

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/>

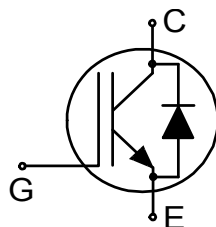
Potential applications

- 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}			± 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}		$T_c = 25\text{ °C}$	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	μA
			$T_{vj} = 175 \text{ °C}$		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		μC
			$T_{vj} = 25 \text{ °C},$ $I_F = 15 \text{ A},$ $-di_F/dt = 1900 \text{ A/}\mu\text{s}$		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	$V_R = 400 \text{ V}$	$T_{vj} = 25 \text{ }^\circ\text{C}$, $I_F = 30 \text{ A}$, $-di_F/dt = 1200 \text{ A}/\mu\text{s}$		900		$\text{A}/\mu\text{s}$
			$T_{vj} = 25 \text{ }^\circ\text{C}$, $I_F = 15 \text{ A}$, $-di_F/dt = 1900 \text{ A}/\mu\text{s}$		1320		
			$T_{vj} = 150 \text{ }^\circ\text{C}$, $I_F = 30 \text{ A}$, $-di_F/dt = 1200 \text{ A}/\mu\text{s}$		1000		
			$T_{vj} = 150 \text{ }^\circ\text{C}$, $I_F = 15 \text{ A}$, $-di_F/dt = 1900 \text{ A}/\mu\text{s}$		1200		
Operating junction temperature	T_{vj}			-40		175	$^\circ\text{C}$

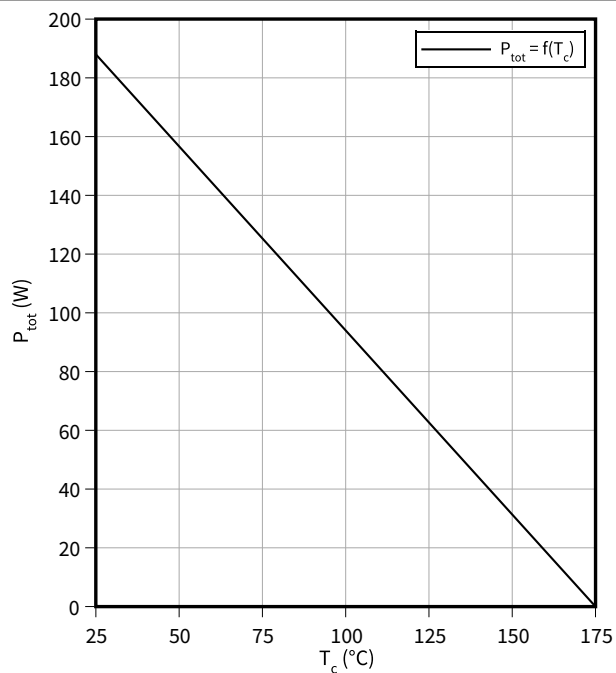
Note: For optimum lifetime and reliability, Infineon recommends operating conditions that do not exceed 80% of the maximum ratings stated in this datasheet.
Electrical Characteristic at $T_{vj} = 25^\circ\text{C}$, unless otherwise specified.
Dynamic test circuit, parasitic inductance $L_\sigma = 30 \text{ nH}$, 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

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

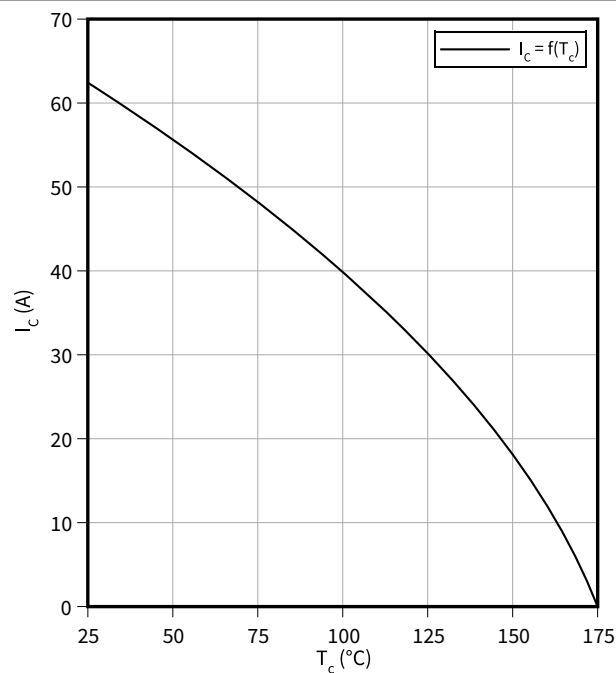
$$T_{vj} \leq 175\text{ °C}$$



Collector current as a function of case temperature

$$I_C = f(T_c)$$

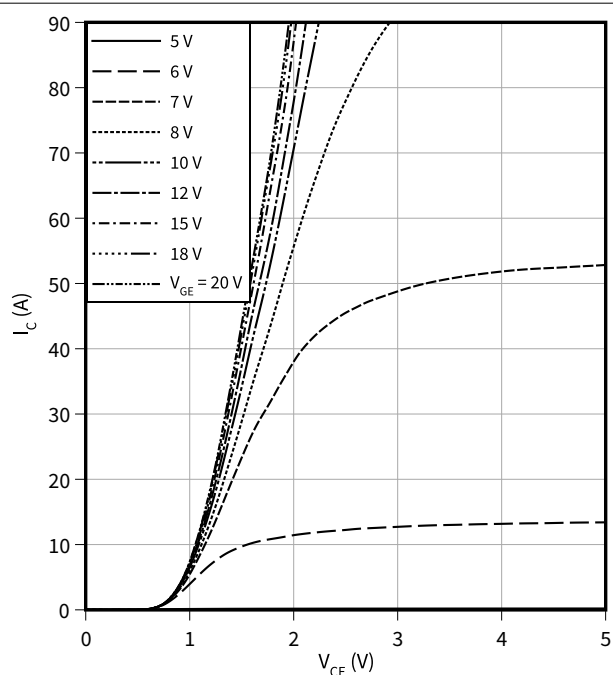
$$T_{vj} \leq 175\text{ °C}, V_{GE} \geq 15\text{ V}$$



