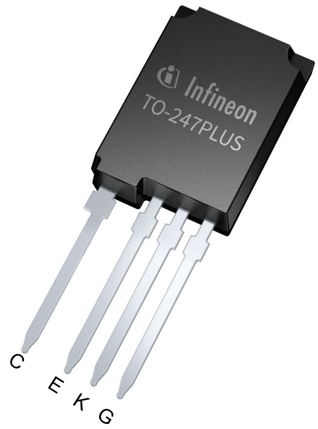
Low switching losses IGBT in Highspeed3 technology co-packed with soft, fast recovery full current rated antiparallel emitter controlled diode

Features

- V_{CE} = 1200 V
- I_C = 40 A
- Ultra-low loss switching losses due to Kelvin emitter pin package in combination with Highspeed3 technology
- High efficiency in hard switching and resonant topologies
- 10 µsec short circuit withstand time at T_{vj} = 175°C
- Easy parallel switching capability due to positive temperature coefficient in V_{CEsat}
- Low EMI
- Low gate charge Q_G
- Very soft, fast recovery full current 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/



Halogen-free
Lead-free
Green
RoHS

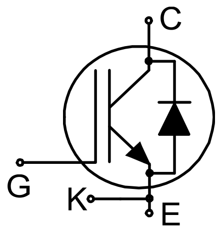
Potential applications

- Industrial UPS
- Charger
- Energy storage
- Three-level solar string inverter

Product validation

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

Description



Type	Package	Marking
IKY40N120CH3	PG-TO247-4-2	K40MCH3

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 1.6 mm (0.063 in.) from case for 10 s			260	°C
Thermal resistance, junction-ambient	$R_{th(j-a)}$				40	K/W
IGBT thermal resistance, junction-case	$R_{th(j-c)}$				0.3	K/W
Diode thermal resistance, junction-case	$R_{th(j-c)}$				0.5	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		1200	V
DC collector current, limited by T_{vjmax}	I_C	limited by bondwire	$T_c = 25$ °C	80	A
			$T_c = 134$ °C	40	
Pulsed collector current, t_p limited by T_{vjmax}	I_{Cpulse}			160	A
Turn-off safe operating area		$V_{CE} \leq 1200$ V, $t_p = 1$ µs, $T_{vj} \leq 175$ °C		160	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}	$V_{CC} \leq 600$ V, $V_{GE} = 15$ V, Allowed number of short circuits < 1000, Time between short circuits ≥ 1.0 s, $T_{vj} = 175$ °C		10	µs
Power dissipation	P_{tot}		$T_c = 25$ °C	500	W
			$T_c = 134$ °C	136	

Table 3 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Collector-emitter breakdown voltage	V_{BRCES}	$I_C = 0.5$ mA, $V_{GE} = 0$ V	1200			V

(table continues...)

Table 3 **(continued) Characteristic values**

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Collector-emitter saturation voltage	V_{CEsat}	I_C = 40 A, V_{GE} = 15 V	T_{vj} = 25 °C		2	2.35	V
			T_{vj} = 175 °C		2.5		
Gate-emitter threshold voltage	V_{GEth}	I_C = 1.5 mA, V_{CE} = V_{GE}		5.1	5.8	6.5	V
Zero gate-voltage collector current	I_{CES}	V_{CE} = 1200 V, V_{GE} = 0 V	T_{vj} = 25 °C			250	µA
			T_{vj} = 175 °C		3000		
Gate-emitter leakage current	I_{GES}	V_{CE} = 0 V, V_{GE} = 20 V				100	nA
Transconductance	g_{fs}	I_C = 40 A, V_{CE} = 20 V			14		S
Input capacitance	C_{ies}	V_{CE} = 25 V, V_{GE} = 0 V, f = 1000 kHz			2385		pF
Output capacitance	C_{oes}	V_{CE} = 25 V, V_{GE} = 0 V, f = 1000 kHz			235		pF
Reverse transfer capacitance	C_{res}	V_{CE} = 25 V, V_{GE} = 0 V, f = 1000 kHz			132		pF
Gate charge	Q_G	I_C = 40 A, V_{GE} = 15 V, V_{CC} = 960 V			190		nC
Turn-on delay time	$t_{d(on)}$	V_{CC} = 600 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 12 Ω, $R_{G(off)}$ = 12 Ω, L_σ = 70 nH, C_σ = 67 pF	T_{vj} = 25 °C, I_C = 40 A		30		ns
			T_{vj} = 175 °C, I_C = 40 A		29		
Rise time (inductive load)	t_r	V_{CC} = 600 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 12 Ω, $R_{G(off)}$ = 12 Ω, L_σ = 70 nH, C_σ = 67 pF	T_{vj} = 25 °C, I_C = 40 A		29		ns
			T_{vj} = 175 °C, I_C = 40 A		32		
Turn-off delay time	$t_{d(off)}$	V_{CC} = 600 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 12 Ω, $R_{G(off)}$ = 12 Ω, L_σ = 70 nH, C_σ = 67 pF	T_{vj} = 25 °C, I_C = 40 A		280		ns
			T_{vj} = 175 °C, I_C = 40 A		375		
Fall time (inductive load)	t_f	V_{CC} = 600 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 12 Ω, $R_{G(off)}$ = 12 Ω, L_σ = 70 nH, C_σ = 67 pF	T_{vj} = 25 °C, I_C = 40 A		26		ns
			T_{vj} = 175 °C, I_C = 40 A		64		
Turn-on energy	E_{on}	V_{CC} = 600 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 12 Ω, $R_{G(off)}$ = 12 Ω, L_σ = 70 nH, C_σ = 67 pF	T_{vj} = 25 °C, I_C = 40 A		2.2		mJ
			T_{vj} = 175 °C, I_C = 40 A		3.1		

(table continues...)

Table 3 (continued) Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Turn-off energy	E_{off}	V_{CC} = 600 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 12 Ω, $R_{G(off)}$ = 12 Ω, L_σ = 70 nH, C_σ = 67 pF	T_{vj} = 25 °C, I_C = 40 A		1.3		mJ
			T_{vj} = 175 °C, I_C = 40 A		2.5		
Total switching energy	E_{ts}	V_{CC} = 600 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 12 Ω, $R_{G(off)}$ = 12 Ω, L_σ = 70 nH, C_σ = 67 pF	T_{vj} = 25 °C, I_C = 40 A		3.5		mJ
			T_{vj} = 175 °C, I_C = 40 A		5.6		
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		1200	V
Diode forward current, limited by T_{vjmax}	I_F		T_c = 25 °C	80	A
			T_c = 100 °C	40	
Diode pulsed current, t_p limited by T_{vjmax}	I_{Fpulse}			160	A

Table 5 Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Diode forward voltage	V_F	I_F = 40 A	T_{vj} = 25 °C		1.9	2.3	V
			T_{vj} = 175 °C		1.85		
Diode reverse recovery time	t_{rr}	V_R = 600 V	T_{vj} = 25 °C, I_F = 40 A, $-di_F/dt$ = 600 A/µs		350		ns
			T_{vj} = 175 °C, I_F = 40 A, $-di_F/dt$ = 600 A/µs		550		

(table continues...)

