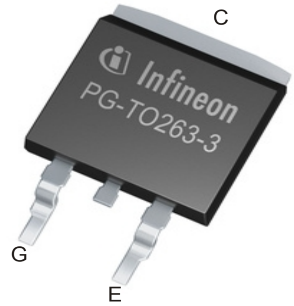
TRENCHSTOP™ 5 high speed soft switching IGBT co-packed with full current rated RAPID 1 fast and soft antiparallel diode

Features

- V_{CE} = 650 V
- I_C = 30 A
- High speed smooth switching device for hard & soft switching
- Very low V_{CEsat}, 1.35 V at nominal current
- 650 V breakdown voltage
- Low gate charge Q_G
- IGBT co-packed with full rated current RAPID 1 fast antiparallel diode
- Maximum junction temperature T_{vjmax} = 175°C
- Pb-free lead plating; RoHS compliant
- Complete product spectrum and PSpice Models: http://www.infineon.com/igbt/



Green
Halogen-free
RoHS

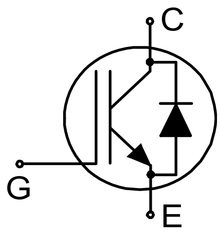
Potential applications

- Solar string inverter
- Solar micro inverter
- Industrial SMPS
- Industrial UPS
- Welding
- Energy storage
- Charger

Product validation

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

Description



Type	Package	Marking
IKB30N65ES5	PG-TO263-3	K30EES5

Table of contents

1 Package

Table 1 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Internal emitter inductance measured 5 mm (0.197 in.) from case	L_E			7		nH
Storage temperature	T_{stg}		-55		150	°C
Soldering temperature	T_{sold}	reflow soldering (MSL1 according to JEDEC J-STA-020)			260	°C
Thermal resistance, min.footprint junction-ambient	$R_{th(j-a)}$				65	K/W
Thermal resistance, 6 cm^2 Cu on PCB junction to ambient	$R_{th(j-a)}$				40	K/W
IGBT thermal resistance, junction-case	$R_{th(j-c)}$				0.8	K/W
Diode thermal resistance, junction-case	$R_{th(j-c)}$				1	K/W

2 IGBT

Table 2 Maximum rated values

Parameter	Symbol	Note or test condition		Values	Unit
Collector-emitter voltage	V_{CE}	$T_{vj} \geq 25$ °C		650	V
DC collector current, limited by T_{vjmax}	I_C		$T_c = 25$ °C	62	A
			$T_c = 100$ °C	39.5	
Pulsed collector current, t_p limited by T_{vjmax}	I_{Cpulse}			120	A
Turn-off safe operating area		$V_{CE} \leq 650$ V, $t_p = 1$ μs, $T_{vj} \leq 175$ °C		120	A
Gate-emitter voltage	V_{GE}			±20	V
Transient gate-emitter voltage	V_{GE}	$t_p \leq 10$ μs, $D < 0.01$		±30	V
Power dissipation	P_{tot}		$T_c = 25$ °C	188	W
			$T_c = 100$ °C	94	

Table 3 **Characteristic values**

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Collector-emitter breakdown voltage	V_{BRCES}	I_C = 0.2 mA, V_{GE} = 0 V		650			V
Collector-emitter saturation voltage	V_{CEsat}	I_C = 30 A, V_{GE} = 15 V	T_{vj} = 25 °C		1.35	1.7	V
			T_{vj} = 125 °C		1.5		
			T_{vj} = 175 °C		1.6		
Gate-emitter threshold voltage	V_{GEth}	I_C = 0.3 mA, V_{CE} = V_{GE}		3.2	4	4.8	V
Zero gate-voltage collector current	I_{CES}	V_{CE} = 650 V, V_{GE} = 0 V	T_{vj} = 25 °C			50	µA
			T_{vj} = 175 °C		1400		
Gate-emitter leakage current	I_{GES}	V_{CE} = 0 V, V_{GE} = 20 V				100	nA
Transconductance	g_{fs}	I_C = 30 A, V_{CE} = 20 V			42		S
Input capacitance	C_{ies}	V_{CE} = 25 V, V_{GE} = 0 V, f = 1000 kHz			1800		pF
Output capacitance	C_{oes}	V_{CE} = 25 V, V_{GE} = 0 V, f = 1000 kHz			55		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 = 30 A, V_{CC} = 520 V, V_{GE} = 15 V			70		nC
Turn-on delay time	$t_{d(on)}$	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 13 Ω, $R_{G(off)}$ = 13 Ω	T_{vj} = 25 °C, I_C = 30 A		17		ns
			T_{vj} = 25 °C, I_C = 15 A		16		
			T_{vj} = 150 °C, I_C = 30 A		17		
			T_{vj} = 150 °C, I_C = 15 A		16		
Rise time (inductive load)	t_r	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 13 Ω, $R_{G(off)}$ = 13 Ω	T_{vj} = 25 °C, I_C = 30 A		12		ns
			T_{vj} = 25 °C, I_C = 15 A		6		
			T_{vj} = 150 °C, I_C = 30 A		13		
			T_{vj} = 150 °C, I_C = 15 A		7		

(table continues...)

Table 3 (continued) Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Turn-off delay time	$t_{d(off)}$	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 13 Ω, $R_{G(off)}$ = 13 Ω	T_{vj} = 25 °C, I_C = 30 A		124		ns
			T_{vj} = 25 °C, I_C = 15 A		133		
			T_{vj} = 150 °C, I_C = 30 A		149		
			T_{vj} = 150 °C, I_C = 15 A		179		
Fall time (inductive load)	t_f	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 13 Ω, $R_{G(off)}$ = 13 Ω	T_{vj} = 25 °C, I_C = 30 A		30		ns
			T_{vj} = 25 °C, I_C = 15 A		33		
			T_{vj} = 150 °C, I_C = 30 A		55		
			T_{vj} = 150 °C, I_C = 15 A		54		
Turn-on energy	E_{on}	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 13 Ω, $R_{G(off)}$ = 13 Ω	T_{vj} = 25 °C, I_C = 30 A		0.56		mJ
			T_{vj} = 25 °C, I_C = 15 A		0.26		
			T_{vj} = 150 °C, I_C = 30 A		0.77		
			T_{vj} = 150 °C, I_C = 15 A		0.41		
Turn-off energy	E_{off}	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 13 Ω, $R_{G(off)}$ = 13 Ω	T_{vj} = 25 °C, I_C = 30 A		0.32		mJ
			T_{vj} = 25 °C, I_C = 15 A		0.17		
			T_{vj} = 150 °C, I_C = 30 A		0.56		
			T_{vj} = 150 °C, I_C = 15 A		0.31		

(table continues...)

