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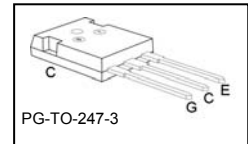
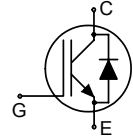
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Low Loss DuoPack : IGBT in TrenchStop®-technology  
with soft, fast recovery anti-parallel EmCon HE diode

### Features:

- Very low  $V_{CE(sat)}$  1.5 V (typ.)
- Maximum junction temperature 175 °C
- Short circuit withstand time – 5µs
- Trench and fieldstop technology for 600 V applications offers :
  - very tight parameter distribution
  - high ruggedness, temperature stable behavior
  - low  $V_{CE(sat)}$  and positive temperature coefficient
- Low EMI
- Low gate charge
- 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/>



### Applications:

- Inductive Cooking
- Soft & Hard Switching Applications

Type	$V_{CE}$	$I_C$	$V_{CE(sat), T_j=25^\circ C}$	$T_{j,max}$	Marking	Package
IHW40T60	600V	40A	1.55V	175°C	H40T60B	PG-TO-247-3

### Maximum Ratings

Parameter	Symbol	Value	Unit
Collector-emitter voltage	$V_{CE}$	600	V
DC collector current, limited by $T_{j,max}$	$I_C$		A
$T_C = 25^\circ C$		80	
$T_C = 100^\circ C$		40	
Pulsed collector current, $t_p$ limited by $T_{j,max}$	$I_{C,puls}$	120	
Turn off safe operating area ( $V_{CE} \leq 600V, T_j \leq 175^\circ C$ )	-	120	
Diode forward current, limited by $T_{j,max}$	$I_F$		
$T_C = 25^\circ C$		60	
$T_C = 100^\circ C$		30	
Diode pulsed current, $t_p$ limited by $T_{j,max}$	$I_{F,puls}$	90	
Gate-emitter voltage	$V_{GE}$	$\pm 20$	V
Transient Gate-emitter voltage ( $t_p < 10 \mu s, D < 0.01$ )		$\pm 25$	
Short circuit withstand time <sup>2)</sup>	$t_{SC}$	5	$\mu s$
$V_{GE} = 15V, V_{CC} \leq 400V, T_j \leq 150^\circ C$			
Power dissipation $T_C = 25^\circ C$	$P_{tot}$	303	W
Operating junction temperature	$T_j$	-40...+175	$^\circ C$
Storage temperature	$T_{stg}$	-55...+175	
Soldering temperature, 1.6mm (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	$R_{thJC}$		0.49	K/W
Diode thermal resistance, junction – case	$R_{thJCD}$		1.05	
Thermal resistance, junction – ambient	$R_{thJA}$		40	

### 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	$V_{(BR)CES}$	$V_{GE}=0V, I_C=0.5mA$	600	-	-	V
Collector-emitter saturation voltage	$V_{CE(sat)}$	$V_{GE} = 15V, I_C=40A$ $T_j=25^\circ\text{C}$ $T_j=175^\circ\text{C}$	-	1.55	2.05	
Diode forward voltage	$V_F$	$V_{GE}=0V, I_F=30A$ $T_j=25^\circ\text{C}$ $T_j=175^\circ\text{C}$	-	1.65	2.05	
Gate-emitter threshold voltage	$V_{GE(th)}$	$I_C=0.58mA,$ $V_{CE}=V_{GE}$	4.1	4.9	5.7	
Zero gate voltage collector current	$I_{CES}$	$V_{CE}=600V,$ $V_{GE}=0V$ $T_j=25^\circ\text{C}$ $T_j=175^\circ\text{C}$	-	-	40	$\mu\text{A}$
Gate-emitter leakage current	$I_{GES}$	$V_{CE}=0V, V_{GE}=20V$	-	-	100	
Transconductance	$g_{fs}$	$V_{CE}=20V, I_C=40A$	-	22	-	S
Integrated gate resistor	$R_{Gint}$			-		$\Omega$

### Dynamic Characteristic

Input capacitance	$C_{iss}$	$V_{CE}=25V,$ $V_{GE}=0V,$ $f=1MHz$	-	2423	-	pF
Output capacitance	$C_{oss}$		-	113	-	
Reverse transfer capacitance	$C_{riss}$		-	72	-	
Gate charge	$Q_{Gate}$	$V_{CC}=480V, I_C=40A$ $V_{GE}=15V$	-	215	-	nC
Internal emitter inductance measured 5mm (0.197 in.) from case	$L_E$		-	13	-	nH

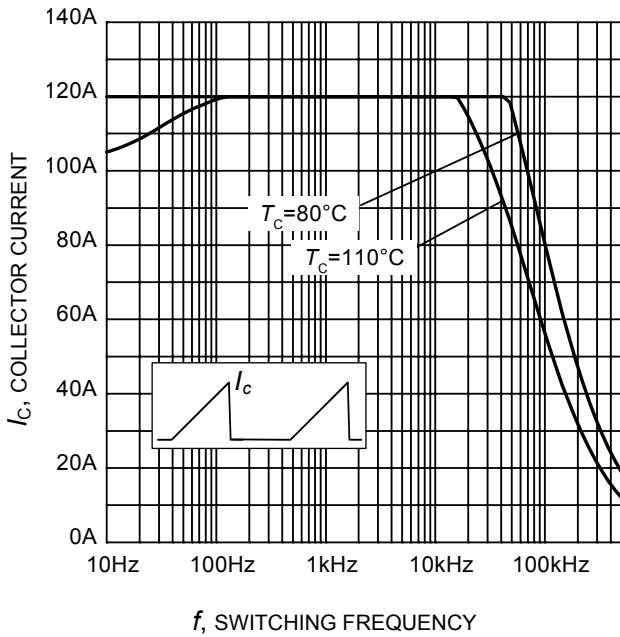
### Switching Characteristic, Inductive Load, at $T_j=25^\circ\text{C}$

Parameter	Symbol	Conditions	Value			Unit
			min.	Typ.	max.	
<b>IGBT Characteristic</b>						
Turn-on delay time	$t_{d(on)}$	$T_j=25^\circ\text{C}$ , $V_{CC}=400\text{V}$ , $I_C=40\text{A}$ , $V_{GE}=0/15\text{V}$ , $R_G=5.6\ \Omega$ , $L_{\sigma}^{1)}=40\text{nH}$ , $C_{\sigma}^{1)}=30\text{pF}$ Energy losses include "tail" and diode reverse recovery.	-	-	-	ns
Rise time	$t_r$		-	-	-	
Turn-off delay time	$t_{d(off)}$		-	186	-	
Fall time	$t_f$		-	66.3	-	
Turn-on energy	$E_{on}$		-	-	-	mJ
Turn-off energy	$E_{off}$		-	0.92	-	
Total switching energy	$E_{ts}$		-	0.92	-	
<b>Anti-Parallel Diode Characteristic</b>						
Diode reverse recovery time	$t_{rr}$	$T_j=25^\circ\text{C}$ , $V_R=400\text{V}$ , $I_F=30\text{A}$ , $di_F/dt=910\text{A}/\mu\text{s}$	-	143	-	ns
Diode reverse recovery charge	$Q_{rr}$		-	0.92	-	$\mu\text{C}$
Diode peak reverse recovery current	$I_{rrm}$		-	16.3	-	A
Diode peak rate of fall of reverse recovery current during $t_b$	$di_{rr}/dt$		-	603	-	$\text{A}/\mu\text{s}$

