

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

Features

- VCE = 650 V
• IC = 40 A
• Low switching losses
• Very low collector-emitter saturation voltage VCEsat
• 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

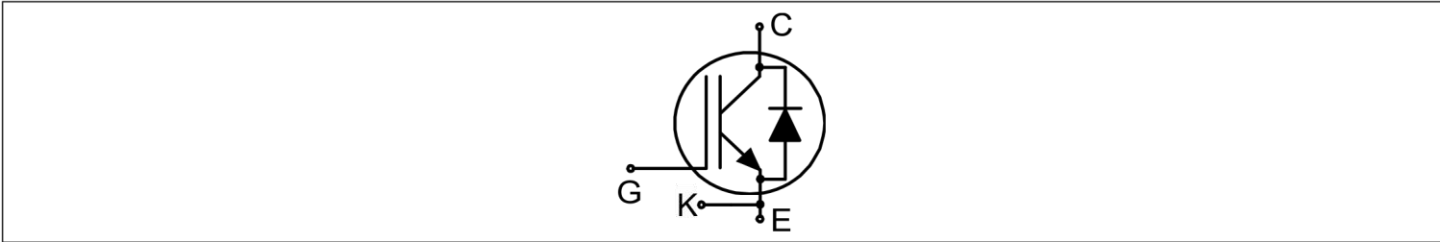


Table with 3 columns: Type, Package, Marking. Row 1: IKZA40N65EH7, PG-TO247-4-STD-NT3.7, K40EEH7

Datasheet Please read the sections "Important notice" and "Warnings" at the end of this document www.infineon.com
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Table of contents

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1 Package
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 process: 3			0.6	Nm
Thermal resistance, junction-ambient	$R_{th(j-a)}$				40	K/W
IGBT thermal resistance, junction-case	$R_{th(j-c)}$			0.54	0.71	K/W
Diode thermal resistance, junction-case	$R_{th(j-c)}$			0.72	0.94	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	$T_c = 25\text{ °C}$	80	A
			$T_c = 100\text{ °C}$	64	
				160	A
Pulsed collector current, t_p limited by T_{vjmax}	I_{Cpulse}				
Turn-off safe operating area		$V_{CE} \leq 650\text{ V}$, $t_p \leq 1\text{ }\mu\text{s}$, $T_{vj} \leq 175\text{ °C}$		160	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}	$T_c = 25\text{ °C}$		210	W
		$T_c = 100\text{ °C}$		105	

Table 3 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	

Collector-emitter saturation voltage	VCEsat	IC = 40 A, VGE = 15 V	Tvj = 25 °C		1.4	1.65	V
			Tvj = 175 °C		1.6		

(table continues...)

(continued) Characteristic values

2 IGBT

Table 3

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Gate-emitter threshold voltage	V_{GEth}	$I_C = 0.35 \text{ mA}$, $V_{CE} = V_{GE}$		2.9	3.85	4.8	V
Zero gate-voltage collector current	I_{CES}	$V_{CE} = 650 \text{ V}$, $V_{GE} = 0 \text{ V}$	$T_{vj} = 25 \text{ °C}$			10	μA
			$T_{vj} = 175 \text{ °C}$		1200		
Gate-emitter leakage current	I_{GES}	$V_{CE} = 0 \text{ V}$, $V_{GE} = 20 \text{ V}$				100	nA
Transconductance	g_{fs}	$I_C = 40 \text{ A}$, $V_{CE} = 20 \text{ V}$			67		S
Input capacitance	C_{ies}	$V_{CE} = 25 \text{ V}$, $V_{GE} = 0 \text{ V}$, $f = 100 \text{ kHz}$			2026		pF
Output capacitance	C_{oes}	$V_{CE} = 25 \text{ V}$, $V_{GE} = 0 \text{ V}$, $f = 100 \text{ kHz}$			71.4		pF
Reverse transfer capacitance	C_{res}	$V_{CE} = 25 \text{ V}$, $V_{GE} = 0 \text{ V}$, $f = 100 \text{ kHz}$			9.1		pF
Gate charge	Q_G	$V_{CC} = 520 \text{ V}$, $I_C = 40 \text{ A}$, $V_{GE} = 15 \text{ V}$			81		nC
Turn-on delay time	$t_{d(on)}$	$V_{CC} = 400 \text{ V}$, $V_{GE} = 0/15 \text{ V}$, $R_{G(on)} = 12.5 \text{ }\Omega$, $R_{G(off)} = 12.5 \text{ }\Omega$	$T_{vj} = 25 \text{ °C}$, $I_C = 40 \text{ A}$		13		ns
			$T_{vj} = 175 \text{ °C}$, $I_C = 40 \text{ A}$		13		
Rise time (inductive load)	t_r	$V_{CC} = 400 \text{ V}$, $V_{GE} = 0/15 \text{ V}$, $R_{G(on)} = 12.5 \text{ }\Omega$, $R_{G(off)} = 12.5 \text{ }\Omega$	$T_{vj} = 25 \text{ °C}$, $I_C = 40 \text{ A}$		8		ns
			$T_{vj} = 175 \text{ °C}$, $I_C = 40 \text{ A}$		11		
Turn-off delay time	$t_{d(off)}$	$V_{CC} = 400 \text{ V}$, $V_{GE} = 0/15 \text{ V}$, $R_{G(on)} = 12.5 \text{ }\Omega$, $R_{G(off)} = 12.5 \text{ }\Omega$	$T_{vj} = 25 \text{ °C}$, $I_C = 40 \text{ A}$		134		ns
			$T_{vj} = 175 \text{ °C}$, $I_C = 40 \text{ A}$		168		
Fall time (inductive load)	t_f	$V_{CC} = 400 \text{ V}$, $V_{GE} = 0/15 \text{ V}$, $R_{G(on)} = 12.5 \text{ }\Omega$, $R_{G(off)} = 12.5 \text{ }\Omega$	$T_{vj} = 25 \text{ °C}$, $I_C = 40 \text{ A}$		13		ns
			$T_{vj} = 175 \text{ °C}$, $I_C = 40 \text{ A}$		17		
Turn-on energy	E_{on}	$V_{CC} = 400 \text{ V}$, $V_{GE} = 0/15 \text{ V}$, $R_{G(on)} = 12.5 \text{ }\Omega$, $R_{G(off)} = 12.5 \text{ }\Omega$	$T_{vj} = 25 \text{ °C}$, $I_C = 40 \text{ A}$		0.37		mJ
			$T_{vj} = 175 \text{ °C}$, $I_C = 40 \text{ A}$		0.65		

(continued) Characteristic values

Turn-off energy	E_{off}	$V_{CC} = 400 \text{ V}$, $V_{GE} = 0/15 \text{ V}$, $R_{G(on)} = 12.5 \Omega$, $R_{G(off)} = 12.5 \Omega$	$T_{vj} = 25 \text{ }^{\circ}\text{C}$, $I_C = 40 \text{ A}$		0.36		mJ
			$T_{vj} = 175 \text{ }^{\circ}\text{C}$, $I_C = 40 \text{ A}$		0.77		

(table continues...)

