

Final datasheet

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

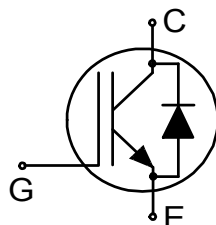
- Industrial UPS
- EV-Charging
- String inverter
- Welding

Product validation

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



Description



Type	Package	Marking
IKWH40N65EH7	PG-TO247-3-STD-NN4.8	K40EEH7



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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 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}	$T_{vj} \geq 25\text{ °C}$		650	V
DC collector current, limited by T_{vjmax}	I_C	limited by bondwire	$T_c = 25\text{ °C}$	80	A
			$T_c = 100\text{ °C}$	54	
Pulsed collector current, t_p limited by T_{vjmax}	I_{Cpulse}			160	A
Turn-off safe operating area		$V_{CE} \leq 650\text{ V}$, $t_p \leq 1\text{ }\mu\text{s}$, $T_{vj} \leq 175\text{ °C}$		160	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}		$T_c = 25\text{ °C}$	208	W
			$T_c = 100\text{ °C}$	103	

Table 3 Characteristic values

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

(table continues...)

Table 3 (continued) Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Turn-off energy	E_{off}	$V_{CC} = 400\text{ V}$, $V_{GE} = 0/15\text{ V}$, $R_{G(on)} = 12.5\ \Omega$, $R_{G(off)} = 12.5\ \Omega$	$T_{vj} = 25\text{ °C}$, $I_C = 40\text{ A}$	0.42		mJ
			$T_{vj} = 175\text{ °C}$, $I_C = 40\text{ A}$	0.69		
Total switching energy	E_{ts}	$V_{CC} = 400\text{ V}$, $V_{GE} = 0/15\text{ V}$, $R_{G(on)} = 12.5\ \Omega$, $R_{G(off)} = 12.5\ \Omega$	$T_{vj} = 25\text{ °C}$, $I_C = 40\text{ A}$	1.39		mJ
			$T_{vj} = 175\text{ °C}$, $I_C = 40\text{ A}$	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
Diode forward current, limited by T_{vjmax}	I_F	$T_c = 25\text{ °C}$	76	A
		$T_c = 100\text{ °C}$	49	
Diode pulsed current, t_p limited by T_{vjmax}	I_{Fpulse}		160	A
Power dissipation	P_{tot}	$T_c = 25\text{ °C}$	158	W
		$T_c = 100\text{ °C}$	78	

Table 5 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Diode forward voltage	V_F	$I_F = 40\text{ A}$	$T_{vj} = 25\text{ °C}$	1.65	2	V
			$T_{vj} = 175\text{ °C}$	1.55		
Diode reverse recovery time	t_{rr}	$V_R = 400\text{ V}$, $R_{G(on)} = 12.5\ \Omega$	$T_{vj} = 25\text{ °C}$, $I_F = 40\text{ A}$	74		ns
			$T_{vj} = 175\text{ °C}$, $I_F = 40\text{ A}$	112		
Diode reverse recovery charge	Q_{rr}	$V_R = 400\text{ V}$, $R_{G(on)} = 12.5\ \Omega$	$T_{vj} = 25\text{ °C}$, $I_F = 40\text{ A}$	0.9		μC
			$T_{vj} = 175\text{ °C}$, $I_F = 40\text{ A}$	2.1		

(table continues...)

Table 5 (continued) Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Diode peak reverse recovery current	I_{rrm}	$V_R = 400\text{ V}$, $R_{G(on)} = 12.5\ \Omega$	$T_{vj} = 25\text{ °C}$, $I_F = 40\text{ A}$		19.9		A
			$T_{vj} = 175\text{ °C}$, $I_F = 40\text{ A}$		29.8		
Diode peak rate of fall of reverse recovery current	di_{rr}/dt	$V_R = 400\text{ V}$, $R_{G(on)} = 12.5\ \Omega$	$T_{vj} = 25\text{ °C}$, $I_F = 40\text{ A}$		-1070		A/ μs
			$T_{vj} = 175\text{ °C}$, $I_F = 40\text{ A}$		-719		
Reverse recovery energy	E_{rec}	$V_R = 400\text{ V}$, $R_{G(on)} = 12.5\ \Omega$	$T_{vj} = 25\text{ °C}$, $I_F = 40\text{ A}$		0.16		mJ
			$T_{vj} = 175\text{ °C}$, $I_F = 40\text{ A}$		0.44		
Operating junction temperature	T_{vj}			-40		175	°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 $T_{vj} = 25\text{ °C}$, unless otherwise specified.

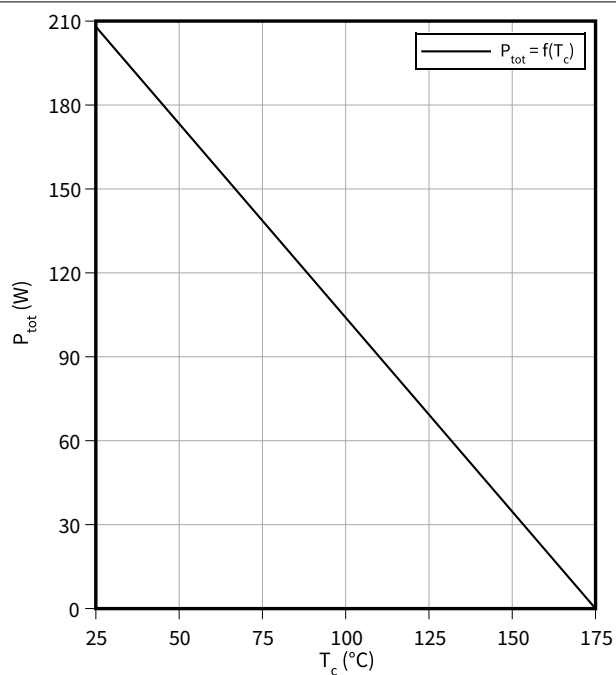
Dynamic test circuit, parasitic inductance $L_\sigma = 8\text{ nH}$, parasitic capacitor $C_\sigma = 30\text{ pF}$ from Fig. E. Energy losses include "tail" and diode reverse recovery.

