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
- Plug and play replacement of previous generation IGBTs
- 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
- Qualified according to JEDEC for target applications
- Pb-free lead plating; RoHS compliant
- Complete product spectrum and PSpice Models: http://www.infineon.com/igbt/

Lead-free
Green
Halogen-free
RoHS

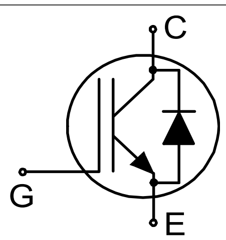
Potential applications

- Resonant converters
- Uninterruptible power supplies
- Welding converters
- Mid to high range switching frequency converters

Description

Package pin definition:

• Pin G - gate
• Pin C & backside - collector
• Pin E - emitter



Type	Package	Marking
IKW30N65ES5	PG-TO247-3	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			13		nH
Storage temperature	T_{stg}		-55		150	°C
Soldering temperature	T_{sold}	wave soldering 1.6 mm (0.063 in.) from case for 10 s			260	°C
Mounting torque	M	M3 screw, Maximum of mounting processes: 3			0.6	Nm
Thermal resistance, junction-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 Min.	Typ.	Max.	Unit
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_{GE} = 15 V, V_{CC} = 520 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.

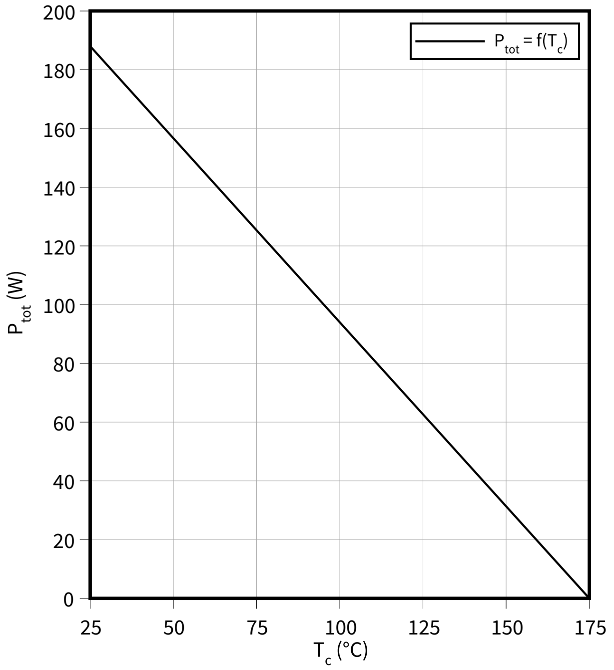
Dynamic test circuit, parasitic inductance $L_σ$ = 30 nH, parasitic capacitor $C_σ$ = 30 pF from Fig. E. Energy losses include “tail” and diode reverse recovery.

4 Characteristics diagrams

Power dissipation as a function of case temperature

$P_{tot} = f(T_c)$

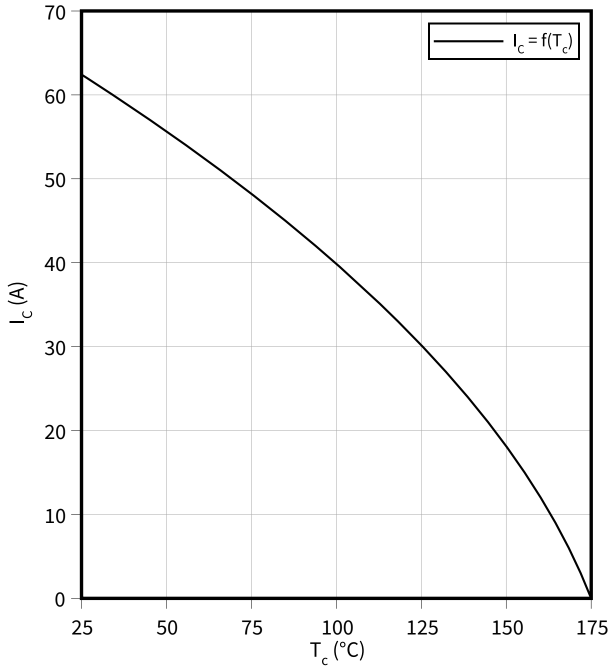
$T_{vj} \leq 175$ °C



Collector current as a function of case temperature

$I_C = f(T_c)$

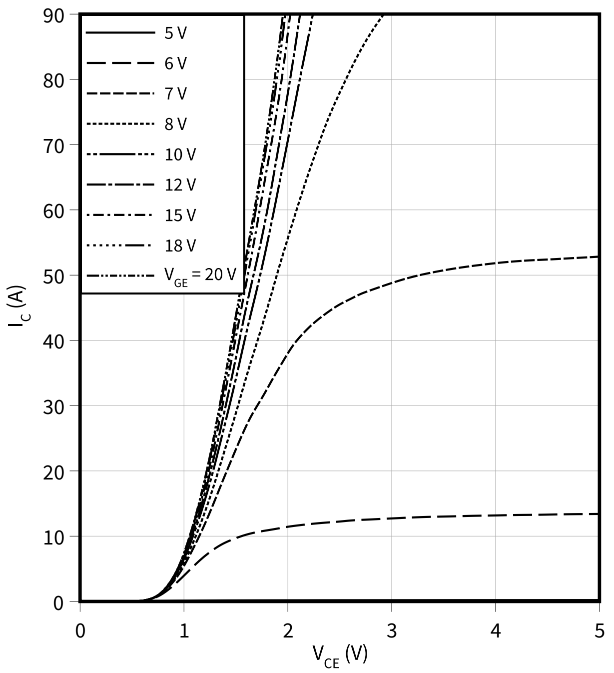
$T_{vj} \leq 175$ °C, $V_{GE} \geq 15$ V



