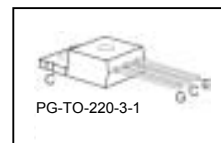
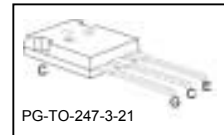
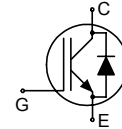


Low Loss DuoPack : IGBT in **TrenchStop®** and Fieldstop technology  
with soft, fast recovery anti-parallel EmCon HE diode

- Very low  $V_{CE(sat)}$  1.5 V (typ.)
- Maximum Junction Temperature 175 °C
- Short circuit withstand time – 5µs
- Designed for :
  - Frequency Converters
  - Uninterrupted Power Supply
- **TrenchStop®** and Fieldstop technology for 600 V applications offers :
  - very tight parameter distribution
  - high ruggedness, temperature stable behavior
  - very high switching speed
  - low  $V_{CE(sat)}$
- Positive temperature coefficient in  $V_{CE(sat)}$
- Low EMI
- Low Gate Charge
- Very soft, fast recovery anti-parallel EmCon 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
IKP20N60T	600V	20A	1.5V	175°C	K20T60	PG-TO-220-3-1
IKW20N60T	600V	20A	1.5V	175°C	K20T60	PG-TO-247-3-21

#### Maximum Ratings

Parameter	Symbol	Value	Unit
Collector-emitter voltage	$V_{CE}$	600	V
DC collector current, limited by $T_{j,max}$	$I_C$	40	A
$T_C = 25^\circ C$		40	
$T_C = 100^\circ C$		20	
Pulsed collector current, $t_p$ limited by $T_{j,max}$	$I_{Cpuls}$	60	
Turn off safe operating area ( $V_{CE} \leq 600V, T_j \leq 175^\circ C$ )	-	60	
Diode forward current, limited by $T_{j,max}$	$I_F$	40	
$T_C = 25^\circ C$		40	
$T_C = 100^\circ C$		20	
Diode pulsed current, $t_p$ limited by $T_{j,max}$	$I_{Fpuls}$	60	
Gate-emitter voltage	$V_{GE}$	$\pm 20$	V
Short circuit withstand time <sup>2)</sup>	$t_{SC}$	5	µs
$V_{GE} = 15V, V_{CC} \leq 400V, T_j \leq 150^\circ C$			
Power dissipation $T_C = 25^\circ C$	$P_{tot}$	166	W
Operating junction temperature	$T_j$	-40...+175	°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 JEDEC-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	$R_{thJC}$		0.9	KW
Diode thermal resistance, junction – case	$R_{thJCD}$		1.5	
Thermal resistance, junction – ambient	$R_{thJA}$		62 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	$V_{(BR)CES}$	$V_{GE}=0V, I_C=0.2mA$	600	-	-	V
Collector-emitter saturation voltage	$V_{CE(sat)}$	$V_{GE} = 15V, I_C=20A$ $T_j=25^\circ\text{C}$ $T_j=175^\circ\text{C}$	- -	1.5 1.9	2.05 -	
Diode forward voltage	$V_F$	$V_{GE}=0V, I_F=20A$ $T_j=25^\circ\text{C}$ $T_j=175^\circ\text{C}$	- -	1.65 1.6	2.05 -	
Gate-emitter threshold voltage	$V_{GE(th)}$	$I_C=290\mu A, V_{CE}=V_{GE}$	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 1000	$\mu A$
Gate-emitter leakage current	$I_{GES}$	$V_{CE}=0V, V_{GE}=20V$	-	-	100	
Transconductance	$g_{fs}$	$V_{CE}=20V, I_C=20A$	-	11	-	S
Integrated gate resistor	$R_{Gint}$			-		$\Omega$

**Dynamic Characteristic**

Input capacitance	$C_{iss}$	$V_{CE}=25V,$ $V_{GE}=0V,$ $f=1MHz$	-	1100	-	$\mu F$
Output capacitance	$C_{oss}$		-	71	-	
Reverse transfer capacitance	$C_{riss}$		-	32	-	
Gate charge	$Q_{Gate}$	$V_{CC}=480V, I_C=20A$ $V_{GE}=15V$	-	120	-	nC
Internal emitter inductance	$L_E$	TO-247-3-21 TO-220-3-1	-	13 7	-	nH
measured 5mm (0.197 in.) from case						
Short circuit collector current <sup>1)</sup>	$I_{C(SC)}$	$V_{GE}=15V, t_{SC}\leq 5\mu s$ $V_{CC}=400V,$ $T_j\leq 150^\circ\text{C}$	-	183.3	-	A

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

<sup>2)</sup> Leakage inductance  $L_\sigma$  and Stray capacity  $C_\sigma$  due to dynamic test circuit in Figure E.

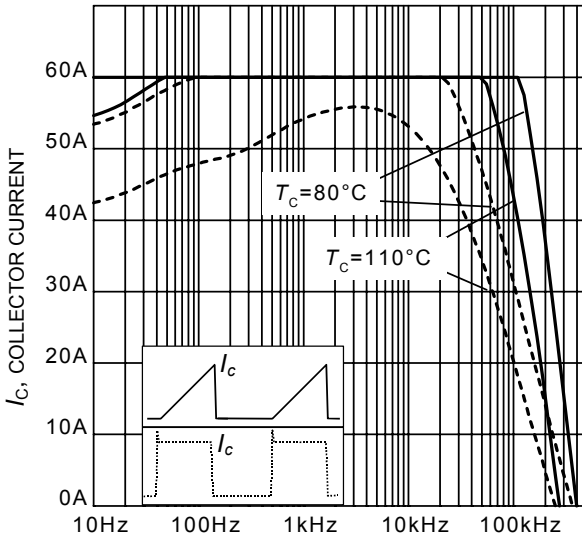
**Switching Characteristic, Inductive Load, at  $T_j=25^\circ\text{C}$** 

Parameter	Symbol	Conditions	Value			Unit
			min.	Typ.	max.	
<b>IGBT Characteristic</b>						
Turn-on delay time	$t_{d(\text{on})}$	$T_j=25^\circ\text{C}$ , $V_{\text{CC}}=400\text{V}$ , $I_{\text{C}}=20\text{A}$ , $V_{\text{GE}}=0/15\text{V}$ , $R_{\text{G}}=12\ \Omega$ , $L_{\sigma}^{2)}=131\text{nH}$ , $C_{\sigma}^{2)}=31\text{pF}$ Energy losses include "tail" and diode reverse recovery.	-	18	-	ns
Rise time	$t_r$		-	14	-	
Turn-off delay time	$t_{d(\text{off})}$		-	199	-	
Fall time	$t_f$		-	42	-	
Turn-on energy	$E_{\text{on}}$		-	0.31	-	mJ
Turn-off energy	$E_{\text{off}}$		-	0.46	-	
Total switching energy	$E_{\text{ts}}$		-	0.77	-	
<b>Anti-Parallel Diode Characteristic</b>						
Diode reverse recovery time	$t_{\text{rr}}$	$T_j=25^\circ\text{C}$ , $V_{\text{R}}=400\text{V}$ , $I_{\text{F}}=20\text{A}$ , $di_{\text{F}}/dt=880\text{A}/\mu\text{s}$	-	41	-	ns
Diode reverse recovery charge	$Q_{\text{rr}}$		-	0.31	-	$\mu\text{C}$
Diode peak reverse recovery current	$I_{\text{rrm}}$		-	13.3	-	A
Diode peak rate of fall of reverse recovery current during $t_{\text{b}}$	$di_{\text{rr}}/dt$		-	711	-	$\text{A}/\mu\text{s}$

