SERVICE MANNUAL

GRAPHICAL INSTRUMENT FOR TRANSISTOR FEATURE

1. Summary

This Graphical Instument for Transistor Feature is an instrument in which the oscilloscope is adopted to display various feature curves of semiconductor device. It can also measure their low frequency static-state parameters, so is a kind of absolutely necessary device for the workers who are engaged in researching, manufacturing and operating transistors and radios.

1.1 Main Components

1.1.1 Vertical Amplifier: Its input is chosen by the switch "I/DIV". It can be the step source voltage, the collector current of the measured triodes or the reversal drain current of the measured diodes.

1.1.2 Horizontal Amplifier: Its input is chosen by the switch "V/DIV". It can be the step source voltage, the "V_{CE}" or the "V_{BE}" voltage of the measured smei-triades.

1.1.3 Amplification and Production of Step Signal: When "V" in the "Step" switch is chosen, the output will be the potential source; and if the "I" is chosen, will be the current source. Therefore, it can be chosen according to the different uses.

1.1.4 Collector supply: Mainly provides the measured device with the collector sweep voltage and the testing voltage of the reversal drain current.

1.1.5 Low Voltage Steady Supply and High Voltage Supply: The low voltage supply is for all the circuits of this instrument, but the high voltage supply is for the oscilloscope tube and its circuits.

1.1.6 Test Floor: It's a device for connecting the measured devices to this instrument and can be changed by the followings (for conjugation): test floor, 5kV drain current test floor(for matching) etc.

1.2 Characteristic

1.2.1 There's a step change blanking circuit, therefore it can make the feature curves clearer.

1.2.2 There's a double cluster display circuit. It can side by side display their feature curves of the same kind of triodes to help the cónjugation for the multiple of the current amplification.

1.2.3 The max. output of the step potential source is up to 2V/STAGE. It can be used to test the VMOS tube of high cut-in voltage.

1.2.4 It has the conjugation function for the parallel field effect tubes.

2. Main Technical Index

2.1 Deflection Coefficient of Vertical Axis

Scope of Collector Voltage (Ic): 20μA/DIV~1A/DIV, divided into 15 grades, error is not more than ± 3%.

Reversal Drain Current of Diode (I_R):

0.2 μA/DIV~1A/DIV, divided into 6 grades

2μA/DIV~10μA/DIV, error not more than ±3%

0.2μA/DIV~1μA/DIV, error not more than ±10%

0.2μA/DIV, interfere ≤ 0.5V/DIV

Base Current or Base Voltage: 20mV/DIV, error not more than ±3%, deflection multifying factor × 0.5, error not more than ±10%

2.2 Deflection Coefficient of Horizontal Axis

Scope of Collector Voltage: 0.05V/DIV~50V/DIV, divided into 10 grades, error not more than ±3%

Scope of Drain Current Voltage of Diode: 100V/DIV~500V/DIV divided into 3 grades, error not more than ±5%, (for matching 5kV test floor)

Scope of Base Voltage: 0.05V/DIV~2V/DIV, divided into 6 grades, error not more than ±3%

Base Current or Base Source Voltage: 0.1V/DIV, error not more than ±3%.

2.3 Step Signal

Scope of Step Current: 1μA/ STAGE~0.1A/STAGE, divided into 16 grades, error not more than ±5%

Scope of Step Voltage: 0.05V/STAGE~2V/STAGE, divided into 6 grades, error not more than ±5%

Stage Number per cluster: 4~10 stages, continuously adjustable

Step Zeroing: Not less than ±1DIV

Stage Number per Second: 200(commercial frequency: 50Hz)

Step Polarity: Positive or negative

Step Form: Continuous or single cluster

2.4 Collector Sweep Supply

Max. Current of Sweep Supply Each Grade: 0~5V GRADE: 10A

0~20V GRADE: 2.5A

0~100V GRADE: 0.5A

0~500V GRADE: 0.1A

Dissipation Resistance: 0~500kΩ, divided into 11 grades

10Ω~500kΩ, error not more than ±10%;

