NTI Digilyzer and MinILINK

Mike Rivers

Most of us know Neutrik as one of the major manufacturers of audio connectors, but they have a whole other division that builds test equipment. Traditionally their test equipment has been oriented toward laboratory and production use, but at the 1998 US AES show, the Minirator, first of the NTI Minstruments (Mini test instruments) product line for the rest of us was introduced. I reviewed this pocket-sized audio signal generator in the June 1999 issue of Recording and since then I've rarely left home on a remote gig or service call without it. Next to come along was the Minilyzer, that, together with the Minirator, puts practically a whole analog audio test bench in your hands. When the Digilyzer was announced at a show a bit more than a year later, I was excited and eager to get my hands on one.

Update:
In 2000, NTi Audio became an independent company, no longer part of Neutrik. The Minirator has been updated to the Minirator MR22

Unfortunately this one took a while longer to get to market and for production to gear up, so it wasn't until shortly after the October 2003 AES show that one appeared on my doorstep along with a MiniLINK kit, the newly announced USB computer interface for the Minilyzer and Digilyzer. For the next couple of days, I ran around the studio and workshop like a kid with a new toy (well, I was, wasn't I?), Digilyzer and cables in hand, measuring everything digital that I could find. Now that the digital dust has settled, it's time to put bits to disk and tell you what it's all about, what's cool, and why you may or may not need one.

What It Is, and What it Isn't

The NTI DL1 Digilyzer is a hand-sized test instrument designed to make measurements of digital audio equipment in the digital domain. It's great for troubleshooting, diagnosis, and, as part of a preventive maintenance program, useful for heading off troubles like deteriorating cables before they bite you during a session. It isn't a replacement for a complete digital analysis workstation like the Audio Precision System Two, but it's less than a quarter the price.

Analog vs. Digital – Comparing the ‘lyzers

In looking over my review of the Minilyzer to make sure I didn’t repeat myself too much since the two Minstruments have a lot in common, I recognized that I expended quite a few paragraphs discussing the user interface and parameters that it measured and kind of short-changed you faithful readers on applications. Since the most interesting thing about the Digilyzer is its potential applications, this time around I’ll point out some of the major differences in the way that the two devices make similarly-named measurements in their respective domains and talk more about applications. After all, you don’t expect a review from me without an education too, do you?

The Digilyzer has a lot in common with the Minilyzer – A very similar package and user interface, and they make many of the same measurements, but from different sources. Digilyzer input connectors are a female XLR for AES3 (AES/EBU), RCA jack for S/PDIF coaxial, and TOSLink for S/PDIF optical and ADAT™ 8-channel optical (Lightpipe).

A mini headphone jack and a built-in loudspeaker (a welcome addition unique to the Digilyzer) allows you to listen to whatever is coming into the active digital input. While the Minilyzer has a permanently engaged automatic volume control for its headphone output, assuring that you’ll hear something no matter what you connect, the Digilyzer allows you to select between automatic and manual level control. With no digital input present, it cleverly defaults to being an analog monitor. When troubleshooting a system, It’s handy to be able to aurally verify that what you’ve connected to the unit actually has a signal present. If you inadvertently connect an analog signal cable to the Digilyzer input, you’ll still hear something from the speaker and be reminded by a blinking “ANALOG MONITOR ON” message on the display that this probably isn’t what you intended to connect.

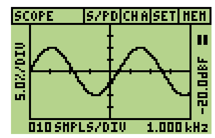
While the Minilzyer can replace a shelf full of analog test equipment that you may already own or have considered buying as old-but-serviceable surplus at a hamfest or auction, the Digilyzer integrates a lot of test equipment that you most likely don’t have, nor are you likely to find inexpensively through the “experienced equipment” channels. Digital measurement and monitoring technology simply hasn’t been around long enough to be in its third or fourth generation.

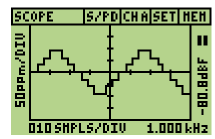
What’s on the Menu?

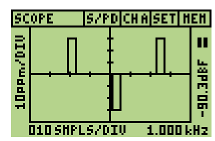
Channel Status, Bit status (the actual audio data), Event logger, VU/PPM level display, Peak and RMS level, swept frequency response, THD+N, and waveform (oscilloscope) display. Depending on the display selected, either information for both channels is shown together (for instance the VU and peak meters) or either of the two channels can be selected from a drop-down menu.

