

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 μs
- Humidity robust design
- Pb-free lead plating; RoHS compliant
- Complete product spectrum and PSpice Models: <http://www.infineon.com/rc-d2>

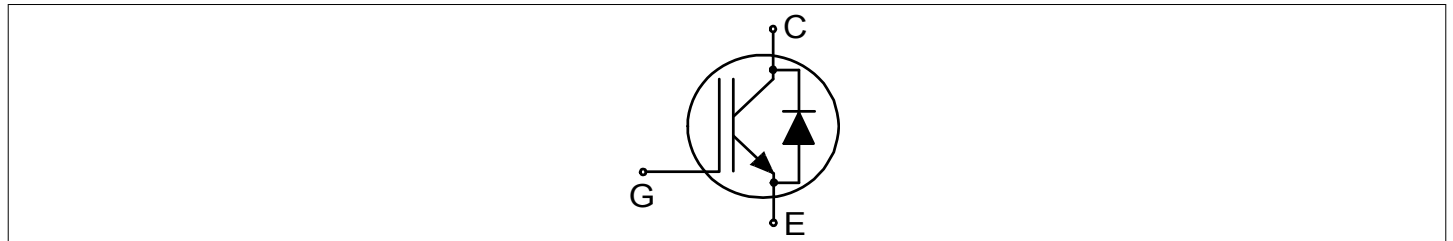
Potential applications

- 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 ² 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} ¹⁾	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}		± 20	V	
Transient gate-emitter voltage	V_{GE}	$t_p \leq 10\text{ }\mu\text{s}$, $D < 0.01$	± 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	μs	
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	μA
			$T_{vj} = 150 \text{ }^\circ\text{C}$		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	μJ
			$T_{vj} = 150 \text{ }^\circ\text{C},$ $I_C = 4.0 A$		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	μJ
			$T_{vj} = 150 \text{ }^\circ\text{C},$ $I_C = 4.0 A$		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		μJ
			$T_{vj} = 150\text{ }^{\circ}\text{C}$, $I_C = 4.0\text{ A}$		209		
IGBT thermal resistance, junction to case ¹⁾	R_{thjc}				18.4	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 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} ¹⁾	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	

¹⁾ 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		μC
					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 ¹⁾	R_{thjc}					26.3	K/W
Operating junction temperature	T_{vj}			-40		150	$^{\circ}\text{C}$

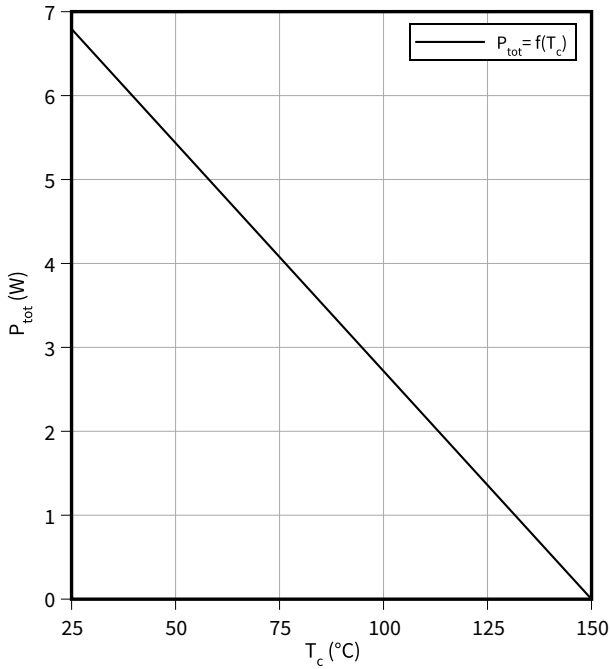
1) R_{th}/Z_{th} based on single cooling pulse. Please be aware that a correct R_{th} measurement of the diode, is not possible using a thermocouple.

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

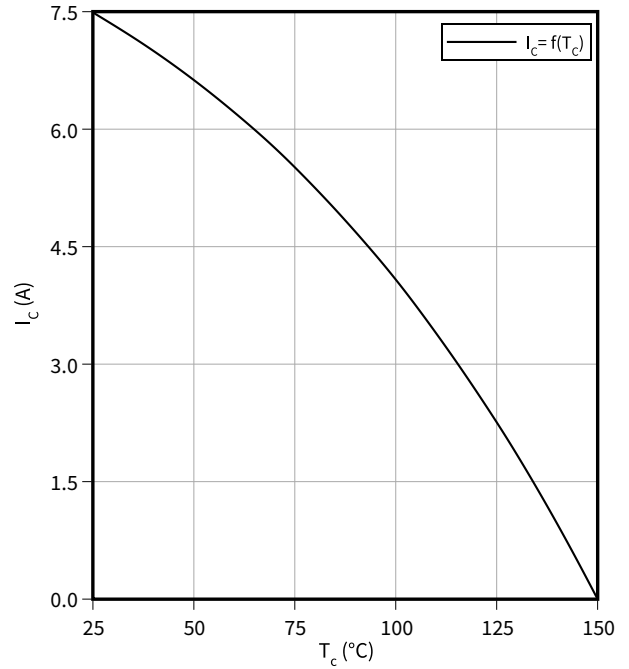
Power dissipation as a function of case temperature, IGBT

