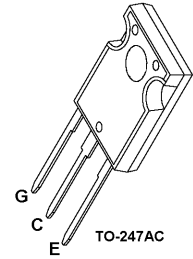
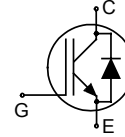


High Speed IGBT in NPT-technology

- 30% lower E_{off} compared to previous generation
12 $\mu\text{J/A}$
- Short circuit withstand time – 10 μs
- NPT-Technology for 600V applications offers:
 - parallel switching capability
 - very tight parameter distribution
 - high ruggedness, temperature stable behaviour



Type	V_{CE}	I_C	$V_{CE(sat)}$	T_j	Package	Ordering Code
SKW20N60HS	600V	20	3.5V	150°C	TO-247AC	Q67040-S4242-A001

Maximum Ratings

Parameter	Symbol	Value	Unit
Collector-emitter voltage	V_{CE}	600	V
DC collector current	I_C	40	A
$T_C = 25^\circ\text{C}$		19	
$T_C = 100^\circ\text{C}$			
Pulsed collector current, t_p limited by T_{jmax}	I_{Cpuls}	80	
Turn off safe operating area	-	80	
$V_{CE} \leq 600\text{V}$, $T_j \leq 150^\circ\text{C}$			
Diode forward current	I_F	40	
$T_C = 25^\circ\text{C}$		20	
$T_C = 100^\circ\text{C}$			
Diode pulsed current, t_p limited by T_{jmax}	I_{Fpuls}	80	
Gate-emitter voltage	V_{GE}	± 20	V
Short circuit withstand time ¹⁾	t_{SC}	10	μs
$V_{GE} = 15\text{V}$, $V_{CC} \leq 600\text{V}$, $T_j \leq 150^\circ\text{C}$			
Power dissipation	P_{tot}	178	W
$T_C = 25^\circ\text{C}$			
Operating junction and storage temperature	T_j , T_{stg}	-55...+150	$^\circ\text{C}$
Soldering temperature, 1.6mm (0.063 in.) from case for 10s	-	260	

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

Thermal Resistance

Parameter	Symbol	Conditions	Max. Value	Unit
Characteristic				
IGBT thermal resistance, junction – case	R_{thJC}		0.7	K/W
Diode thermal resistance, junction – case	R_{thJCD}		tbd	
Thermal resistance, junction – ambient	R_{thJA}	TO-247AC	40	

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

Parameter	Symbol	Conditions	Value			Unit
			min.	Typ.	max.	
Static Characteristic						
Collector-emitter breakdown voltage	$V_{(BR)CES}$	$V_{GE}=0V, I_C=500\mu A$	600	-	-	V
Collector-emitter saturation voltage	$V_{CE(sat)}$	$V_{GE} = 15V, I_C=20A$ $T_j=25^{\circ}C$ $T_j=150^{\circ}C$		2.8 3.5		
Diode forward voltage	V_F	$V_{GE}=0V, I_F=20A$ $T_j=25^{\circ}C$ $T_j=150^{\circ}C$	-		1.95 1.8	
Gate-emitter threshold voltage	$V_{GE(th)}$	$I_C=300\mu A, V_{CE}=V_{GE}$	3	4	5	
Zero gate voltage collector current	I_{CES}	$V_{CE}=600V, V_{GE}=0V$ $T_j=25^{\circ}C$ $T_j=150^{\circ}C$	- -	- -	40 2500	μA
Gate-emitter leakage current	I_{GES}	$V_{CE}=0V, V_{GE}=20V$	-	-	100	
Transconductance	g_{fs}	$V_{CE}=20V, I_C=20A$	-	14		S

Dynamic Characteristic

Input capacitance	C_{iss}	$V_{CE}=25V,$ $V_{GE}=0V,$ $f=1\text{MHz}$	-	1100		pF
Output capacitance	C_{oss}		-	160		
Reverse transfer capacitance	C_{rss}		-	63		
Gate charge	Q_{Gate}	$V_{CC}=480V, I_C=20A$ $V_{GE}=15V$	-	100		nC
Internal emitter inductance measured 5mm (0.197 in.) from case	L_E	TO-247AC	-	13		nH
Short circuit collector current ¹⁾	$I_{C(SC)}$	$V_{GE}=15V, t_{SC}\leq 10\mu s$ $V_{CC}\leq 600V,$ $T_j\leq 150^\circ\text{C}$	-	170		A

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

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

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
IGBT Characteristic						
Turn-on delay time	$t_{d(on)}$	$T_j=25^{\circ}\text{C}$, $V_{CC}=400\text{V}$, $I_C=20\text{A}$, $V_{GE}=0/15\text{V}$, $R_G=2.2\Omega$	-	16		ns
Rise time	t_r		-	6		
Turn-off delay time	$t_{d(off)}$		-	57		
Fall time	t_f		-	23		
Turn-on energy	E_{on}	Energy losses include “tail” and diode reverse recovery.	-	0		mJ
Turn-off energy	E_{off}		-	0.18		
Total switching energy	E_{ts}		-			
Turn-on delay time	$t_{d(on)}$	$T_j=25^{\circ}\text{C}$, $V_{CC}=400\text{V}$, $I_C=20\text{A}$, $V_{GE}=0/15\text{V}$, $R_G=16\Omega$	-	18		ns
Rise time	t_r		-	16		
Turn-off delay time	$t_{d(off)}$		-	207		
Fall time	t_f		-	13		
Turn-on energy	E_{on}	Energy losses include “tail” and diode reverse recovery.	-	0.41		mJ
Turn-off energy	E_{off}		-	0.30		
Total switching energy	E_{ts}		-			

Anti-Parallel Diode Characteristic

Diode reverse recovery time	t_{rr}	$T_j=25^\circ\text{C}$, $V_R=200\text{V}$, $I_F=20\text{A}$, $di_F/dt=200\text{A}/\mu\text{s}$	-	105.4		ns
	t_s		-	TBD		
	t_F		-	TBD		
Diode reverse recovery charge	Q_{rr}		-	TBD		nC
Diode peak reverse recovery current	I_{rrm}		-	16.7		A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	1528.8		A/ μs

