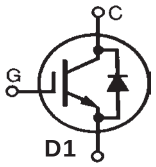
High Speed IGBT with Diode

Short Circuit SOA Capability

IXSH 10N60B2D1
IXSQ 10N60B2D1

V_{CES} = 600 V
I_{C25} = 20 A
$V_{CE(sat)}$ = 2.5 V

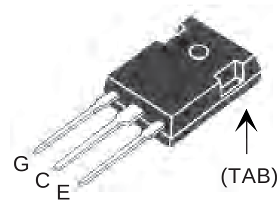
Preliminary Data Sheet



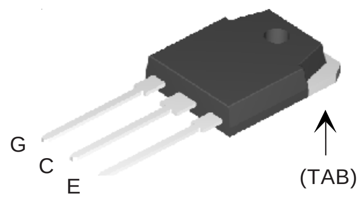
Symbol	Test Conditions	Maximum Ratings	
V_{CES}	T_J = 25°C to 150°C	600	V
V_{CGR}	T_J = 25°C to 150°C; R_{GE} = 1 MΩ	600	V
V_{GES}	Continuous	±20	V
V_{GEM}	Transient	±30	V
I_{C25}	T_C = 25°C	20	A
I_{C110}	T_C = 110°C	10	A
$I_{F(110)}$		11	A
I_{CM}	T_C = 25°C, 1 ms	30	A
SSOA (RBSOA)	V_{GE} = 15 V, T_J = 125°C, R_G = 82Ω Clamped inductive load, V_{GE} = 20 V	I_{CM} = 20 @ 0.8 V_{CES}	A
t_{SC} (SCSOA)	V_{GE} = 15 V, V_{CE} = 360 V, T_J = 125°C R_G = 150 Ω, non repetitive	10	µs
P_C	T_C = 25°C	100	W
T_J		-55 ... +150	°C
T_{JM}		150	°C
T_{stg}		-55 ... +150	°C
M_d	Mounting torque	1.3/10	Nm/lb. in
Weight	TO-247 TO-3P	5 5	g g
Maximum lead temperature for soldering 1.6 mm (0.062 in.) from case for 10 s		300	°C

Symbol	Test Conditions (T_J = 25°C, unless otherwise specified)	Characteristic Values min.	typ.	max.	
BV_{CES}	I_C = 250 µA, V_{GE} = 0 V	600			V
$V_{GE(th)}$	I_C = 750 µA, V_{CE} = V_{GE}	4.0		7.0	V
I_{CES}	V_{CE} = V_{CES} V_{GE} = 0 V			75 200	µA µA
I_{GES}	V_{CE} = 0 V, V_{GE} = ±20 V			±100	nA
$V_{CE(sat)}$	I_C = 10A, V_{GE} = 15 V			2.5	V

TO-247 (IXSH)



TO-3P (IXSQ)



G = Gate C = Collector
E = Emitter TAB = Collector

Features
- International standard package
- Guaranteed Short Circuit SOA capability
- Low $V_{CE(sat)}$
  - for low on-state conduction losses
- High current handling capability
- MOS Gate turn-on
  - drive simplicity
- Fast fall time for switching speeds up to 20 kHz

Applications
- AC motor speed control
- Uninterruptible power supplies (UPS)
- Welding

Advantages
- High power density

DS99236(10/04)

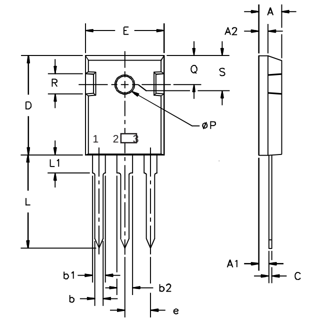
Symbol	Test Conditions	Characteristic Values (T_J = 25°C, unless otherwise specified) min.	typ.	max.	
g_{fs}	I_C = 10A; V_{CE} = 10 V, Note 1	2.0	3.6		S
C_{ies}			400		pF
C_{oes}	V_{CE} = 25 V, V_{GE} = 0 V f = 1 MHz		50		pF
C_{res}			11		pF
Q_g			17		nC
Q_{ge}	I_C = 10A, V_{GE} = 15 V, V_{CE} = 0.5 V_{CES}		6		nC
Q_{gc}			7.5		nC
$t_{d(on)}$	**Inductive load, T_J = 25°C**		30		ns
t_{ri}	I_C = 10A, V_{GE} = 15 V		30		ns
$t_{d(off)}$	V_{CE} = 0.8 V_{CES}, R_G = 30 Ω		180		ns
t_{fi}	Switching times may increase for V_{CE} (Clamp) > 0.8 • V_{CES}, higher T_J or		165		ns
E_{off}	increased R_G		430	750	µJ
$t_{d(on)}$	**Inductive load, T_J = 125°C**		30		ns
t_{ri}	I_C = 10 A, V_{GE} = 15 V		30		ns
E_{on}	V_{CE} = 0.8 V_{CES}, R_G = 30 Ω		0.32		mJ
$t_{d(off)}$	Switching times may increase for		260		ns
t_{fi}	V_{CE} (Clamp) > 0.8 • V_{CES}, higher T_J		270		ns
E_{off}	or increased R_G		790		µJ
R_{thJC}				1.25	K/W
R_{thCS}			0.25		K/W

