

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

Features

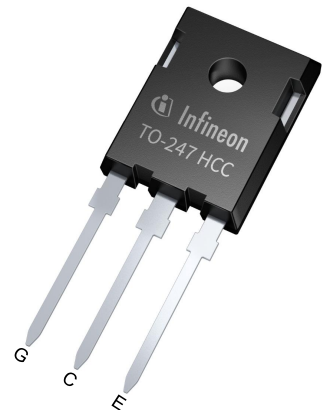
- $V_{CE} = 650\text{ V}$
- $I_C = 40\text{ A}$
- Low switching losses
- Very low collector-emitter saturation voltage V_{CEsat}
- Very soft, fast recovery antiparallel diode
- Smooth switching behavior
- Humidity robustness
- Optimized for hard switching, two- and three-level topologies
- Complete product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

Potential applications

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

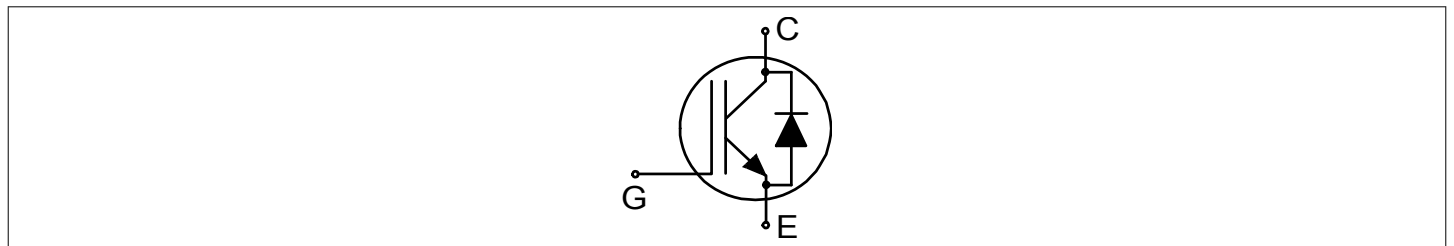
Product validation

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



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

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	$t_{d(on)}$	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V}, R_{G(on)} = 12.5\ \Omega, R_{G(off)} = 12.5\ \Omega$	$T_{vj} = 25\text{ °C}, I_C = 40\text{ A}$		18		ns
			$T_{vj} = 175\text{ °C}, I_C = 40\text{ A}$		18		
Rise time (inductive load)	t_r	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V}, R_{G(on)} = 12.5\ \Omega, R_{G(off)} = 12.5\ \Omega$	$T_{vj} = 25\text{ °C}, I_C = 40\text{ A}$		25		ns
			$T_{vj} = 175\text{ °C}, I_C = 40\text{ A}$		28		
Turn-off delay time	$t_{d(off)}$	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V}, R_{G(on)} = 12.5\ \Omega, R_{G(off)} = 12.5\ \Omega$	$T_{vj} = 25\text{ °C}, I_C = 40\text{ A}$		141		ns
			$T_{vj} = 175\text{ °C}, I_C = 40\text{ A}$		167		
Fall time (inductive load)	t_f	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V}, R_{G(on)} = 12.5\ \Omega, R_{G(off)} = 12.5\ \Omega$	$T_{vj} = 25\text{ °C}, I_C = 40\text{ A}$		34		ns
			$T_{vj} = 175\text{ °C}, I_C = 40\text{ A}$		52		
Turn-on energy	E_{on}	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V}, R_{G(on)} = 12.5\ \Omega, R_{G(off)} = 12.5\ \Omega$	$T_{vj} = 25\text{ °C}, I_C = 40\text{ A}$		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}	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V},$ $R_{G(on)} = 12.5\ \Omega,$ $R_{G(off)} = 12.5\ \Omega$	$T_{vj} = 25\ ^\circ\text{C},$ $I_C = 40\text{ A}$		0.42		mJ
			$T_{vj} = 175\ ^\circ\text{C},$ $I_C = 40\text{ A}$		0.69		
Total switching energy	E_{ts}	$V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V},$ $R_{G(on)} = 12.5\ \Omega,$ $R_{G(off)} = 12.5\ \Omega$	$T_{vj} = 25\ ^\circ\text{C},$ $I_C = 40\text{ A}$		1.39		mJ
			$T_{vj} = 25\ ^\circ\text{C},$ $I_C = 40\text{ A}$		2.19		
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		$T_c = 25\ ^\circ\text{C}$	76	A
			$T_c = 100\ ^\circ\text{C}$	49	
Diode pulsed current, t_p limited by T_{vjmax}	I_{Fpulse}		160	A	
Power dissipation	P_{tot}		$T_c = 25\ ^\circ\text{C}$	158	W
			$T_c = 100\ ^\circ\text{C}$	78	

Table 5 Characteristic values

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

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

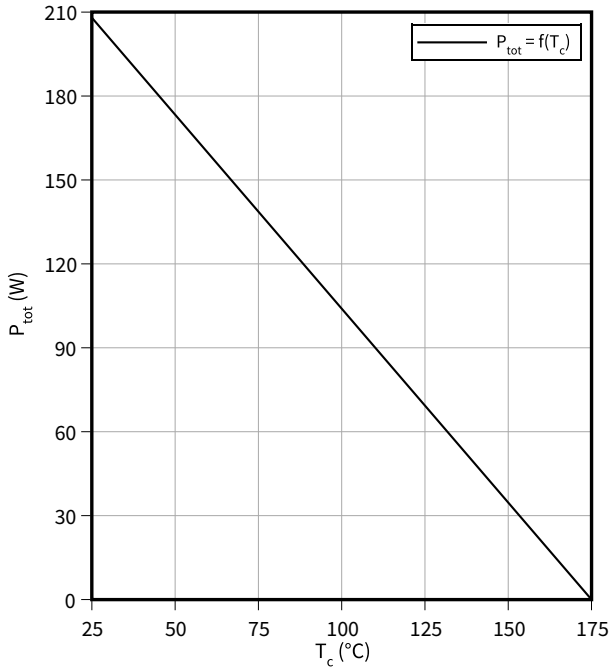
Electrical Characteristic at $T_{vj} = 25\text{ °C}$, unless otherwise specified.

