

**600 V Reverse Conducting Drive 2 offering cost effective IGBT with monolithically integrated diode**

**Features**

- $V_{CE} = 600\text{ V}$
- $I_C = 4\text{ A}$
- Very tight parameter distribution
- Operating range of 1 to 20 kHz
- Maximum junction temperature 150°C
- Short circuit capability of 3  $\mu\text{s}$
- Humidity robust design
- Pb-free lead plating; RoHS compliant
- Complete product spectrum and PSpice Models: <http://www.infineon.com/rc-d2>

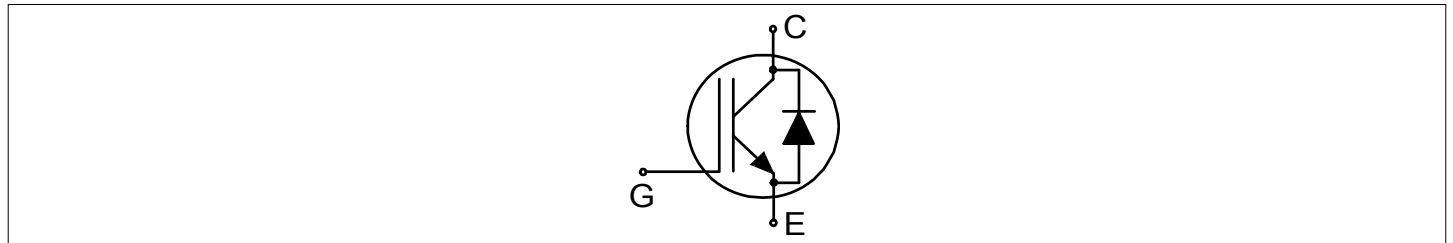
**Potential applications**

- Ceiling fan
- Countertop appliances - mixing
- Kitchen hood
- Refrigerators
- Residential aircon indoor unit
- Washing machines
- General purpose drives (GPD)

**Product validation**

- Qualified for industrial applications according to the relevant tests of JEDEC47/20/22

**Description**



- Green
- Halogen-Free
- RoHS

Type	Package	Marking
IKN04N60RC2	PG-SOT223-3	K4DRC2

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## 1 Package

**Table 1** Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Storage temperature	$T_{stg}$		-55		150	°C
Soldering temperature		reflow soldering (MSL1 according to JEDEC J-STA-020)			260	°C
Thermal resistance, min. footprint junction-ambient	$R_{th(j-a)}$				160	K/W
Thermal resistance, 6 cm <sup>2</sup> Cu on PCB junction to ambient	$R_{th(j-a)}$				75	K/W

## 2 IGBT

**Table 2** Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit	
Collector-emitter voltage	$V_{CE}$	$T_{vj} \geq 25\text{ °C}$	600	V	
DC collector current, limited by $T_{vjmax}$ <sup>1)</sup>	$I_C$		$T_c = 25\text{ °C}$	7.5	A
			$T_c = 100\text{ °C}$	4.1	
Pulsed collector current, $t_p$ limited by $T_{vjmax}$	$I_{Cpuls}$		12	A	
Turn-off safe operating area		$V_{CE} \leq 600\text{ V}$ , $t_p = 1\text{ }\mu\text{s}$ , $T_{vj} \leq 150\text{ °C}$	12	A	
Gate-emitter voltage	$V_{GE}$		$\pm 20$	V	
Transient gate-emitter voltage	$V_{GE}$	$t_p \leq 10\text{ }\mu\text{s}$ , $D < 0.01$	$\pm 30$	V	
Short-circuit withstand time	$t_{SC}$	$V_{CC} \leq 400\text{ V}$ , $V_{GE} = 15\text{ V}$ , Allowed number of short circuits < 1000, Time between short circuits $\geq 1.0\text{ s}$ , $T_{vj} = 150\text{ °C}$	3	$\mu\text{s}$	
Power dissipation	$P_{tot}$		$T_c = 25\text{ °C}$	6.8	W
			$T_c = 100\text{ °C}$	2.7	

1) DPAK equivalent

**Table 3** Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Collector-emitter saturation voltage	$V_{CEsat}$	$I_C = 4.0\text{ A}$ , $V_{GE} = 15\text{ V}$	$T_{vj} = 25\text{ °C}$		2	2.3	V
			$T_{vj} = 150\text{ °C}$		2.3		

(table continues...)

**Table 3 (continued) Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Gate-emitter threshold voltage	$V_{GEth}$	$I_C = 45.00 \mu A, V_{CE} = V_{GE}$	4.3	5	5.7	V
Zero gate-voltage collector current	$I_{CES}$	$V_{CE} = 600 V, V_{GE} = 0 V$	$T_{vj} = 25 \text{ }^\circ\text{C}$		25	$\mu A$
			$T_{vj} = 150 \text{ }^\circ\text{C}$		2500	
Gate-emitter leakage current	$I_{GES}$	$V_{CE} = 0 V, V_{GE} = 20 V$			100	nA
Transconductance	$g_{fs}$	$I_C = 4.0 A, V_{CE} = 20 V$		2		S
Input capacitance	$C_{ies}$	$V_{CE} = 25 V, V_{GE} = 0 V, f = 1000 \text{ kHz}$		180		pF
Output capacitance	$C_{oes}$	$V_{CE} = 25 V, V_{GE} = 0 V, f = 1000 \text{ kHz}$		10		pF
Reverse transfer capacitance	$C_{res}$	$V_{CE} = 25 V, V_{GE} = 0 V, f = 1000 \text{ kHz}$		7		pF
Gate charge	$Q_G$	$I_C = 4.0 A, V_{CE} = 480 V, V_{GE} = 15 V$		24		nC
Turn-on delay time	$t_{don}$	$V_{CE} = 400 V, V_{GE} = 0/15 V,$ $R_{Gon} = 49.0 \Omega,$ $R_{Goff} = 49.0 \Omega,$ $L_\sigma = 30 \text{ nH}, C_\sigma = 32 \text{ pF}$	$T_{vj} = 25 \text{ }^\circ\text{C},$ $I_C = 4.0 A$		8	ns
			$T_{vj} = 150 \text{ }^\circ\text{C},$ $I_C = 4.0 A$		8	
Rise time (inductive load)	$t_r$	$V_{CE} = 400 V, V_{GE} = 0/15 V,$ $R_{Gon} = 49.0 \Omega,$ $R_{Goff} = 49.0 \Omega,$ $L_\sigma = 30 \text{ nH}, C_\sigma = 32 \text{ pF}$	$T_{vj} = 25 \text{ }^\circ\text{C},$ $I_C = 4.0 A$		10	ns
			$T_{vj} = 150 \text{ }^\circ\text{C},$ $I_C = 4.0 A$		10	
Turn-off delay time	$t_{doff}$	$V_{CE} = 400 V, V_{GE} = 0/15 V,$ $R_{Gon} = 49.0 \Omega,$ $R_{Goff} = 49.0 \Omega,$ $L_\sigma = 30 \text{ nH}, C_\sigma = 32 \text{ pF}$	$T_{vj} = 25 \text{ }^\circ\text{C},$ $I_C = 4.0 A$		126	ns
			$T_{vj} = 150 \text{ }^\circ\text{C},$ $I_C = 4.0 A$		137	
Fall time (inductive load)	$t_f$	$V_{CE} = 400 V, V_{GE} = 0/15 V,$ $R_{Gon} = 49.0 \Omega,$ $R_{Goff} = 49.0 \Omega,$ $L_\sigma = 30 \text{ nH}, C_\sigma = 32 \text{ pF}$	$T_{vj} = 25 \text{ }^\circ\text{C},$ $I_C = 4.0 A$		24	ns
			$T_{vj} = 150 \text{ }^\circ\text{C},$ $I_C = 4.0 A$		26	
Turn-on energy	$E_{on}$	$V_{CE} = 400 V, V_{GE} = 0/15 V,$ $R_{Gon} = 49.0 \Omega,$ $R_{Goff} = 49.0 \Omega,$ $L_\sigma = 30 \text{ nH}, C_\sigma = 32 \text{ pF}$	$T_{vj} = 25 \text{ }^\circ\text{C},$ $I_C = 4.0 A$		95	$\mu J$
			$T_{vj} = 150 \text{ }^\circ\text{C},$ $I_C = 4.0 A$		127	
Turn-off energy	$E_{off}$	$V_{CE} = 400 V, V_{GE} = 0/15 V,$ $R_{Gon} = 49.0 \Omega,$ $R_{Goff} = 49.0 \Omega,$ $L_\sigma = 30 \text{ nH}, C_\sigma = 32 \text{ pF}$	$T_{vj} = 25 \text{ }^\circ\text{C},$ $I_C = 4.0 A$		62	$\mu J$
			$T_{vj} = 150 \text{ }^\circ\text{C},$ $I_C = 4.0 A$		82	

