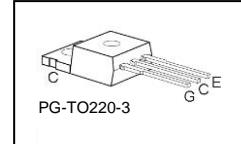
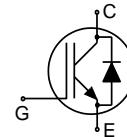


**Low Loss DuoPack : IGBT in TRENCHSTOP™ and Fieldstop technology with soft, fast recovery anti-parallel Emitter Controlled HE diode**


**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, air conditioners and induction cooking
  - Uninterrupted Power Supply
- TRENCHSTOP™ and Fieldstop technology for 600V applications offers :
  - very tight parameter distribution
  - high ruggedness, temperature stable behavior
- NPT technology offers easy parallel switching capability due to positive temperature coefficient in  $V_{CE(sat)}$
- Low EMI
- Low Gate Charge
- Very soft, fast recovery anti-parallel Emitter Controlled HE diode
- Qualified according to JEDEC<sup>1</sup> for target applications
- Pb-free lead plating; RoHS compliant
- Complete product spectrum and PSpice Models : <http://www.infineon.com/igbt/>



Type	$V_{CE}$	$I_C$	$V_{CE(sat)}, T_j=25^\circ C$	$T_{j,max}$	Marking Code	Package
IKP10N60T	600V	10A	1.5V	175°C	K10T60	PG-TO-220-3

**Maximum Ratings**

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

<sup>1</sup> J-STD-020 and JESD-022

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

**Thermal Resistance**

Parameter	Symbol	Conditions	Max. Value		Unit
<b>Characteristic</b>					
IGBT thermal resistance, junction – case	$R_{thJC}$		1.35		K/W
Diode thermal resistance, junction – case	$R_{thJCD}$		1.9		
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.	
<b>Static Characteristic</b>						
Collector-emitter breakdown voltage	$V_{(BR)CES}$	$V_{GE}=0\text{V}, I_C=0.2\text{mA}$	600	-	-	V
Collector-emitter saturation voltage	$V_{CE(\text{sat})}$	$V_{GE} = 15\text{V}, I_C=10\text{A}$ $T_j=25^\circ\text{C}$ $T_j=175^\circ\text{C}$	-	1.5	2.05	
Diode forward voltage	$V_F$	$V_{GE}=0\text{V}, I_F=10\text{A}$ $T_j=25^\circ\text{C}$ $T_j=175^\circ\text{C}$	-	1.6	2.0	
Gate-emitter threshold voltage	$V_{GE(\text{th})}$	$I_C=0.3\text{mA}, V_{CE}=V_{GE}$	4.1	4.6	5.7	
Zero gate voltage collector current	$I_{CES}$	$V_{CE}=600\text{V}, V_{GE}=0\text{V}$ $T_j=25^\circ\text{C}$ $T_j=175^\circ\text{C}$	-	-	40	$\mu\text{A}$
-			-	-	1000	
Gate-emitter leakage current	$I_{GES}$	$V_{CE}=0\text{V}, V_{GE}=20\text{V}$	-	-	100	nA
Transconductance	$g_{fs}$	$V_{CE}=20\text{V}, I_C=10\text{A}$	-	6	-	S
Integrated gate resistor	$R_{Gint}$		none			$\Omega$

**Dynamic Characteristic**

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

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

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

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
<b>IGBT Characteristic</b>						
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	$E_{on}$	$L_\sigma$ , $C_\sigma$ from Fig. E Energy losses include "tail" and diode reverse recovery.	-	0.16	-	mJ
Turn-off energy	$E_{off}$		-	0.27	-	
Total switching energy	$E_{ts}$		-	0.43	-	

**Anti-Parallel Diode Characteristic**

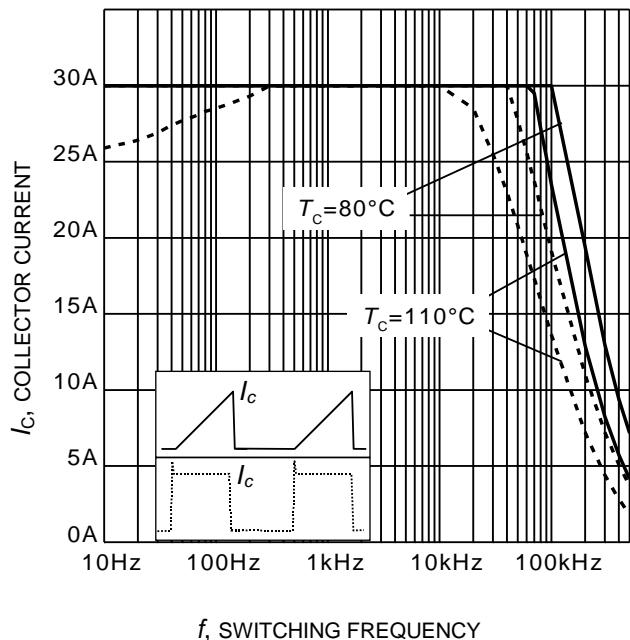
Diode reverse recovery time	$t_{rr}$	$T_j=25^\circ\text{C}$ ,	-	115	-	ns
Diode reverse recovery charge	$Q_{rr}$	$V_R=400\text{V}$ , $I_F=10\text{A}$ ,	-	0.38	-	$\mu\text{C}$
Diode peak reverse recovery current	$I_{rrm}$	$di_F/dt=880\text{A}/\mu\text{s}$	-	10	-	A
Diode peak rate of fall of reverse recovery current during $t_b$	$di_{rr}/dt$		-	680	-	$\text{A}/\mu\text{s}$

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

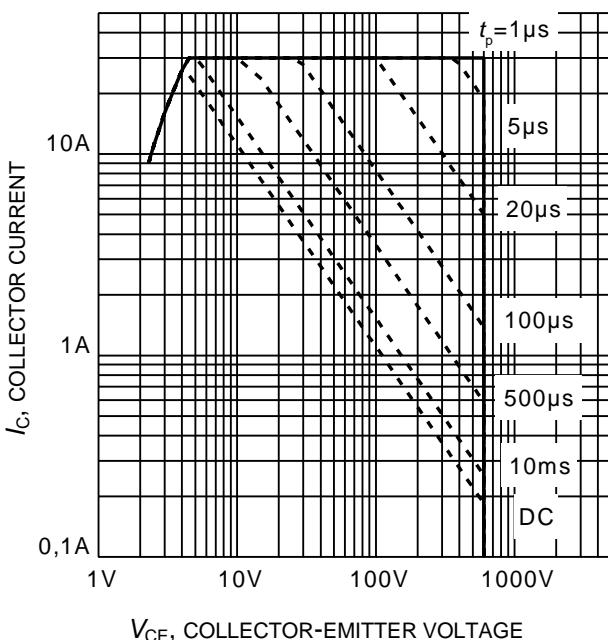
Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
<b>IGBT Characteristic</b>						
Turn-on delay time	$t_{d(on)}$	$T_j=175^\circ\text{C}$ , $V_{CC}=400\text{V}$ , $I_C=10\text{A}$ , $V_{GE}=0/15\text{V}$ , $r_G=23\Omega$ , $L_\sigma=60\text{nH}$ , $C_\sigma=40\text{pF}$	-	10	-	ns
Rise time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

