

The TRENCHSTOP™ 5 WR6 family in the TO-247-3-HCC package offers improved reliability against package contamination

Features

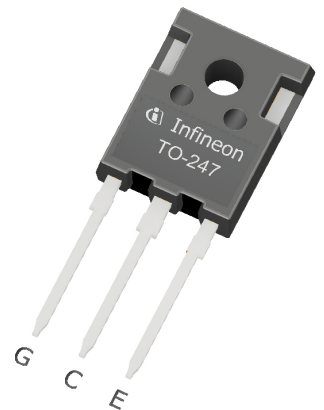
- $V_{CE} = 650\text{ V}$
- $I_C = 20\text{ A}$
- Pin-to-pin creepage distance > 4.8 mm
- Pin-to-pin clearance distance > 3.4 mm
- Monolithic diode optimized for PFC and welding applications
- Stable temperature behavior
- Very low V_{CEsat} and low E_{off}
- Easy parallel switching capability based 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

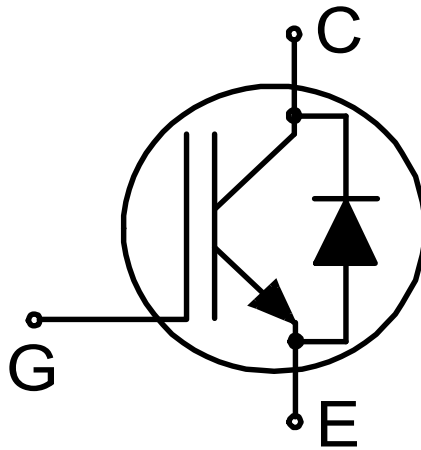
- PFC
- Welding
- ZCS applications

Product validation

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



Description



Type	Package	Marking
IKWH20N65WR6	PG-TO247-3-HCC	H20EWR6



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1 Package

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			13.0		nH
Storage temperature	T_{stg}		-55		150	°C
Soldering temperature		wave soldering 1.6 mm (0.063 in.) from case for 10 s			260	°C
Mounting torque, M3 screw Maximum of mounting processes: 3	M				0.6	Nm
Thermal resistance, junction-ambient	$R_{th(j-a)}$				40	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		$T_C = 25\text{ °C}$	40	A
			$T_C = 100\text{ °C}$	20	
Pulsed collector current, t_p limited by T_{vjmax}	I_{Cpuls}			60	A
Turn-off safe operating area		$V_{CE} \leq 650\text{ V}$, $t_p \leq 1\text{ }\mu\text{s}$, $T_{vj} \leq 175\text{ °C}$		60	A
Gate-emitter voltage	V_{GE}			± 20	V
Transient gate-emitter voltage	V_{GE}	$t_p \leq 10\text{ }\mu\text{s}$, $D < 0.010$		± 20	V
Power dissipation	P_{tot}		$T_C = 25\text{ °C}$	140	W
			$T_C = 100\text{ °C}$	70	

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	$V_{CE\text{ sat}}$	$I_C = 20.0\text{ A}$, $V_{GE} = 15\text{ V}$	$T_{vj} = 25\text{ °C}$	1.35	1.70	V
			$T_{vj} = 175\text{ °C}$	1.60		

Table 3 Characteristic values (continued)

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Gate-emitter threshold voltage	V_{GEth}	$I_C = 0.20 \text{ mA}$, $V_{CE} = V_{GE}$	3.20	4.00	4.80	V
Zero gate voltage collector current	I_{CES}	$V_{CE} = 650 \text{ V}$, $V_{GE} = 0 \text{ V}$			40	μA
					0.5	mA
Gate-emitter leakage current	I_{GES}	$V_{CE} = 0 \text{ V}$, $V_{GE} = 20 \text{ V}$			100	nA
Transconductance	g_{fs}	$I_C = 20.0 \text{ A}$, $V_{CE} = 20 \text{ V}$		50		S
Input capacitance	C_{ies}	$V_{CE} = 25 \text{ V}$, $V_{GE} = 0 \text{ V}$, $f = 100 \text{ kHz}$		2130		pF
Output capacitance	C_{oes}	$V_{CE} = 25 \text{ V}$, $V_{GE} = 0 \text{ V}$, $f = 100 \text{ kHz}$		22		pF
Reverse transfer capacitance	C_{res}	$V_{CE} = 25 \text{ V}$, $V_{GE} = 0 \text{ V}$, $f = 100 \text{ kHz}$		9		pF
Gate charge	Q_G	$I_C = 20.0 \text{ A}$, $V_{GE} = 15 \text{ V}$, $V_{CE} = 520 \text{ V}$		89		nC
Turn-on delay time	t_{don}	$V_{CE} = 400 \text{ V}$, $V_{GE} = 15 \text{ V}$, $R_{Gon} = 24.0 \Omega$, $R_{Goff} = 24.0 \Omega$, $L_\sigma = 30 \text{ nH}$, $C_\sigma = 11 \text{ pF}$	$T_{vj} = 25 \text{ }^\circ\text{C}$, $I_C = 20.0 \text{ A}$	25		ns
			$T_{vj} = 175 \text{ }^\circ\text{C}$, $I_C = 20.0 \text{ A}$	22		
Rise time (inductive load)	t_r	$V_{CE} = 400 \text{ V}$, $V_{GE} = 15 \text{ V}$, $R_{Gon} = 24.0 \Omega$, $R_{Goff} = 24.0 \Omega$, $L_\sigma = 30 \text{ nH}$, $C_\sigma = 11 \text{ pF}$	$T_{vj} = 25 \text{ }^\circ\text{C}$, $I_C = 20.0 \text{ A}$	13		ns
			$T_{vj} = 175 \text{ }^\circ\text{C}$, $I_C = 20.0 \text{ A}$	15		
Turn-off delay time	t_{doff}	$V_{CE} = 400 \text{ V}$, $V_{GE} = 15 \text{ V}$, $R_{Gon} = 24.0 \Omega$, $R_{Goff} = 24.0 \Omega$, $L_\sigma = 30 \text{ nH}$, $C_\sigma = 11 \text{ pF}$	$T_{vj} = 25 \text{ }^\circ\text{C}$, $I_C = 20.0 \text{ A}$	255		ns
			$T_{vj} = 175 \text{ }^\circ\text{C}$, $I_C = 20.0 \text{ A}$	290		
Fall time (inductive load)	t_f	$V_{CE} = 400 \text{ V}$, $V_{GE} = 15 \text{ V}$, $R_{Gon} = 24.0 \Omega$, $R_{Goff} = 24.0 \Omega$, $L_\sigma = 30 \text{ nH}$, $C_\sigma = 11 \text{ pF}$	$T_{vj} = 25 \text{ }^\circ\text{C}$, $I_C = 20.0 \text{ A}$	17		ns
			$T_{vj} = 175 \text{ }^\circ\text{C}$, $I_C = 20.0 \text{ A}$	17		
Turn-on energy	E_{on}	$V_{CE} = 400 \text{ V}$, $V_{GE} = 15 \text{ V}$, $R_{Gon} = 24.0 \Omega$, $R_{Goff} = 24.0 \Omega$, $L_\sigma = 30 \text{ nH}$, $C_\sigma = 11 \text{ pF}$	$T_{vj} = 25 \text{ }^\circ\text{C}$, $I_C = 20.0 \text{ A}$	0.50		mJ
			$T_{vj} = 175 \text{ }^\circ\text{C}$, $I_C = 20.0 \text{ A}$	0.62		
Turn-off energy	E_{off}	$V_{CE} = 400 \text{ V}$, $V_{GE} = 15 \text{ V}$, $R_{Gon} = 24.0 \Omega$, $R_{Goff} = 24.0 \Omega$, $L_\sigma = 30 \text{ nH}$, $C_\sigma = 11 \text{ pF}$	$T_{vj} = 25 \text{ }^\circ\text{C}$, $I_C = 20.0 \text{ A}$	0.20		mJ
			$T_{vj} = 175 \text{ }^\circ\text{C}$, $I_C = 20.0 \text{ A}$	0.35		