4 Characteristics diagrams

Power dissipation as a function of case temperature

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

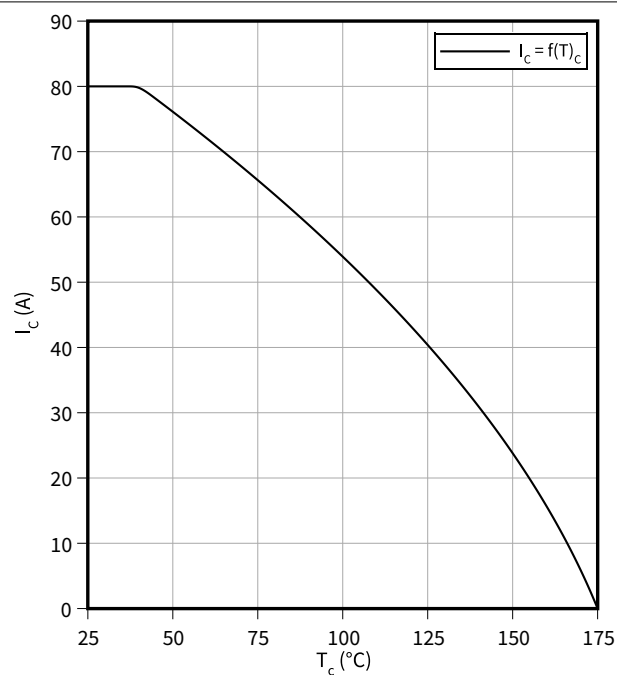
$$T_{vj} \leq 175^\circ\text{C}$$



Collector current as a function of case temperature

$$I_C = f(T_c)$$

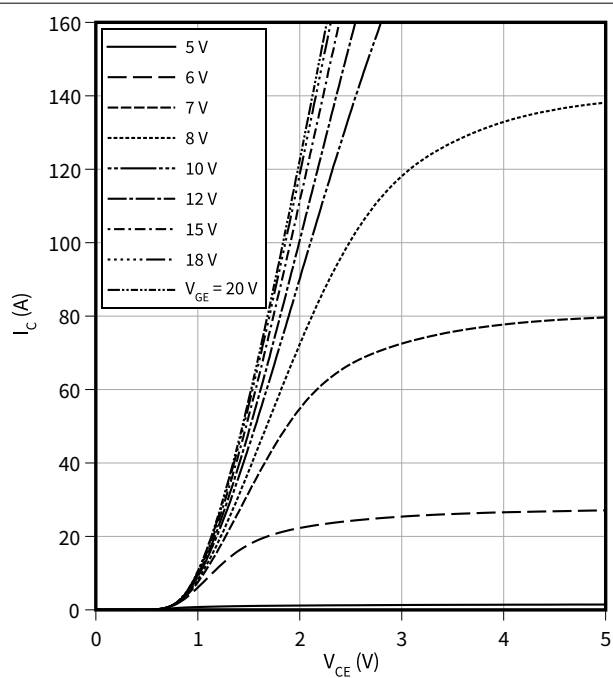
$$T_{vj} \leq 175^\circ\text{C}, V_{GE} \geq 15\text{ V}$$



