



The *SRT* Scale

Supplement to the Manuals on the

4081 LOG LOG DUPLEX DECITRIG®

4083 LOG LOG DUPLEX VECTOR®

4071 POLYPHASE DUPLEX DECITRIG®

Slide Rules

KEUFFEL & ESSER CO.

SRT SCALE REPLACES ST SCALE

For the latest model slide rules on which the *SRT* scale has replaced the *ST* scale, wherever *ST* is mentioned in the instruction manuals, read *SRT*.

The scale designated *SRT* is, as its name indicates, used to find sines, radian equivalents, and tangents of angles, ranging from 0.573 degrees to 5.73 degrees approximately.

SECTION 38 (REVISED)

The revised section 38 below replaces sections in Manuals which do not refer to the *SRT* scale as follows:

In Manual on No. 4081 LOG LOG DUPLEX DECITRIG (used also with No. 4083 LOG LOG DUPLEX VECTOR), it replaces sections 37 and 38 (pages 62-64).

In Manual on No. 4071 POLYPHASE DUPLEX DECITRIG, it replaces sections 39 and 40 (pages 59-62).

38. Radians. Small Angles. A radian is an angular unit equal to $\left(\frac{180}{\pi}\right)^\circ$, or 57.3° accurate to three figures. The *SRT* scale is a *C* scale whose marks represent numbers of degrees ranging from 0.573° to 5.73° approximately. It is so folded that the following rule holds.

Rule. *When the hairline is set to an angle in degrees on the SRT scale, it is also set to the same angle in radians on the C* scale, provided the number on the C scale is prefixed by "0.0" as indicated by the legend 0.01 to 0.1 at the end of the SRT scale.*

For example, in accordance with the rule,
push hairline to 3.56° on *SRT*,
at hairline read 621 on *C*.

Therefore $3.56^\circ = 0.0621$ radian.

* Of course the *D* scale may be used instead of the *C* scale when the rule is closed.

Observe that if we multiply both members of the equation

$$3.56^\circ = 0.0621 \text{ radian}$$

by 10 , 10^2 , $\frac{1}{10}$, and $\frac{1}{10^2}$ in succession, we get

$$(10) (3.56^\circ) = (10) (0.0621), \text{ or } 35.6^\circ = 0.621 \text{ radian,}$$

$$(100) (3.56^\circ) = (100) (0.0621), \text{ or } 356^\circ = 6.21 \text{ radians,}$$

$$\left(\frac{1}{10}\right) (3.56^\circ) = \left(\frac{1}{10}\right) (0.0621), \text{ or } 0.356^\circ = 0.00621 \text{ radian,}$$

$$\left(\frac{1}{100}\right) (3.56^\circ) = \left(\frac{1}{100}\right) (0.0621), \text{ or } 0.0356^\circ = 0.000621 \text{ radian.}$$

In general for any integer k ,

$$\text{positive or negative } 10^k(3.56^\circ) = 10^k(0.0621) \text{ radian.}$$

Now using the rule in reverse,

push the hairline to 1176 on C ,

at hairline read 0.674° on SRT ,

and conclude that

$$0.01176 \text{ radian} = 0.674^\circ.$$

Multiplying this through by 10^2 , $\frac{1}{10}$, and 10^k in succession, we get

$$1.176 \text{ radians} = 67.4^\circ,$$

$$0.001176 \text{ radian} = 0.0674^\circ,$$

$$10^k (0.01176) \text{ radians} = 10^k (0.674^\circ).$$

For angles θ in radians, where θ is less than 0.1 radian (or 5.73°), the following relation holds

$$\theta \text{ radians} \cong \sin \theta \cong \tan \theta, \quad (20)$$

where the symbol " $\cong$ " means "*approximately equals*". In other words, *the value of an angle in radians found by means of the italicized rule is also its sine and its tangent to slide rule accuracy.**

For example:

push hairline to 3.84° on SRT

at hairline read 670 on C .

Therefore, in accordance with the italicized rule,

$$\sin 3.84^\circ = \tan 3.84^\circ = 0.0670,$$

and, in agreement with equation (20),

$$\sin 0.384^\circ = \tan 0.384^\circ = 0.00670,$$

$$\sin 0.0384^\circ = \tan 0.0384^\circ = 0.000670,$$

and so on.

* The greatest error inherent in formula (20) is at $\theta = 0.1$ radian; it is nearly $+0.00017$ for $\sin 0.1$ and -0.00033 for $\tan 0.1$. These errors are comparable in magnitude with other errors occurring in slide rule computation.

By using the relations of §25, the italicized rule, and (20), we can find the values of other trigonometric functions of small angles.

