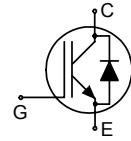


## HighSpeed 2-Technology with soft, fast recovery anti-parallel EmCon HE diode

- **Designed for:**
  - SMPS
  - Lamp Ballast
  - ZVS-Converter
  - optimised for soft-switching / resonant topologies



- **2<sup>nd</sup> generation HighSpeed-Technology for 1200V applications offers:**

- loss reduction in resonant circuits
- temperature stable behavior
- parallel switching capability
- tight parameter distribution
- $E_{off}$  optimized for  $I_C = 1A$



- Qualified according to JEDEC<sup>2</sup> for target applications
- Pb-free lead plating; RoHS compliant
- Complete product spectrum and PSpice Models : <http://www.infineon.com/igbt/>

Type	$V_{CE}$	$I_C$	$E_{off}$	$T_j$	Marking	Package
IKB01N120H2	1200V	1A	0.09mJ	150°C	K01H1202	P-TO-220-3-45

**Maximum Ratings**

Parameter	Symbol	Value	Unit
Collector-emitter voltage	$V_{CE}$	1200	V
Triangular collector current	$I_C$		A
$T_C = 25^\circ\text{C}$ , $f = 140\text{kHz}$		3.2	
$T_C = 100^\circ\text{C}$ , $f = 140\text{kHz}$		1.3	
Pulsed collector current, $t_p$ limited by $T_{jmax}$	$I_{Cpuls}$	3.5	
Turn off safe operating area	-	3.5	
$V_{CE} \leq 1200\text{V}$ , $T_j \leq 150^\circ\text{C}$			
Diode forward current	$I_F$		
$T_C = 25^\circ\text{C}$		3.2	
$T_C = 100^\circ\text{C}$		1.3	
Gate-emitter voltage	$V_{GE}$	$\pm 20$	V
Power dissipation	$P_{tot}$	28	W
$T_C = 25^\circ\text{C}$			
Operating junction and storage temperature	$T_j, T_{stg}$	-40...+150	°C
Soldering temperature (reflow soldering, MSL1)	-	220	

<sup>2</sup> J-STD-020 and JESD-022

**Thermal Resistance**

Parameter	Symbol	Conditions	Max. Value	Unit
<b>Characteristic</b>				
IGBT thermal resistance, junction – case	$R_{thJC}$		4.5	K/W
Diode thermal resistance, Junction - case	$R_{thJCD}$		11	
Thermal resistance, junction – ambient <sup>1)</sup>	$R_{thJA}$		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	$V_{(BR)CES}$	$V_{GE}=0V, I_C=300\mu A$	1200	-	-	V
Collector-emitter saturation voltage	$V_{CE(sat)}$	$V_{GE} = 15V, I_C=1A$ $T_j=25^\circ\text{C}$ $T_j=150^\circ\text{C}$	-	2.2	2.8	
			$V_{GE} = 10V, I_C=1A,$ $T_j=25^\circ\text{C}$	-	2.5	
				-	2.4	-
Gate-emitter threshold voltage	$V_{GE(th)}$	$I_C=30\mu A, V_{CE}=V_{GE}$	2.1	3	3.9	
Zero gate voltage collector current	$I_{CES}$	$V_{CE}=1200V, V_{GE}=0V$ $T_j=25^\circ\text{C}$ $T_j=150^\circ\text{C}$	-	-	20	$\mu A$
			-	-	80	
Diode forward voltage	$V_F$	$V_{GE} = 0, I_F=0.5A$ $T_j=25^\circ\text{C}$ $T_j=150^\circ\text{C}$	-	2.0	2.5	V
			-	1.75	-	
Gate-emitter leakage current	$I_{GES}$	$V_{CE}=0V, V_{GE}=20V$	-	-	40	nA
Transconductance	$g_{fs}$	$V_{CE}=20V, I_C=1A$	-	0.75	-	S
<b>Dynamic Characteristic</b>						
Input capacitance	$C_{iss}$	$V_{CE}=25V,$ $V_{GE}=0V,$ $f=1\text{MHz}$	-	91.6	-	pF
Output capacitance	$C_{oss}$		-	9.8	-	
Reverse transfer capacitance	$C_{riss}$		-	3.4	-	
Gate charge	$Q_{Gate}$	$V_{CC}=960V, I_C=1A$ $V_{GE}=15V$	-	8.6	-	nC
Internal emitter inductance measured 5mm (0.197 in.) from case	$L_E$		-	7	-	nH

<sup>1)</sup> Device on 50mm\*50mm\*1.5mm epoxy PCB FR4 with 6cm<sup>2</sup> (one layer, 70μm thick) copper area for collector connection. PCB is vertical without blown air.

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

Parameter	Symbol	Conditions	Value			Unit
			min.	Typ.	max.	
<b>IGBT Characteristic</b>						
Turn-on delay time	$t_{d(on)}$	$T_j=25\text{ }^\circ\text{C}$ , $V_{CC}=800\text{V}$ , $I_C=1\text{A}$ , $V_{GE}=15\text{V}/0\text{V}$ , $R_G=241\Omega$ , $L_\sigma^{(2)}=180\text{nH}$ , $C_\sigma^{(2)}=40\text{pF}$ Energy losses include "tail" and diode <sup>3)</sup> reverse recovery.	-	13	-	ns
Rise time	$t_r$		-	6.3	-	
Turn-off delay time	$t_{d(off)}$		-	370	-	
Fall time	$t_f$		-	28	-	
Turn-on energy	$E_{on}$		-	0.08	-	mJ
Turn-off energy	$E_{off}$		-	0.06	-	
Total switching energy	$E_{ts}$		-	0.14	-	
<b>Anti-Parallel Diode Characteristic</b>						
Diode reverse recovery time	$t_{rr}$	$T_j=25\text{ }^\circ\text{C}$ , $V_R=800\text{V}$ , $I_F=1\text{A}$ , $R_G=241\Omega$	-	83	-	ns
Diode reverse recovery charge	$Q_{rr}$		-	89	-	$\mu\text{C}$
Diode peak reverse recovery current	$I_{rrm}$		-	2.5	-	A
Diode current slope	$di_F/dt$		-	289	-	$\text{A}/\mu\text{s}$
Diode peak rate of fall of reverse recovery current during $t_b$	$di_{rr}/dt$		-	178	-	

