

CoolSiC™ Hybrid Discrete - TRENCHSTOP™ 5 H5 IGBT co-packed with half-rated 6th generation CoolSiC™ diode

Features

- $V_{CE} = 650\text{ V}$
- $I_C = 40\text{ A}$
- Ultra-low switching losses due to the combination of TRENCHSTOP™ 5 and CoolSiC™ technology
- Benchmark efficiency in hard switching topologies
- Plug-and-play replacement of pure silicon devices
- Maximum junction temperature $T_{vjmax} = 175^\circ\text{C}$
- Qualified according to JEDEC for target applications
- Pb-free lead plating; RoHS compliant
- Complete product spectrum and PSpice Models: <http://www.infineon.com/igbt/>

Potential applications

- Industrial SMPS
- Industrial UPS
- Solar string inverter
- Energy storage
- Charger

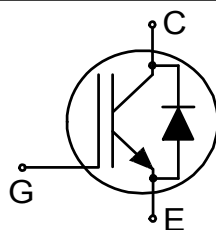
Product validation

- Qualified for applications listed above based on the test conditions in the relevant tests of JEDEC20/22

Description

Package pin definition:

- Pin G - gate
- Pin C & backside - collector
- Pin E - emitter



Type	Package	Marking
IKW40N65RH5	PG-TO247-3	K40ERH5

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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			13.0		nH
Storage temperature	T_{stg}		-55		150	°C
Soldering temperature		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

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		$T_c = 25\text{ °C}$	74	A
			$T_c = 100\text{ °C}$	46	
Pulsed collector current, t_p limited by T_{vjmax}	I_{Cpulse}			160	A
Turn-off safe operating area		$V_{CE} \leq 650\text{ V}$, $t_p = 1\text{ }\mu\text{s}$, $T_{vj} \leq 175\text{ °C}$		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}		$T_c = 25\text{ °C}$	250	W
			$T_c = 100\text{ °C}$	125	

Table 3 Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Collector-emitter saturation voltage	V_{CEsat}	$I_C = 40\text{ A}$, $V_{GE} = 15\text{ V}$	$T_{vj} = 25\text{ °C}$		1.65	2.1	V
			$T_{vj} = 125\text{ °C}$		1.85		
			$T_{vj} = 175\text{ °C}$		1.95		
Gate-emitter threshold voltage	V_{GEth}	$I_C = 0.4\text{ mA}$, $V_{CE} = V_{GE}$		3.2	4	4.8	V

(table continues...)

Table 3 (continued) Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Zero gate-voltage collector current	I_{CES}	$V_{CE} = 650 \text{ V}, V_{GE} = 0 \text{ V}$	$T_{vj} = 25 \text{ °C}$			600	μA
			$T_{vj} = 175 \text{ °C}$		2000		
Zero gate-voltage collector current	I_{CES}	$V_{CE} = 480 \text{ V}, V_{GE} = 0 \text{ V}$	$T_{vj} = 25 \text{ °C}$			16	μA
Gate-emitter leakage current	I_{GES}	$V_{CE} = 0 \text{ V}, V_{GE} = 20 \text{ V}$				100	nA
Transconductance	g_{fs}	$I_C = 40 \text{ A}, V_{CE} = 20 \text{ V}$			50		S
Input capacitance	C_{ies}	$V_{CE} = 25 \text{ V}, V_{GE} = 0 \text{ V}, f = 250 \text{ kHz}$			2190		pF
Output capacitance	C_{oes}	$V_{CE} = 25 \text{ V}, V_{GE} = 0 \text{ V}, f = 250 \text{ kHz}$			265		pF
Reverse transfer capacitance	C_{res}	$V_{CE} = 25 \text{ V}, V_{GE} = 0 \text{ V}, f = 250 \text{ kHz}$			8		pF
Gate charge	Q_G	$I_C = 40 \text{ A}, V_{GE} = 15 \text{ V}, V_{CC} = 520 \text{ V}$			95		nC
Turn-on delay time	$t_{d(on)}$	$V_{CC} = 400 \text{ V}, V_{GE} = 15 \text{ V}, R_{Gon} = 15 \text{ }\Omega, R_{Goff} = 15 \text{ }\Omega, L_\sigma = 30 \text{ nH}, C_\sigma = 30 \text{ pF}$	$T_{vj} = 25 \text{ °C}, I_C = 20 \text{ A}$		18		ns
			$T_{vj} = 25 \text{ °C}, I_C = 5 \text{ A}$		17		
			$T_{vj} = 150 \text{ °C}, I_C = 20 \text{ A}$		18		
			$T_{vj} = 150 \text{ °C}, I_C = 5 \text{ A}$		17		
Rise time (inductive load)	t_r	$V_{CC} = 400 \text{ V}, V_{GE} = 15 \text{ V}, R_{Gon} = 15 \text{ }\Omega, R_{Goff} = 15 \text{ }\Omega, L_\sigma = 30 \text{ nH}, C_\sigma = 30 \text{ pF}$	$T_{vj} = 25 \text{ °C}, I_C = 20 \text{ A}$		8		ns
			$T_{vj} = 25 \text{ °C}, I_C = 5 \text{ A}$		4		
			$T_{vj} = 150 \text{ °C}, I_C = 20 \text{ A}$		9		
			$T_{vj} = 150 \text{ °C}, I_C = 5 \text{ A}$		4		
Turn-off delay time	$t_{d(off)}$	$V_{CC} = 400 \text{ V}, V_{GE} = 15 \text{ V}, R_{Gon} = 15 \text{ }\Omega, R_{Goff} = 15 \text{ }\Omega, L_\sigma = 30 \text{ nH}, C_\sigma = 30 \text{ pF}$	$T_{vj} = 25 \text{ °C}, I_C = 20 \text{ A}$		165		ns
			$T_{vj} = 25 \text{ °C}, I_C = 5 \text{ A}$		190		
			$T_{vj} = 150 \text{ °C}, I_C = 20 \text{ A}$		195		
			$T_{vj} = 150 \text{ °C}, I_C = 5 \text{ A}$		240		

(table continues...)

