TRENCHSTOP™ IGBT6 with soft, fast recovery antiparallel Rapid diode

Features

- V_{CE} = 650 V
- I_C = 15 A
- Very low $V_{CE(sat)}$ 1.5 V (typ.)
- Maximum junction temperature T_{vjmax} = 175°C
- Short circuit withstand time 3 µs
- Very tight parameter distribution
- High ruggedness, temperature stable behavior
- Low $V_{CE(sat)}$ and positive temperature coefficient
- Low gate charge Q_G
- Pb-free lead plating; RoHS compliant
- Very soft, fast recovery antiparallel Rapid diode
- Product spectrum and PSpice Models: http://www.infineon.com/igbt/

Lead-Free
Green
Halogen-Free
RoHS

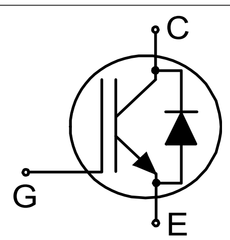
Potential applications

- General purpose drives (GPD)
- Air conditioning
- Other major home appliances
- Other small home appliances

Product validation

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

Description



Type	Package	Marking
IKA15N65ET6	PG-TO220-3 FP	K15EET6

Table of contents

1 Package

Table 1 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Isolation test voltage RMS	V_{isol}	f = +50/+60 Hz, t = 1 min			2500	V
Internal emitter inductance measured 5 mm (0.197 in) from case	L_E			7.0		nH
Storage temperature	T_{stg}		-55		150	°C
Soldering temperature		wave soldering 1.6mm (0.063in.) from case for 10s			260	°C
Mounting torque, M3 screw Maximum of mounting processes: 3	M				0.5	Nm
Thermal resistance, junction-ambient	$R_{th(j-a)}$				65	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} [1)]	I_C		$T_h = 25$ °C	34	A
			$T_h = 100$ °C	21	
Pulsed collector current, t_p limited by T_{vjmax}	I_{Cpuls}			57.5	A
Turn-off safe operating area		$V_{CE} \leq 650$ V, $T_{vj} \leq 175$ °C		57.5	A
Gate-emitter voltage	V_{GE}			±20	V
Transient gate-emitter voltage	V_{GE}	$t_p \leq 10$ µs, $D < 0.010$		±30	V
Short-circuit withstand time	t_{SC}	$V_{CC} \leq 360$ 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}		$T_h = 25$ °C	35.3	W
			$T_h = 100$ °C	17.6	

1) Limited by maximum junction temperature. Applicable for TO220 standard package.

Table 3 Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Collector-emitter breakdown voltage[1)]	V_{BRCES}	I_C = 0.1 mA, V_{GE} = 0 V		650			V
Collector-emitter saturation voltage	V_{CEsat}	I_C = 11.5 A, V_{GE} = 15 V	T_{vj} = 25 °C		1.5	1.9	V
			T_{vj} = 125 °C		1.65		
			T_{vj} = 150 °C		1.75		
Gate-emitter threshold voltage	V_{GEth}	I_C = 0.20 mA, V_{CE} = V_{GE}		4.8	5.6	6.4	V
Zero gate-voltage collector current	I_{CES}	V_{GE} = 0 V, V_{CE} = 650 V	T_{vj} = 25 °C			30	µA
			T_{vj} = 150 °C		450		
Gate-emitter leakage current	I_{GES}	V_{CE} = 0 V, V_{GE} = 20 V				100	nA
Transconductance	g_{fs}	I_C = 11.5 A, V_{CE} = 20 V, T_{vj} ≥ 25 °C			11.6		S
Short-circuit collector current	I_{SC}	V_{CC} ≤ 360 V, V_{GE} = 15 V, t_{SC} ≤ 3 µs, Allowed number of short circuits < 1000 , Time between short circuits ≥ 1.0 s , T_{vj} = 150 °C			120		A
Input capacitance	C_{ies}	V_{CE} = 25 V, V_{GE} = 0 V, f = 1000 kHz			1020		pF
Output capacitance	C_{oes}	V_{CE} = 25 V, V_{GE} = 0 V, f = 1000 kHz			50		pF
Reverse transfer capacitance	C_{res}	V_{CE} = 25 V, V_{GE} = 0 V, f = 1000 kHz			20		pF
Gate charge	Q_G	I_C = 11.5 A, V_{GE} = 15 V			37		nC
Turn-on delay time	t_{don}	V_{CE} = 400 V, V_{GE} = 15 V, R_{Gon} = 47.0 Ω, R_{Goff} = 47.0 Ω, $L_σ$ = 30 nH, $C_σ$ = 150 pF	T_{vj} = 25 °C, I_C = 11.5 A		30		ns
			T_{vj} = 150 °C, I_C = 11.5 A		27		
Rise time (inductive load)	t_r	V_{CE} = 400 V, V_{GE} = 15 V, R_{Gon} = 47.0 Ω, R_{Goff} = 47.0 Ω, $L_σ$ = 30 nH, $C_σ$ = 150 pF	T_{vj} = 25 °C, I_C = 11.5 A		22		ns
			T_{vj} = 150 °C, I_C = 11.5 A		23		
Turn-off delay time	t_{doff}	V_{CE} = 400 V, V_{GE} = 15 V, R_{Gon} = 47.0 Ω, R_{Goff} = 47.0 Ω, $L_σ$ = 30 nH, $C_σ$ = 150 pF	T_{vj} = 25 °C, I_C = 11.5 A		117		ns
			T_{vj} = 150 °C, I_C = 11.5 A		135		
Fall time (inductive load)	t_f	V_{CE} = 400 V, V_{GE} = 15 V, R_{Gon} = 47.0 Ω, R_{Goff} = 47.0 Ω, $L_σ$ = 30 nH, $C_σ$ = 150 pF	T_{vj} = 25 °C, I_C = 11.5 A		42		ns
			T_{vj} = 150 °C, I_C = 11.5 A		67		

(table continues...)

Table 3 **(continued) Characteristic values**

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Turn-on energy	E_{on}	V_{CE} = 400 V, V_{GE} = 15 V, R_{Gon} = 47.0 Ω, R_{Goff} = 47.0 Ω, L_{σ} = 30 nH, C_{σ} = 150 pF	T_{vj} = 25 °C, I_C = 11.5 A		0.23		mJ
			T_{vj} = 150 °C, I_C = 11.5 A		0.32		
Turn-off energy	E_{off}	V_{CE} = 400 V, V_{GE} = 15 V, R_{Gon} = 47.0 Ω, R_{Goff} = 47.0 Ω, L_{σ} = 30 nH, C_{σ} = 150 pF	T_{vj} = 25 °C, I_C = 11.5 A		0.11		mJ
			T_{vj} = 150 °C, I_C = 11.5 A		0.18		
Total switching energy	E_{ts}	V_{CE} = 400 V, V_{GE} = 15 V, R_{Gon} = 47.0 Ω, R_{Goff} = 47.0 Ω, L_{σ} = 30 nH, C_{σ} = 150 pF	T_{vj} = 25 °C, I_C = 11.5 A		0.34		mJ
			T_{vj} = 150 °C, I_C = 11.5 A		0.5		
IGBT thermal resistance, junction to case	R_{thjc}					4.3	K/W
IGBT thermal resistance, junction to heat sink	R_{thjh}					4.30	K/W
Operating junction temperature	T_{vj}			-40		175	°C

1) Measured with filter network.

