

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

**Features**

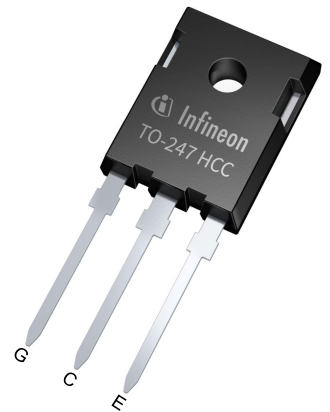
- $V_{CE} = 650\text{ V}$
- $I_C = 50\text{ A}$
- Low switching losses
- Very low collector-emitter saturation voltage  $V_{CEsat}$
- Very soft, fast recovery antiparallel diode
- Smooth switching behavior
- Humidity robustness
- Optimized for hard switching, two- and three-level topologies
- Complete product spectrum and PSpice Models: <http://www.infineon.com/igbt/>

**Potential applications**

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

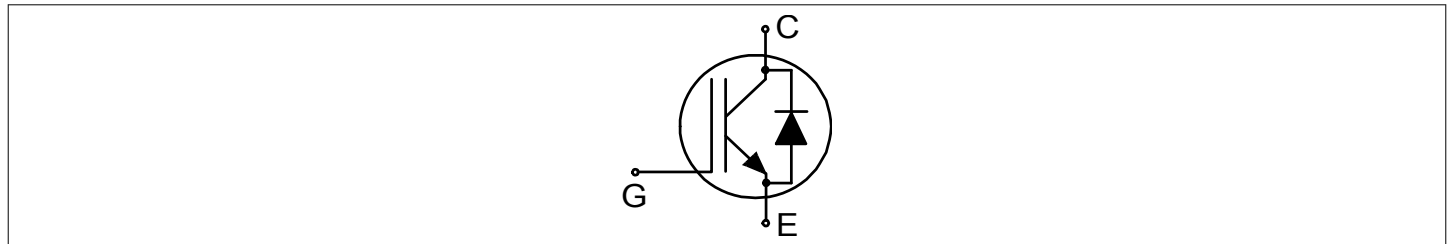
**Product validation**

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



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

**Description**



Type	Package	Marking
IKWH50N65EH7	PG-TO247-3-STD-NN4.8	K50EEH7

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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	$R_{th(j-c)}$			0.46	0.6	K/W
Diode thermal resistance, junction-case	$R_{th(j-c)}$			0.61	0.8	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 $T_{vjmax}$	$I_C$	limited by bondwire	$T_c = 25\text{ °C}$	80	A
			$T_c = 100\text{ °C}$	65	
Pulsed collector current, $t_p$ limited by $T_{vjmax}$	$I_{Cpulse}$		200	A	
Turn-off safe operating area		$V_{CE} \leq 650\text{ V}$ , $t_p \leq 1\text{ }\mu\text{s}$ , $T_{vj} \leq 175\text{ °C}$	200	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	$P_{tot}$		$T_c = 25\text{ °C}$	249	W
			$T_c = 100\text{ °C}$	123	

**Table 3** Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Collector-emitter saturation voltage	$V_{CEsat}$	$I_C = 50\text{ A}$ , $V_{GE} = 15\text{ V}$	$T_{vj} = 25\text{ °C}$	1.4	1.65	V
			$T_{vj} = 175\text{ °C}$	1.6		

(table continues...)  
Datasheet

Table 3 (continued) Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Gate-emitter threshold voltage	$V_{GEth}$	$I_C = 0.44 \text{ mA}$ , $V_{CE} = V_{GE}$	2.9	3.85	4.8	V
Zero gate-voltage collector current	$I_{CES}$	$V_{CE} = 650 \text{ V}$ , $V_{GE} = 0 \text{ V}$	$T_{vj} = 25 \text{ °C}$		15	$\mu\text{A}$
			$T_{vj} = 175 \text{ °C}$		1500	
Gate-emitter leakage current	$I_{GES}$	$V_{CE} = 0 \text{ V}$ , $V_{GE} = 20 \text{ V}$			100	nA
Transconductance	$g_{fs}$	$I_C = 50 \text{ A}$ , $V_{CE} = 20 \text{ V}$		67		S
Input capacitance	$C_{ies}$	$V_{CE} = 25 \text{ V}$ , $V_{GE} = 0 \text{ V}$ , $f = 100 \text{ kHz}$		2566		pF
Output capacitance	$C_{oes}$	$V_{CE} = 25 \text{ V}$ , $V_{GE} = 0 \text{ V}$ , $f = 100 \text{ kHz}$		84		pF
Reverse transfer capacitance	$C_{res}$	$V_{CE} = 25 \text{ V}$ , $V_{GE} = 0 \text{ V}$ , $f = 100 \text{ kHz}$		10.7		pF
Gate charge	$Q_G$	$V_{CC} = 520 \text{ V}$ , $I_C = 50 \text{ A}$ , $V_{GE} = 15 \text{ V}$		102		nC
Turn-on delay time	$t_{d(on)}$	$V_{CC} = 400 \text{ V}$ , $V_{GE} = 0/15 \text{ V}$ , $R_{G(on)} = 10 \text{ }\Omega$ , $R_{G(off)} = 10 \text{ }\Omega$	$T_{vj} = 25 \text{ °C}$ , $I_C = 50 \text{ A}$		19	ns
			$T_{vj} = 175 \text{ °C}$ , $I_C = 50 \text{ A}$		21	
Rise time (inductive load)	$t_r$	$V_{CC} = 400 \text{ V}$ , $V_{GE} = 0/15 \text{ V}$ , $R_{G(on)} = 10 \text{ }\Omega$ , $R_{G(off)} = 10 \text{ }\Omega$	$T_{vj} = 25 \text{ °C}$ , $I_C = 50 \text{ A}$		29	ns
			$T_{vj} = 175 \text{ °C}$ , $I_C = 50 \text{ A}$		41	
Turn-off delay time	$t_{d(off)}$	$V_{CC} = 400 \text{ V}$ , $V_{GE} = 0/15 \text{ V}$ , $R_{G(on)} = 10 \text{ }\Omega$ , $R_{G(off)} = 10 \text{ }\Omega$	$T_{vj} = 25 \text{ °C}$ , $I_C = 50 \text{ A}$		147	ns
			$T_{vj} = 175 \text{ °C}$ , $I_C = 50 \text{ A}$		172	
Fall time (inductive load)	$t_f$	$V_{CC} = 400 \text{ V}$ , $V_{GE} = 0/15 \text{ V}$ , $R_{G(on)} = 10 \text{ }\Omega$ , $R_{G(off)} = 10 \text{ }\Omega$	$T_{vj} = 25 \text{ °C}$ , $I_C = 50 \text{ A}$		42	ns
			$T_{vj} = 175 \text{ °C}$ , $I_C = 50 \text{ A}$		59	
Turn-on energy	$E_{on}$	$V_{CC} = 400 \text{ V}$ , $V_{GE} = 0/15 \text{ V}$ , $R_{G(on)} = 10 \text{ }\Omega$ , $R_{G(off)} = 10 \text{ }\Omega$	$T_{vj} = 25 \text{ °C}$ , $I_C = 50 \text{ A}$		1.27	mJ
			$T_{vj} = 175 \text{ °C}$ , $I_C = 50 \text{ A}$		2.1	
Turn-off energy	$E_{off}$	$V_{CC} = 400 \text{ V}$ , $V_{GE} = 0/15 \text{ V}$ , $R_{G(on)} = 10 \text{ }\Omega$ , $R_{G(off)} = 10 \text{ }\Omega$	$T_{vj} = 25 \text{ °C}$ , $I_C = 50 \text{ A}$		0.65	mJ
			$T_{vj} = 175 \text{ °C}$ , $I_C = 50 \text{ A}$		0.95	

(table continues...)