0.5Ω~2.5Ω, error not more than ±20%

2.5 Structural Form & Size

Form: Table style

Dimension: 510 × 251 × 341mm

Weight: 13.5kg

Supply Voltage: 220V±10%

Frequency: 50Hz±5% Hz

Apparent Power: Non-testing status: About 50VA

Max. Power: About 110VA

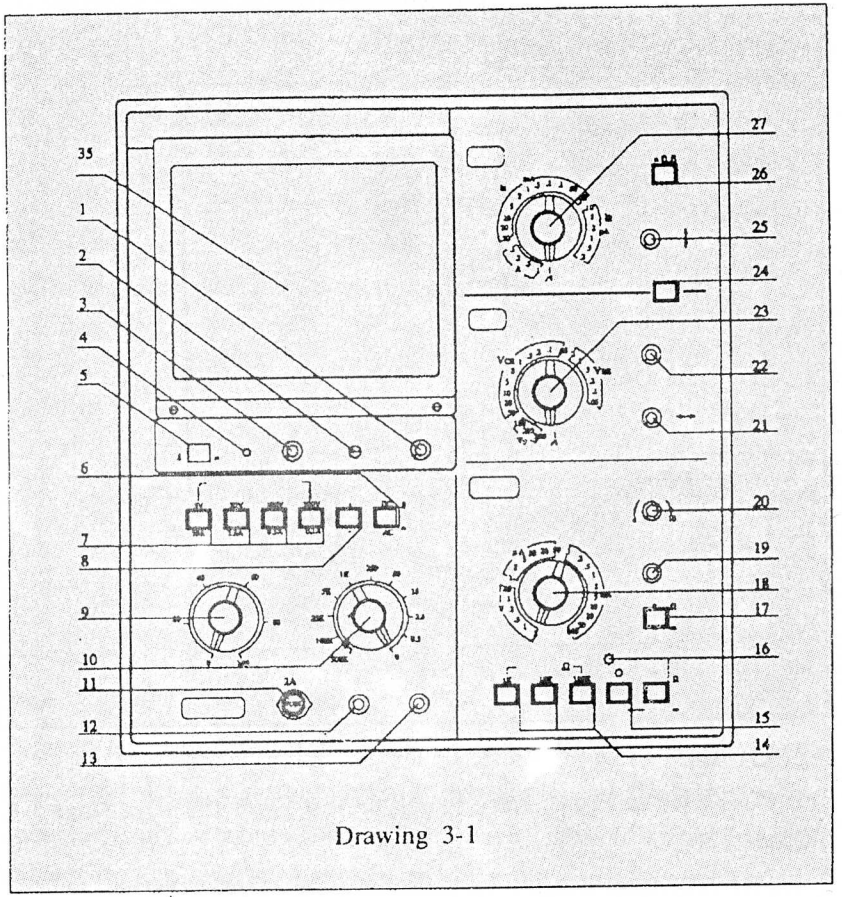
Environmental Group: Belongs to Group II instruments of GB6587.1 "Environmental Test Programme of Electronic Measurement Instrument".

Safe Group: Beongs to Categoty I safe instruments of GB4793 "Basic Safe Requirement of Electronic Measurement Instrument".