Table 3 (continued) Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Fall time (inductive load)	t_f	$V_{CC} = 400 \text{ V}$, $V_{GE} = 15 \text{ V}$, $R_{Gon} = 15 \text{ } \Omega$, $R_{Goff} = 15 \text{ } \Omega$, $L_\sigma = 30 \text{ nH}$, $C_\sigma = 30 \text{ pF}$	$T_{vj} = 25 \text{ } ^\circ\text{C}$, $I_C = 20 \text{ A}$	13		ns
			$T_{vj} = 25 \text{ } ^\circ\text{C}$, $I_C = 5 \text{ A}$	25		
			$T_{vj} = 150 \text{ } ^\circ\text{C}$, $I_C = 20 \text{ A}$	22		
			$T_{vj} = 150 \text{ } ^\circ\text{C}$, $I_C = 5 \text{ A}$	35		
Turn-on energy	E_{on}	$V_{CC} = 400 \text{ V}$, $V_{GE} = 15 \text{ V}$, $R_{Gon} = 15 \text{ } \Omega$, $R_{Goff} = 15 \text{ } \Omega$, $L_\sigma = 30 \text{ nH}$, $C_\sigma = 30 \text{ pF}$	$T_{vj} = 25 \text{ } ^\circ\text{C}$, $I_C = 20 \text{ A}$	0.16		mJ
			$T_{vj} = 25 \text{ } ^\circ\text{C}$, $I_C = 5 \text{ A}$	0.03		
			$T_{vj} = 150 \text{ } ^\circ\text{C}$, $I_C = 20 \text{ A}$	0.18		
			$T_{vj} = 150 \text{ } ^\circ\text{C}$, $I_C = 5 \text{ A}$	0.05		
Turn-off energy	E_{off}	$V_{CC} = 400 \text{ V}$, $V_{GE} = 15 \text{ V}$, $R_{Gon} = 15 \text{ } \Omega$, $R_{Goff} = 15 \text{ } \Omega$, $L_\sigma = 30 \text{ nH}$, $C_\sigma = 30 \text{ pF}$	$T_{vj} = 25 \text{ } ^\circ\text{C}$, $I_C = 20 \text{ A}$	0.12		mJ
			$T_{vj} = 25 \text{ } ^\circ\text{C}$, $I_C = 5 \text{ A}$	0.05		
			$T_{vj} = 150 \text{ } ^\circ\text{C}$, $I_C = 20 \text{ A}$	0.22		
			$T_{vj} = 150 \text{ } ^\circ\text{C}$, $I_C = 5 \text{ A}$	0.07		
Total switching energy	E_{ts}	$V_{CC} = 400 \text{ V}$, $V_{GE} = 15 \text{ V}$, $R_{Gon} = 15 \text{ } \Omega$, $R_{Goff} = 15 \text{ } \Omega$, $L_\sigma = 30 \text{ nH}$, $C_\sigma = 30 \text{ pF}$	$T_{vj} = 25 \text{ } ^\circ\text{C}$, $I_C = 20 \text{ A}$	0.28		mJ
			$T_{vj} = 25 \text{ } ^\circ\text{C}$, $I_C = 5 \text{ A}$	0.08		
			$T_{vj} = 150 \text{ } ^\circ\text{C}$, $I_C = 20 \text{ A}$	0.4		
			$T_{vj} = 150 \text{ } ^\circ\text{C}$, $I_C = 5 \text{ A}$	0.12		
IGBT thermal resistance, junction-case	$R_{th(j-c)}$				0.6	K/W
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
Repetitive peak reverse voltage	V_{RRM}	$T_{vj} \geq 25\text{ °C}$		650	V
Diode forward current, limited by T_{vjmax}	I_F		$T_c = 25\text{ °C}$	27.5	A
			$T_c = 100\text{ °C}$	18.5	
Diode pulsed current, t_p limited by T_{vjmax} ¹⁾	I_{Fpulse}			60	A

1) Pulse current level depends on T_{vj} of diode chip, see also Fig. "Maximum pulse current as a function of junction temperature"

Table 5 Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Diode forward voltage	V_F	$I_F = 16\text{ A}$	$T_{vj} = 25\text{ °C}$		1.35	1.5	V
			$T_{vj} = 125\text{ °C}$		1.55		
			$T_{vj} = 175\text{ °C}$		1.65		
Diode thermal resistance, junction-case	$R_{th(j-c)}$					1.8	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.

Electrical Characteristic at $T_{vj} = 25\text{ °C}$, unless otherwise specified.

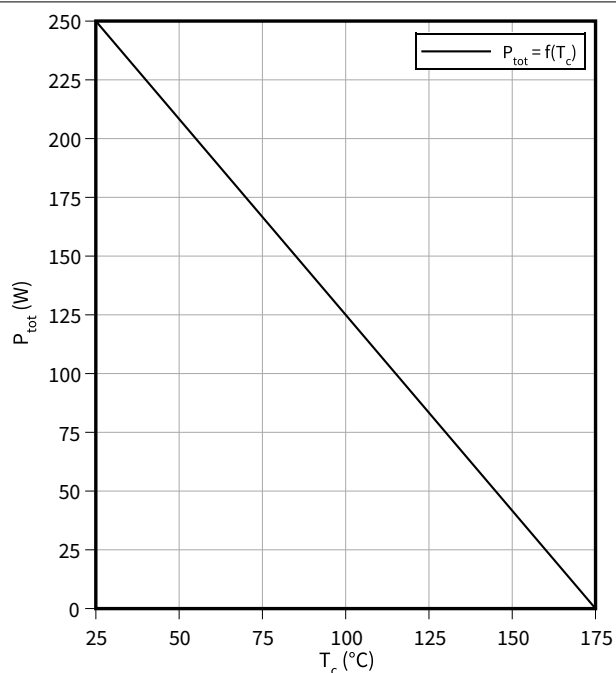
Dynamic test circuit, parasitic inductance L_σ , parasitic capacitor C_σ from Fig. E. Energy losses include "tail" and diode reverse recovery.