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

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
IGBT Characteristic						
Turn-on delay time	$t_{d(on)}$	$T_j=150^{\circ}\text{C}$ $V_{CC}=400\text{V}$, $I_C=20\text{A}$, $V_{GE}=0/15\text{V}$,	-	15		ns
Rise time	t_r		-	6.4		
Turn-off delay time	$t_{d(off)}$		-	65		
Fall time	t_f		-	35		
Turn-on energy	E_{on}	$R_G=2.2\Omega$	-			mJ
Turn-off energy	E_{off}	Energy losses include “tail” and diode reverse recovery.	-	0.24		
Total switching energy	E_{ts}		-			
Turn-on delay time	$t_{d(on)}$	$T_j=150^{\circ}\text{C}$ $V_{CC}=400\text{V}$, $I_C=20\text{A}$, $V_{GE}=0/15\text{V}$,	-	17.2		ns
Rise time	t_r		-	16		
Turn-off delay time	$t_{d(off)}$		-	222		
Fall time	t_f		-	13		
Turn-on energy	E_{on}	$R_G=16\Omega$	-	0.6		mJ
Turn-off energy	E_{off}	Energy losses include “tail” and diode reverse recovery.	-	0.36		
Total switching energy	E_{ts}		-			

Anti-Parallel Diode Characteristic

Diode reverse recovery time	t_{rr}	$T_j=150^\circ\text{C}$ $V_R=200\text{V}$, $I_F=20\text{A}$, $di_F/dt=200\text{A}/\mu\text{s}$	-	163		ns
	t_s		-	TBD		
	t_F		-	TBD		
Diode reverse recovery charge	Q_{rr}		-			nC
Diode peak reverse recovery current	I_{rrm}		-	21.4		A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	2079.6		A/ μs

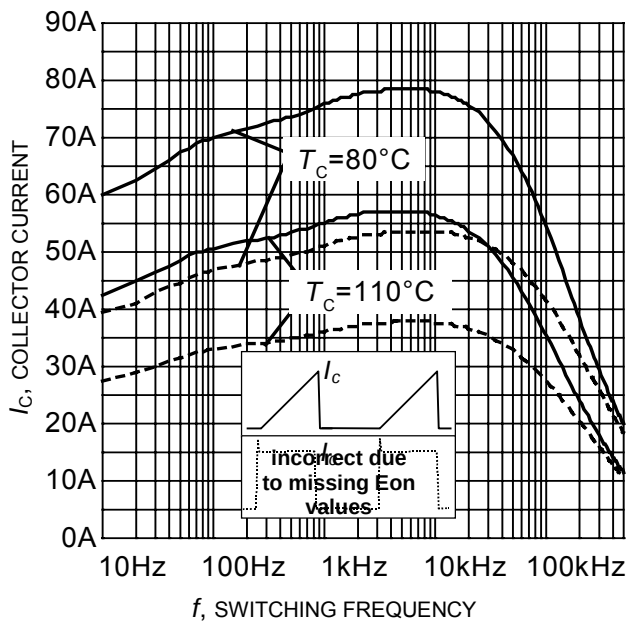


Figure 1. Collector current as a function of switching frequency
 $(T_j \leq 150^\circ\text{C}, D = 0.5, V_{CE} = 400\text{V}, V_{GE} = 0/+15\text{V}, R_G = 11\Omega)$

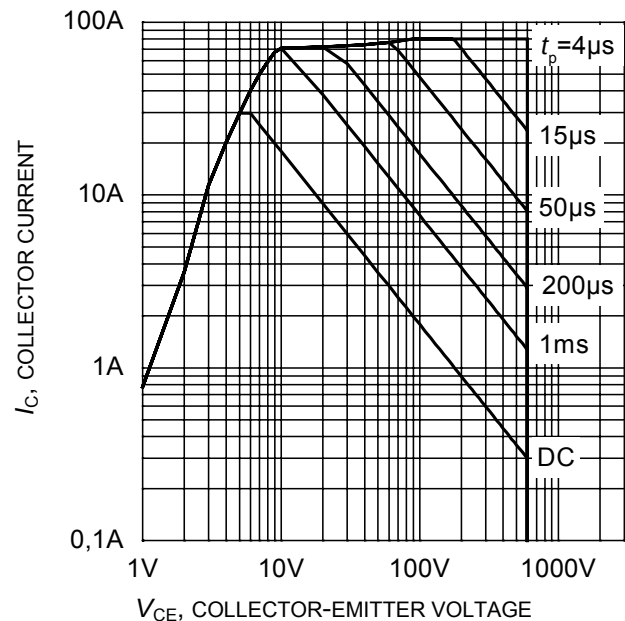


Figure 2. Safe operating area
 $(D = 0, T_C = 25^\circ\text{C}, T_j \leq 150^\circ\text{C}; V_{GE} = 15\text{V})$

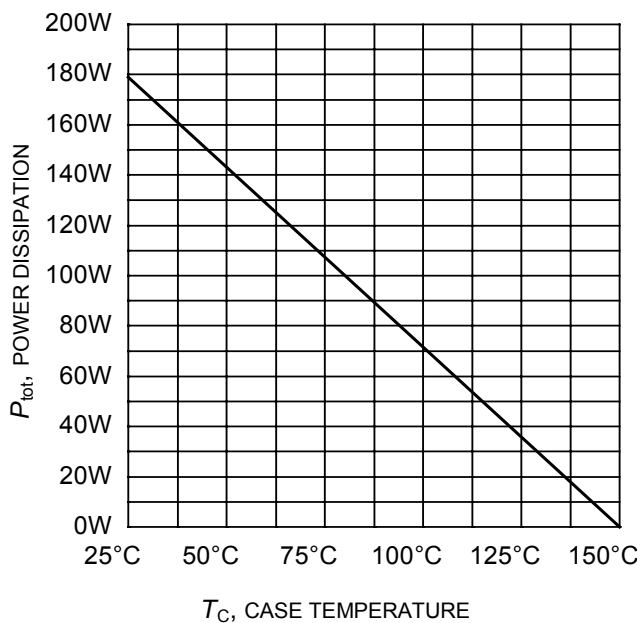


Figure 3. Power dissipation as a function of case temperature
 $(T_j \leq 150^\circ\text{C})$

