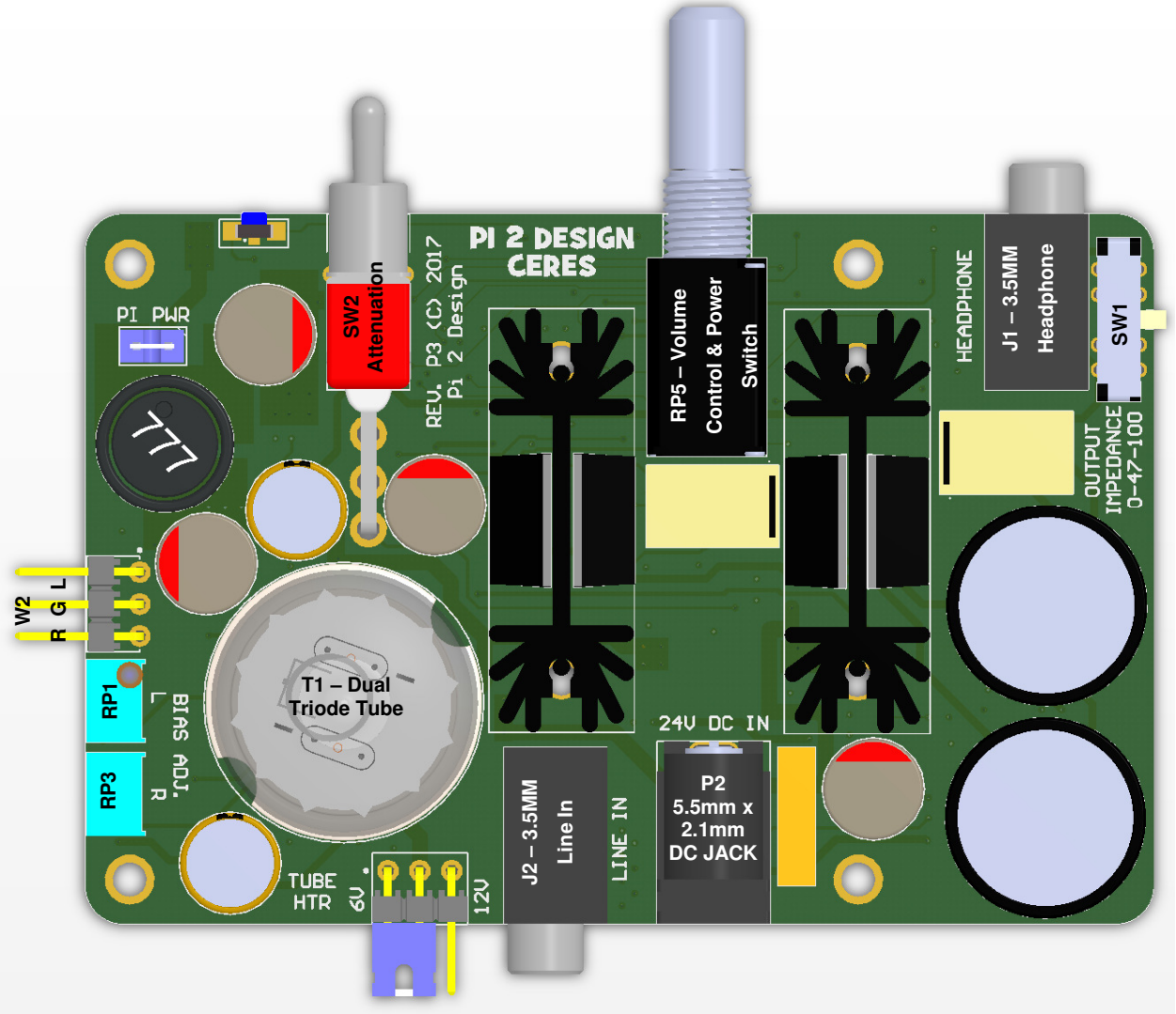


Figure 3 – Ceres Connectors and Switches

6.2 J1 – 3.5MM HEADPHONE JACK

J1 is a 3.5mm Stereo Jack for Headphone Out

6.3 J2 – 3.5MM HEADPHONE JACK

J2 is a 3.5mm Stereo Jack for Line In

6.4 W2 – 3-PIN BIAS ADJUST HEADER

W2 is a 3-pin .1" single row header. It allows measuring the Left and Right Channel Bias voltage. The pins are marked R-G-L for Right, Ground and Left respectively.

