

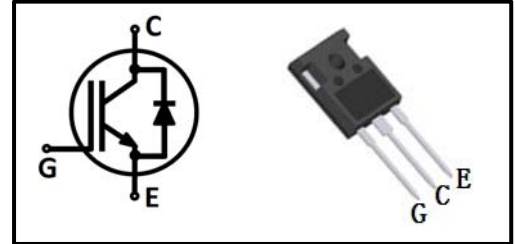
## Features

- Easy parallel switching capability due to positive temperature coefficient in  $V_{CEsat}$
- Low  $V_{CEsat}$ , fast switching
- High ruggedness, good thermal stability
- Very tight parameter distribution

Type	Marking	Package Code
MPBW40N120BF	MP40N120BF	TO-247-3

## Applications

- Frequency converter
- UPS



## Maximum Rated Values

Parameter	Symbol	Value	Unit
Collector-emitter voltage	$V_{CE}$	1200	V
DC collector current, limited by $T_{jmax}$ $T_C=25^\circ C$ $T_C=100^\circ C$	$I_C$	80 40	A
Pulsed collector current, $t_p$ limited by $T_{jmax}^{1)}$	$I_{Cpuls}$	160	
Diode forward current, limited by $T_{jmax}$ $T_C=25^\circ C$ $T_C=100^\circ C$	$I_F$	80 40	
Diode pulsed current, $t_p$ limited by $T_{jmax}^{1)}$	$I_{Fpuls}$	160	
Gate-emitter voltage	$V_{GE}$	$\pm 20$	V
Transient Gate-emitter voltage ( $t_p \leq 10\mu s, D < 0.01$ )		$\pm 30$	
Short circuit withstand time $V_{GE}=15V, V_{CC}=600V, T_j \leq 175^\circ C$ Allowed number of short circuits < 1000 Time between short circuits: $\geq 1.0s$	$t_{SC}$	10	$\mu s$
Power dissipation $T_C=25^\circ C$	$P_{tot}$	428	W
Power dissipation $T_C=100^\circ C$		214	
Operating junction temperature	$T_j$	-40~175	$^\circ C$
Storage temperature	$T_{stg}$	-55~150	
Soldering temperature, wave soldering 1.6mm (0.063in.) from case for 10s		260	
Mounting torque, M3 screw Maximum of mounting processes: 3	M	0.6	Nm

<sup>1)</sup> Defined by design. Not subject to production test.



### Thermal Characteristics

Parameter	Symbol	Min	Typ	Max	Unit
IGBT thermal resistance, junction-case	$R_{thJC}$	-	-	0.35	K/W
Diode thermal resistance, junction-case	$R_{thJCD}$	-	-	0.60	
Thermal Resistance, junction-ambient	$R_{thJA}$	-	-	40	

### Electrical Characteristics (at $T_j=25^\circ\text{C}$ , unless otherwise specified) Static Characteristics

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Collector-emitter breakdown voltage	$V_{(BR)CES}$	$V_{GE}=0V, I_C=0.25mA$	1200	-	-	V
Collector-emitter saturation voltage	$V_{CE(sat)}$	$V_{GE}=15V, I_C=40A$ $T_j=25^\circ\text{C}$	-	1.85	2.2	
		$T_j=150^\circ\text{C}$	-	2.35	-	
		$T_j=175^\circ\text{C}$	-	2.45	-	
G-E threshold voltage	$V_{GE(th)}$	$I_C=1.5mA, V_{CE}=V_{GE}$	5.0	5.8	6.5	
C-E leakage current	$I_{CES}$	$V_{CE}=1200V,$ $V_{GE}=0V$ $T_j=25^\circ\text{C}$	-	-	0.1	mA
		$T_j=175^\circ\text{C}$	-	-	4.0	
G-E leakage current	$I_{GES}$	$V_{CE}=0V, V_{GE}=20V$	-	-	250	nA
Transconductance	$g_{fs}$	$V_{CE}=20V, I_C=40A$	-	20	-	S

### Dynamic Characteristics

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Input capacitance	$C_{ies}$	$V_{CE}=25V,$ $V_{GE}=0V,$ $f=1MHz$	-	3149	-	pF
Output capacitance	$C_{oes}$		-	183	-	
Reverse transfer capacitance	$C_{res}$		-	103	-	
Gate charge	$Q_G$	$V_{CC}=600V, I_C=40A,$ $V_{GE}=15V$	-	240	-	nC
Short circuit collector current	$I_{C(SC)}$	$V_{GE}=15V,$ $V_{CC}\leq 600V,$ $t_{SC}\leq 10\mu s, T_j=175^\circ\text{C}$	-	160	-	A



### IGBT Switching Characteristics

Parameter	Symbol	Conditions	Min	Typ	Max	Unit	
Turn-on delay time	$t_{d(on)}$	$T_j=25^{\circ}\text{C}$ , $V_{CC}=600\text{V}$ , $I_C=40\text{A}$ , $V_{GE}=-15/15\text{V}$ , $R_G=10\Omega$ , Inductive load	-	186	-	ns	
Rise time	$t_r$		-	38	-		
Turn-off delay time	$t_{d(off)}$		-	234	-		
Fall time	$t_f$		-	159	-		
Turn-on energy	$E_{on}$		$T_j=25^{\circ}\text{C}$ , $V_{CC}=600\text{V}$ , $I_C=40\text{A}$ , $V_{GE}=-15/15\text{V}$ , $R_G=10\Omega$ , Inductive load	-	1.6	-	mJ
Turn-off energy	$E_{off}$			-	3.0	-	
Total switching energy	$E_{ts}$			-	4.6	-	
Turn-on delay time	$t_{d(on)}$	$T_j=175^{\circ}\text{C}$ , $V_{CC}=600\text{V}$ , $I_C=40\text{A}$ , $V_{GE}=-15/15\text{V}$ , $R_G=10\Omega$ , Inductive load	-	187	-	ns	
Rise time	$t_r$		-	39	-		
Turn-off delay time	$t_{d(off)}$		-	318	-		
Fall time	$t_f$		-	290	-		
Turn-on energy	$E_{on}$		$T_j=175^{\circ}\text{C}$ , $V_{CC}=600\text{V}$ , $I_C=40\text{A}$ , $V_{GE}=-15/15\text{V}$ , $R_G=10\Omega$ , Inductive load	-	3.4	-	mJ
Turn-off energy	$E_{off}$			-	4.8	-	
Total switching energy	$E_{ts}$			-	8.2	-	

### Diode Characteristics

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Diode forward voltage	$V_F$	$V_{GE}=0\text{V}$ , $I_F=40\text{A}$ $T_j=25^{\circ}\text{C}$	-	2.2	-	V
		$T_j=150^{\circ}\text{C}$	-	1.8	-	
		$T_j=175^{\circ}\text{C}$	-	1.6	-	
Diode reverse recovery time	$t_{rr}$	$T_j=25^{\circ}\text{C}$ , $V_R=600\text{V}$ , $I_F=40\text{A}$ , $di_F/dt=500\text{A}/\mu\text{s}$	-	255	-	ns
Diode reverse recovery charge	$Q_{rr}$		-	2.0	-	$\mu\text{C}$
Diode peak reverse recovery current	$I_{rrm}$		-	18	-	A
Diode reverse recovery time	$t_{rr}$	$T_j=175^{\circ}\text{C}$ , $V_R=600\text{V}$ , $I_F=40\text{A}$ , $di_F/dt=500\text{A}/\mu\text{s}$	-	526	-	ns
Diode reverse recovery charge	$Q_{rr}$		-	9.0	-	$\mu\text{C}$
Diode peak reverse recovery current	$I_{rrm}$		-	37	-	A