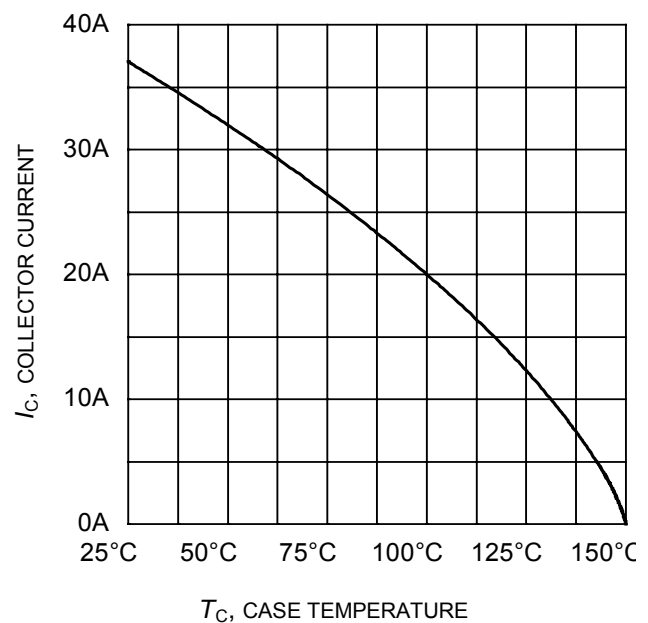


Figure 4. Collector current as a function of case temperature
 $(V_{GE} \leq 15\text{V}, T_j \leq 150^\circ\text{C})$

I_C , COLLECTOR CURRENT

V_{CE} , COLLECTOR-EMITTER VOLTAGE

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

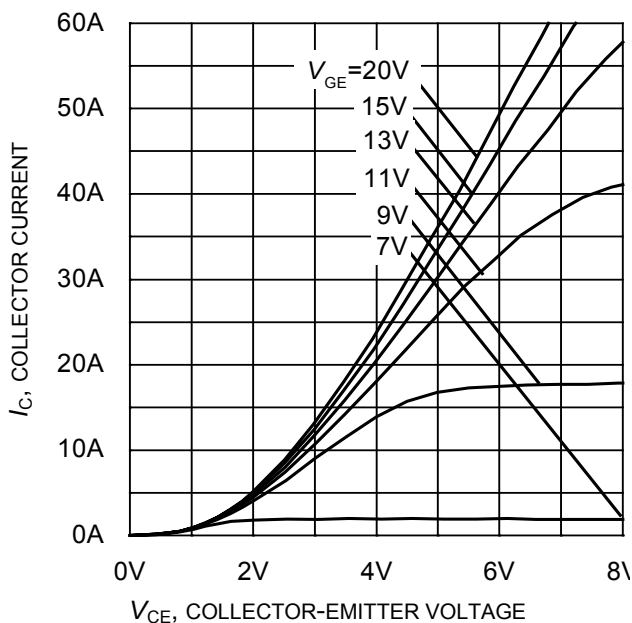


Figure 6. Typical output characteristic
($T_J = 150^\circ\text{C}$)

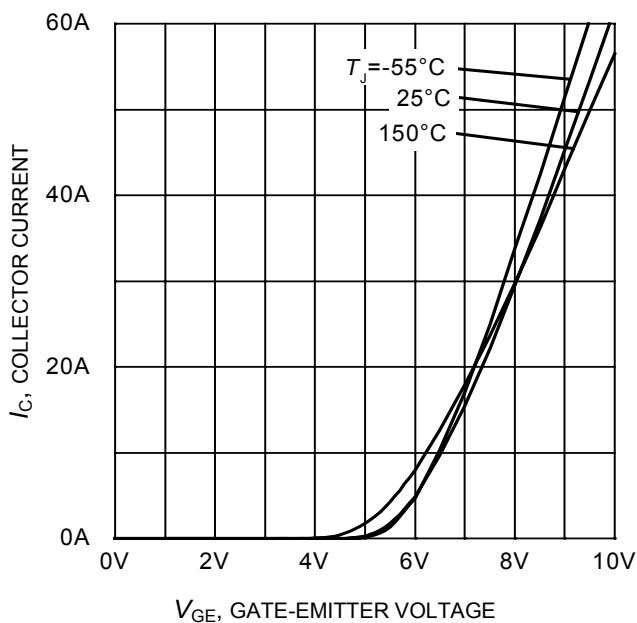


Figure 7. Typical transfer characteristic
($V_{GE} = 10\text{V}$)

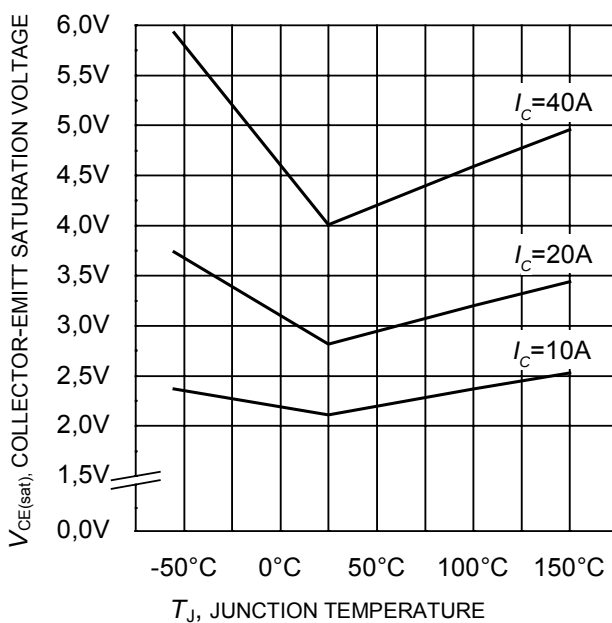


Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature
($V_{GE} = 15\text{V}$)

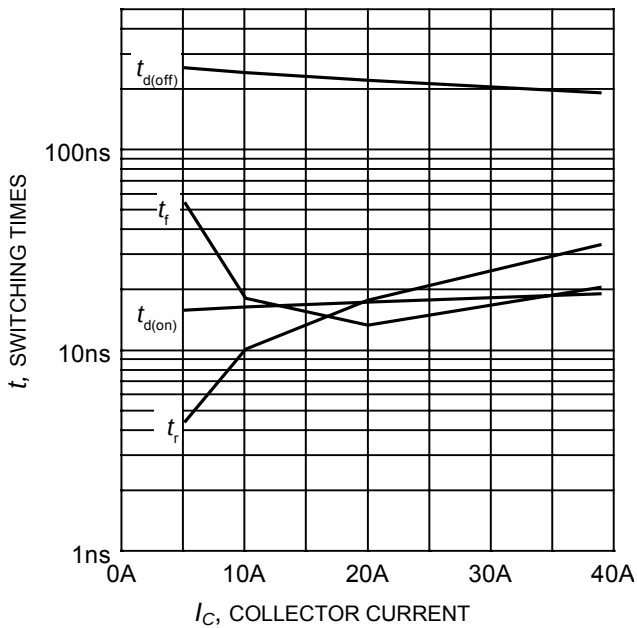


Figure 9. Typical switching times as a function of collector current
(inductive load, $T_J=150^\circ\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=0/15\text{V}$, $R_G=16\Omega$)

