

## CoolSiC™ Hybrid Discrete - TRENCHSTOP™ 5 S5 IGBT co-packed with full-rated 6th generation CoolSiC™ diode

### Features

- $V_{CE} = 650\text{ V}$
- $I_C = 50\text{ A}$
- Ultra-low switching losses due to the combination of TRENCHSTOP™ 5 and CoolSiC™ technology
- Very low on-state losses
- 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

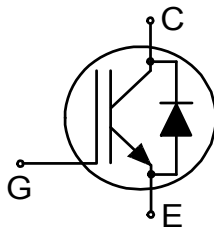
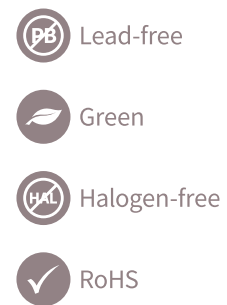
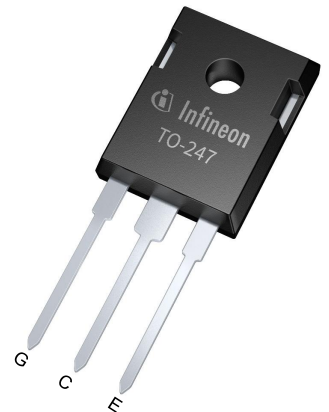
### Product validation

- 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
IKW50N65SS5	PG-TO247-3	K50ESS5

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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		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 $T_{vjmax}$	$I_C$	limited by bondwire	$T_c = 25\text{ °C}$	80	A
			$T_c = 100\text{ °C}$	60.5	
Pulsed collector current, $t_p$ limited by $T_{vjmax}$	$I_{Cpulse}$		200	A	
Turn-off safe operating area		$V_{CE} \leq 650\text{ V}, t_p = 1\text{ }\mu\text{s}, T_{vj} \leq 175\text{ °C}$	200	A	
Gate-emitter voltage	$V_{GE}$		$\pm 20$	V	
Transient gate-emitter voltage	$V_{GE}$	$t_p \leq 10\text{ }\mu\text{s}, D < 0.01$	$\pm 30$	V	
Power dissipation	$P_{tot}$		$T_c = 25\text{ °C}$	274	W
			$T_c = 100\text{ °C}$	137	

**Table 3** Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Collector-emitter saturation voltage	$V_{CEsat}$	$I_C = 50\text{ A}, V_{GE} = 15\text{ V}$	$T_{vj} = 25\text{ °C}$		1.35	1.7	V
			$T_{vj} = 125\text{ °C}$		1.55		
			$T_{vj} = 175\text{ °C}$		1.65		
Gate-emitter threshold voltage	$V_{GEth}$	$I_C = 0.5\text{ mA}, V_{CE} = V_{GE}$	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	$I_{CES}$	$V_{CE} = 650 \text{ V}, V_{GE} = 0 \text{ V}$	$T_{vj} = 25 \text{ }^\circ\text{C}$			1300	$\mu\text{A}$
			$T_{vj} = 175 \text{ }^\circ\text{C}$		2000		
Zero gate-voltage collector current	$I_{CES}$	$V_{CE} = 480 \text{ V}, V_{GE} = 0 \text{ V}$	$T_{vj} = 25 \text{ }^\circ\text{C}$			40	$\mu\text{A}$
Gate-emitter leakage current	$I_{GES}$	$V_{CE} = 0 \text{ V}, V_{GE} = 20 \text{ V}$				100	nA
Transconductance	$g_{fs}$	$I_C = 50 \text{ A}, V_{CE} = 20 \text{ V}$		62			S
Input capacitance	$C_{ies}$	$V_{CE} = 25 \text{ V}, V_{GE} = 0 \text{ V}, f = 250 \text{ kHz}$		2660			pF
Output capacitance	$C_{oes}$	$V_{CE} = 25 \text{ V}, V_{GE} = 0 \text{ V}, f = 250 \text{ kHz}$		530			pF
Reverse transfer capacitance	$C_{res}$	$V_{CE} = 25 \text{ V}, V_{GE} = 0 \text{ V}, f = 250 \text{ kHz}$		10			pF
Gate charge	$Q_G$	$I_C = 50 \text{ A}, V_{GE} = 15 \text{ V}, V_{CC} = 520 \text{ V}$		110			nC
Turn-on delay time	$t_{d(on)}$	$V_{CC} = 400 \text{ V}, V_{GE} = 0/15 \text{ V}, R_{Gon} = 9 \text{ } \Omega, R_{Goff} = 9 \text{ } \Omega, L_\sigma = 30 \text{ nH}, C_\sigma = 30 \text{ pF}$	$T_{vj} = 25 \text{ }^\circ\text{C}, I_C = 50 \text{ A}$		20		ns
			$T_{vj} = 25 \text{ }^\circ\text{C}, I_C = 25 \text{ A}$		19		
			$T_{vj} = 150 \text{ }^\circ\text{C}, I_C = 50 \text{ A}$		20		
			$T_{vj} = 150 \text{ }^\circ\text{C}, I_C = 25 \text{ A}$		18		
Rise time (inductive load)	$t_r$	$V_{CC} = 400 \text{ V}, V_{GE} = 0/15 \text{ V}, R_{Gon} = 9 \text{ } \Omega, R_{Goff} = 9 \text{ } \Omega, L_\sigma = 30 \text{ nH}, C_\sigma = 30 \text{ pF}$	$T_{vj} = 25 \text{ }^\circ\text{C}, I_C = 50 \text{ A}$		10		ns
			$T_{vj} = 25 \text{ }^\circ\text{C}, I_C = 25 \text{ A}$		5		
			$T_{vj} = 150 \text{ }^\circ\text{C}, I_C = 50 \text{ A}$		11		
			$T_{vj} = 150 \text{ }^\circ\text{C}, I_C = 25 \text{ A}$		6		
Turn-off delay time	$t_{d(off)}$	$V_{CC} = 400 \text{ V}, V_{GE} = 0/15 \text{ V}, R_{Gon} = 9 \text{ } \Omega, R_{Goff} = 9 \text{ } \Omega, L_\sigma = 30 \text{ nH}, C_\sigma = 30 \text{ pF}$	$T_{vj} = 25 \text{ }^\circ\text{C}, I_C = 50 \text{ A}$		140		ns
			$T_{vj} = 25 \text{ }^\circ\text{C}, I_C = 25 \text{ A}$		155		
			$T_{vj} = 150 \text{ }^\circ\text{C}, I_C = 50 \text{ A}$		163		
			$T_{vj} = 150 \text{ }^\circ\text{C}, I_C = 25 \text{ A}$		191		

(table continues...)