Typical output characteristic

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

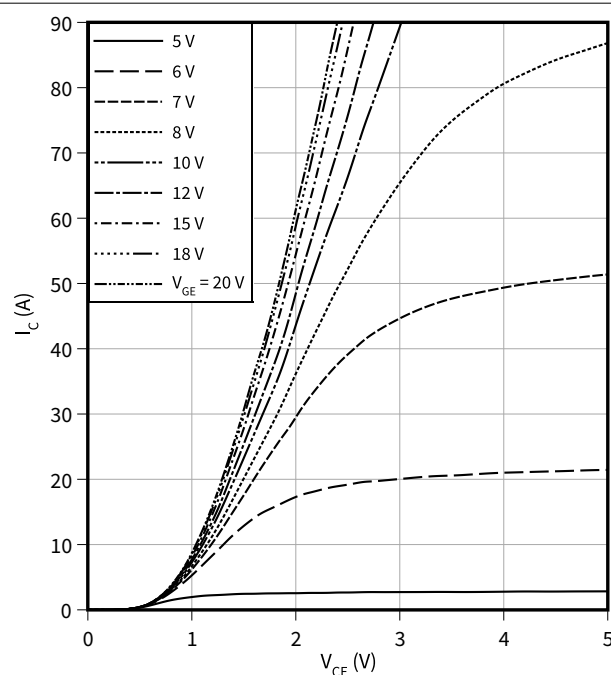
$$T_{vj} = 25\text{ °C}$$



Typical output characteristic

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

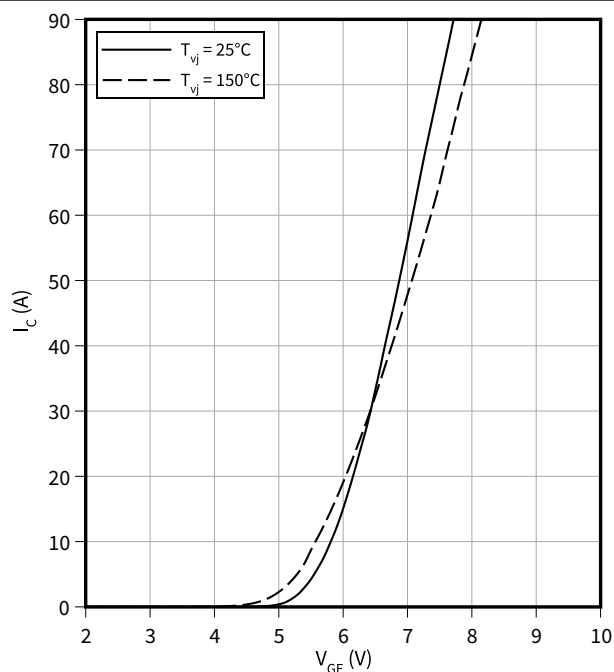
$$T_{vj} = 150\text{ °C}$$



Typical transfer characteristic

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

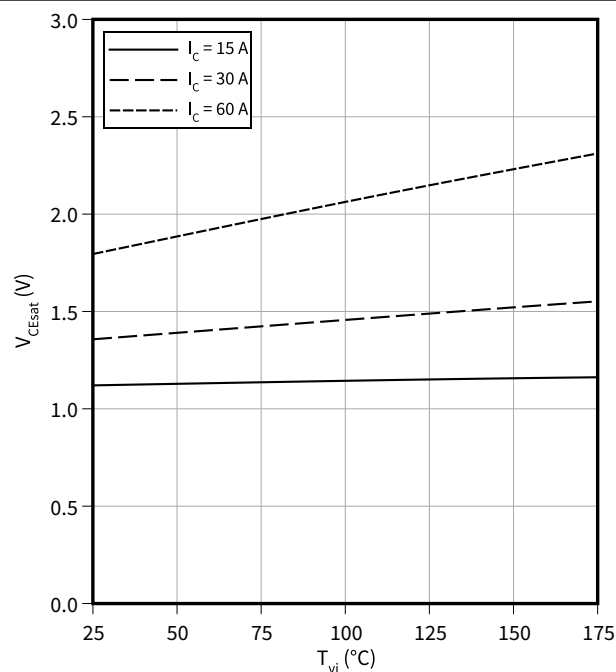
$$V_{CE} = 20 \text{ V}$$



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

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

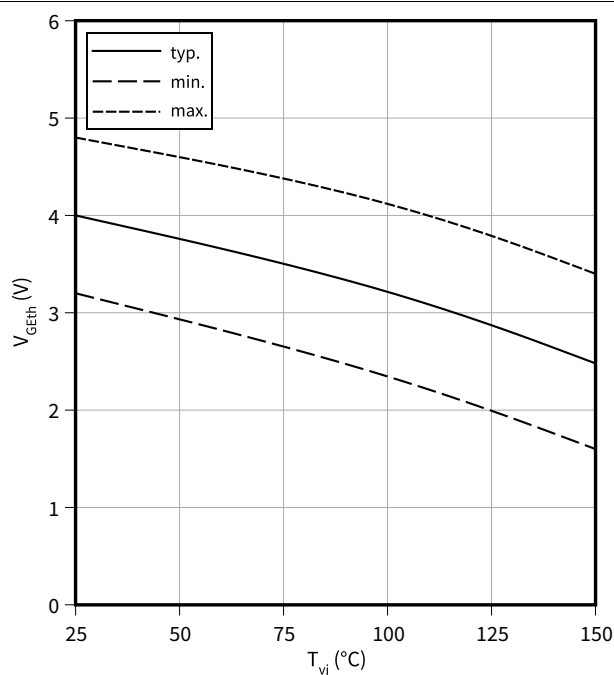
$$V_{GE} = 15 \text{ V}$$



Gate-emitter threshold voltage as a function of junction temperature

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