6.5 P2 – DC JACK

This jack is designed to accept a 5.5mm x 2.1mm center positive plug for external power in. Voltage must be 24V +/- 5%, 2 Amp minimum.

6.6 P3 – 3-PIN HEATER VOLTAGE SELECT

P3 is a 3-pin .1" single row header. It is used to select between 6V or 12V (in series mode) tube heaters.

6.7 RP1 AND RP3 TRIMPOTS

RP1 and RP3 are the bias adjustment potentiometers for the Left and Right Channels respectively.

6.8 RP5 –VOLUME POT WITH ON/OFF SWITCH

RP5 is an Alps RK09 Low Noise, Conductive Plastic Volume Control with built-in On/Off Switch.

6.9 SW1 – ATTENUATION SWITCH

SW1 – a Single Pole, Double Throw (SPDT) toggle switch that controls the attenuation relay.

6.10 SW2 – OUTPUT RESISTANCE SLIDE SWITCH

SW2 is a Double Pole, Three Position (DP3T) Slide Switch. It adds 0, 47 and 100 ohm headphone output resistance when in the Left, Middle and Right positions respectively.

6.11 W2 – BIAS ADJUST HEADER

W2 is a 3-pin right angle header. It carries the Left (L) and Right (R) Bias signals along with Ground (G). This allows the bias voltage to be measured while adjusting for the current tube.

7 TEST RESULTS

7.1 TEST RESULTS SUMMARY

Ceres test conditions were:

- External 24V from low noise benchtop supply
- 0db reference = 2Vrms
- dScope IIIe Analog Generator set to 1Vrms Out, Floating Ground (note – this creates a small artifact at 60hz, but eliminates coupled noise)
- dScope IIIe Analog In Load resistance = 600 ohm
- dScope IIIe Analyzer FFT = 32K, THD w/no weighting, Residual Noise w/A-Weighting

7.2 HEADPHONE OUT, ANALOG LINE IN TEST RESULTS

Using 1-meter RCA to RCA Cable and 1-meter 3.5MM to XLR Adapter cable. dScope IIIe generator set to 1Vrms unless otherwise noted, Attenuation Switch Low, Volume adjusted to desired output level.

