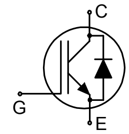
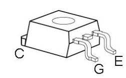
HighSpeed 2-Technology with soft, fast recovery anti-parallel EmCon HE diode



- **Designed for:**
  - SMPS
  - Lamp Ballast
  - ZVS-Converter

- **2nd 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 =3A



P-TO-220-3-45

- Qualified according to JEDEC[2] 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
IKB03N120H2	1200V	3A	0.15mJ	150°C	K03H1202	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°C, f = 140kHz		9.6	
T_C = 100°C, f = 140kHz		3.9	
Pulsed collector current, t_p limited by T_{jmax}	I_{Cpuls}	9.9	
Turn off safe operating area $V_{CE} \leq$ 1200V, $T_j \leq$ 150°C	-	9.9	
Diode forward current	I_F		
T_C = 25°C		9.6	
T_C = 100°C		3.9	
Gate-emitter voltage	V_{GE}	±20	V
Power dissipation T_C = 25°C	P_{tot}	62.5	W
Operating junction and storage temperature	T_j , T_{stg}	-40...+150	°C
Soldering temperature (reflow soldering, MSL1)	-	220	

[2] J-STD-020 and JESD-022

Thermal Resistance

Parameter	Symbol	Conditions	Max. Value	Unit
Characteristic				
IGBT thermal resistance, junction – case	R_{thJC}		2.0	K/W
Diode thermal resistance, junction - case	R_{thJCD}		3.2	
Thermal resistance, junction – ambient[1)]	R_{thJA}		40	

Electrical Characteristic, at T_j = 25 °C, unless otherwise specified

Parameter	Symbol	Conditions	Value			Unit
			min.	Typ.	max.	
Static Characteristic						
Collector-emitter breakdown voltage	$V_{(BR)CES}$	V_{GE}=0V, I_C=300µA	1200	-	-	V
Collector-emitter saturation voltage	$V_{CE(sat)}$	V_{GE} = 15V, I_C=3A				
		T_j=25°C	-	2.2	2.8	
		T_j=150°C	-	2.5	-	
		V_{GE} = 10V, I_C=3A, T_j=25°C	-	2.4	-	
Diode forward voltage	V_F	V_{GE} = 0, I_F=2A				
		T_j=25°C	-	2.0	2.5	
		T_j=150°C	-	1.75	-	
Gate-emitter threshold voltage	$V_{GE(th)}$	I_C=90µA, V_{CE}=V_{GE}	2.1	3	3.9	
Zero gate voltage collector current	I_{CES}	V_{CE}=1200V, V_{GE}=0V				µA
		T_j=25°C	-	-	20	
		T_j=150°C	-	-	80	
Gate-emitter leakage current	I_{GES}	V_{CE}=0V, V_{GE}=20V	-	-	100	nA
Transconductance	g_{fs}	V_{CE}=20V, I_C=3A	-	2	-	S
Dynamic Characteristic						
Input capacitance	C_{iss}	V_{CE}=25V,	-	205	-	pF
Output capacitance	C_{oss}	V_{GE}=0V,	-	24	-	
Reverse transfer capacitance	C_{rss}	f=1MHz	-	7	-	
Gate charge	Q_{Gate}	V_{CC}=960V, I_C=3A V_{GE}=15V	-	22	-	nC
Internal emitter inductance measured 5mm (0.197 in.) from case	L_E		-	7	-	nH

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

Switching Characteristic, Inductive Load, at T_j=25 °C

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
IGBT Characteristic						
Turn-on delay time	$t_{d(on)}$	T_j=25°C, V_{CC}=800V, I_C=3A, V_{GE}=15V/0V, R_G=82Ω, L_σ [2] =180nH, C_σ [2] =40pF Energy losses include "tail" and diode [4] reverse recovery.	-	9.2	-	ns
Rise time	t_r		-	5.2	-	
Turn-off delay time	$t_{d(off)}$		-	281	-	
Fall time	t_f		-	29	-	
Turn-on energy	E_{on}		-	0.14	-	mJ
Turn-off energy	E_{off}		-	0.15	-	
Total switching energy	E_{ts}		-	0.29	-	
Anti-Parallel Diode Characteristic						
Diode reverse recovery time	t_{rr}	T_j=25°C, V_R=800V, I_F=3A, R_G=82Ω	-	42	-	ns
Diode reverse recovery charge	Q_{rr}		-	0.23	-	µC
Diode peak reverse recovery current	I_{rrm}		-	10.3	-	A
Diode current slope	di_F/dt		-	993	-	A/µs
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	1180	-	

Switching Characteristic, Inductive Load, at T_j=150 °C

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
IGBT Characteristic						
Turn-on delay time	$t_{d(on)}$	T_j=150°C V_{CC}=800V, I_C=3A, V_{GE}=15V/0V, R_G=82Ω, L_σ [2] =180nH, C_σ [2] =40pF Energy losses include "tail" and diode [3] reverse recovery.	-	9.4	-	ns
Rise time	t_r		-	6.7	-	
Turn-off delay time	$t_{d(off)}$		-	340	-	
Fall time	t_f		-	63	-	
Turn-on energy	E_{on}		-	0.22	-	mJ
Turn-off energy	E_{off}		-	0.26	-	
Total switching energy	E_{ts}		-	0.48	-	
Anti-Parallel Diode Characteristic						
Diode reverse recovery time	t_{rr}	T_j=150°C V_R=800V, I_F=3A, R_G=82Ω	-	125	-	ns
Diode reverse recovery charge	Q_{rr}		-	0.51	-	µC
Diode peak reverse recovery current	I_{rrm}		-	12	-	A
Diode current slope	di_F/dt		-	829	-	A/µs
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	540	-	

[2] Leakage inductance L_σ and stray capacity C_σ due to dynamic test circuit in figure E
[4] Commutation diode from device IKP03N120H2

Switching Energy ZVT, Inductive Load

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
IGBT Characteristic						
Turn-off energy	E_{off}	V_{CC}=800V, I_C=3A, V_{GE}=15V/0V, R_G=82Ω, C_r[2)]=4nF T_j=25°C T_j=150°C	- -	0.05 0.09	- -	mJ