Reverse Diode (FRED)

Symbol	Test Conditions	Characteristic Values (T_J = 25°C, unless otherwise specified) min.	typ.	max.	
V_F	I_F = 10A, V_{GE} = 0 V	T_J =150°C		1.66 2.66	V V
I_{RM}	I_F = 12A, V_{GE} = 0 V, -di_F/dt = 100 A/µs	T_J = 100°C	1.5		A
t_{rr}	V_R = 100 V	T_J = 100°C	90		ns
t_{rr}	I_F = 1 A; -di/dt = 100 A/µs; V_R = 30 V		25		ns
R_{thJC}				2.5	K/W

Note 1: Pulse test, t ≤ 300 µs, duty cycle d ≤ 2 %

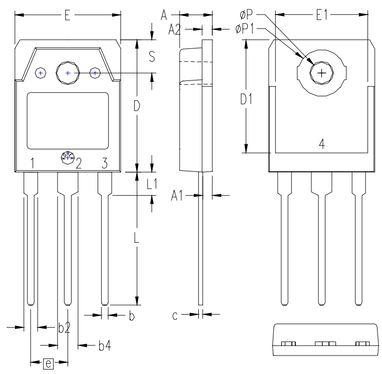
TO-247 Outline



Terminals: 1 - Gate 2 - Drain
3 - Source Tab - Drain

Dim.	Millimeter Min.	Max.	Inches Min.	Max.
A	4.7	5.3	.185	.209
A_1	2.2	2.54	.087	.102
A_2	2.2	2.6	.059	.098
b	1.0	1.4	.040	.055
b_1	1.65	2.13	.065	.084
b_2	2.87	3.12	.113	.123
C	.4	.8	.016	.031
D	20.80	21.46	.819	.845
E	15.75	16.26	.610	.640
e	5.20	5.72	0.205	0.225
L	19.81	20.32	.780	.800
L1		4.50		.177
∅P	3.55	3.65	.140	.144
Q	5.89	6.40	0.232	0.252
R	4.32	5.49	.170	.216
S	6.15	BSC	242	BSC

TO-3P Outline



Terminals: 1 - Gate 2 - Drain
3 - Source Tab - Drain

SYM	INCHES MIN	MAX	MILLIMETERS MIN	MAX
A	.185	.193	4.70	4.90
A1	.051	.059	1.30	1.50
A2	.057	.065	1.45	1.65
b	.035	.045	0.90	1.15
b2	.075	.087	1.90	2.20
b4	.114	.126	2.90	3.20
c	.022	.031	0.55	0.80
D	.780	.791	19.80	20.10
D1	.665	.677	16.90	17.20
E	.610	.622	15.50	15.80
E1	.531	.539	13.50	13.70
e	.215 BSC		5.45 BSC	
L	.779	.795	19.80	20.20
L1	.134	.142	3.40	3.60
øP	.126	.134	3.20	3.40
øP1	.272	.280	6.90	7.10
S	.193	.201	4.90	5.10

All metal area are tin plated.

