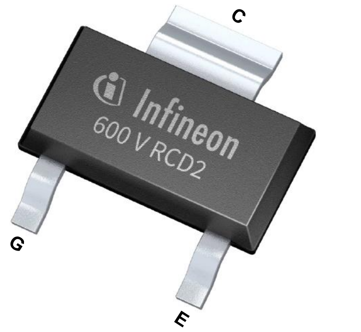
600 V Reverse Conducting Drive 2 offering cost effective IGBT with monolithically integrated diode



Green
Halogen-free
RoHS

Features

- V_{CE} = 600 V
- I_C = 4 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

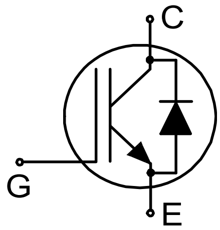
Potential applications

- 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



Type	Package	Marking
IKN04N60RC2	PG-SOT223-3	K4DRC2

Table of contents

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}	$T_{vj} \geq 25$ °C		600	V
DC collector current, limited by T_{vjmax} [1)]	I_C		$T_c = 25$ °C	7.5	A
			$T_c = 100$ °C	4.1	
Pulsed collector current, t_p limited by T_{vjmax}	I_{Cpulse}			12	A
Turn-off safe operating area		$V_{CE} \leq 600$ V, $t_p = 1$ µs, $T_{vj} \leq 150$ °C		12	A
Gate-emitter voltage	V_{GE}			±20	V
Transient gate-emitter voltage	V_{GE}	$t_p \leq 10$ µs, $D < 0.01$		±30	V
Short-circuit withstand time	t_{SC}	$V_{CC} \leq 400$ V, $V_{GE} = 15$ V, Allowed number of short circuits < 1000, Time between short circuits ≥ 1.0 s, $T_{vj} = 150$ °C		3	µs
Power dissipation	P_{tot}		$T_c = 25$ °C	6.8	W
			$T_c = 100$ °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 A, V_{GE} = 15 V	T_{vj} = 25 °C		2	2.3	V
			T_{vj} = 150 °C		2.3		
Gate-emitter threshold voltage	V_{GEth}	I_C = 45 µA, 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 °C			25	µA
			T_{vj} = 150 °C			2500	
Gate-emitter leakage current	I_{GES}	V_{CE} = 0 V, V_{GE} = 20 V				100	nA
Transconductance	g_{fs}	I_C = 4 A, V_{CE} = 20 V			2		S
Input capacitance	C_{ies}	V_{CE} = 25 V, V_{GE}=0 V, f = 1000 kHz			180		pF
Output capacitance	C_{oes}	V_{CE} = 25 V, V_{GE}=0 V, f = 1000 kHz			10		pF
Reverse transfer capacitance	C_{res}	V_{CE} = 25 V, V_{GE}=0 V, f = 1000 kHz			7		pF
Gate charge	Q_G	I_C = 4 A, V_{CC} = 480 V, V_{GE} = 15 V			24		nC
Turn-on delay time	$t_{d(on)}$	V_{CC} = 400 V, V_{GE} = 0/15 V, R_{Gon} = 49 Ω, R_{Goff} = 49 Ω, $L_σ$ = 30 nH, $C_σ$ = 32 pF	T_{vj} = 25 °C, I_C = 4 A		8		ns
			T_{vj} = 150 °C, I_C = 4 A		8		
Rise time (inductive load)	t_r	V_{CC} = 400 V, V_{GE} = 0/15 V, R_{Gon} = 49 Ω, R_{Goff} = 49 Ω, $L_σ$ = 30 nH, $C_σ$ = 32 pF	T_{vj} = 25 °C, I_C = 4 A		10		ns
			T_{vj} = 150 °C, I_C = 4 A		10		
Turn-off delay time	$t_{d(off)}$	V_{CC} = 400 V, V_{GE} = 0/15 V, R_{Gon} = 49 Ω, R_{Goff} = 49 Ω, $L_σ$ = 30 nH, $C_σ$ = 32 pF	T_{vj} = 25 °C, I_C = 4 A		126		ns
			T_{vj} = 150 °C, I_C = 4 A		137		
Fall time (inductive load)	t_f	V_{CC} = 400 V, V_{GE} = 0/15 V, R_{Gon} = 49 Ω, R_{Goff} = 49 Ω, $L_σ$ = 30 nH, $C_σ$ = 32 pF	T_{vj} = 25 °C, I_C = 4 A		24		ns
			T_{vj} = 150 °C, I_C = 4 A		26		
Turn-on energy	E_{on}	V_{CC} = 400 V, V_{GE} = 0/15 V, R_{Gon} = 49 Ω, R_{Goff} = 49 Ω, $L_σ$ = 30 nH, $C_σ$ = 32 pF	T_{vj} = 25 °C, I_C = 4 A		95		µJ
			T_{vj} = 150 °C, I_C = 4 A		127		
Turn-off energy	E_{off}	V_{CC} = 400 V, V_{GE} = 0/15 V, R_{Gon} = 49 Ω, R_{Goff} = 49 Ω, $L_σ$ = 30 nH, $C_σ$ = 32 pF	T_{vj} = 25 °C, I_C = 4 A		62		µJ
			T_{vj} = 150 °C, I_C = 4 A		82		
Total switching energy	E_{ts}	V_{CC} = 400 V, V_{GE} = 0/15 V, R_{Gon} = 49 Ω, R_{Goff} = 49 Ω, $L_σ$ = 30 nH, $C_σ$ = 32 pF	T_{vj} = 25 °C, I_C = 4 A		157		µJ
			T_{vj} = 150 °C, I_C = 4 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°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}	$T_{vj} \geq 25$ °C		600	V
Diode forward current, limited by T_{vjmax} [1)]	I_F		$T_c = 25$ °C	4.9	A
			$T_c = 100$ °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	$I_F = 4$ A	$T_{vj} = 25$ °C		1.85	2.2	V
			$T_{vj} = 150$ °C		1.9		
Diode reverse recovery time	t_{rr}	$V_R = 400$ V	$T_{vj} = 25$ °C, $I_F = 4$ A, $-di_F/dt = 483$ A/µs		39		ns
			$T_{vj} = 150$ °C, $I_F = 4$ A, $-di_F/dt = 500$ A/µs		100		
Diode reverse recovery charge	Q_{rr}	$V_R = 400$ V	$T_{vj} = 25$ °C, $I_F = 4$ A, $-di_F/dt = 483$ A/µs		0.097		µC
			$T_{vj} = 150$ °C, $I_F = 4$ A, $-di_F/dt = 500$ A/µs		0.259		
Diode peak reverse recovery current	I_{rrm}	$V_R = 400$ V	$T_{vj} = 25$ °C, $I_F = 4$ A, $-di_F/dt = 483$ A/µs		4.7		A
			$T_{vj} = 150$ °C, $I_F = 4$ A, $-di_F/dt = 500$ A/µs		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 V	T_{vj} = 25 °C, I_F = 4 A, $-di_F/dt$ = 483 A/µs		174		A/µs
			T_{vj} = 150 °C, I_F = 4 A, $-di_F/dt$ = 500 A/µs		67.4		
Operating junction temperature	T_{vj}			-40		150	°C