**Table 3 (continued) Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Fall time (inductive load)	$t_f$	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V},$ $R_{Gon} = 9\ \Omega, R_{Goff} = 9\ \Omega,$ $L_\sigma = 30\text{ nH}, C_\sigma = 30\text{ pF}$	$T_{vj} = 25\text{ }^\circ\text{C},$ $I_C = 50\text{ A}$		20		ns
			$T_{vj} = 25\text{ }^\circ\text{C},$ $I_C = 25\text{ A}$		25		
			$T_{vj} = 150\text{ }^\circ\text{C},$ $I_C = 50\text{ A}$		20		
			$T_{vj} = 150\text{ }^\circ\text{C},$ $I_C = 25\text{ A}$		25		
Turn-on energy	$E_{on}$	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V},$ $R_{Gon} = 9\ \Omega, R_{Goff} = 9\ \Omega,$ $L_\sigma = 30\text{ nH}, C_\sigma = 30\text{ pF}$	$T_{vj} = 25\text{ }^\circ\text{C},$ $I_C = 50\text{ A}$		0.32		mJ
			$T_{vj} = 25\text{ }^\circ\text{C},$ $I_C = 25\text{ A}$		0.14		
			$T_{vj} = 150\text{ }^\circ\text{C},$ $I_C = 50\text{ A}$		0.39		
			$T_{vj} = 150\text{ }^\circ\text{C},$ $I_C = 25\text{ A}$		0.17		
Turn-off energy	$E_{off}$	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V},$ $R_{Gon} = 9\ \Omega, R_{Goff} = 9\ \Omega,$ $L_\sigma = 30\text{ nH}, C_\sigma = 30\text{ pF}$	$T_{vj} = 25\text{ }^\circ\text{C},$ $I_C = 50\text{ A}$		0.55		mJ
			$T_{vj} = 25\text{ }^\circ\text{C},$ $I_C = 25\text{ A}$		0.3		
			$T_{vj} = 150\text{ }^\circ\text{C},$ $I_C = 50\text{ A}$		0.9		
			$T_{vj} = 150\text{ }^\circ\text{C},$ $I_C = 25\text{ A}$		0.5		
Total switching energy	$E_{ts}$	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V},$ $R_{Gon} = 9\ \Omega, R_{Goff} = 9\ \Omega,$ $L_\sigma = 30\text{ nH}, C_\sigma = 30\text{ pF}$	$T_{vj} = 25\text{ }^\circ\text{C},$ $I_C = 50\text{ A}$		0.87		mJ
			$T_{vj} = 25\text{ }^\circ\text{C},$ $I_C = 25\text{ A}$		0.44		
			$T_{vj} = 150\text{ }^\circ\text{C},$ $I_C = 50\text{ A}$		1.29		
			$T_{vj} = 150\text{ }^\circ\text{C},$ $I_C = 25\text{ A}$		0.67		
IGBT thermal resistance, junction-case	$R_{th(j-c)}$				0.55	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 $T_{vjmax}$	$I_F$		$T_c = 25\text{ °C}$	57.5	A
			$T_c = 100\text{ °C}$	38.5	
Diode pulsed current, $t_p$ limited by $T_{vjmax}$ <sup>1)</sup>	$I_{Fpulse}$		150	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	$V_F$	$I_F = 40\text{ A}$		$T_{vj} = 25\text{ °C}$	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	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.

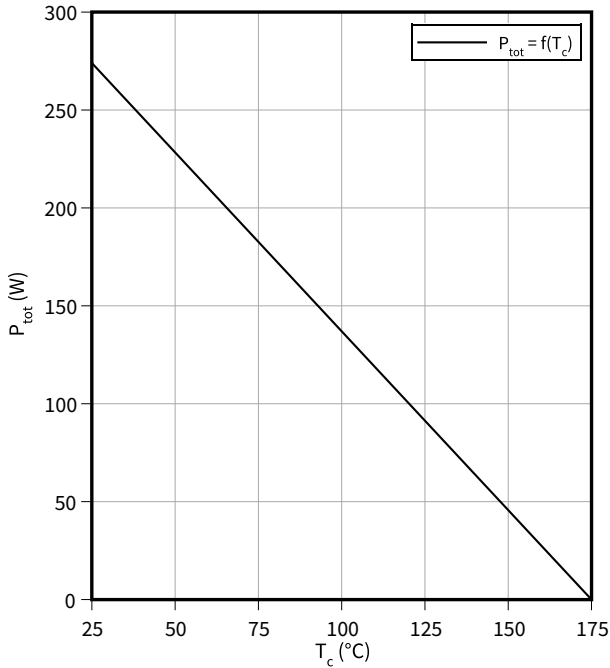
Electrical Characteristic at  $T_{vj} = 25\text{ °C}$ , unless otherwise specified.

Dynamic test circuit, parasitic inductance  $L_\sigma$ , parasitic capacitor  $C_\sigma$  from Fig. E. Energy losses include "tail" and diode reverse recovery.

## 4 Characteristics diagrams

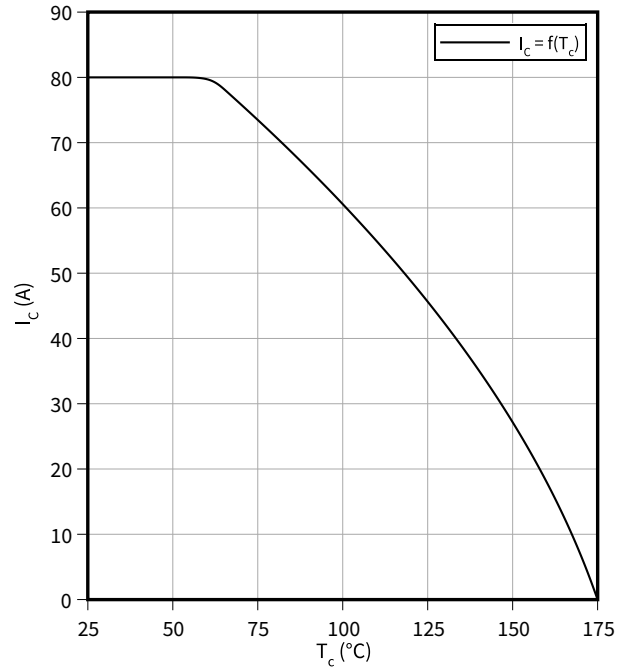
### Power dissipation as a function of case temperature

