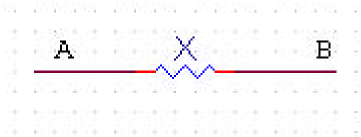
Subject: Theory of R, C, L Measurement

1. Measurement of Jumper

We define that measure value "1" is "Short" in TRI machine.
We define that measure value "4" is "Open" in TRI machine.

1.1 Mode 0 (Adjust by OPS Range Measure)

Example (ops=5, 25, 55)



X = Resistor value A to B

	Measure value of Type J
0<X<5Ω	1
5Ω<X<25Ω	1
25Ω<X<55Ω	3
55Ω<X	4

If, X<25Ω, measure value display 1
25Ω<X<55Ω, measure value display 3
55Ω<X, measure value display 4

1.2 Mode 1(Adjust by resister Measure)

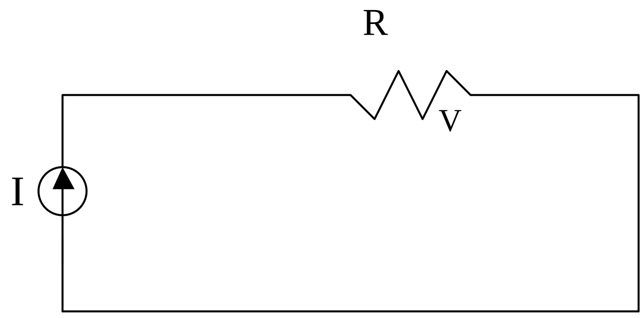
If, X<5Ω measure value display 1
5Ω<X measure value display 4

1.3 Mode 2(Adjust by Resistor Measure)

If, X<10Ω measure value display 1
10Ω<X measure value display 4

2. Measurement of Resistor

2.1 Constant Current MODE 0

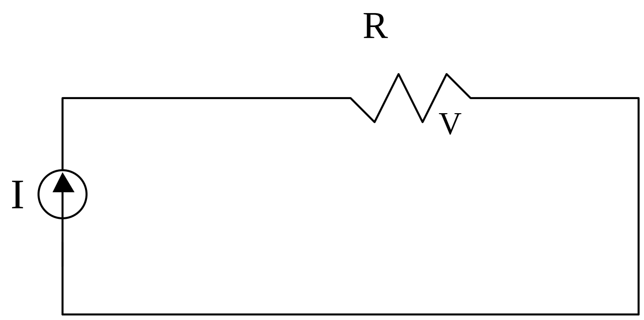


V = I ×R

RANGE	CURRENT
1Ω—299.99Ω	5mA
300Ω—2.99KΩ	500uA
3KΩ—29.99KΩ	50uA
30KΩ—299.9KΩ	5uA
300KΩ—2.99MΩ	0.5uA
3MΩ—40MΩ	0.1uA

In order to measure different resister, we apply different current source to let Voltage value interval 0.15V to 1.5V.

