

IGBT

High speed IGBT in Trench and Fieldstop technology

IGW60N60H3

600V high speed switching series third generation

Data sheet

High speed IGBT in Trench and Fieldstop technology

Features:

TRENCHSTOP™ technology offering

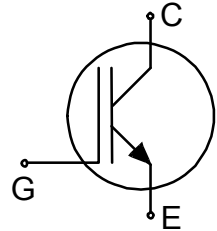
- very low turn-off energy
- low V_{CEsat}
- low EMI
- maximum junction temperature 175°C
- qualified according to JEDEC for target applications
- Pb-free lead plating, halogen-free mould compound, RoHS compliant
- complete product spectrum and PSpice Models:
<http://www.infineon.com/igbt/>

Applications:

- uninterruptible power supplies
- welding converters
- converters with high switching frequency

Package pin definition:

- Pin 1 - gate
- Pin 2 & backside - collector
- Pin 3 - emitter



Key Performance and Package Parameters

Type	V_{CE}	I_C	$V_{CEsat}, T_{vj}=25^\circ\text{C}$	T_{vjmax}	Marking	Package
IGW60N60H3	600V	60A	1.85V	175°C	G60H603	PG-TO247-3



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Maximum ratings

Parameter	Symbol	Value	Unit
Collector-emitter voltage	V_{CE}	600	V
DC collector current, limited by $T_{vjmax}^{1)}$ $T_C = 25^\circ\text{C}$ $T_C = 115^\circ\text{C}$	I_C	80.0 60.0	A
Pulsed collector current, t_p limited by T_{vjmax}	I_{Cpuls}	180.0	A
Turn off safe operating area $V_{CE} \leq 600\text{V}$, $T_{vj} \leq 175^\circ\text{C}$	-	180.0	A
Gate-emitter voltage	V_{GE}	± 20	V
Short circuit withstand time $V_{GE} = 15.0\text{V}$, $V_{CC} \leq 400\text{V}$ Allowed number of short circuits < 1000 Time between short circuits: $\geq 1.0\text{s}$ $T_{vj} = 150^\circ\text{C}$	t_{SC}	5	μs
Power dissipation $T_C = 25^\circ\text{C}$	P_{tot}	416.0	W
Operating junction temperature	T_{vj}	-40...+175	$^\circ\text{C}$
Storage temperature	T_{stg}	-55...+150	$^\circ\text{C}$
Soldering temperature, wave soldering 1.6 mm (0.063 in.) from case for 10s		260	$^\circ\text{C}$
Mounting torque, M3 screw Maximum of mounting processes: 3	M	0.6	Nm

Thermal Resistance

Parameter	Symbol	Conditions	Max. Value	Unit
Characteristic				
IGBT thermal resistance, junction - case	$R_{th(j-c)}$		0.36	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.	
Static Characteristic						
Collector-emitter breakdown voltage	$V_{(BR)CES}$	$V_{GE} = 0\text{V}$, $I_C = 2.00\text{mA}$	600	-	-	V
Collector-emitter saturation voltage	V_{CEsat}	$V_{GE} = 15.0\text{V}$, $I_C = 60.0\text{A}$ $T_{vj} = 25^\circ\text{C}$ $T_{vj} = 125^\circ\text{C}$ $T_{vj} = 175^\circ\text{C}$	- - -	1.85 2.10 2.25	2.30 - -	V
Gate-emitter threshold voltage	$V_{GE(th)}$	$I_C = 1.00\text{mA}$, $V_{CE} = V_{GE}$	4.1	5.1	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 5000.0	μA
Gate-emitter leakage current	I_{GES}	$V_{CE} = 0\text{V}$, $V_{GE} = 20\text{V}$	-	-	100	nA
Transconductance	g_{fs}	$V_{CE} = 20\text{V}$, $I_C = 60.0\text{A}$	-	32.0	-	S

¹⁾ 80A value limited by bondwire

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

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
Dynamic Characteristic						
Input capacitance	C_{ies}	$V_{CE} = 25\text{V}, V_{GE} = 0\text{V}, f = 1\text{MHz}$	-	3660	-	pF
Output capacitance	C_{oes}		-	130	-	
Reverse transfer capacitance	C_{res}		-	106	-	
Gate charge	Q_G	$V_{CC} = 480\text{V}, I_C = 60.0\text{A}, V_{GE} = 15\text{V}$	-	375.0	-	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: $\geq 1.0\text{s}$	$I_{C(SC)}$	$V_{GE} = 15.0\text{V}, V_{CC} \leq 400\text{V}, t_{SC} \leq 5\mu\text{s}, T_{vj} = 150^{\circ}\text{C}$	-	534	-	A

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

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
IGBT Characteristic						
Turn-on delay time	$t_{d(on)}$	$T_{vj} = 25^{\circ}\text{C}, V_{CC} = 400\text{V}, I_C = 60.0\text{A}, V_{GE} = 0.0/15.0\text{V}, r_G = 6.0\Omega, L_{\sigma} = 90\text{nH}, C_{\sigma} = 50\text{pF}$ Energy losses include "tail" and diode (IKW60N60H3) reverse recovery. Switching test with minimized Emitter Stray inductance, see High Speed 3 App Note on www.infineon.com .	-	27	-	ns
Rise time	t_r		-	44	-	ns
Turn-off delay time	$t_{d(off)}$		-	252	-	ns
Fall time	t_f		-	27	-	ns
Turn-on energy	E_{on}		-	2.10	-	mJ
Turn-off energy	E_{off}		-	1.13	-	mJ
Total switching energy	E_{ts}		-	3.23	-	mJ

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

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
IGBT Characteristic						
Turn-on delay time	$t_{d(on)}$	$T_{vj} = 175^{\circ}\text{C}, V_{CC} = 400\text{V}, I_C = 60.0\text{A}, V_{GE} = 0.0/15.0\text{V}, r_G = 6.0\Omega, L_{\sigma} = 90\text{nH}, C_{\sigma} = 50\text{pF}$ Energy losses include "tail" and diode (IKW60N60H3) reverse recovery. Switching test with minimized Emitter Stray inductance, see High Speed 3 App Note on www.infineon.com .	-	25	-	ns
Rise time	t_r		-	39	-	ns
Turn-off delay time	$t_{d(off)}$		-	291	-	ns
Fall time	t_f		-	23	-	ns
Turn-on energy	E_{on}		-	2.63	-	mJ
Turn-off energy	E_{off}		-	1.46	-	mJ
Total switching energy	E_{ts}		-	4.09	-	mJ