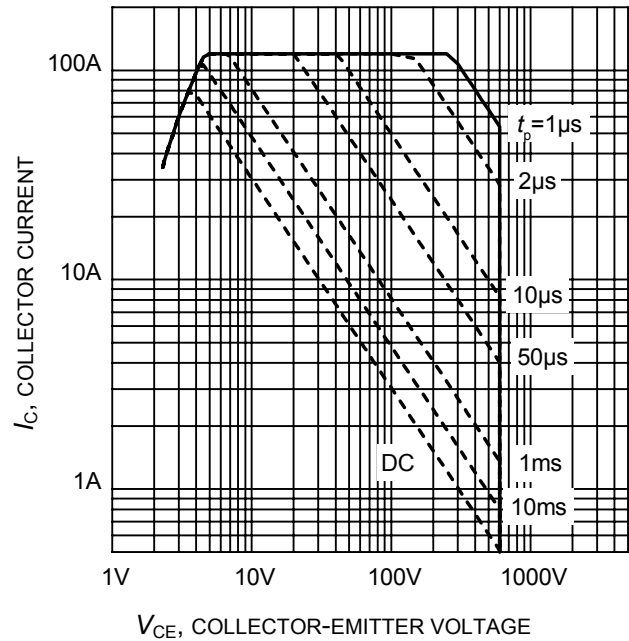
### Switching Characteristic, Inductive Load, at $T_j=175^\circ\text{C}$

Parameter	Symbol	Conditions	Value			Unit
			min.	Typ.	max.	
<b>IGBT Characteristic</b>						
Turn-on delay time	$t_{d(on)}$	$T_j=175^\circ\text{C}$ , $V_{CC}=400\text{V}$ , $I_C=40\text{A}$ , $V_{GE}=0/15\text{V}$ , $R_G=5.6\ \Omega$ , $L_{\sigma}^{1)}=40\text{nH}$ , $C_{\sigma}^{1)}=30\text{pF}$ Energy losses include "tail" and diode reverse recovery.	-	-	-	ns
Rise time	$t_r$		-	-	-	
Turn-off delay time	$t_{d(off)}$		-	196	-	
Fall time	$t_f$		-	76.5	-	
Turn-on energy	$E_{on}$		-	-	-	mJ
Turn-off energy	$E_{off}$		-	1.4	-	
Total switching energy	$E_{ts}$		-	1.4	-	
<b>Anti-Parallel Diode Characteristic</b>						
Diode reverse recovery time	$t_{rr}$	$T_j=175^\circ\text{C}$ $V_R=400\text{V}$ , $I_F=30\text{A}$ , $di_F/dt=910\text{A}/\mu\text{s}$	-	225	-	ns
Diode reverse recovery charge	$Q_{rr}$		-	2.39	-	$\mu\text{C}$
Diode peak reverse recovery current	$I_{rrm}$		-	22.3	-	A
Diode peak rate of fall of reverse recovery current during $t_b$	$di_{rr}/dt$		-	310	-	$\text{A}/\mu\text{s}$

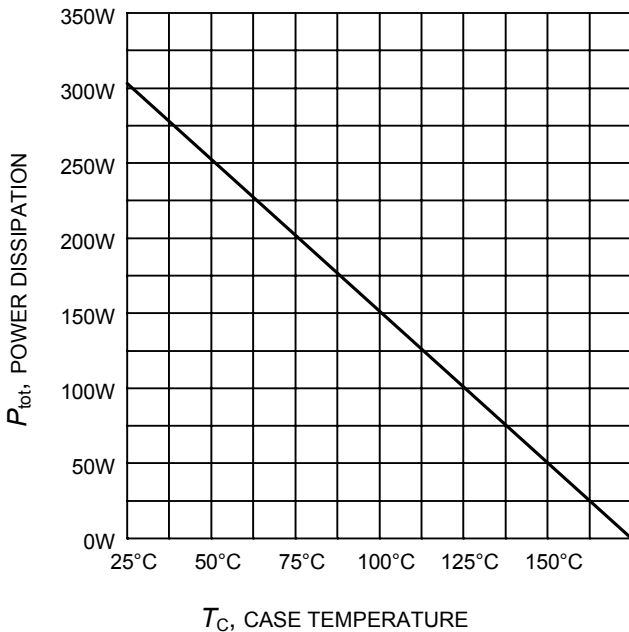
<sup>1)</sup> Leakage inductance  $L_{\sigma}$  and Stray capacity  $C_{\sigma}$  due to dynamic test circuit in Figure E.



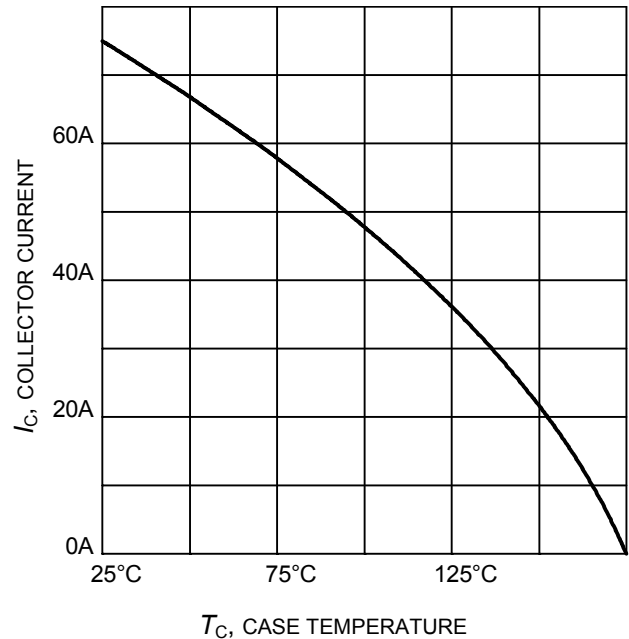
**Figure 1. Collector current as a function of switching frequency for triangular current ( $E_{on} = 0$ , hard turn-off)**  
 ( $T_j \leq 175^\circ\text{C}$ ,  $D = 0.5$ ,  $V_{CE} = 400\text{V}$ ,  $V_{GE} = 0/+15\text{V}$ ,  $R_G = 5.6\Omega$ )



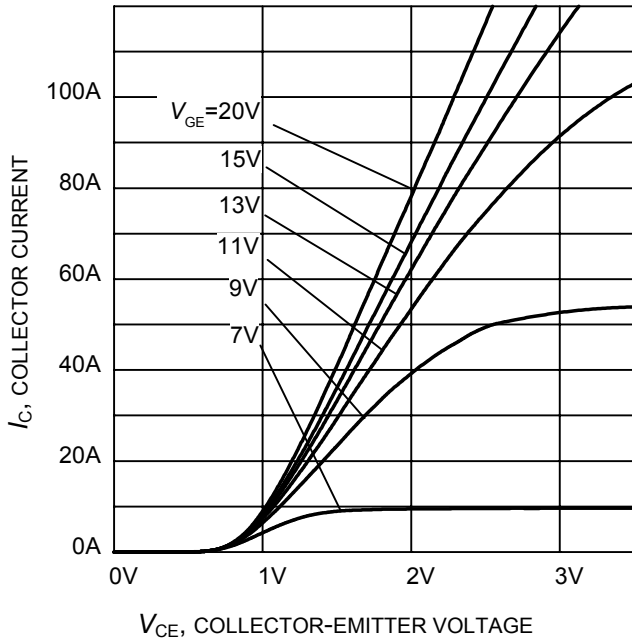
**Figure 2. Safe operating area**  
 ( $D = 0$ ,  $T_C = 25^\circ\text{C}$ ,  $T_j \leq 175^\circ\text{C}$ ;  $V_{GE} = 15\text{V}$ )



