

Low loss Duopack: IGBT 7 with Trench and Fieldstop technology

Features

- $V_{CE} = 650\text{ V}$
- $I_C = 40\text{ A}$
- Very low $V_{CE,sat}$
- Low turn-off losses
- Short tail current
- Reduced EMI
- Very soft, fast recovery antiparallel diode
- Maximum junction temperature $T_{vjmax} = 175^\circ\text{C}$
- Qualified according to JEDEC for target applications
- Pb-free lead plating; RoHS compliant
- Complete product spectrum and PSpice Models: <http://www.infineon.com/igbt7/>

Potential applications

- Servo drives
- General purpose drives (GPD)
- Industrial UPS
- Industrial SMPS
- Energy generation
- Solar optimizer
- Solar string inverter

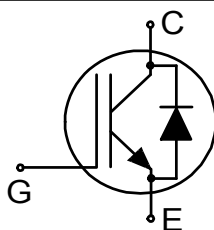
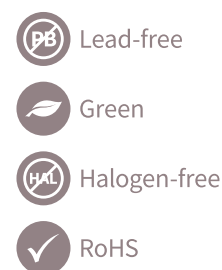
Product validation

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

Description

Package pin definition:

- Pin C & backside - Collector
- Pin E - Emitter
- Pin G - Gate



Type	Package	Marking
IKW40N65ET7	PG-TO247-3	K40EET7

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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	$R_{th(j-c)}$				0.65	K/W
Diode thermal resistance, junction-case	$R_{th(j-c)}$				0.9	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		$T_c = 25\text{ °C}$	76	A
			$T_c = 100\text{ °C}$	49.5	
Pulsed collector current, t_p limited by T_{vjmax} ¹⁾	I_{Cpulse}			120	A
Turn-off safe operating area ²⁾		$V_{CE} \leq 650\text{ V}$, $t_p = 1\text{ }\mu\text{s}$, $T_{vj} \leq 175\text{ °C}$		120	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
Short-circuit withstand time	t_{SC}	$V_{GE} = 15\text{ V}$, Allowed number of short circuits < 1000, Time between short circuits $\geq 1.0\text{ s}$	$V_{CC} \leq 330\text{ V}$, $T_{vj} = 100\text{ °C}$	5	μs
			$V_{CC} \leq 400\text{ V}$, $T_{vj} = 150\text{ °C}$	3	
Power dissipation	P_{tot}		$T_c = 25\text{ °C}$	230.8	W
			$T_c = 100\text{ °C}$	115.4	

1) Defined by design. Not subject to production test.

2) Clamped inductive load current test for each device, $I_C = 120\text{ A}$, $V_{CC} = 400\text{ V}$, $T_c = 25\text{ °C}$, $V_{GE} = 20\text{ V}$, $L = 80\text{ }\mu\text{H}$, $R_G = 10\text{ }\Omega$

Table 3 **Characteristic values**

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Collector-emitter saturation voltage	V_{CEsat}	$I_C = 40\text{ A}$, $V_{GE} = 15\text{ V}$	$T_{vj} = 25\text{ °C}$		1.35	1.65	V
			$T_{vj} = 125\text{ °C}$		1.5		
			$T_{vj} = 175\text{ °C}$		1.6		
Gate-emitter threshold voltage	V_{GETh}	$I_C = 0.4\text{ mA}$, $V_{CE} = V_{GE}$		4.3	5	5.7	V
Zero gate-voltage collector current	I_{CES}	$V_{CE} = 650\text{ V}$, $V_{GE} = 0\text{ V}$	$T_{vj} = 25\text{ °C}$			40	μA
			$T_{vj} = 175\text{ °C}$		900		
Gate-emitter leakage current	I_{GES}	$V_{CE} = 0\text{ V}$, $V_{GE} = 20\text{ V}$				100	nA
Transconductance	g_{fs}	$I_C = 40\text{ A}$, $V_{CE} = 20\text{ V}$			20.5		S
Short-circuit collector current	I_{SC}	$V_{CC} \leq 400\text{ V}$, $V_{GE} = 15\text{ V}$, $t_{SC} \leq 3\text{ }\mu\text{s}$, Allowed number of short circuits < 1000 , Time between short circuits $\geq 1.0\text{ s}$, $T_{vj} = 150\text{ °C}$			205		A
Input capacitance	C_{ies}	$V_{CE} = 25\text{ V}$, $V_{GE} = 0\text{ V}$, $f = 1000\text{ kHz}$			2475		pF
Output capacitance	C_{oes}	$V_{CE} = 25\text{ V}$, $V_{GE} = 0\text{ V}$, $f = 1000\text{ kHz}$			77		pF
Reverse transfer capacitance	C_{res}	$V_{CE} = 25\text{ V}$, $V_{GE} = 0\text{ V}$, $f = 1000\text{ kHz}$			25		pF
Gate charge	Q_G	$I_C = 40\text{ A}$, $V_{GE} = 15\text{ V}$, $V_{CC} = 520\text{ V}$			235		nC
Turn-on delay time	$t_{d(on)}$	$V_{CC} = 400\text{ V}$, $V_{GE} = 0/15\text{ V}$, $R_{G(on)} = 10\text{ }\Omega$, $R_{G(off)} = 10\text{ }\Omega$, $L_\sigma = 32\text{ nH}$, $C_\sigma = 30\text{ pF}$	$T_{vj} = 25\text{ °C}$, $I_C = 40\text{ A}$		20		ns
			$T_{vj} = 25\text{ °C}$, $I_C = 20\text{ A}$		19		
			$T_{vj} = 175\text{ °C}$, $I_C = 40\text{ A}$		23		
			$T_{vj} = 175\text{ °C}$, $I_C = 20\text{ A}$		21		
Rise time (inductive load)	t_r	$V_{CC} = 400\text{ V}$, $V_{GE} = 0/15\text{ V}$, $R_{G(on)} = 10\text{ }\Omega$, $R_{G(off)} = 10\text{ }\Omega$, $L_\sigma = 32\text{ nH}$, $C_\sigma = 30\text{ pF}$	$T_{vj} = 25\text{ °C}$, $I_C = 40\text{ A}$		15		ns
			$T_{vj} = 25\text{ °C}$, $I_C = 20\text{ A}$		9		
			$T_{vj} = 175\text{ °C}$, $I_C = 40\text{ A}$		20		
			$T_{vj} = 175\text{ °C}$, $I_C = 20\text{ A}$		12		

(table continues...)