Table 3 (continued) Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Total switching energy	$E_{ts}$	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V},$ $R_{G(on)} = 10\ \Omega,$ $R_{G(off)} = 10\ \Omega$	$T_{vj} = 25\text{ }^\circ\text{C},$ $I_C = 50\text{ A}$		1.92		mJ
			$T_{vj} = 175\text{ }^\circ\text{C},$ $I_C = 50\text{ A}$		3.05		
Operating junction temperature	$T_{vj}$		-40		175	$^\circ\text{C}$	

### 3 Diode

Table 4 Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit	
Diode forward current, limited by $T_{vjmax}$	$I_F$	limited by bondwire	$T_c = 25\text{ }^\circ\text{C}$	80	A
			$T_c = 100\text{ }^\circ\text{C}$	59	
Diode pulsed current, $t_p$ limited by $T_{vjmax}$	$I_{Fpulse}$		200	A	
Power dissipation	$P_{tot}$		$T_c = 25\text{ }^\circ\text{C}$	187	W
			$T_c = 100\text{ }^\circ\text{C}$	92	

Table 5 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Diode forward voltage	$V_F$	$I_F = 50\text{ A}$	$T_{vj} = 25\text{ }^\circ\text{C}$	1.65	2	V
			$T_{vj} = 175\text{ }^\circ\text{C}$	1.55		
Diode reverse recovery time	$t_{rr}$	$V_R = 400\text{ V}, R_{G(on)} = 10\ \Omega$	$T_{vj} = 25\text{ }^\circ\text{C},$ $I_F = 50\text{ A}$	76		ns
			$T_{vj} = 175\text{ }^\circ\text{C},$ $I_F = 50\text{ A}$	115		
Diode reverse recovery charge	$Q_{rr}$	$V_R = 400\text{ V}, R_{G(on)} = 10\ \Omega$	$T_{vj} = 25\text{ }^\circ\text{C},$ $I_F = 50\text{ A}$	1.12		$\mu\text{C}$
			$T_{vj} = 175\text{ }^\circ\text{C},$ $I_F = 50\text{ A}$	2.41		
Diode peak reverse recovery current	$I_{rrm}$	$V_R = 400\text{ V}, R_{G(on)} = 10\ \Omega$	$T_{vj} = 25\text{ }^\circ\text{C},$ $I_F = 50\text{ A}$	24.3		A
			$T_{vj} = 175\text{ }^\circ\text{C},$ $I_F = 50\text{ A}$	33.8		

(table continues...)

Table 5 (continued) Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Diode peak rate of fall of reverse recovery current	$di_{rr}/dt$	$V_R = 400 \text{ V}, R_{G(on)} = 10 \text{ } \Omega$	$T_{vj} = 25 \text{ } ^\circ\text{C},$ $I_F = 50 \text{ A}$		-1480		A/ $\mu\text{s}$
			$T_{vj} = 175 \text{ } ^\circ\text{C},$ $I_F = 50 \text{ A}$		-861		
Reverse recovery energy	$E_{rec}$	$V_R = 400 \text{ V}, R_{G(on)} = 10 \text{ } \Omega$	$T_{vj} = 25 \text{ } ^\circ\text{C},$ $I_F = 50 \text{ A}$		0.25		mJ
			$T_{vj} = 175 \text{ } ^\circ\text{C},$ $I_F = 50 \text{ A}$		0.51		
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.

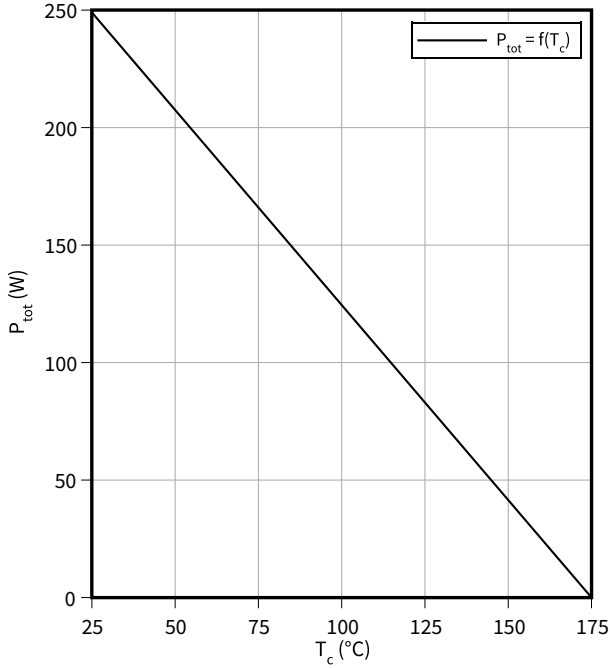
Electrical Characteristic at  $T_{vj} = 25^\circ\text{C}$ , unless otherwise specified.

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

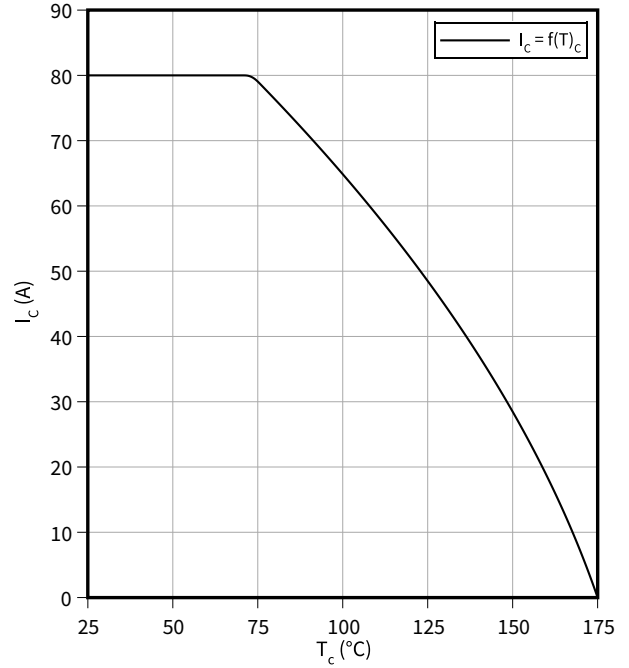
### Power dissipation as a function of case temperature