Table 3 **(continued) Characteristic values**

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Total switching energy	E_{ts}	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 13 Ω, $R_{G(off)}$ = 13 Ω	T_{vj} = 25 °C, I_C = 30 A		0.88		mJ
			T_{vj} = 25 °C, I_C = 15 A		0.43		
			T_{vj} = 150 °C, I_C = 30 A		1.33		
			T_{vj} = 150 °C, I_C = 15 A		0.72		
Operating junction temperature	T_{vj}			-40		175	°C

3 Diode

Table 4 **Maximum rated values**

Parameter	Symbol	Note or test condition		Values	Unit
Repetitive peak reverse voltage	V_{RRM}	T_{vj} ≥ 25 °C		650	V
Diode forward current, limited by T_{vjmax}	I_F	limited by bondwire	T_c = 25 °C	40	A
			T_c = 100 °C	39.5	
Diode pulsed current, t_p limited by T_{vjmax}	I_{Fpulse}			120	A

Table 5 **Characteristic values**

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Diode forward voltage	V_F	I_F = 30 A	T_{vj} = 25 °C		1.45	1.7	V
			T_{vj} = 125 °C		1.42		
			T_{vj} = 175 °C		1.39		

(table continues...)

Table 5 (continued) Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Diode reverse recovery time	t_{rr}	V_R = 400 V	T_{vj} = 25 °C, I_F = 30 A, $-di_F/dt$ = 1200 A/μs		75		ns
			T_{vj} = 25 °C, I_F = 15 A, $-di_F/dt$ = 1900 A/μs		52		
			T_{vj} = 150 °C, I_F = 30 A, $-di_F/dt$ = 1200 A/μs		110		
			T_{vj} = 150 °C, I_F = 15 A, $-di_F/dt$ = 1900 A/μs		78		
Diode reverse recovery charge	Q_{rr}	V_R = 400 V	T_{vj} = 25 °C, I_F = 30 A, $-di_F/dt$ = 1200 A/μs		0.83		μC
			T_{vj} = 25 °C, I_F = 15 A, $-di_F/dt$ = 1900 A/μs		0.6		
			T_{vj} = 150 °C, I_F = 30 A, $-di_F/dt$ = 1200 A/μs		1.75		
			T_{vj} = 150 °C, I_F = 15 A, $-di_F/dt$ = 1900 A/μs		1.25		
Diode peak reverse recovery current	I_{rrm}	V_R = 400 V	T_{vj} = 25 °C, I_F = 30 A, $-di_F/dt$ = 1200 A/μs		18		A
			T_{vj} = 25 °C, I_F = 15 A, $-di_F/dt$ = 1900 A/μs		18.5		
			T_{vj} = 150 °C, I_F = 30 A, $-di_F/dt$ = 1200 A/μs		26.5		
			T_{vj} = 150 °C, I_F = 15 A, $-di_F/dt$ = 1900 A/μs		26.2		

(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 = 30 A, $-di_F/dt$ = 1200 A/µs		900		A/µs
			T_{vj} = 25 °C, I_F = 15 A, $-di_F/dt$ = 1900 A/µs		1320		
			T_{vj} = 150 °C, I_F = 30 A, $-di_F/dt$ = 1200 A/µs		1000		
			T_{vj} = 150 °C, I_F = 15 A, $-di_F/dt$ = 1900 A/µs		1200		
Operating junction temperature	T_{vj}			-40		175	°C

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

Electrical Characteristic at T_{vj} = 25°C, unless otherwise specified.

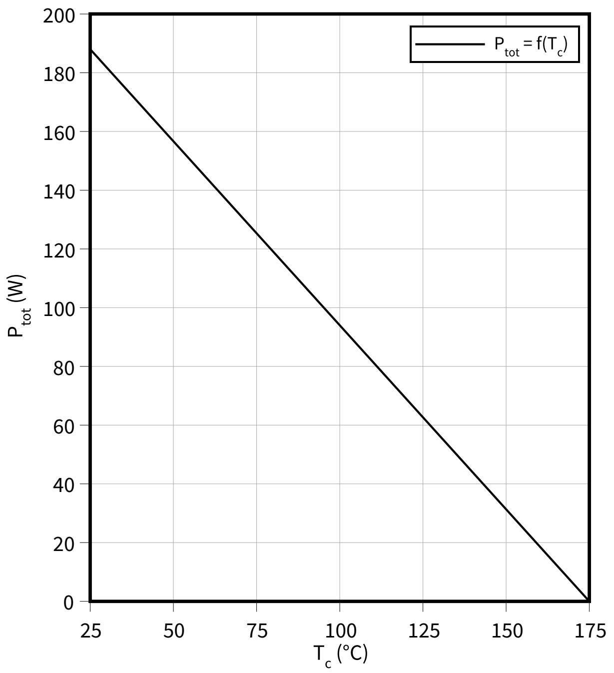
Dynamic test circuit, parasitic inductance L_σ = 30 nH, parasitic capacitor C_σ = 30 pF from Fig. E. Energy losses include "tail" and diode reverse recovery.

4 Characteristics diagrams

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_c)$

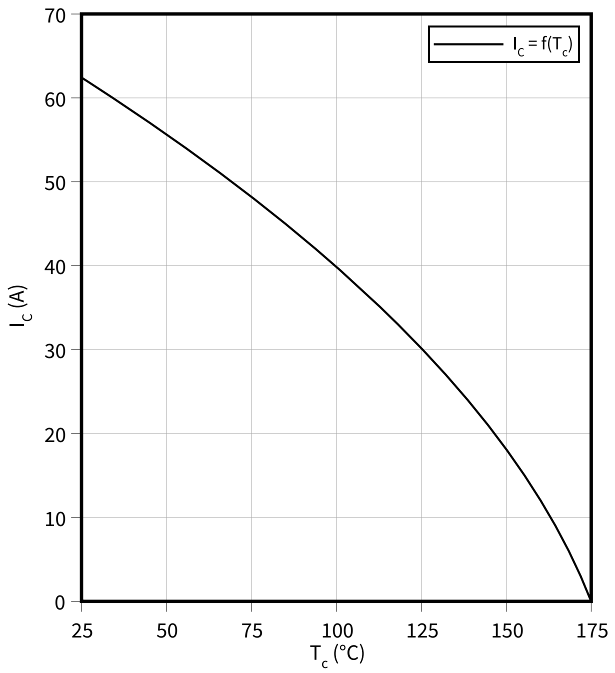
$T_{vj} \leq 175$ °C



Collector current as a function of case temperature

$I_C = f(T_c)$

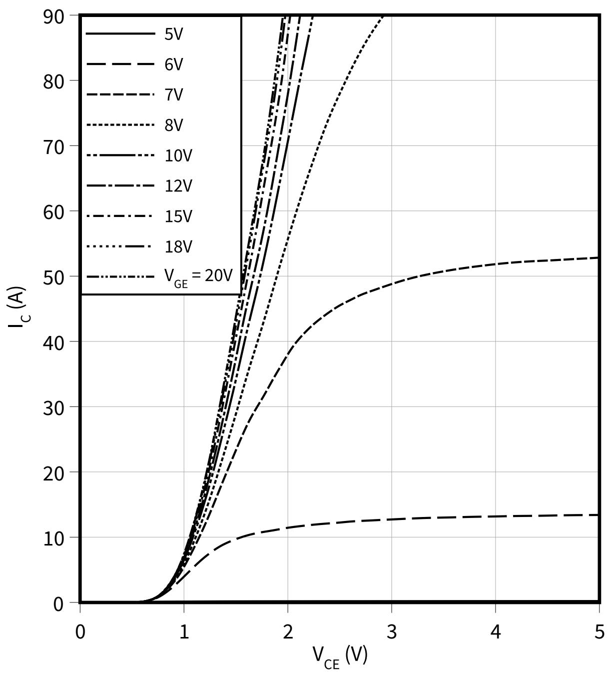
$T_{vj} \leq 175$ °C, $V_{GE} \geq 15$ V



