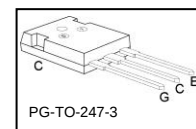
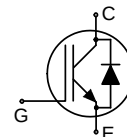


Low Loss DuoPack : IGBT in 2nd generation **TrenchStop®**
with soft, fast recovery anti-parallel Emitter Controlled Diode

- 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 HEDiode
- Qualified according to JEDEC¹ 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	$V_{CE(sat)}, T_J=25^\circ\text{C}$	$T_{j,max}$	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 ($T_J=150^\circ\text{C}$)	I_C	75 ²	A
$T_C = 25^\circ\text{C}$		40	
$T_C = 110^\circ\text{C}$			
Pulsed collector current, t_p limited by $T_{j,max}$	$I_{C,puls}$	160	
Turn off safe operating area	-	160	
$V_{CE} \leq 1200\text{V}, T_J \leq 175^\circ\text{C}$			
DC Diode forward current ($T_J=150^\circ\text{C}$)	I_F	75 ²	
$T_C = 25^\circ\text{C}$		40	
$T_C = 110^\circ\text{C}$			
Diode pulsed current, t_p limited by $T_{j,max}$	$I_{F,puls}$	160	
Gate-emitter voltage	V_{GE}	± 20	V
Short circuit withstand time ³⁾	t_{SC}	10	µs
$V_{GE} = 15\text{V}, V_{CC} \leq 600\text{V}, T_{j,start} \leq 175^\circ\text{C}$			
Power dissipation	P_{tot}	480	W
$T_C = 25^\circ\text{C}$			
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	-	260	
Wavesoldering only, temperature on leads only			

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

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
Static Characteristic						
Collector-emitter breakdown voltage	$V_{(BR)CES}$	$V_{GE}=0V, I_C=500\mu A$	1200	-	-	V
Collector-emitter saturation voltage	$V_{CE(sat)}$	$V_{GE} = 15V, I_C=40A$				
		$T_j=25^{\circ}C$	-	1.75	2.2	
		$T_j=150^{\circ}C$	-	2.25	-	
		$T_j=175^{\circ}C$	-	2.3	-	
Diode forward voltage	V_F	$V_{GE}=0V, I_F=40A$				
		$T_j=25^{\circ}C$	-	1.75	2.2	
		$T_j=150^{\circ}C$	-	1.80	-	
		$T_j=175^{\circ}C$	-	1.80	-	
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}	$V_{CE}=1200V, V_{GE}=0V$				mA
		$T_j=25^{\circ}C$	-	-	0.4	
		$T_j=150^{\circ}C$	-	-	4.0	
		$T_j=175^{\circ}C$	-	-	20	
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⁾	$I_{C(SC)}$	$V_{GE}=15V, t_{SC} \leq 10\mu s$ $V_{CC} = 600V,$ $T_{j,start} = 25^\circ C$ $T_{j,start} = 175^\circ C$	-	220 156	-	A

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

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
IGBT Characteristic						
Turn-on delay time	$t_{d(on)}$	$T_j=25^{\circ}\text{C}$, $V_{CC}=600\text{V}$, $I_C=40\text{A}$, $V_{GE}=0/15\text{V}$, $R_G=12\Omega$, $L_{\sigma}^{(2)}=80\text{nH}$, $C_{\sigma}^{(2)}=67\text{pF}$ 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}	$T_j=25^{\circ}\text{C}$, $V_R=600\text{V}$, $I_F=40\text{A}$, $di_F/dt=950\text{A}/\mu\text{s}$	-	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 $T_j=175^\circ\text{C}$

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
IGBT Characteristic						
Turn-on delay time	$t_{d(on)}$	$T_j=175^{\circ}\text{C}$ $V_{CC}=600\text{V}, I_C=40\text{A},$ $V_{GE}=0/15\text{V},$ $R_G=12\Omega,$ $L_{\sigma}^{1)}=180\text{nH},$ $C_{\sigma}^{1)}=67\text{pF}$ 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}	$T_j=175^{\circ}\text{C}$ $V_R=600\text{V}, I_F=40\text{A},$ $di_F/dt=950\text{A}/\mu\text{s}$	-	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.

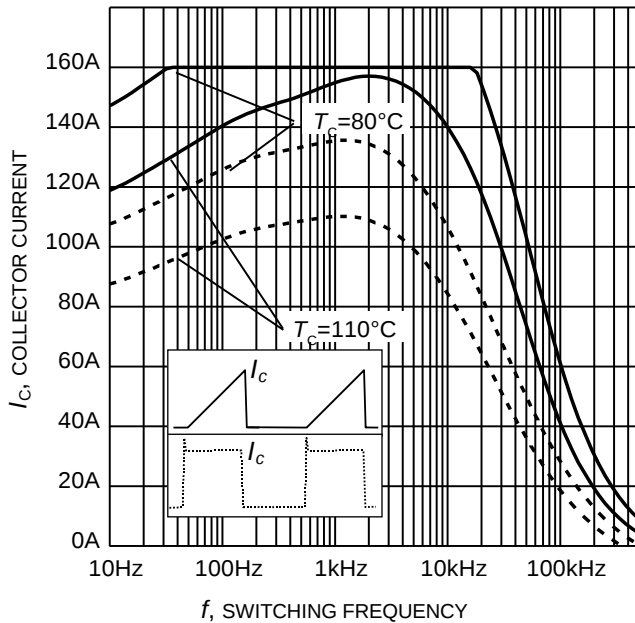


Figure 1. Collector current as a function of switching frequency
 $(T_j \leq 175^\circ\text{C}, D = 0.5, V_{CE} = 600\text{V}, V_{GE} = 0/+15\text{V}, R_G = 12\Omega)$

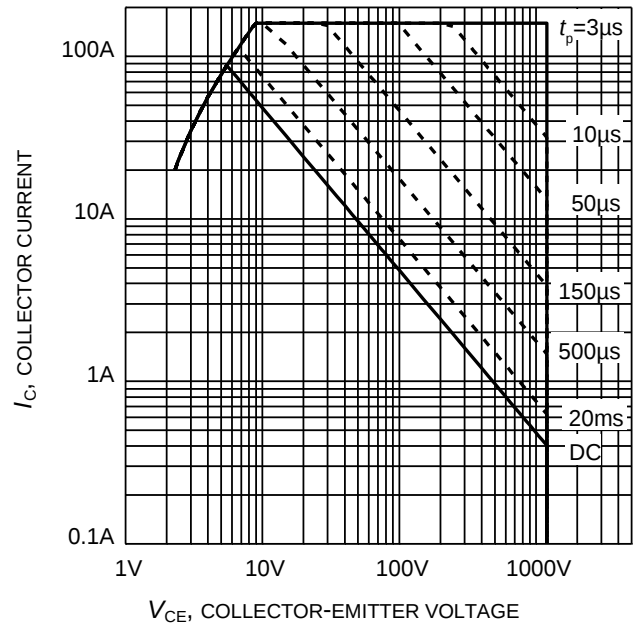


Figure 2. Safe operating area
 $(D = 0, T_C = 25^\circ\text{C}, T_j \leq 175^\circ\text{C}; V_{GE} = 15\text{V})$

