Lafayette

BAMBOO SLIDE RULES

INSTRUCTIONS
for the Use of

MODEL 99-7128

LAFAYETTE RADIO ELECTRONICS CORPORATION

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CONTENTS

INSTRUCTIONS

FOR THE USE OF YOUR ELECTRICAL COMMUNICATION SLIDE RULE

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1. GENERAL DESCRIPTION

This slide rule has been designed to speed up calculations for radio and electrical communication engineering; for decibel, inductive reactance, capacitive reactance, resonance frequency and surge impedance, namely not only the computation of multiplication and division can be done with the DF, CF, CIF, CI, C and D scales, but also the S, T and DI scales make it possible to obtain the result of $a \pm jb \rightleftarrows R \underline{/\theta}$.

2. SCALE ARRANGEMENT AND USAGE

(Front Face) db, DF, CF, CIF, CI, C, D, A
(Back Face) X_C, X_L, K, KI, S, T, F_2, F_1, DI

(a) db

This decibel scale is useful in the computation of electric communication circuit. Moreover this equaly subdivided scale can be used as ordinary mantissa scale to obtain the common logarithms of a number.

(b) DF and CF

These are the same as the D and C scales, except that they are "folded" at π. Therefore, any number on the D scale is automatically multiplied by π on the DF scale. And in order to avoid resetting when the answer runs off scale, they are used with the C and D scales.

(c) CIF

This is an inverted CF scale and is used with the DF scale in the same relation as the CI scale with the D scale.

(d) CI

This is an inverted C scale and is used with the C scale in reading directly the reciprocal of a number. And it lets us do multiplication of three factors with just one setting of the slide.

(e) C and D

These are exactly alike and the fundamental scales of the slide rule. And they are used for general fundamental calculations.

(f) A

This is used with the D scale to find the square and square root.

(g) Xc

This scale is a KI scale folded at $1/2\pi$ and is used in the computation of capacitive reactance $Xc=1/2\pi fC$ with the K and KI scales.

(h) XL

This scale is a K scale folded at 2π, and is used in the computation of inductive reactance $X_L=2\pi fL$ with the K and KI scales

(i) K

This is used in finding the cube and cube root.

(j) KI

This is an inverted K scale and is used with the K scale in reading directly the reciprocal of a number.

(k) S

This scale gives the sine and cosine of an angle.

(l) T

This scale gives the tangent of an angle.

(m) F_1 and F_2

These are special scales, which together from a continuous scale of resonance frequency in two parts, and they can be used in the computation of resonance frequency $F=\frac{1}{2\pi\sqrt{LC}}$ and surge impedance $X=\sqrt{\frac{L}{C}}$ with the K and KI scales.

(n) DI

This is an inverted D scale and just the same as the CI scale. By the co-operation of S, T and DI scales, vector problems can be obtained.

3. APPLICATION TO ELECTRICAL ENGINEERING COMPUTATION

The fundamental calculations are worked out by the use of the DF, CF, CIF, CI, C, D and A scales. The following is the application to electrical engineering computation.

(1) Frequency Modulation

When the maximum amplitude A and minimum amplitude B in the modulation wave are known, the value of the modulation degree m may be found from

$$m=\frac{A-B}{A+B}.$$

Example 1. Calculate the value of the modulation degree, if $A=73.6$ mm and $B=18.5$ mm are given.

Answer 0.598

$$m=\frac{73.6-18.5}{73.6+18.5}=\frac{55.1}{92.1}=0.598$$

Move hairline to 5.51 on DF,
set 9.21 on CF under hairline,
opposite left index of C find 5.98 on D,
read answer as 0.598.

(2) Frequency and Wave Length

There is the following relation between frequency F kc and wave length λ m.

$$F^{(kc)}\times\lambda^{(m)}=3\times10^{5}$$

Therefore, when 3 on the CIF scale is set at the left index of the D scale, there exists frequency-wave length relation between the D and CIF scales on your slide rule.

The position of the decimal point is easily decided by the use of the following table.

F	100 kc	1000 kc	10 Mc	100 Mc	1000Mc	10000 Mc
λ	3000 m	300 m	30 m	3 m	30 cm	3 cm

Example 2. Find the value of wave length, if frequency $F=215$ Mc is given. Answer 1.396 m

Move hairline to left index of D,
set 3 on CIF under hairline,
move hairline to 2.15 on D,
under hairline find 1.396 on CIF,
read answer as 1.396 m.

