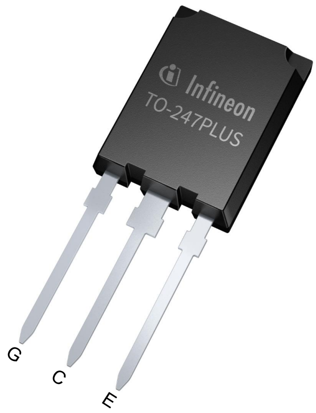
High speed and low saturation voltage 650 V TRENCHSTOP™ IGBT7 technology copacked with soft, fast recovery Emitter Controlled 7 diode

Features

- V_{CE} = 650 V
- I_C = 120 A
- Low switching losses
- Very low collector-emitter saturation voltage V_{CEsat}
- Very soft, fast recovery antiparallel diode
- Smooth switching behavior
- Humidity robustness
- Optimized for hard switching, two- and three-level topologies
- Complete product spectrum and PSpice Models: http://www.infineon.com/igbt/



Lead-free
Green
Halogen-free
RoHS

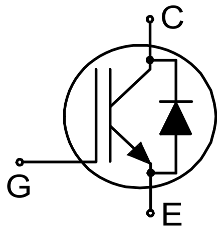
Potential applications

- Industrial UPS
- EV-Charging
- String inverter
- Welding

Product validation

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

Description



Type	Package	Marking
IKQ120N65EH7	PG-TO247-3-PLUS-NN3.7	K120EEH7

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
Thermal resistance, junction-ambient	$R_{th(j-a)}$				40	K/W
IGBT thermal resistance, junction-case	$R_{th(j-c)}$			0.23	0.3	K/W
Diode thermal resistance, junction-case	$R_{th(j-c)}$			0.31	0.4	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	limited by bondwire	$T_c = 25$ °C	160	A
			$T_c = 100$ °C	136	
Pulsed collector current, t_p limited by T_{vjmax}	I_{Cpulse}			480	A
Turn-off safe operating area		$V_{CE} \leq 650$ V, $t_p \leq 1$ µs, $T_{vj} \leq 175$ °C		480	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	498	W
			$T_c = 100$ °C	249	

Table 3 Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Collector-emitter saturation voltage	V_{CEsat}	$I_C = 120$ A, $V_{GE} = 15$ V	$T_{vj} = 25$ °C		1.4	1.65	V
			$T_{vj} = 175$ °C		1.6		

(table continues...)

Table 3 **(continued) Characteristic values**

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Gate-emitter threshold voltage	V_{GEth}	I_C = 1.05 mA, V_{CE} = V_{GE}		2.9	3.85	4.8	V
Zero gate-voltage collector current	I_{CES}	V_{CE} = 650 V, V_{GE} = 0 V	T_{vj} = 25 °C			35	µA
			T_{vj} = 175 °C		5500		
Gate-emitter leakage current	I_{GES}	V_{CE} = 0 V, V_{GE} = 20 V				100	nA
Transconductance	g_{fs}	I_C = 120 A, V_{CE} = 20 V			148		S
Input capacitance	C_{ies}	V_{CE} = 25 V, V_{GE} = 0 V, f = 100 kHz			6644		pF
Output capacitance	C_{oes}	V_{CE} = 25 V, V_{GE} = 0 V, f = 100 kHz			197		pF
Reverse transfer capacitance	C_{res}	V_{CE} = 25 V, V_{GE} = 0 V, f = 100 kHz			27.5		pF
Gate charge	Q_G	V_{CC} = 520 V, I_C = 120 A, V_{GE} = 15 V			251		nC
Turn-on delay time	$t_{d(on)}$	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 10 Ω, $R_{G(off)}$ = 10 Ω	T_{vj} = 25 °C, I_C = 120 A		38		ns
			T_{vj} = 175 °C, I_C = 120 A		38		
Rise time (inductive load)	t_r	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 10 Ω, $R_{G(off)}$ = 10 Ω	T_{vj} = 25 °C, I_C = 120 A		62		ns
			T_{vj} = 175 °C, I_C = 120 A		62		
Turn-off delay time	$t_{d(off)}$	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 10 Ω, $R_{G(off)}$ = 10 Ω	T_{vj} = 25 °C, I_C = 120 A		287		ns
			T_{vj} = 175 °C, I_C = 120 A		317		
Fall time (inductive load)	t_f	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 10 Ω, $R_{G(off)}$ = 10 Ω	T_{vj} = 25 °C, I_C = 120 A		98		ns
			T_{vj} = 175 °C, I_C = 120 A		90		
Turn-on energy	E_{on}	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 10 Ω, $R_{G(off)}$ = 10 Ω	T_{vj} = 25 °C, I_C = 120 A		4.2		mJ
			T_{vj} = 175 °C, I_C = 120 A		6.1		
Turn-off energy	E_{off}	V_{CC} = 400 V, V_{GE} = 0/15 V, $R_{G(on)}$ = 10 Ω, $R_{G(off)}$ = 10 Ω	T_{vj} = 25 °C, I_C = 120 A		3.7		mJ
			T_{vj} = 175 °C, I_C = 120 A		3.7		

(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, $R_{G(on)}$ = 10 Ω, $R_{G(off)}$ = 10 Ω	T_{vj} = 25 °C, I_C = 120 A		7.9		mJ
			T_{vj} = 175 °C, I_C = 120 A		9.8		
Operating junction temperature	T_{vj}			-40		175	°C

3 Diode

Table 4 Maximum rated values

Parameter	Symbol	Note or test condition		Values	Unit
Diode forward current, limited by T_{vjmax}	I_F	limited by bondwire	T_c = 25 °C	160	A
			T_c = 100 °C	125	
Diode pulsed current, t_p limited by T_{vjmax}	I_{Fpulse}			480	A
Power dissipation	P_{tot}		T_c = 25 °C	375	W
			T_c = 100 °C	188	

Table 5 Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Diode forward voltage	V_F	I_F = 120 A	T_{vj} = 25 °C		1.65	2	V
			T_{vj} = 175 °C		1.55		
Diode reverse recovery time	t_{rr}	V_R = 400 V, $R_{G(on)}$ = 10 Ω	T_{vj} = 25 °C, I_F = 120 A		82		ns
			T_{vj} = 175 °C, I_F = 120 A		154		
Diode reverse recovery charge	Q_{rr}	V_R = 400 V, $R_{G(on)}$ = 10 Ω	T_{vj} = 25 °C, I_F = 120 A		2.4		µC
			T_{vj} = 175 °C, I_F = 120 A		6.7		
Diode peak reverse recovery current	I_{rrm}	V_R = 400 V, $R_{G(on)}$ = 10 Ω	T_{vj} = 25 °C, I_F = 120 A		44.5		A
			T_{vj} = 175 °C, I_F = 120 A		67		

(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, $R_{G(on)}$ = 10 Ω	T_{vj} = 25 °C, I_F = 120 A		-2320		A/µs
			T_{vj} = 175 °C, I_F = 120 A		-2440		
Reverse recovery energy	E_{rec}	V_R = 400 V, $R_{G(on)}$ = 10 Ω	T_{vj} = 25 °C, I_F = 120 A		0.46		mJ
			T_{vj} = 175 °C, I_F = 120 A		1.38		
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.