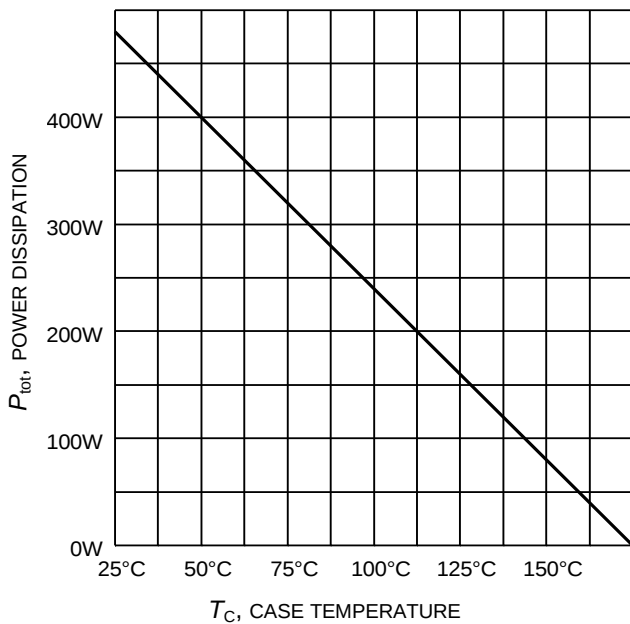


Figure 3. Maximum power dissipation as a function of case temperature
 $(T_j \leq 175^\circ\text{C})$

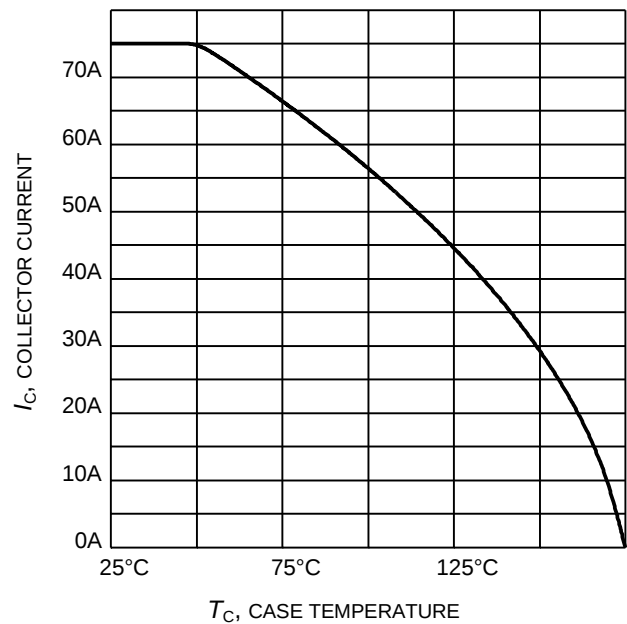
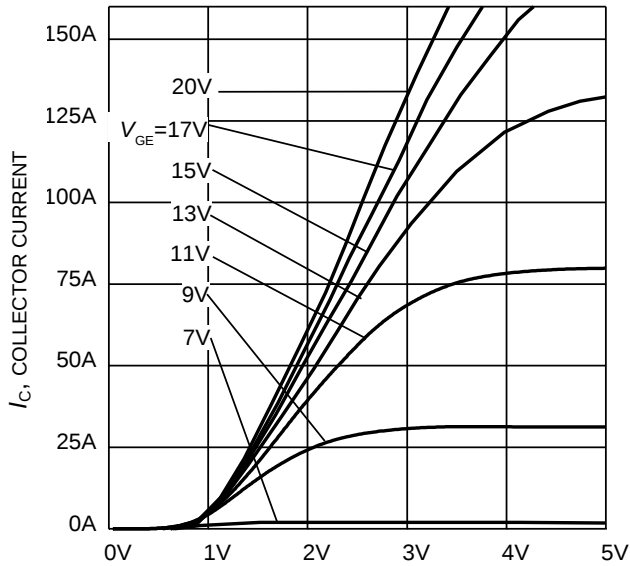
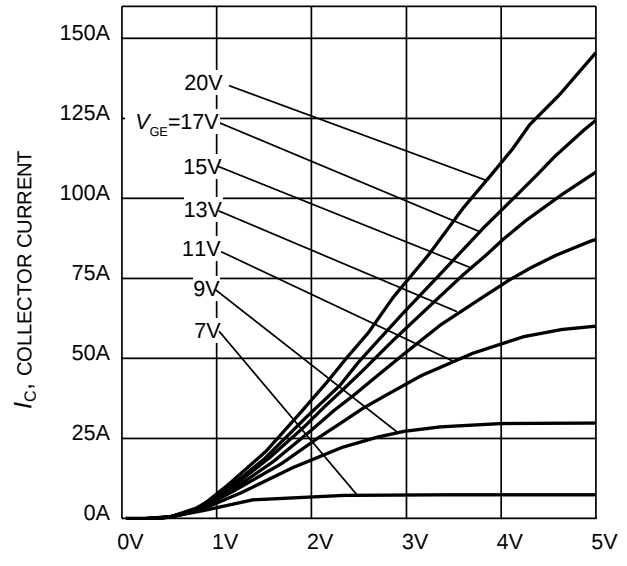


Figure 4. Maximum collector current as a function of case temperature
 $(V_{GE} \geq 15\text{V}, T_j \leq 175^\circ\text{C})$



