The Origins of the K&E "Radio" Rule

Clark McCoy

The 1930s were a time of great change in the K&E slide rule line of products. New slide rule designs, scale sets, and construction methods evolved greatly during this time frame. Hyperbolic scales, pocket sized rules made of all celluloid, and new cursor designs were released at this time. The K&E catalogs show a number of special purpose slide rules for many different disciplines, but they failed to offer anything for the new (at that time) electronics field.

In the last year, I have been made aware of a special production rule that K&E apparently made for the Navy in 1936. This slide rule has the model number 4091-3 SPEC. printed on the rule. This is a standard 4091-3 from the 1933-1936 time frame with an LC* scale added on the top of the front side (See Figure 1). The serial number places manufacturing about 1936-1937. The owner stated that she found this slide rule in her desk at the China Lake facility when she started working there. This rule started me thinking that this special production rule could be the birth of the "Radio" slide rules for K&E.

*LC refers to L for inductance and C for capacitance. An LC circuit is an original basic radio circuit consisting of an inductor and a capacitor. Each LC circuit has a characteristic oscillating frequency. LC circuits now have a variety of uses in electronics.

In early 1937, K&E produced a Morrison Radio Engineer's Rule with specialized scales for propagation of radio waves. The model number 4138 was assigned to this slide rule. This rule also has a manual and just appears in the 1939 slide rule only catalog. One to two years later we see a slightly different rule that is a variant of the 4081-3, and that variant was designated Model 4082-3. The K scale was replaced with an F scale, which is folded at the the constant $1/(2\pi)$. The 4082-3 never showed up in K&E catalogs. However, I do have the manual for this slide rule. Finally, in 1942, K&E released the "Cooke Radio Rule" with a model number of 4139. This rule stayed in the catalogs until 1972. This paper will document these early variants and their time line.

The SPEC. 4091-3

The 4090-3, 4091-3, and 4093-3 were released in 1930 and 1931. They featured an enhanced version of the scale set found on the older 4092-3. The major change was that the trig scales were referenced to the D scale rather than to the B scale with a second sine scale to accommodate the range. The 4091-3 (See Figure 1) is the first use of decimal trig scales, while the 4093-3 featured the first use of hyperbolic scales on a production slide rule.

Apparently around 1935-1936, the US Navy requested a rule specialized for electronic calculations. Obviously K&E was already collaborating with several math instructors at the Naval Academy to write the manual for their soon to be released 4080-3/4081-3 family of slide rules.

The specimen shown in Figure 1 has a serial number of 564602, which dates the production of the rule to around 1937. I have pictures of two other rules with serial numbers 486592 and 517903, which are probably from 1936. There is a curious inscription on the bottom of this rule, "RMS No 72". At this time I do not know the significance of the inscription. One of the other two rules that I have pictures of, has an "RMS No 38" inscription. The third rule has no such inscription.