Table 3 Characteristic values (continued)

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Total switching energy	E_{ts}	$V_{CE} = 400 \text{ V}$, $V_{GE} = 15 \text{ V}$, $R_{Gon} = 24.0 \text{ } \Omega$, $R_{Goff} = 24.0 \text{ } \Omega$, $L_{\sigma} = 30 \text{ nH}$, $C_{\sigma} = 11 \text{ pF}$	$T_{vj} = 25 \text{ }^{\circ}\text{C}$, $I_C = 20.0 \text{ A}$	0.70		mJ
			$T_{vj} = 175 \text{ }^{\circ}\text{C}$, $I_C = 20.0 \text{ A}$	0.97		
IGBT thermal resistance, junction-case	R_{thjc}				1.10	K/W
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}	$T_{vj} \geq 25 \text{ }^{\circ}\text{C}$	650	V
Diode forward current, limited by T_{vjmax}	I_F	$T_C = 25 \text{ }^{\circ}\text{C}$	17	A
		$T_C = 100 \text{ }^{\circ}\text{C}$	10	
Diode pulsed current, limited by T_{vjmax}	I_{Fpuls}		30	A

Table 5 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Diode forward voltage	V_F	$I_F = 8.5 \text{ A}$	$T_{vj} = 25 \text{ }^{\circ}\text{C}$	1.30	1.60	V
			$T_{vj} = 175 \text{ }^{\circ}\text{C}$	1.35		
Diode reverse recovery time	t_{rr}	$V_R = 400 \text{ V}$	$T_{vj} = 25 \text{ }^{\circ}\text{C}$, $I_F = 10.0 \text{ A}$, $-di_F/dt = 1340 \text{ A}/\mu\text{s}$	89		ns
			$T_{vj} = 175 \text{ }^{\circ}\text{C}$, $I_F = 10.0 \text{ A}$, $-di_F/dt = 1300 \text{ A}/\mu\text{s}$	92		

Table 5 **Characteristic values (continued)**

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Diode reverse recovery charge	Q_{rr}	$V_R = 400 \text{ V}$	$T_{vj} = 25 \text{ °C}$, $I_F = 10.0 \text{ A}$, $-di_F/dt = 1340 \text{ A/}\mu\text{s}$		1.00		μC
			$T_{vj} = 175 \text{ °C}$, $I_F = 10.0 \text{ A}$, $-di_F/dt = 1300 \text{ A/}\mu\text{s}$		1.70		
Diode peak reverse recovery current	I_{rrm}	$V_R = 400 \text{ V}$	$T_{vj} = 25 \text{ °C}$, $I_F = 10.0 \text{ A}$, $-di_F/dt = 1340 \text{ A/}\mu\text{s}$		23.0		A
			$T_{vj} = 175 \text{ °C}$, $I_F = 10.0 \text{ A}$, $-di_F/dt = 1300 \text{ A/}\mu\text{s}$		29.1		
Diode peak rate off fall of reverse recovery current	di_{rr}/dt	$V_R = 400 \text{ V}$	$T_{vj} = 25 \text{ °C}$, $I_F = 10.0 \text{ A}$, $-di_F/dt = 1340 \text{ A/}\mu\text{s}$		-3328		$\text{A/}\mu\text{s}$
			$T_{vj} = 175 \text{ °C}$, $I_F = 10.0 \text{ A}$, $-di_F/dt = 1300 \text{ A/}\mu\text{s}$		-775		
Diode thermal resistance, junction-case	R_{thjc}					4.70	K/W
Operating junction temperature	T_{vj}			-40		175	$^{\circ}\text{C}$

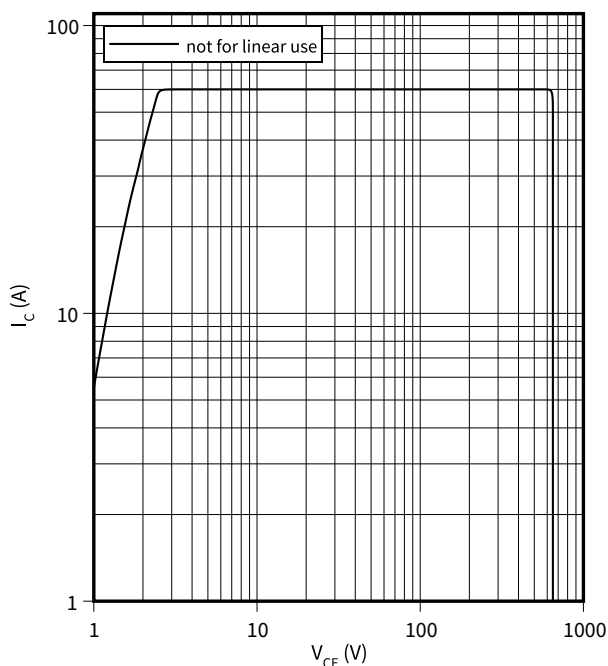
Note: *For optimum lifetime and reliability, Infineon recommends operating conditions that do not exceed 80% of the maximum ratings stated in this datasheet.*

4 Characteristics diagrams

Forward bias safe operating area, IGBT

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

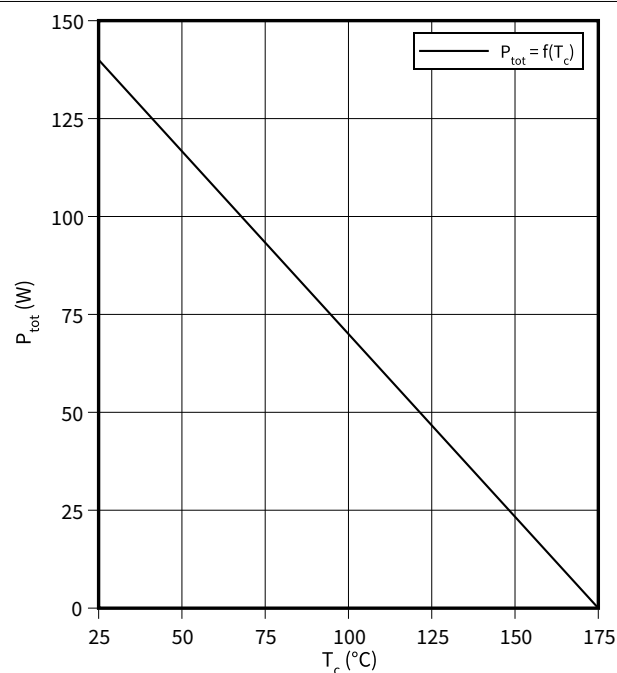
$$t_p = 1 \mu s, D = 0, T_{vj} \leq 175^\circ C, T_C = 25^\circ C, V_{GE} = 15 V$$



