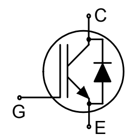
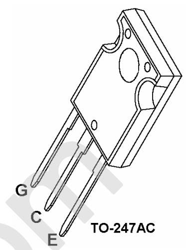
Low Loss DuoPack : IGBT in Trench and Fieldstop technology with soft, fast recovery anti-parallel EmCon HE diode





- Short circuit withstand time – 10µs
- Designed for :
  - Soft Switching Applications
  - Induction Heating
- Trench and Fieldstop technology for 1200 V applications offers :
  - very tight parameter distribution
  - high ruggedness, temperature stable behavior
  - easy parallel switching capability due to positive temperature coefficient in $V_{CE(sat)}$
- Very soft, fast recovery anti-parallel EmCon™ HE diode
- Low EMI
- Application specific optimisation of inverse diode

Type	V_{CE}	I_C	$V_{CE(sat),Tj=25°C}$	$T_{j,max}$	Marking	Package	Ordering Code
IHW20T120	1200V	20A	1.7V	150°C	H20T120	TO-247AC	Q67040-S4652

Maximum Ratings

Parameter	Symbol	Value	Unit
Collector-emitter voltage	V_{CE}	1200	V
DC collector current	I_C		A
T_C = 25°C		40	
T_C = 100°C		20	
Pulsed collector current, t_p limited by T_{jmax}	I_{Cpuls}	60	
Turn off safe operating area	-	60	
$V_{CE} \leq$ 1200V, $T_j \leq$ 150°C			
Diode forward current	I_F		
T_C = 25°C		23	
T_C = 100°C		13	
Diode pulsed current, t_p limited by T_{jmax}	I_{Fpuls}	36	
Diode surge non repetitive current, t_p limited by T_{jmax}	I_{FSM}		A
T_C = 25°C, t_p = 10ms, sine halfwave		50	
T_C = 25°C, $t_p \leq$ 2.5µs, sine halfwave		130	
T_C = 100°C, $t_p \leq$ 2.5µs, sine halfwave		120	
Gate-emitter voltage	V_{GE}	±20	V
Short circuit withstand time[1)]	t_{SC}	10	µs
V_{GE} = 15V, $V_{CC} \leq$ 1200V, $T_j \leq$ 150°C			
Power dissipation, T_C = 25°C	P_{tot}	178	W
Operating junction temperature	T_j	-40...+150	°C
Storage temperature	T_{stg}	-55...+150	°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}		1.3	
Thermal resistance, junction – ambient	R_{thJA}	TO-247AC	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=500µA	1200	-	-	V
Collector-emitter saturation voltage	$V_{CE(sat)}$	V_{GE} = 15V, I_C=20A				
		T_j=25°C	-	1.7	2.2	
		T_j=125°C	-	2.0	-	
		T_j=150°C	-	2.2	-	
Diode forward voltage	V_F	V_{GE}=0V, I_F=9A				
		T_j=25°C	-	1.7	2.2	
		T_j=125°C	-	1.7	-	
		T_j=150°C	-	1.7	-	
Gate-emitter threshold voltage	$V_{GE(th)}$	I_C=300µA, V_{CE}=V_{GE}	5.0	5.8	6.5	
Zero gate voltage collector current	I_{CES}	V_{CE}=1200V, V_{GE}=0V				µA
		T_j=25°C	-	-	250	
		T_j=150°C	-	-	2500	
Gate-emitter leakage current	I_{GES}	V_{CE}=0V, V_{GE}=20V	-	-	600	nA
Transconductance	g_{fs}	V_{CE}=20V, I_C=20A	-	13	-	S

Dynamic Characteristic

Input capacitance	C_{iss}	V_{CE}=25V, V_{GE}=0V, f=1MHz	-	1460	-	pF
Output capacitance	C_{oss}		-	78	-	
Reverse transfer capacitance	C_{rss}		-	65	-	
Gate charge	Q_{Gate}	V_{CC}=960V, I_C=20A V_{GE}=15V	-	120	-	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}≤10µs V_{CC} = 600V, T_j = 25°C	-	120	-	A

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}=600V, I_C=20A, V_{GE}=-15/15V, R_G=28Ω, Energy losses include "tail" and diode reverse recovery.	-	50	-	ns
Rise time	t_r		-	30	-	
Turn-off delay time	$t_{d(off)}$		-	560	-	
Fall time	t_f		-	70	-	
Turn-on energy	E_{on}		-	1.8	-	mJ
Turn-off energy	E_{off}		-	1.5	-	
Total switching energy	E_{ts}		-	3.3	-	
Anti-Parallel Diode Characteristic						
Diode reverse recovery time	t_{rr}	T_j=25°C, V_R=800V, I_F=9A, di_F/dt=750A/µs	-	140	-	ns
Diode reverse recovery charge	Q_{rr}		-	950		nC
Diode peak reverse recovery current	I_{rrm}		-	13.3		A

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

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}=600V, I_C=20A, V_{GE}=-15/15V, R_G= 28Ω, Energy losses include "tail" and diode reverse recovery.	-	50	-	ns
Rise time	t_r		-	32	-	
Turn-off delay time	$t_{d(off)}$		-	660	-	
Fall time	t_f		-	130	-	
Turn-on energy	E_{on}		-	2.6	-	mJ
Turn-off energy	E_{off}		-	2.6	-	
Total switching energy	E_{ts}		-	5.2	-	
Anti-Parallel Diode Characteristic						
Diode reverse recovery time	t_{rr}	T_j=150°C, V_R=800V, I_F=18A, di_F/dt=750A/µs	-	210	-	ns
Diode reverse recovery charge	Q_{rr}		-	1600	-	nC
Diode peak reverse recovery current	I_{rrm}		-	16.5	-	A