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

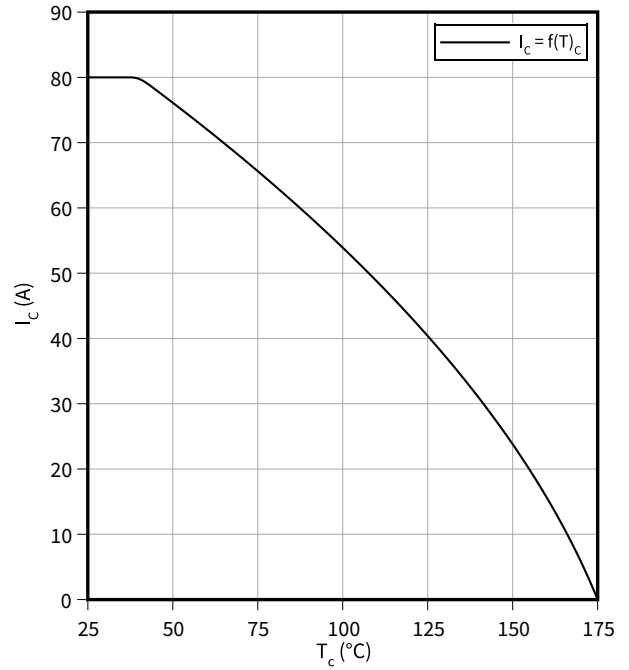
Power dissipation as a function of case temperature

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



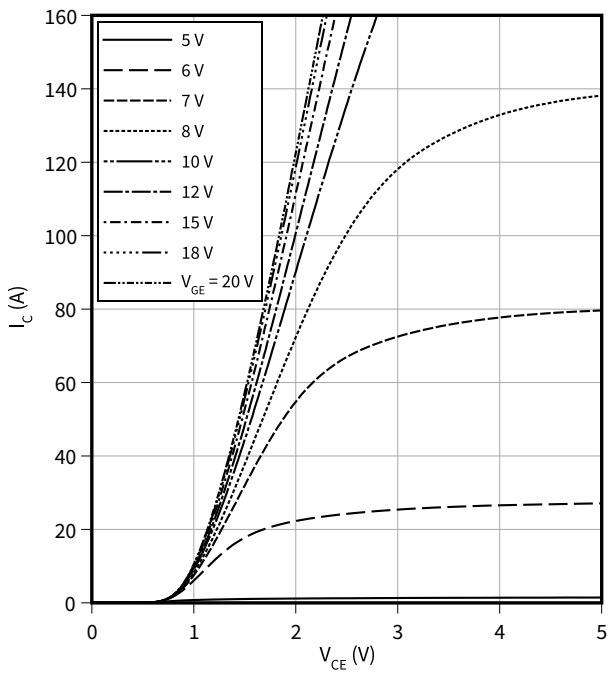
Collector current as a function of case temperature