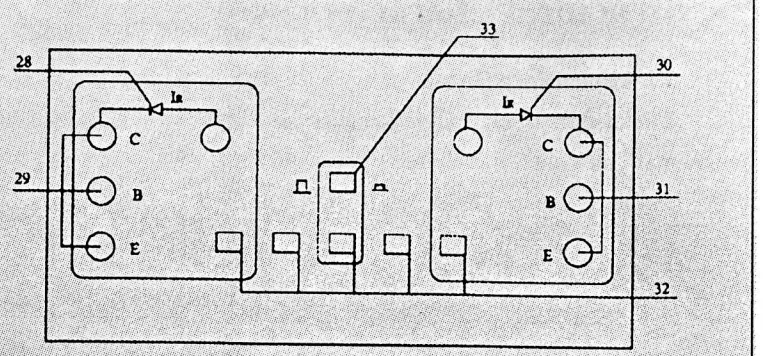
3. Structural Characteristic

3.1 Appearance Drawing

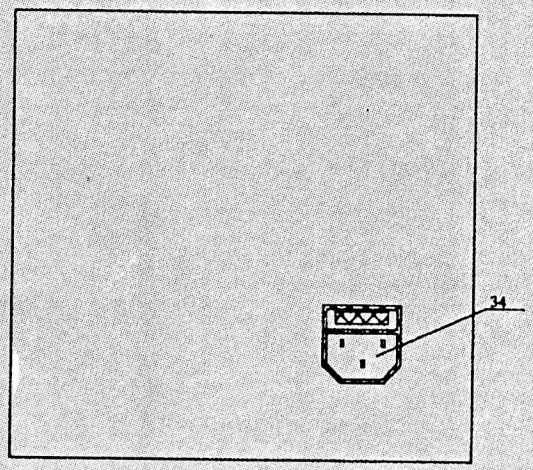
The distribution of front panel is shown as Drawing 3-1; test floor shown as Drawing 3-2; and rare panel as Drawing 3-3.



Drawing 3-1



Drawing 3-2



Drawing 3-3

3.2 Function

1. Introduction to Front, Rare Panels & Test Floor (See Drawings 3-1, 3-2 and 3-3)

(1) Focus: Used to adjust the clearness of light trace to the best.

(2)Turning Botton for Light Trace: Used to adjust the sweep lines and make them parallel to the horizontal graduation line of oscilloscope.

(3) Brightness: Used to adjust the luminosity of sweep lines or feature curves.

(4) Indicator of Supply: The power is truned on, the indicator "lights".

(5) Switch for Supply: Used to turn on or off the power for this instrument. When press down the switch, it's on; spring up, it's off.

(6) AC & DC Transfer Switch of Collector Voltage: When put it at AC, the output voltage of collector is the alternative voltage (as Drawing 3-4); When put it at DC, the output voltage of collector is the DC pulsating voltage which is rectified but not filtered (as Drawing 3-5); when put it at DC and put "I/DIV" switch at I_R again, the output voltage will be the flat DC voltage which is rectified and filtered (as Drawing 3-6); AC voltage can be used to test the device whose forward and reversal C-V characteristic curves can be observed at the same time; for example, bilateral diode, etc.

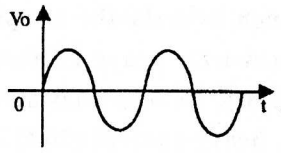


图3-4

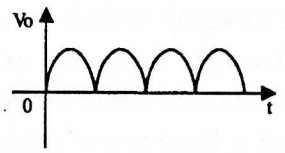


图3-5

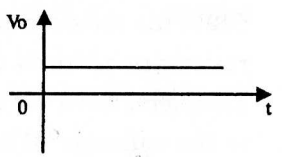


图3-6

(7) Scope of Peak Voltage of Collector: There are 4 grades: 5V10A, 20V2.5A, 100V0.5A and 500V0.01A. They can be chosen according to the different test conditions for the measured device. **!!! Warning: When the collector voltage is shifted, must anticlockwise put the adjustor for collector peak voltage to the position "Zero" first. After shifting and raising voltage, then put it clockwise to the position of needed voltage, otherwise it will lead to the damage to the measure device and using instrament.**

(8) Polarity of Collector Voltage: The botton is sprung out, the collector will export the positive voltage, suitable for measuring Type NPN transistors, on the contrary, the botton is pressed in, the collector will export the negative voltage, suitable for measuring Type PNP transistors.

(9) Dissipation Limit Resistance: It's, inseries, installed to the loop of the collector of the measured device to limit the dissipation. It can also be regarded as the load resistance of the collector of the measured device.

(10) Collector peak Voltage Adjustor: Matching the peak voltage scope, it can adjust the collector peak voltage from 0V to 500V. **Generally, first put it to "Zero", when it's used,** then put it to the needed value according to the testing conditions.

(11) Fuse for Collector: When the suuply of the colector exceeds its rated power, the fuse will be blown off. At this time, there's no collector voltage outpu. **!!! Caution: when measure the small-power, and low voltage-withstand triode, if the collctor voltage is suddenly changed to 500V, the triode will be easily broken through to make the sample resistance of Yaxis damaged ude to the excessirely heavy current. Therefore, when the instrument leaves the factory, 1A fuse is installed to the collector. When a large-power tube, heavy current (10A) is measured, if the fuse is blown off, please replace it into 2A fuse to measure it again.**

(12) Capacitive Current Balance: The eapacitive current produced by many kinds of direct-to-ground stray capacitance of collector supply can cause the error at small current measurement. Therefore, must adjust the turning botton to make the capacitive current reduce to the lowest before testing.