4 Characteristics diagrams

Power dissipation as a function of case temperature

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

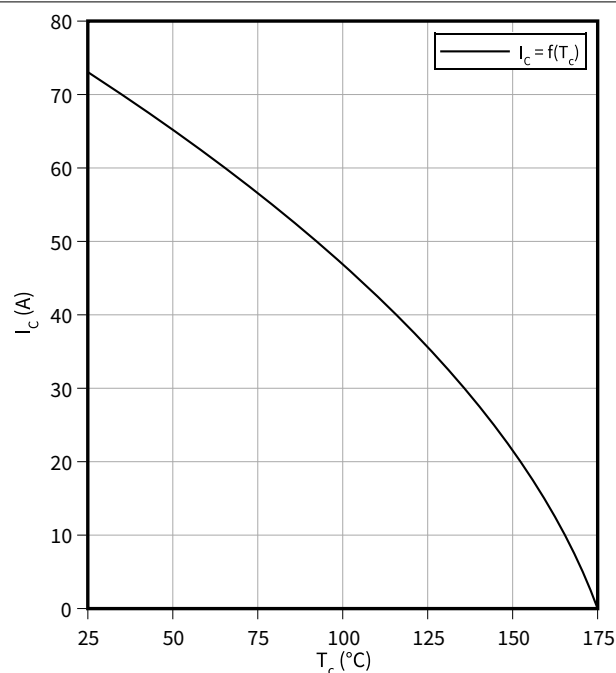
$$T_{vj} \leq 175\text{ °C}$$



Collector current as a function of case temperature

$$I_C = f(T_c)$$

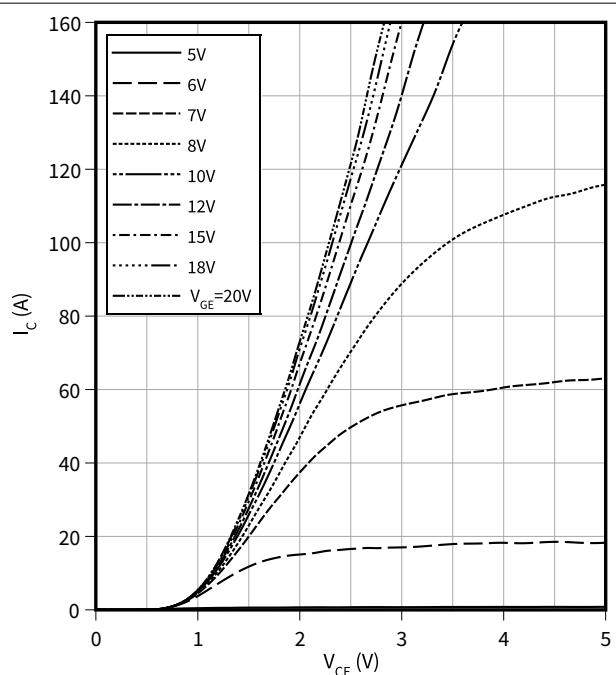
$$T_{vj} \leq 175\text{ °C}, V_{GE} \geq 15\text{ V}$$