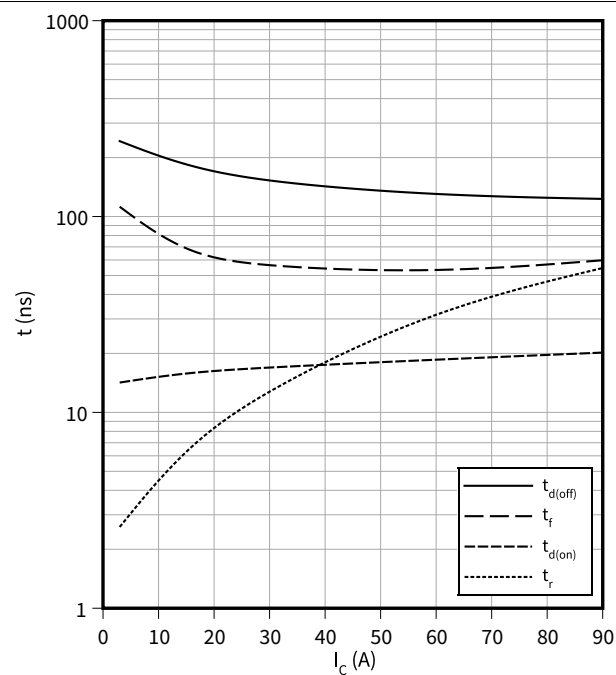
$$I_C = 0.3 \text{ mA}$$



Typical switching times as a function of collector current

$$t = f(I_C)$$

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

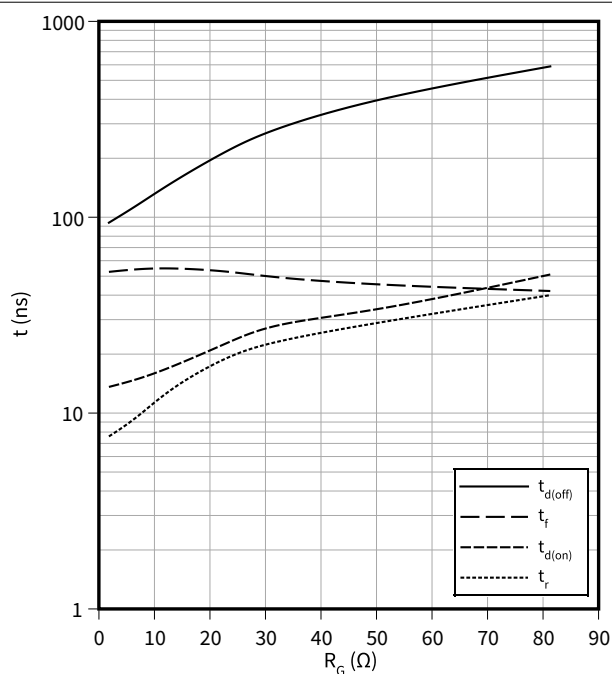


4 Characteristics diagrams

Typical switching times as a function of gate resistor

$$t = f(R_G)$$

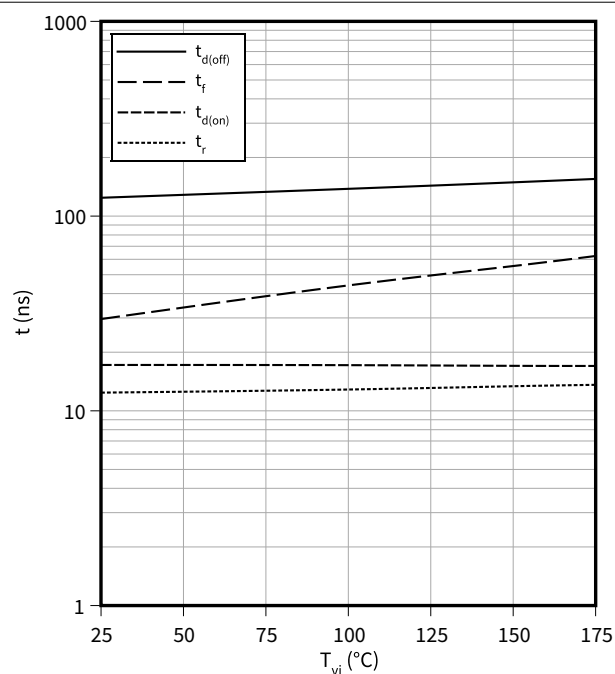
$I_C = 30\text{ A}$, $V_{CC} = 400\text{ V}$, $T_{vj} = 150\text{ °C}$, $V_{GE} = 0/15\text{ V}$



Typical switching times as a function of junction temperature

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

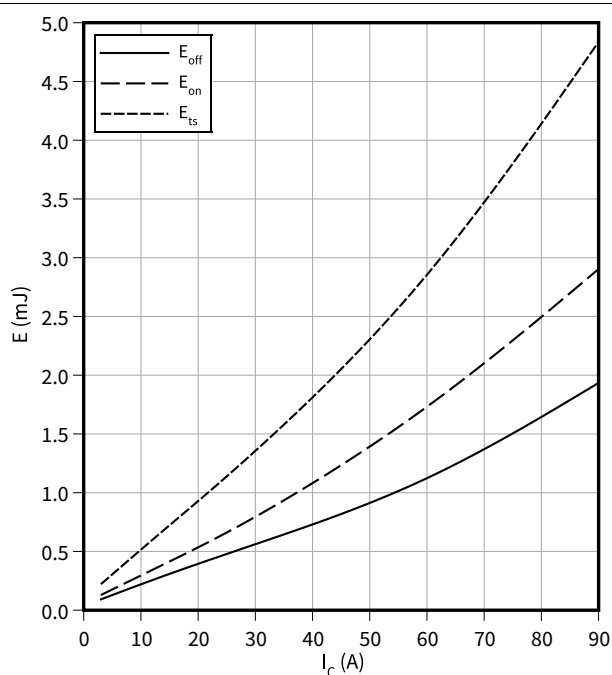
$I_C = 30\text{ A}$, $V_{CC} = 400\text{ V}$, $V_{GE} = 0/15\text{ V}$, $R_G = 13\text{ }\Omega$