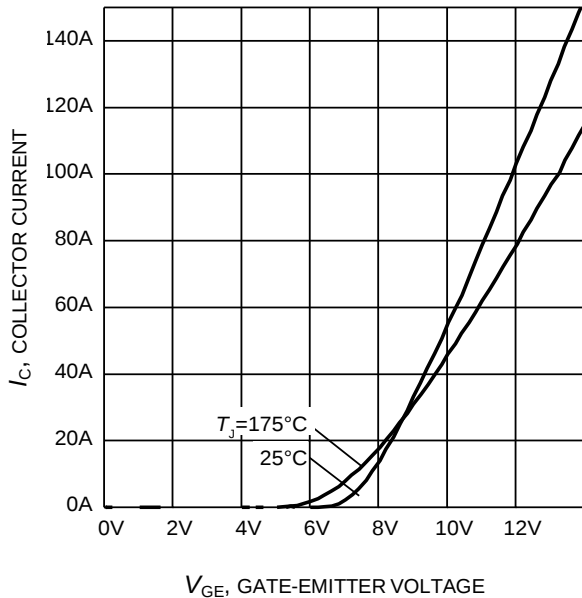
V_{CE} , COLLECTOR-EMITTER VOLTAGE

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



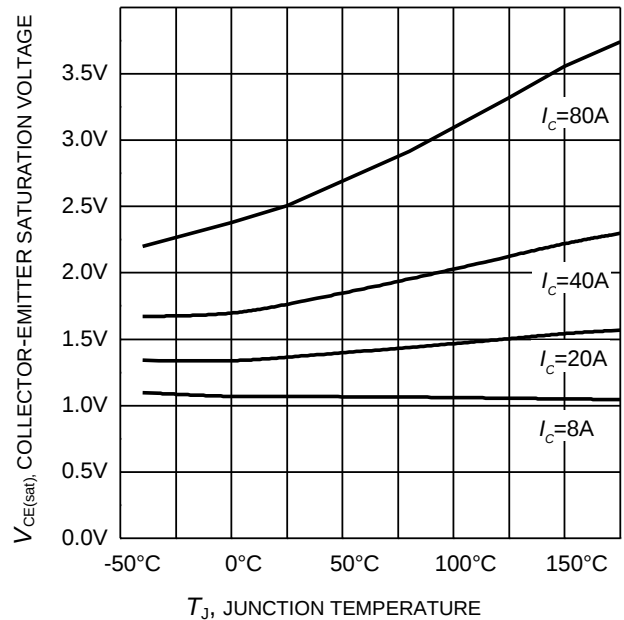
V_{CE} , COLLECTOR-EMITTER VOLTAGE

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



V_{GE} , GATE-EMITTER VOLTAGE

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



T_j , JUNCTION TEMPERATURE

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

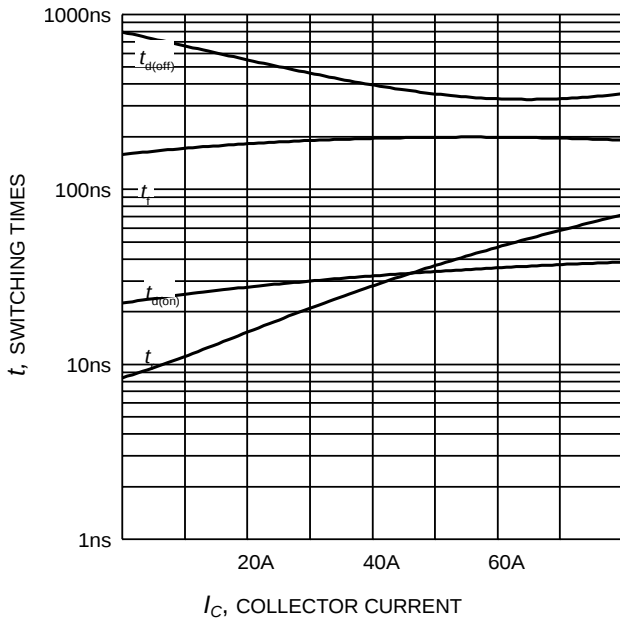


Figure 9. Typical switching times as a function of collector current
(inductive load, $T_J=175^\circ\text{C}$, $V_{CE}=600\text{V}$, $V_{GE}=0/15\text{V}$, $R_G=12\Omega$, Dynamic test circuit in Figure E)

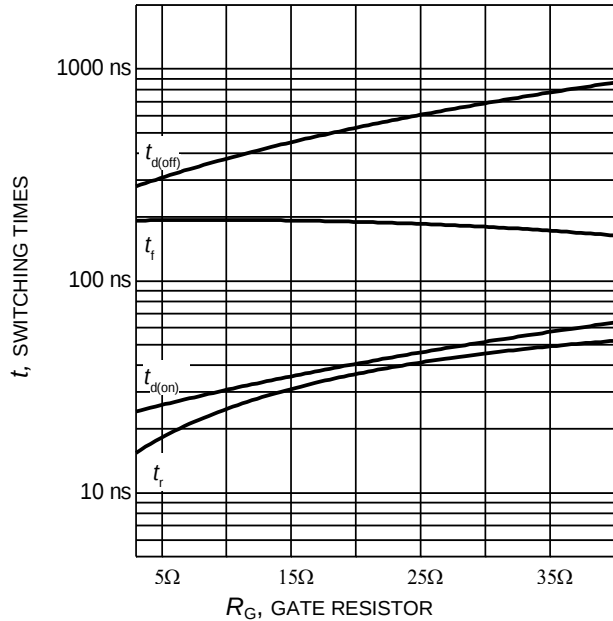


Figure 10. Typical switching times as a function of gate resistor
(inductive load, $T_J=175^\circ\text{C}$, $V_{CE}=600\text{V}$, $V_{GE}=0/15\text{V}$, $I_C=40\text{A}$, Dynamic test circuit in Figure E)

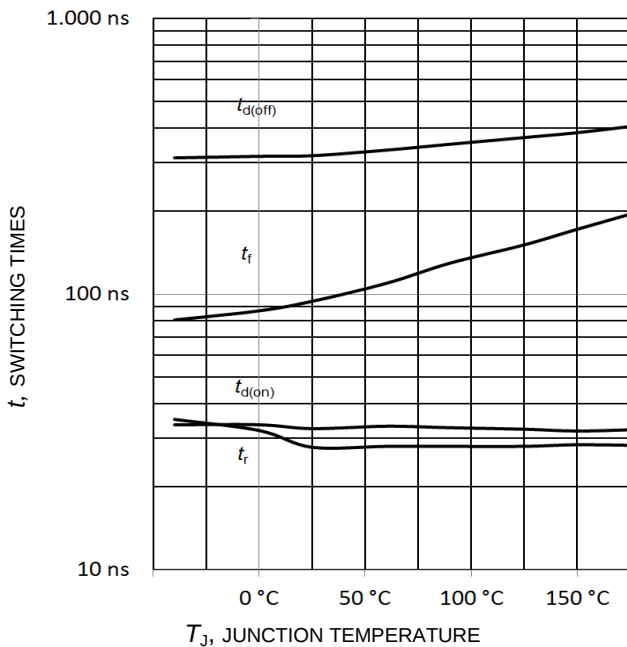


Figure 11. Typical switching times as a function of junction temperature
(inductive load, $V_{CE}=600\text{V}$, $V_{GE}=0/15\text{V}$, $I_C=40\text{A}$, $R_G=12\Omega$, Dynamic test circuit in Figure E)

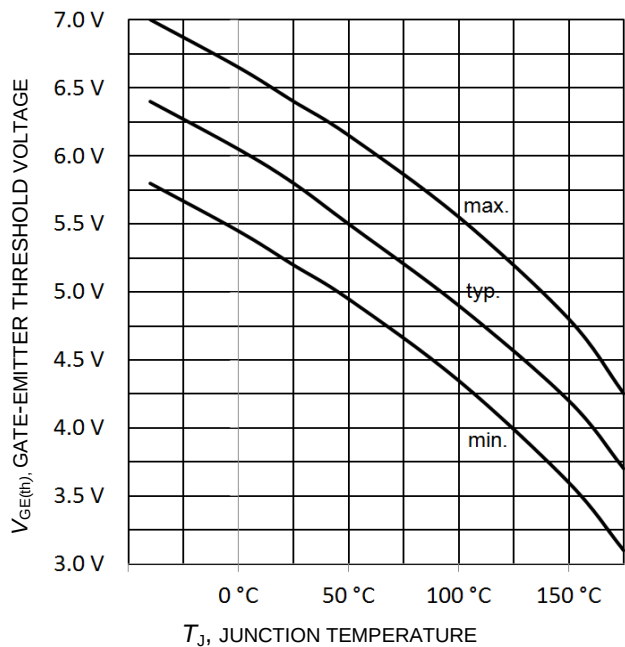


Figure 12. Gate-emitter threshold voltage as a function of junction temperature
($I_C = 1.5\text{mA}$)