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



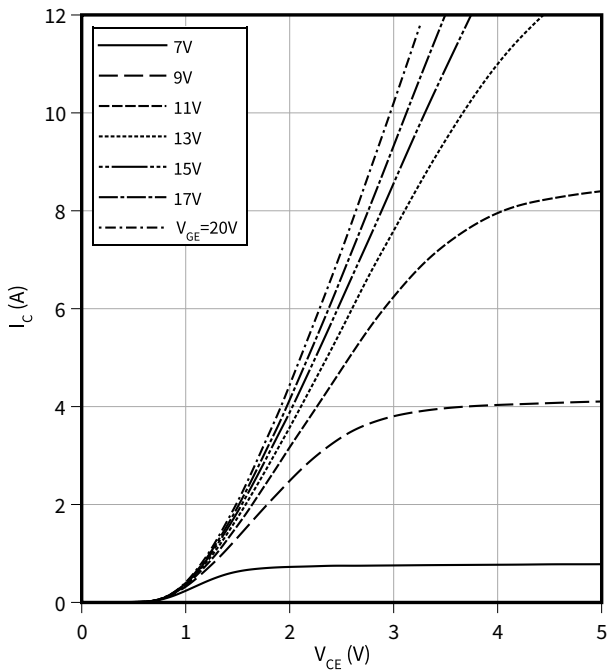
Collector current, DPAK equivalent, as a function of case temperature, IGBT

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



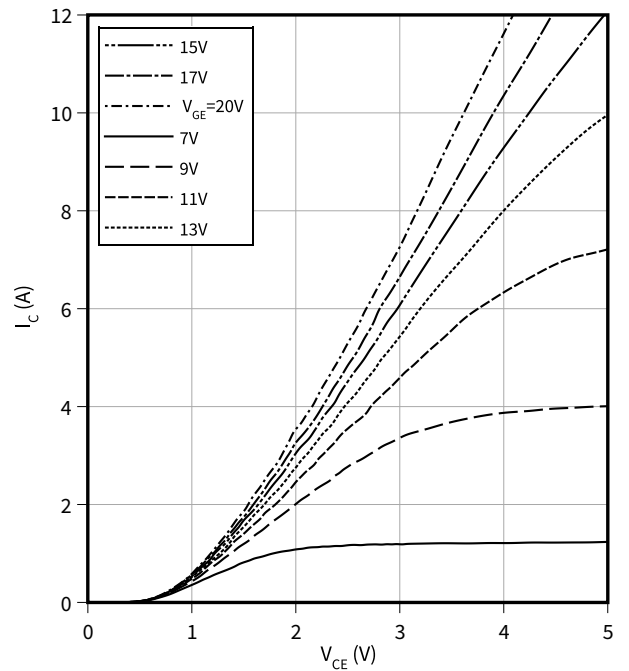
Typical output characteristic, IGBT

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



Typical output characteristic, IGBT

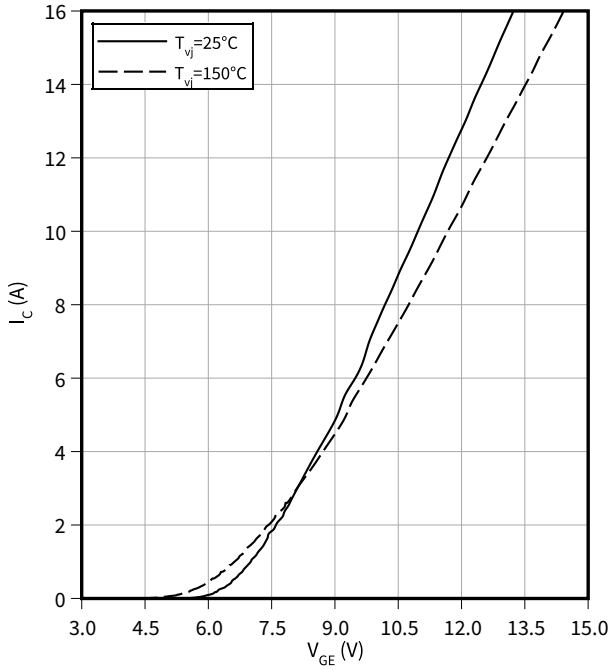
$I_c = f(V_{CE})$
 $T_{vj} = 150\text{ }^\circ\text{C}$