Typical output characteristic

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

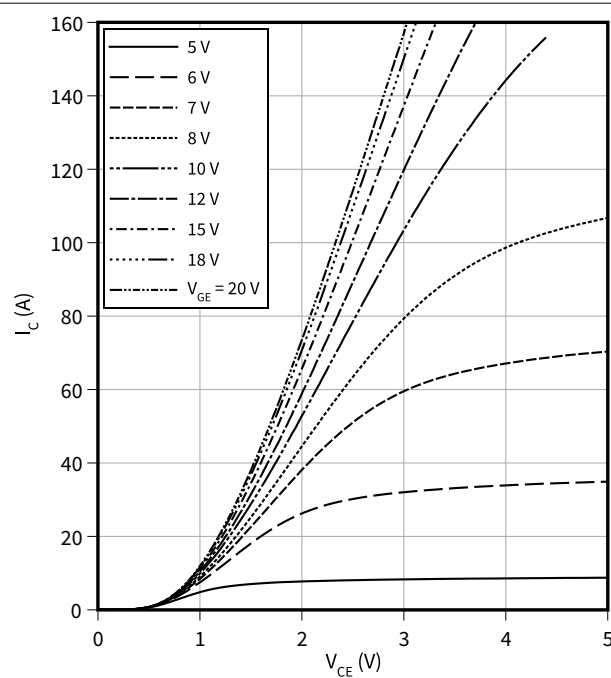
$$T_{vj} = 25^\circ\text{C}$$



Typical output characteristic

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

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

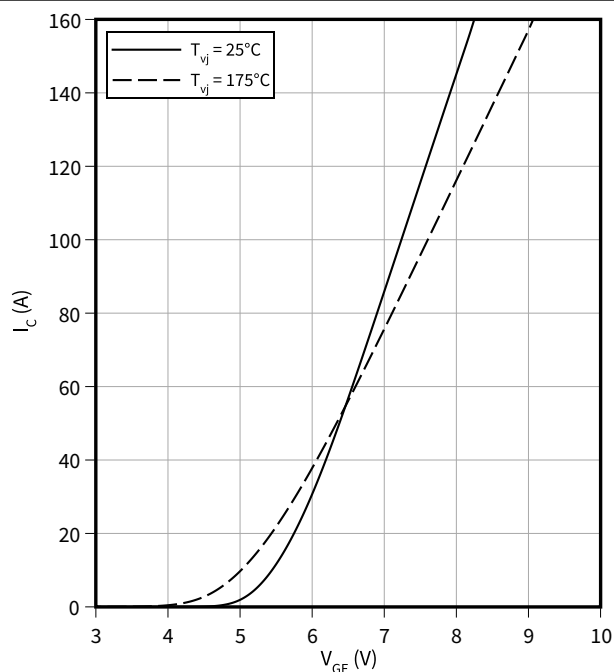


4 Characteristics diagrams

Typical transfer characteristic

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

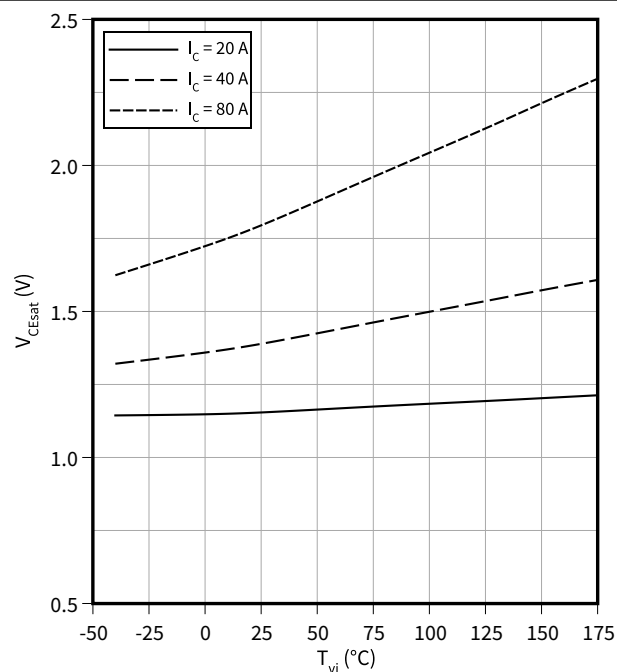
$$V_{CE} = 20 \text{ V}$$



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

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

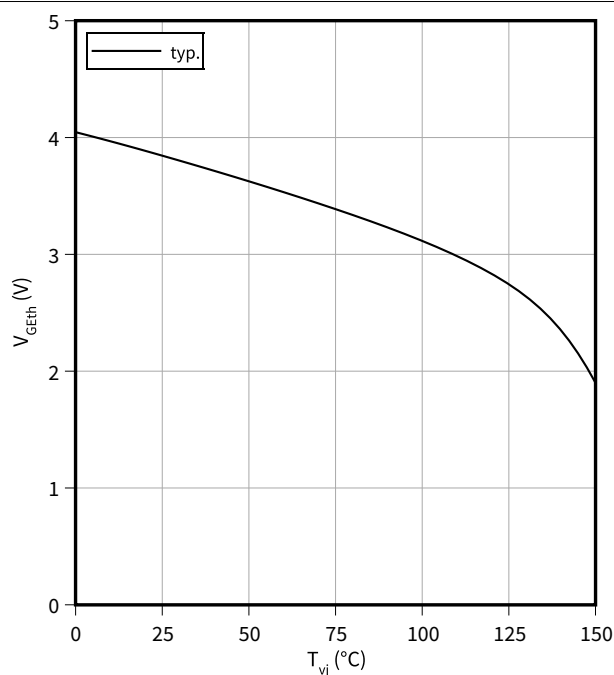
$$V_{GE} = 15 \text{ V}$$



Gate-emitter threshold voltage as a function of junction temperature

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

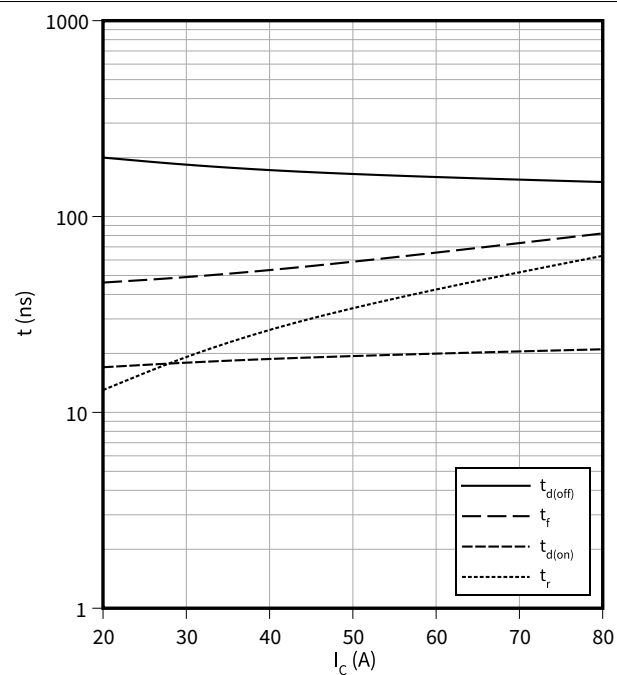
$$I_C = 0.35 \text{ mA}$$



Typical switching times as a function of collector current

$$t = f(I_C)$$

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

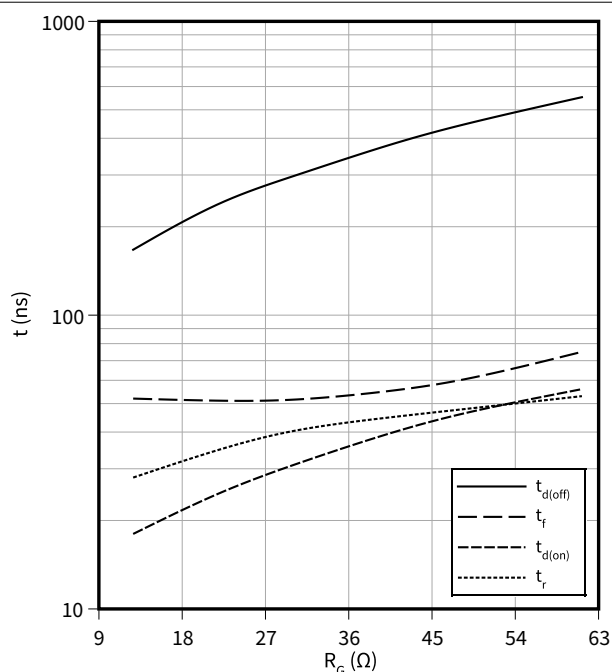


4 Characteristics diagrams

Typical switching times as a function of gate resistor

$$t = f(R_G)$$

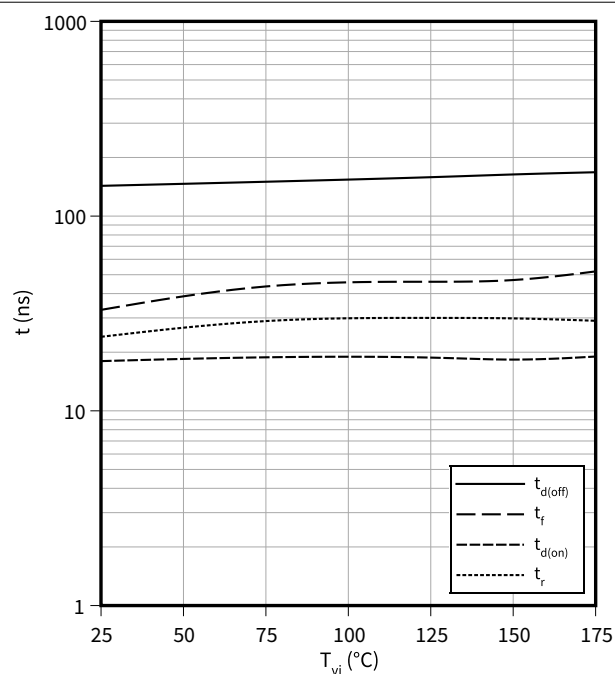
$$I_C = 40 \text{ A}, V_{CC} = 400 \text{ V}, T_{vj} = 175 \text{ }^{\circ}\text{C}, V_{GE} = 0/15 \text{ V}$$



