Thermal Resistance

Parameter	Symbol	Conditions	Max. Value	Unit
Characteristic				
IGBT thermal resistance, junction – case	R_{thJC}		0.63	K/W
Diode thermal resistance, junction – case	R_{thJCD}		1.12	
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	$V_{(BR)CES}$	$V_{GE}=0V$, $I_C=500\mu A$	1200	-	-	V
Collector-emitter saturation voltage	$V_{CE(sat)}$	$V_{GE} = 15V$, $I_C=15A$				
		$T_j=25°C$	-	1.7	2.2	
		$T_j=150°C$	-	2.1	-	
		$T_j=175°C$	-	2.2	-	
Diode forward voltage	V_F	$V_{GE}=0V$, $I_F=15A$				
		$T_j=25°C$	-	1.75	2.2	
		$T_j=150°C$	-	1.8	-	
		$T_j=175°C$	-	1.75	-	
Gate-emitter threshold voltage	$V_{GE(th)}$	$I_C=0.6mA$, $V_{CE}=V_{GE}$	5.2	5.8	6.4	
Zero gate voltage collector current	I_{CES}	$V_{CE}=1200V$, $V_{GE}=0V$				mA
		$T_j=25°C$	-	-	0.4	
		$T_j=150°C$	-	-	4.0	
		$T_j=175°C$	-	-	20	
Gate-emitter leakage current	I_{GES}	$V_{CE}=0V$, $V_{GE}=20V$	-	-	600	nA
Transconductance	g_{fs}	$V_{CE}=20V$, $I_C=15A$	-	8	-	S

Dynamic Characteristic

Input capacitance	C_{iss}	$V_{CE}=25V$,	-	1000	-	pF
Output capacitance	C_{oss}	$V_{GE}=0V$,	-	100	-	
Reverse transfer capacitance	C_{rss}	$f=1MHz$	-	56	-	
Gate charge	Q_{Gate}	$V_{CC}=960V$, $I_C=15A$ $V_{GE}=15V$	-	93	-	nC
Internal emitter inductance measured 5mm (0.197 in.) from case	L_E		-	13	-	nH
Short circuit collector current[1]	$I_{C(SC)}$	$V_{GE}=15V, t_{SC} \leq 10\mu s$ $V_{CC}=600V$, $T_{j,start}=25°C$ $T_{j,start}=175°C$	-	82 60	-	A

Switching Characteristic, Inductive Load, at T_j=25 °C

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
IGBT Characteristic						
Turn-on delay time	$t_{d(on)}$	$T_j=25°C$, $V_{CC}=600V, I_C=15A$, $V_{GE}=0/15V$, $R_G=41.8\Omega$, $L_\sigma^{2)}=126nH$, $C_\sigma^{2)}=34pF$ Energy losses include "tail" and diode reverse recovery.	-	32	-	ns
Rise time	t_r		-	25	-	
Turn-off delay time	$t_{d(off)}$		-	362	-	
Fall time	t_f		-	95	-	
Turn-on energy	E_{on}		-	1.25	-	mJ
Turn-off energy	E_{off}		-	0.8	-	
Total switching energy	E_{ts}		-	2.05	-	
Anti-Parallel Diode Characteristic						
Diode reverse recovery time	t_{rr}	$T_j=25°C$, $V_R=600V$, $I_F=15A$, $di_F/dt=450A/\mu s$	-	300	-	ns
Diode reverse recovery charge	Q_{rr}		-	1.3		μC
Diode peak reverse recovery current	I_{rrm}		-	10		A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	215	-	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=15A, V_{GE}=0/15V, R_G= 41.8Ω, $L_\sigma^{1)}$=315nH, $C_\sigma^{1)}$=34pF Energy losses include "tail" and diode reverse recovery.	-	31	-	ns
Rise time	t_r		-	30	-	
Turn-off delay time	$t_{d(off)}$		-	450	-	
Fall time	t_f		-	176	-	
Turn-on energy	E_{on}		-	1.5	-	mJ
Turn-off energy	E_{off}		-	1.3	-	
Total switching energy	E_{ts}		-	2.8	-	
Anti-Parallel Diode Characteristic						
Diode reverse recovery time	t_{rr}	T_j=175°C V_R=600V, I_F=15A, di_F/dt=460A/µs	-	460	-	ns
Diode reverse recovery charge	Q_{rr}		-	2.65	-	µC
Diode peak reverse recovery current	I_{rrm}		-	13	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	123		A/µs

