

High speed 5 IGBT in TRENCHSTOP™ 5 technology co-packed with full-rated RAPID 1 fast and soft antiparallel diode

Features

- $V_{CE} = 650\text{ V}$
- $I_C = 50\text{ A}$
- Best-in-class efficiency in hard switching and resonant topologies
- Plug and play replacement of previous generation IGBTs
- 650 V breakdown voltage
- Low gate charge Q_G
- IGBT co-packed with full-rated RAPID 1 fast and soft 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/>

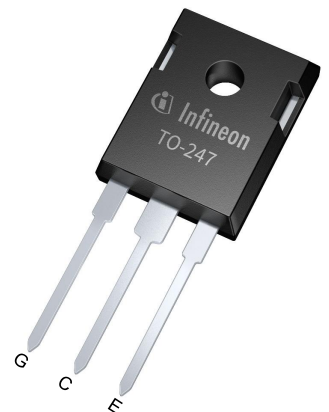
Potential applications

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

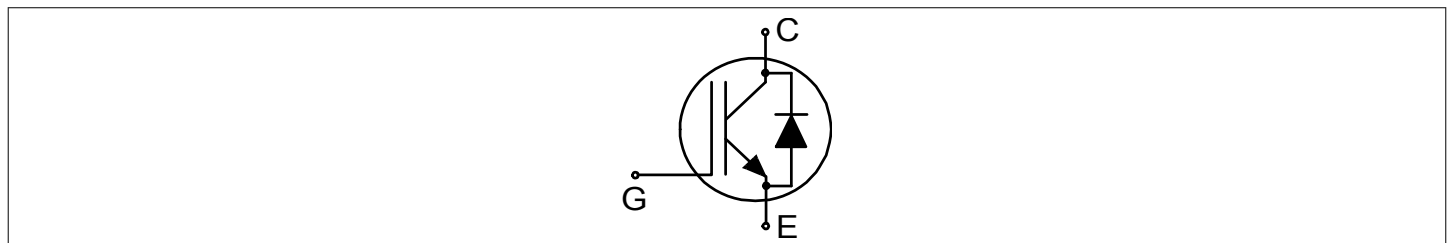
Description

Package pin definition:

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



- Lead-free
- Green
- Halogen-free
- RoHS



Type	Package	Marking
IKW50N65EH5	PG-TO247-3	K50EEH5

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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	$R_{th(j-c)}$				0.55	K/W
Diode thermal resistance, junction-case	$R_{th(j-c)}$				0.63	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
			$T_c = 100\text{ °C}$	50	
Pulsed collector current, t_p limited by T_{vjmax} ¹⁾	I_{Cpulse}		200	A	
Turn-off safe operating area ¹⁾		$V_{CE} \leq 650\text{ V}, t_p = 1\ \mu\text{s}, T_{vj} \leq 175\text{ °C}$	200	A	
Gate-emitter voltage	V_{GE}		± 20	V	
Transient gate-emitter voltage	V_{GE}	$t_p \leq 10\ \mu\text{s}, D < 0.01$	± 30	V	
Power dissipation	P_{tot}		$T_c = 25\text{ °C}$	275	W
			$T_c = 100\text{ °C}$	138	

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

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}	$I_C = 50 \text{ A}, V_{GE} = 15 \text{ V}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	1.65	2.1	V
			$T_{vj} = 125 \text{ }^\circ\text{C}$	1.85		
			$T_{vj} = 175 \text{ }^\circ\text{C}$	1.95		
Gate-emitter threshold voltage	V_{GETh}	$I_C = 0.5 \text{ mA}, V_{CE} = V_{GE}$	3.2	4	4.8	V
Zero gate-voltage collector current	I_{CES}	$V_{CE} = 650 \text{ V}, V_{GE} = 0 \text{ V}$	$T_{vj} = 25 \text{ }^\circ\text{C}$	1	50	μA
			$T_{vj} = 175 \text{ }^\circ\text{C}$	2000		
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}	$V_{CE} = 25 \text{ V}, V_{GE} = 0 \text{ V}, f = 1000 \text{ kHz}$		3000		pF
Output capacitance	C_{oes}	$V_{CE} = 25 \text{ V}, V_{GE} = 0 \text{ V}, f = 1000 \text{ kHz}$		90		pF
Reverse transfer capacitance	C_{res}	$V_{CE} = 25 \text{ V}, V_{GE} = 0 \text{ V}, f = 1000 \text{ kHz}$		12		pF
Gate charge	Q_G	$I_C = 50 \text{ A}, V_{GE} = 15 \text{ V}, V_{CC} = 520 \text{ V}$		120		nC
Turn-on delay time	$t_{d(on)}$	$V_{CC} = 400 \text{ V}, V_{GE} = 15 \text{ V}, R_{Gon} = 12 \text{ } \Omega, R_{Goff} = 12 \text{ } \Omega$	$T_{vj} = 25 \text{ }^\circ\text{C}, I_C = 50 \text{ A}$	25		ns
			$T_{vj} = 25 \text{ }^\circ\text{C}, I_C = 25 \text{ A}$	24		
			$T_{vj} = 150 \text{ }^\circ\text{C}, I_C = 50 \text{ A}$	24		
			$T_{vj} = 150 \text{ }^\circ\text{C}, I_C = 25 \text{ A}$	23		
Rise time (inductive load)	t_r	$V_{CC} = 400 \text{ V}, V_{GE} = 15 \text{ V}, R_{Gon} = 12 \text{ } \Omega, R_{Goff} = 12 \text{ } \Omega$	$T_{vj} = 25 \text{ }^\circ\text{C}, I_C = 50 \text{ A}$	29		ns
			$T_{vj} = 25 \text{ }^\circ\text{C}, I_C = 25 \text{ A}$	12		
			$T_{vj} = 150 \text{ }^\circ\text{C}, I_C = 50 \text{ A}$	30		
			$T_{vj} = 150 \text{ }^\circ\text{C}, I_C = 25 \text{ A}$	14		

(table continues...)

Table 3 (continued) Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Turn-off delay time	$t_{d(off)}$	$V_{CC} = 400\text{ V}, V_{GE} = 15\text{ V},$ $R_{Gon} = 12\ \Omega, R_{Goff} = 12\ \Omega$	$T_{vj} = 25\text{ }^\circ\text{C},$ $I_C = 50\text{ A}$		172		ns
			$T_{vj} = 25\text{ }^\circ\text{C},$ $I_C = 25\text{ A}$		173		
			$T_{vj} = 150\text{ }^\circ\text{C},$ $I_C = 50\text{ A}$		190		
			$T_{vj} = 150\text{ }^\circ\text{C},$ $I_C = 25\text{ A}$		203		
Fall time (inductive load)	t_f	$V_{CC} = 400\text{ V}, V_{GE} = 15\text{ V},$ $R_{Gon} = 12\ \Omega, R_{Goff} = 12\ \Omega$	$T_{vj} = 25\text{ }^\circ\text{C},$ $I_C = 50\text{ A}$		35		ns
			$T_{vj} = 25\text{ }^\circ\text{C},$ $I_C = 25\text{ A}$		15		
			$T_{vj} = 150\text{ }^\circ\text{C},$ $I_C = 50\text{ A}$		30		
			$T_{vj} = 150\text{ }^\circ\text{C},$ $I_C = 25\text{ A}$		20		
Turn-on energy	E_{on}	$V_{CC} = 400\text{ V}, V_{GE} = 15\text{ V},$ $R_{Gon} = 12\ \Omega, R_{Goff} = 12\ \Omega$	$T_{vj} = 25\text{ }^\circ\text{C},$ $I_C = 50\text{ A}$		1.5		mJ
			$T_{vj} = 25\text{ }^\circ\text{C},$ $I_C = 25\text{ A}$		0.57		
			$T_{vj} = 150\text{ }^\circ\text{C},$ $I_C = 50\text{ A}$		2		
			$T_{vj} = 150\text{ }^\circ\text{C},$ $I_C = 25\text{ A}$		0.95		
Turn-off energy	E_{off}	$V_{CC} = 400\text{ V}, V_{GE} = 15\text{ V},$ $R_{Gon} = 12\ \Omega, R_{Goff} = 12\ \Omega$	$T_{vj} = 25\text{ }^\circ\text{C},$ $I_C = 50\text{ A}$		0.5		mJ
			$T_{vj} = 25\text{ }^\circ\text{C},$ $I_C = 25\text{ A}$		0.16		
			$T_{vj} = 150\text{ }^\circ\text{C},$ $I_C = 50\text{ A}$		0.6		
			$T_{vj} = 150\text{ }^\circ\text{C},$ $I_C = 25\text{ A}$		0.25		