Table 3 (continued) **Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Turn-off delay time	$t_{d(off)}$	$V_{CC} = 400\text{ V}$, $V_{GE} = 0/15\text{ V}$, $R_{G(on)} = 10\ \Omega$, $R_{G(off)} = 10\ \Omega$, $L_{\sigma} = 32\text{ nH}$, $C_{\sigma} = 30\text{ pF}$	$T_{vj} = 25\text{ }^{\circ}\text{C}$, $I_C = 40\text{ A}$	310		ns
			$T_{vj} = 25\text{ }^{\circ}\text{C}$, $I_C = 20\text{ A}$	330		
			$T_{vj} = 175\text{ }^{\circ}\text{C}$, $I_C = 40\text{ A}$	380		
			$T_{vj} = 175\text{ }^{\circ}\text{C}$, $I_C = 20\text{ A}$	430		
Fall time (inductive load)	t_f	$V_{CC} = 400\text{ V}$, $V_{GE} = 0/15\text{ V}$, $R_{G(on)} = 10\ \Omega$, $R_{G(off)} = 10\ \Omega$, $L_{\sigma} = 32\text{ nH}$, $C_{\sigma} = 30\text{ pF}$	$T_{vj} = 25\text{ }^{\circ}\text{C}$, $I_C = 40\text{ A}$	13		ns
			$T_{vj} = 25\text{ }^{\circ}\text{C}$, $I_C = 20\text{ A}$	17		
			$T_{vj} = 175\text{ }^{\circ}\text{C}$, $I_C = 40\text{ A}$	57		
			$T_{vj} = 175\text{ }^{\circ}\text{C}$, $I_C = 20\text{ A}$	70		
Turn-on energy	E_{on}	$V_{CC} = 400\text{ V}$, $V_{GE} = 0/15\text{ V}$, $R_{G(on)} = 10\ \Omega$, $R_{G(off)} = 10\ \Omega$, $L_{\sigma} = 32\text{ nH}$, $C_{\sigma} = 30\text{ pF}$	$T_{vj} = 25\text{ }^{\circ}\text{C}$, $I_C = 40\text{ A}$	1.05		mJ
			$T_{vj} = 25\text{ }^{\circ}\text{C}$, $I_C = 20\text{ A}$	0.45		
			$T_{vj} = 175\text{ }^{\circ}\text{C}$, $I_C = 40\text{ A}$	1.65		
			$T_{vj} = 175\text{ }^{\circ}\text{C}$, $I_C = 20\text{ A}$	0.84		
Turn-off energy	E_{off}	$V_{CC} = 400\text{ V}$, $V_{GE} = 0/15\text{ V}$, $R_{G(on)} = 10\ \Omega$, $R_{G(off)} = 10\ \Omega$, $L_{\sigma} = 32\text{ nH}$, $C_{\sigma} = 30\text{ pF}$	$T_{vj} = 25\text{ }^{\circ}\text{C}$, $I_C = 40\text{ A}$	0.59		mJ
			$T_{vj} = 25\text{ }^{\circ}\text{C}$, $I_C = 20\text{ A}$	0.26		
			$T_{vj} = 175\text{ }^{\circ}\text{C}$, $I_C = 40\text{ A}$	1.13		
			$T_{vj} = 175\text{ }^{\circ}\text{C}$, $I_C = 20\text{ A}$	0.59		

(table continues...)

Table 3 (continued) **Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Total switching energy	E_{ts}	$V_{CC} = 400\text{ V}$, $V_{GE} = 0/15\text{ V}$, $R_{G(on)} = 10\ \Omega$, $R_{G(off)} = 10\ \Omega$, $L_{\sigma} = 32\text{ nH}$, $C_{\sigma} = 30\text{ pF}$	$T_{vj} = 25\text{ }^{\circ}\text{C}$, $I_C = 40\text{ A}$	1.64		mJ
			$T_{vj} = 25\text{ }^{\circ}\text{C}$, $I_C = 20\text{ A}$	0.71		
			$T_{vj} = 175\text{ }^{\circ}\text{C}$, $I_C = 40\text{ A}$	2.78		
			$T_{vj} = 175\text{ }^{\circ}\text{C}$, $I_C = 20\text{ A}$	1.43		
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
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	limited by bondwire	$T_c = 25\text{ }^{\circ}\text{C}$	72	A
			$T_c = 100\text{ }^{\circ}\text{C}$	43.5	
Diode pulsed current, t_p limited by T_{vjmax}	I_{Fpulse}			120	A

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	2	V
			$T_{vj} = 125\text{ }^{\circ}\text{C}$	1.6		
			$T_{vj} = 175\text{ }^{\circ}\text{C}$	1.55		

(table continues...)

Table 5 (continued) Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Diode reverse recovery time	t_{rr}	$V_R = 650 \text{ V}$		$T_{vj} = 25 \text{ }^{\circ}\text{C}$, $I_F = 40 \text{ A}$, $-di_F/dt = 1779 \text{ A}/\mu\text{s}$	85	ns
				$T_{vj} = 25 \text{ }^{\circ}\text{C}$, $I_F = 20 \text{ A}$, $-di_F/dt = 2381 \text{ A}/\mu\text{s}$	59	
				$T_{vj} = 175 \text{ }^{\circ}\text{C}$, $I_F = 40 \text{ A}$, $-di_F/dt = 1660 \text{ A}/\mu\text{s}$	145	
				$T_{vj} = 175 \text{ }^{\circ}\text{C}$, $I_F = 20 \text{ A}$, $-di_F/dt = 1881 \text{ A}/\mu\text{s}$	105	
Diode reverse recovery charge	Q_{rr}	$V_R = 650 \text{ V}$		$T_{vj} = 25 \text{ }^{\circ}\text{C}$, $I_F = 40 \text{ A}$, $-di_F/dt = 1779 \text{ A}/\mu\text{s}$	0.95	μC
				$T_{vj} = 25 \text{ }^{\circ}\text{C}$, $I_F = 20 \text{ A}$, $-di_F/dt = 2381 \text{ A}/\mu\text{s}$	0.7	
				$T_{vj} = 175 \text{ }^{\circ}\text{C}$, $I_F = 40 \text{ A}$, $-di_F/dt = 1660 \text{ A}/\mu\text{s}$	2.8	
				$T_{vj} = 175 \text{ }^{\circ}\text{C}$, $I_F = 20 \text{ A}$, $-di_F/dt = 1881 \text{ A}/\mu\text{s}$	2.02	
Diode peak reverse recovery current	I_{rrm}	$V_R = 650 \text{ V}$		$T_{vj} = 25 \text{ }^{\circ}\text{C}$, $I_F = 40 \text{ A}$, $-di_F/dt = 1779 \text{ A}/\mu\text{s}$	22	A
				$T_{vj} = 25 \text{ }^{\circ}\text{C}$, $I_F = 20 \text{ A}$, $-di_F/dt = 2381 \text{ A}/\mu\text{s}$	24.5	
				$T_{vj} = 175 \text{ }^{\circ}\text{C}$, $I_F = 40 \text{ A}$, $-di_F/dt = 1660 \text{ A}/\mu\text{s}$	35	
				$T_{vj} = 175 \text{ }^{\circ}\text{C}$, $I_F = 20 \text{ A}$, $-di_F/dt = 1881 \text{ A}/\mu\text{s}$	35	

(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	$V_R = 650 \text{ V}$	$T_{vj} = 25 \text{ }^{\circ}\text{C}$, $I_F = 40 \text{ A}$, $-di_F/dt = 1779 \text{ A}/\mu\text{s}$		380		$\text{A}/\mu\text{s}$
			$T_{vj} = 25 \text{ }^{\circ}\text{C}$, $I_F = 20 \text{ A}$, $-di_F/dt = 2381 \text{ A}/\mu\text{s}$		520		
			$T_{vj} = 175 \text{ }^{\circ}\text{C}$, $I_F = 40 \text{ A}$, $-di_F/dt = 1660 \text{ A}/\mu\text{s}$		290		
			$T_{vj} = 175 \text{ }^{\circ}\text{C}$, $I_F = 20 \text{ A}$, $-di_F/dt = 1881 \text{ A}/\mu\text{s}$		425		
Operating junction temperature	T_{vj}			-40		175	$^{\circ}\text{C}$

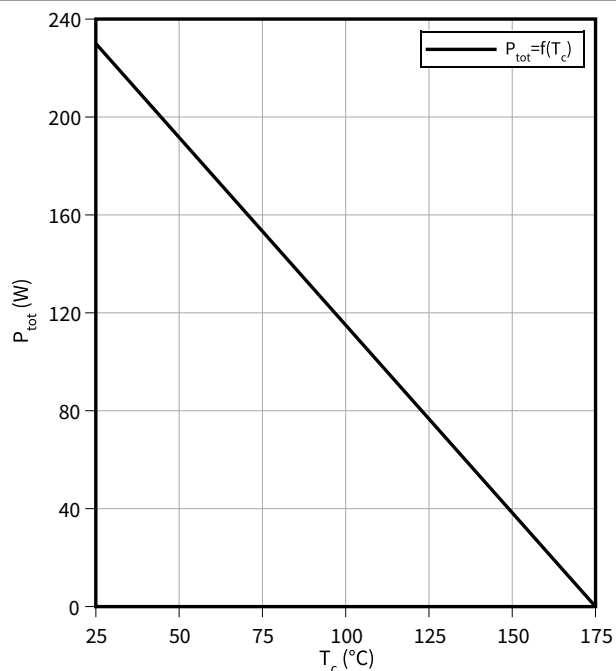
Note: *Maximum rated values: For optimum lifetime and reliability, Infineon recommends operating conditions that do not exceed 80% of the maximum ratings stated in this datasheet.*
Electrical Characteristic, at $T_{vj} = 25^{\circ}\text{C}$, unless otherwise specified.
Dynamic test circuit, L_{σ} , C_{σ} from Fig. E. Energy losses include “tail” and diode reverse recovery.