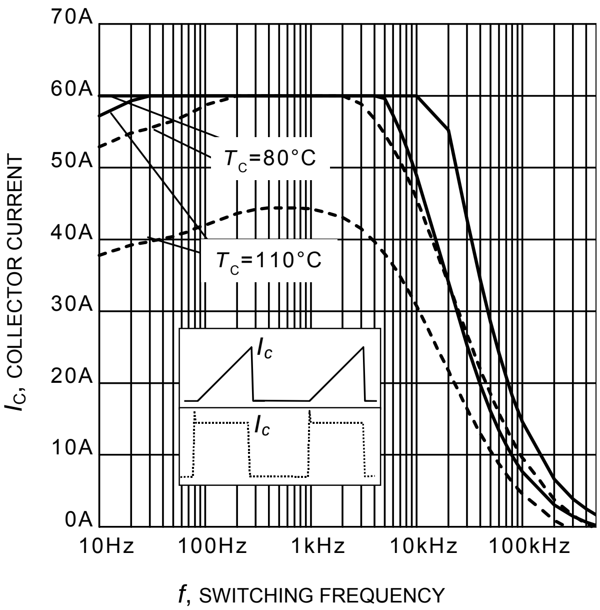


Figure 1. Collector current as a function of switching frequency
($T_j \leq 150°C$, $D = 0.5$, $V_{CE} = 600V$, $V_{GE} = 0/+15V$, $R_G = 28\Omega$)

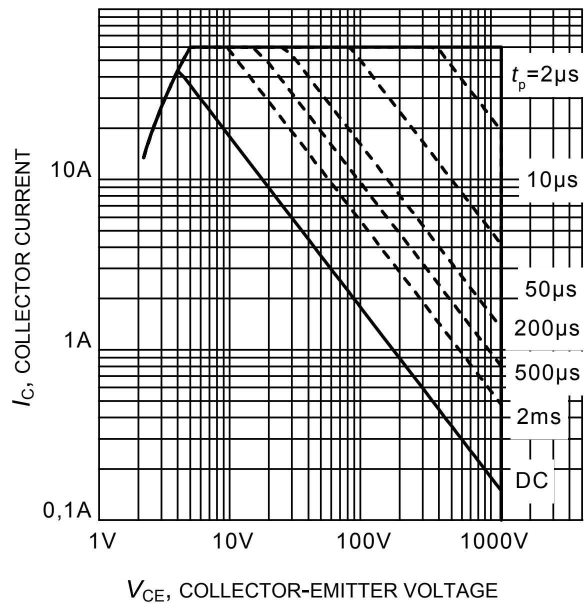


Figure 2. IGBT Safe operating area
($D = 0$, $T_C = 25°C$, $T_j \leq 150°C$; $V_{GE}=15V$)

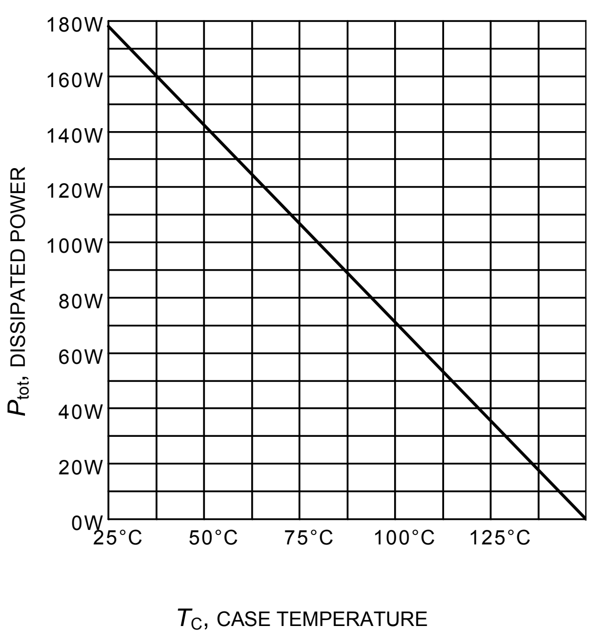


Figure 3. Power dissipation as a function of case temperature
($T_j \leq 150°C$)

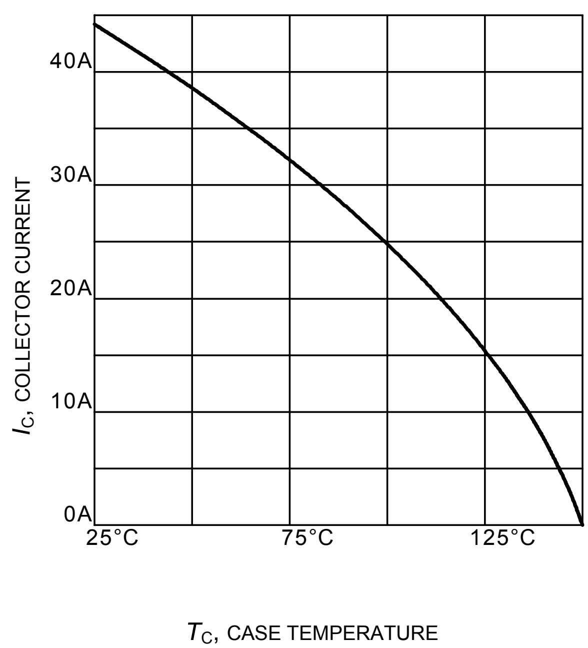


Figure 4. Collector current as a function of case temperature
($V_{GE} \geq 15V$, $T_j \leq 150°C$)

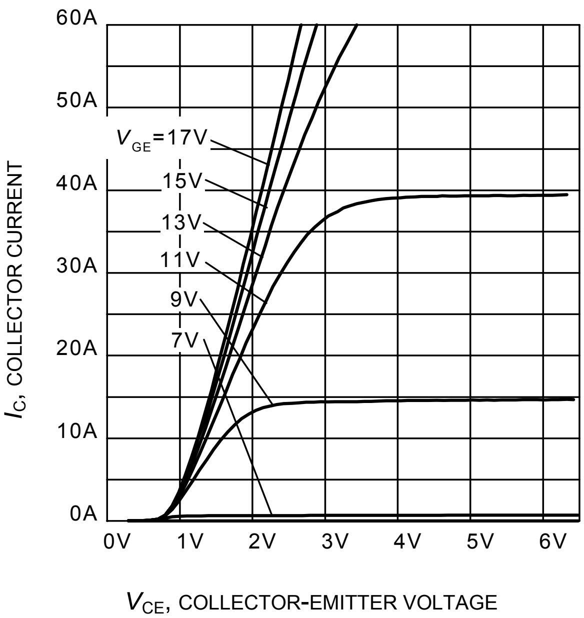


Figure 5. Typical output characteristic
(T_j = 25°C)

