

## TRENCHSTOP™ 5 high speed soft switching IGBT co-packed with full current rated RAPID 1 fast and soft antiparallel diode

### Features

- $V_{CE} = 650\text{ V}$
- $I_C = 30\text{ A}$
- High speed smooth switching device for hard & soft switching
- Very low  $V_{CEsat}$ , 1.35 V at nominal current
- Plug and play replacement of previous generation IGBTs
- 650 V breakdown voltage
- Low gate charge  $Q_G$
- IGBT co-packed with full rated current RAPID 1 fast 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/igbt/>

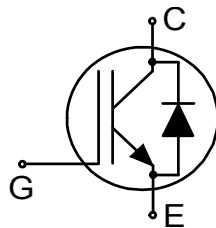
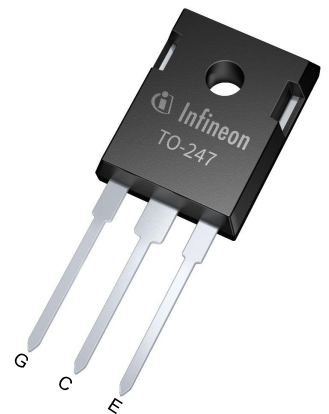
### Potential applications

- Resonant converters
- Uninterruptible power supplies
- Welding converters
- Mid to high range switching frequency converters

### Description

Package pin definition:

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



Type	Package	Marking
IKW30N65ES5	PG-TO247-3	K30EES5

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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 processes: 3			0.6	Nm
Thermal resistance, junction-ambient	$R_{th(j-a)}$				40	K/W
IGBT thermal resistance, junction-case	$R_{th(j-c)}$				0.8	K/W
Diode thermal resistance, junction-case	$R_{th(j-c)}$				1	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 $T_{vjmax}$	$I_C$	$T_c = 25\text{ °C}$	62	A
		$T_c = 100\text{ °C}$	39.5	
Pulsed collector current, $t_p$ limited by $T_{vjmax}$	$I_{Cpulse}$		120	A
Turn-off safe operating area		$V_{CE} \leq 650\text{ V}$ , $t_p = 1\text{ }\mu\text{s}$ , $T_{vj} \leq 175\text{ °C}$	120	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	$P_{tot}$	$T_c = 25\text{ °C}$	188	W
		$T_c = 100\text{ °C}$	94	

**Table 3 Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Collector-emitter breakdown voltage	$V_{BRCES}$	$I_C = 0.2 \text{ mA}, V_{GE} = 0 \text{ V}$	650			V
Collector-emitter saturation voltage	$V_{CESat}$	$I_C = 30 \text{ A}, V_{GE} = 15 \text{ V}$	$T_{vj} = 25 \text{ °C}$	1.35	1.7	V
			$T_{vj} = 125 \text{ °C}$	1.5		
			$T_{vj} = 175 \text{ °C}$	1.6		
Gate-emitter threshold voltage	$V_{GETh}$	$I_C = 0.3 \text{ mA}, V_{CE} = V_{GE}$	3.2	4	4.8	V
Zero gate-voltage collector current	$I_{CES}$	$V_{CE} = 650 \text{ V}, V_{GE} = 0 \text{ V}$	$T_{vj} = 25 \text{ °C}$		50	$\mu\text{A}$
			$T_{vj} = 175 \text{ °C}$		1400	
Gate-emitter leakage current	$I_{GES}$	$V_{CE} = 0 \text{ V}, V_{GE} = 20 \text{ V}$			100	nA
Transconductance	$g_{fs}$	$I_C = 30 \text{ A}, V_{CE} = 20 \text{ V}$		42		S
Input capacitance	$C_{ies}$	$V_{CE} = 25 \text{ V}, V_{GE} = 0 \text{ V}, f = 1000 \text{ kHz}$		1800		pF
Output capacitance	$C_{oes}$	$V_{CE} = 25 \text{ V}, V_{GE} = 0 \text{ V}, f = 1000 \text{ kHz}$		55		pF
Reverse transfer capacitance	$C_{res}$	$V_{CE} = 25 \text{ V}, V_{GE} = 0 \text{ V}, f = 1000 \text{ kHz}$		7		pF
Gate charge	$Q_G$	$I_C = 30 \text{ A}, V_{GE} = 15 \text{ V}, V_{CC} = 520 \text{ V}$		70		nC
Turn-on delay time	$t_{d(on)}$	$V_{CC} = 400 \text{ V}, V_{GE} = 0/15 \text{ V},$ $R_{G(on)} = 13 \text{ }\Omega,$ $R_{G(off)} = 13 \text{ }\Omega$	$T_{vj} = 25 \text{ °C},$ $I_C = 30 \text{ A}$		17	ns
			$T_{vj} = 25 \text{ °C},$ $I_C = 15 \text{ A}$		16	
			$T_{vj} = 150 \text{ °C},$ $I_C = 30 \text{ A}$		17	
			$T_{vj} = 150 \text{ °C},$ $I_C = 15 \text{ A}$		16	
Rise time (inductive load)	$t_r$	$V_{CC} = 400 \text{ V}, V_{GE} = 0/15 \text{ V},$ $R_{G(on)} = 13 \text{ }\Omega,$ $R_{G(off)} = 13 \text{ }\Omega$	$T_{vj} = 25 \text{ °C},$ $I_C = 30 \text{ A}$		12	ns
			$T_{vj} = 25 \text{ °C},$ $I_C = 15 \text{ A}$		6	
			$T_{vj} = 150 \text{ °C},$ $I_C = 30 \text{ A}$		13	
			$T_{vj} = 150 \text{ °C},$ $I_C = 15 \text{ A}$		7	

(table continues...)

**Table 3 (continued) Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Turn-off delay time	$t_{d(off)}$	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V},$ $R_{G(on)} = 13\ \Omega,$ $R_{G(off)} = 13\ \Omega$	$T_{vj} = 25\text{ }^\circ\text{C},$ $I_C = 30\text{ A}$		124		ns
			$T_{vj} = 25\text{ }^\circ\text{C},$ $I_C = 15\text{ A}$		133		
			$T_{vj} = 150\text{ }^\circ\text{C},$ $I_C = 30\text{ A}$		149		
			$T_{vj} = 150\text{ }^\circ\text{C},$ $I_C = 15\text{ A}$		179		
Fall time (inductive load)	$t_f$	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V},$ $R_{G(on)} = 13\ \Omega,$ $R_{G(off)} = 13\ \Omega$	$T_{vj} = 25\text{ }^\circ\text{C},$ $I_C = 30\text{ A}$		30		ns
			$T_{vj} = 25\text{ }^\circ\text{C},$ $I_C = 15\text{ A}$		33		
			$T_{vj} = 150\text{ }^\circ\text{C},$ $I_C = 30\text{ A}$		55		
			$T_{vj} = 150\text{ }^\circ\text{C},$ $I_C = 15\text{ A}$		54		
Turn-on energy	$E_{on}$	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V},$ $R_{G(on)} = 13\ \Omega,$ $R_{G(off)} = 13\ \Omega$	$T_{vj} = 25\text{ }^\circ\text{C},$ $I_C = 30\text{ A}$		0.56		mJ
			$T_{vj} = 25\text{ }^\circ\text{C},$ $I_C = 15\text{ A}$		0.26		
			$T_{vj} = 150\text{ }^\circ\text{C},$ $I_C = 30\text{ A}$		0.77		
			$T_{vj} = 150\text{ }^\circ\text{C},$ $I_C = 15\text{ A}$		0.41		
Turn-off energy	$E_{off}$	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V},$ $R_{G(on)} = 13\ \Omega,$ $R_{G(off)} = 13\ \Omega$	$T_{vj} = 25\text{ }^\circ\text{C},$ $I_C = 30\text{ A}$		0.32		mJ
			$T_{vj} = 25\text{ }^\circ\text{C},$ $I_C = 15\text{ A}$		0.17		
			$T_{vj} = 150\text{ }^\circ\text{C},$ $I_C = 30\text{ A}$		0.56		
			$T_{vj} = 150\text{ }^\circ\text{C},$ $I_C = 15\text{ A}$		0.31		