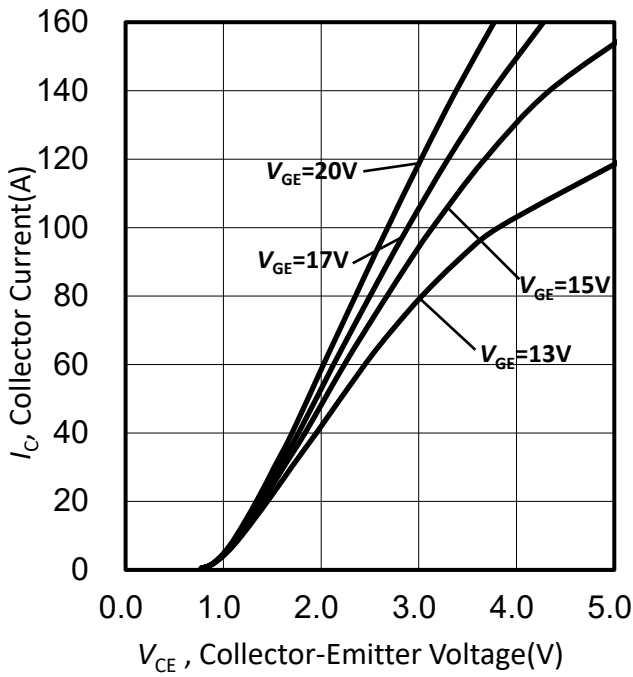


Figure 1. Typical output characteristic ( $T_j=25^{\circ}\text{C}$ )

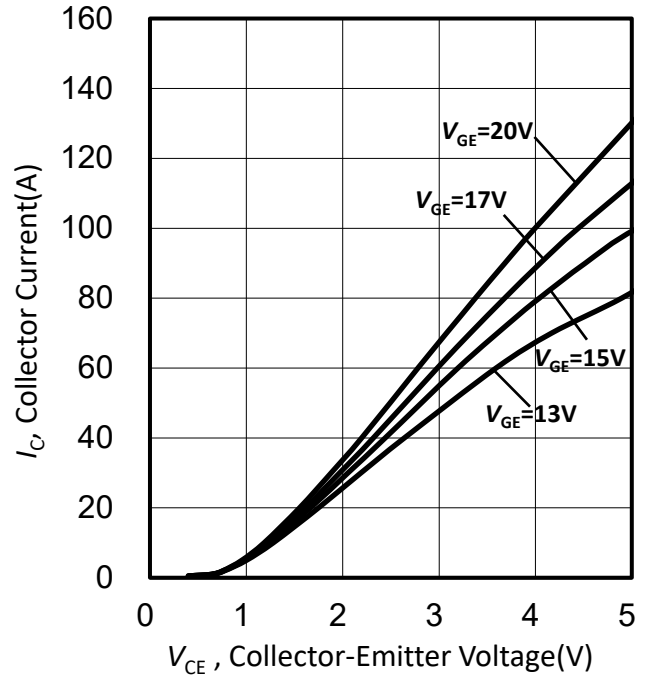


Figure 2. Typical output characteristic ( $T_j=175^{\circ}\text{C}$ )

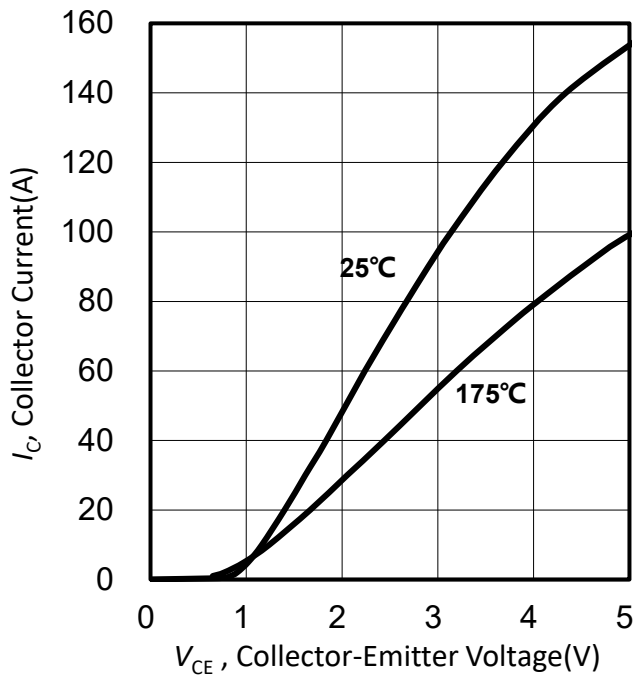


Figure 3. Typical  $V_{\text{CE(sat)}}-I_c$  characteristic ( $V_{\text{GE}}=15\text{V}$ )

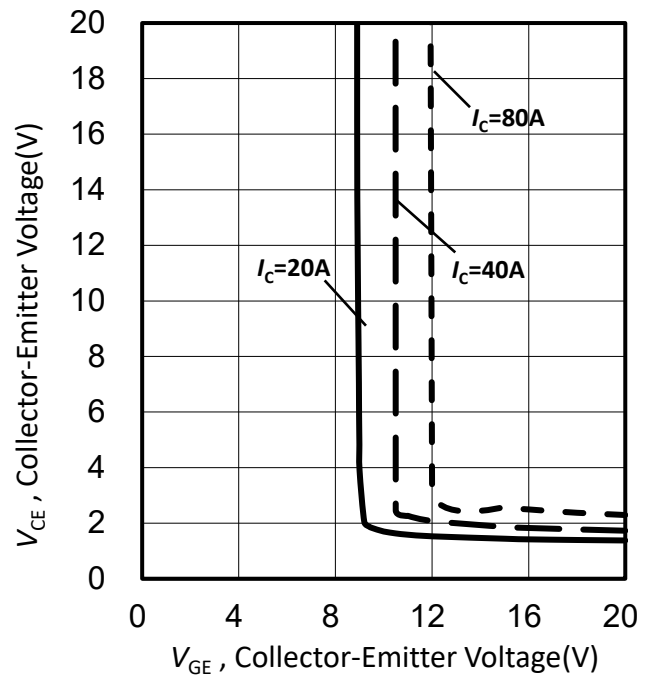


Figure 4. Typical  $V_{\text{CE(sat)}}-V_{\text{GE(th)}}$  characteristic ( $T_{\text{vj}}=25^{\circ}\text{C}$ )

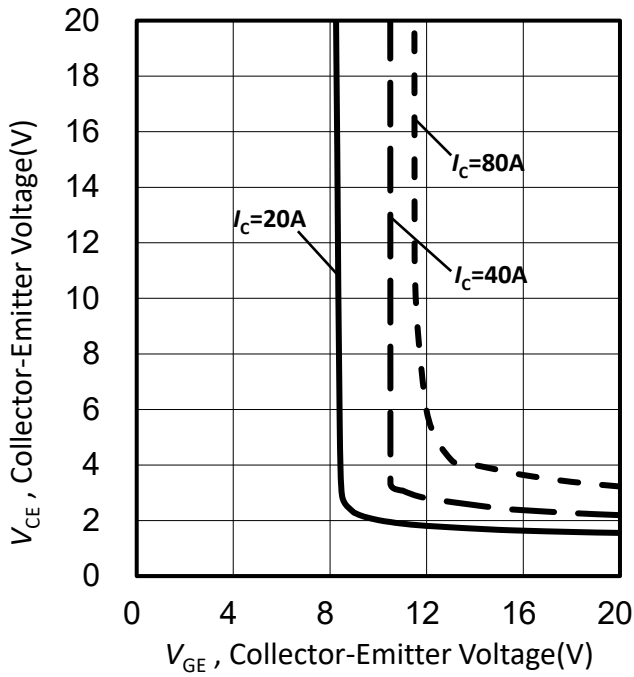


Figure 5. Typical  $V_{CE(sat)}-V_{GE(th)}$  characteristic ( $T_{vj}=175^{\circ}C$ )

