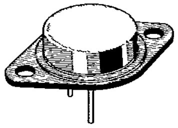
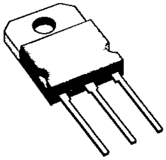
BUT13/13P/13PFI

HIGH VOLTAGE POWER SWITCH

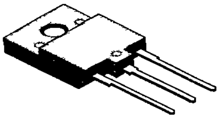
- HIGH POWER
- INTEGRATED SPEED-UP DIODE



TO-3

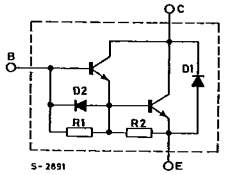


TO-218



ISOWATT218

INTERNAL SCHEMATIC DIAGRAM



DESCRIPTION

The BUT13 , BUT13P and BUT13PFI are silicon multiepitaxial planar NPN transistors in monolithic darlington configuration with integrated base-emitter speed-up diode, mounted respectively in TO-3 metal case, TO-218 plastic package and ISOWATT218 fully isolated package.

They are particularly suited for output stages in power, fast switching applications.

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value			Unit
V_{CBO}	Collector-base Voltage ($I_E = 0$)	600			V
V_{CEO}	Collector-emitter Voltage ($I_B = 0$)	400			V
V_{EBO}	Emitter-base Voltage ($I_C = 0$)	10			V
I_C	Collector Current	28			A
I_{CM}	Collector Peak Current	35			A
I_B	Base Current	6			A
		TO-3	TO-218	ISOWATT218	
P_{tot}	Total Dissipation at $T_c < 25°C$	175	125	60	W
T_{stg}	Storage Temperature	– 65 to 200	– 65 to 150	– 65 to 150	°C
T_j	Max. Operating Junction Temperature	200	150	150	°C

THERMAL DATA

		TO-3	TO-218	ISOWATT218	
$R_{th\ j\text{-}case}$	Thermal Resistance Junction-case Max	1	1	2.08	°C/W

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

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
I_{CEV}	Collector Cutoff Current	V_{CE} = 600 V V_{CE} = 600 V T_{case} = 100 °C			100 2	µA mA
I_{CEO}	Collector Cutoff Current (I_B = 0)	V_{CE} = 400 V			1	mA
I_{EBO}	Emitter Cuttoff Current (I_C = 0)	V_{EB} = 2 V			20	mA
$V_{CEO(sus)}$*	Collector-emitter Sustaining Voltage	I_C = 100 mA	400			V
$V_{CE(sat)}$*	Collector-emitter Saturation Voltage	I_C = 10 A I_B = 0.5 A I_C = 18 A I_B = 1.8 A I_C = 22 A I_B = 2.2 A I_C = 28 A I_B = 5.6 A		1.3 1.7 2 2.35	2 2.5 3 5	V V V V
$V_{BE(sat)}$*	Base-emitter Saturation Voltage	I_C = 10 A I_B = 0.5 A I_C = 18 A I_B = 1.8 A I_C = 22 A I_B = 2.2 A		 2.5 	2.5 3 3.3	V V V
h_{FE}*	DC Current Gain	I_C = 10 A V_{CE} = 5 V I_C = 18 A V_{CE} = 5 V	30 30	300 90		
V_F*	Diode Forward Voltage	I_F = 22 A		2.2	4	V

RESISTIVE SWITCHING TIMES

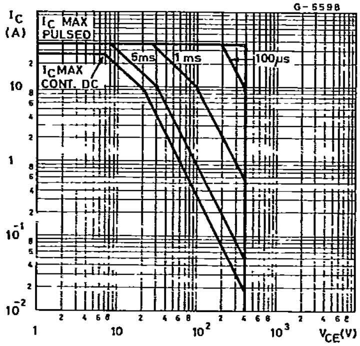
Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
t_{on}	Turn-on Time	V_{CC} = 250 V I_C = 10 A I_{B1} = 0.5 A $V_{BE(off)}$ = – 5 V		0.5	0.6	µs
t_s	Storage Time			1.1	1.5	µs
t_f	Fall Time			0.3	0.6	µs

INDUCTIVE SWITCHING TIMES

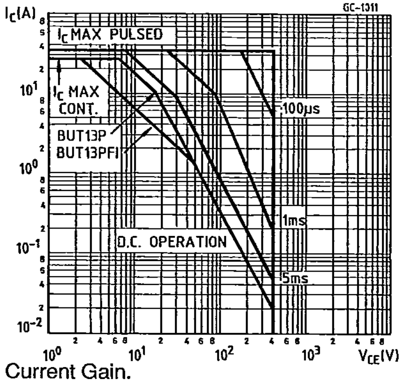
Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
t_s	Storage Time	V_{clamp} = 250 V I_C = 10 A I_{B1} = 0.2 A ; $V_{BE(off)}$ = – 5 V		1.3	2	µs
t_f	Fall Time			0.11	0.5	µs
t_c	Crossover Time			0.4	0.8	µs
t_s	Storage Time	V_{clamp} = 250 V I_C = 20 A I_{B1} = 0.4 A ; $V_{BE(off)}$ = – 5 V		1.4	2.6	µs
t_f	Fall Time			0.4	0.7	µs
t_c	Crossover Time			0.8	1.5	µs

* Pulsed : pulse duration = 300 µs, duty cycle = 1.5 %.