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



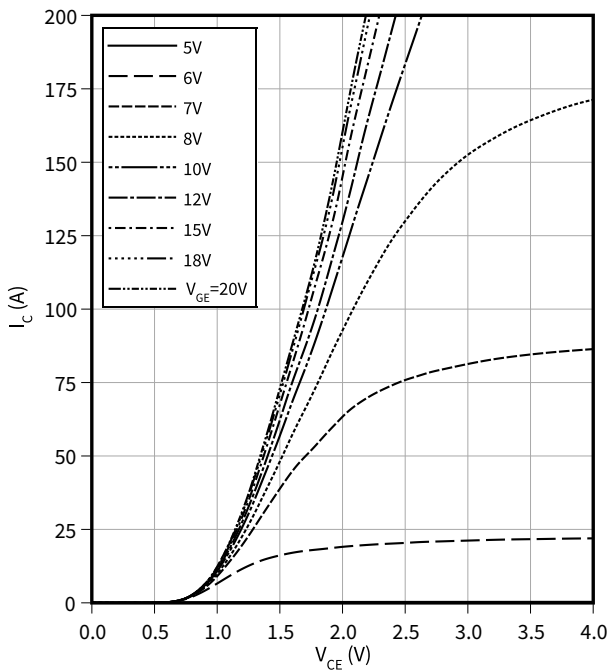
### Collector current as a function of case temperature

