

## R A Q s

# Rarely Asked Questions

Strange but true stories from the call logs of Analog Devices



**Contributing Writer**  
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## How Big Is It?

**Q.** How can I handle signals with huge variations in amplitude?

**A.** With a Logarithmic Amplifier.

The world's smallest mammal is the Etruscan Pygmy Shrew, which is about 3 cm long (plus tail) and weighs less than 1.5 gm (that's 20 to the ounce - one tenth the size of a mouse). The largest, the Blue Whale, can be over 30 meters in length and over 150 tons or thirty times the size of an elephant in weight. That's a thousand times longer and more than one hundred million times heavier than the pygmy shrew.

It is easy to measure small things and equally easy to measure large ones but when it is necessary to measure both, matters become complex. The ratio of the smallest and the largest signal that a system can handle is known as its "dynamic range" and is usually expressed in dB. A system where the largest voltage or current is a thousand times the smallest has a dynamic range of 60 dB, for a million times the figure is 120 dB.

We need a 28-bit digital system before an LSB is less than 1/100,000,000 of an MSB so a digital system that must handle such variation needs either very high resolution, or complex signal processing.

But some analog circuits can easily handle very large dynamic ranges. These are known as "logarithmic amplifiers" (log amps) or, more properly but less commonly, "logarithmic converters." The output of a log amp is proportional to the logarithm of the input. Some log amps can handle dynamic ranges of over 160 dB.



There are a number of different log amp architectures. Some, which use the log properties of silicon junctions, have a very large dynamic range but low speed, others (successive detection log amps), which use cascaded detector/amplifiers to create a log response, can be made with bandwidths of many GHz and still have an accurate log response over a dynamic range of 60 to 90 dB.

Both types can be made as integrated circuits. The linked article describes their various structures and properties in more detail. They are easy to understand and easy to use, but are not often discussed in basic textbooks, so they are often overlooked by inexperienced analog designers.

Wherever systems must handle very large analog signal ranges, engineers should consider the use of log amps. They are simple, affordable, and **very** useful.

**To learn more about logarithmic amplifiers,**

<http://designnews.hotims.com/22339-100>

**Have a question involving a perplexing or unusual analog problem? Submit your question to:**

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