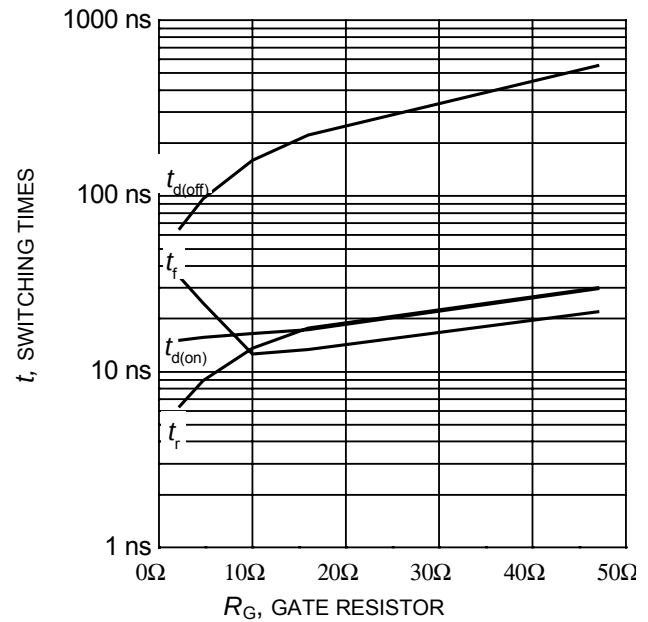


Figure 10. Typical switching times as a function of gate resistor
(inductive load, $T_J=150^\circ\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=0/15\text{V}$, $I_C=20\text{A}$)

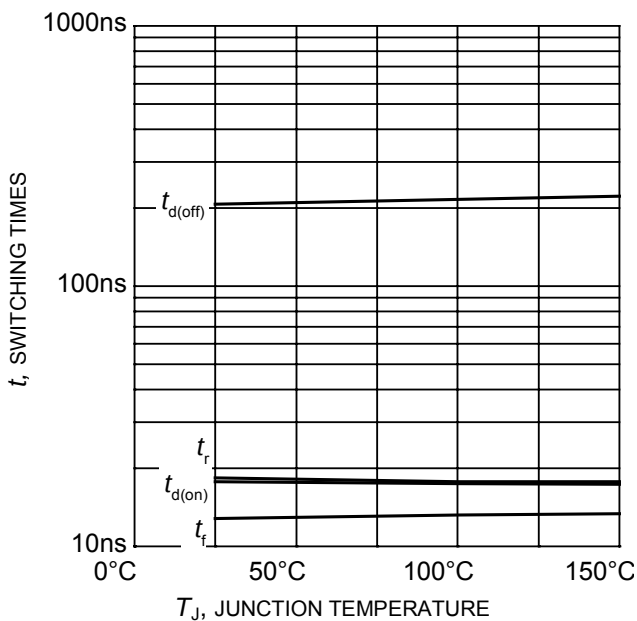


Figure 11. Typical switching times as a function of junction temperature
(inductive load, $V_{CE}=400\text{V}$, $V_{GE}=0/15\text{V}$, $I_C=20\text{A}$, $R_G=16\Omega$)

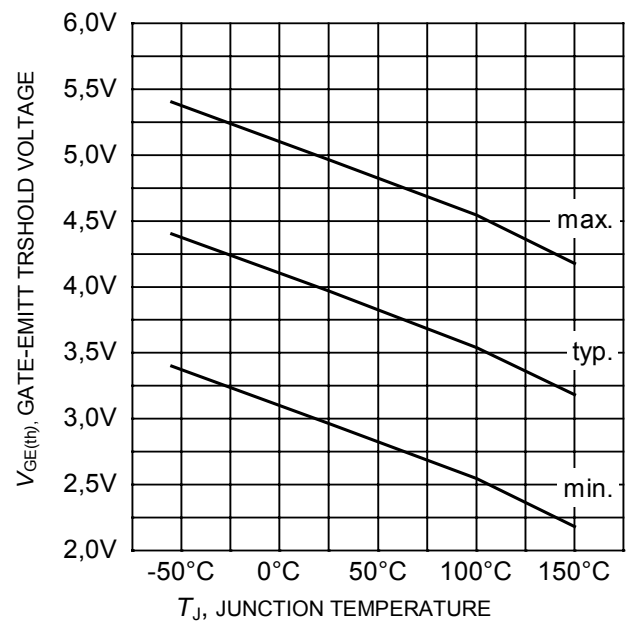


Figure 12. Collector current as a function of case temperature
($V_{GE} \leq 15\text{V}$, $T_J \leq 150^\circ\text{C}$)

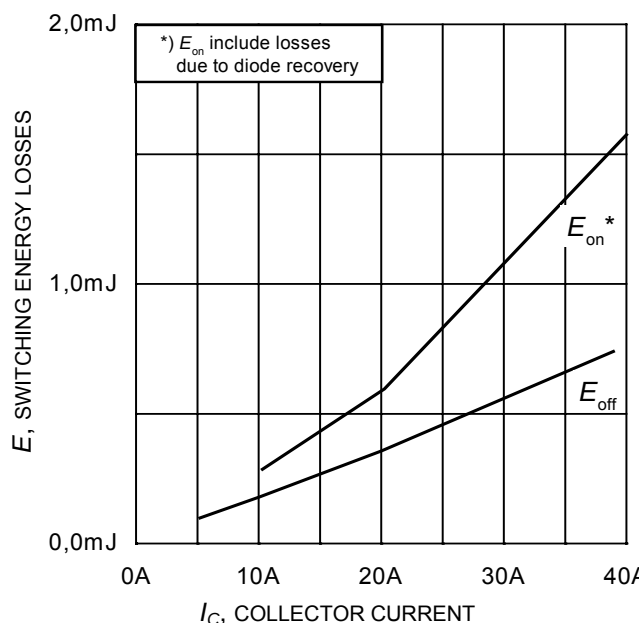


Figure 13. Typical switching energy losses as a function of collector current
(inductive load, $T_J=150^\circ\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=0/15\text{V}$, $R_G=16\Omega$)