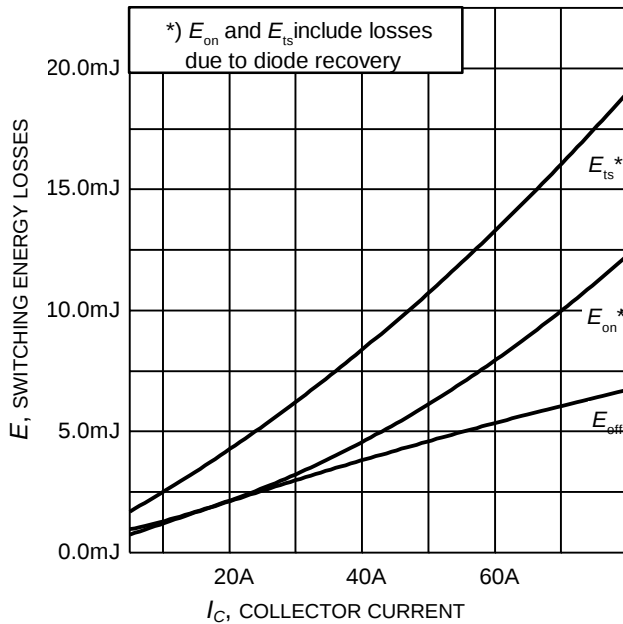


Figure 13. Typical switching energy losses as a function of collector current
(inductive load, $T_J=175^\circ\text{C}$, $V_{CE}=600\text{V}$, $V_{GE}=0/15\text{V}$, $R_G=12\Omega$,
Dynamic test circuit in Figure E)

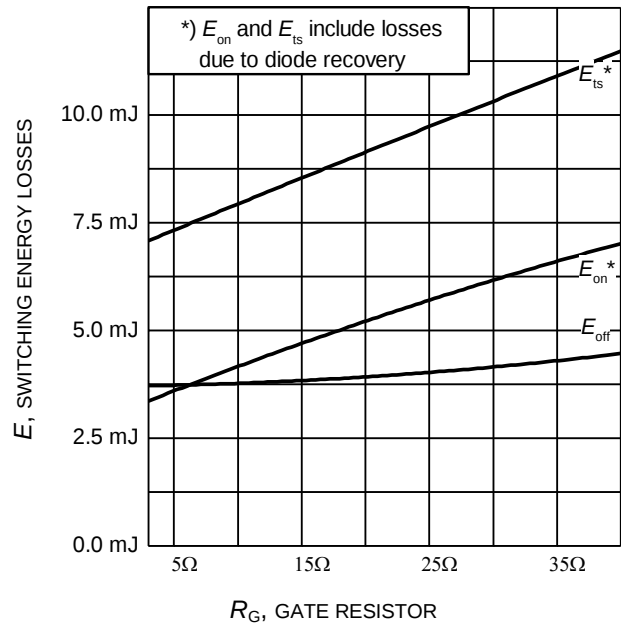


Figure 14. Typical switching energy losses as a function of gate resistor
(inductive load, $T_J=175^\circ\text{C}$, $V_{CE}=600\text{V}$, $V_{GE}=0/15\text{V}$, $I_C=40\text{A}$,
Dynamic test circuit in Figure E)

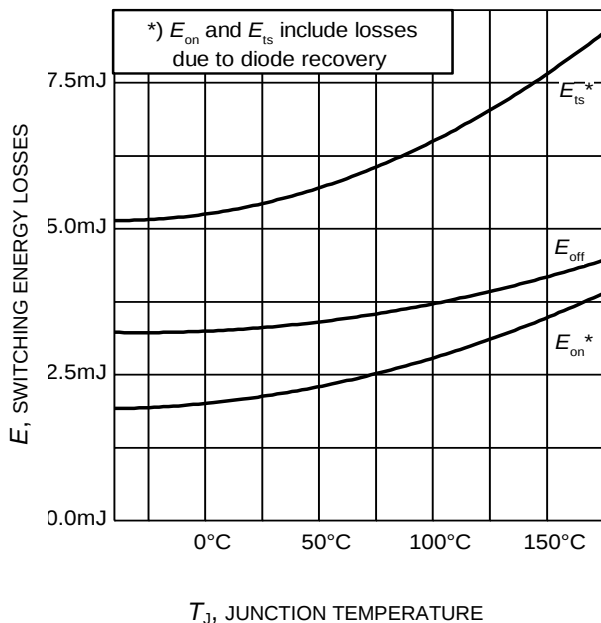


Figure 15. Typical switching energy losses as a function of junction temperature
(inductive load, $V_{CE}=600\text{V}$, $V_{GE}=0/15\text{V}$, $I_C=40\text{A}$, $R_G=12\Omega$,
Dynamic test circuit in Figure E)

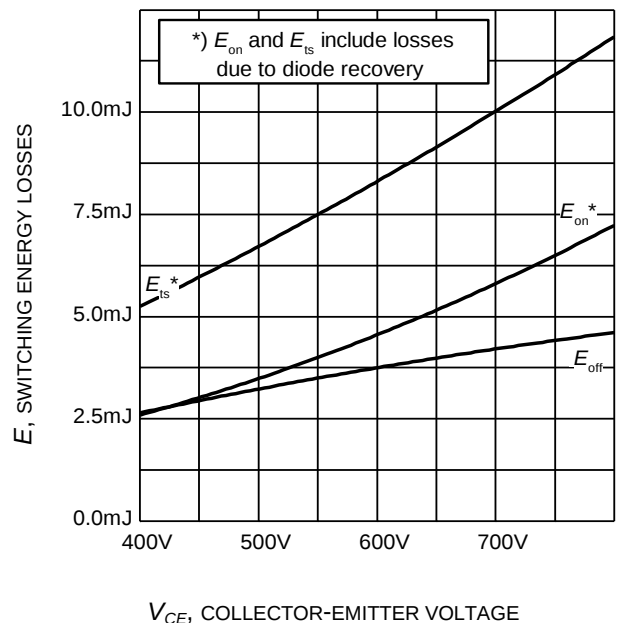


Figure 16. Typical switching energy losses as a function of collector emitter voltage
(inductive load, $T_J=175^\circ\text{C}$, $V_{GE}=0/15\text{V}$, $I_C=40\text{A}$, $R_G=12\Omega$,
Dynamic test circuit in Figure E)