Power dissipation as a function of case temperature, IGBT

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

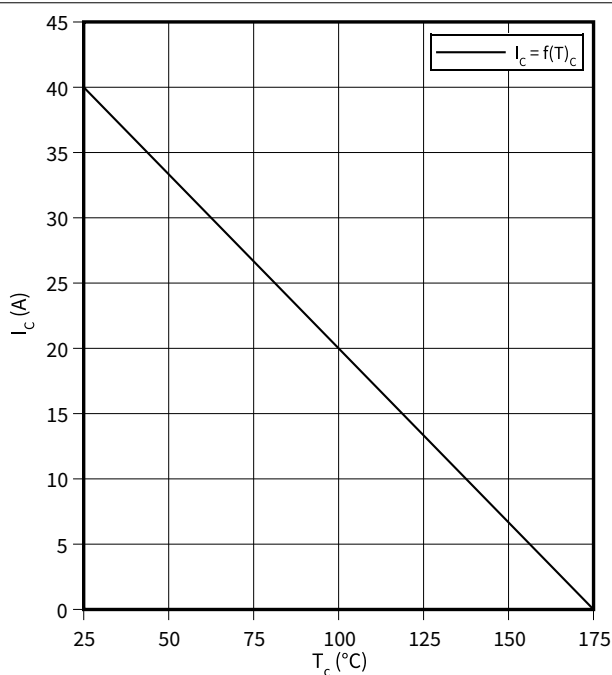
$$T_{vj} \leq 175^\circ C$$



Collector current as a function of case temperature, IGBT

$$I_C = f(T_C)$$

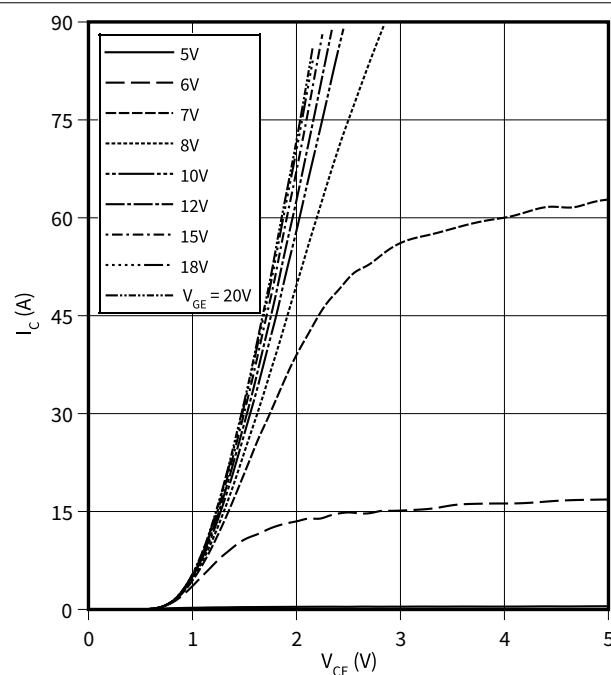
$$T_{vj} \leq 175^\circ C, V_{GE} \geq 15 V$$



Typical output characteristic, IGBT

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

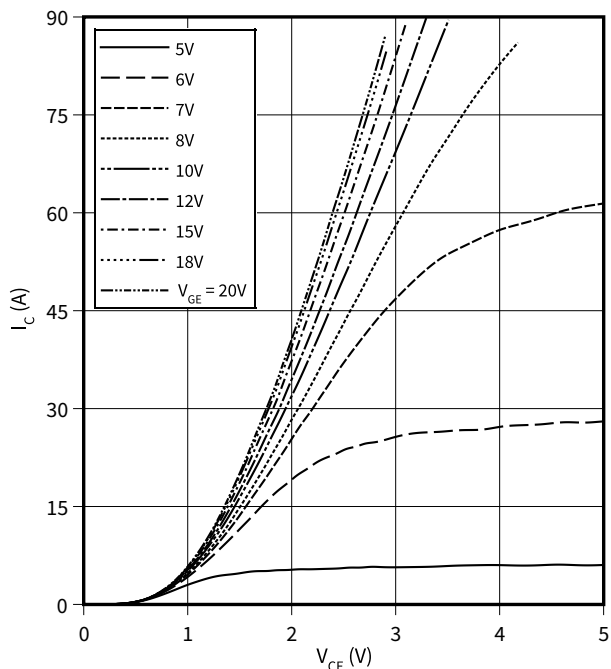
$$T_{vj} = 25^\circ C$$



4 Characteristics diagrams

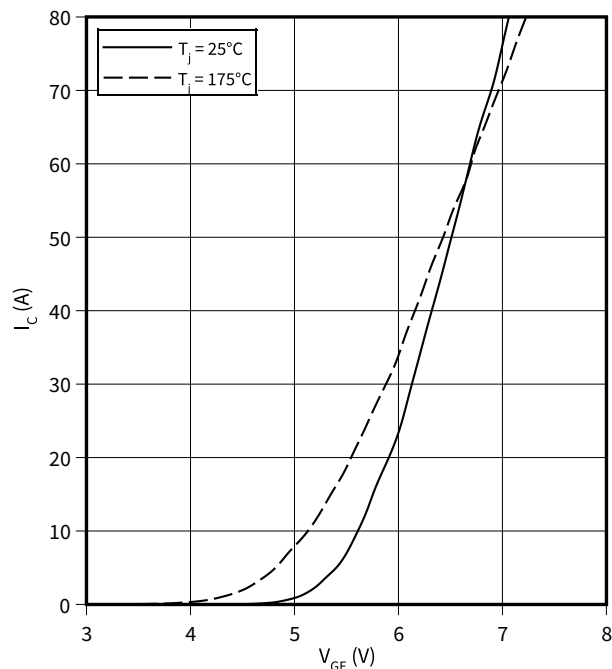
Typical output characteristic, IGBT

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



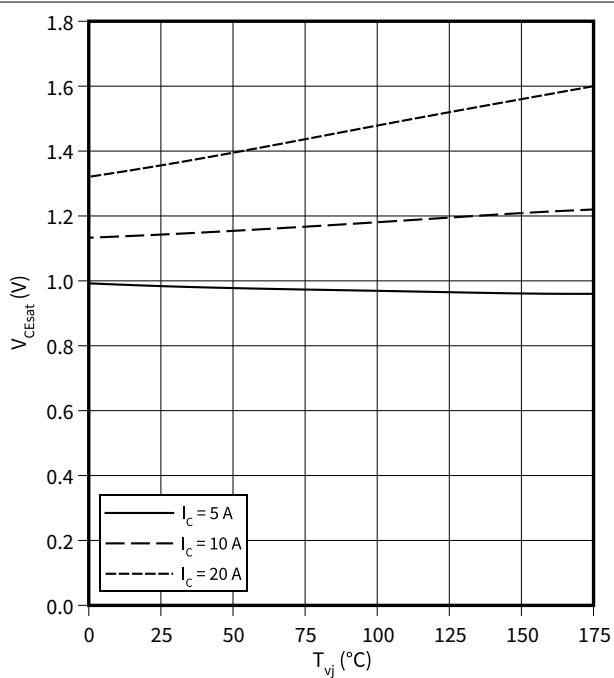
Typical transfer characteristic, IGBT

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



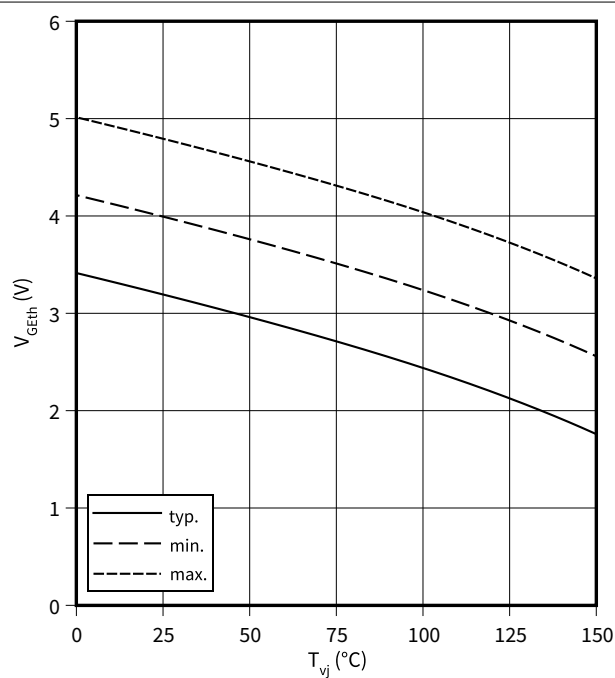
Typical collector-emitter saturation voltage as a function of junction temperature, IGBT

