

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>

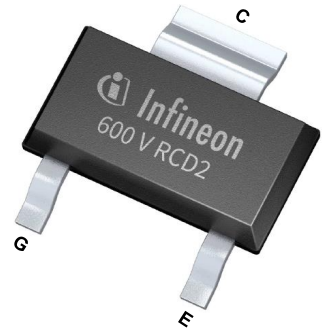
Potential applications

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

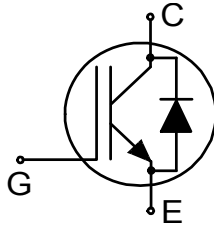
Product validation

- 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	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	2.2	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**

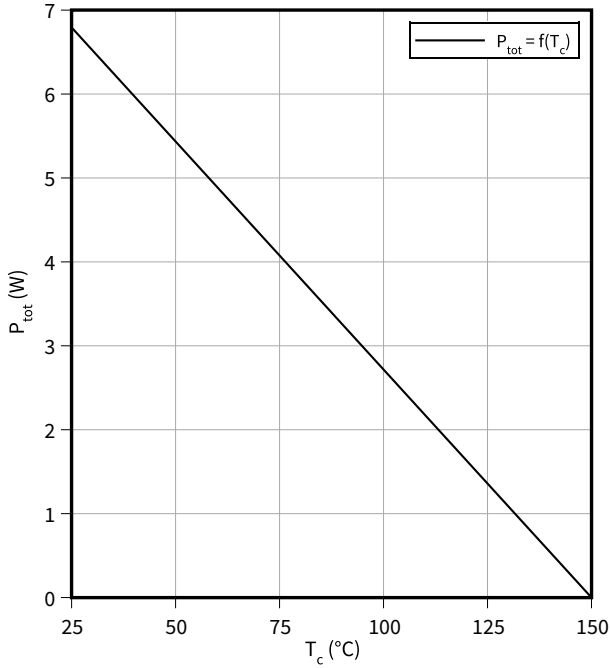
Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Diode peak rate of fall of reverse recovery current	di_{rr}/dt	$V_R = 400 \text{ V}$	$T_{vj} = 25 \text{ °C}, I_F = 4 \text{ A},$ $-di_F/dt = 483 \text{ A}/\mu\text{s}$		174		A/ μs
			$T_{vj} = 150 \text{ °C},$ $I_F = 4 \text{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

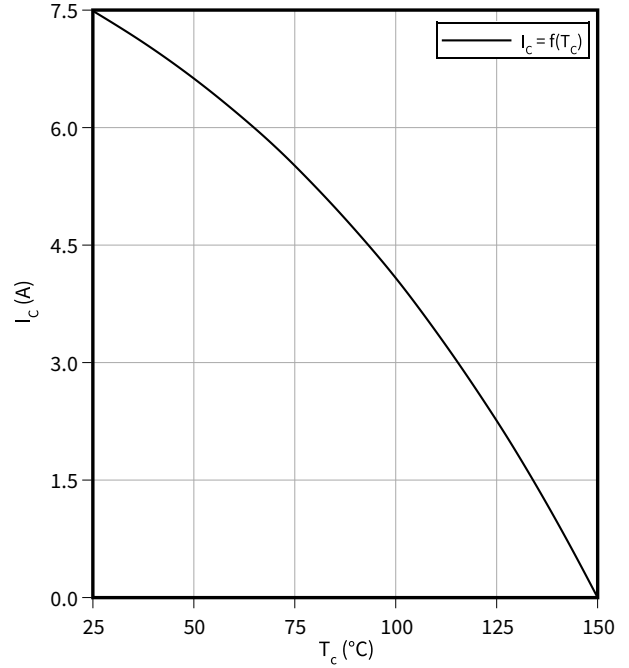
Power dissipation as a function of heatsink temperature

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



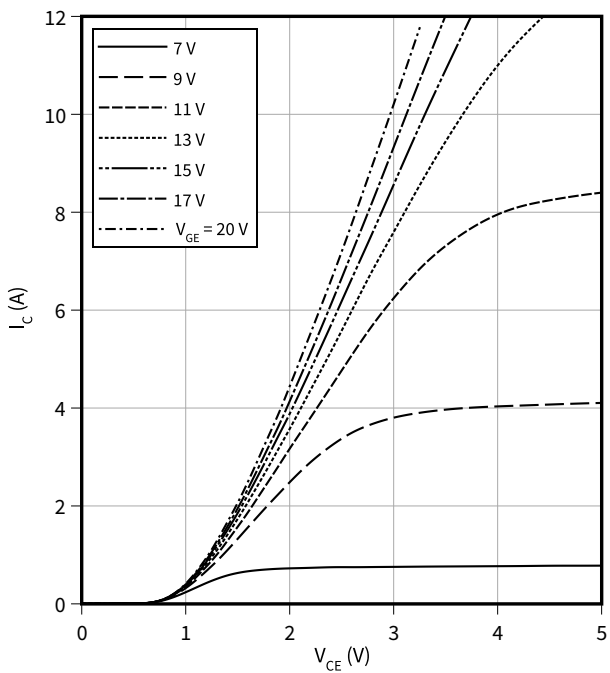
Collector current as a function of heatsink temperature