Fig. 1. Output Characteristics @ 25 ºC

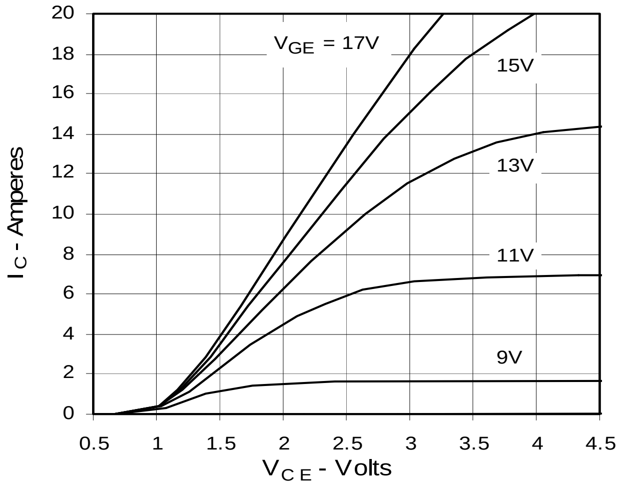


Fig. 2. Extended Output Characteristics @ 25 ºC

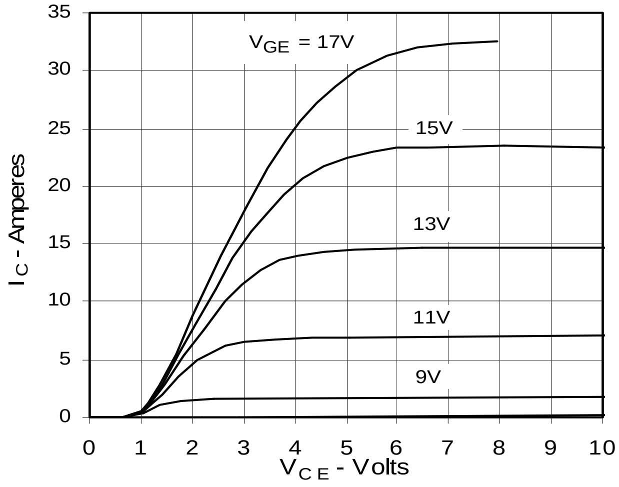


Fig. 3. Output Characteristics @ 125 ºC

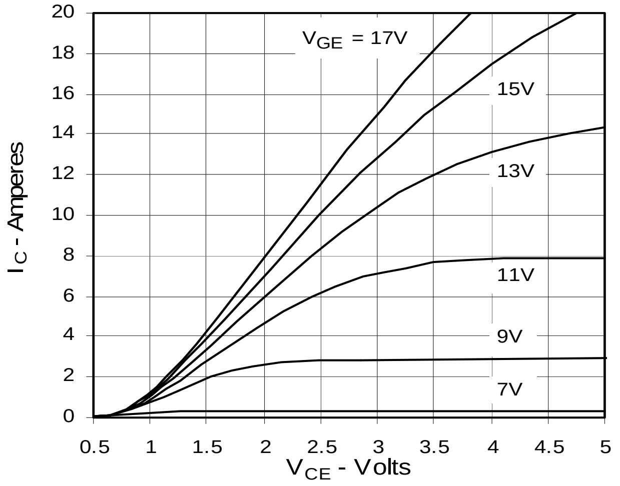


Fig. 4. Dependence of $V_{CE(sat)}$ on Temperature

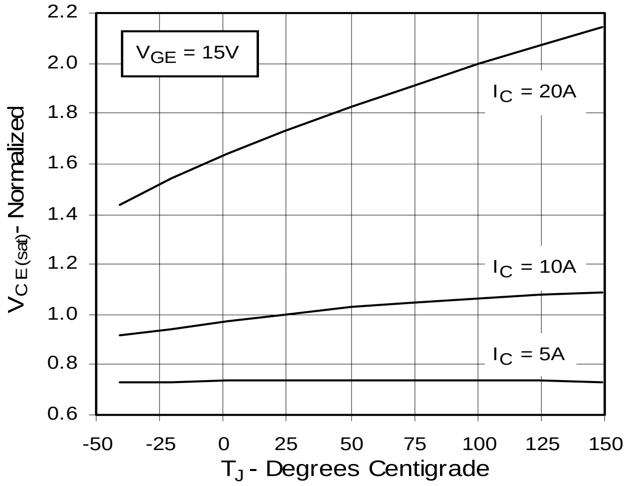