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



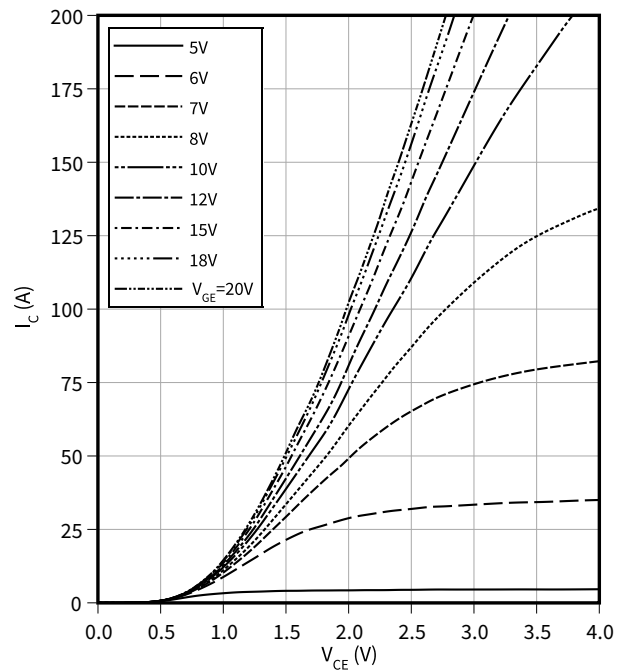
### Typical output characteristic

$I_C = f(V_{CE})$   
 $T_{vj} = 25\text{ °C}$



### Typical output characteristic

$I_C = f(V_{CE})$   
 $T_{vj} = 150\text{ °C}$

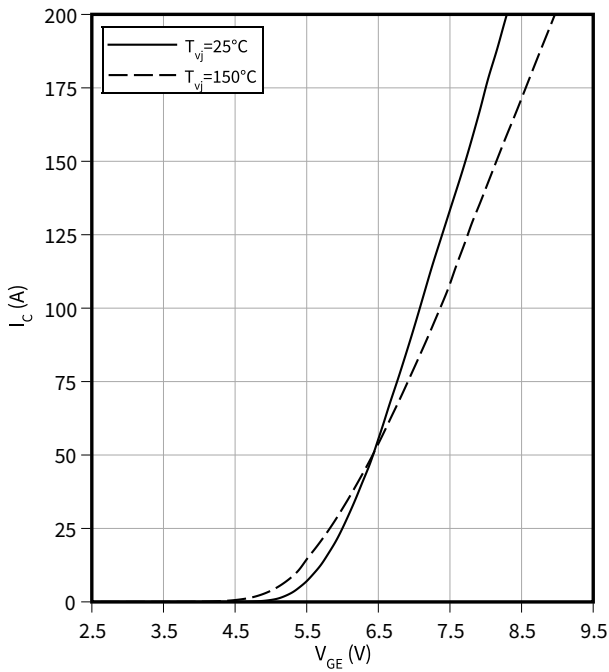


4 Characteristics diagrams

**Typical transfer characteristic**

$I_C = f(V_{GE})$

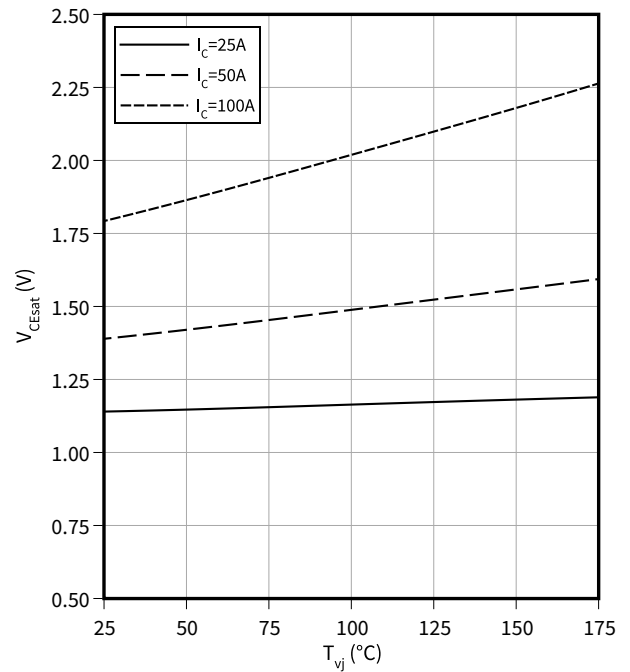
$V_{CE} = 20\text{ V}$



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

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

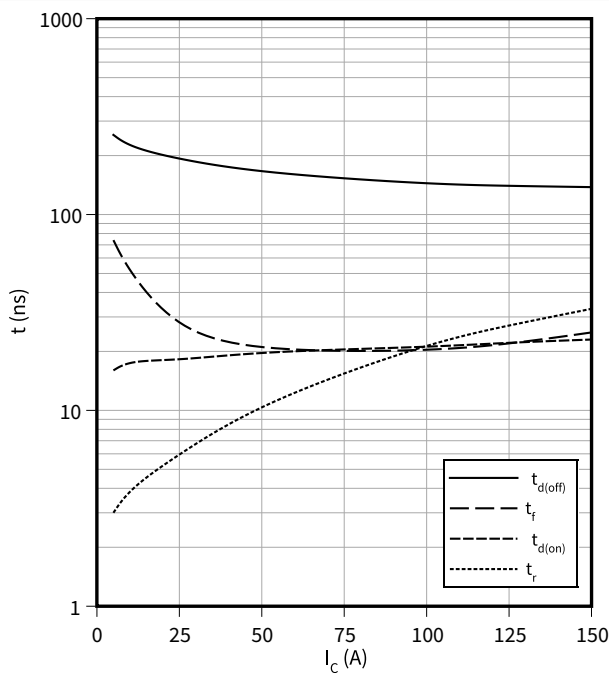
$V_{GE} = 15\text{ V}$



**Typical switching times as a function of collector current**

$t = f(I_C)$

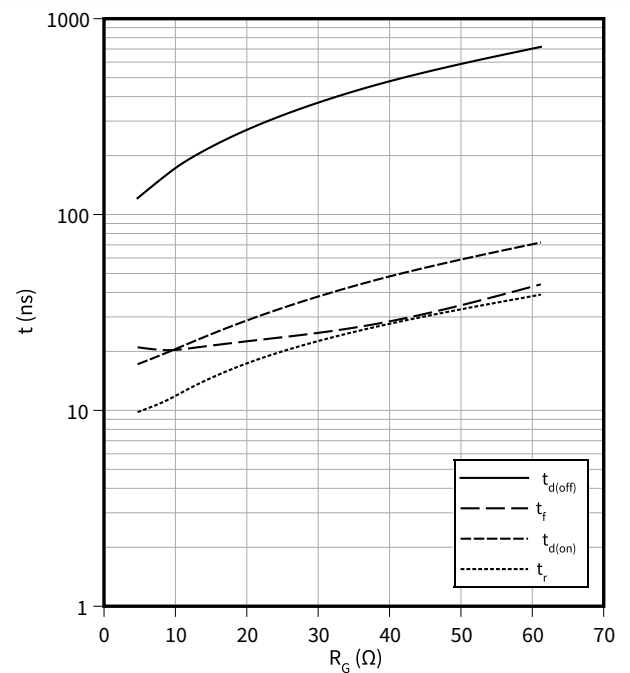
$V_{CC} = 400\text{ V}, T_{vj} = 150\text{ °C}, V_{GE} = 0/15\text{ V}, R_G = 9\text{ }\Omega$



**Typical switching times as a function of gate resistor**

$t = f(R_G)$

$I_C = 50\text{ A}, V_{CC} = 400\text{ V}, T_{vj} = 150\text{ °C}, V_{GE} = 0/15\text{ V}$



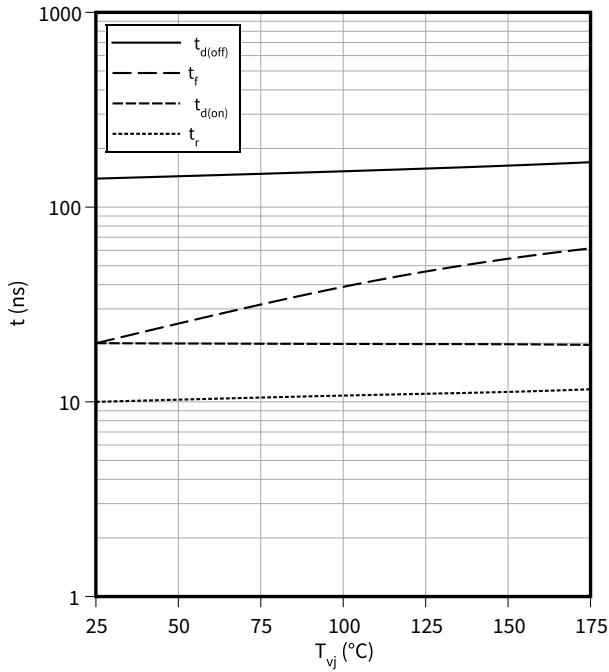


4 Characteristics diagrams

**Typical switching times as a function of junction temperature**

$t = f(T_{vj})$

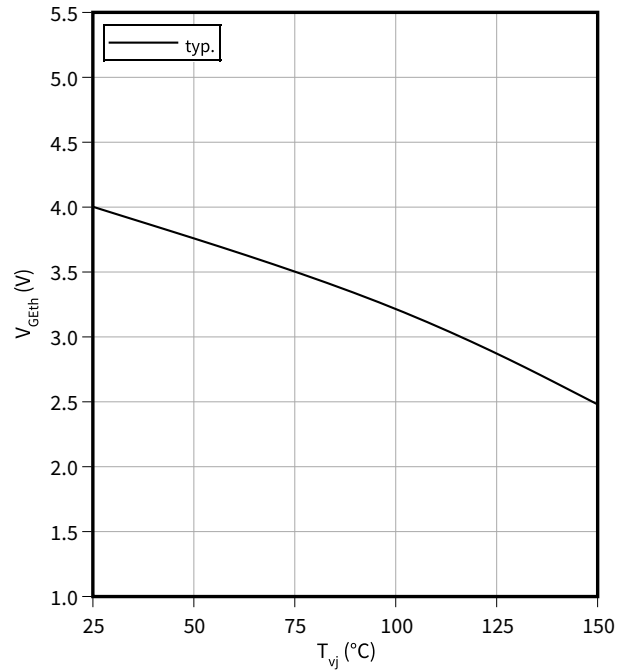
$I_C = 50 \text{ A}$ ,  $V_{CC} = 400 \text{ V}$ ,  $V_{GE} = 0/15 \text{ V}$ ,  $R_G = 9 \Omega$



