

TRENCHSTOP™ 5 WR6 technology in enhanced creepage and clearance package offers improved reliability against package contamination

Features

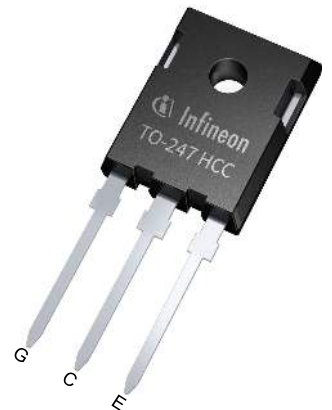
- $V_{CE} = 650\text{ V}$
- $I_C = 60\text{ A}$
- Pin-to-pin creepage distance > 4.8 mm
- Pin-to-pin clearance distance > 3.4 mm
- Monolithic diode optimized for PFC and welding applications
- Stable temperature behavior
- Very low V_{CEsat} and low E_{off}
- Easy paralleling capability due to positive temperature coefficient in V_{CEsat}
- Low temperature dependence of V_{CEsat} and E_{sw}
- Product spectrum and PSpice Models: <http://www.infineon.com/igbt/>

Potential applications

- PFC
- Welding
- ZCS applications

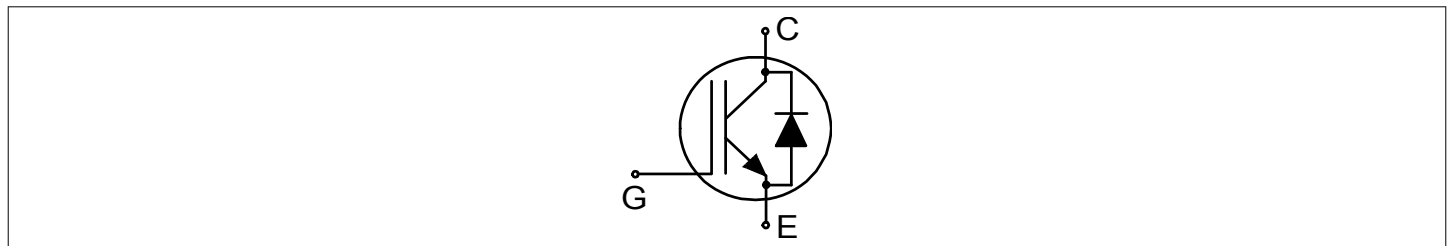
Product validation

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



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

Description



Type	Package	Marking
IKWH60N65WR6	PG-TO247-3-STD-NN4.8	H60EWR6

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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	$R_{th(j-c)}$				0.6	K/W
Diode thermal resistance, junction-case	$R_{th(j-c)}$				2.3	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		$T_c = 25\text{ °C}$	100	A
			$T_c = 100\text{ °C}$	63	
Pulsed collector current, t_p limited by T_{vjmax}	I_{Cpulse}		180	A	
Turn-off safe operating area		$V_{CE} \leq 650\text{ V}, T_{vj} \leq 175\text{ °C}$	180	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}		$T_c = 25\text{ °C}$	240	W
			$T_c = 100\text{ °C}$	120	

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

(table continues...)

Table 3 (continued) Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Collector-emitter saturation voltage	V_{CEsat}	$I_C = 60\text{ A}, V_{GE} = 15\text{ V}$	$T_{vj} = 25\text{ °C}$		1.55	1.85	V
			$T_{vj} = 175\text{ °C}$		1.8		
Gate-emitter threshold voltage	V_{GETh}	$I_C = 0.6\text{ mA}, V_{CE} = V_{GE}$		3.2	4	4.8	V
Zero gate-voltage collector current	I_{CES}	$V_{CE} = 650\text{ V}, V_{GE} = 0\text{ V}$	$T_{vj} = 25\text{ °C}$			40	μA
			$T_{vj} = 175\text{ °C}$		0.5		mA
Gate-emitter leakage current	I_{GES}	$V_{CE} = 0\text{ V}, V_{GE} = 20\text{ V}$				100	nA
Transconductance	g_{fs}	$I_C = 60\text{ A}, V_{CE} = 20\text{ V}$			150		S
Input capacitance	C_{ies}	$V_{CE} = 25\text{ V}, V_{GE} = 0\text{ V}, f = 100\text{ kHz}$			4270		pF
Output capacitance	C_{oes}	$V_{CE} = 25\text{ V}, V_{GE} = 0\text{ V}, f = 100\text{ kHz}$			44		pF
Reverse transfer capacitance	C_{res}	$V_{CE} = 25\text{ V}, V_{GE} = 0\text{ V}, f = 100\text{ kHz}$			19		pF
Gate charge	Q_G	$I_C = 60\text{ A}, V_{GE} = 15\text{ V}, V_{CC} = 520\text{ V}$			174		nC
Turn-on delay time	$t_{d(on)}$	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V},$ $R_{G(on)} = 15\ \Omega,$ $R_{G(off)} = 15\ \Omega, L_\sigma = 30\text{ nH},$ $C_\sigma = 31\text{ pF}$	$T_{vj} = 25\text{ °C},$ $I_C = 60\text{ A}$		35		ns
			$T_{vj} = 175\text{ °C},$ $I_C = 60\text{ A}$		32		
Rise time (inductive load)	t_r	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V},$ $R_{G(on)} = 15\ \Omega,$ $R_{G(off)} = 15\ \Omega, L_\sigma = 30\text{ nH},$ $C_\sigma = 31\text{ pF}$	$T_{vj} = 25\text{ °C},$ $I_C = 60\text{ A}$		28		ns
			$T_{vj} = 175\text{ °C},$ $I_C = 60\text{ A}$		30		
Turn-off delay time	$t_{d(off)}$	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V},$ $R_{G(on)} = 15\ \Omega,$ $R_{G(off)} = 15\ \Omega, L_\sigma = 30\text{ nH},$ $C_\sigma = 31\text{ pF}$	$T_{vj} = 25\text{ °C},$ $I_C = 60\text{ A}$		311		ns
			$T_{vj} = 175\text{ °C},$ $I_C = 60\text{ A}$		344		
Fall time (inductive load)	t_f	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V},$ $R_{G(on)} = 15\ \Omega,$ $R_{G(off)} = 15\ \Omega, L_\sigma = 30\text{ nH},$ $C_\sigma = 31\text{ pF}$	$T_{vj} = 25\text{ °C},$ $I_C = 60\text{ A}$		23		ns
			$T_{vj} = 175\text{ °C},$ $I_C = 60\text{ A}$		20		
Turn-on energy	E_{on}	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V},$ $R_{G(on)} = 15\ \Omega,$ $R_{G(off)} = 15\ \Omega, L_\sigma = 30\text{ nH},$ $C_\sigma = 31\text{ pF}$	$T_{vj} = 25\text{ °C},$ $I_C = 60\text{ A}$		1.82		mJ
			$T_{vj} = 175\text{ °C},$ $I_C = 60\text{ A}$		2.04		

(table continues...)

