

# SACD Production Using Direct Stream Digital

## Super Audio Compact Disc. The Next Generation of Audio.

For all the improvements in PCM digital audio, it was clear that better sound would require a new technology. Both Philips and Sony decided that a new approach to audio recording and reproduction was needed hence the Super Audio Compact Disc (SACD) standard was born.

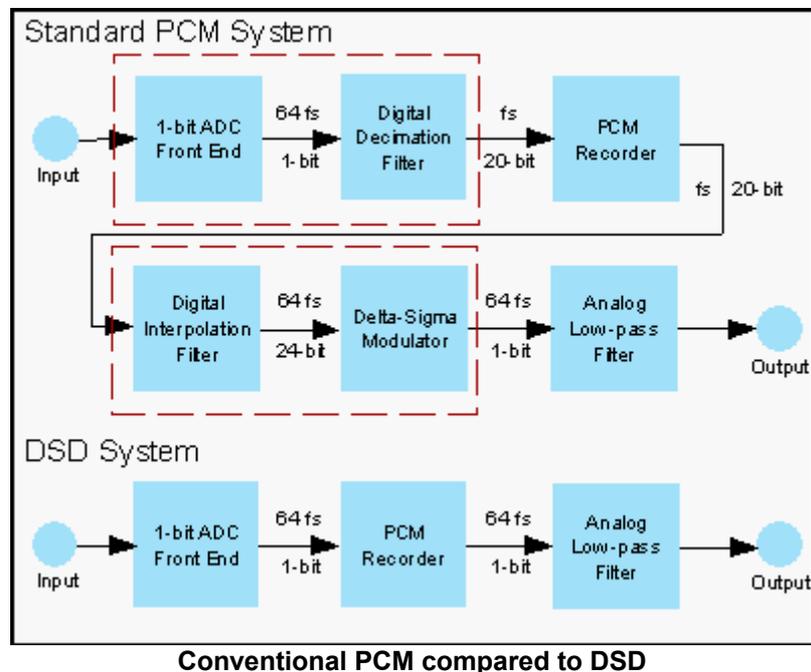
SACD is a two-layer hybrid disc, one layer containing traditional "Red Book Audio" 16bit / 44.1kHz CD standard so that the new disc can still be played on standard CD players and a second high-density layer, which can be played on a SACD player offering the ultimate quality in 2 channel (stereo) and multi-channel (6 channel or surround) with a frequency response of DC to 100kHz and a dynamic range greater than 120dB. The high-density layer also can be used to store text, graphics and video information creating a multimedia performance during playback.

Along with the sonic improvements, SACD also offers an active copyright management system, a copyright identification system and both visible and invisible digital watermarking and is the perfect medium for archiving.

## Direct Stream Digital (DSD) Encoding

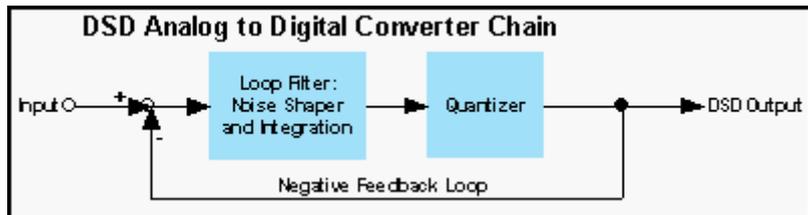
DSD is the technology used to record and produce audio content on the SACD. DSD is a 1-bit representation of the audio waveform with 2.8224Mhz of sampling. This allows SACD to achieve its unprecedented audio quality allowing it to reproduce audio better than any other digital or analog technology.

The main problem with standard PCM technology is that it requires both steep (brick wall) filters to block frequencies above 20kHz (specifically at 22.05kHz) which is difficult to build. It also requires the addition of re-quantization noise for its decimation (down-sampling) digital filters and interpolation (up-sampling) digital filters. These problems limit the actual fidelity of the reproduced audio.



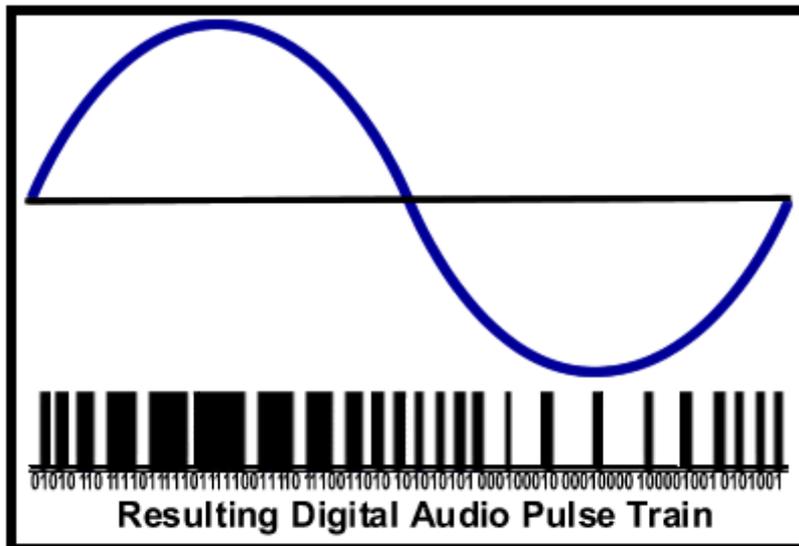
Conventional PCM compared to DSD

DSD simply removes all the filters and records the audio directly in its 1-bit, 64x over-sampled delta sigma modulated form.



