# Teardown Report: Chime DAC

Here is a detailed look at design architecture and part selection. **By Jim Hagerman**

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Having built a reputation with analog phonostages, I decided it was time to pursue the dark side of digital. Why not bring the same high quality to the CD format? And so the Chime was born.


*Fig 1. Chime vacuum tube DAC.*

### Features

This is no cheap DAC. It is an all-out assault on the state-of-the-art. Only the best integrated circuits were chosen. The Chime is loaded with features and technology that even the $10,000 and $20,000 DACs cannot match. The key to its extraordinary performance is the simplicity and elegance of the architecture. It is purposely designed for 44.1kHz-operation only, shunning SACD or DVD-A inputs. It does, however, have a USB port, which permits you to play CDs from your computer. A phase switch let's you switch output signal polarity on the fly, compensating for misrecorded CDs. A handy volume control eliminates the need for a linestage, allowing a minimalist system configuration.

## Motherboard

The main board contains the power supplies, tube output stage, USB circuit, and I/O connectors and controls. It is the same size and shape as the circuit boards found in the Cornet2 phonostage, Clarinet linestage, and Cymbal power amplifiers. The HagDac daughter card mounts on the backside of the circuit board, along with the tube sockets. When installed in the chassis, the sockets face upwards. All connectors and controls are mounted right to the board, minimizing external wiring for an exceptionally clean chassis.

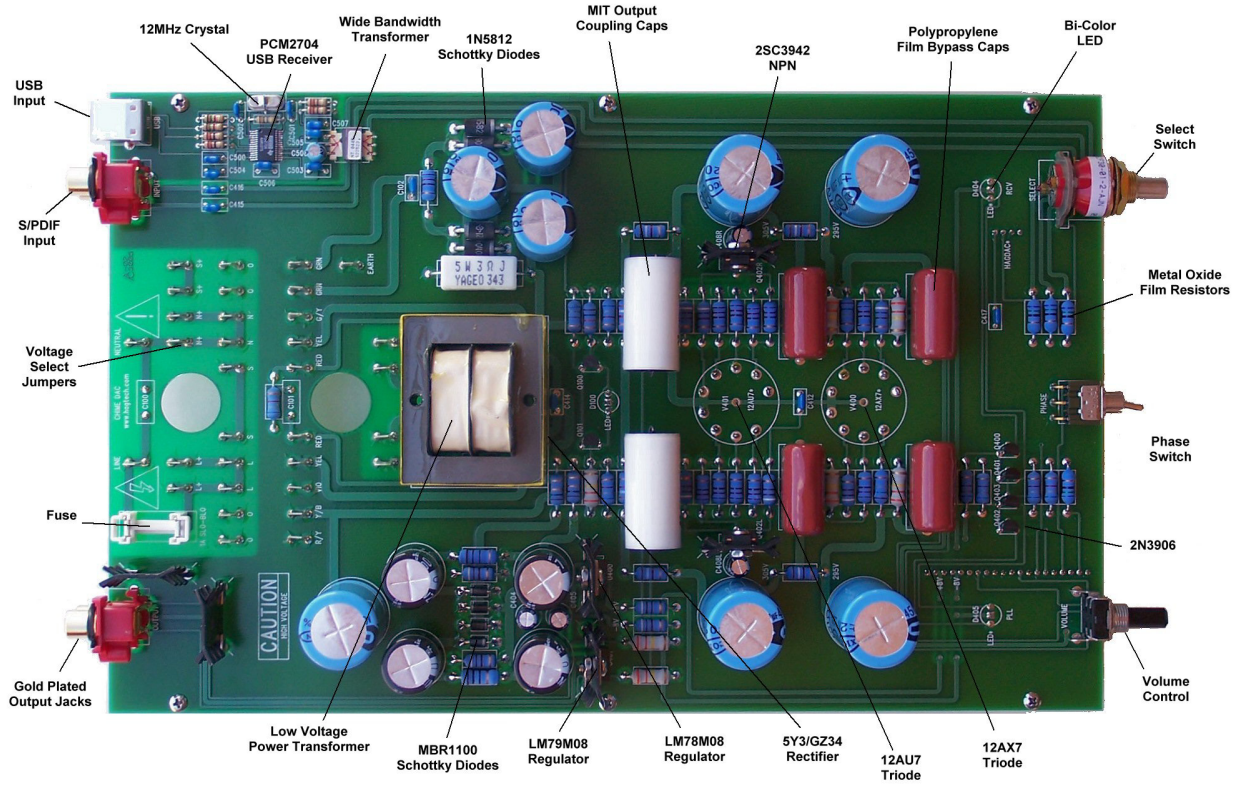


*Fig. 2. Breakdown of Chime motherboard. The 370BX transformer plugs into terminals.*

The HagDac is powered by a separate low voltage supply, the transformer mounted below the tube rectifier used in the high voltage supply. Schottky diodes and linear regulation provide clean +/-8V power to the HagDac (which then filters and regulates again). The regulators are biased deep into class-A operation, so they effectively operate as shunt types.