**Switching Characteristic, Inductive Load, at  $T_j=150\text{ }^\circ\text{C}$** 

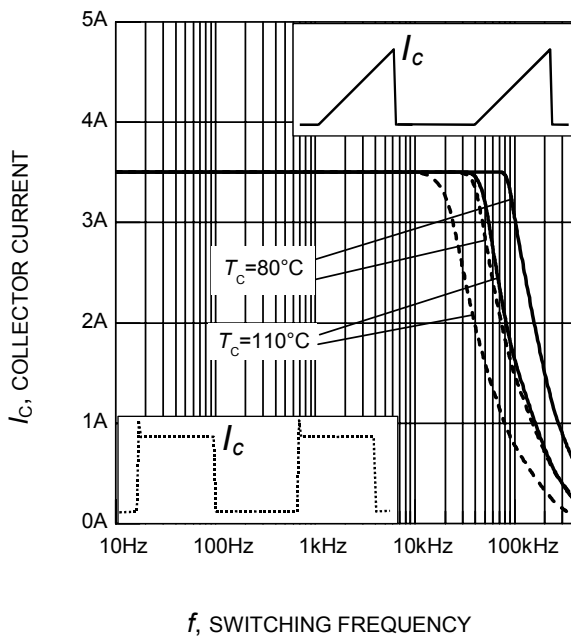
Parameter	Symbol	Conditions	Value			Unit
			min.	Typ.	max.	
<b>IGBT Characteristic</b>						
Turn-on delay time	$t_{d(on)}$	$T_j=150\text{ }^\circ\text{C}$ $V_{CC}=800\text{V}$ , $I_C=1\text{A}$ , $V_{GE}=15\text{V}/0\text{V}$ , $R_G=241\Omega$ , $L_\sigma^{(2)}=180\text{nH}$ , $C_\sigma^{(2)}=40\text{pF}$ Energy losses include "tail" and diode <sup>4)</sup> reverse recovery.	-	12	-	ns
Rise time	$t_r$		-	8.9	-	
Turn-off delay time	$t_{d(off)}$		-	450	-	
Fall time	$t_f$		-	43	-	
Turn-on energy	$E_{on}$		-	0.11	-	mJ
Turn-off energy	$E_{off}$		-	0.09	-	
Total switching energy	$E_{ts}$		-	0.2	-	
<b>Anti-Parallel Diode Characteristic</b>						
Diode reverse recovery time	$t_{rr}$	$T_j=150\text{ }^\circ\text{C}$ $V_R=800\text{V}$ , $I_F=1\text{A}$ , $R_G=241\Omega$	-	213	-	ns
Diode reverse recovery charge	$Q_{rr}$		-	180	-	$\mu\text{C}$
Diode peak reverse recovery current	$I_{rrm}$		-	2.7	-	A
Diode current slope	$di_F/dt$		-	240	-	$\text{A}/\mu\text{s}$
Diode peak rate of fall of reverse recovery current during $t_b$	$di_{rr}/dt$		-	135	-	

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

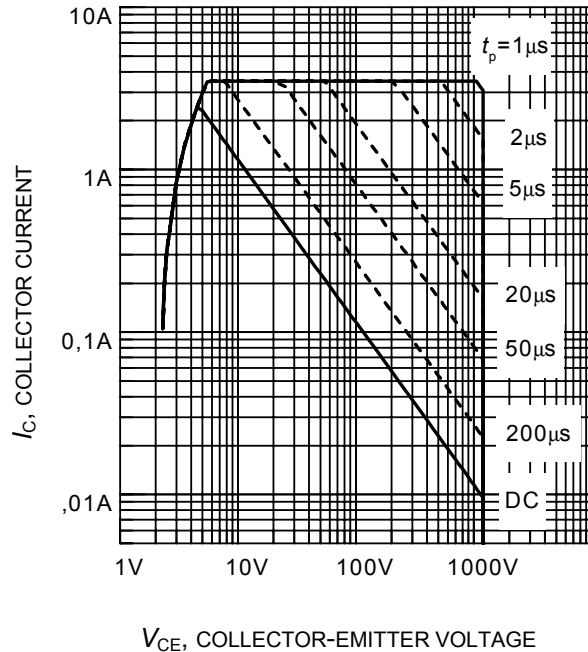
<sup>4)</sup> Commutation diode from device IKP01N120H2

**Switching Energy ZVT, Inductive Load**

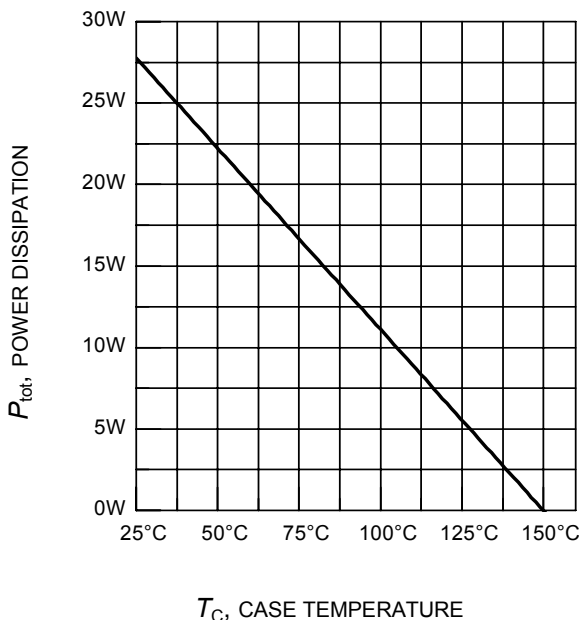
Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
<b>IGBT Characteristic</b>						
Turn-off energy	$E_{off}$	$V_{CC}=800V,$ $I_C=1A,$ $V_{GE}=15V/0V,$ $R_G=241\Omega,$ $C_r^{(2)}=1nF$ $T_j=25^\circ C$ $T_j=150^\circ C$	-	0.02	-	mJ
			-	0.044	-	



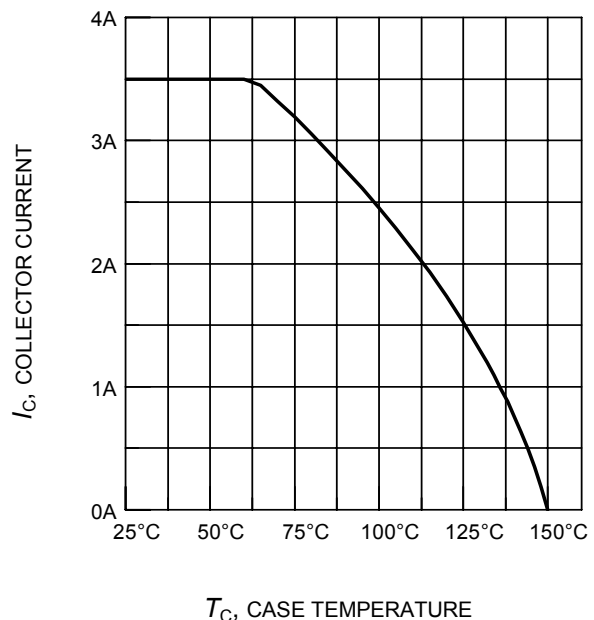
**Figure 1. Collector current as a function of switching frequency**  
 ( $T_j \leq 150^\circ\text{C}$ ,  $D = 0.5$ ,  $V_{CE} = 800\text{V}$ ,  $V_{GE} = +15\text{V}/0\text{V}$ ,  $R_G = 241\Omega$ )