Typical output characteristic

$I_C = f(V_{CE})$

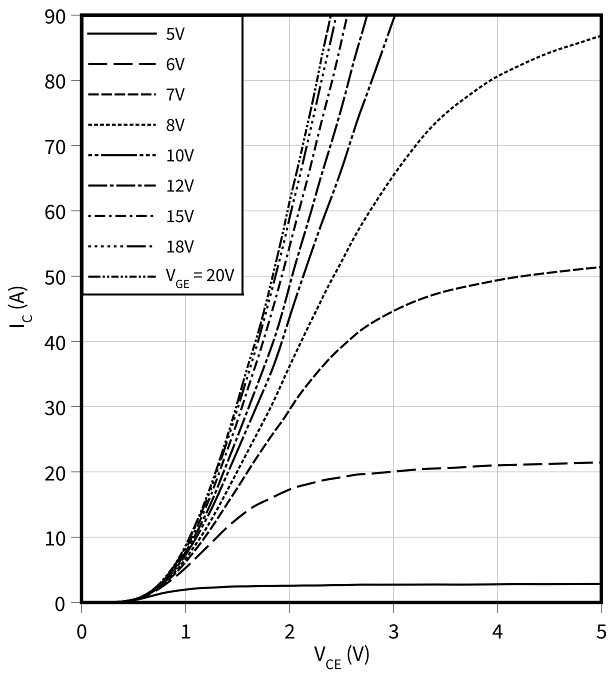
$T_{vj} = 25$ °C

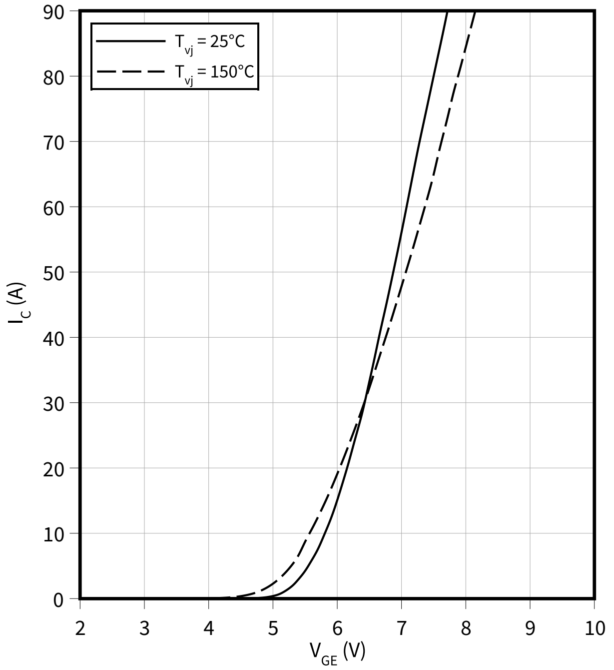
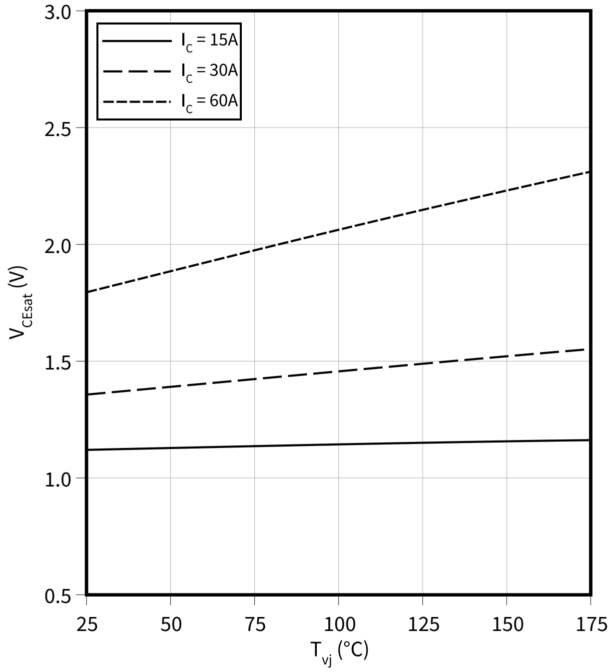
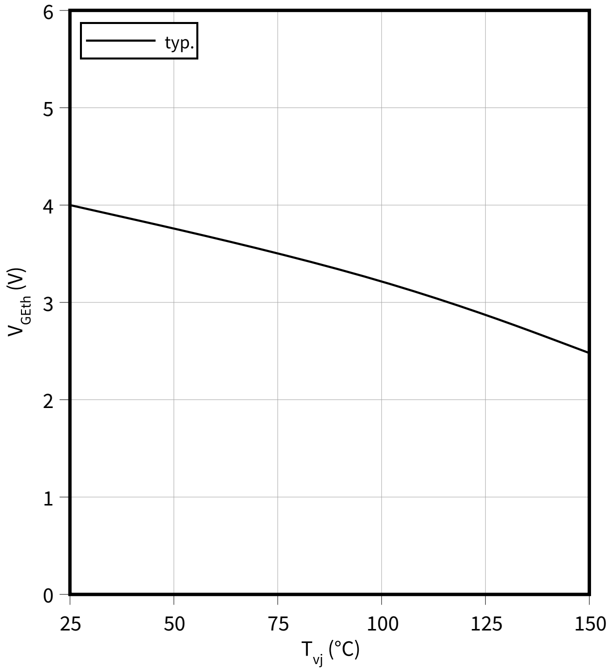
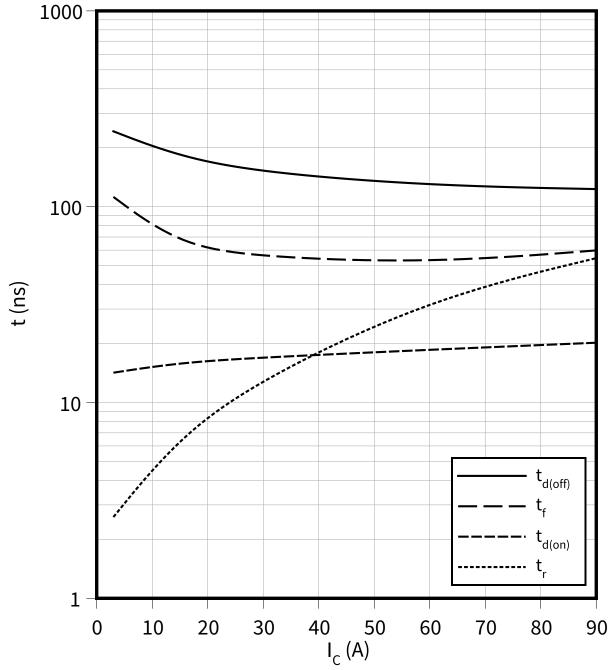