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



Gate-emitter threshold voltage as a function of junction temperature, IGBT

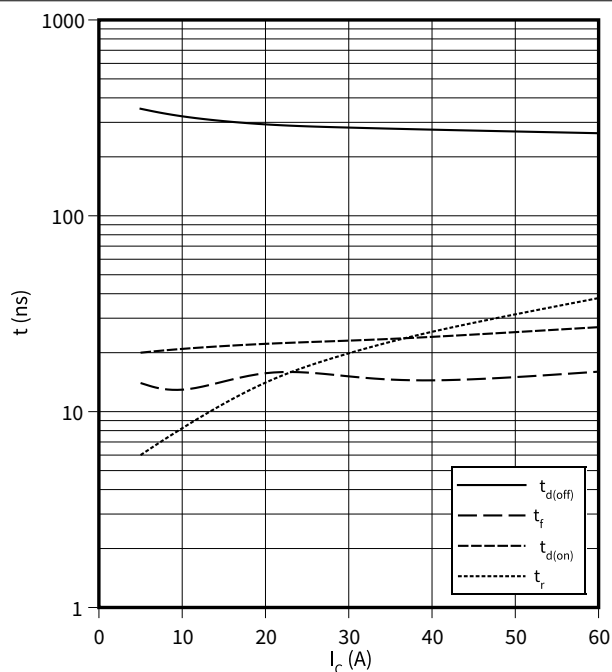
$V_{GEth} = f(T_{vj})$
 $I_C = 0.20\text{ mA}$



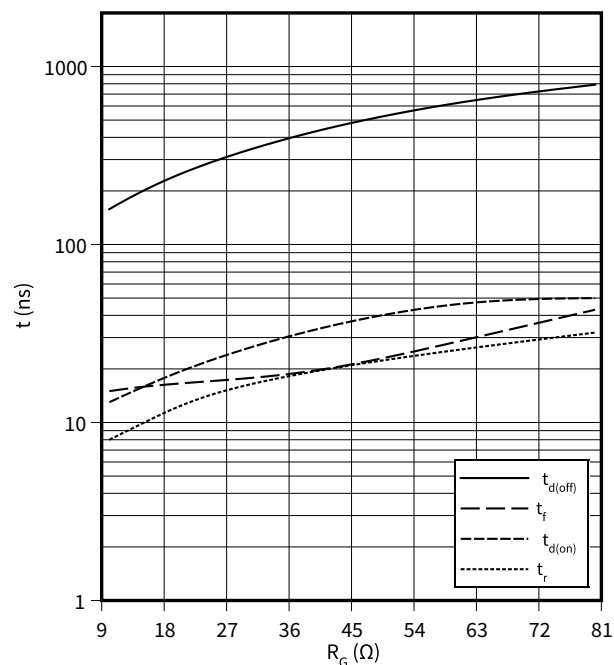
4 Characteristics diagrams

Typical switching times as a function of collector current, IGBT

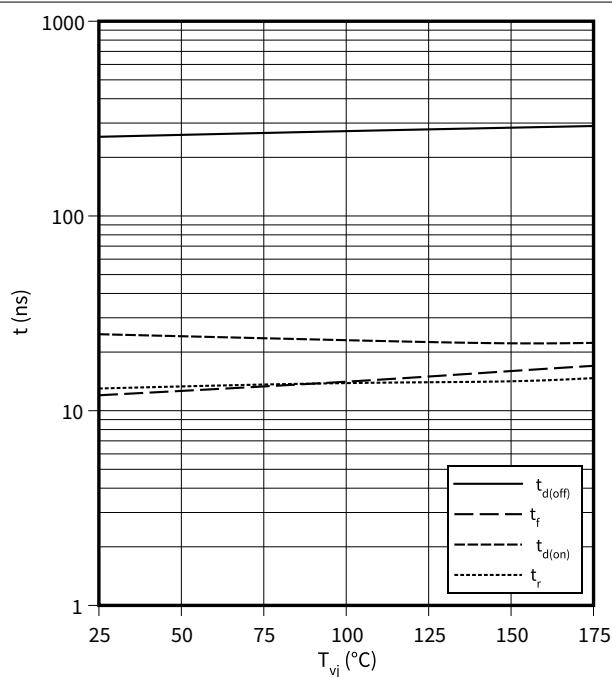
$t = f(I_C)$

 $V_{CE} = 400 \text{ V}$, $T_{vj} = 175 \text{ }^{\circ}\text{C}$, $V_{GE} = 0/15 \text{ V}$, $R_G = 24 \text{ } \Omega$ **Typical switching times as a function of gate resistor, IGBT**

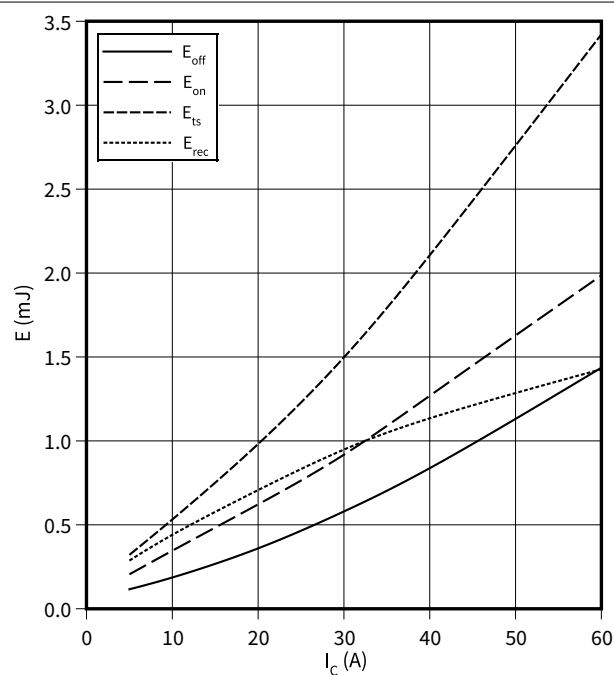
$t = f(R_G)$

 $I_C = 20.0 \text{ A}$, $V_{CE} = 400 \text{ V}$, $T_{vj} = 175 \text{ }^{\circ}\text{C}$, $V_{GE} = 0/15 \text{ V}$ **Typical switching times as a function of junction temperature, IGBT**

$t = f(T_{vj})$

 $I_C = 20.0 \text{ A}$, $V_{CE} = 400 \text{ V}$, $V_{GE} = 0/15 \text{ V}$, $R_G = 24 \text{ } \Omega$ **Typical switching energy losses as a function of collector current, IGBT**

$E = f(I_C)$

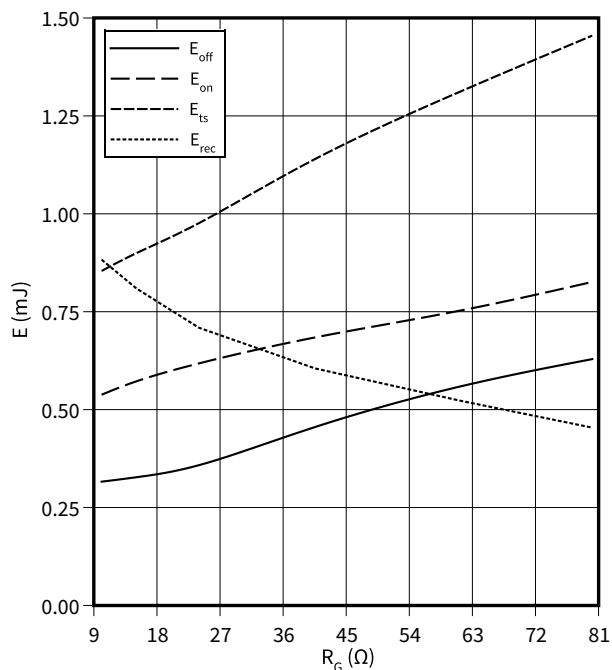
 $V_{CE} = 400 \text{ V}$, $T_{vj} = 175 \text{ }^{\circ}\text{C}$, $V_{GE} = 0/15 \text{ V}$, $R_G = 24 \text{ } \Omega$ 

