

## Transistor Gain (hfe) Measurement

This aims to detect wrong insertion and/or characteristic fault of the Transistors by measuring Gain (hfe=DC current gain).

### Target tester

Only APT-9411 Series

(Remarks)

The hfe measurement mode for the Transistors is available only when “Programmable DC Power Supply Board (option)” is installed in the tester.

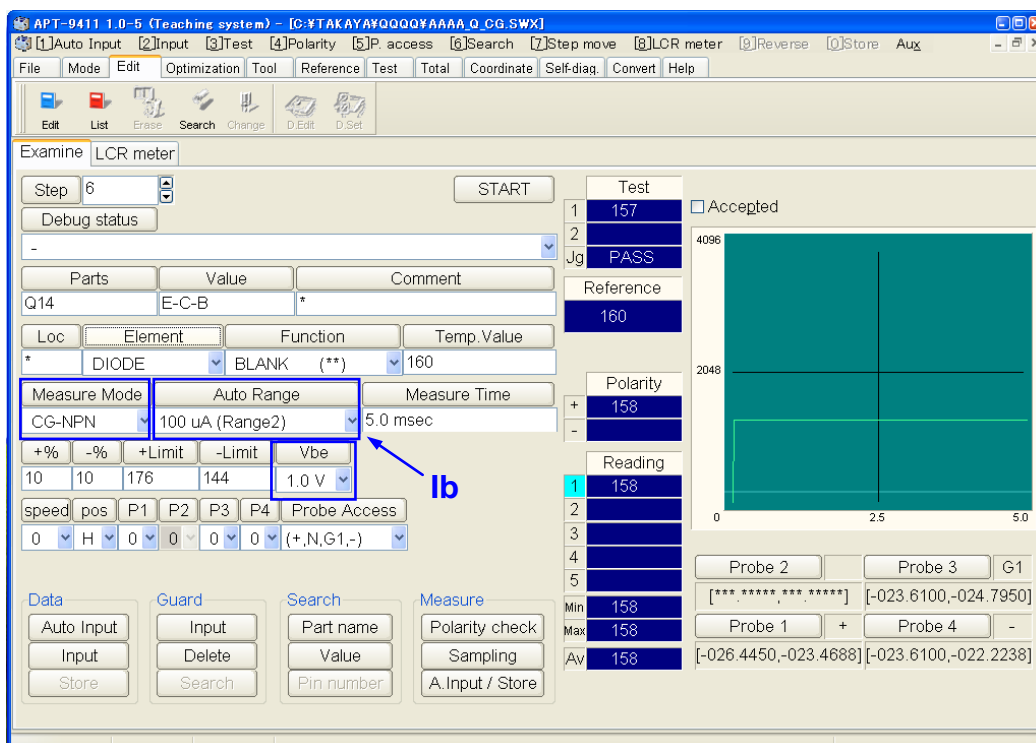
### Data programming method

1. Create Digital transistor step (DT-NPN, DT-PNP).
2. Go into Step data review and change to the hfe measurement mode (CG-NPN,CG-PNP).
3. Press Key1 (Auto input) or Key2 (Input) to input the reference value.

(Remark)

When the steps can't be measured as Digital transistor due to the influence from the surrounding circuits, the hfe measurement will be not possible as well. In addition, even if the steps can be measured as Digital transistor, there are cases that the hfe measurement will be not possible.

### Step data review



The screenshot shows the software interface for step data review. The main window is titled "APT-9411 1.0-5 (Teaching system) - [C:\TAKAYA\Q\AAAA.Q.CG.SWX]". The interface includes a menu bar (File, Mode, Edit, Optimization, Tool, Reference, Test, Total, Coordinate, Self-diaq., Convert, Help) and a toolbar with icons for Edit, List, Erase, Search, Change, D.Edit, and D.Set.

The "Examine LCR meter" section shows the following settings:

- Step: 6
- Debug status: -
- Parts: Q14, Value: E-C-B, Comment: \*
- Loc: \*, Element: DIODE, Function: BLANK (\*\*), Temp. Value: 160
- Measure Mode: Auto Range
- CG-NPN: 100 uA (Range2)
- Measure Time: 5.0 msec
- +%: 10, -%: 10, +Limit: 176, -Limit: 144, Vbe: 1.0 V
- speed: 0, pos: H, P1: 0, P2: 0, P3: 0, P4: 0, Probe Access: (+,N,G1,-)

The "Test" section shows a table of test results:

Test	Value	Status
1	157	Accepted
2	PASS	
Reference	160	
Polarity	158	
Reading	158	
Min	158	
Max	158	
Av	158	

A graph on the right side of the interface shows a plot of the test results. The y-axis ranges from 0 to 4096, and the x-axis ranges from 0 to 5.0. The plot shows a single data point at approximately (1.0, 158).