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



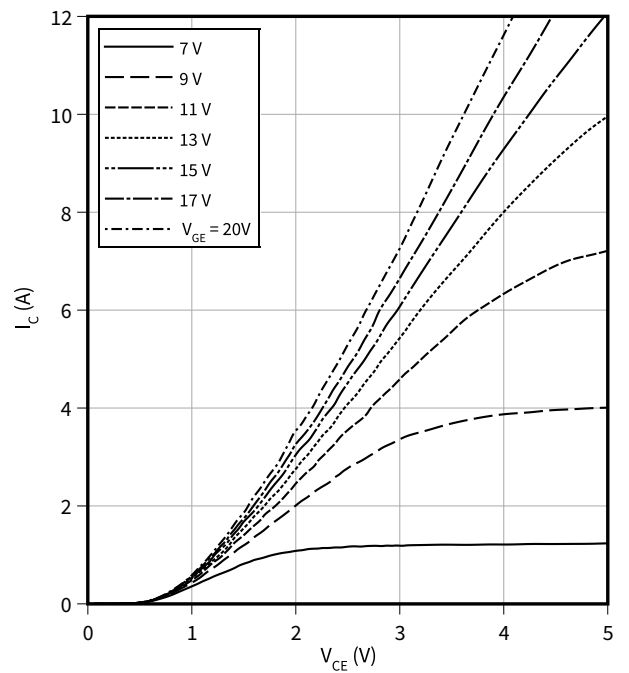
Typical output characteristic

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



Typical output characteristic

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

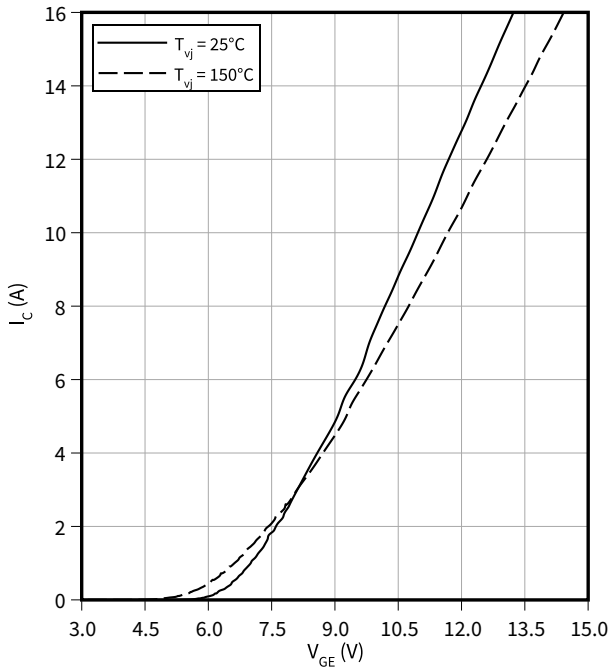


4 Characteristics diagrams

Typical transfer characteristic

$I_C = f(V_{GE})$

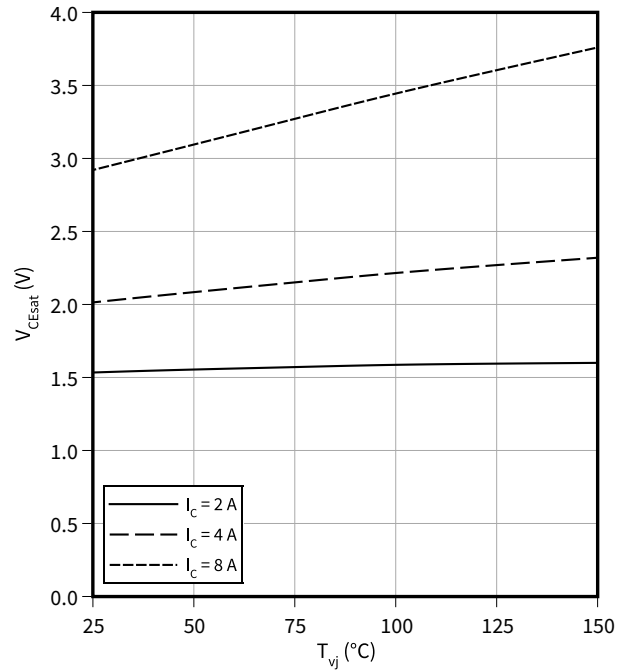
$V_{CE} = 20 \text{ V}$



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

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

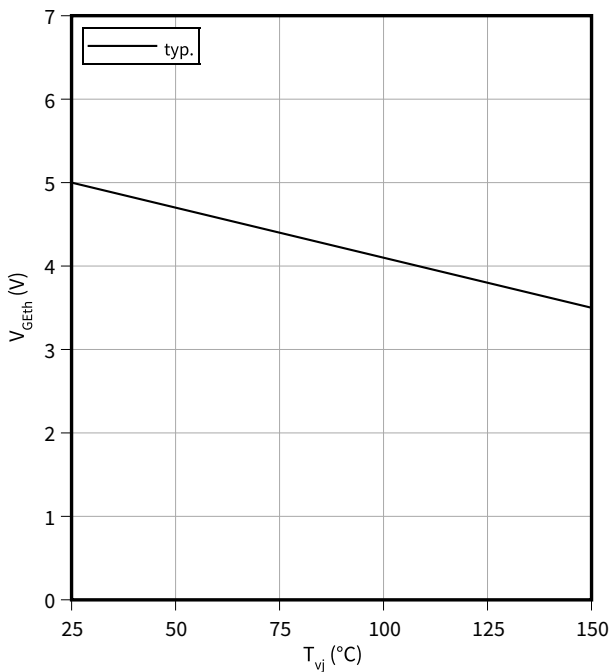
$V_{GE} = 15 \text{ V}$



Gate-emitter threshold voltage as a function of junction temperature