Typical switching energy losses as a function of collector current

$$E = f(I_C)$$

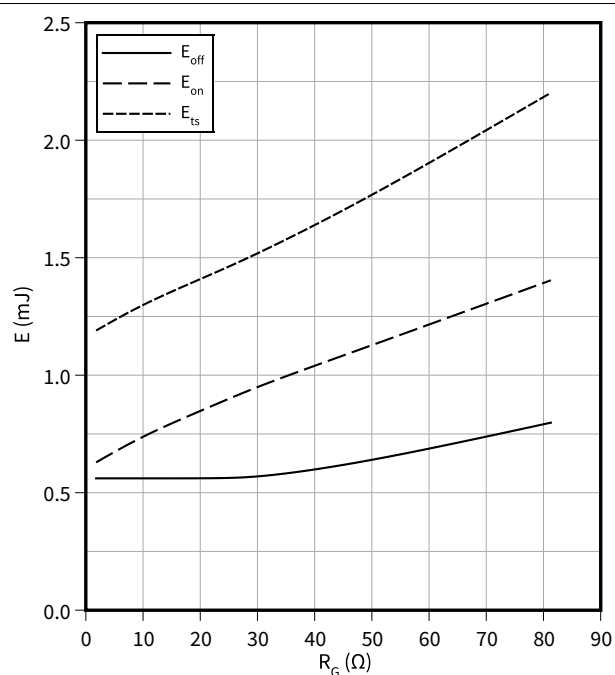
$V_{CC} = 400\text{ V}$, $T_{vj} = 150\text{ °C}$, $V_{GE} = 0/15\text{ V}$, $R_G = 13\text{ }\Omega$



Typical switching energy losses as a function of gate resistor

$$E = f(R_G)$$

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

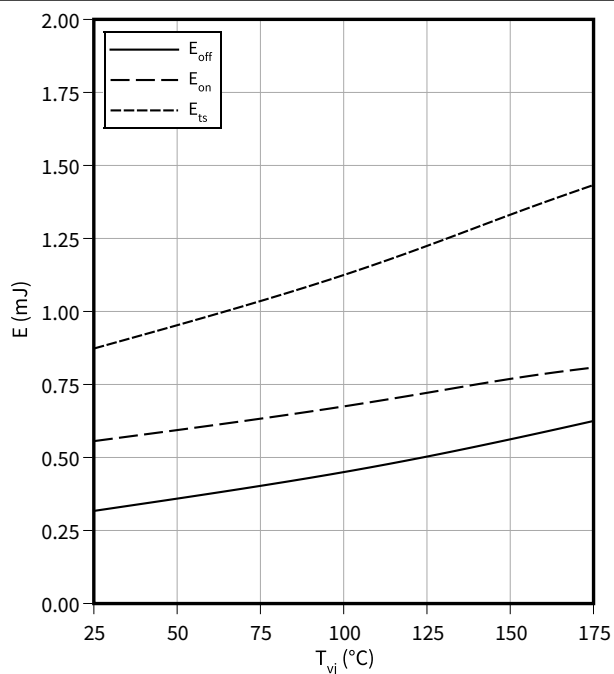


4 Characteristics diagrams

Typical switching energy losses as a function of junction temperature

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

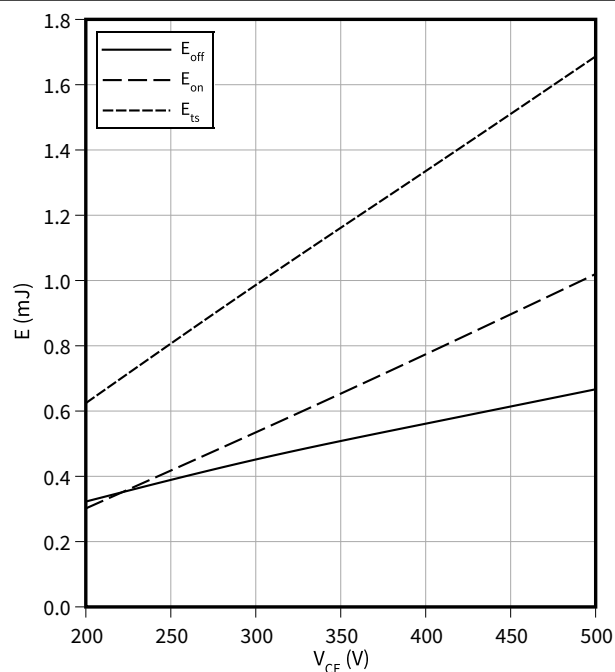
$I_C = 30\text{ A}$, $V_{CC} = 400\text{ V}$, $V_{GE} = 0/15\text{ V}$, $R_G = 13\ \Omega$



Typical switching energy losses as a function of collector emitter voltage

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

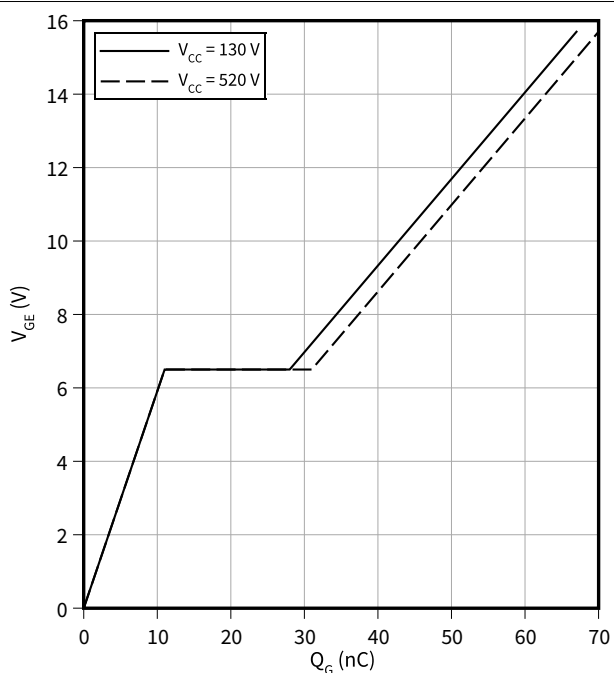
$I_C = 30\text{ A}$, $T_{vj} = 150\text{ °C}$, $V_{GE} = 0/15\text{ V}$, $R_G = 13\ \Omega$