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



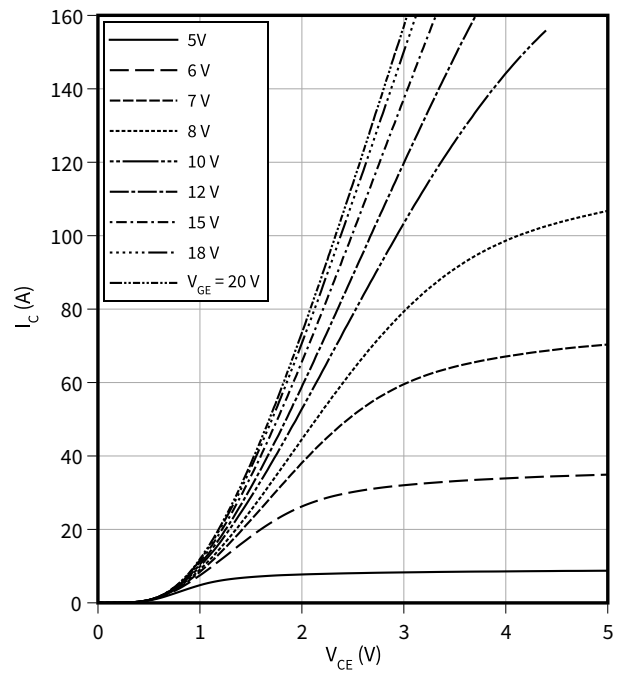
Typical output characteristic

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



Typical output characteristic

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

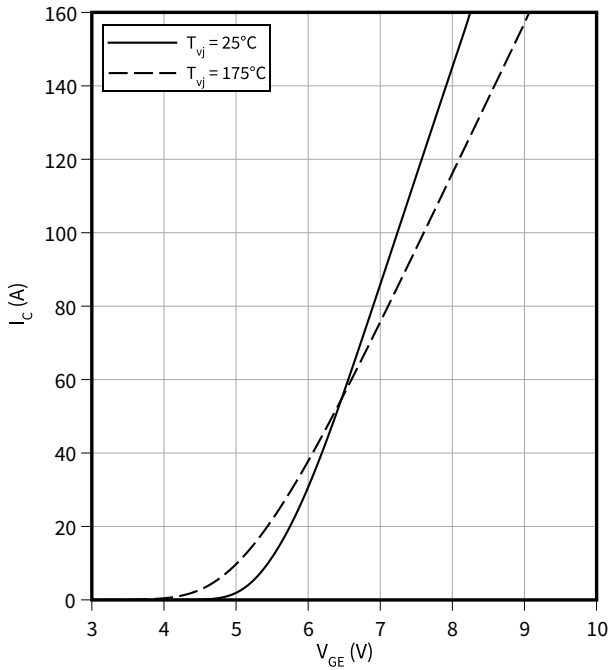


4 Characteristics diagrams

Typical transfer characteristic

$I_C = f(V_{GE})$

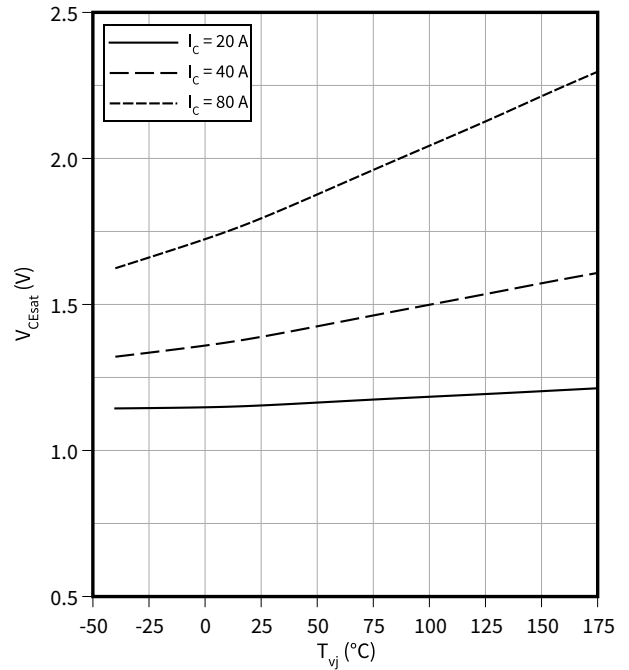
$V_{CE} = 20\text{ V}$



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

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

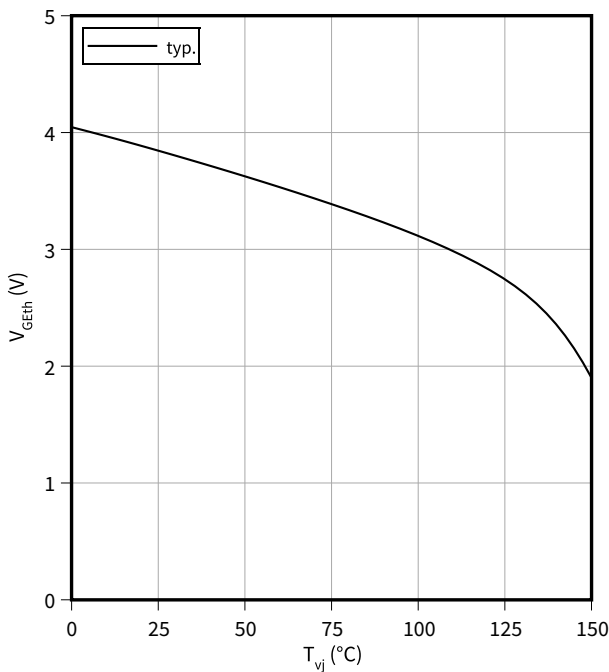
$V_{GE} = 15\text{ V}$



Gate-emitter threshold voltage as a function of junction temperature

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

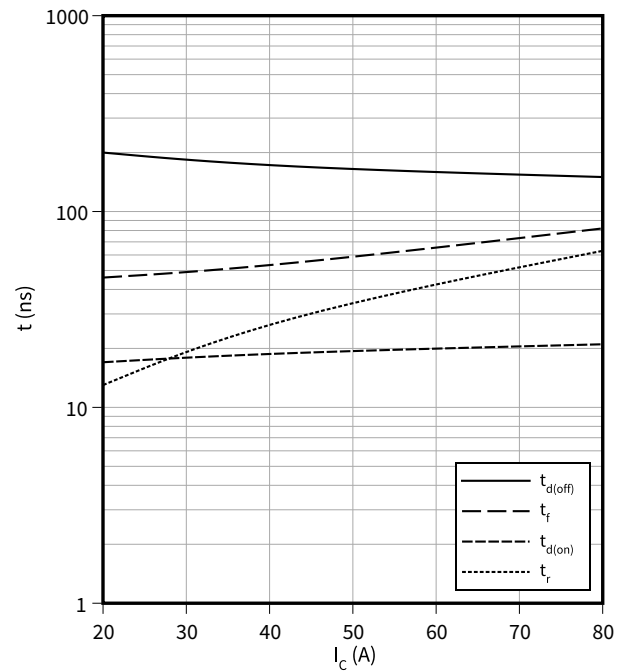
$I_C = 0.35\text{ mA}$