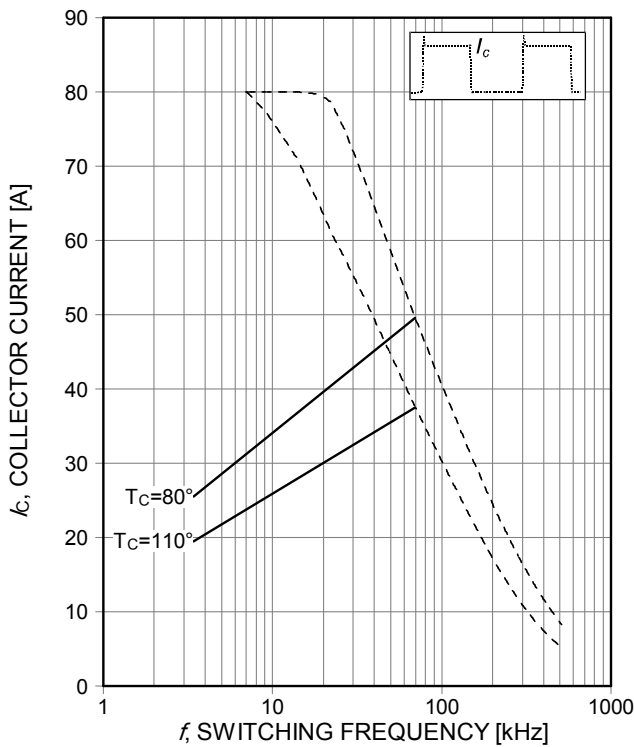


Figure 1. Collector current as a function of switching frequency
 ($T_j \leq 175^\circ\text{C}$, $D=0.5$, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $r_G=6\Omega$)

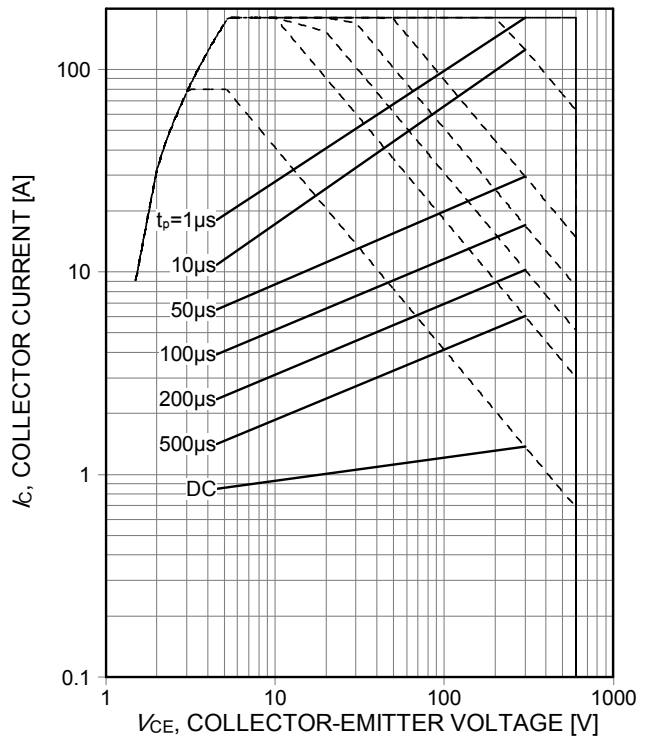


Figure 2. Forward bias safe operating area
 ($D=0$, $T_C=25^\circ\text{C}$, $T_j \leq 175^\circ\text{C}$; $V_{GE}=15\text{V}$)

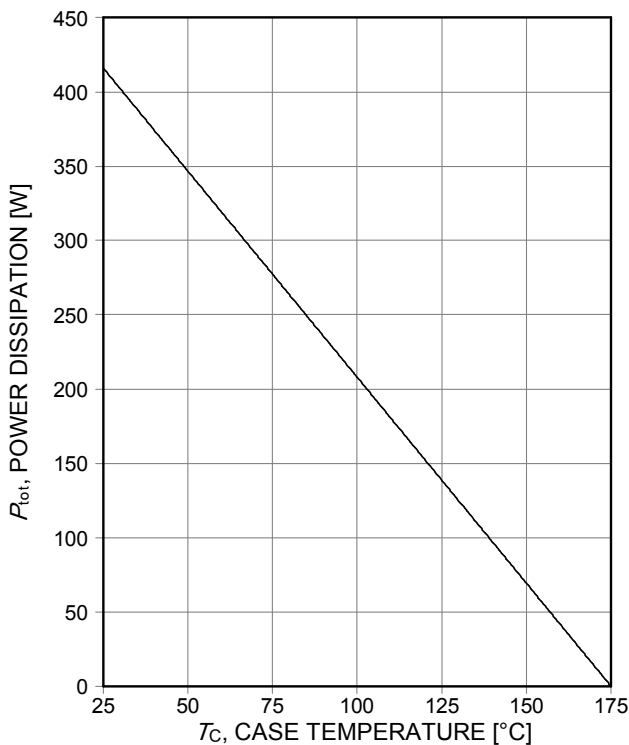


Figure 3. Power dissipation as a function of case temperature
 ($T_j \leq 175^\circ\text{C}$)

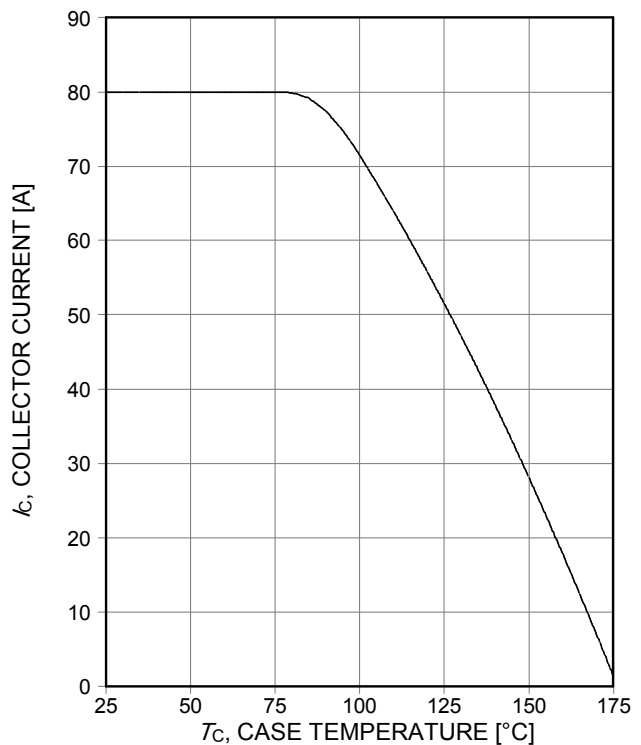


Figure 4. Collector current as a function of case temperature
 ($V_{GE} \geq 15\text{V}$, $T_j \leq 175^\circ\text{C}$)