Typical gate charge

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

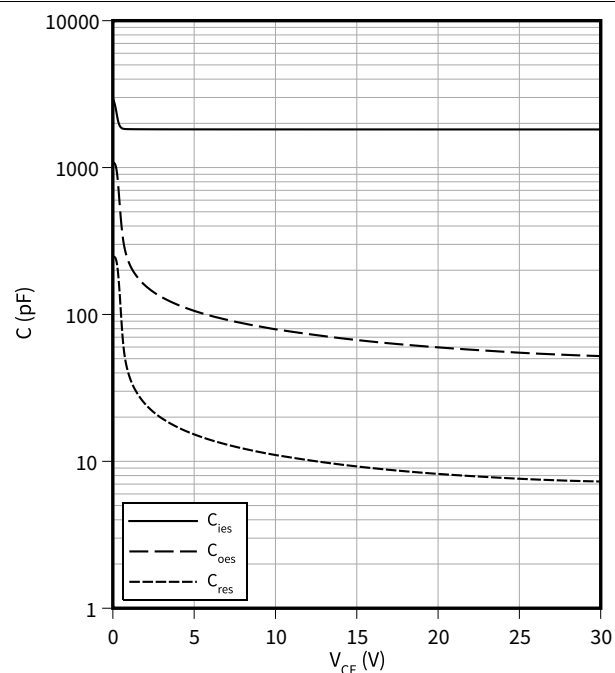
$I_C = 30\text{ A}$



Typical capacitance as a function of collector-emitter voltage

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

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

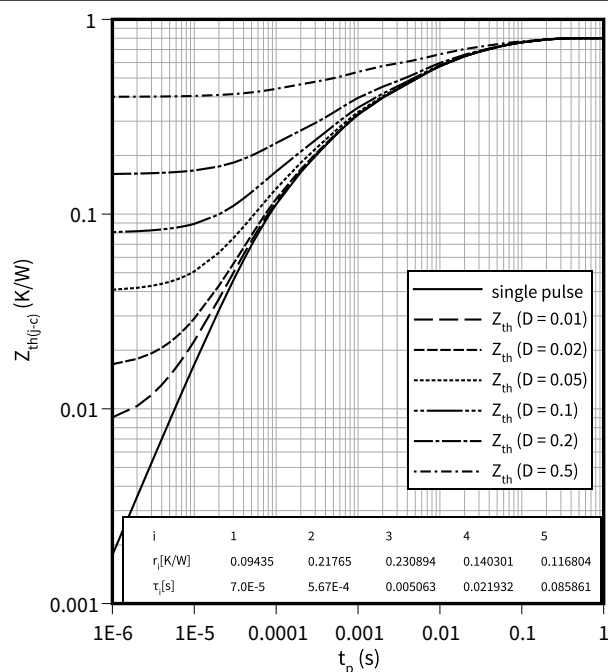


4 Characteristics diagrams

IGBT transient thermal impedance as a function of pulse width

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

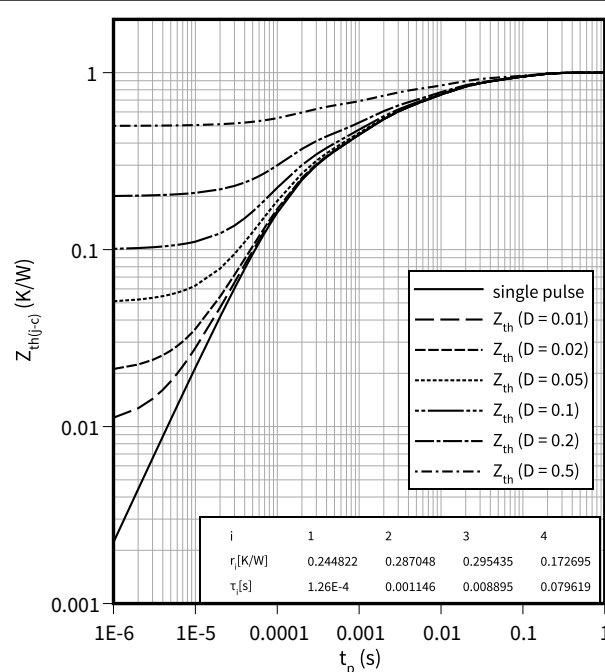
$$D = t_p/T$$



Diode transient thermal impedance as a function of pulse width

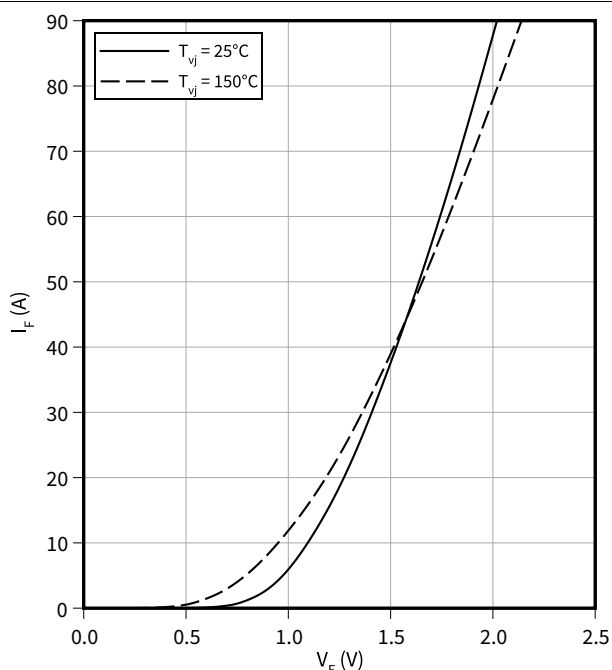
$$Z_{th(j-c)} = f(t_p)$$

$$D = t_p/T$$