Fig. 5. Collector-to-Emitter Voltage vs. Gate-to-Emitter voltage

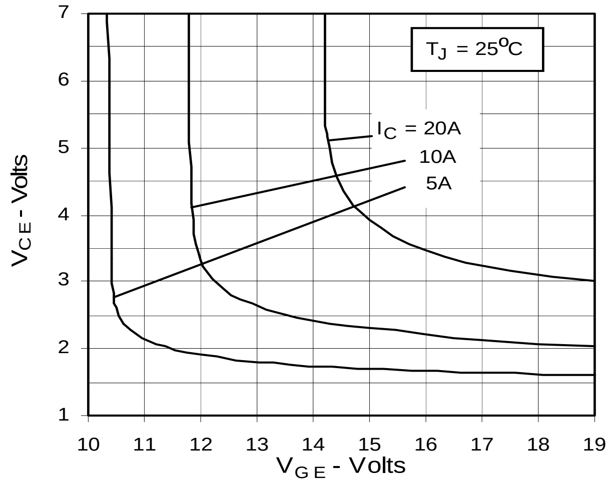


Fig. 6. Input Admittance

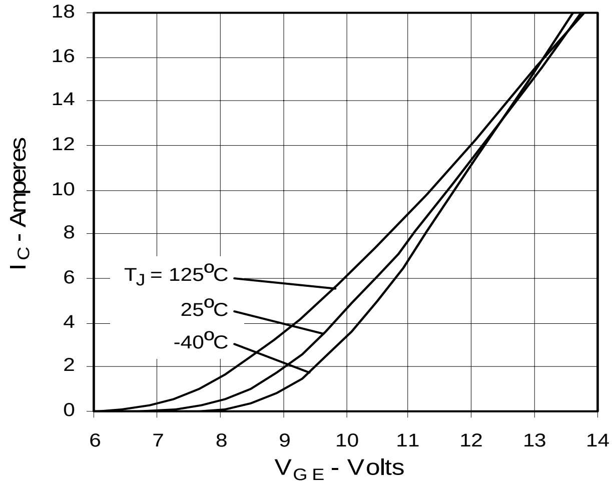


Fig. 7. Transconductance

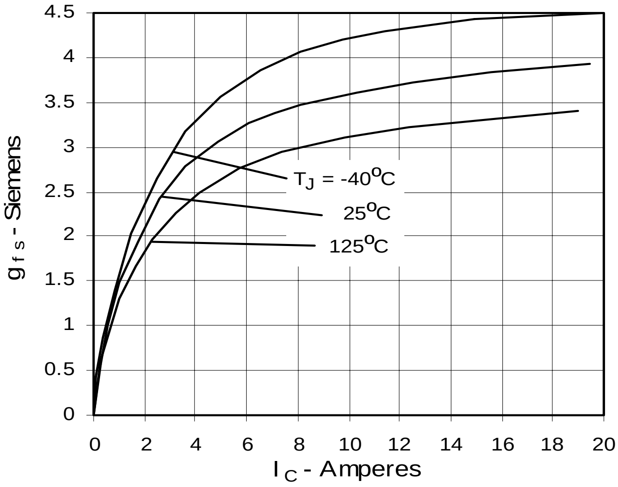


Fig. 8. Dependence of Turn-off Energy Loss on R_G

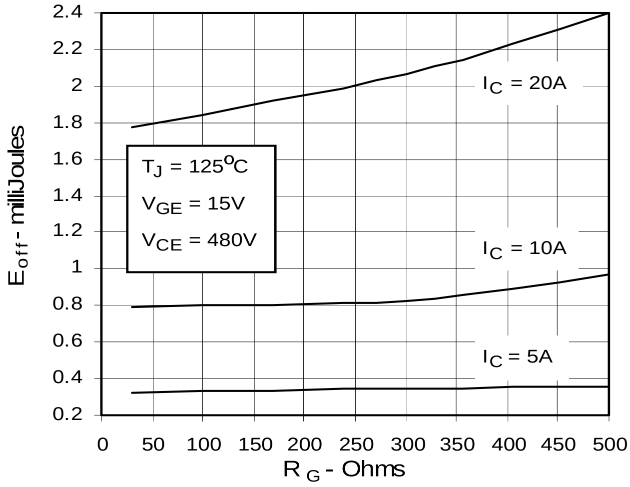