**Anti-Parallel Diode Characteristic**

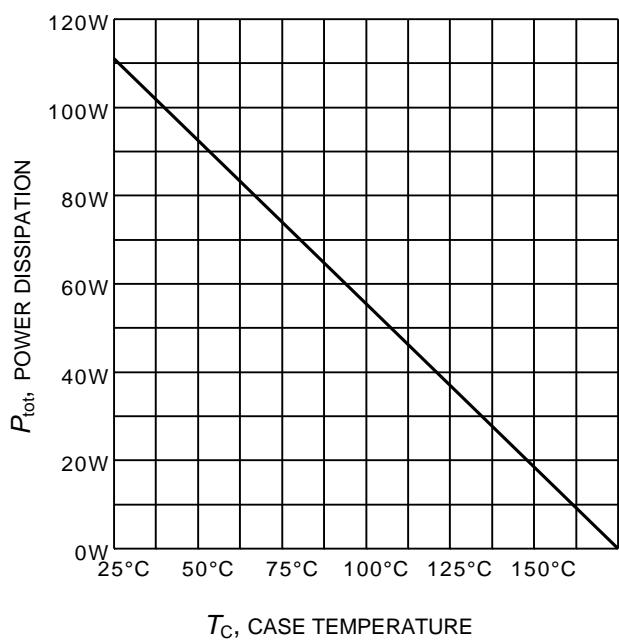
Diode reverse recovery time	$t_{rr}$	$T_j=175^\circ\text{C}$	-	200	-	ns
Diode reverse recovery charge	$Q_{rr}$	$V_R=400\text{V}$ , $I_F=10\text{A}$ ,	-	0.92	-	$\mu\text{C}$
Diode peak reverse recovery current	$I_{rrm}$	$di_F/dt=880\text{A}/\mu\text{s}$	-	13	-	A
Diode peak rate of fall of reverse recovery current during $t_b$	$di_{rr}/dt$		-	390	-	$\text{A}/\mu\text{s}$



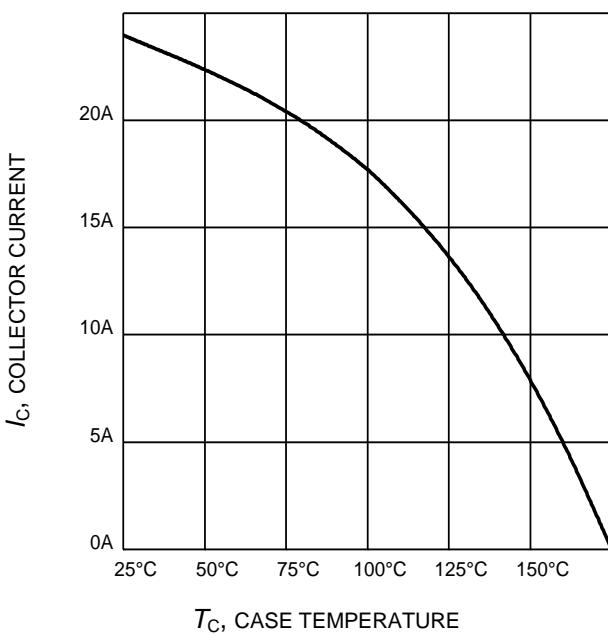
**Figure 1. Collector current as a function of switching frequency**  
 $(T_j \leq 175^\circ\text{C}, D = 0.5, V_{CE} = 400\text{V}, V_{GE} = 0/15\text{V}, r_G = 23\Omega)$



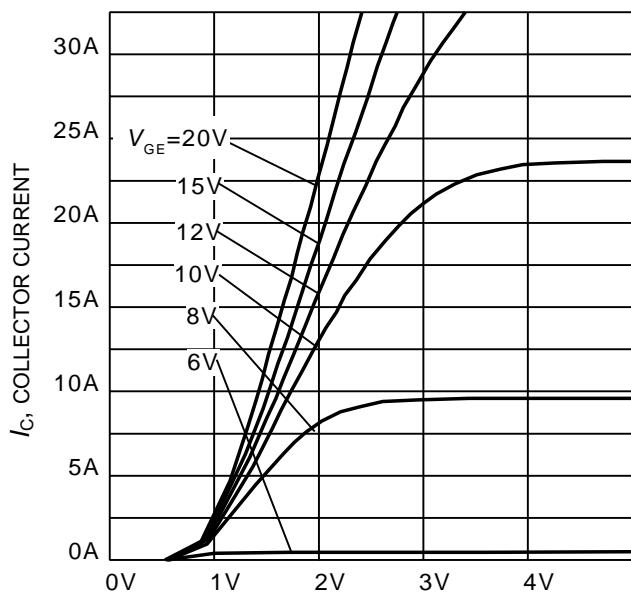
**Figure 2. Safe operating area**  
 $(D = 0, T_C = 25^\circ\text{C}, T_j \leq 175^\circ\text{C}; V_{GE}=0/15\text{V})$

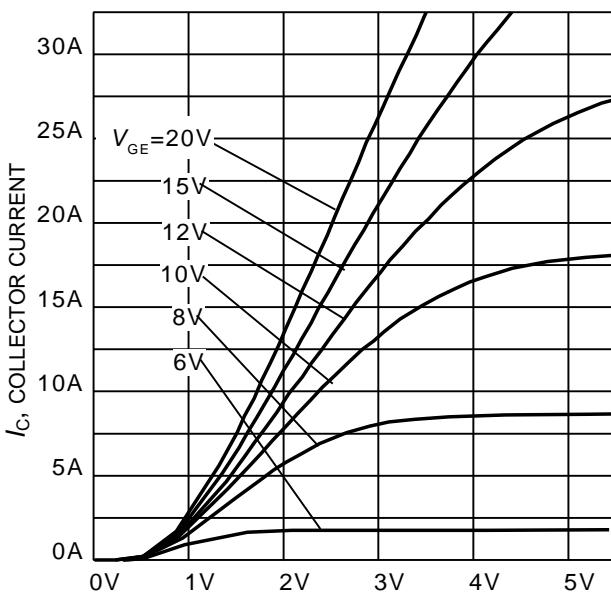


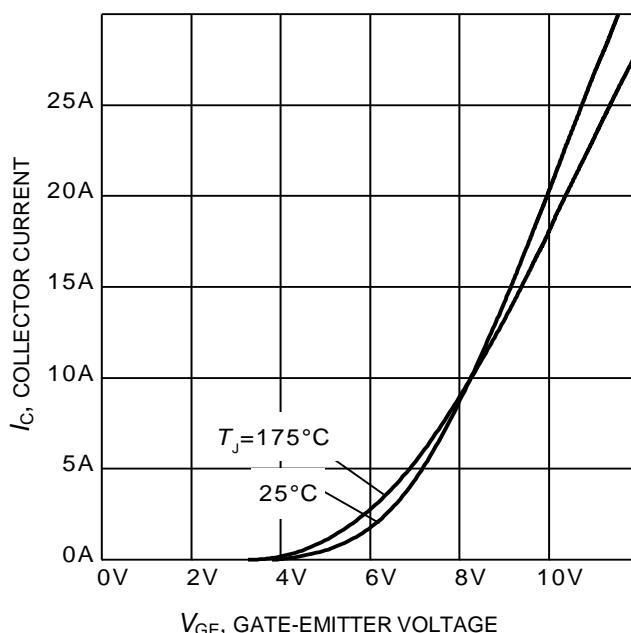
**Figure 3. Power dissipation as a function of case temperature**  
 $(T_j \leq 175^\circ\text{C})$

