

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

Features

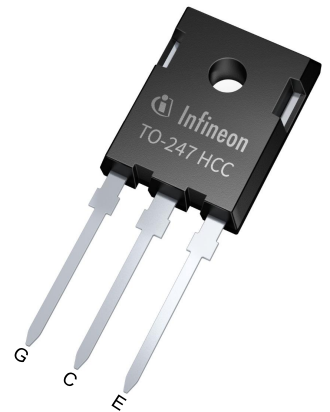
- $V_{CE} = 650\text{ V}$
- $I_C = 40\text{ A}$
- Pin-to-pin creepage distance > 4.8 mm
- Pin-to-pin clearance distance > 3.4 mm
- Monolithic diode optimized for PFC and welding applications
- Stable temperature behavior
- Very low V_{CEsat} and low E_{off}
- Easy parallel switching capability based on positive temperature coefficient of 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

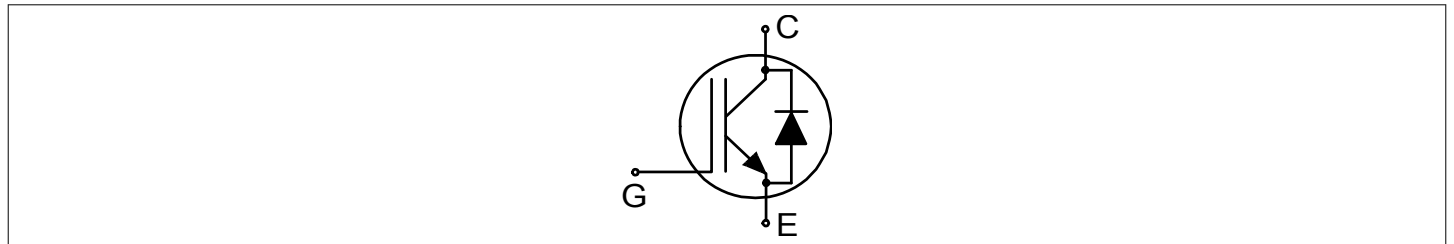
Product validation

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



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

Description



Type	Package	Marking
IKWH40N65WR6	PG-TO247-3-STD-NN4.8	H40EWR6

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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	$R_{th(j-c)}$				0.9	K/W
Diode thermal resistance, junction-case	$R_{th(j-c)}$				4.2	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	$T_c = 25\text{ °C}$	70	A
		$T_c = 100\text{ °C}$	45	
Pulsed collector current, t_p limited by T_{vjmax}	I_{Cpulse}		120	A
Turn-off safe operating area		$V_{CE} \leq 650\text{ V}, T_{vj} \leq 175\text{ °C}$	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}	$T_c = 25\text{ °C}$	175	W
		$T_c = 100\text{ °C}$	78	

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}	$I_C = 40\text{ A}, V_{GE} = 15\text{ V}$	$T_{vj} = 25\text{ °C}$		1.55	1.85	V
			$T_{vj} = 175\text{ °C}$		1.8		
Gate-emitter threshold voltage	V_{GETh}	$I_C = 0.4\text{ mA}, V_{CE} = V_{GE}$		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}	$I_C = 40\text{ A}, V_{CE} = 20\text{ V}$			89		S
Input capacitance	C_{ies}	$V_{CE} = 25\text{ V}, V_{GE} = 0\text{ V}, f = 100\text{ kHz}$			2890		pF
Output capacitance	C_{oes}	$V_{CE} = 25\text{ V}, V_{GE} = 0\text{ V}, f = 100\text{ kHz}$			28		pF
Reverse transfer capacitance	C_{res}	$V_{CE} = 25\text{ V}, V_{GE} = 0\text{ V}, f = 100\text{ kHz}$			11		pF
Gate charge	Q_G	$I_C = 40\text{ A}, V_{GE} = 15\text{ V}, V_{CC} = 520\text{ V}$			117		nC
Turn-on delay time	$t_{d(on)}$	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V}, R_{G(on)} = 27\ \Omega, R_{G(off)} = 27\ \Omega, L_\sigma = 30\text{ nH}, C_\sigma = 26\text{ pF}$	$T_{vj} = 25\text{ °C}, I_C = 40\text{ A}$		37		ns
			$T_{vj} = 175\text{ °C}, I_C = 40\text{ A}$		34		
Rise time (inductive load)	t_r	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V}, R_{G(on)} = 27\ \Omega, R_{G(off)} = 27\ \Omega, L_\sigma = 30\text{ nH}, C_\sigma = 26\text{ pF}$	$T_{vj} = 25\text{ °C}, I_C = 40\text{ A}$		24		ns
			$T_{vj} = 175\text{ °C}, I_C = 40\text{ A}$		25		
Turn-off delay time	$t_{d(off)}$	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V}, R_{G(on)} = 27\ \Omega, R_{G(off)} = 27\ \Omega, L_\sigma = 30\text{ nH}, C_\sigma = 26\text{ pF}$	$T_{vj} = 25\text{ °C}, I_C = 40\text{ A}$		353		ns
			$T_{vj} = 175\text{ °C}, I_C = 40\text{ A}$		401		
Fall time (inductive load)	t_f	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V}, R_{G(on)} = 27\ \Omega, R_{G(off)} = 27\ \Omega, L_\sigma = 30\text{ nH}, C_\sigma = 26\text{ pF}$	$T_{vj} = 25\text{ °C}, I_C = 40\text{ A}$		23		ns
			$T_{vj} = 175\text{ °C}, I_C = 40\text{ A}$		18		
Turn-on energy	E_{on}	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V}, R_{G(on)} = 27\ \Omega, R_{G(off)} = 27\ \Omega, L_\sigma = 30\text{ nH}, C_\sigma = 26\text{ pF}$	$T_{vj} = 25\text{ °C}, I_C = 40\text{ A}$		1.09		mJ
			$T_{vj} = 175\text{ °C}, I_C = 40\text{ A}$		1.23		

(table continues...)

