

## Low loss Duopack: IGBT 7 with Trench and Fieldstop technology

### Features

- $V_{CE} = 650\text{ V}$
- $I_C = 20\text{ A}$
- Very low  $V_{CE,sat}$
- Low turn-off losses
- Short tail current
- Reduced EMI
- Very soft, fast recovery antiparallel diode
- 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/igbt7/>

### Potential applications

- Servo drives
- General purpose drives (GPD)
- Industrial UPS
- Industrial SMPS
- Solar optimizer
- Solar string inverter

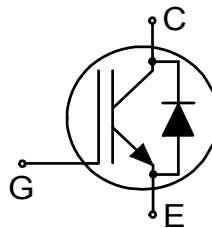
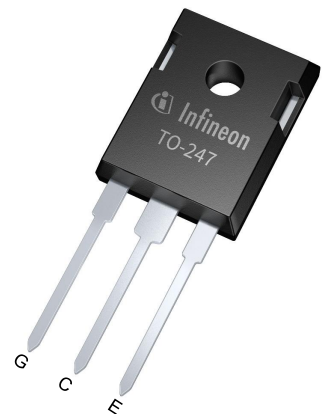
### Product validation

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

### Description

Package pin definition:

- Pin C & backside - Collector
- Pin E - Emitter
- Pin G - Gate



Type	Package	Marking
IKW20N65ET7	PG-TO247-3	K20EET7

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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
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	$R_{th(j-c)}$				1.1	K/W
Diode thermal resistance, junction-case	$R_{th(j-c)}$				1.4	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	$T_c = 25\text{ °C}$	40	A
			$T_c = 100\text{ °C}$	27.5	
Pulsed collector current, $t_p$ limited by $T_{vjmax}$ <sup>1)</sup>	$I_{Cpulse}$		60	A	
Turn-off safe operating area <sup>2)</sup>		$V_{CE} \leq 650\text{ V}$ , $t_p = 1\text{ }\mu\text{s}$ , $T_{vj} \leq 175\text{ °C}$	60	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	
Short-circuit withstand time	$t_{SC}$	$V_{GE} = 15\text{ V}$ , Allowed number of short circuits < 1000, Time between short circuits $\geq 1.0\text{ s}$	$V_{CC} \leq 330\text{ V}$ , $T_{vj} = 100\text{ °C}$	5	$\mu\text{s}$
			$V_{CC} \leq 400\text{ V}$ , $T_{vj} = 150\text{ °C}$	3	
Power dissipation	$P_{tot}$		$T_c = 25\text{ °C}$	136	W
			$T_c = 100\text{ °C}$	68	

1) Defined by design. Not subject to production test.

2) Clamped inductive load current test for each device,  $I_C = 60\text{ A}$ ,  $V_{CC} = 400\text{ V}$ ,  $T_c = 25\text{ °C}$ ,  $V_{GE} = 20\text{ V}$ ,  $L = 80\text{ }\mu\text{H}$ ,  $R_G = 10\text{ }\Omega$

**Table 3** Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Collector-emitter saturation voltage	$V_{CEsat}$	$I_C = 20\text{ A}, V_{GE} = 15\text{ V}$	$T_{vj} = 25\text{ °C}$	1.35	1.65	V
			$T_{vj} = 125\text{ °C}$	1.5		
			$T_{vj} = 175\text{ °C}$	1.6		
Gate-emitter threshold voltage	$V_{GETh}$	$I_C = 0.2\text{ mA}, V_{CE} = V_{GE}$	4.3	5	5.7	V
Zero gate-voltage collector current	$I_{CES}$	$V_{CE} = 650\text{ V}, V_{GE} = 0\text{ V}$	$T_{vj} = 25\text{ °C}$		40	$\mu\text{A}$
			$T_{vj} = 175\text{ °C}$		700	
Gate-emitter leakage current	$I_{GES}$	$V_{CE} = 0\text{ V}, V_{GE} = 20\text{ V}$			100	nA
Transconductance	$g_{fs}$	$I_C = 20\text{ A}, V_{CE} = 20\text{ V}$		10		S
Short-circuit collector current	$I_{SC}$	$V_{CC} \leq 400\text{ V}, V_{GE} = 15\text{ V}, t_{SC} \leq 3\text{ }\mu\text{s}$ , Allowed number of short circuits < 1000, Time between short circuits $\geq 1.0\text{ s}$ , $T_{vj} = 150\text{ °C}$		110		A
Input capacitance	$C_{ies}$	$V_{CE} = 25\text{ V}, V_{GE} = 0\text{ V}, f = 1000\text{ kHz}$		1310		pF
Output capacitance	$C_{oes}$	$V_{CE} = 25\text{ V}, V_{GE} = 0\text{ V}, f = 1000\text{ kHz}$		42		pF
Reverse transfer capacitance	$C_{res}$	$V_{CE} = 25\text{ V}, V_{GE} = 0\text{ V}, f = 1000\text{ kHz}$		13		pF
Gate charge	$Q_G$	$I_C = 20\text{ A}, V_{GE} = 15\text{ V}, V_{CC} = 520\text{ V}$		128		nC
Turn-on delay time	$t_{d(on)}$	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V}, R_{G(on)} = 12\text{ }\Omega, R_{G(off)} = 12\text{ }\Omega, L_\sigma = 32\text{ nH}, C_\sigma = 30\text{ pF}$	$T_{vj} = 25\text{ °C}, I_C = 20\text{ A}$	16		ns
			$T_{vj} = 25\text{ °C}, I_C = 10\text{ A}$	15		
			$T_{vj} = 175\text{ °C}, I_C = 20\text{ A}$	17		
			$T_{vj} = 175\text{ °C}, I_C = 10\text{ A}$	15		
Rise time (inductive load)	$t_r$	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V}, R_{G(on)} = 12\text{ }\Omega, R_{G(off)} = 12\text{ }\Omega, L_\sigma = 32\text{ nH}, C_\sigma = 30\text{ pF}$	$T_{vj} = 25\text{ °C}, I_C = 20\text{ A}$	10		ns
			$T_{vj} = 25\text{ °C}, I_C = 10\text{ A}$	6		
			$T_{vj} = 175\text{ °C}, I_C = 20\text{ A}$	12		
			$T_{vj} = 175\text{ °C}, I_C = 10\text{ A}$	7		

(table continues...)

