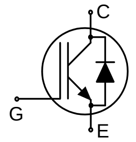
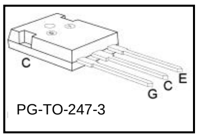
Low Loss DuoPack : IGBT in 2nd generation TRENCHSTOP™ with soft, fast recovery anti-parallel Emitter Controlled Diode





- Best in class TO247
- Short circuit withstand time – 10µs
- Designed for :
  - Frequency Converters
  - Uninterrupted Power Supply
- TRENCHSTOP™ 2nd generation for 1200 V applications offers :
  - very tight parameter distribution
  - high ruggedness, temperature stable behavior
- Easy paralleling capability due to positive temperature coefficient in $V_{CE(sat)}$
- Low EMI
- Low Gate Charge
- Very soft, fast recovery anti-parallel Emitter Controlled HE Diode
- Qualified according to JEDEC[1] 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	$V_{CE(sat),Tj=25°C}$	$T_{j,max}$	Marking Code	Package
IKW40N120T2	1200V	40A	1.75V	175°C	K40T1202	PG-TO-247-3

Maximum Ratings

Parameter	Symbol	Value	Unit
Collector-emitter voltage	V_{CE}	1200	V
DC collector current (T_j=150°C) T_C = 25°C T_C = 110°C	I_C	 75[2] 40	A
Pulsed collector current, t_p limited by T_{jmax}	I_{Cpuls}	160	
Turn off safe operating area $V_{CE} \leq$ 1200V, $T_j \leq$ 175°C	-	160	
DC Diode forward current (T_j=150°C) T_C = 25°C T_C = 110°C	I_F	 75[2] 40	
Diode pulsed current, t_p limited by T_{jmax}	I_{Fpuls}	160	
Gate-emitter voltage	V_{GE}	±20	V
Short circuit withstand time[3)] V_{GE} = 15V, $V_{CC} \leq$ 600V, $T_{j,start} \leq$ 175°C	t_{SC}	10	µs
Power dissipation T_C = 25°C	P_{tot}	480	W
Operating junction temperature	T_j	-40...+175	°C
Storage temperature	T_{stg}	-55...+150	
Soldering temperature, 1.6mm (0.063 in.) from case for 10s Wavesoldering only, temperature on leads only	-	260	

[1] J-STD-020 and JESD-022
[2] Limited by bond wire
[3)] 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}		0.31	K/W
Diode thermal resistance, junction – case	R_{thJCD}		0.53	
Thermal resistance, junction – ambient	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=500µA	1200	-	-	V
Collector-emitter saturation voltage	$V_{CE(sat)}$	V_{GE} = 15V, I_C=40A T_j=25°C T_j=150°C T_j=175°C	 - - -	 1.75 2.25 2.3	 2.2 - -	
Diode forward voltage	V_F	V_{GE}=0V, I_F=40A T_j=25°C T_j=150°C T_j=175°C	 - - -	 1.75 1.80 1.80	 2.2 - -	
Gate-emitter threshold voltage	$V_{GE(th)}$	I_C=1.5mA,V_{CE}=V_{GE}	5.2	5.8	6.4	
Zero gate voltage collector current	I_{CES}	V_{CE}=1200V, V_{GE}=0V T_j=25°C T_j=150°C T_j=175°C	 - - -	 - - -	 0.4 4.0 20	mA
Gate-emitter leakage current	I_{GES}	V_{CE}=0V,V_{GE}=20V	-	-	200	nA
Transconductance	g_{fs}	V_{CE}=20V, I_C=40A	-	21	-	S

Dynamic Characteristic

Input capacitance	C_{iss}	V_{CE}=25V, V_{GE}=0V, f=1MHz	-	2360	-	pF
Output capacitance	C_{oss}		-	230	-	
Reverse transfer capacitance	C_{rss}		-	125	-	
Gate charge	Q_{Gate}	V_{CC}=960V, I_C=40A V_{GE}=15V	-	192	-	nC
Internal emitter inductance measured 5mm (0.197 in.) from case	L_E		-	13	-	nH
Short circuit collector current[1]	$I_{C(SC)}$	V_{GE}=15V, $t_{SC}\leq$10µs V_{CC} = 600V, $T_{j,start}$ = 25°C $T_{j,start}$ = 175°C	-	220 156	-	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=40A, V_{GE}=0/15V, R_G=12Ω, L_σ[2]=80nH, C_σ[2]=67pF Energy losses include "tail" and diode reverse recovery.	-	33	-	ns
Rise time	t_r		-	28	-	
Turn-off delay time	$t_{d(off)}$		-	314	-	
Fall time	t_f		-	94	-	
Turn-on energy	E_{on}		-	3.2	-	mJ
Turn-off energy	E_{off}		-	2.05	-	
Total switching energy	E_{ts}		-	5.25	-	
Anti-Parallel Diode Characteristic						
Diode reverse recovery time	t_{rr}	T_j=25°C, V_R=600V, I_F=40A, di_F/dt=950A/µs	-	285	-	ns
Diode reverse recovery charge	Q_{rr}		-	3.3		µC
Diode peak reverse recovery current	I_{rrm}		-	23		A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	350	-	A/µs

[1] Allowed number of short circuits: <1000; time between short circuits: >1s.
[2] Leakage inductance L_σ and Stray capacity C_σ due to dynamic test circuit in Figure E.

Switching Characteristic, Inductive Load, at T_j=175 °C

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
IGBT Characteristic						
Turn-on delay time	$t_{d(on)}$	T_j=175°C V_{CC}=600V, I_C=40A, V_{GE}=0/15V, R_G= 12Ω, L_σ[1)]=180nH, C_σ[1)]=67pF Energy losses include "tail" and diode reverse recovery.	-	32	-	ns
Rise time	t_r		-	28	-	
Turn-off delay time	$t_{d(off)}$		-	405	-	
Fall time	t_f		-	195	-	
Turn-on energy	E_{on}		-	4.5	-	mJ
Turn-off energy	E_{off}		-	3.8	-	
Total switching energy	E_{ts}		-	8.3	-	
Anti-Parallel Diode Characteristic						
Diode reverse recovery time	t_{rr}	T_j=175°C V_R=600V, I_F=40A, di_F/dt=950A/µs	-	480	-	ns
Diode reverse recovery charge	Q_{rr}		-	6.6	-	µC
Diode peak reverse recovery current	I_{rrm}		-	31	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	200		A/µs

1) Leakage inductance L_σ and Stray capacity C_σ due to dynamic test circuit in Figure E.