The Digilyzer operates at sample rates from 32 to 96 kHz. At 96 kHz, both the double-frequency and double-wire modes are accepted. Since there's only a single input connector, when using the double-wire mode, only the connected channel's data is displayed.

One important difference between these analog and digital siblings is the audio frequency range. The Minilyzer cover the audio frequency range of 20 Hz to 20kHz. Since the Digilyzer can accommodate sample rates up to 96 kHz, audio frequency measurements cover the full legal range, up to just below 48 kHz when connected to a 96 kHz sample rate source.

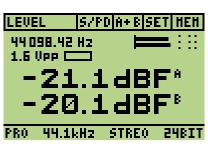


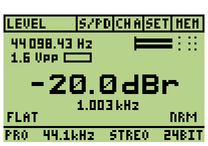




Like the Minilyzer, the oscilloscope display is self-scaling, but the vertical scale is in percentage of digital full scale (all bits on for the selected word length), with the nominal signal level displayed numerically along the right hand edge of the scope trace. With more or less normal levels, a sine wave looks like a sine wave, but (here comes some education) as the amplitude drops, you can see where the samples are taken. Here's the scope display of a 1 kHz 16-bit sine wave at three different amplitudes. The lower the amplitude, the fewer discrete amplitudes are sampled, and at –90 dBFS, only one sample is taken during each half cycle. However, according to the Shannon/Nyquist sampling theorem, this is sufficient for complete and accurate reconstruction of the input signal, and in fact, the total harmonic distortion as measured by the Digilyzer for each of these three waveforms is essentially identical.

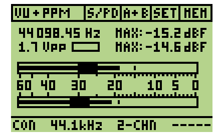
While the horizontal sweep of the scope doesn't go lower than 10 Hz, the scope's response goes down to DC, so it will show the presence (and effect of) a DC offset. A pause button allows you to freeze the scope display for closer examination.



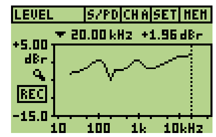


Static levels can be displayed either as peak level relative to full scale, or as RMS level relative to a sine wave with a peak value of 0 dBFS. A bar graph at the upper right displays the relative level of both channels continuously. Displays are combined in a somewhat curious way, with the peak display showing the level of each of the two channels (but not the frequency) and the RMS display showing the level of the selected channel and the audio frequency of the input signal. This suggest that the peak display may be more useful when testing with program material or noise, while the RMS display is more suitable for testing with sine waves.

In the VU+PPM metering mode, the display presents the level of both channels in a horizontal bar graph, with the tip of the bar indicating the peak level and a



larger block along the bar that emulates the response of a VU meter. The maximum level for each channel is displayed numerically (re-settable with a press of the Enter button), and an Over indicator at the end of the bar lets you know when you've reached full scale for 1 to 9 consecutive samples, as configured from the SET(up) menu. These days we usually want to know if even a single sample hits full scale when working at 24-bit resolution, but we tend to be more liberal when working at 16-bit since we'd like to keep the average level a bit higher to maintain resolution.



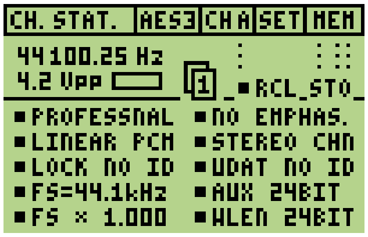
In addition to displaying static level and frequency, like the Minilyzer, the Digilyzer can plot a frequency response graph when the test frequency is swept through the measurement range. Here's a plot of a randomly tweaked equalizer.