[1] Leakage inductance L_σ and Stray capacity C_σ due to dynamic test circuit in Figure E.
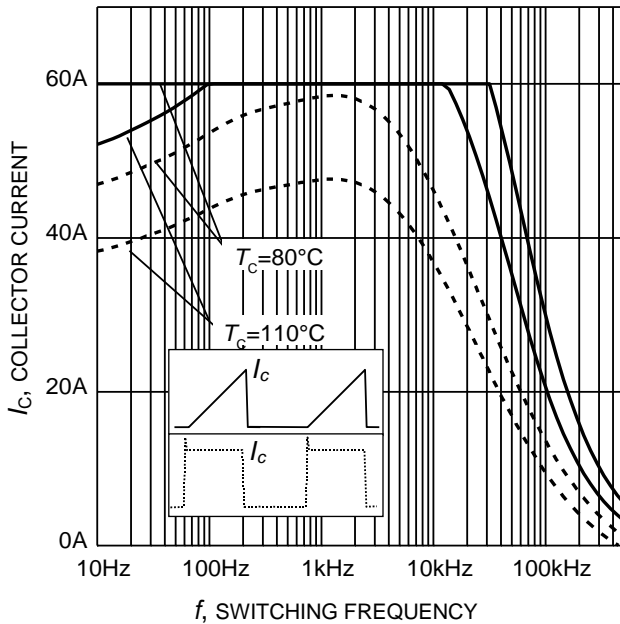
Figure 1. **Collector current as a function of switching frequency**
($T_j \leq 175°C$, $D = 0.5$, $V_{CE} = 600V$, $V_{GE} = 0/+15V$, $R_G = 41.8\Omega$)
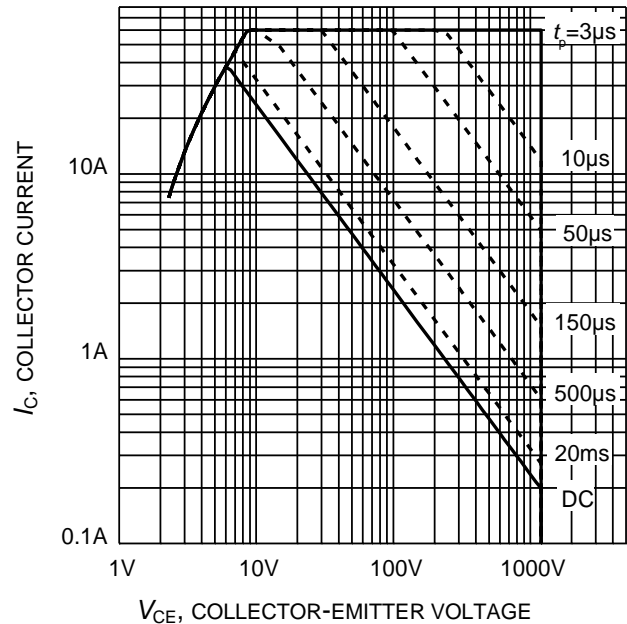
Figure 2. **Safe operating area**
($D = 0$, $T_C = 25°C$, $T_j \leq 175°C$; $V_{GE}=15V$)
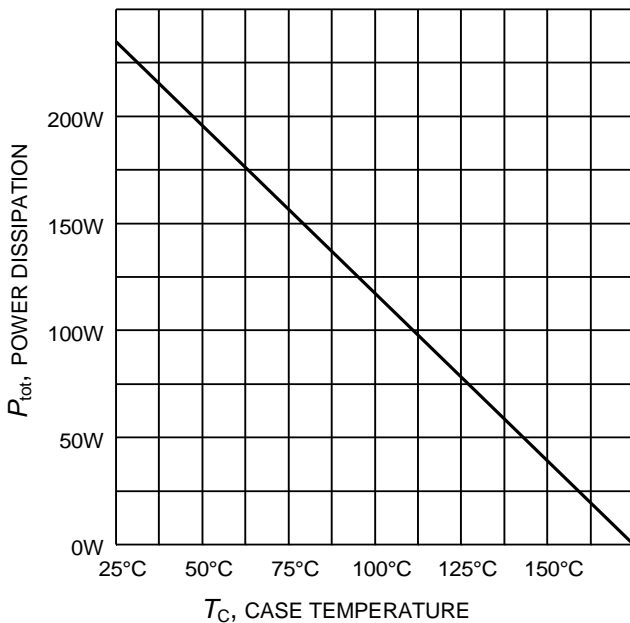
Figure 3. **Maximum power dissipation as a function of case temperature**
($T_j \leq 175°C$)
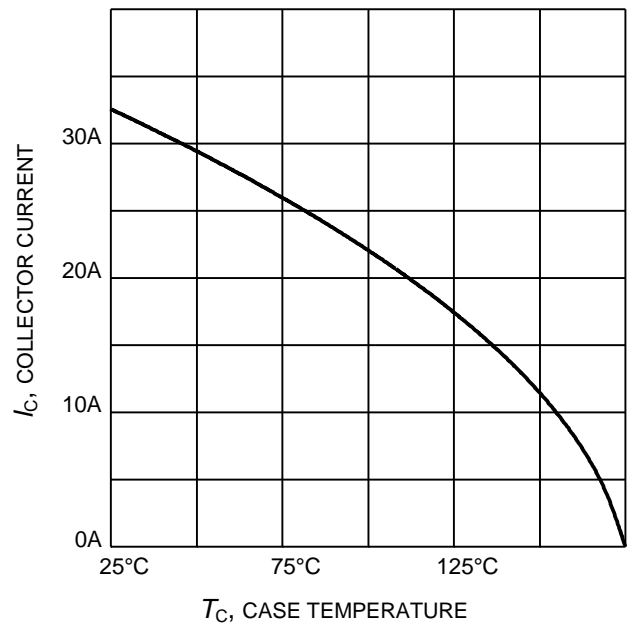