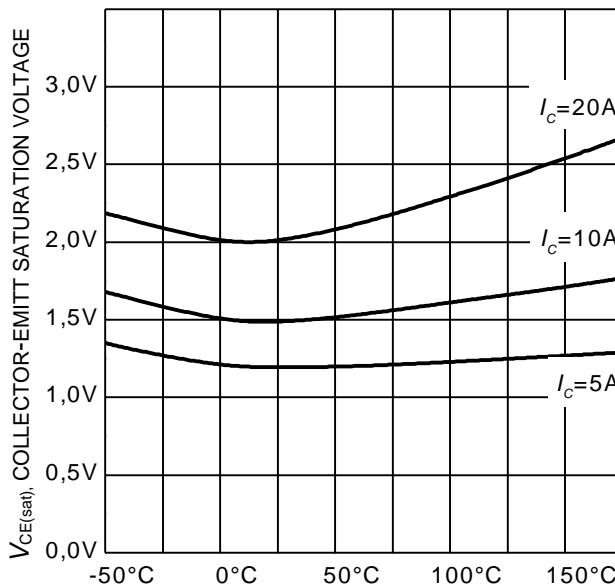


**Figure 4. Collector current as a function of case temperature**  
 $(V_{GE} \geq 15\text{V}, T_j \leq 175^\circ\text{C})$

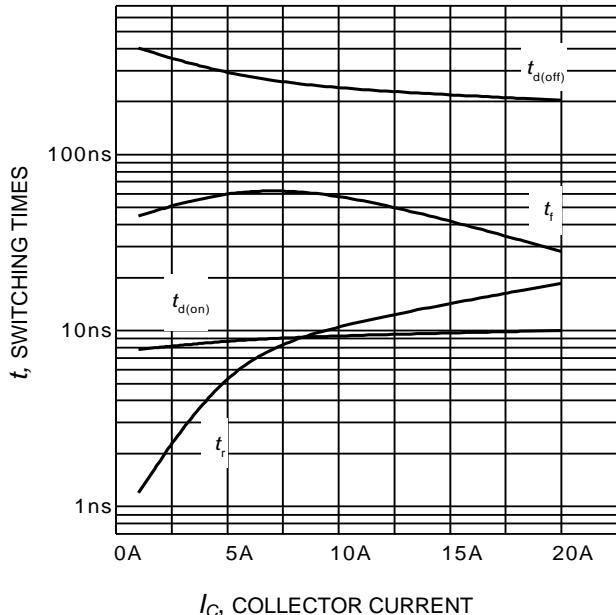

 $V_{CE}$ , COLLECTOR-EMITTER VOLTAGE

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

 $V_{CE}$ , COLLECTOR-EMITTER VOLTAGE

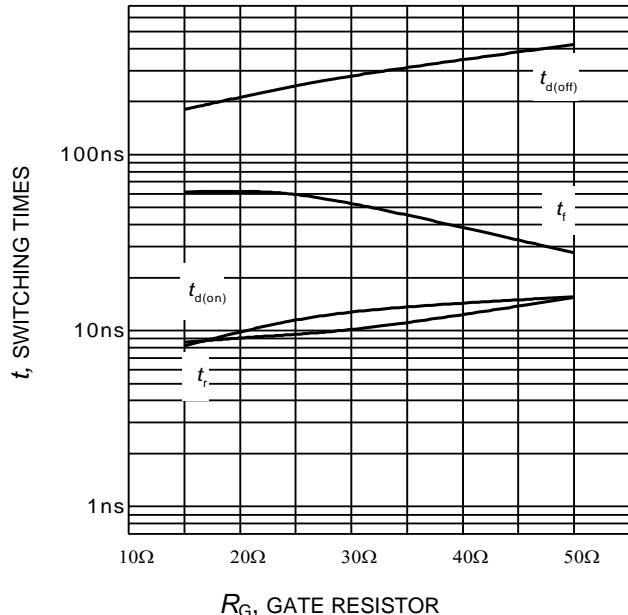
**Figure 6. Typical output characteristic**  
 $(T_j = 175^\circ\text{C})$ 

 $V_{GE}$ , GATE-EMITTER VOLTAGE

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

 $T_j$ , JUNCTION TEMPERATURE

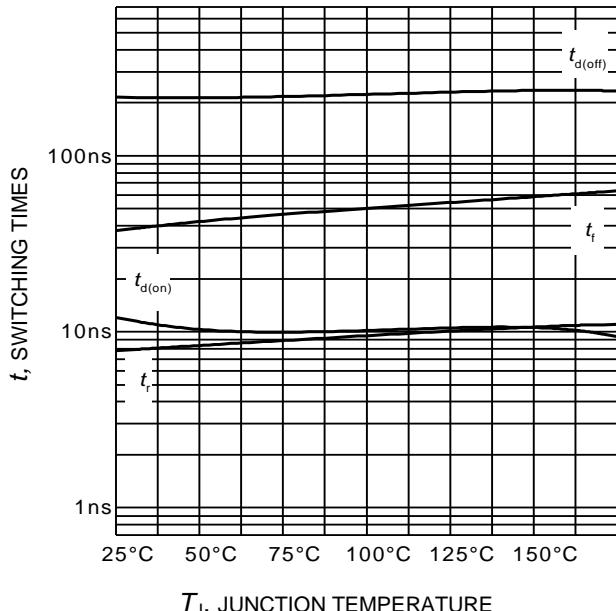
**Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature**  
 $(V_{GE} = 15\text{V})$



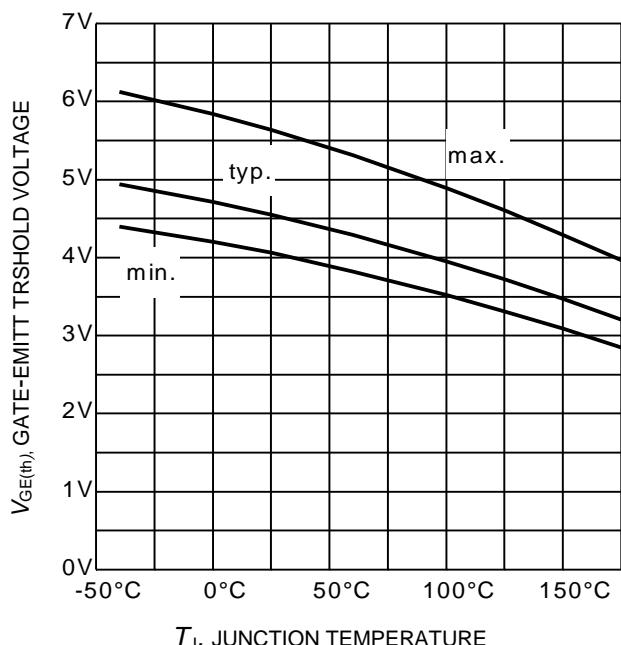
**Figure 9.** Typical switching times as a function of collector current  
(inductive load,  $T_J=175^\circ\text{C}$ ,  
 $V_{CE} = 400\text{V}$ ,  $V_{GE} = 0/15\text{V}$ ,  $r_G = 23\Omega$ ,  
Dynamic test circuit in Figure E)