Table 5 **(continued) Characteristic values**

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Diode reverse recovery charge	Q_{rr}	V_R = 600 V	T_{vj} = 25 °C, I_F = 40 A, $-di_F/dt$ = 600 A/µs		3		µC
			T_{vj} = 175 °C, I_F = 40 A, $-di_F/dt$ = 600 A/µs		7.5		
Diode peak reverse recovery current	I_{rrm}	V_R = 600 V	T_{vj} = 25 °C, I_F = 40 A, $-di_F/dt$ = 600 A/µs		22		A
			T_{vj} = 175 °C, I_F = 40 A, $-di_F/dt$ = 600 A/µs		30		
Diode peak rate of fall of reverse recovery current	di_{rr}/dt	V_R = 600 V	T_{vj} = 25 °C, I_F = 40 A, $-di_F/dt$ = 600 A/µs		188		A/µs
			T_{vj} = 175 °C, I_F = 40 A, $-di_F/dt$ = 600 A/µs		142		
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.

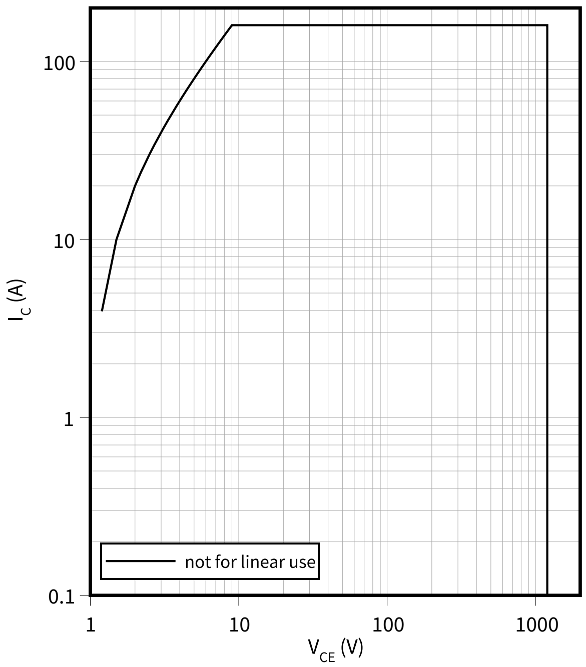
Dynamic test circuit, parasitic inductance $L_σ$, parasitic capacitor $C_σ$ from Fig. E. Energy losses include "tail" and diode reverse recovery.

4 Characteristics diagrams

Forward bias safe operating area

$I_C = f(V_{CE})$

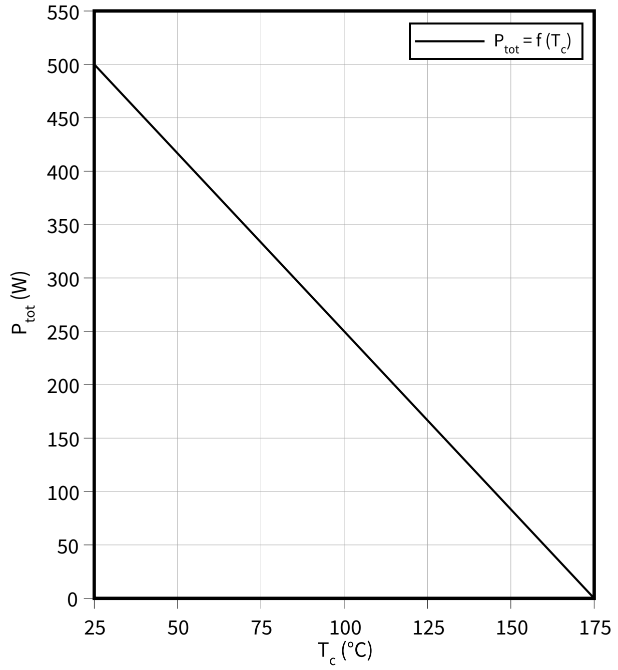
$D = 0$, $T_{vj} \leq 175$ °C, $V_{GE} = 15$ V, $T_c = 25$ °C



Power dissipation as a function of case temperature

$P_{tot} = f(T_c)$

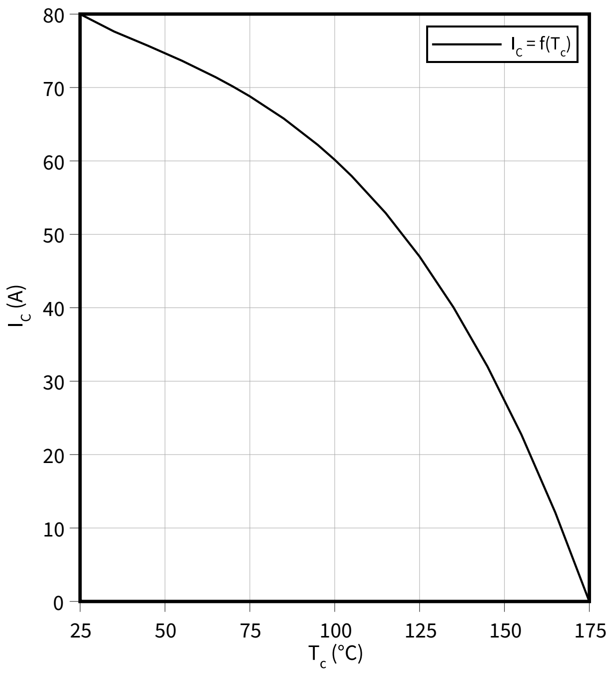
$T_{vj} \leq 175$ °C



Collector current as a function of case temperature

$I_C = f(T_c)$

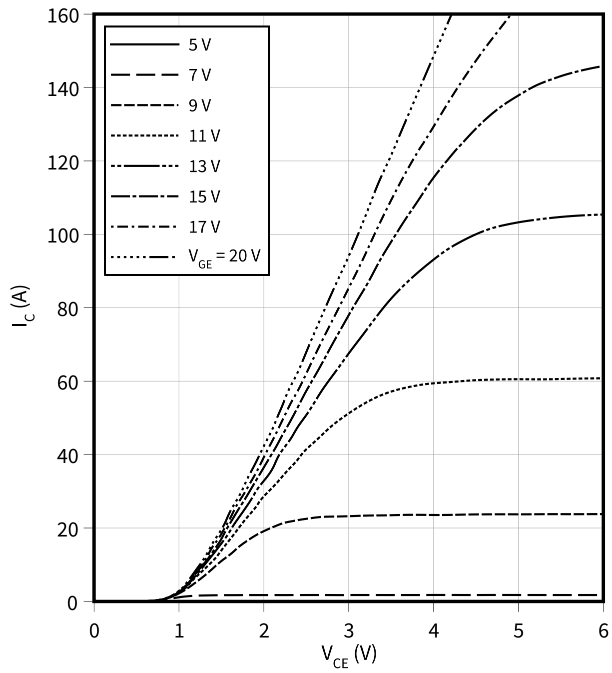
$T_{vj} \leq 175$ °C, $V_{GE} \geq 15$ V