**Table 3 (continued) Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Turn-off delay time	$t_{d(off)}$	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V},$ $R_{G(on)} = 12\ \Omega,$ $R_{G(off)} = 12\ \Omega, L_{\sigma} = 32\text{ nH},$ $C_{\sigma} = 30\text{ pF}$	$T_{vj} = 25\text{ }^{\circ}\text{C},$ $I_C = 20\text{ A}$		210	ns
			$T_{vj} = 25\text{ }^{\circ}\text{C},$ $I_C = 10\text{ A}$		235	
			$T_{vj} = 175\text{ }^{\circ}\text{C},$ $I_C = 20\text{ A}$		255	
			$T_{vj} = 175\text{ }^{\circ}\text{C},$ $I_C = 10\text{ A}$		310	
Fall time (inductive load)	$t_f$	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V},$ $R_{G(on)} = 12\ \Omega,$ $R_{G(off)} = 12\ \Omega, L_{\sigma} = 32\text{ nH},$ $C_{\sigma} = 30\text{ pF}$	$T_{vj} = 25\text{ }^{\circ}\text{C},$ $I_C = 20\text{ A}$		20	ns
			$T_{vj} = 25\text{ }^{\circ}\text{C},$ $I_C = 10\text{ A}$		18	
			$T_{vj} = 175\text{ }^{\circ}\text{C},$ $I_C = 20\text{ A}$		75	
			$T_{vj} = 175\text{ }^{\circ}\text{C},$ $I_C = 10\text{ A}$		80	
Turn-on energy	$E_{on}$	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V},$ $R_{G(on)} = 12\ \Omega,$ $R_{G(off)} = 12\ \Omega, L_{\sigma} = 32\text{ nH},$ $C_{\sigma} = 30\text{ pF}$	$T_{vj} = 25\text{ }^{\circ}\text{C},$ $I_C = 20\text{ A}$		0.36	mJ
			$T_{vj} = 25\text{ }^{\circ}\text{C},$ $I_C = 10\text{ A}$		0.16	
			$T_{vj} = 175\text{ }^{\circ}\text{C},$ $I_C = 20\text{ A}$		0.58	
			$T_{vj} = 175\text{ }^{\circ}\text{C},$ $I_C = 10\text{ A}$		0.3	
Turn-off energy	$E_{off}$	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V},$ $R_{G(on)} = 12\ \Omega,$ $R_{G(off)} = 12\ \Omega, L_{\sigma} = 32\text{ nH},$ $C_{\sigma} = 30\text{ pF}$	$T_{vj} = 25\text{ }^{\circ}\text{C},$ $I_C = 20\text{ A}$		0.36	mJ
			$T_{vj} = 25\text{ }^{\circ}\text{C},$ $I_C = 10\text{ A}$		0.21	
			$T_{vj} = 175\text{ }^{\circ}\text{C},$ $I_C = 20\text{ A}$		0.65	
			$T_{vj} = 175\text{ }^{\circ}\text{C},$ $I_C = 10\text{ A}$		0.38	

**(table continues...)**

**Table 3 (continued) Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Total switching energy	$E_{ts}$	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V},$ $R_{G(on)} = 12\ \Omega,$ $R_{G(off)} = 12\ \Omega, L_{\sigma} = 32\text{ nH},$ $C_{\sigma} = 30\text{ pF}$	$T_{vj} = 25\text{ }^{\circ}\text{C},$ $I_C = 20\text{ A}$		0.72		mJ
			$T_{vj} = 25\text{ }^{\circ}\text{C},$ $I_C = 10\text{ A}$		0.37		
			$T_{vj} = 175\text{ }^{\circ}\text{C},$ $I_C = 20\text{ A}$		1.23		
			$T_{vj} = 175\text{ }^{\circ}\text{C},$ $I_C = 10\text{ A}$		0.68		
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	$V_{RRM}$	$T_{vj} \geq 25\text{ }^{\circ}\text{C}$	650	V	
Diode forward current, limited by $T_{vjmax}$	$I_F$	limited by bondwire	$T_C = 25\text{ }^{\circ}\text{C}$	40	A
			$T_C = 100\text{ }^{\circ}\text{C}$	27.5	
Diode pulsed current, $t_p$ limited by $T_{vjmax}$ <sup>1)</sup>	$I_{Fpulse}$		60	A	

1) Defined by design. Not subject to production test.

**Table 5 Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Diode forward voltage	$V_F$	$I_F = 20\text{ A}$	$T_{vj} = 25\text{ }^{\circ}\text{C}$		1.65	2	V
			$T_{vj} = 125\text{ }^{\circ}\text{C}$		1.6		
			$T_{vj} = 175\text{ }^{\circ}\text{C}$		1.55		

(table continues...)

**Table 5 (continued) Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Diode reverse recovery time	$t_{rr}$	$V_R = 400\text{ V}$	$T_{vj} = 25\text{ °C},$ $I_F = 20\text{ A},$ $-di_F/dt = 1420\text{ A}/\mu\text{s}$		70		ns
			$T_{vj} = 25\text{ °C},$ $I_F = 10\text{ A},$ $-di_F/dt = 1800\text{ A}/\mu\text{s}$		42		
			$T_{vj} = 175\text{ °C},$ $I_F = 20\text{ A},$ $-di_F/dt = 1420\text{ A}/\mu\text{s}$		120		
			$T_{vj} = 175\text{ °C},$ $I_F = 10\text{ A},$ $-di_F/dt = 1450\text{ A}/\mu\text{s}$		88		
Diode reverse recovery charge	$Q_{rr}$	$V_R = 400\text{ V}$	$T_{vj} = 25\text{ °C},$ $I_F = 20\text{ A},$ $-di_F/dt = 1420\text{ A}/\mu\text{s}$		0.44		$\mu\text{C}$
			$T_{vj} = 25\text{ °C},$ $I_F = 10\text{ A},$ $-di_F/dt = 1800\text{ A}/\mu\text{s}$		0.28		
			$T_{vj} = 175\text{ °C},$ $I_F = 20\text{ A},$ $-di_F/dt = 1420\text{ A}/\mu\text{s}$		1.18		
			$T_{vj} = 175\text{ °C},$ $I_F = 10\text{ A},$ $-di_F/dt = 1450\text{ A}/\mu\text{s}$		0.85		
Diode peak reverse recovery current	$I_{rrm}$	$V_R = 400\text{ V}$	$T_{vj} = 25\text{ °C},$ $I_F = 20\text{ A},$ $-di_F/dt = 1420\text{ A}/\mu\text{s}$		13		A
			$T_{vj} = 25\text{ °C},$ $I_F = 10\text{ A},$ $-di_F/dt = 1800\text{ A}/\mu\text{s}$		14		
			$T_{vj} = 175\text{ °C},$ $I_F = 20\text{ A},$ $-di_F/dt = 1420\text{ A}/\mu\text{s}$		19		
			$T_{vj} = 175\text{ °C},$ $I_F = 10\text{ A},$ $-di_F/dt = 1450\text{ A}/\mu\text{s}$		20		

**(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	$di_{rr}/dt$	$V_R = 400\text{ V}$	$T_{vj} = 25\text{ °C},$ $I_F = 20\text{ A},$ $-di_F/dt = 1420\text{ A}/\mu\text{s}$		210		A/ $\mu\text{s}$
			$T_{vj} = 25\text{ °C},$ $I_F = 10\text{ A},$ $-di_F/dt = 1800\text{ A}/\mu\text{s}$		420		
			$T_{vj} = 175\text{ °C},$ $I_F = 20\text{ A},$ $-di_F/dt = 1420\text{ A}/\mu\text{s}$		180		
			$T_{vj} = 175\text{ °C},$ $I_F = 10\text{ A},$ $-di_F/dt = 1450\text{ A}/\mu\text{s}$		265		
Operating junction temperature	$T_{vj}$			-40		175	°C

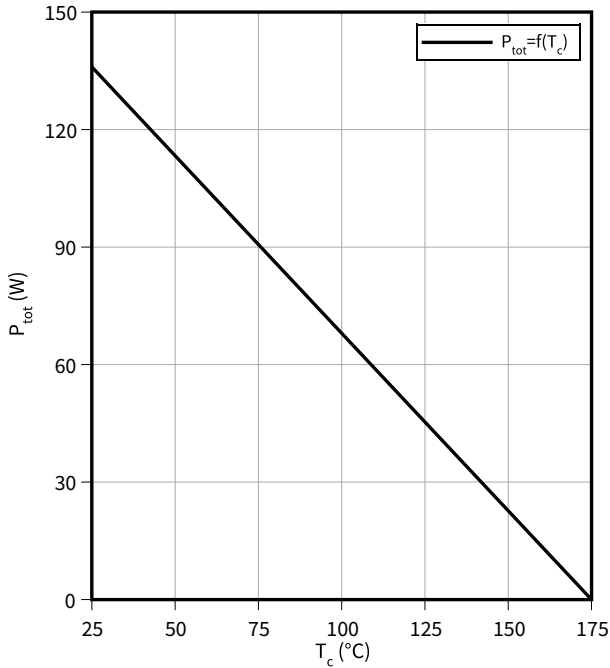
**Note:** *Maximum rated values: For optimum lifetime and reliability, Infineon recommends operating conditions that do not exceed 80% of the maximum ratings stated in this datasheet.*  
*Electrical Characteristic, at  $T_{vj} = 25\text{ °C}$ , unless otherwise specified.*  
*Dynamic test circuit,  $L_\sigma, C_\sigma$  from Fig. E. Energy losses include “tail” and diode reverse recovery.*