4 Characteristics diagrams

Typical switching energy losses as a function of gate resistor, IGBT

$$E = f(R_G)$$

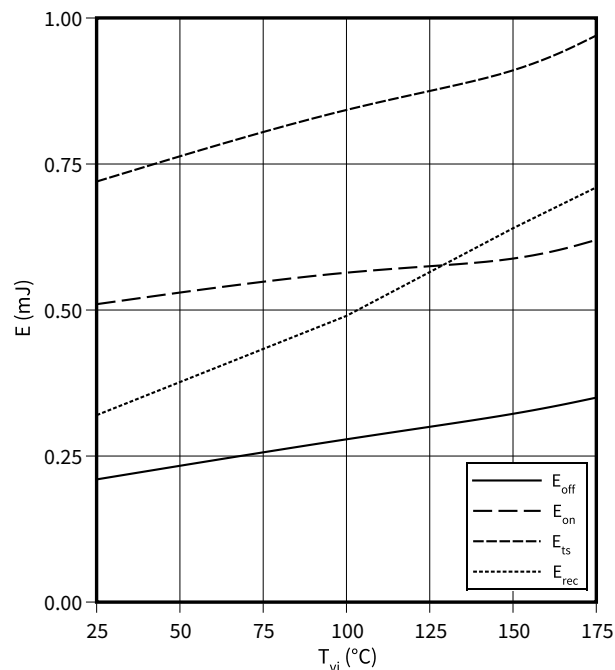
$I_C = 20.0 \text{ A}$, $V_{CE} = 400 \text{ V}$, $T_{vj} = 175 \text{ }^\circ\text{C}$, $V_{GE} = 0/15 \text{ V}$



Typical switching energy losses as a function of junction temperature, IGBT

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

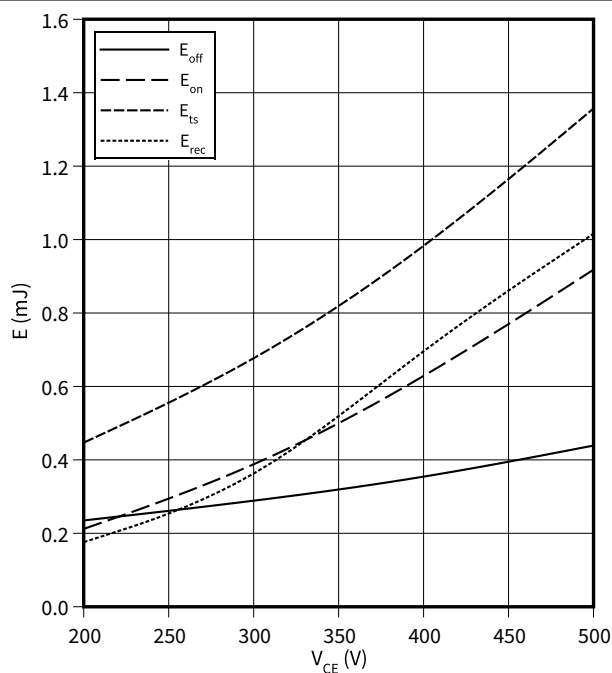
$I_C = 20.0 \text{ A}$, $V_{CE} = 400 \text{ V}$, $V_{GE} = 0/15 \text{ V}$, $R_G = 24 \text{ } \Omega$



Typical switching energy losses as a function of collector emitter voltage, IGBT

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

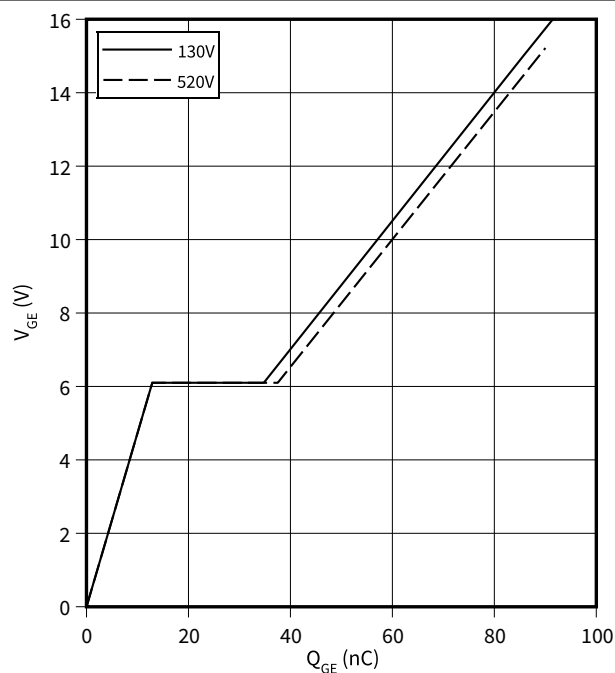
$I_C = 20.0 \text{ A}$, $T_{vj} = 175 \text{ }^\circ\text{C}$, $V_{GE} = 0/15 \text{ V}$, $R_G = 24 \text{ } \Omega$



Typical gate charge, IGBT

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

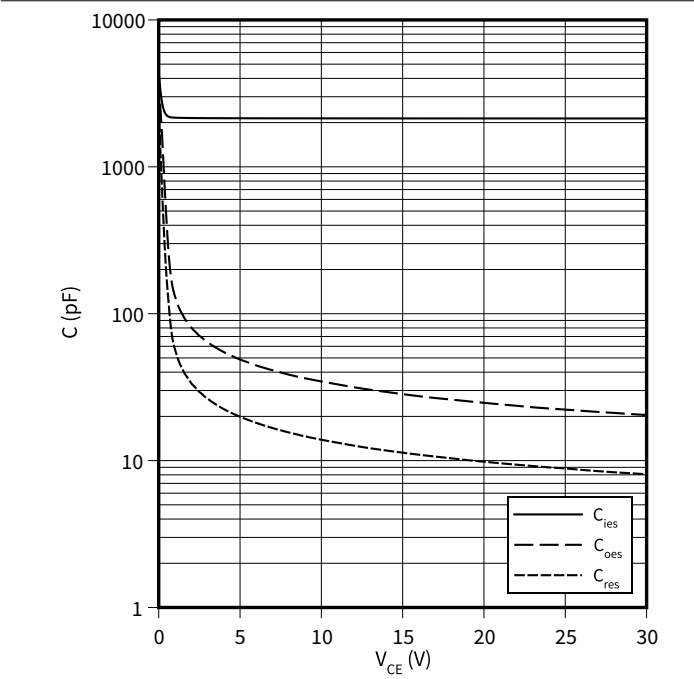
$I_C = 20.0 \text{ A}$



4 Characteristics diagrams

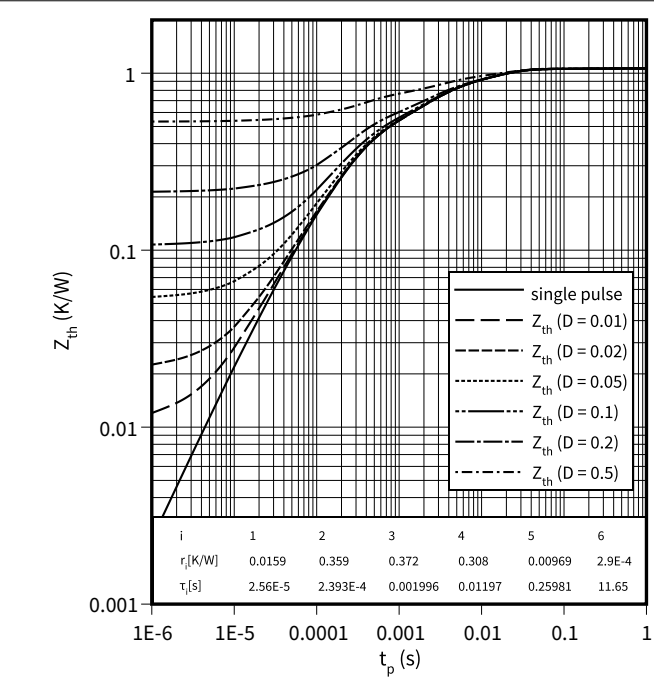
Typical capacitance as a function of collector-emitter voltage, IGBT