Table 3 (continued) Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Turn-off energy	E_{off}	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V},$ $R_{G(on)} = 27\ \Omega,$ $R_{G(off)} = 27\ \Omega, L_{\sigma} = 30\text{ nH},$ $C_{\sigma} = 26\text{ pF}$	$T_{vj} = 25\ ^\circ\text{C},$ $I_C = 40\text{ A}$		0.57		mJ
			$T_{vj} = 175\ ^\circ\text{C},$ $I_C = 40\text{ A}$		0.89		
Total switching energy	E_{ts}	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V},$ $R_{G(on)} = 27\ \Omega,$ $R_{G(off)} = 27\ \Omega, L_{\sigma} = 30\text{ nH},$ $C_{\sigma} = 26\text{ pF}$	$T_{vj} = 25\ ^\circ\text{C},$ $I_C = 40\text{ A}$		1.66		mJ
			$T_{vj} = 175\ ^\circ\text{C},$ $I_C = 40\text{ A}$		2.12		
Operating junction temperature	T_{vj}		-40		175	$^\circ\text{C}$	

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

3 Diode

Table 4 Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit	
Repetitive peak reverse voltage	V_{RRM}	$T_{vj} \geq 25\ ^\circ\text{C}$	650	V	
Diode forward current, limited by T_{vjmax}	I_F		$T_c = 25\ ^\circ\text{C}$	20	A
			$T_c = 100\ ^\circ\text{C}$	11	
Diode pulsed current, t_p limited by T_{vjmax}	I_{Fpulse}		40	A	

Table 5 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Diode forward voltage	V_F	$I_F = 10\text{ A}$	$T_{vj} = 25\ ^\circ\text{C}$		1.3	1.6	V
			$T_{vj} = 175\ ^\circ\text{C}$		1.3		
Diode reverse recovery time	t_{rr}	$V_R = 400\text{ V}$	$T_{vj} = 25\ ^\circ\text{C},$ $I_F = 20\text{ A},$ $-di_F/dt = 1460\text{ A}/\mu\text{s}$		79		ns
			$T_{vj} = 175\ ^\circ\text{C},$ $I_F = 20\text{ A},$ $-di_F/dt = 1350\text{ A}/\mu\text{s}$		104		

(table continues...)

Table 5 (continued) Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Diode reverse recovery charge	Q_{rr}	$V_R = 400\text{ V}$	$T_{vj} = 25\text{ °C},$ $I_F = 20\text{ A},$ $-di_F/dt = 1460\text{ A}/\mu\text{s}$		1.4		μC
					2.5		
Diode peak reverse recovery current	I_{rrm}	$V_R = 400\text{ V}$	$T_{vj} = 25\text{ °C},$ $I_F = 20\text{ A},$ $-di_F/dt = 1460\text{ A}/\mu\text{s}$		24.7		A
					38.3		
Diode peak rate of fall of reverse recovery current	di_{rr}/dt	$V_R = 400\text{ V}$	$T_{vj} = 25\text{ °C},$ $I_F = 20\text{ A},$ $-di_F/dt = 1460\text{ A}/\mu\text{s}$		383		$\text{A}/\mu\text{s}$
					821		
Operating junction temperature	T_{vj}			-40		175	$^{\circ}\text{C}$

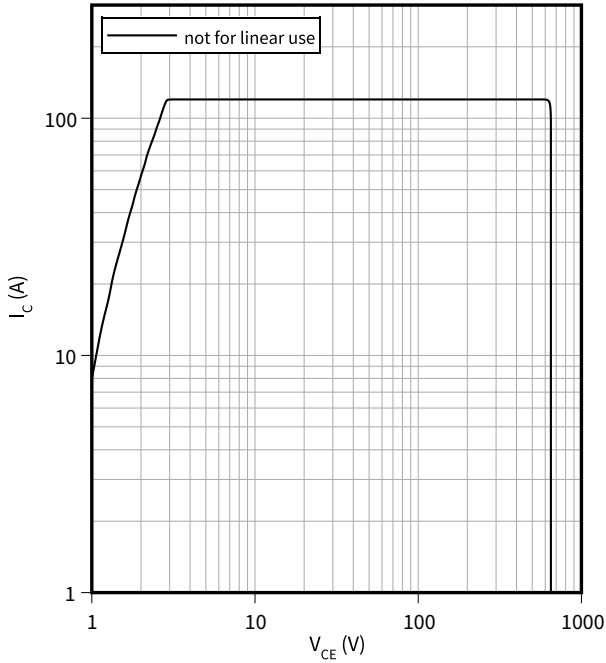
Note: For optimum lifetime and reliability, Infineon recommends operating conditions that do not exceed 80% of the maximum ratings stated in this datasheet.

4 Characteristics diagrams

Reverse bias safe operating area

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

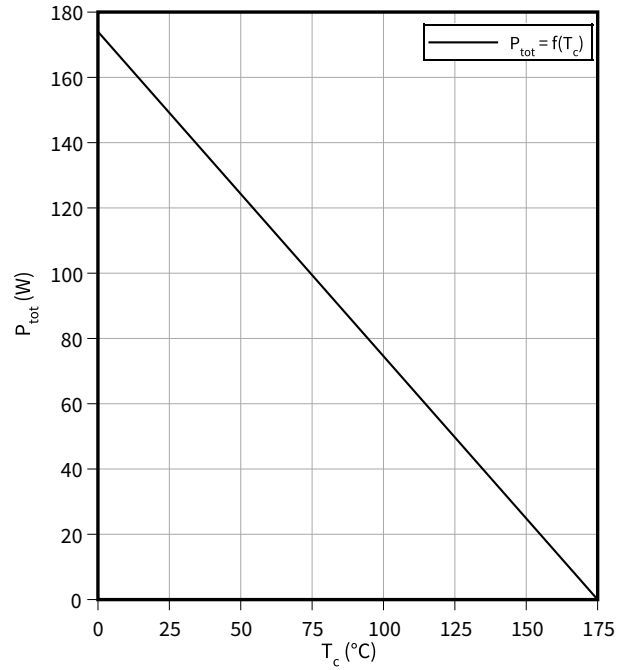
$$T_{vj} \leq 175\text{ °C}, T_c = 25\text{ °C}, V_{GE} = 15\text{ V}$$



