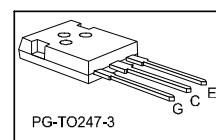
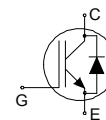


## Reverse conducting IGBT

**Features:**

- Powerful monolithic body diode with low forward voltage designed for soft commutation only
- TrenchStop® technology applications offers:
  - very tight parameter distribution
  - high ruggedness, temperature stable behavior
  - low  $V_{CEsat}$
- Low EMI
- Qualified according to JEDEC J-STD-020 and JESD-022 for target applications
- Pb-free lead plating; RoHS compliant
- Complete product spectrum and PSpice Models: <http://www.infineon.com/igbt/>


**Applications:**

- Inductive cooking
- Soft switching applications

Type	$V_{CE}$	$I_C$	$V_{CEsat}, T_{vj}=25^{\circ}C$	$T_{vjmax}$	Marking	Package
IHW40N60RF	600V	40A	1.85V	175°C	H40RF60	PG-TO247-3

**Maximum ratings**

Parameter	Symbol	Value	Unit
Collector-emitter voltage	$V_{CE}$	600	V
DC collector current, limited by $T_{vjmax}$ $T_C = 25^{\circ}C$ $T_C = 100^{\circ}C$	$I_C$	80.0 40.0	A
Pulsed collector current, $t_p$ limited by $T_{vjmax}$	$I_{Cpuls}$	120.0	A
Turn off safe operating area $V_{CE} \leq 600V, T_{vj} \leq 175^{\circ}C$	-	120.0	A
Diode forward current, limited by $T_{vjmax}$ $T_C = 25^{\circ}C$ $T_C = 100^{\circ}C$	$I_F$	80.0 40.0	A
Diode pulsed current, $t_p$ limited by $T_{vjmax}$	$I_{Fpuls}$	120.0	A
Gate-emitter voltage	$V_{GE}$	$\pm 20$	V
Power dissipation $T_C = 25^{\circ}C$ Power dissipation $T_C = 100^{\circ}C$	$P_{tot}$	305.0 152.5	W
Operating junction temperature	$T_{vj}$	-40...+175	°C
Storage temperature	$T_{stg}$	-55...+175	°C
Soldering temperature, wavesoldering 1.6 mm (0.063 in.) from case for 10s		260	°C
Mounting torque, M3 screw Maximum of mounting processes: 3	$M$	0.6	Nm

**Thermal Resistance**

Parameter	Symbol	Conditions	Max. Value	Unit
<b>Characteristic</b>				
IGBT thermal resistance, junction - case	$R_{th(j-c)}$		0.49	K/W
Diode thermal resistance, junction - case	$R_{th(j-c)}$		0.49	K/W
Thermal resistance junction - ambient	$R_{th(j-a)}$		40	K/W

**Electrical Characteristic, at  $T_{vj} = 25^{\circ}\text{C}$ , unless otherwise specified**

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
<b>Static Characteristic</b>						
Collector-emitter breakdown voltage	$V_{(BR)CES}$	$V_{GE} = 0\text{V}, I_C = 0.50\text{mA}$	600	-	-	V
Collector-emitter saturation voltage	$V_{CEsat}$	$V_{GE} = 15.0\text{V}, I_C = 40.0\text{A}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	- -	1.85 2.30	2.40 -	V
Diode forward voltage	$V_F$	$V_{GE} = 0\text{V}, I_F = 40.0\text{A}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	- -	1.75 2.00	2.20	V
Gate-emitter threshold voltage	$V_{GE(th)}$	$I_C = 0.58\text{mA}, V_{CE} = V_{GE}$	4.1	4.9	5.7	V
Zero gate voltage collector current	$I_{CES}$	$V_{CE} = 600\text{V}, V_{GE} = 0\text{V}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	- -	- -	40.0 1000.0	$\mu\text{A}$
Gate-emitter leakage current	$I_{GES}$	$V_{CE} = 0\text{V}, V_{GE} = 20\text{V}$	-	-	100	nA
Transconductance	$g_{fs}$	$V_{CE} = 20\text{V}, I_C = 40.0\text{A}$	-	24.0	-	S
Integrated gate resistor	$r_G$			none		$\Omega$

**Electrical Characteristic, at  $T_{vj} = 25^{\circ}\text{C}$ , unless otherwise specified**

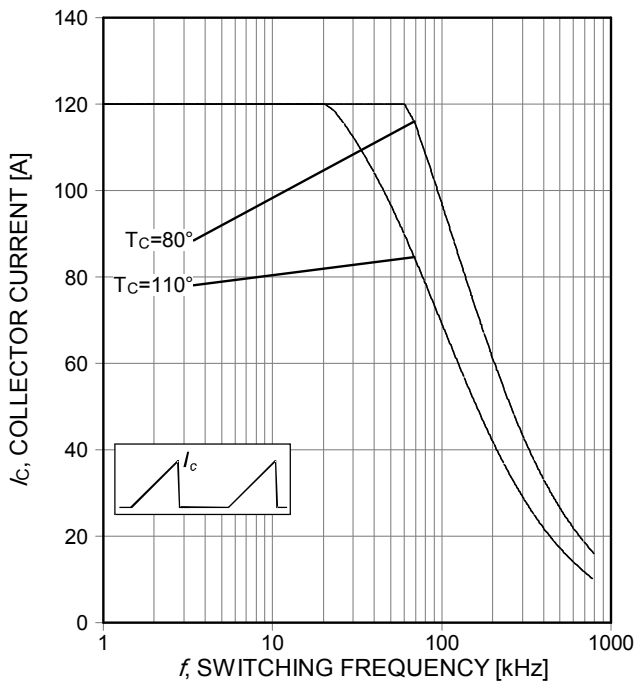
Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
<b>Dynamic Characteristic</b>						
Input capacitance	$C_{ies}$	$V_{CE} = 25\text{V}, V_{GE} = 0\text{V}, f = 1\text{MHz}$	-	2400	-	pF
Output capacitance	$C_{oes}$		-	88	-	
Reverse transfer capacitance	$C_{res}$		-	68	-	
Gate charge	$Q_G$	$V_{CC} = 480\text{V}, I_C = 40.0\text{A},$ $V_{GE} = 15\text{V}$	-	220.0	-	nC
Internal emitter inductance measured 5mm (0.197 in.) from case	$L_E$		-	13.0	-	nH
Short circuit collector current Max. 1000 short circuits Time between short circuits: $\geq 1.0\text{s}$	$I_{C(SC)}$	$V_{GE} = 15.0\text{V}, V_{CC} \leq 400\text{V}$	-		-	A