(table continues...)

**Table 3 (continued) Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Total switching energy	$E_{ts}$	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V},$ $R_{G(on)} = 13\ \Omega,$ $R_{G(off)} = 13\ \Omega$	$T_{vj} = 25\text{ °C},$ $I_C = 30\text{ A}$		0.88		mJ
			$T_{vj} = 25\text{ °C},$ $I_C = 15\text{ A}$		0.43		
			$T_{vj} = 150\text{ °C},$ $I_C = 30\text{ A}$		1.33		
			$T_{vj} = 150\text{ °C},$ $I_C = 15\text{ A}$		0.72		
Operating junction temperature	$T_{vj}$		-40		175	°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 $T_{vjmax}$	$I_F$	limited by bondwire	$T_C = 25\text{ °C}$	40	A
			$T_C = 100\text{ °C}$	39.5	
Diode pulsed current, $t_p$ limited by $T_{vjmax}$	$I_{Fpulse}$		120	A	

**Table 5 Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Diode forward voltage	$V_F$	$I_F = 30\text{ A}$	$T_{vj} = 25\text{ °C}$		1.45	1.7	V
			$T_{vj} = 125\text{ °C}$		1.42		
			$T_{vj} = 175\text{ °C}$		1.39		

(table continues...)

**Table 5 (continued) Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Diode reverse recovery time	$t_{rr}$	$V_R = 400\text{ V}$	$T_{vj} = 25\text{ °C},$ $I_F = 30\text{ A},$ $-di_F/dt = 1200\text{ A}/\mu\text{s}$		75		ns
			$T_{vj} = 25\text{ °C},$ $I_F = 15\text{ A},$ $-di_F/dt = 1900\text{ A}/\mu\text{s}$		52		
			$T_{vj} = 150\text{ °C},$ $I_F = 30\text{ A},$ $-di_F/dt = 1200\text{ A}/\mu\text{s}$		110		
			$T_{vj} = 150\text{ °C},$ $I_F = 15\text{ A},$ $-di_F/dt = 1900\text{ A}/\mu\text{s}$		78		
Diode reverse recovery charge	$Q_{rr}$	$V_R = 400\text{ V}$	$T_{vj} = 25\text{ °C},$ $I_F = 30\text{ A},$ $-di_F/dt = 1200\text{ A}/\mu\text{s}$		0.83		$\mu\text{C}$
			$T_{vj} = 25\text{ °C},$ $I_F = 15\text{ A},$ $-di_F/dt = 1900\text{ A}/\mu\text{s}$		0.6		
			$T_{vj} = 150\text{ °C},$ $I_F = 30\text{ A},$ $-di_F/dt = 1200\text{ A}/\mu\text{s}$		1.75		
			$T_{vj} = 150\text{ °C},$ $I_F = 15\text{ A},$ $-di_F/dt = 1900\text{ A}/\mu\text{s}$		1.25		
Diode peak reverse recovery current	$I_{rrm}$	$V_R = 400\text{ V}$	$T_{vj} = 25\text{ °C},$ $I_F = 30\text{ A},$ $-di_F/dt = 1200\text{ A}/\mu\text{s}$		18		A
			$T_{vj} = 25\text{ °C},$ $I_F = 15\text{ A},$ $-di_F/dt = 1900\text{ A}/\mu\text{s}$		18.5		
			$T_{vj} = 150\text{ °C},$ $I_F = 30\text{ A},$ $-di_F/dt = 1200\text{ A}/\mu\text{s}$		26.5		
			$T_{vj} = 150\text{ °C},$ $I_F = 15\text{ A},$ $-di_F/dt = 1900\text{ A}/\mu\text{s}$		26.2		

**(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	$di_{rr}/dt$	$V_R = 400\text{ V}$	$T_{vj} = 25\text{ °C},$ $I_F = 30\text{ A},$ $-di_F/dt = 1200\text{ A}/\mu\text{s}$		900		A/ $\mu\text{s}$
			$T_{vj} = 25\text{ °C},$ $I_F = 15\text{ A},$ $-di_F/dt = 1900\text{ A}/\mu\text{s}$		1320		
			$T_{vj} = 150\text{ °C},$ $I_F = 30\text{ A},$ $-di_F/dt = 1200\text{ A}/\mu\text{s}$		1000		
			$T_{vj} = 150\text{ °C},$ $I_F = 15\text{ A},$ $-di_F/dt = 1900\text{ A}/\mu\text{s}$		1200		
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.

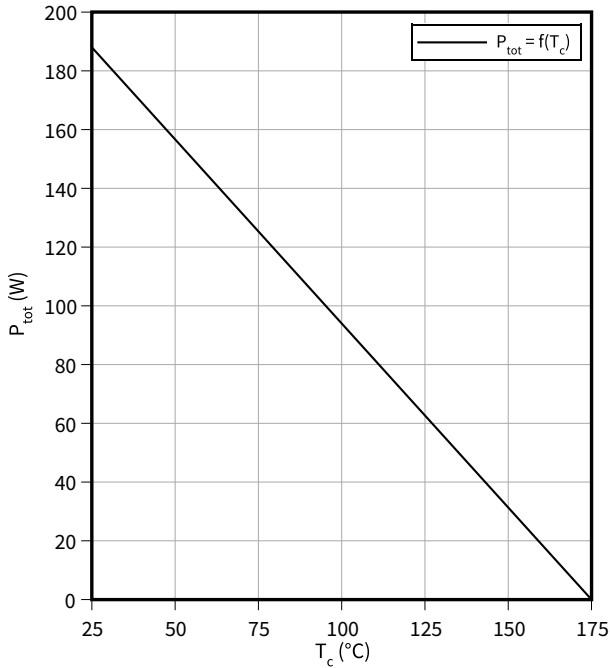
Dynamic test circuit, parasitic inductance  $L_\sigma = 30\text{ nH}$ , parasitic capacitor  $C_\sigma = 30\text{ pF}$  from Fig. E. Energy losses include “tail” and diode reverse recovery.



