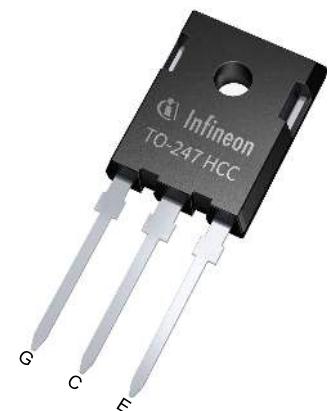


**TRENCHSTOP™ 5 WR6 technology in enhanced creepage and clearance package offers improved reliability against package contamination**

## Features

- $V_{CE} = 650 \text{ V}$
- $I_C = 20 \text{ A}$
- 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

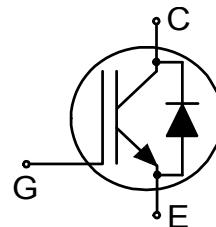
- PFC
- Welding
- ZCS applications

## Product validation

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



## Description



Type	Package	Marking
IWH20N65WR6	PG-T0247-3-STD-NN4.8	H20EWR6

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## 1 Package

## 1 Package

**Table 1 Characteristic values**

<b>Parameter</b>	<b>Symbol</b>	<b>Note or test condition</b>	<b>Values</b>			<b>Unit</b>
			<b>Min.</b>	<b>Typ.</b>	<b>Max.</b>	
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	$R_{th(j-c)}$				1.1	K/W
Diode thermal resistance, junction-case	$R_{th(j-c)}$				4.7	K/W

## 2 IGBT

**Table 2 Maximum rated values**

<b>Parameter</b>	<b>Symbol</b>	<b>Note or test condition</b>	<b>Values</b>		<b>Unit</b>
Collector-emitter voltage	$V_{CE}$	$T_{vj} \geq 25^\circ\text{C}$	650		V
DC collector current, limited by $T_{vjmax}$	$I_C$		$T_c = 25^\circ\text{C}$	55	A
			$T_c = 100^\circ\text{C}$	35	
Pulsed collector current, $t_p$ limited by $T_{vjmax}$	$I_{Cpulse}$		60		A
Turn-off safe operating area		$V_{CE} \leq 650\text{ V}, T_{vj} \leq 175^\circ\text{C}$	60		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	$P_{tot}$		$T_c = 25^\circ\text{C}$	140	W
			$T_c = 100^\circ\text{C}$	70	

**Table 3 Characteristic values**

<b>Parameter</b>	<b>Symbol</b>	<b>Note or test condition</b>	<b>Values</b>			<b>Unit</b>
			<b>Min.</b>	<b>Typ.</b>	<b>Max.</b>	
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**

<b>Parameter</b>	<b>Symbol</b>	<b>Note or test condition</b>	<b>Values</b>			<b>Unit</b>
			<b>Min.</b>	<b>Typ.</b>	<b>Max.</b>	
Collector-emitter saturation voltage	$V_{CEsat}$	$I_C = 20 \text{ A}, V_{GE} = 15 \text{ V}$	$T_{vj} = 25^\circ\text{C}$		1.35	1.7
			$T_{vj} = 175^\circ\text{C}$		1.6	
Gate-emitter threshold voltage	$V_{GEth}$	$I_C = 0.2 \text{ mA}, V_{CE} = V_{GE}$		3.2	4	4.8
Zero gate-voltage collector current	$I_{CES}$	$V_{CE} = 650 \text{ V}, V_{GE} = 0 \text{ V}$	$T_{vj} = 25^\circ\text{C}$		40	$\mu\text{A}$
			$T_{vj} = 175^\circ\text{C}$		0.5	$\text{mA}$
Gate-emitter leakage current	$I_{GES}$	$V_{CE} = 0 \text{ V}, V_{GE} = 20 \text{ V}$			100	$\text{nA}$
Transconductance	$g_{fs}$	$I_C = 20 \text{ A}, V_{CE} = 20 \text{ V}$		50		$\text{s}$
Input capacitance	$C_{ies}$	$V_{CE} = 25 \text{ V}, V_{GE} = 0 \text{ V}, f = 100 \text{ kHz}$		2130		$\text{pF}$
Output capacitance	$C_{oes}$	$V_{CE} = 25 \text{ V}, V_{GE} = 0 \text{ V}, f = 100 \text{ kHz}$		22		$\text{pF}$
Reverse transfer capacitance	$C_{res}$	$V_{CE} = 25 \text{ V}, V_{GE} = 0 \text{ V}, f = 100 \text{ kHz}$		9		$\text{pF}$
Gate charge	$Q_G$	$I_C = 20 \text{ A}, V_{GE} = 15 \text{ V}, V_{CC} = 520 \text{ V}$		89		$\text{nC}$
Turn-on delay time	$t_{d(on)}$	$V_{CC} = 400 \text{ V}, V_{GE} = 0/15 \text{ V}, R_{G(on)} = 24 \Omega, R_{G(off)} = 24 \Omega, L_\sigma = 30 \text{ nH}, C_\sigma = 11 \text{ pF}$	$T_{vj} = 25^\circ\text{C}, I_C = 20 \text{ A}$		25	
			$T_{vj} = 175^\circ\text{C}, I_C = 20 \text{ A}$		22	
Rise time (inductive load)	$t_r$	$V_{CC} = 400 \text{ V}, V_{GE} = 0/15 \text{ V}, R_{G(on)} = 24 \Omega, R_{G(off)} = 24 \Omega, L_\sigma = 30 \text{ nH}, C_\sigma = 11 \text{ pF}$	$T_{vj} = 25^\circ\text{C}, I_C = 20 \text{ A}$		13	
			$T_{vj} = 175^\circ\text{C}, I_C = 20 \text{ A}$		15	
Turn-off delay time	$t_{d(off)}$	$V_{CC} = 400 \text{ V}, V_{GE} = 0/15 \text{ V}, R_{G(on)} = 24 \Omega, R_{G(off)} = 24 \Omega, L_\sigma = 30 \text{ nH}, C_\sigma = 11 \text{ pF}$	$T_{vj} = 25^\circ\text{C}, I_C = 20 \text{ A}$		255	
			$T_{vj} = 175^\circ\text{C}, I_C = 20 \text{ A}$		290	
Fall time (inductive load)	$t_f$	$V_{CC} = 400 \text{ V}, V_{GE} = 0/15 \text{ V}, R_{G(on)} = 24 \Omega, R_{G(off)} = 24 \Omega, L_\sigma = 30 \text{ nH}, C_\sigma = 11 \text{ pF}$	$T_{vj} = 25^\circ\text{C}, I_C = 20 \text{ A}$		17	
			$T_{vj} = 175^\circ\text{C}, I_C = 20 \text{ A}$		17	
Turn-on energy	$E_{on}$	$V_{CC} = 400 \text{ V}, V_{GE} = 0/15 \text{ V}, R_{G(on)} = 24 \Omega, R_{G(off)} = 24 \Omega, L_\sigma = 30 \text{ nH}, C_\sigma = 11 \text{ pF}$	$T_{vj} = 25^\circ\text{C}, I_C = 20 \text{ A}$		0.5	
			$T_{vj} = 175^\circ\text{C}, I_C = 20 \text{ A}$		0.62	

(table continues...)