4 Characteristics diagrams

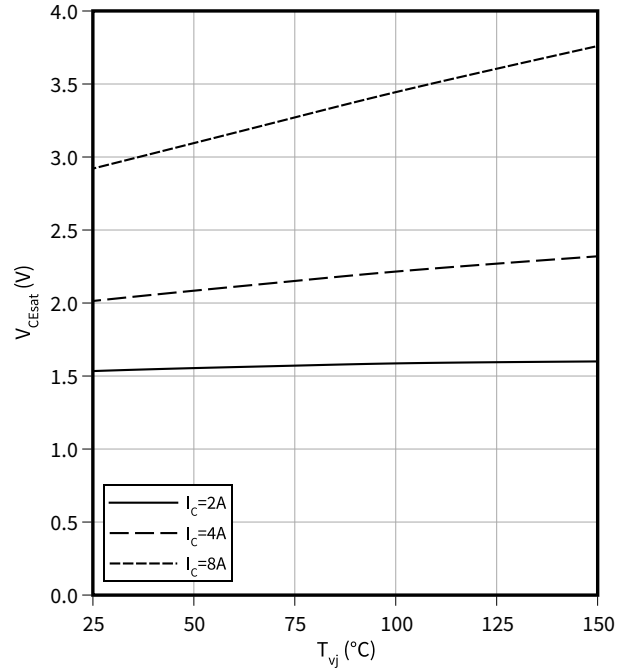
Typical transfer characteristic, IGBT

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



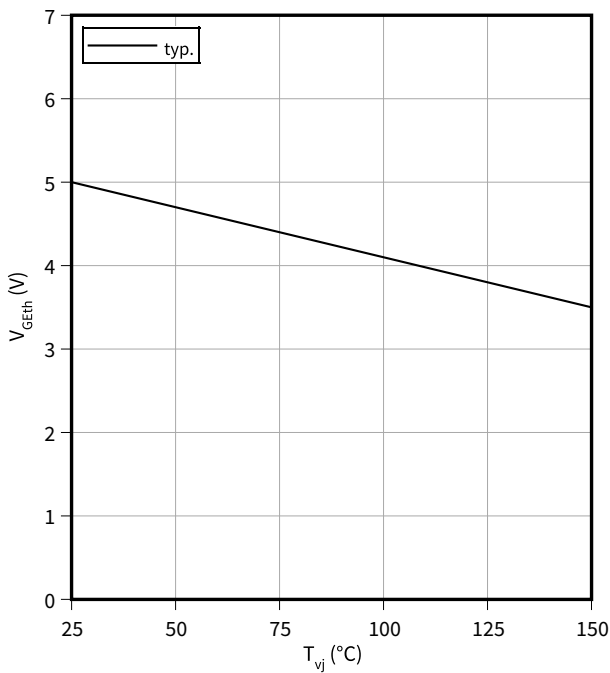
Typical collector-emitter saturation voltage as a function of junction temperature, IGBT

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



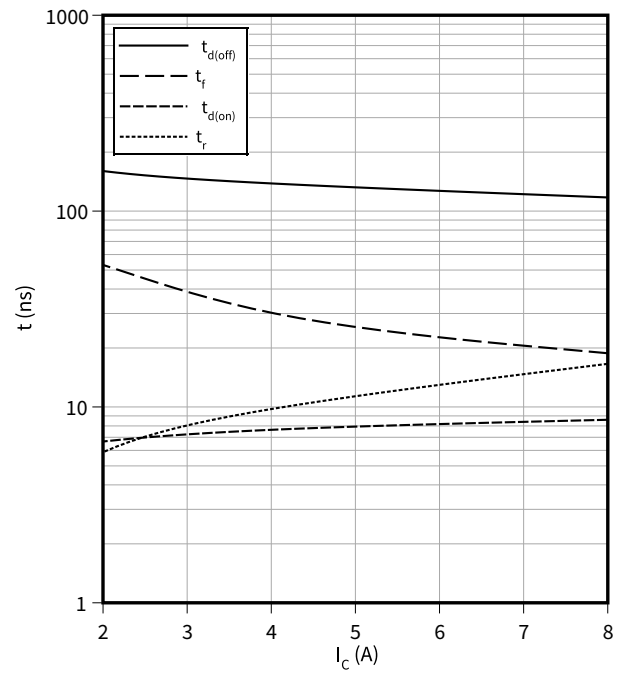
Gate-emitter threshold voltage as a function of junction temperature, IGBT

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



Typical switching times as a function of collector current, IGBT

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

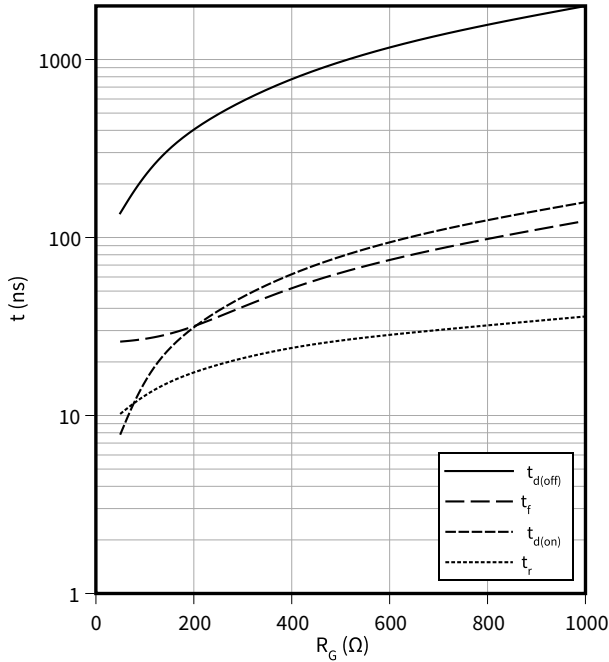


4 Characteristics diagrams

Typical switching times as a function of gate resistor, IGBT

$t = f(R_G)$

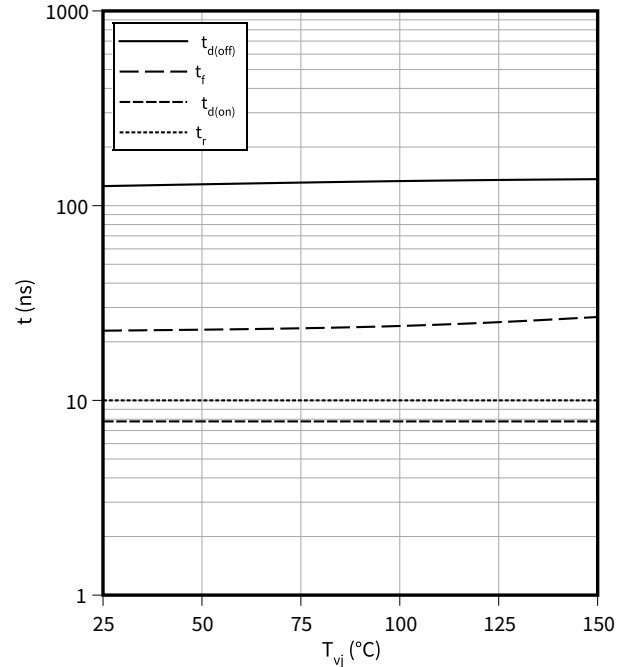
$I_C = 4 \text{ A}, V_{CE} = 400 \text{ V}, T_{vj} = 150 \text{ }^\circ\text{C}, V_{GE} = 0/15 \text{ V}$