(table continues...)

**Table 3 (continued) Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Total switching energy	$E_{ts}$	$V_{CE} = 400\text{ V}$ , $V_{GE} = 0/15\text{ V}$ , $R_{Gon} = 49.0\ \Omega$ , $R_{Goff} = 49.0\ \Omega$ , $L_{\sigma} = 30\text{ nH}$ , $C_{\sigma} = 32\text{ pF}$	$T_{vj} = 25\text{ }^{\circ}\text{C}$ , $I_C = 4.0\text{ A}$		157		$\mu\text{J}$
			$T_{vj} = 150\text{ }^{\circ}\text{C}$ , $I_C = 4.0\text{ A}$		209		
IGBT thermal resistance, junction to case <sup>1)</sup>	$R_{thjc}$				18.4	K/W	
Operating junction temperature	$T_{vj}$		-40		150	$^{\circ}\text{C}$	

<sup>1)</sup>  $R_{th}/Z_{th}$  based on single cooling pulse. Please be aware that a correct  $R_{th}$  measurement of the IGBT, is not possible using a thermocouple.

Note: Electrical Characteristic, at  $T_{vj}=25^{\circ}\text{C}$ , unless otherwise specified

### 3 Diode

**Table 4 Maximum rated values**

Parameter	Symbol	Note or test condition	Values	Unit	
Repetitive peak reverse voltage	$V_{RRM}$	$T_{vj} \geq 25\text{ }^{\circ}\text{C}$	600	V	
Diode forward current, limited by $T_{vjmax}$ <sup>1)</sup>	$I_F$		$T_c = 25\text{ }^{\circ}\text{C}$	4.9	A
			$T_c = 100\text{ }^{\circ}\text{C}$	2.3	
Diode pulsed current, limited by $T_{vjmax}$	$I_{Fpuls}$		12	A	

<sup>1)</sup> DPAK equivalent

**Table 5 Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Diode forward voltage	$V_F$	$I_F = 4.0\text{ A}$	$T_{vj} = 25\text{ }^{\circ}\text{C}$		1.85	2.2	V
			$T_{vj} = 150\text{ }^{\circ}\text{C}$		1.9		
Diode reverse recovery time	$t_{rr}$	$V_R = 400\text{ V}$	$T_{vj} = 25\text{ }^{\circ}\text{C}$ , $I_F = 4.0\text{ A}$ , $-di_F/dt = 483\text{ A}/\mu\text{s}$		39		ns
			$T_{vj} = 150\text{ }^{\circ}\text{C}$ , $I_F = 4.0\text{ A}$ , $-di_F/dt = 500\text{ A}/\mu\text{s}$		100		

(table continues...)

**Table 5 (continued) Characteristic values**

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Diode reverse recovery charge	$Q_{rr}$	$V_R = 400\text{ V}$	$T_{vj} = 25\text{ °C},$ $I_F = 4.0\text{ A},$ $-di_F/dt = 483\text{ A}/\mu\text{s}$		0.097		$\mu\text{C}$
					0.259		
Diode peak reverse recovery current	$I_{rrm}$	$V_R = 400\text{ V}$	$T_{vj} = 25\text{ °C},$ $I_F = 4.0\text{ A},$ $-di_F/dt = 483\text{ A}/\mu\text{s}$		4.7		A
					5.8		
Diode peak rate of fall of reverse recovery current	$di_{rr}/dt$	$V_R = 400\text{ V}$	$T_{vj} = 25\text{ °C},$ $I_F = 4.0\text{ A},$ $-di_F/dt = 483\text{ A}/\mu\text{s}$		-174		$\text{A}/\mu\text{s}$
					-67.4		
Diode thermal resistance, junction to case <sup>1)</sup>	$R_{thjc}$					26.3	K/W
Operating junction temperature	$T_{vj}$			-40		150	$^{\circ}\text{C}$

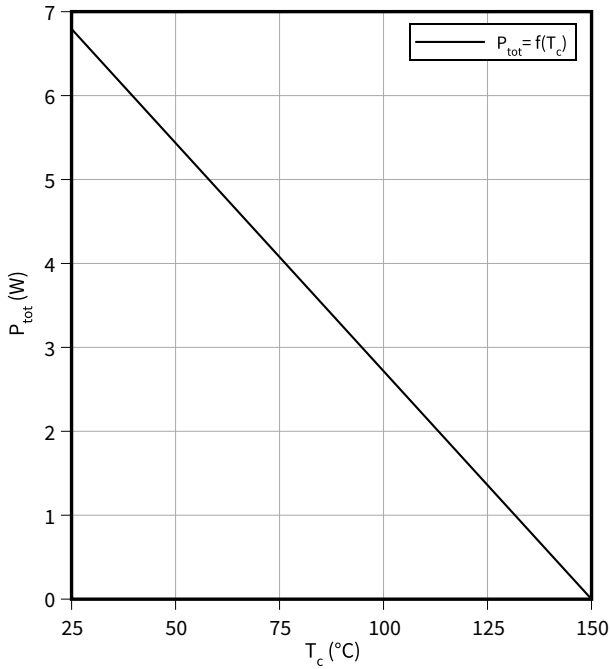
1)  $R_{th}/Z_{th}$  based on single cooling pulse. Please be aware that a correct  $R_{th}$  measurement of the diode, is not possible using a thermocouple.

**Note:** For optimum lifetime and reliability, Infineon recommends operating conditions that do not exceed 80% of the maximum ratings stated in this datasheet.

