Designation: F 528 – 99 (Reapproved 2005)

Standard Test Method of Measurement of Common-Emitter DC Current Gain of Junction Transistors [1]

This standard is issued under the fixed designation F 528; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers the measurement of common-emitter dc current gain (forward, h_{FE}, or inverted, h_{FEI}) of bipolar transistors, for which the collector-emitter leakage current, I_{CEO}, is less than 10 % of the collector current, I_C, at which the measurement is to be made, and for which the shunt leakage current in the base circuit is less than 10 % of the base current required.

1.2 This test method is suitable for measurement of common-emitter dc current gain at a single given value of test transistor collector current or over a given range of collector currents (for example, over the range of the transistor to be tested).

1.2.1 The nominal ranges of collector current over which the three test circuits are intended to be used are as follows:

1.2.1.1 *Circuit 1*, less than 100 μA,

1.2.1.2 *Circuit 2*, from 100 μA to 100 mA, and

1.2.1.3 *Circuit 3*, greater than 100 mA.

1.3 This test method incorporates tests to determine if the power dissipated in the transistor is low enough that the temperature of the junction is approximately the same as the ambient temperature.

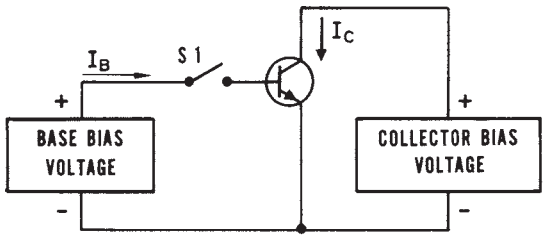
1.4 The values stated in International System of Units (SI) are to be regarded as standard. No other units of measurement are included in this standard.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

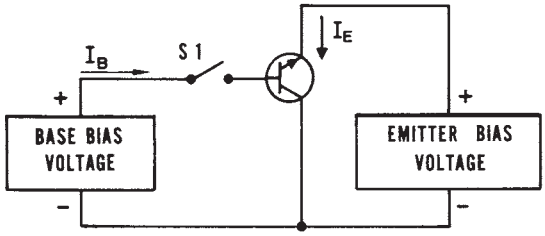
2. Terminology

2.1 *Definitions:*

2.1.1 *common-emitter dc current gain, h_{FE}*—the ratio of dc collector current (in excess of collector-emitter leakage current I_{CEO}) to base current when the transistor is connected in the common-emitter configuration (see Fig. 1a); that is:



(a) I_{CEO} IS THE COLLECTOR CURRENT WITH S 1 OPEN



(b) I_{ECO} IS THE EMITTER CURRENT WITH S 1 OPEN

NOTE 1—The transistor shown is an *npn* type; for *pnp* types the polarities of the bias supplies are reversed.

FIG. 1 Explanatory Circuits to Illustrate the Meaning of Terms Used in Calculation of h_{FE} and h_{FEI}

$$h_{FE} = (I_C - I_{CEO})/I_B$$

2.1.2 *inverted common-emitter dc current gain, h_{FEI}*—the ratio of dc emitter current I_E(in excess of emitter-collector leakage current I_{ECO}) to base current when the transistor is connected in the common-collector configuration (see Fig. 1b); that is:

$$h_{FEI} = (I_E - I_{ECO})/I_B$$

NOTE 1—In the remainder of this test method only h_{FE} is discussed. Measurements and calculations for h_{FEI} are identical and the same apparatus and procedures apply.

3. Summary of Test Method

3.1 Sufficient current, I_B, is driven into the base of a transistor to achieve the desired collector current at the required collector-emitter voltage. The magnitude of the base

[1] This test method is under the jurisdiction of ASTM Committee F01 on Electronics, and is the direct responsibility of Subcommittee F01.11 on Quality and Hardness Assurance.

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current is measured and the gain calculated. Three test circuits are available for tests at low, intermediate, and high transistor collector currents, respectively. The measurements and calculations are repeated for all collector-current values of interest.

