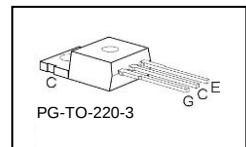
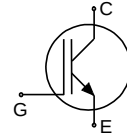


Low Loss IGBT : IGBT in TRENCHSTOP™ and Fieldstop technology



Features:

- Very low $V_{CE(sat)}$ 1.5V (typ.)
- Maximum Junction Temperature 175°C
- Short circuit withstand time 5μs
- Designed for :
 - Variable Speed Drive for washing machines and air conditioners
 - induction cooking
 - Uninterrupted Power Supply
- TRENCHSTOP™ and Fieldstop technology for 600V applications offers :
 - very tight parameter distribution
 - high ruggedness, temperature stable behaviour
- NPT technology offers easy parallel switching capability due to positive temperature coefficient in $V_{CE(sat)}$
- Low EMI
- Low Gate Charge
- Qualified according to JEDEC¹ for target applications
- Pb-free lead plating; RoHS compliant
- Complete product spectrum and PSpice Models : <http://www.infineon.com/igbt/>



Type	V_{CE}	I_C	$V_{CE(sat)}, T_j=25^\circ\text{C}$	$T_{j,max}$	Marking Code	Package
IGP10N60T	600V	10A	1.5V	175°C	G10T60	PG-TO-220-3

Maximum Ratings

Parameter	Symbol	Value	Unit
Collector-emitter voltage, $T_j \geq 25^\circ\text{C}$	V_{CE}	600	V
DC collector current, limited by $T_{j,max}$	I_C	24	A
$T_C = 25^\circ\text{C}$			
$T_C = 100^\circ\text{C}$		18	
Pulsed collector current, t_p limited by $T_{j,max}$		30	
Turn off safe operating area, $V_{CE} = 600\text{V}$, $T_j = 175^\circ\text{C}$, $t_p = 1\mu\text{s}$	-	30	
Gate-emitter voltage	V_{GE}	± 20	V
Short circuit withstand time ²⁾	t_{SC}	5	μs
$V_{GE} = 15\text{V}$, $V_{CC} \leq 400\text{V}$, $T_j \leq 150^\circ\text{C}$			
Power dissipation $T_C = 25^\circ\text{C}$	P_{tot}	110	W
Operating junction temperature	T_j	-40...+175	°C
Storage temperature	T_{stg}	-55...+150	
Soldering temperature, 1.6mm (0.063 in.) from case for 10s		260	

¹ J-STD-020 and JEDEC-022

²⁾ Allowed number of short circuits: <1000; time between short circuits: >1s.

Thermal Resistance

Parameter	Symbol	Conditions	Max. Value	Unit
Characteristic				
IGBT thermal resistance, junction – case	R_{thJC}		1.35	K/W
Thermal resistance, junction – ambient	R_{thJA}		62	

Electrical Characteristic, at $T_j = 25^\circ\text{C}$, unless otherwise specified

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
Static Characteristic						
Collector-emitter breakdown voltage	$V_{(BR)CES}$	$V_{GE}=0V, I_C=0.2mA$	600	-	-	V
Collector-emitter saturation voltage	$V_{CE(sat)}$	$V_{GE} = 15V, I_C=10A$				
		$T_j=25^{\circ}C$	-	1.5	2.05	
		$T_j=175^{\circ}C$	-	1.8	-	
Gate-emitter threshold voltage	$V_{GE(th)}$	$I_C=0.3mA, V_{CE}=V_{GE}$	4.1	4.6	5.7	μA
Zero gate voltage collector current	I_{CES}	$V_{CE}=600V,$ $V_{GE}=0V$				
		$T_j=25^{\circ}C$	-	-	40	
		$T_j=175^{\circ}C$	-	-	1000	
Gate-emitter leakage current	I_{GES}	$V_{CE}=0V, V_{GE}=20V$	-	-	100	nA
Transconductance	g_{fs}	$V_{CE}=20V, I_C=10A$	-	6	-	S
Integrated gate resistor	R_{Gint}		none			Ω

Dynamic Characteristic

Input capacitance	C_{iss}	$V_{CE}=25V,$ $V_{GE}=0V,$ $f=1MHz$	-	551	-	pF
Output capacitance	C_{oss}		-	40	-	
Reverse transfer capacitance	C_{rss}		-	17	-	
Gate charge	Q_{Gate}	$V_{CC}=480V, I_C=10A$ $V_{GE}=15V$	-	62	-	nC
Internal emitter inductance measured 5mm (0.197 in.) from case	L_E	TO-220-3-1	-	7	-	nH
Short circuit collector current ¹⁾	$I_{C(SC)}$	$V_{GE}=15V, t_{SC}\leq 5\mu s$ $V_{CC} = 400V,$ $T_j = 25^\circ\text{C}$	-	100	-	A

¹⁾ Allowed number of short circuits: <1000; time between short circuits: >1s.

Switching Characteristic ³⁾, Inductive Load, at $T_j=25^\circ\text{C}$

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
IGBT Characteristic						
Turn-on delay time	$t_{d(on)}$	$T_j=25^{\circ}\text{C}$, $V_{CC}=400\text{V}$, $I_C=10\text{A}$, $V_{GE}=0/15\text{V}$, $r_G=23\Omega$, $L_{\sigma}=60\text{nH}$, $C_{\sigma}=40\text{pF}$	-	12	-	ns
Rise time	t_r		-	8	-	
Turn-off delay time	$t_{d(off)}$		-	215	-	
Fall time	t_f		-	38	-	
Turn-on energy	E_{on}	L_{σ} , C_{σ} from Fig. E Energy losses include “tail” and diode reverse recovery.	-	0.16	-	mJ
Turn-off energy	E_{off}		-	0.27	-	
Total switching energy	E_{ts}		Diode from IKP10N60T	-	0.43	