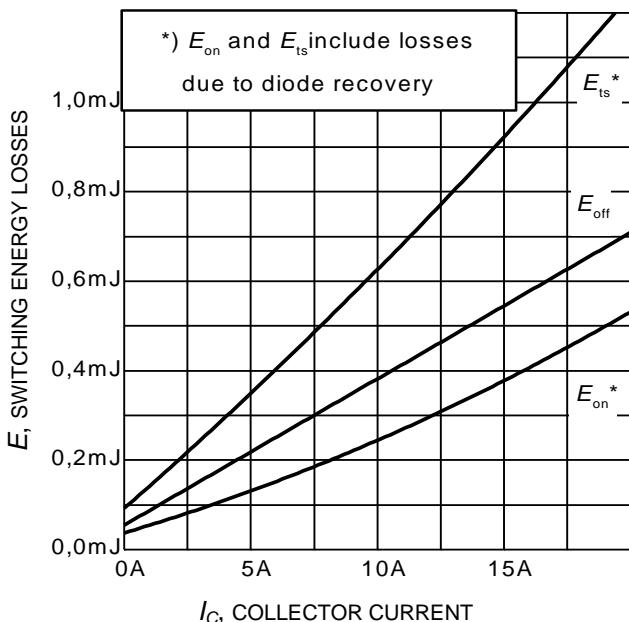
**Figure 10.** Typical switching times as a function of gate resistor  
(inductive load,  $T_J = 175^\circ\text{C}$ ,  
 $V_{CE} = 400\text{V}$ ,  $V_{GE} = 0/15\text{V}$ ,  $I_C = 10\text{A}$ ,  
Dynamic test circuit in Figure E)



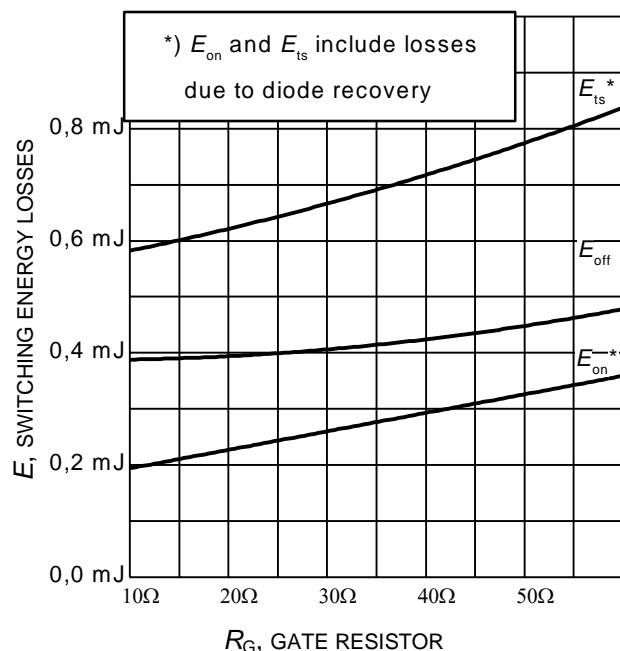
**Figure 11.** Typical switching times as a function of junction temperature  
(inductive load,  $V_{CE} = 400\text{V}$ ,  
 $V_{GE} = 0/15\text{V}$ ,  $I_C = 10\text{A}$ ,  $r_G = 23\Omega$ ,  
Dynamic test circuit in Figure E)



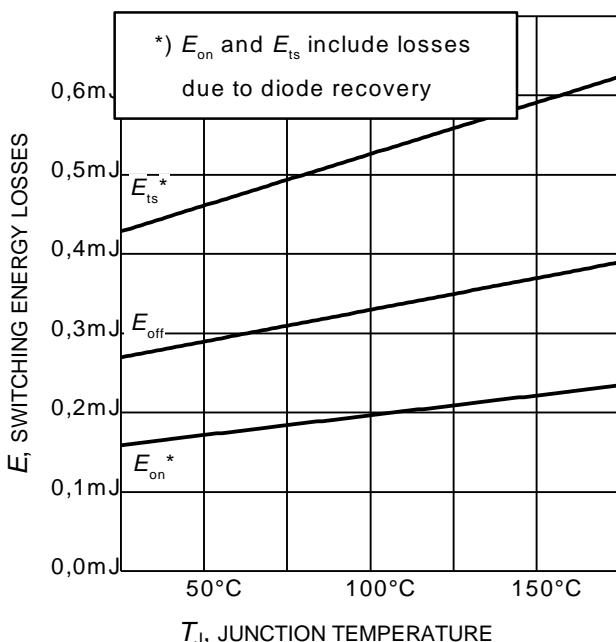
**Figure 12.** Gate-emitter threshold voltage as a function of junction temperature  
( $I_C = 0.3\text{mA}$ )



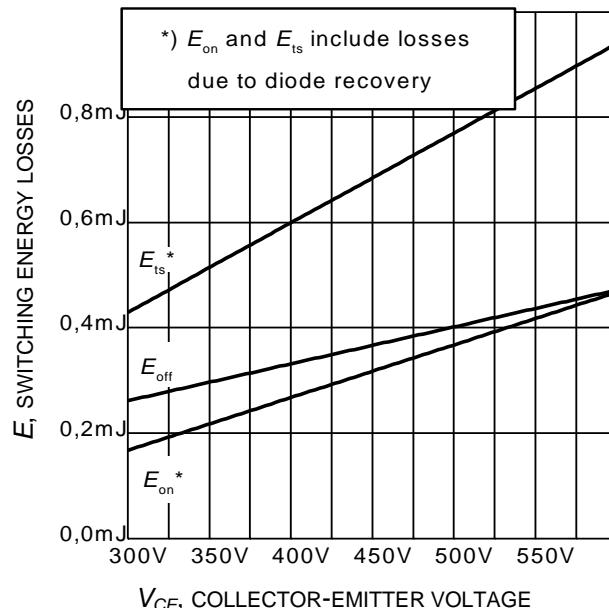
**Figure 13. Typical switching energy losses as a function of collector current**  
(inductive load,  $T_J = 175^\circ\text{C}$ ,  
 $V_{CE} = 400\text{V}$ ,  $V_{GE} = 0/15\text{V}$ ,  $r_G = 23\Omega$ ,  
Dynamic test circuit in Figure E)