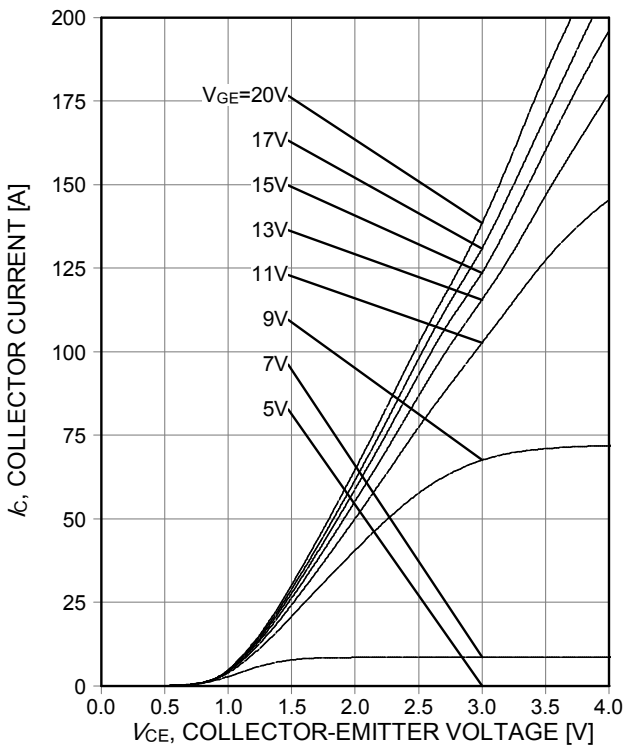


Figure 5. Typical output characteristic ($T_j=25^\circ\text{C}$)

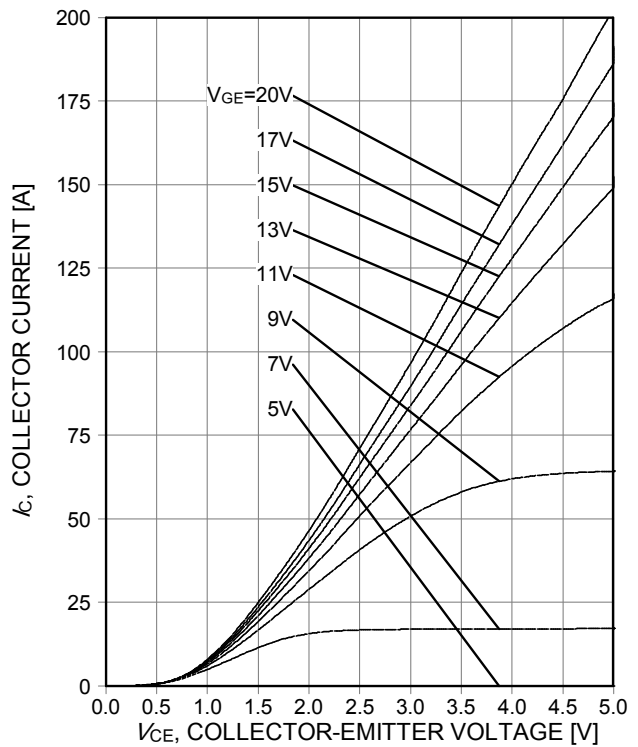


Figure 6. Typical output characteristic ($T_j=175^\circ\text{C}$)

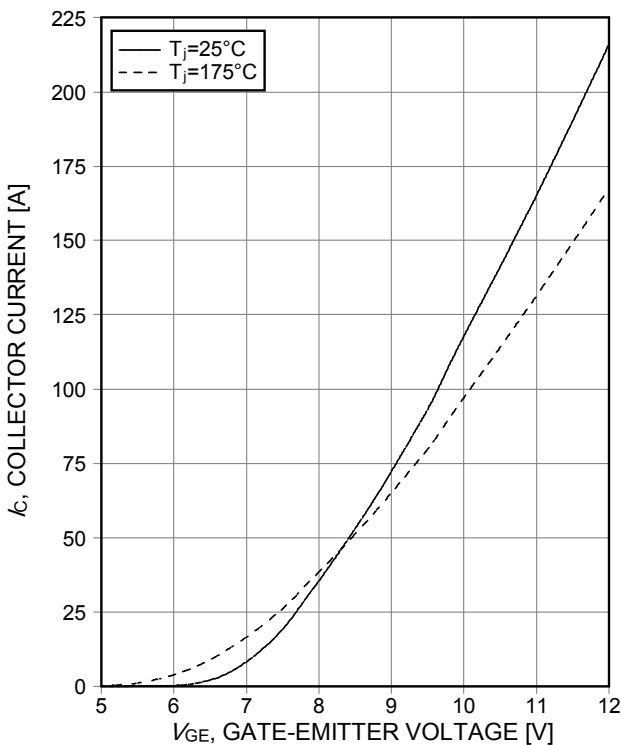


Figure 7. Typical transfer characteristic ($V_{CE}=20\text{V}$)

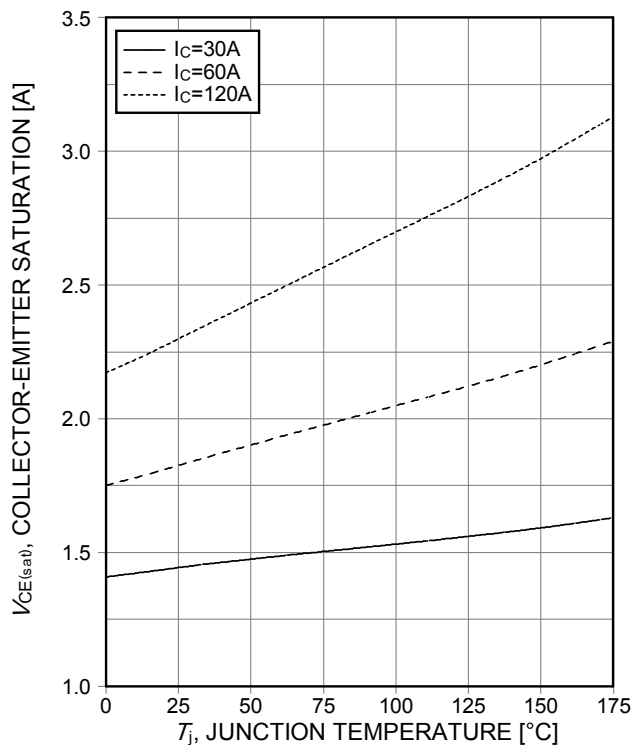


Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature ($V_{GE}=15\text{V}$)

