Editor's Notes

NEW PRODUCTS

We've never felt the need to apologize for anything that has appeared in *Dialogue*, and we intend to keep matters that way. However, we do think that fans of our "Applications" section deserve an explanation for its truncation in favor of a veritable "raft" of New Products in this issue.

Simply stated, our innovative "boys in the back room" have gone-and-done-it again. There is something about the Spring season (in sway at this writing) that quickens the processes of life: after conception last year (or earlier) and a winter of gestation, the budding and flowering occur with a suddenness and massiveness that is breathtaking. And our creative colleagues, similarly, seem to be graced with this Call of Nature.

And so, we suddenly have an embarrassingly-rich assortment of new products, each of which seems —in its own way— to be the ideal answer to some unheralded need. The significance of some should be obvious, for example, the tremendous potential inherent in the utility and low cost of monolithic 10-bit DAC's*. Many of the others can be "sold" on the basis of salient improvements in specifications, packaging, or price, all of which add up to increased value for the knowledgeable user.

But then there are some that have potentially-great significance that is not immediately obvious because they are unfamiliar: the type 433 $Y(Z/X)^m$ device, the AD2002 2½-digit (0.5%) infra-low-cost DPM, the MDA-11MF fast multiplying DAC; their novelty poses a challenge to the imagination. For this reason, the stories describing them include suggestions for applications that amount to gem-like little "Application Briefs." And that is where much of this issue's "Applications" section is, not in one neat package, but widely dispersed in the context of the products that make the applications possible. Perhaps these ideas, and products, will help *you* now plant the seeds of new uses that may come to fruition by *next* Spring! ▶▶▶

TEASER UNMASKED

In Volume 5, No. 5, we offered this formidable expression and suggested that it had a neat closed-form solution, that could be embodied with a new multi-purpose module, soon to be announced.

$$W = f(U,V) = U + \cfrac{V^2}{2U + \cfrac{V^2}{2U + \cfrac{V^2}{2U + \cdots}}} \qquad (1)$$

The closed-form solution (to dispense with suspense) is

$$W = \sqrt{U^2 + V^2} \qquad (2)$$

and it is achieved with low cost and good accuracy by the Model 433 (described in the adjacent pages) and two op amps. If you solved the problem in the following way, you were inevitably led to the scheme described below:

Recognize that 2U (indicated by the arrow) = U + U, and that consequently

$$W = U + \frac{V^2}{U + W} \qquad (3)$$

This expression is an *implicit* solution for W, containing the key to the use of the 433, which we'll come back to in a moment. The rest of the solution goes:

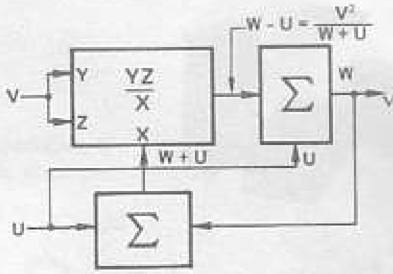
$$(W - U)(W + U) = V^2 \qquad (4)$$

whence

$$W^2 = U^2 + V^2 \qquad (5)$$

and $$W = \sqrt{U^2 + V^2}$$

Returning to equation (3), it is evident that if you have a device that computes Y·Z/X, and two summing devices (op amps), a configuration that embodies equation (3) can be drawn.



Then, if the input-signal polarities and scale factors are correct, in terms of the devices used and the sign of the square-root, the computation will be performed to good accuracy over a wide dynamic range of either (or both) input(s).

The conventional (and hardly satisfactory) configuration for performing vector summation is simply to use two multipliers (or squarers), followed by a square-root-connected multiplier/divider. Besides being expensive, it has serious dynamic-range problems. Configurations using squarers and rooters employing logarithmic techniques solve the dynamic range problem, but still have undesirable cost and complexity. The Model 433 would appear to be a *better way*.

A number of readers sent us correct solutions in terms of the final equation, but they all used a method of substitution that involved a (more-difficult) quadratic equation that completely obscured the point established by equation (3), i.e., an implicit solution was possible, given the availability of a YZ/X device.