3.2 The following quantities are unspecified in the method and are to be agreed upon by the parties to the test:

3.2.1 The collector currents, I_C, at which the measurements are to be made,

3.2.2 The collector-emitter voltage, V_{CE}, to be used when making the measurements, and

3.2.3 The temperature at which the measurements are to be made.

4. Significance and Use

4.1 The current gain of a transistor is basic to its operation and is its single most important parameter.

4.2 Ionizing radiation, that is, gamma radiation due to a nuclear burst, will degrade the current gain due to lifetime damage in the bulk material. Degradation of gain will be greatest immediately following a burst of ionizing radiation and the gain will rapidly recover to a quasi steady-state value. Defect annealing may continue for weeks but usually the current gain recovery is small or negligible.

4.3 This method provides a procedure that does not require special-purpose test equipment.

4.4 This method is suitable for use for specification acceptance, service evaluation, or manufacturing control.

5. Interferences

5.1 *Shunt Leakage*— When the magnitude of the impedance between the base and emitter connections on the test fixture is comparable to the base-emitter impedance of the transistor being tested, the measurement results are invalid.

NOTE 2—The shunt leakage current can be affected by high humidity. Since the range over which valid current gain measurements can be made is reduced by shunt leakage, transistors that require measurement of very low currents must be tested in an environment of less than 40 % relative humidity.

5.2 *Temperature*— For referee measurements, the temperature of the device must be controlled or a set of correction factors developed for adjusting the data to a common temperature since h_{FE} may vary as much as 1 to 3 %/°C. Care must be exercised in handling the device as well as in controlling the ambient temperature. The operator may use one or any combination of the following to reduce operator-induced temperature increases:

5.2.1 *Gloves*.

5.2.2 *Tongs* or some other suitable means for inserting the device into the test fixture.

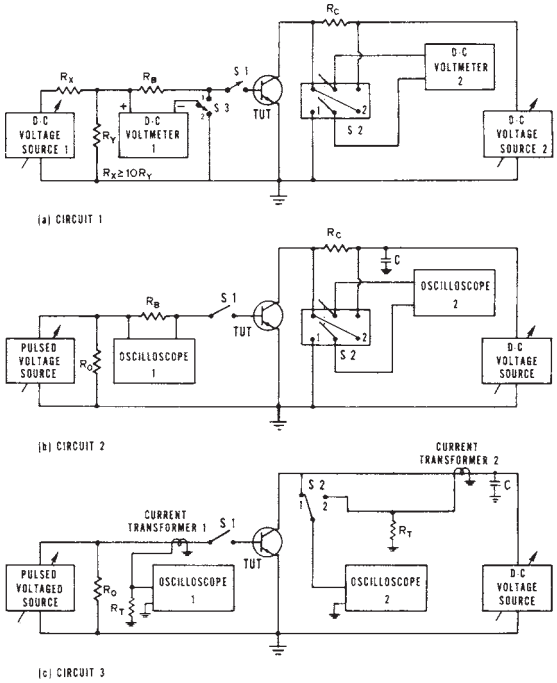
5.2.3 Procedure of waiting for the device to reach thermal equilibrium (usually 20 to 30 s is sufficient).

6. Apparatus

6.1 *Circuit 1*— Measuring circuit for low currents with the following components (see Fig. 2a):

6.1.1 *DC Voltage Source 1*—dc power supply meeting the following specifications:

6.1.1.1 Stable to within ±0.1 % of the set voltage,



NOTE 1—Capacitor C in Circuits 2 and 3 is a bypass capacitor that is used if required. (see Note 4).

NOTE 2—Oscilloscopes 1 and 2 may be digitizers.

FIG. 2 Schematics of Circuits for Measurement of h_{FE}

6.1.1.2 Noise and ripple less than 0.5 % of the output voltage,

6.1.1.3 Adjustable over a nominal range of 0 to 30 V, and

6.1.1.4 Capable of supplying currents up to 250 mA.

6.1.2 *DC Voltage Source 2*—dc power supply meeting the following specifications:

6.1.2.1 Stability, noise and ripple, and current specifications the same as dc voltage source 1 (see 6.1.1), and

6.1.2.2 Adjustable over the range from 0 to $V_{CE} + I_C R_C$ (typically less than 0.1 V_{CE}).

6.1.3 *DC Voltmeters 1 and 2*—dc digital voltmeters meeting the following specifications:

6.1.3.1 At least 3½-digit display,

6.1.3.2 Accuracy of at least ±0.5 % of full-scale reading,

6.1.3.3 Resolution of ±1 least-significant digit,

6.1.3.4 Scales of at least 100 mV and 1, 10, and 100 V, and

6.1.3.5 Input impedance at least 100 times that of the resistor (R_B or R_C) across which the voltmeters are used to measure voltages.