(table continues...)

Table 3 (continued) Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Total switching energy	E_{ts}	$V_{CC} = 400\text{ V}, V_{GE} = 15\text{ V},$ $R_{Gon} = 12\ \Omega, R_{Goff} = 12\ \Omega$	$T_{vj} = 25\text{ }^\circ\text{C},$ $I_C = 50\text{ A}$		2		mJ
			$T_{vj} = 25\text{ }^\circ\text{C},$ $I_C = 25\text{ A}$		0.73		
			$T_{vj} = 150\text{ }^\circ\text{C},$ $I_C = 50\text{ A}$		2.6		
			$T_{vj} = 150\text{ }^\circ\text{C},$ $I_C = 25\text{ A}$		1.2		
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	$T_c = 25\text{ }^\circ\text{C}$	80	A
			$T_c = 100\text{ }^\circ\text{C}$	50	
Diode pulsed current, t_p limited by T_{vjmax} ¹⁾	I_{Fpulse}		200	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	$I_F = 50\text{ A}$	$T_{vj} = 25\text{ }^\circ\text{C}$		1.35	1.7	V
			$T_{vj} = 125\text{ }^\circ\text{C}$		1.33		
			$T_{vj} = 175\text{ }^\circ\text{C}$		1.3		

(table continues...)

Table 5 (continued) Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Diode reverse recovery time	t_{rr}	$V_R = 400\text{ V}$	$T_{vj} = 25\text{ °C},$ $I_F = 50\text{ A},$ $-di_F/dt = 1000\text{ A}/\mu\text{s}$		81		ns
			$T_{vj} = 25\text{ °C},$ $I_F = 25\text{ A},$ $-di_F/dt = 1000\text{ A}/\mu\text{s}$		56		
			$T_{vj} = 150\text{ °C},$ $I_F = 50\text{ A},$ $-di_F/dt = 1000\text{ A}/\mu\text{s}$		108		
			$T_{vj} = 150\text{ °C},$ $I_F = 25\text{ A},$ $-di_F/dt = 1000\text{ A}/\mu\text{s}$		98		
Diode reverse recovery charge	Q_{rr}	$V_R = 400\text{ V}$	$T_{vj} = 25\text{ °C},$ $I_F = 50\text{ A},$ $-di_F/dt = 1000\text{ A}/\mu\text{s}$		1.1		μC
			$T_{vj} = 25\text{ °C},$ $I_F = 25\text{ A},$ $-di_F/dt = 1000\text{ A}/\mu\text{s}$		0.7		
			$T_{vj} = 150\text{ °C},$ $I_F = 50\text{ A},$ $-di_F/dt = 1000\text{ A}/\mu\text{s}$		2.6		
			$T_{vj} = 150\text{ °C},$ $I_F = 25\text{ A},$ $-di_F/dt = 1000\text{ A}/\mu\text{s}$		1.8		
Diode peak reverse recovery current	I_{rrm}	$V_R = 400\text{ V}$	$T_{vj} = 25\text{ °C},$ $I_F = 50\text{ A},$ $-di_F/dt = 1000\text{ A}/\mu\text{s}$		17		A
			$T_{vj} = 25\text{ °C},$ $I_F = 25\text{ A},$ $-di_F/dt = 1000\text{ A}/\mu\text{s}$		19.7		
			$T_{vj} = 150\text{ °C},$ $I_F = 50\text{ A},$ $-di_F/dt = 1000\text{ A}/\mu\text{s}$		36		
			$T_{vj} = 150\text{ °C},$ $I_F = 25\text{ A},$ $-di_F/dt = 1000\text{ A}/\mu\text{s}$		28.8		

(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	$V_R = 400\text{ V}$	$T_{vj} = 25\text{ °C},$ $I_F = 50\text{ A},$ $-di_F/dt = 1000\text{ A}/\mu\text{s}$		1000		A/ μs
			$T_{vj} = 25\text{ °C},$ $I_F = 25\text{ A},$ $-di_F/dt = 1000\text{ A}/\mu\text{s}$		1500		
			$T_{vj} = 150\text{ °C},$ $I_F = 50\text{ A},$ $-di_F/dt = 1000\text{ A}/\mu\text{s}$		2000		
			$T_{vj} = 150\text{ °C},$ $I_F = 25\text{ A},$ $-di_F/dt = 1000\text{ A}/\mu\text{s}$		1500		
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.

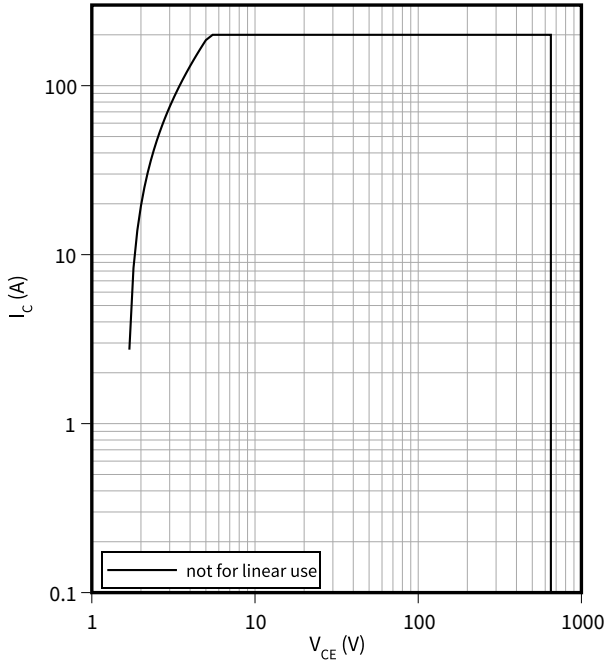
Electrical Characteristic at $T_{vj} = 25\text{ °C}$, unless otherwise specified.

Dynamic test circuit, parasitic inductance $L_\sigma = 30\text{ nH}$, parasitic capacitor $C_\sigma = 25\text{ pF}$ from Fig. E. Energy losses include “tail” and diode reverse recovery.