3 Diode
Table 3

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Total switching energy	E_{ts}	$V_{CC} = 400 \text{ V}$, $V_{GE} = 0/15 \text{ V}$, $R_{G(on)} = 12.5 \Omega$, $R_{G(off)} = 12.5 \Omega$	$T_{vj} = 25 \text{ }^{\circ}\text{C}$, $I_C = 40 \text{ A}$	0.73		mJ
			$T_{vj} = 175 \text{ }^{\circ}\text{C}$, $I_C = 40 \text{ A}$	1.42		
Operating junction temperature	T_{vj}		-40		175	$^{\circ}\text{C}$

3 Diode
Table 4 Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit
Diode forward current, limited by T_{vjmax}	I_F	$T_c = 25 \text{ }^{\circ}\text{C}$	76	A
		$T_c = 100 \text{ }^{\circ}\text{C}$	49	
Diode pulsed current, t_p limited by T_{vjmax}	I_{Fpulse}		160	A
Power dissipation	P_{tot}	$T_c = 25 \text{ }^{\circ}\text{C}$	159	W
		$T_c = 100 \text{ }^{\circ}\text{C}$	80	

Table 5 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Diode forward voltage	V_F	$I_F = 40 \text{ A}$	$T_{vj} = 25 \text{ }^{\circ}\text{C}$	1.65	2	V
			$T_{vj} = 175 \text{ }^{\circ}\text{C}$	1.55		
Diode reverse recovery time	t_{rr}	$V_R = 400 \text{ V}$, $R_{G(on)} = 12.5 \Omega$	$T_{vj} = 25 \text{ }^{\circ}\text{C}$, $I_F = 40 \text{ A}$	49.6		ns
			$T_{vj} = 175 \text{ }^{\circ}\text{C}$, $I_F = 40 \text{ A}$	80		

(continued) Characteristic values

Diode reverse recovery charge	Q_{rr}	$V_R = 400 \text{ V},$ $R_{G(on)} = 12.5 \Omega$	$T_{vj} = 25 \text{ }^\circ\text{C},$ $I_F = 40 \text{ A}$		1.09		μC
			$T_{vj} = 175 \text{ }^\circ\text{C},$ $I_F = 40 \text{ A}$		2.75		
Diode peak reverse recovery current	I_{rrm}	$V_R = 400 \text{ V},$ $R_{G(on)} = 12.5 \Omega$	$T_{vj} = 25 \text{ }^\circ\text{C},$ $I_F = 40 \text{ A}$		38		A
			$T_{vj} = 175 \text{ }^\circ\text{C},$ $I_F = 40 \text{ A}$		64.6		

(table continues...)
3 Diode
Table 5

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Diode peak rate of fall of reverse recovery current	di_{rr}/dt	$V_R = 400 \text{ V},$ $R_{G(on)} = 12.5 \Omega$	$T_{vj} = 25 \text{ }^\circ\text{C},$ $I_F = 40 \text{ A}$		-1340		A/ μs
			$T_{vj} = 175 \text{ }^\circ\text{C},$ $I_F = 40 \text{ A}$		-1460		
Reverse recovery energy	E_{rec}	$V_R = 400 \text{ V},$ $R_{G(on)} = 12.5 \Omega$	$T_{vj} = 25 \text{ }^\circ\text{C},$ $I_F = 40 \text{ A}$		0.3		mJ
			$T_{vj} = 175 \text{ }^\circ\text{C},$ $I_F = 40 \text{ A}$		0.78		
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

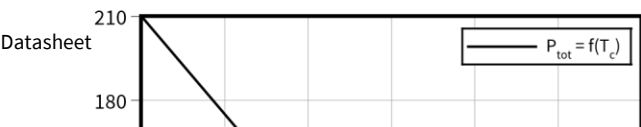
Characteristics diagrams





Power dissipation as a function of case temperature

$P_{\text{tot}} = f(T_c)$
 $T_{vj} \leq 175\text{ °C}$



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Collector current as a function of case temperature