Typical output characteristic

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

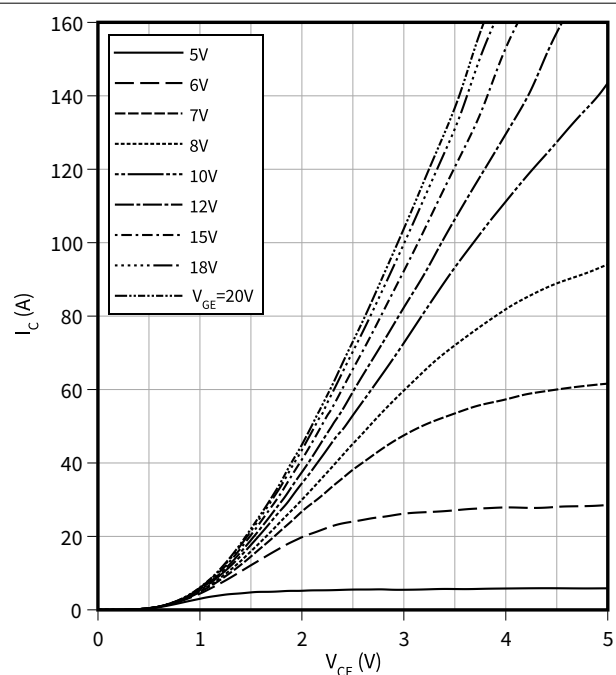
$$T_{vj} = 25\text{ °C}$$



Typical output characteristic

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

$$T_{vj} = 150\text{ °C}$$

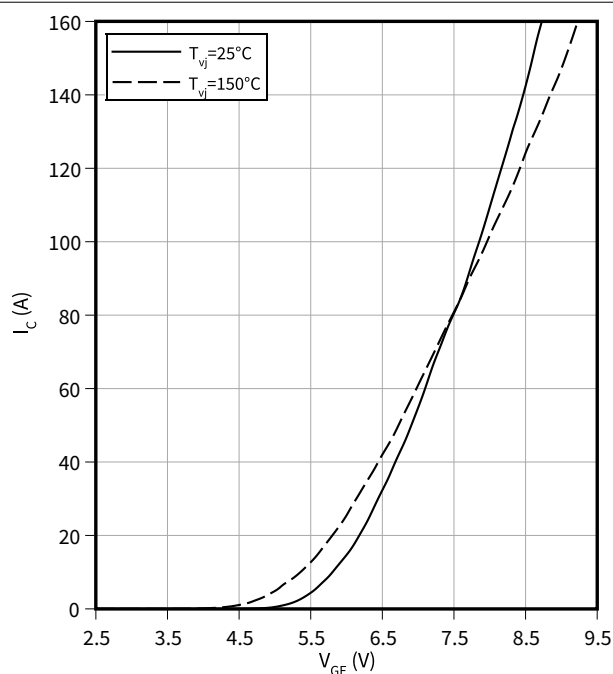


4 Characteristics diagrams

Typical transfer characteristic

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

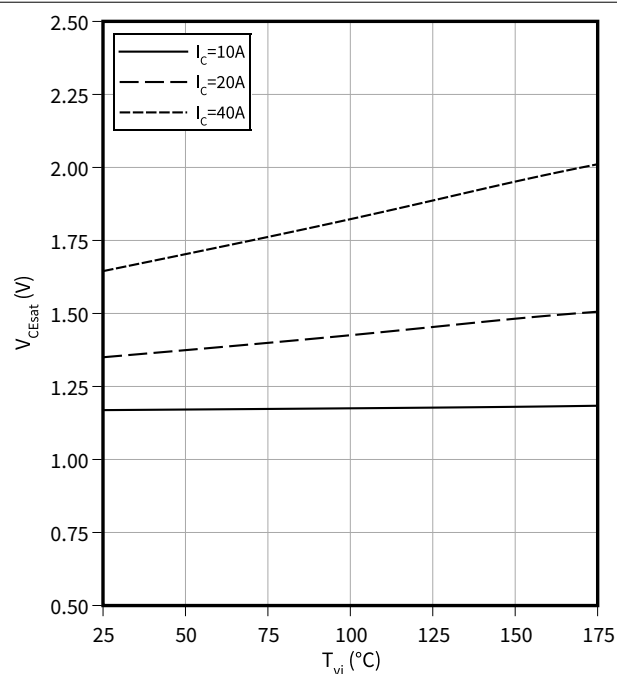
$$V_{CE} = 20 \text{ V}$$



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

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

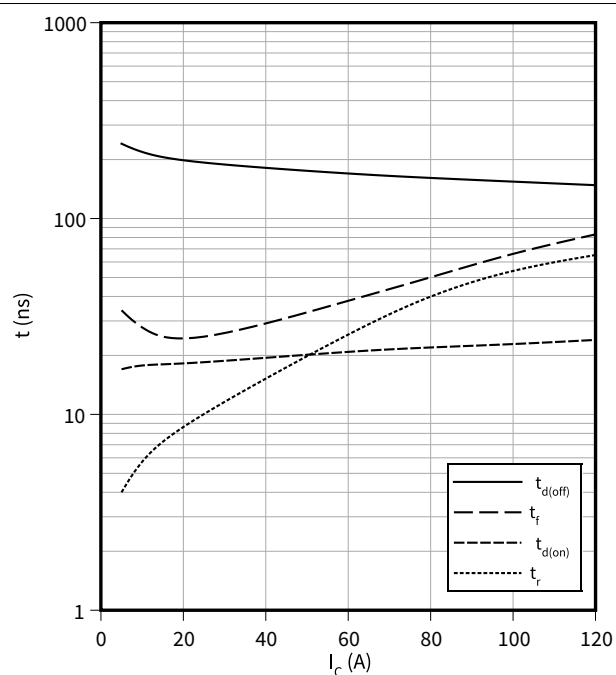
$$V_{GE} = 15 \text{ V}$$



Typical switching times as a function of collector current

$$t = f(I_C)$$

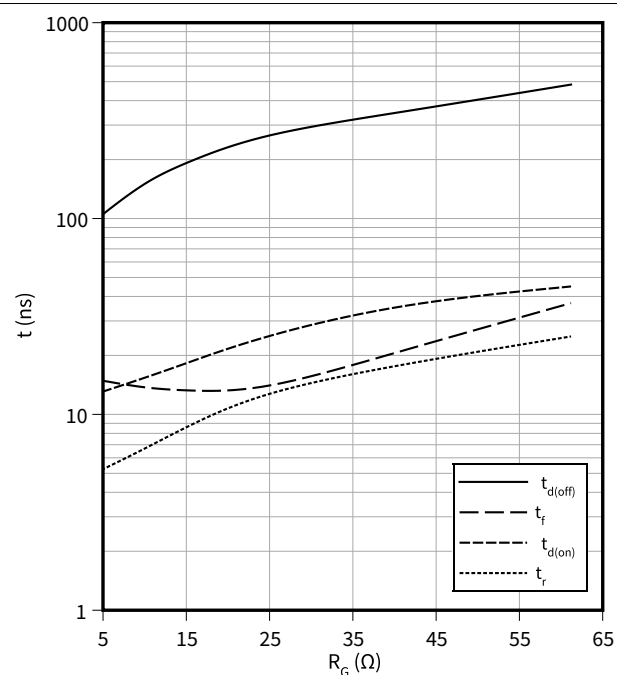
$$V_{CC} = 400 \text{ V}, T_{vj} = 150^\circ\text{C}, V_{GE} = 0/15 \text{ V}, R_G = 15 \Omega$$



Typical switching times as a function of gate resistor

$$t = f(R_G)$$

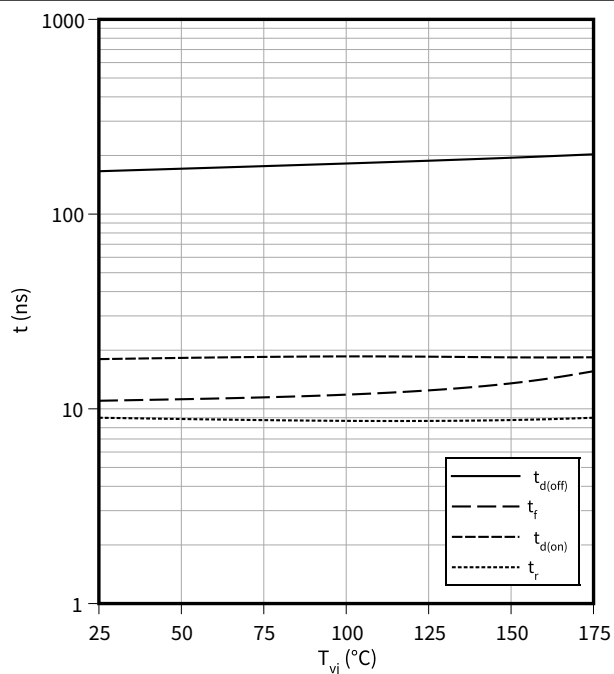
$$I_C = 20 \text{ A}, V_{CC} = 400 \text{ V}, T_{vj} = 150^\circ\text{C}, V_{GE} = 0/15 \text{ V}$$



Typical switching times as a function of junction temperature

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

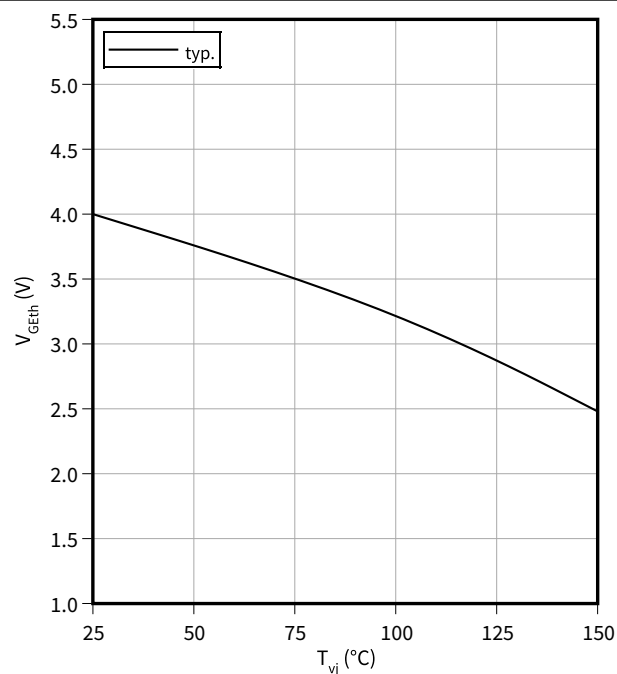
$I_C = 20 \text{ A}$, $V_{CC} = 400 \text{ V}$, $V_{GE} = 0/15 \text{ V}$, $R_G = 15 \Omega$