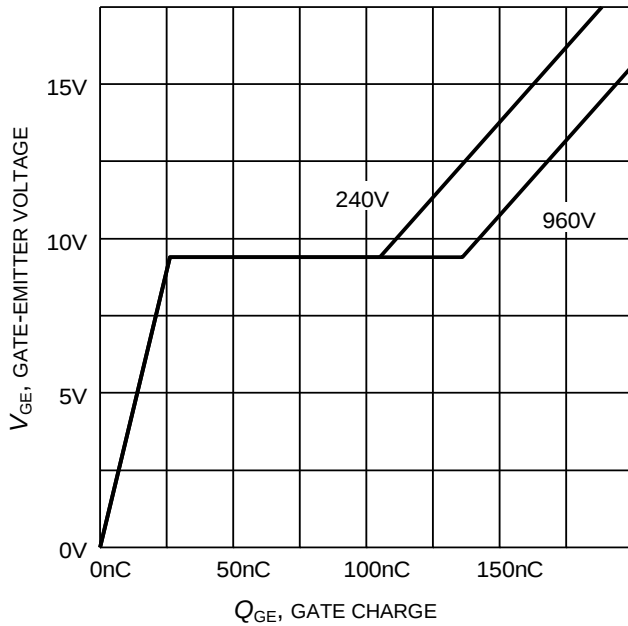


Figure 17. Typical gate charge
($I_C = 40\text{ A}$)

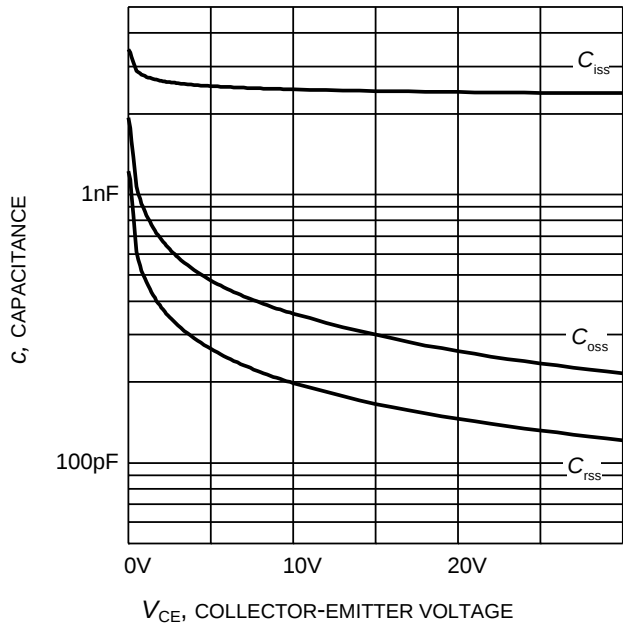


Figure 18. Typical capacitance as a function of collector-emitter voltage
($V_{GE} = 0\text{V}$, $f = 1\text{ MHz}$)

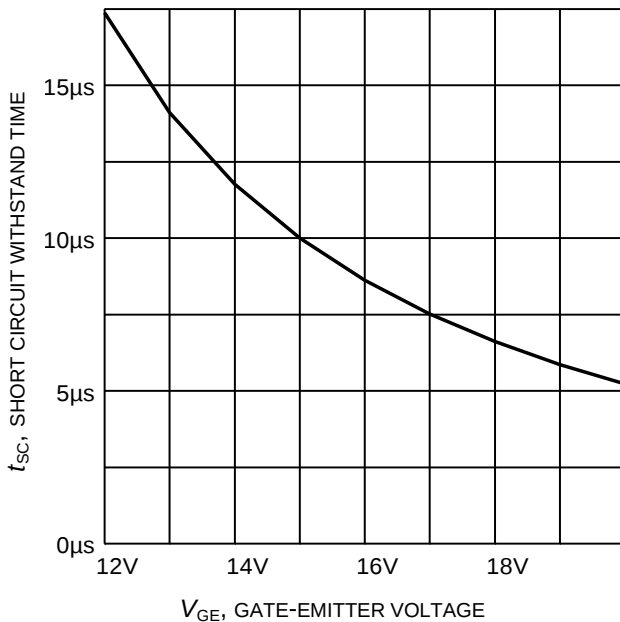


Figure 19. Short circuit withstand time as a function of gate-emitter voltage
($V_{CE} = 600\text{V}$, start at $T_J \leq 175^\circ\text{C}$)

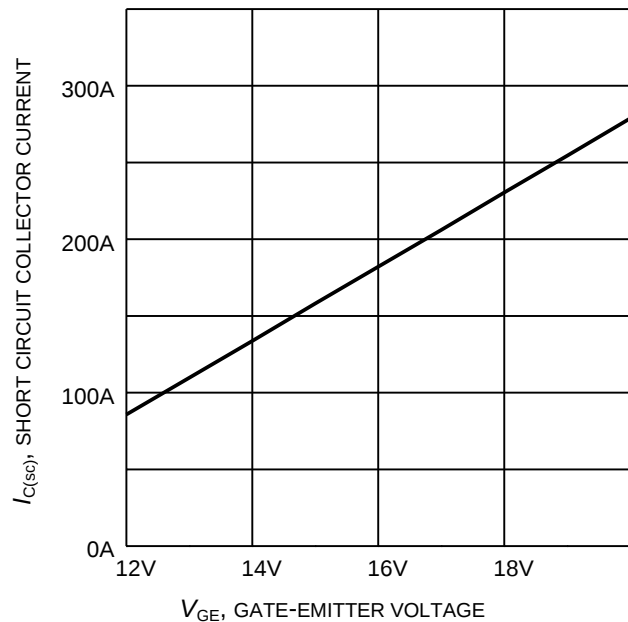


Figure 20. Typical short circuit collector current as a function of gate-emitter voltage
($V_{CE} \leq 600\text{V}$, $T_{J,\text{start}} = 175^\circ\text{C}$)

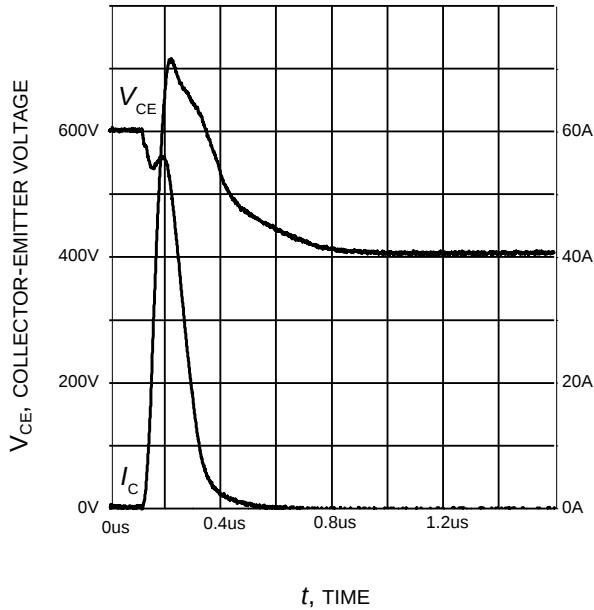


Figure 21. Typical turn on behavior
 $(V_{GE}=0/15V, R_G=12\Omega, T_j = 175^\circ C,$
 Dynamic test circuit in Figure E)