Example 3. Compute the value of frequency, if $\lambda=41.2$ cm is given. Answer 728 Mc

Move hairline to left index of D,
set 3 on CIF under hairline,
move hairline to 4.12 on CIF,
under hairline find 7.28 on D,
read answer as 728 Mc.

4. DECIBEL CALCULATION

In the electric communication circuit, let voltage and current at the input side be V_1 and I_1, and those at the output side be V_2 and I_2, the decibel for voltage ratio $db_{(v)}$ and the decibel for current ratio $db_{(i)}$ are as follows:

$$db_{(v)}=20\cdot\log_{10}\frac{V_2}{V_1}$$

$$db_{(i)}=20\cdot\log_{10}\frac{I_2}{I_1}$$

When V_2, V_1 or I_2, I_1 are given, the ratio $\frac{V_2}{V_1}$ or $\frac{I_2}{I_1}$ is obtained by using the C and D scales, and the decibel of the ratio $\frac{V_2}{V_1}$ or $\frac{I_2}{I_1}$ is read on the db scale.

The black numbers on the db scale represent the gain value ($+db$) in the decibel calculation and the red numbers the loss value ($-db$). And the value of the decibel is decided from the following tables.

range of $\frac{V_2}{V_1}\left(=\frac{I_2}{I_1}\right)=r$	value of decibel
$1<r<10$	$+db$
$10<r<100$	$+db+20$
$100<r<1000$	$+db+40$
$1000<r<10000$	$+db+60$
$10000<r<100000$	$+db+80$

range of $\frac{V_2}{V_1}\left(=\frac{I_2}{I_1}\right)=r$	value of decibel
$0.1<r<1$	$-db$
$0.01<r<0.1$	$-db-20$
$0.001<r<0.01$	$-db-40$
$0.0001<r<0.001$	$-db-60$
$0.00001<r<0.0001$	$-db-80$

Example 4. Find the decibel voltage gain, if $\frac{V_2}{V_1}=2.4$ is given. Answer 7.6 db

$1<r=2.4<10 \rightarrow$ gain value (black)

Move hairline to 2.4 on D.

under hairline read answer as 7.6 on db (black).

Example 5 Find the decibel voltage loss, if $\frac{V_2}{V_1}=0.24$ is given. Answer −12.4 db

$0.1<r=0.24<1 \rightarrow$ loss value (red)

Move hairline to 2.4 on D,

under hairline read answer as −12.4 on db (red).

Example 6. Fill the following blanks.

$\frac{V_2}{V_1}=r$	24	240	0.024	0.0024
value of decibel	27.6^db^*	47.6*	−32.4*	−52.4*

*...shown answer

$r=24 \quad \therefore db_{v=24}=7.6+20=27.6$ db

$r=240 \quad \therefore db_{v=240}=7.6+40=47.6$ db

$r=0.024 \quad \therefore db_{v=0.024}=-12.4-20=-32.4$ db

$r=0.0024 \quad \therefore db_{v=0.0024}=-12.4-40=-52.4$ db

Example 7. In a radio frequency amplifier the input voltage is 11.3 μV. The output voltage is 36.1 μV Find the decibel voltage gain.

Answer 10.9 db

$$1<r=\frac{36.1}{11.3}<10 \rightarrow \text{gain value (black)}$$

Move hairline to 3.61 on D,

set 1.13 on C under hairline,

move hairline to left index of C,

under hairline read answer as 10.9 on db (black).

Example 8. Find the decibel current loss, if $I_1=5.13$ mA

and I_2=2.36 mA are given.
Answer −6.75 db

$$0.1<r=\frac{2.36}{5.13}<1 \rightarrow \text{loss value (red)}$$

Move hairline to 2.36 on D,
set 5.13 on C under hairline,
move hairline to right index of C,
under hairline read answer as −6.75 on db (red).

Example 9. Find the decibel current gain, if I_1=1.91 mA and I_2=21.3 mA are given. Answer 20.95 db

$$10<r=\frac{21.3}{1.91}<100 \rightarrow \text{gain value (black)}$$

Move hairline to 2.13 on D,
set 1.91 on C under hairline,
move hairline to left index of C,
under hairline find 0.95 on db (black),
read answer as 0.95+20=20.95.

