Five Pickett Electronics Slide Rules

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The five Pickett slide rules described in this article were especially designed for electronics calculations. Several of these rules were manufactured by Pickett for various correspondence courses in electronics. In the following, I will describe these slide rules and their specialized scales, and present some examples of how these slide rules could be used to solve some common problems in electrical engineering.

The model N515–T was made for the Cleveland Institute of Electronics. This slide rule had conventional A, B, S, T, CI, C, D, L, and Ln scales on the front, along with two specialized scales for electronics applications. The H scale is an inverse A scale folded at $\frac{1}{(2\pi)^2}$. It can be used to compute $\frac{1}{2\pi\sqrt{x}}$. As we shall see, this is important in computing the resonant frequency of an LC oscillator. The 2π scale is simply a C scale folded at 2π. This scale can be used to multiply or divide by 2π. On the back of this slide rule are special decimal keeper scales for resonance and reactance problems. The back of the slide rule also has a collection of useful formulas and constants. A virtually identical rule, in plastic instead of aluminum, was manufactured by Aristo with the model number 10175.

The model N531–ES was made by Pickett for the Capitol Radio Electronics Institute. This slide rule has conventional L, Ln, A, B, CI, C, D, K, S, ST, T, and LL scales. Like the N515–T, this slide rule also has a 2π scale. However, it lacks the H scale and decimal keeper scales of the N515–T.

The model N535–ES was designed for Pickett by Chan Street. On the front side, this slide rule has conventional L, Ln, AI, B, ST, T, S, C, D, DI, and K scales. The AI scale is particularly useful for resonant frequency calculations. The back side of this rule has decimal keeper scales for use in resonance and reactance calculations. These scales are longer than the decimal keeper scales on the N515–T, and they have ten graduations per decade.

The model N1020–ES is another electronics school rule. This rule was made for the National Radio Institute (NRI). The scales on the front side of this rule are identical to the scales on the front of the N1010–ES. Like the model N531–ES, this slide rule has a 2π scale on the back.

The model N16–ES is by far the most sophisticated of the five rules. Like the N535–ES, this slide rule was designed by Chan Street. This slide rule has conventional scales on the front side, including a two part scale of hyperbolic sines and a scale of hyperbolic tangents. The reverse side of this rule has a large number of specialized circuits for electrical engineering applications. These include conventional and decimal keeper scales for resonance problems, reactance problems, and frequency response problems for filters. One particularly nice feature of this slide rule is that many of the scales have special gauge points for the resistance and capacitance of standard electronic components.

All of these slide rules are designed to help in solving problems associated with electronic circuits made of inductors (L), capacitors (C), and resistors (R). Two important quantities associated with these circuits are the inductive reactance

$$X_L = 2\pi f L$$

and the capacitive reactance

$$X_C = \frac{1}{2\pi f C}.$$

The factor of 2π is very common in electronics calculations, so several of these electronics slide rules include scales folded at 2π to help in multiplying or dividing by 2π. The N535–ES avoids the use of a scale folded at 2π by including a gauge mark at $1/2\pi$ on the C scale. This gauge mark is labeled “F”.

Another very important issue is that typical values of the inductance L range from 10^{-6} (microhenries) to 10 (henries) while typical values of C range from 10^{-9} (picofarads) all the way up to 1 (farads). Similarly, the frequency can range from ten’s of cycles per second to millions of cycles per second. Locating the decimal point by estimation can be quite difficult in these problems. The decimal keeper scales on the N515–T, N535–ES, and N16–ES are designed to make it easy to locate the decimal point.

In working with these electronics scales we may need to find a point on the scale when our value is either larger or smaller than the labeled values on the scale. As usual with slide rules, we can multiply or divide are quantity by factors of 10 to find a point on the scale. However, because of the presence of square roots it is sometimes necessary to adjust by factors of 100. The C/L, Cr, and Lr scales on the N16–ES each cover four orders of magnitude, so that it is easy to make this adjustment.

A common computation is the determination of the resonant frequency of a circuit with an inductor and a capacitor. The resonant frequency is given by the formula

$$f = \frac{1}{2\pi\sqrt{LC}}$$

The reciprocal square root in this formula is something not often encountered in slide rule computations. The N515–T, N535–ES, and N16–ES have special scales for computing this reciprocal square root.