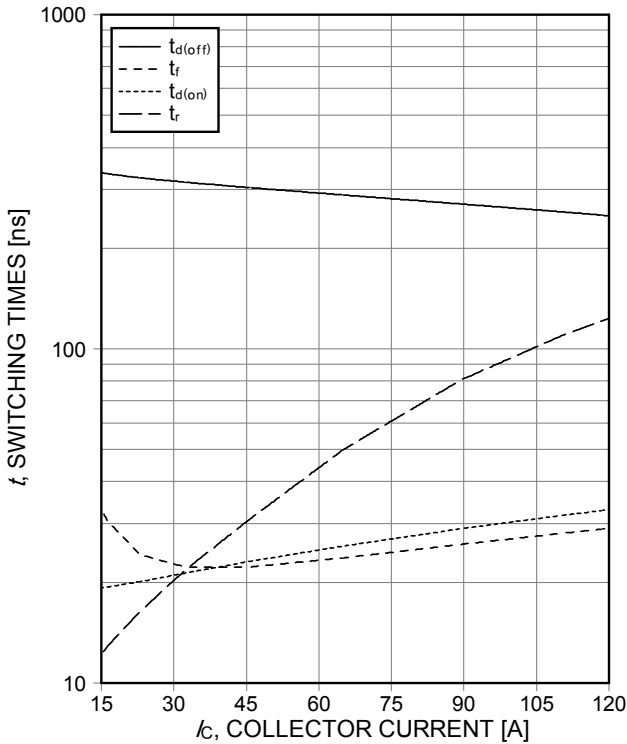


Figure 9. Typical switching times as a function of collector current
 (ind. load, $T_j=175^{\circ}\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $r_G=6\Omega$, test circuit in Fig. E)

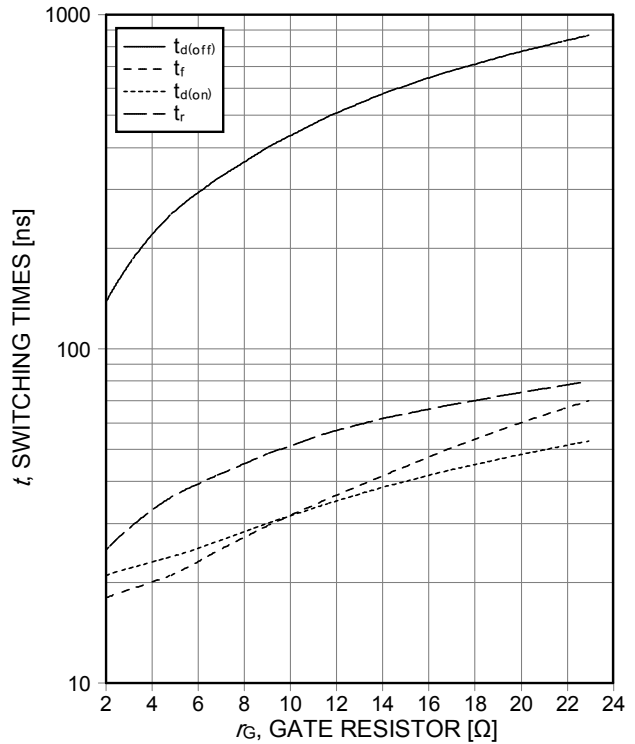


Figure 10. Typical switching times as a function of gate resistor
 (ind. load, $T_j=175^{\circ}\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $I_C=60\text{A}$, test circuit in Fig. E)

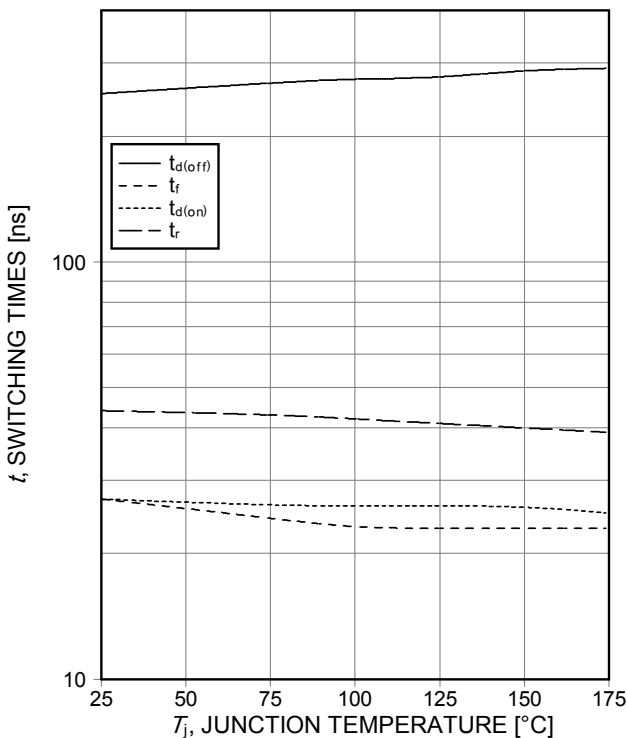


Figure 11. Typical switching times as a function of junction temperature
 (ind. load, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $I_C=60\text{A}$, $r_G=6\Omega$, test circuit in Fig. E)