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

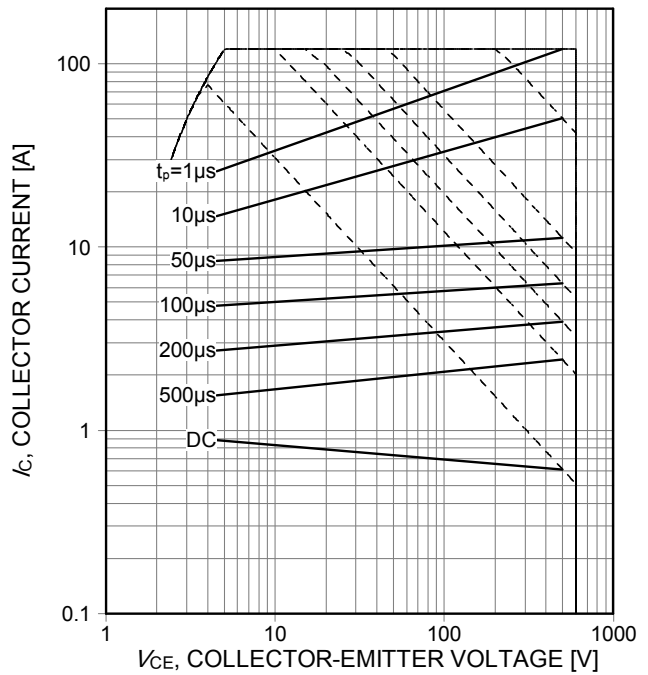
Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
<b>IGBT Characteristic</b>						
Turn-off delay time	$t_{d(off)}$	$T_{vj} = 25^{\circ}\text{C}$ , $V_{CC} = 400\text{V}$ , $I_C = 40.0\text{A}$ , $V_{GE} = 0.0/15.0\text{V}$ , $r_G = 5.6\Omega$ , $L_{\sigma} = 90\text{nH}$ , $C_{\sigma} = 67\text{pF}$ $L_{\sigma}$ , $C_{\sigma}$ from Fig. E Energy losses include "tail" and diode reverse recovery.	-	175	-	ns
Fall time	$t_f$		-	14	-	ns
Turn-off energy	$E_{off}$		-	0.56	-	mJ

 Switching Characteristic, Inductive Load, at  $T_{vj} = 125^{\circ}\text{C}$ 

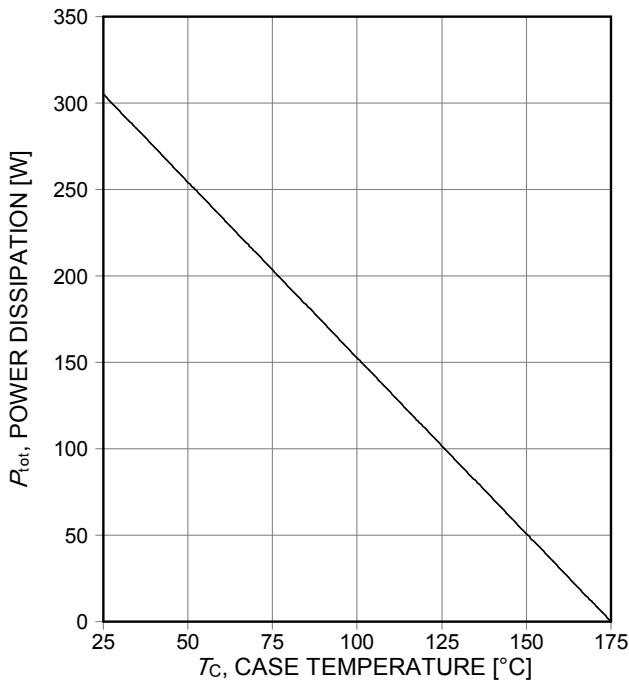
Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
<b>IGBT Characteristic</b>						
Turn-off delay time	$t_{d(off)}$	$T_{vj} = 125^{\circ}\text{C}$ , $V_{CC} = 400\text{V}$ , $I_C = 40.0\text{A}$ , $V_{GE} = 0.0/15.0\text{V}$ , $r_G = 5.6\Omega$ , $L_{\sigma} = 90\text{nH}$ , $C_{\sigma} = 67\text{pF}$ $L_{\sigma}$ , $C_{\sigma}$ from Fig. E Energy losses include "tail" and diode reverse recovery.	-	205	-	ns
Fall time	$t_f$		-	23	-	ns
Turn-off energy	$E_{off}$		-	0.79	-	mJ



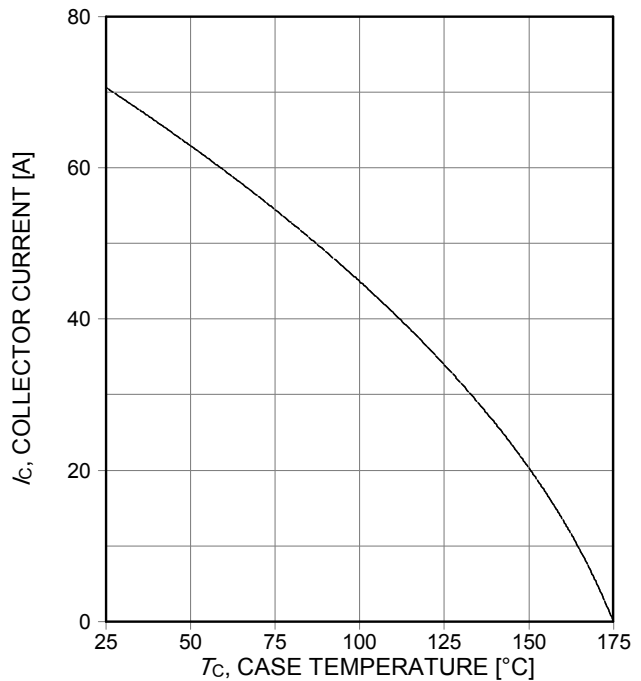
**Figure 1. Collector current as a function of switching frequency**  
 ( $T_{vj} \leq 175^\circ\text{C}$ ,  $D=0.5$ ,  $V_{CE}=400\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $r_G=5.6\Omega$ )



