

**High speed and low saturation voltage 650 V TRENCHSTOP™ IGBT7 technology copacked with soft, fast recovery Emitter Controlled 7 diode**

### Features

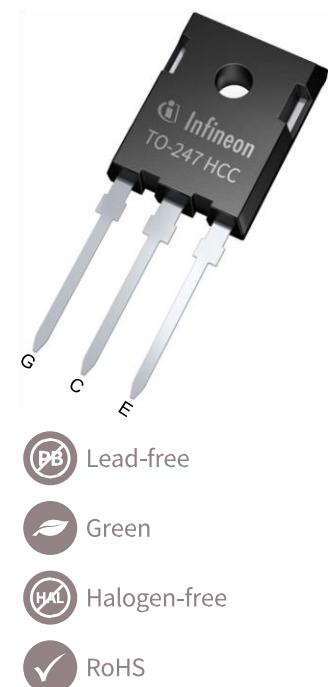
- $V_{CE} = 650 \text{ V}$
- $I_C = 40 \text{ A}$
- Low switching losses
- Very low collector-emitter saturation voltage  $V_{CEsat}$
- Very soft, fast recovery antiparallel diode
- Smooth switching behavior
- Humidity robustness
- Optimized for hard switching, two- and three-level topologies
- Complete product spectrum and PSpice Models: <http://www.infineon.com/igbt/>

### Potential applications

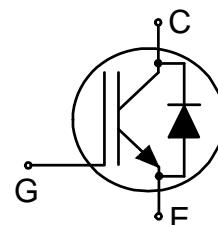
- Industrial UPS
- EV-Charging
- String inverter
- Welding

### Product validation

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



### Description



Type	Package	Marking
IKWH40N65EH7	PG-T0247-3-STD-NN4.8	K40EEH7

Datasheet Please read the sections "Important notice" and "Warnings" at the end of this document [www.infineon.com](http://www.infineon.com)

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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		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 processes: 3			0.6	Nm
Thermal resistance, junction-ambient	$R_{th(j-a)}$				40	K/W
IGBT thermal resistance, junction-case	$R_{th(j-c)}$			0.54	0.71	K/W
Diode thermal resistance, junction-case	$R_{th(j-c)}$			0.72	0.94	K/W

## 2 IGBT

**Table 2 Maximum rated values**

Parameter	Symbol	Note or test condition		Values		Unit
Collector-emitter voltage	$V_{CE}$	$T_{vj} \geq 25^\circ\text{C}$		650		V
DC collector current, limited by $T_{vjmax}$	$I_c$	limited by bondwire	$T_c = 25^\circ\text{C}$	80		A
			$T_c = 100^\circ\text{C}$	54		A
				160		A
Pulsed collector current, $t_p$ , limited by $T_{vjmax}$	$I_{Cpulse}$					
Turn-off safe operating area		$V_{CE} \leq 650\text{ V}$ , $t_p \leq 1\text{ }\mu\text{s}$ , $T_{vj} \leq 175^\circ\text{C}$		160		A
Gate-emitter voltage	$V_{GE}$			$\pm 20$		V
Transient gate-emitter voltage	$V_{GE}$	$t_p \leq 10\text{ }\mu\text{s}$ , $D < 0.01$		$\pm 30$		V
Power dissipation	$P_{tot}$		$T_c = 25^\circ\text{C}$	208		W
			$T_c = 100^\circ\text{C}$	103		

2 IGBT

**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 saturation voltage	$V_{CEsat}$	$I_C = 40 \text{ A}, V_{GE} = 15 \text{ V}$	$T_{vj} = 25^\circ\text{C}$		1.4	1.65	<b>V</b>
			$T_{vj} = 175^\circ\text{C}$		1.6		
Gate-emitter threshold voltage	$V_{GEth}$	$I_C = 0.35 \text{ mA}, V_{CE} = V_{GE}$		2.9	3.85	4.8	<b>V</b>
Zero gate-voltage collector current	$I_{CES}$	$V_{CE} = 650 \text{ V}, V_{GE} = 0 \text{ V}$	$T_{vj} = 25^\circ\text{C}$		10		<b>µA</b>
			$T_{vj} = 175^\circ\text{C}$		1200		
Gate-emitter leakage current	$I_{GES}$	$V_{CE} = 0 \text{ V}, V_{GE} = 20 \text{ V}$			100		<b>nA</b>
Transconductance	$g_{fs}$	$I_C = 40 \text{ A}, V_{CE} = 20 \text{ V}$			56		<b>S</b>
Input capacitance	$C_{ies}$	$V_{CE} = 25 \text{ V}, V_{GE} = 0 \text{ V}, f = 100 \text{ kHz}$			2016		<b>pF</b>
Output capacitance	$C_{oies}$	$V_{CE} = 25 \text{ V}, V_{GE} = 0 \text{ V}, f = 100 \text{ kHz}$			70		<b>pF</b>
Reverse transfer capacitance	$C_{res}$	$V_{CE} = 25 \text{ V}, V_{GE} = 0 \text{ V}, f = 100 \text{ kHz}$			8.6		<b>pF</b>
Gate charge	$Q_G$	$V_{CC} = 520 \text{ V}, I_C = 40 \text{ A}, V_{GE} = 15 \text{ V}$			81		<b>nC</b>
Turn-on delay time	$t_{d(on)}$	$V_{CC} = 400 \text{ V}, V_{GE} = 0/15 \text{ V}, R_{G(on)} = 12.5 \Omega, R_{G(off)} = 12.5 \Omega$	$T_{vj} = 25^\circ\text{C}, I_C = 40 \text{ A}$		18		<b>ns</b>
			$T_{vj} = 175^\circ\text{C}, I_C = 40 \text{ A}$		18		
Rise time (inductive load)	$t_r$	$V_{CC} = 400 \text{ V}, V_{GE} = 0/15 \text{ V}, R_{G(on)} = 12.5 \Omega, R_{G(off)} = 12.5 \Omega$	$T_{vj} = 25^\circ\text{C}, I_C = 40 \text{ A}$		25		<b>ns</b>
			$T_{vj} = 175^\circ\text{C}, I_C = 40 \text{ A}$		28		
Turn-off delay time	$t_{d(off)}$	$V_{CC} = 400 \text{ V}, V_{GE} = 0/15 \text{ V}, R_{G(on)} = 12.5 \Omega, R_{G(off)} = 12.5 \Omega$	$T_{vj} = 25^\circ\text{C}, I_C = 40 \text{ A}$		141		<b>ns</b>
			$T_{vj} = 175^\circ\text{C}, I_C = 40 \text{ A}$		167		
Fall time (inductive load)	$t_f$	$V_{CC} = 400 \text{ V}, V_{GE} = 0/15 \text{ V}, R_{G(on)} = 12.5 \Omega, R_{G(off)} = 12.5 \Omega$	$T_{vj} = 25^\circ\text{C}, I_C = 40 \text{ A}$		34		<b>ns</b>
			$T_{vj} = 175^\circ\text{C}, I_C = 40 \text{ A}$		52		
Turn-on energy	$E_{on}$	$V_{CC} = 400 \text{ V}, V_{GE} = 0/15 \text{ V}, R_{G(on)} = 12.5 \Omega, R_{G(off)} = 12.5 \Omega$	$T_{vj} = 25^\circ\text{C}, I_C = 40 \text{ A}$		0.97		<b>mJ</b>
			$T_{vj} = 175^\circ\text{C}, I_C = 40 \text{ A}$		1.52		