6.1.4 *Resistors*, specified as follows:

6.1.4.1 R_B—1 % resistor in the nominal resistance range 10 Ω to 100 kΩ, depending on the base current being used.

6.1.4.2 R_C—1 % resistor in the nominal resistance range 10 Ω to 10 kΩ, depending on the collector current.

6.1.4.3 *Voltage Divider Resistors* R_X and R_Y—R_X shall be at least equal to 10 R_Y.

NOTE 3—These resistors form a voltage divider used to simplify the adjustment of base current. No further tolerance or value specifications are applicable (see Fig. 2a).

6.2 *Circuit 2*—Measuring circuit for intermediate currents with the following components (see Fig. 2b):

6.2.1 *DC Voltage Source*, meeting the specifications of dc voltage source 2 (see 6.1.2), and with the capability of supplying current pulses of the magnitude required for the transistor under test.

NOTE 4—For power transistors that need large current pulses, this requirement can be met with a power supply inadequate in itself by placing a large capacitor (1000 to 10 000 μF) across the output terminals of the power supply. To compensate for possible inductive components of the impedance of this large capacitor, it should be paralleled by a small capacitor (0.001 to 0.1 μF).

6.2.2 *Pulsed Voltage Source*, meeting the following specifications:

6.2.2.1 Polarity selectable as positive or negative,

6.2.2.2 Rise time, t_r, and fall time, t_f, (see Fig. 3) less than or equal to 0.1 times the width of the pulse to be used,

6.2.2.3 Pulse width, t_p, (see Fig. 3) adjustable from 1.0 to 350 μs, inclusive,

6.2.2.4 Pulse top flat within 3 % over interval, t_m(see Fig. 3),

6.2.2.5 An output adjustable over a nominal range from 0 to 20 V, and

6.2.2.6 Capability of driving the maximum base current required for the transistor to be tested.

NOTE 5—The nonuniform impedance of the base-emitter diode of the transistor under test may cause the output of some pulse sources to vary to such a degree that the requirement of 6.2.2.4 cannot be met. The use of a resistive termination and judicious choice of R_B, R_X, and R_Y to provide an essentially resistive and constant load to the pulse source may help to avoid this difficulty.

6.2.3 *Oscilloscopes or Digitizers*:

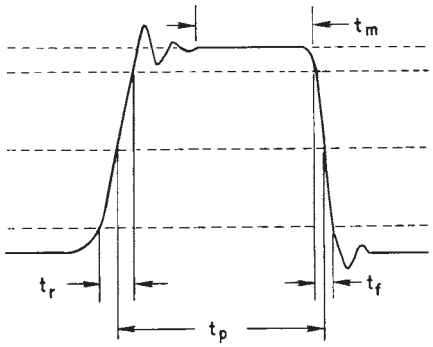
6.2.3.1 General-purpose laboratory oscilloscopes meeting the following specifications:

(*a*) (*a*) Bandwidth of dc to 10 MHz minimum,

(*b*) Deflection factors covering, as a minimum, the range from 5 mV/div to 1V/div, inclusive,

(*c*) Input impedance greater than or equal to 100 times the dc resistance across which the oscilloscopes are used to measure voltages,

(*d*) Capability of differential measurements with both inputs isolated from test-circuit common,



NOTE 1—t_m must be at least equal to $t_p/3$.

FIG. 3 Minimum Width t_p of Pulse that May Be Used in h_{FE} Test Measurements

(*e*) Common-mode rejection ratio of 20 dB minimum, and

6.2.3.2 *Digitizers with Bandwidth, Sampling Interval, and Time-base Capabilities*, adequate for handling the transient signals with good resolution for all pulse widths utilized in the test may be used. Hard copy printouts of the recorded signal may be a part of the capability of this apparatus.

6.2.4 *Resistors*, specified as follows:

6.2.4.1 R_O—1 % resistor of the proper value to match the output impedance of the pulsed source,

6.2.4.2 R_B—1 % resistor in the nominal resistance range 1 Ω to 10 kΩ, depending on the base current being used, and across which the voltage developed by the base current is measured, and

6.2.4.3 R_C—1 % resistor in the nominal resistance range 1 Ω to 1 kΩ, depending on the collector current being used, and across which the voltage developed by the collector current is measured.