Gate-emitter threshold voltage as a function of junction temperature

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

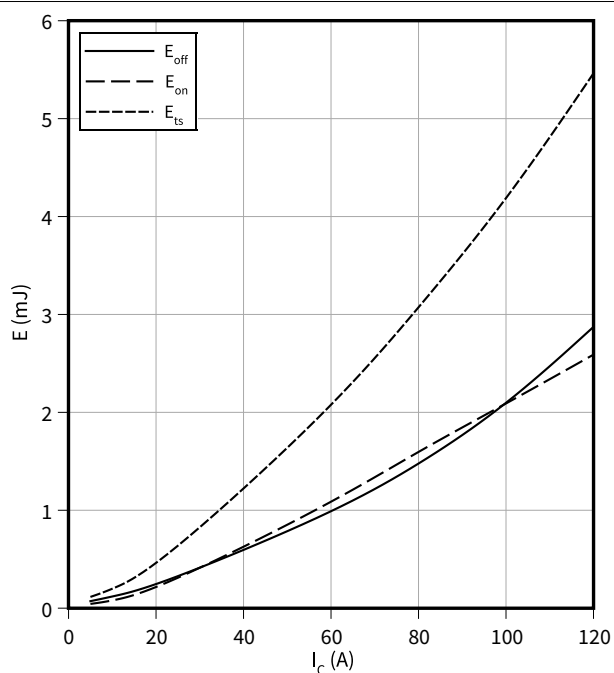
$I_C = 0.4 \text{ mA}$



Typical switching energy losses as a function of collector current

$$E = f(I_C)$$

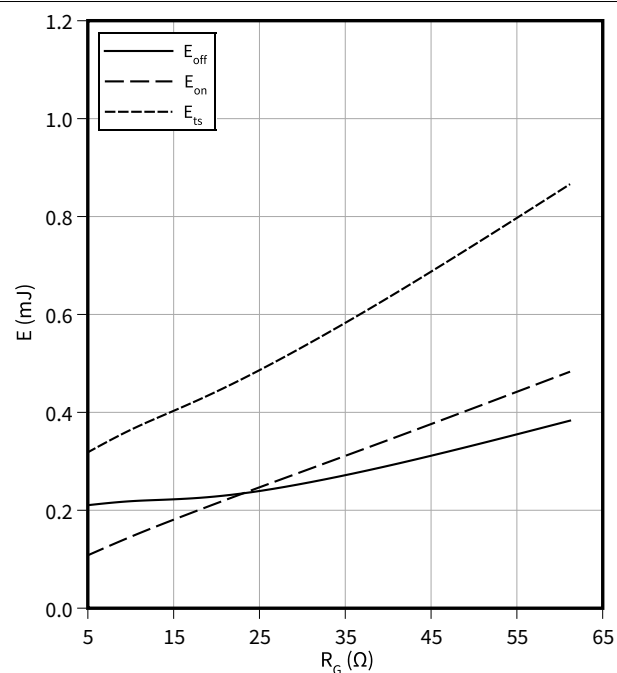
$V_{CC} = 400 \text{ V}$, $T_{vj} = 150 \text{ °C}$, $V_{GE} = 0/15 \text{ V}$, $R_G = 15 \Omega$



Typical switching energy losses as a function of gate resistor

$$E = f(R_G)$$

$I_C = 20 \text{ A}$, $V_{CC} = 400 \text{ V}$, $T_{vj} = 150 \text{ °C}$, $V_{GE} = 0/15 \text{ V}$

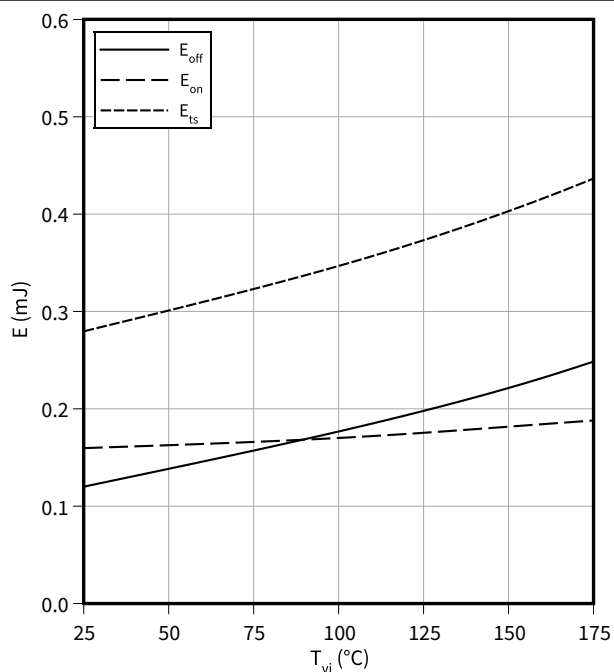


4 Characteristics diagrams

Typical switching energy losses as a function of junction temperature

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

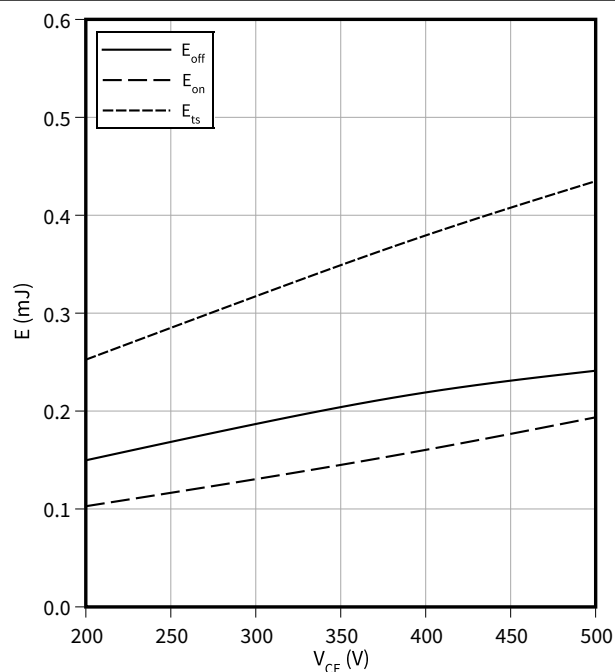
$I_C = 20\text{ A}$, $V_{CC} = 400\text{ V}$, $V_{GE} = 0/15\text{ V}$, $R_G = 15\ \Omega$



Typical switching energy losses as a function of collector emitter voltage

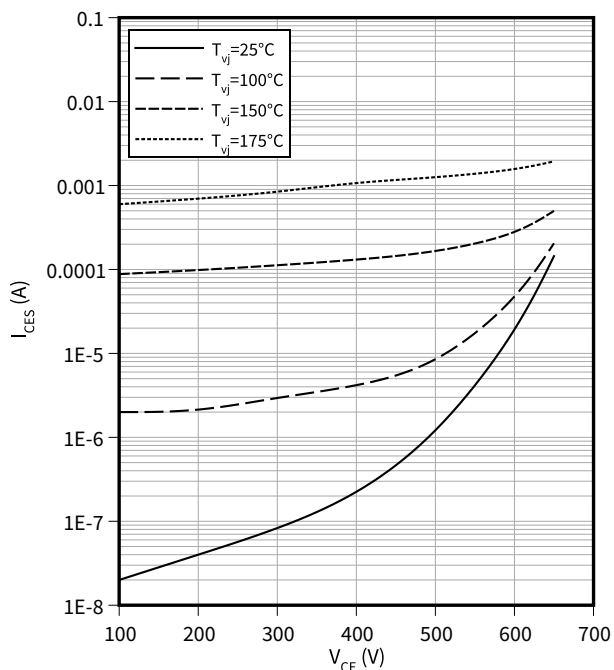
$$E = f(V_{CE})$$

$I_C = 20\text{ A}$, $V_{GE} = 0/15\text{ V}$, $T_{vj} = 150\text{ °C}$, $R_G = 15\ \Omega$