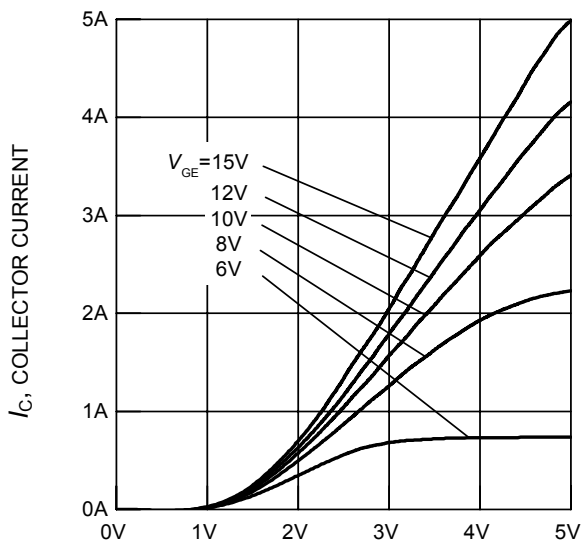
**Figure 2. Safe operating area**  
 ( $D = 0$ ,  $T_C = 25^\circ\text{C}$ ,  $T_j \leq 150^\circ\text{C}$ )



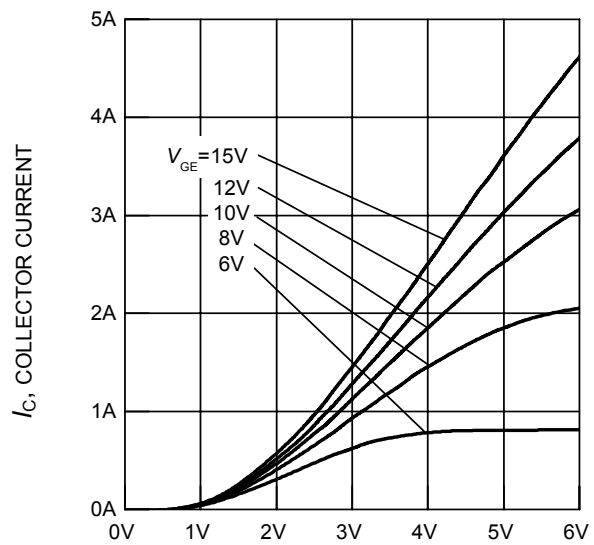
**Figure 3. Power dissipation as a function of case temperature**  
 ( $T_j \leq 150^\circ\text{C}$ )



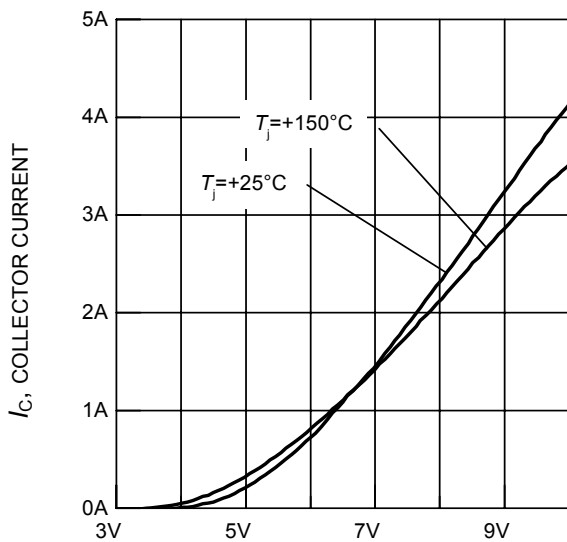
**Figure 4. Collector current as a function of case temperature**  
 ( $V_{GE} \leq 15\text{V}$ ,  $T_j \leq 150^\circ\text{C}$ )



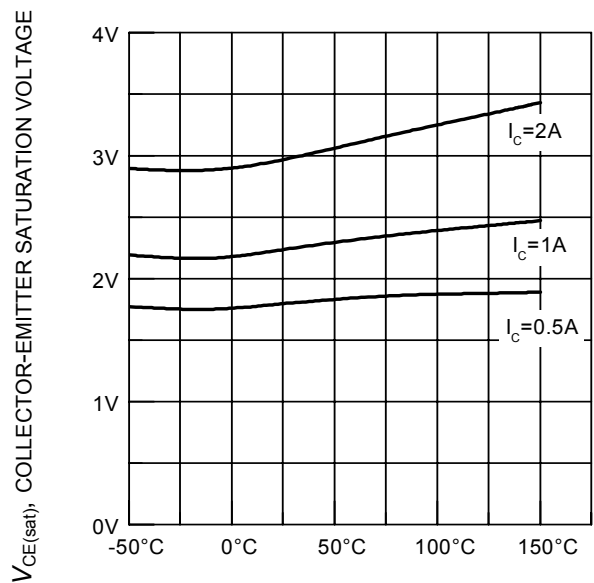
$V_{CE}$ , COLLECTOR-EMITTER VOLTAGE  
**Figure 5. Typical output characteristics**  
 ( $T_j = 25^\circ\text{C}$ )



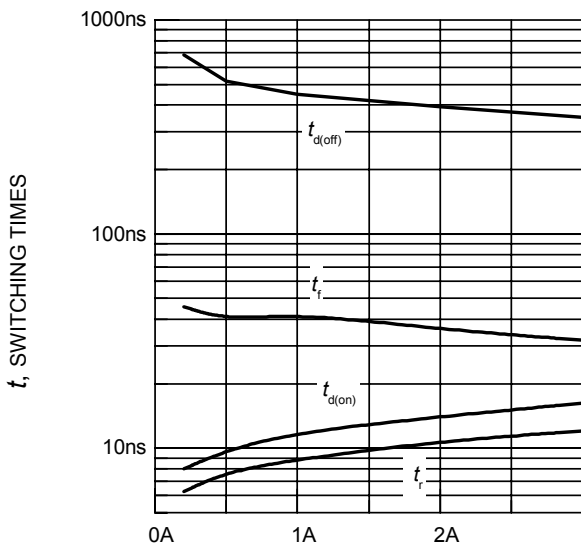
$V_{CE}$ , COLLECTOR-EMITTER VOLTAGE  
**Figure 6. Typical output characteristics**  
 ( $T_j = 150^\circ\text{C}$ )



$V_{GE}$ , GATE-EMITTER VOLTAGE  
**Figure 7. Typical transfer characteristics**  
 ( $V_{CE} = 20\text{V}$ )



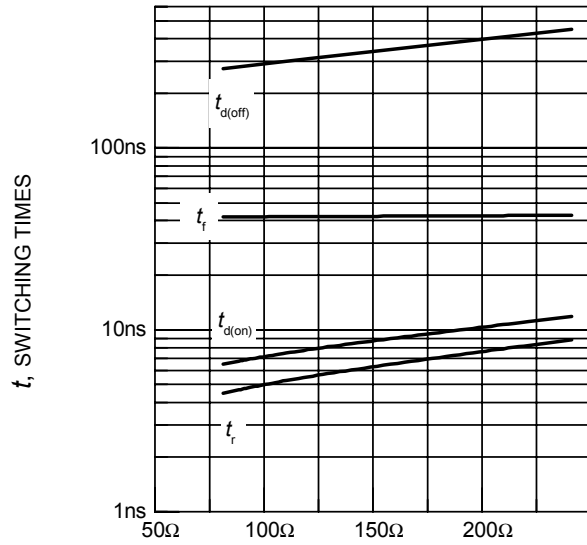
$T_j$ , JUNCTION TEMPERATURE  
**Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature**  
 ( $V_{GE} = 15\text{V}$ )



