# FAST SWITCHING POWER TRANSISTOR

- FAST SWITCHING TIMES
- LOW SWITCHING LOSSES
- VERY LOW SATURATION VOLTAGE AND HIGH GAIN

TO-218
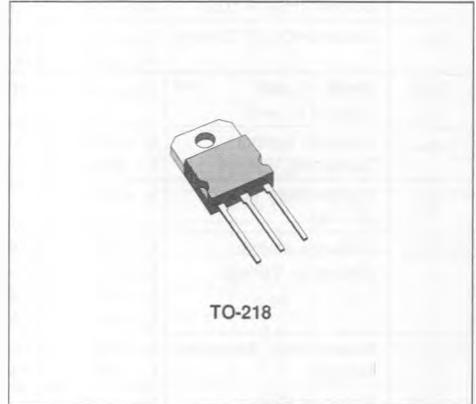
INTERNAL SCHEMATIC DIAGRAM

NPN
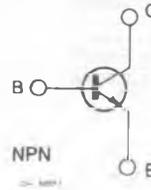
ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{CEV}	Collector-emitter Voltage ($V_{BE} = -1.5$ V)	350	V
V_{CEO}	Collector-emitter Voltage ($I_B = 0$)	250	V
V_{EBO}	Emitter-base Voltage ($I_C = 0$)	7	V
I_C	Collector Current	12	A
I_{CM}	Collector Peak Current	18	A
I_B	Base Current	2.5	A
I_{BM}	Base Peak Current	4	A
P_{base}	Reverse Bias Base Power Dissipation (B.E. junction in avalanche)	1	W
P_{tot}	Total Dissipation at $T_c < 25°C$	125	W
T_{stg}	Storage Temperature	-65 to 175	°C
T_J	Max. Operating Junction Temperature	175	°C

THERMAL DATA

$R_{thj-case}$	Thermal Resistance Junction-case	max	1.2	°C/W

ELECTRICAL CHARACTERISTICS (T_{case} = 25°C unless otherwise specified)

Symbol	Parameter	Test Conditions			Min.	Typ.	Max.	Unit
I_{CER}	Collector Cutoff Current (R_{BE} = 10Ω)	$V_{CE} = V_{CEV}$ $V_{CE} = V_{CEV}$ T_c = 100°C					0.5 2.5	mA mA
I_{CEV}	Collector Cutoff Current	$V_{CE} = V_{CEV}$ $V_{BE} = -1.5V$ $V_{CE} = V_{CEV}$ $V_{BE} = -1.5V$ T_c = 100°C					0.5 2	mA mA
I_{EBO}	Emitter Cutoff Current (I_C = 0)	V_{EB} = 5V					1	mA
$V_{CEO(sus)}$*	Collector Emitter Sustaining Voltage	I_C = 0.2A L = 25mH			250			V
V_{EBO}	Emitter-base Voltage (I_C = 0)	I_E = 50mA			7			V
$V_{CE(sat)}$*	Collector-emitter Saturation Voltage	I_C = 2A I_C = 5A I_C = 2A I_C = 5A	I_B = 0.13A I_B = 0.5A I_B = 0.13A I_B = 0.5A	T_j = 100°C T_j = 100°C		0.25 0.4 0.25 0.45	0.8 0.9 0.9 1.2	V V V V
$V_{BE(sat)}$*	Base-emitter Saturation Voltage	I_C = 4A I_C = 4A	I_B = 0.4A I_B = 0.4A	T_j = 100°C		1 0.9	1.3 1.3	V V
di_C/dt	Rated of Rise of on-state Collector Current	V_{CC} = 200V R_C = 0 See fig. 2	I_{B1} = 0.6A T_j = 25°C T_j = 100°C		25 20	40 35		A/µs A/µs
$V_{CE(2µs)}$	Collector Emitter Dynamic Voltage	V_{CC} = 200V R_C = 50Ω See fig. 2	I_{B1} = 0.4A T_j = 25°C T_j = 100°C			1.7 2.5	2.5 4	V V
$V_{CE(4µs)}$	Collector Emitter Dynamic Voltage	V_{CC} = 200V R_C = 50Ω See fig. 2	I_{B1} = 0.4A T_j = 25°C T_j = 100°C			0.9 1.1	1.7 2	V V

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ELECTRICAL CHARATERISTICS (continued)