Typical switching times as a function of junction temperature

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

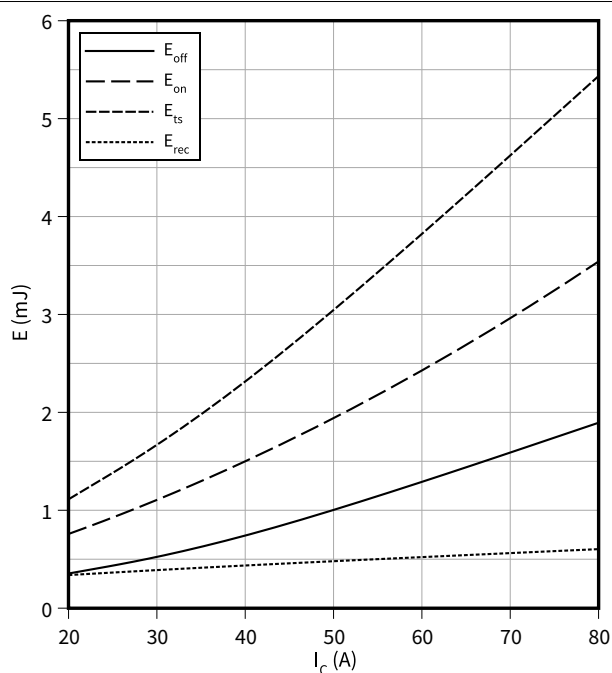
$$I_C = 40 \text{ A}, V_{CC} = 400 \text{ V}, V_{GE} = 0/15 \text{ V}, R_G = 12.5 \text{ } \Omega$$



Typical switching energy losses as a function of collector current

$$E = f(I_C)$$

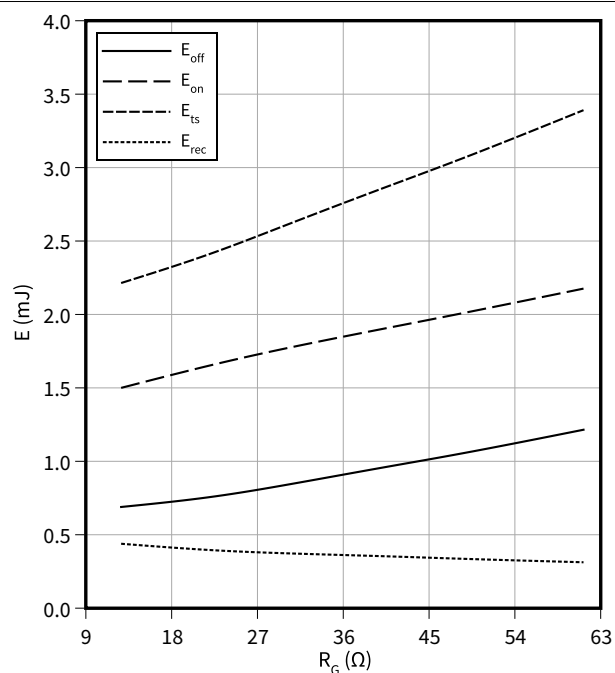
$$V_{CC} = 400 \text{ V}, T_{vj} = 175 \text{ }^{\circ}\text{C}, V_{GE} = 0/15 \text{ V}, R_G = 12.5 \text{ } \Omega$$