(13) Assisting Capacitive Current Balance: due to the asymmetry of the ground distribution parameters of the collector transformer winding, it's mecessary to adjust the turning botton to make the capacitive current reduce to the lowest.

(14) Series Resistance: When step "V-I/STAGE" switch is adjusted to voltage output, the voltage will be sent to the grid of the field effect tube through the series resistance, then change the series resistance again to judge the input impedence of the measured device.

(15) Press: When "Repeat/Single Cluster" switch is adjusted to single cluster, push down the botton every time, a cluster of steps will be exported. The function is suitable for measuring the output feature of the heavy current transistor.

(16) "Repeat/Single Cluster" Switch: When the straight-key switch is "sprung out", the steps will be continuously exported; when the switch is "Pressed in", the step output will be stopped. At this time, push down "Press" switch, the steps will be exported and the lighting diode "lights". When measure the large-power tube, generally use the single time observation to prevent damaging the device and the instrumant.

(17) Step "+/-" Switch: When the straight key is "sprung out", the step output is the positive polarity and when it's "pressed down", will be negative polarity.

(18) V-I/STAGE Switch: It's a kind of switch which has 22 grades and 2 output functions

a. Base Current Source from 1μA/STAGE to 0.1A/STAGE, divided into 16 grades.

b. Base Potential Source from 0.05V/STAGE to 2V/STAGE, divided into 6 grades.

(19) Step Zeroing: Its Zeroing scope is not less than ±1stage. Therefore it can cover any position between stages of the step. Generally must put it at the zero level when measure the amplifying multiple.

(20) Step "Stage/Cluster" : According to the requirement, it can continuously adjust the step of every cluster from 4 to 10 stages.

(21) Horizontal Replacement: Adjust the horizontal position of the light trace and shown curves on oscilloscope screen.

(22) Double Cluster Separation: When the "double cluster" of test floor is chosen, can adjust the horizontal position of the measured semiconductor tube on the right side.

(23) "V/DIV" Switch: It's a kind of switch which has 20 grades and 4 deflection functions.

a. Collector Voltage (V_{CE}): 0.05V/DIV~50V/DIV, altogether 10 grades

b. Drain Current Voltage (V_R): 100V/DIV~500V/DIV, altogether 3 grades (for matching 5kV test floor)

c. Base Voltage (V_{BE}): 0.05V/DIV~2V/DIV,altogether 6 grades; put the step switch (18) to the potential source position, at the same time, put "V/DIV" switch to V_{BE}, X axis will display the step voltage and change along with the different step voltage of switch (18).

d. Base current or Base Source Voltage: When the switch is set to this grade, X axis will display the stage number of step.

(24) Reversal Phase Switch: The key switch is "pressed in", both the the vertical and horizontal signals will reverse 180°. It's extraeasy that press the key to transfer to the test for PNP tube after testing NPN tube.

(25) Vertical Replacement: Adjust the vertical position of the light trace or shown curves on the screen of oscilloscope.

(26) I/DIV × 0.5 Switch: When the straight key switch is "pushed in", the deflection coefficient of I/DIV switch will be expanded two times.

(27) "I/DIV" Switch: It's a kind of switch which has 22 grades and 3 deflection functions.

a. Collector Current (Ic): 20μA/DIV~1A/DIV, altogether 15 grades

b. Drain Current (I_R): 10μA/DIV~0.2μA/DIV, altogether 6 grades; This grade can only measure the reversal drain current of diodes.

c. Base Current or Base Source Voltage: When the switch is put to this grade, Y axis will display the stage number of step.

(28/30) Connecting Plughole for Testing Floor Test: Connect the measured device to the testing floor by the special accessories to complete the test for reversal breakdown current of the diodes.

(29/31) Connecting Plughole for Testing Floor Test: Connect the measured device to the testing floor by the special accessories. The testing holder for the triode is mainly used to complete the feature test for the triodes and the field effect tubes; and the testing holder for larger power tube is mainly used to complete the function measurement of large-power tubes.