Power dissipation as a function of case temperature

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

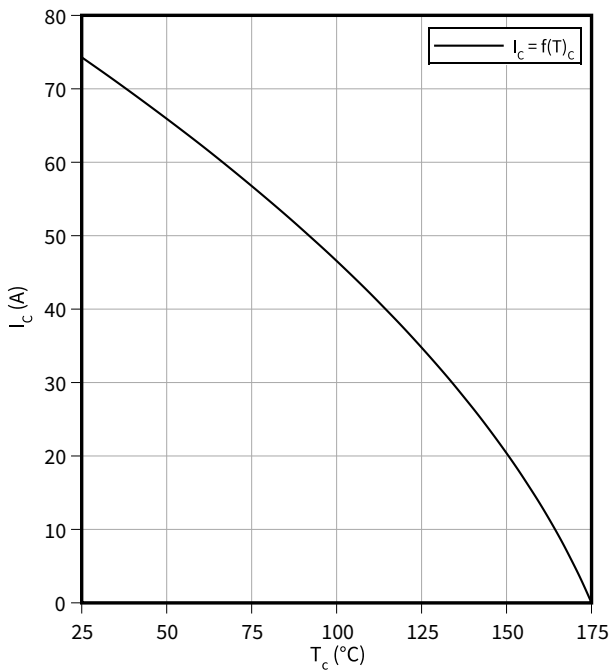
$$T_{vj} \leq 175\text{ °C}$$



Collector current as a function of case temperature

$$I_C = f(T_c)$$

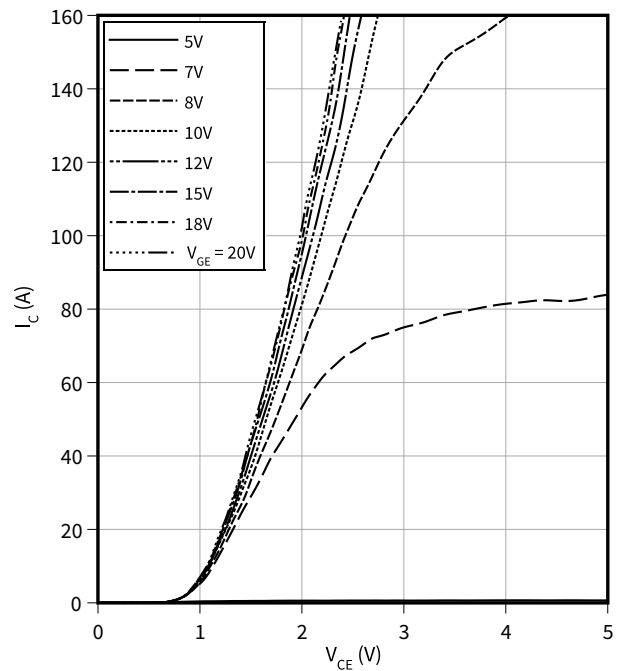
$$T_{vj} \leq 175\text{ °C}, V_{GE} \geq 15\text{ V}$$



Typical output characteristic

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

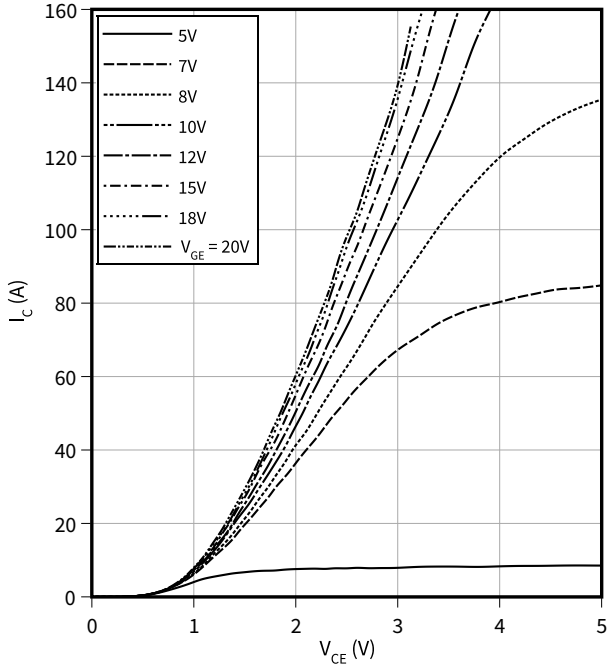
$$T_{vj} = 25\text{ °C}$$



4 Characteristics diagrams

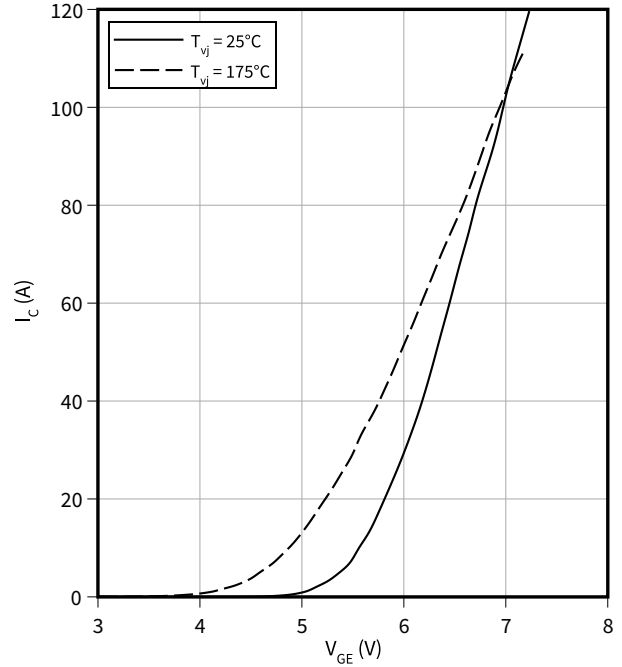
Typical output characteristic

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



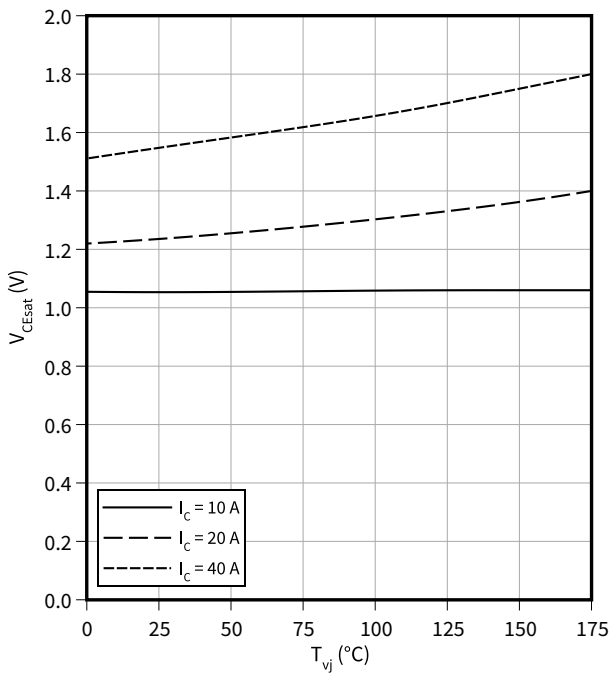
Typical transfer characteristic

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



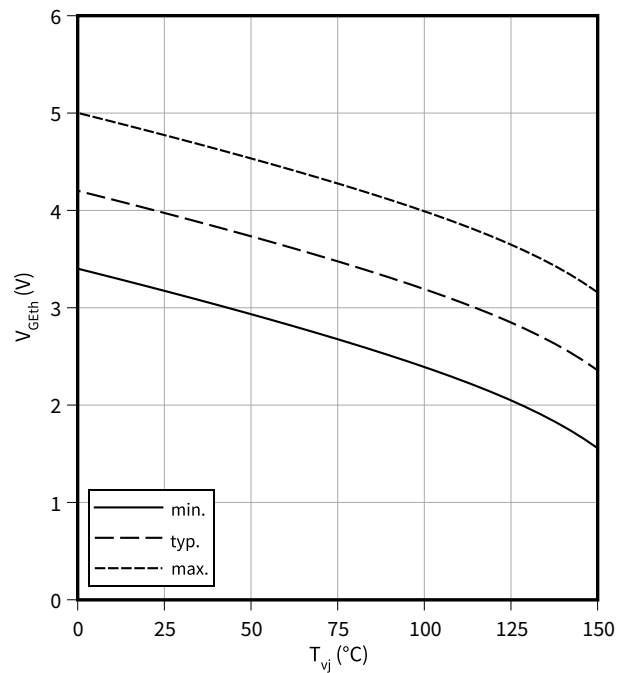
Typical collector-emitter saturation voltage as a function of junction temperature