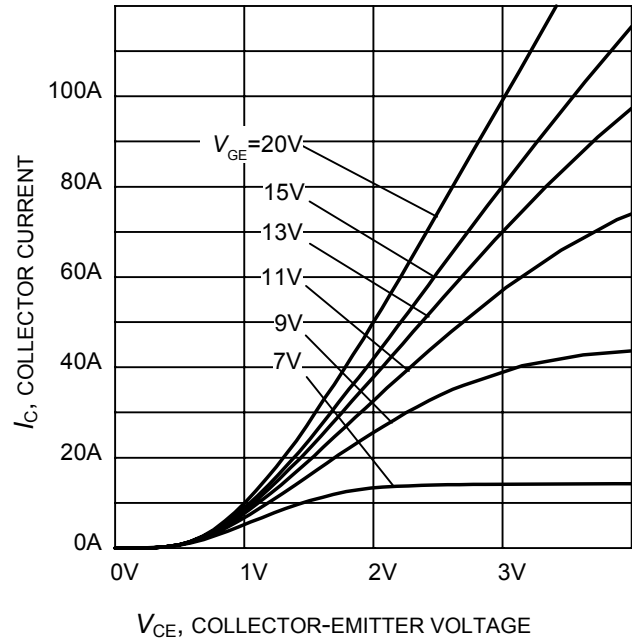
**Figure 3. Power dissipation as a function of case temperature**  
 ( $T_j \leq 175^\circ\text{C}$ )



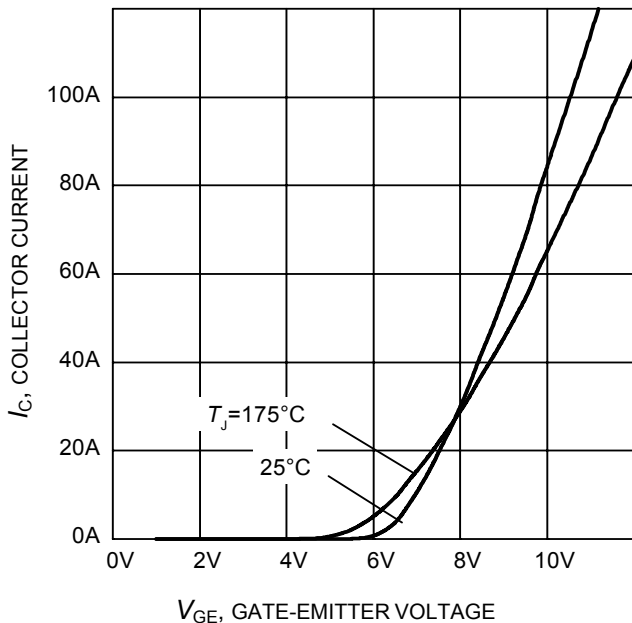
**Figure 4. Collector current as a function of case temperature**  
 ( $V_{GE} \geq 15\text{V}$ ,  $T_j \leq 175^\circ\text{C}$ )



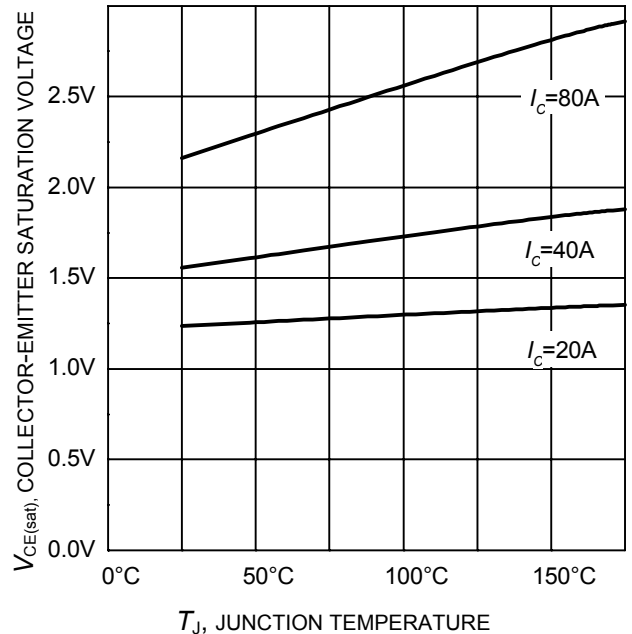
**Figure 5. Typical output characteristic**  
( $T_j = 25^\circ\text{C}$ )



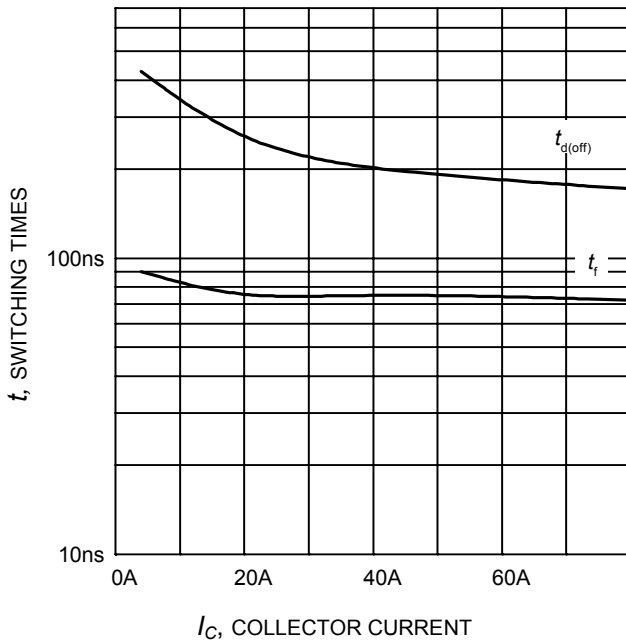
**Figure 6. Typical output characteristic**  
( $T_j = 175^\circ\text{C}$ )



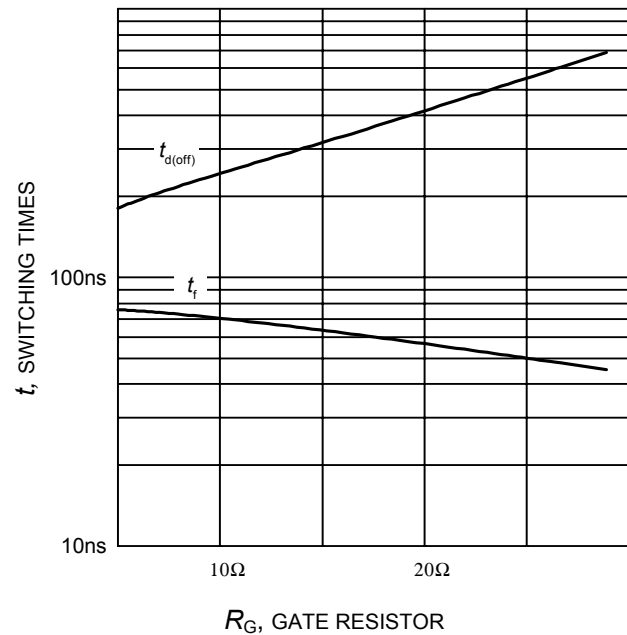
**Figure 7. Typical transfer characteristic**  
( $V_{CE} = 20\text{V}$ )