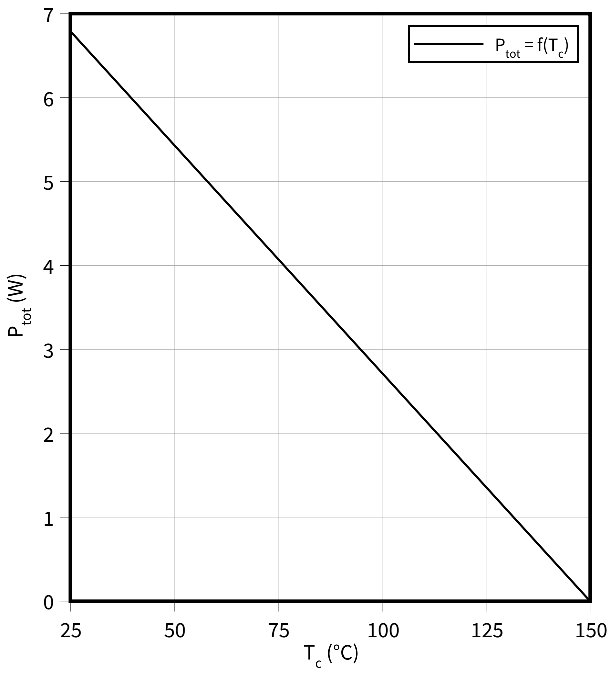
Note: *For optimum lifetime and reliability, Infineon recommends operating conditions that do not exceed 80% of the maximum ratings stated in this datasheet.*

4 Characteristics diagrams

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_c)$

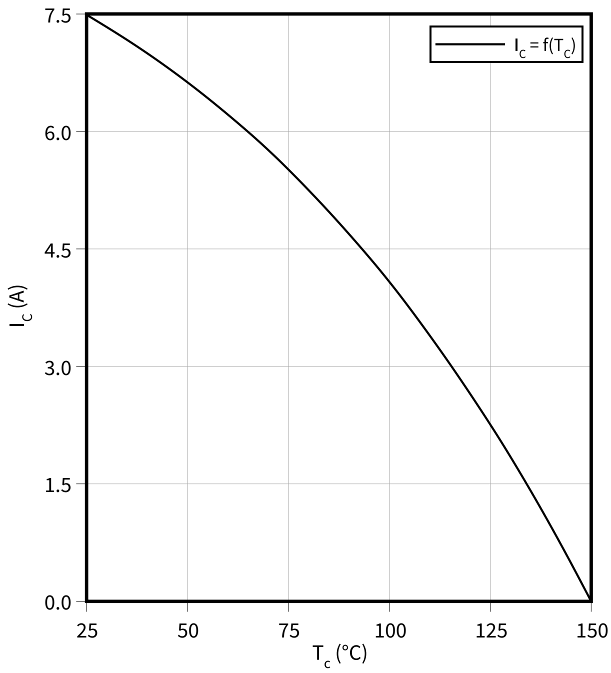
$T_{vj} \leq 150$ °C



Collector current as a function of heatsink temperature

$I_C = f(T_c)$

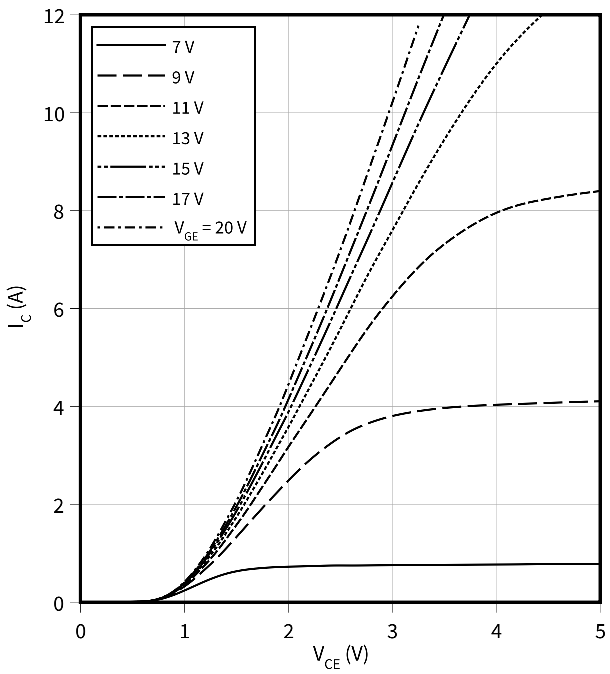
$T_{vj} \leq 150$ °C, $V_{GE} \geq 15$ V