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

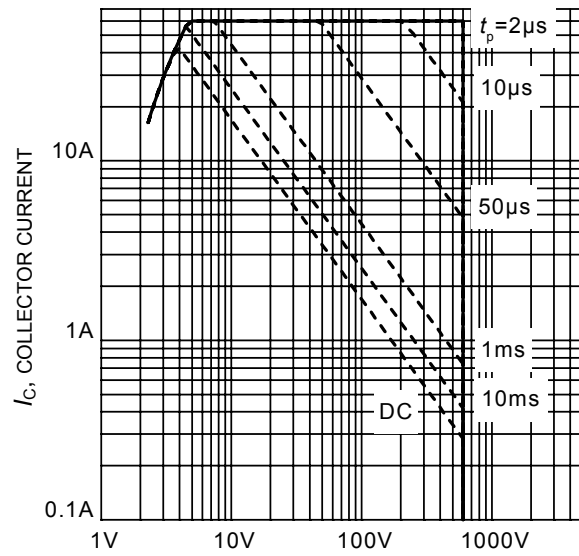
Parameter	Symbol	Conditions	Value			Unit
			min.	Typ.	max.	
<b>IGBT Characteristic</b>						
Turn-on delay time	$t_{d(\text{on})}$	$T_j=175^\circ\text{C}$ , $V_{\text{CC}}=400\text{V}$ , $I_{\text{C}}=20\text{A}$ , $V_{\text{GE}}=0/15\text{V}$ , $R_{\text{G}}=12\ \Omega$ , $L_{\sigma}^{1)}=131\text{nH}$ , $C_{\sigma}^{1)}=31\text{pF}$ Energy losses include "tail" and diode reverse recovery.	-	18	-	ns
Rise time	$t_r$		-	18	-	
Turn-off delay time	$t_{d(\text{off})}$		-	223	-	
Fall time	$t_f$		-	76	-	
Turn-on energy	$E_{\text{on}}$		-	0.51	-	mJ
Turn-off energy	$E_{\text{off}}$		-	0.64	-	
Total switching energy	$E_{\text{ts}}$		-	1.15	-	
<b>Anti-Parallel Diode Characteristic</b>						
Diode reverse recovery time	$t_{\text{rr}}$	$T_j=175^\circ\text{C}$ , $V_{\text{R}}=400\text{V}$ , $I_{\text{F}}=20\text{A}$ , $di_{\text{F}}/dt=880\text{A}/\mu\text{s}$	-	176	-	ns
Diode reverse recovery charge	$Q_{\text{rr}}$		-	1.46	-	$\mu\text{C}$
Diode peak reverse recovery current	$I_{\text{rrm}}$		-	18.9	-	A
Diode peak rate of fall of reverse recovery current during $t_{\text{b}}$	$di_{\text{rr}}/dt$		-	467	-	$\text{A}/\mu\text{s}$

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



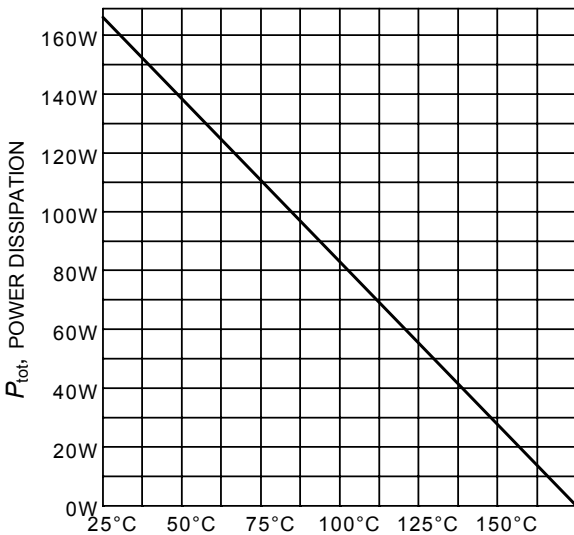
$f$ , SWITCHING FREQUENCY

**Figure 1. Collector current as a function of switching frequency**  
( $T_j \leq 175^\circ\text{C}$ ,  $D = 0.5$ ,  $V_{CE} = 400\text{V}$ ,  
 $V_{GE} = 0/+15\text{V}$ ,  $R_G = 12\Omega$ )



