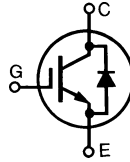


# IGBT with Diode

**IXSK 50N60BD1**  
**IXSX 50N60BD1**

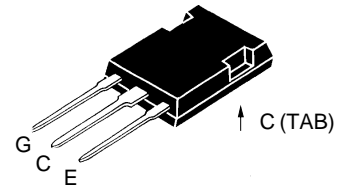
**V<sub>CES</sub> = 600 V**  
**I<sub>C25</sub> = 75 A**  
**V<sub>CE(sat)</sub> = 2.5 V**

## Short Circuit SOA Capability

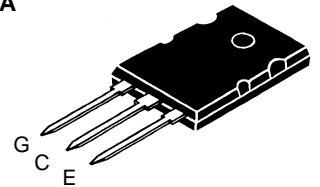


Symbol	Test Conditions	Maximum Ratings	
<b>V<sub>CES</sub></b>	T <sub>J</sub> = 25°C to 150°C	600	V
<b>V<sub>CGR</sub></b>	T <sub>J</sub> = 25°C to 150°C; R <sub>GE</sub> = 1 MΩ	600	V
<b>V<sub>GES</sub></b>	Continuous	±20	V
<b>V<sub>GEM</sub></b>	Transient	±30	V
<b>I<sub>C25</sub></b>	T <sub>C</sub> = 25°C, limited by leads	75	A
<b>I<sub>C90</sub></b>	T <sub>C</sub> = 90°C	50	A
<b>I<sub>CM</sub></b>	T <sub>C</sub> = 25°C, 1 ms	200	A
<b>SSOA (RBSOA)</b>	V <sub>GE</sub> = 15 V, T <sub>VJ</sub> = 125°C, R <sub>G</sub> = 22 Ω Clamped inductive load, L = 30 μH	I <sub>CM</sub> = 100 @ 0.8 V <sub>CES</sub>	A
<b>t<sub>SC</sub> (SCSOA)</b>	V <sub>GE</sub> = 15 V, V <sub>CE</sub> = 360 V, T <sub>J</sub> = 125°C R <sub>G</sub> = 22 Ω, non repetitive	10	μs
<b>P<sub>C</sub></b>	T <sub>C</sub> = 25°C	300	W
<b>T<sub>J</sub></b>		-55 ... +150	°C
<b>T<sub>JM</sub></b>		150	°C
<b>T<sub>stg</sub></b>		-55 ... +150	°C
<b>M<sub>d</sub></b>	Mounting torque	0.9/6	Nm/lb.in.
<b>Weight</b>		10	g
	Maximum lead temperature for soldering 1.6 mm (0.062 in.) from case for 10 s	300	°C

**PLUS247 (IXSX)**



**TO-264 AA (IXSK)**



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

### Features

- International standard package JEDEC TO-264 AA, and hole-less TO-247 package for clip mounting
- Guaranteed Short Circuit SOA capability
- High frequency IGBT and anti-parallel FRED in one package
- Latest generation HDMOS™ process
- Low V<sub>CE(sat)</sub>
  - for minimum on-state conduction losses
- MOS Gate turn-on
  - drive simplicity
- Fast Recovery Epitaxial Diode (FRED)
  - soft recovery with low I<sub>RM</sub>

### Applications

- AC motor speed control
- DC servo and robot drives
- DC choppers
- Uninterruptible power supplies (UPS)
- Switch-mode and resonant-mode power supplies

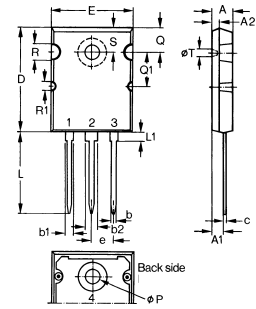
### Advantages

- Space savings (two devices in one package)
- Easy to mount with 1 screw (isolated mounting screw hole)
- Reduces assembly time and cost

