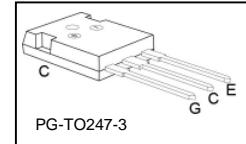
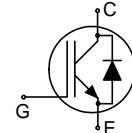


Low Loss DuoPack : IGBT in TRENCHSTOP™ and Fieldstop technology with soft, fast recovery anti-parallel Emitter Controlled HE diode


**Features:**

- Very low  $V_{CE(sat)}$  1.5V (typ.)
- Maximum Junction Temperature 175°C
- Short circuit withstand time 5μs
- Designed for :
  - Frequency Converters
  - Uninterrupted Power Supply
- TRENCHSTOP™ and Fieldstop technology for 600V applications offers :
  - very tight parameter distribution
  - high ruggedness, temperature stable behavior
  - very high switching speed
- 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	Package
IKW50N60T	600V	50A	1.5V	175°C	K50T60	PG-T0247-3

**Maximum Ratings**

Parameter	Symbol	Value	Unit
Collector-emitter voltage, $T_j \geq 25^\circ C$	$V_{CE}$	600	V
DC collector current, limited by $T_{j,max}$	$I_C$	80 <sup>2)</sup> 50	A
$T_C = 25^\circ C$		80 <sup>2)</sup>	
$T_C = 100^\circ C$		50	
Pulsed collector current, $t_p$ limited by $T_{j,max}$	$I_{Cpuls}$	150	
Turn off safe operating area, $V_{CE} = 600V$ , $T_j = 175^\circ C$ , $t_p = 1\mu s$	-	150	
Diode forward current, limited by $T_{j,max}$	$I_F$	100 50	
$T_C = 25^\circ C$		100	
$T_C = 100^\circ C$		50	
Diode pulsed current, $t_p$ limited by $T_{j,max}$	$I_{Fpuls}$	150	
Gate-emitter voltage	$V_{GE}$	$\pm 20$	V
Short circuit withstand time <sup>3)</sup> $V_{GE} = 15V$ , $V_{CC} \leq 400V$ , $T_j \leq 150^\circ C$	$t_{SC}$	5	$\mu s$
Power dissipation $T_C = 25^\circ C$	$P_{tot}$	333	W
Operating junction temperature	$T_j$	-40...+175	
Storage temperature	$T_{stg}$	-55...+150	$^\circ C$
Soldering temperature, 1.6mm (0.063 in.) from case for 10s	-	260	

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

<sup>2)</sup> Value limited by bond wire

<sup>3)</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	$R_{thJC}$		0.45	K/W
Diode thermal resistance, junction – case	$R_{thJCD}$		0.8	
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	$V_{(BR)CES}$	$V_{GE}=0\text{V}, I_C=0.2\text{mA}$	600	-	-	V
Collector-emitter saturation voltage	$V_{CE(\text{sat})}$	$V_{GE} = 15\text{V}, I_C=50\text{A}$	-	1.5	2	
		$T_j=25^\circ\text{C}$	-	1.9	-	
Diode forward voltage	$V_F$	$V_{GE}=0\text{V}, I_F=50\text{A}$	-	1.65	2.05	
		$T_j=25^\circ\text{C}$	-	1.6	-	
Gate-emitter threshold voltage	$V_{GE(\text{th})}$	$I_C=0.8\text{mA}, V_{CE}=V_{GE}$	4.1	4.9	5.7	
Zero gate voltage collector current	$I_{CES}$	$V_{CE}=600\text{V}, V_{GE}=0\text{V}$	-	-	40	
		$T_j=25^\circ\text{C}$	-	-	3500	$\mu\text{A}$
Gate-emitter leakage current	$I_{GES}$	$V_{CE}=0\text{V}, V_{GE}=20\text{V}$	-	-	100	nA
Transconductance	$g_{fs}$	$V_{CE}=20\text{V}, I_C=50\text{A}$	-	31	-	S
Integrated gate resistor	$R_{Gint}$			-		$\Omega$

**Dynamic Characteristic**

Input capacitance	$C_{iss}$	$V_{CE}=25\text{V},$	-	3140	-	pF
Output capacitance	$C_{oss}$	$V_{GE}=0\text{V},$	-	200	-	
Reverse transfer capacitance	$C_{rss}$	$f=1\text{MHz}$	-	93	-	
Gate charge	$Q_{Gate}$	$V_{CC}=480\text{V}, I_C=50\text{A}$	-	310	-	nC
$V_{GE}=15\text{V}$						
Internal emitter inductance measured 5mm (0.197 in.) from case	$L_E$		-	13	-	nH
Short circuit collector current <sup>1)</sup>	$I_{C(SC)}$	$V_{GE}=15\text{V}, t_{SC}\leq 5\mu\text{s}$	-	458.3	-	A
		$V_{CC} = 400\text{V},$				
		$T_j \leq 150^\circ\text{C}$				

<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	$t_{d(on)}$	$T_j=25^\circ\text{C}$ , $V_{CC}=400\text{V}$ , $I_C=50\text{A}$ , $V_{GE}=0/15\text{V}$ , $r_G=7\Omega$ , $L_\sigma=103\text{nH}$ , $C_\sigma=39\text{pF}$ $L_\sigma$ , $C_\sigma$ from Fig. E Energy losses include "tail" and diode reverse recovery.	-	26	-	ns
Rise time	$t_r$		-	29	-	
Turn-off delay time	$t_{d(off)}$		-	299	-	
Fall time	$t_f$		-	29	-	
Turn-on energy	$E_{on}$		-	1.2	-	mJ
Turn-off energy	$E_{off}$		-	1.4	-	
Total switching energy	$E_{ts}$		-	2.6	-	

**Anti-Parallel Diode Characteristic**

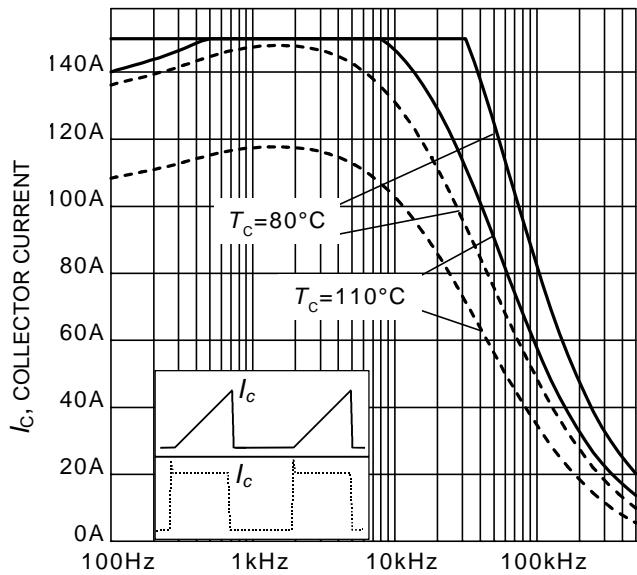
Diode reverse recovery time	$t_{rr}$	$T_j=25^\circ\text{C}$ , $V_R=400\text{V}$ , $I_F=50\text{A}$ , $di_F/dt=1280\text{A}/\mu\text{s}$	-	143	-	ns
Diode reverse recovery charge	$Q_{rr}$		-	1.8	-	$\mu\text{C}$
Diode peak reverse recovery current	$I_{rrm}$		-	27.7	-	A
Diode peak rate of fall of reverse recovery current during $t_b$	$di_{rr}/dt$		-	671	-	$\text{A}/\mu\text{s}$