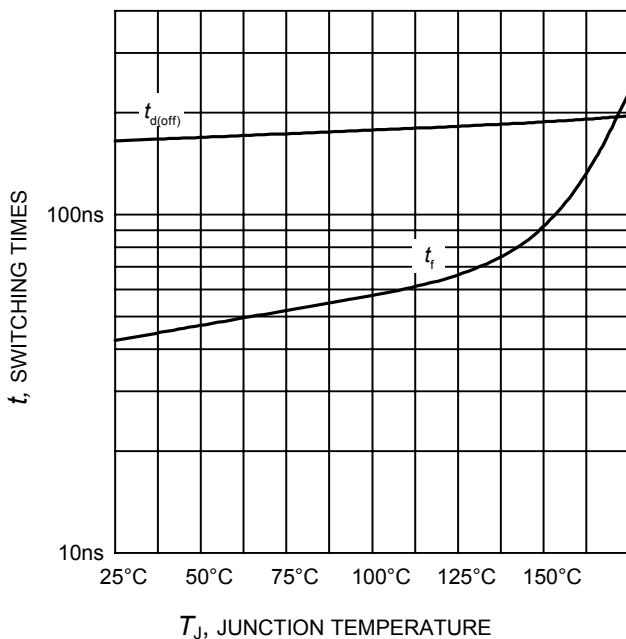
**Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature**  
( $V_{GE} = 15\text{V}$ )



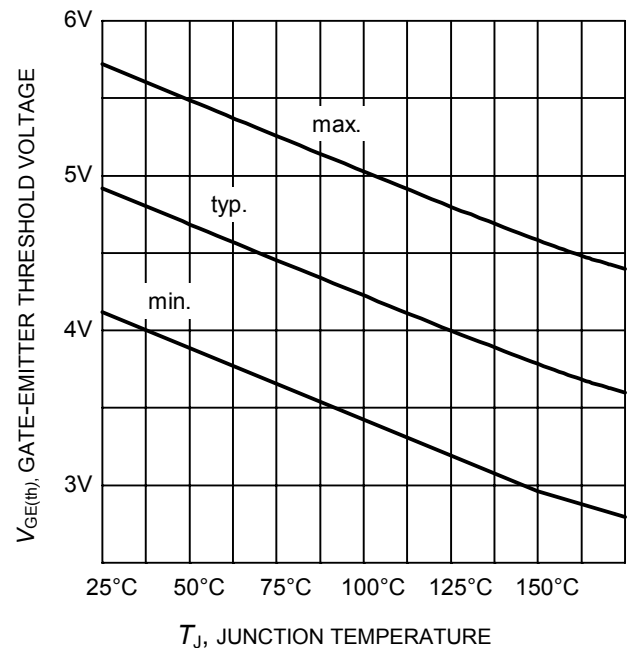
**Figure 9. Typical switching times as a function of collector current**  
 (inductive load,  $T_J=175^\circ\text{C}$ ,  
 $V_{CE} = 400\text{V}$ ,  $V_{GE} = 0/15\text{V}$ ,  $R_G = 5.6\Omega$ ,  
 Dynamic test circuit in Figure E)



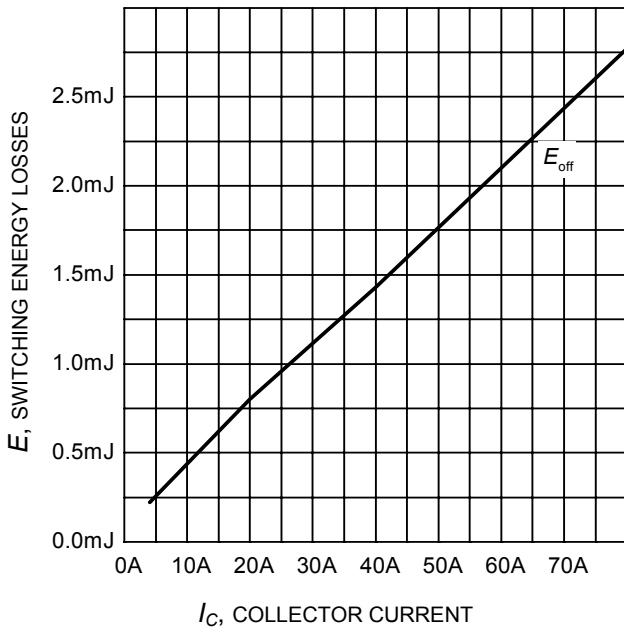
**Figure 10. Typical switching times as a function of gate resistor**  
 (inductive load,  $T_J = 175^\circ\text{C}$ ,  
 $V_{CE} = 400\text{V}$ ,  $V_{GE} = 0/15\text{V}$ ,  $I_C = 40\text{A}$ ,  
 Dynamic test circuit in Figure E)



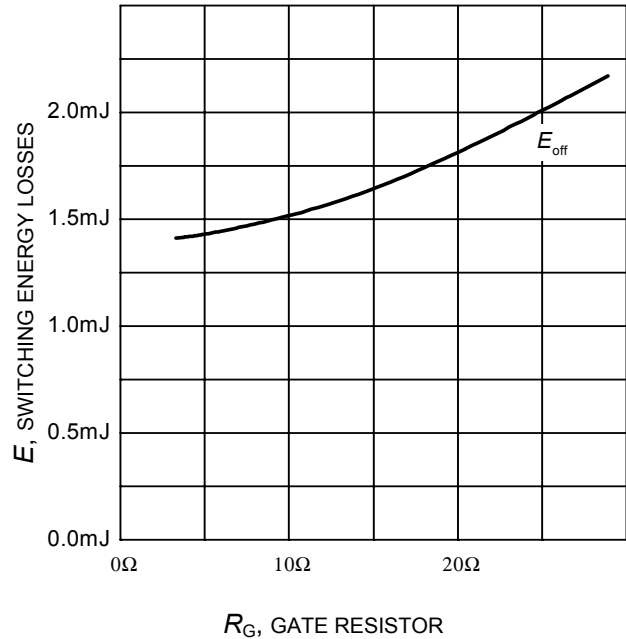
**Figure 11. Typical switching times as a function of junction temperature**  
 (inductive load,  $V_{CE} = 400\text{V}$ ,  
 $V_{GE} = 0/15\text{V}$ ,  $I_C = 40\text{A}$ ,  $R_G=5.6\Omega$ ,  
 Dynamic test circuit in Figure E)