**Gate-emitter threshold voltage as a function of junction temperature**

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

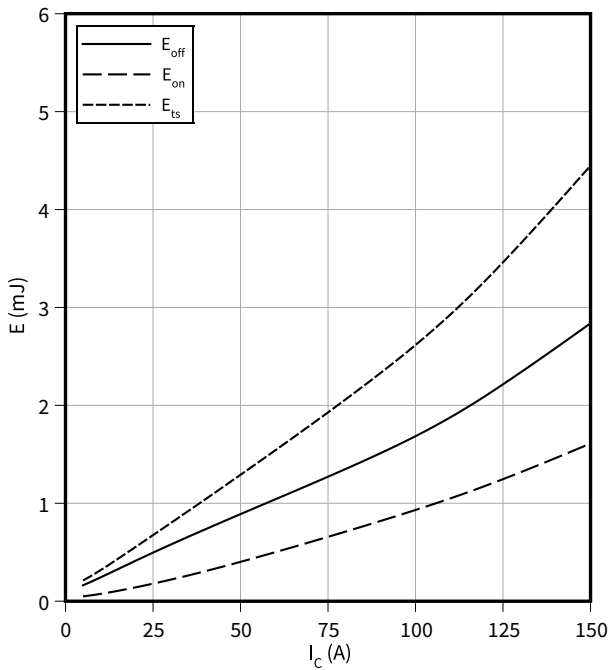
$I_C = 0.5 \text{ mA}$



**Typical switching energy losses as a function of collector current**

$E = f(I_C)$

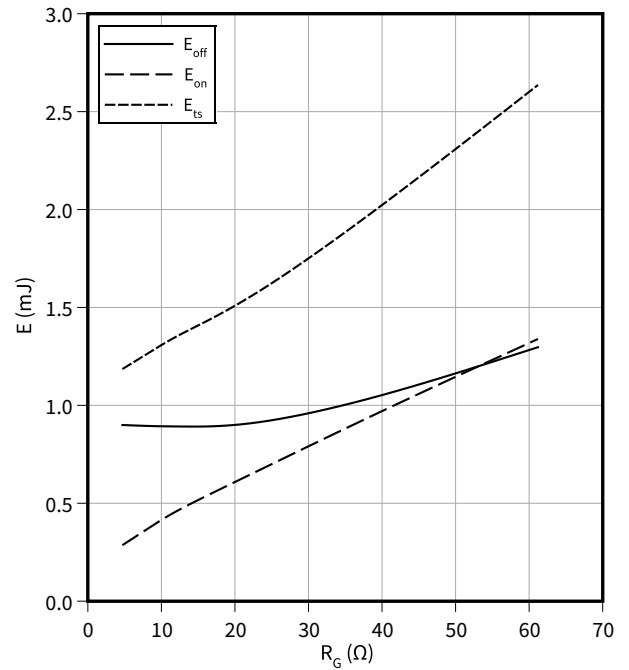
$V_{CC} = 400 \text{ V}$ ,  $T_{vj} = 150 \text{ °C}$ ,  $V_{GE} = 0/15 \text{ V}$ ,  $R_G = 9 \Omega$



**Typical switching energy losses as a function of gate resistor**

$E = f(R_G)$

$I_C = 50 \text{ A}$ ,  $V_{CC} = 400 \text{ V}$ ,  $T_{vj} = 150 \text{ °C}$ ,  $V_{GE} = 0/15 \text{ V}$

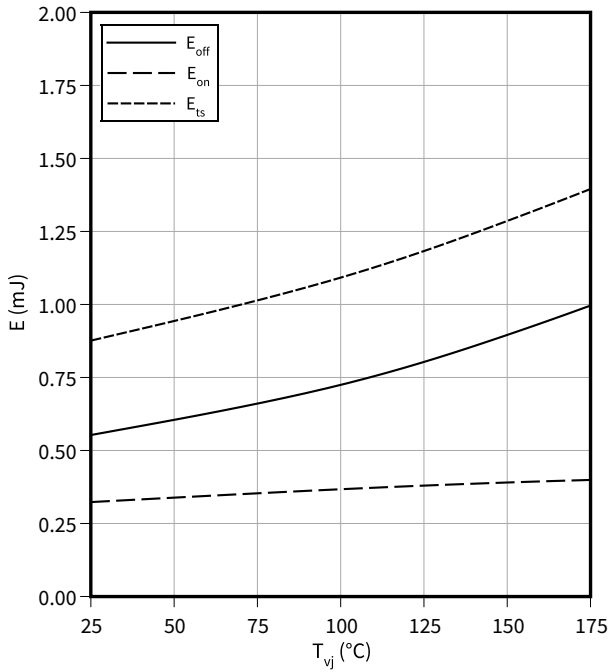


4 Characteristics diagrams

**Typical switching energy losses as a function of junction temperature**

$E = f(T_{vj})$

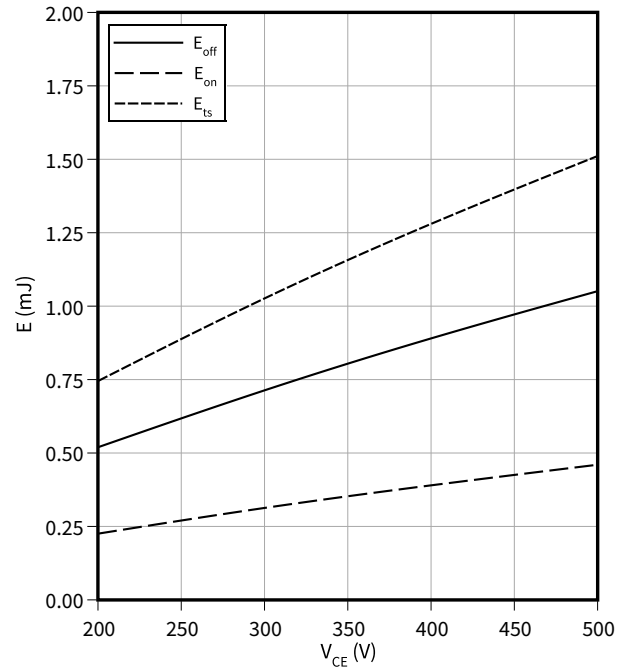
$I_C = 50\text{ A}$ ,  $V_{CC} = 400\text{ V}$ ,  $V_{GE} = 0/15\text{ V}$ ,  $R_G = 9\ \Omega$