Figure 4. **Maximum DC Collector current as a function of case temperature**
($V_{GE} \geq 15V$, $T_j \leq 175°C$)
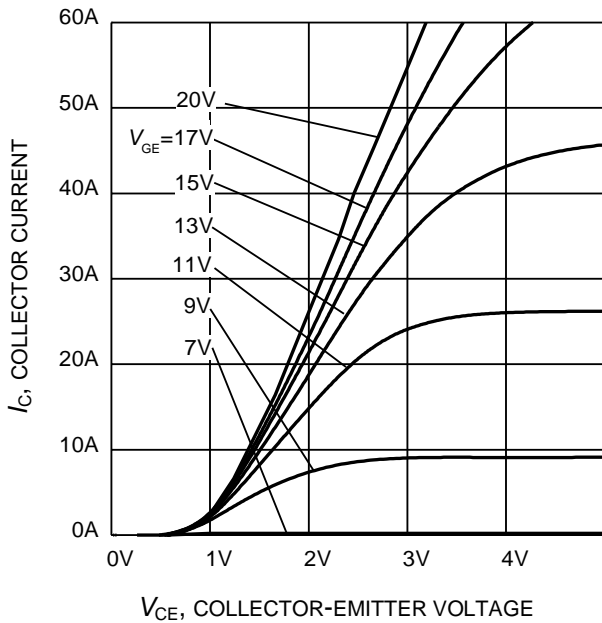
Figure 5. **Typical output characteristic**
(T_j = 25°C)
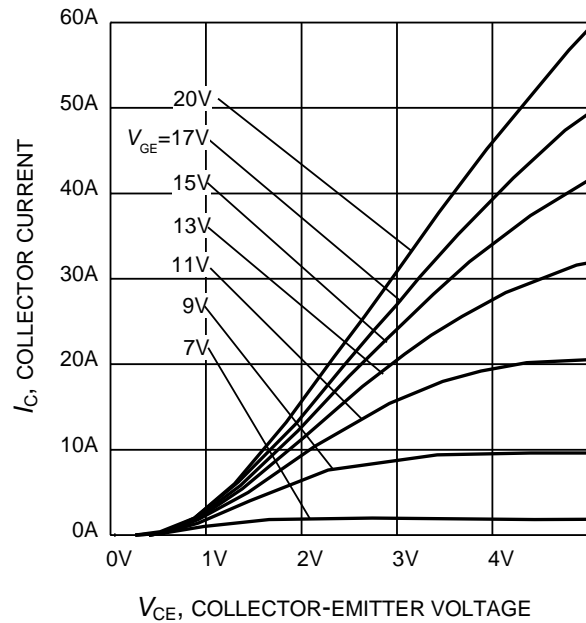
Figure 6. **Typical output characteristic**
(T_j = 175°C)
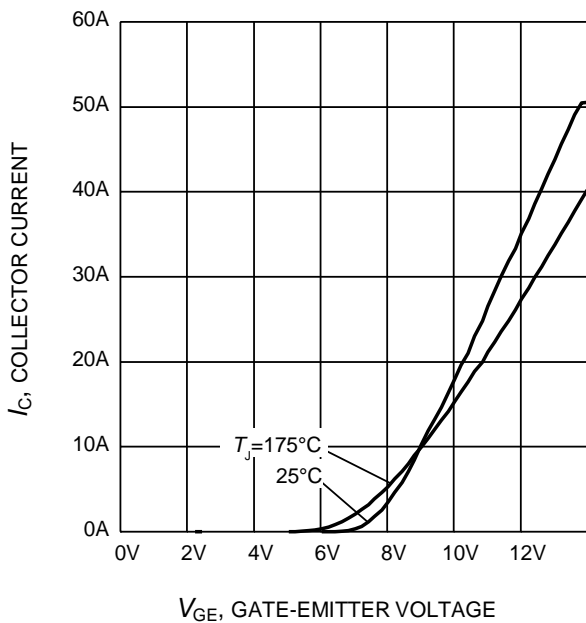
Figure 7. **Typical transfer characteristic**
(V_{CE}=20V)
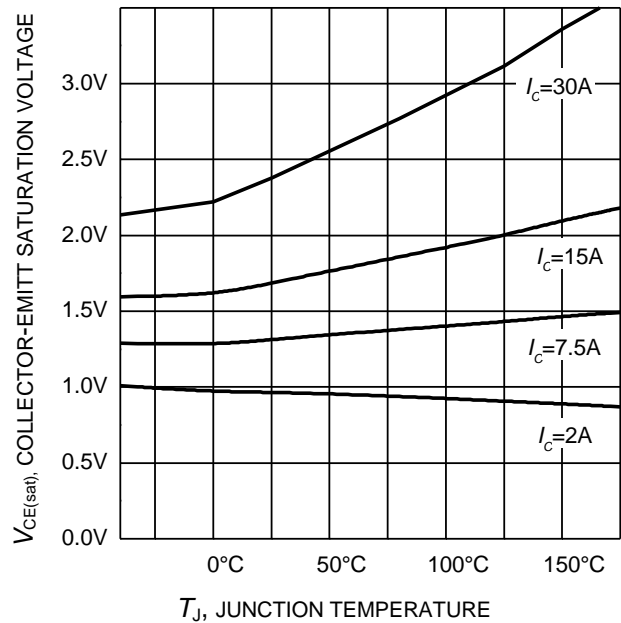
Figure 8. **Typical collector-emitter
saturation voltage as a function of
junction temperature**
(V_{GE} = 15V)

