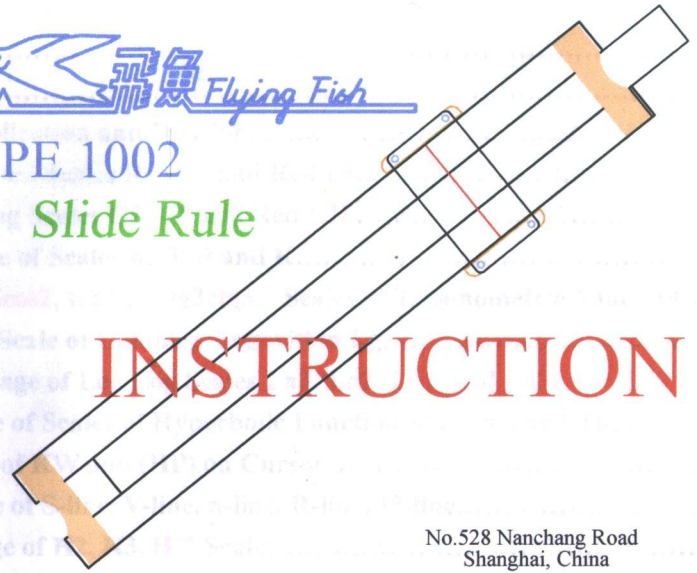
飛魚 Flying Fish

TYPE 1002

Slide Rule



INSTRUCTION

No.528 Nanchang Road
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Instruction for The Use of
Flying Fish slide Rule Type 1002

Preface

In order to simplify the procedure of computation with greater ease and rapidity for the scientific and technological personnel, our company has designed and developed Log-Log slide Rule Type 1002. This type is comprehensive in its designs and served for multifarious purposes, containing the scales of multiplication and division, square and cube, common logarithm, natural logarithm, trigonometric function and hyperbolic function, etc. This Slide Rule Proves to be most convenient for calculations in the field of electrical engineering, dynamics and civil engineering. Subsequently, it is a advanced computing instrument for the broad masses of the scientific and technological personnel.

I. Scales

Log Log Slide Rule Type 1002 provides 28 scales. Side 1 has Ln1I, Ln2I, Ln3I, DF, CF, CIF, H2, H3, CI, C, D, Ln3, Ln2, Ln1 14 scales. Side 2 has sh2, sh3, K, A, B, sin2cos2, H`2, tg2ctg2, tg3ctg3, C, D, DI, Lg, th2 14 scales .

The first graduated line at the left end of C is called the left index (C:1), The first graduated line at the right end of C is called the right index (C:10), the fine vertical red line on the cursor is called the hairline by the combined movement of slide and cursor, calculations involving several factors may be readily effected.

C scale and D scale are also known as the fundamental scales. The number marked on the represent the significant figures. The readings between two small engraved lines are apparent to the eyes. Placing decimal point depends upon the actual and concrete situation during operation.

II. multiplication and Division

Joint operation of multiplication and division can be worked out through the use of C scale and D scale in general.

Use of C and D scales calculate multiplication

Example 2×4=?

Move the slide to right, set the left index C:1 opposite D:2 (first factor), move cursor, set hairline on C:4(Other factor), under hairline read D:8 is the Product.

i.e. 2×4=8

Example 3×8=?

In this case, if set the left index C:1 opposite D:3 (first factor), then, C:8(Other factor) out off body. So, in this case, move the slide to left, set the right index C:10 opposite D:3 (first factor), move hairline on C:8(Other factor), under hairline read D:24 is the Product.

i.e. 3×8=24

Use C and D scales calculate Division

Example 18÷3=?.

Move hairline on D:18, move slide set C:3 under hairline. Opposite right

index C:10 read D:6 is the Result.

i.e. 18÷3=6.

Example 7.68÷4.8=?.

Move hairline on D:7.68, move slide set C:4.8 under hairline. Opposite left index C:1 read D:1.6 is the Result.

i.e. 7.68÷4.8=1.6

Example $\frac{284\times 5.19}{65.2}=(22.6)$ [estimated $\frac{280\times 5}{70}=20$]

Move the slide, set C:65.2 on D:284, set the hairline directly over C:5.19, Read D:22.6 under the hairline is the Result..

