

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 $3\text{ }\mu\text{s}$
- Humidity robust design
- Pb-free lead plating; RoHS compliant
- Complete product spectrum and PSpice Models: <http://www.infineon.com/rc-d2>

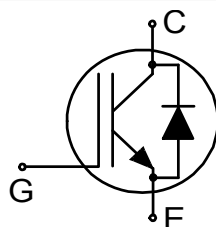
Potential applications

- 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



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	T_{sold}	wave soldering / 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
IGBT thermal resistance, junction-case ¹⁾	$R_{th(j-c)}$				18.4	K/W
Diode thermal resistance, junction-case ¹⁾	$R_{th(j-c)}$				26.3	K/W

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.

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_{Cpulse}			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}	$I_C = 4 \text{ A}$, $V_{GE} = 15 \text{ V}$	$T_{vj} = 25 \text{ °C}$		2	2.3	V
			$T_{vj} = 150 \text{ °C}$		2.3		
Gate-emitter threshold voltage	V_{GETh}	$I_C = 45 \text{ }\mu\text{A}$, $V_{CE} = V_{GE}$		4.3	5	5.7	V
Zero gate-voltage collector current	I_{CES}	$V_{CE} = 600 \text{ V}$, $V_{GE} = 0 \text{ V}$	$T_{vj} = 25 \text{ °C}$			25	μA
			$T_{vj} = 150 \text{ °C}$			2500	
Gate-emitter leakage current	I_{GES}	$V_{CE} = 0 \text{ V}$, $V_{GE} = 20 \text{ V}$				100	nA
Transconductance	g_{fs}	$I_C = 4 \text{ A}$, $V_{CE} = 20 \text{ V}$			2		S
Input capacitance	C_{ies}	$V_{CE} = 25 \text{ V}$, $V_{GE} = 0 \text{ V}$, $f = 1000 \text{ kHz}$			180		pF
Output capacitance	C_{oes}	$V_{CE} = 25 \text{ V}$, $V_{GE} = 0 \text{ V}$, $f = 1000 \text{ kHz}$			10		pF
Reverse transfer capacitance	C_{res}	$V_{CE} = 25 \text{ V}$, $V_{GE} = 0 \text{ V}$, $f = 1000 \text{ kHz}$			7		pF
Gate charge	Q_G	$I_C = 4 \text{ A}$, $V_{CC} = 480 \text{ V}$, $V_{GE} = 15 \text{ V}$			24		nC
Turn-on delay time	$t_{d(on)}$	$V_{CC} = 400 \text{ V}$, $V_{GE} = 0/15 \text{ V}$, $R_{Gon} = 49 \text{ }\Omega$, $R_{Goff} = 49 \text{ }\Omega$, $L_\sigma = 30 \text{ nH}$, $C_\sigma = 32 \text{ pF}$	$T_{vj} = 25 \text{ °C}$, $I_C = 4 \text{ A}$		8		ns
			$T_{vj} = 150 \text{ °C}$, $I_C = 4 \text{ A}$		8		
Rise time (inductive load)	t_r	$V_{CC} = 400 \text{ V}$, $V_{GE} = 0/15 \text{ V}$, $R_{Gon} = 49 \text{ }\Omega$, $R_{Goff} = 49 \text{ }\Omega$, $L_\sigma = 30 \text{ nH}$, $C_\sigma = 32 \text{ pF}$	$T_{vj} = 25 \text{ °C}$, $I_C = 4 \text{ A}$		10		ns
			$T_{vj} = 150 \text{ °C}$, $I_C = 4 \text{ A}$		10		
Turn-off delay time	$t_{d(off)}$	$V_{CC} = 400 \text{ V}$, $V_{GE} = 0/15 \text{ V}$, $R_{Gon} = 49 \text{ }\Omega$, $R_{Goff} = 49 \text{ }\Omega$, $L_\sigma = 30 \text{ nH}$, $C_\sigma = 32 \text{ pF}$	$T_{vj} = 25 \text{ °C}$, $I_C = 4 \text{ A}$		126		ns
			$T_{vj} = 150 \text{ °C}$, $I_C = 4 \text{ A}$		137		
Fall time (inductive load)	t_f	$V_{CC} = 400 \text{ V}$, $V_{GE} = 0/15 \text{ V}$, $R_{Gon} = 49 \text{ }\Omega$, $R_{Goff} = 49 \text{ }\Omega$, $L_\sigma = 30 \text{ nH}$, $C_\sigma = 32 \text{ pF}$	$T_{vj} = 25 \text{ °C}$, $I_C = 4 \text{ A}$		24		ns
			$T_{vj} = 150 \text{ °C}$, $I_C = 4 \text{ A}$		26		
Turn-on energy	E_{on}	$V_{CC} = 400 \text{ V}$, $V_{GE} = 0/15 \text{ V}$, $R_{Gon} = 49 \text{ }\Omega$, $R_{Goff} = 49 \text{ }\Omega$, $L_\sigma = 30 \text{ nH}$, $C_\sigma = 32 \text{ pF}$	$T_{vj} = 25 \text{ °C}$, $I_C = 4 \text{ A}$		95		μJ
			$T_{vj} = 150 \text{ °C}$, $I_C = 4 \text{ A}$		127		
Turn-off energy	E_{off}	$V_{CC} = 400 \text{ V}$, $V_{GE} = 0/15 \text{ V}$, $R_{Gon} = 49 \text{ }\Omega$, $R_{Goff} = 49 \text{ }\Omega$, $L_\sigma = 30 \text{ nH}$, $C_\sigma = 32 \text{ pF}$	$T_{vj} = 25 \text{ °C}$, $I_C = 4 \text{ A}$		62		μJ
			$T_{vj} = 150 \text{ °C}$, $I_C = 4 \text{ A}$		82		
Total switching energy	E_{ts}	$V_{CC} = 400 \text{ V}$, $V_{GE} = 0/15 \text{ V}$, $R_{Gon} = 49 \text{ }\Omega$, $R_{Goff} = 49 \text{ }\Omega$, $L_\sigma = 30 \text{ nH}$, $C_\sigma = 32 \text{ pF}$	$T_{vj} = 25 \text{ °C}$, $I_C = 4 \text{ A}$		157		μJ
			$T_{vj} = 150 \text{ °C}$, $I_C = 4 \text{ A}$		209		

(table continues...)