6.3 *Circuit 3*—Measuring circuit for high currents with the following components (see Fig. 2c):

6.3.1 *DC Voltage Source*, as specified in 6.2.1,

6.3.2 *Pulsed Voltage Source*, as specified in 6.2.2,

6.3.3 *Oscilloscopes or Digitizers*, as specified in 6.2.3, with the exception that differential measurement capability is not required,

6.3.4 *Current Transformers 1 and 2*, meeting the following specifications:

6.3.4.1 Sensitivity of 0.1 V/A or better,

6.3.4.2 Calibrated accuracy of ±3 % or better,

6.3.4.3 Core saturation rating exceeding the product of the current to be measured and its pulse width,

6.3.4.4 Rise and fall times less than or equal to 0.1 times the width of the pulse used, and

6.3.4.5 Low-frequency response such that a square pulse of the width used in the test results in a droop (voltage drop) of less than 3 % over the interval t_m.

6.3.5 *Resistors*, specified as follows:

6.3.5.1 R_O—1 % resistor of the proper value to match the output impedance of the pulsed voltage source, and

6.3.5.2 R_T—1 % resistor of the value specified by the manufacturer as the termination for the current transformer.

6.4 *Test Fixture*— Transistor socket suitable for transistor under test, to be used as required in each of the three test circuits (see Fig. 2).

6.5 *Miscellaneous Circuit Components*, to be used as required in each of the test circuits (see Fig. 2). The switches, leads, and connections shall be of a quality customarily used in electronic circuit fabrication.

6.6 *Temperature-Measuring Device*, capable of measuring the temperature in the vicinity of the device under test to an accuracy of± 1°C at the temperature specified for the measurement.

7. Sampling

7.1 This test method is not intended for use as a 100 % inspection test.

7.2 In any test program utilizing this test method, sample sizes and selection techniques shall be agreed upon by the parties to the test.

8. Procedure

8.1 *Circuit 1*—Low Current Levels (see Note 6):

8.1.1 Assemble the test circuit incorporating a socket suitable for the transistor to be tested (see Fig. 2a).

8.1.1.1 Use R_B = 100 kΩ.

8.1.2 With no transistor in the test fixture, S1 closed, and S3 in position 1, adjust dc voltage source 1 to its maximum value.

8.1.3 Using dc voltmeter 1, measure the voltage across R_B. Record this value as V_{RB}, in volts.

8.1.4 Move S3 to position 2. Using dc voltmeter 1, measure and record the voltage across R_Y, V_{RY}, in volts.

8.1.5 Calculate and record R_{SHUNT}, Ω (Note 2).

$$R_{SHUNT} = R_B\left(\frac{V_{RY}}{V_{RB}} - 1\right) \quad (1)$$

8.1.6 Replace the 100-kΩ resistor used for R_B in 8.1.1.1 with a resistor chosen to have a sufficiently low value of resistance so that the required base current can be supplied without exceeding the voltage rating of dc voltage source 1, but have a sufficiently high value of resistance so that the voltage developed across it, V_{RB}, is at least 20 % of the most sensitive range of dc voltmeter 1.

8.1.6.1 Adjust the value of R_B as required during the test so that these criteria are always met.

8.1.7 Select R_C to have a sufficiently low value of resistance so that no more than 10 % of the output of dc voltage source 2 is dropped across it, but have a sufficiently high value of resistance so that the voltage developed across it, V_{RC}, is at least 20 % of the most sensitive range of dc voltmeter 2.

8.1.7.1 Adjust the value of R_C as required during the test so that these criteria are always met.

8.1.8 With all voltage sources adjusted to zero, insert the transistor under test (TUT) into the test fixture. Do not touch the TUT with bare hands (see 5.2).

8.1.9 With S1 open and S2 and S3 in Position 1, adjust dc voltage source 2 until the desired value of V_{CE} is read on dc voltmeter 2 (see 3.2.2).