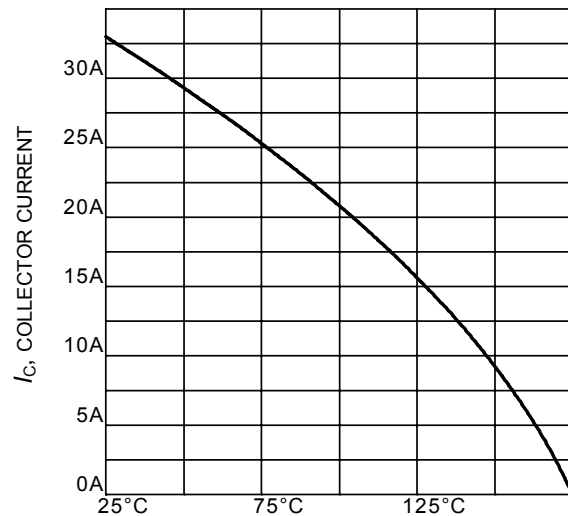
$V_{CE}$ , COLLECTOR-EMITTER VOLTAGE

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



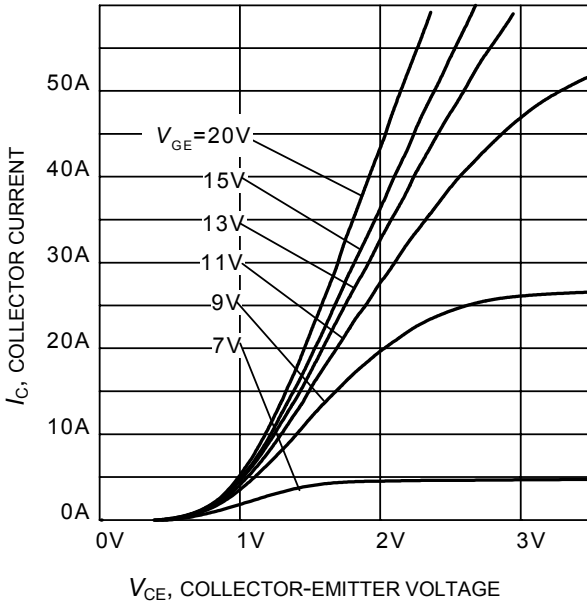
$T_C$ , CASE TEMPERATURE

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

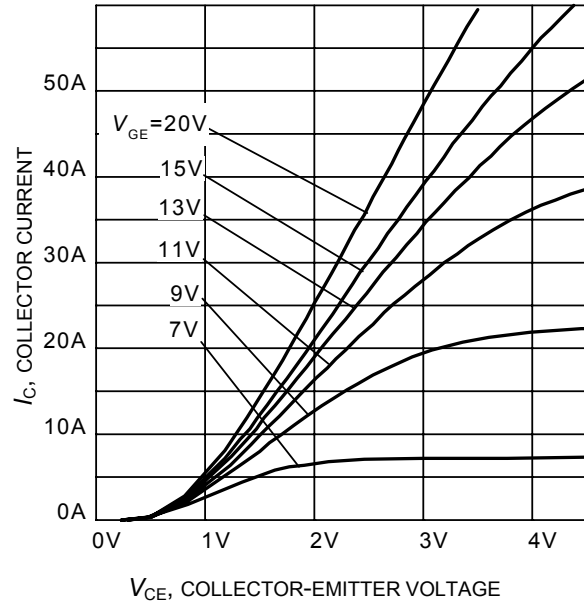


$T_C$ , CASE TEMPERATURE

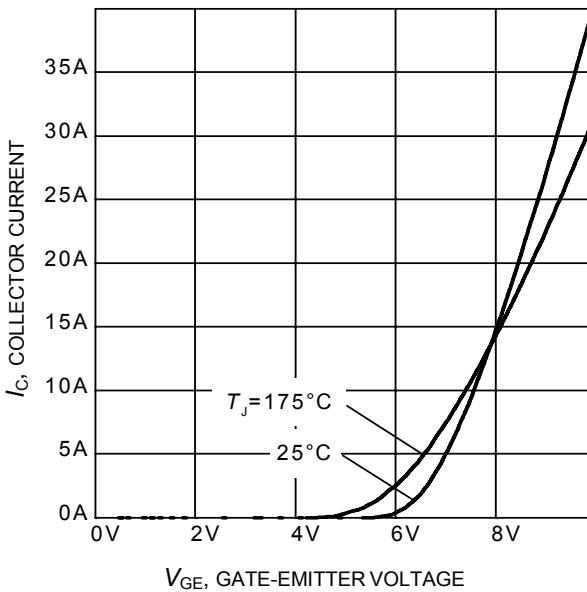
**Figure 4. Collector current as a function of case temperature**  
( $V_{GE} \geq 15\text{V}$ ,  $T_j \leq 175^\circ\text{C}$ )



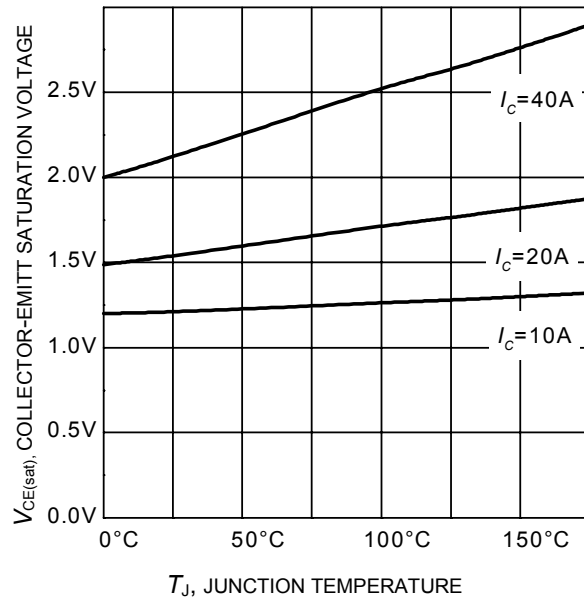
**Figure 5. Typical output characteristic**  
( $T_j = 25^\circ\text{C}$ )



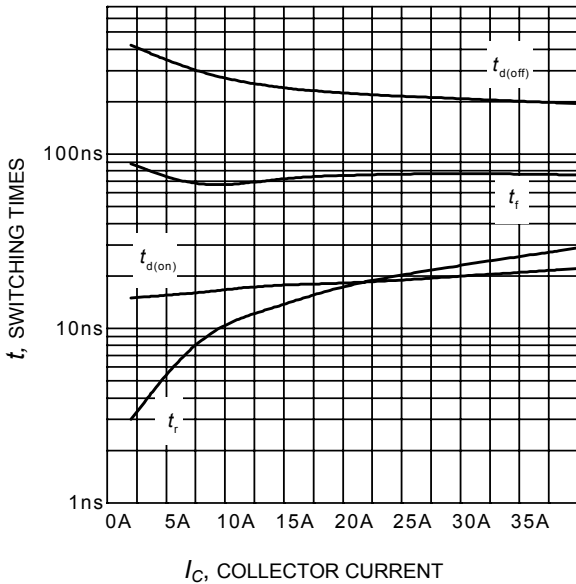
**Figure 6. Typical output characteristic**  
( $T_j = 175^\circ\text{C}$ )



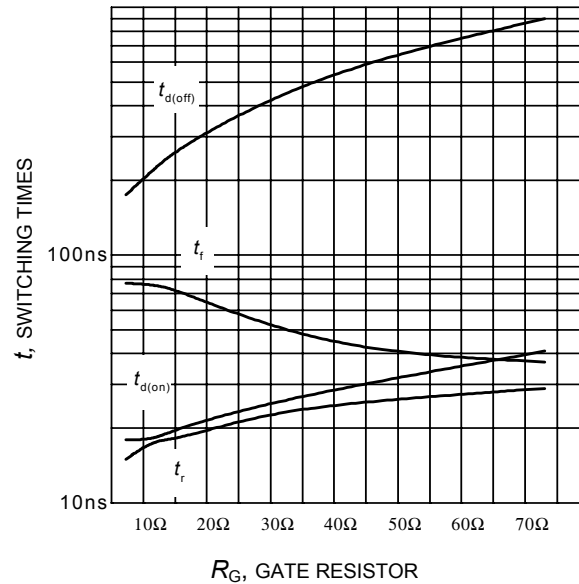
**Figure 7. Typical transfer characteristic**  
( $V_{CE} = 10\text{V}$ )



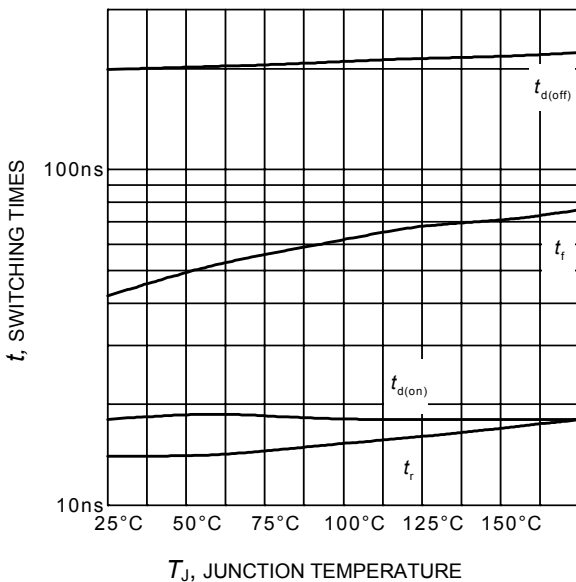
**Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature**  
( $V_{GE} = 15\text{V}$ )