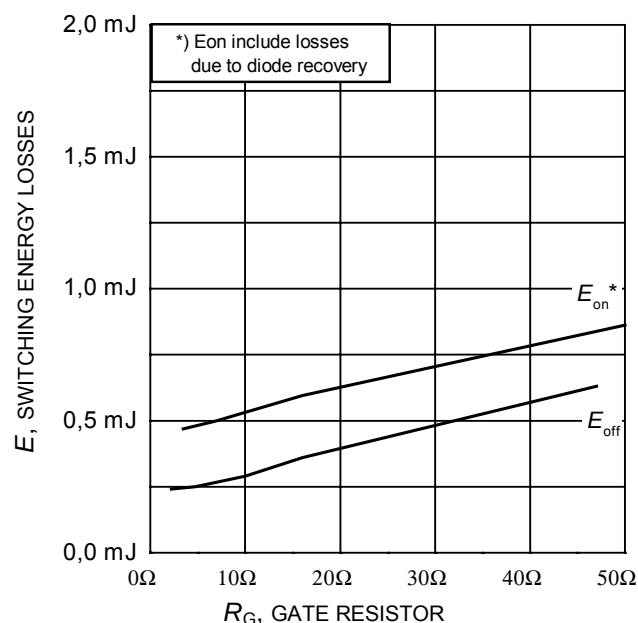


Figure 14. Typical switching energy losses as a function of gate resistor
(inductive load, $T_J=150^\circ\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=0/15\text{V}$, $I_C=20\text{A}$)

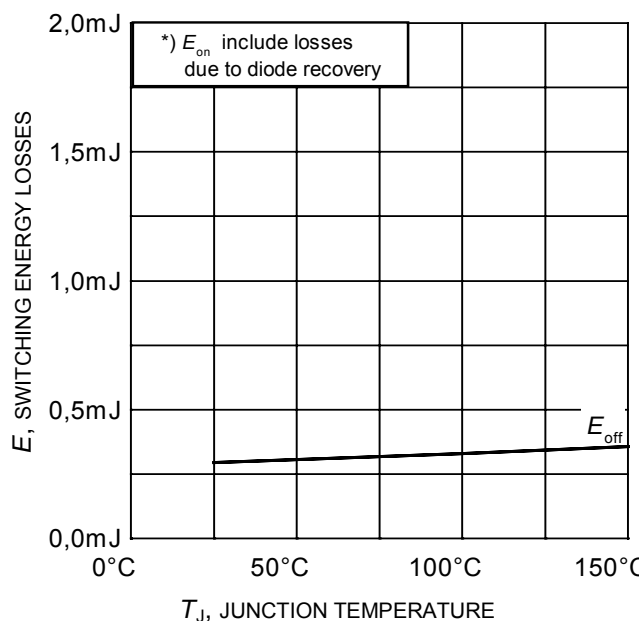


Figure 15. Typical switching energy losses as a function of junction temperature
(inductive load, $V_{CE}=400\text{V}$, $V_{GE}=0/15\text{V}$, $I_C=20\text{A}$, $R_G=11\Omega$)

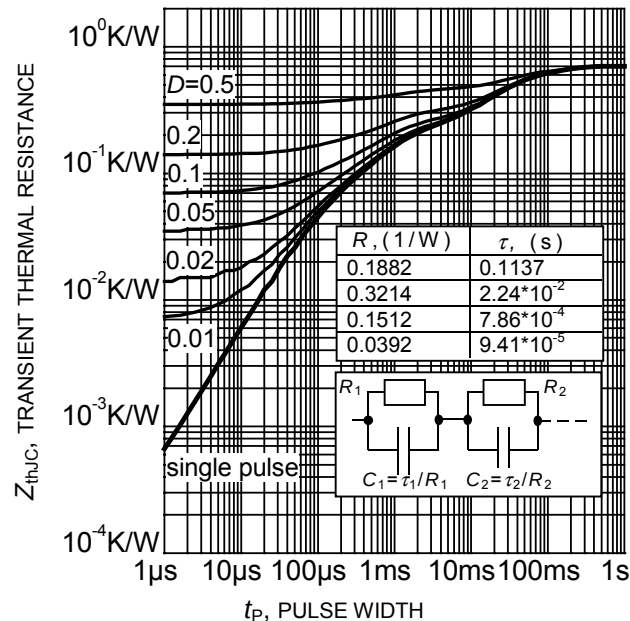


Figure 16. IGBT transient thermal resistance
($D = t_p / T$)

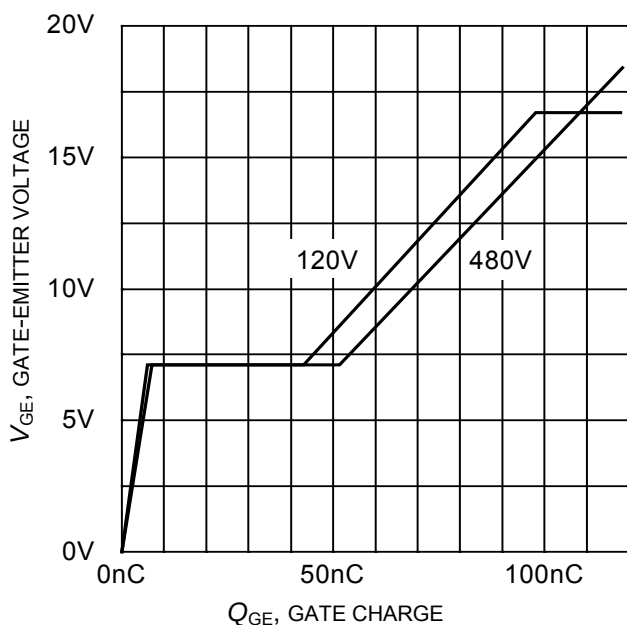


Figure 17. Typical gate charge
($I_C=20\text{ A}$)

