

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

Features

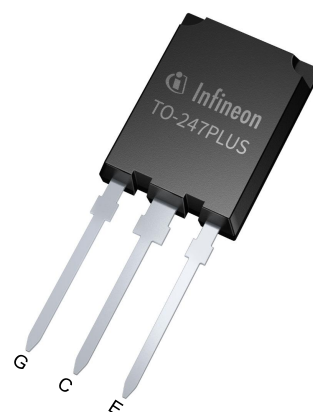
- $V_{CE} = 650\text{ V}$
- $I_C = 120\text{ A}$
- Low switching losses
- Very low collector-emitter saturation voltage V_{CEsat}
- Very soft, fast recovery antiparallel diode
- Smooth switching behavior
- Humidity robustness
- Optimized for hard switching, two- and three-level topologies
- Complete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

Potential applications

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

Product validation

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



Lead-free



Green

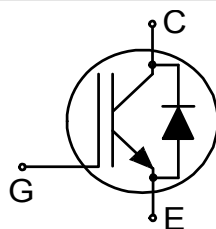


Halogen-free



RoHS

Description



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



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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}	$T_{vj} \geq 25\text{ °C}$		650	V
DC collector current, limited by T_{vjmax}	I_C	limited by bondwire	$T_c = 25\text{ °C}$	160	A
			$T_c = 100\text{ °C}$	136	
Pulsed collector current, t_p limited by T_{vjmax}	I_{Cpulse}			480	A
Turn-off safe operating area		$V_{CE} \leq 650\text{ V}$, $t_p \leq 1\text{ }\mu\text{s}$, $T_{vj} \leq 175\text{ °C}$		480	A
Gate-emitter voltage	V_{GE}			± 20	V
Transient gate-emitter voltage	V_{GE}	$t_p \leq 10\text{ }\mu\text{s}$, $D < 0.01$		± 30	V
Power dissipation	P_{tot}		$T_c = 25\text{ °C}$	498	W
			$T_c = 100\text{ °C}$	249	

Table 3 Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Collector-emitter saturation voltage	V_{CEsat}	$I_C = 120\text{ A}$, $V_{GE} = 15\text{ V}$	$T_{vj} = 25\text{ °C}$		1.4	1.65	V
			$T_{vj} = 175\text{ °C}$		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}	$I_C = 1.05 \text{ mA}$, $V_{CE} = V_{GE}$	2.9	3.85	4.8	V
Zero gate-voltage collector current	I_{CES}	$V_{CE} = 650 \text{ V}$, $V_{GE} = 0 \text{ V}$	$T_{vj} = 25^\circ\text{C}$		35	μA
			$T_{vj} = 175^\circ\text{C}$		5500	
Gate-emitter leakage current	I_{GES}	$V_{CE} = 0 \text{ V}$, $V_{GE} = 20 \text{ V}$			100	nA
Transconductance	g_{fs}	$I_C = 120 \text{ A}$, $V_{CE} = 20 \text{ V}$		148		S
Input capacitance	C_{ies}	$V_{CE} = 25 \text{ V}$, $V_{GE} = 0 \text{ V}$, $f = 100 \text{ kHz}$		6644		pF
Output capacitance	C_{oes}	$V_{CE} = 25 \text{ V}$, $V_{GE} = 0 \text{ V}$, $f = 100 \text{ kHz}$		197		pF
Reverse transfer capacitance	C_{res}	$V_{CE} = 25 \text{ V}$, $V_{GE} = 0 \text{ V}$, $f = 100 \text{ kHz}$		27.5		pF
Gate charge	Q_G	$V_{CC} = 520 \text{ V}$, $I_C = 120 \text{ A}$, $V_{GE} = 15 \text{ V}$		251		nC
Turn-on delay time	$t_{d(on)}$	$V_{CC} = 400 \text{ V}$, $V_{GE} = 0/15 \text{ V}$, $R_{G(on)} = 10 \Omega$, $R_{G(off)} = 10 \Omega$	$T_{vj} = 25^\circ\text{C}$, $I_C = 120 \text{ A}$		38	ns
			$T_{vj} = 175^\circ\text{C}$, $I_C = 120 \text{ A}$		38	
Rise time (inductive load)	t_r	$V_{CC} = 400 \text{ V}$, $V_{GE} = 0/15 \text{ V}$, $R_{G(on)} = 10 \Omega$, $R_{G(off)} = 10 \Omega$	$T_{vj} = 25^\circ\text{C}$, $I_C = 120 \text{ A}$		62	ns
			$T_{vj} = 175^\circ\text{C}$, $I_C = 120 \text{ A}$		62	
Turn-off delay time	$t_{d(off)}$	$V_{CC} = 400 \text{ V}$, $V_{GE} = 0/15 \text{ V}$, $R_{G(on)} = 10 \Omega$, $R_{G(off)} = 10 \Omega$	$T_{vj} = 25^\circ\text{C}$, $I_C = 120 \text{ A}$		287	ns
			$T_{vj} = 175^\circ\text{C}$, $I_C = 120 \text{ A}$		317	
Fall time (inductive load)	t_f	$V_{CC} = 400 \text{ V}$, $V_{GE} = 0/15 \text{ V}$, $R_{G(on)} = 10 \Omega$, $R_{G(off)} = 10 \Omega$	$T_{vj} = 25^\circ\text{C}$, $I_C = 120 \text{ A}$		98	ns
			$T_{vj} = 175^\circ\text{C}$, $I_C = 120 \text{ A}$		90	
Turn-on energy	E_{on}	$V_{CC} = 400 \text{ V}$, $V_{GE} = 0/15 \text{ V}$, $R_{G(on)} = 10 \Omega$, $R_{G(off)} = 10 \Omega$	$T_{vj} = 25^\circ\text{C}$, $I_C = 120 \text{ A}$		4.2	mJ
			$T_{vj} = 175^\circ\text{C}$, $I_C = 120 \text{ A}$		6.1	
Turn-off energy	E_{off}	$V_{CC} = 400 \text{ V}$, $V_{GE} = 0/15 \text{ V}$, $R_{G(on)} = 10 \Omega$, $R_{G(off)} = 10 \Omega$	$T_{vj} = 25^\circ\text{C}$, $I_C = 120 \text{ A}$		3.7	mJ
			$T_{vj} = 175^\circ\text{C}$, $I_C = 120 \text{ A}$		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}	$V_{CC} = 400\text{ V}$, $V_{GE} = 0/15\text{ V}$, $R_{G(on)} = 10\ \Omega$, $R_{G(off)} = 10\ \Omega$		7.9		mJ
				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	$T_c = 25\text{ °C}$	A
			$T_c = 100\text{ °C}$	
Diode pulsed current, t_p limited by T_{vjmax}	I_{Fpulse}		480	A
Power dissipation	P_{tot}	$T_c = 25\text{ °C}$	375	W
		$T_c = 100\text{ °C}$	188	