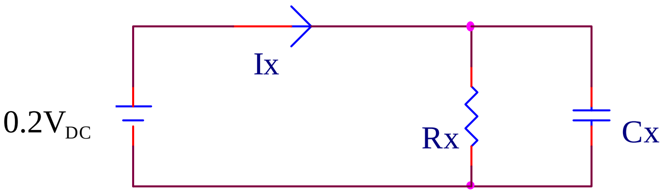
2.2 Low Constant Current MODE 1



V = I ×R

RANGE	CURRENT
1Ω—299.99Ω	500uA
300Ω—2.99KΩ	50uA
3KΩ—29.99KΩ	5uA
30KΩ—299.9KΩ	0.5uA
300KΩ—2.99MΩ	0.1uA

2.3 High-Speed Test MODE2



$$R_X = \frac{0.2V_{DC}}{I_X}$$

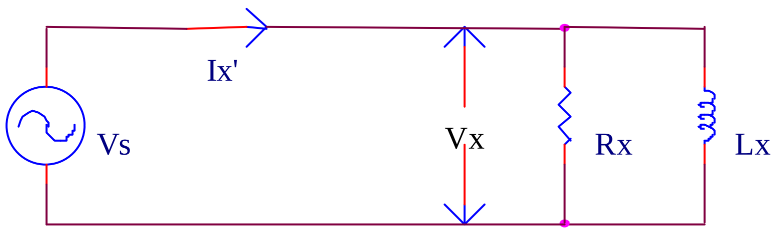
1, Give DC 0.2V, let C saturated

2, Ic=0

3, V= I ✕R

2.4 AC Phase Test (MODE3, MODE4, MODE5)

1KHz~100KHz
Constant
Amplitude



$$Y' = Y_{RX} + Y_{LX} = -j\frac{1}{w \cdot L_X} + \frac{1}{R_X}$$

$$Y' = -j\frac{1}{w \cdot L'_X}$$

$$\left| Y' \right| \cos q = Y_{RX} = \frac{1}{R_X}$$

$$V_S = I'_X * Y'$$

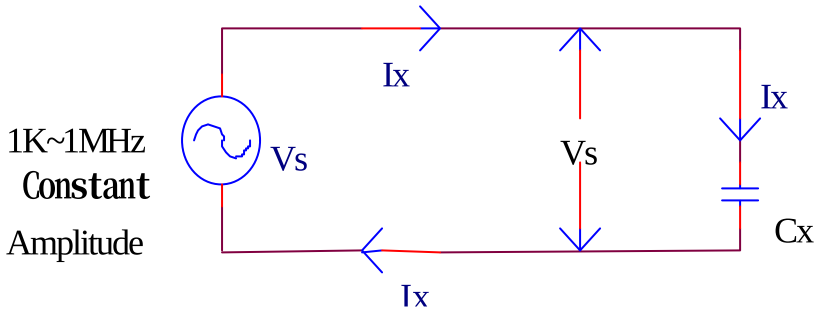
$$Y' = V_S / I'_X$$

RANGE(R)	SIGNAL	MODE
5Ω~300K ohm	1KHZ	0
5Ω~40K ohm	10KHZ	1
5Ω~4K ohm	100KHZ	2

3. Measurement of Capacitor

If we choose DC sign to measure capacitor, capacitor is similar to short in the initial state and open in the stable state.
We can't choose DC sign to measure capacitor, we must choose AC sign to measure capacitor.
For this reason, We choose different SIN wave to measure capacitor, and the amplitude of sin wave is constant value 40 mV$_{RMS}$.

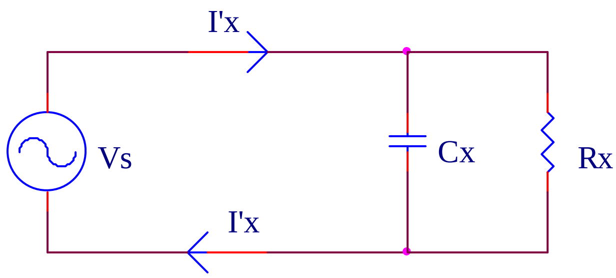
3.1 AC Measure (MODE 0,1,2,3)

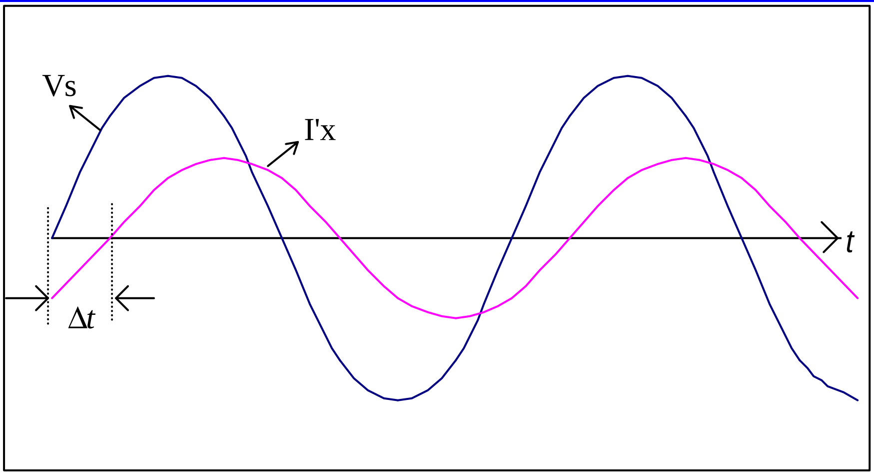


$$V_S / I_X = Z_C = \frac{1}{2\pi f \times C_X}$$

	AC SOURCE(Frequency)
MODE0	1KHz
MODE1	10KHz
MODE2	100KHz
MODE3	1MHz

3.2 Cx // Rx (MODE 5,6,7)





Phase Means TIME-DELAY $(\Delta t), \Delta t \times 2pf = \Delta q$

$$Y' = Y_{CX} + Y_{RX}$$

$$Y' = jwC_X + 1/R_X$$

$$Y' = jwC'_X$$

$$|Y'| \cdot \sin q = |Y_{CX}| \quad , \quad if \quad R_X \to \infty \Rightarrow q \to 90^\circ$$

$$w \cdot C'_X \cdot \sin q = w \cdot C_X \quad R_X \to 0 \Rightarrow q \to 0^\circ$$