Table 3 (continued) Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Turn-off energy	E_{off}	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V},$ $R_{G(on)} = 15\ \Omega,$ $R_{G(off)} = 15\ \Omega, L_{\sigma} = 30\text{ nH},$ $C_{\sigma} = 31\text{ pF}$	$T_{vj} = 25\text{ }^{\circ}\text{C},$ $I_C = 60\text{ A}$		0.85	mJ
			$T_{vj} = 175\text{ }^{\circ}\text{C},$ $I_C = 60\text{ A}$		1.17	
Total switching energy	E_{ts}	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V},$ $R_{G(on)} = 15\ \Omega,$ $R_{G(off)} = 15\ \Omega, L_{\sigma} = 30\text{ nH},$ $C_{\sigma} = 31\text{ pF}$	$T_{vj} = 25\text{ }^{\circ}\text{C},$ $I_C = 60\text{ A}$		2.67	mJ
			$T_{vj} = 175\text{ }^{\circ}\text{C},$ $I_C = 60\text{ A}$		3.21	
Operating junction temperature	T_{vj}		-40		175	$^{\circ}\text{C}$

Note: Electrical Characteristic, at $T_{vj} = 25\text{ }^{\circ}\text{C}$, unless otherwise specified.

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		$T_c = 25\text{ }^{\circ}\text{C}$	32	A
			$T_c = 100\text{ }^{\circ}\text{C}$	19	
Diode pulsed current, t_p limited by T_{vjmax}	I_{Fpulse}		60	A	

Table 5 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Diode forward voltage	V_F	$I_F = 16\text{ A}$	$T_{vj} = 25\text{ }^{\circ}\text{C}$		1.3	1.6	V
			$T_{vj} = 175\text{ }^{\circ}\text{C}$		1.3		
Diode reverse recovery time	t_{rr}	$V_R = 400\text{ V}, R_{G(on)} = 15\ \Omega$	$T_{vj} = 25\text{ }^{\circ}\text{C},$ $I_F = 30\text{ A},$ $-di_F/dt = 1700\text{ A}/\mu\text{s}$		92		ns
			$T_{vj} = 175\text{ }^{\circ}\text{C},$ $I_F = 30\text{ A},$ $-di_F/dt = 1600\text{ A}/\mu\text{s}$		121		

(table continues...)

Table 5 (continued) Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Diode reverse recovery charge	Q_{rr}	$V_R = 400 \text{ V}, R_{G(on)} = 15 \text{ } \Omega$	$T_{vj} = 25 \text{ } ^\circ\text{C},$ $I_F = 30 \text{ A},$ $-di_F/dt = 1700 \text{ A}/\mu\text{s}$		2.3	μC
			$T_{vj} = 175 \text{ } ^\circ\text{C},$ $I_F = 30 \text{ A},$ $-di_F/dt = 1600 \text{ A}/\mu\text{s}$		3.8	
Diode peak reverse recovery current	I_{rrm}	$V_R = 400 \text{ V}, R_{G(on)} = 15 \text{ } \Omega$	$T_{vj} = 25 \text{ } ^\circ\text{C},$ $I_F = 30 \text{ A},$ $-di_F/dt = 1700 \text{ A}/\mu\text{s}$		34	A
			$T_{vj} = 175 \text{ } ^\circ\text{C},$ $I_F = 30 \text{ A},$ $-di_F/dt = 1600 \text{ A}/\mu\text{s}$		48.3	
Diode peak rate of fall of reverse recovery current	di_{rr}/dt	$V_R = 400 \text{ V}, R_{G(on)} = 15 \text{ } \Omega$	$T_{vj} = 25 \text{ } ^\circ\text{C},$ $I_F = 30 \text{ A},$ $-di_F/dt = 1700 \text{ A}/\mu\text{s}$		450	$\text{A}/\mu\text{s}$
			$T_{vj} = 175 \text{ } ^\circ\text{C},$ $I_F = 30 \text{ A},$ $-di_F/dt = 1600 \text{ A}/\mu\text{s}$		900	
Operating junction temperature	T_{vj}			-40	175	$^\circ\text{C}$

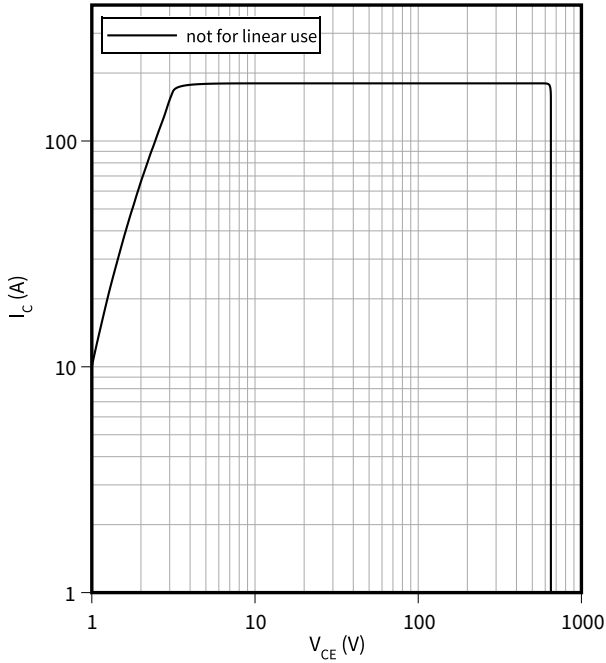
Note: For optimum lifetime and reliability, Infineon recommends operating conditions that do not exceed 80% of the maximum ratings stated in this datasheet.

4 Characteristics diagrams

Reverse bias safe operating area

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

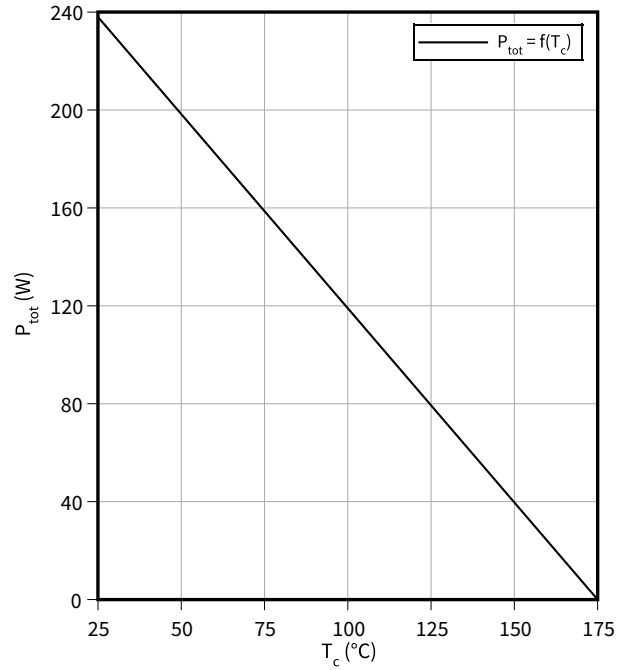
$$T_{vj} \leq 175\text{ °C}, T_c = 25\text{ °C}, V_{GE} = 15\text{ V}$$