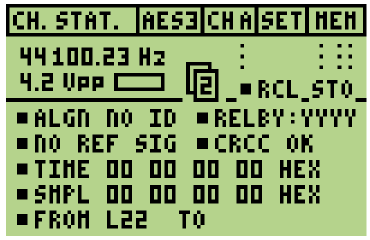
One feature of the Minilyzer that's lacking on the Digilyzer is the 1/3 octave spectrum display. By looking at the spectrum, you can easily determine whether you have honest-to-goodness distortion or if what's coming out that didn't go in is buzz at the AC power line frequency and its harmonics. On the Digilyzer, THD+Noise measurements are made in the digital domain, measuring the deviation of the digital output from a perfect sine wave at the input frequency. Like the Minilyzer, a 400 Hz high pass filter can be switched in to eliminate the contribution of a dodgy power supply from distortion measurements. A 22 Hz – 22 kHz bandpass filter is also available for measuring distortion over the common audio bandwidth. Since distortion skyrockets once samples start hitting full scale, the THD+N display includes an indicator that warns you to reduce the level.

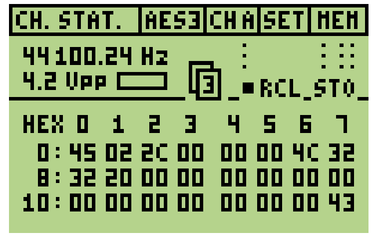
The Real Geeky Stuff

Measurements of the basic A/D conversion process is useful and information, but the real meat of the Digilyzer is its power to read and display the non-audio parts of a digital audio data stream known as the channel status data. Audio is just audio, but this is where the interesting stuff, little things that can keep your system from working if you have some conflicts, can be found and analyzed. Channel status information is defined in two published standards. The Professional format is in AES 3-2002, which you can download from the Audio Engineering Society Standards Committee web page http://www.aes.org/standards. The consumer format is documented in IEC standard 60958 which is not free. The Digilyzer instruction manual includes an abbreviated listing of the channel status bytes in each format, enough to get you started.

The DL1 displays three pages of channel status data – that's a lot! The good news is that it decodes most of it for you so that it's readable in reasonably plain English. Here's a set of the displays for the output of my Lynx L22 audio I/O card:







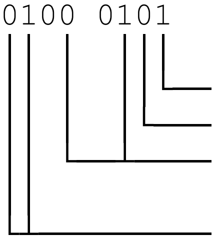
Page 1 is the most user friendly, Page 2 is a bit more obscure, and Page 3 is where the fun starts. This is the raw channel status data displayed in hexadecimal format. Here you can really get into what the device you're testing thinks it is and how it's representing its data. Most of the action as far as what makes interfaces talk together (or not) is in the first four bytes, and these are pretty clearly decoded on the first Channel Status page of the Digilyzer.

Let's take a look at the channel status data for one channel of the digital output of the Lynx L22 audio I/O card set for the Professional (IEC-958 Type 1) format and running at 44.1 kHz sample rate. The channel status is organized as 192 bit blocks subdivided into 24 bytes, with each byte consisting of two hexadecimal numbers which represent eight bits.

```
HEX   0  1  2  3  4  5  6  7
 0:  45 02 2C 00 00 00 4C 32
 1:  32 20 00 00 00 00 00 00
 2:  00 00 00 00 00 00 00 43
```

Let's see how these break down. Byte 0, 45$ (the dollar sign means that it's a hexadecimal number) represents the following binary word:

0100 0101



```
0=Consumer, 1=Professional
0=Linear PCM, 1=Non-linear PCM
000=No emphasis flag, 100=No emphasis,
110=50+15µS emphasis, 111=CCITT emphasis
00=Extended (96kHz) sample rate defined in
another byte, 01=48kHz, 10=44.1kHz, 11=32kHz
```

The representation is a little screwy for those of us not accustomed to counting backwards on all sixteen fingers. The least significant bit (LSB) is the rightmost bit so you need read codes represented by more than a single bit , for example the emphasis status, from right to left within their group of bits. For this reason, the three-bit emphasis code in the above example which looks like 001 to a normal reader is actually 100, which translates to "no emphasis." The sample rate code, which looks like 01, is actually 10, representing 44.1 kHz. This took me a while and some documentation-by-example to figure out. Single bit codes are, of course obvious.

For homework, get out your copy of AES 3-2002 and decode the third byte (2C$). The standard defines 20 bits for audio data, but there are four Auxiliary bits which can be used for a number of things. The lower 3 bits [001] tell us that the Auxiliary bits are used to carry the rest of a 24-bit audio data word. The next three bits [101] tell us that the word length is indeed 24 bits.

