Handy Gadgets and Resistor Divider Calculations

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Bruce Trump May 13 2013 18:34 PM 5

Handy gadgets make our engineering life easier—the little special purpose computer programs or spreadsheets that you might find or create yourself.

Back in the old days, engineers used nomographs. These are graphical aids that solve common multivariable problems of all sorts. Calculators and desktop computing caused their decline so you seldom see them today. I still use a variant of one—an old cardboard R-L-C reactance slide rule given to me in my first electric circuits class back in the '60s. It helps me find approximate values in the right impedance range when I'm positioning poles and zeros. I think better with it in my hands.

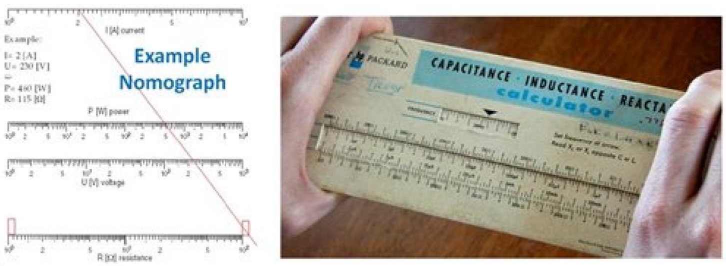


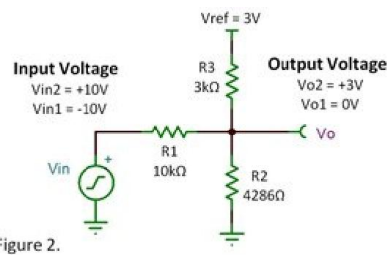
Figure 1.

I believe that the graphical nature of a nomograph can aid in visualization and optimization. Has something has been lost when we just plug numbers into a computer?

In previous blogs, I've provided gadgets for calculating op amp noise and 1/f noise. Here is another, an Excel sheet that calculates resistor values for a three-resistor divider with a voltage reference to offset the output voltage. For example, if you have a -10V to +10V input and you want attenuate and shift it to a 0 to 3V output, this gadget calculates the resistor values.

0083.Voltage Divider with offset v1.xlsx

It's a sub-circuit that is often needed in signal processing. The math is a bit messy, so if you solve it once you probably don't want to do it again. It's the type of task that is worth the time to create a gadget. The equations are in figure 2, if you don't want to use the worksheet. I refined it a bit, adding some checking for out-of bound values and minimum required value for the reference voltage. Try it and see. With the annotations I think you'll find it easy to use.



$$\text{Vout} = \frac{R2\cdot(R3\cdot Vin + R1\cdot Vref)}{R1\cdot R2 + R1\cdot R3 + R2\cdot R3} \qquad \text{Gain} = G = \frac{Vo2 - Vo1}{Vin2 - Vin1}$$

$$R2 = \frac{G\cdot R1\cdot Vref}{G\cdot Vin2 - Vo2 + Vref - G\cdot Vref} \qquad Zin = R1 + \frac{R2\cdot R3}{R2 + R3}$$

$$R3 = \frac{R2\cdot Vo2 + G\cdot R2\cdot Vin2 + R2\cdot Vref\cdot(G-1)}{G\cdot Vin2 - Vo2} \qquad Zout = \frac{1}{\frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3}}$$

Figure 2.

Excel (or equivalent) is pretty handy for calculations like this but I find it awkward for some types of programs. I have some gadget programs that parse long files to manipulate data. I've used various forms of BASIC for this through the years but now I use Excel's Visual Basic (macros), loading data into the associated worksheet to use its graphing capabilities. I wouldn't publish these gadgets. Excel macros are so easily written or modified to create serious damage that they're scary. I only give them to close associates and I'm not even sure they trust me. :-)

What handy gadget design aids have you made? What ones do you wish you had? Do you use any old-style nomographs or slide-rules like mine?

Thanks for reading and your comments are welcome below,

Bruce email: thesignal@list.ti.com (Email for direct communications. Comments for all, below.)

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