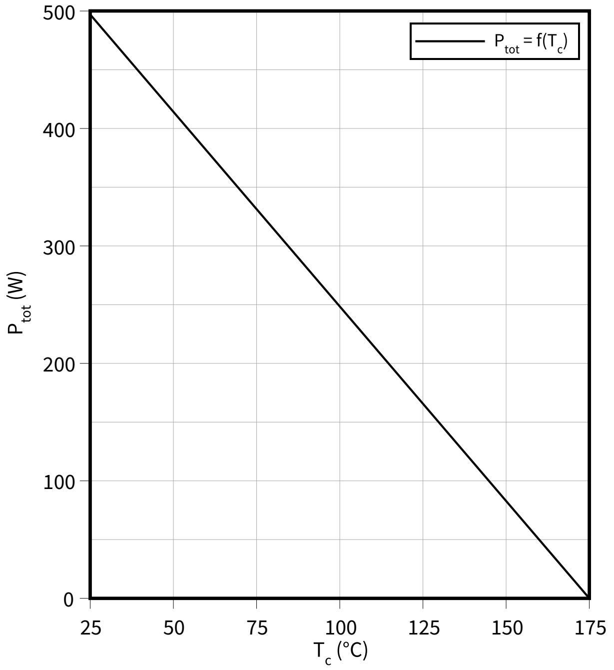
Dynamic test circuit, parasitic inductance L_σ = 8 nH, parasitic capacitor C_σ = 30 pF from Fig. E. Energy losses include "tail" and diode reverse recovery.

4 Characteristics diagrams

Power dissipation as a function of case temperature

$P_{tot} = f(T_c)$

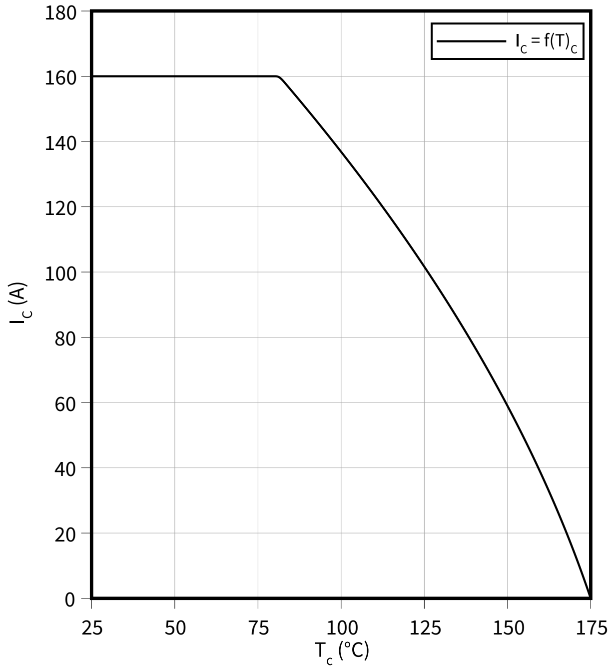
$T_{vj} \leq 175$ °C



Collector current as a function of case temperature

$I_C = f(T_c)$

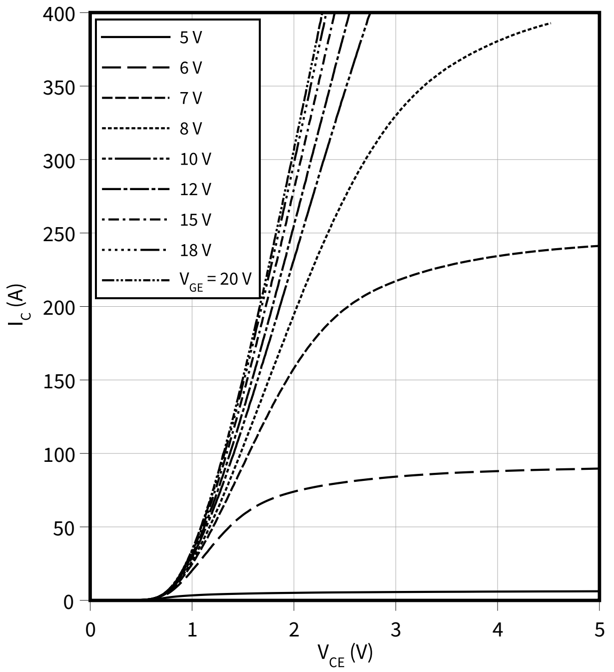
$T_{vj} \leq 175$ °C, $V_{GE} \geq 15$ V