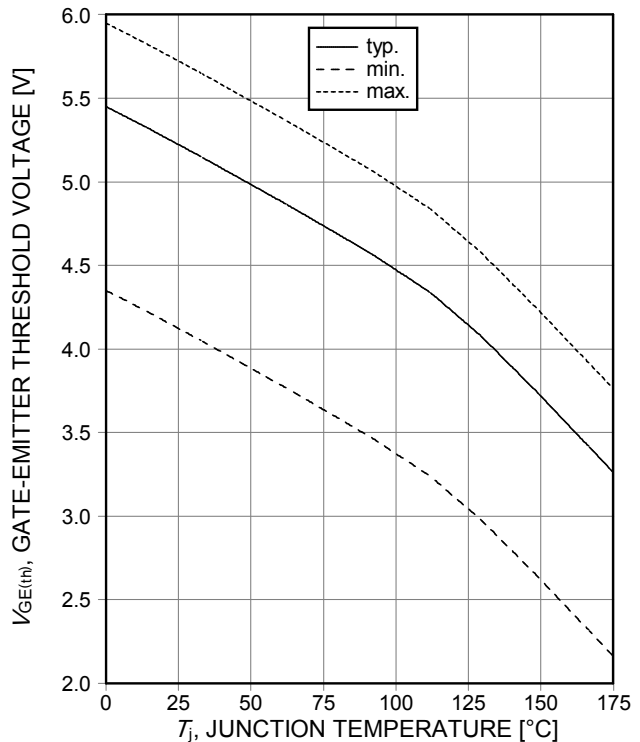


Figure 12. Gate-emitter threshold voltage as a function of junction temperature
 ($I_C=1\text{mA}$)

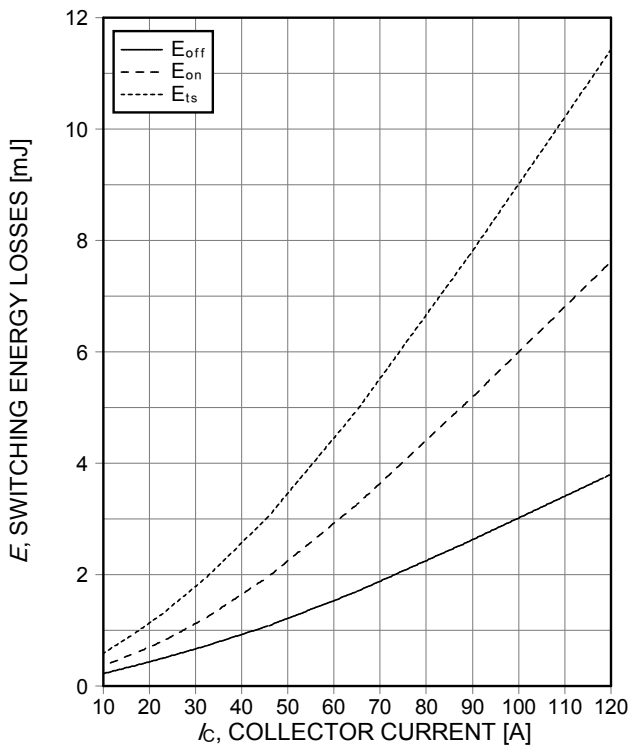


Figure 13. Typical switching energy losses as a function of collector current
 (ind. load, $T_j=175^\circ\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $r_G=6\Omega$, test circuit in Fig. E)

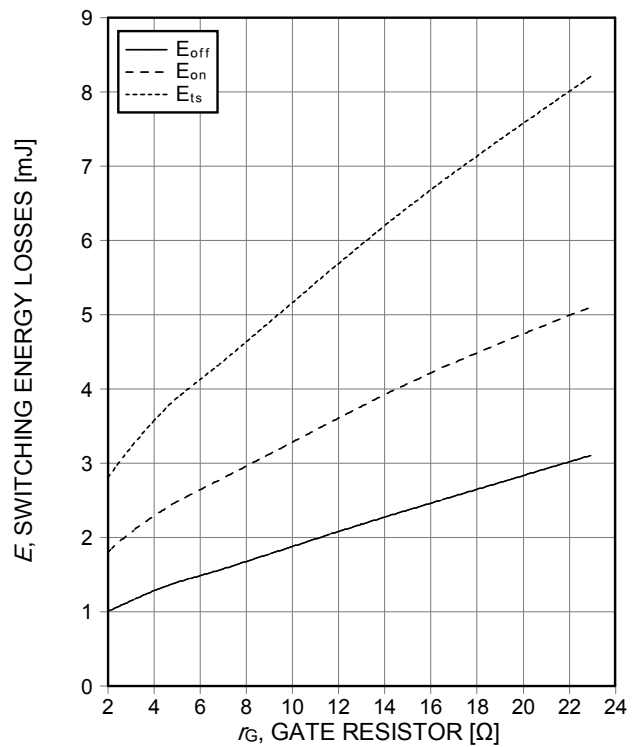


Figure 14. Typical switching energy losses as a function of gate resistor
 (ind. load, $T_j=175^\circ\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $I_c=60\text{A}$, test circuit in Fig. E)

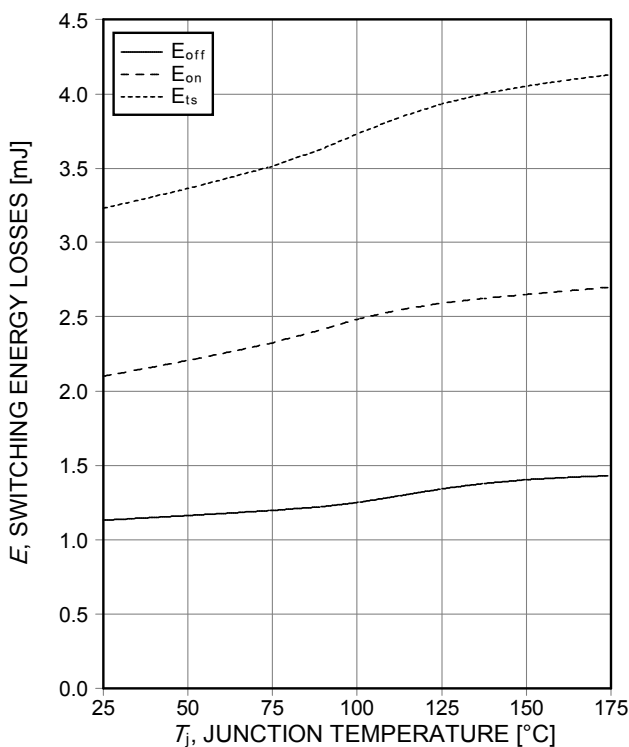


Figure 15. Typical switching energy losses as a function of junction temperature
 (ind. load, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $I_c=60\text{A}$, $r_G=6\Omega$, test circuit in Fig. E)