Typical switching times as a function of collector current

$t = f(I_C)$

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

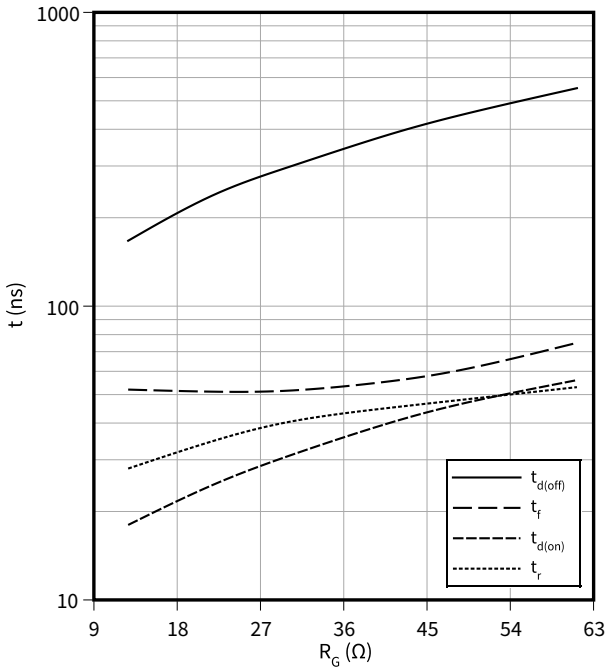


4 Characteristics diagrams

Typical switching times as a function of gate resistor

$t = f(R_G)$

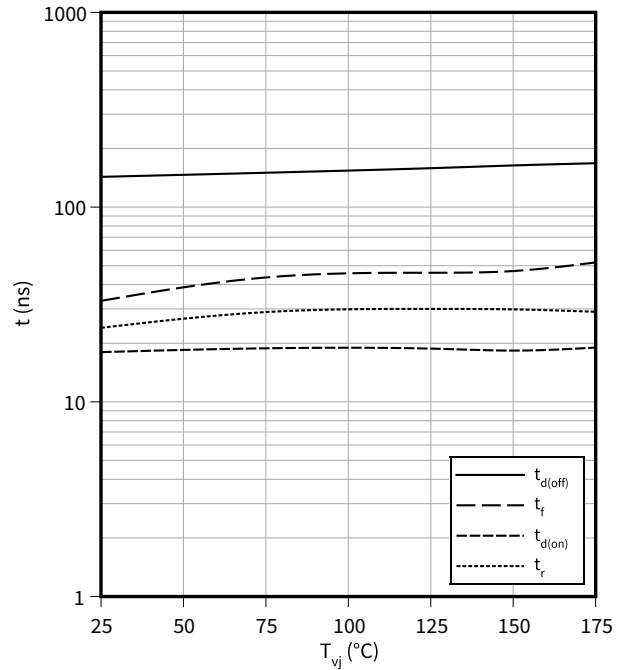
$I_C = 40\text{ A}, V_{CC} = 400\text{ V}, T_{vj} = 175\text{ °C}, V_{GE} = 0/15\text{ V}$



Typical switching times as a function of junction temperature

$t = f(T_{vj})$

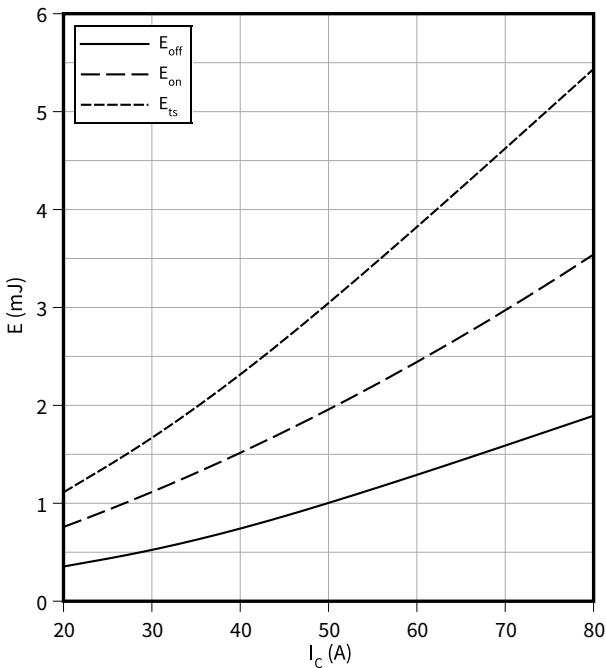
$I_C = 40\text{ A}, V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V}, R_G = 12.5\text{ }\Omega$



Typical switching energy losses as a function of collector current

$E = f(I_C)$

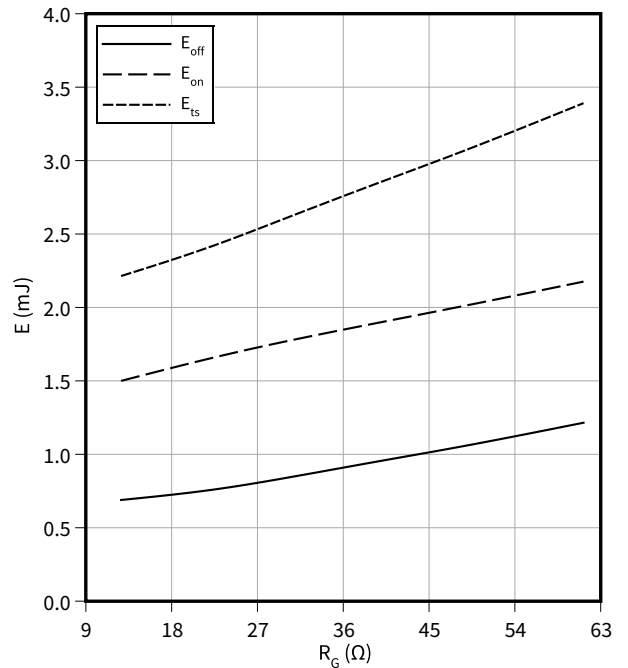
$V_{CC} = 400\text{ V}, T_{vj} = 175\text{ °C}, V_{GE} = 0/15\text{ V}, R_G = 12.5\text{ }\Omega$