**(table continues...)****3 Diode**

**Table 3** (continued) Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Turn-off energy	$E_{off}$	$V_{CC} = 400 \text{ V}$ , $V_{GE} = 0/15 \text{ V}$ , $R_{G(on)} = 12.5 \Omega$ , $R_{G(off)} = 12.5 \Omega$	$T_{vj} = 25 \text{ }^\circ\text{C}$ , $I_c = 40 \text{ A}$		0.42	mJ	
			$T_{vj} = 175 \text{ }^\circ\text{C}$ , $I_c = 40 \text{ A}$		0.69		
Total switching energy	$E_{ts}$	$V_{CC} = 400 \text{ V}$ , $V_{GE} = 0/15 \text{ V}$ , $R_{G(on)} = 12.5 \Omega$ , $R_{G(off)} = 12.5 \Omega$	$T_{vj} = 25 \text{ }^\circ\text{C}$ , $I_c = 40 \text{ A}$		1.39	mJ	
			$T_{vj} = 25 \text{ }^\circ\text{C}$ , $I_c = 40 \text{ A}$		2.19		
Operating junction temperature	$T_{vj}$			-40		175	°C

### 3 Diode

**Table 4** Maximum rated values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Diode forward current, limited by $T_{vjmax}$	$I_F$		$T_c = 25 \text{ }^\circ\text{C}$		76	A
			$T_c = 100 \text{ }^\circ\text{C}$		49	
Diode pulsed current, $t_p$ limited by $T_{vjmax}$	$I_{Fpulse}$				160	A
Power dissipation	$P_{tot}$		$T_c = 25 \text{ }^\circ\text{C}$		158	W
			$T_c = 100 \text{ }^\circ\text{C}$		78	

**Table 5** Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Diode forward voltage	$V_F$	$I_F = 40 \text{ A}$	$T_{vj} = 25 \text{ }^\circ\text{C}$		1.65	V
			$T_{vj} = 175 \text{ }^\circ\text{C}$		1.55	
Diode reverse recovery time	$t_{rr}$	$V_R = 400 \text{ V}$ , $R_{G(on)} = 12.5 \Omega$	$T_{vj} = 25 \text{ }^\circ\text{C}$ , $I_F = 40 \text{ A}$		74	ns
			$T_{vj} = 175 \text{ }^\circ\text{C}$ , $I_F = 40 \text{ A}$		112	
Diode reverse recovery charge	$Q_{rr}$	$V_R = 400 \text{ V}$ , $R_{G(on)} = 12.5 \Omega$	$T_{vj} = 25 \text{ }^\circ\text{C}$ , $I_F = 40 \text{ A}$		0.9	$\mu\text{C}$
			$T_{vj} = 175 \text{ }^\circ\text{C}$ , $I_F = 40 \text{ A}$		2.1	

(table continues...)

3 Diode

**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 peak reverse recovery current	$I_{rrm}$	$V_R = 400 \text{ V}$ , $R_{G(on)} = 12.5 \Omega$	$T_{vj} = 25^\circ\text{C}$ , $I_F = 40 \text{ A}$		19.9	A
			$T_{vj} = 175^\circ\text{C}$ , $I_F = 40 \text{ A}$		29.8	
Diode peak rate of fall of reverse recovery current	$di_{rr}/dt$	$V_R = 400 \text{ V}$ , $R_{G(on)} = 12.5 \Omega$	$T_{vj} = 25^\circ\text{C}$ , $I_F = 40 \text{ A}$		-1070	$\text{A}/\mu\text{s}$
			$T_{vj} = 175^\circ\text{C}$ , $I_F = 40 \text{ A}$		-719	
Reverse recovery energy	$E_{rec}$	$V_R = 400 \text{ V}$ , $R_{G(on)} = 12.5 \Omega$	$T_{vj} = 25^\circ\text{C}$ , $I_F = 40 \text{ A}$		0.16	$\text{mJ}$
			$T_{vj} = 175^\circ\text{C}$ , $I_F = 40 \text{ A}$		0.44	
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.

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

Dynamic test circuit, parasitic inductance  $L_\sigma = 8 \text{ nH}$ , parasitic capacitor  $C_\sigma = 30 \text{ pF}$  from Fig. E. Energy losses include "tail" and diode reverse recovery.

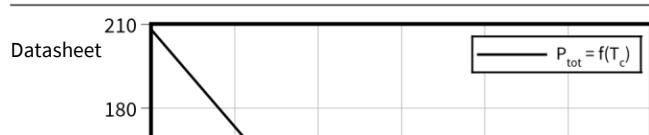
## **4      Characteristics diagrams**

## 4 Characteristics diagrams

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

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

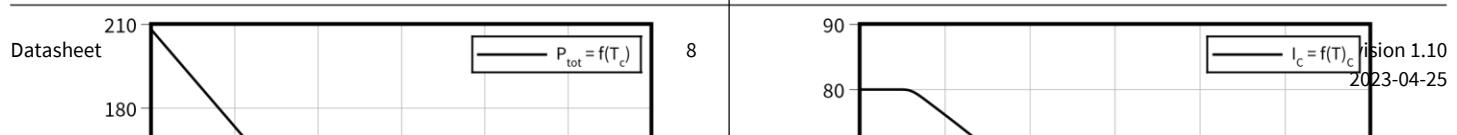
$$T_{vj} \leq 175 \text{ }^\circ\text{C}$$