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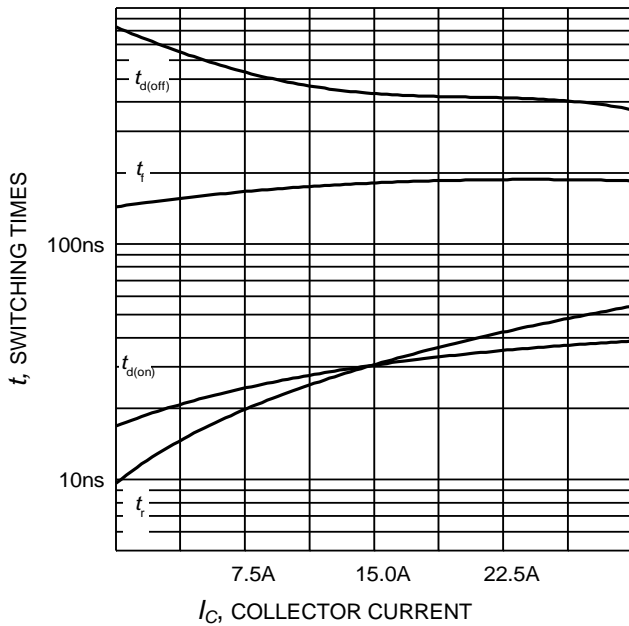
Figure 9. Typical switching times as a function of collector current
(inductive load, T_J=175°C, V_{CE}=600V, V_{GE}=0/15V, R_G=41.8Ω, Dynamic test circuit in Figure E)
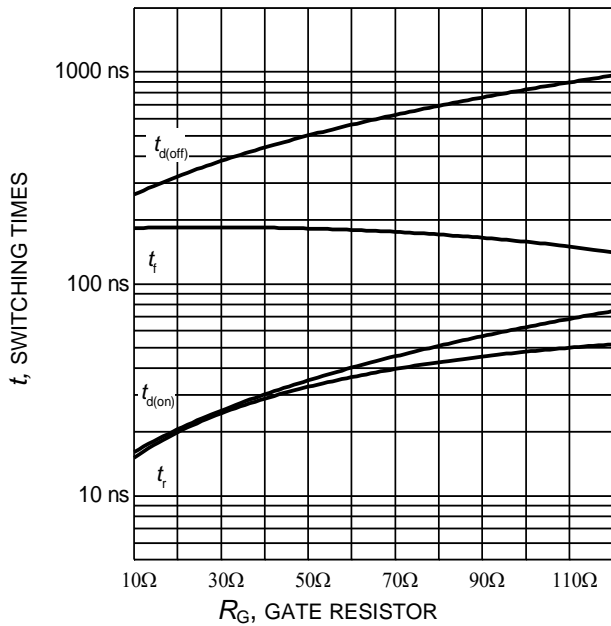
Figure 10. Typical switching times as a function of gate resistor
(inductive load, T_J=175°C, V_{CE}=600V, V_{GE}=0/15V, I_C=15A, Dynamic test circuit in Figure E)
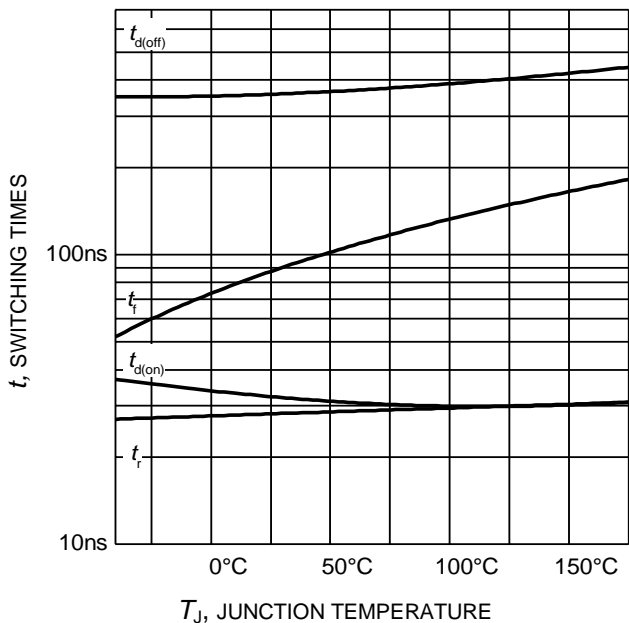
Figure 11. Typical switching times as a function of junction temperature
(inductive load, V_{CE}=600V, V_{GE}=0/15V, I_C=15A, R_G=41.8Ω, Dynamic test circuit in Figure E)
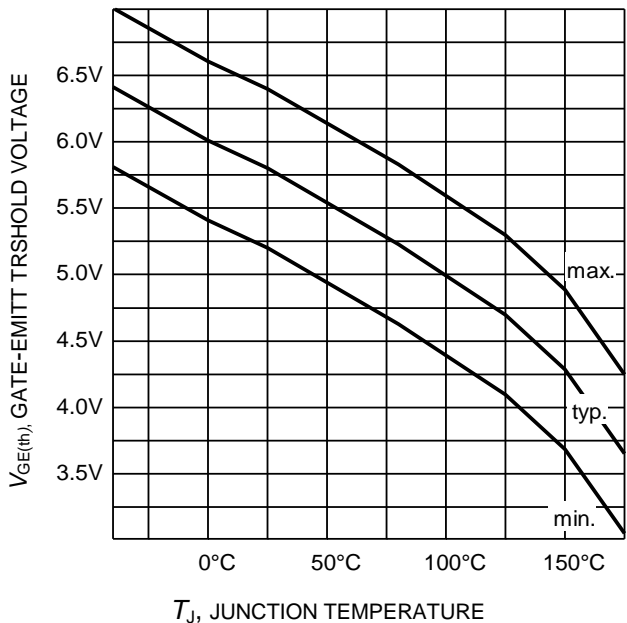
Figure 12. Gate-emitter threshold voltage as a function of junction temperature
(I_C = 600µA)
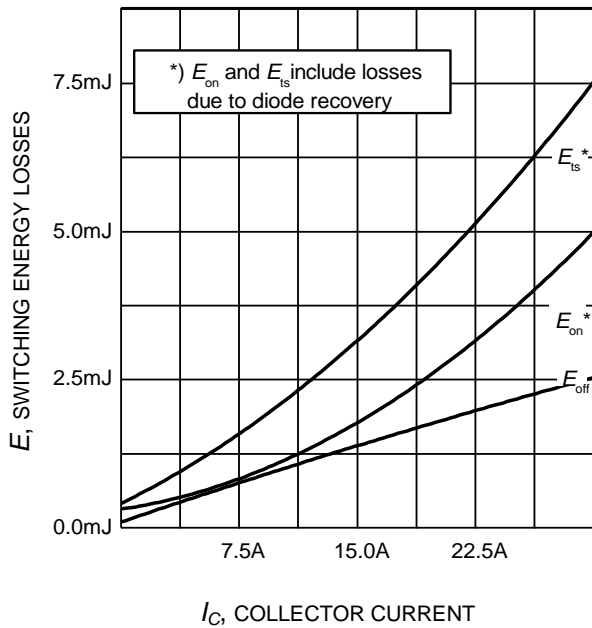
Figure 13. Typical switching energy losses as a function of collector current
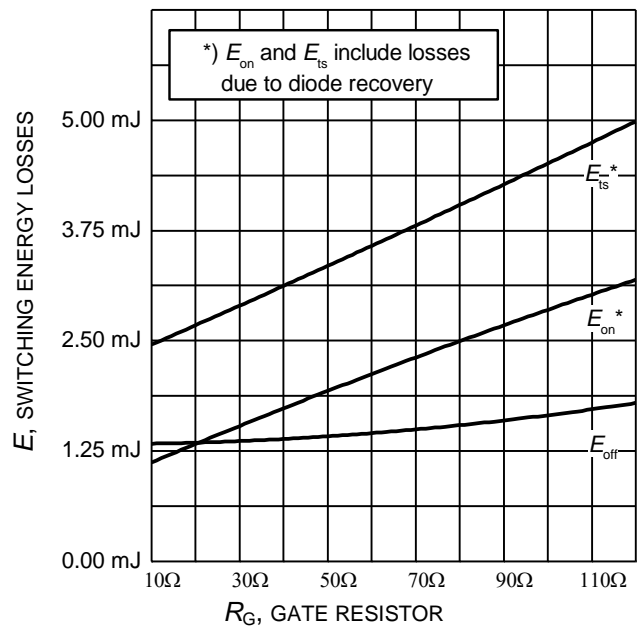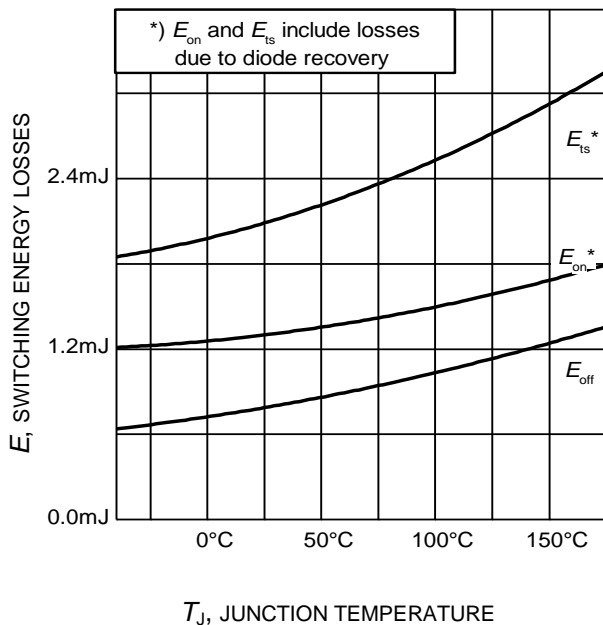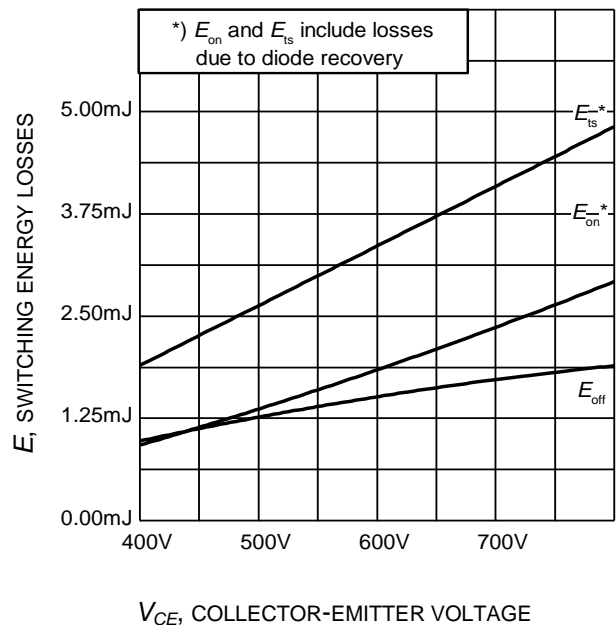(inductive load, T_J=175°C, V_{CE}=600V, V_{GE}=0/15V, R_G=41.8Ω, Dynamic test circuit in Figure E)