$I_C = f(T_c)$
 $T_{vj} \leq 175\text{ °C}, V_{GE} \geq 15\text{ V}$

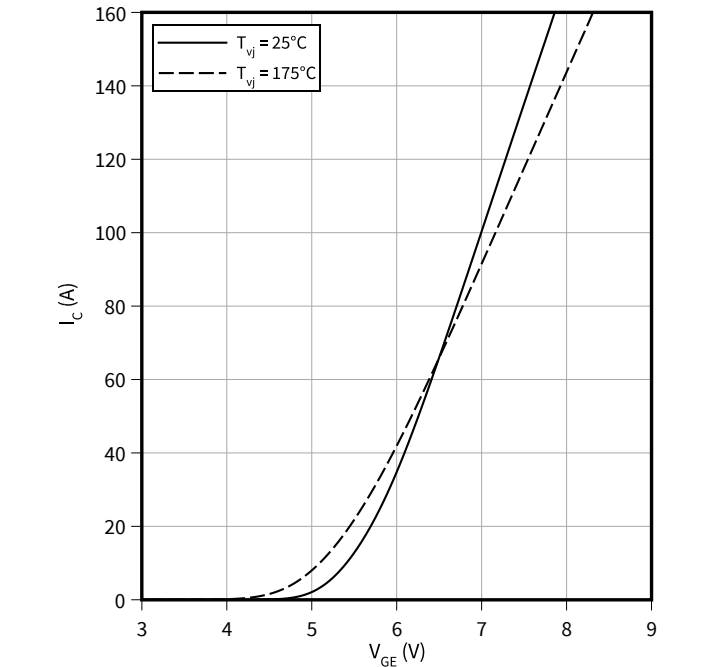


Revision 1.00
2023-04-27

Typical transfer characteristic

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

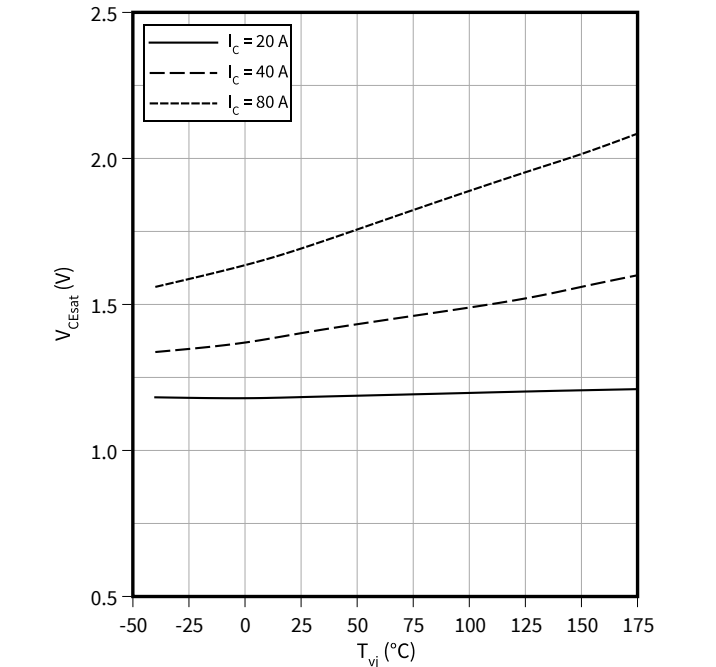
$$V_{CE} = 20\text{ V}$$



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

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

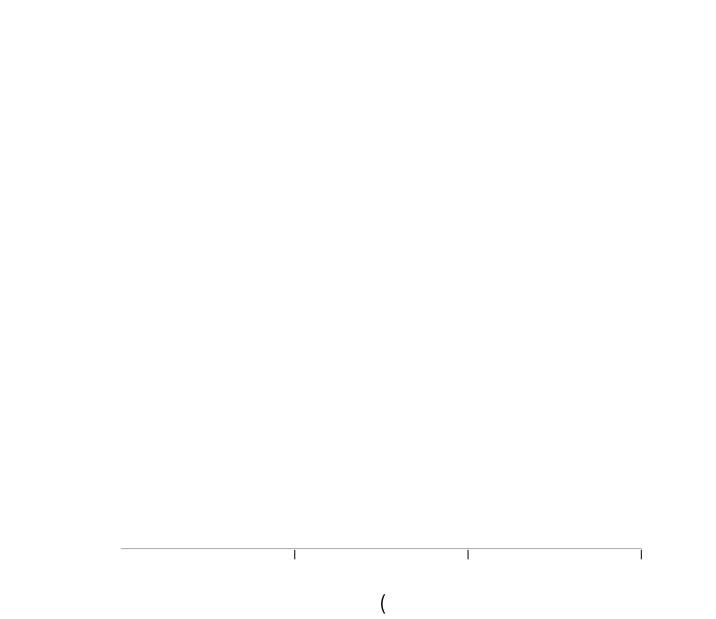
$$V_{GE} = 15\text{ V}$$



Gate-emitter threshold voltage as a function of junction temperature

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

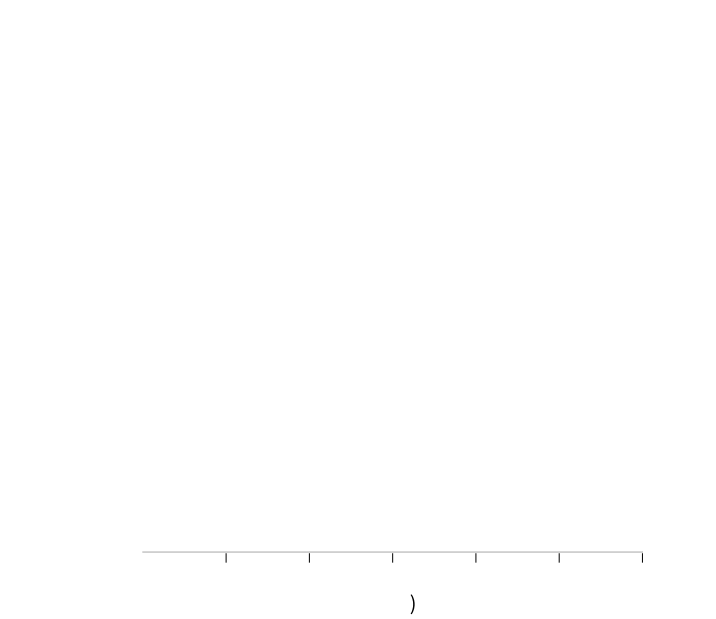
$$I_C = 0.35\text{ mA}$$

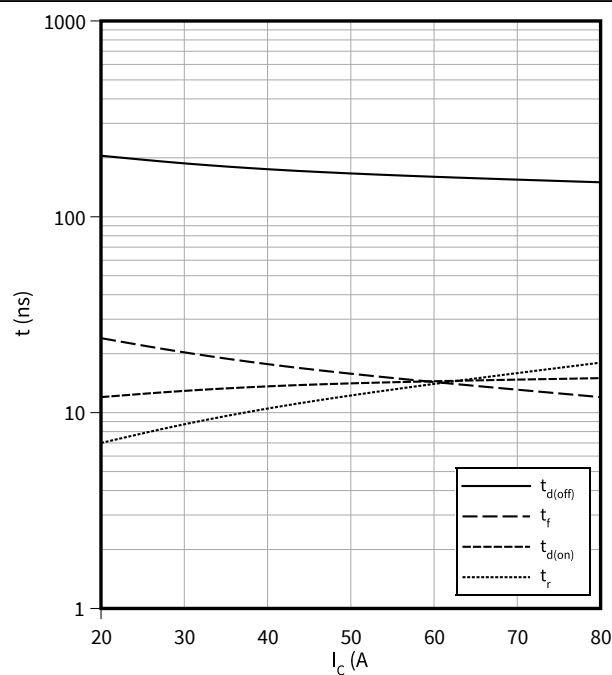
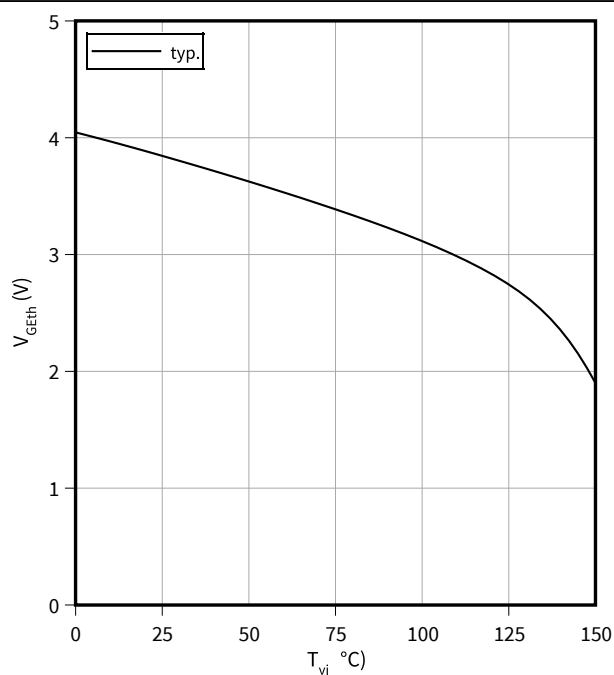


Typical switching times as a function of collector current

$$t = f(I_C)$$

$$V_{CC} = 400\text{ V}, T_{vj} = 175^\circ\text{C}, V_{GE} = 0/15\text{ V}, R_G = 12.5\ \Omega$$