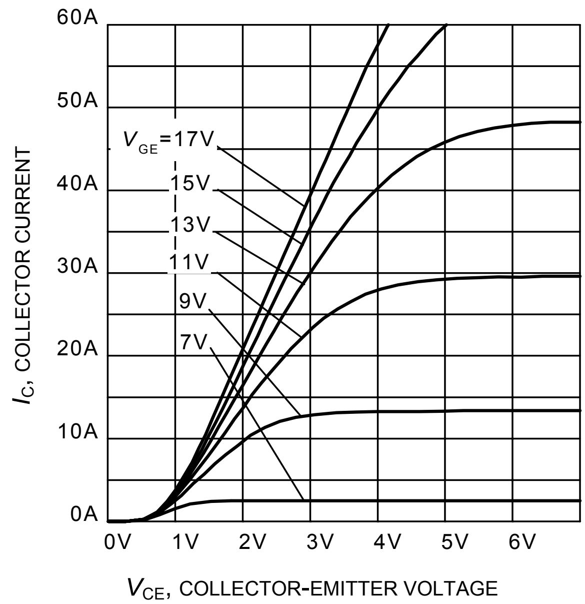


Figure 6. Typical output characteristic
(T_j = 150°C)

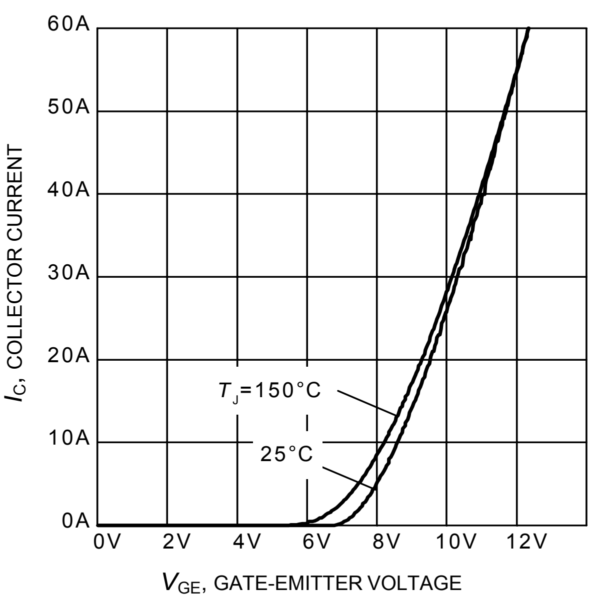


Figure 7. Typical transfer characteristic
(V_{CE}=20V)

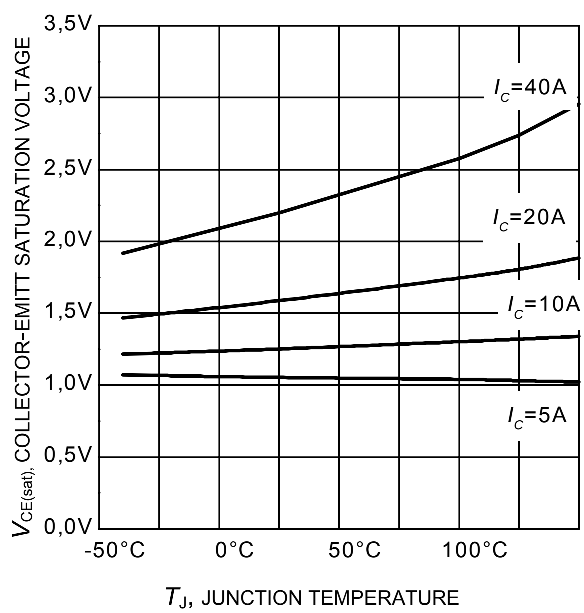


Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature
(V_{GE} = 15V)

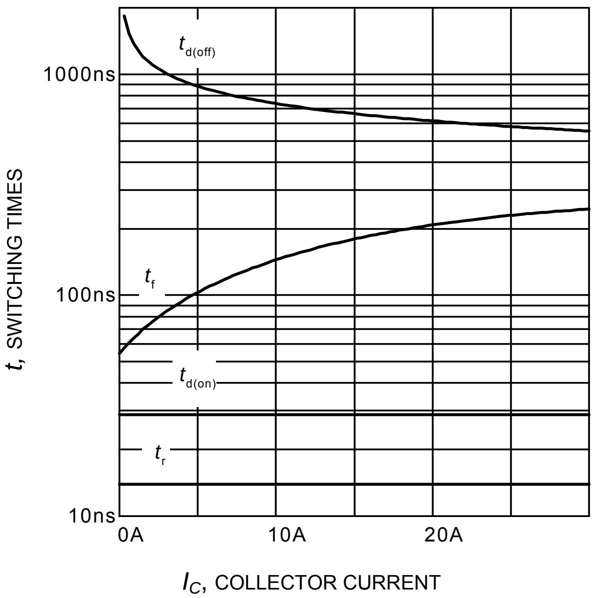


Figure 9. Typical switching times as a function of collector current
(inductive load, T_J=150°C, V_{CE}=600V, V_{GE}=0/15V, R_G=35Ω, Dynamic test circuit in Figure E)

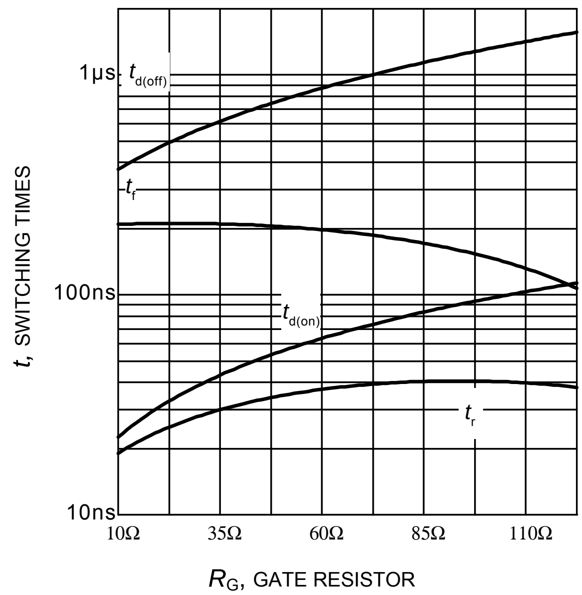


Figure 10. Typical switching times as a function of gate resistor
(inductive load, T_J=150°C, V_{CE}=600V, V_{GE}=0/15V, I_C=20A, Dynamic test circuit in Figure E)