4 Characteristics diagrams

Power dissipation as a function of case temperature

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

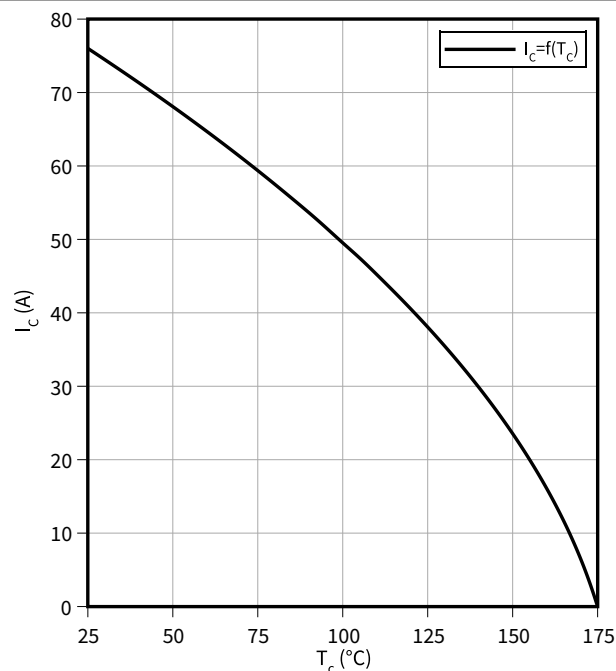
$$T_{vj} \leq 175^\circ\text{C}$$



Collector current as a function of case temperature

$$I_c = f(T_c)$$

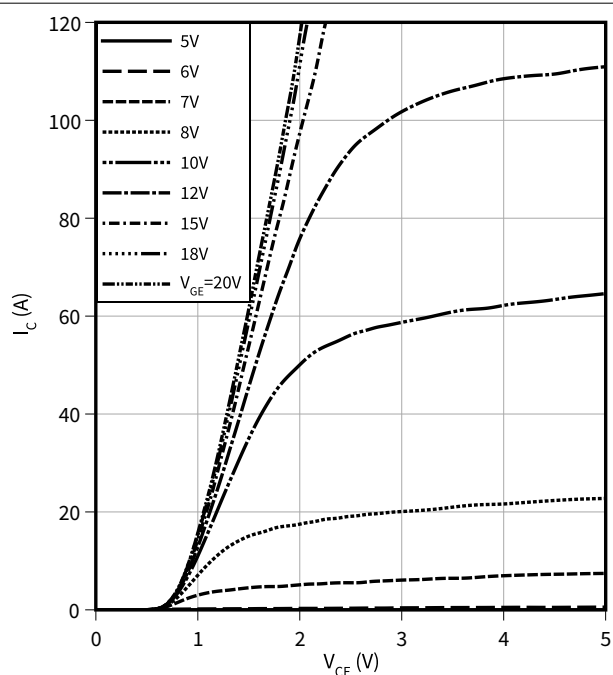
$$T_{vj} \leq 175^\circ\text{C}, V_{GE} \geq 15\text{ V}$$