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



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



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

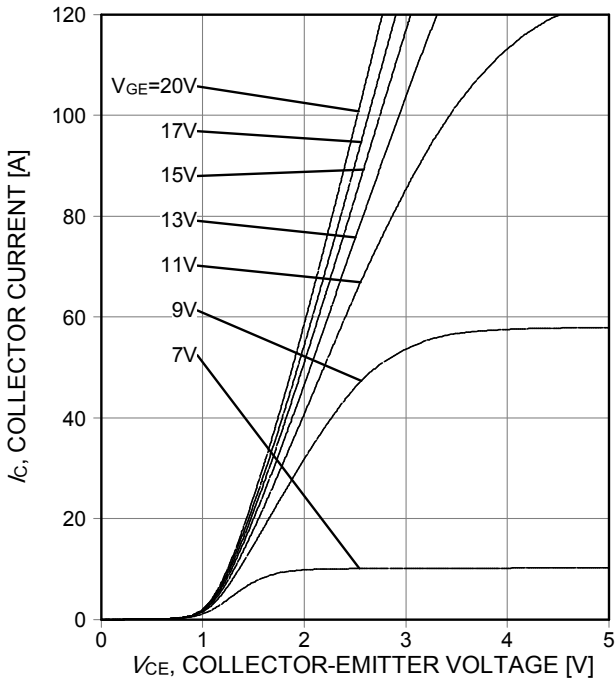


Figure 5. Typical output characteristic ( $T_{vj}=25^{\circ}\text{C}$ )

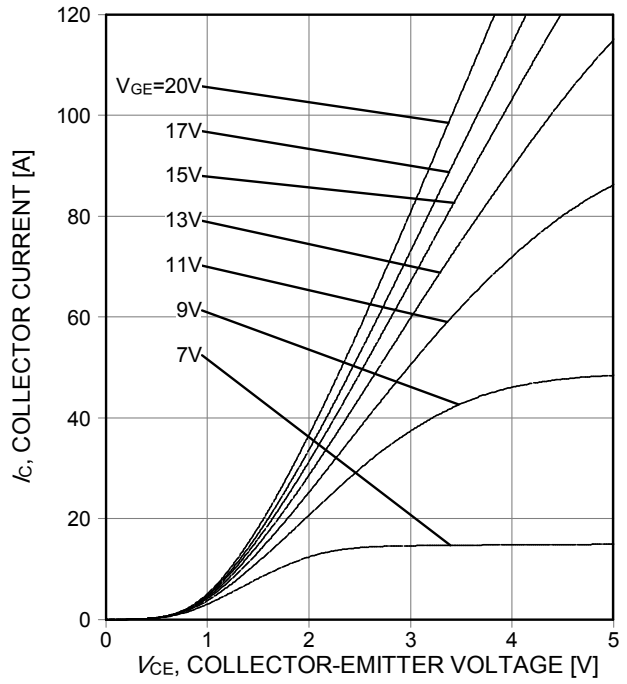


Figure 6. Typical output characteristic ( $T_{vj}=175^{\circ}\text{C}$ )

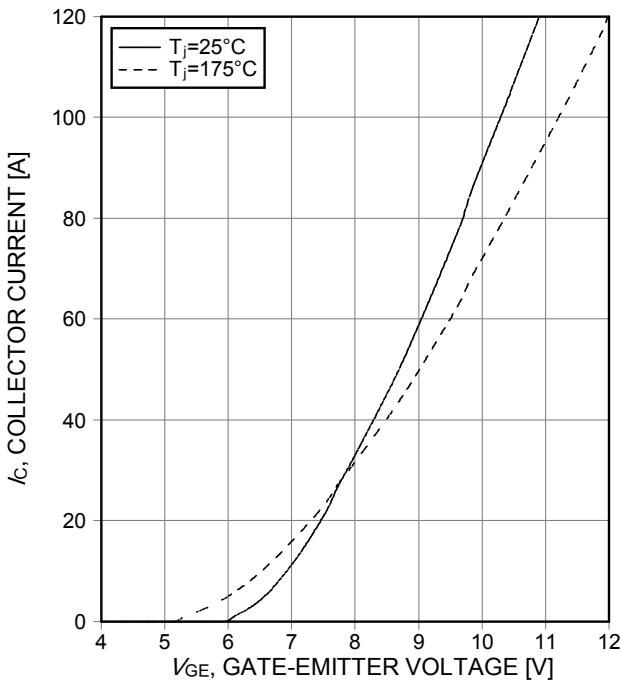


Figure 7. Typical transfer characteristic ( $V_{ce}=20\text{V}$ )