## 4 Characteristics diagrams

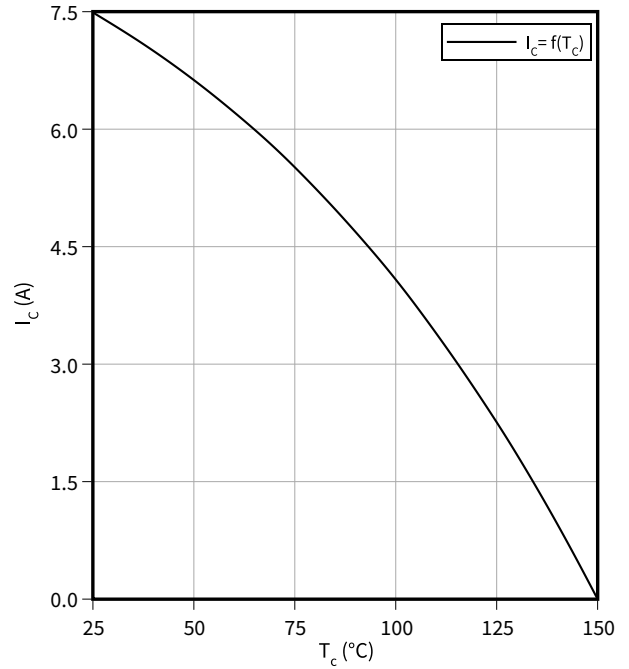
**Power dissipation as a function of case temperature, IGBT**

$P_{tot} = f(T_c)$   
 $T_{vj} \leq 150\text{ }^\circ\text{C}$



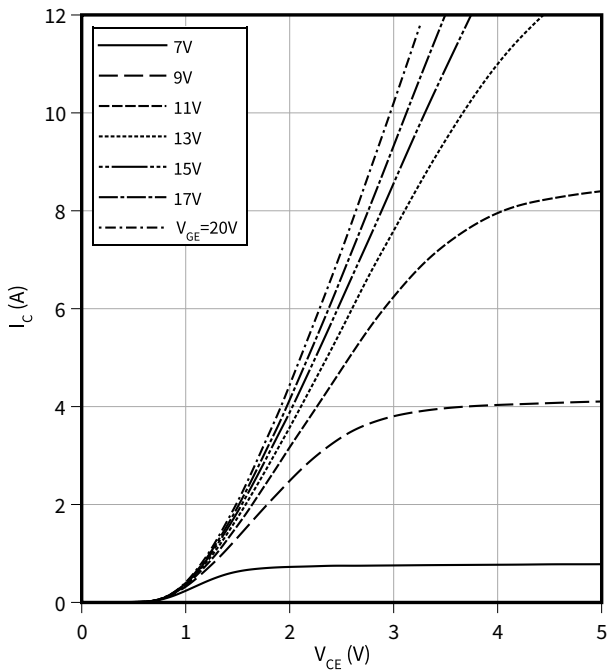
**Collector current, DPAK equivalent, as a function of case temperature, IGBT**

$I_C = f(T_c)$   
 $T_{vj} \leq 150\text{ }^\circ\text{C}, V_{GE} \geq 15\text{ V}$



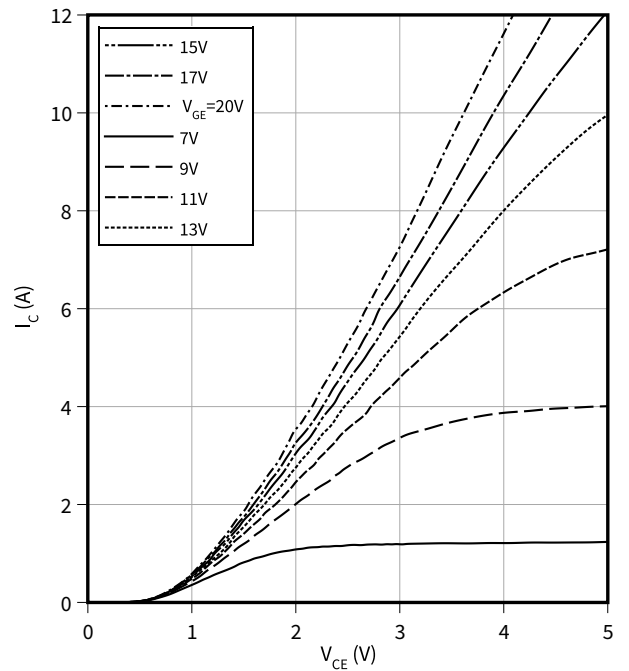
**Typical output characteristic, IGBT**

$I_C = f(V_{CE})$   
 $T_{vj} = 25\text{ }^\circ\text{C}$



**Typical output characteristic, IGBT**

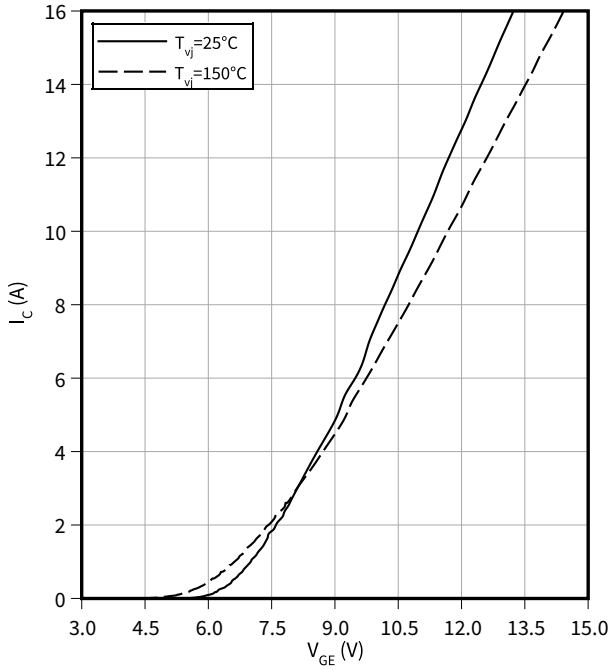
$I_C = f(V_{CE})$   
 $T_{vj} = 150\text{ }^\circ\text{C}$



4 Characteristics diagrams

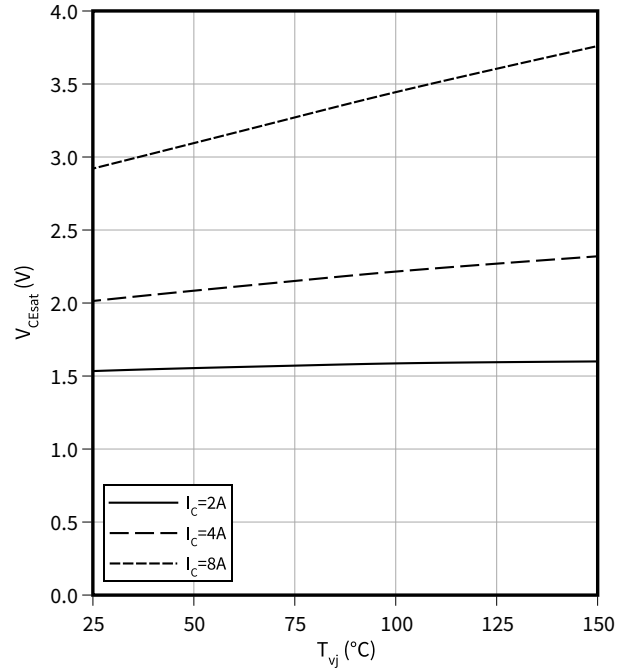
**Typical transfer characteristic, IGBT**