Fig. 9. Dependence of Turn-Off Energy Loss on I_C

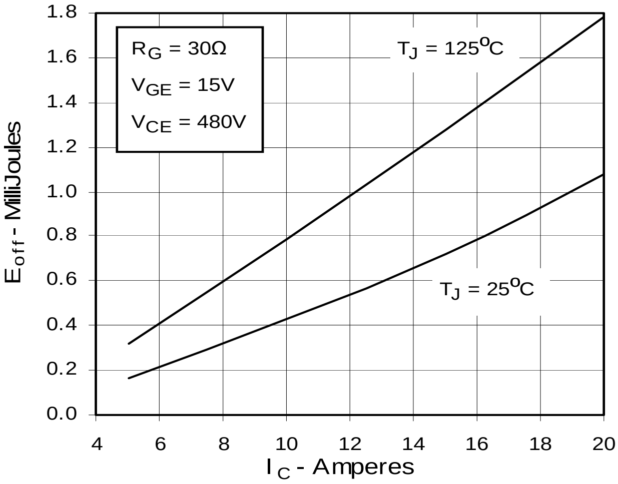


Fig. 10. Dependence of Turn-off Energy Loss on Temperature

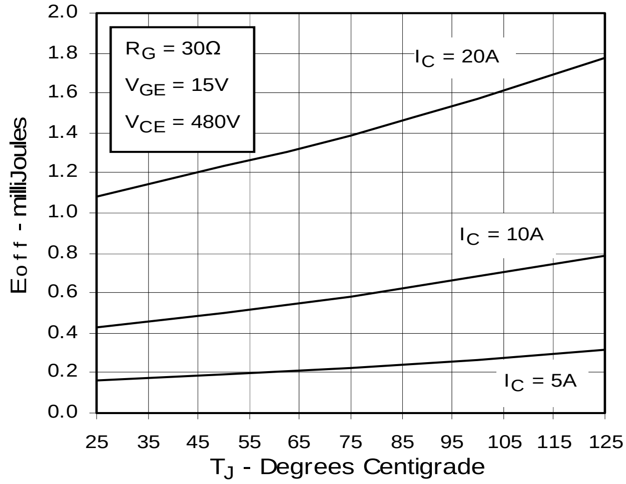


Fig. 11. Dependence of Turn-off Switching Time on R_G

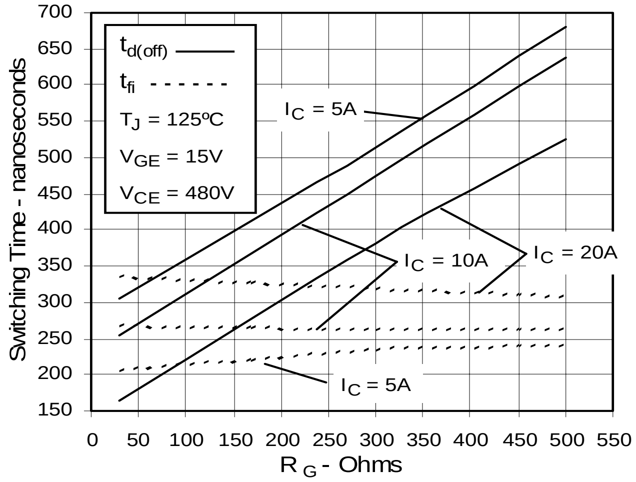
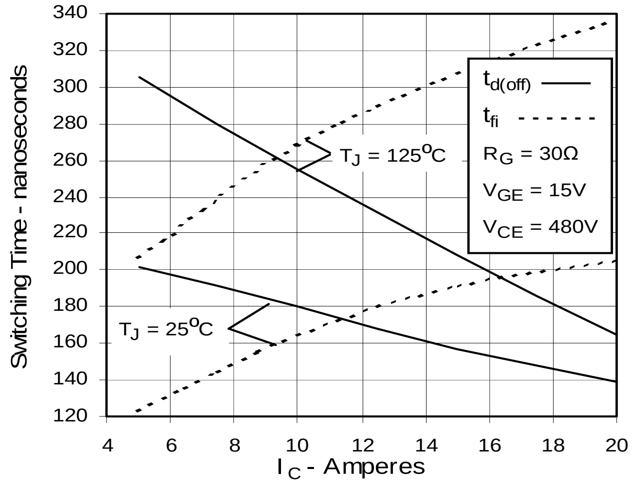