**Table 3** (continued) Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Turn-off energy	$E_{\text{off}}$	$V_{\text{CC}} = 400 \text{ V}$ , $V_{\text{GE}} = 0/15 \text{ V}$ , $R_{\text{G(on)}} = 24 \Omega$ , $R_{\text{G(off)}} = 24 \Omega$ , $L_{\sigma} = 30 \text{ nH}$ , $C_{\sigma} = 11 \text{ pF}$	$T_{\text{vj}} = 25 \text{ }^{\circ}\text{C}$ , $I_{\text{C}} = 20 \text{ A}$		0.2	mJ
			$T_{\text{vj}} = 175 \text{ }^{\circ}\text{C}$ , $I_{\text{C}} = 20 \text{ A}$		0.35	
Total switching energy	$E_{\text{ts}}$	$V_{\text{CC}} = 400 \text{ V}$ , $V_{\text{GE}} = 0/15 \text{ V}$ , $R_{\text{G(on)}} = 24 \Omega$ , $R_{\text{G(off)}} = 24 \Omega$ , $L_{\sigma} = 30 \text{ nH}$ , $C_{\sigma} = 11 \text{ pF}$	$T_{\text{vj}} = 25 \text{ }^{\circ}\text{C}$ , $I_{\text{C}} = 20 \text{ A}$		0.7	mJ
			$T_{\text{vj}} = 175 \text{ }^{\circ}\text{C}$ , $I_{\text{C}} = 20 \text{ A}$		0.97	
Operating junction temperature	$T_{\text{vj}}$		-40		175	°C

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

### 3 Diode

**Table 4** Maximum rated values

Parameter	Symbol	Note or test condition	Values			Unit
Repetitive peak reverse voltage	$V_{\text{RRM}}$	$T_{\text{vj}} \geq 25 \text{ }^{\circ}\text{C}$	650			V
Diode forward current, limited by $T_{\text{vjmax}}$	$I_{\text{F}}$		$T_{\text{c}} = 25 \text{ }^{\circ}\text{C}$			A
			$T_{\text{c}} = 100 \text{ }^{\circ}\text{C}$			A
Diode pulsed current, $t_{\text{p}}$ limited by $T_{\text{vjmax}}$	$I_{\text{Fpulse}}$		30			A

**Table 5** Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Diode forward voltage	$V_{\text{F}}$	$I_{\text{F}} = 8.5 \text{ A}$	$T_{\text{vj}} = 25 \text{ }^{\circ}\text{C}$		1.3	1.6
			$T_{\text{vj}} = 175 \text{ }^{\circ}\text{C}$		1.35	
Diode reverse recovery time	$t_{\text{rr}}$	$V_{\text{R}} = 400 \text{ V}$	$T_{\text{vj}} = 25 \text{ }^{\circ}\text{C}$ , $I_{\text{F}} = 10 \text{ A}$ , $-di_{\text{F}}/dt = 1340 \text{ A}/\mu\text{s}$		89	ns
			$T_{\text{vj}} = 175 \text{ }^{\circ}\text{C}$ , $I_{\text{F}} = 10 \text{ A}$ , $-di_{\text{F}}/dt = 1300 \text{ A}/\mu\text{s}$		92	

(table continues...)

**Table 5 (continued) Characteristic values**

<b>Parameter</b>	<b>Symbol</b>	<b>Note or test condition</b>	<b>Values</b>			<b>Unit</b>
			<b>Min.</b>	<b>Typ.</b>	<b>Max.</b>	
Diode reverse recovery charge	$Q_{rr}$	$V_R = 400 \text{ V}$	$T_{vj} = 25^\circ\text{C}$ , $I_F = 10 \text{ A}$ , $-di_F/dt = 1340 \text{ A}/\mu\text{s}$		1	$\mu\text{C}$
			$T_{vj} = 175^\circ\text{C}$ , $I_F = 10 \text{ A}$ , $-di_F/dt = 1300 \text{ A}/\mu\text{s}$		1.7	
Diode peak reverse recovery current	$I_{rrm}$	$V_R = 400 \text{ V}$	$T_{vj} = 25^\circ\text{C}$ , $I_F = 10 \text{ A}$ , $-di_F/dt = 1340 \text{ A}/\mu\text{s}$		23	$\text{A}$
			$T_{vj} = 175^\circ\text{C}$ , $I_F = 10 \text{ A}$ , $-di_F/dt = 1300 \text{ A}/\mu\text{s}$		29.1	
Diode peak rate of fall of reverse recovery current	$di_{rr}/dt$	$V_R = 400 \text{ V}$	$T_{vj} = 25^\circ\text{C}$ , $I_F = 10 \text{ A}$ , $-di_F/dt = 1340 \text{ A}/\mu\text{s}$		3330	$\text{A}/\mu\text{s}$
			$T_{vj} = 175^\circ\text{C}$ , $I_F = 10 \text{ A}$ , $-di_F/dt = 1300 \text{ A}/\mu\text{s}$		775	
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.