The "Data" section includes buttons for Auto Input, Input, Store, Guard, Delete, Search, and Measure. The "Measure" section includes buttons for Polarity check, Sampling, and A. Input / Store.

### Measurement mode

Two kinds of hfe measurement modes are available and they should be used appropriately according to NPN/PNP types.

“CG-NPN” mode → NPN type

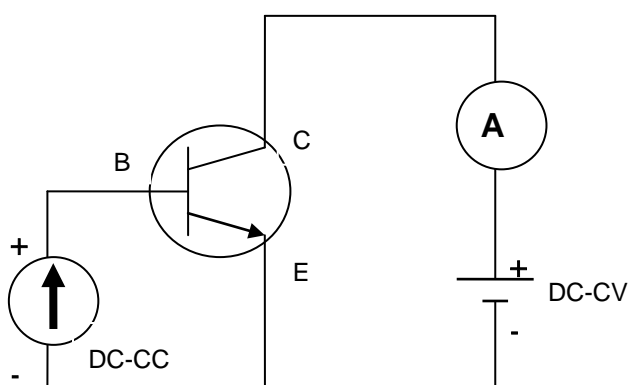
“CG-PNP” mode → PNP type

Because it is not judged automatically whether NPN type or PNP type the component is at Auto reference input, you need to specify the hfe measurement mode (CG-NPN or CG-PNP) by manual before you go into Auto reference input.

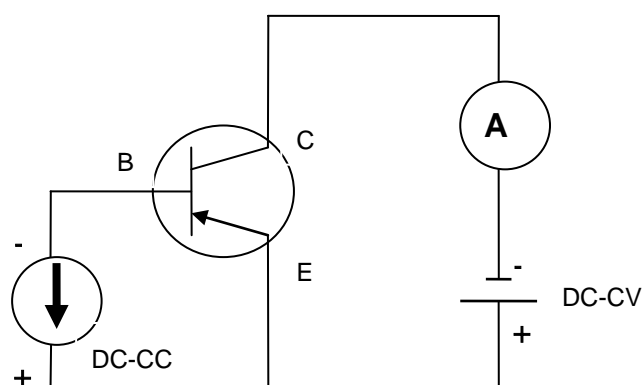
(Remarks)

These hfe measurement modes are unavailable when “Programmable DC Power Supply Board (option)” is not installed in the tester.

**CG-NPN mode**



**CG-PNP mode**



### Measurement range

Measurement range  $I_b=50\mu\text{A}$ ,  $100\mu\text{A}$ ,  $200\mu\text{A}$ ,  $500\mu\text{A}$ ,  $1\text{mA}$  is substituted automatically or by manual (DC Constant current). In addition, any of  $0.5\text{V}$ ,  $1.0\text{V}$ ,  $1.5\text{V}$ ,  $2.0\text{V}$ ,  $2.5\text{V}$ ,  $3.0\text{V}$ ,  $5.0\text{V}$  is substituted for  $V_{be}$  limit voltage automatically or by manual. ( $3.0\text{V}$  and  $5.0\text{V}$  are selectable by manual only)

$V_{ce}$  voltage is  $0.3\text{V}$  (DC Constant voltage) and the range of measuring current  $I_c$  is  $0\text{-}50\text{mA}$ .

## About Measurement

### [Reference value]

Collector current (Ic) is measured across a transistor when it turns ON by applying DC-constant current (Ib) to Base(B) - Emitter(E) and DC-constant voltage to Collector (C) -Emitter(E). Accordingly, the hfe value will be found based on the measured Collector current (Ic) and the Base current (Ib).

$$Hfe \text{ (DC current gain)} = \text{Collector current (Ic)} / \text{Base current (Ib)}$$

### [Measurement range]

Measurable Gain (hfe) is 1 ~1,000.

(Remarks)

- The hfe of the transistor with built-in resistor is also measurable.
- The Darlington transistor is not measurable because its hfe is over 1,000.
- There are cases that the measurement is impossible due to the influence from the surrounding circuits.
- The hfe value may differ from the manufacturer's datasheet due to the influence from the surrounding circuits, the difference of measurement conditions, so on.

### Remarks

- It will display an error message "Hfe measurement in the transistor is hard to perform!" at Auto reference input, if the resistance of B-C or B-E was less than 400 ohm. Once this happened, the measuring conditions will be initialized.
- Reference Value Generation doesn't target the hfe measurement step.
- Polarity (KEY4) on Step data review menu doesn't show the measured value at negative (-) side.
- It will display an error message "Hfe measurement in the transistor is hard to perform!" on Step data review menu, if the hfe value was over 1001 or became 0 when the reference value was input.
- AUX filed on the list menu is substituted by "CGTR".
- In Step data test and Test menu, it judges "G-OVER" if the hfe value was over 1001. In this case, any measured value will be not displayed (blank).