**Typical switching energy losses as a function of collector emitter voltage**

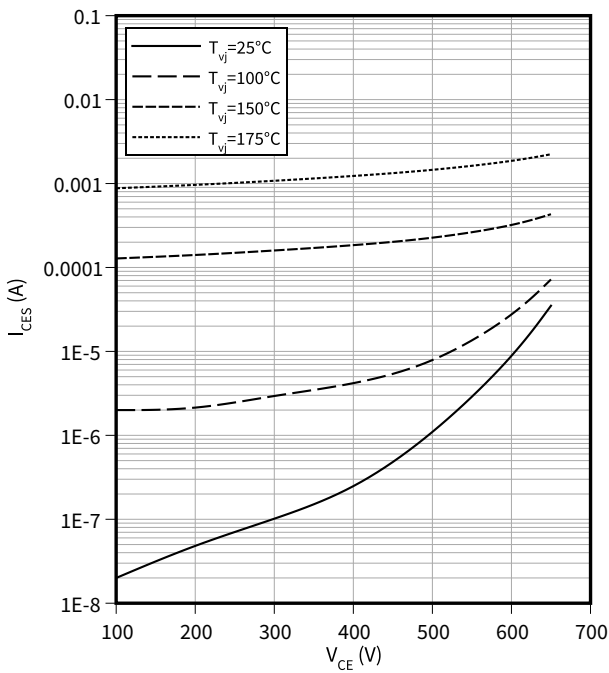
$E = f(V_{CE})$

$I_C = 50\text{ A}$ ,  $T_{vj} = 150\text{ °C}$ ,  $V_{GE} = 0/15\text{ V}$ ,  $R_G = 9\ \Omega$



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

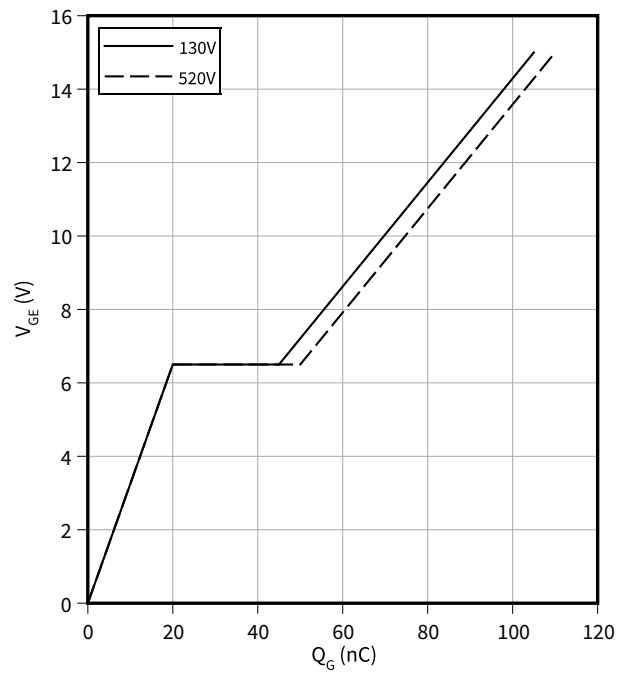
$I_{CES} = f(V_{CE})$



**Typical gate charge**

$V_{GE} = f(Q_G)$

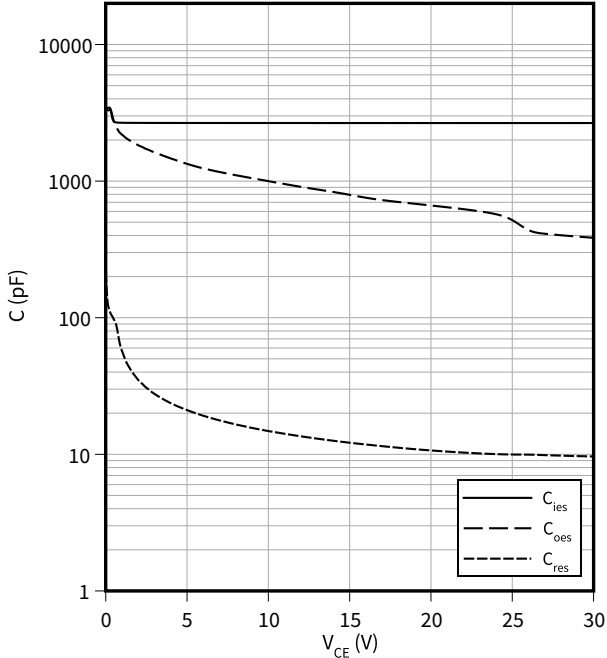
$I_C = 50\text{ A}$



4 Characteristics diagrams

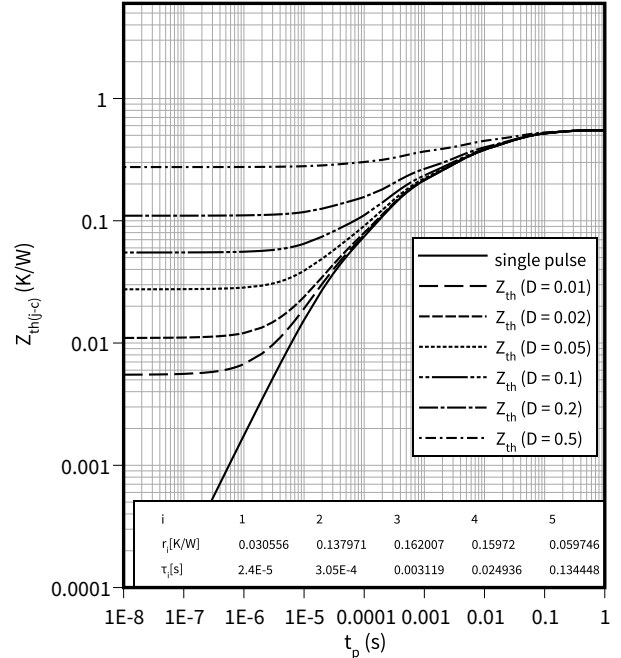
**Typical capacitance as a function of collector-emitter voltage**

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



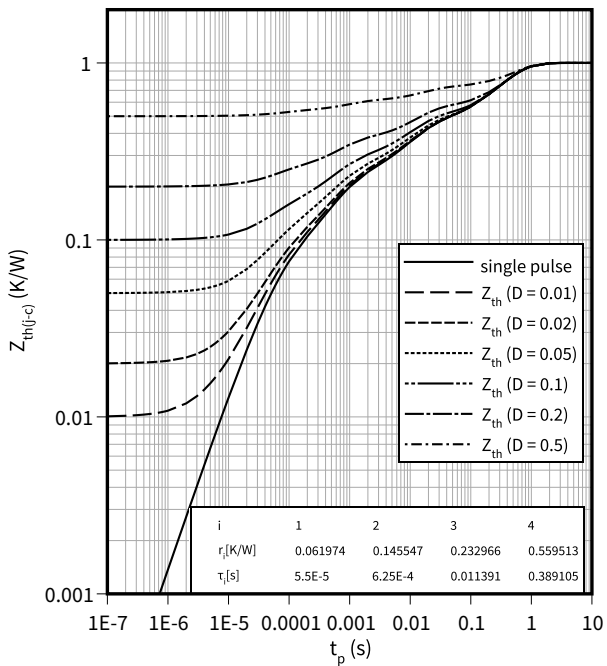
**IGBT transient thermal impedance as a function of pulse width**