## 4 Characteristics diagrams

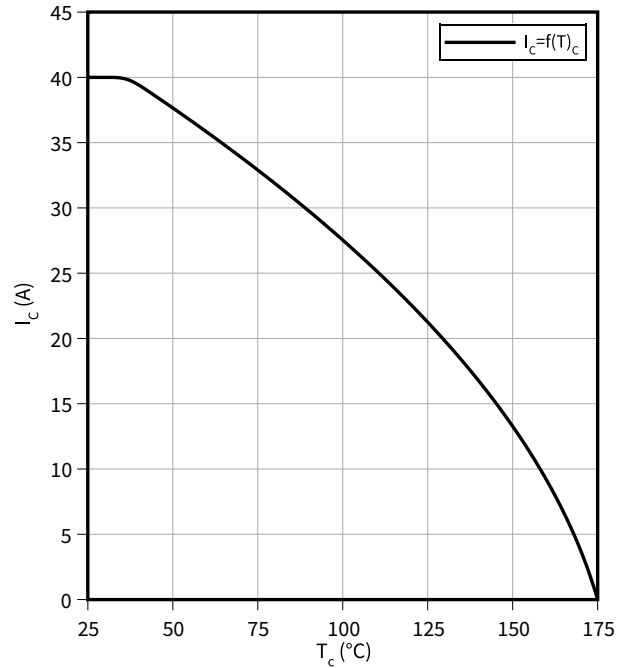
### Power dissipation as a function of case temperature

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



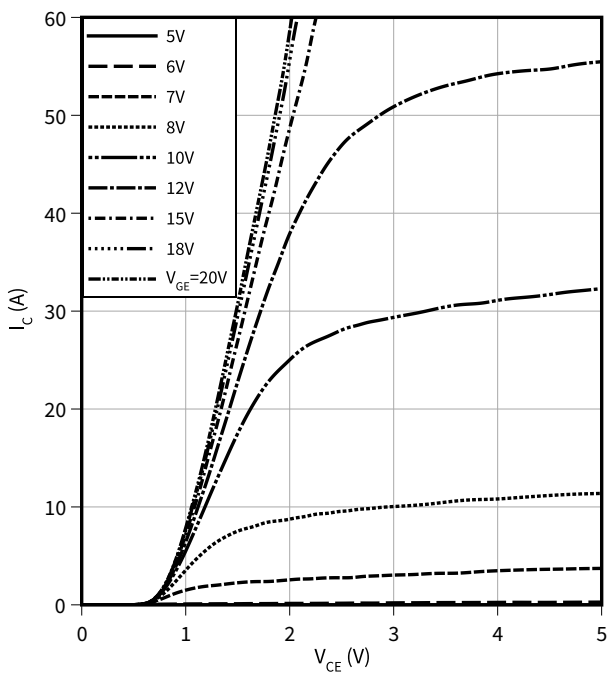
### Collector current as a function of case temperature

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



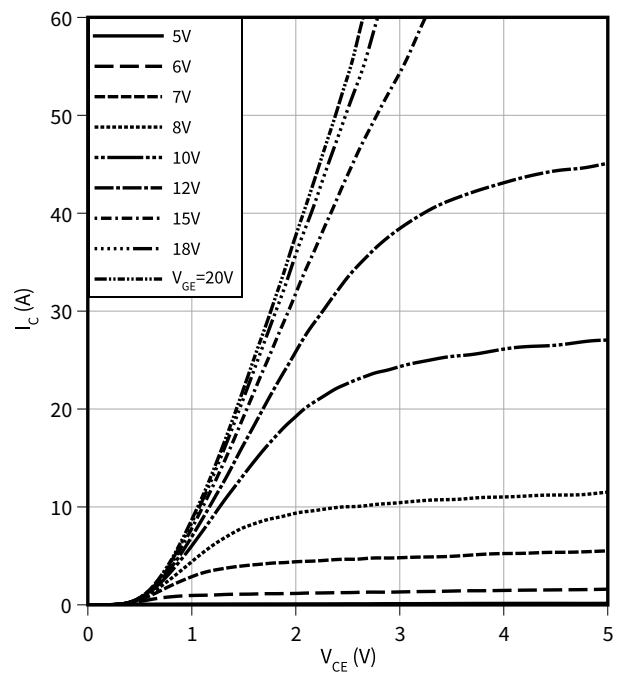
### Typical output characteristic

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



### Typical output characteristic

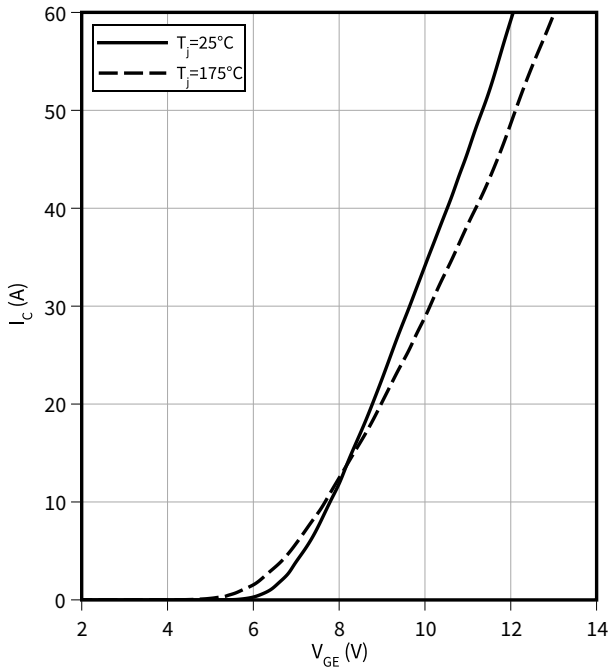
$I_C = f(V_{CE})$   
 $T_{vj} = 175\text{ °C}$