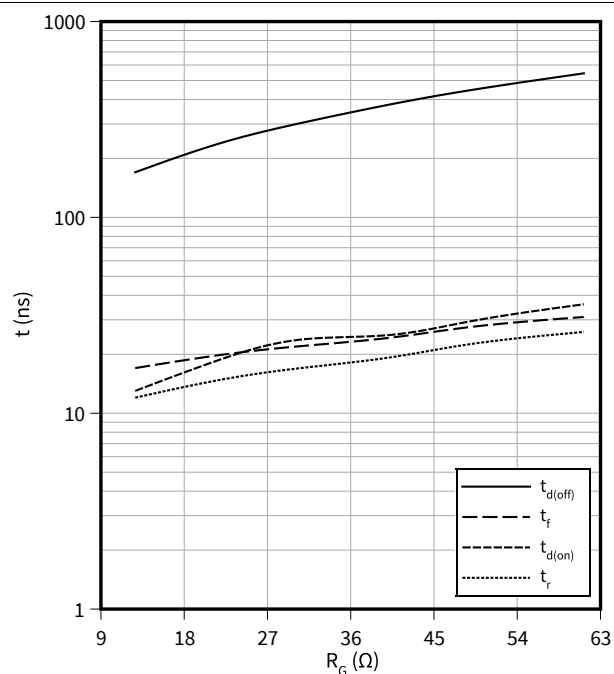




Typical switching times as a function of gate resistor

$t = f(R_G)$

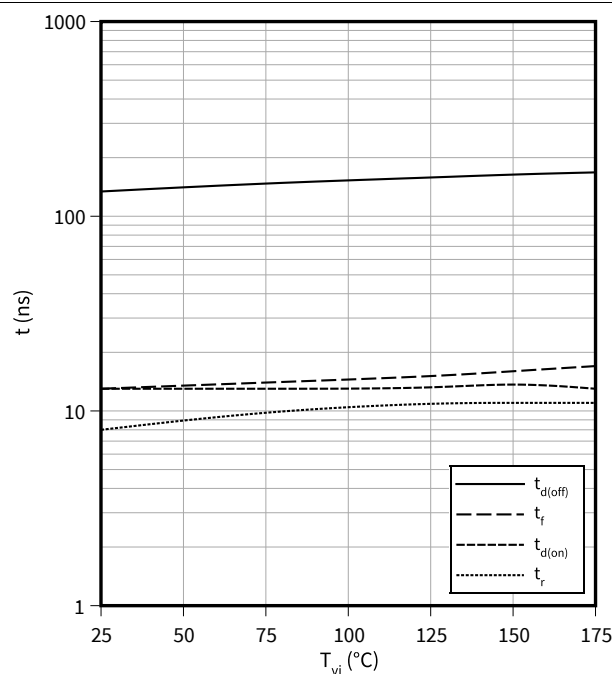
$I_C = 40$ A, $V_{CC} = 400$ V, $T_{vj} = 175$ °C, $V_{GE} = 0/15$ V



Typical switching times as a function of junction temperature

$t = f(T_{vj})$

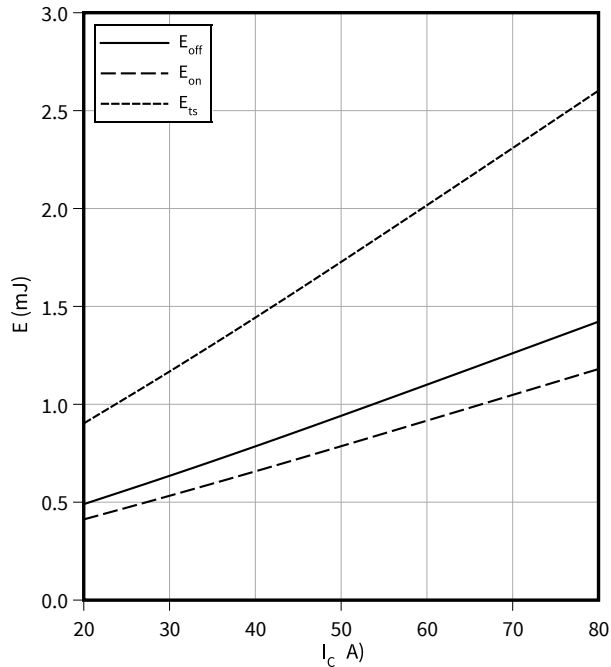
$I_C = 40$ A, $V_{CC} = 400$ V, $V_{GE} = 0/15$ V, $R_G = 12.5$ Ω



Typical switching energy losses as a function of collector current

$E = f(I_C)$

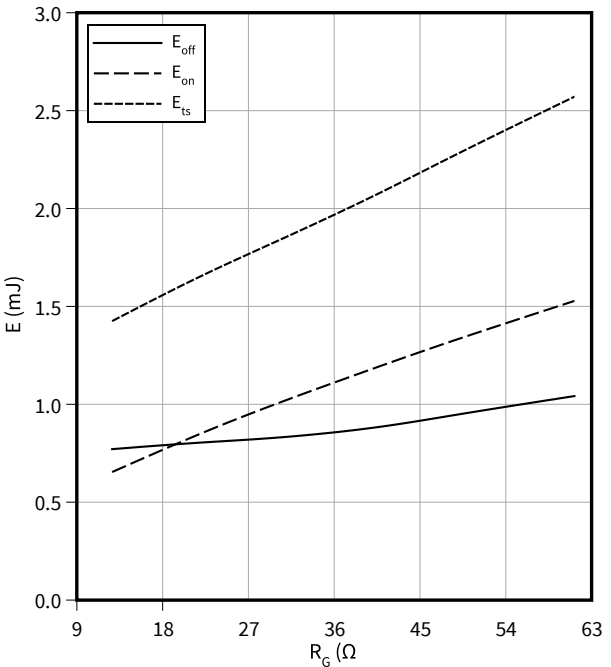
$V_{CC} = 400\text{ V}$, $T_{vj} = 175\text{ °C}$, $V_{GE} = 0/15\text{ V}$, $R_G = 12.5\text{ }\Omega$



Typical switching energy losses as a function of gate resistor

$E = f(R_G)$

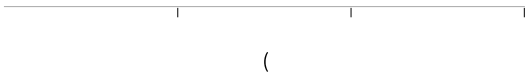
$I_C = 40\text{ A}$, $V_{CC} = 400\text{ V}$, $T_{vj} = 175\text{ °C}$, $V_{GE} = 0/15\text{ V}$



Typical switching energy losses as a function of junction temperature

$E = f(T_{vj})$

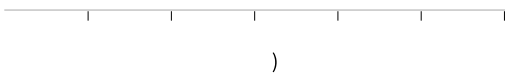
$I_C = 40\text{ A}$, $V_{CC} = 400\text{ V}$, $V_{GE} = 0/15\text{ V}$, $R_G = 12.5\text{ }\Omega$