Typical switching energy losses as a function of gate resistor

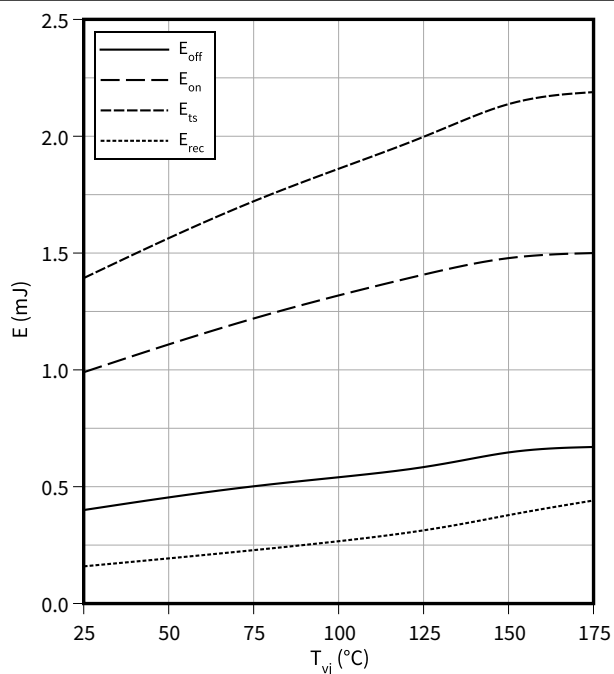
$$E = f(R_G)$$

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

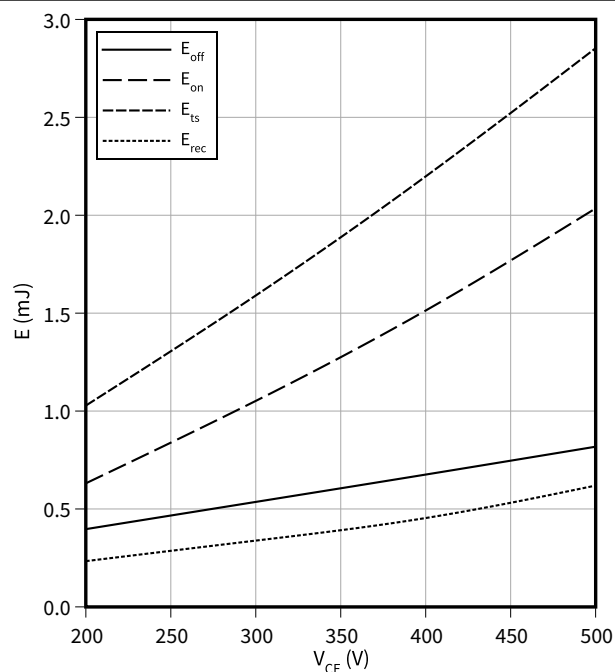


4 Characteristics diagrams
Typical switching energy losses as a function of junction temperature

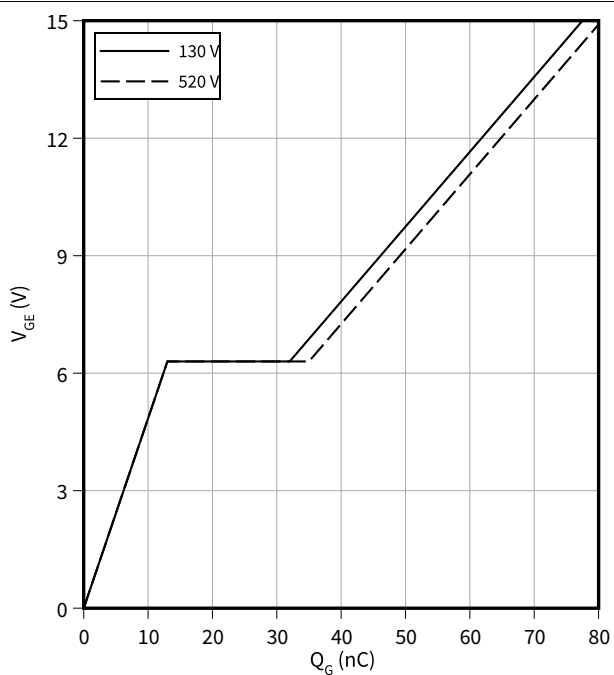
$$E = f(T_{vj})$$

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

Typical switching energy losses as a function of collector emitter voltage

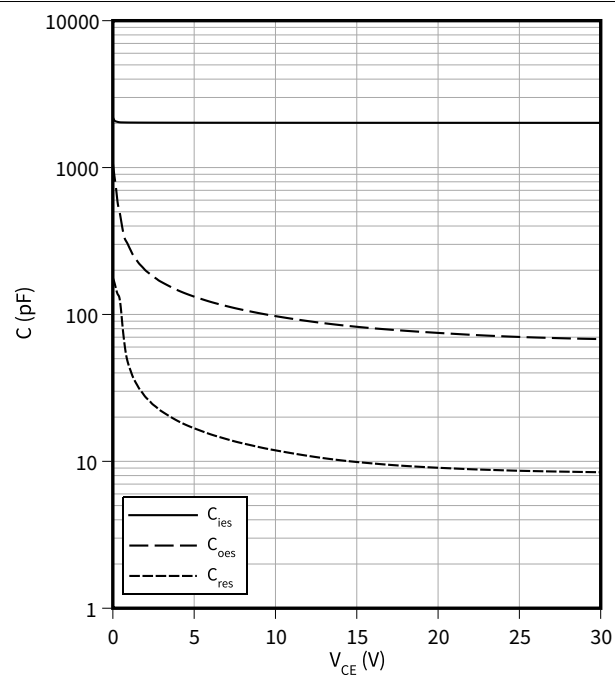
$$E = f(V_{CE})$$

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

Typical gate charge

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

 $I_C = 40 \text{ A}$

Typical capacitance as a function of collector-emitter voltage

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

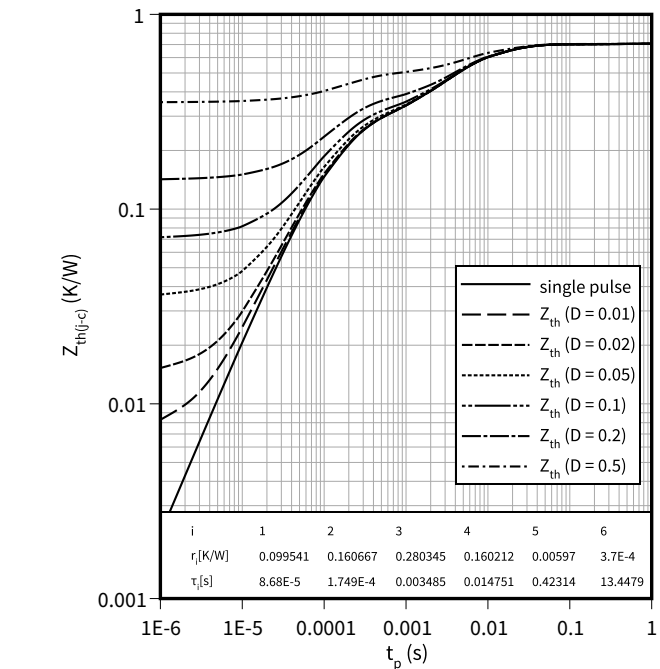
 $f = 100 \text{ kHz}, V_{GE} = 0 \text{ V}$