## 4 Characteristics diagrams

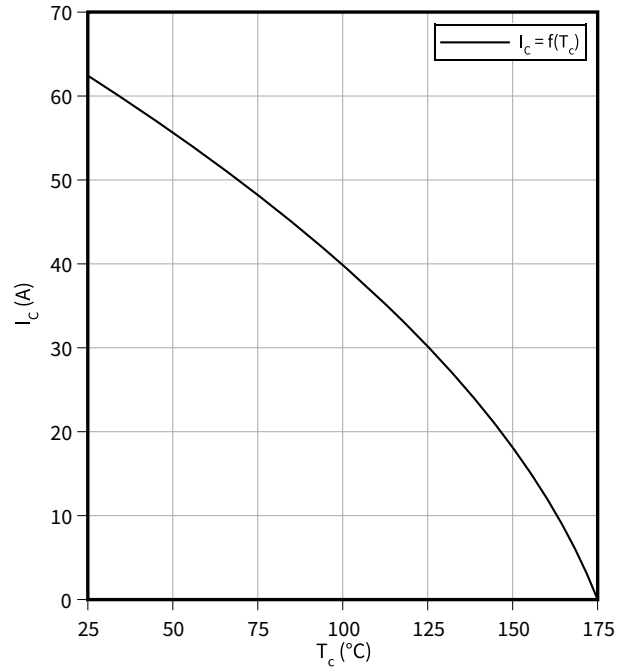
### Power dissipation as a function of case temperature

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



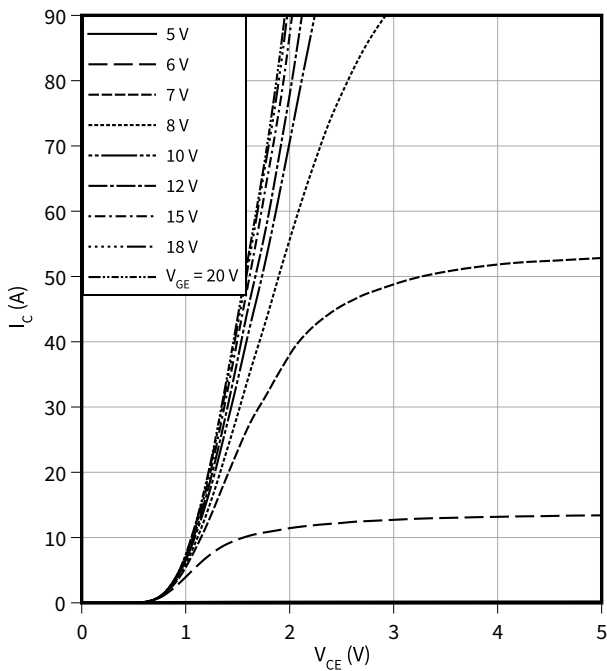
### Collector current as a function of case temperature