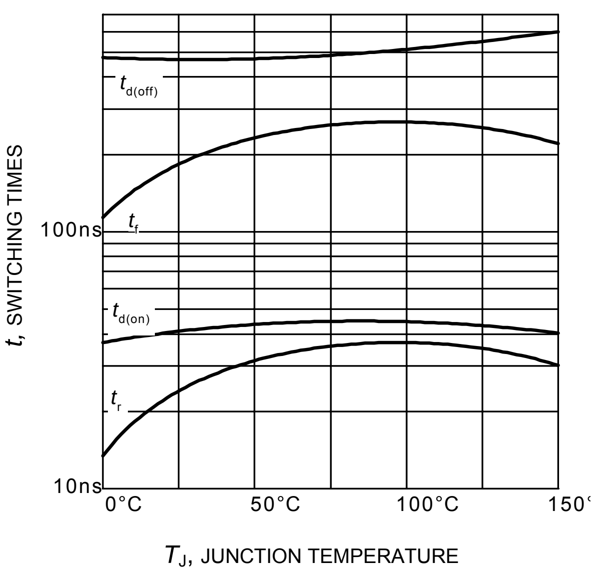


Figure 11. Typical switching times as a function of junction temperature
(inductive load, V_{CE}=600V, V_{GE}=0/15V, I_C=20A, R_G=35Ω, Dynamic test circuit in Figure E)

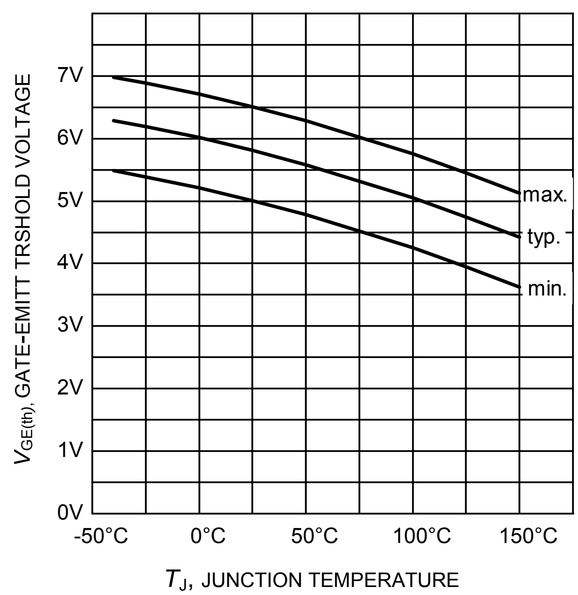


Figure 12. Gate-emitter threshold voltage as a function of junction temperature
(I_C = 0.3mA)

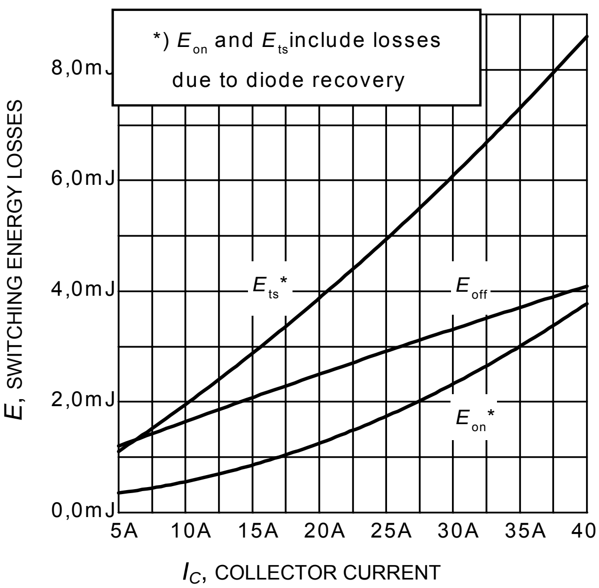


Figure 13. Typical switching energy losses as a function of collector current
(inductive load, T_J=150°C, V_{CE}=600V, V_{GE}=0/15V, R_G=35Ω, Dynamic test circuit in Figure E)

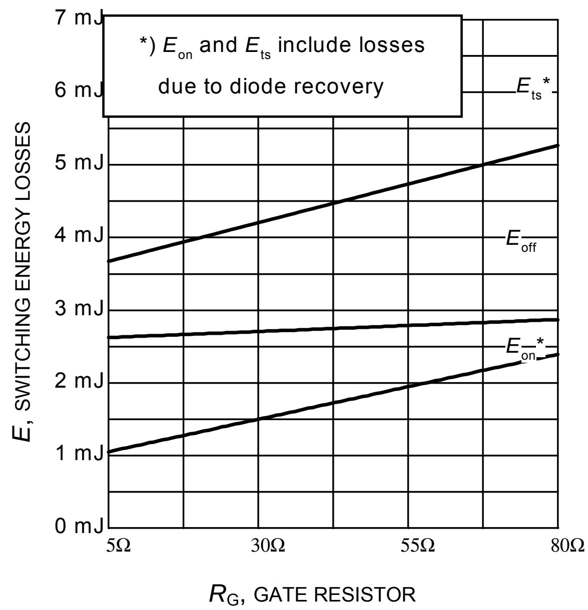


Figure 14. Typical switching energy losses as a function of gate resistor
(inductive load, T_J=150°C, V_{CE}=600V, V_{GE}=0/15V, I_C=20A, Dynamic test circuit in Figure E)