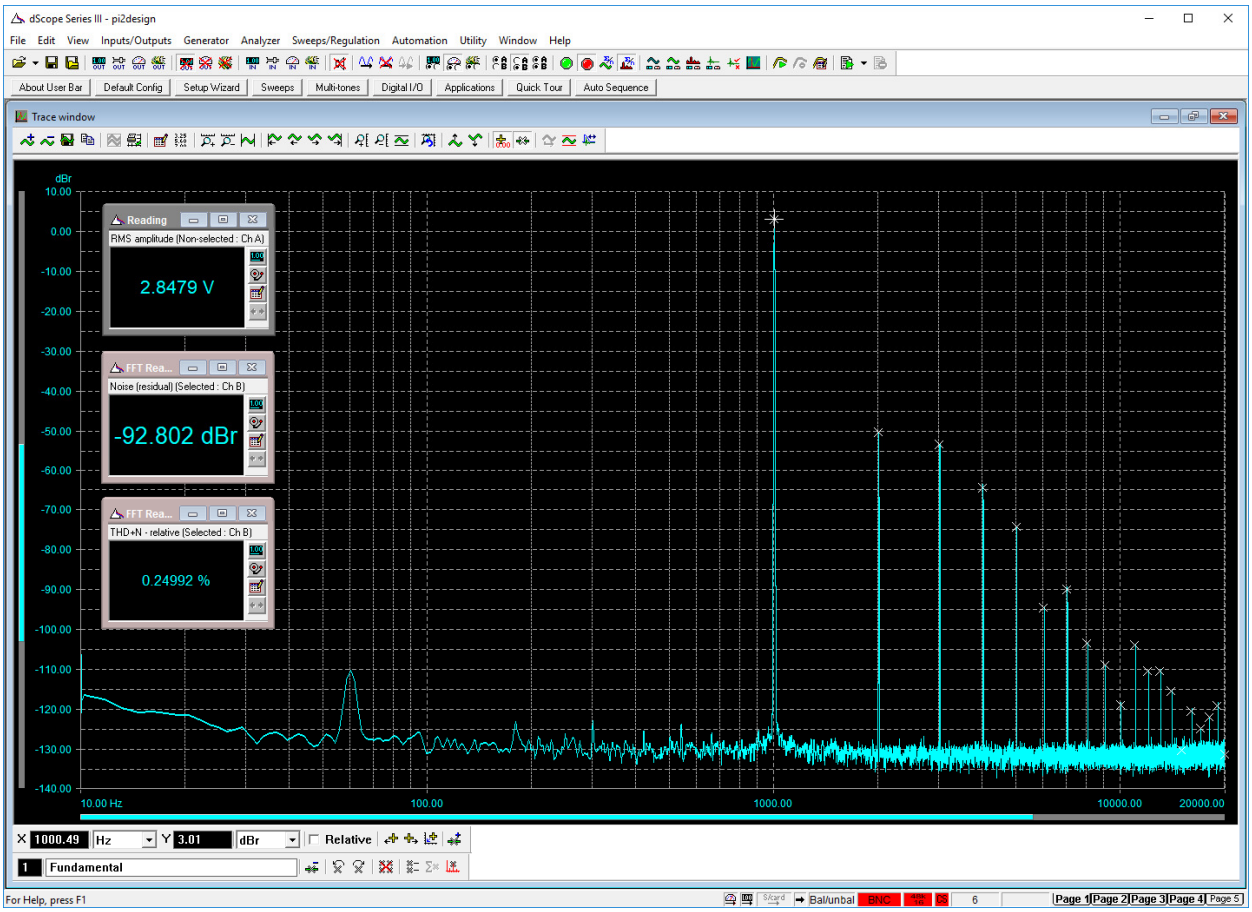


Figure 4 - Ceres Headphone Out, 1Khz, 24-Bit@96Khz, 3dB, 600 ohm

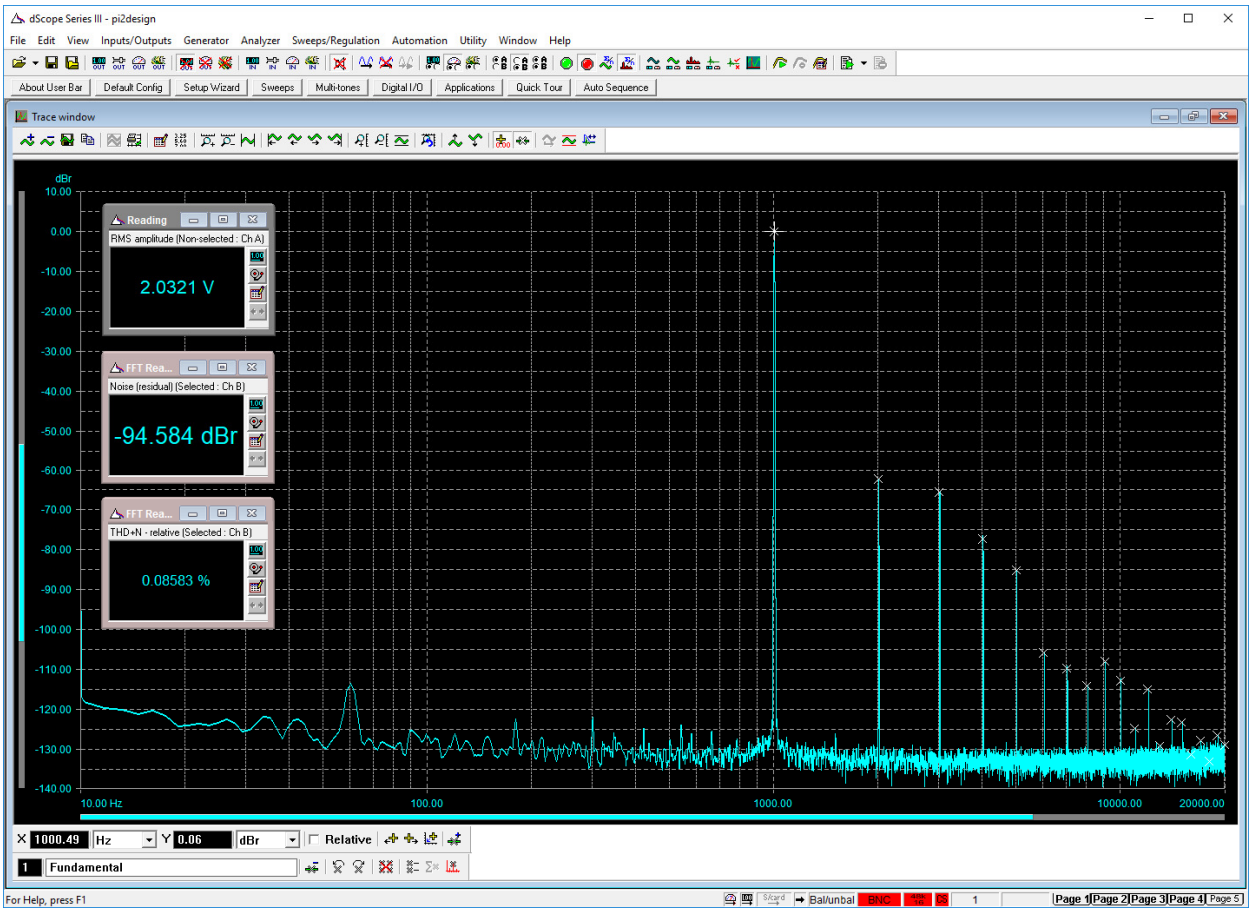