Typical output characteristic

$I_C = f(V_{CE})$

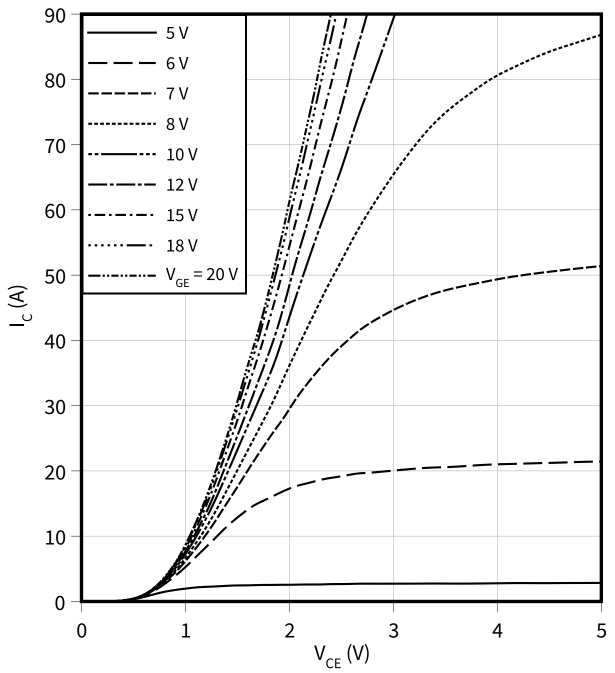
$T_{vj} = 25$ °C



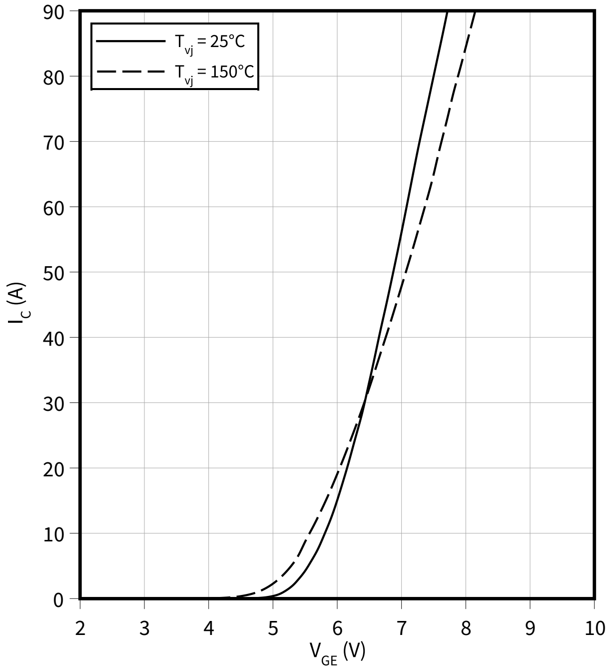
Typical output characteristic

$I_C = f(V_{CE})$

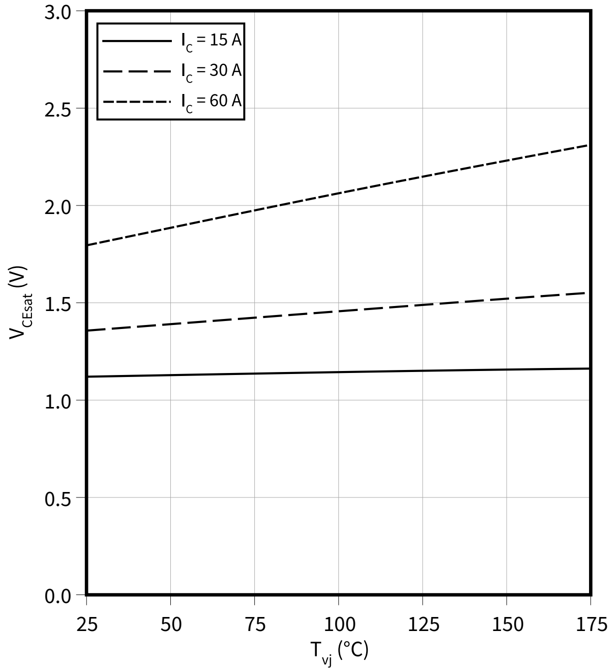
$T_{vj} = 150$ °C



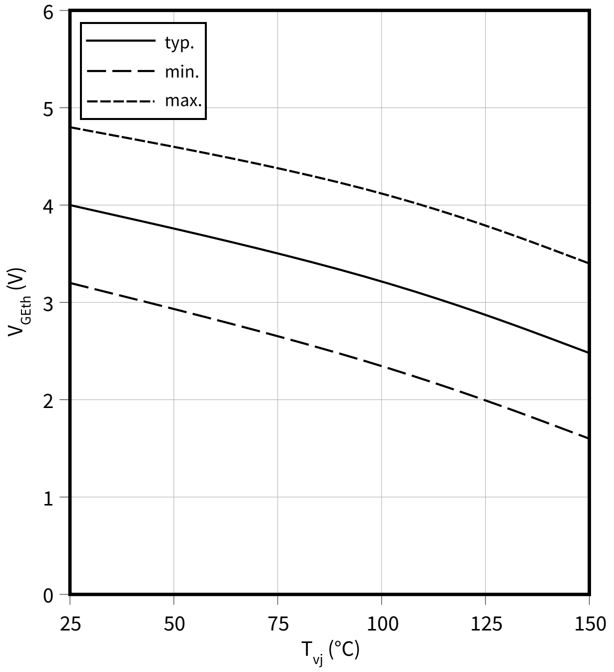
Typical transfer characteristic
$I_C = f(V_{GE})$
$V_{CE} = 20$ V