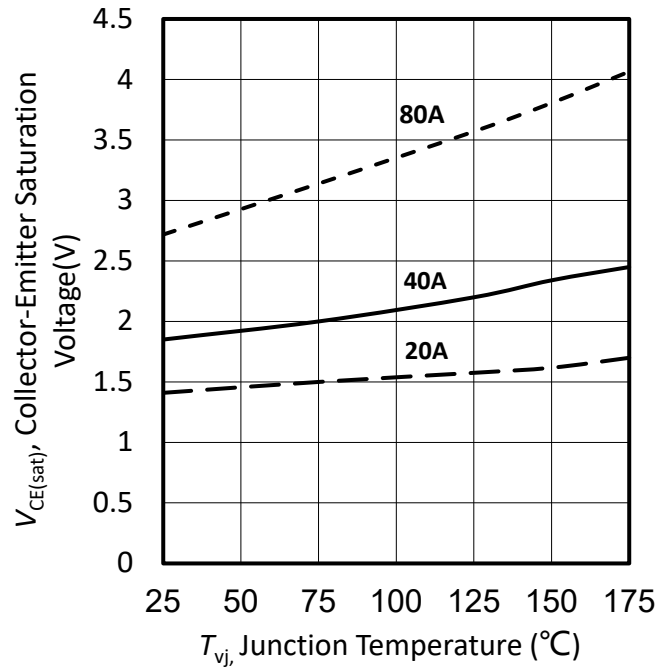


Figure 6. Typical  $V_{CE(sat)}-T_j$  characteristic ( $V_{GE}=15V$ )

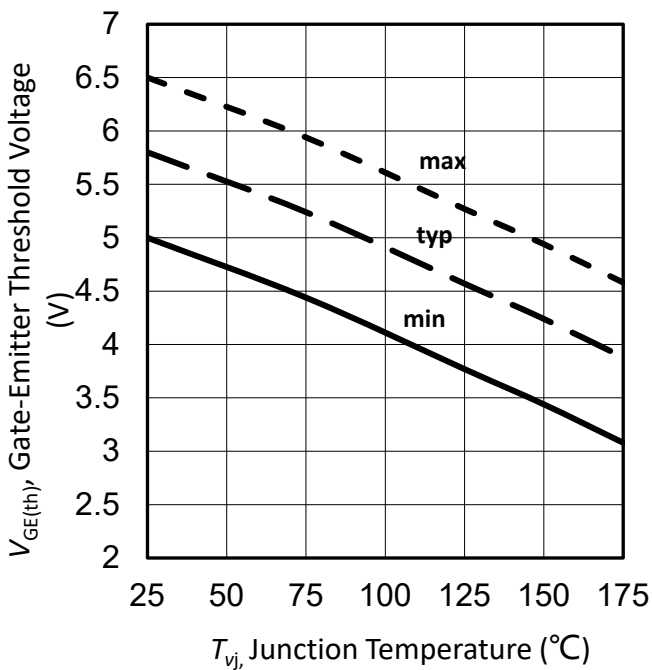


Figure 7.  $V_{GE(th)}-T_j$  characteristic ( $I_c=1.5mA$ )

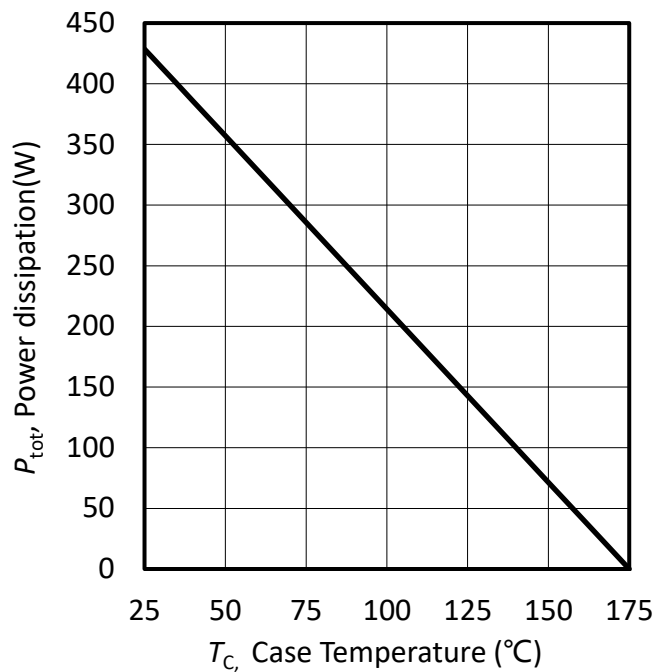
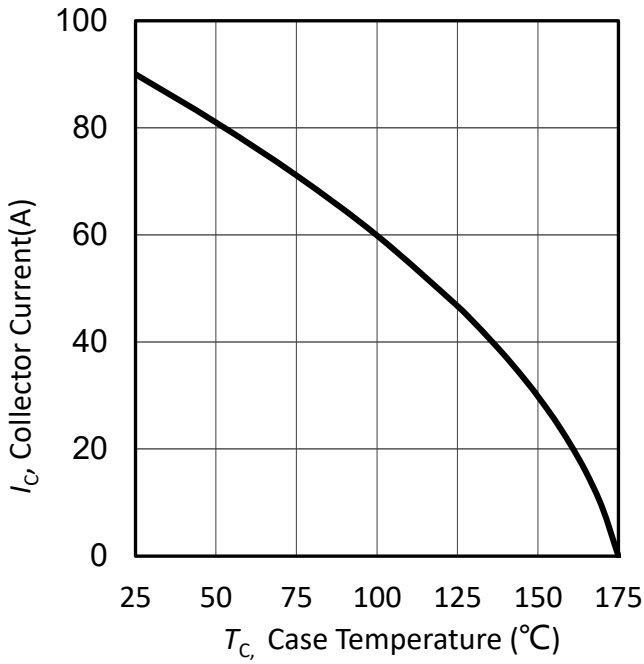
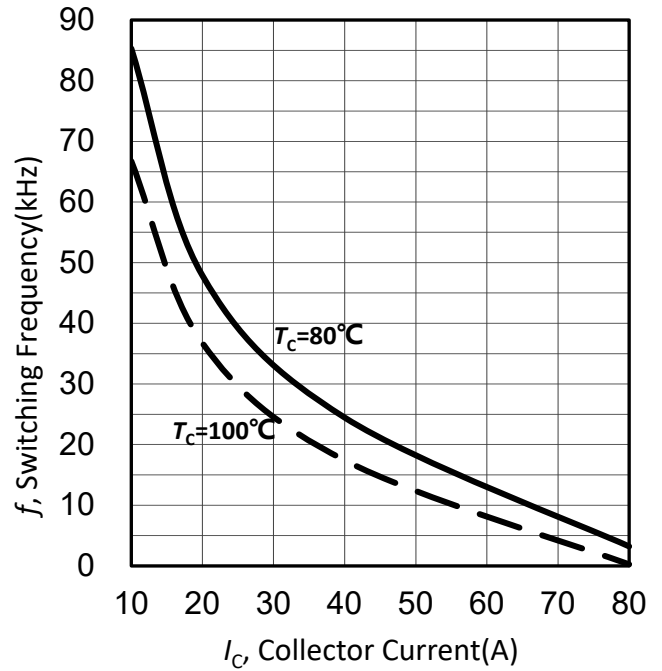


