An audio-level meter

As we've seen a time or two in the past, the new three-volume *Linear IC Databook* set from *Samsung* has been crammed to the rafters with top-notch hacker integrated circuits. For this month, I though we might take a look at some of their audio-level indicator chips.

But first, let's go over some fundamentals. You will often find two popular ways of dealing with any electronic or physical quantity, *linear* and *log*, short for logarithmic.

The linear scale has equal steps everywhere in it. Obvious examples include a ruler where the distance between 1 and 2 is exactly the same as the distance from 8 to 9. The channels on the AM-radio dial are also linearly spaced with frequency, each being 10 kilohertz above or below its nearest neighbor.

Now a linear scale sounds great, and it is the *only* way to go if you want to prevent any interaction, multiplication, or distortion when two or more quantities of something are present at once. But, if you attempted to go too far with a linear scale, one end or the other ends up far too cramped or way too spread out. Put another way, the *dynamic range* of a linear scale or system is often limited.

The log system instead works with *constant percentage* scales. Equal anythings are close together on the "low" end and farther apart on the "high" end. For instance, the notes on a musical instrument are usually a tad under six percent above or below one another. Or, more precisely, we are dealing with the twelfth root of two, or 1.059545, since the frequency of your notes doubles as you go up a twelve-note *octave*, or a ratio of 2:1 in frequency.

Log systems will often have a much higher dynamic range than the linear ones. And there's lots of places where "equal change" is more important than "equal steps." For instance, rank beginners are often mystified why standard resistors do not simply go 1.0, 2.0, 3.0, 4.0..., instead of 1, 2.2, 3.3, 4.7, 6.8...

Obviously, we are dealing with a log scale here. First because you'll normally want to cause a constant percentage change when you alter a resistor in an electronic circuit. And second, because stocking resistors in one-ohm increments in the megohm range would get out of hand.

Some physical systems are inherently logarithmic. In fact, anything linear over a wide range in the real world is usually the exception rather than the rule.

The ear is logarithmic, allowing it to deal with everything from a whisper to a shout over an incredible dynamic range. And since radio began with audio, it is convenient to employ log systems to describe the differences between powerful transmitted signals and weak received ones.

All of which leads us around to *decibels*. Decibels are simply one convenient way of measuring things on a log scale with a potentially wide dynamic range. Since you'll usually measure voltage rather than power, most hackers typically use voltage decibels rather than the much rarer power ones.

A reading of so many decibels tells you the *relative* strength between two quantities. For instance, a one-decibel change is about a ten-percent change in amplitude. It is also roughly the smallest amplitude change you can usually pick up with your ear.

A two-decibel change is around twenty percent, and a three-decibel change is around thirty percent. More specifically, when one signal is at a −3-decibel level from another (or "three dB down"), you will be at 0.707 relative amplitude.

Now, since power is related to the square of your circuit voltage, and since 0.707 squared is 0.5, being three decibels down is also at *half power* from whatever your 0-decibel level happened to be.

Hi-fi components normally have their frequency responses specified between their upper and lower −3-dB points. Put another way, this is the range over which the available power remains over half of what you would get in the "middle" of whatever frequency range you're measuring.

Moving right along, a ten-decibel change is roughly a 3:1 amplitude ratio, twelve decibels is one quarter,

60 Decibels is a **1000:1 amplitude gain.**
40 Decibels is a **100:1 amplitude gain.**
20 Decibels is a **10:1 amplitude gain.**

18 Decibels is an **8:1 amplitude gain.**
12 Decibels is an **4:1 amplitude gain.**
10 Decibels is roughly a **3:1 gain.**
6 Decibels is a **2:1 gain.**

3 Decibels is about a **30 percent gain** and the **double power point.**

2 Decibels is a **20 percent amplitude gain**
1 Decibels is a **10 percent amplitude gain.**

0 Decibels is a **unity amplitude ratio of 1:1.**

-1 Decibels is a **10 percent drop.**
-2 Decibels is a **20 percent drop.**

-3 Decibels is about a **30 percent drop** and the **half power point.**

-6 Decibels is **half amplitude.**
-10 Decibels is around **one-third amplitude.**
-12 Decibels is **quarter amplitude.**
-18 Decibels is **eighth amplitude.**