As a specific example, consider the problem of finding the resonant frequency of an LC circuit with L=25 mh, and C=2 μf. Using the decimal keeper scales on the back of the N515–T, we set the indicator to 2 on the $C_{\mu f}$ scale and adjust the slide so that 25 mh appears on the L_{mh} scale under the indicator. We can then read under the f_{cps} arrow that the resonant frequency is approximately 700 cycles per second. On the front of the rule, we can use the H scale to obtain a more accurate value. First, we find that the product of L and C is 5. The exponent isn't an issue at this point, since we already know the magnitude of the answer. We then move the indicator to 5 on the H scale, and read the resonant frequency of 711 cycles per second from the D scale. Note that we know that the answer is not found under 50 on the H scale, since that would give an answer of about 220 cycles, which is clearly wrong from our earlier work with the decimal keeper scales.

Using the decimal keeper scales on the model N535–ES, it's also easy to find that the resonant frequency is approximately 700 cycles per second. To find a more precise value we use the AI scale to find $1/\sqrt{LC}$ and then divide by 2π using the "F" gauge mark.

The N16–ES also has decimal keeper scales that can be used to see that the answer in the hundreds of cycles per second. Once the approximate magnitude of the answer is known, the user can obtain a more accurate answer. First, set the indicator at 25 mh on the Lr scale. It happens that 25 mh is at the extreme end of the scale. If we moved up the scale to 250 mh, we would change our final answer by a factor of $\sqrt{10}$. Instead, we move up the scale by a factor of 100 to 2.5 h. This will change our final answer by a factor of 10. Next, we move the slide so that 2 μf on the Cr scale is under the indicator, and then move the indicator to the right index and read off the resonant frequency of 711 cycles per second.

On the N1020–ES and N531–ES, we can use the 2π scale to simplify the calculation slightly, but but without the decimal keeper scales and specialized scales for the reciprocal square root, the calculations are somewhat harder. The user must keep track of the decimal point by hand.

For a more complicated example that demonstrates the power of the N16–ES, consider the problem of determining the frequency response and phase shift of a simple RC high pass filter. The relative gain is given by

$$\cos(\theta) = \frac{1}{\sqrt{1 + \left(\frac{1}{2\pi fRC}\right)^2}}$$

while the phase shift is given by

$$\alpha = \cot^{-1}(2\pi fRC).$$

The relative gain and phase shift depend entirely on the quantity $2\pi fRC$. Once the product $2\pi fRC$ has been computed by using the f, Xc and C/L scales, the relative gain, relative gain in db and phase shift can all be read directly.

For example, we can find the relative gain and phase shift at 5 Hz for an RC filter with R=30 k ohms and C= 1.0 μ f. The relative gain is $\cos(\theta) = 0.686$ or -3.28 db, and the phase shift is $\alpha = 46.7$ degrees. To perform this computation on the N16–ES, set the indicator at 0.03 M ohms on the Xc scale. Move 1.0 μf on the C/L scale under the indicator. Move the indicator to 5 Hz on the F scale. The relative gain of 0.686 (-3.28 db) can be read on the $\cos(\theta)$ and db scales. The phase shift of 46.7 degrees can be read directly from the α scale.

Pickett N515–T Cleveland Institute of Electronics

Front: Lr/H, (fx)/2Pi, A, [Cr/B, S, T, Lx/Cx/CI, Xl/fr/C], D/Xc, L, Ln
Back: Decimal Keeper Scales for Reactance/Resonance Problems

Pickett N531–ES Capitol Radio Engineering Institute

Front: L, Ln, A, [B, CI, C], D, 2Pi, K
Back: LL2, LL1, [S, ST, T, C], D, LL3

Pickett N535–ES Electronic Technician

Front: L, Ln, Cr/AI, [Lr/B, ST, T, S, C/L/I], F/Xl/E/R/W/D, Xc/DI, K
Back: Decimal Keeper Scales Cr, Lr, C/L/I, F/Xl/E/R/W, Xc

Pickett N1020–ES National Radio Institute
Front: K, A, [B, ST, T, S, C], D, DI
Back: 2Pi, DF, [CF, L, CI, C], D, DI

Pickett N16–ES Electronic Log Log Dual Base Speed Rule

Front: SH1, SH2, TH, DF, [CF, L, S, ST, T, CI, C], D, LL3, LL2, LL1, Ln
Back: Theta/alpha, db, D/Q, Xl, Zs/Xc, [C/L, F, Lambda, Omega, Tau, TauR'/X'c, Cr], Lr, db, COS Theta