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



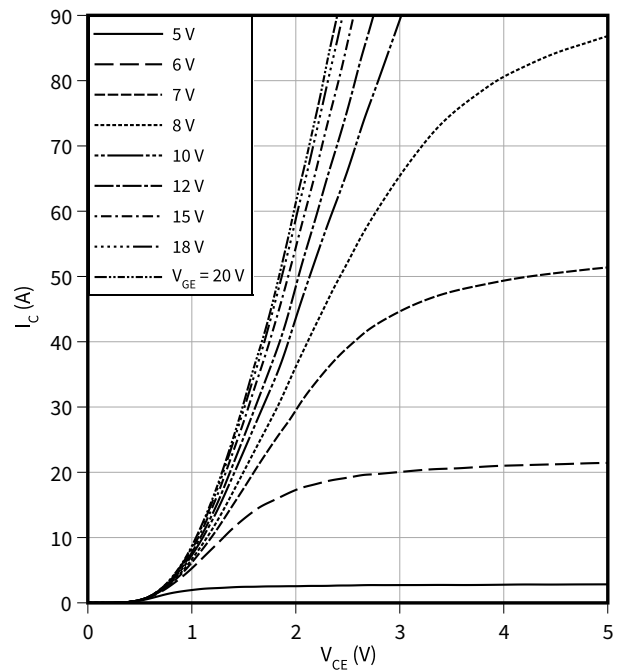
### Typical output characteristic

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



### Typical output characteristic

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

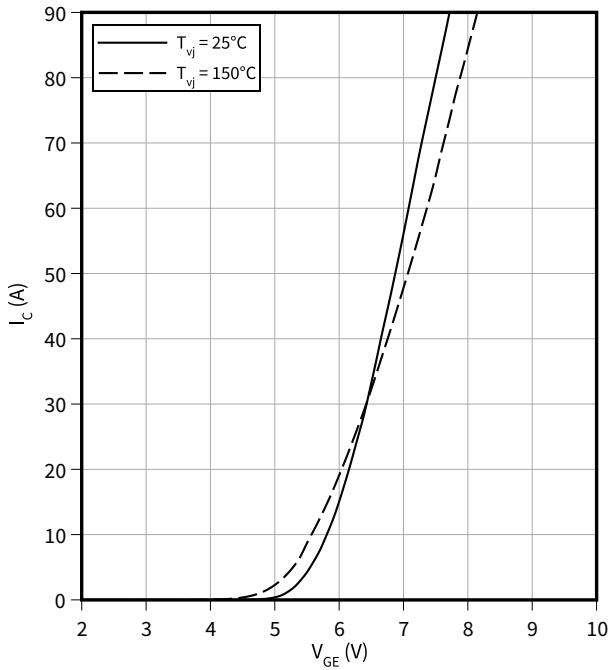


4 Characteristics diagrams

**Typical transfer characteristic**

$I_C = f(V_{GE})$

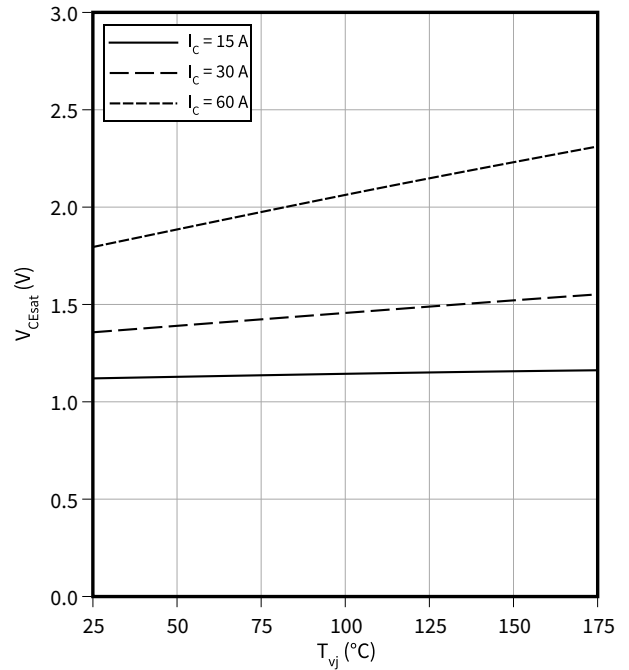
$V_{CE} = 20\text{ V}$



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

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

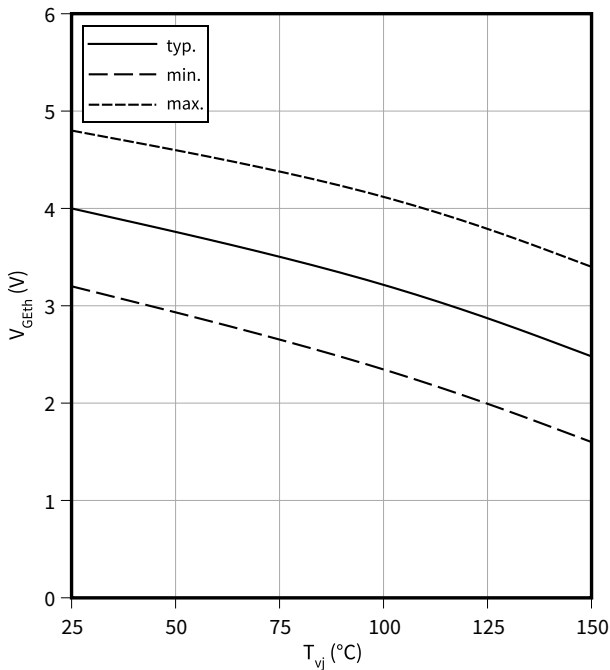
$V_{GE} = 15\text{ V}$



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

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

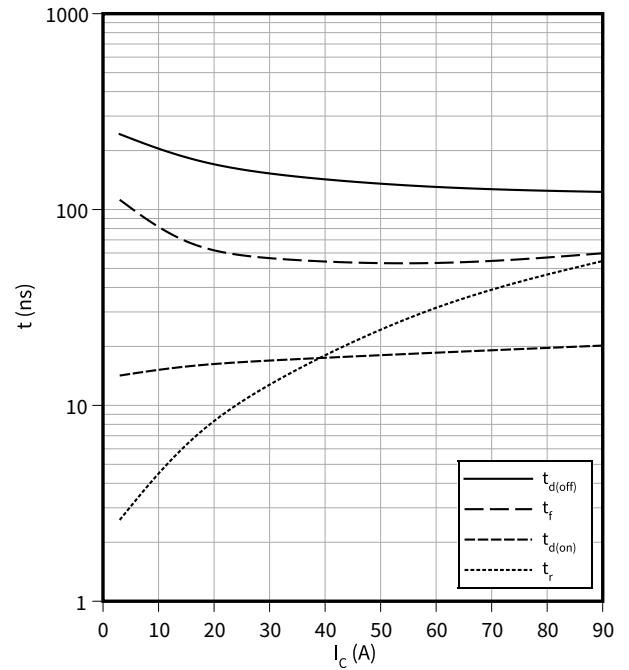
$I_C = 0.3\text{ mA}$



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

$t = f(I_C)$

$V_{CC} = 400\text{ V}, T_{vj} = 150^\circ\text{C}, V_{GE} = 0/15\text{ V}, R_G = 13\ \Omega$

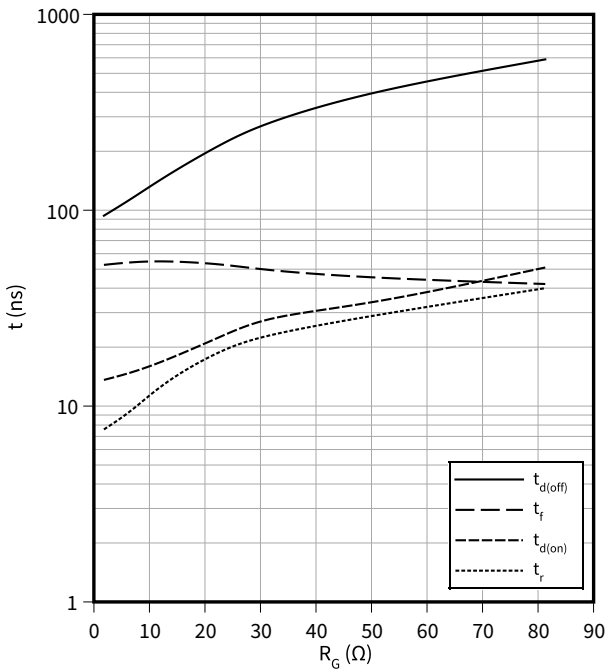


4 Characteristics diagrams

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

$t = f(R_G)$

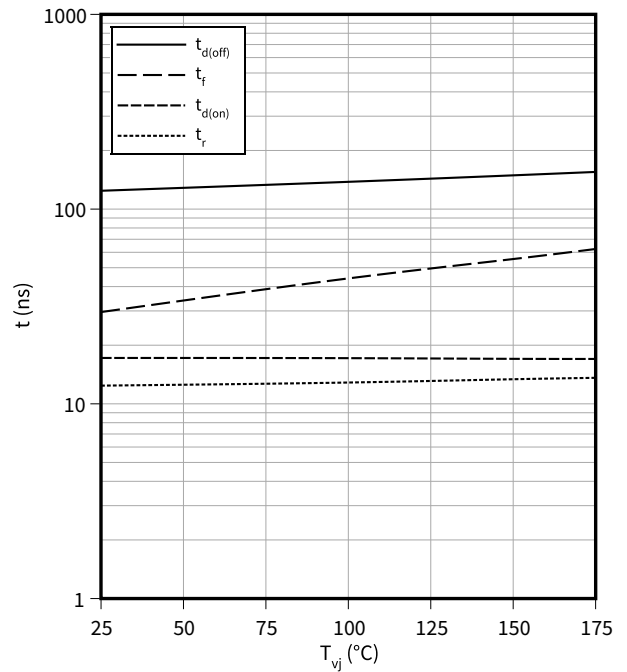
$I_C = 30\text{ A}, V_{CC} = 400\text{ V}, T_{vj} = 150\text{ °C}, V_{GE} = 0/15\text{ V}$



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

$t = f(T_{vj})$

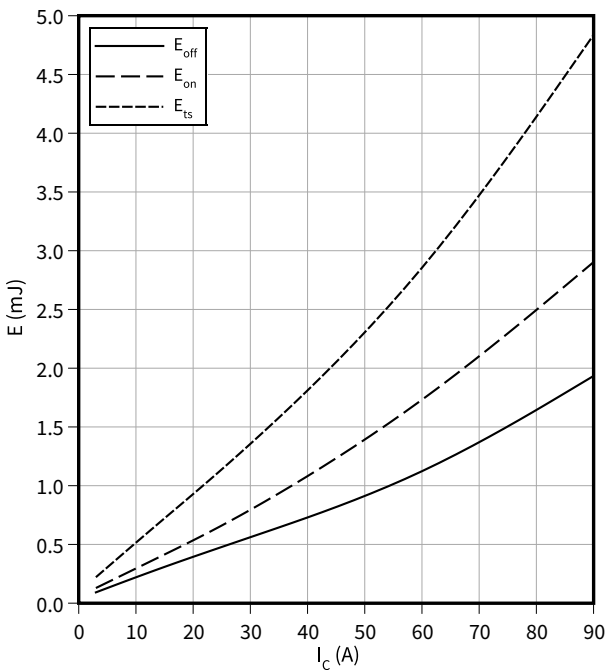
$I_C = 30\text{ A}, V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V}, R_G = 13\text{ }\Omega$



