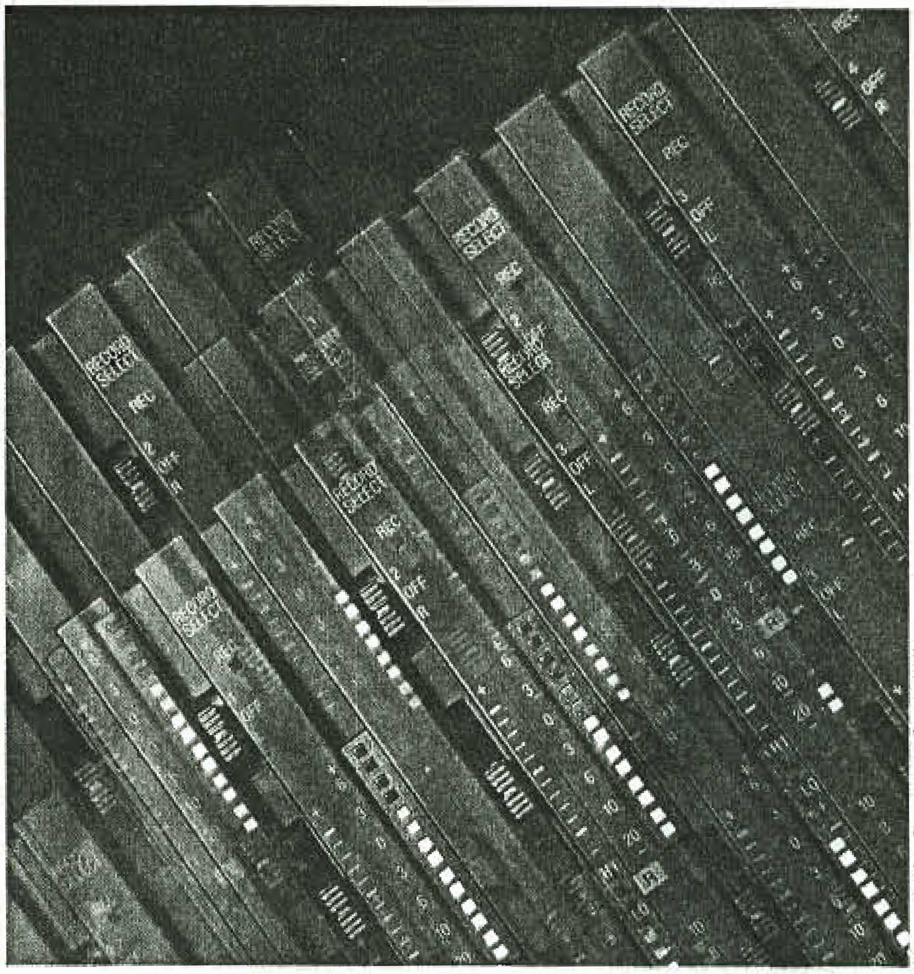
ON THE LEVEL



Photography *Rosemarie Rounseville*

If you've ever wondered why some equipment operates at +4 while other equipment operates at −10, or why there are so many different types of dB, then relax - you're not alone. *Text by Paul White and Eric Turkell.*

THERE IS A lot of confusion about the terminology associated with measuring and describing the operating levels of audio gear. Let's try and clear up the confusion by looking at some of the most common issues concerning levels.

The decibel is the unit most commonly used to measure sound levels. "Deci" means ten, and "bel" is named for Alexander Graham Bell, the man who brought us the telephone (among other devices). Decibels (dB) are used to express the ratio, or relationship between two values. One of these values is a reference (or constant) to which the other number is compared. Thus, when 0dB does not stand for absolute silence, but for the threshold of human hearing, or the level at which the "average" human ear begins to detect sound. The decibel remains the accepted standard of voltage and power comparison.

To understand why this is so, it is important to understand how the ear perceives sound. Our ears hear the logarithmic representations of sound level or volume changes. If you hear one sound, followed by another sound which is twice as powerful, your ear will not perceive the second sound as being twice as loud. To make our measurements reflect our perceptions, the measurement of decibels increases logarithmically.