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=15A, 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=15A, R_G=41.8Ω, Dynamic test circuit in Figure E)

Figure 16. Typical switching energy losses as a function of collector emitter voltage
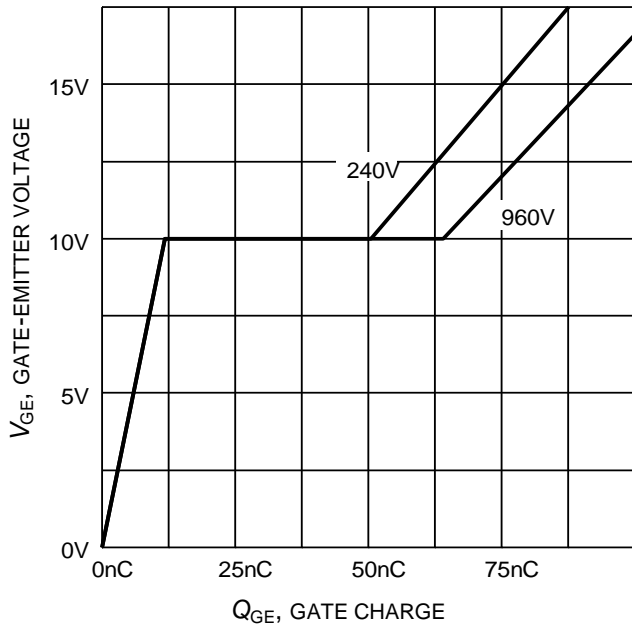(inductive load, T_J=175°C, V_{GE}=0/15V, I_C=15A, R_G=41.8Ω, Dynamic test circuit in Figure E)
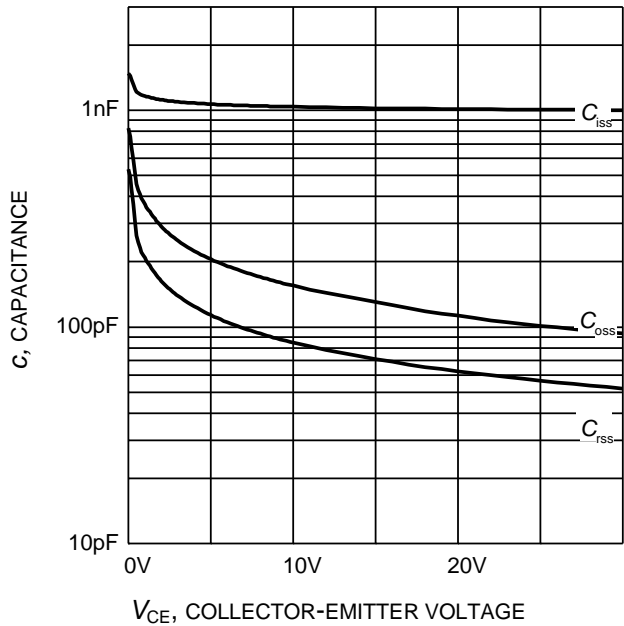
Figure 17. Typical gate charge
(I_C=15 A)

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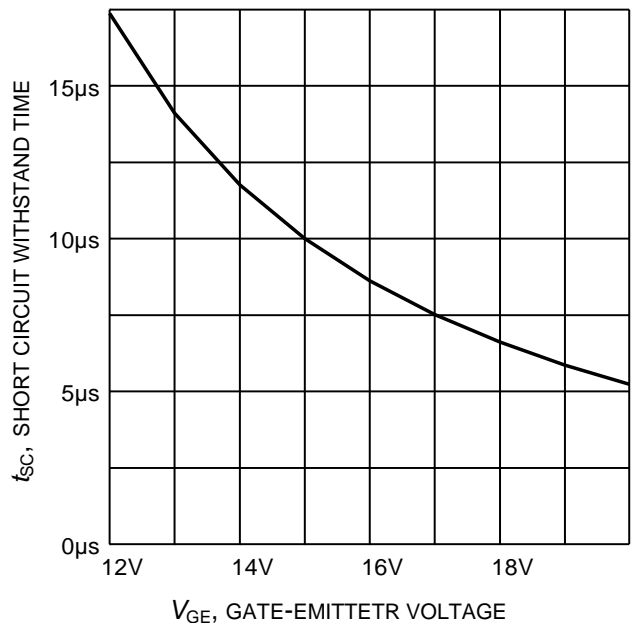(V_{GE}=0V, f = 1 MHz)

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

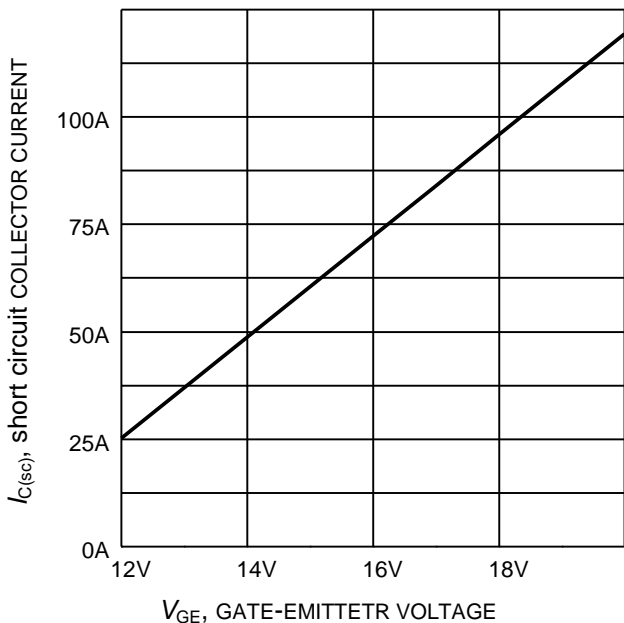**Figure 20. Typical short circuit collector current as a function of gate-emitter voltage**
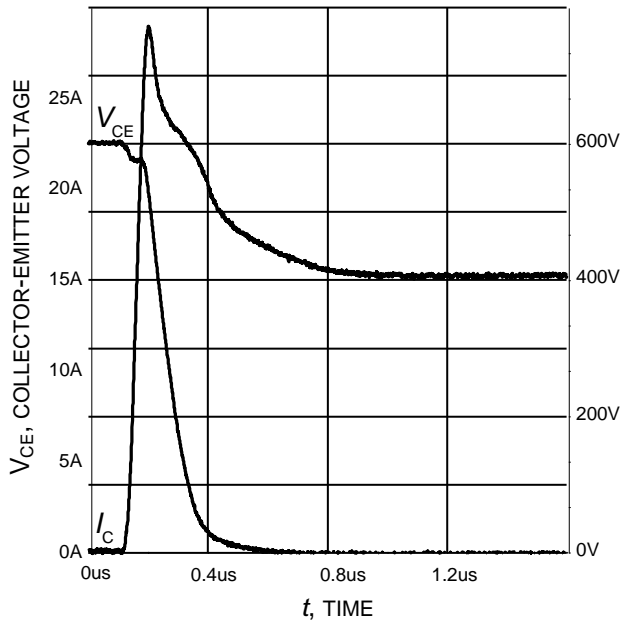($V_{CE} \leq 600V$, $T_{j,start}$ =175°C)