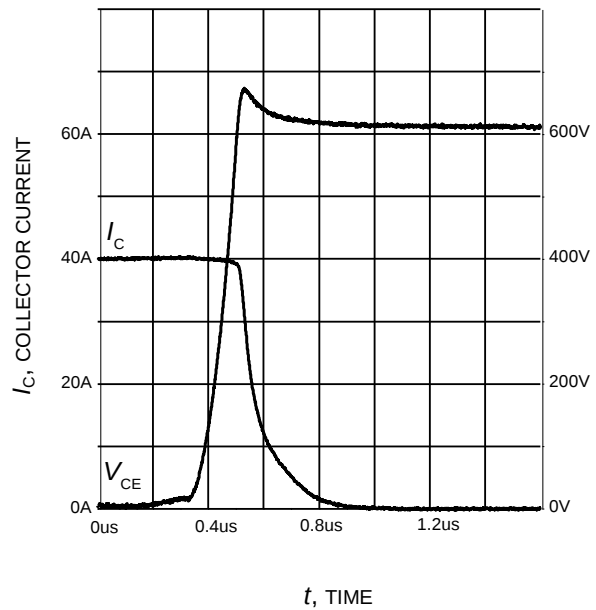


Figure 22. Typical turn off behavior
 $(V_{GE}=15/0V, R_G=12\Omega, T_j = 175^\circ C,$
 Dynamic test circuit in Figure E)

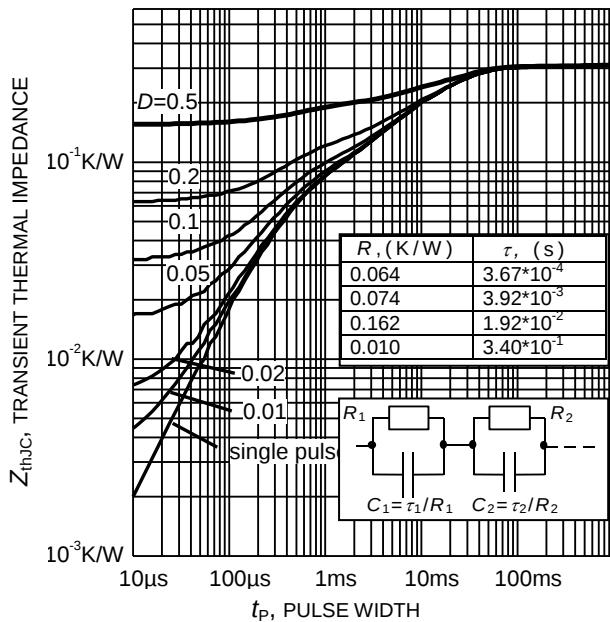


Figure 23. IGBT transient thermal impedance
 $(D = t_p / T)$

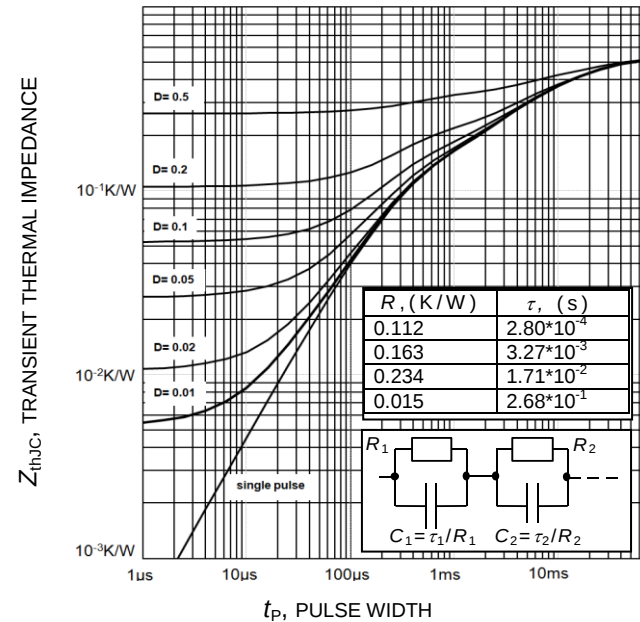


Figure 24. Diode transient thermal impedance as a function of pulse width
 $(D = t_p / T)$

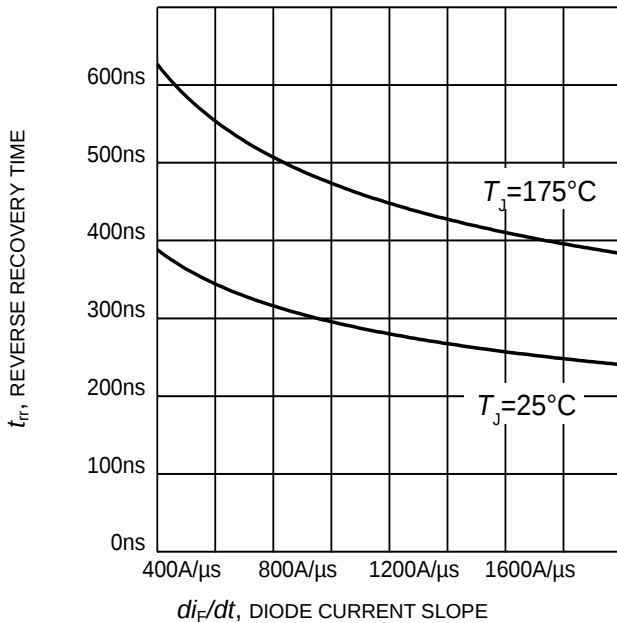


Figure 23. Typical reverse recovery time as a function of diode current slope
 $(V_R=600\text{V}, I_F=40\text{A},$
 Dynamic test circuit in Figure E)

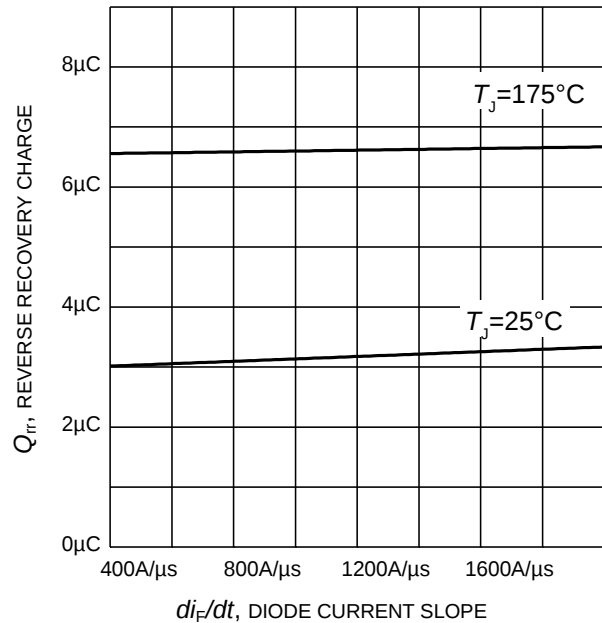


Figure 24. Typical reverse recovery charge as a function of diode current slope
 $(V_R=600\text{V}, I_F=40\text{A},$
 Dynamic test circuit in Figure E)