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

$E = f(I_C)$

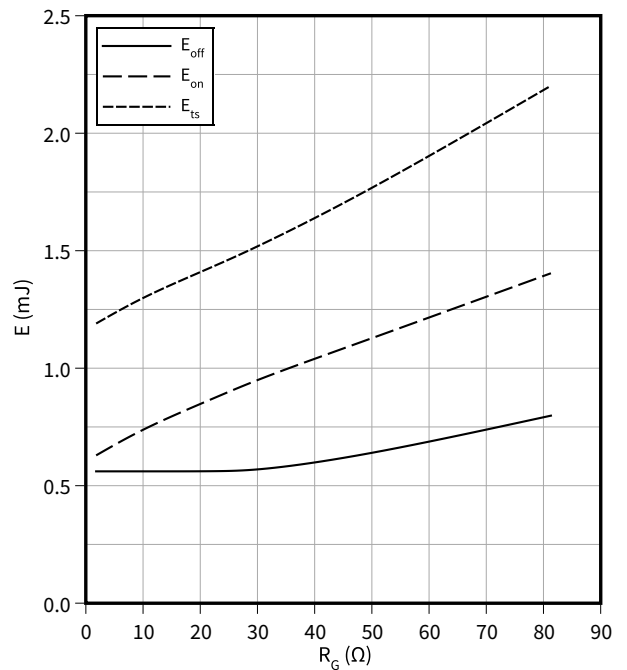
$V_{CC} = 400\text{ V}, T_{vj} = 150\text{ °C}, V_{GE} = 0/15\text{ V}, R_G = 13\text{ }\Omega$



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

$E = f(R_G)$

$I_C = 30\text{ A}, V_{CC} = 400\text{ V}, T_{vj} = 150\text{ °C}, V_{GE} = 0/15\text{ V}$

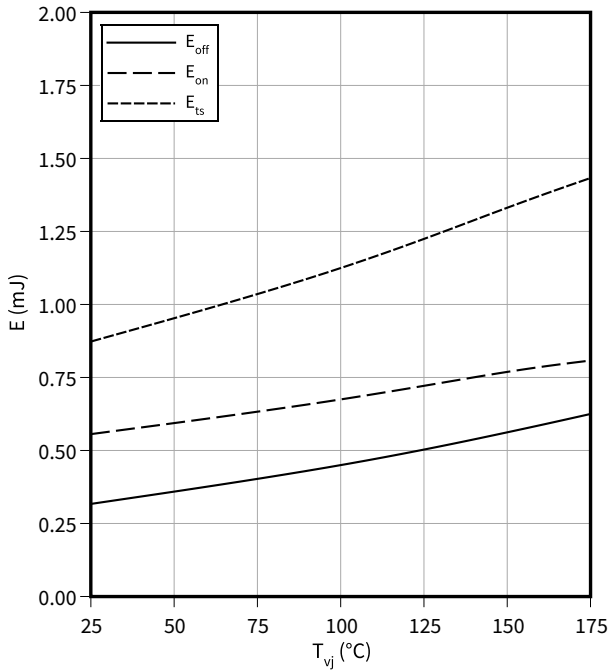


4 Characteristics diagrams

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

$E = f(T_{vj})$

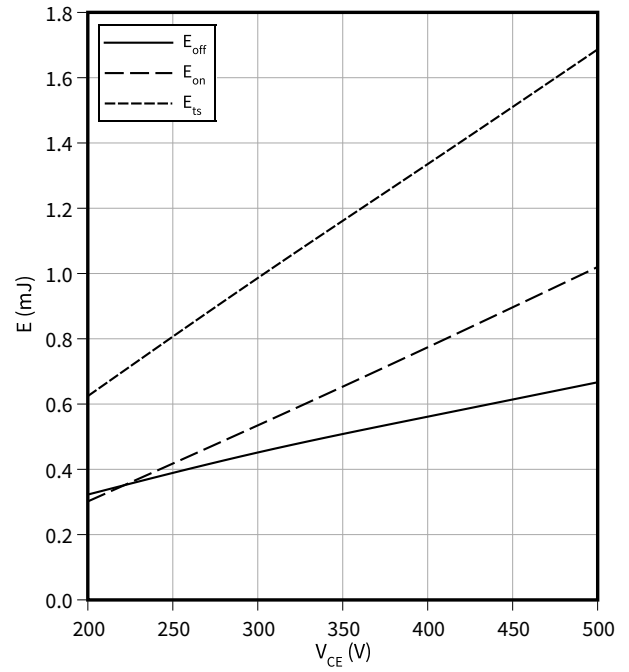
$I_C = 30\text{ A}$ ,  $V_{CC} = 400\text{ V}$ ,  $V_{GE} = 0/15\text{ V}$ ,  $R_G = 13\ \Omega$



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

$E = f(V_{CE})$

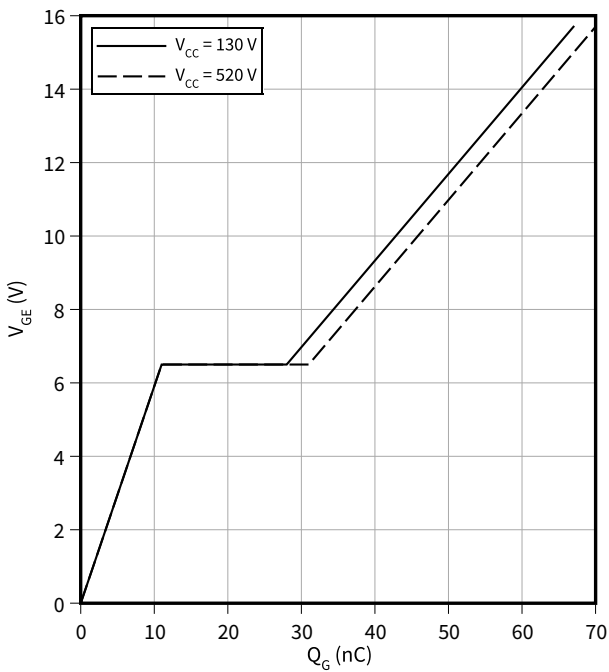
$I_C = 30\text{ A}$ ,  $T_{vj} = 150\text{ °C}$ ,  $V_{GE} = 0/15\text{ V}$ ,  $R_G = 13\ \Omega$