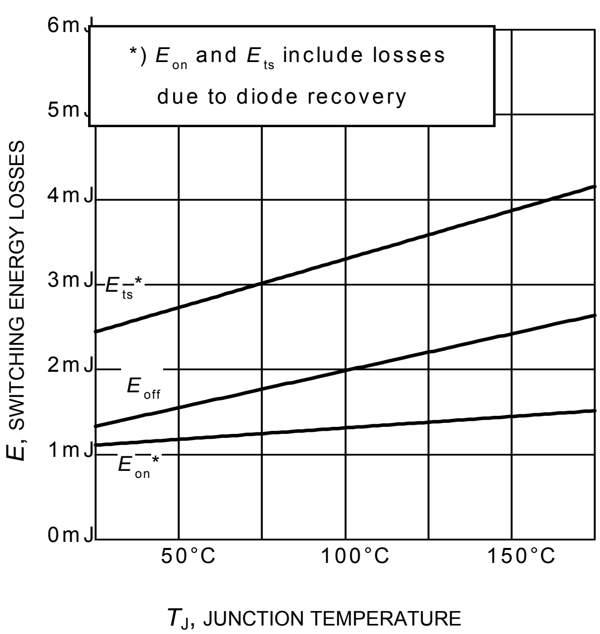


Figure 15. Typical switching energy losses as a function of junction temperature
(inductive load, V_{CE}=600V, V_{GE}=0/15V, I_C=20A, R_G=35Ω, Dynamic test circuit in Figure E)

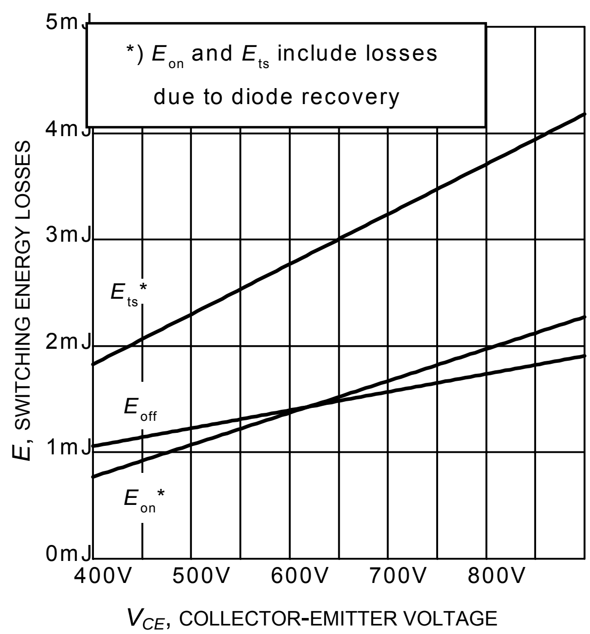


Figure 16. Typical switching energy losses as a function of collector emitter voltage
(inductive load, T_J=150°C, V_{GE}=0/15V, I_C=20A, R_G=35Ω, Dynamic test circuit in Figure E)

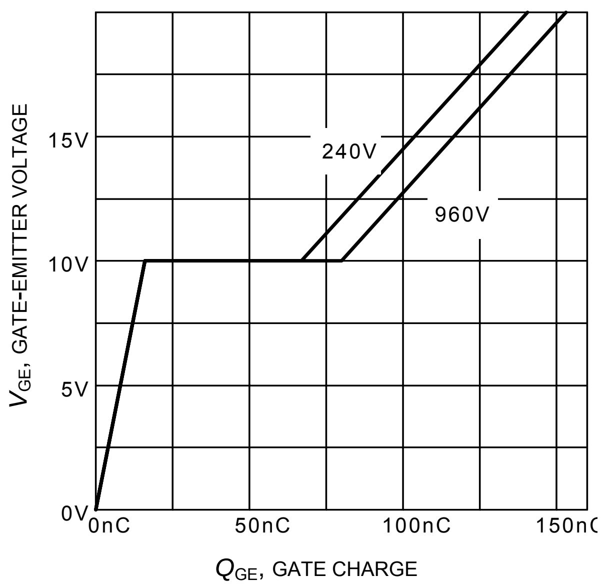


Figure 17. Typical gate charge
(I_C=20 A)

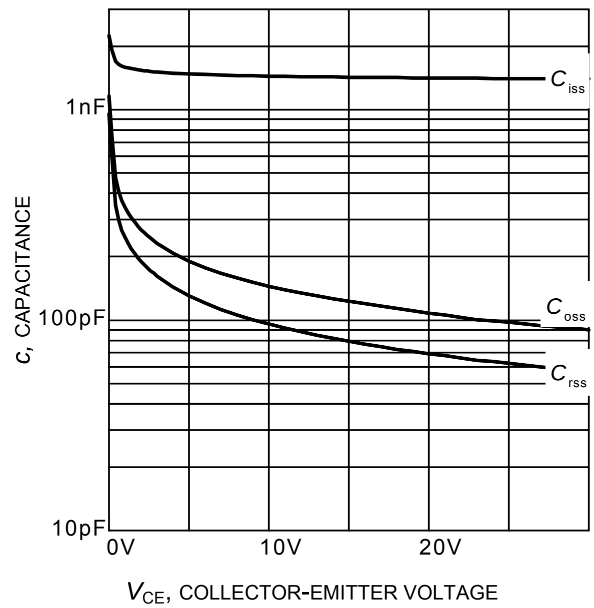


Figure 18. Typical capacitance as a function of collector-emitter voltage
(V_{GE}=0V, f = 1 MHz)

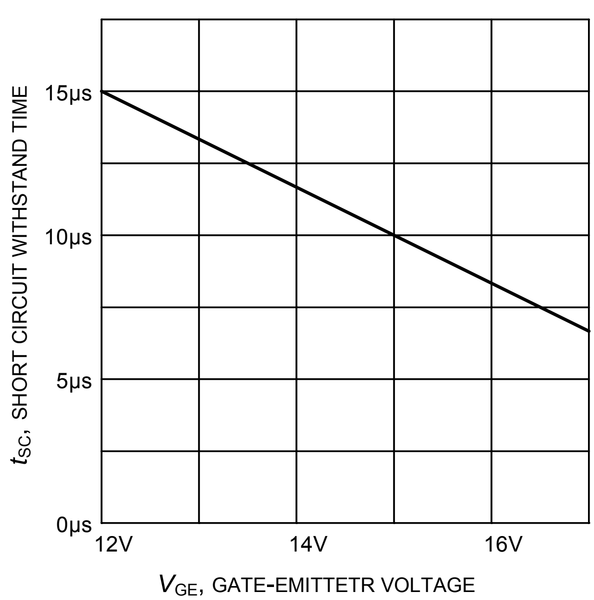


Figure 19. Short circuit withstand time as a function of gate-emitter voltage
(V_{CE}=600V, start at T_J=25°C)