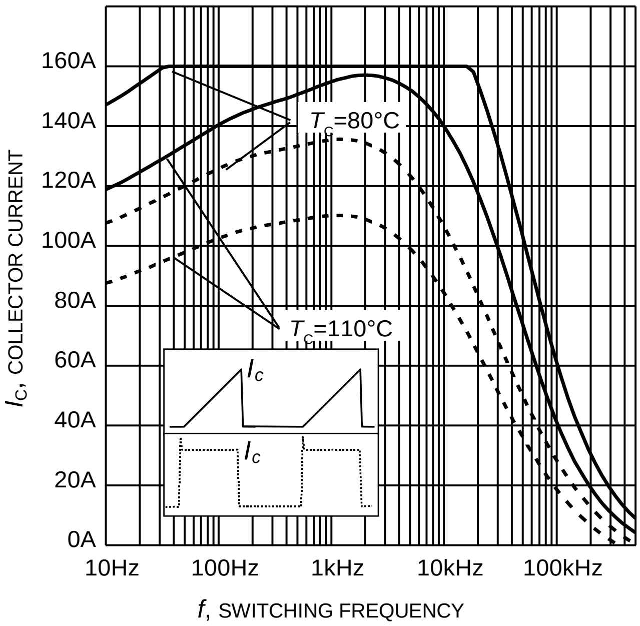


Figure 1. Collector current as a function of switching frequency
($T_j \leq 175°C$, $D = 0.5$, $V_{CE} = 600V$, $V_{GE} = 0/+15V$, $R_G = 12\Omega$)

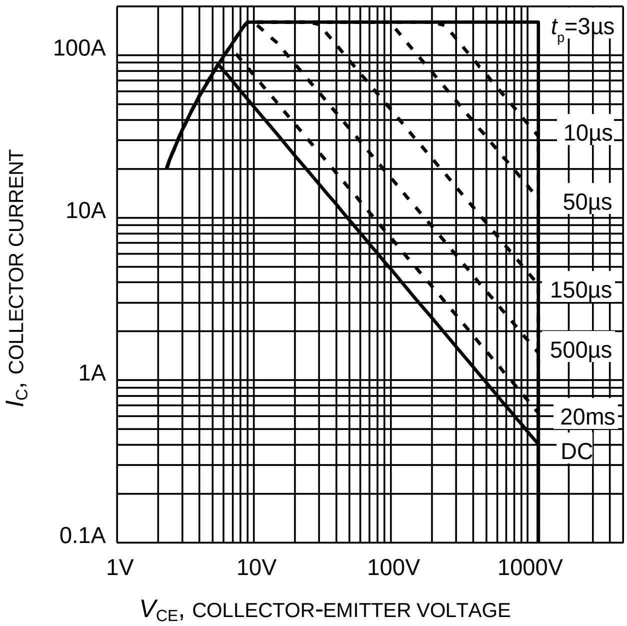


Figure 2. Safe operating area
($D = 0$, $T_C = 25°C$, $T_j \leq 175°C$; $V_{GE}=15V$)

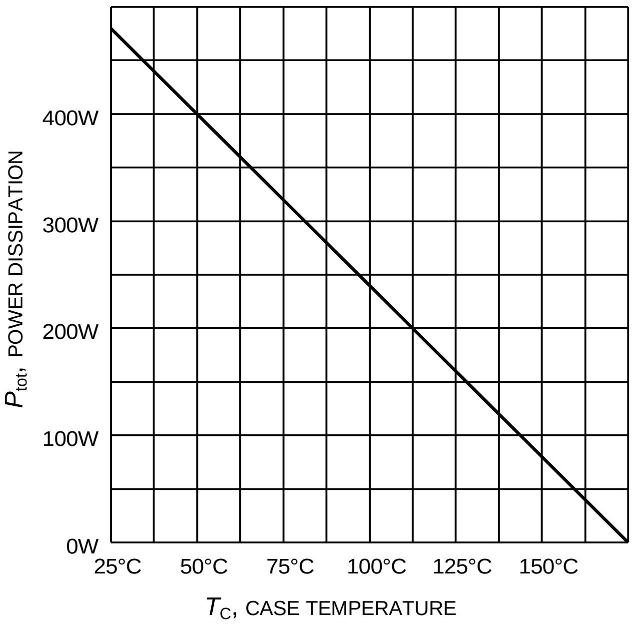


Figure 3. Maximum power dissipation as a function of case temperature
($T_j \leq 175°C$)

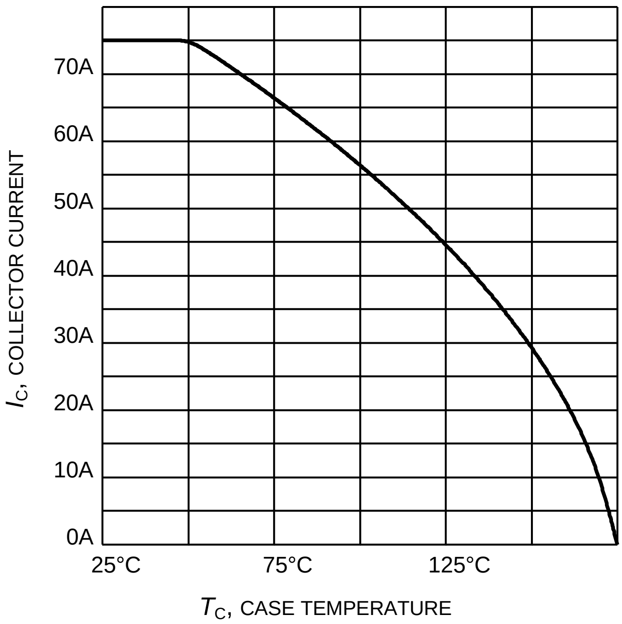


Figure 4. Maximum collector current as a function of case temperature
($V_{GE} \geq 15V$, $T_j \leq 175°C$)

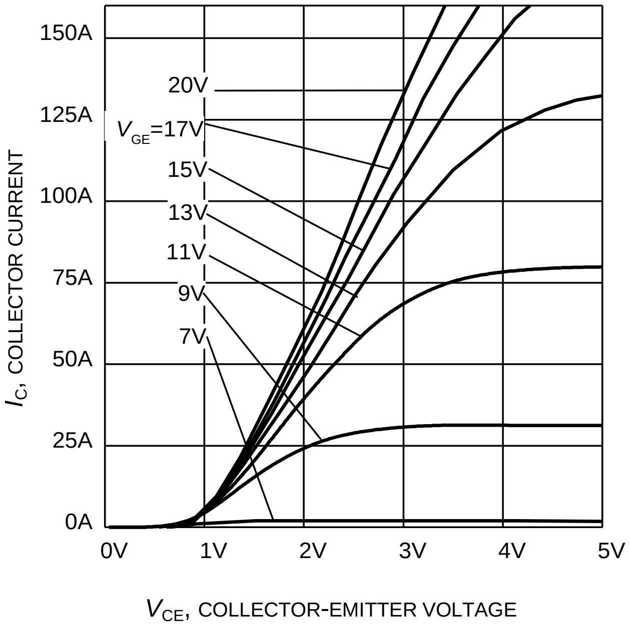


Figure 5. Typical output characteristic
(T_j = 25°C)

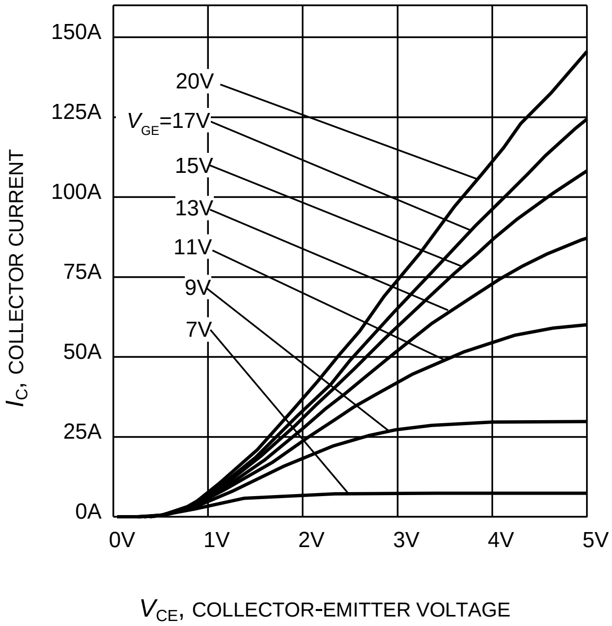


Figure 6. Typical output characteristic
(T_j = 175°C)