$I_C = f(V_{GE})$   
 $V_{CE} = 20 \text{ V}$



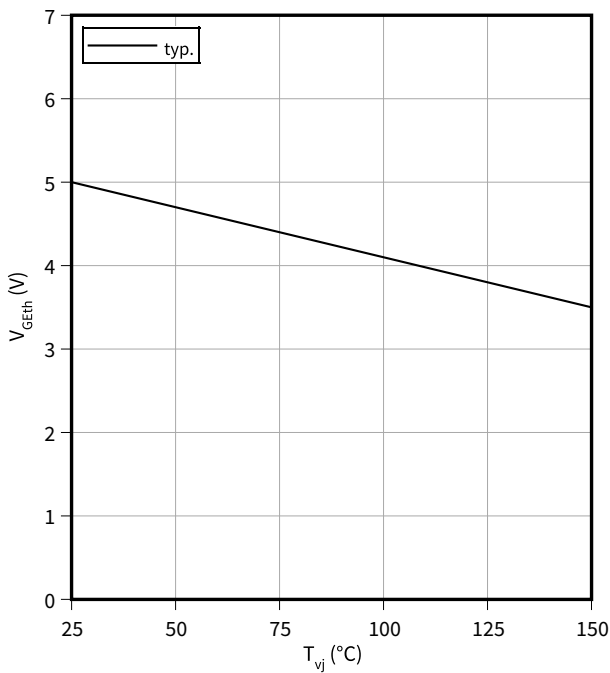
**Typical collector-emitter saturation voltage as a function of junction temperature, IGBT**

$V_{CEsat} = f(T_{vj})$   
 $V_{GE} = 15 \text{ V}$



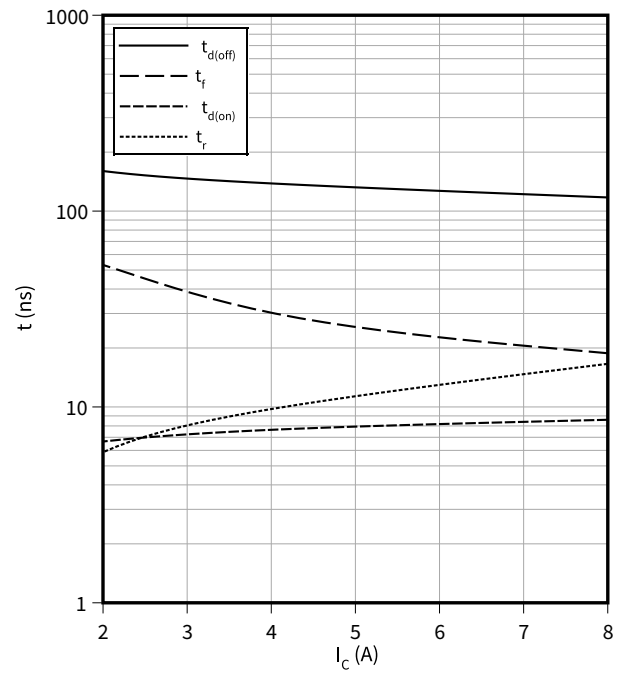
**Gate-emitter threshold voltage as a function of junction temperature, IGBT**

$V_{GEth} = f(T_{vj})$   
 $I_C = 45 \mu\text{A}$



**Typical switching times as a function of collector current, IGBT**

$t = f(I_C)$   
 $V_{CE} = 400 \text{ V}, T_{vj} = 150 \text{ °C}, V_{GE} = 0/15 \text{ V}, R_G = 49 \Omega$



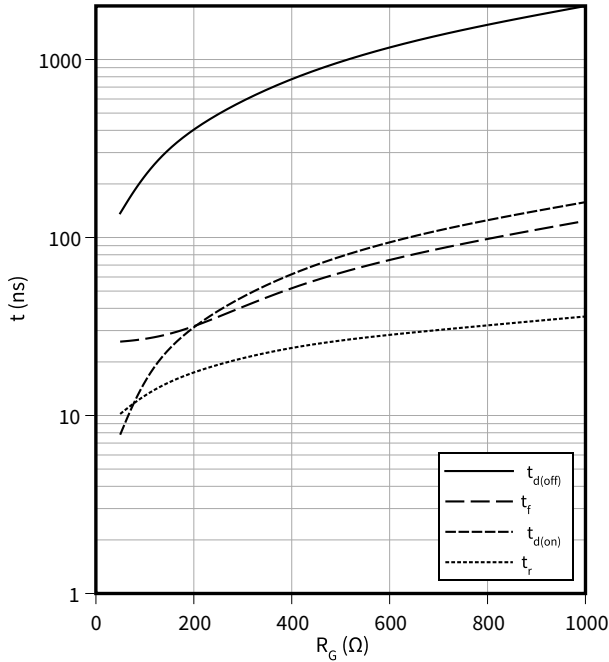


4 Characteristics diagrams

**Typical switching times as a function of gate resistor, IGBT**

$t = f(R_G)$

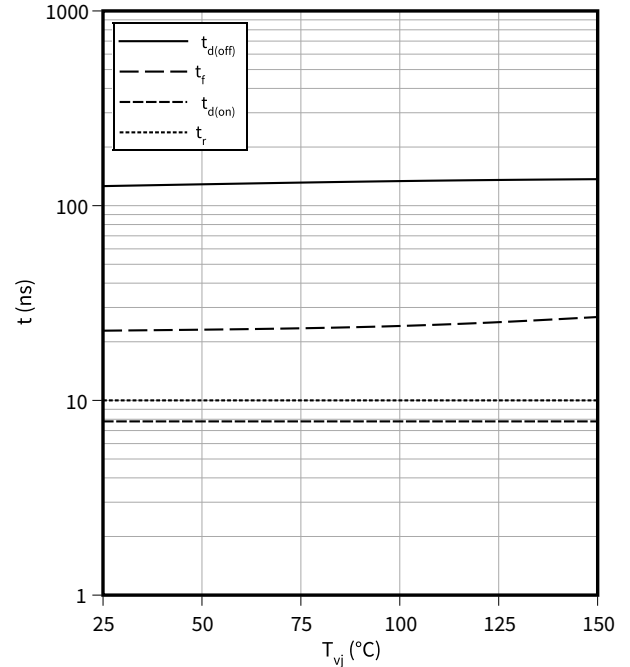
$I_C = 4 \text{ A}, V_{CE} = 400 \text{ V}, T_{vj} = 150 \text{ }^\circ\text{C}, V_{GE} = 0/15 \text{ V}$



**Typical switching times as a function of junction temperature, IGBT**

$t = f(T_{vj})$

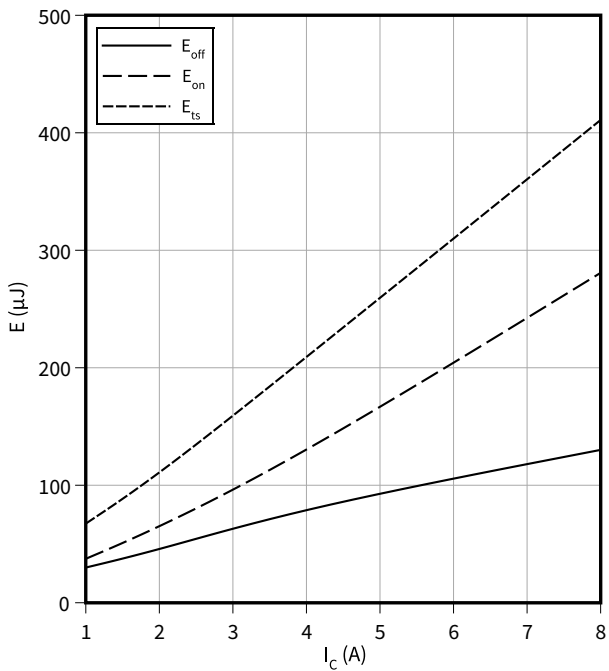
$I_C = 4 \text{ A}, V_{CE} = 400 \text{ V}, V_{GE} = 0/15 \text{ V}, R_G = 49 \text{ } \Omega$