$$\therefore C'_X \cdot \sin q = C_X$$

(1) If the resistor value of Rx is high,

$\sin\theta$ 1→ C'_X C_X

(2) If the resistor value of Rx is low,

$\sin\theta$ 0→ C'_X 0

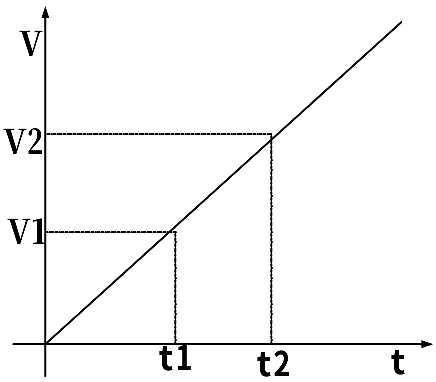
3.3 DC Constant Current test MODE4, MODE8

Theory：

$$Q_C = C_X \times V_C = It$$

$$\Delta Q_C = C_X \times \Delta V_C = I_S \times \Delta t$$

$$\frac{I_S}{C_X} = \frac{\Delta V_C}{\Delta t} = const = \text{Slope}$$



MODE 4 Current: 5mA Max: 40000uF

MODE 8 Current: 10mA Max: 80000uF

If you test the value of capacitor under 1000uF, you select MODE8 is better than MODE4. It will let you test fast.

RESISTOR OF CAPACITOR				
	MODE0	MODE1	MODE2	MODE3
	1KHz	10KHz	100KHz	1MHz
1Pf		16M	1.6M	160K
10pF	16M	1.6M	160K	16K
100pF	1.6M	160K	16K	1.6K
1nF	160K	16K	1.6K	160
10nF	16K	1.6K	160	16
100nF	1.6K	160	16	
1uF	160	16		
10uF	16	1.6		
100uF	1.6			

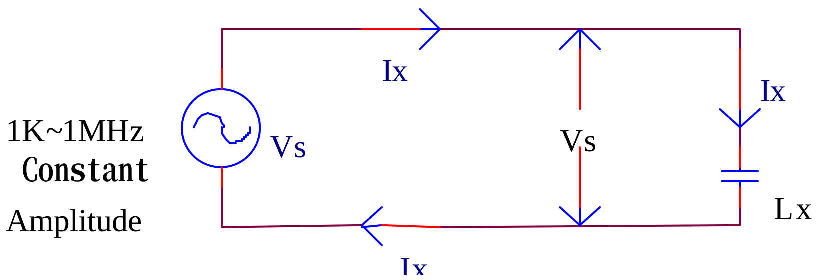
4. Measurement of Inductor

If we choose DC sign to measure inductor, inductor is similar to open in the initial state and short in the stable state.

We can't choose DC sign to measure inductor, we must choose AC sign to measure inductor.

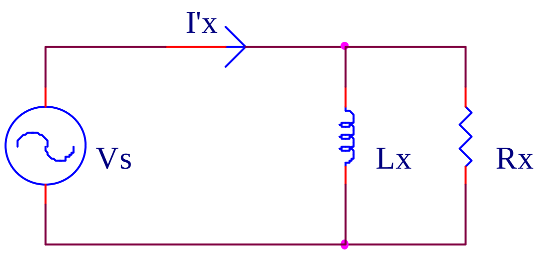
For this reason, We choose different SIN wave to measure inductor, and the amplitude of sin wave is constant value 40 mV$_{RMS}$.

4.1 AC Measure (MODE 0,1,2,3)



$$V_S / I_X = Z_L = 2\pi f \cdot L_X$$

4.2 Lx // Rx (MODE 5,6,7)



$$Y' = Y_{LX} + Y_{RX} = -j\frac{1}{\omega \cdot L_X} + \frac{1}{R_X}$$

$$Y' = -j\frac{1}{\omega \cdot L'_X}$$

$$\Rightarrow |Y'| \cdot \sin\theta = |Y_{LX}|$$

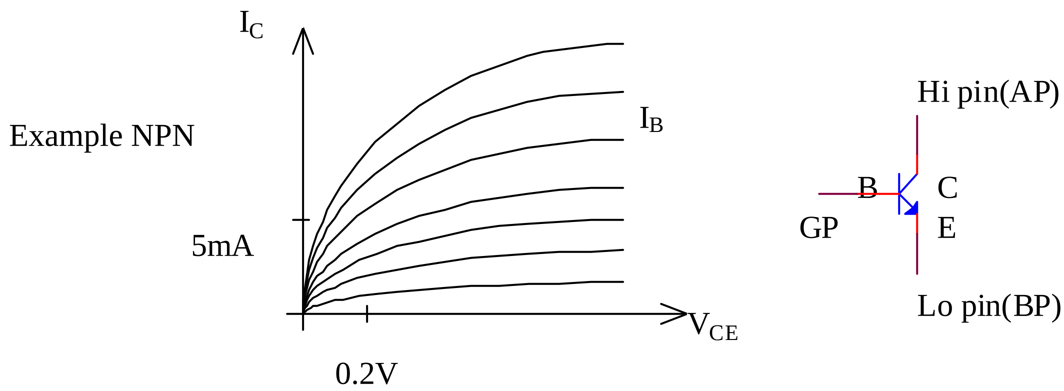
$$\frac{1}{\omega \cdot L'_X} \cdot \sin\theta = \frac{1}{\omega \cdot L_X}$$