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

$$I_C = f(T_c)$$

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

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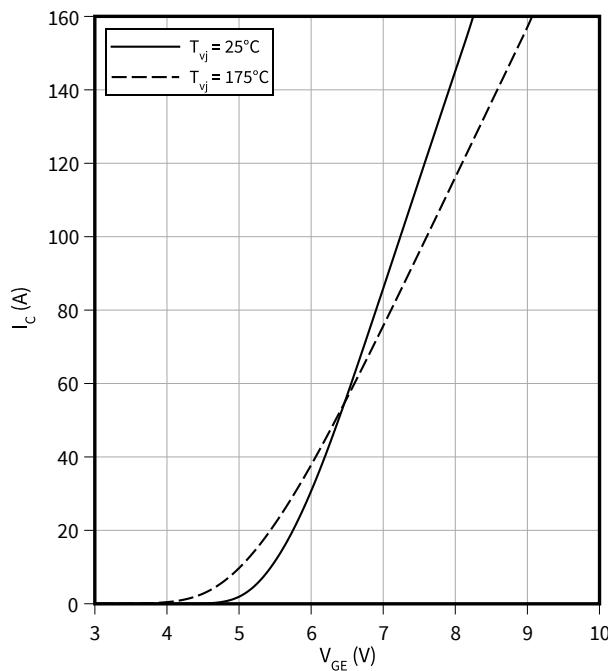


## 4 Characteristics diagrams

**Typical transfer characteristic**

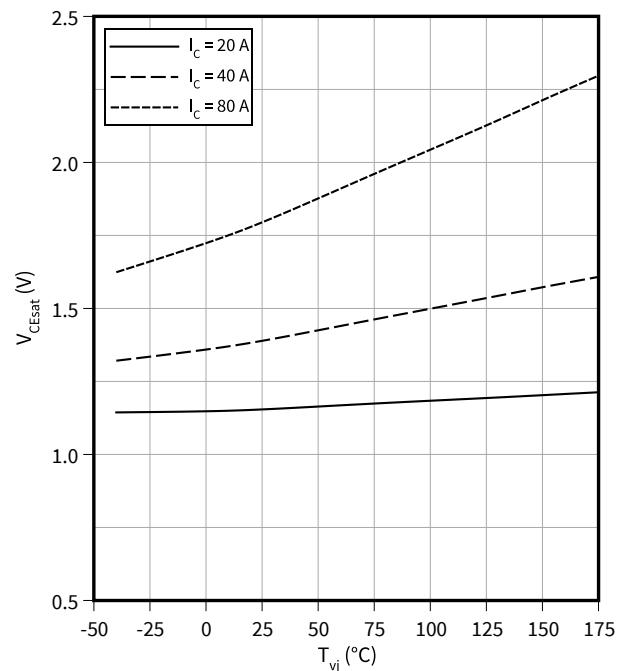
$$I_C = f(V_{GE})$$

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

**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**

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

$$I_C = 0.35 \text{ mA}$$

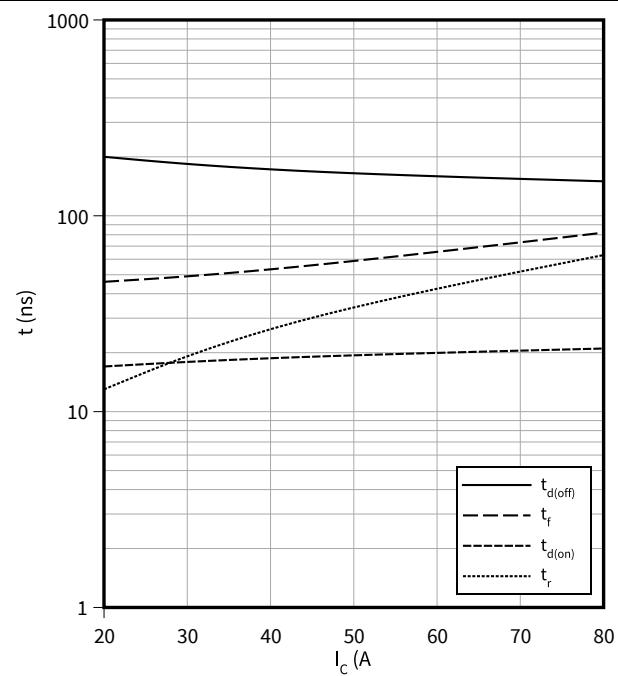
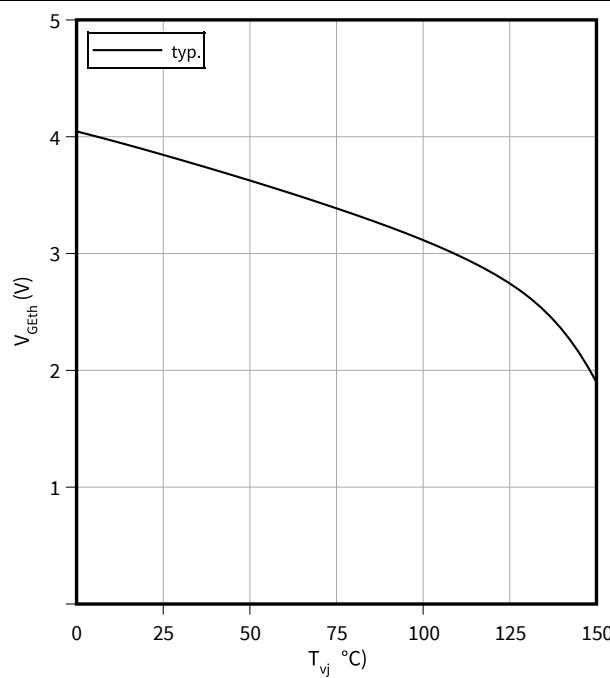
**Typical switching times as a function of collector current**

$$t = f(I_C)$$

$$V_{CC} = 400 \text{ V}, T_{vj} = 175^\circ\text{C}, V_{GE} = 0/15 \text{ V}, R_G = 12.5 \Omega$$

0 ( )