Typical output characteristic

$I_C = f(V_{CE})$

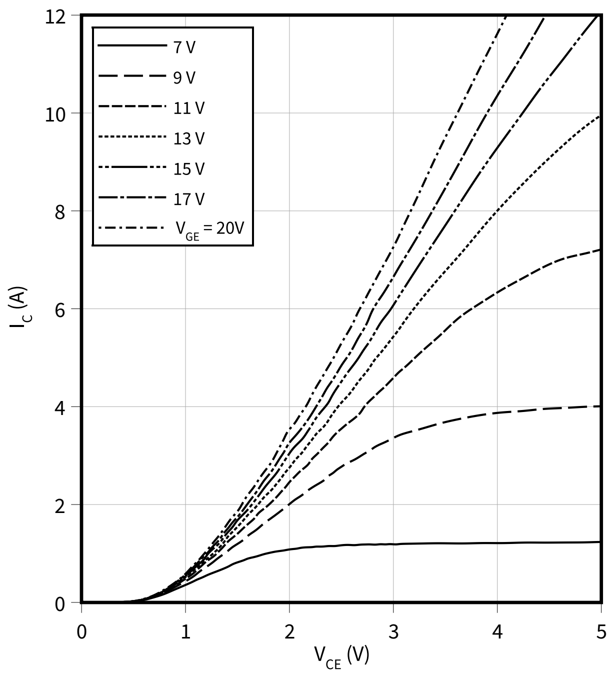
$T_{vj} = 25$ °C



Typical output characteristic

$I_C = f(V_{CE})$

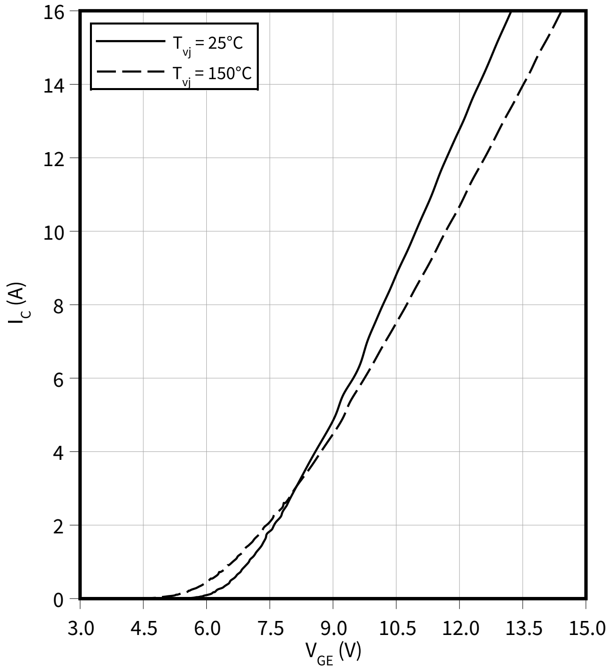
$T_{vj} = 150$ °C



Typical transfer characteristic

$I_C = f(V_{GE})$

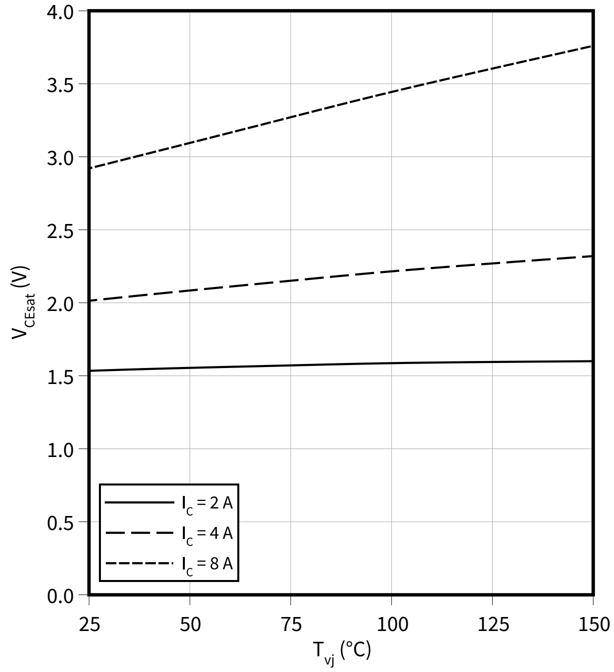
$V_{CE} = 20$ V



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

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

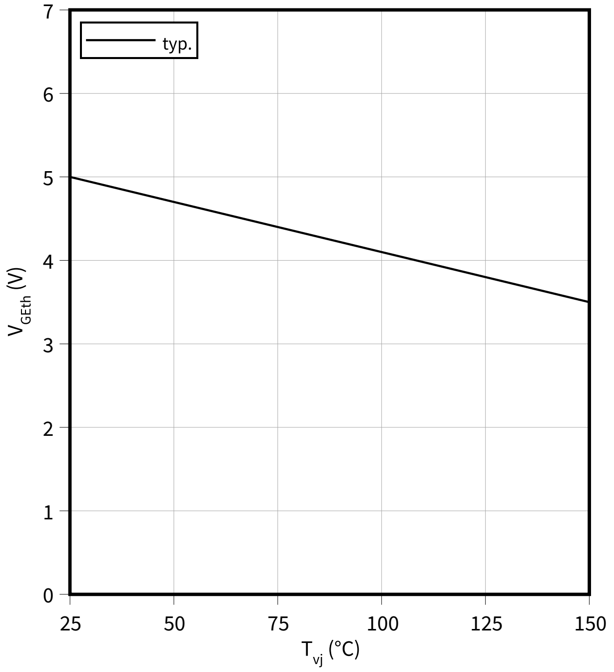
$V_{GE} = 15$ V



Gate-emitter threshold voltage as a function of junction temperature

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

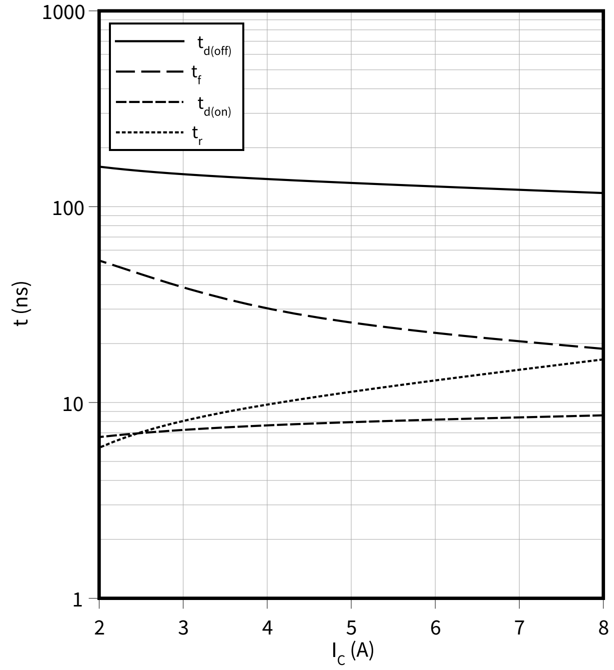
$I_C = 45$ μA



Typical switching times as a function of collector current

$t = f(I_C)$

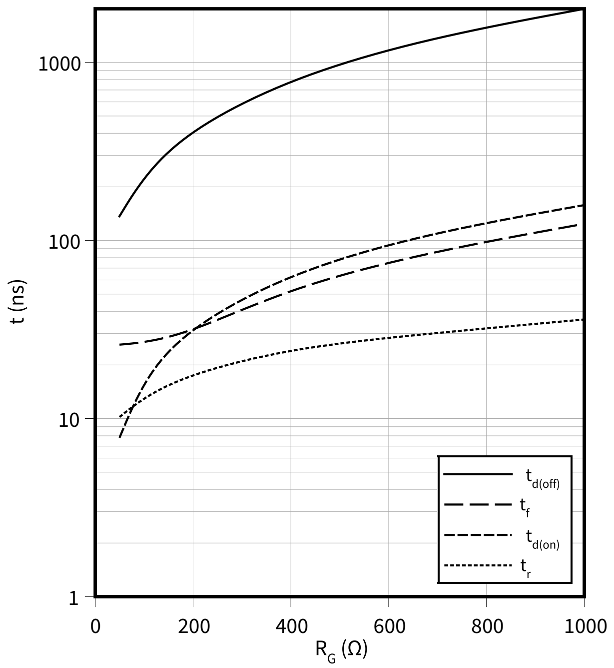
$V_{CC} = 400$ V, $T_{vj} = 150$ °C, $V_{GE} = 0/15$ V, $R_G = 49$ Ω



