

By Charles Dube

Sencore's SPDATB Toolbox

A Digital Watchdog That Catches the Bits

[AMHERST, Massachusetts] Although digital audio has been around within the walls of WFCR's studios for several years now in the form of PC soundcards and DAT machines, it was the station's addition of an HD Radio service that made it clear that our diagnostic tools were in need of an upgrade.

SINE WAVES SQUARE OFF

For over a century the world of analog audio has been with us, exemplified by the needle vibrating in the groove of an LP record, recreating the original vibrations of the performance with tiny electronic vibrations. It is a world of easily measurable signal transients, electrons bouncing through the familiar mediums that we can recover into sound and images by common methods.

Analog audio can be converted easily enough to empirically determine certain aspects of its transmission: a cheap audio amplifier connected to a speaker lets us listen to a signal for level, distortion and tonal quality. We also may see the visual representation created by the oscilloscope, which allows us to view waveform characteristics such as frequency, noise and distortion.

In the digital world, the signal is radically different; things are moving at speeds inherently much faster than anything we might perceive in analog. The extremely quick on and off pulses comprising the bitstream flood present a whole new dialogue of issues and definitions; distortion now can be the wrong state of change at a given moment of time – an “off” when there should have been an “on,” or visa-versa.

Since this digital signal has no visible resemblance to the vibrations it purports to represent, the lack of authenticity between a particular digital “word” (representing a given signal's state at a microcosmic fraction of time) stored in a medium, and then recovered to be converted back to analog again, may not be at all perceptible to the ear with a cause that is easy to determine.

A BASIC DIGITAL ANALYZER

There are several flavors of digital decoders, generators and the like available, but what I was looking for was a veritable tool-kit; something rugged and portable for use in the studio and at the transmitter site that could tell me with some precision what I was looking at; some of the characteristics of a perplexing bitstream. The TerraSonde DATB-1 Digital Audio Toolbox (recently acquired by Sencore and renamed the SPDATB) meets that description with ease.

The SPDATB “Toolset” functions include a digital transparency test and a bitstream analyzer which shows voltage level, bit depth, and levels. Stuck bits and errors will be shown here if existent. The transparency test is very useful in determining the authenticity of a recording device's ability to record digital data without error or digital distortion.



The SPDATB is a welcome addition to the WFCR test bench.

Checking a digital audio workstation at unity gain, the validity of an ISDN, duplex STL, or other digitally encoded bitstream transmission (accomplished by recording on the far end and retransmitting back to the source) are other valuable uses for this test.

WHAT TO CHECK FOR

The delay of digital signals through signal processing devices can result in phase error that can be measured with a latency test. Jitter, a condition in which the timing of the digital signal is askew of its clock reference, can seriously degrade (or “smear”) the quality of the digital audio through the signal path.

Measuring the signal at various interface points can help determine the location of problems created by mismatched cable, connector (interface jitter), or trouble in the output of a device that creates conversion jitter.

A digital signal generator is also your digital “function” generator replete with square waves, sine waves, white and pink noise, as well as Dolby 5.1 generic test signals. Known and accurate digital levels can be generated for use with various test functions described herein.

The SPDATB accepts AES/EBU, S/PDIF, Toslink (light)/ADAT, and can output in these formats as well. A 1/4" analog output can be set up as unbalanced stereo (i.e. headphones for monitoring) or as balanced mono. A built in speaker is used for monitoring digital audio without headphones and is menu selectable. Word clock and video input (for testing lock between a sync signal such as blackburst and associated digital audio) is accomplished through a BNC jack.

UNDERSTANDING THE DATA

With the SPDATB, I am able not only to translate a digital bitstream into analog audio to monitor my signal, but am given a great deal of information about the nature of what I am hearing as well. A bitscope function displays the digital signal in a manner much like that of an oscilloscope.



The Bitscope function here is showing a 44.1 kHz AES signal (each horizontal division representing 2.5 samples). Dynamics are indicated by the vertical expansion of the waveform (in this example, about 12 bits positive peak at a 24 bits full scale setting).

The bits P-P setting can be adjusted to amplify this signal immensely; for example, a 6 dB gain is achieved by setting the bitscope to a 23 bit FS resolution. The maximum amplification, 120 dB of gain, achieves a FS resolution of just 4 bits for viewing of very small details such as dither or converter noise.

In this mode one is able to actually listen for dither (the purposeful addition of noise [!]) to enhance resolution and dynamic range), converter noise and verify phase between the left and right channels of an incoming stereo signal. A simple cable tester (utilizing a “Julian Dunn J-test” which outputs a special worst case signal and measures it) allows for quick checking of an AES or S/PDIF cable's ability to pass a signal without affecting it.