Typical output characteristic

$I_C = f(V_{CE})$

$T_{vj} = 150$ °C

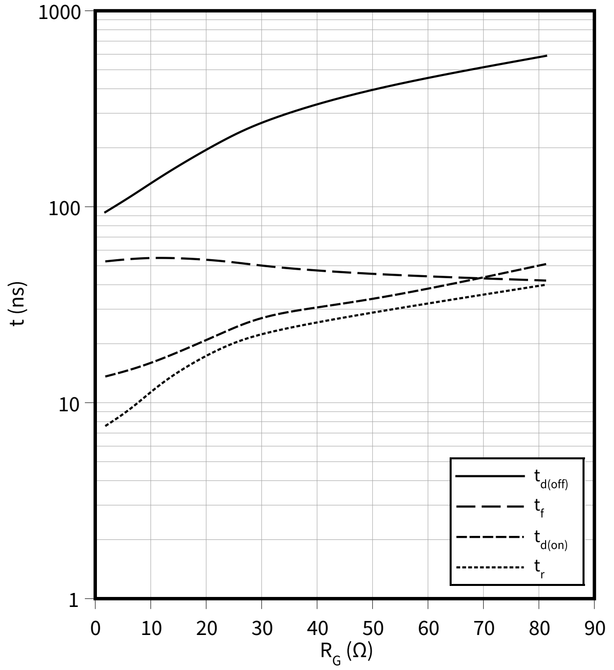


Typical transfer characteristic $I_C = f(V_{GE})$ $V_{CE} = 20$ V	**Typical collector-emitter saturation voltage as a function of junction temperature** $V_{CEsat} = f(T_{vj})$ $V_{GE} = 15$ V
	
Gate-emitter threshold voltage as a function of junction temperature $V_{GEth} = f(T_{vj})$ $I_C = 0.3$ mA	**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, $R_G = 13\ \Omega$
	

Typical switching times as a function of gate resistor

$t = f(R_G)$

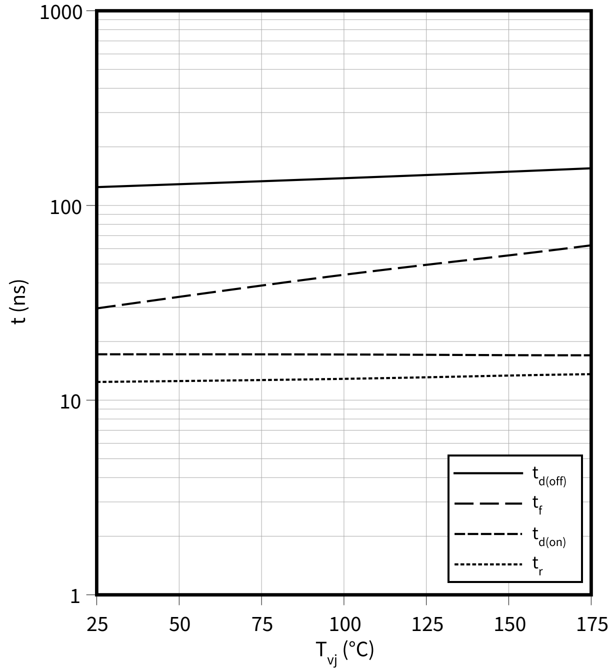
I_C = 30 A, V_{CC} = 400 V, T_{vj} = 150 °C, V_{GE} = 0/15 V



Typical switching times as a function of junction temperature

$t = f(T_{vj})$

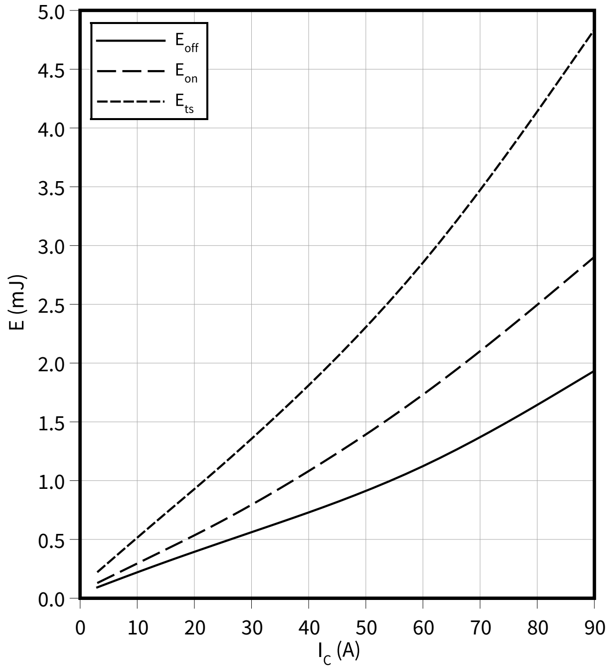
I_C = 30 A, V_{CC} = 400 V, V_{GE} = 0/15 V, R_G = 13 Ω



Typical switching energy losses as a function of collector current

$E = f(I_C)$

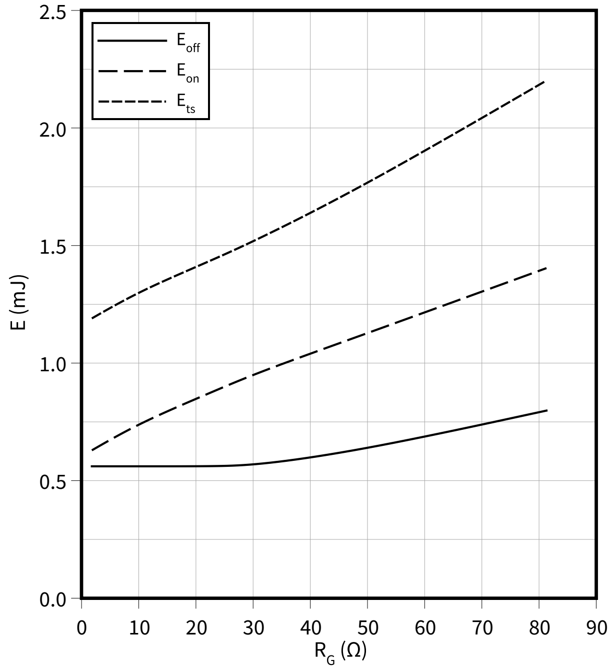
V_{CC} = 400 V, T_{vj} = 150 °C, V_{GE} = 0/15 V, R_G = 13 Ω