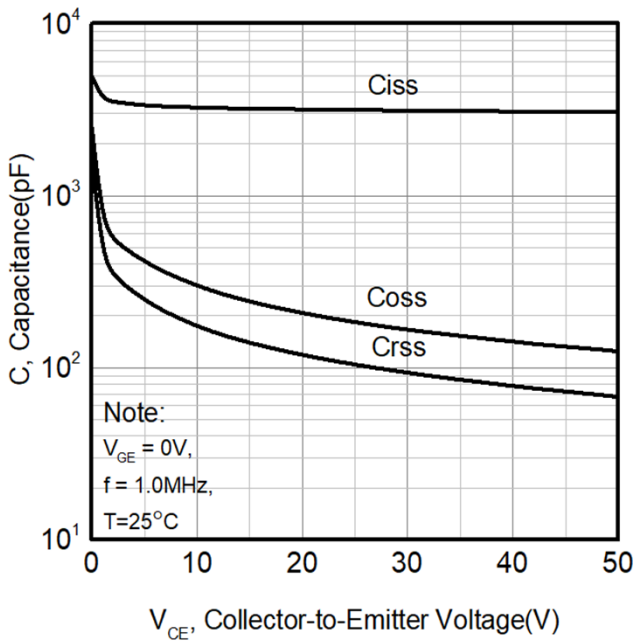
Figure 8. Power dissipation as a function of case temperature ( $T_j \le 175^{\circ}C$ )



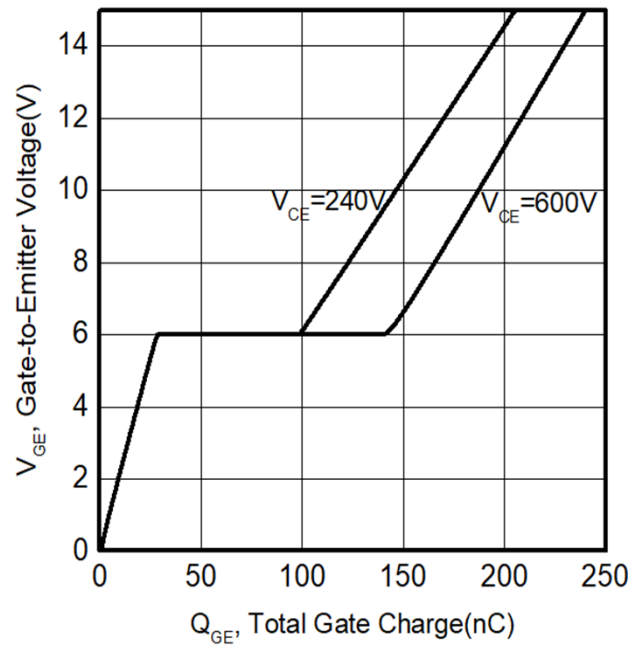
**Figure 9. Collector current as a function of case temperature**  
 ( $T_{vj} \leq 175^{\circ}\text{C}$ ,  $V_{GE} \geq 15\text{V}$ )



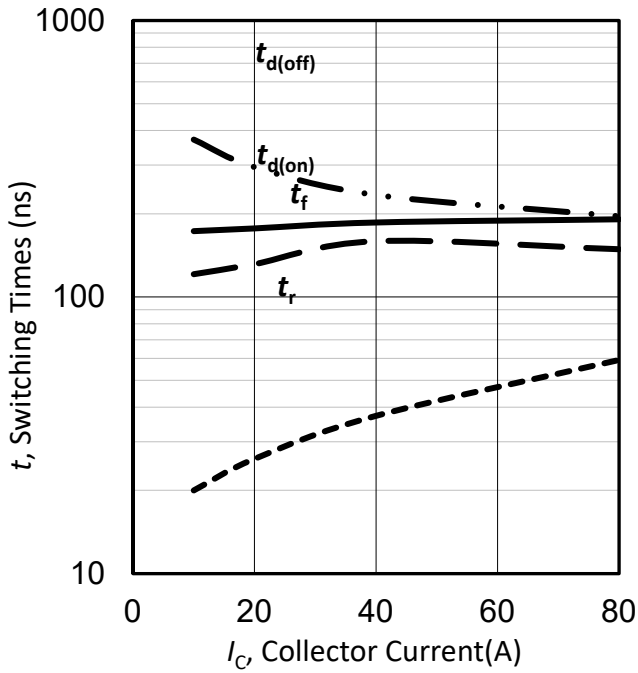
**Figure 10. Maximum possible switching frequency as a function of collector current**  
 ( $T_{vj} \leq 175^{\circ}\text{C}$ ,  $V_{GE} = -15\text{V}/15\text{V}$ ,  $R_G = 10\Omega$ ,  $D = 0.5$ )



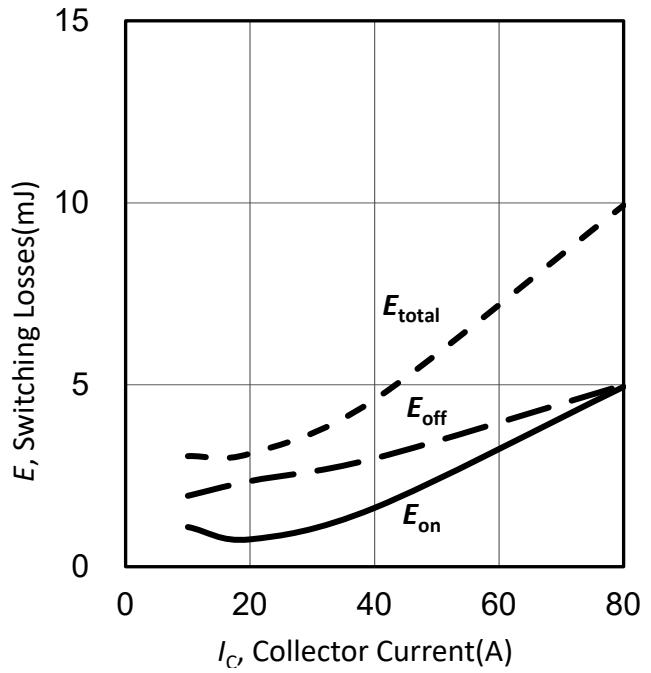
**Figure 11. Typical capacitance as a function of collector-emitter voltage**