4 Characteristics diagrams

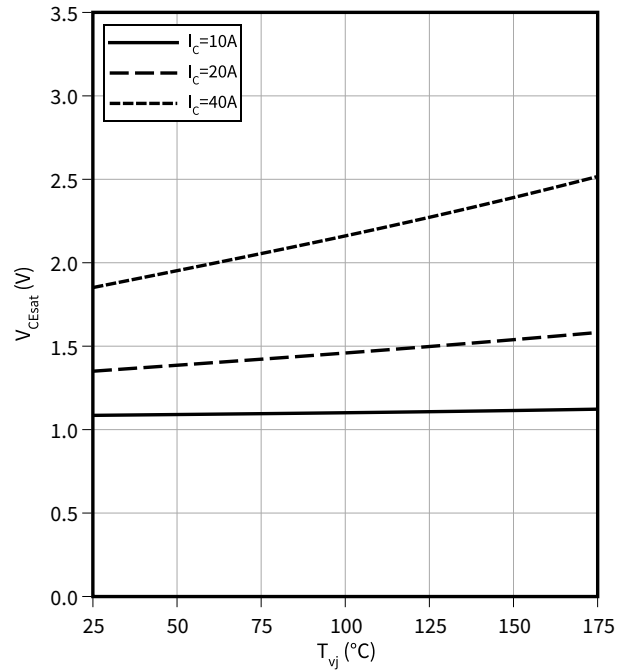
**Typical transfer characteristic**

$I_C = f(V_{GE})$   
 $V_{CE} = 20\text{ V}$



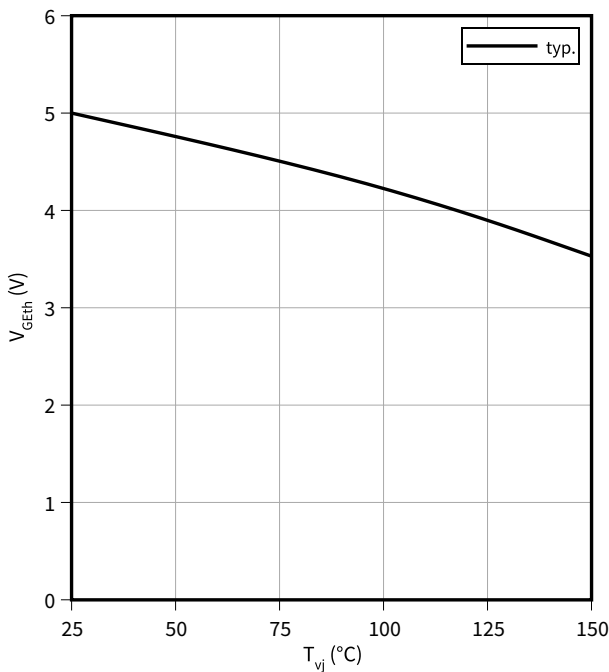
**Typical collector-emitter saturation voltage as a function of junction temperature**

$V_{CEsat} = f(T_{vj})$   
 $V_{GE} = 15\text{ V}$



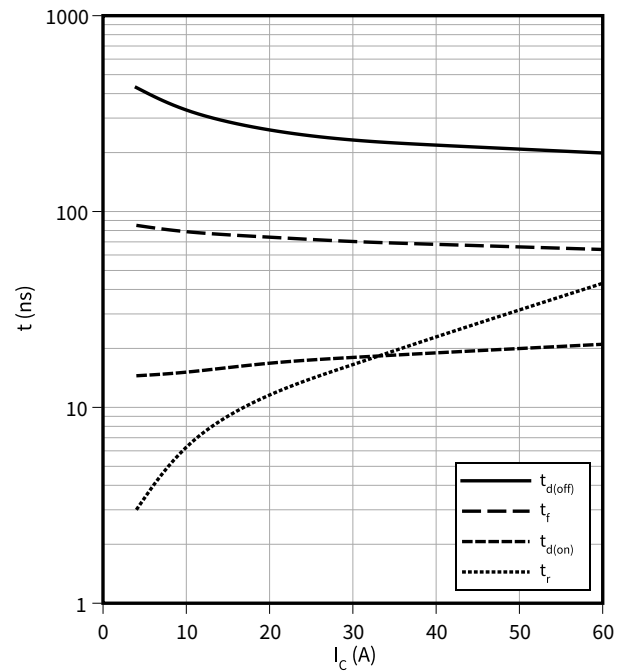
**Gate-emitter threshold voltage as a function of junction temperature**

$V_{GEth} = f(T_{vj})$   
 $I_C = 0.2\text{ mA}$



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

$t = f(I_C)$   
 $V_{CC} = 400\text{ V}, T_{vj} = 175^\circ\text{C}, V_{GE} = 0/15\text{ V}, R_G = 12\ \Omega$

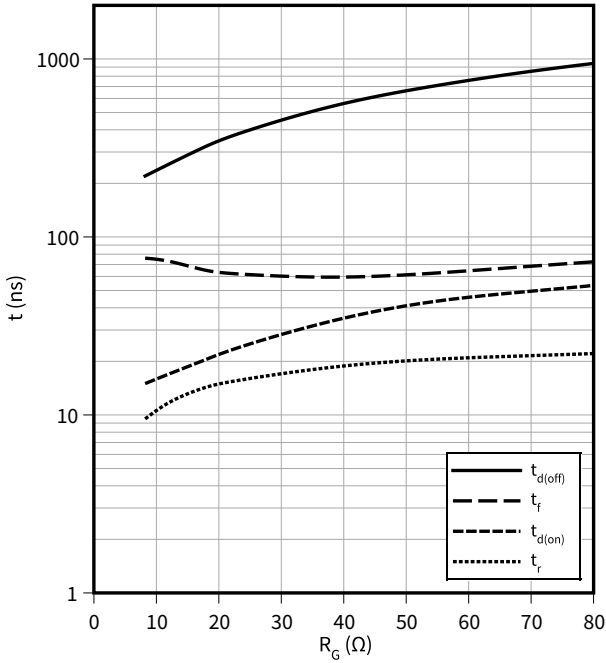


4 Characteristics diagrams

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

$t = f(R_G)$

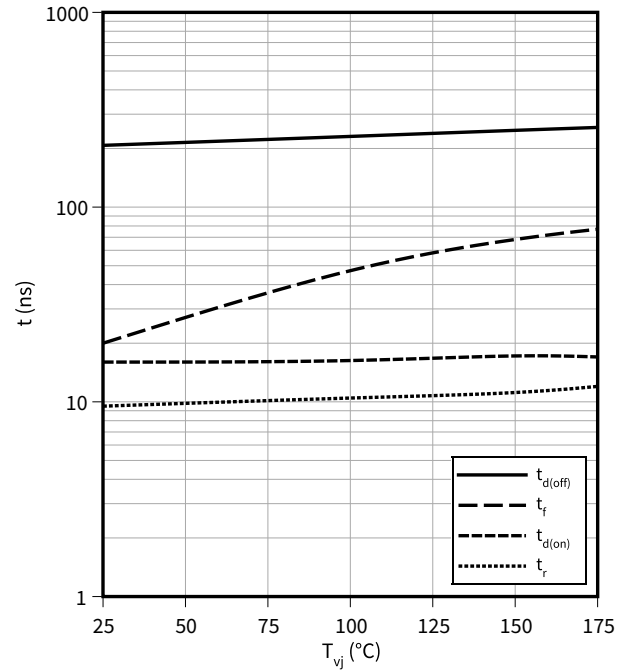
$I_C = 20\text{ A}$ ,  $V_{CC} = 400\text{ V}$ ,  $T_{vj} = 175\text{ °C}$ ,  $V_{GE} = 0/15\text{ V}$



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

$t = f(T_{vj})$

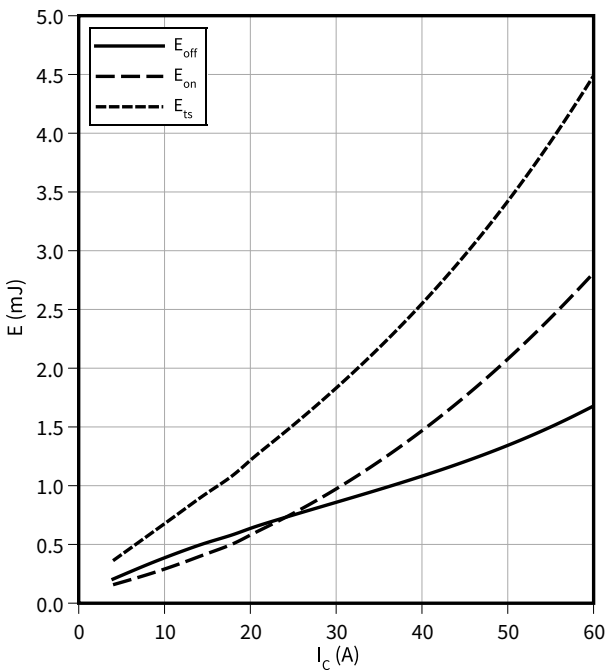
$I_C = 20\text{ A}$ ,  $V_{CC} = 400\text{ V}$ ,  $V_{GE} = 0/15\text{ V}$ ,  $R_G = 12\text{ Ω}$



