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The *DI* Scale

on the

LOG LOG DUPLEX DECITRIG®

Slide Rule

No. 4081

(and LOG LOG DUPLEX TRIG® No. 4080)

Supplement to the Manuals

KEUFFEL & ESSER CO.

THE *DI* SCALE

The *DI* scale is very useful in continuous manipulation for reading the reciprocal of a result falling on the *D* scale.

Another important application of the *DI* scale is its use with the *T* and *S* scales for computing the right triangle when two legs are given (vector calculations). It is more expedient than the use of the *D* scale for this purpose.

Accordingly the following discussion should be studied in connection with sections 32-34 of the Slide Rule Manual relating to the solution of triangles.

Fig. 1 represents a triangle having a less than b. From the triangle read

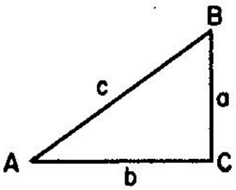

Fig. 1

$$\frac{a}{c} = \sin A, \text{ or } a = c \sin A$$

$$\frac{a}{b} = \tan A, \text{ or } a = b \tan A$$

Equating these values of a obtain

$$a = b \tan A = c \sin A$$

This is easily transformed to the reciprocal right triangle proportion

$$\frac{1}{1/a} = \frac{\tan A}{1/b} = \frac{\sin A}{1/c} \qquad \text{(I)}$$

Since, strictly speaking, the tangent scale *T* does not go beyond 45°, angle *A* must not be greater than 45°, and therefore a must be the smaller side. The following rule, based on Proportion (I), states a method of solving a right triangle when two legs are given. This is the most important case.

Rule: To solve a right triangle when two legs are given:

opposite smaller leg on *DI* set index of *C*,

opposite longer leg on *DI* read the smaller angle on *T* (black),

opposite this angle on *S* read hypothenuse on *DI*.

Example 1. Solve the right triangle of Fig. 1 in which

$$a = 3, b = 4$$

Solution: In this case Proportion (I) is

$$\frac{1}{1/3} = \frac{\tan A}{1/4} = \frac{\sin A}{1/c}$$

Accordingly:

opposite 3 on *DI* set 1 (right) of *C*,

opposite 4 on *DI* read $A =$ **36.9**° * on *T* (black)
and $B =$ **53.1**° * on *T* (red),

opposite 36.9° on *S* read $c =$ **5** on *DI*.

Example 2. Solve the right triangle in which

$$a = 15, b = 8.$$

Solution. Irrespective of the letters assigned to the sides in Fig. 1, apply the rule. The short leg is 8. Hence:

opposite 8 on *DI* set index of *C*,

opposite 15 on *DI* read $B =$ **28.1°** * on *T* (black)
and $A =$ **61.9°** * on *T* (red),

opposite 28.1° on *S* read $c =$ **17** on *DI*.

* When this Supplement is used with LOG LOG DUPLEX TRIG Slide Rule No. 4080:
36.9° becomes **36°54′**, **53.1°** becomes **53°06′**, **28.1°** becomes **28°06′**, **61.9°** becomes **61°54′**.

EXERCISES

Solve the following right triangles:

1. $a = 12.3$, $b = 20.2$.	4. $a = 273$, $b = 418$.	7. $a = 13.2$, $b = 13.2$.
2. $a = 101$, $b = 116$.	5. $a = 28$, $b = 34$.	8. $a = 42$, $b = 71$.
3. $a = 50$, $b = 23.3$.	6. $a = 12$, $b = 5$.	9. $a = 0.31$, $b = 4.8$.

10. The length of a shadow cast by a 10 ft. vertical stick on a horizontal plane is 8.39 ft. Find the angle of elevation of the sun.

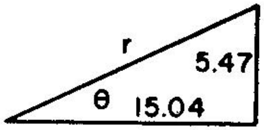

Fig.2

11. The rectangular components of a vector r are 15.04 and 5.47 as shown in Fig. 2. Find the magnitude and direction of the vector.

12. Find the magnitude and direction of a vector having as the horizontal and vertical components 18.12 and 8.45, respectively.

Another application of the *DI* scale in vector computations is to find the magnitude and phase angle relative to voltage of the current flowing in a series circuit of R ohms resistance and X ohms total reactance due to an applied voltage E. The formula is:

$$I = E/R + jX = E/Z\underline{/\theta} = \frac{1}{Z}E\,\overline{\backslash\theta}$$

Perform the vector computation using the *DI* scale but read only the angle θ. The negative of this is the desired phase angle. In the last step of this computation the hairline will be at Z on the *DI* scale but it is not necessary to

read the value of Z. Continue by drawing E on the *CI* scale under the hairline. Read the magnitude of I on the D scale opposite the index of the C scale.