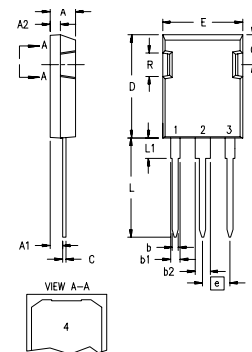
Symbol	Test Conditions	Characteristic Values (T <sub>J</sub> = 25°C, unless otherwise specified)		
		min.	typ.	max.
<b>BV<sub>CES</sub></b>	I <sub>C</sub> = 3 mA, V <sub>GE</sub> = 0 V	600		V
<b>V<sub>GE(th)</sub></b>	I <sub>C</sub> = 4 mA, V <sub>CE</sub> = V <sub>GE</sub>	4		V
<b>I<sub>CES</sub></b>	V <sub>CE</sub> = 0.8 • V <sub>CES</sub> V <sub>GE</sub> = 0 V			350 μA 5 mA
<b>I<sub>GES</sub></b>	V <sub>CE</sub> = 0 V, V <sub>GE</sub> = ±20 V			±100 nA
<b>V<sub>CE(sat)</sub></b>	I <sub>C</sub> = I <sub>C90</sub> ; V <sub>GE</sub> = 15 V	2.2	2.5	V

Symbol	Test Conditions	Characteristic Values ( $T_J = 25^\circ\text{C}$ , unless otherwise specified)		
		min.	typ.	max.
$g_{fs}$	$I_C = I_{C90}, V_{CE} = 10\text{ V}$ , Pulse test, $t \leq 300\ \mu\text{s}$ , duty cycle $\leq 2\%$	16	23	S
$I_{C(on)}$	$V_{GE} = 15\text{ V}, V_{CE} = 10\text{ V}$		160	A
$C_{ies}$	$V_{CE} = 25\text{ V}, V_{GE} = 0\text{ V}, f = 1\text{ MHz}$		3850	pF
$C_{oes}$		440	pF	
$C_{res}$		50	pF	
$Q_g$	$I_C = I_{C90}, V_{GE} = 15\text{ V}, V_{CE} = 0.5 V_{CES}$		167	nC
$Q_{ge}$		45	nC	
$Q_{gc}$		88	nC	
$t_{d(on)}$	<b>Inductive load, <math>T_J = 25^\circ\text{C}</math></b>		70	ns
$t_{ri}$	$I_C = I_{C90}, V_{GE} = 15\text{ V}, L = 100\ \mu\text{H}$ , $V_{CE} = 0.8 V_{CES}, R_G = 2.7\ \Omega$ Remarks: Switching times may increase for $V_{CE}$ (Clamp) $> 0.8 \cdot V_{CES}$ , higher $T_J$ or increased $R_G$		70	ns
$t_{d(off)}$		150	300	ns
$t_{fi}$		150	300	ns
$E_{off}$		3.3	6.0	mJ
$t_{d(on)}$	<b>Inductive load, <math>T_J = 125^\circ\text{C}</math></b>		70	ns
$t_{ri}$	$I_C = I_{C90}, V_{GE} = 15\text{ V}, L = 100\ \mu\text{H}$ , $V_{CE} = 0.8 V_{CES}, R_G = 2.7\ \Omega$ Remarks: Switching times may increase for $V_{CE}$ (Clamp) $> 0.8 \cdot V_{CES}$ , higher $T_J$ or increased $R_G$		70	ns
$E_{on}$		2.5		mJ
$t_{d(off)}$		230		ns
$t_{fi}$		230		ns
$E_{off}$		4.8		mJ
$R_{thJC}$				0.42 K/W
$R_{thCK}$		0.15		K/W

Symbol	Test Conditions	Characteristic Values ( $T_J = 25^\circ\text{C}$ , unless otherwise specified)		
		min.	typ.	max.
$V_F$	$I_F = I_{C90}, V_{GE} = 0\text{ V}$ , Pulse test, $t \leq 300\ \mu\text{s}$ , duty cycle $d \leq 2\%$			2.5 V
$I_{RM}$	$I_F = I_{C90}, V_{GE} = 0\text{ V}, -di_F/dt = 100\text{ A}/\mu\text{s}$ $V_R = 100\text{ V}$		2	2.5 A
$t_{rr}$		$I_F = 1\text{ A}, -di/dt = 200\text{ A}/\mu\text{s}; V_R = 30\text{ V}, T_J = 25^\circ\text{C}$	35	
$R_{thJC}$				0.75 K/W