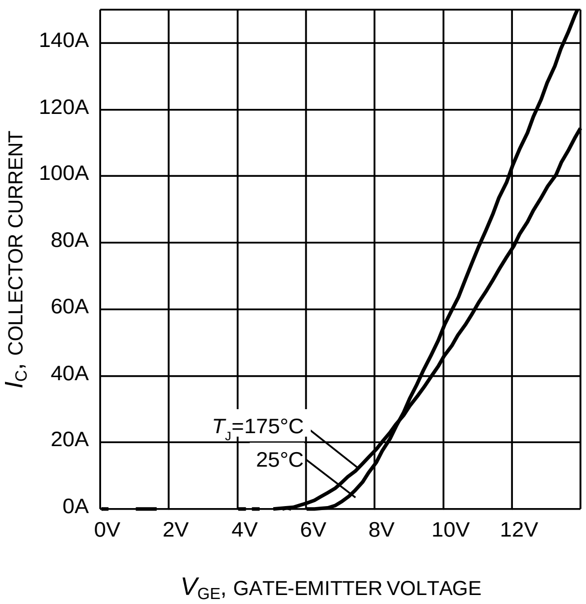


Figure 7. Typical transfer characteristic
(V_{CE}=20V)

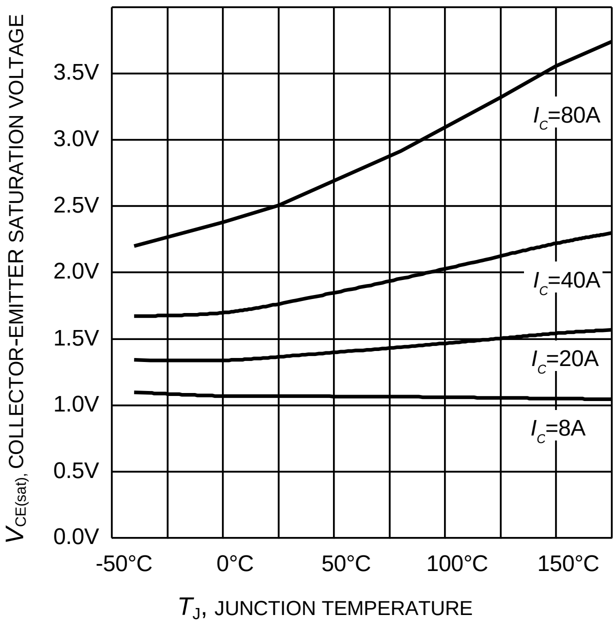


Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature
(V_{GE} = 15V)

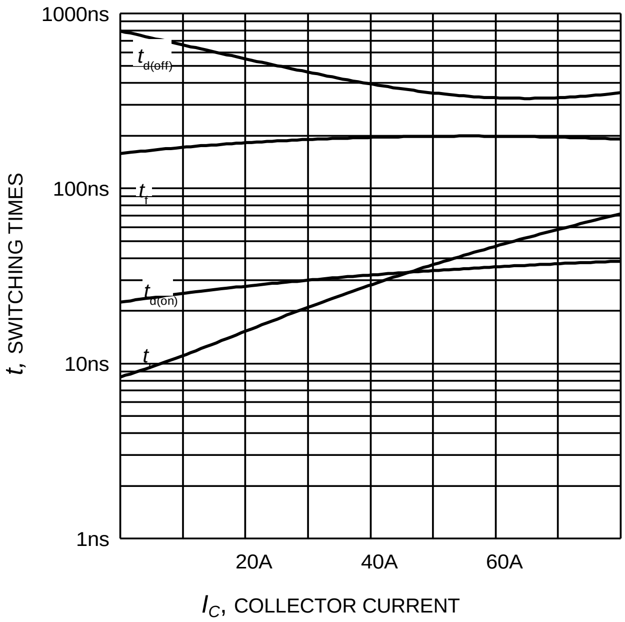


Figure 9. Typical switching times as a function of collector current
(inductive load, T_J=175°C, V_{CE}=600V, V_{GE}=0/15V, R_G=12Ω,
Dynamic test circuit in Figure E)

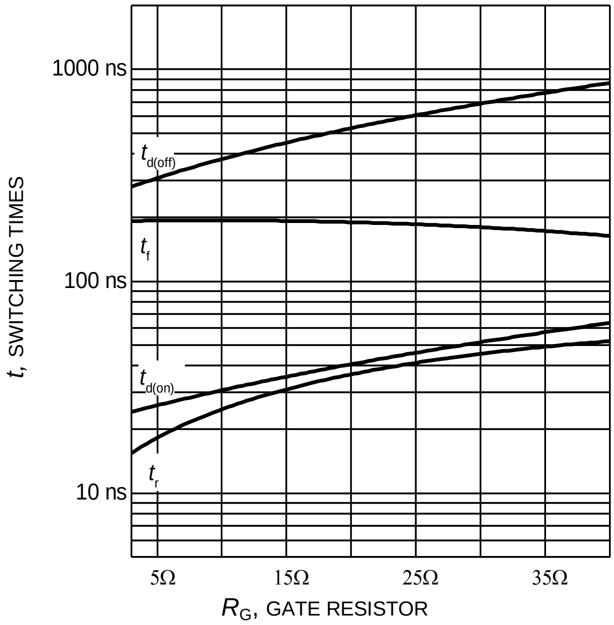


Figure 10. Typical switching times as a function of gate resistor
(inductive load, T_J=175°C, V_{CE}=600V, V_{GE}=0/15V, I_C=40A,
Dynamic test circuit in Figure E)

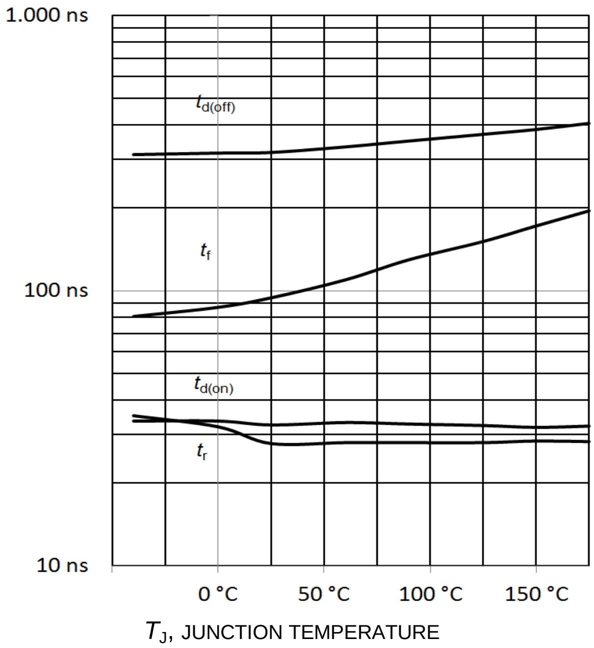


Figure 11. Typical switching times as a function of junction temperature
(inductive load, V_{CE}=600V, V_{GE}=0/15V, I_C=40A, R_G=12Ω,
Dynamic test circuit in Figure E)