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

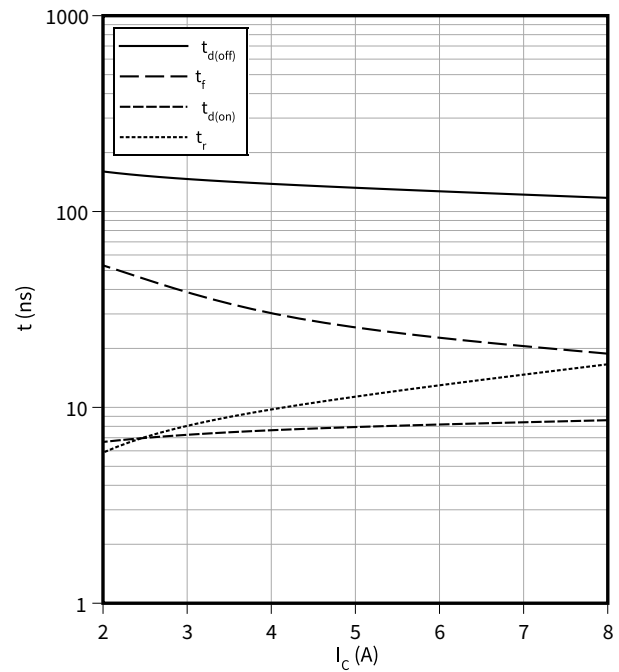
$I_C = 45 \mu\text{A}$



Typical switching times as a function of collector current

$t = f(I_C)$

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

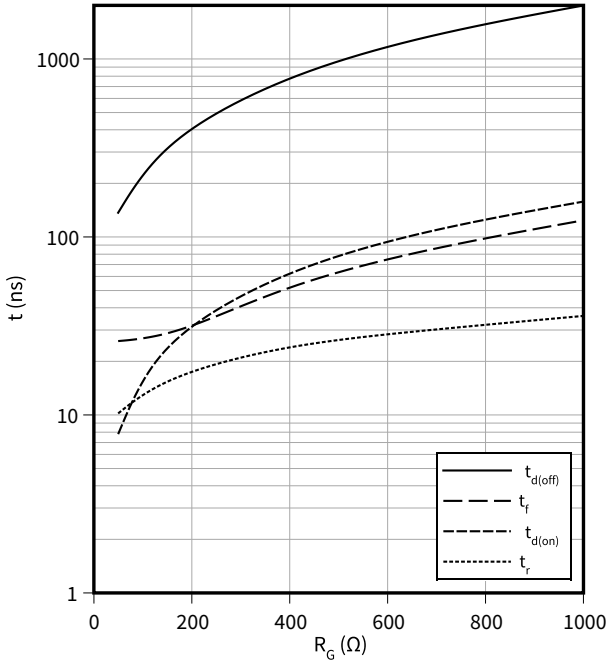


4 Characteristics diagrams

Typical switching times as a function of gate resistor

$t = f(R_G)$

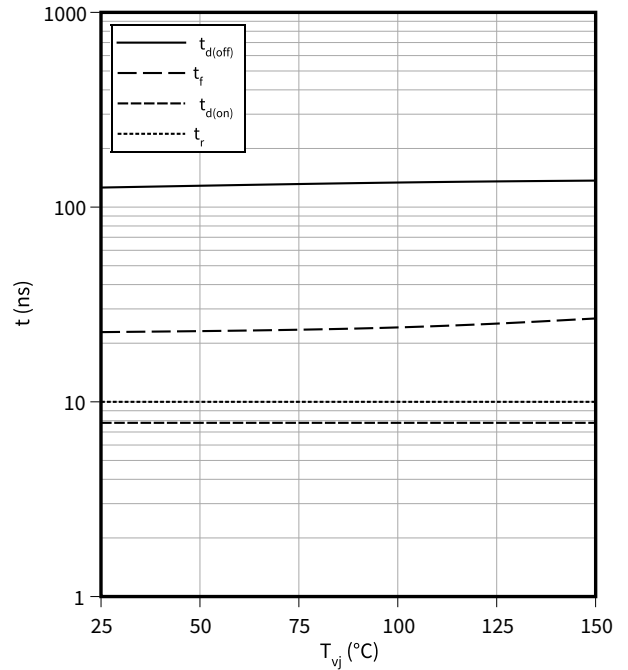
$I_C = 4 \text{ A}, V_{CC} = 400 \text{ V}, T_{vj} = 150 \text{ }^\circ\text{C}, V_{GE} = 0/15 \text{ V}$



Typical switching times as a function of junction temperature

$t = f(T_{vj})$

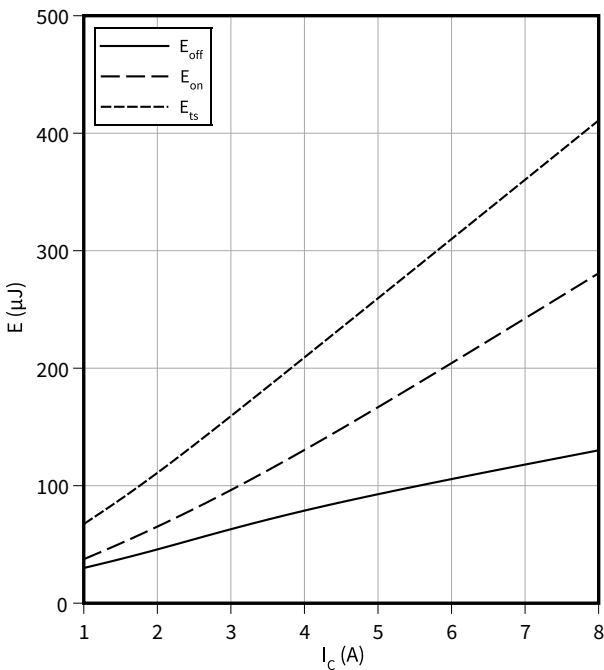
$I_C = 4 \text{ A}, V_{CC} = 400 \text{ V}, V_{GE} = 0/15 \text{ V}, R_G = 49 \text{ } \Omega$