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



Gate-emitter threshold voltage as a function of junction temperature

$V_{GEth} = f(T_{vj})$
 $I_C = 0.4\text{ mA}$

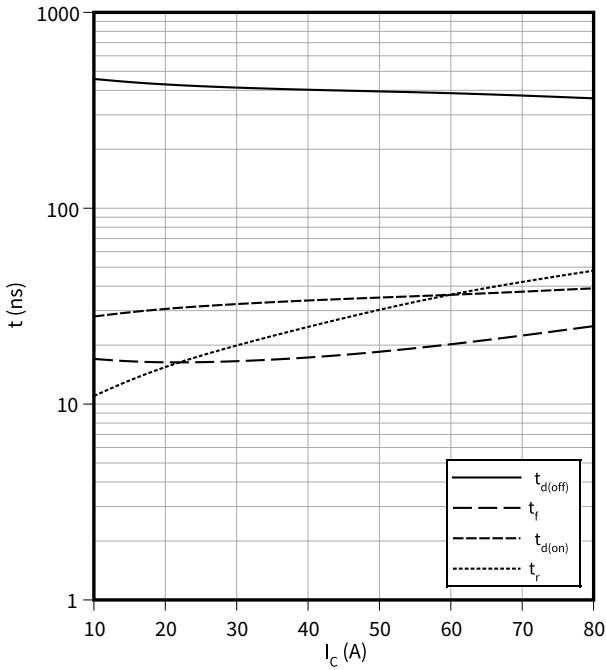


4 Characteristics diagrams

Typical switching times as a function of collector current

$t = f(I_C)$

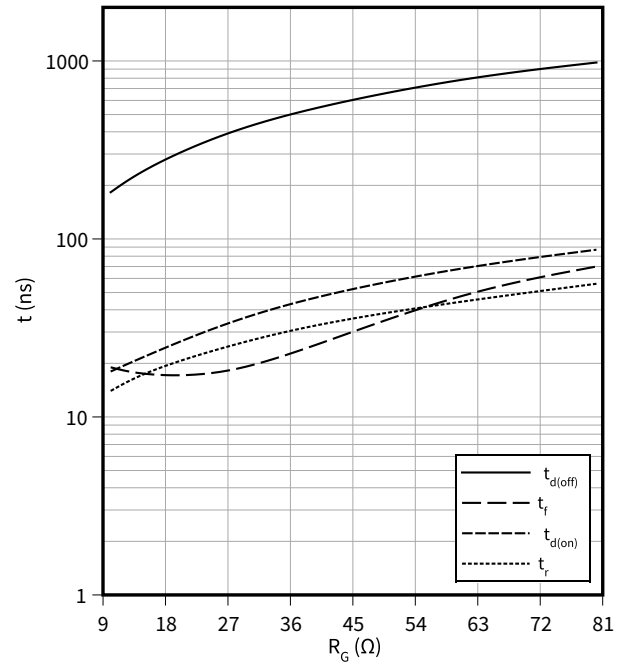
$V_{CC} = 400\text{ V}, T_{vj} = 175\text{ °C}, V_{GE} = 0/15\text{ V}, R_G = 27\text{ }\Omega$



Typical switching times as a function of gate resistor

$t = f(R_G)$

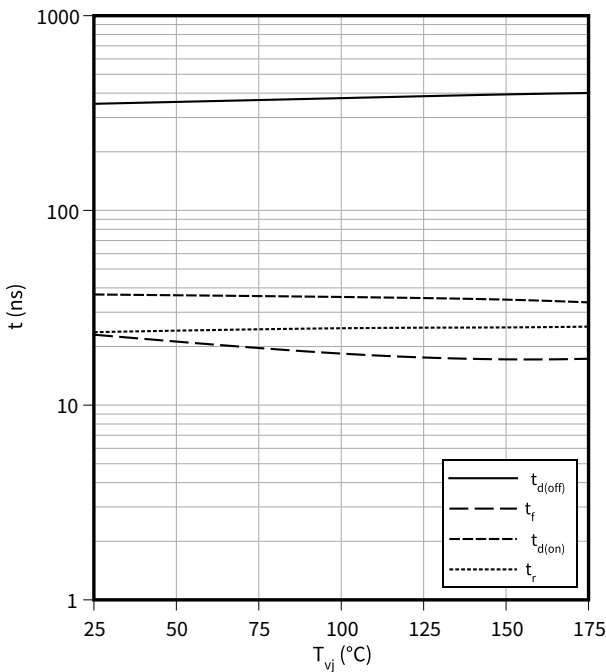
$I_C = 40\text{ A}, V_{CC} = 400\text{ V}, T_{vj} = 175\text{ °C}, V_{GE} = 0/15\text{ V}$



Typical switching times as a function of junction temperature

$t = f(T_{vj})$

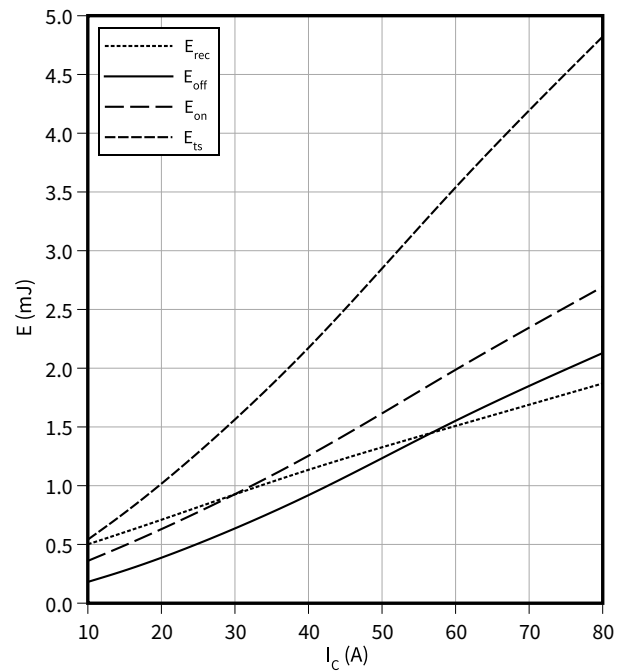
$I_C = 40\text{ A}, V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V}, R_G = 27\text{ }\Omega$