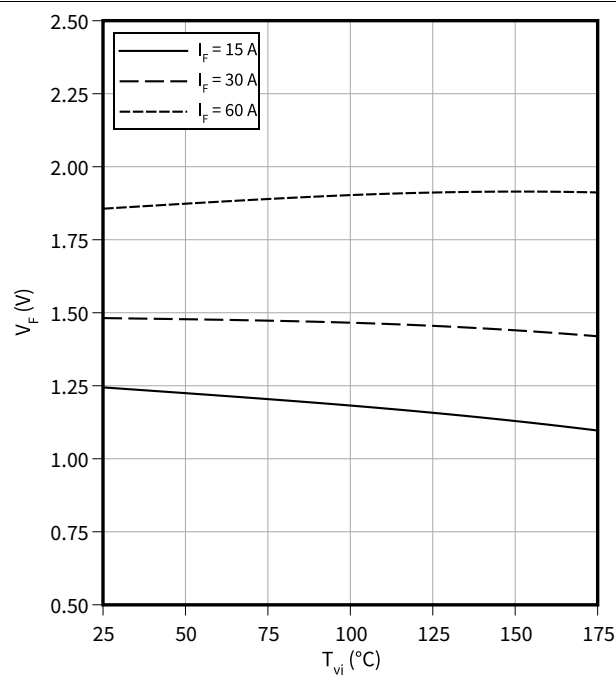
Typical diode forward current as a function of forward voltage

$$I_F = f(V_F)$$



Typical diode forward voltage as a function of junction temperature

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

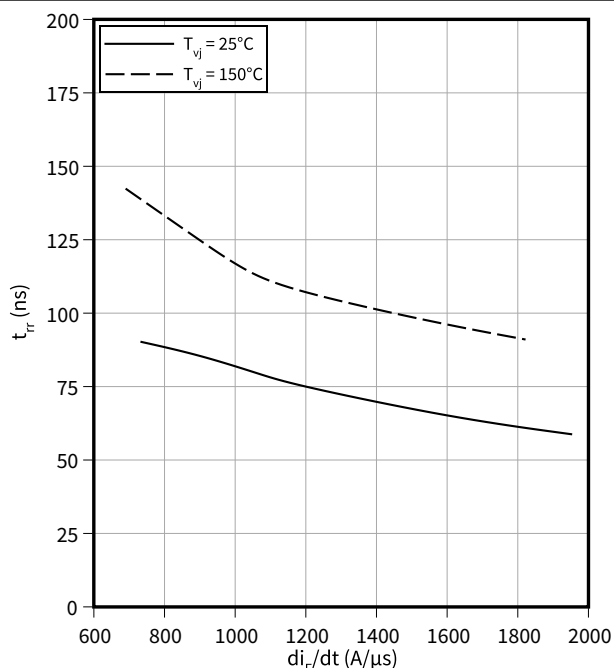


4 Characteristics diagrams

Typical reverse recovery time as a function of diode current slope

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

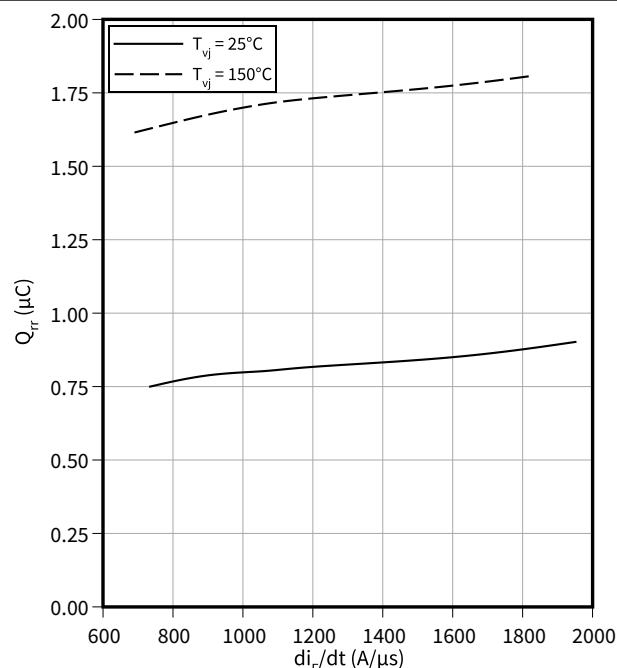
$V_R = 400 \text{ V}$, $I_F = 30 \text{ A}$



Typical reverse recovery charge as a function of diode current slope

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

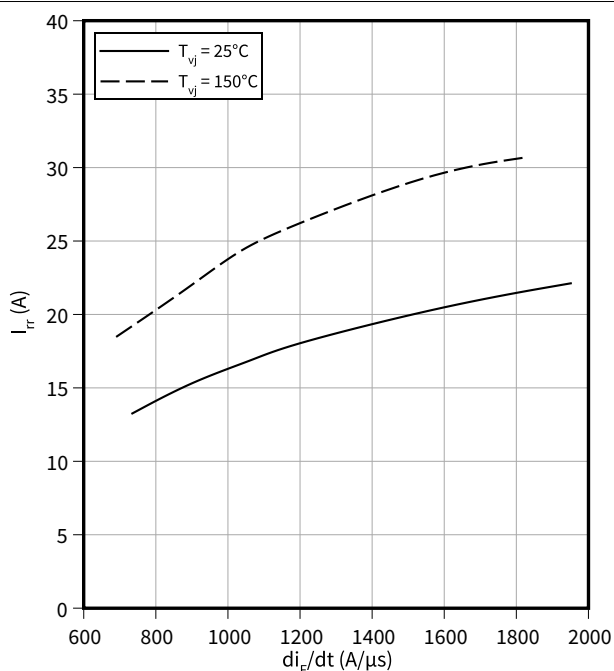
$V_R = 400 \text{ V}$, $I_F = 30 \text{ A}$