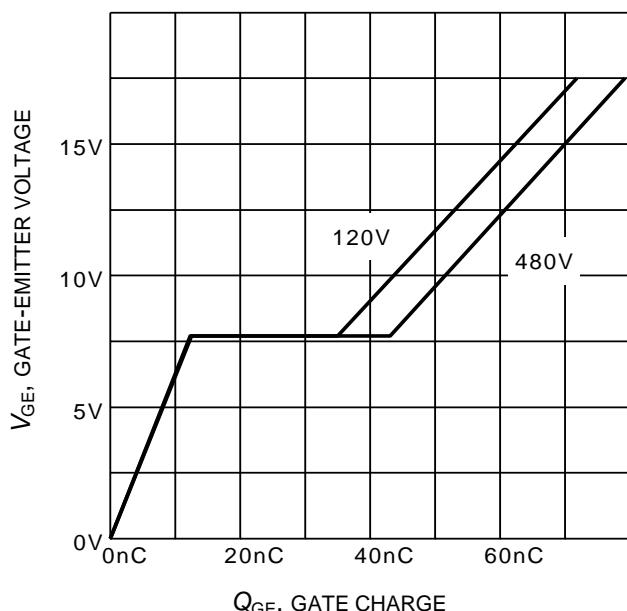
**Figure 14. Typical switching energy losses as a function of gate resistor**  
(inductive load,  $T_J = 175^\circ\text{C}$ ,  
 $V_{CE} = 400\text{V}$ ,  $V_{GE} = 0/15\text{V}$ ,  $I_C = 10\text{A}$ ,  
Dynamic test circuit in Figure E)



**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)

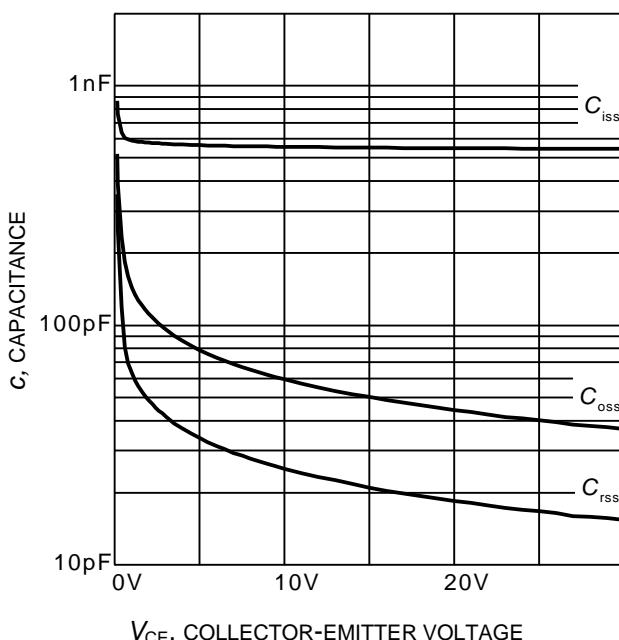


**Figure 16. Typical switching energy losses as a function of collector-emitter voltage**  
(inductive load,  $T_J = 175^\circ\text{C}$ ,  
 $V_{GE} = 0/15\text{V}$ ,  $I_C = 10\text{A}$ ,  $r_G = 23\Omega$ ,  
Dynamic test circuit in Figure E)