Typical switching energy losses as a function of collector current

$E = f(I_C)$

$V_{CC} = 400\text{ V}, T_{vj} = 175\text{ °C}, V_{GE} = 0/15\text{ V}, R_G = 27\text{ }\Omega$

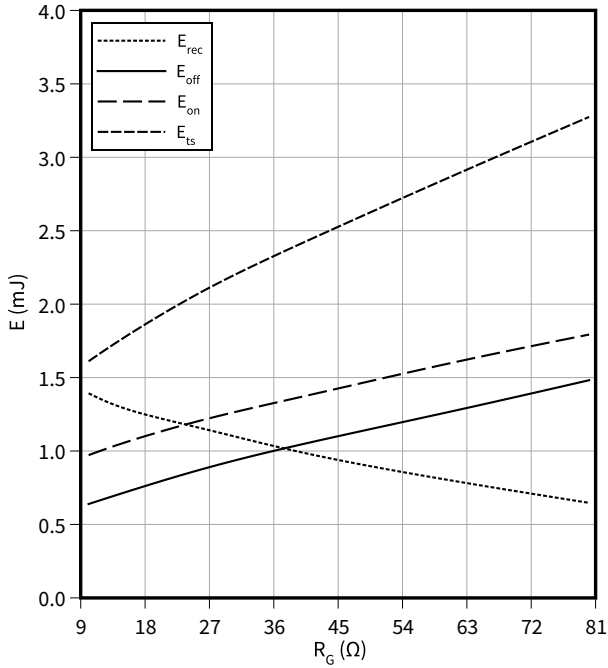


4 Characteristics diagrams

Typical switching energy losses as a function of gate resistor

$E = f(R_G)$

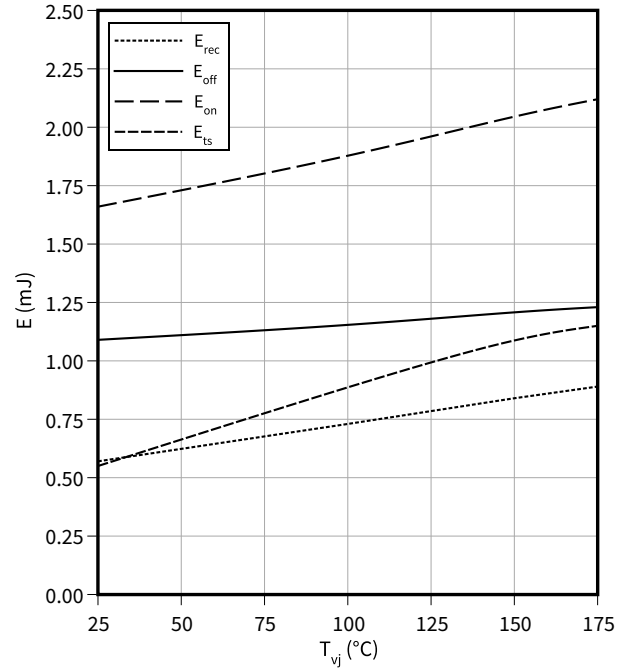
$I_C = 40\text{ A}, V_{CC} = 400\text{ V}, T_{vj} = 175\text{ °C}, V_{GE} = 0/15\text{ V}$



Typical switching energy losses as a function of junction temperature

$E = f(T_{vj})$

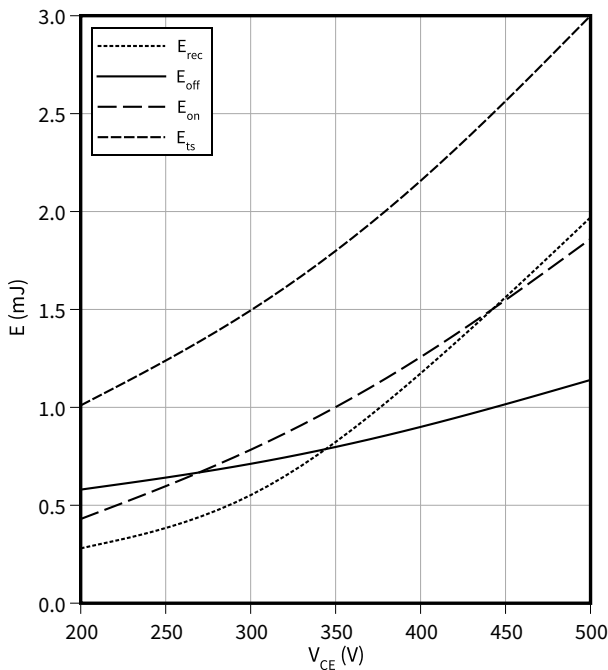
$I_C = 40\text{ A}, V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V}, R_G = 27\text{ Ω}$



Typical switching energy losses as a function of collector emitter voltage

$E = f(V_{CE})$

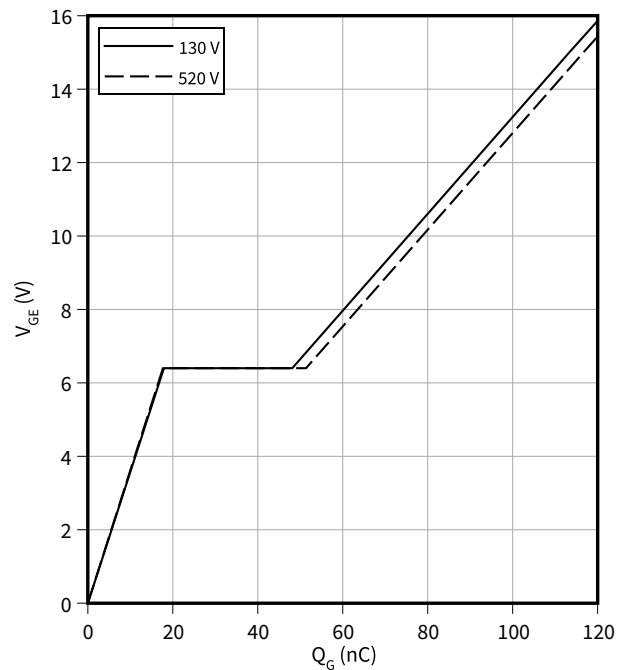
$I_C = 40\text{ A}, T_{vj} = 175\text{ °C}, V_{GE} = 0/15\text{ V}, R_G = 27\text{ Ω}$