Other bytes are designated for descriptive data such as a date/time field, and some are available as user-settable bits. Bytes 6 through 9 are ASCII text identifying the device sending the data. 4C 32 32 20 translates to L22[space], the Lynx L22 sound card. The last byte is a cyclic redundancy check (CRC) character on the entire channel status data block and is used to verify that the data received is valid.

When switching to the Consumer (IEC-958 Type 2) format, the interpretation of just about every bit changes. Here's the output from the same Lynx card, but switched to the Consumer format.

```
HEX   0  1  2  3  4  5  6  7
  0: 04 00 00 10 00 00 00 00
  1: 00 00 00 00 00 00 00 00
  2: 00 00 00 00 00 00 00 00
```

Note that the least significant bit of the first byte has changed from one to zero, indicating the consumer data format and telling us that all of the rest of the bits have a different meaning than in the "pro" example above.

```
0000 0100
               0=Consumer, 1=Professional
               0=Linear PCM, 1=Non-linear PCM
               1=No copy protection, 0=Copy protected
               000=No emphasis, 100=50+15µS emphasis
               Not defined
```

In the Consumer format, the sample rate is defined in the four lowest order bits of byte 3 (0000 = 44.1 kHz), and other bits define the generation of the recording, which in turn defines whether a digital copy can be made.

Knowledge is Power

Class is over for the day. Hope you didn't sleep through it. So what's the value of being able to look into the guts of the data stream? It can tell you why things don't play nicely together. Here's a real world example.

A while back, a regular reader of an on-line forum where I'm active asked for my assistance in troubleshooting his system. He had connected his 24-track hard disk recorder to his digital console using AES/EBU interfaces. Every once in a while when mixing or tracking, some channels would all of a sudden become dull-sounding. He'd play them back later and they were fine. He had swapped the interface cards around in the recorder (three cards, each supporting four AES/EBU channel pairs), and interchanged banks going to the console in an attempt to narrow it down to a particular signal path, but it all seemed quite random to him.

Being an analog sort of guy, I started out by connecting my NTI Minirator to one input on the console and routing it to all the recorder tracks simultaneously. I recorded steady tones as well as a frequency sweep. We confirmed that the record levels were identical on all channels, and that the playback response was flat at least as far as the recorder's meters was concerned. With the recorder in the Input Monitor mode so the inputs were routed directly out to the console, we could monitor what was coming out of the recorder with the console's meters. When looking for an intermittent, you try everything to make it happen, including turning things on and off. Sure enough, one time after cycling power to the recorder, we discovered that 10 kHz was about 6 dB lower on one group of eight channels than on the other two groups, however those channels were fine at 1 kHz and lower. A few more power down-and-up cycles and we found that on occasion, either the second, third, or both groups of channels would misbehave in the same manner. The first group was always OK.

This is digital, so what could be acting as a high-cut filter? The answer is emphasis. In the early days of digital recording, high frequencies were boosted in the recording pass, and there was a reciprocal high frequency cut in playback, much like the high frequency equalization in an analog tape deck or phonograph record. This "emphasis" improved the signal-to-noise ratio and high frequency resolution, but created some other problems as well, so its use was discontinued (but it remained defined in the standard) when converters became good enough to do without it. The playback system knows to engage the de-emphasis filter by detecting the emphasis flag (see the channel status analysis above) which gets switched on by the recorder when it's using emphasis.

This recorder doesn't use emphasis, but it uses an AES/EBU transmitter chip that can insert the emphasis flag (just the flag, not the high frequency boost, which has to be done elsewhere) if one of its pins is at the proper logic state. Apparently what was happening here was that something was causing the emphasis flag to switch on, making the recorder appear to be using emphasis when it was not. The console saw the emphasis flag and did exactly what it was supposed to do – roll off the high frequencies on the channels on which emphasis was indicated.