Switching Characteristic ³⁾, Inductive Load, at $T_j=175^\circ\text{C}$

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
IGBT Characteristic						
Turn-on delay time	$t_{d(on)}$	$T_j=175^{\circ}\text{C}$, $V_{CC}=400\text{V}$, $I_C=10\text{A}$, $V_{GE}=0/15\text{V}$, $r_G=23\Omega$, $L_{\sigma}=60\text{nH}$, $C_{\sigma}=40\text{pF}$	-	10	-	ns
Rise time	t_r		-	11	-	
Turn-off delay time	$t_{d(off)}$		-	233	-	
Fall time	t_f		-	63	-	
Turn-on energy	E_{on}	L_{σ} , C_{σ} from Fig. E Energy losses include “tail” and diode reverse recovery.	-	0.26	-	mJ
Turn-off energy	E_{off}		-	0.35	-	
Total switching energy	E_{ts}		Diode from IKP10N60T	-	0.61	

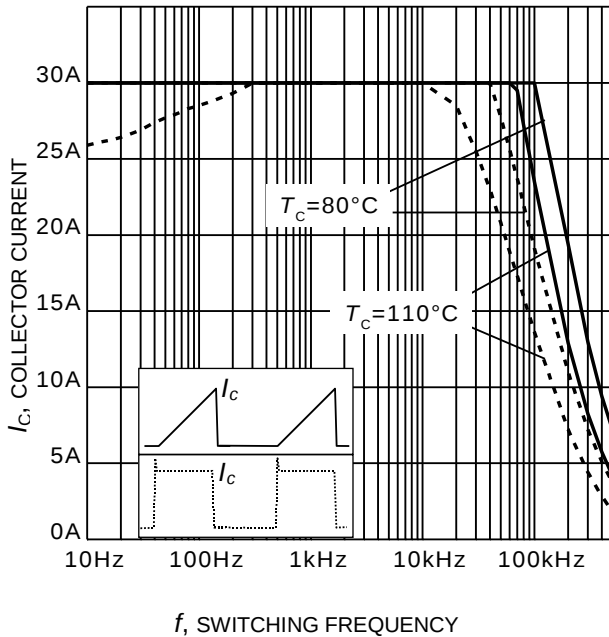


Figure 1. Collector current as a function of switching frequency
 $(T_j \leq 175^\circ\text{C}, D = 0.5, V_{CE} = 400\text{V}, V_{GE} = 0/15\text{V}, r_G = 23\Omega)$

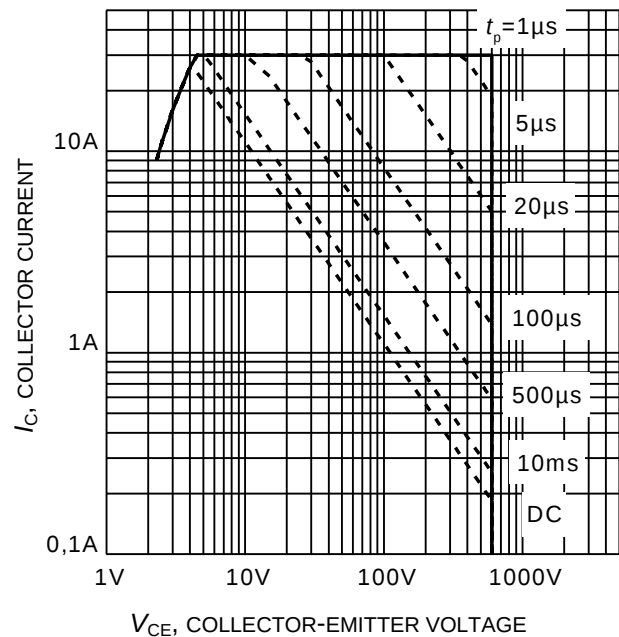


Figure 2. Safe operating area
 $(D = 0, T_C = 25^\circ\text{C}, T_j \leq 175^\circ\text{C}; V_{GE} = 0/15\text{V})$

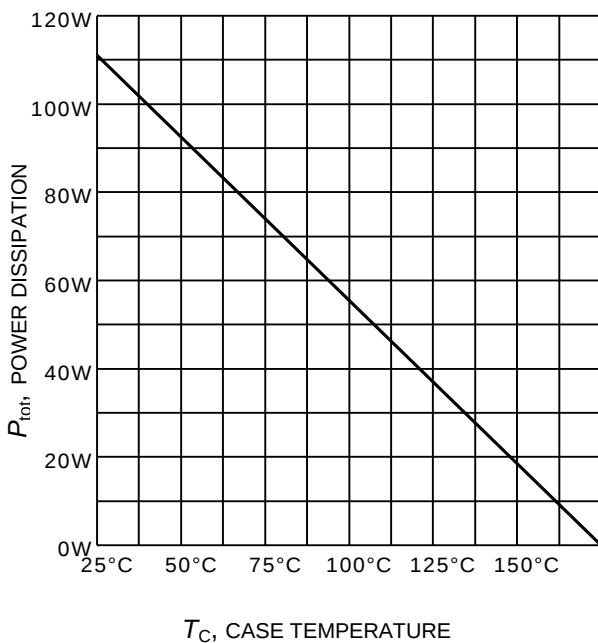


Figure 3. Power dissipation as a function of case temperature
 $(T_j \leq 175^\circ\text{C})$