**TO-264 AA Outline**


Dim.	Millimeter		Inches	
	Min.	Max.	Min.	Max.
A	4.82	5.13	.190	.202
A1	2.54	2.89	.100	.114
A2	2.00	2.10	.079	.083
b	1.12	1.42	.044	.056
b1	2.39	2.69	.094	.106
b2	2.90	3.09	.114	.122
c	0.53	0.83	.021	.033
D	25.91	26.16	1.020	1.030
E	19.81	19.96	.780	.786
e	5.46 BSC		.215 BSC	
J	0.00	0.25	.000	.010
K	0.00	0.25	.000	.010
L	20.32	20.83	.800	.820
L1	2.29	2.59	.090	.102
P	3.17	3.66	.125	.144
Q	6.07	6.27	.239	.247
Q1	8.38	8.69	.330	.342
R	3.81	4.32	.150	.170
R1	1.78	2.29	.070	.090
S	6.04	6.30	.238	.248
T	1.57	1.83	.062	.072

**PLUS247™ (IXSX)**


Dim.	Millimeter		Inches	
	Min.	Max.	Min.	Max.
A	4.83	5.21	.190	.205
A1	2.29	2.54	.090	.100
A2	1.91	2.16	.075	.085
b	1.14	1.40	.045	.055
b1	1.91	2.13	.075	.084
b2	2.92	3.12	.115	.123
C	0.61	0.80	.024	.031
D	20.80	21.34	.819	.840
E	15.75	16.13	.620	.635
e	5.45 BSC		.215 BSC	
L	19.81	20.32	.780	.800
L1	3.81	4.32	.150	.170
Q	5.59	6.20	.220	.244
R	4.32	4.83	.170	.190