Typical switching times as a function of junction temperature, IGBT

$t = f(T_{vj})$

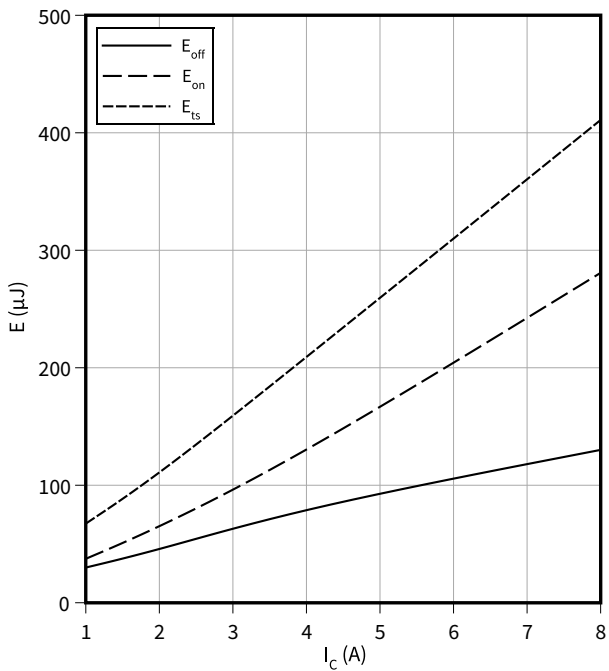
$I_C = 4 \text{ A}, V_{CE} = 400 \text{ V}, V_{GE} = 0/15 \text{ V}, R_G = 49 \text{ } \Omega$



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

$E = f(I_C)$

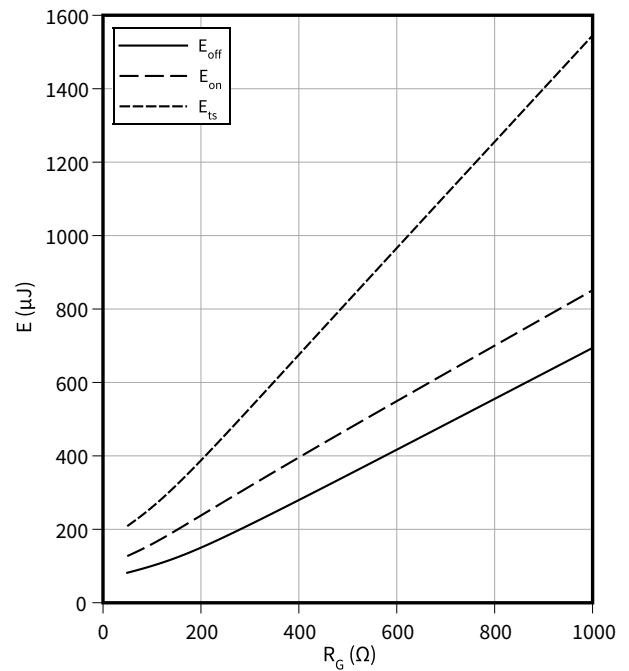
$V_{CE} = 400 \text{ V}, T_{vj} = 150 \text{ }^\circ\text{C}, V_{GE} = 0/15 \text{ V}, R_G = 49 \text{ } \Omega$



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

$E = f(R_G)$

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

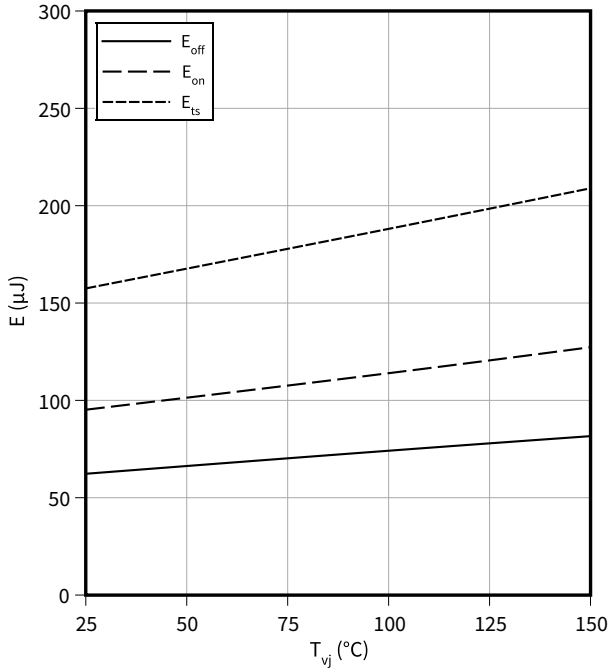


4 Characteristics diagrams

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

$E = f(T_{vj})$

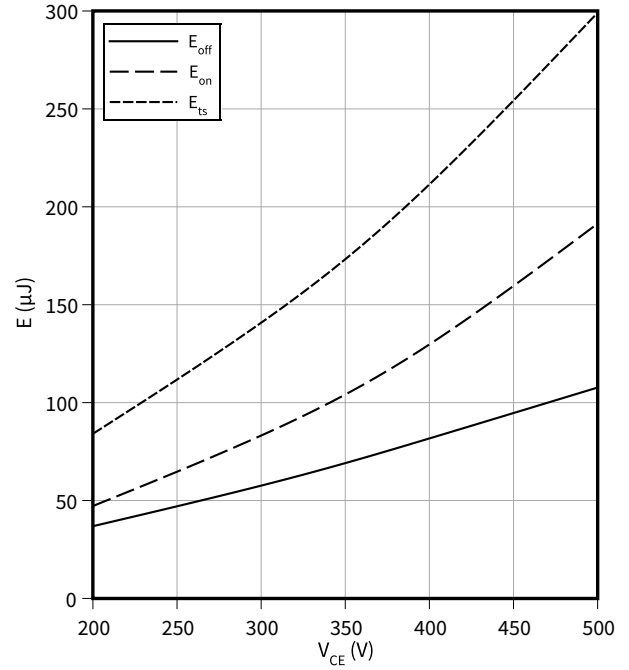
$I_C = 4 \text{ A}$, $V_{CE} = 400 \text{ V}$, $V_{GE} = 0/15 \text{ V}$, $R_G = 49 \Omega$