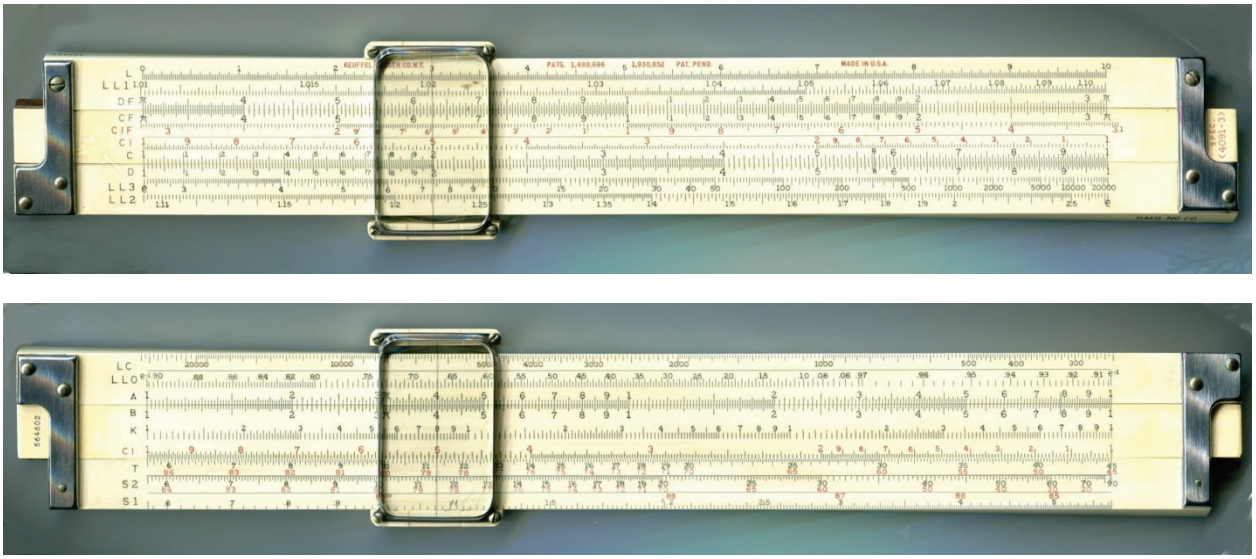

FIGURE 1. The SPEC. K&E 4091-3

FIGURE 2. The K&E SPEC. 4091-3 with a Curious Inscription

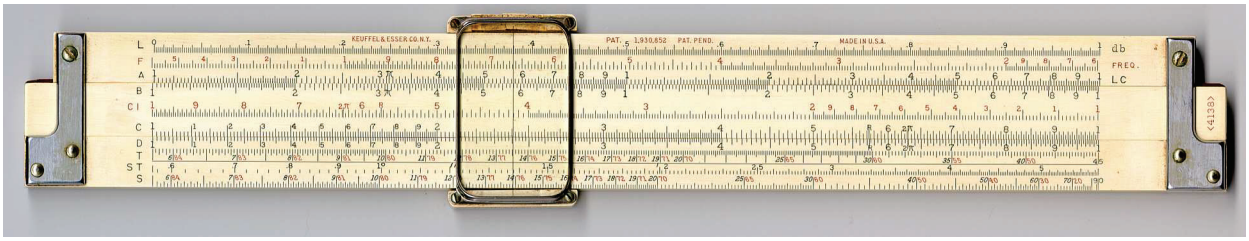

FIGURE 3. The K&E 4138

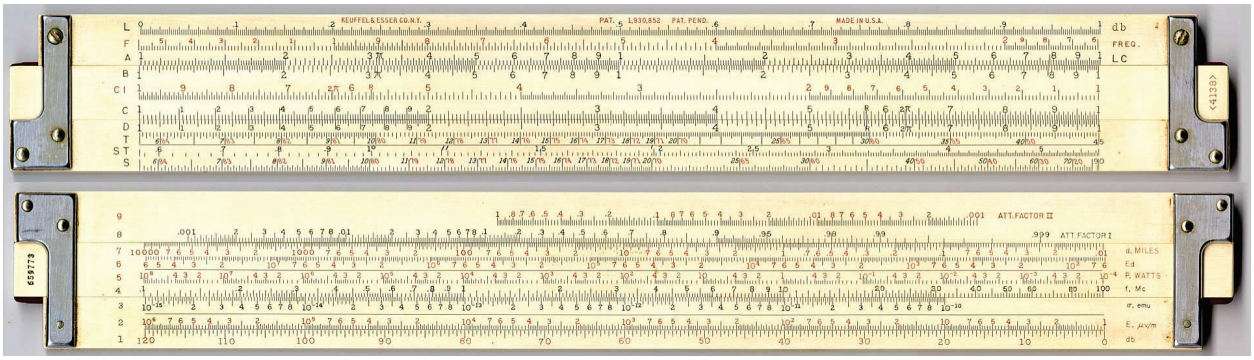

FIGURE 4. The K&E 4138 (without cursor)

4138 - The Morrison Radio Engineer's Slide Rule

The manufacturing group for Bell Labs, Western Electric, was producing broadcast equipment for the broadcast industry and was very involved with broadcasting in the 1930s. Performing the calculations used in this industry was tedious. J. F. Morrison of Bell Labs designed this slide rule to handle the general problems encountered in electronics, and he also added a set of specialized scales for predicting RF propagation. The 4138 shown in Figures 3 and 4 was produced in 1937, and the manual has a copyright date of 1937 (See Figure 6). The 4138 was only listed in the 1939 K&E slide rule catalog and does not show up in any other catalog.

Figure 6 is a copy of the first page of the manual for the 4138.

4082-3 – The Log Log Duplex Decitrig Slide Rule with the F Scale

Between the years of 1938 and 1940, K&E introduced a variant of the newly released 4081-3 Log Log Duplex Decitrig slide rule. The 4082-3 (See Figure 5) features an F scale, which is in the place of the K scale on a 4081-3. The F scale is a C scale folded at the constant $1/(2\pi)$. Note, this constant $1/(2\pi)$ is used for reactance and other frequency related calculations. The rule was given a model number, but the 4082-3 never showed up in any K&E catalogs. However, a manual was printed for this slide rule (See Figure 7).

I have seen an early version of this rule that did not have a model number, but rather had a label on the top of the front stating "Radio Rule". Unfortunately I have not been able to get scans of this rule as this rule is lost in the basement of one of our well known collectors.

The 4082-3 slide rules show up on eBay from time to time. How many of these rules were manufactured is unknown. The serial number distribution of these rules indicate that the 4082-3 was produced for several years.