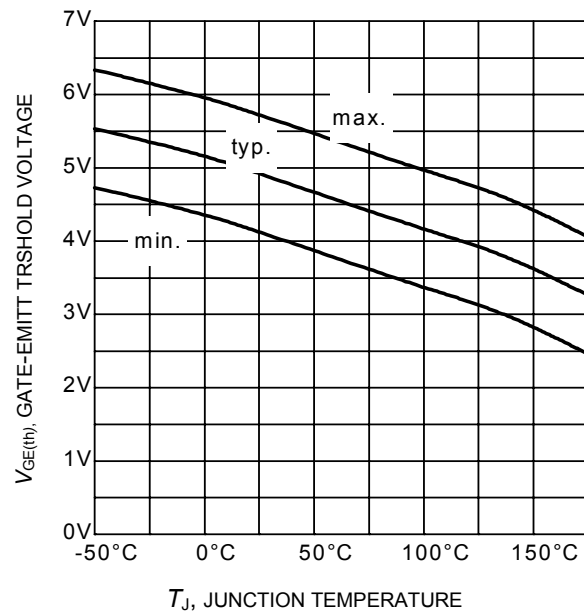
**Figure 9. Typical switching times as a function of collector current**  
(inductive load,  $T_J = 175^\circ\text{C}$ ,  $V_{CE} = 400\text{V}$ ,  $V_{GE} = 0/15\text{V}$ ,  $R_G = 12\Omega$ , Dynamic test circuit in Figure E)



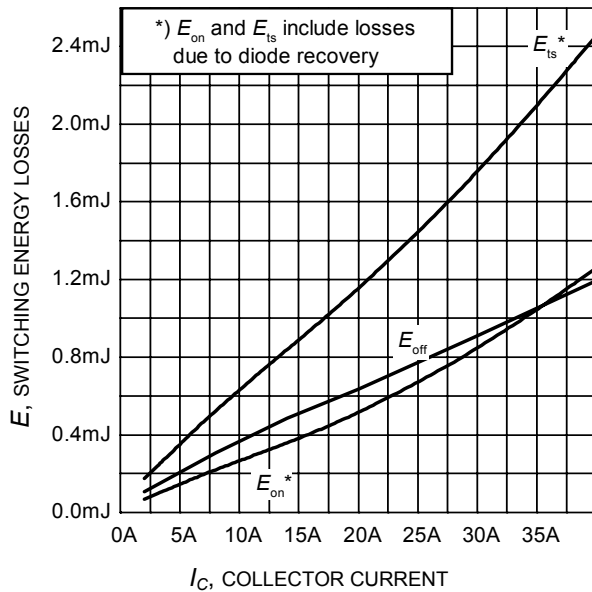
**Figure 10. Typical switching times as a function of gate resistor**  
(inductive load,  $T_J = 175^\circ\text{C}$ ,  $V_{CE} = 400\text{V}$ ,  $V_{GE} = 0/15\text{V}$ ,  $I_C = 20\text{A}$ , Dynamic test circuit in Figure E)



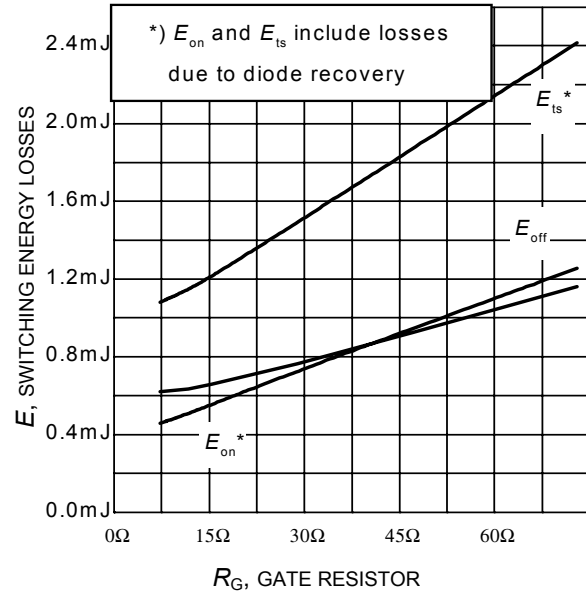
**Figure 11. Typical switching times as a function of junction temperature**  
(inductive load,  $V_{CE} = 400\text{V}$ ,  $V_{GE} = 0/15\text{V}$ ,  $I_C = 20\text{A}$ ,  $R_G = 12\Omega$ , Dynamic test circuit in Figure E)



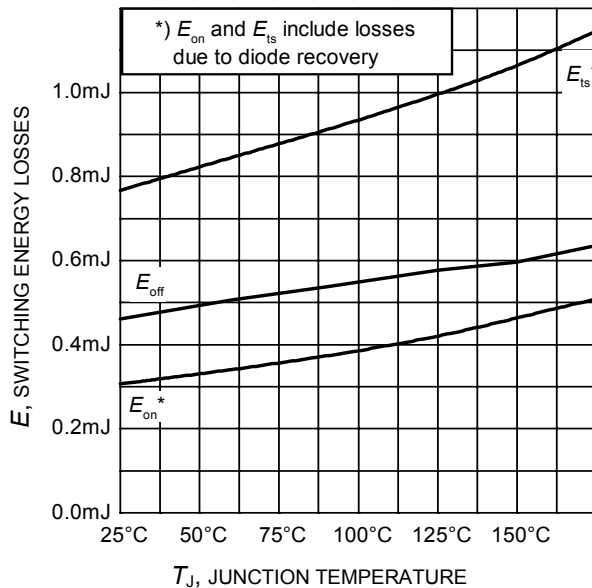
**Figure 12. Gate-emitter threshold voltage as a function of junction temperature**  
( $I_C = 0.29\text{mA}$ )



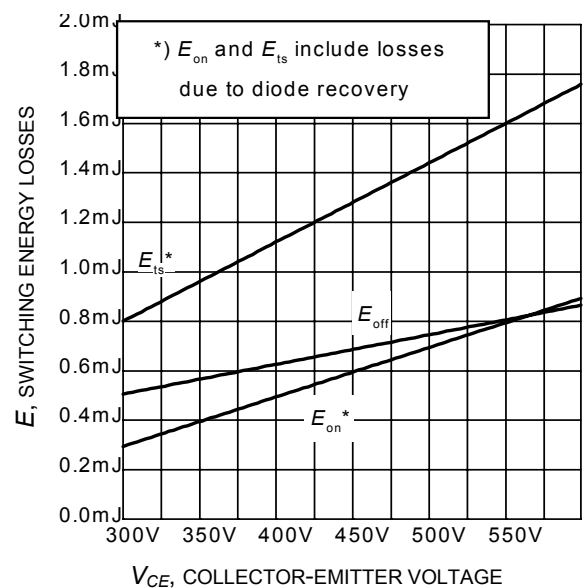
**Figure 13. Typical switching energy losses as a function of collector current**  
(inductive load,  $T_J = 175^\circ\text{C}$ ,  $V_{CE} = 400\text{V}$ ,  $V_{GE} = 0/15\text{V}$ ,  $R_G = 12\Omega$ , Dynamic test circuit in Figure E)