Typical output characteristic

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

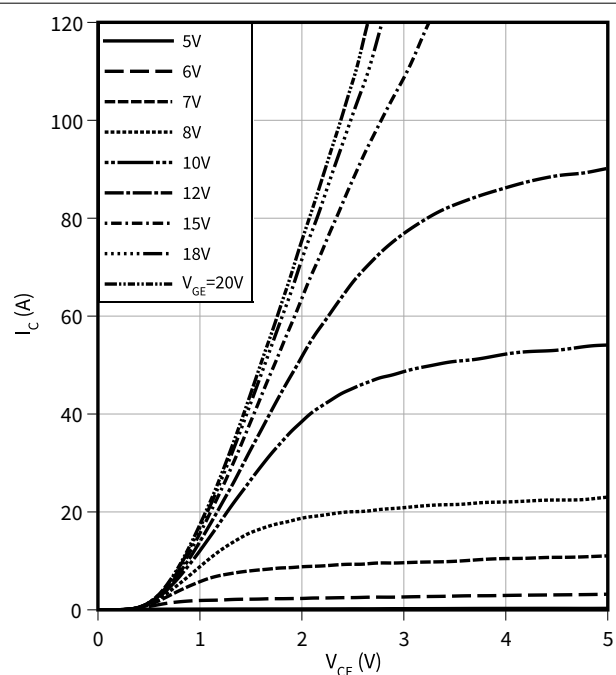
$$T_{vj} = 25^\circ\text{C}$$



Typical output characteristic

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

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

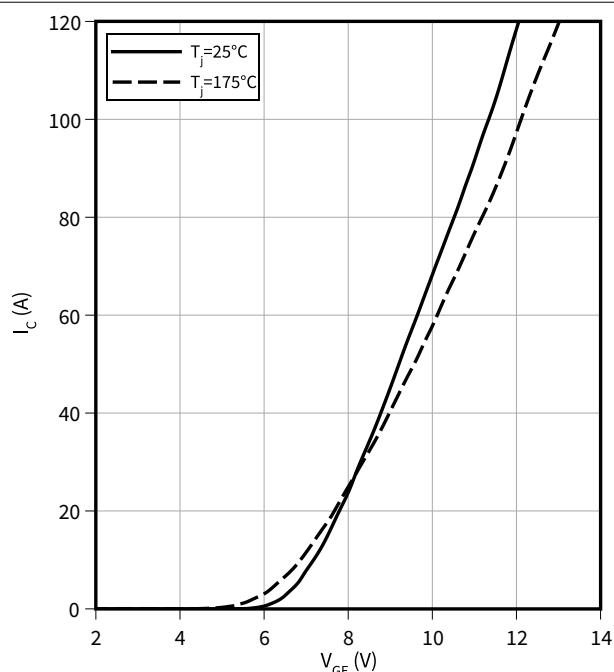


4 Characteristics diagrams

Typical transfer characteristic

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

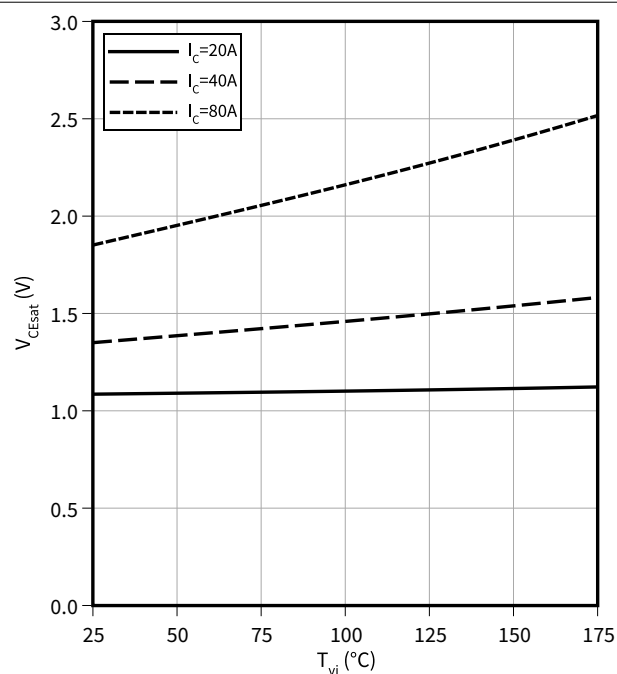
$$V_{CE} = 20 \text{ V}$$



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

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

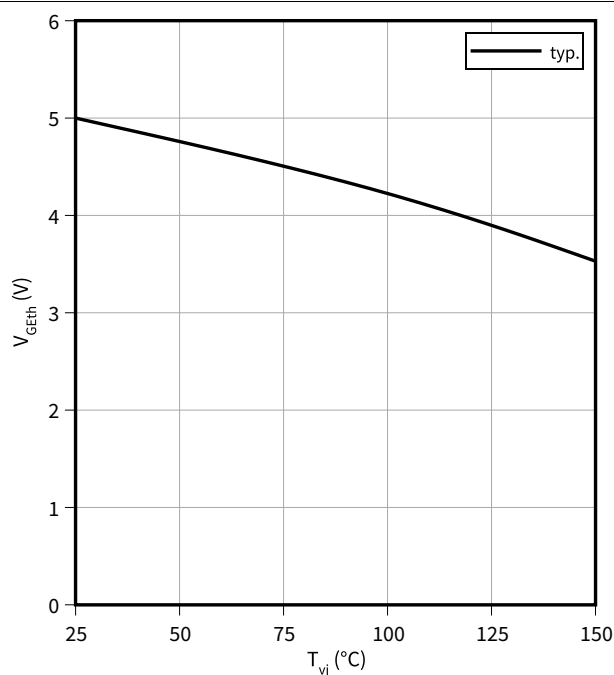
$$V_{GE} = 15 \text{ V}$$



Gate-emitter threshold voltage as a function of junction temperature

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

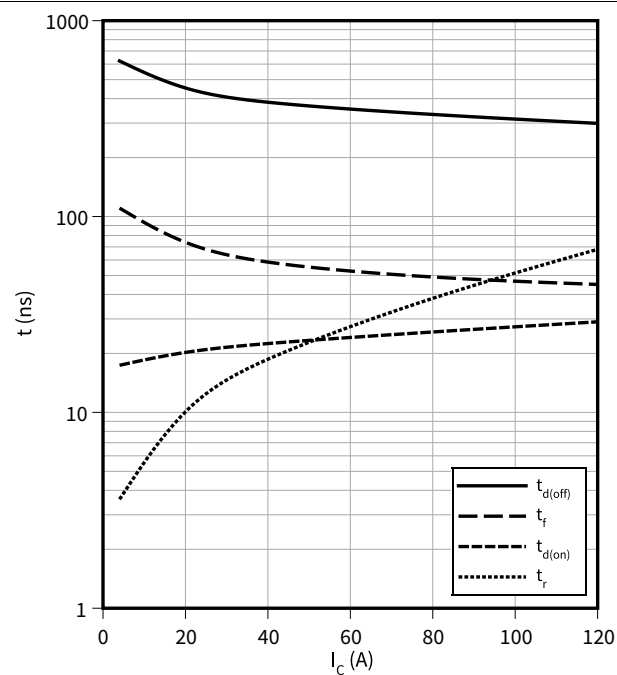
$$I_C = 0.4 \text{ mA}$$



Typical switching times as a function of collector current

$$t = f(I_C)$$

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

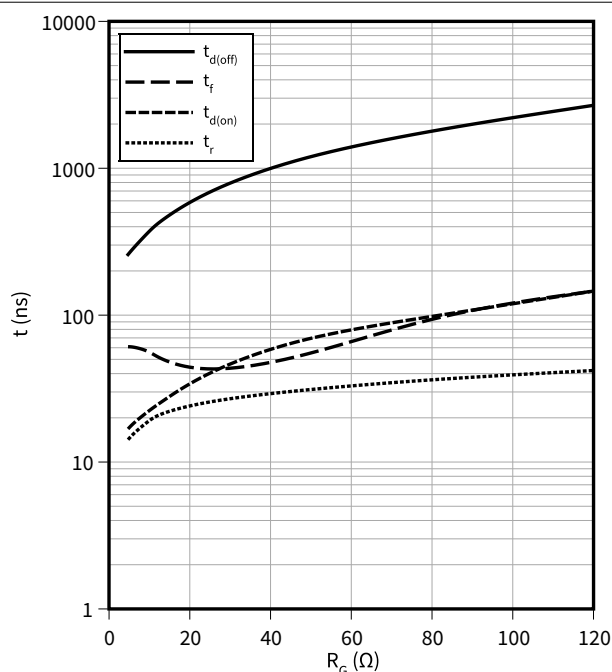


4 Characteristics diagrams

Typical switching times as a function of gate resistor

$$t = f(R_G)$$

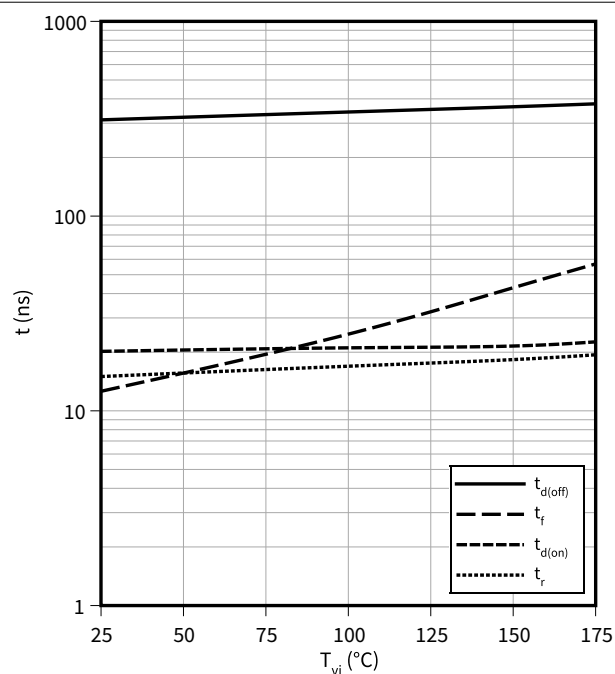
$I_C = 40 \text{ A}$, $V_{CC} = 400 \text{ V}$, $T_{vj} = 175 \text{ }^\circ\text{C}$, $V_{GE} = 0/15 \text{ V}$



Typical switching times as a function of junction temperature

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

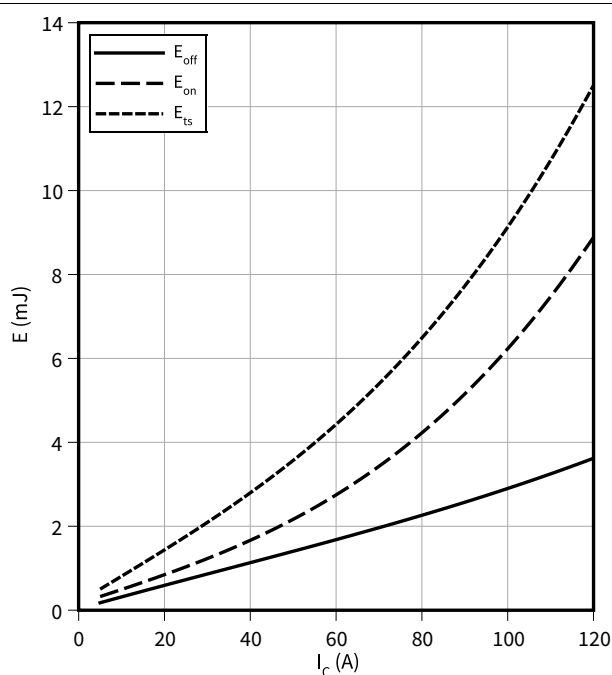
$I_C = 40 \text{ A}$, $V_{CC} = 400 \text{ V}$, $V_{GE} = 0/15 \text{ V}$, $R_G = 10 \Omega$