APPLICATIONS OF THE *DI* SCALE IN ELECTRICAL ENGINEERING CALCULATIONS

In addition to its use in vector computations the *DI* scale enables one to use the method of continuous manipulation (i.e., without taking intermediate readings) without excessive use of the index when an expression contains only unity as the factor in the numerator, e.g., an expression such as $1/abc$ may be computed as if it were abc by reading the answer on the *DI* scale instead of the D scale as follows:

To a on the D scale set the hairline.
to the hairline draw b on the *CI* scale,
opposite c on the C scale read $1/abc$ on the *DI* scale.

The formula for the reactance of a capacitance to the flow of alternating current is of exactly this form, i.e.. $1/abc$. It is a very common calculation made by electrical engineers, particularly in radio and television. The formula is as follows:

Reactance $= 1/6.28fC$
where f = frequency and C = capacitance

It is very simple and convenient to perform the computation in the manner just given for $1/abc$. The advantages are even greater when more than one computation must be made. For example, suppose (which is often the case) one wishes to find the reactance at a given frequency of several capacitances connected in series. The formula is then:

Reactance
$= 1/6.28fC_1 + 1/6.28fC_2 + \ldots\ldots 1/6.28fC_n$

The usual method is to write the formula in the form:

$$\text{Reactance } 1/6.28F\ (1/C_1 + 1/C_2 + \ldots\ldots 1/C_n)$$

which involves the awkward step of calculating the ( ) factor first. It becomes quite simple and straightforward however if the $1/abc$ procedure given above is followed. That is:

To 6.28 on the *D* scale set the hairline,
draw *f* on the *CI* scale under the hairline,
opposite C_1 on the *C* scale read the first term on the *DI* scale,
opposite C_2 on the *C* scale read the second term on the *DI* scale, etc.

set down each of these readings and add.

As another example which occurs frequently, find the reactance of a given capacitance at several different frequencies. By interchanging *f* and *C* in the above example the reactance is found at each frequency without further change of the slide by reading the result on the *DI* scale opposite each *f* on the *C* scale.

Yet another useful example in computing the total reactance of a circuit containing inductance *L* and capacitance *C* in series. The formula is:

$$\text{Reactance} = (6.28fL - 1/6.28fC).$$

The procedure is the same for both *L* and *C* except $6.28fL$ is read on the *D* scale opposite *L* on the *C* scale, and without moving the slide $1/6.28fC$ is read on the *DI* scale opposite *C* on the *C* scale.

Many times it is desirable to know what value of *C* will resonate at a given frequency with a given *L* or vice versa. First compute $6.28fL$ reading the result on the *D* scale opposite *L* on the *C* scale. Without moving the slide transfer this reading to the *DI* scale by moving the hairline. Then under the hairline on the *C* scale is the desired value of *C*.

ANSWERS

Applying to LOG LOG DUPLEX DECITRIG No. 4081 Page 4.

1.	$A = 31.35°$	$B = 58.65°$	$c = 23.65$
2.	$A = 41.05°$	$B = 48.95°$	$c = 153.8$
3.	$A = 65°$	$B = 25°$	$c = 55.2$
4.	$A = 33.15°$	$B = 56.85°$	$c = 499$
5.	$A = 39.5°$	$B = 50.5°$	$c = 44$
6.	$A = 67.38°$	$B = 22.62°$	$c = 13$
7.	$A = 45°$	$B = 45°$	$c = 18.67$
8.	$A = 30.6°$	$B = 59.4°$	$c = 82.5$
9.	$A = 3.7°$	$B = 86.3°$	$c = 4.8$

10. 50° 11. 16, 20° 12. 20, 25°

Applying to LOG LOG DUPLEX TRIG No. 4080

1.	$A = 31°21'$	$B = 58°39'$	$c = 23.65$
2.	$A = 41°03'$	$B = 48°57'$	$c = 153.8$
3.	$A = 65°$	$B = 25°$	$c = 55.2$
4.	$A = 33°09'$	$B = 56°51'$	$c = 499$
5.	$A = 39°30'$	$B = 50°30'$	$c = 44$
6.	$A = 67°23'$	$B = 22°37'$	$c = 13$
7.	$A = 45°$	$B = 45°$	$c = 18.67$
8.	$A = 30°36'$	$B = 59°24'$	$c = 82.5$
9.	$A = 3°42'$	$B = 86°18'$	$c = 4.8$

10. 50° 11. 16, 20° 12. 20, 25°