Typical switching energy losses as a function of collector current

$E = f(I_C)$

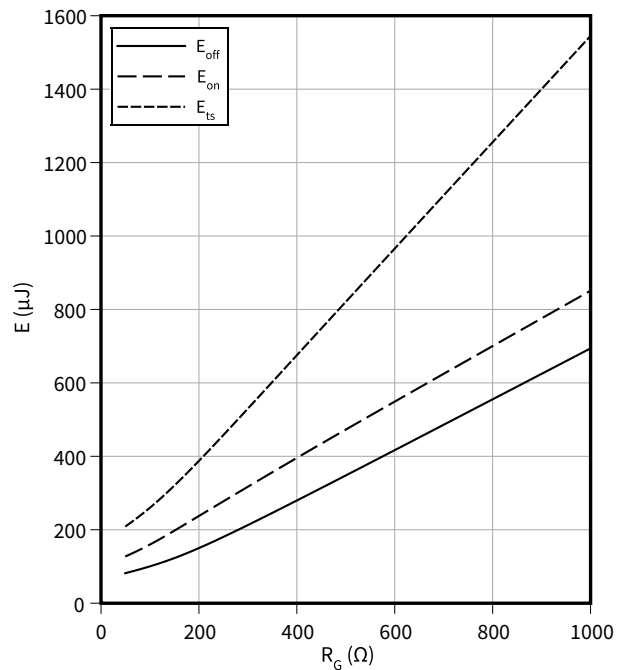
$V_{CC} = 400 \text{ V}, T_{vj} = 150 \text{ }^\circ\text{C}, V_{GE} = 0/15 \text{ V}, R_G = 49 \text{ } \Omega$



Typical switching energy losses as a function of gate resistor

$E = f(R_G)$

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

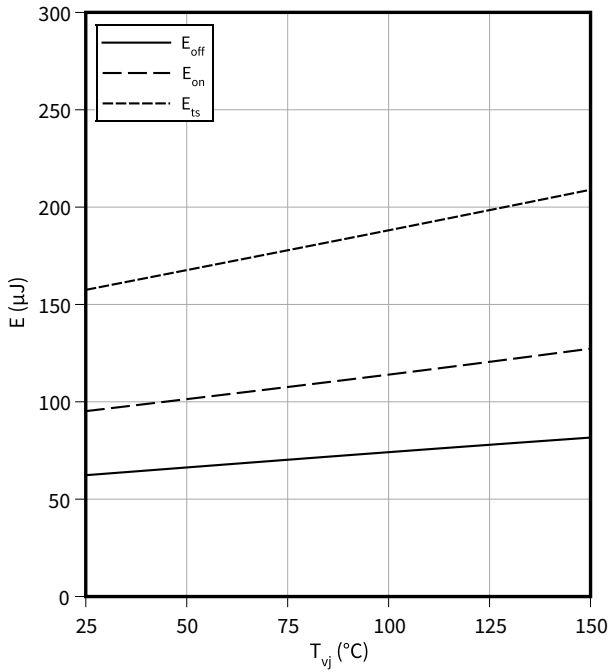


4 Characteristics diagrams

Typical switching energy losses as a function of junction temperature

$E = f(T_{vj})$

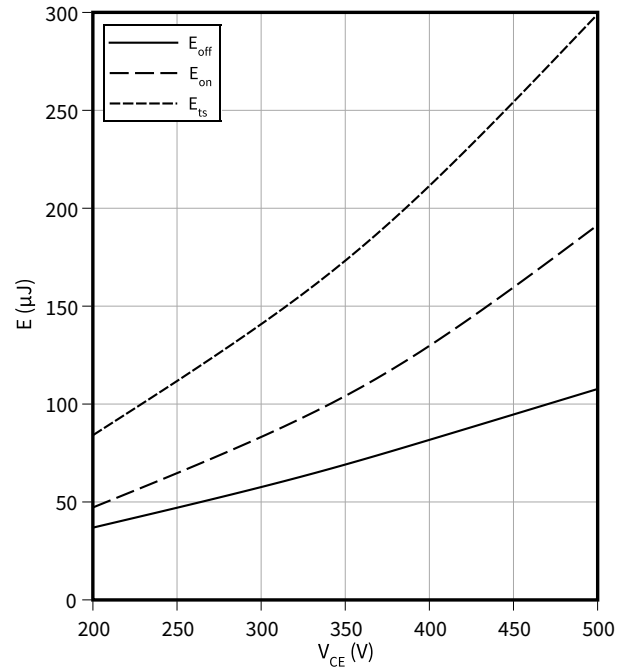
$I_C = 4 \text{ A}$, $V_{CC} = 400 \text{ V}$, $V_{GE} = 0/15 \text{ V}$, $R_G = 49 \ \Omega$