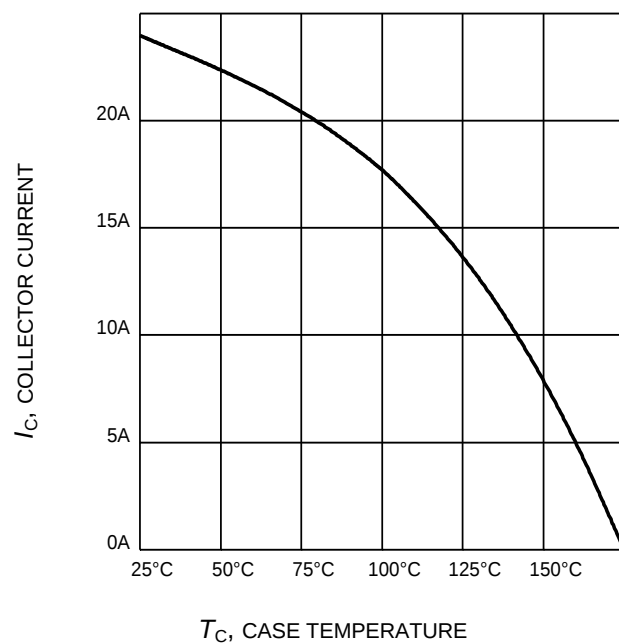


Figure 4. Collector current as a function of case temperature
 $(V_{GE} \geq 15\text{V}, T_j \leq 175^\circ\text{C})$

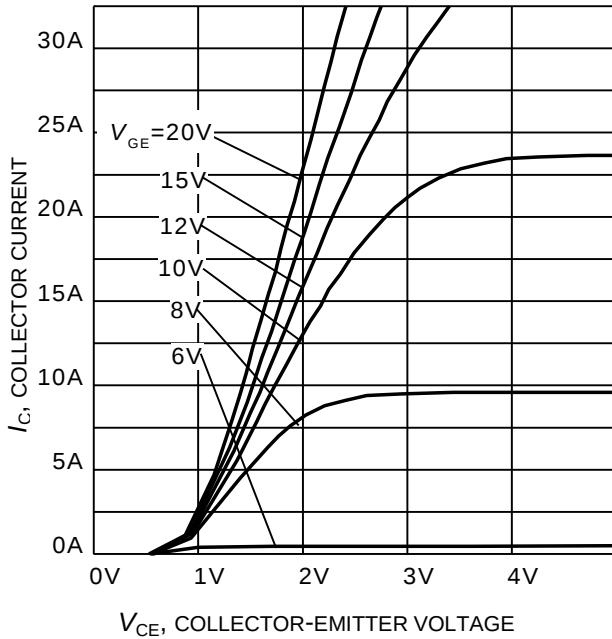


Figure 5. Typical output characteristic
($T_j = 25^\circ\text{C}$)

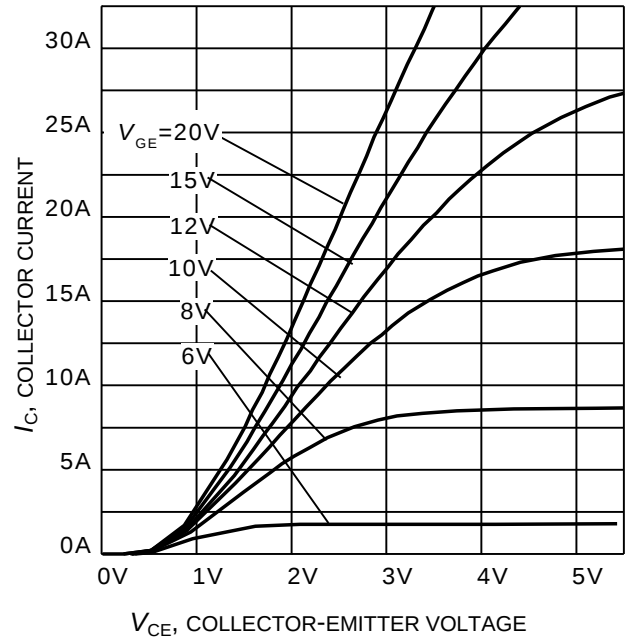


Figure 6. Typical output characteristic
($T_j = 175^\circ\text{C}$)

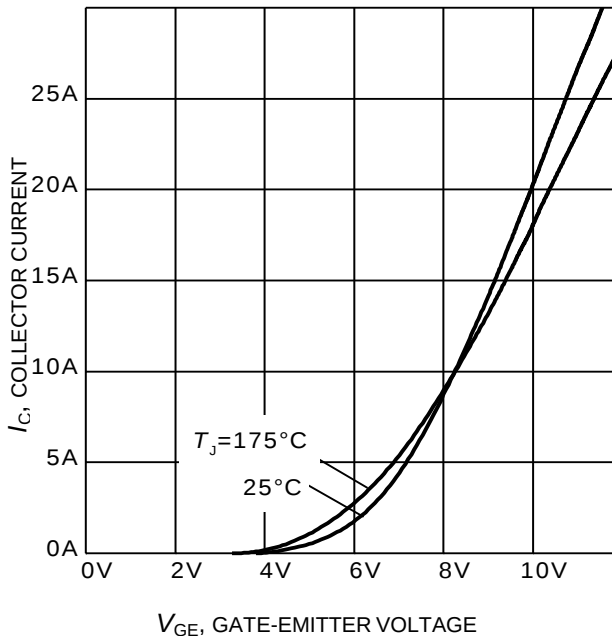


Figure 7. Typical transfer characteristic
($V_{ce} = 20\text{V}$)