$$L_X = L'_X / \sin\theta$$

RESISTOR OF INDUCTOR				
	MODE0	MODE1	MODE2	MODE3
	1KHz	10KHz	100KHz	1MHz
1uH	6.3mΩ	63mΩ	0.63Ω	6.3Ω
10uH	63mΩ	0.63Ω	6.3Ω	63Ω
100uH	0.63Ω	6.3Ω	63Ω	630Ω
1mH	6.3Ω	63Ω	630Ω	6.3KΩ
10mH	63Ω	630Ω	6.3KΩ	63KΩ
100mH	630Ω	6.3KΩ	63KΩ	630KΩ
1H	6.3KΩ	63KΩ	630KΩ	6.3MΩ
10H	63KΩ	630KΩ	6.3MΩ	
60H	378KΩ			

5. Measurement of Transistor

5.1, Measurement of V_{CE} (MODE3, 4)



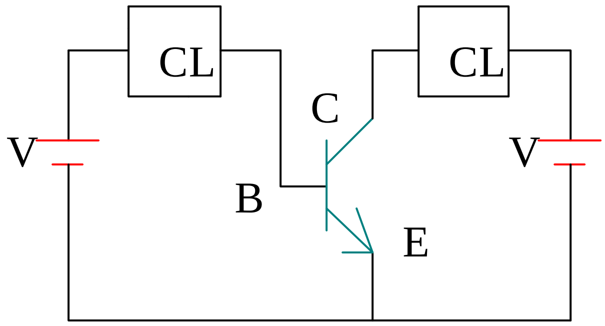
a. Emitter connect to ground and I_{CE}=5mA(AP).

b. V_{BE} (GP) input voltage that it modulate from 0~10V.

c. When V_{BE} increase, I_B increase at the some time. Let Transistor go to saturated.

d. The voltage of V_{CE} below to 0.2V

5.2 Measurement of hFE (MODE12, 13)



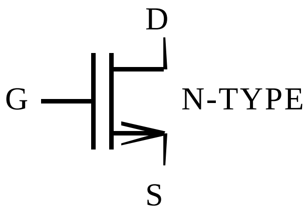
a. V_{BE} input voltage that it modulate from 0~5V

b. V_{CE} input voltage that it modulate from 0~5V.

c. Measure IB, IC

d. β = hFE =IC / IB

5.3 Measurement of FET (MODE14, 15)

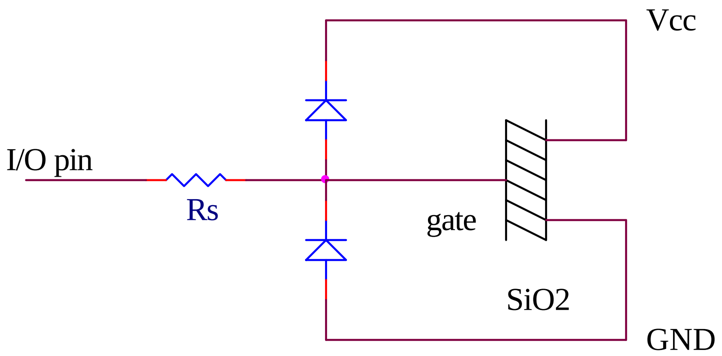


a. VDS input voltage that it modulate from 0~5V

b. VGS input voltage that it modulate from 0~5V.

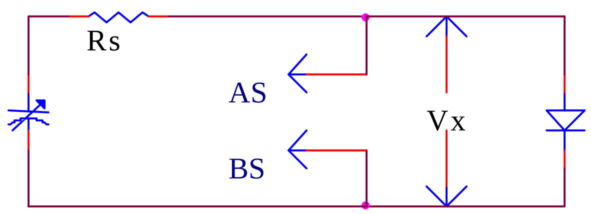
c. Measure IDS

6. Measurement IC Clamping Diode



1, Clamping Diode protects gate.

2, Rs protects Clamping Diode.



1, The voltage from TCB Board has current limit (3mA / 20mA) to avoid short of load.

2, Measure voltage from load.

3.The source of voltage can modulate by DAC(Digital-to-Analog Converter)