Table 3 (continued) Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Operating junction temperature	T_{vj}		-40		150	°C

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}	$T_{vj} \geq 25^{\circ}\text{C}$	600	V
Diode forward current, limited by T_{vjmax} ¹⁾	I_F	$T_c = 25^{\circ}\text{C}$	4.9	A
		$T_c = 100^{\circ}\text{C}$	2.3	
Diode pulsed current, t_p limited by T_{vjmax}	I_{Fpulse}		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	$I_F = 4\text{ A}$		$T_{vj} = 25^{\circ}\text{C}$	1.85	V
				$T_{vj} = 150^{\circ}\text{C}$	1.9	
Diode reverse recovery time	t_{rr}	$V_R = 400\text{ V}$		$T_{vj} = 25^{\circ}\text{C}$, $I_F = 4\text{ A}$, $-di_F/dt = 483\text{ A}/\mu\text{s}$	39	ns
				$T_{vj} = 150^{\circ}\text{C}$, $I_F = 4\text{ A}$, $-di_F/dt = 500\text{ A}/\mu\text{s}$	100	
Diode reverse recovery charge	Q_{rr}	$V_R = 400\text{ V}$		$T_{vj} = 25^{\circ}\text{C}$, $I_F = 4\text{ A}$, $-di_F/dt = 483\text{ A}/\mu\text{s}$	0.097	μC
				$T_{vj} = 150^{\circ}\text{C}$, $I_F = 4\text{ A}$, $-di_F/dt = 500\text{ A}/\mu\text{s}$	0.259	
Diode peak reverse recovery current	I_{rrm}	$V_R = 400\text{ V}$		$T_{vj} = 25^{\circ}\text{C}$, $I_F = 4\text{ A}$, $-di_F/dt = 483\text{ A}/\mu\text{s}$	4.7	A
				$T_{vj} = 150^{\circ}\text{C}$, $I_F = 4\text{ A}$, $-di_F/dt = 500\text{ A}/\mu\text{s}$	5.8	

(table continues...)

Table 5 (continued) Characteristic values

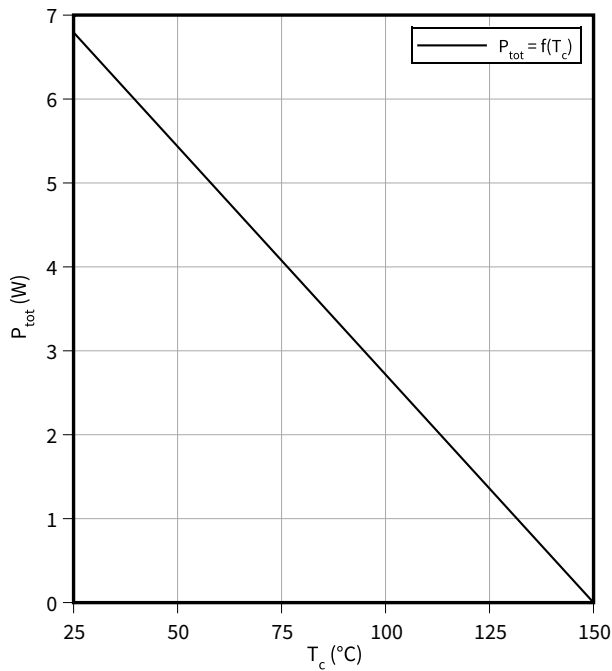
Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Diode peak rate of fall of reverse recovery current	di_{rr}/dt	$V_R = 400 \text{ V}$	$T_{vj} = 25 \text{ °C}, I_F = 4 \text{ A}, -di_F/dt = 483 \text{ A}/\mu\text{s}$		174		$\text{A}/\mu\text{s}$
			$T_{vj} = 150 \text{ °C}, I_F = 4 \text{ A}, -di_F/dt = 500 \text{ A}/\mu\text{s}$		67.4		
Operating junction temperature	T_{vj}			-40		150	$^{\circ}\text{C}$

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

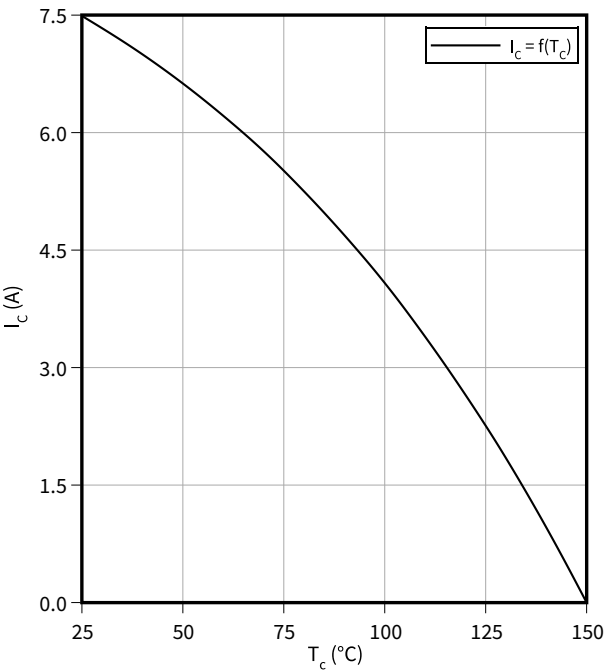
Power dissipation as a function of heatsink temperature

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



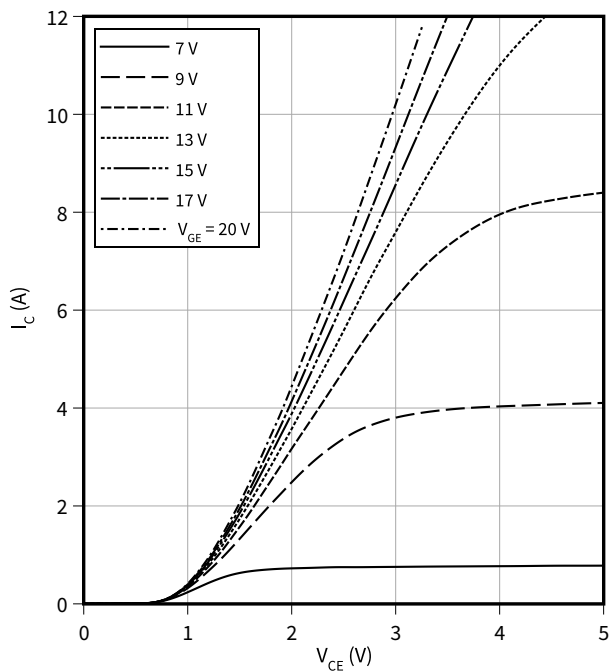
Collector current as a function of heatsink temperature