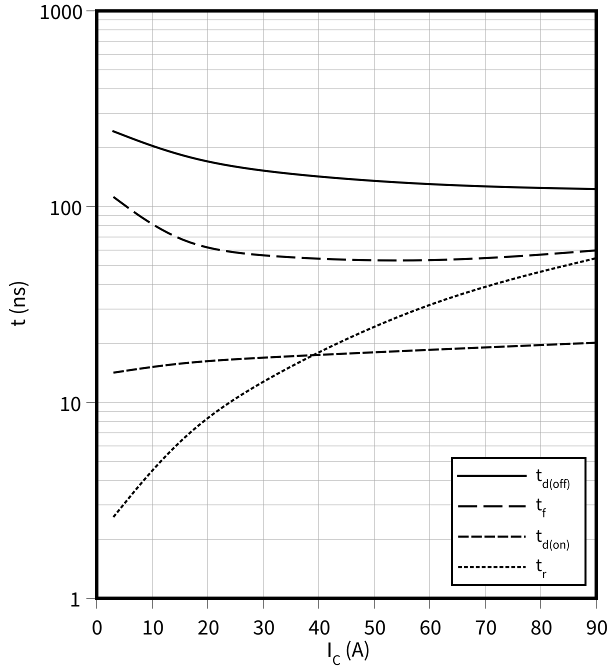
Typical collector-emitter saturation voltage as a function of junction temperature
$V_{CEsat} = f(T_{vj})$
$V_{GE} = 15$ V



Gate-emitter threshold voltage as a function of junction temperature
$V_{GEth} = f(T_{vj})$
$I_C = 0.3$ mA



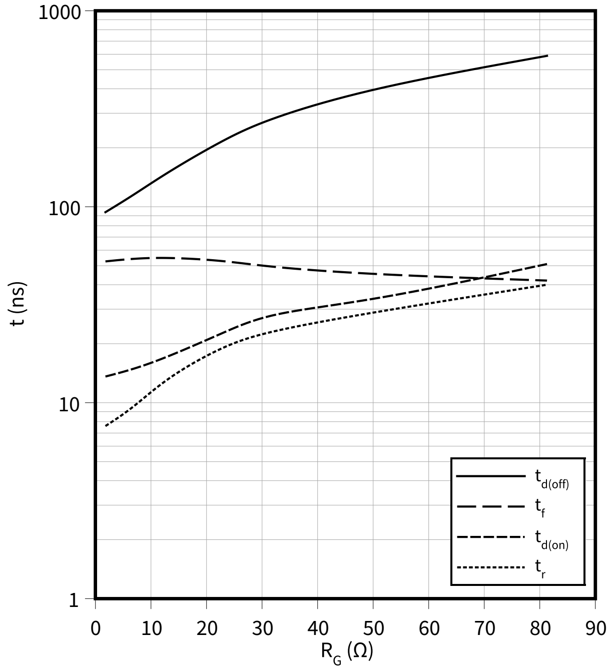
Typical switching times as a function of collector current
$t = f(I_C)$
$V_{CC} = 400$ V, $T_{vj} = 150$ °C, $V_{GE} = 0/15$ V, $R_G = 13\ \Omega$



Typical switching times as a function of gate resistor

$t = f(R_G)$

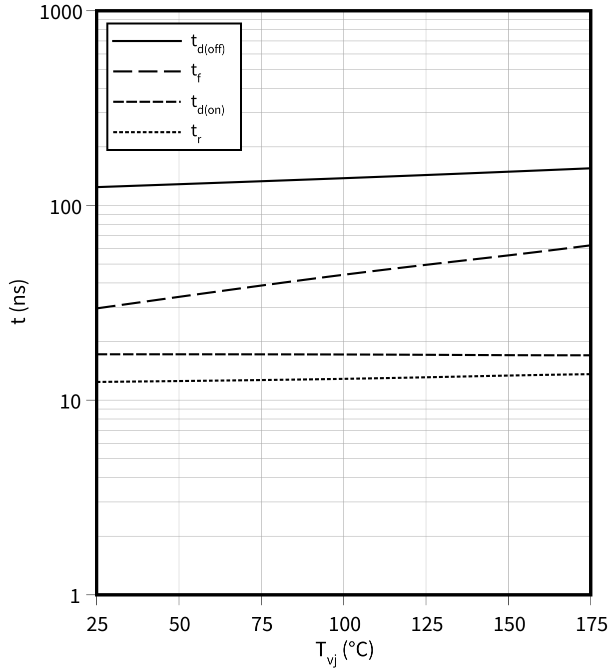
I_C = 30 A, V_{CC} = 400 V, T_{vj} = 150 °C, V_{GE} = 0/15 V



Typical switching times as a function of junction temperature

$t = f(T_{vj})$

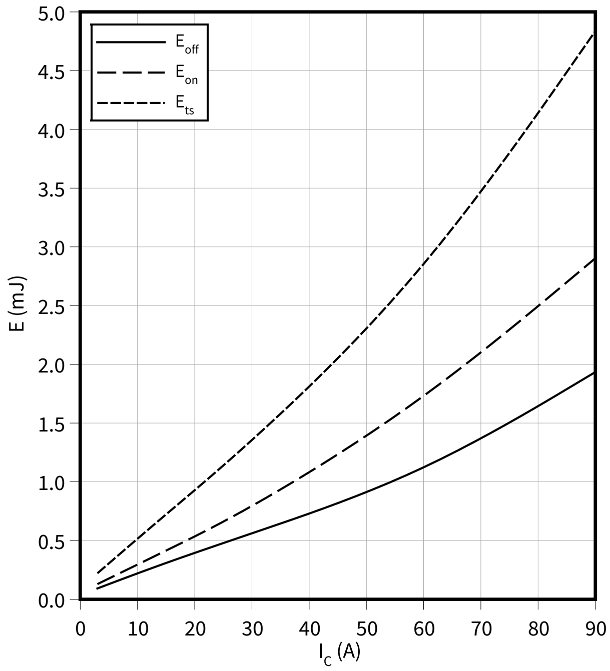
I_C = 30 A, V_{CC} = 400 V, V_{GE} = 0/15 V, R_G = 13 Ω