Typical output characteristic

$I_C = f(V_{CE})$

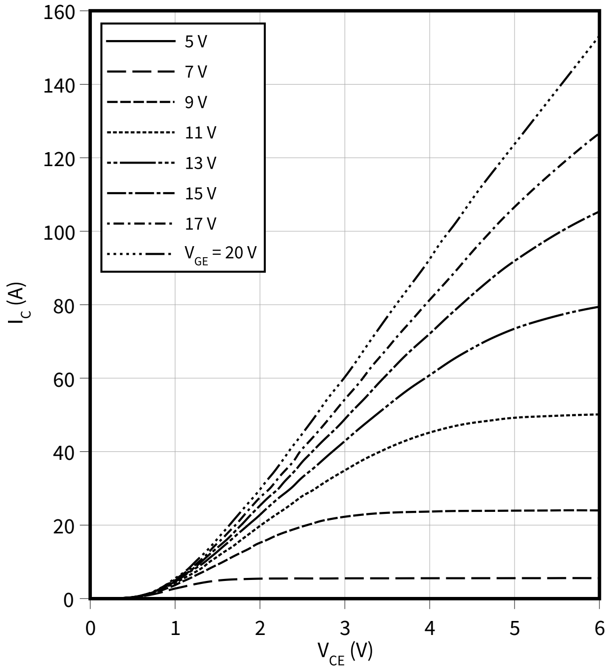
$T_{vj} = 25$ °C



Typical output characteristic

$I_C = f(V_{CE})$

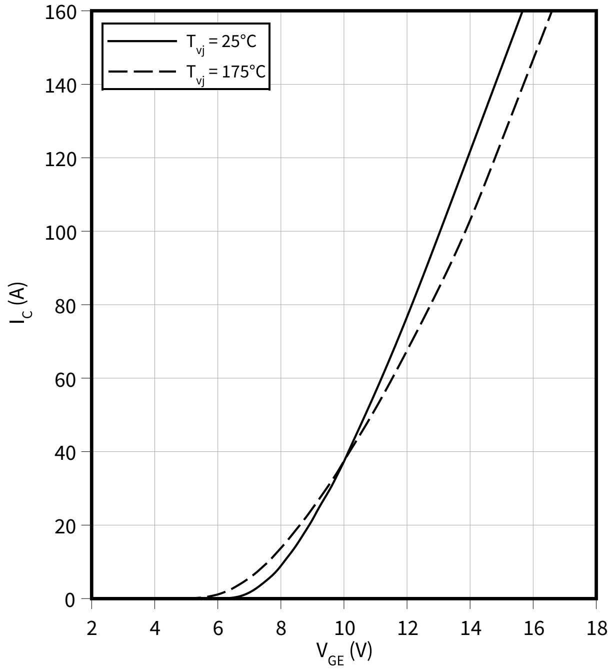
$T_{vj} = 175\ °C$



Typical transfer characteristic

$I_C = f(V_{GE})$

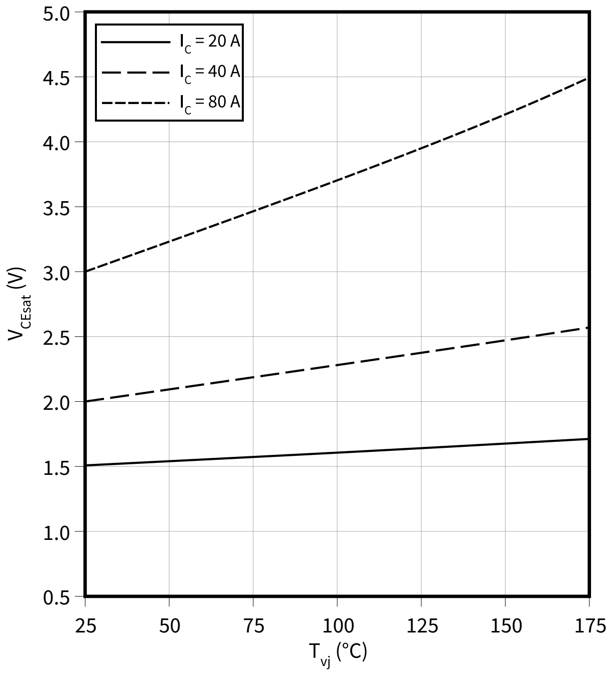
$V_{CE} = 20\ V$



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

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

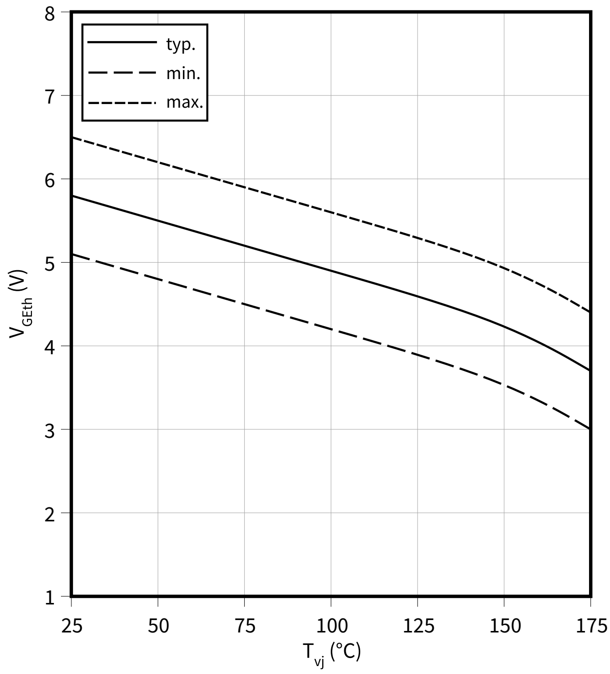
$V_{GE} = 15\ V$



Gate-emitter threshold voltage as a function of junction temperature

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

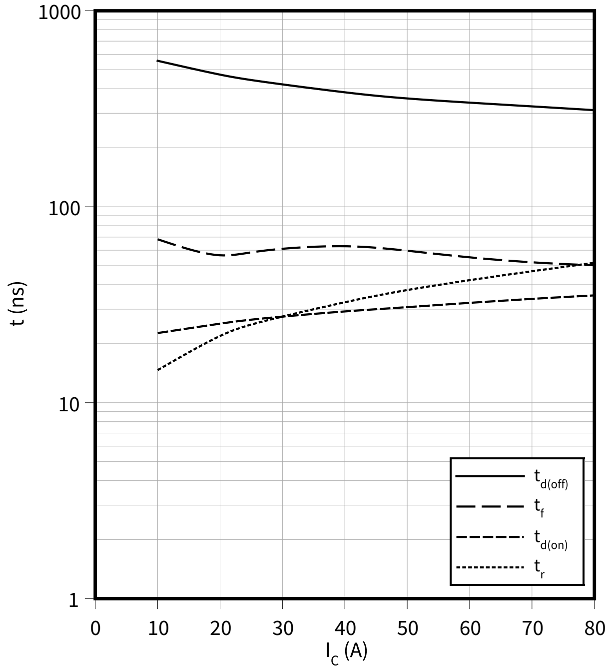
$I_C = 1.5\ mA$



Typical switching times as a function of collector current

$t = f(I_C)$

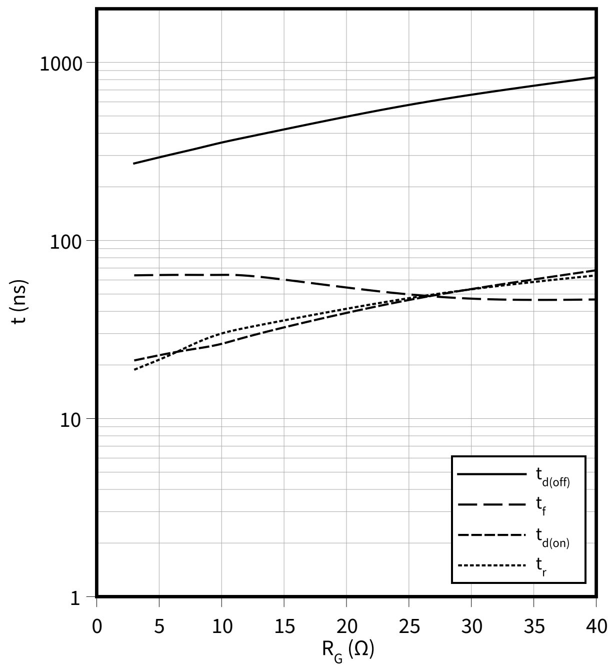
$V_{CC} = 600$ V, $T_{vj} = 175$ °C, $V_{GE} = 0/15$ V, $R_G = 12$ Ω