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

$E = f(I_C)$

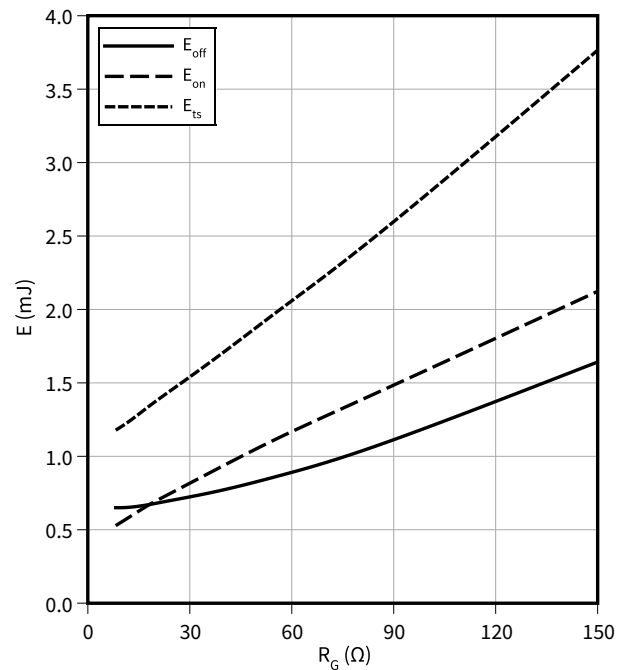
$V_{CC} = 400\text{ V}$ ,  $T_{vj} = 175\text{ °C}$ ,  $V_{GE} = 0/15\text{ V}$ ,  $R_G = 12\text{ Ω}$



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

$E = f(R_G)$

$I_C = 20\text{ A}$ ,  $V_{CC} = 400\text{ V}$ ,  $T_{vj} = 175\text{ °C}$ ,  $V_{GE} = 0/15\text{ V}$

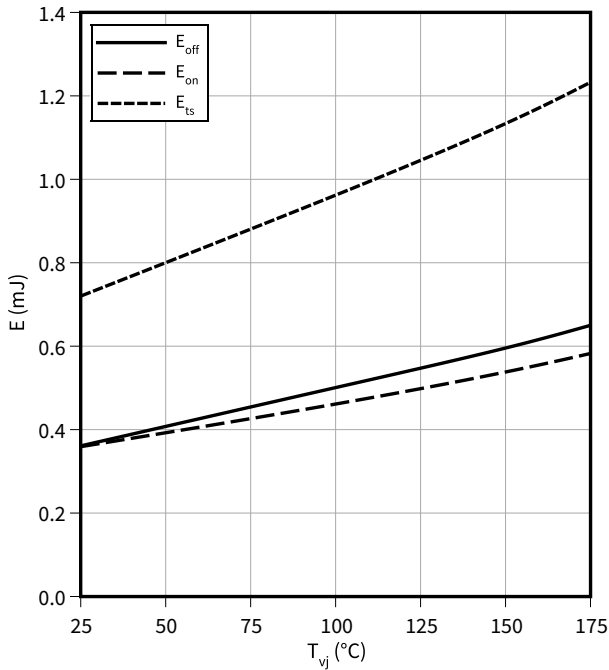


4 Characteristics diagrams

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

$E = f(T_{vj})$

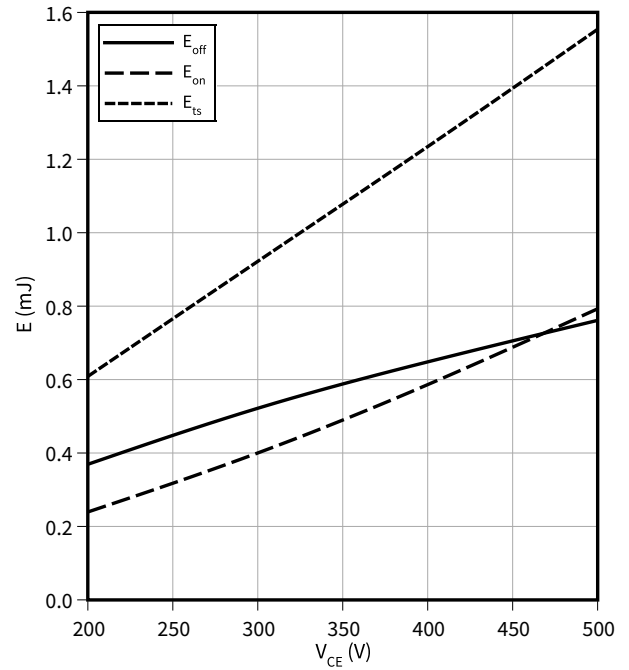
$I_C = 20\text{ A}$ ,  $V_{CC} = 400\text{ V}$ ,  $V_{GE} = 0/15\text{ V}$ ,  $R_G = 12\ \Omega$



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

$E = f(V_{CE})$

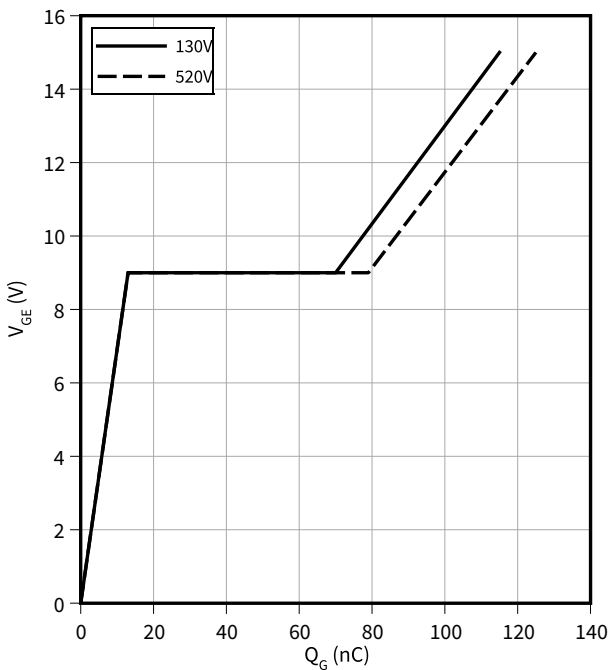
$I_C = 20\text{ A}$ ,  $T_{vj} = 175\text{ °C}$ ,  $V_{GE} = 0/15\text{ V}$ ,  $R_G = 12\ \Omega$