$I_C$ , COLLECTOR CURRENT

**Figure 9. Typical switching times as a function of collector current**

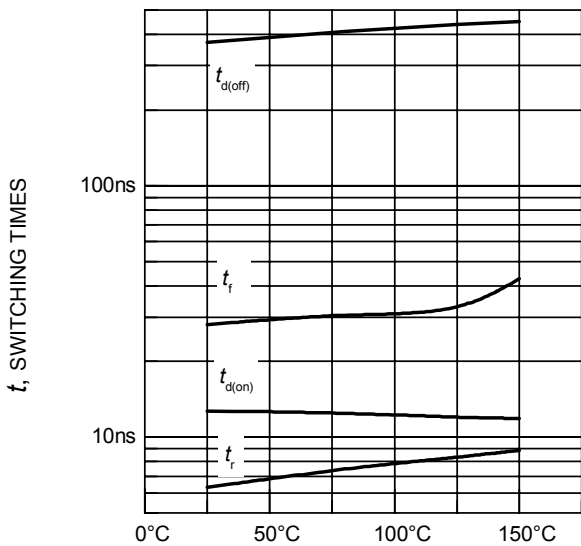
(inductive load,  $T_j = 150^\circ\text{C}$ ,  $V_{CE} = 800\text{V}$ ,  $V_{GE} = +15\text{V}/0\text{V}$ ,  $R_G = 241\Omega$ , dynamic test circuit in Fig.E)



$R_G$ , GATE RESISTOR

**Figure 10. Typical switching times as a function of gate resistor**

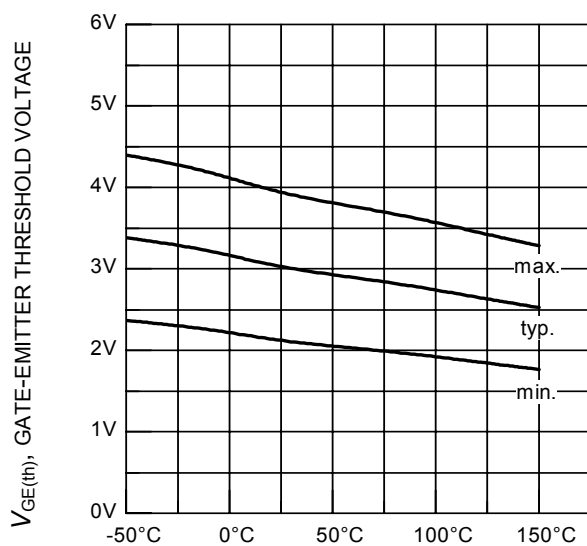
(inductive load,  $T_j = 150^\circ\text{C}$ ,  $V_{CE} = 800\text{V}$ ,  $V_{GE} = +15\text{V}/0\text{V}$ ,  $I_C = 1\text{A}$ , dynamic test circuit in Fig.E)



$T_j$ , JUNCTION TEMPERATURE

**Figure 11. Typical switching times as a function of junction temperature**

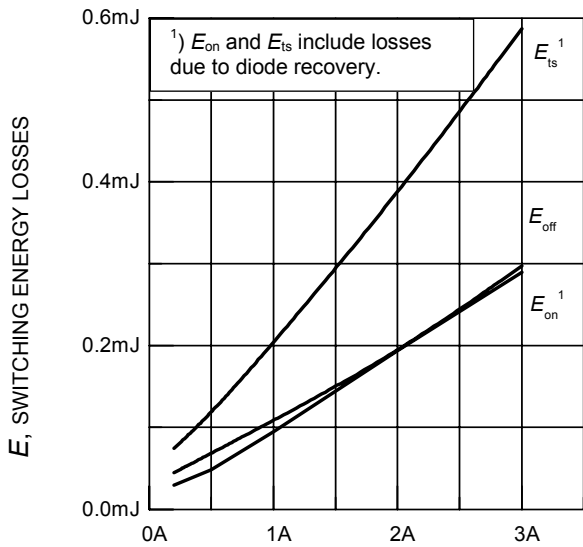
(inductive load,  $V_{CE} = 800\text{V}$ ,  $V_{GE} = +15\text{V}/0\text{V}$ ,  $I_C = 1\text{A}$ ,  $R_G = 241\Omega$ , dynamic test circuit in Fig.E)



$T_j$ , JUNCTION TEMPERATURE

**Figure 12. Gate-emitter threshold voltage as a function of junction temperature**

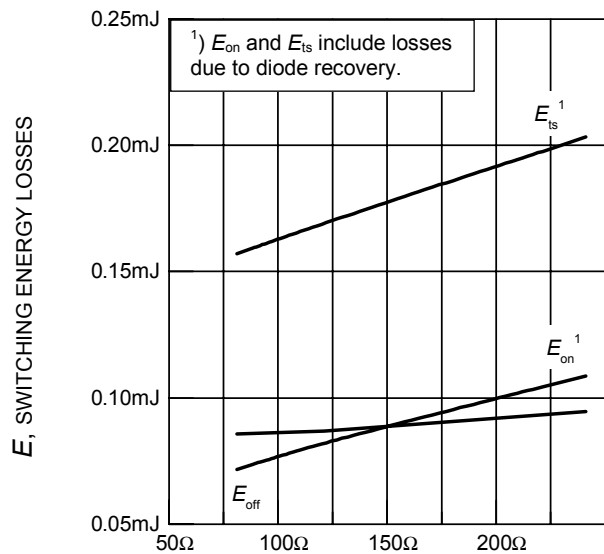
( $I_C = 0.03\text{mA}$ )



$I_C$ , COLLECTOR CURRENT

**Figure 13. Typical switching energy losses as a function of collector current**

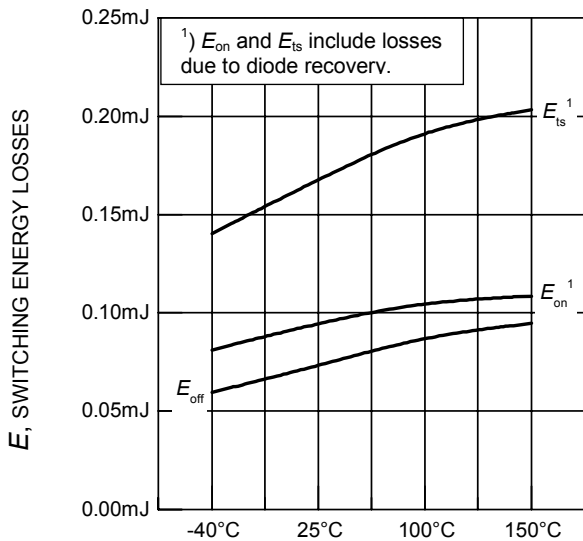
(inductive load,  $T_j = 150^\circ\text{C}$ ,  $V_{CE} = 800\text{V}$ ,  $V_{GE} = +15\text{V}/0\text{V}$ ,  $R_G = 241\Omega$ , dynamic test circuit in Fig.E )