There are two S/PDIF digital audio inputs, terminated in 75 ohms. A PCM2704 USB-to-S/PDIF converter chip provides a third input. Special PCB microstrip transmission lines maintain proper impedance loading. A rotary switch selects an input and routes it to the HagDac. The output from HagDac is a relatively low amplitude voltage (50mV), which drives the volume control. 30dB of gain is provided by a low-noise 12AX7 stage (adapted from the Cornet), followed by a

current sink loaded 12AU7 cathode follower. High quality polypropylene film capacitors are used for output signal coupling and as supply filters.

## HagDac Daughterboard

The conversion from digital to analog is all performed on the HagDac engine. A discrete fully differential input stage receives the incoming S/PDIF and cleans it up for optimal reception by the CS8415A. Careful layout, grounding, and special supply filtering, insure maximum performance by its internal PLL. Regardless, when using such a wideband VCO, there will be measurable jitter. The output signals are then upclocked by 8x and interpolated to 24 bits by a DF1704 digital filter. The output clock from here is the input to the fancy reclocking circuit. A zero-hysteresis HCT9046A phase detector is used in a very slow PLL loop, controlling a low-jitter VCXO. The VCXO clock tracks the input clock, but is a very clean regenerated version without the jitter. This new clock drives the expensive PCM1704 converters.

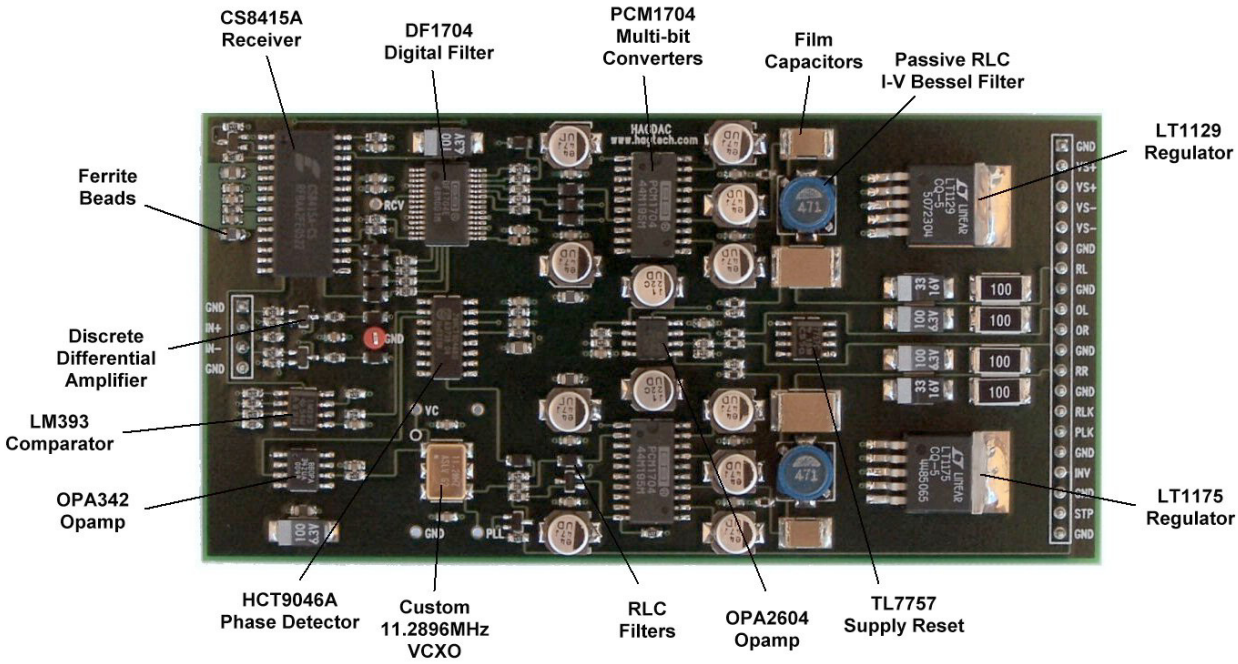


*Fig. 3. Breakdown of HagDac daughter card.*

The PCM1704 converters have current outputs, which are converted to voltage by an innovative RLC passive Bessel filter. The loading on the converter is 50 ohms in the audio band, so linearity is maintained. The phase-linear low pass filtering removes all ultrasonic switching noise, leaving only a pure and clean audio band signal.

Ferrite beads, power planes, and a specific mixture of ceramic, film, tantalum and aluminum electrolytic capacitors are used to provide clean and isolated supplies for each circuit section. Careful separation and interfacing between digital and analog circuits insures quiet operation. There are fifteen inductors sprinkled across this all surface-mount board.

## Conclusion

Exploiting my background in analog design, I was able to bring an innovative twist to conventional DAC circuits, improving them beyond what was traditionally available. The Chime DAC brings top-notch performance within the reach of many.

**ABOUT THE AUTHOR**

Jim Hagerman owns Hagerman Technology LLC, a supplier of unique DIY half-kits and high-end audio products. He's been designing analog circuits for 23 years. (www.hagtech.com)