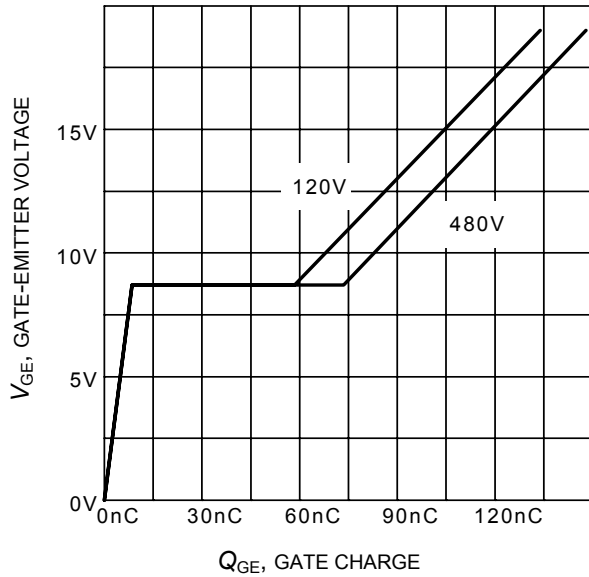
**Figure 14. Typical switching energy losses as a function of gate resistor**  
(inductive load,  $T_J = 175^\circ\text{C}$ ,  $V_{CE} = 400\text{V}$ ,  $V_{GE} = 0/15\text{V}$ ,  $I_C = 20\text{A}$ , Dynamic test circuit in Figure E)



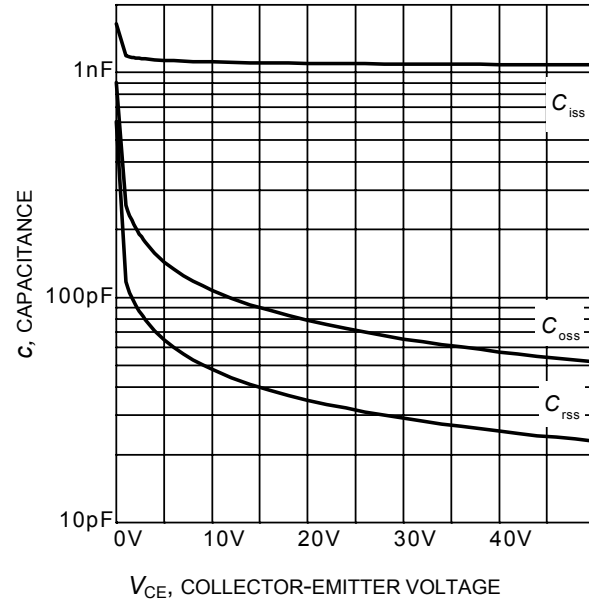
**Figure 15. Typical switching energy losses as a function of junction temperature**  
(inductive load,  $V_{CE} = 400\text{V}$ ,  $V_{GE} = 0/15\text{V}$ ,  $I_C = 20\text{A}$ ,  $R_G = 12\Omega$ , Dynamic test circuit in Figure E)



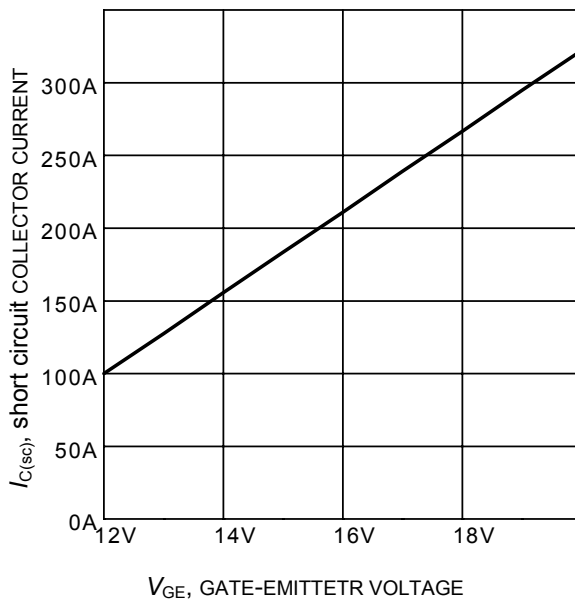
**Figure 16. Typical switching energy losses as a function of collector emitter voltage**  
(inductive load,  $T_J = 175^\circ\text{C}$ ,  $V_{GE} = 0/15\text{V}$ ,  $I_C = 20\text{A}$ ,  $R_G = 12\Omega$ , Dynamic test circuit in Figure E)



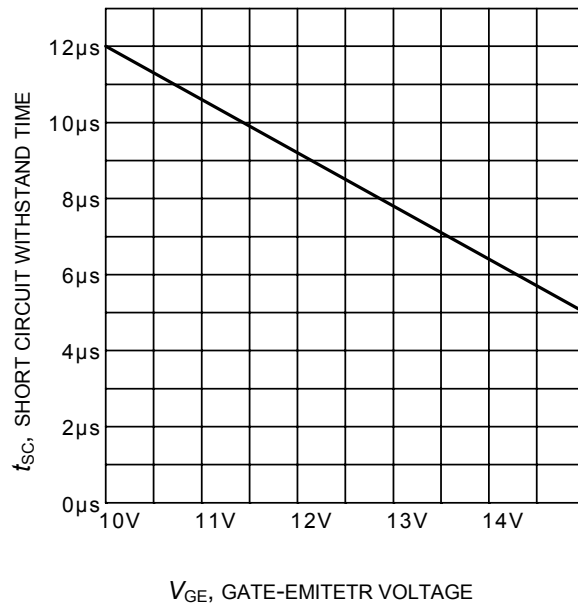
**Figure 17. Typical gate charge**  
( $I_C=20\text{ A}$ )



**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**  
( $V_{CE}=600\text{V}$ , start at  $T_j=25^\circ\text{C}$ ,  $T_{jmax}<150^\circ\text{C}$ )



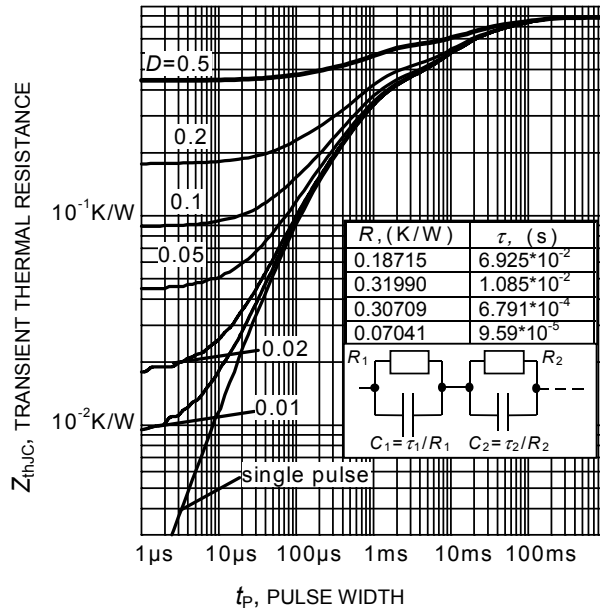


Figure 21. IGBT transient thermal resistance ( $D = t_p / T$ )