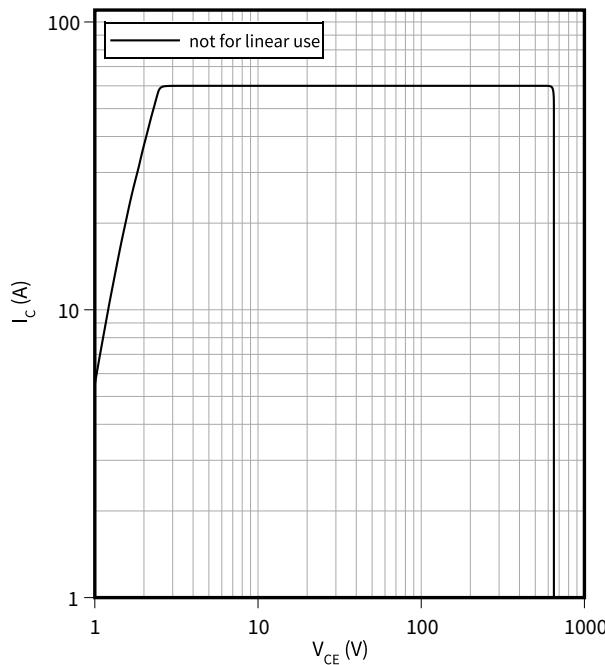
## 4 Characteristics diagrams

## 4 Characteristics diagrams

**Reverse bias safe operating area**

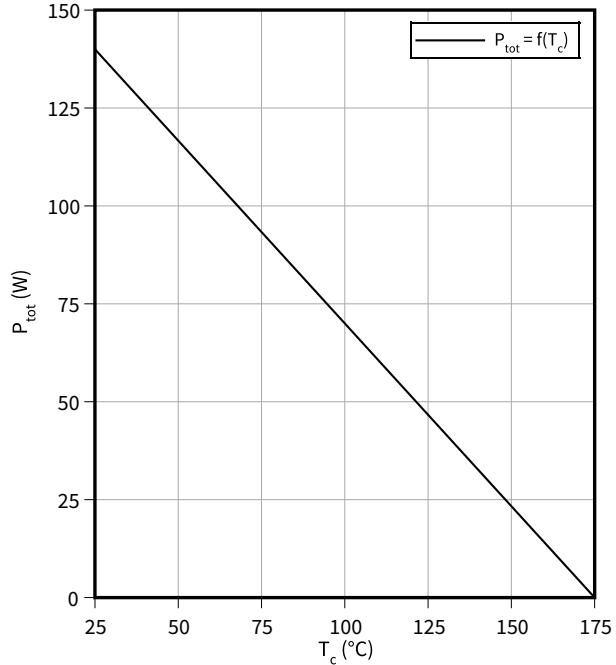
$$I_C = f(V_{CE})$$

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


**Power dissipation as a function of case temperature**

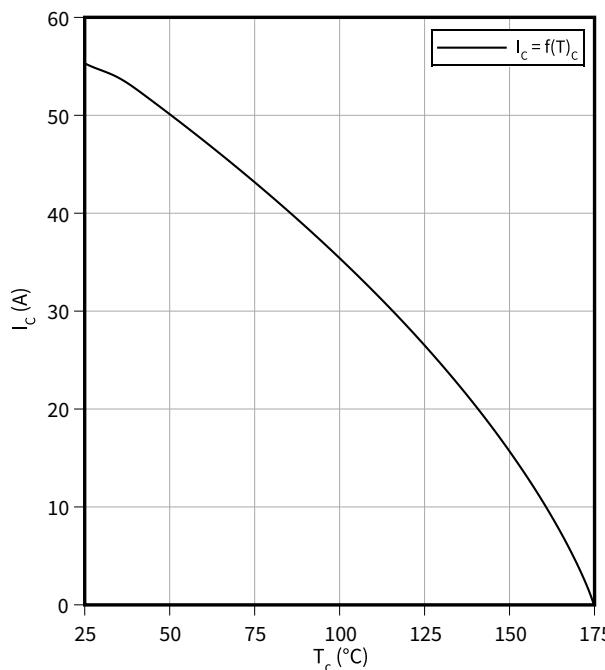
$$P_{tot} = f(T_c)$$

$T_{vj} \leq 175^\circ\text{C}$


**Collector current as a function of case temperature**

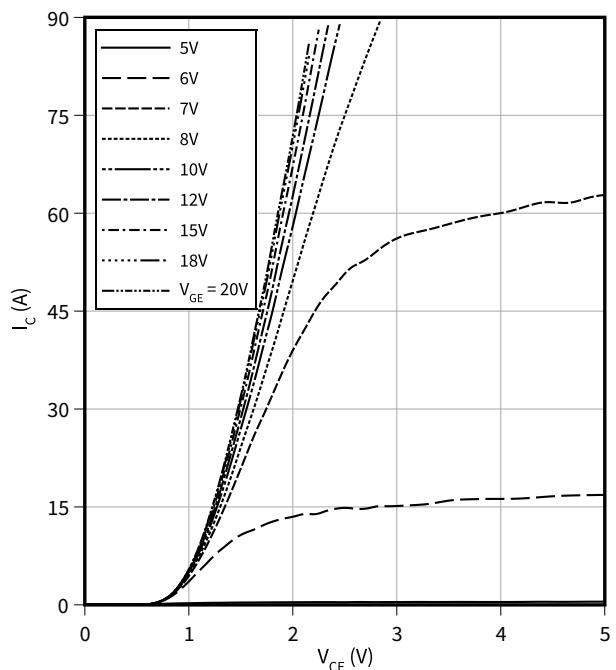
$$I_C = f(T_c)$$

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


**Typical output characteristic**

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

$T_{vj} = 25^\circ\text{C}$

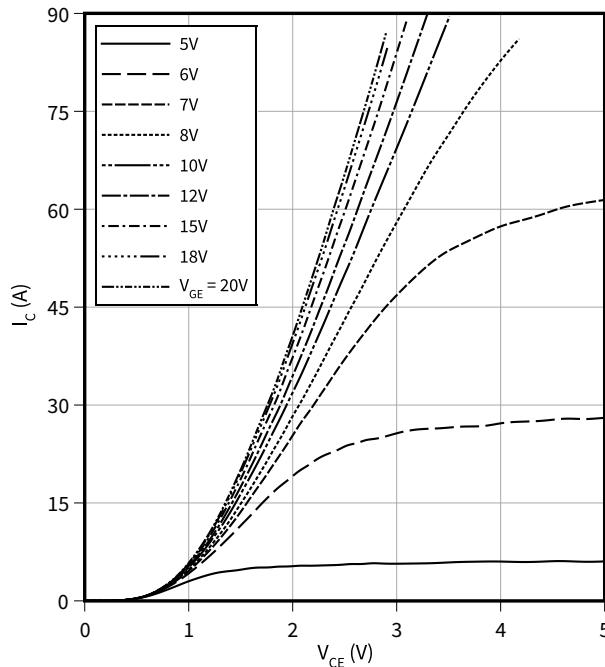


## 4 Characteristics diagrams

**Typical output characteristic**

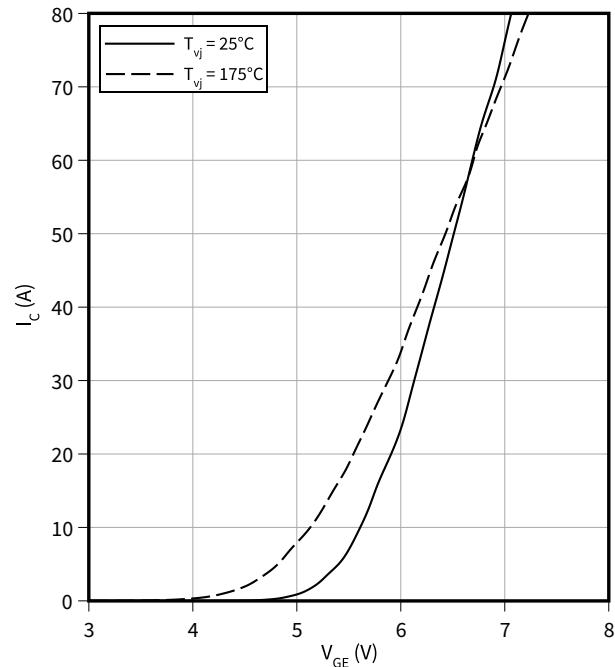
$$I_C = f(V_{CE})$$

$$T_{vj} = 175^\circ\text{C}$$

**Typical transfer characteristic**

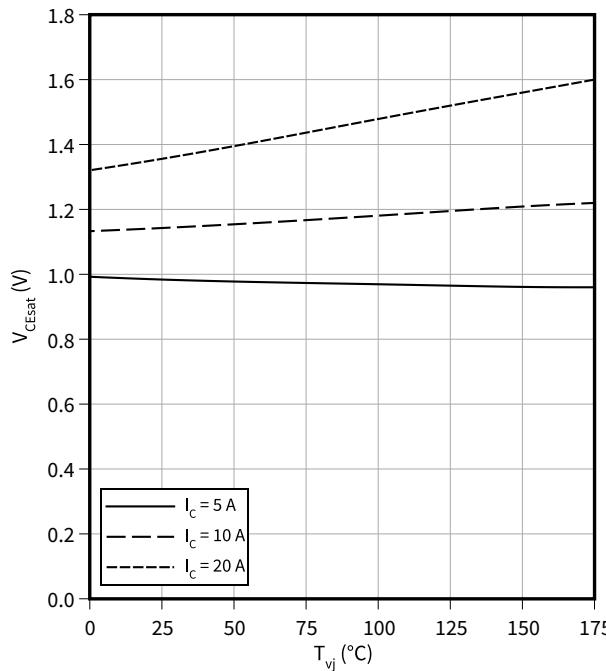
$$I_C = f(V_{GE})$$

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

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

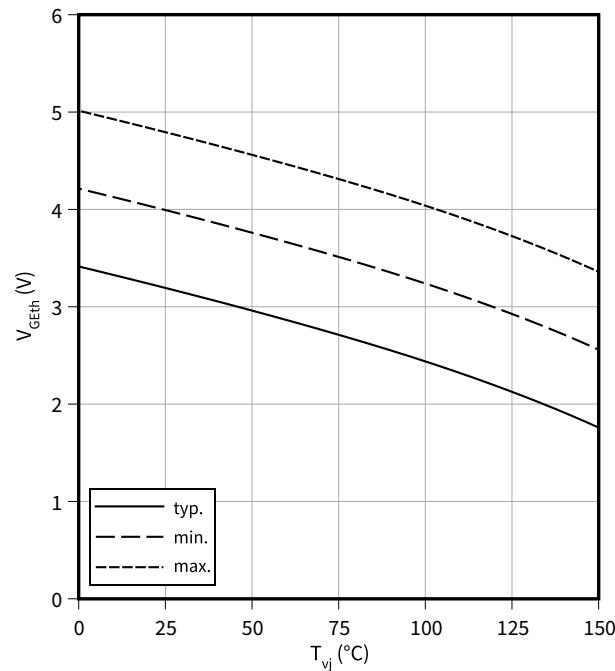
$$V_{CESat} = f(T_{vj})$$