I didn't have the Digilyzer at the time, so I came to this conclusion in a rather roundabout way - observing what happened in the analog domain, plotting the frequency response when the recorder was misbehaving, verifying that it matched the de-emphasis curve, then looking at the schematic diagram of the card and the data book for the AES/EBU transmitter chip, confirming that it indeed had an input (presumably tied to ground in this case) for control of the emphasis flag. If I had the Digilyzer, connecting it to the AES/EBU output of one of the misbehaving channels would have indicated right on Page 1 of the channel status display that emphasis was on, and I knew that it shouldn't be so.

A features of the Digilyzer's that would have been really handy for troubleshooting an intermittent like this its ability to continuously monitor the channel status data and record and store any changes over time. Reading the log is a bit confusing since there are a lot of parameters to examine, but the log can be filtered when reading through it (everything is always recorded) so it's easier to spot changes if things are pretty unstable and there are many log entries. In addition to changes to the channel status data such as this flopping emphasis flag, it also records changes in sample rate (where the actual clock rate is different from the indicated sample rate), audio muting, changes in the digital signal level, and transmission problems such as parity errors or the slow rise time (similar to the "eye pattern" used to represent overall digital data transmission confidence).

Another cool troubleshooting function is the ability to store the entire channel status block and indicate any changes. Note the STO and RCL legends at the upper right of the channel status page and. Pressing the Enter button with the cursor on STO stores the current channel status. If anything changes, the little square next to the RCL button becomes a flipping triangle. Holding the Enter button with the cursor on RCL displays the previously stored status so you can see what's changed. In the case of our errant recorder, we'd be able to see NO EMPHAS change to something else.

Where are all of those Pictures Coming From?

The other box that came in the package with the Digilyzer was the MiniLINK. This is a small circuit board which can be installed in either the Digilyzer or Minilyzer. Installation is a snap, literally. It fits along side the battery compartment, connects with a small multi-pin connector, and is secured with a strip of double-faced tape. A new battery cover supplied with the kit has a cutout for the 4-pin USB connector on the card, and that's the link. With the MiniLINK connected to a computer, screen displays can be captured and stored in the computer as bitmap files, and in some cases (such as channel status data and sweep frequency measurements) also as text files. The application program and drivers are for Windows only (Win98SE, 2000, ME, XP, Vista, Win7, 32- and 64-bit versions)

Memory Storage (a MiniLINK bonus feature)

A ‘lyzer firmware update applicable when the MINILink is installed, adds a new menu item, Memory Storage. Select this and the current screen will be stored in internal memory where you can retrieve and re-display it at any time. Like with most things digital, it’s easy to store too much data for too long, and the MiniLINK is no exception. When you store a screen, it’s identified as a sequentially numbered file name (001 to 999) plus an abbreviated name of the function. D042_SCOPE means it’s the 42nd screen you’ve stored, and it’s a scope display. You can’t really store that many shots - the Minilyzer can store 39 shots and the Digilyzer 78, fewer if you’re storing shots with text data.

After testing several different digital sources and storing their data, it didn’t take me very long to have so many shots stored that I couldn’t remember which came from where. In practice, it’s a good idea to start a testing or troubleshooting project with a clean memory, then jot down what each file name represents. Although you’re free to rename files once they’re stored on a computer, there’s no “Save As” for the screen shots. You can tell from the file name (and the data displayed) what measurement function the shot represents, but it’s up to you to know which one is the output of the sound card and which is the output of the mixer.

In addition to the event logging function for channel status data built into the Digilyzer, the MiniLINK provides an additional logging function for continuous recording of the bit status, level (peak or RMS) and THD+N. The log can be saved as a text file.

With the MiniLINK program opens, all of the screen shots in the instrument’s memory are displayed on the computer screen, so it’s a bit easier to pick out the one you want to review or store on the computer. With the MiniLINK connected, the instrument is powered from the computer’s USB port, saving the batteries.

While I found it a bit awkward, it’s possible to operate the Digilyzer from the computer, either by clicking on the cursor and Enter buttons on the graphic display of the instrument of by using the cursor and Enter keys on the computer keyboard. It would have been nice, with that big picture of the Digilyzer on the screen, to click and drag right on the screen display, but try that and you get a friendly reminder to use the cursor buttons. I did notice that starting up the MiniLINK application shot the CPU usage as indicated by the Windows Task

Manager from a calm 2% up to nearly 50%. I suspect this may be a function of the relative inefficiency of the USB1.1 interface on the MiniLINK.