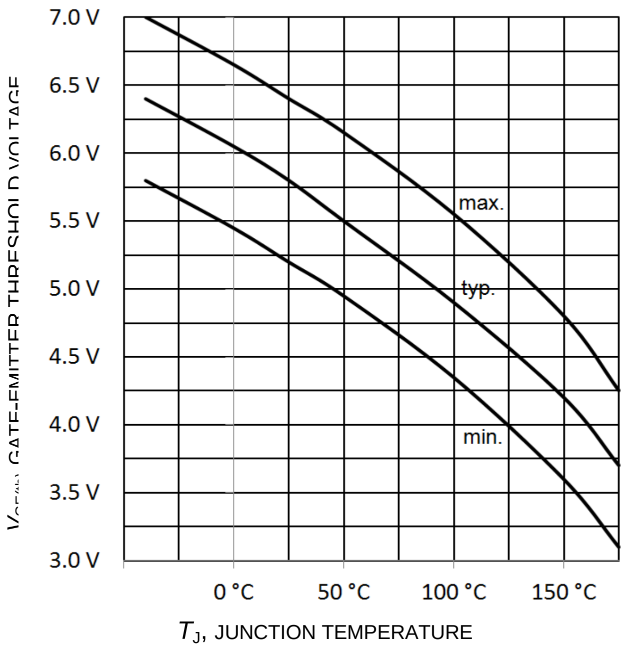


Figure 12. Gate-emitter threshold voltage as a function of junction temperature
(I_C = 1.5mA)

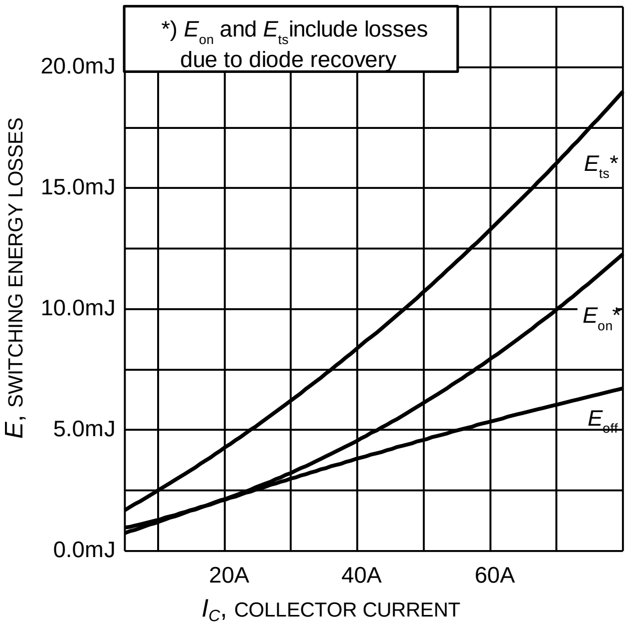


Figure 13. Typical switching energy losses as a function of collector current
(inductive load, T_J=175°C, V_{CE}=600V, V_{GE}=0/15V, R_G=12Ω, Dynamic test circuit in Figure E)

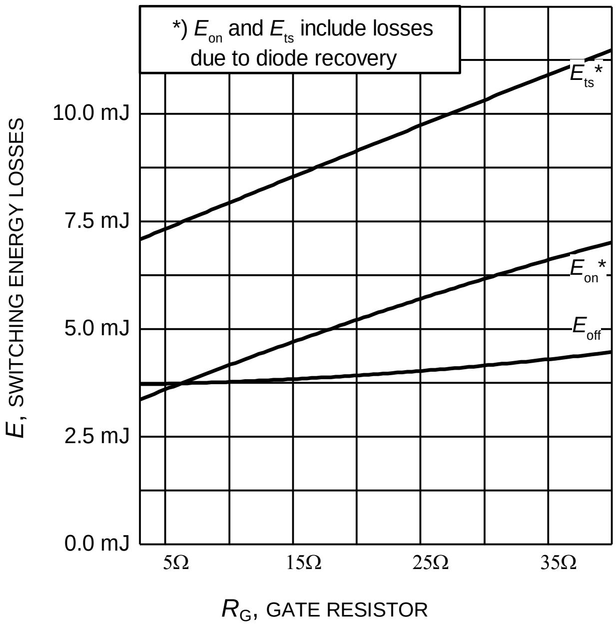


Figure 14. Typical switching energy losses as a function of gate resistor
(inductive load, T_J=175°C, V_{CE}=600V, V_{GE}=0/15V, I_C=40A, Dynamic test circuit in Figure E)

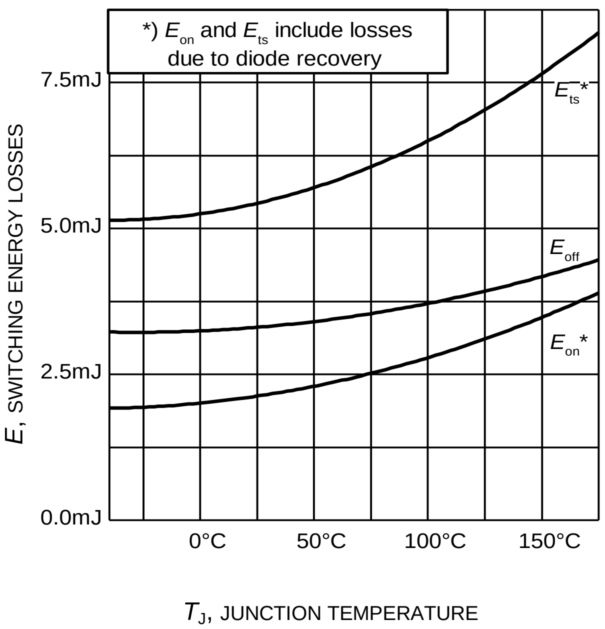


Figure 15. Typical switching energy losses as a function of junction temperature
(inductive load, V_{CE}=600V, V_{GE}=0/15V, I_C=40A, R_G=12Ω, Dynamic test circuit in Figure E)

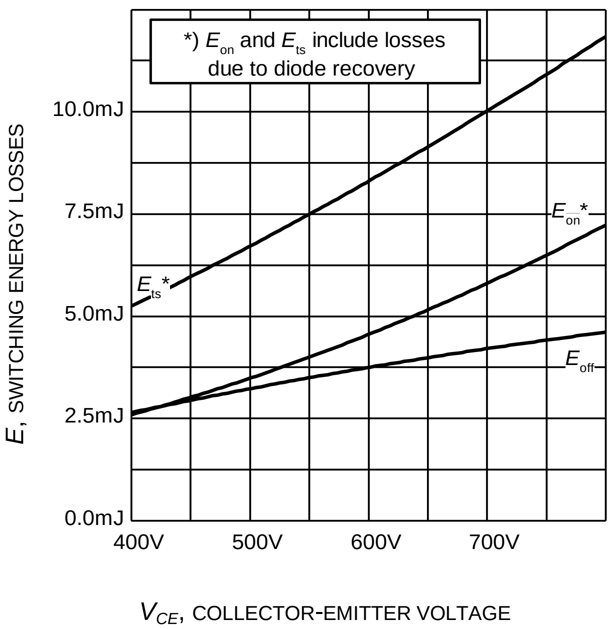


Figure 16. Typical switching energy losses as a function of collector emitter voltage
(inductive load, T_J=175°C, V_{GE}=0/15V, I_C=40A, R_G=12Ω, Dynamic test circuit in Figure E)