C = f(VCE)
f = 100 kHz, VGE = 0 V



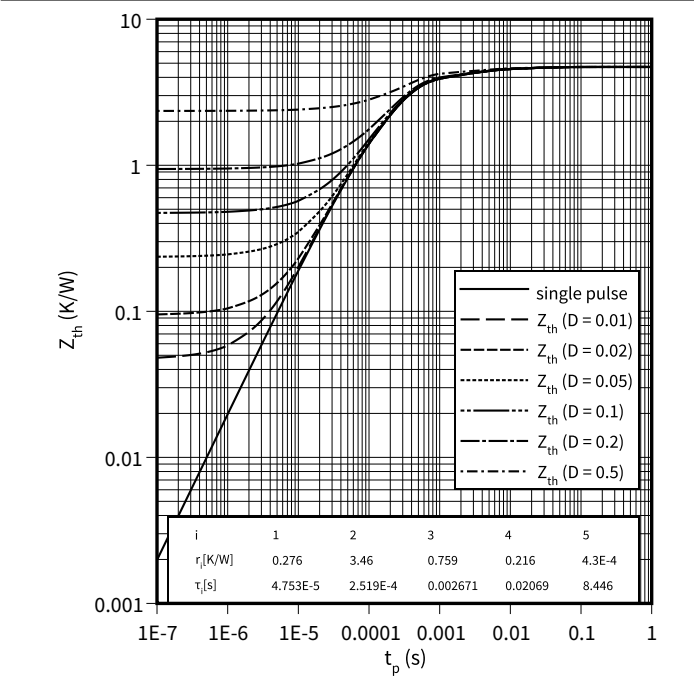
IGBT transient thermal impedance as a function of pulse width, IGBT

Zth = f(tp)
D = tp/T



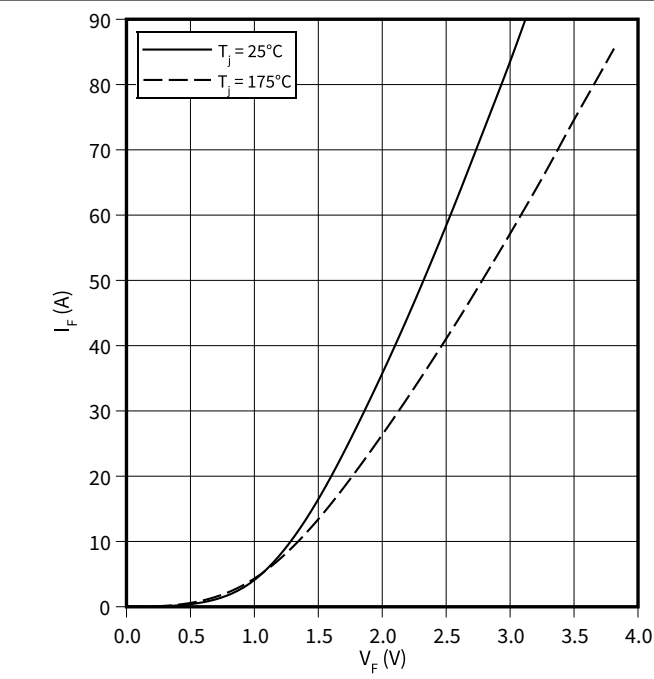
Diode transient thermal impedance as a function of pulse width, Diode

Zth = f(tp)
D = tp/T



Typical diode forward current as a function of forward voltage, Diode

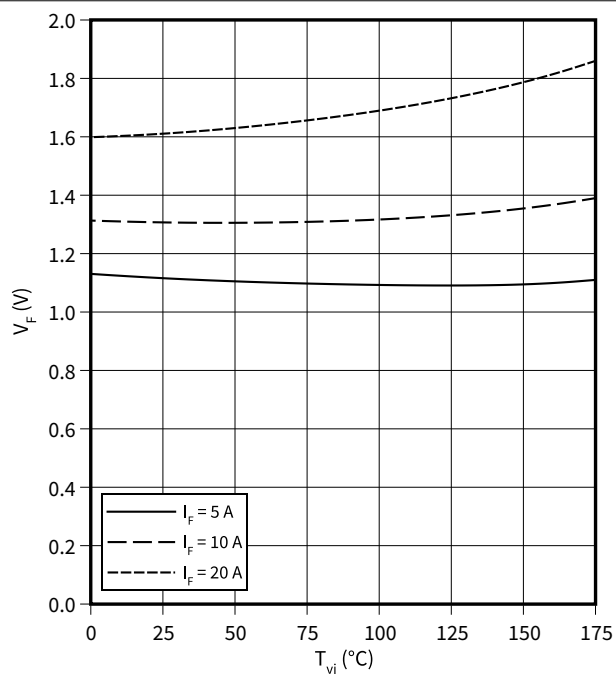
IF = f(VF)



4 Characteristics diagrams

Typical diode forward voltage as a function of junction temperature, Diode

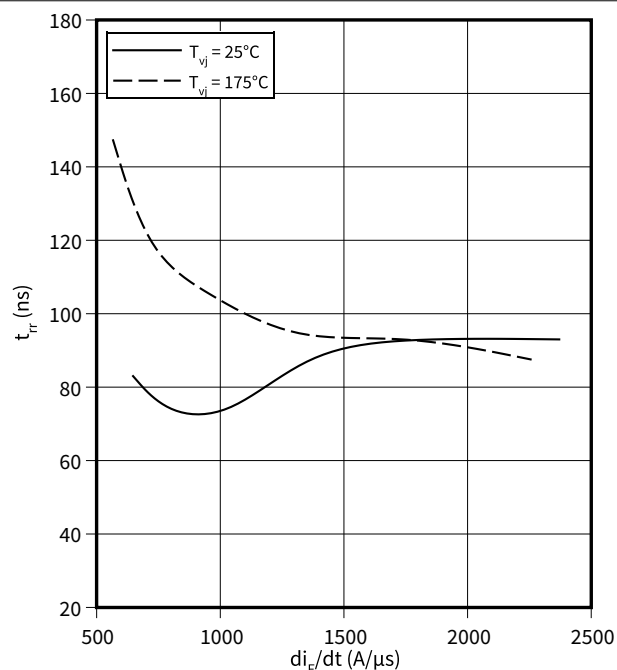
$$V_F = f(T_{vj})$$



Typical reverse recovery time as a function of diode current slope, Diode

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

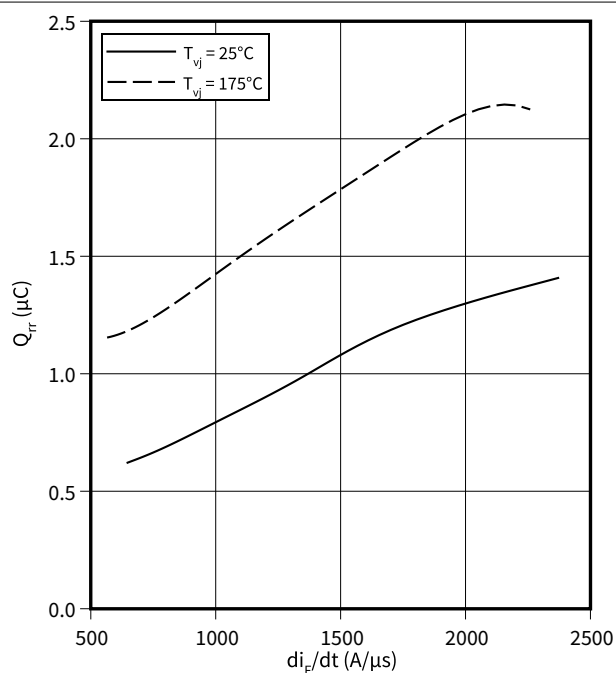
$$V_R = 400 \text{ V}, I_F = 10 \text{ A}$$