**Typical gate charge**

$V_{GE} = f(Q_G)$

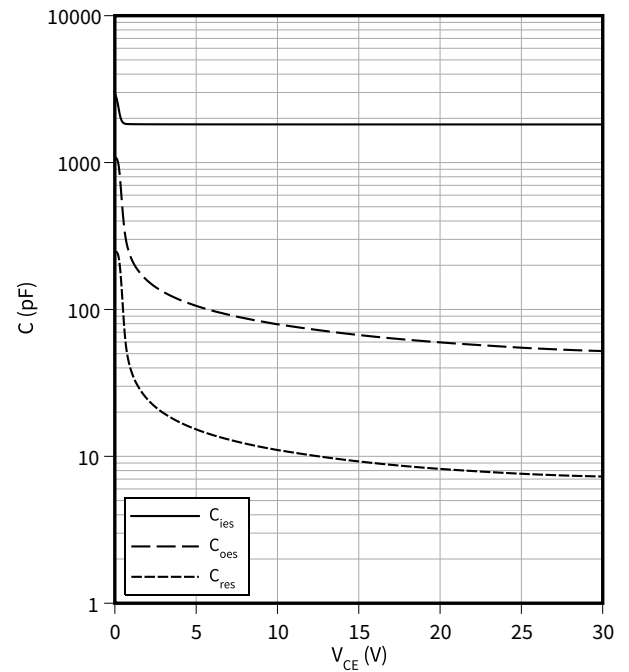
$I_C = 30\text{ A}$



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

$C = f(V_{CE})$

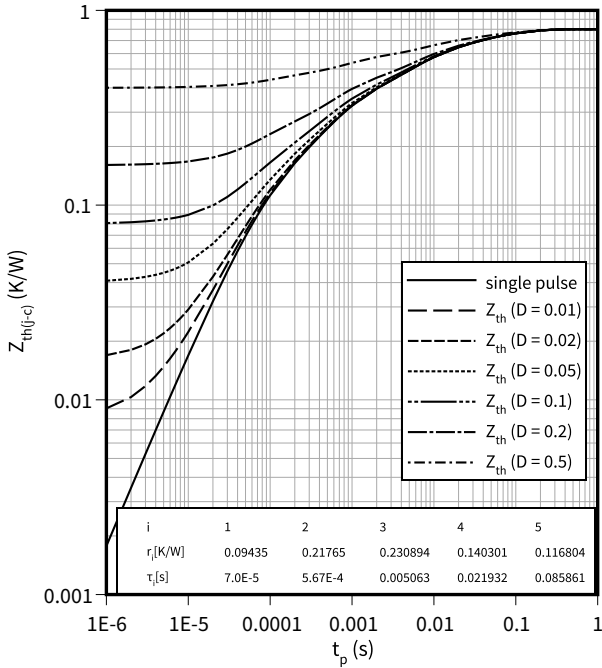
$f = 1000\text{ kHz}$ ,  $V_{GE} = 0\text{ V}$



4 Characteristics diagrams

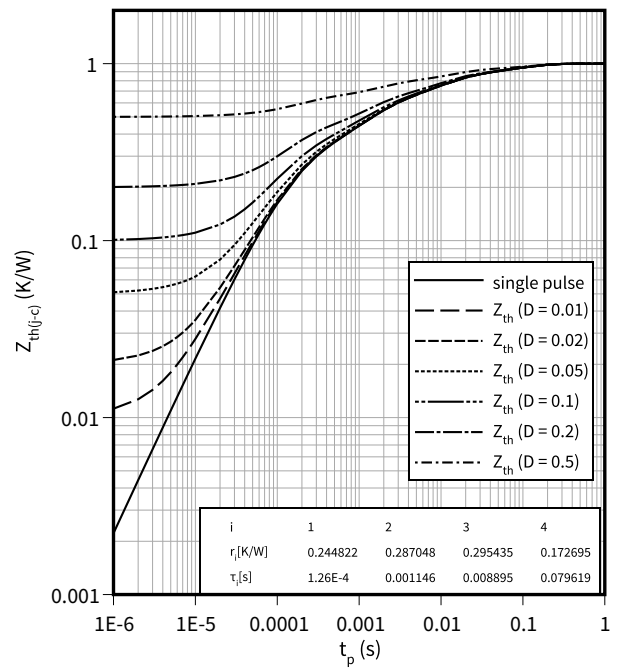
**IGBT transient thermal impedance as a function of pulse width**

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



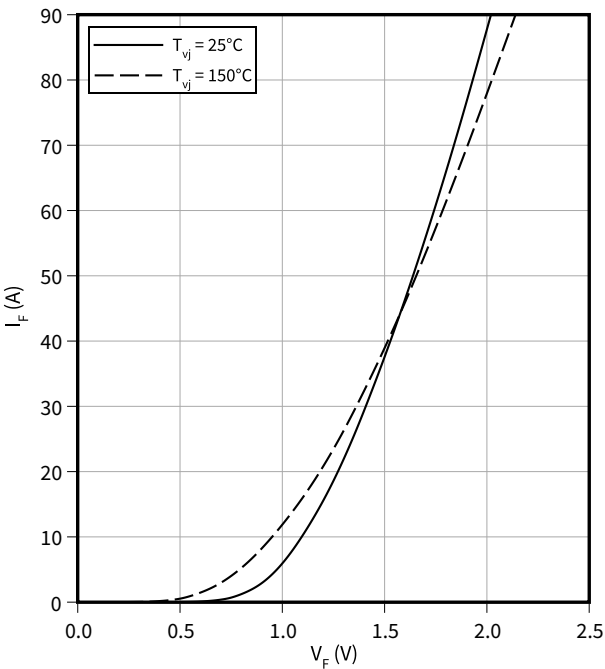
**Diode transient thermal impedance as a function of pulse width**

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



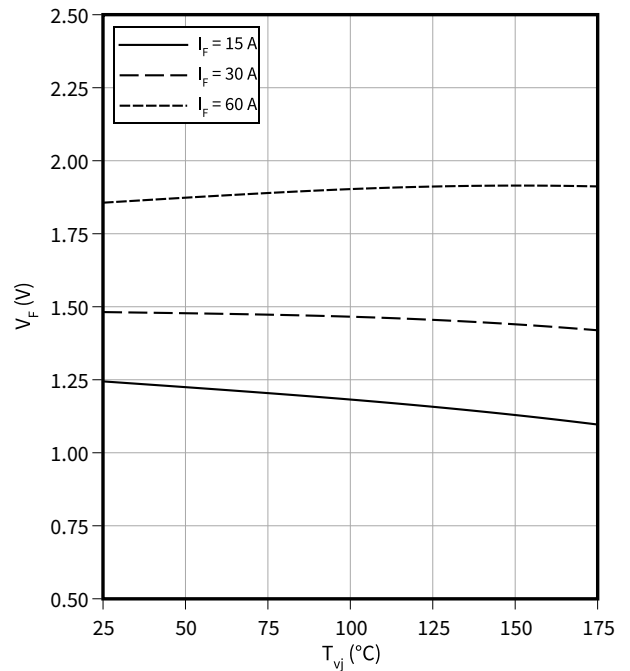
**Typical diode forward current as a function of forward voltage**