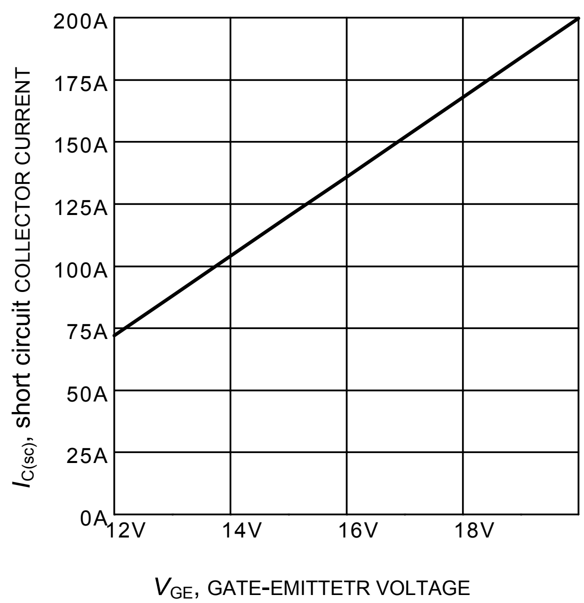


Figure 20. Typical short circuit collector current as a function of gate-emitter voltage
(V_{CE} ≤ 600V, T_j ≤ 150°C)

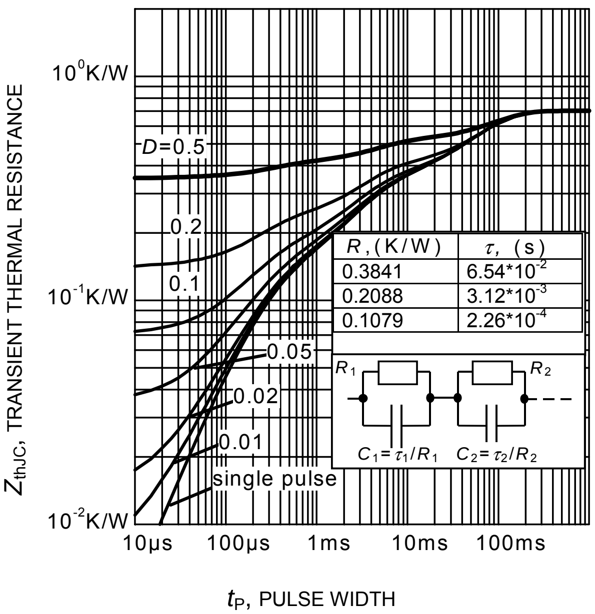


Figure 23. IGBT transient thermal resistance
($D = t_p / T$)

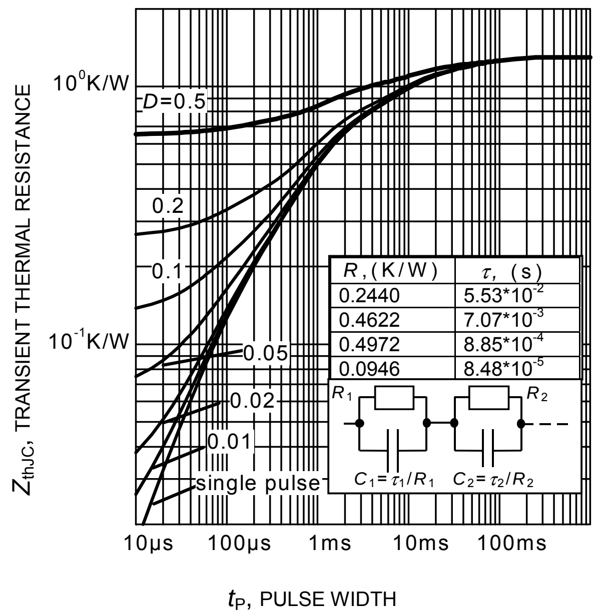


Figure 24. Typical Diode transient thermal impedance as a function of pulse width
($D=t_P/T$)

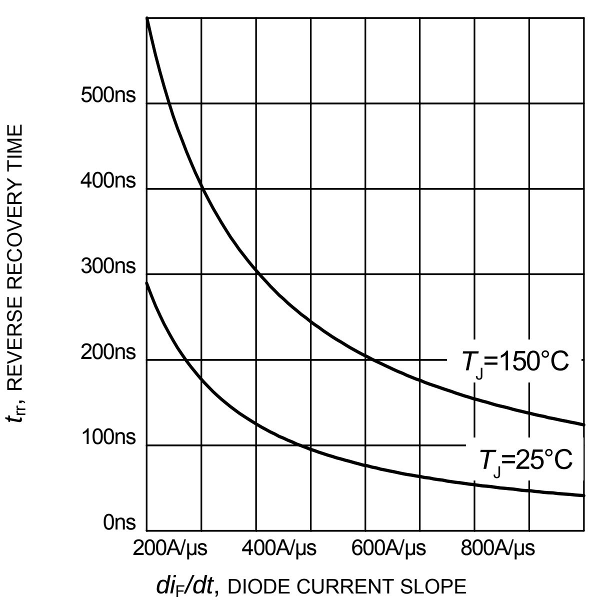


Figure 23. Typical reverse recovery time as a function of diode current slope
(V_R=600V, I_F=8A,
Dynamic test circuit in Figure E)

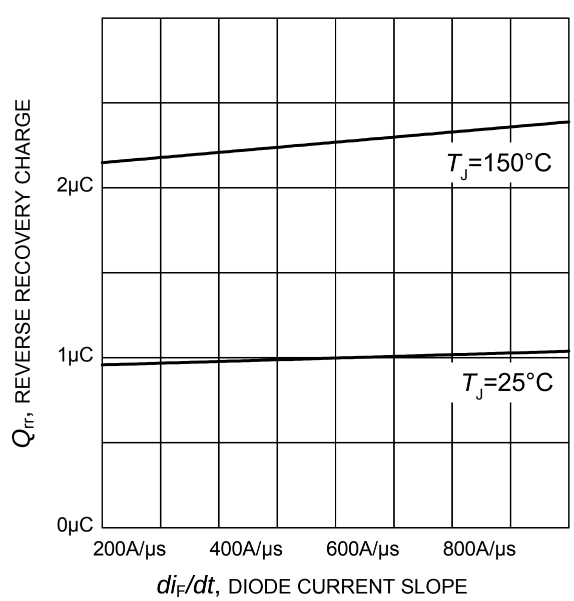


Figure 24. Typical reverse recovery charge as a function of diode current slope
(V_R=600V, I_F=8A,
Dynamic test circuit in Figure E)