Table 5 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Diode forward voltage	V_F	$I_F = 120\text{ A}$		$T_{vj} = 25\text{ °C}$	1.65	V
				$T_{vj} = 175\text{ °C}$	1.55	
Diode reverse recovery time	t_{rr}	$V_R = 400\text{ V}$, $R_{G(on)} = 10\ \Omega$		$T_{vj} = 25\text{ °C}$, $I_F = 120\text{ A}$	82	ns
				$T_{vj} = 175\text{ °C}$, $I_F = 120\text{ A}$	154	
Diode reverse recovery charge	Q_{rr}	$V_R = 400\text{ V}$, $R_{G(on)} = 10\ \Omega$		$T_{vj} = 25\text{ °C}$, $I_F = 120\text{ A}$	2.4	μC
				$T_{vj} = 175\text{ °C}$, $I_F = 120\text{ A}$	6.7	
Diode peak reverse recovery current	I_{rrm}	$V_R = 400\text{ V}$, $R_{G(on)} = 10\ \Omega$		$T_{vj} = 25\text{ °C}$, $I_F = 120\text{ A}$	44.5	A
				$T_{vj} = 175\text{ °C}$, $I_F = 120\text{ A}$	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	$V_R = 400 \text{ V}, R_{G(on)} = 10 \text{ } \Omega$		$T_{vj} = 25 \text{ } ^\circ\text{C}, I_F = 120 \text{ A}$	-2320	A/ μs
				$T_{vj} = 175 \text{ } ^\circ\text{C}, I_F = 120 \text{ A}$	-2440	
Reverse recovery energy	E_{rec}	$V_R = 400 \text{ V}, R_{G(on)} = 10 \text{ } \Omega$		$T_{vj} = 25 \text{ } ^\circ\text{C}, I_F = 120 \text{ A}$	0.46	mJ
				$T_{vj} = 175 \text{ } ^\circ\text{C}, I_F = 120 \text{ A}$	1.38	
Operating junction temperature	T_{vj}		-40		175	$^\circ\text{C}$

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 $T_{vj} = 25^\circ\text{C}$, unless otherwise specified.

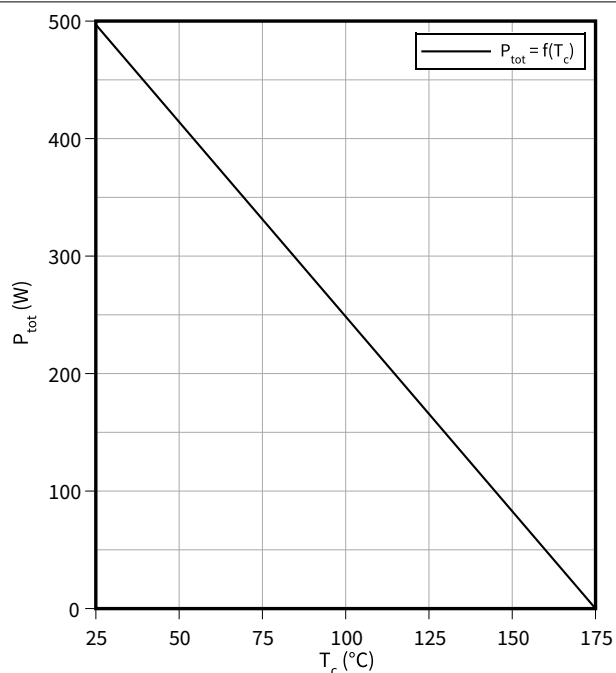
Dynamic test circuit, parasitic inductance $L_\sigma = 8 \text{ nH}$, parasitic capacitor $C_\sigma = 30 \text{ pF}$ from Fig. E. Energy losses include "tail" and diode reverse recovery.

4 Characteristics diagrams

Power dissipation as a function of case temperature

$$P_{\text{tot}} = f(T_c)$$

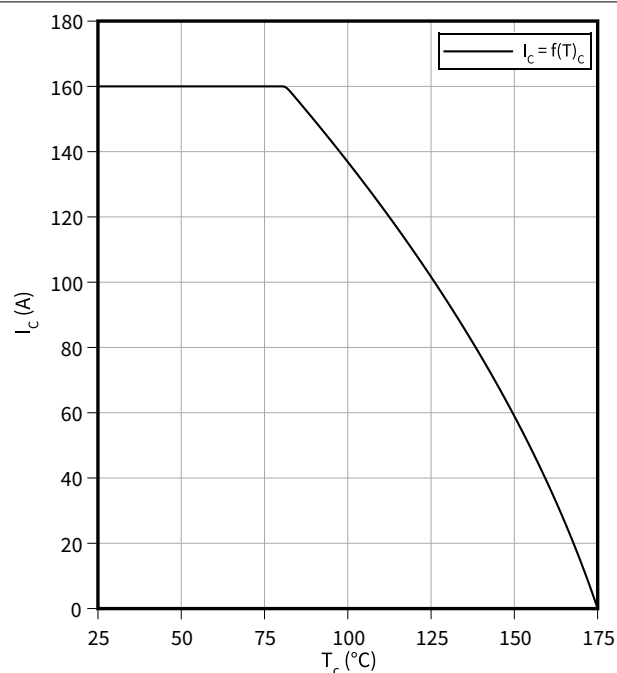
$$T_{vj} \leq 175^\circ\text{C}$$



Collector current as a function of case temperature

$$I_c = f(T_c)$$

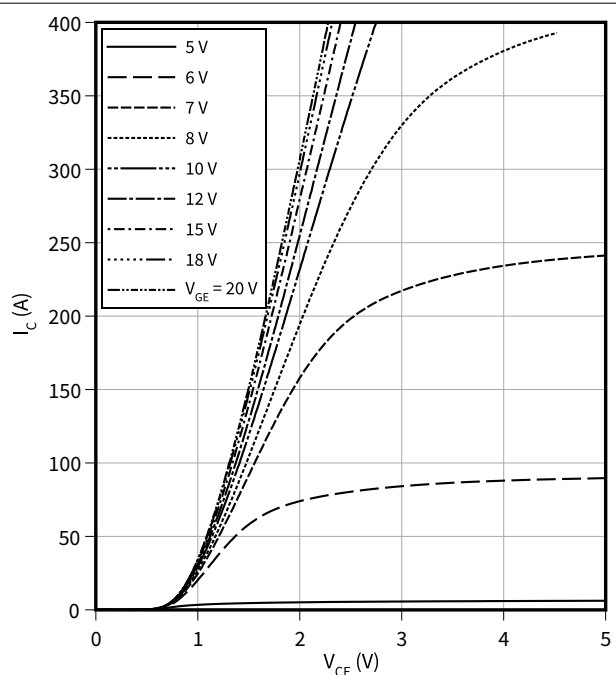
$$T_{vj} \leq 175^\circ\text{C}, V_{GE} \geq 15\text{ V}$$