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



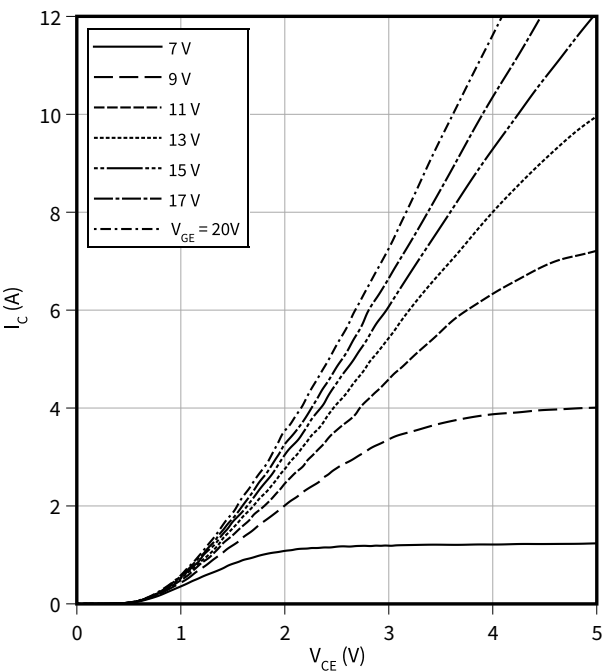
Typical output characteristic

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



Typical output characteristic

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

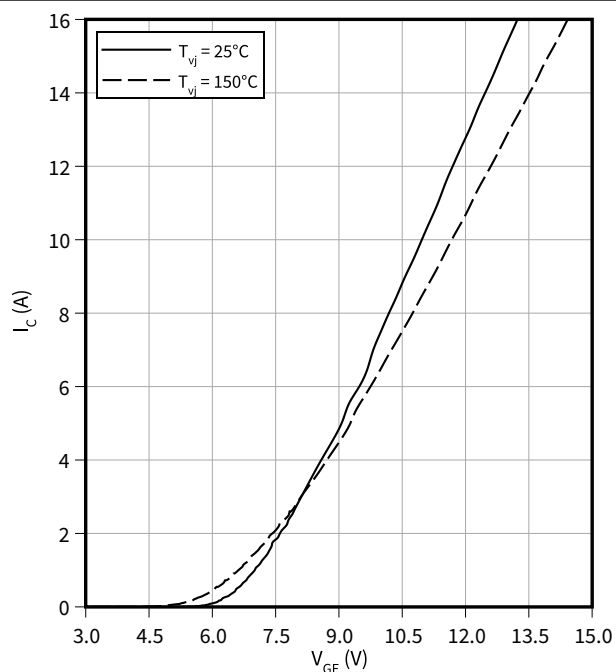


4 Characteristics diagrams

Typical transfer characteristic

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

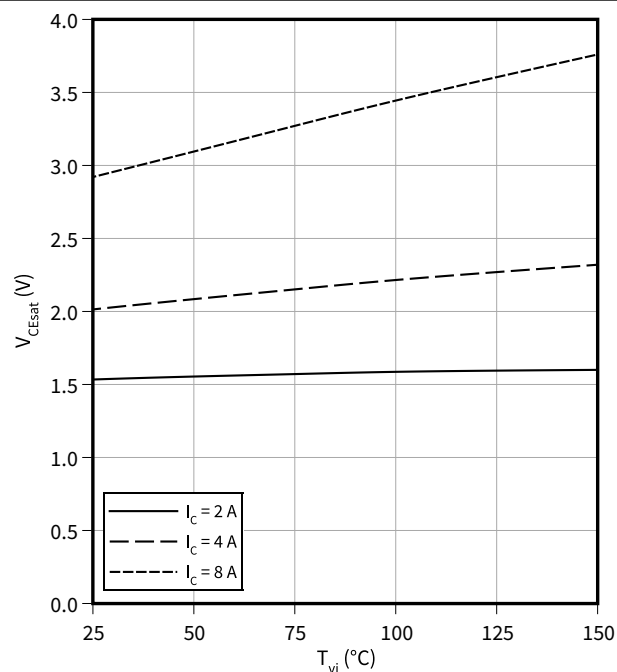
$$V_{CE} = 20 \text{ V}$$



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

$$V_{CEsat} = f(T_{vj})$$

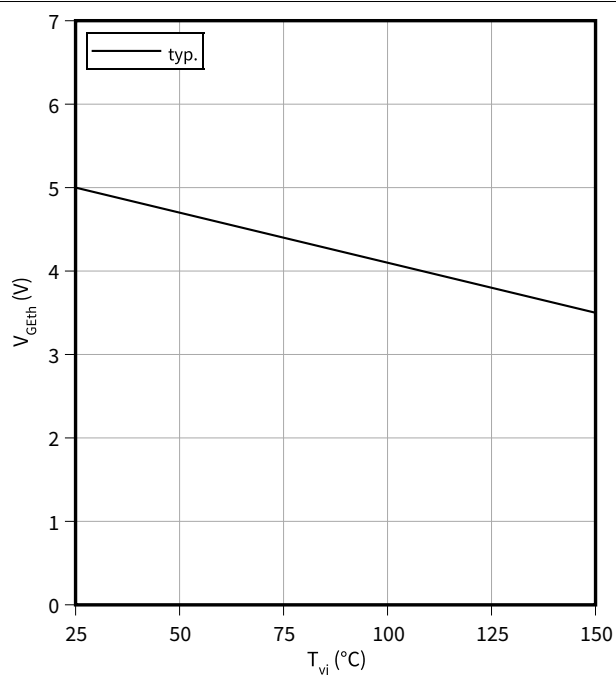
$$V_{GE} = 15 \text{ V}$$



Gate-emitter threshold voltage as a function of junction temperature

$$V_{GEth} = f(T_{vj})$$

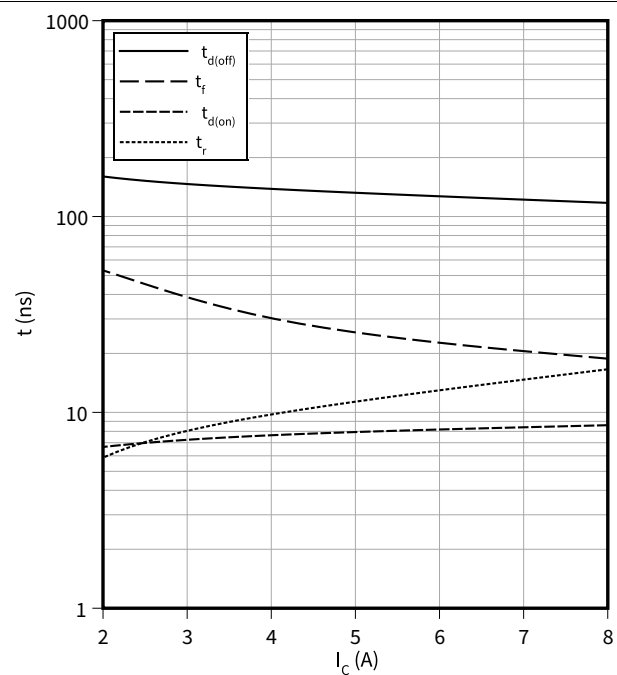
$$I_C = 45 \mu\text{A}$$



Typical switching times as a function of collector current

$$t = f(I_C)$$

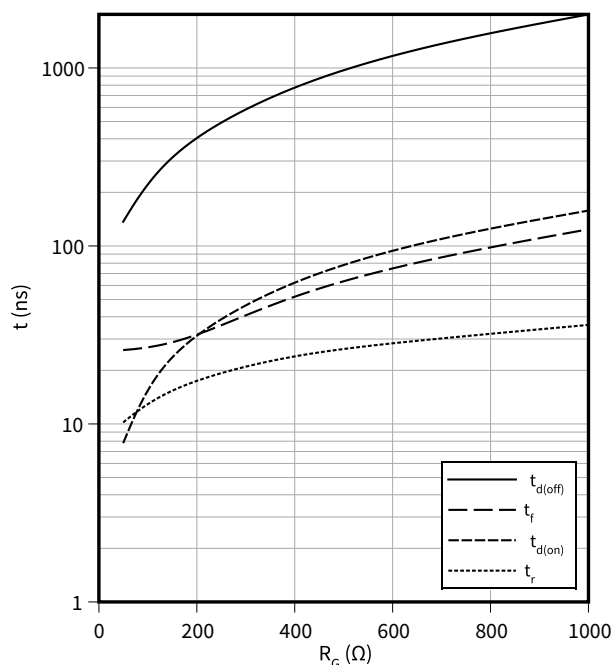
$$V_{CC} = 400 \text{ V}, T_{vj} = 150^\circ\text{C}, V_{GE} = 0/15 \text{ V}, R_G = 49 \Omega$$