4 Characteristics diagrams

IGBT transient thermal impedance as a function of pulse width

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

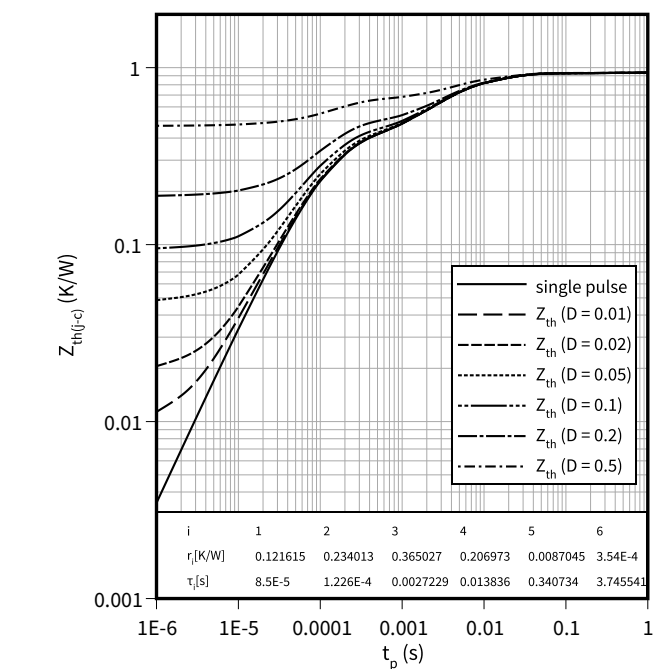
$$D = t_p/T$$



Diode transient thermal impedance as a function of pulse width

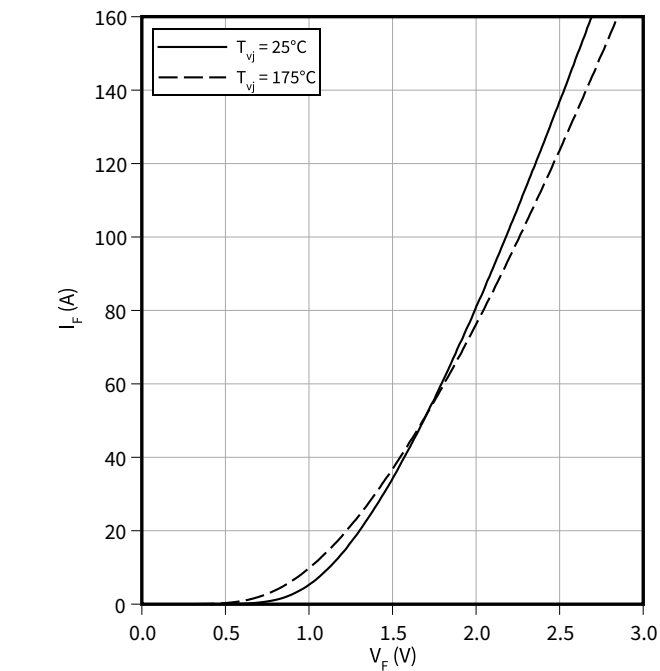
$$Z_{th(j-c)} = f(t_p)$$

$$D = t_p/T$$



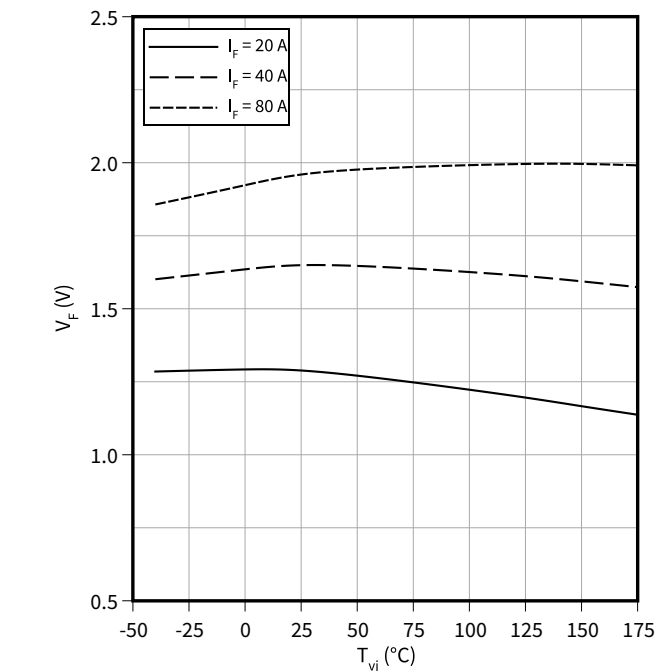
Typical diode forward current as a function of forward voltage