Typical switching energy losses as a function of gate resistor

$E = f(R_G)$

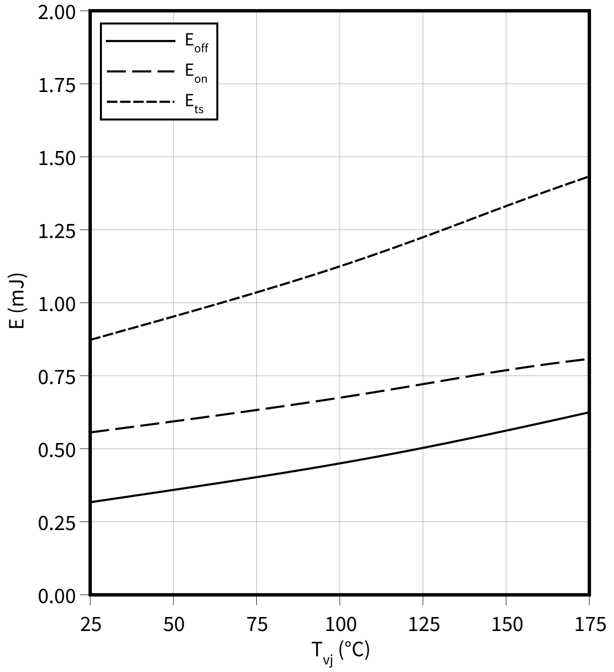
I_C = 30 A, V_{CC} = 400 V, T_{vj} = 150 °C, V_{GE} = 0/15 V



Typical switching energy losses as a function of junction temperature

$E = f(T_{vj})$

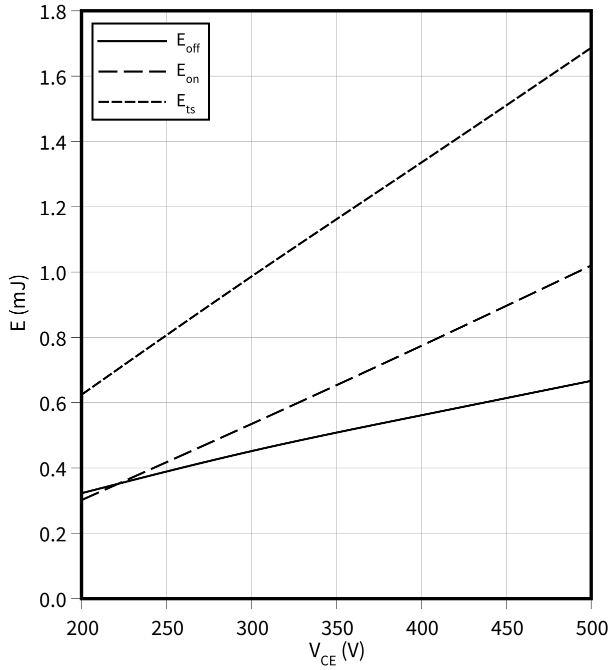
$I_C = 30$ A, $V_{CC} = 400$ V, $V_{GE} = 0/15$ V, $R_G = 13\ \Omega$



Typical switching energy losses as a function of collector emitter voltage

$E = f(V_{CE})$

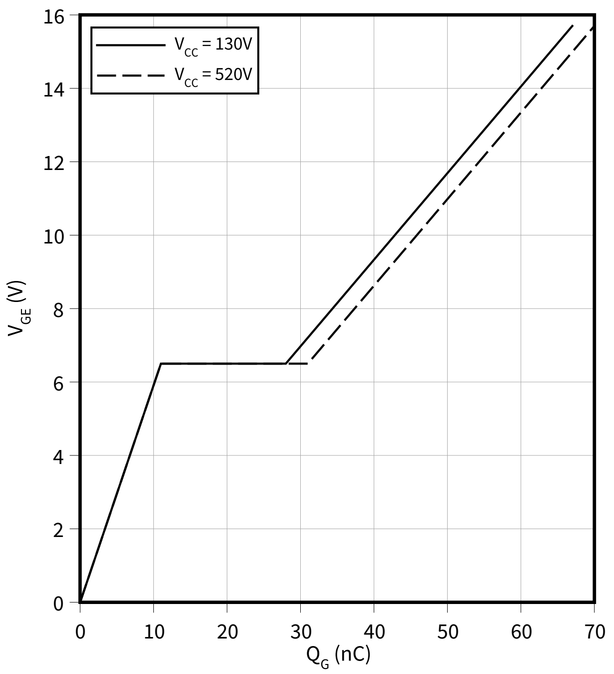
$I_C = 30$ A, $T_{vj} = 150$ °C, $V_{GE} = 0/15$ V, $R_G = 13\ \Omega$