Figure 5 - Ceres Headphone Out, 1Khz, 24-Bit@96Khz, 0dB, 600 ohm

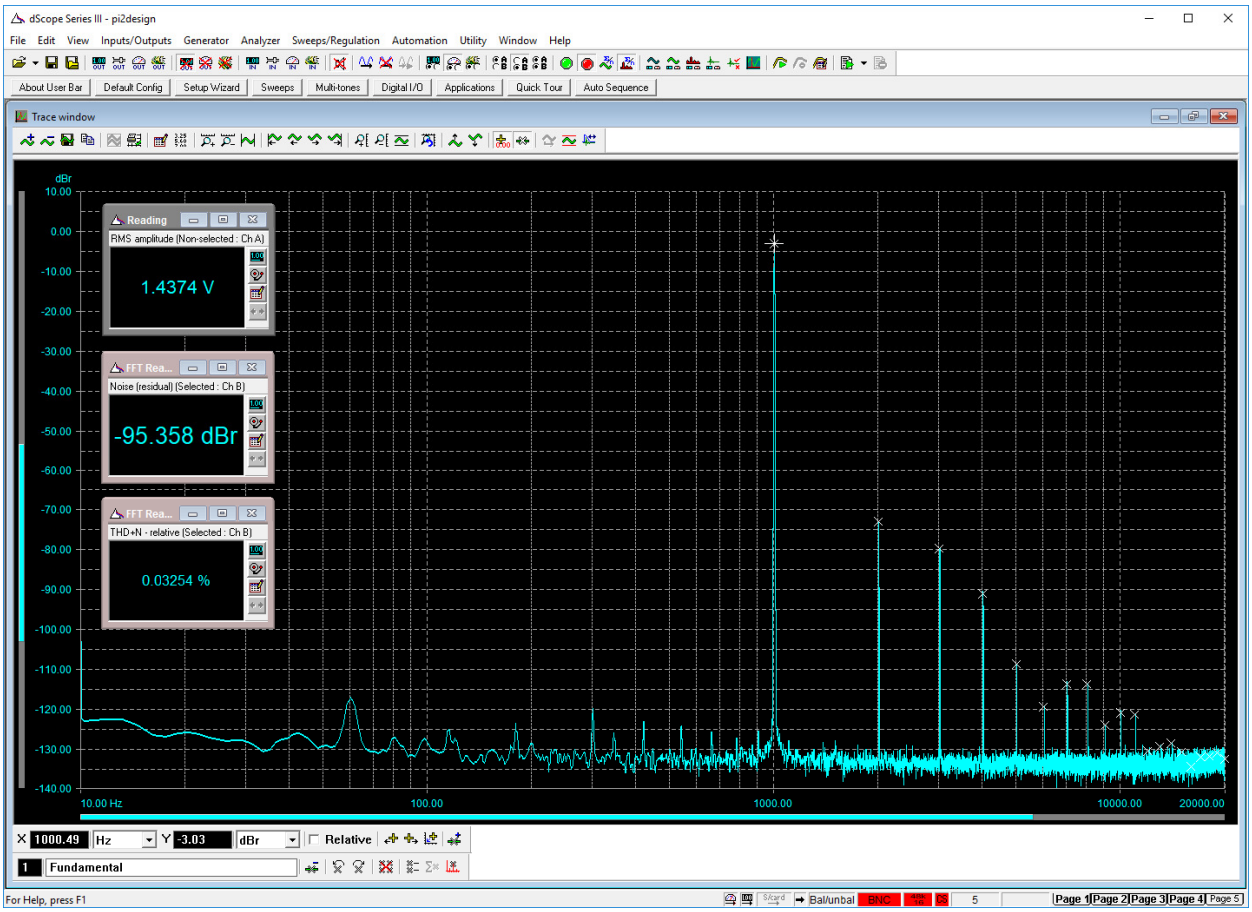


Figure 6 - Ceres Headphone Out, 1Khz, 24-Bit@96Khz, -3dB, 600 ohm