5. VECTOR AND ITS APPLICATION

By the co-operation of S, T and DI scales, solution of the right triangle, vector and its application can be obtained.

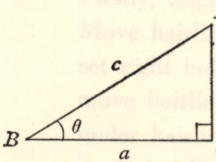

Fig. 1

In the right triangle △ABC, there is the following relation:

$$c\cdot\sin\theta=a\cdot\tan\theta=b$$

$$\therefore \frac{\sin\theta}{\frac{1}{c}}=\frac{\tan\theta}{\frac{1}{a}}=\frac{1}{\frac{1}{b}}$$

Therefore, move the hairline to b on the DI scale, set the right or left index of the slide under the hairline, move the hairline to a on the DI scale, under the hairline read θ on the

T scale, move the hairline to θ on the S scale, under hairline read c on the DI scale.

(1) Vector Problems

Example 10. $4.81+j2.35=5.36\ \underline{/26.05^\circ}$

Move hairline to 2.35 on DI,
set right index of slide under hairline.
move hairline to 4.81 on DI,
under hairline read answer as 26.05 on T,
move halrline to 26.05 on S,
under hairline read answer as 5.36 on DI.

Example 11. $15.4+j19.7=25.0\ \underline{/52^\circ}$

$a=15.4<b=19.7 \quad \therefore$ Angle of phase difference$>45^\circ$

Move hairline to 1.54 on DI,
set right index of slide under hairline,
move hairline to 1.97 on DI,
under hairline read answer as 52 on T (red),
move hairline to 52 on S (red),
under hairline find 2.5 on DI,
read auswer as 25.

Example 12 $21.9\ \overline{\diagdown 15.5^\circ}=21.1-j5.85$

Move hairline to 2.19 on DI,
set 15.5 on S under hairline,
move hairline to 15.5 on T,
under hairline find 2.11 on DI.
read answer as 21.1,
move hairline to left index of slide,
under hairline read answer as 5.85 on DI.

Example 13. $4.25\ \underline{/67.6^\circ}=1.62+j3.93$

Angle of phase difference$>45^\circ \quad \therefore a<b$

Move hairline to 4.25 on DI,
set 67.6 on S (red) under hairline,
move hairline to 67.6 on T (red),
under hairline read answer as 3.93 on DI.
move hairline to left index of slide,
under hairline read answer as 1.62 on DI.

(2) Effective Value of Distorted Wave

When the effective values of the harmonic components are known, the effective value of a distorted voltage or current wave may be found from

$$E=\sqrt{E_1{}^2+E_2{}^2+E_3{}^2+\cdots}.$$

$$I=\sqrt{I_1{}^2+I_2{}^2+I_3{}^2+\cdots}.$$

Example 14. Calculate the effective value of a distorted voltage wave, when the effective values of its components are known as follows;

the fundamental wave $E_{e1}=80$,
the 3rd harmonics $E_{e3}=31$,
the 5th harmonics $E_{e5}=15$.

Answer $E_{e0}=87.2$

Compute as $E_{e0}=\sqrt{E_{e1}{}^2+E_{e3}{}^2+E_{e5}{}^2}=\sqrt{80^2+31^2+15^2}$.

Firstly, calculate as 80^2+31^2.
Move hairline to 3.1 on DI,
set right index of slide under hairline,
move hairline to 8 on DI,
under hairline find 21.2 on T,
move hairline to 21.2 on S,
under hairline find 8.58 on DI,
read answer as $85.8^2=80^2+31^2$.
Secondly, calculate as $\sqrt{85.8^2+15^2}$

Move hairline to 1.5 on DI,
set right index of slide under hairline,
move hairline to 8.58 on DI,
under hairline find 9.92 on T,
move hairline to 9.92 on S,
under hairline find 8.72 on DI,
read answer as 87.2.

(3) Impedance Calculation

Example 15. Find the resultant impedance $\dot{Z}$ in an alternating current circuit as shown by Fig. 2.