-20 Decibels is a **10:1 attenuation.**
-40 Decibels is a **100:1 attenuation.**
-60 Decibels is a **1000:1 attenuation.**

FIG. 2—SOME SIMPLE RULES that make learning how to use decibels much easier.

eighteen decibels is one eighth, and twenty decibels equals one tenth. One hundredth is forty decibels, and one thousandth is sixty decibels. The 143-decibel phase detector asked for above is the ratio between one microvolt and fourteen volts, an almost impossible dynamic range to deal with gracefully at reasonable cost in the real world. I've gathered some of these "rule of thumb" decibel ratios into Fig. 2 for your reference.

Once again, almost all your decibel measurements are *relative* and will always refer to two different levels in two points in your circuit. Decibels usually answer the question "How strong is the present signal or response compared to another one?"

How strong is a six-decibel signal? Somewhere between a femtowatt and a gigawatt, at least sometimes. Maybe. It all depends. All we know for sure is that this particular signal is twice as strong in amplitude as some other one at some other time or

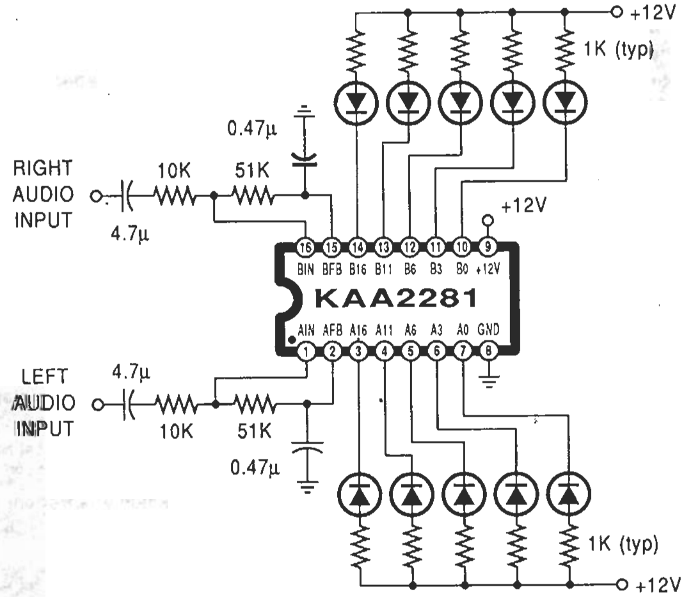

FIG. 3—A STEREO AUDIO-LEVEL METER using the Samsung KAA2281. Levels displayed are −16, −11, −6, −3, and 0 decibels. Input sensitivity is one millivolt.

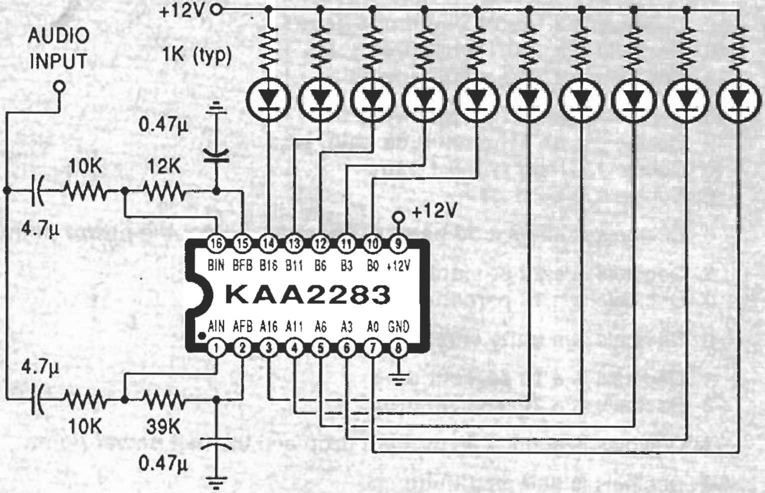

FIG. 4—A MONO AUDIO-LEVEL METER can be built by using both halves of the Samsung KAA2283. Levels displayed are −18, −16, −14, −12, −10, −8, −6, −4, −2 and 0 decibels. Sensitivity is from 0.1 to 0.9 millivolts.