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

$E = f(V_{CE})$

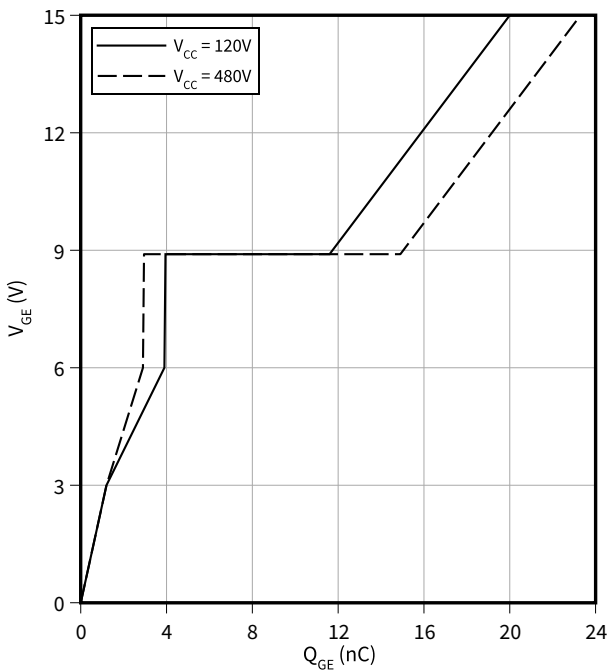
$I_C = 4 \text{ A}$, $T_{vj} = 150 \text{ °C}$, $V_{GE} = 0/15 \text{ V}$, $R_G = 49 \Omega$



Typical gate charge, IGBT

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

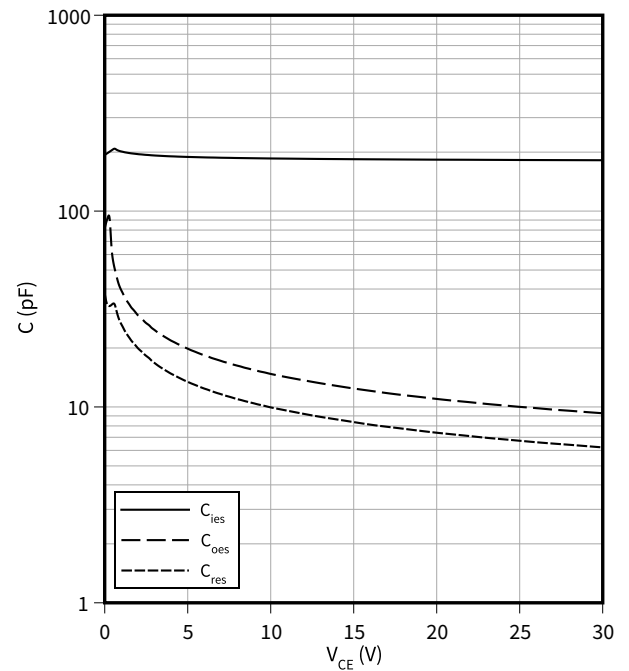
$I_C = 4 \text{ A}$



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

$C = f(V_{CE})$

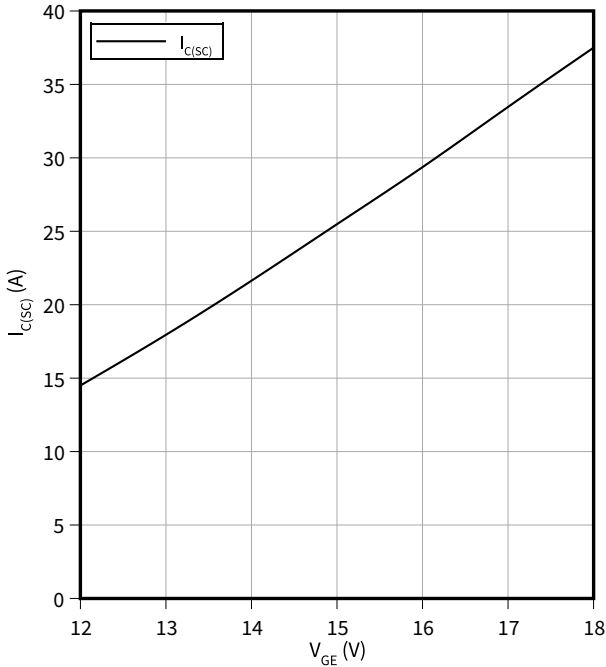
$f = 1000 \text{ kHz}$, $V_{GE} = 0 \text{ V}$



4 Characteristics diagrams

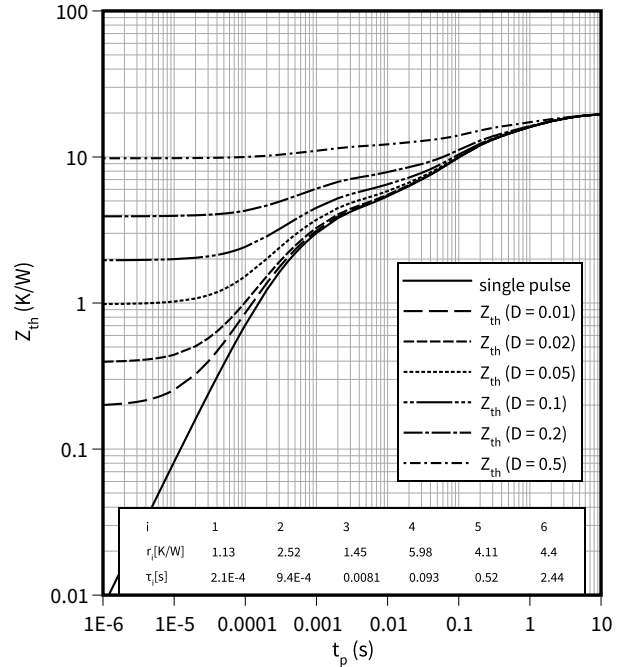
Typical short circuit collector current as a function of gate-emitter voltage, IGBT