Typical switching energy losses as a function of collector emitter voltage

$E = f(V_{CE})$

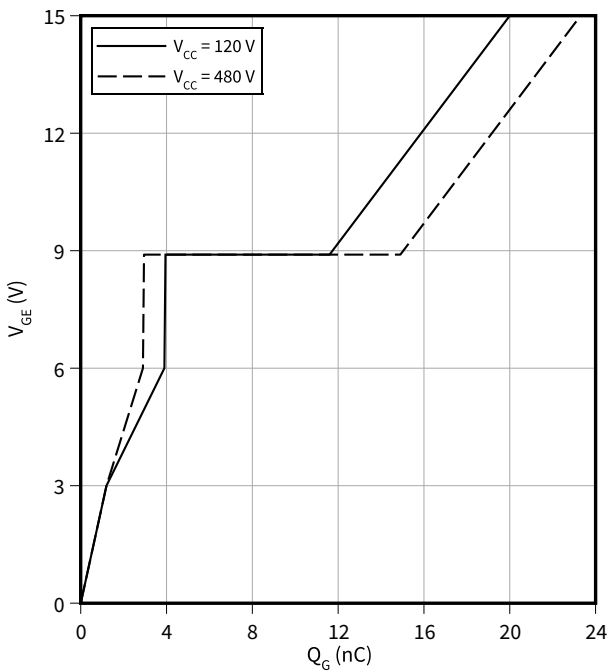
$I_C = 4 \text{ A}$, $T_{vj} = 150 \text{ °C}$, $V_{GE} = 0/15 \text{ V}$, $R_G = 49 \ \Omega$



Typical gate charge

$V_{GE} = f(Q_G)$

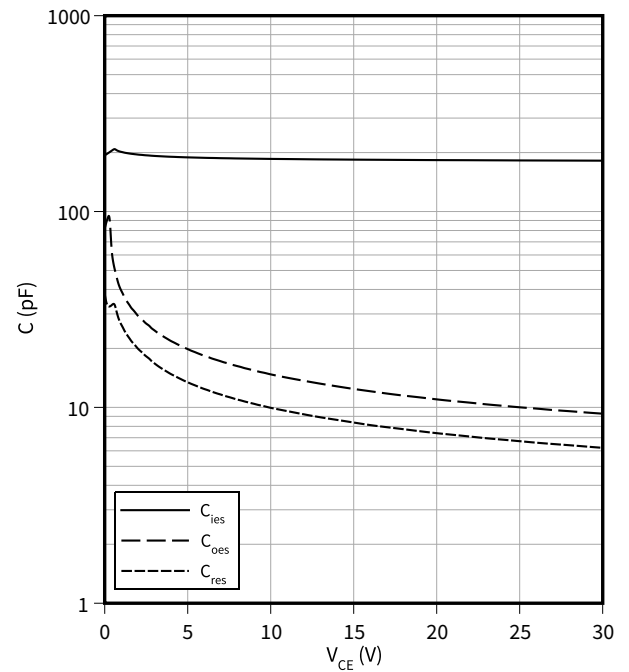
$I_C = 4 \text{ A}$



Typical capacitance as a function of collector-emitter voltage

$C = f(V_{CE})$

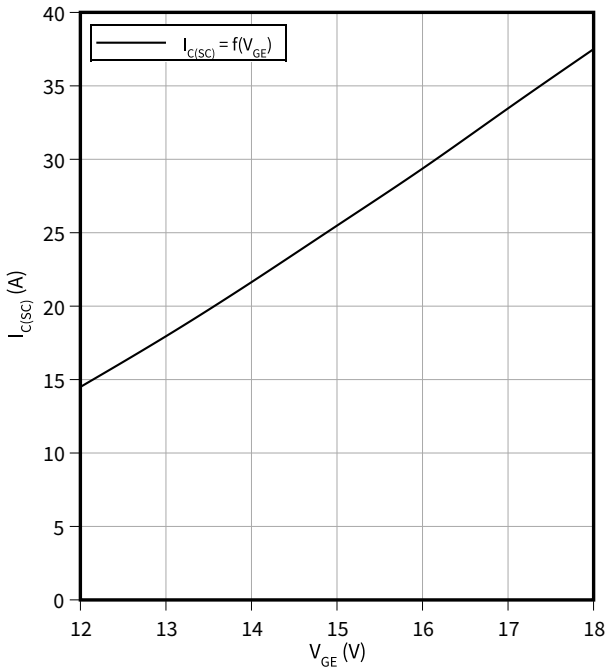
$f = 1000 \text{ kHz}$, $V_{GE} = 0 \text{ V}$



4 Characteristics diagrams

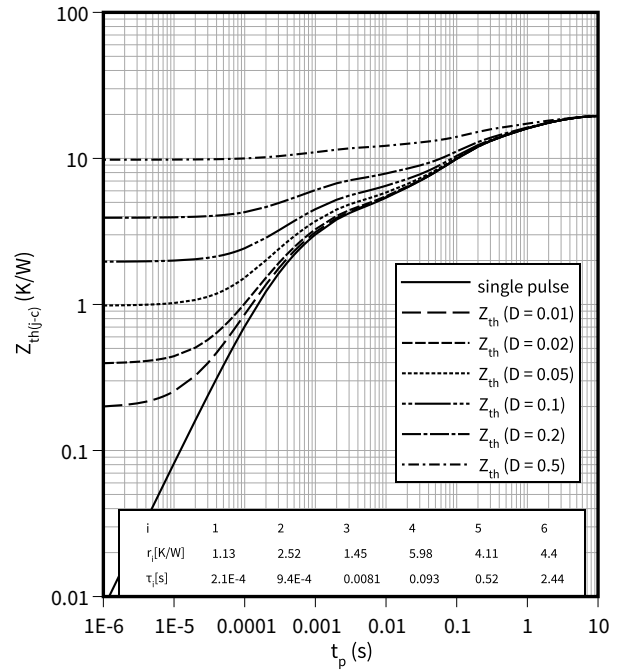
Typical short circuit collector current as a function of gate-emitter voltage