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} ≥ 25 °C		650	V
Diode forward current, limited by T_{vjmax} [1)]	I_F		T_h = 25 °C	34	A
			T_h = 100 °C	21	
Diode pulsed current, limited by T_{vjmax}	I_{Fpuls}			57.5	A

1) Limited by maximum junction temperature. Applicable for TO220 standard package.

Table 5 Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Diode forward voltage	V_F	I_F = 11.5 A	T_{vj} = 25 °C		1.5	1.95	V
			T_{vj} = 125 °C		1.48		
			T_{vj} = 150 °C		1.43		
Reverse leakage current	I_R	V_R = 650 V	T_{vj} = 25 °C			30	µA
			T_{vj} = 150 °C		450		
Diode reverse recovery time	t_{rr}	V_R = 400 V	T_{vj} = 25 °C, I_F = 11.5 A, $-di_F/dt$ = 400 A/µs		69		ns
			T_{vj} = 150 °C, I_F = 11.5 A, $-di_F/dt$ = 400 A/µs		113		
Diode reverse recovery charge	Q_{rr}	V_R = 400 V	T_{vj} = 25 °C, I_F = 11.5 A, $-di_F/dt$ = 400 A/µs		0.210		µC
			T_{vj} = 150 °C, I_F = 11.5 A, $-di_F/dt$ = 400 A/µs		0.500		
Diode peak reverse recovery current	I_{rrm}	V_R = 400 V	T_{vj} = 25 °C, I_F = 11.5 A, $-di_F/dt$ = 400 A/µs		5.1		A
			T_{vj} = 150 °C, I_F = 11.5 A, $-di_F/dt$ = 400 A/µs		8.0		
Diode peak rate of fall of reverse recovery current	dI_{rr}/dt	V_R = 400 V	T_{vj} = 25 °C, I_F = 11.5 A, $-di_F/dt$ = 400 A/µs		-265		A/µs
			T_{vj} = 150 °C, I_F = 11.5 A, $-di_F/dt$ = 400 A/µs		-228		
Diode thermal resistance, junction to case	R_{thjc}					5.8	K/W
Diode thermal resistance, junction to heat sink	R_{thjh}					5.80	K/W
Operating junction temperature	T_{vj}			-40		175	°C

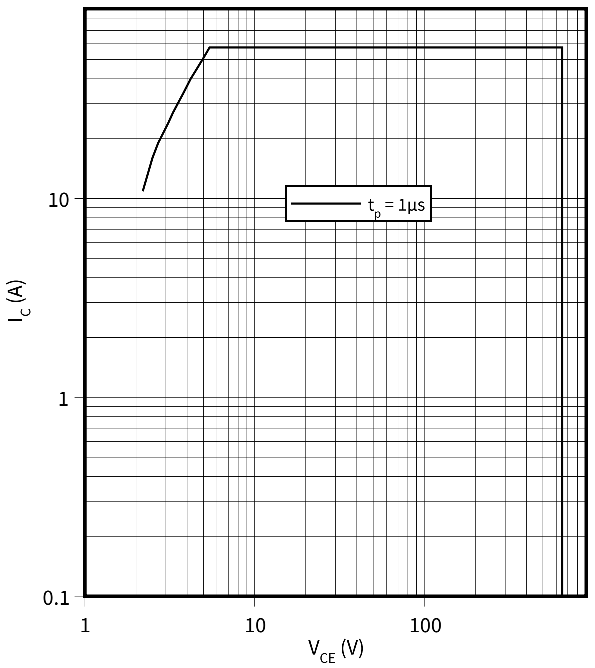
Note: *For optimum lifetime and reliability, Infineon recommends operating conditions that do not exceed 80% of the maximum ratings stated in this datasheet.*

4 Characteristics diagrams

Forward bias safe operating area, IGBT

$I_C = f(V_{CE})$

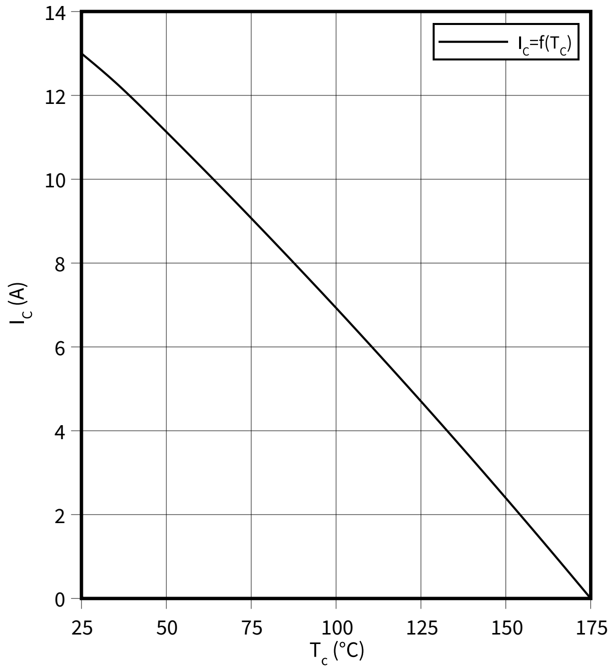
$D = 0$, $T_{vj} \geq 25$ °C, $V_{GE} \geq 15$ V, $T_h = 25$ °C



Collector current as a function of case temperature, IGBT

$I_C = f(T_c)$

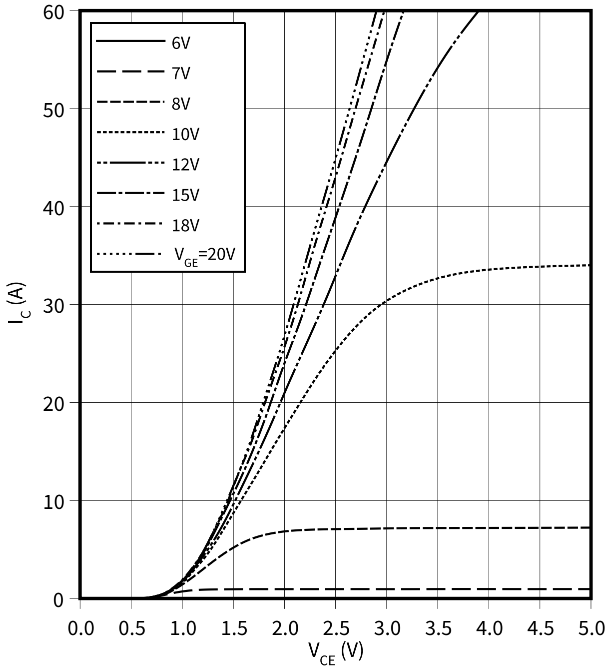
$T_{vj} \leq 175$ °C, $V_{GE} \geq 15$ V