## 4 Characteristics diagrams



## Typical switching times as a function of gate resistor

$$t = f(R_G)$$

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

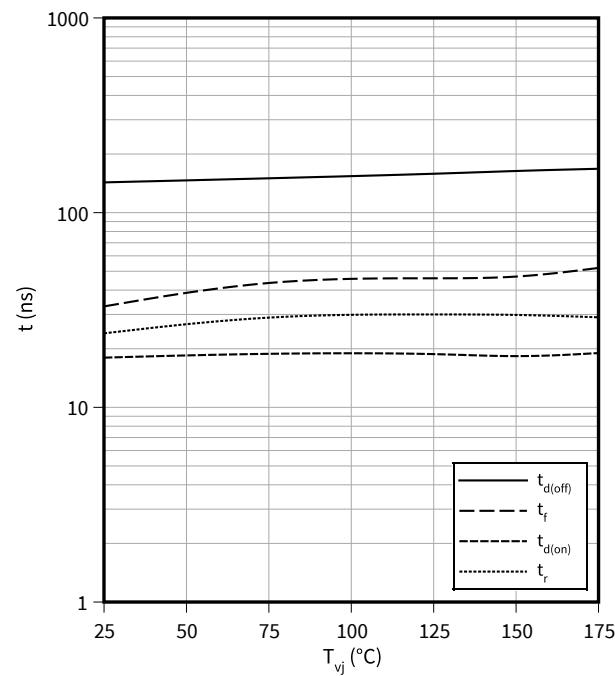
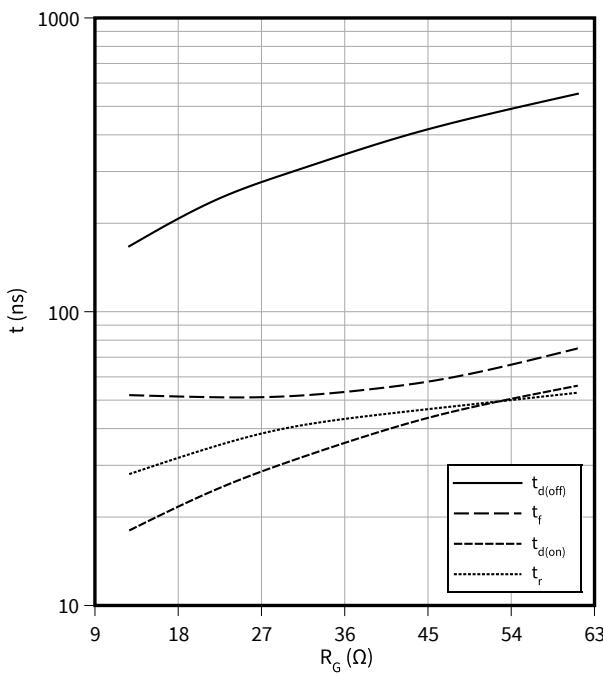
## Typical switching times as a function of junction temperature

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

$I_C = 40 \text{ A}$ ,  $V_{CC} = 400 \text{ V}$ ,  $V_{GE} = 0/15 \text{ V}$ ,  $R_G = 12.5 \Omega$

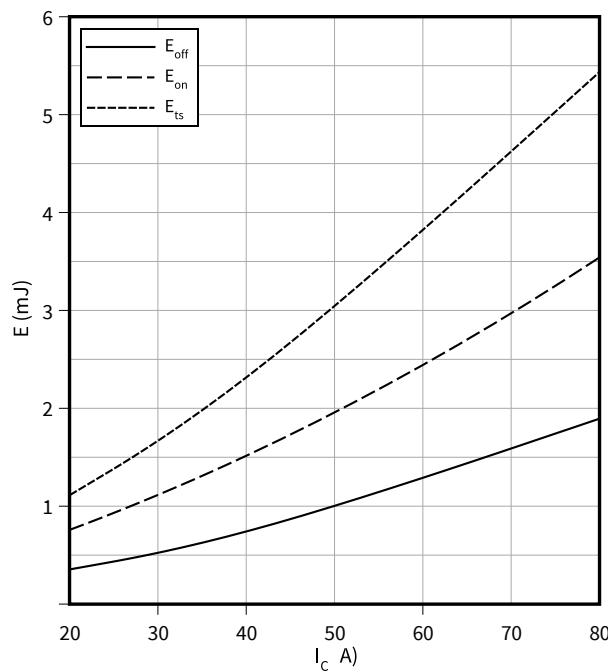
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## 4 Characteristics diagrams

**Typical switching energy losses as a function of collector current**

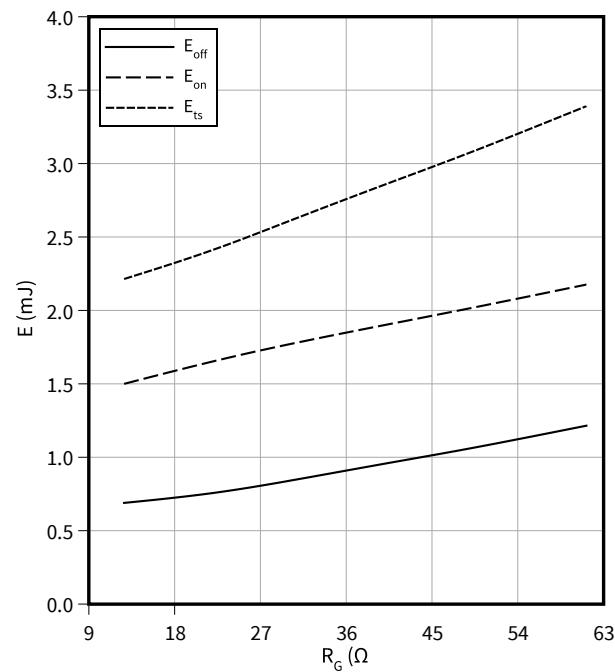
$$E = f(I_C)$$

$V_{CC} = 400 \text{ V}$ ,  $T_{vj} = 175 \text{ }^{\circ}\text{C}$ ,  $V_{GE} = 0/15 \text{ V}$ ,  $R_G = 12.5 \Omega$