Power dissipation as a function of case temperature

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

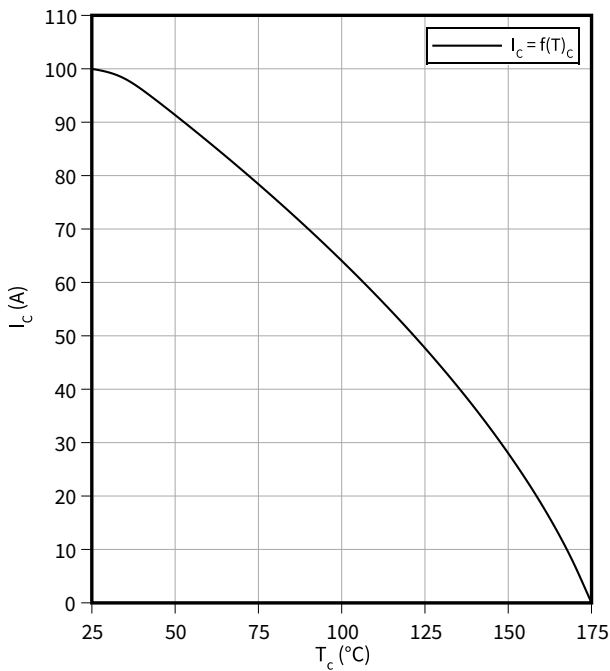
$$T_{vj} \leq 175\text{ °C}$$



Collector current as a function of case temperature

$$I_C = f(T_c)$$

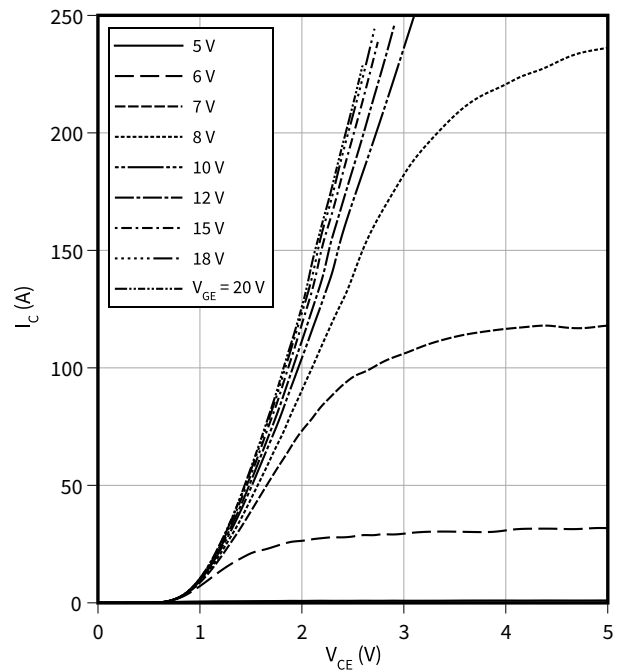
$$T_{vj} \leq 175\text{ °C}, V_{GE} \geq 15\text{ V}$$



Typical output characteristic

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

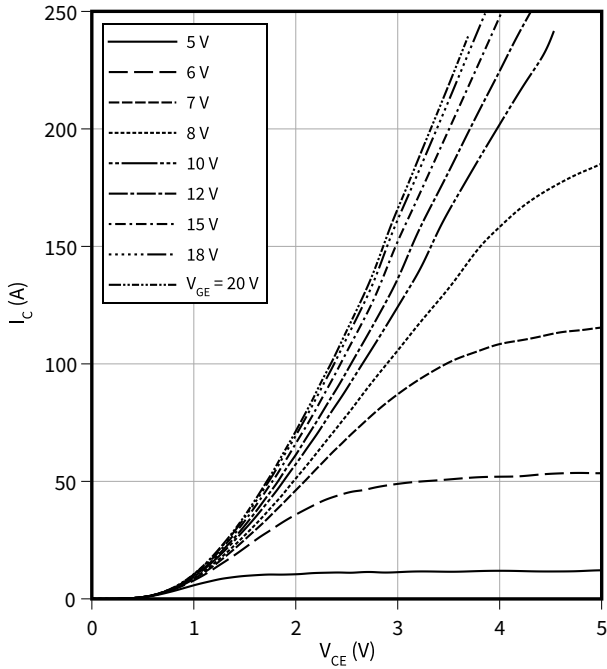
$$T_{vj} = 25\text{ °C}$$



4 Characteristics diagrams

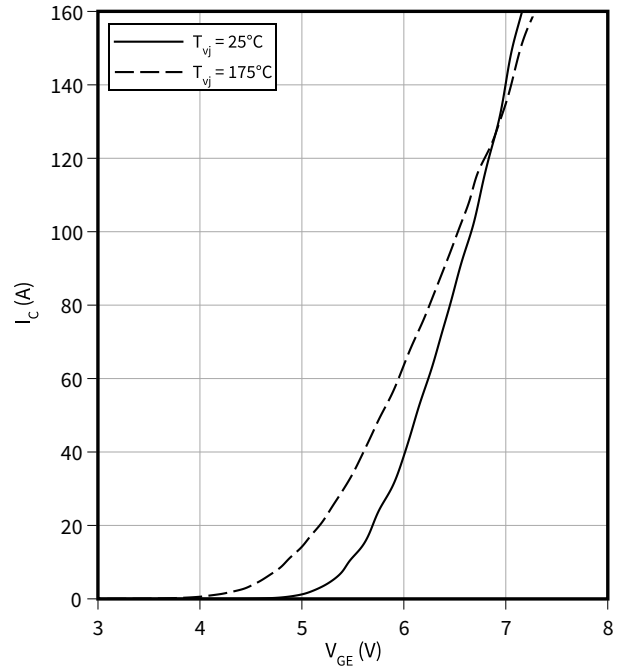
Typical output characteristic

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



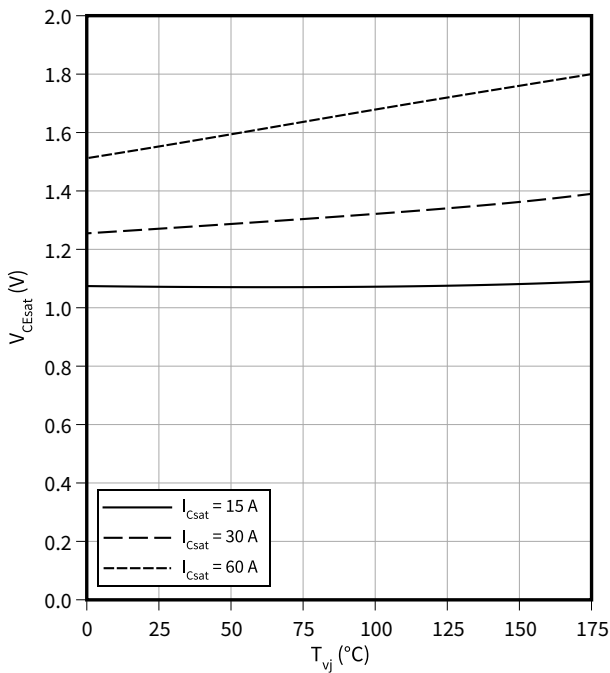
Typical transfer characteristic

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



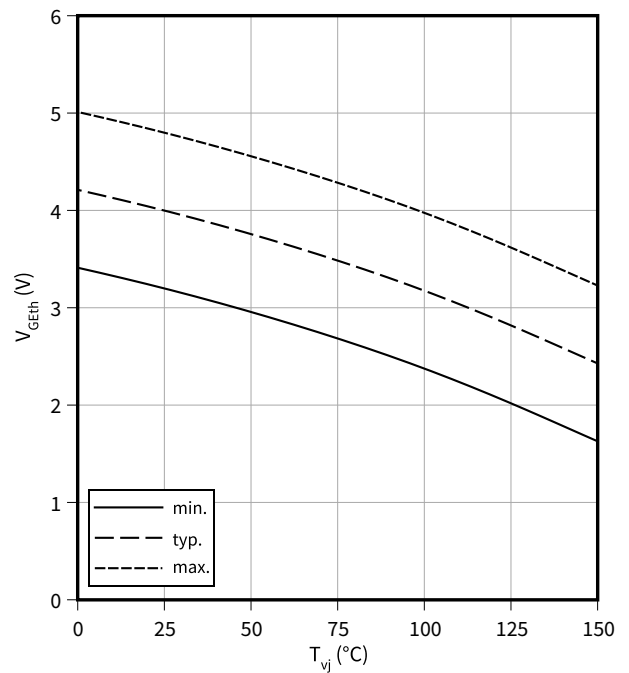
Typical collector-emitter saturation voltage as a function of junction temperature