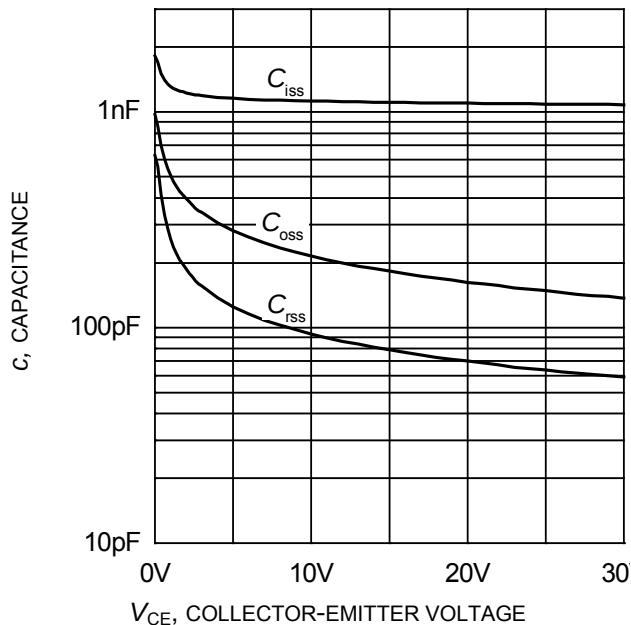


Figure 18. Typical capacitance as a function of collector-emitter voltage
($V_{GE}=0\text{ V}$, $f = 1\text{ MHz}$)

t_{SC} , SHORT CIRCUIT WITHSTAND TIME

V_{GE} , GATE-EMITTER VOLTAGE

Figure 19. Short circuit withstand time as a function of gate-emitter voltage
($V_{CE}=600\text{ V}$, start at $T_J=25^\circ\text{C}$)

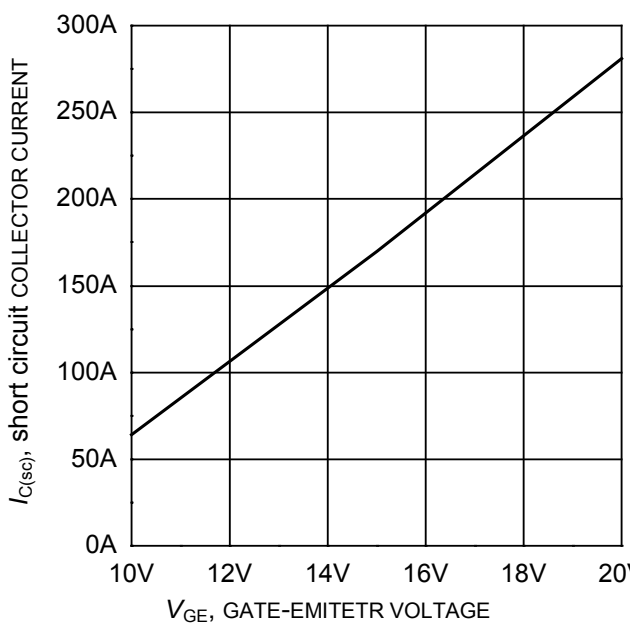


Figure 20. Typical short circuit collector current as a function of gate-emitter voltage
($V_{CE} \leq 600\text{ V}$, $T_J \leq 150^\circ\text{C}$)

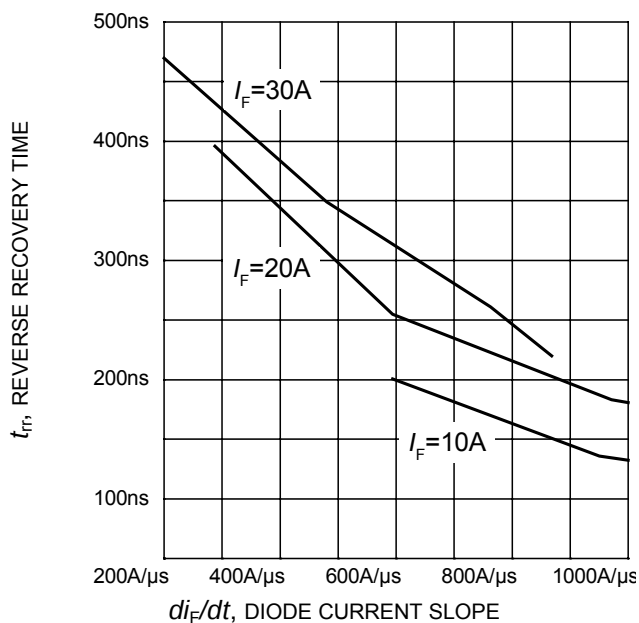


Figure 21. Typical reverse recovery time as a function of diode current slope
($V_R=200V$, $T_J=125^\circ C$)

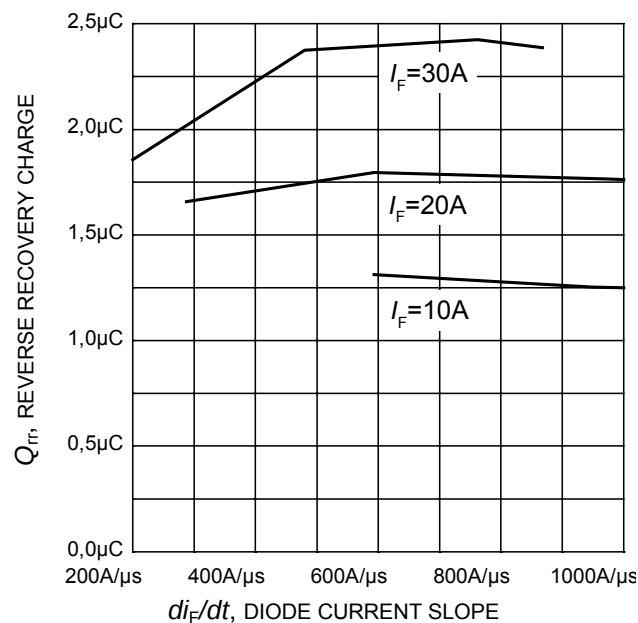


Figure 22. Typical reverse recovery charge as a function of diode current slope
($V_R=200V$, $T_J=125^\circ C$)