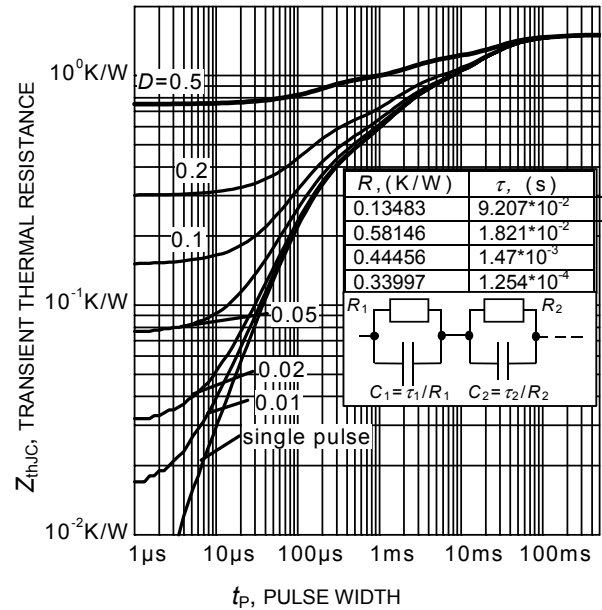


Figure 22. Diode transient thermal impedance as a function of pulse width ( $D = t_p / T$ )

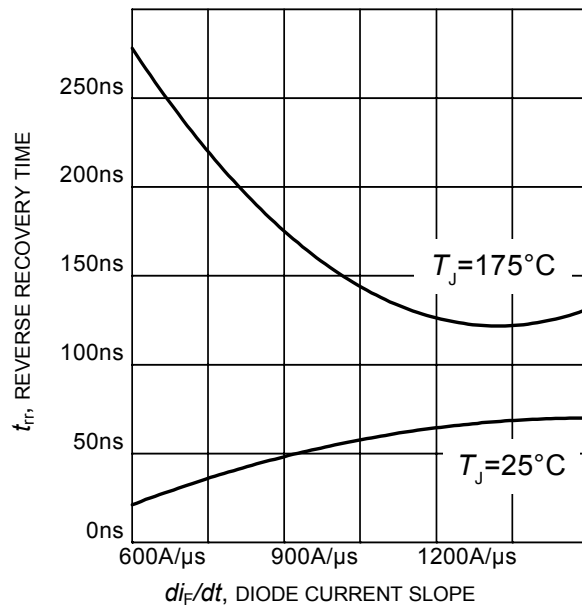


Figure 23. Typical reverse recovery time as a function of diode current slope ( $V_R = 400V$ ,  $I_F = 20A$ , Dynamic test circuit in Figure E)

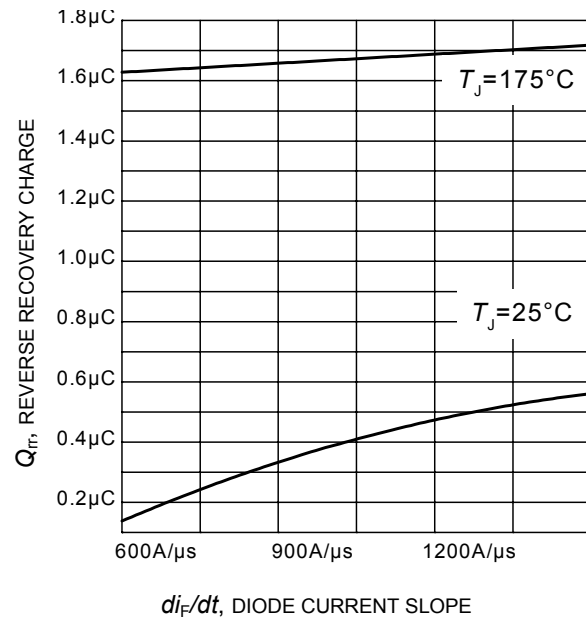
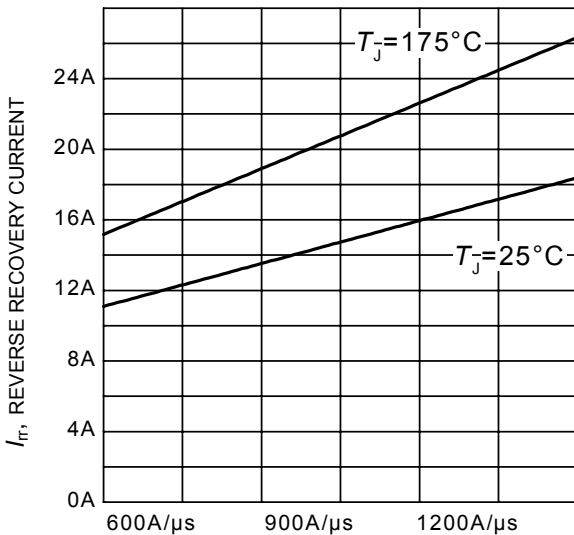


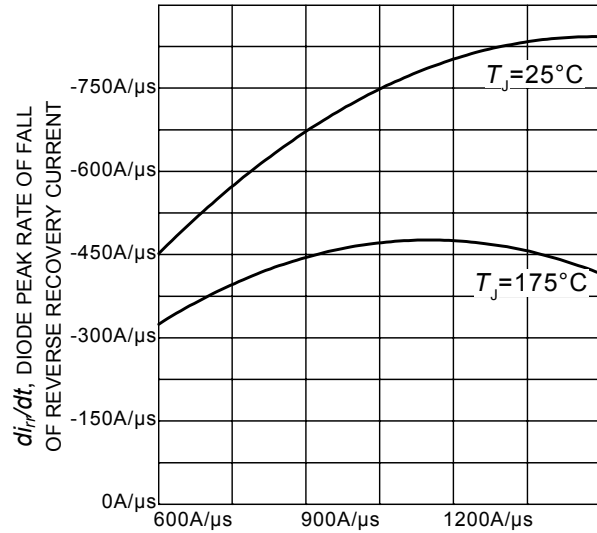
Figure 24. Typical reverse recovery charge as a function of diode current slope ( $V_R = 400V$ ,  $I_F = 20A$ , Dynamic test circuit in Figure E)



$di_F/dt$ , DIODE CURRENT SLOPE

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

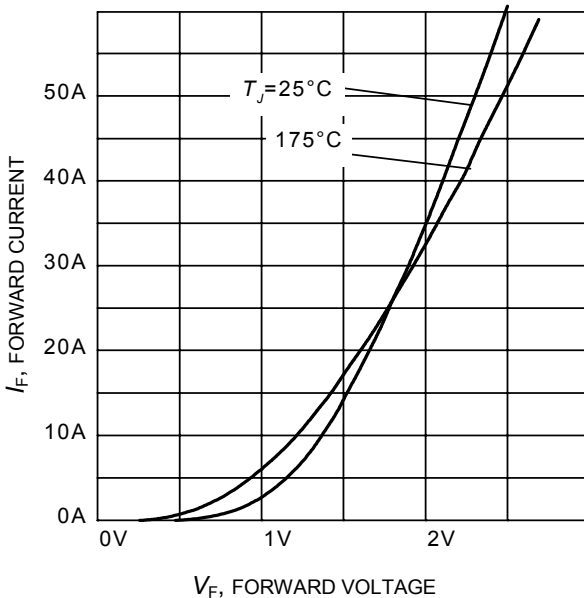
( $V_R = 400V$ ,  $I_F = 20A$ ,  
Dynamic test circuit in Figure E)