Fig. 12. Dependence of Turn-off Switching Time on I_C



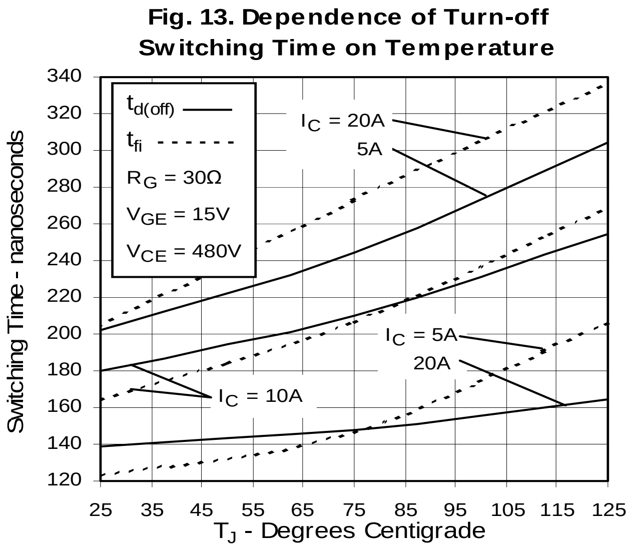


Fig. 13. Dependence of Turn-off Switching Time on Temperature
Switching Time - nanoseconds
TJ - Degrees Centigrade
td(off)
tfi
RG = 30Ω
VGE = 15V
VCE = 480V
IC = 20A
5A
IC = 5A
20A
IC = 10A

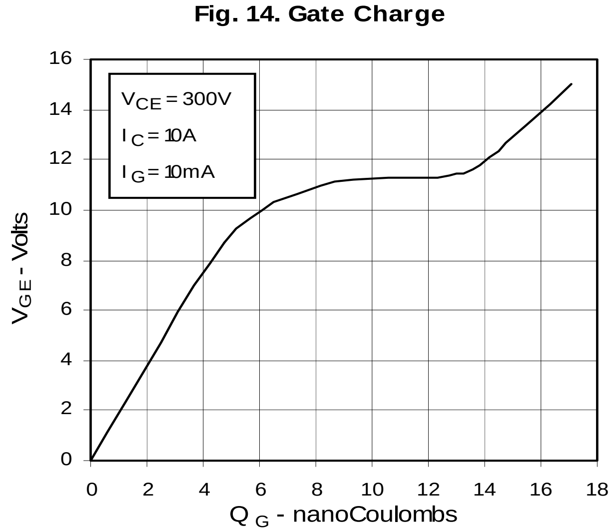


Fig. 14. Gate Charge
VGE - Volts
Q G - nanoCoulombs
VCE = 300V
IC = 10A
IG = 10mA

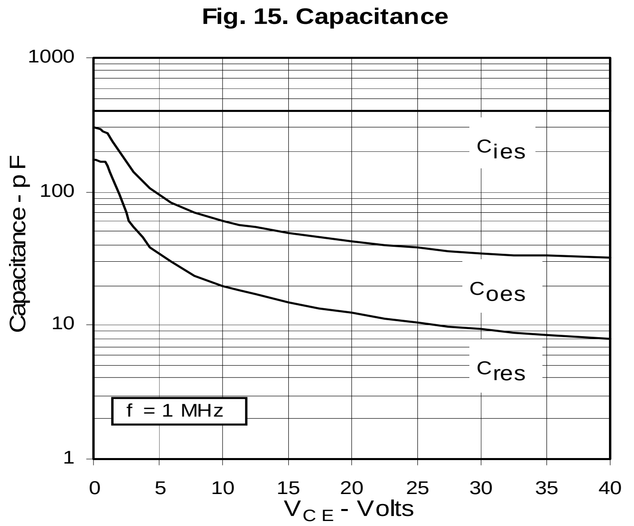


Fig. 15. Capacitance
Capacitance - pF
VCE - Volts
Cies
Coes
Cres
f = 1 MHz

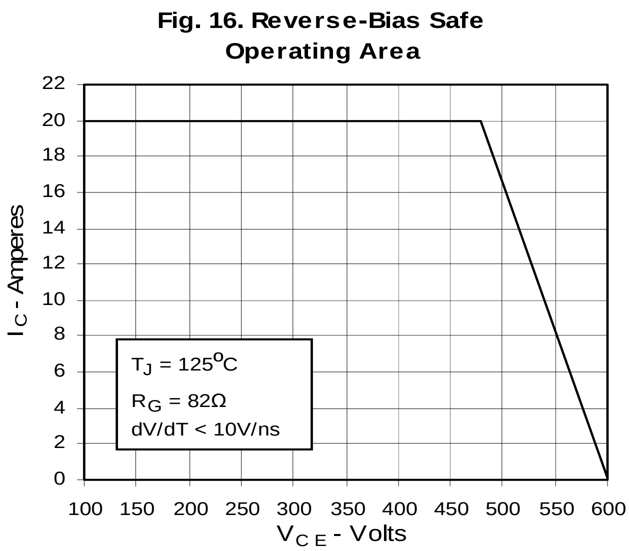


Fig. 16. Reverse-Bias Safe Operating Area
IC - Amperes
VCE - Volts
TJ = 125°C
RG = 82Ω
dV/dT < 10V/ns