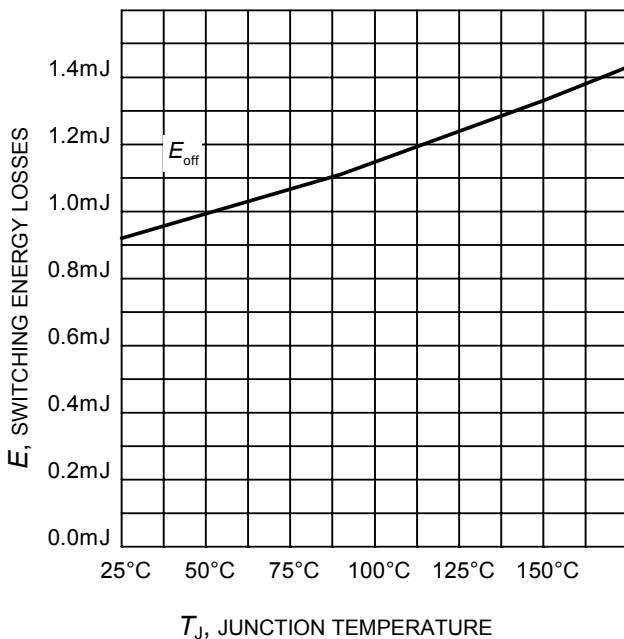
**Figure 12. Gate-emitter threshold voltage as a function of junction temperature**  
 ( $I_C = 0.8\text{mA}$ )



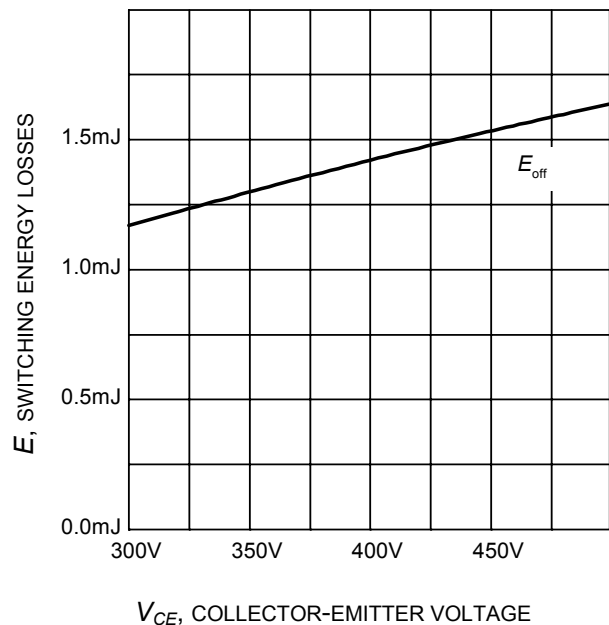
**Figure 13. Typical switching energy losses as a function of collector current**  
 (inductive load,  $T_J = 175^\circ\text{C}$ ,  $V_{CE} = 400\text{V}$ ,  $V_{GE} = 0/15\text{V}$ ,  $R_G = 5.6\Omega$ , Dynamic test circuit in Figure E)



**Figure 14. Typical switching energy losses as a function of gate resistor**  
 (inductive load,  $T_J = 175^\circ\text{C}$ ,  $V_{CE} = 400\text{V}$ ,  $V_{GE} = 0/15\text{V}$ ,  $I_C = 40\text{A}$ , Dynamic test circuit in Figure E)

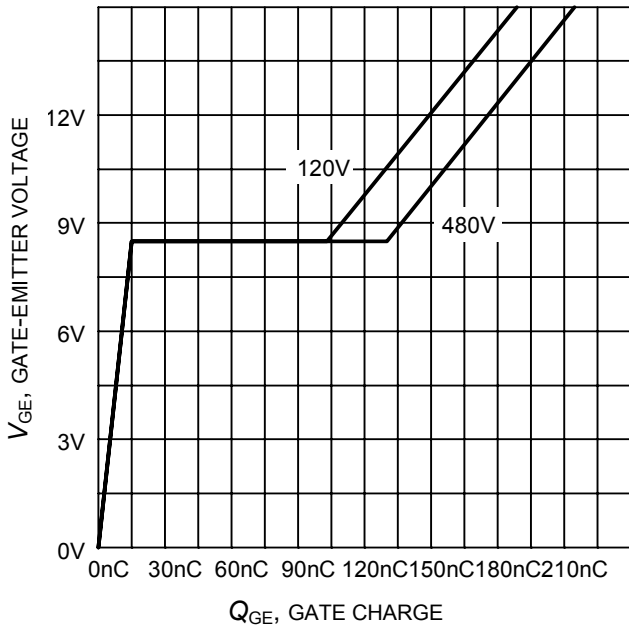


**Figure 15. Typical switching energy losses as a function of junction temperature**  
 (inductive load,  $V_{CE} = 400\text{V}$ ,  $V_{GE} = 0/15\text{V}$ ,  $I_C = 40\text{A}$ ,  $R_G = 5.6\Omega$ , Dynamic test circuit in Figure E)

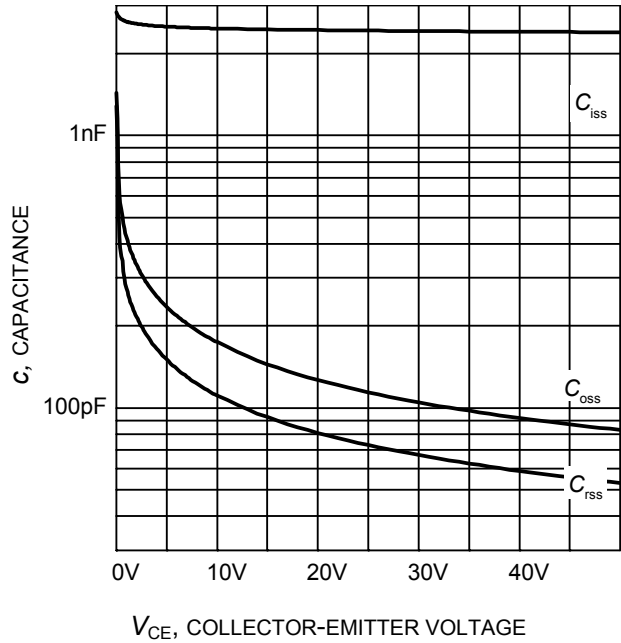


**Figure 16. Typical switching energy losses as a function of collector emitter voltage**  
 (inductive load,  $T_J = 175^\circ\text{C}$ ,  $V_{GE} = 0/15\text{V}$ ,  $I_C = 40\text{A}$ ,  $R_G = 5.6\Omega$ , Dynamic test circuit in Figure E)