Typical switching energy losses as a function of gate resistor

$E = f(R_G)$

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

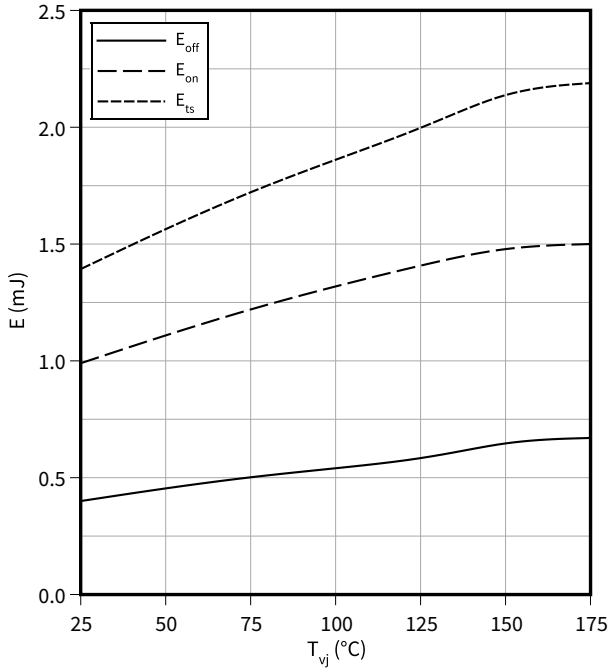


4 Characteristics diagrams

Typical switching energy losses as a function of junction temperature

$E = f(T_{vj})$

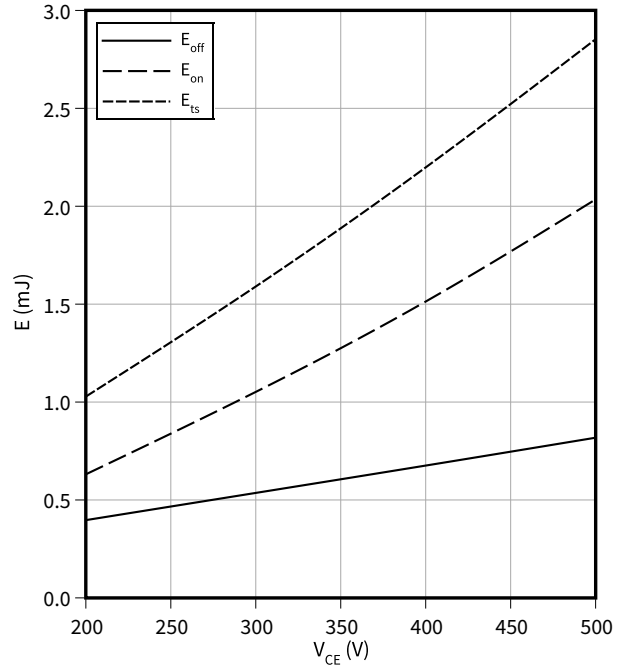
$I_C = 40\text{ A}$, $V_{CC} = 400\text{ V}$, $V_{GE} = 0/15\text{ V}$, $R_G = 12.5\ \Omega$



Typical switching energy losses as a function of collector emitter voltage

$E = f(V_{CE})$

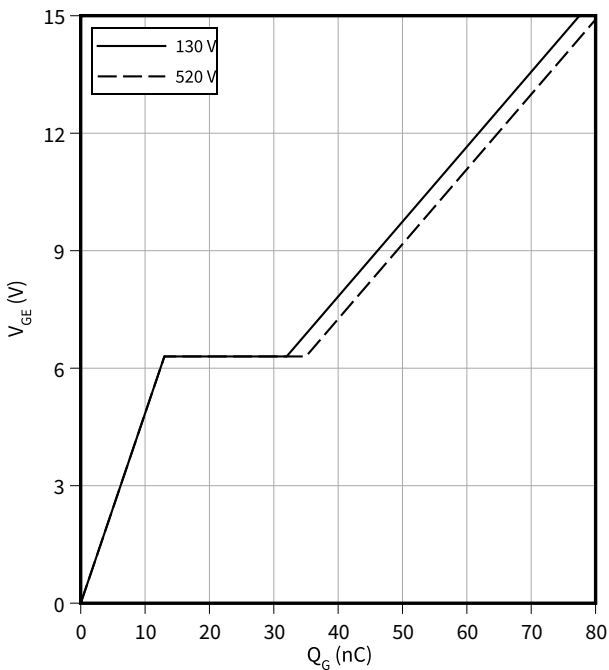
$I_C = 40\text{ A}$, $T_{vj} = 175\text{ °C}$, $V_{GE} = 0/15\text{ V}$, $R_G = 12.5\ \Omega$