Typical switching times as a function of gate resistor

$t = f(R_G)$

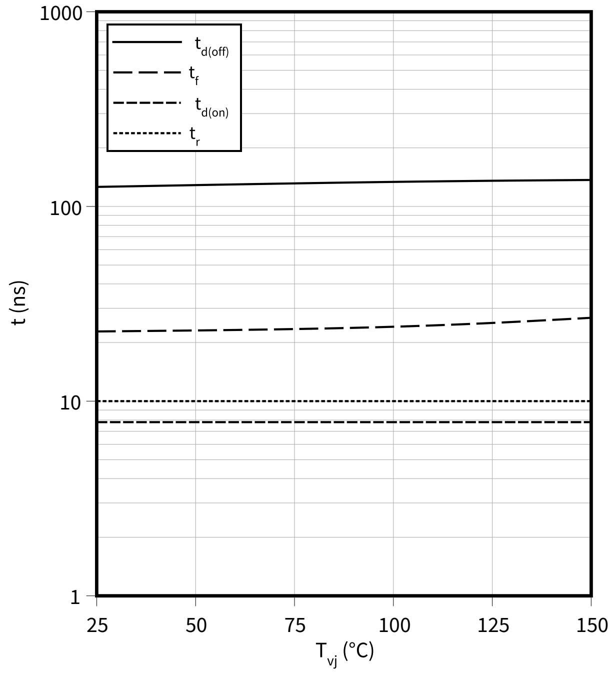
$I_C = 4$ A, $V_{CC} = 400$ V, $T_{vj} = 150$ °C, $V_{GE} = 0/15$ V



Typical switching times as a function of junction temperature

$t = f(T_{vj})$

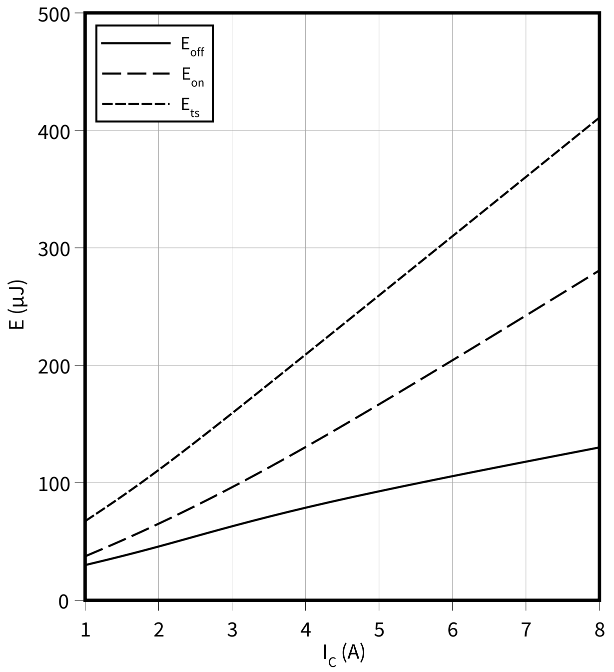
$I_C = 4$ A, $V_{CC} = 400$ V, $V_{GE} = 0/15$ V, $R_G = 49$ Ω



Typical switching energy losses as a function of collector current

$E = f(I_C)$

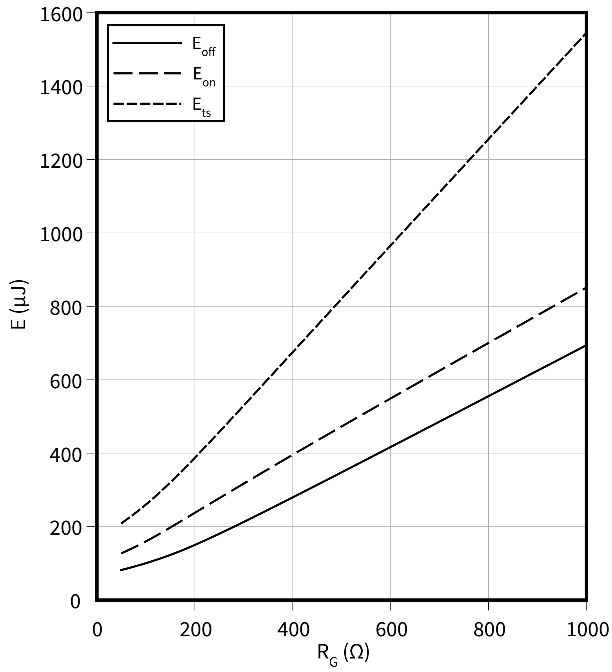
$V_{CC} = 400$ V, $T_{vj} = 150$ °C, $V_{GE} = 0/15$ V, $R_G = 49$ Ω



Typical switching energy losses as a function of gate resistor

$E = f(R_G)$

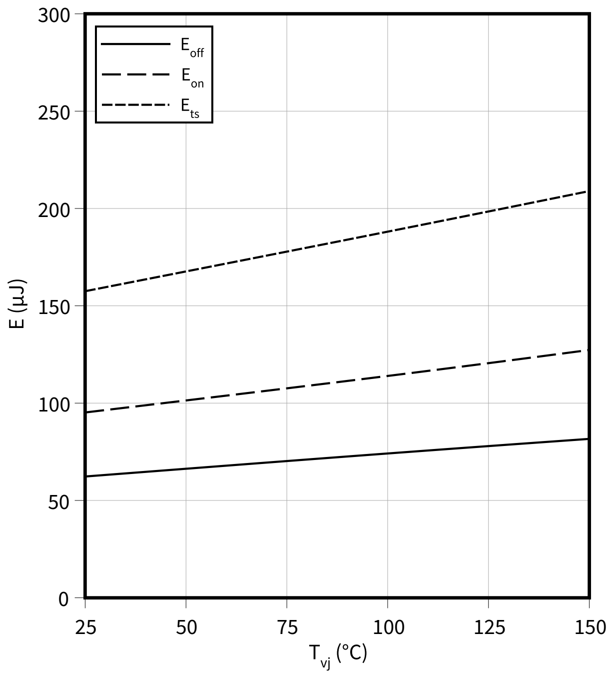
$I_C = 4$ A, $V_{CC} = 400$ V, $T_{vj} = 150$ °C, $V_{GE} = 0/15$ V