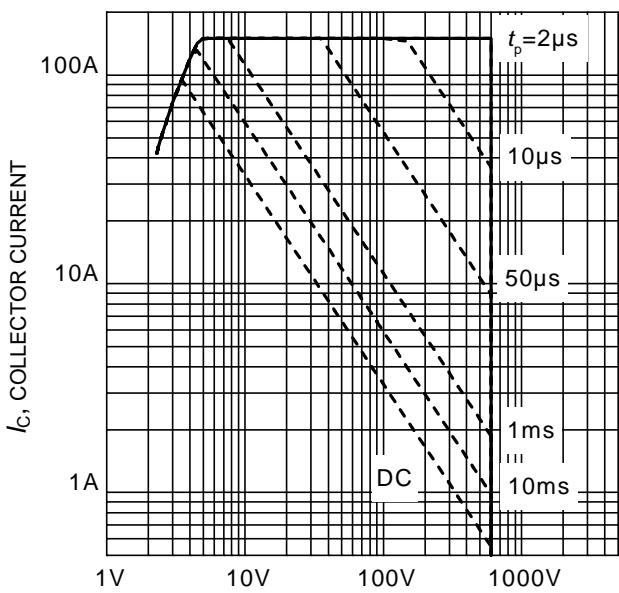
**Switching Characteristic, Inductive Load, at  $T_j=175^\circ\text{C}$** 

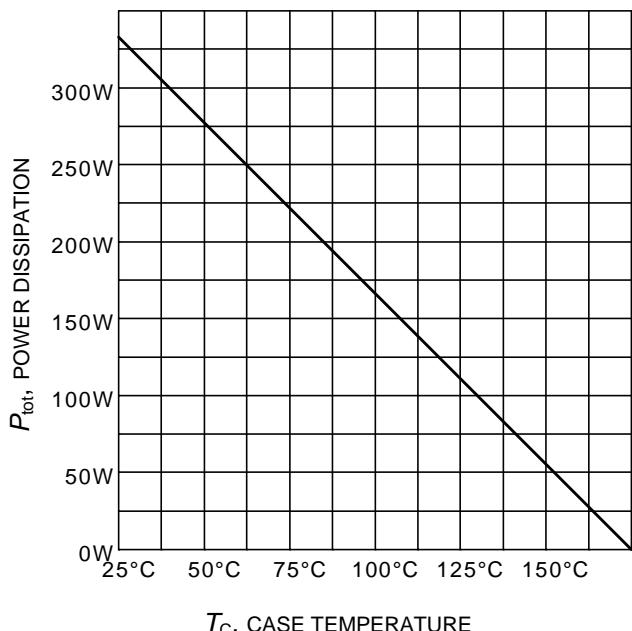
Parameter	Symbol	Conditions	Value			Unit
			min.	Typ.	max.	
<b>IGBT Characteristic</b>						
Turn-on delay time	$t_{d(on)}$	$T_j=175^\circ\text{C}$ , $V_{CC}=400\text{V}$ , $I_C=50\text{A}$ , $V_{GE}=0/15\text{V}$ , $r_G=7\Omega$ , $L_\sigma=103\text{nH}$ , $C_\sigma=39\text{pF}$ $L_\sigma$ , $C_\sigma$ from Fig. E Energy losses include "tail" and diode reverse recovery.	-	27	-	ns
Rise time	$t_r$		-	33	-	
Turn-off delay time	$t_{d(off)}$		-	341	-	
Fall time	$t_f$		-	55	-	
Turn-on energy	$E_{on}$		-	1.8	-	mJ
Turn-off energy	$E_{off}$		-	1.8	-	
Total switching energy	$E_{ts}$		-	3.6	-	

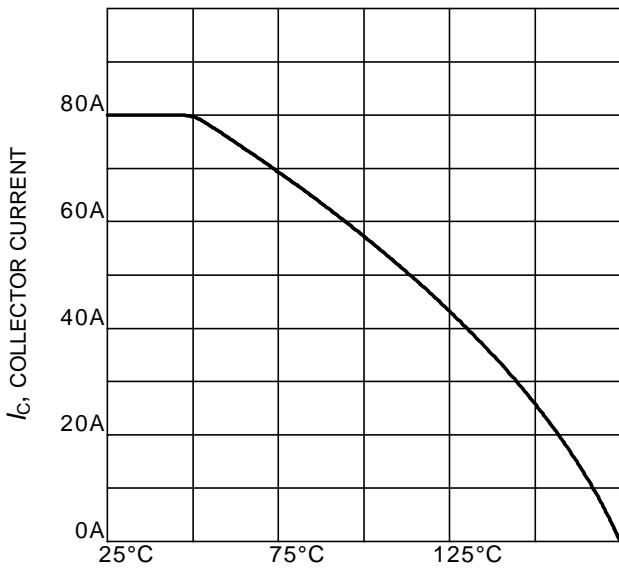
**Anti-Parallel Diode Characteristic**

Diode reverse recovery time	$t_{rr}$	$T_j=175^\circ\text{C}$ , $V_R=400\text{V}$ , $I_F=50\text{A}$ , $di_F/dt=1280\text{A}/\mu\text{s}$	-	205	-	ns
Diode reverse recovery charge	$Q_{rr}$		-	4.3	-	$\mu\text{C}$
Diode peak reverse recovery current	$I_{rrm}$		-	40.7	-	A
Diode peak rate of fall of reverse recovery current during $t_b$	$di_{rr}/dt$		-	449	-	$\text{A}/\mu\text{s}$

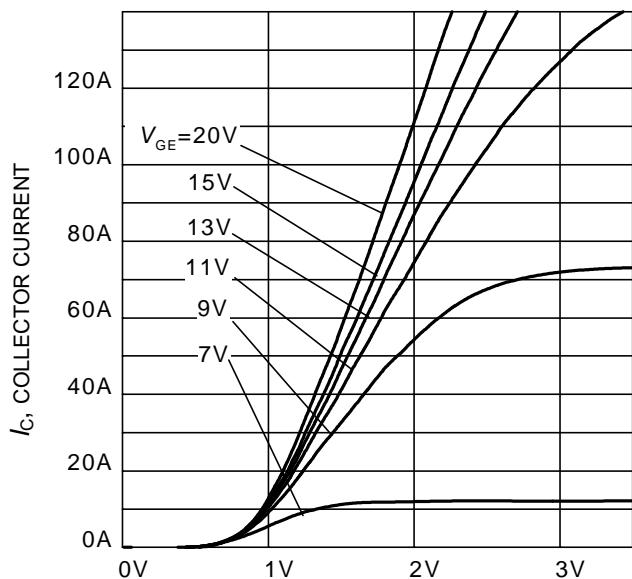

 $f$ , SWITCHING FREQUENCY

**Figure 1. Collector current as a function of switching frequency**
 $(T_j \leq 175^\circ\text{C}, D = 0.5, V_{CE} = 400\text{V}, V_{GE} = 0/15\text{V}, r_G = 7\Omega)$ 