Typical output characteristic, IGBT

$I_C = f(V_{CE})$

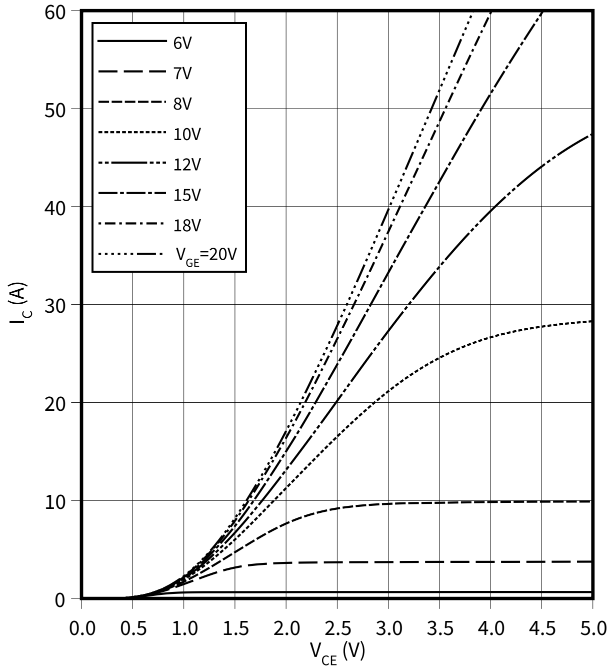
$T_{vj} = 25$ °C



Typical output characteristic, IGBT

$I_C = f(V_{CE})$

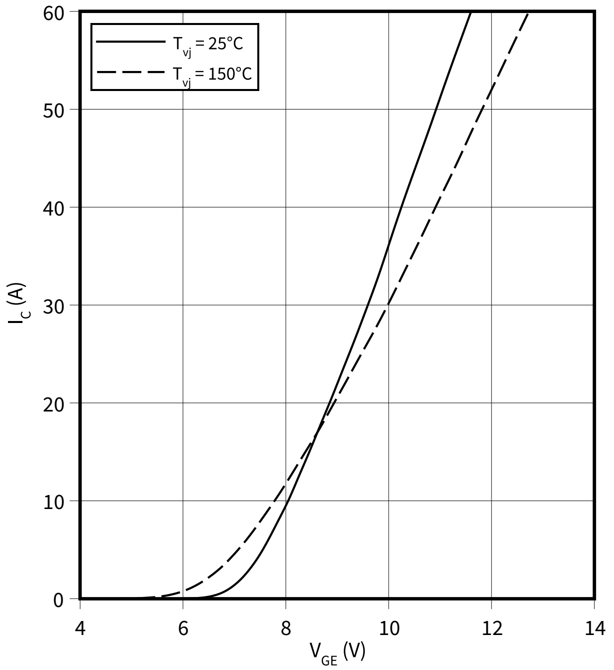
$T_{vj} = 150$ °C



Typical transfer characteristic, IGBT

$I_C = f(V_{GE})$

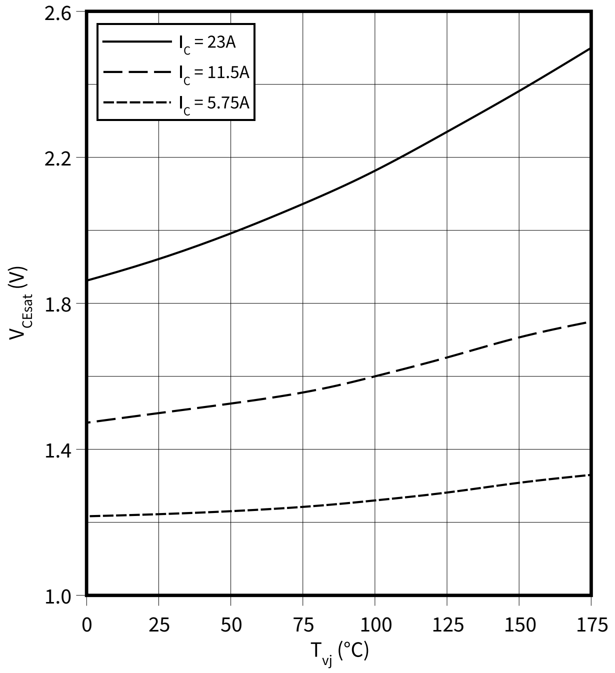
$V_{CE} = 50$ V



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

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

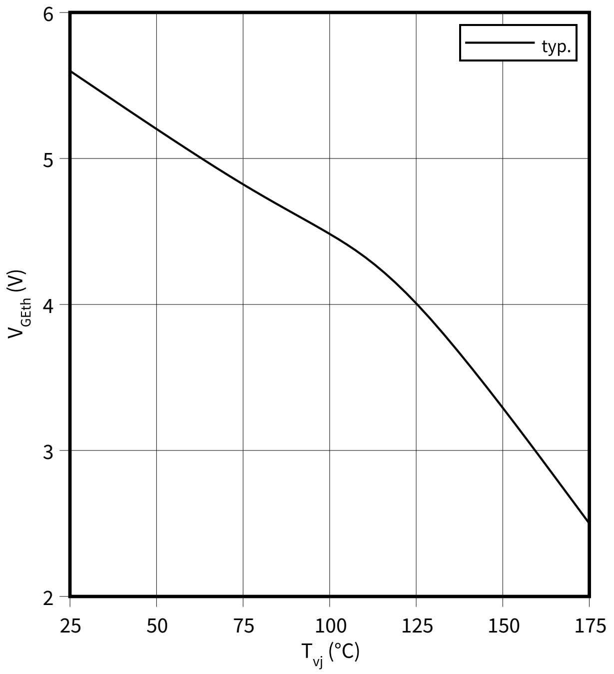
$V_{GE} = 15$ V



Gate-emitter threshold voltage as a function of junction temperature, IGBT

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

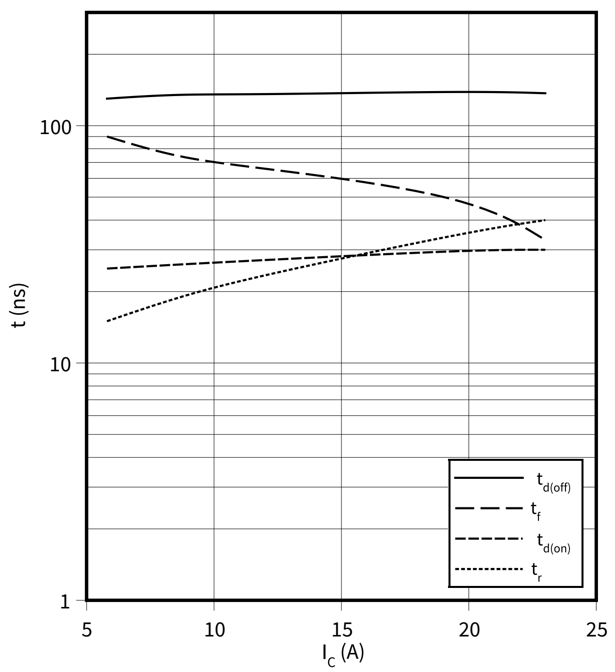
$I_C = 0.20$ mA