Typical switching times as a function of gate resistor

$t = f(R_G)$

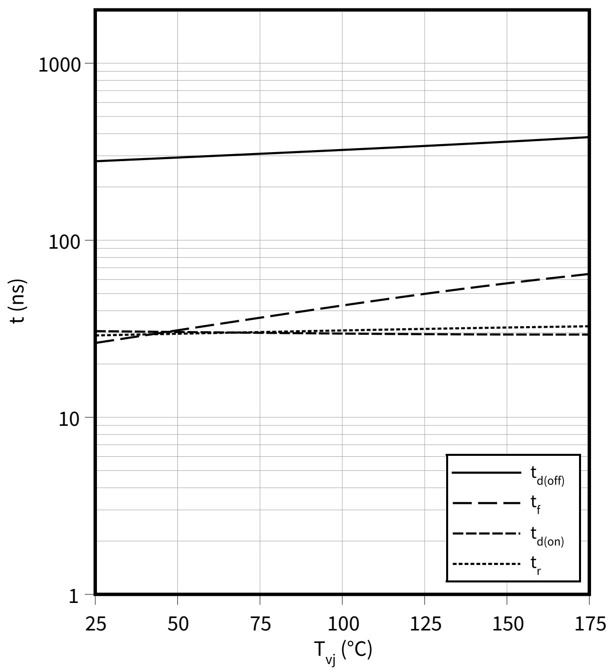
$I_C = 40$ A, $V_{CC} = 600$ V, $T_{vj} = 175$ °C, $V_{GE} = 0/15$ V



Typical switching times as a function of junction temperature

$t = f(T_{vj})$

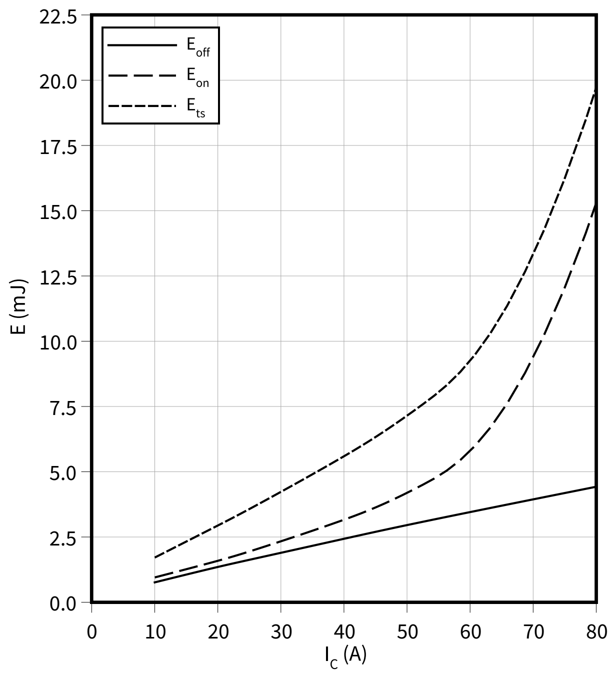
$I_C = 40$ A, $V_{CC} = 600$ V, $V_{GE} = 0/15$ V, $R_G = 12$ Ω



Typical switching energy losses as a function of collector current

$E = f(I_C)$

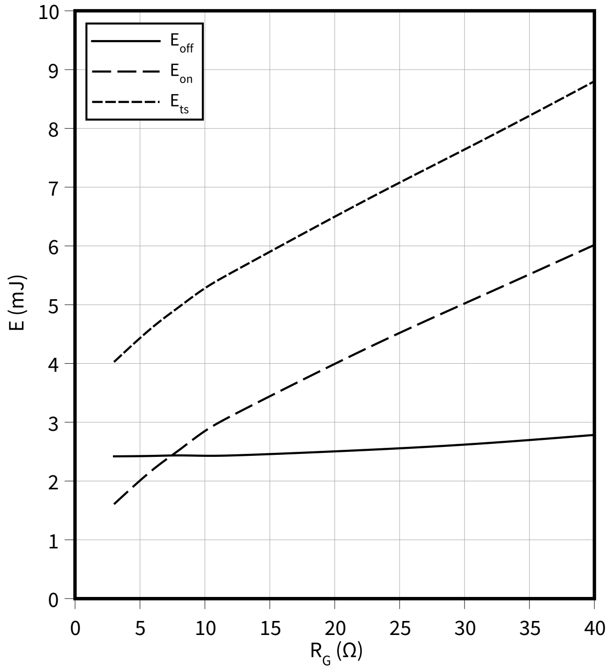
$V_{CC} = 600$ V, $T_{vj} = 175$ °C, $V_{GE} = 0/15$ V, $R_G = 12$ Ω



Typical switching energy losses as a function of gate resistor

$E = f(R_G)$

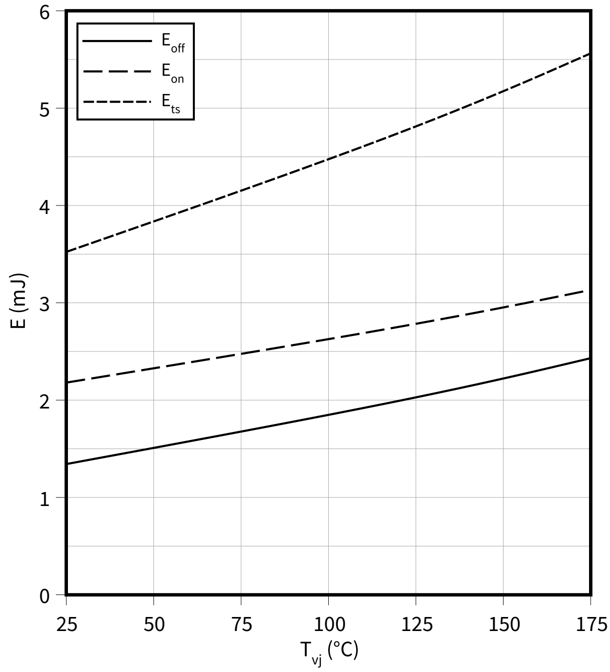
$I_C = 40$ A, $V_{CC} = 600$ V, $T_{vj} = 175$ °C, $V_{GE} = 0/15$ V