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



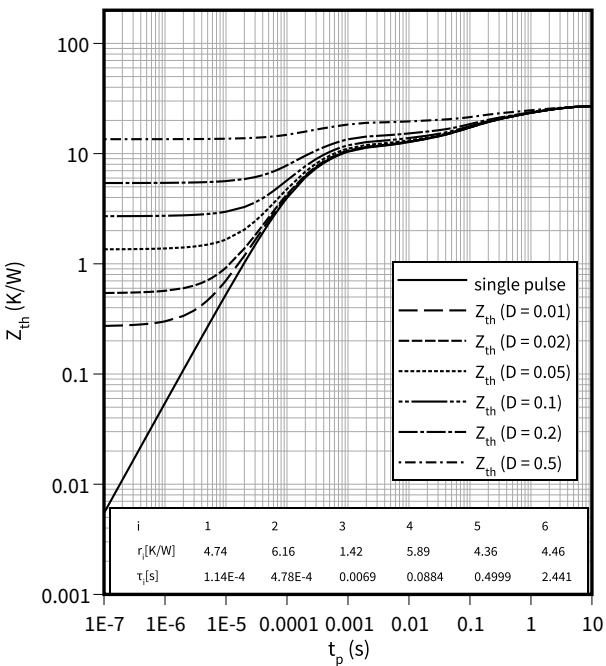
IGBT transient thermal resistance, IGBT

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



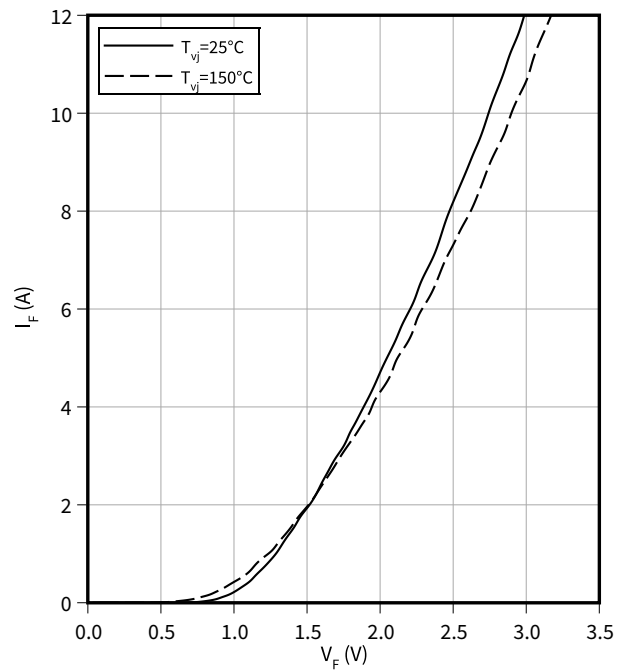
Diode transient thermal impedance as a function of pulse width, Diode