Typical switching times as a function of collector current, IGBT

$t = f(I_C)$

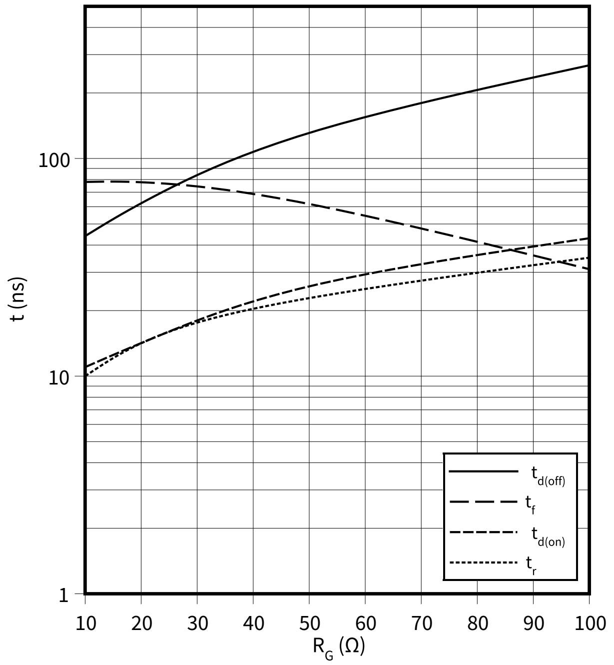
$V_{CE} = 400$ V, $T_{vj} = 150$ °C, $V_{GE} = 0/15$ V, $R_G = 47$ Ω



Typical switching times as a function of gate resistor, IGBT

$t = f(R_G)$

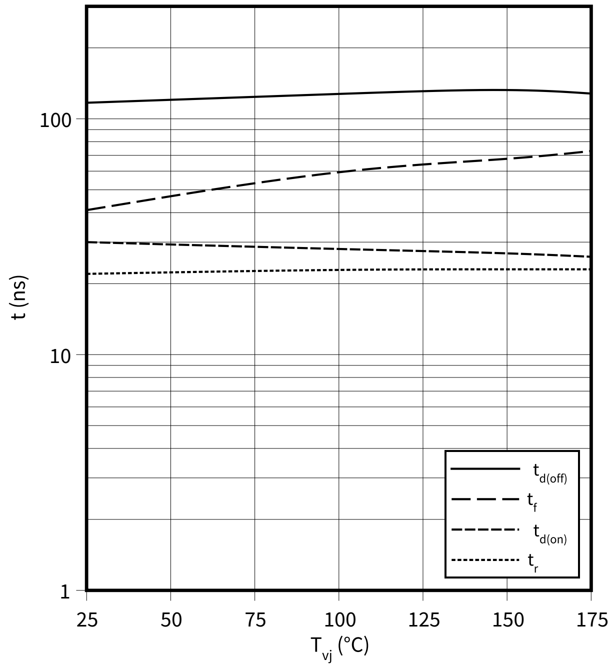
I_C = 11.5 A, V_{CE} = 400 V, T_{vj} = 150 °C, V_{GE} = 0/15 V



Typical switching times as a function of junction temperature, IGBT

$t = f(T_{vj})$

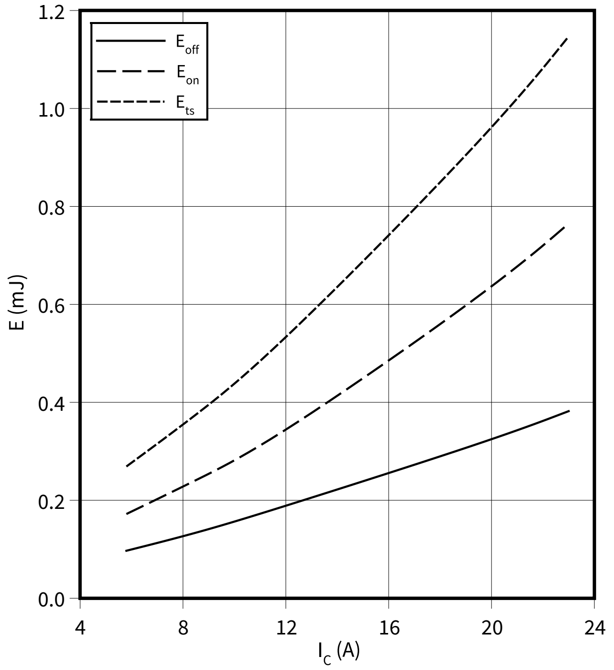
I_C = 11.5 A, V_{CE} = 400 V, V_{GE} = 0/15 V, R_G = 47 Ω



Typical switching energy losses as a function of collector current, IGBT

$E = f(I_C)$

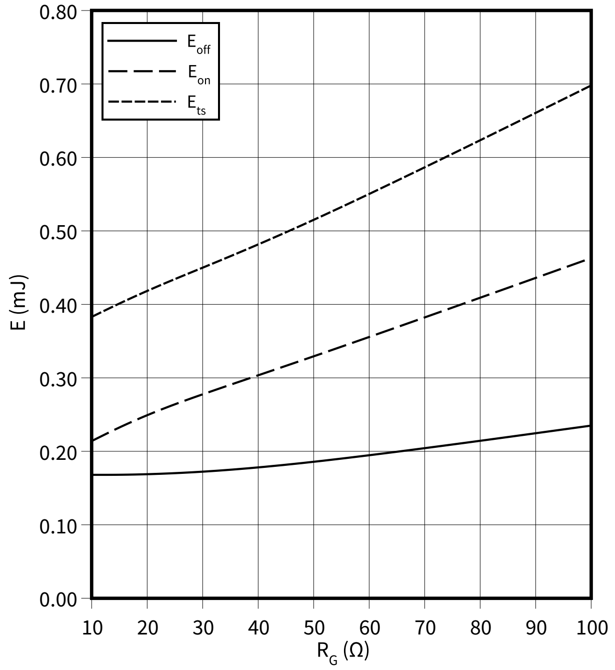
V_{CE} = 400 V, T_{vj} = 150 °C, V_{GE} = 0/15 V, R_G = 47 Ω