III. Inverted Scales Red CI and Red DI

CI and DI are the inverted scales of C and D. The readings should be read from right to left. When the hairline is set over any number x on C scale (or D

scale), the volue 1/x can be read off from CI scale (or DI scale) under the hairline. For successive operation of multiplication and division, CI scale can be used to convert multiplication into division and vice versa, thus simplifying the procedure of operation.

Example $18.5\times 6.2\times 4.75=18.5\div\frac{1}{6.2}\times 4.75=(545)$ [estimated 20×6×5=600]

Set the hairline directly over D:18.5, then move the slide until DI:6.2 is also set directly under the hairline, finally set the hairline over C:4.75, read D:545 under hairline is the Result.

IV. Folding Scales CF, DF and Red CIF

CF is Folding Scales of C , with graduation started from $\sqrt{10}$ and

terminated at 10, and again in turn started from 1 and terminated at $\sqrt{10}$. DF is Folding Scales of D, with graduation started from$\pi$and terminated at 10, and again in turn started from 1 and terminated atπ.CIF is the inverted scale of CF. It can be used in combination with CF scale and DF scale. So as to prevent from the extreme shifting of the scale and diminish errors. Evidently, this method is much convenient as compared with that by only making use of C and D scales. For multiplication and division include π, we need not shift the scale. Move the cursor and set the hairline directly over a given number on D scale, and correspondingly the product of that given number andπwill be obtained on DF scale.

Example 22.7×6.45=(146.4)

Move the slide until C:1 exactly against the line D:22.7, then set the hairline directly over CF:6.45, read DF:146.4 under the hairline is the Result.

Example 2.5×π=(7.85)

Set the hairline directly over D:2.5, read DF:7.85 under the hairline is the Result.

V. Usage of Scales A, B, D and K

The A and B scales are the squares of C and D scales. As the contrary, C and D scales is the square roots of A and B scales. Opposite D:x on A scale is x^2, contrarily, Opposite A:x on D scale is $\sqrt{x}$.

The K scale is the cube of C and D scales. As the contrary, C and D scales are the cube roots of K scale. The K scale has 3 sects of same parts. First sect is 1-10, second sect is 10-100, third sect is 100-1000. Move hairline on D:x, read the number on K scale under hairline is x^3, contrarily, Opposite K: x on D scale is $\sqrt[3]{x}$.

Find Squares

Example 278^2=?

Move hairline on D:2.78, under hairline read A:7.73. Before you give the answer, you should determine the digits of the number.

Hairline on the left sect of A scale	Hairline on the right sect of A scale
Digits of power=digits of factor × 2 -1	digits of power=digits of factor × 2

278 is 3 places, hairline on the left sect of A scale , 3×2-1= 5,

i.e. $278^2=77300$

Example $0.0565^2=?$

Move hairline on D:5.65, under hairline read A:31.9. 0.0565 is –1 place, The hairline on the right sect of A scale, (-1) ×2=-2,

i.e. $0.0565^2=0.00319$

Find Square Roots

In general, to find the square root of any number with an odd number of digits or zero (1,3,5,7,…), the left half of the A scale is used. And the digits of root = (digits of number +1) ÷ 2.

If the number with an even number of digits or zero (2,4,6,8,…), the right

half of the A scale is used. And the digits of root = digits of number ÷ 2.

Example $\sqrt{30000} = (173.2)$

30,000 is a 5 digits odd number, so, move the hairline on A:3 at left half of the A scale, read D:1.732 under hairline. (5+1) ÷ 2.=3, the digits of root

Example $\sqrt{0.000585} = (0.0242)$

0.000585 is a -3 digits odd number, so, move the hairline on A:5.85 at left half of the A scale, read D:2.42 under hairline. (-3+1) ÷ 2.= -1, the digits of root is -1.

Example $\sqrt{5300} = (72.8)$

5300 is a 4 digits even number, so, move the hairline on A:53 at right half of the A scale, read D:7.28 under hairline. 4 ÷ 2.= 2, the digits of root is 2.

Find Power of Cube,

When find the power of cube, the way that determine the digits of the number is as follow,

1. Hairline on the 1st sect (the left third) of K scale, the digits of power = digits of factor ×3-2.
2. Hairline on the 2nd sect (the middle third) of K scale, the digits of power = digits of factor ×3-1.
3. Hairline on the 3rd sect (the right third) of K scale, the digits of power = digits of factor ×3

Example 252^3 =?