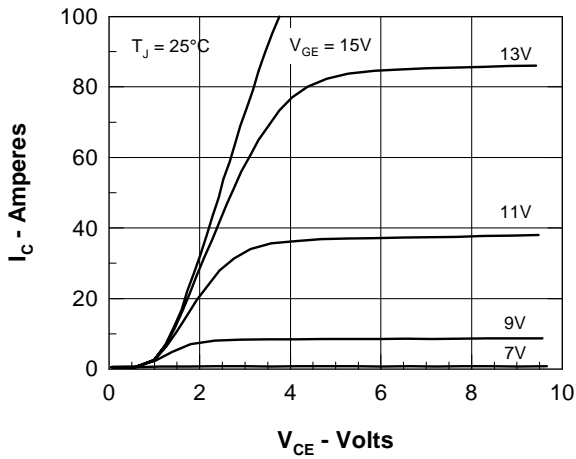


Figure 1. Saturation Voltage Characteristics

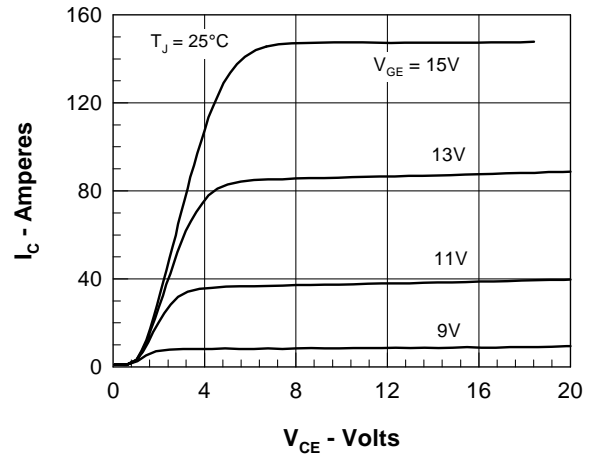


Figure 2. Extended Output Characteristics

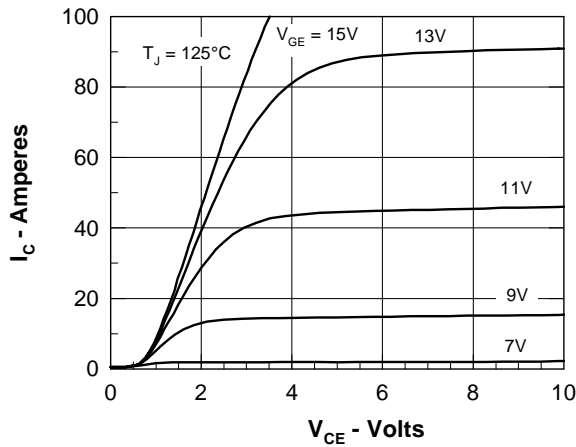


Figure 3. Saturation Voltage Characteristics

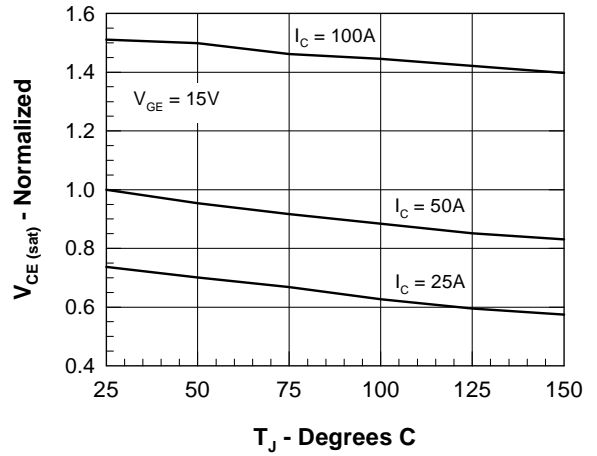
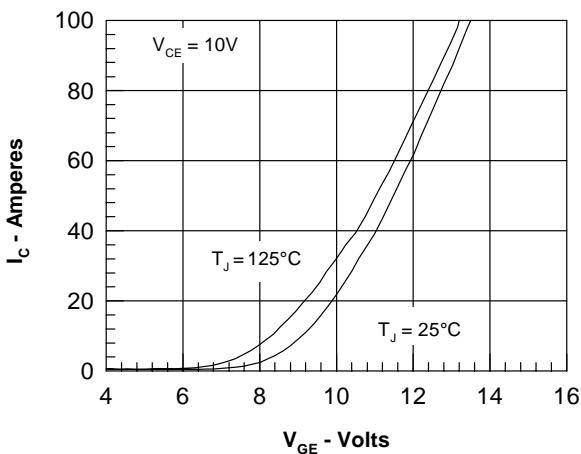