$$I_F = f(V_F)$$



Typical diode forward voltage as a function of junction temperature

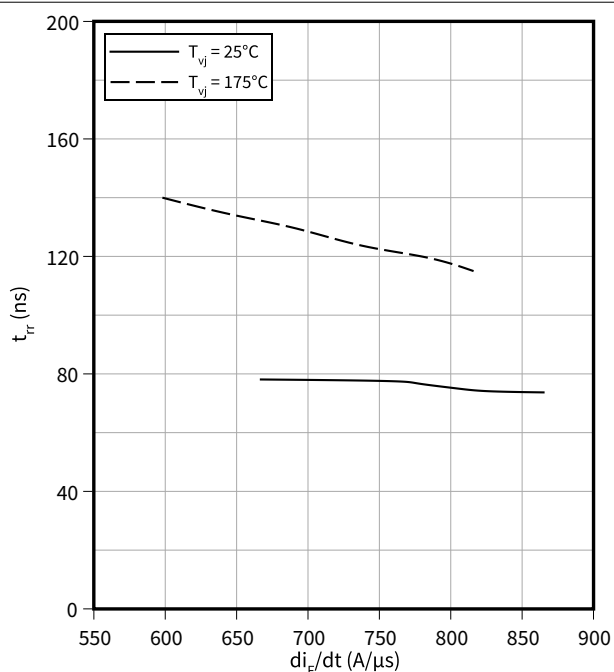
$$V_F = f(T_{vj})$$



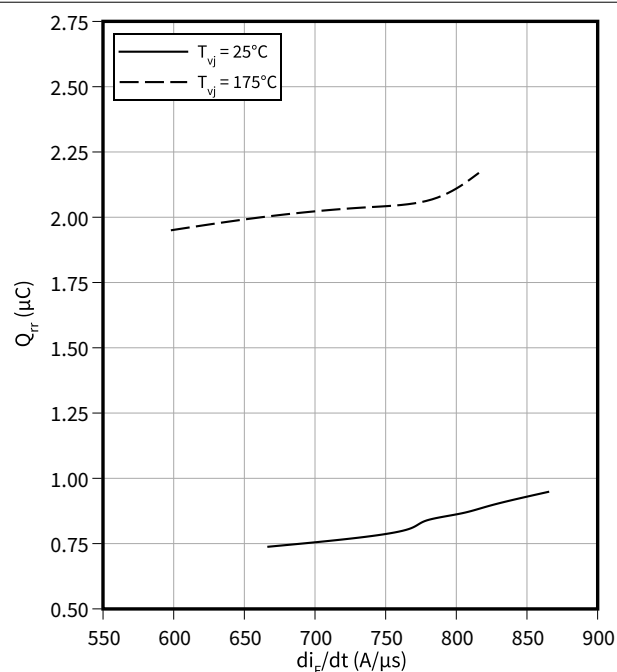
4 Characteristics diagrams

Typical reverse recovery time as a function of diode current slope

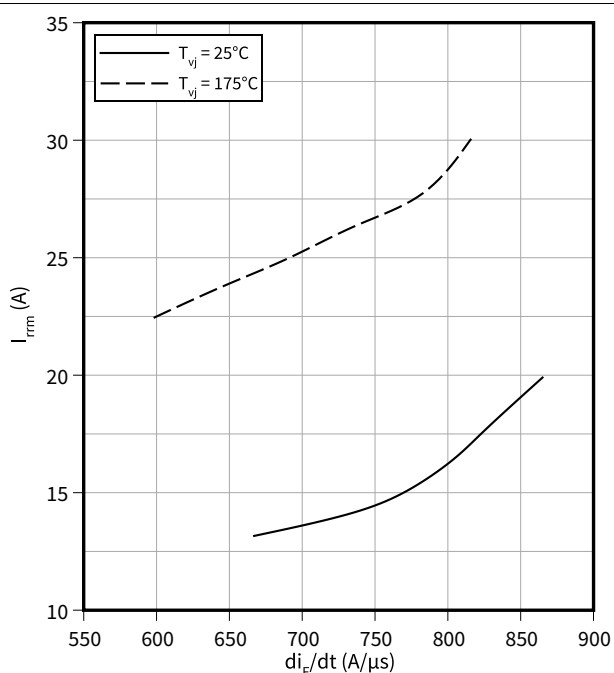
$$t_{rr} = f(di_F/dt)$$

 $I_F = 40 \text{ A}, V_R = 400 \text{ V}$
**Typical reverse recovery charge as a function of diode current slope**