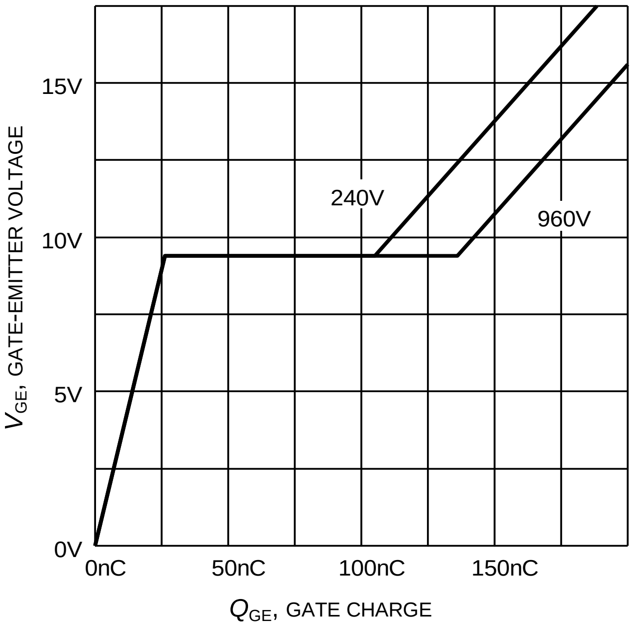


Figure 17. Typical gate charge
(I_C=40 A)

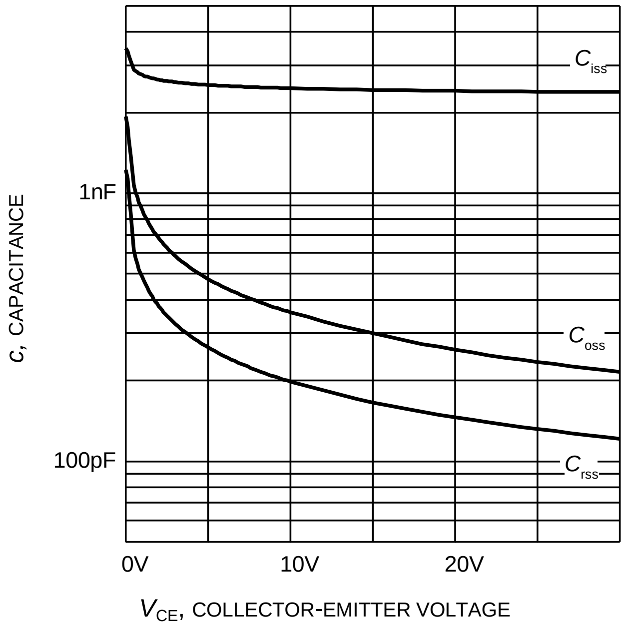


Figure 18. Typical capacitance as a function of collector-emitter voltage
(V_{GE}=0V, f = 1 MHz)

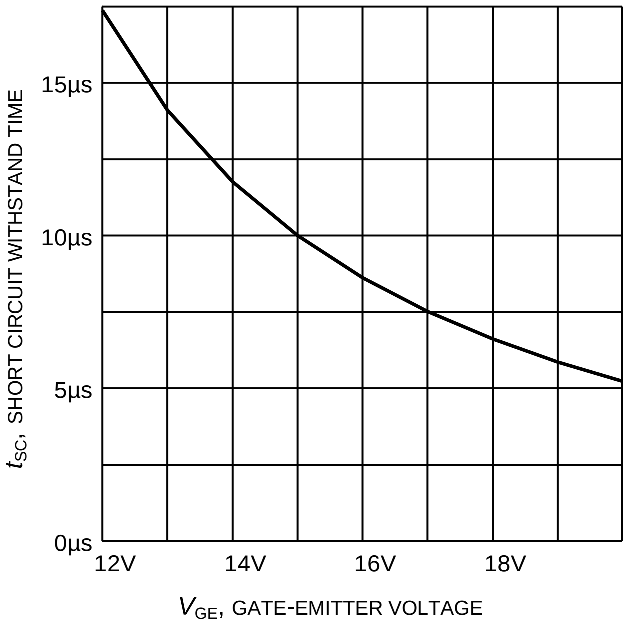


Figure 19. Short circuit withstand time as a function of gate-emitter voltage
(V_{CE}=600V, start at $T_J \leq$ 175°C)

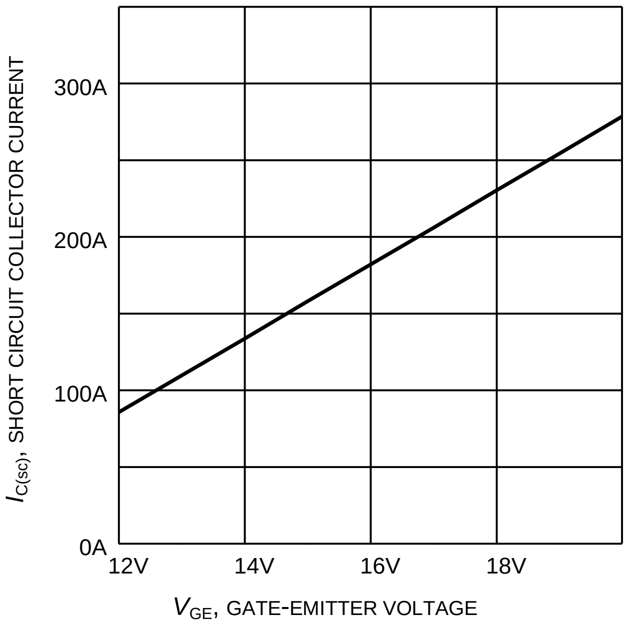


Figure 20. Typical short circuit collector current as a function of gate-emitter voltage
($V_{CE} \leq$ 600V, $T_{j,start}$ = 175°C)

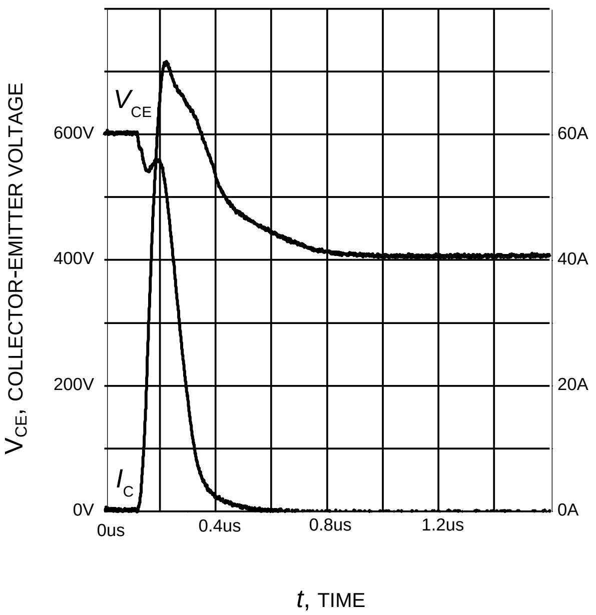


Figure 21. Typical turn on behavior
(V_{GE}=0/15V, R_G=12Ω, T_j = 175°C, Dynamic test circuit in Figure E)