32 Choice Switch for Testing Floor: Composed of 5 straight key switches. There are 5 choices:

a. Left: When the choice switch "Left" is pressed down, the messured device feature on the left side on the oscilloscope screen will be displayed.

b. Right: When the choice switch "right" is pressed down, the measured device feature on the right side on the oscilloscope screen will be displayed.

c. Double Cluster: When the choice switch "double cluster" is pressed down, the feature of measured semiconductor triode on both left and right sides will be alternatively displayed on the screen of oscilloscope. Its function is suitable for the conjugation for the current amplification multiples of the tube.

d. Zero Current: When the key is pressed down, the base of the measured transistor will be in an open-circuit status and the I_{CEO} fealure can be tested.

e. Zero Voltage: When the key is pressed down, the base of measured device is at zero potential. This status is generally used to test the I_{DSS} of the field effect tube. After gaining the I_{DSS}, then reset it and adjust the "step zeroing" turning botton again to make zero step reclose the I_{DSS}. It's just right to adopt this method to test the feature of the field effect tubes.

(33) Conjugation Switch for Field Effect Tube: Used to match the eonjugation of the output feature of the small-power field effect tubes. For the conjugation of the field effect tubes, must press down the switch if need the display of the double clusters. This function is unique among the semiconductor graphical instruments made in China.

(34) Supply Input Socket: AC~220V/50Hz supply for the instrument is imported by this socket. 1A fuse is installed at the lower part of the socket.

(35) Color Filter for Oscilloscope: Make the wave display clearer.

4. Operation

4.1 Introduction and Caution before Using

4.1.1 To the beginnens, it will cause the damage to the measured devices if some switches on the panels are set inappropriately. Therefore, before using this instrument, should put step "V-I/STAGE" switch at the smaller grade, the "series resistance" at the max. valus (100kΩ), collector "dissipation limit resistance" at larger resistance grade. **"Peak voltage scope" at 5V grade, and "peak voltage adjustor" at zero.** Then adjust them to the needed position one by one according to the test conditions of the measured devices.

4.1.2 When measure the large power tube, in general, put the step at "single time" position, After observating the feature every time, again adjust the collector peak voltage, choose smaller value for dissipation limit resistance and larger grade for step current to make them reach the measuring value.

4.1.3 When measure the reversal high-voltage device, must put the dissipation limit resistance to the max. value (500kΩ or 1000kΩ); the collector current to I_R grade, then increase slowly the peak voltage to make it to reach the breakdown value; when choose AC from the transfer switch of collector voltage, I_R feature is a continuous curve line, when choose DC, I_R feature is continuously changing points.

4.1.4 The double cluster function is mainly used for the conjugation for the current amplification multiples of the transistor. Therefore for the safety of the measured devices, the followings are under consideration:

When double cluster test is adopted, in the collector voltage scope, '100V 0.5A' and '500V 0.1A' 2 grades are without voltage output.

When collector voltage scope is in '100V 0.5A' and '500V 0.1A', they are without double cluster feature.

If the step current is between 10mA/stage and 0.1A/stage, they are without double cluster feature.

4.2 Examples for Operation

4.2.1 Output feature of Type NPN 9013 Transistor (shown as Drawing 4-1)

Testing Conditions: Peak Voltage Scope: 0~5V

Polarity: Positive (+)

Dissipation Limit Resistance: 250Ω

X Axis: Collector Voltage (V_{CE}): 0.5V/DIV

Y Axis: Collector Current (I_C): 1mA/DIV

Step Signal: Repeat

Polarity: Positive (+)