RESISTIVE LOAD

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
t_r	Rise Time	$V_{CC} = 200V$	$I_C = 6A$		0.3	0.4	µs
t_s	Storage Time	$V_{BB} = -5V$ $R_{B2} = 3.3\Omega$	$I_{B1} = 0.75A$ $t_p = 30µs$		1	1.6	µs
t_f	Fall Time	See fig. 1			0.15	0.3	µs

INDUCTIVE LOAD

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
t_s	Storage Time	$V_{CC} = 200V$	$V_{clamp} = 250V$		1.2	1.8	µs
t_f	Fall Time	$I_C = 4A$	$I_B = 0.4A$		0.08	0.2	µs
t_t	Tail Time in Turn-on	$V_{BB} = -5V$ $L_C = 2.5mH$	$R_{B2} = 6.3\Omega$ See fig. 3		0.03	0.12	µs
t_c	Crossover Time				0.15	0.35	µs
t_s	Storage Time	$V_{CC} = 200V$	$V_{clamp} = 250V$		1.8	2.4	µs
t_f	Fall Time	$I_C = 4A$	$I_B = 0.4A$		0.2	0.4	µs
t_t	Tail Time in Turn-on	$V_{BB} = -5V$ $L_C = 2.5mH$	$R_{B2} = 6.3\Omega$ $T_j = 100°C$		0.08	0.2	µs
t_c	Crossover Time	See fig. 3			0.4	0.7	µs
t_s	Storage Time	$V_{CC} = 200V$	$V_{clamp} = 250V$		2.5		µs
t_f	Fall Time	$I_C = 4A$	$I_B = 0.4A$		0.4		µs
t_t	Tail Time in Turn-on	$V_{BB} = 0$ $L_C = 2.5mH$	$R_{B2} = 7.5\Omega$ See fig. 3		0.15		µs
t_s	Storage Time	$V_{CC} = 200V$	$V_{clamp} = 250V$		4.8		µs
t_f	Fall Time	$I_C = 4A$ $V_{BB} = 0$	$I_B = 0.4A$ $R_{B2} = 7.5\Omega$		0.7		µs
t_t	Tail Time in Turn-on	$L_C = 2.5mH$ See fig. 3	$T_j = 100°C$		0.4		µs

* Pulsed : Pulse duration = 300 µs, duty cycle = 2 %.

Figure 1 : Switching Times Test Circuit (resistive load).

(1) Fast electronic switch
(2) Non-inductive resistor
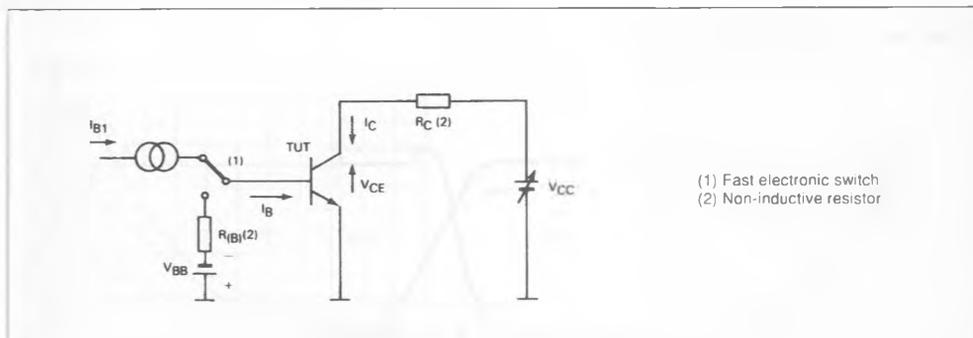
Figure 2 : Turn-on Switching Waveforms.
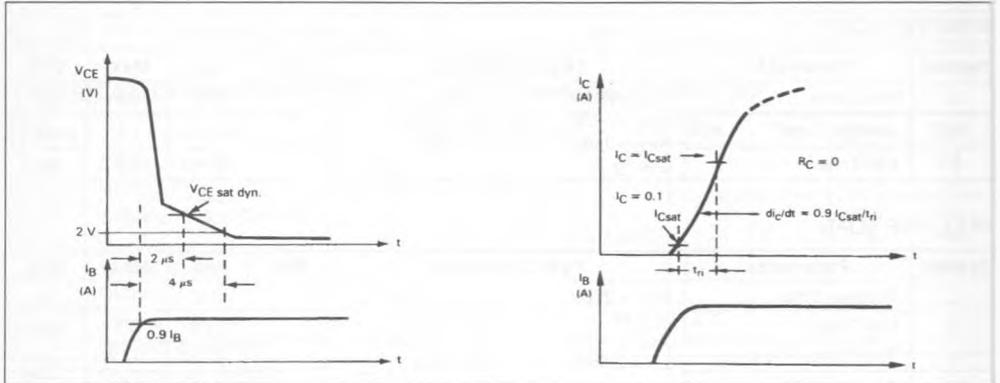
Figure 3a : Turn-off Switching Test Circuit.