Typical output characteristic

$$I_c = f(V_{CE})$$

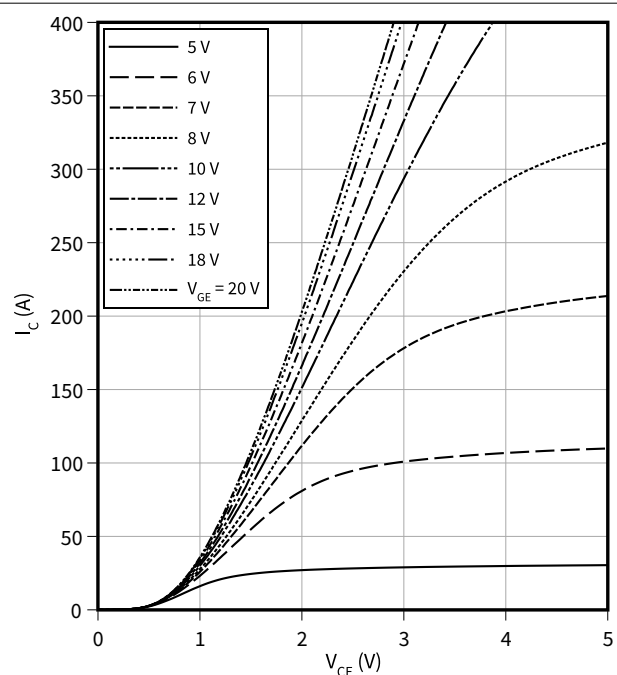
$$T_{vj} = 25^\circ\text{C}$$



Typical output characteristic

$$I_c = f(V_{CE})$$

$$T_{vj} = 175^\circ\text{C}$$

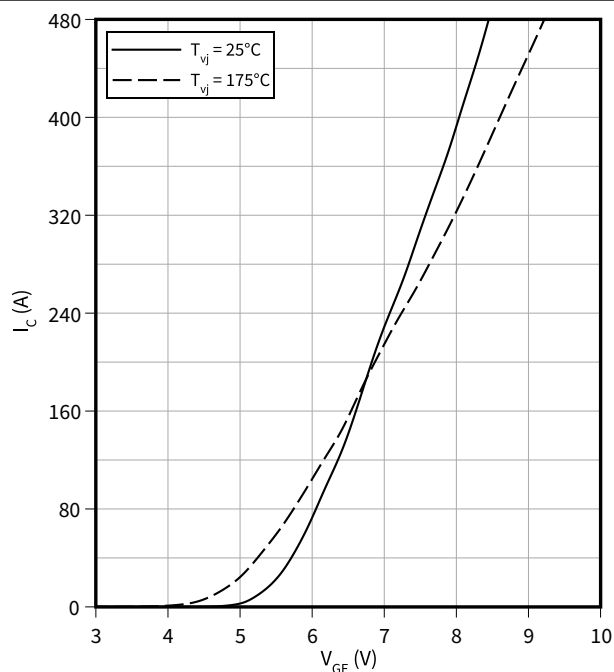


4 Characteristics diagrams

Typical transfer characteristic

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

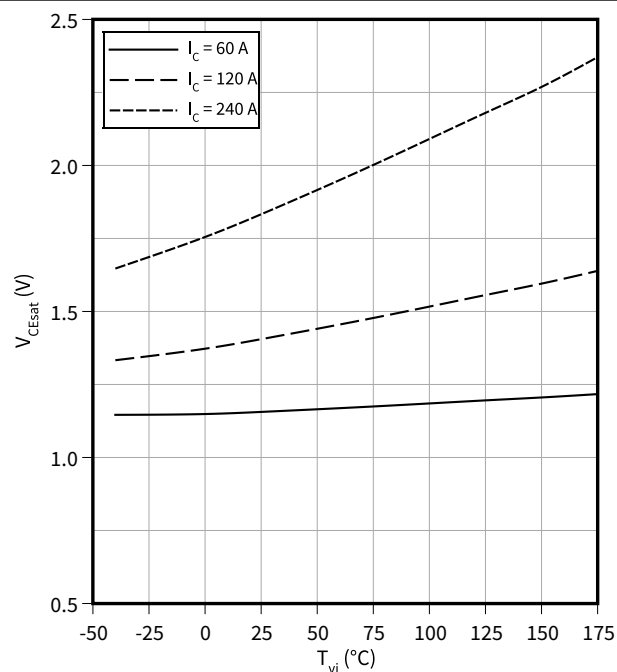
$$V_{CE} = 20 \text{ V}$$



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

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

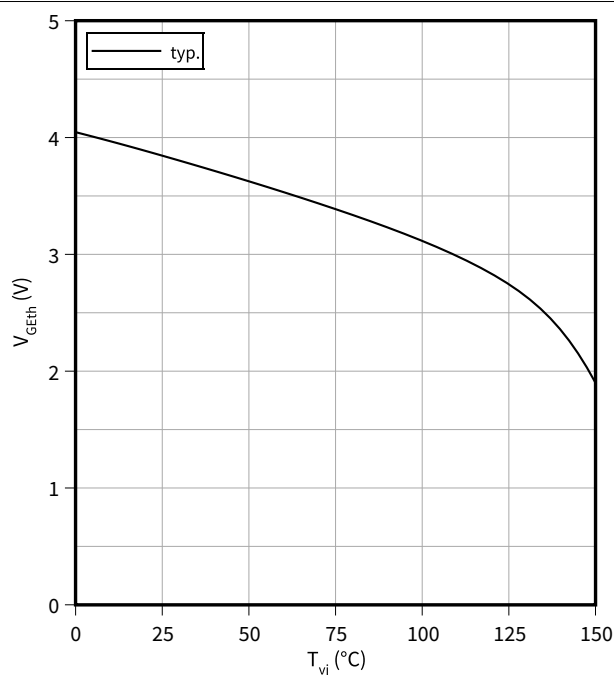
$$V_{GE} = 15 \text{ V}$$



Gate-emitter threshold voltage as a function of junction temperature

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

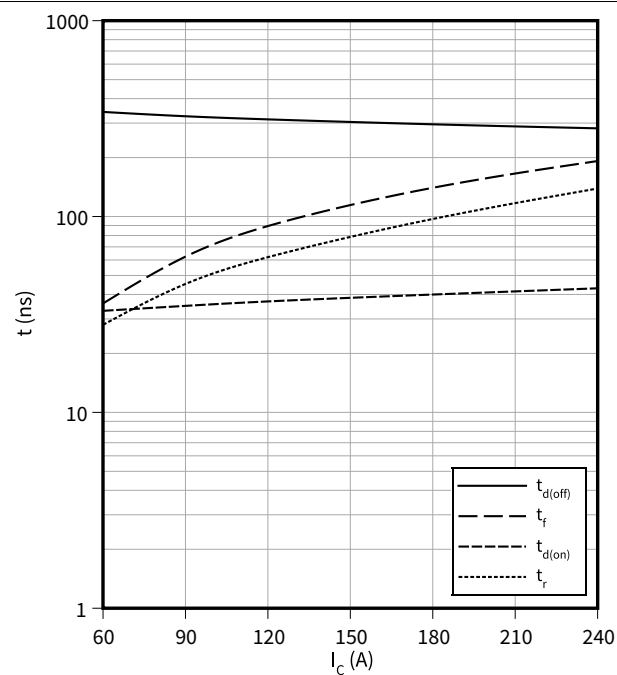
$$I_C = 1.05 \text{ mA}$$



