UDC 621.382.3:621.317.6.001.4

JIS

JAPANESE INDUSTRIAL STANDARD

Measuring methods for transistors

JIS C 7030-1993

Translated and Published

by

Japanese Standards Association

Printed in Japan

51 S

PROTECTED BY COPYRIGHT

In the event of any doubt arising,
the original Standard in Japanese is to be final authority.

PROTECTED BY COPYRIGHT

Contents

		Page
1.	Scope	1
2.	Graphical symbols used	1
3.	Measuring power supply and instrument	1
3.1	Measuring power supply	1
3.2	Instruments	2
4.	Reference measuring conditions	2
4.1	Temperature and humidity	2
4.2	Measuring frequency	2
4.3	Signal amplitude	2
4.4	Ideal voltage supply and ideal current supply	2
4.5	Pulse conditions	3
4.6	Open circuit and closed circuit	3
5.	Precaution for measurements	3
5.1	Keeping of maximum rating	3
5.2	Precaution at attaching and detaching	3
5.3	Treatment of insulated-gate field-effect transistors	3
5.4	Condition of temperature stabilization (thermal equilibrium)	4
5.5	Measurement of pulse	4
5.6	Measuring circuit	4
6.	Measuring methods	4
6.1	Measuring methods for bipolar transistors	4
6.1.1	Measurement of collector current (d.c. method)	4
6.1.2	Measurement of collector current (pulse method)	5
6.1.3	Measurement of emitter current (d.c. method)	6
6.1.4	Measurement of emitter current (pulse method)	6
6.1.5	Measurement of base current (d.c. method)	7
6.1.6	Measurement of base current (pulse method)	8
6.1.7	Measurement of collector-emitter cut-off current	8
6.1.8	Measurement of collector-base cut-off current	9
6.1.9	Measurement of emitter-base cut-off current	10