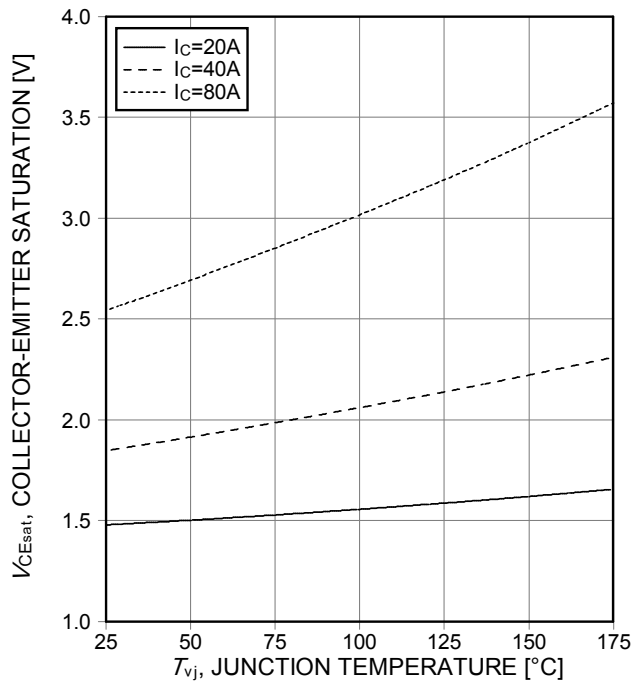
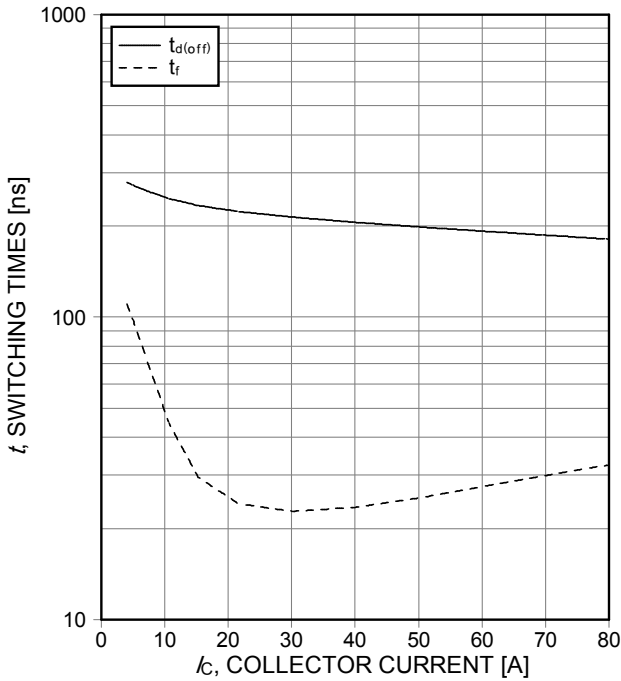
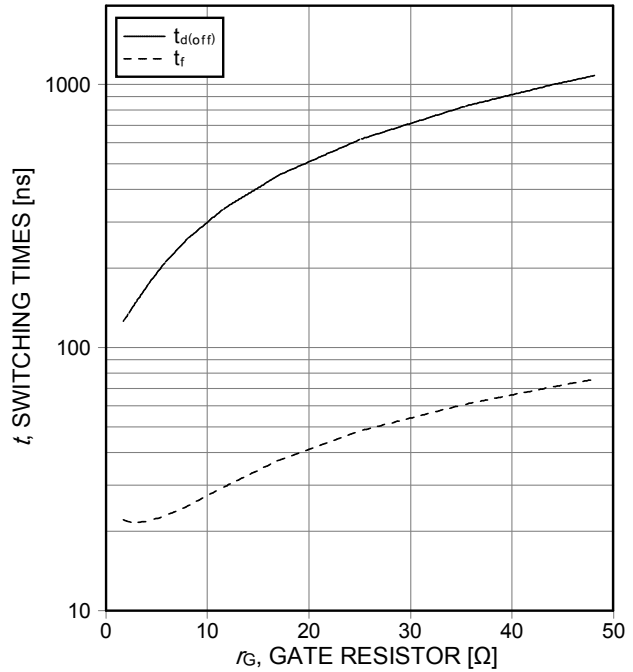


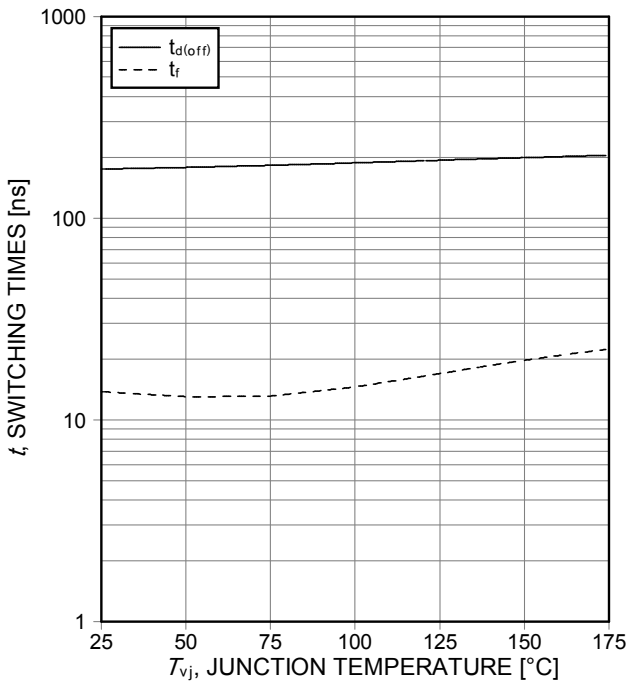
Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature ( $V_{ge}=15\text{V}$ )



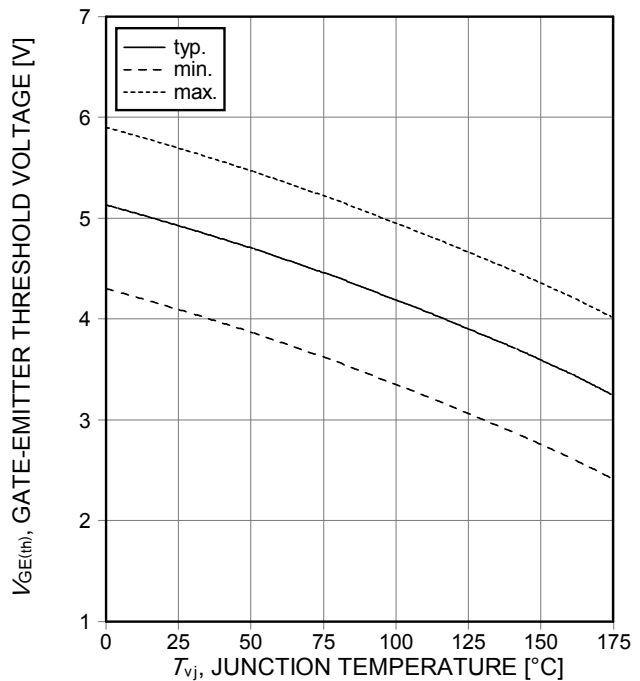
**Figure 9. Typical switching times as a function of collector current**  
 (inductive load,  $T_{vj}=175^{\circ}\text{C}$ ,  $V_{CE}=400\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $r_G=5.6\Omega$ , Dynamic test circuit in Figure E)