$P_{tot} = f(T_c)$   
 $T_{vj} \leq 175\text{ °C}$



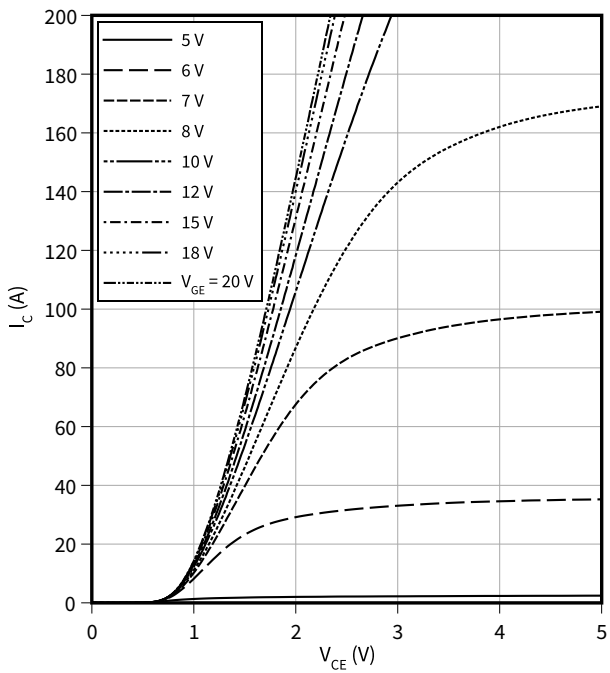
### Collector current as a function of case temperature