$di_F/dt$ , DIODE CURRENT SLOPE

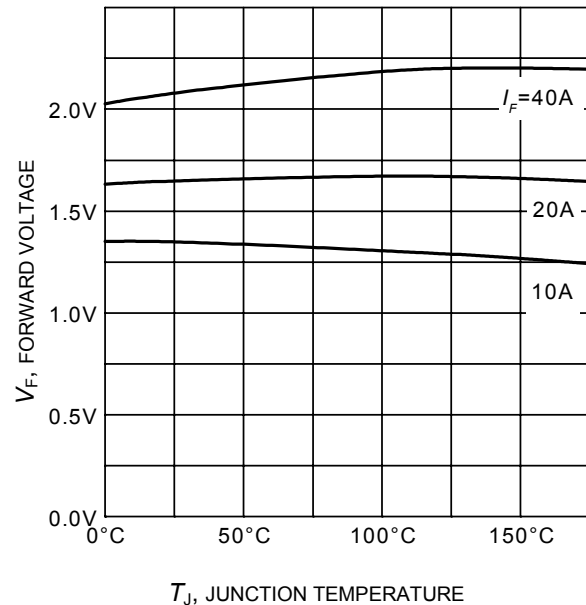
**Figure 26. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope**

( $V_R = 400V$ ,  $I_F = 20A$ ,  
Dynamic test circuit in Figure E)



$V_F$ , FORWARD VOLTAGE

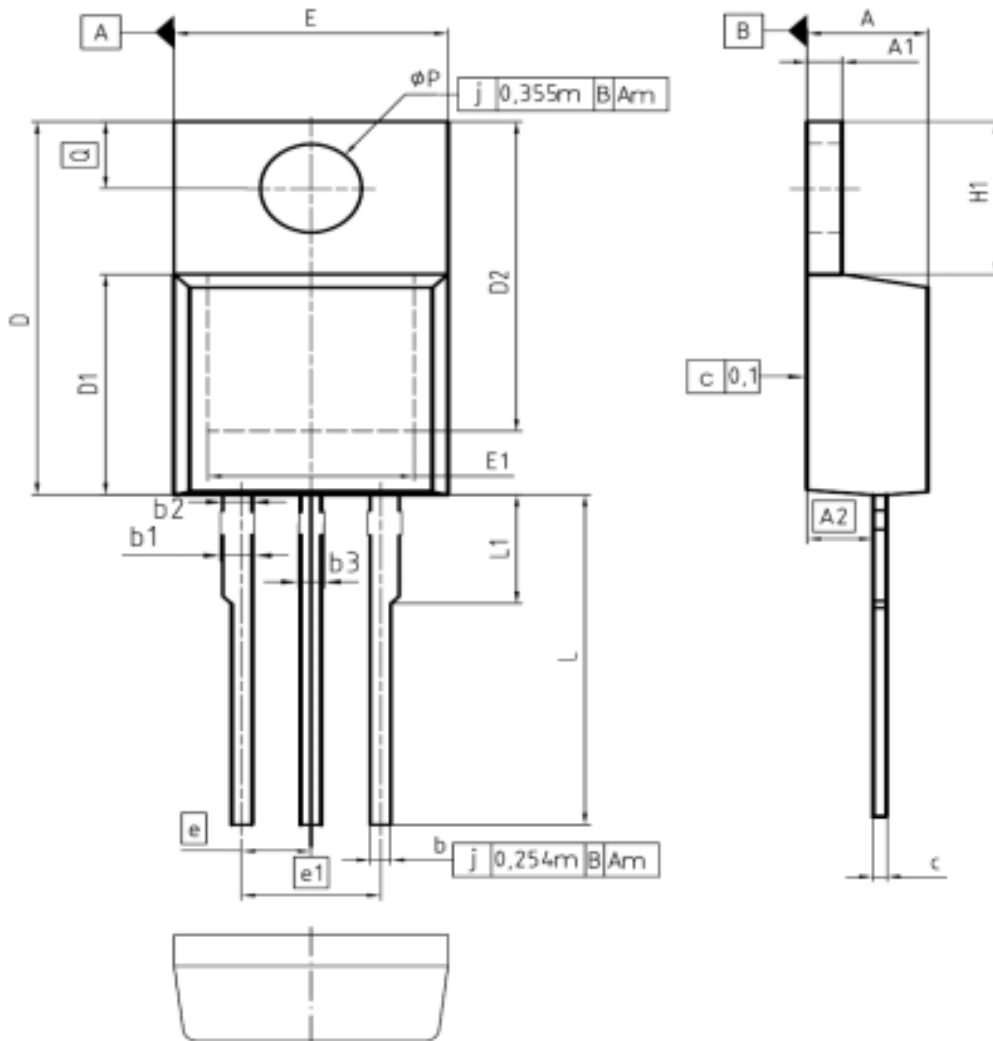
**Figure 27. Typical diode forward current as a function of forward voltage**



$T_J$ , JUNCTION TEMPERATURE

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

PG-TO-220-3-1



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.30	4.57	0.169	0.180
A1	1.17	1.40	0.046	0.055
A2	2.15	2.72	0.085	0.107
b	0.65	0.86	0.026	0.034
b1	0.95	1.40	0.037	0.055
b2	0.95	1.15	0.037	0.045
b3	0.65	1.15	0.026	0.045
c	0.33	0.60	0.013	0.024
D	14.81	15.95	0.583	0.628
D1	8.51	9.45	0.335	0.372
D2	12.19	13.10	0.480	0.516
E	9.70	10.36	0.382	0.408
E1	8.50	8.60	0.256	0.339
e	2.54		0.100	
e1	5.08		0.200	
N	3		3	
H1	5.90	6.90	0.232	0.272
L	13.00	14.00	0.512	0.551
L1	-	4.80	-	0.189
phi P	3.60	3.89	0.142	0.153
Q	2.60	3.00	0.102	0.118