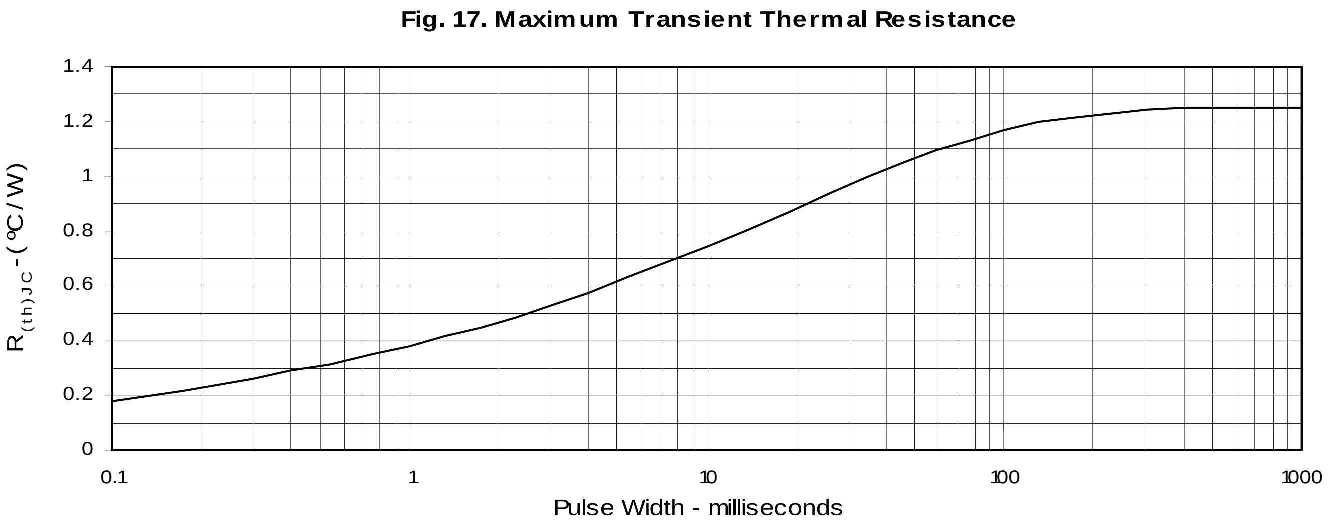


Fig. 17. Maximum Transient Thermal Resistance
R(th)JC - (°C / W)
Pulse Width - milliseconds