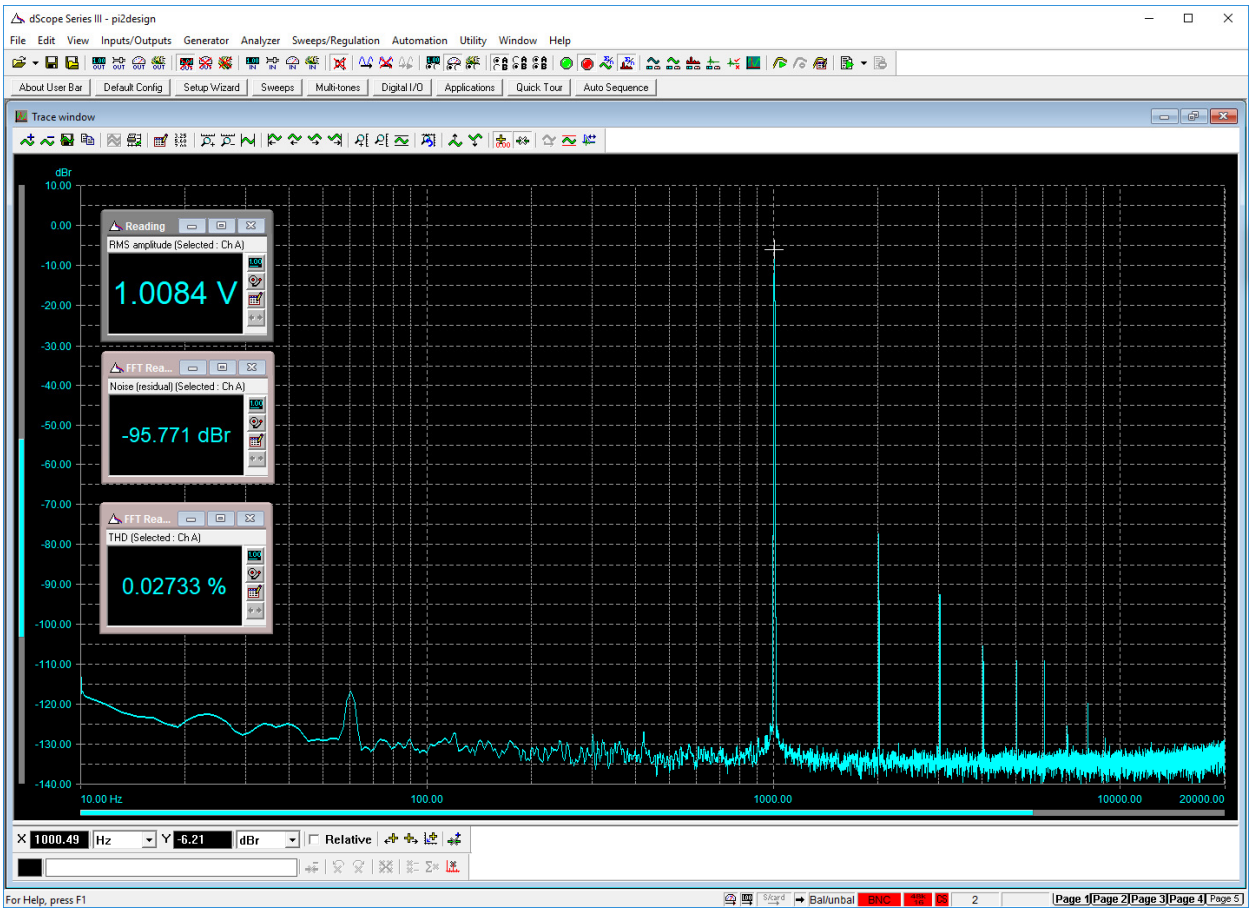


Figure 7 - Ceres Headphone Out, 1Khz, 24-Bit@96Khz, -6dB, 600 ohm

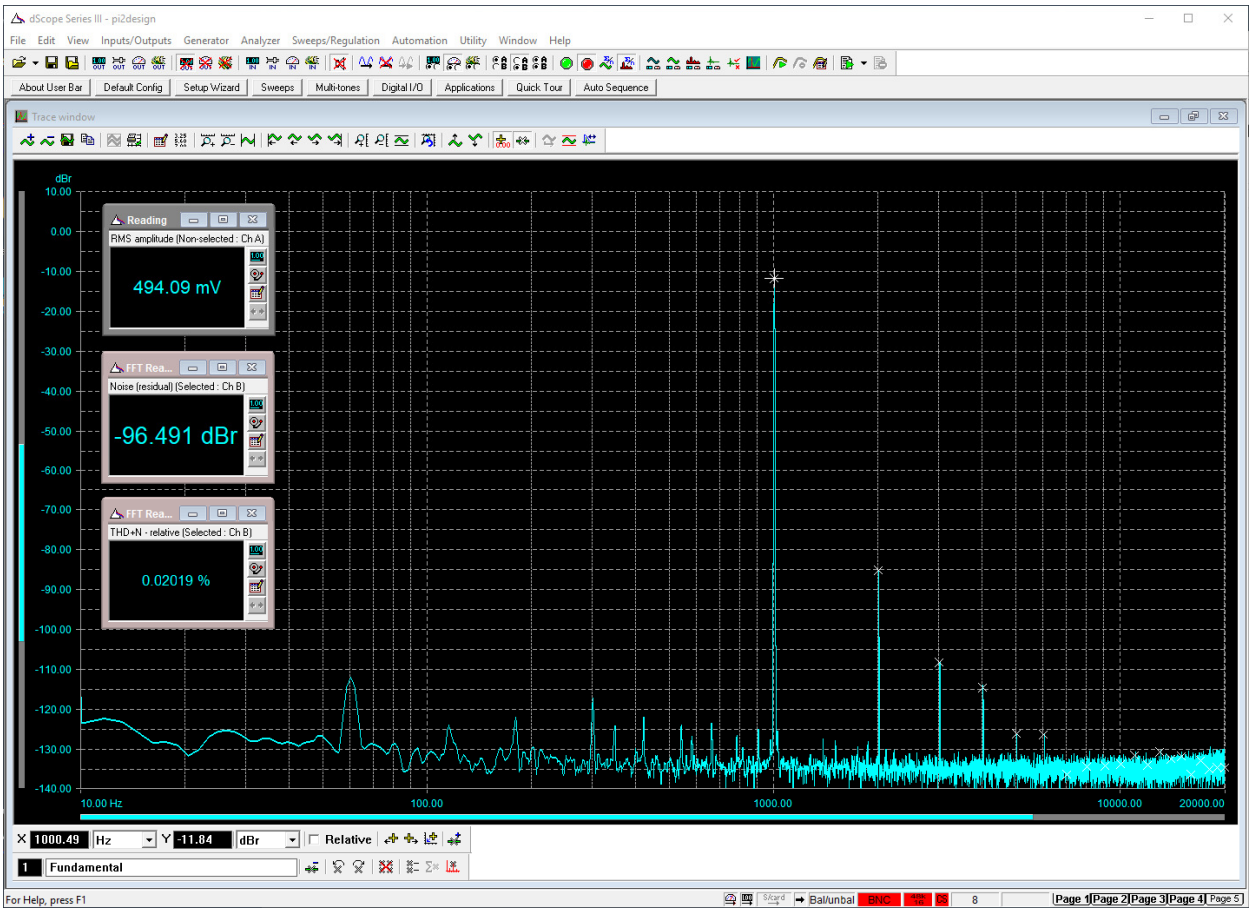


Figure 8 - Ceres Headphone Out, 1Khz, 24-Bit@96Khz, -12dB, 600 ohm