Typical switching times as a function of collector current

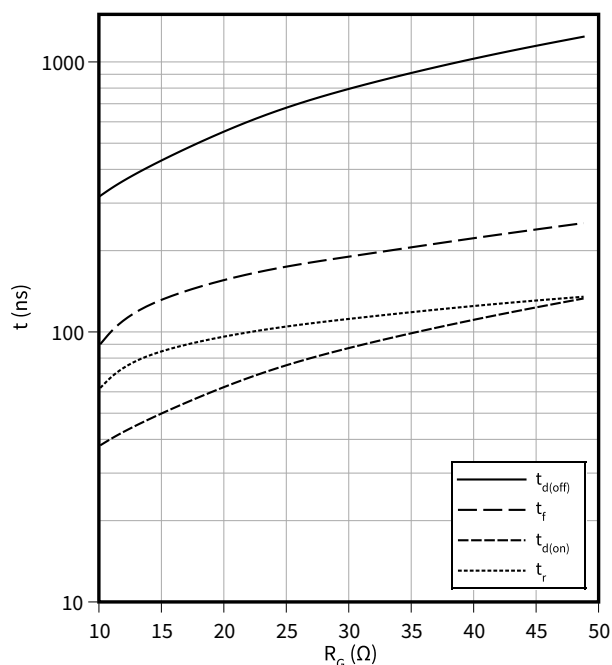
$$t = f(I_C)$$

$$V_{CC} = 400 \text{ V}, T_{vj} = 175^\circ\text{C}, V_{GE} = 0/15 \text{ V}, R_G = 10 \Omega$$

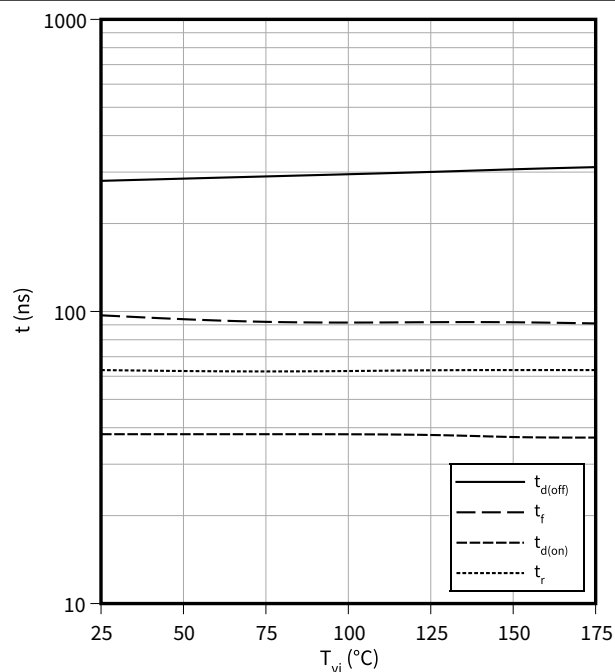


Typical switching times as a function of gate resistor

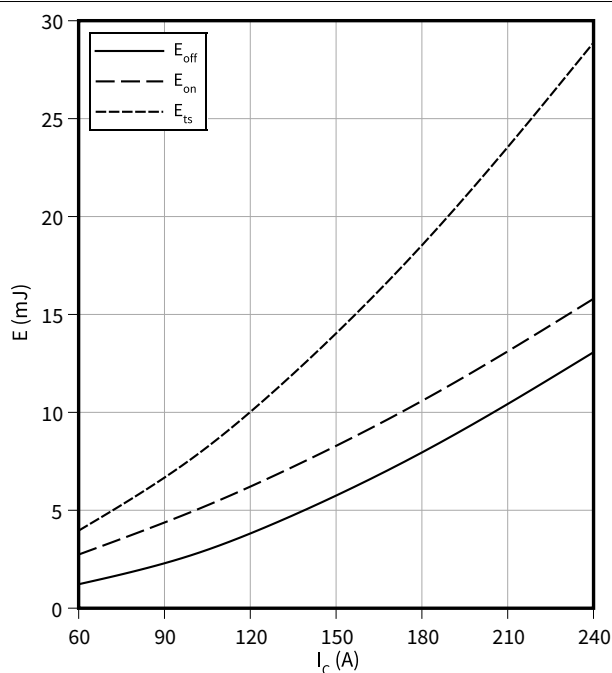
$$t = f(R_G)$$

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

Typical switching times as a function of junction temperature

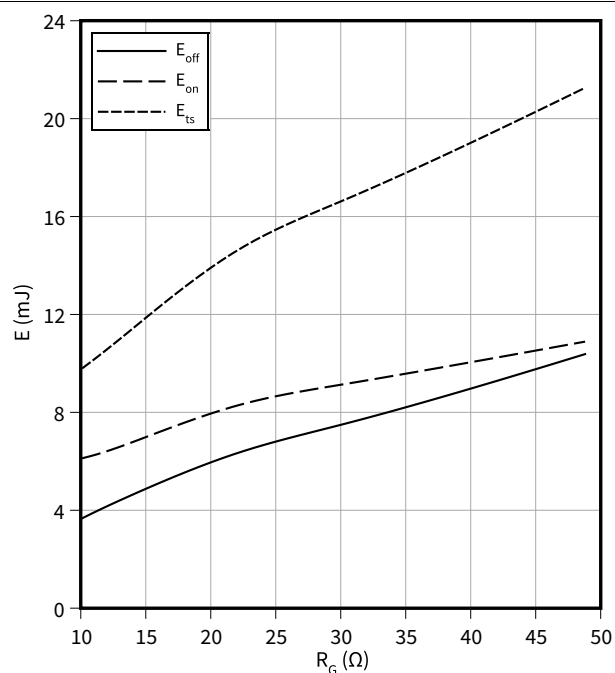
$$t = f(T_{vj})$$

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

Typical switching energy losses as a function of collector current

$$E = f(I_C)$$

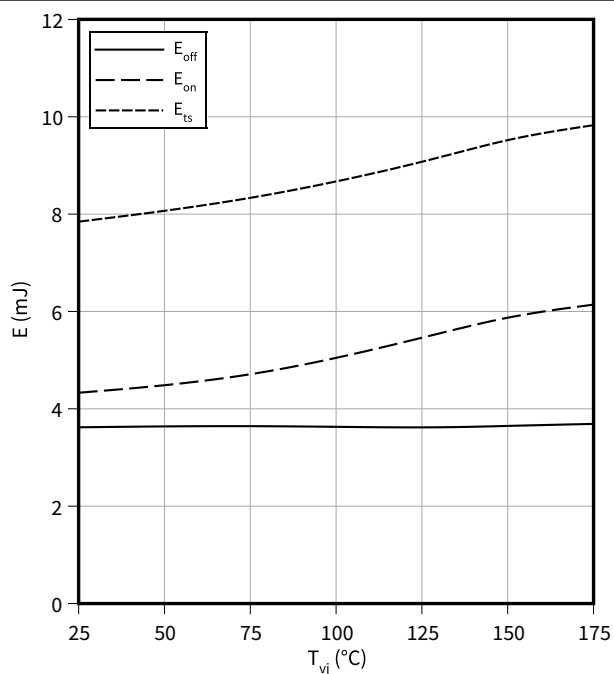
 $V_{CC} = 400 \text{ V}, T_{vj} = 175 \text{ °C}, V_{GE} = 0/15 \text{ V}, R_G = 10 \text{ Ω}$