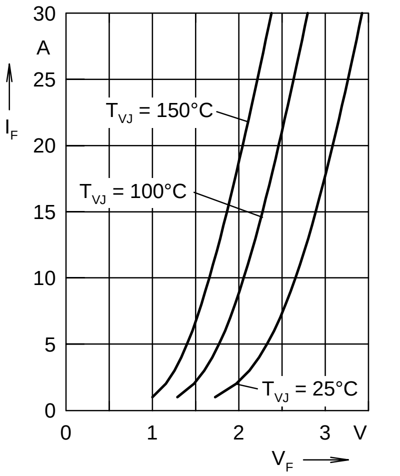


Fig. 18. Forward current I_F versus V_F

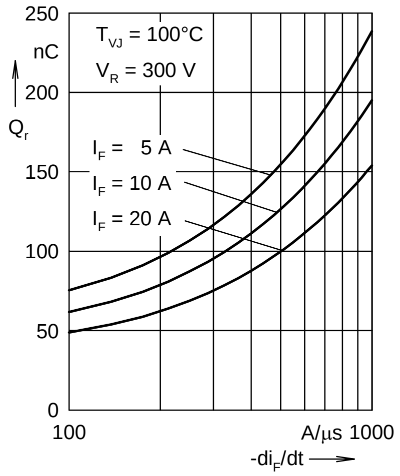


Fig. 19. Reverse recovery charge Q_r versus $-di_F/dt$

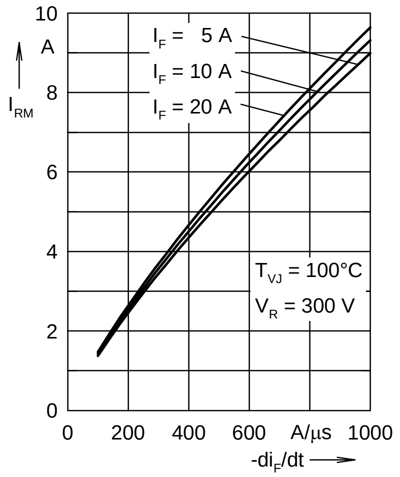


Fig. 20. Peak reverse current I_{RM} versus $-di_F/dt$

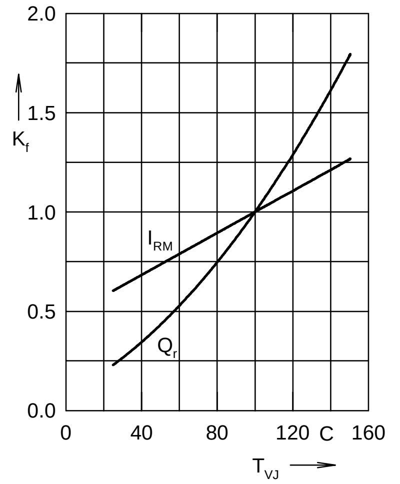


Fig. 21. Dynamic parameters Q_r, I_{RM} versus T_{VJ}

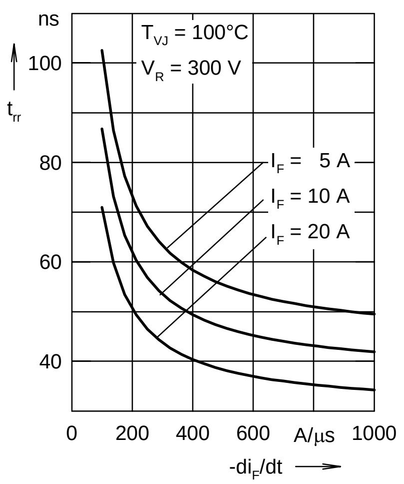


Fig. 22. Recovery time t_{rr} versus $-di_F/dt$

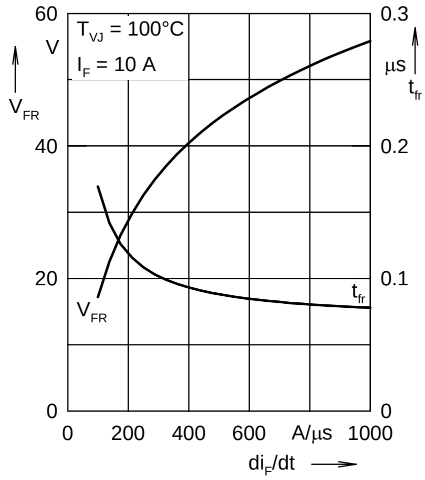


Fig. 23. Peak forward voltage V_{FR} and t_{fr} versus di_F/dt

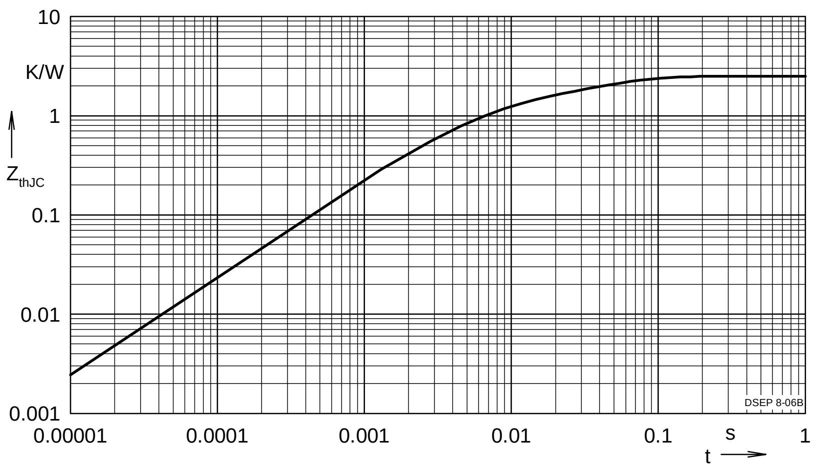


Fig. 24. Transient thermal resistance junction-to-case

Constants for Z_{thJC} calculation:

i	R_{thi} (K/W)	t_i (s)
1	1.449	0.0052
2	0.5578	0.0003
3	0.4931	0.0169

NOTE: Fig. 19 to Fig. 23 shows typical values