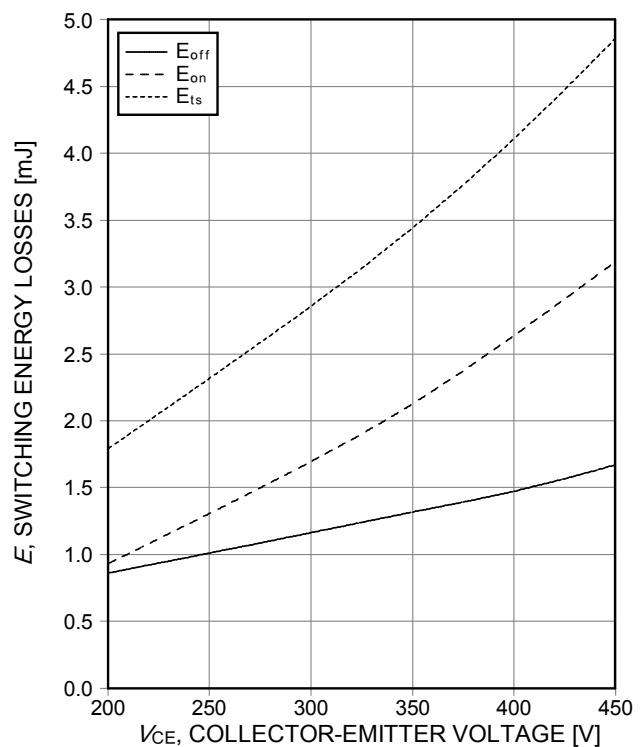


Figure 16. Typical switching energy losses as a function of collector emitter voltage
 (ind. load, $T_j=175^\circ\text{C}$, $V_{GE}=15/0\text{V}$, $I_c=60\text{A}$, $r_G=6\Omega$, test circuit in Fig. E)

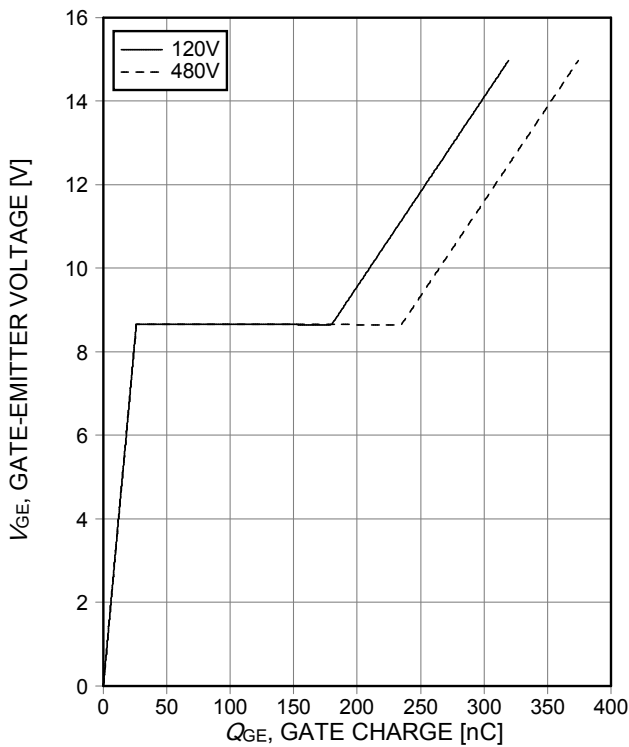


Figure 17. Typical gate charge
($I_C=60A$)

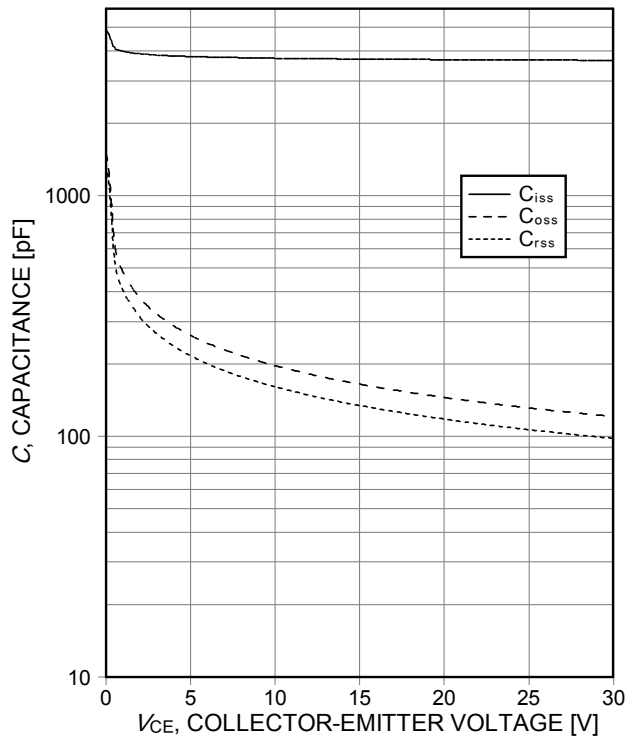


Figure 18. Typical capacitance as a function of collector-emitter voltage
($V_{GE}=0V$, $f=1MHz$)

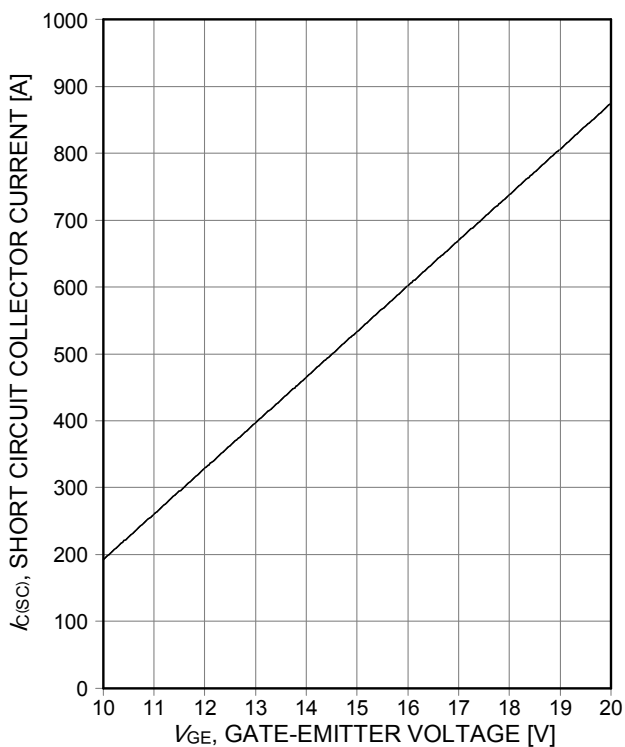


Figure 19. Typical short circuit collector current as a function of gate-emitter voltage
($V_{CE}\leq 400V$, start at $T_j=25^\circ C$)