$R_G$ , GATE RESISTOR

**Figure 14. Typical switching energy losses as a function of gate resistor**

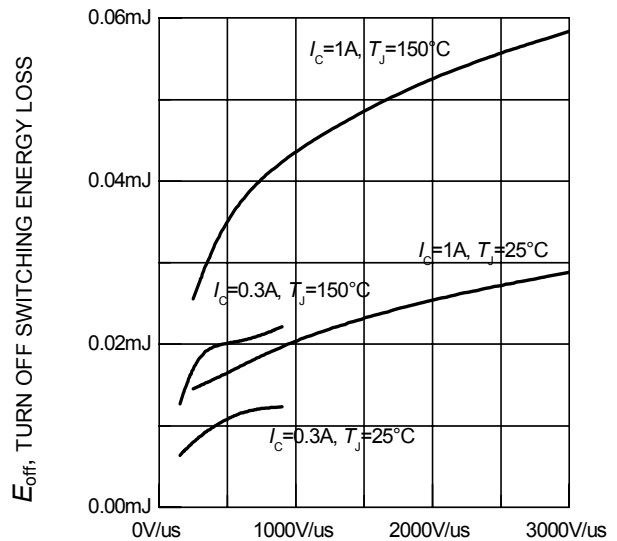
(inductive load,  $T_j = 150^\circ\text{C}$ ,  $V_{CE} = 800\text{V}$ ,  $V_{GE} = +15\text{V}/0\text{V}$ ,  $I_C = 1\text{A}$ , dynamic test circuit in Fig.E )



$T_j$ , JUNCTION TEMPERATURE

**Figure 15. Typical switching energy losses as a function of junction temperature**

(inductive load,  $V_{CE} = 800\text{V}$ ,  $V_{GE} = +15\text{V}/0\text{V}$ ,  $I_C = 1\text{A}$ ,  $R_G = 241\Omega$ , dynamic test circuit in Fig.E )

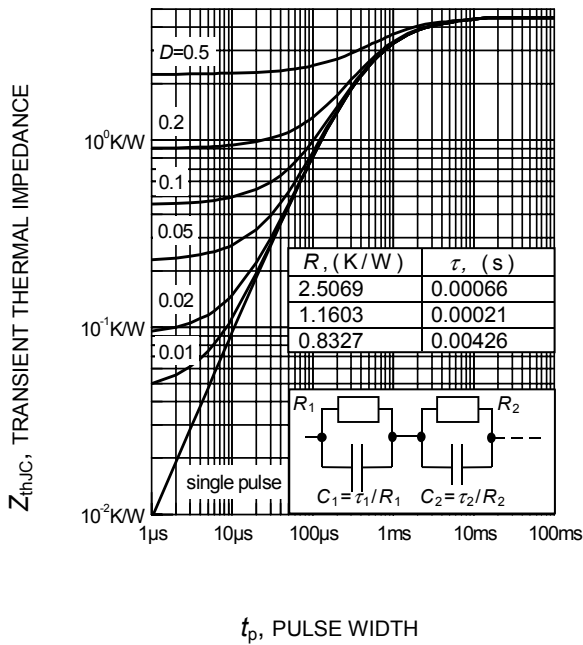


$dv/dt$ , VOLTAGE SLOPE

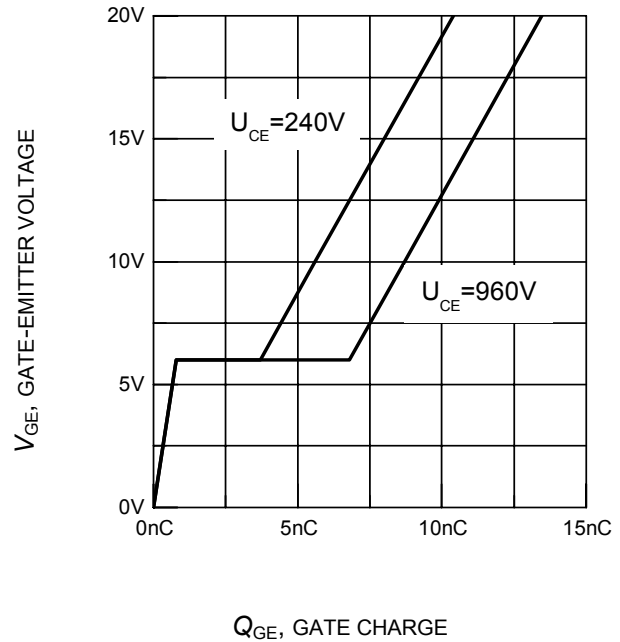
**Figure 16. Typical turn off switching energy loss for soft switching**

(dynamic test circuit in Fig. E)

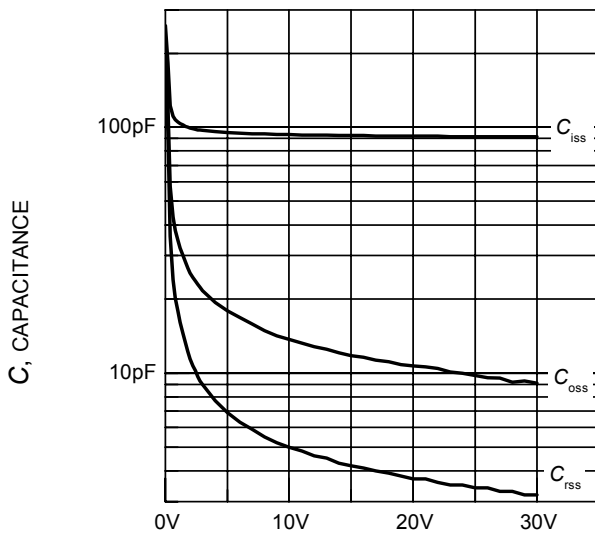




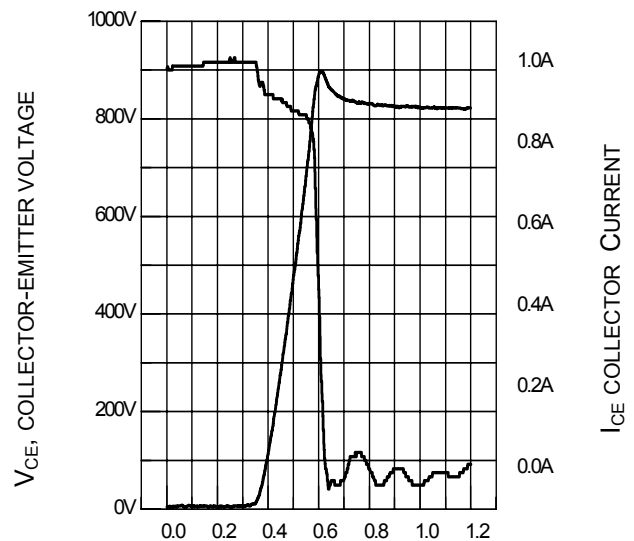
**Figure 17. IGBT transient thermal impedance as a function of pulse width**  
 $(D = t_p / T)$