8.1.10 Switch S2 to Position 2. Using dc voltmeter 2, measure the voltage across R_C and record it as V_{RC}, in volts.

8.1.11 Calculate and record the collector leakage current, I_{CEO}, using the equation

$$I_{CEO} = V_{RC}/R_C.$$

8.1.12 Close S1 and adjust dc voltage source 1 to obtain the lowest desired collector current, I_C, using the equation

$$I_C = V_{RC}/R_C.$$

8.1.13 Compare the I_C value with ten times the I_{CEO} value recorded in 8.1.11.

8.1.13.1 If $I_C \leq 10\ I_{CEO}$, continue the test at a higher value of collector current or, if there is no permissible higher I_C, discontinue the test (see Note 7).

8.1.14 Switch S2 to Position 1 and check whether or not V_{CE}(on dc voltmeter 2) is still the value desired.

8.1.14.1 If so, continue with the test.

8.1.14.2 If not, adjust dc voltage source 2 to achieve the desired V_{CE} value.

8.1.14.3 Switch S2 to Position 2 and readjust dc voltage source 1 to obtain again the desired I_C.

8.1.14.4 Repeat 8.1.14.2 and 8.1.14.3 until the desired I_C and V_{CE} values are obtained.

8.1.15 Measure and record V_{RB}, in volts.

8.1.16 Calculate and record I_B, in amperes, using the following equation:

$$I_B = V_{RB}/R_B \quad (2)$$

8.1.17 Calculate and record h_{FE}, using the following equation:

$$h_{FE} = (I_C - I_{CEO})/I_B \quad (3)$$

8.1.18 Using the temperature-measuring device, measure the ambient temperature within 50 mm of the test fixture. Record this value as T_a, in °C.

8.1.19 Move S3 to Position 2. Using dc voltmeter 1, measure and record the voltage across R_Y with the test transistor in the test fixture. Record this value as V_{RYT}, in volts.

8.1.20 Calculate and record the base to emitter resistance R_{BE}, in ohms, using the following equation:

$$R_{BE} = \frac{V_{RYT} - V_{RB}}{I_B} \quad (4)$$

8.1.21 If $R_{BE} > 0.1\ R_{SHUNT}$, record the gain measurement at this current as invalid.

8.1.21.1 Repeat 8.1.7 through 8.1.17 using the next higher I_C value for which the measurement is to be made or, if there is no permissible higher I_C, terminate the test.

8.1.22 Open S1. Wait 30 s, close S1, move S3 to position 1 and repeat the voltmeter readings, measuring R_Y with S3 in Position 2.

8.1.22.1 If the readings differ from the original values by less than 2 %, increase the current to the next higher I_C value for which the measurement is to be made and repeat 8.1.9 through 8.1.22, but omitting 8.1.19, 8.1.20, and 8.1.21.

8.1.22.2 If the readings show more than 2 % change, discontinue the use of Circuit 1. Continue using Circuit 2.

NOTE 6—See 1.2.1 for the nominal intended ranges of collector current for each circuit. Select circuits appropriate to the agreed-upon collector currents at which measurements are to be made. The sensitivity of the method is less for Circuits 2 and 3 than for Circuit 1.

NOTE 7— With Circuit 1, measurements of current gain are only valid when the collector current of the TUT is greater than 10 I_{CEO}.

8.2 *Circuit 2—Intermediate Current Levels*:

8.2.1 Assemble the test circuit incorporating a socket suitable for the transistor to be tested (see Fig. 2b).

8.2.2 Select R_B to *(1)* be in the range 1 to 10 000 Ω, inclusive, and *(2)* have a sufficiently low value of resistance so that the required base current can be obtained within the compliance of the pulsed voltage source, but have a sufficiently high value of resistance so that at least three divisions of deflection are achieved on oscilloscope 1 during the pulse.

8.2.2.1 Adjust the value of R_B as required during the test so that these criteria are always met.

8.2.3 Select R_C to be in the range 1 to 1000 Ω, inclusive, and to have a sufficiently low value of resistance so that no more than 10 % of the output voltage of the dc voltage source is dropped across it during a pulse, but have a sufficiently high value of resistance so that, with S2 in Position 2, at least three divisions of deflection are achieved on oscilloscope 2 during the pulse.

8.2.3.1 Adjust the value of R_C as required during the test so that these criteria are always met.

8.2.4 Adjust the pulsed voltage source controls for a width of pulse and repetition rate such that the width of the pulse is in the range from 1 to 350 µs, inclusive, and the duty cycle is no greater than 2 %.