Typical switching energy losses as a function of junction temperature

$E = f(T_{vj})$

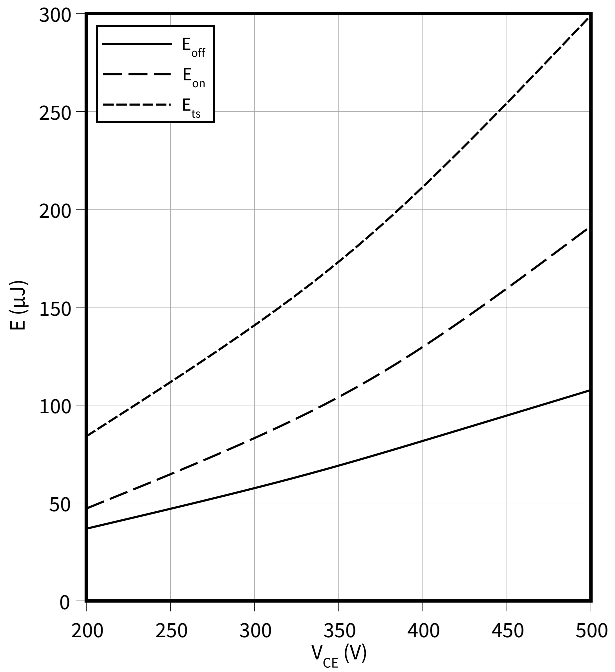
$I_C = 4$ A, $V_{CC} = 400$ V, $V_{GE} = 0/15$ V, $R_G = 49\ \Omega$



Typical switching energy losses as a function of collector emitter voltage

$E = f(V_{CE})$

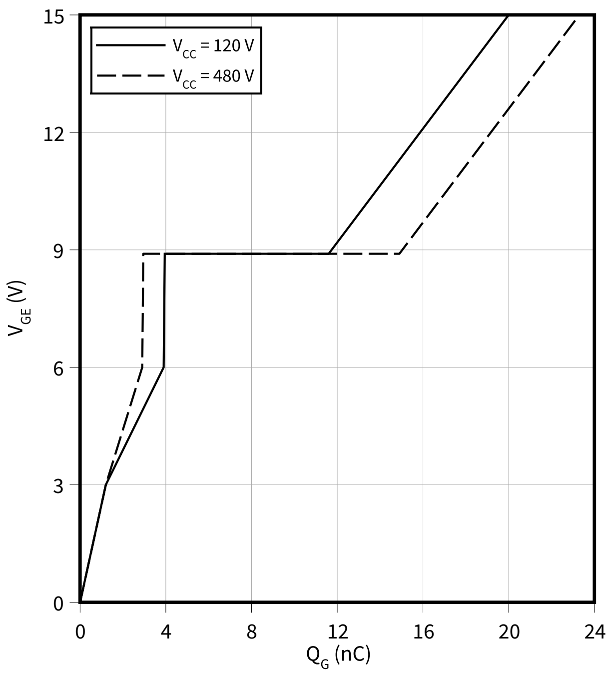
$I_C = 4$ A, $T_{vj} = 150$ °C, $V_{GE} = 0/15$ V, $R_G = 49\ \Omega$