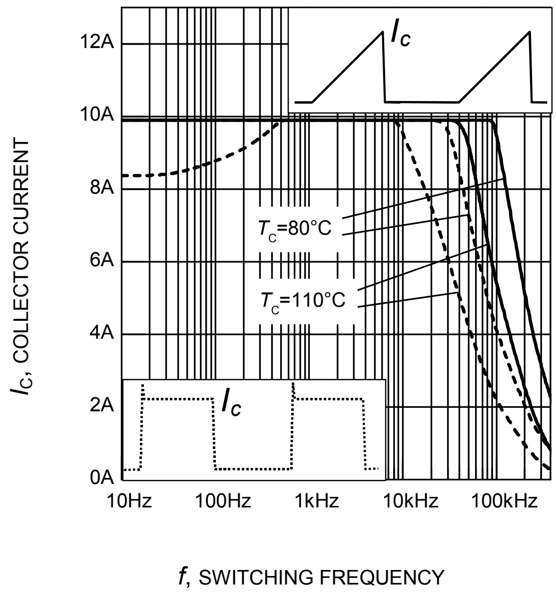


Figure 1. Collector current as a function of switching frequency
($T_j \leq 150°C$, $D = 0.5$, V_{CE} = 800V, V_{GE} = +15V/0V, $R_G = 82\Omega$)

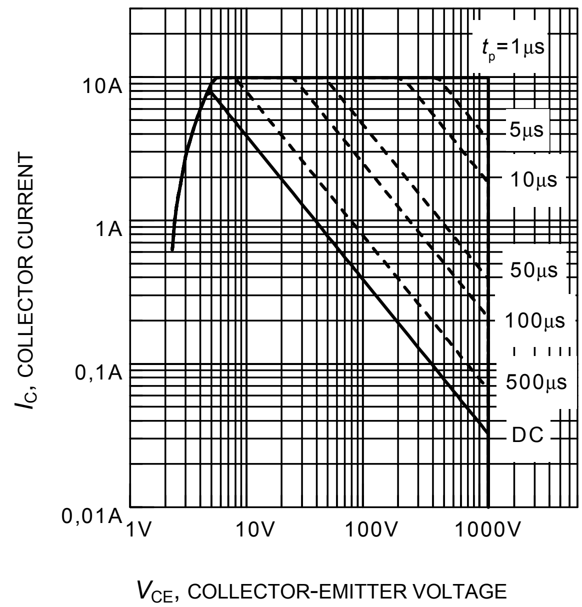


Figure 2. Safe operating area
($D = 0$, T_C = 25°C, $T_j \leq 150°C$)

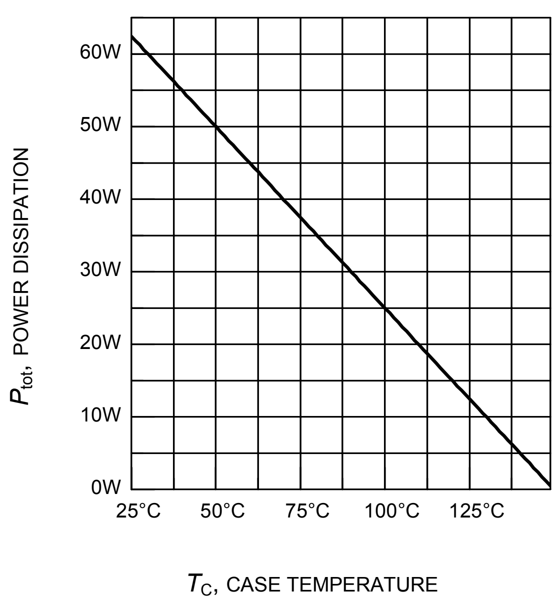


Figure 3. Power dissipation as a function of case temperature
($T_j \leq 150°C$)

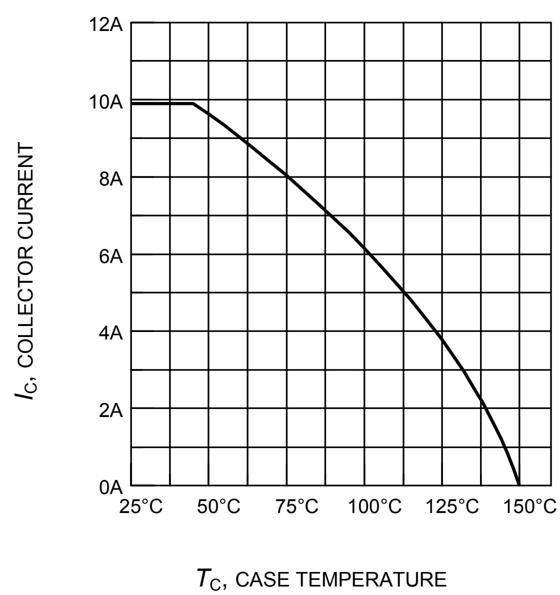


Figure 4. Collector current as a function of case temperature
($V_{GE} \leq 15V$, $T_j \leq 150°C$)

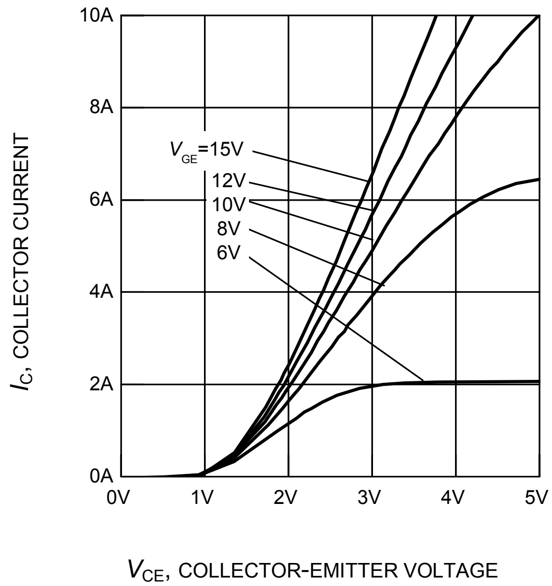


Figure 5. Typical output characteristics
(T_j = 25°C)