4 Characteristics diagrams

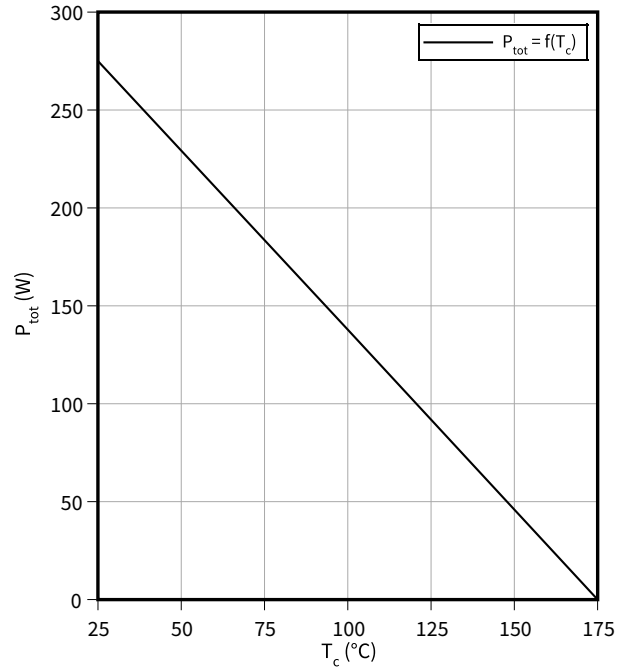
Forward bias safe operating area

$I_C = f(V_{CE})$
 $D = 0, T_{vj} \leq 175\text{ °C}, V_{GE} = 15\text{ V}, t_p = 1\text{ }\mu\text{s}, T_c = 25\text{ °C}$



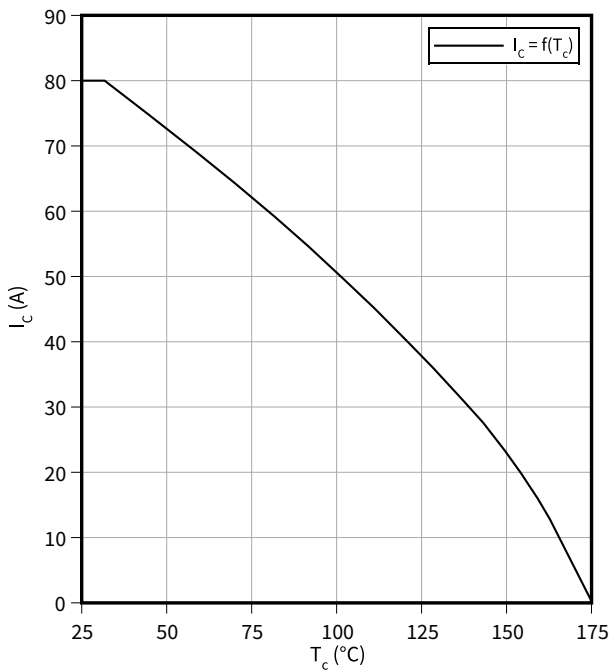
Power dissipation as a function of case temperature

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



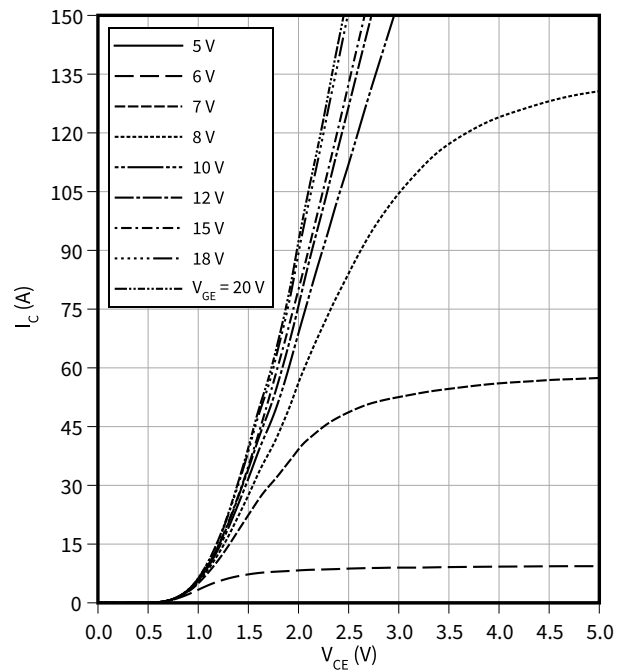
Collector current as a function of case temperature

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



Typical output characteristic

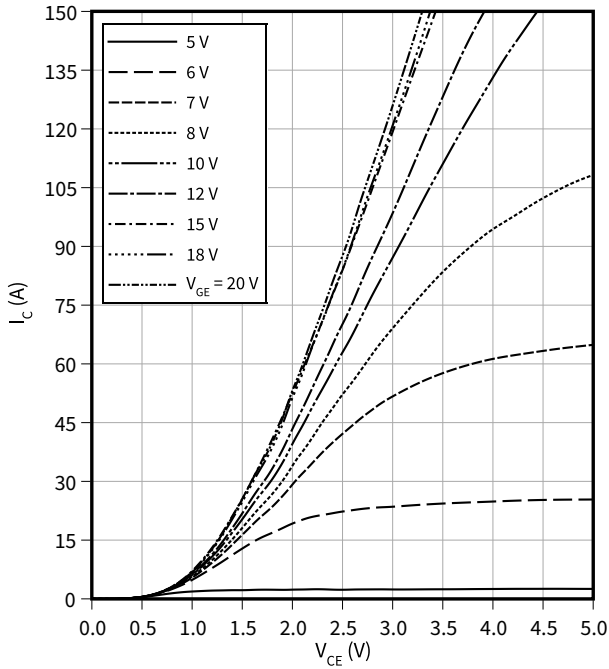
$I_C = f(V_{CE})$
 $T_{vj} = 25\text{ °C}$