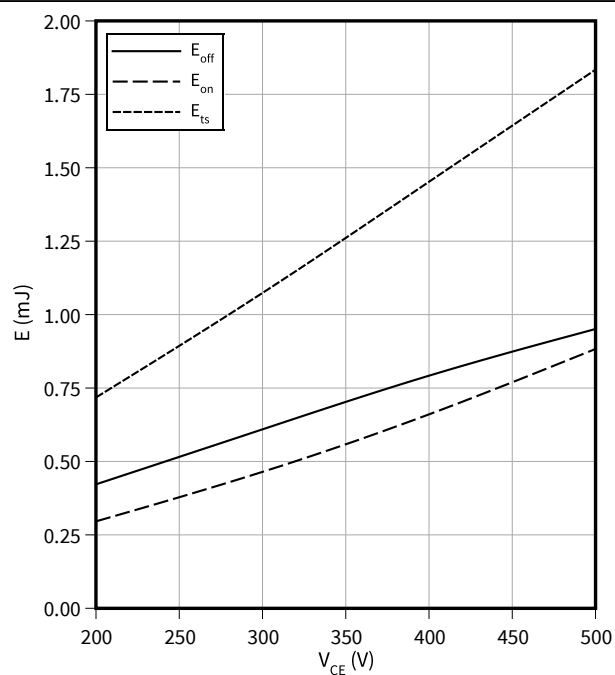
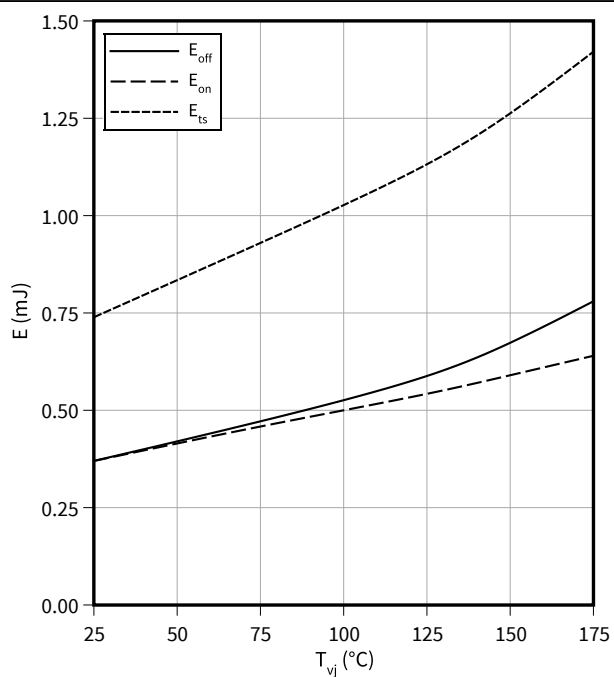


Typical switching energy losses as a function of collector emitter voltage

$E = f(V_{CE})$

$I_C = 40\text{ A}$, $T_{vj} = 175\text{ °C}$, $V_{GE} = 0/15\text{ V}$, $R_G = 12.5\text{ }\Omega$

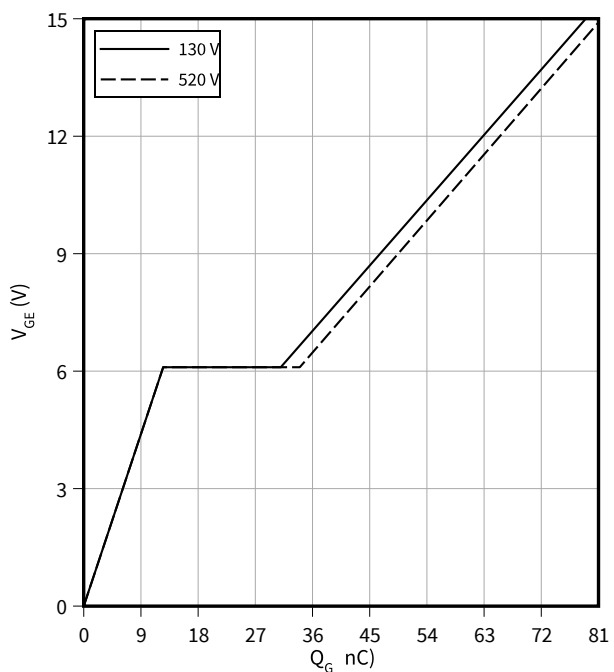




Typical gate charge

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

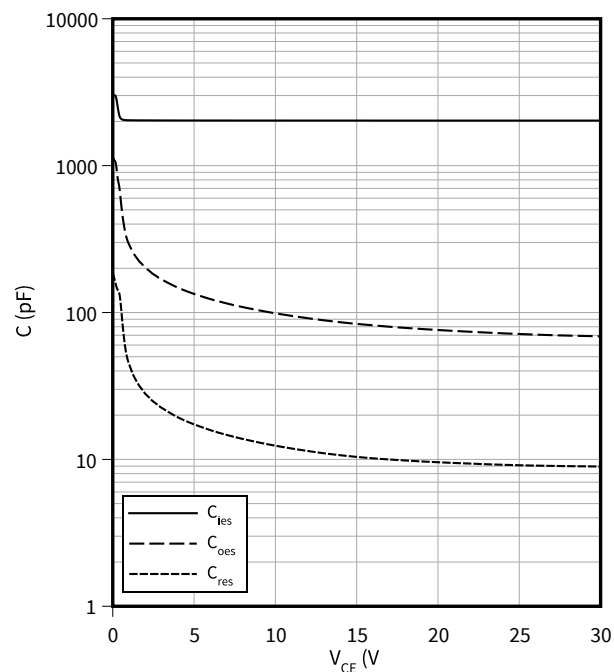
$$I_C = 40 \text{ A}$$



Typical capacitance as a function of collector-emitter voltage

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

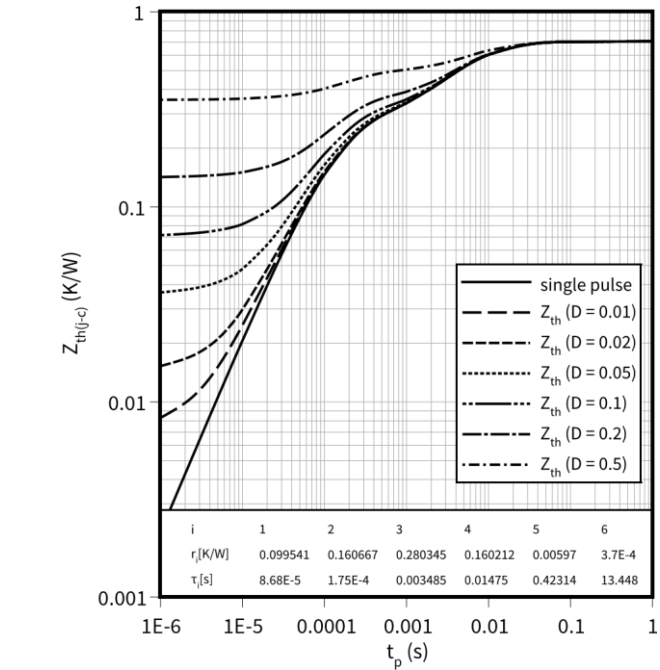
$$f = 100 \text{ kHz}, V_{GE} = 0 \text{ V}$$