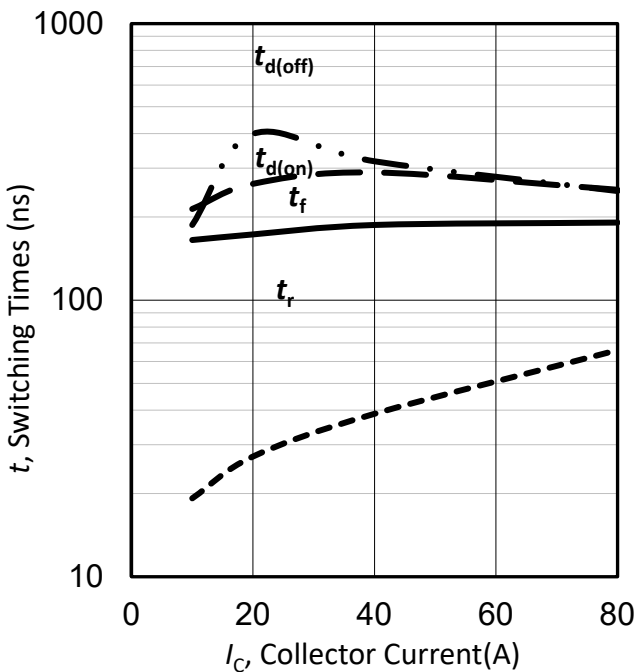
**Figure 12. Typical gate charge**



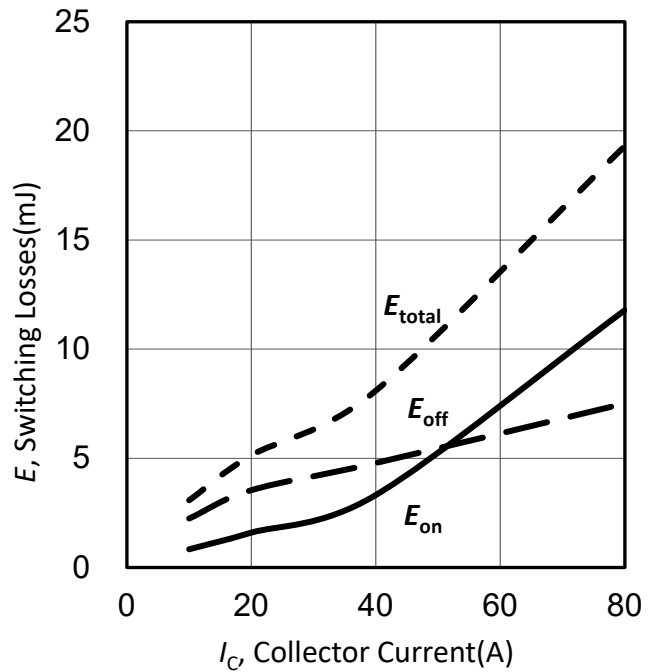
**Figure 13. Typical switching times as a function of collector current**  
(inductive load,  $T_{vj}=25^{\circ}\text{C}$ ,  
 $V_{CE}=600\text{V}$ ,  $V_{GE}=-15/15\text{V}$ ,  $R_G=10\Omega$ )



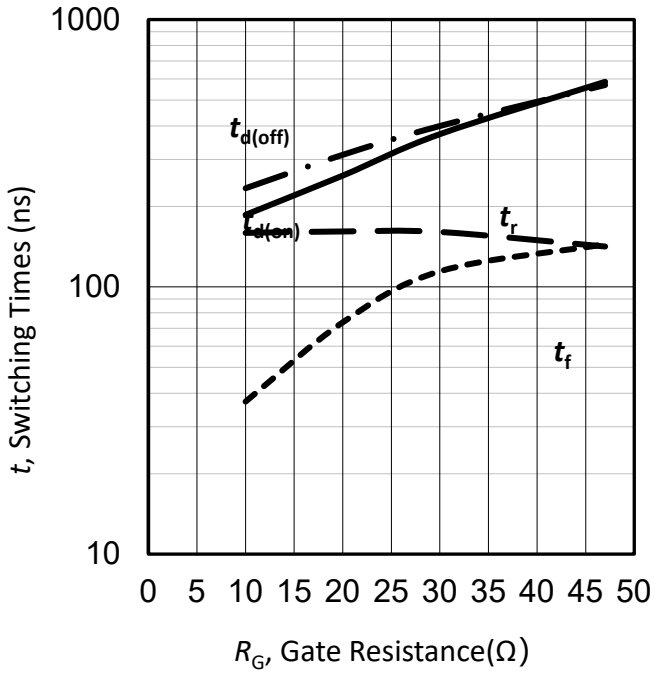
**Figure 14. Typical switching losses as a function of collector current**  
(inductive load,  $T_{vj}=25^{\circ}\text{C}$ ,  
 $V_{CE}=600\text{V}$ ,  $V_{GE}=-15/15\text{V}$ ,  $R_G=10\Omega$ )



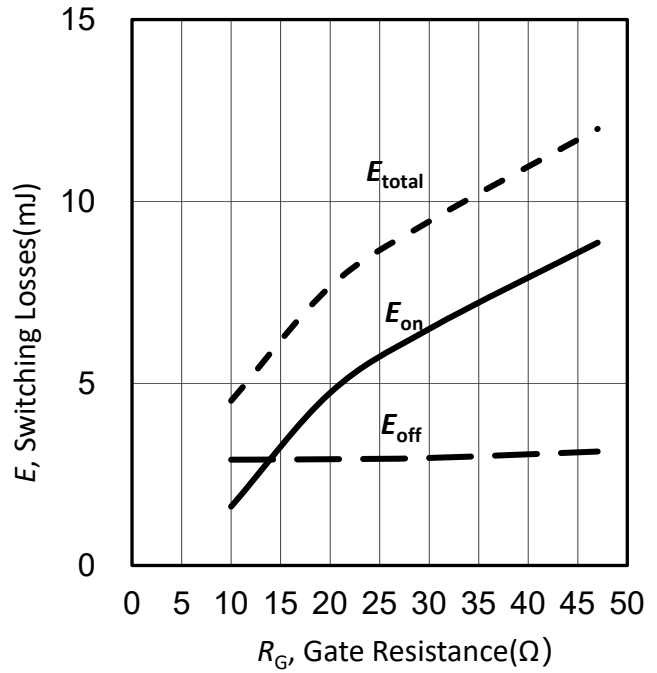
**Figure 15. Typical switching times as a function of collector current**  
(inductive load,  $T_{vj}=175^{\circ}\text{C}$ ,  
 $V_{CE}=600\text{V}$ ,  $V_{GE}=-15/15\text{V}$ ,  $R_G=10\Omega$ )



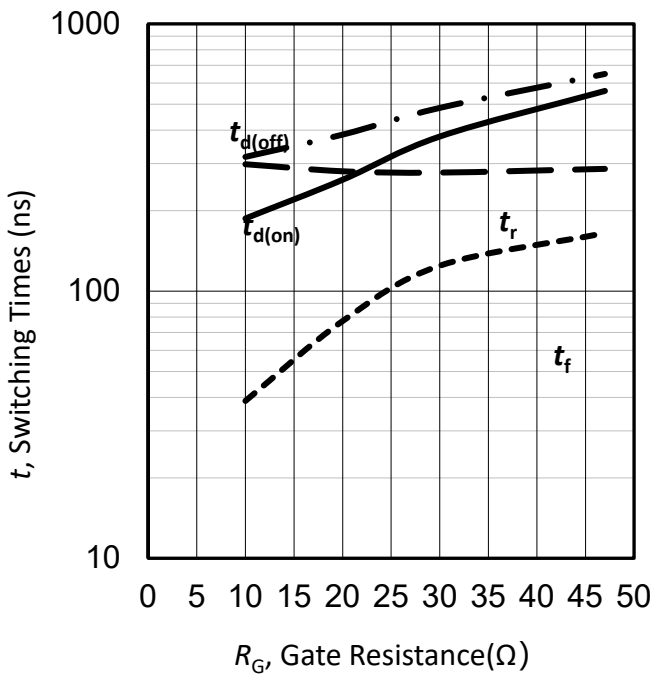
**Figure 16. Typical switching losses as a function of collector current**  
(inductive load,  $T_{vj}=175^{\circ}\text{C}$ ,  
 $V_{CE}=600\text{V}$ ,  $V_{GE}=-15/15\text{V}$ ,  $R_G=10\Omega$ )