(1) Fast electronic switch
(2) Non-inductive resistor
(3) Fast recovery rectifier
SW : – closed for t_s, t_{ri}, t_c
　　 – open for V_{CEW}
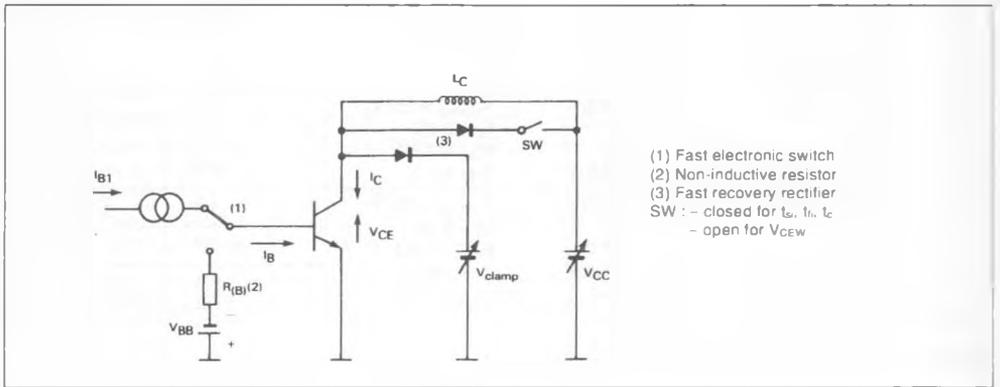
Figure 3b : Turn-off Switching Waveforms (inductive load).

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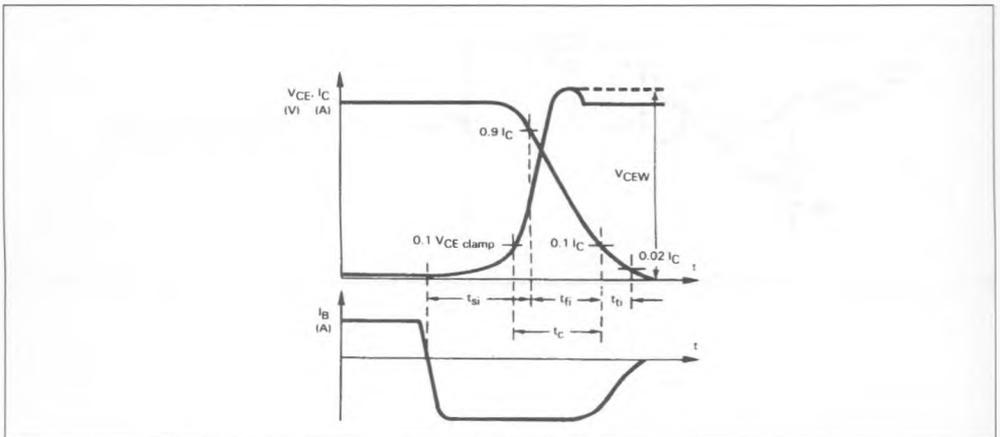
DC and AC Pulse Area.
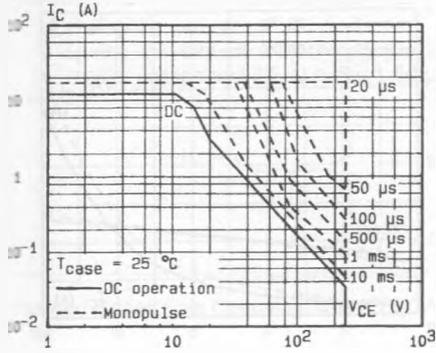
Power and $I_{S/B}$ Derating versus Case Temperature.
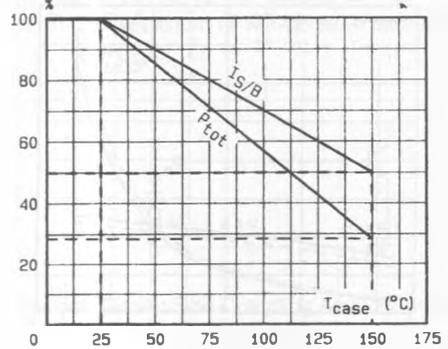
Transient Thermal Response.
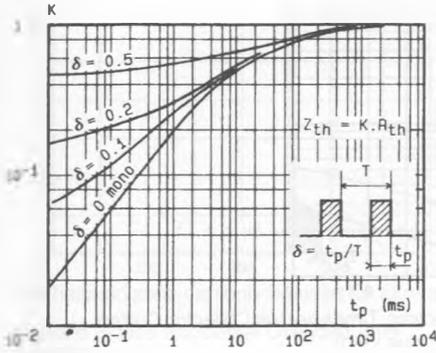
Collector-emitter Voltage versus Base-emitter Resistance.
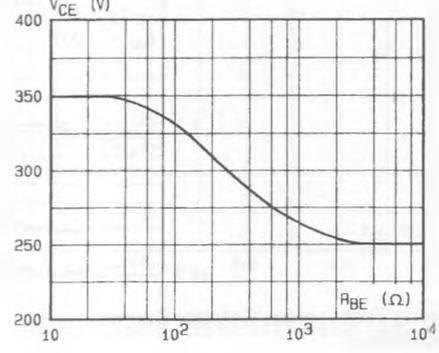
DC Current Gain.
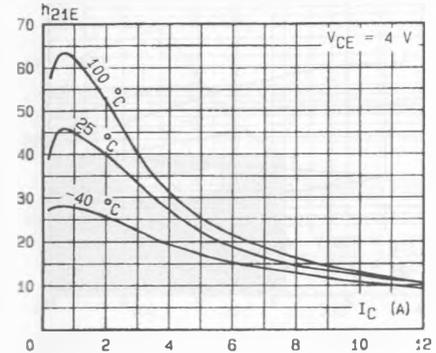
Minimum Base Current to Saturate the Transistor.