Typical gate charge

$V_{GE} = f(Q_G)$

$I_C = 40\text{ A}$

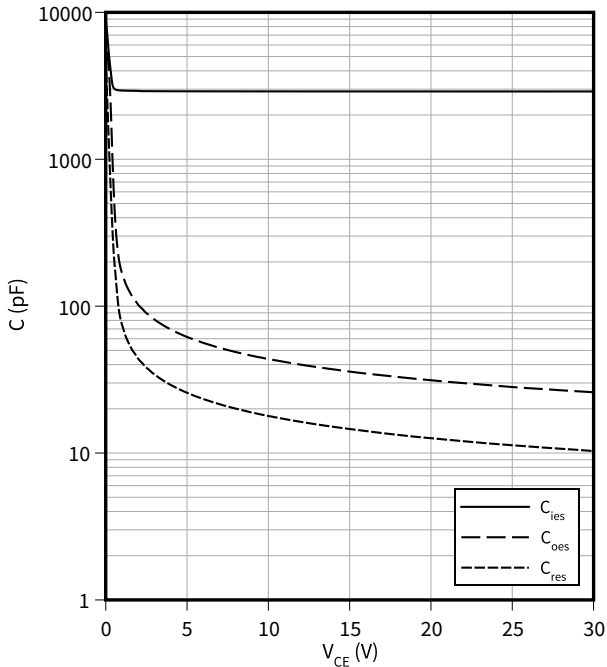


4 Characteristics diagrams

Typical capacitance as a function of collector-emitter voltage

$C = f(V_{CE})$

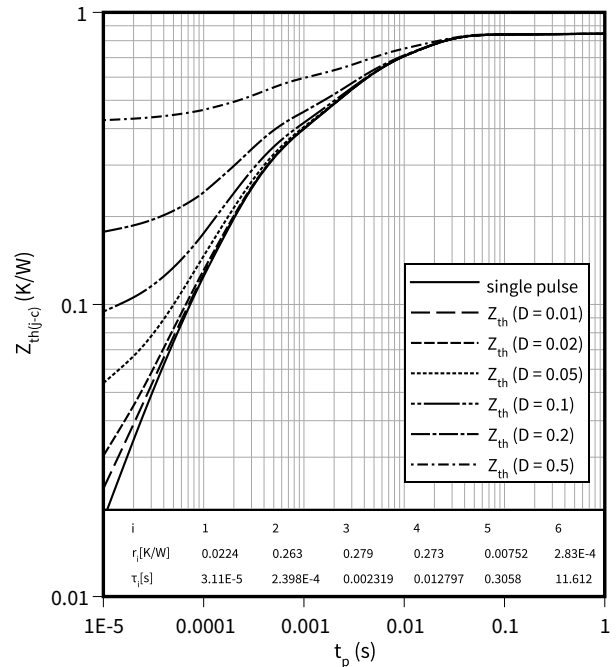
$f = 100 \text{ kHz}, V_{GE} = 0 \text{ V}$