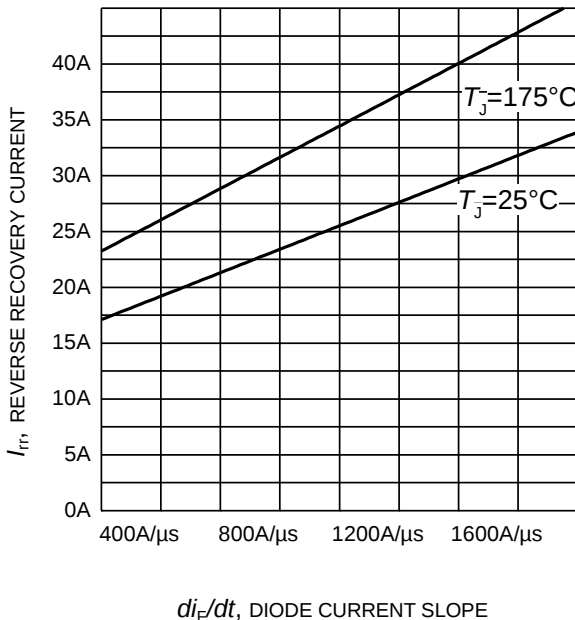


Figure 25. Typical reverse recovery current as a function of diode current slope
 $(V_R=600\text{V}, I_F=40\text{A},$
 Dynamic test circuit in Figure E)

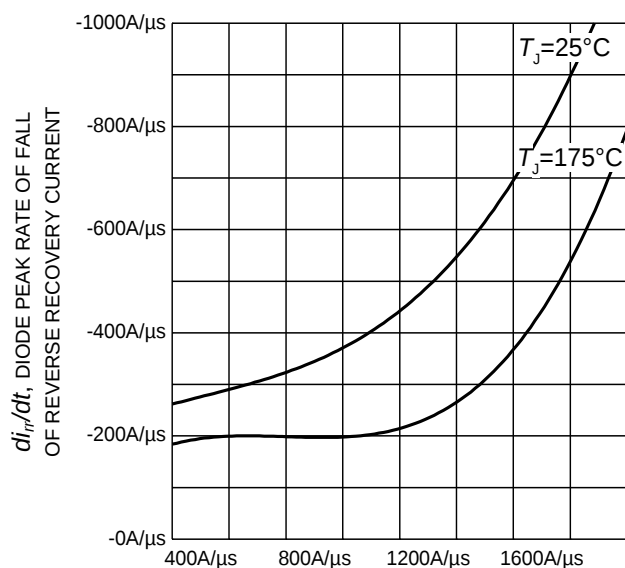


Figure 26. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope
 $(V_R=600\text{V}, I_F=40\text{A},$
 Dynamic test circuit in Figure E)

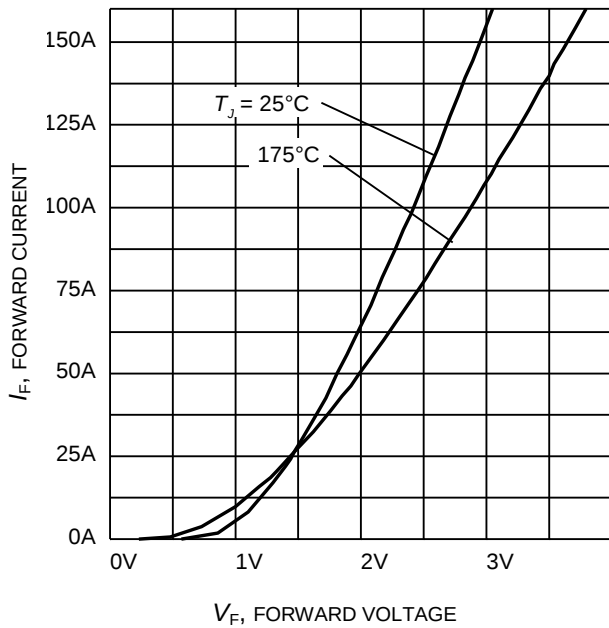


Figure 27. Typical diode forward current as a function of forward voltage

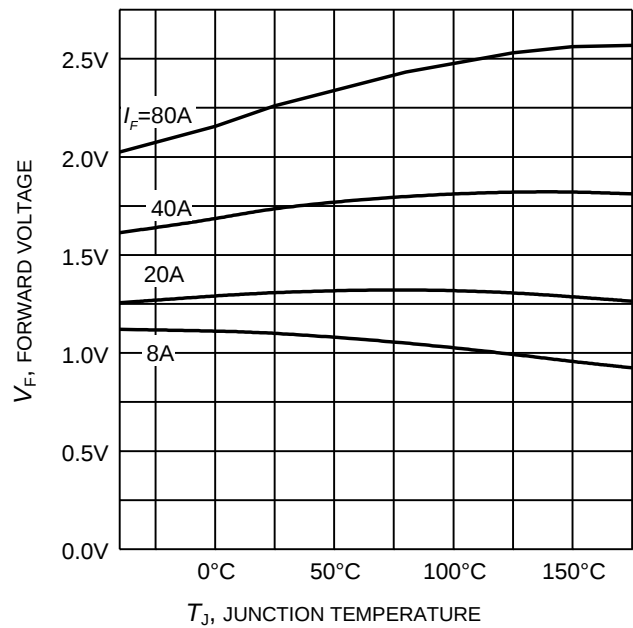
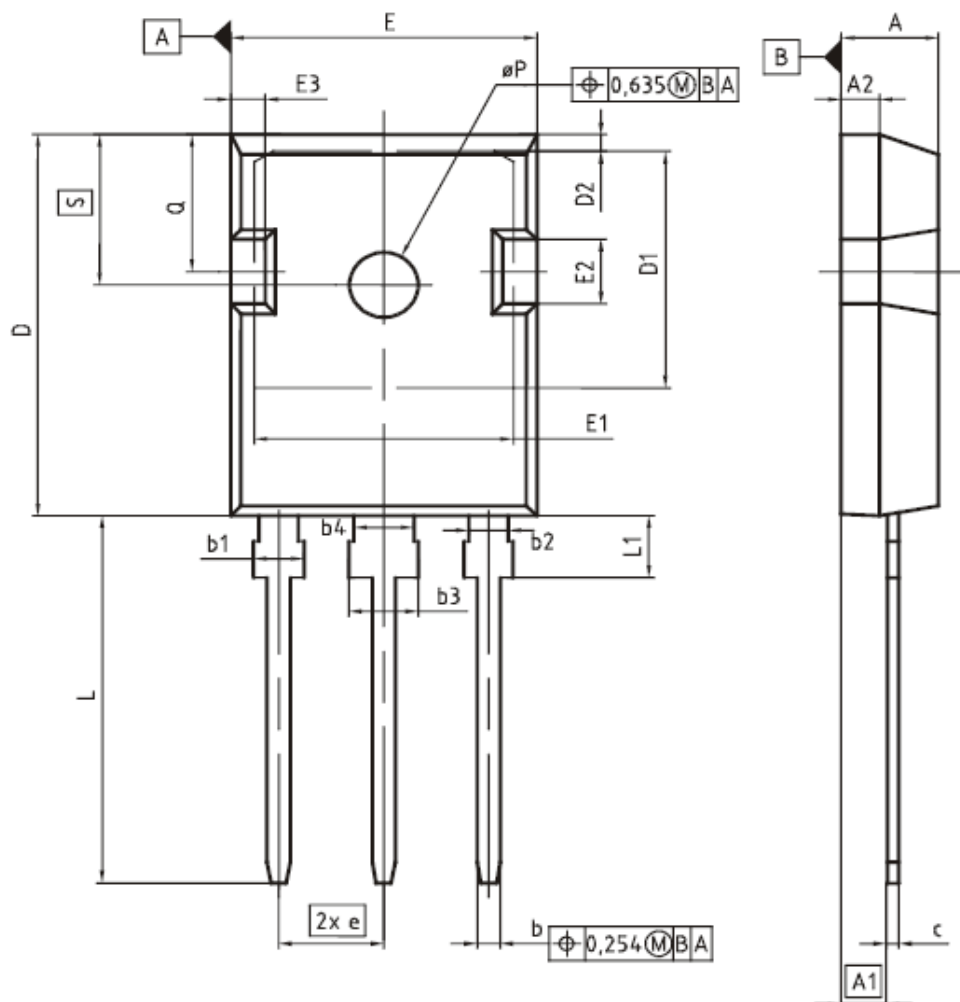
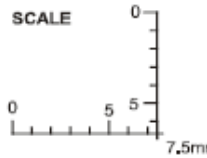
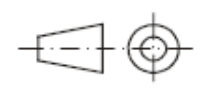