 Figure 4. Temperature Dependence of  $V_{CE(sat)}$ 


Figure 5. Admittance Curves

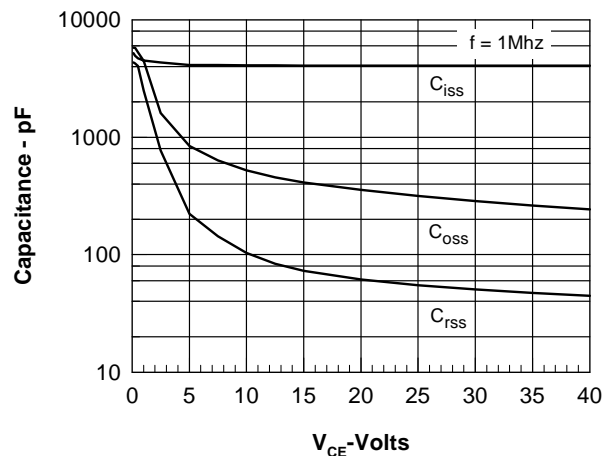


Figure 6. Capacitance Curves

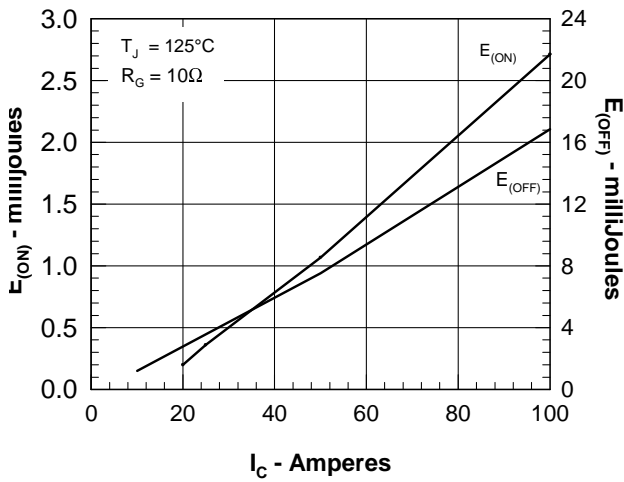


Figure 7. Dependence of  $E_{ON}$  and  $E_{OFF}$  on  $I_C$ .

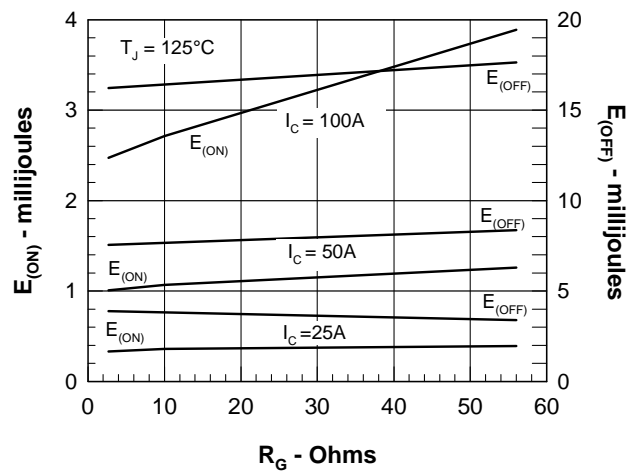


Figure 8. Dependence of  $E_{ON}$  and  $E_{OFF}$  on  $R_G$ .