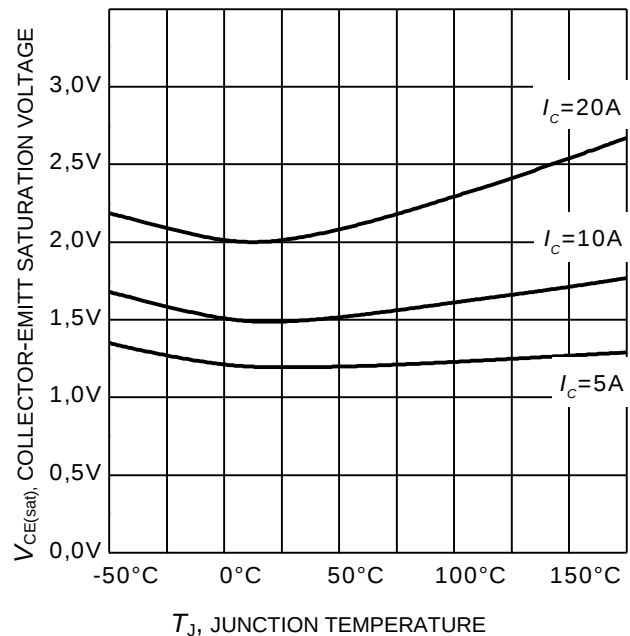
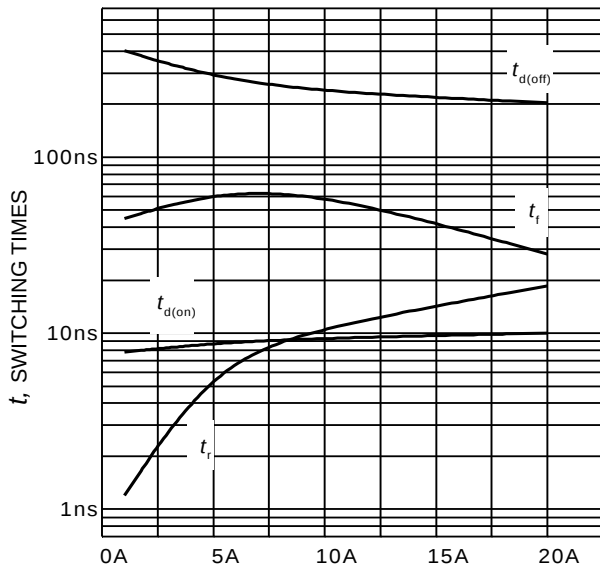
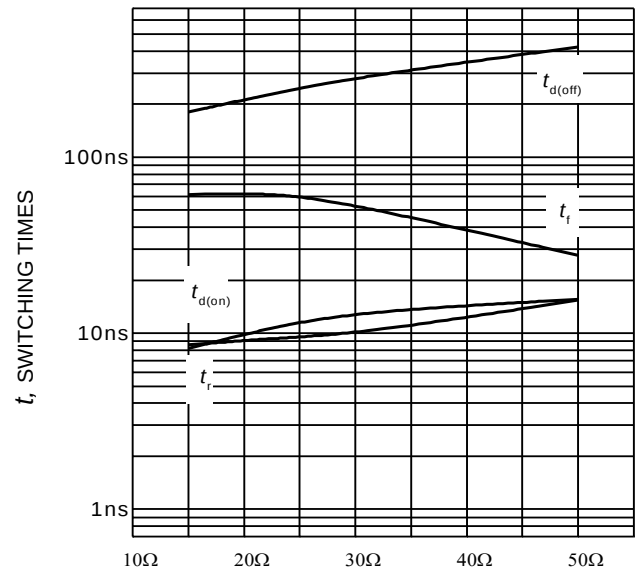


Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature
($V_{ge} = 15\text{V}$)



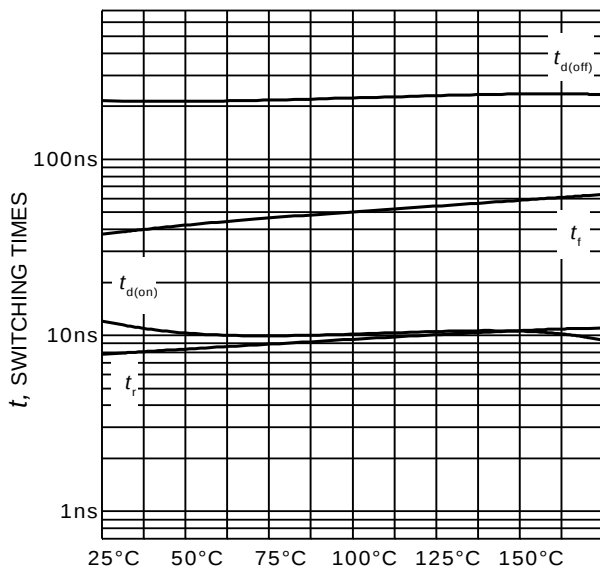
I_C , COLLECTOR CURRENT

Figure 9. Typical switching times as a function of collector current
(inductive load, $T_J=175^\circ\text{C}$, $V_{CE} = 400\text{V}$, $V_{GE} = 0/15\text{V}$, $r_G = 23\Omega$, Dynamic test circuit in Figure E)



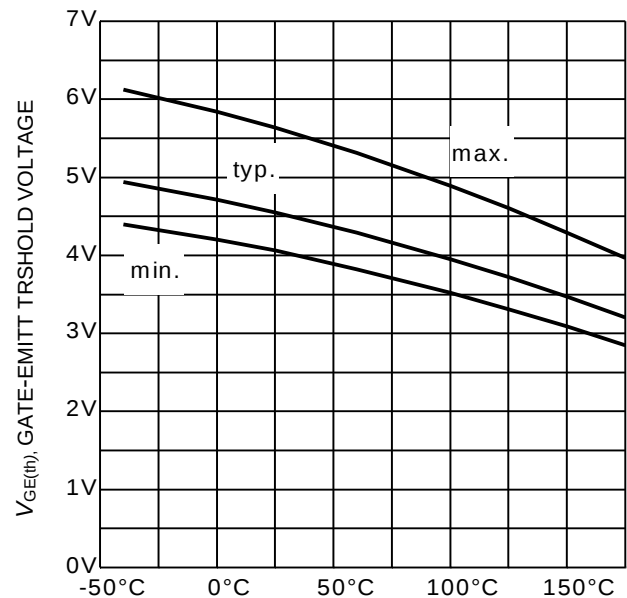
R_G , GATE RESISTOR

Figure 10. Typical switching times as a function of gate resistor
(inductive load, $T_J = 175^\circ\text{C}$, $V_{CE} = 400\text{V}$, $V_{GE} = 0/15\text{V}$, $I_C = 10\text{A}$, Dynamic test circuit in Figure E)