Typical switching times as a function of gate resistor

$$t = f(R_G)$$

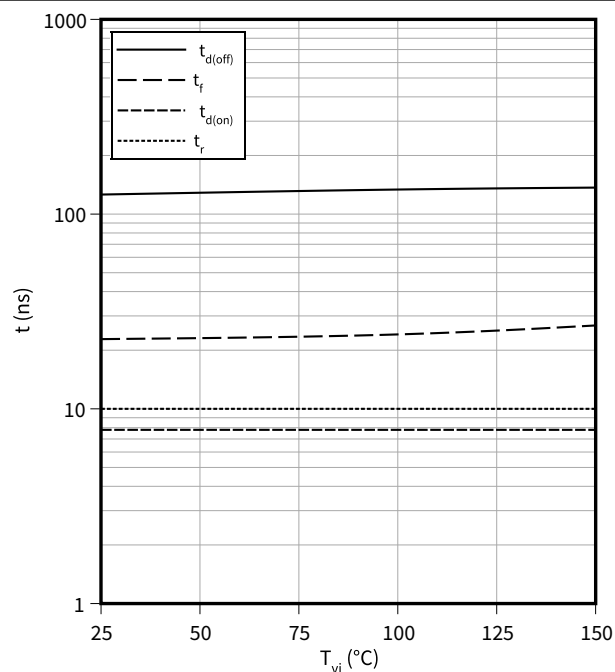
$I_C = 4 \text{ A}$, $V_{CC} = 400 \text{ V}$, $T_{vj} = 150 \text{ }^\circ\text{C}$, $V_{GE} = 0/15 \text{ V}$



Typical switching times as a function of junction temperature

$$t = f(T_{vj})$$

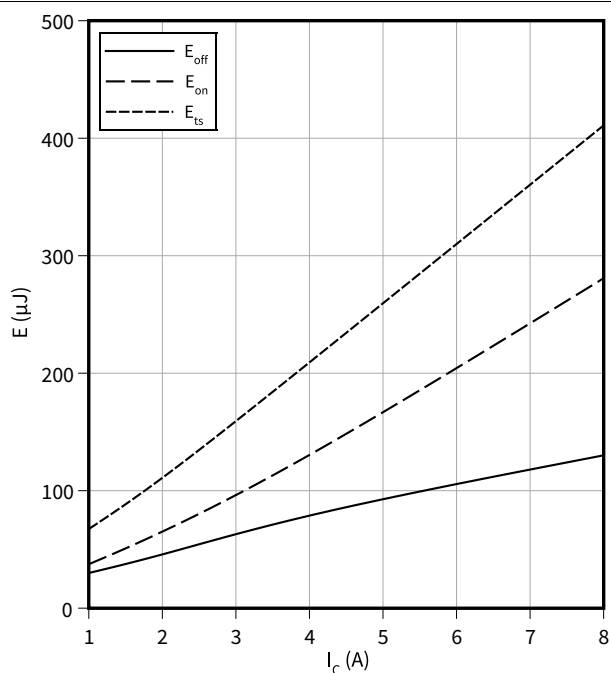
$I_C = 4 \text{ A}$, $V_{CC} = 400 \text{ V}$, $V_{GE} = 0/15 \text{ V}$, $R_G = 49 \text{ } \Omega$



Typical switching energy losses as a function of collector current

$$E = f(I_C)$$

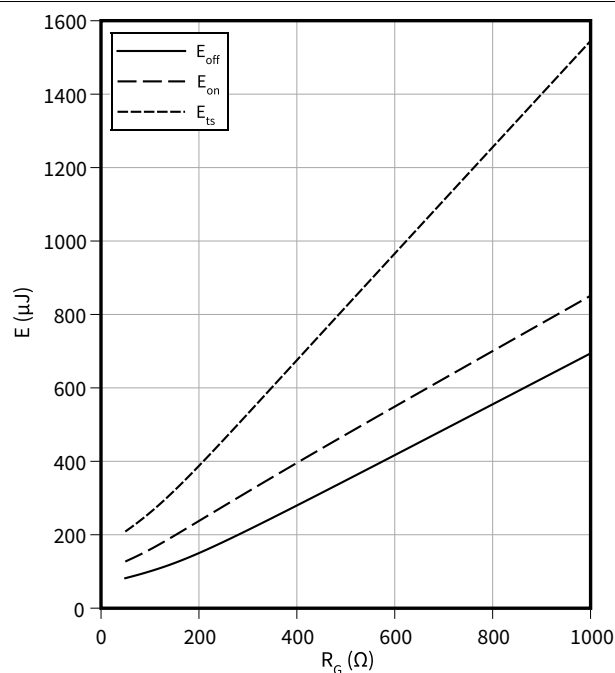
$V_{CC} = 400 \text{ V}$, $T_{vj} = 150 \text{ }^\circ\text{C}$, $V_{GE} = 0/15 \text{ V}$, $R_G = 49 \text{ } \Omega$



Typical switching energy losses as a function of gate resistor

$$E = f(R_G)$$

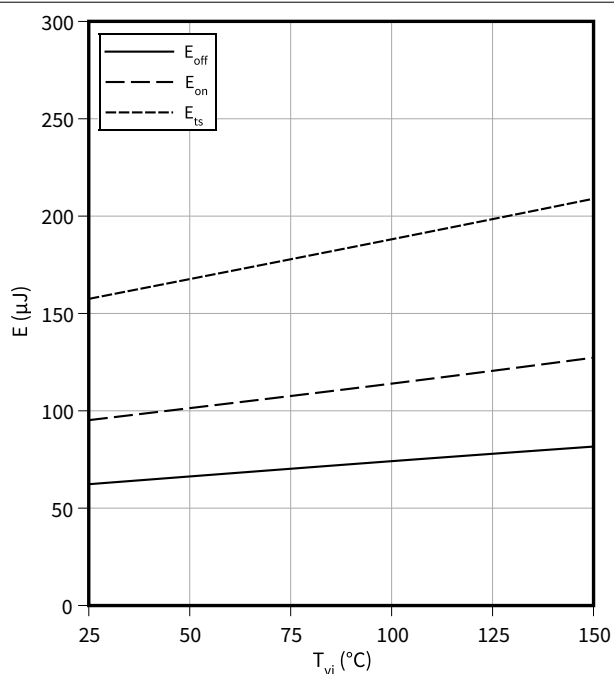
$I_C = 4 \text{ A}$, $V_{CC} = 400 \text{ V}$, $T_{vj} = 150 \text{ }^\circ\text{C}$, $V_{GE} = 0/15 \text{ V}$