$I_C = f(T_c)$   
 $T_{vj} \leq 175\text{ °C}, V_{GE} \geq 15\text{ V}$



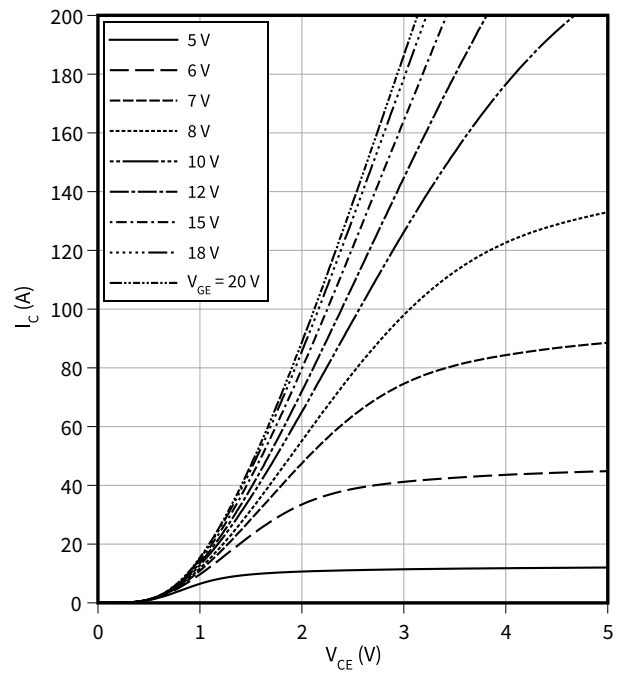
### Typical output characteristic

$I_C = f(V_{CE})$   
 $T_{vj} = 25\text{ °C}$



### Typical output characteristic

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

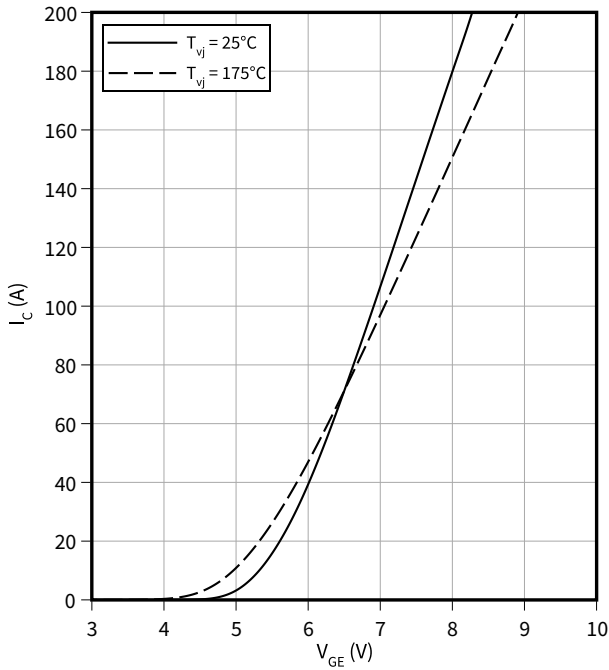


4 Characteristics diagrams

**Typical transfer characteristic**

$I_C = f(V_{GE})$

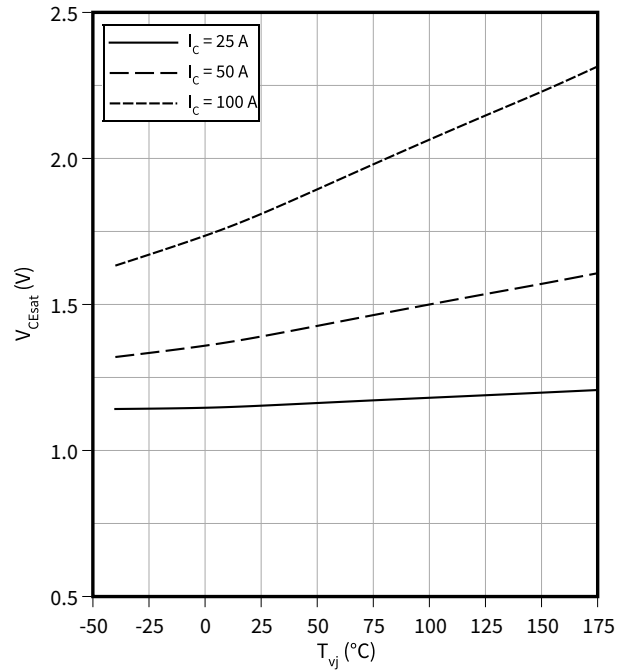
$V_{CE} = 20\text{ V}$



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

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

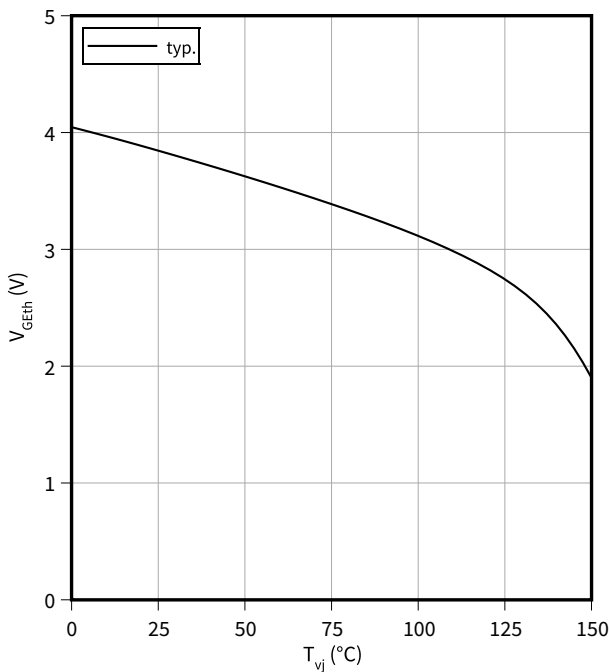
$V_{GE} = 15\text{ V}$



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

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

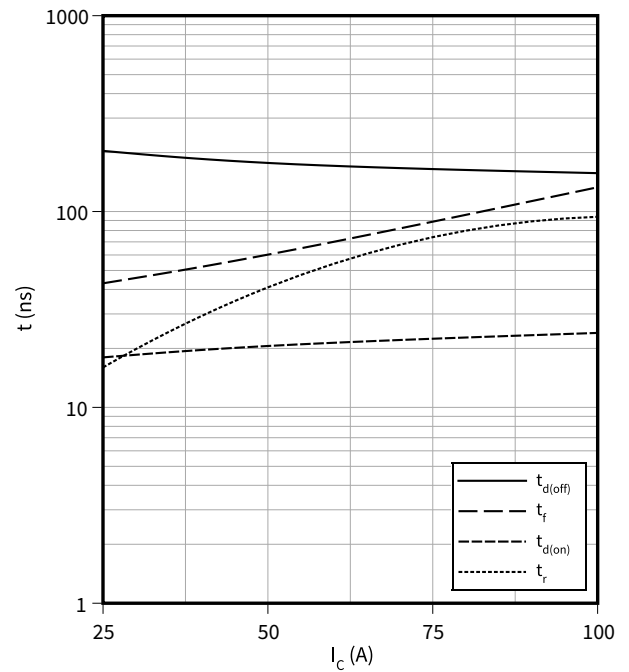
$I_C = 0.44\text{ mA}$



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

$t = f(I_C)$

$V_{CC} = 400\text{ V}, T_{vj} = 175^\circ\text{C}, V_{GE} = 0/15\text{ V}, R_G = 10\ \Omega$

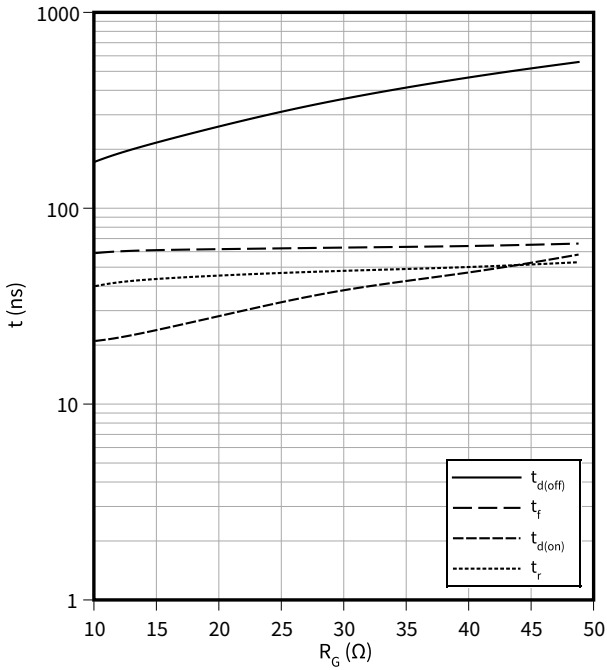


**4 Characteristics diagrams**

**Typical switching times as a function of gate resistor**

$t = f(R_G)$

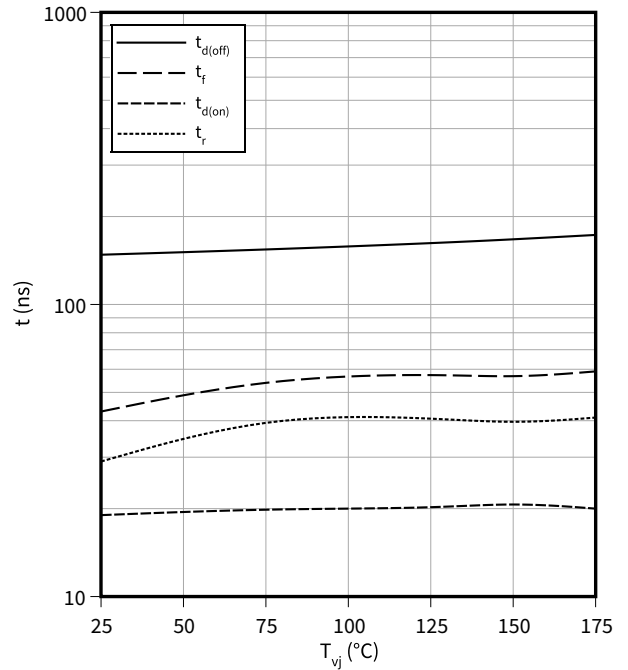
$I_C = 50 \text{ A}, V_{CC} = 400 \text{ V}, T_{vj} = 175 \text{ }^\circ\text{C}, V_{GE} = 0/15 \text{ V}$



**Typical switching times as a function of junction temperature**

$t = f(T_{vj})$

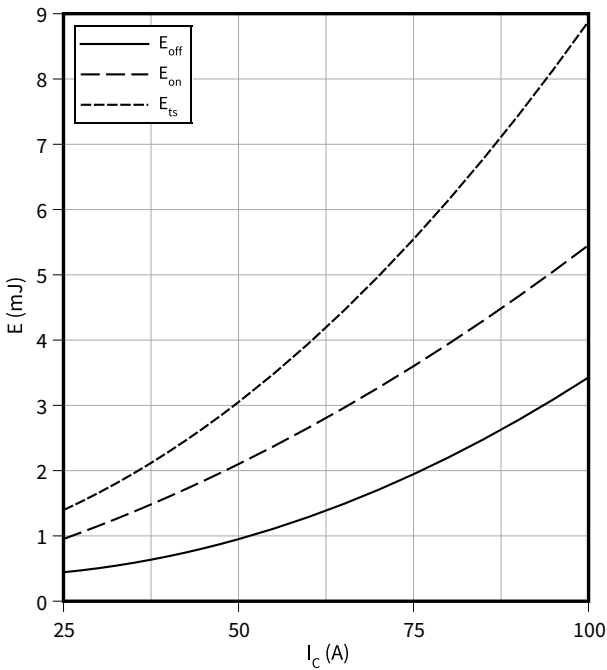
$I_C = 50 \text{ A}, V_{CC} = 400 \text{ V}, V_{GE} = 0/15 \text{ V}, R_G = 10 \text{ } \Omega$