Typical switching energy losses as a function of collector current

$$E = f(I_C)$$

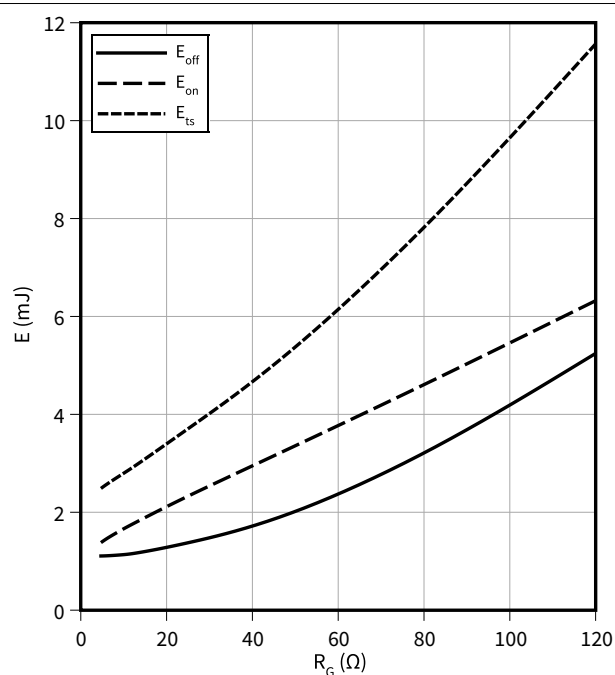
$V_{CC} = 400 \text{ V}$, $T_{vj} = 175 \text{ }^\circ\text{C}$, $V_{GE} = 0/15 \text{ V}$, $R_G = 10 \Omega$



Typical switching energy losses as a function of gate resistor

$$E = f(R_G)$$

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

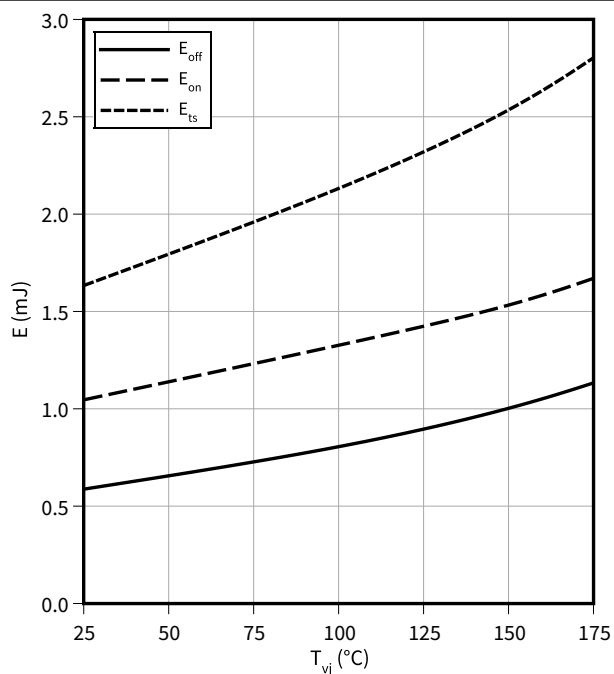


4 Characteristics diagrams

Typical switching energy losses as a function of junction temperature

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

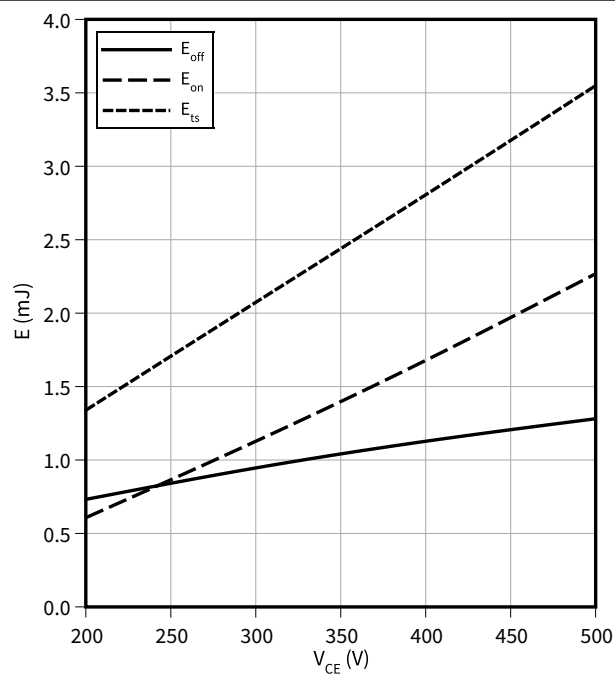
$I_C = 40 \text{ A}$, $V_{CC} = 400 \text{ V}$, $V_{GE} = 0/15 \text{ V}$, $R_G = 10 \text{ } \Omega$



Typical switching energy losses as a function of collector emitter voltage

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

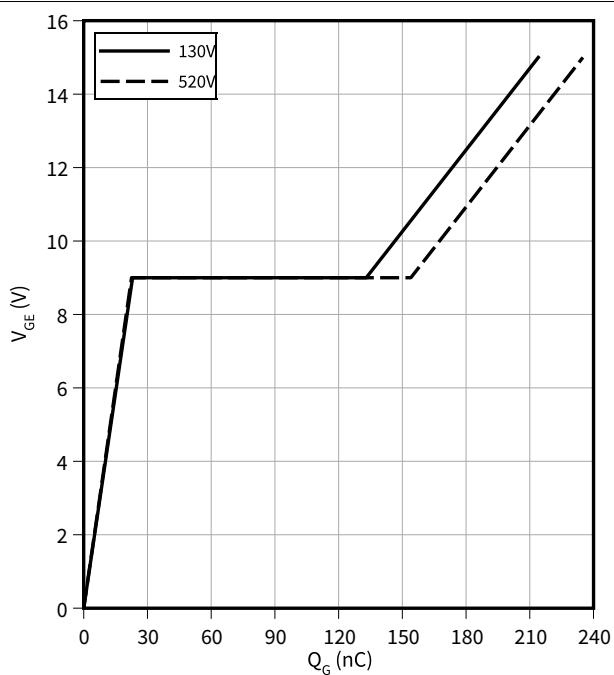
$I_C = 40 \text{ A}$, $T_{vj} = 175 \text{ }^\circ\text{C}$, $V_{GE} = 0/15 \text{ V}$, $R_G = 10 \text{ } \Omega$



Typical gate charge

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

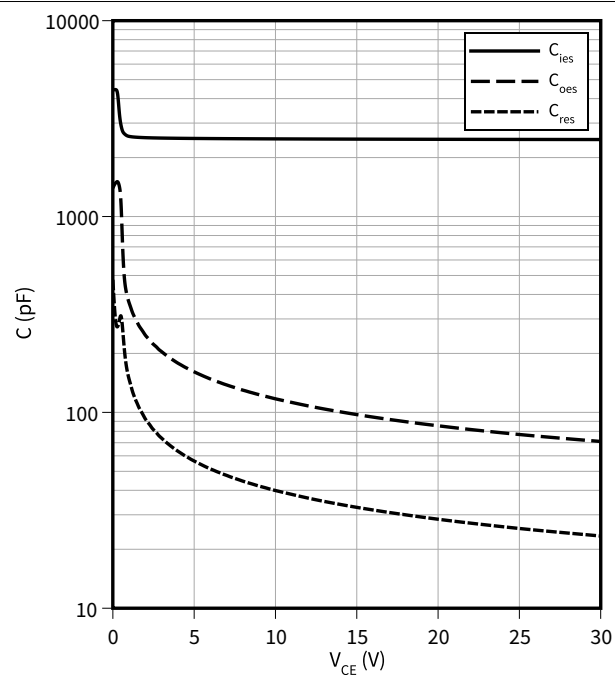
$I_C = 40 \text{ A}$



Typical capacitance as a function of collector-emitter voltage

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

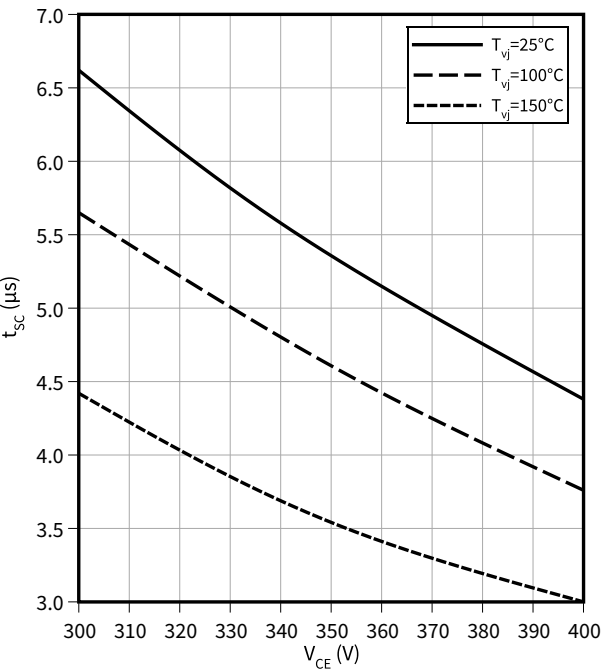
$f = 1000 \text{ kHz}$, $V_{GE} = 0 \text{ V}$