Answer $\dot{Z}=2.95+j2.45$

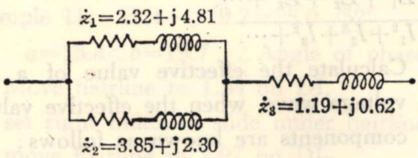

Fig. 2

The calculation of the resultant impedance $\dot{Z}$ as shown by Fig. 2 is worked out the following procedures;

i) calculate $\dot{Z}_1+\dot{Z}_2$,

ii) calculate $\dot{Z}_1\times\dot{Z}_2$,

iii) calculate $\dot{Z}'=\dfrac{\dot{Z}_1\times\dot{Z}_2}{\dot{Z}_1+\dot{Z}_2}$,

iv) calculate $\dot{Z}=\dot{Z}'+\dot{Z}_3$.

Firstly, calculate $\dot{Z}_1+\dot{Z}_2$.

$\dot{Z}_1+\dot{Z}_2=2.32+j4.81+3.85+j2.30=6.17+j7.11=9.42\ \underline{/49^\circ}$. And calculate $\dot{Z}_1\times\dot{Z}_2$.

$$\dot{Z}_1\times\dot{Z}_2=(2.32+j4.81)\times(3.85+j2.30)$$
$$=5.33\ \underline{/64.25^\circ}\times 4.48\ \underline{/30.9^\circ}$$
$$=5.33\times4.48\ \underline{/64.25^\circ+30.9^\circ}.$$

Therefore, $\dot{Z}'=\dfrac{5.33\times4.48\ \angle 64.25^\circ+30.9^\circ}{9.42\ \angle 49^\circ}$

$=\dfrac{5.33\times4.48}{9.42}\ \angle 64.25^\circ+30.9^\circ-49^\circ$

$=2.54\ \angle 46.15^\circ=1.760+j1.832$

Thus, $\dot{Z}=\dot{Z}'+\dot{Z}_3=1.760+j1.832+1.19+j0.62$

$=2.95+j2.45.$

Example 16 Compute the power factor and electric power in an electric circuit, which current is $34-j19$ and the potential difference between its terminals is $75+j54$.

Answer $\cos\theta=0.423$ and $P=1524$ W

Compute as $\dot{Z}=\dfrac{\dot{V}}{\dot{I}}=\dfrac{75+j54}{34-j19}=\dfrac{92.4\ \angle 35.75^\circ}{39\ \angle -29.2^\circ}$

$=\dfrac{92.4}{39}\ \angle 35.75^\circ-(-29.2^\circ)$

$=23.7\ \angle 64.95^\circ$

And calculate power factor as $\cos\theta=\cos 64.95^\circ$.

Move hairline to 64.95 on S (red),
under hairline find 4.23 on C (back face),
read answer as 0.423.

Thus, $P=|\dot{V}|\times|\dot{I}|\times\cos\theta$

$=92.4\times39\times0.423=1524\ (\mathrm{W}).$

(4) Current Calculation

Example 17 Find the current in an electric circuit, which impedance is $4.3+j2.6$ and the potential difference between its terminals is $5.3+j9.1$.

Answer $\dot{I}=1.842+j1.007$

$$I=\frac{V}{\dot{Z}}=\frac{5.3+j9.1}{4.3+j2.6}=\frac{10.53\ \angle 59.8^\circ}{5.02\ \angle 31.15^\circ}=\frac{10.53}{5.02}\ \angle 59.8^\circ-31.15^\circ$$

$=2.10\ \angle 28.65° = 1.842 + j1.007$

Example 18. Compute the resultant current $\dot{I}$, of $\dot{I}_1 = 0.386 + j0.202$ and $\dot{I}_2 = 0.815 + j0.332$ in polar coordinate. Answer $\dot{I} = 1.315\ \angle 23.96°$

$\dot{I} = (0.386 + j0.202) + (0.815 + j0.332)$

$= 1.201 + j0.534 = 1.315\ \angle 23.96°$

6. REACTANCE CALCULATION

(1) Inductive Reactance

To find the inductive reactance X_L, we use the following formula:

$X_L = 2\pi fL$ f ··· frequency
  L ··· inductance

However, above computation can be easily obtained by the co-operation of the X_L, K and KI scales, namely opposite the frequency f on the K scale, set the inductance L on the KI scale. So, you can read the inductive reactance X_L on the X_L scale, opposite the left or right index of the KI scale.