Although I didn't observe any such problems, given that the MiniLINK is attached to a computer, there's potential for noise and ground contamination from the computer influencing a measurement. If I was trying to do any really low level measurements, I'd be inclined to power the unit from its batteries, storing the results, then if I wished, connect the MiniLINK and save them to the computer.

I was itching to try it in my Minilyzer since it adds a different set of bonus features depending on which instrument it's in. The Minilyzer + MiniLINK can log SPL so you can prove to the Sound Police that you never got too loud during that three hour concert. It also expands on the polarity test function to tailor speaker polarity to full range or woofer, and adds some cable test features.

The initial release of the MiniLINK firmware (which is what I had for review) registers the MiniLINK interface with the instrument on which it's first installed, and the two need to live together as a set. Despite warnings in the manual, I moved the MiniLINK board to my Minilyzer, started up the Windows application program, and received a friendly reminder that the MiniLINK was in the wrong unit, and that if I put it back where it belonged, nobody would get hurt. The factory was going to try to find a work-around for this, but I never got it before I decided that I'd better get this review written. Actually they did have a deal for users with more than one Minstrument, an additional MiniLINK at a reduced price. They've since relented on this MiniLINK-for-life policy and future versions of the MiniLINK will be able to be swapped between units, though you don't want to do it too often because the connector is rather fragile and may not take too many insertions.

One neat feature of the MiniLINK is the ability to personalize it with an alternate startup screen to the NTI trademark. I scanned a Recording Magazine letterhead and loaded that in my demo unit, so when they get it back, they'll know where it's been.

In Summary

The Digilyzer is a really powerful tool, but you have to know more than the average bear about what you're looking for in order to get its full value. If you have a digital interfacing problem, it can tell you things about the transmitting device that the receiving device doesn't understand or is misinterpreting. At $1499 [**Update**: Street price in 2010 appears to be around $1600], it's a bit pricy for me to recommend that every reader run out and buy one. If you're constantly juggling digital gear around, combining new and old devices, or if you're a busy studio that works with clients who often bring in their own gear and expect you to connect it to your system, it could be a real timesaver when you're having trouble getting something balky to work properly.

One thing that I feel obligated to point out is that while the Digilyzer can often tell you what's wrong, much of the time there just isn't a darn thing you can do about it other than replace something that's defective or inappropriate for the application. In the hard disk recorder scenario I described, while perhaps one channel might be salvaged by inserting a Digital Domain FCN-1 Format Converter in line with the signal and using its DIP switches to turn off the emphasis flag at the output (I used my FCN-1 to simulate a lot of problems in doing this review), the real solution would have been for the manufacturer fix what was wrong – assure that the emphasis flag remained off under all conditions - and although I called their attention to the problem, they never resolved it. The ultimate solution in this case was that the studio owner sold off his recorder's AES/EBU cards, replaced them (at 1/3 the cost) with ADAT Lightpipe cards (no emphasis flag there), and happily continued with his projects. This is what it's like in the real world.

The MiniLINK, at $325 ($50 cheaper if you order it together with a Digilyzer or Minilyzer) is a worthwhile addition if you need to keep records of performance or, like me, you use these tools when writing magazine reviews. The MiniLINK software is still evolving – I received a couple of updates during the period I had the units for review – and I did find a couple of instances where I crashed the program (requiring it to be terminated via the Windows Task Manager) by disconnecting the USB cable or turning the Digilyzer power off at an inappropriate time. On other occasions, when bringing up the MiniLINK software with the Digilyzer connected, it complained about a failure in USB communication, tried to read each stored screen, reported that it couldn't, then tried the next one until it was put out of its misery. I trust these kinks will be worked out eventually.

I dearly wish I could justify the cost of owning a Digilyzer, but unfortunately I can't. Being an analog kind of guy, I just don't do that much digital work, so it's going back when they finally send the guy with the baseball bat around to collect. However if I did enough digital interfacing that would save me a couple of hours a month, I'd write them a check in an instant. Give it a hard thought if you've ever encountered the sort of problems it can uncover. It might save you some time and hair pulling.