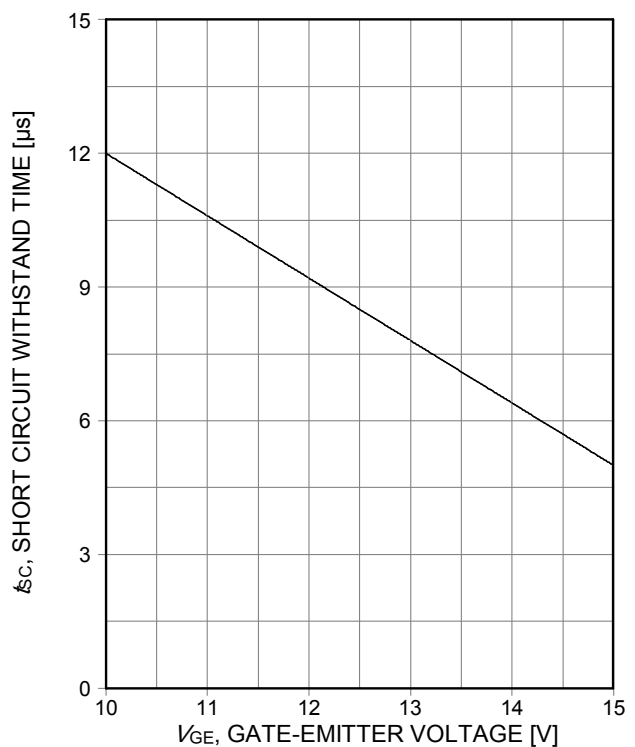


Figure 20. Short circuit withstand time as a function of gate-emitter voltage
($V_{CE}\leq 400V$, start at $T_j\leq 150^\circ C$)

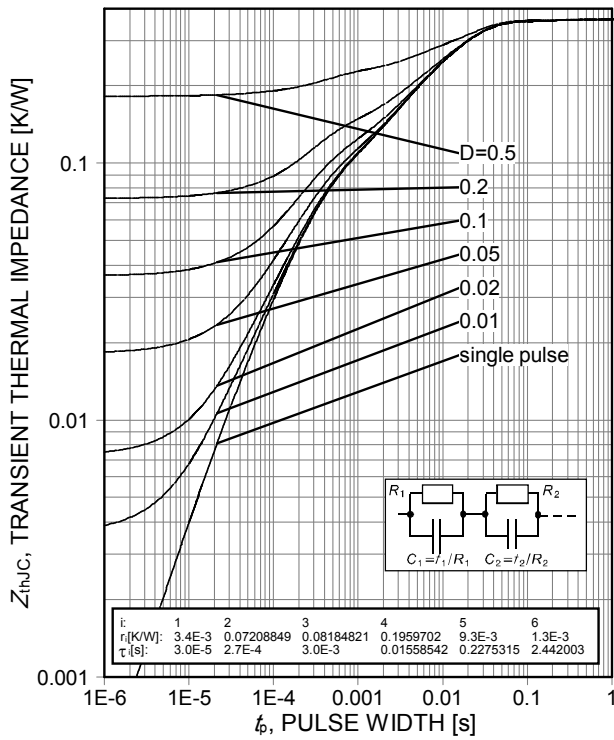
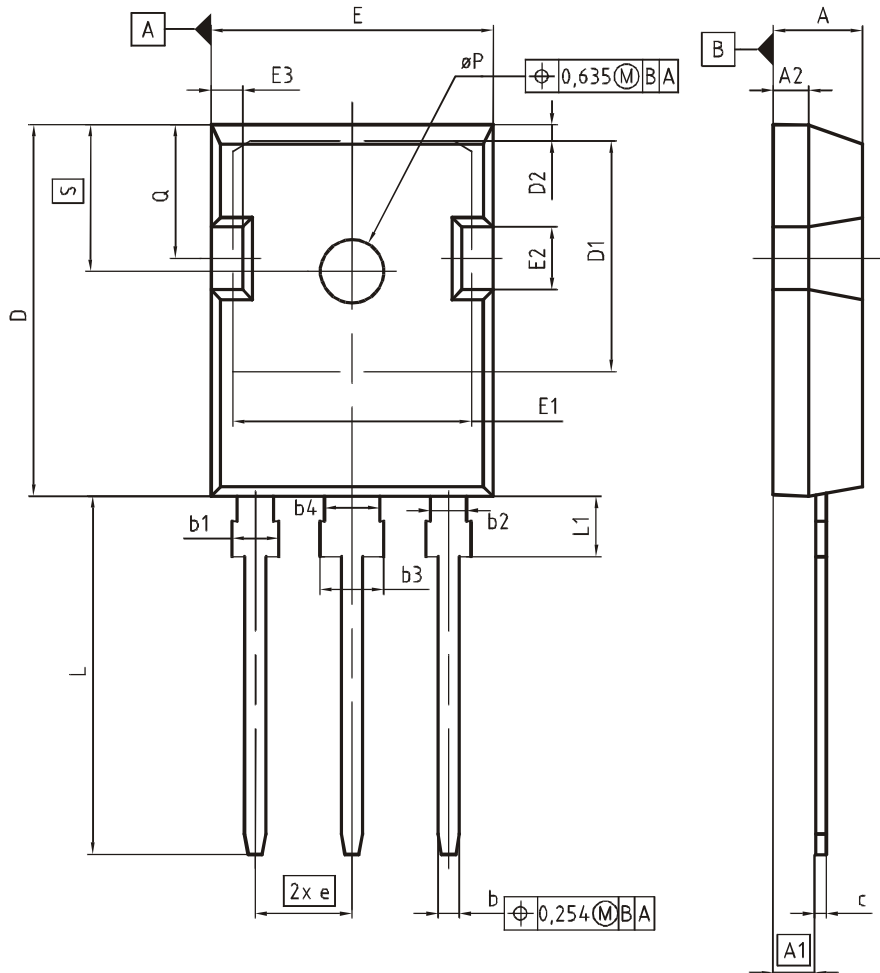


Figure 21. IGBT transient thermal impedance ($D = t_p/T$)

PG-TO247-3



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
ØP	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

