

TUNG-SOL

TRANSISTOR ELECTRICAL SYMBOLS

SMALL SIGNAL AND HIGH FREQUENCY PARAMETERS
AT SPECIFIED BIAS

h_{ob}	Common base - output admittance, input AC open-circuited
h_{ib}	Common base - input impedance, output AC short-circuited
h_{rb}	Common base - reverse voltage transfer ratio, input AC open-circuited
h_{fb}	Common base
h_{fe}	Common emitter
h_{fc}	Common collector
	} forward current transfer ratio, output AC short-circuited
h_{oe}, h_i	Examples of other corresponding common emitter symbols
f_{ab}	Common base
f_{ae}	Common emitter
	} the frequency at which the magnitude of the small-signal short-circuit forward current transfer ratio is 0.707 of its low frequency value.
C_{ob}	Collector to base
C_{oe}	Collector to emitter
	} Capacitance measured across the output terminals with the input AC open-circuited.
r_b	Base spreading resistance
G_e	Common emitter Power Gain (use G_b for common base)
NF	Noise Figure

SWITCHING CHARACTERISTICS
AT SPECIFIED BIAS

t_d	Ohmic delay time
t_r	Rise time
t_s	Storage time
t_f	Fall time
	} These depend on both transistor and circuit parameters
$V_{CE} (SAT.)$	Saturation voltage at specified I_C and I_B . This is defined only within the collector saturation region.
h_{FE}	Common emitter - static value of short-circuit forward current transfer ratio. $h_{FE} = \frac{I_C}{I_B}$

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TRANSISTOR ELECTRICAL SYMBOLS - cont'd

SWITCHING CHARACTERISTICS - cont'd AT SPECIFIED BIAS

h_{FE} (INV) Inverse h_{FE} (emitter and collector leads switched)

$\overline{h_{fe}}$ Large-signal value of h_{fe} . Large-signal values of parameters are indicated by proper symbol and subscripts, with addition of a bar over the symbol.

DC MEASUREMENTS

I_C, I_E, I_B DC currents into collector, emitter, or base terminal

V_{CB}, V_{EB} Voltage collector to base, or emitter to base

V_{CE} Voltage collector to emitter

V_{BE} Voltage base to emitter

BV_{CBO} Breakdown voltage, collector to base junction reverse biased, emitter open-circuited (value of I_C should be specified)

V_{CEO} Voltage collector to emitter, at zero base current, with the collector junction reverse biased. Specify I_C .

BV_{CEO} Breakdown voltage, collector to emitter, with base open-circuited. This may be a function of both "m" (the charge carrier multiplication factor) and the h_{fb} of the transistor. Specify I_C .

V_{CER} Similar to V_{CEO} except a resistor of value "R" between base and emitter

V_{CES} Similar to V_{CEO} but base shorted to emitter

V_{PT} Punch-through voltage, collector to base voltage at which the collector space charge layer has widened until it contacts the emitter junction. At voltages above punch-through, $V_{PT} = V_{CB} - V_{EB}$

V_{CCB} Supply Voltage collector to base

V_{CCE} Supply voltage collector to emitter

V_{BBE} Supply voltage base to emitter

} NOTE - third subscript may be omitted if no confusion results.

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TRANSISTOR ELECTRICAL SYMBOLS - cont'd

DC MEASUREMENTS - cont'd

I_{CO}, I_{CBO}	Collector current when collector junction is reverse biased and emitter is DC open-circuited.
I_{EO}, I_{EBO}	Emitter current when emitter junction is reverse biased and collector is DC open-circuited.
I_{CEO}	Collector current with collector junction reverse biased and base open-circuited
I_{CES}	Collector current with collector junction reverse biased and base shorted to emitter.
I_{ECS}	Emitter current with emitter junction reverse biased and base shorted to collector.

NOTE:

SUBSCRIPTS FOR MULTI-ELECTRODE DEVICES ARE DEVELOPED BY NUMERIC ADDITIONS TO THE SUBSCRIPTS. SIMILAR ELECTRODES MAY BE NUMBERED IN SEQUENCE FROM THE INTENDED INPUT TO THE INTENDED OUTPUT ELECTRODES. EXAMPLES: $V_{EB2}, V_{IB2}, V_{CB2}, I_{c2}, I_{e2}$

NOTE:

REVERSE BIASED JUNCTION MEANS BIASED FOR CURRENT FLOW IN THE HIGH RESISTANCE DIRECTION.