Typical gate charge

$V_{GE} = f(Q_G)$

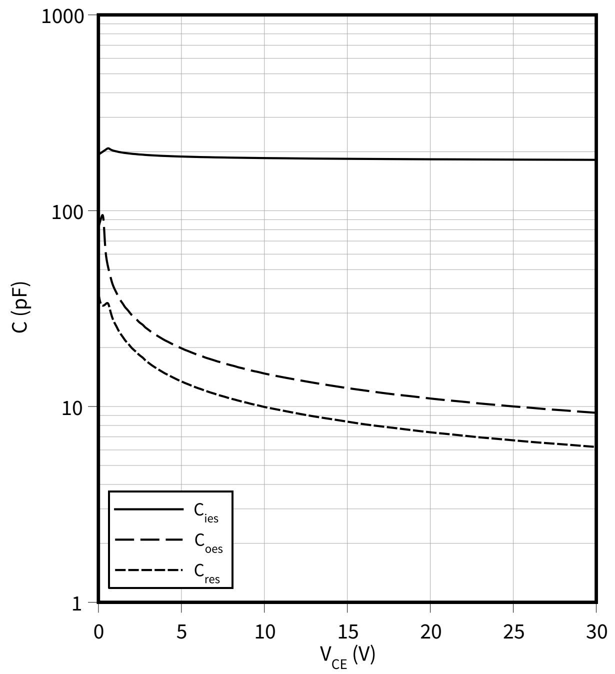
$I_C = 4$ A



Typical capacitance as a function of collector-emitter voltage

$C = f(V_{CE})$

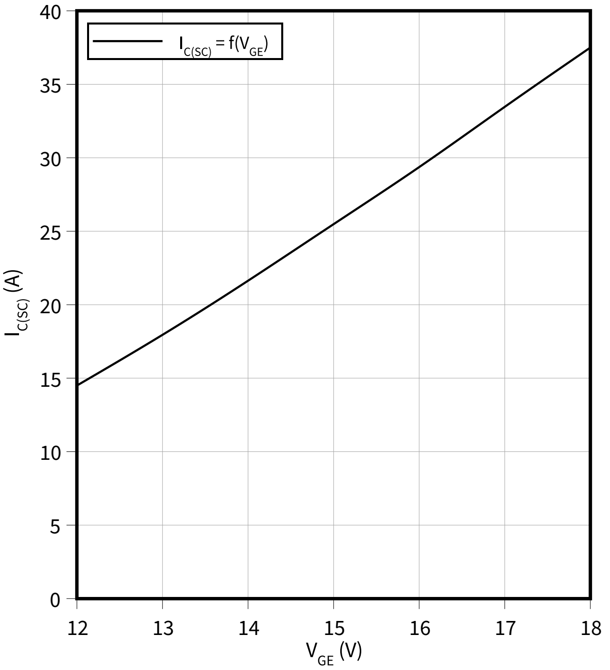
f = 1000 kHz, $V_{GE} = 0$ V



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

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

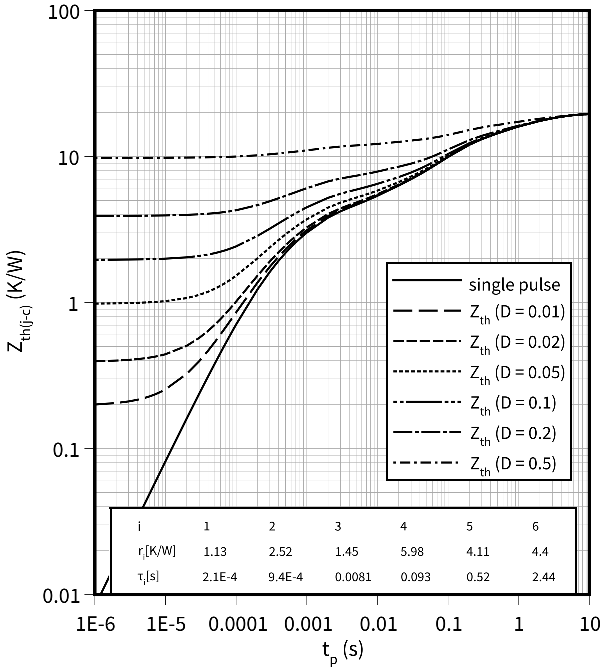
$T_{vj} \leq 150\ °C$, $V_{CC} \leq 400\ V$



IGBT transient thermal impedance as a function of pulse width

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

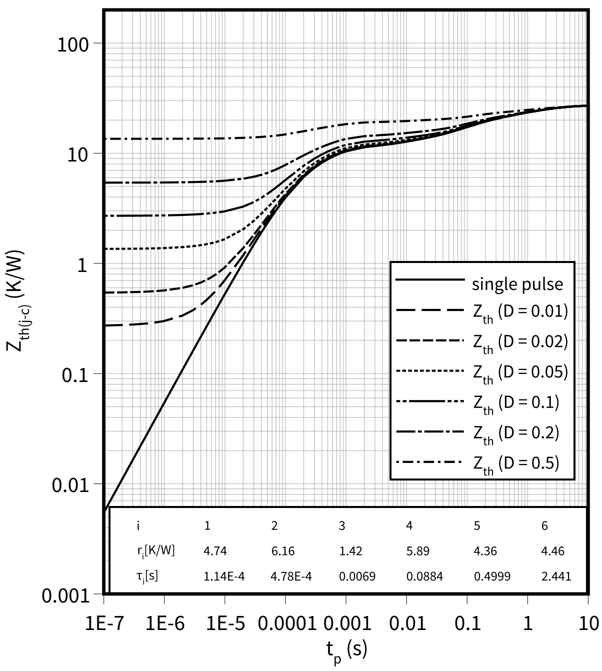
$D = t_p/T$



Diode transient thermal impedance as a function of pulse width

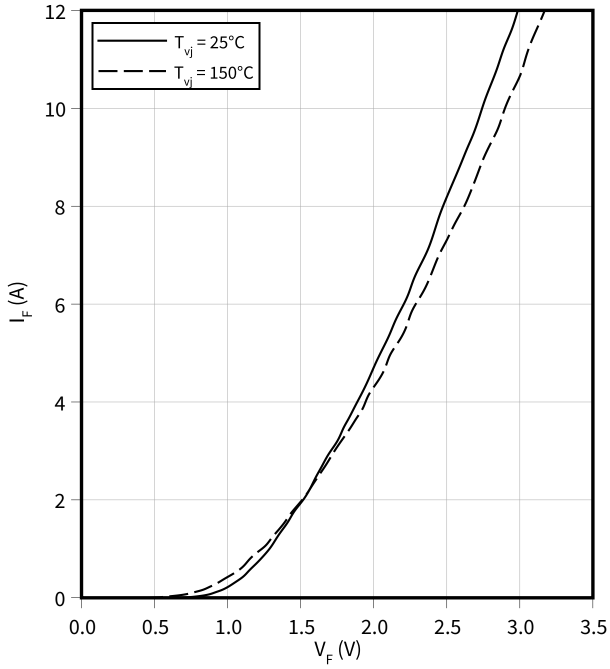
$Z_{th(j-c)} = f(t_p)$

$D = t_p/T$



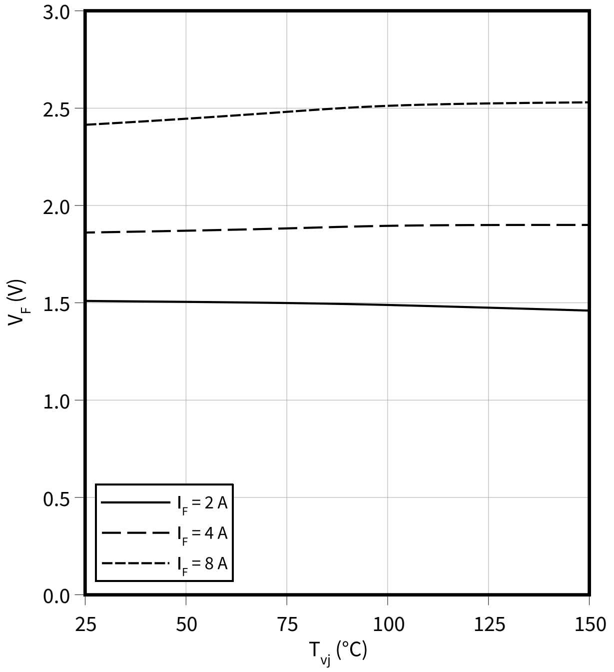
Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