IGBT transient thermal impedance as a function of pulse width

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

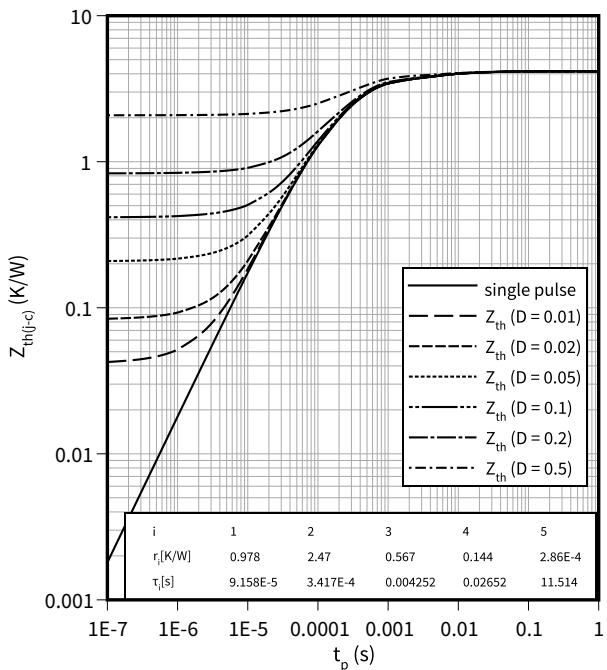
$D = t_p/T$



Diode transient thermal impedance as a function of pulse width

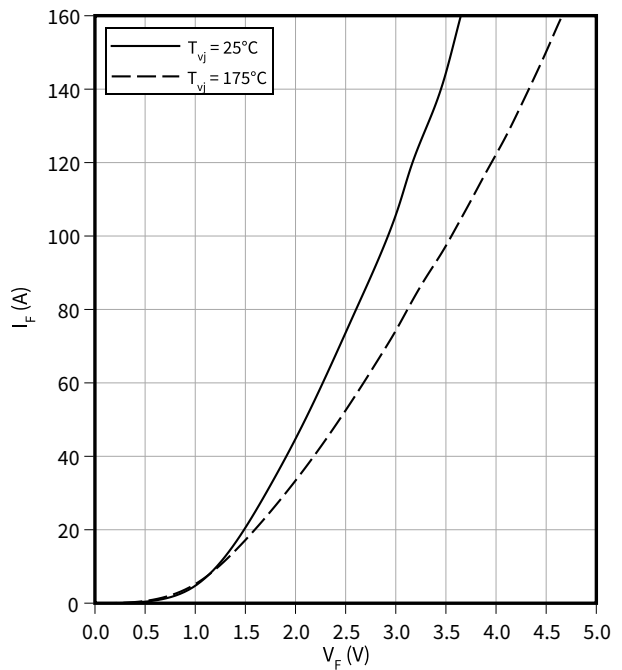
$Z_{th(j-c)} = f(t_p)$

$D = t_p/T$



Typical diode forward current as a function of forward voltage

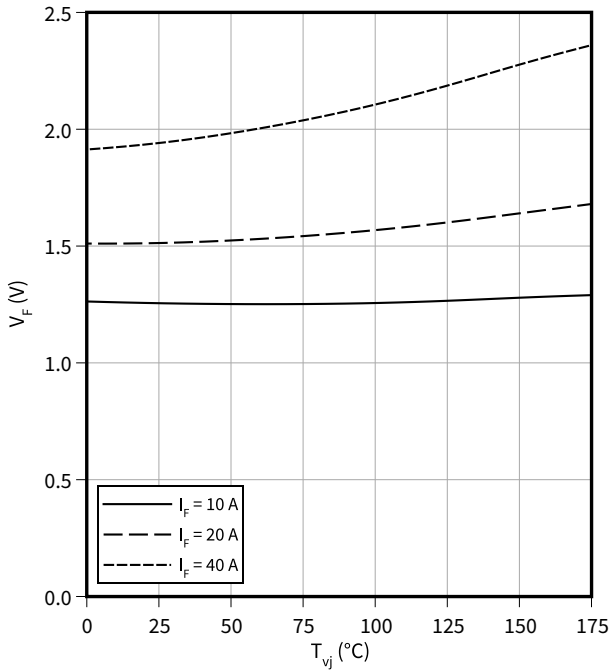
$I_F = f(V_F)$



4 Characteristics diagrams

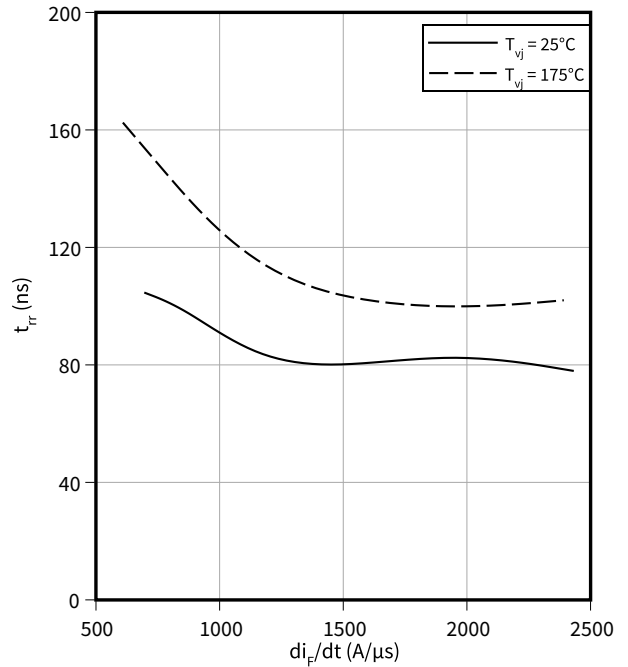
Typical diode forward voltage as a function of junction temperature

$V_F = f(T_{vj})$



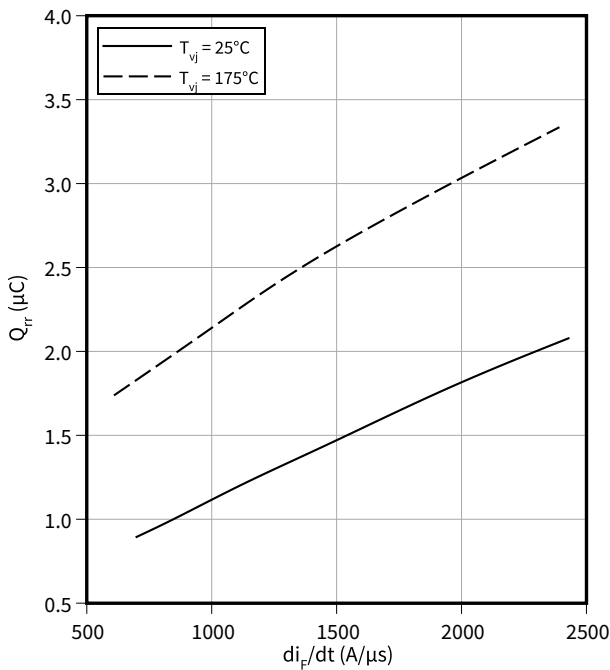
Typical reverse recovery time as a function of diode current slope

$t_{rr} = f(di_F/dt)$
 $V_R = 400$ V, $I_F = 20$ A



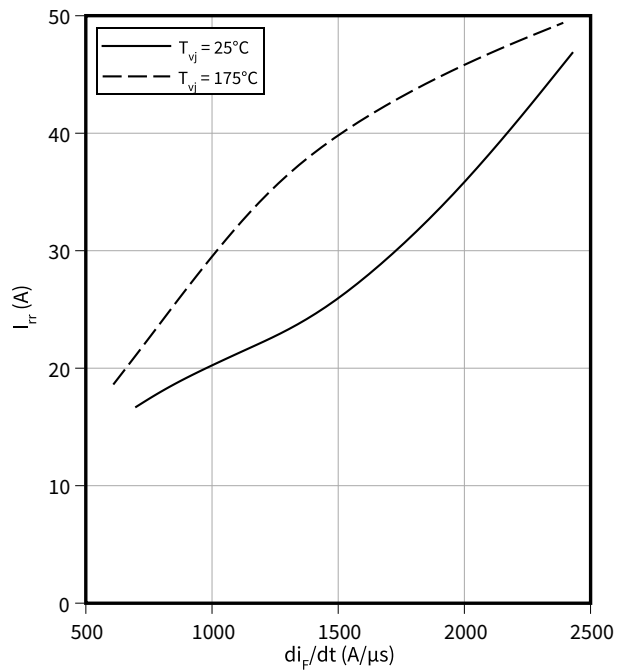
Typical reverse recovery charge as a function of diode current slope