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



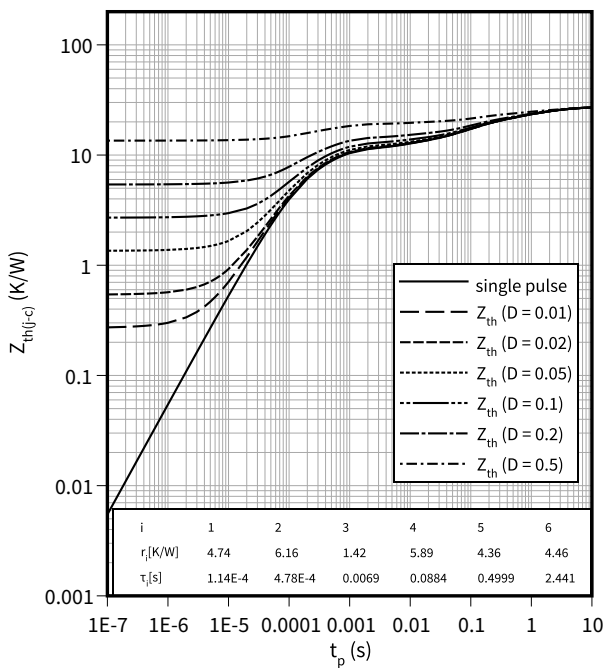
IGBT transient thermal impedance as a function of pulse width

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



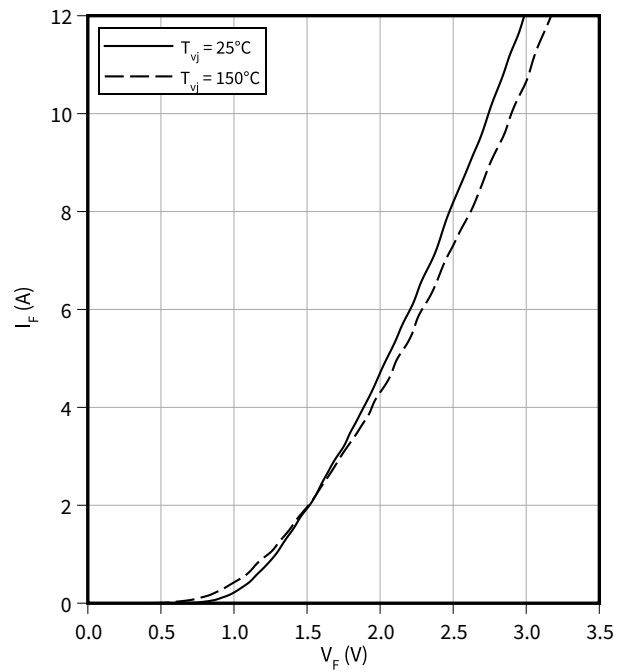
Diode transient thermal impedance as a function of pulse width