Figure 7 is a copy of the first page of the manual for the 4082-3. The cover of the manual is damaged enough that a copyright date is not available.

4139 – The Cooke Radio Slide Rule

The Cooke Radio Slide Rule was the final version of a "Radio Rule" and stayed in the K&E product line until the end of slide rule production. The rule is named for Nelson M. Cooke, a Lieutenant Commander in the United States Navy. Cooke was a teacher of electronics in the Navy. I assume that the rule was designed by Cooke and licensed to K&E. Note that all of the Cooke Radio Slide Rules to the end of production carry the old K&E circular logo even though the logo was dropped on the rest of the K&E line in about 1945.

For a more detailed analysis of the variants of the Cooke Radio rule the reader is referred to the article by Richard Smith Hughes (on page 36).

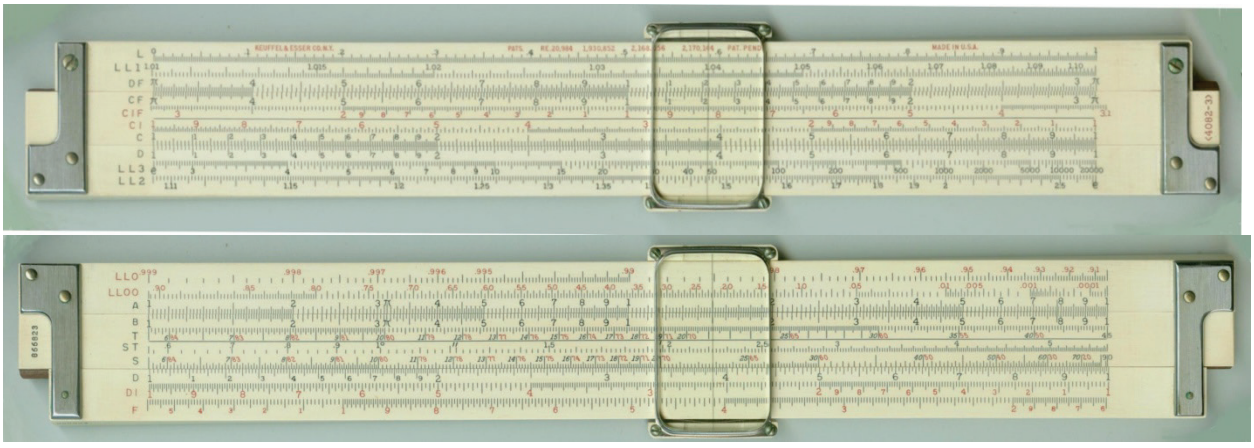

FIGURE 5. The K&E 4082-3

THE RADIO ENGINEER'S SLIDE RULE

Designed by

J. F. MORRISON

Bell Telephone Laboratories

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KEUFFEL & ESSER CO.

Engineering practices have branched into many specialized fields each of which present problems of unique and specialized nature. In working with these problems engineers probably use the slide rule more frequently than any other tool, as it provides a convenient and rapid means for performing computations. While the conventional scales of the slide rule are convenient for many problems common to the various branches of engineering, its usefulness to a specialist can be greatly enhanced by the addition of special scales. Radio engineering is today being recognized as a specialty, and the Keuffel & Esser Company, in cooperation with the Bell Telephone Laboratories, have made available the Radio Engineer's Slide Rule.

A major difference between radio and other types of electrical communication is the means by which the signal energy is propagated. The transmission of signal energy is of primary importance and the radio engineer is often concerned with problems involving the propagation of electro-magnetic waves over the surface of the earth. Special scales for solving many practical problems of this nature are placed on one face of the rule. (scales 1-9). The conventional A, B, C, D, CI, L and complete trigonometric scales are all conveniently arranged upon the other face of the rule.

The rule facilitates the computation of:

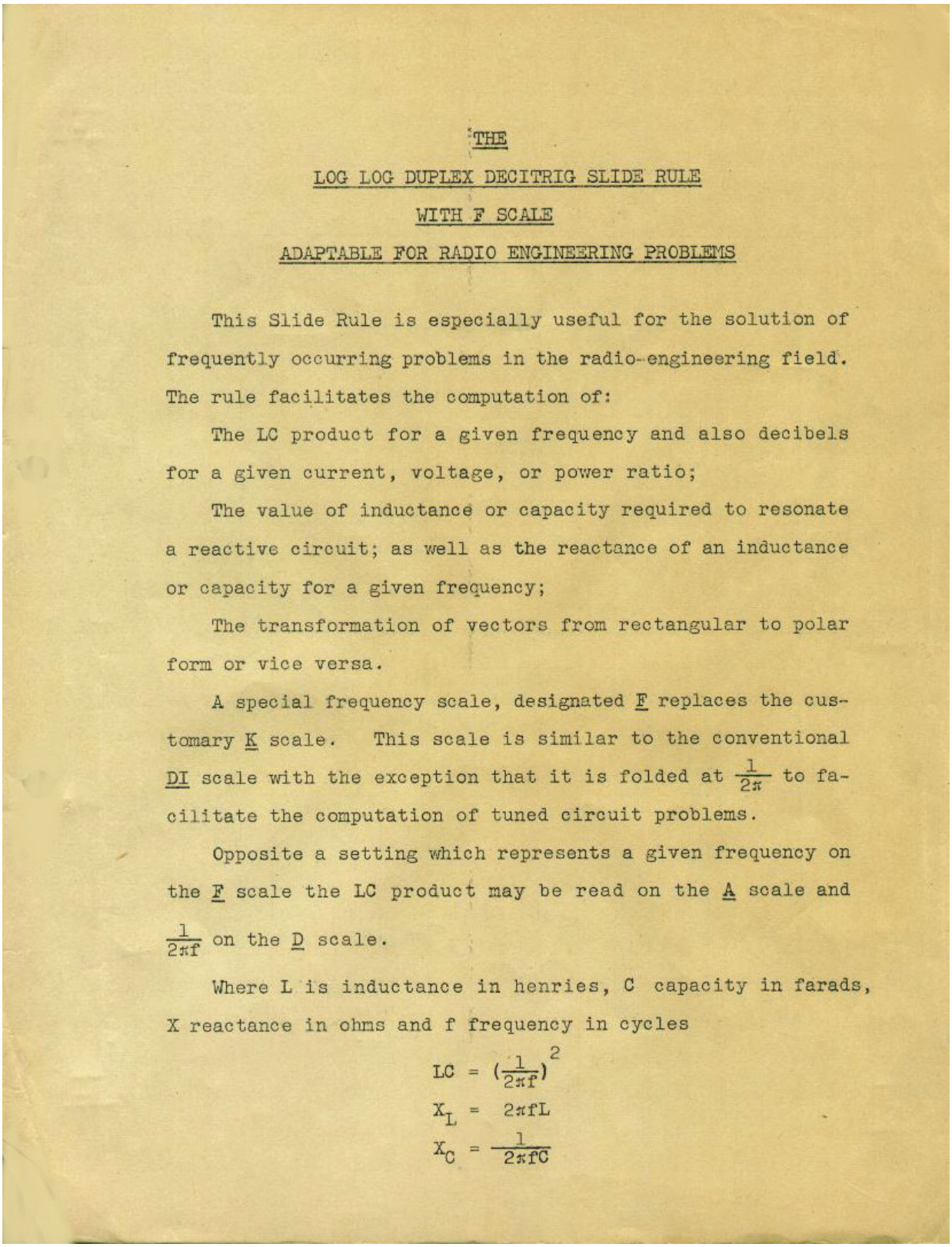
(1) Radio propagation over a plane earth for the conductivity case. By two settings of the slide, corresponding values of field intensity for wide ranges of distance, frequency, power and soil conductivity are obtained.

(2) The LC product for a given frequency and also decibels for a given current, voltage, or power ratio may be read directly from the scales.

(3) The value of inductance or capacity required to resonate a reactive circuit, as well as the reactance of an inductance or capacity for a given frequency may be obtained with one setting of the slide.

(4) The transformation of vectors from rectangular to polar form or vice versa can be accomplished by one setting of the slide.

FIGURE 6. First Page of the Manual for the K&E 4138



THE

LOG LOG DUPLEX DECITRIG SLIDE RULE

WITH F SCALE

ADAPTABLE FOR RADIO ENGINEERING PROBLEMS

This Slide Rule is especially useful for the solution of frequently occurring problems in the radio-engineering field. The rule facilitates the computation of:

The LC product for a given frequency and also decibels for a given current, voltage, or power ratio;

The value of inductance or capacity required to resonate a reactive circuit; as well as the reactance of an inductance or capacity for a given frequency;

The transformation of vectors from rectangular to polar form or vice versa.

A special frequency scale, designated F replaces the customary K scale. This scale is similar to the conventional DI scale with the exception that it is folded at $\frac{1}{2\pi}$ to facilitate the computation of tuned circuit problems.

Opposite a setting which represents a given frequency on the F scale the LC product may be read on the A scale and $\frac{1}{2\pi f}$ on the D scale.

Where L is inductance in henries, C capacity in farads, X reactance in ohms and f frequency in cycles

$$LC = \left(\frac{1}{2\pi f}\right)^2$$

$$X_L = 2\pi fL$$

$$X_C = \frac{1}{2\pi fC}$$

FIGURE 7. First Page of the Manual for the K&E 4082-3