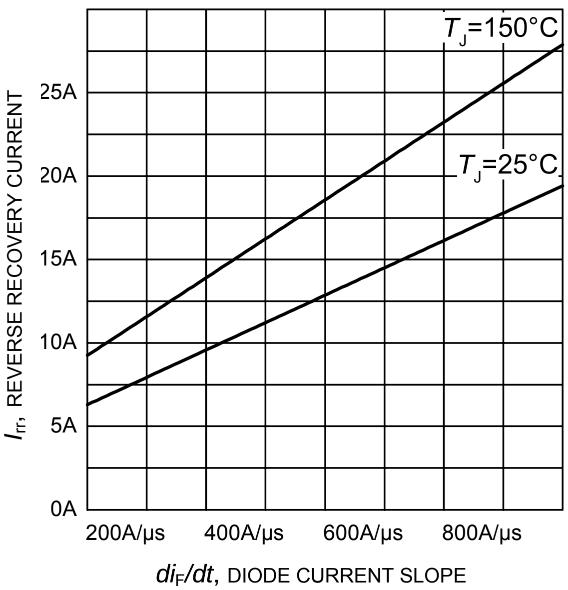


Figure 25. Typical reverse recovery current as a function of diode current slope
(V_R=600V, I_F=8A,
Dynamic test circuit in Figure E)

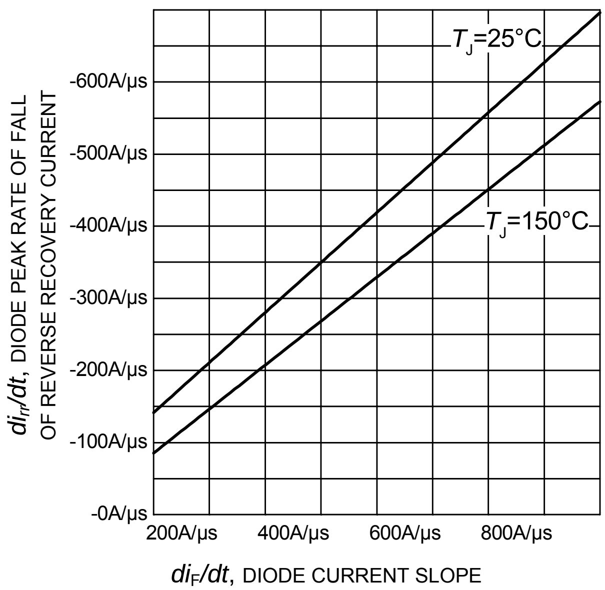


Figure 26. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope
(V_R=600V, I_F=8A,
Dynamic test circuit in Figure E)

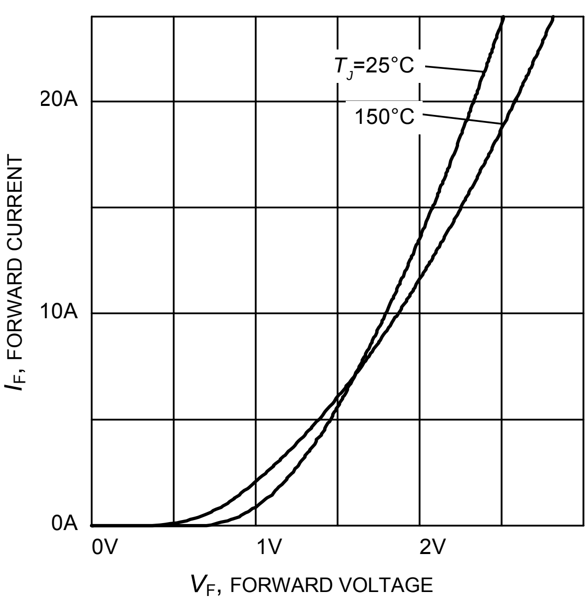


Figure 27. Typical diode forward current as a function of forward voltage

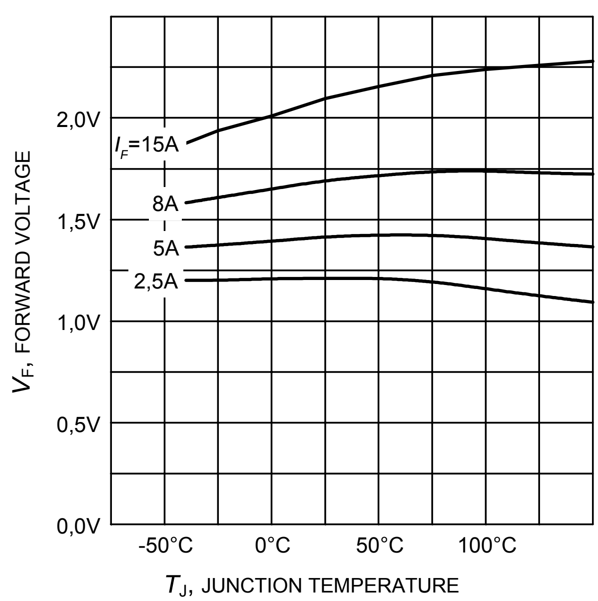
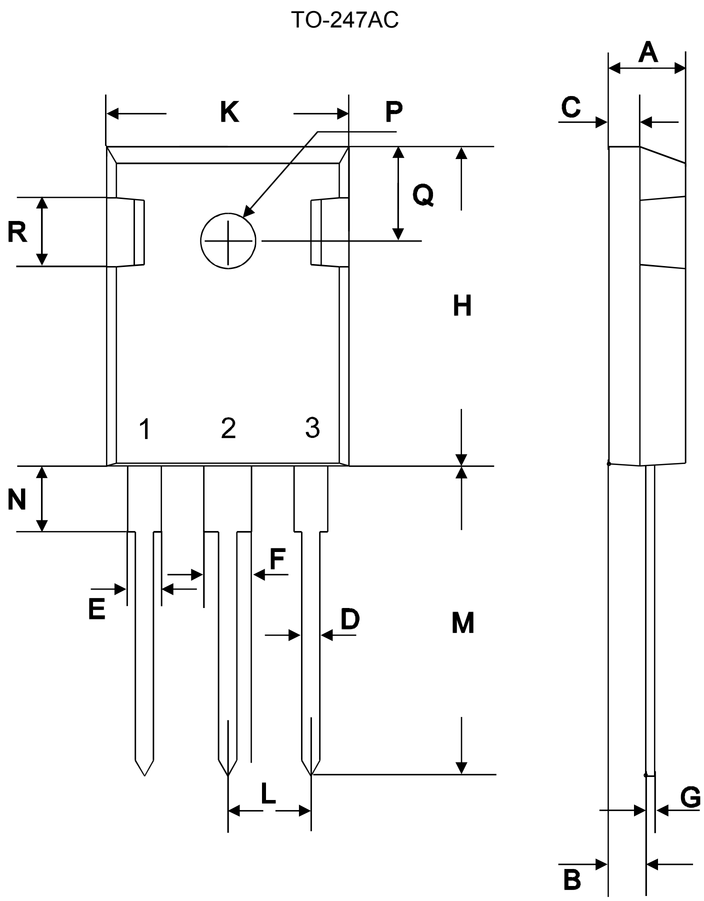