Figure 21. Typical turn on behavior
(V_{GE}=0/15V, R_G=41.8Ω, T_j = 175°C,
Dynamic test circuit in Figure E)
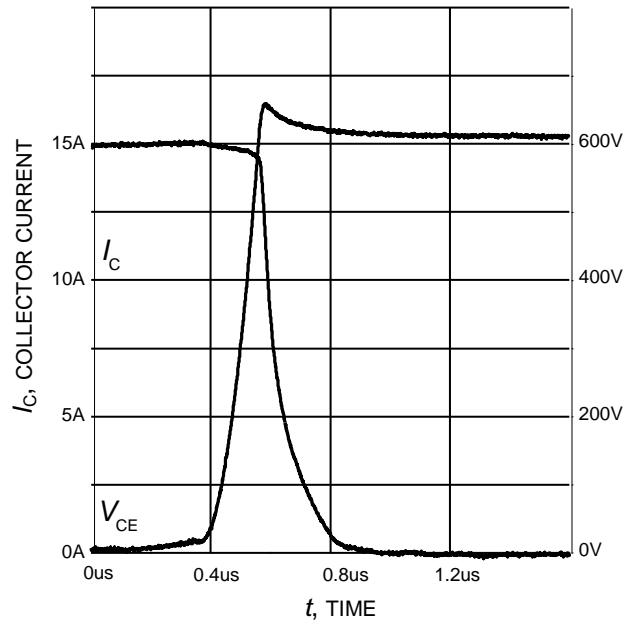
Figure 22. Typical turn off behavior
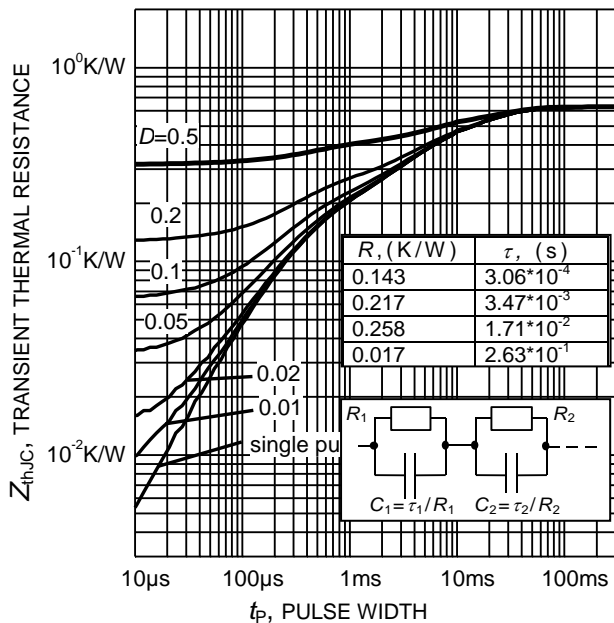(V_{GE}=15/0V, R_G=41.8Ω, T_j = 175°C,
Dynamic test circuit in Figure E)

R, (K/W)	τ, (s)
0.143	$3.06*10^{-4}$
0.217	$3.47*10^{-3}$
0.258	$1.71*10^{-2}$
0.017	$2.63*10^{-1}$

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

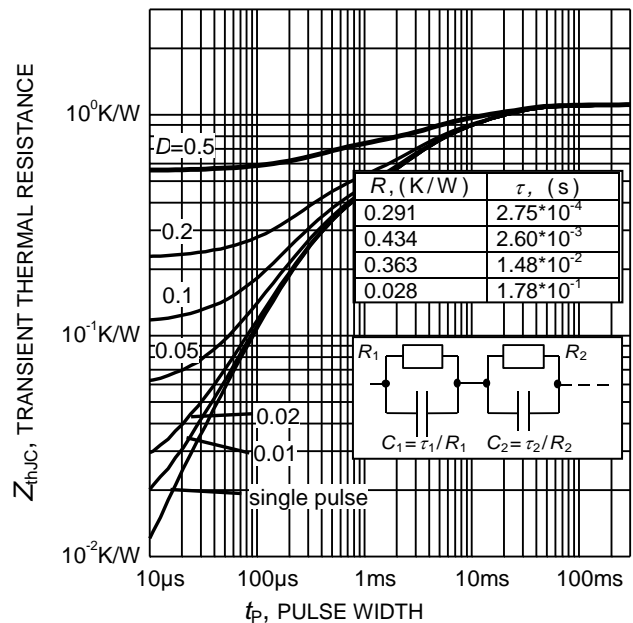| R, (K/W)	τ, (s)
0.291	$2.75*10^{-4}$
0.434	$2.60*10^{-3}$
0.363	$1.48*10^{-2}$
0.028	$1.78*10^{-1}$

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

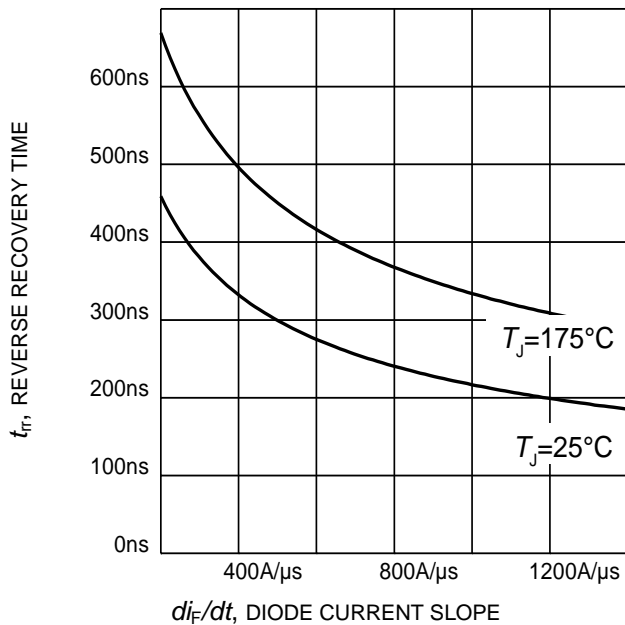**Figure 23. Typical reverse recovery time as a function of diode current slope**
(V_R=600V, I_F=15A,
Dynamic test circuit in Figure E)

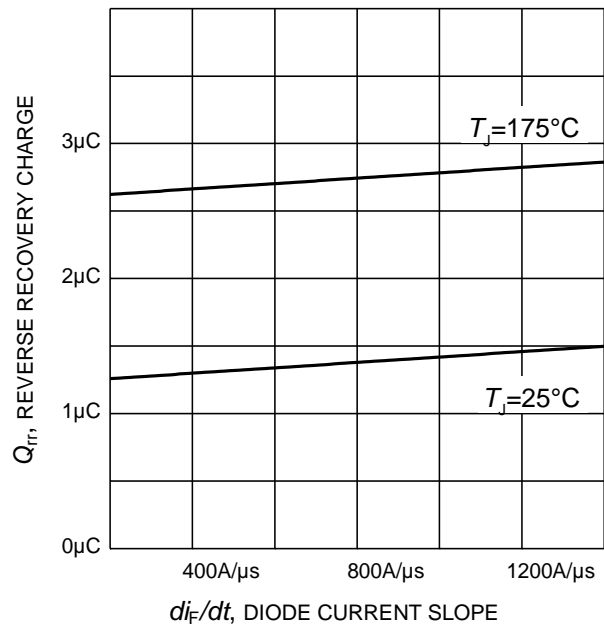**Figure 24. Typical reverse recovery charge as a function of diode current slope**
(V_R=600V, I_F=15A,
Dynamic test circuit in Figure E)