Typical gate charge

$V_{GE} = f(Q_G)$

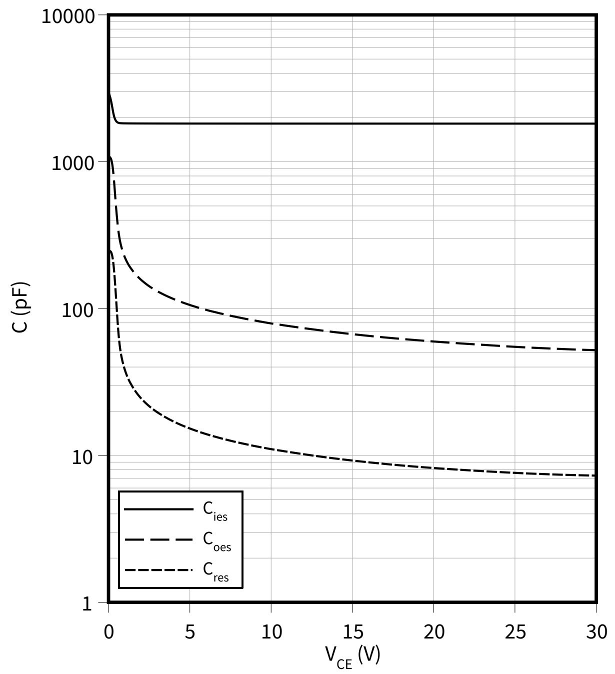
$I_C = 30$ A



Typical capacitance as a function of collector-emitter voltage

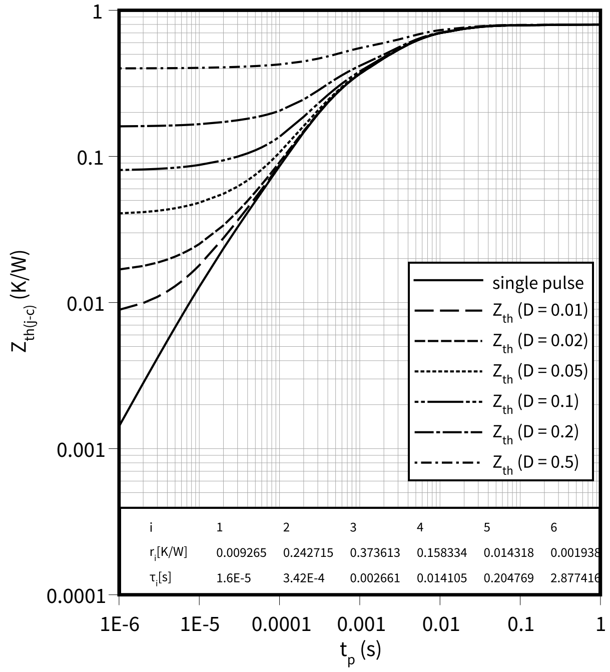
$C = f(V_{CE})$

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



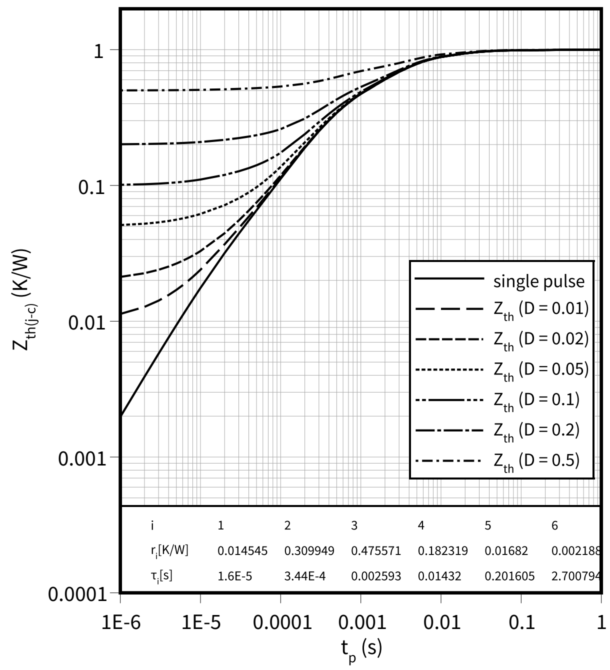
IGBT transient thermal impedance as a function of pulse width

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



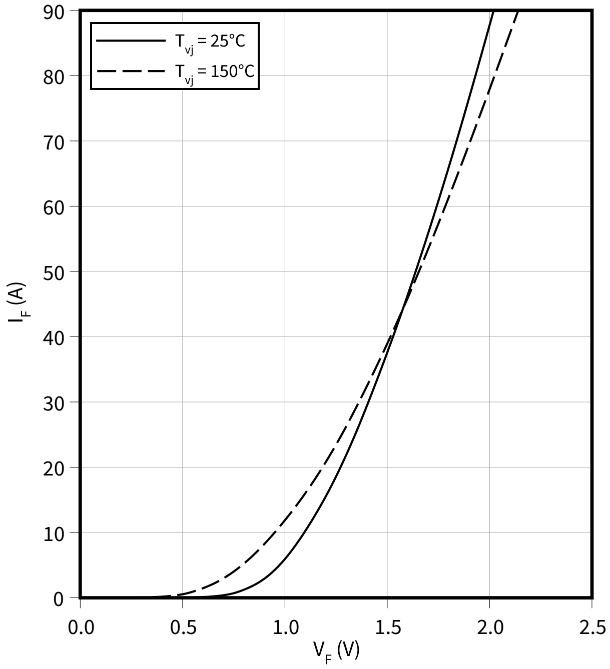
Diode transient thermal impedance as a function of pulse width

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



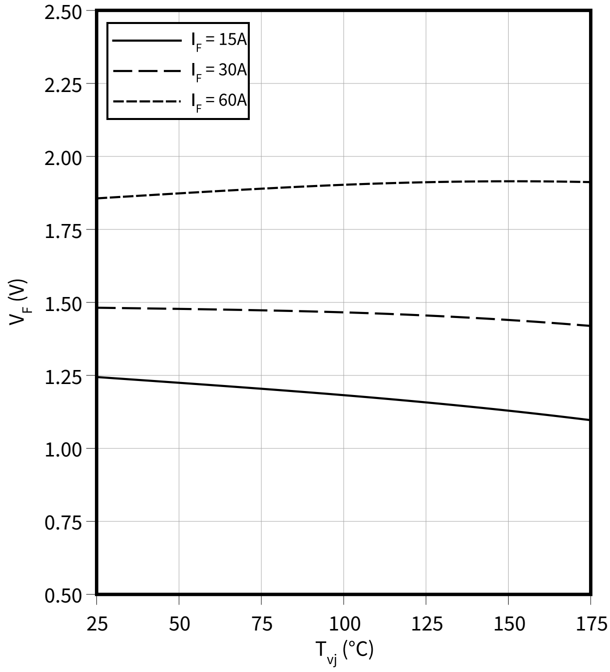
Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$