**DSD Analog Input Chain**

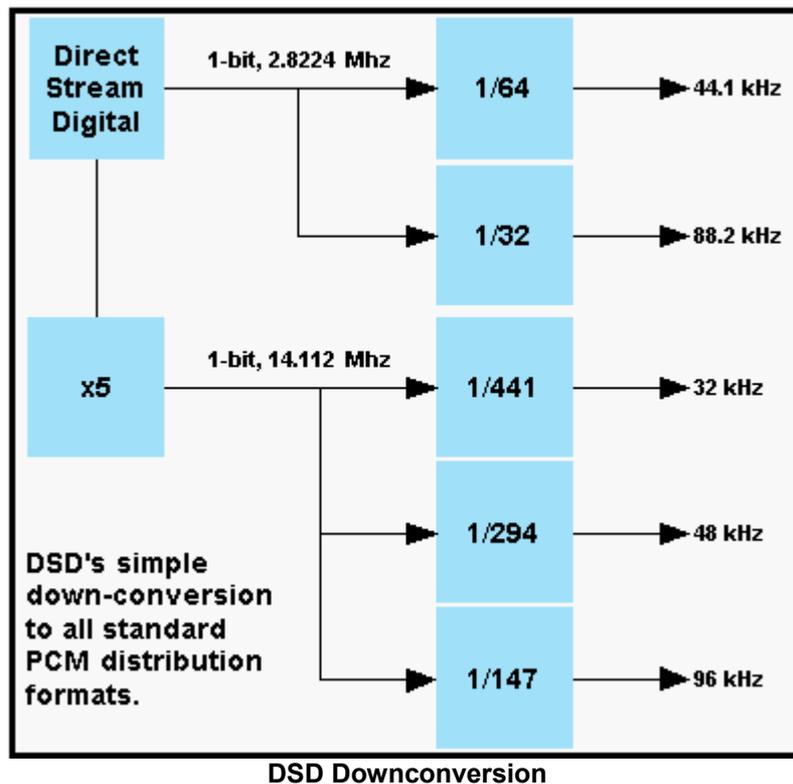
Using a negative feedback, if the input waveform, accumulated over one sampling period, rises above the value accumulated in the negative feedback loop during previous samples, the converter outputs a digital "1." If the waveform falls relative to the accumulated value, a digital "0" is output. As a result, full positive waveforms will be all 1s. Full negative waveforms will be all 0s. Alternating 1s and 0s will represent the zero point.



**Resulting Digital Audio Pulse Train**

The resulting pulse trains "looks" remarkably like the audio waveform that it represents. Furthermore digital to analog conversion can be as simple as running the pulse train through an analog low pass filter!

Sony and Philips designed DSD to capture the complete information of today's best analog systems. The best 30ips half-inch analog recorders can capture frequencies past 50 kHz. DSD can represent this with a frequency response from DC to 100 kHz. To cover the dynamic range of a good analog mixing console, the residual noise power was held at -120 dB through the audio band. This combination of frequency response and dynamic range is unmatched by any other recording system, digital or analog.



Using single stage FIR digital filtering and noise shaping, 1-bit DSD can be down-converted into standard 24, 20 or even 16-bit PCM audio for CD distribution while still retaining the maximum possible audio quality. The system's 2.8224 MHz sampling rate is specifically designed for high precision down-conversion to all current PCM sampling rates using simple integer multiplies and divides.

### **DSD Recording and Mastering Systems for SACD Production**

Currently there are only 2 fully compliant DSD editing tools available; Merging Technologies (in partnership with Philips) Pyramix System and Sony's DSD prototype DSD editor.

Sony's prototype DSD editor is meant as an initial test recording system for DSD mastering. It is an 8-channel DSD only editor that allows mastering and mixing in both stereo and surround. Basic equalization is also included with the system and full annex D and E metering for SACD Scarlet Book conformance.

Built as an additional high-end DSP add-on to the Pyramix's current VS\24 core, the DSD option offers seamless integration of multi-channel real-time DSD editing, mixing, processing and mastering. Current software and DSD hardware revisions offer real-time simultaneous mastering of both stereo and surround sound DSD and the ability to record up to 24 channels of DSD. By simply adding additional Mykerinos cards more DSP is available to support more channels of DSD. Further flexibility comes from the choice of I/O that is available, including ADAT, AES-EBU, SDIF, TDIF, MADI and MADI-XS.

The Pyramix is currently the only digital audio workstation in the world that offers all possibilities of mixing and mastering, 16 to 32-bit with real-time dither, in all sample frequencies 32-384kHz covering CD, DVD and DVD-A formats plus the DSD format 1-bit/2.8442Mhz. Other features include a full suite of real-time effects including dynamics, equalization, compression, gate, delay etc. Real-time surround sound mixing, PCM to DSD conversion, real-time cross-fades, full annex D and E metering for SACD Scarlet Book conformance and the only real-time high definition reverb plug-ins in the industry for 1-bit/2.8442Mhz DSD, 24-bit/192kHz DVD-A and 24-bit/96kHz DVD that can be used for both stereo or surround sound production.



**Pyramix Interface click to see large view**

The ultimate DSD production systems need the ultimate analog to digital, digital to analog DSD converters. Both Sony and Philips are exclusively using EMM Labs 8-channel DSD converters. Created by the famous Mr.Ed Meitner a pioneer in the field of professional digital audio especially for DSD production technology, these are the first and best DSD converters in the world.