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

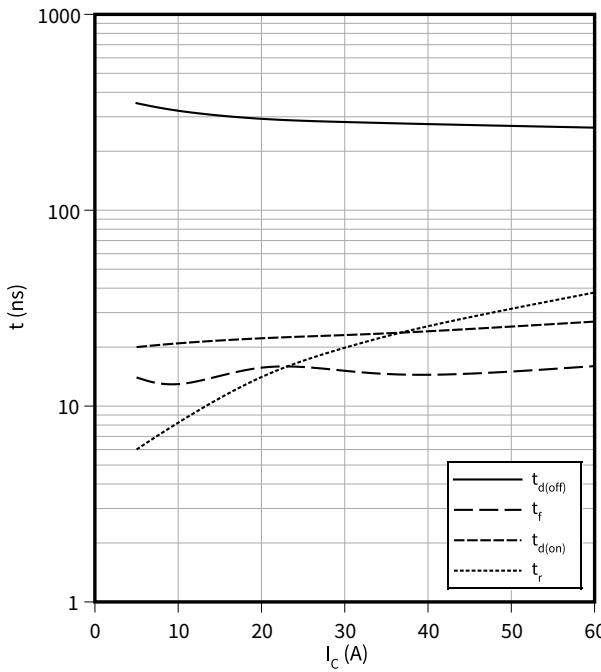
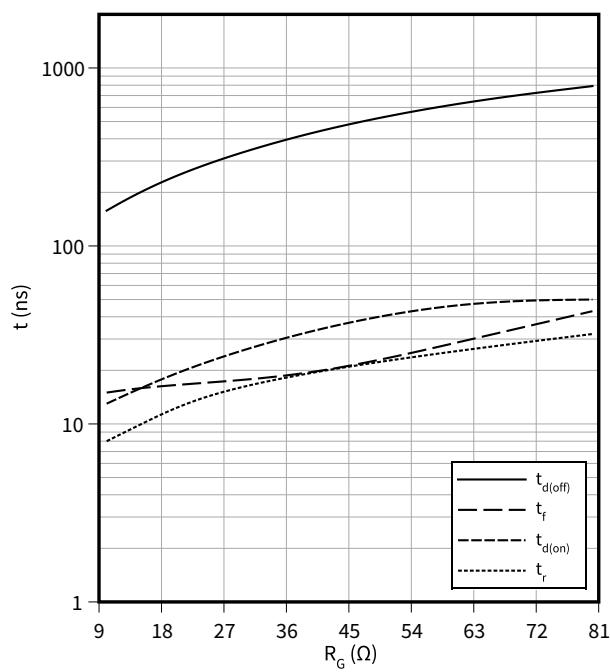
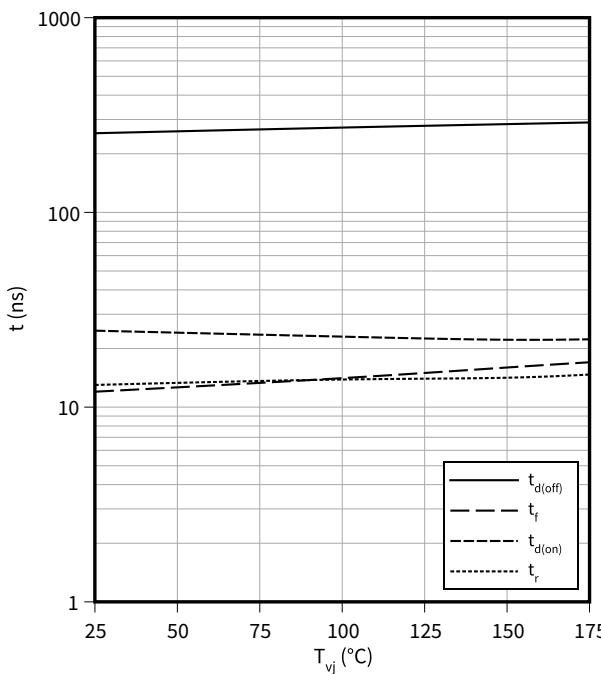
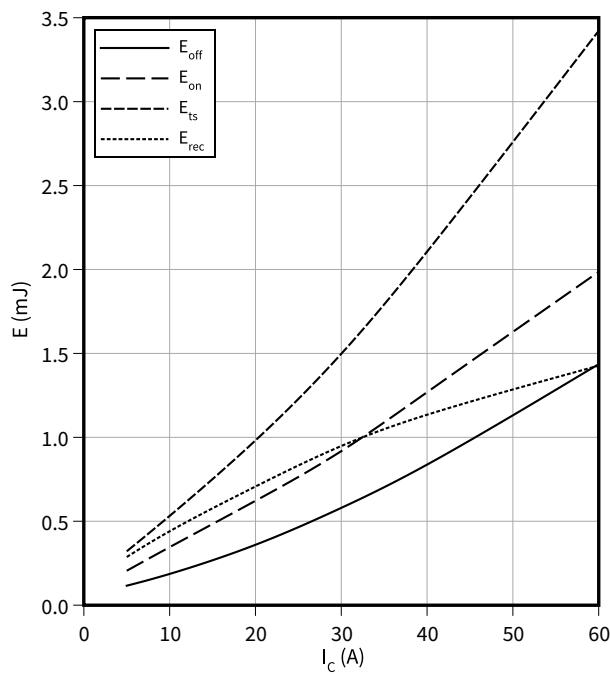
**Gate-emitter threshold voltage as a function of junction temperature**

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

$$I_C = 0.2\text{ mA}$$



## 4 Characteristics diagrams

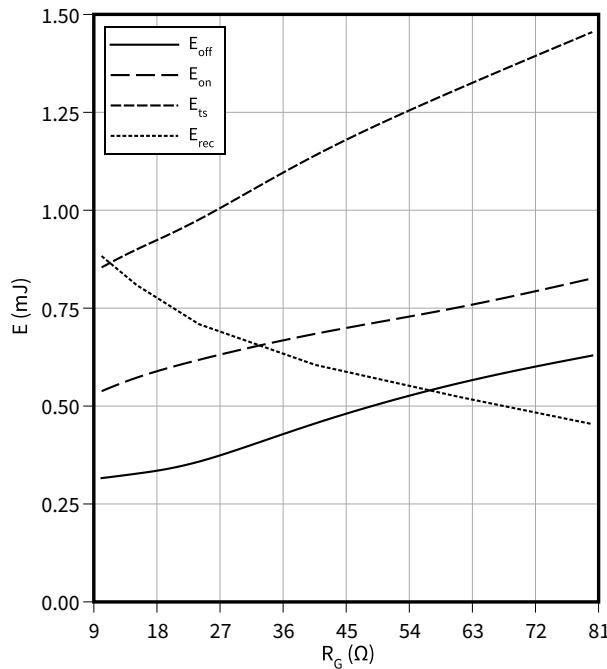
**Typical switching times as a function of collector current**
 $t = f(I_C)$   
 $V_{CC} = 400 \text{ V}, T_{vj} = 175 \text{ }^\circ\text{C}, V_{GE} = 0/15 \text{ V}, R_G = 24 \Omega$ 
**Typical switching times as a function of gate resistor**
 $t = f(R_G)$   
 $I_C = 20 \text{ A}, V_{CC} = 400 \text{ V}, T_{vj} = 175 \text{ }^\circ\text{C}, V_{GE} = 0/15 \text{ V}$ 
**Typical switching times as a function of junction temperature**
 $t = f(T_{vj})$   
 $I_C = 20 \text{ A}, V_{CC} = 400 \text{ V}, V_{GE} = 0/15 \text{ V}, R_G = 24 \Omega$ 
**Typical switching energy losses as a function of collector current**
 $E = f(I_C)$   
 $V_{CC} = 400 \text{ V}, T_{vj} = 175 \text{ }^\circ\text{C}, V_{GE} = 0/15 \text{ V}, R_G = 24 \Omega$ 