Typical reverse recovery charge as a function of diode current slope, Diode

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

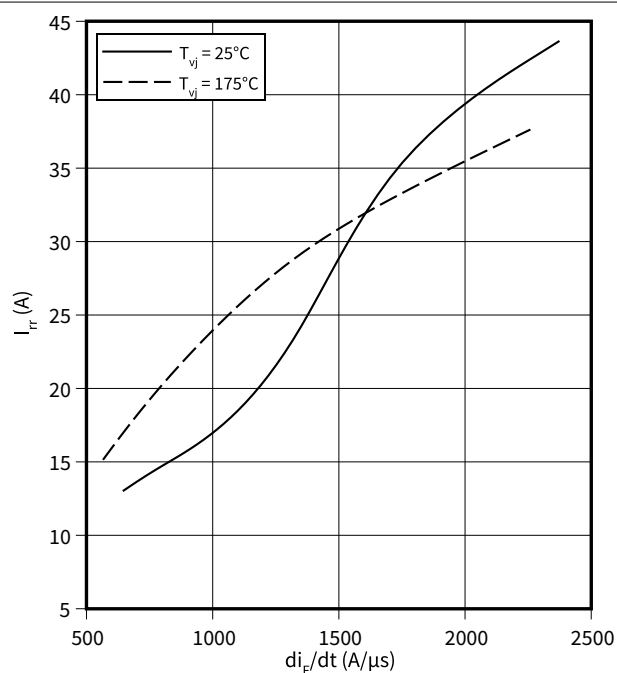
$$V_R = 400 \text{ V}, I_F = 10 \text{ A}$$