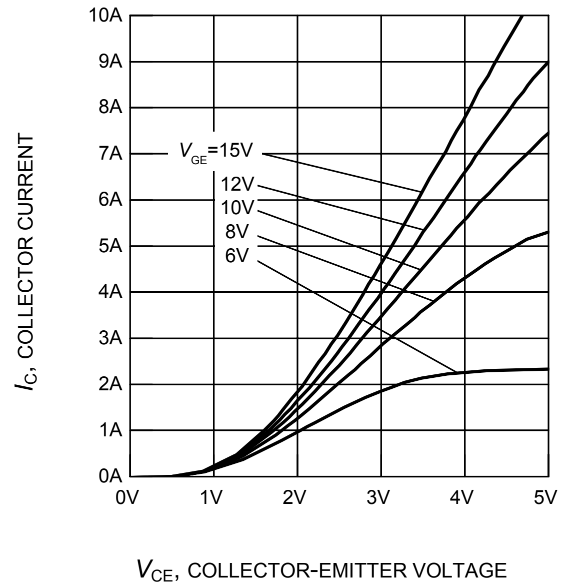


Figure 6. Typical output characteristics
(T_j = 150°C)

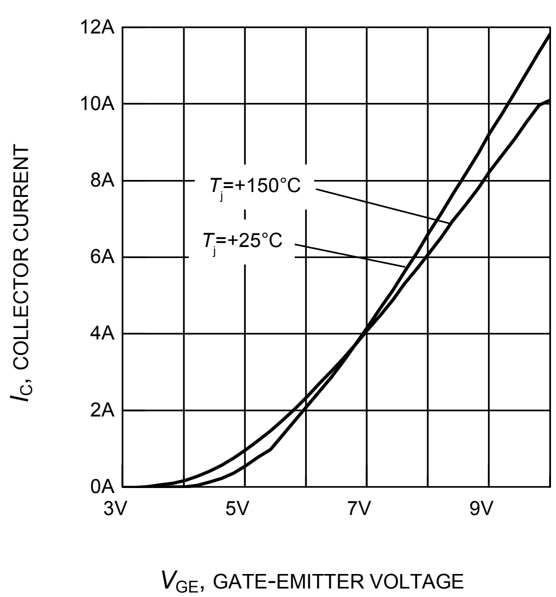


Figure 7. Typical transfer characteristics
(V_{CE} = 20V)

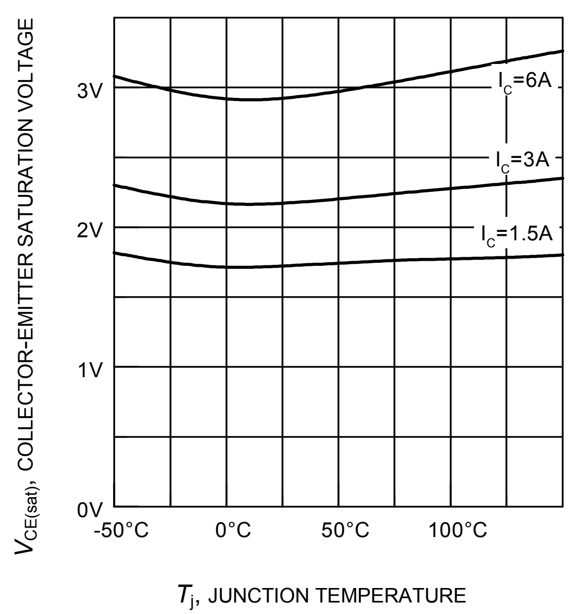


Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature
(V_{GE} = 15V)

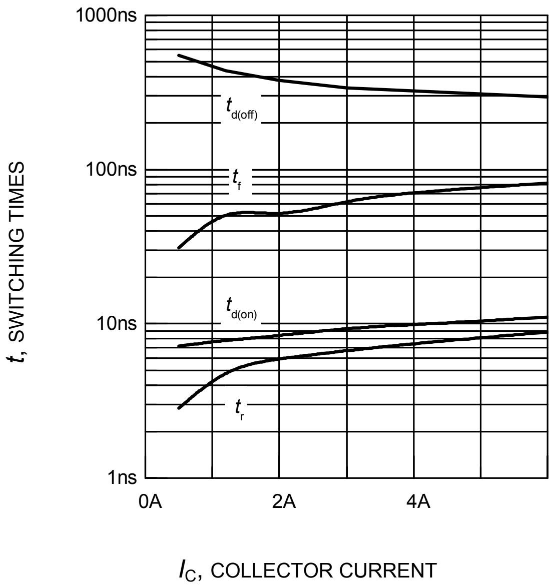


Figure 9. Typical switching times as a function of collector current
(inductive load, T_j = 150°C,
V_{CE} = 800V, V_{GE} = +15V/0V, R_G = 82Ω,
dynamic test circuit in Fig.E)

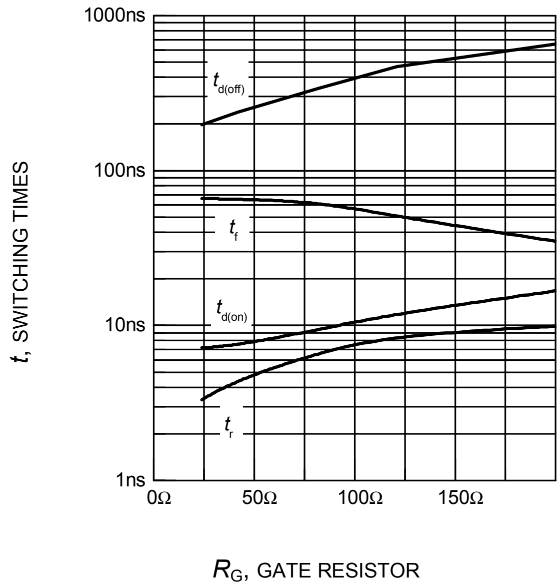


Figure 10. Typical switching times as a function of gate resistor
(inductive load, T_j = 150°C,
V_{CE} = 800V, V_{GE} = +15V/0V, I_C = 3A,
dynamic test circuit in Fig.E)