**Typical switching energy losses as a function of collector current, IGBT**

$E = f(I_C)$

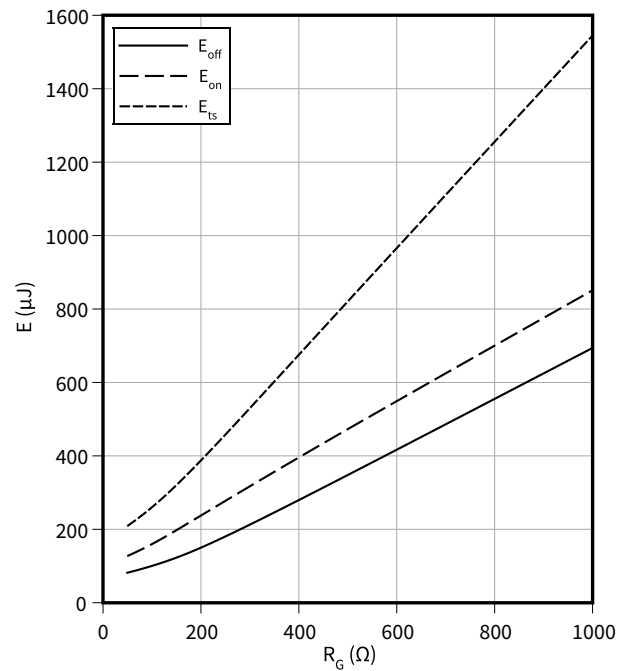
$V_{CE} = 400 \text{ V}, T_{vj} = 150 \text{ }^\circ\text{C}, V_{GE} = 0/15 \text{ V}, R_G = 49 \text{ } \Omega$



**Typical switching energy losses as a function of gate resistor, IGBT**

$E = f(R_G)$

$I_C = 4 \text{ A}, V_{CE} = 400 \text{ V}, T_{vj} = 150 \text{ }^\circ\text{C}, V_{GE} = 0/15 \text{ V}$

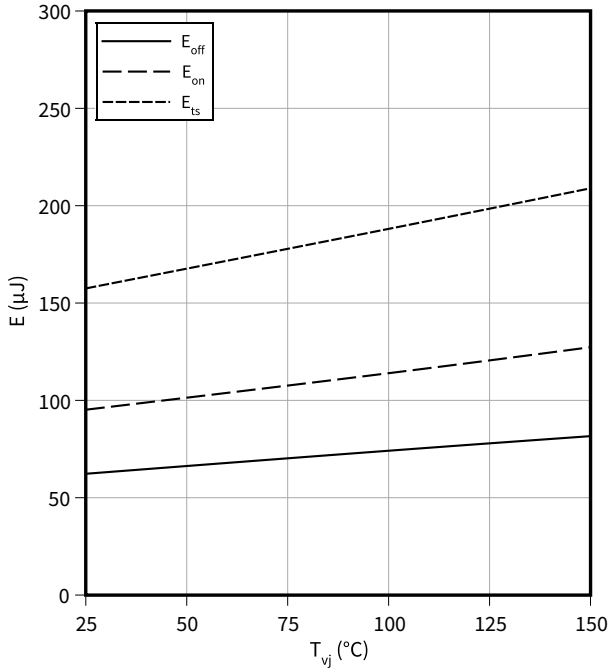


4 Characteristics diagrams

**Typical switching energy losses as a function of junction temperature, IGBT**

$E = f(T_{vj})$

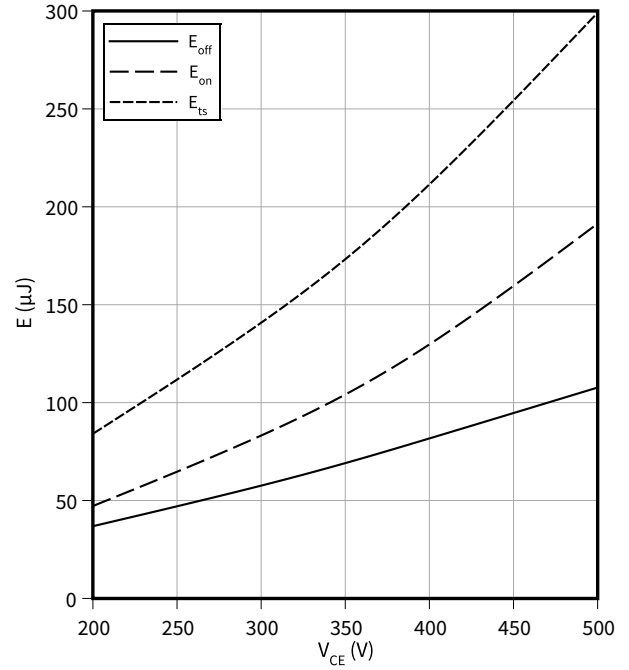
$I_C = 4 \text{ A}$ ,  $V_{CE} = 400 \text{ V}$ ,  $V_{GE} = 0/15 \text{ V}$ ,  $R_G = 49 \Omega$



**Typical switching energy losses as a function of collector emitter voltage, IGBT**

$E = f(V_{CE})$

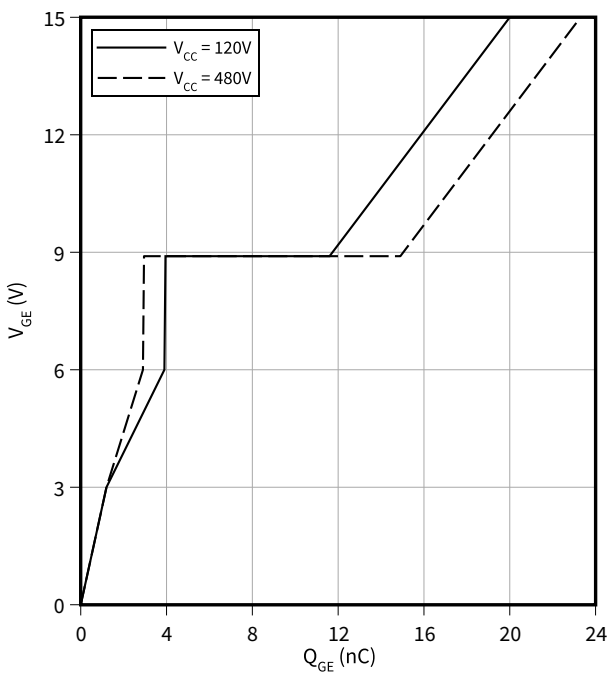
$I_C = 4 \text{ A}$ ,  $T_{vj} = 150 \text{ °C}$ ,  $V_{GE} = 0/15 \text{ V}$ ,  $R_G = 49 \Omega$