8.2.5 With both voltage sources adjusted to zero, insert the TUT into the text fixture. Do not touch the TUT with bare hands (see 5.2).

8.2.6 With S1 closed and S2 in Position 1, adjust the dc voltage source until the desired value of V_{CE} is displayed on Oscilloscope 2.

8.2.7 Switch S2 to Position 2 and adjust the pulsed voltage source until I_C during the pulse is of the same value as that last used in tests with Circuit 1, or if Circuit 1 was not used, until I_C is approximately 100 µA.

8.2.8 Switch S2 to Position 1 and check (on Oscilloscope 2) whether V_{CE} during the test pulse is within 2 % of the value selected in 8.2.6.

8.2.8.1 If so, continue with the test.

8.2.8.2 If not, readjust the dc voltage source until V_{CE} is the desired value during the pulse.

8.2.8.3 Switch S2 to Position 2 and readjust the pulsed voltage source to obtain the I_C value desired.

8.2.8.4 Repeat 8.2.8.2 and 8.2.8.3 until no further adjustment is required.

8.2.9 Using Oscilloscope 1, measure and record V_{RB}, in volts.

NOTE 8—Read oscilloscope as "Oscilloscope or Digitizer" throughout this procedure section.

8.2.10 Calculate and record I_B, in amperes, using the following equation:

$$I_B = V_{RB}/R_B \quad (5)$$

8.2.11 Calculate and record h_{FE} using the following equation:

$$h_{FE} = I_C / I_B \quad (6)$$

8.2.12 Using the temperature-measuring device, measure the ambient temperature within 50 mm of the test fixture. Record this value as T_a, in °C.

8.2.13 With S2 in Position 2, open S1. Wait 30 s and close S1 while observing V_{RC} on Oscilloscope 2.

8.2.13.1 If a change of less than 5 % in the observed signal occurs during the first 10 s after S1 is closed, continue with the test (see Note 9).

8.2.13.2 If a change of 5 % or greater in the observed signal occurs during the 10-s period after S1 is closed, decrease the width of the pulse and repeat. Reduce the width of the pulse no further than that width at which the stable portion of the pulse top (t_m, Fig. 3) is equal to ⅓ of the pulse width, t_p.

8.2.13.3 If the reduced pulse width does not result in meeting the condition of 8.2.13.1, decrease the repetition rate of the pulsed voltage source by 20 to 40 % and repeat the test.

8.2.13.4 If the condition of 8.2.13.1 still is not met, terminate the test for the TUT and record this fact.

8.2.14 If the condition of 8.2.13.1 is met, repeat 8.2.6 through 8.2.13 at each successively higher I_C value for which data are desired.

8.2.15 If a current level is reached at which the conditions of 8.2.2 or 8.2.3, or both, can no longer be satisfied, discontinue use of Circuit 2 and continue measurements using Circuit 3.

NOTE 9—An excessive change in V_{RC} indicates that the measurement process is producing temperature excursions in the TUT that invalidate the test.

8.3 *Circuit 3—High Current Levels*:

8.3.1 Assemble the test circuit incorporating a socket suitable for the transistor to be tested (see Fig. 2c).

8.3.2 With both voltage sources adjusted to zero, insert the TUT into the test fixture. Do not touch the TUT with bare hands (see 5.2).

8.3.3 With S1 closed and S2 in Position 1, adjust the dc voltage source until the desired value of V_{CE} is displayed on Oscilloscope 2.

8.3.4 Switch S2 to Position 2 and adjust the pulsed voltage source until I_C during the pulse is of the same value as that last used in tests with Circuit 2, or if Circuit 2 is not used, until I_C is approximately 100 mA.

8.3.5 Switch S2 to Position 1 and check (on Oscilloscope 2) whether V_{CE} during the test pulse is within 2 % of the value obtained in 8.3.3.

8.3.5.1 If so, continue with the test.

8.3.5.2 If not, readjust the dc voltage source until V_{CE} is the desired value during the pulse.

8.3.5.3 Switch S2 to Position 2 and readjust the pulsed voltage source, if necessary, to obtain the I_C value desired. Record the measured value of I_C, in amperes.