4 Characteristics diagrams

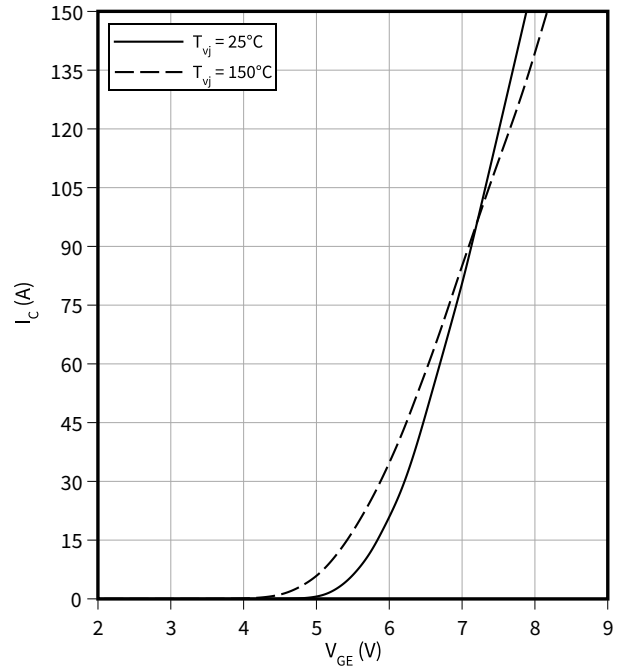
Typical output characteristic

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



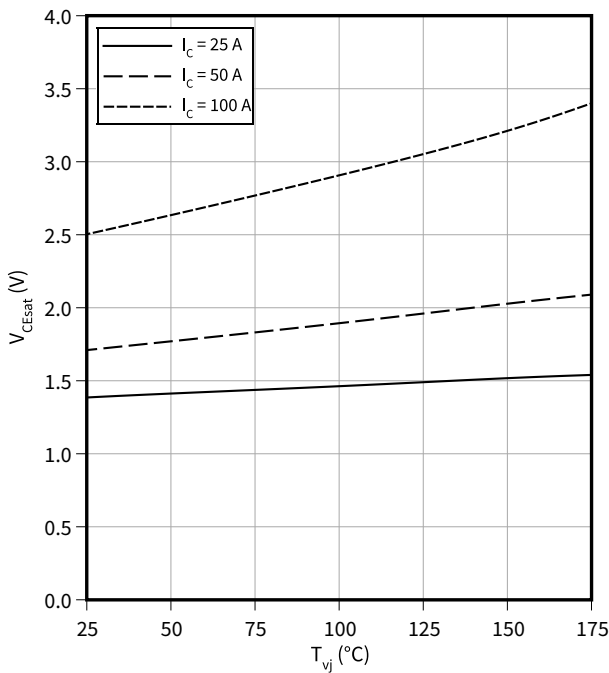
Typical transfer characteristic

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



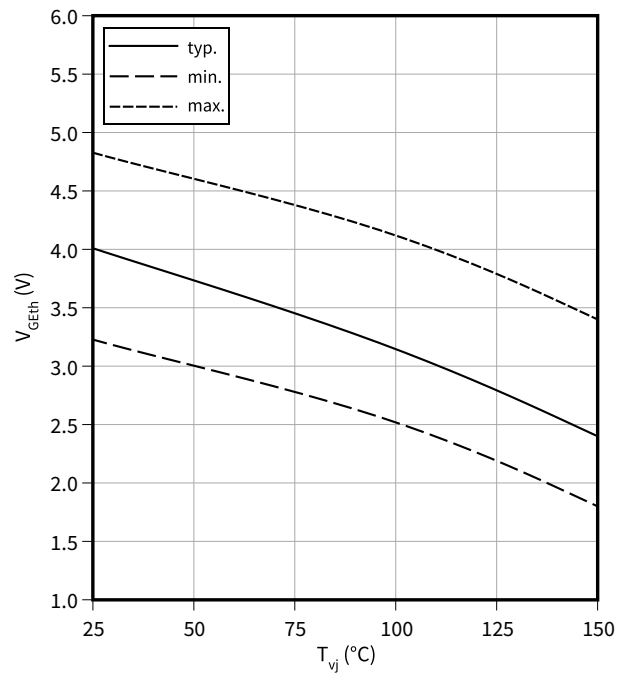
Typical collector-emitter saturation voltage as a function of junction temperature

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



Gate-emitter threshold voltage as a function of junction temperature

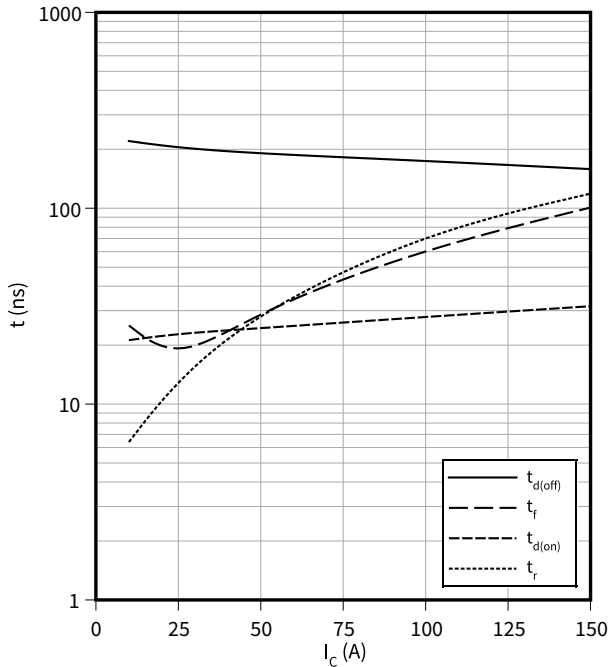
$V_{GEth} = f(T_{vj})$
 $I_C = 0.5\text{ mA}$



4 Characteristics diagrams

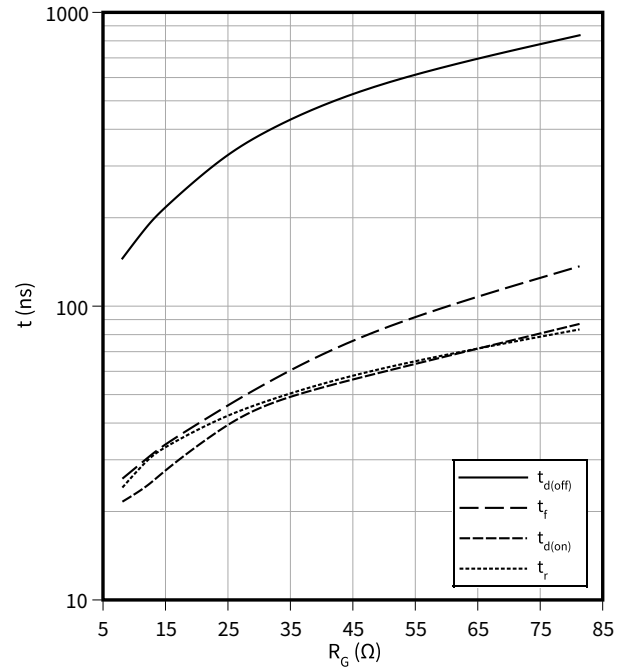
Typical switching times as a function of collector current

$t = f(I_C)$
 $V_{CC} = 400 \text{ V}, T_{vj} = 150 \text{ }^\circ\text{C}, V_{GE} = 0/15 \text{ V}, R_G = 12 \text{ } \Omega$



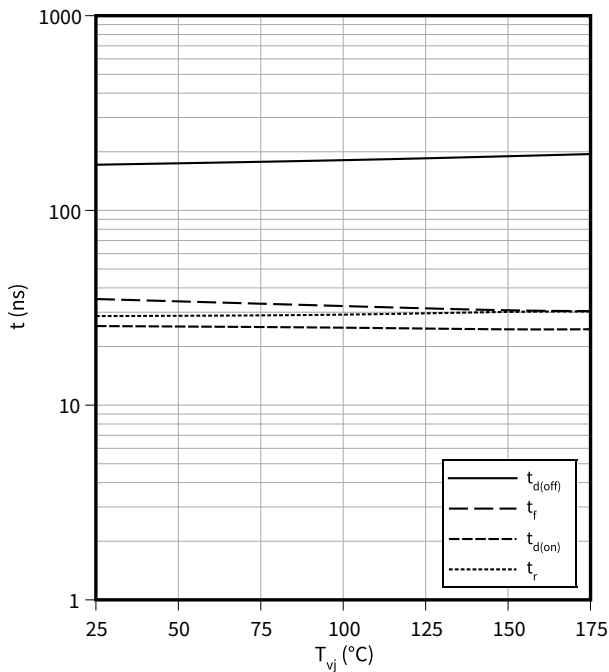
Typical switching times as a function of gate resistor

$t = f(R_G)$
 $I_C = 50 \text{ A}, V_{CC} = 400 \text{ V}, T_{vj} = 150 \text{ }^\circ\text{C}, V_{GE} = 0/15 \text{ V}$