Typical reverse recovery current as a function of diode current slope

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

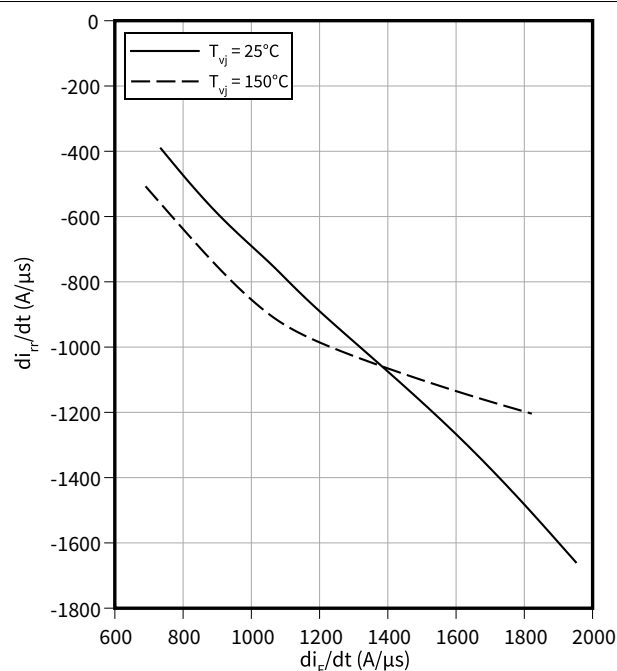
$V_R = 400 \text{ V}$, $I_F = 30 \text{ A}$