Step Choice: 10μA/STAGE

Step Zeroing: Zero level

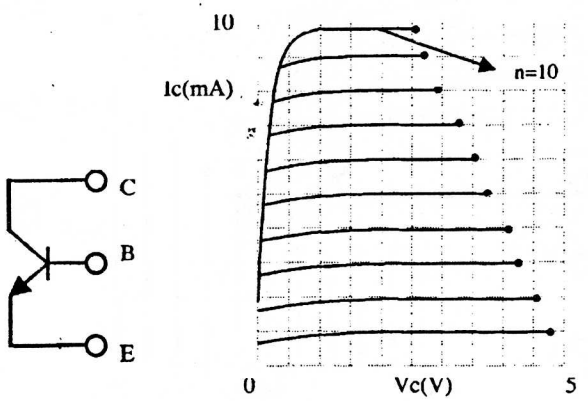
Stage Number of Step: 10 stage

Voltage Amplification Multiple

$$H_{FE}=\frac{\text{Shown DIV of n}^{th}\text{ Horiontal Line, Y Axis} \times \text{I/DIV(27) Indicating Value}}{\text{n} \times \text{Step Switch (18) Indicating Value}}$$

(n is any of horizontal lines in Drawing 4-1)

$$\text{This Drawing } H_{FE}=\frac{4 \times 1\text{mA}}{5 \times (5 \times 10^{-3})\text{mA}}=160 \text{ times}$$



Drawing 4-1

4.2.2 HFE Test for Type NPN 9013 Transistor (Shown as Drawing 4-2)

Testing Conditions: Peak Voltage Scope: 0~5V

Polarity: Positive (+)

Dissipation Limit Resistance: 250Ω

X Axis: Collector Voltage (V_{CE}): 0.5V/DIV

Y Axis: Collector Current (I_C): 1mA/DIV

Step Signal: Repeat

Polarity: Positive (+)

Step Choice: 5μA/STAGE

Step Zeroing: Zero level

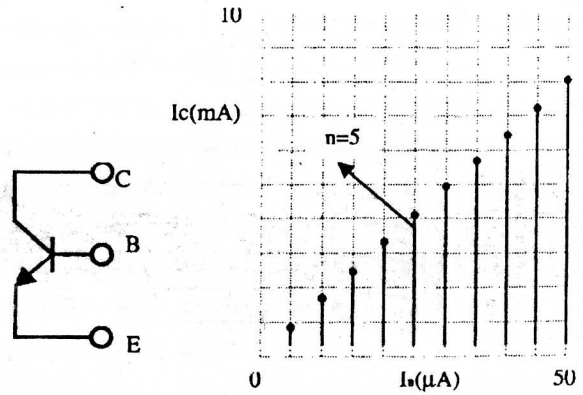
Stage Number of Step: 10 stage

Ture the Xaxis horizontal switch to the bottom anticlockwise, can gain Drawing 4-2, Voltage Amplification Multiple

$$H_{FE}= \frac{\text{Shown DIV of Vertical n}^{th}\text{ Upright Line, Y Axis} \times \text{I/DIV(27) Indicating Value}}{n \times \text{Step Switch (18) Indicating Value}}$$

(n is any of Upright lines in Drawing 4-2)

$$\text{This Drawing } H_{FE}= \frac{8 \times 1mA}{10 \times (5 \times 10^{-3})mA} = 160 \text{ times}$$



Drawing 4-2

4.2.3 Output Feature of N Channel-depletion Type Field Effect Tube 3 DJ7G (Shown as 4-3)

Testing Conditions: Peak Voltage Scope: 0~20V

Polarity: Positive (+)

Dissipation Limit Resistance: 250Ω

X Axis: Collector Voltage (V_{CE}): 0.5V/DIV

Y Axis: Collector Current (I_C): 0.5mA/ DIV

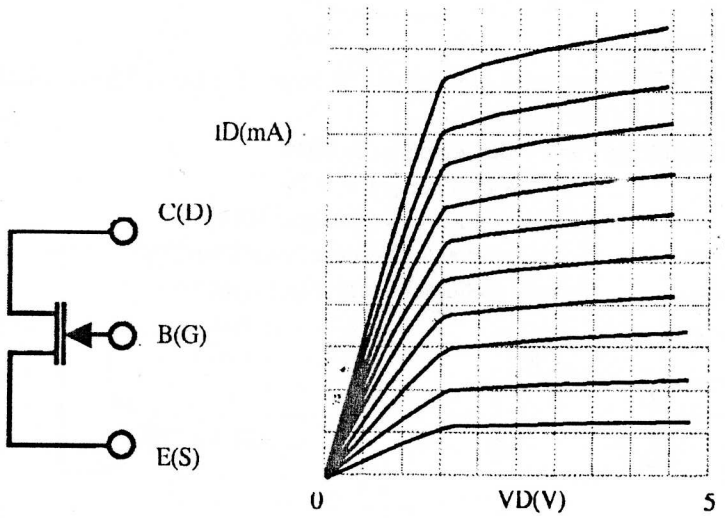
Step Signal: Repeat

Polarity: Negative(-)