## 4 Characteristics diagrams

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

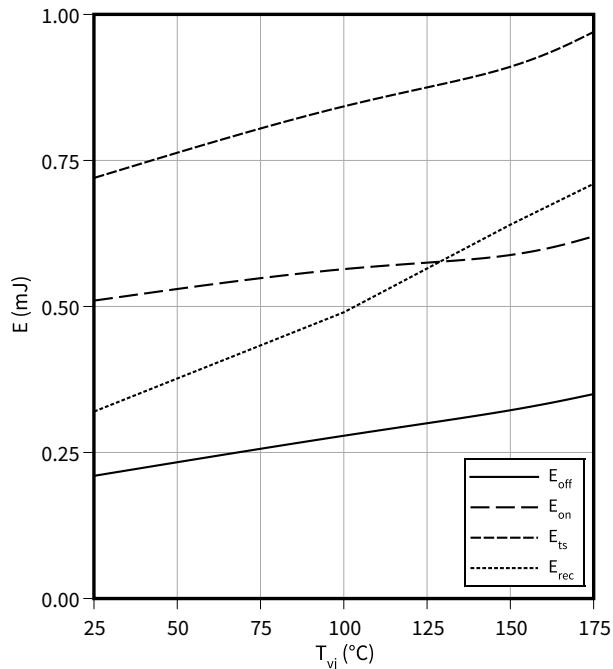
$$E = f(R_G)$$

$I_C = 20 \text{ A}$ ,  $V_{CC} = 400 \text{ V}$ ,  $T_{vj} = 175^\circ\text{C}$ ,  $V_{GE} = 0/15 \text{ V}$

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

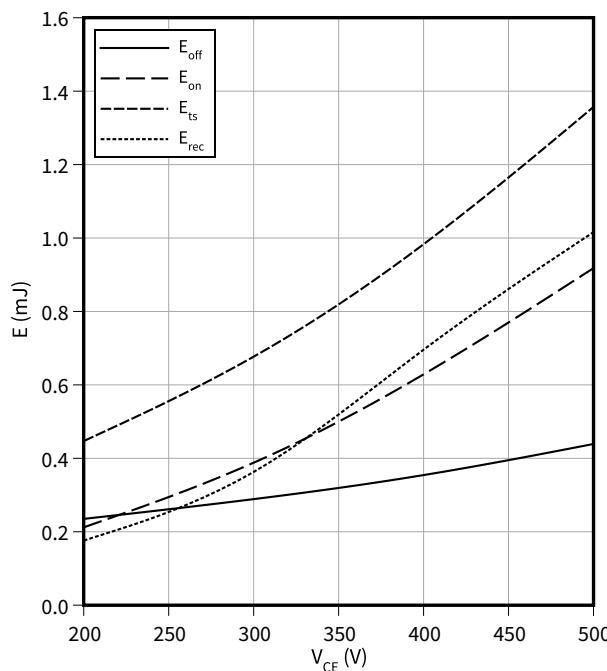
$$E = f(T_{vj})$$

$I_C = 20 \text{ A}$ ,  $V_{CC} = 400 \text{ V}$ ,  $V_{GE} = 0/15 \text{ V}$ ,  $R_G = 24 \Omega$

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

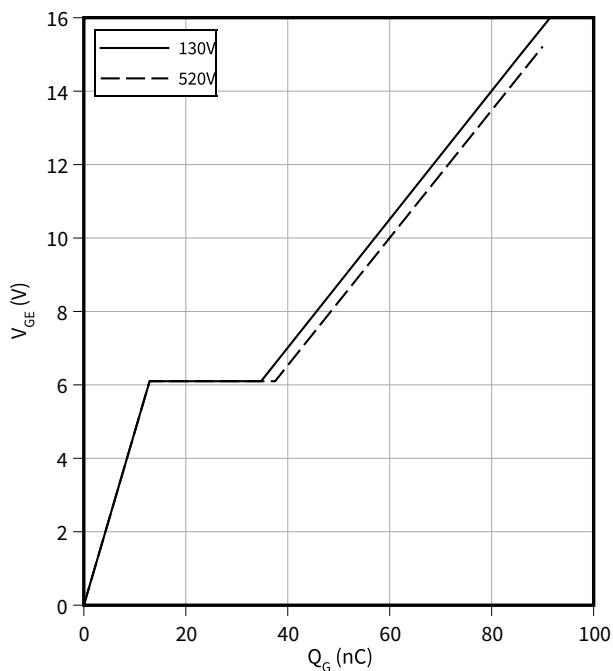
$$E = f(V_{CE})$$

$I_C = 20 \text{ A}$ ,  $T_{vj} = 175^\circ\text{C}$ ,  $V_{GE} = 0/15 \text{ V}$ ,  $R_G = 24 \Omega$

**Typical gate charge**

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

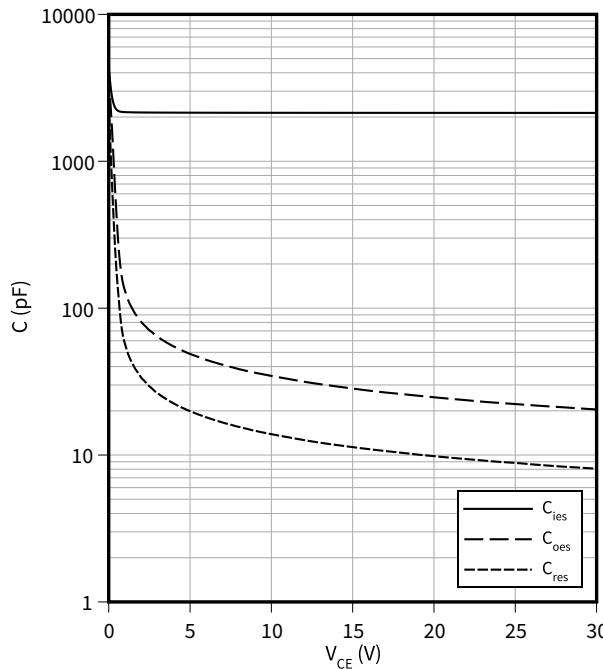
$I_C = 20 \text{ A}$



## 4 Characteristics diagrams

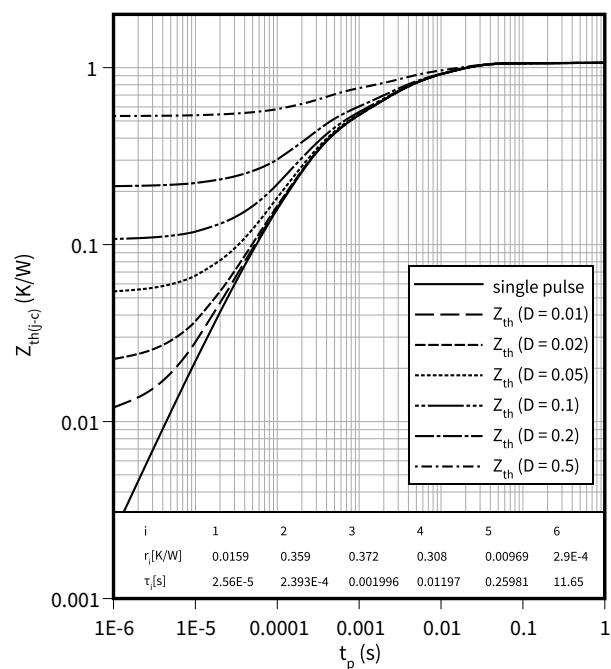
**Typical capacitance as a function of collector-emitter voltage**