**Typical gate charge**

$V_{GE} = f(Q_G)$

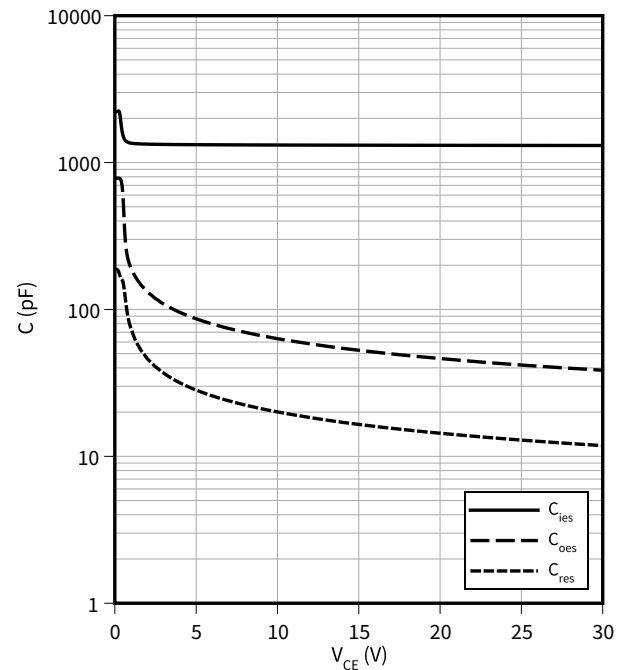
$I_C = 20\text{ A}$



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

$C = f(V_{CE})$

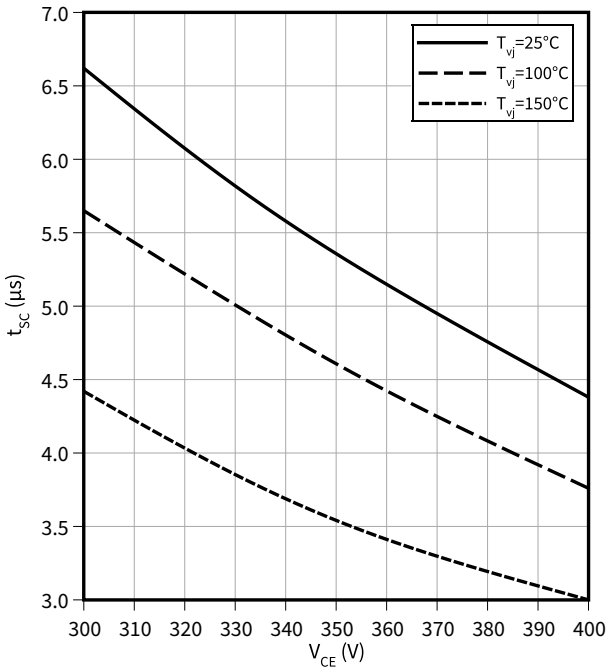
$f = 1000\text{ kHz}$ ,  $V_{GE} = 0\text{ V}$



4 Characteristics diagrams

**Typical short circuit safe operating range as a function of collector-emitter voltage**

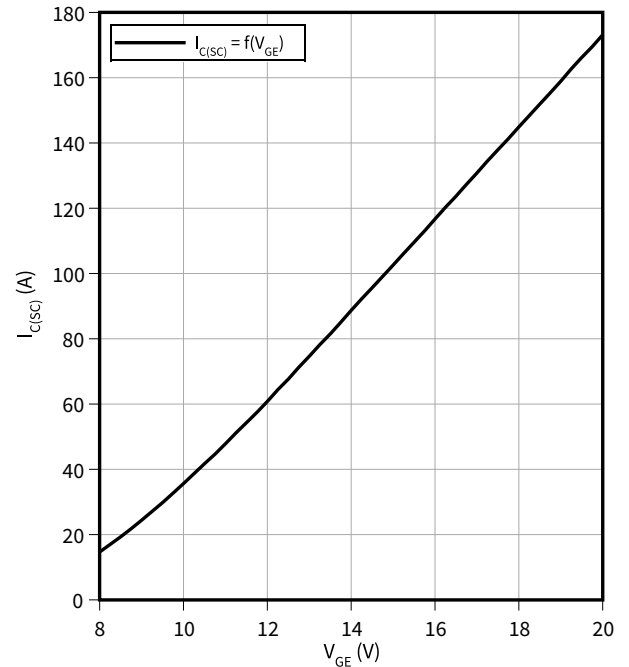
$$t_{SC} = f(V_{CE})$$



**Typical short circuit collector current as a function of gate-emitter voltage**

$$I_{C(SC)} = f(V_{GE})$$

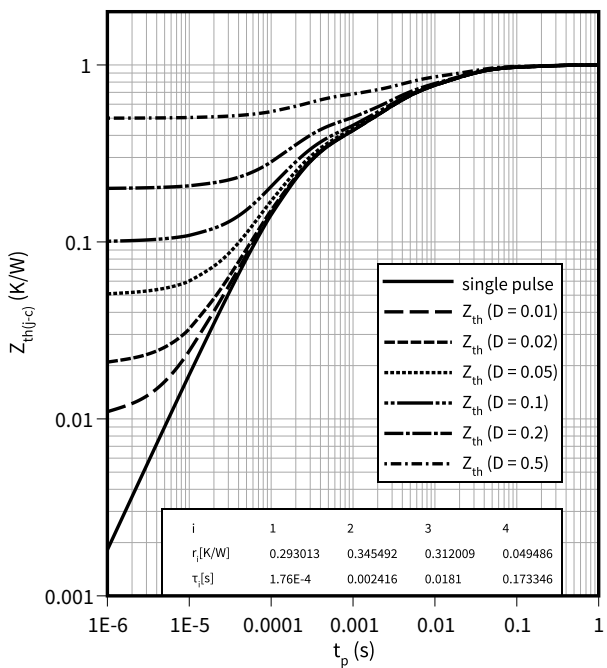
$T_{vj} = 150\text{ °C}, V_{CC} \leq 400\text{ V}$



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

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

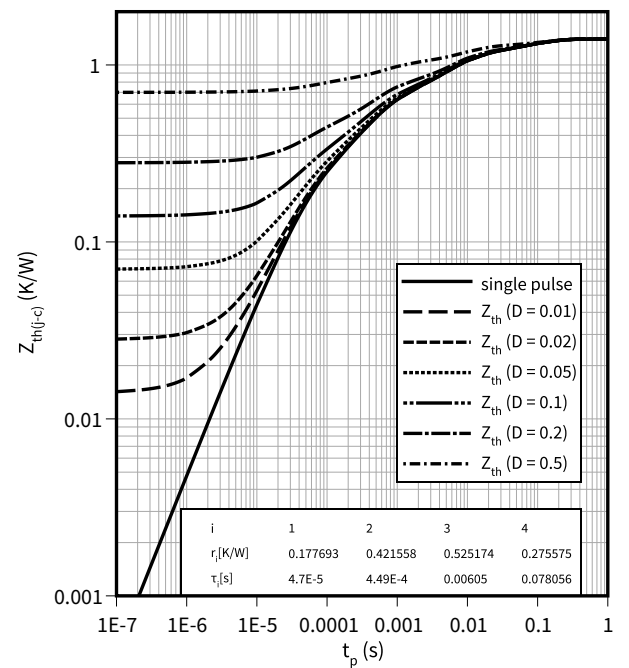
$$D = t_p/T$$



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

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

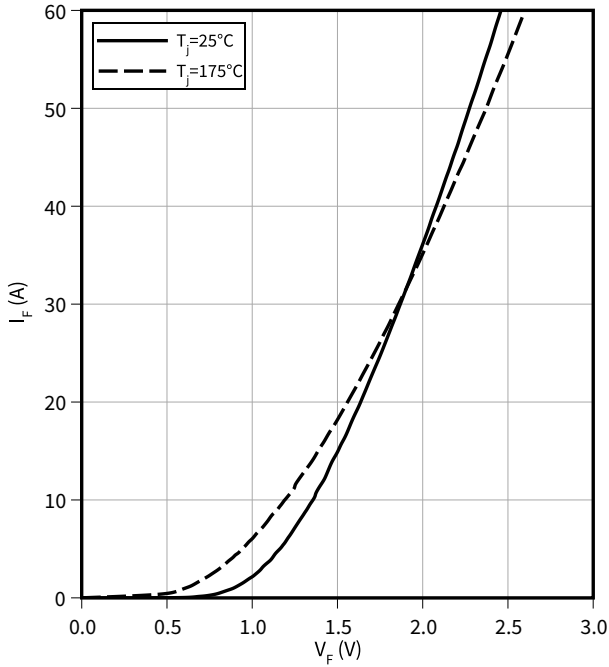
$$D = t_p/T$$



4 Characteristics diagrams

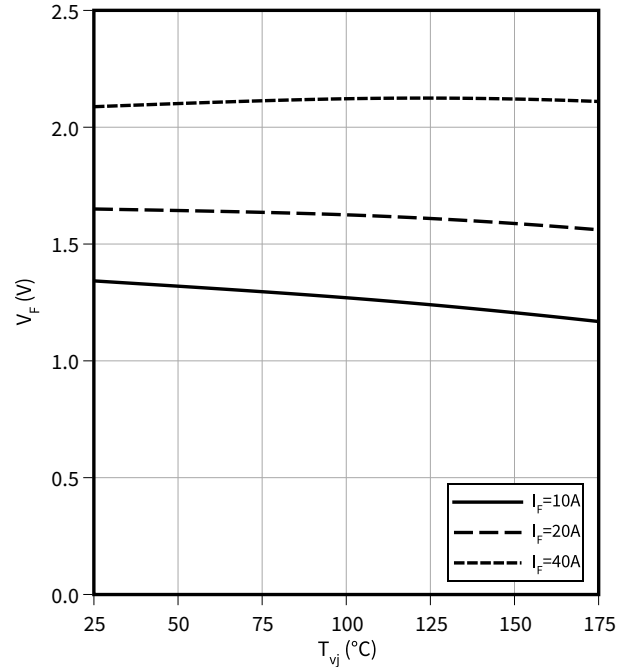
**Typical diode forward current as a function of forward voltage**