Typical switching energy losses as a function of collector current

$E = f(I_C)$

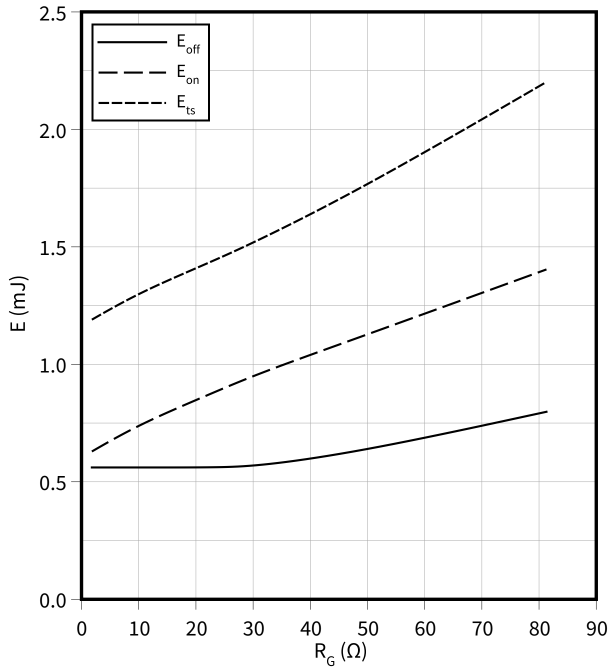
V_{CC} = 400 V, T_{vj} = 150 °C, V_{GE} = 0/15 V, R_G = 13 Ω



Typical switching energy losses as a function of gate resistor

$E = f(R_G)$

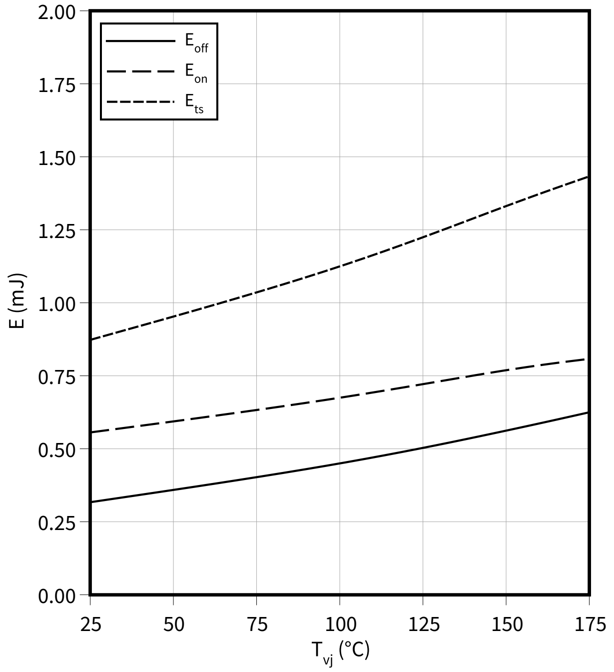
I_C = 30 A, V_{CC} = 400 V, T_{vj} = 150 °C, V_{GE} = 0/15 V



Typical switching energy losses as a function of junction temperature

$E = f(T_{vj})$

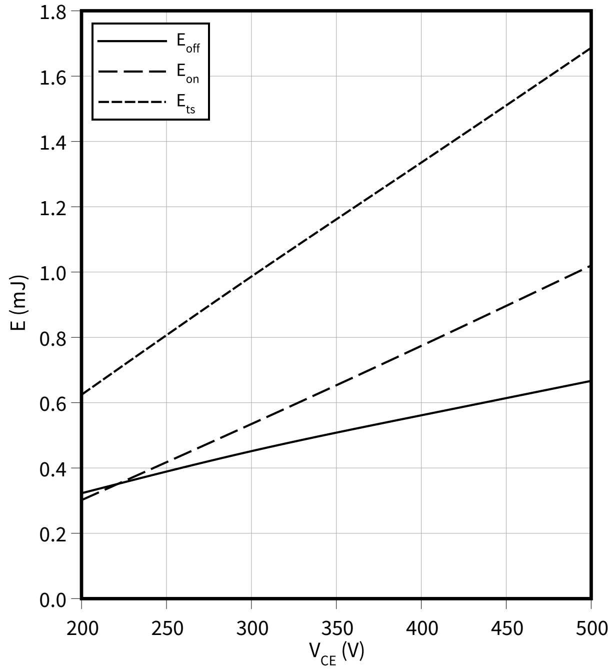
$I_C = 30$ A, $V_{CC} = 400$ V, $V_{GE} = 0/15$ V, $R_G = 13\ \Omega$



Typical switching energy losses as a function of collector emitter voltage

$E = f(V_{CE})$

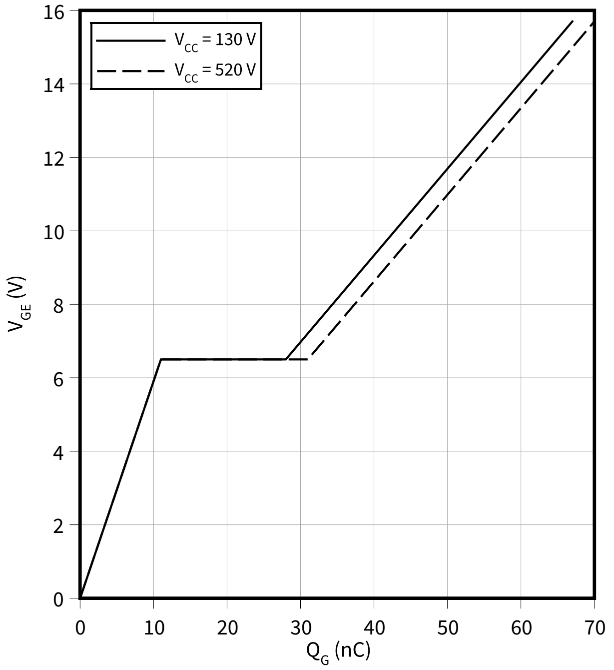
$I_C = 30$ A, $T_{vj} = 150$ °C, $V_{GE} = 0/15$ V, $R_G = 13\ \Omega$