$C = f(V_{CE})$

 $f = 100 \text{ kHz}, V_{GE} = 0 \text{ V}$ **IGBT transient thermal impedance as a function of pulse width**

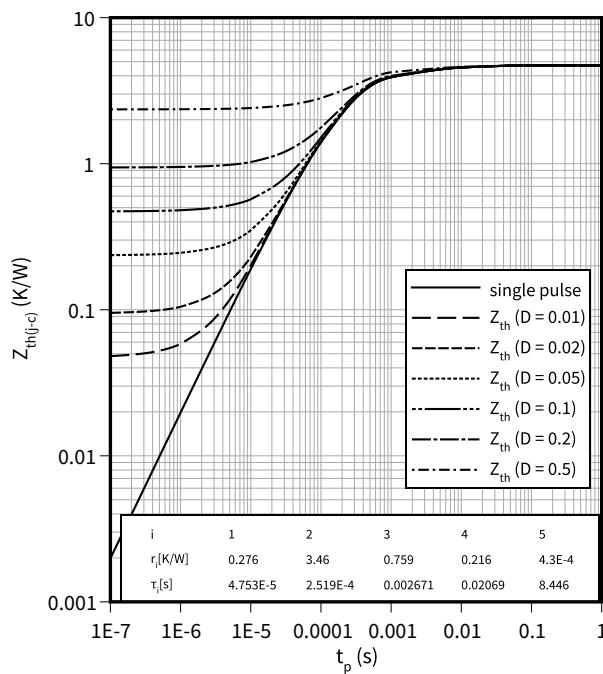
$Z_{th(j-c)} = f(t_p)$

$D = t_p/T$

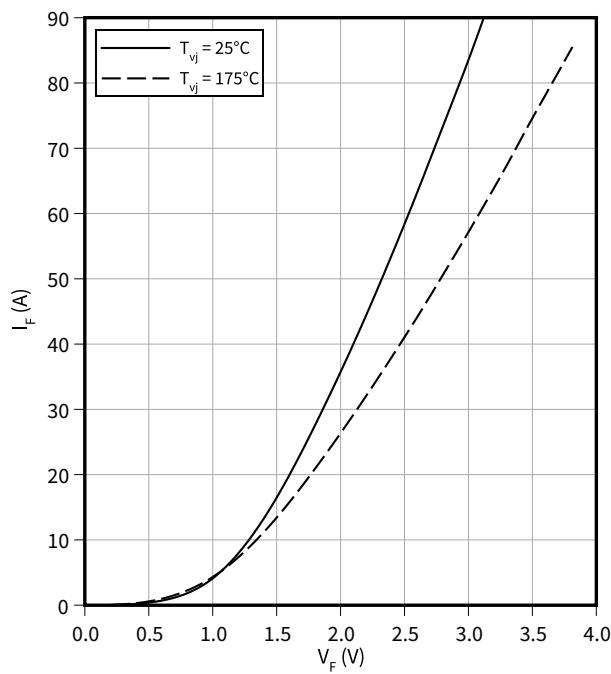
**Diode transient thermal impedance as a function of pulse width**

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

$D = t_p/T$

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

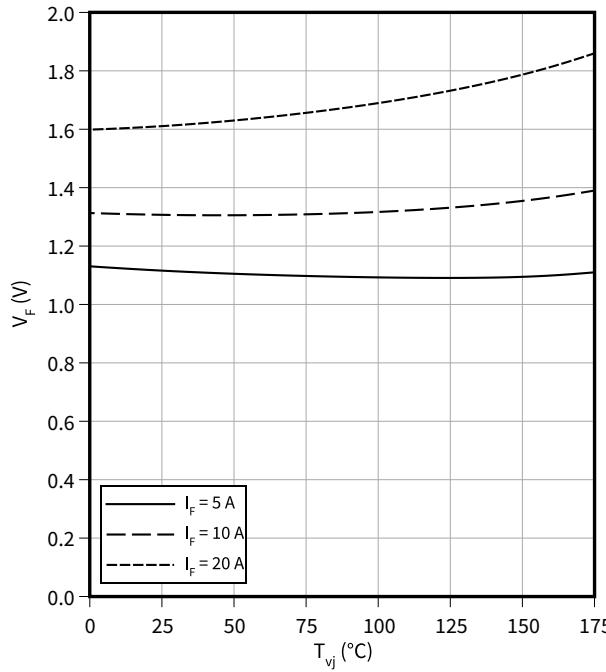
$I_F = f(V_F)$



## 4 Characteristics diagrams

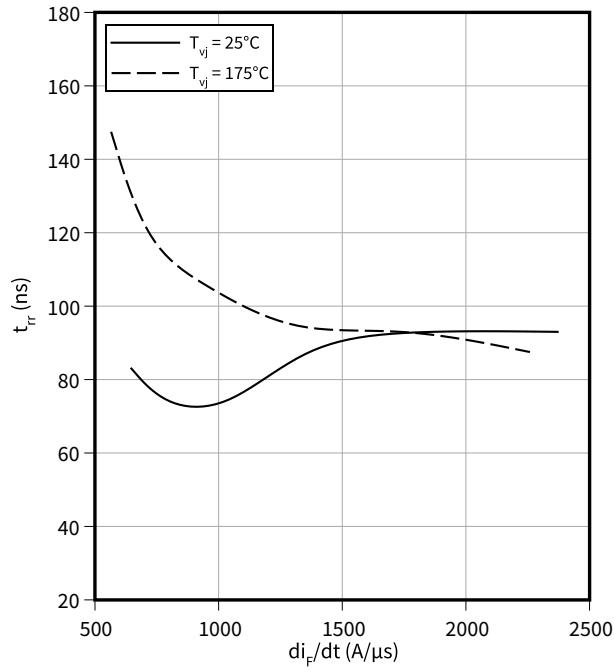
**Typical diode forward voltage as a function of junction temperature**