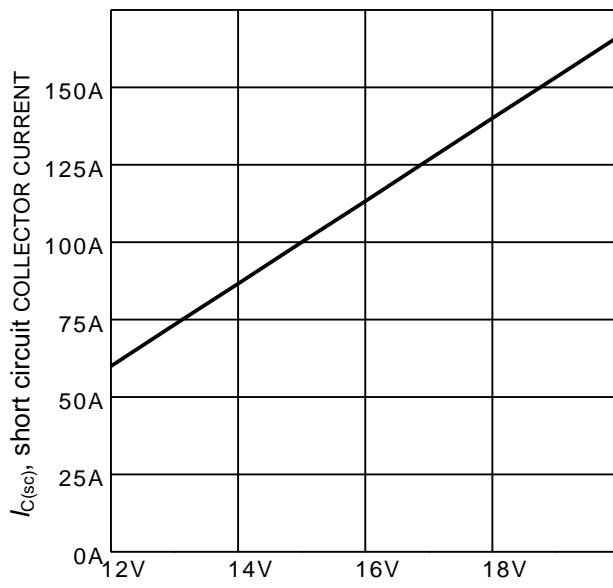
$V_{GE}$ , GATE-EMITTER VOLTAGE

**Figure 17. Typical gate charge**  
( $I_C=10$  A)



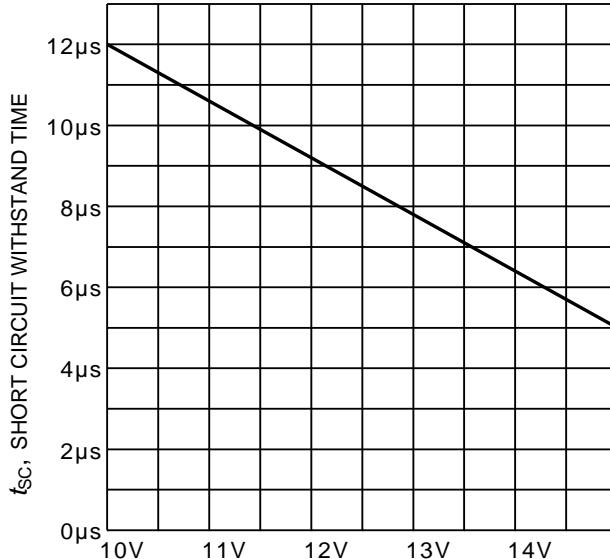
$V_{CE}$ , COLLECTOR-EMITTER VOLTAGE

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



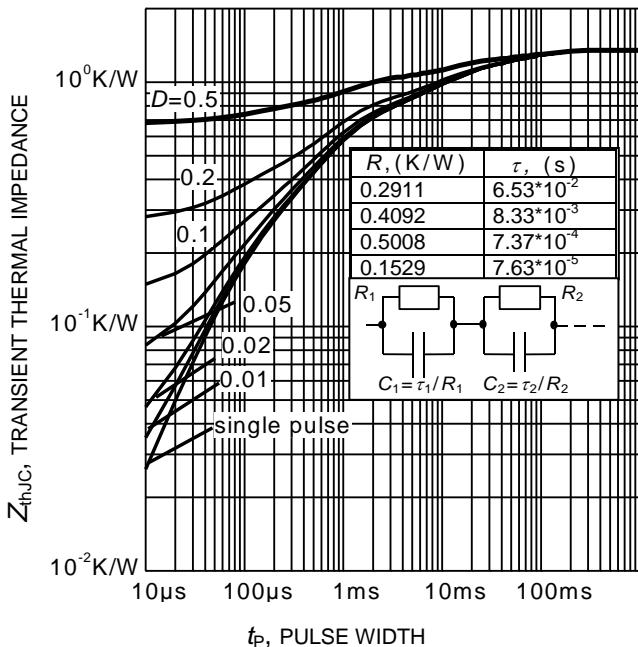
$V_{GE}$ , GATE-EMITTER VOLTAGE

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

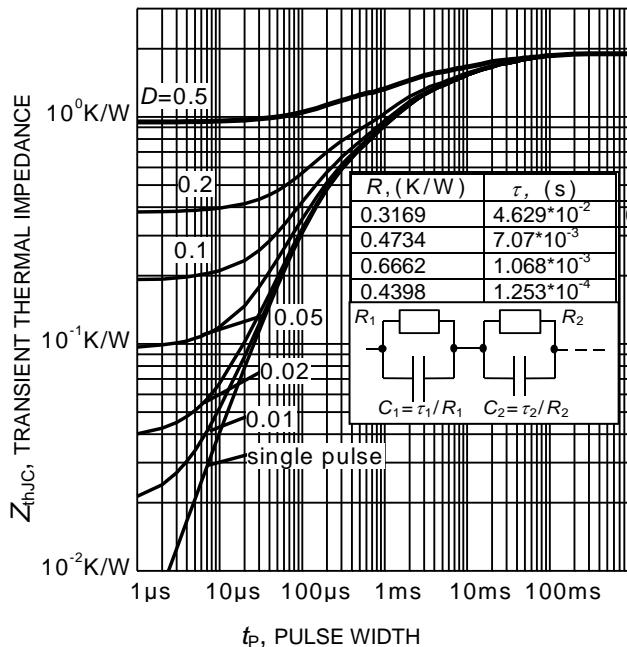


$V_{GE}$ , GATE-EMITTER VOLTAGE

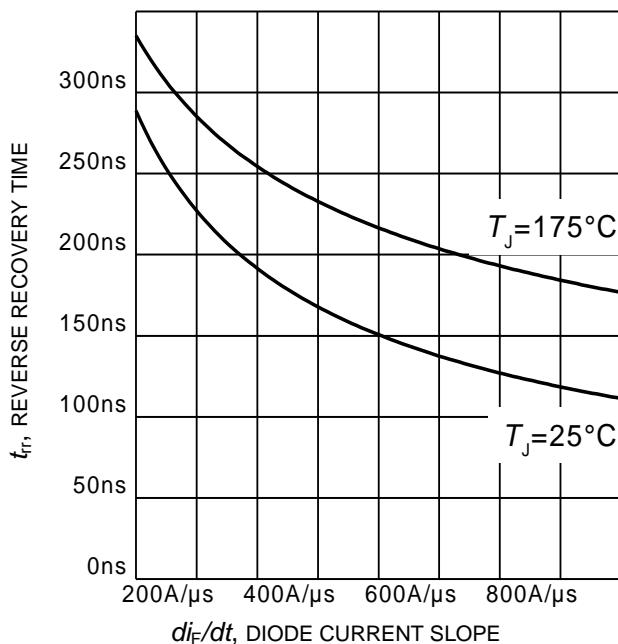
**Figure 20. Short circuit withstand time as a function of gate-emitter voltage**  
( $V_{CE}=400$  V, start at  $T_j=25^\circ\text{C}$ ,  $T_{jmax}<150^\circ\text{C}$ )



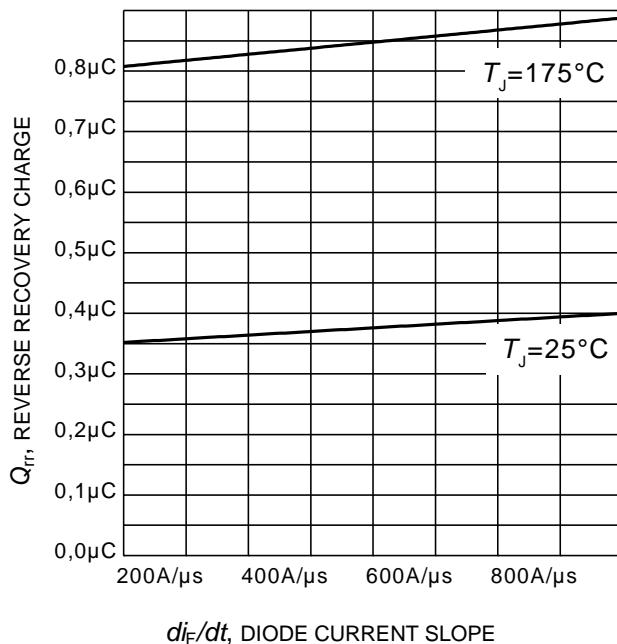
**Figure 21. IGBT transient thermal impedance**  
( $D = t_p / T$ )



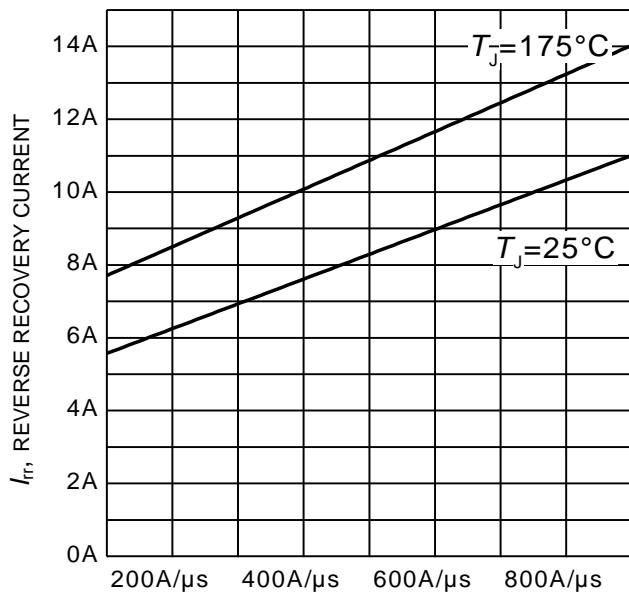
**Figure 22. Diode transient thermal impedance as a function of pulse width**  
( $D=t_p/T$ )



**Figure 23. Typical reverse recovery time as a function of diode current slope**  
( $V_R=400V$ ,  $I_F=10A$ ,  
Dynamic test circuit in Figure E)

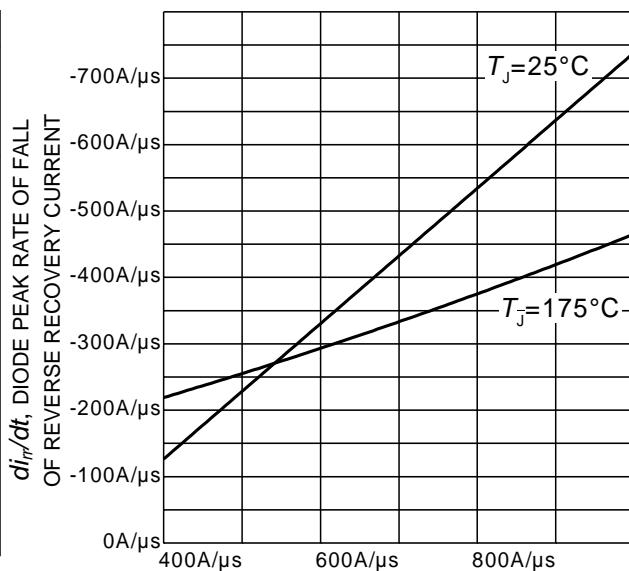


**Figure 24. Typical reverse recovery charge as a function of diode current slope**  
( $V_R = 400V$ ,  $I_F = 10A$ ,  
Dynamic test circuit in Figure E)