PROTECTED BY COPYRIGHT

6.1.10 Measurement of collector-emitter saturation voltage (d.c. method) 11

6.1.11 Measurement of collector-emitter saturation voltage (pulse method) 12

6.1.12 Measurement of base-emitter saturation voltage (d.c. method) 13

6.1.13 Measurement of base-emitter saturation voltage (pulse method) 13

6.1.14 Measurement of base-emitter voltage 14

6.1.15 Measurement of d.c. current amplification (d.c. method) 15

6.1.16 Measurement of d.c. current amplification (pulse method) 16

6.1.17 Measurement of small-signal short-circuit input impedance 17

6.1.18 Measurement of small-signal short-circuit forward current transfer ratio 18

6.1.19 Measurement of small-signal open-circuit reverse voltage transfer ratio 20

6.1.20 Measurement of small-signal open-circuit output admittance 22

6.1.21 Measurement of small-signal short-circuit forward current transfer ratio cut-off frequency 24

6.1.22 Measurement of output capacitance 26

6.1.23 Measurement of input capacitance 28

6.1.24 Measurement of base time constant 29

6.1.25 Measurement of base resistance 31

6.1.26 Measurement of transition frequency 32

6.1.27 Measurement of scattering parameters 33

6.1.28 Measurement of low-frequency power gain 37

6.1.29 Measurement of high-frequency power gain 38

6.1.30 Measurement of converted power gain 39

6.1.31 Measurement of low-frequency noise voltage 41

6.1.32 Measurement of low-frequency noise figure 43

6.1.33 Measurement of high-frequency noise figure 47

6.1.34 Measurement of oscillation voltage 49

6.1.35 Measurement of oscillation power 50

6.1.36 Measurement of total higher harmonic distortion factor 51

6.1.37 Measurement of intermodulation distortion 52

6.1.38 Measurement of switching times 54

6.1.39 Measurement of thermal resistance 55

PROTECTED BY COPYRIGHT

6.2 Measuring methods of field-effect transistors 59
6.2.1 Measurement of gate-source cut-off current (A) 59
6.2.2 Measurement of gate-drain cut-off current (A) 59
6.2.3 Measurement of drain-source cut-off current (A, B and C) 60
6.2.4 Measurement of gate-source leakage current (B, C) 61
6.2.5 Measurement of gate-drain leakage current (B, C) 62
6.2.6 Measurement of gate-source cut-off voltage (A, B) 63
6.2.7 Measurement of gate-source threshold voltage (C) 63
6.2.8 Measurement of drain current (A, B and C) 64
6.2.9 Measurement of small-signal forward transfer admittance (A, B and C) 65
6.2.10 Measurement of small-signal output admittance (A, B and C) 67
6.2.11 Measurement of small-signal input capacitance (A, B and C) 68
6.2.12 Measurement of small-signal feedback capacitance (A, B and C) 69
6.2.13 Measurement of small-signal output capacitance (A, B and C) 70
6.2.14 Measurement of scattering parameters (A, B and C) 71
6.2.15 Measurement of equivalent input noise voltage (A, B and C) 71
6.2.16 Measurement of low-frequency noise figure (A, B and C) 73
6.2.17 Measurement of high-frequency noise figure (A, B and C) 73
6.2.18 Measurement of high-frequency power gain (A, Band C) 73
6.2.19 Measurement of oscillation power (A, B and C) 74
6.2.20 Measurement of intermodulation distortion (A, B and C) 74
6.2.21 Measurement of on-state resistance (A, B and C) 75
6.2.22 Measurement of off-state resistance (A, B and C) 76
6.2.23 Measurement of switching times (A, B and C) 77
6.2.24 Measurement of channel temperature (A, B and C) 79

Annex. Measurements and tests in which excess of maximum rating is possible 82

1. Scope 82

2. Measurements and tests 82
2.1 Bipolar transistors 82
2.1.1 Collector-emitter sustaining voltage test 82
2.1.2 Safe operation area test (transient thermal resistance method) 83

PROTECTED BY COPYRIGHT

2.1.3 Safe operation area test (forward direction) 84
2.1.4 Safe operation area test (switching method) 85
2.1.5 Measurement of collector-emitter breakdown voltage 86
2.1.6 Measurement of collector-base breakdown voltage 87
2.1.7 Measurement of emitter-base breakdown voltage 88
2.2 Field-effect transistors 88
2.2.1 Safe operation area test (forward direction (A, B and C) 88
2.2.2 Safe operation area test (reverse direction) (A, B and C) 90
2.2.3 Measurement of gate-source voltage (A) 91
2.2.4 Measurement of gate-drain voltage (A) 92
2.2.5 Measurement of drain-source voltage (A, B and C) 93

PROTECTED BY COPYRIGHT

UDC 621. 382. 3: 621. 317. 6. 001. 4

JAPANESE INDUSTRIAL STANDARD JIS

Measuring methods for transistors C 7030-1993

1. Scope This Japanese Industrial Standard specifies the measuring methods for electrical performances of bipolar transistors and field-effect transistors (hereafter referred to only "transistors" when they are not classified) mainly used in electronic equipment.

Remarks 1. The following standards are cited in this Standard:

JIS C 0301 Graphical symbols for electrical apparatus

JIS C 1102 Electrical indicating instruments

2. The International standards corresponding to this Standard are given below:

IEC 747-7 (1988) Semiconductor discrete devices and integrated circuits
Part 7: Bipolar transistors

IEC 747-8 (1984) Semiconductor devices, Discrete devices
Part 8: Field-effect transistors

2. Graphical symbols used For the purpose of this Standard, in addition to the symbols specified in JIS C 0301, the symbols in Table 1 are used in the measuring circuit diagram.

Table 1

Graphical symbol	Name	Graphical symbol	Name
	Two-phenomenon oscilloscope	I	Current probe

3. Measuring power supply and instrument

3.1 Measuring power supply A d.c. power supply with a ripple content not exceeding 3 % and an a.c. power supply with a higher harmonic not exceeding 5 % shall be used. However, in the case of power frequency, a supply of ripple content not exceeding 10 % shall be used. In the measurements of a.c. characteristics, the ripple content of d.c. power supply, the higher harmonic content of a.c. supply, and the a.c. impedance of the d.c. power supply circuit through which an a.c. current flows shall be small enough so that they will not affect the measurements.

Unless otherwise specified, the values of a.c. voltage and a.c. current shall be expressed in r.m.s. value.

PROTECTED BY COPYRIGHT