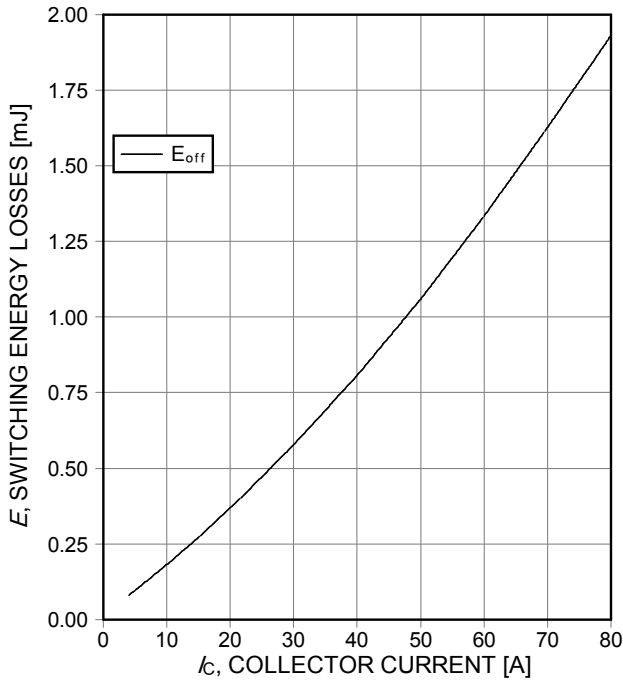
**Figure 10. Typical switching times as a function of gate resistor**  
 (inductive load,  $T_{vj}=175^{\circ}\text{C}$ ,  $V_{CE}=400\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $I_C=40\text{A}$ , Dynamic test circuit in Figure E)



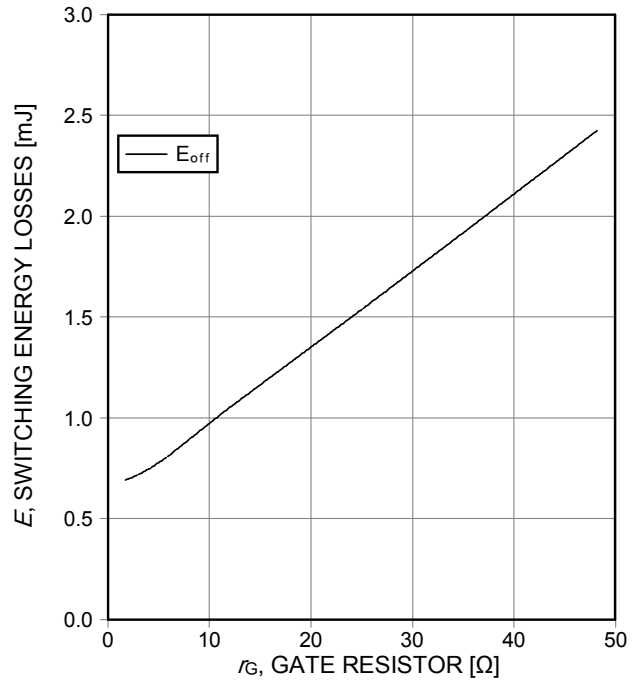
**Figure 11. Typical switching times as a function of junction temperature**  
 (inductive load,  $V_{CE}=400\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $I_C=40\text{A}$ ,  $r_G=5.6\Omega$ , Dynamic test circuit in Figure E)



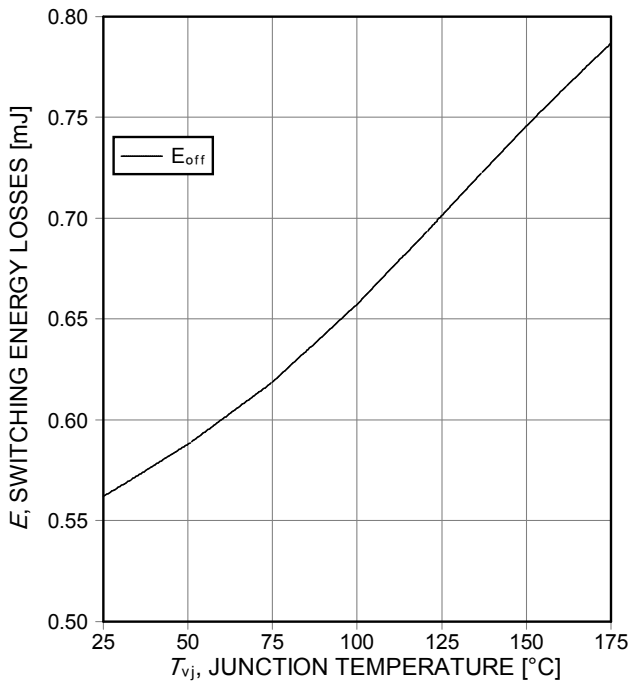
**Figure 12. Gate-emitter threshold voltage as a function of junction temperature**  
 ( $I_C=0.58\text{mA}$ )



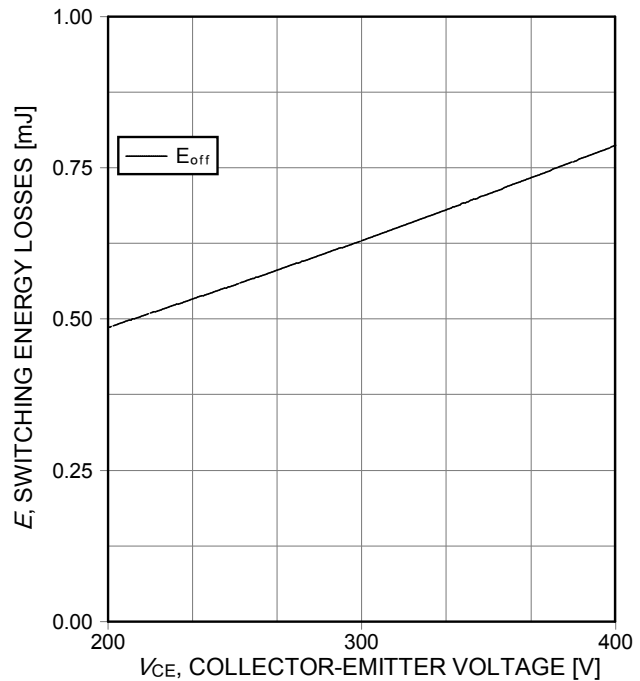
**Figure 13. Typical switching energy losses as a function of collector current**  
 (inductive load,  $T_{vj}=175^{\circ}\text{C}$ ,  $V_{CE}=400\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $r_G=5.6\Omega$ , Dynamic test circuit in Figure E)