Typical gate charge

$V_{GE} = f(Q_G)$

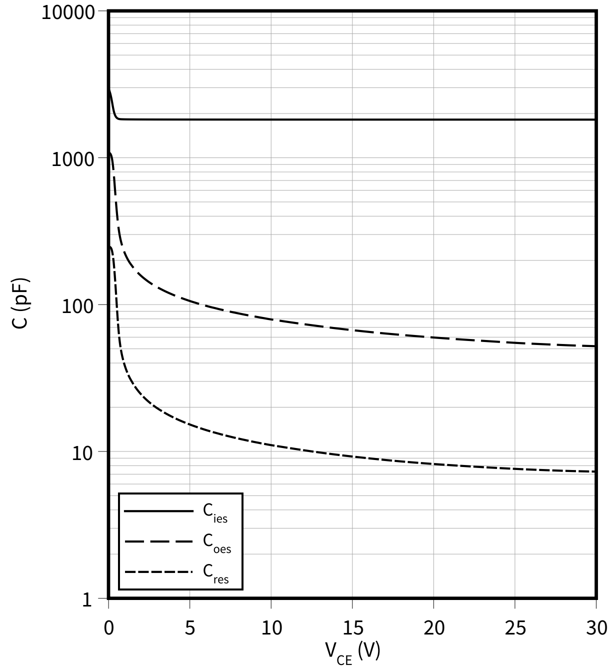
$I_C = 30$ A



Typical capacitance as a function of collector-emitter voltage

$C = f(V_{CE})$

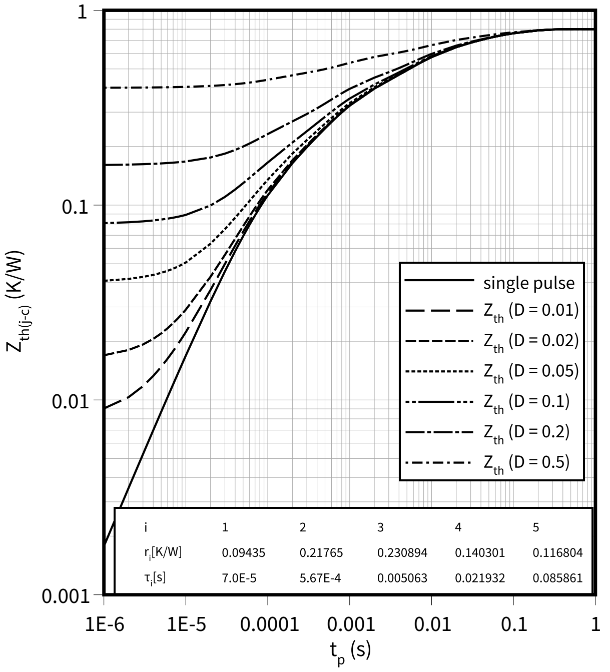
$f = 1000$ kHz, $V_{GE} = 0$ V



IGBT transient thermal impedance as a function of pulse width

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

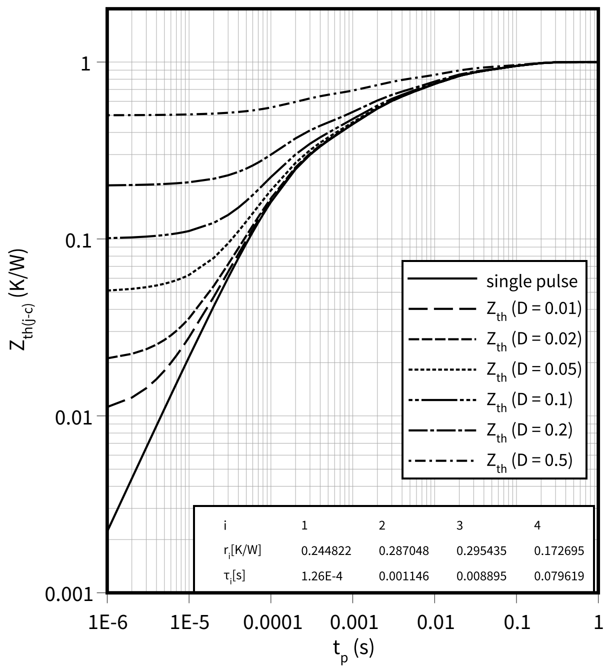
$D = t_p/T$



Diode transient thermal impedance as a function of pulse width

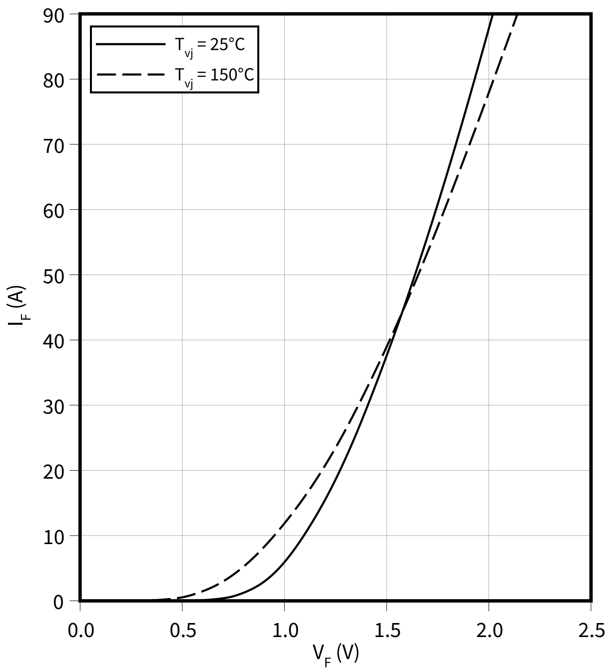
$Z_{th(j-c)} = f(t_p)$

$D = t_p/T$



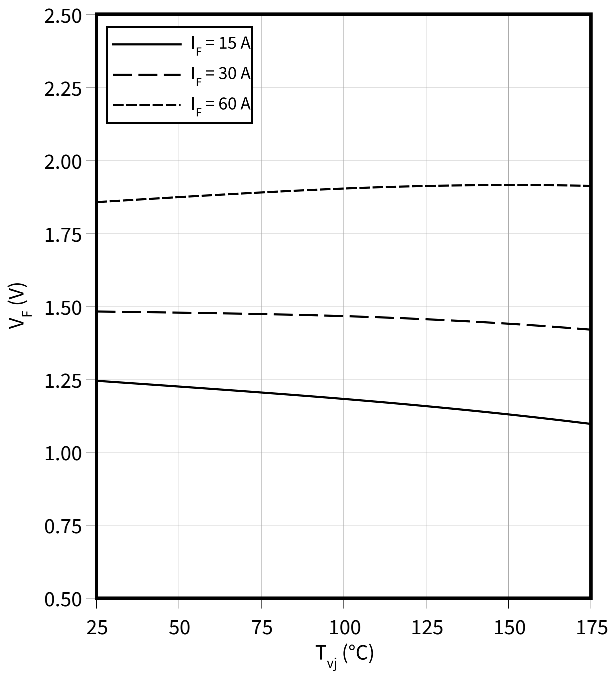
Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