Move the hairline on D:2.52, read K:16 under hairline. Hairline on the 2nd sect of K scale, so, the digits of power is 3×3-1=8

i.e. 252^3=16000000

Example 0.0575^3 =?

Move the hairline on D:5.75, read K:190 under hairline. Hairline on the 3rd sect of K scale, so, the digits of power is (-1)×3=-3

i.e. 0.0575^3=0.00019

Find Cube Roots

When find the **cube roots,** to decide which part of the K scale to use in locating a number, mark off the digits in groups of three starting from the decimal point. If the left group contains one digit, the left third of K scale is used; If the left group contains two digits, the middle third of K scale is used; If there are three digits in the left group, the right third of K scale is used. In other words, numbers containing 1,4,7,... digits are located on the left third; numbers containing 2,5,8,... digits are located on the middle third; and numbers containing 3,6,9,... digits are located on the right third of the K scale. The root digits of integral is equal the number of groups of integral. The pure decimal fraction how many number of groups all in 0, the root has the number "0" after the decimal point.

Example $\sqrt[3]{89600}$ = ?

89600 can mark off 89'600, the left group contains two digits, so, use the middle third find the answer. Move the hairline on K:89.6 of the 2nd sect of K scale, read D:4.48 under the hairline on D scale. The integral is in 2 groups, so, the integral digits of the root is 2..

i.e. $\sqrt[3]{89600} = 44.8$

Example $\sqrt[3]{0.00763} = ?$

0.00763 can mark off 0.007'630, the left group contains 1 digits, so, use the left third find the answer. Move the hairline on K:7.63 of the 1st sect of K scale, read D:1.969 under the hairline on D scale. The all in 0 groups is 0 group, so, the root is in 0 digits.

i.e. $\sqrt[3]{0.00763} = 0.1969$

VI. sin2cos2, tg2ctg2, tg3ctg3 Scales of Trigonometric Function

1002 Slide rule provides 3 scales of trigonometric functions of angles, i.e. **sin2cos2, tg2ctg2, tg3ctg3**. It should be noted that black figures marked on the scales represent computations for the positive functional angles, while red figures represent those for the complementary functional angles. Set the hairline directly over any angles x on the scale of trigonometric function, read answer on C scale under the hairline, this is precisely the functional value.

Find sinθ

Use **sin2cos2 (short for S)** and C scales. **S** scale from 5.5° to 90°, Let the number on C scale be divided by 10, move the cursor, under the hairline the number on C scale opposite the S scale will be the answer of sinθ.

Example sin30°=? sin42°=?

Move hairline on S:30, read the C:0.5 under hairline is the answer;

Move hairline on S:42, read the C:0.682 is the answer.

Find $\sin^{-1}x$

Example $\sin\theta=0.286$, find $\theta=?$,

As the contrary, move hairline on C:0.286, read the S:16.6 is the answer.

i.e. $\theta=16.6^\circ$.

Find $\cos\theta$,

$\cos\theta=\sin(90^\circ-\theta)$, The S scale from left to right, it is marked by black number, for find $\sin\theta$; from right to left, it is marked by red number, for find $\cos\theta$.

Example, $\cos60^\circ=?$

Move hairline on S:60(red), read the C:0.5 under hairline is the answer.

i.e. $\cos60^\circ=0.5$

Use tg2ctg2, tg3ctg3 scale find tgθ and ctgθ

tg2ctg2, scale from left to right marked 5.5° to 45° for Find tgθ of 5.71° to 45°, From right to left marked red 45° to 84.5° for Find ctgθ of 45° to 84.29°.

tg3ctg3, scale from left to right marked 45° to 84.5° for Find tgθ of 45° to 84.29°, From right to left marked red 5.5° to 45° for Find ctgθ of 5.71° to 45°. In order to easily read reason, in the following examples, both the **tg2ctg2** and **tg3ctg3** short for T.

Find tgθ,

Example $tg12.4^\circ=?$

Move hairline on T:12.4°, read the C:0.22 under hairline is the answer.

Example $tg60^\circ=?$

Move hairline on T:60°, read the C:1.732 under hairline is the answer.

Find ctgθ,

Example $ctg15^\circ=?$

Move hairline on T:15°, read the C:3.73 under hairline is the answer.