 $V_{CE}$ , COLLECTOR-EMITTER VOLTAGE

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

 $T_C$ , CASE TEMPERATURE

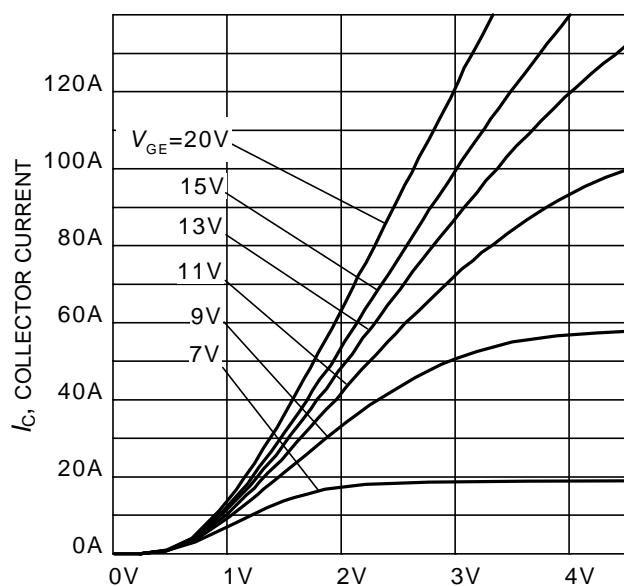
**Figure 3. Power dissipation as a function of case temperature**
 $(T_j \leq 175^\circ\text{C})$ 

 $T_C$ , CASE TEMPERATURE

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



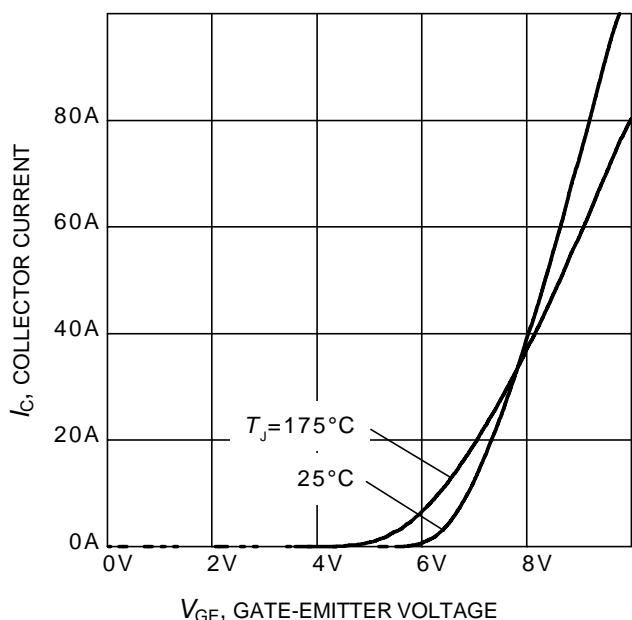
$V_{CE}$ , COLLECTOR-EMITTER VOLTAGE

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



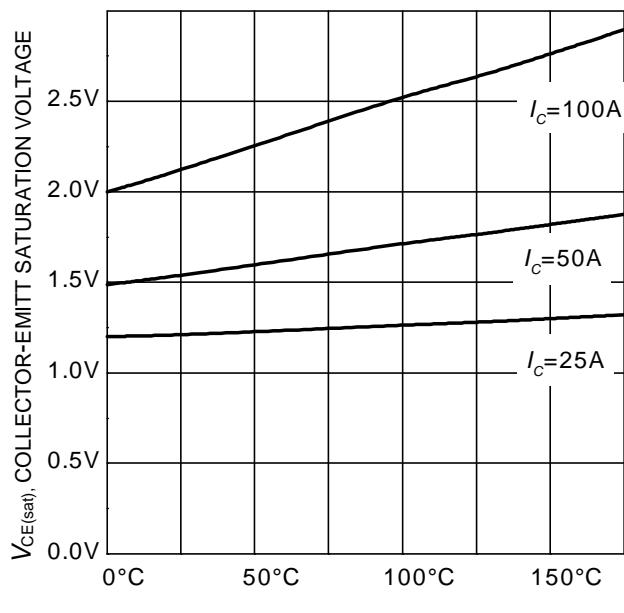
$V_{CE}$ , COLLECTOR-EMITTER VOLTAGE

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



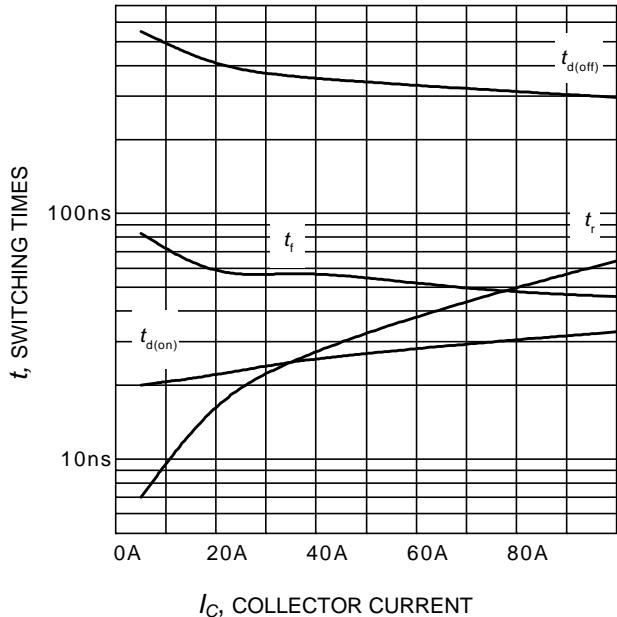
$V_{GE}$ , GATE-EMITTER VOLTAGE

**Figure 7. Typical transfer characteristic**  
( $V_{CE} = 10\text{V}$ )

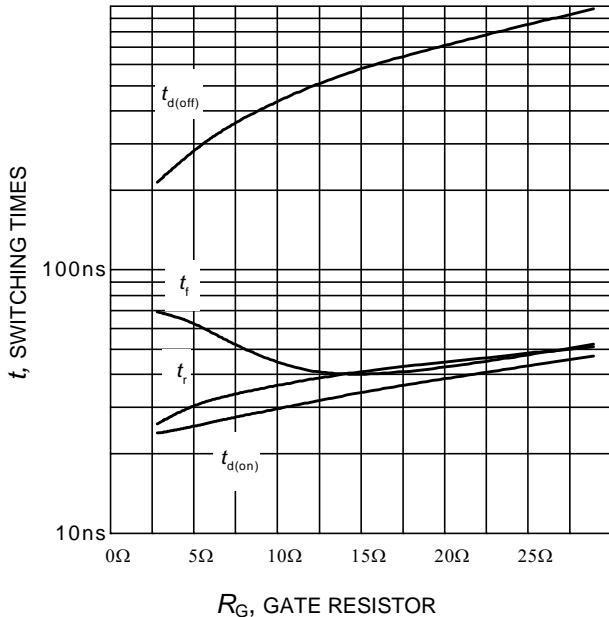


$T_j$ , JUNCTION TEMPERATURE

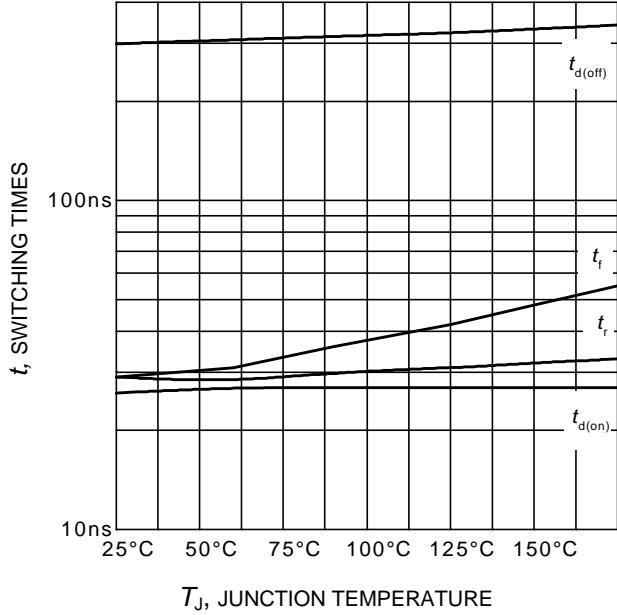
**Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature**  
( $V_{GE} = 15\text{V}$ )