The position of the decimal point is easily decided by the use of the X_L-decimal point table.

	f	c	kc	Mc	c	kc	Mc
	L	mH			μH		
X_L	Opposite 1	mΩ	Ω	kΩ	MΩ	mΩ	Ω
	Opposite 10^3	Ω	kΩ	MΩ	mΩ	Ω	kΩ

cf. (position of decimal point) K···Mc
KI···mH
1→X_L···kΩ

or $10^3 \rightarrow X_L \cdots M\Omega$

Example 19. Find the inductive reactance X_L in an alternating current circuit with 30 mH inductance under 60 c frequency. Answer 11.3Ω

Move hairline to 60 on K,
set 30 on KI under hairline,
move hairline to 10^3 of KI,
under hairline find 11.3 on XL,
read answer as 11.3Ω.

$$\begin{pmatrix} K \cdots C \\ KI \cdots mH \\ 10^3 \rightarrow X_L \cdots \Omega \end{pmatrix}$$

Example 20. Compute the current in an alternating current circuit, with a 250 mH coil under 650 kc frequency. The potential difference between its terminals is 100 V. Answer 0.0972 mA

Move hairline to 650 on K,
set 252 on KI under hairline,
move hairline to 10^3 of KI,
under hairline find 1030 on X_L
read answer as 1030 kΩ.

$$\begin{pmatrix} K \cdots kc \\ KI \cdots mH \\ 10^3 \rightarrow X_L \cdots k\Omega \end{pmatrix}$$

$$\text{Thus, } I=\frac{100}{X_L}=\frac{100}{1030\times 10^3}=0.0972\times 10^{-3}$$
$$=0.0972\text{ mA}.$$

Example 21. Compute the current and angle of phase difference in a series circuit with 570 mH inductance and 65Ω resistance under 60 c frequency. The potential difference between its terminals is 100V. Answer 0.445A, 73.2°

The impedance may be found from

$$\dot{Z}=R+jX_L.$$

Firstly, calculate X_L.

Move hairline to 60 on K,
set 570 on KI under hairline,

move hairline to 10^3 of KI,
under hairline find 215 on X_L
read answer as 215Ω.

$$\left(\begin{array}{l} K \cdots kc \\ KI \cdots mH \\ 10^3 \rightarrow X_L \cdots \Omega \end{array}\right)$$

Therefore,

$$\dot{Z} = R + jX_L = 65 + j215 = 225 \angle 73.2^\circ$$

$$\therefore \quad I = \frac{V}{|\dot{Z}|} = \frac{100}{225} = 0.445 \text{ A}$$

(2) Capacitive Reactance

To find the capacitive reactance X_c, we use the following formula:

$$X_c = \frac{1}{2\pi fC} \qquad \begin{array}{l} f \cdots \text{frequency} \\ C \cdots \text{capacitance} \end{array}$$

However, above computation can be easily obtained by the co-operation of the Xc, K and KI scales, namely opposite the frequency f on the K scale, set the capacitance C on the KI scale. So, you can read the capacitive reactance X_c on the Xc scale, opposite the left or right index of the KI scale.

The position of the decimal point is easily decided by the use of the X_c-decimal point table.

	f	c	kc	Mc	c	kc	Mc	c	kc	Mc
	C		μF			$10^{-3}\mu$F			pF	
Xc	Opposite 1	kΩ	Ω	mΩ	MΩ	kΩ	Ω	10^3MΩ	MΩ	kΩ
	Opposite 10^3	Ω	mΩ	μΩ	kΩ	Ω	mΩ	MΩ	kΩ	Ω

cf. (position of decimal point)

$$\begin{array}{l} K \cdots Kc \\ KI \cdots pF \\ 1 \rightarrow Xc \cdots M\Omega \\ \text{or } 10^3 \rightarrow Xc \cdots k\Omega \end{array}$$

Example 22. Compute the capacitive reactance X_c in alternating current circuit with 2.5 μF capacitance under 60 c frequency. Answer 1.06 kΩ

Move hairline to 60 on K,
set 2.5 on KI under hairline.
move hairline to 1 of KI,
under hairline find 1.06 on Xc.
read answer as 1.06 kΩ.

(K···c
KI···μF
1 → Xc···kΩ)

Example 23. Compute the currert in an alternating current circuit with a 3.5 μF condenser under 50 c frequency. The effective potential difference between its terminals is 1500 V.
Answer 1.649 A.

Firstly, calculate X_c.