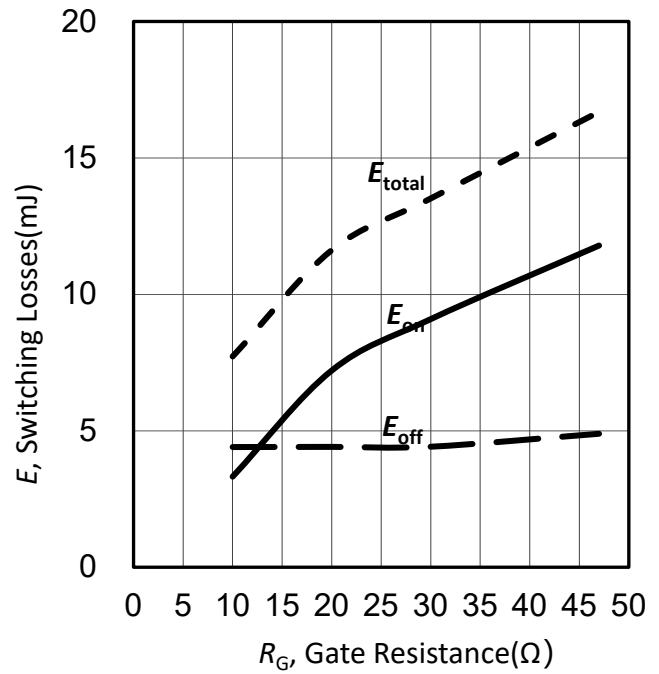
**Figure 17. Typical switching times as a function of gate resistor**  
(inductive load,  $T_{vj}=25^{\circ}\text{C}$ ,  
 $V_{CE}=600\text{V}$ ,  $V_{GE}=-15/15\text{V}$ ,  $I_C=40\text{A}$ )



**Figure 18. Typical switching energy losses as a function of gate resistor**  
(inductive load,  $T_{vj}=25^{\circ}\text{C}$ ,  
 $V_{CE}=600\text{V}$ ,  $V_{GE}=-15/15\text{V}$ ,  $I_C=40\text{A}$ )



**Figure 19. Typical switching times as a function of gate resistor**  
(inductive load,  $T_{vj}=175^{\circ}\text{C}$ ,  
 $V_{CE}=600\text{V}$ ,  $V_{GE}=-15/15\text{V}$ ,  $I_C=40\text{A}$ )



**Figure 20. Typical switching energy losses as a function of gate resistor**  
(inductive load,  $T_{vj}=175^{\circ}\text{C}$ ,  
 $V_{CE}=600\text{V}$ ,  $V_{GE}=-15/15\text{V}$ ,  $I_C=40\text{A}$ )



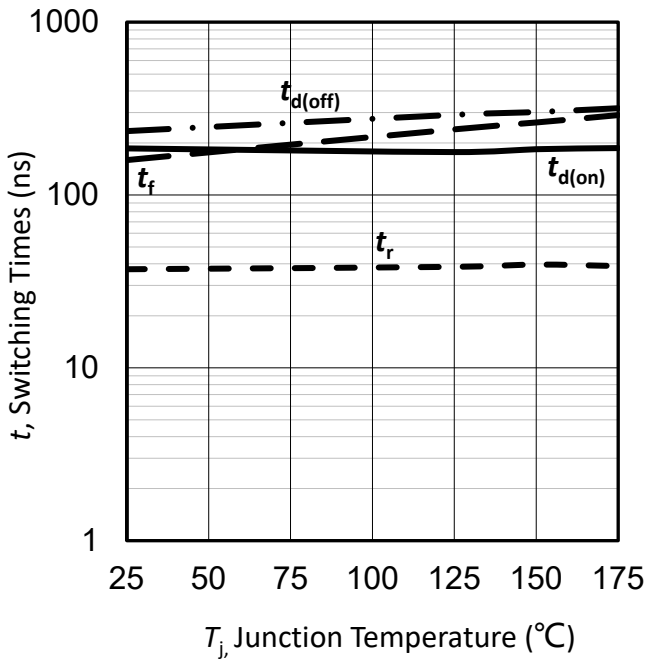


Figure 21. Typical switching times as a function of junction temperature (inductive load,  $V_{CE}=600V$ ,  $V_{GE}=-15/15V$ ,  $I_C=40A$ ,  $R_G=10\Omega$ )

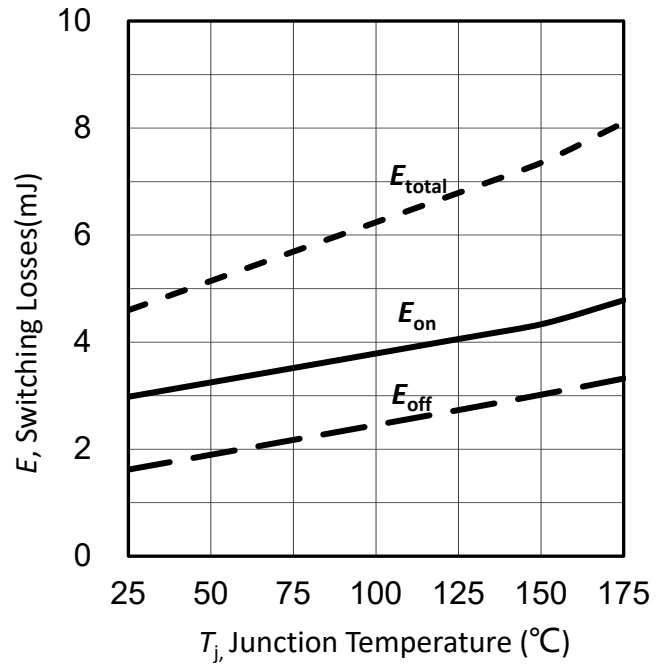


Figure 22. Typical switching energy losses as a function of junction temperature (inductive load,  $V_{CE}=600V$ ,  $V_{GE}=-15/15V$ ,  $I_C=40A$ ,  $R_G=10\Omega$ )