Typical switching energy losses as a function of junction temperature

$E = f(T_{vj})$

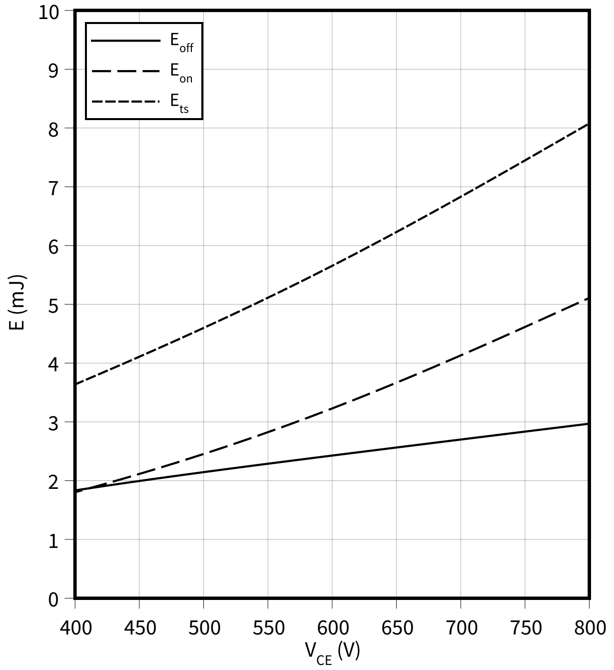
$I_C = 40$ A, $V_{CC} = 600$ V, $V_{GE} = 0/15$ V, $R_G = 12$ Ω



Typical switching energy losses as a function of collector emitter voltage

$E = f(V_{CE})$

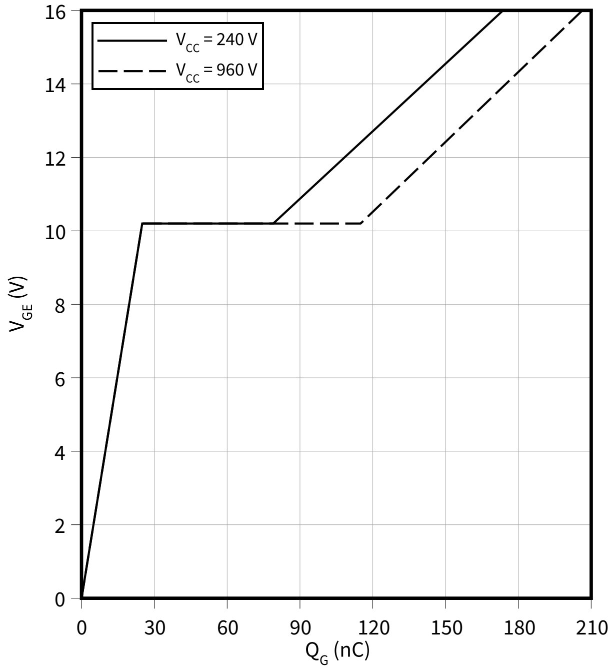
$I_C = 40$ A, $T_{vj} = 175$ °C, $V_{GE} = 0/15$ V, $R_G = 12$ Ω



Typical gate charge

$V_{GE} = f(Q_G)$

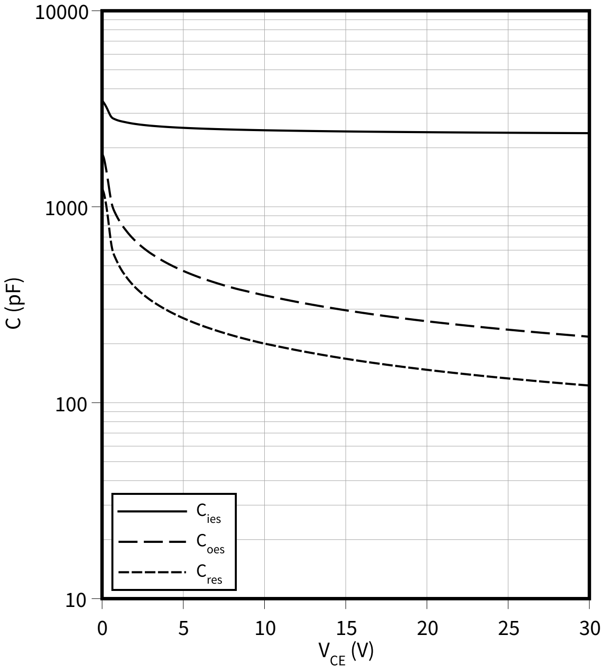
$I_C = 40$ A



Typical capacitance as a function of collector-emitter voltage

$C = f(V_{CE})$

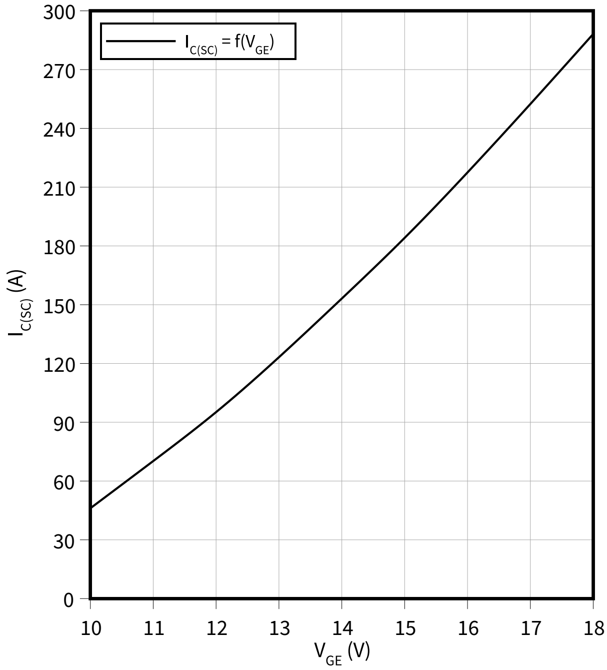
$f = 1000$ kHz, $V_{GE} = 0$ V



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

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

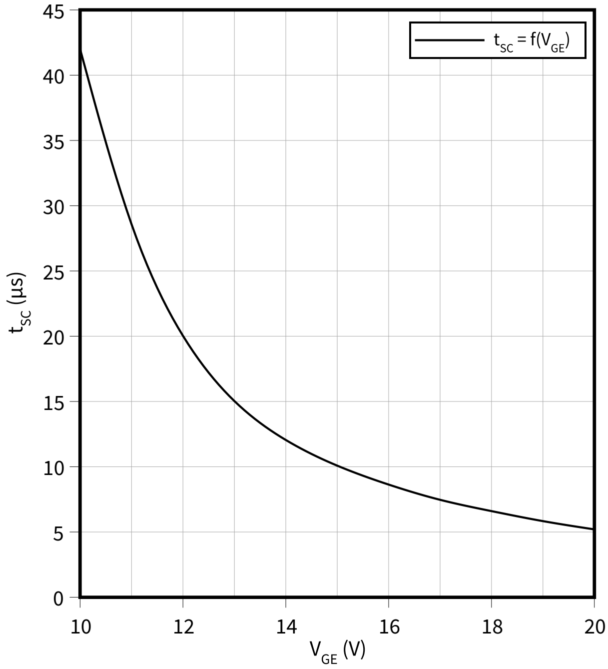
$T_{vj} \leq 175$ °C, $V_{CC} \leq 600$ V