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



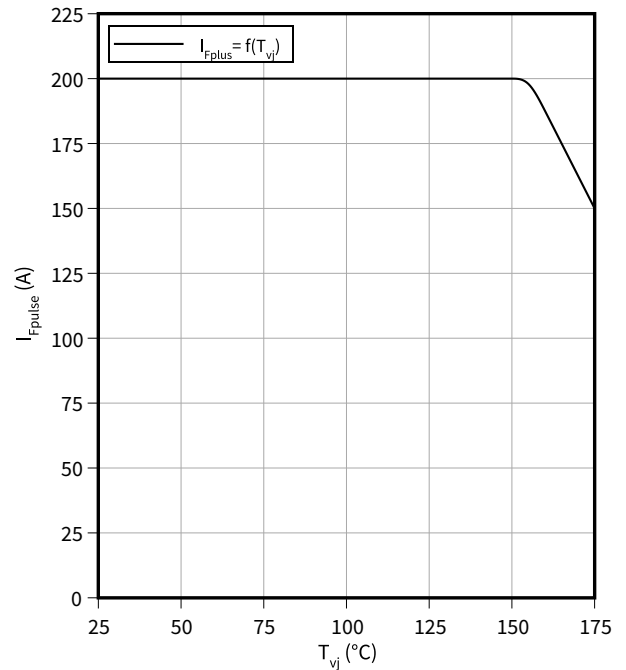
**Diode transient thermal impedance as a function of pulse width**

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



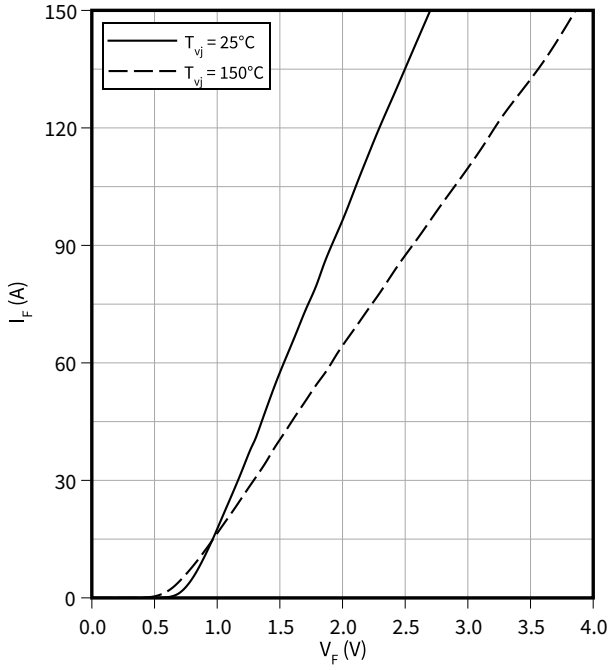
**Maximum pulse current as a function of junction temperature**

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



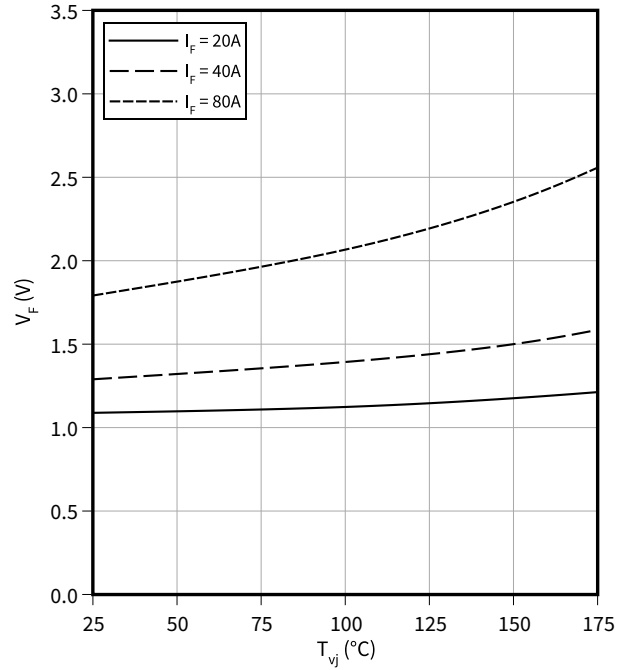
**Typical diode forward current as a function of forward voltage**