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

$$E = f(R_G)$$

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

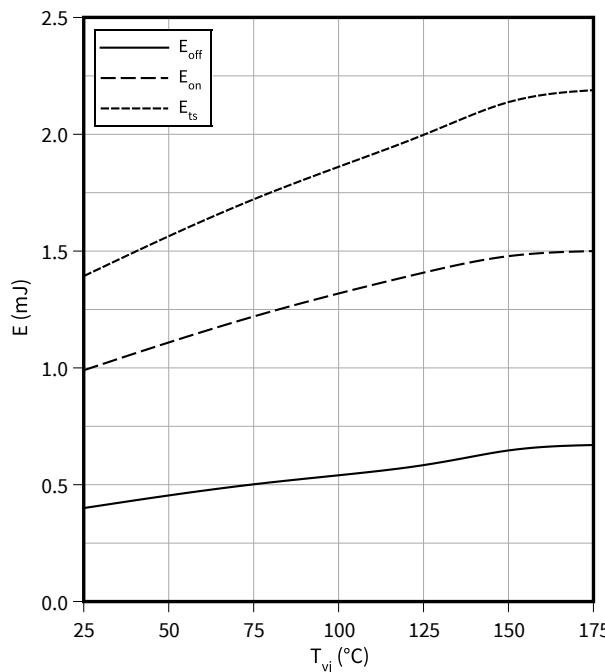


## 4 Characteristics diagrams

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

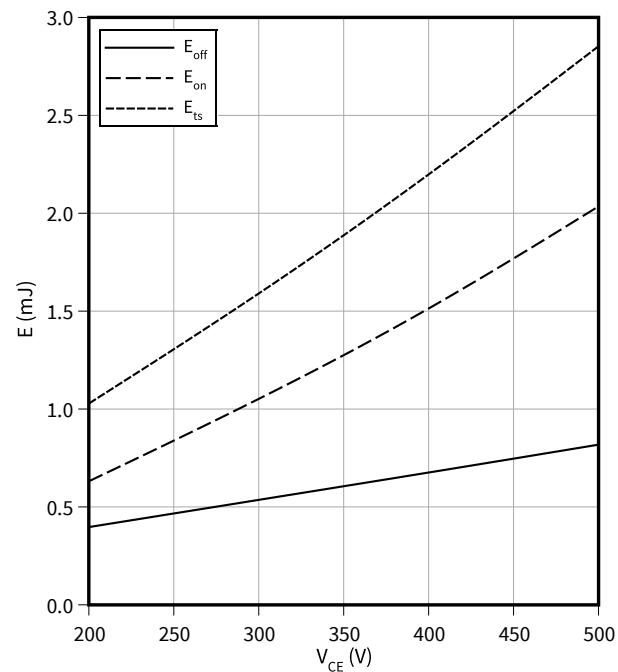
$$E = f(T_{vj})$$

$I_C = 40 \text{ A}$ ,  $V_{CC} = 400 \text{ V}$ ,  $V_{GE} = 0/15 \text{ V}$ ,  $R_G = 12.5 \Omega$

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

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

$I_C = 40 \text{ A}$ ,  $T_{vj} = 175 \text{ °C}$ ,  $V_{GE} = 0/15 \text{ V}$ ,  $R_G = 12.5 \Omega$

**Typical gate charge**

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

$I_C = 40 \text{ A}$

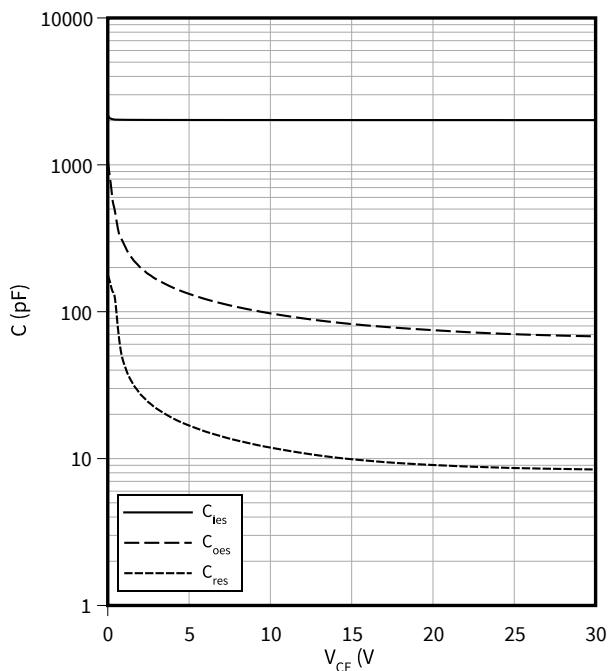
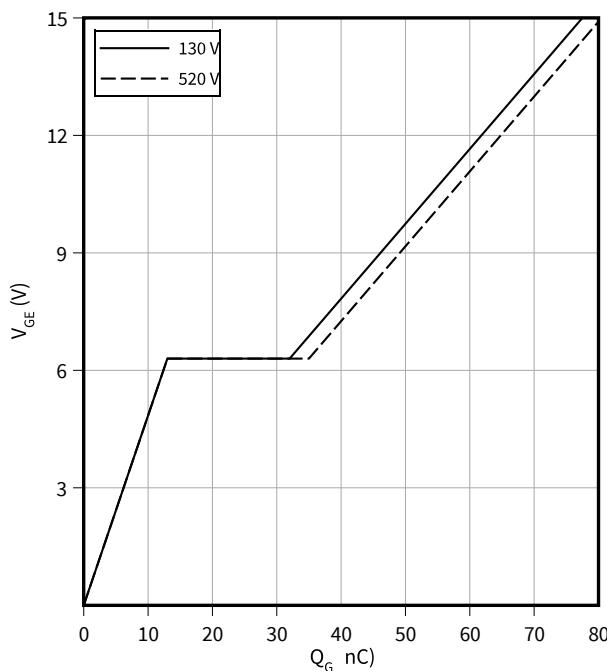
**Typical capacitance as a function of collector-emitter voltage**

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

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

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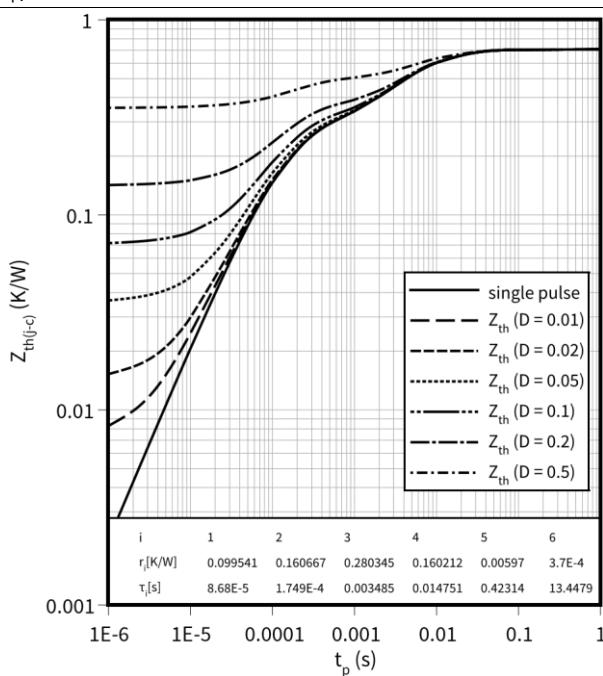
## 4 Characteristics diagrams