Typical output characteristic

$I_C = f(V_{CE})$

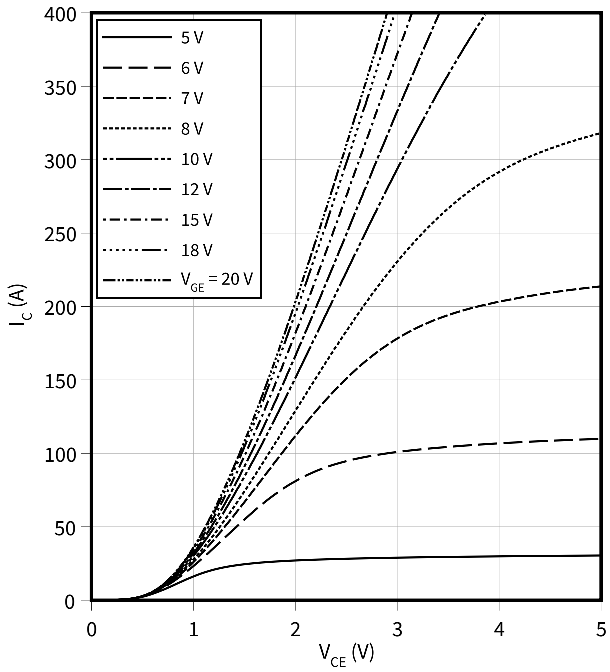
$T_{vj} = 25$ °C

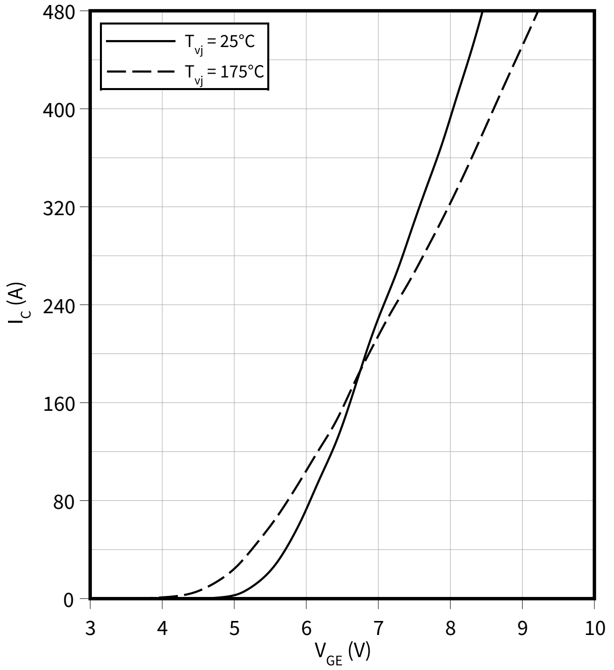
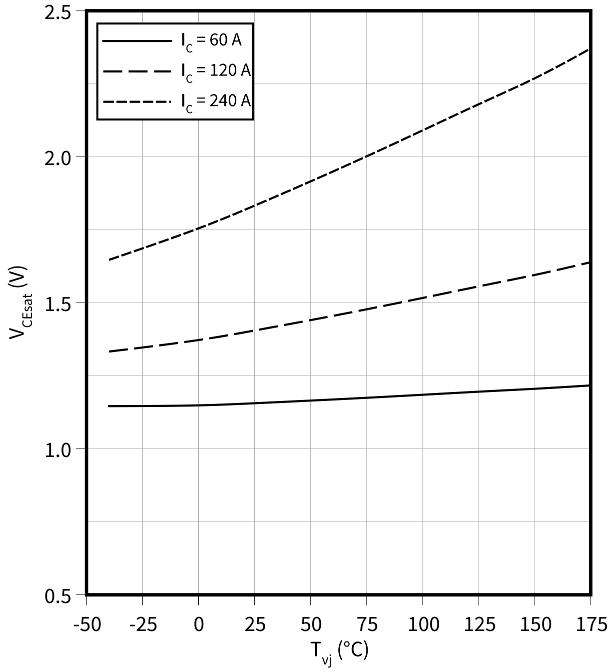
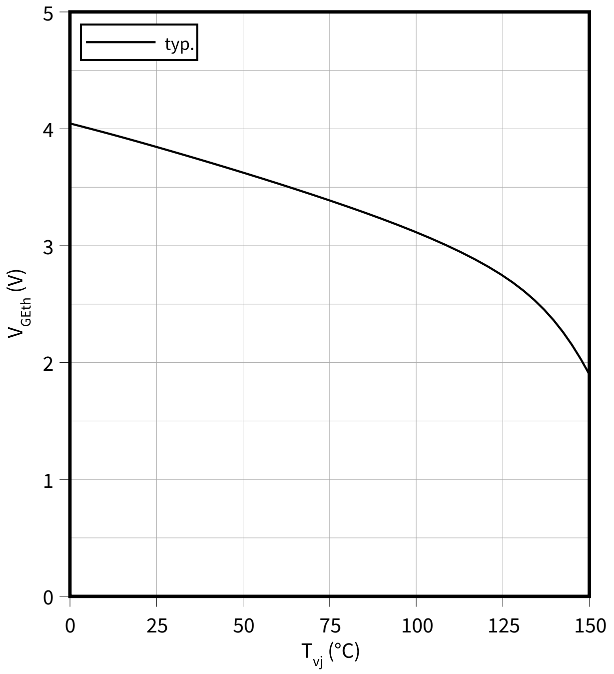
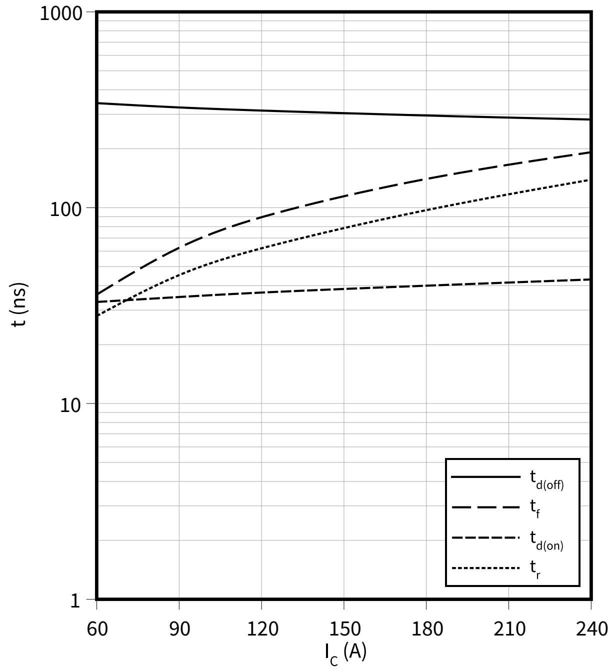


Typical output characteristic

$I_C = f(V_{CE})$

$T_{vj} = 175$ °C

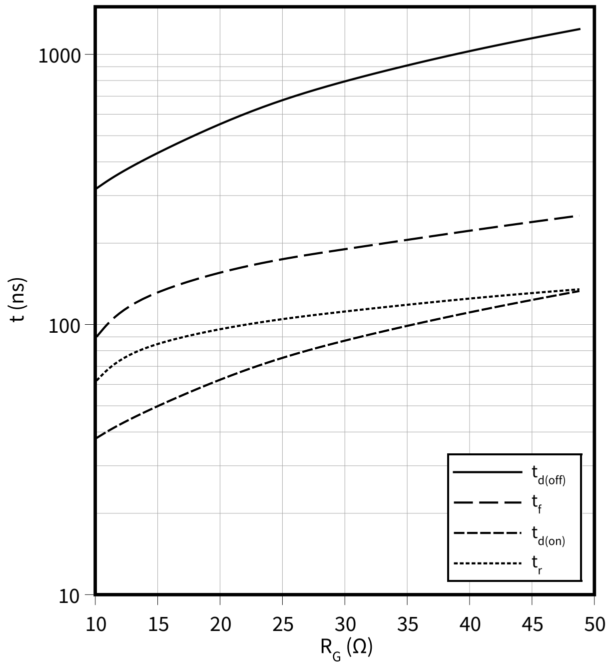


Typical transfer characteristic $I_C = f(V_{GE})$ $V_{CE} = 20$ V	**Typical collector-emitter saturation voltage as a function of junction temperature** $V_{CEsat} = f(T_{vj})$ $V_{GE} = 15$ V
	
Gate-emitter threshold voltage as a function of junction temperature $V_{GEth} = f(T_{vj})$ $I_C = 1.05$ mA	**Typical switching times as a function of collector current** $t = f(I_C)$ $V_{CC} = 400$ V, $T_{vj} = 175$ °C, $V_{GE} = 0/15$ V, $R_G = 10\ \Omega$
	