Move hairline to 50 on K,
set 3.5 on KI under hairline.
move hairline to 1 of KI,
under hairline find 0.91 on Xc,
read answer as 0.91 kΩ=910Ω.

(K···c
KI···μF
1 → Xc···kΩ)

So, the value of current is worked out as follows:

$$I=\frac{1500}{910}=1.649\ \text{A}.$$

(3) Electric Circuit involving Inductance, Capacitance and Resistance

Example 24. In Fig. 3, compute the current I in an alternating current circuit with 6.5 Ω resistance, 16 mH inductance and 770 μF capasitance under 50 c frequency. The potential difference between its

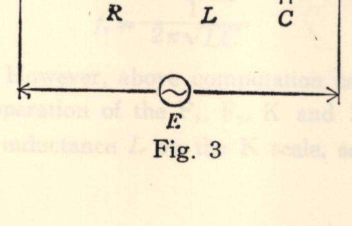

Fig. 3

terminals is 100V. Answer 15.25 A

The impedance $\dot{Z}$ may be found from

$$\dot{Z}=R+j\,(X_L-X_c).$$

Firstly, calculate X_L.

Move hairline to 50 on K,
set 16 on KI under hairline.
move hairline to 1 of KI,
under hairline find 5020 on X_L,
read answer as 5020mΩ=5.02Ω.

(K···c; KI···mH; $1\rightarrow X_L$···mΩ)

Secondly, calcutate X_c.

Move hairline to 50 on K,
set 770 on KI under hairline
move hairline to 10^3 of KI,
under hairline find 4.14 on X_L
read answer as 4.14Ω.

(K···c; KI···μF; $10^3\rightarrow X_L$···Ω)

Thus,

$$\dot{Z}=R+j(X_L-X_c)=6.5+j(5.02-4.14)$$
$$=6.5+j0.88=6.56\,\underline{/7.71^\circ}\ \Omega.$$
$$\therefore I=\frac{100}{6.56}=15.25\text{ A}$$

Example 25. In Fig. 4, compute the resultant impedance $\dot{Z}$, if L=120 mH and C = 150 μF are given. The frequency is 60 c.

Answer 29.1Ω

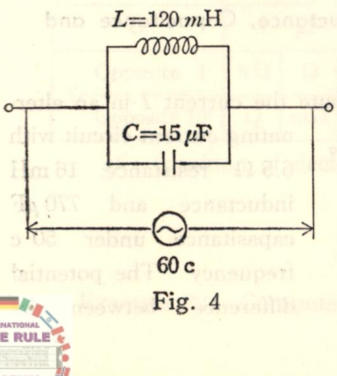

Fig. 4

Compute as $\dot{Z}_1 = jX_L$.

Move hairline to 60 on K,
set 120 on KI under hairline,
move hairline to 10^3 of KI,
under hairline find 45.2 on X_L,
read answer as 45.2Ω.

(K···c; KI···mH; $10^3 \rightarrow X_L$···Ω)

Compute as $\dot{Z}_2 = -jX_c$.

Move hairline to 60 on K,
set 150 on KI under hairline,
move hairline to 10^3 of KI,
under hairline find 17.7 on Xc
read answer as 17.7Ω.

(K···c; KI···μF; $10^3 \rightarrow$ Xc···Ω)

Thus, $$\frac{1}{\dot{Z}} = \frac{1}{\dot{Z}_1} + \frac{1}{\dot{Z}_2} = \frac{\dot{Z}_1 + \dot{Z}_2}{\dot{Z}_1 \times \dot{Z}_2},$$

$$\therefore \dot{Z} = \frac{\dot{Z}_1 \times \dot{Z}_2}{\dot{Z}_1 + \dot{Z}_2} = \frac{j45.2 \times (-j17.7)}{j45.2 - j17.7} = \frac{-j^2 800}{j27.5}$$

$$= \frac{-j800}{27.5} = -j29.1$$

$$|\dot{Z}| = 29.1\Omega$$

7. FREQUENCY CALCULATION

(1) Resonance Frequency

To find the resonance frequency f_r, we use the following formula:

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

L ··· inductance
C ··· capacitance

However, above computation can be easily obtained by the co-operation of the F_1, F_2, K and KI scales, namely opposite the inductance L on the K scale, set the capacitance C on the

KI scale. So, you can read the resonance frequency f_r on the F_1 or F_2 scale, opposite the left or right index of the KI scale.