$I_F = f(V_F)$



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

$V_F = f(T_{vj})$

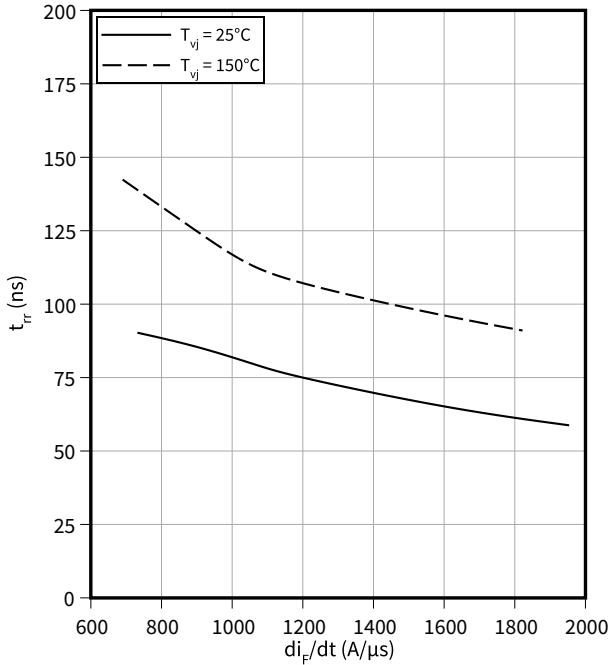


4 Characteristics diagrams

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

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

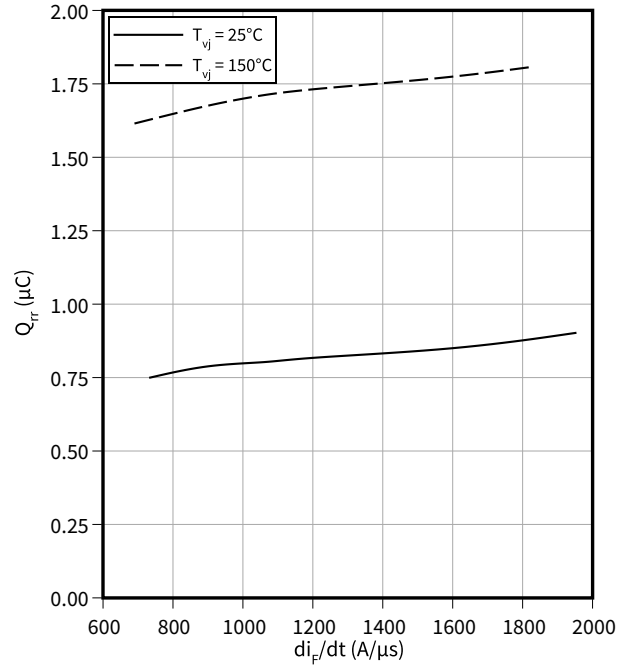
$V_R = 400\text{ V}, I_F = 30\text{ A}$



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

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

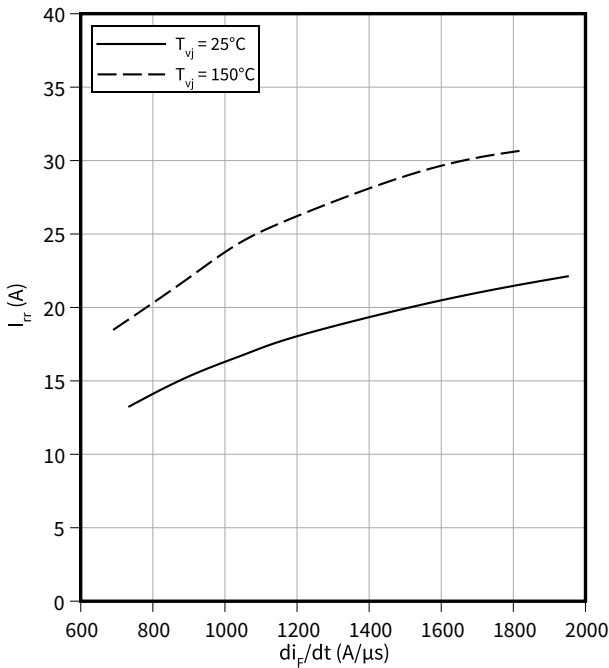
$V_R = 400\text{ V}, I_F = 30\text{ A}$



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

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

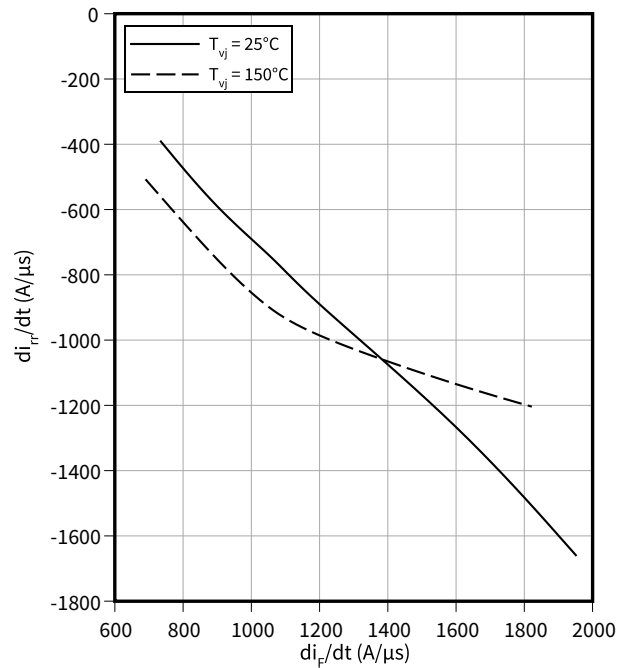
$V_R = 400\text{ V}, I_F = 30\text{ A}$