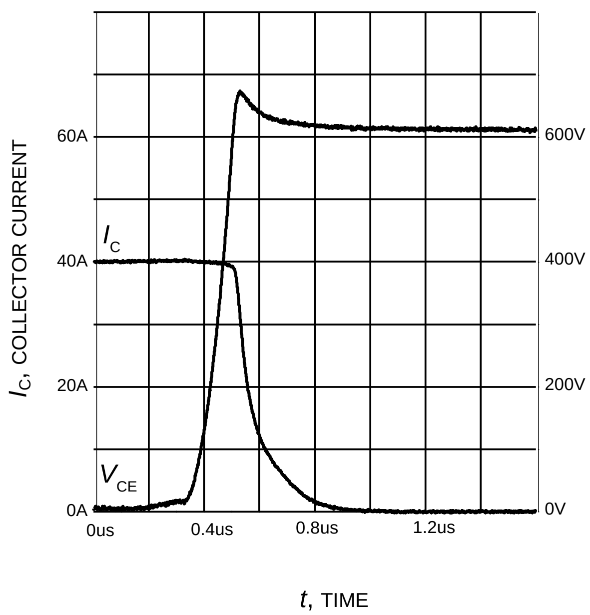


Figure 22. Typical turn off behavior
(V_{GE}=15/0V, R_G=12Ω, T_j = 175°C, Dynamic test circuit in Figure E)

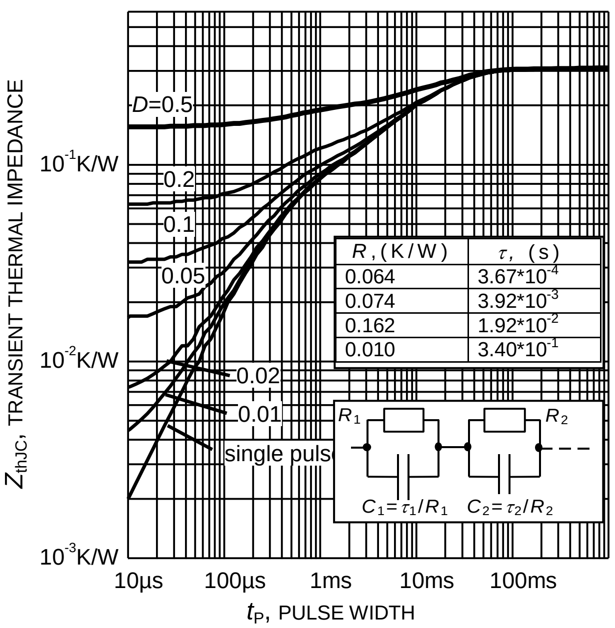


Figure 23. IGBT transient thermal impedance
($D = t_p / T$)

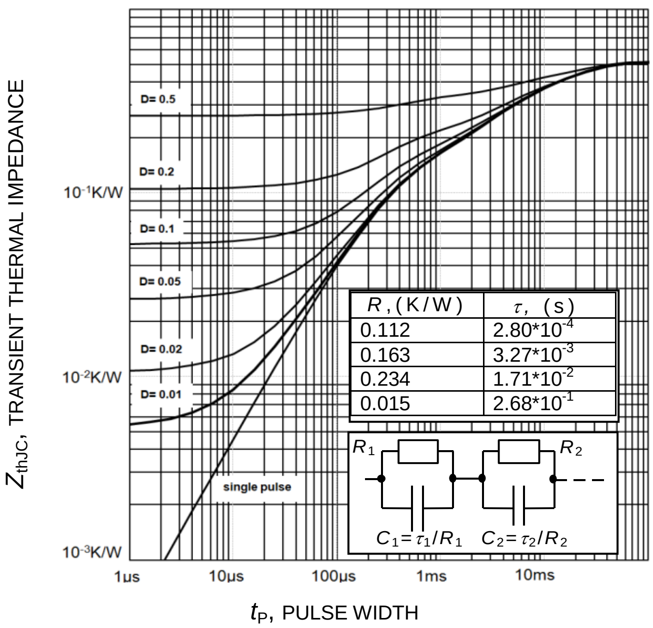


Figure 24. Diode transient thermal impedance as a function of pulse width
($D=t_P/T$)

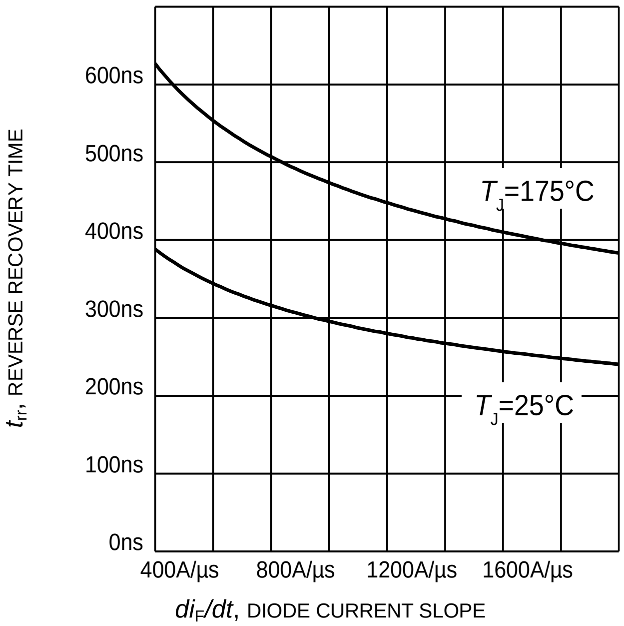


Figure 23. Typical reverse recovery time as a function of diode current slope
(V_R=600V, I_F=40A,
Dynamic test circuit in Figure E)

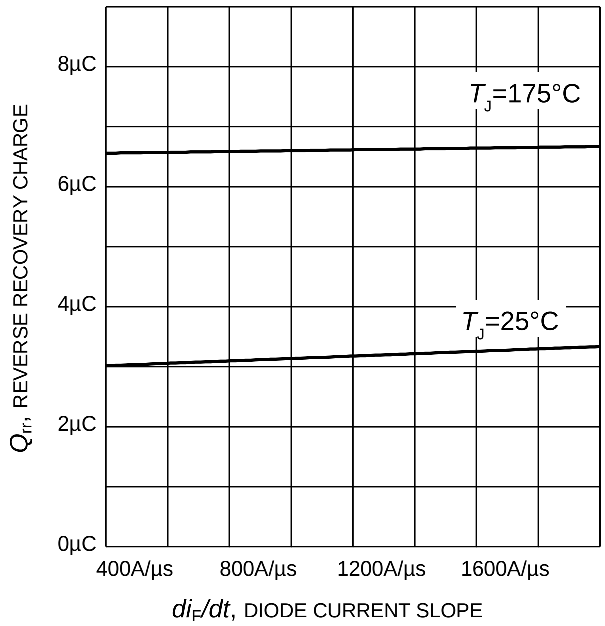


Figure 24. Typical reverse recovery charge as a function of diode current slope
(V_R=600V, I_F=40A,
Dynamic test circuit in Figure E)

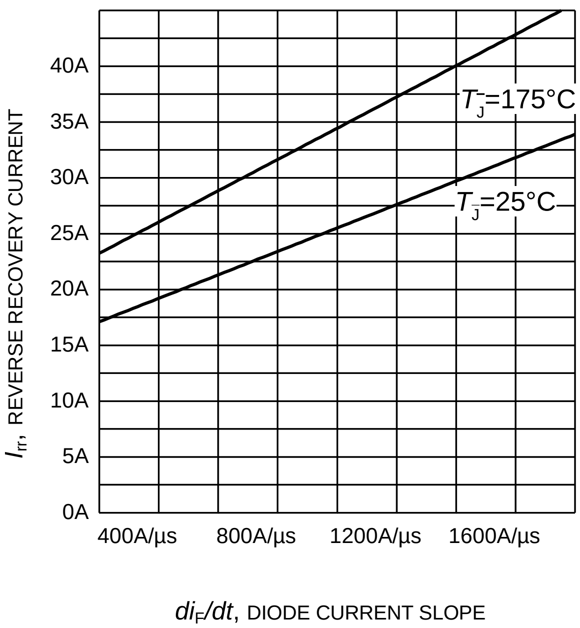


Figure 25. Typical reverse recovery current as a function of diode current slope
(V_R=600V, I_F=40A,
Dynamic test circuit in Figure E)