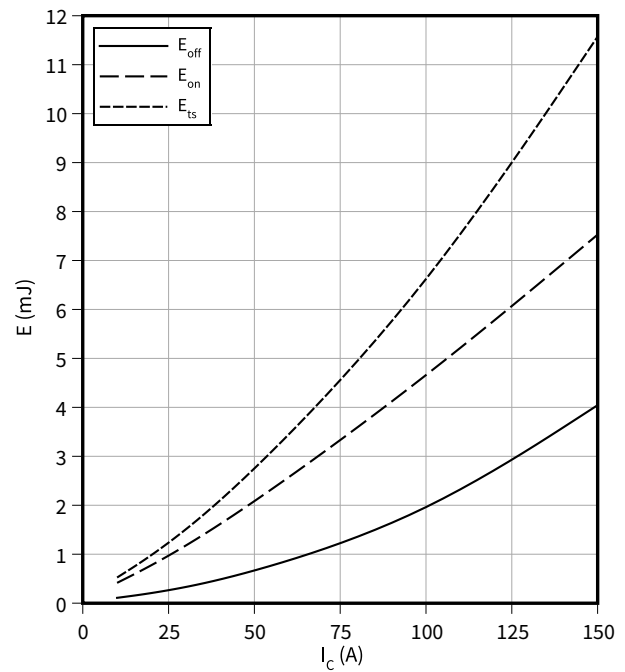
Typical switching times as a function of junction temperature

$t = f(T_{vj})$
 $I_C = 50 \text{ A}, V_{CC} = 400 \text{ V}, V_{GE} = 0/15 \text{ V}, R_G = 12 \text{ } \Omega$



Typical switching energy losses as a function of collector current

$E = f(I_C)$
 $V_{CC} = 400 \text{ V}, T_{vj} = 150 \text{ }^\circ\text{C}, V_{GE} = 0/15 \text{ V}, R_G = 12 \text{ } \Omega$

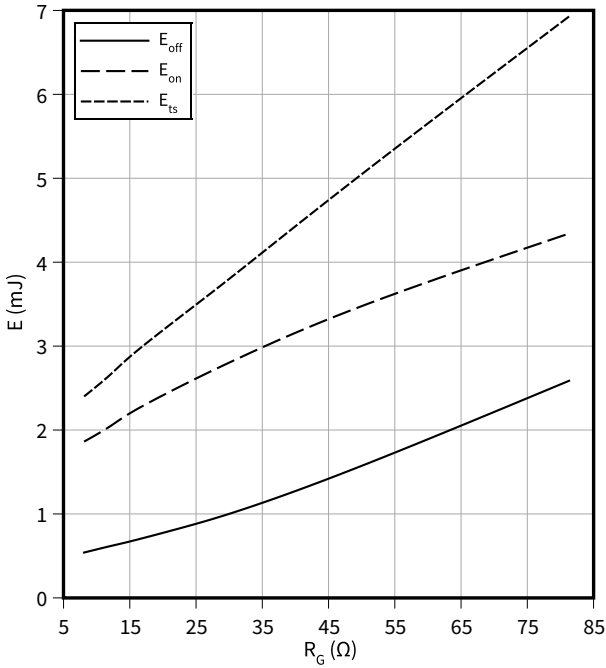


4 Characteristics diagrams

Typical switching energy losses as a function of gate resistor

$E = f(R_G)$

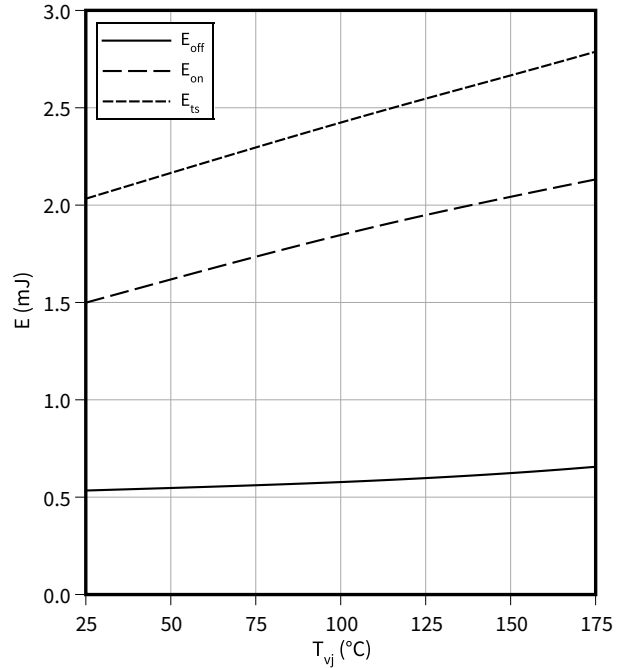
$I_C = 50 \text{ A}, V_{CC} = 400 \text{ V}, T_{vj} = 150 \text{ }^\circ\text{C}, V_{GE} = 0/15 \text{ V}$



Typical switching energy losses as a function of junction temperature

$E = f(T_{vj})$

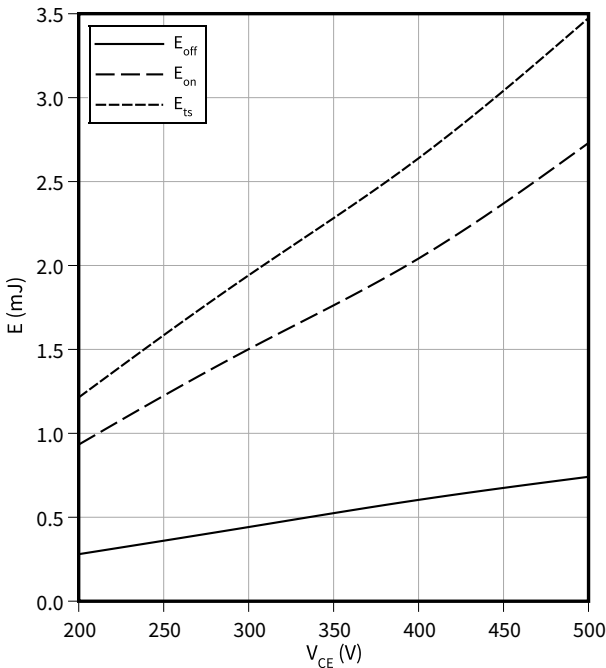
$I_C = 50 \text{ A}, V_{CC} = 400 \text{ V}, V_{GE} = 0/15 \text{ V}, R_G = 12 \text{ } \Omega$