IGBT transient thermal impedance as a function of pulse width

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

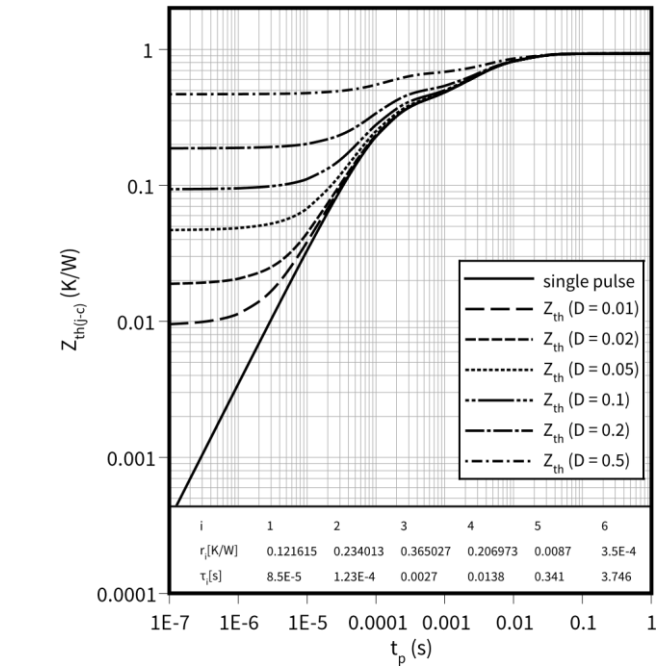
$$D = t_p/T$$



Diode transient thermal impedance as a function of pulse width

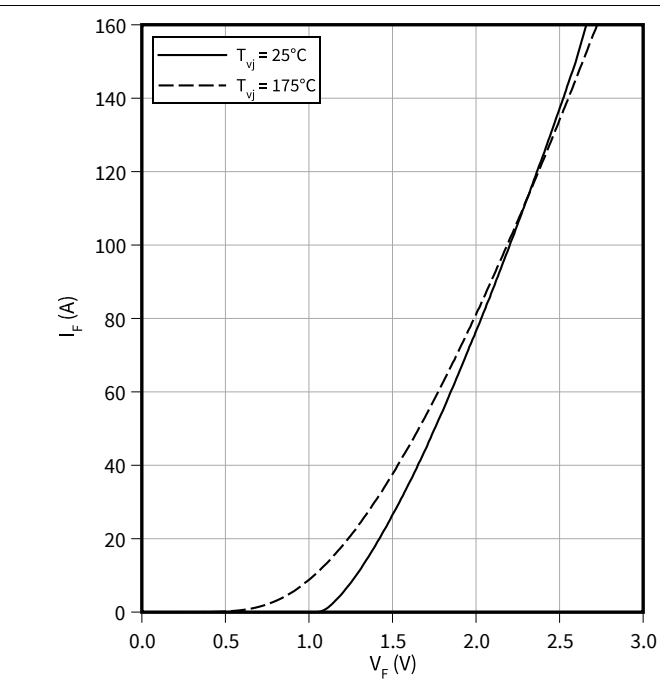
$$Z_{th(j-c)} = f(t_p)$$

$$D = t_p/T$$



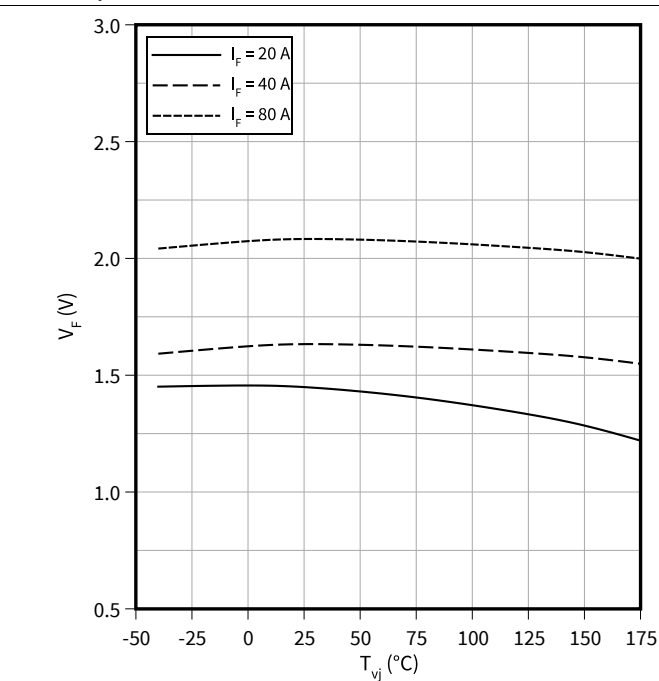
Typical diode forward current as a function of forward voltage

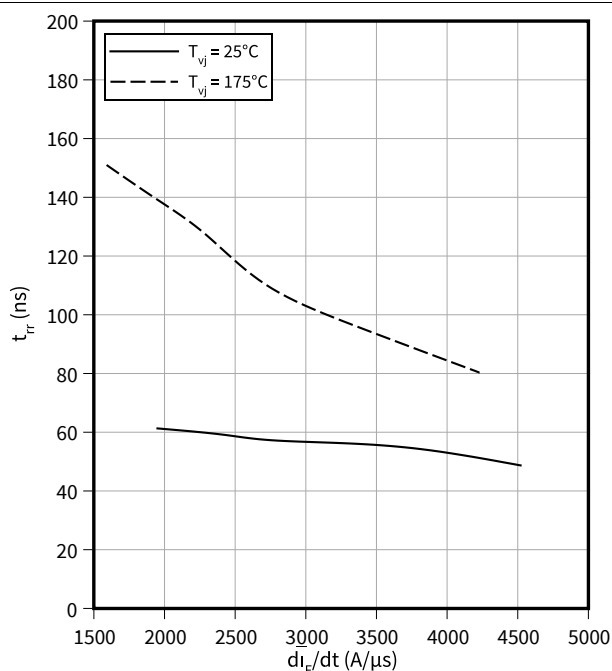
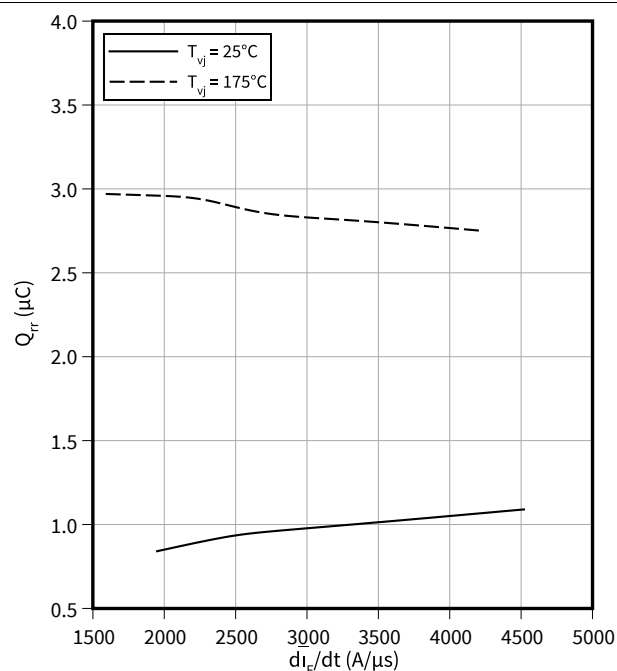
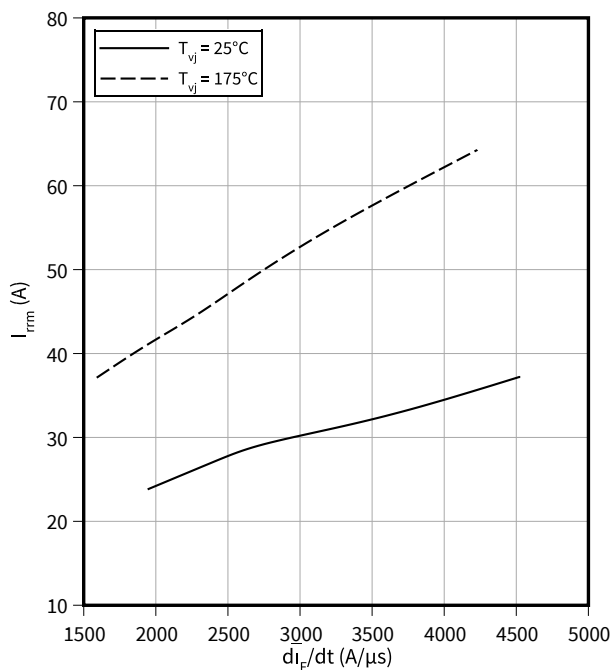
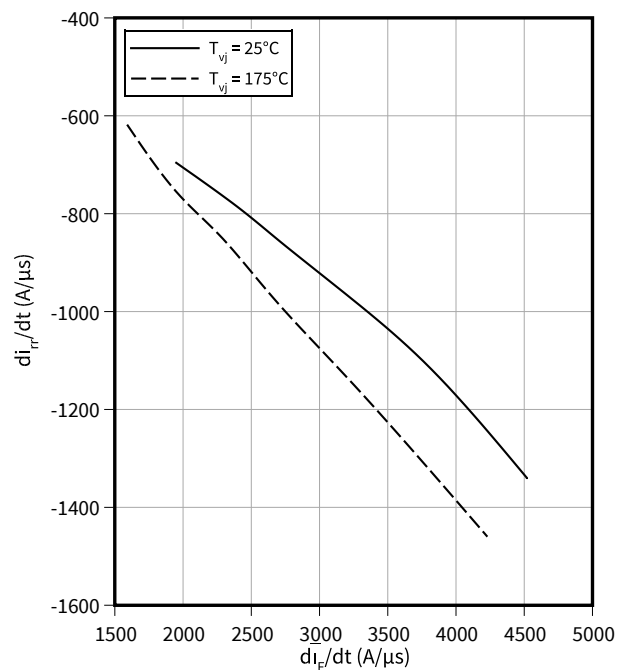
$$I_F = f(V_F)$$