T_J , JUNCTION TEMPERATURE

Figure 11. Typical switching times as a function of junction temperature
(inductive load, $V_{CE} = 400\text{V}$, $V_{GE} = 0/15\text{V}$, $I_C = 10\text{A}$, $r_G=23\Omega$, Dynamic test circuit in Figure E)



T_J , JUNCTION TEMPERATURE

Figure 12. Gate-emitter threshold voltage as a function of junction temperature
($I_C = 0.3\text{mA}$)

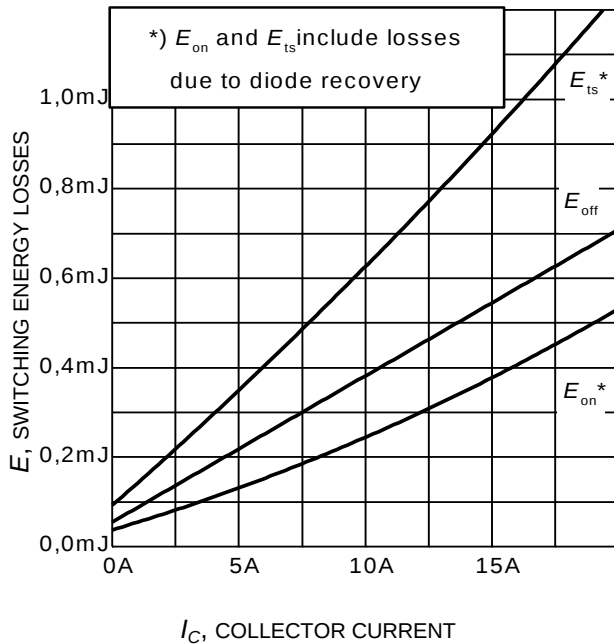


Figure 13. Typical switching energy losses as a function of collector current
(inductive load, $T_J = 175^\circ\text{C}$, $V_{CE} = 400\text{V}$, $V_{GE} = 0/15\text{V}$, $r_G = 23\Omega$, Dynamic test circuit in Figure E)

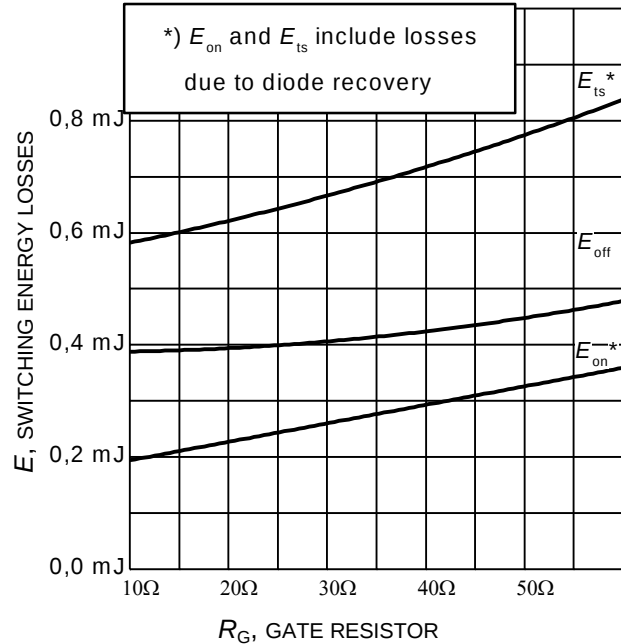


Figure 14. Typical switching energy losses as a function of gate resistor
(inductive load, $T_J = 175^\circ\text{C}$, $V_{CE} = 400\text{V}$, $V_{GE} = 0/15\text{V}$, $I_C = 10\text{A}$, Dynamic test circuit in Figure E)

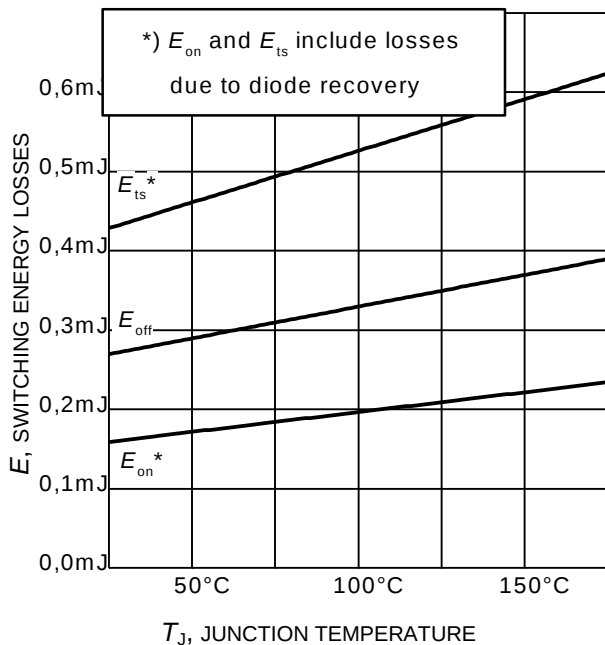


Figure 15. Typical switching energy losses as a function of junction temperature
(inductive load, $V_{CE} = 400\text{V}$, $V_{GE} = 0/15\text{V}$, $I_C = 10\text{A}$, $r_G = 23\Omega$, Dynamic test circuit in Figure E)