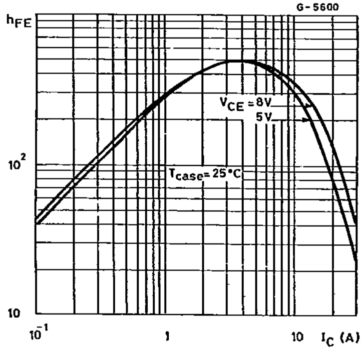
Safe Operating Areas (for BUT13).



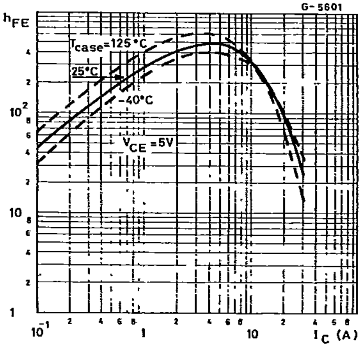
Safe Operaging Areas (for BUT13P and BUT13PFI).



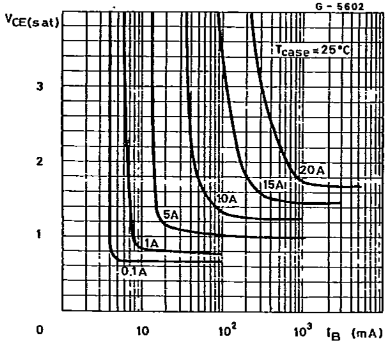
DC Current Gain.



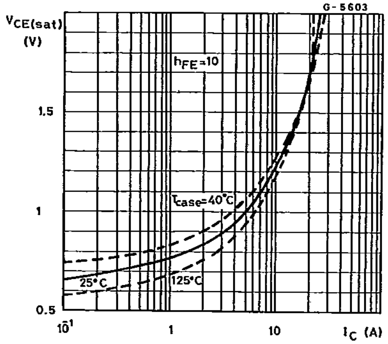
DC Current Gain.



Collector-emitter Saturation Voltage.



Collector-emitter Saturation Voltage.



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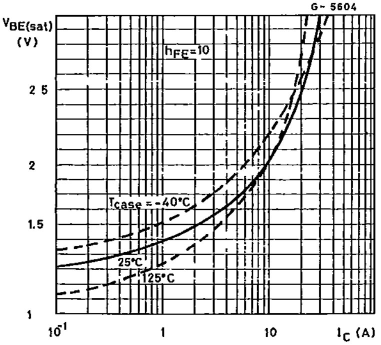
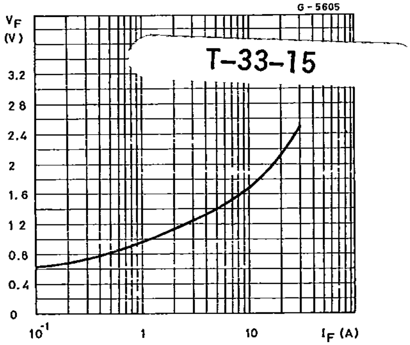
Base-emitter Saturation Voltage.



Freewheel Diode Forward Voltage.



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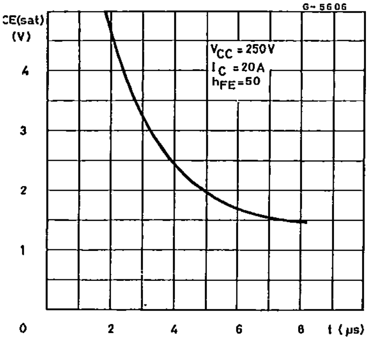
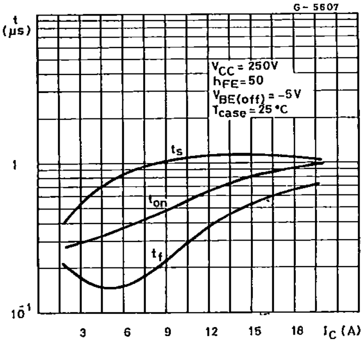
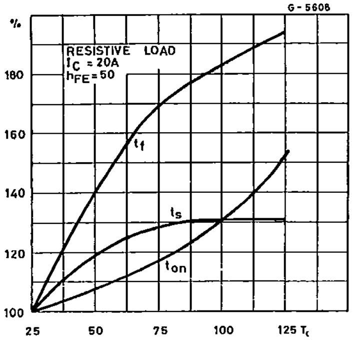
Collector-emitter Saturation Voltage Dynamic.