Typical switching energy losses as a function of collector emitter voltage

$E = f(V_{CE})$

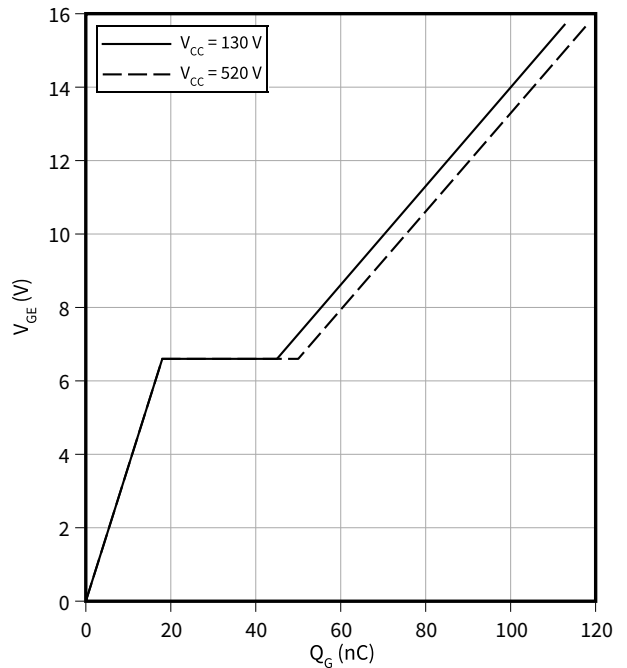
$I_C = 50 \text{ A}, T_{vj} = 150 \text{ }^\circ\text{C}, V_{GE} = 0/15 \text{ V}, R_G = 12 \text{ } \Omega$



Typical gate charge

$V_{GE} = f(Q_G)$

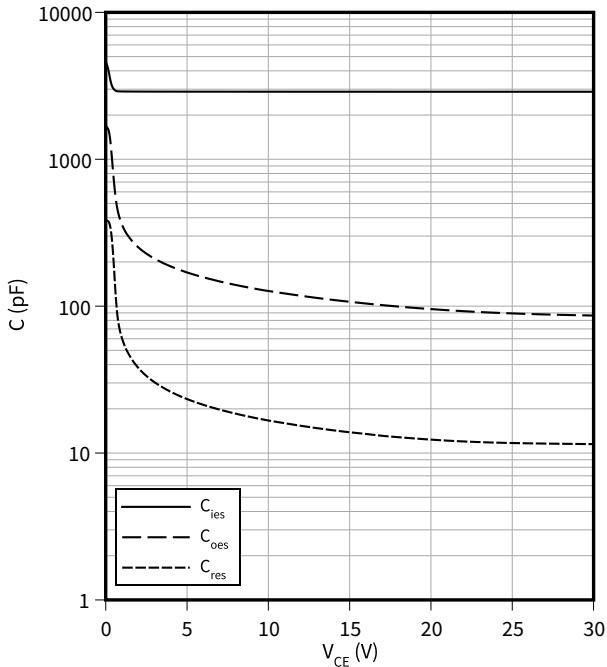
$I_C = 50 \text{ A}$



4 Characteristics diagrams

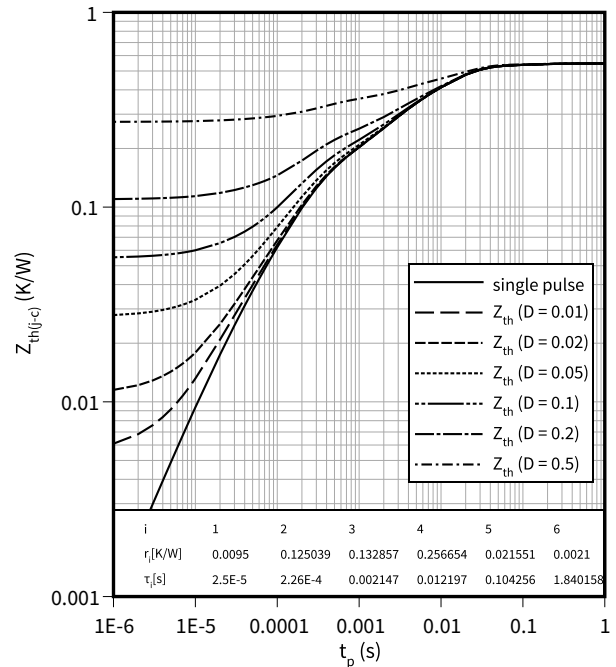
Typical capacitance as a function of collector-emitter voltage

$C = f(V_{CE})$
 $f = 1000 \text{ kHz}, V_{GE} = 0 \text{ V}$



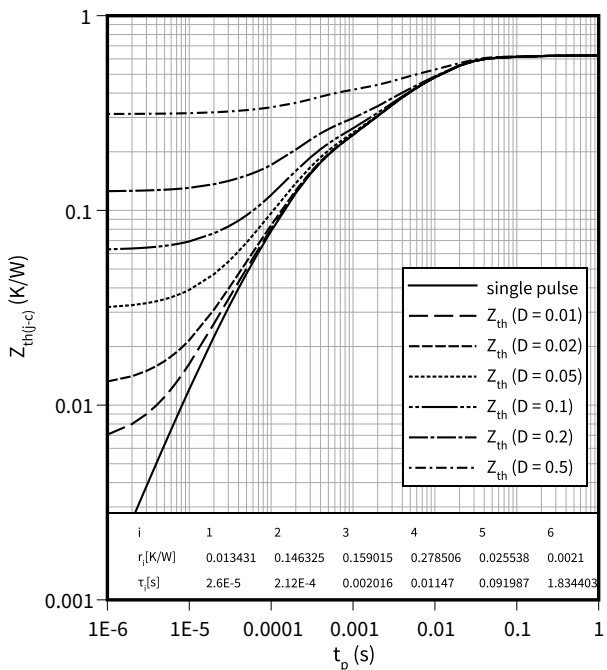
IGBT transient thermal impedance as a function of pulse width

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



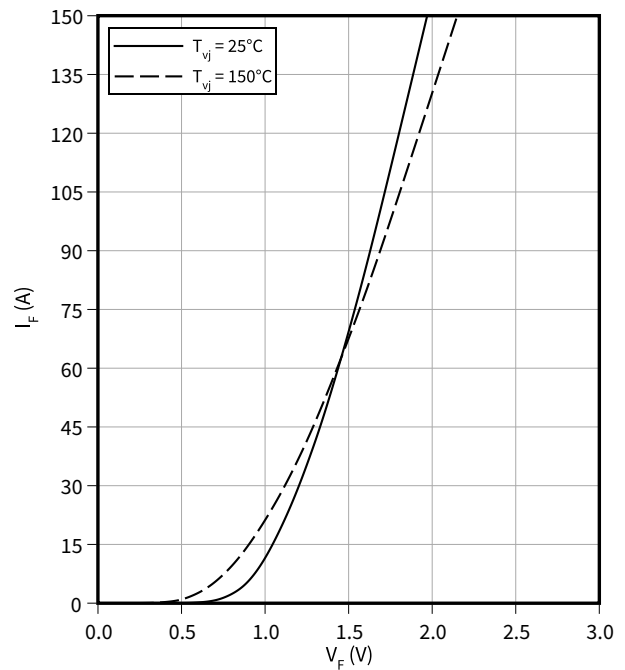
Diode transient thermal impedance as a function of pulse width