Typical switching energy losses as a function of gate resistor

$$E = f(R_G)$$

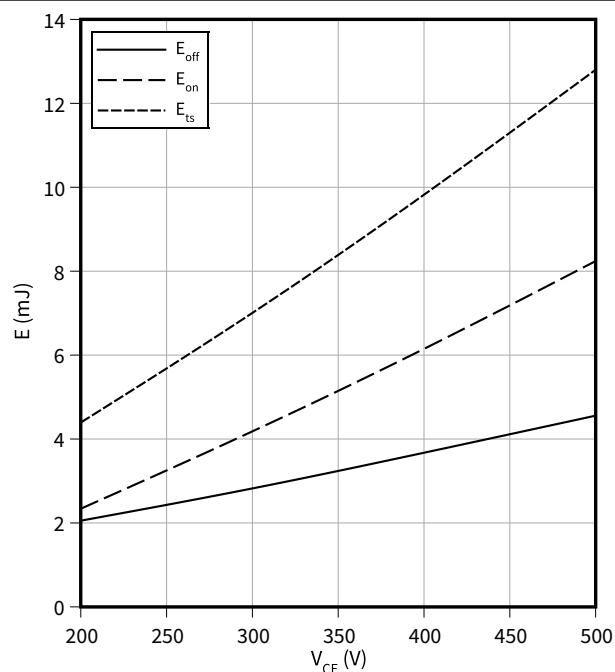
 $I_C = 120 \text{ A}, V_{CC} = 400 \text{ V}, T_{vj} = 175 \text{ °C}, V_{GE} = 0/15 \text{ V}$


Typical switching energy losses as a function of junction temperature

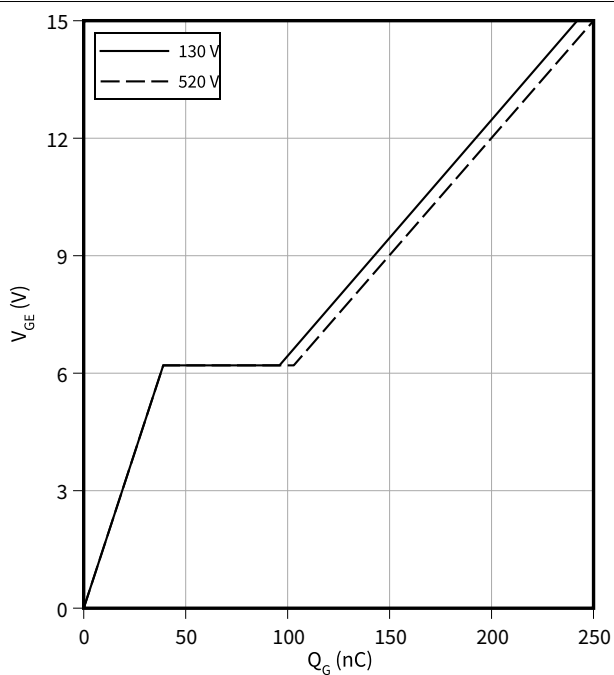
$$E = f(T_{vj})$$

 $I_C = 120 \text{ A}, V_{CC} = 400 \text{ V}, V_{GE} = 0/15 \text{ V}, R_G = 10 \Omega$

Typical switching energy losses as a function of collector emitter voltage

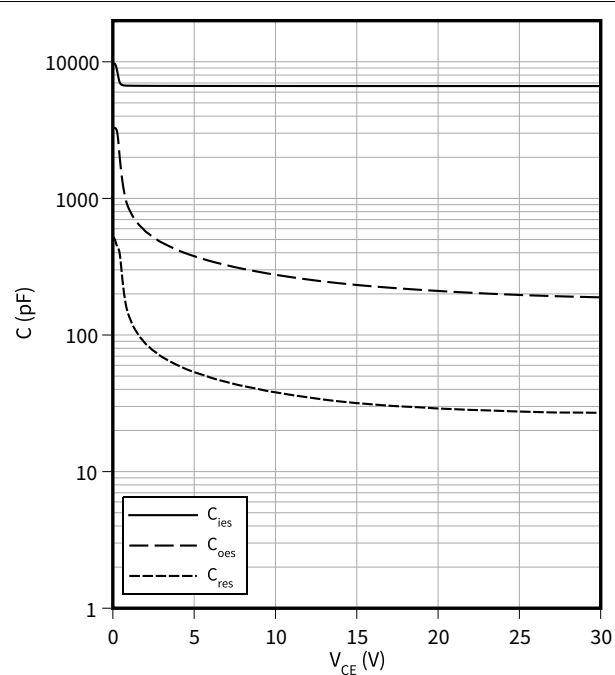
$$E = f(V_{CE})$$

 $I_C = 120 \text{ A}, T_{vj} = 175 \text{ }^\circ\text{C}, V_{GE} = 0/15 \text{ V}, R_G = 10 \Omega$