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



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

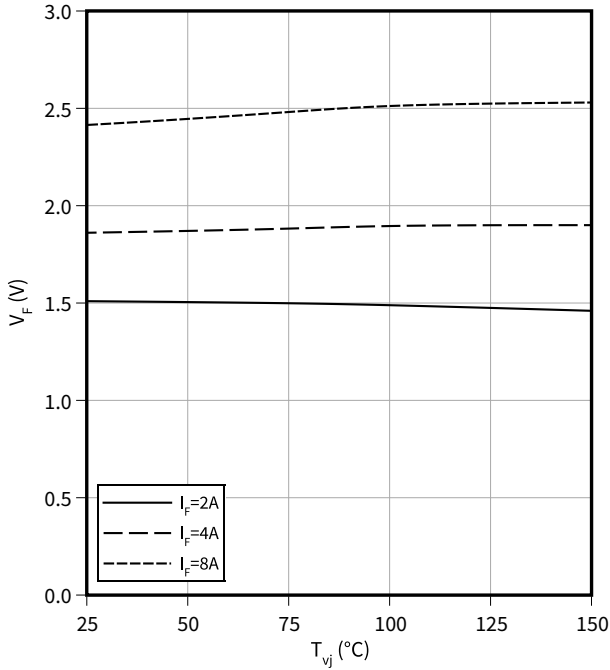
$I_F = f(V_F)$



4 Characteristics diagrams

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

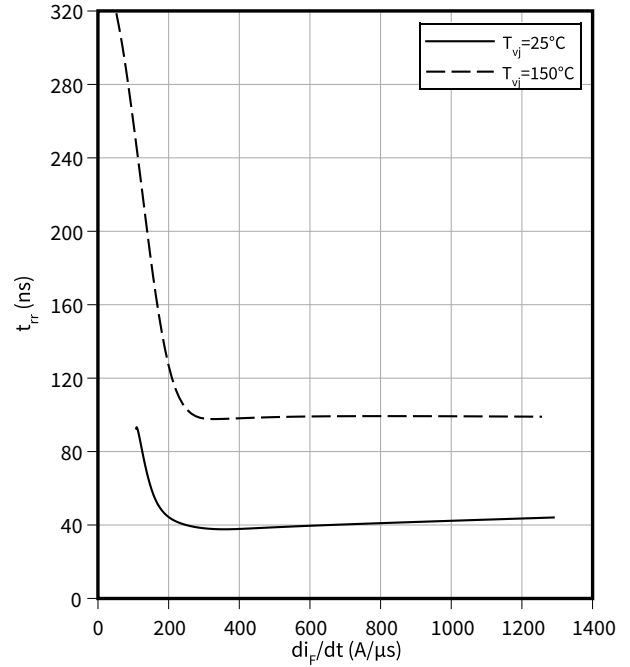
$V_F = f(T_{vj})$



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

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

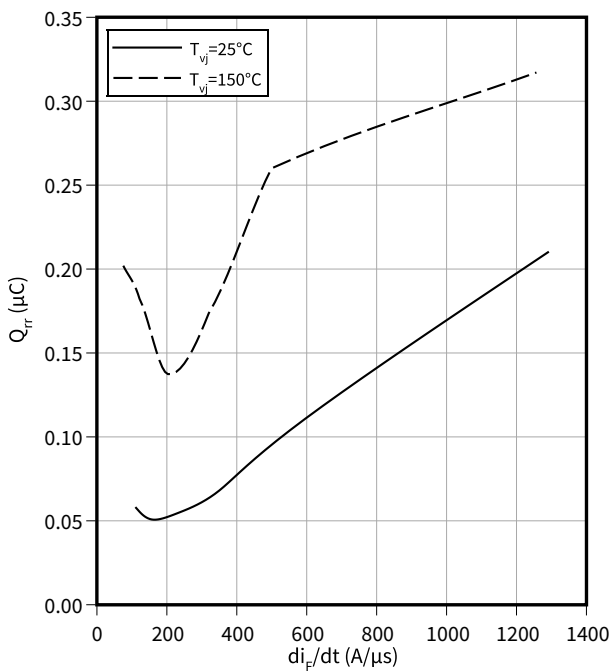
$V_R = 400 V, I_F = 4 A$



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

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

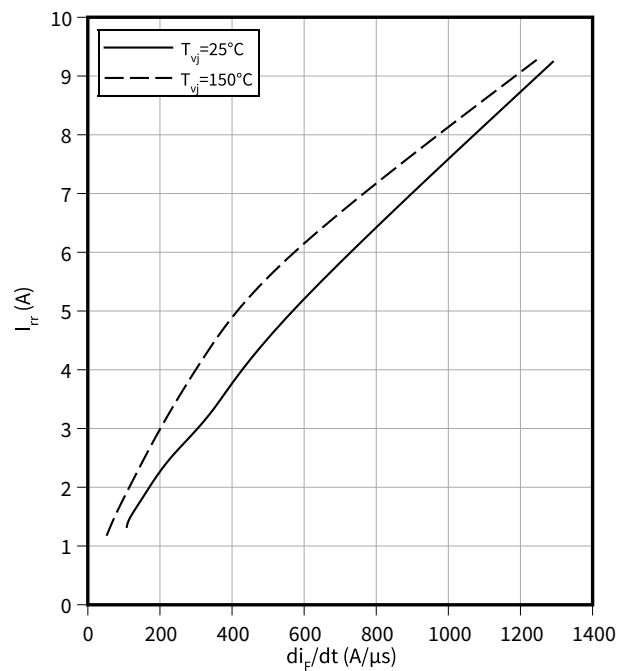
$V_R = 400 V, I_F = 4 A$



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

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

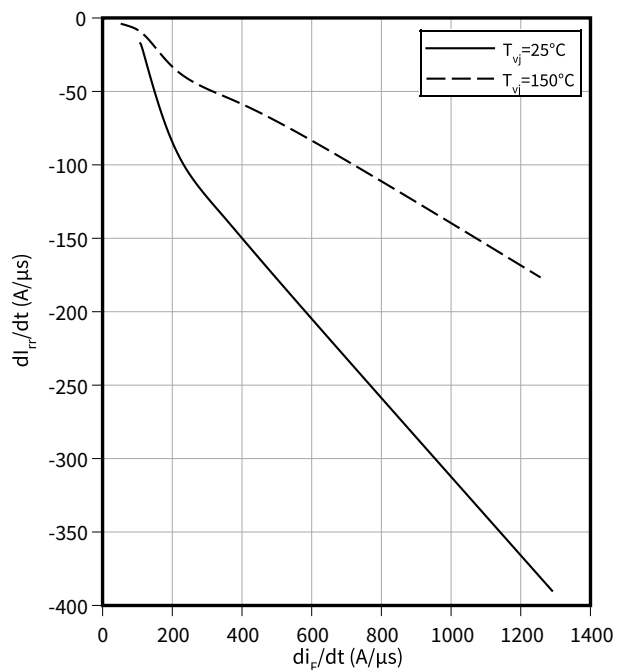
$V_R = 400 V, I_F = 4 A$



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