$I_F = f(V_F)$



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

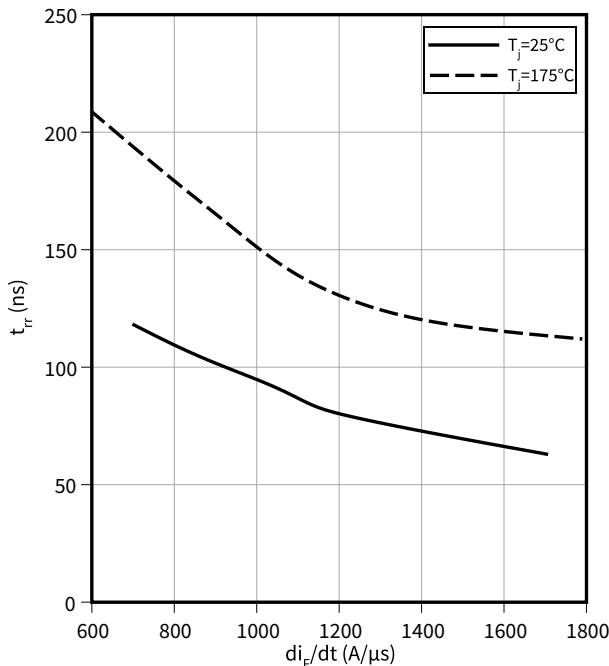
$V_F = f(T_{vj})$



**Typical reverse recovery time as a function of diode current slope**

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

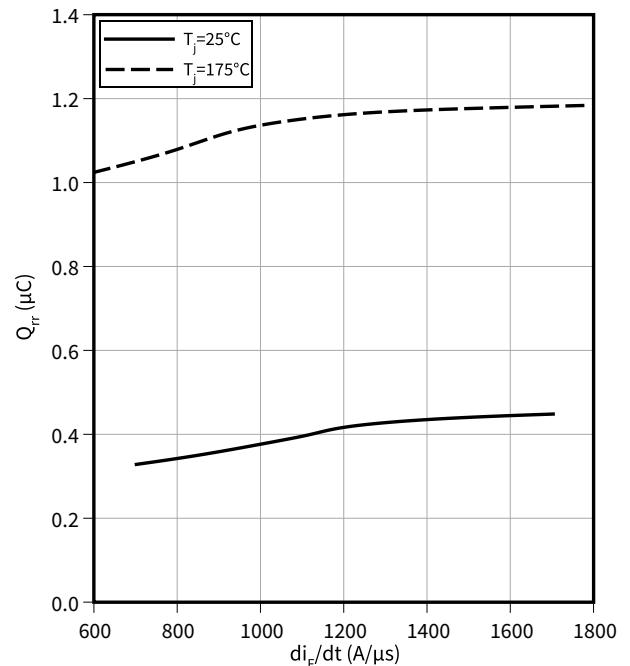
$V_R = 400\text{ V}, I_F = 20\text{ A}$



**Typical reverse recovery charge as a function of diode current slope**

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

$V_R = 400\text{ V}, I_F = 20\text{ A}$

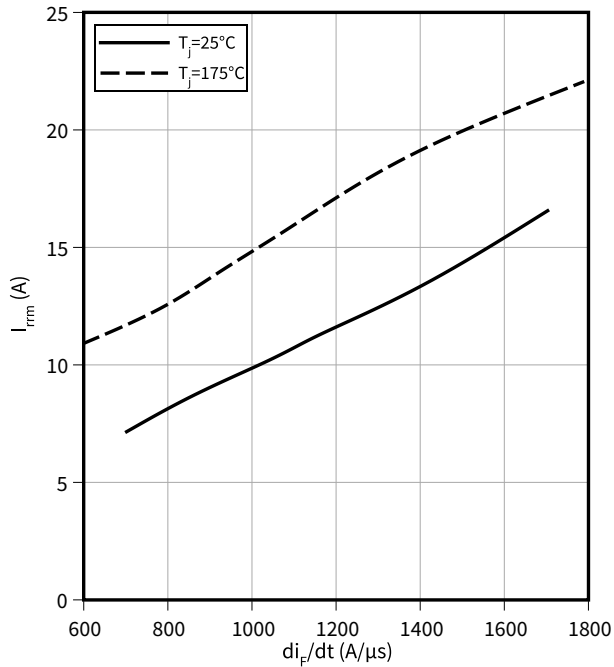


4 Characteristics diagrams

**Typical reverse recovery current as a function of diode current slope**

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

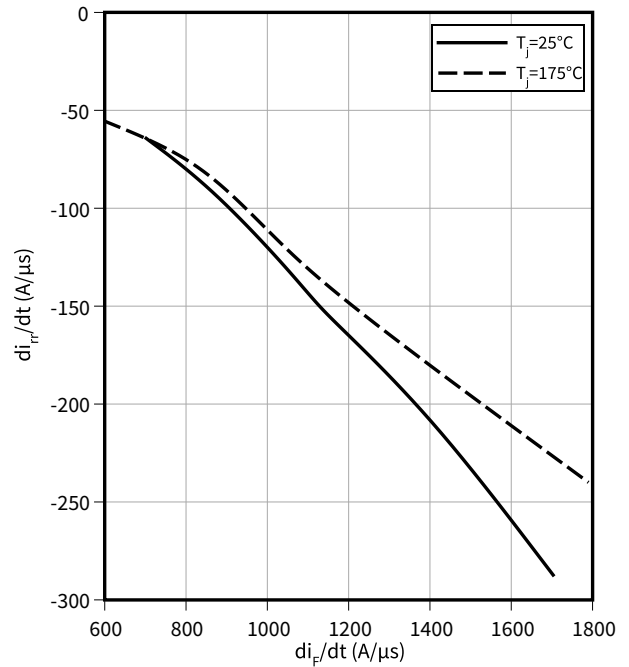
$V_R = 400\text{ V}, I_F = 20\text{ A}$



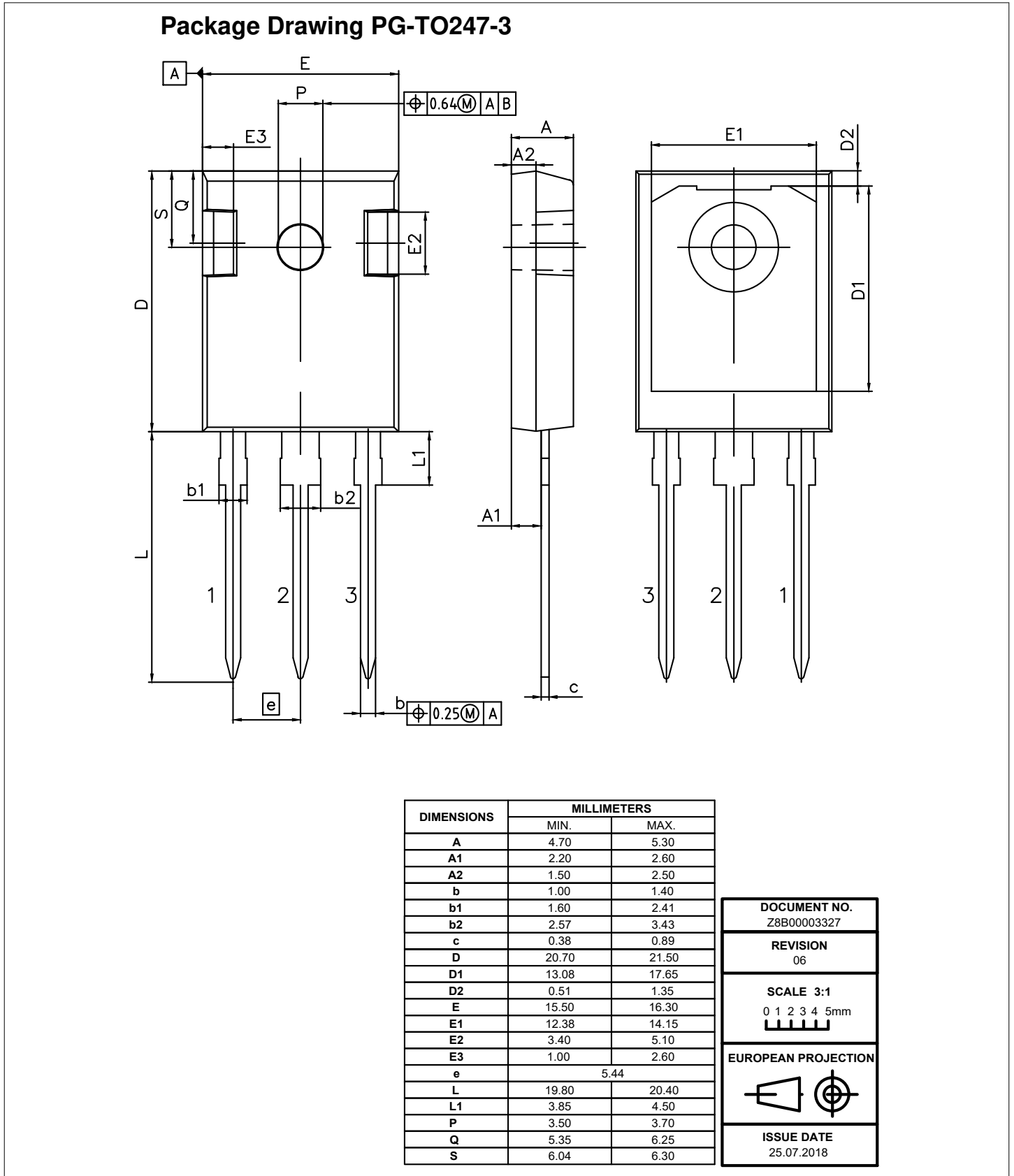