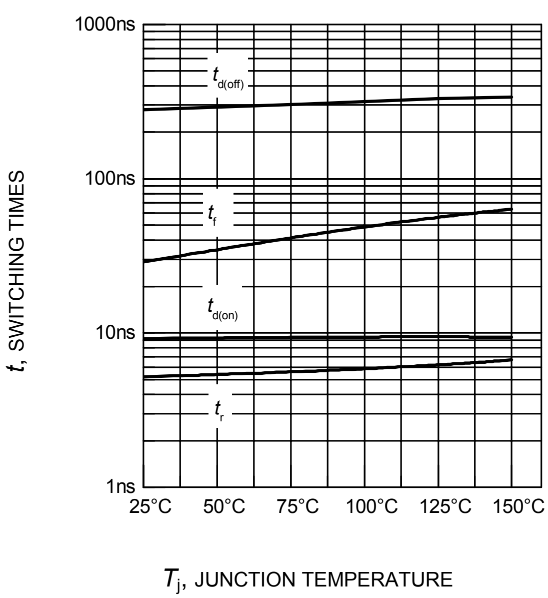


Figure 11. Typical switching times as a function of junction temperature
(inductive load, V_{CE} = 800V,
V_{GE} = +15V/0V, I_C = 3A, R_G = 82Ω,
dynamic test circuit in Fig.E)

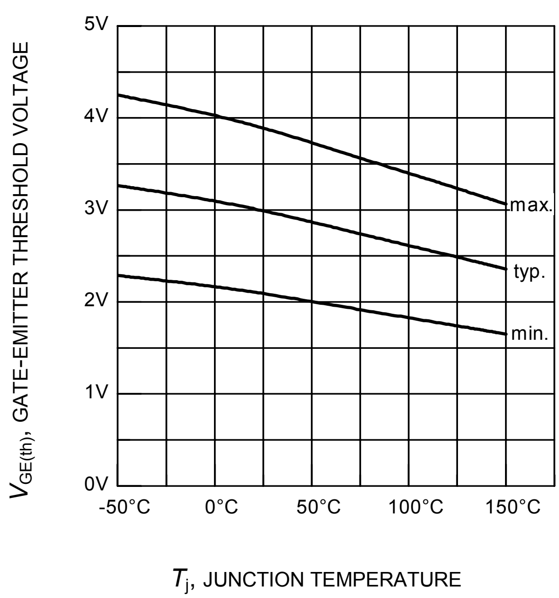


Figure 12. Gate-emitter threshold voltage as a function of junction temperature
(I_C = 0.09mA)

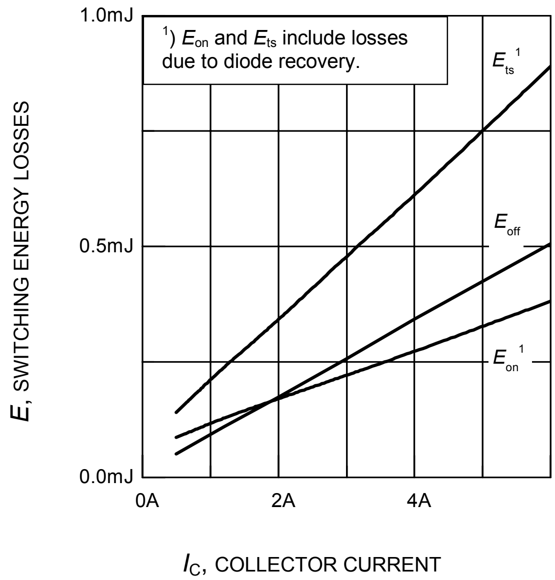


Figure 13. Typical switching energy losses as a function of collector current
(inductive load, T_j = 150°C,
V_{CE} = 800V, V_{GE} = +15V/0V, R_G = 82Ω,
dynamic test circuit in Fig.E)

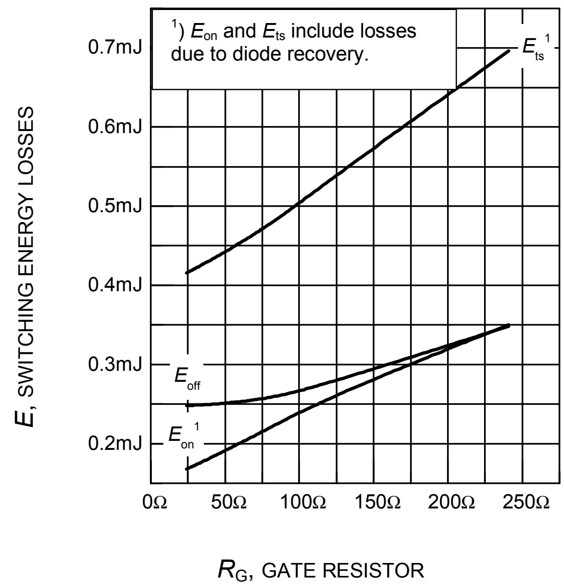


Figure 14. Typical switching energy losses as a function of gate resistor
(inductive load, T_j = 150°C,
V_{CE} = 800V, V_{GE} = +15V/0V, I_C = 3A,
dynamic test circuit in Fig.E)

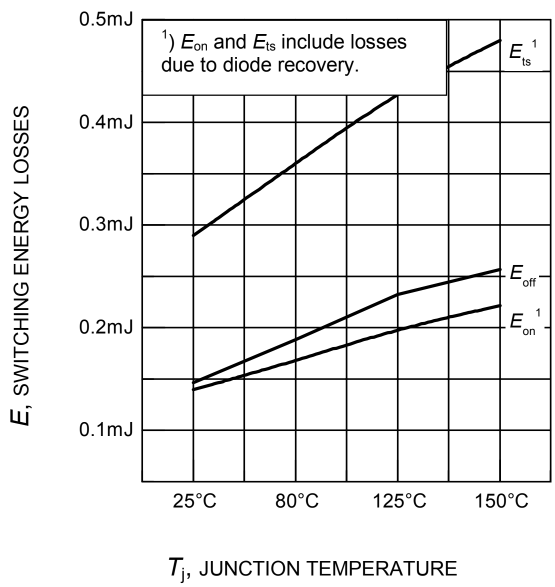


Figure 15. Typical switching energy losses as a function of junction temperature
(inductive load, V_{CE} = 800V,
V_{GE} = +15V/0V, I_C = 3A, R_G = 82Ω,
dynamic test circuit in Fig.E)