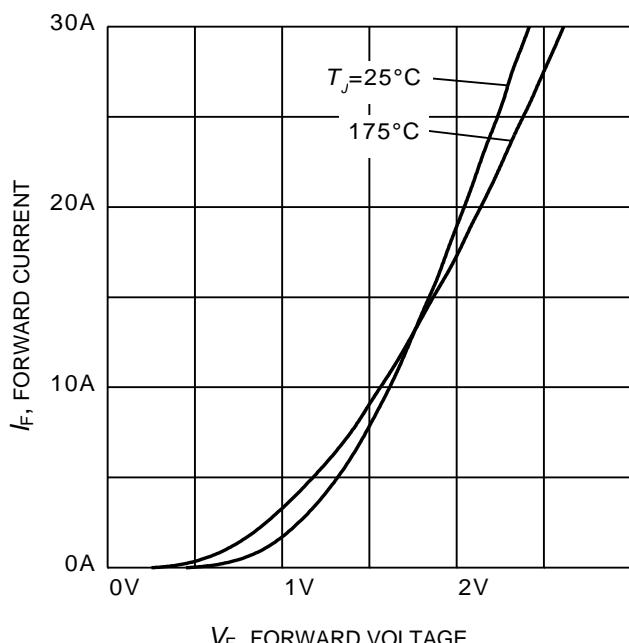
**Figure 25. Typical reverse recovery current as a function of diode current slope**

( $V_R = 400\text{V}$ ,  $I_F = 10\text{A}$ ,  
Dynamic test circuit in Figure E)

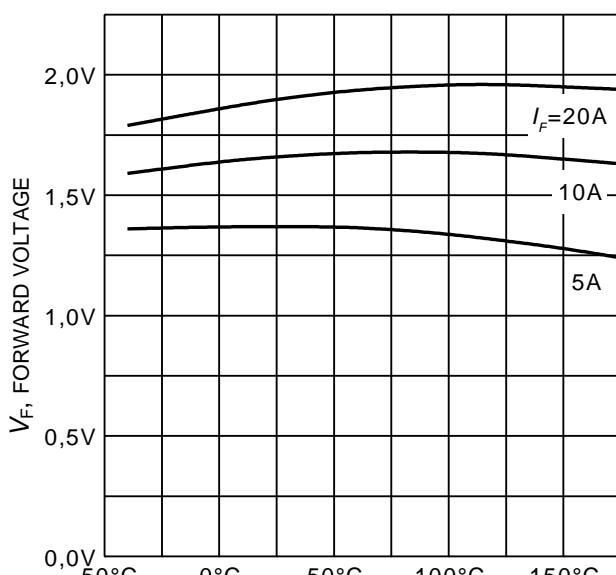


**Figure 26. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope**

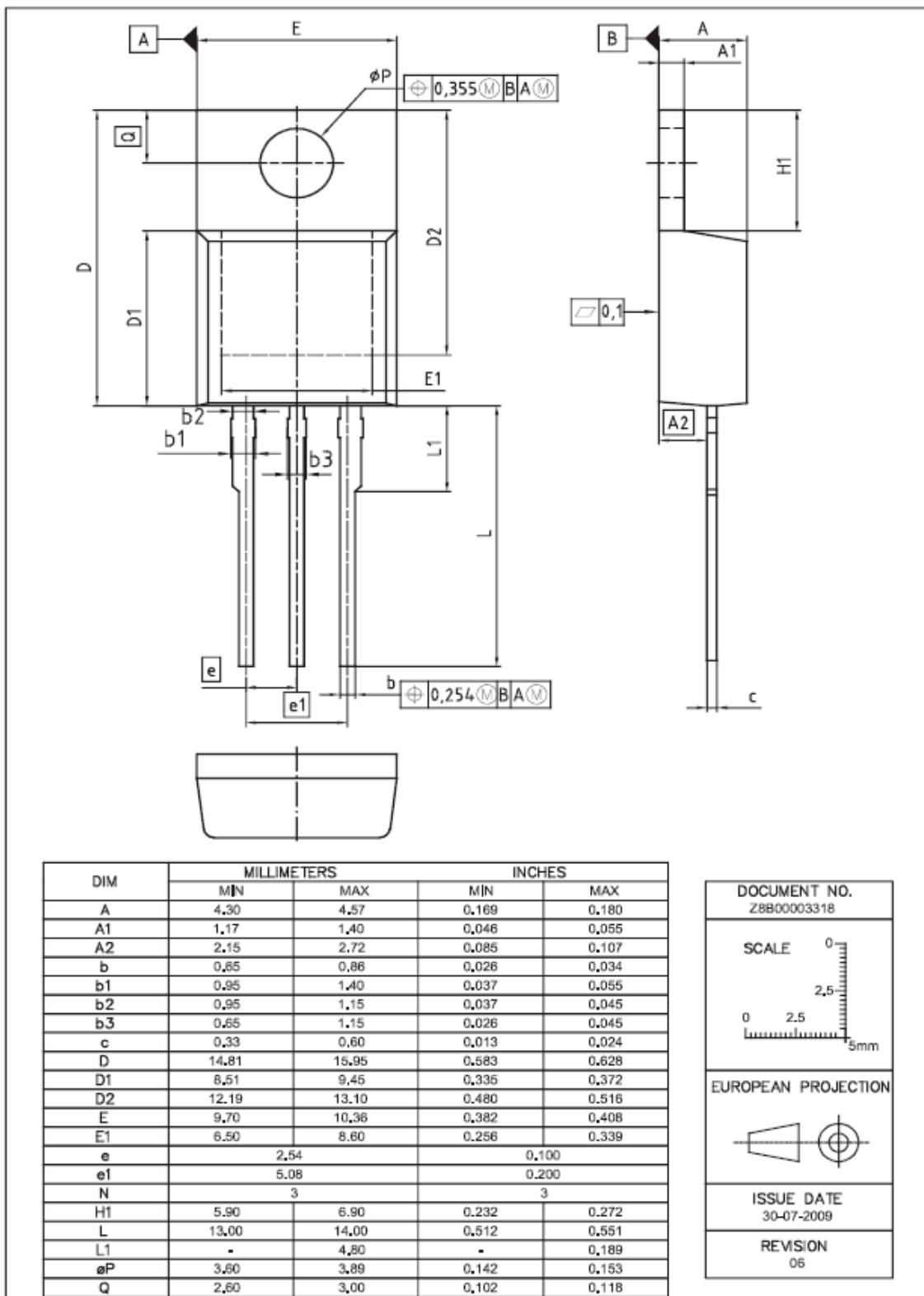
( $V_R=400\text{V}$ ,  $I_F=10\text{A}$ ,  
Dynamic test circuit in Figure E)