**Typical gate charge, IGBT**

$V_{GE} = f(Q_{GE})$

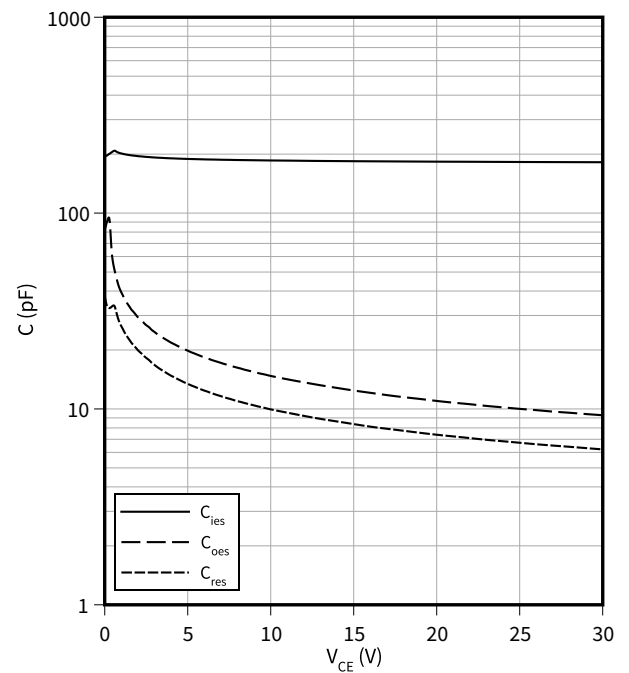
$I_C = 4 \text{ A}$



**Typical capacitance as a function of collector-emitter voltage, IGBT**

$C = f(V_{CE})$

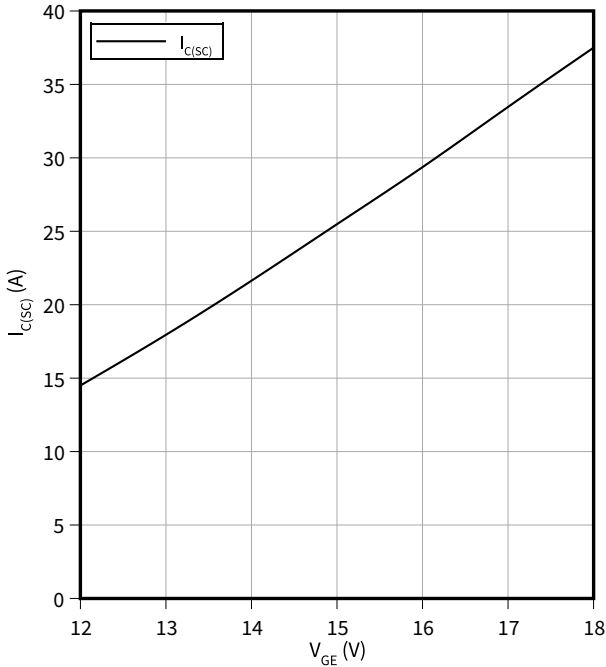
$f = 1000 \text{ kHz}$ ,  $V_{GE} = 0 \text{ V}$



4 Characteristics diagrams

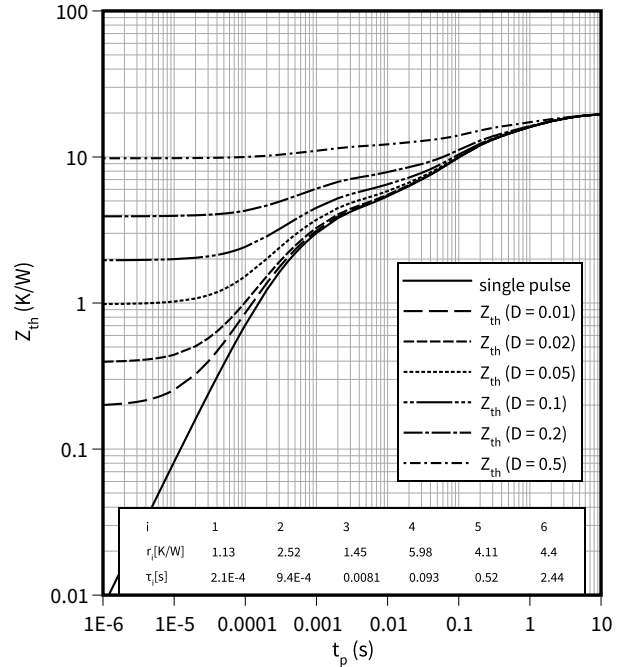
**Typical short circuit collector current as a function of gate-emitter voltage, IGBT**

$I_{C(SC)} = f(V_{GE})$   
 $V_{CE} \leq 400 \text{ V}, T_{vj} \leq 150 \text{ }^\circ\text{C}$



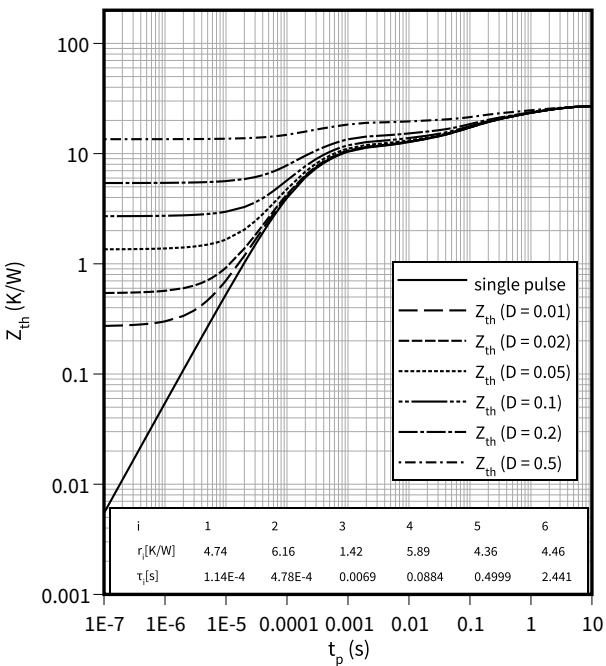
**IGBT transient thermal resistance, IGBT**

$Z_{th} = f(t_p)$   
 $D = t_p/T$



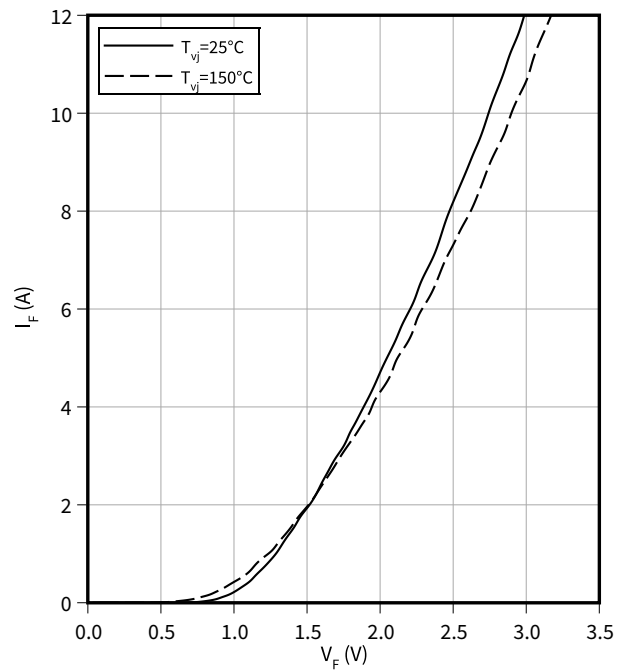
**Diode transient thermal impedance as a function of pulse width, Diode**