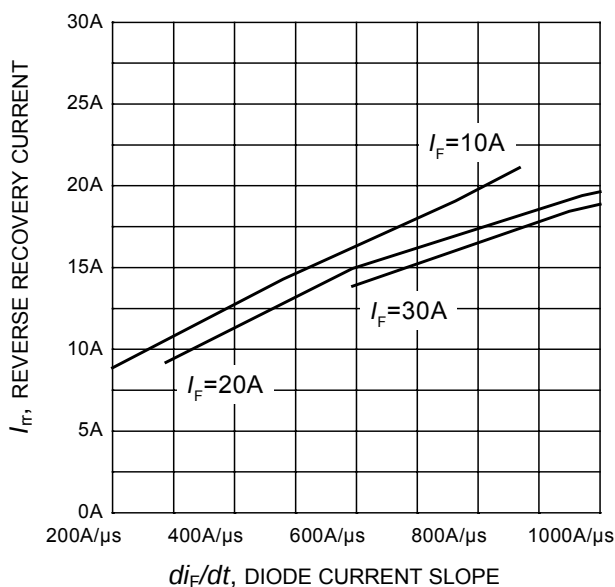


Figure 23. Typical reverse recovery current as a function of diode current slope
($V_R=200V$, $T_J=125^\circ C$)

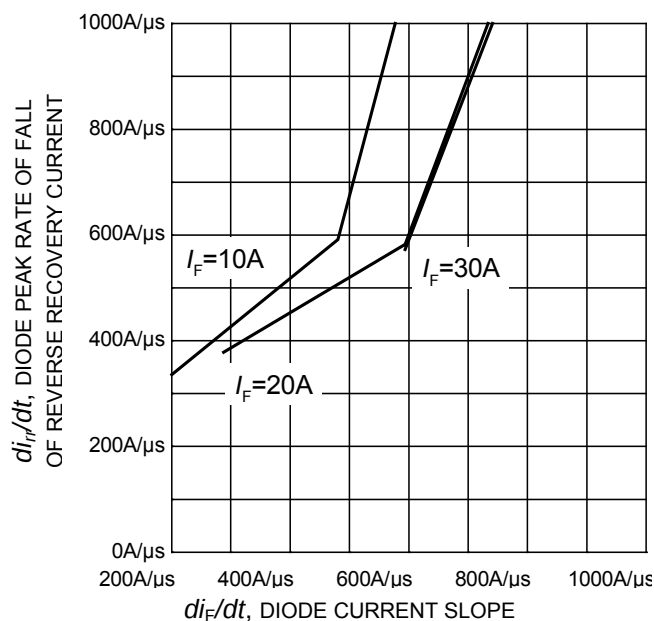


Figure 24. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope
($V_R=200V$, $T_J=125^\circ C$)

I_F , FORWARD CURRENT

 V_F , FORWARD VOLTAGE

 V_F , FORWARD VOLTAGE

Figure 25. Typical diode forward current as a function of forward voltage

 T_J , JUNCTION TEMPERATURE

Figure 26. Typical diode forward voltage as a function of junction temperature

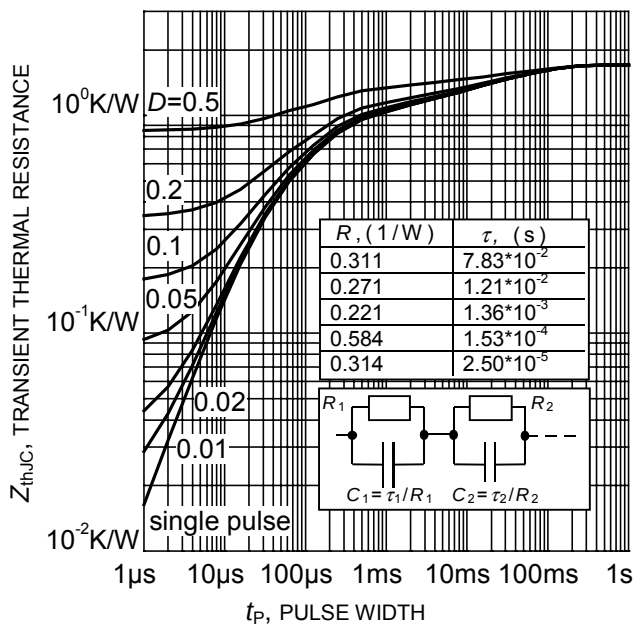
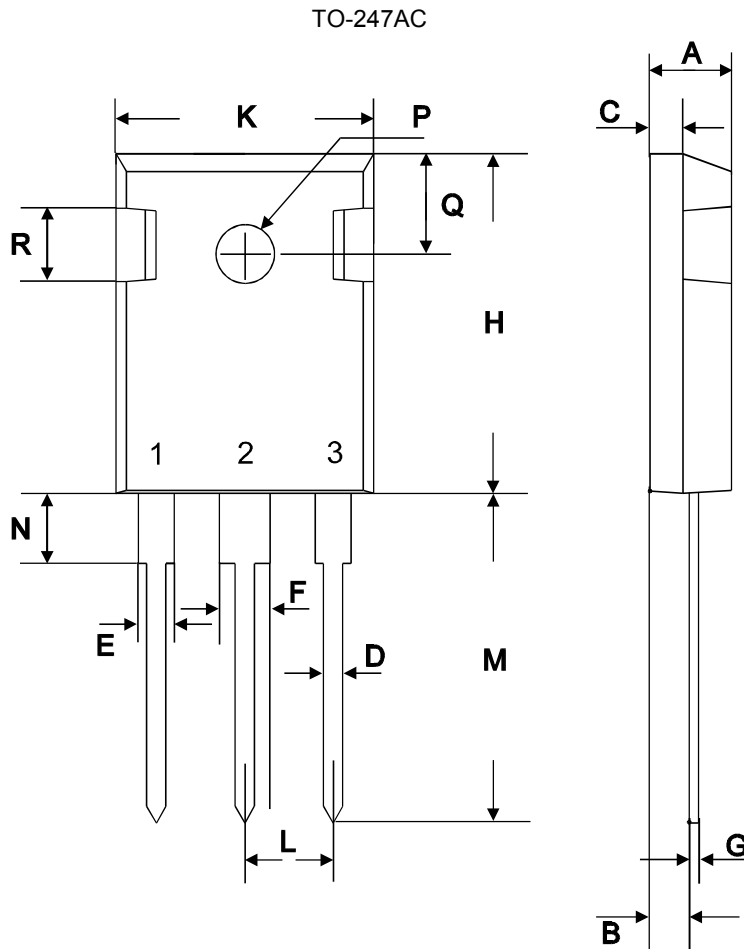