**Typical diode peak rate of fall of reverse recovery current as a function of diode current slope**

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

$V_R = 400\text{ V}, I_F = 20\text{ A}$



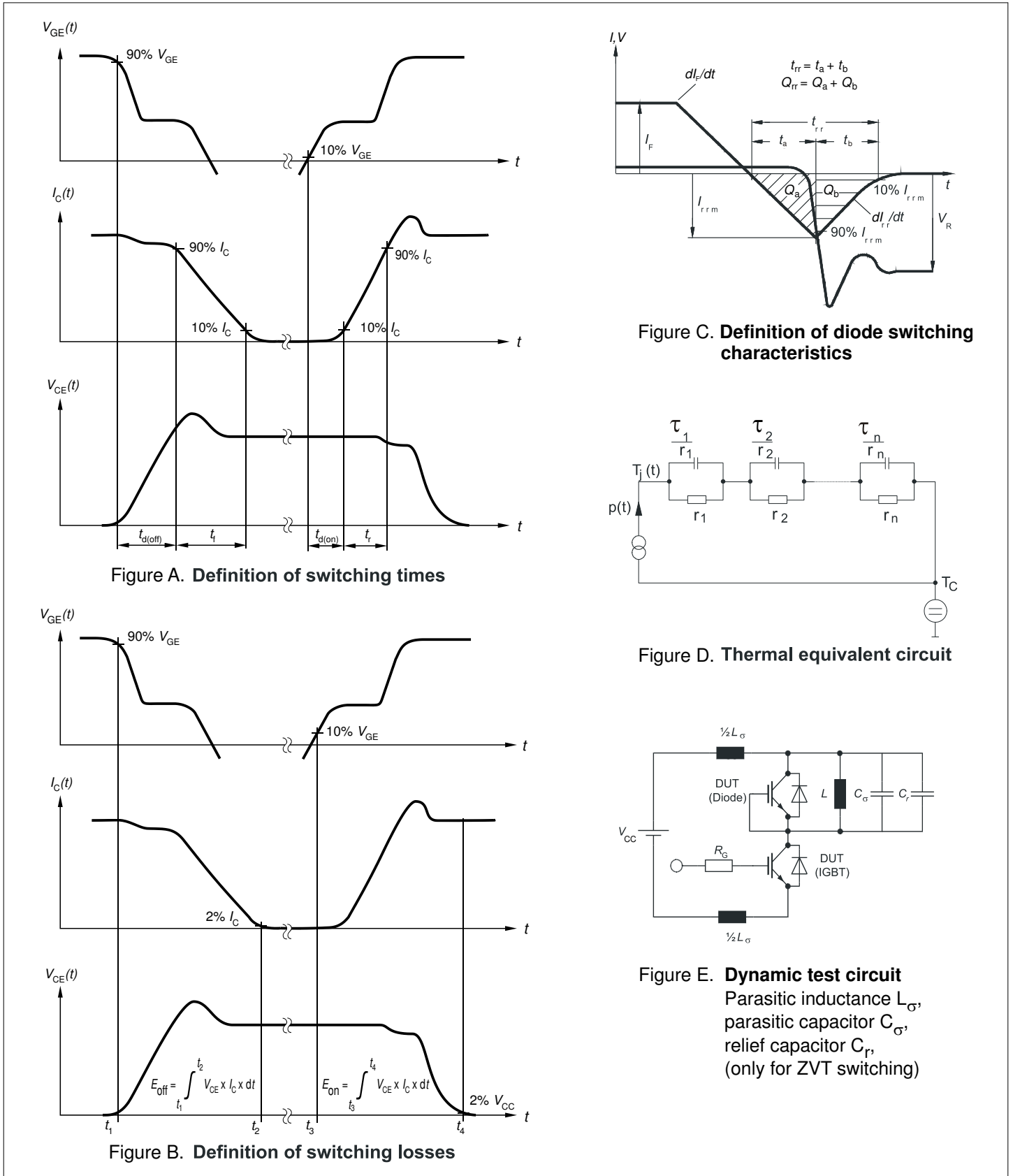
**5 Package outlines**



**Figure 1**



**6 Testing conditions**



**Figure 2**

## Revision history

Document revision	Date of release	Description of changes
V1.1	2020-04-20	Preliminary Data Sheet
V2.1	2020-05-12	Final data sheet
V2.2	2020-06-29	Increase of forward current rating at Tc=100°C to 27.5A
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
1.00	2021-06-29	Change of potential applications and new diagram added ( $t_{SC}$ as function of $V_{CE}$ )
1.10	2023-01-26	Feature list corrections Editorial changes

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