Typical diode forward voltage as a function of junction temperature

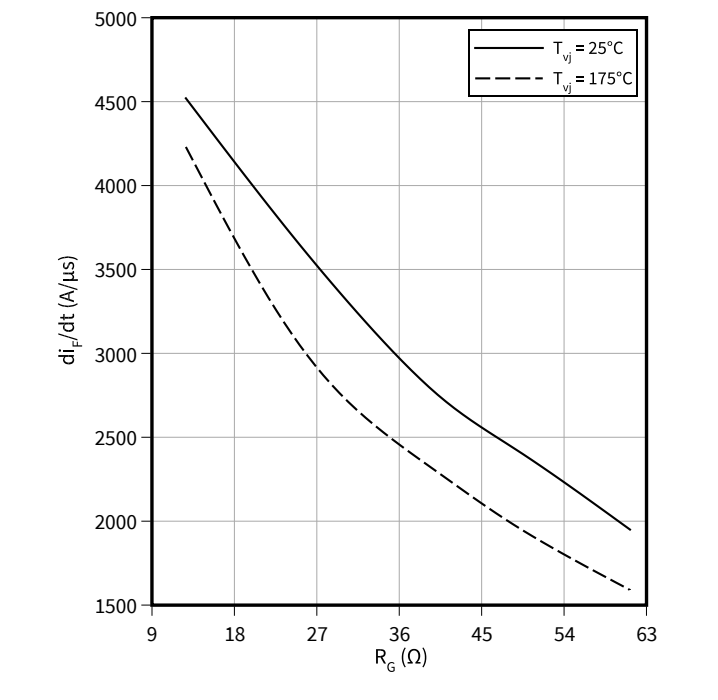
$$V_F = f(T_{vj})$$



4 Characteristics diagrams
Typical reverse recovery time as a function of diode current slope
 $t_{rr} = f(di_F/dt) \ V_R = 400 \text{ V}, I_F = 40 \text{ A}$

Typical reverse recovery charge as a function of diode current slope
 $Q_{rr} = f(di_F/dt) \ V_R = 400 \text{ V}, I_F = 40 \text{ A}$

Typical reverse recovery current as a function of diode current slope
 $I_{rrm} = f(di_F/dt) \ V_R = 400 \text{ V}, I_F = 40 \text{ A}$

Typical diode peak rate of fall of reverse recovery current as a function of diode current slope $di_{rr}/dt = f(di_F/dt) \ V_R = 400 \text{ V}, I_F = 40 \text{ A}$




Typical diode current slope as a function of gate resistor $di_F/dt = f(R_G)$ $V_R = 400\text{ V}$, $I_F = 40\text{ A}$