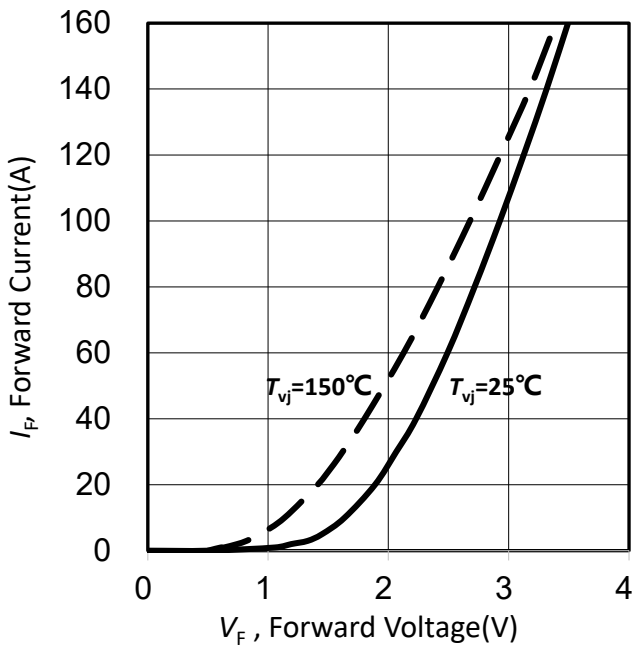


Figure 23. Typical diode forward current as a function of forward voltage

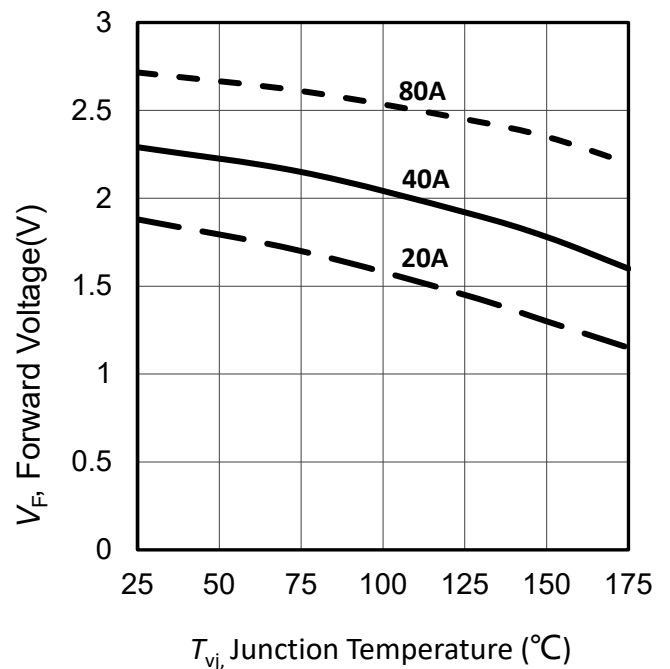


Figure 24. Typical  $V_F$ - $T_j$  characteristic

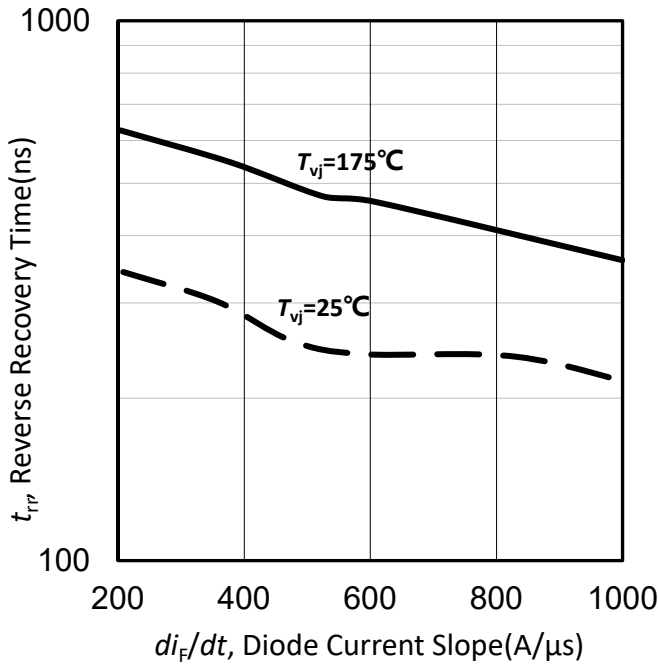


Figure 25. Typical reverse recovery time as a function of diode current slope ( $V_R=600\text{V}$ ,  $I_F=40\text{A}$ )

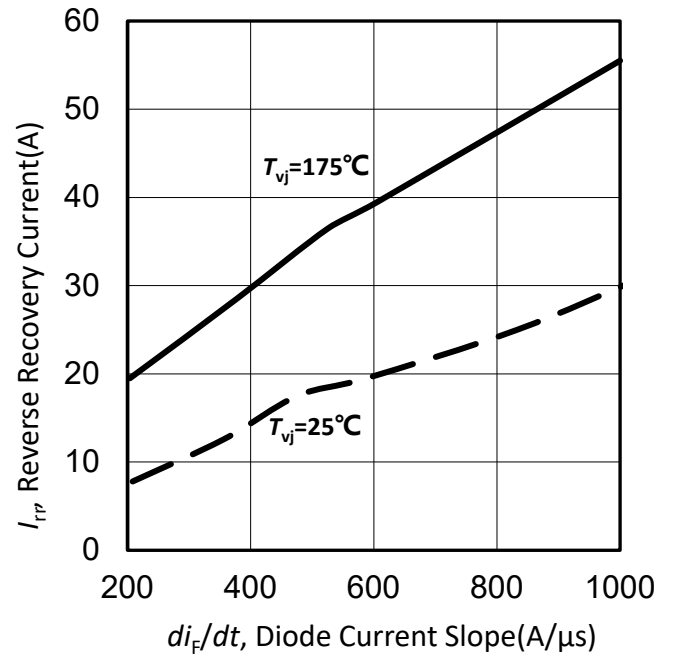


Figure 26. Typical reverse recovery current as a function of diode current slope ( $V_R=600\text{V}$ ,  $I_F=40\text{A}$ )

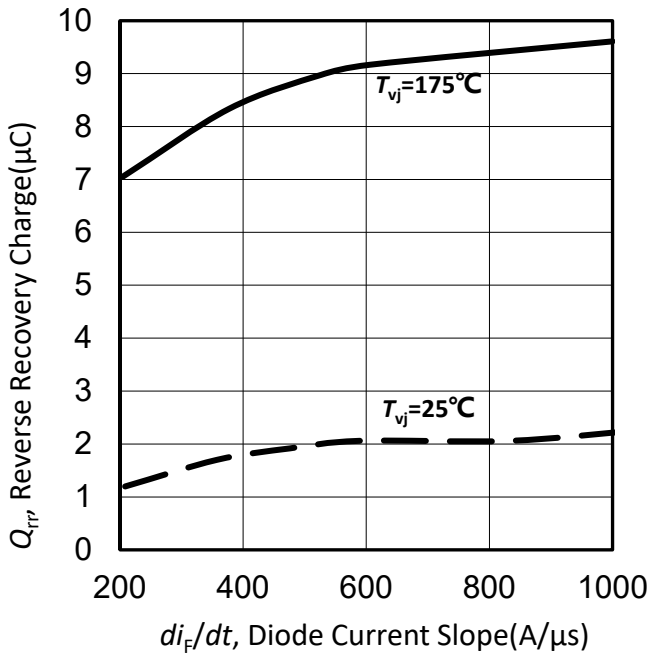


Figure 27. Typical reverse recovery charge as a function of diode current slope ( $V_R=600\text{V}$ ,  $I_F=40\text{A}$ )

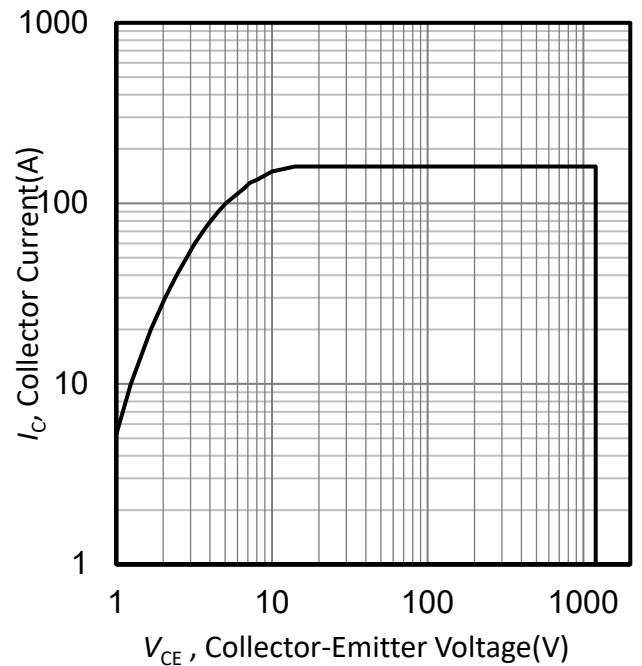


Figure 28. IGBT reverse bias safe operating area ( $T_{vj} \leq 175^\circ\text{C}$ ,  $V_{GE}=15\text{V}$ )