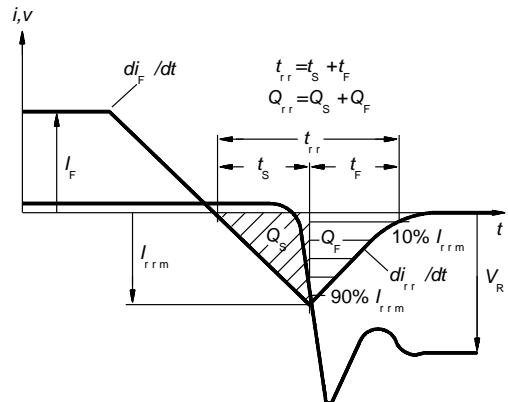
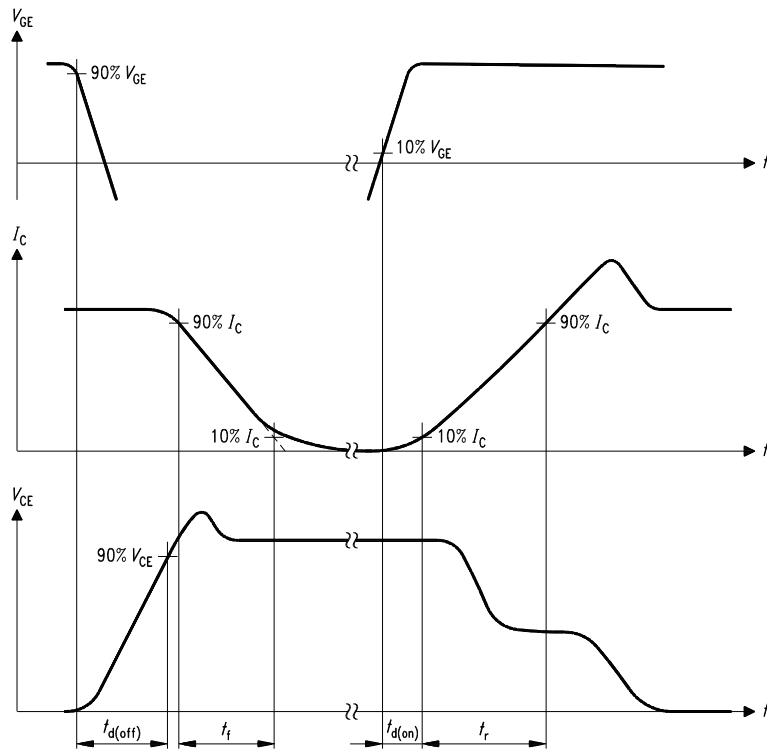


**Figure 27. Typical diode forward current as a function of forward voltage**

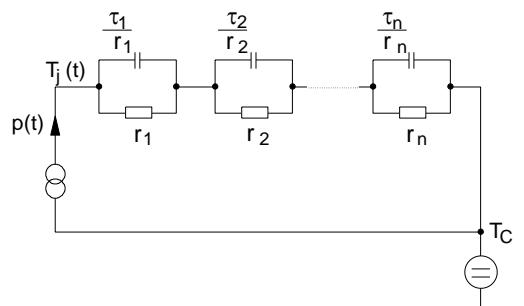


**Figure 28. Typical diode forward voltage as a function of junction temperature**

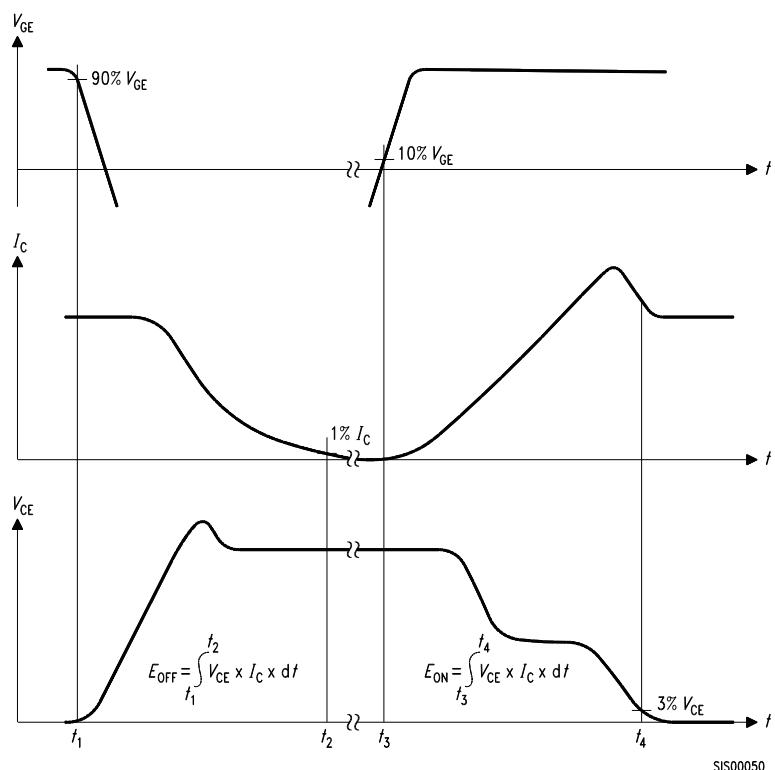
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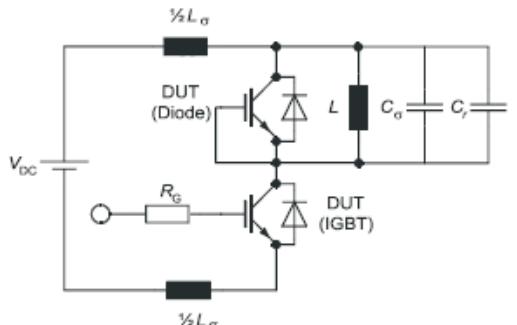
SIS00053



**Figure D. Thermal equivalent circuit**



SIS00050



**Figure E. Dynamic test circuit**  
 Parasitic inductance  $L_\alpha$ ,  
 Parasitic capacitor  $C_\alpha$ ,  
 Relief capacitor  $C_r$   
 (only for ZVT switching)

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**Стандарт  
Электрон  
Связь**

Мы молодая и активно развивающаяся компания в области поставок электронных компонентов. Мы поставляем электронные компоненты отечественного и импортного производства напрямую от производителей и с крупнейших складов мира.

Благодаря сотрудничеству с мировыми поставщиками мы осуществляем комплексные и плановые поставки широчайшего спектра электронных компонентов.

Собственная эффективная логистика и склад в обеспечивает надежную поставку продукции в точно указанные сроки по всей России.

Мы осуществляем техническую поддержку нашим клиентам и предпродажную проверку качества продукции. На все поставляемые продукты мы предоставляем гарантию .

Осуществляем поставки продукции под контролем ВП МО РФ на предприятия военно-промышленного комплекса России , а также работаем в рамках 275 ФЗ с открытием отдельных счетов в уполномоченном банке. Система менеджмента качества компании соответствует требованиям ГОСТ ISO 9001.

Минимальные сроки поставки, гибкие цены, неограниченный ассортимент и индивидуальный подход к клиентам являются основой для выстраивания долгосрочного и эффективного сотрудничества с предприятиями радиоэлектронной промышленности, предприятиями ВПК и научно-исследовательскими институтами России.

С нами вы становитесь еще успешнее!

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