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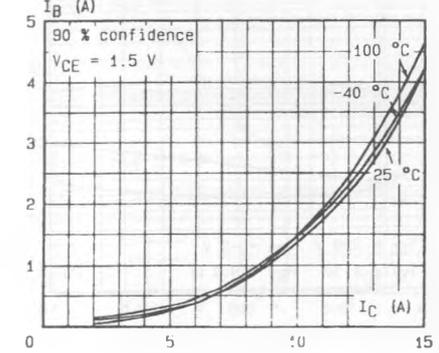
Saturation Voltage.
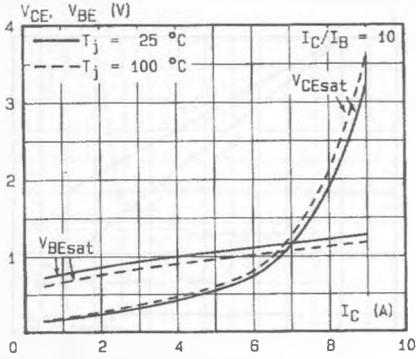
Saturation Voltage.
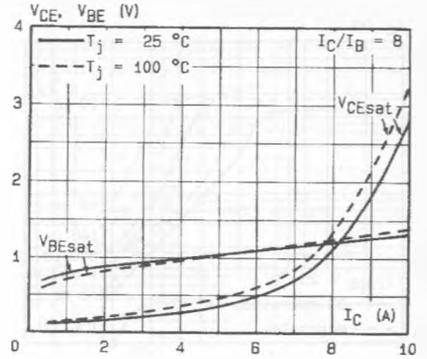
Switching Times versus Collector.
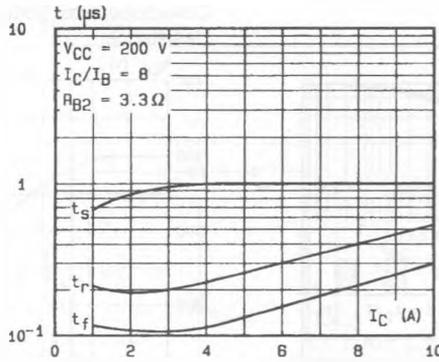
Switching Times versus Collector Current (inductive load).

Switching Times versus Collector Current (inductive load).