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



Gate-emitter threshold voltage as a function of junction temperature

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

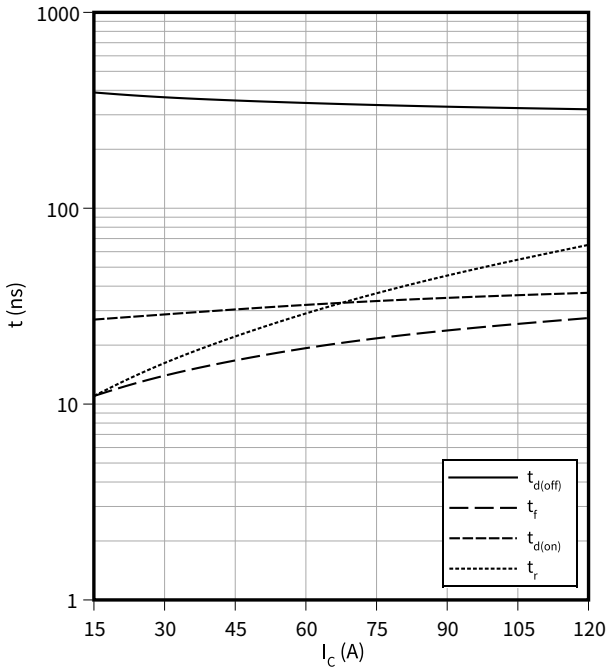


4 Characteristics diagrams

Typical switching times as a function of collector current

$t = f(I_C)$

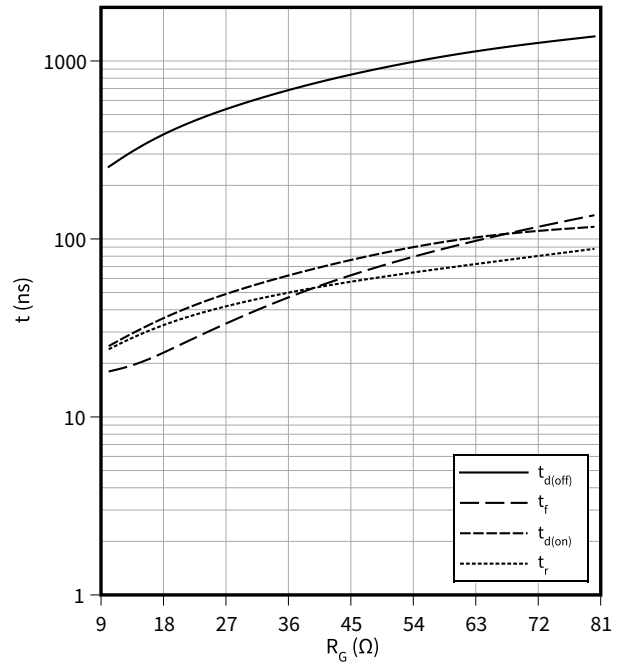
$V_{CC} = 400\text{ V}, T_{vj} = 175\text{ °C}, V_{GE} = 0/15\text{ V}, R_G = 15\text{ }\Omega$



Typical switching times as a function of gate resistor

$t = f(R_G)$

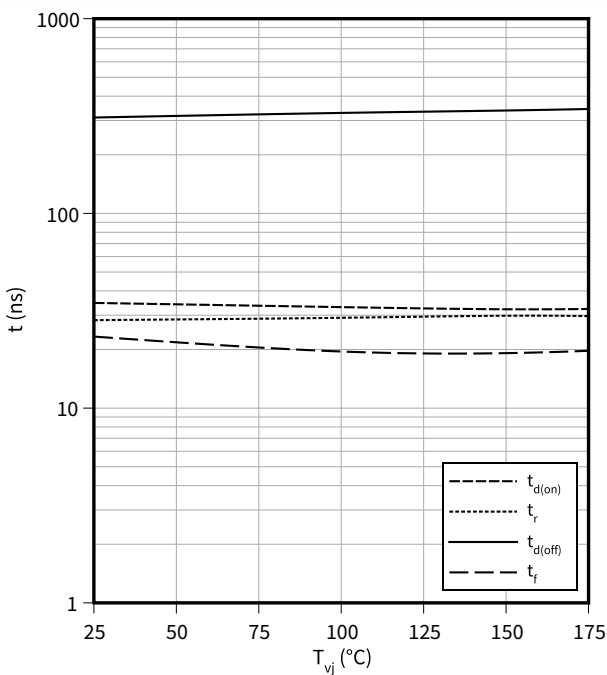
$I_C = 60\text{ A}, V_{CC} = 400\text{ V}, T_{vj} = 175\text{ °C}, V_{GE} = 0/15\text{ V}$



Typical switching times as a function of junction temperature

$t = f(T_{vj})$

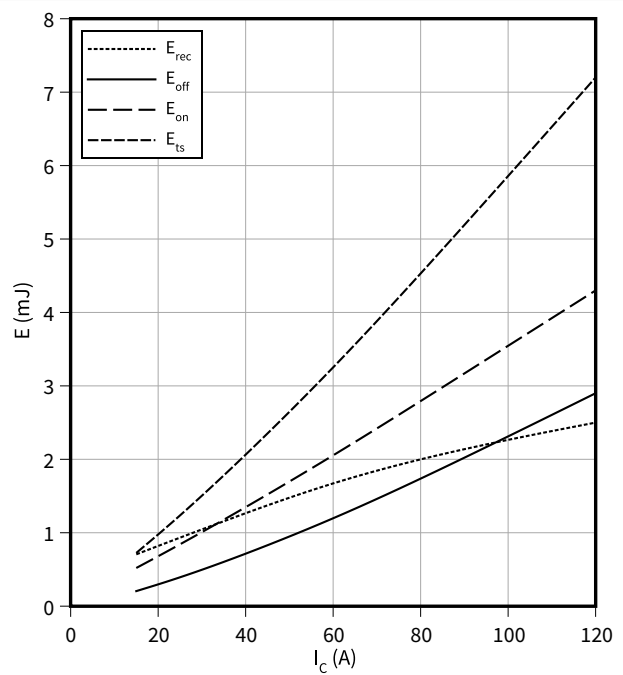
$I_C = 60\text{ A}, V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V}, R_G = 15\text{ }\Omega$