Typical diode forward voltage as a function of junction temperature

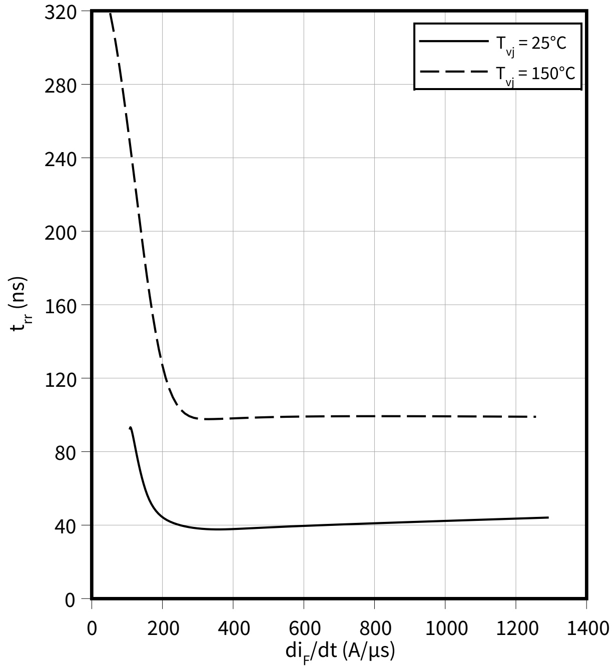
$V_F = f(T_{vj})$



Typical reverse recovery time as a function of diode current slope

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

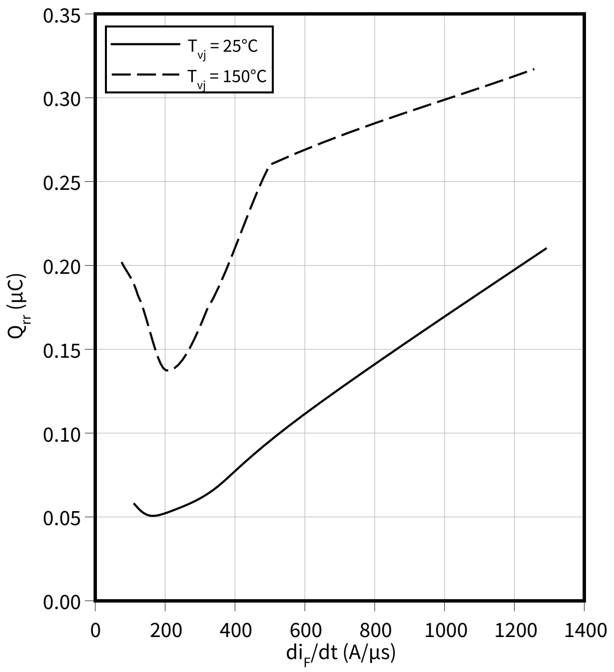
$V_R = 400$ V, $I_F = 4$ A



Typical reverse recovery charge as a function of diode current slope

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

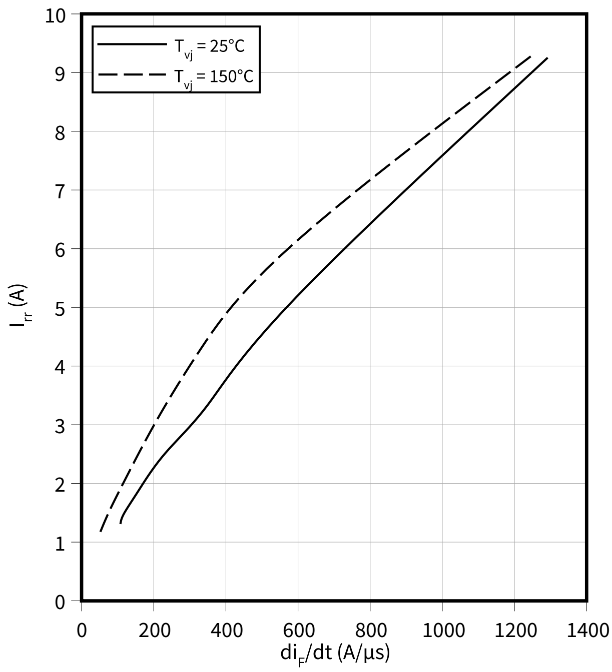
$V_R = 400$ V, $I_F = 4$ A



Typical reverse recovery current as a function of diode current slope

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

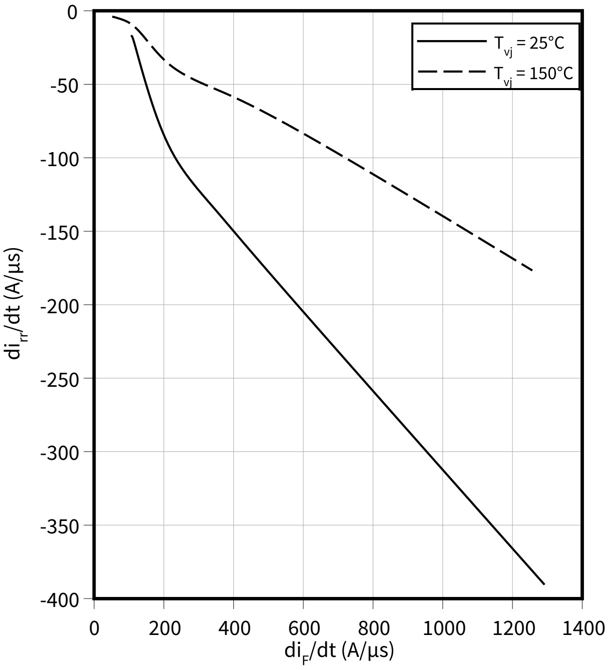
$V_R = 400$ V, $I_F = 4$ A



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

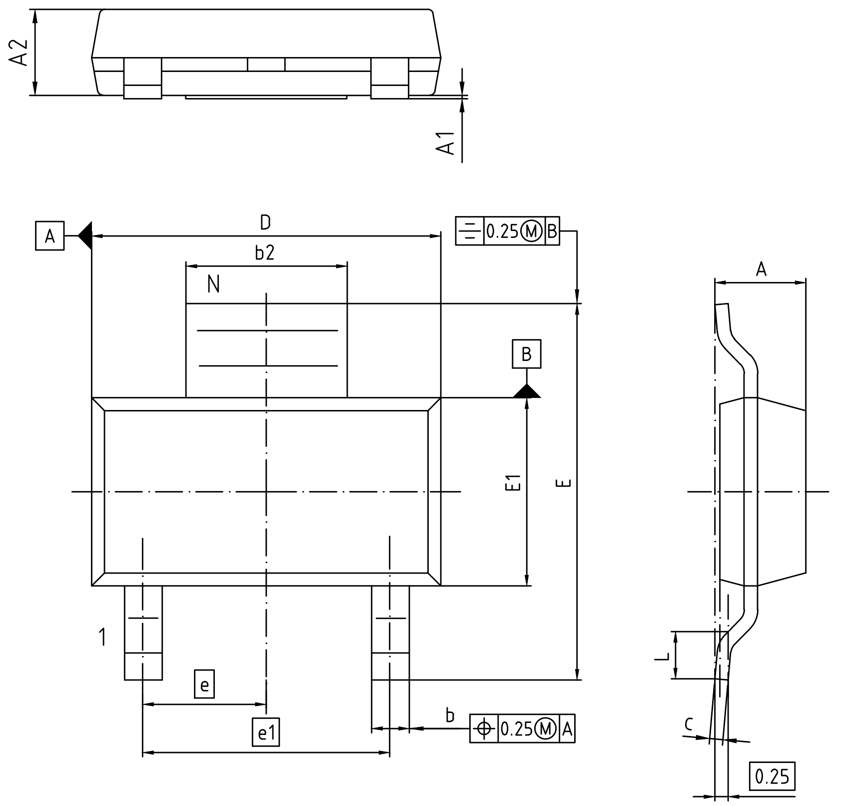
$di_{rr}/dt = f(di_F/dt)$