5 Package outlines

5 Package outlines

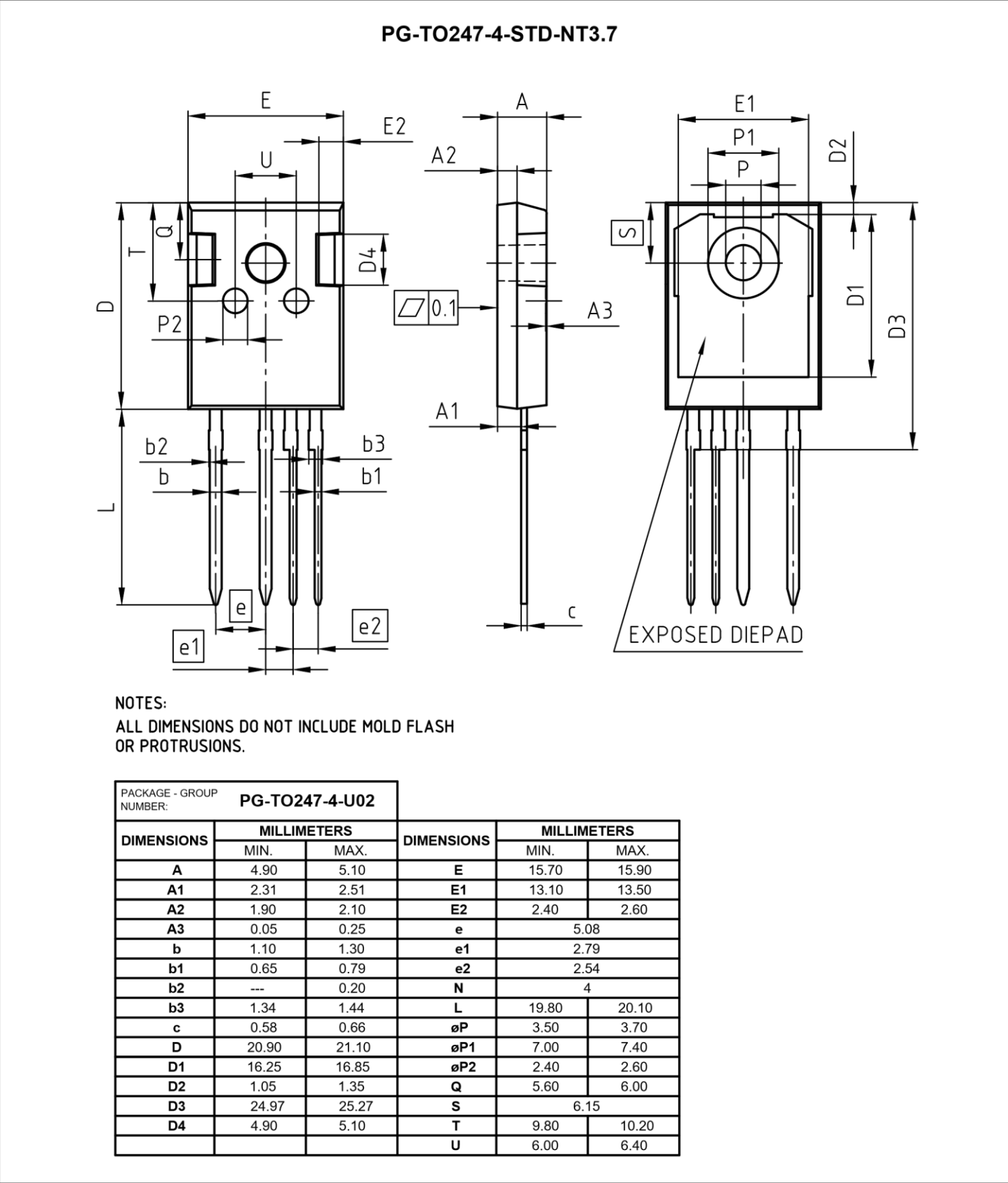


Figure 1

6 Testing conditions

6 Testing conditions

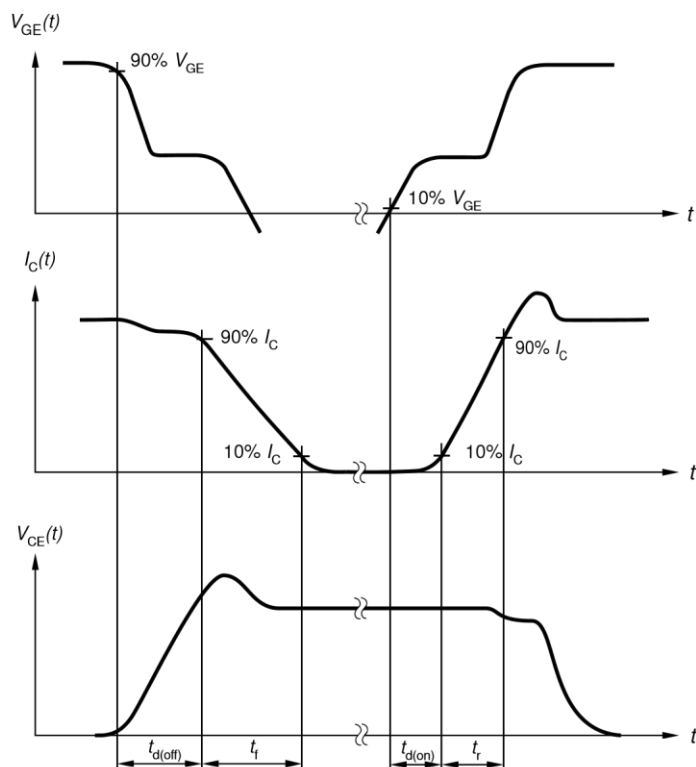


Figure A. Definition of switching times

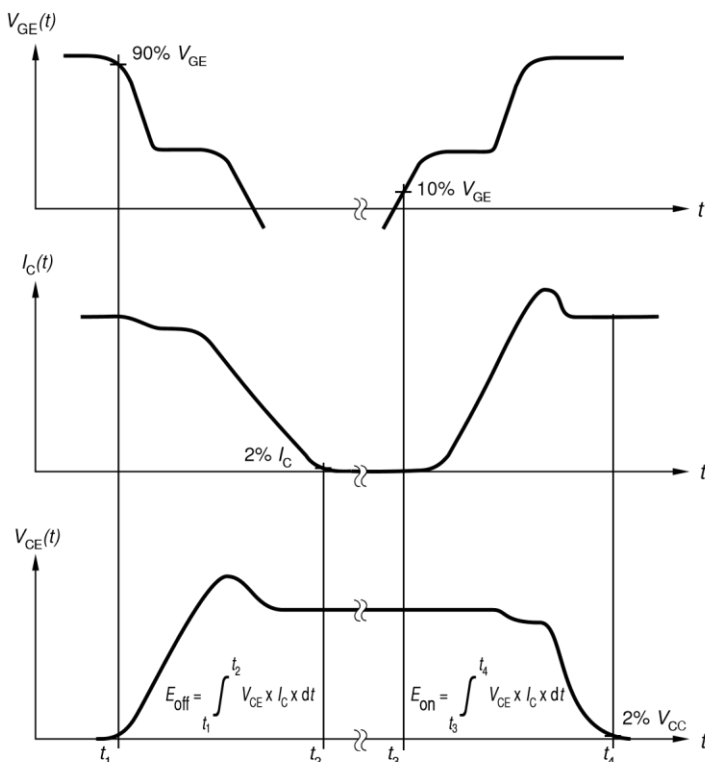


Figure B. Definition of switching losses

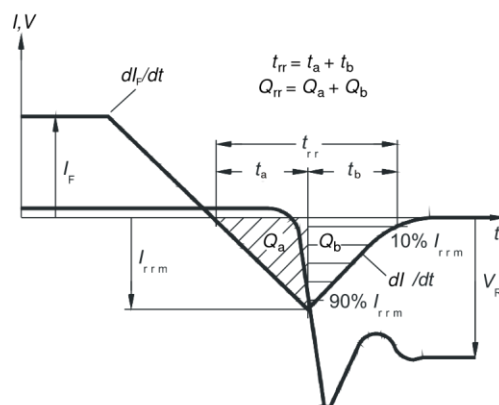


Figure C. Definition of diode switching characteristics

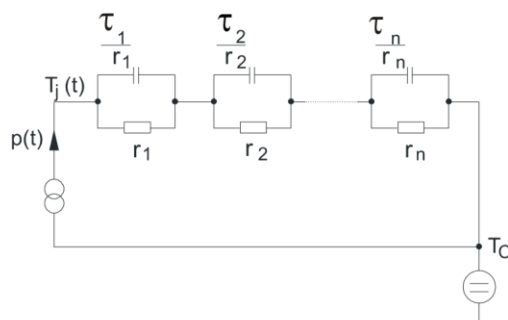


Figure D. Thermal equivalent circuit

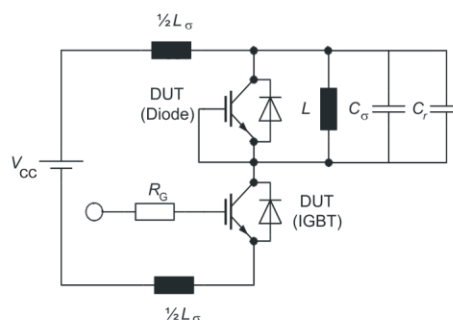


Figure E. Dynamic test circuit
Parasitic inductance L_σ ,
parasitic capacitor C_σ ,
relief capacitor C_r ,
(only for ZVT switching)

Figure 2

Revision history

Revision history

Document revision	Date of release	Description of changes
1.00	2023-04-27	Final datasheet

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