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



Typical diode forward current as a function of forward voltage

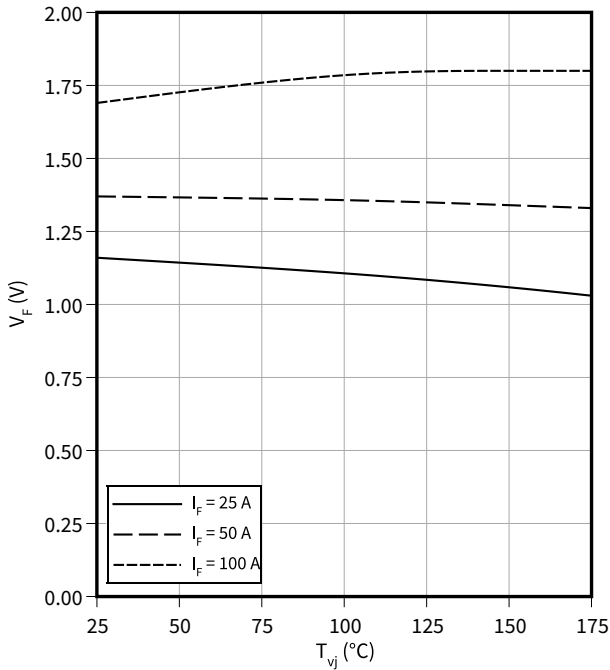
$I_F = f(V_F)$



4 Characteristics diagrams

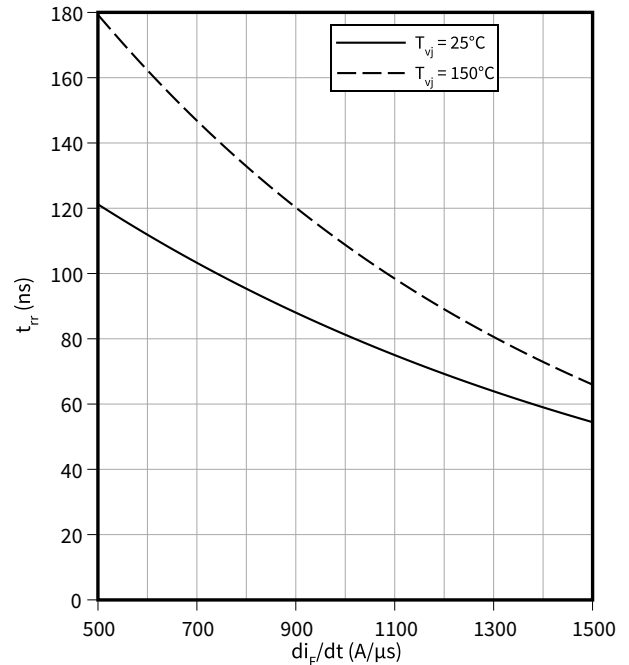
Typical diode forward voltage as a function of junction temperature

$V_F = f(T_{vj})$



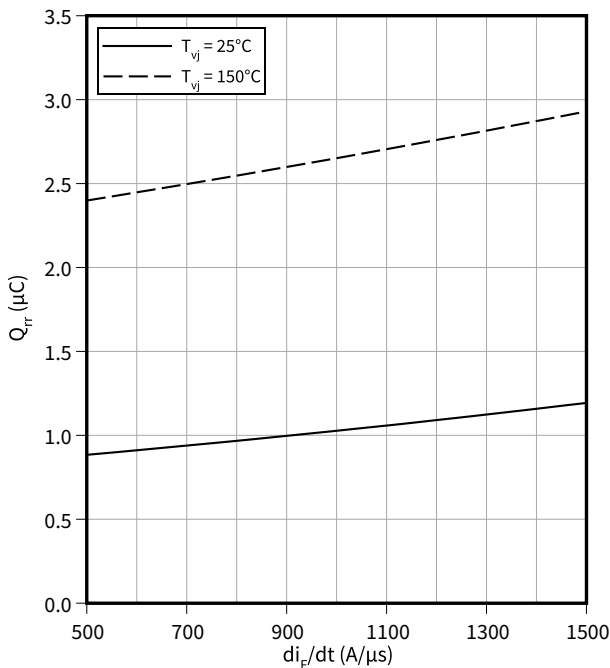
Typical reverse recovery time as a function of diode current slope

$t_{rr} = f(di_F/dt)$
 $V_R = 400$ V, $I_F = 50$ A



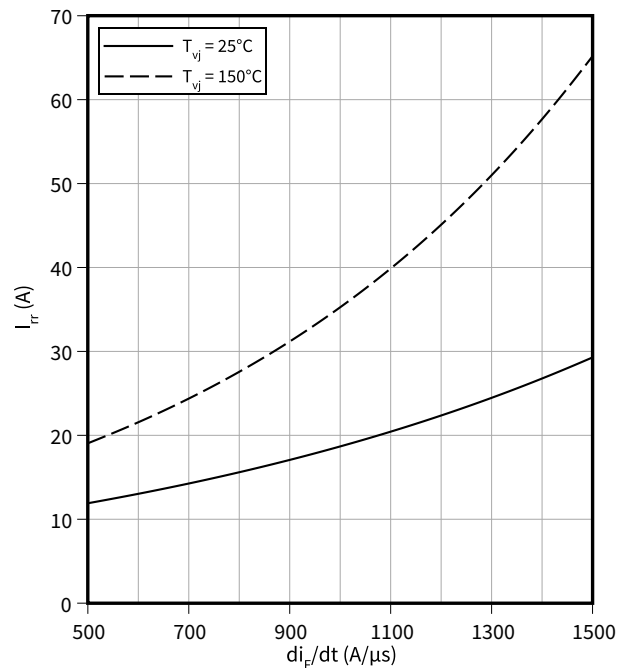
Typical reverse recovery charge as a function of diode current slope

$Q_{rr} = f(di_F/dt)$
 $V_R = 400$ V, $I_F = 50$ A



Typical reverse recovery current as a function of diode current slope

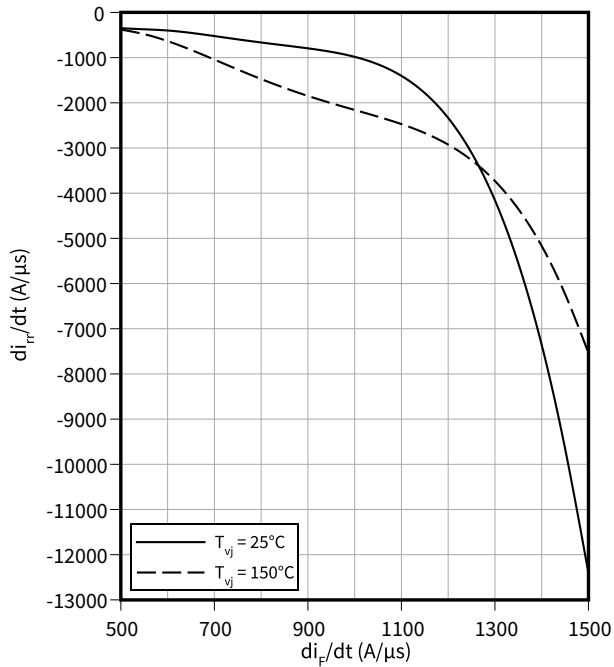
$I_{rr} = f(di_F/dt)$
 $V_R = 400$ V, $I_F = 50$ A