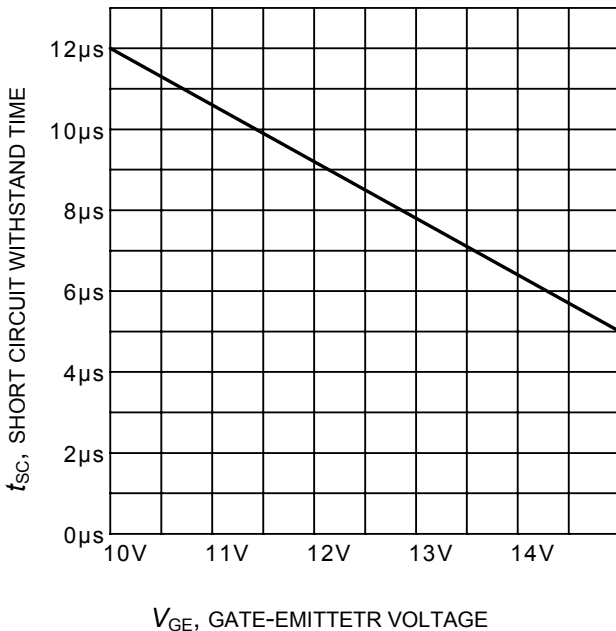




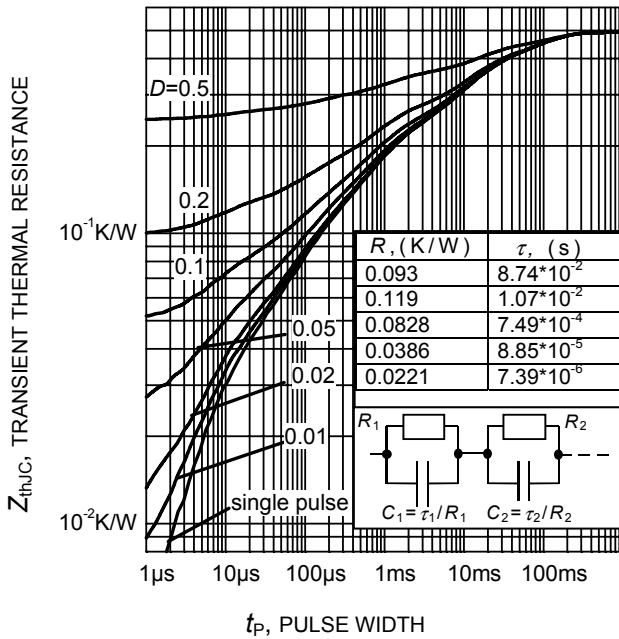
**Figure 17. Typical gate charge**  
( $I_C=40\text{ A}$ )



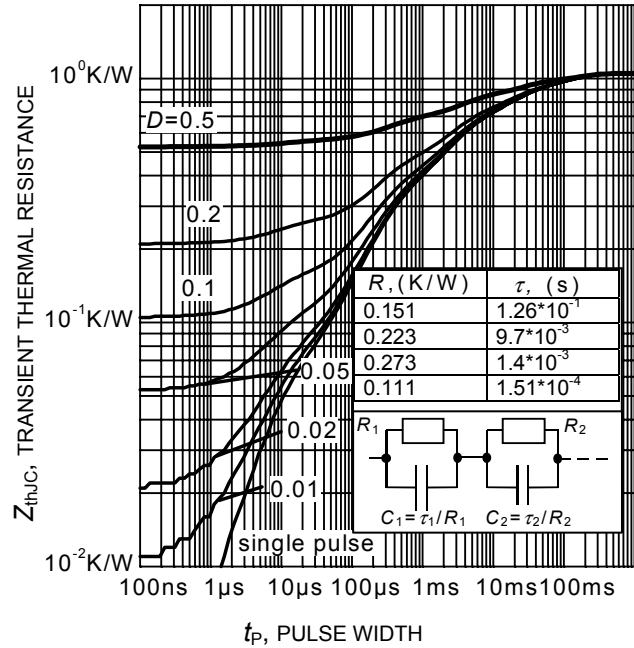
**Figure 18. Typical capacitance as a function of collector-emitter voltage**  
( $V_{GE}=0\text{V}$ ,  $f = 1\text{ MHz}$ )



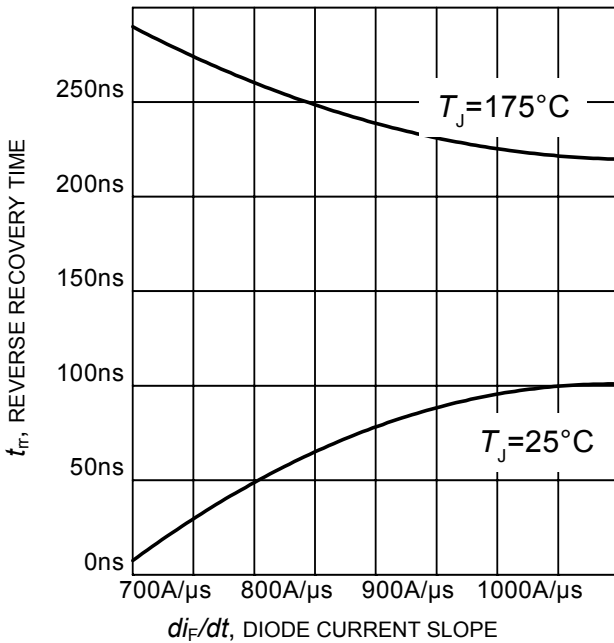
**Figure 19. Short circuit withstand time as a function of gate-emitter voltage**  
( $V_{CE}=600\text{V}$ , start at  $T_J=25^\circ\text{C}$ ,  
 $T_{Jmax}<150^\circ\text{C}$ )



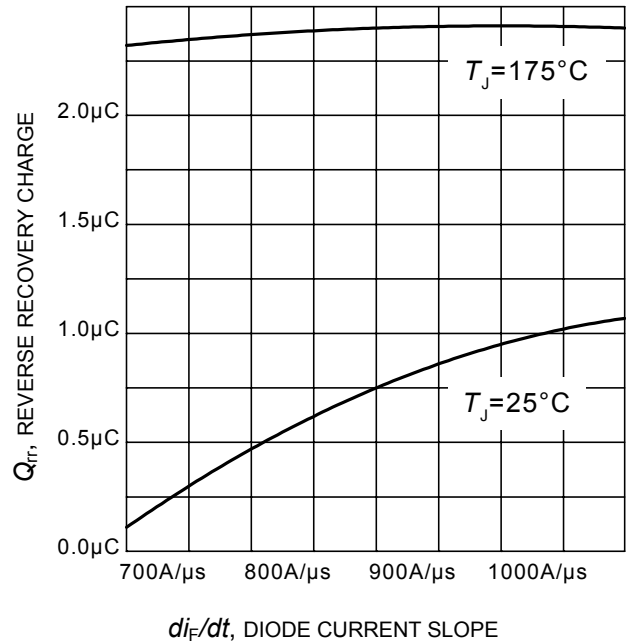
**Figure 20. IGBT transient thermal resistance**  
( $D = t_p / T$ )



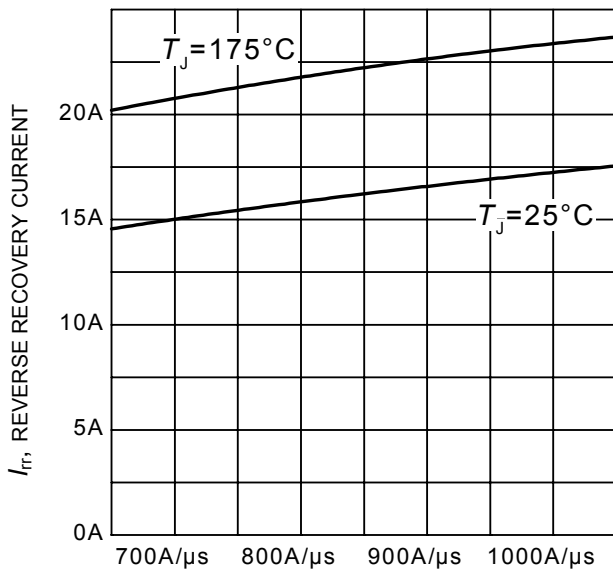
**Figure 21. Diode transient thermal impedance as a function of pulse width**  
( $D = t_p / T$ )



**Figure 22. Typical reverse recovery time as a function of diode current slope**  
( $V_R = 400V$ ,  $I_F = 30A$ ,  
Dynamic test circuit in Figure E)