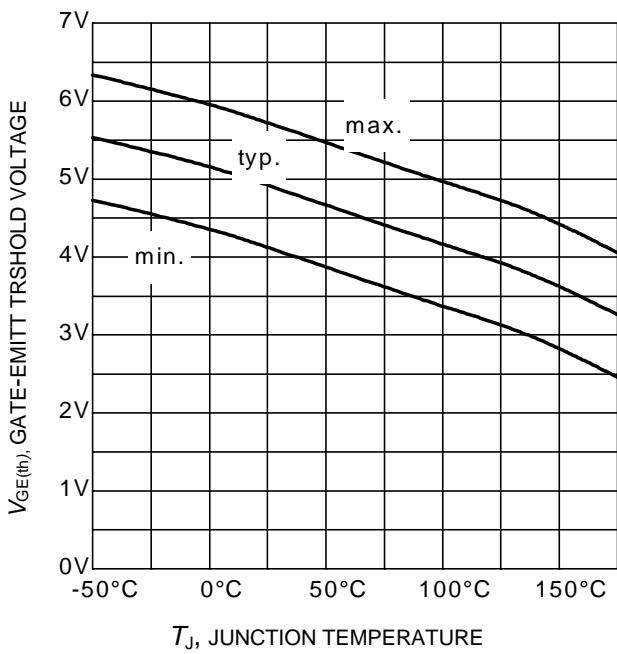
**Figure 9.** Typical switching times as a function of collector current  
(inductive load,  $T_J=175^\circ\text{C}$ ,  
 $V_{CE} = 400\text{V}$ ,  $V_{GE} = 0/15\text{V}$ ,  $r_G = 7\Omega$ ,  
Dynamic test circuit in Figure E)



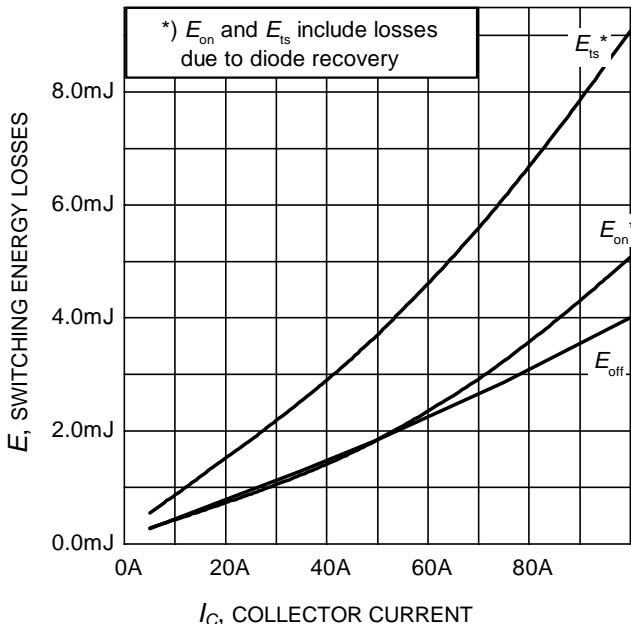
**Figure 10.** Typical switching times as a function of gate resistor  
(inductive load,  $T_J = 175^\circ\text{C}$ ,  
 $V_{CE} = 400\text{V}$ ,  $V_{GE} = 0/15\text{V}$ ,  $I_C = 50\text{A}$ ,  
Dynamic test circuit in Figure E)



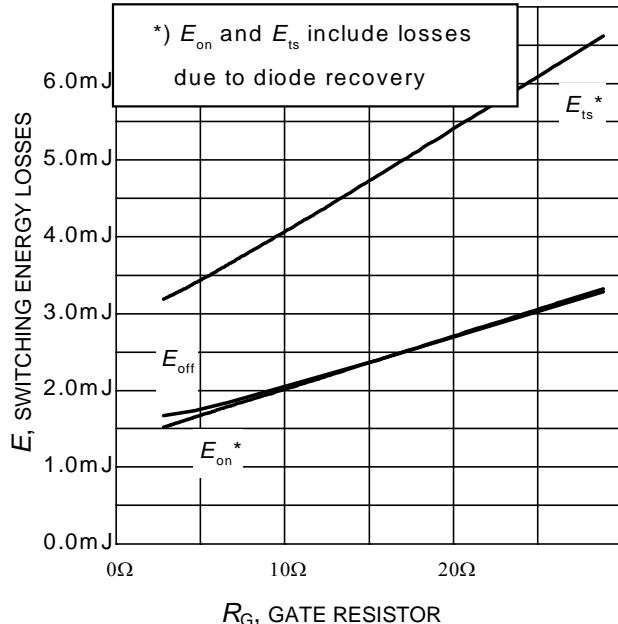
**Figure 11.** Typical switching times as a function of junction temperature  
(inductive load,  $V_{CE} = 400\text{V}$ ,  
 $V_{GE} = 0/15\text{V}$ ,  $I_C = 50\text{A}$ ,  $r_G = 7\Omega$ ,  
Dynamic test circuit in Figure E)



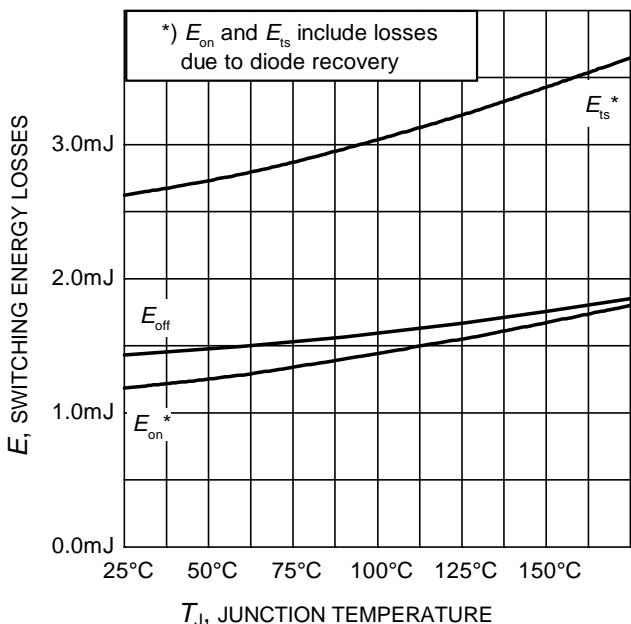
**Figure 12.** Gate-emitter threshold voltage as a function of junction temperature  
( $I_C = 0.8\text{mA}$ )