$I_F = f(V_F)$

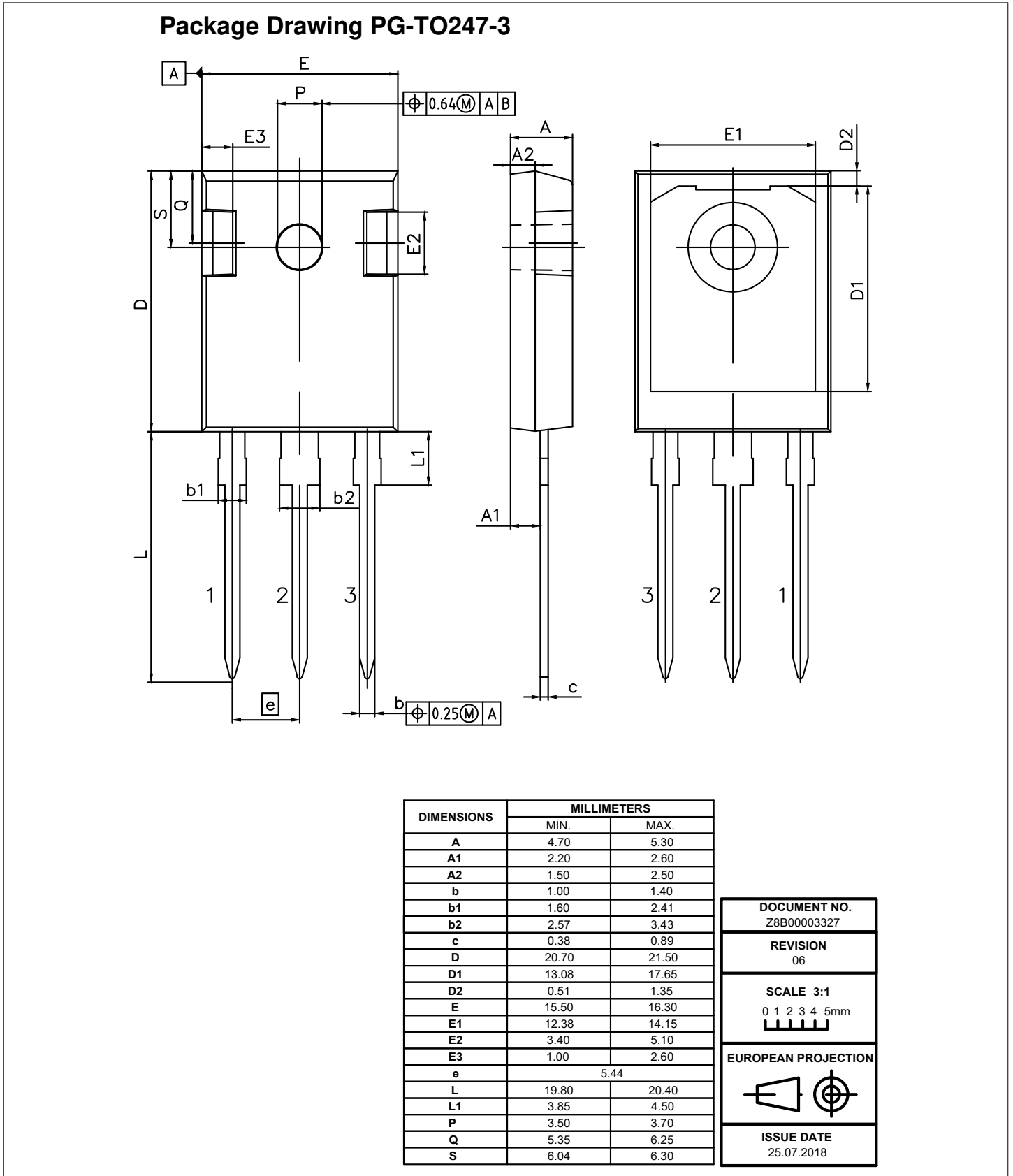


**Typical diode forward voltage as a function of junction temperature**

$V_F = f(T_{vj})$

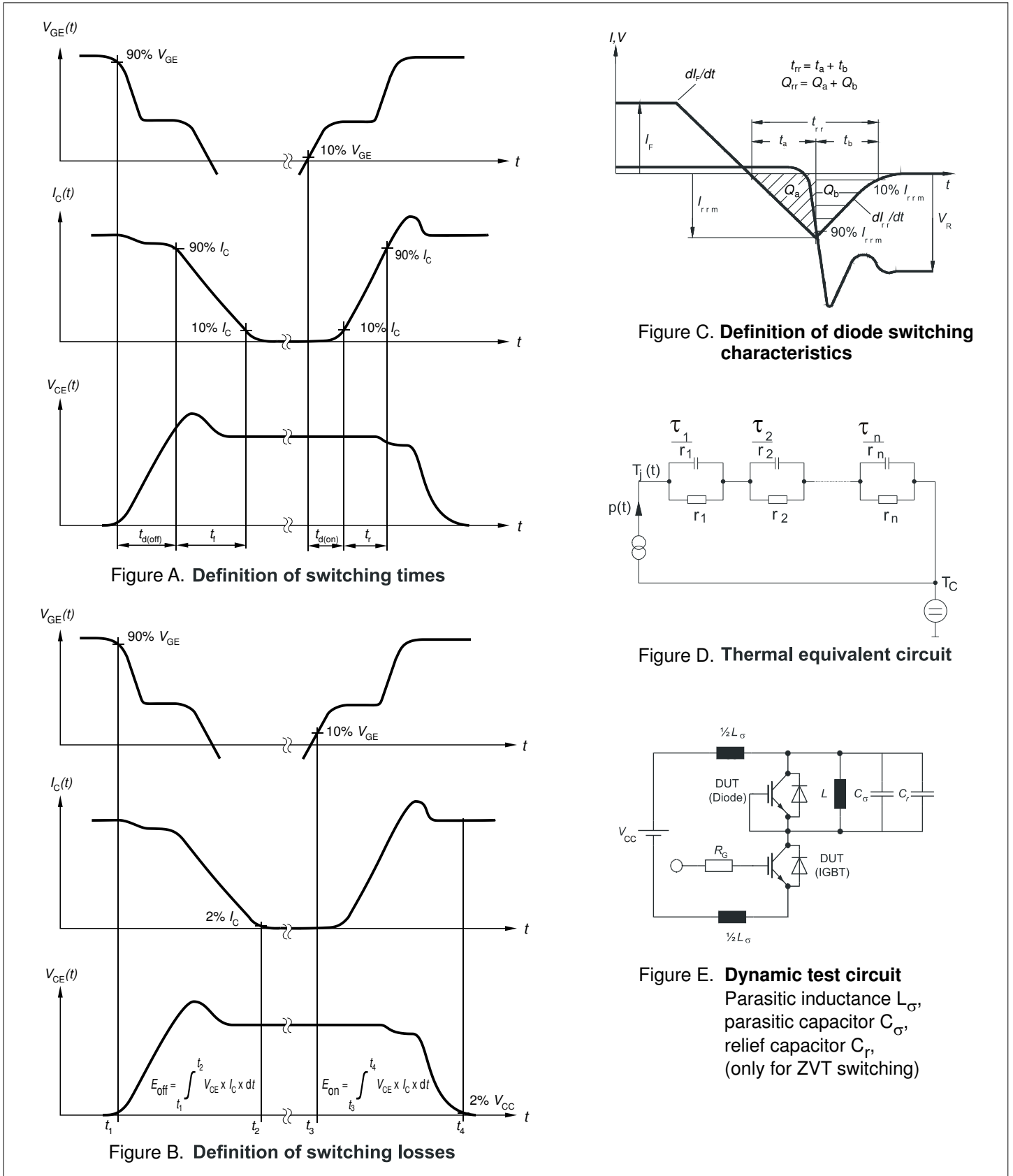


**5 Package outlines**



**Figure 1**

**6 Testing conditions**



**Figure 2**

## 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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