Short circuit withstand time as a function of gate-emitter voltage

$t_{SC} = f(V_{GE})$

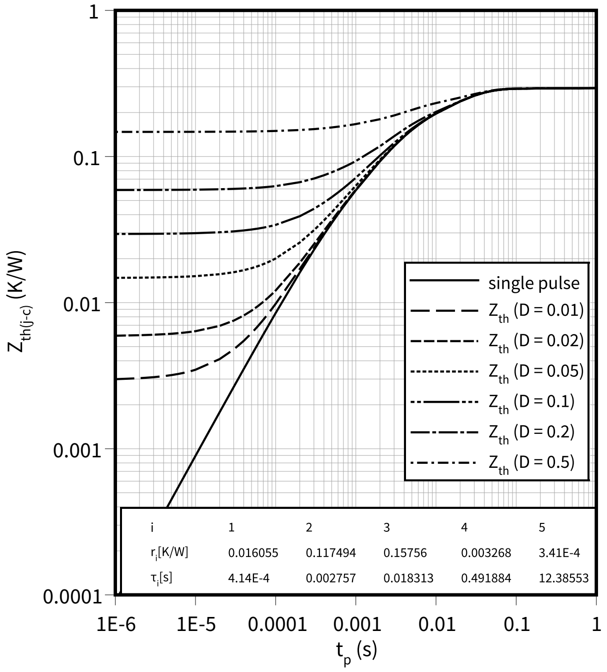
$T_{vj} \leq 175$ °C, $V_{CC} \leq 600$ V



IGBT transient thermal impedance as a function of pulse width

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

$D = t_p/T$

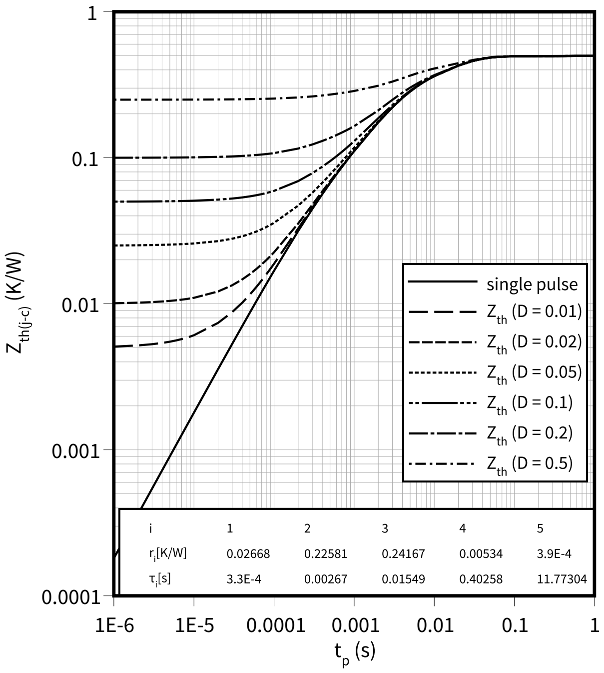


i	1	2	3	4	5
r_i[K/W]	0.016055	0.117494	0.15756	0.003268	3.41E-4
$τ_i$[s]	4.14E-4	0.002757	0.018313	0.491884	12.38553

Diode transient thermal impedance as a function of pulse width

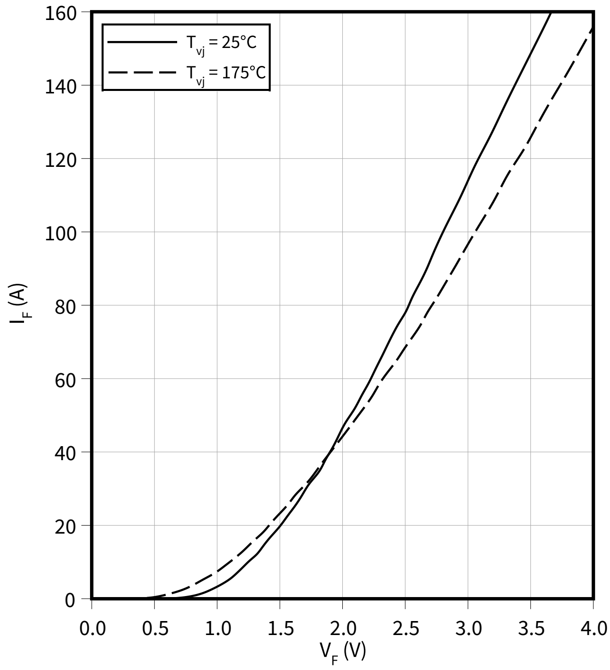
$Z_{th(j-c)} = f(t_p)$

$D = t_p/T$



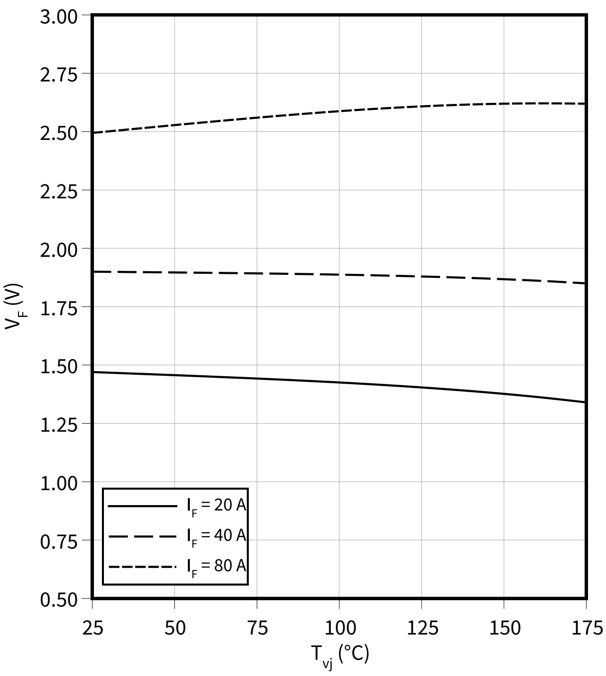
Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