Figure 28. Typical diode forward voltage as a function of junction temperature

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
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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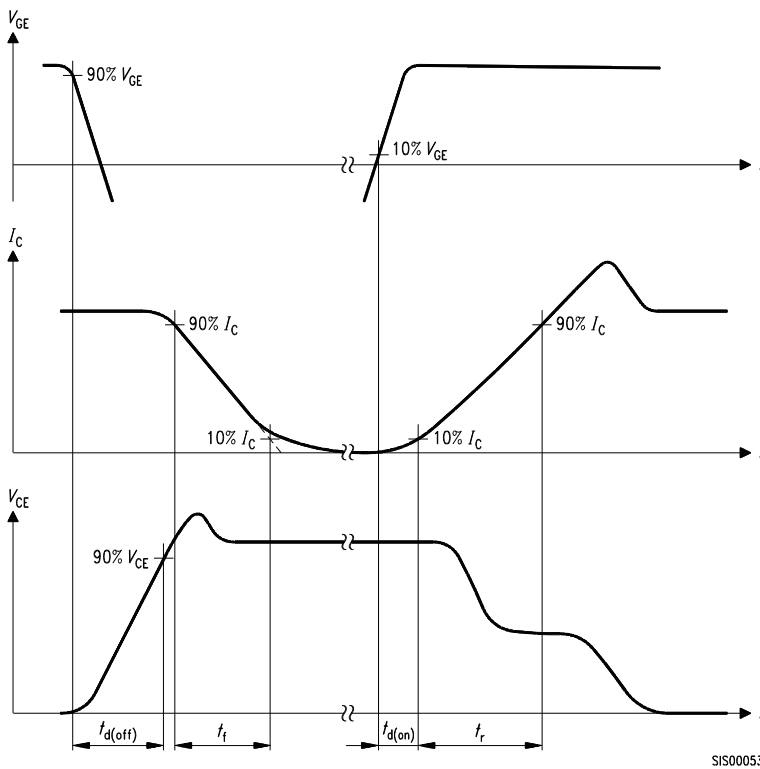


Figure A. Definition of switching times

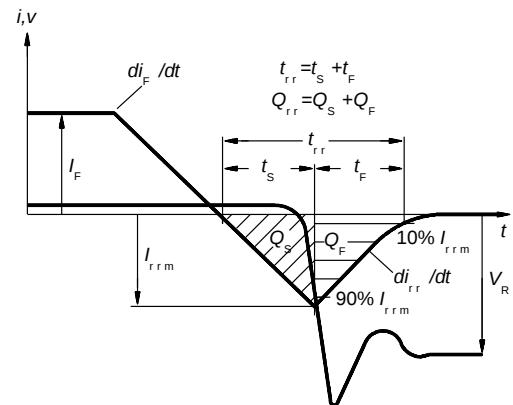


Figure C. Definition of diodes switching characteristics

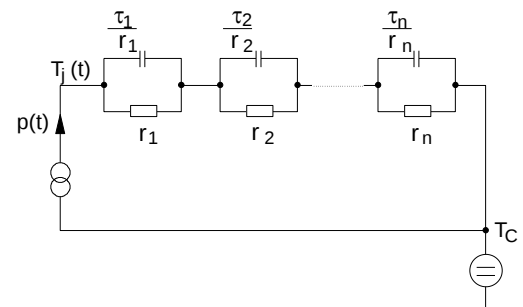


Figure D. Thermal equivalent circuit

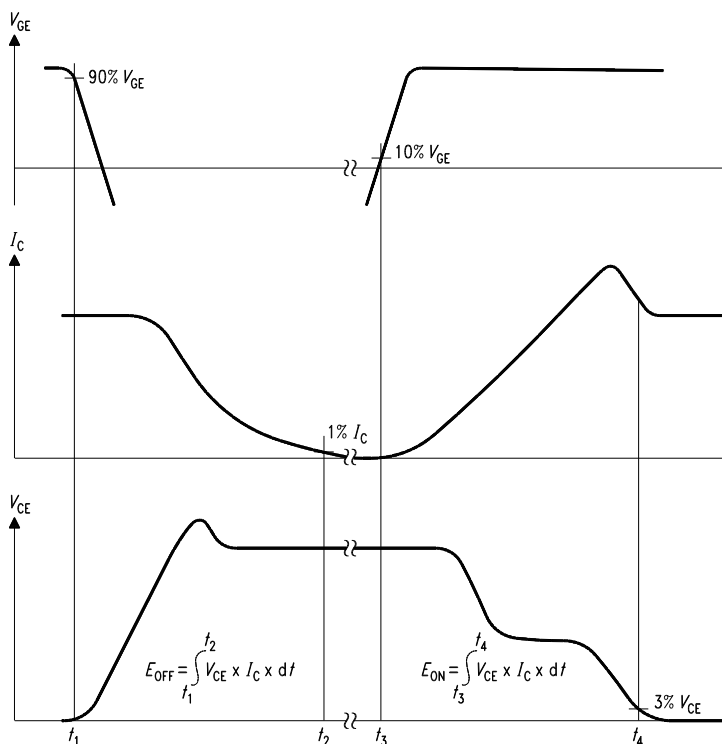


Figure B. Definition of switching losses

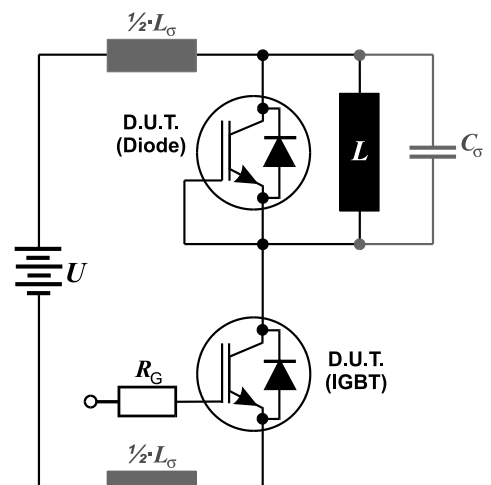


Figure E. Dynamic test circuit

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