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

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

$V_R = 400\text{ V}$, $I_F = 50\text{ A}$



5 Package outlines

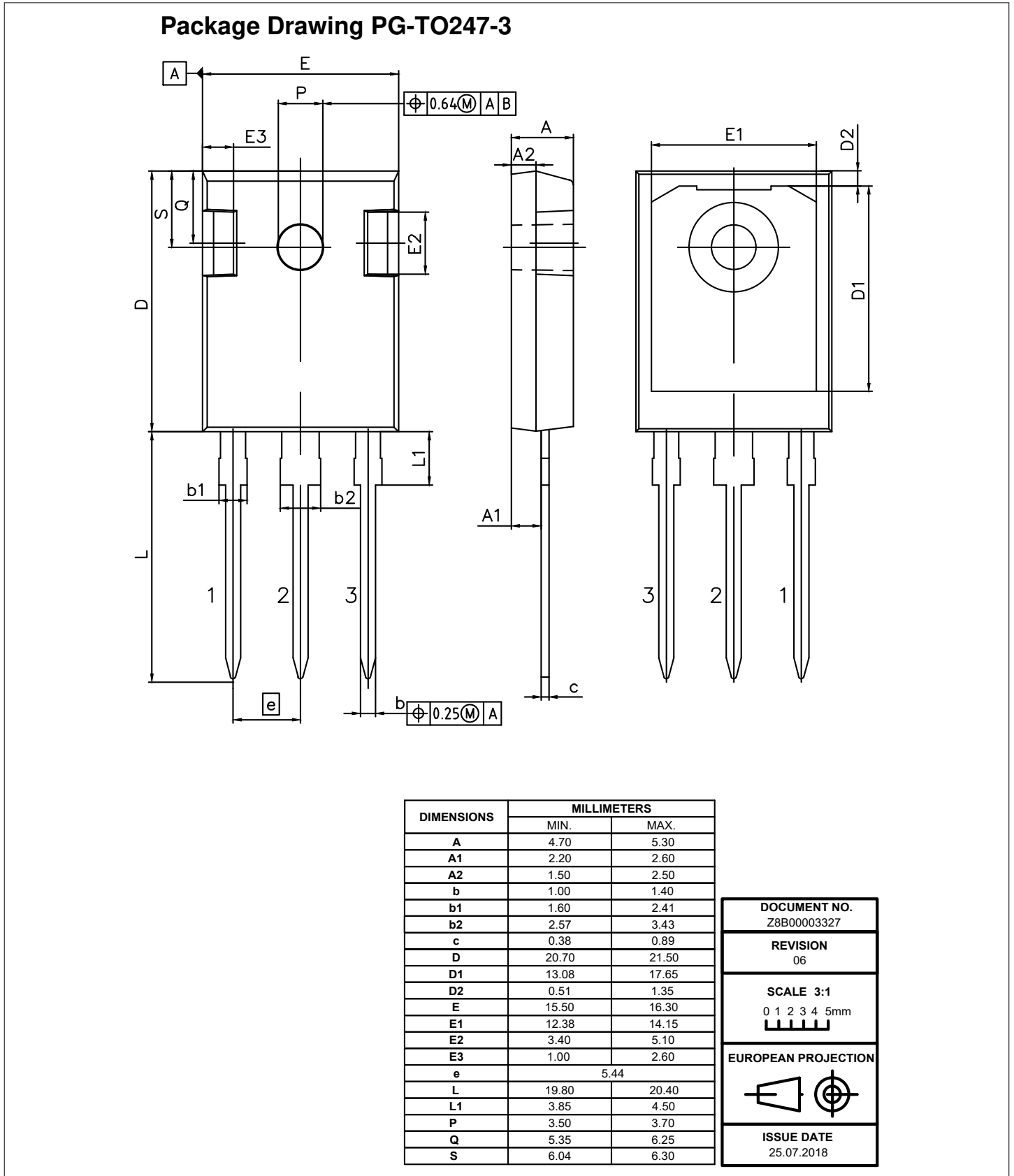


Figure 1

6 Testing conditions

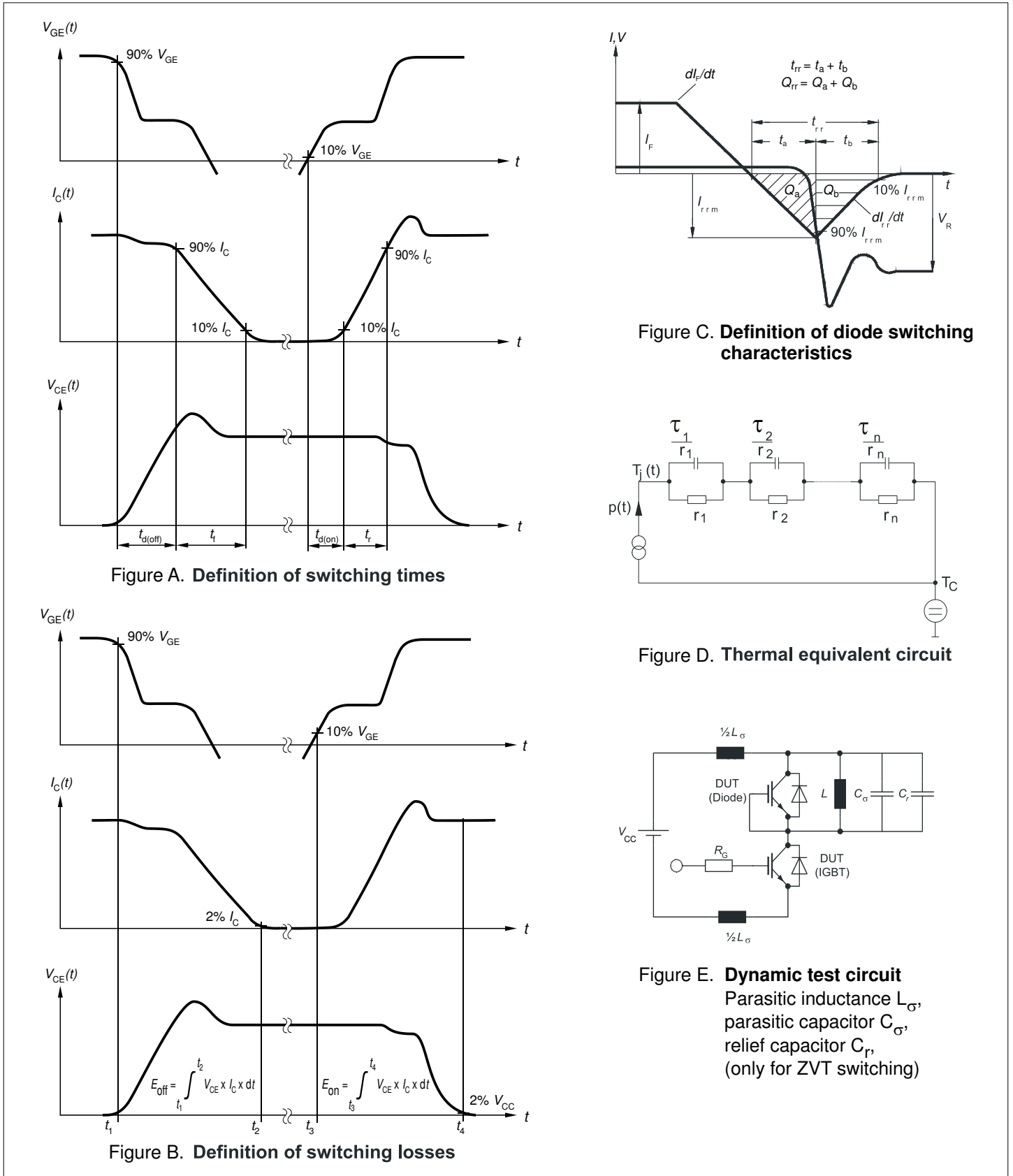


Figure 2

Revision history

Document revision	Date of release	Description of changes
V2.1	2015-05-20	Final data sheet
V2.2	2017-07-27	Correction Fig.1
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	2022-11-09	Correction of diagram: “Typical switching energy losses as a function of collector emitter voltage”

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