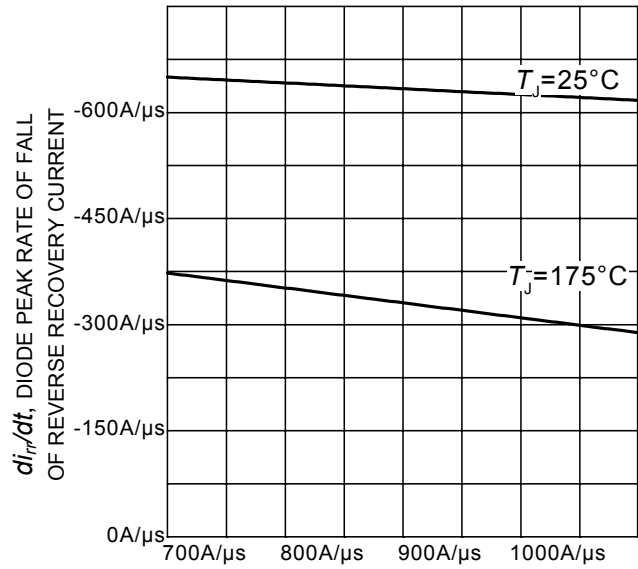


**Figure 23. Typical reverse recovery charge as a function of diode current slope**  
( $V_R = 400V$ ,  $I_F = 30A$ ,  
Dynamic test circuit in Figure E)



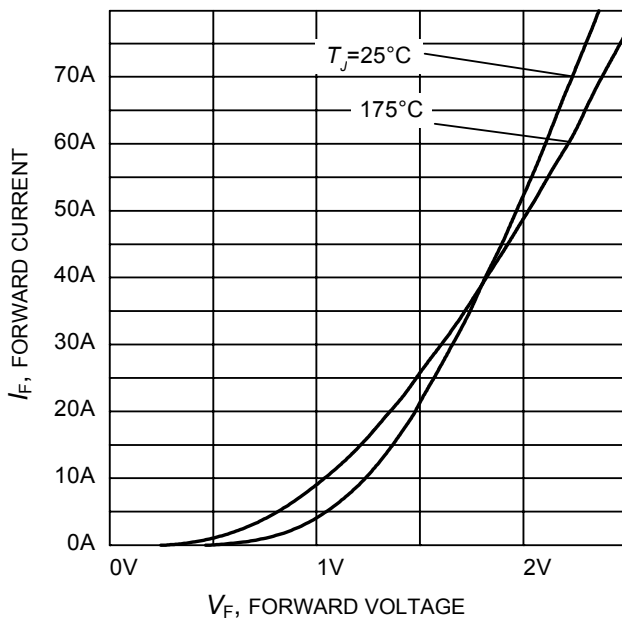
$di_F/dt$ , DIODE CURRENT SLOPE

**Figure 24. Typical reverse recovery current as a function of diode current slope**  
 ( $V_R = 400V$ ,  $I_F = 30A$ ,  
 Dynamic test circuit in Figure E)

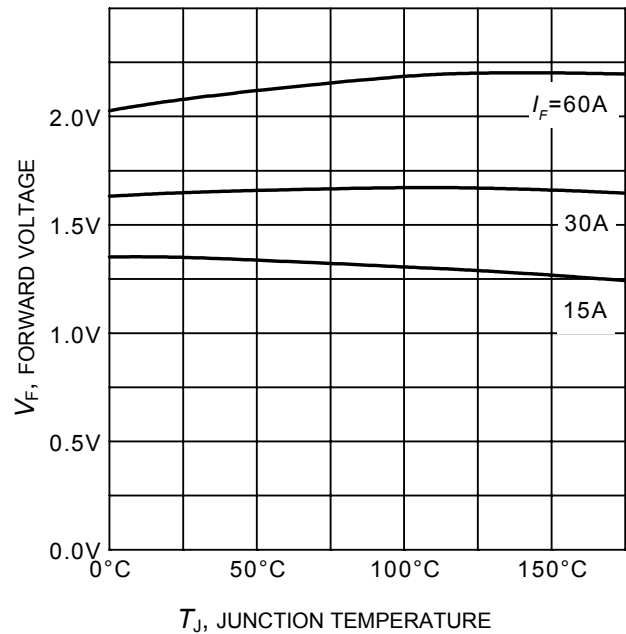


$di_F/dt$ , DIODE CURRENT SLOPE

**Figure 25. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope**  
 ( $V_R = 400V$ ,  $I_F = 30A$ ,  
 Dynamic test circuit in Figure E)