Figure 27. Diode transient thermal impedance as a function of pulse width
($D = t_p / T$)



symbol	dimensions			
	[mm]		[inch]	
	min	max	min	max
A	4.78	5.28	0.1882	0.2079
B	2.29	2.51	0.0902	0.0988
C	1.78	2.29	0.0701	0.0902
D	1.09	1.32	0.0429	0.0520
E	1.73	2.06	0.0681	0.0811
F	2.67	3.18	0.1051	0.1252
G	0.76 max		0.0299 max	
H	20.80	21.16	0.8189	0.8331
K	15.65	16.15	0.6161	0.6358
L	5.21	5.72	0.2051	0.2252
M	19.81	20.68	0.7799	0.8142
N	3.560	4.930	0.1402	0.1941
ØP	3.61		0.1421	
Q	6.12	6.22	0.2409	0.2449

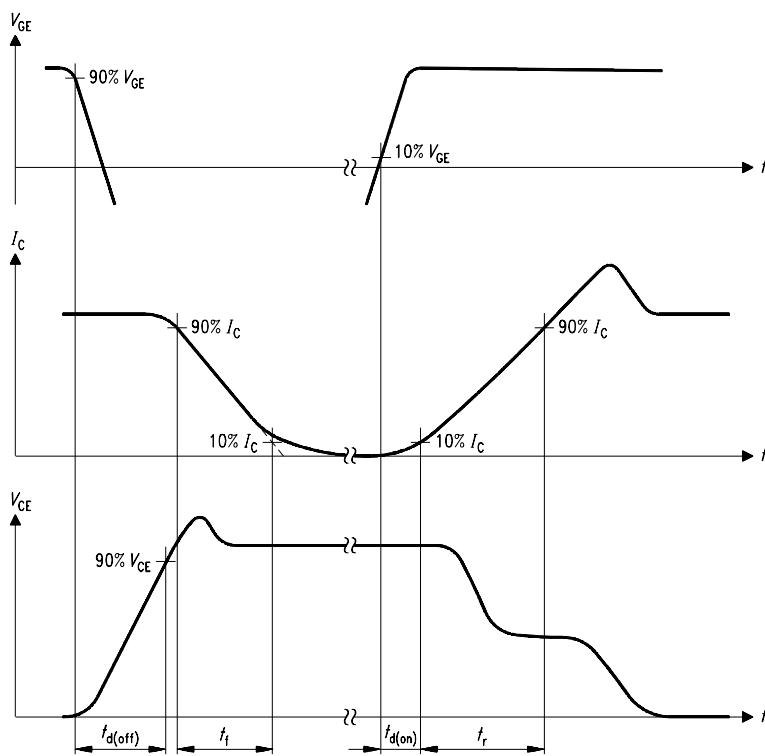


Figure A. Definition of switching times

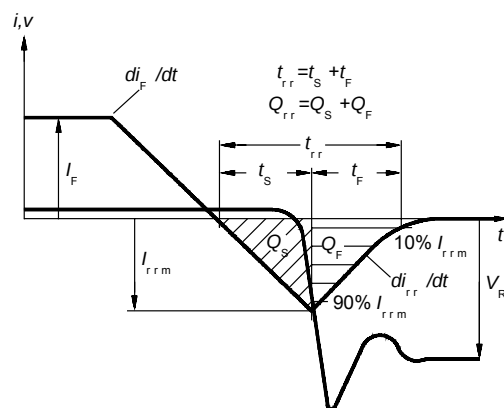


Figure C. Definition of diodes switching characteristics

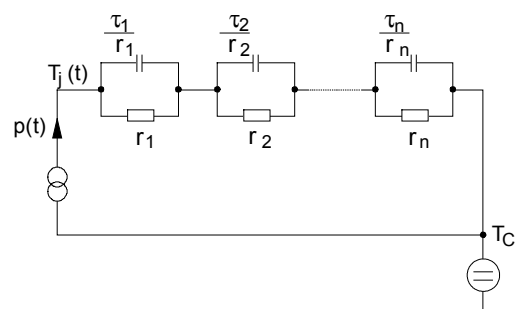


Figure D. Thermal equivalent circuit

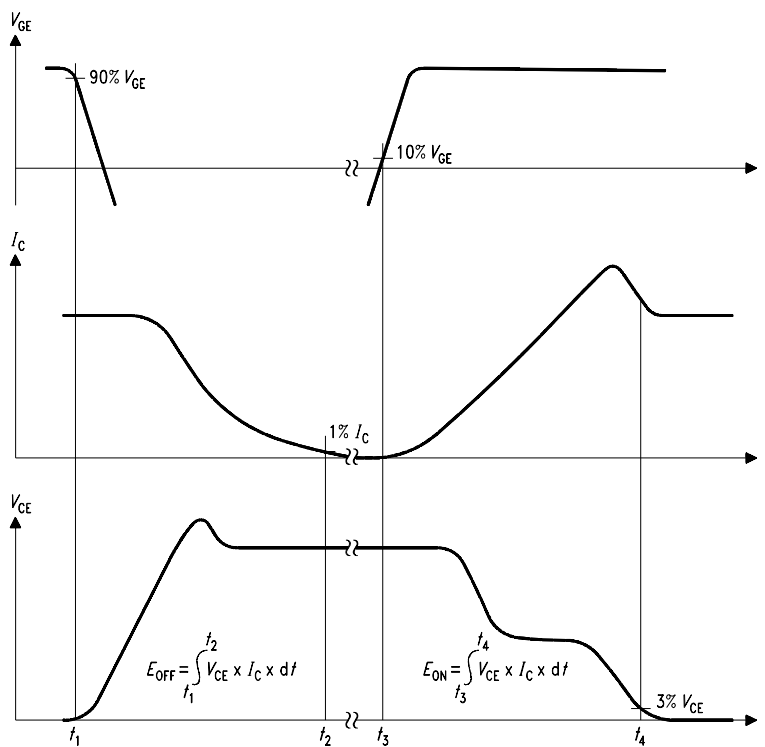


Figure B. Definition of switching losses

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