4 Characteristics diagrams

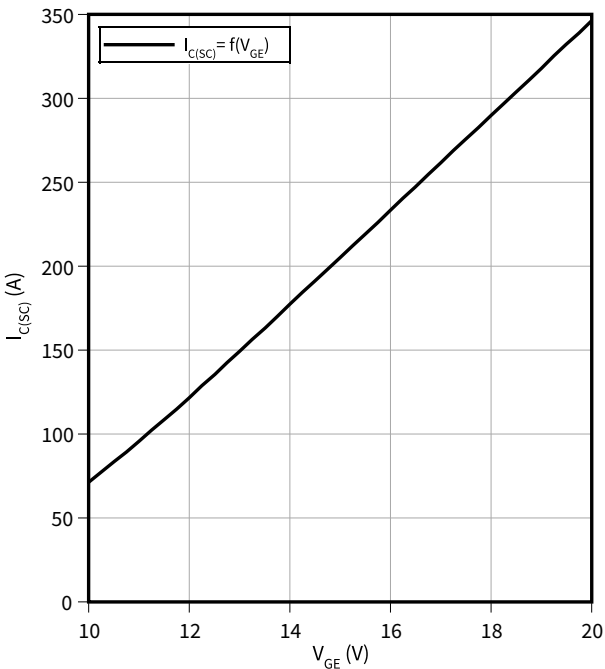
Typical short circuit safe operating range as a function of collector-emitter voltage

$t_{SC} = f(V_{CE})$



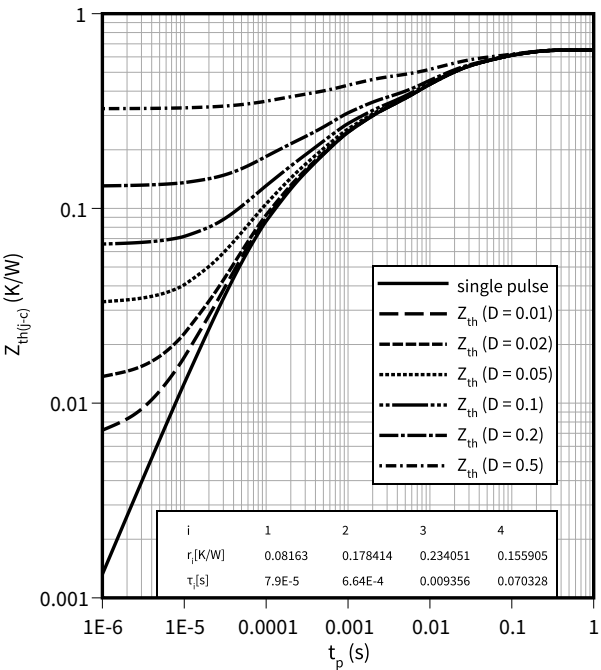
Typical short circuit collector current as a function of gate-emitter voltage

$I_{C(SC)} = f(V_{GE})$
 $T_{vj} = 150^{\circ}C, V_{CC} \leq 400 V$



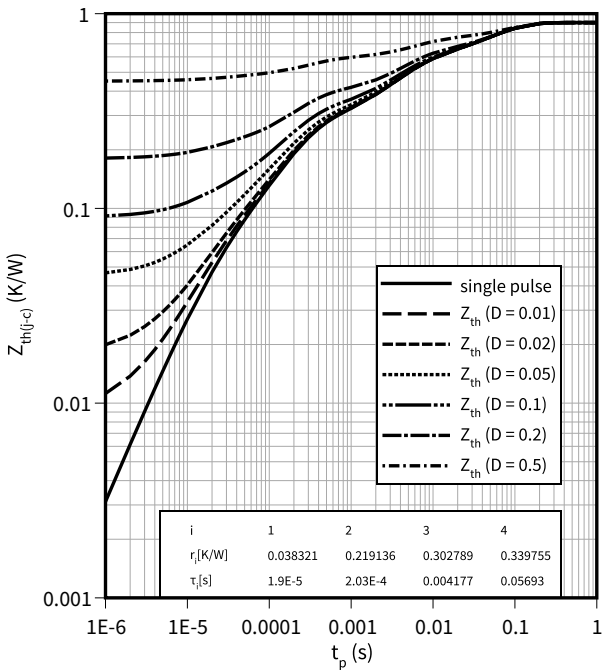
IGBT transient thermal impedance as a function of pulse width

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



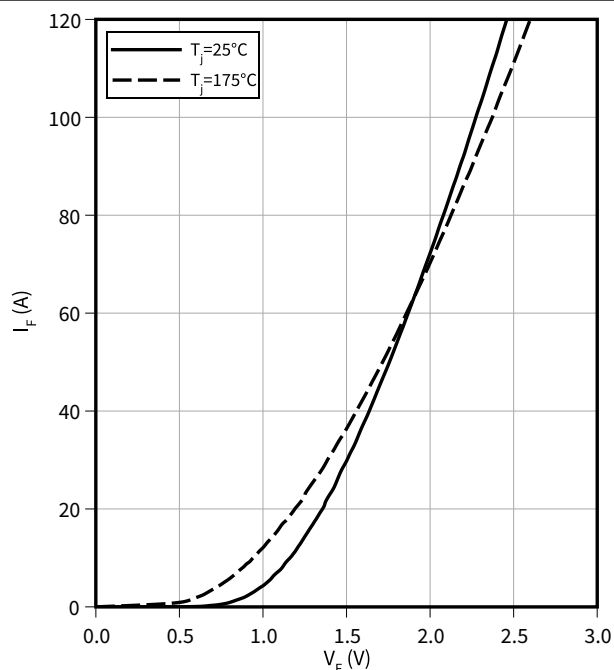
Diode transient thermal impedance as a function of pulse width

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



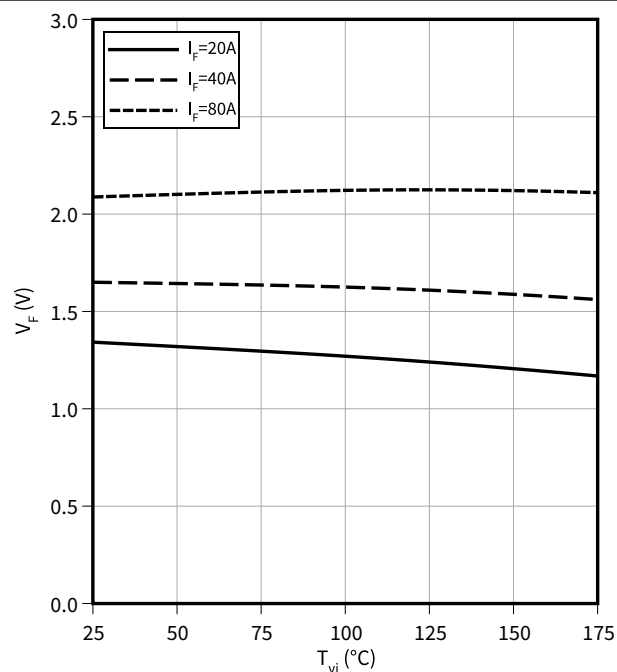
Typical diode forward current as a function of forward voltage