The dB itself is simply the ratio between two voltages or powers; it is not an absolute measurement of value. Expressed mathematically, $NdB = 10\log(P1/P2)$ where P1 and P2 are the two power levels being compared. Because power is a function of the square of voltage, if we were to compare two voltages rather than two powers, the formula would be $NdB = 10\log(V1^2/V2^2) = 20\log(V1/V2)$. In this case, adding 20dB corresponds to a signal level being increased by a factor of ten.

However, we are concerned with both ratios and absolute levels when it comes to the recording studio and that's where the dBm comes in.

dBm and dBV

If you were to have a standard reference power, then the decibel could be used to indicate absolute measurements. As it turns out, during Bell's experimentation with early telephone systems, it was decided that 1 milliwatt (1/1000 of a watt) would become the reference, or constant, when measuring power (electrical power) and the unit of measure using this reference would be called dBm. As Bell, for some reason, decided to dissipate this power through a 600Ω resistor, the 0dBm level ended up corresponding to 0.775 volts.

When it comes to reading meters in studio applications, the dBm may be used as the unit of measure *if* measurements are made across a 600Ω resistor. Unfortunately, this is not commonplace in the studio where the input and output impedances of equipment vary. This has led to the invention of a new unit which ignores the load resistance. The dBV is the unit of measure, and the reference was changed to one volt.

Because nothing is ever as standard as we would like it to be, dBV measurements are also made to the old 0.775 volt reference which only adds to the confusion. This happens because some multi-meters are incapable of telling what the line impedance is and so measure everything to the dBm standard but ignore the line impedance, assuming it to be 600Ω regardless of its actual value. dBs referenced to 0.775 volts are called dBu to avoid confusion with dBV. Some manufacturers even play it safe by printing both scales onto their meters but, fortunately, this unwelcome source of confusion should not find its way into the studio to disturb your piece of mind.

More Chaos

Back in the early days of broadcasting, it was found that the problems involved in building a meter to accurately measure dBm could not be readily solved due to the loading effect of the meter coil, which at that time was in the vicinity of 4KΩ. Not to be outdone, someone suggested connecting a series resistor of 3.6K to reduce the loading. This was fine, but now the meter read 4dBm too low because of the power dissipated in this extra resistor - so guess what they did next. That's right, instead of re-defining the zero reference level or waiting for someone to invent the high-impedance meter, they decided to accept the fact that a reading of 0VU (or Volume Unit - we'll get into that another time) reading corresponded to +4dBm, and that is where our professional operating standard came from.

So, from all this historic chaos and confusion, we have a universally agreed upon standard that says 0VU should be +4dBm. Or do we?

Along came the Japanese, who regarded all this historic telephone exchange stuff with some suspicion and set up their own standard of −10dBm=0VU, which is now commonly used on semi-pro gear by Tascam, Fostex and so on, but then the designers at VestaFire decided to knock off an additional 10dBm for good measure and came up with a set of effects that would only output −20dBm flat out. That isn't so bad because such devices would just about work with semi-pro gear using the −10dBm level standard.

But wait - there's more . . .

Some of the very nice semi-pro mixing boards currently available lure you into a false sense of security by giving you nice, standard −10dBm inputs and outputs, but when you look at the small print, you find that the insert points work at +4dBm. This isn't always the case, but it is certainly something to consider when patching up your in-line effects.

Standard Levels

With all the decibels out of the way, we can turn our attentions towards the various level categories.

First, there is "mic" level. This is the lowest level, usually around −60dBV. This is a fairly low level (compared to the others) and is one reason why mics are so prone to picking up R.F.I., and why high-quality shielded (preferably balanced) cables are used whenever possible.

Next, there are "line" levels, −10dBV and +4dBm. Audio signals at −10dBV are at 0.316 volts and levels at +4dBm are at 1.23 volts.

Finally, there is "instrument" level. This is wide open territory. Instrument levels can vary from as low as −60dBV and −10dBV, and as high as +4dBm. This means that instrument level can be anywhere between mic and line level. So check your instrument specifications, and if you're not sure about the level, then play it safe - use your mic/line trims, pads, faders and mic/line selector switches carefully to reach an optimum level.

Hopefully, this article has helped clear up some of the confusion for you, though it certainly can't change the fact that there are so many different operating levels and units of measure. They all tie together in an odd sort of way. Really.

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