Typical diode forward voltage as a function of junction temperature

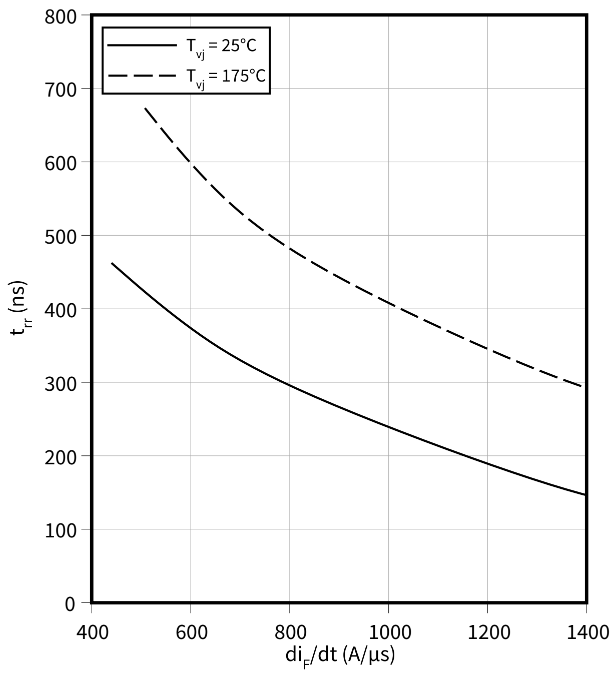
$V_F = f(T_{vj})$



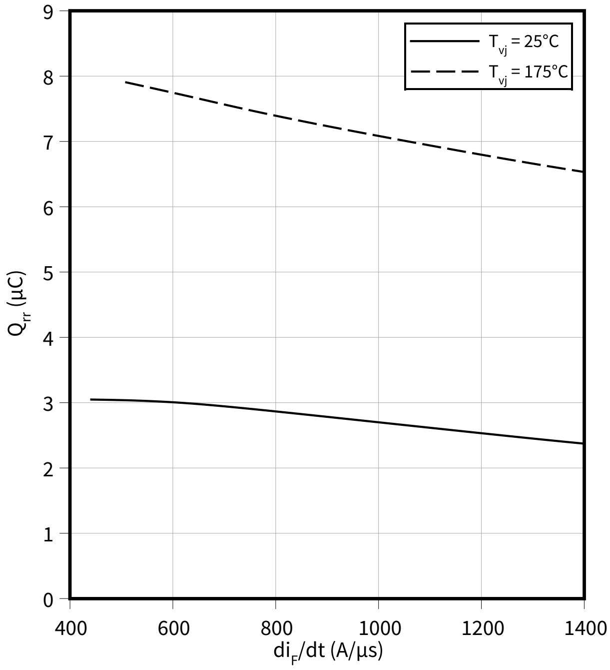
Typical reverse recovery time as a function of diode current slope

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

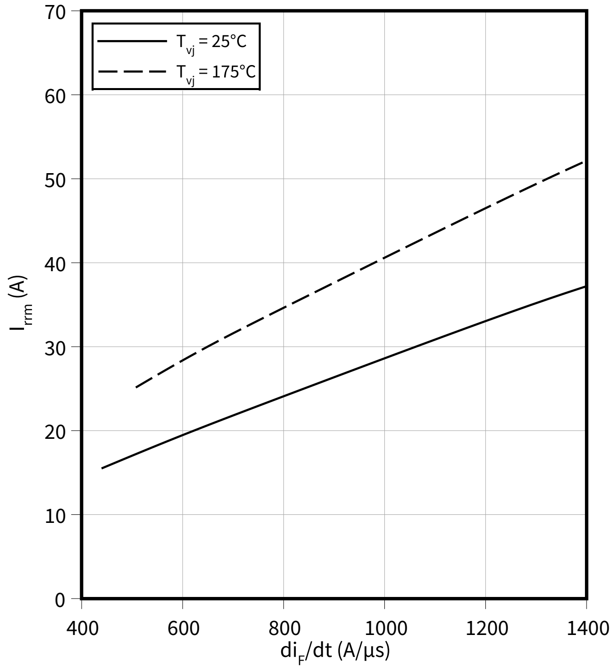
$V_R = 600$ V, $I_F = 40$ A



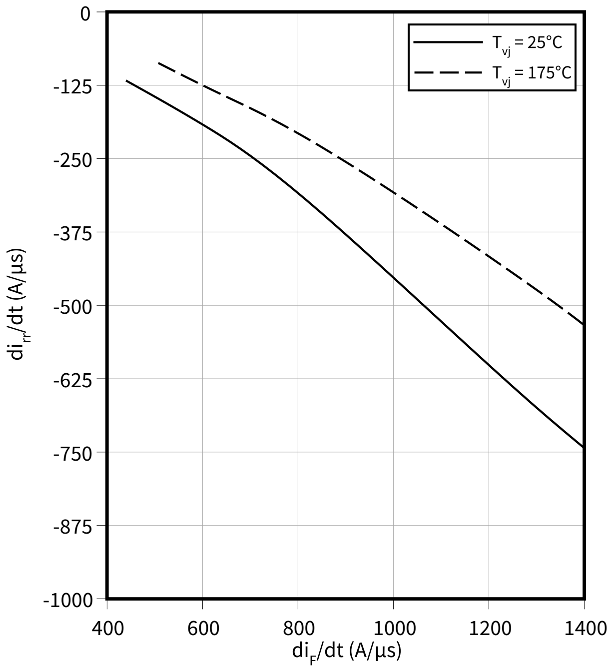
Typical reverse recovery charge as a function of diode current slope
$Q_{rr} = f(di_F/dt)$
$V_R = 600$ V, $I_F = 40$ A



Typical reverse recovery current as a function of diode current slope
$I_{rrm} = f(di_F/dt)$
$V_R = 600$ V, $I_F = 40$ A

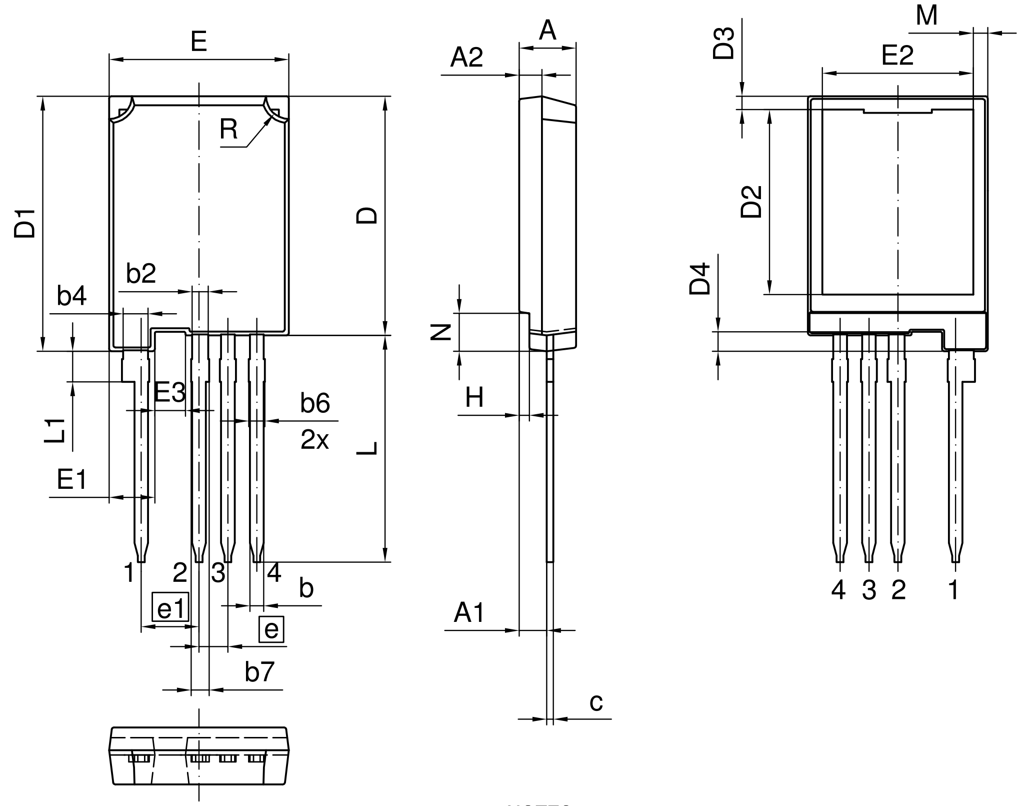


Typical diode peak rate of fall of reverse recovery current as a function of diode current slope
$di_{rr}/dt = f(di_F/dt)$
$V_R = 600$ V, $I_F = 40$ A



5 Package outlines

PG-TO247-4-2



NOTES:
PACKAGE SURFACE ROUTE BETWEEN PIN 1 & PIN 2 WILL BE 5.1mm MIN.