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

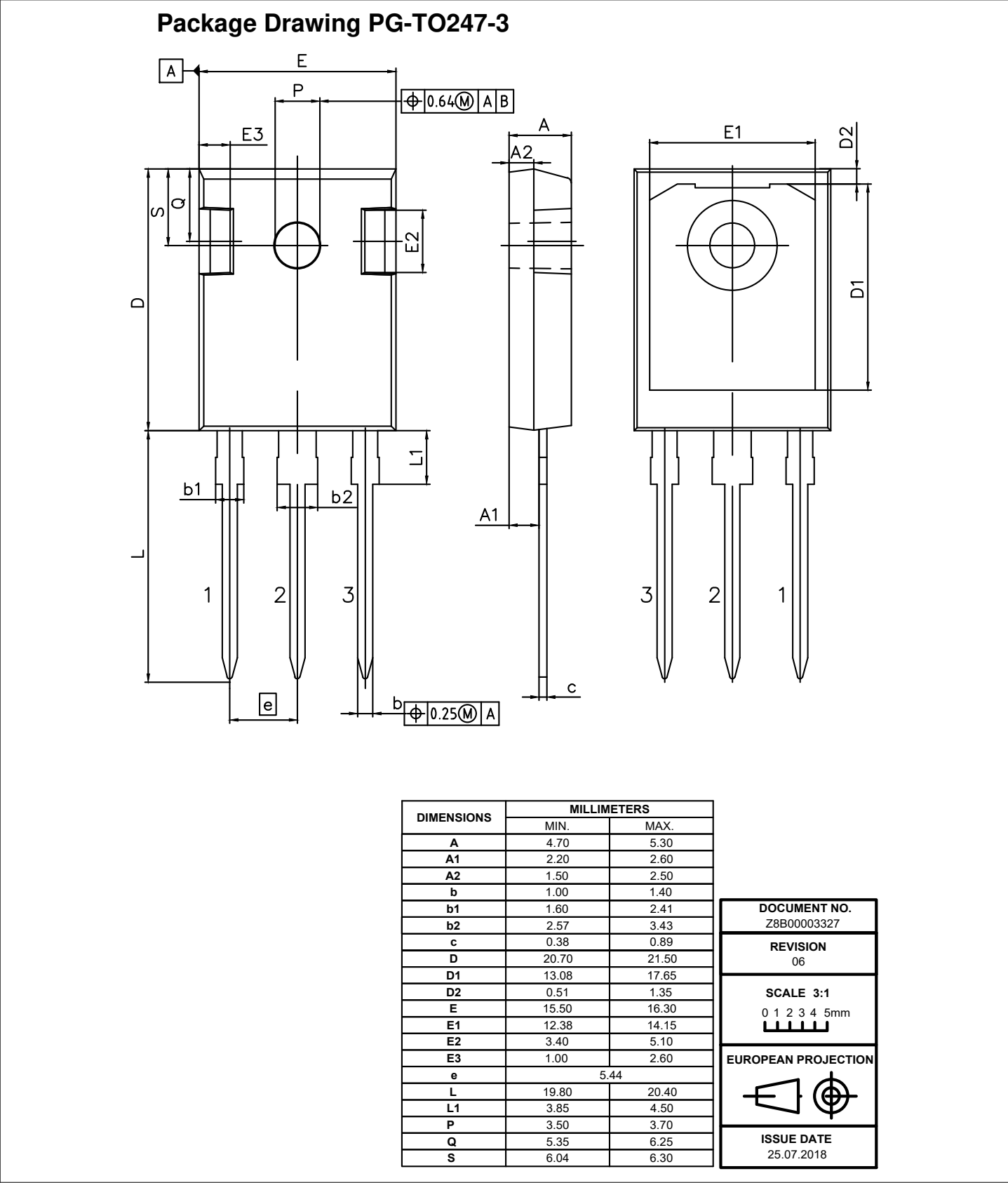


Figure 1

6 Testing conditions

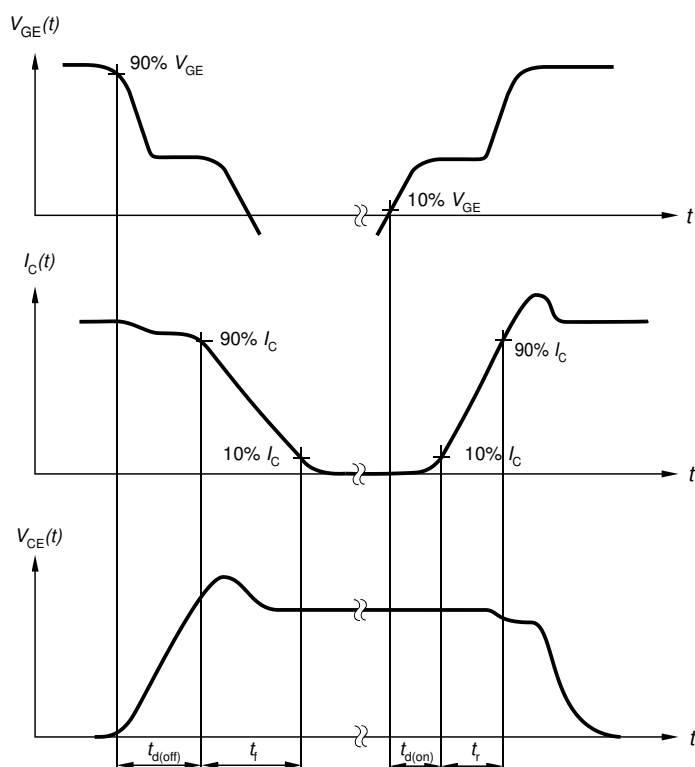


Figure A. Definition of switching times

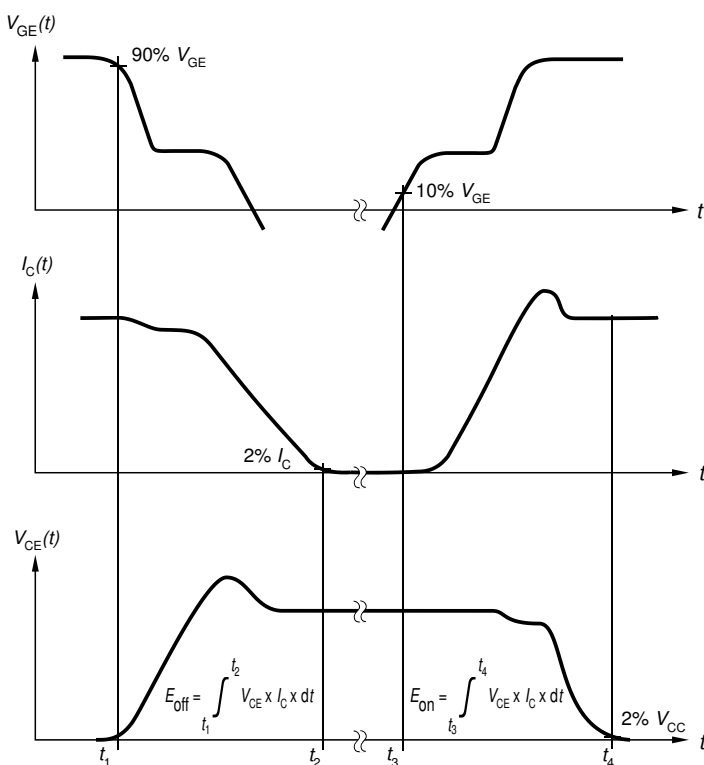


Figure B. Definition of switching losses

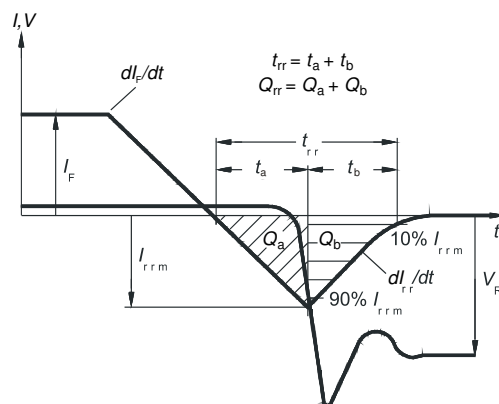


Figure C. Definition of diode switching characteristics

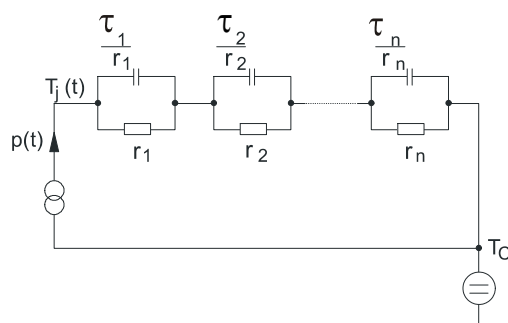


Figure D. Thermal equivalent circuit

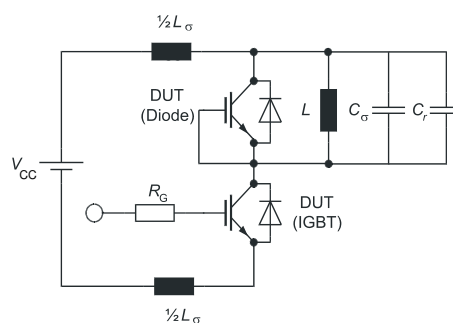


Figure E. **Dynamic test circuit**
 Parasitic inductance L_{σ} ,
 parasitic capacitor C_{σ} ,
 relief capacitor C_r ,
 (only for ZVT switching)

Revision history

Document revision	Date of release	Description of changes
V1.1	2015-08-12	Preliminary data sheet
V2.1	2015-09-22	Final data sheet
V2.2	2015-10-16	Minor change $I_c(V_{CE})$ 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

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