Typical switching energy losses as a function of junction temperature

$$E = f(T_{vj})$$

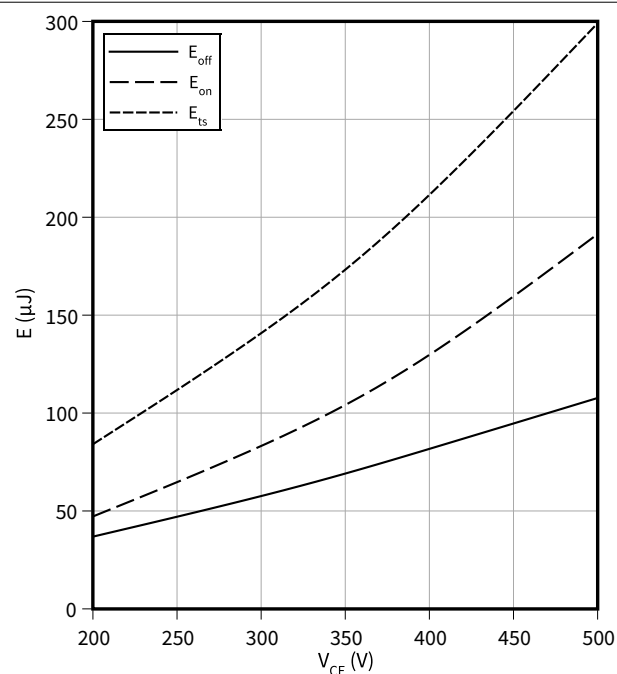
$I_C = 4 \text{ A}$, $V_{CC} = 400 \text{ V}$, $V_{GE} = 0/15 \text{ V}$, $R_G = 49 \Omega$



Typical switching energy losses as a function of collector emitter voltage

$$E = f(V_{CE})$$

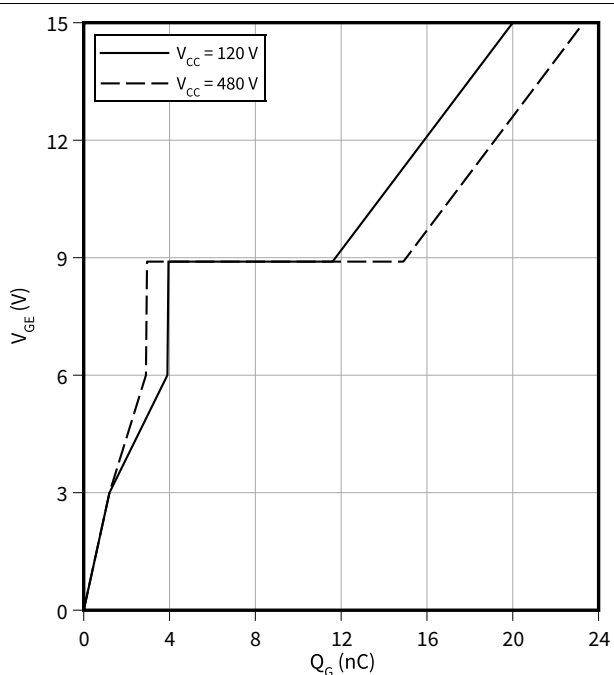
$I_C = 4 \text{ A}$, $T_{vj} = 150 \text{ }^\circ\text{C}$, $V_{GE} = 0/15 \text{ V}$, $R_G = 49 \Omega$



Typical gate charge

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

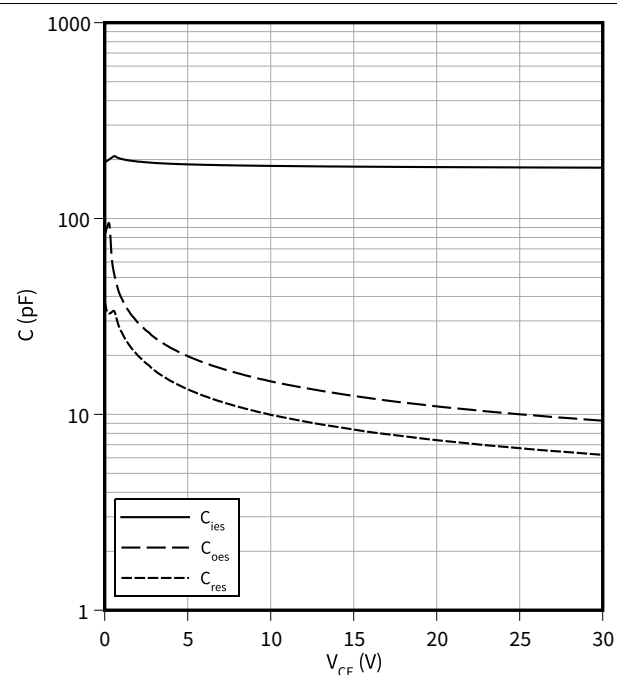
$I_C = 4 \text{ A}$



Typical capacitance as a function of collector-emitter voltage

$$C = f(V_{CE})$$

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

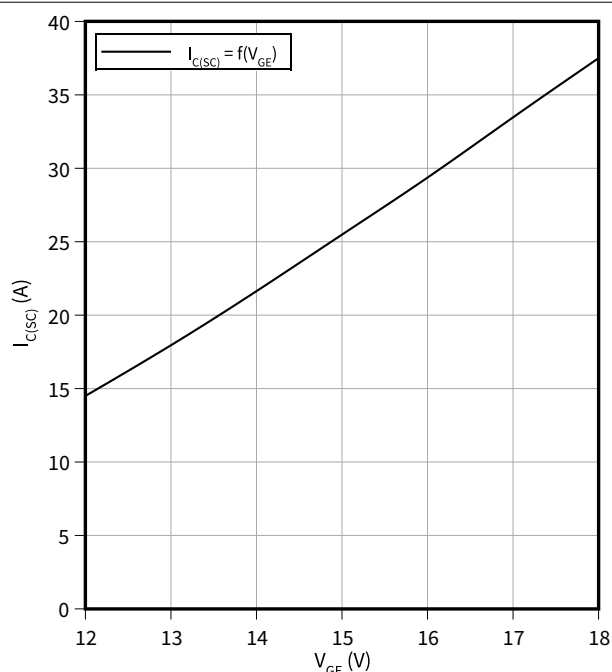


4 Characteristics diagrams

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

$$I_{C(SC)} = f(V_{GE})$$

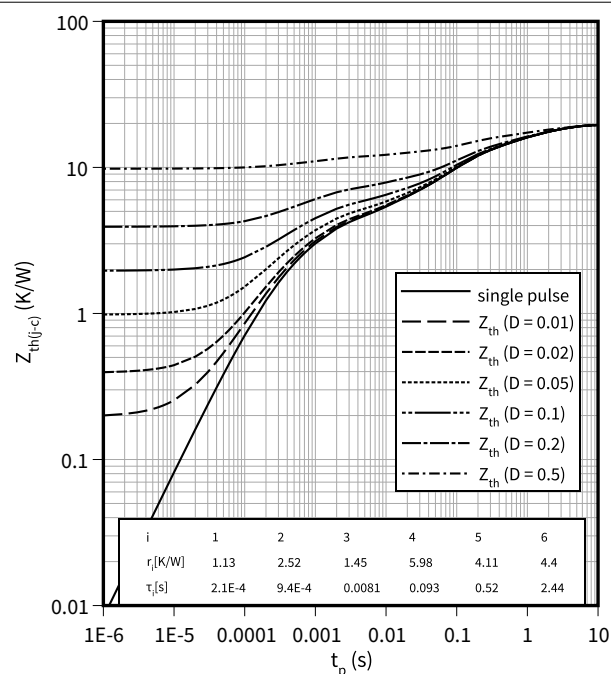
$T_{vj} \leq 150\text{ }^{\circ}\text{C}$, $V_{CC} \leq 400\text{ V}$