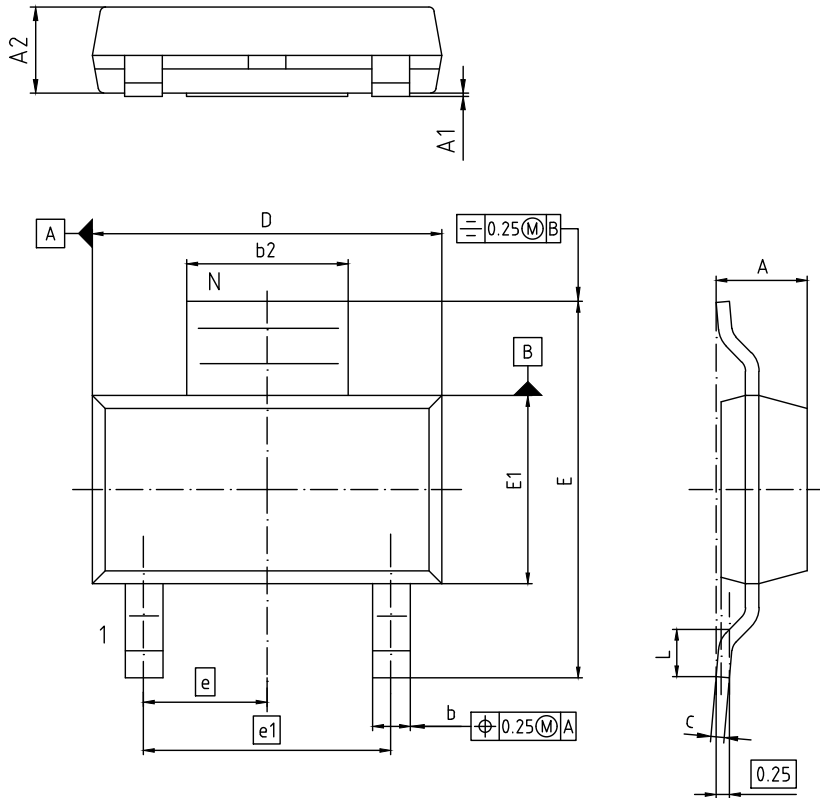
$$di_{rr}/dt = f(di_F/dt)$$

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



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

REVISION
01

Figure 1

6 Testing conditions

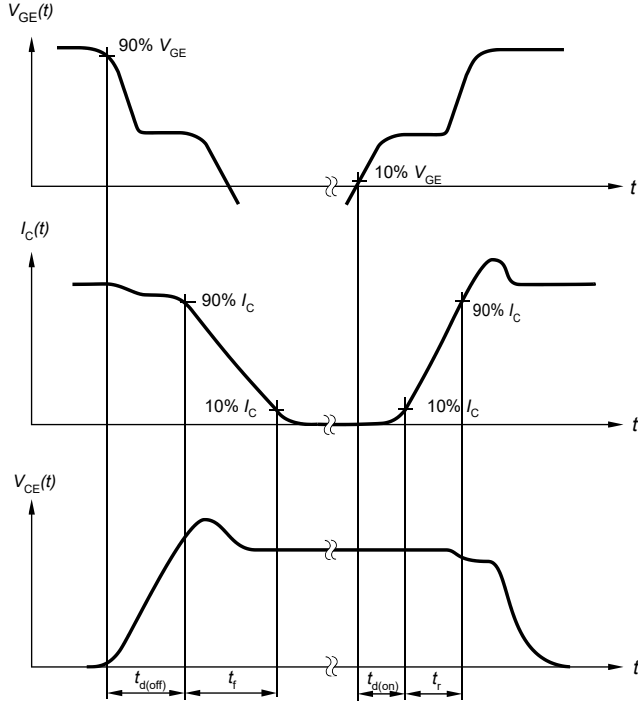


Figure A. Definition of switching times

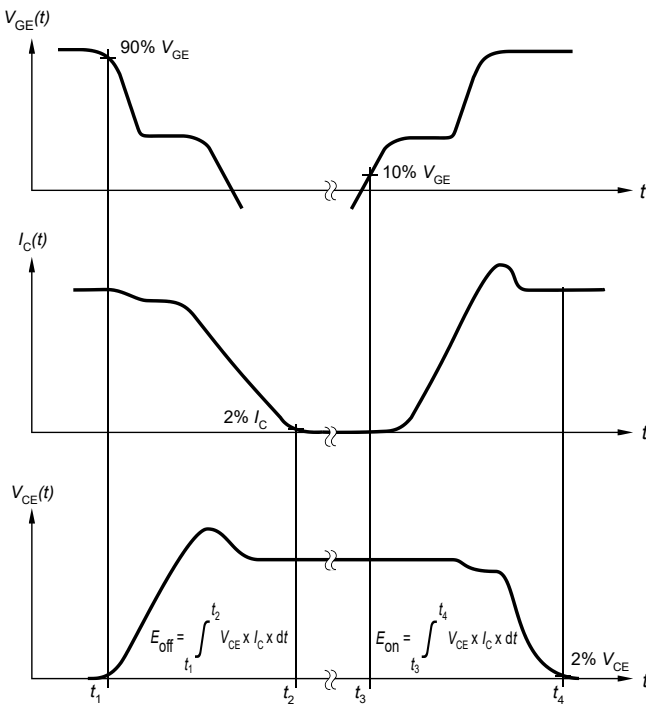


Figure B. Definition of switching losses

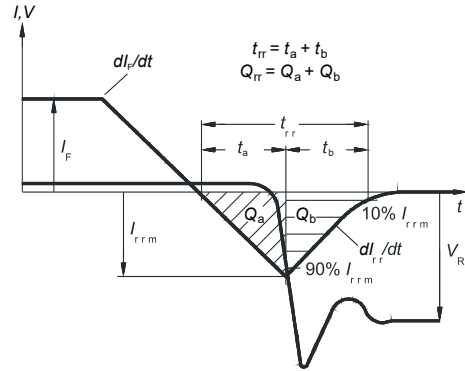


Figure C. Definition of diode switching characteristics

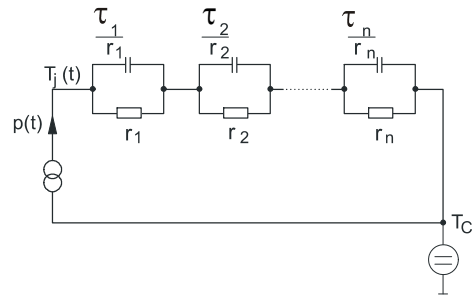


Figure D. Thermal equivalent circuit

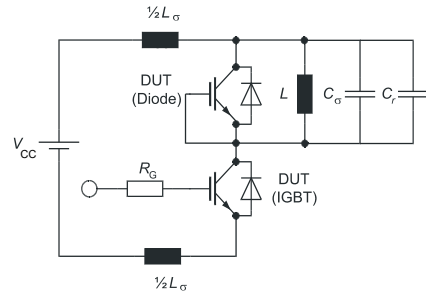


Figure E. Dynamic test circuit
 Parasitic inductance L_{σ} ,
 parasitic capacitor C_{σ} ,
 relief capacitor C_r ,
 (only for ZVT switching)

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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