Example $ctg82^\circ=?$

Move hairline on T:82°, read the C:0.1405 under hairline is the answer.

VII. The Scale of Common Logarithm Lg

Lg is a scale of common logarithm, which is used to determine the mantissa of the logarithm of any given number. For prefixing the characteristic to the mantissa for 1 and all numbers greater than 1, the characteristic is one less than the number of place to the left of the decimal point in the given number.

For example lg25=1.398. here the characteristic is 1, and the mantissa is 0.398.

For numbers smaller than 1, that is for number wholly decimal, the characteristic is negative and its numerical value is one more than the number of ciphers between the decimal point and the first decimal which is not a cipher.

For example, $\lg 0.25 = \bar{1}.398$

VIII. Usage of Log Log Scales Ln3, Ln2, Ln1, and Ln1I, Ln2I, Ln3I

Find Reciprocals

The scales Ln1 and Ln1I are reciprocals scales to each other, and so are Ln2 and Ln2I, Ln3 and Ln3I.

For example, set hairline directly over **Ln3:10,** read off the **Ln3I:0.1** is the reciprocal.

Find the natural logarithm having positive characteristics or for a real number which is larger than 1.

Set hairline directly over any real number **X** on scales **Ln1, Ln2, Ln3,** then read the value **LnX** on **D** scale under hairline.

For example: Ln20.1=(3), Ln1.6=(0.47), Ln1.032=(0.0315)

Find the natural logarithm having negative characteristics or for a real number which is smaller than 1.

Set hairline directly over any real number **Y** on scales **Ln1I, Ln2I, Ln3I,** then read the value **LnY** on **D** scale under hairline.

For example: Ln0.0497=(-3), Ln0.67=(-0.4), Ln0.9608=(-0.04)

Find a^x

Set hairline directly over **a** on **Ln3** scale (or a on **Ln3I** scale), move the slide until C:1 is also set under the hairline, then set the hairline over C:x, read the value a^xon Ln3 scale (or a^x on Ln3I scale) under hairline. Meanwhile, the value a^{-x} can be read off on Ln3I scale (or a^{-x} on Ln3 scale) under hairline.

For example: 3^4=(81), 3^{-4}=(0.0124); 0.25^2=(0.625), 0.25^{-2}=(16).

Find $a^{\frac{1}{x}}$

Set hairline directly over **a on Ln3 scale** (or a on **Ln3I** scale), move the slide until C:x is also set under the hairline, then set the hairline over C:1,

read the value $a^{\frac{1}{x}}$ on Ln3 scale (or $a^{\frac{1}{x}}$ on Ln3I scale) under hairline.

Meanwhile, the value $a^{\frac{1}{x}}$ can be read off on Ln3I scale (or a^{-x} on Ln3 scale) under hairline.

For example: $144^{1/2}$=(12), $144^{-1/2}$=(0.0833).

Find logarithm for any base

For example: find $\lg_9 729$=(3)

Set hairline directly over **9 on Ln3 scale,** move the slide until C:1 is also set under the hairline, then set the hairline over Ln3:729, the value **3** on C scale under hairline is the answer.

IX. Usage of Scales of Hyperbolic Functions Sh2, Sh3, and Th2

Find Shθ

Example: Sh0.39=(0.4), Set hairline directly over 0.39 on Sh2 scale, read D:0.4 under the hairline is the answer.

Example: Sh 2.095=(4), Set hairline directly over 2.095 on Sh3 scale, read D:4 under the hairline is the answer.

Find Thθ

Example: Th 0.424=(0.4), Set hairline directly over 0.424 on Th2 scale, read D:0.4 under the hairline is the answer.

X. Usage of KW and (HP) on Cursor,

KW and HP

Above the long vertical hairline of the front cursor, the sign KW is engraved, it is used in conjunction with the vertical short hairline which is for HP. They are for the conversion of KW into Hp, and vice versa.

Example: 25KW=(34)HP

Set the long hairline over 25 on A scale, the numerical value 34 on A scale under the right short hairline is exactly the answer.