Typical switching energy losses as a function of collector current

$E = f(I_C)$

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

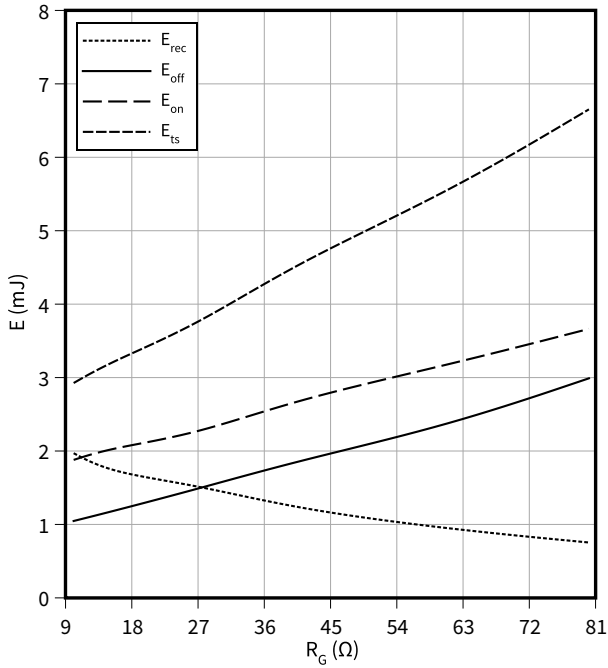


4 Characteristics diagrams

Typical switching energy losses as a function of gate resistor

$E = f(R_G)$

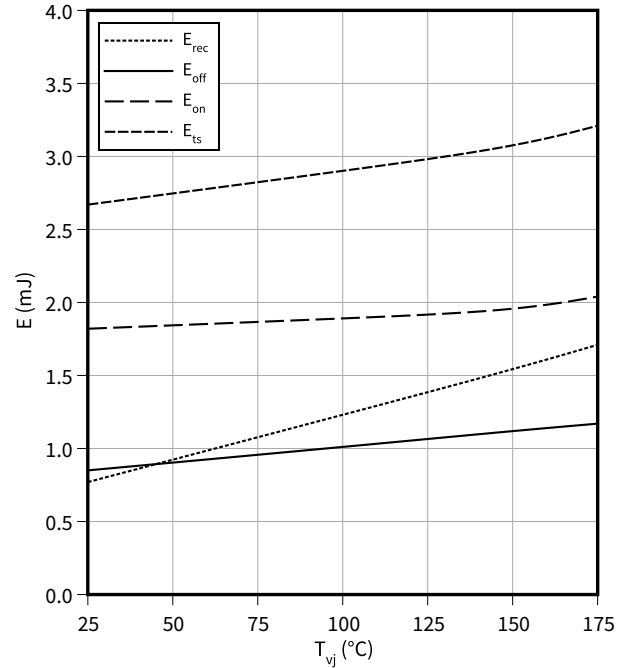
$I_C = 60\text{ A}, V_{CC} = 400\text{ V}, T_{vj} = 175\text{ }^\circ\text{C}, V_{GE} = 0/15\text{ V}$



Typical switching energy losses as a function of junction temperature

$E = f(T_{vj})$

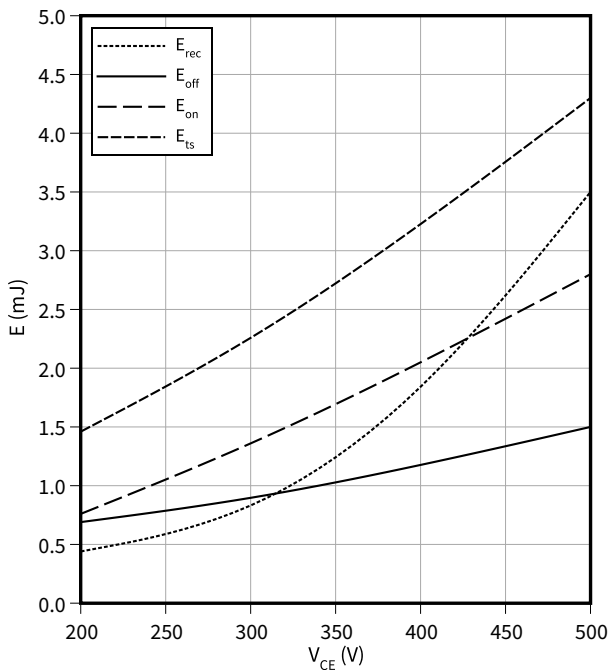
$I_C = 60\text{ A}, V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V}, R_G = 15\text{ }\Omega$



Typical switching energy losses as a function of collector emitter voltage

$E = f(V_{CE})$

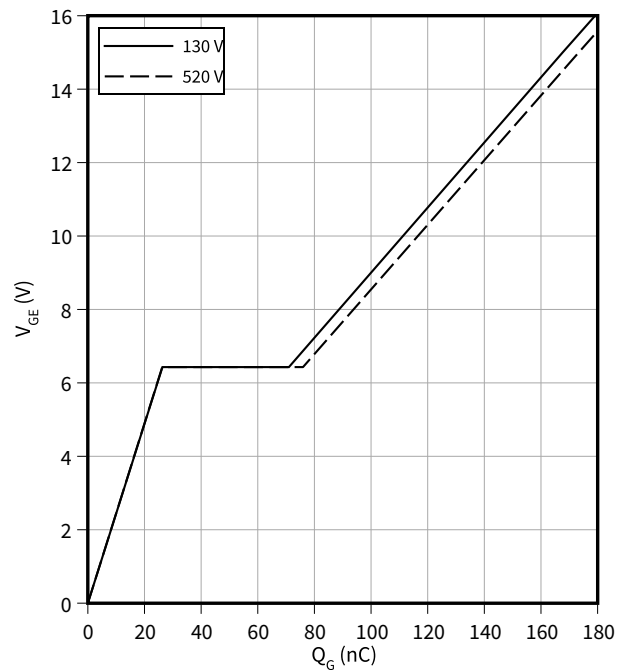
$I_C = 60\text{ A}, T_{vj} = 175\text{ }^\circ\text{C}, V_{GE} = 0/15\text{ V}, R_G = 15\text{ }\Omega$



Typical gate charge

$V_{GE} = f(Q_G)$

$I_C = 60\text{ A}$

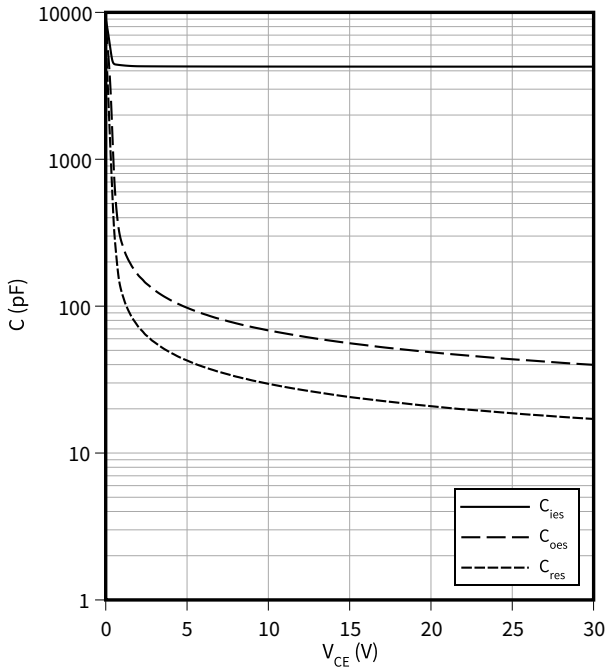


4 Characteristics diagrams

Typical capacitance as a function of collector-emitter voltage

$C = f(V_{CE})$

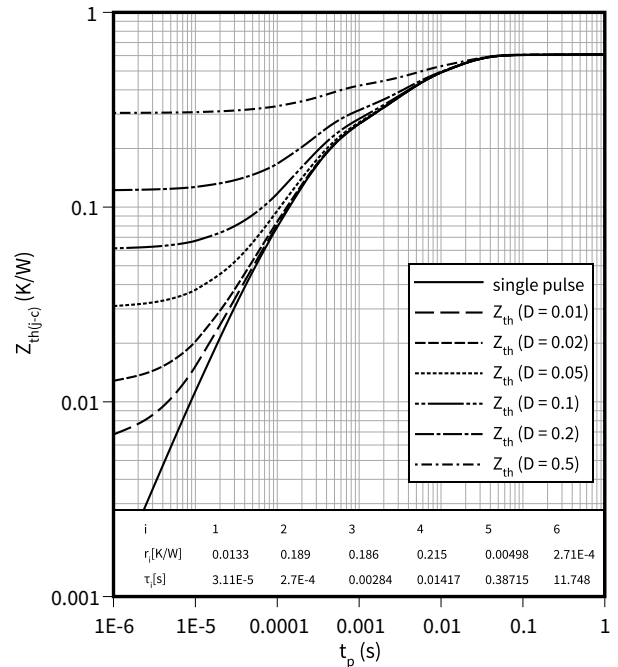
$f = 100 \text{ kHz}, V_{GE} = 0 \text{ V}$