Typical gate charge

$V_{GE} = f(Q_G)$

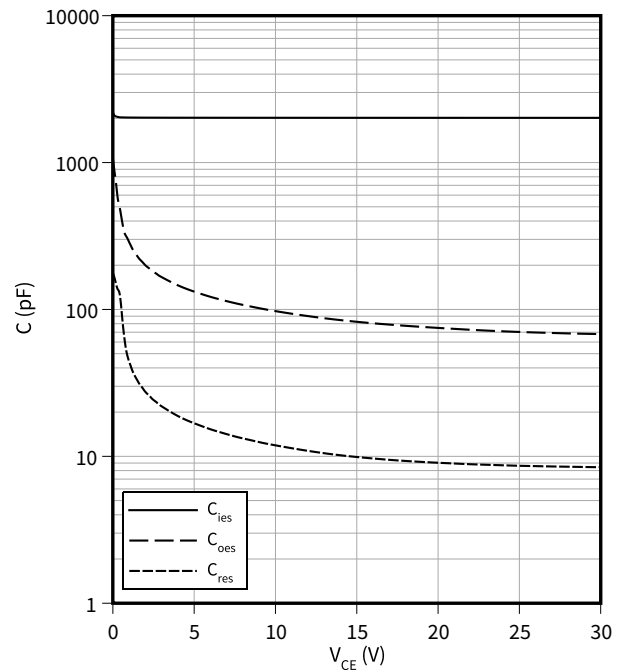
$I_C = 40\text{ A}$



Typical capacitance as a function of collector-emitter voltage

$C = f(V_{CE})$

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

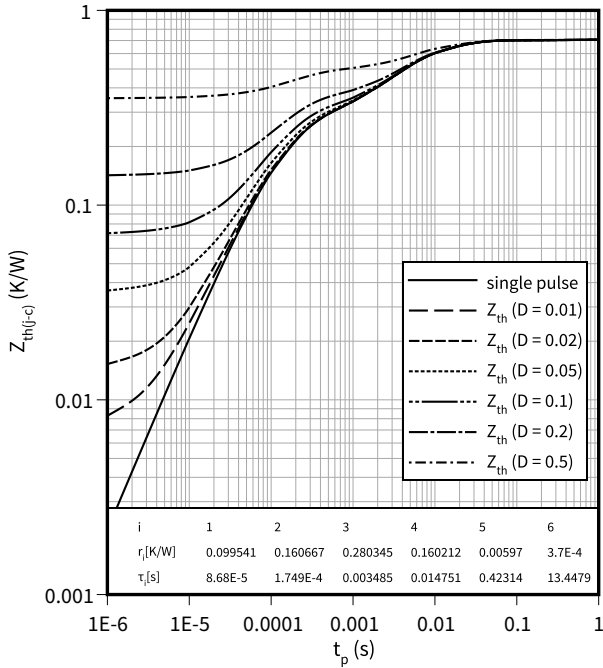


4 Characteristics diagrams

IGBT transient thermal impedance as a function of pulse width

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

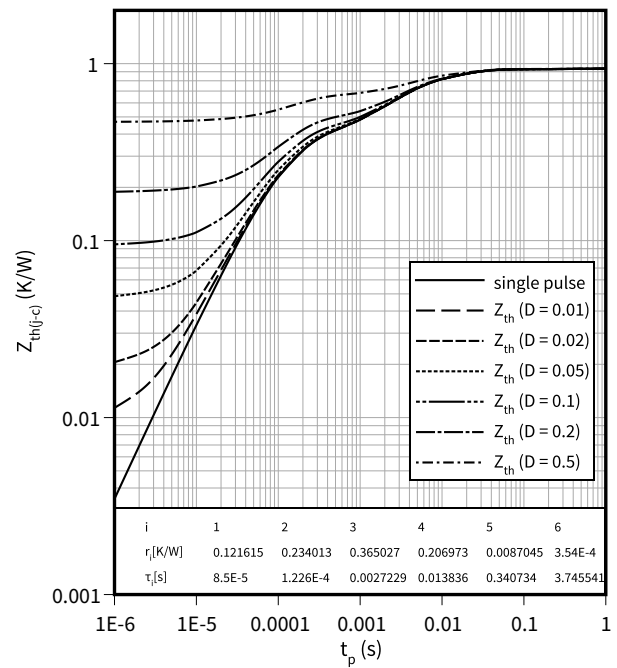
$$D = t_p/T$$



Diode transient thermal impedance as a function of pulse width

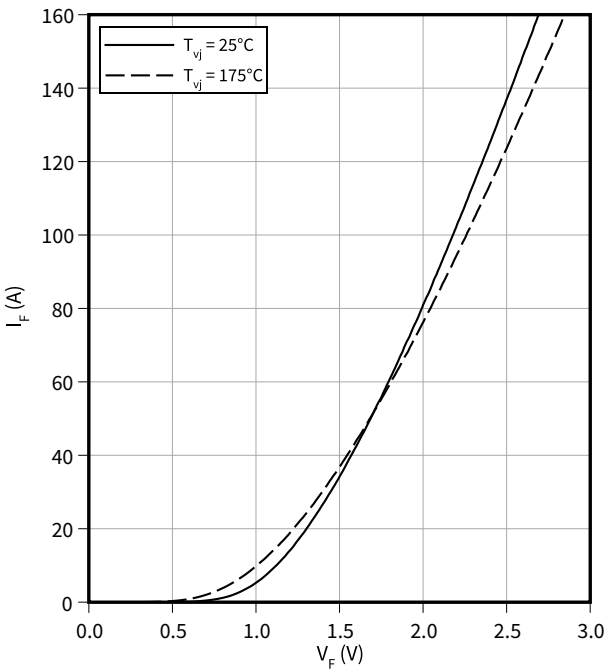
$$Z_{th(j-c)} = f(t_p)$$

$$D = t_p/T$$



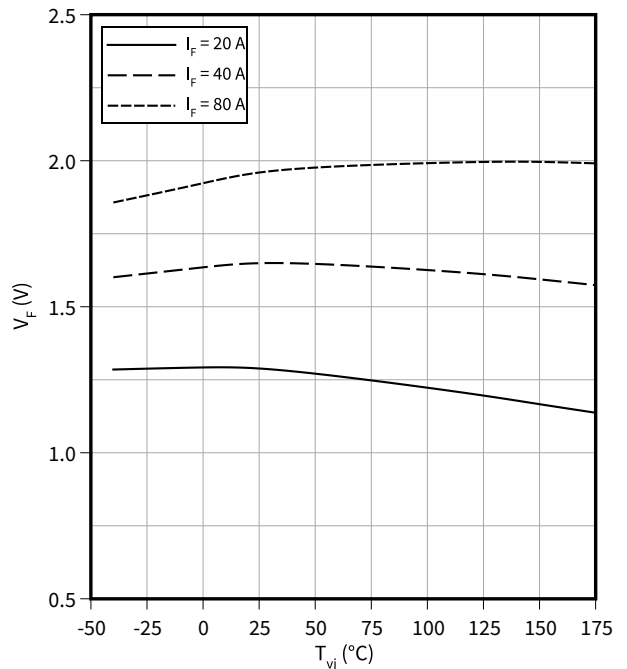
Typical diode forward current as a function of forward voltage