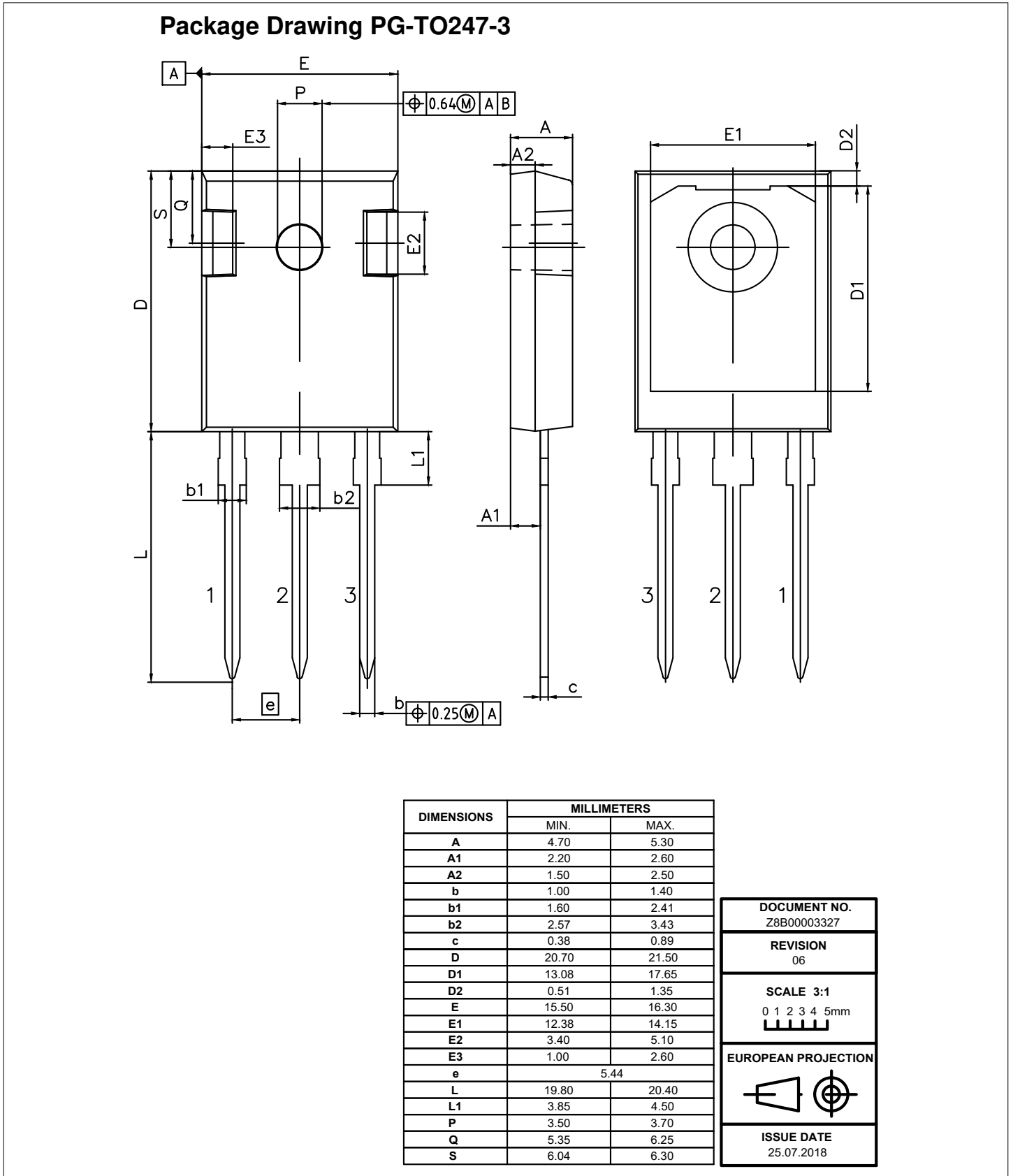
**Typical diode peak rate of fall of reverse recovery current as a function of diode current slope**

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

$V_R = 400\text{ V}, I_F = 30\text{ A}$

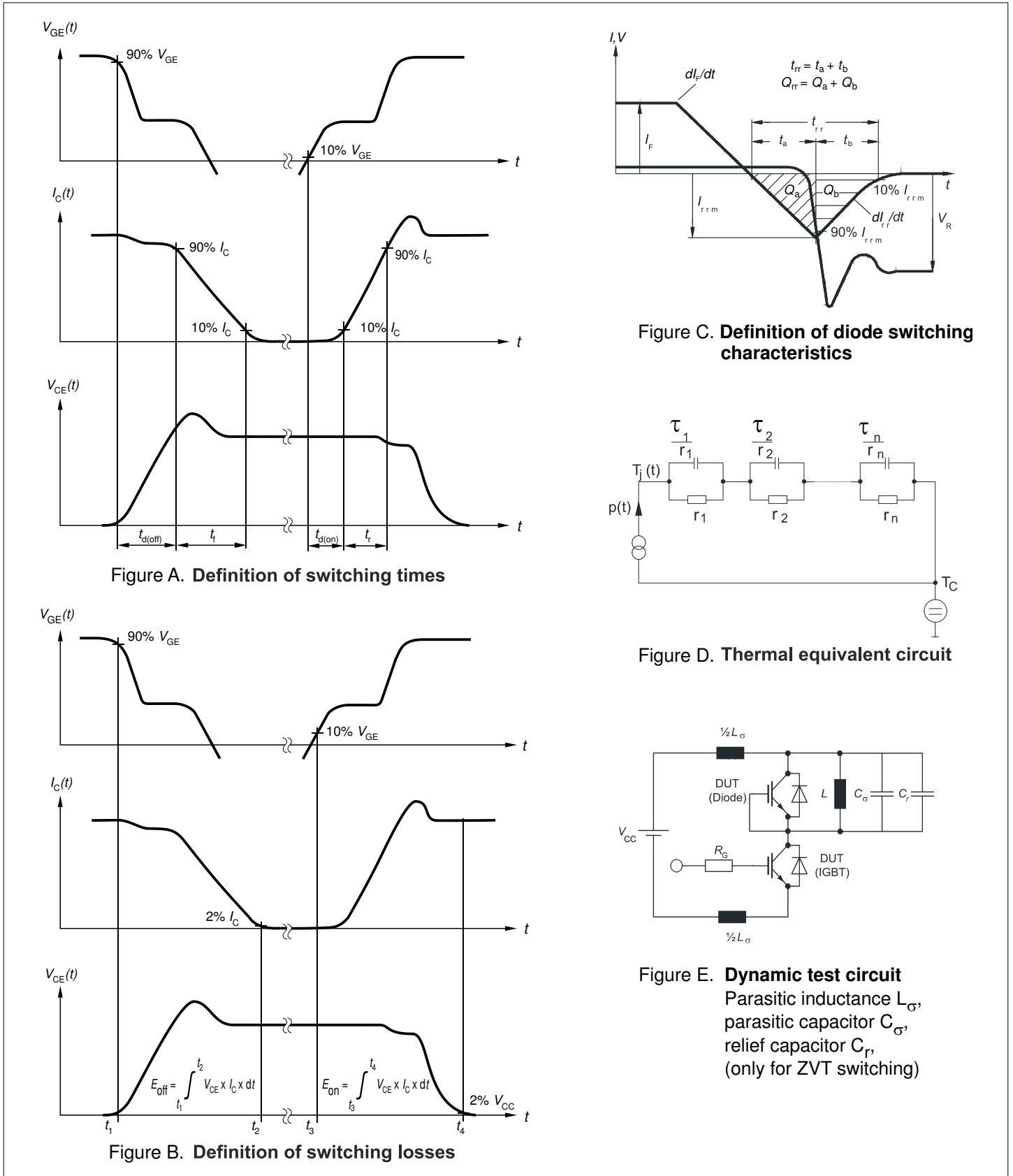


**5 Package outlines**



**Figure 1**

**6 Testing conditions**



**Figure 2**



## Revision history

Document revision	Date of release	Description of changes
V1.1	2015-08-12	Preliminary data sheet
V2.1	2015-09-22	Final data sheet
V2.2	2015-10-16	Minor change $I_c(VCE)$ Fig. 3 and Fig. 4
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	2023-01-17	Correction of diagram: "Typical switching energy losses as a function of collector emitter voltage" Editorial changes