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

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

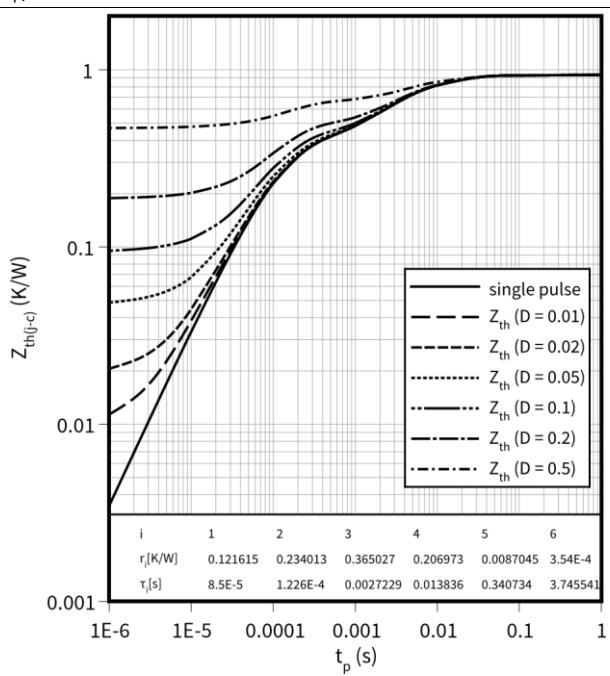
$$D = t_p/T$$



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

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

$$D = t_p/T$$



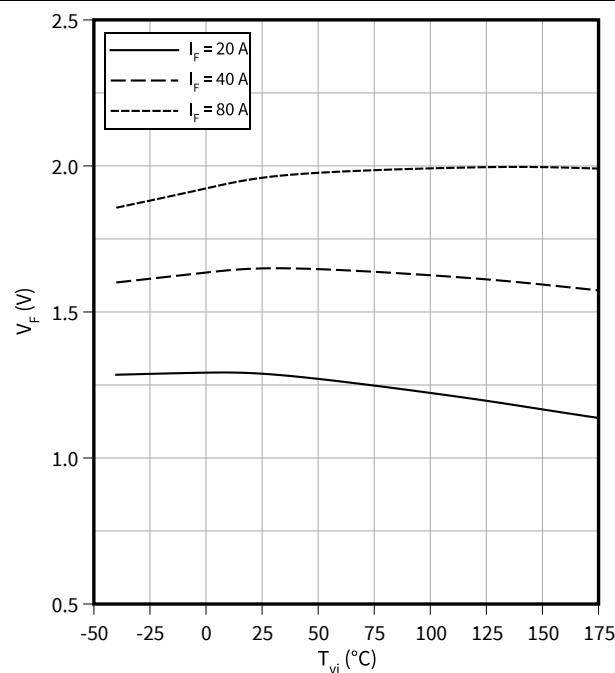
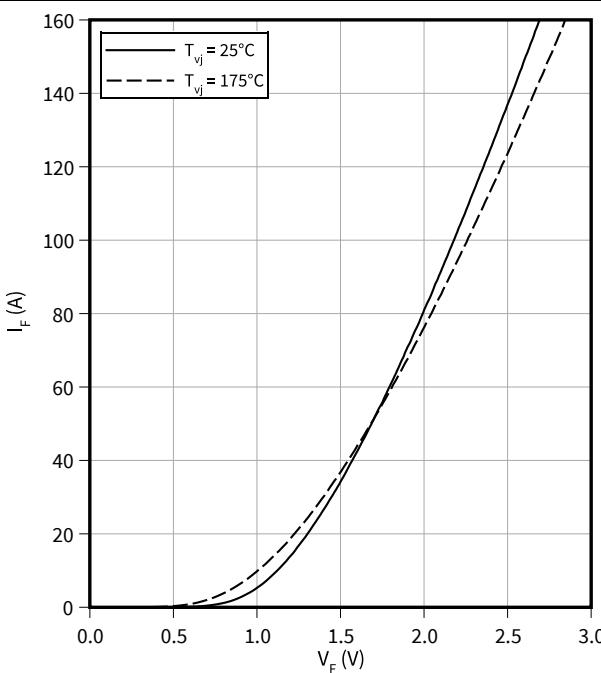
## Typical diode forward current as a function of forward voltage

$$I_F = f(V_F)$$

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

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

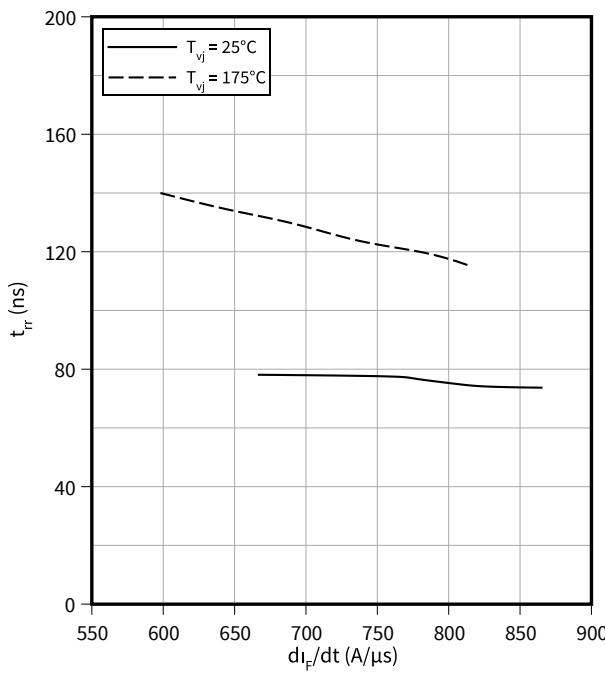
## 4 Characteristics diagrams



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

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

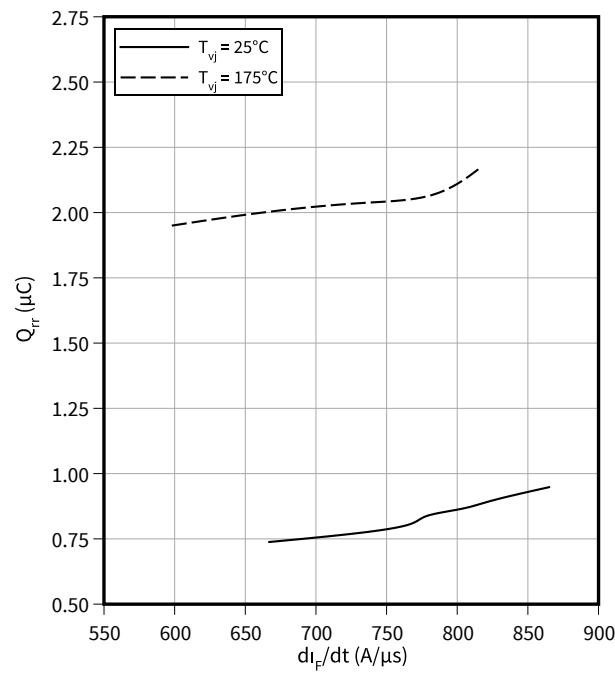
$I_F = 40\text{ A}$ ,  $V_R = 400\text{ V}$