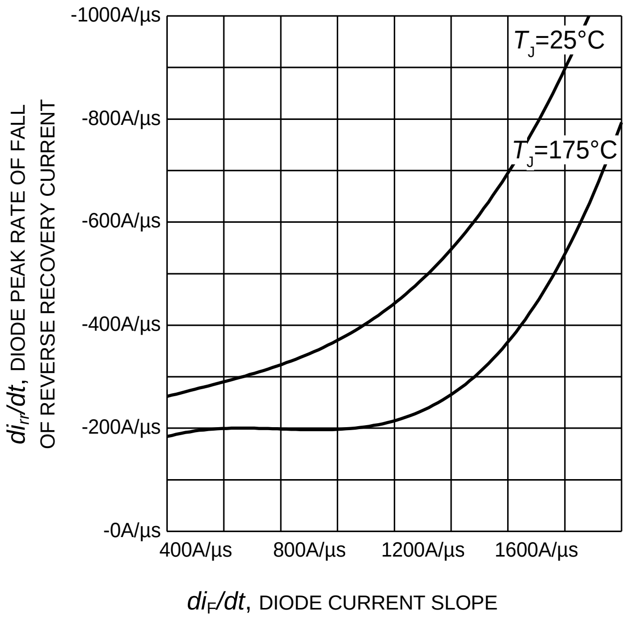


Figure 26. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope
(V_R=600V, I_F=40A,
Dynamic test circuit in Figure E)

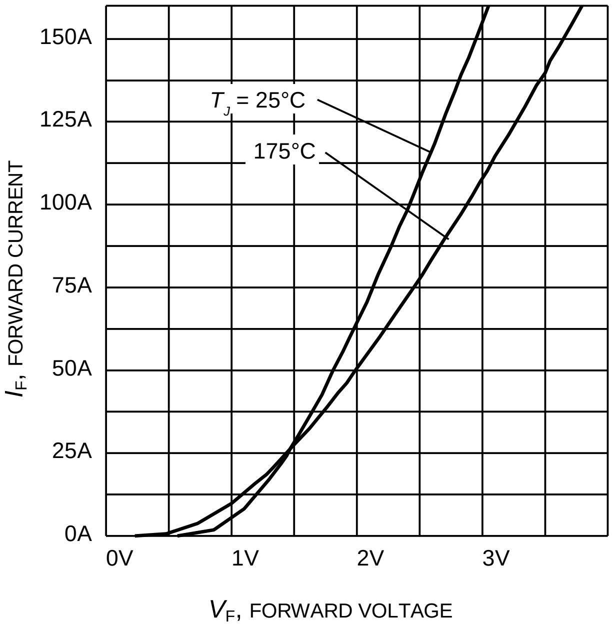


Figure 27. Typical diode forward current as a function of forward voltage

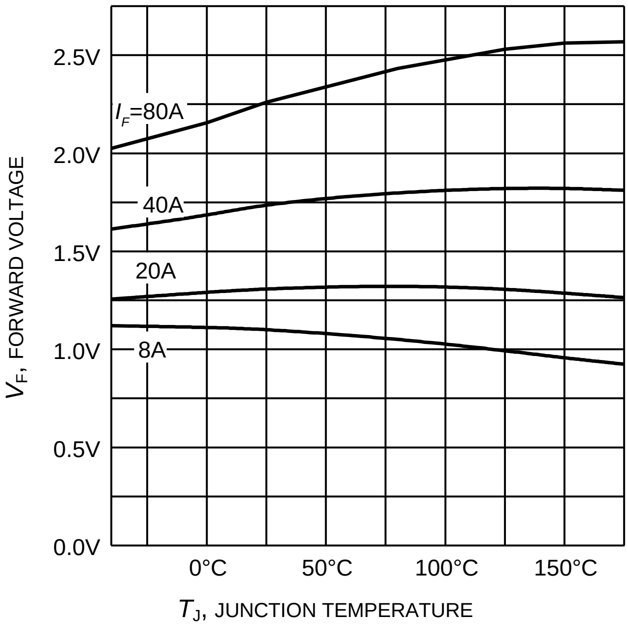


Figure 28. Typical diode forward voltage as a function of junction temperature

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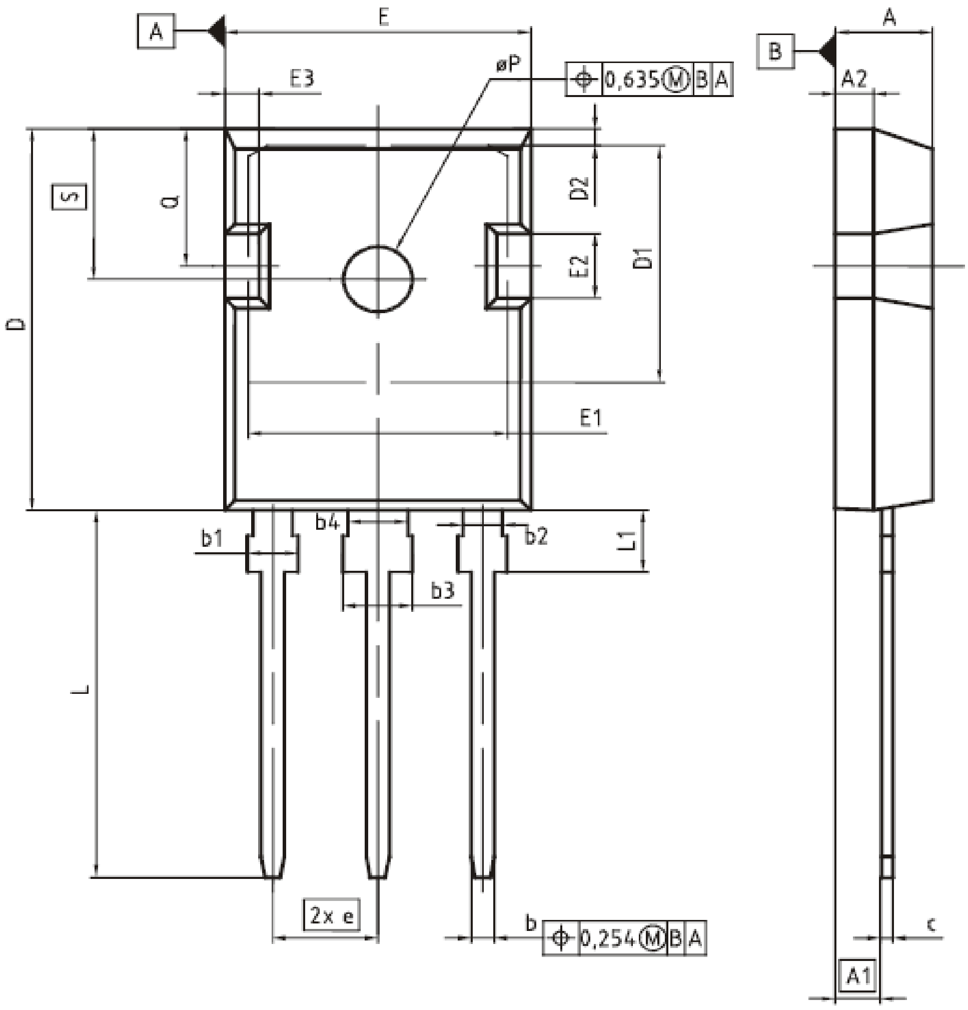