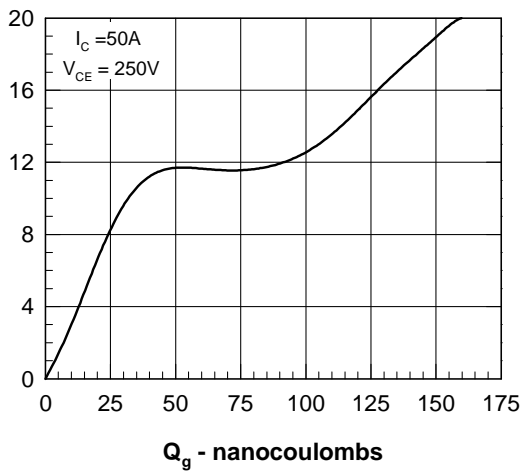


Figure 9. Gate Charge

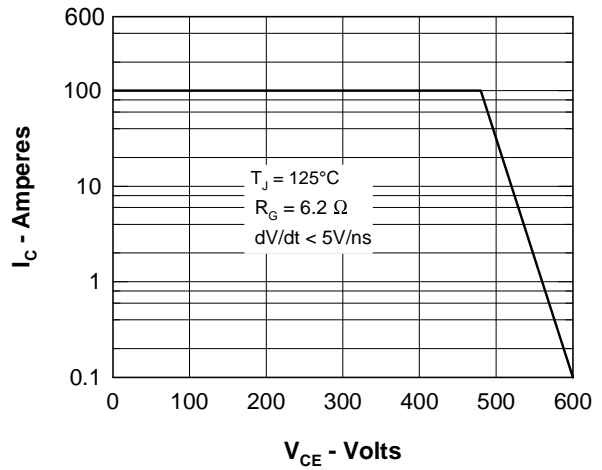


Figure 10. Turn-off Safe Operating Area

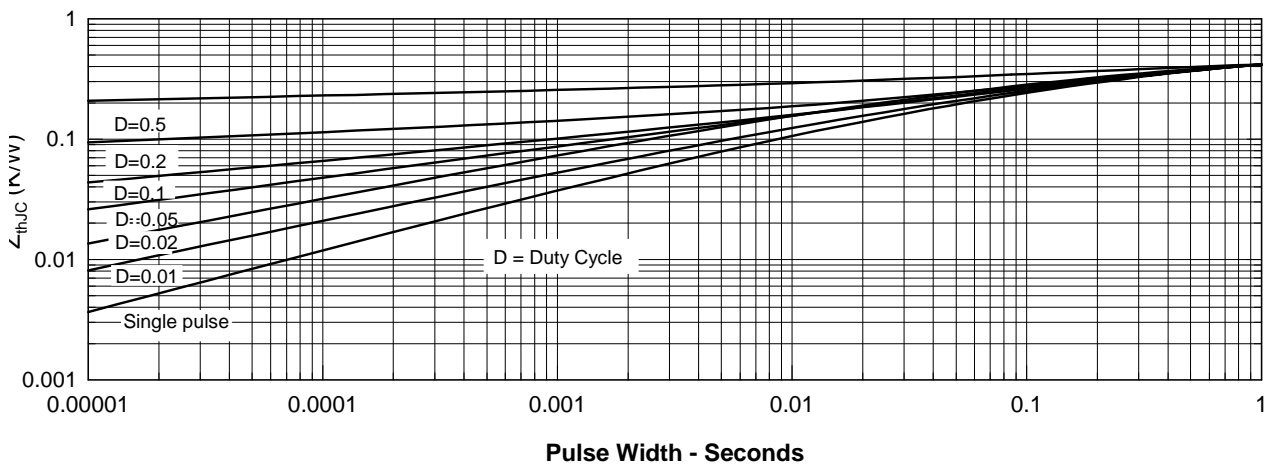


Figure 11. Transient Thermal Resistance

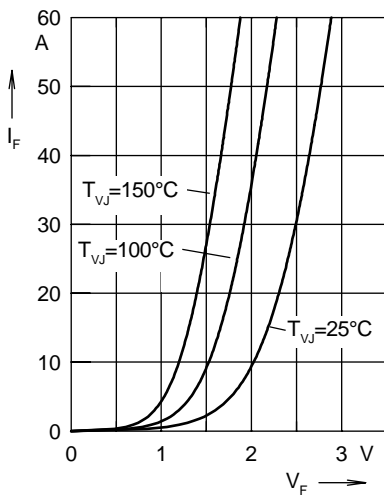


Fig. 12 Forward current  $I_F$  versus  $V_F$

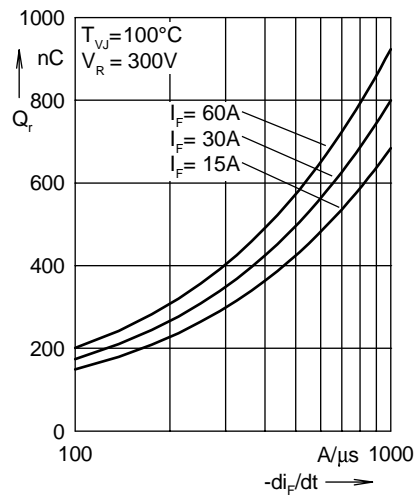


Fig. 13 Reverse recovery charge  $Q_r$  versus  $-di_F/dt$

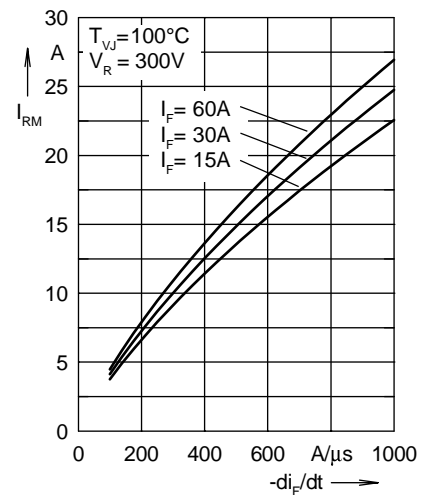


Fig. 14 Peak reverse current  $I_{RM}$  versus  $-di_F/dt$