Typical switching energy losses as a function of gate resistor, IGBT

$E = f(R_G)$

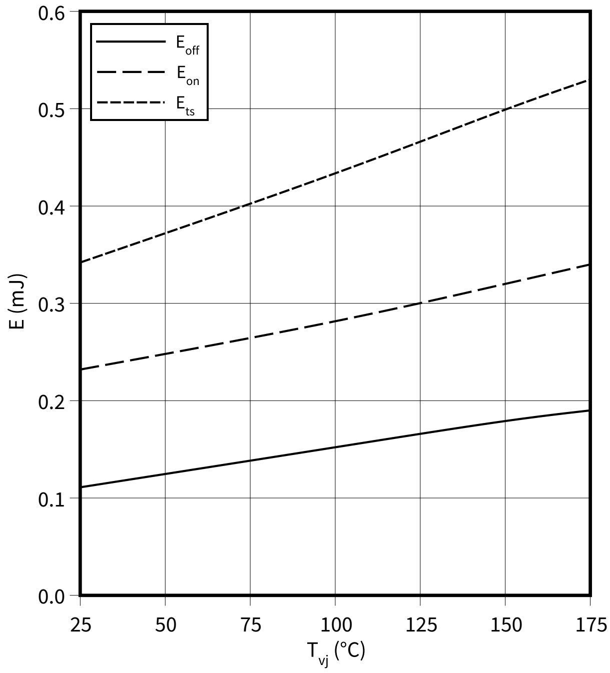
I_C = 11.5 A, V_{CE} = 400 V, T_{vj} = 150 °C, V_{GE} = 0/15 V



Typical switching energy losses as a function of junction temperature, IGBT

$E = f(T_{vj})$

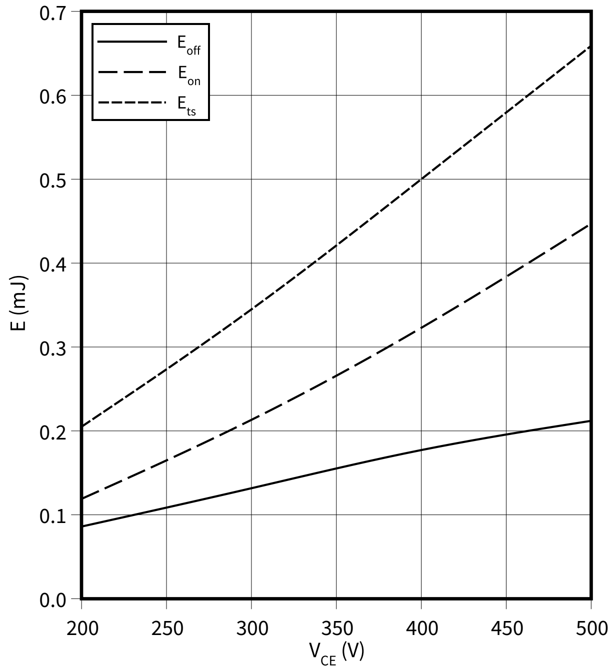
$I_C = 11.5$ A, $V_{CE} = 400$ V, $V_{GE} = 0/15$ V, $R_G = 47\ \Omega$



Typical switching energy losses as a function of collector emitter voltage, IGBT

$E = f(V_{CE})$

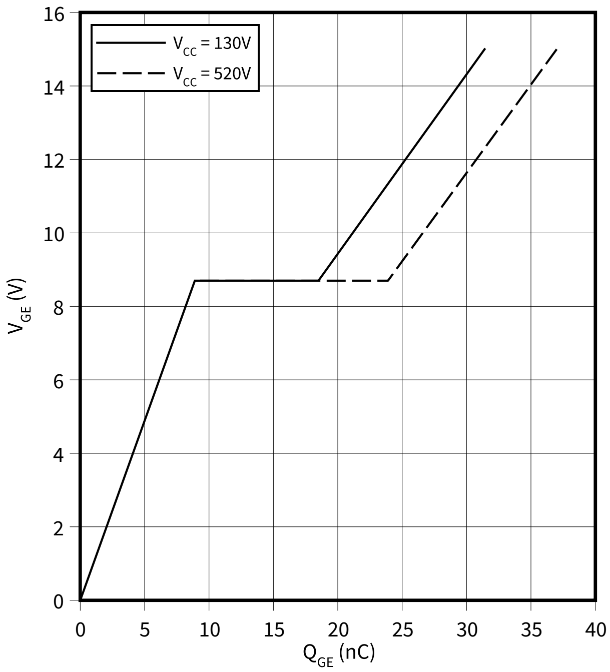
$I_C = 11.5$ A, $V_{GE} = 0/15$ V, $T_{vj} = 150$ °C, $R_G = 47\ \Omega$