Typical diode forward voltage as a function of junction temperature

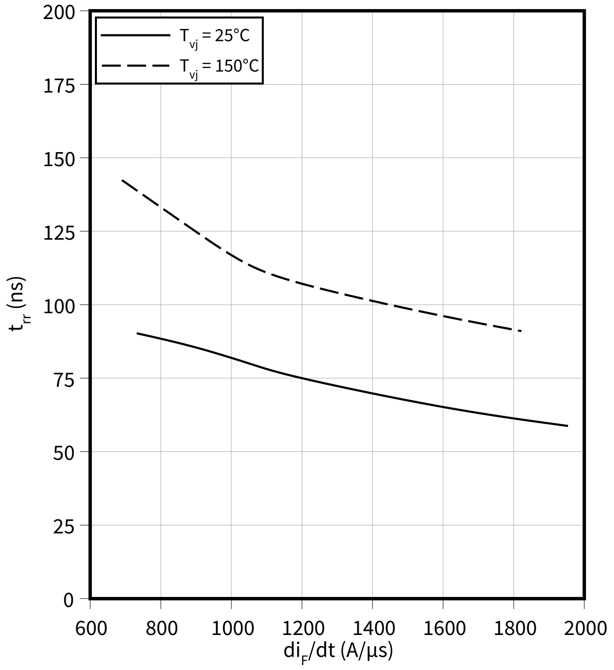
$V_F = f(T_{vj})$



Typical reverse recovery time as a function of diode current slope

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

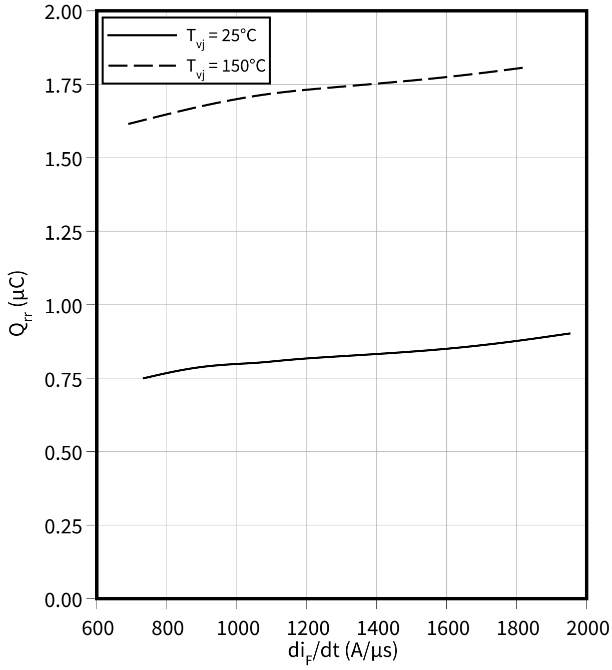
$V_R = 400$ V, $I_F = 30$ A



Typical reverse recovery charge as a function of diode current slope

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

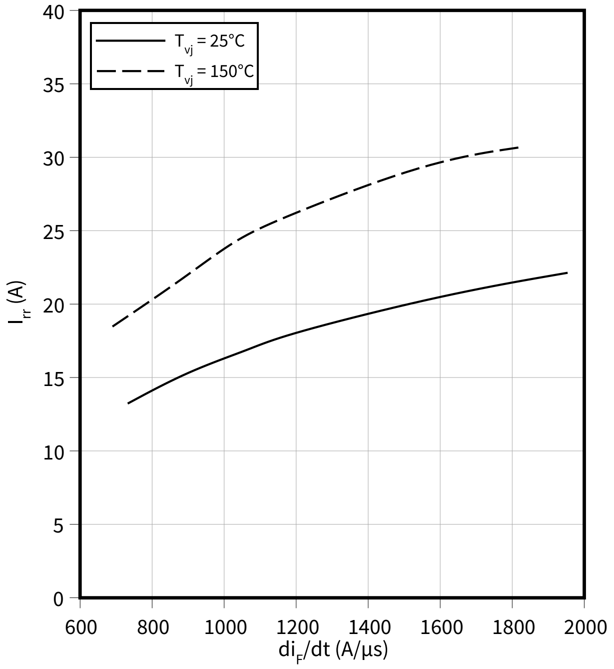
$V_R = 400$ V, $I_F = 30$ A



Typical reverse recovery current as a function of diode current slope

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