The position of the decimal point is easily decided by the use of the f_r - decimal point table.

	L	mH	μH	mH	μH	mH	μH
	C	μF		10^{-3}μF		pF	
f_r	Opposite 1	F_1 kc	F_2 kc	F_2 kc	F_1 Mc	F_1 Mc	F_2 Mc
	Opposite 10^3	F_2 c	F_1 kc	F_1 kc	F_2 kc	F_2 kc	F_1 Mc

cf. (position of decimal point) K···mH
KI···pF
$1 \rightarrow F_1$···Mc
or $10^3 \rightarrow F_2$···kc

Example 26. Compute the resonance frequency f_r in a series resonance circuit, with 210 μH inductance and 360 pF capacitance. Answer 0.578 Mc

Move hairline to 210 on K,
set 360 on KI under hairline,
move hairline to 10^3 of KI,
under hairline find 0.578 on F_1.
read answer as 0.578 Mc.

(K···μH
Kl···pF
$10^3 \rightarrow F_1$···Mc)

Example 27. Compute the resonance frequency f_r in a parallel resonance circuit with 150 mH inductance and 230μF capacitance. Answer 27.1 c

Move hairline to 150 on K,
set 230 on KI under hairline,
move hairline to 10^3 of KI,
under hairline find 27.1 on F_2.
read answer as 27.1 c.

(K···mH
KI···μH
$10^3 \rightarrow F_2$···c)

Example 28. There is a tuning circuit with 1.1 mH self inductance coil and the air variable condenser to receive the radio wave of frequency range from 550 kc and 1650 kc. Find the minimum and maximum capacities of its condenser.

Answer $C_{min}=8.45$ pF, $C_{max}=76.0$ pF

$$1650\,(\text{kc})=1.65\,(\text{Mc})=\frac{1}{2\pi\sqrt{1.1^{(mH)}\times C_{min}}}.$$

Move hairline to 1.65 on F_1.
set 1 of KI under hairline,
move hairline to 1.1 on K,
under hairline find 8.45 on KI
read answer as 8.45 pF $=C_{min}$

(F_1···Mc, K···mH, 1→KI···pF)

$$550\,(\text{kc})=0.55\,(\text{Mc})=\frac{1}{2\pi\sqrt{1.1^{(mH)}\times C_{max}}}$$

Move hairline to 0.55 on F_1.
set 1 of KI under hairline,
move hairline to 1.1 on K,
under hairline find 76.0 on KI,
read answer as 76.0 pF $=C_{max}$.

(F_1···Mc, K···mH, 1→KI···pF)

Example 29. Compute the oscillated frequency in a Hartly oscillator as shown by Fig. 5, if $L_1=L_2=18\,\mu$H, $M=2.5\,\mu$H, $C=950$ pF and $R_1+R_2=1\Omega$ are given.

Answer 806 kc

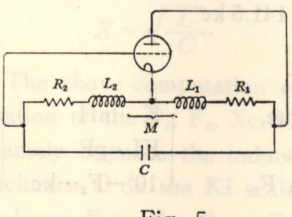

Fig. 5

In Fig. 5, the oscillated frequency f_r may be found from

$$f_r=\frac{1}{2\pi\sqrt{(L_1+L_2+2M)\cdot C}}.$$

$\therefore L_1+L_2+2M=18+18+2\times 2.5=41\ \mu H$

Move hairline to 41 on K,
set 950 on KI under hairline,
move hairline to 10^3 of KI,
under hairline find 0.806 on F_1,
read answer as 0.806 Mc=806 kc.

(K···μH; KI···pF; $10^3\rightarrow F_1$···Mc)

(2) Natural Frequency

To find the natural frequency ω we use the following formula;

$$\omega=\frac{1}{\sqrt{LC}}.$$

L ··· inductance
C ··· capacitance

However, $\omega=2\pi\times\frac{1}{2\pi\sqrt{LC}}=2\pi\times f_r$.

Therefore, we can calculate the value of f_r by the use of the F_1, F_2, K and KI scales in the same way as in chapter 7, (1). And the value of the natural frequency is calculated by multiplying f_r by 2π.

The above multiplication is easily done by the use of gauge mark line ω on the slide.

Example 30. Find ω, if $L=250$ mH and $C=200$ pF are given. Answer 141.5 kc

Firstly, calculate f_r.