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

$E = f(I_C)$

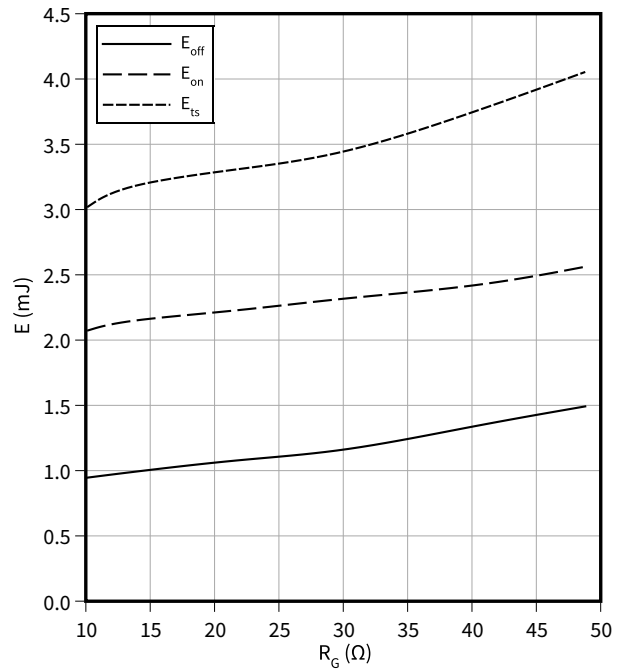
$V_{CC} = 400 \text{ V}, T_{vj} = 175 \text{ }^\circ\text{C}, V_{GE} = 0/15 \text{ V}, R_G = 10 \text{ } \Omega$



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

$E = f(R_G)$

$I_C = 50 \text{ A}, V_{CC} = 400 \text{ V}, T_{vj} = 175 \text{ }^\circ\text{C}, V_{GE} = 0/15 \text{ V}$

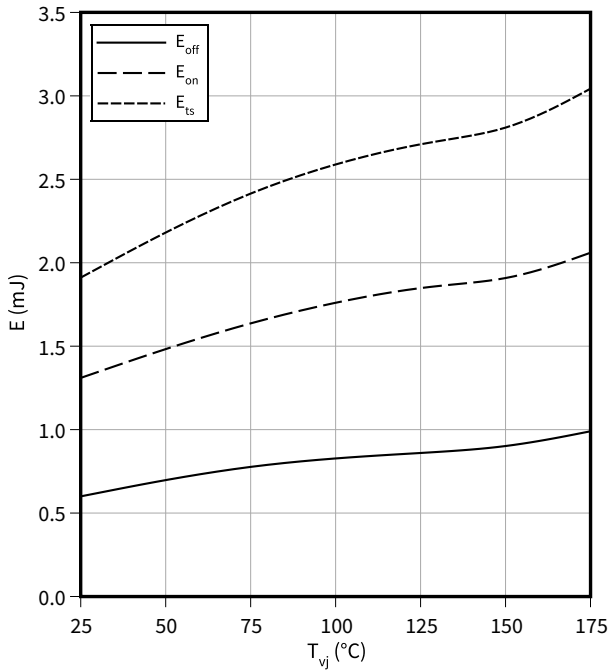


4 Characteristics diagrams

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

$E = f(T_{vj})$

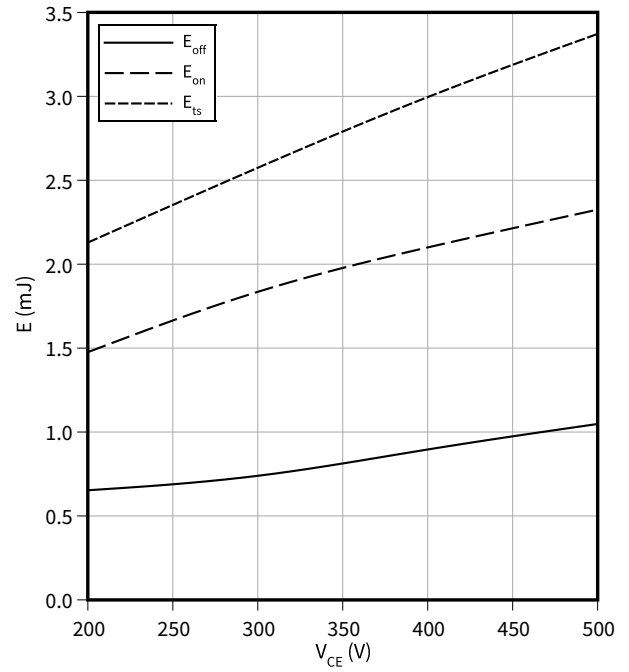
$I_C = 50\text{ A}$ ,  $V_{CC} = 400\text{ V}$ ,  $V_{GE} = 0/15\text{ V}$ ,  $R_G = 10\ \Omega$



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

$E = f(V_{CE})$

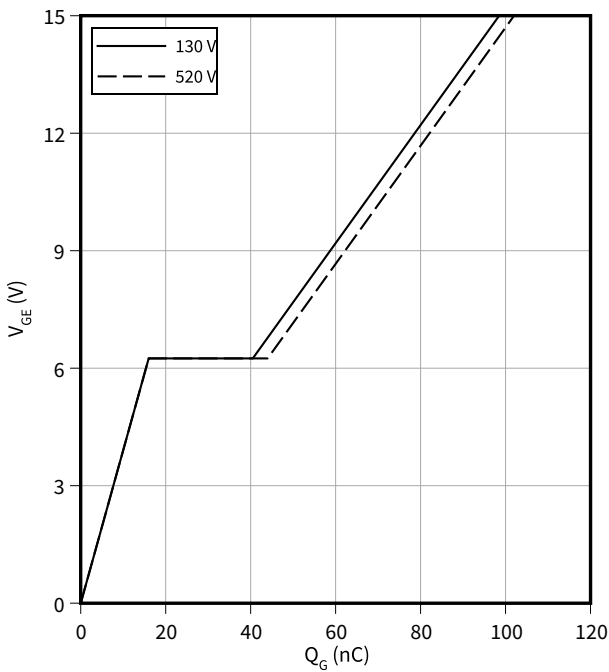
$I_C = 50\text{ A}$ ,  $T_{vj} = 175\text{ °C}$ ,  $V_{GE} = 0/15\text{ V}$ ,  $R_G = 10\ \Omega$