Typical gate charge

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

 $I_C = 120 \text{ A}$

Typical capacitance as a function of collector-emitter voltage

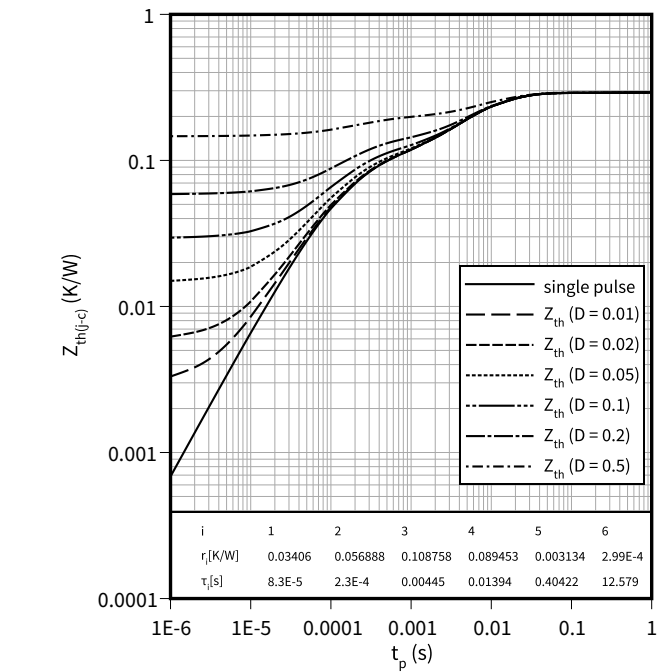
$$C = f(V_{CE})$$

 $f = 100 \text{ kHz}, V_{GE} = 0 \text{ V}$


IGBT transient thermal impedance as a function of pulse width

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

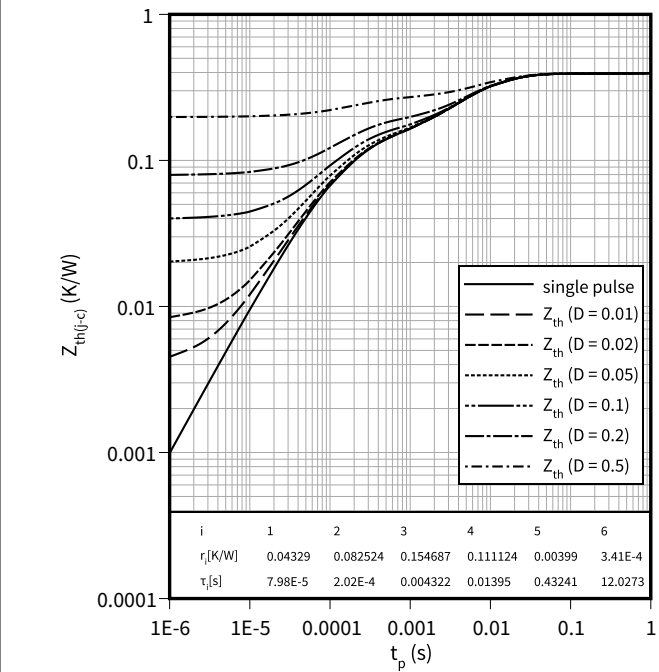
$$D = t_p/T$$



Diode transient thermal impedance as a function of pulse width

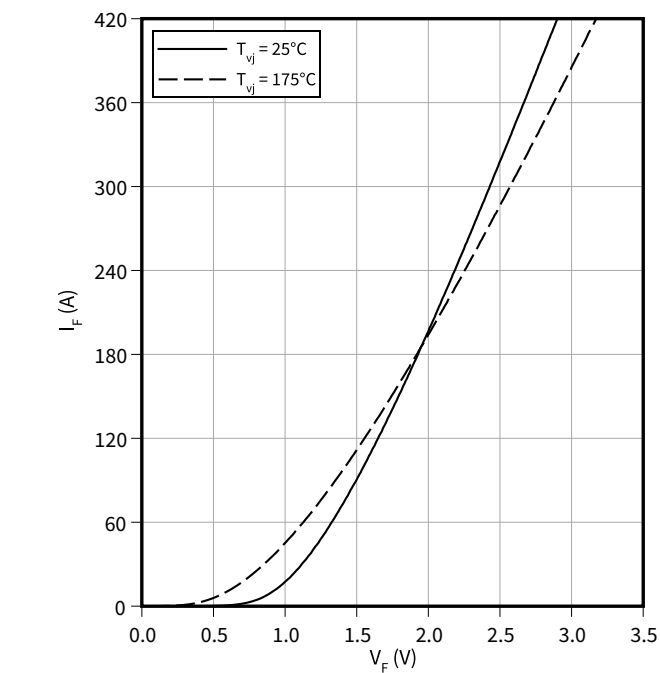
$$Z_{th(j-c)} = f(t_p)$$

$$D = t_p/T$$



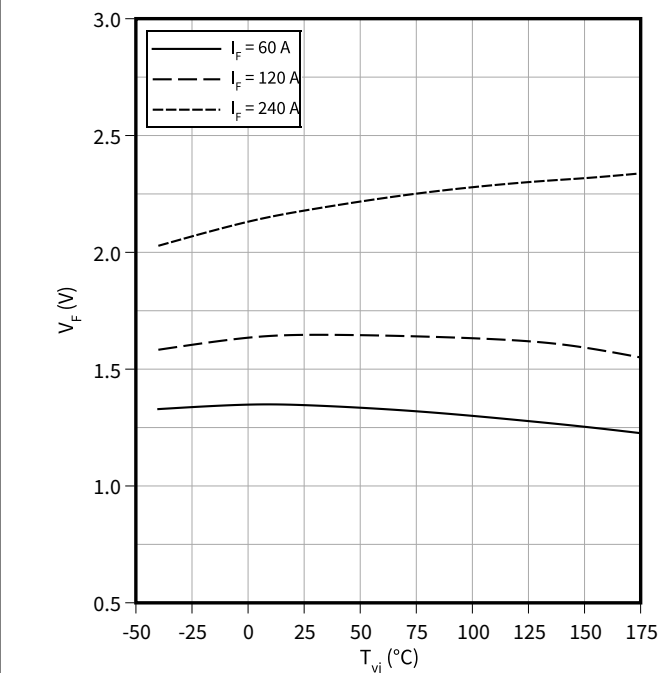
Typical diode forward current as a function of forward voltage

$$I_F = f(V_F)$$



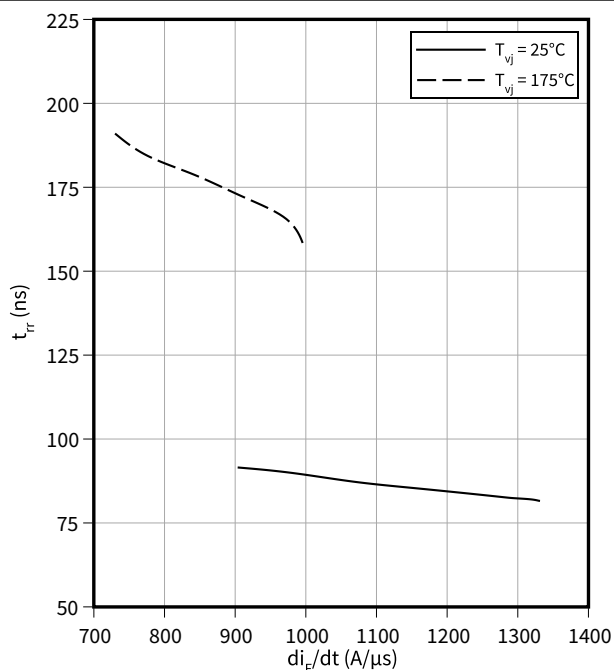
Typical diode forward voltage as a function of junction temperature