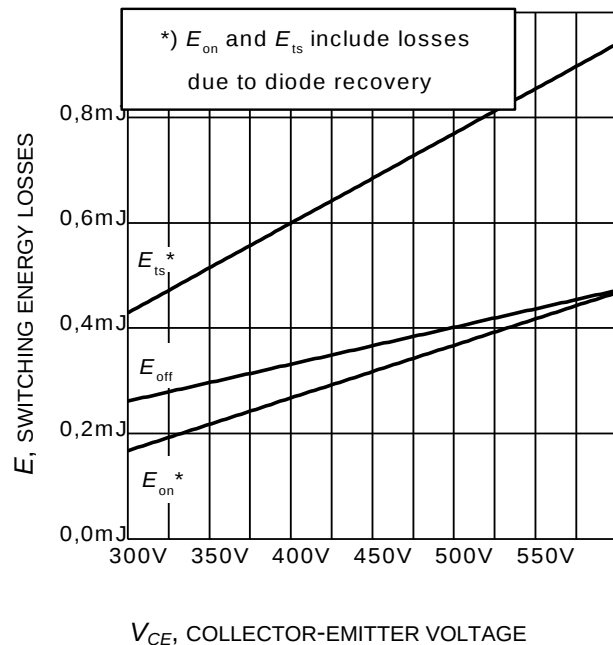


Figure 16. Typical switching energy losses as a function of collector emitter voltage
(inductive load, $T_J = 175^\circ\text{C}$, $V_{GE} = 0/15\text{V}$, $I_C = 10\text{A}$, $r_G = 23\Omega$, Dynamic test circuit in Figure E)

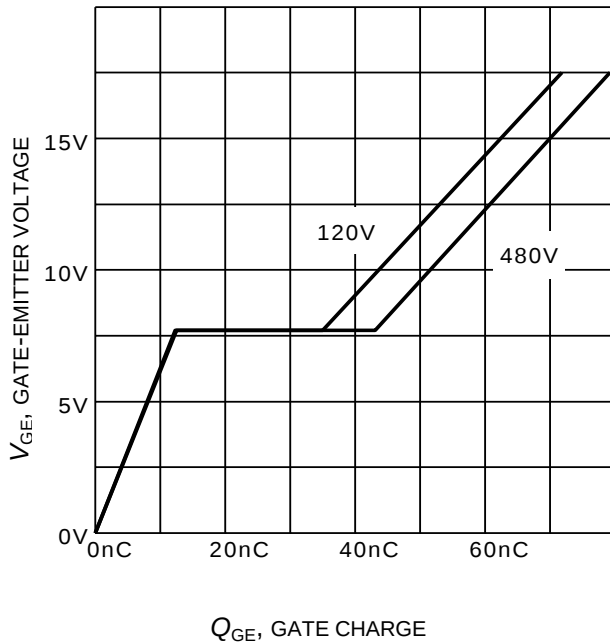


Figure 17. Typical gate charge
($I_C=10\text{ A}$)

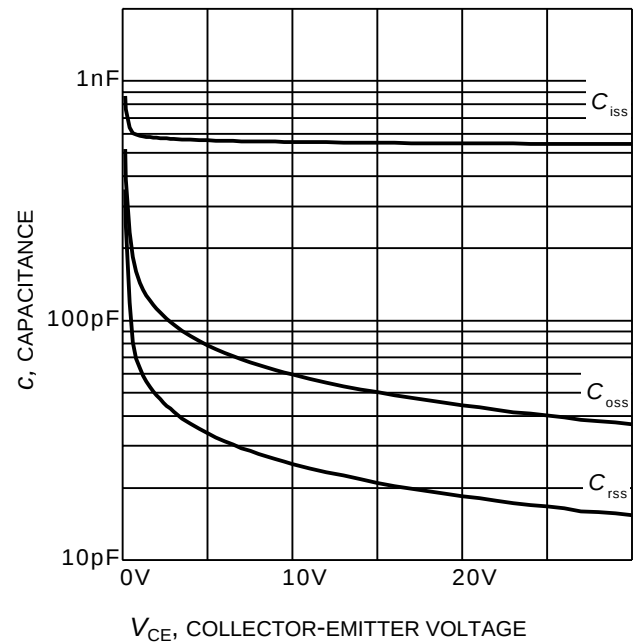


Figure 18. Typical capacitance as a function of collector-emitter voltage
($V_{GE}=0\text{V}$, $f = 1\text{ MHz}$)

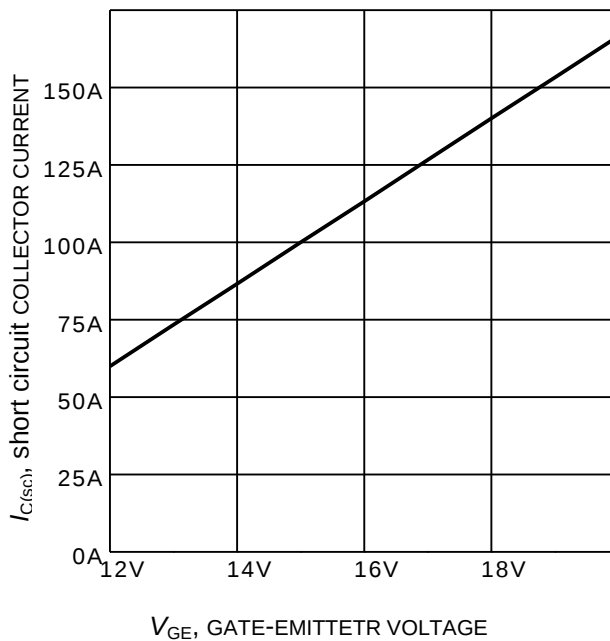


Figure 19. Typical short circuit collector current as a function of gate-emitter voltage
($V_{CE} \leq 400\text{V}$, $T_j \leq 150^\circ\text{C}$)



Figure 20. Short circuit withstand time as a function of gate-emitter voltage
($V_{CE}=400\text{V}$, start at $T_j=25^\circ\text{C}$, $T_{Jmax}<150^\circ\text{C}$)