$Z_{th} = f(t_p)$   
 $D = t_p/T$



**Typical diode forward current as a function of forward voltage, Diode**

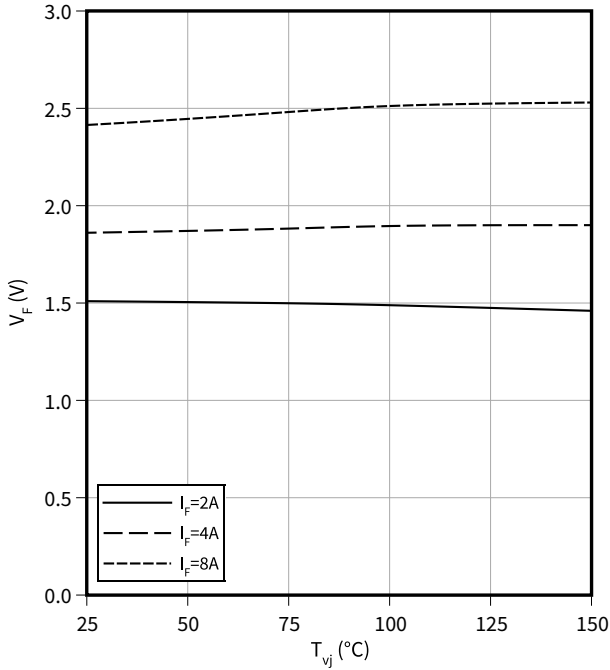
$I_F = f(V_F)$



4 Characteristics diagrams

**Typical diode forward voltage as a function of junction temperature, Diode**

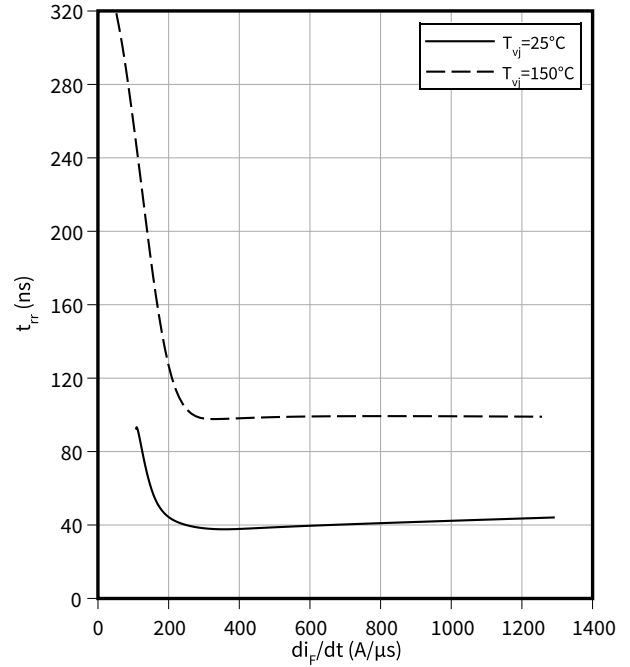
$V_F = f(T_{vj})$



**Typical reverse recovery time as a function of diode current slope, Diode**

$t_{rr} = f(di_F/dt)$

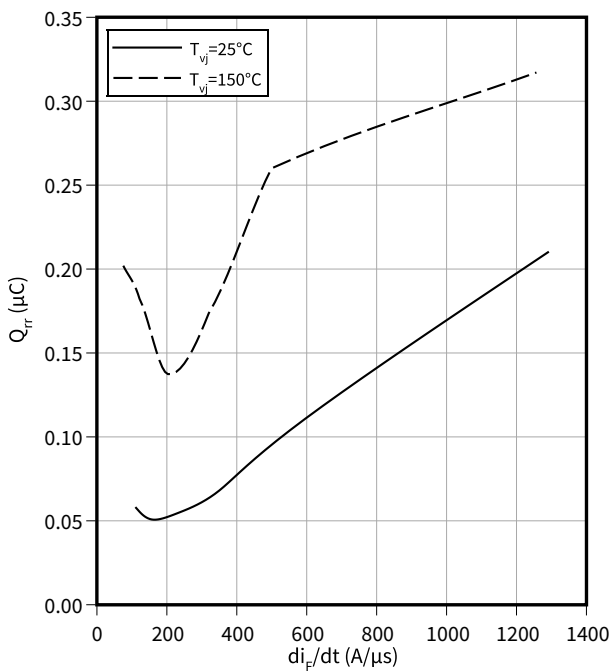
$V_R = 400 V, I_F = 4 A$



**Typical reverse recovery charge as a function of diode current slope, Diode**

$Q_{rr} = f(di_F/dt)$

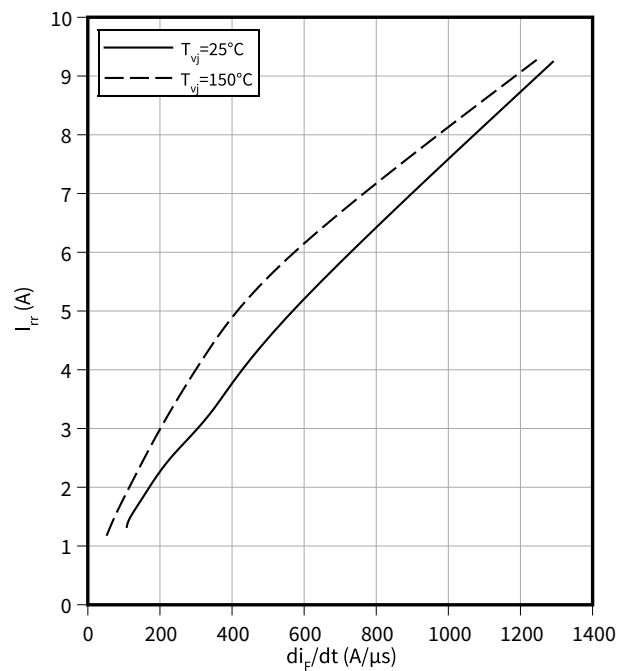
$V_R = 400 V, I_F = 4 A$



**Typical reverse recovery current as a function of diode current slope, Diode**

$I_{rr} = f(di_F/dt)$

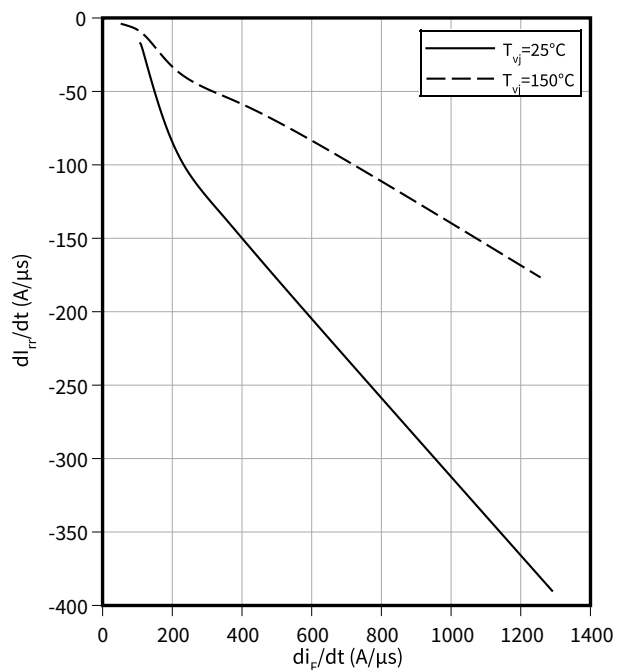
$V_R = 400 V, I_F = 4 A$



**Typical diode peak rate of fall of reverse recovery current as a function of diode current slope, Diode**

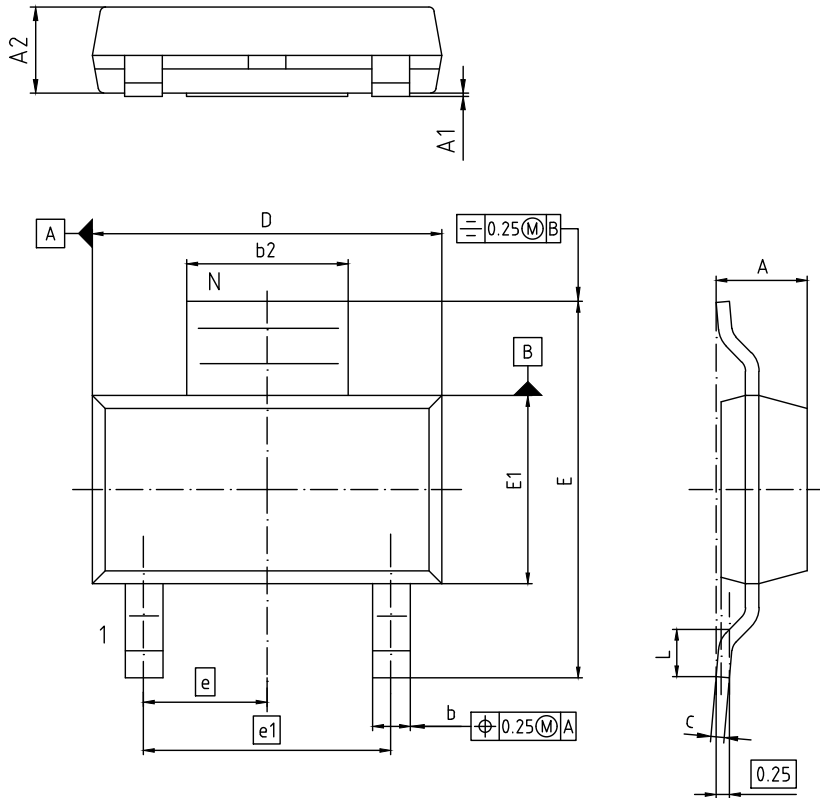
$$di_{rr}/dt = f(di_F/dt)$$

$V_R = 400 \text{ V}$ ,  $I_F = 4 \text{ A}$



**5 Package outlines**

**PG-SOT223-3**



NOTES:  
 1. ALL DIMENSIONS REFER TO JEDEC STANDARD TO-261

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	1.52	1.80	0.060	0.071