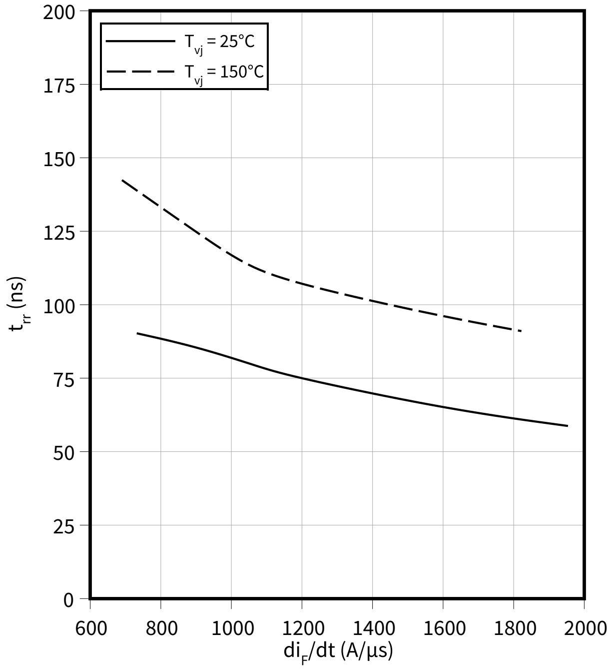


Typical diode forward voltage as a function of junction temperature

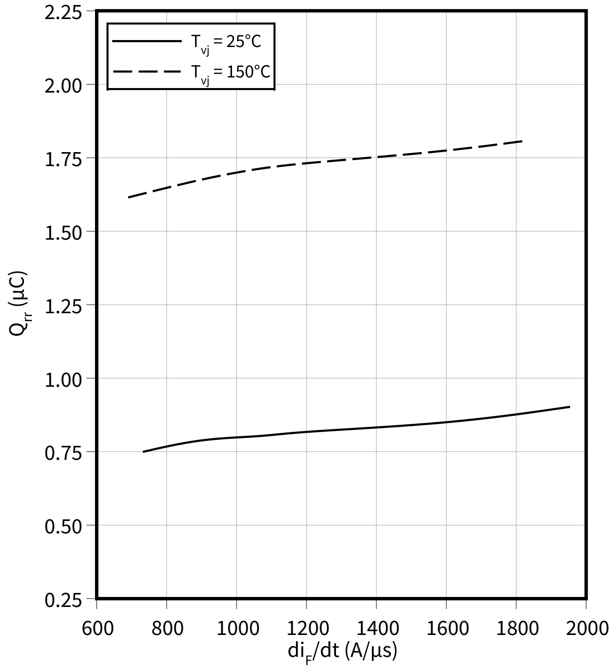
$V_F = f(T_{vj})$



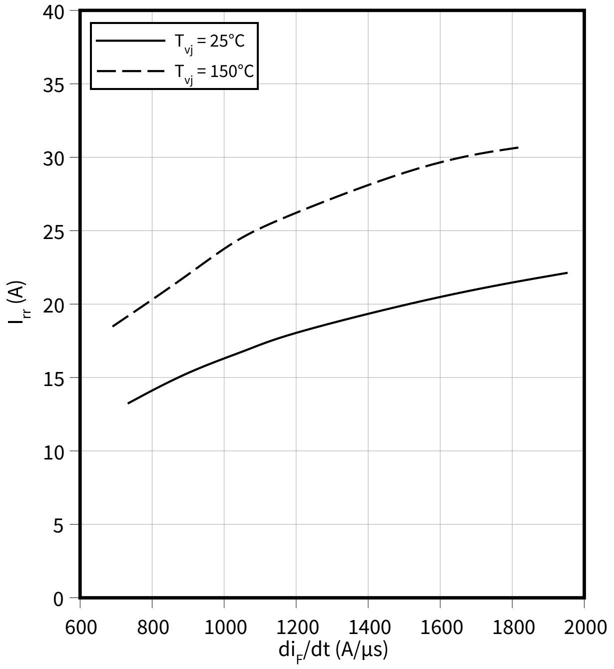
Typical reverse recovery time as a function of diode current slope
$t_{rr} = f(di_F/dt)$
$V_R = 400$ V, $I_F = 30$ A



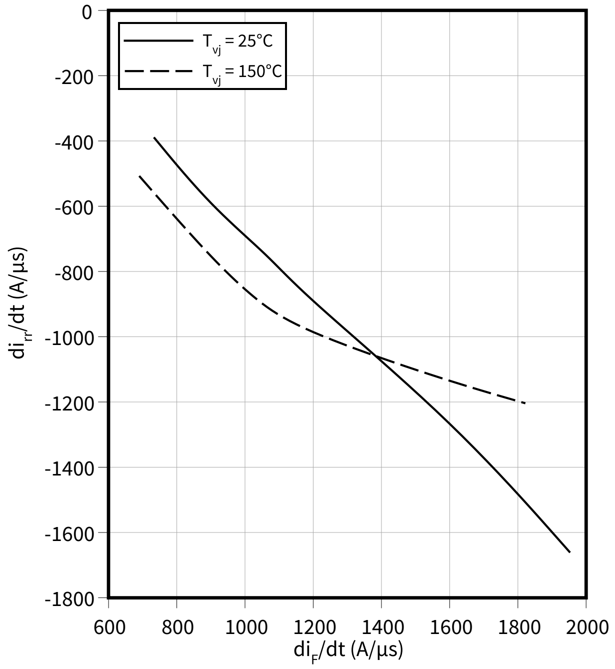
Typical reverse recovery charge as a function of diode current slope
$Q_{rr} = f(di_F/dt)$
$V_R = 400$ V, $I_F = 30$ A



Typical reverse recovery current as a function of diode current slope
$I_{rrm} = f(di_F/dt)$
$V_R = 400$ V, $I_F = 30$ A

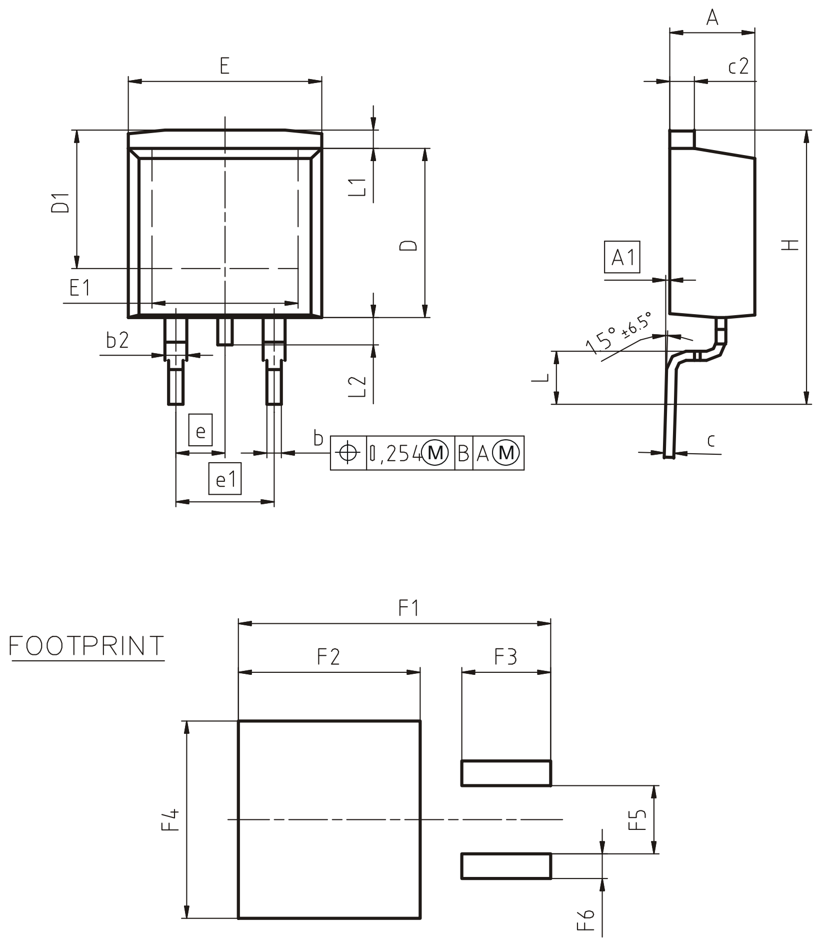


Typical diode peak rate of fall of reverse recovery current as a function of diode current slope
$di_{rr}/dt = f(di_F/dt)$
$V_R = 400$ V, $I_F = 30$ A



5 Package outlines

Package Drawing PG-TO263-3



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.30	4.57	0.169	0.180
A1	0.00	0.25	0.000	0.010
b	0.65	0.85	0.026	0.033
b2	0.95	1.15	0.037	0.045
c	0.33	0.65	0.013	0.026
c2	1.17	1.40	0.046	0.055
D	8.51	9.45	0.335	0.372
D1	7.10	7.90	0.280	0.311
E	9.80	10.31	0.386	0.406
E1	6.50	8.60	0.256	0.339
e	2.54		0.100	
e1	5.08		0.200	
N	2		2	
H	14.61	15.88	0.575	0.625
L	2.29	3.00	0.090	0.118
L1	0.70	1.60	0.028	0.063
L2	1.00	1.78	0.039	0.070
F1	16.05	16.25	0.632	0.640
F2	9.30	9.50	0.366	0.374
F3	4.50	4.70	0.177	0.185
F4	10.70	10.90	0.421	0.429
F5	3.65	3.85	0.144	0.152
F6	1.25	1.45	0.049	0.057