Move hairline to 250 on K,
set 200 on KI under hairline,
move hairline to 10^3 of KI,
under hairline find 22.5 on F_2,
read answer as 22.5 kc.

(K···mH; KI···pF; $10^3\rightarrow F_2$···kc)

$\therefore \omega=2\pi\times f_r=2\pi\times 22.5$ kc.

Next, opposite gauge mark line ω, value of natural frequency runs off scale

Move hairline to 22.5 on F_2,
set 1 of KI under hairline,
move hairline to gauge mark line ω,
under hairline read answer as 141.5 kc.

Example 31 Find ω, if $L=200$ mH and $C=0.07\,\mu$F are given.

Answer 8.44 kc

$0.07\,\mu F = 70\times 10^{-3}\mu F$.

Move hairline to 200 on K,
set 70 on KI under hairline,
move hairline to 10^3 of KI,
under hairline find 1.343 on F_1
read answer as 1.343 kc.

K···mH
KI···$10^{-3}\mu$F
$10^3\rightarrow F_1$···kc

$\therefore \omega = 2\pi \times f_r = 2\pi \times 1.343$ kc.

Move hairline to gauge mark line ω,
under hairline read answer as 8.44 kc on F_2.

8. SURGE IMPEDANCE

To find the surge impedance X, we use the following formula:

$$X=\sqrt{\frac{L}{C}}.$$

L ··· inductance
C ··· capacitance

The above computation can be easily obtained by the co-operation of the F_1, F_2, Xc, KI scales and the gauge mark line x, namely opposite the inductance L on the Xc scale, set the capacitance C on the KI scale. So, you can read the surge impedance X on the F_1 or F_2 scale, opposite the gauge mark line x.

The position of the decimal point is easily decided by the use of the X-decimal point table.

		H	mH	μH	H	mH	μH	H	mH	μH
L		H	mH	μH	H	mH	μH	H	mH	μH
C		μF			10^{-3}μF			pF		
X	Opposite Index x	F_1 kΩ	F_2Ω	F_1Ω	F_2 kΩ	F_1 kΩ	F_2Ω	F_1 MΩ	F_2 kΩ	F_1 kΩ
	Opposite Index x (reset)	F_2Ω	F_1Ω	F_2 mΩ	F_1 kΩ	F_2Ω	F_1Ω	F_2 kΩ	F_1 kΩ	F_2Ω

cf. (position of decimal point) Xc…mH

KI…μF

Index x→F_2…Ω

If the answer runs off scale, we reset the slide as follows.

Index x (reset)→F_1…Ω

Example 32. Compute the surge impedance of a radio-frequency transmission line whose inductance per km of line is L=280 mH and whose capacitance per km is C=330 pF.

Answer 29.1 kΩ

280 mH=0.28 H.

Move hairline to 0.28 on Xc,
set 330 on KI under hairline,
opposite gauge mark line x, answer runs off scale.
therefore, move hairline to 10^3 of KI,
set 1 of KI under hairline,
move hairline to gauge mark line x.
under hairline find 29.1 on F_2,
read answer as 29.1 kΩ.

(Xc…H
KI…pF
x(reset)→F_2·kΩ)

Example 33. In Fig. 6, compute the potential difference between both terminals of C

Answer V_c=1.02 V

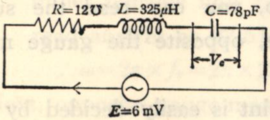

Fig. 6

V_c may be found from

$$V_c = \frac{E}{R} \cdot \sqrt{\frac{L}{C}}\,.$$

Firstly, calculate $\sqrt{\frac{L}{C}}$.

325 μH = 0.325 mH.

Move hairline to 0.325 on Xc,
set 78 on KI under hairline,
opposite gauge mark line x, answer runs off scale.
therefore, move hairline to 10^3 of KI,
set 1 of KI under hairline,
move hairline to gauge mark line x,
under hairline find 2.04 on F_1.
read answer as 2.04 kΩ.

(Xc···mH
KI···pF
x(reset)→F_1···kΩ)

$$\therefore V_c = \frac{E}{R} \cdot \sqrt{\frac{L}{C}} = \frac{6\times10^{-3}}{12} \times 2.04\times10^{3} = 1.02\ \text{V}.$$

— THE END —

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