**Typical gate charge**

$V_{GE} = f(Q_G)$

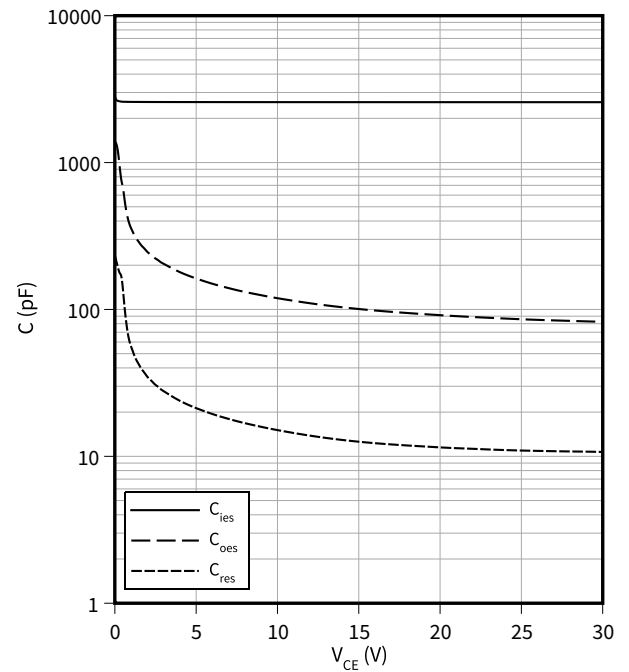
$I_C = 50\text{ A}$



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

$C = f(V_{CE})$

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

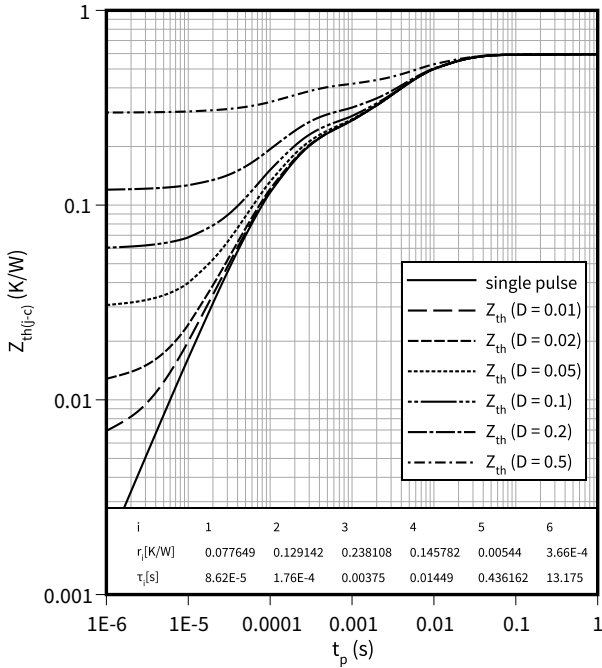


**4 Characteristics diagrams**

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

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

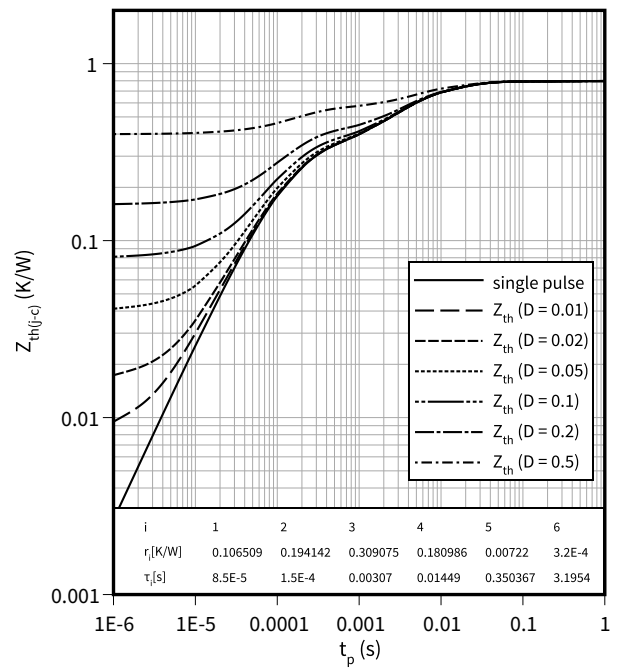
$$D = t_p/T$$



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

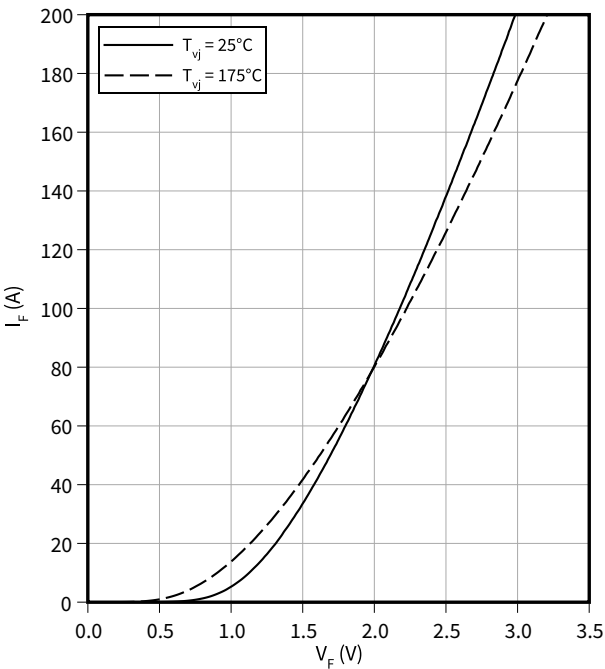
$$Z_{th(j-c)} = f(t_p)$$

$$D = t_p/T$$



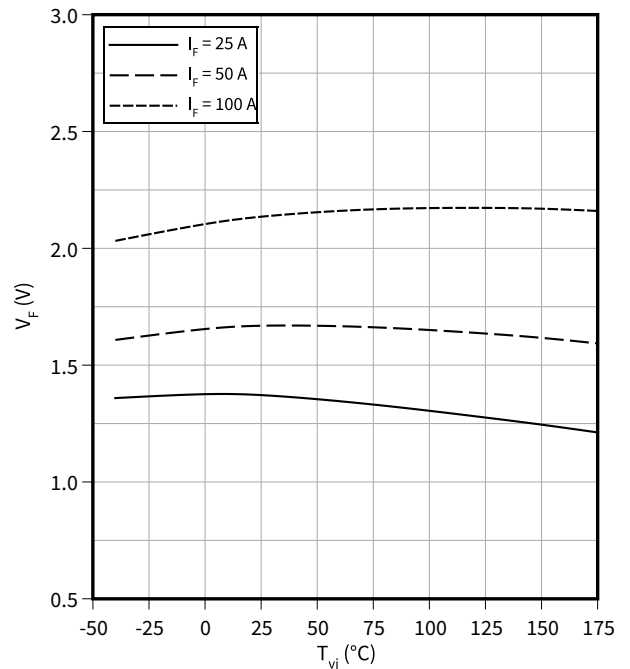
**Typical diode forward current as a function of forward voltage**