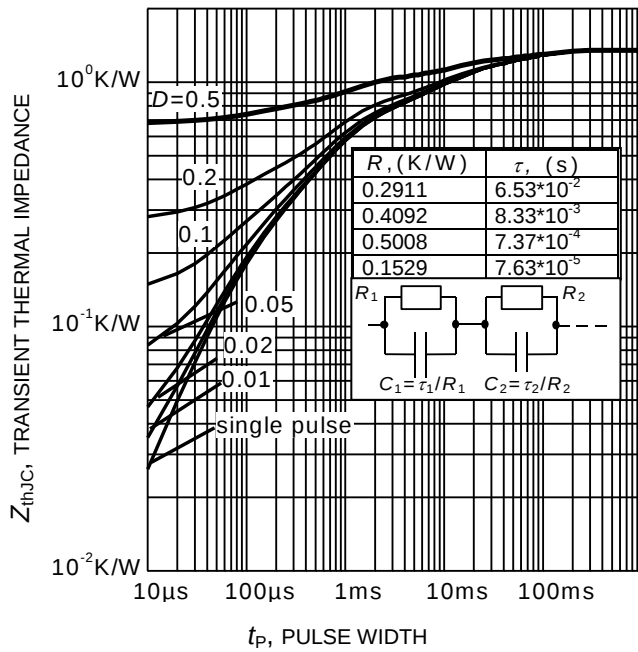
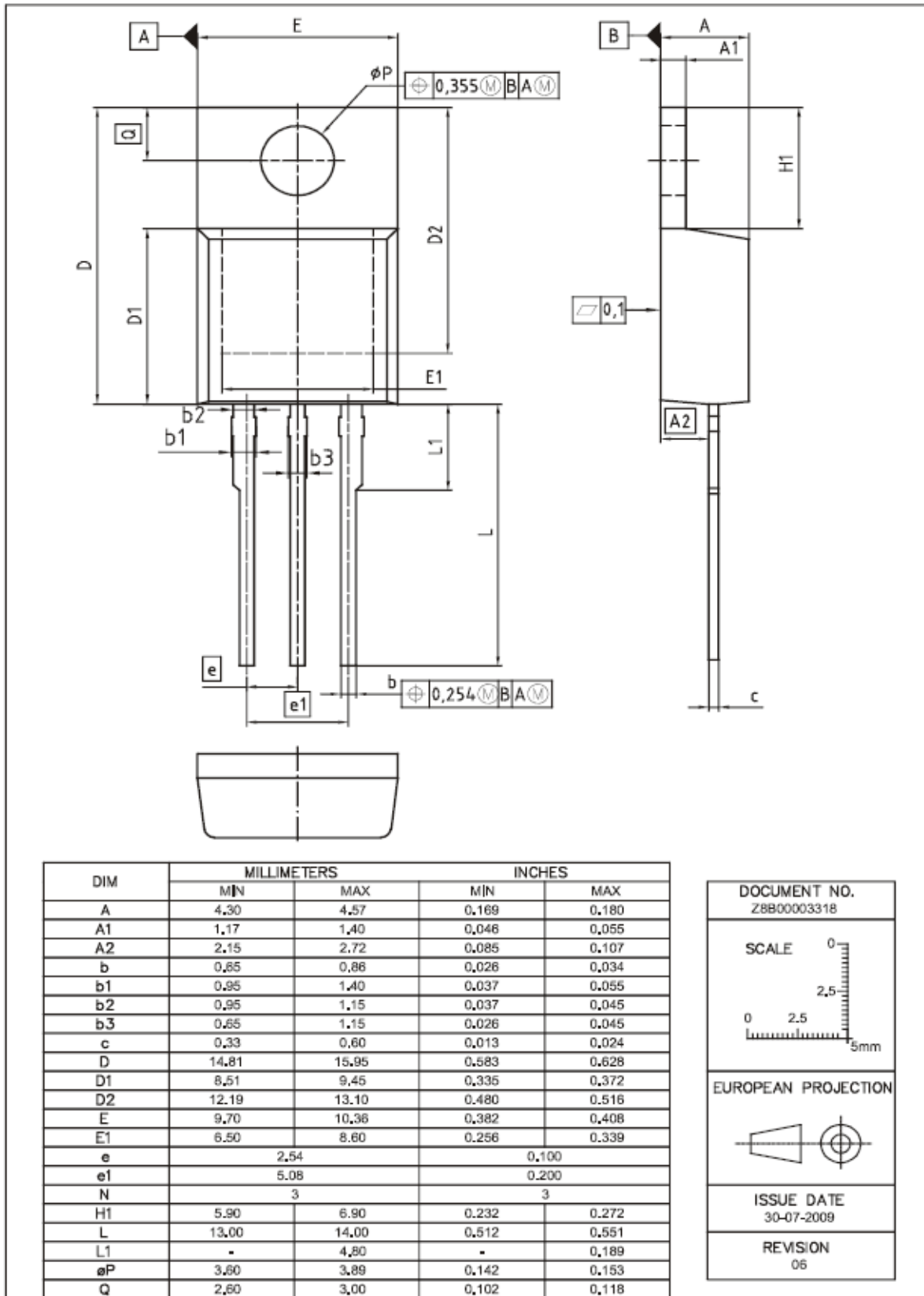