Typical switching times as a function of gate resistor

$t = f(R_G)$

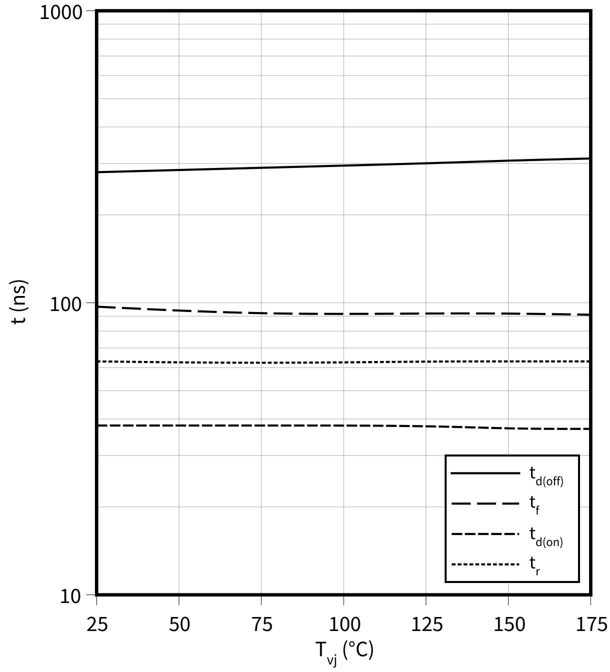
I_C = 120 A, V_{CC} = 400 V, T_{vj} = 175 °C, V_{GE} = 0/15 V



Typical switching times as a function of junction temperature

$t = f(T_{vj})$

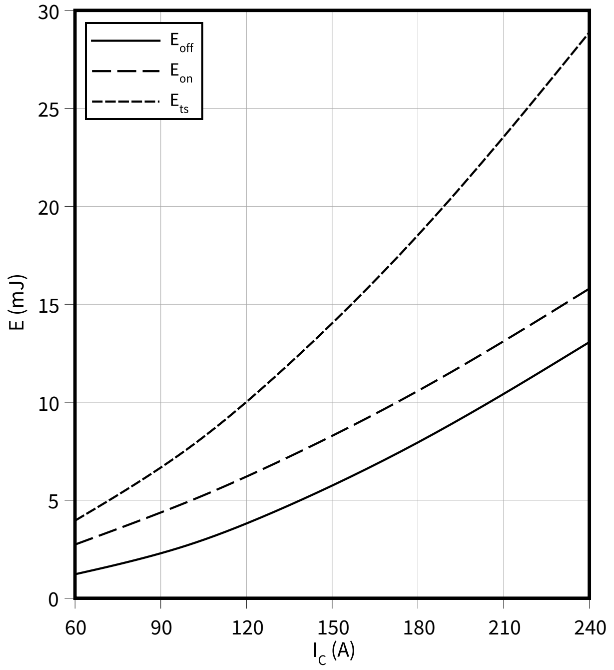
I_C = 120 A, V_{CC} = 400 V, V_{GE} = 0/15 V, R_G = 10 Ω



Typical switching energy losses as a function of collector current

$E = f(I_C)$

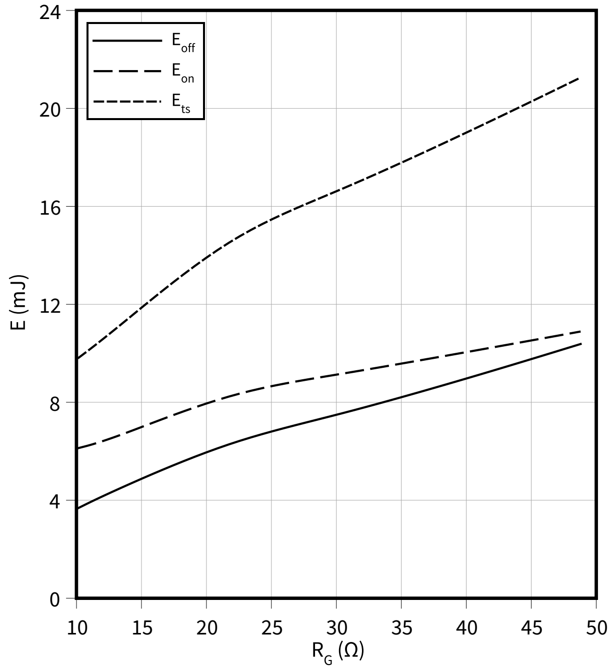
V_{CC} = 400 V, T_{vj} = 175 °C, V_{GE} = 0/15 V, R_G = 10 Ω



Typical switching energy losses as a function of gate resistor

$E = f(R_G)$

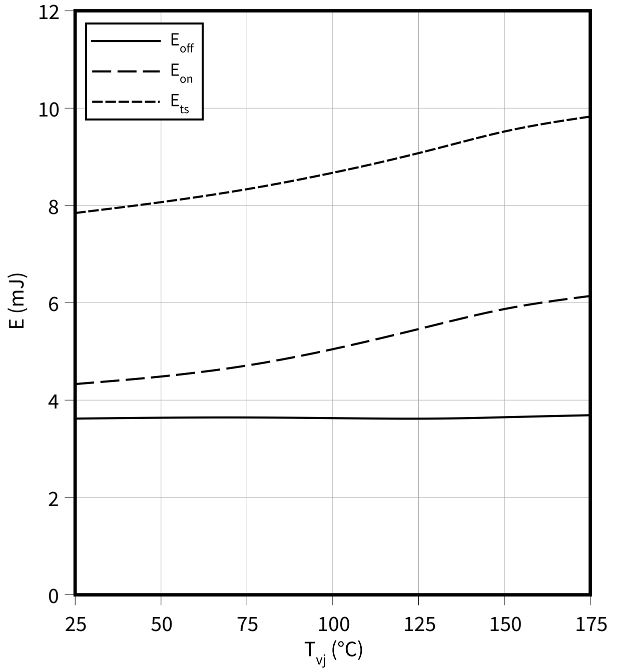
I_C = 120 A, V_{CC} = 400 V, T_{vj} = 175 °C, V_{GE} = 0/15 V



Typical switching energy losses as a function of junction temperature

$E = f(T_{vj})$

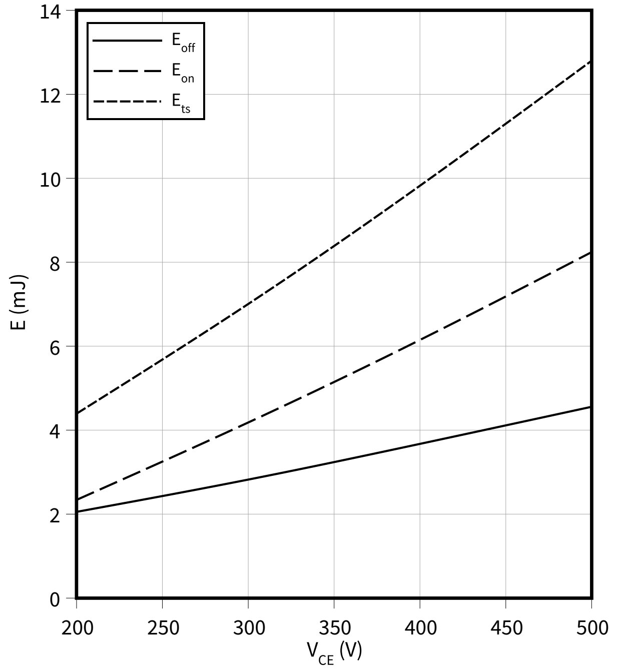
I_C = 120 A, V_{CC} = 400 V, V_{GE} = 0/15 V, R_G = 10 Ω