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



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



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

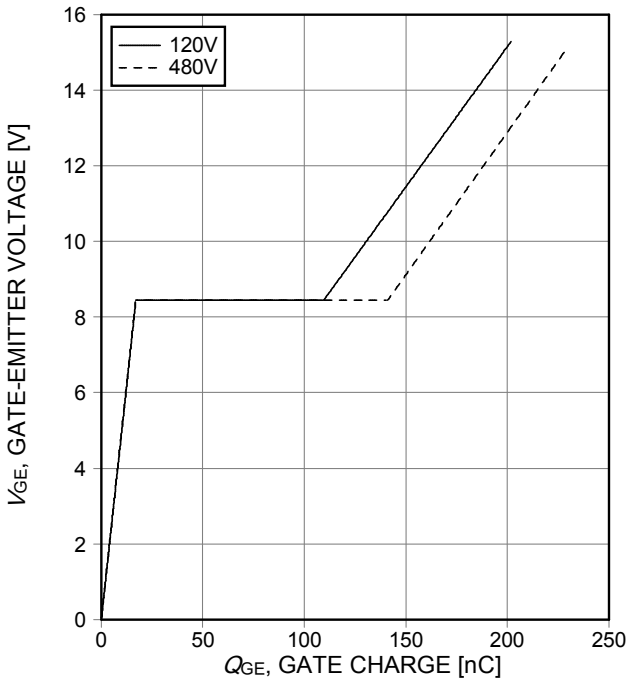


Figure 17. Typical gate charge  
( $I_C=40A$ )

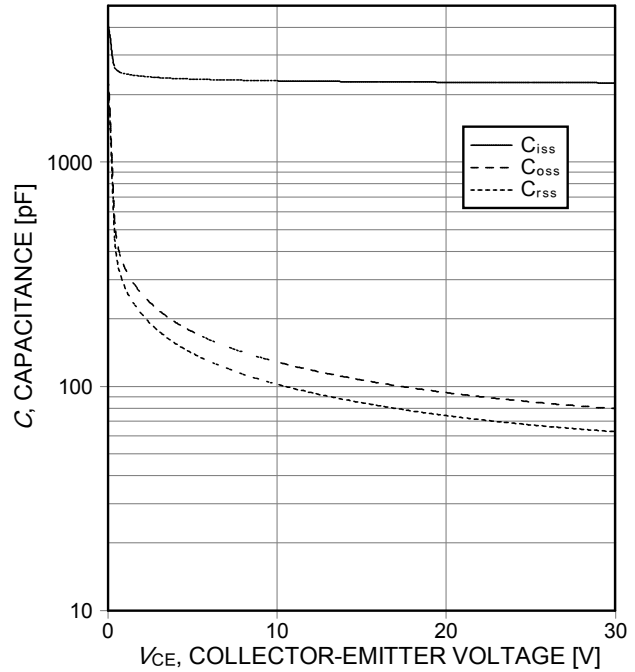


Figure 18. Typical capacitance as a function of collector-emitter voltage  
( $V_{GE}=0V$ ,  $f=1MHz$ )

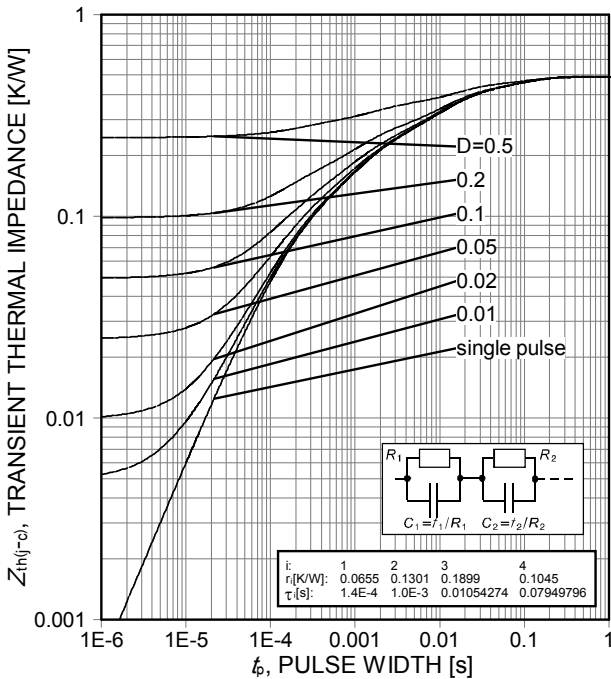


Figure 19. IGBT transient thermal impedance  
( $D=tp/T$ )

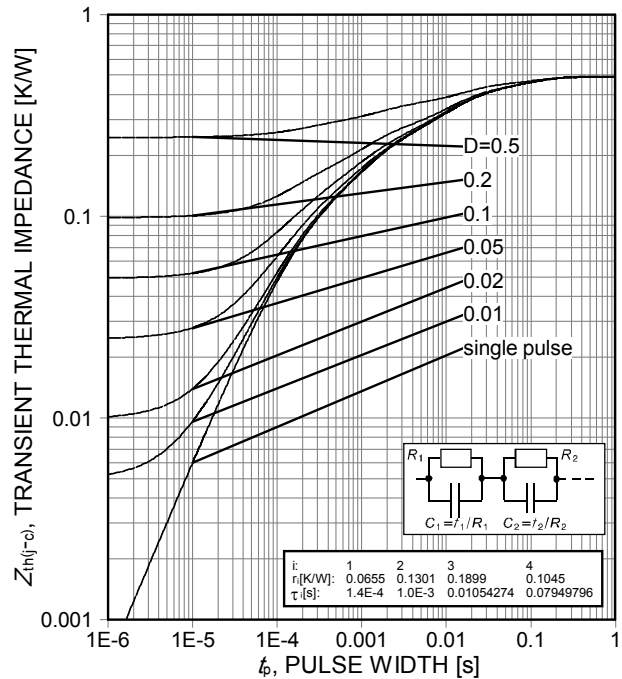


Figure 20. Diode transient thermal impedance as a function of pulse width  
( $D=tp/T$ )