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.83	5.21	0.190	0.205
A1	2.27	2.54	0.089	0.100
A2	1.85	2.16	0.073	0.085
b	1.07	1.33	0.042	0.052
b1	1.90	2.41	0.075	0.095
b2	1.90	2.16	0.075	0.085
b3	2.87	3.38	0.113	0.133
b4	2.87	3.13	0.113	0.123
c	0.55	0.68	0.022	0.027
D	20.80	21.10	0.819	0.831
D1	16.25	17.65	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

DOCUMENT NO.
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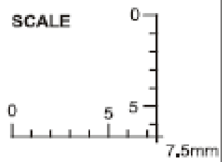
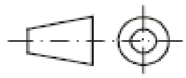
SCALE



EUROPEAN PROJECTION



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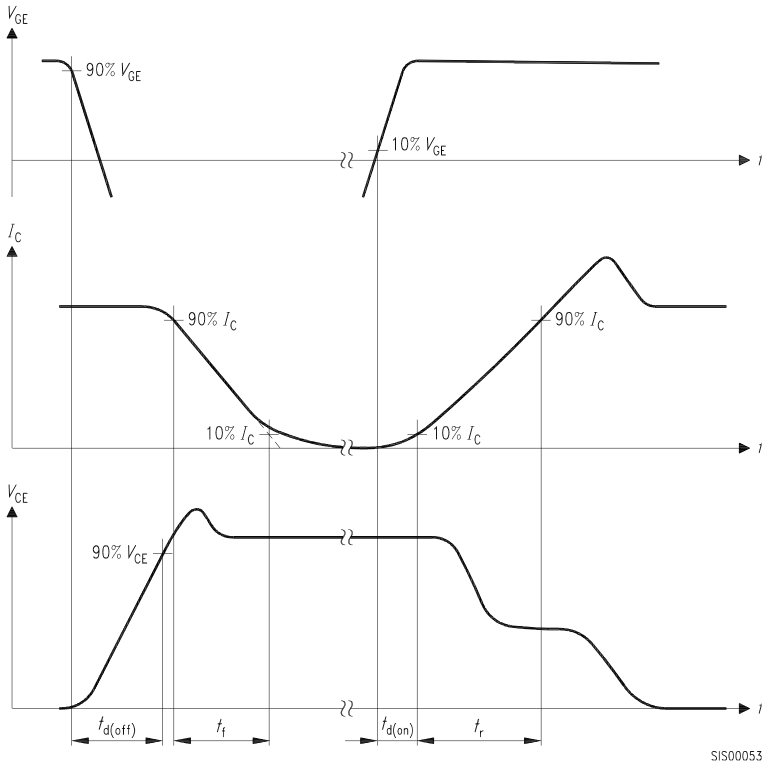


Figure A. Definition of switching times

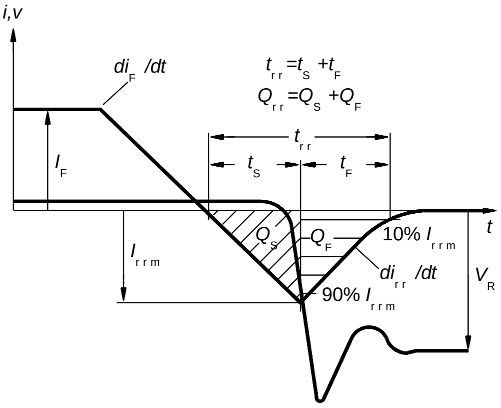


Figure C. Definition of diodes switching characteristics

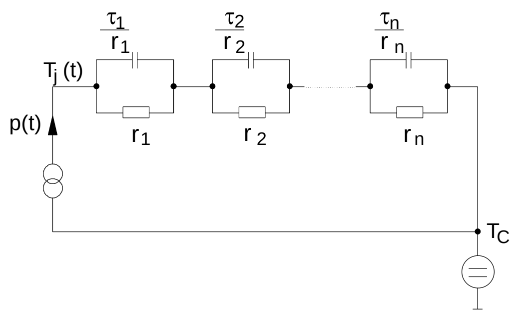
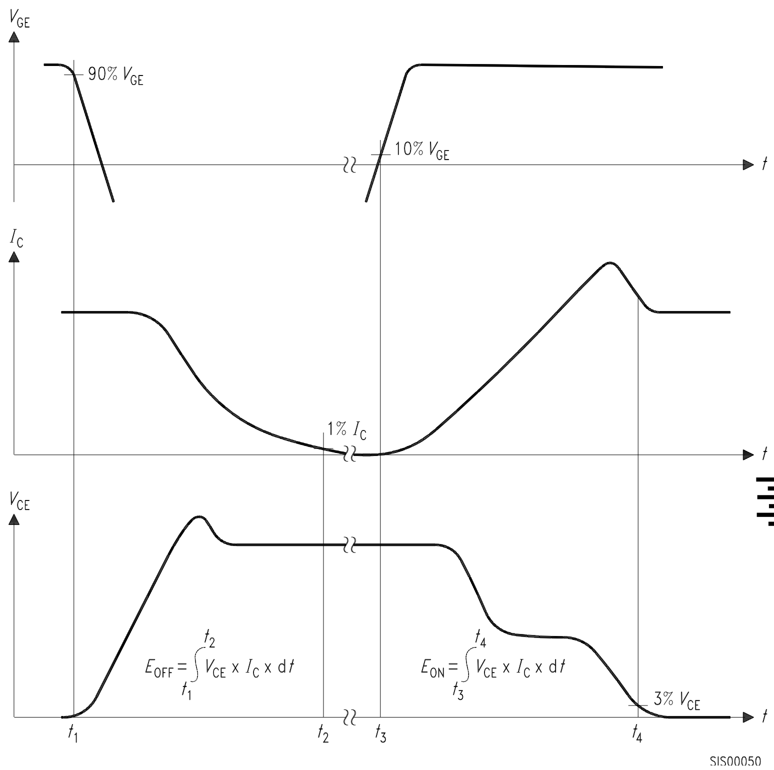


Figure D. Thermal equivalent circuit



$E_{OFF} = \int_{t_1}^{t_2} V_{CE} \times I_C \times dt$ $E_{ON} = \int_{t_3}^{t_4} V_{CE} \times I_C \times dt$

Figure B. Definition of switching losses

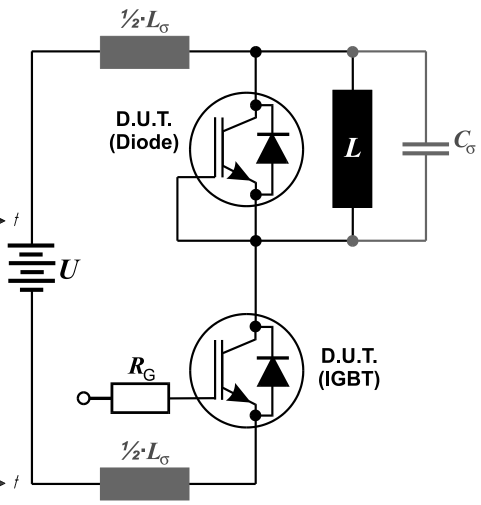


Figure E. Dynamic test circuit

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Information

For further information on technology, delivery terms and conditions and prices, please contact the nearest Infineon Technologies Office (**www.infineon.com**).

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