IGBT transient thermal impedance as a function of pulse width

$$Z_{th(j-c)} = f(t_p)$$

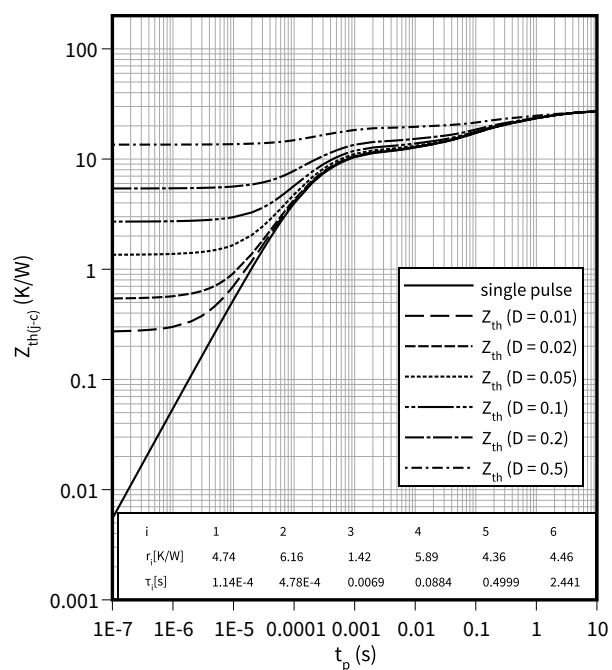
$D = t_p/T$



Diode transient thermal impedance as a function of pulse width

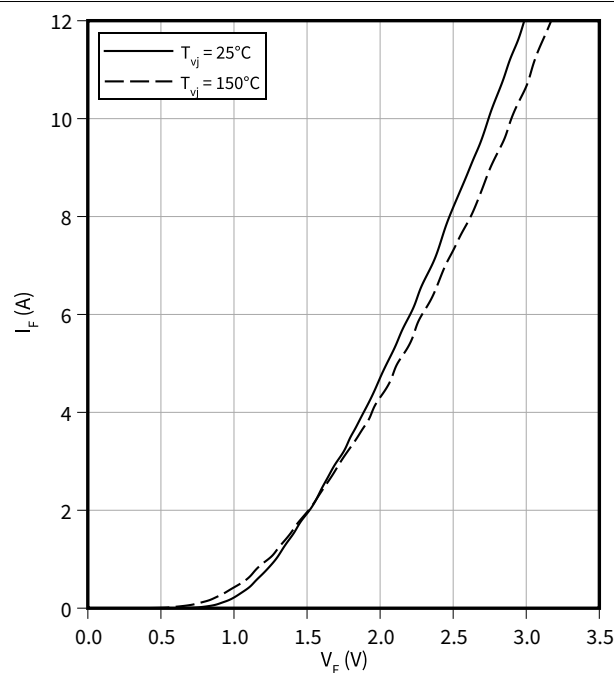
$$Z_{th(j-c)} = f(t_p)$$

$D = t_p/T$



Typical diode forward current as a function of forward voltage

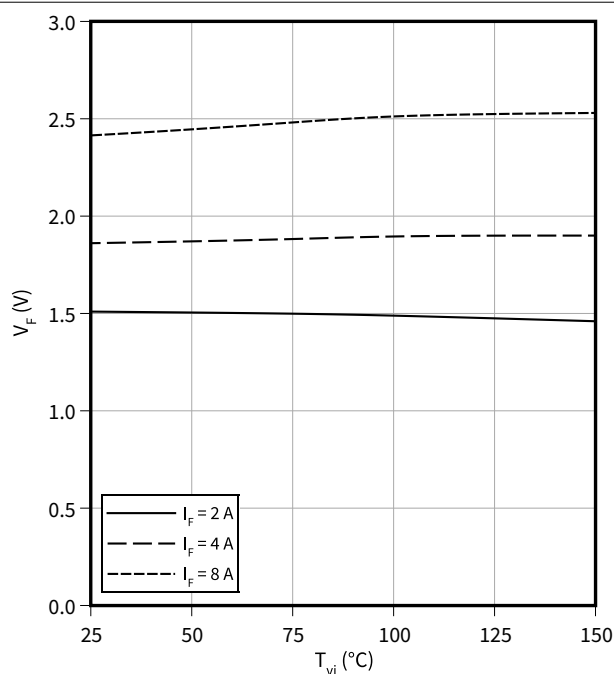
$$I_F = f(V_F)$$



4 Characteristics diagrams

Typical diode forward voltage as a function of junction temperature

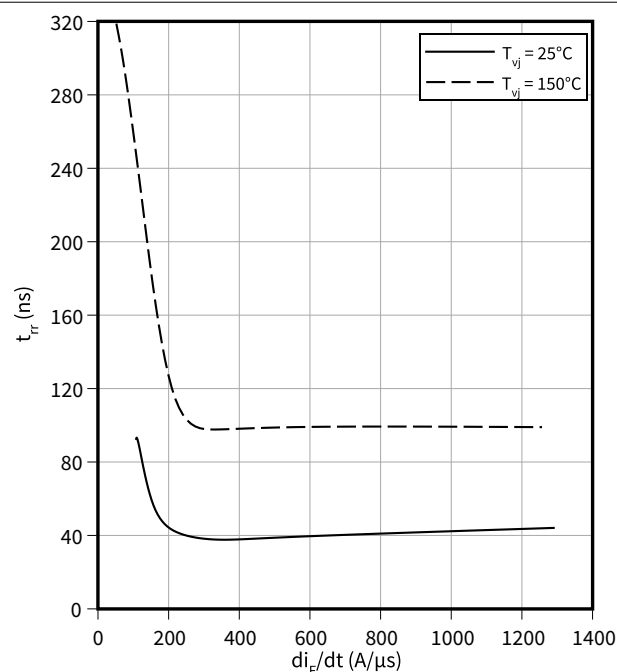
$$V_F = f(T_{vj})$$