$$I_F = f(V_F)$$



Typical diode forward voltage as a function of junction temperature

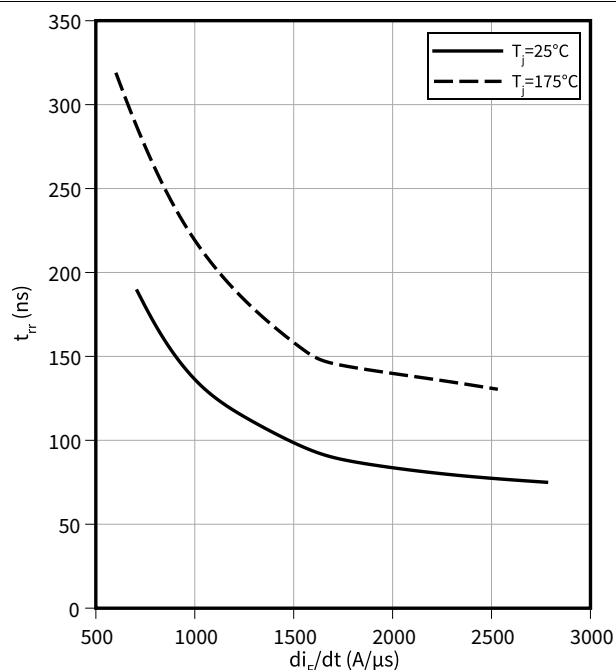
$$V_F = f(T_{vj})$$



Typical reverse recovery time as a function of diode current slope

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

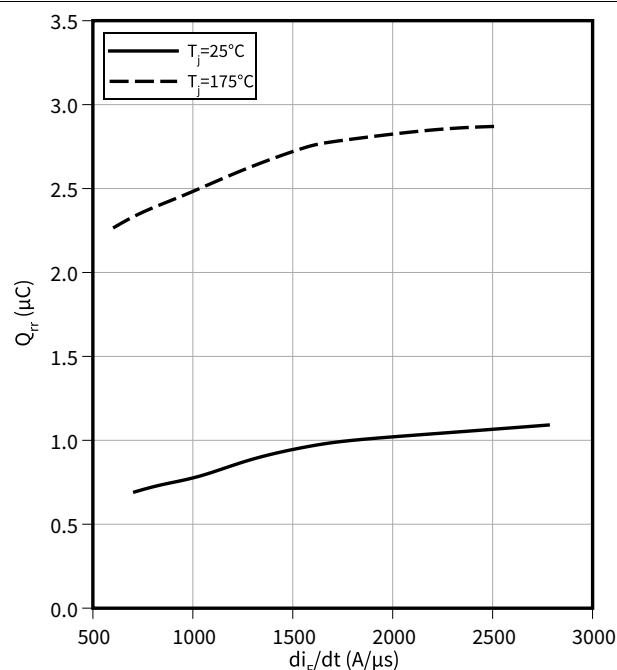
$$V_R = 400 \text{ V}, I_F = 40 \text{ A}$$



Typical reverse recovery charge as a function of diode current slope

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

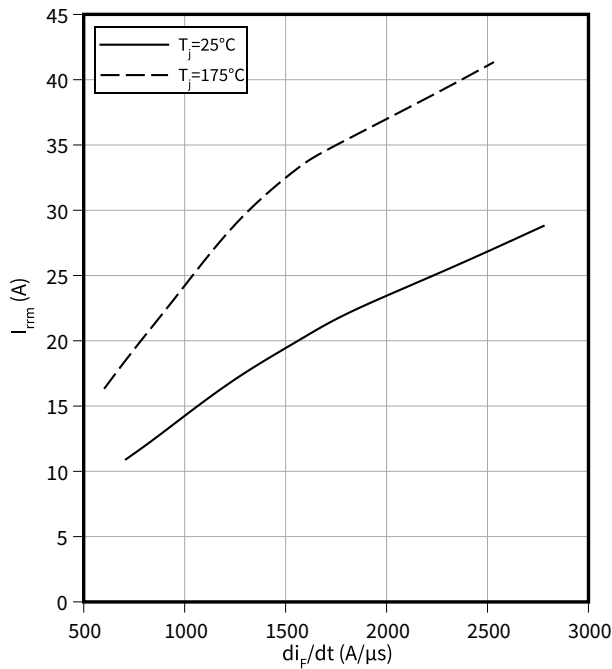
$$V_R = 400 \text{ V}, I_F = 40 \text{ A}$$



4 Characteristics diagrams

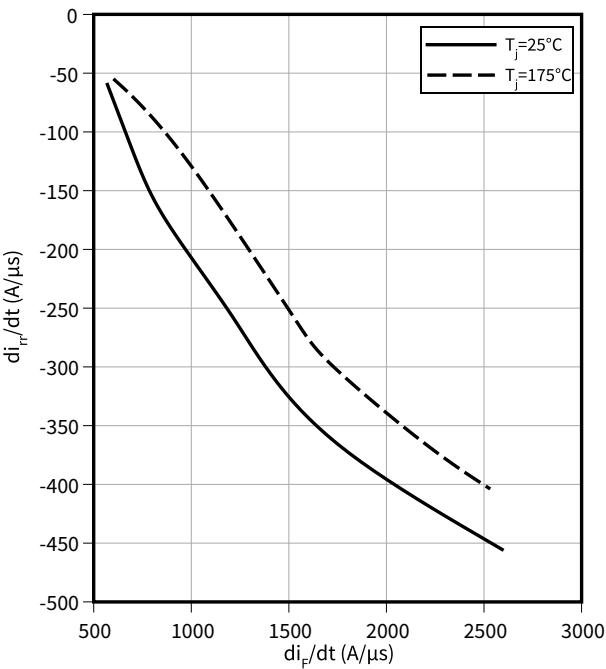
Typical reverse recovery current as a function of diode current slope