Typ. reverse current vs. reverse voltage as a function of Tvj

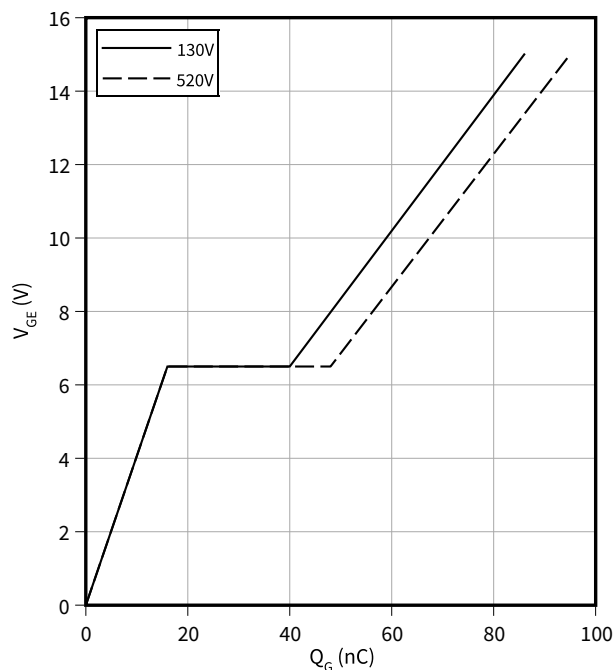
$$I_{CES} = f(V_{CE})$$



Typical gate charge

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

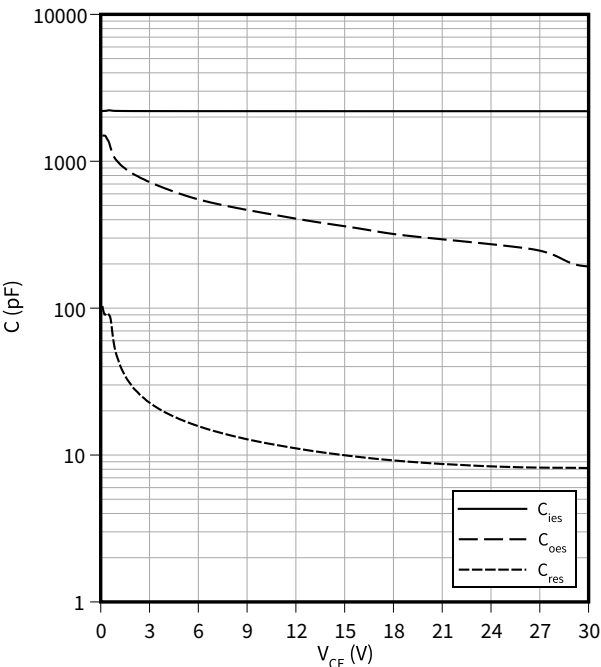
$I_C = 40\text{ A}$



4 Characteristics diagrams

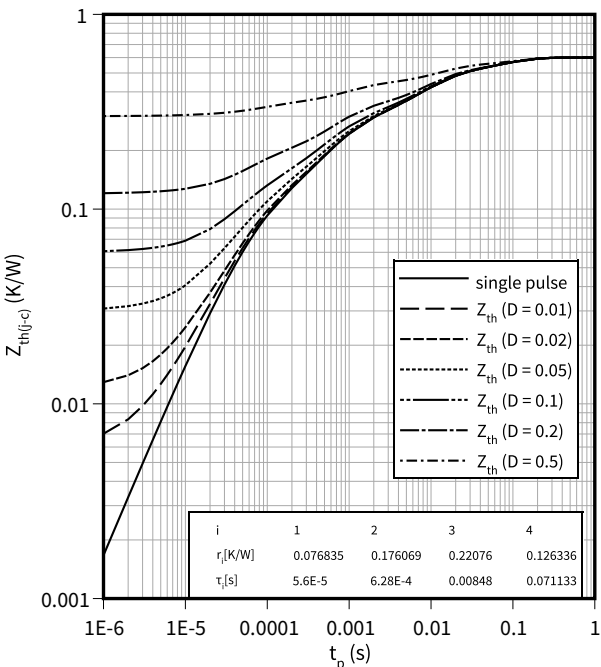
Typical capacitance as a function of collector-emitter voltage

$C = f(V_{CE})$
 $f = 250\text{ kHz}, V_{GE} = 0\text{ V}$



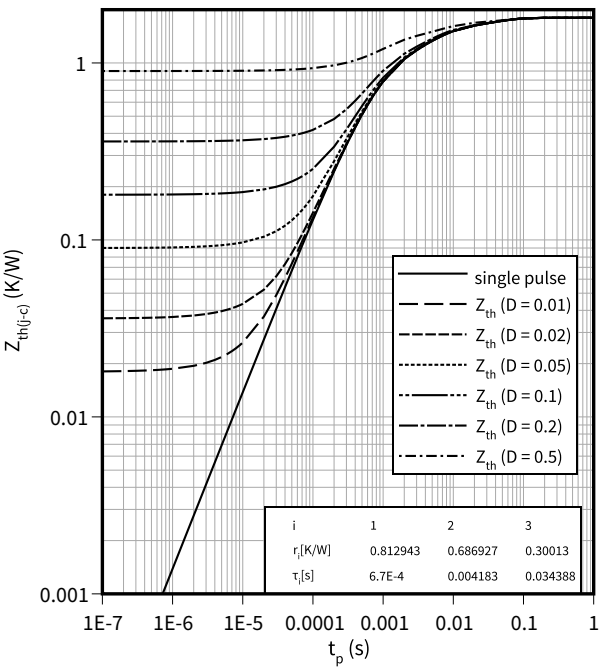
IGBT transient thermal impedance as a function of pulse width

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



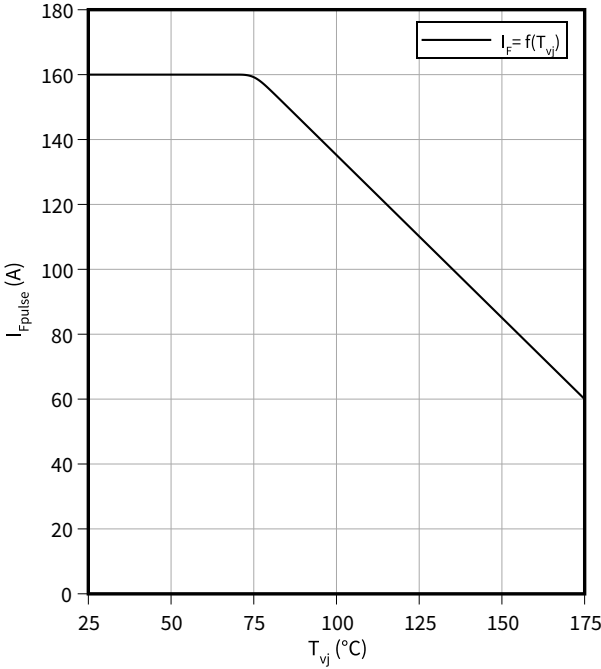
Diode transient thermal impedance as a function of pulse width