Typical switching energy losses as a function of collector emitter voltage

$E = f(V_{CE})$

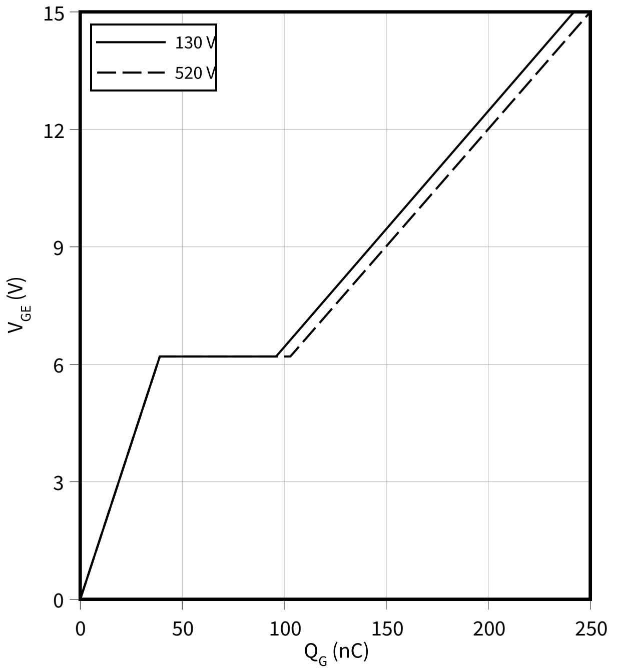
I_C = 120 A, T_{vj} = 175 °C, V_{GE} = 0/15 V, R_G = 10 Ω



Typical gate charge

$V_{GE} = f(Q_G)$

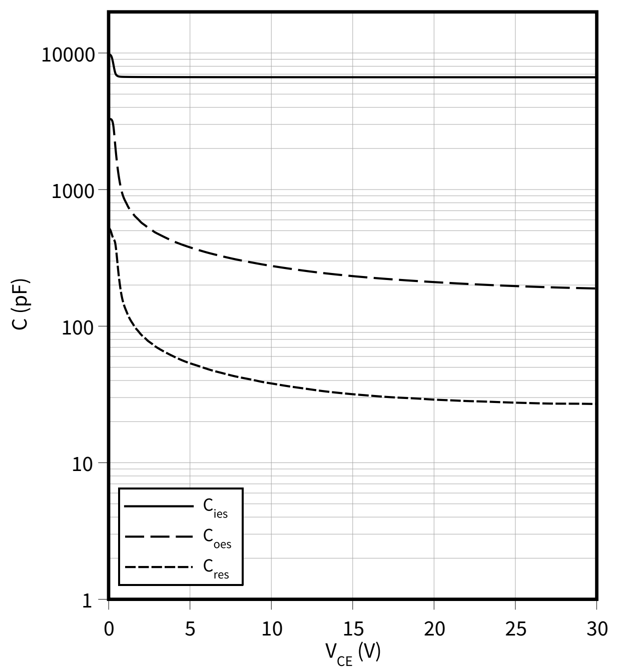
I_C = 120 A



Typical capacitance as a function of collector-emitter voltage

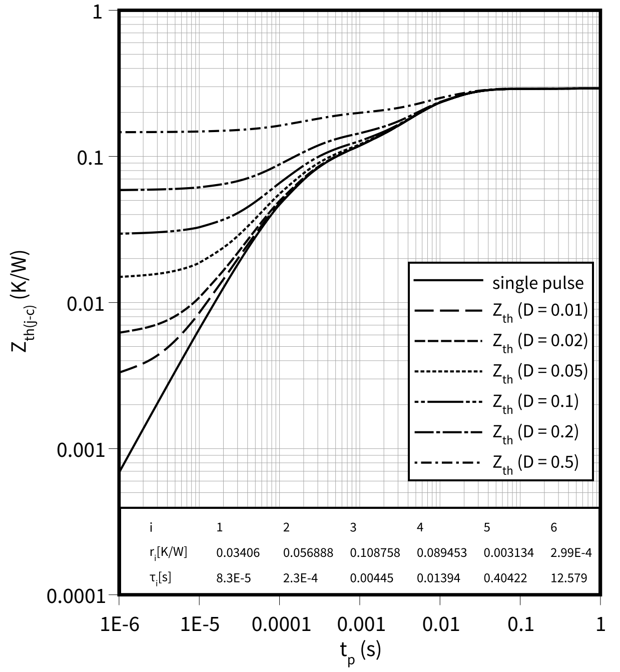
$C = f(V_{CE})$

f = 100 kHz, V_{GE} = 0 V



IGBT transient thermal impedance as a function of pulse width

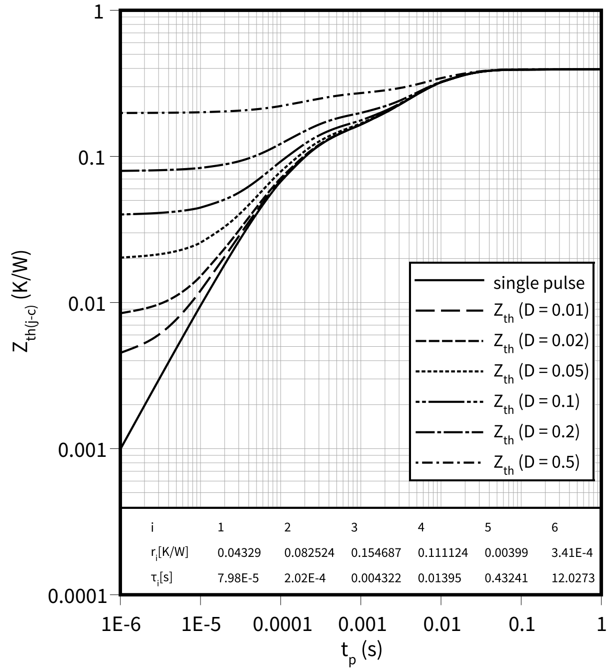
$Z_{th(j\text{-}c)} = f(t_p)$
$D = t_p/T$



i	1	2	3	4	5	6
r_i[K/W]	0.03406	0.056888	0.108758	0.089453	0.003134	2.99E-4
τ_i[s]	8.3E-5	2.3E-4	0.00445	0.01394	0.40422	12.579