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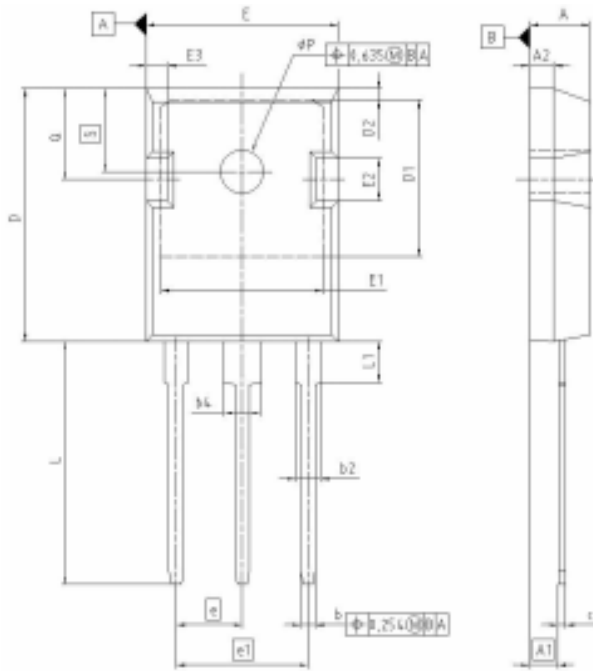
SCALE

EUROPEAN PROJECTION

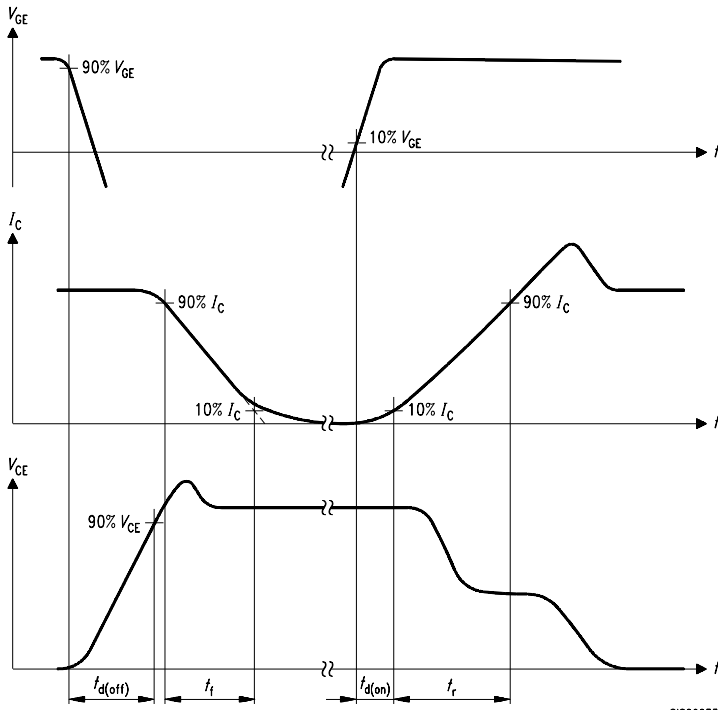
ISSUE DATE  
23-08-2007

REVISION  
05

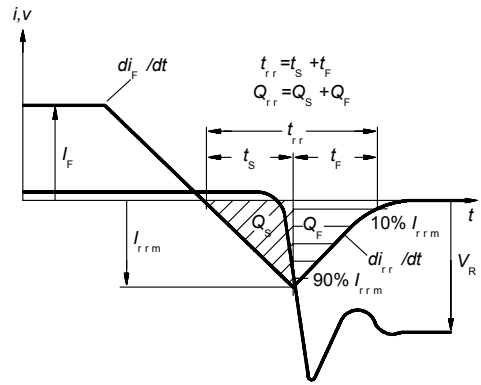
PG-TO247-3-21



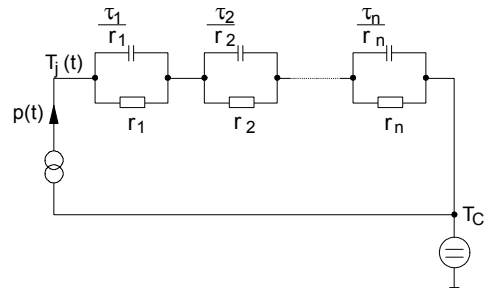
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.900	5.157	0.193	0.203
A1	2.275	2.527	0.090	0.100
A2	1.880	2.107	0.075	0.083
b	1.073	1.327	0.042	0.052
b2	1.900	2.588	0.075	0.102
b4	2.870	3.454	0.113	0.136
c	0.549	0.752	0.021	0.030
D	20.823	21.077	0.820	0.830
D1	17.323	17.831	0.682	0.702
D2	1.063	1.317	0.042	0.052
E	15.773	16.027	0.621	0.631
E1	13.890	14.147	0.547	0.557
E2	3.883	3.067	0.153	0.158
E3	1.903	1.907	0.075	0.076
e	5.450		0.215	
e1	10.000		0.430	
M	3		3	
L	20.053	20.307	0.793	0.799
L1	4.168	4.472	0.164	0.176
øP	3.259	3.261	0.128	0.128
Q	5.495	5.747	0.216	0.226
S	6.043	6.297	0.238	0.248



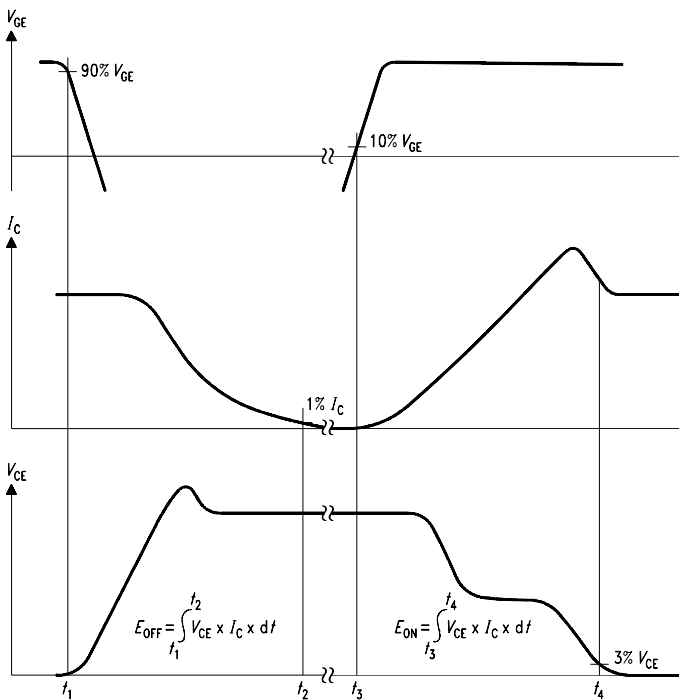
**Figure A. Definition of switching times**



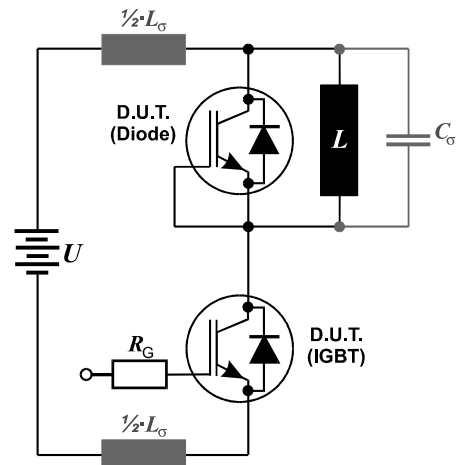
**Figure C. Definition of diodes switching characteristics**



**Figure D. Thermal equivalent circuit**



**Figure B. Definition of switching losses**



**Figure E. Dynamic test circuit**

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