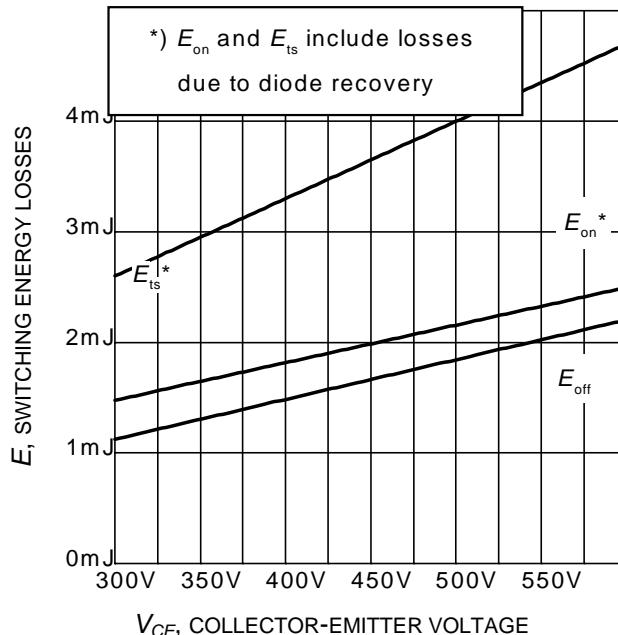
**Figure 13. Typical switching energy losses as a function of collector current**  
(inductive load,  $T_J = 175^\circ\text{C}$ ,  
 $V_{CE} = 400\text{V}$ ,  $V_{GE} = 0/15\text{V}$ ,  $r_G = 7\Omega$ ,  
Dynamic test circuit in Figure E)



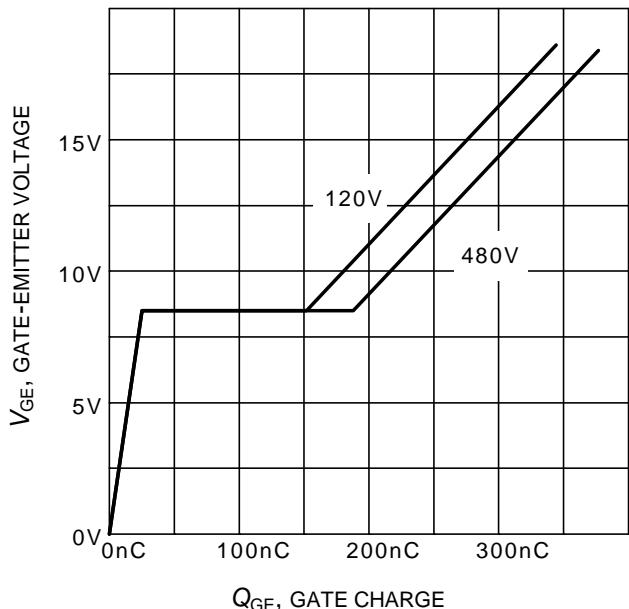
**Figure 14. Typical switching energy losses as a function of gate resistor**  
(inductive load,  $T_J = 175^\circ\text{C}$ ,  
 $V_{CE} = 400\text{V}$ ,  $V_{GE} = 0/15\text{V}$ ,  $I_C = 50\text{A}$ ,  
Dynamic test circuit in Figure E)



**Figure 15. Typical switching energy losses as a function of junction temperature**  
(inductive load,  $V_{CE} = 400\text{V}$ ,  
 $V_{GE} = 0/15\text{V}$ ,  $I_C = 50\text{A}$ ,  $r_G = 7\Omega$ ,  
Dynamic test circuit in Figure E)

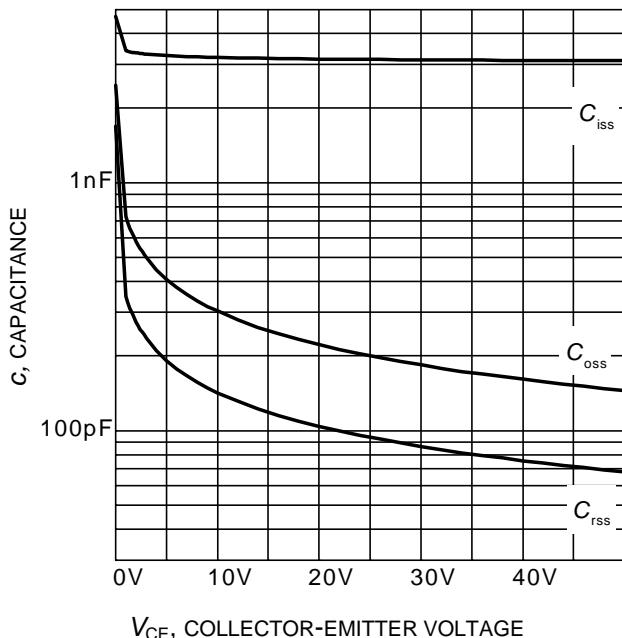


**Figure 16. Typical switching energy losses as a function of collector-emitter voltage**  
(inductive load,  $T_J = 175^\circ\text{C}$ ,  
 $V_{GE} = 0/15\text{V}$ ,  $I_C = 50\text{A}$ ,  $r_G = 7\Omega$ ,  
Dynamic test circuit in Figure E)