Diode transient thermal impedance as a function of pulse width

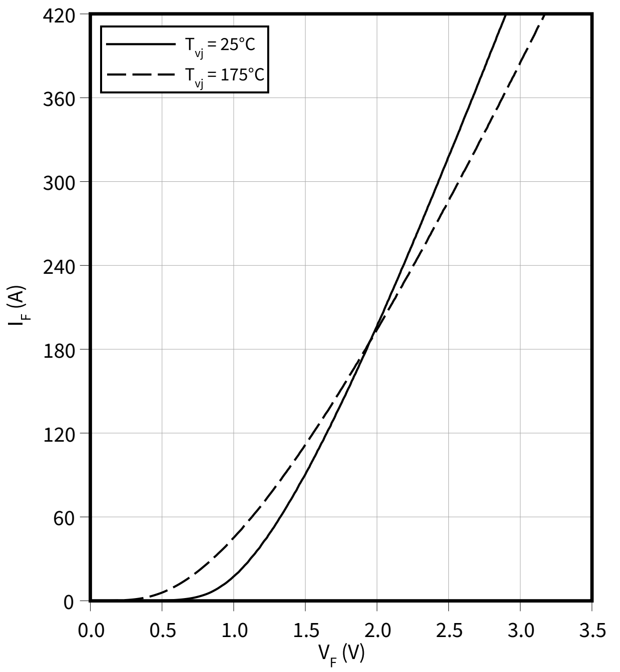
$Z_{th(j\text{-}c)} = f(t_p)$
$D = t_p/T$



i	1	2	3	4	5	6
r_i[K/W]	0.04329	0.082524	0.154687	0.111124	0.00399	3.41E-4
τ_i[s]	7.98E-5	2.02E-4	0.004322	0.01395	0.43241	12.0273

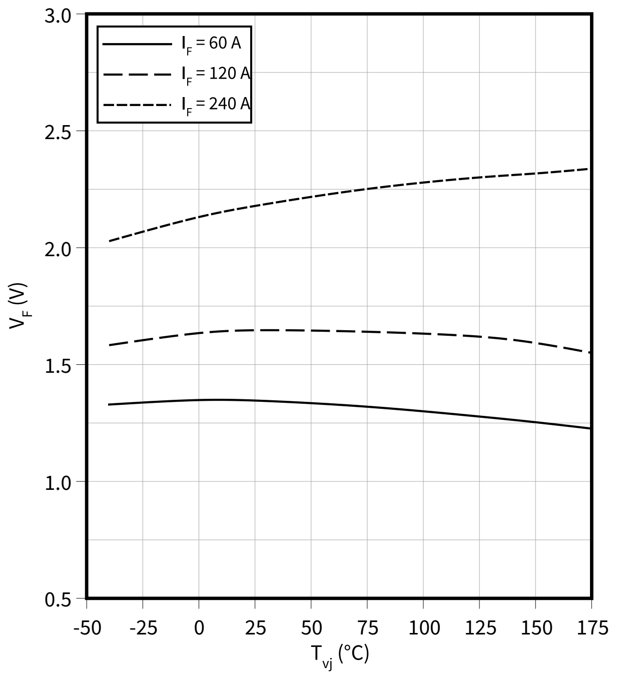
Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