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



Typical diode forward current as a function of forward voltage

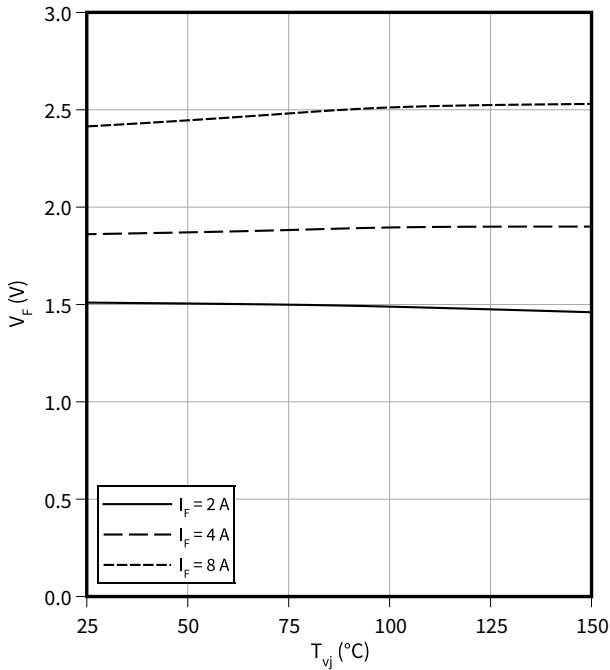
$I_F = f(V_F)$



4 Characteristics diagrams

Typical diode forward voltage as a function of junction temperature

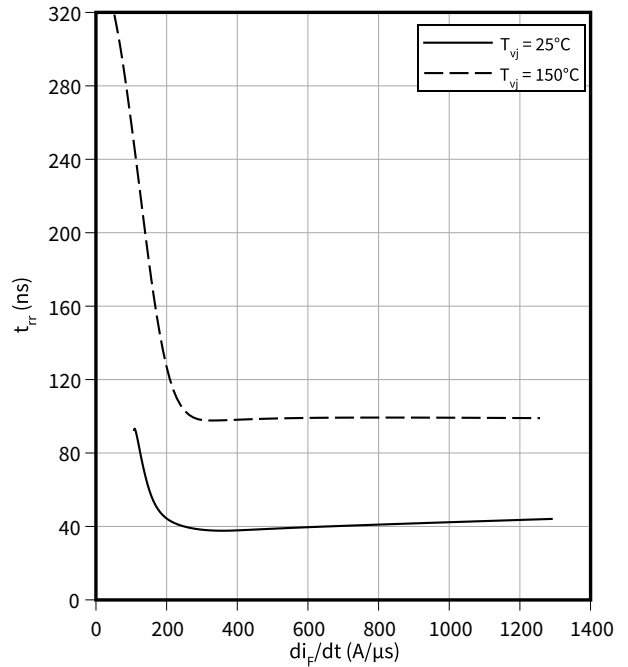
$V_F = f(T_{vj})$



Typical reverse recovery time as a function of diode current slope

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

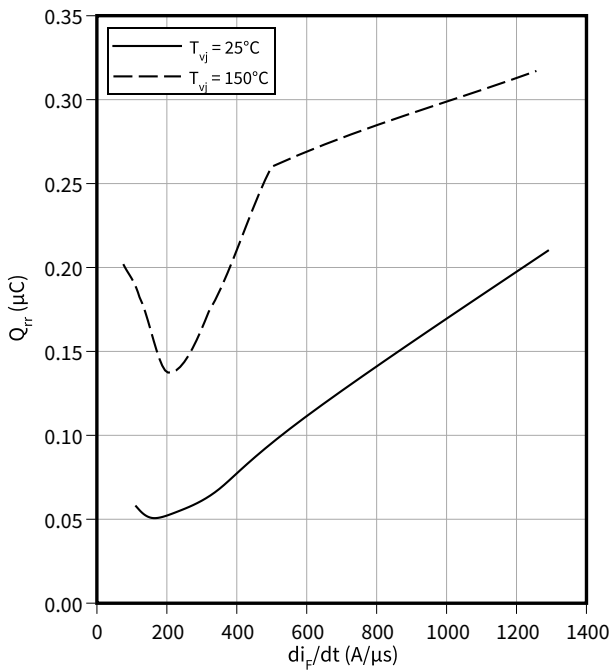
$V_R = 400$ V, $I_F = 4$ A



Typical reverse recovery charge as a function of diode current slope

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

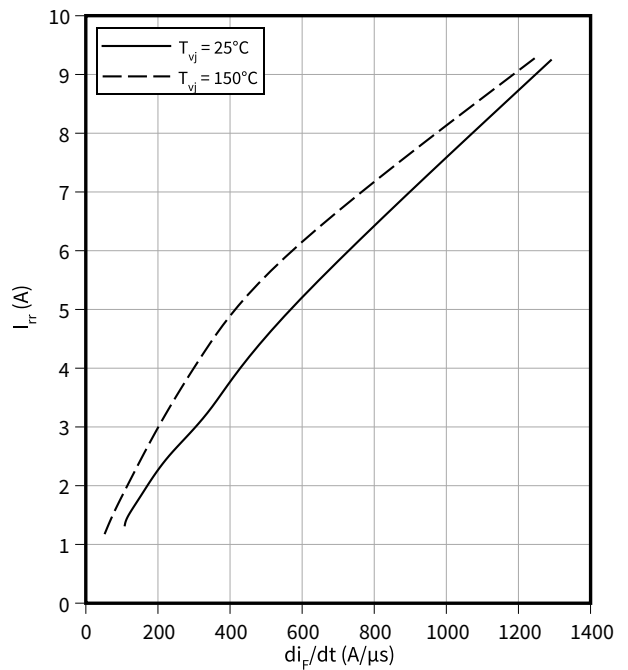