Typical gate charge, IGBT

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

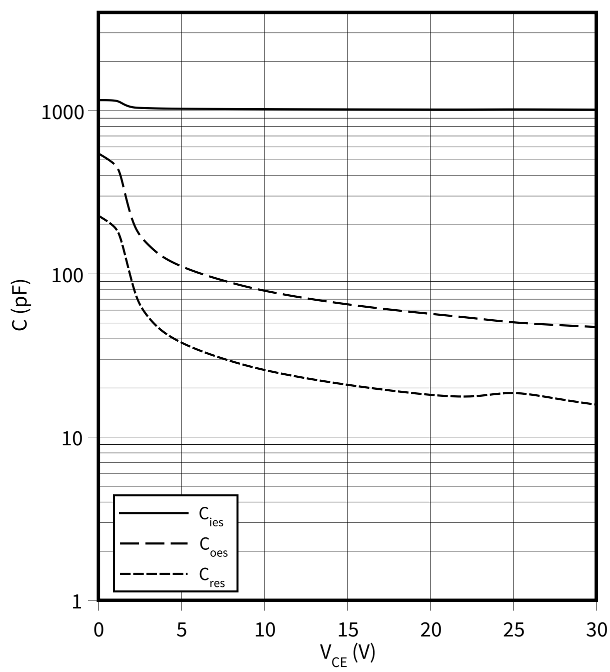
$I_C = 11.5$ A



Typical capacitance as a function of collector-emitter voltage, IGBT

$C = f(V_{CE})$

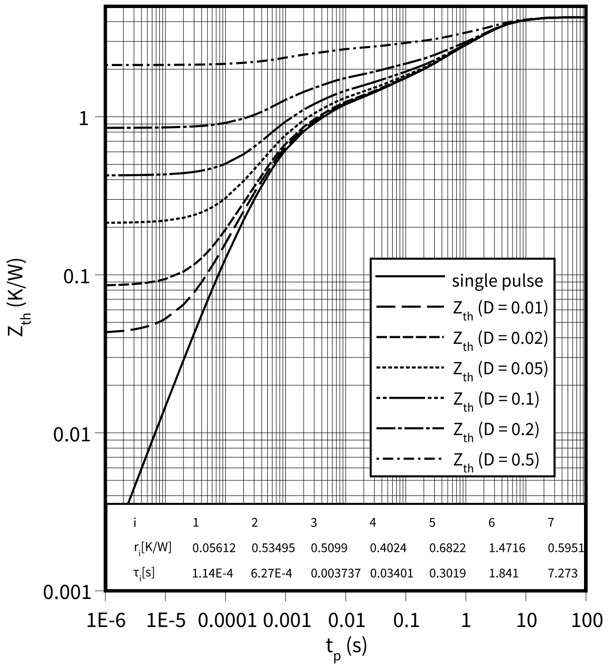
f = 1000 kHz, $V_{GE} = 0$ V



IGBT transient thermal impedance, IGBT

$Z_{th} = f(t_p)$

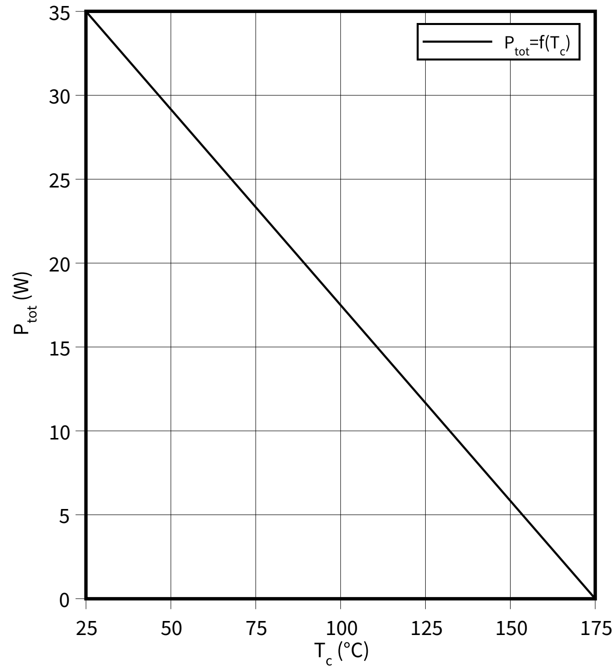
$D = t_p/T$



Power dissipation as a function of case temperature, IGBT

$P_{tot} = f(T_c)$

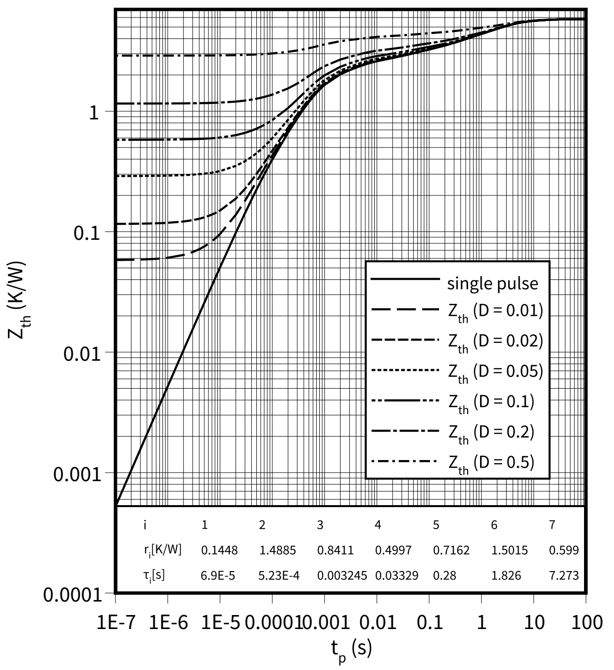
$T_{vj} \leq 175$ °C



Diode transient thermal impedance as a function of pulse width, Diode

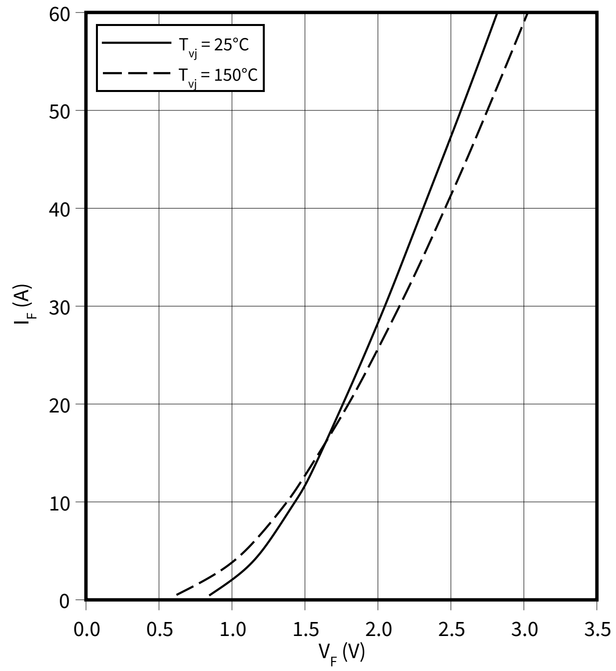
$Z_{th} = f(t_p)$

$D = t_p/T$



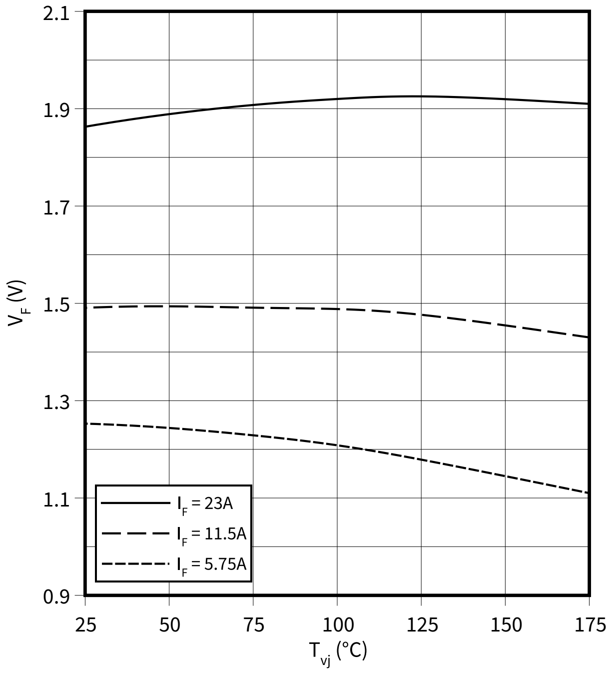
Typical diode forward current as a function of forward voltage, Diode