Typical diode forward voltage as a function of junction temperature

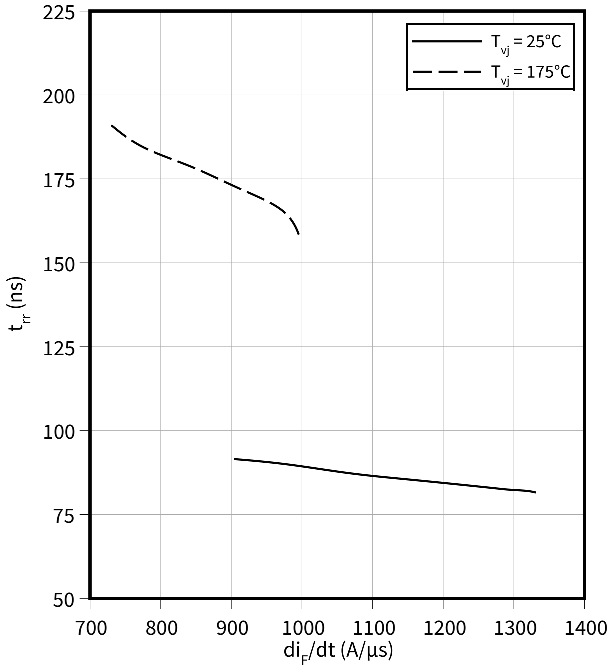
$V_F = f(T_{vj})$



Typical reverse recovery time as a function of diode current slope

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

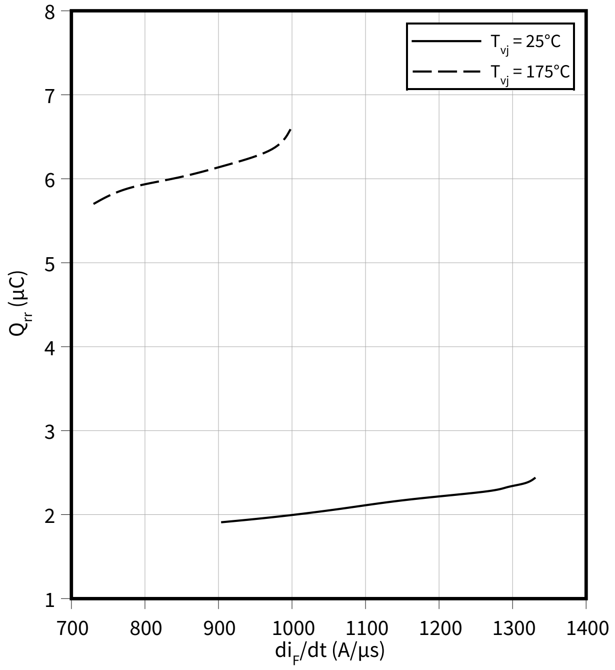
$V_R = 400\ V$, $I_F = 120\ A$



Typical reverse recovery charge as a function of diode current slope

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

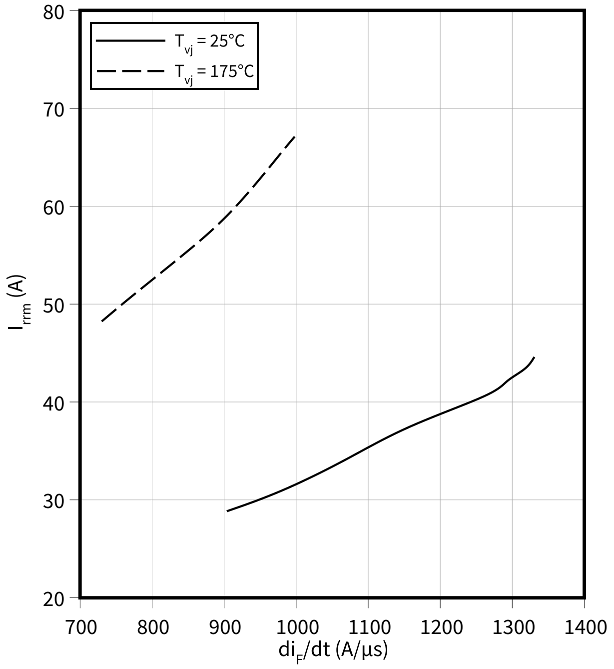
$V_R = 400\ V$, $I_F = 120\ A$



Typical reverse recovery current as a function of diode current slope

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

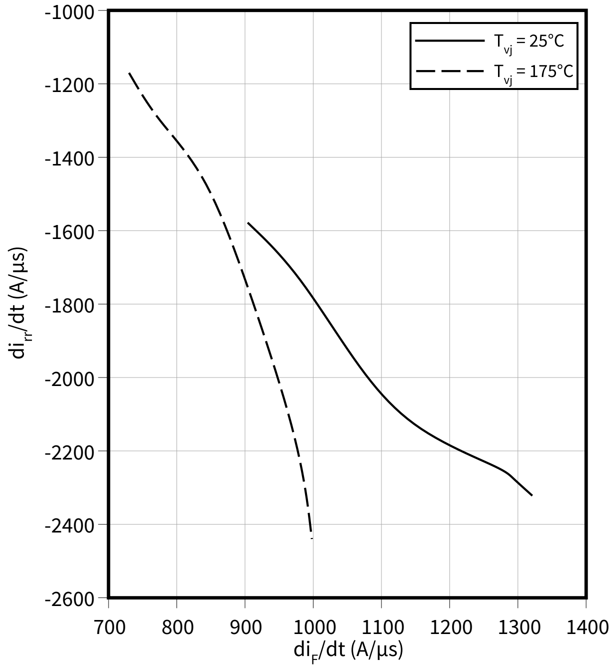
$V_R = 400\ V$, $I_F = 120\ A$



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

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

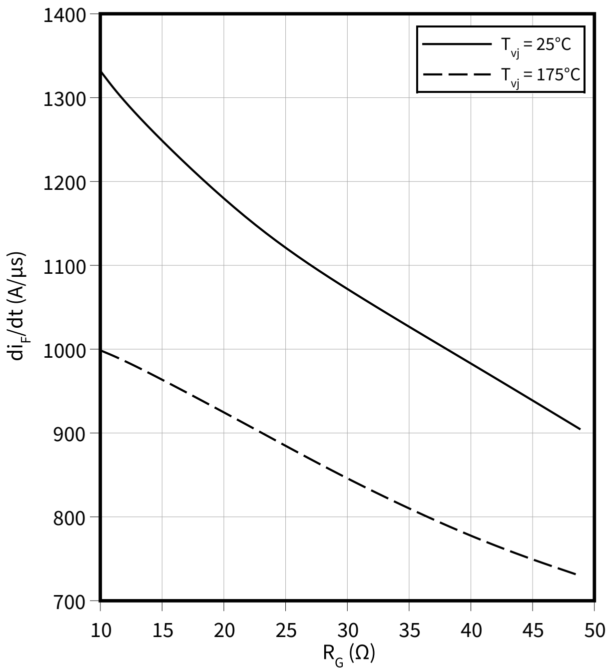
$V_R = 400\ V$, $I_F = 120\ A$



Typical diode current slope as a function of gate resistor

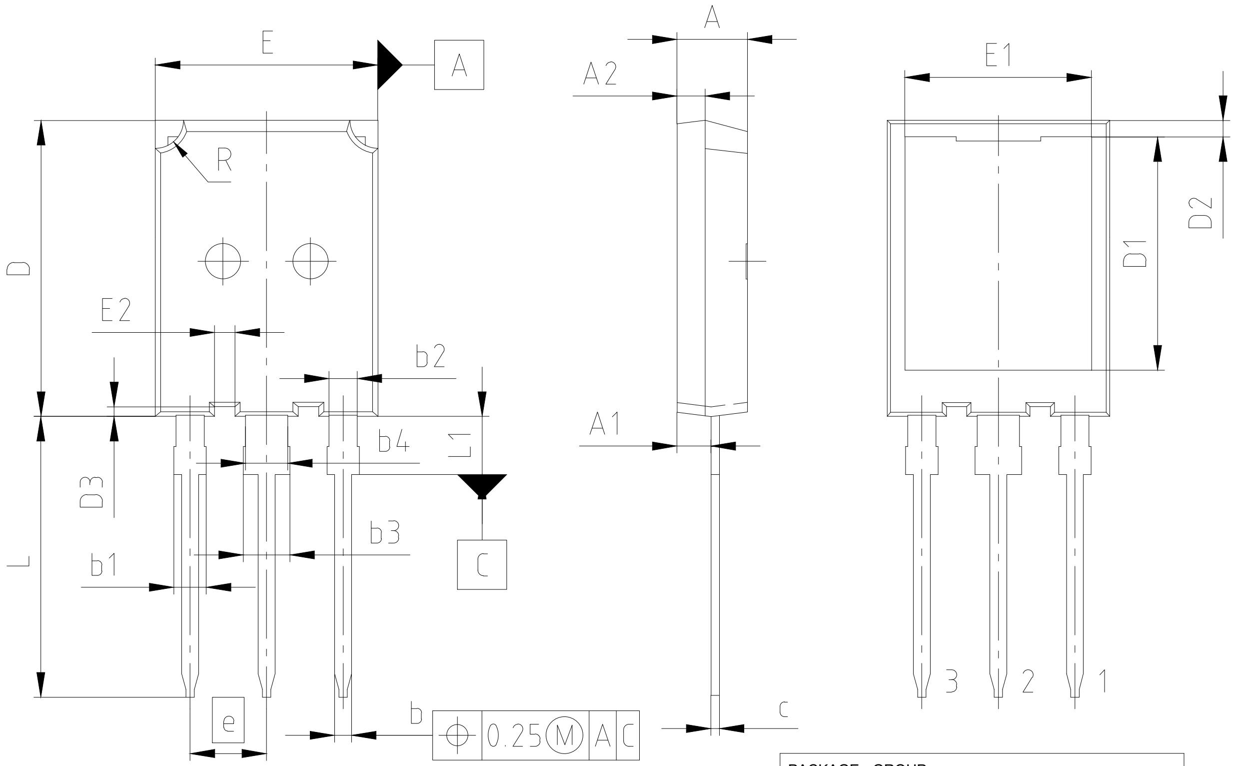
$di_F/dt = f(R_G)$

$V_R = 400$ V, $I_F = 120$ A



5 Package outlines

PG-TO247-3-PLUS-NN3.7



PACKAGE - GROUP NUMBER:	PG-TO247-3-U01	
DIMENSIONS	MILLIMETERS	
	MIN.	MAX.
A	4.90	5.10
A1	2.31	2.51
A2	1.90	2.10
b	1.16	1.26
b1	---	2.25
b2	1.96	2.06
b3	---	3.25
b4	2.96	3.06
c	0.59	0.66
D	20.90	21.10
D1	16.25	16.85
D2	1.05	1.35
D3	0.58	0.78
E	15.70	15.90
E1	13.10	13.50
E2	1.35	1.55
e	5.44 (BSC)	
N	3	
L	19.80	20.10
L1	3.90	4.30
R	1.90	2.10