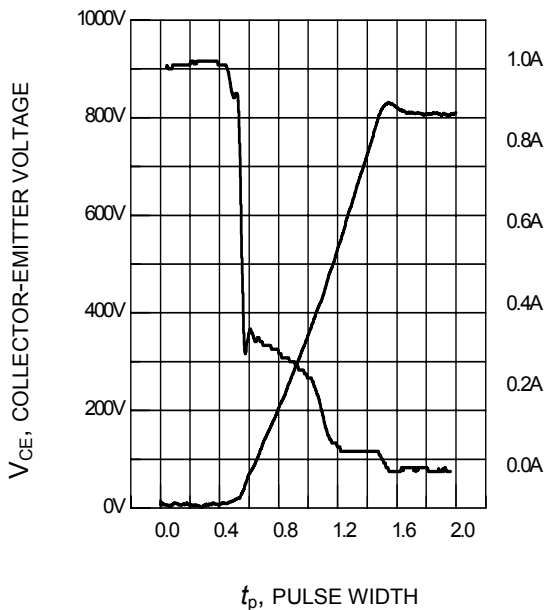
**Figure 18. Typical gate charge**  
 $(I_C = 1A)$



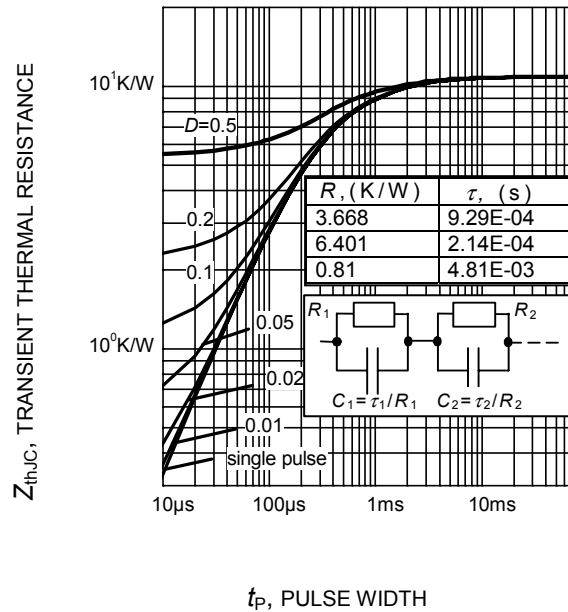
**Figure 19. Typical capacitance as a function of collector-emitter voltage**  
 $(V_{GE} = 0V, f = 1MHz)$



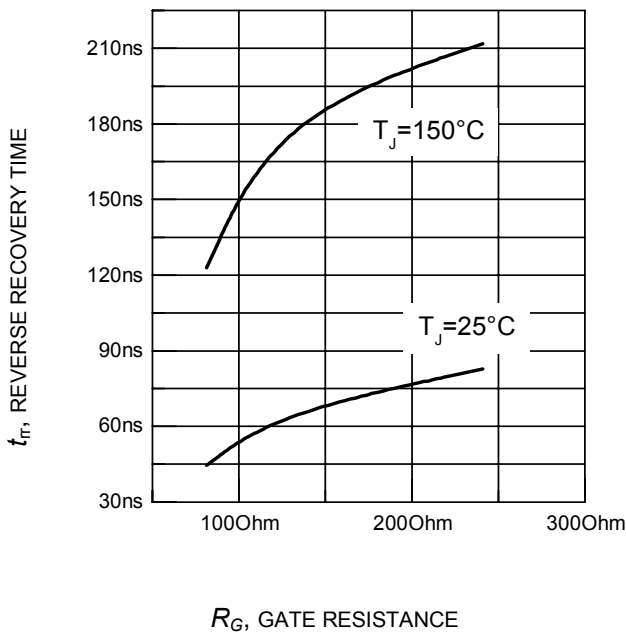
**Figure 20. Typical turn off behavior, hard switching**  
 $(V_{GE}=15/0V, R_G=220\Omega, T_j = 150^\circ C,$   
 Dynamic test circuit in Figure E)



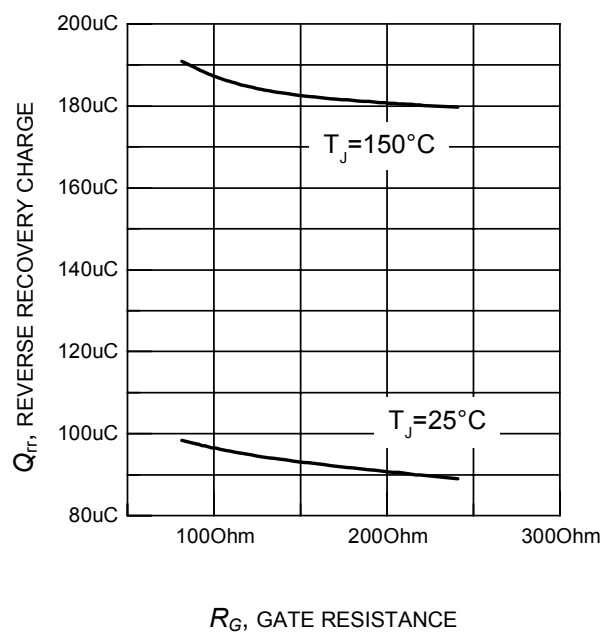
**Figure 21. Typical turn off behavior, soft switching**  
 ( $V_{GE}=15/0V$ ,  $R_G=220\Omega$ ,  $T_j = 150^\circ C$ ,  
 Dynamic test circuit in Figure E)



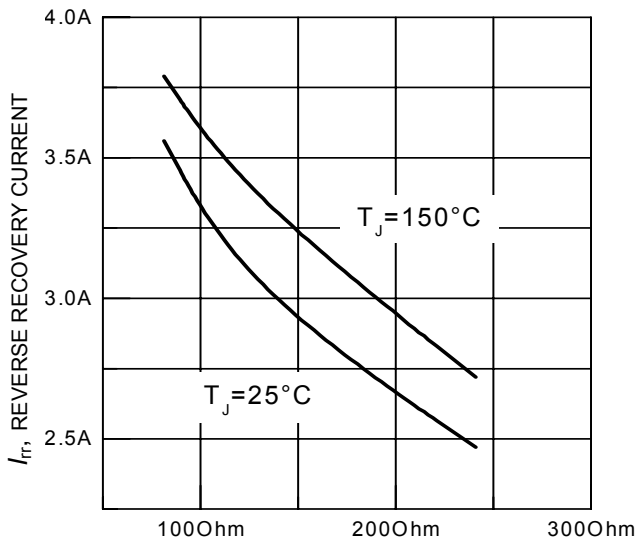
**Figure 22. Diode transient thermal impedance as a function of pulse width**  
 ( $D=t_p/T$ )



**Figure 23. Typical reverse recovery time as a function of diode current slope**  
 ( $V_R=800V$ ,  $I_F=3A$ ,  
 Dynamic test circuit in Figure E)