XI. Usage of S-line, V-line, π-line, R-line, 1°-line

S-line: On the both A and B scales, a S-line is engraved between the figures 78 and 79, its value isπ/4, it is used for finding circle area ($A = \frac{\pi}{4} d^2$) when its diameter is known. Set the right index C:10 on the s-line, under the same hairline, the value on A scale is the area A, the value on C scale is the diameter d.

v–line: On the K scale, a v–line is engraved between the figures 520 and 530, its value isπ/6, it is used for finding the spherical volume of sphere ($V = \frac{\pi}{6} d^3$) when its diameter is known. Set the right index C:10 on the v-line, under the same hairline, the value on K scale is the volume V, the value on C

scale is the diameter d.

π-line: On the DF scale, a π–line is engraved at the left end, its value isπ, it is used for finding the perimeter of circle ($L = \pi d$) when its diameter d is known. Set the left index C:1 on the **π**-line, under the same hairline, the value on DF scale is the perimeter L, the value on C scale is the diameter d.

On C and D scales, There are **π**–line too, they are used for finding the perimeter of circle.

On A and B scales, There are **π**–line also, they are used for finding the area of circle or sphere.

R-line: On C and D scales of side 2, there are a **R**–line is engraved between the figures 5.7 and 5.75, its value is 52.2958°, it is used for convert the radian into degree using multiplication, or convert the degree into radian using division.

1°-line: On C and D scales of side 2, there are a is engraved between the figures 1.74 and 1.75, its value is 0.01745, it is used for finding sinθ and tgθ

for small angles 0.573°～5.73°.When the angle is very small, sinθ is about equal tgθ, and, it is about equal radian of θ. So, use 1°–line doing multiplication can get the answer.

Example sin1.5°=tg1.5°=?

Move the slide right until C:1 exactly against the 1°–line on D, then set the hairline directly over C:1.5, read the D:0.0262 under hairline is the answer.

Example ctg1.5°=?

As ctg1.5°=1/tg1.5°, same the above Example, read the DI:38.2 under hairline is the answer.

Example cos89.4°=?

As cos89.4°=sin0.6°=tg0.6°.

Move the slide left until C:10 exactly against the 1°–line on D, then set the hairline directly over C:6, read the D:0.0105 under hairline is the answer.

Example ctg0.6°=?

As ctg0.6°=1/tg0.6°, same the above Example, read the DI:95.5 under

hairline is the answer.

XII. Usage of H2, H3, H'2 Scales

1. Usage of H'2 Scale

This scale is for finding the base angle and opposite line when known the hypotenuse and base line of a right triangle.

The scales on **H'2** are engraved according to $\sqrt{1-(0.1C)^2}$, the **2** means it will combine use with the C scale on side 2. When hairline on the **H'2:0.6,** meanwhile on C:0.8, $0.6^2+0.8^2=1$. Other numbers have the same relation. i.e. the number on C scales divide by 10 are the value of sin or cos, then the number on **H'2** scale are the value of cos or sin of same angle.

Example A right triangle, known the hypotenuse is 5, base line is 4, find base angle and opposite line.

Move the slide left until C:10 exactly against D:5, then set the hairline

over D:4, read the C D:8 under hairline, under the same hairline read the **cos2:36.9°**is the value of base angle, and the **H'2:6**, move the hairline over C:6, read the D:3 under hairline is the opposite line.

2.Usage of H2, H3 scales

These two scales are for finding the base angle and hypotenuse when known the opposite line and base line of a right triangle.

The scales on H2 are engraved according to $\sqrt{1+(0.1C)^2}$, The scales on H3 are engraved according to $\sqrt{1+C^2}$.

Example A right triangle, known the base line is 4, opposite line is 3, find base angle and hypotenuse. (usage of H2)

Use the side2 of the slide rule, move the slide left until C:10 exactly against D:4, then set the hairline over D:3, read the C:0.75 under hairline, under the same hairline read the **tg2:36.9°**is the value of base angle, turn off

the rule to side1, under the same place hairline can read the H2:1.25, move the hairline over CF:1.25, read the DF:5 under hairline is the hypotenuse.

Example A right triangle, known the base line is 3, opposite line is 4, find base angle and hypotenuse. (usage of H3)

Use the side2 of the slide rule, move the slide right until C:1 exactly against D:3, then set the hairline over D:4, read the C:1.33 under hairline, under the same hairline read the **tg3:53.1°**is the value of base angle, turn off the rule to side1, under the same place hairline can read the H3:1.667, move the hairline over C:1.667, read the D:5 under hairline is the hypotenuse.