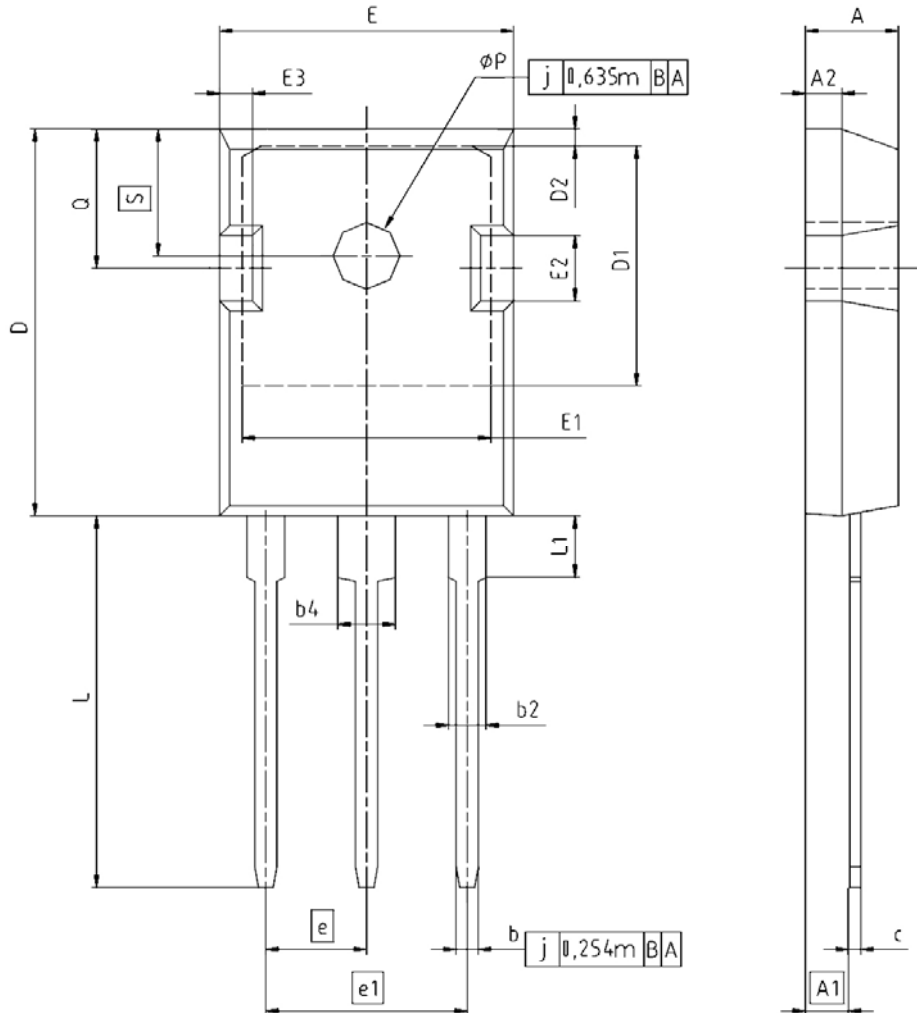


**Figure 26. Typical diode forward current as a function of forward voltage**



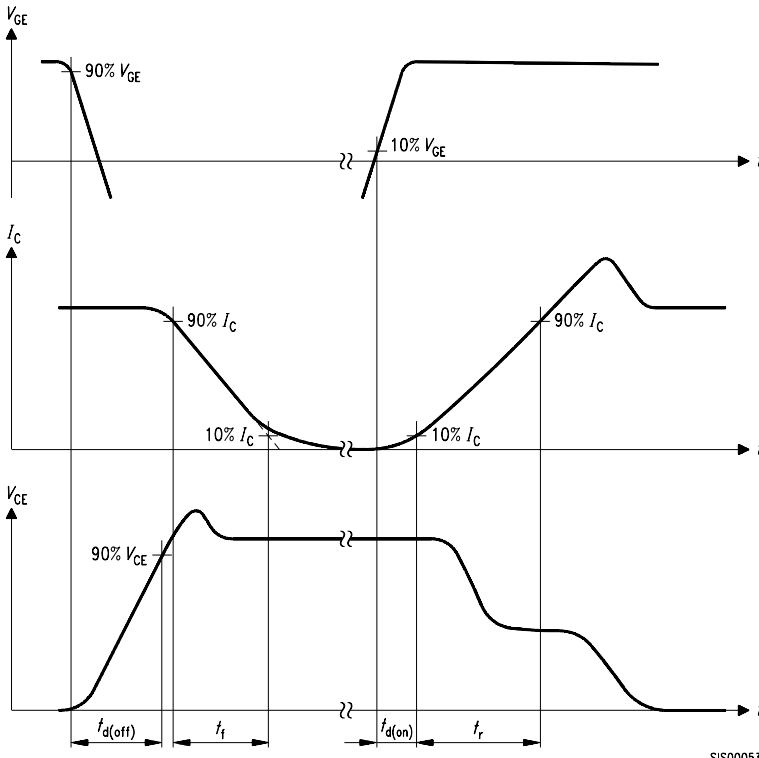
**Figure 27. Typical diode forward voltage as a function of junction temperature**

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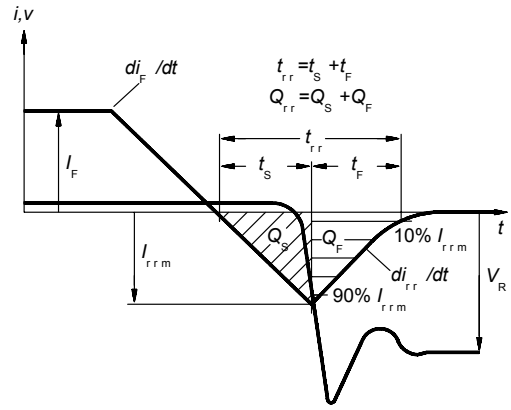


DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.90	5.16	0.193	0.203
A1	2.27	2.53	0.089	0.099
A2	1.85	2.11	0.073	0.083
b	1.07	1.33	0.042	0.052
b2	1.90	2.39	0.075	0.094
b4	2.87	3.45	0.113	0.136
c	0.55	0.75	0.022	0.030
D	20.82	21.10	0.820	0.831
D1	16.25	17.83	0.640	0.702
D2	1.05	1.35	0.041	0.053
E	15.70	16.03	0.618	0.631
E1	13.10	14.15	0.516	0.557
E2	3.68	5.10	0.145	0.201
E3	1.68	2.60	0.066	0.102
e	5.44		0.214	
e1	10.90		0.429	
N	3		3	
L	19.80	20.31	0.780	0.799
L1	4.17	4.47	0.164	0.176
φP	3.50	3.70	0.138	0.146
Q	5.49	6.00	0.216	0.236
S	6.04	6.30	0.238	0.248

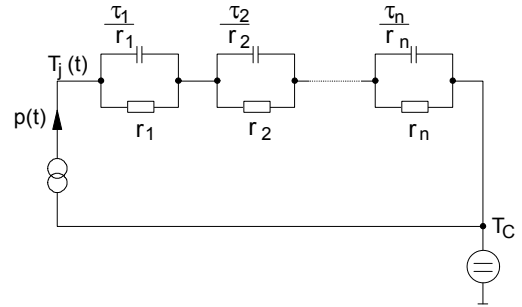
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EUROPEAN PROJECTION 
ISSUE DATE 30-03-2007
REVISION 02



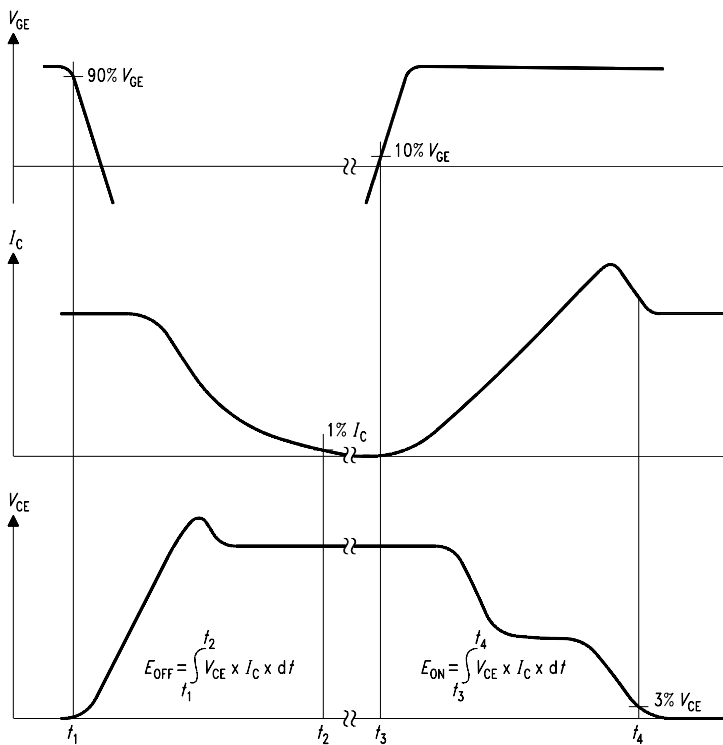
**Figure A. Definition of switching times**



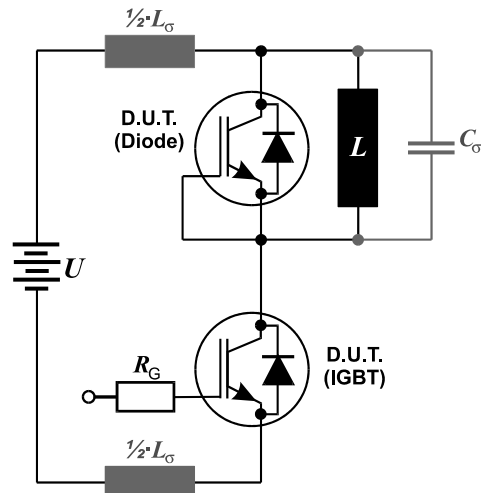
**Figure C. Definition of diodes switching characteristics**



**Figure D. Thermal equivalent circuit**



**Figure B. Definition of switching losses**



**Figure E. Dynamic test circuit**

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