Dan Sheingold ▶▶▶

*Watch for the AD560, to be announced in the next issue of *Dialogue*.

analog dialogue

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VERSATILE NEW MODULE: $Y(Z/X)^m$ AT LOW COST

LOG-ANTILOG TECHNIQUES ARE USED TO MULTIPLY, DIVIDE, EXPONENTIATE
0.5%(FS) ERROR AS A DIVIDER WITH 100:1 RANGE OF DENOMINATOR (NO-TRIM)
0.5%(FS) ERROR AS A SQUARE-ROOTER WITH 10,000:1 INPUT RANGE (NO-TRIM)

by Fred Pouliot and Lew Counts

In Volume 5, Number 5 of *Dialogue*, we predicted the introduction of a new "LAMDE" module. LAMDE is an acronym that implies a set of capabilities: Log, Antilog, Multiplication, Division, Exponentials. However, the new Model 433* has applicability that goes so far beyond even this impressive list, that we decided simply to call it by the unglamorous but apt designation "Programmable Multi-Function Module."

WHAT IT DOES

The equation describing its overall functioning, with appropriate external connections, is (for its 3 inputs, X, Y, Z)

$$E_0 = \frac{10}{9} V_Y \left(\frac{V_Z}{V_X}\right)^m \qquad V_X, V_Y, V_Z, E_0 > 0 \qquad 1/5 < m < 5$$

from which one can deduce that it will multiply, divide, raise (or lower) ratios to an arbitrary power. In addition, it can be connected to perform squaring, rooting, and –with a small amount of external circuitry– rms and vector computation. Terminals that are available for manipulation of the exponent m also permit logarithmic outputs to be developed. To provide scale constants for operations involving only pairs of variables, or for operations where a low-drift reference voltage is (in general) desirable, a nominal 9V low-TC reference output is available.

As a multiplier or a divider, maximum error, without trimming, is in the 0.5% (of full-scale output) class, for a wide range of inputs. Typical error is 0.3% of output plus 5mV. (See tabulation on page 5.) Small-signal and large-signal bandwidth tend to be proportional to input voltage, ranging from 50 or 100kHz downward.

WHERE TO USE IT

Typical application areas for the Model 433 are those that involve manipulation of analog voltages in analog data-reduction and computing, pre-processing before digitizing in data acquisition, and design of sophisticated measuring instruments.

Examples include "true-rms" measurements, computing vector sums and differences, and –using the adjustable exponent– ideal gas computations, curve fitting, linearizing, and developing approximations for analog computation.

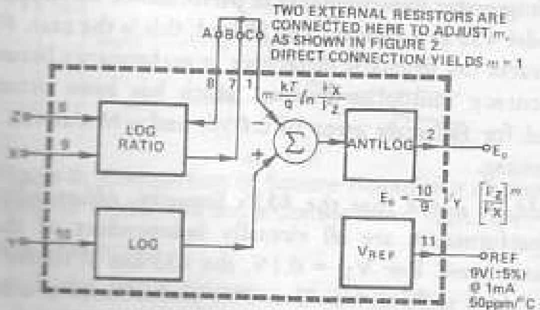

Figure 1. Functional Block Diagram of Model 433

*For complete information on the Model 433, use the reply card. Request G1.

Perhaps the most important area of application is a quite prosaic (but hitherto neglected) one: *performing division of analog voltages over wide dynamic ranges*. When conventional analog multipliers are used in feedback configurations for division, errors and noise increase in inverse proportion to the denominator voltage. Even if such a circuit has been arduously trimmed for less than 0.05%(FS) error in one quadrant with 10V denominator, its error will be comparable to the 0.5% guaranteed no-trim maximum error of Model 433 at 1V, and ten times worse at 0.1V. The log/antilog techniques used in Model 433 inherently yield small, nearly-constant errors (without tweaking) that are essentially independent of the denominator level and are well-behaved near zero. This advantage becomes especially significant in such applications as square rooting, when the output is fed back as the denominator input.

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