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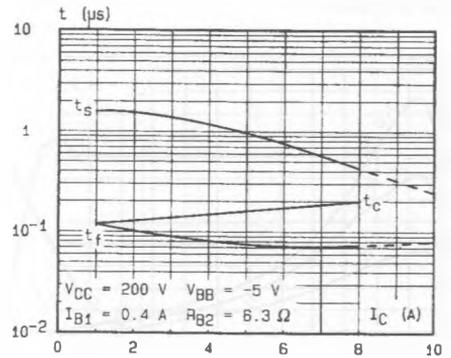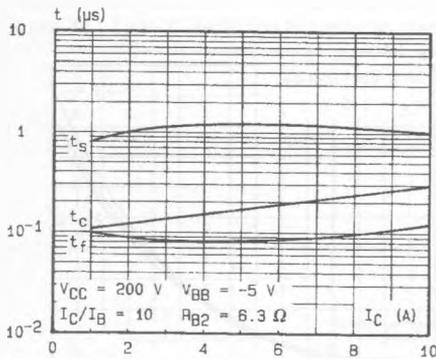
## SWITCHING OPERATING AND OVERLOAD AREAS

TRANSISTOR FORWARD BIASED

- _ During the turn-on
- _ During the turn-off without negative base-emitter voltage and $7.5 \ \Omega \le R_{BE} \le 50 \ \Omega$.

TRANSISTOR REVERSE BIASED

- _ During the turn-off with negative base-emitter voltage.
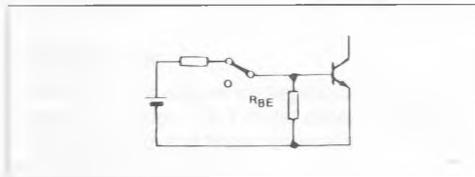
Forward Biased Safe Operating Area (FBSOA).
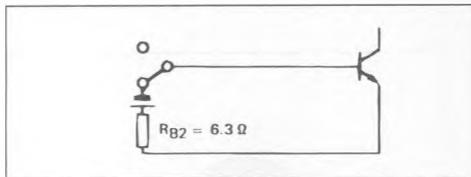
Reverse Biased Safe Operating Area (RBSOA).
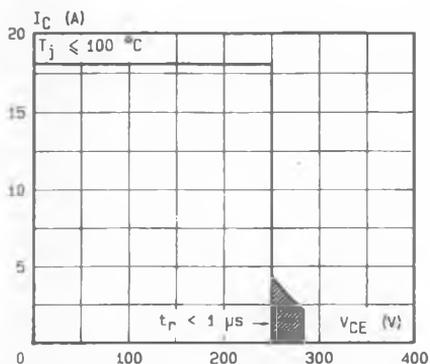

The hatched zone can only be used for turn-on.
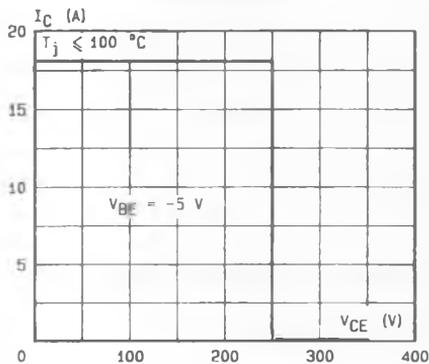
Forward Biased Accidental Overload Area (FBAOA).

Reverse Biased Accidental Overload Area (RBAOA).
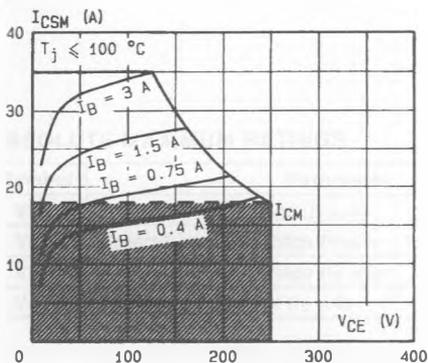
The Kellog network (heavy point) allows the calculation of the maximum value of the short-circuit for a given base current I_B.
(90 % confidence).
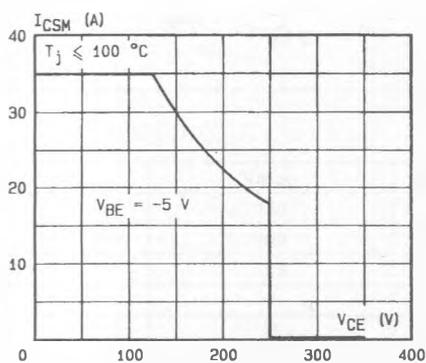
After the acidental overload current the RBAOA has to be used for the turn-off.

High accidental surge currents ($I > I_{CM}$) are allowed if they are non repetitive and applied less than 3000 times during the component life.