IGBT transient thermal impedance as a function of pulse width

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

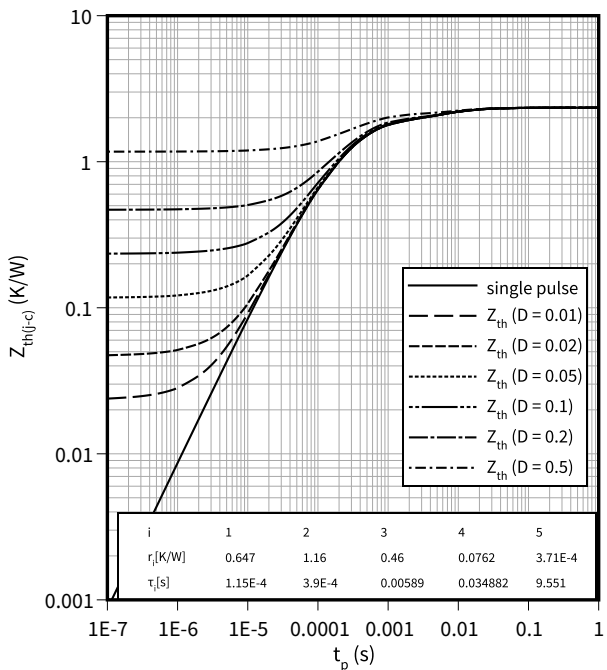
$D = t_p/T$



Diode transient thermal impedance as a function of pulse width

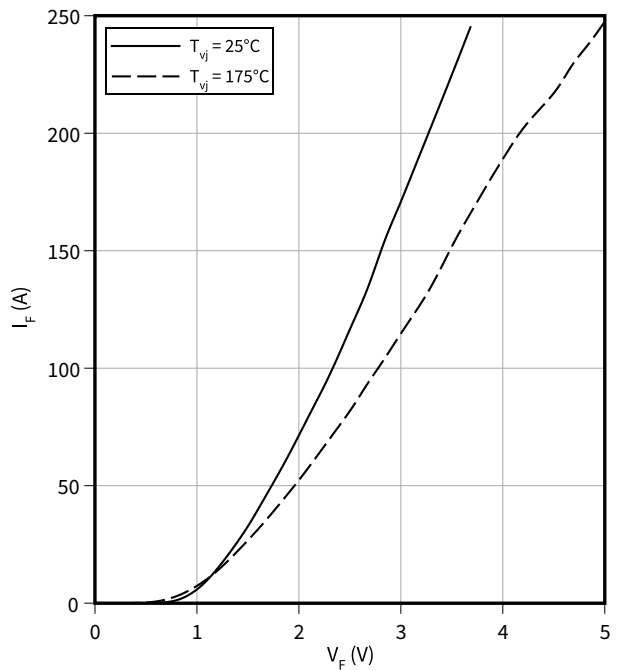
$Z_{th(j-c)} = f(t_p)$

$D = t_p/T$



Typical diode forward current as a function of forward voltage

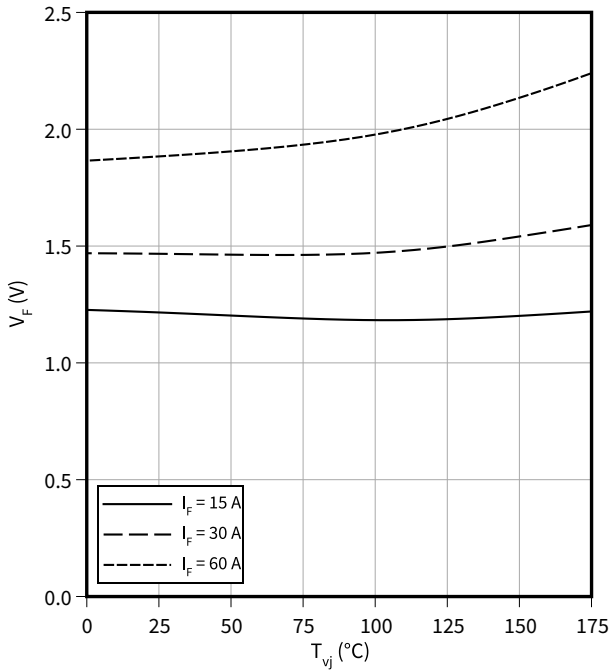
$I_F = f(V_F)$



4 Characteristics diagrams

Typical diode forward voltage as a function of junction temperature

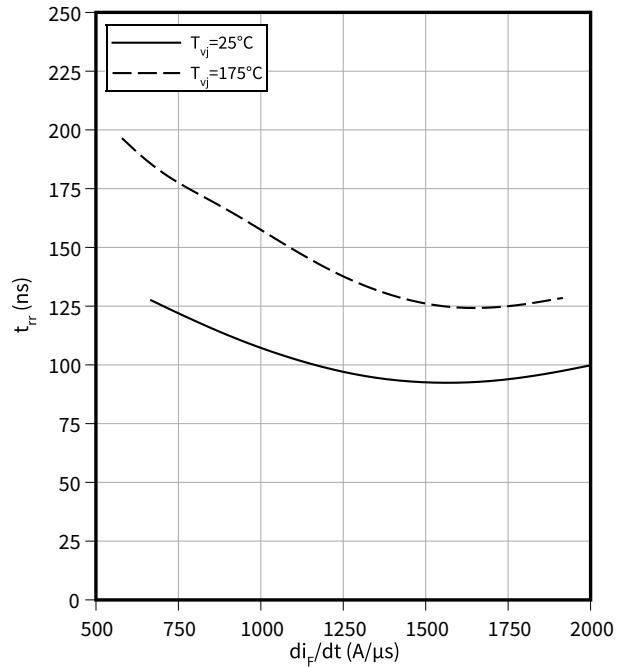
$V_F = f(T_{vj})$



Typical reverse recovery time as a function of diode current slope

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

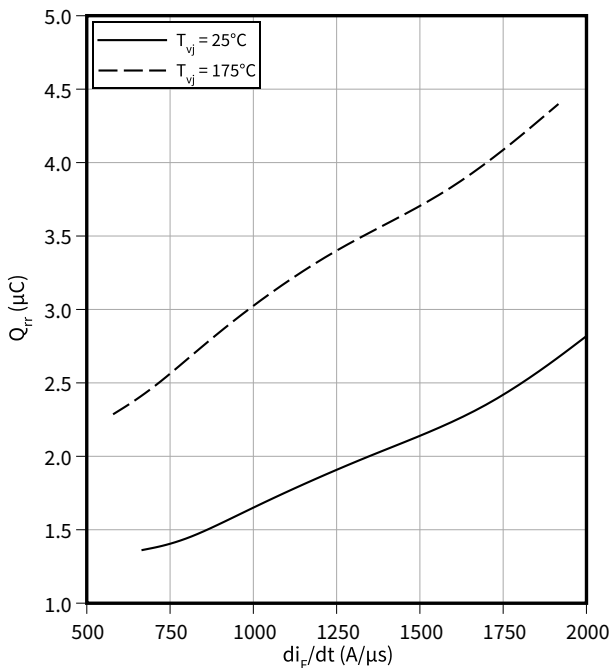
$V_R = 400$ V, $I_F = 30$ A



Typical reverse recovery charge as a function of diode current slope