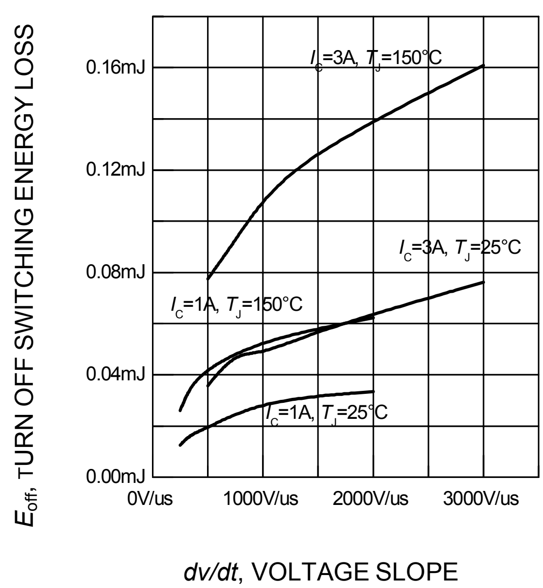


Figure 16. Typical turn off switching energy loss for soft switching
(*dynamic test circuit in Fig. E*)

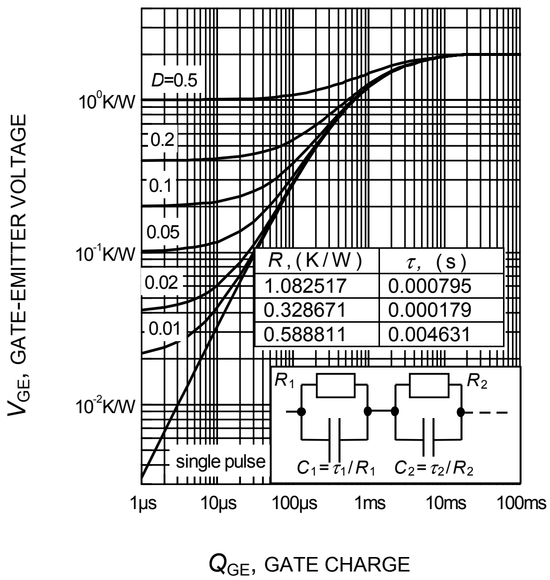


Figure 17. Typical gate charge
(I_C = 3A)

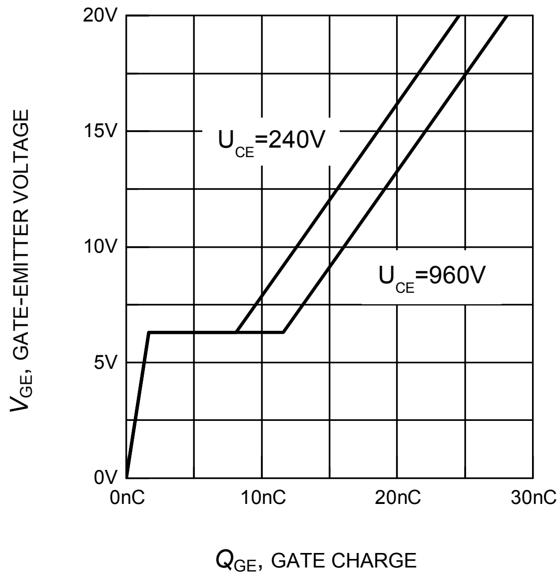


Figure 17. Typical gate charge
(I_C = 3A)

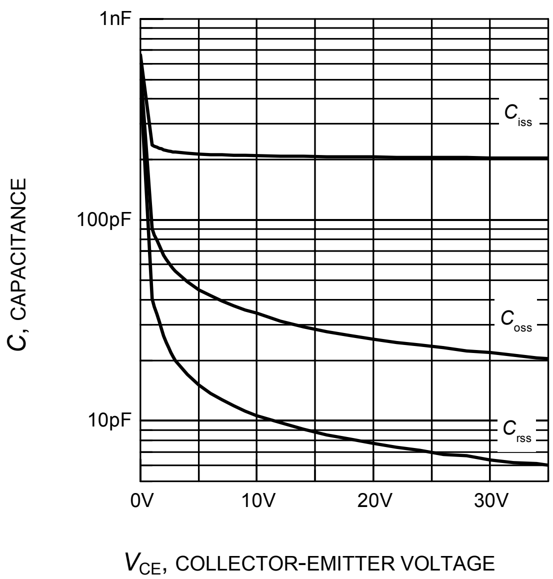


Figure 18. Typical capacitance as a function of collector-emitter voltage
(V_{GE} = 0V, f = 1MHz)

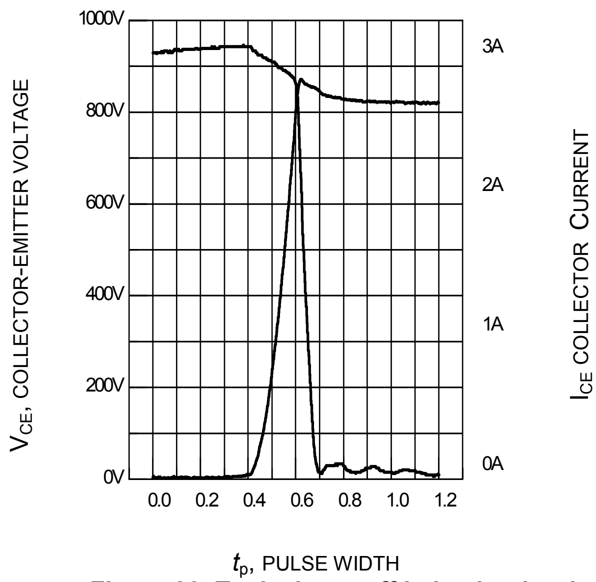


Figure 20. Typical turn off behavior, hard switching
(V_{GE}=15/0V, R_G=82Ω, T_j = 150°C, Dynamic test circuit in Figure E)

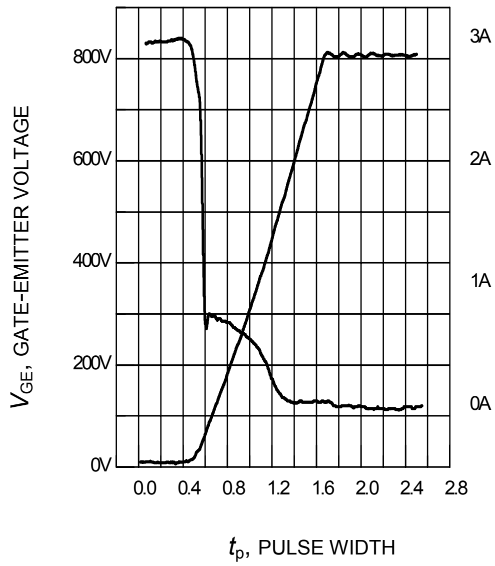


Figure 21. Typical turn off behavior, soft switching
(V_{GE}=15/0V, R_G=82Ω, T_j = 150°C, Dynamic test circuit in Figure E)