Typical reverse recovery current as a function of diode current slope, Diode

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

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

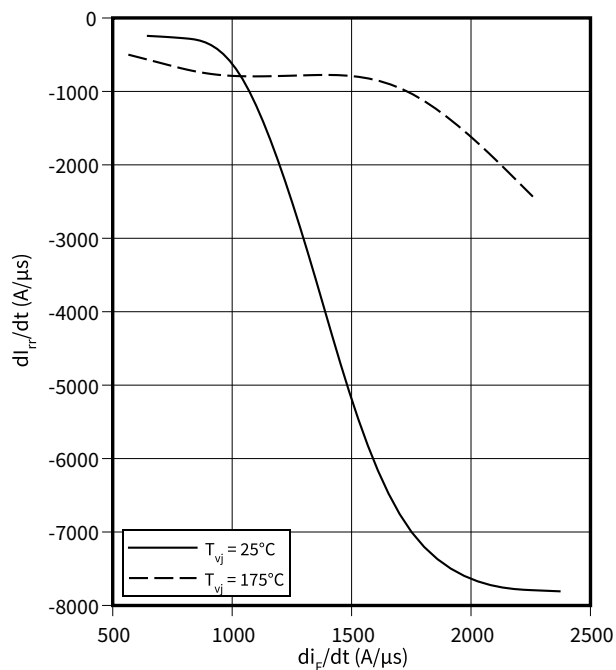


4 Characteristics diagrams

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

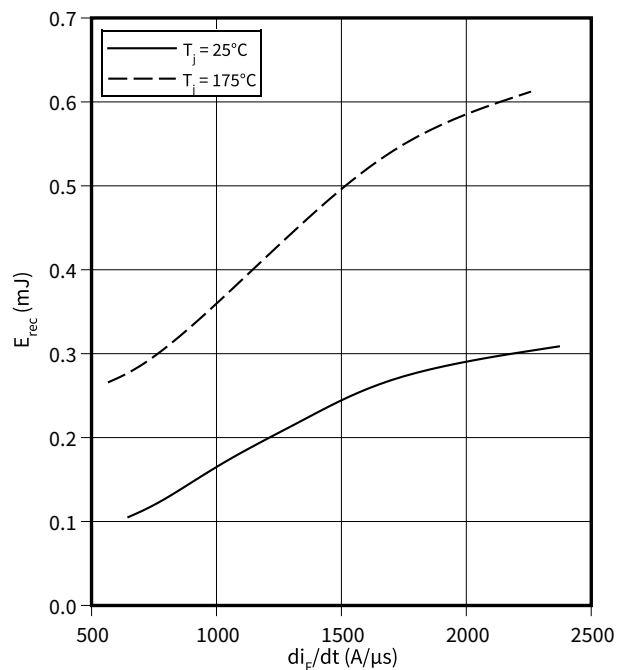
$$dI_{rr}/dt = f(di_F/dt)$$

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


Typical reverse energy losses as a function of diode current slope, Diode

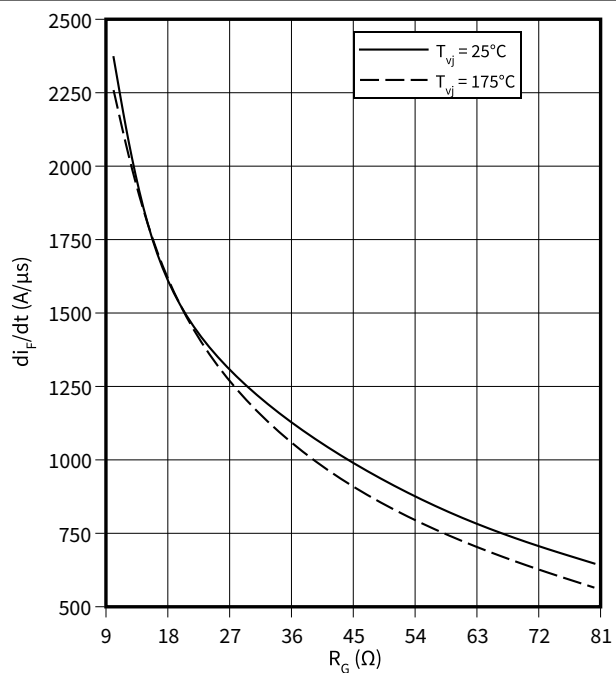
$$E_{rec} = f(di_F/dt)$$

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


Typical diode current slope as a function of gate resistor, Diode

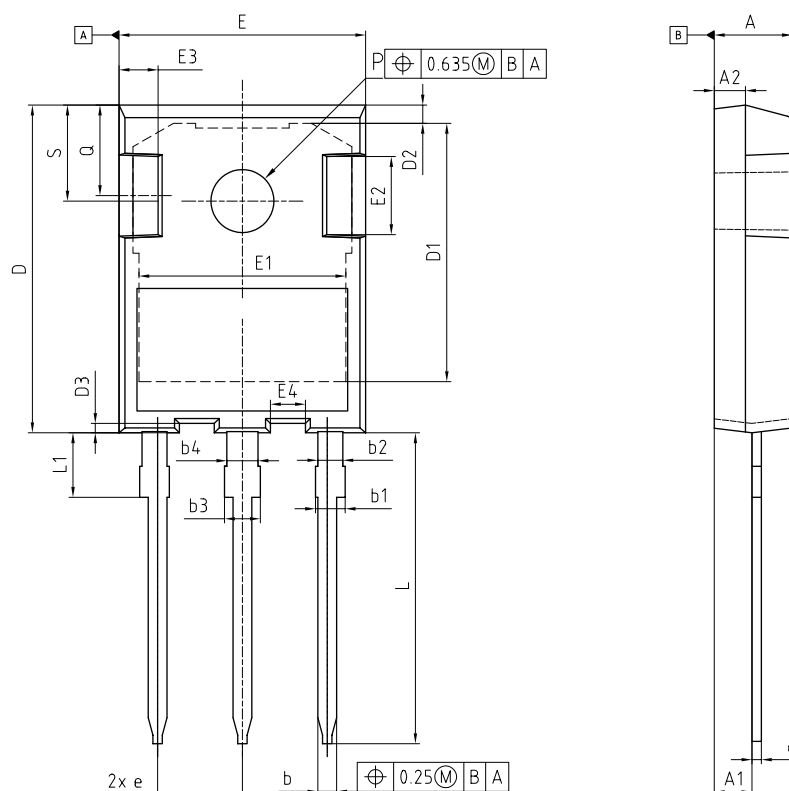
$$di_F/dt = f(R_G)$$

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



5 Package outlines

PG-TO247-3-HCC



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.83	5.21	0.190	0.205
A1	2.27	2.54	0.089	0.100
A2	1.85	2.16	0.073	0.085
b	1.07	1.33	0.042	0.052
b1	1.48	2.02	0.058	0.080
b2	1.48	1.72	0.058	0.068
b3	1.84	2.42	0.072	0.095
b4	1.84	2.18	0.072	0.086
c	0.55	0.68	0.022	0.027
D	20.80	21.10	0.819	0.831
D1	16.25	17.65	0.640	0.695
D2	0.95	1.35	0.037	0.053
D3	0.55	0.65	0.022	0.026
E	15.70	16.13	0.618	0.635
E1	13.10	14.15	0.516	0.557
E2	3.68	5.10	0.145	0.201
E3	1.00	2.60	0.039	0.102
E4	3.44	3.76	0.135	0.148
e	5.44 (BSC)		0.214 (BSC)	
L	19.80	20.32	0.780	0.800
L1	4.90	5.10	0.161	0.176
øP	2.40	2.60	0.138	0.146
Q	5.34	5.54	0.216	0.236
S	2.14	2.34	0.238	0.248
N	3		3	

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ISSUE DATE 25.09.2020
REVISION 0

Figure 6

6 Testing conditions

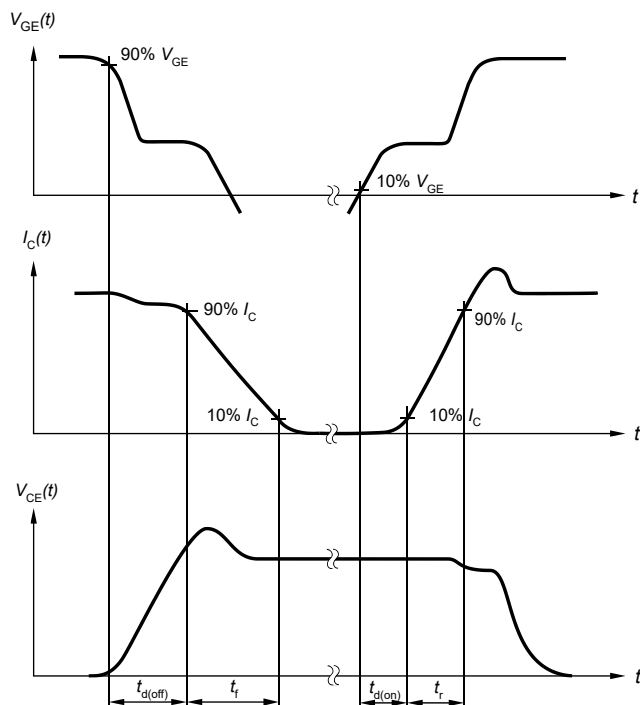


Figure A. Definition of switching times

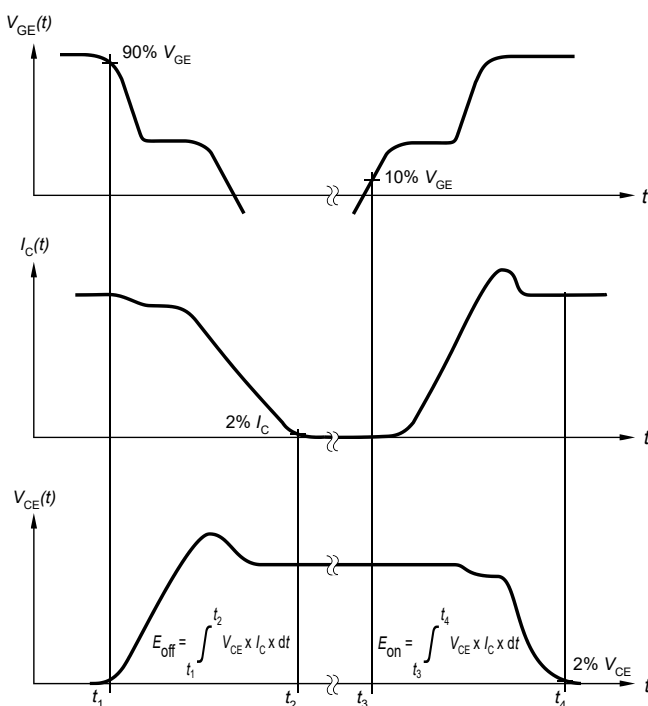


Figure B. Definition of switching losses

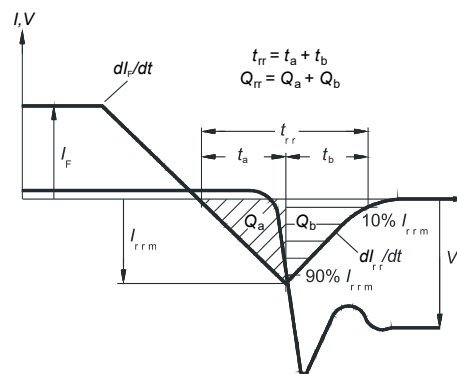


Figure C. Definition of diode switching characteristics

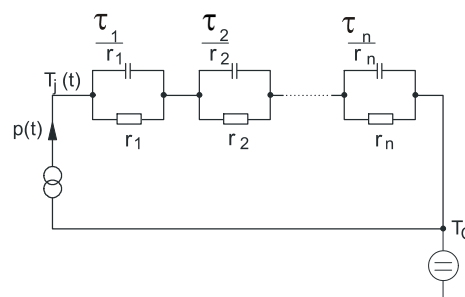


Figure D. Thermal equivalent circuit

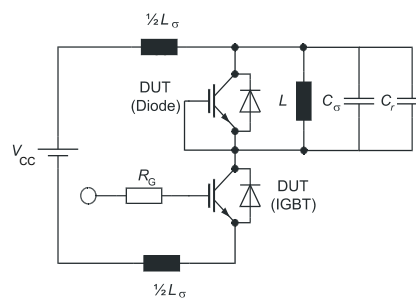


Figure E. **Dynamic test circuit**
Parasitic inductance L_σ ,
parasitic capacitor C_σ ,
relief capacitor C_r ,
(only for ZVT switching)

Figure 7

IKWH20N65WR6
The TRENCHSTOP™ 5 WR6 family in the TO-247-3-HCC package



Revision history

Revision history

Document revision	Date of release	Description of changes
1.00	2021-05-21	Final datasheet

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Edition 2021-05-21

Published by

Infineon Technologies AG
81726 Munich, Germany

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Document reference
IFX-AAL382-004

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