$$V_F = f(T_{vj})$$

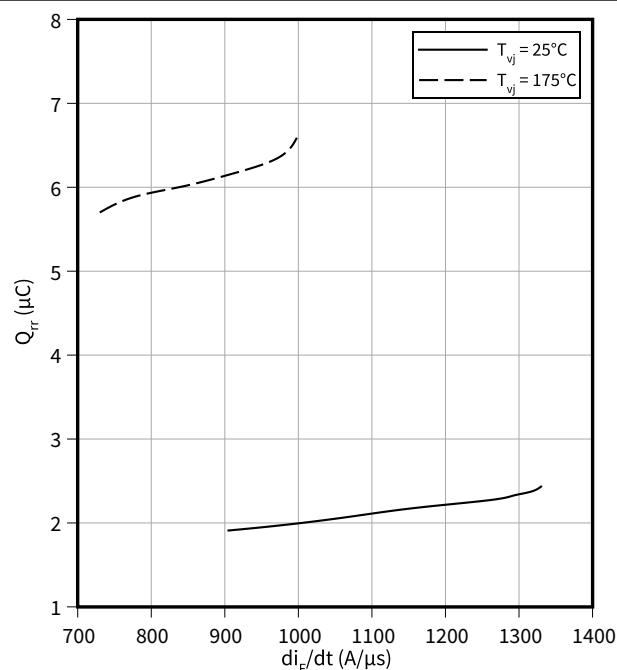


Typical reverse recovery time as a function of diode current slope

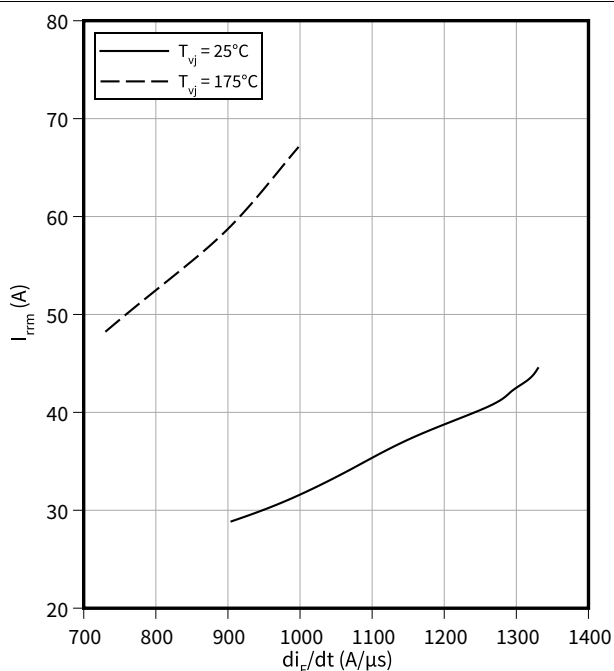
$$t_{rr} = f(di_F/dt)$$

 $V_R = 400 \text{ V}, I_F = 120 \text{ A}$

Typical reverse recovery charge as a function of diode current slope

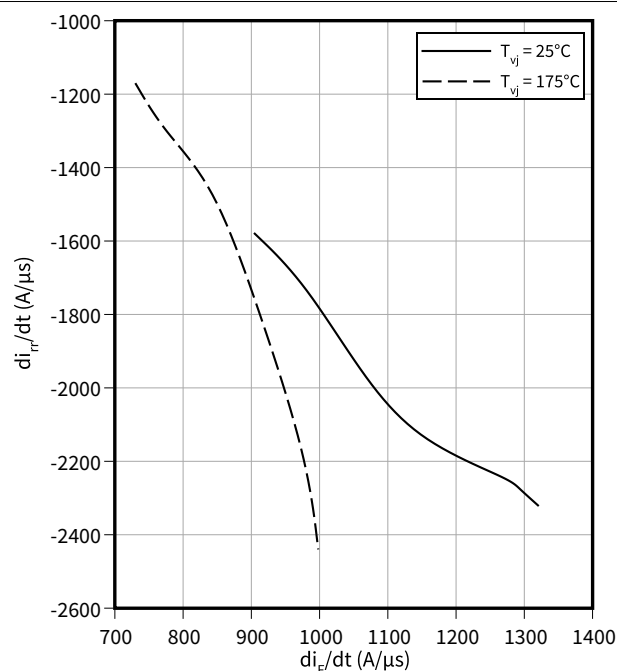
$$Q_{rr} = f(di_F/dt)$$

 $V_R = 400 \text{ V}, I_F = 120 \text{ A}$

Typical reverse recovery current as a function of diode current slope

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

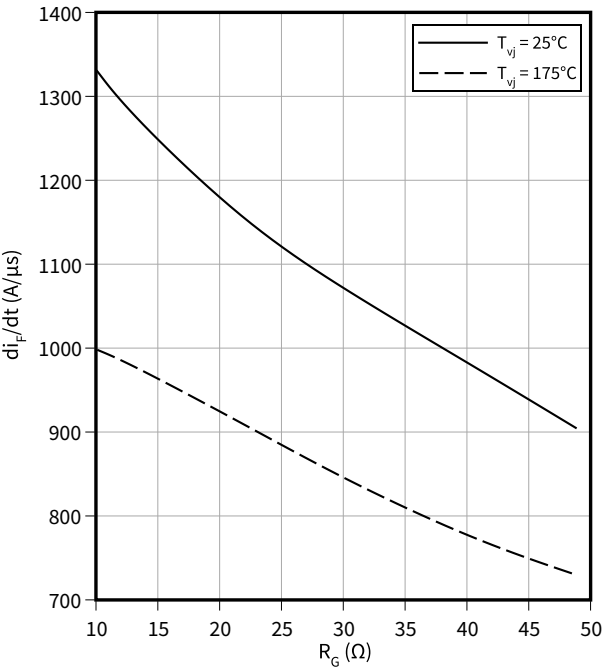
 $V_R = 400 \text{ V}, I_F = 120 \text{ A}$

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

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

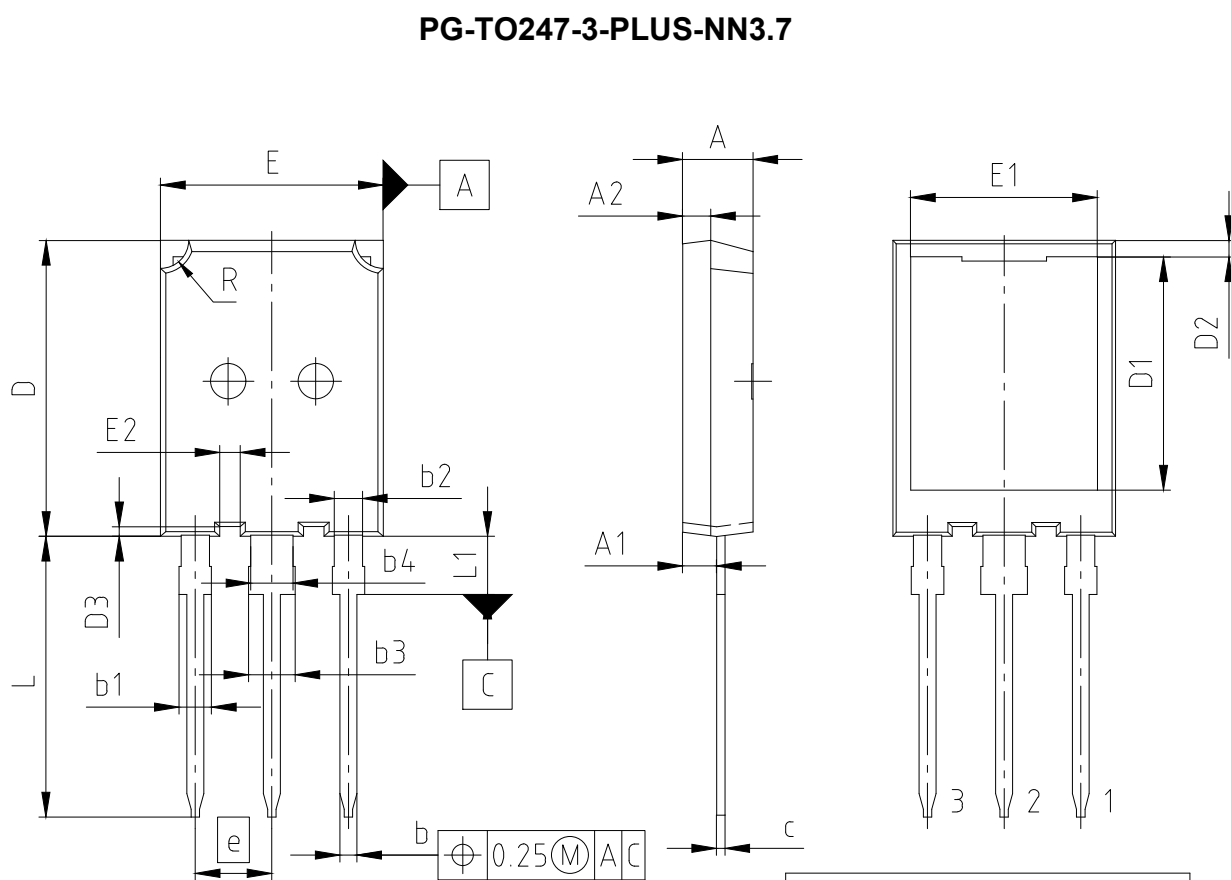
 $V_R = 400 \text{ V}, I_F = 120 \text{ A}$