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



Maximum pulse current as a function of junction temperature

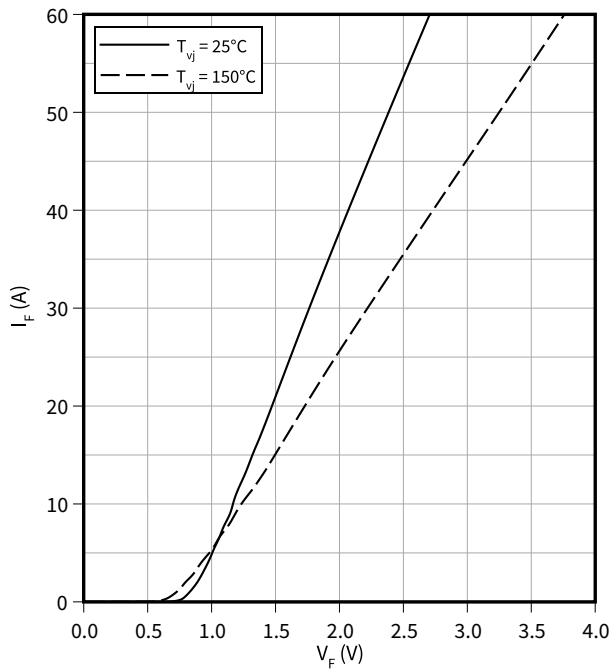
$I_{Fpulse} = f(T_{vj})$



4 Characteristics diagrams

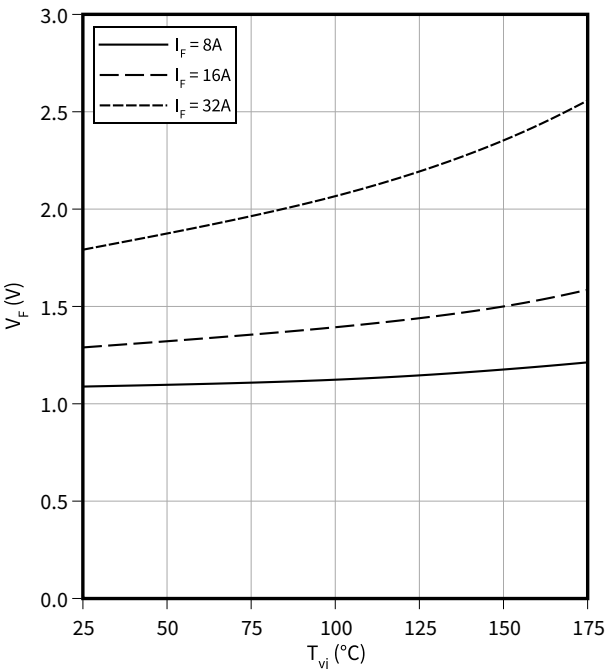
Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