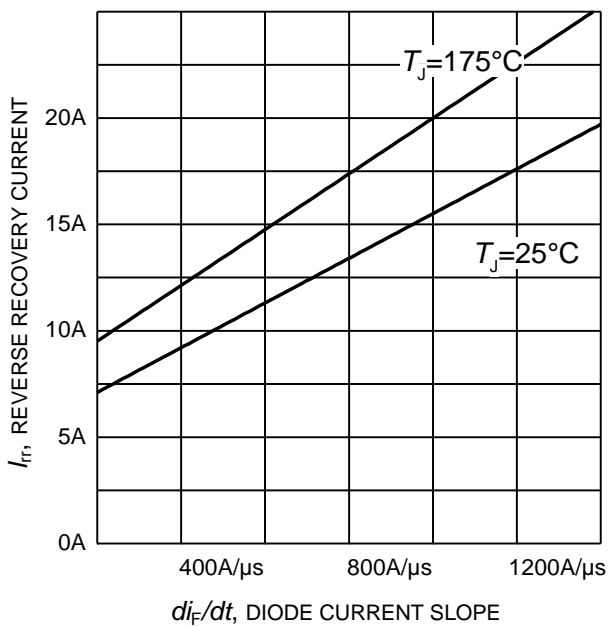**Figure 25. Typical reverse recovery current as a function of diode current slope**
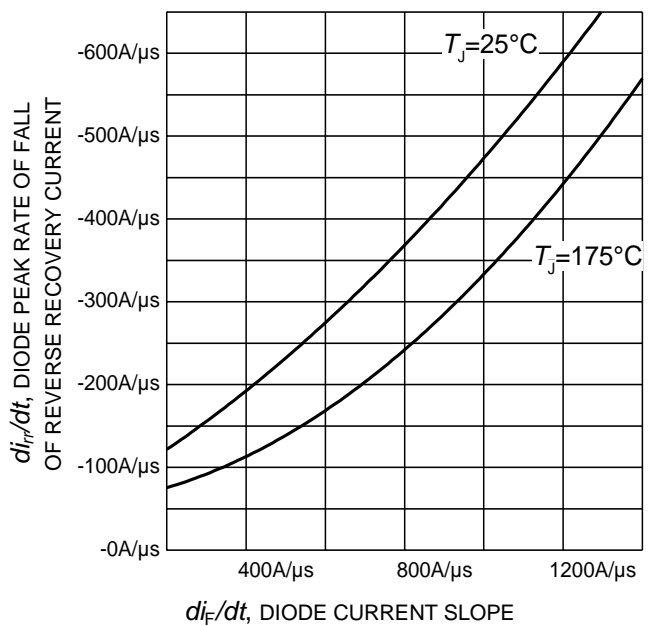(V_R=600V, I_F=15A,
Dynamic test circuit in Figure E)

Figure 26. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope
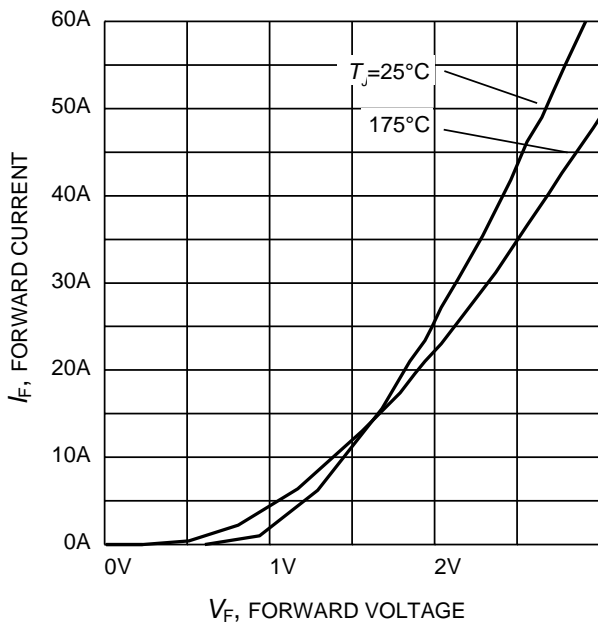(V_R=600V, I_F=15A,
Dynamic test circuit in Figure E)

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

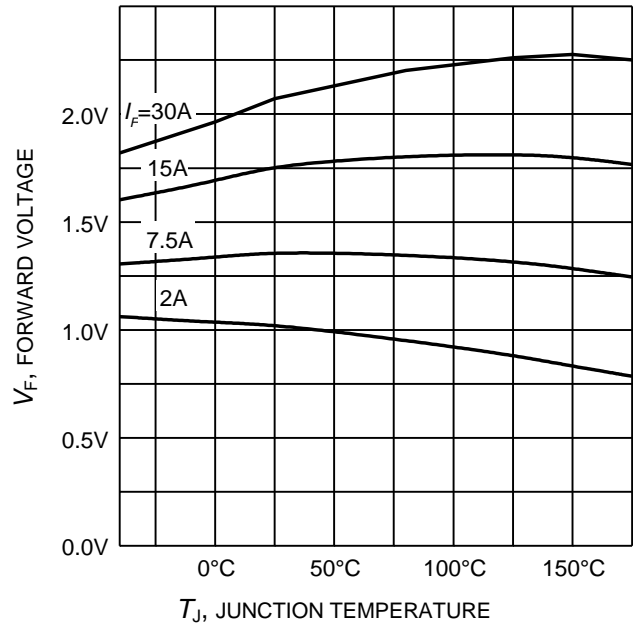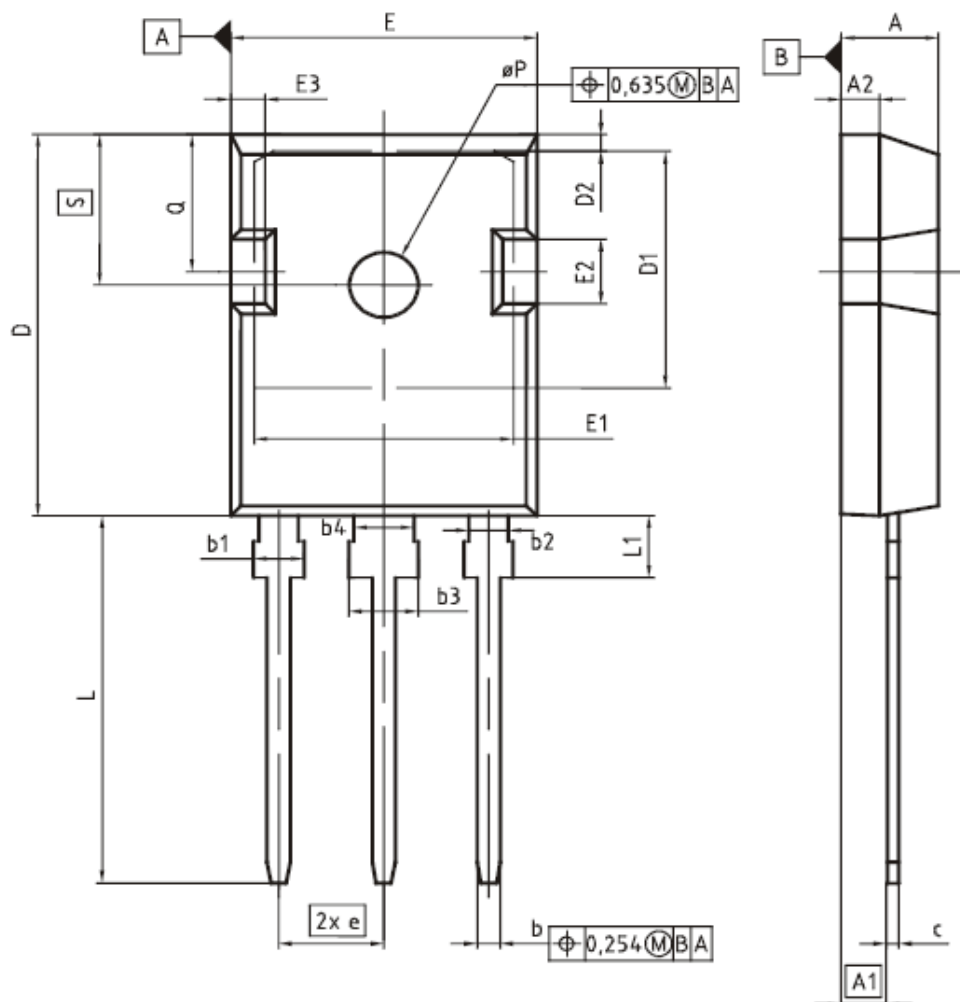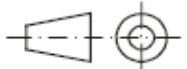**Figure 28. Typical diode forward voltage as a function of junction temperature**