Step Choice: 0.2V/STAGE

Step Zeroing: Zero level

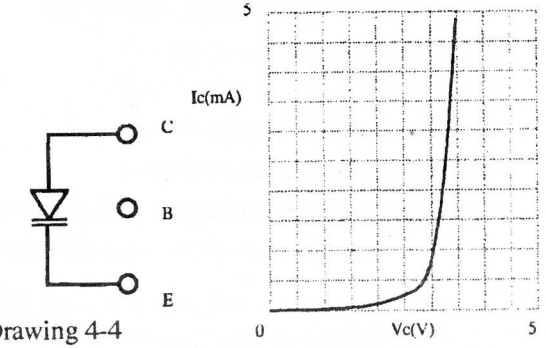
Stage Number of Step: 10 stages



Drawing 4-3

4.2.4 Forward Feature Curve of Silieon Swithc Diode IN4148 (Shown as Drawing 4-4)

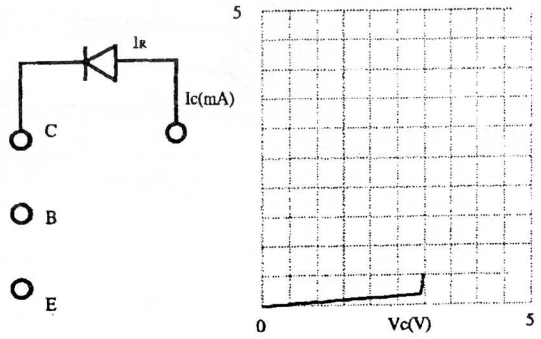
Testing Conditions: Peak Voltage Scope: 0~5V
Polarity: Positive (+)
Dissipation Limit Resistance: 250Ω
X Axis: Collector Voltage (V_{CE}): 0.1V/DIV
Y Axis: Collector Current (Ic): 1mA/DIV



Drawing 4-4

4.2.5 Test for Reversal Breakdown Voltage of Silicon Switch Diode IN4148 (Shown as Drawing 4-5)

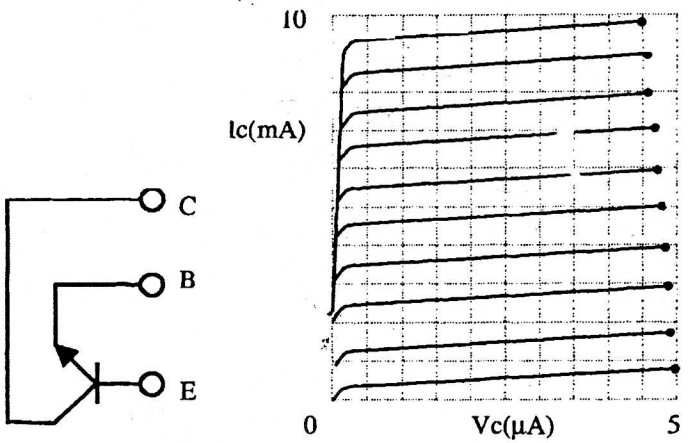
Testing Conditions: Peak Voltage Scope: 0~500V
Polarity: Positive (+)
Dissipation Limit Resistance: 100kΩ
X Axis: Collector Voltage (V_{CE}): 20V/DIV
Y Axis: Collector Current (Ic): 1μA/DIV



Drawing 4-5

4.2.6 Common Base Output Feature of Type NPN 9013 Transistor (Shown as Drawing 4-6)

Testing Conditions: Peak Voltage Scope: 0~5V
Polarity: Positive (+)
Dissipation Limit Resistance: 250Ω
X Axis: Collector Voltage (V_{CE}): 0.5V/DIV
Y Axis: Collector Current (Ic): 1mV/DIV
Step Signal: Repeat
Polarity: Negative (-)
Step Choice: 0.1mA/STAGE
Step Zeroing: Zero level
Stage Number of Step: 10 stages