Typical diode forward voltage as a function of junction temperature

$V_F = f(T_{vj})$



5 Package outlines

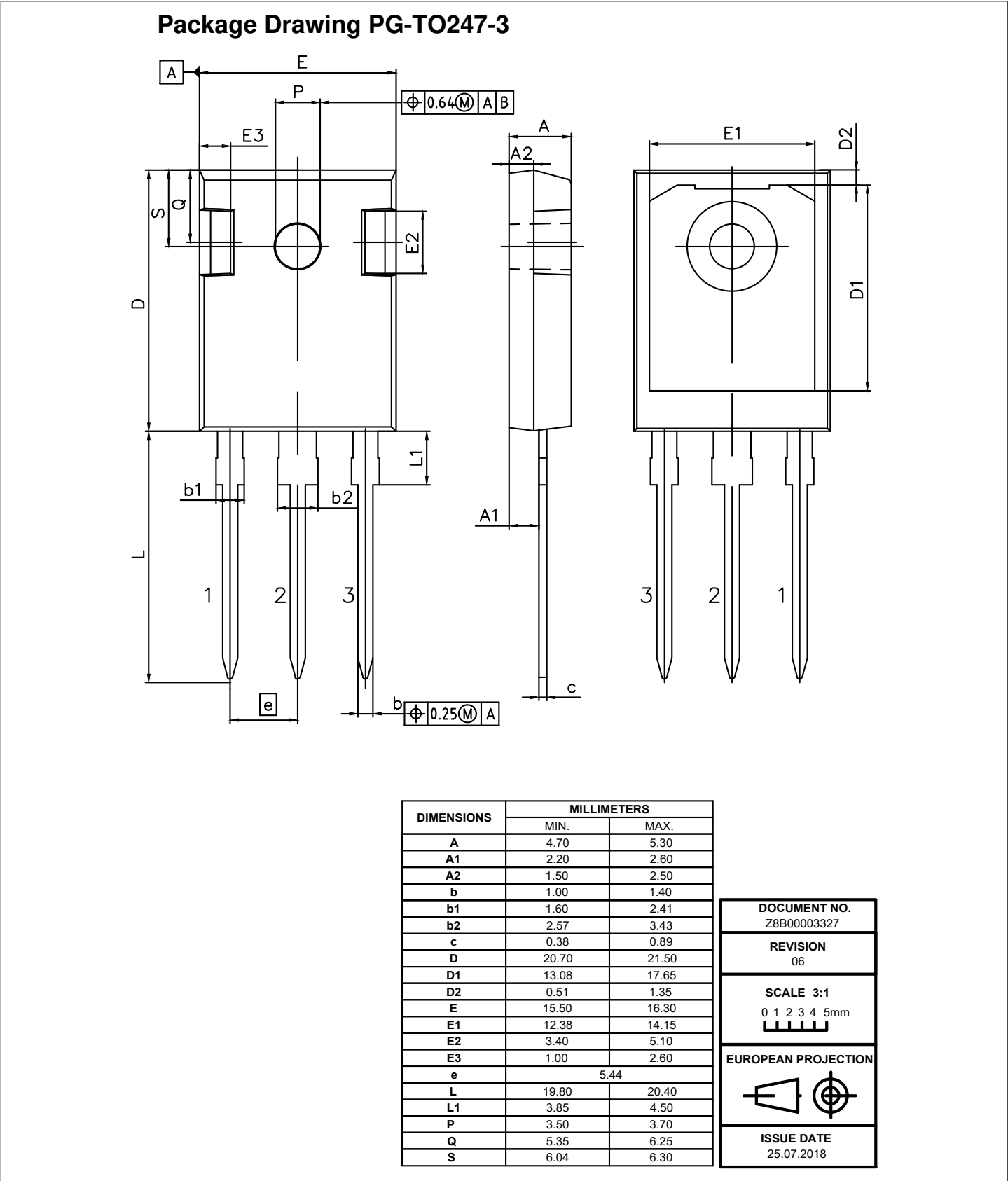


Figure 1

6 Testing conditions

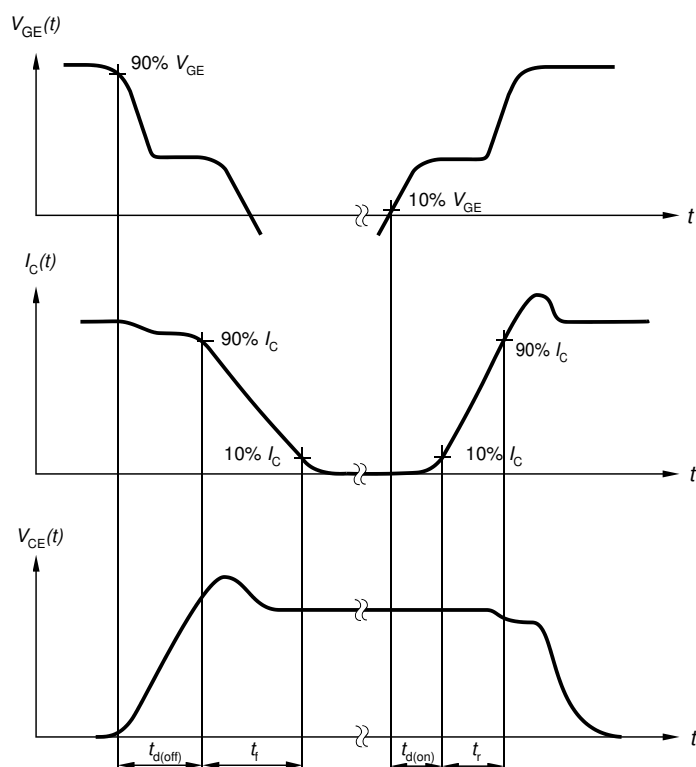


Figure A. Definition of switching times

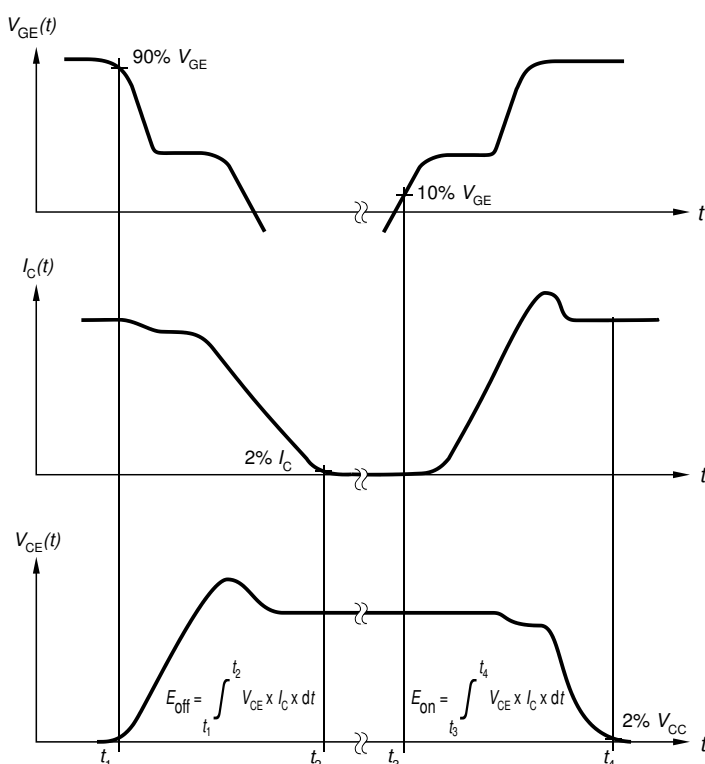


Figure B. Definition of switching losses

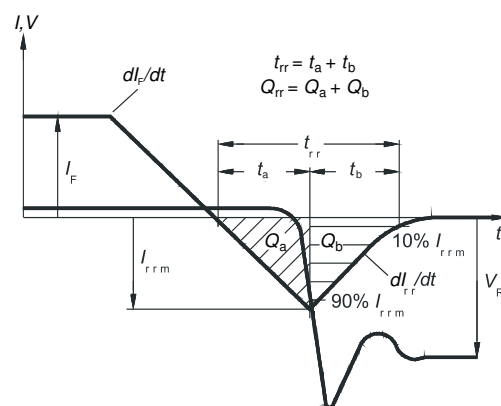


Figure C. Definition of diode switching characteristics

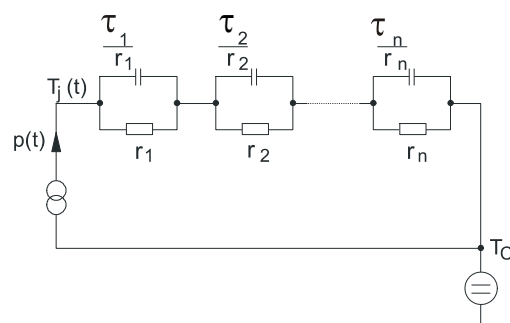


Figure D. Thermal equivalent circuit

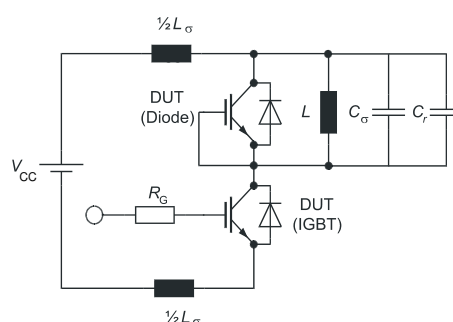


Figure E. **Dynamic test circuit**
Parasitic inductance L_σ ,
parasitic capacitor C_σ ,
relief capacitor C_r ,
(only for ZVT switching)

Revision history

Document revision	Date of release	Description of changes
V1.1	2020-03-20	Preliminary data sheet
V2.1	2020-07-27	Final Data Sheet
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	2022-09-22	Rename of product family name from “Hybrid CoolSiC™ IGBT” to “CoolSiC™ hybrid discrete”

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