$Q_{rr} = f(di_F/dt)$
 $I_F = 20$ A, $V_R = 400$ V



Typical reverse recovery current as a function of diode current slope

$I_{rrm} = f(di_F/dt)$
 $I_F = 20$ A, $V_R = 400$ V

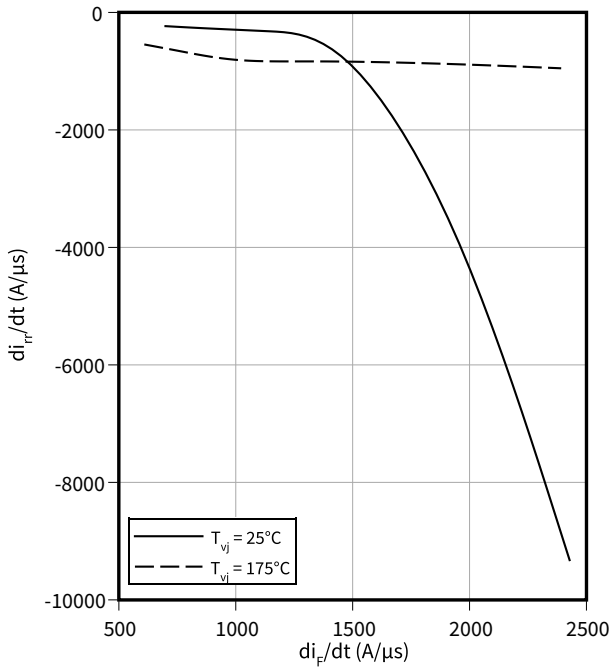


4 Characteristics diagrams

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

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

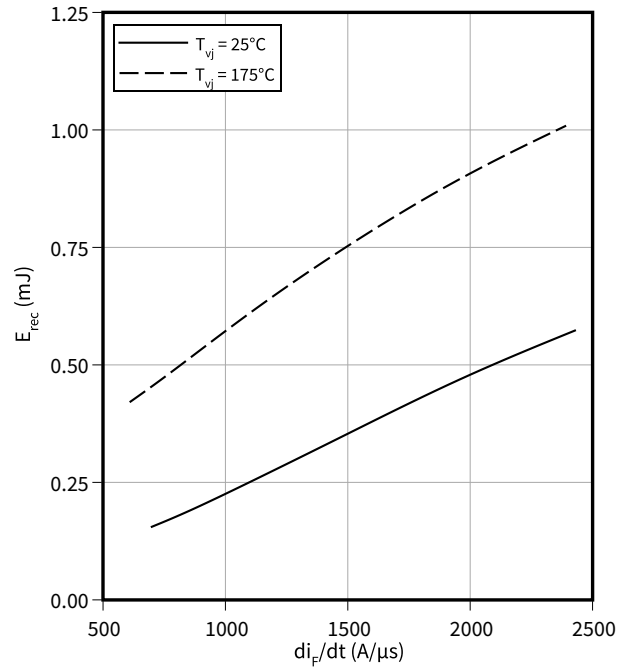
$V_R = 400\text{ V}, I_F = 20\text{ A}$



Typical reverse energy losses as a function of diode current slope

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

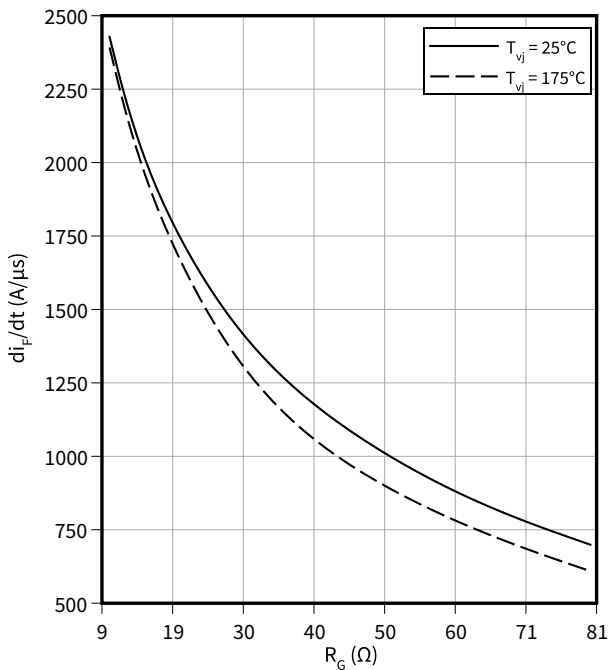
$V_R = 400\text{ V}, I_F = 20\text{ A}$



Typical diode current slope as a function of gate resistor

$di_F/dt = f(R_G)$

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



5 Package outlines

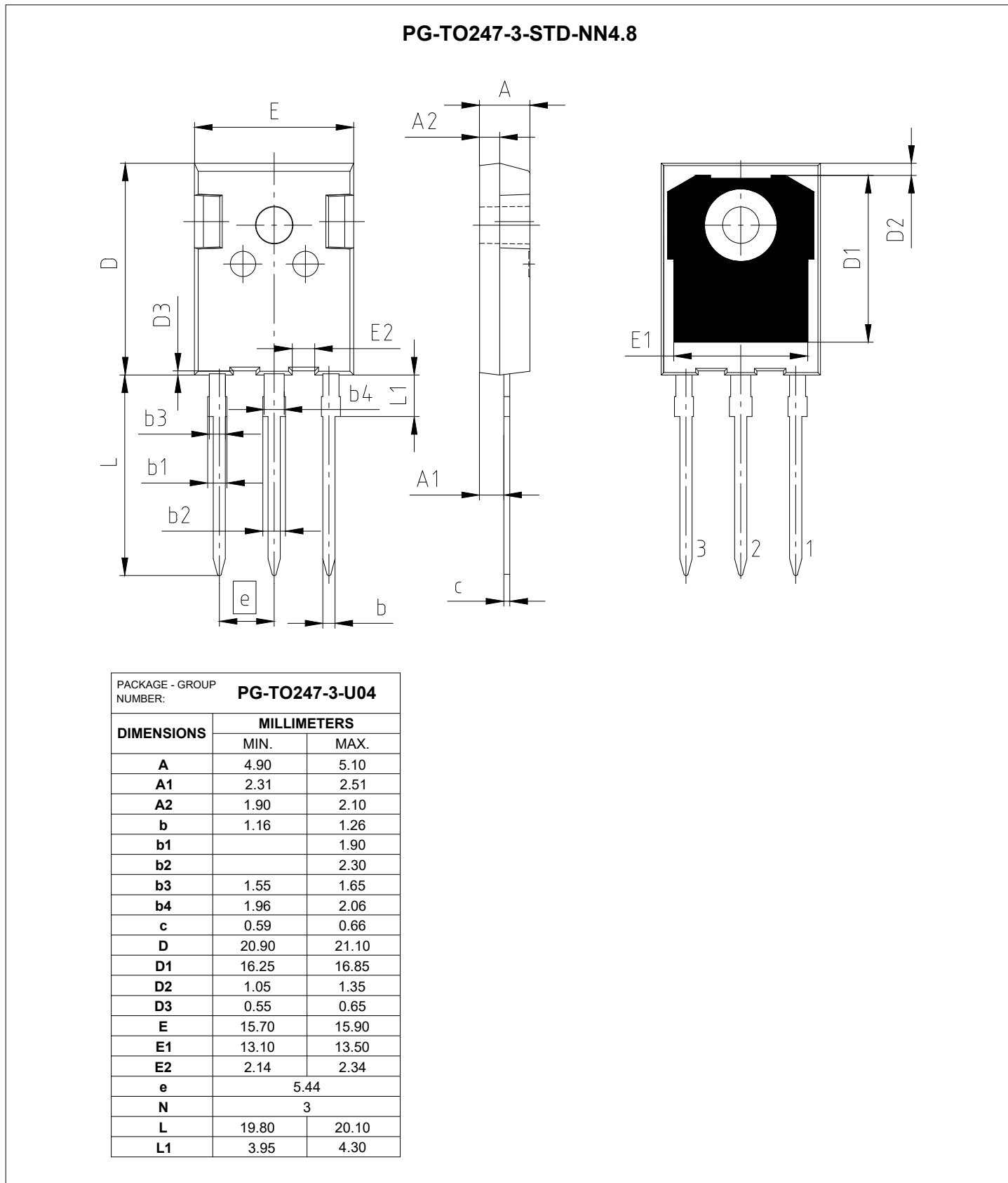


Figure 1

6 Testing conditions



Figure 2

Revision history

Document revision	Date of release	Description of changes
1.00	2021-05-17	Final datasheet
1.10	2021-05-18	Update of diagram $E = f(T_{vj})$
1.20	2021-06-29	Update of diagram $E = f(T_{vj})$
1.30	2022-12-06	<p>Update of “DC collector current, limited by T_{vjmax}” in table “Maximum rated values”, for 25°C and 100°C</p> <p>Transient gate-emitter voltage V_{GE} in table “Maximum rated values” of IGBT changed to $\pm 30V$</p> <p>Update of diagram “Collector current as a function of case temperature”, $I_C = f(T_C)$</p> <p>“Forward bias safe operating area” diagram renamed to “Reverse bias safe operating area”</p> <p>Correction of package outline dimensions</p> <p>Change package name to marketing name</p> <p>Editorial changes</p>