EUROPEAN PROJECTION

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REVISION
05

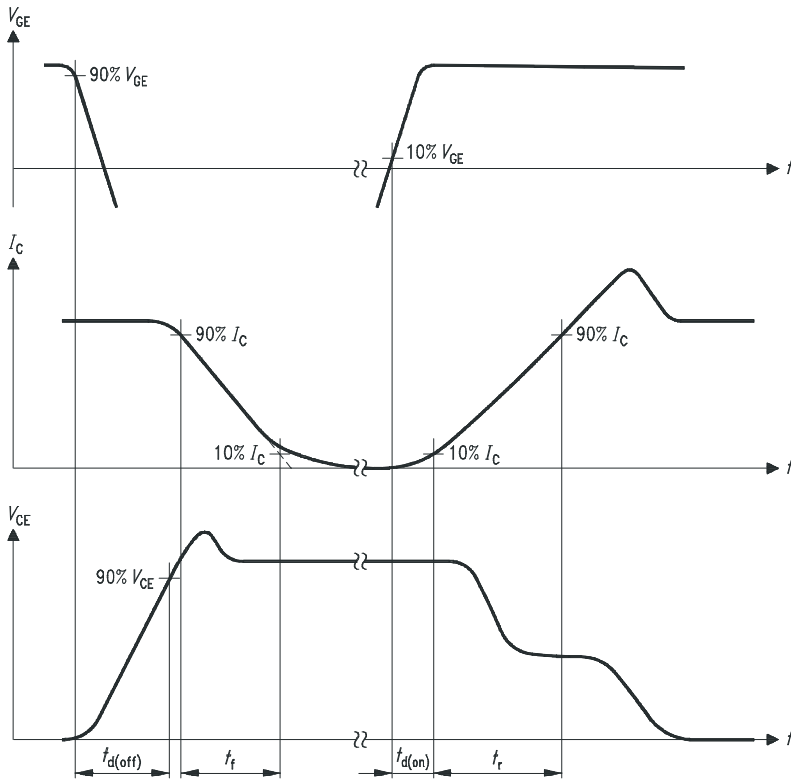


Figure A. Definition of switching times

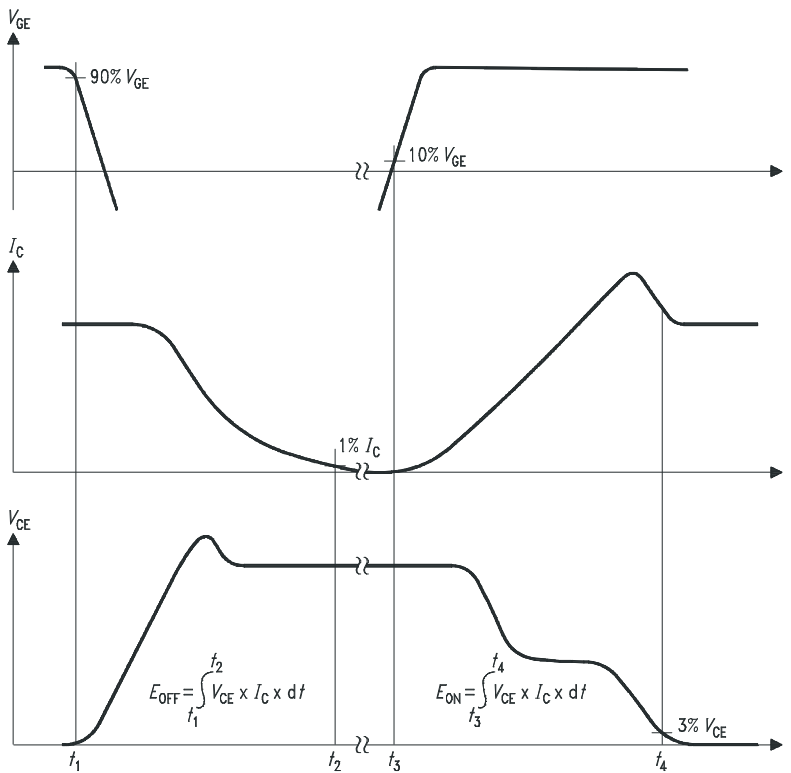


Figure B. Definition of switching losses

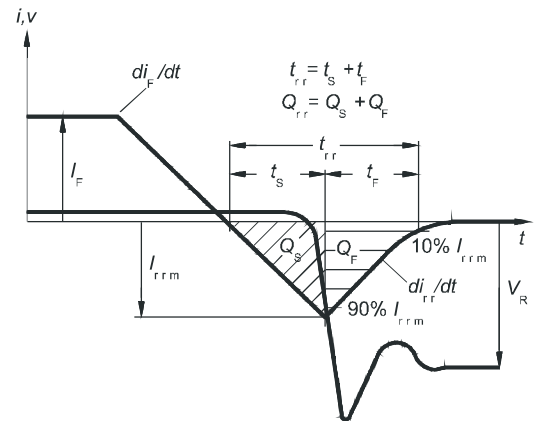


Figure C. Definition of diodes switching characteristics

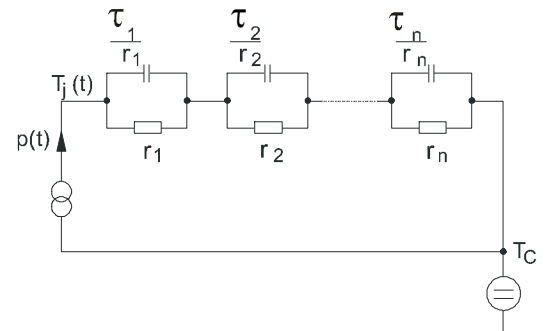


Figure D. Thermal equivalent circuit

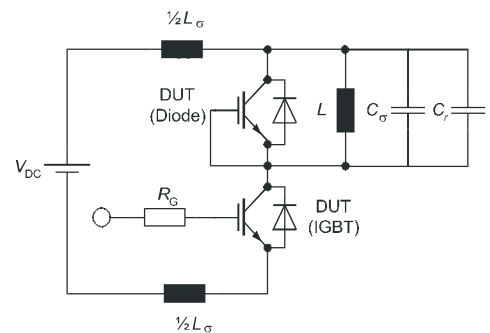


Figure E. Dynamic test circuit
Parasitic inductance L_{σ} ,
Parasitic capacitor C_{σ} ,
Relief capacitor C_r
(only for ZVT switching)