Drawing 4-6

4.2.7 Double Cluster Display for Output Feature Curve of Type NPN 9013 Transistor (Shown as Drawing 4-7)

Testing Conditions: Peak Voltage Scope: 0~5V

Polarity: Positive (+)

Dissipation Limit Resistance: 250Ω

X Axis: Collector Voltage (V_{CE}): 1V/DIV

Y Axis: Collector Current (Ic): 1mA/DIV

Step Signal: Repeat

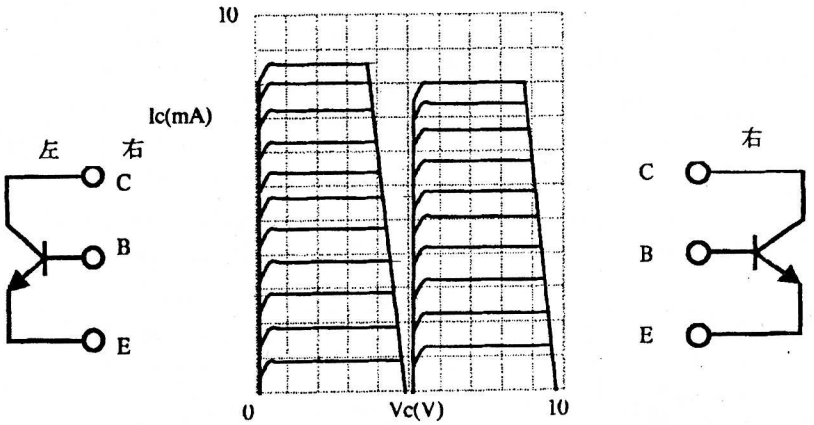
Polarity: Positive (+)

Step Choice: 5μA/STAGE

Step Zeroing: Zero level

Stage Number of Step: 10 stages

Choice for Test Floor: Double cluster



Drawing 4-7

When the testing demands are more precise, can adjust the separating displacement to make the left and right two clusters of feature curres lapped to observe their reclosing degree.

4.2.8 Switch Feature of High Cut-in Voltage VMOS Tube IRF840 (Shown as 4-8)

Testing Conditions: Peak Voltage Scope: 0~20V

Polarity: Positive (+)

Dissipation Limit Resistance: 250Ω

X Axis: Collector Voltage (V_{CE}): 0.5V/DIV

Y Axis: Collector Current (Ic): 1mAl/DIV

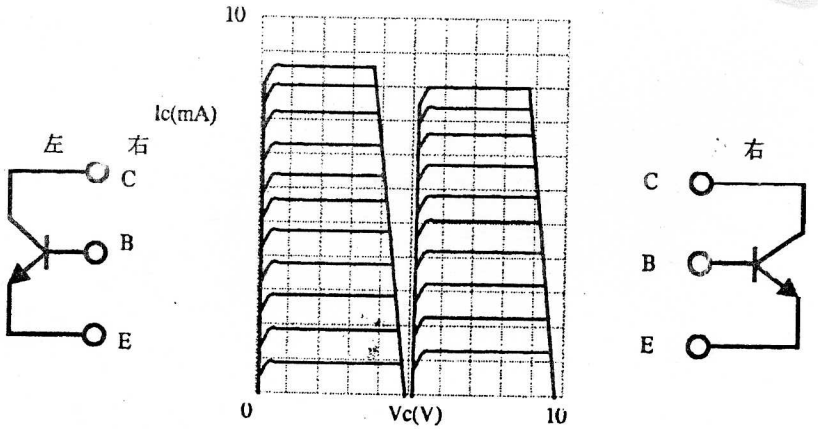
Step Signal: Repeat

Polarity: Negative (-)

Step Choice: 0.5V/STAGE

Step Zeroing: Zero level

Stage Number of step: 4 stages



Drawing 4-8

Adjust the stage number of stap and observe the breakover step voltage. If 4 stage × 0.5V/stage has been brokenover, can adjust the step switch to 0.2V/stage, on the contrary, the grade of switch will be enlarged.