Figure 28. Typical diode forward voltage as a function of junction temperature



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
∅P	3.61		0.1421	
Q	6.12	6.22	0.2409	0.2449

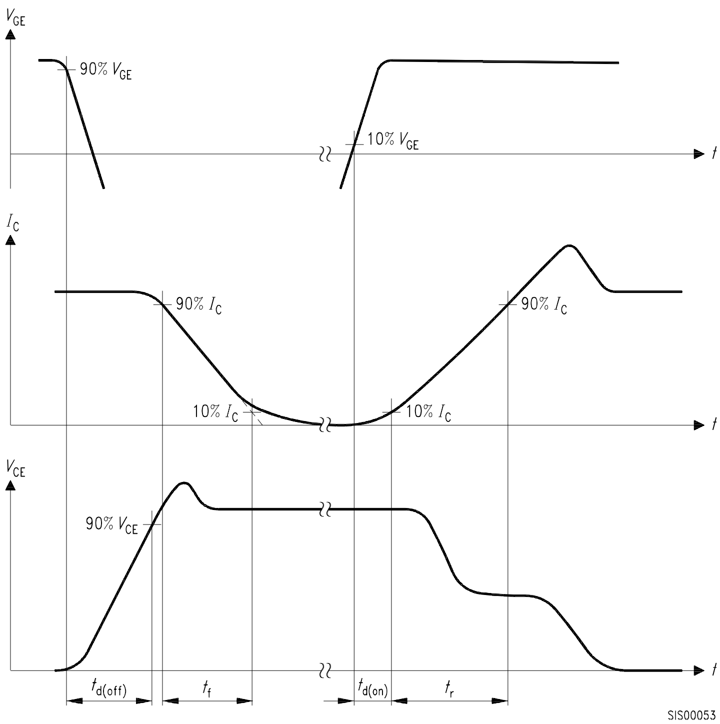


Figure A. Definition of switching times

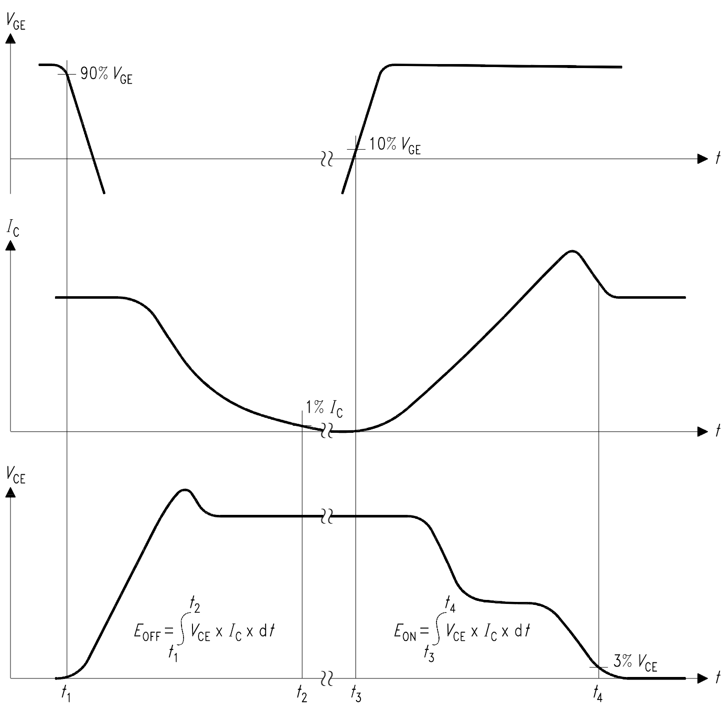


Figure B. Definition of switching losses

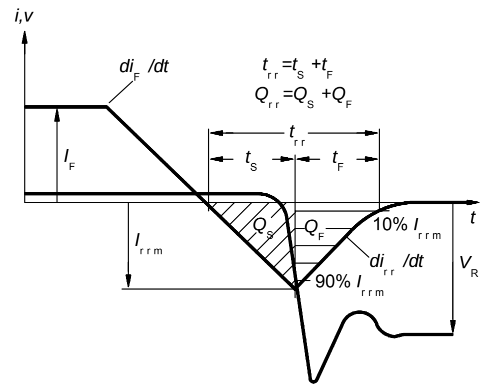


Figure C. Definition of diodes switching characteristics

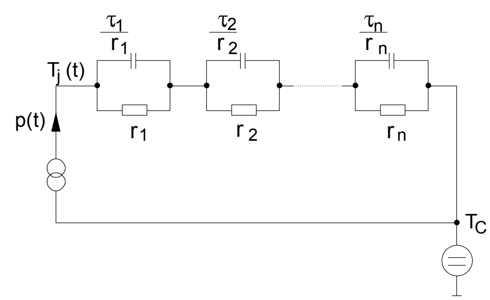


Figure D. Thermal equivalent circuit

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