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

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

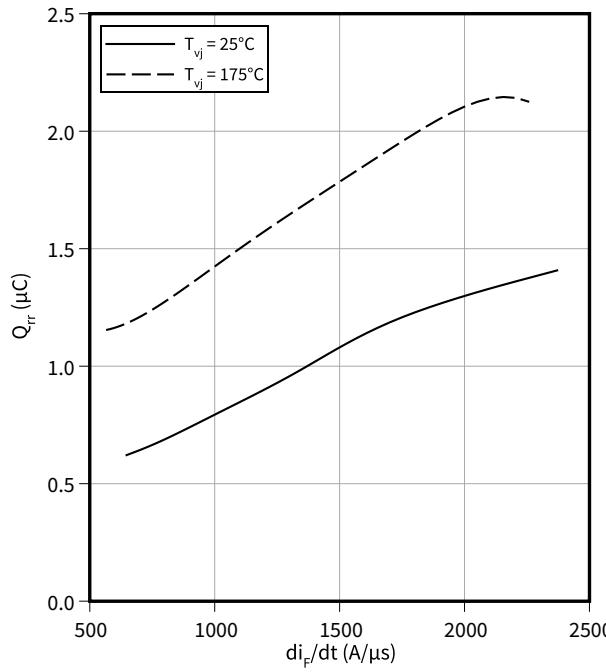
$$t_{rr} = f(dI_F/dt)$$

$$V_R = 400 \text{ V}, I_F = 10 \text{ A}$$

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

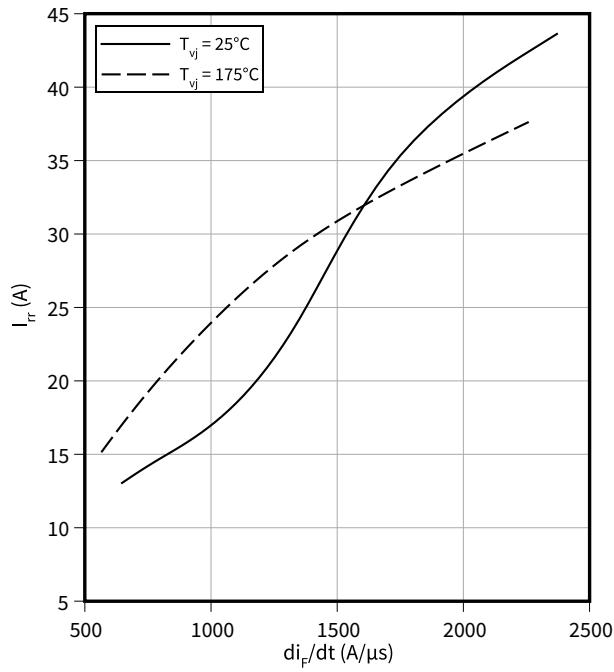
$$Q_{rr} = f(dI_F/dt)$$

$$V_R = 400 \text{ V}, I_F = 10 \text{ A}$$

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

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

$$V_R = 400 \text{ V}, I_F = 10 \text{ A}$$

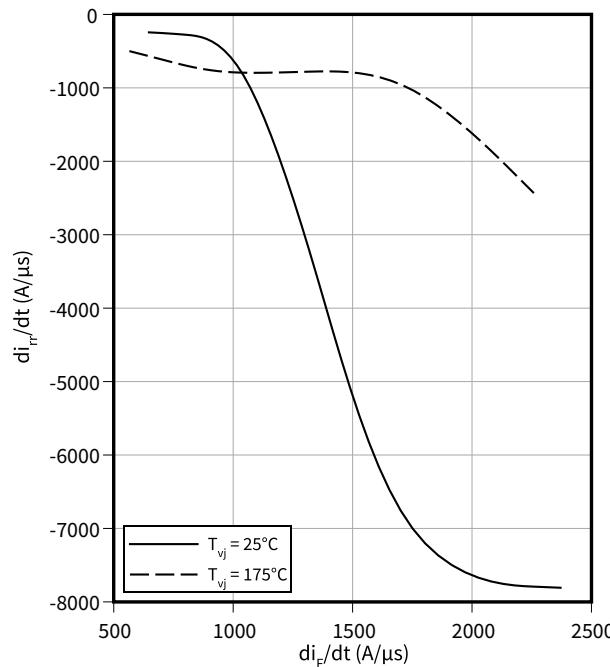


## 4 Characteristics diagrams

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

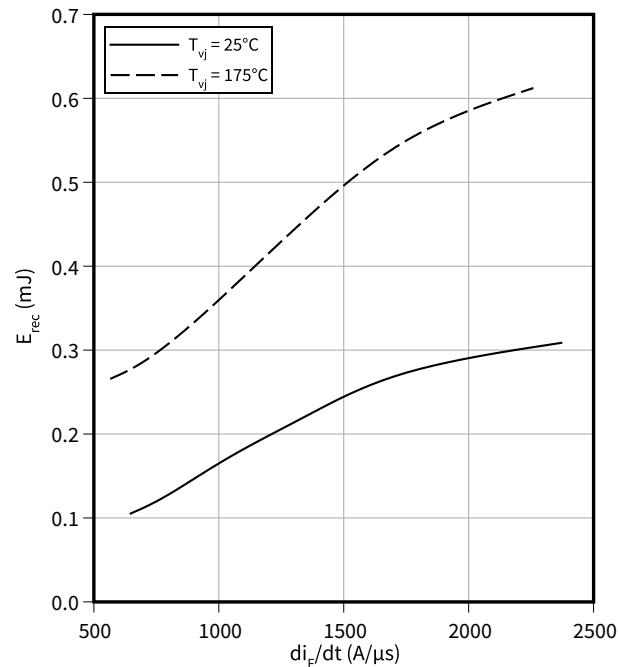
$$di_{rr}/dt = f(di_F/dt)$$

$V_R = 400 \text{ V}$ ,  $I_F = 10 \text{ A}$

**Typical reverse energy losses as a function of diode current slope**

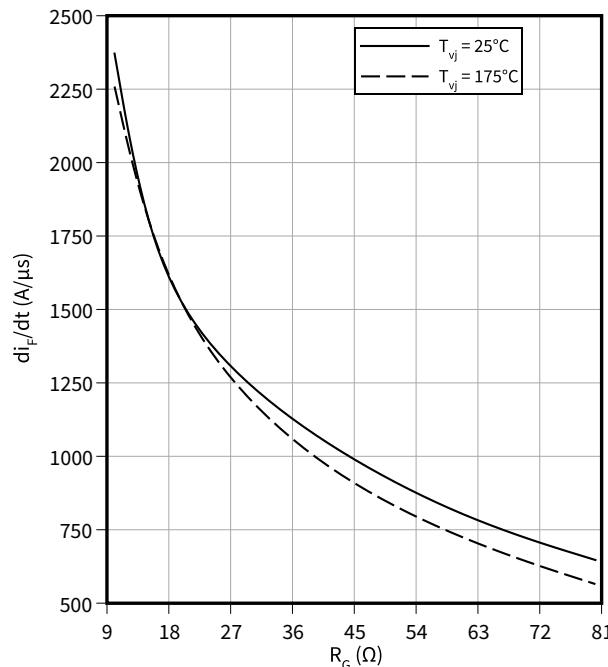
$$E_{rec} = f(di_F/dt)$$

$V_R = 400 \text{ V}$ ,  $I_F = 10 \text{ A}$

**Typical diode current slope as a function of gate resistor**

$$di_F/dt = f(R_G)$$

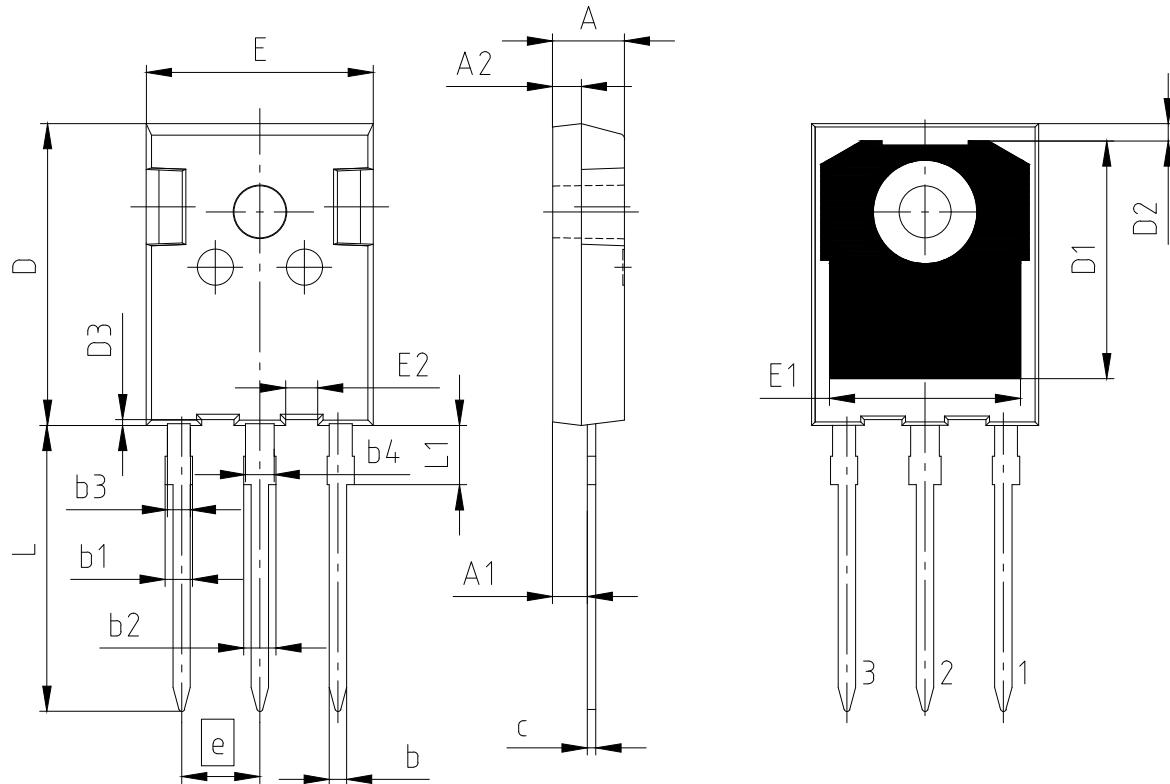
$V_R = 400 \text{ V}$ ,  $I_F = 10 \text{ A}$