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



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

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



5 Package outlines

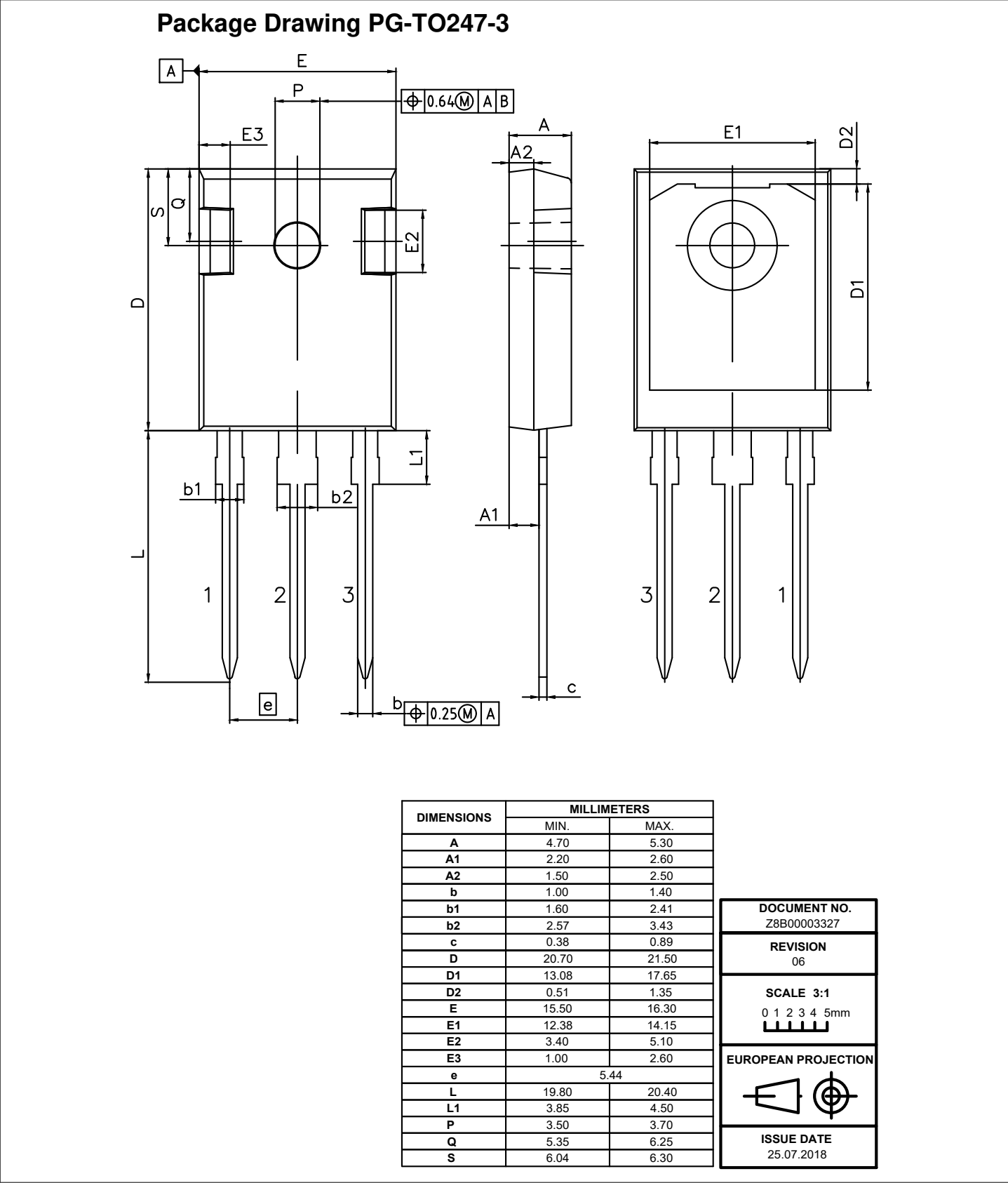


Figure 1

6 Testing conditions

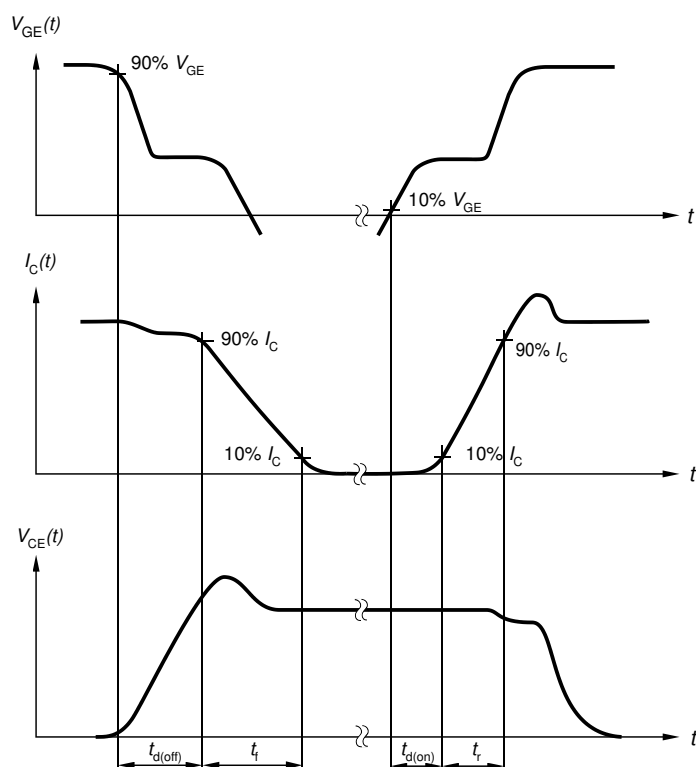


Figure A. Definition of switching times

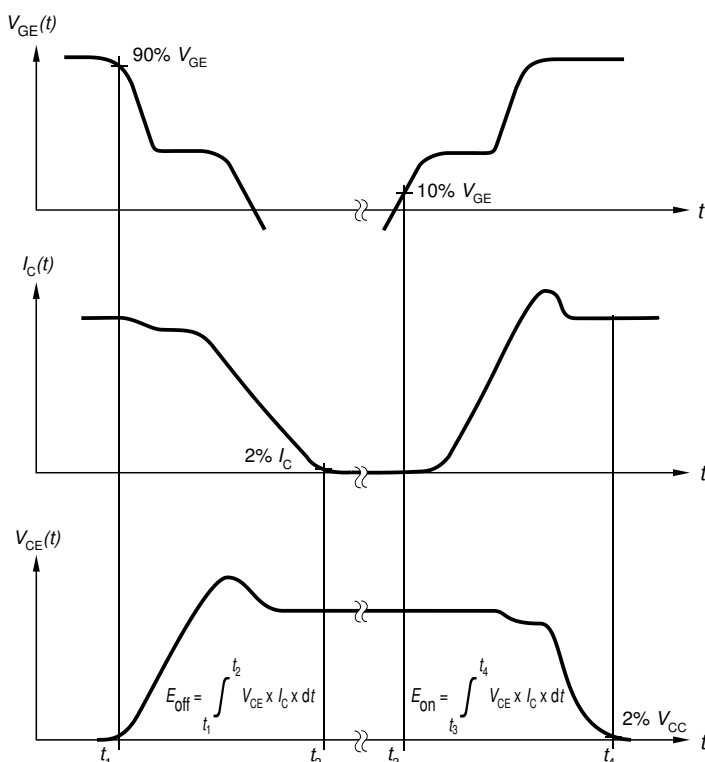


Figure B. Definition of switching losses

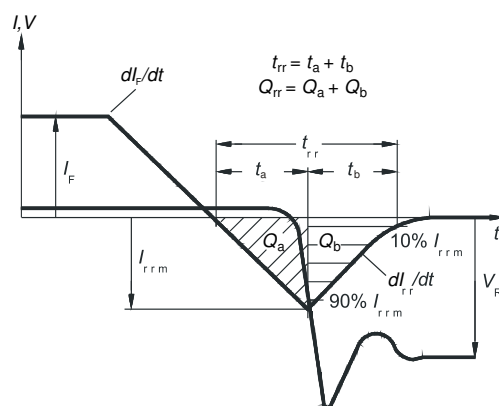


Figure C. Definition of diode switching characteristics

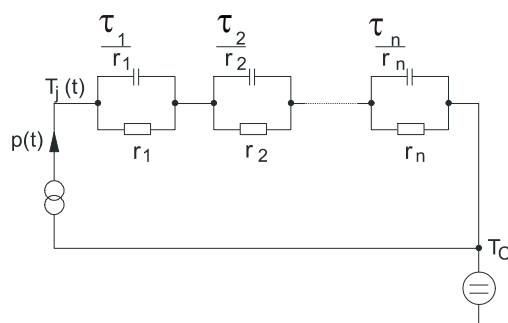


Figure D. Thermal equivalent circuit

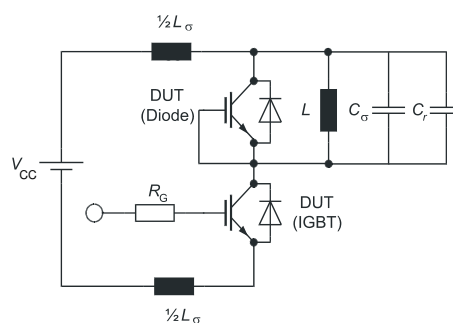


Figure E. **Dynamic test circuit**
 Parasitic inductance L_σ ,
 parasitic capacitor C_σ ,
 relief capacitor C_r ,
 (only for ZVT switching)

Revision history

Document revision	Date of release	Description of changes
V1.1	2020-04-28	Preliminary data sheet
V2.1	2020-05-12	Final data sheet
n/a	2020-11-30	Datasheet migrated to a new system with a new layout and new revision number schema: target or preliminary datasheet = 0.xy; final datasheet = 1.xy
1.00	2021-06-29	Change of potential applications and new diagram added (t_{SC} as function of V_{CE})
1.10	2023-01-26	Feature list corrections Editorial changes

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