$V_R = 400$ V, $I_F = 4$ A



Typical reverse recovery current as a function of diode current slope

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

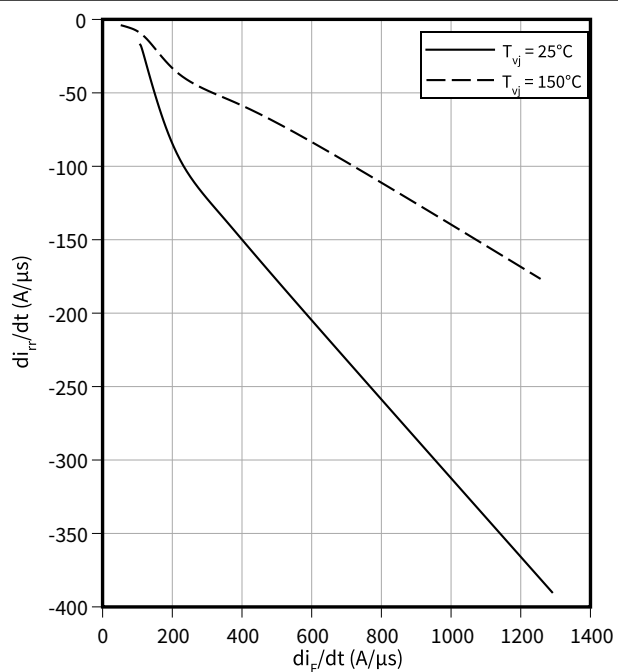
$V_R = 400$ V, $I_F = 4$ A



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

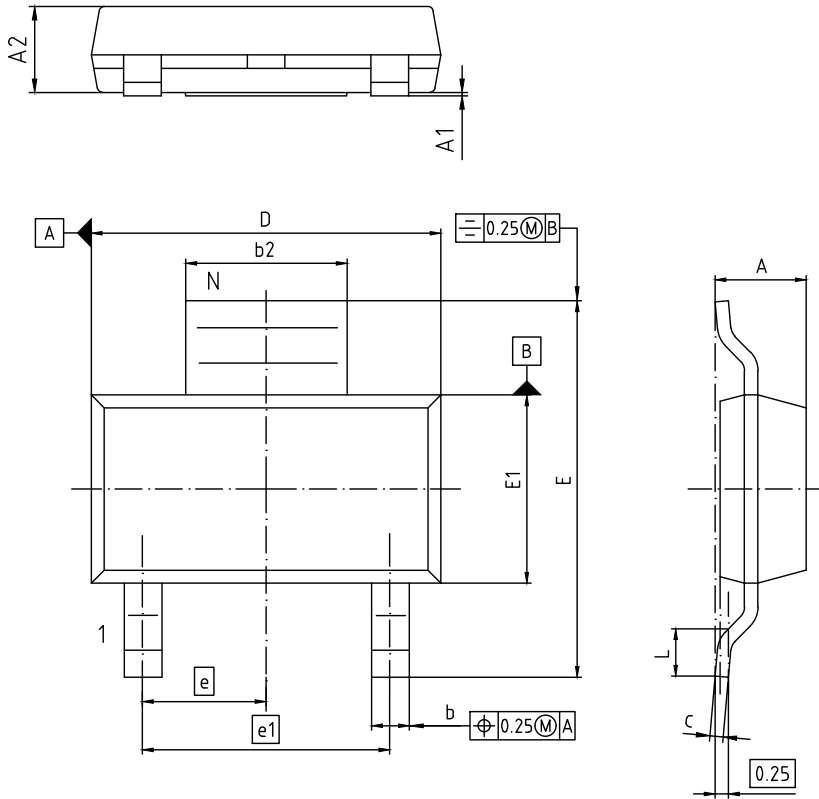
$$di_{rr}/dt = f(di_F/dt)$$

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



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°

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REVISION 01

Figure 1

6 Testing conditions

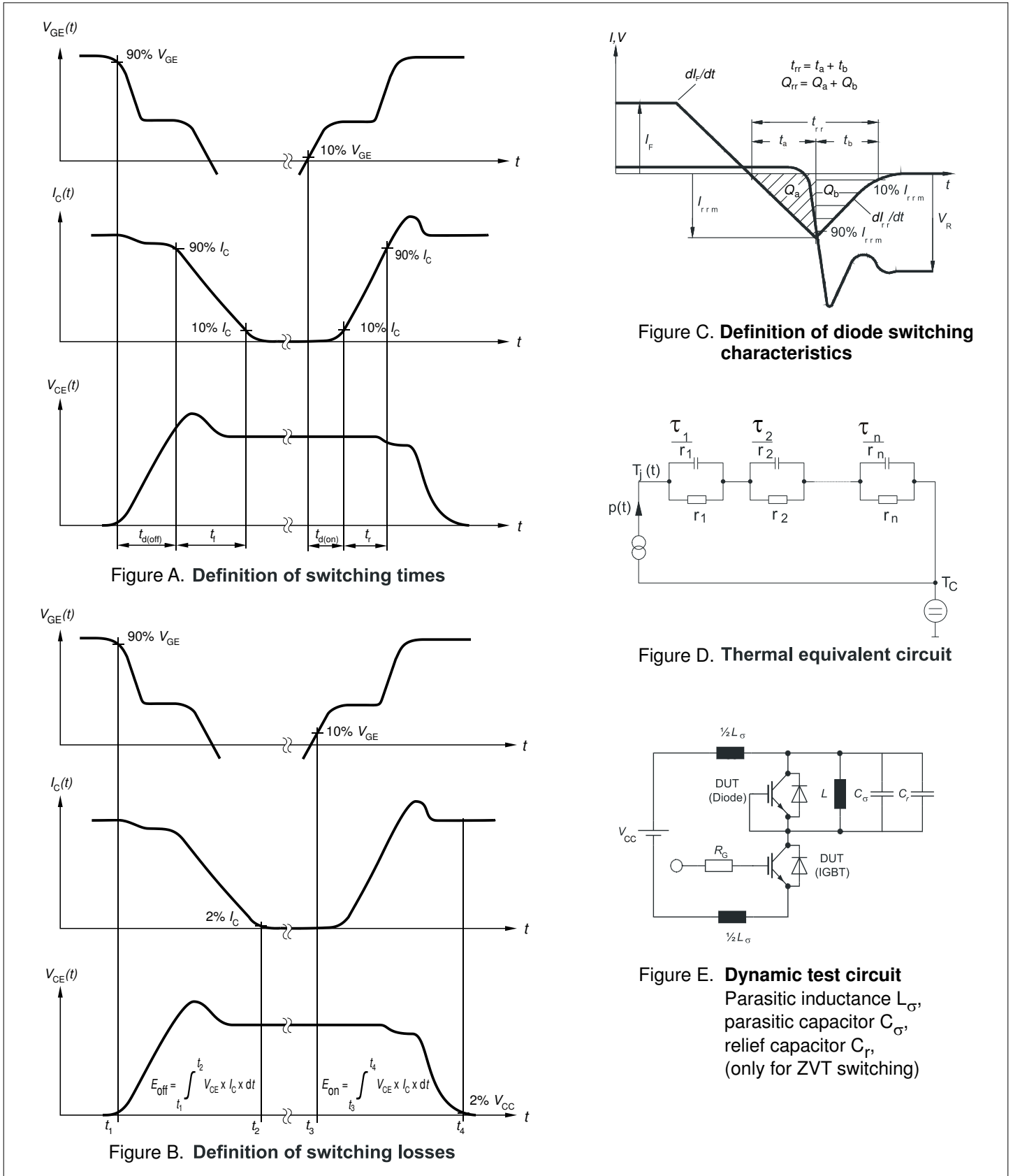


Figure 2

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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