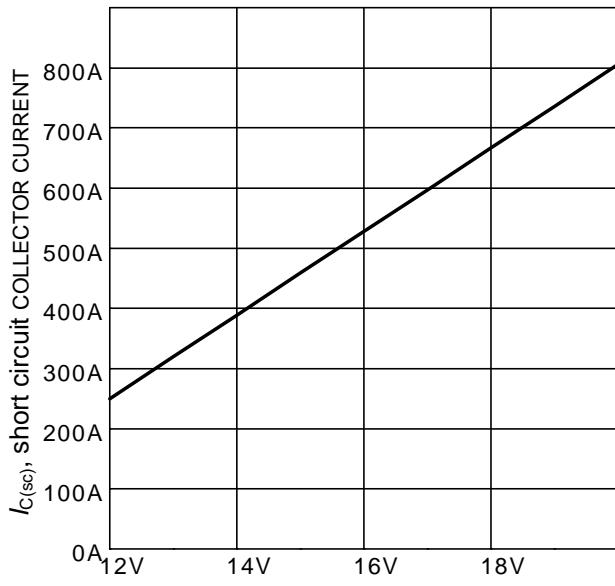
$V_{GE}$ , GATE-EMITTER VOLTAGE

**Figure 17. Typical gate charge**  
( $I_C=50$  A)



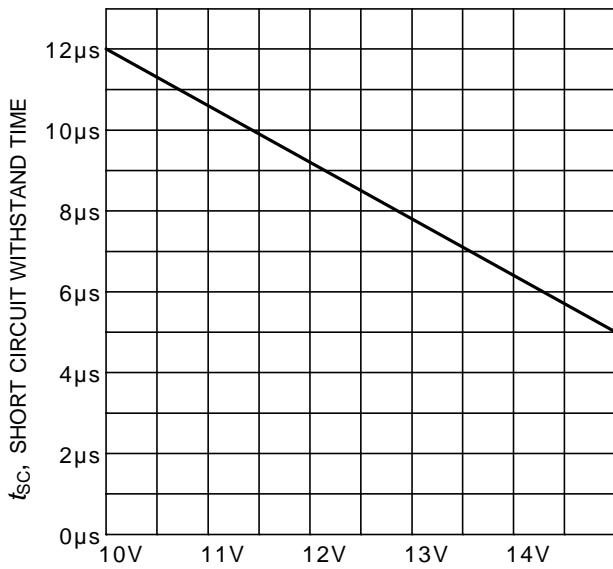
$V_{CE}$ , COLLECTOR-EMITTER VOLTAGE

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



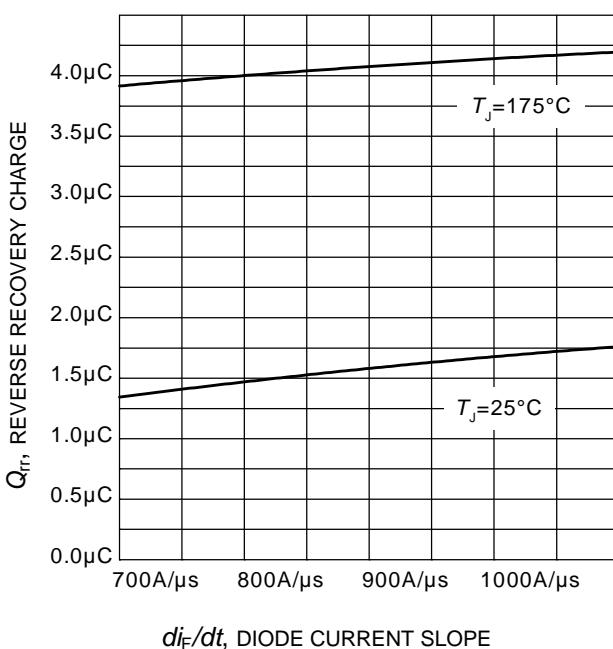
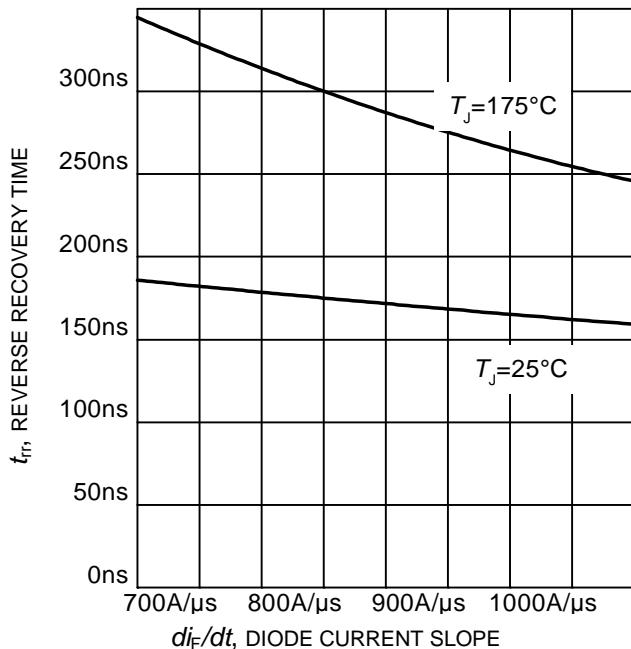
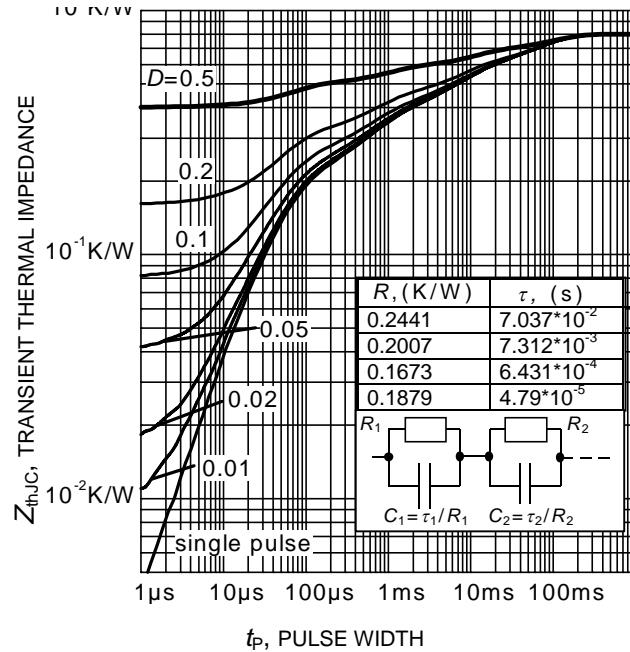
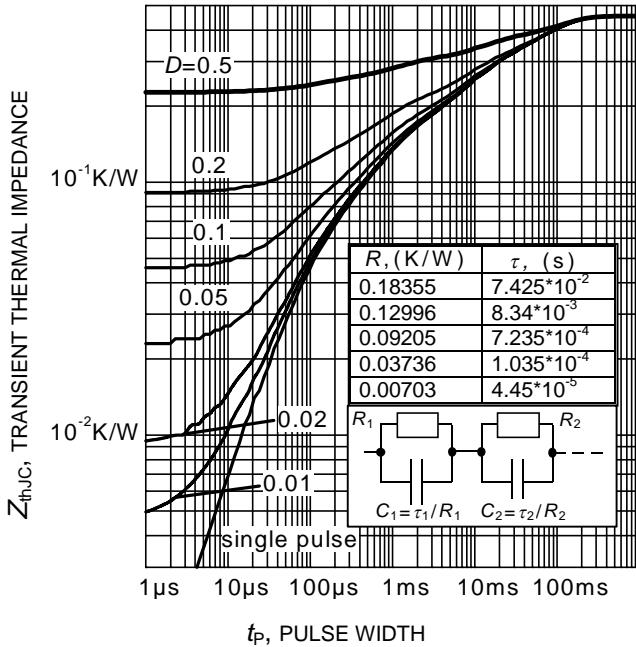
$V_{GE}$ , GATE-EMITTER VOLTAGE

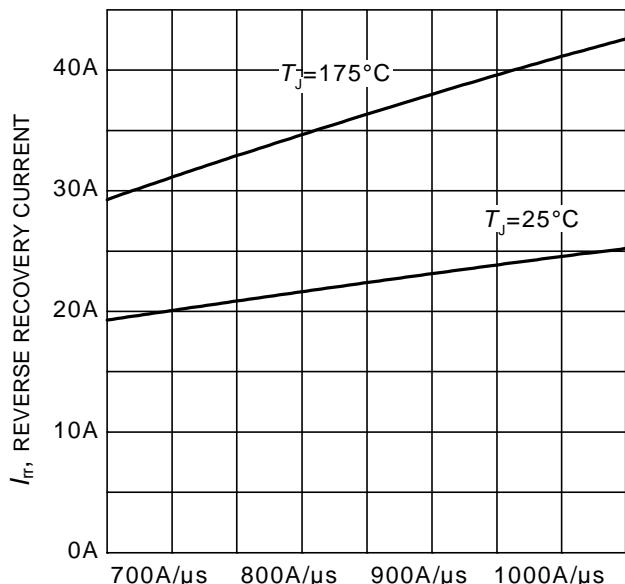
**Figure 19. Typical short circuit collector**  
**current as a function of gate-**  
**emitter voltage**  
( $V_{CE} \leq 400$  V,  $T_j \leq 150^\circ\text{C}$ )