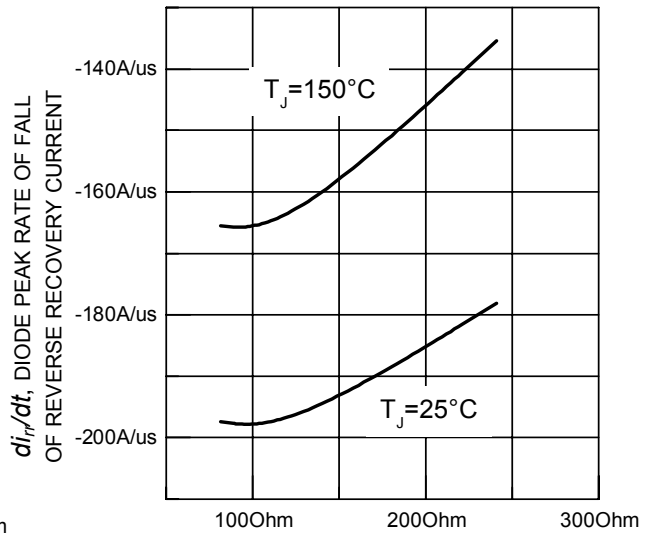


**Figure 24. Typical reverse recovery charge as a function of diode current slope**  
 ( $V_R=800V$ ,  $I_F=3A$ ,  
 Dynamic test circuit in Figure E)



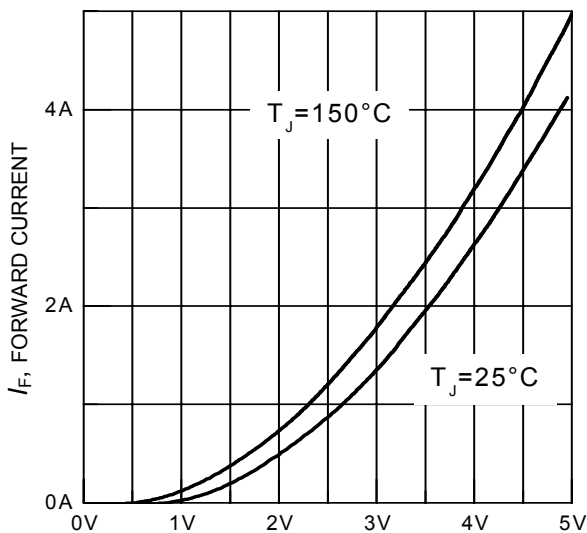
$R_G$ , GATE RESISTANCE

**Figure 25. Typical reverse recovery current as a function of diode current slope**  
 ( $V_R=800V$ ,  $I_F=3A$ ,  
 Dynamic test circuit in Figure E)



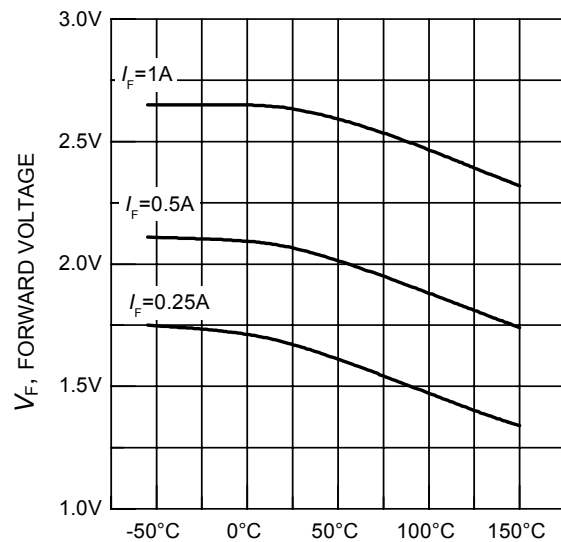
$R_G$ , GATE RESISTANCE

**Figure 26. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope**  
 ( $V_R=800V$ ,  $I_F=3A$ ,  
 Dynamic test circuit in Figure E)



$V_F$ , FORWARD VOLTAGE

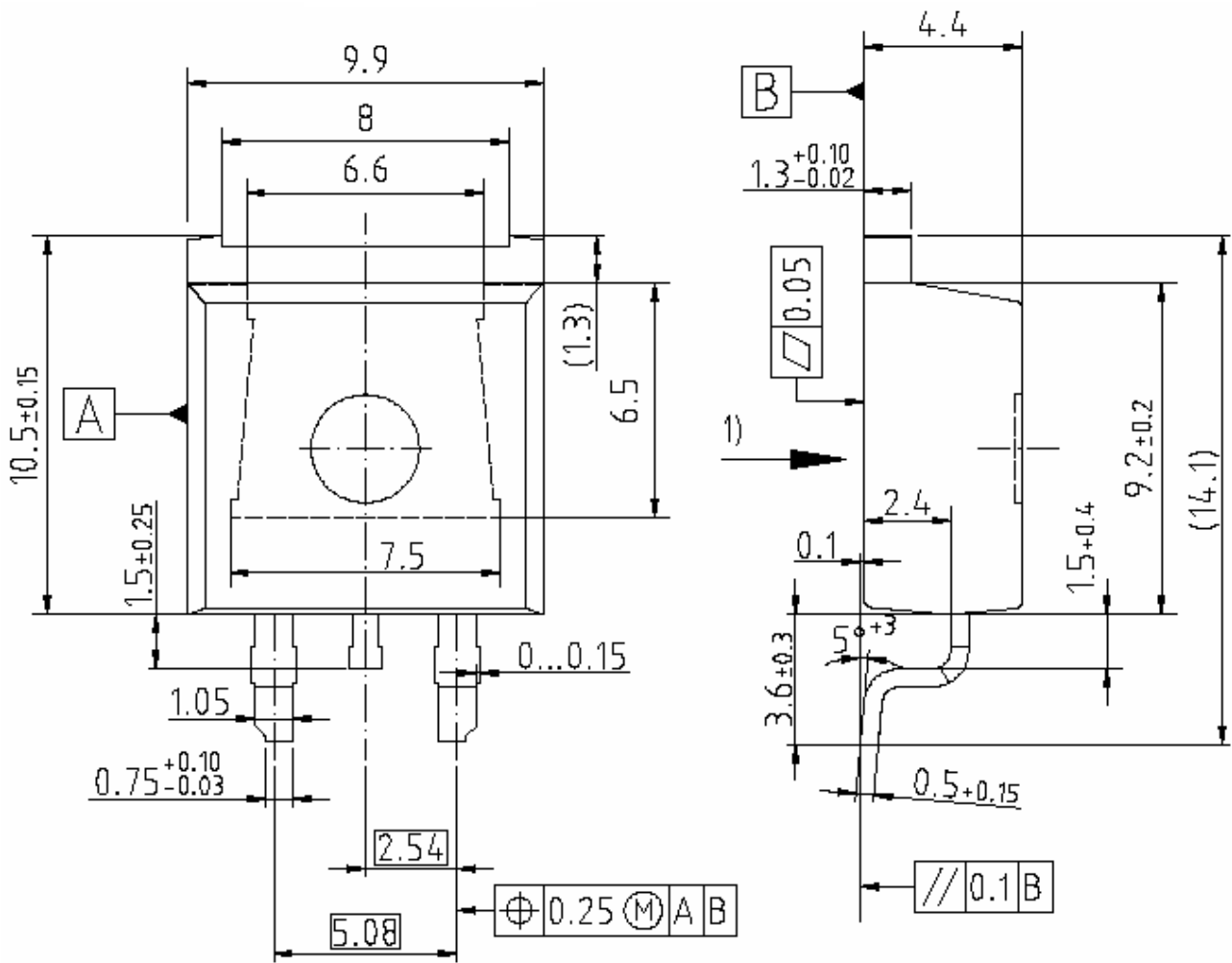
**Figure 27. Typical diode forward current as a function of forward voltage**