A1	-	0.10	-	0.004
A2	1.50	1.70	0.059	0.067
b	0.60	0.80	0.024	0.031
b2	2.95	3.10	0.116	0.122
c	0.24	0.32	0.009	0.013
D	6.30	6.70	0.248	0.264
E	6.70	7.30	0.264	0.287
E1	3.30	3.70	0.130	0.146
e	2.3 BASIC		0.091 BASIC	
e1	4.6 BASIC		0.181 BASIC	
L	0.75	1.10	0.030	0.043
N	3		3	
O	0°	10°	0°	10°

DOCUMENT NO.  
Z8B00180553

SCALE

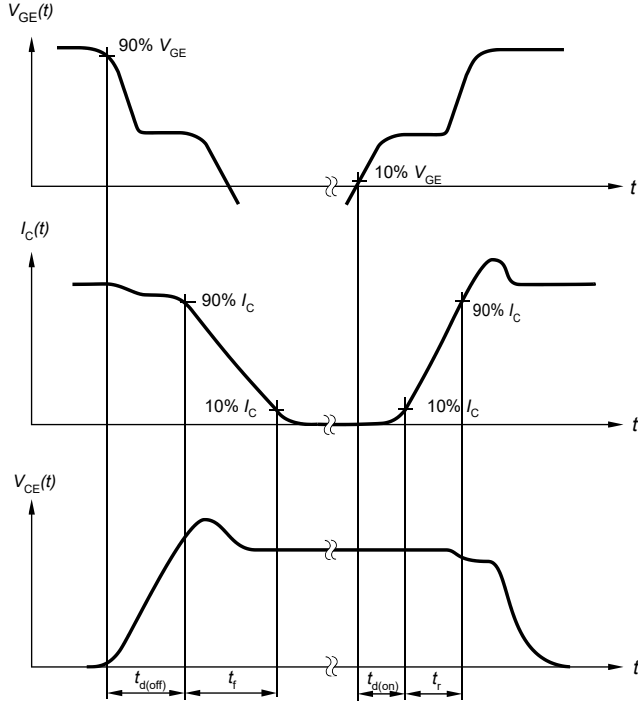
EUROPEAN PROJECTION

ISSUE DATE  
24-02-2016

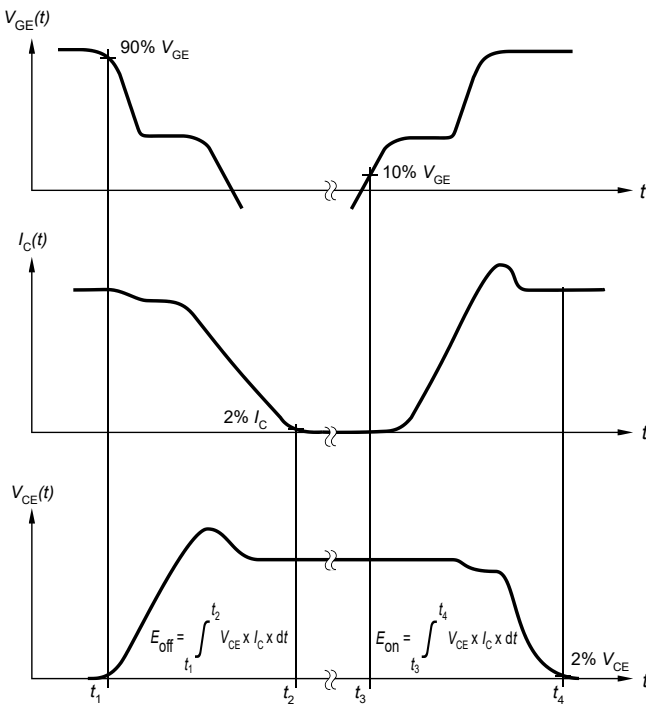
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**Figure 1**

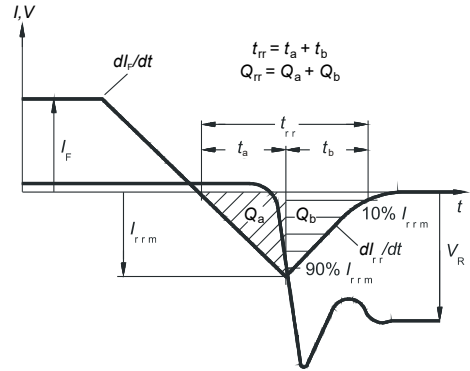
**6 Testing conditions**



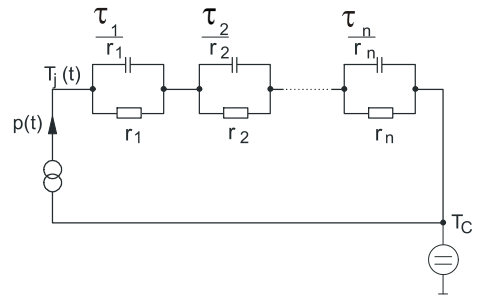
**Figure A. Definition of switching times**



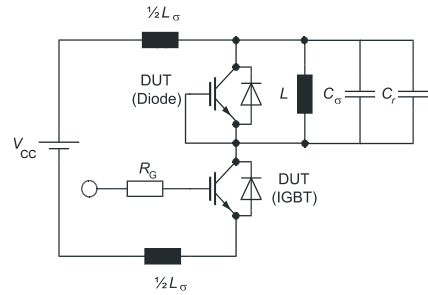
**Figure B. Definition of switching losses**



**Figure C. Definition of diode switching characteristics**



**Figure D. Thermal equivalent circuit**



**Figure E. Dynamic test circuit**  
 Parasitic inductance  $L_\sigma$ ,  
 parasitic capacitor  $C_\sigma$ ,  
 relief capacitor  $C_r$ ,  
 (only for ZVT switching)

**Figure 2**

## Revision history

Document revision	Date of release	Description of changes
1.00	2021-09-28	Final datasheet
1.01	2021-10-14	Change of Potential Applications



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