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

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

$V_R = 400\text{ V}$ ,  $I_F = 40\text{ A}$

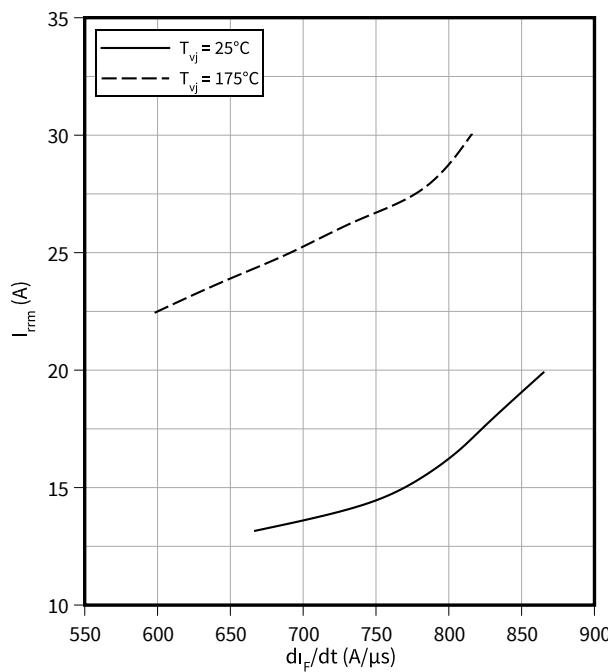


## 4 Characteristics diagrams

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

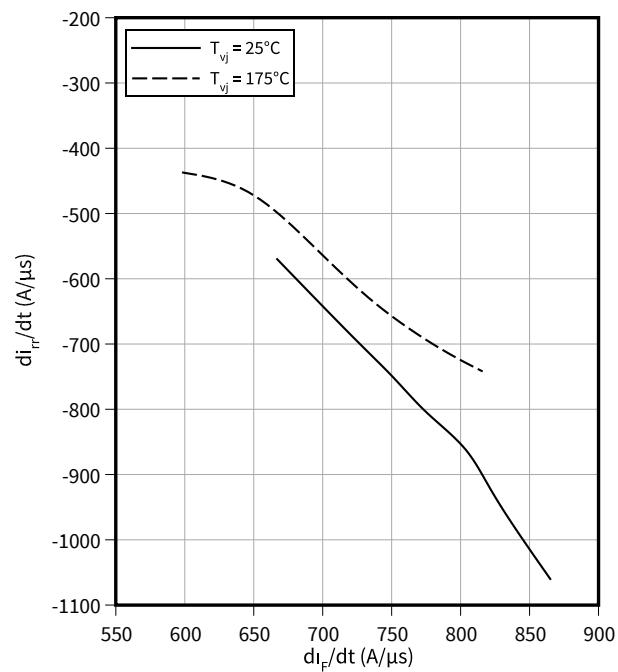
$$I_{rrm} = f(dI_F/dt)$$

$V_R = 400 \text{ V}$ ,  $I_F = 40 \text{ A}$

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

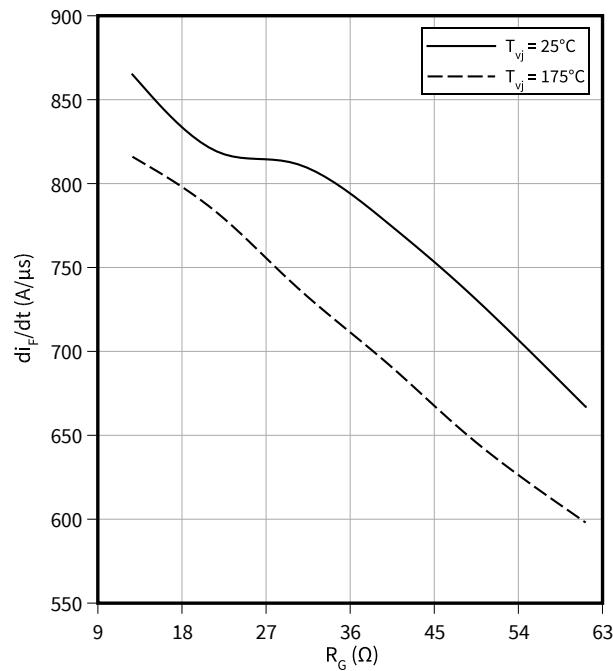
$$di_{rr}/dt = f(dI_F/dt)$$

$V_R = 400 \text{ V}$ ,  $I_F = 40 \text{ A}$



## 4 Characteristics diagrams

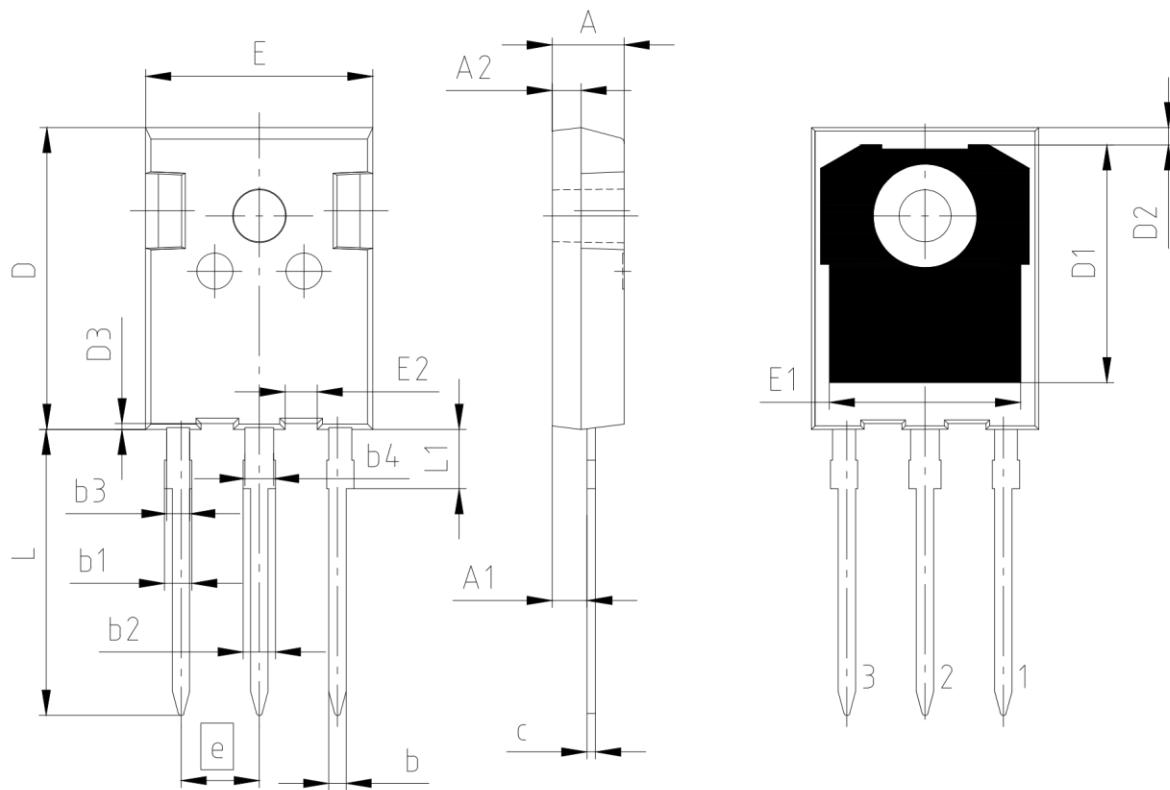
## Typical diode current slope as a function of gate

resistor  $di_F/dt = f(R_G)$   $V_R = 400$  V,  $I_F = 40$  A

## 5 Package outlines

## 5 Package outlines

PG-T0247-3-STD-NN4.8



PACKAGE - GROUP NUMBER: PG-T0247-3-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