For example

$$\cot 1.352^\circ = 1/\tan 1.352^\circ \cong 1/\sin 1.352^\circ = \csc 1.352^\circ.$$

Hence

push hairline to 1.352° on *SRT*,

at hairline read on *C*, $0.0236 \cong \sin 1.352^\circ$,

at hairline read on *CI*, $40.31 \cong \csc 1.352^\circ \cong \cot 1.352^\circ$.

Also to find $\cos 88.76^\circ$, use (8) §25 to get

$$\cos 88.76^\circ = \sin(90^\circ - 88.76^\circ) = \sin 1.24^\circ.$$

push hairline to 1.24° on *SRT*

at hairline read 0.0216 on *C*.

Therefore

$$\cos 88.76^\circ = \sin 1.24^\circ = 0.0216.$$

Then without moving the slide

at hairline read 462 on *CI*

and conclude that

$$\sec 88.76^\circ = 1/\cos 88.76^\circ = 46.3,$$

$$\tan 88.76^\circ = 1/\cot 88.76^\circ = 1/\cos 88.76^\circ = 46.3.$$

Before beginning the exercises, the student should use the slide rule, the italicized rule of this section and (20) to verify the following approximate equations:

(a) $1.272^\circ = 0.0222$ radian

(b) $12.72^\circ = 0.222$ radian

(c) 0.0531 radian $= 3.04^\circ$

(d) 5.31 radians $= 304^\circ$

(e) $\sin 2.86^\circ = 0.0499$

(f) $\sin 0.286^\circ = 0.00499$

(g) $\tan 0.286^\circ = 0.00499$

(h) $\csc 0.286^\circ = 20.0$

(i) $\cot 0.286^\circ = 20.0$

(j) $\sec 87.25^\circ = 20.8$

EXERCISES

1. Express in radians:

(a) 1.416° (b) 0.833° (c) 2.5° (d) 2.67° .

2. Express in degrees:

(a) 0.01823 radian (b) 0.0462 radian (c) 0.0865 radian

3. Express in radians:

(a) 3.59° (b) 0.0359° (c) 35.9° (d) 359° .

4. Express in degrees:

(a) 0.0296 radian (b) 0.296 radian (c) 0.000296 radian

5. Express in radians:

(a) 912° (b) 435° (c) 0.000314° (d) 2900° .

6. Find $\sin 3.42^\circ$, $\tan 3.42^\circ$, $\csc 3.42^\circ$, $\cot 3.42^\circ$.
7. Find $\sin 0.056^\circ$, $\tan 0.056^\circ$, $\csc 0.056^\circ$, $\cot 0.056^\circ$.
8. Find $\cos 89.75^\circ$, $\sec 89.75^\circ$, $\tan 89.75^\circ$, $\cot 89.75^\circ$.
9. Express in degrees the following angles expressed in radians:

(a) $\frac{\pi}{3}$ (b) $\frac{3\pi}{4}$ (c) $\frac{\pi}{72}$ (d) $\frac{\pi}{180}$ (e) $\frac{5\pi}{6}$

Hint: Since π radians = 180° , replace π by 180° . However to change $\frac{5\pi}{6}$ radians to degrees

opposite 6 on *DF* set 5 of *C*

opposite index of *D* read 15 on *SRT*, and

$5\pi/6$ radians = 150 degrees.

10. Evaluate the following:

(a) $83 \sin 0.0144^\circ$

(d) $\frac{\tan 0.2^\circ}{0.0001745}$

(b) $500 \tan 0.0097^\circ$

(e) $\frac{\sin 0.3^\circ}{0.131}$

(c) $432 \sin 0.716^\circ$

(f) $\frac{8 \sec 88.25^\circ}{4.72}$

11. The angles in the following exercises are in radians. Change these angles to degrees and then find the values of the functions:

(a) $\sin 0.345$ (b) $\tan 0.524$ (c) $\sin 1$ (d) $\cos 1$

(e) $\sin 0.628$ (f) $\csc 2$ (g) $\cot 4.17$ (h) $\cos 2.81$

ANSWERS

1. (a) 0.0247 (b) 0.01454 (c) 0.0436 (d) 0.0466
2. (a) 1.044° (b) 2.65° (c) 4.96°
3. (a) 0.0627 (b) 0.000627 (c) 0.627 (d) 6.27
4. (a) 1.696° (b) 16.96° (c) 0.01696°
5. (a) 15.92 (b) 7.59 (c) 0.00000548 (d) 50.6
6. 0.0597, 0.0597, 16.75, 16.75
7. 0.000977, 0.000977, 1023, 1023
8. 0.00436, 229, 229, 0.00436
9. (a) 60° , (b) 135° (c) 2.5° (d) 1° (e) 150°
10. (a) 0.0209 (b) 0.0846 (c) 5.40 (d) 20.0 (e) 0.0400
(f) 55.5
11. (a) 0.338 (b) 0.578 (c) 0.841 (d) 0.540 (e) 0.588
(f) 1.100 (g) 0.603 (h) -0.946