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
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.
Z8B00003327

SCALE

0 5 7.5mm

EUROPEAN PROJECTION

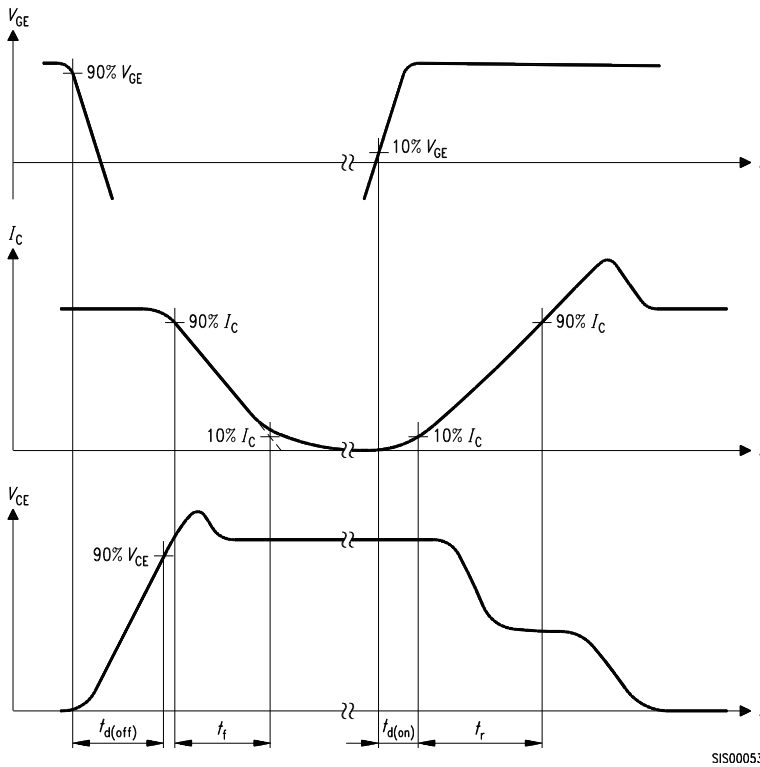**ISSUE DATE**
09-07-2010

REVISION
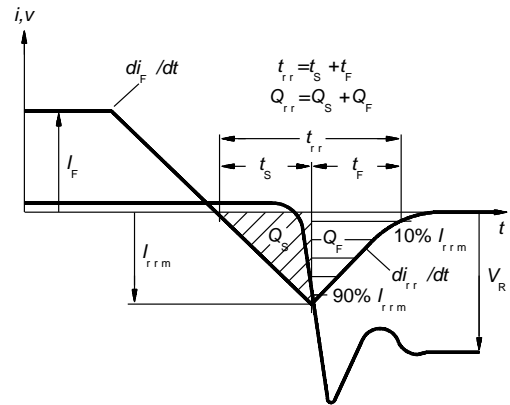05

Figure A. Definition of switching times

SIS00053

Figure C. Definition of diodes switching characteristics
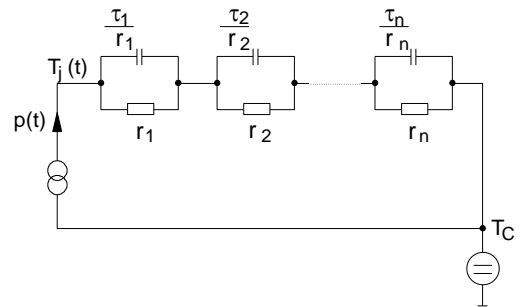
Figure D. Thermal equivalent circuit

$$E_{OFF} = \int_{t_1}^{t_2} V_{CE} \times I_C \times dt \qquad E_{ON} = \int_{t_3}^{t_4} V_{CE} \times I_C \times dt$$
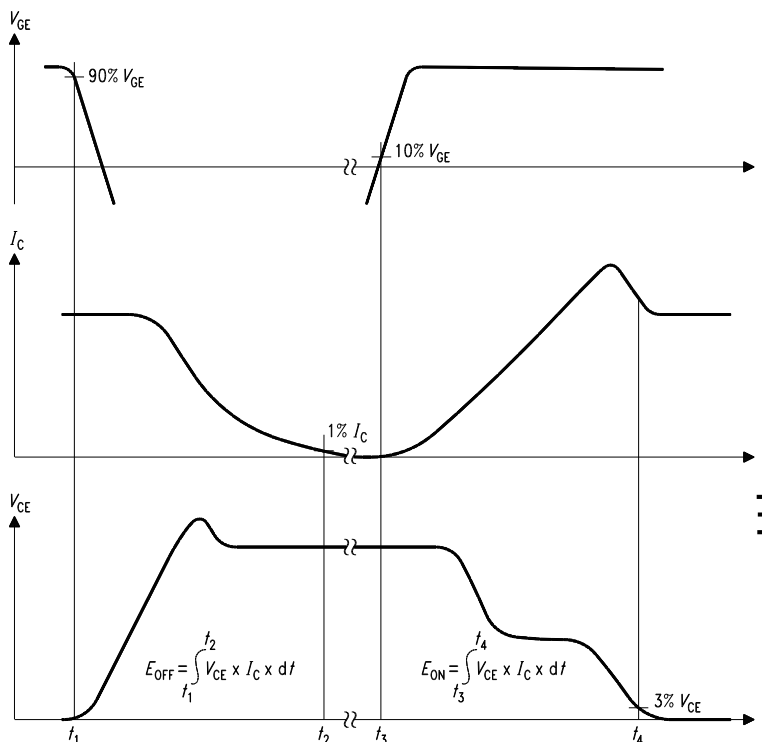
Figure B. Definition of switching losses
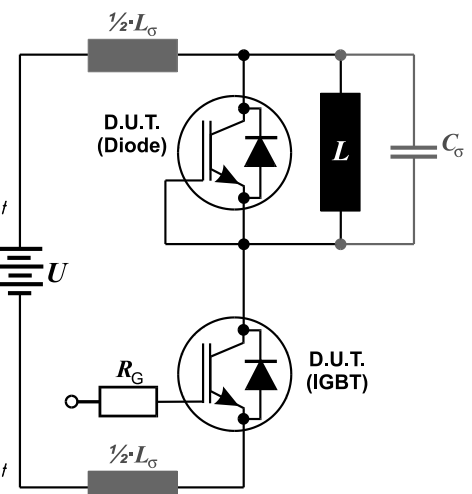
SIS00050

Figure E. Dynamic test circuit

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