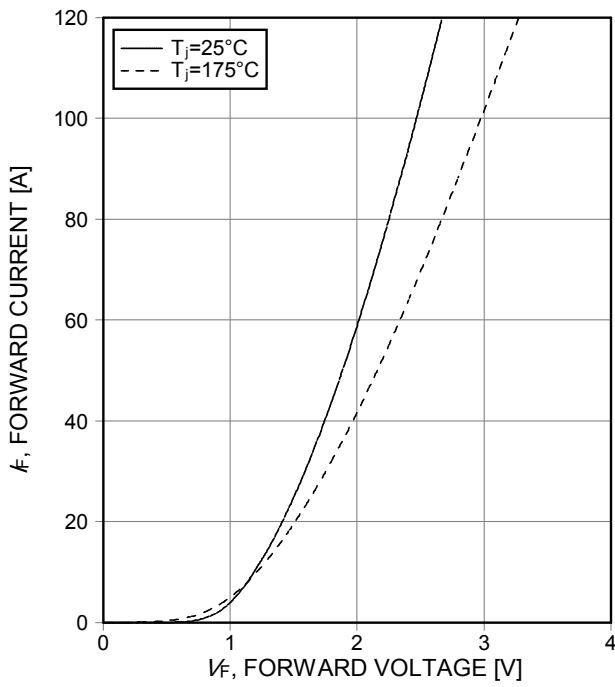


Figure 21. Typical diode forward current as a function of forward voltage

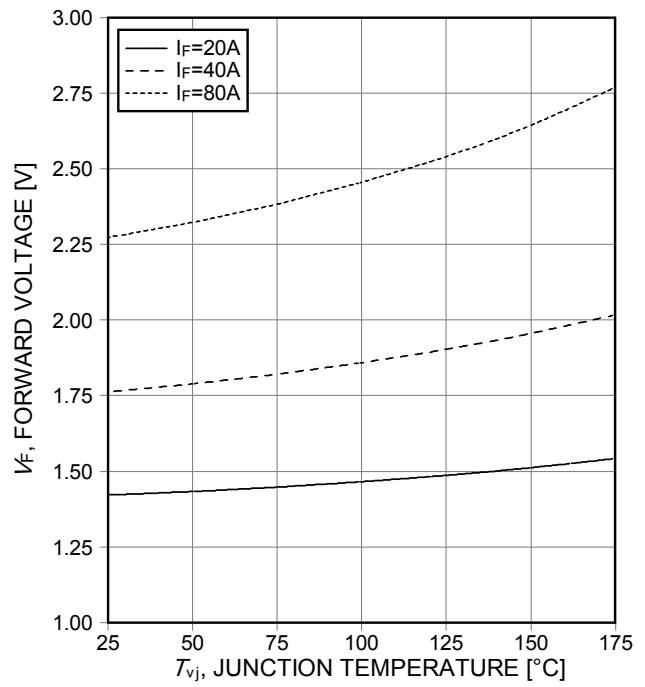
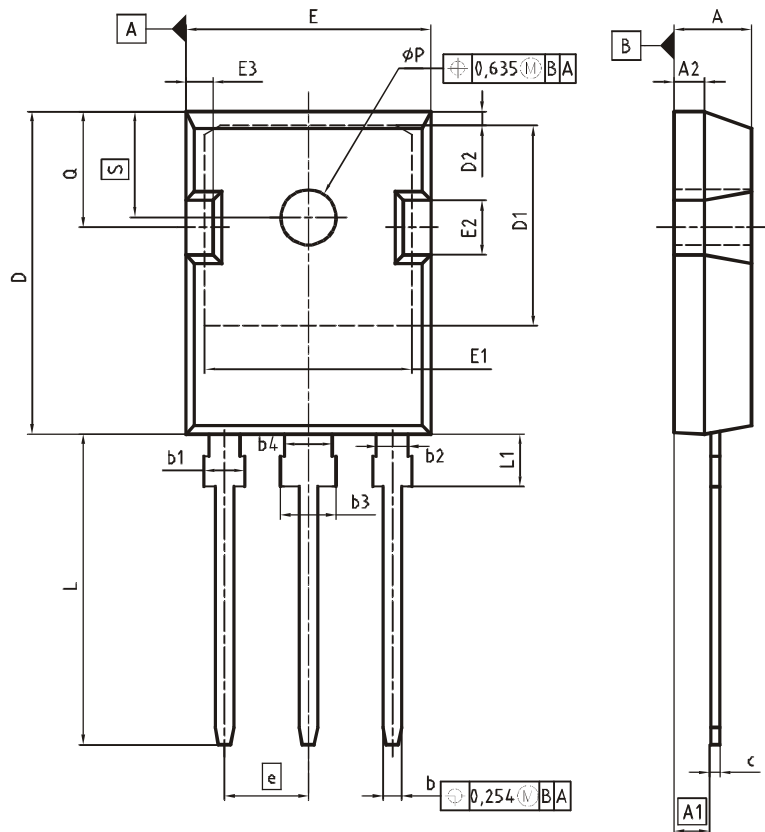


Figure 22. Typical diode forward voltage as a function of junction temperature

PG-TO247-3



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.63	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		0.214	
N	3		3	
L	19.80	20.32	0.780	0.800
L1	4.10	4.47	0.161	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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SCALE  
0 5 5 7.5mm