$V_R = 400$ V, $I_F = 4$ 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°

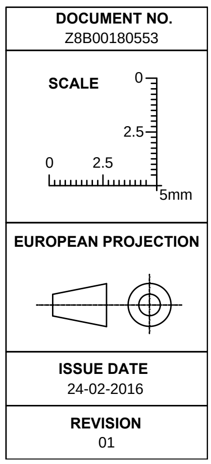


Figure 1

6 Testing conditions

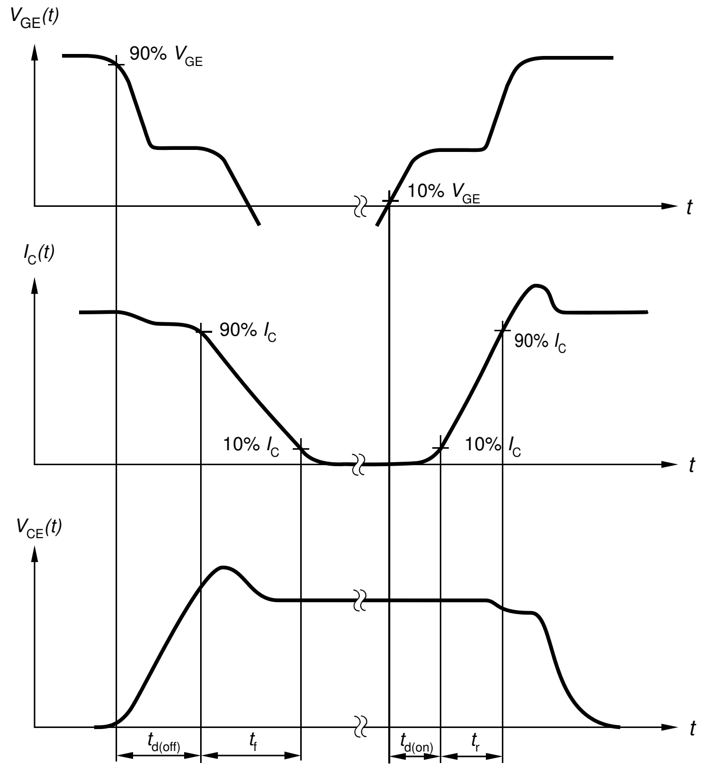


Figure A. **Definition of switching times**

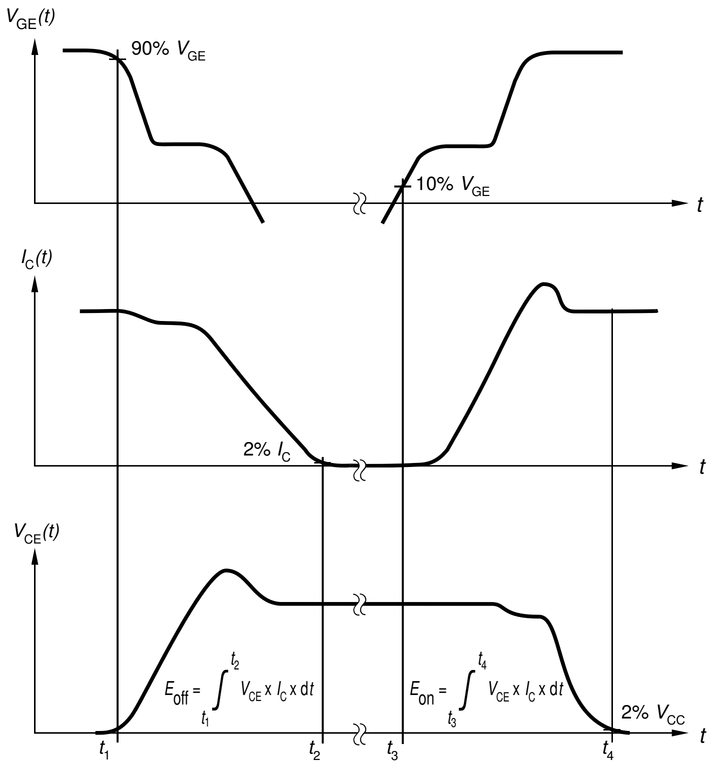


Figure B. **Definition of switching losses**

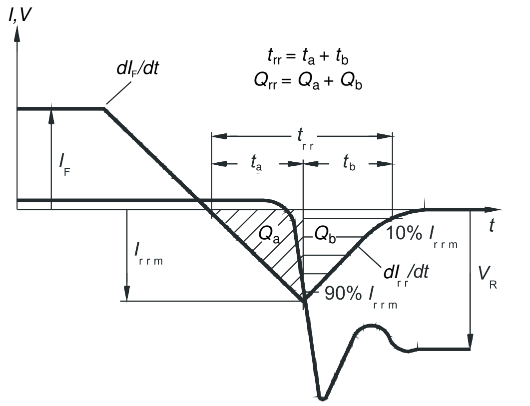


Figure C. **Definition of diode switching characteristics**

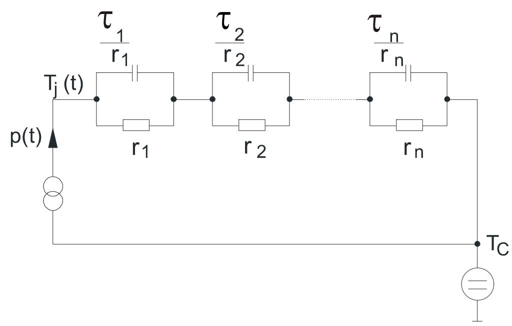


Figure D. **Thermal equivalent circuit**

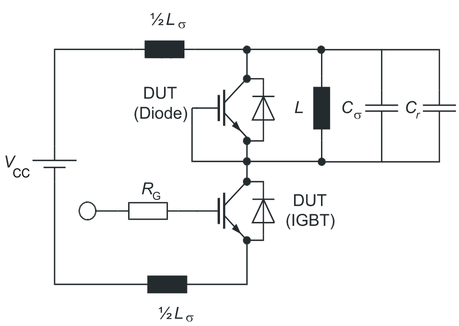


Figure E. **Dynamic test circuit**
Parasitic inductance L_σ,
parasitic capacitor C_σ,
relief capacitor C_r,
(only for ZVT switching)

Figure 2

Revision history

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

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