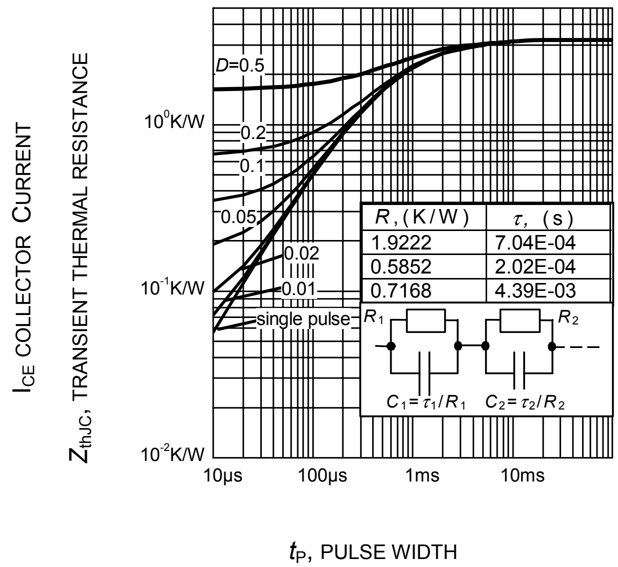


Figure 22. Diode transient thermal impedance as a function of pulse width
(D=t_P/T)

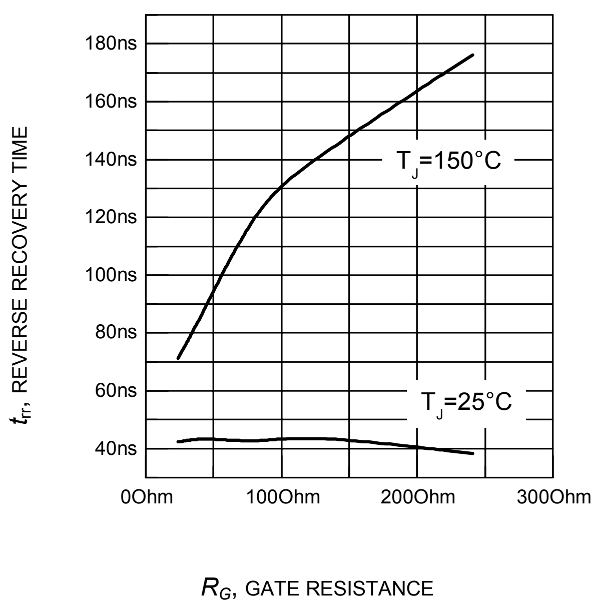


Figure 23. Typical reverse recovery time as a function of diode current slope
V_R=800V, I_F=3A,
Dynamic test circuit in Figure E)

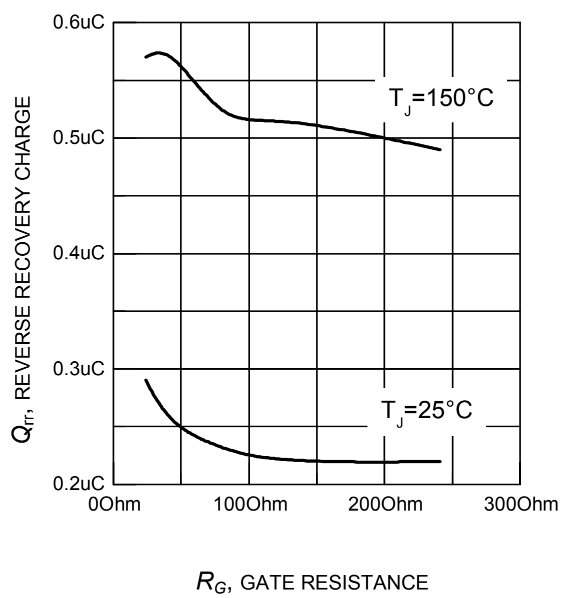


Figure 24. Typical reverse recovery charge as a function of diode current slope
(V_R=800V, I_F=3A,
Dynamic test circuit in Figure E)

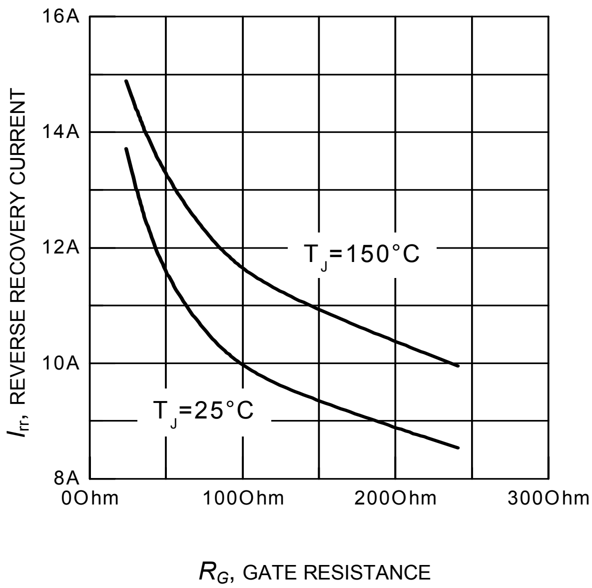


Figure 25. Typical reverse recovery current as a function of diode current slope
(V_R=800V, I_F=3A,
Dynamic test circuit in Figure E)