ALL b... AND c DIMENSIONS INCLUDING PLATING EXCEPT AREA OF CUTTING

DIMENSION	MILLIMETERS	
	MIN.	MAX.
A	4.9	5.1
A1	2.31	2.51
A2	1.9	2.1
b	1.16	1.29
b2	1.36	1.49
b4	2.16	2.29
b6	1.16	1.45
b7	1.16	1.65
c	0.59	0.66
D	20.9	21.1
D1	22.3	22.5
D2	15.95	16.55
D3	1	1.35
D4	1.6	1.8
E	15.7	15.9
E1	3.9	4.1
E2	13.1	13.5
E3	2.58	2.78
e	2.54	
e1	5.08	
H	0.8	1
L	19.8	20.1
L1	2.55	2.85
M	0.97	1.57
N	3.24	3.44
R	1.9	2.1

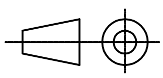
DOCUMENT NO.
Z8B00182798

REVISION
01

SCALE 2:1

0 5 10mm

EUROPEAN PROJECTION



ISSUE DATE
23.09.2016

Figure 1

6 Testing conditions

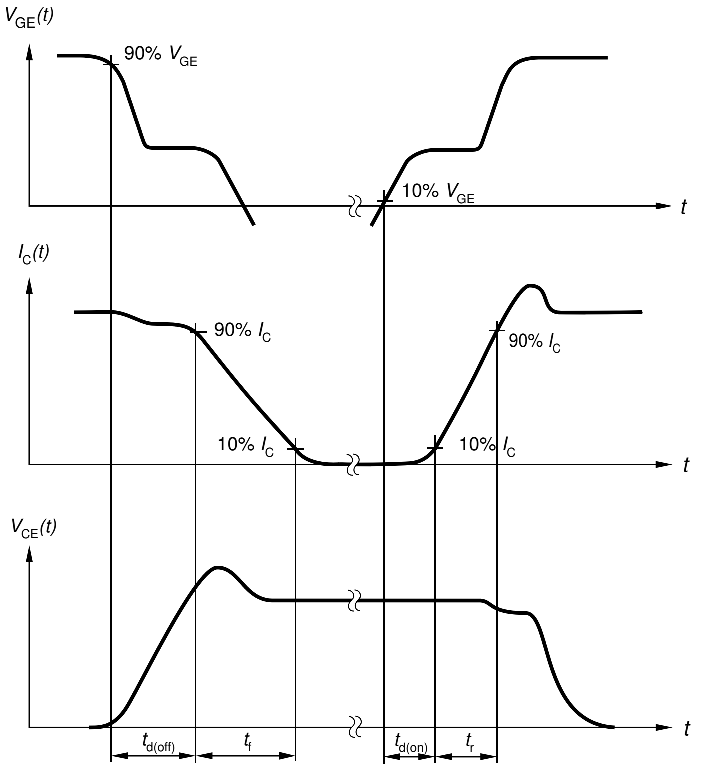


Figure A. **Definition of switching times**

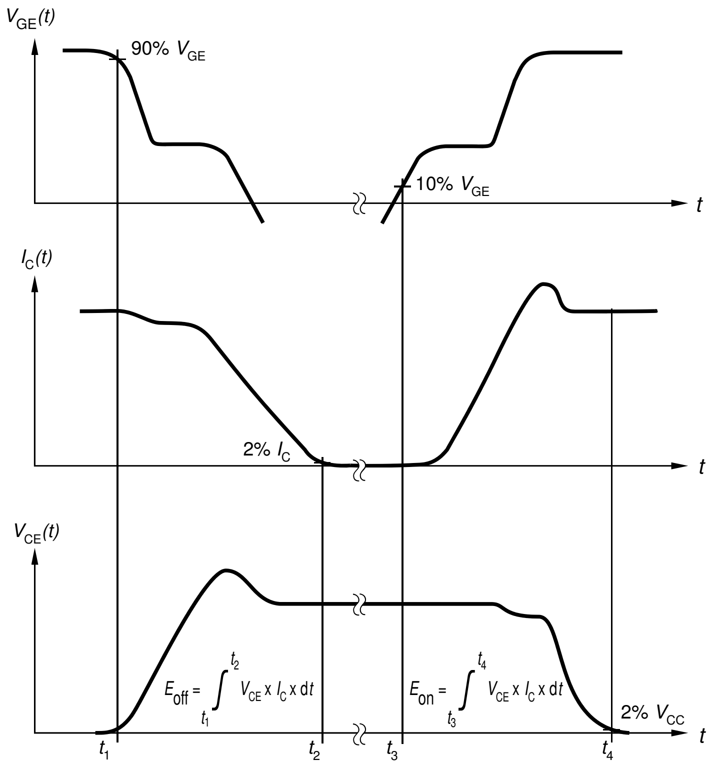


Figure B. **Definition of switching losses**

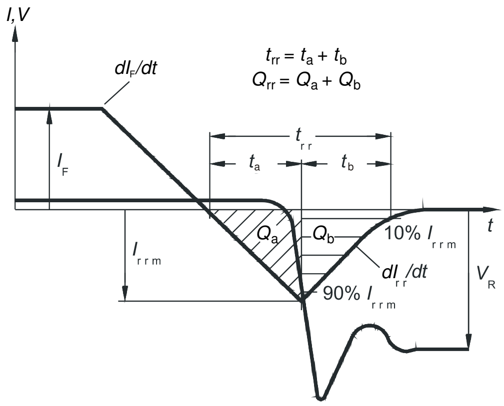


Figure C. **Definition of diode switching characteristics**

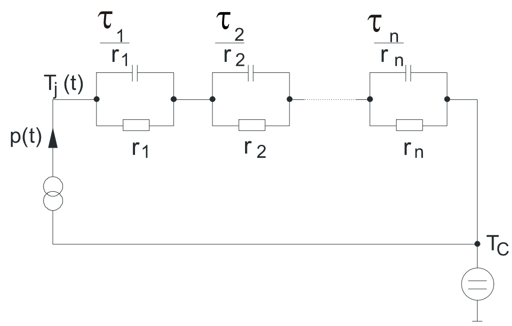


Figure D. **Thermal equivalent circuit**

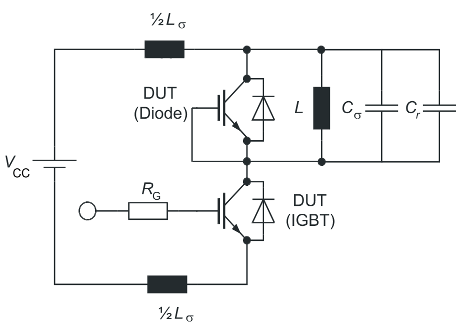


Figure E. **Dynamic test circuit**
Parasitic inductance L_{σ},
parasitic capacitor C_{σ},
relief capacitor C_r,
(only for ZVT switching)

Figure 2

Revision history

Document revision	Date of release	Description of changes
V2.1	2017-04-26	Final data sheet
V2.2	2017-06-09	Update Figure 26
V2.3	2019-04-15	Update codition for Vgeth page 4 and Fig.11
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	2023-01-19	Correction of diagram: “Typical switching energy losses as a function of junction temperature”