## 5 Package outlines

## 5 Package outlines

PG-TO247-3-STD-NN4.8



PACKAGE - GROUP NUMBER: PG-TO247-3-U04		
DIMENSIONS	MILLIMETERS	
	MIN.	MAX.
A	4.90	5.10
A1	2.31	2.51
A2	1.90	2.10
b	1.16	1.26
b1		1.90
b2		2.30
b3	1.55	1.65
b4	1.96	2.06
c	0.59	0.66
D	20.90	21.10
D1	16.25	16.85
D2	1.05	1.35
D3	0.55	0.65
E	15.70	15.90
E1	13.10	13.50
E2	2.14	2.34
e	5.44	
N	3	
L	19.80	20.10
L1	3.95	4.30

Figure 1

## 6 Testing conditions

## 6 Testing conditions

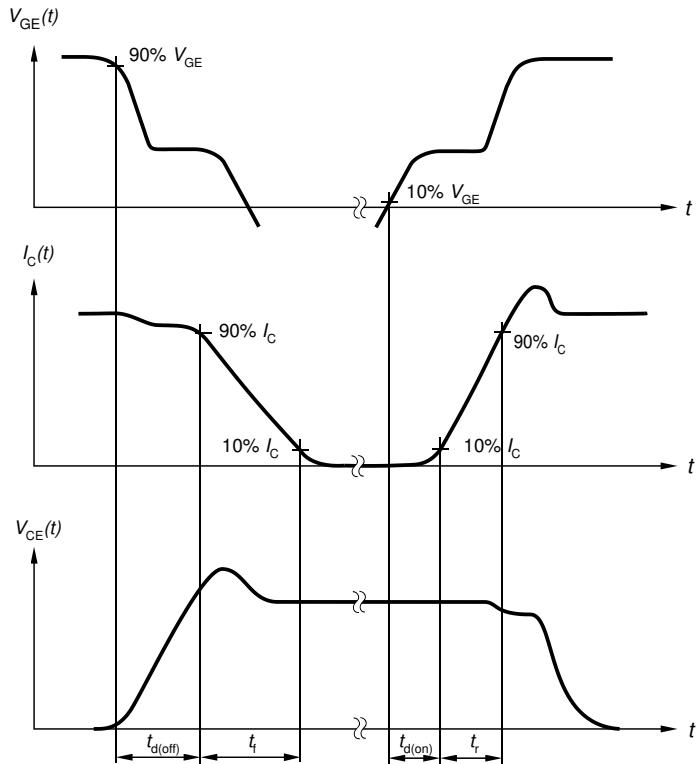


Figure A. Definition of switching times

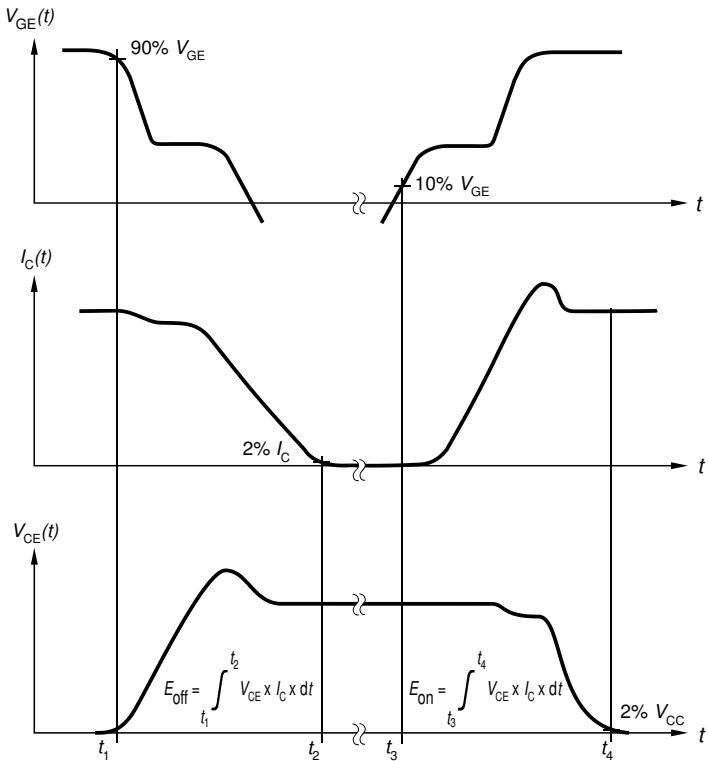


Figure B. Definition of switching losses

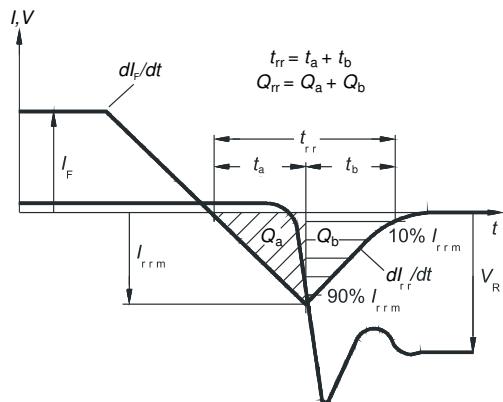


Figure C. Definition of diode switching characteristics

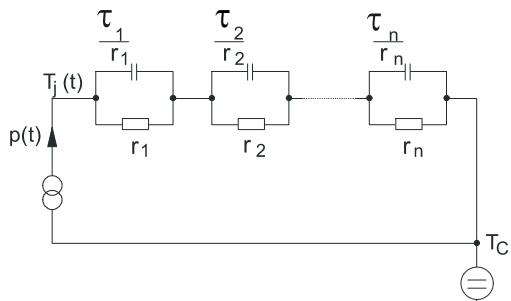


Figure D. Thermal equivalent circuit

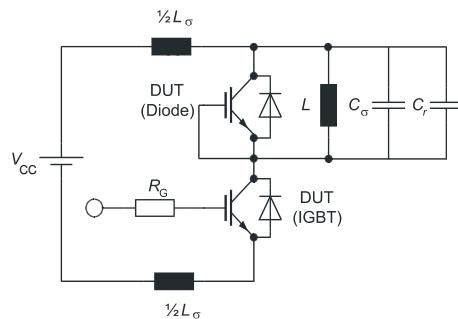


Figure E. Dynamic test circuit  
 Parasitic inductance  $L_\sigma$ ,  
 parasitic capacitor  $C_\sigma$ ,  
 relief capacitor  $C_r$ ,  
 (only for ZVT switching)

Figure 2

## Revision history

## Revision history

Document revision	Date of release	Description of changes
1.00	2021-05-21	Final datasheet
1.10	2022-12-06	<p>Update of “DC collector current, limited by <math>T_{vjmax}</math>” in table “Maximum rated values”, for 25°C and 100°C</p> <p>Transient gate-emitter voltage <math>V_{GE}</math> in table “Maximum rated values” of IGBT changed to ±30V</p> <p>Update of diagram “Collector current as a function of case temperature”, <math>I_C = f(T_c)</math></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>

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