NOTE:
DIMENSIONS DO NOT INCLUDE MOLDFLASH; PROTRUSION OR GATE BURRS

Figure 1

6 Testing conditions

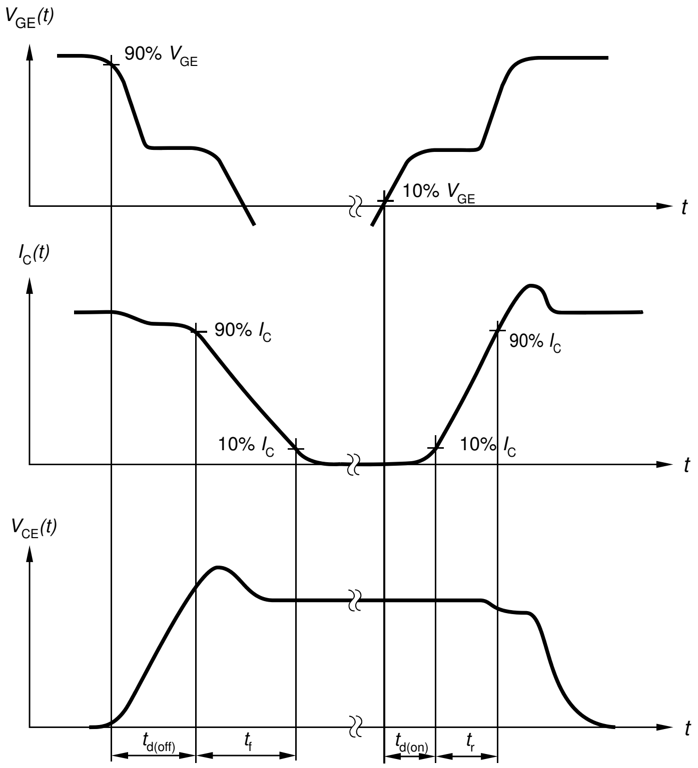


Figure A. **Definition of switching times**

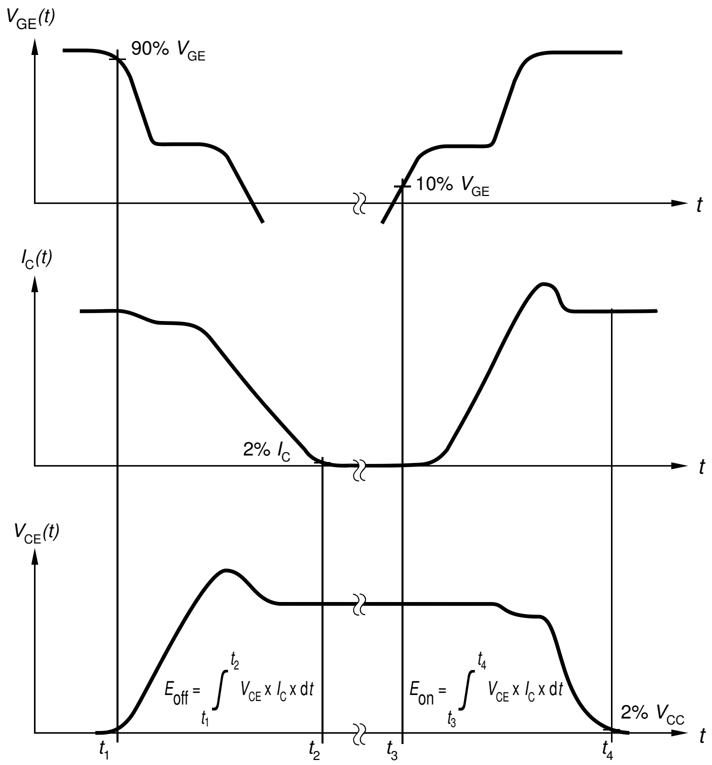


Figure B. **Definition of switching losses**

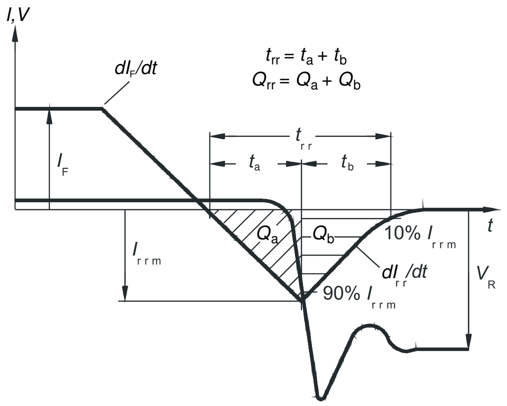


Figure C. **Definition of diode switching characteristics**

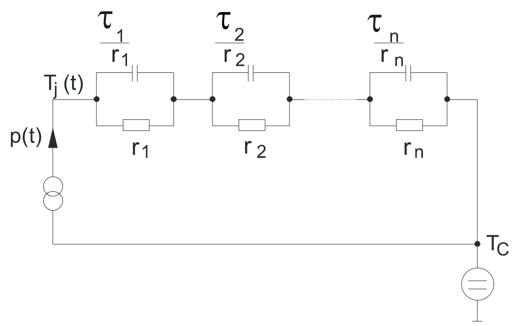


Figure D. **Thermal equivalent circuit**

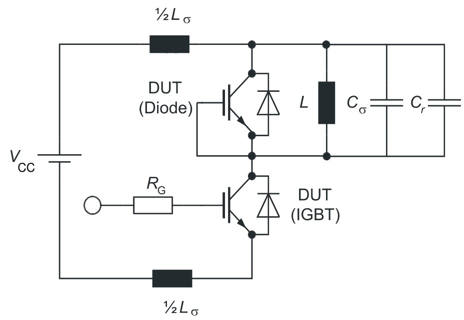


Figure E. **Dynamic test circuit**
Parasitic inductance L_σ,
parasitic capacitor C_σ,
relief capacitor C_r,
(only for ZVT switching)

Figure 2

Revision history

Document revision	Date of release	Description of changes
1.00	2023-01-24	Final datasheet
1.10	2023-04-27	Correction of switching values in Table 3 Update of diagrams t = f(R_G) and E = f(R_G)

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