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

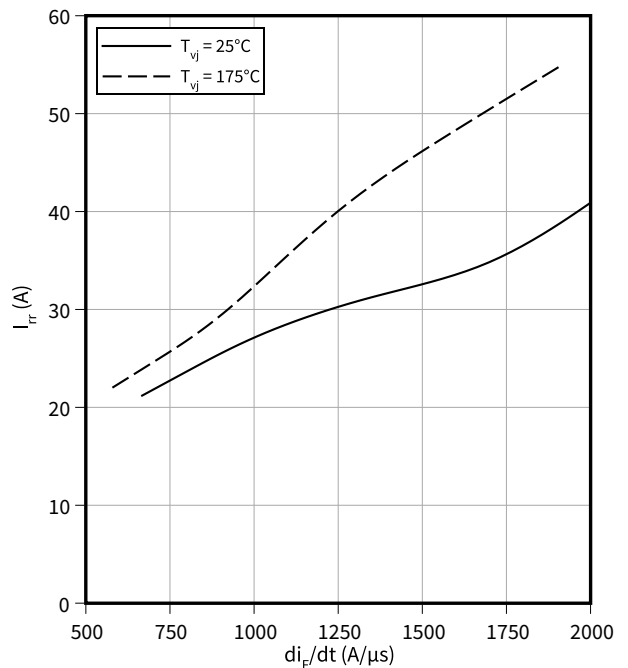
$V_R = 400$ V, $I_F = 30$ A



Typical reverse recovery current as a function of diode current slope

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

$V_R = 400$ V, $I_F = 30$ A

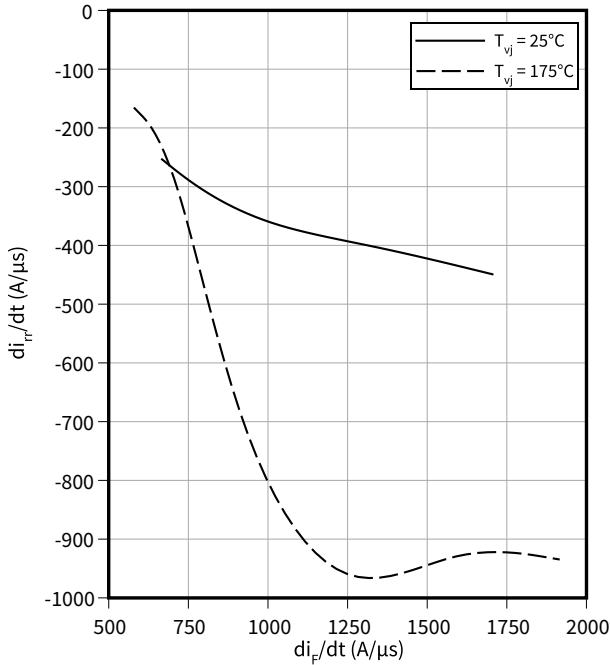


4 Characteristics diagrams

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

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

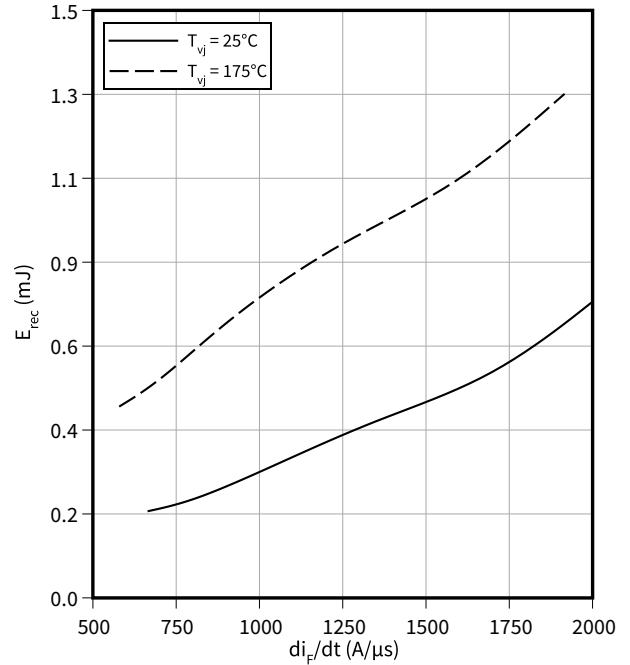
$V_R = 400\text{ V}, I_F = 30\text{ A}$



Typical reverse energy losses as a function of diode current slope

$E_{rec} = f(di_F/dt)$

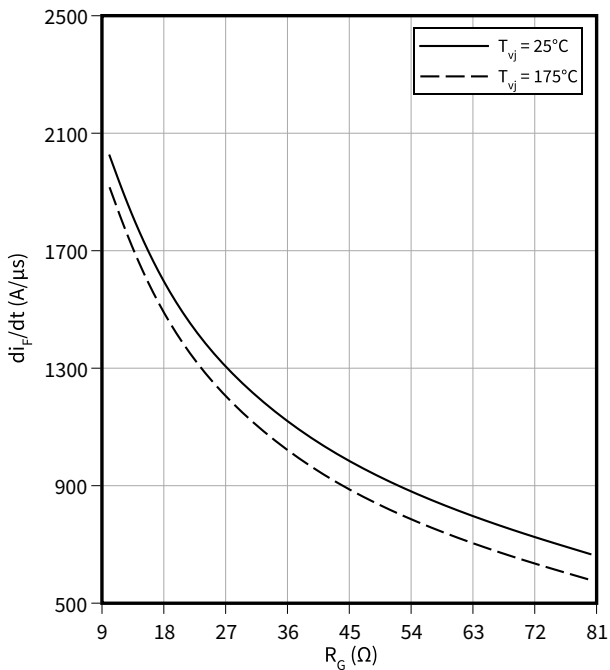
$V_R = 400\text{ V}, I_F = 30\text{ A}$



Typical diode current slope as a function of gate resistor

$di_F/dt = f(R_G)$