$$I_F = f(V_F)$$



Typical diode forward voltage as a function of junction temperature

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

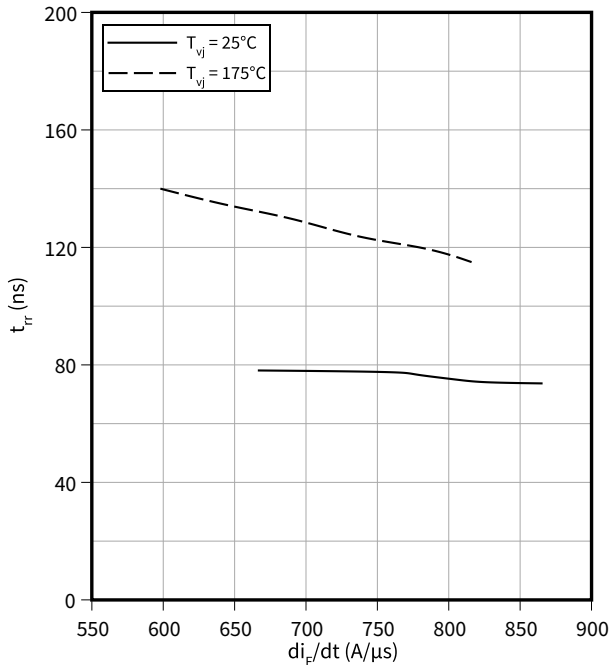


4 Characteristics diagrams

Typical reverse recovery time as a function of diode current slope

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

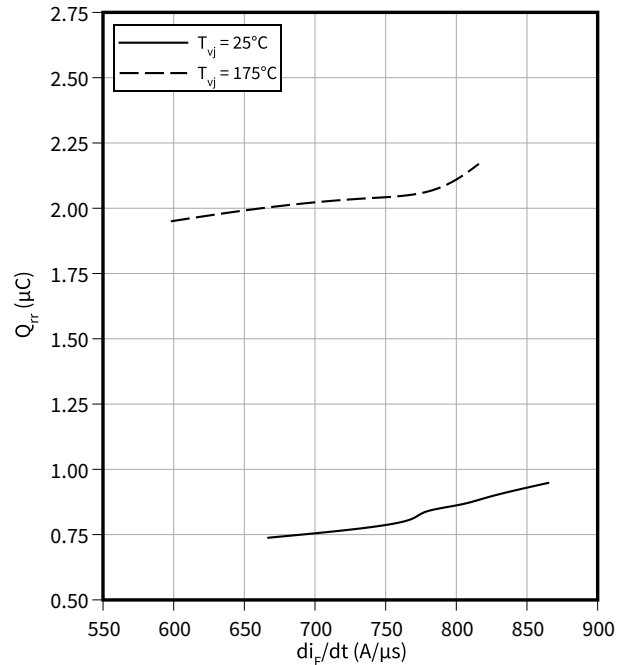
$I_F = 40\text{ A}, V_R = 400\text{ V}$



Typical reverse recovery charge as a function of diode current slope

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

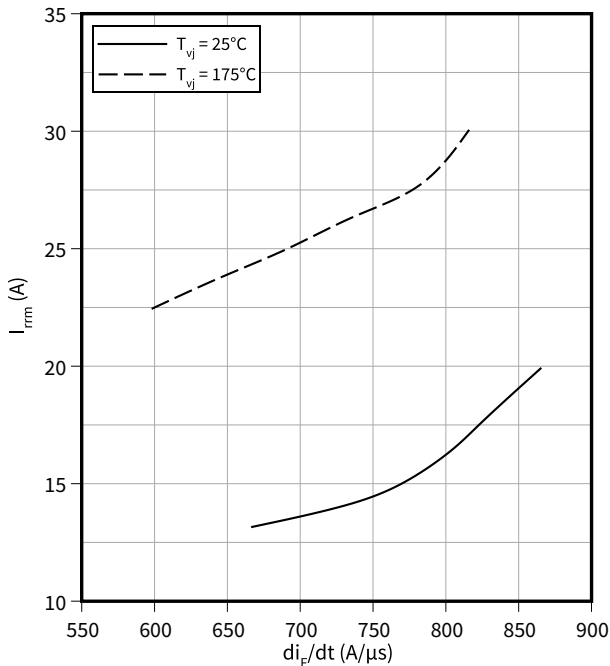
$V_R = 400\text{ V}, I_F = 40\text{ A}$