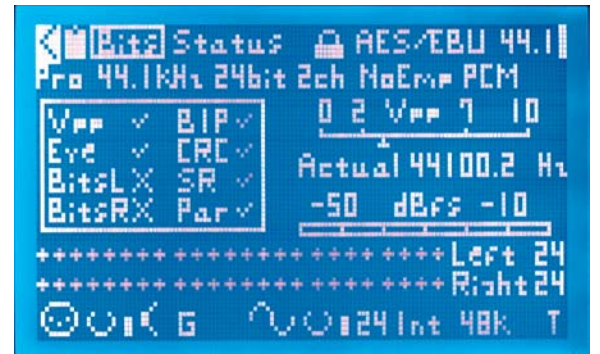
All of this comes in a sturdy metal package (an SPDATB falling off of a shelf and hitting one on the head will assure a “0” state of consciousness for a good length of time) with an easy to read LCD display. A self-contained rechargeable battery and power supply allows for portability and versatility. A foam-padded case for protection while the SPDATB is being transported is standard issue.

TESTING THE SYSTEM

At WFCR, although much of our current studio plant is analog, once the programming leaves the building it is mostly digital (aside from restoring analog for the analog transmitter).

The audio is converted to a 44.1 kHz bitstream at the beginning of our studio to transmitter (STL) link and stays digital (QAM to recovered AES) for the duration of our HD Radio chain. In the process of making its way from the link's receiver to IBOC and FM, several cables, digital signal processing and some rate conversion does occur.

The basic diagnostic tools contained within the SPDATB provide graphic displays of this bitstream which I can use to confirm proper operation of various stages. The Bitstream Indicator selection sports a sample rate counter, voltage meter, and word length and bit activity monitors.



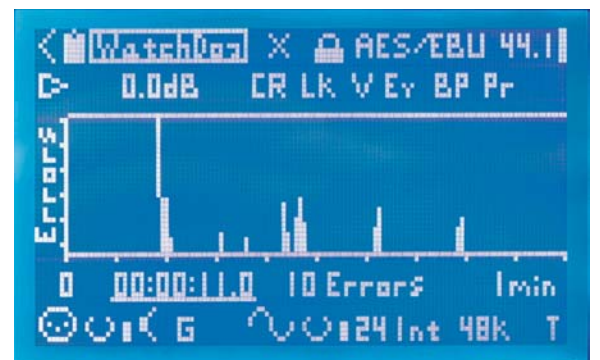
Here a 44.1 kHz AES signal is confirmed as PCM with good “eye” and level characteristics. The dotted lines represent the changing states of bits in the digital word. In this case, the signal is utilizing almost all available bits indicating a fairly hot signal with little dynamics.

An “eye error” (pass/fail) indicator will be displayed should the digital signal's change of state become sluggish or insufficient due to conditions such as inadequate cabling capacitance.

THE DIGITAL WATCHDOG

One particularly useful feature in the SPDATB is the inclusion of the “Digital Watchdog,” which allows one to select a period of time from one minute to 24 hours; the Watchdog will indicate when and if digital disruptions or errors have occurred within that time period.

This function is detailed enough to unearth one sample error in a 24 hour period. Problems caused by intermittent digital devices in the signal chain, or (as I found especially useful) disruptions in the studio to transmitter link's RF signal path, are acknowledged when the SPDATB is connected to the link's AES output, or even further downstream.



In this signal, we can see frequent disruptions caused by a poor cable connection. The line running horizontally across the top indicates elapsed time. The vertical bars in the display indicate errors times. The unlocked lock at the top shows the signal came unlocked at the end of the test period.

Using the graphic display, one can determine when the errors occurred during the sample period, which is certainly useful for troubleshooting regularly occurring interruptions like those caused by STL interference.

The Digital Watchdog will indicate excessive levels, lock trouble, data integrity, and bitphase errors. Knowing that intermittent failures never occur when the engineer's eyes are on a troubled device (quantum physics at work?), the Digital Watchdog takes on the burden of monitoring for failure over a chosen time frame, which can prove invaluable.

With the variety of functions available in one package, I am confident the SPDATB will save me time and aggravation in troubleshooting the growing number of digital signals residing in our plant, and doing so without having to resort to the nuisance of swapping out of boxes and cards.

Chief Engineer at WFCR, Amherst, MA, Charles Dube has worked at radio stations in Massachusetts and Connecticut for over 15 years. Contact Charles at cld@admin.umass.edu