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



5 Package outlines

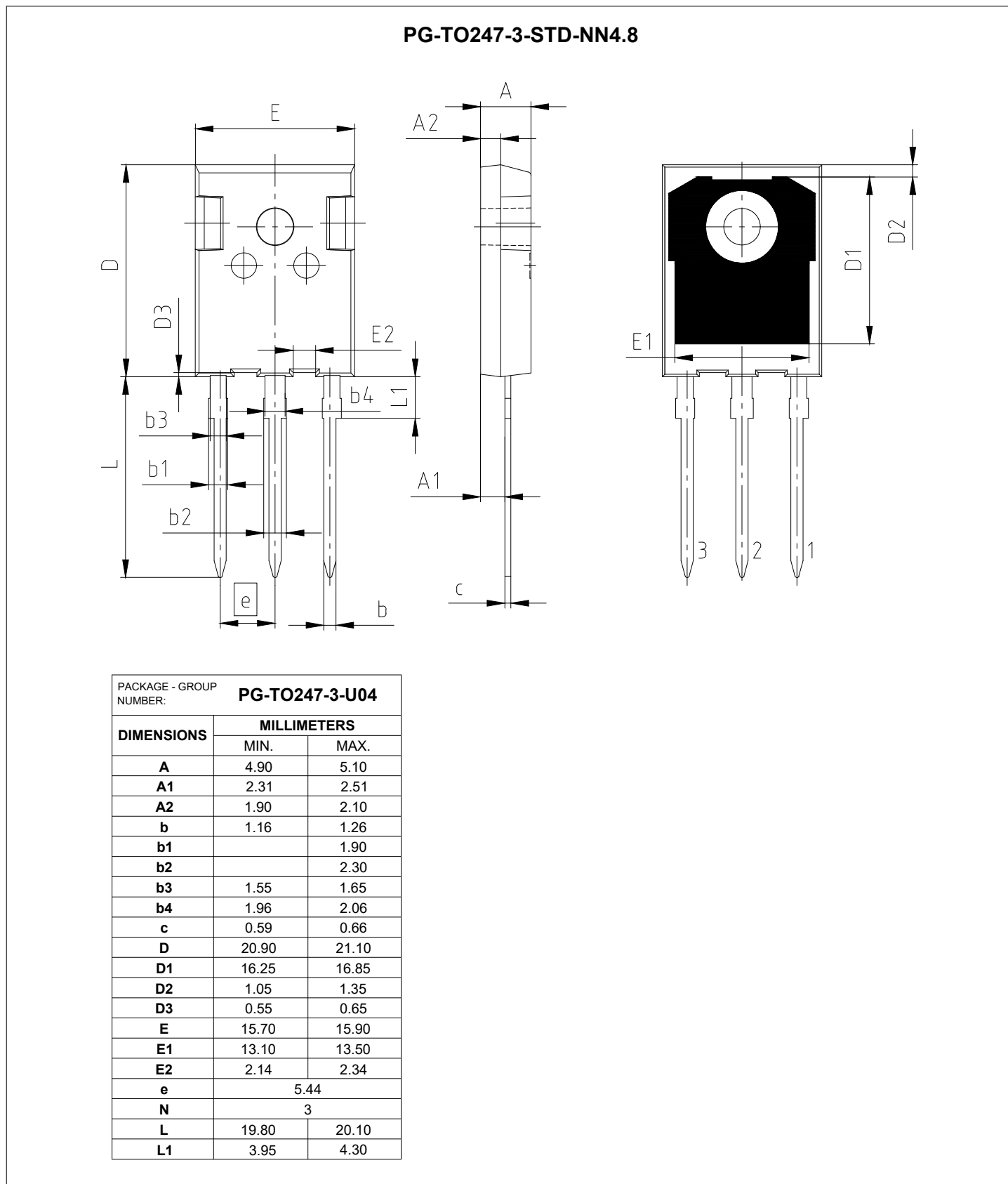


Figure 1

6 Testing conditions

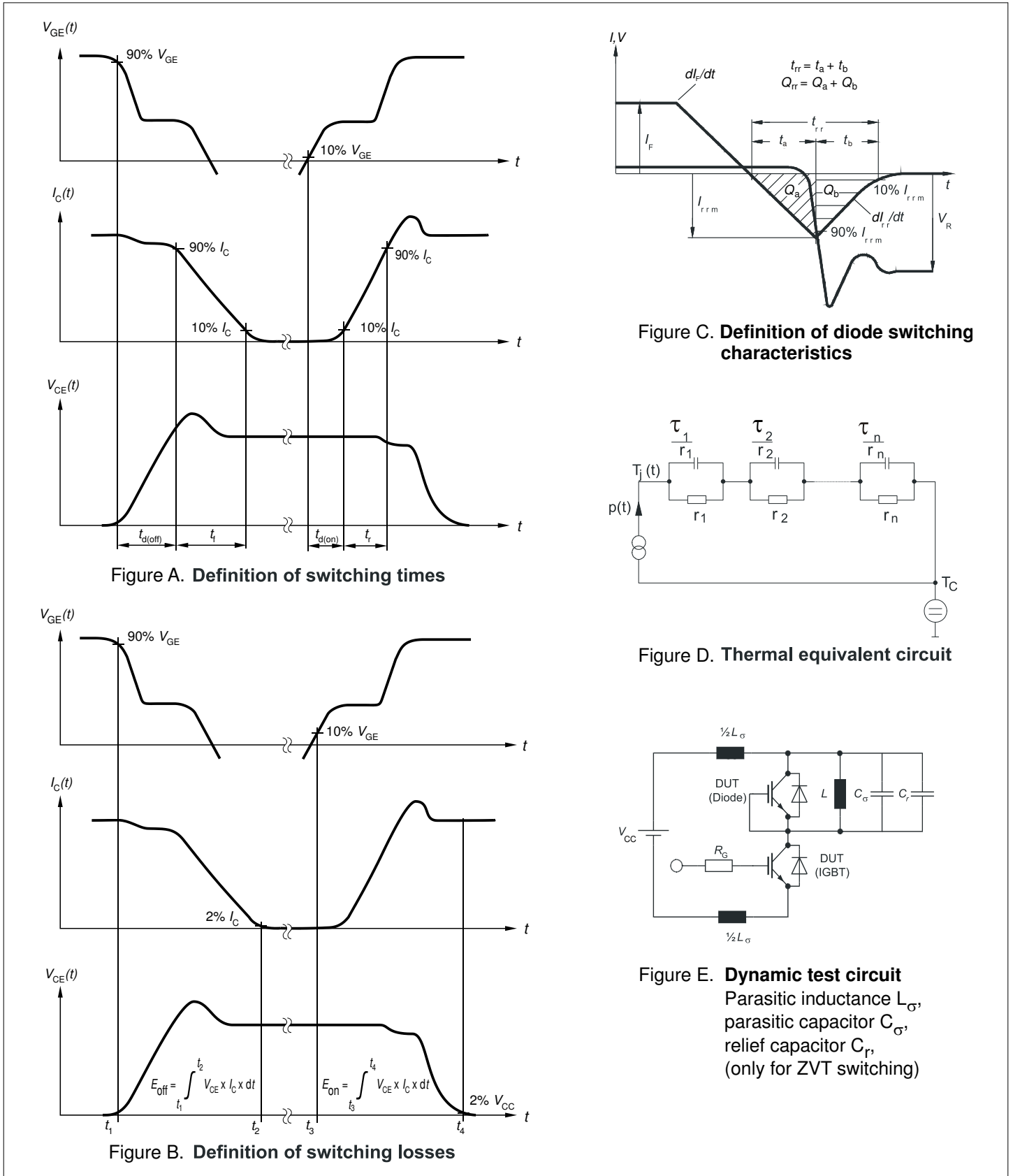


Figure 2

Revision history

Document revision	Date of release	Description of changes
1.00	2021-05-21	Final datasheet
1.10	2022-12-06	Update of “DC collector current, limited by T_{vjmax} ” in table “Maximum rated values”, for 25°C and 100°C Transient gate-emitter voltage V_{GE} in table “Maximum rated values” of IGBT changed to $\pm 30V$ Update of diagram “Collector current as a function of case temperature”, $I_C = f(T_C)$ "Forward bias safe operating area" diagram renamed to “Reverse bias safe operating area” Correction of package outline dimensions Change package name to marketing name Editorial changes

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