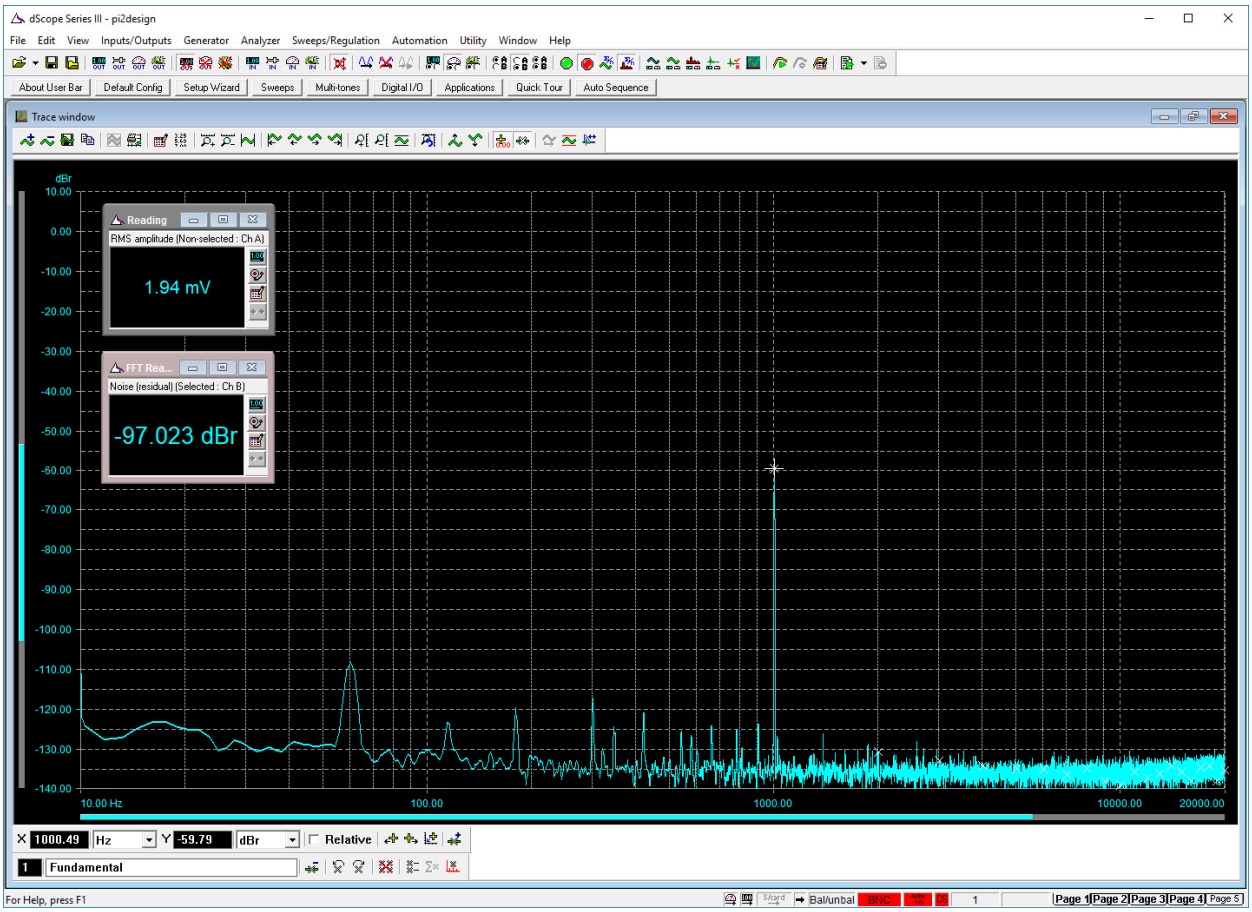


Figure 9 - Ceres Headphone Out, 1Khz, 24-Bit@96Khz, -60dB, 600 ohm (Generator set to 50mV rms)

8 DOCUMENT REVISIONS

Date	Revision	Change
10/1/2017	P1	Preliminary Release

Table 2 – Document Revisions

9 ERRATA

9.1 OVERVIEW

There are currently no known errata for Ceres Rev. P1.