Typical reverse recovery current as a function of diode current slope

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

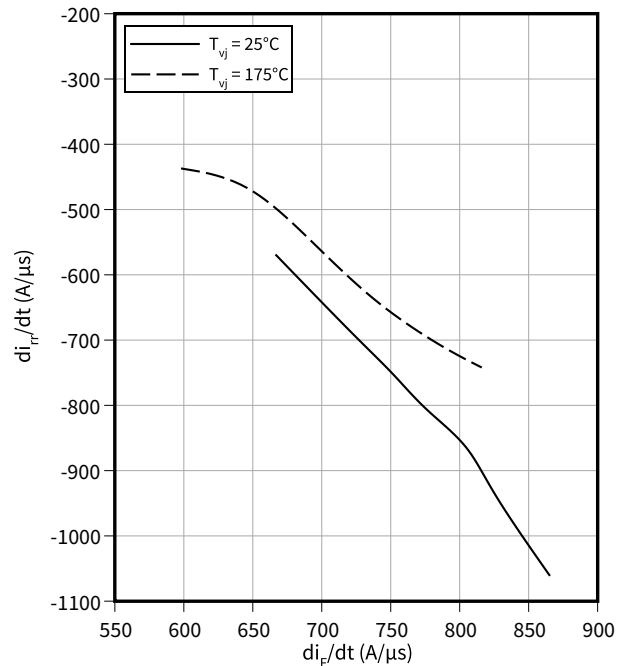
$V_R = 400\text{ V}, I_F = 40\text{ A}$



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

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

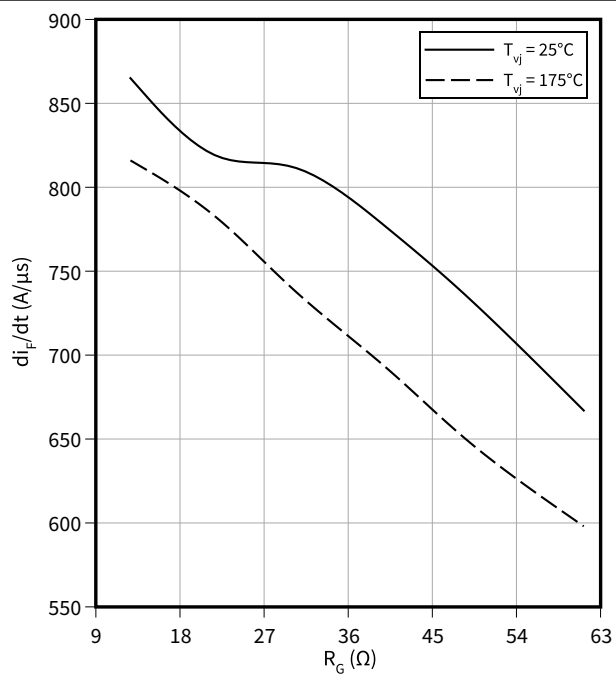
$V_R = 400\text{ V}, I_F = 40\text{ A}$



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

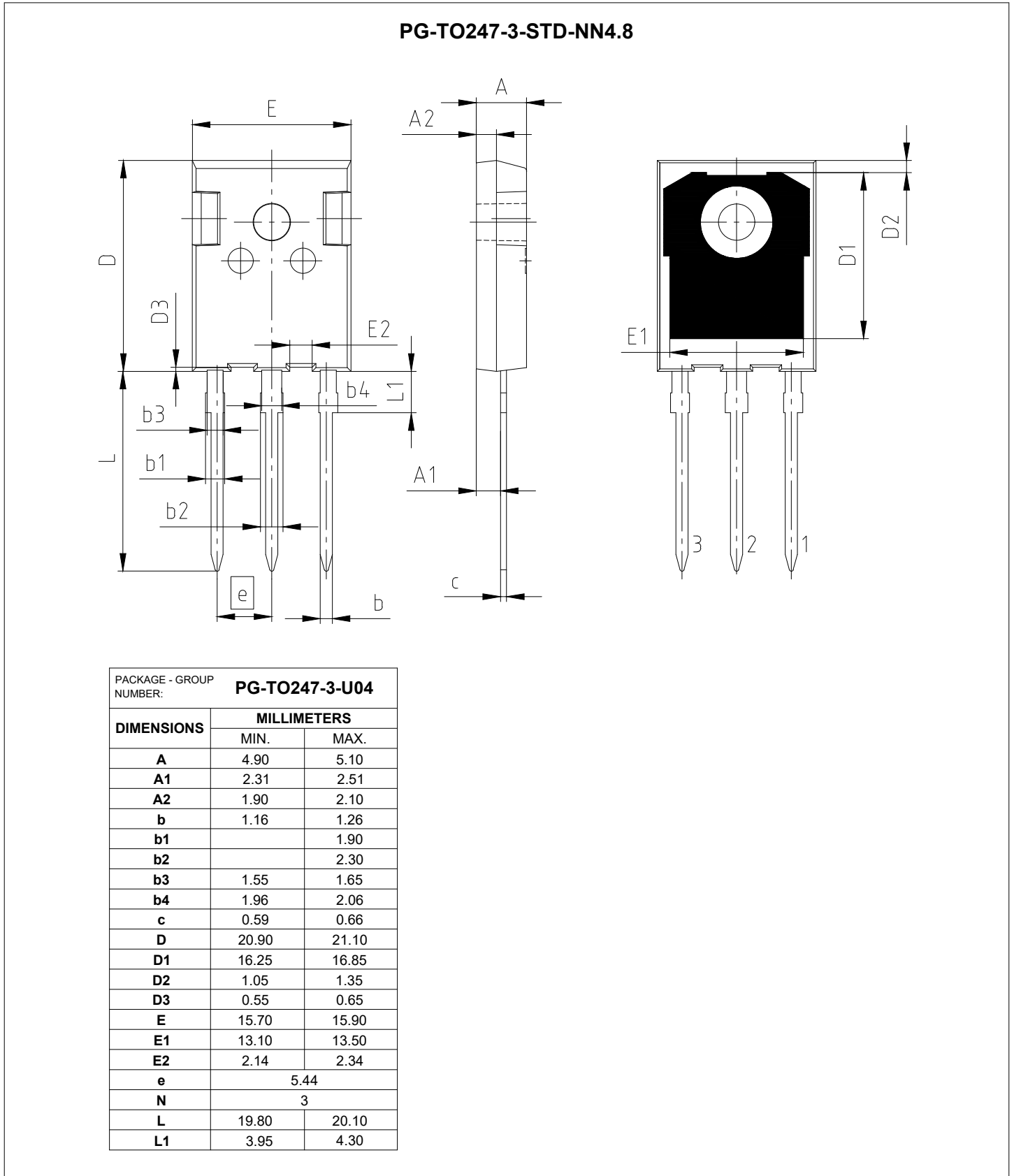


Figure 1

6 Testing conditions



Figure 2

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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