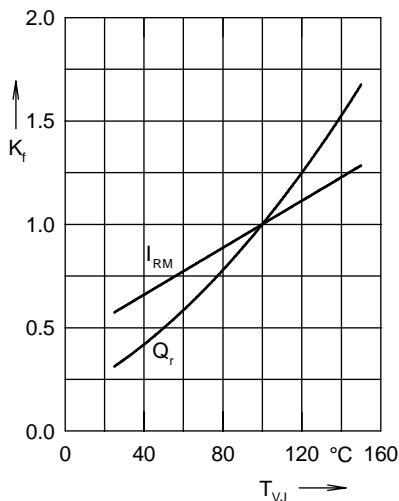


Fig. 15 Dynamic parameters  $Q_r$ ,  $I_{RM}$  versus  $T_{VJ}$

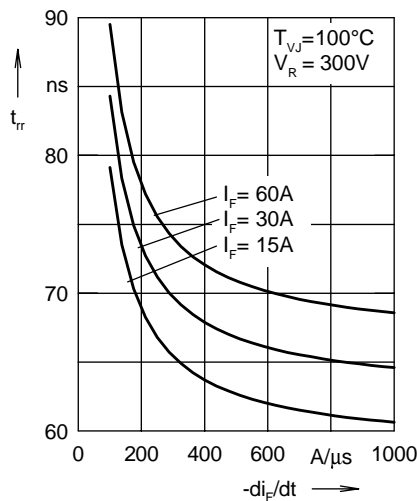


Fig. 16 Recovery time  $t_{rr}$  versus  $-di_F/dt$

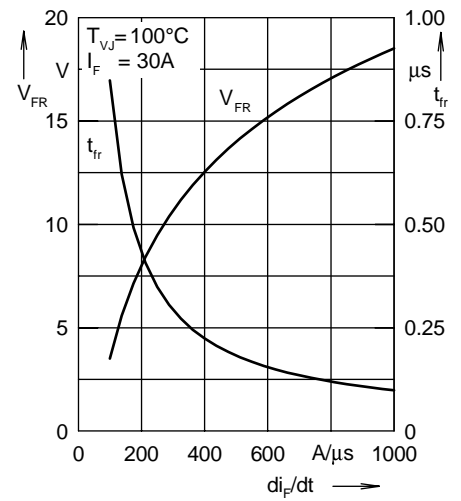


Fig. 17 Peak forward voltage  $V_{FR}$  and  $t_{fr}$  versus  $di_F/dt$

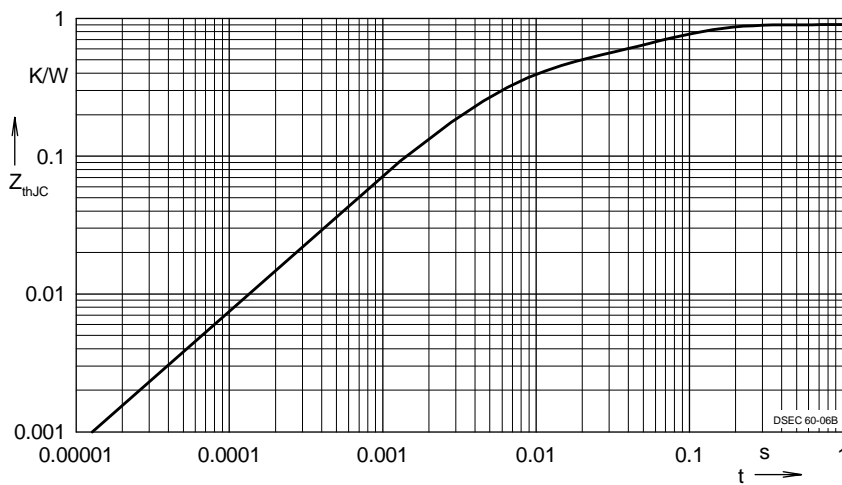


Fig. 18 Transient thermal resistance junction to case

Constants for  $Z_{thJC}$  calculation:

i	$R_{thi}$ (K/W)	$t_i$ (s)
1	0.465	0.0052
2	0.179	0.0003
3	0.256	0.0396