$$I_F = f(V_F)$$



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

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

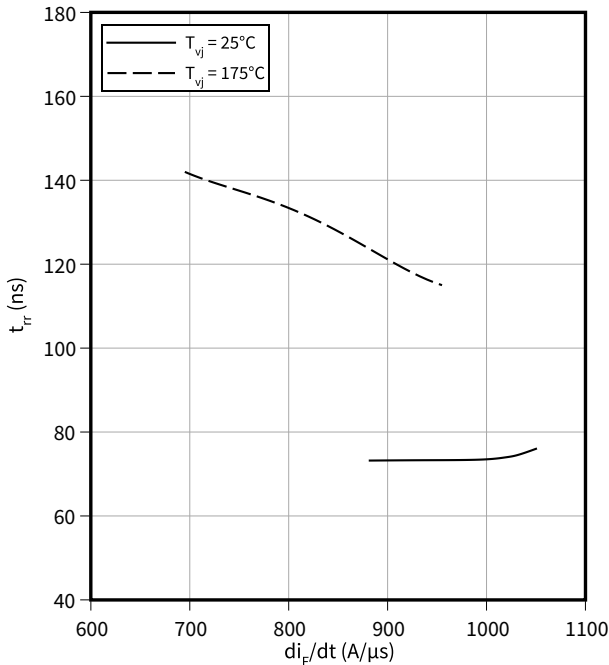


4 Characteristics diagrams

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

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

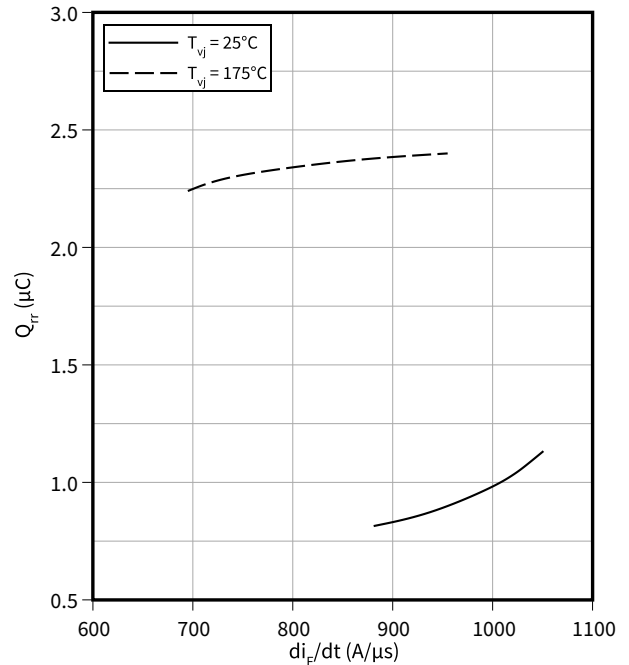
$V_R = 400\text{ V}, I_F = 50\text{ A}$



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

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

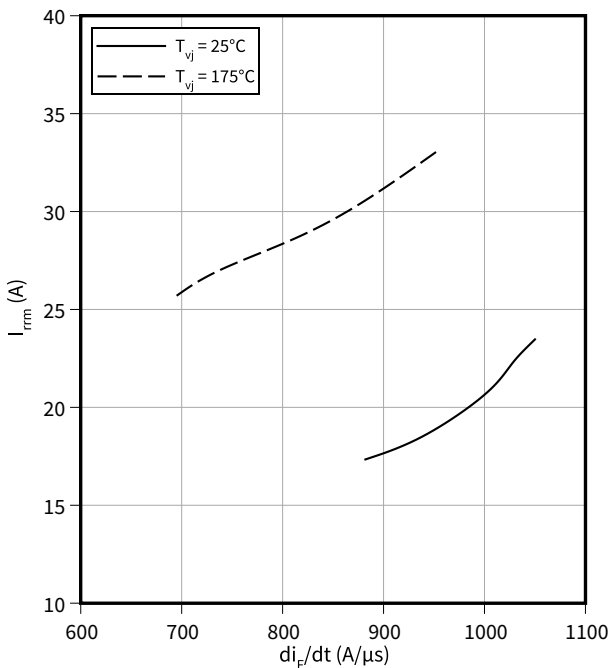
$V_R = 400\text{ V}, I_F = 50\text{ A}$



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

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

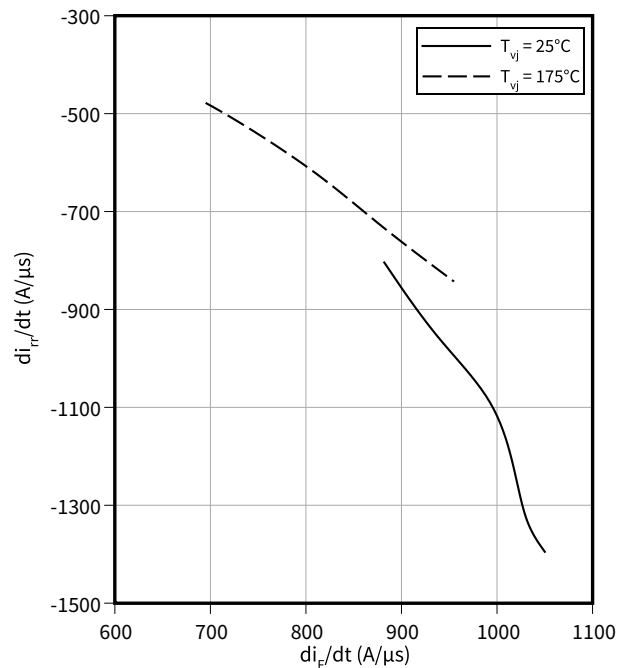