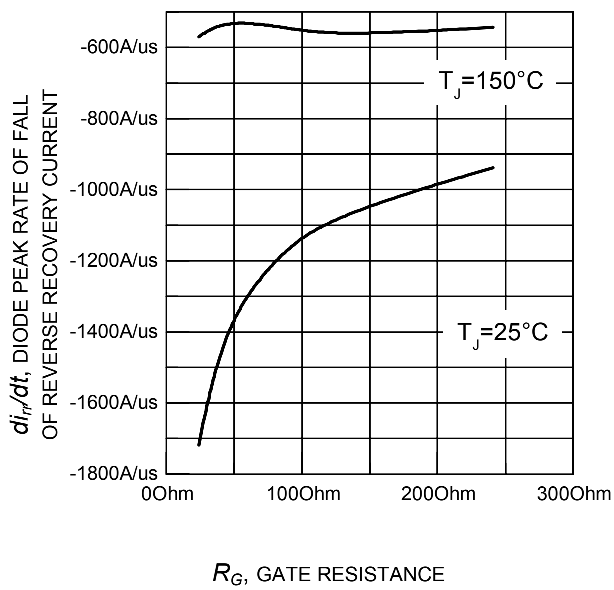


Figure 26. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope
(V_R=800V, I_F=3A,
Dynamic test circuit in Figure E)

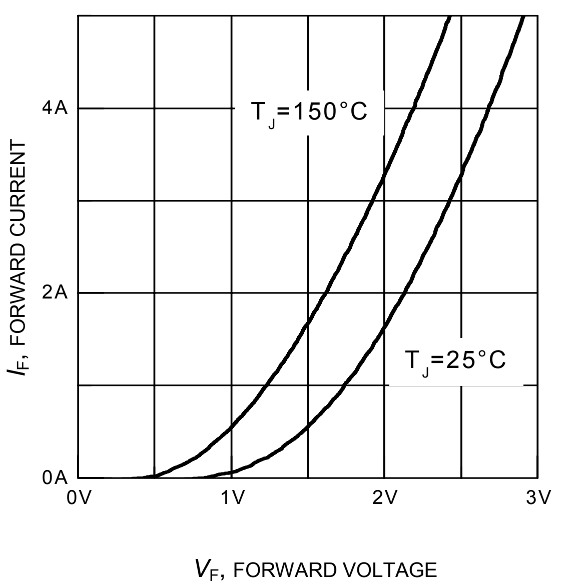


Figure 27. Typical diode forward current as a function of forward voltage

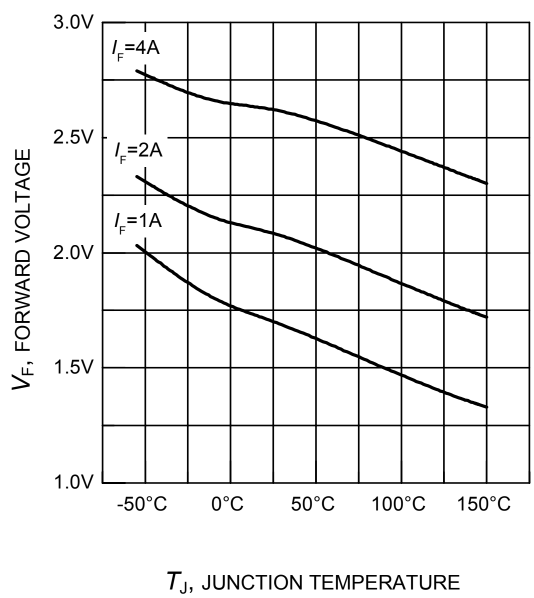


Figure 28. Typical diode forward voltage as a function of junction temperature

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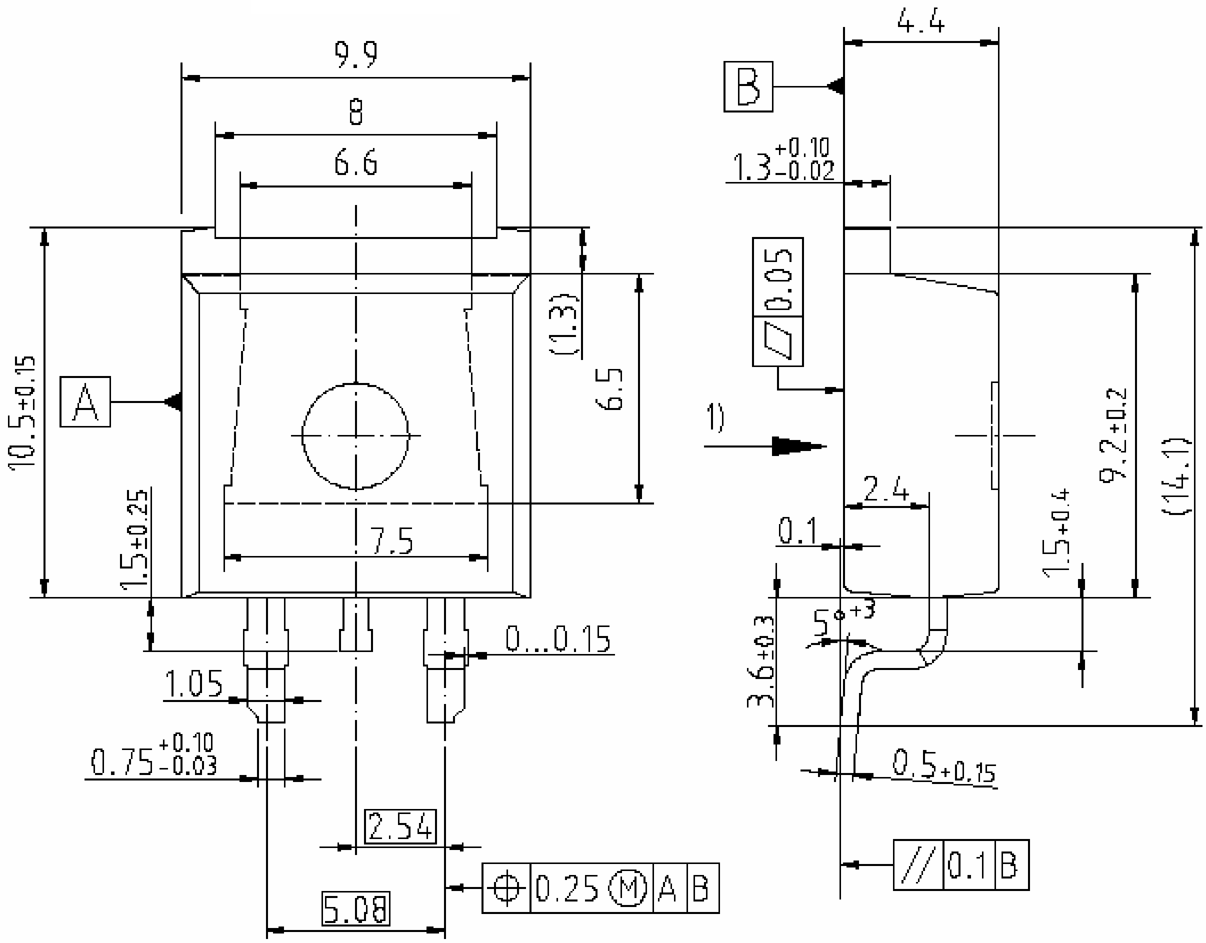
9.9
8
6.6
4.4
B
1.3 +0.10 -0.02
(1.3)
6.5
0.05
A
10.5±0.15
1.5±0.25
7.5
1)
9.2±0.2
(14.1)
2.4
0.1
1.5+0.4
5° +3
3.6±0.3
0...0.15
1.05
0.75 +0.10 -0.03
0.5+0.15
2.54
5.08
0.25 M A B
// 0.1 B