8.3.5.4 Repeat 8.3.5.2 and 8.3.5.3 until no further adjustment is required.

8.3.6 Using Oscilloscope 1, measure and record I_B, in amperes.

8.3.7 Calculate and record h_{FE} using the following equation:

$$h_{FE} = I_C \text{ (meas)} / I_B \quad (7)$$

8.3.8 Using the temperature-measuring device, measure the ambient temperature within 50 mm of the test fixture. Record this value as T_a, in °C.

8.3.9 With S2 in Position 2, open S1. Wait 30 s and close S1 while observing I_C on oscilloscope 2.

8.3.9.1 Repeat 8.2.13.1 through 8.2.13.4.

8.3.10 If the condition of 8.2.13.1 is met, repeat 8.3.3 through 8.3.9 at each successively higher I_C value for which data are desired.

9. Report

9.1 The report shall include, as a minimum, all information required by the report forms shown in Fig. 4 and Fig. 5.

10. Precision

10.1 The precision of this test method has been evaluated by an interlaboratory test involving five laboratories. Four laboratories measured fifteen specimens, five each of three types of transistors; one measured five each of two types of transistors. Each type of transistor was measured by using one of three circuits of Fig. 2. Measurements were made by each laboratory once for a given combination of type, circuit, and current level.

10.2 Type 2N2219 transistors were measured using Circuit 1 at collector current levels of 1, 5, 10, 50, and 100 μA; the collector-emitter voltage was 10 V. The average (1S) precision ranged from 14.9 % at the lowest collector current level to 1.7 % at the highest level. The average 1S precision for all measurements was 6.4 %.

10.3 Type 2N2905A transistors were measured using Circuit 2 at collector current levels of 0.05, 0.5, 5, and 50 mA; the collector-emitter voltage was 10 V. The average (1S) precision was not greatly dependent on collector current. It ranged from 9.3 to 5.2 % and averaged 6.7 %.

10.4 Type 2N3772 transistors were measured using Circuit 3 at collector current levels of 0.5, 1, 2, and 4 A; the collector-emitter voltage was 4 V. The average (1S) precision was not dependent on collector current. It ranged from 8.3 to 5.8 % and averaged 8.0 %.

10.5 The average (1S) precision calculated from all of the measurements was 6.7 %.

11. Keywords

11.1 common-emitter dc current gain; current gain; h_{FE}; junction transistors; transistor test

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h_{FE} TEST REPORT FORM

Test Operator _____ Date _____

Test Equipment	Manufacturer	Model No.	Serial No.	Calibration Date
Circuit 1				
1. D-C Voltage Source 1				
2. D-C Voltage Source 2				
3. D-C Voltmeter 1				
4. D-C Voltmeter 2				
Circuit 2				
1. Pulsed Voltage Source				
2. D-C Voltage Source				
3. Oscilloscope/Digitizer 1 Preamp				
4. Oscilloscope/Digitizer 2 Preamp				
Circuit 3				
1. Pulsed Voltage Source				
2. D-C Voltage Source				
3. Oscilloscope/Digitizer 1 Preamp				
4. Oscilloscope/Digitizer 2 Preamp				
5. Current Transfer 1				
6. Current Transfer 2				

(a) Cover Page.

FIG. 4 Data Report Format (Page 1)

Page ___of ___

h_{FE} REPORT FORM

Test Operator _____ Date _____

Transistor Type _____ Lot No. _____ Serial No. _____

Circuit 1

T_{CEO} Data: V_{CE} = _____, R_C = _____, V_{RC} = _____, I_{CEO} =_____

R_{SHUNT} Data: V_{RY} = _____, V_{RB} = _____, R_{SHUNT} =_____

V_{CE}	I_C (spec)	V_{RYT}	R_{BE}	R_C	V_{RC}	I_C (calc)	R_B	V_{RB}	I_B (calc)	h_{FE} (calc)	T_a (°C)

Circuit 2: t_p = _____ µs, Pulse Rate = _____ pps

V_{CE}	I_C (spec)	R_C	V_{RC}	I_C (calc)	R_B	V_{RB}	I_B (calc)	h_{FE} (calc)	T_a (°C)

Circuit 3: t_p = _____ µs, Pulse Rate = _____ pps

V_{CE}	I_C (spec)	I_C (meas)	I_B (meas)	h_{FE}	T_a (°C)

(b) Data Page. (One such page is required per TUT.)

FIG. 5 Data Report Form (Page 2)

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