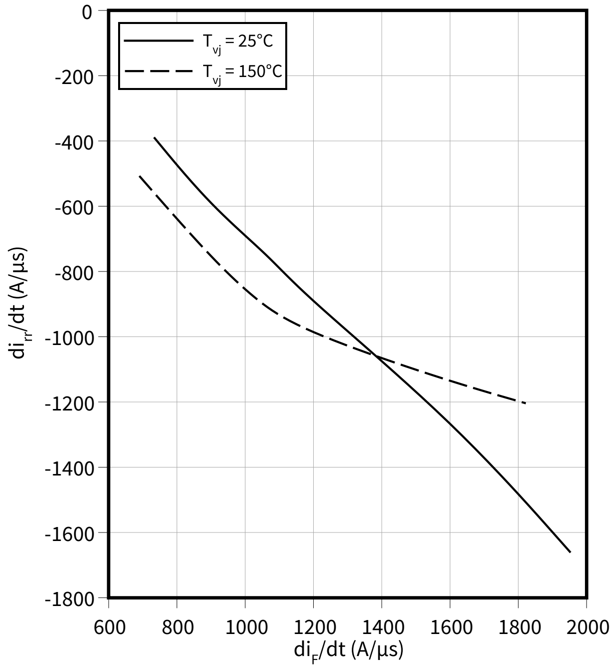
$V_R = 400$ V, $I_F = 30$ A



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

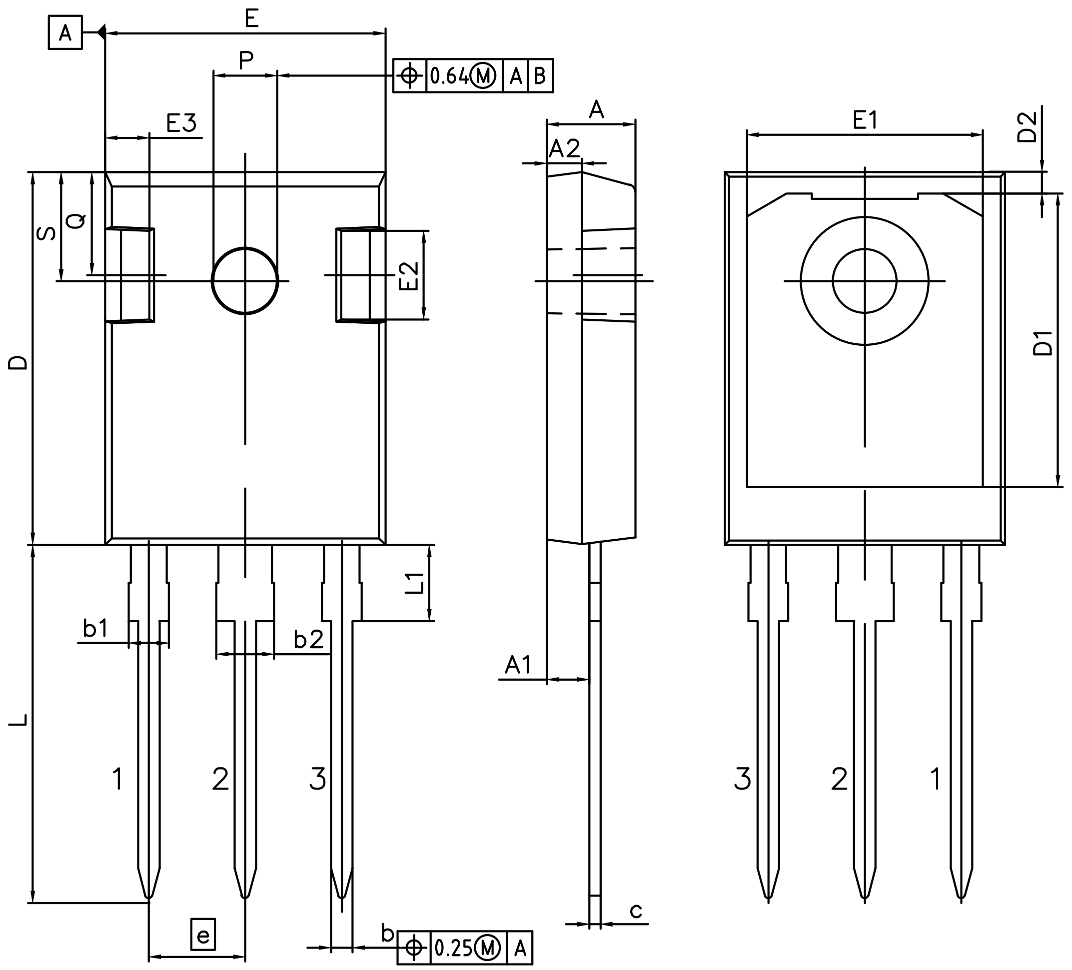
$di_{rr}/dt = f(di_F/dt)$

$V_R = 400$ V, $I_F = 30$ A



5 Package outlines

Package Drawing PG-TO247-3



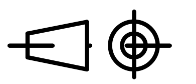
DIMENSIONS	MILLIMETERS	
	MIN.	MAX.
A	4.70	5.30
A1	2.20	2.60
A2	1.50	2.50
b	1.00	1.40
b1	1.60	2.41
b2	2.57	3.43
c	0.38	0.89
D	20.70	21.50
D1	13.08	17.65
D2	0.51	1.35
E	15.50	16.30
E1	12.38	14.15
E2	3.40	5.10
E3	1.00	2.60
e	5.44	
L	19.80	20.40
L1	3.85	4.50
P	3.50	3.70
Q	5.35	6.25
S	6.04	6.30