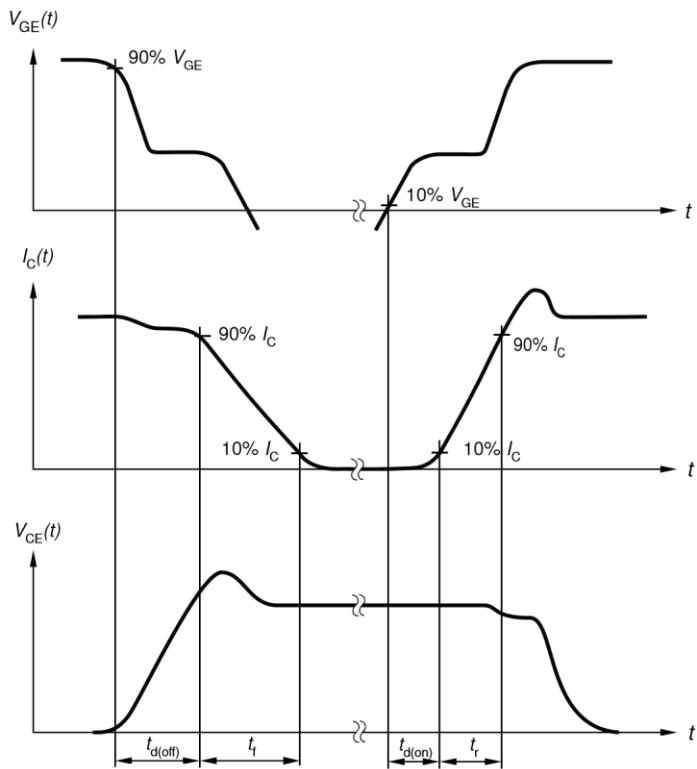


Figure A. Definition of switching times

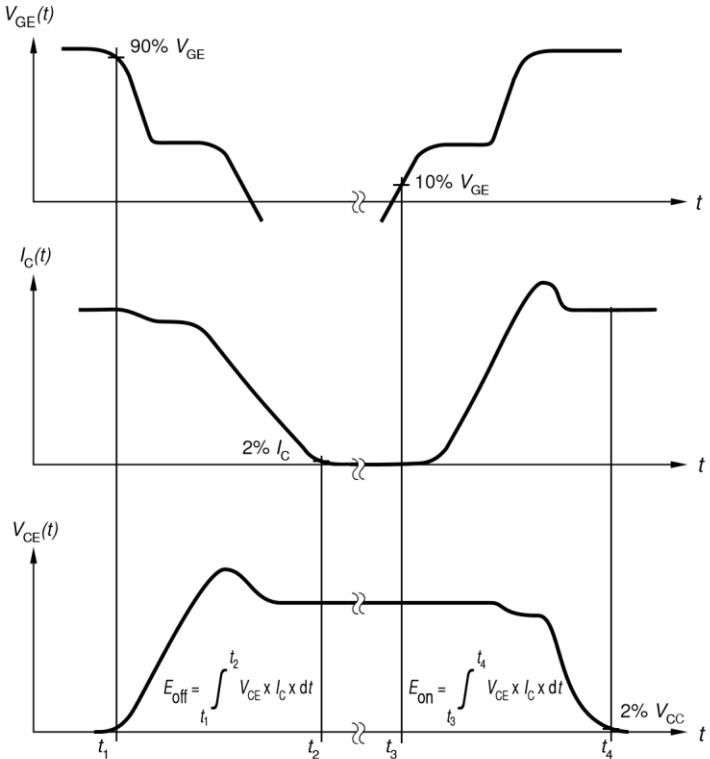


Figure B. Definition of switching losses

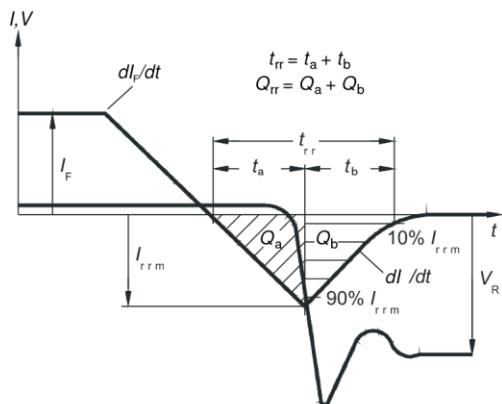


Figure C. Definition of diode switching characteristics

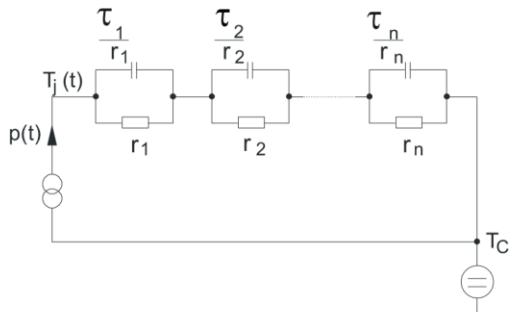


Figure D. Thermal equivalent circuit

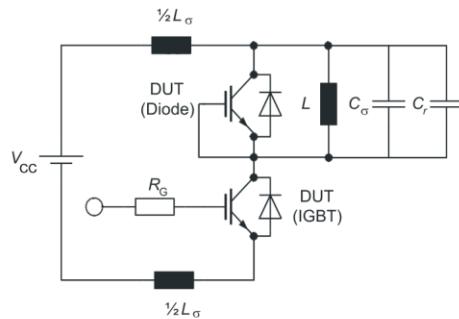


Figure E. Dynamic test circuit  
 Parasitic inductance  $L_\sigma$ ,  
 parasitic capacitor  $C_\sigma$ ,  
 relief capacitor  $C_r$ ,  
 (only for ZVT switching)

Figure 2

## Revision history

## Revision history

Document revision	Date of release	Description of changes
1.00	2023-02-09	Final datasheet
1.10	2023-04-25	Correction of switching values in Table 3 Correction of diagram $V_{GE} = f(Q_G)$

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