$I_F = f(V_F)$



Typical diode forward voltage as a function of junction temperature, Diode

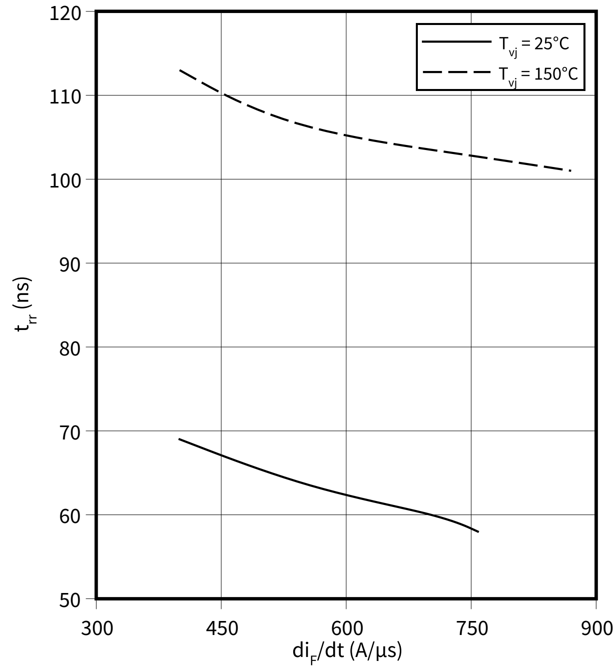
$V_F = f(T_{vj})$



Typical reverse recovery time as a function of diode current slope, Diode

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

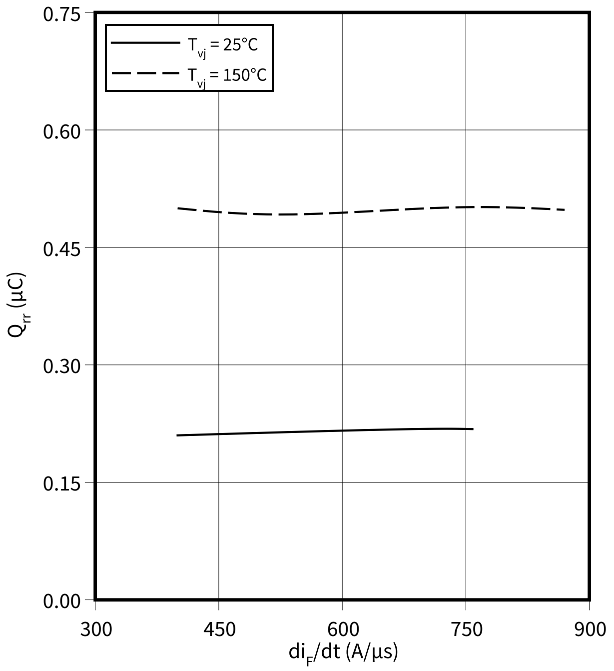
V_R = 400 V, I_F = 11.5 A



Typical reverse recovery charge as a function of diode current slope, Diode

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

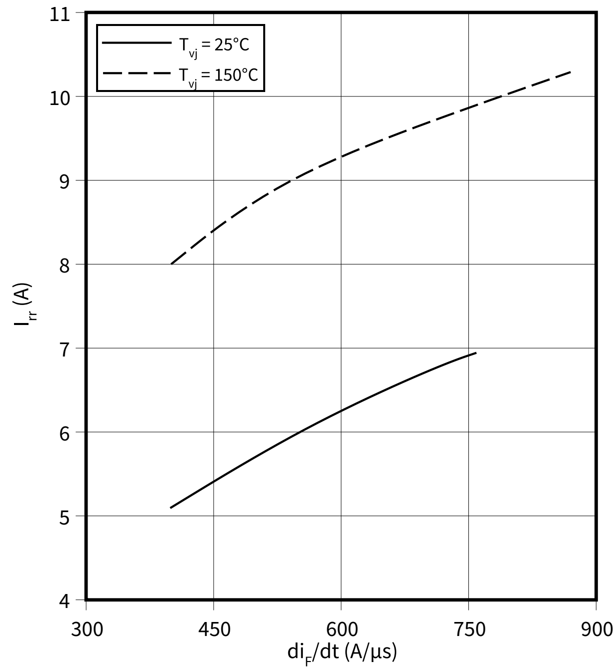
V_R = 400 V, I_F = 11.5 A



Typical reverse recovery current as a function of diode current slope, Diode

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

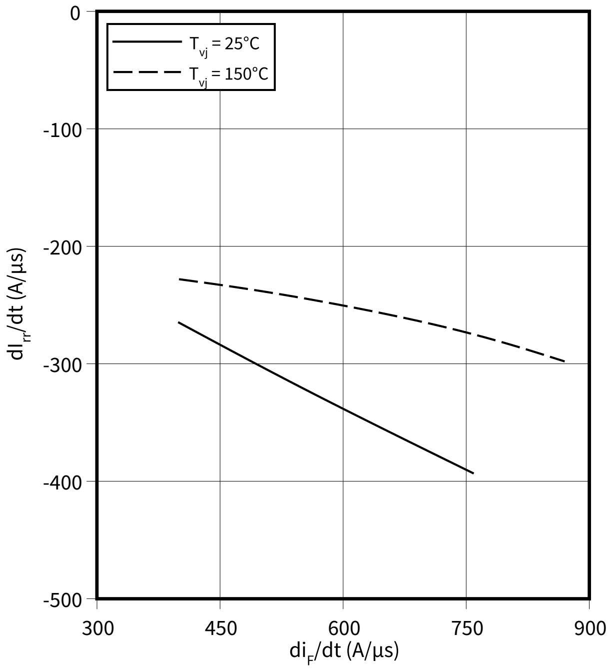
V_R = 400 V, I_F = 11.5 A



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

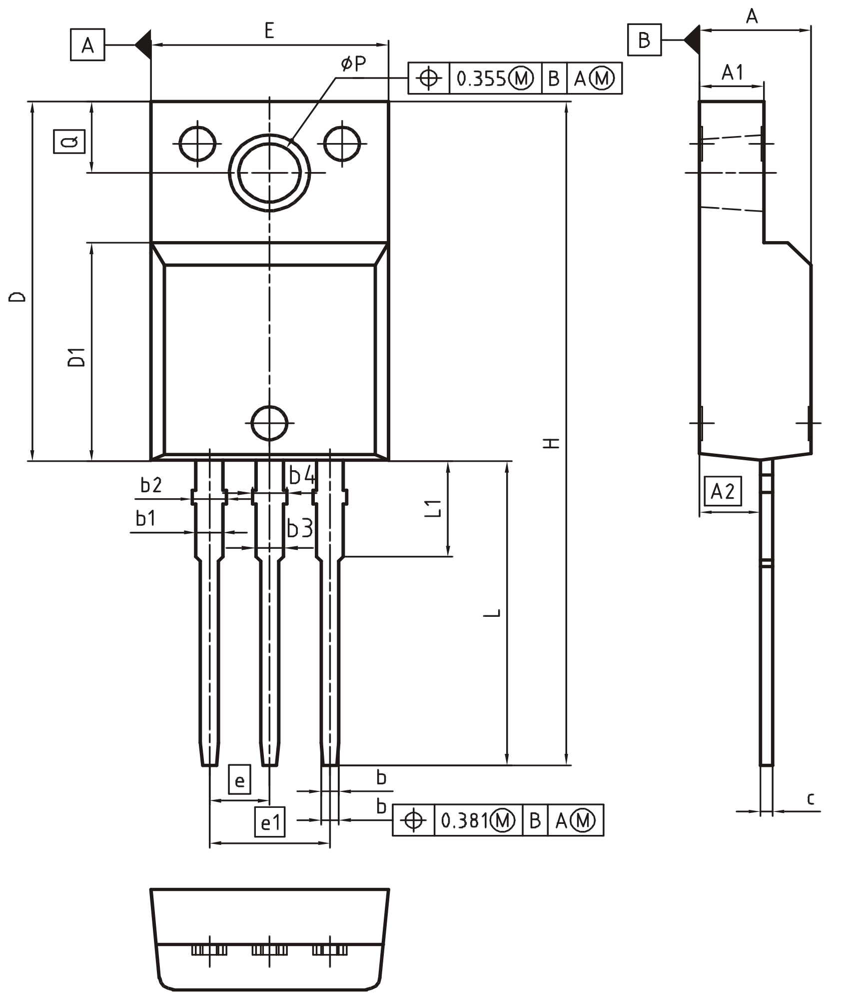
$dI_{rr}/dt = f(di_F/dt)$

$V_R = 400$ V, $I_F = 11.5$ A



5 Package outlines

Package Drawing PG-TO220-3-FP



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.55	4.85	0.179	0.191
A1	2.55	2.85	0.100	0.112
A2	2.42	2.72	0.095	0.107
b	0.65	0.85	0.026	0.033
b1	0.95	1.33	0.037	0.052
b2	0.95	1.51	0.037	0.059
b3	0.65	1.33	0.026	0.052
b4	0.65	1.51	0.026	0.059
c	0.40	0.63	0.016	0.025