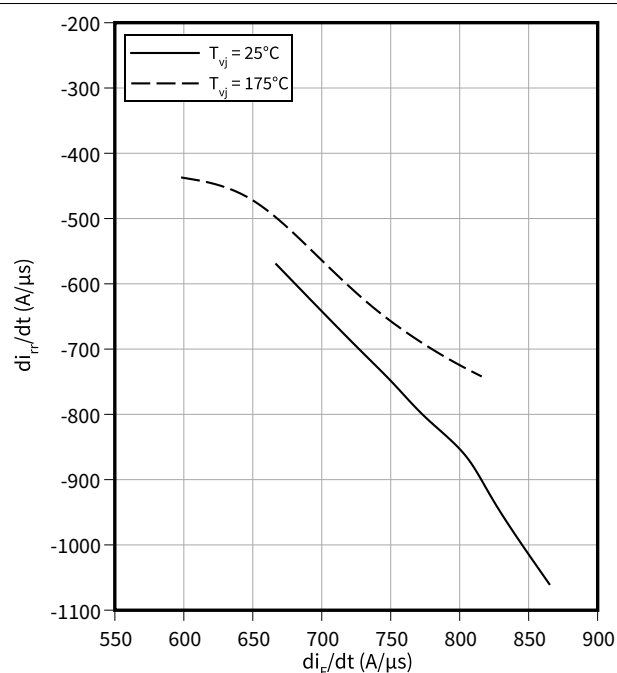
$$Q_{rr} = f(di_F/dt)$$

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

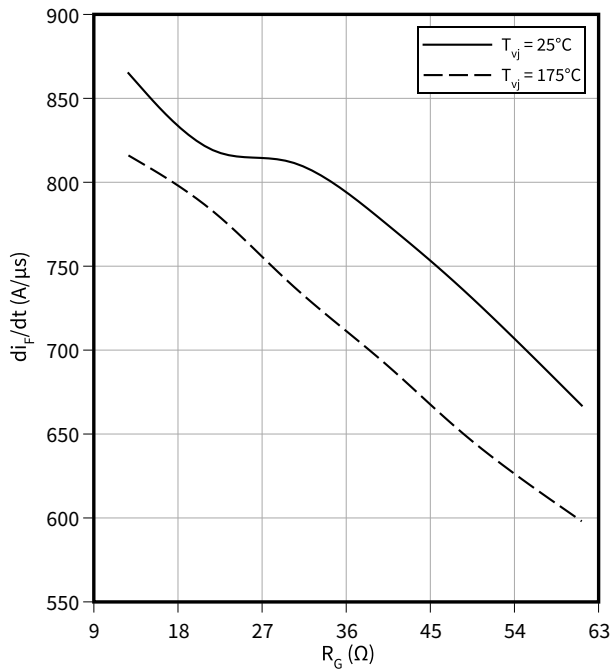
$$di_{rr}/dt = f(di_F/dt)$$

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


4 Characteristics diagrams

Typical diode current slope as a function of gate resistor

$di_F/dt = f(R_G)$
 $V_R = 400\text{ V}, I_F = 40\text{ A}$



5 Package outlines

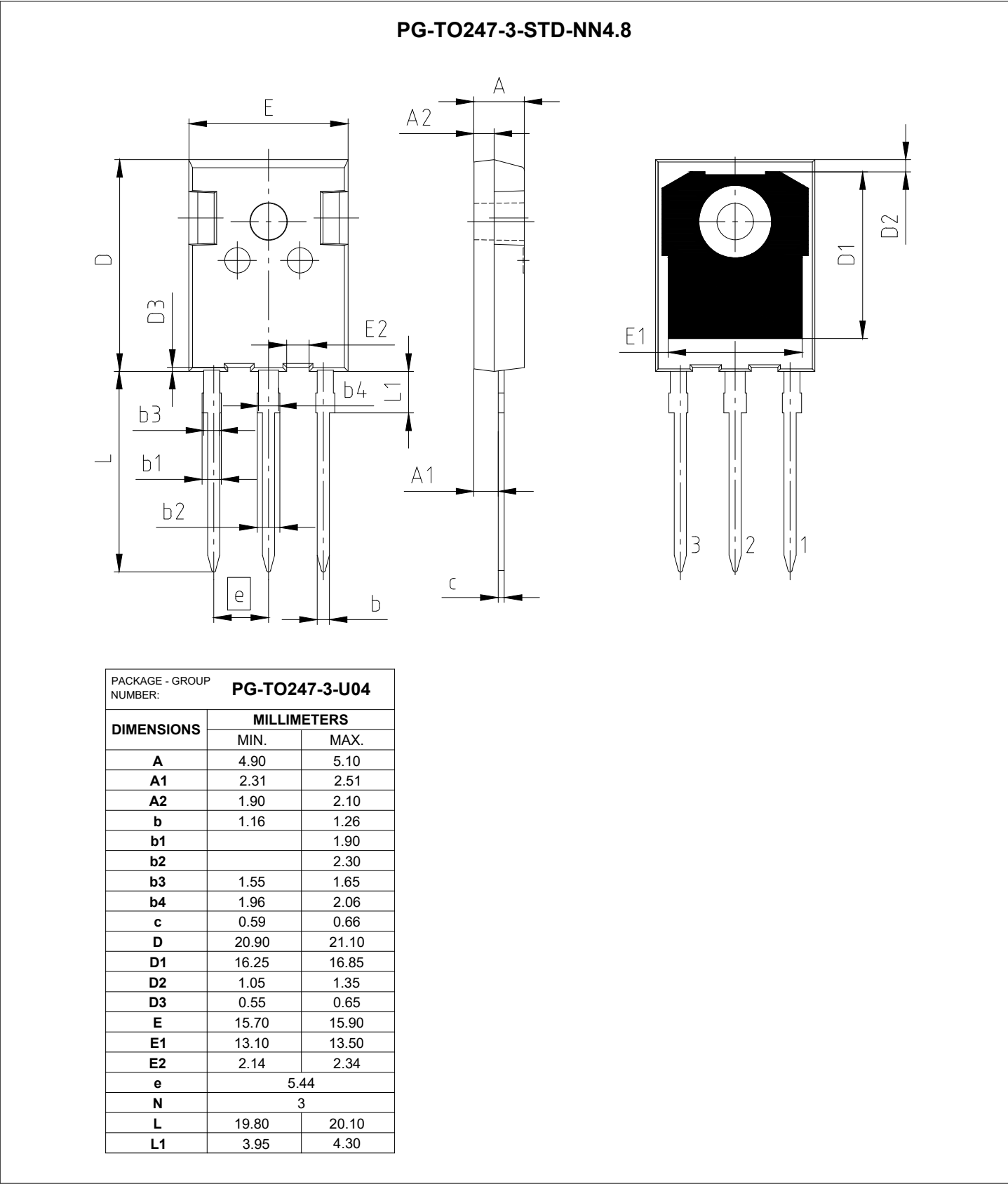


Figure 1

6 Testing conditions



Figure A. Definition of switching times

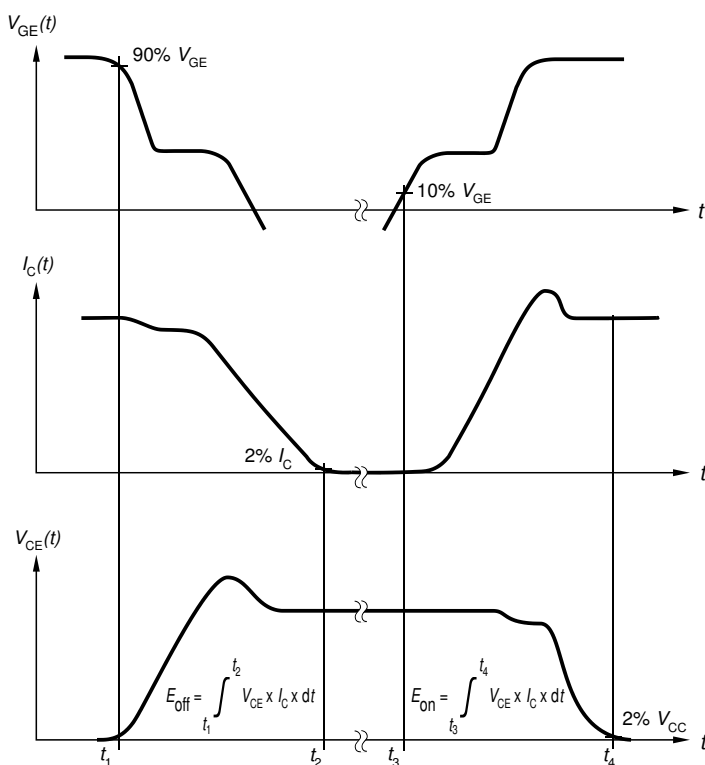


Figure B. Definition of switching losses

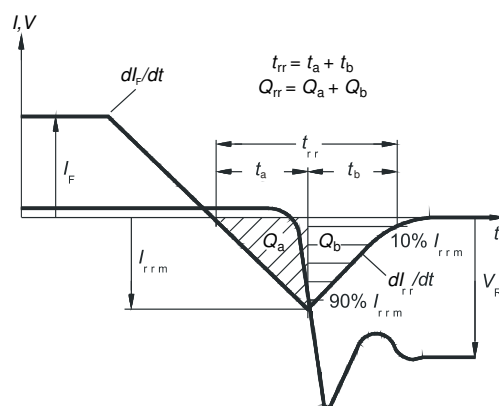


Figure C. Definition of diode switching characteristics

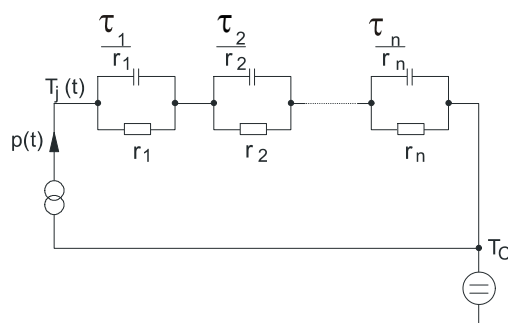


Figure D. Thermal equivalent circuit

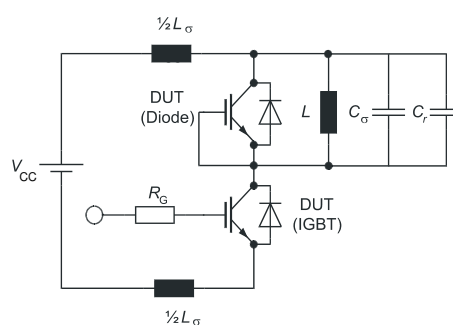


Figure E. Dynamic test circuit
Parasitic inductance L_σ ,
parasitic capacitor C_σ ,
relief capacitor C_r ,
(only for ZVT switching)

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 $V_{GE} = f(Q_G)$
1.20	2023-11-13	Update of E_{ts} temperature conditions in Table 3 Update of energy diagrams

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