DOCUMENT NO.
Z8B00003327

REVISION
06

SCALE 3:1
0 1 2 3 4 5mm

EUROPEAN PROJECTION



ISSUE DATE
25.07.2018

Figure 1

6 Testing conditions

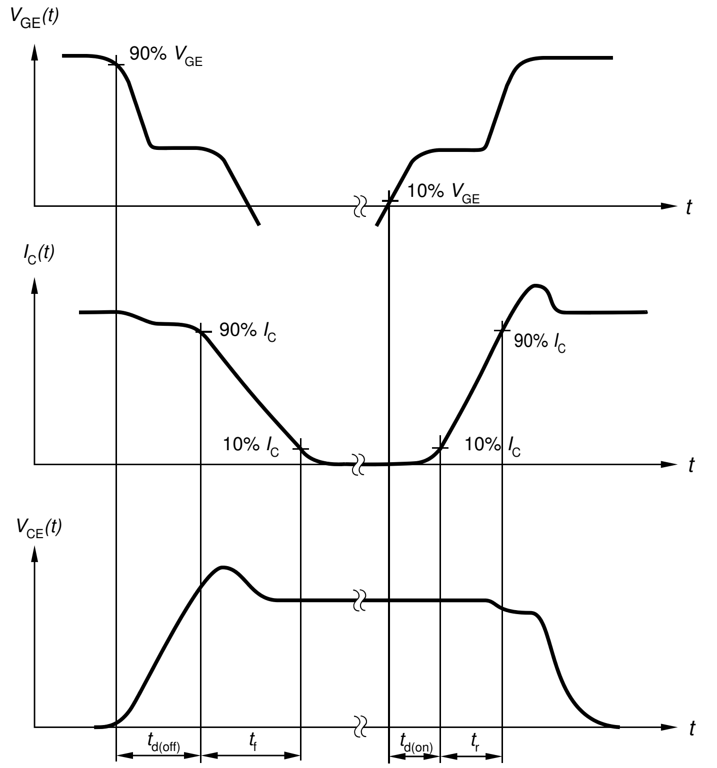


Figure A. **Definition of switching times**

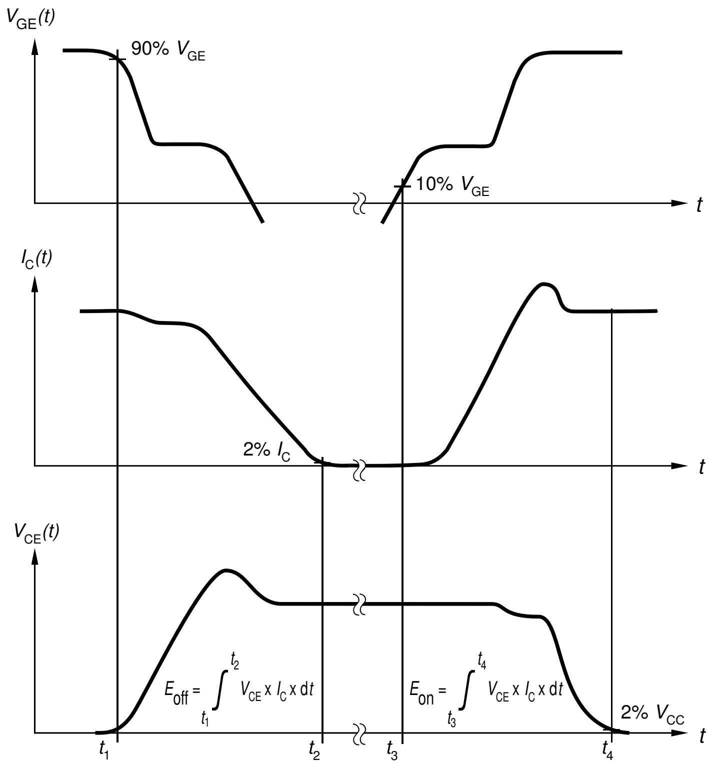


Figure B. **Definition of switching losses**

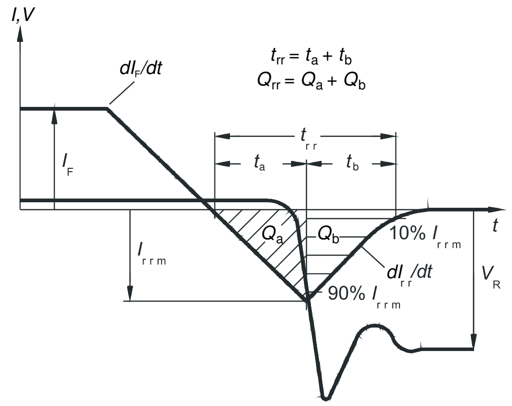


Figure C. **Definition of diode switching characteristics**

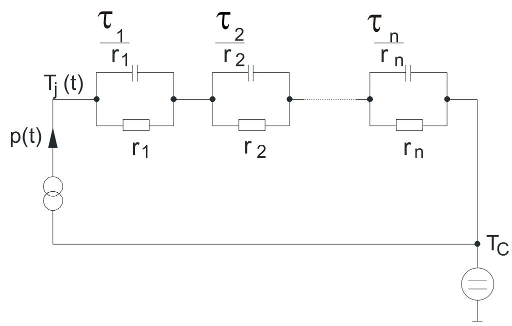


Figure D. **Thermal equivalent circuit**

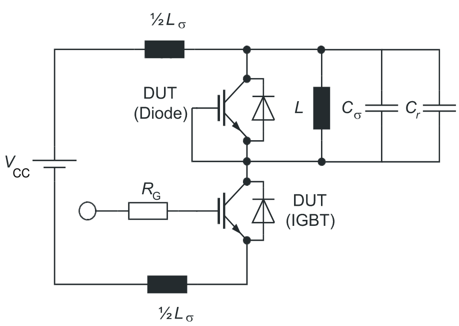


Figure E. **Dynamic test circuit**
Parasitic inductance L_σ,
parasitic capacitor C_σ,
relief capacitor C_r,
(only for ZVT switching)

Figure 2

Revision history

Document revision	Date of release	Description of changes
V1.1	2015-08-12	Preliminary data sheet
V2.1	2015-09-22	Final data sheet
V2.2	2015-10-16	Minor change Ic(VCE) Fig. 3 and Fig. 4
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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