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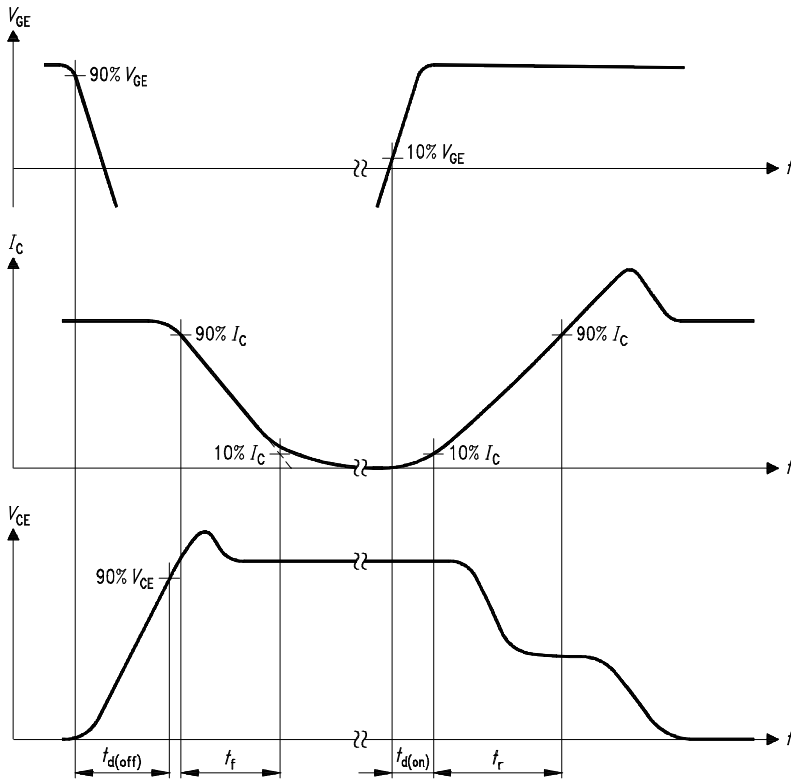


Figure A. Definition of switching times

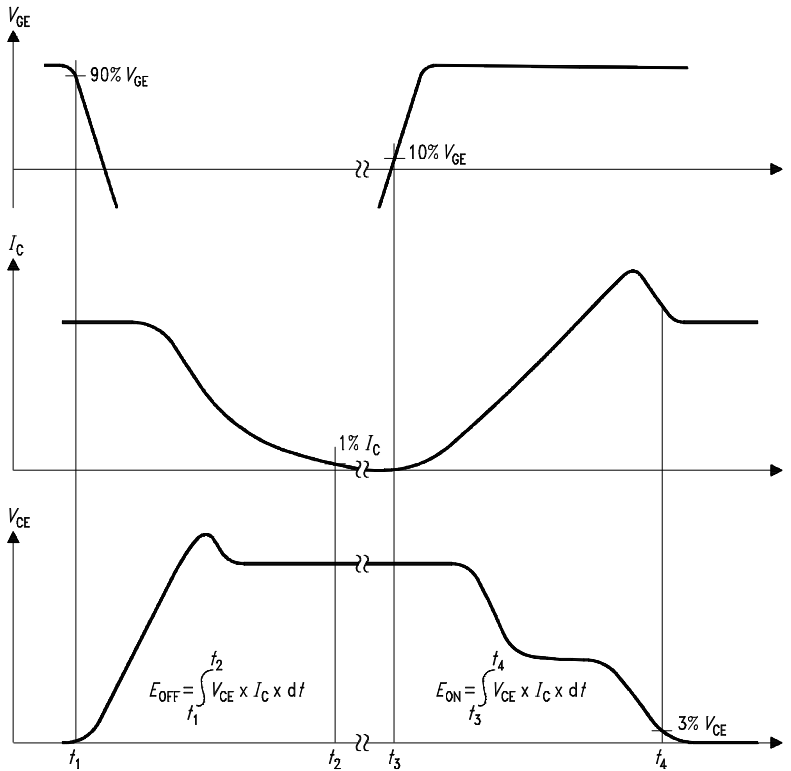


Figure B. Definition of switching losses

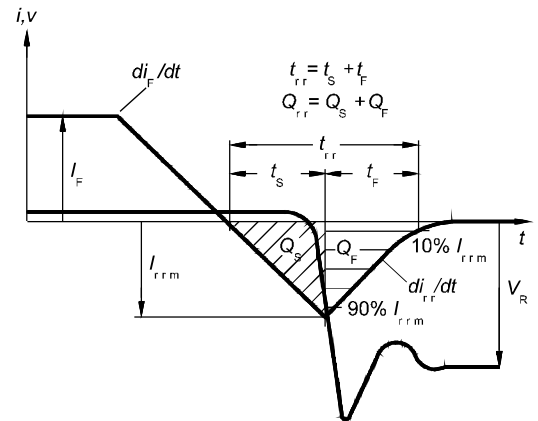


Figure C. Definition of diodes switching characteristics

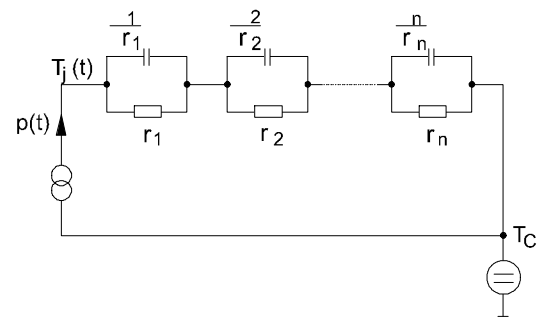


Figure D. Thermal equivalent circuit

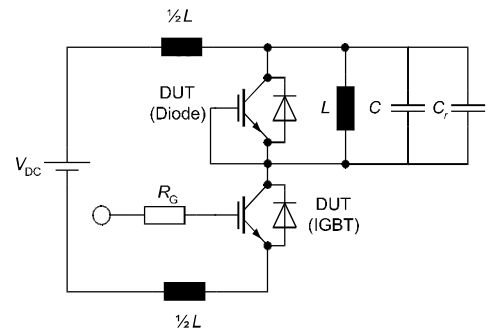


Figure E. Dynamic test circuit  
 Leakage inductance  $L = 180\text{nH}$ ,  
 Stray capacitor  $C_s = 40\text{pF}$ ,  
 Relief capacitor  $C_r = 1\text{nF}$   
 (only for ZVT switching)

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