$V_{GE}$ , GATE-EMITTER VOLTAGE

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

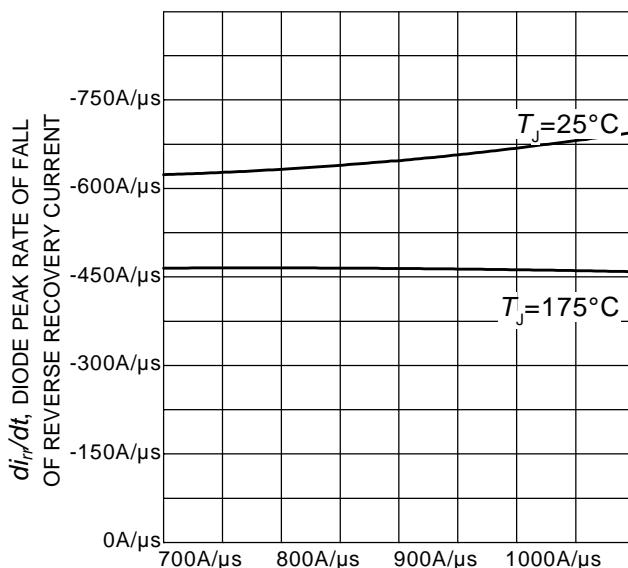




$di_F/dt$ , DIODE CURRENT SLOPE

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

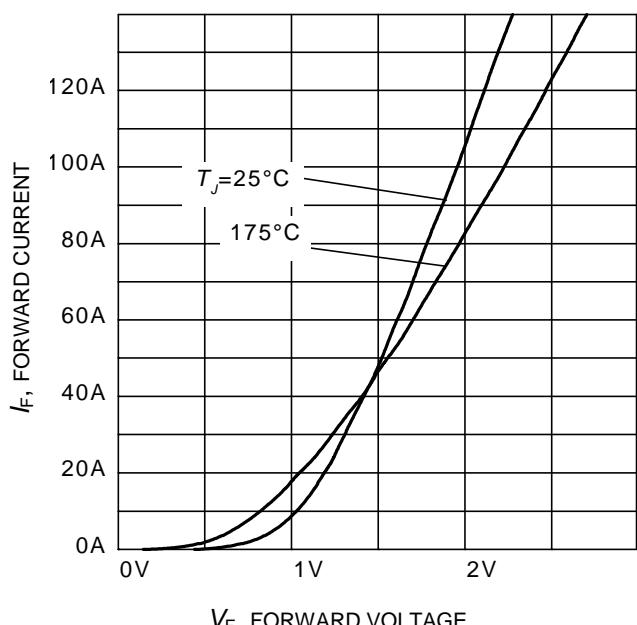
( $V_R = 400\text{V}$ ,  $I_F = 50\text{A}$ ,  
Dynamic test circuit in Figure E)



$di_F/dt$ , DIODE CURRENT SLOPE

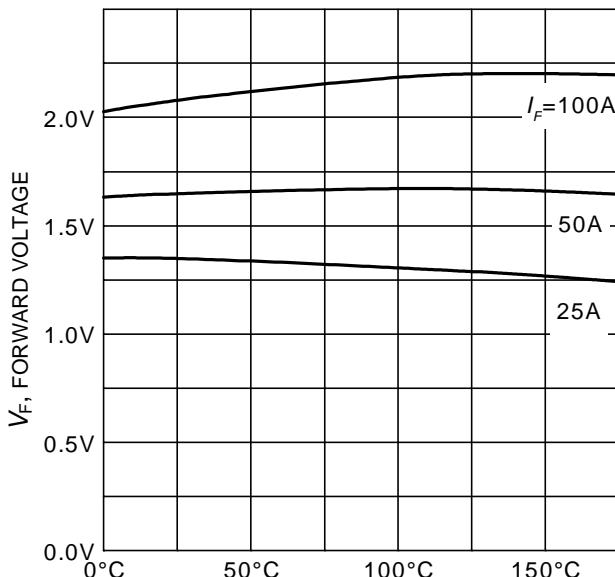
**Figure 26. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope**

( $V_R = 400\text{V}$ ,  $I_F = 50\text{A}$ ,  
Dynamic test circuit in Figure E)