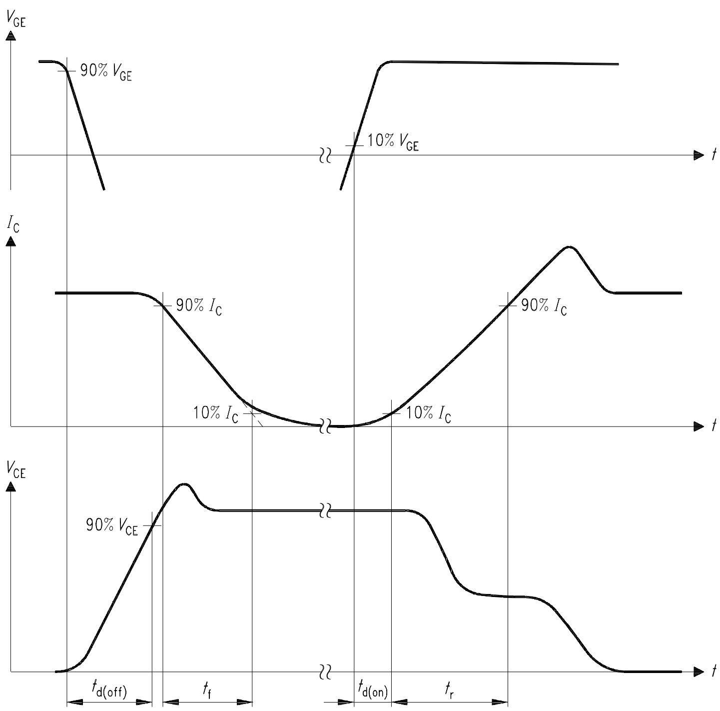

Figure A. Definition of switching times

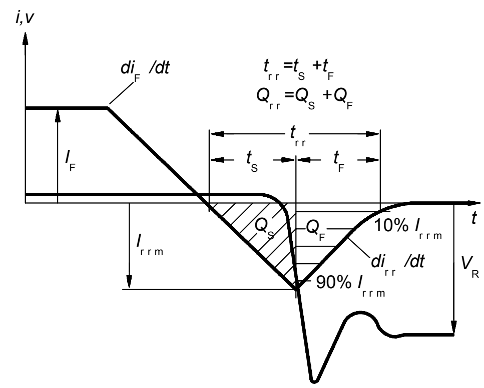

Figure C. Definition of diodes switching characteristics

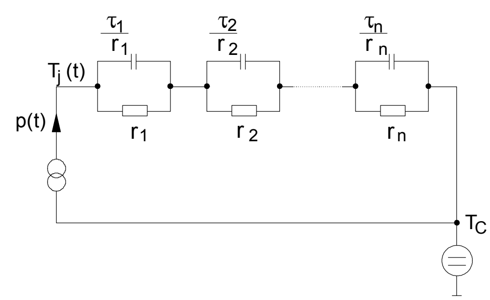

Figure D. Thermal equivalent circuit

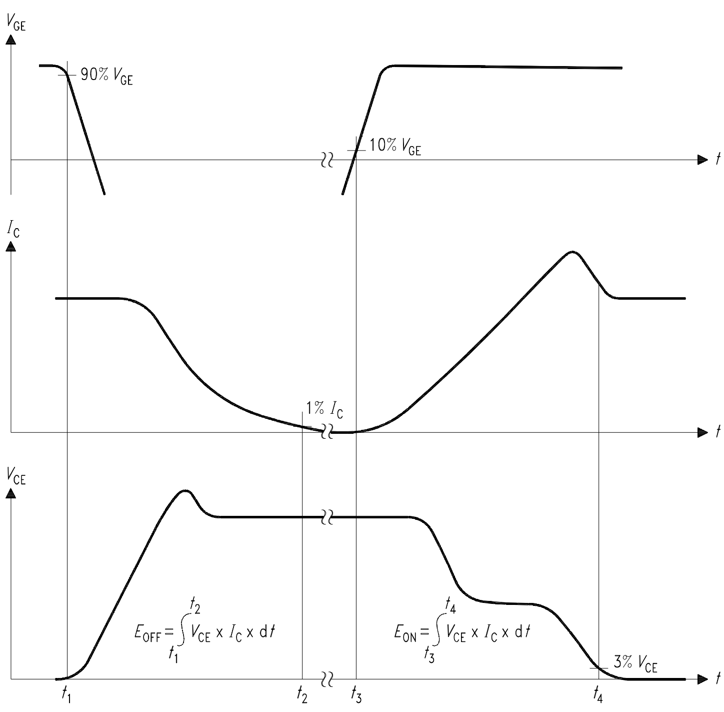

Figure B. Definition of switching losses

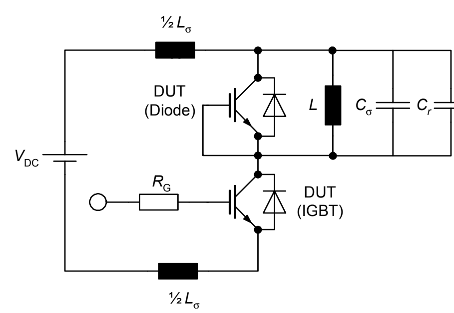

Figure E. Dynamic test circuit
Leakage inductance L_σ = 180nH,
Stray capacitor C_σ = 40pF,
Relief capacitor C_r = 4nF (only for ZVT switching)

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