$V_R = 400\text{ V}, I_F = 50\text{ A}$



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

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

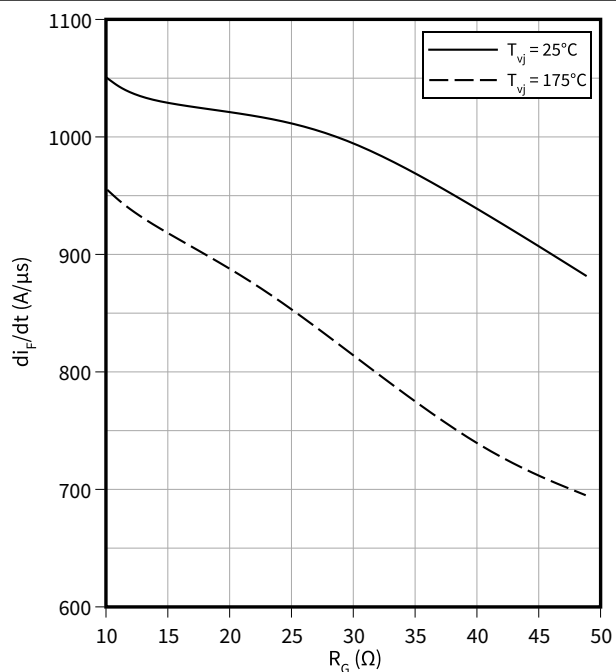
$V_R = 400\text{ V}, I_F = 50\text{ A}$



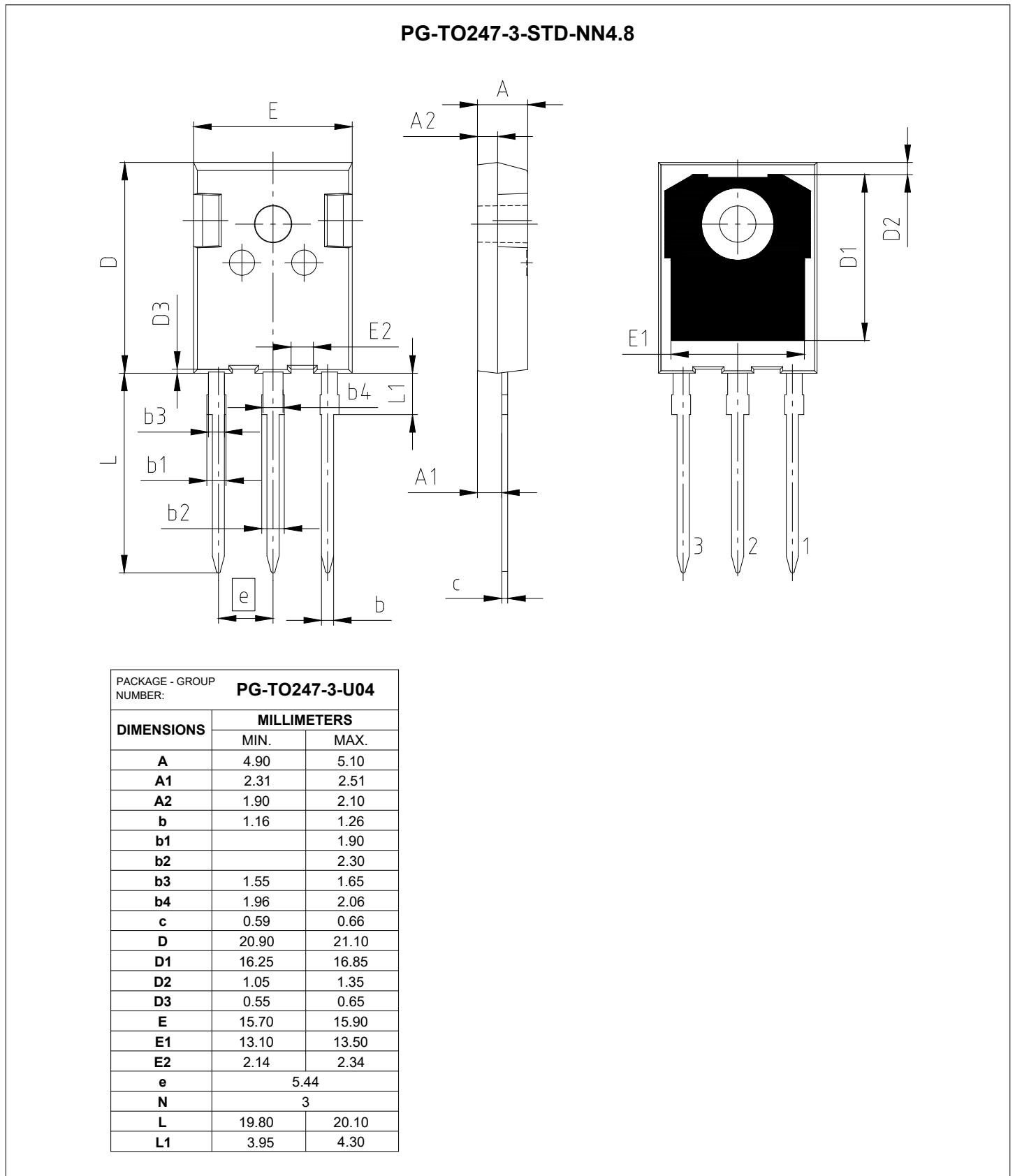
**Typical diode current slope as a function of gate resistor**

$di_F/dt = f(R_G)$

$V_R = 400\text{ V}, I_F = 50\text{ A}$



**5 Package outlines**



**Figure 1**

6 Testing conditions

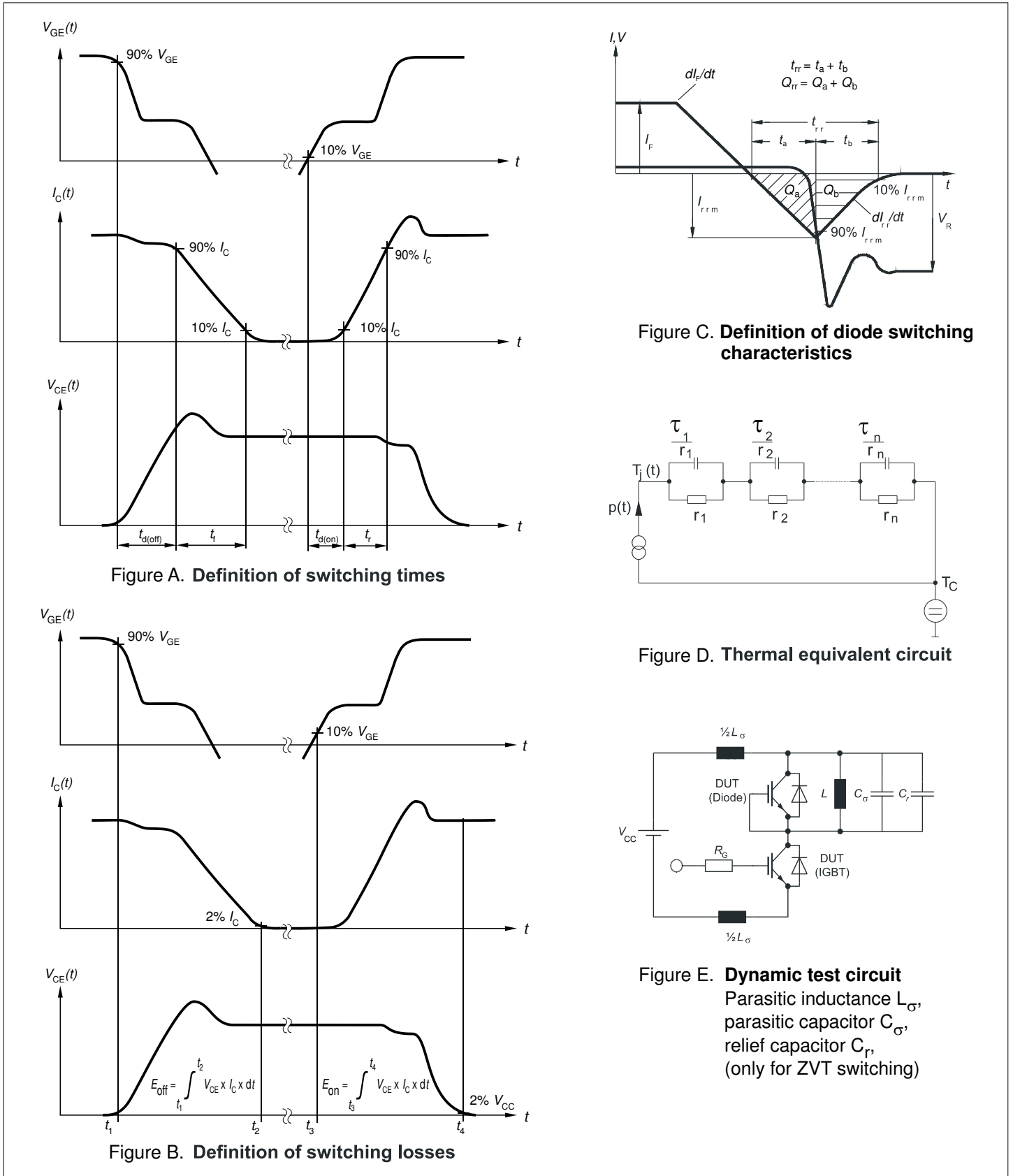


Figure 2

**Revision history**

<b>Document revision</b>	<b>Date of release</b>	<b>Description of changes</b>
1.00	2023-04-27	Final datasheet

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