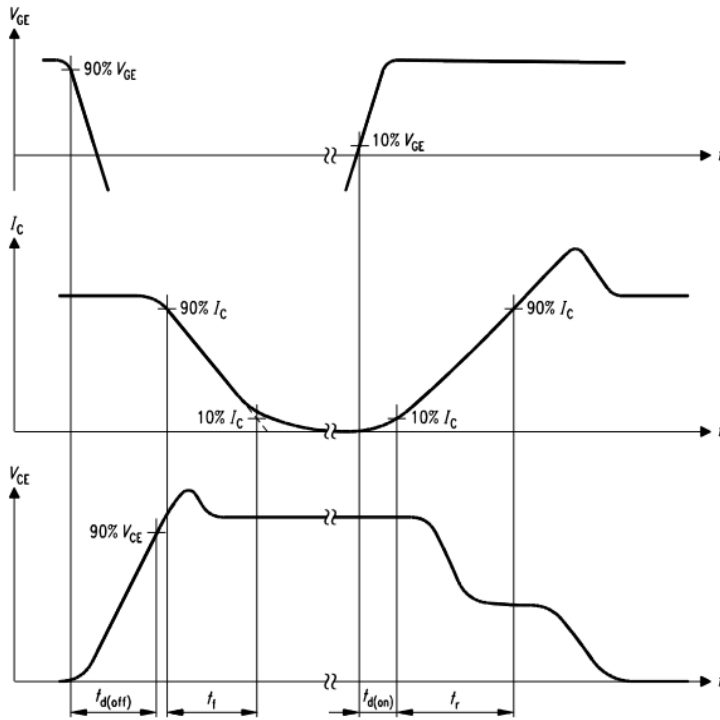


Figure A. Definition of switching times

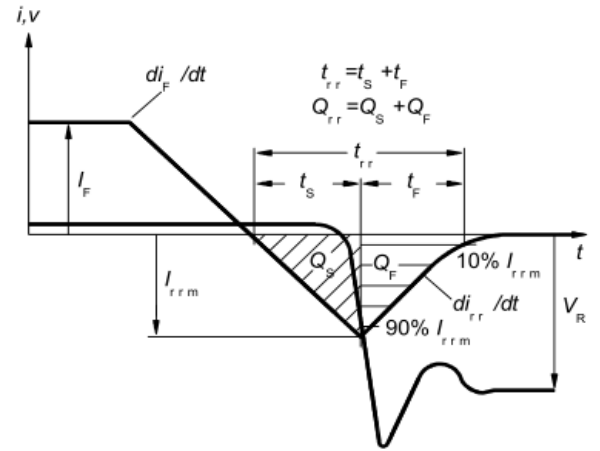


Figure C. Definition of diodes switching characteristics

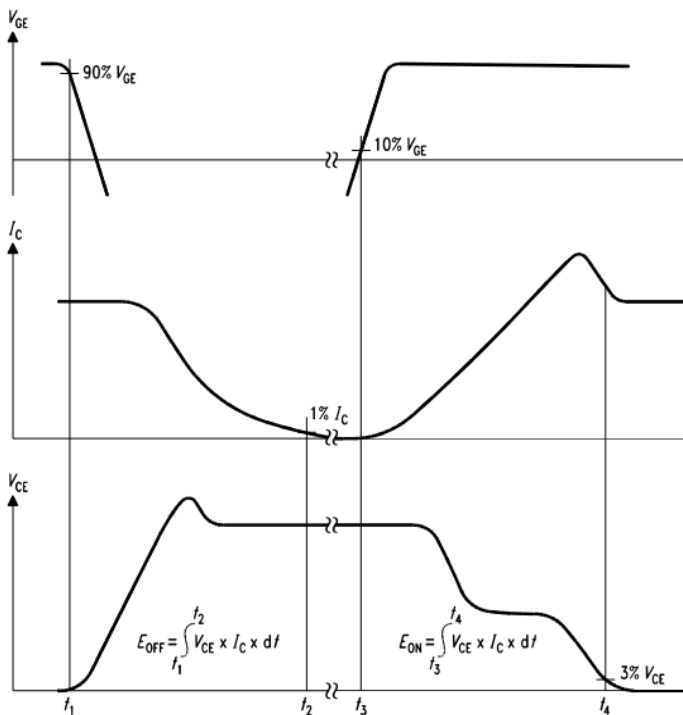


Figure B. Definition of switching losses

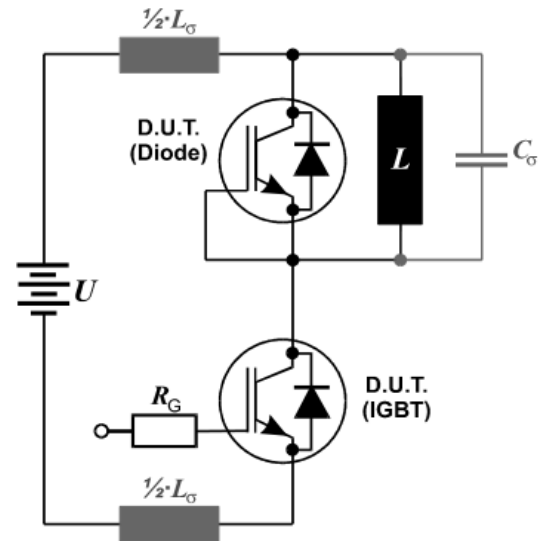
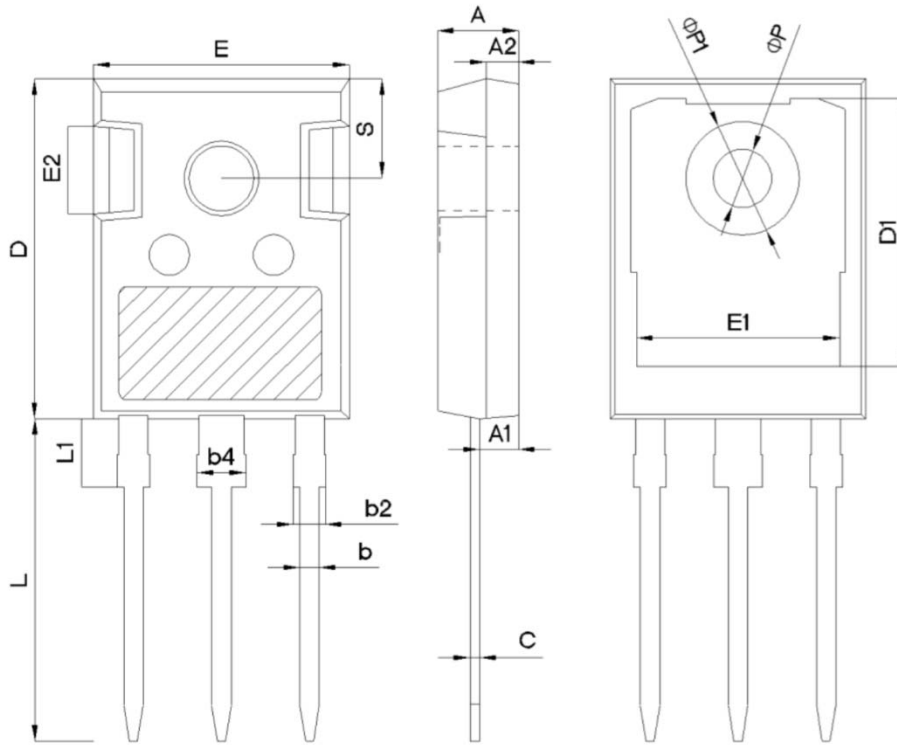


Figure D. Switching test circuit

TO-247-3



SYMBOL	mm		
	MIN	NOM	MAX
A	4.80	5.00	5.20
A1	2.21	2.41	2.61
A2	1.85	2.00	2.15
b	1.11	1.21	1.36
b2	1.91	2.01	2.21
b4	2.91	3.01	3.21
c	0.51	0.61	0.75
D	20.70	21.00	21.30
D1	16.25	16.55	16.85
E	15.50	15.80	16.10
E1	13.00	13.30	13.60
E2	4.80	5.00	5.20
E3	2.30	2.50	2.70
e	5.44BSC		
L	19.62	19.92	20.22
L1	-	-	4.30
ΦP	3.40	3.60	3.80
ΦP1	-	-	7.30
S	6.15BSC		



### Revision History

Revision	Subjects (major changes since last revision)	Date
1.0	Initial version	2019.8
2.0	Add chart	2020.6
2.1	Add Electrical Characteristics at $T_j=175^{\circ}\text{C}$	2021.8
2.2	Update chart	2021.8
3.0	Update Electrical Characteristics and chart	2021.11

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