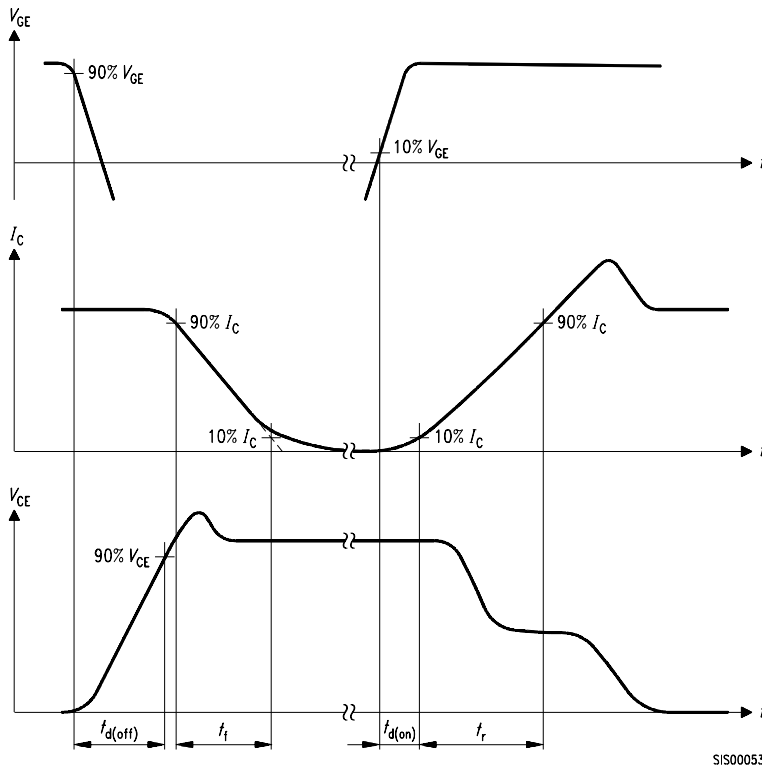
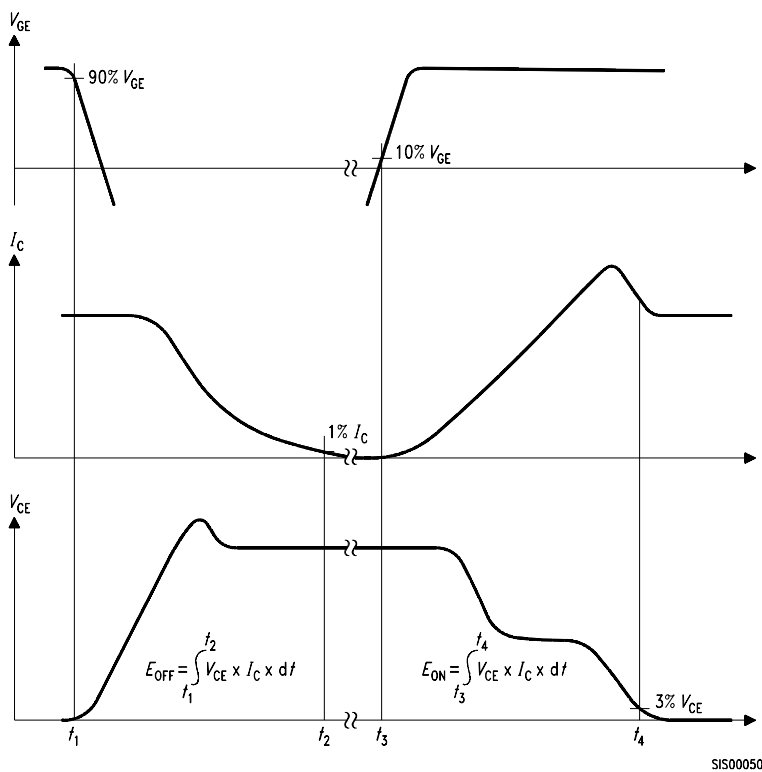
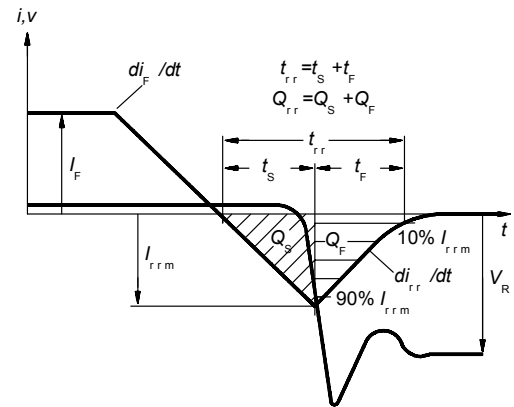
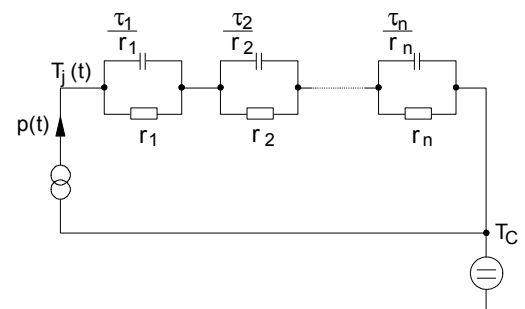
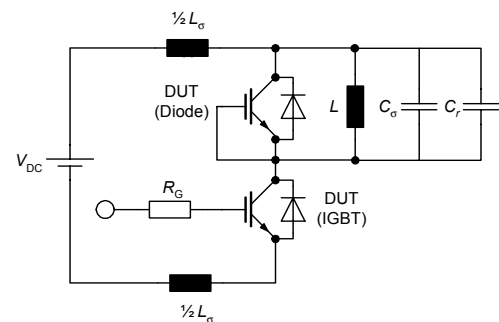


$T_J$ , JUNCTION TEMPERATURE

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

P-TO220-3-45




**Figure A. Definition of switching times**

**Figure B. Definition of switching losses**

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

**Figure D. Thermal equivalent circuit**

**Figure E. Dynamic test circuit**  
 Leakage inductance  $L_\sigma = 180\text{nH}$ ,  
 Stray capacitor  $C_\sigma = 40\text{pF}$ ,  
 Relief capacitor  $C_r = 1\text{nF}$  (only for ZVT switching)

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