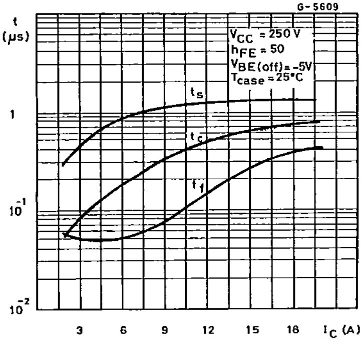
Switching Times Resistive Load (test circuit fig. 1).



Switching Times Percentage Variation vs. T_{case}.



Switching Times Inductive Load Test (test circuit fig. 1).



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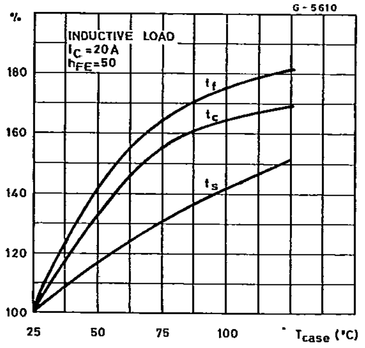
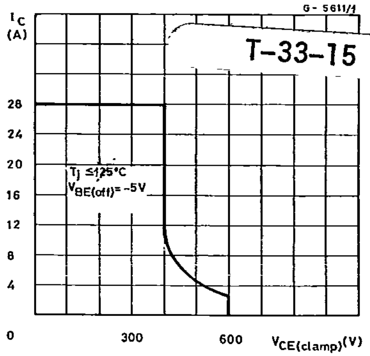
Switching Times Percentage Variation vs. T_{case}.



Clamped Reverse Bias Safe Operating Area.



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TEST CIRCUITS

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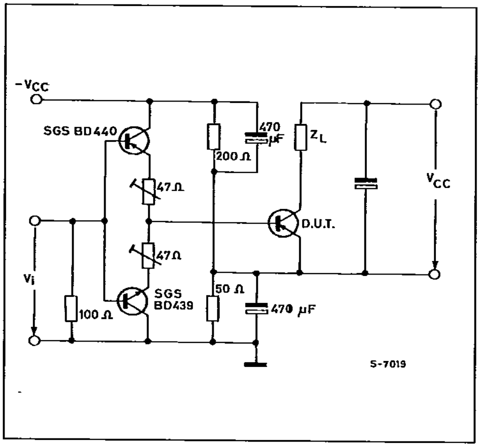
Figure 1.



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ISOWATT218 PACKAGE CHARACTERISTICS AND APPLICATION

ISOWATT218 is fully isolated to 4000V dc. Its thermal impedance, given in the data sheet, is optimised to give efficient thermal conduction together with excellent electrical isolation.

The structure of the case ensures optimum distances between the pins and heatsink. These distances are in agreement with VDE and UL creepage and clearance standards. The ISOWATT218 package eliminates the need for external isolation so reducing fixing hardware.

The package is supplied with leads longer than the standard TO-218 to allow easy mounting on pcbs.

Accurate moulding techniques used in manufacture assures consistent heat spreader-to-heatsink capacitance.

ISOWATT218 thermal performance is equivalent to that of the standard part, mounted with a 0.1mm mica washer.

The thermally conductive plastic has a higher breakdown rating and is less fragile than mica or plastic sheets. Power derating for ISOWATT218 packages is determined by :

$$P_D = \frac{T_j - T_c}{R_{th}}$$

THERMAL IMPEDANCE OF ISOWATT218 PACKAGE

Figure 2 illustrates the elements contributing to the thermal resistance of a transistor heatsink assembly, using ISOWATT218 package.

The total thermal resistance $R_{th(tot)}$ is the sum of each of these elements.

The transient thermal impedance, Zth for different pulse durations can be estimated as follows :

1-For a short duration power pulse of less than 1 ms :

$$Z_{th} < R_{thJ\text{-}C}$$

2-For an intermediate power pulse of 5ms to 50ms seconds :

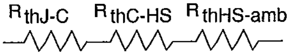
$$Z_{th} = R_{thJ\text{-}C}$$

3-For long power pulses of the order of 500ms seconds or greater :

$$Z_{th} = R_{thJ\text{-}C} + R_{thC\text{-}HS} + R_{thHS\text{-}amb}$$

It is often possible to discern these areas on transient thermal impedance curves.

Figure 2.



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