Typical diode current slope as a function of gate resistor

$di_F/dt = f(R_G)$
 $V_R = 400\text{ V}, I_F = 120\text{ A}$



5 Package outlines



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

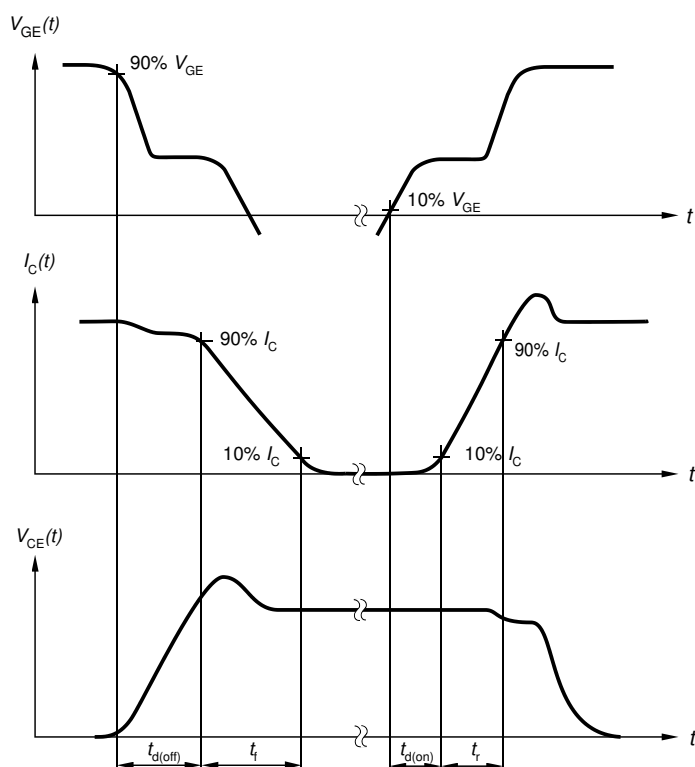


Figure A. Definition of switching times

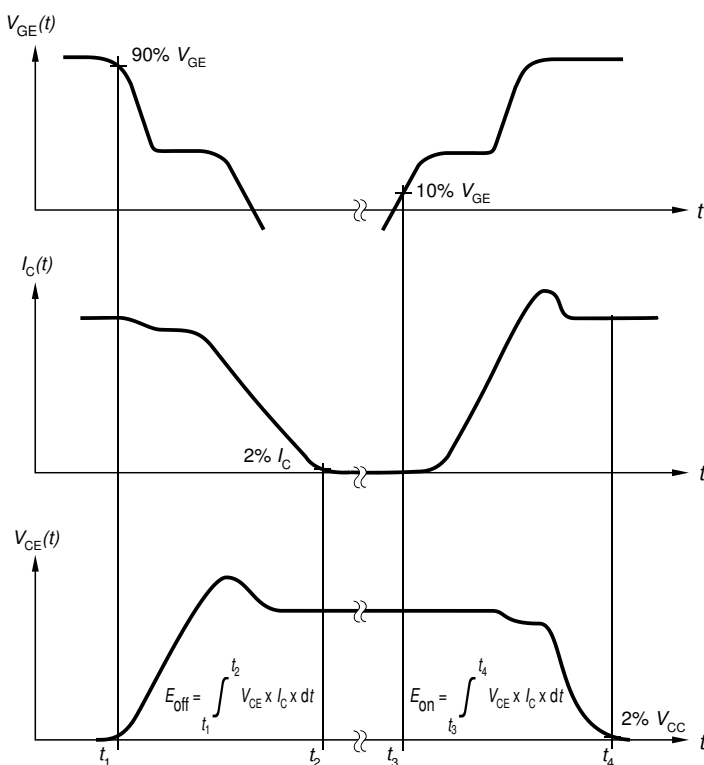


Figure B. Definition of switching losses

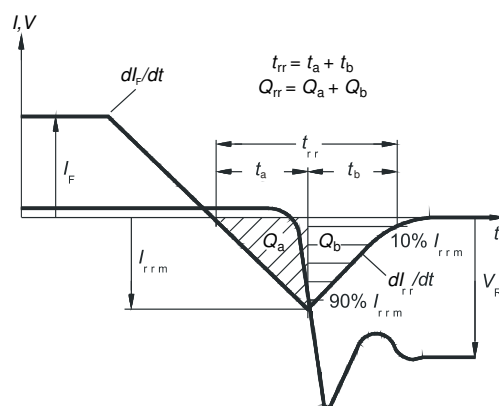


Figure C. Definition of diode switching characteristics

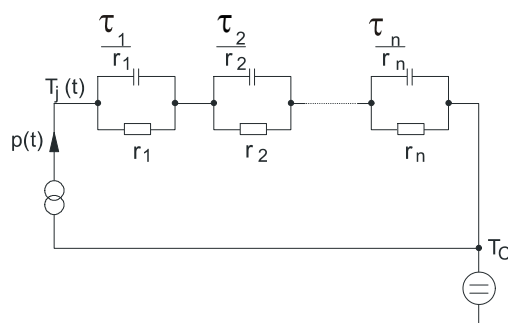


Figure D. Thermal equivalent circuit

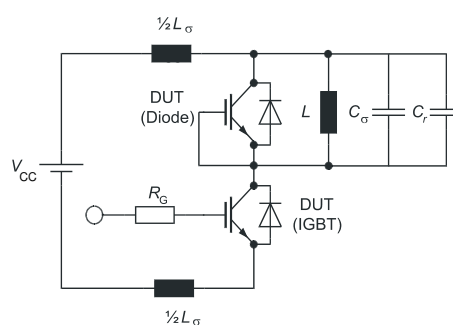


Figure E. **Dynamic test circuit**
Parasitic inductance L_σ ,
parasitic capacitor C_σ ,
relief capacitor C_r ,
(only for ZVT switching)

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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