Typical reverse recovery time as a function of diode current slope

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

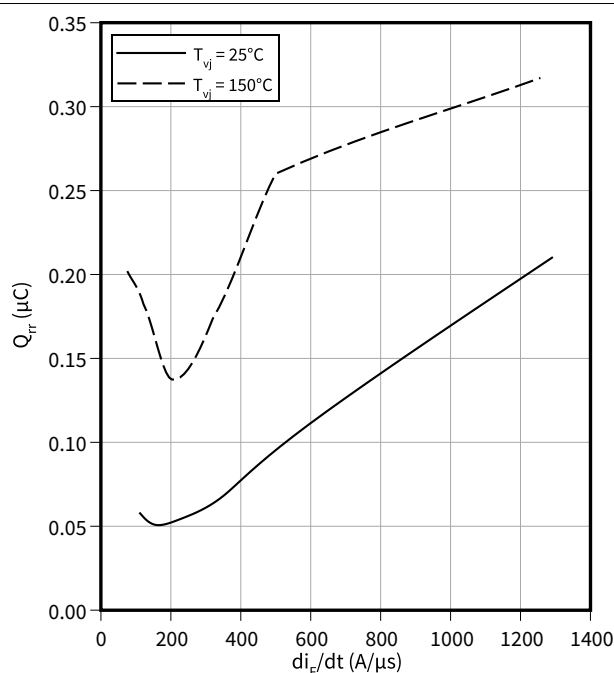
$$V_R = 400 \text{ V}, I_F = 4 \text{ A}$$



Typical reverse recovery charge as a function of diode current slope

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

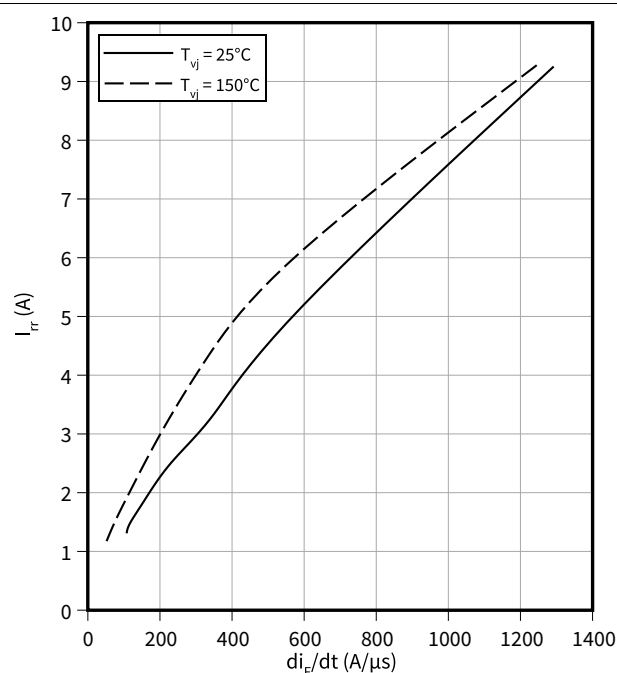
$$V_R = 400 \text{ V}, I_F = 4 \text{ A}$$



Typical reverse recovery current as a function of diode current slope

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

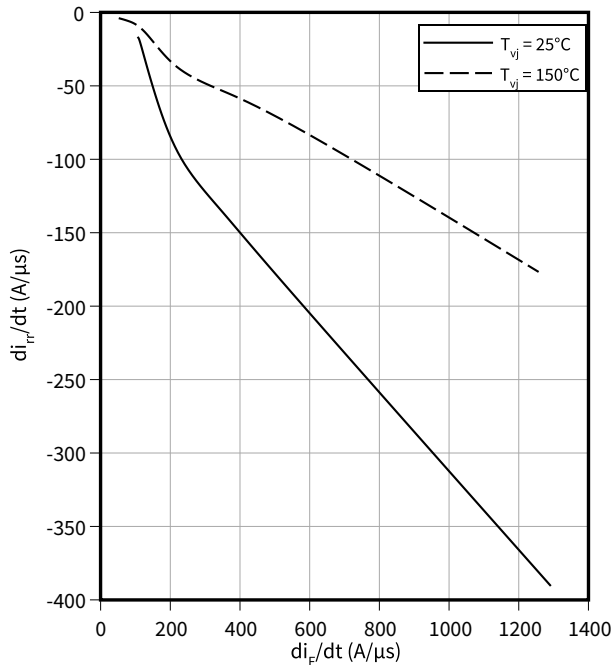
$$V_R = 400 \text{ V}, I_F = 4 \text{ A}$$