D	15.85	16.15	0.624	0.636
D1	9.53	9.83	0.375	0.387
E	10.35	10.65	0.407	0.419
e	2.54		0.100	
e1	5.08		0.200	
N	3		3	
H	29.45	29.75	1.159	1.171
L	13.45	13.75	0.530	0.541
L1	3.15	3.45	0.124	0.136
øP	2.95	3.20	0.116	0.126
Q	3.15	3.50	0.124	0.138

DOCUMENT NO.
Z8B00003319

SCALE
0 2.5 5mm

EUROPEAN PROJECTION

ISSUE DATE
08-03-2007

REVISION
03

Figure 1

6 Testing conditions

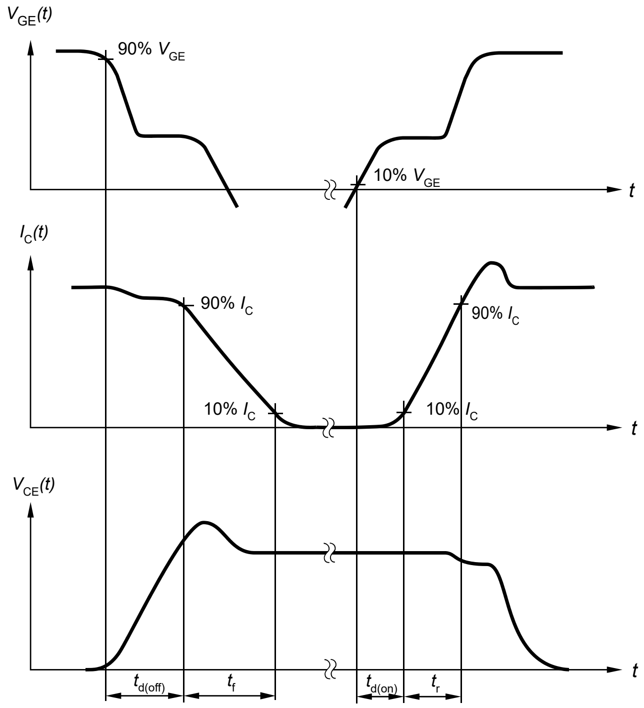


Figure A. **Definition of switching times**

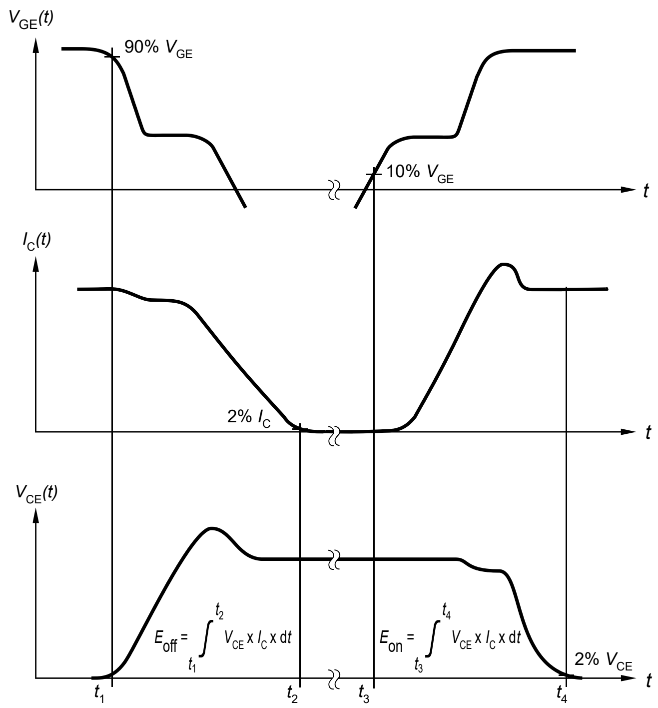


Figure B. **Definition of switching losses**

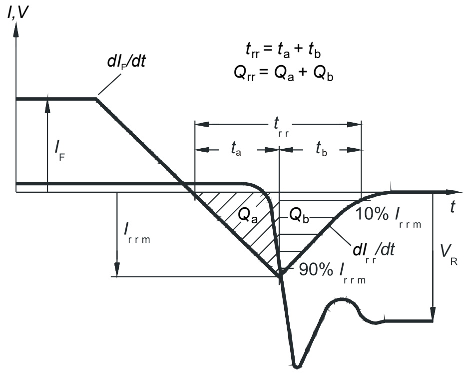


Figure C. **Definition of diode switching characteristics**

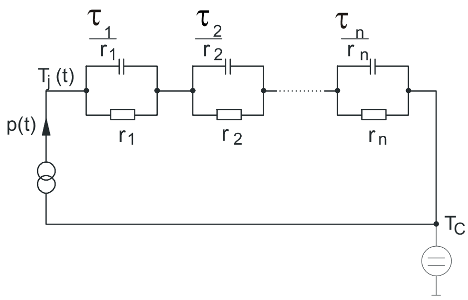


Figure D. **Thermal equivalent circuit**

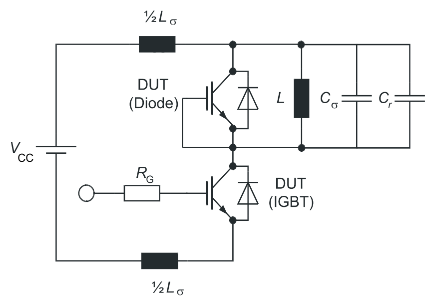


Figure E. **Dynamic test circuit**
Parasitic inductance L_{σ},
parasitic capacitor C_{σ},
relief capacitor C_r,
(only for ZVT switching)

Figure 2

Revision history

Document revision	Date of release	Description of changes
V2.1	2017-09-11	Final Datasheet
V2.2	2017-11-30	New Gfs Value at VCE=20V
V2.3	2019-09-13	Change of Rth/Zth values and maximum DC ratings
1.10	2021-10-18	Change of unit in thermal impedance figures

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