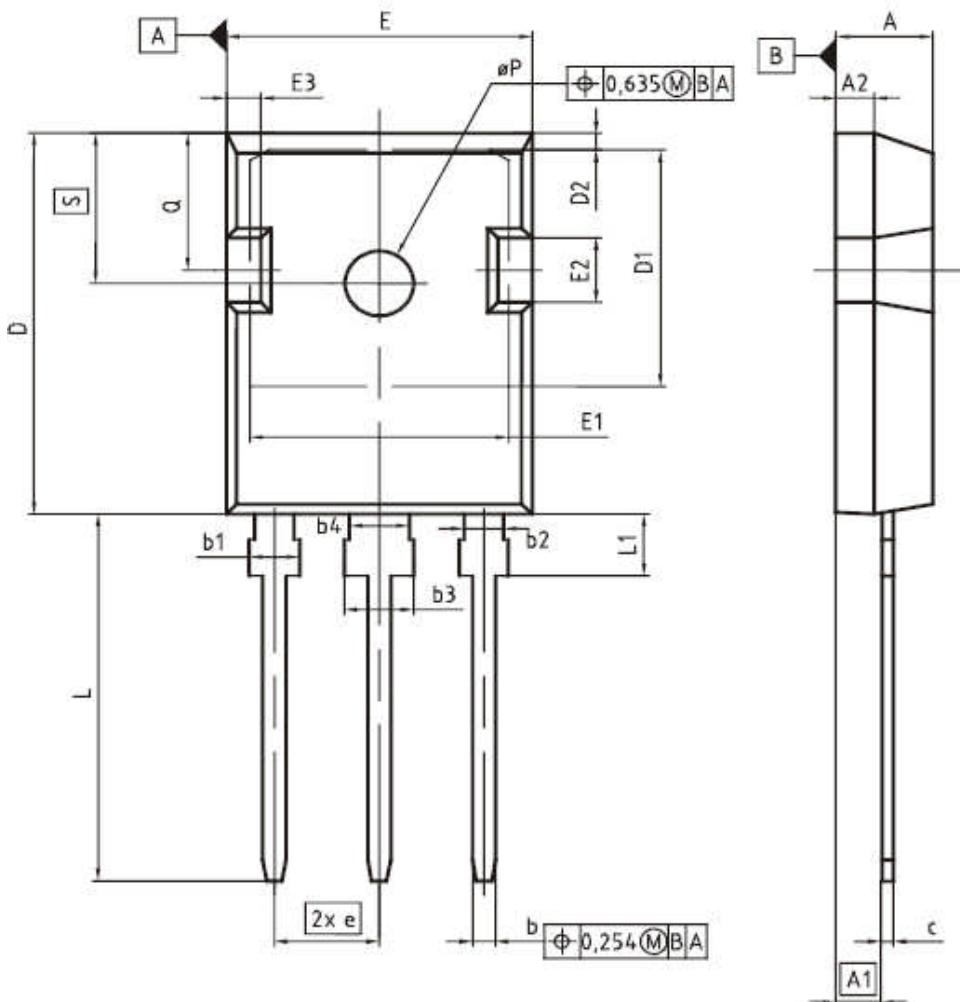
$V_F$ , FORWARD VOLTAGE

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



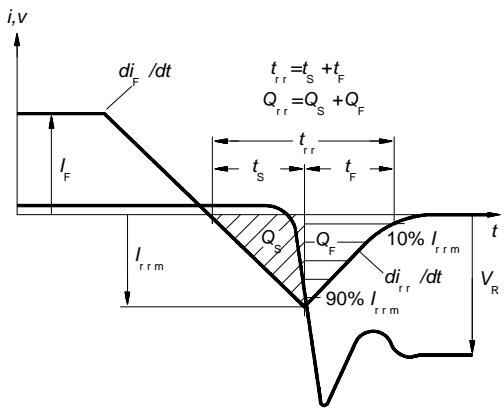
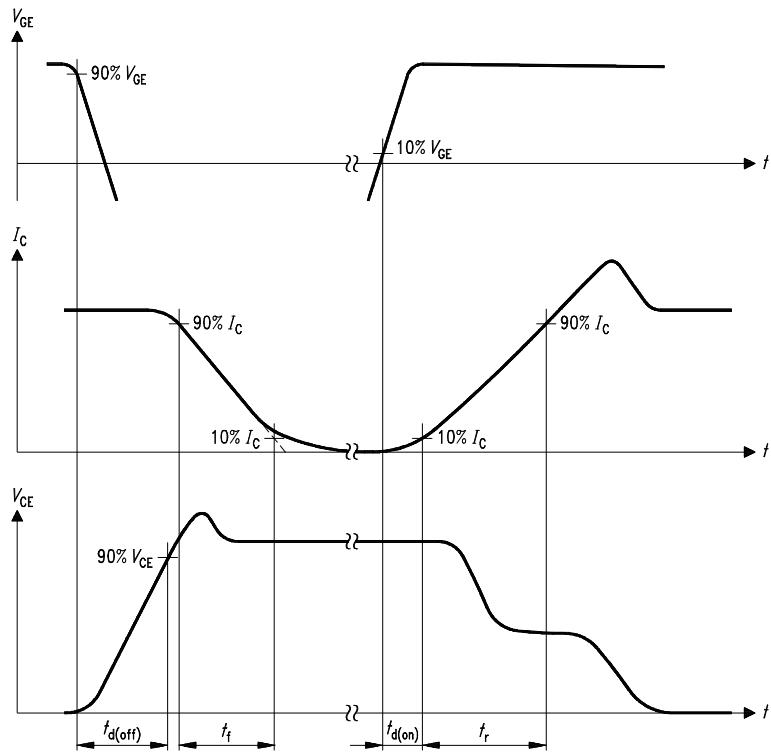
$T_J$ , JUNCTION TEMPERATURE

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

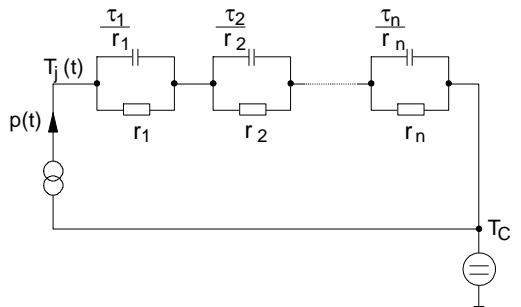
**PG-T0247-3**


DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.83	5.21	0.190	0.205
A1	2.27	2.54	0.089	0.100
A2	1.85	2.16	0.073	0.085
b	1.07	1.33	0.042	0.052
b1	1.90	2.41	0.075	0.095
b2	1.90	2.16	0.075	0.085
b3	2.87	3.38	0.113	0.133
b4	2.87	3.13	0.113	0.123
c	0.55	0.68	0.022	0.027
D	20.80	21.10	0.819	0.831
D1	16.25	17.65	0.640	0.695
D2	0.95	1.35	0.037	0.053
E	15.70	16.13	0.618	0.635
E1	13.10	14.15	0.516	0.557
E2	3.68	5.10	0.145	0.201
E3	1.00	2.60	0.039	0.102
e	5.44 (BSC)		0.214 (BSC)	
N	3		3	
L	19.80	20.32	0.780	0.800
L1	4.10	4.47	0.161	0.176
sP	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

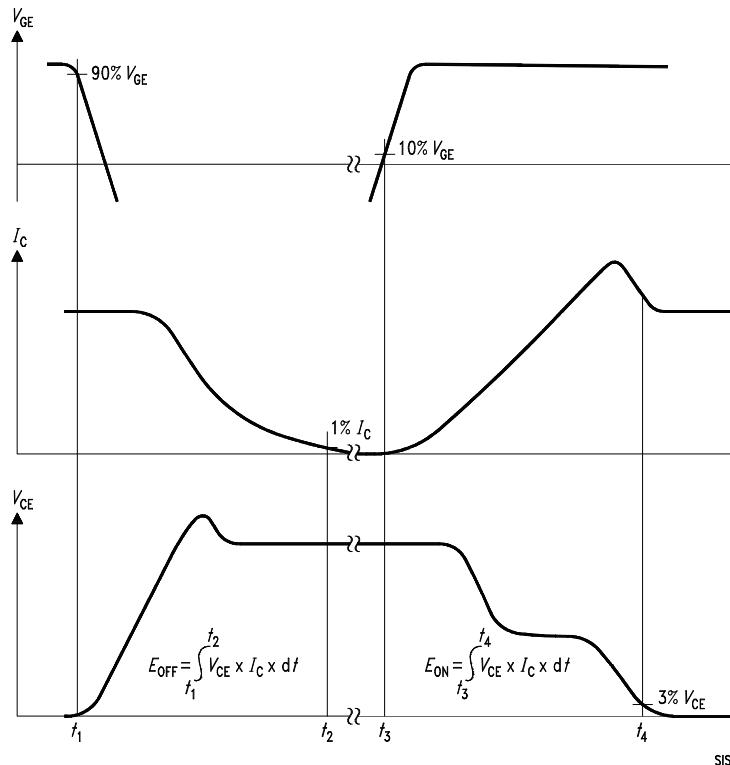
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ISSUE DATE	09-07-2010
REVISION	05



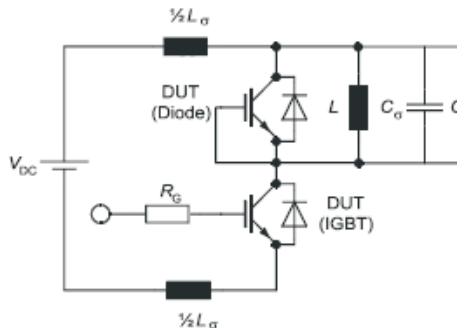
**Figure C. Definition of diodes switching characteristics**



**Figure D. Thermal equivalent circuit**



**Figure B. Definition of switching losses**



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

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