4 Characteristics diagrams

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

$$di_{rr}/dt = f(di_F/dt)$$
$$V_R = 400\text{ V}, I_F = 4\text{ A}$$



5 Package outlines

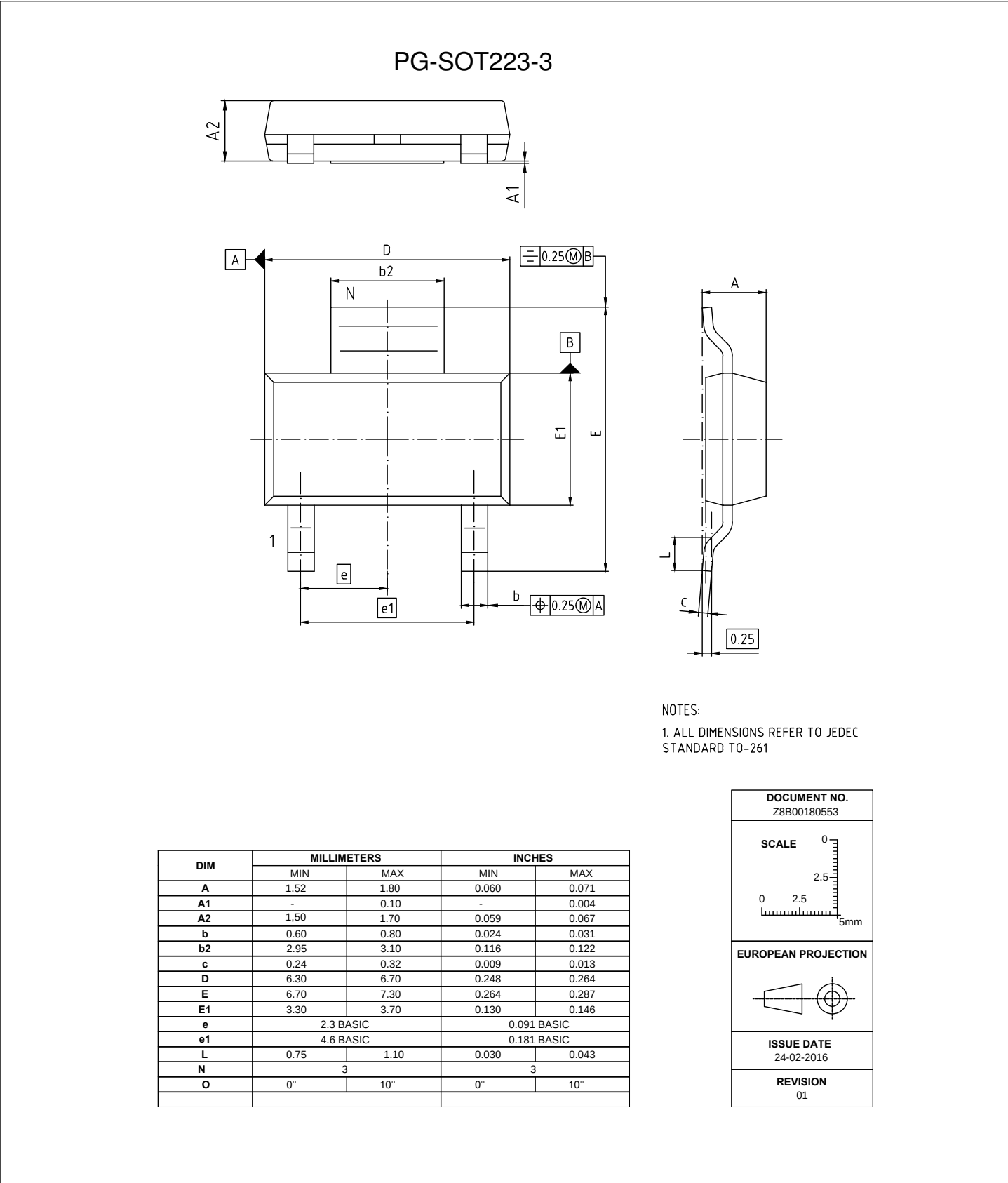


Figure 1

6 Testing conditions

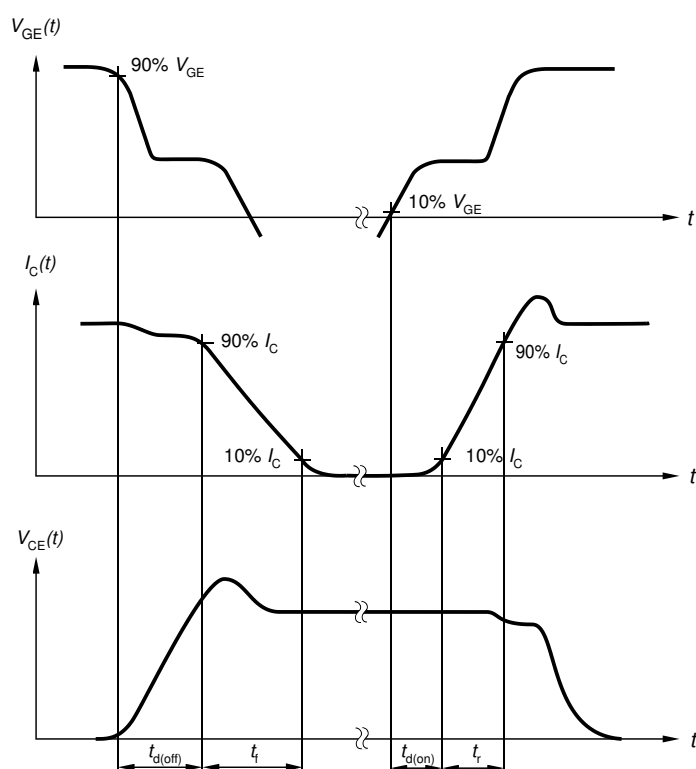


Figure A. Definition of switching times

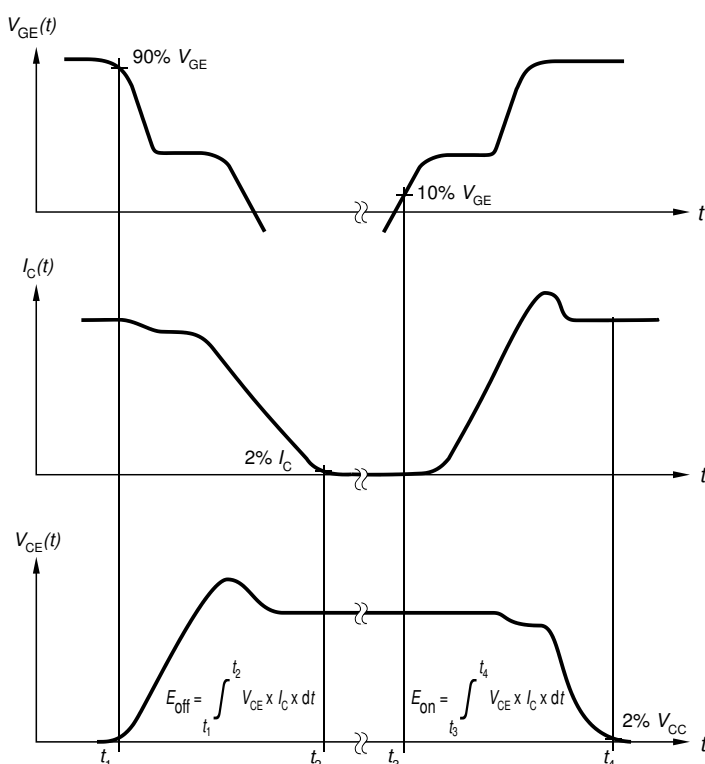


Figure B. Definition of switching losses

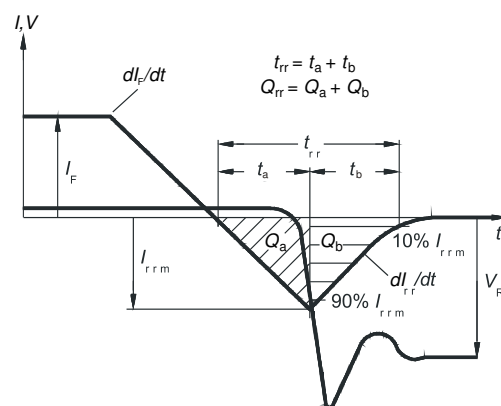


Figure C. Definition of diode switching characteristics

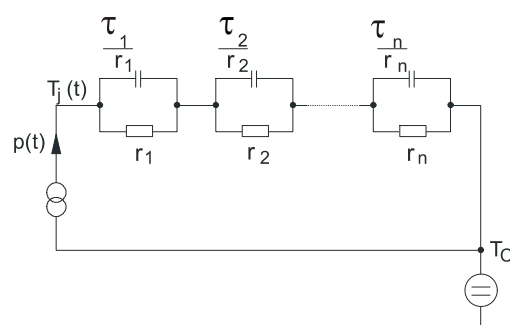


Figure D. Thermal equivalent circuit

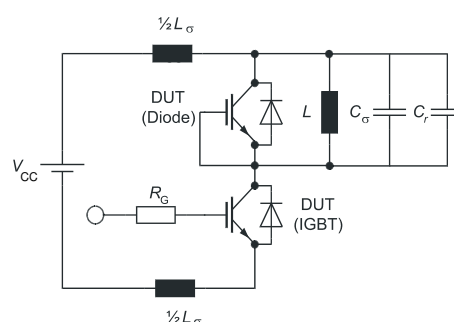


Figure E. **Dynamic test circuit**
 Parasitic inductance L_σ ,
 parasitic capacitor C_σ ,
 relief capacitor C_r ,
 (only for ZVT switching)

Revision history

Document revision	Date of release	Description of changes
1.00	2021-09-28	Final datasheet
1.01	2021-10-15	Change of Potential Applications
1.10	2022-09-21	Add of wave soldering conditions

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Edition 2022-09-21

Published by

Infineon Technologies AG
81726 Munich, Germany

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Document reference
IFX-ABB482-003

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