Figure 21. IGBT transient thermal impedance
 $(D = t_p / T)$

PG-TO220-3



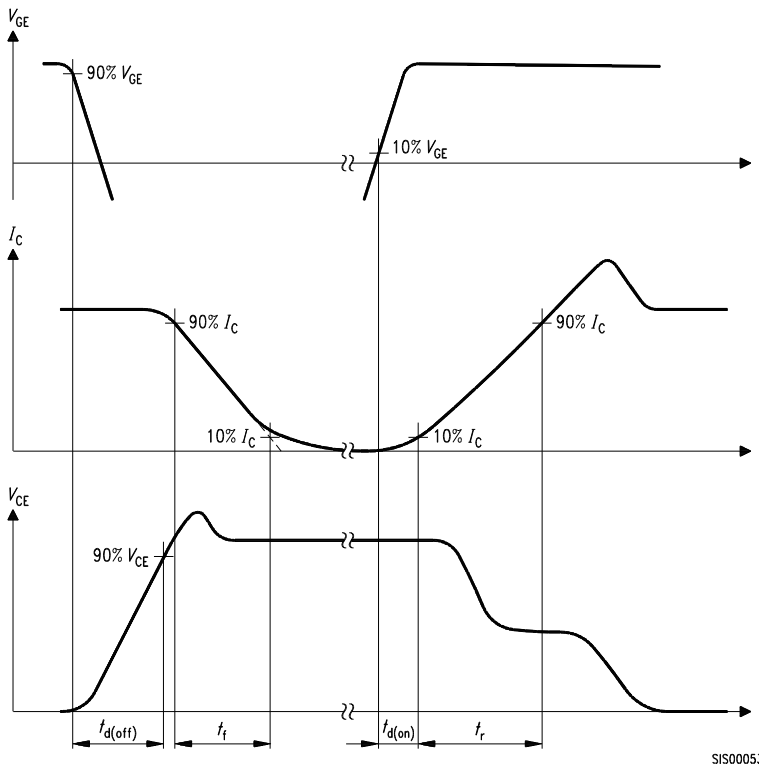


Figure A. Definition of switching times

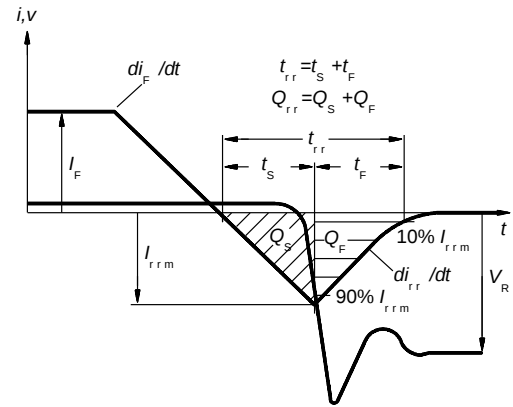


Figure C. Definition of diodes switching characteristics

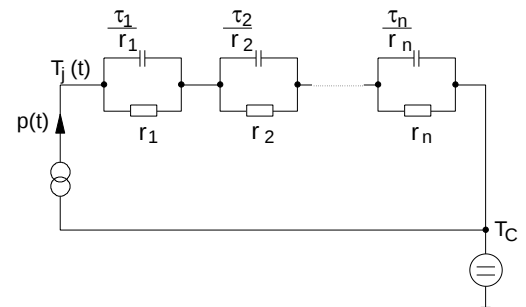


Figure D. Thermal equivalent circuit

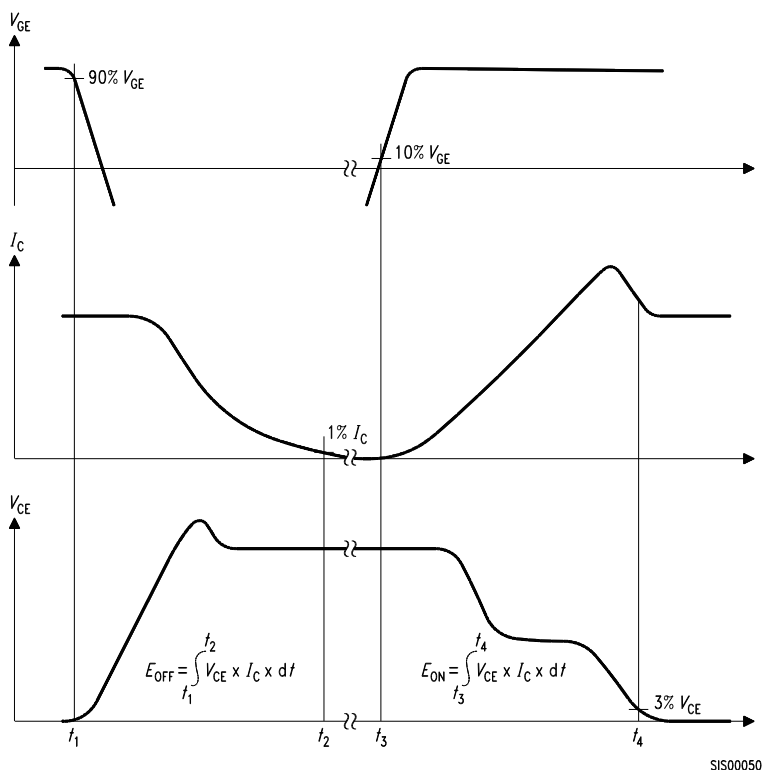


Figure B. Definition of switching losses

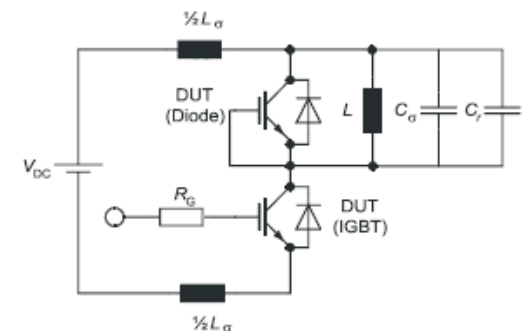


Figure E. Dynamic test circuit
Parasitic inductance L_σ ,
Parasitic capacitor C_σ ,
Relief capacitor C_r
(only for ZVT switching)

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Infineon Technologies AG
81726 Munich, Germany
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