DOCUMENT NO.
Z8B00003324

SCALE 0 5 0 5 7.5mm

EUROPEAN PROJECTION

ISSUE DATE
30-08-2007

REVISION
01

Figure 1

6 Testing conditions

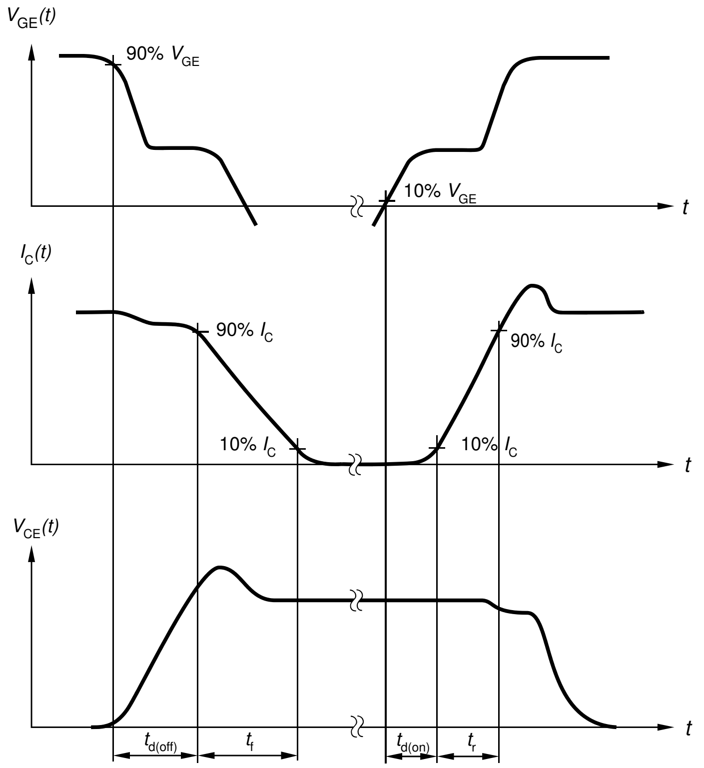


Figure A. **Definition of switching times**

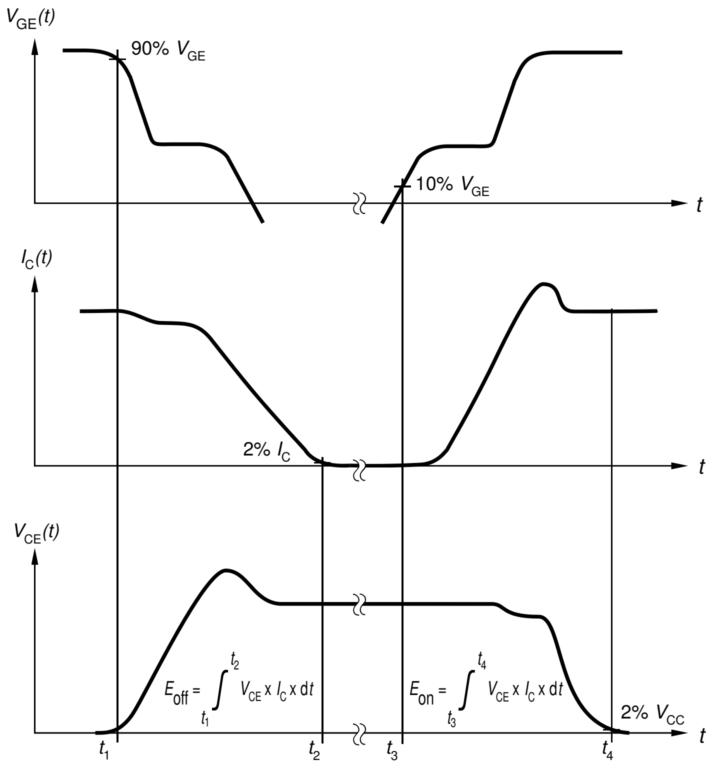


Figure B. **Definition of switching losses**

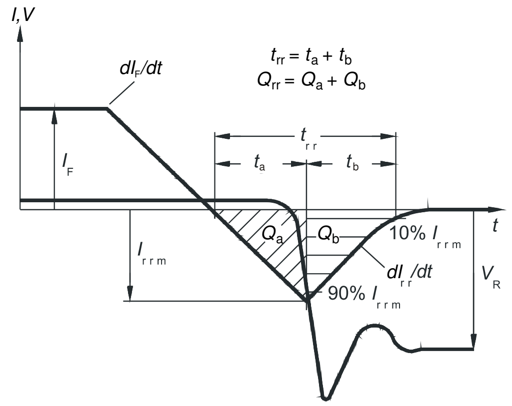


Figure C. **Definition of diode switching characteristics**

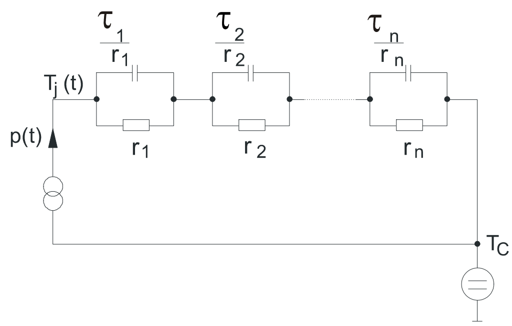


Figure D. **Thermal equivalent circuit**

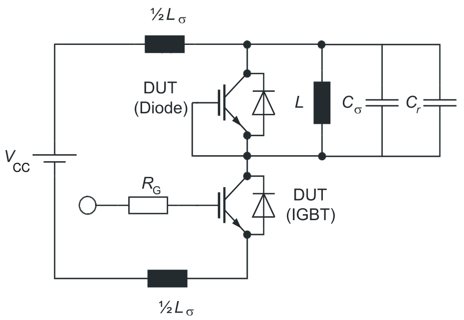


Figure E. **Dynamic test circuit**
Parasitic inductance L_σ,
parasitic capacitor C_σ,
relief capacitor C_r,
(only for ZVT switching)

Figure 2

Revision history

Document revision	Date of release	Description of changes
V2.1	2018-01-11	Final data sheet
n/a	2020-11-30	Datasheet migrated to a new system with a new layout and new revision number schema: target or preliminary datasheet = 0.xy; final datasheet = 1.xy
1.10	2023-01-17	Correction of diagram: “Typical switching energy losses as a function of collector emitter voltage” Editorial changes

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